

REAL-EDWARDS CONSERVATION & RECLAMATION DISTRICT



Groundwater Management Plan 2025-2030

Revised and Adopted April 2025

**234 Evergreen Street
Leakey, Texas 78873**

Phone: 830-232-5733

Fax: 830-232-5734

email: manager@recred.org

Contact Information

Physical Address: 234 Evergreen
Leakey, TX 78873

Mailing Address: PO Box 1208
Leakey, TX 78873

Consulting Manager: Joel Pigg
Email: manager@recrd.org

Telephone: 830-232-5733

Fax: 830-232-5734

Website: recrd.org

District Rules: [recrd/District Rules](#)

Real-Edwards Conservation & Reclamation District Groundwater Management Plan

Table of Contents

Mission Statement	4
Guiding Principles	4
History.....	5
Planning Period	5
General Description	6
Geographical Information.....	6
Groundwater Resources	6
Edwards-Trinity (Plateau) Aquifer.....	6
Trinity Aquifer	7
Frio River Alluvium Aquifer	7
Nueces River Alluvium Aquifer	8
Estimated Available Groundwater	8
Desired Future Conditions and Modeled Available Groundwater	8
Natural and/or Artificial Recharge	9
Additional Recharge.....	9
Natural or Artificial Discharge.....	10
Surface Water Resources and Availability	11
Water Supply Needs Within the District.....	11
Water Management Strategies: Current Use and Projected Water Supply	12
Management of Groundwater Supplies	12
Actions, Procedures, Performance, and Avoidance for Plan Implementation	13
Methodology for Tracking Progress.....	13

Goals, Objectives and Performance Standards.....	14
Goal 1 – Providing for the Most Efficient Use of Groundwater	14
Goal 2 – Controlling and Preventing Waste of Groundwater	15
Goal 4 – Addressing Conjunctive Surface Water Management Issues	15
Goal 5 - Addressing Natural Resource Issues that Impact the Use and Availability of Groundwater and Which are Impacted by the Use of Groundwater.....	16
Goal 6 – Addressing Drought Conditions	17
Goal 7 – Addressing (a) Conservation, (b) Recharge Enhancement, (c) Rainwater Harvesting, (d) Precipitation Enhancement, and (e) Brush Control Where Appropriate and Cost Effective	18
Goal 8 – Addressing the Desired Future Conditions	19
Management Goal Not Applicable to District.....	19
Goal 7 – Addressing (a) Recharge Enhancement and (b) Precipitation Enhancement.....	19
.....	
.....	
.....	
.....	22
Goal 3 – Controlling and Preventing Subsidence.....	20
Definitions and Concepts	20
Appendix 1: GAM Run 24-014: Real-Edwards Conservation and Reclamation District Management Plan	
Appendix 2: Estimated Historical Water Use (2019) And 2022 State Water Plan Datasets: Real-Edwards Conservation and Reclamation District	
Appendix 3: GAM Run 21-012 MAG: Modeled Available Groundwater For the Aquifers in Groundwater Management Area 7	
Appendix 4: GAM Run 24-005: Lone Wolf Groundwater Conservation District Management Plan, March 1, 2024	
Appendix 5: 2021 Plateau Region Water Plan	

Real-Edwards Conservation & Reclamation District

Groundwater Management Plan

Mission Statement

The Real-Edwards Conservation & Reclamation District (the District) was created to provide for the conservation, preservation, development and recharging of the underground waters and water-bearing formations within the District consistent with Article XVI, Section 59, of the Texas Constitution and Chapter 36 of the Texas Water Code.

Guiding Principles

The District has operated from its inception, with a strong belief in private property rights and that when some of those rights relating to the management of groundwater are relinquished for the benefit of the community, local control through an elected Board of Directors is the preferred way to manage those rights.

The District has adopted the principle of education first and regulation second in their effort to encourage conservation of groundwater. The rules of the District are designed to give landowners a fair and equal opportunity to use the groundwater underlying their property for beneficial purposes. The District will monitor groundwater quality and quantity in order to better understand the dynamics of the aquifer systems over which it has jurisdiction. This Groundwater Management Plan document is intended to be used as a tool to provide continuity in the management of the District. It will be used by the District staff as a guide to ensure that all aspects of the goals of the District are carried out and will be referred to by the Board of Directors for future planning.

The dynamic nature of this Management Plan shall be maintained in a manner that allows the District to best serve the needs of the constituents. At a minimum, the Board of Directors will review and readopt this plan every five years.

The goals, management objectives, and performance standards put forth in this planning document have been set at a reasonable level considering existing and future fiscal and technical resources. Whatever the future holds, the following guidelines will be used to ensure that the management objectives are set at a sufficient level to be realistic and effective:

- The duly elected Board of Directors will guide and direct the District staff and will gauge the achievement of the goals set forth in this document.
- The interests and needs of the District's constituency, including absentee landowners, shall control the direction of the management of the District.
- The Board of Directors will endeavor to maintain local control of the privately-owned resource over which the District has jurisdictional authority.
- The District budget operates on an October 1st through September 30th fiscal year.

- The Board of Directors will evaluate District activities based upon the fiscal year, when considering stated goals, management objectives, and performance standards.

History

The Real-Edwards Conservation & Reclamation District was created by Senate Bill 447 in the 56th Texas Legislature in 1959. Initially, the District included parts of Edwards and Real counties; however, during the 71st Texas Legislature in 1989, House Bill 3127 was passed modifying the District's enabling legislation to include all of Edwards and Real counties. The District is funded through fees and a \$0.017 per one hundred dollars valuation ad valorem tax on property within the District.

Planning Period

This Management Plan becomes effective upon adoption by the District Board of Directors and approval by the Texas Water Development Board (TWDB) and remains in effect until a revised plan is approved or five (5) years from the date of approval, whichever is earlier. The plan may be reviewed annually. The Groundwater Management Plan must be reviewed by the Board of Directors, readopted with or without revisions, and be resubmitted to the TWDB for approval at least once every five years.

As outlined in Chapter 36.1071, Texas Water Code, the District's Management Plan is required, as applicable, to address the following management goals:

- Providing the most efficient use of groundwater §36.1071(a)(1);
- Controlling and preventing waste of groundwater §36.1071(a)(2);
- Controlling and preventing subsidence §36.1071(a)(3);
- Addressing conjunctive surface water management issues §36.1071(a)(4);
- Addressing natural resource issues that impact the use and availability of groundwater and which are impacted by the use of groundwater §36.1071(a)(5);
- Addressing drought conditions §36.1071(a)(6);
- Addressing conservation, recharge enhancement, rainwater harvesting, precipitation enhancement, and brush control where appropriate and cost effective, §36.1071(a)(7) and;
- Addressing the desired future conditions established under TWC §36.108. §36.1071(a)(8).

The following goals referenced in Chapter 36.1071, Texas Water Code, have been determined not applicable to the District:

§36.1071(a)(3) Controlling and preventing subsidence;
 §36.1071(a)(7) Addressing recharge enhancement and; precipitation enhancement.

General Description

The District is governed by nine Directors who are elected by local voters and serve four-year staggered terms of office. District rules were revised in April 2016 which will affect this Groundwater Management Plan. The District encompasses the total of Real and Edwards counties, located in the southwestern part of the Texas Hill Country with Leakey and Rocksprings as the county seats, respectively. Real and Edwards counties' economies are primarily based on agriculture, tourism, and hunting industries. The rugged terrain with its winding roads, magnificent vistas, coupled with pristine springs, streams, and rivers, along with some of the best hunting in Texas, have made the area a favorite for vacationers and absentee landowners alike.

Geographical Information

The District lies within the Edwards Plateau and consists of approximately 1,810,169 acres in Real and Edwards counties. The land is generally rolling to mountainous with elevations from 1500 to 4000 ft. The District is included in three different river basins, the Nueces, Colorado, and the Rio Grande. The headwaters of the Nueces River and Frio River and a portion of the headwaters of the Sabinal River and the South Llano River are located within the District. The western half of Edwards County slopes southwestward into the Devils River. The eastern part of Edwards County drains into the Nueces River and the northern part drains into the Llano River. Real County drains into the Nueces River on the west and into the Frio River on the east with a small northern portion draining into the South Llano River. The land also includes many shallow depressions that catch rainfall and run off to either evaporate or infiltrate the soil.

Groundwater Resources

Aquifers within Edwards and Real counties have been divided by the Texas Water Development Board (TWDB) into two types; namely, major and minor aquifers. The TWDB has classified two major aquifers within the District: the Edwards-Trinity (Plateau) Aquifer and the Trinity Aquifer in the southeast corner of Real County. The District, along with the Plateau Region Planning Group, has identified two minor aquifers in the District; the Frio River Alluvium Aquifer and the Nueces River Alluvium Aquifer. These minor aquifers were included in the Plateau Region Water Plan that was approved by the TWDB in January 2021 ([2021 Plateau Region Water Plan](#)). There are numerous wells completed in the alluvial, with a majority being used for domestic and/or livestock purposes; others are used for irrigation and municipal purposes. The City of Leakey's well field is completed in the Frio River Alluvium Aquifer, and the Barksdale Water Supply Corporation's wells are completed in the Nueces River Alluvium Aquifer approximately one-half mile from the Nueces River in the community of Barksdale.

Edwards-Trinity (Plateau) Aquifer

Limestone is the predominant rock underlying the Edwards Plateau soils. The permeability of the limestone is not necessarily due to inter-granular pore space as in sandstone, but more to joints, crevices, and solution openings that have been enlarged by solvent action of

water charged with carbon dioxide. The Edwards-Trinity (Plateau) Aquifer covers all or part of thirty-three (33) counties, or the boundary of Groundwater Management Area 7. Real and Edwards counties sit on the southeastern edge of this aquifer. Groundwater availability data from GAM Run 21-012 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 7, Table 7, show that there is approximately 13,199 acre-feet/year of water per year available to the District from this aquifer (Appendix 3). The Pecos Valley Aquifer does not occur within the District; therefore, no groundwater budget values are included in this report. Within the District, groundwater is fresh, with total dissolved solids of less than 500 milligrams per liter in most sampled wells. The permeability of the formation is such that a well's pumping capacity may vary from as little as one (1) gallon per minute (gpm) to several hundred gallons per minute in limited locations. For the most part, wells completed in this formation within Edwards and Real counties consistently yield between 3 and 10 gpm.

Trinity Aquifer

The Trinity Aquifer is composed of marine sediments (primarily limestone) deposited during the Cretaceous Period. The Trinity Group in Edwards and Real counties includes the Glen Rose and underlying Travis Peak formations. In some areas, the Glen Rose consists of up to approximately 1,000 feet of limestone with embedded shale, marl and occasional anhydrite (gypsum) and is the primary unit in the Trinity Aquifer in the southern part of the Edwards Plateau area. The Travis Peak contains sands, clays and limestones that are subdivided into water-bearing members of the Glen Rose Limestone, Hensell Sand, Cow Creek Limestone, Sligo Limestone, and Hosston Sand water-bearing formations. Samples from the Trinity Aquifer have total dissolved solids (TDS) concentrations above the secondary standard of slightly saline (1,000 - 3,000 mg/l).

Groundwater availability data from GAM Run 21-012 MAG of the groundwater availability model for the Edwards-Trinity (Plateau), Trinity, and Pecos Valley aquifers were used for this report and show there is approximately 52 acre-feet/year available to the District from this aquifer (Appendix 3). Wells completed within the Trinity Formation of the District (southeast Real County) tend to yield substantially more water (50 -150+ gpm). However, as noted above, often the high TDS and sulfate content requires water from this formation to undergo extensive treatment prior to becoming potable.

Frio River Alluvium Aquifer

The Frio River Alluvium Aquifer in central Real County extends over an area of approximately 9,530 acres. The alluvial (clay, silt, gravel, etc. deposited by running water) generally follows the flood plain of the Frio River in Real County. The aquifer's width varies from almost nonexistent to over a mile. As with the width, the aquifer's thickness varies but is thought to not exceed 42 feet. Wells in the Frio River Alluvium Aquifer are generally shallow and provide water in small quantities for domestic and livestock purposes within Real County. However, as mentioned above, there are several large capacity wells completed in this zone and the City of Leakey's well field is completed in this aquifer. Because of the limited extent of this aquifer and its shallow water table, the aquifer system

is potentially susceptible to contamination from surface sources. Recharge to the aquifer is from stream loss and direct infiltration of precipitation. The Plateau Region Water Plan, January 2021, indicates there is approximately 2,145 acre-feet/year available within this aquifer (Appendix 5).

Nueces River Alluvium Aquifer

The Nueces River Alluvium Aquifer lies between Edwards and Real counties and extends over an area of approximately 24,450 acres. As with the Frio Alluvium Aquifer, the Nueces River Alluvium Aquifer is readily susceptible to diminished supplies during drought conditions, potentially from over-pumping, and from contaminated surface sources. Recharge of this aquifer is much like that of the Frio River Alluvium Aquifer, from stream loss and direct infiltration of precipitation. Alluvial deposits of the Pleistocene and Holocene Epoch materials occur along nearly all the stream courses on the Edwards Plateau. These deposits consist of sand, gravel, silt and clay derived from the erosion of the underlying rocks and occur primarily as terrace and flood plain alluvial. As with the defined Frio River Alluvium Aquifer, the alluvial deposits along the flood plains of the Nueces, West Nueces and South Llano rivers vary in width and thickness. The thickness is thought not to exceed 35 feet. There appears to be some hydraulic connection between the alluvial formations and the rivers and streams that meander through them. For the most part, wells in the alluvial formations within the District are generally shallow and provide water in small quantities for domestic and livestock purposes. The Barksdale Water Supply Corporation (serving the community of Barksdale) has its well field completed within the alluvium approximately one-half mile from the Nueces River. The Plateau Region Water Plan, January 2021, indicate there is approximately 3,574 acre-feet/year available within this aquifer (Appendix 5).

Estimated Available Groundwater

All estimates of groundwater availability, usage, supply, recharge, storage and future demands are from data supplied by the Texas Water Development Board, unless otherwise noted. Tables 1 thru 5 herein are taken from the TWDB GAM Run 24-014, December 18th, 2024 (Appendix 1). The groundwater model used in completing this analysis is the best available scientific tool that can be used to meet the stated objectives. While the District is required to use these estimates, it is hoped that the TWDB will continue to improve the models, and the data used herein. The District contends that the methodology used by the TWDB to project current and future water use is flawed in that it fails to consider factors including but not limited to: absentee landowners, vacationers, hunters, wildlife management, and exotic game.

Desired Future Conditions and Modeled Available Groundwater

House Bill (HB) 1763 passed by the 79th Legislature became effective and incorporated into Chapter 36 of the Texas Water Code. This bill regionalizes decisions of groundwater availability, requires regional water planning groups to use groundwater availability numbers, desired future conditions, from groundwater conservation districts, and defines a

permitting target for groundwater production modeled available groundwater. Groundwater conservation districts, in accordance with HB-1763 must establish their respective desired future conditions of how their aquifer will be managed for the period 2020 through 2070.

TWC § 36.001 defines modeled available groundwater as “the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under Section 36.108.” The joint planning process set forth in TWC § 36.108 must be collectively conducted by all groundwater conservation districts within the same groundwater management area. The District is a member of Groundwater Management Area 7, which along with the other districts in the groundwater management area did establish a comprehensive desired future condition. GAM Run: 21-012 MAG results are based on a desired future condition of 2 to 4 feet of drawdown across the District from 2020 to 2070 (Appendix 3).

Natural and/or Artificial Recharge

Recharge is the addition of water to an aquifer. The principal source of groundwater recharge in Edwards and Real counties is precipitation that falls on the outcrop of the various aquifers. In addition, seepage from streams located on the outcrop and, possibly, intraformational leakage are sources of groundwater recharge. Recharge is a limiting factor in the amount of water that can be developed from an aquifer, as it must balance discharge over a long period of time or the water in storage in the aquifer will eventually be depleted. Among the factors that influence the amount of recharge received by an aquifer are: the amount and frequency of precipitation; the extent of the outcrop or intake area; topography, type and amount of vegetation, the condition of soil cover in the outcrop area; and the ability of the aquifer to accept recharge and transmit it to areas of discharge. On aquifer outcrops where vegetation is dense, the removal of underbrush and non-beneficial plants will reduce evaporation and transpiration losses, making more water available for groundwater recharge. According to estimates from the TWDB GAM Run 24-014, December 18th, 2024, Table 1, the District receives approximately 75,275 acre-feet/year of recharge annually from precipitation (Appendix 1).

In the Edwards Plateau region, the annual rate of evaporation is three times greater than the annual rate of precipitation, thus creating perpetual low soil moisture content that retards percolation except under the most ideal conditions. Percolation usually occurs during relatively short periods after rainfall. Soil permeability is an expression of the ability of water to pass through pore spaces of the soil and varies throughout the Edwards Plateau from less than 0.06 to 0.63 inches per hour. This information is derived from a 1979 report by Lloyd Walker titled “Occurrence, Availability, and Chemical Quality of Ground Water in the Edwards Plateau Region of Texas, Report 235, Texas Department of Water Resources.”

Additional Recharge

The estimate of the annual amount of additional natural or artificial recharge of groundwater within the District that could result from implementation of feasible methods

for increasing the natural or artificial recharge is difficult to determine due to the direct correlation to rainfall. There are several feasible methods of additional recharge:

Flood Prevention Sites: Along the headwaters of the Frio and Nueces River there are numerous privately-owned dams that catch and retain water. On the Nueces, there is a public dam along the Uvalde and Real County line. There are a few privately owned dams on the Llano River as well. Construction of small dams to slow down runoff may be beneficial to the recharge of the aquifers within the District.

Range Management through Brush Control: Real and Edwards counties have a coverage of approximately 65% ash juniper or cedar. Brush control can be accomplished by mechanical control, prescribed burning, a combination of mechanical and burning, or chemical application. Brush control may be considered more of a conservation method than an additional recharge method. Recent studies indicate in certain instances over certain terrain and with proper techniques, brush control may enhance recharge as well as serve as a water conservation measure.

Natural and Artificial Discharge

Discharge is the loss of water from an aquifer. The discharge may be either artificial or natural. Artificial discharge takes place from flowing and pumped water wells, drainage ditches, gravel pits, and other excavations that intersect the water table. Natural discharge occurs as seepage, springs, evaporation, transpiration, and intraformational leakage. Groundwater moves from areas of recharge to areas of discharge, or from points of higher hydraulic head to points of lower hydraulic head. Movement is in the direction of the hydraulic gradient just as in the case of surface water flow. Under normal artesian conditions, movement of groundwater usually is in the direction of the aquifer's regional dip. The slope of the water-table, and consequently, the direction of groundwater movement, is closely related to the slope of the land surface. However, for both artesian and water-table conditions, local anomalies are developed in areas of pumping and some water moves toward the point of artificial discharge. The rate of groundwater movement in an aquifer is usually very slow, being in the magnitude of a few feet to a few hundred feet per year. While it appears that substantial recharge occurs via precipitation, approximately 41,232 acre-feet/year of water per year is discharged from the aquifer to springs, streams and rivers within the District according to Table 1 of GAM Run 24-014 (Appendix 1).

In planning for future use and availability, it is necessary to look at the amount of water coming into the District from each aquifer. The TWDB estimates in Table 1 of GAM Run 24-014 that there is a total of 25,079 acre-feet/year flowing into the District (Appendix 1).

Likewise, it is equally important to know how much water is leaving the District and how much flow there is between the different aquifers. The section above addressed the issue relating to discharges to springs, streams and rivers. However, if there is water entering the District through the aquifers, there is also water leaving the District via the aquifers. According to the TWDB GAM Run 24-014, Table 1, there is 78,817 acre-feet/year flowing out of the District annually (Appendix 1). There also appears to be a limited amount of flow

between the Edwards formation and the Trinity units which amounts to about 272 acre-feet/year (Appendix 1).

Surface Water Resources and Availability

Surface water sources within the District include the Nueces River, the Frio River, and the Llano River, along with numerous small streams and hundreds of springs. Major springs include: Seven Hundred Springs, Evans Springs, and Old Faithful Springs. The City of Camp Wood, in Real County, uses Old Faithful Springs as its sole source of municipal water. During the Drought of Record in the 1950's Old Faithful Spring still flowed at a rate that was adequate for the City of Camp Wood's municipal use. According to projections, the City of Camp Wood may be short as much as 130 acre-feet of water per year thru 2070 (Appendix 2). The District asked the Plateau Planning Group (Region J) to include a strategy relating to the City of Camp Wood drilling one or more wells to supplement the community's water supply.

Water Supply Needs Within the District

District water supply needs exist for the following groups indicating each group by 2070 (Appendix 2):

- Municipal
 - Camp Wood – 135 Acre Feet shortfall
 - Rocksprings – 94 Acre Feet shortfall
- Mining
 - Edwards county – 59 Acre Feet shortfall

These shortfalls can be mitigated by management strategies that include drilling of additional groundwater wells into the Edwards-Trinity (Plateau) Aquifer. There are water management strategies (drilling of additional wells) to develop additional aquifer supplies from the Nueces River Alluvium Aquifer for Barksdale WSC and from the Frio River Alluvium for the City of Leakey. The Edwards-Trinity (Plateau) Aquifer can supply additional water for the Oakmont Saddle Mountain WSC. The City of Leakey can also interconnect the current system wells and increase frequency of water loss audits and repairs to benefit local water availability. The City of Rocksprings, Barksdale WSC, and the Real WSC need to also increase frequency of water loss audits and line repairs to benefit water availability issues.

Projected surface water from the Frio, Nueces, and South Llano Rivers, as well as springs, contribute 1,877 acre-feet/year (Appendix 2). However, this cannot be considered available as surface water as it does not fall under the jurisdiction of the District. Flow data on most of the springs is sparse. The District has been monitoring the flow of the Nueces, Frio, and South Llano Rivers gathering data to be utilized to set future conditions, as well as use for specific drought triggers when combined with other data. As mentioned above, the aquifers discharge approximately 41,232 acre-feet/year to numerous springs, streams and rivers within the District (Appendix 1).

Water Management Strategies Current Use and Projected Water Supply

As previously mentioned, artificial discharge is considered the amount of water from flowing and pumped water wells, drainage ditches, gravel pits, and other excavations that intersect the water table. According to the TWDB, the projected total water demand for the District in 2021 was estimated to be 1,919 acre-feet and estimates from the Plateau Region Water Plan indicate a decline in water use in the District through the year 2060 (Appendix 2). These figures are based primarily upon population through census and livestock use. The District feels these figures do not take into consideration the large number of absentee landowners in the Real and Edwards counties (approximately 65-70%), nor do the figures consider the rapid change from normal livestock to Game Management and Exotic Game ranches. Other factors the District feels were not considered in these estimates are the abundance of wild game such as hog, axis deer, blackbuck antelope, mouflon sheep and aoudad, nor do these figures account for the large amount of tourism and summer homes. The TWDB estimated historical water use values are found in Appendix 2.

According to data from the Plateau Region Water Plan (January 2021), there are approximately 21,405 acre-feet/year of water available for District use (Appendix 5). However, since a part of this water is surface water, and, for the most part, is permitted by TCEQ and not under District control, that number should be lowered to 19,057 acre-feet/year.

According to the Estimated Historical Groundwater Use and 2022 State Water Plan Datasets: Real-Edwards Conservation and Reclamation District, the District has an estimated 1,877 acre-feet of surface water supply (Appendix 2).

Projected water supply needs listed in the TWDB estimated historical water use/2022 state water plan data packet (Appendix 2) are primarily municipal. Municipal needs for Edwards County exist for Rocksprings and for Real County exist for Camp Wood and Leakey. Additional needs for both Edwards and Real counties exist for livestock, irrigation and a small amount for mining in Edwards County.

Management of Groundwater Supplies

The District will work with other agencies and entities including but not limited to the Texas Water Development Board, The Plateau Region (Region J) Planning Group and the Groundwater Management Area 7 to establish and monitor the modeled available groundwater within the District. On an annual basis, the District will assess water supply and groundwater storage conditions and will report those conditions to the Board of Directors and to the public through the District website and news articles.

The District has, or will, amend as necessary, rules to regulate groundwater withdrawals by means of spacing and/or production limits.

The relevant factors to be considered in making the determination to grant a permit or limit groundwater withdrawal will include but not be limited to:

- The equitable conservation and preservation of the resource;
- The economic hardship resulting from granting or denying a permit or the terms prescribed by the rules;
- The modeled available groundwater for use in the District; and
- The desired future conditions of the aquifer.

In pursuit of the District's mission of protecting the resource, the District may require reduction of groundwater withdrawals to amounts which will not cause harm to the aquifer. To achieve this purpose, the District may, at the Board of Directors' discretion, amend or revoke any permits after notice and public hearing. The determination to seek the amendment or revocation of a permit by the District will be based on aquifer conditions observed by the District. The District will enforce the terms and conditions of permits and the rules of the District by enjoining the permit holder in a court of competent jurisdiction as provided for in TWC 36.102.

Actions, Procedures, Performance and Avoidance for Plan Implementation

The District will implement this plan and will utilize this plan as a guidepost for determining the direction or priority for all District activities. All operations of the District, all agreements entered by the District, and any additional planning efforts in which the District may participate will be consistent with this plan. The District has adopted and will amend, as necessary, rules relating to the implementation of this plan. The rules adopted by the District shall be pursuant to TWC Chapter 36, the District's enabling act, applicable law, and this plan. All rules will be adhered to and enforced. The promulgation and enforcement of the rules will be based on the best technical evidence available. The District shall treat all citizens fairly, in a nondiscriminatory manner, and with due process in accordance with the District's enabling act, TWC Chapter 36, and applicable law. Current District rules may be found on the District website <https://recrd.org/wp-content/uploads/2023/11/2023-District-Rules.pdf>.

Methodology for Tracking Progress

Prior to the first quarterly Board of Directors meeting of the fiscal year, the District staff will prepare an annual report on District performance in achieving the management goals for the preceding year. This report will be presented to the Board of Directors during the first quarterly Board of Directors meeting annually. The report will include the number of instances in which each of the activities specified in the District's management objectives was engaged in during the fiscal year. The Board of Directors will maintain the report on file, for public inspection, at the District's offices upon adoption. This methodology will apply to all management goals contained within this plan.

Goals, Management Objectives and Performance Standards

Goal 1 – Providing the most Efficient Use of Groundwater TWC §36.1071(a)(1)

Management Objective

1.1: Registration of Wells - The District will review all new well applications and may conduct site visits prior to any new well construction. The District will encourage the registration of existing well through news articles and other means.

Performance Standards

1.1 (a): Within five days of the receipt of an application for a new well, staff will review the application and may contact the applicant to arrange for a site visit.

1.1 (b): Staff may conduct an onsite inspection of the well location prior to any new construction.

1.1 (c): Data will be entered into the District's computer system and a well number will be issued within five days of the receipt of the well log/report from the Driller.

1.1 (d): Staff will furnish a report to the Board of Directors on the number of wells currently listed in the District's computer system on a quarterly basis. The report will include at a minimum; the total number of wells in the data base, the completed number of wells, and the number of pending well files.

1.1 (e): At least 2 times per year, the District will publish an article on the need to register existing wells.

Management Objective

1.2: Operating Permits, Transport Permits, and Other Permits - The District will review and act upon all requests for all permits as outlined in the District's Rules.

Performance Standards

1.2 (a): The District will follow procedures as outlined in District rules for permitting.

1.2 (b): On a quarterly basis, the staff will furnish the Board of Directors with the number of active permits and the number of permits pending.

Management Objective

1.3: Improve/Enhance Water Level Monitoring Program - The District will improve its water level monitoring network by identifying additional wells to be monitored, and by annually measuring the depth to water in those wells; record all measurements and/or observations; enter all measurements into District's computer data base. Establish a baseline by using existing wells, preferably those for which the

District already has some historical data, in all major and minor aquifers where wells are available.

Performance Standards

1.3 (a): Annually report to the Board of Directors on the percentage of water level monitoring wells for which measurements were recorded each year; the number of data records cataloged in the District's data base each year; the number of wells in the water level measurement network each year; the number of wells added to the network each year.

Goal 2 - Controlling and Preventing Waste of Groundwater TWC §36.1071(a)(2)

Management Objective

2.1: Control and Prevention of Water Waste - The District will investigate all identified wasteful practices within a reasonable number of working days of identification or complaint received. The District will publish at least three (3) articles per year via the local newspapers regarding the prevention of waste.

Performance Standards

2.1 (a): Annually report to the Board of Directors on the number of wasteful practices identified and the average number of days District personnel took to respond or investigate after identification or complaint received. Report to Board of Directors the actions taken to resolve the identification or complaint received.

2.1 (b): Annually report to the Board of Directors on the number of news articles published.

Goal 4 - Addressing Conjunctive Surface Water Management Issues TWC §36.1071(a)(4)

Except as provided in Chapter 36 of the Texas Water Code, the District has no jurisdiction over surface water. The District shall consider the effects of surface water resources as required by Section 36.113 and other state law. However, the Headwaters to the Nueces, Frio, and to some extent the South Llano Rivers, initiate in the District and the District is fully aware of the ecological and economic impact of these rivers. The Nueces River Authority is the predominant agency in dealing with the Nueces River and Frio River, and the District works with that entity in promoting water conservation and the prevention of waste and contamination of ground and surface water. The District also promotes the Clean Rivers Program initiated by the Nueces River Authority.

Management Objective

4.1: The District will work in conjunction with the Nueces River Authority and other stakeholder groups to promote the Clean Rivers Program and will include information about that program.

Performance Standards

4.1 (a): Annually report the number of programs, meetings etc. participated in.

4.1 (b): Annually report the number of articles relating to the Clean Rivers program.

Management Objective

4.2: The District will include information regarding the need to prevent contamination of the springs, streams, and rivers within the District.

Performance Standards

4.2 (a): Annually report the number of news articles relating to contamination.

Management Objective

4.3: Upon request and in conjunction with the Nueces River Authority, the District will conduct school and/or public presentations relating to the impact of contamination on the Nueces River Basin Watershed.

Performance Standards

4.3 (a): Annually report the number of requests and number of programs participated in.

**Goal 5 – Addressing Natural Resource Issues that Impact the Use and Availability of Groundwater and Which are Impacted by the Use of Groundwater
TWC §36.1071(a)(5)**

Management Objective

5.1: The District will investigate any reported contamination and work with the Railroad Commission, the Texas Commission on Environmental Quality, and/or other entities/agencies to ensure that any contamination is minimized or eliminated.

Performance Standards

5.1 (a): Investigate any report of potential contamination.

5.1 (b): Annually report the number of potential contamination incidents and the location of such incidents to the Board of Directors.

Management Objective

5.2: During the regional planning process, the District will work to include strategies relating to the investigation and/or impact of the contamination of wells in the District.

Performance Standards

5.2 (a): Annually report to the Board of Directors on the progress and/or the success of the objective.

Goal 6 –Addressing Drought Conditions TWC §36.1071(a)(6)

Management Objective

6.1: Curtailment of Groundwater Withdrawal - The annual amount of groundwater permitted by the District for withdrawal from the portion of the aquifers located within the District may be curtailed during periods of extreme drought in the recharge zones of the aquifers or because of other conditions that cause significant declines in groundwater surface elevations. Such curtailment may be triggered by the District's Board of Directors based on the groundwater elevation measured in the District's monitoring well(s) and/or stream flow measurements along with other indices such as rainfall and soil moisture. District staff currently monitors five locations along the Frio River and its tributaries, two locations on the Nueces River, and two locations on the South Llano River.

Performance Standards

6.1 (a): Flow measurements will be taken monthly on the Frio, Nueces and South Llano Rivers. The information will be published on the District's webpage for public viewing and in local papers.

6.1 (b): Upon declaration of a change in drought stage, all permit holders will be notified of the need to curtail production.

6.1 (c): Upon declaration of a change in drought stage, staff will submit an article to the local papers. The article will describe the drought stage and the conditions and request that the public initiate conservation measures.

6.1. (d): The District will annually review its drought contingency plan to see what, if any, changes need to be made.

6.1. (e): District staff will report quarterly to the Board of Directors on local drought conditions. Such reports may be oral or written and presented at Board of Directors Meetings. Data for this report may be drawn from information contained on the TWDB web site: <https://waterdatafortexas.org/drought> or from other sites as deemed relevant by District staff.

Goal 7 – Addressing: a) Conservation, b) Rainwater Harvesting, and c) Brush Control Where Appropriate and Cost Effective TWC §36.1071(a)(7)

Management Objective

7.1: Emphasize Water Conservation through Public Education - The District will sponsor the "Water Wise" conservation education curriculum, available upon request, for all 5th Grade Classrooms within the District.

Performance Standards

7.1(a): Annually report to the Board of Directors on the number of school districts and number of students instructed in the “Water Wise” conservation education curriculum, and the number of water conservation articles presented to the public.

Management Objective

7.2: Public Education – Provide and distribute literature on water conservation by publishing news articles.

Performance Standards

7.2 (a): Annually document number of news articles published.

7.2 (b): Promote rainwater harvesting, xeriscaping and brush control where appropriate and cost-effective. Promotion of these projects may be accomplished through news articles and/or the District’s webpage.

7.2 (c): Update District Webpage with informative links that relate to conservation, waste prevention and enhancement of groundwater. The District web page is a direct link to numerous individuals who reside in or own property within the District. Links on the District webpage will be reviewed regularly to insure they are current and that the linked information reflects the management objective. Annually document that the District webpage was reviewed and/or updated.

Management Objective

7.3: Addressing Rainwater Harvesting - The District believes that the harvesting of rainwater is a viable way to both conserve groundwater and to supplement domestic supply in areas within the District where groundwater is in sparse supply. The District will promote rainwater harvesting through news articles and through the District’s website.

Performance Standards

7.3 (a): Information regarding rainwater harvesting will be included in news articles.

7.3 (b): On at least a quarterly basis the District web page will be reviewed to ensure that links to information on rainwater harvesting are current.

Management Objective

7.4: Addressing Brush and Invasive plant control - The District is supportive of activities related to brush and invasive plant control as it relates to the recharge of the aquifers. The District will promote brush and invasive plant control through newspaper articles and through links on the District’s webpage.

Performance Standards

7.4 (a): The control of brush and/or other invasive plants will be included in news articles.

7.4 (b): On at least a quarterly basis the District web page will be reviewed to ensure that links to information on brush control are current.

Goal 8 – Addressing the Desired Future Conditions TWC §36.1071(a)(8)

Management Objective

8.1: The desired future condition established for the District is for average drawdown not to exceed 2 feet of drawdown from 2010 to 2070. The GAM Run 21-012 MAG results include estimates of groundwater elevations and drawdown for each year of the predictive period from 2020 to 2070 (Appendix 3). In order to assess the desired future condition, each year the District will measure water levels of at least three wells within the District. These measurements, and others in the area taken by the TWDB, will be used over five years to determine average drawdown over that time period.

Performance Standard

8.1: The District will report to the Board of Directors the results of the monitoring the sample wells each year, as well as report on downloaded groundwater data for Real and Edwards counties from the TWDB. After five years, the averages will be used to determine if the District is on track to meet the desired future condition projections from 2020 to 2070.

8.2: The District actively participates in developing the desired future conditions for the aquifers within the District's boundaries and within the boundaries of Groundwater Management Area 7.

Management Goals Not Applicable to the District

Goal 7 – Addressing: a) Recharge Enhancement and b) Precipitation Enhancement TWC §36.1071(a)(7)

Addressing Recharge Enhancement: This management goal is not applicable to the operations of the District as it is cost prohibitive at this time therefore it is not cost effective.

While the District is supportive of Precipitation Enhancement, such a program is costly, thus making it prohibitive. This portion of Management Goal 7 is currently not applicable to the operations of the District.

Goal 3 - Controlling and Preventing Subsidence TWC §36.1071(a)(3)

Tables 1.3 and 1.4 in the LRE Water report *Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping* – TWDB Contract Number 1648302062, by LRE Water (<http://www.twdb.texas.gov/groundwater/models/research/subsidence/subsidence.asp>)

indicate that the risk of subsidence in the District ranges from low (Edwards-Trinity (Plateau) Aquifer) to medium (Trinity Aquifer). Therefore, controlling and preventing subsidence are not applicable to the District.

Definitions and Concepts

In the administration of its duties, the Real-Edwards Conservation & Reclamation District follows the definitions of terms set forth in the District Enabling Act, Chapter 36 of the Texas Water Code, and other definitions as follows:

“Acre” means the unit of measure used to calculate the total land surface area. One acre is equal to 42,560 square feet.

“Acre-foot” means the amount of water necessary to cover one acre of land one foot deep, or about 325,851 gallons of water.

Agricultural Use or Purpose” means any use or activity involving agriculture, including irrigation.

“Alluvial” means a geological deposit composed of sediment deposited by a stream or river and may be in direct hydraulic connection with the rivers and streams that meander through the area.

“Alluvium Aquifer” means a minor aquifer(s) in the District that is mostly composed of gravel and sands eroded from the surrounding limestone hills and deposited along the flood plains near rivers and streams.

“Aquifer” means a geologic formation, group of formations, or part of a formation that can yield a sufficient amount of groundwater to make the production from this formation feasible for beneficial use.

“Board” means the Board of Directors of the District.

“Conservation” means those water saving practices, techniques, and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses.

“Desired Future Conditions” means a quantitative description, adopted in accordance with Section 36.108 of the Texas Water Code of the desired condition of the groundwater resources in a management area at one or more specified future times.

“Discharge” means the amount of water that leaves an aquifer by natural or artificial means.

“Director” means a person elected or appointed to serve on the Board of Directors of the District.

“District” means the Real-Edwards Conservation and Reclamation District.

“District Act” means Chapter 341, Acts of the 56th Legislature, Regular Session, 1959 (Article 8280-233, Vernon's Texas Civil Statutes), including all amendments thereto, and the non-conflicting provisions of Chapter 36, Texas Water Code.

“District boundaries” means the boundaries of the District, and such boundaries that are coexisting with the outside boundary lines of Edwards and Real counties.

“District Official” means District Directors and Officers.

“District Office” means the office of the District as established by the Board.

“Drought” means that term as defined in the District's Drought Contingency Plan.

“Drought Contingency Plan” (DCP) means a plan by the District that is designed to reduce demand on the available water supply through a process that becomes more restrictive as drought conditions worsen.

“Drought Stage” means one of the designated drought conditions listed in the District's Drought Contingency Plan.

“Edwards Trinity (Plateau) Aquifer” means the major aquifer within the District. The Edwards Trinity Aquifer extends from the Texas Hill Country to the Trans-Pecos area of West Texas.

“Frio River Alluvium Aquifer” means the minor aquifer in central Real County that extends over an area of approximately 9,530 acres and is mostly composed of gravel and sands eroded from the surrounding limestone hills and deposited along the floodplain of the Frio River.

“Groundwater” means water percolating beneath the surface of the earth.

“Modeled Available Groundwater” means the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under Section 36.108 of the Texas Water Code.

“Monitor Well” means a well that is used to measure or monitor the level, quality, quantity, or movement of subsurface water. The monitor well may be used to collect data on groundwater levels, water pressure and general movement.

“Municipal or Public Water Supply Use” means the use of groundwater through

public water systems that are authorized for providing potable water to the public by the State of Texas.

"Nueces River Alluvium Aquifer" means the minor aquifer within the District extending into both Edwards and Real counties that extends over an area of approximately 24,450 acres and is mostly composed of gravel and sands eroded from the surrounding limestone hills and deposited along the floodplain of the Nueces River.

"Pollution" means the alteration of the physical, thermal, chemical, or biological quality of, or the contamination of any water in the District that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property or to public health, safety, or welfare, or impairs the usefulness or public enjoyment of the water for any lawful or reasonable purpose including the alteration of groundwater by saltwater or other deleterious matter admitted from another stratum or from the surface of the ground.

"Recharge" means the amount of water that infiltrates into the water table of an aquifer from the surface of the ground or from other underground formations.

"Registration" means a certificate issued by the District for an exempt or excluded well, or the initial registration of a well that upon completion is to be determined by the District to be non-exempt.

"Rules" means the rules of the District compiled in this document and as may be supplemented, repealed or amended from time to time.

"Spring" means a point of natural discharge from an aquifer.

"Waste" means any one or more of the following:

- (a) withdrawal of groundwater from a groundwater reservoir at a rate and in an amount that causes or threatens to cause intrusion into the reservoir of water unsuitable for agricultural use, gardening, domestic or stock watering purposes;
- (b) the flowing or producing of wells from a groundwater reservoir if the water produced is not used for a beneficial purpose;
- (c) escape of groundwater from a groundwater reservoir to any other reservoir or geologic strata that does not contain groundwater;
- (d) pollution or harmful alteration of groundwater in a groundwater reservoir by saltwater or by other deleterious matter admitted from another stratum or from the surface of the ground;
- (e) willfully or negligently causing, suffering, or allowing groundwater to escape into any river, creek, natural watercourse, depression, lake, reservoir, drain, sewer, street, highway, road, or ditch, or onto any land other than that of the owner of the well, unless such

discharge is authorized by permit, rule, or order issued by the Texas Commission on Environmental Quality under Chapter 26, Texas Water Code;

- (f) groundwater pumped for irrigation that escapes as irrigation tail water onto land other than that of the owner of the well, unless the occupant of the land receiving the discharge has granted permission;
- (g) for water produced from an artesian well, “waste” has the meaning assigned by Section 11.205 of the Texas Water Code.

In event of a conflict between “Beneficial Use” or “Beneficial Purposes” and “Waste,” “Beneficial Use” or “Beneficial Purposes” shall be subordinate to “Waste.”

“Water Table” means the upper boundary of the saturated zone in an unconfined aquifer.

“Well” means any facility, device, or method used to withdraw groundwater; or any artificial excavation or borehole constructed for the purposes of exploring for or producing groundwater, or for injection, monitoring, or dewatering purposes, or a leachate or remediation well.

“Well Registration” means the creation of a record of a well, as determined by its use, and a well identification number for purposes of registering the well as to its geographic location, and for notification to the well owner in cases of spills or accidents, data collection, record keeping, or future planning purposes.

“Xeriscape” means a landscape practice combining the use of low water use plants, design, conservation, and other landscaping principles to conserve water and energy.

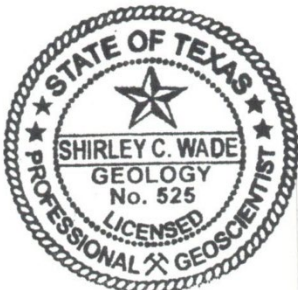
Appendix 1

Real-Edwards Conservation and Reclamation District

Part 2 – Data Required for Management Plan GAM Run 24-014



Saheli Majumdar, Ph.D. and Shirley Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Modeling Department
December 18, 2024



Shirley C. Wade
12/18/2024

INTRODUCTION

Texas Water Code § 36.1071(h), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator.

The TWDB provides data and information to the Real-Edwards Conservation and Reclamation District in two parts. This report constitutes part 2, the required groundwater availability modeling information, which includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
2. the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers, for each aquifer within the district; and
3. the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

This report replaces the results of GAM Run 13-023 (Boghici, 2013). We used one groundwater availability model for the Real-Edwards Conservation and Reclamation District. Information for the [Edwards-Trinity \(Plateau\) and Trinity aquifers](#) is from version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas (Anaya and Jones, 2009).

The groundwater management plan for the Real-Edwards Conservation and Reclamation District should be adopted by the district on or before March 6, 2025 and submitted to the Executive Administrator of the TWDB on or before April 5, 2025. The current management plan for the Real-Edwards Conservation and Reclamation District expires on June 4, 2025.

METHODS

In accordance with the provisions of the Texas Water Code § 36.1071 (h), the groundwater availability model mentioned above was used to estimate information for the Real-Edwards Conservation and Reclamation District management plan. The average annual water budget values for recharge, surface-water outflow, inflow to the district, outflow from the district, and the flow between aquifers within the district are summarized in this report.

Values may differ from the previous report as a result of routine updates to the spatial grid file used to define county, groundwater conservation district, and aquifer boundaries, which can impact the calculated water budget values. Additionally, the approach used for analyzing model results is reviewed during each update and may have been refined to better delineate groundwater flows. Finally, results may differ due to the use of more recent models or techniques.

It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

If the Real-Edwards Conservation and Reclamation District determines that the district boundaries used in the assessment do not reflect current conditions after reviewing the figures, please notify the TWDB Groundwater Modeling Department at your earliest convenience.

The flow components presented in this report do not represent the full groundwater budget. If additional inflow and outflow information would be helpful for planning purposes, the district may submit a request in writing to the [TWDB Groundwater Modeling Department](#) for the full groundwater budget.

Models and Aquifers

Groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas

- Version 1.01 (Anaya and Jones, 2009)
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).
- Water budgets were extracted for the historical calibration period (1981 through 2000) using ZONEBUDGET Version 3.01 (Harbaugh, 2009).
- This model was used to analyze the following aquifers:
 - [Edwards-Trinity \(Plateau\) Aquifer](#)
 - [Trinity Aquifer](#)

For more information on model parameters, packages used to simulate groundwater flow, other model layers, or model assumptions, please see the associated model reports linked in the References section.

RESULTS

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the [Edwards-Trinity \(Plateau\) and Trinity aquifers](#) located within Real-Edwards Conservation and Reclamation District:

1. [Precipitation recharge](#) - the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.
2. [Surface-water outflow](#) - the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.
3. [Flow into and out of district](#) - the lateral flow within the aquifer between the district and adjacent counties.
4. [Flow between aquifers](#) - the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Tables 1 and 2. Figures 1 and 3 show the area of the model from which the values in Tables 1 and 2 were extracted. Figures 2 and 4 provide a generalized diagram of the groundwater flow components provided in Tables 1 and 2.

Table 1: Summarized information for the Edwards-Trinity (Plateau) Aquifer. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.

Management Plan requirement	Aquifer or Confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	75,275
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams and rivers	Edwards-Trinity (Plateau) Aquifer	41,232
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	25,079
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	78,817
Estimated net annual volume of flow within each aquifer in the district	To Edwards-Trinity (Plateau) Aquifer from Trinity Aquifer	272

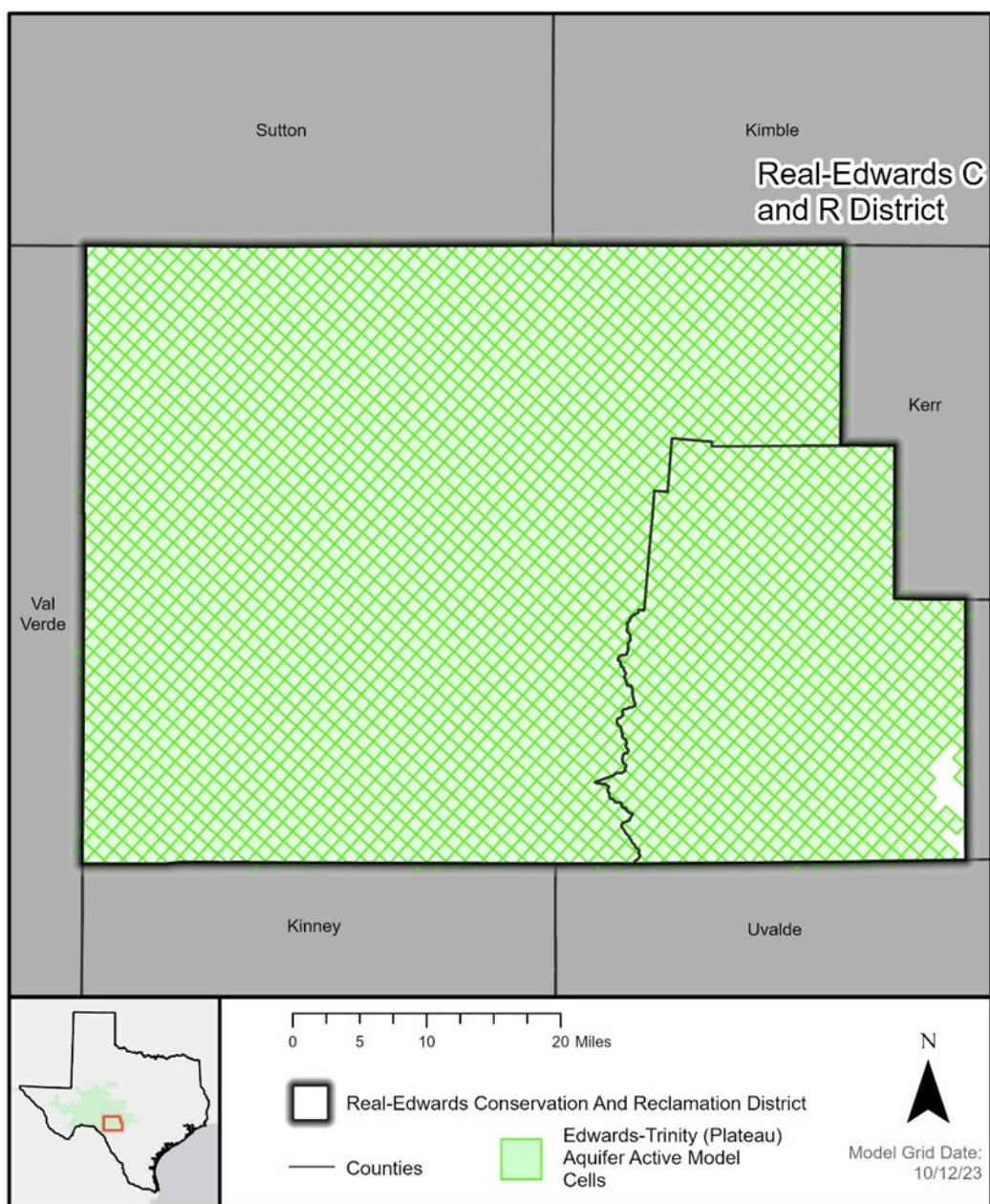
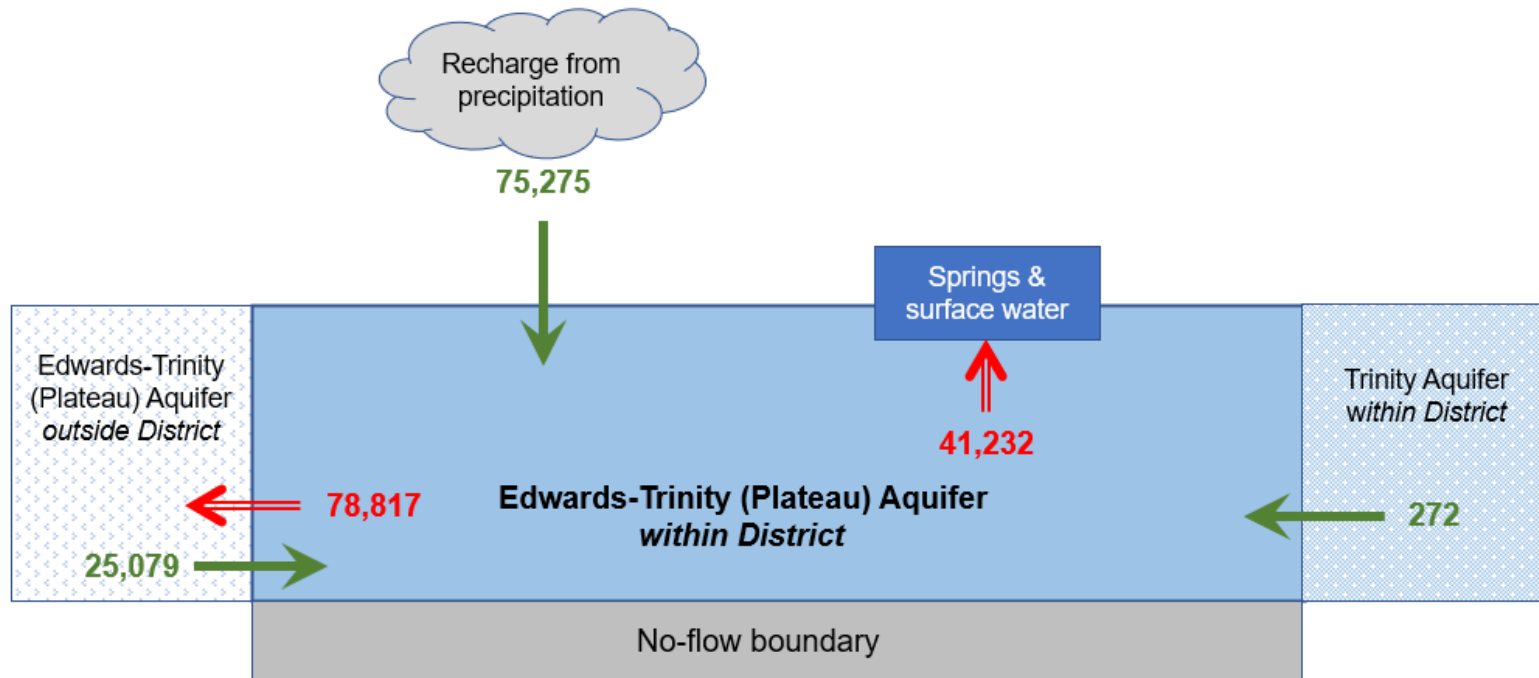


Figure 1: Area of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas from which the information in Table 1 was extracted (the Edwards-Trinity [Plateau] Aquifer extent within the district boundary).



Caveat: This diagram only includes the water budget items provided in Table 1. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 2: Generalized diagram of the summarized budget information from Table 1, representing directions of flow for the Edwards-Trinity (Plateau) Aquifer within the Real-Edwards Conservation and Reclamation District. Flow values are expressed in acre-feet per year.

Table 2: Summarized information for the Trinity Aquifer. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.

Management Plan requirement	Aquifer or Confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Trinity Aquifer	1,080
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams and rivers	Trinity Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	650
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	1,455
Estimated net annual volume of flow within each aquifer in the district	From Trinity Aquifer to Edwards-Trinity (Plateau) Aquifer	272

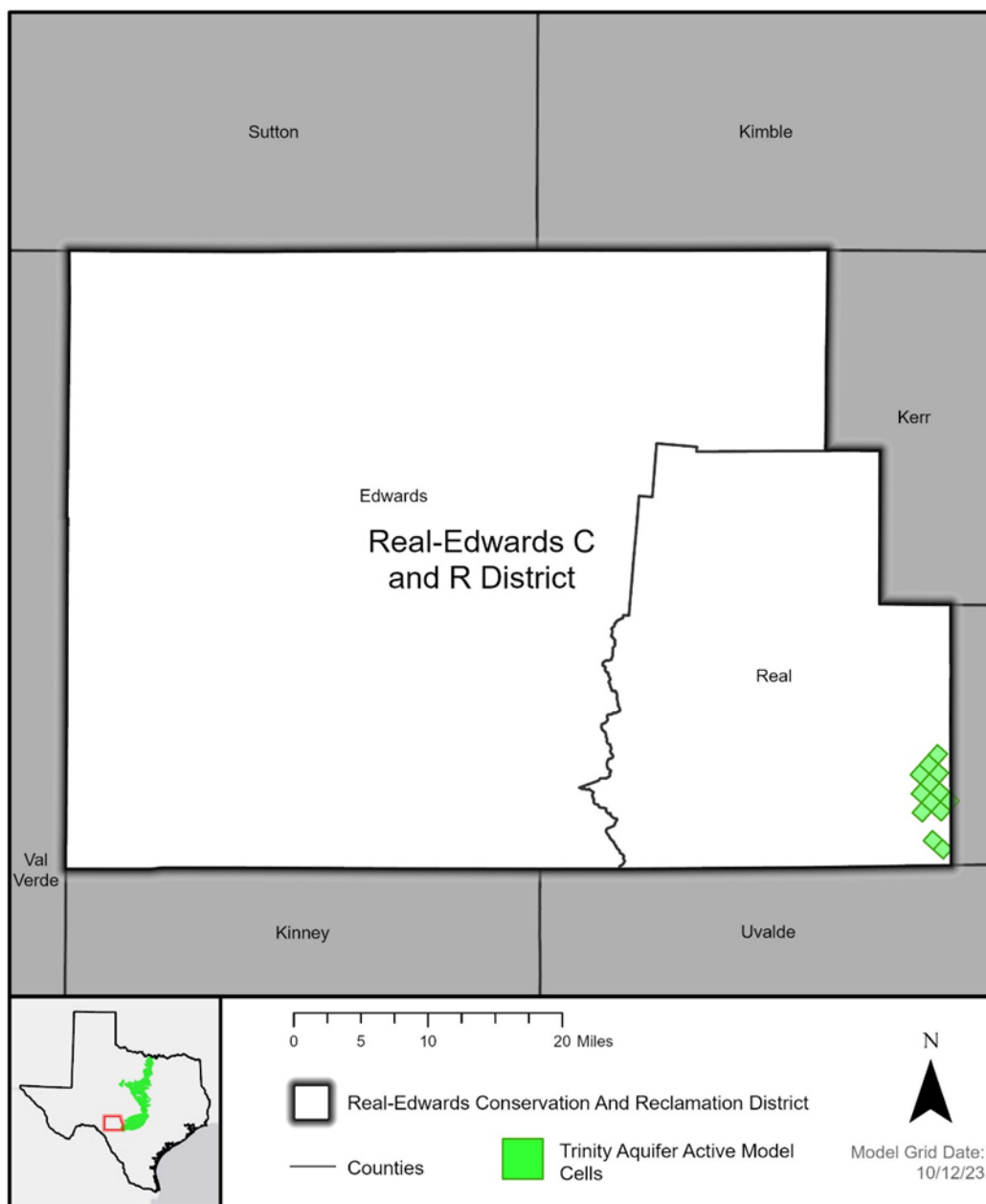
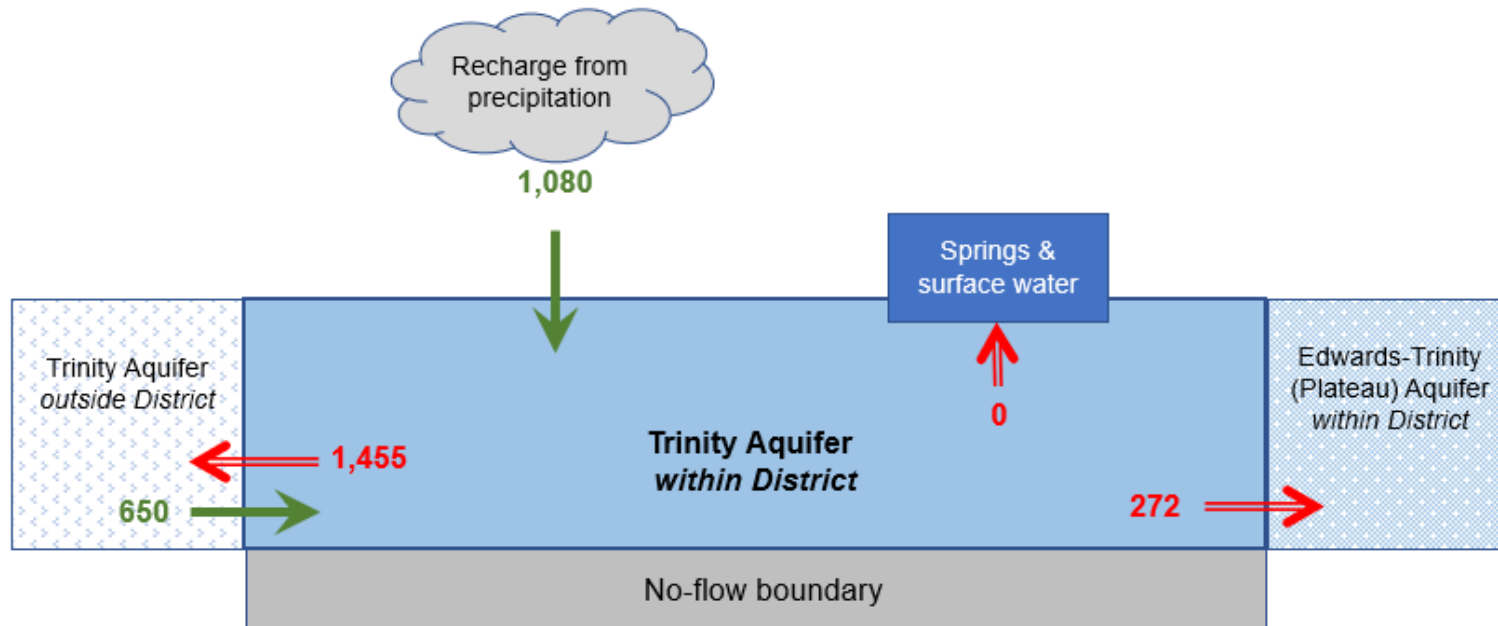


Figure 3: Area of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas from which the information in Table 2 was extracted (the Trinity Aquifer extent within the district boundary).



Caveat: This diagram only includes the water budget items provided in Table 2. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 4: Generalized diagram of the summarized budget information from Table 2, representing directions of flow for the Trinity Aquifer within the Real-Edwards Conservation and Reclamation District. Flow values are expressed in acre-feet per year.

LIMITATIONS

The groundwater model used in completing this analysis are the best available scientific tools that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

“Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results.”

A key aspect of using a groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historical pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and interaction with streams are specific to particular historic time periods.

Because the application of groundwater models was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of groundwater models and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

REFERENCES

- Anaya, R., and Jones, I., 2009, Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas: Texas Water Development Board Report 373, 103 p., www.twdb.texas.gov/groundwater/models/gam/eddt_p/ET-Plateau_Full.pdf.
- Boghici, R., 2013, GAM Run 13-023: Texas Water Development Board, GAM Run 13-023 Report, 10 p., www.twdb.texas.gov/groundwater/docs/GAMruns/GR13-023.pdf.
- Harbaugh, A. W., and McDonald, M.G., 1996, User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 96-485, 56 p., water.usgs.gov/software/MODFLOW-96/.
- Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software., water.usgs.gov/nrp/gwsoftware/zonebud3/zonebudget3.html.
- National Research Council, 2007, Models in Environmental Regulatory Decision Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p., www.nap.edu/catalog/11972/models-in-environmental-regulatory-decision-making.
- Texas Water Code § 36.1071

Appendix 2

TWDB Estimated Historical Groundwater Use and 2022 State Water Plan Datasets

Real-Edwards Conservation and Reclamation District

Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Department
stephen.allen@twdb.texas.gov
(512) 463-7317
March 12, 2025

GROUNDWATER MANAGEMENT PLAN DATA

This set of water data tables (part one of a two-part package of information) is being provided to groundwater conservation districts to help them meet the requirements for approval of their five-year groundwater management plan. Each table addresses a specific numbered requirement in the Texas Water Development Board's groundwater management plan review checklist. The checklist can be found by clicking on this weblink:

Groundwater Management Plan Review Checklist

The five tables included in part one of this data package are:

TWDB Historical Water Use Survey (WUS)

- Estimated Historical Water Use (checklist item 2)

State Water Plan (SWP)

- Projected Surface Water Supplies (checklist item 6),
- Projected Water Demands (checklist item 7),
- Projected Water Supply Needs (checklist item 8),
- Projected Water Management Strategies (checklist item 9)

Part two of the two-part package is the groundwater availability model (GAM) run report for the district (checklist items 3 through 5). The district should have received, or will receive, this report from the TWDB Groundwater Modeling Department. Questions about the GAM can be directed to daryn.hardwick@twdb.texas.gov , (512) 475-0470.

DISCLAIMER:

Data presented in these tables are the most up to date WUS and SWP data available as of 3/12/2025. Although it does not happen often, these data are subject to change pending the availability of more accurate WUS data or an amendment to the 2022 SWP. District personnel should review the data table values and correct any discrepancies to ensure approval of their groundwater management plan.

The WUS data can be verified at this web address:

<https://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/>

The 2022 SWP data can be verified by contacting Sabrina Anderson, (sabrina.anderson@twdb.texas.gov or 512-936-0886).

The values presented in the data tables are county based. In cases where groundwater conservation districts cover only a portion of one or more counties the data values are modified with an apportioning multiplier to create new values that more accurately represent conditions within district boundaries. The multiplier used in the following formula is a land area ratio: (data value * (land area of district in county / land area of county)). For two of the four SWP tables (Projected Surface Water Supplies and Projected Water Demands) only the county-wide water user group (WUG) data values (county other, manufacturing, steam electric power, irrigation, mining, and livestock) are modified using the multiplier. WUG values for municipalities, water supply corporations, and utility districts are not apportioned; instead, their full values are retained when they are located within the district and eliminated when they are located outside (we offer districts the opportunity to review this determination).

The county values in two of the SWP tables (Projected Water Supply Needs and Projected Water Management Strategies) are not apportioned because district-specific values are not required to be presented in the groundwater management plan. However, a district is required to “consider” the county values in these two tables by drafting a short summary of the needs and strategies values in the groundwater management plan.

In the WUS table every category of water use (including municipal) is apportioned. Staff determined that breaking down the annual municipal values into individual WUGs was too complex.

TWDB recognizes that the apportioning formula used is not ideal but it is the best available process with respect to time and staffing constraints. If a district believes it has data that are more accurate, they can add those data to the plan with an explanation of how the data were derived. Apportioning percentages that the TWDB used are listed above each applicable table.

For additional questions regarding this data, please contact Stephen Allen (stephen.allen@twdb.texas.gov or 512-463-7317).

Estimated Historical Water Use

TWDB Historical Water Use Survey (WUS) Data

EDWARDS COUNTY

100% (multiplier)

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2021	GW	272	0	1	0	258	330	861
	SW	0	0	0	0	11	37	48
2020	GW	293	0	1	0	184	337	815
	SW	0	0	0	0	11	37	48
2019	GW	227	0	1	0	175	344	747
	SW	0	0	0	0	29	39	68
2018	GW	284	0	0	0	210	343	837
	SW	0	0	0	0	38	39	77
2017	GW	265	0	0	0	180	330	775
	SW	0	0	0	0	41	37	78
2016	GW	286	0	0	0	240	343	869
	SW	0	0	0	0	22	39	61
2015	GW	282	0	0	0	43	343	668
	SW	0	0	0	0	76	39	115
2014	GW	292	0	0	0	234	267	793
	SW	0	0	0	0	8	30	38
2013	GW	295	0	0	0	127	288	710
	SW	0	0	0	0	63	32	95
2012	GW	339	0	0	0	97	372	808
	SW	0	0	0	0	63	41	104

REAL COUNTY*100% (multiplier)*

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2021	GW	443	0	0	0	272	42	757
	SW	171	0	0	0	71	11	253
2020	GW	446	0	0	0	152	44	642
	SW	149	0	0	0	148	11	308
2019	GW	457	0	0	0	202	44	703
	SW	199	0	0	0	92	11	302
2018	GW	472	0	0	0	145	44	661
	SW	103	0	0	0	120	11	234
2017	GW	460	0	0	0	165	42	667
	SW	103	0	0	0	81	11	195
2016	GW	471	0	0	0	146	50	667
	SW	143	0	0	0	71	13	227
2015	GW	436	0	0	0	120	48	604
	SW	143	0	0	0	83	12	238
2014	GW	465	0	0	0	176	48	689
	SW	107	0	0	0	108	12	227
2013	GW	470	0	0	0	149	62	681
	SW	107	0	0	0	119	15	241
2012	GW	494	0	0	0	107	85	686
	SW	136	0	0	0	122	21	279

Projected Surface Water Supplies

TWDB 2022 State Water Plan Data

EDWARDS COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
J	Irrigation, Edwards	Colorado	Colorado Run-of-River	32	32	32	32	32	32
J	Irrigation, Edwards	Nueces	Nueces Run-of-River	94	94	94	94	94	94
Sum of Projected Surface Water Supplies (acre-feet)				126	126	126	126	126	126

REAL COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
J	Camp Wood	Nueces	Nueces Run-of-River	0	0	0	0	0	0
J	County-Other, Real	Nueces	Nueces Run-of-River	0	0	0	0	0	0
J	Irrigation, Real	Nueces	Nueces Run-of-River	1,751	1,751	1,751	1,751	1,751	1,751
Sum of Projected Surface Water Supplies (acre-feet)				1,751	1,751	1,751	1,751	1,751	1,751

Projected Water Demands

TWDB 2022 State Water Plan Data

Please note that the demand numbers presented here include the plumbing code savings found in the Regional and State Water Plans.

EDWARDS COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
J	County-Other, Edwards	Colorado	15	14	14	14	14	14
J	County-Other, Edwards	Nueces	72	69	66	65	65	65
J	County-Other, Edwards	Rio Grande	8	8	7	7	7	7
J	Irrigation, Edwards	Colorado	66	66	66	66	66	66
J	Irrigation, Edwards	Nueces	89	89	89	89	89	89
J	Irrigation, Edwards	Rio Grande	60	60	60	60	60	60
J	Livestock, Edwards	Colorado	106	106	106	106	106	106
J	Livestock, Edwards	Nueces	192	192	192	192	192	192
J	Livestock, Edwards	Rio Grande	99	99	99	99	99	99
J	Mining, Edwards	Colorado	19	19	19	19	19	19
J	Mining, Edwards	Nueces	25	25	25	25	25	25
J	Mining, Edwards	Rio Grande	45	45	45	45	45	45
J	Rocksprings	Colorado	198	194	191	190	190	190
J	Rocksprings	Nueces	98	96	94	94	94	94
Sum of Projected Water Demands (acre-feet)			1,092	1,082	1,073	1,071	1,071	1,071

REAL COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
J	Camp Wood	Nueces	143	139	136	135	135	135
J	County-Other, Real	Colorado	4	4	3	3	3	3
J	County-Other, Real	Nueces	120	116	113	111	111	111
J	Irrigation, Real	Colorado	12	12	12	12	12	12
J	Irrigation, Real	Nueces	258	258	258	258	258	258
J	Leakey	Nueces	193	186	180	178	177	177
J	Livestock, Real	Colorado	13	13	13	13	13	13
J	Livestock, Real	Nueces	138	138	138	138	138	138
Sum of Projected Water Demands (acre-feet)			881	866	853	848	847	847

Projected Water Supply Needs

TWDB 2022 State Water Plan Data

Negative values (in red) reflect a projected water supply need, positive values a surplus.

EDWARDS COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
J	County-Other, Edwards	Colorado	42	43	43	43	43	43
J	County-Other, Edwards	Nueces	201	204	207	208	208	208
J	County-Other, Edwards	Rio Grande	22	22	23	23	23	23
J	Irrigation, Edwards	Colorado	44	44	44	44	44	44
J	Irrigation, Edwards	Nueces	114	114	114	114	114	114
J	Irrigation, Edwards	Rio Grande	10	10	10	10	10	10
J	Livestock, Edwards	Colorado	365	365	365	365	365	365
J	Livestock, Edwards	Nueces	14	14	14	14	14	14
J	Livestock, Edwards	Rio Grande	11	11	11	11	11	11
J	Mining, Edwards	Colorado	-12	-12	-12	-12	-12	-12
J	Mining, Edwards	Nueces	-16	-16	-16	-16	-16	-16
J	Mining, Edwards	Rio Grande	-31	-31	-31	-31	-31	-31
J	Rocksprings	Colorado	673	677	680	681	681	681
J	Rocksprings	Nueces	-98	-96	-94	-94	-94	-94
Sum of Projected Water Supply Needs (acre-feet)			-157	-155	-153	-153	-153	-153

REAL COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
J	Camp Wood	Nueces	-143	-139	-136	-135	-135	-135
J	County-Other, Real	Colorado	11	11	12	12	12	12
J	County-Other, Real	Nueces	352	356	359	361	361	361
J	Irrigation, Real	Colorado	176	176	176	176	176	176
J	Irrigation, Real	Nueces	1,680	1,680	1,680	1,680	1,680	1,680
J	Leakey	Nueces	105	112	118	120	121	121
J	Livestock, Real	Colorado	5	5	5	5	5	5
J	Livestock, Real	Nueces	38	38	38	38	38	38
Sum of Projected Water Supply Needs (acre-feet)			-143	-139	-136	-135	-135	-135

Projected Water Management Strategies

TWDB 2022 State Water Plan Data

EDWARDS COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
County-Other, Edwards, Nueces (J)							
Barksdale WSC - Additional Groundwater Well and RO Wellhead Treatment	Nueces River Alluvium Aquifer [Edwards]	54	54	54	54	54	54
		54	54	54	54	54	54
Mining, Edwards, Colorado (J)							
Edwards County Mining - Additional Groundwater Well (Colorado)	Edwards-Trinity-Plateau, Pecos Valley, and Trinity Aquifers [Edwards]	12	12	12	12	12	12
		12	12	12	12	12	12
Mining, Edwards, Nueces (J)							
Edwards County Mining - Additional Groundwater Well (Nueces)	Edwards-Trinity-Plateau, Pecos Valley, and Trinity Aquifers [Edwards]	16	16	16	16	16	16
		16	16	16	16	16	16
Mining, Edwards, Rio Grande (J)							
Edwards County Mining - Additional Groundwater Wells (Rio Grande)	Edwards-Trinity-Plateau, Pecos Valley, and Trinity Aquifers [Edwards]	31	31	31	31	31	31
		31	31	31	31	31	31
Rocksprings, Colorado (J)							
City of Rocksprings - Public Conservation Education	DEMAND REDUCTION [Edwards]	1	1	1	1	1	1
		1	1	1	1	1	1
Rocksprings, Nueces (J)							
City of Rocksprings - Additional Groundwater Wells	Edwards-Trinity-Plateau, Pecos Valley, and Trinity Aquifers [Edwards]	121	121	121	121	121	121
		121	121	121	121	121	121
Sum of Projected Water Management Strategies (acre-feet)		235	235	235	235	235	235

REAL COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Camp Wood, Nueces (J)							
City of Camp Wood - Additional Groundwater Well	Edwards-Trinity-Plateau, Pecos Valley, and Trinity Aquifers [Real]	143	143	143	143	143	143
City of Camp Wood - Public Conservation Education	DEMAND REDUCTION [Real]	1	1	1	1	1	1
		144	144	144	144	144	144

Estimated Historical Water Use and 2022 State Water Plan Dataset:

Real-Edwards Conservation and Reclamation District

March 12, 2025

Page 8 of 9

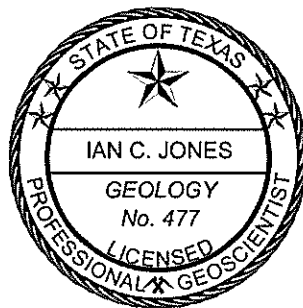
County-Other, Real, Nueces (J)

City of Leakey - Develop Interconnections Between Wells Within the City	Frio River Alluvium Aquifer [Real]	0	81	81	81	81	81
City of Leakey - Additional Groundwater Well in the Lower Trinity Aquifer	Edwards-Trinity-Plateau, Pecos Valley, and Trinity Aquifers [Real]	91	91	91	91	91	91
Real County Other - Oakmont Saddle Mountain WSC - Additional Groundwater Well	Frio River Alluvium Aquifer [Real]	54	54	54	54	54	54
Real County Other - Real WSC - Water Loss Audit and Main-Line Repair	DEMAND REDUCTION [Real]	2	2	2	2	2	2
		147	228	228	228	228	228
Sum of Projected Water Management Strategies (acre-feet)		291	372	372	372	372	372

Appendix 3

**GAM RUN 21-012 MAG:
MODELED AVAILABLE GROUNDWATER FOR
THE AQUIFERS IN GROUNDWATER
MANAGEMENT AREA 7**

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-6641
August 12, 2022



A handwritten signature in black ink, appearing to read "I. C. Jones", written over a light blue horizontal line.

This page is intentionally left blank.

GAM RUN 21-012 MAG: MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-6641
August 12, 2022

EXECUTIVE SUMMARY:

The Texas Water Development Board (TWDB) has prepared estimates of the modeled available groundwater for the relevant aquifers of Groundwater Management Area 7—the Capitan Reef Complex, Dockum, Edwards-Trinity (Plateau), Ellenburger-San Saba, Hickory, Ogallala, Pecos Valley, Rustler, and Trinity aquifers. The estimates are based on the desired future conditions for these aquifers adopted by the groundwater conservation districts in Groundwater Management Area 7 on August 19, 2021. The explanatory reports and other materials submitted to the TWDB were determined to be administratively complete on February 23, 2022.

The modeled available groundwater values are summarized by decade for the groundwater conservation districts (Tables 1, 3, 5, 7, 9, 11, 13) and for use in the regional water planning process (Tables 2, 4, 6, 8, 10, 12, 14). The modeled available groundwater estimates for each decade from 2020 through 2070 are:

- 26,164 acre-feet per year in the Capitan Reef Complex Aquifer,
- 2,324 acre-feet per year in the Dockum Aquifer,
- 6,570 to 7,925 acre-feet per year in the Ogallala Aquifer,
- 479,063 acre-feet per year in the undifferentiated Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers,
- 22,616 acre-feet per year in the Ellenburger-San Saba Aquifer,
- 49,936 acre-feet per year in the Hickory Aquifer, and
- 7,040 acre-feet per year in the Rustler Aquifer.

The modeled available groundwater estimates were extracted from results of model runs using the groundwater availability models for the Capitan Reef Complex Aquifer [Version

1.01] (Jones, 2016) for the Capitan Reef Complex Aquifer; the High Plains Aquifer System [Version 1.01] (Deeds and Jigmond, 2015) for the Dockum and Ogallala aquifers; the minor aquifers of the Llano Uplift Area [Version 1.01] (Shi and others, 2016) for the Ellenburger-San Saba and Hickory aquifers, and the Rustler Aquifer [Version 1.01] (Ewing and others, 2012) for the Rustler Aquifer. In addition, the alternative 1-layer model for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers (Hutchison and others, 2011a) was used for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers, except for Kinney and Val Verde counties. In these two counties, the alternative Kinney County model (Hutchison and others, 2011b) and the model associated with a hydrogeological study for Val Verde County and the City of Del Rio (EcoKai and Hutchison, 2014), respectively, were used to estimate modeled available groundwater.

REQUESTOR:

Ms. Meredith Allen, coordinator of Groundwater Management Area 7 districts.

DESCRIPTION OF REQUEST:

In an email dated August 28, 2021, Dr. William Hutchison on behalf of Groundwater Management Area 7 provided the TWDB with the desired future conditions for the Capitan, Dockum, Ellenburger-San Saba, Hickory, Ogallala, and Rustler aquifers, as well as for the undifferentiated Edwards-Trinity (Plateau), Pecos Valley and Trinity aquifers, in Groundwater Management Area 7. Groundwater Management Area 7 provided additional clarifications through an email to the TWDB on November 12, 2021, for the assumptions and model files to be used to calculate modeled available groundwater.

The final adopted desired future conditions as stated in signed resolutions for the aquifers in Groundwater Management Area 7 are as follows:

Capitan Reef Complex Aquifer (Resolution #08-19-2021-2)

- | |
|---|
| <ul style="list-style-type: none">a) Total net drawdown of the Capitan Reef Complex Aquifer not to exceed 56 feet in Pecos County (Middle Pecos GCD) in 2070 as compared with 2006 aquifer levels.
<i>*(Reference: Scenario 4, GMA 7 Technical Memorandum 16-03)</i>b) The Capitan Reef Complex Aquifer is not relevant for joint planning purposes in all other areas of GMA 7. |
|---|

Dockum and Ogallala aquifers *(Resolution #08-19-2021-5)*

Ogallala Aquifer:

- a) Total net drawdown of the Ogallala Aquifer not to exceed **6 feet in Glasscock County** in 2070 as compared with 2010 aquifer levels.

Dockum Aquifer:

- b) Total net drawdown of the Dockum Aquifer not to exceed **52 feet in Pecos County** in 2070 as compared with 2010 aquifer levels.
- c) Total net drawdown of the Dockum Aquifer not to exceed **14 feet in Reagan County** in 2070 as compared with 2010 aquifer levels.

**(Reference items a) through c): Scenario 17, GMA 7 Technical Memorandum 16-01)*

- d) The Ogallala and Dockum Aquifers are not relevant for joint planning purposes in all other areas of GMA 7.

Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers (Resolution #08-19-2021-3)

- a) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **0 feet in Coke County** in 2070 as compared with 2010 aquifer levels.
- b) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **10 feet in Crockett County** in 2070 as compared with 2010 aquifer levels.
- c) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **4 feet in Ector County** in 2070 as compared with 2010 aquifer levels.
- d) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **2 feet in Edwards County** in 2070 as compared with 2010 aquifer levels.
- e) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **5 feet in Gillespie County** in 2070 as compared with 2010 aquifer levels.
- f) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **42 feet in Glasscock County** in 2070 as compared with 2010 aquifer levels.
- g) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **10 feet in Irion County** in 2070 as compared with 2010 aquifer levels.
- h) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **1 foot in Kimble County** in 2070 as compared with 2010 aquifer levels.
- i) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **1 foot in Menard County** in 2070 as compared with 2010 aquifer levels.
- j) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **12 feet in Midland County** in 2070 as compared with 2010 aquifer levels.
- k) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **14 feet in Pecos County** in 2070 as compared with 2010 aquifer levels.
- l) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **42 feet in Reagan County** in 2070 as compared with 2010 aquifer levels.
- m) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **4 feet in Real County** in 2070 as compared with 2010 aquifer levels.
- n) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **8 feet in Schleicher County** in 2070 as compared with 2010 aquifer levels.
- o) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **7 feet in Sterling County** in 2070 as compared with 2010 aquifer levels.
- p) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **6 feet in Sutton County** in 2070 as compared with 2010 aquifer levels.
- q) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **0 feet in Taylor County** in 2070 as compared with 2010 aquifer levels.
- r) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **2 feet in Terrell County** in 2070 as compared with 2010 aquifer levels.
- s) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **20 feet in Upton County** in 2070 as compared with 2010 aquifer levels.
- t) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **2 feet in Uvalde County** in 2070 as compared with 2010 aquifer levels.

*(Reference items a) through t): GMA 7 Technical Memorandum 18-01)

Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers (continued)

- u) Total net drawdown in **Kinney County** in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an annual average flow of **23.9 cfs at Las Moras Springs**.
**(Reference: Groundwater Flow Model of the Kinney County Area by W.R. Hutchison and others, 2011).*
- v) Total net drawdown in **Val Verde County** in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an average annual flow of **73-75 mgd at San Felipe Springs**.
**(Reference: EcoKai, 2014)*
- w) The Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers are not relevant for joint planning purposes in all other areas of GMA 7.

Minor Aquifers of the Llano Uplift Area (Resolution #08-19-2021-4)

Ellenburger-San Saba Aquifer:

- a) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **8 feet in Gillespie County** in 2070 as compared with 2010 aquifer levels.
- b) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **18 foot in Kimble County** in 2070 as compared with 2010 aquifer levels.
- c) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **14 foot in Mason County** in 2070 as compared with 2010 aquifer levels.
- d) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **29 feet in McCulloch County** in 2070 as compared with 2010 aquifer levels.
- e) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **46 feet in Menard County** in 2070 as compared with 2010 aquifer levels.
- f) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **5 feet in San Saba County** in 2070 as compared with 2010 aquifer levels.

Hickory Aquifer:

- g) Total net drawdown of the Hickory Aquifer not to exceed **53 feet in Concho County** in 2070 as compared with 2010 aquifer levels.
- h) Total net drawdown of the Hickory Aquifer not to exceed **9 feet in Gillespie County** in 2070 as compared with 2010 aquifer levels.
- i) Total net drawdown of the Hickory Aquifer not to exceed **18 feet in Kimble County** in 2070 as compared with 2010 aquifer levels.
- j) Total net drawdown of the Hickory Aquifer not to exceed **17 feet in Mason County** in 2070 as compared with 2010 aquifer levels.

Minor Aquifers of the Llano Uplift Area *(continued)*

- k) Total net drawdown of the Hickory Aquifer not to exceed **29 feet in McCulloch County** in 2070 as compared with 2010 aquifer levels.
- l) Total net drawdown of the Hickory Aquifer not to exceed **46 feet in Menard County** in 2070 as compared with 2010 aquifer levels.
- m) Total net drawdown of the Hickory Aquifer not to exceed **6 feet in San Saba County** in 2070 as compared with 2010 aquifer levels.
**(Reference items a) through m): Scenario 3, GMA 7 Technical Memorandum 16-02)*
- n) The Llano Uplift Region (Ellenburger-San Saba, Hickory, Marble Falls) Aquifers are not relevant for joint planning purposes in all other areas of GMA 7.

Rustler Aquifer *(Resolution #08-19-2021-6)*

- a) Total net drawdown of the Rustler Aquifer not to exceed **94 feet in Pecos County** in 2070 as compared with 2010 aquifer levels.
**(Reference: Scenario 4, GMA 7 Technical Memorandum 15-05)*
- b) The Rustler Aquifer not relevant for joint planning purposes in all other areas of GMA 7.

In addition to the non-relevant statements provided above in the individual resolutions, Groundwater Management Area 7 also provided additional non-relevant documentation dated August 27, 2021 and January 20, 2022 as part of their submittal to TWDB. The following aquifers or parts of aquifers are non-relevant for the purposes of joint planning:

- The entirety of the Blaine, Cross Timbers, Igneous, Lipan, Marble Falls, and Seymour aquifers.
- The Capitan Reef Complex Aquifer outside of the boundaries of the Middle Pecos Groundwater Conservation District.
- The Edwards-Trinity (Plateau) Aquifer in Concho, Mason, McCulloch, Nolan, and Tom Green counties.
- The Ellenburger-San Saba Aquifer in Coleman, Concho, and Mason counties.
- The Hickory Aquifer in Coleman and Llano counties.
- The Dockum Aquifer outside of Reagan and Pecos counties.
- The Ogallala Aquifer outside of Glasscock County.

CLARIFICATIONS:

In response to a request for clarifications from the TWDB in 2021, the Groundwater Management Area 7 Chair, Ms. Meredith Allen, and Groundwater Management Area 7 consultant, Dr. William R. Hutchison, provided the following clarifications regarding the definition of the desired future conditions. These clarifications were necessary for verifying that the desired future conditions of the aquifers were attainable and for confirming approval of the TWDB methodology to calculate modeled available groundwater volumes in Groundwater Management Area 7:

Capitan Reef Complex Aquifer

- The calculated modeled available groundwater values are based on the official TWDB aquifer boundary.
- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions are acceptable).
- Drawdown calculations used to define the desired future conditions value take into consideration the occurrence of “dry” cells, where water levels are below the base of the aquifer.

Dockum Aquifer

- The calculated modeled available groundwater values are based on the spatial extent of the Dockum Formation, as represented in the groundwater availability model for the High Plains Aquifer System, rather than the official TWDB aquifer boundary.
- Modeled available groundwater analysis excludes model pass-through cells.
- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions are acceptable).

Ogallala Aquifer

- The calculated modeled available groundwater values are based on the official TWDB aquifer boundary and use the same model assumptions used in Groundwater Management Area 7 Technical Memorandum 16-01 (Hutchison, 2016c).
- Drawdown calculations used to define the desired future conditions do not take into consideration the occurrence of “dry” cells, where water levels are below the base of the aquifer.

- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions are acceptable).

Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers

- The calculated modeled available groundwater values are based on the official TWDB aquifer boundaries.
- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions value are acceptable).
- Drawdown calculations used to define the desired future conditions include drawdowns for cells with water levels below the base elevation of the cell (“dry” cells).

Kinney County

- The modeled available groundwater values, model assumptions, and simulated springflow are from GAM Run 10-043 MAG Version 2 (Shi, 2012).

Val Verde County

- There is no associated drawdown as a desired future condition. The desired future condition is based solely on simulated spring flow conditions at San Felipe Spring of 73 to 75 million gallons per day. Pumping scenarios—50,000 acre-feet per year—in three well field locations and monthly hydrologic conditions for the historic period 1969 to 2012 meet the desired future conditions set by Groundwater Management Area 7 (EcoKai and Hutchison, 2014; Hutchison 2021).

Minor Aquifers of the Llano Uplift Area

- The calculated modeled available groundwater values are based on the full spatial extent of the Ellenburger-San Saba and Hickory formations in the groundwater availability model for the aquifers of the Llano Uplift Area rather than the official TWDB aquifer boundaries and use the same model assumptions used in Groundwater Management Area 7 Technical Memorandum 16-02 (Hutchison 2016b).
- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions value are acceptable).

- The drawdown calculations used to define desired future conditions did not include “dry” cells, where water levels are below the base of the aquifer.

Rustler Aquifer

- The model used to define desired future conditions and calculate modeled available groundwater assumes that the initial model heads represent the heads at the end of 2008 (the baseline for calculating desired future conditions drawdown values).
- Calculated modeled available groundwater values are based on the full spatial extent of the Rustler Formation, as represented in the groundwater availability model for the Rustler Aquifer, rather than the official TWDB aquifer boundary.
- The predictive model used to define desired future conditions and calculate modeled available groundwater uses the same model assumptions used in Groundwater Management Area 7 Technical Memorandum 15-05 (Hutchison, 2016d).
- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions value are acceptable).

METHODS:

As defined in Chapter 36 of the Texas Water Code (TWC, 2011), “modeled available groundwater” is the estimated average amount of water that may be produced annually to achieve a desired future condition. Groundwater conservation districts are required to consider modeled available groundwater, along with several other factors, when issuing permits to manage groundwater production to achieve the desired future condition(s). The other factors districts must consider include annual precipitation and production patterns, the estimated amount of pumping exempt from permitting, existing permits, and a reasonable estimate of actual groundwater production under existing permits.

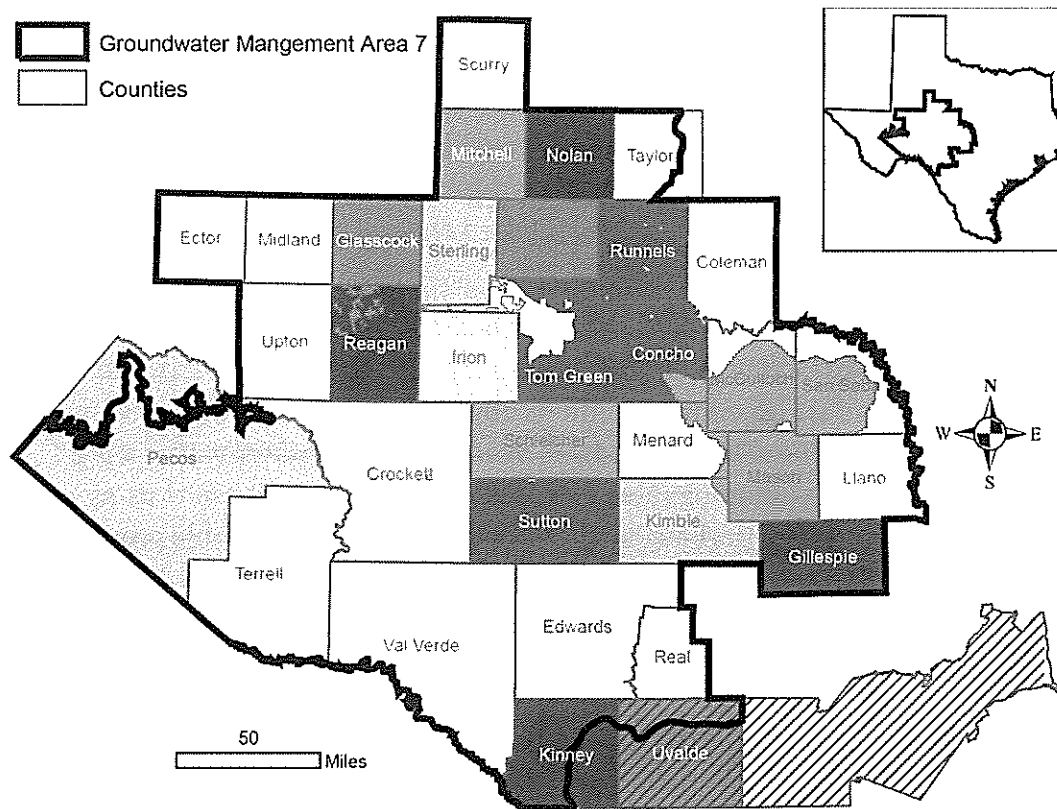
For relevant aquifers with desired future conditions based on water-level drawdown, water levels simulated at the end of the predictive simulations were compared to the water levels in the baseline year. These baseline years are 2005 in the groundwater availability model for the Capitan Reef Complex Aquifer and the alternative model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers, 2012 in the groundwater availability model for the High Plains Aquifer System, 2010 in the groundwater availability model for the minor aquifers of the Llano Uplift Area, and 2008 in the groundwater availability model for the Rustler Aquifer. The predictive model runs used average pumping rates from the historical period for the respective model except in the aquifer or area of interest. In those areas, pumping rates are varied until they produce drawdowns consistent with the adopted desired future conditions. In most cases, these model runs were supplied by Groundwater Management Area 7 for review by TWDB staff before they were used to calculate the modeled available groundwater. Pumping rates or modeled available groundwater are reported in 10-year intervals.

Water-level drawdown averages were calculated for the relevant portions of each aquifer. Drawdown for model cells that became dry during the simulation—when the water level dropped below the base of the cell—were excluded from the averaging. In Groundwater Management Area 7, dry cells only occur during the predictive period in the Ogallala Aquifer of Glasscock County. Consequently, estimates of modeled available groundwater decrease over time as continued simulated pumping predicts the development of increasing numbers of dry model cells in areas of the Ogallala Aquifer in Glasscock County. The calculated water-level drawdown averages for all aquifers were compared with the desired future conditions to verify that the pumping scenario achieved the desired future conditions.

In Kinney and Val Verde counties, the desired future conditions are based on discharge from selected springs. In these cases, spring discharge was estimated based on simulated average spring discharge over a historical period, maintaining all historical hydrologic conditions—such as recharge and river stage—except pumping. In other words, we

assume that past average hydrologic conditions—the range of fluctuation—will continue in the future. In the cases of Kinney and Val Verde counties, simulated spring discharge was based on hydrologic variations that took place over the periods 1950 through 2005 and 1968 through 2013, respectively. The desired future condition for the Edwards-Trinity (Plateau) Aquifer in Kinney County is similar to the one adopted in 2010 and the associated modeled available groundwater is based on a specific model run—GAM Run 10-043 (Shi, 2012).

Modeled available groundwater values for the Ellenburger-San Saba and Hickory aquifers were determined by extracting pumping rates by decade from the model results using ZONBUDUSG Version 1.01 (Panday and others, 2013). For the remaining relevant aquifers in Groundwater Management Area 7 modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Decadal modeled available groundwater for the relevant aquifers is reported by groundwater conservation district and county (Figure 1; Tables 1, 3, 5, 7, 9, 11, 13), and by county, regional water planning area, and river basin (Figures 2 and 3; Tables 2, 4, 6, 8, 10, 12, 14).



Groundwater Conservation Districts

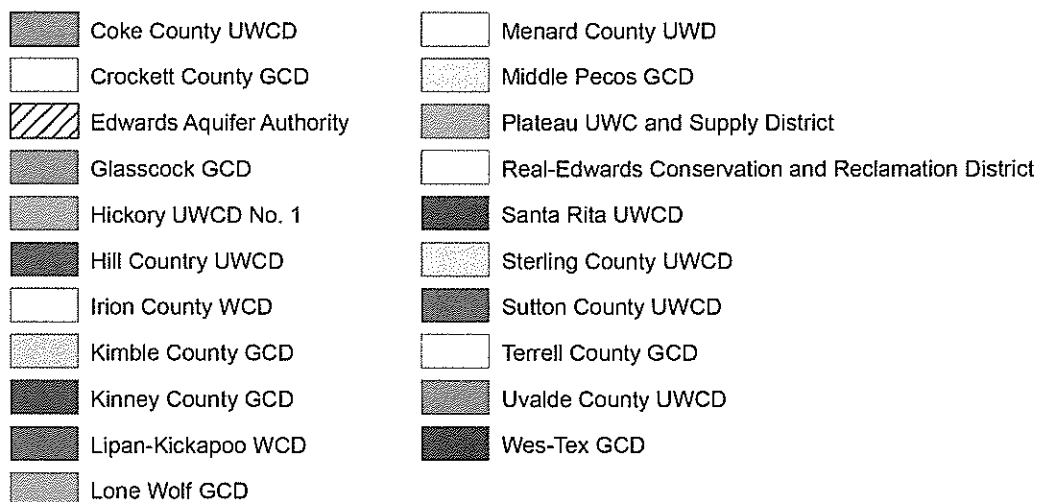


FIGURE 1. MAP SHOWING THE GROUNDWATER CONSERVATION DISTRICTS (GCD) IN GROUNDWATER MANAGEMENT AREA 7. NOTE: THE BOUNDARIES OF THE EDWARDS AQUIFER AUTHORITY OVERLAP WITH THE UVALDE COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (UWCD).

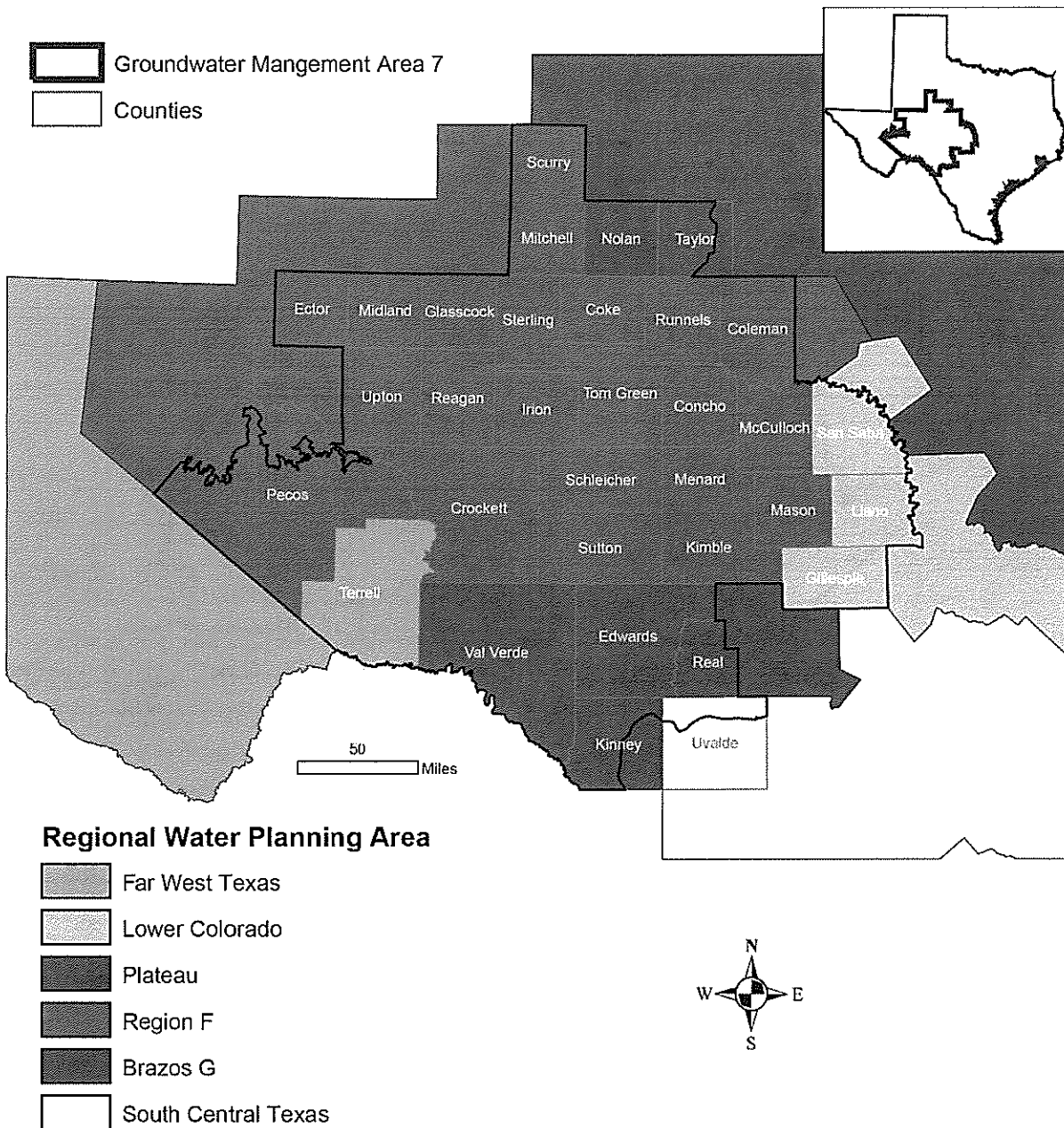


FIGURE 2. MAP SHOWING REGIONAL WATER PLANNING AREAS IN GROUNDWATER MANAGEMENT AREA 7.

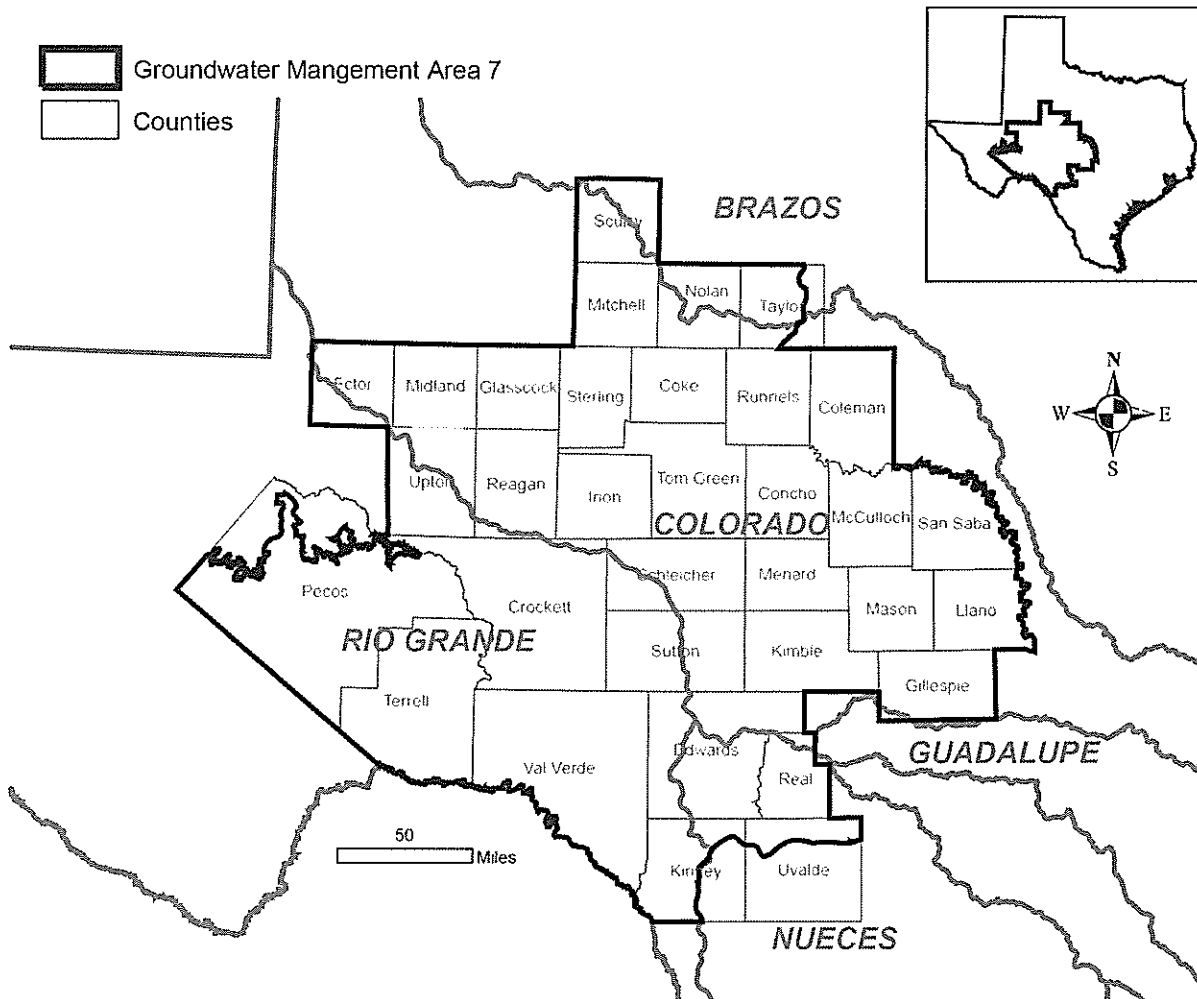


FIGURE 3. MAP SHOWING RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 7. THESE INCLUDE PARTS OF THE BRAZOS, COLORADO, GUADALUPE, NUECES, AND RIO GRANDE RIVER BASINS.

PARAMETERS AND ASSUMPTIONS:

Capitan Reef Complex Aquifer

- Version 1.01 of the groundwater availability model of the eastern arm of the Capitan Reef Complex Aquifer was used. See Jones (2016) for assumptions and limitations of the groundwater availability model. See Hutchison (2016a) for details on the assumptions used for predictive simulations.
- The model has five layers: Layer 1, the Edwards-Trinity (Plateau) and Pecos Valley aquifers; Layer 2, the Dockum Aquifer and the Dewey Lake Formation; Layer 3, the Rustler Aquifer; Layer 4, a confining unit made up of the Salado and Castile formations, and the overlying portion of the Artesia Group; and Layer 5, the Capitan Reef Complex Aquifer, part of the Artesia Group, and the Delaware Mountain Group. Layers 1 through 4 are intended to act solely as boundary conditions facilitating groundwater inflow and outflow relative to the Capitan Reef Complex Aquifer (Layer 5).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).
- The model was run for the interval 2006 through 2070 for a 64-year predictive simulation. Drawdowns were calculated by subtracting 2006 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7.
- During predictive simulations, there were no cells where water levels were below the base elevation of the cell ("dry" cells). Therefore, all drawdowns were included in the averaging.
- Drawdown averages and modeled available groundwater volumes are based on the official TWDB aquifer boundary within Groundwater Management Area 7.

Dockum and Ogallala Aquifers

- Version 1.01 of the groundwater availability model for the High Plains Aquifer System by Deeds and Jigmond (2015) was used to construct the predictive model simulation for this analysis. See Hutchison (2016c) for details of the initial assumptions.
- The model has four layers which represent the Ogallala and Pecos Valley Alluvium aquifers (Layer 1), the Edwards-Trinity (High Plains) and Edwards-Trinity (Plateau) aquifers (Layer 2), the Upper Dockum Aquifer (Layer 3), and the Lower Dockum Aquifer (Layer 4). Pass-through cells exist in layers 2 and 3 to hydraulically connect the Ogallala Aquifer to the Lower Dockum where the Edwards-Trinity (High Plains)

and Upper Dockum aquifers are absent. These pass-through cells were excluded from the calculations of drawdowns and modeled available groundwater.

- The model was run with MODFLOW-NWT (Niswonger and others, 2011). The model uses the Newton formulation and the upstream weighting package, which automatically reduces pumping as heads drop in a particular cell, as defined by the user. This feature may simulate the declining production of a well as saturated thickness decreases. Deeds and Jigmond (2015) modified the MODFLOW-NWT code to use a saturated thickness of 30 feet as the threshold—instead of percent of the saturated thickness—when pumping reductions occur during a simulation. Therefore, the groundwater management area should be aware that the modeled available groundwater values will be less than pumping input values if the modeled saturated thickness drops below that threshold.
- The model was run for the interval 2013 through 2070 for a 58-year predictive simulation. Drawdowns were calculated by subtracting initial water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7.
- During predictive simulations, there were no cells in the Dockum Aquifer where water levels were below the base elevation of the cell (“dry” cells). Therefore, all drawdowns were included in the averaging. However, in the Ogallala Aquifer, dry cells occurred during the predictive simulation. These dry cells were excluded from the modeled available groundwater calculations.
- Drawdown averages and modeled available groundwater volumes are based on the model boundary within Groundwater Management Area 7 for the Dockum Aquifer and the official TWDB aquifer boundary for the Ogallala Aquifer.

Pecos Valley, Edwards-Trinity (Plateau) and Trinity Aquifers

- The single-layer alternative groundwater flow model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers was used for this analysis. This model is an update to the previously developed groundwater availability model documented in Anaya and Jones (2009). See Hutchison and others (2011a) and Anaya and Jones (2009) for assumptions and limitations of the model. See Hutchison (2016e; 2018) for details on the assumptions used for predictive simulations.
- The groundwater model has one layer representing the Pecos Valley Aquifer and the Edwards-Trinity (Plateau) Aquifer. In the relatively narrow area where both aquifers are present, the model is a lumped representation of both aquifers.
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

- The model was run for the interval 2006 through 2070 for a 65-year predictive simulation. Drawdowns were calculated by subtracting 2010 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7.
- Because simulated water levels for the baseline year (2010) are not included in the original calibrated historical model, these water levels had to be verified against measured water levels to confirm that the predictive model satisfactorily matched real-world conditions. Comparison of 2010 simulated and measured water levels indicated a root mean squared error of 100 feet or 4 percent of the range in water-level elevations, which is within acceptable limits. Based on these results, we consider the predictive model an appropriate tool for evaluating the attainability of desired future conditions and for calculating modeled available groundwater.
- Drawdowns for cells with water levels below the base elevation of the cell ("dry" cells) were included in the averaging.
- Drawdown averages and modeled available groundwater volumes are based on the official TWDB aquifer boundaries within Groundwater Management Area 7.

Edwards-Trinity (Plateau) Aquifer of Kinney County

- All parameters and assumptions for the Edwards-Trinity (Plateau) Aquifer of Kinney County in Groundwater Management Area 7 are described in GAM Run 10-043 MAG Version 2 (Shi, 2012). This report assumes a planning period from 2010 to 2070.
- The Kinney County Groundwater Conservation District model developed by Hutchison and others (2011b) was used for this analysis. The model was calibrated to water level and spring flux collected from 1950 to 2005.
- The model has four layers representing the following hydrogeologic units (from top to bottom): Carrizo-Wilcox Aquifer (Layer 1), Upper Cretaceous Unit (Layer 2), Edwards (Balcones Fault Zone) Aquifer/Edwards portion of the Edwards-Trinity (Plateau) Aquifer (Layer 3), and Trinity portion of the Edwards-Trinity (Plateau) Aquifer (Layer 4).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).
- The model was run for 56 annual stress periods under the conditions set in Scenario 3 in Task 10-027 (Hutchison, 2011).
- Modeled available groundwater volumes are based on the official TWDB aquifer boundary within Groundwater Management Area 7 in Kinney County.

Edwards-Trinity (Plateau) Aquifer of Val Verde County

- The single-layer numerical groundwater flow model for the Edwards-Trinity (Plateau) Aquifer of Val Verde County was used for this analysis. This model is based on the previously developed alternative groundwater model of the Kinney County area documented in Hutchison and others (2011b). See EcoKai and Hutchison (2014) for assumptions and limitations of the model. See Hutchison (2016e; 2021) for details on the assumptions used for predictive simulations, including recharge and pumping assumptions.
- The groundwater model has one layer representing the Edwards-Trinity (Plateau) Aquifer of Val Verde County.
- The model was run with MODFLOW-2005 (Harbaugh, 2005).
- The model was run for a 45-year predictive simulation representing hydrologic conditions of the interval 1968 through 2013. Simulated spring discharge from San Felipe Springs was averaged over duration of the simulation. The resultant pumping rate that met the desired future conditions was applied to the predictive period—2010 through 2070—based on the assumption that average conditions over the predictive period are the same as those over the historic period represented by the model run.
- Modeled available groundwater volumes are based on the official TWDB aquifer boundary within Groundwater Management Area 7 in Val Verde County.

Minor aquifers of the Llano Uplift Area

- We used version 1.01 of the groundwater availability model for the minor aquifers in the Llano Uplift Area. See Shi and others (2016) for assumptions and limitations of the model. See Hutchison (2016b) for details of the initial assumptions.
- The model contains eight layers: Trinity Aquifer, Edwards-Trinity (Plateau) Aquifer, and younger alluvium deposits (Layer 1), confining units (Layer 2), Marble Falls Aquifer and equivalent units (Layer 3), confining units (Layer 4), Ellenburger-San Saba Aquifer and equivalent units (Layer 5), confining units (Layer 6), Hickory Aquifer and equivalent units (Layer 7), and Precambrian units (Layer 8).
- The model was run with MODFLOW-USG beta (development) version (Panday and others, 2013). Perennial rivers and reservoirs were simulated using the MODFLOW-USG river package. Springs were simulated using the MODFLOW-USG drain package.
- The model was run for the interval 2011 through 2070 for a 60-year predictive simulation. Drawdowns were calculated by subtracting initial water levels from 2070 simulated water levels, which were then averaged over the portion of the

aquifer in Groundwater Management Area 7. During predictive simulations, there were no cells where water levels were below the base elevation of the cell ("dry" cells). Therefore, all drawdowns were included in the averaging.

- Drawdown averages and modeled available groundwater volumes are based on the model boundaries within Groundwater Management Area 7.

Rustler Aquifer

- Version 1.01 of the groundwater availability model for the Rustler Aquifer by Ewing and others (2012) was used to construct the predictive model simulation for this analysis. See Hutchison (2016d) for details of the initial assumptions, including recharge conditions.
- The model has two layers, the top one representing the Rustler Aquifer, and the other representing the Dewey Lake Formation and the Dockum Aquifer.
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).
- The model was run for the interval 2009 through 2070 for a 61-year predictive simulation. Drawdowns were calculated by subtracting 2009 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7.
- The predictive model used to define desired future conditions uses 2008 recharge conditions throughout the predictive period.
- The predictive model used to define desired future conditions has general-head boundary heads that decline at a rate of 1.5 feet per year.
- During predictive simulations, there were no cells where water levels were below the base elevation of the cell ("dry" cells). Therefore, all drawdowns were included in the averaging.
- Drawdown averages and modeled available groundwater volumes are based on the model boundaries within Groundwater Management Area 7.

RESULTS:

The modeled available groundwater estimates for each decade from 2020 through 2070 are:

- 26,164 acre-feet per year in the Capitan Reef Complex Aquifer,
- 2,324 acre-feet per year in the Dockum Aquifer,
- 6,570 to 7,925 acre-feet per year in the Ogallala Aquifer,

- 479,063 acre-feet per year in the undifferentiated Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers,
- 22,616 acre-feet per year in the Ellenburger-San Saba Aquifer,
- 49,936 acre-feet per year in the Hickory Aquifer, and
- 7,040 acre-feet per year in the Rustler Aquifer.

The modeled available groundwater for the respective aquifers has been summarized by aquifer, county, and groundwater conservation district (Tables 1, 3, 5, 7, 9, 11, and 13). The modeled available groundwater is also summarized by county, regional water planning area, river basin, and aquifer for use in the regional water planning process (Tables 2, 4, 6, 8, 10, 12, and 14). The modeled available groundwater for the Ogallala Aquifer that achieves the desired future conditions adopted by districts in Groundwater Management Area 7 decreases from 7,925 to 6,570 acre-feet per year between 2020 and 2070 (Tables 5 and 6). This decline is attributable to the occurrence of increasing numbers of cells where water levels were below the base elevation of the cell ("dry" cells) in parts of Glasscock County. Please note that MODFLOW-NWT automatically reduces pumping as water levels decline.

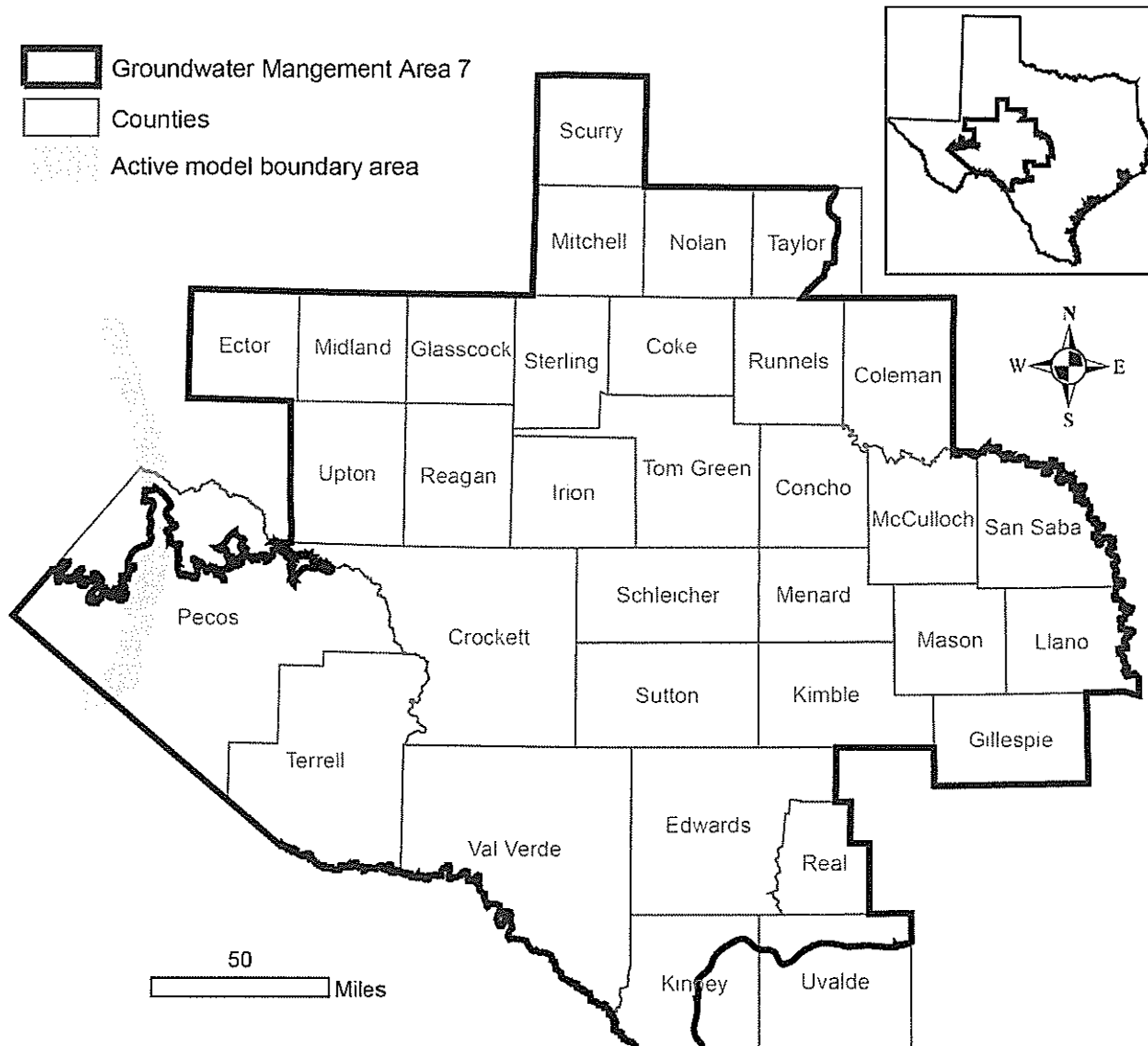


FIGURE 4. MAP SHOWING THE AREAS COVERED BY THE CAPITAN REEF COMPLEX AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE EASTERN ARM OF THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year					
		2020	2030	2040	2050	2060	2070
Middle Pecos GCD	Pecos	26,164	26,164	26,164	26,164	26,164	26,164
	Total	26,164	26,164	26,164	26,164	26,164	26,164
GMA 7		26,164	26,164	26,164	26,164	26,164	26,164

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Pecos	F	Rio Grande	26,164	26,164	26,164	26,164	26,164
		Total	26,164	26,164	26,164	26,164	26,164
GMA 7			26,164	26,164	26,164	26,164	26,164

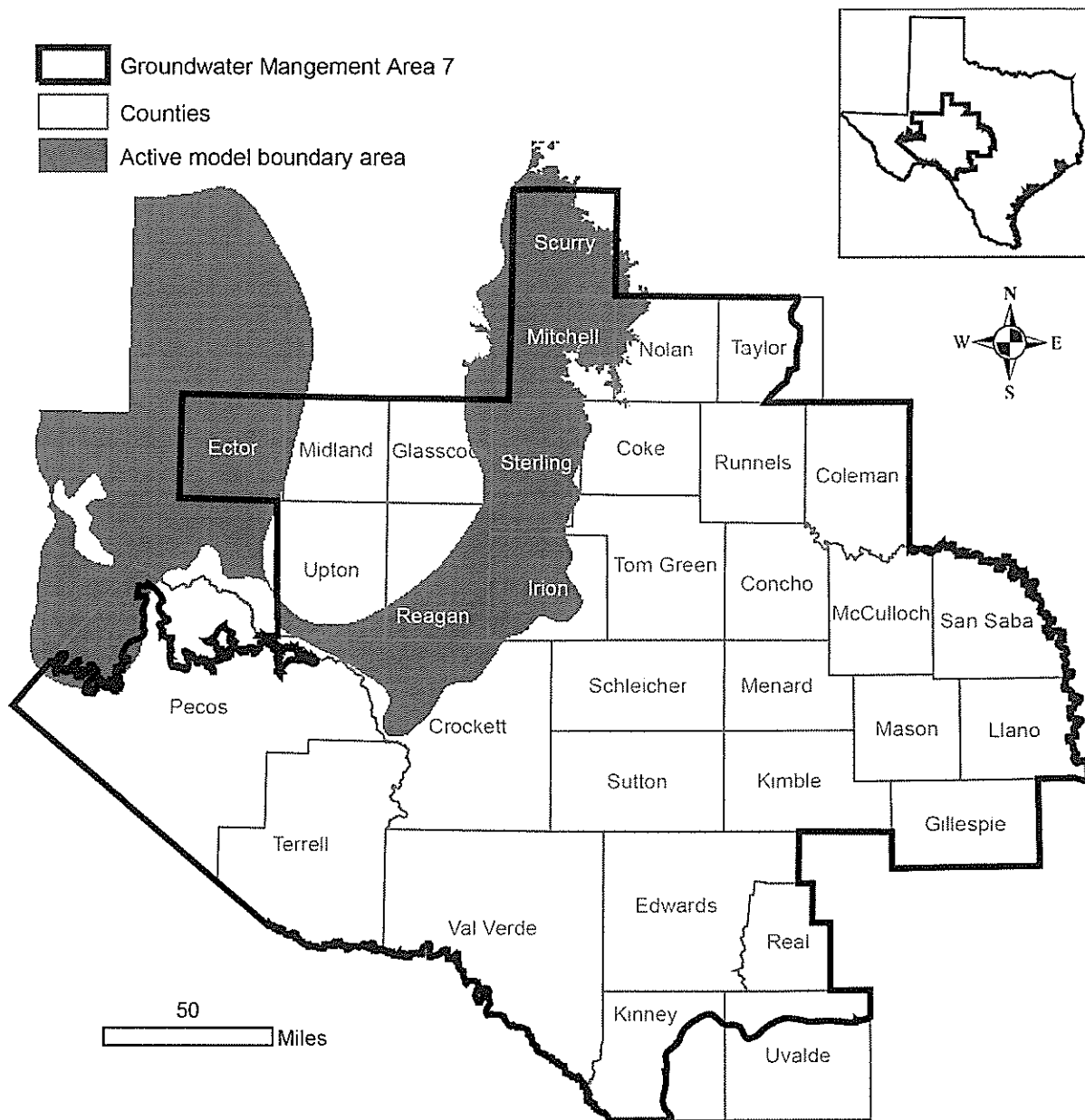


FIGURE 5. MAP SHOWING AREAS COVERED BY THE DOCKUM AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 4. MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Pecos	F	Rio Grande	2,022	2,022	2,022	2,022	2,022
		Total	2,022	2,022	2,022	2,022	2,022
Reagan	F	Colorado	302	302	302	302	302
		Rio Grande	0	0	0	0	0
		Total	302	302	302	302	302
GMA 7			2,324	2,324	2,324	2,324	2,324

Note: The modeled available groundwater for Reagan County excludes parts of Reagan County that fall outside of Santa Rita Underground Water Conservation District.

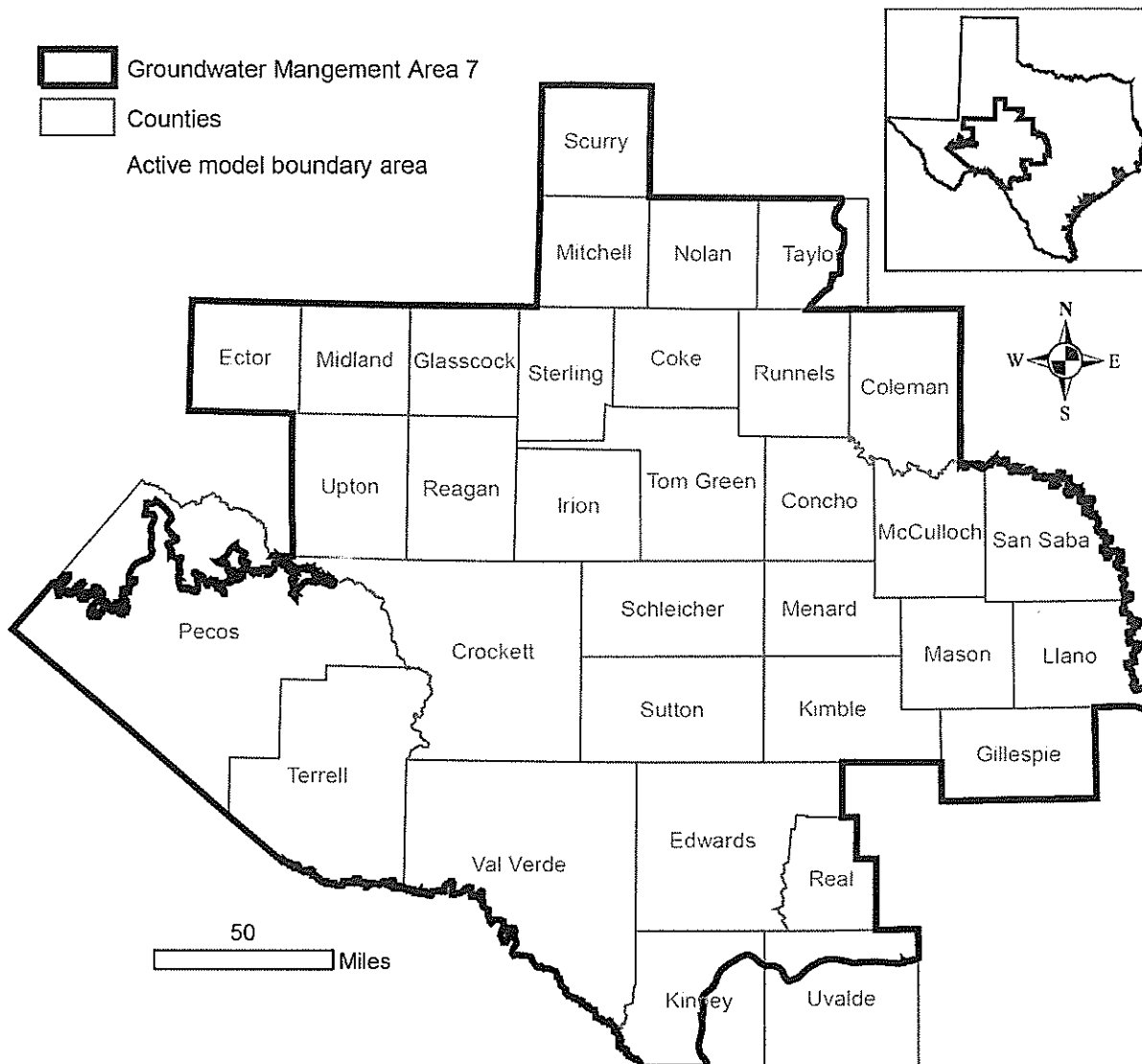


FIGURE 6. MAP SHOWING THE AREAS COVERED BY THE OGALLALA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 5. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year					
		2020	2030	2040	2050	2060	2070
Glasscock GCD	Glasscock	7,925	7,673	7,372	7,058	6,803	6,570
	Total	7,925	7,673	7,372	7,058	6,803	6,570
GMA 7		7,925	7,673	7,372	7,058	6,803	6,570

TABLE 6. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Glasscock	F	Colorado	7,673	7,372	7,058	6,803	6,570
		Total	7,673	7,372	7,058	6,803	6,570
GMA 7			7,673	7,372	7,058	6,803	6,570

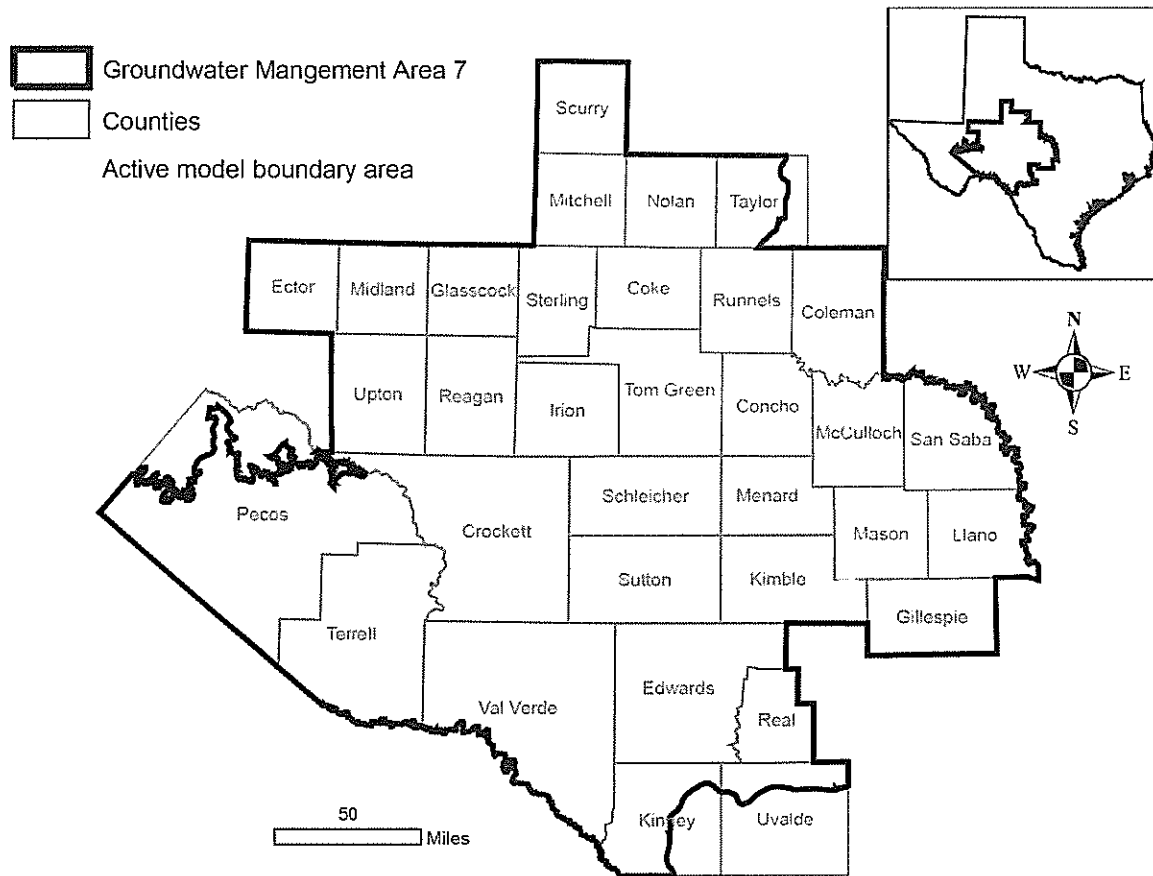


FIGURE 7. MAP SHOWING THE AREAS COVERED BY THE UNDIFFERENTIATED EDWARDS-TRINITY (PLATEAU), PECOS VALLEY, AND TRINITY AQUIFERS IN THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7.

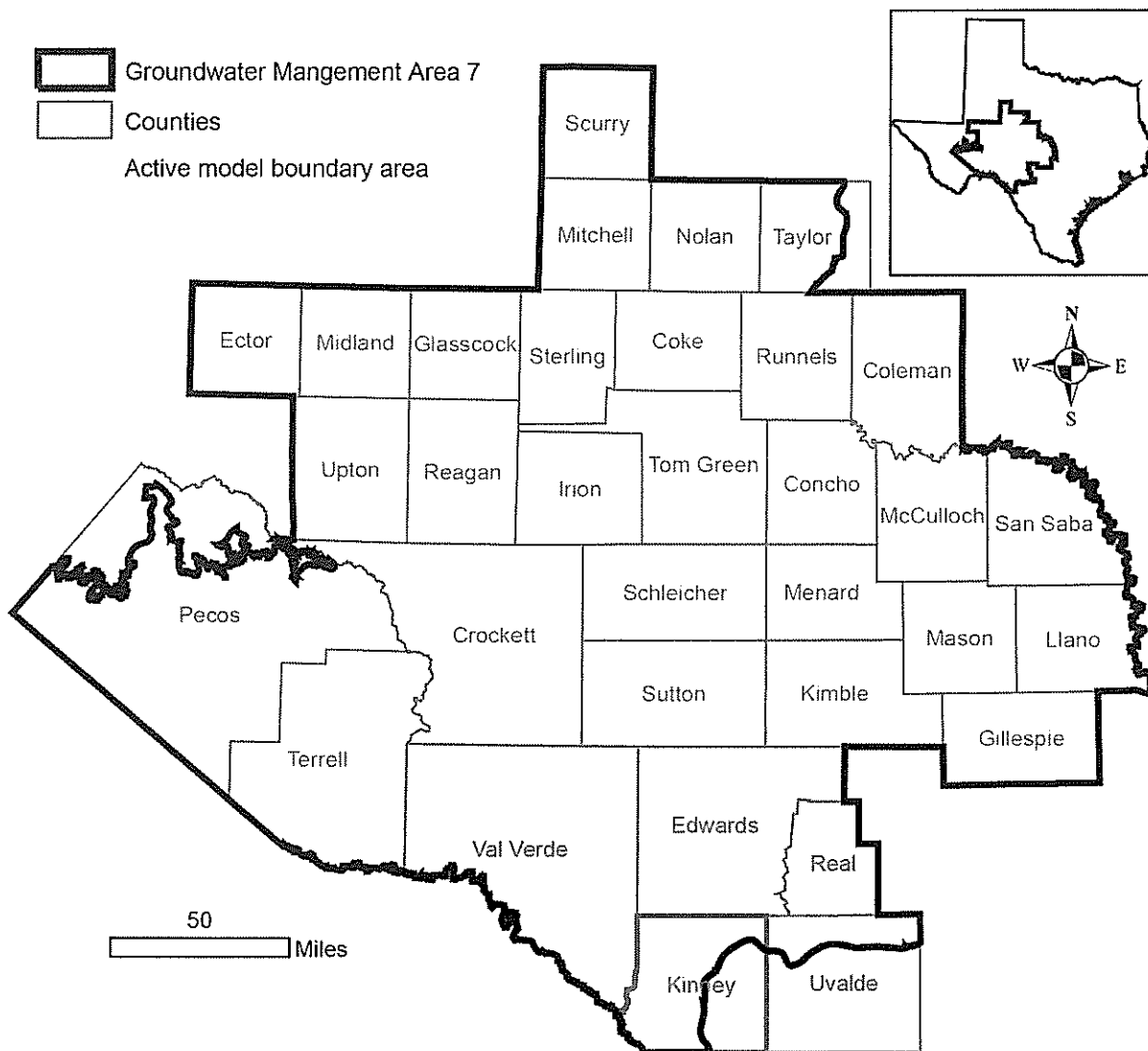


FIGURE 8. MAP SHOWING THE AREAS COVERED BY THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN THE ALTERNATIVE MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN KINNEY COUNTY [HIGHLIGHTED IN RED].

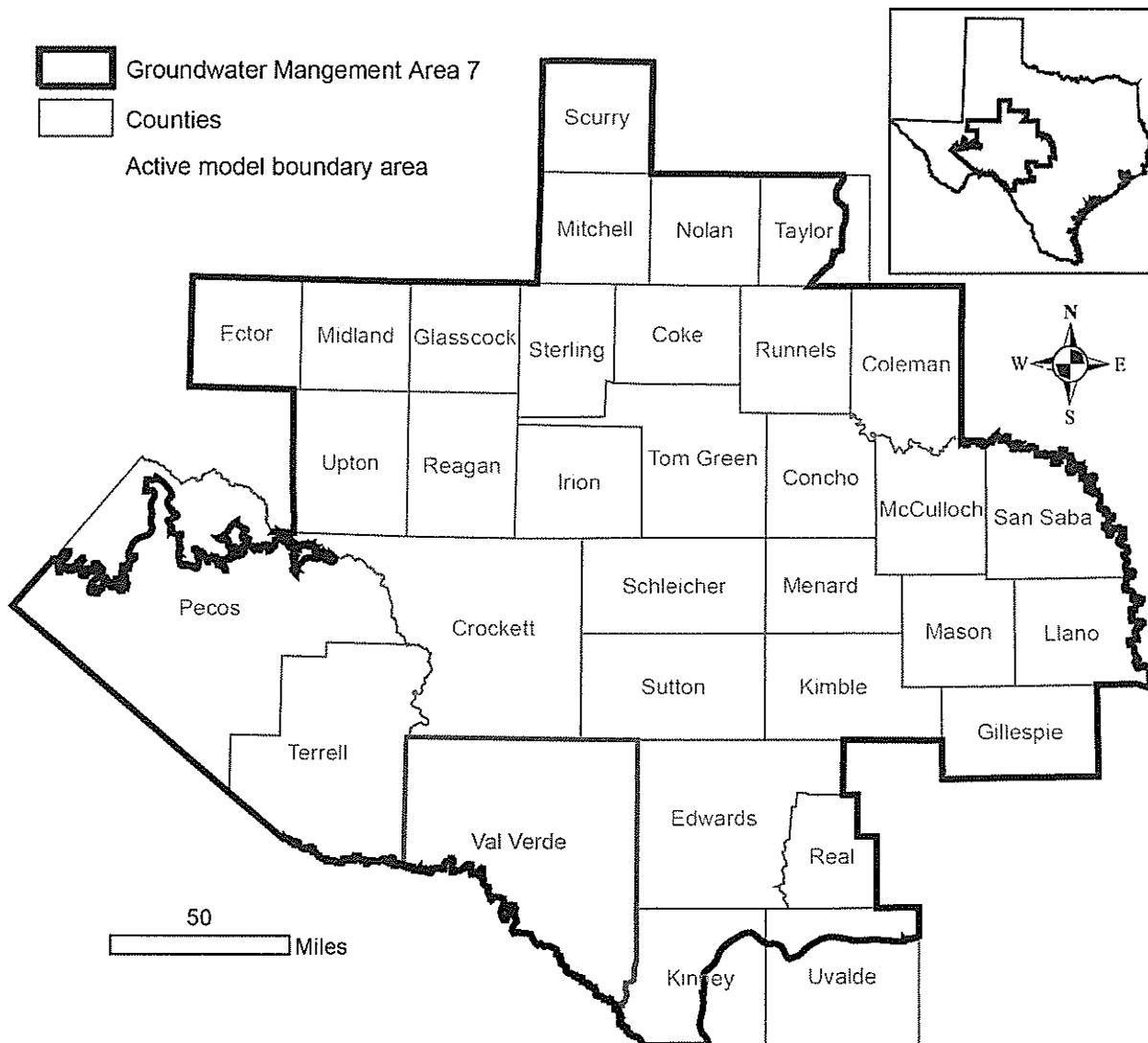


FIGURE 9. MAP SHOWING THE AREAS COVERED BY THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN THE GROUNDWATER FLOW MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN VAL VERDE COUNTY [HIGHLIGHTED IN RED].

TABLE 8. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE UNDIFFERENTIATED EDWARDS-TRINITY (PLATEAU), PECOS VALLEY, AND TRINITY AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Coke	F	Colorado	997	997	997	997	997
		Total	997	997	997	997	997
Crockett	F	Colorado	20	20	20	20	20
		Rio Grande	5,427	5,427	5,427	5,427	5,427
		Total	5,447	5,447	5,447	5,447	5,447
Ector	F	Colorado	4,925	4,925	4,925	4,925	4,925
		Rio Grande	617	617	617	617	617
		Total	5,542	5,542	5,542	5,542	5,542
Edwards	J	Colorado	2,305	2,305	2,305	2,305	2,305
		Nueces	1,631	1,631	1,631	1,631	1,631
		Rio Grande	1,740	1,740	1,740	1,740	1,740
		Total	5,676	5,676	5,676	5,676	5,676
		Colorado	4,843	4,843	4,843	4,843	4,843
Gillespie	K	Guadalupe	136	136	136	136	136
		Total	4,979	4,979	4,979	4,979	4,979
Glasscock	F	Colorado	65,186	65,186	65,186	65,186	65,186
		Total	65,186	65,186	65,186	65,186	65,186

TABLE 8. (CONTINUED).

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Irion	F	Colorado	3,289	3,289	3,289	3,289	3,289
		Total	3,289	3,289	3,289	3,289	3,289
Kimble	F	Colorado	1,386	1,386	1,386	1,386	1,386
		Total	1,386	1,386	1,386	1,386	1,386
Kinney	J	Nueces	12	12	12	12	12
		Rio Grande	70,329	70,329	70,329	70,329	70,329
		Total	70,341	70,341	70,341	70,341	70,341
Menard	F	Colorado	2,597	2,597	2,597	2,597	2,597
		Total	2,597	2,597	2,597	2,597	2,597
Midland	F	Colorado	23,233	23,233	23,233	23,233	23,233
		Total	23,233	23,233	23,233	23,233	23,233
Pecos	F	Rio Grande	117,309	117,309	117,309	117,309	117,309
		Total	117,309	117,309	117,309	117,309	117,309

TABLE 8. (CONTINUED).

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Reagan	F	Colorado	68,205	68,205	68,205	68,205	68,205
		Rio Grande	28	28	28	28	28
		Total	68,233	68,233	68,233	68,233	68,233
Real	J	Colorado	277	277	277	277	277
		Guadalupe	3	3	3	3	3
		Nueces	7,243	7,243	7,243	7,243	7,243
		Total	7,523	7,523	7,523	7,523	7,523
Schleicher	F	Colorado	6,403	6,403	6,403	6,403	6,403
		Rio Grande	1,631	1,631	1,631	1,631	1,631
		Total	8,034	8,034	8,034	8,034	8,034
Sterling	F	Colorado	2,495	2,495	2,495	2,495	2,495
		Total	2,495	2,495	2,495	2,495	2,495
Sutton	F	Colorado	388	388	388	388	388
		Rio Grande	6,022	6,022	6,022	6,022	6,022
		Total	6,410	6,410	6,410	6,410	6,410
Taylor	G	Brazos	331	331	331	331	331
		Colorado	158	158	158	158	158
		Total	489	489	489	489	489
Terrell	E	Rio Grande	1,420	1,420	1,420	1,420	1,420
		Total	1,420	1,420	1,420	1,420	1,420

TABLE 8. (CONTINUED).

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Upton	F	Colorado	21,243	21,243	21,243	21,243	21,243
		Rio Grande	1,126	1,126	1,126	1,126	1,126
		Total	22,369	22,369	22,369	22,369	22,369
Uvalde	L	Nueces	1,993	1,993	1,993	1,993	1,993
		Total	1,993	1,993	1,993	1,993	1,993
Val Verde	J	Rio Grande	50,000	50,000	50,000	50,000	50,000
		Total	50,000	50,000	50,000	50,000	50,000
GMA 7			479,063	479,063	479,063	479,063	479,063

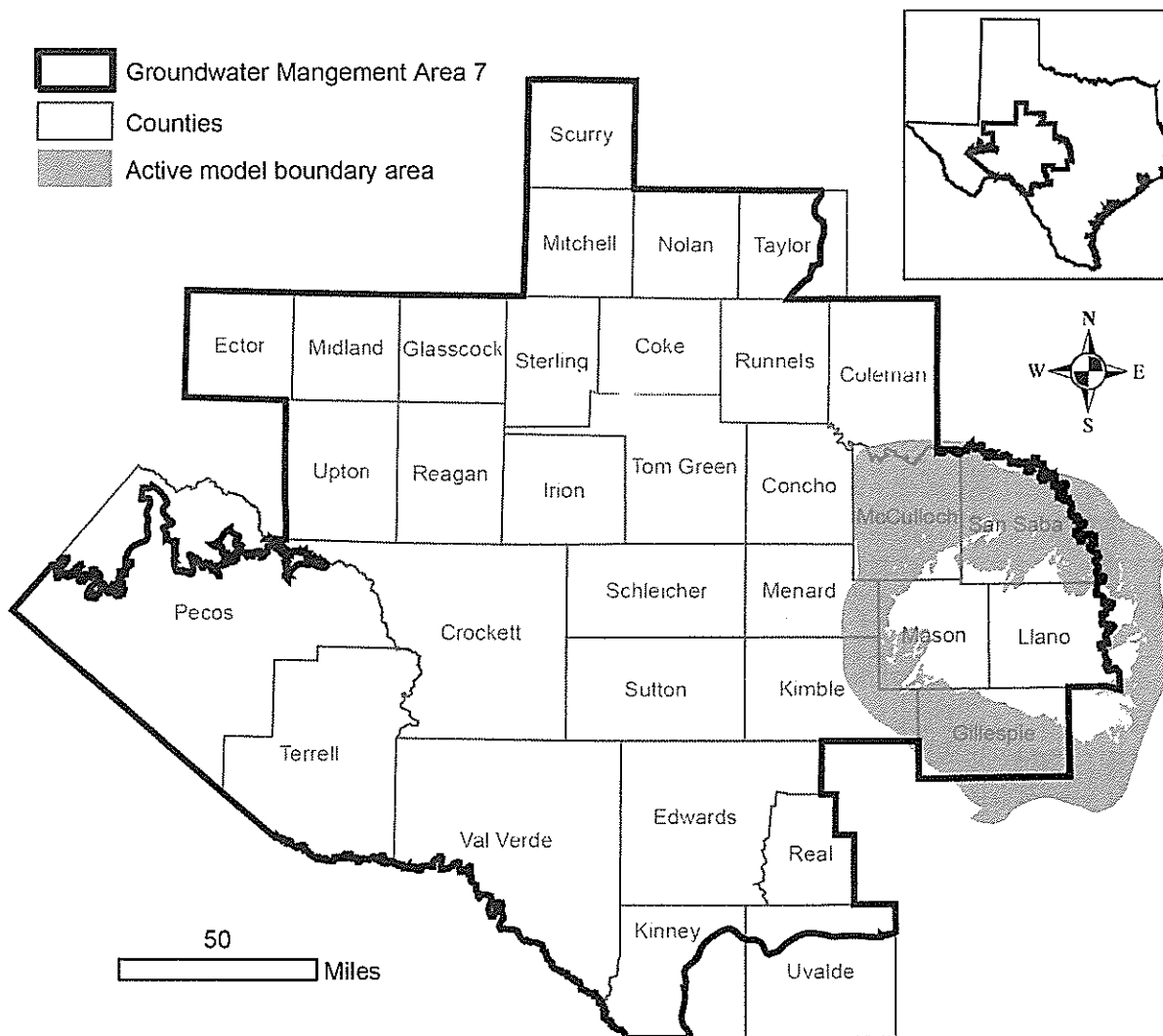


FIGURE 10. MAP SHOWING THE AREAS COVERED BY THE ELLENBURGER-SAN SABA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS OF THE LLANO UPLIFT AREA IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 9. MODELED AVAILABLE GROUNDWATER FOR THE ELLENBURGER-SAN SABA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD IS THE ABBREVIATION FOR UNDERGROUND WATER CONSERVATION DISTRICT AND UWD IS UNDERGROUND WATER DISTRICT.

District	County	Year					
		2020	2030	2030	2050	2060	2070
Hickory UWCD No. 1	Kimble	344	344	344	344	344	344
	Mason	3,237	3,237	3,237	3,237	3,237	3,237
	McCulloch	3,466	3,466	3,466	3,466	3,466	3,466
	Menard	282	282	282	282	282	282
	San Saba	5,559	5,559	5,559	5,559	5,559	5,559
	Total	12,887	12,887	12,887	12,887	12,887	12,887
Hill Country UWCD	Gillespie	6,294	6,294	6,294	6,294	6,294	6,294
	Total	6,294	6,294	6,294	6,294	6,294	6,294
Kimble County GCD	Kimble	178	178	178	178	178	178
	Total	178	178	178	178	178	178
Menard County UWD	Menard	27	27	27	27	27	27
	Total	27	27	27	27	27	27
No District	McCulloch	898	898	898	898	898	898
	San Saba	2,331	2,331	2,331	2,331	2,331	2,331
	Total	3,229	3,229	3,229	3,229	3,229	3,229
GMA 7		22,615	22,615	22,615	22,615	22,615	22,615

TABLE 10. MODELED AVAILABLE GROUNDWATER FOR THE ELLENBURGER-SAN SABA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Gillespie	K	Colorado	6,294	6,294	6,294	6,294	6,294
		Total	6,294	6,294	6,294	6,294	6,294
Kimble	F	Colorado	521	521	521	521	521
		Total	521	521	521	521	521
Mason	F	Colorado	3,237	3,237	3,237	3,237	3,237
		Total	3,237	3,237	3,237	3,237	3,237
McCulloch	F	Colorado	4,364	4,364	4,364	4,364	4,364
		Total	4,364	4,364	4,364	4,364	4,364
Menard	F	Colorado	309	309	309	309	309
		Total	309	309	309	309	309
San Saba	K	Colorado	7,890	7,890	7,890	7,890	7,890
		Total	7,890	7,890	7,890	7,890	7,890
GMA 7			22,615	22,615	22,615	22,615	22,615

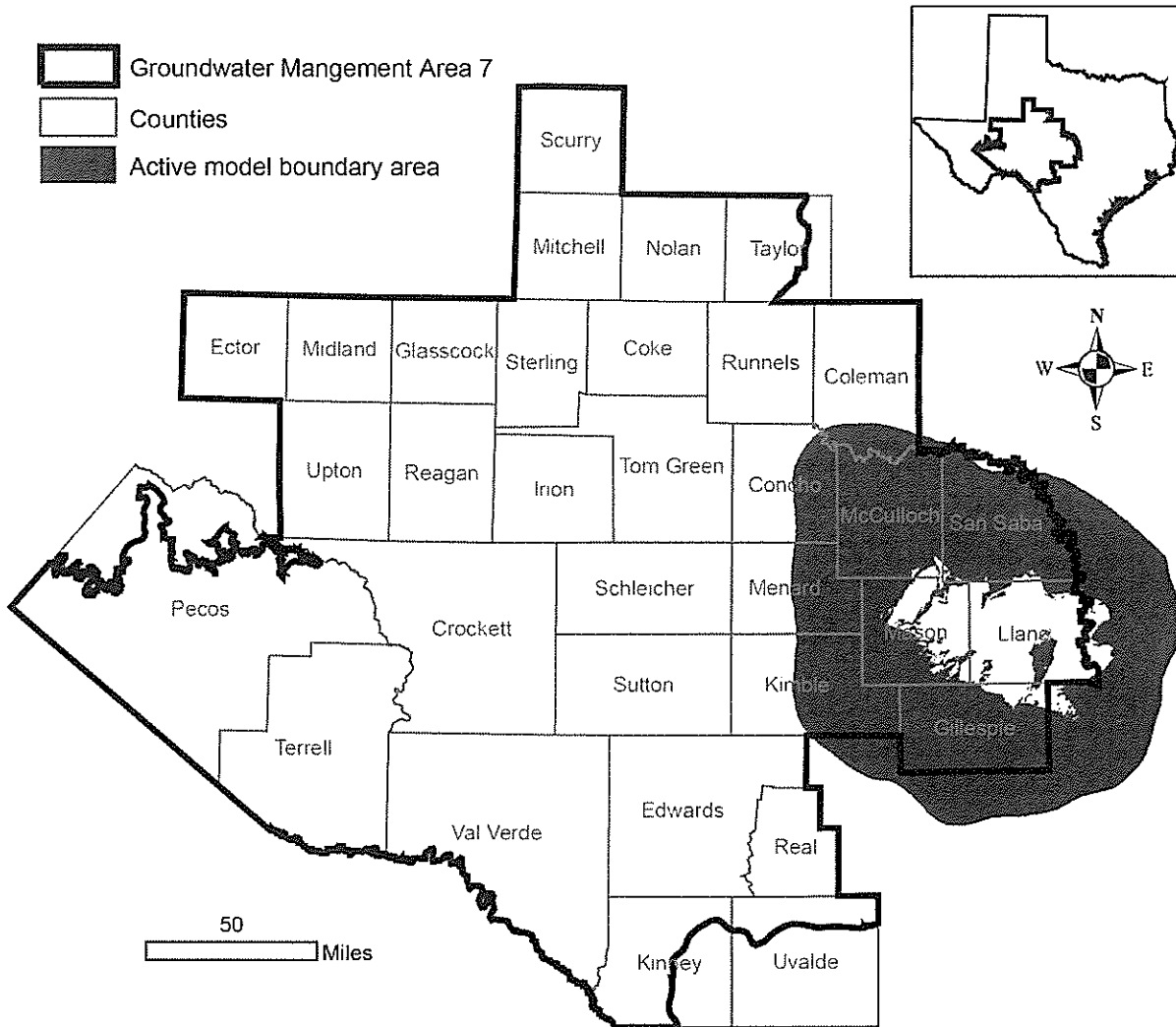


FIGURE 11. MAP SHOWING AREAS COVERED BY THE HICKORY AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS OF THE LLANO UPLIFT AREA IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 11. MODELED AVAILABLE GROUNDWATER FOR THE HICKORY AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD IS THE ABBREVIATION FOR UNDERGROUND WATER CONSERVATION DISTRICT AND UWD IS UNDERGROUND WATER DISTRICT.

District	County	Year					
		2020	2030	2040	2050	2060	2070
Hickory UWCD No. 1	Concho	13	13	13	13	13	13
	Kimble	42	42	42	42	42	42
	Mason	13,212	13,212	13,212	13,212	13,212	13,212
	McCulloch	21,950	21,950	21,950	21,950	21,950	21,950
	Menard	2,600	2,600	2,600	2,600	2,600	2,600
	San Saba	7,027	7,027	7,027	7,027	7,027	7,027
Hill Country UWCD	Total	44,843	44,843	44,843	44,843	44,843	44,843
	Gillespie	1,751	1,751	1,751	1,751	1,751	1,751
	Total	1,751	1,751	1,751	1,751	1,751	1,751
Kimble County GCD	Kimble	123	123	123	123	123	123
	Total	123	123	123	123	123	123
Lipan-Kickapoo WCD	Concho	13	13	13	13	13	13
	Total	13	13	13	13	13	13
Menard County UWD	Menard	126	126	126	126	126	126
	Total	126	126	126	126	126	126
No District	McCulloch	2,427	2,427	2,427	2,427	2,427	2,427
	San Saba	652	652	652	652	652	652
	Total	3,080	3,080	3,080	3,080	3,080	3,080
GMA 7		49,937	49,937	49,937	49,937	49,937	49,937

TABLE 12. MODELED AVAILABLE GROUNDWATER FOR THE HICKORY AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Concho	F	Colorado	27	27	27	27	27
		Total	27	27	27	27	27
Gillespie	K	Colorado	1,751	1,751	1,751	1,751	1,751
		Total	1,751	1,751	1,751	1,751	1,751
Kimble	F	Colorado	165	165	165	165	165
		Total	165	165	165	165	165
Mason	F	Colorado	13,212	13,212	13,212	13,212	13,212
		Total	13,212	13,212	13,212	13,212	13,212
McCulloch	F	Colorado	24,377	24,377	24,377	24,377	24,377
		Total	24,377	24,377	24,377	24,377	24,377
Menard	F	Colorado	2,725	2,725	2,725	2,725	2,725
		Total	2,725	2,725	2,725	2,725	2,725
San Saba	K	Colorado	7,680	7,680	7,680	7,680	7,680
		Total	7,680	7,680	7,680	7,680	7,680
GMA 7			49,937	49,937	49,937	49,937	49,937

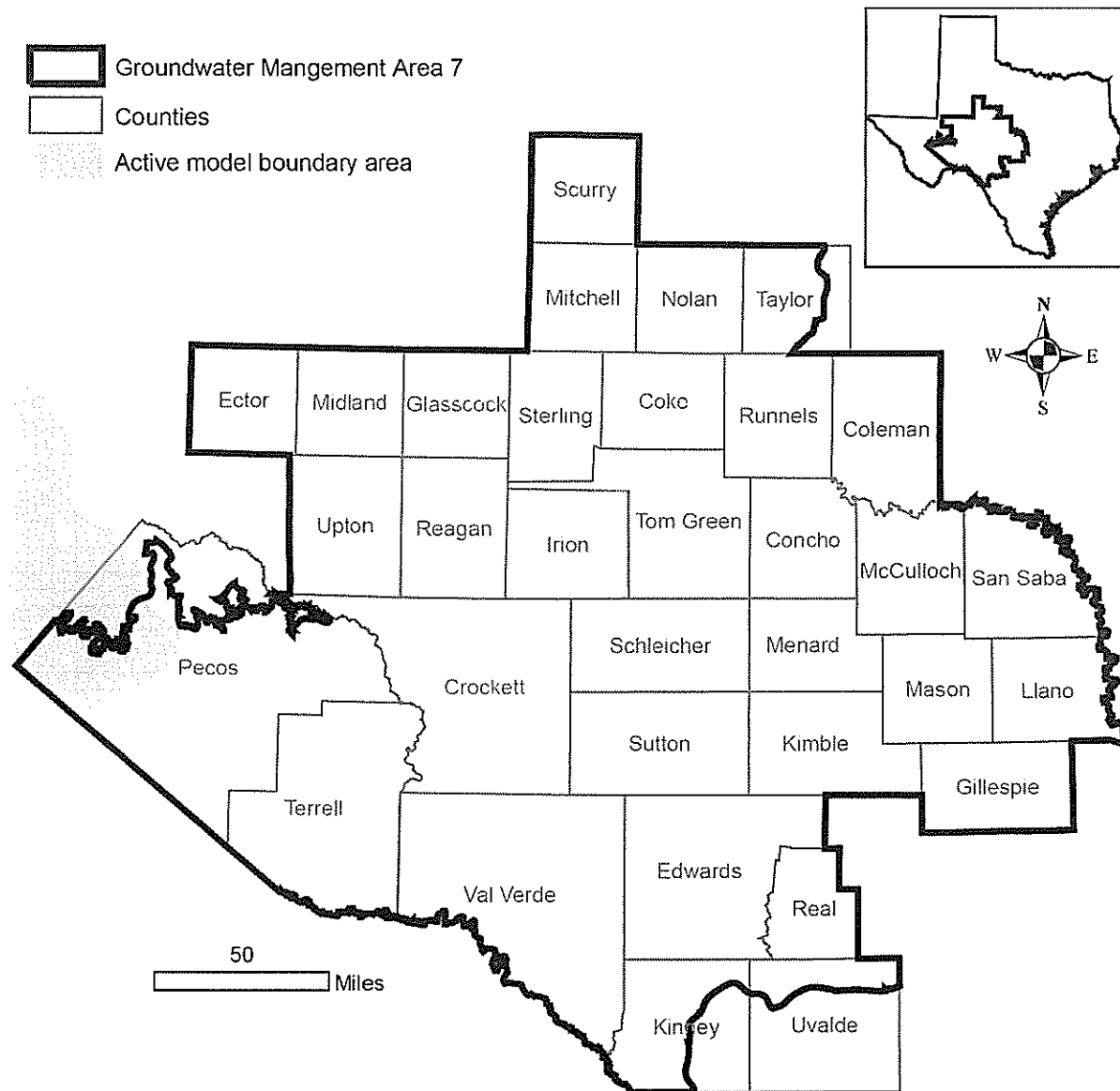


FIGURE 13. MAP SHOWING AREAS COVERED BY THE RUSTLER AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE RUSTLER AQUIFER IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 13. MODELED AVAILABLE GROUNDWATER FOR THE RUSTLER AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year					
		2020	2030	2040	2050	2060	2070
Middle Pecos GCD	Pecos	7,040	7,040	7,040	7,040	7,040	7,040
	Total	7,040	7,040	7,040	7,040	7,040	7,040

TABLE 14. MODELED AVAILABLE GROUNDWATER FOR THE RUSTLER AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Pecos	F	Rio Grande	7,040	7,040	7,040	7,040	7,040
		Rio Grande	7,040	7,040	7,040	7,040	7,040

LIMITATIONS:

The groundwater model used in completing this analysis is the best available scientific tool that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."

A key aspect of using the groundwater model to evaluate historical groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historical pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and streamflow are specific to a particular historical time period.

Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and groundwater levels in the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

Model “Dry” Cells

In some cases, the predictive model run for this analysis could result in water levels in some model cells dropping below the base elevation of the cell during the simulation. In terms of water level, the cells have gone dry. However, as noted in the model assumptions the transmissivity of the cell remains constant and will produce water. This would mean that the modeled available groundwater would include imaginary “pumping” values that are coming from cells that are actually dry.

REFERENCES:

- Anaya, R., and Jones, I. C., 2009, Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas: Texas Water Development Board Report 373, 103p.
http://www.twdb.texas.gov/groundwater/models/gam/eddt_p/ET-Plateau_Full.pdf
- Deeds, N. E. and Jigmond, M., 2015, Numerical Model Report for the High Plains Aquifer System Groundwater Availability Model, Prepared by INTERA Incorporated for Texas Water Development Board, 640p.
http://www.twdb.texas.gov/groundwater/models/gam/hpas/HPAS_GAM_Numerical_Report.pdf
- EcoKai Environmental, Inc. and Hutchison, W. R., 2014, Hydrogeological Study for Val Verde and Del Rio, Texas: Prep. For Val Verde County and City of Del Rio, 167 p.
- Ewing, J. E., Kelley, V. A., Jones, T. L., Yan, T., Singh, A., Powers, D. W., Holt, R. M., and Sharp, J. M., 2012, Final Groundwater Availability Model Report for the Rustler Aquifer, Prepared for the Texas Water Development Board, 460p.
http://www.twdb.texas.gov/groundwater/models/gam/rslr/RSLR_GAM_Report.pdf
- Harbaugh, A. W., 2005, MODFLOW-2005, The US Geological Survey Modular Groundwater-Model – the Ground-Water Flow Process. Chapter 16 of Book 6. Modeling techniques, Section A Ground Water: U.S. Geological Survey Techniques and Methods 6-A16. 253p.
- Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing sub-regional water budgets for MODFLOW ground-water flow models: U.S. Geological Survey Groundwater Software.
- Harbaugh, A. W., Banta, E. R., Hill, M. C., 2000, MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process: U.S. Geological Survey, Open-File Report 00-92, 121p.
- Hutchison, W. R., Jones, I. C., and Anaya, R., 2011a, Update of the Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas, Texas

Water Development Board, 61 p.

[http://www.twdb.texas.gov/groundwater/models/alt/eddt_p_2011/ETP PV One Layer Model.pdf](http://www.twdb.texas.gov/groundwater/models/alt/eddt_p_2011/ETP_PV_One_Layer_Model.pdf)

Hutchison, W. R., Shi, J., and Jigmond, M., 2011b, Groundwater Flow Model of the Kinney County Area, Texas Water Development Board, 217 p.

[http://www.twdb.texas.gov/groundwater/models/alt/knny/Kinney County Model Report.pdf](http://www.twdb.texas.gov/groundwater/models/alt/knny/Kinney_County_Model_Report.pdf)

Hutchison, W. R., 2011, Draft GAM Task 10-027 (revised), 8 p.

Hutchison, W. R., 2016a, GMA 7 Technical Memorandum 16-03—Final, Capitan Reef Complex Aquifer: Initial Predictive Simulations with Draft GAM, 8 p.

Hutchison, W. R., 2016b, GMA 7 Technical Memorandum 16-02—Final, Llano Uplift Aquifers: Initial Predictive Simulations with Draft GAM, 24 p.

Hutchison, W. R., 2016c, GMA 7 Technical Memorandum 16-01—Final, Dockum and Ogallala Aquifers: Initial Predictive Simulations with HPAS, 29 p.

Hutchison, W. R., 2016d, GMA 7 Technical Memorandum 15-05—Final, Rustler Aquifer: Nine Factor Documentation and Predictive Simulation with Rustler GAM, 27 p.

Hutchison, W. R., 2016e, GMA 7 Technical Memorandum 15-06—Final, Edwards-Trinity (Plateau) and Pecos Valley Aquifers: Nine Factor Documentation and Predictive Simulation, 60 p.

Hutchison, W. R., 2018, GMA 7 Technical Memorandum 18-01—Final, Edwards-Trinity (Plateau) and Pecos Valley Aquifers: Update of Average Drawdown Calculations, 10 p.

Hutchison, W. R., 2021, GMA 7 Explanatory Report—Final, Edwards-Trinity, Pecos Valley and Trinity Aquifers: Prep. For Groundwater Management Area 7, 173 p.

Jones, I. C., 2016, Groundwater Availability Model: Eastern Arm of the Capitan Reef Complex Aquifer of Texas. Texas Water Development Board, March 2016, 488p.
[http://www.twdb.texas.gov/groundwater/models/gam/crcx/CapitanModelReport Final.pdf](http://www.twdb.texas.gov/groundwater/models/gam/crcx/CapitanModelReport_Final.pdf)

National Research Council, 2007, Models in Environmental Regulatory Decision-Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p., http://www.nap.edu/catalog.php?record_id=11972.

Niswonger, R.G., Panday, S., and Ibaraki, M., 2011, MODFLOW-NWT, a Newton formulation for MODFLOW-2005: United States Geological Survey, Techniques and Methods 6-A37, 44 p.

Panday, S., Langevin, C. D., Niswonger, R. G., Ibaraki, M., and Hughes, J. D., 2013, MODFLOW-USG version 1: An unstructured grid version of MODFLOW for

simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p.

Shi, J, 2012, GAM Run 10-043 MAG (Version 2): Modeled Available Groundwater for the Edwards-Trinity (Plateau), Trinity, and Pecos Valley aquifers in Groundwater Management Area 7, Texas Water Development Board GAM Run Report 10-043, 15 p. www.twdb.texas.gov/groundwater/docs/GAMruns/GR10-043_MAG_v2.pdf

Shi, J., Boghici, R., Kohlrenken, W., and Hutchison, W., 2016, Numerical model report: minor aquifers of the Llano Uplift Region of Texas (Marble Falls, Ellenburger-San Saba, and Hickory): Texas Water Development Board published report, 400 p.
[http://www.twdb.texas.gov/groundwater/models/gam/llano/Llano Uplift Numerical Model Report Final.pdf](http://www.twdb.texas.gov/groundwater/models/gam/llano/Llano_Uplift_Numerical_Model_Report_Final.pdf)

Texas Water Code, 2011, <http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf>

Appendix 4

GAM RUN 24-005: LONE WOLF GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Dwight Zedric Q. Capus, GIT and Grayson Dowlearn, P.G.

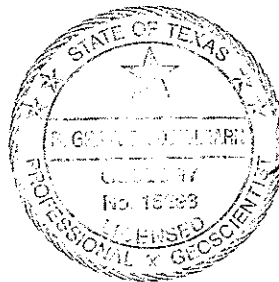
Texas Water Development Board

Groundwater Division

Groundwater Modeling Department

512-936-2404

March 1, 2024



Grayson Dowlearn
3/1/2024

This page is intentionally blank

GAM RUN 24-005: LONE WOLF GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Dwight Zedric Q. Capus, GIT and Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-936-2404
March 1, 2024

EXECUTIVE SUMMARY:

Texas Water Code § 36.1071(h), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator.

The TWDB provides data and information to the Lone Wolf Groundwater Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan dataset report, which will be provided to you separately by the TWDB Groundwater Technical Assistance Department. Please direct questions about the water data report to Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov. Part 2 is the required groundwater availability modeling information, which includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
2. the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers, for each aquifer within the district; and
3. the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The groundwater management plan for the Lone Wolf Groundwater Conservation District should be adopted by the district on or before June 20, 2024 and submitted to the executive administrator of the TWDB on or before July 20, 2024. The current management plan for the Lone Wolf Groundwater Conservation District expires on September 18, 2024.

We used one groundwater availability model for the Lone Wolf Groundwater Conservation District. Information for the Dockum Aquifer is from version 1.01 of the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015).

This report replaces the results of GAM Run 19-004 (Jones, 2019). Values may differ from the previous report as a result of routine updates to the spatial grid file used to define county, groundwater conservation district, and aquifer boundaries, which can impact the calculated water budget values. Additionally, the approach used for analyzing model results is reviewed during each update and may have been refined to better delineate groundwater flows. Table 1 summarizes the groundwater availability model data required by statute. Figure 1 shows the area of the model from which the values in Table 1 were extracted. Figure 2 provides a generalized diagram of the groundwater flow components provided in Tables 1. If the Lone Wolf Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions after reviewing the figures, please notify the TWDB Groundwater Modeling Department at your earliest convenience.

The flow components presented in this report do not represent the full groundwater budget. If additional inflow and outflow information would be helpful for planning purposes, the district may submit a request in writing to the TWDB Groundwater Modeling Department for the full groundwater budget.

METHODS:

In accordance with the provisions of the Texas Water Code § 36.1071(h), the groundwater availability model mentioned above was used to estimate information for the Lone Wolf Groundwater Conservation District management plan. The water budget for the Dockum Aquifer was extracted over the historical calibration period (1980 through 2012) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface-water outflow, inflow to the district, outflow from the district, and the flow between aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Groundwater availability model for the High Plains Aquifer System

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond 2015) to analyze the Dockum Aquifer. See Deeds and Jigmond (2015) for assumptions and limitations of the model.
- The groundwater availability model for the High Plains Aquifer System contains 4 layers:
 - Layer 1 represents the Ogallala and Pecos Valley aquifers
 - Layer 2 represents the Rita Blanca Aquifer and Edwards-Trinity (High Plains & Plateau) aquifers
 - Layer 3 represents the upper Dockum Aquifer
 - Layer 4 represents the lower Dockum Aquifer
- Perennial rivers and reservoirs were simulated using the MODFLOW-NWT river package. Springs were simulated using the MODFLOW-NWT drain package. For this management plan, groundwater discharge to surface water includes groundwater leakage to the river and drain boundaries.
- Budget values were estimated only for the Dockum Aquifer by combining budget values for layers 3 and 4 within Lone Wolf Groundwater Conservation District.
- Water budget terms were averaged for the period 1980 through 2012 (stress periods 52 through 84).
- Overlying units within district represent Ogallala equivalent and Lingos Formation units.

- The model was run with MODFLOW-NWT (Niswonger and others, 2011).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the Dockum Aquifer located within the Lone Wolf Groundwater Conservation District and averaged over the historical calibration period, as shown in Tables 1.

1. Precipitation recharge—the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.
2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.
3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.
4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Table 1. Figure 1 shows the area of the model from which the values in Table 1 were extracted. Figure 2 provides a generalized diagram of the groundwater flow components provided in Table 1. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

Table 1: Summarized information for the Dockum Aquifer that is needed for the Lone Wolf Groundwater Conservation District groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.

Management plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Dockum Aquifer	18,105
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Dockum Aquifer	11,967
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	2,708
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	360
Estimated net annual volume of flow between each aquifer in the district	To Dockum Aquifer from overlying units	438

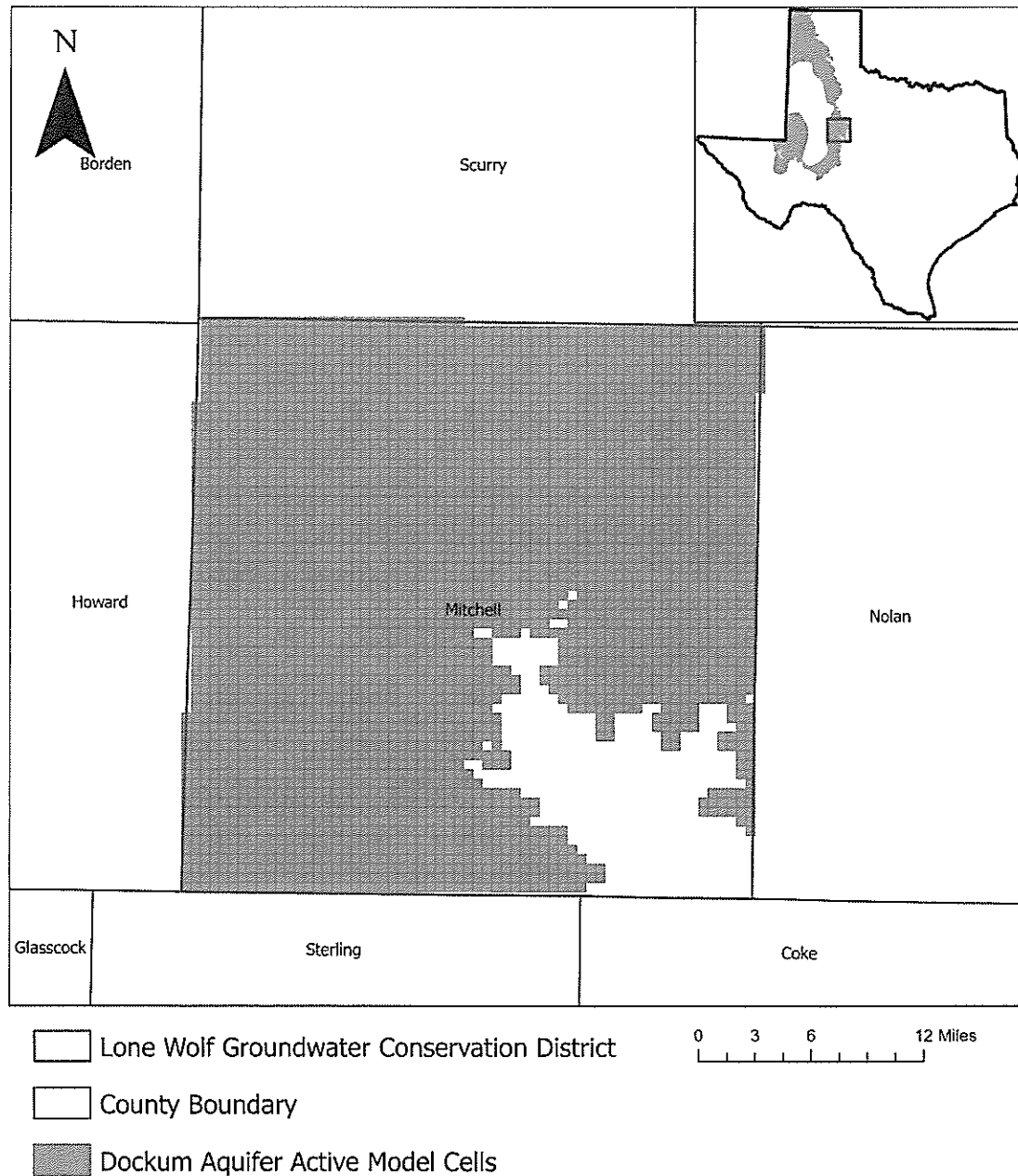
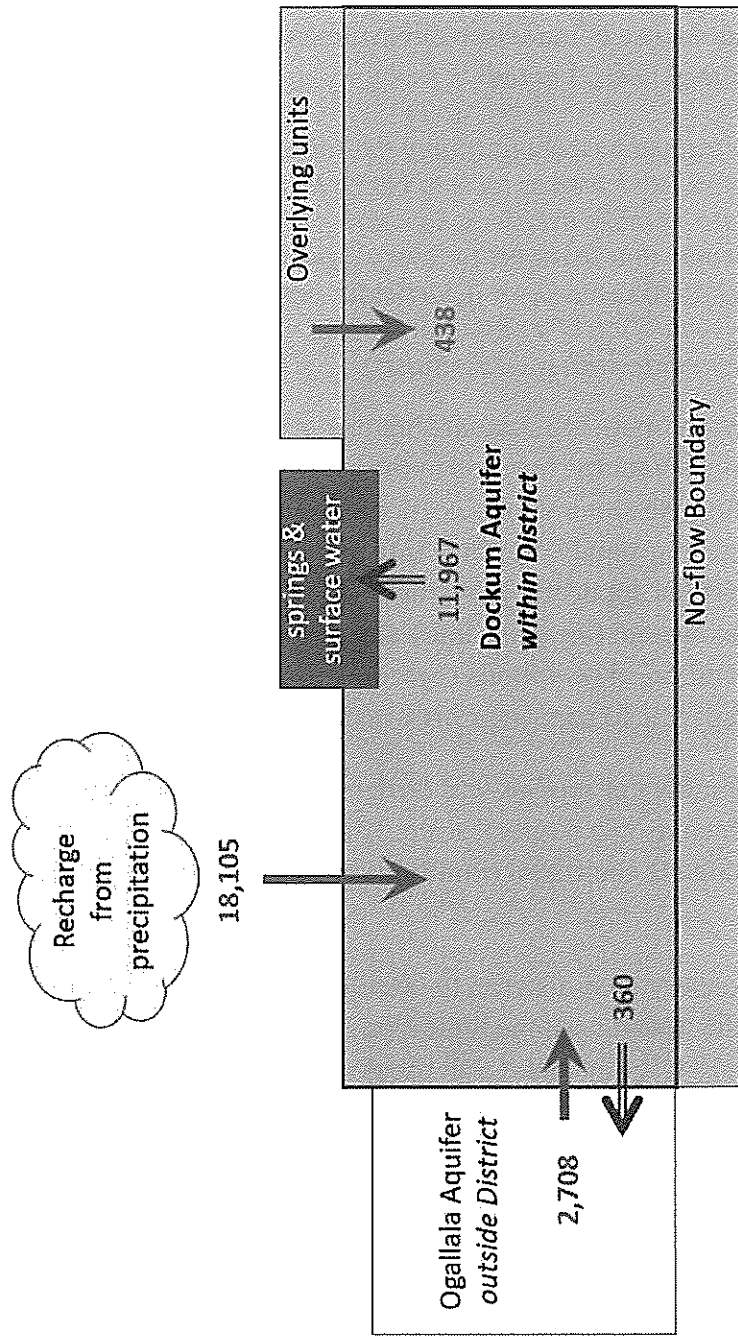


Figure 1: Area of the groundwater availability model for High Plains Aquifer System from which the information in Table 1 was extracted (the Dockum Aquifer extent within the district boundary).



Caveat: This diagram only includes the water budget items provided in Table 1. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 2: Generalized diagram of the summarized budget information from Table 1, representing directions of flow for the Dockum Aquifer within the Lone Wolf Groundwater Conservation District. Flow values are expressed in acre-feet per year.

LIMITATIONS:

The groundwater models used in completing this analysis are the best available scientific tools that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historical pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and interaction with streams are specific to particular historic time periods.

Because the application of the groundwater models was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

REFERENCES:

- Deeds, N. E., and Jigmond, M., 2015, Numerical model report for the High Plains Aquifer System Groundwater Availability Model: Prepared for the Texas Water Development Board, Intera Inc., 640 p.
- Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software.
- Jones, I., 2019, GAM Run 19-004: Lone Wolf Groundwater Conservation District Management Plan,
<http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR19-004.pdf>
- National Research Council, 2007, Models in Environmental Regulatory Decision Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p., http://www.nap.edu/catalog.php?record_id=11972.
- Niswonger, R.G., Panday, S., and Ibaraki, M., 2011, MODFLOW-NWT, a Newton formulation for MODFLOW-2005: USGS, Techniques and Methods 6-A37, 44 p.
- Texas Water Code § 36.1071

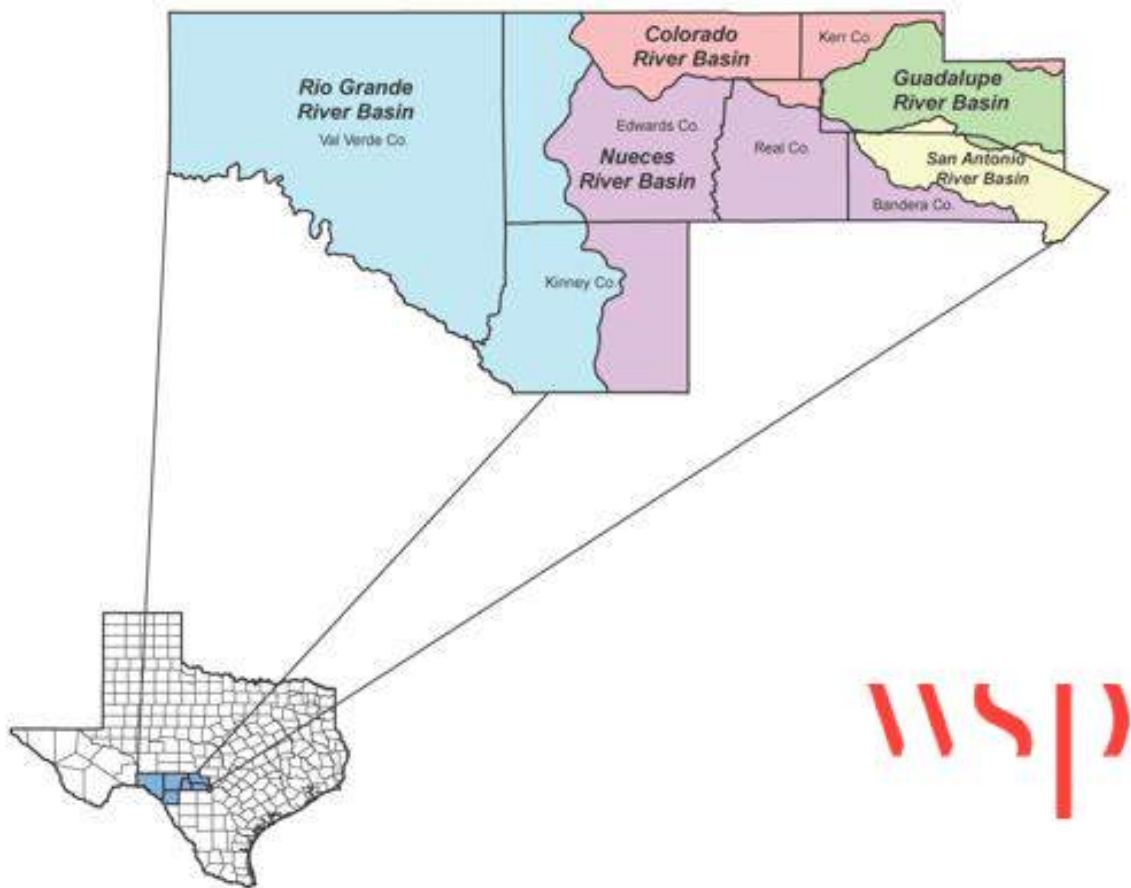
Appendix 5

PLATEAU REGION WATER PLAN

January 2021

Prepared by
Plateau Water Planning Group

Prepared for
Texas Water Development Board



WSP

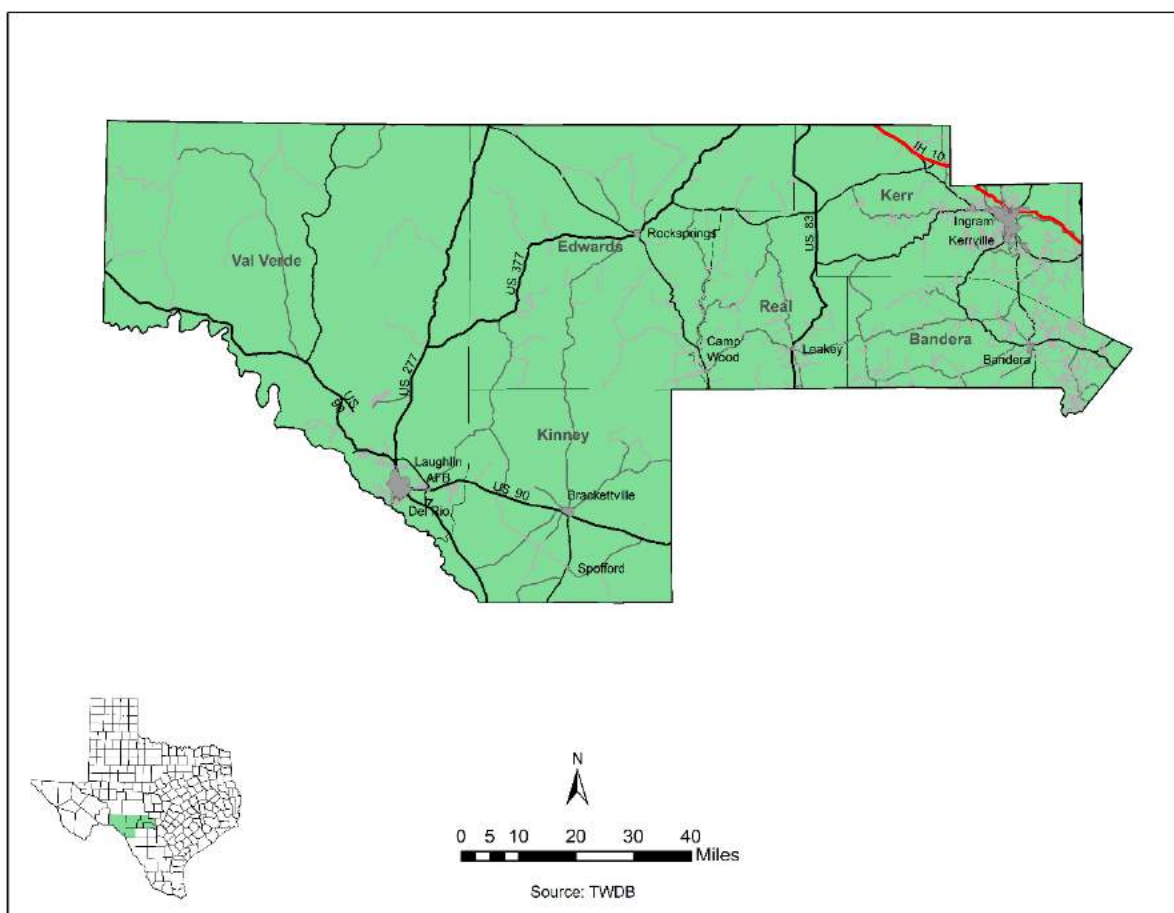
carollo
Engineers...Working Wonders With Water®

This page intentionally left blank

EXECUTIVE SUMMARY

Located along the southern boundary of the Edwards Plateau, the Plateau Water Planning Region (Region J) stretches from the Central Texas Hill Country westward to the Rio Grande and consists of Bandera, Edwards, Kerr, Kinney, Real and Val Verde Counties (Figure ES-1). Tourism, hunting, ranching, agribusiness, government and military activities support the regional economy. The beauty of the Hill Country, the solitude of the forested canyons and plateau grasslands, and the gateway to Mexico all support a major tourist and recreational trade. Natural resources of the Region include both terrestrial and aquatic habitats that boast some of the best scenic drives, beautiful vistas, river rafting, and hunting and fishing in Texas.

Figure ES-1. Plateau Region Water Planning Area Map



In January of 2016, the fourth round of regional water planning was concluded with the adoption of the *2016 Plateau Region Water Plan*. It is understood that this is not a static *Plan* but rather is intended to be revised as conditions change. For this reason, the current *2021 Plateau Region Water Plan* put forth in this document is not a new *Plan*, but rather an evolutionary modification of the preceding *Plan*. Only those parts of the original *Plan* that require updating, and there are many, have been revised.

The purpose of the *Plateau Region Water Plan* is to provide a document that water planners and water users can reference for long- and short-term water management recommendations. Equally important, this

Plan serves as an educational tool to enlighten all citizens to the importance of properly managing and conserving the pristine water resources of this Region. The *2021 Plateau Region Water Plan* follows an identical format as the *Plans* prepared by the other 15 water planning regions in the State as mandated by the Texas Legislature and overseen by the Texas Water Development Board. The *Plan* provides an evaluation of current and future water demands for all water-use categories, and water supplies available during drought-of-record conditions to meet those demands. Where future water demands exceed an entity's ability to supply that need, alternative strategies are considered to meet the potential water shortages. Water management strategies are also presented that reflects an entity's desire to upgrade their water supply system. In all cases, conservation practices are first considered in managing water supplies.

Because our understanding of current and future water demand and supply sources is constantly changing, it is intended for this *Regional Water Plan* to be revised every five years or sooner if deemed necessary. This *Plan* fully recognizes and protects existing water rights, water contracts, and option agreements, and there are no known conflicts between this *Plan* and plans prepared for other regions.

POPULATION AND WATER DEMAND

The U.S. Census Bureau performed a census count in 2010, which provides the base year for future population projections. Although the Plateau Water Planning Group (PWPG) accepts the 2010 census count, members express concern that the census does not recognize the significant seasonal population increase that occurs in these counties as the area draws large numbers of hunters and recreational visitors, as well as absentee land owners who maintain vacation, retirement, and hunting properties. Therefore, an emphasis is made in this *Plan*, especially for the rural counties, to recognize a need for more water than is justified simply from the population-derived water-demand estimates.

The Plateau Region covers 9,252 square miles and contains a projected year-2020 population of 141,476 (Table ES-1). The mostly rural nature of this Region is reflected in its population density of 15.3 (in 2020) people per square mile, which is significantly less than the State average of 72 people per square mile. Approximately 46 percent of the total population of the area is located in the two largest cities, Del Rio and Kerrville. In the year 2020, Del Rio, including the population of Laughlin Air Force Base, is projected to have 39,542 residents and Kerrville with 25,658. The projected year-2020 populations of other major communities in the Region are: Bandera (1,875); Rocksprings (1,259); Brackettville and Fort Clark Springs (3,217); and Camp Wood (747) and are presented in Figure ES-2. These population estimates do not include a significant transient (tourist, hunting, recreation, etc.) population that has a resulting significant impact on overall water supply demand in the Region.

Total population of the six counties is expected to increase by 52 percent from the projected year-2020 census count of 141,476 to 184,595 by 2070. The greatest percentage increase in population is projected to occur in Val Verde County, which is expected to grow from a projected year-2020 population of 54,694 to 82,161 by the year 2070, an increase of 50 percent. Bandera County (30 percent) and Kerr County (15 percent) are also anticipating growth. Population in the rural counties of Edwards, Kinney and Real is expected to remain relatively constant over the 50-year planning period, however the transient population will likely increase.

Total projected water consumptive use in the Plateau Region in the year 2020 is 37,337 acre-feet (Table ES-1). The largest category of projected demand is municipal and county-other (25,975 acre-feet), followed by irrigation (8,805 acre-feet), livestock (2,182 acre-feet), mining (355 acre-feet), and manufacturing (20 acre-feet) as illustrated in Figure ES-3. Municipal and irrigation combined represent 93 percent of all water used in the Region. The forecasted total demand for water needed in the Region will increase from the year 2020 by 44,937 acre-feet (13 percent) by the year 2070. Municipal and County-Other water demand in the Plateau Region is projected to increase from a year-2020 level of 25,975 acre-feet to 31,767 acre-feet by the year 2070.

The largest center of municipal demand in the Region is the City of Del Rio in Val Verde County, where 10,558 acre-feet of water is projected to be used in 2020 to supply the residents and businesses within the City. Fifty-five percent of the Region's total municipal water use occurs in Val Verde County. The City of Del Rio is the only entity in the Plateau Region that is designated as a wholesale water provider. In addition to its own use, the City provides water to Laughlin Air Force Base and subdivisions outside of the City.

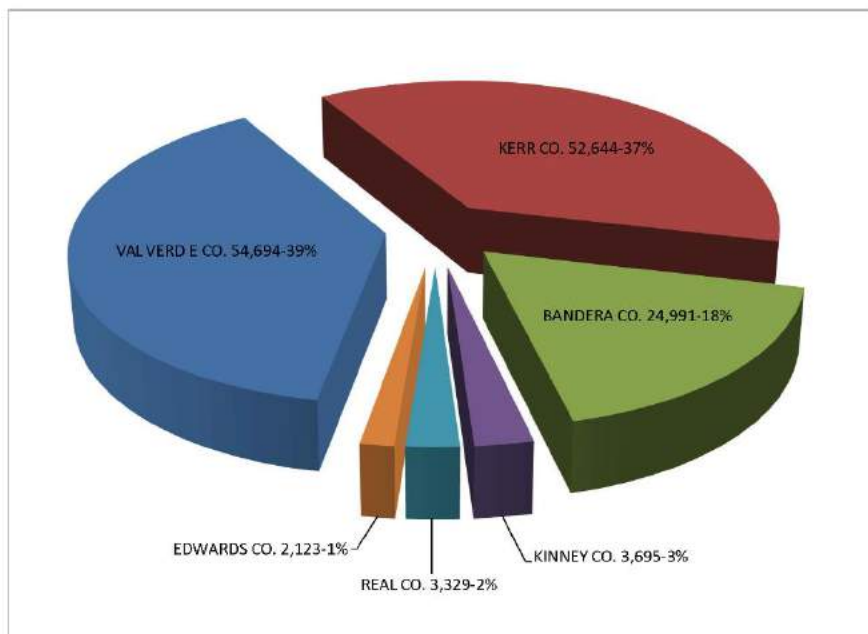


Figure ES-2. Year 2020 Projected Population

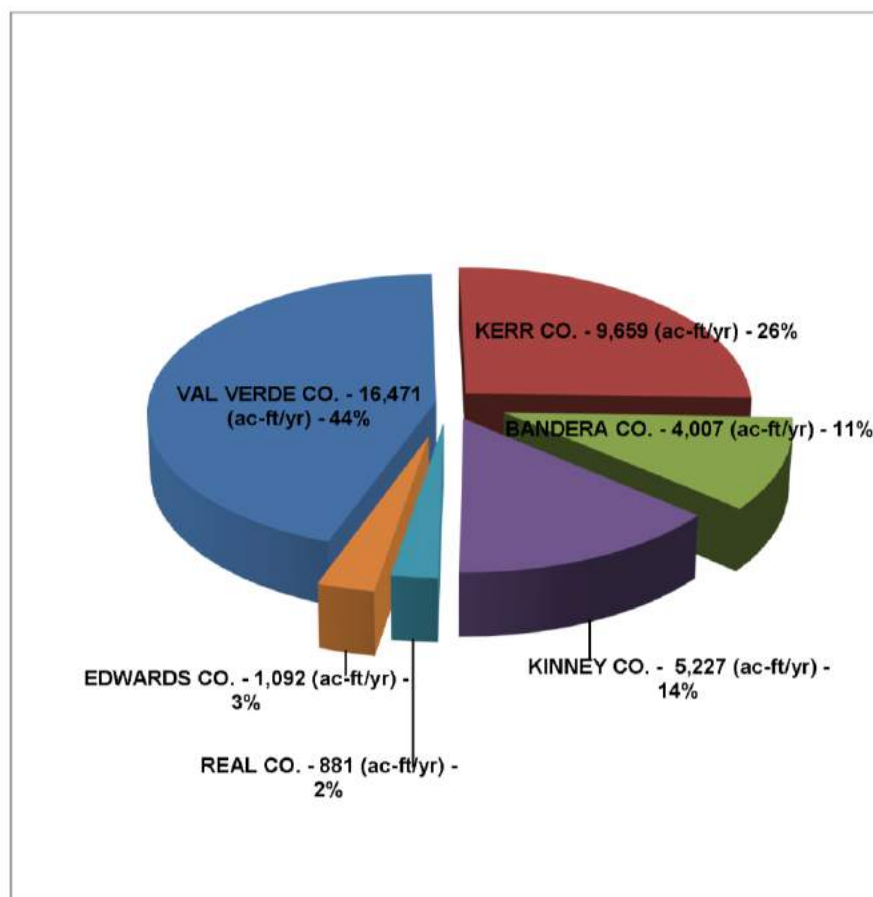


Figure ES-3. Year 2020 Projected Water Demand by County

The Upper Guadalupe River Authority (UGRA) anticipates becoming a wholesale water provider in coming years with the intent to provide conjunctive water-supply sources to meet the needs of Kerr County citizens that will not be served by the City of Kerrville. The use of water for manufacturing purposes only occurs in Kerr County.

Most irrigation that occurs in the Plateau Region is for the watering of pastures and hay fields. Because of the typically rocky and uneven terrain throughout much of the Region, irrigation of commercial row crops is minimal other than in Kinney County. Kinney County has the highest irrigation water use (62 percent of the Region's total) and is the only county in which irrigation use is greater than municipal use. On a regional basis, water used for irrigation is projected to remain consistent at 8,805 acre-feet per year over the 50-year planning horizon. However, as any irrigator can attest, climate, water availability, and the market play key roles in how much water is actually applied on a year-by-year basis.

Environmental and recreational water use in the Plateau Region is recognized as being an important consideration as it relates to the natural community in which the residents of this Region share and appreciate. In addition, for rural counties, tourism activities centered around the natural resources offer perhaps the best hope for modest economic growth to areas that have seen a long decline in traditional economic activities such as agriculture.

WATER SUPPLY RESOURCES

Water supply sources in the Plateau Region include groundwater from six aquifers (176,292 acre-feet in 2020), and surface water within five river basins (20,654 acre-feet in 2020) (Chapter 3, Table 3-2). Reuse of existing supplies is also considered a water supply source. Water supply availability under drought-of-record conditions is considered in the planning process to insure that water demands can be met under the worst of circumstances. In the consideration of available water supply sources, this *Plan* fully recognizes and protects existing water rights, water contracts, and option agreements.

Within the Plateau Region, the TWDB recognizes three major aquifers [the Trinity, the Edwards-Trinity (Plateau), and the Edwards (Balcones Fault Zone)] as illustrated in Figure ES-4. For this *Plan*, the Austin Chalk Aquifer in Kinney County, and the Frio and Nueces River Alluvium Aquifers in Edwards and Real Counties are also identified as groundwater sources. Groundwater conservation districts in Bandera, Kerr, Kinney, Real and Edwards Counties provide for local management control of the groundwater resources in their respective districts. Over much of the Region, water levels generally fluctuate with seasonal precipitation and are highly susceptible to declines during drought conditions. Discharge from the aquifers occurs naturally through springs and seeps, and artificially by pumping from wells. Some discharge also occurs through leakage from one aquifer to another and through natural down-gradient subsurface flow out of the Region.

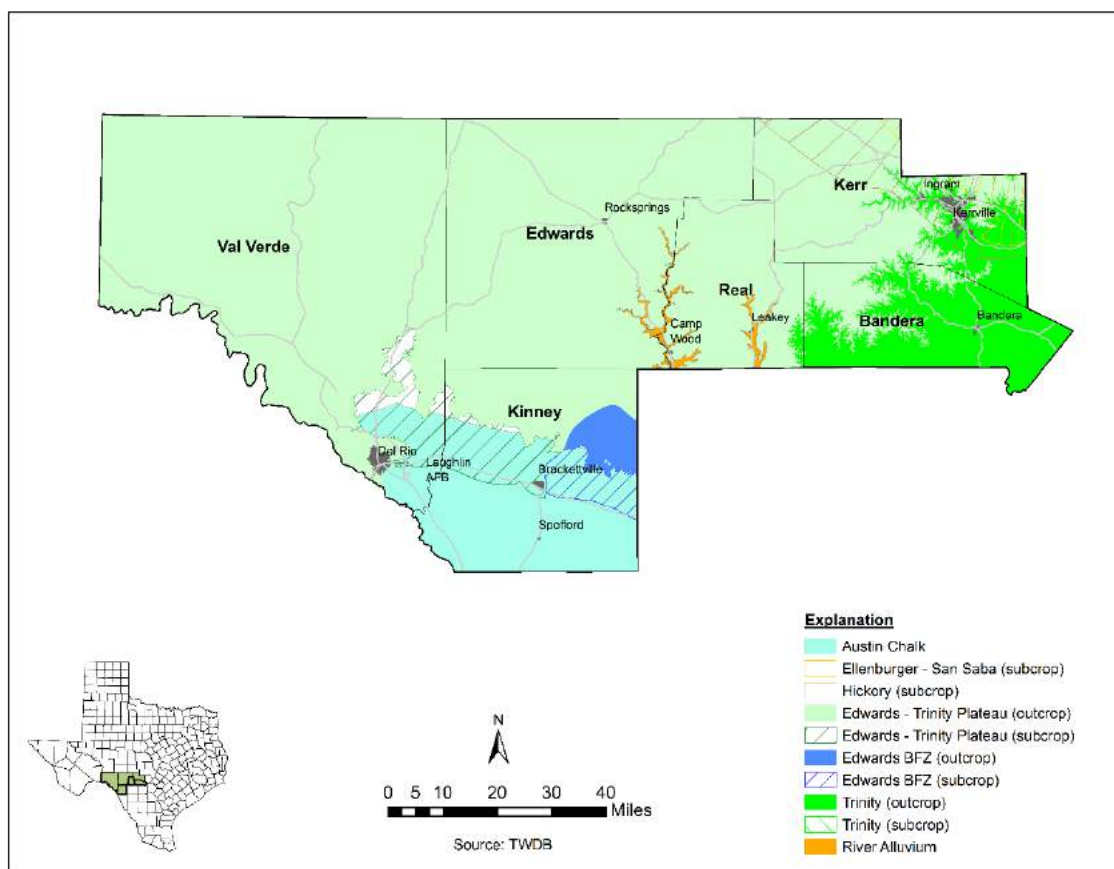


Figure ES-4. Groundwater Sources

Base flow to the many rivers and streams that flow through the Plateau Region is principally generated from the numerous springs that issue from rock formations that form the major aquifers. It is thus recognized that sustaining flow in these important rivers and streams is highly dependent on maintaining an appropriate water level in the aquifer systems that feed the supporting springs. With the sustainability of local water supplies and the economic welfare of the Region in mind, the PWPG thus defines groundwater availability as a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact such that the base flow in rivers and streams is not significantly affected beyond a level that would be anticipated due to naturally occurring conditions. The PWPG also acknowledges that groundwater conservation districts have regulatory authority over permitted withdrawals.

The volumetric availability of groundwater for this *2021 Plan* is based on TWDB provided Modeled Available Groundwater (MAG) as developed through the Groundwater Management Area process. Aquifers recognized in this *Plan* that are not included in the GAM-MAG process are termed “non-relevant” and “other aquifer”. Groundwater availability for these sources is calculated by modeling or standard geohydrologic methods, with include the following:

The counties that comprise the Plateau Region contain the headwaters of the Guadalupe, San Antonio, Medina, Sabinal, Frio, Nueces, and West Nueces rivers; and tributaries to the Colorado River and Rio Grande such as the Pecos, Devils, and South Llano rivers. Flow in these rivers and streams is critical to the Plateau Region in that it provides municipal drinking water, supplies irrigation and livestock needs, maintains environmental habitats, and supports a thriving ecological and recreational tourist economy. Water users downstream of the Plateau Region (Regions K, L, and M) likewise have a stake in maintaining and protecting river flows.

Although rather limited during severe drought conditions, surface-water supplies in the Region are important (Figure ES-5). The Cities of Kerrville and Del Rio currently use surface water from the Guadalupe River and from San Felipe Springs, respectively. Camp Wood in Real County is supplied from Old Faithful Spring located on a tributary to the Nueces River. For surface-water supplies, drought-of-record conditions relate to the quantity of water available to meet existing permits from the Rio Grande, Nueces, Colorado, Guadalupe, and San Antonio rivers and their tributaries as estimated by Run 3 of the TCEQ Water Availability Models (WAMs).

Water recycling, or reuse, is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation or industrial processes, and potentially for public consumption. The Cities of Kerrville and Camp Wood have active water reuse programs.

The PWPG recognizes the important ecological water supply function that all springs perform in the Region. Springs create and maintain base flow to rivers, contribute to the esthetic and recreational value of land, and are significant sources of water for wild game and aquatic species. Water issuing from springs forms wetlands that attract migratory birds and other fowl that inhabit the Region throughout the year. The spring wetlands host numerous terrestrial and aquatic species, some of which are recognized as threatened and endangered.

The PWPG has identified three “Major Springs” that are important for their municipal water supply contribution. The fourth largest spring system in Texas, San Felipe Springs, discharges to San Felipe Creek east of Del Rio and provides municipal drinking water for the City, as well as irrigation use downstream. Las Moras Springs in Kinney County is of historical significance for its importance as a supply source on early travel routes and military fortifications. Today, Las Moras Springs supports the

Fort Clark Springs community and is hydrologically associated with the same aquifer system that serves Fort Clark Springs MUD and the City of Brackettville. The third major spring is Old Faithful in Real County, which is the drinking-water supply source for the City of Camp Wood. Although only three springs are identified as “Major Springs”, the PWPG recognizes that all springs in the Region are important and are deserving of natural resource protection.

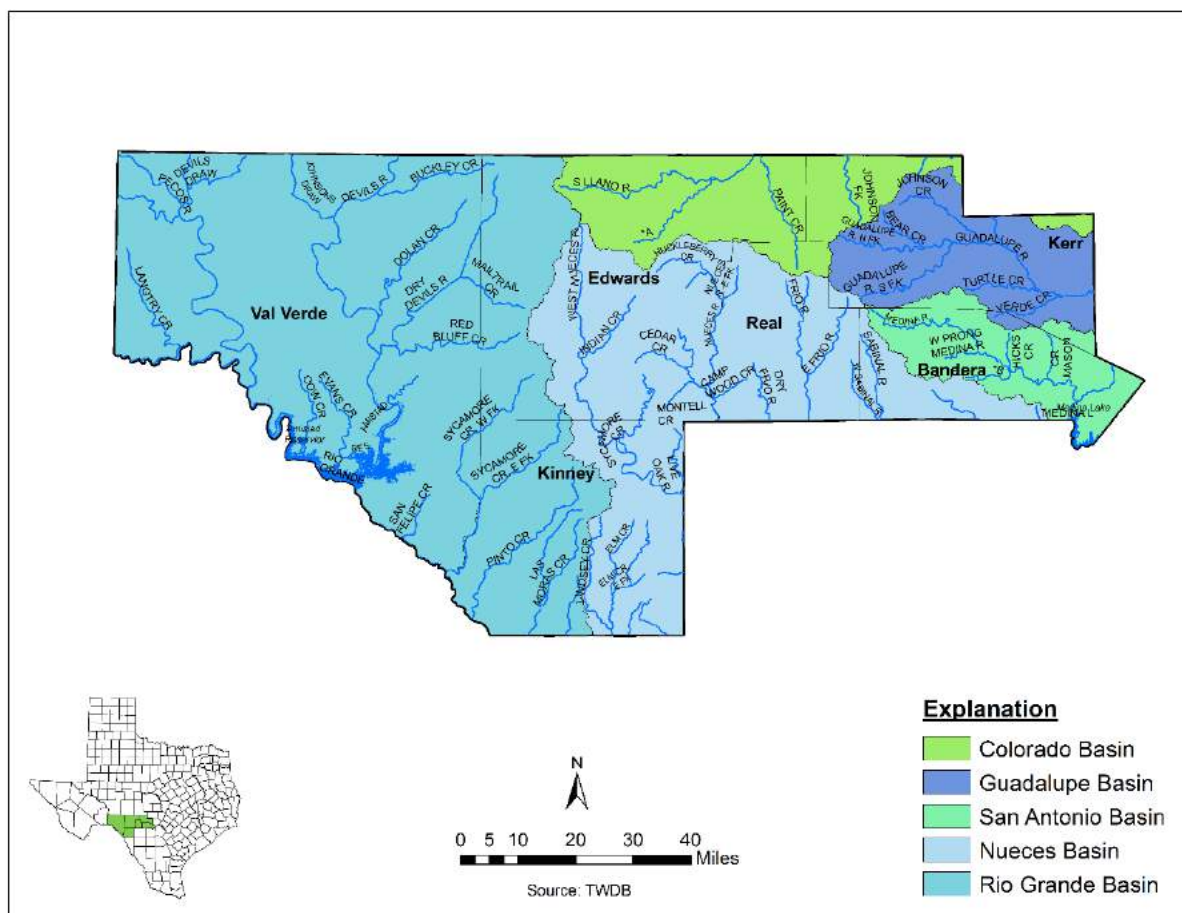


Figure ES-5. Surface Water Sources

WATER MANAGEMENT STRATEGIES

A major component of this *Plan* is to identify municipalities and water-use categories that may, in times of severe drought, be unable to meet expected water-supply needs based on today's ability to access, treat, and distribute the supply. Recommended alternatives, or water management strategies, to meet anticipated drought-induced shortages are presented for consideration. It should be acknowledged that the PWPG has no authority to mandate that any recommended strategy be implemented, and that it is the individual entity's initiative to act on needed changes.

Tables provided in the Executive Summary Appendix (TWDB Water Planning Data Reports) list projected water supply shortages within the Region under drought-of-record conditions based on no new infrastructure development, along with a secondary water needs analysis for all water user groups and wholesale water providers for which conservation or direct reuse water management strategies are recommended. This secondary water needs analysis calculates the water needs that would remain after assuming all recommended conservation and reuse water management strategies are fully implemented. Additional tables provide a listing of all recommended (68) and alternative (6) water management strategies in this *Plan* that if implemented may assist in meeting supply shortages. Additional strategies are recommended for other entities that have no projected supply shortage, but have desired projects to be considered for funding. Conservation and water-loss strategies are also recommended where appropriate. Total capital cost to implement the recommended strategies is \$230,456,000.

A goal of this *Plan* is to provide for the health, safety, and welfare of the human community, with as little detrimental effect to the environment as possible. Recreation activities involve human interaction with the outdoor environment and are often directly dependent on water resources. It is recognized that the maintenance of the regional environmental community's water supply needs serves to enhance the lives of citizens of the Plateau Region as well as the tens of thousands of annual visitors to this Region.

The implementation of water management strategies recommended in Chapter 5 of this Regional *Plan* is not expected to have any impact on native water quality. Primary and secondary safe drinking water standards, which are the key parameters of water quality identified by the PWPG as important to the use of the water resource, are not compromised by the implementation of the strategies. Also, no recommended strategies involve moving water from a rural location for use in an urban area.

WATER QUALITY

Water quality plays an important role in determining the suitability of water supplies to meet current and future water needs. Primary and secondary safe drinking water standards are the key parameters of water quality identified by the PWPG as important to the use of water resources and are used for comparisons of water quality data. The reservoirs within the Plateau Region - Amistad Reservoir and Medina Lake - are some of the clearest (most transparent) water bodies in the State of Texas. Amistad Reservoir is the third clearest water body in Texas and Medina Lake is the fifth clearest.

Groundwater resources in the Plateau Region are generally potable, although between five and ten percent of the groundwater is brackish. Groundwater quality problems are generally related to naturally high concentrations of total dissolved solids (TDS) or to the occurrence of elevated concentrations of individual dissolved constituents. High concentrations of TDS are primarily the result of the lack of sufficient recharge and restricted circulation. Together, these retard the flushing action of fresh water moving through the aquifers.

Water quality is generally good throughout the Plateau Region; however, a few specific water quality issues are of concern.

- Increase in urban runoff generally comes with an increase in impervious cover in populated areas. Urbanization also causes increased pollutant loads, including sediment, chemicals from motor vehicles, pesticides/herbicides/fertilizers from gardens and lawns, viruses/bacteria/ nutrients from human and animal wastes including septic systems, heavy metals from a variety of sources, and higher temperatures of the runoff.
- Increasing population has also manifested itself in the fragmentation of larger properties. With the advent of fragmentation comes the proliferation of new wells being drilled to serve individual properties. Each new well thus becomes another potential conduit for surface contamination to reach the underlying aquifer system.
- Vehicular traffic in streambeds disrupts streamflow, damages plants and animals living in these areas, damages channels and erodes banks, and decreases water quality by increasing the turbidity of the water in these rivers and streams.
- The constituent of most concern is nitrate, which was found above the primary maximum contaminant level in a number of water-sample analyses from the Edwards (BFZ) Aquifer and the Austin Chalk Aquifer in Kinney County. Historically, the primary contribution to poor groundwater quality occurs in wells that do not have adequately cemented casing.
- Poorer groundwater quality in the Region is generally from two sources, evaporite beds in the Glen Rose limestone and from surface contamination, both of which can be prevented by proper well construction. Also of concern are above normal levels of radioactivity that have been detected in sand sequences of the Glen Rose and Hensell Formations.

WATER CONSERVATION AND DROUGHT CONTINGENCY

Water conservation and drought contingency planning are two of the most important components of water supply management. Recognizing their potential contribution, setting realistic goals, and aggressively enforcing their implementation may significantly extend the time when new supplies and associated infrastructure are needed. Water conservation are those practices, techniques, programs, and technologies that will protect water resources, reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling or reuse of water so that a water supply is made available for future or alternative uses. Water conservation strategies and recommendations are discussed in Chapter 5, Section 5.3.

Although residents of the Plateau Region are generally accustomed to highly variable climatic conditions, the relatively low rainfall and the accompanying high levels of evaporation underscore the necessity of developing plans that respond to potential disruptions in the supply of groundwater and surface water caused by drought conditions.

Drought contingency plans provide a structured response that is intended to minimize the damaging effects caused by water shortage conditions. A common feature of drought contingency plans is a structure that allows increasingly stringent drought response measures to be implemented in successive stages as water supply or water demand conditions intensify. This measured or gradual approach allows for timely and appropriate action as a water shortage develops. The onset and termination of each implementation stage should be defined by specific “triggering” criteria. Triggering criteria are intended to ensure that timely action is taken in response to a developing situation and that the response is appropriate to the level of severity of the situation. Chapter 7 provides a detailed discussion on drought impact and preparedness in the Plateau Region.

PROTECTION OF WATER, AGRICULTURAL AND NATURAL RESOURCES

The long-term protection of the Plateau Region's water resources, agricultural resources, and natural resources is an important component of this 2021 update of the *Plateau Region Water Plan*. Long-term water resources protection occurs in the conservative methodology of estimating water supply availability, evaluation of water management strategies for potential threats to water resources, the recommendation of water conservation strategies, and regional recommendations pertaining to water conservation and drought management practices. When enacted, the conservation practices will diminish water demand, the drought management practices will extend supplies over stress periods, and land management practices (land stewardship) will potentially increase aquifer recharge and stream base flow conditions.

Agricultural resources are protected in this *Plan*. There is no current movement of water from agricultural areas in the Region for use in urban areas; and there are no recommended strategies in this *Plan* that involve moving water from rural locations. Also, non-agricultural strategies include an analysis of potential impact to agricultural interests.

The protection of natural resources as intended in this *Plan* is closely linked with the protection of water resources as discussed above. The methodology adopted to assess groundwater source availability is based on not significantly impacting spring flows that contribute to base flows in area rivers. Thus, the intention to protect surface flows is directly related to those natural resources that are dependent on surface water sources for their existence.

Environmental impacts were evaluated in the consideration of strategies to meet water-supply deficits. Of prime consideration was whether a strategy potentially could diminish the quantity of water currently existing in the natural environment and if a strategy could impact water quality to a level that would be detrimental to animals and plants that naturally inhabit the area under consideration. Although no specific "ecologically unique river and stream segments" are recommended in this *Plan*, the PWPG is very explicit in acknowledging the importance of all springs and stream segments for their significance as wildlife habitat.

POLICY RECOMMENDATIONS

Water-supply resources intended to meet the future needs of all water-use categories in the Plateau Region are recognized to be limited in comparison to resources available in many other parts of the State. A conscientious effort to maintain an awareness of existing conditions and anticipate future water needs is recognized by the PWPG as being the foundation of continued regional water planning. In support of this belief, the PWPG is providing specific recommendations in this *Plan* that address:

- Water Conservation
- Water Management
- Water Planning
- Water Research Needs
- Consideration of Ecologically Unique River and Stream Segments
- Consideration of Unique Sites for Reservoir Construction

The PWPG encourages the continued public process of developing region-based water plans. Copies of the *2021 Plateau Region Water Plan* are accessible in county courthouses, public libraries, and through the PWPG website at <http://www.ugra.org/waterdevelopment.html>. The *Plan* is also accessible through the Texas Water Development Board web site: <http://www.twdb.state.tx.us/>.

Page intentionally left blank

ES – APPENDIX

TWDB WATER PLANNING

DATA REPORTS

- **Water User Group (WUG) Population**
- **WUG Demand**
- **WUG Category Summary**
- **Source Availability**
- **WUG Existing Water Supply**
- **WUG Needs / Surplus**
- **WUG Second-Tier Identified Water Needs**
- **WUG Second-Tier Water Needs Summary**
- **Source Water Balance (Availability – WUG Supply)**
- **WUG Data Comparison to 2016 Regional Water Plan**
- **Source Data Comparison to 2016 Regional Water Plan**
- **WUG Unmet Needs**
- **WUG Unmet Needs Summary**
- **Recommended WUG Water Management Strategies**
- **Recommended Projects Associated with Water Management Strategies**
- **Alternate WUG Water Management Strategies**
- **Alternate Projects Associated with Water Management Strategies**
- **WUG Management Supply Factor**
- **Recommended Water Management Strategy Supply Associated with a New or Amended Inter-Basin Transfer Permit *(No relevant data for the Plateau Region)***
- **WUG Recommended WUG Supply Associated with a New or Amended Inter-Basin Transfer Permit and Total Recommended Conservation Water Management Supply *(No relevant data for the Plateau Region)***
- **Recommended Water Management Strategy Supplies Unallocated to WUG *(No relevant data for the Plateau Region)***
- **WUG Strategy Supplies by Water Management Strategy Type**
- **WUG Recommended Water Management Strategy Supplies by Source Type**
- **Major Water Provider Existing Sales and Transfers**
- **Major Water Provider Water Management Strategy Summary**

Page intentionally left blank

Region J Water User Group (WUG) Population

	WUG POPULATION					
	2020	2030	2040	2050	2060	2070
COUNTY-OTHER	122	140	150	155	157	158
GUADALUPE BASIN TOTAL	122	140	150	155	157	158
COUNTY-OTHER	1,114	1,282	1,376	1,414	1,438	1,450
NUECES BASIN TOTAL	1,114	1,282	1,376	1,414	1,438	1,450
BANDERA	1,875	2,160	2,316	2,380	2,420	2,442
BANDERA COUNTY FWSD 1	679	781	838	862	876	883
COUNTY-OTHER BANDERA RIVER RANCH 1	929	1,070	1,148	1,180	1,199	1,209
COUNTY-OTHER LAKE MEDINA SHORES	2,415	2,781	2,985	3,068	3,118	3,144
COUNTY-OTHER MEDINA WSC	895	1,031	1,107	1,137	1,156	1,166
COUNTY-OTHER	16,962	19,535	20,961	21,546	21,901	22,085
SAN ANTONIO BASIN TOTAL	23,755	27,358	29,355	30,173	30,670	30,929
BANDERA COUNTY TOTAL	24,991	28,780	30,881	31,742	32,265	32,537
ROCKSPRINGS	844	844	844	844	844	844
COUNTY-OTHER	136	136	136	136	136	136
COLORADO BASIN TOTAL	980	980	980	980	980	980
ROCKSPRINGS	415	415	415	415	415	415
COUNTY-OTHER BARKSDALE WSC	264	264	264	264	264	264
COUNTY-OTHER	391	391	391	391	391	391
NUECES BASIN TOTAL	1,070	1,070	1,070	1,070	1,070	1,070
COUNTY-OTHER	73	73	73	73	73	73
RIO GRANDE BASIN TOTAL	73	73	73	73	73	73
EDWARDS COUNTY TOTAL	2,123	2,123	2,123	2,123	2,123	2,123
COUNTY-OTHER	507	541	562	582	596	607
COLORADO BASIN TOTAL	507	541	562	582	596	607
KERRVILLE	25,658	26,638	27,217	27,792	28,203	28,522
KERRVILLE SOUTH WATER	2,821	2,969	3,057	3,143	3,206	3,254
COUNTY-OTHER CENTER POINT	161	172	178	184	189	192
COUNTY-OTHER CENTER POINT NORTH WATER SYSTEM	255	272	282	291	298	304
COUNTY-OTHER CENTER POINT TAYLOR SYSTEM	530	564	585	605	619	631
COUNTY-OTHER HILLS AND DALES ESTATES	202	216	223	231	237	241
COUNTY-OTHER NICKERSON FARM WATER SYSTEM	200	213	221	229	234	238
COUNTY-OTHER OAK FOREST SOUTH WATER	669	712	738	763	782	796
COUNTY-OTHER PARK PLACE SUBDIVISION	129	138	143	148	151	154
COUNTY-OTHER PECAN VALLEY	123	131	135	140	144	146
COUNTY-OTHER RUSTIC HILLS WATER	80	85	88	91	93	95
COUNTY-OTHER VERDE PARK ESTATES	178	189	196	203	208	211
COUNTY-OTHER WESTWOOD WATER SYSTEM	269	287	297	307	315	320
COUNTY-OTHER	20,583	21,982	22,813	23,636	24,226	24,679
GUADALUPE BASIN TOTAL	51,858	54,568	56,173	57,763	58,905	59,783
COUNTY-OTHER	6	7	7	7	8	8
NUECES BASIN TOTAL	6	7	7	7	8	8
COUNTY-OTHER	273	291	302	313	321	327
SAN ANTONIO BASIN TOTAL	273	291	302	313	321	327
KERR COUNTY TOTAL	52,644	55,407	57,044	58,665	59,830	60,725
COUNTY-OTHER	81	82	82	82	82	82
NUECES BASIN TOTAL	81	82	82	82	82	82
BRACKETTVILLE	1,958	1,971	1,971	1,971	1,971	1,971
FORT CLARK SPRINGS MUD	1,259	1,267	1,267	1,267	1,267	1,267

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Population

	WUG POPULATION					
	2020	2030	2040	2050	2060	2070
COUNTY-OTHER	397	400	400	400	400	400
RIO GRANDE BASIN TOTAL	3,614	3,638	3,638	3,638	3,638	3,638
KINNEY COUNTY TOTAL	3,695	3,720	3,720	3,720	3,720	3,720
COUNTY-OTHER	35	35	35	35	35	35
COLORADO BASIN TOTAL	35	35	35	35	35	35
CAMP WOOD	747	747	747	747	747	747
LEAKEY	1,415	1,415	1,415	1,415	1,415	1,415
COUNTY-OTHER	1,132	1,132	1,132	1,132	1,132	1,132
NUECES BASIN TOTAL	3,294	3,294	3,294	3,294	3,294	3,294
REAL COUNTY TOTAL	3,329	3,329	3,329	3,329	3,329	3,329
DEL RIO UTILITIES COMMISSION	37,775	40,196	42,540	44,948	47,242	49,453
LAUGHLIN AIR FORCE BASE	1,767	1,951	2,129	2,239	2,239	2,239
COUNTY-OTHER	15,152	18,242	21,233	24,379	27,479	30,469
RIO GRANDE BASIN TOTAL	54,694	60,389	65,902	71,566	76,960	82,161
VAL VERDE COUNTY TOTAL	54,694	60,389	65,902	71,566	76,960	82,161
REGION J POPULATION TOTAL	141,476	153,748	162,999	171,145	178,227	184,595

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Demand

	WUG DEMAND (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
COUNTY-OTHER	13	14	15	15	15	15
LIVESTOCK	11	11	11	11	11	11
GUADALUPE BASIN TOTAL	24	25	26	26	26	26
COUNTY-OTHER	116	129	136	138	140	141
LIVESTOCK	47	47	47	47	47	47
IRRIGATION	182	182	182	182	182	182
NUECES BASIN TOTAL	345	358	365	367	369	370
BANDERA	342	383	404	413	419	423
BANDERA COUNTY FWSD 1	141	158	167	171	174	175
COUNTY-OTHER BANDERA RIVER RANCH 1	97	108	113	115	117	118
COUNTY-OTHER LAKE MEDINA SHORES	251	280	294	299	303	306
COUNTY-OTHER MEDINA WSC	93	104	109	111	112	113
COUNTY-OTHER	1,765	1,965	2,066	2,102	2,132	2,149
LIVESTOCK	185	185	185	185	185	185
IRRIGATION	764	764	764	764	764	764
SAN ANTONIO BASIN TOTAL	3,638	3,947	4,102	4,160	4,206	4,233
BANDERA COUNTY TOTAL	4,007	4,330	4,493	4,553	4,601	4,629
ROCKSPRINGS	198	194	191	190	190	190
COUNTY-OTHER	15	14	14	14	14	14
MINING	19	19	19	19	19	19
LIVESTOCK	106	106	106	106	106	106
IRRIGATION	66	66	66	66	66	66
COLORADO BASIN TOTAL	404	399	396	395	395	395
ROCKSPRINGS	98	96	94	94	94	94
COUNTY-OTHER BARKSDALE WSC	29	28	27	26	26	26
COUNTY-OTHER	43	41	39	39	39	39
MINING	25	25	25	25	25	25
LIVESTOCK	192	192	192	192	192	192
IRRIGATION	89	89	89	89	89	89
NUECES BASIN TOTAL	476	471	466	465	465	465
COUNTY-OTHER	8	8	7	7	7	7
MINING	45	45	45	45	45	45
LIVESTOCK	99	99	99	99	99	99
IRRIGATION	60	60	60	60	60	60
RIO GRANDE BASIN TOTAL	212	212	211	211	211	211
EDWARDS COUNTY TOTAL	1,092	1,082	1,073	1,071	1,071	1,071
COUNTY-OTHER	43	44	44	44	45	46
MINING	14	15	18	19	20	22
LIVESTOCK	166	166	166	166	166	166
IRRIGATION	61	61	61	61	61	61
COLORADO BASIN TOTAL	284	286	289	290	292	295
KERRVILLE	5,082	5,158	5,178	5,237	5,305	5,364
KERRVILLE SOUTH WATER	341	346	347	352	358	363
COUNTY-OTHER CENTER POINT	14	14	14	14	14	15
COUNTY-OTHER CENTER POINT NORTH WATER SYSTEM	22	22	22	22	23	23
COUNTY-OTHER CENTER POINT TAYLOR SYSTEM	45	45	46	46	47	48
COUNTY-OTHER HILLS AND DALES ESTATES	17	17	17	18	18	18
COUNTY-OTHER NICKERSON FARM WATER SYSTEM	17	17	17	17	18	18

*A single asterisk next to a WUG's name denotes that the WUG is split by more than one planning region.

Region J Water User Group (WUG) Demand

	WUG DEMAND (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
COUNTY-OTHER OAK FOREST SOUTH WATER	56	57	57	58	59	60
COUNTY-OTHER PARK PLACE SUBDIVISION	11	11	11	11	11	12
COUNTY-OTHER PECAN VALLEY	10	11	11	11	11	11
COUNTY-OTHER RUSTIC HILLS WATER	7	7	7	7	7	7
COUNTY-OTHER VERDE PARK ESTATES	15	15	15	15	16	16
COUNTY-OTHER WESTWOOD WATER SYSTEM	23	23	23	23	24	24
COUNTY-OTHER	1,737	1,769	1,773	1,804	1,842	1,875
MANUFACTURING	20	21	21	21	21	21
MINING	62	65	82	83	91	98
LIVESTOCK	546	546	546	546	546	546
IRRIGATION	1,239	1,239	1,239	1,239	1,239	1,239
GUADALUPE BASIN TOTAL	9,264	9,383	9,426	9,524	9,650	9,758
COUNTY-OTHER	1	1	1	1	1	1
LIVESTOCK	9	9	9	9	9	9
NUECES BASIN TOTAL	10	10	10	10	10	10
COUNTY-OTHER	23	23	24	24	24	25
LIVESTOCK	36	36	36	36	36	36
IRRIGATION	42	42	42	42	42	42
SAN ANTONIO BASIN TOTAL	101	101	102	102	102	103
KERR COUNTY TOTAL	9,659	9,780	9,827	9,926	10,054	10,166
COUNTY-OTHER	11	11	11	11	10	10
LIVESTOCK	100	100	100	100	100	100
IRRIGATION	1,300	1,300	1,300	1,300	1,300	1,300
NUECES BASIN TOTAL	1,411	1,411	1,411	1,411	1,410	1,410
BRACKETTVILLE	608	602	594	593	592	592
FORT CLARK SPRINGS MUD	618	616	612	610	609	609
COUNTY-OTHER	53	52	51	51	51	51
LIVESTOCK	124	124	124	124	124	124
IRRIGATION	2,413	2,413	2,413	2,413	2,413	2,413
RIO GRANDE BASIN TOTAL	3,816	3,807	3,794	3,791	3,789	3,789
KINNEY COUNTY TOTAL	5,227	5,218	5,205	5,202	5,199	5,199
COUNTY-OTHER	4	4	3	3	3	3
LIVESTOCK	13	13	13	13	13	13
IRRIGATION	12	12	12	12	12	12
COLORADO BASIN TOTAL	29	29	28	28	28	28
CAMP WOOD	143	139	136	135	135	135
LEAKEY	193	186	180	178	177	177
COUNTY-OTHER	120	116	113	111	111	111
LIVESTOCK	138	138	138	138	138	138
IRRIGATION	258	258	258	258	258	258
NUECES BASIN TOTAL	852	837	825	820	819	819
REAL COUNTY TOTAL	881	866	853	848	847	847
DEL RIO UTILITIES COMMISSION	10,558	11,053	11,554	12,130	12,733	13,326
LAUGHLIN AIR FORCE BASE	1,018	1,114	1,215	1,277	1,276	1,276
COUNTY-OTHER	1,976	2,307	2,637	3,002	3,376	3,741
MINING	190	249	259	223	192	171
LIVESTOCK	410	410	410	410	410	410

*A single asterisk next to a WUG's name denotes that the WUG is split by more than one planning region.

Region J Water User Group (WUG) Demand

	WUG DEMAND (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
IRRIGATION	2,319	2,319	2,319	2,319	2,319	2,319
RIO GRANDE BASIN TOTAL	16,471	17,452	18,394	19,361	20,306	21,243
VAL VERDE COUNTY TOTAL	16,471	17,452	18,394	19,361	20,306	21,243
REGION J DEMAND TOTAL	37,337	38,728	39,845	40,961	42,078	43,155

*A single asterisk next to a WUG's name denotes that the WUG is split by more than one planning region.

Region J Water User Group (WUG) Category Summary

MUNICIPAL	2020	2030	2040	2050	2060	2070
POPULATION	77,213	81,354	84,756	88,023	90,845	93,452
DEMAND (acre-feet per year)	19,340	20,045	20,672	21,380	22,062	22,724
EXISTING SUPPLIES (acre-feet per year)	17,880	17,880	17,880	17,880	17,880	17,880
NEEDS (acre-feet per year)*	4,817	5,419	6,025	6,666	7,271	7,865
COUNTY-OTHER	2020	2030	2040	2050	2060	2070
POPULATION	64,263	72,394	78,243	83,122	87,382	91,143
DEMAND (acre-feet per year)	6,635	7,257	7,717	8,159	8,616	9,043
EXISTING SUPPLIES (acre-feet per year)	18,661	18,661	18,661	18,661	18,661	18,661
NEEDS (acre-feet per year)*	265	316	341	350	370	742
MANUFACTURING	2020	2030	2040	2050	2060	2070
DEMAND (acre-feet per year)	20	21	21	21	21	21
EXISTING SUPPLIES (acre-feet per year)	48	48	48	48	48	48
NEEDS (acre-feet per year)*	0	0	0	0	0	0
MINING	2020	2030	2040	2050	2060	2070
DEMAND (acre-feet per year)	355	418	448	414	392	380
EXISTING SUPPLIES (acre-feet per year)	194	194	194	194	194	194
NEEDS (acre-feet per year)*	221	281	294	259	229	210
LIVESTOCK	2020	2030	2040	2050	2060	2070
DEMAND (acre-feet per year)	2,182	2,182	2,182	2,182	2,182	2,182
EXISTING SUPPLIES (acre-feet per year)	2,562	2,562	2,562	2,562	2,562	2,562
NEEDS (acre-feet per year)*	357	357	357	357	357	357
IRRIGATION	2020	2030	2040	2050	2060	2070
DEMAND (acre-feet per year)	8,805	8,805	8,805	8,805	8,805	8,805
EXISTING SUPPLIES (acre-feet per year)	22,233	22,233	22,233	22,233	22,233	22,233
NEEDS (acre-feet per year)*	75	75	75	75	75	75

*WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. The needs shown in the WUG Category Summary report are calculated by first deducting the WUG split's projected demand from its total existing water supply volume. If the WUG split has a greater existing supply volume than projected demand in any given decade, this amount is considered a surplus volume. Before aggregating the difference between supplies and demands to the WUG category level, calculated surpluses are updated to zero so that only the WUGs with needs in the decade are included with the Needs totals.

Region J Source Availability

GROUNDWATER SOURCE TYPE				SOURCE AVAILABILITY (ACRE-FEET PER YEAR)					
SOURCE NAME	COUNTY	BASIN	SALINITY *	2020	2030	2040	2050	2060	2070
AUSTIN CHALK AQUIFER	KINNEY	NUECES	BRACKISH	875	875	875	875	875	875
AUSTIN CHALK AQUIFER	KINNEY	RIO GRANDE	BRACKISH	1,894	1,894	1,894	1,894	1,894	1,894
EDWARDS-BFZ AQUIFER	KINNEY	NUECES	FRESH	6,319	6,319	6,319	6,319	6,319	6,319
EDWARDS-BFZ AQUIFER	KINNEY	RIO GRANDE	FRESH	2	2	2	2	2	2
EDWARDS-TRINITY-PLATEAU AQUIFER	BANDERA	GUADALUPE	FRESH	81	81	81	81	81	81
EDWARDS-TRINITY-PLATEAU AQUIFER	BANDERA	NUECES	FRESH	38	38	38	38	38	38
EDWARDS-TRINITY-PLATEAU AQUIFER	BANDERA	SAN ANTONIO	FRESH	1,890	1,890	1,890	1,890	1,890	1,890
EDWARDS-TRINITY-PLATEAU AQUIFER	KERR	COLORADO	FRESH	245	245	245	245	245	245
EDWARDS-TRINITY-PLATEAU AQUIFER	KERR	GUADALUPE	FRESH	1,015	1,015	1,015	1,015	1,015	1,015
EDWARDS-TRINITY-PLATEAU AQUIFER	KERR	NUECES	FRESH	5	5	5	5	5	5
EDWARDS-TRINITY-PLATEAU AQUIFER	KERR	SAN ANTONIO	FRESH	12	12	12	12	12	12
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	EDWARDS	COLORADO	FRESH	2,305	2,305	2,305	2,305	2,305	2,305
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	EDWARDS	NUECES	FRESH	1,631	1,631	1,631	1,631	1,631	1,631
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	EDWARDS	RIO GRANDE	FRESH	1,740	1,740	1,740	1,740	1,740	1,740
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	KINNEY	NUECES	FRESH	12	12	12	12	12	12
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	KINNEY	RIO GRANDE	FRESH	70,329	70,329	70,329	70,329	70,329	70,329
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	REAL	COLORADO	FRESH	277	277	277	277	277	277
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	REAL	GUADALUPE	FRESH	3	3	3	3	3	3
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	REAL	NUECES	FRESH	7,243	7,243	7,243	7,243	7,243	7,243
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	VAL VERDE	RIO GRANDE	FRESH	50,000	50,000	50,000	50,000	50,000	50,000
ELLENBURGER-SAN SABA AQUIFER	KERR	COLORADO	FRESH	200	200	200	200	200	200
ELLENBURGER-SAN SABA AQUIFER	KERR	GUADALUPE	FRESH	1,802	1,802	1,802	1,802	1,802	1,802
FRIO RIVER ALLUVIUM AQUIFER	REAL	NUECES	FRESH	2,145	2,145	2,145	2,145	2,145	2,145
NUECES RIVER ALLUVIUM AQUIFER	EDWARDS	NUECES	FRESH	1,787	1,787	1,787	1,787	1,787	1,787
NUECES RIVER ALLUVIUM AQUIFER	REAL	NUECES	FRESH	1,787	1,787	1,787	1,787	1,787	1,787
TRINITY AQUIFER	BANDERA	GUADALUPE	FRESH	76	76	76	76	76	76
TRINITY AQUIFER	BANDERA	NUECES	FRESH/ BRACKISH	903	903	903	903	903	903
TRINITY AQUIFER	BANDERA	SAN ANTONIO	FRESH/ BRACKISH	6,305	6,305	6,305	6,305	6,305	6,305
TRINITY AQUIFER	KERR	COLORADO	FRESH	318	318	318	318	318	318
TRINITY AQUIFER	KERR	GUADALUPE	FRESH/ BRACKISH	14,129	14,056	13,767	13,450	13,434	13,434
TRINITY AQUIFER	KERR	NUECES	FRESH	0	0	0	0	0	0
TRINITY AQUIFER	KERR	SAN ANTONIO	FRESH	471	471	471	471	471	471
TRINITY AQUIFER ASR	KERR	GUADALUPE	FRESH	453	453	453	453	453	453
GROUNDWATER SOURCE AVAILABILITY TOTAL				176,292	176,219	175,930	175,613	175,597	175,597

* Salinity field indicates whether the source availability is considered 'fresh' (less than 1,000 mg/L), 'brackish' (1,000 to 10,000 mg/L), 'saline' (10,001 mg/L to 34,999 mg/L), or 'seawater' (35,000 mg/L or greater). Sources can also be labeled as 'fresh/brackish' or 'brackish/saline', if a combination of the salinity types is appropriate.

** Since reservoir sources can exist across multiple counties, the county field value, 'reservoir' is applied to all reservoir sources.

Region J Source Availability

REUSE SOURCE TYPE				SOURCE AVAILABILITY (ACRE-FEET PER YEAR)					
SOURCE NAME	COUNTY	BASIN	SALINITY *	2020	2030	2040	2050	2060	2070
DIRECT REUSE	KERR	GUADALUPE	FRESH	5,000	5,000	5,000	5,000	5,000	5,000
REUSE SOURCE AVAILABILITY TOTAL				5,000	5,000	5,000	5,000	5,000	5,000

SURFACE WATER SOURCE TYPE				SOURCE AVAILABILITY (ACRE-FEET PER YEAR)					
SOURCE NAME	COUNTY	BASIN	SALINITY *	2020	2030	2040	2050	2060	2070
COLORADO RUN-OF-RIVER	EDWARDS	COLORADO	FRESH	32	32	32	32	32	32
GUADALUPE RUN-OF-RIVER	BANDERA	GUADALUPE	FRESH	3	3	3	3	3	3
GUADALUPE RUN-OF-RIVER	KERR	GUADALUPE	FRESH	1,375	1,375	1,375	1,375	1,375	1,375
MEDINA LAKE/RESERVOIR	RESERVOIR**	SAN ANTONIO	FRESH	0	0	0	0	0	0
NUECES RUN-OF-RIVER	BANDERA	NUECES	FRESH	5	5	5	5	5	5
NUECES RUN-OF-RIVER	EDWARDS	NUECES	FRESH	94	94	94	94	94	94
NUECES RUN-OF-RIVER	REAL	NUECES	FRESH	1,751	1,751	1,751	1,751	1,751	1,751
RIO GRANDE RUN-OF-RIVER	KINNEY	RIO GRANDE	FRESH	3,616	3,616	3,616	3,616	3,616	3,616
RIO GRANDE RUN-OF-RIVER	VAL VERDE	RIO GRANDE	FRESH	13,776	13,776	13,776	13,776	13,776	13,776
SAN ANTONIO RUN-OF-RIVER	BANDERA	SAN ANTONIO	FRESH	2	2	2	2	2	2
SURFACE WATER SOURCE AVAILABILITY TOTAL				20,654	20,654	20,654	20,654	20,654	20,654

REGION J SOURCE AVAILABILITY TOTAL				201,946	201,873	201,584	201,267	201,251	201,251

* Salinity field indicates whether the source availability is considered 'fresh' (less than 1,000 mg/L), 'brackish' (1,000 to 10,000 mg/L), 'saline' (10,001 mg/L to 34,999 mg/L), or 'seawater' (35,000 mg/L or greater). Sources can also be labeled as 'fresh/brackish' or 'brackish/saline', if a combination of the salinity types is appropriate.

** Since reservoir sources can exist across multiple counties, the county field value, 'reservoir' is applied to all reservoir sources.

Region J Water User Group (WUG) Existing Water Supply

WUG NAME	SOURCE REGION	SOURCE DESCRIPTION	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
			2020	2030	2040	2050	2060	2070
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU AQUIFER BANDERA COUNTY	34	34	34	34	34	34
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU AQUIFER BANDERA COUNTY	9	9	9	9	9	9
GUADALUPE BASIN TOTAL			43	43	43	43	43	43
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU AQUIFER BANDERA COUNTY	38	38	38	38	38	38
COUNTY-OTHER	J	NUECES RUN-OF-RIVER	0	0	0	0	0	0
COUNTY-OTHER	J	TRINITY AQUIFER BANDERA COUNTY	399	399	399	399	399	399
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU AQUIFER BANDERA COUNTY	0	0	0	0	0	0
LIVESTOCK	J	TRINITY AQUIFER BANDERA COUNTY	44	44	44	44	44	44
IRRIGATION	J	NUECES RUN-OF-RIVER	5	5	5	5	5	5
IRRIGATION	J	TRINITY AQUIFER BANDERA COUNTY	279	279	279	279	279	279
NUECES BASIN TOTAL			765	765	765	765	765	765
BANDERA	J	TRINITY AQUIFER BANDERA COUNTY	534	534	534	534	534	534
BANDERA COUNTY FWSD 1	J	TRINITY AQUIFER BANDERA COUNTY	75	75	75	75	75	75
COUNTY-OTHER BANDERA RIVER RANCH 1	J	NUECES RUN-OF-RIVER	0	0	0	0	0	0
COUNTY-OTHER BANDERA RIVER RANCH 1	J	SAN ANTONIO RUN-OF-RIVER	0	0	0	0	0	0
COUNTY-OTHER BANDERA RIVER RANCH 1	J	TRINITY AQUIFER BANDERA COUNTY	69	69	69	69	69	69
COUNTY-OTHER LAKE MEDINA SHORES	J	NUECES RUN-OF-RIVER	0	0	0	0	0	0
COUNTY-OTHER LAKE MEDINA SHORES	J	SAN ANTONIO RUN-OF-RIVER	0	0	0	0	0	0
COUNTY-OTHER LAKE MEDINA SHORES	J	TRINITY AQUIFER BANDERA COUNTY	55	55	55	55	55	55
COUNTY-OTHER MEDINA WSC	J	NUECES RUN-OF-RIVER	0	0	0	0	0	0
COUNTY-OTHER MEDINA WSC	J	SAN ANTONIO RUN-OF-RIVER	0	0	0	0	0	0
COUNTY-OTHER MEDINA WSC	J	TRINITY AQUIFER BANDERA COUNTY	58	58	58	58	58	58
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU AQUIFER BANDERA COUNTY	379	379	379	379	379	379
COUNTY-OTHER	J	SAN ANTONIO RUN-OF-RIVER	0	0	0	0	0	0
COUNTY-OTHER	J	TRINITY AQUIFER BANDERA COUNTY	4,356	4,356	4,356	4,356	4,356	4,356
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU AQUIFER BANDERA COUNTY	111	111	111	111	111	111
LIVESTOCK	J	TRINITY AQUIFER BANDERA COUNTY	85	85	85	85	85	85
IRRIGATION	J	GUADALUPE RUN-OF-RIVER	3	3	3	3	3	3
IRRIGATION	J	SAN ANTONIO RUN-OF-RIVER	2	2	2	2	2	2
IRRIGATION	J	TRINITY AQUIFER BANDERA COUNTY	684	684	684	684	684	684
SAN ANTONIO BASIN TOTAL			6,411	6,411	6,411	6,411	6,411	6,411
BANDERA COUNTY TOTAL			7,219	7,219	7,219	7,219	7,219	7,219
ROCKSPRINGS	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	871	871	871	871	871	871
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	57	57	57	57	57	57
MINING	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	7	7	7	7	7	7
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	471	471	471	471	471	471

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Existing Water Supply

WUG NAME	SOURCE REGION	SOURCE DESCRIPTION	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
			2020	2030	2040	2050	2060	2070
IRRIGATION	J	COLORADO RUN-OF-RIVER	32	32	32	32	32	32
IRRIGATION	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	78	78	78	78	78	78
COLORADO BASIN TOTAL			1,516	1,516	1,516	1,516	1,516	1,516
ROCKSPRINGS		NO WATER SUPPLY ASSOCIATED WITH WUG	0	0	0	0	0	0
COUNTY-OTHER BARKSDALE WSC	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	110	110	110	110	110	110
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	155	155	155	155	155	155
COUNTY-OTHER	J	NUECES RIVER ALLUVIUM AQUIFER EDWARDS COUNTY	8	8	8	8	8	8
MINING	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	9	9	9	9	9	9
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	206	206	206	206	206	206
IRRIGATION	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	109	109	109	109	109	109
IRRIGATION	J	NUECES RUN-OF-RIVER	94	94	94	94	94	94
NUECES BASIN TOTAL			691	691	691	691	691	691
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	30	30	30	30	30	30
MINING	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	14	14	14	14	14	14
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	110	110	110	110	110	110
IRRIGATION	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	70	70	70	70	70	70
RIO GRANDE BASIN TOTAL			224	224	224	224	224	224
EDWARDS COUNTY TOTAL			2,431	2,431	2,431	2,431	2,431	2,431
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	64	64	64	64	64	64
MINING	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	3	3	3	3	3	3
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	47	47	47	47	47	47
IRRIGATION	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	92	92	92	92	92	92
COLORADO BASIN TOTAL			206	206	206	206	206	206
KERRVILLE	J	DIRECT REUSE	2,425	2,425	2,425	2,425	2,425	2,425
KERRVILLE	J	GUADALUPE RUN-OF-RIVER	150	150	150	150	150	150
KERRVILLE	J	TRINITY AQUIFER KERR COUNTY	3,605	3,605	3,605	3,605	3,605	3,605
KERRVILLE	J	TRINITY AQUIFER ASR KERR COUNTY	453	453	453	453	453	453
KERRVILLE SOUTH WATER	J	TRINITY AQUIFER KERR COUNTY	387	387	387	387	387	387
COUNTY-OTHER CENTER POINT	J	TRINITY AQUIFER KERR COUNTY	11	11	11	11	11	11
COUNTY-OTHER CENTER POINT NORTH WATER SYSTEM	J	TRINITY AQUIFER KERR COUNTY	23	23	23	23	23	23
COUNTY-OTHER CENTER POINT TAYLOR SYSTEM	J	TRINITY AQUIFER KERR COUNTY	43	43	43	43	43	43
COUNTY-OTHER HILLS AND DALES ESTATES	J	TRINITY AQUIFER KERR COUNTY	18	18	18	18	18	18
COUNTY-OTHER NICKERSON FARM WATER SYSTEM	J	TRINITY AQUIFER KERR COUNTY	22	22	22	22	22	22
COUNTY-OTHER OAK FOREST SOUTH WATER	J	TRINITY AQUIFER KERR COUNTY	80	80	80	80	80	80
COUNTY-OTHER PARK PLACE SUBDIVISION	J	TRINITY AQUIFER KERR COUNTY	14	14	14	14	14	14
COUNTY-OTHER PECAN VALLEY	J	TRINITY AQUIFER KERR COUNTY	12	12	12	12	12	12

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Existing Water Supply

WUG NAME	SOURCE REGION	SOURCE DESCRIPTION	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
			2020	2030	2040	2050	2060	2070
COUNTY-OTHER RUSTIC HILLS WATER	J	TRINITY AQUIFER KERR COUNTY	9	9	9	9	9	9
COUNTY-OTHER VERDE PARK ESTATES	J	TRINITY AQUIFER KERR COUNTY	16	16	16	16	16	16
COUNTY-OTHER WESTWOOD WATER SYSTEM	J	TRINITY AQUIFER KERR COUNTY	28	28	28	28	28	28
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	616	616	616	616	616	616
COUNTY-OTHER	J	GUADALUPE RUN-OF-RIVER	10	10	10	10	10	10
COUNTY-OTHER	J	TRINITY AQUIFER KERR COUNTY	7,636	7,636	7,636	7,636	7,636	7,636
MANUFACTURING	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	20	20	20	20	20	20
MANUFACTURING	J	GUADALUPE RUN-OF-RIVER	11	11	11	11	11	11
MANUFACTURING	J	TRINITY AQUIFER KERR COUNTY	17	17	17	17	17	17
MINING	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	14	14	14	14	14	14
MINING	J	GUADALUPE RUN-OF-RIVER	77	77	77	77	77	77
MINING	J	TRINITY AQUIFER KERR COUNTY	31	31	31	31	31	31
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	230	230	230	230	230	230
LIVESTOCK	J	TRINITY AQUIFER KERR COUNTY	143	143	143	143	143	143
IRRIGATION	J	GUADALUPE RUN-OF-RIVER	1,127	1,127	1,127	1,127	1,127	1,127
IRRIGATION	J	TRINITY AQUIFER KERR COUNTY	533	533	533	533	533	533
GUADALUPE BASIN TOTAL			17,761	17,761	17,761	17,761	17,761	17,761
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	0	0	0	0	0	0
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	3	3	3	3	3	3
NUECES BASIN TOTAL			3	3	3	3	3	3
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	3	3	3	3	3	3
COUNTY-OTHER	J	TRINITY AQUIFER KERR COUNTY	258	258	258	258	258	258
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	9	9	9	9	9	9
IRRIGATION	J	EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	0	0	0	0	0	0
IRRIGATION	J	TRINITY AQUIFER KERR COUNTY	63	63	63	63	63	63
SAN ANTONIO BASIN TOTAL			333	333	333	333	333	333
KERR COUNTY TOTAL			18,303	18,303	18,303	18,303	18,303	18,303
COUNTY-OTHER	J	EDWARDS-BFZ AQUIFER KINNEY COUNTY	29	29	29	29	29	29
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS KINNEY COUNTY	5	5	5	5	5	5
LIVESTOCK	J	EDWARDS-BFZ AQUIFER KINNEY COUNTY	66	66	66	66	66	66
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS KINNEY COUNTY	7	7	7	7	7	7
IRRIGATION	J	EDWARDS-BFZ AQUIFER KINNEY COUNTY	2,357	2,357	2,357	2,357	2,357	2,357
NUECES BASIN TOTAL			2,464	2,464	2,464	2,464	2,464	2,464
BRACKETTVILLE	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS KINNEY COUNTY	645	645	645	645	645	645
BRACKETTVILLE	J	RIO GRANDE RUN-OF-RIVER	0	0	0	0	0	0
FORT CLARK SPRINGS MUD	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS KINNEY COUNTY	1,371	1,371	1,371	1,371	1,371	1,371
COUNTY-OTHER	J	AUSTIN CHALK AQUIFER KINNEY COUNTY	80	80	80	80	80	80
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS KINNEY COUNTY	85	85	85	85	85	85
LIVESTOCK	J	AUSTIN CHALK AQUIFER KINNEY COUNTY	226	226	226	226	226	226
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS KINNEY COUNTY	95	95	95	95	95	95
IRRIGATION	J	AUSTIN CHALK AQUIFER KINNEY COUNTY	952	952	952	952	952	952

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Existing Water Supply

WUG NAME	SOURCE REGION	SOURCE DESCRIPTION	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
			2020	2030	2040	2050	2060	2070
IRRIGATION	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS KINNEY COUNTY	3,425	3,425	3,425	3,425	3,425	3,425
IRRIGATION	J	RIO GRANDE RUN-OF-RIVER	3,616	3,616	3,616	3,616	3,616	3,616
RIO GRANDE BASIN TOTAL			10,495	10,495	10,495	10,495	10,495	10,495
KINNEY COUNTY TOTAL			12,959	12,959	12,959	12,959	12,959	12,959
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS REAL COUNTY	15	15	15	15	15	15
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS REAL COUNTY	18	18	18	18	18	18
IRRIGATION	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS REAL COUNTY	188	188	188	188	188	188
COLORADO BASIN TOTAL			221	221	221	221	221	221
CAMP WOOD	J	NUECES RUN-OF-RIVER	0	0	0	0	0	0
LEAKEY	J	FRIO RIVER ALLUVIUM AQUIFER REAL COUNTY	298	298	298	298	298	298
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS REAL COUNTY	156	156	156	156	156	156
COUNTY-OTHER	J	FRIO RIVER ALLUVIUM AQUIFER REAL COUNTY	311	311	311	311	311	311
COUNTY-OTHER	J	NUECES RIVER ALLUVIUM AQUIFER REAL COUNTY	5	5	5	5	5	5
COUNTY-OTHER	J	NUECES RUN-OF-RIVER	0	0	0	0	0	0
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS REAL COUNTY	176	176	176	176	176	176
IRRIGATION	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS REAL COUNTY	187	187	187	187	187	187
IRRIGATION	J	NUECES RUN-OF-RIVER	1,751	1,751	1,751	1,751	1,751	1,751
NUECES BASIN TOTAL			2,884	2,884	2,884	2,884	2,884	2,884
REAL COUNTY TOTAL			3,105	3,105	3,105	3,105	3,105	3,105
DEL RIO UTILITIES COMMISSION	J	RIO GRANDE RUN-OF-RIVER	6,135	6,135	6,135	6,135	6,135	6,135
LAUGHLIN AIR FORCE BASE	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS VAL VERDE COUNTY	60	60	60	60	60	60
LAUGHLIN AIR FORCE BASE	J	RIO GRANDE RUN-OF-RIVER	871	871	871	871	871	871
COUNTY-OTHER	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS VAL VERDE COUNTY	2,904	2,904	2,904	2,904	2,904	2,904
COUNTY-OTHER	J	RIO GRANDE RUN-OF-RIVER	460	460	460	460	460	460
MINING	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS VAL VERDE COUNTY	39	39	39	39	39	39
LIVESTOCK	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS VAL VERDE COUNTY	506	506	506	506	506	506
IRRIGATION	J	EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS VAL VERDE COUNTY	276	276	276	276	276	276
IRRIGATION	J	RIO GRANDE RUN-OF-RIVER	6,310	6,310	6,310	6,310	6,310	6,310
RIO GRANDE BASIN TOTAL			17,561	17,561	17,561	17,561	17,561	17,561
VAL VERDE COUNTY TOTAL			17,561	17,561	17,561	17,561	17,561	17,561
REGION J EXISTING WATER SUPPLY TOTAL			61,578	61,578	61,578	61,578	61,578	61,578

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Needs/Surplus

WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. The needs shown in the WUG Needs/Surplus report are calculated by first deducting the WUG split's projected demand from its total existing water supply volume. If the WUG split has a greater existing supply volume than projected demand in any given decade, this amount is considered a surplus volume. Surplus volumes are shown as positive values, and needs are shown as negative values in parentheses.

	(NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
BANDERA COUNTY - GUADALUPE BASIN						
COUNTY-OTHER	21	20	19	19	19	19
LIVESTOCK	(2)	(2)	(2)	(2)	(2)	(2)
BANDERA COUNTY - NUECES BASIN						
COUNTY-OTHER	321	308	301	299	297	296
LIVESTOCK	(3)	(3)	(3)	(3)	(3)	(3)
IRRIGATION	102	102	102	102	102	102
BANDERA COUNTY - SAN ANTONIO BASIN						
BANDERA	192	151	130	121	115	111
BANDERA COUNTY FWSD 1	(66)	(83)	(92)	(96)	(99)	(100)
COUNTY-OTHER BANDERA RIVER RANCH 1	(28)	(39)	(44)	(46)	(48)	(49)
COUNTY-OTHER LAKE MEDINA SHORES	(196)	(225)	(239)	(244)	(248)	(251)
COUNTY-OTHER MEDINA WSC	(35)	(46)	(51)	(53)	(54)	(55)
COUNTY-OTHER	2,970	2,770	2,669	2,633	2,603	2,586
LIVESTOCK	11	11	11	11	11	11
IRRIGATION	(75)	(75)	(75)	(75)	(75)	(75)
EDWARDS COUNTY - COLORADO BASIN						
ROCKSPRINGS	673	677	680	681	681	681
COUNTY-OTHER	42	43	43	43	43	43
MINING	(12)	(12)	(12)	(12)	(12)	(12)
LIVESTOCK	365	365	365	365	365	365
IRRIGATION	44	44	44	44	44	44
EDWARDS COUNTY - NUECES BASIN						
ROCKSPRINGS	(98)	(96)	(94)	(94)	(94)	(94)
COUNTY-OTHER BARKSDALE WSC	81	82	83	84	84	84
COUNTY-OTHER	120	122	124	124	124	124
MINING	(16)	(16)	(16)	(16)	(16)	(16)
LIVESTOCK	14	14	14	14	14	14
IRRIGATION	114	114	114	114	114	114
EDWARDS COUNTY - RIO GRANDE BASIN						
COUNTY-OTHER	22	22	23	23	23	23
MINING	(31)	(31)	(31)	(31)	(31)	(31)
LIVESTOCK	11	11	11	11	11	11
IRRIGATION	10	10	10	10	10	10
KERR COUNTY - COLORADO BASIN						
COUNTY-OTHER	21	20	20	20	19	18
MINING	(11)	(12)	(15)	(16)	(17)	(19)
LIVESTOCK	(119)	(119)	(119)	(119)	(119)	(119)
IRRIGATION	31	31	31	31	31	31
KERR COUNTY - GUADALUPE BASIN						
KERRVILLE	1,551	1,475	1,455	1,396	1,328	1,269
KERRVILLE SOUTH WATER	46	41	40	35	29	24
COUNTY-OTHER CENTER POINT	(3)	(3)	(3)	(3)	(3)	(4)
COUNTY-OTHER CENTER POINT NORTH WATER SYSTEM	1	1	1	1	0	0

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Needs/Surplus

COUNTY-OTHER CENTER POINT TAYLOR SYSTEM	(2)	(2)	(3)	(3)	(4)	(5)
COUNTY-OTHER HILLS AND DALES ESTATES	1	1	1	0	0	0
COUNTY-OTHER NICKERSON FARM WATER SYSTEM	5	5	5	5	4	4
COUNTY-OTHER OAK FOREST SOUTH WATER	24	23	23	22	21	20
COUNTY-OTHER PARK PLACE SUBDIVISION	3	3	3	3	3	2
COUNTY-OTHER PECAN VALLEY	2	1	1	1	1	1
COUNTY-OTHER RUSTIC HILLS WATER	2	2	2	2	2	2
COUNTY-OTHER VERDE PARK ESTATES	1	1	1	1	0	0
COUNTY-OTHER WESTWOOD WATER SYSTEM	5	5	5	5	4	4
COUNTY-OTHER	6,525	6,493	6,489	6,458	6,420	6,387
MANUFACTURING	28	27	27	27	27	27
MINING	60	57	40	39	31	24
LIVESTOCK	(173)	(173)	(173)	(173)	(173)	(173)
IRRIGATION	421	421	421	421	421	421
KERR COUNTY - NUECES BASIN						
COUNTY-OTHER	(1)	(1)	(1)	(1)	(1)	(1)
LIVESTOCK	(6)	(6)	(6)	(6)	(6)	(6)
KERR COUNTY - SAN ANTONIO BASIN						
COUNTY-OTHER	238	238	237	237	237	236
LIVESTOCK	(27)	(27)	(27)	(27)	(27)	(27)
IRRIGATION	21	21	21	21	21	21
KINNEY COUNTY - NUECES BASIN						
COUNTY-OTHER	23	23	23	23	24	24
LIVESTOCK	(27)	(27)	(27)	(27)	(27)	(27)
IRRIGATION	1,057	1,057	1,057	1,057	1,057	1,057
KINNEY COUNTY - RIO GRANDE BASIN						
BRACKETTVILLE	37	43	51	52	53	53
FORT CLARK SPRINGS MUD	753	755	759	761	762	762
COUNTY-OTHER	112	113	114	114	114	114
LIVESTOCK	197	197	197	197	197	197
IRRIGATION	5,580	5,580	5,580	5,580	5,580	5,580
REAL COUNTY - COLORADO BASIN						
COUNTY-OTHER	11	11	12	12	12	12
LIVESTOCK	5	5	5	5	5	5
IRRIGATION	176	176	176	176	176	176
REAL COUNTY - NUECES BASIN						
CAMP WOOD	(143)	(139)	(136)	(135)	(135)	(135)
LEAKEY	105	112	118	120	121	121
COUNTY-OTHER	352	356	359	361	361	361
LIVESTOCK	38	38	38	38	38	38
IRRIGATION	1,680	1,680	1,680	1,680	1,680	1,680
VAL VERDE COUNTY - RIO GRANDE BASIN						
DEL RIO UTILITIES COMMISSION	(4,423)	(4,918)	(5,419)	(5,995)	(6,598)	(7,191)
LAUGHLIN AIR FORCE BASE	(87)	(183)	(284)	(346)	(345)	(345)
COUNTY-OTHER	1,388	1,057	727	362	(12)	(377)
MINING	(151)	(210)	(220)	(184)	(153)	(132)
LIVESTOCK	96	96	96	96	96	96
IRRIGATION	4,267	4,267	4,267	4,267	4,267	4,267

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Second-Tier Identified Water Needs

Second-tier needs are WUG split needs adjusted to include the implementation of recommended demand reduction and direct reuse water management strategies.

	WUG SECOND-TIER NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
BANDERA COUNTY - GUADALUPE BASIN						
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	1	1	1	1	1	1
BANDERA COUNTY - NUECES BASIN						
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	2	2	2	2	2	2
IRRIGATION	0	0	0	0	0	0
BANDERA COUNTY - SAN ANTONIO BASIN						
BANDERA	0	0	0	0	0	0
BANDERA COUNTY FWSD 1	66	83	92	96	99	100
COUNTY-OTHER	0	0	0	0	0	0
COUNTY-OTHER BANDERA RIVER RANCH 1	24	35	40	42	44	45
COUNTY-OTHER LAKE MEDINA SHORES	193	222	236	241	245	248
COUNTY-OTHER MEDINA WSC	34	45	50	52	53	54
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	39	39	39	39	39	39
EDWARDS COUNTY - COLORADO BASIN						
ROCKSPRINGS	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MINING	12	12	12	12	12	12
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
EDWARDS COUNTY - NUECES BASIN						
ROCKSPRINGS	98	96	94	94	94	94
COUNTY-OTHER	0	0	0	0	0	0
COUNTY-OTHER BARKSDALE WSC	0	0	0	0	0	0
MINING	16	16	16	16	16	16
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
EDWARDS COUNTY - RIO GRANDE BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	31	31	31	31	31	31
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
KERR COUNTY - COLORADO BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	11	12	15	16	17	19
LIVESTOCK	95	95	95	95	95	95
IRRIGATION	0	0	0	0	0	0
KERR COUNTY - GUADALUPE BASIN						
KERRVILLE	0	0	0	0	0	0
KERRVILLE SOUTH WATER	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
COUNTY-OTHER CENTER POINT	0	2	2	2	2	3
COUNTY-OTHER CENTER POINT NORTH WATER SYSTEM	0	0	0	0	0	0

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Second-Tier Identified Water Needs

	WUG SECOND-TIER NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
KERR COUNTY - GUADALUPE BASIN						
COUNTY-OTHER CENTER POINT TAYLOR SYSTEM	0	1	2	2	3	4
COUNTY-OTHER HILLS AND DALES ESTATES	0	0	0	0	0	0
COUNTY-OTHER NICKERSON FARM WATER SYSTEM	0	0	0	0	0	0
COUNTY-OTHER OAK FOREST SOUTH WATER	0	0	0	0	0	0
COUNTY-OTHER PARK PLACE SUBDIVISION	0	0	0	0	0	0
COUNTY-OTHER PECAN VALLEY	0	0	0	0	0	0
COUNTY-OTHER RUSTIC HILLS WATER	0	0	0	0	0	0
COUNTY-OTHER VERDE PARK ESTATES	0	0	0	0	0	0
COUNTY-OTHER WESTWOOD WATER SYSTEM	0	0	0	0	0	0
MANUFACTURING	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	138	138	138	138	138	138
IRRIGATION	0	0	0	0	0	0
KERR COUNTY - NUECES BASIN						
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	5	5	5	5	5	5
KERR COUNTY - SAN ANTONIO BASIN						
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	22	22	22	22	22	22
IRRIGATION	0	0	0	0	0	0
KINNEY COUNTY - NUECES BASIN						
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	27	27	27	27	27	27
IRRIGATION	0	0	0	0	0	0
KINNEY COUNTY - RIO GRANDE BASIN						
BRACKETTVILLE	0	0	0	0	0	0
FORT CLARK SPRINGS MUD	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
REAL COUNTY - COLORADO BASIN						
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
REAL COUNTY - NUECES BASIN						
CAMP WOOD	142	138	135	134	134	134
LEAKEY	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
VAL VERDE COUNTY - RIO GRANDE BASIN						
DEL RIO UTILITIES COMMISSION	4,411	1,814	2,315	2,891	3,494	4,087
LAUGHLIN AIR FORCE BASE	87	183	284	346	345	345
COUNTY-OTHER	0	0	0	0	0	365
MINING	151	210	220	184	153	132
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Second-Tier Identified Water Needs

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Second-Tier Identified Water Needs Summary

Second-tier needs are WUG split needs adjusted to include the implementation of recommended demand reduction and direct reuse water management strategies.

WUG CATEGORY	NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
MUNICIPAL	4,804	2,314	2,920	3,561	4,166	4,760
COUNTY-OTHER	251	305	330	339	347	719
MANUFACTURING	0	0	0	0	0	0
MINING	221	281	294	259	229	210
LIVESTOCK	290	290	290	290	290	290
IRRIGATION	39	39	39	39	39	39

Region J Source Water Balance (Availability - WUG Supply)

GROUNDWATER SOURCE TYPE				SOURCE WATER BALANCE (ACRE-FEET PER YEAR)					
SOURCE NAME	COUNTY	BASIN	SALINITY*	2020	2030	2040	2050	2060	2070
AUSTIN CHALK AQUIFER	KINNEY	NUECES	BRACKISH	875	875	875	875	875	875
AUSTIN CHALK AQUIFER	KINNEY	RIO GRANDE	BRACKISH	636	636	636	636	636	636
EDWARDS-BFZ AQUIFER	KINNEY	NUECES	FRESH	3,867	3,867	3,867	3,867	3,867	3,867
EDWARDS-BFZ AQUIFER	KINNEY	RIO GRANDE	FRESH	2	2	2	2	2	2
EDWARDS-TRINITY-PLATEAU AQUIFER	BANDERA	GUADALUPE	FRESH	38	38	38	38	38	38
EDWARDS-TRINITY-PLATEAU AQUIFER	BANDERA	NUECES	FRESH	0	0	0	0	0	0
EDWARDS-TRINITY-PLATEAU AQUIFER	BANDERA	SAN ANTONIO	FRESH	1,400	1,400	1,400	1,400	1,400	1,400
EDWARDS-TRINITY-PLATEAU AQUIFER	KERR	COLORADO	FRESH	39	39	39	39	39	39
EDWARDS-TRINITY-PLATEAU AQUIFER	KERR	GUADALUPE	FRESH	135	135	135	135	135	135
EDWARDS-TRINITY-PLATEAU AQUIFER	KERR	NUECES	FRESH	2	2	2	2	2	2
EDWARDS-TRINITY-PLATEAU AQUIFER	KERR	SAN ANTONIO	FRESH	0	0	0	0	0	0
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	EDWARDS	COLORADO	FRESH	821	821	821	821	821	821
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	EDWARDS	NUECES	FRESH	1,042	1,042	1,042	1,042	1,042	1,042
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	EDWARDS	RIO GRANDE	FRESH	1,516	1,516	1,516	1,516	1,516	1,516
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	KINNEY	NUECES	FRESH	0	0	0	0	0	0
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	KINNEY	RIO GRANDE	FRESH	64,708	64,708	64,708	64,708	64,708	64,708
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	REAL	COLORADO	FRESH	56	56	56	56	56	56
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	REAL	GUADALUPE	FRESH	3	3	3	3	3	3
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	REAL	NUECES	FRESH	6,724	6,724	6,724	6,724	6,724	6,724
EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS	VAL VERDE	RIO GRANDE	FRESH	45,755	45,755	45,755	45,755	45,755	45,755
ELLENBURGER-SAN SABA AQUIFER	KERR	COLORADO	FRESH	200	200	200	200	200	200
ELLENBURGER-SAN SABA AQUIFER	KERR	GUADALUPE	FRESH	1,802	1,802	1,802	1,802	1,802	1,802
FRIO RIVER ALLUVIUM AQUIFER	REAL	NUECES	FRESH	1,536	1,536	1,536	1,536	1,536	1,536
NUECES RIVER ALLUVIUM AQUIFER	EDWARDS	NUECES	FRESH	1,779	1,779	1,779	1,779	1,779	1,779
NUECES RIVER ALLUVIUM AQUIFER	REAL	NUECES	FRESH	1,782	1,782	1,782	1,782	1,782	1,782
TRINITY AQUIFER	BANDERA	GUADALUPE	FRESH	76	76	76	76	76	76
TRINITY AQUIFER	BANDERA	NUECES	FRESH/ BRACKISH	181	181	181	181	181	181
TRINITY AQUIFER	BANDERA	SAN ANTONIO	FRESH/ BRACKISH	389	389	389	389	389	389
TRINITY AQUIFER	KERR	COLORADO	FRESH	318	318	318	318	318	318
TRINITY AQUIFER	KERR	GUADALUPE	FRESH/ BRACKISH	1,501	1,428	1,139	822	806	806
TRINITY AQUIFER	KERR	NUECES	FRESH	0	0	0	0	0	0
TRINITY AQUIFER	KERR	SAN ANTONIO	FRESH	150	150	150	150	150	150

* Salinity field indicates whether the source availability is considered 'fresh' (less than 1,000 mg/L), 'brackish' (1,000 to 10,000 mg/L), 'saline' (10,001 mg/L to 34,999 mg/L), or 'seawater' (35,000 mg/L or greater). Sources can also be labeled as 'fresh/brackish' or 'brackish/saline', if a combination of the salinity types is appropriate.

** Since reservoir sources can exist across multiple counties, the county field value, 'reservoir' is applied to all reservoir sources.

Region J Source Water Balance (Availability - WUG Supply)

GROUNDWATER SOURCE TYPE				SOURCE WATER BALANCE (ACRE-FEET PER YEAR)					
SOURCE NAME	COUNTY	BASIN	SALINITY*	2020	2030	2040	2050	2060	2070
TRINITY AQUIFER ASR	KERR	GUADALUPE	FRESH	0	0	0	0	0	0
GROUNDWATER SOURCE WATER BALANCE TOTAL				137,333	137,260	136,971	136,654	136,638	136,638

REUSE SOURCE TYPE				SOURCE WATER BALANCE (ACRE-FEET PER YEAR)					
SOURCE NAME	COUNTY	BASIN	SALINITY*	2020	2030	2040	2050	2060	2070
DIRECT REUSE	KERR	GUADALUPE	FRESH	2,575	2,575	2,575	2,575	2,575	2,575
REUSE SOURCE WATER BALANCE TOTAL				2,575	2,575	2,575	2,575	2,575	2,575

SURFACE WATER SOURCE TYPE				SOURCE WATER BALANCE (ACRE-FEET PER YEAR)					
SOURCE NAME	COUNTY	BASIN	SALINITY*	2020	2030	2040	2050	2060	2070
COLORADO RUN-OF-RIVER	EDWARDS	COLORADO	FRESH	0	0	0	0	0	0
GUADALUPE RUN-OF-RIVER	BANDERA	GUADALUPE	FRESH	0	0	0	0	0	0
GUADALUPE RUN-OF-RIVER	KERR	GUADALUPE	FRESH	0	0	0	0	0	0
MEDINA LAKE/RESERVOIR	RESERVOIR**	SAN ANTONIO	FRESH	0	0	0	0	0	0
NUECES RUN-OF-RIVER	BANDERA	NUECES	FRESH	0	0	0	0	0	0
NUECES RUN-OF-RIVER	EDWARDS	NUECES	FRESH	0	0	0	0	0	0
NUECES RUN-OF-RIVER	REAL	NUECES	FRESH	0	0	0	0	0	0
RIO GRANDE RUN-OF-RIVER	KINNEY	RIO GRANDE	FRESH	0	0	0	0	0	0
RIO GRANDE RUN-OF-RIVER	VAL VERDE	RIO GRANDE	FRESH	0	0	0	0	0	0
SAN ANTONIO RUN-OF-RIVER	BANDERA	SAN ANTONIO	FRESH	0	0	0	0	0	0
SURFACE WATER SOURCE WATER BALANCE TOTAL				0	0	0	0	0	0

REGION J SOURCE WATER BALANCE TOTAL				139,908	139,835	139,546	139,229	139,213	139,213

* Salinity field indicates whether the source availability is considered 'fresh' (less than 1,000 mg/L), 'brackish' (1,000 to 10,000 mg/L), 'saline' (10,001 mg/L to 34,999 mg/L), or 'seawater' (35,000 mg/L or greater). Sources can also be labeled as 'fresh/brackish' or 'brackish/saline', if a combination of the salinity types is appropriate.

** Since reservoir sources can exist across multiple counties, the county field value, 'reservoir' is applied to all reservoir sources.

Region J Water User Group (WUG) Data Comparison to 2016 Regional Water Plan (RWP)

	2020 PLANNING DECADE			2070 PLANNING DECADE		
	2016 RWP	2021 RWP	DIFFERENCE (%)	2016 RWP	2021 RWP	DIFFERENCE (%)
BANDERA COUNTY COUNTY-OTHER WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	2,541	5,388	112.0%	2,541	5,388	112.0%
PROJECTED DEMAND TOTAL (acre-feet per year)	2,493	2,335	-6.3%	3,033	2,842	-6.3%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	259	100.0%	493	355	-28.0%
BANDERA COUNTY IRRIGATION WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	703	973	38.4%	703	973	38.4%
PROJECTED DEMAND TOTAL (acre-feet per year)	432	946	119.0%	432	946	119.0%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	129	75	-41.9%	129	75	-41.9%
BANDERA COUNTY LIVESTOCK WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	298	249	-16.4%	298	249	-16.4%
PROJECTED DEMAND TOTAL (acre-feet per year)	297	243	-18.2%	297	243	-18.2%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	13	5	-61.5%	13	5	-61.5%
BANDERA COUNTY MUNICIPAL WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	660	609	-7.7%	660	609	-7.7%
PROJECTED DEMAND TOTAL (acre-feet per year)	191	483	152.9%	236	598	153.4%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	66	100.0%	0	100	100.0%
EDWARDS COUNTY COUNTY-OTHER WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	362	360	-0.6%	362	360	-0.6%
PROJECTED DEMAND TOTAL (acre-feet per year)	96	95	-1.0%	87	86	-1.1%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	0	0.0%	0	0	0.0%
EDWARDS COUNTY IRRIGATION WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	443	383	-13.5%	443	383	-13.5%
PROJECTED DEMAND TOTAL (acre-feet per year)	227	215	-5.3%	184	215	16.8%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	0	0.0%	0	0	0.0%
EDWARDS COUNTY LIVESTOCK WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	523	787	50.5%	523	787	50.5%
PROJECTED DEMAND TOTAL (acre-feet per year)	523	397	-24.1%	523	397	-24.1%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	16	0	-100.0%	16	0	-100.0%
EDWARDS COUNTY MINING WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	89	30	-66.3%	89	30	-66.3%
PROJECTED DEMAND TOTAL (acre-feet per year)	89	89	0.0%	89	89	0.0%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	22	59	168.2%	22	59	168.2%
EDWARDS COUNTY MUNICIPAL WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	919	871	-5.2%	919	871	-5.2%
PROJECTED DEMAND TOTAL (acre-feet per year)	295	296	0.3%	283	284	0.4%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	98	98	0.0%	94	94	0.0%
KERR COUNTY COUNTY-OTHER WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	5,349	8,863	65.7%	5,349	8,863	65.7%
PROJECTED DEMAND TOTAL (acre-feet per year)	2,029	2,041	0.6%	2,196	2,199	0.1%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	6	6	0.0%	8	10	25.0%
KERR COUNTY IRRIGATION WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	1,405	1,815	29.2%	1,405	1,815	29.2%
PROJECTED DEMAND TOTAL (acre-feet per year)	842	1,342	59.4%	719	1,342	86.6%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	14	0	-100.0%	12	0	-100.0%

*WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. The needs shown in the WUG Data Comparison to 2016 RWP report are calculated by first deducting the WUG split's projected demand from its total existing water supply volume. If the WUG split has a greater existing supply volume than projected demand in any given decade, this amount is considered a surplus volume. Before aggregating the difference between supplies and demands to the WUG county and category level, calculated surpluses are updated to zero so that only the WUGs with needs in the decade are included with the Needs totals.

Region J Water User Group (WUG) Data Comparison to 2016 Regional Water Plan (RWP)

	2020 PLANNING DECADE			2070 PLANNING DECADE		
	2016 RWP	2021 RWP	DIFFERENCE (%)	2016 RWP	2021 RWP	DIFFERENCE (%)
KERR COUNTY LIVESTOCK WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	891	432	-51.5%	891	432	-51.5%
PROJECTED DEMAND TOTAL (acre-feet per year)	890	757	-14.9%	890	757	-14.9%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	130	325	150.0%	130	325	150.0%
KERR COUNTY MANUFACTURING WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	34	48	41.2%	34	48	41.2%
PROJECTED DEMAND TOTAL (acre-feet per year)	25	20	-20.0%	34	21	-38.2%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	0	0.0%	0	0	0.0%
KERR COUNTY MINING WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	106	125	17.9%	106	125	17.9%
PROJECTED DEMAND TOTAL (acre-feet per year)	76	76	0.0%	120	120	0.0%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	12	11	-8.3%	21	19	-9.5%
KERR COUNTY MUNICIPAL WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	2,364	7,020	197.0%	2,364	7,020	197.0%
PROJECTED DEMAND TOTAL (acre-feet per year)	5,201	5,423	4.3%	5,474	5,727	4.6%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	3,224	0	-100.0%	3,507	0	-100.0%
KINNEY COUNTY COUNTY-OTHER WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	291	199	-31.6%	291	199	-31.6%
PROJECTED DEMAND TOTAL (acre-feet per year)	95	64	-32.6%	90	61	-32.2%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	0	0.0%	0	0	0.0%
KINNEY COUNTY IRRIGATION WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	7,833	10,350	32.1%	7,833	10,350	32.1%
PROJECTED DEMAND TOTAL (acre-feet per year)	6,730	3,713	-44.8%	6,730	3,713	-44.8%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	0	0.0%	0	0	0.0%
KINNEY COUNTY LIVESTOCK WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	422	394	-6.6%	422	394	-6.6%
PROJECTED DEMAND TOTAL (acre-feet per year)	422	224	-46.9%	422	224	-46.9%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	22	27	22.7%	22	27	22.7%
KINNEY COUNTY MUNICIPAL WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	2,016	2,016	0.0%	2,016	2,016	0.0%
PROJECTED DEMAND TOTAL (acre-feet per year)	1,159	1,226	5.8%	1,136	1,201	5.7%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	0	0.0%	0	0	0.0%
REAL COUNTY COUNTY-OTHER WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	1,108	487	-56.0%	1,108	487	-56.0%
PROJECTED DEMAND TOTAL (acre-feet per year)	280	124	-55.7%	257	114	-55.6%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	0	0.0%	0	0	0.0%
REAL COUNTY IRRIGATION WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	2,365	2,126	-10.1%	2,365	2,126	-10.1%
PROJECTED DEMAND TOTAL (acre-feet per year)	238	270	13.4%	191	270	41.4%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	0	0.0%	0	0	0.0%
REAL COUNTY LIVESTOCK WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	261	194	-25.7%	261	194	-25.7%
PROJECTED DEMAND TOTAL (acre-feet per year)	261	151	-42.1%	261	151	-42.1%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	33	0	-100.0%	33	0	-100.0%

*WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. The needs shown in the WUG Data Comparison to 2016 RWP report are calculated by first deducting the WUG split's projected demand from its total existing water supply volume. If the WUG split has a greater existing supply volume than projected demand in any given decade, this amount is considered a surplus volume. Before aggregating the difference between supplies and demands to the WUG county and category level, calculated surpluses are updated to zero so that only the WUGs with needs in the decade are included with the Needs totals.

Region J Water User Group (WUG) Data Comparison to 2016 Regional Water Plan (RWP)

	2020 PLANNING DECADE			2070 PLANNING DECADE		
	2016 RWP	2021 RWP	DIFFERENCE (%)	2016 RWP	2021 RWP	DIFFERENCE (%)
REAL COUNTY MUNICIPAL WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	0	298	100.0%	0	298	100.0%
PROJECTED DEMAND TOTAL (acre-feet per year)	134	336	150.7%	126	312	147.6%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	134	143	6.7%	126	135	7.1%
VAL VERDE COUNTY COUNTY-OTHER WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	4,513	3,364	-25.5%	4,513	3,364	-25.5%
PROJECTED DEMAND TOTAL (acre-feet per year)	1,937	1,976	2.0%	3,694	3,741	1.3%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	0	0.0%	0	377	100.0%
VAL VERDE COUNTY IRRIGATION WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	2,795	6,586	135.6%	2,795	6,586	135.6%
PROJECTED DEMAND TOTAL (acre-feet per year)	2,460	2,319	-5.7%	2,026	2,319	14.5%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	0	0.0%	0	0	0.0%
VAL VERDE COUNTY LIVESTOCK WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	533	506	-5.1%	533	506	-5.1%
PROJECTED DEMAND TOTAL (acre-feet per year)	533	410	-23.1%	533	410	-23.1%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	0	0.0%	0	0	0.0%
VAL VERDE COUNTY MINING WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	186	39	-79.0%	186	39	-79.0%
PROJECTED DEMAND TOTAL (acre-feet per year)	190	190	0.0%	171	171	0.0%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	4	151	3675.0%	0	132	100.0%
VAL VERDE COUNTY MUNICIPAL WUG TYPE						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	29,199	7,066	-75.8%	29,199	7,066	-75.8%
PROJECTED DEMAND TOTAL (acre-feet per year)	11,657	11,576	-0.7%	14,703	14,602	-0.7%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	0	4,510	100.0%	0	7,536	100.0%
REGION J						
EXISTING WUG SUPPLY TOTAL (acre-feet per year)	68,209	61,578	-9.7%	68,209	61,578	-9.7%
PROJECTED DEMAND TOTAL (acre-feet per year)	39,802	37,337	-6.2%	44,937	43,155	-4.0%
WATER SUPPLY NEEDS TOTAL (acre-feet per year)*	3,857	5,735	48.7%	4,626	9,249	99.9%

*WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. The needs shown in the WUG Data Comparison to 2016 RWP report are calculated by first deducting the WUG split's projected demand from its total existing water supply volume. If the WUG split has a greater existing supply volume than projected demand in any given decade, this amount is considered a surplus volume. Before aggregating the difference between supplies and demands to the WUG county and category level, calculated surpluses are updated to zero so that only the WUGs with needs in the decade are included with the Needs totals.

Region J Source Data Comparison to 2016 Regional Water Plan (RWP)

	2020 PLANNING DECADE			2070 PLANNING DECADE		
	2016 RWP	2021 RWP	DIFFERENCE (%)	2016 RWP	2021 RWP	DIFFERENCE (%)
BANDERA COUNTY						
GROUNDWATER AVAILABILITY TOTAL (acre-feet per year)	7,967	9,293	16.6%	7,967	9,293	16.6%
SURFACE WATER AVAILABILITY TOTAL (acre-feet per year)	104	10	-90.4%	104	10	-90.4%
EDWARDS COUNTY						
GROUNDWATER AVAILABILITY TOTAL (acre-feet per year)	7,425	7,463	0.5%	7,425	7,463	0.5%
SURFACE WATER AVAILABILITY TOTAL (acre-feet per year)	304	126	-58.6%	304	126	-58.6%
KERR COUNTY						
GROUNDWATER AVAILABILITY TOTAL (acre-feet per year)	16,576	18,650	12.5%	15,881	17,955	13.1%
SURFACE WATER AVAILABILITY TOTAL (acre-feet per year)	1,683	1,375	-18.3%	1,683	1,375	-18.3%
KINNEY COUNTY						
GROUNDWATER AVAILABILITY TOTAL (acre-feet per year)	81,587	79,431	-2.6%	81,587	79,431	-2.6%
SURFACE WATER AVAILABILITY TOTAL (acre-feet per year)	1,187	3,616	204.6%	1,187	3,616	204.6%
REAL COUNTY						
GROUNDWATER AVAILABILITY TOTAL (acre-feet per year)	11,461	11,455	-0.1%	11,461	11,455	-0.1%
SURFACE WATER AVAILABILITY TOTAL (acre-feet per year)	2,215	1,751	-20.9%	2,215	1,751	-20.9%
VAL VERDE COUNTY						
GROUNDWATER AVAILABILITY TOTAL (acre-feet per year)	24,988	50,000	100.1%	24,988	50,000	100.1%
SURFACE WATER AVAILABILITY TOTAL (acre-feet per year)	14,111	13,776	-2.4%	14,111	13,776	-2.4%
REGION J						
GROUNDWATER AVAILABILITY TOTAL (acre-feet per year)	150,004	176,292	17.5%	149,309	175,597	17.6%
SURFACE WATER AVAILABILITY TOTAL (acre-feet per year)	19,604	20,654	5.4%	19,604	20,654	5.4%

* Since reservoir sources can exist across multiple counties, the county field value, 'reservoir' is applied to all reservoir sources.

Region J Water User Group (WUG) Unmet Needs

WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. The unmet needs shown in the WUG Unmet Needs report are calculated by first deducting the WUG split's projected demand from the sum of its total existing water supply volume and all associated recommended water management strategy water volumes. If the WUG split has a greater future supply volume than projected demand in any given decade, this amount is considered a surplus volume. In order to display only unmet needs associated with the WUG split, these surplus volumes are updated to a zero and the unmet needs water volumes are shown as absolute values.

	WUG UNMET NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
BANDERA COUNTY - SAN ANTONIO BASIN						
COUNTY-OTHER BANDERA RIVER RANCH 1	24	35	40	42	44	45
COUNTY-OTHER LAKE MEDINA SHORES	193	222	236	241	245	248
KERR COUNTY - COLORADO BASIN						
LIVESTOCK	95	95	95	95	95	95
KERR COUNTY - GUADALUPE BASIN						
LIVESTOCK	138	138	138	138	138	138
KERR COUNTY - NUECES BASIN						
LIVESTOCK	5	5	5	5	5	5
KERR COUNTY - SAN ANTONIO BASIN						
LIVESTOCK	22	22	22	22	22	22
KINNEY COUNTY - NUECES BASIN						
LIVESTOCK	27	27	27	27	27	27
VAL VERDE COUNTY - RIO GRANDE BASIN						
COUNTY-OTHER	0	0	0	0	0	365

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Water User Group (WUG) Unmet Needs Summary

WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. The unmet needs shown in the WUG Unmet Needs Summary report are calculated by first deducting the WUG split's projected demand from the sum of its total existing water supply volume and all associated recommended water management strategy water volumes. If the WUG split has a greater future supply volume than projected demand in any given decade, this amount is considered a surplus volume. Before aggregating the difference between supplies and demands to the WUG category level, calculated surpluses are updated to zero so that only the WUGs with unmet needs in the decade are included with the Needs totals. Unmet needs water volumes are shown as absolute values.

WUG CATEGORY	NEEDS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
MUNICIPAL	0	0	0	0	0	0
COUNTY-OTHER	217	257	276	283	289	658
MANUFACTURING	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	287	287	287	287	287	287
IRRIGATION	0	0	0	0	0	0

Region J Recommended Water User Group (WUG) Water Management Strategies (WMS)

						WATER MANAGEMENT STRATEGY SUPPLY (ACRE-FEET PER YEAR)					
WUG ENTITY NAME	WMS SPONSOR REGION	WMS NAME	SOURCE NAME	UNIT COST 2020	UNIT COST 2070	2020	2030	2040	2050	2060	2070
BANDERA	J	CITY OF BANDERA - ADDITIONAL MIDDLE TRINITY WELLS WITHIN CITY WATER INFRASTRUCTURE AREA	J TRINITY AQUIFER FRESH/BRACKISH BANDERA COUNTY	\$335	\$62	161	161	161	161	161	161
BANDERA	J	CITY OF BANDERA - PROMOTE, DESIGN AND INSTALL RAINWATER HARVESTING SYSTEMS ON PUBLIC BUILDINGS	J RAINWATER HARVESTING	N/A	\$0	0	1	1	1	1	1
BANDERA	J	CITY OF BANDERA - REUSE TREATED WASTEWATER EFFLUENT FOR IRRIGATION OF PUBLIC SPACES	J DIRECT NON-POTABLE REUSE	N/A	\$84	0	310	310	310	310	310
BANDERA	J	CITY OF BANDERA - SURFACE WATER ACQUISITION, TREATMENT AND ASR	J TRINITY AQUIFER ASR FRESH/BRACKISH BANDERA COUNTY	N/A	\$8	0	1,500	1,500	1,500	1,500	1,500
BANDERA COUNTY FWSD 1	J	BANDERA COUNTY OTHER (FWSD #1) - ADDITIONAL GROUNDWATER WELL	J TRINITY AQUIFER FRESH/BRACKISH BANDERA COUNTY	\$1030	\$330	100	100	100	100	100	100
BRACKETTVILLE	J	CITY OF BRACKETTVILLE - INCREASE SUPPLY TO SPOFFORD WITH NEW WATER LINE AND STORAGE	J EDWARDS-TRINITY- PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS KINNEY COUNTY	N/A	\$13571	0	6	6	6	6	6
CAMP WOOD	J	CITY OF CAMP WOOD - ADDITIONAL GROUNDWATER WELL	J EDWARDS-TRINITY- PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS REAL COUNTY	\$972	\$133	143	143	143	143	143	143
CAMP WOOD	J	CITY OF CAMP WOOD - PUBLIC CONSERVATION EDUCATION	DEMAND REDUCTION	\$374	\$374	1	1	1	1	1	1
COUNTY-OTHER, BANDERA	J	BANDERA COUNTY OTHER - DROUGHT MANAGEMENT (BCRAGD) (NUECES)	DEMAND REDUCTION	\$0	\$0	23	26	27	28	28	28
COUNTY-OTHER, BANDERA	J	BANDERA COUNTY OTHER - DROUGHT MANAGEMENT (BCRAGD) (SAN ANTONIO)	DEMAND REDUCTION	\$0	\$0	441	491	516	525	533	537
COUNTY-OTHER, BANDERA	J	BANDERA COUNTY OTHER (BANDERA RIVER RANCH #1) - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION	\$17275	\$1703	4	4	4	4	4	4
COUNTY-OTHER, BANDERA	J	BANDERA COUNTY OTHER (ENCHANTED RIVER ESTATES) - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION	\$12329	\$1370	1	1	1	1	1	1
COUNTY-OTHER, BANDERA	J	BANDERA COUNTY OTHER (FWSD #1) - PUBLIC CONSERVATION EDUCATION	DEMAND REDUCTION	\$170	\$221	2	2	2	2	2	2
COUNTY-OTHER, BANDERA	J	BANDERA COUNTY OTHER (LAKE MEDINA SHORES) - PUBLIC CONSERVATION EDUCATION	DEMAND REDUCTION	\$403	\$524	3	3	3	3	3	3
COUNTY-OTHER, BANDERA	J	BANDERA COUNTY OTHER (MEDINA WSC) - ADDITIONAL GROUNDWATER WELL	J TRINITY AQUIFER FRESH/BRACKISH BANDERA COUNTY	\$2582	\$764	55	55	55	55	55	55
COUNTY-OTHER, BANDERA	J	BANDERA COUNTY OTHER (MEDINA WSC) - PUBLIC CONSERVATION EDUCATION	DEMAND REDUCTION	\$448	\$583	1	1	1	1	1	1

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Recommended Water User Group (WUG) Water Management Strategies (WMS)

						WATER MANAGEMENT STRATEGY SUPPLY (ACRE-FEET PER YEAR)					
WUG ENTITY NAME	WMS SPONSOR REGION	WMS NAME	SOURCE NAME	UNIT COST 2020	UNIT COST 2070	2020	2030	2040	2050	2060	2070
COUNTY-OTHER, EDWARDS	J	BARKSDALE WSC - ADDITIONAL GROUNDWATER WELL AND RO WELLHEAD TREATMENT	J NUECES RIVER ALLUVIUM AQUIFER EDWARDS COUNTY	\$852	\$611	54	54	54	54	54	54
COUNTY-OTHER, KERR	J	EASTERN KERR COUNTY REGIONAL WATER SUPPLY PROJECT	J ELLENBURGER-SAN SABA AQUIFER KERR COUNTY	N/A	\$241	0	108	108	108	108	108
COUNTY-OTHER, KERR	J	EASTERN KERR COUNTY REGIONAL WATER SUPPLY PROJECT	J GUADALUPE RIVER OFF-CHANNEL LAKE/RESERVOIR	N/A	\$130	0	1,121	1,121	1,121	1,121	1,121
COUNTY-OTHER, KERR	J	EASTERN KERR COUNTY REGIONAL WATER SUPPLY PROJECT	J TRINITY AQUIFER ASR FRESH/BRACKISH KERR COUNTY	N/A	\$10	0	1,124	1,124	1,124	1,124	1,124
COUNTY-OTHER, KERR	J	EASTERN KERR COUNTY REGIONAL WATER SUPPLY PROJECT	J TRINITY AQUIFER FRESH/BRACKISH KERR COUNTY	N/A	\$294	0	860	860	806	806	806
COUNTY-OTHER, KERR	J	KERR COUNTY OTHER - CENTER POINT - PUBLIC CONSERVATION EDUCATION	DEMAND REDUCTION	\$128	\$152	3	1	1	1	1	1
COUNTY-OTHER, KERR	J	KERR COUNTY OTHER - CENTER POINT TAYLOR SYSTEM - PUBLIC CONSERVATION EDUCATION	DEMAND REDUCTION	\$265	\$316	2	1	1	1	1	1
COUNTY-OTHER, KERR	J	KERR COUNTY OTHER - PUBLIC CONSERVATION EDUCATION (NUECES)	DEMAND REDUCTION	\$3	\$4	1	1	1	1	1	1
COUNTY-OTHER, KERR	J	KERR COUNTY OTHER - VERDE PARK ESTATES WWW - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION	\$12000	\$1000	1	1	1	1	1	1
COUNTY-OTHER, REAL	J	CITY OF LEAKEY - DEVELOP INTERCONNECTIONS BETWEEN WELLS WITHIN THE CITY	J FRIO RIVER ALLUVIUM AQUIFER REAL COUNTY	N/A	\$12	0	81	81	81	81	81
COUNTY-OTHER, REAL	J	CITY OF LEAKEY - ADDITIONAL GROUNDWATER WELL IN THE LOWER TRINITY AQUIFER	J EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS REAL COUNTY	\$374	\$231	91	91	91	91	91	91
COUNTY-OTHER, REAL	J	REAL COUNTY OTHER - OAKMONT SADDLE MOUNTAIN WSC - ADDITIONAL GROUNDWATER WELL	J FRIO RIVER ALLUVIUM AQUIFER REAL COUNTY	\$593	\$56	54	54	54	54	54	54
COUNTY-OTHER, REAL	J	REAL COUNTY OTHER - REAL WSC - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION	\$23457	\$2469	2	2	2	2	2	2
COUNTY-OTHER, VAL VERDE	J	VAL VERDE COUNTY OTHER - SAN PEDRO CANYON SUBDIVISION - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION	\$5500	\$500	7	7	7	7	7	7
COUNTY-OTHER, VAL VERDE	J	VAL VERDE COUNTY OTHER - TIERRA DEL LAGO - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION	\$2072	\$188	4	4	4	4	4	4

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Recommended Water User Group (WUG) Water Management Strategies (WMS)

						WATER MANAGEMENT STRATEGY SUPPLY (ACRE-FEET PER YEAR)					
WUG ENTITY NAME	WMS SPONSOR REGION	WMS NAME	SOURCE NAME	UNIT COST 2020	UNIT COST 2070	2020	2030	2040	2050	2060	2070
COUNTY-OTHER, VAL VERDE	J	VAL VERDE COUNTY OTHER - VAL VERDE COUNTY WCID COMSTOCK- WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION	\$41026	\$3846	1	1	1	1	1	1
DEL RIO UTILITIES COMMISSION	J	CITY OF DEL RIO - DEVELOP A WASTEWATER REUSE PROGRAM	J DIRECT POTABLE REUSE	N/A	\$6	0	3,092	3,092	3,092	3,092	3,092
DEL RIO UTILITIES COMMISSION	J	CITY OF DEL RIO - DRILL AND EQUIP A NEW WELL AND CONNECT TO DISTRIBUTION SYSTEM	J EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS VAL VERDE COUNTY	\$202	\$78	7,191	7,191	7,191	7,191	7,191	7,191
DEL RIO UTILITIES COMMISSION	J	CITY OF DEL RIO - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION	\$13960	\$1330	12	12	12	12	12	12
DEL RIO UTILITIES COMMISSION	J	CITY OF DEL RIO - WATER TREATMENT PLANT EXPANSION	J EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS VAL VERDE COUNTY	N/A	\$661	0	943	943	943	943	943
FORT CLARK SPRINGS MUD	J	FORT CLARK SPRINGS MUD - INCREASE STORAGE FACILITY	J EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS KINNEY COUNTY	N/A	\$18	0	620	620	620	620	620
FORT CLARK SPRINGS MUD	J	FORT CLARK SPRINGS MUD - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION	\$1515	\$140	79	79	79	79	79	79
IRRIGATION, BANDERA	J	BANDERA COUNTY IRRIGATION - ADDITIONAL GROUNDWATER WELLS (SAN ANTONIO)	J TRINITY AQUIFER FRESH/BRACKISH BANDERA COUNTY	\$333	\$67	75	75	75	75	75	75
IRRIGATION, BANDERA	J	BANDERA COUNTY IRRIGATION - IRRIGATION SCHEDULING	DEMAND REDUCTION	\$0	\$0	36	36	36	36	36	36
KERRVILLE	J	CITY OF KERRVILLE - EXPLORE AND DEVELOP NEW ELLENBURGER AQUIFER WELL SUPPLY	J ELLENBURGER-SAN SABA AQUIFER KERR COUNTY	\$1075	\$193	1,156	1,156	1,156	1,156	1,156	1,156
KERRVILLE	J	CITY OF KERRVILLE - INCREASE WASTEWATER REUSE	J DIRECT NON-POTABLE REUSE	\$289	\$53	2,500	2,500	2,500	2,500	2,500	2,500
KERRVILLE	J	CITY OF KERRVILLE - INCREASED WATER TREATMENT AND ASR CAPACITY	J TRINITY AQUIFER ASR KERR COUNTY	N/A	\$256	0	3,360	3,360	3,360	3,360	3,360
KERRVILLE	J	CITY OF KERRVILLE - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION	\$3979	\$384	134	134	134	134	134	134
LAUGHLIN AIR FORCE BASE	J	PURCHASE WATER FROM CITY OF DEL RIO	J RIO GRANDE RUN-OF-RIVER	\$616	\$616	87	183	284	346	345	345
LIVESTOCK, BANDERA	J	BANDERA COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL (GUADALUPE)	J TRINITY AQUIFER BANDERA COUNTY	\$5000	\$500	2	2	2	2	2	2
LIVESTOCK, BANDERA	J	BANDERA COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL (NUECES)	J TRINITY AQUIFER FRESH/BRACKISH BANDERA COUNTY	\$3333	\$333	3	3	3	3	3	3
LIVESTOCK, BANDERA	J	BANDERA COUNTY LIVESTOCK - CONSERVATION (GUADALUPE)	DEMAND REDUCTION	\$0	\$0	1	1	1	1	1	1

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Recommended Water User Group (WUG) Water Management Strategies (WMS)

						WATER MANAGEMENT STRATEGY SUPPLY (ACRE-FEET PER YEAR)					
WUG ENTITY NAME	WMS SPONSOR REGION	WMS NAME	SOURCE NAME	UNIT COST 2020	UNIT COST 2070	2020	2030	2040	2050	2060	2070
LIVESTOCK, BANDERA	J	BANDERA COUNTY LIVESTOCK - CONSERVATION (NUECES)	DEMAND REDUCTION	\$0	\$0	1	1	1	1	1	1
LIVESTOCK, KERR	J	KERR COUNTY LIVESTOCK - CONSERVATION (COLORADO)	DEMAND REDUCTION	\$0	\$0	24	24	24	24	24	24
LIVESTOCK, KERR	J	KERR COUNTY LIVESTOCK - CONSERVATION (GUADALUPE)	DEMAND REDUCTION	\$0	\$0	35	35	35	35	35	35
LIVESTOCK, KERR	J	KERR COUNTY LIVESTOCK - CONSERVATION (NUECES)	DEMAND REDUCTION	\$0	\$0	1	1	1	1	1	1
LIVESTOCK, KERR	J	KERR COUNTY LIVESTOCK - CONSERVATION (SAN ANTONIO)	DEMAND REDUCTION	\$0	\$0	5	5	5	5	5	5
MINING, EDWARDS	J	EDWARDS COUNTY MINING - ADDITIONAL GROUNDWATER WELL (COLORADO)	J EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	\$500	\$83	12	12	12	12	12	12
MINING, EDWARDS	J	EDWARDS COUNTY MINING - ADDITIONAL GROUNDWATER WELL (NUECES)	J EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	\$688	\$125	16	16	16	16	16	16
MINING, EDWARDS	J	EDWARDS COUNTY MINING - ADDITIONAL GROUNDWATER WELLS (RIO GRANDE)	J EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	\$387	\$97	31	31	31	31	31	31
MINING, KERR	J	KERR COUNTY MINING - ADDITIONAL GROUNDWATER WELLS (COLORADO)	J EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	\$842	\$105	19	19	19	19	19	19
MINING, VAL VERDE	J	VAL VERDE COUNTY MINING - ADDITIONAL GROUNDWATER WELLS (RIO GRANDE)	J EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS VAL VERDE COUNTY	\$384	\$66	242	242	242	242	242	242
ROCKSPRINGS	J	CITY OF ROCKSPRINGS - ADDITIONAL GROUNDWATER WELLS	J EDWARDS-TRINITY-PLATEAU, PECOS VALLEY, AND TRINITY AQUIFERS EDWARDS COUNTY	\$587	\$190	121	121	121	121	121	121
ROCKSPRINGS	J	CITY OF ROCKSPRINGS - PUBLIC CONSERVATION EDUCATION	DEMAND REDUCTION	\$208	\$208	1	1	1	1	1	1
REGION J RECOMMENDED WMS SUPPLY TOTAL						12,939	26,211	26,338	26,356	26,363	26,367

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Recommended Projects Associated with Water Management Strategies

SPONSOR NAME	SPONSOR IS WWP?	ONLINE DECADE	PROJECT NAME	PROJECT DESCRIPTION	CAPITAL COST
BANDERA	YES	2020	CITY OF BANDERA - ADDITIONAL MIDDLE TRINITY WELLS WITHIN CITY WATER INFRASTRUCTURE	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	\$625,000
BANDERA	YES	2030	CITY OF BANDERA - PROMOTE, DESIGN AND INSTALL RAINWATER HARVESTING SYSTEMS	RAINWATER HARVESTING SYSTEM	\$56,000
BANDERA	YES	2030	CITY OF BANDERA - REUSE TREATED WASTEWATER EFFLUENT FOR IRRIGATION	CONTRACT AMENDMENT; CONVEYANCE/TRANSMISSION PIPELINE; PUMP STATION; STORAGE TANK; WATER TREATMENT PLANT EXPANSION	\$1,496,000
BANDERA	YES	2030	CITY OF BANDERA - SURFACE WATER ACQUISITION, TREATMENT AND ASR	CONVEYANCE/TRANSMISSION PIPELINE; DIVERSION AND CONTROL STRUCTURE; MULTIPLE WELLS/WELL FIELD; NEW WATER TREATMENT PLANT	\$34,188,000
BANDERA COUNTY FWSD 1	YES	2020	BANDERA COUNTY FWSD #1 - ADDITIONAL GROUNDWATER WELL	SINGLE WELL; CONVEYANCE/TRANSMISSION PIPELINE; PUMP STATION; STORAGE TANK	\$990,000
BRACKETTVILLE	YES	2030	CITY OF BRACKETTVILLE - INCREASE STORAGE FACILITY	STORAGE TANK	\$1,272,000
BRACKETTVILLE	YES	2030	CITY OF BRACKETTVILLE - INCREASE SUPPLY TO SPOFFORD WITH NEW WATER LINE	CONVEYANCE/TRANSMISSION PIPELINE; STORAGE TANK	\$4,271,000
CAMP WOOD	YES	2020	CITY OF CAMP WOOD - ADDITIONAL GROUNDWATER WELLS	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	\$1,709,000
COUNTY-OTHER, BANDERA	YES	2020	ADDITIONAL GROUNDWATER WELL FOR THE TOWN OF MEDINA	CONVEYANCE/TRANSMISSION PIPELINE; NEW CONTRACT; STORAGE TANK; SINGLE WELL	\$1,417,000
COUNTY-OTHER, BANDERA	YES	2020	BANDERA COUNTY OTHER - ENCHANTED RIVER ESTATES - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DATA GATHERING/MONITORING TECHNOLOGY; WATER LOSS CONTROL	\$117,000
COUNTY-OTHER, BANDERA	YES	2020	BANDERA RIVER RANCH #1 - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DATA GATHERING/MONITORING TECHNOLOGY; WATER LOSS CONTROL	\$902,000
COUNTY-OTHER, EDWARDS	YES	2020	BARKSDALE WSC - ADDITIONAL GROUNDWATER WELL	CONVEYANCE/TRANSMISSION PIPELINE; SINGLE WELL	\$178,000
COUNTY-OTHER, KERR	YES	2030	EKCRWSP - CONSTRUCTION OF AN ELLENBURGER AQUIFER WATER SUPPLY WELL	SINGLE WELL	\$652,000
COUNTY-OTHER, KERR	YES	2030	EKCRWSP - CONSTRUCTION OF ASR FACILITY	INJECTION WELL; CONVEYANCE/TRANSMISSION PIPELINE	\$1,461,000
COUNTY-OTHER, KERR	YES	2030	EKCRWSP - CONSTRUCTION OF DESALINATION PLANT	CONVEYANCE/TRANSMISSION PIPELINE; NEW WATER TREATMENT PLANT; EVAPORATIVE POND	\$21,126,000
COUNTY-OTHER, KERR	YES	2030	EKCRWSP - CONSTRUCTION OF OFF-CHANNEL SURFACE WATER STORAGE	DIVERSION AND CONTROL STRUCTURE; CONVEYANCE/TRANSMISSION PIPELINE	\$25,231,000
COUNTY-OTHER, KERR	YES	2030	EKCRWSP - CONSTRUCTION OF SURFACE WATER TREATMENT FACILITIES AND TRANSMISSION LINES	CONVEYANCE/TRANSMISSION PIPELINE; NEW WATER TREATMENT PLANT; SURFACE WATER INTAKE MODIFICATION; PUMP STATION; STORAGE TANK	\$22,829,000
COUNTY-OTHER, KERR	YES	2030	EKCRWSP - CONSTRUCTION OF WELLFIELD FOR DENSE, RURAL AREAS	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD; NEW WATER TREATMENT PLANT; NEW WATER RIGHT/PERMIT NO IBT	\$8,367,000
COUNTY-OTHER, KERR	YES	2020	VERDE PARK ESTATES WWW - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DATA GATHERING/MONITORING TECHNOLOGY; WATER LOSS CONTROL	\$155,000
COUNTY-OTHER, REAL	YES	2020	CITY OF LEAKEY - ADDITIONAL GROUNDWATER WELL	CONVEYANCE/TRANSMISSION PIPELINE; SINGLE WELL	\$189,000
COUNTY-OTHER, REAL	YES	2030	CITY OF LEAKEY - DEVELOP INTERCONNECTIONS BETWEEN WELLS WITHIN THE CITY	CONVEYANCE/TRANSMISSION PIPELINE	\$202,000
COUNTY-OTHER, REAL	YES	2020	REAL COUNTY OTHER - ADDITIONAL WELL FOR OAKMONT SADDLE WSC	SINGLE WELL	\$417,000
COUNTY-OTHER, REAL	YES	2020	REAL WSC - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DATA GATHERING/MONITORING TECHNOLOGY; WATER LOSS CONTROL	\$482,000
COUNTY-OTHER, VAL VERDE	YES	2020	VAL VERDE COUNTY OTHER - SAN PEDRO CANYON SUBDIVISION - WATER LOSS AUDIT AND MAIN-LINE REPAIR	WATER LOSS CONTROL; DATA GATHERING/MONITORING TECHNOLOGY	\$142,000
COUNTY-OTHER, VAL VERDE	YES	2020	VAL VERDE COUNTY OTHER - TIERRA DEL LAGO - WATER LOSS AUDIT AND MAIN-LINE REPAIR	WATER LOSS CONTROL; DATA GATHERING/MONITORING TECHNOLOGY	\$146,000
COUNTY-OTHER, VAL VERDE	YES	2020	VAL VERDE COUNTY OTHER - VAL VERDE COUNTY WCID - WATER LOSS AUDIT AND MAIN-LINE REPAIR	WATER LOSS CONTROL; DATA GATHERING/MONITORING TECHNOLOGY	\$406,000
DEL RIO UTILITIES COMMISSION	YES	2020	CITY OF DEL RIO - ADDITIONAL GROUNDWATER WELL	SINGLE WELL; CONVEYANCE/TRANSMISSION PIPELINE	\$12,695,000
DEL RIO UTILITIES COMMISSION	YES	2030	CITY OF DEL RIO - DEVELOP A WASTEWATER REUSE PROGRAM	CONVEYANCE/TRANSMISSION PIPELINE	\$2,846,000

Region J Recommended Projects Associated with Water Management Strategies

SPONSOR NAME	SPONSOR IS WWP?	ONLINE DECADE	PROJECT NAME	PROJECT DESCRIPTION	CAPITAL COST
DEL RIO UTILITIES COMMISSION	YES	2020	CITY OF DEL RIO - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DATA GATHERING/MONITORING TECHNOLOGY; WATER LOSS CONTROL	\$5,672,000
DEL RIO UTILITIES COMMISSION	YES	2030	CITY OF DEL RIO - WATER TREATMENT PLANT EXPANSION	WATER TREATMENT PLANT EXPANSION	\$8,646,000
FORT CLARK SPRINGS MUD	YES	2030	FORT CLARK SPRINGS MUD - INCREASE STORAGE FACILITY	STORAGE TANK	\$1,501,000
FORT CLARK SPRINGS MUD	YES	2020	FORT CLARK SPRINGS MUD - WATER LOSS AUDIT AND MAIN-LINE REPAIR	WATER LOSS CONTROL; DATA GATHERING/MONITORING TECHNOLOGY	\$1,531,000
IRRIGATION, BANDERA	YES	2020	BANDERA COUNTY IRRIGATION - ADDITIONAL GROUNDWATER WELLS	MULTIPLE WELLS/WELL FIELD	\$291,000
KERRVILLE	YES	2020	CITY OF KERRVILLE - EXPLORE AND DEVELOP NEW ELLENBURGER AQUIFER WELL SUPPLY	SINGLE WELL	\$14,493,000
KERRVILLE	YES	2020	CITY OF KERRVILLE - INCREASE WASTEWATER REUSE	DIVERSION AND CONTROL STRUCTURE	\$12,570,000
KERRVILLE	YES	2030	CITY OF KERRVILLE - INCREASED WATER TREATMENT AND ASR CAPACITY	INJECTION WELL; WATER TREATMENT PLANT EXPANSION	\$15,393,000
KERRVILLE	YES	2020	CITY OF KERRVILLE - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DATA GATHERING/MONITORING TECHNOLOGY; WATER LOSS CONTROL	\$12,636,000
LIVESTOCK, BANDERA	YES	2020	BANDERA COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL (GUADALUPE)	SINGLE WELL	\$135,000
LIVESTOCK, BANDERA	YES	2020	BANDERA COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL (NUECES)	SINGLE WELL	\$126,000
MINING, EDWARDS	YES	2020	EDWARDS COUNTY MINING - ADDITIONAL GROUNDWATER WELLS	MULTIPLE WELLS/WELL FIELD	\$132,000
MINING, EDWARDS	YES	2020	EDWARDS COUNTY MINING - ADDITIONAL GROUNDWATER WELLS (COLORADO)	MULTIPLE WELLS/WELL FIELD	\$73,000
MINING, EDWARDS	YES	2020	EDWARDS COUNTY MINING - ADDITIONAL GROUNDWATER WELLS (NUECES)	MULTIPLE WELLS/WELL FIELD	\$125,000
MINING, KERR	YES	2020	KERR COUNTY MINING - ADDITIONAL GROUNDWATER WELL	SINGLE WELL	\$197,000
MINING, VAL VERDE	YES	2020	VAL VERDE MINING - ADDITIONAL GROUNDWATER WELL	MULTIPLE WELLS/WELL FIELD	\$1,096,000
ROCKSPRINGS	YES	2020	CITY OF ROCKSPRINGS - ADDITIONAL GROUNDWATER WELL	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	\$681,000

REGION J RECOMMENDED CAPITAL COST TOTAL	\$219,865,000

Region J Alternative Water User Group (WUG) Water Management Strategies (WMS)

						WATER MANAGEMENT STRATEGY SUPPLY (ACRE-FEET PER YEAR)					
WUG ENTITY NAME	WMS SPONSOR REGION	WMS NAME	SOURCE NAME	UNIT COST 2020	UNIT COST 2070	2020	2030	2040	2050	2060	2070
BANDERA	J	CITY OF BANDERA - ADDITIONAL LOWER TRINITY WELL AND LAY NECESSARY PIPELINE	J TRINITY AQUIFER FRESH/BRACKISH BANDERA COUNTY	N/A	\$206	0	403	403	403	403	403
COUNTY-OTHER, BANDERA	J	BANDERA COUNTY OTHER - ADDITIONAL WELLS TO PROVIDE EMERGENCY SUPPLY TO VFD (SAN ANTONIO)	J TRINITY AQUIFER FRESH/BRACKISH BANDERA COUNTY	\$1894	\$302	189	189	189	189	189	189
COUNTY-OTHER, BANDERA	J	BANDERA COUNTY OTHER (LAKE MEDINA SHORES) - ADDITIONAL GROUNDWATER WELL	J TRINITY AQUIFER FRESH/BRACKISH BANDERA COUNTY	\$582	\$167	251	251	251	251	251	251
LIVESTOCK, KERR	J	KERR COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL (COLORADO)	J EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	\$706	\$126	119	119	119	119	119	119
LIVESTOCK, KERR	J	KERR COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL (NUECES)	J EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	\$833	\$0	6	6	6	6	6	6
LIVESTOCK, KERR	J	KERR COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL (SAN ANTONIO)	J TRINITY AQUIFER KERR COUNTY	\$333	\$111	27	27	27	27	27	27
LIVESTOCK, KERR	J	KERR COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELLS - (GUADALUPE)	J EDWARDS-TRINITY-PLATEAU AQUIFER KERR COUNTY	\$237	\$87	173	173	173	173	173	173
REGION J ALTERNATIVE WMS SUPPLY TOTAL						765	1,168	1,168	1,168	1,168	1,168

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Region J Alternative Projects Associated with Water Management Strategies

SPONSOR NAME	SPONSOR IS WWP?	ONLINE DECADE	PROJECT NAME	PROJECT DESCRIPTION	CAPITAL COST
BANDERA	YES	2030	CITY OF BANDERA - ADDITIONAL LOWER TRINITY WELL AND LAY NECESSARY PIPELINE	CONVEYANCE/TRANSMISSION PIPELINE; NEW CONTRACT; NEW WATER RIGHT/PERMIT NO IBT; SINGLE WELL	\$3,298,000
COUNTY-OTHER, BANDERA	YES	2020	BANDERA COUNTY OTHER - ADDITIONAL GROUNDWATER WELLS TO PROVIDE EMERGENCY SUPPLY TO VFD	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	\$4,280,000
COUNTY-OTHER, BANDERA	YES	2020	BANDERA COUNTY OTHER - LAKE MEDINA SHORES - ADDITIONAL GROUNDWATER WELLS	CONVEYANCE/TRANSMISSION PIPELINE; MULTIPLE WELLS/WELL FIELD	\$1,477,000
LIVESTOCK, KERR	YES	2020	KERR COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL	SINGLE WELL	\$79,000
LIVESTOCK, KERR	YES	2020	KERR COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELL (NUECES)	SINGLE WELL	\$66,000
LIVESTOCK, KERR	YES	2020	KERR COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELLS	MULTIPLE WELLS/WELL FIELD	\$985,000
LIVESTOCK, KERR	YES	2020	KERR COUNTY LIVESTOCK - ADDITIONAL GROUNDWATER WELLS - GUADALUPE RIVER BASIN	MULTIPLE WELLS/WELL FIELD	\$370,000
REGION J ALTERNATIVE CAPITAL COST TOTAL					\$10,555,000

Region J Water User Group (WUG) Management Supply Factor

WUG supplies and projected demands are entered for each of a WUG's region-county-basin divisions. To calculate the Management Supply Factor for each WUG as a whole, not split by region-county-basin, the combined total of existing and future supply is divided by the total projected demand. If a WUG is split by more than one planning region, the whole WUG's management supply factor will show up in each of its planning region's management supply factor reports.

WUG NAME	WUG MANAGEMENT SUPPLY FACTOR					
	2020	2030	2040	2050	2060	2070
BANDERA	2.0	6.5	6.2	6.1	6.0	5.9
BANDERA COUNTY FWSD 1	1.2	1.1	1.0	1.0	1.0	1.0
BRACKETTVILLE	1.1	1.1	1.1	1.1	1.1	1.1
CAMP WOOD	1.0	1.0	1.1	1.1	1.1	1.1
COUNTY-OTHER, BANDERA	3.0	2.7	2.6	2.6	2.5	2.5
COUNTY-OTHER, BANDERA BANDERA RIVER RANCH 1	0.8	0.7	0.6	0.6	0.6	0.6
COUNTY-OTHER, BANDERA LAKE MEDINA SHORES	0.2	0.2	0.2	0.2	0.2	0.2
COUNTY-OTHER, BANDERA MEDINA WSC	1.2	1.1	1.0	1.0	1.0	1.0
COUNTY-OTHER, EDWARDS	3.8	4.0	4.2	4.2	4.2	4.2
COUNTY-OTHER, EDWARDS BARKSDALE WSC	5.7	5.9	6.1	6.3	6.3	6.3
COUNTY-OTHER, KERR	4.8	6.4	6.4	6.3	6.1	6.0
COUNTY-OTHER, KERR CENTER POINT	1.0	1.0	1.0	1.0	1.0	1.0
COUNTY-OTHER, KERR CENTER POINT NORTH WATER SYSTEM	1.0	1.0	1.0	1.0	1.0	1.0
COUNTY-OTHER, KERR CENTER POINT TAYLOR SYSTEM	1.0	1.0	1.0	1.0	1.0	1.0
COUNTY-OTHER, KERR HILLS AND DALES ESTATES	1.1	1.1	1.1	1.0	1.0	1.0
COUNTY-OTHER, KERR NICKERSON FARM WATER SYSTEM	1.3	1.3	1.3	1.3	1.2	1.2
COUNTY-OTHER, KERR OAK FOREST SOUTH WATER	1.4	1.4	1.4	1.4	1.4	1.3
COUNTY-OTHER, KERR PARK PLACE SUBDIVISION	1.3	1.3	1.3	1.3	1.3	1.2
COUNTY-OTHER, KERR PECAN VALLEY	1.2	1.1	1.1	1.1	1.1	1.1
COUNTY-OTHER, KERR RUSTIC HILLS WATER	1.3	1.3	1.3	1.3	1.3	1.3
COUNTY-OTHER, KERR VERDE PARK ESTATES	1.1	1.1	1.1	1.1	1.0	1.0
COUNTY-OTHER, KERR WESTWOOD WATER SYSTEM	1.2	1.2	1.2	1.2	1.2	1.2
COUNTY-OTHER, KINNEY	3.1	3.2	3.2	3.2	3.3	3.3
COUNTY-OTHER, REAL	5.1	6.0	6.2	6.3	6.3	6.3
COUNTY-OTHER, VAL VERDE	1.7	1.5	1.3	1.1	1.0	0.9
DEL RIO UTILITIES COMMISSION	1.3	1.6	1.5	1.4	1.3	1.3
FORT CLARK SPRINGS MUD	2.3	3.4	3.4	3.4	3.4	3.4
IRRIGATION, BANDERA	1.1	1.1	1.1	1.1	1.1	1.1
IRRIGATION, EDWARDS	1.8	1.8	1.8	1.8	1.8	1.8
IRRIGATION, KERR	1.4	1.4	1.4	1.4	1.4	1.4
IRRIGATION, KINNEY	2.8	2.8	2.8	2.8	2.8	2.8
IRRIGATION, REAL	7.9	7.9	7.9	7.9	7.9	7.9
IRRIGATION, VAL VERDE	2.8	2.8	2.8	2.8	2.8	2.8
KERRVILLE	2.1	2.7	2.7	2.6	2.6	2.6
KERRVILLE SOUTH WATER	1.1	1.1	1.1	1.1	1.1	1.1
LAUGHLIN AIR FORCE BASE	1.0	1.0	1.0	1.0	1.0	1.0
LEAKEY	1.5	1.6	1.7	1.7	1.7	1.7
LIVESTOCK, BANDERA	1.1	1.1	1.1	1.1	1.1	1.1
LIVESTOCK, EDWARDS	2.0	2.0	2.0	2.0	2.0	2.0
LIVESTOCK, KERR	0.7	0.7	0.7	0.7	0.7	0.7
LIVESTOCK, KINNEY	1.8	1.8	1.8	1.8	1.8	1.8
LIVESTOCK, REAL	1.3	1.3	1.3	1.3	1.3	1.3
LIVESTOCK, VAL VERDE	1.2	1.2	1.2	1.2	1.2	1.2
MANUFACTURING, KERR	2.4	2.3	2.3	2.3	2.3	2.3

*A single asterisk next to a WUG's name denotes that the WUG is split by more than one planning region.

Region J Water User Group (WUG) Management Supply Factor

	WUG MANAGEMENT SUPPLY FACTOR					
WUG NAME	2020	2030	2040	2050	2060	2070
MINING, EDWARDS	1.0	1.0	1.0	1.0	1.0	1.0
MINING, KERR	1.9	1.8	1.4	1.4	1.3	1.2
MINING, VAL VERDE	1.5	1.1	1.1	1.3	1.5	1.6
ROCKSPRINGS	3.4	3.4	3.5	3.5	3.5	3.5

*A single asterisk next to a WUG's name denotes that the WUG is split by more than one planning region.

**Region J Recommended Water Management Strategy (WMS) Supply
Associated with a New or Amended Inter-Basin Transfer (IBT) Permit**

IBT WMS supply is the portion of the total WMS benefitting WUGs that will require a new or amended IBT permit that is not considered exempt under the Texas Water Code § 11.085.

			IBT WMS SUPPLY (ACRE-FEET PER YEAR)					
WMS NAME	SOURCE BASIN	RECIPIENT WUG BASIN	2020	2030	2040	2050	2060	2070

Region J Water User Groups (WUGs)

Recommended Water Management Strategy (WMS) Supply Associated with a

New or Amended Inter-Basin Transfer (IBT) Permit and Total Recommended Conservation WMS Supply

IBT WMS supply is the portion of the total WMS benefitting the WUG basin split listed that will require a new or amended IBT permit that is not considered exempt under the Texas Water Code § 11.085. Total conservation supply represents all conservation WMS volumes recommended within the WUG's region-basin geographic split.

BENEFITTING WUG NAME BASIN	WMS SOURCE ORIGIN BASIN WMS NAME	WMS SUPPLY (ACRE-FEET PER YEAR)					
		2020	2030	2040	2050	2060	2070

**Region J Sponsored Recommended Water Management Strategy (WMS) Supplies
Unallocated* to Water User Groups (WUG)**

WMS NAME	WMS SPONSOR	SOURCE NAME	UNALLOCATED STRATEGY SUPPLY (ACRE-FEET PER YEAR)					
			2020	2030	2040	2050	2060	2070
TOTAL UNALLOCATED STRATEGY SUPPLIES								

* Strategy supplies created through the WMS that have not been assigned to a WUG will be allocated to the entity responsible for the water through an 'unassigned water volumes' entity. Only strategy supplies associated with an 'unassigned water volume' entity are shown in this report, and may not represent all strategy supplies associated with the listed WMS.

Region J Water User Group (WUG) Strategy Supplies by Water Management Strategy (WMS) Type

WMS TYPE *	STRATEGY SUPPLY (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
AQUIFER STORAGE & RECOVERY	0	5,984	5,984	5,984	5,984	5,984
DIRECT POTABLE REUSE	0	3,092	3,092	3,092	3,092	3,092
DROUGHT MANAGEMENT	464	517	543	553	561	565
GROUNDWATER WELLS & OTHER	9,526	12,144	12,144	12,090	12,090	12,090
IRRIGATION CONSERVATION	36	36	36	36	36	36
MUNICIPAL CONSERVATION	259	256	256	256	256	256
OTHER CONSERVATION	67	67	67	67	67	67
OTHER DIRECT REUSE	2,500	2,810	2,810	2,810	2,810	2,810
OTHER STRATEGIES	0	1	1	1	1	1
OTHER SURFACE WATER	87	1,304	1,405	1,467	1,466	1,466
NEW MAJOR RESERVOIR	0	0	0	0	0	0
INDIRECT REUSE	0	0	0	0	0	0
CONJUNCTIVE USE	0	0	0	0	0	0
SEAWATER DESALINATION	0	0	0	0	0	0
GROUNDWATER DESALINATION	0	0	0	0	0	0
TOTAL STRATEGY SUPPLIES	12,939	26,211	26,338	26,356	26,363	26,367

* WMS type descriptions can be found on the interactive state water plan website at <http://texasstatewaterplan.org/> using the 'View data for' drop-down menus to navigate to a specific WMS Type page. The data used to create each WMS type value is available in Appendix 3 of the Guidelines for Regional Water Planning Data Deliverable (Exhibit D) document at http://www.twdb.texas.gov/waterplanning/rwp/planningdocu/2021/doc/current_docs/contract_docs/ExhibitD.pdf.

Region J Water User Group (WUG)
Recommended Water Management Strategy (WMS) Supplies by Source Type

SOURCE SUBTYPE*	STRATEGY SUPPLY (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
AQUIFER STORAGE & RECOVERY	0	5,984	5,984	5,984	5,984	5,984
GROUNDWATER	9,526	12,144	12,144	12,090	12,090	12,090
GROUNDWATER TOTAL STRATEGY SUPPLIES	9,526	18,128	18,128	18,074	18,074	18,074
DIRECT NON-POTABLE REUSE	2,500	2,810	2,810	2,810	2,810	2,810
DIRECT POTABLE REUSE	0	3,092	3,092	3,092	3,092	3,092
INDIRECT NON-POTABLE REUSE	0	0	0	0	0	0
INDIRECT POTABLE REUSE	0	0	0	0	0	0
REUSE TOTAL STRATEGY SUPPLIES	2,500	5,902	5,902	5,902	5,902	5,902
ATMOSPHERE	0	0	0	0	0	0
GULF OF MEXICO	0	0	0	0	0	0
LIVESTOCK LOCAL SUPPLY	0	0	0	0	0	0
OTHER LOCAL SUPPLY	0	0	0	0	0	0
RAINWATER HARVESTING	0	1	1	1	1	1
RESERVOIR	0	1,121	1,121	1,121	1,121	1,121
RESERVOIR SYSTEM	0	0	0	0	0	0
RUN-OF-RIVER	87	183	284	346	345	345
SURFACE WATER TOTAL STRATEGY SUPPLIES	87	1,305	1,406	1,468	1,467	1,467
REGION J TOTAL STRATEGY SUPPLIES	12,113	25,335	25,436	25,444	25,443	25,443

* A full list of source subtype definitions can be found in section 3 of the Guidelines for Regional Water Planning Data Deliverable (Exhibit D) document at http://www.twdb.texas.gov/waterplanning/rwp/planningdocu/2021/doc/current_docs/contract_docs/ExhibitD.pdf.

Region J Major Water Provider (MWP) Existing Sales and Transfers

Major Water Providers are entities of particular significance to a region's water supply as defined by the Regional Water Planning Group (RWPG), and may be a Water User Group (WUG) entity, Wholesale Water Provider (WWP) entity, or both (WUG/WWP).

Retail denotes WUG projected demands and existing water supplies used by the WUG. Wholesale denotes a WWP or WUG/WWP selling water to another entity.

DEL RIO UTILITIES COMMISSION - WUG/WWP	WATER VOLUMES (ACRE-FEET PER YEAR)					
DATA DESCRIPTION	2020	2030	2040	2050	2060	2070
PROJECTED RETAIL WUG DEMANDS	10,558	11,053	11,554	12,130	12,733	13,326
PROJECTED WHOLESALE CONTRACT DEMANDS	1,331	1,331	1,331	1,331	1,331	1,331
TOTAL PROJECTED WHOLESALE CONTRACT AND RETAIL DEMANDS	11,889	12,384	12,885	13,461	14,064	14,657
SURFACE WATER SALES TO RETAIL CUSTOMERS	6,135	6,135	6,135	6,135	6,135	6,135
GROUNDWATER SALES TO WHOLESALE CUSTOMERS	0	0	0	0	0	0
SURFACE WATER SALES TO WHOLESALE CUSTOMERS	1,331	1,331	1,331	1,331	1,331	1,331
TOTAL WHOLESALE AND RETAIL SALES TO CUSTOMERS	7,466	7,466	7,466	7,466	7,466	7,466

Region J Major Water Provider (MWP) Water Management Strategy (WMS) Summary

MWPs are entities of significance to a region's water supply as defined by the Regional Water Planning Group (RWPG) and may be a Water User Group (WUG) entity, Wholesale Water Provider (WWP) entity, or both (WUG/WWP). 'MWP Retail Customers' denotes recommended WMS supply used by the WUG. 'Transfers Related to Wholesale Customers' denotes a WWP or WUG/WWP selling or transferring recommended WMS supply to another entity. Supply associated with the MWP's wholesale transfers will only display if it is listed as the main seller in the State Water Planning database, even if multiple sellers are involved with the sale of water to WUGs. Unallocated water volumes represent MWP recommended WMS supply not currently allocated to a customer of the MWP. 'Total MWP Related WMS Supply' will display if the MWP's WMS is related to more than one WMS supply type (retail, wholesale, and/or unallocated). Associated WMS Projects are listed when the MWP is one of the project's sponsors. Report contains draft data and is subject to change.

DEL RIO UTILITIES COMMISSION CITY OF DEL RIO - DEVELOP A WASTEWATER REUSE PROGRAM						
DATA DESCRIPTION	WATER VOLUMES (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
MWP RETAIL CUSTOMERS	0	3,092	3,092	3,092	3,092	3,092
WMS RELATED MWP SPONSORED PROJECTS	PROJECT DESCRIPTION					
CITY OF DEL RIO - DEVELOP A WASTEWATER REUSE PROGRAM	CONVEYANCE/TRANSMISSION PIPELINE					

DEL RIO UTILITIES COMMISSION CITY OF DEL RIO - DRILL AND EQUIP A NEW WELL AND CONNECT TO DISTRIBUTION SYSTEM						
DATA DESCRIPTION	WATER VOLUMES (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
MWP RETAIL CUSTOMERS	7,191	7,191	7,191	7,191	7,191	7,191
WMS RELATED MWP SPONSORED PROJECTS	PROJECT DESCRIPTION					
CITY OF DEL RIO - ADDITIONAL GROUNDWATER WELL	SINGLE WELL; CONVEYANCE/TRANSMISSION PIPELINE					

DEL RIO UTILITIES COMMISSION CITY OF DEL RIO - WATER LOSS AUDIT AND MAIN-LINE REPAIR						
DATA DESCRIPTION	WATER VOLUMES (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
MWP RETAIL CUSTOMERS	12	12	12	12	12	12
WMS RELATED MWP SPONSORED PROJECTS	PROJECT DESCRIPTION					
CITY OF DEL RIO - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DATA GATHERING/MONITORING TECHNOLOGY; WATER LOSS CONTROL					

DEL RIO UTILITIES COMMISSION CITY OF DEL RIO - WATER TREATMENT PLANT EXPANSION						
DATA DESCRIPTION	WATER VOLUMES (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
MWP RETAIL CUSTOMERS	0	943	943	943	943	943
WMS RELATED MWP SPONSORED PROJECTS	PROJECT DESCRIPTION					
CITY OF DEL RIO - WATER TREATMENT PLANT EXPANSION	WATER TREATMENT PLANT EXPANSION					

DEL RIO UTILITIES COMMISSION PURCHASE WATER FROM CITY OF DEL RIO						
DATA DESCRIPTION	WATER VOLUMES (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
TRANSFERS RELATED TO WHOLESALE CUSTOMERS	87	183	284	346	345	345

This page intentionally left blank

Table of Contents

ES	EXECUTIVE SUMMARY	ES-1
	ES APPENDIX A – TWDB WATER PLANNING DATA REPORTS	
1	PLATEAU REGION.....	1-1
1.1	WATER PLANNING AND MANAGEMENT	1-2
1.1.1	Regional Water Planning	1-2
1.1.2	Interim Project Reports.....	1-3
1.1.3	State Water Plan	1-4
1.1.4	Local Water Management Plans.....	1-4
1.1.5	Groundwater Conservation Districts	1-5
1.1.6	Groundwater Management Areas	1-6
1.1.7	Hill Country Priority Groundwater Management Area	1-7
1.2	REGIONAL GEOGRAPHIC SETTING	1-8
1.2.1	Plateau Region	1-8
1.2.2	Physiography	1-8
1.2.3	Population and Regional Economy	1-8
1.2.4	Land Use	1-9
1.2.5	Climate and Drought	1-10
1.2.6	Native Vegetation and Ecology	1-13
1.2.7	Agricultural and Natural Resources	1-14
1.2.8	Upper Llano River Watershed Protection Plan	1-15
1.2.9	Water-Supply Source Vulnerability / Security	1-15
1.2.10	Supply Source Protection	1-16
1.3	REGIONAL WATER DEMAND	1-18
1.3.1	Major Demand Categories	1-18
1.3.2	Municipal	1-19
1.3.3	Agriculture and Ranching	1-19
1.3.4	Manufacturing and Mining	1-19
1.3.5	Environmental and Recreational Water Needs	1-19
1.4	WATER SUPPLY SOURCES	1-21
1.4.1	Groundwater	1-21
1.4.1.1	Trinity Aquifer	1-22
1.4.1.2	Edwards-Trinity (Plateau) Aquifer	1-22
1.4.1.3	Edwards (BFZ) Aquifer	1-22
1.4.1.4	Austin Chalk Aquifer	1-22
1.4.1.5	Nueces River Alluvium Aquifer	1-23
1.4.1.6	Frio River Alluvium Aquifer	1-23
1.4.1.7	Ellenburger-San Saba Aquifer	1-23
1.4.1.8	Other Aquifers	1-23
1.4.2	Surface Water	1-24
1.4.2.1	Rio Grande Basin	1-24
1.4.2.2	Nueces River Basin	1-25

	1.4.2.3 Colorado River Basin	1-25
	1.4.2.4 Guadalupe River Basin	1-25
	1.4.2.5 San Antonio River Basin	1-25
	1.4.3 Springs and Wildlife Habitat	1-25
	1.4.4 Reuse	1-27
	1.4.5 Water Quality Issues	1-27
1.5	COLONIAS	1-28
1.6	WATER LOSS AUDITS	1-30
1.7	STATE AND FEDERAL AGENCIES	1-31
	1.7.1 Texas Water Development Board	1-31
	1.7.2 Texas Commission on Environmental Quality	1-31
	1.7.3 Texas Parks and Wildlife Department	1-31
	1.7.4 Texas Department of Agriculture	1-31
	1.7.5 Texas State Soil and Water Conservation Board	1-32
	1.7.6 South Texas Watermaster Program	1-32
	1.7.7 Public Utilities Commission of Texas	1-32
	1.7.8 International Boundary and Water Commission and Comisión Internacional de Límites y Aguas	1-32
	1.7.9 United States Geological Survey	1-32
	1.7.10 United States Environmental Protection Agency	1-32
	1.7.11 United States Fish and Wildlife department	1-33
	1.7.12 Upper Guadalupe River Authority	1-33
	1.7.13 Nueces River Authority	1-33
2	POPULATION AND WATER DEMAND	2-1
2.1	POPULATION	2-2
	2.1.1 Population Projection Methodology	2-2
	2.1.2 Current and Projected Population	2-2
2.2	WATER DEMAND	2-8
	2.2.1 Water Demand Projections	2-8
	2.2.2 Municipal and County-Other	2-14
	2.2.3 Major Water Providers	2-19
	2.2.4 Manufacturing	2-20
	2.2.5 Irrigation	2-20
	2.2.6 Livestock	2-21
	2.2.7 Mining	2-23
2.3	ENVIRONMENTAL AND RECREATIONAL WATER NEEDS	2-25
3	REGIONAL WATER SUPPLY SOURCES	3-1
3.1	GROUNDWATER RESOURCES	3-9
	3.1.1 Groundwater Availability	3-10
	3.1.2 Trinity Aquifer	3-12
	3.1.3 Edwards-Trinity (Plateau) Aquifer	3-13
	3.1.4 Edwards (BFZ) Aquifer	3-14

3.1.5	Austin Chalk Aquifer	3-14
3.1.6	Frio River Alluvium Aquifer	3-14
3.1.7	Nueces River Alluvium Aquifer	3-15
3.1.8	Ellenburger-San Saba Aquifer	3-15
3.1.9	Public Supply Use of Groundwater	3-16
3.1.9.1	City of Bandera	3-16
3.1.9.2	Bandera County FWSD#1	3-17
3.1.9.3	City of Kerrville	3-17
3.1.9.4	City of Rocksprings	3-17
3.1.9.5	City of Brackettville and Fort Clark Springs MUD	3-17
3.1.9.6	City of Camp Wood	3-18
3.1.9.7	City of Leakey	3-18
3.1.9.8	City of Del Rio	3-18
3.1.10	Agricultural Use of Groundwater	3-18
3.1.11	Brackish Groundwater Desalination Sources	3-19
3.2	SURFACE WATER SUPPLIES	3-20
3.2.1	Rio Grande Basin	3-22
3.2.2	Amistad International Reservoir on the Rio Grande	3-23
3.2.3	Nueces River Basin	3-24
3.2.4	Colorado River Basin	3-24
3.2.5	San Antonio River Basin	3-24
3.2.6	Medina Lake on the Medina River	3-25
3.2.7	Guadalupe River Basin	3-26
3.2.8	San Felipe Springs	3-27
3.2.9	Old Faithful Springs	3-27
3.2.10	Surface Water Rights	3-28
3.3	GROUNDWATER / SURFACE WATER RELATIONSHIP	3-29
3.3	REUSE	3-30
3.4	LOCAL SUPPLY	3-31
	APPENDIX 3A – AUTHORIZED SURFACE WATER RIGHTS	
4	IDENTIFICATION OF WATER NEEDS	4-1
5	WATER MANAGEMENT STRATEGIES AND CONSERVATION RECOMMENDATIONS	5-1
5.1	IDENTIFICATION OF POTENTIALLY FEASIBLE WATER MANAGEMENT STRATEGIES	5-2
5.2	EVALUATION AND RECOMMENDATION OF WATER MANAGEMENT STRATEGIES	5-8
5.2.1	Strategy Evaluation Procedure	5-8
5.2.2	Emphasis on Conservation and Reuse	5-9
5.2.3	Water Loss Audit Strategies	5-10
5.2.4	Recommended Water Management Strategies	5-10
5.2.5	Assessment of ASR Potential	5-11

5.2.6	Unqualified Strategies	5-12
5.2.7	Vegetative Management and Land Stewardship.....	5-12
5.3	WATER CONSERVATION	5-25
5.3.1	State Water Conservation Overview	5-25
5.3.2	Model Water Conservation Plans.....	5-26
5.3.3	State Water Conservation Programs and Guides.....	5-27
5.3.4	Regional Conservation Water Management Strategies.....	5-31
5.3.5	Municipal Conservation.....	5-32
5.3.6	Gallons Per Capita Daily Goals.....	5-32
5.3.7	Groundwater Conservation Districts Management Plans	5-33
5.3.8	Upper Guadalupe River Authority Conservation Programs	5-36
	APPENDIX 5A – RECOMMENDED AND ALTERNATE WATER MANAGEMENT STRATEGIES	
	APPENDIX 5B – STRATEGY EVALUATION QUANTIFICATION MATRIX	
6	REGIONAL WATER PLAN IMPACTS AND CONSISTENCY WITH PROTECTION OF WATER AGRICULTURAL AND NATURAL RESOURCES	6-1
6.1	PROTECTION OF WATER RESOURCES	6-2
6.2	PROTECTION OF AGRICULTURAL RESOURCES	6-3
6.3	PROTECTION OF NATURAL RESOURCES	6-4
6.4	PROTECTION OF PUBLIC HEALTH AND SAFETY	6-4
	APPENDIX 6A – SOCIOECONOMIC IMPACT OF UNMET WATER NEEDS	
7	REGIONAL DROUGHT RESPONSE, INFORMATION, ACTIVITIES, AND RECOMMENDATIONS	7-1
7.1	DROUGHTS OF RECORD IN THE PLATEAU REGION	7-2
7.1.1	Precipitation Indicator	7-3
7.1.2	Stream Flow Indicator	7-4
7.1.3	Spring Discharge Indicator	7-6
7.1.4	Groundwater Level Indicator	7-7
7.1.5	Plateau Region Drought of Record	7-8
7.2	CURRENT DROUGHT PREPARATIONS AND RESPONSE	7-9
7.2.1	Drought Response Triggers	7-9
7.2.2	Surface Water Triggers	7-10
7.2.3	Groundwater Triggers	7-10
7.2.4	System Capacity Triggers	7-11
7.2.5	Municipal and Wholesale Water Provider Drought Contingency Plans	7-11
7.2.6	Groundwater Conservation District Drought Contingency Plans	7-15
	7.2.6.1 Bandera County River Authority and Groundwater	7-15
	7.2.6.2 Headwaters Groundwater Conservation District	7-16
	7.2.6.3 Kinney County Groundwater Conservation District	7-16
	7.2.6.4 Real-Edwards Conservation and Reclamation District	7-16
7.3	EXISTING AND POTENTIAL EMERGENCY INTERCONNECTS	7-18

7.4	EMERGENCY RESPONSES TO LOCAL DROUGHT CONDITIONS	7-19
7.5	REGION-SPECIFIC DROUGHT RESPONSE RECOMMENDATIONS AND MODEL DROUGHT CONTINGENCY PLANS	7-22
7.5.1	Regional Groundwater Resources and Monitoring	7-22
7.5.2	Regional Surface Water Resources and Monitoring	7-26
7.5.3	Regional Model Drought Contingency Plan	7-29
7.5.4	Model Drought Contingency Plans	7-32
7.6	DROUGHT WATER MANAGEMENT STRATEGIES.....	7-33
7.7	OTHER DROUGHT-RELATED CONSIDERATIONS AND RECOMMENDATIONS.....	7-34
7.7.1	Texas Drought Preparedness Council and Drought Preparedness Plan	7-34
7.7.2	Other Drought Recommendations	7-34
8	POLICY AND UNIQUE SITES RECOMMENDATIONS	8-1
8.1	CONSERVATION RECOMMENDATIONS	8-2
8.2	WATER MANAGEMENT RECOMMENDATIONS	8-4
8.3	WATER PLANNING RECOMMENDATIONS	8-5
8.4	WATER RESEARCH NEEDS.....	8-8
8.5	CONSIDERATION OF ECOLOGICALLY UNIQUE RIVER AND STREAM SEGMENTS	8-11
8.6	CONSIDERATION OF UNIQUE SITES FOR RESERVOIR CONSTRUCTION	8-12
9	WATER INFRASTRUCTURE FINANCING ANALYSIS	9-1
9.1	TWDB FUNDING PROGRAMS	9-2
9.1.1	State Water Implementation Fund for Texas (SWIFT)	9-2
9.1.2	Water Infrastructure Fund (WIF)	9-2
9.1.3	State Participation Fund (SP)	9-2
9.1.4	Rural and Economically Distressed Areas (EDAP)	9-2
9.2	INFRASTRUCTURE FINANCE SURVEY	9-3
10	PUBLIC PARTICIPATION AND PLAN ADOPTION	10-1
10.1	PLATEAU WATER PLANNING GROUP	10-2
10.2	ADMINISTRATIVE PROCESS AND PROJECT MANAGEMENT	10-3
10.3	PLANNING GROUP MEETINGS AND PUBLIC HEARINGS	10-4
10.4	COORDINATION WITH OTHER REGIONS	10-5
10.5	PLAN IMPLEMENTATION	10-5
	APPENDIX 10A – RESPONSE TO PUBLIC COMMENTS	
	APPENDIX 10B – RESPONSE TO TWDB COMMENTS	
	APPENDIX 10C – RESPONSE TO TPWD COMMENTS	

11	IMPLEMENTATION AND COMPARISON TO THE PREVIOUS REGIONAL WATER PLAN	11-1
11.1	IMPLEMENTATION OF PREVIOUS REGIONAL WATER PLAN	11-2
11.2	COMPARISON TO PREVIOUS PLAN	11-4
11.2.1	Water Demand Projections	11-4
11.2.2	Drought of Record and Hydrologic and Modeling Assumptions	11-4
11.2.3	Source Water Availability	11-5
11.2.4	Existing Water Supplies of WUGs	11-5
11.2.5	WUG and WWP Needs	11-5
11.2.6	Recommended Water Management Strategies	11-6
11.3	PROGRESS OF REGIONALIZATION.....	11-22

CHAPTER 1

PLATEAU REGION DESCRIPTION

This page intentionally left blank.

1 PLATEAU REGION

Located along the southern boundary of the Texas Edwards Plateau, the six-county Plateau Water Planning Region stretches from the Central Texas Hill Country westward to the Rio Grande (Figure 1-1). Under land grants issued by Mexico and later by the Republic of Texas in the early 1800s, European immigrants (predominantly German) and transient settlers from the southern United States colonized this rugged land formally occupied for centuries by citizens of Mexico and Native Americans. These immigrants and those to follow settled small towns along many of the spring-fed streams that crossed the area and from these way stations spread out to establish farms and ranches throughout the Region. Even today, the area retains much of its original cowboy frontier and German and Hispanic heritage. Chapter 1 that follows is a broad introduction to this Region and the water supply challenges it faces. The Region's economic health and quality of life concerns, including the aquatic environment and recreational opportunities, are dependent on a sustainable water supply that is equitably managed.

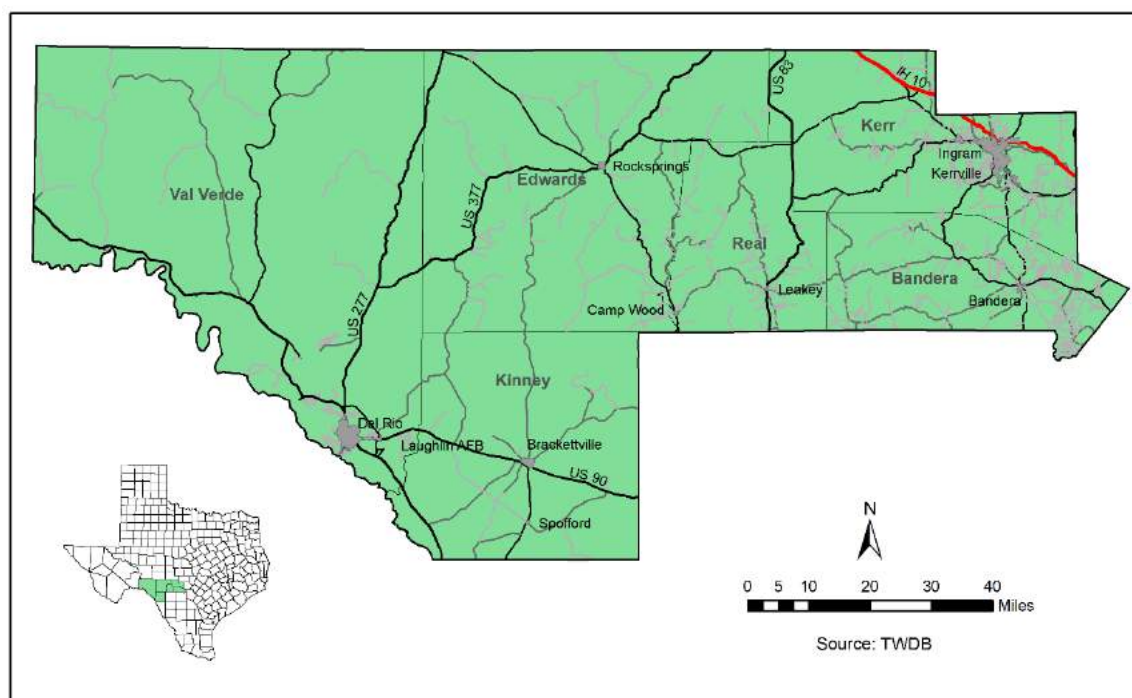


Figure 1-1. Location of the Plateau Region

1.1 WATER PLANNING AND MANAGEMENT

1.1.1 Regional Water Planning

In January of 2021, the fifth round of regional water planning was concluded with the adoption of the *2021 Plateau Region Water Plan*. It is understood that this *Plan* is not a static plan but rather is intended to be revised as conditions change. For this reason, the *Plan* put forth in this document is not a new *Plan*, but rather an evolutionary modification of preceding *Plans* (2001, 2006, 2011 and 2016). Only those parts of the previous 2016 *Plan* that required updating, and there were many, have been revised.

The purpose of the *2021 Plateau Region Water Plan* is to provide a document that water planners and users can reference for long- and short-term water management recommendations. Equally important, this *Plan* serves as an educational tool to enlighten all citizens as to the importance of properly managing and conserving the delicate water resources of this pristine Region. Chapter 1 presents a broad overview of the Region and many of the key issues that must be addressed as part of any attempt to develop a comprehensive water management plan that is acceptable and beneficial to those who reside here.

The Plateau Water Planning Group (PWPG) is a voluntary association comprised of voting and non-voting members whom represent a minimum of 11 water use categories. Since 1997, the PWPG has been involved in a wide range of projects, programs and the development of the *Plateau Region Water Plan*.

The *2021 Plateau Region Water Plan* follows an identical format as the plans prepared by the other 15 water planning regions in the State as mandated by the Texas Legislature and overseen by the Texas Water Development Board (TWDB). The *Plan* provides an evaluation of current and future water demands for all water-use categories, and evaluates water supplies available during drought-of-record conditions to meet those demands. Where future water demands exceed available supplies, management strategies are considered to meet the potential water shortages. Because our understanding of current and future water demand and supply sources are constantly changing, it is intended for this *Plan* to be revised every five years or sooner if deemed necessary.

For the first time, water planning projections have been reassembled by utility service areas rather than political boundaries to better plan for the actual water-supply service entity. Previous Regional and State water plans have been aligned with political boundaries, such as city limits rather than water utility service areas. Recent TWDB rule changes now define a municipal water user group (WUG) as being utility-based, and thus emphasis of the development of municipal water demands and supplies for the 2021 regional water plans transition from political boundaries to utility-service area boundaries.

In the development of this *Plan* it was essential to coordinate planning efforts with adjacent regions (Regions E, F, K, L and M) to ensure that there were no conflicting strategies pertaining to shared or transferred water-supply sources. This coordination resulted in there being no known conflicts between this *Plan* and plans prepared for other regions.

Water-supply availability under drought-of-record conditions is considered in the planning process to ensure that water demands can be met under the worst of circumstances. Recommendations of the Drought Preparedness Council are considered in this *Plan*.

For surface water supplies, drought-of-record conditions relate to the quantity of water available to meet existing permits from the Rio Grande, Nueces, Colorado, Guadalupe, and San Antonio rivers and their

tributaries as estimated by Run 3 of the Texas Commission on Environmental Quality (TCEQ) - Water Availability Models (WAM). This *Plan* has no impact on navigation on these surface-water courses.

The availability of groundwater during drought-of-record conditions is based primarily on Modeled Available Groundwater (MAG) declarations based on Groundwater Management Area (GMA) “desired future conditions”. The GMA process is described in greater detail in Section 1.1.6 of this chapter. Chapter 3 contains a detailed analysis of water supply availability in the Region.

This *Plan* continues to benefit from environmental data on the more prominent watercourses in the Region as provided by the Texas Parks & Wildlife Department. This data was useful in the assessment and consideration of environmental flow needs, springs, and ecologically significant stream segments.

This *2021 Plateau Region Water Plan* fully recognizes and protects existing water rights, water contracts, and option agreements. The PWPG strongly encourages all entities to participate in the planning process so that their specific concerns can be recognized and addressed. The PWPG also encourages the participation of Groundwater Conservation Districts and recognizes their management plans and rules.

Water quality is recognized as an important component in this 50-year water plan. Water supplies can be diminished or made more costly for its intended use if water quality is compromised. To ensure that this *Plan* fully considers water quality, the Federal Clean Water Act and the State Clean Rivers Program were reviewed and considered when developing water-supply availability estimates (Chapter 3), water management strategies and water quality impacts (Chapter 5), and policy recommendations (Chapter 8).

Also, considered in the above segments of the *Plan* were the Water Quality Management Plans (WQMPs) of TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB). TCEQ’s WQMP is tied to the State’s water quality assessments that identify and direct planning for implementation measure that control and/or prevent priority water quality problems. Elements contained in the WQMP include effluent limitations of wastewater facilities, total maximum daily loads, nonpoint source management controls, identification of designated management agencies, and groundwater and source water protection planning. TSSWCB’s WQMP is a site-specific plan developed through and approved by Soil and Water Conservation Districts for agricultural or silvicultural lands. The plan includes appropriate land treatment practices, production practices, management measure, and technologies.

In the year 2010, the U.S. Census Bureau performed a census count, which provides the base year for future population projections in the Region. Although the PWPG accepts the 2010 census count, members express concern that the census does not recognize the significant seasonal population increase that occurs in these counties as the area draws large numbers of hunters and recreational visitors, as well as absentee land owners who maintain vacation, retirement, and hunting homes and cabins. Therefore, an emphasis is being made in this planning document, especially in the rural counties, to recognize a need for more water than is justified simply from the population-derived water demand quantities.

1.1.2 Interim Planning Project Reports

Previous planning periods included interim projects designated by the Plateau Water Planning Group (PWPG) to evaluate specific water supply availability and management issues (Table 1-1). These reports can be accessed on the Upper Guadalupe River Authority website at <http://www.ugra.org/waterdevelopment.html>.

Table 1-1. Interim Planning Project Reports

Interim Planning Project Reports	Date
Ground-Water Resources of the Edwards Aquifer in the Del Rio Area, Texas	2001
The Lower Trinity Aquifer of Bandera and Kerr Counties, Texas	2001
Springs of Kinney and Val Verde Counties	2005
Spring Flow Contribution to the Headwaters of the Guadalupe River in Western Kerr County, Texas	2005
Installation of Groundwater Monitoring Equipment in Designated Wells in the Plateau Planning Region	2005
Water Rights Analysis and ASR Feasibility in Kerr County	2009
ASR Feasibility in Bandera County	2009
Groundwater Data Acquisition in Edwards, Kinney and Val Verde Counties, Texas	2010
Water Use by Livestock and Game Animals in the Plateau Regional Water Planning Area	2010
Occurrence of Significant River Alluvium Aquifers in the Plateau Region	2010

1.1.3 State Water Plan

The Texas Water Development Board adopted *Water for Texas 2017* as the official State Water Plan of Texas. The Texas Water Code directs the TWDB to periodically update this comprehensive water plan, which is used as a guide to State water policy. The 2017 State Water Plan is the fourth water plan to incorporate water management and policy decisions made at the regional level as expressed in the 16 approved regional water plans.

1.1.4 Local Water Management Plans

The Plateau Region often experiences periods of limited rainfall, especially compared with more humid areas in the eastern part of the State. Although residents of the Region are generally accustomed to these conditions, the low rainfall and accompanying high evaporation underscore the necessity of developing plans to manage resources responsibly and to respond to potential disruptions in the supply of groundwater and surface water caused by drought conditions. The following entities have developed water management and drought contingency plans:

- City of Del Rio
- City of Brackettville
- City of Kerrville
- Fort Clark Municipal Utility District
- Headwaters Groundwater Conservation District
- City of Bandera
- Bandera County River Authority and Groundwater District
- Wiedenfeld Water Works
- Kinney County Groundwater Conservation District
- Real-Edwards Conservation and Reclamation District

- City of Leakey
- City of Camp Wood

1.1.5 Groundwater Conservation Districts

The Texas Legislature has established a process for local management of groundwater resources through Groundwater Conservation Districts, which are charged with managing groundwater by providing for the conservation, preservation, protection, recharging and prevention of waste of groundwater within their jurisdictions. An elected or appointed board governs these districts and establishes rules, programs and activities specifically designed to address local problems and opportunities. Texas Water Code §36.0015 states in part, “Groundwater Conservation Districts created as provided by this chapter are the State’s preferred method of groundwater management.” Four districts are currently in operation within the Plateau Region (Figure 1-2); their management goals are discussed in further detail in Chapter 6.

- Bandera County River Authority and Groundwater District
- Headwaters Groundwater Conservation District
- Real-Edwards Conservation and Reclamation District
- Kinney County Groundwater Conservation District

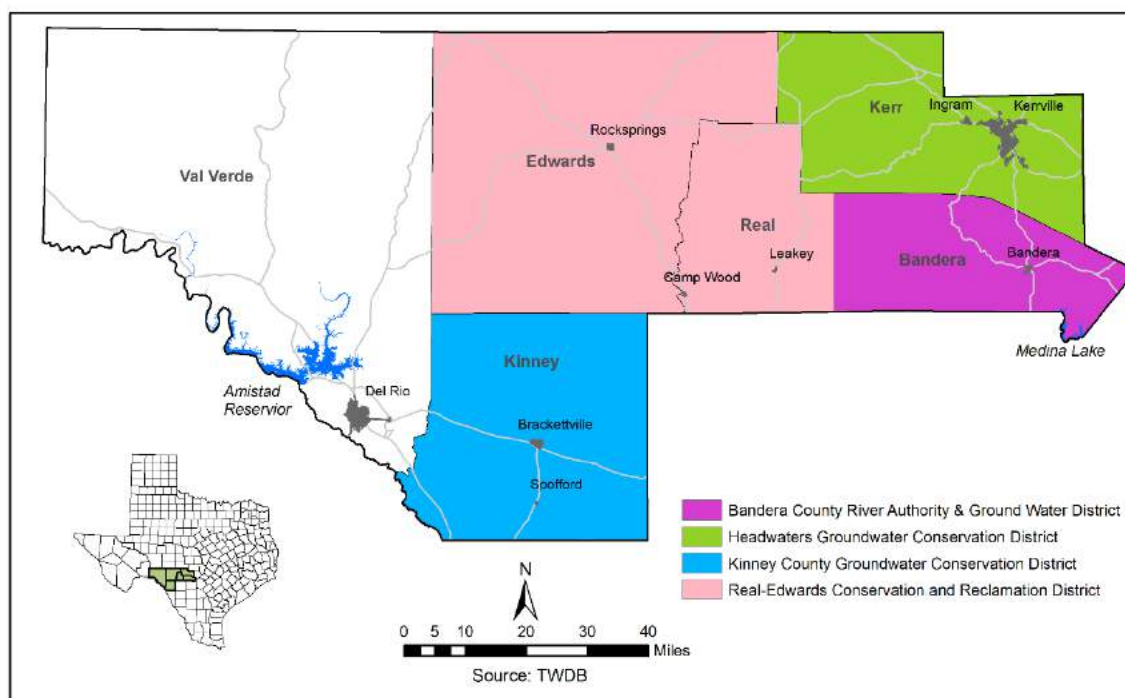


Figure 1-2. Groundwater Conservation Districts

1.1.6 Groundwater Management Areas

In previous sessions, the Texas Legislature has redefined the manner in which groundwater is to be managed (http://www.twdb.texas.gov/groundwater/management_areas/index.asp) Senate Bill 2 of the 77th Texas Legislature (2001) authorized:

- The TWDB to designate Groundwater Management Areas that would include all major and minor aquifers of the State.
- Required Groundwater Conservation Districts to share groundwater plans with other districts in the Groundwater Management Area.
- Allowed a Groundwater Conservation District to call for joint planning among districts in a Groundwater Management Area.

The objective was to delineate areas considered suitable for management of groundwater resources. A Groundwater Management Area (GMA) should ideally coincide with the boundaries of a groundwater reservoir (aquifer) or a subdivision of a groundwater reservoir, but it may also be defined by other factors, including the boundaries of political subdivisions. In December 2002, the TWDB designated 16 GMAs covering the entire State (<http://www.twdb.texas.gov/mapping/index.asp>).

In 2005, the Legislature once again changed the direction of groundwater management. The new requirements, codified in Texas Water Code Chapter 36.108, required joint planning in management areas among Groundwater Conservation Districts. The new requirements direct that,

“Not later than September 1, 2010, and every five years thereafter, the districts shall consider groundwater availability models and other data or information for the management area and shall establish desired future conditions for the relevant aquifers within the management area.”

Desired future conditions (DFCs) are a description of aquifers at some time in the future. This description is a precursor to developing a volumetric number called *modeled available groundwater (MAG)*. The TWDB is responsible for providing each Groundwater Conservation District and Regional Water Planning Group, located wholly or partly in the management area, with *MAG* volumes for each specified aquifer. Once the *MAG* is determined, the districts begin issuing groundwater withdrawal permits to support the *DFC* of the aquifer up to the total amount of the *MAG*. These permits express *DFCs* by only allowing withdrawals that will support the conditions established by the GMA. Regional water plans must also incorporate the *MAG* for each aquifer within their regions. *GMA DFCs* are thus recognized as the conservative means of sustainably preserving groundwater supplies for use by future generations.

The counties of the Plateau Region are included in three GMAs:

- GMA 7 includes Edwards, Kinney (partial), Real and Val Verde
- GMA 9 includes Bandera and Kerr
- GMA 10 includes Kinney (partial)

DFCs have been adopted for specified aquifers in these GMAs, and, therefore, this *2021 Plateau Region Water Plan* includes a significant revision to all groundwater source availability estimates based on *MAG* volumes generated from the GMA process.

1.1.7 Hill Country Priority Groundwater Management Area

A portion of the Plateau Region (Bandera and Kerr Counties) is included in the initial Hill Country Priority Groundwater Management Area (PGMA). The PGMA process is initiated by the TCEQ, who designates a PGMA when an area is experiencing critical groundwater problems, or is expected to do so within 25 years. These problems include shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, or contamination of groundwater supplies. Once an area is designated a PGMA, landowners have two years to create a Groundwater Conservation District (GCD). Otherwise, the TCEQ is required to create a GCD or to recommend that the area be added to an existing district. The TWDB works with the TCEQ to produce a legislative report every two years on the status of PGMA's in the state. The PGMA process is completely independent of the current Groundwater Management Area (GMA) process and each process has different goals. The goal of the PGMA process is to establish GCDs in these designated areas so that there will be a management entity to address the identified groundwater issues. PGMA's are still relevant if there remain portions within these designated areas without GCDs. The Plateau Region's portion of the Hill Country PGMA (Bandera & Kerr Counties) has established GCDs. A statewide map of the declared PGMA areas is available at:

http://www.tceq.state.tx.us/assets/public/permitting/watersupply/groundwater/maps/pgma_areas.pdf.

1.2 REGIONAL GEOGRAPHIC SETTING

1.2.1 Plateau Region

The Plateau Region encompasses six counties in the west-central part of the State of Texas, stretching from the headwaters of the Guadalupe and San Antonio rivers in the Central Texas Hill Country westward to Del Rio and the Rio Grande international border (Figure 1-1). With a total area of 9,252 square miles (mi²), the Plateau Region represents 3.5 percent of the total area of the State and includes the counties of Bandera (792mi²), Edwards (2,120mi²), Kerr (1,106mi²), Kinney (1,364mi²), Real (700mi²), and Val Verde (3,171mi²).

1.2.2 Physiography

The Plateau Region lies along the southern edge of the Edwards Plateau and is bounded on the east by the Central Texas Hill Country and on the west by the Rio Grande international border. The Balcones escarpment generally forms the southern boundary of the Plateau Region. The escarpment is a steep topographic feature that traces the path of a major fault system that was active more than 10 million years ago. The escarpment separates the more resistant rocks of the Edwards Plateau to the north from softer and more easily erodible rocks to the south. Erosion by streams has cut steep canyons into the thick limestone beds of the Edwards Plateau.

Its rolling prairies, steep canyons, and the large number of spring-fed perennially flowing streams characterize the Region. The uplands are fairly level, but the landscape of the stream valleys is very hilly with steep canyons that provide rapid drainage. Upland soils are dark alkaline clays and clay loams; the river valley soils are gravelly and light colored. Some cultivation takes place in the deep, dark-gray or brown loams and clays of the river bottoms and, over the broad flat farming belt of Kinney County. The major soil-management concerns are brush control, low fertility and excess lime.

1.2.3 Population and Regional Economy

The projected year-2020 population in the Plateau Region of 141,476 results in a population density of 15.3 people per square mile, which is much less than the state average of 72 people per square mile. The regional population is projected to grow by 30 percent to 184,595 by 2070. Approximately 46 percent of the total population of the Region is in the two largest cities, Del Rio / Laughlin AFB (39,542) and Kerrville (25,658). The projected year-2020 populations of other major communities in the Region are: Brackettville and Fort Clark Springs (3,217); Bandera (1,875); Leakey (1,415); Rocksprings (1,259); and Camp Wood (747) (Figure 1-3). These population estimates do not include a significant transient (tourist, hunting, recreation, etc.) population that has a resulting significant impact on overall water supply demand in the Region. Current and projected future population of the Region is discussed in detail in Chapter 2.

The regional economy is based primarily on tourism, hunting, ranching agribusiness and government. The beauty of the Hill Country, the solitude of the forested canyons and plateau grasslands, and the gateway to Mexico all support a major tourist trade. Agribusiness is predominantly associated with the raising of sheep, goats, beef cattle and exotic game throughout the Region. Apple orchards in Bandera County, oil and gas production and mohair production in Edwards and Real Counties, medical services

and manufacturing in Kerr County, irrigated cotton, hay and wheat in Kinney County, and a military base and trade with Mexico in Val Verde County all contribute largely to the Region's overall economy.

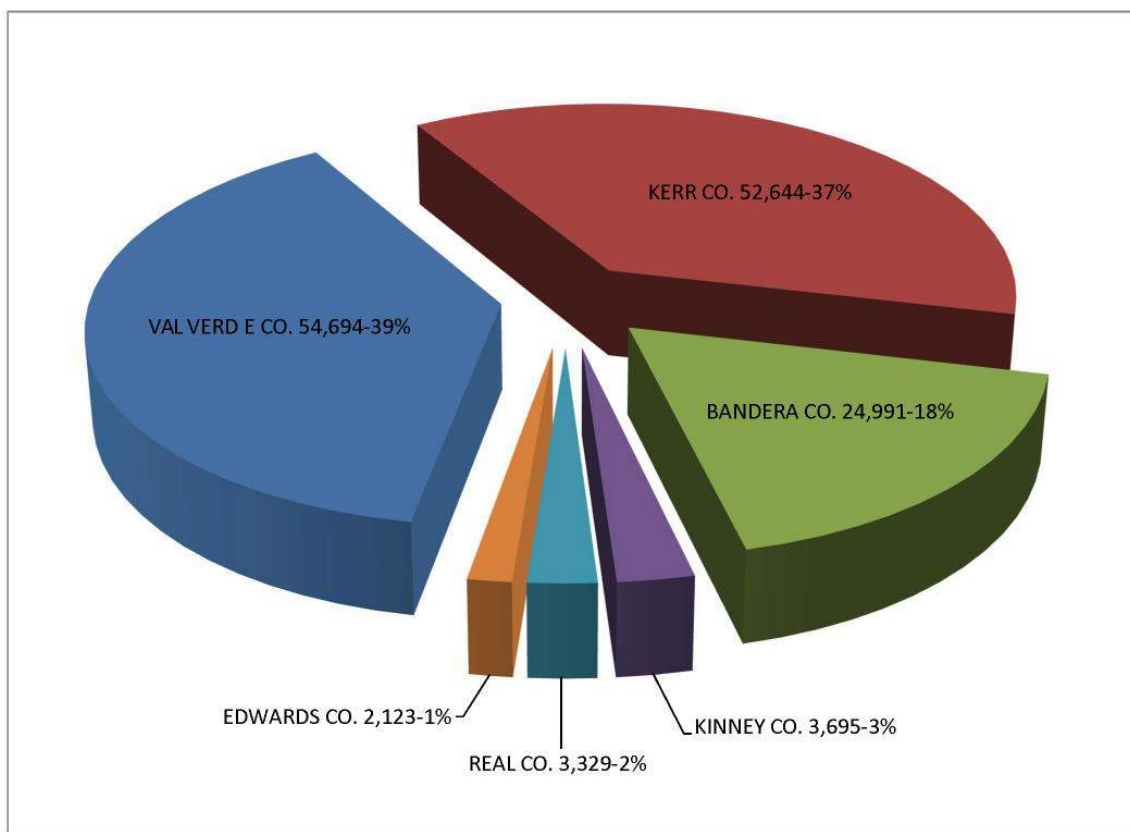


Figure 1-3. Year 2020 Projected Population

1.2.4 Land Use

Land use in the six-county Region is divided into seven categories (Figure 1-4):

- Urban (or developed)
- Agricultural (cultivated)
- Range
- Forest
- Water
- Wetlands
- Barren

Urban lands are the location of cities and towns that make up less than one percent of the Region's total land area. Agricultural lands are identified as areas that support the cultivation of crops. These lands, which potentially involve extensive irrigation, also occupy less than one percent of the Region. Together,

urban and agricultural lands comprise the two most significant areas of water consumption in the Plateau Region.

Rangeland is defined as all areas that are either associated with or are suitable for livestock production. Although this is the largest category of land use in areal extent in the Region, rangeland accounts for one of the smallest sources of water demand. Forestland is limited to areas where topography and climate support the growth of native trees. Areas designated as either water or wetlands are associated with the rivers and their tributaries. Barren lands are defined as undeveloped areas with little potential for use as agricultural land, rangeland or forestland.

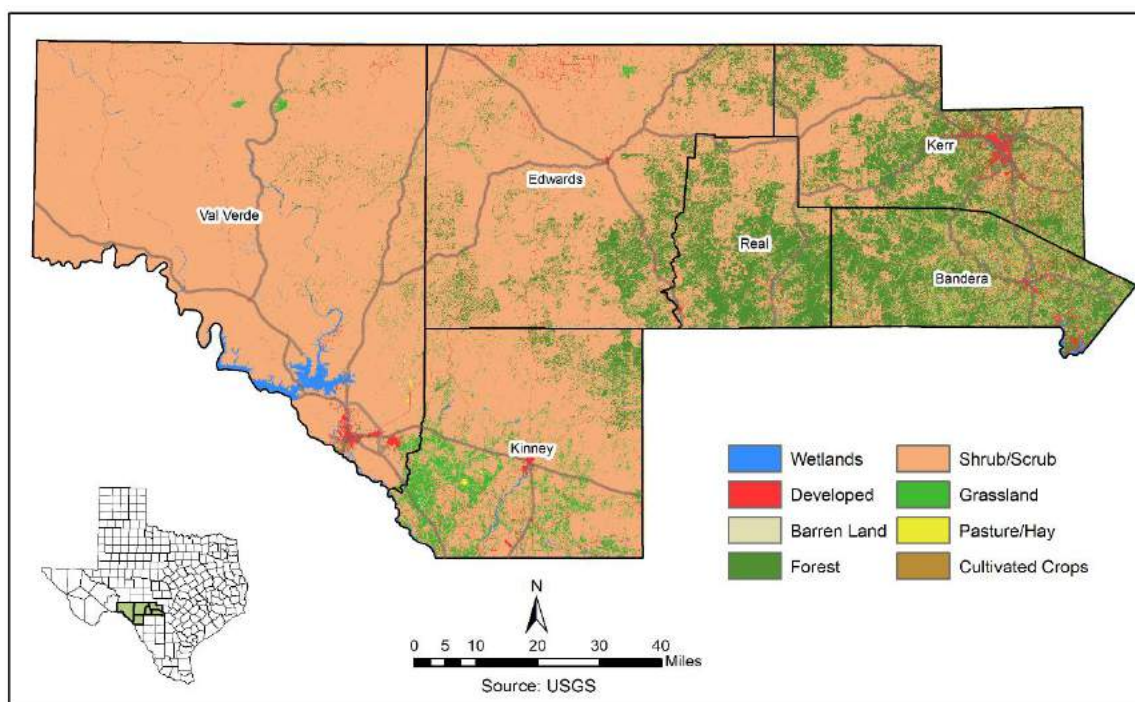


Figure 1-4. Land Use

1.2.5 Climate and Drought

The climate of the Plateau Region is semi-arid to arid as precipitation decreases westward across the Region. The average for the Edwards Plateau is 25 inches. Figure 1-5 illustrates the variability with respect to the six counties of the Region with precipitation decreasing from approximately 33 inches in the easternmost reaches of Bandera and Kerr Counties to less than 18 inches in western Val Verde County (National Weather Service). Net lake evaporation (Figure 1-6) increases from 58 inches in Bandera and Kerr Counties to about 78 inches in western Val Verde County (TWDB). Net lake evaporation is the difference between total evaporation from a lake and total precipitation. Figure 1-7 illustrates average monthly rainfall recorded at selected stations.

Long periods of below-normal rainfall may have severe impacts on groundwater recharge, spring flow, and stream flow. Under these conditions, the lack of rainfall leads to reduced recharge to aquifers and to lower water levels in wells. As water levels fall in aquifers in drought-stricken areas, the volume of water

discharging from important water-supply related springs may diminish to the point that communities reliant on spring water, such as Camp Wood in Real County, may experience an insufficient water supply to meet its full needs. Landowners who are dependent on spring-fed stream flow may also find insufficient volumes of surface water needed to support irrigation or other farming and ranching activities. The direct linkage between precipitation and water levels in aquifers of the Plateau Region is indicated by hydrograph records of wells that show rapid rises in water levels as a response to local rainstorms.

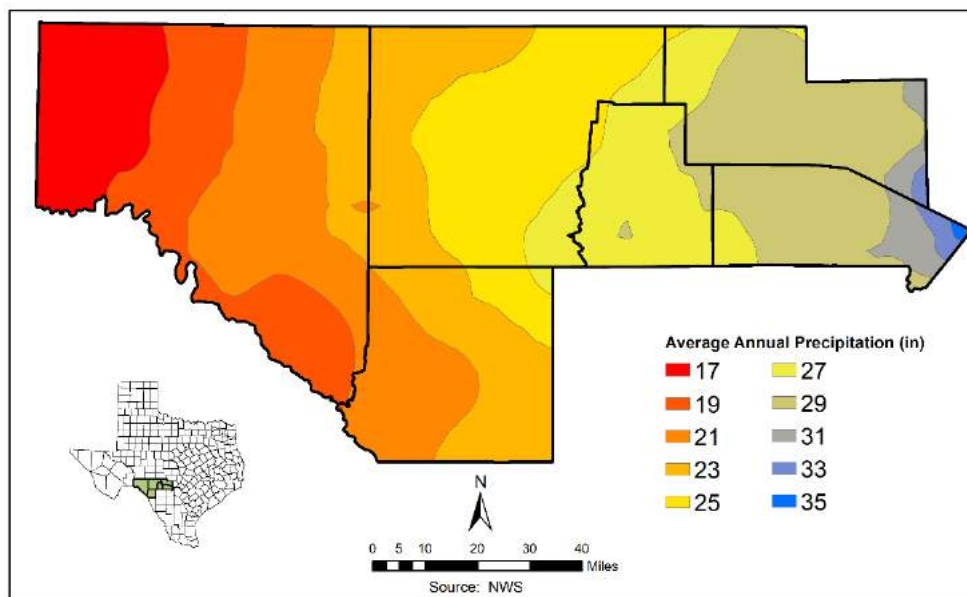


Figure 1-5. Variation of Precipitation

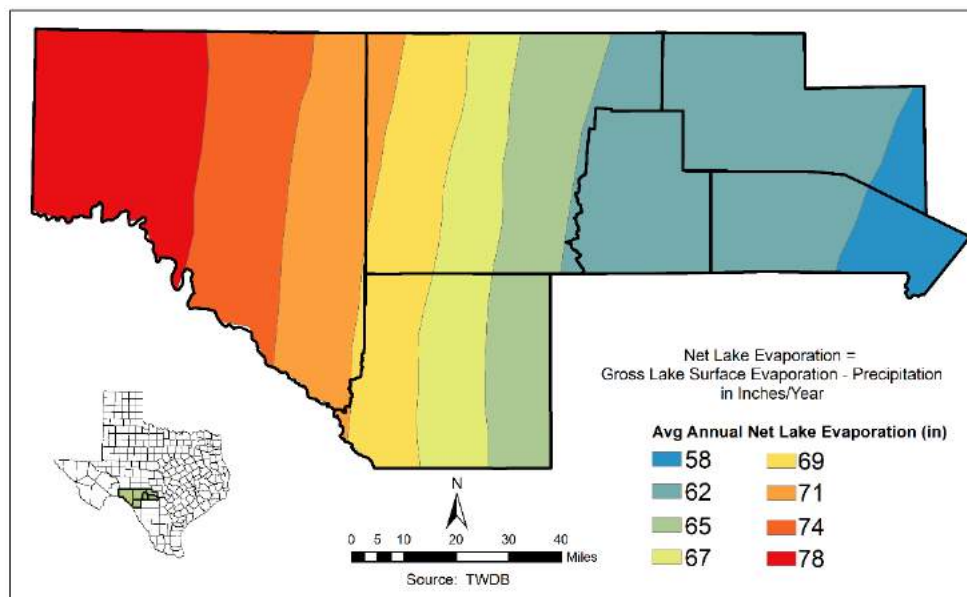


Figure 1-6. Net Lake Evaporation

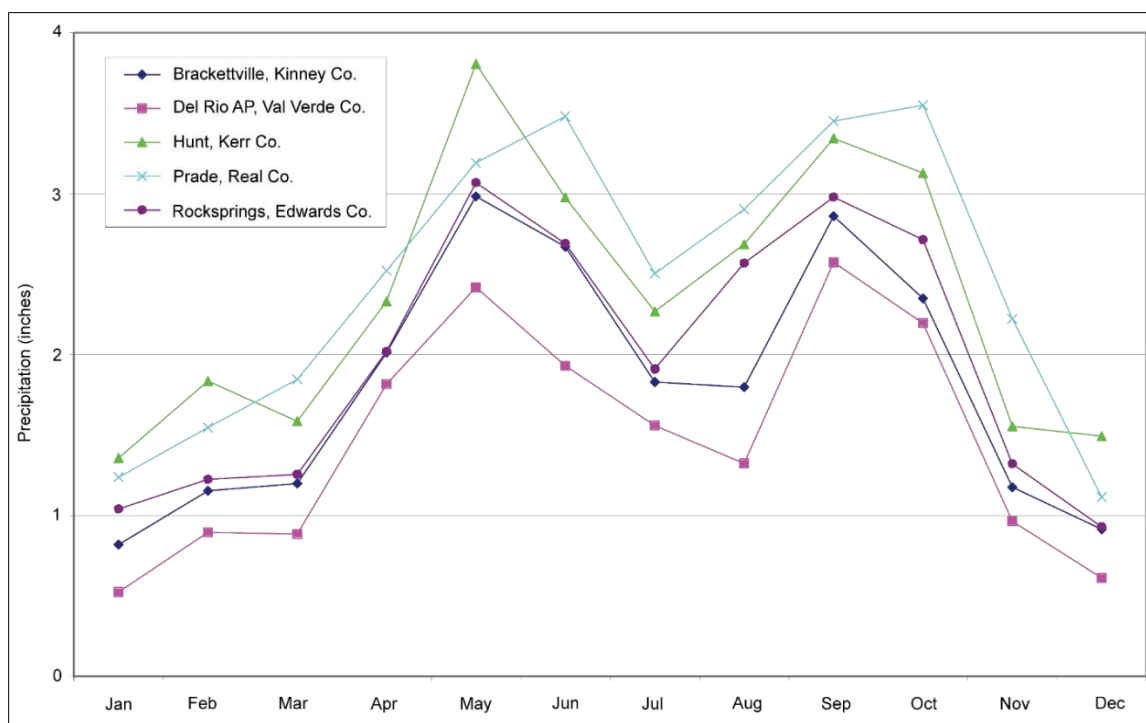


Figure 1-7. Average Monthly Rainfall for Selected Stations

Drought conditions are assumed in the planning process to ensure that adequate infrastructure and planning is in place under severe water shortage conditions. Drought in the Plateau Region is discussed in detail in Chapter 7 of this *Plan*. Drought in the Plateau Region can be defined in the following operational definitions:

Meteorologic drought is an interval of time, usually over a period of months or years, during which precipitation cumulatively falls short of the expected supply.

Agricultural drought is that condition when rainfall and soil moisture are insufficient to support the healthy growth of crops and to prevent extreme crop stress. It may also be defined as a deficiency in the amount of precipitation required to support livestock and other farming or ranching operations.

Hydrologic drought is a long-term condition of abnormally dry weather that ultimately leads to the depletion of surface water and groundwater supplies, the drying up of lakes and reservoirs, and the reduction or cessation of springflow or streamflow.

Comparing the 1950s Drought of Record (DOR) and the current drought can be accomplished by using historic precipitation, stream flow records, spring discharges and water level measurements in wells for locations that have accumulated data measurements since the 1940s, which is discussed further in Chapter 7 Section 7.2. For this planning cycle, the drought of the 1950s is declared the DOR. However, it is the intent of the current 2021 *Plan*, to illustrate in Chapter 7 that although the 1950s drought is the Historic Drought of Record, current drought conditions are of major significance. Current preparation for drought in the Plateau planning region is presented in detail in Chapter 7. Existing groundwater conservation district and water utility drought management plans and actions are recognized, drought monitoring triggers and actions are recommended (Table 7-8), and emergency response options are discussed.

1.2.6 Native Vegetation and Ecology

A biotic province is a considerable and continuous geographic area that is characterized by the occurrence of one or more ecologic associations that differ, at least in proportional area covered, from the associations of adjacent provinces. In general, biotic provinces are characterized by peculiarities of vegetation type, ecological climax, flora, fauna, climate, physiography and soil. Most of the Plateau Region has been classified as belonging to the "Balconian" Biotic Province, but small portions of Val Verde and Kinney Counties also lie within the "Tamaulipan" and "Chihuahuan" Biotic Provinces (Figure 1-8). In the 1800s, the area was predominantly savannas of tall native grasses with occasional stands of Live Oak and Spanish Oak. While Live Oak and Spanish Oak are still prevalent in many areas, most of the region has become blanketed by Ashe Juniper (commonly referred to as "Mountain Cedar") largely because of the suppression of prairie fires in the last century. Another infestation of tree species found in the area is that of Mesquite. Infestation of trees may reduce the quantity and quality of water from watersheds, as well as reduce the diversity of plant species beneath the trees' canopies.

Cypress trees line the banks of many of the rivers and are known to reduce flows in the streams during their active season. Along with the Live Oak, Spanish Oak and Cypress, other species of trees that are generally found are Post Oak, Elm, Hackberry, Cottonwood, Sycamore and Willow. Native grass species include Little and Big Bluestem, Indian Grass, Sideoat Grama and Texas Winter Grass. Some of the introduced species of grass include Coastal Bermuda, Plains Lovegrass, Klein Grass and King Ranch Bluestem. In the western portion of the Region, a varying growth of prickly pear, other cactus species, sage, and other brushy species predominate.

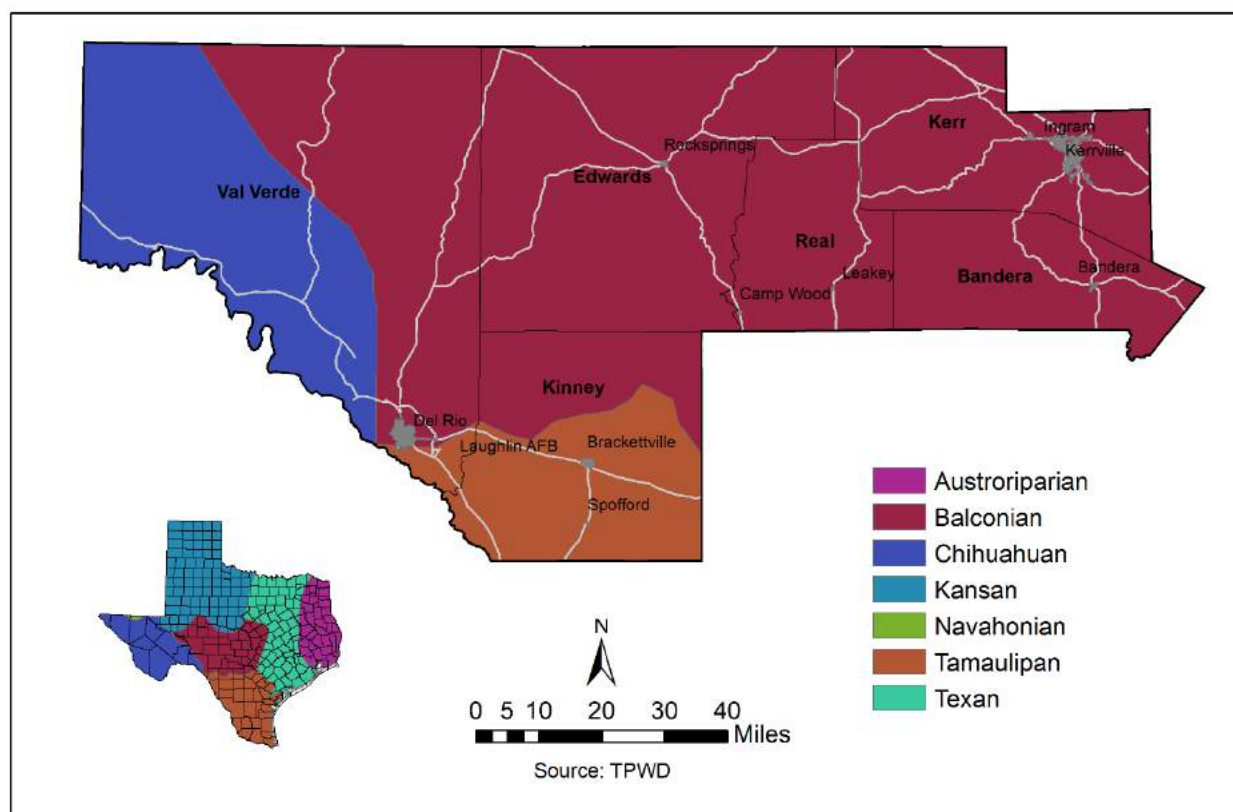


Figure 1-8. Biotic Provinces

1.2.7 Agricultural and Natural Resources

Agricultural resources in the Region include beef cattle, sheep, goat, and exotic game animals. Apple and pecan orchards, along with hay, are grown in the eastern part of the Region. Kinney County, with its extensive irrigated lands in the western half of the county, account for twice the amount of water used for irrigation as the rest of the Region combined.

The natural resources of the Region include both terrestrial and aquatic habitats that boast some of the best scenic drives and vistas, river rafting, and hunting and fishing in Texas. Natural resources also include the great diversity of plant and animal wildlife that inhabit these environments. Texas Parks and Wildlife Department maintains a comprehensive source of information on State and Federally listed rare, threatened, and endangered plants and animals, and Species of Greatest Conservation need (last updated March 30, 2020) (http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/nongame/listed-species).

Understandably, both local residents and tourists make use of these resources in their enjoyment of numerous public parks, dude ranches, resorts, recreational vehicle parks, and camping facilities. The following protected sites located within the Plateau Region depend upon adequate water to supply both environmental and recreational needs:

- Lost Maples State Natural area
- Hill Country State Natural Area
- Devil's River State Natural Area
- Seminole Canyon State Historic Park
- Dolan Falls Ranch Preserve (Nature Conservancy)
- Devils Sinkhole State Natural Area
- Kickapoo Cavern State Park
- Kerrville-Schreiner Park
- Heart of the Hills Fisheries Science Center
- Amistad National Recreation Area
- Love Creek Preserve
- Bandera Canyonlands

Both agricultural and natural resources water-supply needs are directly influenced by the quantity and quality of water available primarily in rivers and tributaries that flow through the Region and to a lesser extent on impounded lakes, ponds and tanks. Except for the Rio Grande, much of the drainage basins for the headwater of local rivers lie within Plateau Region counties. Springflow emanating from bedrock aquifers, particularly the Edwards-Trinity (Plateau) Aquifer, create the base flow of these streams. As such, these headwater watershed areas are particularly susceptible to drought conditions as the water table naturally drops and springflow diminishes.

Agricultural activities in the Region that rely on surface water are designed to accommodate the intermittent nature of the supply. In most cases, this means that agricultural water supply needs will be supplemented by groundwater sources, or that irrigation activities will cease until river supplies are replenished. Both plant and animal species endemic to this Region have developed a tolerance for the intermittent nature of surface water availability; however, significantly long drought conditions can have a severe effect on these species. Riparian water needs for birding habitat is particularly critical.

Of recognized importance to the water planning process is the concern of the impact that future development of water supplies might have on preexisting conditions in the Region. Water- supply management strategies developed in Chapter 5 of this *Plan* include an evaluation of each strategy's impact on agricultural, natural resources, and environmental concerns (see Tables 5-2 and 5-4, and Appendix 5B).

The principal potential impact to agriculture is the possible change in water rights use from agricultural use to municipal use of Guadalupe River flows in Kerr County. As these strategies only potentially change the use of the water and not the volume of diversion, there is no anticipated significant impact to natural resources.

1.2.8 Upper Llano River Watershed Protection Plan

"The Upper Llano River, which includes the North and South Llano Rivers, is a true gem of the Texas Hill Country. Due to the pristine nature and relatively constant flow of its springs, the Upper Llano is currently a healthy ecosystem supporting a variety of aquatic and terrestrial communities and numerous recreational opportunities" (Upper Llano River WPP Brochure). As part of the Healthy Watersheds Initiative under the Clean Water Act, the Upper Llano River Watershed Plan was published and implemented in 2016. The South Llano River Watershed contains portions of Edward, Kerr, and Real Counties, all within the Plateau Region planning area. Voluntary implementation efforts will focus on the following conservation measures:

- Repair and replace septic systems
- Decrease the feral hog population by 66%
- Increase the number of ranches with wildlife management plans by at least two annually, particularly in riparian areas
- Enroll more than 250,000 acres of ranchlands in conservation plans
- Treat more than 144,000 acres of brush to improve range conditions and increase water supply
- Begin restoration on 14 miles of areas lacking a riparian buffer and begin to improve vegetation conditions along 10% of the riparian zone
- Identify and implement best management practices to address urban runoff
- Improve water use efficiency by 10%

1.2.9 Water-Supply Source Vulnerability/Security

Following the events of September 11th 2001, Congress passed the Bio-Terrorism Preparedness and Response Act. Drinking water utilities serving more than 3,300 people were required and have completed vulnerability preparedness assessments and response plans for their water, wastewater, and stormwater facilities. The U.S. Environmental Protection Agency (EPA) funded the development of three voluntary

guidance documents, which provide practical advice on improving security in new and existing facilities of all sizes. The documents include:

Interim Voluntary Security Guidance for Water Utilities www.awwa.org

Interim Voluntary Security Guidance for Wastewater/Stormwater Utilities www.wef.org

Interim Voluntary Guidelines for Designing an Online Contaminant Monitoring System www.asce.org

1.2.10 Supply Source Protection

According to the 1996 Safe Drinking Water Act Amendments, the Texas Commission on Environmental Quality (TCEQ) is required to assess every public drinking water source for susceptibility to certain chemical constituents. The Source Water Protection Program is a voluntary program designed to help public water systems identify and implement measures that will protect their sources of water from potential contamination. Assessment reports are provided to the public water systems and are often used to implement local source water protection projects. Table 1-2 lists Plateau Region public water systems currently involved in the TCEQ's Source Water Protection Program.

Table 1-2. Plateau Region Source Water Protection Participants

PWS Name	County	Report Date
Bandera County FWSD 1	Bandera	7/1/1997
City of Bandera	Bandera	7/1/1997
Medina Children's Home	Bandera	7/1/1999
Flying L Ranch PUD	Bandera	7/1/1999
Bandera River Ranch 1	Bandera	7/31/2000
TPWD Lost Maples SNA	Bandera	7/1/1999
Bandina Christian Youth Camp	Bandera	7/1/1999
Camp Sionito Business	Bandera	7/1/1999
Bandera ISD Bandera High School	Bandera	7/1/1999
Mayan Dude Ranch	Bandera	7/1/1999
Dixie Dude Ranch	Bandera	7/1/1999
Blue Medina Water	Bandera	1/31/2001
Lake Medina Shores	Bandera	6/30/2005
Bandera Homestead Condominiums	Bandera	7/31/1999
MHC Medina Lake Campgrounds	Bandera	5/30/2000
Bandera ISD Alkek Elementary	Bandera	7/1/1999
Pipe Creek Junction Café	Bandera	7/1/1999
Lakewood Water	Bandera	7/31/1999
Elmwood Estates	Bandera	7/31/1999
Twin Elm Guest Ranch and RV Park	Bandera	7/1/1999
Bandina	Bandera	7/1/1999
Hill Country Mobile Home Park	Bandera	7/1/1999
Oak Country Property Owners Assn	Bandera	7/1/1999
Mansfield Park	Bandera	7/1/1999
Comanche Cliffs	Bandera	7/31/1999
Pomarosa RV Park	Bandera	7/1/1999
Bandera East Utility (Bridlegate)	Bandera	8/31/2015
Scenic Valley Mobile Home Park	Kerr	1/31/2001

Table 1-3. (Continued) Plateau Region Source Water Protection Participants

PWS Name	County	Report Date
Cedar Springs MHP	Kerr	5/31/2000
Verde Park Estates Wiedenfeld Water Work	Kerr	7/31/2000
Westcreek Estates Water System	Kerr	9/1/2002
Hills & Dales Wiedenfeld Water Work	Kerr	5/31/2000
Verde Hills WSC	Kerr	7/31/1999
Oak Forest South Water Supply	Kerr	5/31/2000
Nickerson Farm Water System	Kerr	5/31/2000
Park Place Subdivision	Kerr	8/31/2015
Four Seasons	Kerr	5/31/2000
Sleepy Hollow	Kerr	5/31/2000
Pecan Valley	Kerr	7/31/2000
Forest Oaks Mobile Home Park	Kerr	5/31/2000
Center Point North Water System	Kerr	5/31/2000
Center Point Taylor System	Kerr	8/31/2014
Four Seasons	Kerr	5/31/2000
Horseshoe Oaks Subdivision Water System	Kerr	5/31/2000
Northwest Hills Subdivision	Kerr	7/31/1999
Bear Paw Water System	Kerr	7/31/1999
Southern Hills	Kerr	5/31/2000
Cardinal Acres	Kerr	7/31/1999
Kamira Water System	Kerr	5/31/2000
Real Oaks Subdivision	Kerr	7/31/2000
Cherry Ridge Water	Kerr	5/31/2000
Silver Hills Park	Kerr	1/31/2001
Saddlewood Subdivision	Kerr	5/31/2000
Ingram Water Supply	Kerr	8/31/2015
Twin Forks Estates WSC	Real	8/31/2010
Del Rio Utilities Commission	Val Verde	12/31/1986

1.3 REGIONAL WATER DEMAND

1.3.1 Major Demand Categories

Total estimated year-2020 water consumptive use in the Plateau Region is 37,337 acre-feet. The largest category of demand is municipal and county other (25,975 acre-feet), followed by irrigation (8,805 acre-feet), livestock (2,182 acre-feet), mining (355 acre-feet), and manufacturing (20 acre-feet). Municipal, county-other and irrigation combined represent 93 percent of all water use in the Region (Figure 1-9). Current and projected water demand for all water-use types are discussed in detail in Chapter 2.

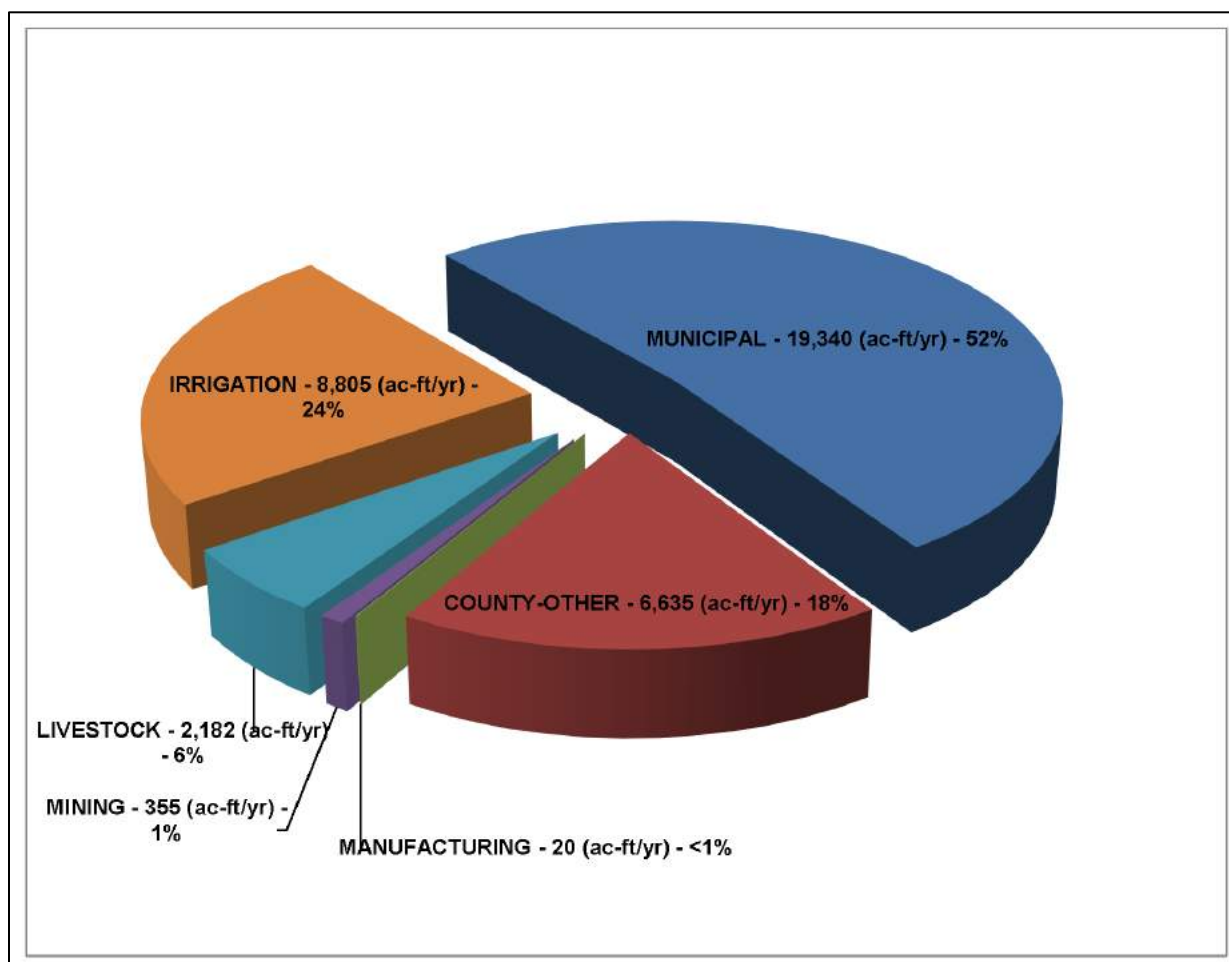


Figure 1-9. Year 2020 Projected Water Demand by Water-Use Category

1.3.2 Municipal

Municipal demand consists of both residential and commercial water uses. Commercial water consumption includes business establishments, public offices, and institutions, but does not include industrial water use. Residential and commercial uses are categorized together because they are similar types of uses, i.e.: they both use water primarily for drinking, cleaning, sanitation, air conditioning, and landscape watering.

The largest center of municipal demand is served by Del Rio Utilities in Val Verde County, where 10,558 acre-feet of water was estimated to be used in 2020 to supply residents and businesses. Fifty-five percent of regional municipal water is used in Val Verde County, and 28 percent is used in Kerr County.

Del Rio Utilities is the only entity in the Plateau Region that is designated as a major water provider. In addition to its own use, the city provides water to Laughlin Air Force Base and subdivisions outside of the City. The city also provides water and wastewater services to two colonias, Cienegas Terrace and Val Verde Park Estates.

1.3.3 Agriculture and Ranching

Agriculture and ranching water demand consists of all water used by the agricultural industry to support the cultivation of crops and the watering of livestock and wildlife. Where groundwater is the source of irrigation water, the TWDB defines irrigation use as “on farm demand.” Where surface water is the source of irrigation water, the TWDB defines irrigation use as both “on farm” demand and “diversion loss.” Surface water is typically conveyed by an open canal system, which exposes the water supply to possible loss from seepage, breaks, evaporation, and uptake by riparian vegetation. In the year 2020, irrigation represents the second greatest water use in the Region (8,805 acre-feet) with Kinney County accounting for 42 percent of the regional total. Livestock use in the Region amounted to 2,182 acre-feet.

1.3.4 Manufacturing and Mining

Manufacturing (and industrial) demand consists of all water used in the production of goods for domestic and foreign markets. Some processes require direct consumption of water as part of the manufacturing process. Others require very little water consumption but may require large volumes of water for cooling or cleaning purposes. In some manner or another, water is passed through the manufacturing facility and used either as a component of the product or as a transporter of waste heat and materials. Within the Plateau Region, manufacturing is only accounted for in Kerr County.

Mining demand consists of all water used in the production and processing of nonfuel (e.g., sulfur, clay, gypsum, lime, salt, stone and aggregate) and fuel (e.g., oil, gas, and coal) natural resources by the mining industry. In all instances, water is required in the mining of minerals either for processing, leaching to extract certain ores, controlling dust at the plant site, or for reclamation. This also includes the production of crude petroleum and natural gas. Water used in the mining industry in the Plateau Region is principally reported in Edwards, Kerr, and Val Verde Counties.

1.3.5 Environmental and Recreational Water Needs

Environmental and recreational water use in the Plateau Region is recognized as being an important consideration as it relates to the natural community in which the residents of this Region share and appreciate. In addition, for rural counties, tourism activities based on natural resources offer perhaps the

best hope for modest economic growth to areas that have seen a long decline in traditional economic activities such as agriculture.

A goal of this *Plan* is to provide for the health, safety, and welfare of the human community, with as little detrimental effect to the environment as possible. To accomplish this goal, the evaluation of strategies to meet future water needs (Chapter 5) includes a distinct consideration of the impact that each implemented strategy might have on the environment.

Recreation activities involving human interaction with the outdoor environment are often directly dependent on water resources. It is recognized that the maintenance of the regional environmental community's water supply needs serves to enhance the lives of citizens of the Plateau Region as well as the tens of thousands of annual visitors to this Region. Environmental and recreational water needs are further discussed throughout the *Plan* and especially in Chapters 2, 3, and 8.

1.4 WATER SUPPLY SOURCES

Water supply sources in the Plateau Region include groundwater primarily from six aquifers and surface water from five river basins. Reuse of existing supplies is also considered a water supply source. A more detailed description of these sources and estimates of their supply availability are provided in Chapter 3.

1.4.1 Groundwater

Within the Plateau Region, the TWDB recognizes three major aquifers [the Trinity, the Edwards-Trinity (Plateau), and the Edwards (Balcones Fault Zone)]. For this *Plan*, the Austin Chalk Aquifer in Kinney County, the Frio and Nueces River Alluvium Aquifers in Real and Edwards Counties, and the Ellenburger-San Saba Aquifer in Kerr County have also been identified as groundwater sources (Figure 1-10). Groundwater Conservation Districts in Bandera, Kerr, Kinney, Real and Edwards Counties provide for local management control of their groundwater resources.

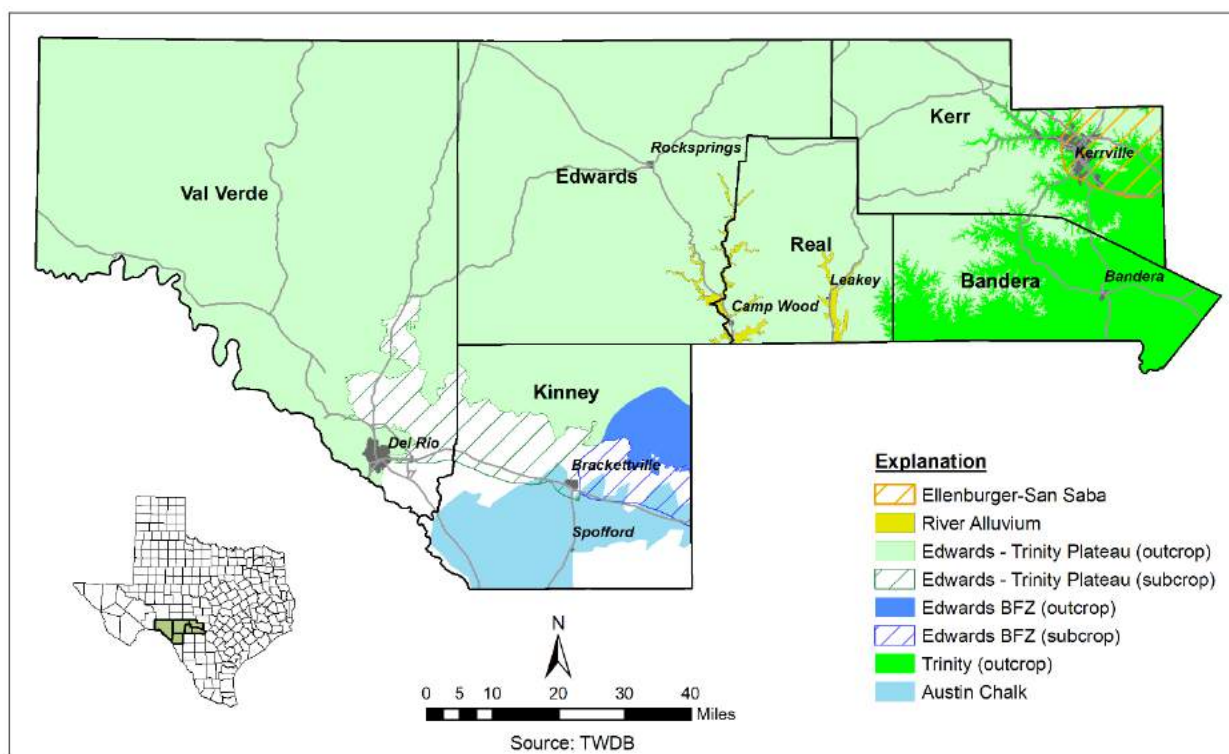


Figure 1-10. Groundwater Sources

1.4.1.1 Trinity Aquifer

The Trinity Aquifer occurs in its entirety in a band from the Red River in North Texas to the Hill Country of south-central Texas and provides water in all or parts of 55 counties. Trinity Group formations also occur as far west as the Panhandle and Trans-Pecos regions where they are included as part of the Edwards-Trinity (High Plains) and Edwards-Trinity (Plateau) Aquifers. The Trinity Aquifer in south-centrals Texas has been further subdivided into:

- Upper Trinity Aquifer
 - Upper Glen Rose Limestone
- Middle Trinity Aquifer
 - Lower Glen Rose Limestone
 - Hensell Sand / Bexar Shale
 - Cow Creek Limestone
- Lower Trinity Aquifer
 - Sligo Limestone / Hosston Formation

1.4.1.2 Edwards-Trinity (Plateau) Aquifer

Rock formations of the Edwards-Trinity (Plateau) Aquifer form the Edwards Plateau east of the Pecos River, and in its entirety, provide water to all or parts of 38 counties. The aquifer extends from the Hill Country of Central Texas to the Trans-Pecos region of West Texas. The aquifer consists of saturated sediments of lower Cretaceous age Trinity Group formations and overlying limestones and dolomites of the Edwards Group. The Glen Rose limestone is the primary unit in the Trinity in the southern part of the Plateau. Springs issuing from the aquifer form the headwaters of several eastward and southerly flowing rivers. Some of the largest springs of the area are in Val Verde and Kinney Counties, such as San Felipe Springs near Del Rio and Los Moras Springs in Brackettville.

1.4.1.3 Edwards (BFZ) Aquifer

The Edwards (Balcones Fault Zone (BFZ)) Aquifer in its entirety covers approximately 4,350 mi² in parts of 11 counties. It forms a narrow belt extending from a groundwater divide in Kinney County through the San Antonio area northeastward to the Leon River in Bell County. Within the Plateau Region, water in the aquifer generally moves from the recharge zone toward natural spring discharge points such as Las Moras Springs near Brackettville or southeasterly underground toward San Antonio.

1.4.1.4 Austin Chalk Aquifer

The Austin Chalk Aquifer occurs in the southern half of Kinney County and in the southernmost extent of Val Verde County. Most Austin Chalk wells discharge only enough water for domestic or livestock use; however, primarily in the area along Las Moras Creek, a few wells are large enough to support irrigation.

1.4.1.5 Nueces River Alluvium Aquifer

The Nueces River Alluvium occurs along the boundary between Edwards and Real Counties. Extending over an area of approximately 24,450 acres, the alluvial aquifer contains approximately 3,574 acre-feet of annually available water. The Community of Barksdale, local subdivisions, and other rural domestic homes derive their water supply from this aquifer.

1.4.1.6 Frio River Alluvium Aquifer

The Frio River Alluvium in central Real County extends over an area of approximately 9,530 acres and contains approximately 2,145 acre-feet of annually available water. Water supplies for the Community of Leakey, several subdivisions, and other rural domestic homes are derived from this small aquifer.

1.4.1.7 Ellenburger-San Saba Aquifer

Recent advances in aquifer research has suggested the desirability of adding the Ellenburger-San Saba Aquifer in Kerr County to the list of available groundwater sources in the Plateau Planning Region. Although no production wells in the Ellenburger are currently in use, the Headwaters GCD has authorized rules for future permitting of this resource.

1.4.1.8 Other Aquifers

Located along many of the streams and rivers throughout most of the Region are shallow alluvial floodplain deposits mostly composed of gravels and sands eroded from surrounding limestone hills. Wells completed in these deposits supply small to moderate quantities of water mostly for domestic and livestock purposes.

1.4.2 Surface Water

The Plateau Region is unique within all planning regions in that it straddles five river basins rather than generally following a single river basin or a large part of a single river basin (Figure 1-11). From west to east, these basins include the Rio Grande, Nueces, Colorado, Guadalupe, and San Antonio. The headwaters of rivers that form the Nueces, Guadalupe, and San Antonio river basins originate within this Region; and the headwaters of the South Llano River, a major tributary to the Colorado River, also occur here.

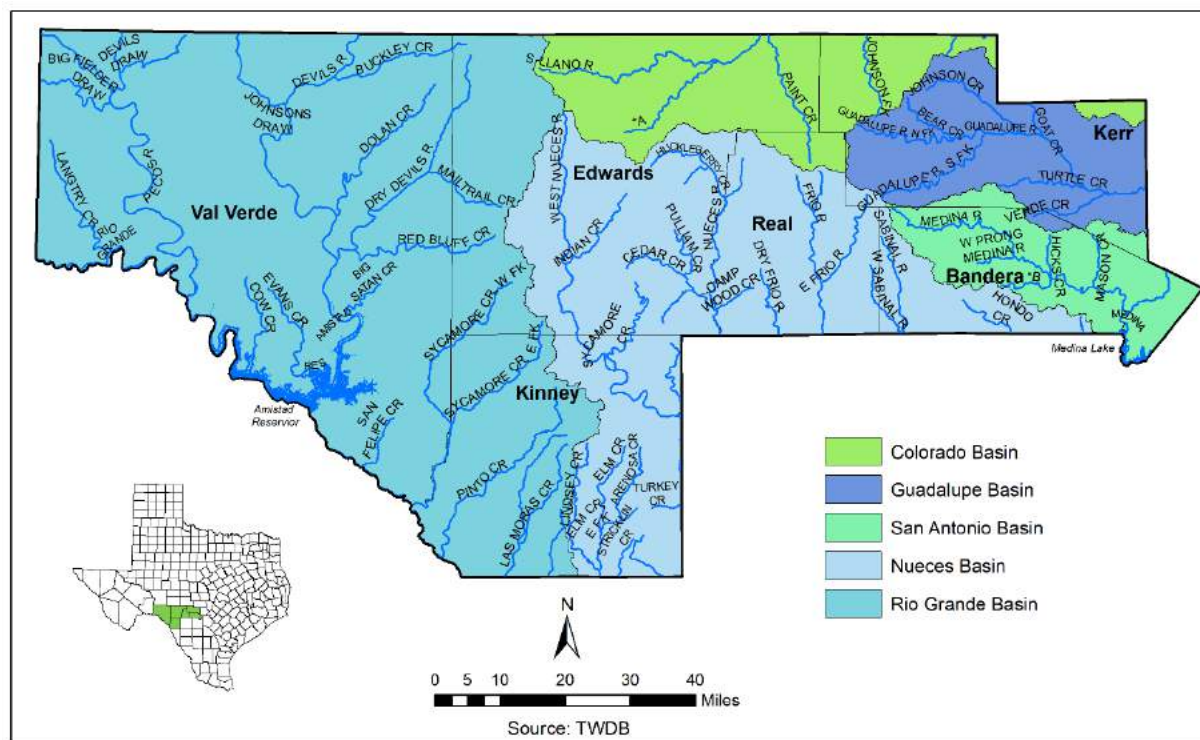


Figure 1-11. Surface Water Sources

1.4.2.1 Rio Grande Basin

The Rio Grande, or Rio Bravo as it is known in Mexico, forms the border between the United States and Mexico. International treaties governing the ownership and distribution of water in the Rio Grande are discussed in Chapter 3. The 3.4 million acre-foot International Amistad Reservoir is located on the Rio Grande in Val Verde County. Within the Plateau Region, the Pecos and Devil's Rivers in Val Verde County are the primary tributaries to the Rio Grande. Numerous springs, including San Felipe, Goodenough, and Las Moras, issue from the Edwards Aquifer and flow into tributaries of the Rio Grande. The main stream of the Rio Grande does not provide water for municipal use in the Plateau Region and only provides limited amounts for irrigation use, primarily from a tributary, San Felipe Creek.

1.4.2.2 Nueces River Basin

The main stem of the Nueces River forms a portion of the border between Edwards and Real Counties. Tributaries of the Nueces River located in the Plateau Region include the Sabinal River and Hondo Creek in Bandera County, the West Nueces River in Edwards and Kinney Counties, and the Frio, East Frio, Dry Frio Rivers in Real County, and other minor tributaries.

1.4.2.3 Colorado River Basin

The City of Rocksprings in Edwards County straddles the drainage divide between the Nueces River Basin and the Colorado River Basin. The portion of Edwards County north of Rocksprings, small northern portions of Real County and the northwestern part of Kerr County drain to the Llano River watershed in the Colorado River Basin. The South Llano River, part of the headwaters of the Llano/Colorado, begins in Edwards County.

1.4.2.4 Guadalupe River Basin

Most of Kerr County lies in the Guadalupe River Basin. The Guadalupe is not only an important water supply source for Kerrville and other communities in Kerr County, but is also a major tourist attraction for the area. Although Kerrville and the Upper Guadalupe River Authority own water rights, much of the flow of the Guadalupe is permitted for downstream use.

1.4.2.5 San Antonio River Basin

Bandera County is mostly split between the Nueces and San Antonio River Basins. The Medina River flows through Bandera County and drains to the San Antonio River. Medina Lake straddles the boundary between Bandera, Medina and Bexar Counties and serves as a major irrigation source for land downstream in Medina County. This reservoir has a conservation storage capacity of 254,823 acre-feet. In the spring 2015 the reservoir was only 3.5 percent full; however, as of March 2019 the reservoir had recovered to full capacity. The firm yield of Medina Lake and its associated Diversion Lake is zero.

1.4.3 Springs and Wildlife Habitat

Springs have played an important role in the development of the Plateau Region. They were important sources of water for Native American Indians, as indicated by the artifacts and petroglyphs found in the vicinity of many of the springs. These springs were also principal sources of water for early settlers and ranchers. Although springs are often recognized by a given name, in reality most springs are complexes of numerous openings through which groundwater flows to the surface. Additional discussion pertaining to springs and their function in the relationship between groundwater and surface water is contained in Chapter 3.

The PWPG has identified three “Major Springs” that are important for their municipal water supply (Figure 1-12). The fourth largest spring in Texas, San Felipe Springs, discharges to San Felipe Creek east of Del Rio and provides municipal drinking water for Del Rio, as well as irrigation use downstream. Las Moras Springs in Kinney County is of historical significance for its importance as a supply source on early travel routes and military fortifications. Today, Las Moras Springs supports the Fort Clark community and is hydrologically associated with the same aquifer system that serves Fort Clark MUD and the City of Brackettville. The third major spring is Old Faithful in Real County, which is the drinking-water supply source for the City of Camp Wood. While still the major contributor to the City of

Camp Wood's water supply, it is no longer the sole source as the City has drilled a deep well (Trinity aquifer) that supplements the spring especially during drought conditions.

Although only three springs are identified as “Major Springs”, the PWPG recognizes that all springs in the Region are important and are deserving of natural resource protection. The PWPG also recognizes the important ecological water supply function that all springs perform in the Region. Springs create and maintain base flow to rivers, contribute to the esthetic and recreational value of land, and are significant sources of water for wild game and aquatic species. Water issuing from springs forms wetlands that attract migratory birds and other fowl throughout the year. The wetlands host numerous terrestrial and aquatic species, some of which are listed as threatened or endangered.

Two supplemental study reports were prepared during the previous planning period for the PWPG that address springs (Table 1-1). The first report considers the location and geohydrology of springs in Kinney and Val Verde Counties, and the second report relates springflow in western Kerr County to base flow in the three branches of the upper Guadalupe River.

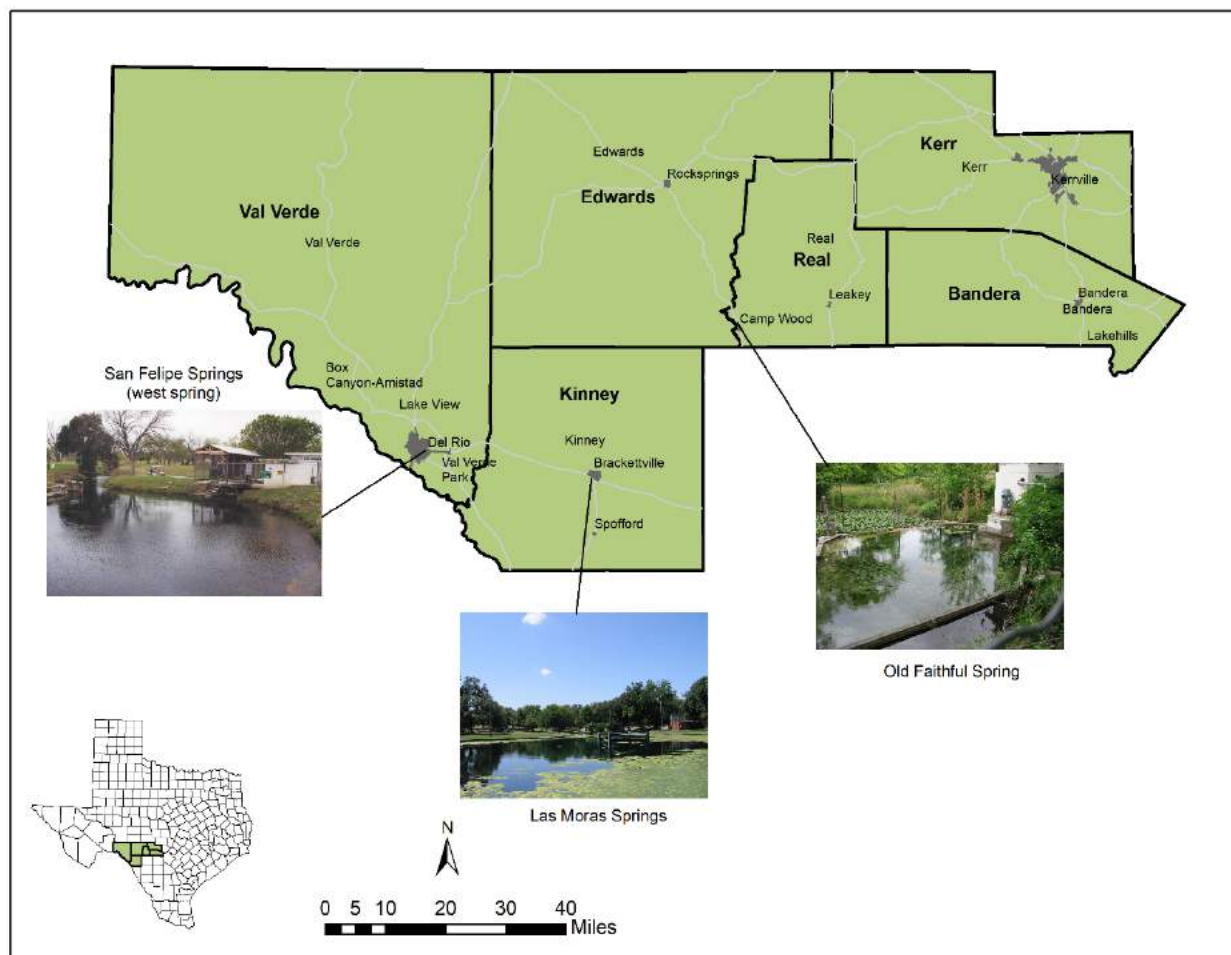


Figure 1-12. Major Springs

1.4.4 Reuse

Water recycling, or reuse, is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation or industrial processes. The Cities of Kerrville, Bandera and Camp Wood have active water reuse programs that are described in Chapter 3.

1.4.5 Water Quality Issues

Water quality is generally good throughout the Plateau Region; however, a few specific water quality issues should be mentioned. Increasing population impacts water quality in many ways, one of which is the increase in urban runoff that comes with the increase in impervious cover in populated areas.

Impervious cover concentrates runoff into storm sewers and drains, which then discharges into streams, increasing the flow, which also increases the erosional power of the water. In addition, urbanization also causes increased pollutant loads, including sediment, oil/grease/toxic chemicals from motor vehicles, pesticides/herbicides/fertilizers from gardens and lawns, viruses/bacteria/ nutrients from human and animal wastes including septic systems, and heavy metals from a variety of sources.

Increasing population has also manifested itself in the fragmentation of larger properties. With the advent of fragmentation comes the proliferation of new wells being drilled to serve the individual properties. Each new well thus becomes another potential conduit for surface contamination to reach the underlying aquifer system.

From a regional perspective, groundwater quality is relatively good. However, the constituent of most concern is nitrate, which is found above the primary maximum contaminant level in a number of water-sample analyses from the Edwards (BFZ) Aquifer and the Austin Chalk Aquifer in Kinney County.

Historically, the primary contribution to poor groundwater quality occurs in wells that do not have adequately cemented casing. Improperly completed wells allow poorer quality water to migrate into zones containing good quality water. Poorer groundwater quality in the Region is generally from two different sources, evaporite beds in the Glen Rose formation and from surface contamination, both of which can be prevented by proper well construction. Also of concern are above normal levels of radioactivity that have been detected in sand sequences of the Glen Rose and Hensell formations in some areas.

1.5 COLONIAS

Disadvantaged political subdivisions, often referred to as “colonias” represent a special subset of municipal demand in the Region, and a challenge to water suppliers. Most colonias are subdivisions in unincorporated areas located along the United States/Mexico international border and typically consist of small land parcels sold to citizens of low-income. These subdivisions often lack basic services such as potable water, sewage disposal and treatment, paved roads, and proper drainage. Public health problems are often associated with these colonias.

The Economically Distressed Area Program (EDAP) was created by the Texas Legislature in 1989 and is administered by the TWDB. The intent of the program is to provide local governments with financial assistance for bringing water and wastewater services to disadvantaged political subdivisions, including cities, counties, water districts and non-profit water supply corporations. An economically distressed area is defined as one in which water supply or wastewater systems are not adequate to meet minimal state standards, financial resources are inadequate to provide services to meet those needs, and there was an established residential subdivision on or prior to June 1, 2005. Affected counties are counties adjacent to the Texas/Mexico border, or that have per capita income 25 percent below the state median and unemployment rates 25 percent above the state average for the most recent three consecutive years for which statistics are available. Additional information pertaining to eligibility and requirements for this program are available on the TWDB web site:

<http://www.twdb.texas.gov/financial/programs/EDAP/index.asp>.

EDAP projects in the Plateau Region are located in Kerr, Kinney, Real and Val Verde Counties (Table 1-3). Data pertaining to all EDAP projects in the State can be accessed through the TWDB web site:

http://www.twdb.texas.gov/publications/reports/edap_reports/doc/Status.pdf. The following construction and planning projects are listed as EDAP funded as of February 28, 2019:

Table 1-3. Economically Distressed Area Program Projects (February 2019)

County	Recipient	Project	EDAP Funding	Other TWDB Funding	Status
Kerr	Upper Guadalupe RA	Center Point Water System	\$39,554		Completed
Kerr	Kerr County	Center Point Wastewater System	\$27,668,118	\$33,697,673	Active
Kerr	Kerr County		\$13,375,000		New commitment 12 / 2018
Kinney	City of Spoford	Brackettville Transmission Line	\$243,113		Completed
Real	Nueces River Authority	Leakey Wastewater System	\$20,251,979	\$9,961,460	Active

Table 1-3. (Continued) Economically Distressed Area Program Projects (February 2019)

County	Recipient	Project	EDAP Funding	Other TWDB Funding	Status
Val Verde	Val Verde County	Colonia Water Service	\$942,000		Active
Val Verde	City of Del Rio	Cienega Terrace	\$3,245,986		Completed
Val Verde	City of Del Rio	Val Verde Park Estates	\$10,747,009		Completed
Val Verde	Val Verde County	Water & Wastewater Planning	\$283,284		Completed
Val Verde	Val Verde County	Lakeview Estates Water & Wastewater	\$410,967		Completed

1.6 WATER LOSS AUDITS

In 2003, the 78th Texas Legislature, enacted House Bill 3338 to help conserve the State's water resources by reducing water loss occurring in the systems of drinking water utilities. This statute requires that retail public utilities providing water within Texas file a standardized water audit once every five years with the Texas Water Development Board (TWDB). In response to the mandates of House Bill 3338, TWDB developed a water audit methodology for utilities that measures efficiency, encourages water accountability, quantifies water losses, and standardizes water loss reporting across the State. This standardized approach to auditing water loss provides utilities with a reliable means to analyze their water loss performance. By reducing water loss, utilities can increase their efficiency, improve their financial status, minimize their need for additional water resources, and assist long-term water sustainability.

Any retail water supplier that has an active financial obligation with the TWDB is required to submit a water loss audit annually. Additionally, retail water suppliers with more than 3,300 connections are now required to submit an audit annually; all other retail public water suppliers are required to submit a water loss audit once every five years. Utilizing a methodology derived from the American Water Works Association (AWWA) and the International Water Association (IWA), the TWDB has published a manual that outlines the process of completing a water loss audit: Water Loss Audit Manual for Texas Utilities – TWDB Report 367 (2008).

Table 1-4 provides a listing of reported utility audits performed in the Plateau Region that show a loss of more than 10 percent.

Table 1-4. Public Water System Water Loss Reports (Gallons per year)

Public Water System	Report Year	Reported Breaks Leaks	Unreported Loss	Total Real Losses	Cost of Real Losses \$	Total Loss Percent
Bandera River Ranch 1	2015	364,487	4,426,897	4,791,384	3,656	27.9
City of Kerrville	2017	13,534,319	224,001,131	237,535,450	539,443	18.4
Community Water Group WSC	2015	1,252,104	663,788	1,915,892	1,341	20.3
Del Rio Utilities Commission	2016	1,540,400	33,261,796	34,802,196	144,777	11.4
Enchanted River Estates	2015	1,667,400	365,663	2,033,063	1,789	11.7
Fort Clark Springs MUD	2015	0	62,273,567	62,273,567	9,341	41.1
Real WSC	2015	100,000	1,533,416	1,633,416	1,111	32.3
San Pedro Canyon Subdivision - Upper	2016	0	5,394,010	5,394,010	2,551	40.0
Tierra Del Lago	2016	0	2,471,426	2,471,426	989	54.9
Val Verde County WCID Comstock	2015	20,000	1,534,206	1,554,206	894	16.4
Verde Park Estates	2015	32,000	630,140	662,140	2,715	15.5

American Water Works Association (AWWA) recommends entities with more than 10% water loss take corrective action.

1.7 STATE AND FEDERAL AGENCIES

1.7.1 Texas Water Development Board (TWDB)

The TWDB (<http://www.twdb.texas.gov>) is the State agency charged with statewide water planning and administration of low-cost financial programs for the planning, design and construction of water supply, wastewater treatment, flood control and agricultural water conservation projects. The TWDB, especially the Water Resources Planning Division, is at the center of the legislatively mandated regional water planning effort. The agency has been given the responsibility of directing the process in order to ensure consistency and to guarantee that all regions of the state submit plans in a timely manner.

1.7.2 Texas Commission on Environmental Quality (TCEQ)

The TCEQ (<http://www.tceq.texas.gov>) strives to protect the State's natural resources, consistent with a policy of sustainable economic development. TCEQ's goal is clean air, clean water, and the safe management of waste, with an emphasis on pollution prevention. The TCEQ is the major State agency with regulatory authority over State waters in Texas and administers water rights of the Lower Rio Grande through the office of the Watermaster. The TCEQ is also responsible for ensuring that all public drinking water systems are in compliance with the strict requirements of the State of Texas. TCEQ is involved with the TWDB in developing a state consensus water plan. Prior to permit approval, TCEQ is required to determine if projects are consistent with regional water plans.

1.7.3 Texas Parks and Wildlife Department (TPWD)

The TPWD (<http://www.tpwd.state.tx.us>) provides outdoor recreational opportunities by managing and protecting wildlife and wildlife habitat and acquiring and managing parklands and historic areas. The agency currently has six internal divisions: Wildlife, Coastal Fisheries, Inland Fisheries, Law Enforcement, State Parks, Infrastructure. TPWD is involved with the TWDB in developing a state consensus water plan. Specifically, the agency looks to see that statewide environmental water needs are included. A TPWD staff person is a non-voting member of the Plateau Water Planning Group and provides essential environmental expertise to the planning process.

1.7.4 Texas Department of Agriculture (TDA)

The TDA (<http://www.texasagriculture.gov/Home.aspx>) was established by the Texas Legislature in 1907. The TDA has marketing and regulatory responsibilities and administers more than 50 separate laws. The current duties of the Department include: (1) promoting agricultural products locally, national, and internationally (2) assisting in the development of the agribusiness in Texas; (3) regulating the sale, use and disposal of pesticides and herbicides; (4) controlling destructive plant pests and diseases; and (5) ensuring the accuracy of all weighing or measuring devices used in commercial transactions. The Department also collects and reports statistics on all activities related to the agricultural industry in Texas. A TDA staff person is a non-voting member of the Plateau Water Planning Group and provides essential agricultural expertise to the planning process.

1.7.5 Texas State Soil and Water Conservation Board (TSSWCB)

The TSSWCB (<http://www.tsswcb.texas.gov/>) is charged with the overall responsibility for administering and coordinating the state's soil and water conservation program with the State's soil and water conservation districts. The agency is responsible for planning, implementing, and managing programs and practices for abating agricultural and sivicultural nonpoint source pollution. Currently, the agricultural/sivicultural nonpoint source management program includes: problem assessment, management program development and implementation, monitoring, education, and coordination.

1.7.6 South Texas Watermaster Program

The South Texas Watermaster Program is responsible for an area that encompasses 50 counties in south central Texas and manages water rights based on "run of the river rights". Individuals and groups are informed as needed concerning water rights and other matters related to availability of surface water. The water master program also updates and maintains water-right ownerships and assessments due to each water-right account.

1.7.7 Public Utility Commission of Texas

The Public Utility Commission of Texas regulates the state's electric, telecommunication, and water and sewer utilities, implements respective legislation, and offers customer assistance in resolving consumer complaints.

1.7.8 International Boundary and Water Commission (IBWC) and Comisión Internacional de Límites y Aguas (CILA)

The IBWC (<http://ibwc.state.gov/>) and CILA provide binational solutions to issues that arise during the application of United States - Mexico treaties regarding boundary demarcation, national ownership of waters, sanitation, water quality, and flood control in the border region; the treaties are discussed in Chapter 3.

1.7.9 United States Geological Survey (USGS)

The USGS (<http://www.usgs.gov/>) serves the Nation by providing reliable scientific information to (1) describe and understand the Earth; (2) minimize loss of life and property from natural disasters; (3) manage water, biological, energy, and mineral resources; and (4) enhance and protect quality of life. The USGS's Water Resources Division has played a major role in the understanding of the groundwater resources of Texas. Scientists with the USGS have conducted regional studies of water availability and water quality. Many of these studies have been conducted in conjunction with the TWDB. These studies have provided much of the data for more recent investigations conducted by graduate students and faculty members of many Texas universities.

1.7.10 United States Environmental Protection Agency (EPA)

The mission of the EPA (<http://www.epa.gov/>) is to protect human health and the environment. Programs of the EPA are designed (1) to promote national efforts to reduce environmental risk, based on the best available scientific information; (2) ensure that federal laws protecting human health and the environment are enforced fairly and effectively; (3) guarantee that all parts of society have access to accurate

information sufficient to manage human health and environmental risks; and (4) guarantee that environmental protection contributes to making communities and ecosystems diverse, sustainable, and economically productive.

1.7.11 United States Fish and Wildlife Department (USFWS)

The USFWS (<http://www.fws.gov>) enforces federal wildlife laws, manages migratory bird populations, restores nationally significant fisheries, conserves and restores vital wildlife habitat, protects and recovers endangered species, and helps other governments with conservation efforts. It also administers a federal aid program that distributes money for fish and wildlife restoration, hunter education, and related projects across the country. The USFWS has provided comments that are pertinent to wildlife water needs to draft planning documents.

1.7.12 Upper Guadalupe River Authority

The Upper Guadalupe River Authority (UGRA) (<http://www.ugra.org>) was created as a conservation and reclamation district by the Texas Legislature in 1939. UGRA is a highly respected steward in managing the watershed and water resources of the Upper Guadalupe River benefiting both people and the environment. The mission of the UGRA is to conserve and reclaim surface water through the preservation and distribution of the water resources for future growth in order to maintain and enhance the quality of life for all Kerr County citizens.

1.7.13 Nueces River Authority

The Nueces River Authority (NRA) (<http://www.nueces-ra.org>) was created in 1935 by special act of the 44th Texas Legislature. Under supervision of the Texas Commission on Environmental Quality, NRA has broad authority to preserve, protect, and develop surface water resources including flood control, irrigation, navigation, water supply, wastewater treatment, and water quality control. NRA may develop parks and recreational facilities, acquire and dispose of solid wastes, and issue bonds and receive grants and loans.

This page intentionally left blank

CHAPTER 2

POPULATION AND WATER DEMAND

This page intentionally left blank.

2 POPULATION AND WATER DEMAND

Planning for the wise use of the existing water resources in the Plateau Region requires a reasonable estimation of current and future water needs for all water-use categories. Regional population and water demand data was initially provided to the Plateau Water Planning Group (PWPG) at the beginning of the planning period, which incorporated data from the State Data Center and the U.S. Census Bureau's 2010 census count. The Plateau Water Planning Group (PWPG) requested revisions to specific water demand categories for use in the *2021 Plateau Region Water Plan*, which were subsequently approved by the TWDB. Thus, the population and water demand projections shown in this chapter are derived from a combination of TWDB data and approved revisions.

The PWPG made available the draft population and water demand summary tables to municipalities, water providers, county judges, and non-municipal water use representatives, and solicited all entities within the Region to submit desired changes to the projections. After thoughtful consideration, the PWPG chose to accept the draft population and water demand estimates. However, the PWPG did voice reservations with the way that these population numbers are used to calculate county rural water demand projections as further expressed in Section 2.2.1 below. Requested revisions in draft water demand projections fell into two categories, City of Kerrville and Kerr County-Other. Both of the revision requests were subsequently granted by the TWDB.

Population projections and associated water demand projections have been reassembled by utility service areas rather than political boundaries in order to better plan for the actual water-supply service entity. Previous regional and State water plans have been aligned with political boundaries, such as city limits rather than water utility service areas. Recent TWDB rule changes now define a municipal water user group (WUG) as being utility-based, and thus emphasis of the development of population and municipal water demands for the 2021 regional water plans transition from political boundaries to utility-service area boundaries.

2.1 POPULATION

2.1.1 Population Projection Methodology

County population projections are prepared by the Texas State Data Center / Office of the State Demographer and are based on recent and projected demographic trends, including birth and survival rates and net migration rates of population groups defined by age, gender, and race/ethnicity. Because the fifth cycle of regional water planning falls within an inter-census planning cycle, no new decennial census data is available in time for the use of this *Plan*. Population projections are therefore based on the 2017 State Water Plan population data.

The projected municipal population is allocated to water systems or utilities that provide an average of more than 100 acre-feet per year for municipal use. This newly defined (municipal WUG) includes water systems that vary from privately-owned, systems serving institutions, facilities owned by the State and Federal government, and all other retail public utilities that meet the 100-acre feet criteria.

Rural “county-other” population is calculated as the difference between the total projected population of the utility service areas and the total projected county population. Population is then projected from the 2010 base year by decade to the year 2070. However, a new set of 2010 population estimates were developed to reflect a utility based boundary (not political boundary) as a baseline population to be projected for the use of this *Plan*. A more detailed explanation of the TWDB population projection methodology is available at

http://www.twdb.texas.gov/waterplanning/rwp/planningdocu/2021/doc/current_docs/project_docs/20170405_pop_muni_proj_method_summ.pdf?d=75388.485.

The PWPG expresses concern that the population projections do not recognize the impact to the municipal and rural population and its related water demand that occurs as the result of seasonal vacationers, hunters, and absentee land-owner homes, especially in the rural counties. The PWPG recommends that for future regional water plans, that a region be allowed to adjust the total regional population rather than having to adjust individual county populations to achieve a non-changeable total population.

2.1.2 Current and Projected Population

In the year 2010, the U.S. Census Bureau performed a census count, which provides the base year for future population projections. Although the PWPG accepts the 2010 census count, members again expressed concern that the census does not recognize the significant seasonal population increase that occurs as the Region draws large numbers of hunters and recreational visitors, as well as absentee land owners who maintain vacation, retirement, and hunting properties. Therefore, an emphasis is being made in this planning document, especially for the rural counties, to recognize a need for more water than is justified simply from the population-derived water demand quantities.

The approved projections may also underestimate population and subsequent water demand in Kerr County. The cohort-component model used to project population growth does not adequately account for expected business and market factors that can influence population growth. Several Kerr County organizations are actively pursuing market development and business growth in order to maintain a

consistent double-digit growth rate not reflected in the long-term population forecast. Similar underestimations may also occur elsewhere in the Region.

Population projections by decade for water utilities, and county rural areas in the Plateau Region are listed in Table 2-1. The projected year-2020 population for the entire Region is 141,476 of which 76 percent reside in Kerr and Val Verde Counties (Figure 2-1). Del Rio, with a year-2020 projected population of 37,775 is the largest community in the Region. The Regional population is projected to increase by 30 percent to 184,595 by the year 2070, which is an increase of 43,119 citizens (Figure 2-2). The water demand table (Table 2-2) depicts water demand for county-other use as equally distributed throughout the rural portion of each county; whereas in reality, county-other population and water demand are often concentrated in smaller areas of the county, such as unincorporated communities, subdivisions and mobile home parks.

Population estimates do not consider rural population density, which concentrates water demand and strains available local water supplies. Figure 2-3 shows the concentration of rural population in the eastern portions of both Kerr and Bandera Counties. The challenge of meeting the water needs for these concentrated rural areas is addressed in water management strategies provided in Chapter 5.

Table 2-1. Plateau Region Population Projections

	2020	2030	2040	2050	2060	2070
Bandera County - Guadalupe Basin						
County-Other	122	140	150	155	157	158
Guadalupe Basin Total Population	122	140	150	155	157	158
Bandera County - Nueces Basin						
County-Other	1,114	1,282	1,376	1,414	1,438	1,450
Nueces Basin Total Population	1,114	1,282	1,376	1,414	1,438	1,450
Bandera County - San Antonio Basin						
Bandera	1,875	2,160	2,316	2,380	2,420	2,442
Bandera County FWSD #1	679	781	838	862	876	883
County-Other	16,962	19,535	20,961	21,546	21,901	22,085
County-Other (Bandera River Ranch 1)	929	1,070	1,148	1,180	1,199	1,209
County-Other (Lake Medina Shores)	2,415	2,781	2,985	3,068	3,118	3,144
County-Other (Medina WSC)	895	1,031	1,107	1,137	1,156	1,166
San Antonio Basin Total Population	23,755	27,358	29,355	30,173	30,670	30,929
Bandera County Total Population	24,991	28,780	30,881	31,742	32,265	32,537
Edwards County - Colorado Basin						
Rocksprings	844	844	844	844	844	844
County-Other	136	136	136	136	136	136
Colorado Basin Total Population	980	980	980	980	980	980
Edwards County - Nueces Basin						
Rocksprings	415	415	415	415	415	415
County-Other	391	391	391	391	391	391
County-Other (Barksdale WSC)	264	264	264	264	264	264
Nueces Basin Total Population	1,070	1,070	1,070	1,070	1,070	1,070
Edwards County - Rio Grande Basin						
County-Other	73	73	73	73	73	73
Rio Grande Basin Total Population	73	73	73	73	73	73
Edwards County Total Population	2,123	2,123	2,123	2,123	2,123	2,123
Kerr County - Colorado Basin						
County-Other	507	541	562	582	596	607
Colorado Basin Total Population	507	541	562	582	596	607
Kerr County - Guadalupe Basin						
Kerrville	25,658	26,638	27,217	27,792	28,203	28,522
Kerrville South Water	2,821	2,969	3,057	3,143	3,206	3,254
County-Other	20,583	21,982	22,813	23,636	24,226	24,679
County-Other (Center Point North Water System)	255	272	282	291	298	304
County-Other (Center Point Taylor System)	530	564	585	605	619	631
County-Other (Center Point)	161	172	178	184	189	192
County-Other (Hills and Dales Estates)	202	216	223	231	237	241
County-Other (Nickerson Farm Water System)	200	213	221	229	234	238
County-Other (Oak Forest South Water)	669	712	738	763	782	796
County-Other (Park Place Subdivision)	129	138	143	148	151	154
County-Other (Pecan Valley)	123	131	135	140	144	146
County-Other (Rustic Hills Water)	80	85	88	91	93	95
County-Other (Verde Park Estates)	178	189	196	203	208	211
County-Other (Westwood Water System)	269	287	297	307	315	320
Guadalupe Basin Total Population	51,858	54,568	56,173	57,763	58,905	59,783
Kerr County - Nueces Basin						
County-Other	6	7	7	7	8	8
Nueces Basin Total Population	6	7	7	7	8	8

Table 2-1. (continued) Plateau Region Population Projections

	2020	2030	2040	2050	2060	2070
Kerr County - San Antonio Basin						
County-Other	273	291	302	313	321	327
San Antonio Basin Total Population	273	291	302	313	321	327
Kerr County Total Population	52,644	55,407	57,044	58,665	59,830	60,725
Kinney County - Nueces Basin						
County-Other	81	82	82	82	82	82
Nueces Basin Total Population	81	82	82	82	82	82
Kinney County - Rio Grande Basin						
Brackettville	1,958	1,971	1,971	1,971	1,971	1,971
Fort Clark Springs MUD	1,259	1,267	1,267	1,267	1,267	1,267
County-Other	397	400	400	400	400	400
Rio Grande Basin Total Population	3,614	3,638	3,638	3,638	3,638	3,638
Kinney County Total Population	3,695	3,720	3,720	3,720	3,720	3,720
Real County - Colorado Basin						
County-Other	35	35	35	35	35	35
Colorado Basin Total Population	35	35	35	35	35	35
Real County - Nueces Basin						
Camp Wood	747	747	747	747	747	747
Leakey	1,415	1,415	1,415	1,415	1,415	1,415
County-Other	1,132	1,132	1,132	1,132	1,132	1,132
Nueces Basin Total Population	3,294	3,294	3,294	3,294	3,294	3,294
Real County Total Population	3,329	3,329	3,329	3,329	3,329	3,329
Val Verde County - Rio Grande Basin						
Del Rio Utilities Commission	37,775	40,196	42,540	44,948	47,242	49,453
Laughlin AFB	1,767	1,951	2,129	2,239	2,239	2,239
County-Other	15,152	18,242	21,233	24,379	27,479	30,469
Rio Grande Basin Total Population	54,694	60,389	65,902	71,566	76,960	82,161
Val Verde County Total Population	54,694	60,389	65,902	71,566	76,960	82,161
Region J Total Population	141,476	153,748	162,999	171,145	178,227	184,595

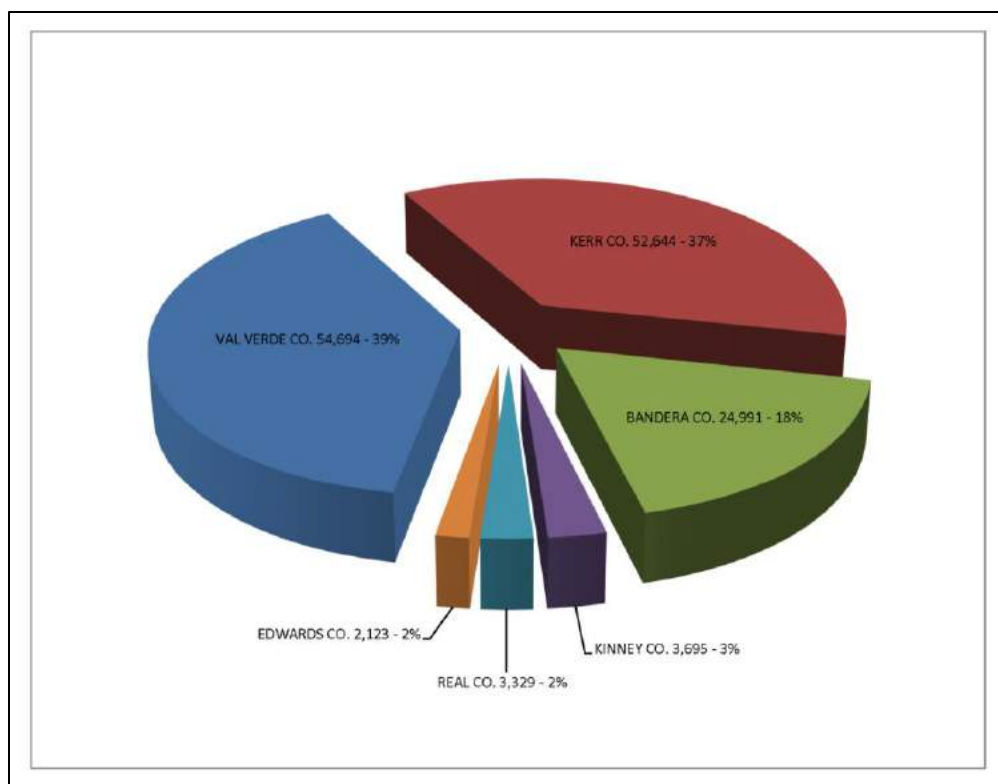


Figure 2-1. Year 2020 Population Projection

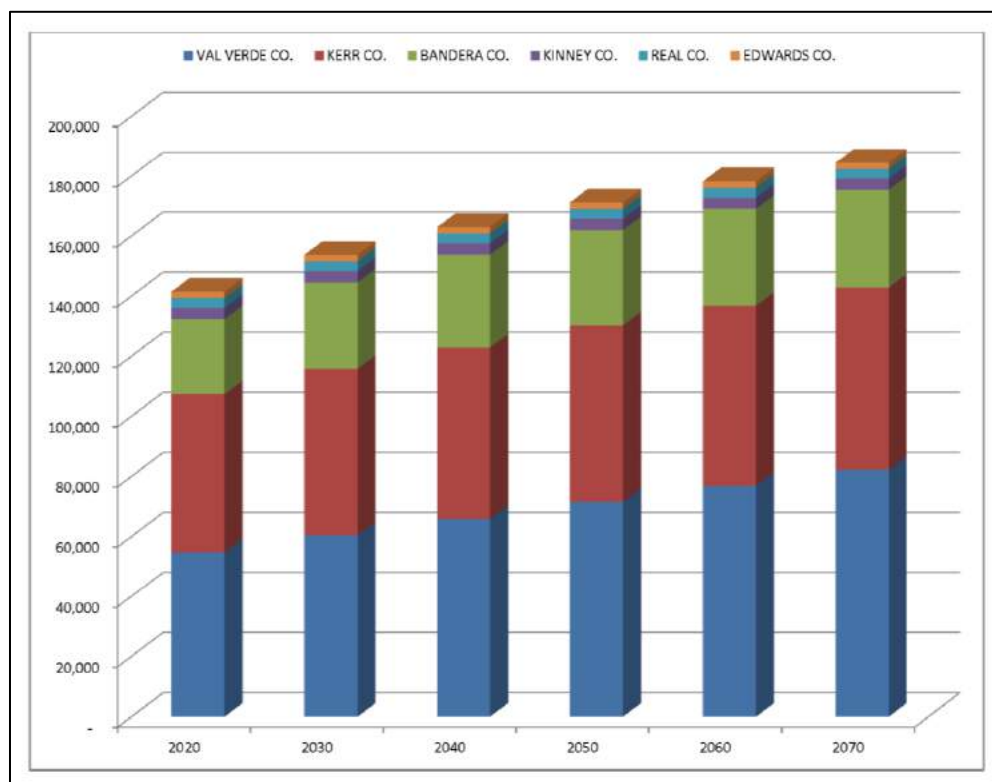


Figure 2-2. Regional Population Projection

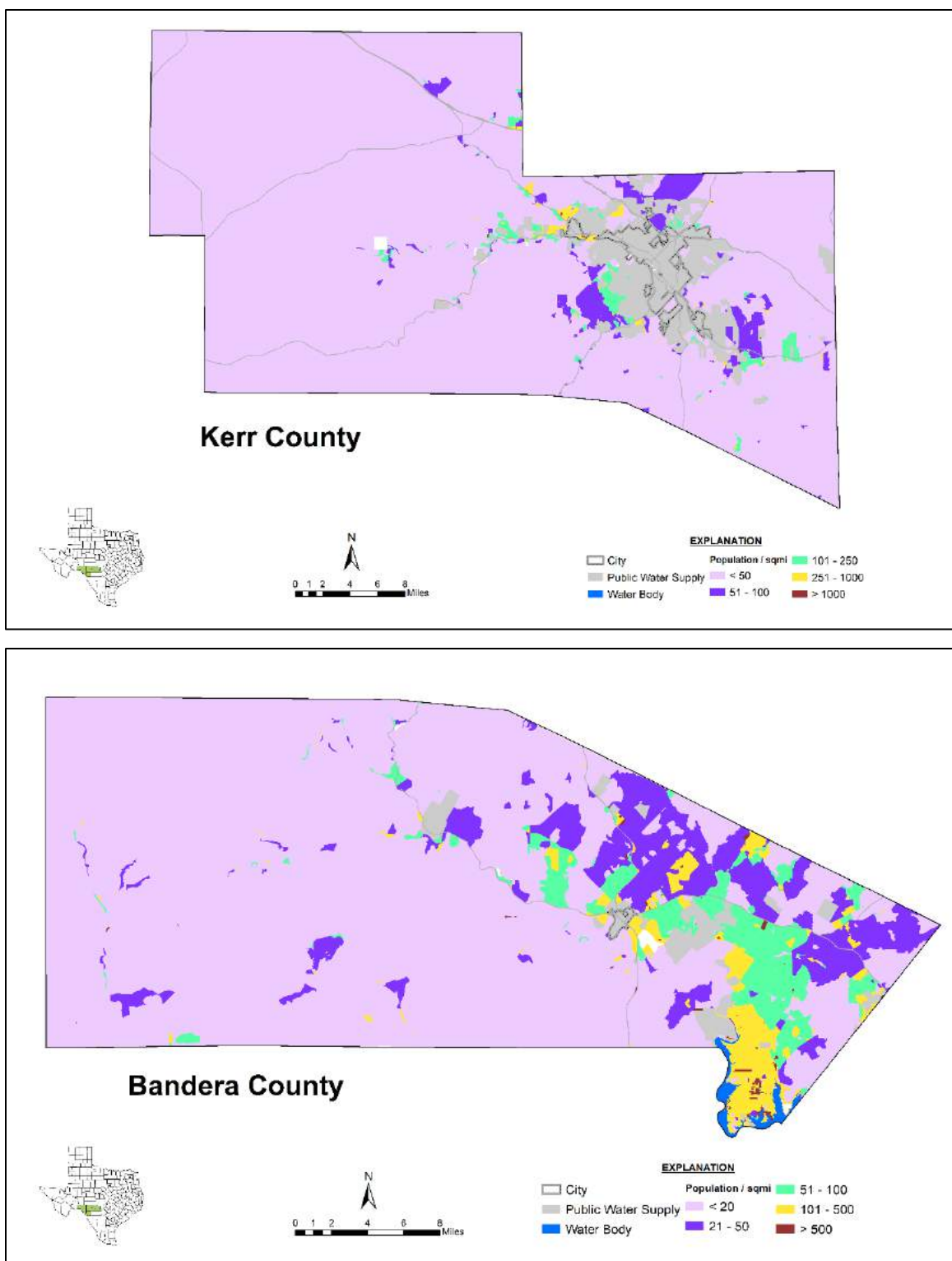


Figure 2-3. Rural Population Concentration in Kerr and Bandera Counties

2.2 WATER DEMAND

2.2.1 Water Demand Projections

A major component of water planning is the establishment of accurate water demand estimates for all water-use categories. Categories of water use include (1) municipal, (2) county-other (rural domestic), (3) manufacturing, (4) irrigation, (5) livestock, and (6) mining. There is no recognized water use in the Plateau Region for “steam-electric power generation”. Other water use categories that are not quantified in this *Plan* include environmental and recreational needs, and are addressed in Section 2.3.

In early 2016, the TWDB contracted CDM Smith to review the projection methodologies previously used, provide insight on how projections were developed in other state planning efforts, and recommend alternative methodologies. The TWDB determined that the water demand projections methodologies for three of the categories – manufacturing, irrigation and steam-electric power – should be revised to better reflect reported historical water use. Summaries of the methodologies are provided in the following subsections. A more descriptive report can be found here:

http://www.twdb.texas.gov/waterplanning/rwp/planningdocu/2021/current_docs.asp.

Table 2-2 lists the current and future projected Regional water demand by county and water-use category. The percent distribution of water demand in the Region by the six water-use categories is shown in Figure 2-4. Water demand is reported in “acre-feet”; one acre-foot is equivalent to a quantity of water one-foot deep occupying one acre, or 325, 851 gallons.

Figure 2-5 and Figure 2-6 show projected water demand by county in acre-feet per year. From the 2020 decade to the 2070 decade the total water demand in the Region is projected to increase from 37,337 acre-feet to 43,155 acre-feet.

The potential role of conservation is an important factor in projecting future water supply requirements. In this *Plan*, conservation is included in the municipal projections as a measure of expected savings based on requirements of the State plumbing code. All other conservation practices are discussed in terms of water supply management strategies in Chapter 5 and as a component of drought management plans in Chapter 7.

As stated previously, the PWPG is concerned that the population and subsequent water demand projections throughout the Region may be understated due to the large number of temporary residents in the Region including hunters, tourists and absentee landowners. In addition to these factors, water demand may be understated in Kerr County (as well as elsewhere in the Region) because the cohort-component model does not reflect market and business factors that are expected to increase water demand in the county, especially in the municipal and manufacturing use category. Population estimates do not consider population density, which concentrates water demand and strains available local water supplies.

The following sections present an overview of water supply needs for major water providers and for each of the six-designated water-use categories and include methods and assumptions used in the State’s consensus water planning process.

**Table 2-2. Plateau Region Water Demand Projections
(Acre-Feet per Year)**

	2020	2030	2040	2050	2060	2070
Bandera County - Guadalupe Basin						
County-Other	13	14	15	15	15	15
Livestock	11	11	11	11	11	11
Guadalupe Basin Total Water Demand	24	25	26	26	26	26
Bandera County - Nueces Basin						
County-Other	116	129	136	138	140	141
Irrigation	182	182	182	182	182	182
Livestock	47	47	47	47	47	47
Nueces Basin Total Water Demand	345	358	365	367	369	370
Bandera County - San Antonio Basin						
Bandera	342	383	404	413	419	423
Bandera County FWSD #1	141	158	167	171	174	175
County-Other	1,765	1,965	2,066	2,102	2,132	2,149
County-Other (Bandera River Ranch #1)	97	108	113	115	117	118
County-Other (Lake Medina Shores)	251	280	294	299	303	306
County-Other (Medina WSC)	93	104	109	111	112	113
Irrigation	764	764	764	764	764	764
Livestock	185	185	185	185	185	185
San Antonio Basin Total Water Demand	3,638	3,947	4,102	4,160	4,206	4,233
Bandera County Total Water Demand	4,007	4,330	4,493	4,553	4,601	4,629
Edwards County - Colorado Basin						
Rocksprings	198	194	191	190	190	190
County-Other	15	14	14	14	14	14
Irrigation	66	66	66	66	66	66
Livestock	106	106	106	106	106	106
Mining	19	19	19	19	19	19
Colorado Basin Total Water Demand	404	399	396	395	395	395
Edwards County - Nueces Basin						
Rocksprings	98	96	94	94	94	94
County-Other	43	41	39	39	39	39
County-Other (Barksdale WSC)	29	28	27	26	26	26
Irrigation	89	89	89	89	89	89
Livestock	192	192	192	192	192	192
Mining	25	25	25	25	25	25
Nueces Basin Total Water Demand	476	471	466	465	465	465
Edwards County - Rio Grande Basin						
County-Other	8	8	7	7	7	7
Irrigation	60	60	60	60	60	60
Livestock	99	99	99	99	99	99
Mining	45	45	45	45	45	45
Rio Grande Basin Total Water Demand	212	212	211	211	211	211
Edwards County Total Water Demand	1,092	1,082	1,073	1,071	1,071	1,071
Kerr County - Colorado Basin						
County-Other	43	44	44	44	45	46
Irrigation	61	61	61	61	61	61
Livestock	166	166	166	166	166	166
Mining	14	15	18	19	20	22
Colorado Basin Total Water Demand	284	286	289	290	292	295

**Table 2-2. (continued) Plateau Region Water Demand Projections
(Acre-Feet per Year)**

	2020	2030	2040	2050	2060	2070
Kerr County - Guadalupe Basin						
Kerrville	5,082	5,158	5,178	5,237	5,305	5,364
Kerrville South Water	341	346	347	352	358	363
County-Other	1,737	1,769	1,773	1,804	1,842	1,875
County-Other (Center Point North Water System)	22	22	22	22	23	23
County-Other (Center Point Taylor System)	45	45	46	46	47	48
County-Other (Center Point)	14	14	14	14	14	15
County-Other (Hills and Dales Estates)	17	17	17	18	18	18
County-Other (Nickerson Farm Water System)	17	17	17	17	18	18
County-Other (Oak Forest South Water)	56	57	57	58	59	60
County-Other (Park Place Subdivision)	11	11	11	11	11	12
County-Other (Pecan Valley)	10	11	11	11	11	11
County-Other (Rustic Hills Water)	7	7	7	7	7	7
County-Other (Verde Park Estates)	15	15	15	15	16	16
County-Other (Westwood Water System)	23	23	23	23	24	24
Irrigation	1,239	1,239	1,239	1,239	1,239	1,239
Livestock	546	546	546	546	546	546
Manufacturing	20	21	21	21	21	21
Mining	62	65	82	83	91	98
Guadalupe Basin Total Water Demand	9,264	9,383	9,426	9,524	9,650	9,758
Kerr County - Nueces Basin						
County-Other	1	1	1	1	1	1
Livestock	9	9	9	9	9	9
Nueces Basin Total Water Demand	10	10	10	10	10	10
Kerr County - San Antonio Basin						
County-Other	23	23	24	24	24	25
Irrigation	42	42	42	42	42	42
Livestock	36	36	36	36	36	36
San Antonio Basin Total Water Demand	101	101	102	102	102	103
Kerr County Total Water Demand	9,659	9,780	9,827	9,926	10,054	10,166
Kinney County - Nueces Basin						
County-Other	11	11	11	11	10	10
Irrigation	1,300	1,300	1,300	1,300	1,300	1,300
Livestock	100	100	100	100	100	100
Nueces Basin Total Water Demand	1,411	1,411	1,411	1,411	1,410	1,410
Kinney County - Rio Grande Basin						
Brackettville	608	602	594	593	592	592
Fort Clark Springs MUD	618	616	612	610	609	609
County-Other	53	52	51	51	51	51
Irrigation	2,413	2,413	2,413	2,413	2,413	2,413
Livestock	124	124	124	124	124	124
Rio Grande Basin Total Water Demand	3,816	3,807	3,794	3,791	3,789	3,789
Kinney County Total Water Demand	5,227	5,218	5,204	5,201	5,199	5,199
Real County - Colorado Basin						
County-Other	4	4	3	3	3	3
Irrigation	12	12	12	12	12	12
Livestock	13	13	13	13	13	13
Colorado Basin Total Water Demand	29	29	28	28	28	28

**Table 2-2. (continued) Plateau Region Water Demand Projections
(Acre-Feet per Year)**

	2020	2030	2040	2050	2060	2070
Real County - Nueces Basin						
Camp Wood	143	139	136	135	135	135
Leakey	193	186	180	178	177	177
County-Other	120	116	113	111	111	111
Irrigation	258	258	258	258	258	258
Livestock	138	138	138	138	138	138
Nueces Basin Total Water Demand	852	837	825	820	819	819
Real County Total Water Demand	881	866	853	848	847	847
Val Verde County - Rio Grande Basin						
Del Rio Utilities Commission	10,558	11,053	11,554	12,130	12,733	13,326
Laughlin AFB	1,018	1,114	1,215	1,277	1,276	1,276
County-Other	1,976	2,307	2,637	3,002	3,376	3,741
Irrigation	2,319	2,319	2,319	2,319	2,319	2,319
Livestock	410	410	410	410	410	410
Mining	190	249	259	223	192	171
Rio Grande Basin Total Water Demand	16,471	17,452	18,394	19,361	20,306	21,243
Val Verde County Total Water Demand	16,471	17,452	18,394	19,361	20,306	21,243
Region J Total Water Demand	37,337	38,728	39,844	40,960	42,078	43,155

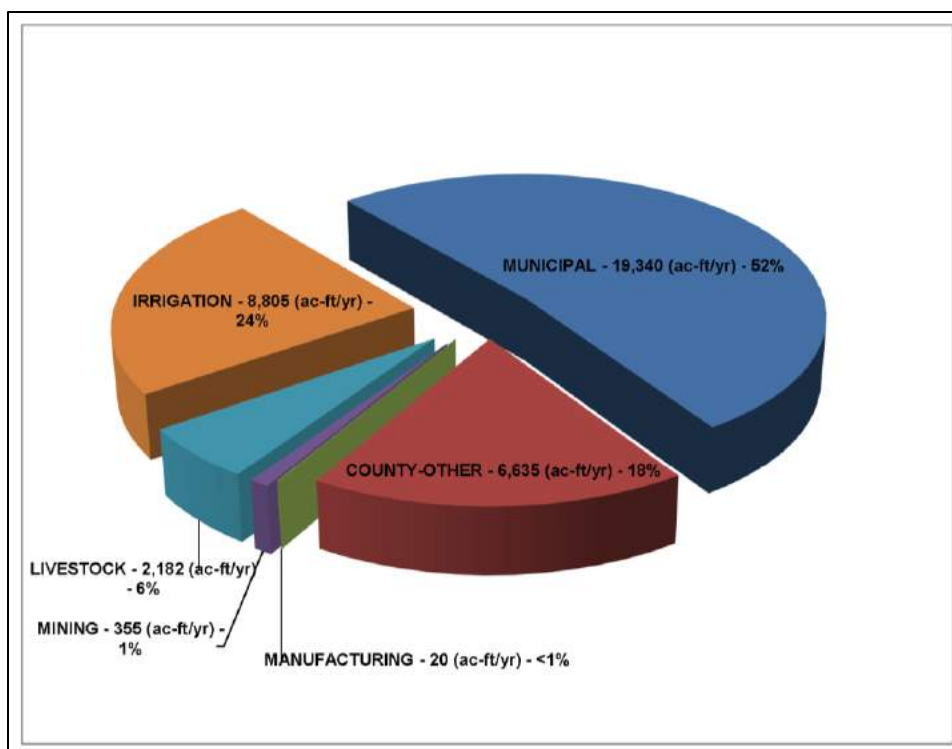


Figure 2-4. Year 2020 Projected Water Demand by Water-Use Category

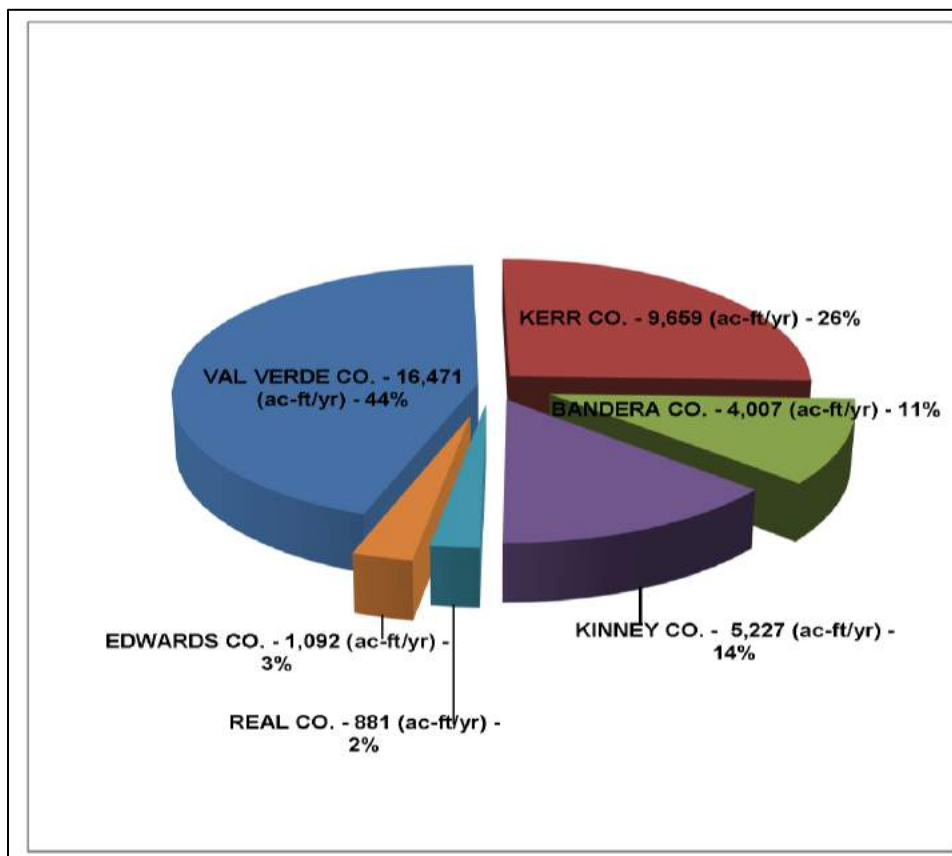


Figure 2-5. Year 2020 Projected Water Demand by County

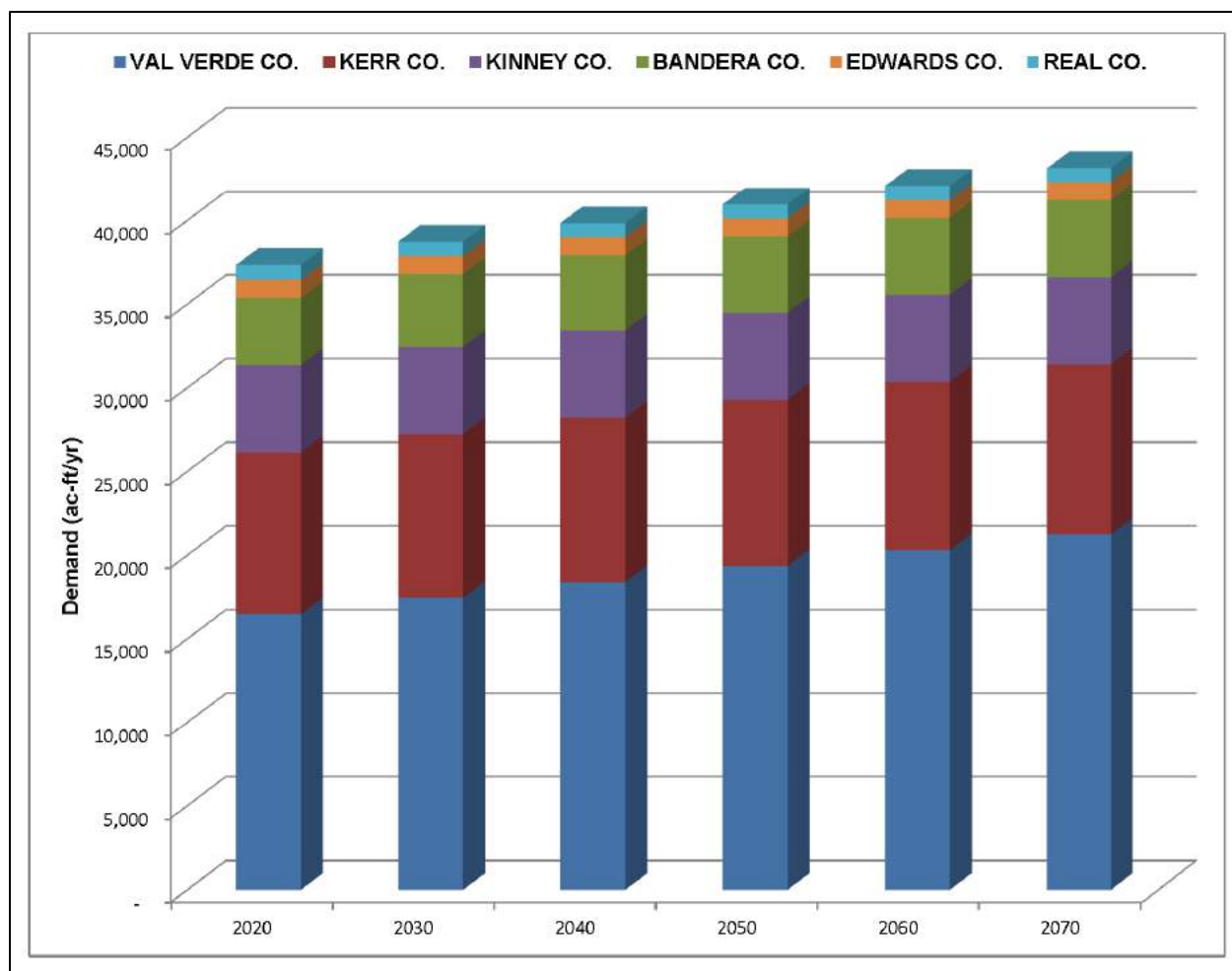


Figure 2-6. Projected Water Demand by County

2.2.2 Municipal and County-Other

The quantity of water used for municipal and county-other (rural domestic) is heavily dependent on population growth, climatic conditions, and water-conservation measures. For planning purposes, municipal water use comprises both residential and commercial. Commercial water use includes business establishments, public offices, and institutions. Residential and commercial uses are categorized together because they are similar types of uses: i.e., they both use water primarily for drinking, cleaning, sanitation, air conditioning, and landscape watering. Also included in this category is water supplied to golf courses from municipal supply sources. Water use within a utility service area that is not included in the quantification of municipal demand, is that used in manufacturing and industrial processes that are self-supplied.

Municipal and county-other water demand is calculated based on utility service boundaries designated in the population projections process and include rural domestic use. Projected municipal and county-other water demand is based on the year-2010 per-capita water use, which is calculated with year-2010 population counts divided into reported water use for the same year. Per-capita water use in communities with significant non-residential water demands, such as commercial customers will appear abnormally high. The year-2010 per-capita water use is reduced slightly over time to simulate expected conservation savings due to State-mandated plumbing code implementation. Table 2-3 presents municipal savings due to the expected installation of more water efficient fixtures and appliances. The conservation adjusted per-capita water use is then applied to each of the decade population estimates to produce the projected water demand for each entity. Table 2-4 presents the municipal and county-other projected water use for each decade in the current planning cycle.

**Table 2-3. Municipal Savings Due to Plumbing Fixture Requirements
(Acre-Feet per Year)**

County	Entity Name	2020	2030	2040	2050	2060	2070
Bandera	Bandera	24	38	48	51	52	53
Bandera	Bandera County FWSD#1	9	14	17	18	19	19
Bandera	County-Other	228	353	435	476	491	496
Edwards	Rocksprings	14	20	25	26	26	26
Edwards	County-Other	10	14	17	18	18	18
Kerr	Kerrville	264	391	493	554	571	579
Kerr	Kerrville South	29	43	53	60	62	63
Kerr	County-Other	234	351	436	492	514	524
Kinney	Brackettville	21	31	40	41	41	41
Kinney	Fort Clark Springs MUD	13	18	22	25	25	25
Kinney	County-Other	4	5	6	7	7	7
Real	Camp Wood	8	11	15	16	16	16
Real	Leakey	15	22	28	30	30	30
Real	County-Other	11	15	18	20	21	21
Val Verde	Del Rio	401	609	788	910	973	1021
Val Verde	Laughlin AFB	23	35	39	42	43	43
Val Verde	County-Other	163	268	360	439	502	559
Total		1,468	2,239	2,840	3,224	3,413	3,542

Municipal (and county-other) water demand in the Plateau Region is projected to increase from 25,711 acre-feet in 2020 to 31,478 acre-feet by 2070 (Table 2-4). Because municipal water demand is directly related to population, Val Verde County has the highest demand in the Region.

**Table 2-4. Municipal and County-Other Water Demand Projection
(Acre-Feet per Year)**

County	2020	2030	2040	2050	2060	2070
Bandera	2,818	3,141	3,304	3,364	3,412	3,440
Edwards	391	381	372	370	370	370
Kerr	7,464	7,580	7,607	7,704	7,823	7,926
Kinney	1,290	1,281	1,267	1,264	1,262	1,262
Real	460	445	432	427	426	426
Val Verde	13,552	14,474	15,406	16,409	17,385	18,343
County Total Demand	25,975	27,302	28,388	29,538	30,678	31,767

A significant portion of the municipal water demand in Bandera and Kerr Counties is assigned to the county-other (rural) category. This category represents the aggregation of utilities that provide less than an average of 100 acre-feet per year, as well as rural areas not served by a water utility in a given county. Table 2-5 presents a listing of water systems that comprise the county other category along with the corresponding annual water use survey data (2010-2015).

A water user group (WUG) within county-other can be further divided into a “sub-WUG” at the discretion of the planning group for a more detailed analysis. This option allows for a higher resolution in water needs analyses to better account for present water supplies and needs within certain county-other systems of interest, that would otherwise be aggregated at the county level. Table 2-5 indicates in green the water systems that the Plateau Region Water Planning Group designated as official sub-WUGs.

**Table 2-5. County-Other Water Supply Entities
(Acre-Feet per Year)**

	2010	2011	2012	2013	2014	2015
Bandera County-Other						
**Medina WSC	49	58	45	41	48	46
**Lake Medina Shores	112	110	106	116	43	59
**Bandera River Ranch 1	36	46	64	65	65	48
Enchanted River Estates	21	23	26	29	22	55
Flying L Ranch PUD	66	65	73	50	52	47
Lakewood Water	28	28	28	28	63	59
The Falls WSC	19	25	23	22	22	13
Ranch Hills WSC	15	18	13	13	14	13
River Bend Estates	0	12	11	8	12	13

**Table 2-5. (continued) County-Other Water Supply Entities
(Acre-Feet per Year)**

	2010	2011	2012	2013	2014	2015
Bandera County-Other						
Blue Medina Water	15	15	12	11	11	13
Elmwood Estates	10	10	10	10	9	7
Bandina	4	5	5	6	5	5
Bear Springs Trails Subdivision	5	4	4	4	4	5
Bandera Homestead Condominiums	4	4	3	3	3	3
Comanche Cliffs	3	3	3	3	9	11
Medina Highlands	3	2	2	2	2	2
San Julian Creek Estates	0	0	0	0	4	5
TPWD Lost Maples SNA	3	2	3	3	0	3
*Medina Children's Home	0	0	0	0	0	0
Bandera ISD - Bandera High School	3	3	3	0	0	0
Bandera ISD - Alkek Elementary	0	4	0	0	0	0
Cielo Rio Ranch Water System	0	35	0	0	10	9
Bridlegate	0	9	0	24	11	32
Edwards County-Other						
**Barksdale WSC	17	16	16	17	18	15
Kerr County-Other						
Ingram Water Supply	373	373	373	373	373	373
Woodcreek Utility CO2	331	331	331	331	273	273
Guadalupe Heights Utility	69	69	69	69	69	69
Canyon Springs Water Works	65	81	65	67	67	67
VA Hospital Kerrville	93	98	95	89	66	66
**Oak Forest South Water Supply	62	62	62	62	62	62
Erlund Subdivision	54	54	54	54	54	54
Southern Hills Wiedenfeld Water Works	50	55	51	50	50	50
Woods WSC	45	55	44	39	43	38
Community Water Group WSC	25	43	28	34	32	36
Bumblebee Hills	0	0	0	3	37	31
Mary Mead Water System	31	32	24	28	28	28
Sleepy Hallow	27	27	27	27	27	27
Fremont Water	33	40	41	30	29	25
**Westwood Water System	23	27	25	25	24	24
Aqua Vista Utilities	35	35	24	24	24	24
White Oak Ranch Section One	24	24	24	24	24	24
Northwest Hills Subdivision	22	22	22	22	22	22
Kamira Water System	24	25	24	21	27	20
The Wilderness	13	16	12	14	17	17

**Table 2-5. (continued) County-Other Water Supply Entities
(Acre-Feet per Year)**

	2010	2011	2012	2013	2014	2015
Kerr County-Other						
Bear Paw Water System	17	17	17	17	17	17
Royal Oaks Water	15	15	15	15	15	15
**Nickerson Farm Water System	14	14	14	14	14	14
**Verde Park Estates Wiedenfeld Water Works	12	12	12	13	14	13
Hill River Country Estates	11	12	13	0	0	13
**Hills & Dales Wiedenfeld Water Works	18	17	14	13	13	12
Shalako Water Supply	11	14	13	12	12	12
Horseshoe Oaks Subdivision Water System	10	10	10	10	10	10
Castlecomb Water System	0	11	12	12	10	10
**Center Point Wiedenfeld Water Works	11	11	11	9	9	9
Four Seasons	9	9	9	9	9	9
Village West Water System	7	8	10	8	8	8
Camp Honey Creek	4	5	8	8	8	8
Oak Ridge Estates Water System	8	8	8	8	8	8
**Pecan Valley	8	8	8	8	8	8
Ranchero Estates	5	5	7	7	8	8
Verde Hills WSC	11	11	7	7	7	7
Split Rock Water System	10	10	8	7	7	6
**Rustic Hills Water	6	9	7	6	6	6
Real Oaks Subdivision	6	6	6	6	6	6
Heritage Park Water System	5	6	5	4	5	5
Cherry Ridge Water	4	4	4	4	4	4
Windwood Oaks Water System	4	5	4	4	4	4
Sherman's Mill	0	6	4	3	6	3
**Park Place Subdivision	3	3	3	3	3	3
Vista Hills	0	0	0	2	3	2
Wood Trail Water Supply	0	0	0	0	0	0
Woodhaven Mobile Home Park	6	6	5	0	0	0
Cedar Springs Mobile Home Park	7	7	7	0	0	0
Oak Grove Mobile Home Park	22	0	0	0	0	0
Ingram Oaks Retirement Community	40	49	0	0	0	0
Hill Country Ranch Estates	0	6	5	5	6	0
Generis Water Works	0	17	17	17	17	0
*Cypress Springs	0	0	0	0	0	0
*TX Dot Kerr County SRA	0	0	0	0	0	0
Scenic Valley Mobile Home Park	23	0	0	0	0	0
River Front Village	20	24	24	0	0	0

**Table 2-5. (continued) County-Other Water Supply Entities
(Acre-Feet per Year)**

	2010	2011	2012	2013	2014	2015
Kerr County-Other						
Kerr Villa Mobile Home Park	12	9	10	0	0	0
Ingram Tom Moore High School	16	24	14	0	0	0
Hideaway Mobile Home Park	7	6	5	0	0	0
*Country Hills Water	0	0	0	0	0	0
City of Kerrville Schreiner Park	5	4	5	0	0	0
Cherokee Mobile Home Park	5	29	7	0	0	0
Camp Flaming Arrow	4	7	6	0	0	0
*Blue Ridge Mobile Home Park	0	0	0	0	0	0
*Armadillo Junction RV Park	0	0	0	0	0	0
**Center Point North Water System	6	8	7	6	6	7
**Center Point Taylor System	11	13	14	12	11	11
Falling Water Subdivision	1	12	12	9	18	7
Saddlewood Subdivision	12	22	18	14	16	14
Westcreek Estates Water System	19	22	24	18	17	13
Kinney County-Other						
City of Spofford	17	17	17	14	14	11
Real County-Other						
Oakmont Saddle Mountain Water System	16	16	15	16	16	17
Real WSC	38	32	20	18	19	17
Twin Forks Estates WSC	18	23	17	16	18	15
Frio Canon Water Co, LLC			5	10	10	16
*H.E.B. Family Foundation						
*Crown Mountain Water Supply						
Val Verde County-Other						
Val Verde County WCID Comstock	89	89	101	68	82	65
Upper San Pedro Canyon Subdivision	38	38	38	38	38	34
Del Grande Mobile Home Park	26	26	26	26	26	26
Langtry WSC	8	10	10	23	23	23
La Caleta Estates	52	52	52	18	18	18
Devils Shores WSC	0	15	18	16	13	13
Amistad Village Water System	14	25	33	41	19	13
Lago Vista Water System	0	0	0	0	7	7
*Lake Ridge Water System	0	0	0	0	0	0
*TPWD Seminole Canyon SHP	0	0	0	0	0	0
*Seguro Water Company	0	0	0	0	0	0
Laughlin AFB Recreation Area	0	9	4	2	2	0

Note: *No survey data provided. **Indicate designated sub-WUGs.

2.2.3 Major Water Providers

Recent TWDB rule changes (31TAC §357.30(4)) now require regional water planning groups to identify “major water providers” as opposed to “wholesale water providers” as performed in previous plans. A major water provider (MWP) is defined as a significant public or private WUG or wholesale water provider (WWP) whose significance is determined by the RWPG, and provides water for any water use category in a regional water planning area. This rule revision gives regional water planning groups more flexibility in identifying which large water providers ought to be reported in their regional water plan.

The Plateau Region Water Planning Group has developed and adopted the following definition of a MWP, and feels that this definition captures all significant municipal WUGs or WWPs that provide water for other water use categories within the Region.

“An entity that currently provides significant water supplies (>10,000 acre-feet per year) to other users and which will continue to develop new supplies to meet future needs of those whom they supply during the period covered by this Plan.”

Del Rio Utilities is the only entity in the Plateau Region to meet this criterion. In addition to its own use, the utility provides water to Laughlin Air Force Base and subdivisions outside of the City. Del Rio also provides water and wastewater services to two colonias, Cienegas Terrace and Val Verde Park Estates. Table 2-6 shows the distribution of water demand supplied by the City of Del Rio in the Rio Grande River Basin.

**Table 2-6. Del Rio Wholesale / Major Water Provider Water Demand
(Acre-Feet per Year)**

County	Basin	Water User Group	2020	2030	2040	2050	2060	2070
Val Verde	Rio Grande	City of Del Rio	10,558	11,053	11,554	12,130	12,733	13,326
		Laughlin AFB 94%	957	1,047	1,142	1,200	1,199	1,199
		County Other 6%	454	607	607	690	776	860
Total Wholesale Demand			11,969	12,707	13,303	14,020	14,708	15,385

2.2.4 Manufacturing

Manufacturing and industrial water use that is self-supplied is quantified separately from municipal use even though the demand centers may be located within a utility service area. Draft manufacturing water demand projections are based on the highest county aggregated manufacturing water use in the most recent five years (2010-2015) of reported annual water use survey data. The most recent 10-year projections for employment growth from the Texas Workforce Commission was used as proxy for growth by manufacturing sectors between 2020 and 2030. After 2030, the manufacturing water use was held constant through 2070. In the Plateau Region, the use of water for manufacturing purposes is only recognized in Kerr County (Table 2-7).

**Table 2-7. Manufacturing Water Demand Projection
(Acre-Feet per Year)**

County	2020	2030	2040	2050	2060	2070
Bandera	0	0	0	0	0	0
Edwards	0	0	0	0	0	0
Kerr	20	21	21	21	21	21
Kinney	0	0	0	0	0	0
Real	0	0	0	0	0	0
Val Verde	0	0	0	0	0	0
County Total Demand	20	21	21	21	21	21

2.2.5 Irrigation

Draft irrigation water demand projections utilize an average of TWDB's 2010-2015 irrigation water use estimates as a base. Those values are held constant between 2020 and 2070. Annual water use estimates are developed at the county level by applying a calculated evapotranspiration-based "crop water need" estimate to reported irrigated acreage from Farm Service Agency (FSA). These estimates are then adjusted based on surface water release data from TCEQ and Texas Water Masters and comments from Groundwater Conservation Districts. In counties where the total groundwater availability over the planning period is projected to be less than the groundwater portion of the baseline water demand projections, the irrigation water demand projections will begin to decline in 2030 or later, to be compatible with the groundwater availability. However, this approach to a 'groundwater constrained' area presently does not occur in the Plateau Region.

Statewide, irrigation water demands are expected to decline over time. More efficient canal delivery systems have improved water-use efficiencies of surface water irrigation. More efficient on-farm irrigation systems have also improved the efficiency of groundwater irrigation. Other factors that have contributed to decreased irrigation demands are declining groundwater supplies and the voluntary transfer of water rights historically used for irrigation to municipal uses.

Kinney County has the highest irrigation water use in the Region (42 percent) and is the only county in which irrigation use is greater than municipal use (Table 2-8). Elsewhere in the Region, most irrigation that occurs is for the watering of pastures and hay fields. Because of the typically rocky and uneven terrain throughout much of the Region, irrigation of commercial row crops is minimal. On a regional basis, water used for irrigation is projected to be held constant at approximately 8,805 acre-feet per year

over the 50-year planning horizon. However, as any irrigator can attest, climate, water availability, and the market play key roles in how much water is actually applied on a year- by-year basis.

The PWPG is concerned about the accuracy of the irrigation surveys and believes that there is significantly more irrigation water use than is documented. For example, numerous small irrigated exotic and wildlife feed plots are likely not identified. Also, groundwater used to irrigate golf courses, if not provided by municipalities, may not be accounted for in the irrigation survey estimates. These withdrawals may have a significant impact on local supplies.

**Table 2-8. Irrigation Water Demand Projection
(Acre-Feet per Year)**

County	2020	2030	2040	2050	2060	2070
Bandera	946	946	946	946	946	946
Edwards	215	215	215	215	215	215
Kerr	1,342	1,342	1,342	1,342	1,342	1,342
Kinney	3,713	3,713	3,713	3,713	3,713	3,713
Real	270	270	270	270	270	270
Val Verde	2,319	2,319	2,319	2,319	2,319	2,319
County Total Demand	8,805	8,805	8,805	8,805	8,805	8,805

2.2.6 Livestock

Texas is the nation's leading livestock producer, accounting for approximately 11 percent of the total United States production. Although livestock production is an important component of the Texas economy, the industry consumes a relatively small amount of water.

Draft livestock water demand projections are a combination of an average of the 2010-2014 water use survey information provided by the TWDB, which is based on livestock inventory data from the National Agricultural Statistical Service (NASS) and the Texas Department of Agriculture, and per head water use consumptions by animal class (Table 2-9). County level water use estimates are calculated by applying a water use coefficient for each livestock category to county level inventory estimates. The rate of change for projections from the *2016 Regional Water Plan* was then applied to the new base. Many counties chose to hold the base constant throughout the planning horizon.

Table 2-9. Estimated per Head Daily Water Use (in gallons)

TWDB	NASS Data Type	Per Head Daily Water Use
Cattle	Milk	75
	Fed & Other	15
Poultry	Hens	86* (per 1,000 head)
	Broilers	77* (per 1,000 head)
Horses	Horses, Ponies, & Burros	12
Hogs	Hogs	11
Sheep	Sheep	2
Goats	Milk, Meat, Angora	0.5

Source: University of Georgia – College of Agricultural and Environment

For water-supply planning purposes, in the Plateau Region Plan, livestock water use is held constant throughout the 50-year planning period. However, reality dictates that during prolonged drought periods, when poor range conditions exist and/or during unfriendly market conditions, livestock herds are generally reduced thus resulting in significantly less water demand. Kerr County has the greatest livestock water use in the Region (Table 2-10).

In recent years, an expanding use of groundwater in the Region has been to fill and maintain artificial lakes that primarily are intended to add aesthetic value to the property. Although not quantified, the amount of water pumped from local aquifers for this purpose is likely significant and is not reflected in the water demand estimates provided in this chapter. To manage the volume of groundwater used for this purpose, the Headwaters Groundwater Conservation District in Kerr County permits a maximum production of one acre-foot (325,851 gallons) per year.

Exotic game ranching has become commonplace throughout the State, and is quite evident in the Plateau Region counties. Bandera and Kerr Counties have the largest population of exotic game in the State (Texas A&M Exotics on the Range). The total number of exotic game likely may equal or even exceed domestic livestock. Yet the livestock water demand projections reported in this *Plan* does not fully reflect this water use.

High game fences that come with the exotic game industry often block the ability of both native and exotic game to access surface water, thus requiring more wells and groundwater use. Groundwater is also often used to irrigate small acreage feed plots for these animals. Future water plans will need to attempt to quantify this specific use and include it in the overall total projected water needs in the State.

In an analysis report prepared for the PWPG during the previous planning period, Water Use by Livestock and Game Animals in the Plateau Regional Water Planning Area, the amount of water used by various exotic game species is estimated. However, the report states that there is insufficient data on the number of animals in the Region to make an estimate of total use. Estimates made by the Real-Edwards Conservation and Reclamation District find that approximately 602 and 233 acre-feet per year in Edwards and Real Counties is consumed by exotic game animals.

**Table 2-10. Livestock Water Demand Projection
(Acre-Feet per Year)**

County	2020	2030	2040	2050	2060	2070
Bandera	243	243	243	243	243	243
Edwards	397	397	397	397	397	397
Kerr	757	757	757	757	757	757
Kinney	224	224	224	224	224	224
Real	151	151	151	151	151	151
Val Verde	410	410	410	410	410	410
County Total Demand	2,182	2,182	2,182	2,182	2,182	2,182

2.2.7 Mining

Although the Texas mineral industry is foremost in the production of crude petroleum and natural gas in the United States, it also produces a wide variety of important nonfuel minerals. In all instances, water is required in the mining of these minerals either for processing, leaching to extract certain ores, controlling dust at the plant site, or for reclamation.

Draft mining water demand projections were developed by combining annual reported water use data (2010-2014), including reuse and additional oil and gas estimates provided by the TWDB using the FracFocus database. Oil and gas water use estimates are then broken down by water source based on a TWDB-contracted study with the University of Texas Bureau of Economic Geology (BEG) as summarized in Table 2-11 below. The BEG study estimated current mining water use and projected that use across the planning horizon using data collected from trade, organizations, government agencies, and other industry representatives. County-level projections are compiled as the sum of individual projections for four sub-sector mining categories: oil and gas, aggregates, coal and lignite, and other.

Table 2-11. Estimated Percentages of Reuse and Brackish Water Use in Hydraulic Fracturing

Play	Fresh Water	Reuse / Recycle	Brackish
Permian Farwest	20%	0%	80%
Permian Midland	68%	2%	30%
Anadarko Basin	50%	20%	30%
Barnett Shale	92%	5%	3%
Eagle Ford Shale	80%	0%	20%
East Texas Basin	95%	5%	0%

Source: University of Texas Bureau of Economics Geology, 2012

Although the oil and gas industry is relatively minor in the Plateau Region compared to other parts of the State, in recent years increased oil and gas exploration activity has occurred. Railroad Commission of Texas files list 90 wells drilled in Edwards County from 2010 through 2017. As a result, increased water demand is projected for the mining category in Edwards County (Table 2-12).

In Texas, there is an ongoing need for additional fresh water sources, and an unregulated/largely unknown amount of fresh water use occurs in the exploration for oil and gas within the State. The Oil and Gas

industry is strongly encouraged to use brackish and /or recycled water in exploration so that fresh water can be preserved for human needs.

**Table 2-12. Mining Water Demand Projection
(Acre Feet per Year)**

County	2020	2030	2040	2050	2060	2070
Bandera	0	0	0	0	0	0
Edwards	89	89	89	89	89	89
Kerr	76	80	100	102	111	120
Kinney	0	0	0	0	0	0
Real	0	0	0	0	0	0
Val Verde	190	249	259	223	192	171
County Total Demand	355	394	424	390	368	356

2.3 ENVIRONMENTAL AND RECREATIONAL WATER NEEDS

Environmental and recreational water use in the Plateau Region is not quantified but is recognized as being an important consideration as it relates to the natural community in which the residents of this region share and appreciate. In Chapter 1, environmental and recreational resources are identified and described. In this section, the water resources needed to maintain these functions are discussed. Water-supply sources that serve environmental needs are characterized in Chapter 3 and potential water-supply strategy consequences on the environment are analyzed in Chapter 5.

All living organisms require water. The amount and quality of water required to maintain a viable population, whether it is plant or animal, is highly variable. While some individuals are capable of migrating long distances in search of water (birds, larger mammals, etc.), others are stationary (plants, fishes, etc.) and must rely on existing supplies.

Natural and environmental resources are often overlooked when considering the consequences of prolonged drought conditions. As water supplies diminish during drought periods, the balance between both human and environmental water requirements becomes increasingly competitive. A goal of this *Plan* is to provide for the health, safety, and welfare of the human community, with as little detrimental effect to the environment as possible. To accomplish this goal, the evaluation of strategies to meet future water needs includes a distinct consideration of the impact that each implemented strategy might have on the environment.

As discussed in Section 2.2.6 (Livestock), an expanding use of groundwater in the Region has been to fill and maintain artificial lakes. Although this use may exert stress on the local aquifer system, the resulting impoundments do provide aesthetic value to the property and a water source for wildlife.

Recreational activities that involve human interaction with the outdoors environment are often directly dependent on water resources such as fishing, swimming and boating; while a healthy environment enhances many others, such as hunting, hiking, and bird watching. Thus, it is recognized that the maintenance of the regional environmental community's water-supply needs serves to enhance the lives of citizens of the Plateau Region as well as the multitude of annual visitors to this Region.

In Chapter 5, each water management strategy contains an environmental impact assessment. A review of these strategies reveals that while some strategies may contain variable levels of negative impact, other strategies may likely have a positive effect. Negative environmental impacts are generally associated with the lowering of aquifer water levels due to increased groundwater withdrawals and its potential to cause a reduction or cessation of spring flow. Also of concern is that lowered water levels could deplete supplies in shallow livestock wells, which are often the only available source of water for some wildlife. The positive environmental aspect of the strategies is that during severe drought conditions when normal wildlife water supplies may naturally diminish, new supply sources might be developed such that wildlife could benefit. Water supply availability estimated for surface water management strategies in Chapter 5 follow environmental flow standards in TCEQ 30 TAC Chapter 298 rules or the 1997 Consensus Criteria for Environmental Needs.

This page intentionally left blank

CHAPTER 3

REGIONAL WATER SUPPLY SOURCES

This page intentionally left blank.

3 REGIONAL WATER SUPPLY SOURCES

From the semi-arid Hill Country to the arid Rio Grande Basin, both groundwater and surface water are critical resources for the livelihood of the citizens of the Plateau Region and the environment in which they reside. Chapter 3 explores the current and future availability of all water supply resources in the Region including groundwater, surface water, springs, and reuse. The water demand and supply availability analysis developed in Chapters 2 and 3, respectively, form the basis for identifying in Chapter 4 the areas within the Plateau Region that potentially could experience supply shortages in future years. The following tables list water supplies available to meet future needs (demands) reported in Chapter 2:

- Table 3-1 lists groundwater and surface water availability as estimated in each identified source (aquifer, river, spring) by county and river basin. Water source availability analyses, including water-quality concerns, are discussed in more detail in Section 3.1 (groundwater) and Section 3.2 (surface water).
- Table 3-2 lists water supplies available to municipal utilities and general water use categories based on the current infrastructure ability of each to obtain water supplies. These abilities primarily include existing infrastructure, water-rights limitations, and Groundwater Conservation District (GCD) permit limitations.
- Table 3-3 lists water supplies available to Del Rio Utilities as a major water provider.

Only three municipal utilities within the Plateau Region derive municipal supplies from surface water or spring sources. The City of Kerrville currently uses surface water from the Guadalupe River in conjunction with their groundwater supply. Kerrville also injects excess treated surface water into the Trinity Aquifer through an aquifer storage and recovery (ASR) facility. The City of Del Rio obtains most of its water supply from San Felipe Springs, which issues from the Edwards limestone. The spring water is treated to drinking water standards in a new microfiltration plant prior to distribution. For planning purposes, San Felipe Springs is recognized as a surface water source that falls within the Rio Grande Run-of-River. Camp Wood in Real County is supplied from Old Faithful Springs on a tributary of the Nueces River. All other communities in the Region are totally dependent on groundwater sources for their supplies. All water supplies based upon contracts are assumed to be renewed.

Table 3-1. Water Source Availability (Acre-Feet per Year)

Groundwater	County	Basin	Salinity*	2020	2030	2040	2050	2060	2070
Austin Chalk Aquifer	Kinney	Nueces	Brackish	875	875	875	875	875	875
Austin Chalk Aquifer	Kinney	Rio Grande	Brackish	1,894	1,894	1,894	1,894	1,894	1,894
Edwards-BFZ Aquifer	Kinney	Nueces	Fresh	6,319	6,319	6,319	6,319	6,319	6,319
Edwards-BFZ Aquifer	Kinney	Rio Grande	Fresh	2	2	2	2	2	2
Edwards-Trinity (Plateau) Aquifer	Bandera	Guadalupe	Fresh	81	81	81	81	81	81
Edwards-Trinity (Plateau) Aquifer	Bandera	Nueces	Fresh	38	38	38	38	38	38
Edwards-Trinity (Plateau) Aquifer	Bandera	San Antonio	Fresh	1,890	1,890	1,890	1,890	1,890	1,890
Edwards-Trinity (Plateau) Aquifer	Kerr	Colorado	Fresh	245	245	245	245	245	245
Edwards-Trinity (Plateau) Aquifer	Kerr	Guadalupe	Fresh	1,015	1,015	1,015	1,015	1,015	1,015
Edwards-Trinity (Plateau) Aquifer	Kerr	Nueces	Fresh	5	5	5	5	5	5
Edwards-Trinity (Plateau) Aquifer	Kerr	San Antonio	Fresh	12	12	12	12	12	12
Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	Edwards	Colorado	Fresh	2,305	2,305	2,305	2,305	2,305	2,305
Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	Edwards	Nueces	Fresh	1,631	1,631	1,631	1,631	1,631	1,631
Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	Edwards	Rio Grande	Fresh	1,740	1,740	1,740	1,740	1,740	1,740
Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	Kinney	Nueces	Fresh	12	12	12	12	12	12
Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	Kinney	Rio Grande	Fresh	70,329	70,329	70,329	70,329	70,329	70,329
Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	Real	Colorado	Fresh	277	277	277	277	277	277
Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	Real	Guadalupe	Fresh	3	3	3	3	3	3
Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	Real	Nueces	Fresh	7,243	7,243	7,243	7,243	7,243	7,243
Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	Val Verde	Rio Grande	Fresh	50,000	50,000	50,000	50,000	50,000	50,000
Ellenburger-San Saba Aquifer	Kerr	Colorado	Fresh	200	200	200	200	200	200
Ellenburger-San Saba Aquifer	Kerr	Guadalupe	Fresh	1,802	1,802	1,802	1,802	1,802	1,802
Frio River Alluvium Aquifer	Real	Nueces	Fresh	2,145	2,145	2,145	2,145	2,145	2,145
Hickory Aquifer	Kerr	Colorado	Fresh	0	0	0	0	0	0
Hickory Aquifer	Kerr	Guadalupe	Fresh	0	0	0	0	0	0
Nueces River Alluvium Aquifer	Edwards	Nueces	Fresh	1,787	1,787	1,787	1,787	1,787	1,787
Nueces River Alluvium Aquifer	Real	Nueces	Fresh	1,787	1,787	1,787	1,787	1,787	1,787
Trinity Aquifer	Bandera	Guadalupe	Fresh	76	76	76	76	76	76
Trinity Aquifer	Bandera	Nueces	Fresh/Brackish	903	903	903	903	903	903
Trinity Aquifer	Bandera	San Antonio	Fresh/Brackish	6,305	6,305	6,305	6,305	6,305	6,305
Trinity Aquifer	Kerr	Colorado	Fresh	318	318	318	318	318	318

Table 3-1. (Continued). Water Source Availability (Acre-Feet per Year)

Groundwater	County	Basin	Salinity*	2020	2030	2040	2050	2060	2070
Trinity Aquifer	Kerr	Guadalupe	Fresh/Brackish	14,129	14,056	13,767	13,450	13,434	13,434
Trinity Aquifer	Kerr	Nueces	Fresh	0	0	0	0	0	0
Trinity Aquifer	Kerr	San Antonio	Fresh	471	471	471	471	471	471
Trinity Aquifer ASR	Kerr	Guadalupe	Fresh	453	453	453	453	453	453
Groundwater Total Source Availability				176,292	176,219	175,930	175,613	175,597	175,597

Reuse Source Name Type	County	Basin	Salinity*	2020	2030	2040	2050	2060	2070
Direct Reuse	Kerr	Guadalupe	Fresh	5,000	5,000	5,000	5,000	5,000	5,000
Direct Reuse	Bandera	San Antonio	Fresh	310	310	310	310	310	310
Direct Reuse	Val Verde	Rio Grande	Fresh	3,100	3,100	3,100	3,100	3,100	3,100
Reuse Total Source Availability				8,410	8,410	8,410	8,410	8,410	8,410

Surface Water	County	Basin	Salinity	2020	2030	2040	2050	2060	2070
Colorado Run-Of-River	Edwards	Colorado	Fresh	32	32	32	32	32	32
Guadalupe Run-Of-River	Bandera	Guadalupe	Fresh	3	3	3	3	3	3
Guadalupe Run-Of-River	Kerr	Guadalupe	Fresh	1,375	1,375	1,375	1,375	1,375	1,375
Medina Lake/Reservoir	Bandera	San Antonio	Fresh	0	0	0	0	0	0
Nueces Run-Of-River	Bandera	Nueces	Fresh	5	5	5	5	5	5
Nueces Run-Of-River	Edwards	Nueces	Fresh	94	94	94	94	94	94
Nueces Run-Of-River	Real	Nueces	Fresh	1,751	1,751	1,751	1,751	1,751	1,751
Rio Grande Run-Of-River	Kinney	Rio Grande	Fresh	3,616	3,616	3,616	3,616	3,616	3,616
Rio Grande Run-Of-River	Val Verde	Rio Grande	Fresh	13,776	13,776	13,776	13,776	13,776	13,776
San Antonio Run-Of-River	Bandera	San Antonio	Fresh	2	2	2	2	2	2
Surface Water Total Source Availability				20,654	20,654	20,654	20,654	20,654	20,654
Region J Total Source Availability				205,356	205,283	204,994	204,677	204,661	204,661

* Salinity field indicates whether the source availability is considered ‘fresh’ (less than 1,000 mg/L), ‘brackish’ (1,000 to 10,000 mg/L), ‘saline’ (10,001 mg/L to 34,999 mg/L), or ‘seawater’ (35,000 mg/L or greater). Sources can also be labeled as ‘fresh/brackish’ or ‘brackish/saline’, if a combination of the salinity types is appropriate.

Table 3-2. Existing Supply (Acre-Feet per Year)

		2020	2030	2040	2050	2060	2070
Bandera County							
Guadalupe Basin							
County-Other	Edwards-Trinity (Plateau) Aquifer	34	34	34	34	34	34
Livestock	Edwards-Trinity (Plateau) Aquifer	9	9	9	9	9	9
Guadalupe Basin Total Existing Supply		43	43	43	43	43	43
Nueces Basin							
County-Other	Edwards-Trinity (Plateau) Aquifer	38	38	38	38	38	38
County-Other	Nueces Run-of-River	0	0	0	0	0	0
County-Other	Trinity Aquifer	399	399	399	399	399	399
Livestock	Edwards-Trinity (Plateau) Aquifer	0	0	0	0	0	0
Livestock	Trinity Aquifer	44	44	44	44	44	44
Irrigation	Nueces Run-of-River	5	5	5	5	5	5
Irrigation	Trinity Aquifer	279	279	279	279	279	279
Nueces Basin Total Existing Supply		765	765	765	765	765	765
San Antonio Basin							
Bandera	Trinity Aquifer	534	534	534	534	534	534
Bandera County FWSD 1	Trinity Aquifer	75	75	75	75	75	75
County-Other Bandera River Ranch 1	Trinity Aquifer	69	69	69	69	69	69
County-Other Lake Medina Shores	Trinity Aquifer	55	55	55	55	55	55
County-Other Medina WSC	Trinity Aquifer	58	58	58	58	58	58
County-Other	Edwards-Trinity (Plateau) Aquifer	379	379	379	379	379	379
County-Other	San Antonio Run-Of-River	0	0	0	0	0	0
County-Other	Trinity Aquifer	4,356	4,356	4,356	4,356	4,356	4,356
Livestock	Edwards-Trinity (Plateau) Aquifer	111	111	111	111	111	111
Livestock	Trinity Aquifer	85	85	85	85	85	85
Irrigation	Guadalupe Run-Of-River	3	3	3	3	3	3
Irrigation	San Antonio Run-Of-River	2	2	2	2	2	2
Irrigation	Trinity Aquifer	684	684	684	684	684	684
San Antonio Basin Total Existing Supply		6,411	6,411	6,411	6,411	6,411	6,411
Bandera County Total Existing Supply		7,219	7,219	7,219	7,219	7,219	7,219
Edwards County							
Colorado Basin							
Rocksprings	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	871	871	871	871	871	871
County-Other	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	57	57	57	57	57	57
Mining	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	7	7	7	7	7	7
Livestock	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	471	471	471	471	471	471
Irrigation	Colorado Run-Of-River	32	32	32	32	32	32
Irrigation	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	78	78	78	78	78	78
Colorado Basin Total Existing Supply		1,516	1,516	1,516	1,516	1,516	1,516
Nueces Basin							
County-Other Barksdale WSC	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	110	110	110	110	110	110
County-Other	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	155	155	155	155	155	155
County-Other	Nueces River Alluvium Aquifer	8	8	8	8	8	8

Table 3-2. (Continued). Existing Supply (Acre-Feet per Year)

		2020	2030	2040	2050	2060	2070
Edwards County							
Nueces Basin							
Mining	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	9	9	9	9	9	9
Livestock	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	206	206	206	206	206	206
Irrigation	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	109	109	109	109	109	109
Irrigation	Nueces Run-of-River	94	94	94	94	94	94
Nueces Basin Total Existing Supply		691	691	691	691	691	691
Rio Grande Basin							
County-Other	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	30	30	30	30	30	30
Mining	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	14	14	14	14	14	14
Livestock	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	110	110	110	110	110	110
Irrigation	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	70	70	70	70	70	70
Rio Grande Basin Total Existing Supply		224	224	224	224	224	224
Edwards County Total Existing Supply		2,431	2,431	2,431	2,431	2,431	2,431
Kerr County							
Colorado Basin							
County-Other	Edwards-Trinity (Plateau) Aquifer	64	64	64	64	64	64
Mining	Edwards-Trinity (Plateau) Aquifer	3	3	3	3	3	3
Livestock	Edwards-Trinity (Plateau) Aquifer	47	47	47	47	47	47
Irrigation	Edwards-Trinity (Plateau) Aquifer	92	92	92	92	92	92
Colorado Basin Total Existing Supply		206	206	206	206	206	206
Guadalupe Basin							
Kerrville	Guadalupe Run-Of-River	150	150	150	150	150	150
Kerrville	Trinity Aquifer	3,605	3,605	3,605	3,605	3,605	3,605
Kerrville	Trinity ASR	453	453	453	453	453	453
Kerrville	Direct Reuse	2,425	2,425	2,425	2,425	2,425	2,425
Kerrville South Water	Trinity Aquifer	387	387	387	387	387	387
County-Other Center Point	Trinity Aquifer	11	11	11	11	11	11
County-Other Center Point North WS	Trinity Aquifer	23	23	23	23	23	23
County-Other Center Point Taylor System	Trinity Aquifer	43	43	43	43	43	43
County-Other Hills & Dales Estates	Trinity Aquifer	18	18	18	18	18	18
County-Other Nickerson Farm WS	Trinity Aquifer	22	22	22	22	22	22
County-Other Oak Forest South Water	Trinity Aquifer	80	80	80	80	80	80
County-Other Park Place Subdivision	Trinity Aquifer	14	14	14	14	14	14
County-Other Pecan Valley	Trinity Aquifer	12	12	12	12	12	12

Table 3-2. (Continued). Existing Supply (Acre-Feet per Year)

		2020	2030	2040	2050	2060	2070
Kerr County							
Guadalupe Basin							
County-Other Rustic Hills Water	Trinity Aquifer	9	9	9	9	9	9
County-Other Verde Park Estates	Trinity Aquifer	16	16	16	16	16	16
County-Other Westwood WS	Trinity Aquifer	28	28	28	28	28	28
County-Other	Edwards-Trinity (Plateau) Aquifer	616	616	616	616	616	616
County-Other	Guadalupe Run-Of-River	10	10	10	10	10	10
County-Other	Trinity Aquifer	7,636	7,636	7,636	7,636	7,636	7,636
Manufacturing	Edwards-Trinity (Plateau) Aquifer	20	20	20	20	20	20
Manufacturing	Guadalupe Run-Of-River	11	11	11	11	11	11
Manufacturing	Trinity Aquifer	17	17	17	17	17	17
Mining	Edwards-Trinity (Plateau) Aquifer	14	14	14	14	14	14
Mining	Guadalupe Run-Of-River	77	77	77	77	77	77
Mining	Trinity Aquifer	31	31	31	31	31	31
Livestock	Edwards-Trinity (Plateau) Aquifer	230	230	230	230	230	230
Livestock	Trinity Aquifer	143	143	143	143	143	143
Irrigation	Guadalupe Run-Of-River	1,127	1,127	1,127	1,127	1,127	1,127
Irrigation	Trinity Aquifer	533	533	533	533	533	533
Guadalupe Basin Total Existing Supply		17,761	17,761	17,761	17,761	17,761	17,761
Nueces Basin							
County-Other	Edwards-Trinity (Plateau) Aquifer	0	0	0	0	0	0
Livestock	Edwards-Trinity (Plateau) Aquifer	3	3	3	3	3	3
Nueces Basin Total Existing Supply		3	3	3	3	3	3
San Antonio Basin							
County-Other	Edwards-Trinity (Plateau) Aquifer	3	3	3	3	3	3
County-Other	Trinity Aquifer	258	258	258	258	258	258
Livestock	Edwards-Trinity (Plateau) Aquifer	9	9	9	9	9	9
Irrigation	Edwards-Trinity Plateau Aquifer	0	0	0	0	0	0
Irrigation	Trinity Aquifer	63	63	63	63	63	63
San Antonio Basin Total Existing Supply		333	333	333	333	333	333
Kerr County Total Existing Supply		18,303	18,303	18,303	18,303	18,303	18,303
Kinney County							
Nueces Basin							
County-Other	Edwards-BFZ Aquifer	29	29	29	29	29	29
County-Other	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	5	5	5	5	5	5
Livestock	Edwards-BFZ Aquifer	66	66	66	66	66	66
Livestock	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	7	7	7	7	7	7
Irrigation	Edwards-BFZ Aquifer	2,357	2,357	2,357	2,357	2,357	2,357
Nueces Basin Total Existing Supply		2,464	2,464	2,464	2,464	2,464	2,464
Rio Grande Basin							
Brackettville	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	645	645	645	645	645	645
Brackettville	Rio Grande Run-Of-River	0	0	0	0	0	0
Fort Clark Springs MUD	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	1,371	1,371	1,371	1,371	1,371	1,371
County-Other	Austin Chalk Aquifer	80	80	80	80	80	80
County-Other	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	85	85	85	85	85	85

Table 3-2. (Continued). Existing Supply (Acre-Feet per Year)

		2020	2030	2040	2050	2060	2070
Kinney County							
Rio Grande Basin							
Livestock	Austin Chalk Aquifer	226	226	226	226	226	226
Livestock	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	95	95	95	95	95	95
Irrigation	Austin Chalk Aquifer	952	952	952	952	952	952
Irrigation	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	3,425	3,425	3,425	3,425	3,425	3,425
Irrigation	Rio Grande Run-Of-River	3,616	3,616	3,616	3,616	3,616	3,616
Rio Grande Basin Total Existing Supply		10,495	10,495	10,495	10,495	10,495	10,495
Kinney County Total Existing Supply		12,959	12,959	12,959	12,959	12,959	12,959
Real County							
Colorado Basin							
County-Other	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	15	15	15	15	15	15
Livestock	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	18	18	18	18	18	18
Irrigation	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	188	188	188	188	188	188
Colorado Basin Total Existing Supply		221	221	221	221	221	221
Nueces Basin							
Camp Wood	Nueces Other Local Supply	0	0	0	0	0	0
Leakey	Frio River Alluvium Aquifer	298	298	298	298	298	298
County-Other	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	156	156	156	156	156	156
County-Other	Frio River Alluvium Aquifer	311	311	311	311	311	311
County-Other	Nueces River Alluvium Aquifer	5	5	5	5	5	5
County-Other	Nueces Run-of-River	0	0	0	0	0	0
Livestock	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	176	176	176	176	176	176
Irrigation	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	187	187	187	187	187	187
Irrigation	Nueces Run-of-River	1,751	1,751	1,751	1,751	1,751	1,751
Nueces Basin Total Existing Supply		2,884	2,884	2,884	2,884	2,884	2,884
Real County Total Existing Supply		3,105	3,105	3,105	3,105	3,105	3,105
Val Verde County							
Rio Grande Basin							
Del Rio Utilities	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	0	0	0	0	0	0
Del Rio Utilities	Rio Grande Run-Of-River	6,135	6,135	6,135	6,135	6,135	6,135
Laughlin AFB	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	60	60	60	60	60	60
Laughlin AFB	Rio Grande Run-Of-River	871	871	871	871	871	871
County-Other	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	2,904	2,904	2,904	2,904	2,904	2,904
County-Other	Rio Grande Run-Of-River	460	460	460	460	460	460
Mining	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	39	39	39	39	39	39
Livestock	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	506	506	506	506	506	506
Irrigation	Edwards-Trinity (Plateau), Pecos Valley & Trinity Aquifer	276	276	276	276	276	276
Irrigation	Rio Grande Run-Of-River	6,310	6,310	6,310	6,310	6,310	6,310
Rio Grande Basin Total Existing Supply		17,561	17,561	17,561	17,561	17,561	17,561
Val Verde County Total Existing Supply		17,561	17,561	17,561	17,561	17,561	17,561
Region J Total Existing Supply		61,578	61,578	61,578	61,578	61,578	61,578

Table 3-3. Del Rio Utilities Major Water Provider Supply (Acre-Feet per Year)

County	Basin	Major Water Provider	Receiving Entity	2020	2030	2040	2050	2060	2070
Val Verde	Rio Grande	Del Rio Utilities	City of Del Rio	6,135	6,135	6,135	6,135	6,135	6,135
			Laughlin AFB	871	871	871	871	871	871
			County Other (6%)	685	685	685	685	685	685
Total Wholesale Supply				7,691	7,691	7,691	7,691	7,691	7,691

3.1 GROUNDWATER RESOURCES

The principal aquifers in the Plateau Region are the Trinity, Edwards-Trinity (Plateau), Edwards (Balcones Fault Zone), Austin Chalk, Frio and Nueces River Alluviums, and new to this *Plan*, the Ellenburger-San Saba Aquifer (Figure 3-1). Aquifer descriptions provided in this chapter are relatively limited; more detailed hydrogeological characterization of the aquifers may be obtained from reports published by the TWDB, USGS, UTBEG, and other agencies and universities. The water quality of aquifers is relatively good and a detailed discussion on water-quality characteristics and issues is provided in Chapter 1, Section 1.4.5.

Two water-source characterization studies were conducted during a previous planning period. The first study (*Occurrence of Significant River Alluvium Aquifers in the Plateau Region, 2010*) identifies and quantifies viable groundwater sources in shallow alluvial aquifers that parallel many of the major streams in the Region. As a result of the study, substantial volumes were estimated for the Frio and Nueces River Alluvium Aquifers in Real and Edwards Counties.

The second study (*Groundwater Data Acquisition in Edwards, Kinney and Val Verde Counties, Texas, 2009*) was performed to assist in the further characterization of the Edwards and associated aquifers in the western part of the Plateau Region. The project included four general tasks: (1) review of existing aquifer evaluations, field studies and new well data; (2) performance of dye tracer tests to analyze groundwater flow direction and speed; (3) measurement of water levels in wells during two seasonal periods; and (4) review of recent water quality sampling projects. These two reports can be viewed at (www.ugra.org/plateau-water-planning-group).

The Ellenburger-San Saba Aquifer is added to this *Plan* as a new source. Recent test hole exploration, pumping test results, and water chemistry analysis have verified this aquifer as a potential source of water to meet the supply needs of northeastern Kerr County.

Over much of the Region, water levels generally fluctuate with seasonal precipitation and are highly susceptible to declines during drought conditions. Water levels generally recover during wet periods; however, a long-term decline is being observed in some Trinity Aquifer wells in the eastern portion of the Region where pumping is exceeding the capacity of the local aquifer to fully recharge.

Discharge from the aquifers occurs naturally through springs and artificially by pumping from wells. Some discharge also occurs through leakage from one water-bearing unit to another and through natural down-gradient flow out of the Region.

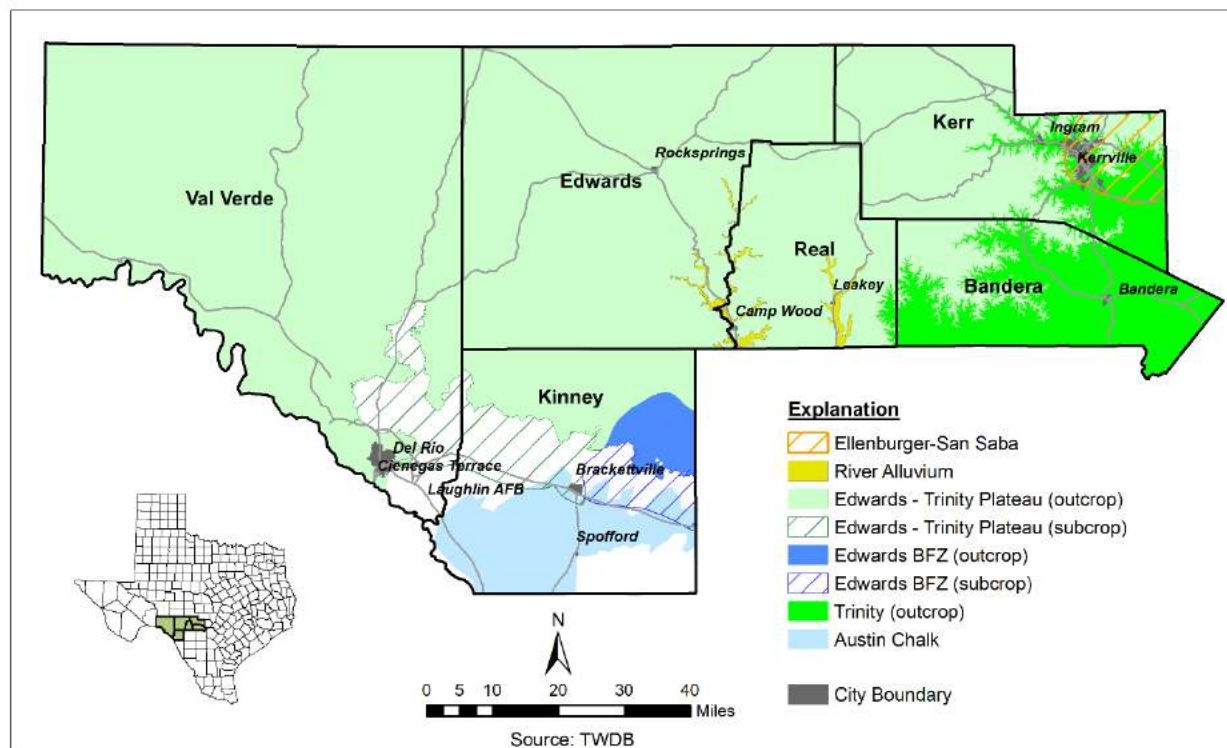


Figure 3-1. Groundwater Sources

3.1.1 Groundwater Availability

Base flow to the many rivers and streams that flow through the Plateau Region is principally generated from the numerous springs that issue from rock formations that form the major aquifers in the Region. The Plateau Region contains the headwaters of the Guadalupe, San Antonio, Medina, Sabinal, Frio, Nueces, and West Nueces Rivers; and tributaries to the Rio Grande and Colorado River such as the Pecos, Devils, and South Llano Rivers. Flow in these rivers and streams is critical to the Plateau Region in that it provides municipal drinking water, supplies irrigation and livestock needs, maintains environmental habitat, and supports a thriving ecological and recreational tourist economy. Water users downstream of the Plateau Region (Regions K, L, and M) likewise have a stake in maintaining and protecting spring-fed base flows of rivers that originate in the Plateau Region.

It is thus recognized that sustaining flow in these important rivers and streams is highly dependent on maintaining an appropriate water level in the aquifer systems that feed the supporting springs. With the sustainability of local water supplies and the economic welfare of the Region in mind, the PWPG defines groundwater availability as a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact such that the base flow in rivers and streams is not significantly affected beyond a level that would be anticipated due to naturally occurring conditions. In so defining groundwater availability, the planning group establishes a policy decision to protect the long-term water supply and related economic needs of the Plateau Region. The PWPG acknowledges and supports GCD's regulatory authority over permitted withdrawals from aquifers within their respective boundaries.

Groundwater availability as listed in Table 3-1 in this 2021 *Plateau Region Water Plan* is based on the Modeled Available Groundwater (MAG) volumes that may be produced on an average annual basis to achieve a Desired Future Condition (DFC) as adopted by Groundwater Management Areas (GMAs) (per Texas Water Code §36.001). The GMA process is explained in more detail in Chapter 1, Section 1.1.5. Groundwater availability for these sources is calculated by modeling or standard geohydrologic methods. Table 3-4 lists the methodology used to calculate groundwater source availability.

Table 3-4. Groundwater Availability Methodology

Source Supply	County	Basin	Methodology
Austin Chalk Aquifer	Kinney	Rio Grande	0.6% (0.006) of average annual rainfall (22 in) over the aquifer outcrop (189,377 acres) as recharge. Calculated by Planning Group consultant (WSP).
		Nueces	0.6% (0.006) of average annual rainfall (22 in) over the aquifer outcrop (87,549 acres) as recharge. Calculated by Planning Group consultant (WSP).
Nueces River Alluvium Aquifer	Edwards	Nueces	Recharge plus 0.1 volume of water in storage. See Plateau Region Report: Occurrence of Significant River Alluvium Aquifers in the Plateau Region (2010). www.ugra/plateau-water-planning-group
	Real	Nueces	
Frio River Alluvium Aquifer	Real	Nueces	
Ellenburger/San Saba Aquifer	Kerr	Colorado	Annual availability of 0.007 acre-feet/acre/year over 286,000 acres of prime production zone in eastern Kerr County. See Sec 3.1.8 of this 2021 Plan.
		Guadalupe	
Edwards-BFZ Aquifer	Kinney	Nueces	GMA10 MAG
		Rio Grande	
Edwards Group of the Edwards-Trinity (Plateau) Aquifer	Kerr	Colorado	GMA9 Non-Relavant, TWDB modeled run compatible with DFC, which was provided to PWPG.
		Guadalupe	
		Nueces	
		San Antonio	
	Bandera	Guadalupe	GMA9 MAG
		Nueces	
		San Antonio	
Edwards-Trinity (Plateau), Pecos Valley, Trinity Aquifer	Edwards	Colorado	GMA7 MAG
		Nueces	
		Rio Grande	
	Kinney	Nueces	
		Rio Grande	
	Real	Colorado	
		Nueces	
		Guadalupe	

Table 3-4. (continued) Groundwater Availability Methodology

Source Supply	County	Basin	Methodology
Edwards-Trinity (Plateau), Pecos Valley, Trinity Aquifer	Val Verde	Rio Grande	
Trinity Aquifer	Bandera	Guadalupe	GMA9 MAG
		Nueces	
		San Antonio	
	Kerr	Colorado	
		Guadalupe	
		Nueces	
		San Antonio	

3.1.2 Trinity Aquifer

Located mostly in the Hill Country counties of Bandera and Kerr, the Trinity Aquifer system is composed of deposits of sand, clay and limestone of the Glen Rose and Travis Peak formations of the Lower Cretaceous Trinity Group where they are not overlain by Edwards Limestone. Limited exposures of Trinity also occur in southern Edwards and Real Counties. The water-bearing units include, in descending order, the Glen Rose Limestone, Hensell Sand, Cow Creek Limestone, Sligo Limestone and Hosston Sand. The Glen Rose formation is divided informally into upper and lower members. Based on their hydrologic relationships, the water-bearing rocks of the Trinity Group, collectively referred to as the Trinity Aquifer system, are organized into the following aquifer units.

- Upper Trinity Aquifer – Upper member of the Glen Rose Limestone
- Middle Trinity Aquifer – Lower Member of the Glen Rose Limestone, Hensell Sand and Cow Creek Limestone
- Pine Island / Hammet Shale - confining bed
- Lower Trinity Aquifer – Sligo Limestone and Hosston Sand

Because of fractures, faults and other hydrogeological factors, the Upper, Middle and Lower Trinity Aquifer units often are in hydraulic communication with one another and collectively should be considered a leaky-aquifer system.

3.1.2.1 Upper and Middle Trinity Aquifer

The upper member of the Glen Rose, when weathered on the land surface, creates the distinctive "stair-step" topography found throughout the hilly train of the Hill Country. The upper Glen Rose, which forms the Upper Trinity Aquifer, often contains water with total dissolved solids (TDS) often exceeding 1,000 milligrams per liter (mg/l), especially in wells that penetrate "gyp" (evaporite) beds. Water percolating through evaporite beds has a tendency to be high in sulfate and generally should be sealed off in a well. Upper Trinity wells are generally shallow and are mostly used for domestic and livestock purposes.

The Middle Trinity Aquifer, consisting of lower Glen Rose, Hensell, and Cow Creek formations, generally contains TDS of less than 1,000 mg/l. In the Hill Country region, the primary contribution to

poor water-quality occurs in wells that do not adequately case off water from evaporite beds in the upper part of the Glen Rose (Upper Trinity Aquifer). Water levels in Upper and Middle Trinity wells fluctuate with seasonal precipitation and are highly susceptible to declines during drought conditions. Radium has been detected in some Trinity wells in Kerr County.

3.1.2.2 Lower Trinity Aquifer in Bandera and Kerr Counties

Separating the Middle and Lower Trinity is the Hammett Shale (sometimes referred to as the Pine Island Shale). The approximately 60-foot thick formation acts as a confining bed, or barrier to cross-formational flow in most areas, and thus divides the producing sections of the Middle and Lower Trinity Aquifer units.

The Lower Trinity Aquifer is composed of sandy limestone, sand, clay and shale of the Sligo and Hosston formation. The Lower Trinity thins toward the northeast and is completely missing or coalesces with upper Trinity units near the Llano Uplift. The Lower Trinity is principally a water supply source for the Cities of Bandera and Kerrville and for a few private water-supply companies and resorts.

Yields from wells completed into the Lower Trinity are generally unpredictable and vary greatly. The greater depth and difficulty of sealing off the Hammett Shale make completing wells into the Lower Trinity more difficult and more expensive. However, in some areas, the Lower Trinity has higher yields and better water quality than shallower aquifers. Recharge to the Lower Trinity in Bandera and Kerr Counties likely occurs primarily by lateral underflow from the north and west. The overlying Hammett Shale mostly prevents vertical movement of water downward except possibly in highly fractured or faulted areas.

3.1.3 Edwards-Trinity (Plateau) Aquifer

The Edwards-Trinity (Plateau) Aquifer consists of lower Cretaceous age saturated limestone and dolomite formations of the Edwards Group and underlying sediments of the Trinity Group where they occur underlying the Edwards Plateau. The upper Edwards portion of the aquifer system is generally more porous and permeable than the underlying Trinity. Numerous springs that form the headwaters of several eastward and southerly flowing rivers, occur where the contact between the base of the Edwards and the top of the Trinity is exposed at the land surface. See Section 3.3 for a more detailed discussion pertaining to groundwater / surface water relationship.

In Kinney and Val Verde Counties, the Edwards Aquifer consists of groundwater contained in the Salmon Peak and McKnight units of the Devils River Limestone. Aquifer thickness is as much as 1,000 feet. San Felipe and Los Moras Springs in Val Verde and Kinney Counties issue from the Edwards and is the primary municipal supply source for the City of Del Rio.

Recharge to the aquifer occurs primarily by the downward percolation of surface water from streams draining off the Edwards Plateau to the north and west and by direct infiltration of precipitation on the outcrop. Some water enters the Region in the aquifer as underflow from counties up gradient (generally north).

The Glen Rose Limestone is the primary unit in the underlying Trinity in the southern part of the Plateau. The Aquifer generally exists under water-table conditions; however, where the Glen Rose is fully saturated and a zone of low permeability occurs near the base of the overlying Edwards, artesian conditions exist.

Reported well yields commonly range from less than 50 gallons per minute (gpm) where saturated thickness is thin to more than 1,000 gpm where large-capacity wells are completed in jointed and cavernous limestone. There are little pumping withdrawals from the Aquifer over most of its extent, and water levels have generally fluctuated only with seasonal precipitation. In some local instances, water levels have declined as a result of increased pumping.

3.1.4 Edwards (BFZ) Aquifer

In the Plateau Region, the Edwards-Balcones Fault Zone (BFZ) Aquifer is designated only in eastern Kinney County at its westernmost extent. The Edwards portion of the Edwards-Trinity (Plateau) Aquifer and the Edwards of the Edwards (BFZ) Aquifer are the same geologic formation and their boundary is arbitrarily established by the TWDB. There is no significant hydrologic boundary between the outcrops of these two aquifer systems, thus groundwater in the Edwards-Trinity freely moves down gradient into the Edwards (BFZ).

The Edwards (BFZ) Aquifer exists under water-table conditions in the outcrop and under artesian conditions where it is confined below the overlying Del Rio Clay in its downdip extent. Water in the Aquifer generally moves from the recharge zone toward natural discharge points such as Las Moras Springs at Brackettville. Additional water is lost from the Kinney County area as underflow that leaves the County to the east into Uvalde County (Region L). Very little pumping has occurred from this Aquifer in Kinney County, and therefore water levels have remained relatively constant with only minor changes over time.

3.1.5 Austin Chalk Aquifer

The Austin Chalk Aquifer occurs in the southern half of Kinney County primarily south of Highway 90. A veneer of sand and gravel deposits cover much of the southwest portion of Kinney County, which provides a soil base for agricultural production. Crops grown in this area are irrigated with mostly brackish quality groundwater pumped from the underlying Austin Chalk Aquifer. Much less production is apparent in the Nueces River Basin in the eastern part of the County. Recharge to the Austin Chalk is from precipitation and stream loss over the outcrop area and likely from Edwards Aquifer underflow through faults located up-gradient.

A wide range of production rates exists for wells completed in the Austin Chalk. The best production from the Aquifer occurs in areas that have been fractured or contain numerous solution openings. Most wells only discharge enough water for domestic or livestock use, but a few wells are large enough for irrigation purposes. The largest reported yield for an Austin Chalk well in Kinney County is 2,000 gpm (Bennett and Sayre, 1962). Most of the more productive wells completed in the Austin Chalk are located along Las Moras Creek.

3.1.6 Frio River Alluvium Aquifer

The Frio River Alluvium in central Real County extends over an area of approximately 9,530 acres. Recharge to the Aquifer is from cross-formational flow from the adjacent Edwards-Trinity Aquifer and direct infiltration of precipitation. Water supplies for the City of Leakey and other rural domestic homes are derived from this small Aquifer. Because of the limited extent of this Aquifer and its shallow water

table, the aquifer system is readily susceptible to diminished supplies during drought conditions and potentially from over pumping. Also, due to its shallow nature, the Aquifer is susceptible to contamination from surface sources.

3.1.7 Nueces River Alluvium Aquifer

The Nueces River Alluvium between Edwards and Real Counties extends over an area of approximately 24,450 acres. Recharge to the Aquifer is from cross-formational flow from the adjacent Edwards-Trinity Aquifer and direct infiltration of precipitation. Water supplies for the Community of Barksdale and rural domestic homes are derived from this small Aquifer. As with the Frio Alluvium, the Nueces River Alluvium Aquifer is readily susceptible to diminished supplies during drought conditions and potentially from over pumping, and to contamination from surface sources.

3.1.8 Ellenburger – San Saba Aquifer

Recent advances in aquifer research has suggested the desirability of adding the Ellenburger-San Saba Aquifer in Kerr County to the list of available groundwater sources in the Plateau Planning Region. Although no production wells in the Ellenburger are currently in use, the Headwaters GCD has authorized rules for future permitting of this resource.

An exploratory test well (Headwaters GCD Monitor Well #17) in the northeast corner of Kerr County was completed in the Ellenburger Limestone to a total depth of 1,153 feet below land surface in December 2016. A subsequent 24-hour pumping test was performed on the test well, which produced 600 gallons per minute with 69 feet of drawdown. The results suggest a transmissivity range of 7,920 to 12,670 gpd/ft. Water samples were collected and analyzed for chemical quality. Total dissolved solids are 498 mg/l and all constituents are within both primary and secondary drinking-water standards.

Groundwater Management Area 9 (GMA9) is currently classifying the Ellenburger-San Saba Aquifer in Kerr County as non-relevant, and therefore the Texas Water Development Board (TWDB) has not issued a MAG volume for this aquifer in Kerr County. The TWDB Llano Uplift Groundwater Availability Model (LUGAM) (Shi and others, 2017) does include the Ellenburger-San Saba as layer 5.

The Headwaters GCD has been assisted by a voluntary group of local geologists that has refined the structural component of the conceptual model. Their findings are that the most potentially viable part of the Aquifer lies within the eastern half of the County and that within this portion the hydraulic conductivity can be defined between two values, 0.3 feet/day in the less permeable portion and 3.5 feet/day in the more productive areas.

Based on this refined structure and resulting hydraulic conductivities, LBG-Guyton (now WSP USA) was tasked with running the TWDB LUGAM with the above modifications for the identified 286,000-acre eastern portion of Kerr County. To assess the impact of Ellenburger pumping on water level decline, 20 hypothetical wells were added to the selected area and five pumping scenarios (2,000; 5,000; 10,000; 15,000 and 20,000 acre-feet per year) were applied to these wells. The potential groundwater availability calculated for these five pumping scenarios are as follows:

Table 3-5. Ellenburger Aquifer Availability

Pumping Scenario	Annual Availability (acre-feet/acre)	Annual Availability (gallons/acre)
2,000 acre-feet/year	0.007	2,300
5,000 acre-feet/year	0.017	5,700
10,000 acre-feet/year	0.035	11,400
15,000 acre-feet/year	0.052	17,100
20,000 acre-feet/year	0.07	22,800

Calculated water-level declines resulting from the above pumping scenarios ranged from a minimum of less than five feet with the 2,000 acre-feet/year, to an average of 35 to 40 feet with the 20,000 acre-feet/year pumping rate.

For Regional Water Planning purposes, it is proposed that until actual production is monitored, the 2021 Plateau Region Plan will adopt a conservative Ellenburger-San Saba Aquifer availability rate of 0.007 acre-feet/acre/year over the 286,000-acre productive area or a total of 2,002 acre-feet/year. This volume is subdivided between the Colorado and Guadalupe river basins in eastern Kerr County into 200 acre-feet/year and 1,802 acre-feet/year respectfully.

3.1.9 Public Supply Use of Groundwater

All communities in the Plateau Region rely partially or completely on groundwater supply sources. Even the spring sources (classified as surface water) used by Del Rio and Camp Wood originate from aquifers. The higher concentration of wells in Kerr and Bandera Counties related to population growth may present water supply availability problems in the future. Public supply wells serving communities in Edwards, Kinney, Real and Val Verde Counties are not anticipated to have long-term declines due to the relatively smaller quantities of water that are needed to serve these communities. Also, no long-term water-quality deterioration has been detected in groundwater supplies for these communities. Long-term viability of the aquifers serving these other communities appears to be acceptable. However, new wells should be located outside the local areas of pumping influence of the existing wells. Although no evidence of contamination from surface sources have been detected in public-supply groundwater sources in the Plateau Region, a wellhead protection program should be considered by all communities.

3.1.9.1 City of Bandera

The City of Bandera is primarily dependent on wells completed into the Lower Trinity Aquifer and must compete for this water with numerous private wells in the County. However, a new Middle Trinity well was recently completed, which will provide some backup to the Lower Trinity well supply. Long-term viability of the Trinity Aquifer as a supply source for Bandera and outlying areas will require implementation of management policies aimed at establishing withdrawals based on the sustainable yield of the Aquifer.

City of Bandera Well No. 69-24-202 shows a consistent decline from the 1950s through the 1990s, with a total of approximately 400 feet of water level decline. Most of the water withdrawn by Bandera public supply wells is produced from the Lower Trinity (Hosston) which receives very little vertical recharge

and an undetermined amount of lateral underflow from the north and west of the well fields. Because of the continuous water-level decline in these well fields, the City, with the assistance of the BCRAGD, should monitor levels to anticipate production reductions.

3.1.9.2 Bandera County FWSD #1

Bandera County FWSD #1 provides water to the Pebble Beach subdivision and obtains its water from wells completed in the Trinity Aquifer. This District currently has four active wells and competes for this water with numerous private wells within the County. Growing subdivisions will increase water demands, causing the District to consider the need for additional supply.

3.1.9.3 City of Kerrville

The City of Kerrville is dependent on conjunctive use of surface water from the Guadalupe River and groundwater from Lower Trinity Aquifer wells. Kerrville Wells No. 4 and No. 11 experienced declines of as much as 200 feet through the early to mid-1980s. Between the early to mid-1980s and the early 1990s, water levels in these two wells increased by as much as 200 feet in response to the decreased pumpage by the City when surface water sources were brought on-line. Since 1998, water levels have remained relatively constant.

The only long-term water-quality degradation trend observed in Kerrville public-supply wells is noted in the increase in sodium, chloride and total dissolved solids in the City's Travis Well No. 14 during the late 1960s to mid-1970s. The well showed steady increases in sodium (18 to 72 mg/l), chloride (55 to 200 mg/l), and total dissolved solids (417 to 624 mg/l) between 1968 and 1976. This corresponded with the time period that large drawdowns in water levels were occurring in the Kerrville area. This well is designated as an "Emergency Only" well and is not used for production.

The City of Kerrville operates an aquifer storage and recovery (ASR) operation where treated surface water is injected into the Lower Trinity Aquifer to maintain aquifer pressure and provide a source for peak demand periods.

Specific strategies to meet Kerrville's future water needs are addressed in Chapter 5. If additional wells are needed for increasing supply needs, the City could consider locating new wells outside the local area of pumping influence. The City will continue to cooperate with efforts of the local Groundwater Conservation Districts to establish aquifer management policies.

3.1.9.4 City of Rocksprings

The City of Rocksprings obtains its water supply from wells completed in the Edwards Limestone of the Edwards-Trinity (Plateau) Aquifer. This rural community has little competition for groundwater and, thus, its supply is considered dependable. A new well has been drilled and is currently being connected to the City's distribution system.

3.1.9.5 City of Brackettville and Fort Clark Springs MUD

Water wells completed in the Edwards portion of the Edwards-Trinity (Plateau) Aquifer produce water used for municipal supply in these two adjacent communities. Las Moras Springs, an identified major spring, also exists at the same location of the Fort Clark Springs wells. Under existing conditions, there appears to be sufficient supply to meet futures needs. The Kinney County GCD is currently evaluating potential impacts that might result from increased future pumping within the District.

3.1.9.6 City of Camp Wood

Camp Wood located in southwestern Real County derives its water supply mostly from Old Faithful Springs. The spring has reportedly always flowed. However, with increasing population and the drilling of additional wells in the area, the spring may experience decreasing flow during drought periods in the future. To supplement its supply, the City has completed a new well in the underlying Edwards-Trinity Aquifer.

3.1.9.7 City of Leakey

The City of Leakey obtains its water supply from shallow water wells ranging in depth from 34 to 42 feet in the Frio River Alluvium Aquifer. The City competes for groundwater from this small Aquifer with numerous private domestic wells. Trinity Aquifer wells in the local area have proven to be unreliable and often contain poor-quality groundwater.

3.1.9.8 City of Del Rio

The City of Del Rio is supplied with water from San Felipe Springs, which issue from the Edwards portion of the Edwards-Trinity (Plateau) Aquifer. The water is collected through pumps set in the springs, treated with microfiltration and chlorine and then distributed to the City, Laughlin Air Force Base, and outlying neighborhoods.

The average discharge of San Felipe Springs since Lake Amistad was filled is about 110 cubic feet per second or about 80,000 acre-feet/yr. During recent droughts, the spring discharge has fallen below 50 cfs or, extrapolated over one year, about 36,000 acre-feet. Recent droughts as compared to the 1950s drought would be appropriate to use as a drought-condition gage because the filling of Amistad Lake has generally increased the springflow after the late 1960s.

3.1.10 Agricultural Use of Groundwater

Because of the arid conditions and lack of well-developed soils over much of the Region, irrigated agricultural activities are generally limited in most of the counties. Low well yields common throughout much of the Region also limit the development of large-scale irrigation. Water quality however, is not generally a limiting factor for irrigation in the Region. Kinney County has the greatest amount of agricultural use of water. The acreage of land irrigated by groundwater in the year 2000 in each county as reported in TWDB Report 347 is, from most to least, Kinney, 4,865 acres; Bandera, 173 acres; Val Verde, 145 acres; Kerr, 57 acres; Edwards, 40 acres; and Real, 15 acres. In addition, numerous surveyed small feed plots for game are irrigated with groundwater. The PWPG is concerned about the accuracy of the irrigation surveys and believes that there is significantly more irrigation water use than is documented. For example, the Headwaters Groundwater Conservation District in Kerr County documents approximately 700 acres being irrigated just with groundwater.

A review of historical and current data suggests that there has been no long-term change in regional water levels or water quality as a result of agricultural pumping. Local water-level declines occur during the irrigation season but generally recover during the off-season. Although irrigation conservation efficiencies could be improved, currently used equipment and practices are not resulting in depletion of the aquifers. At the current rate of agricultural use, groundwater of sufficient quantity in the Edwards-Trinity (Plateau), Edwards (BFZ), and Austin Chalk Aquifers should remain available for future

agricultural use. However, the competition for Trinity Aquifer water between municipal and agricultural needs in Bandera and Kerr Counties is increasing. The Bandera County River Authority and Groundwater District and the Headwaters Groundwater Conservation District are both actively involved in managing the use of groundwater in these counties.

3.1.11 Brackish Groundwater Desalination Sources

Most groundwater in the Plateau Region contains total dissolved-solids (TDS) concentrations of less than 1,000 mg/l and thus meets drinking water standards. Groundwater of slightly poorer quality (1,000 to 3,000 mg/l) occurs in the Trinity Aquifer in some areas. Elevated levels of calcium-sulfate resulting from the dissolution of evaporate beds in the upper Glen Rose is the primary source of higher TDS groundwater. Productivity from this aquifer source makes desalination a marginal option at this time.

3.2 SURFACE WATER SUPPLIES

The Plateau Region straddles several different river basins, rather than generally following a single river basin or a large part of a single river basin (Figure 3-2). From west to east, these basins include the Rio Grande, Nueces, Colorado, San Antonio, and Guadalupe. The headwaters of three of these river basins (Nueces, San Antonio, and Guadalupe), as well as major tributaries of the Rio Grande and Colorado River, originate in this Region.

Available surface water supplies under drought-of-record conditions depend on two components: water that is physically present (usually substantially reduced during a drought-of-record since by definition it is the most severe) and the authorized amount per existing water right adjudications. Use of the Texas Commission on Environmental Quality (TCEQ) Water Availability Models (WAMs) allows for the performance of a simulation of availability and diversion for all water rights in a river basin based on naturalized flows over a specified hydrologic period. These models generally follow an appropriation of water in priority date order, but appropriation order from upstream to downstream may also be simulated. The TCEQ WAMs of the five Plateau Region river basins have been used to determine surface water availability during a drought-of-record.

- Rio Grande River Basin WAM Run 3 – Version Feb. 1, 2018 - Hydrologic period 1940-2000.
- Nueces River Basin WAM Run 3 – Version Jan. 7, 2013 – Hydrologic period 1934-1996.
- Colorado River Basin WAM Run 3 – Version Feb. 1, 2018 – Hydrologic period 1940-2013.
- San Antonio River Basin WAM Run 3 – Version Oct. 17, 2014 – Hydrologic period 1934-1989.
- Guadalupe River Basin WAM Run 3 – Version Oct. 17, 2014 – Hydrologic period 1934-1989.

The simulations used to determine water availability assume that all water rights in each basin are allowed to divert the full authorized amount when water is available, following appropriation in priority date order. They also reflect the conservative assumption that no return flows are present, as is consistent with both TWDB regional planning guidelines and TCEQ modeling of water availability and permitting. Municipal run-of-river calculations use the unmodified TCEQ WAM Run 3 to ensure that all monthly demands are fully met. Area-capacity of major reservoirs was adjusted to reflect sedimentation conditions for 2020 through 2070. Drought-of-record source amounts by county and river basin are provided in Table 3-1. Water Source Availability (Acre-Feet per Year). A list of all authorized surface water rights in the Region is available in Appendix 3A.

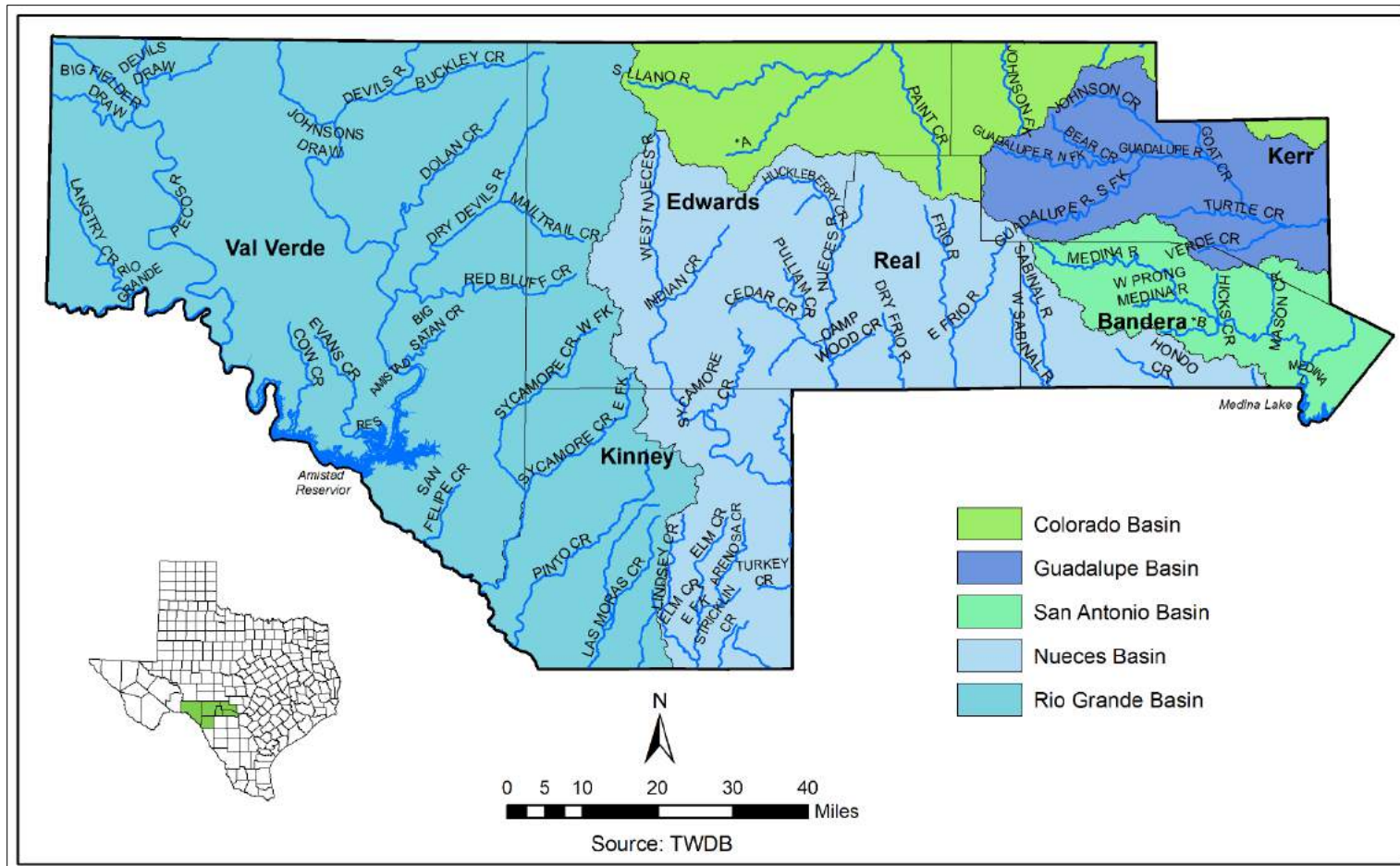


Figure 3-2. Surface Water Sources

The term "run-of-the-river" is used to distinguish water rights with diversion points directly on a watercourse from water rights with diversion points on a reservoir. Generally, run-of-the-river water rights, also referred to as "direct diversions", are less dependable than water rights on reservoirs because of the lack of storage. However, run-of-the-river diversions are often very convenient, especially for irrigators and small entities, because a diversion point on a watercourse can be located extremely close to the location where the water will be consumed, thereby negating the need to pipe the water over long distances.

Diversions under a drought-of-record are extracted from results of a WAM simulation for each basin. For purposes of this *Plan*, a drought-of-record supply for run-of-the-river diversions is categorized by use (municipal, irrigation, industrial and other) and by county. Supply amounts on river segments have always been difficult to assess due to the lack of storage to catch excess flows. In this *Plan*, the reliable supply for run-of-the-river diversions for non-municipal use is expressed as the minimum annual diversion for each category during the hydrologic period considered in the water availability models. The reliable supply for run-of-the-river diversions for municipal use is expressed as the minimum monthly diversion amount that is available in all months of the hydrologic period considered in the water availability models.

Drought-of-record supply amounts for reservoirs are on a firm-yield basis. To understand firm yield, one must understand the concept of "mass balance" - the simple but true principle of physics that mass can neither be created nor be destroyed (i.e., what goes in must come out). In practical terms as applied to a reservoir, the water going in (inflows from drainage areas of tributaries feeding the reservoir site and direct precipitation upon the reservoir itself) equals the water going out (evaporation off the lake surface plus water spilled over the dam plus any water allowed to pass through the dam to satisfy senior water rights downstream plus the demand placed on the reservoir plus other factors which may exist). The operation of a reservoir is simulated under various demands, iterating the simulation to find a demand that the reservoir can supply consistently throughout a repeat of the historical hydrologic record. Demand is termed the "firm yield" of the reservoir if for every year of the historical hydrologic record (even during a drought-of-record) the reservoir can supply the demand placed on it.

Canyon Reservoir and the Medina/Diversion system are potential water supply reservoirs for the Plateau Region's future water needs. Although neither reservoir currently serves a water need within the Region, both reservoirs could likely do so in the future. Although recreational use of streams and lakes serves an important function in the Plateau Region, its use has no impact on reservoir yields, as these uses are non-consumptive.

3.2.1 Rio Grande Basin (Including the Pecos and Devils River)

The Rio Grande, or Rio Bravo as it is known in Mexico, forms the border between the United States and Mexico. International treaties govern the ownership and distribution of the water in this river. Under the 1906 Treaty, the United States is obligated to deliver 60,000 acre-feet annually from the Rio Grande to Mexico, except in the cases of severe drought or serious accident to the irrigation system in the United States. Diversion of this allotment occurs upriver in El Paso. The 1944 Treaty addresses the waters in the international segment of the Rio Grande from Fort Quitman, Texas to the Gulf of Mexico. The United States receives 1/3 of the flow from six tributaries (Rio Conchos, San Diego, San Rodrigo, Escondido,

Salado Rivers, and Las Vacas Arroyo), provided that the running average over a five-year period cannot be less than 350,000 acre-feet/yr.

While the International Boundary and Water Commission is responsible for implementing the allocation of water on the U.S. side, the Watermaster office of TCEQ administers the allocation of Texas' share of the international waters. The two reservoirs located in the middle of the lower Rio Grande, the Amistad and Falcon, store the water regulated by the Watermaster. The Watermaster oversees Texas' share of water in the Rio Grande and its Texas tributaries from Fort Quitman to Amistad Dam, excluding drainage basins of the Pecos River and Devils River.

The Pecos River forms a portion of the boundary between Terrell County in the Far West Texas Region and Crockett County in Region F before reaching Langtry in Val Verde County in the Plateau Region. The Devils River originates in Sutton County and proceeds generally southward through Val Verde County before reaching Amistad International Reservoir. There are no surface-water rights on the Pecos and Devils Rivers within the Plateau Region.

Flow of the Pecos River within the Plateau Region is inconsistent, with livestock and wildlife watering apparently being the only use made of whatever water that may remain in the River. Independence Creek, a large spring-fed creek in northern Terrell County west of Val Verde County, is the most important of the few remaining freshwater tributaries to the lower Pecos River. Independence Creek's contribution increases the Pecos River water volume by 42 percent at the confluence and reduces the total suspended solids by 50 percent, thus improving both water quantity and quality (Nature Conservancy of Texas descriptive flier).

Flows of the Devils River are gaged at the Spafford Crossing near Comstock in Val Verde County. This gage (USGS 08449400) began recording in 1978 and was discontinued in 1985. Therefore, it does not record flows for the 1950s. However, from 1978 through 1985 the flows are consistently between approximately 100 and 300 cfs, with rare spikes ranging from 4,000 cfs up to 50,000 cfs. These spikes result from unusually intense but short rainfall events. In absence of data for the 1950s-drought period, and considering the generally low and undependable flows within the Devils River, a realistic estimate of the drought-of-record amount of supply from the Devils River within the Plateau Region is zero.

3.2.2 Amistad International Reservoir on the Rio Grande

The Amistad International Reservoir is located on the border between the United States and Mexico near the City of Del Rio, and was constructed jointly by the two nations. It was completed in 1968 with a maximum capacity of 5,250,000 acre-feet, 3,505,000 acre-feet of which are used for water conservation. The water is distributed among downstream users of Mexico and the United States. Amistad is not a source of supply for the Plateau Region, as the City of Del Rio and downstream irrigators in Val Verde County obtain their supply primarily from San Felipe Springs and Creek. Thus, the constraints on Amistad Reservoir as a source of water supply for the Plateau Region are the existing water rights held by water rights holders and enforced by the Rio Grande Watermaster.

Goodenough Spring is inundated by Lake Amistad and was at one time considered the third largest spring in Texas. The spring, which discharges from the Edwards-Trinity (Plateau) Aquifer, still provides a significant flow contribution to the Rio Grande.

3.2.3 Nueces River Basin

The upper Nueces River Basin lies in Edwards, Real, Bandera, and Kinney Counties, with the main stem Nueces forming a portion of the border between Real County and Edwards County. Headwater tributaries of the Nueces River located in the Plateau Region include the Sabinal River and Hondo Creek in Bandera County, the West Nueces River in Edwards and Kinney Counties, and the Frio, East Frio, and Dry Frio Rivers in Real County. Although undocumented, in some places there appears to be an amount of underflow occurring through gravel beds that line long stretches of the river bottom.

Total authorized diversions by water rights on the Nueces River within the Plateau Region are 11,419 acre-feet/year. Most of this amount (10,116 acre-feet/year or 88 percent) is for irrigation use. Diversions for municipal use total 1,259 acre-feet/year. The City of Camp Wood holds the largest municipal right for 1,000 acre-feet/year. Small water rights for other uses have a total authorized diversion of 44 acre-feet/year.

The TCEQ Water Availability Model for the Nueces River Basin was used to evaluate surface water supplies. The model includes data through the year 1996, and addresses the drought-of-record of the 1950's.

3.2.4 Colorado River Basin

The headwaters of the South Llano River, a tributary of the Colorado River, lie in Edwards County. There are three water rights on the South Llano River and Paint Creek within the Plateau Region for irrigation use. The combined authorized amount of these rights is 180 acre-feet/year.

The TCEQ Colorado River Basin WAM was used to evaluate the supply for these rights. This model covers the period 2013. Hydrologic data for these streams suggests that the drought-of-record occurred in 2011. The minimum annual diversion for the three rights is 32 acre-ft/yr.

3.2.5 San Antonio River Basin

The headwaters of the San Antonio River lie in Bandera County. Most water right authorizations from the San Antonio Basin are run-of-the-river diversions for irrigation use. Run-of-the-river diversions exclude authorizations on Medina Lake. Eight authorized water rights on the Medina River main stem total 236 acre-feet/year. Of these eight water-right holders on the River, six use the water for irrigation. The sum of these six irrigation rights totals 227 acre-feet/year. Of the remaining two water-right holders, one is for 9 acre-feet of water per year used by an individual for municipal purposes, and the other is for a non-consumptive recreation reservoir owned by the City of Bandera. This recreation-only reservoir is for non-consumptive use only.

Since the Guadalupe-San Antonio WAM covers the period 1934-1989, it is appropriate to consider if the drought of 1996 exceeded the severity of the drought of the mid-1950s. USGS gage 08178880 on the Medina River at Bandera just downstream of State Highway 173 gives a lowest annual streamflow amount at 33.7 cubic feet per second (cfs) (approximately 24,600 acre-feet/year) in 1996. However, this gage did not begin recording until 1982, and therefore records from the 1950s drought are missing and cannot be compared directly to the low flows of 1996. Data for the 1950s at the Bandera gage as extracted from the Guadalupe-San Antonio River Basin WAM indicates an annual naturalized flow of 2,662 acre-feet in 1956. Regulated flows would be even lower once upstream diversions and

impoundments are accounted for. Therefore, based on estimates of the Guadalupe-San Antonio Basins WAM, the drought of the 1950s represents the drought-of-record conditions for the San Antonio Basin in the Plateau Region.

3.2.6 Medina Lake on the Medina River

Medina Lake was constructed in 1911 to provide irrigation water for farmers to the southwest of San Antonio. Although commonly referred to as Medina Lake, the lake is actually a system consisting of Medina Lake and Diversion Lake. Impounded in 1913, Diversion Lake is approximately 4 miles downstream of Medina Lake.

Diversions from the dual-lake system are authorized only from Diversion Lake, as per the water right held by Bexar-Medina-Atascosa Water Control and Improvement District #1 (BMAWCID#1).

BMAWCID#1's Adjudication Certificate No. 19-2130C authorizes the District to divert up to 65,830 acre-feet/year of water for irrigation, municipal and industrial use, up to 750 acre-feet/year specifically for domestic and livestock purposes, and up to 170 acre-feet/year specifically for municipal use.

BMAWCID#1 has signed contracts to supply several irrigators and a development corporation with water. In January 2000, BMAWCID#1 signed a contract with Bexar Metropolitan Water Authority indicating that BMAWCID#1 will sell 20,000 acre-feet/year to the Authority for municipal use.

Bandera County currently has a Water Supply Agreement with BMAWCID#1 for purchase of up to 5,000 acre-feet/year; however, this agreement is not currently associated with the infrastructure necessary to carry out the purchase and subsequent distribution of the water.

Loss of impounded water from Medina Lake to the Trinity Aquifer and Diversion Lake to the Edwards Aquifer reduces the firm yield of the system. This loss has long been known to be substantial. Quantification of water recharging the aquifers has been elusive, as different estimates of recharge have resulted in different firm-yield estimates for the system. In 1957, a Bureau of Reclamation study estimated the firm annual yield of the Medina Lake/Diversion Lake system to be 27,500 acre-feet/year if the lake system were operated under an agricultural (irrigation) demand only scenario, but it estimated 29,700 acre-feet/year as the firm yield for municipal and industrial demand. Due to effects of seepage around the dam and of recharge to the underlying aquifers, Espey Huston estimated a firm yield of zero for Medina Lake in 1994, based on the relationship they found between the Lake stage and recharge. HDR Engineering modified the Espey Huston stage-recharge curves for its Trans-Texas report and cited 8,770 acre-feet/year as the firm yield. According to previous communications, HDR assumed diversions would be from Medina Lake rather than from Diversion Lake and that all irrigation use would be curtailed. This assumption does not comply with existing conditions as regards to water right authorizations.

The latest USGS report, "Assessment of Hydrogeology, Hydrologic Budget, and Water Chemistry of the Medina Lake Area, Medina and Bandera Counties, Texas," maintains that earlier methods of estimating recharge (Lowry, Espey Huston curves as modified by HDR for the Trans-Texas report) overestimate recharge. Overestimation of recharge would result in an underestimation of firm yield; however, the USGS report did not include a firm-yield estimate for the reservoir system.

The TCEQ Guadalupe-San Antonio River Basins WAM incorporates the HDR Trans-Texas method of estimating recharge and probably provides the best overall data (water rights, inflows determined by

water rights) available at this time. The model was thus used to determine a firm yield of the Medina/Diversion system of zero acre-feet/year.

3.2.7 Guadalupe River Basin

Within the Plateau Region, the Guadalupe River Basin occurs almost exclusively within Kerr County. The Basin drains approximately 510 square miles at Kerrville, and approximately 839 square miles at Comfort near the eastern county line. The River originates almost entirely within western Kerr County as three branches (Johnson Creek, North Fork, and South Fork) merge west of Kerrville to form the main river course. A study report titled Spring Flow Contribution to the Headwaters of the Guadalupe River in Western Kerr County (2005) was prepared for the PWPG (<http://www.ugra.org/plateau-water-planning-group>).

The total amount of authorized water rights for the Guadalupe River within the Plateau Region is 21,020 acre-feet/year. Municipal use accounts for 8,076 acre-feet/year. Holders of these water rights include the City of Kerrville, the Upper Guadalupe River Authority (UGRA), and independent persons.

The City of Kerrville and the UGRA own the largest municipal water rights. Certificate of Adjudication 1996, 5394-B, 2026 and Permit 3505 are held by Kerrville. UGRA holds Permit 5394-A. Authorized diversions from the Guadalupe River associated with these water rights are taken from an 840-acre on-channel reservoir located in the City of Kerrville and are pumped from the reservoir to Kerrville's water treatment plant. A summary of the pertinent information for their water rights is shown in Table 3-6.

Texas Parks and Wildlife Department owns a continuous flow-through water right for 5,780 acre-feet/year used for the Heart of the Hills Fisheries Science Center, consumptive use is approximately 400 acre-feet/year. Industrial use permits are authorized for 17 acre-feet/year and irrigation rights for 6,904 acre-feet/year. The remaining water-rights holders use their water for mining, hydroelectric power, and recreation. One individual holds a water right (35,125 acre-feet/year) for hydroelectric use; however, this right has not been exercised. Kerr County holds the rights for three non-consumptive recreation-use reservoirs in and near Kerrville.

Table 3-6. Municipal Water Rights for Kerrville and UGRA

Water Rights Permit	Authorized Diversion (acre-ft/yr)	Permit Holder	Priority Data	Storage (acre-feet)	Restrictions
1996 (amended 4/10/98)	225 (Mun.)	Kerrville	4/4/1914		
3505	3,603	Kerrville	5/23/1977	840	Max diversion rate = 9.7 cfs Divert only when reservoir is above 1,608 ft msl
5394A and 5394-B (amended 4/10/98)	2,169	Kerrville (Kerrville Municipal use)	1/6/1992	Utilizes the storage authorized for Permit 3505	Max combined diversion rate for water rights #3505 and #5394 = 15.5 cfs. Minimum instream flow requirements vary from 30 to 50 cfs during year.
	2,000	UGRA (County Municipal use)			

Note: Permit 2026 (priority 1961) 54 ac/ft municipal use.

During winter months when there is surplus surface water supply, a portion of the treated water is injected into the Lower Trinity Aquifer for subsequent use during the typically dry summer months. This aquifer storage and recovery (ASR) program has been in full operation since 1998.

Both the City of Kerrville and the UGRA have within their authorizations (Permits Nos. 5394B and 5394A respectively) a Special Condition addressing the seasonal distribution of allowed diversions. The Special Condition stipulates that during the months of October through May, the permittees may divert only when the flow of the Guadalupe River exceeds 50 cfs, and during the months of June through September, the permittees are authorized to divert only when the flow of the Guadalupe River exceeds 30 cfs. Another Special Condition common to both permittees is that, when inflows to Canyon Reservoir are less than 50 cfs, each permittee is to restrict diversions to allow a flow of at least 50 cfs to pass through. Yet another Special Condition imposed on both permittees is that diversions may be made only when the level of UGRA Lake is above 1,608 feet above mean sea level.

Pursuant to a Memorandum of Understanding (MOU) between the Guadalupe-Blanco River Authority (GBRA) and the Commissioner's Court of Kerr County, the South Central Texas Water Planning Group (Region L) recognizes a potential commitment of approximately 2,000 acre-feet/year from the firm yield of Canyon Reservoir for the calendar years 2021 through 2050. GBRA's hydrology studies indicate that a commitment of about 2,000 acre-feet/year would be necessary to allow permits for 6,000 acre-feet/year to be issued by TCEQ for diversions in Kerr County.

Data from the Corps of Engineers show a computed inflow into Lake Canyon of 132,900 acre-feet/year in 1996. The Guadalupe-San Antonio WAM estimates naturalized flows to be 27,800 acre-feet in 1956. The USGS gage 08167000 on the Guadalupe River at Comfort gives a lowest annual streamflow amount of 14.5 cfs (approximately 10,585 acre-feet/year) occurring in 1956. This gage has been recording since 1939. Interestingly, statistics for the gage include the fact that, for water years 1939 through 1997, the mean annual runoff was 157,800 acre-feet or approximately 216 cfs, and that 90 percent of these flows exceeded 25 cfs. This puts the 1956 occurrence of 14.5 cfs within the 0 to 10 percent non-exceedance category. In calendar year 1996, the annual mean was 151 cfs and the median was 85 cfs. The mean and median for 1997 exceeded the 1996 values. These facts seem to substantiate that the drought-of-record for Kerr County occurred in 1956, not in 1996, as consistent with most other areas of the State.

3.2.8 San Felipe Springs

The City of Del Rio has a water right authorizing it to divert 11,416 acre-feet/year from San Felipe Springs for municipal use. San Felipe Manufacturing and Irrigation Company has a water right authorizing it to divert 4,962 acre-feet/year for irrigation use and 50 acre-feet/year for industrial use. No data exists for flows during the drought of the 1950s. The only available records are from USGS gage 08452800 maintained by the IBWC at San Felipe Springs that covers the period of February 1961 to present. The minimum annual amount during this time period was 36,580 acre-feet/year (occurring in 1963).

3.2.9 Old Faithful Springs

Issuing from the upper Glen Rose Limestone portion of the Edwards-Trinity (Plateau) Aquifer, Old Faithful Springs is the primary water supply for the City of Camp Wood. The Spring has been a dependable source and was reported to have continuously flowed during the 1950s drought. There is current concern that the increase in the number of wells being drilled in the area may lower the local water table and thus negatively impact spring flow. The Spring is privately owned and may not be available for City use after the current contract expires.

3.2.10 Surface Water Rights

The right to use surface water from streams and lakes is permitted through the State of Texas. A list of all authorized surface water rights in the Region is available in Appendix 3A.

Major downstream water rights include those in Region L supplied by the Guadalupe-Blanco River Authority out of Canyon Lake and by the Bexar-Medina-Atascosa WCID#1 out of the Medina/Diversion system. The firm yields of Canyon and Medina limit the amount of water available for appropriation in both the Plateau Region and Region L. Major downstream water rights in Region M (i.e., cities and irrigators on the Rio Grande downstream from Amistad Reservoir) do not limit the amount of water available for appropriation in the Plateau Region because currently the Plateau Region does not depend on the Falcon-Amistad system. TCEQ's Lower Rio Grande Watermaster allocates water rights on the Rio Grande according to the supply in the Amistad Reservoir and in accordance with the 1944 International Treaty with Mexico.

3.3 GROUNDWATER/SURFACE WATER RELATIONSHIP

In the natural environment, water is constantly in transition between the land surface and underground aquifers. Under certain conditions, stream losses percolate downward to underlying aquifers as recharge; while in other cases, aquifers give up water to the land surface in the form of springs and seeps.

Most of the Plateau Region occurs at higher elevations that constitute the headwaters of the numerous streams and tributaries that frequent this Region. At these elevations, significant quantities of water exit the aquifer systems through springs and form the base flow of the surface streams. Downstream, only a portion of that water may render the underground system. For this reason, these streams are generally gaining throughout much of their extent within the Plateau Region. Spring flows are also environmentally important in that they are the primary source of water for wildlife in the area. These discharges from springs are thus the primary source of continuous flow to the rivers downstream and, therefore, their protection is warranted. Springs are so common to this headwater region that a popular beverage slogan touted “From the Land of 1,100 Springs”.

Some of the largest springs in the Region, such as San Felipe Springs (Val Verde County) and Las Moras Springs (Kinney County), issue from the Edwards limestone. However, numerous other springs issue from either the Edwards or Glen Rose Limestones. Many of the springs, such as Fessenden Spring (Kerr County), issue near the contact between the Edwards and the upper Glen Rose Limestones. Smaller springs are more prevalent where they issue from the Glen Rose, particularly in Bandera and Kerr Counties.

Most springs located in the headwaters of rivers that traverse the eastern part of the Region issue from the contact between the Edwards limestone and underlying upper Glen Rose limestone. Most well production in this area is from deeper aquifers and, therefore, little impact to spring flow from the pumping is anticipated. However, as new development expands to the west, care should be given to potential water level declines that could diminish spring flow and base flow to the rivers.

Springs located in the western part of the Region issue primarily from the Edwards Limestone. Because of limited pumping of groundwater from wells in the Del Rio area, San Felipe Springs has not had to compete for source water. A significant increase in groundwater pumpage immediate updip and to the east of the springs may lower the water table sufficiently to affect flow from the springs. Because much of the recharge areas for the contributing zones of these western springs occur in remote areas, very little information is available concerning the relationship between the springs and the underlying aquifers.

Gain/loss studies are needed to identify stream segments that are critical to aquifer recharge and spring discharge. The studies can be used to identify where recharge structures would be most efficient and where most river base-flow gain occurs. Specific candidate areas occur over the plateau area that is underlain by Edwards Limestone, especially in the upper tributaries of all the rivers. Gain/loss studies of tributaries in the vicinity of Del Rio would be beneficial in understanding the recharge areas that contribute to San Felipe Springs.

Two supplemental study reports were prepared for the *Plateau Region Water Plan* that address springs. The first report (Springs of Kinney and Val Verde Counties, 2005) considers the location and geohydrology of springs in Kinney and Val Verde Counties, and the second report (Spring Flow Contribution to the Headwaters of the Guadalupe River in Western Kerr County, Texas, 2005) relates springflow in western Kerr County to base flow in the three branches of the upper Guadalupe River.

3.4 WATER REUSE

While recycling is a term generally applied to aluminum cans, glass bottles, and newspapers, water can be recycled as well. Water recycling is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing, and replenishing a groundwater aquifer (referred to as groundwater recharge or ASR for aquifer storage and recovery). Water is sometimes recycled and reused onsite; for example, when an industrial facility recycles water used for cooling processes. A common type of recycled water is water that has been reclaimed from municipal wastewater, or sewage. The term "water recycling" is generally used synonymously with water reclamation and water reuse.

Kerrville treats its wastewater to TCEQ type 1 level. The treated wastewater is pumped through a dedicated pipeline for reuse as irrigation water for the Scott Schreiner Municipal Golf Course, the Hill Country Youth Soccer Fields, Kerrville Sports Complex, Schreiner University, River Hills Golf Course, Tivy High School Sports Fields, Kerr County Animal Shelter, and the golf course at Comanche Trace Ranch & Golf Club. Additional treated water is sold by the truckload for construction projects. The remaining wastewater is released into Third Creek, which flows into Flatrock Lake on the Guadalupe River. That water is then available for use downstream of Kerrville. Future expansion of Kerrville's reuse project is anticipated to yield approximately 1 million gallons per day. The Cities of Del Rio and Bandera also have wastewater treatment capacities with the potential for future reuse applications.

Future direct reuse supply availability as shown in Table 3-1 is listed as:

- Kerr County – Guadalupe Basin – 5,000 acre-feet/year
(City of Kerrville permitted volume)
- Bandera County – San Antonio Basin – 310 acre-feet/year
(City of Bandera average discharge)
- Val Verde County – Rio Grande basin – 3,100 acre-feet/year
(Del Rio Utilities Commission permitted volume)

3.5 LOCAL SUPPLY

“Local Supplies” are limited, unnamed individual surface water supplies that, separately, are available only to particular non-municipal WUGs. These supplies are generally contained within “stock tanks” that catch precipitation runoff and are used primarily for livestock watering, but at times may be available for other local needs such as mining. For planning purposes, the volume of runoff water in these catchment basins is considered to be significantly reduced during drought-of-record conditions and does not include any groundwater that might be pumped into them. No documentation has been identified that quantifies the available supply during a drought of record for these local supplies. Thus, per TWDB guidelines established for the regional water planning process, it has been assumed for the purposes of the 2021 Plateau Region Water Plan that all local supplies not represented by a specific, identified water right are zero ac-ft per year.

This page intentionally left blank

APPENDIX 3A AUTHORIZED SURFACE WATER RIGHTS

This page intentionally left blank.

APPENDIX 3A. AUTHORIZED SURFACE WATER RIGHTS
AS EXTRACTED FROM TCEQ'S ACTIVE WATER RIGHTS MASTER FILE

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
2027-000	6	Bandera	7720000000	ROBERT L PARKER SR ET AL	VERDE CRK	IRRG	8	3		
2028-000	6	Bandera	7750000000	HOWARD E BUTT	PALMER CRK	OTHER			30	
2103-000	6	Bandera	5903000000	O S PETTY	HONEY CRK	IRRG	96	38		
2104-000	6	Bandera	5902000000	CLARENCE E LAUTZENHEISER	N PRONG MEDINA RIVER	IRRG	20.24	23.85		AMEND 9/29/88, 8/22/89
2105-000	6	Bandera	5901500000	STEVEN L PRICHARD TRUSTEE	MICKLE	IRRG	5.44	8.16	5	
2105-000	6	Bandera	5901500000	NEAL INCORPORATED	MICKLE	IRRG	7.32	10.99	5	
2106-000	6	Bandera	5901450000	BREWINGTON LAKE RANCH ASSN	BREWINGTON CRK	REC	190		190	
2107-000	6	Bandera	5901100000	JOEL HELD, TRUSTEE/JJJ RANCH	N PRONG MEDINA RIVER	IRRG	19	25		OUT OF A 1666.5 ACRE TRACT
2108-000	6	Bandera	5900100000	BEN & KAY MAYBERRY FAM PART	ROCKY CRK	IRRG	19.82	14.41		ALSO KERR CO
2108-000	6	Bandera	5900100000	WALTER A WILLOUGHBY	ROCKY CRK	IRRG	24.18	17.59		ALSO KERR CO
2109-000	6	Bandera	5897200000	NEVIN MARR	N PRONG MEDINA RIVER	IRRG	2	10		AMEND 1-21-83 INCREASE ACRES
2110-000	6	Bandera	5897000000	DONALD F & MARTHA M MEAD	N PRONG MEDINA RIVER	IRRG	21	12		
2111-000	6	Bandera	5896000000	TEXAS PETROLEUM CO. TR EST	COLLINS CRK	IRRG	4	2	16	
2112-000	6	Bandera	5894500000	MRS MARY WINKENHOWER	ELAM CRK	IRRG	27	27		JOINTLY OWNS 27 AF TO IRR 27 ACRES
2113-000	6	Bandera	5894000000	SUSAN CRAWFORD TRACY	W PRONG MEDINA RIVER	IRRG	35	45		OUT OF A 156 ACRE TRACT
2114-000	6	Bandera	5892000000	PHIL A GROTHUES ET UX	UNNAMED TRIB	IRRG	5.705	20.715		
2114-000	6	Bandera	5892000000	INMANN T DABNEY JR ET UX	UNNAMED TRIB	IRRG	6.542	23.756		
2114-000	6	Bandera	5892000000	RICHARD E WILSON	UNNAMED TRIB	IRRG	3.753	13.629		
2115-000	6	Bandera	5891500000	DAVID R SCHMIDT MD ET AL	BAUERLEIN CRK	IRRG	15	16		
2116-000	6	Bandera	5891000000	PAUL LAVON GARRISON	W PRONG MEDINA RIVER	IRRG	36	36		
2116-000	6	Bandera	5891000000	GEORGE C. YAX	W PRONG MEDINA RIVER	IRRG	15	15	162	
2117-000	6	Bandera	5889000000	G. MILTON JOHNSON, ET UX	MEDINA RIVER	IRRG	7	7		OUT OF A 175.5 ACRE TRACT
2118-000	6	Bandera	5888870000	DAVID J BRASK	UNNAMED TRIB	IRRG	16	16		
2119-000	6	Bandera	5888090000	RAYMOND HICKS	MEDINA RIVER	IRRG	3	8		
2120-000	6	Bandera	5888051000	BANDERA ELECTRIC COOP INC	MEDINA RIVER	IRRG	2	4		7/8/82 ADD DIV PT
2121-000	6	Bandera	5888087000	ANN DARTHULA MAULDIN	INDIAN CRK	IRRG	31.03	8.27		
2121-000	6	Bandera	5888087000	TOLBERT S WILKINSON ET UX	INDIAN CRK	IRRG	69.47	18.53		AMEND 7/30/90

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
2121-000	6	Bandera	5888087000	JOHN W DINSE ET UX	INDIAN CRK	IRRG	49.5	13.2		
2122-000	6	Bandera	5887330000	DON HICKS	MEDINA RIVER	MUNI	9			
2123-000	6	Bandera	5887150000	DON F TOBIN	MEDINA RIVER	IRRG	152	61		OUT OF A 452 ACRE TRACT
2124-000	6	Bandera	5887130000	EVANGELINE RATCLIFFE WILSON	SAN JULIAN CRK	IRRG	3	5		
2125-000	6	Bandera	5887129000	PETER K SHAVER ET UX	SAN JULIAN CRK	IRRG	18	30		
2126-000	6	Bandera	5887105000	STANLEY D ROSENBERG ET UX	MEDINA RIVER	IRRG	47	36		
2127-000	6	Bandera	5887100000	JERRY B PARKER ET AL	MEDINA RIVER	IRRG	16	8		
2128-000	6	Bandera	5887050000	JOE H BERRY	SADDLE CRK	IRRG	14	12	3	
2129-000	6	Bandera	5887000000	JOE H BERRY	PRIVILEGE CRK	IRRG	40	33	110	
2135-000	6	Bandera	5660000000	KITTIE NELSON FERGUSON	SAN GERONIMO CRK	IRRG	5	5	28	
3176-000	6	Bandera	2851020000	TEXAS PARKS & WILDLIFE DEPT	CAN CRK	MUNI	7			
3176-000	6	Bandera	2851020000	TEXAS PARKS & WILDLIFE DEPT	CAN CRK	IRRG		3		
3177-000	6	Bandera	2850500000	BETTY F LEIGHTON	SABINAL RIVER	MUNI	4			
3178-000	6	Bandera	2850000000	KING & JEWEL FISHER	SABINAL RIVER	IRRG	40	56	2	AMENDED 6/21/96
3179-000	6	Bandera	2825000000	JOHN K HARRELL	SABINAL RIVER	IRRG	28.196	95.257		
3179-000	6	Bandera	2825000000	BARBARA JEAN GROTH ET VIR	SABINAL RIVER	IRRG	8.804	29.743		
3184-000	6	Bandera	2675000000	ENRIQUE S PALOMO ET UX	SPRING CRK	IRRG	10	5	42	
3185-000	6	Bandera	2651700000	W H THOMPSON JR	WILLIAMS CRK	IRRG	15	5	2	CURRENT OWNER UNKNOWN, 5/98
3186-000	6	Bandera	2651500000	DOROTHY BAIRD MATTIZA	WILLIAMS CRK	IRRG	128	88	73	
3187-000	6	Bandera	2651000000	CHESTER N POSEY ET UX	WILLIAMS CRK	IRRG	23	21	15	
3188-000	6	Bandera	2650000000	W J SCHMIDT	HONDO CRK	IRRG	24	47	16	
3693-000	1	Bandera	5887260000	GERALD H PERSYN	UNNAMED TRIB BANDERA CRK	REC			11	
3824-000	1	Bandera	5887295000	CITY OF BANDERA	MEDINA RIVER	REC			22	
3825-000	1	Bandera	7718000000	ROBERT L PARKER SR ET AL	VERDE CRK	REC			277	
3853-000	1	Bandera	5888230000	ROCK CLIFF RESERVOIR LAND ASSN	SPIRES CRK	REC			925.4	AMENDED 2/17/98: IMPOUNDMENT AND EXP
3909-000	1	Bandera	5888150000	MAUDEEN M MARKS	MONTAGUE HOLLOW	REC			500	DOMESTIC, LIVESTOCK & REC
3944-000	1	Bandera	5887120000	CONOCO INCORPORATED	UNNAMED TRIB MEDINA RIVER	REC			180	2 DAMS
3949-000	1	Bandera	5886550000	CASTLE LAND & LIVESTOCK CO INC	BEAR CRK	REC	33		33	DOM & LIVESTOCK - SC
4026-000	1	Bandera	5887125000	HILL COUNTRY MANAGEMENT CORP	SAN JULIAN	REC			3	ALSO DOM & LIVESTOCK

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
5097-000	1	Bandera	5890300000	DON CODY ET UX	W PRONG MEDINA RIVER	IRRG	120	72		EXP 2/2/2016 BY CONTRACT 1610;AMEND 9/94 BOTTLED WATER, .049 RES
5186-000	1	Bandera	2824000000	HILL COUNTRY SPRING WATER TX	SPRING	MUNI	161			
5204-000	1	Bandera	2840000000	ROGER E. CANTER ET UX	SABINAL RIVER	IRRG	60	20		
5305-000	1	Bandera	2621000000	UTOPIA SPRING WATER INC	W SECO CRK	MUNI	72			
5339-000	1	Bandera	5888089000	YMCA/GREATER HOUSTON AREA	INDIAN CRK	REC			30	
5342-000	1	Bandera	5890200000	RENE H GRACIDA	W PRONG MEDIA	REC			7	
5475-000	1	Bandera	2850600000	GALLERIA HOLDING, LTD	JERNIGAN CRK	IRRG	26	18	63	2 RESERVOIRS
5575-000	1	Bandera	2850900000	ALBERT R GAGE ET UX	MARLER CRK	IRRG	12	6		SC: FLOW RESTRICTIONS
1527-000	6	Edwards	1750010000	ADDISON LEE PFLUGER	HUFFMAN SPRING	IRRG	32	20	1	
1528-000	6	Edwards	1735000000	RUTH MCLEAN BOWERS	PAINT CREEK	IRRG	60	54	58	CO 134, 2 RES
2451-000	6	Edwards	1750000000	ADDISON LEE PFLUGER ET AL	S LLANO RIVER	IRRG	88	74	7	AMEND 5/9/83
3017-000	6	Edwards	9520000000	RAY H EUBANK	RUTH DRAW	IRRG	50	50		AMEND 7/3/84
3023-000	6	Edwards	9195000000	DONALD P TARPEY	NUECES RIVER	IRRG	108	27		
3024-000	6	Edwards	9170000000	DOUGLAS B & MARGARET MARSHALL	NUECES RIVER	IRRG	65	43		
3038-000	6	Edwards	8900000000	ROYCE I REID ESTATE	PULLIAM CRK	IRRG	48	20		
3039-000	6	Edwards	8800000000	OLGA H. CLOUDT, ET AL	PULLIAM CRK	IRRG	75	50	8	
3039-000	6	Edwards	8800000000	OLGA H. CLOUDT, ET AL	PULLIAM CRK	IRRG	30	20		
3040-000	6	Edwards	8790000000	J R WILLIAMS ET AL	PULLIAM CRK	IRRG	34	17		
3041-000	6	Edwards	8780000000	JOSEPH C WILLIAMS	PULLIAM CRK	IRRG	60	44		1/2 INTEREST IN 60 AF FOR IRR OF 44 AC
3042-000	6	Edwards	8779000000	J R WILLIAMS ET AL	PULLIAM CRK	IRRG	22	13		
3043-000	6	Edwards	8760000000	JOY JERNIGAN OWENS	PULLIAM CRK	IRRG	32	16		
3044-000	6	Edwards	8700010000	SUSAN PETTY ARNIM ET AL	CEDAR CRK	IRRG	6	12		
3044-000	6	Edwards	8700010000	SUSAN PETTY ARNIM ET AL	CEDAR CRK	IRRG	20			
3044-000	6	Edwards	8700010000	SUSAN PETTY ARNIM ET AL	CEDAR CRK	IRRG	4	20		
3046-000	6	Edwards	8460500000	NORMA JEAN EASLEY	PULLIAM CRK	IRRG	30	59		
3047-000	6	Edwards	8400000000	BRUCE I HENDRICKSON ET UX	CLEAR CRK	IRRG	6	6	11	
3048-000	6	Edwards	8340000000	L A MALACHEK ET AL	PULLIAM CRK	IRRG	27	14		
3049-000	6	Edwards	7630010000	EDWARDS CO INVEST. PARTNER	PULLIAM CRK	IRRG	250	400		
3049-000	6	Edwards	7630010000	BRUCE I HENDRICKSON ET UX	PULLIAM CRK	IRRG	350	150		

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
3070-000	6	Edwards	7041600000	E B CARRUTH, JR, TRUST	W NUECES RIVER	IRRG	200	184		
3070-000	6	Edwards	7041600000	E B CARRUTH, JR, TRUST	W NUECES RIVER	REC			19	
3957-000	1	Edwards	8550000000	S A WILLIAMS	CEDAR CRK	IRRG	40	40		AMEND 1/13/87
4006-000	1	Edwards	8790100000	BAY-HOUSTON TOWING CO	PULLIAM	IRRG	150	75		
4278-000	1	Edwards	8920000000	BERRYMAN INVESTMENTS INC	PULLIAM CRK	IRRG	4.34	7.38		OWNS DAM & RESERVOIR
4278-000	1	Edwards	8920000000	SAM P WORDEN ET UX	PULLIAM CRK	IRRG	5.66	9.62		
1930-000	6	Kerr	9570000000	HERSHEL REID ET UX	FLAT ROCK CRK	IRRG	69	66	35	
1932-000	6	Kerr	9560000000	PRESBYTERIAN MO-RANCH ASSEMBLY	N FRK GUADALUPE RIVER	MUNI	60			AMEND 6/7/94
1932-000	6	Kerr	9560000000	PRESBYTERIAN MO-RANCH ASSEMBLY	N FRK GUADALUPE RIVER	IRRG	14	7		AMEND 6/7/94
1932-000	6	Kerr	9560000000	PRESBYTERIAN MO-RANCH ASSEMBLY	N FRK GUADALUPE RIVER	REC	25		20	AMEND 6/7/94
1934-000	6	Kerr	9527000000	CHARLES K HICKEY JR ET AL	DRY CRK	IRRG	0.45	0.68		
1934-000	6	Kerr	9527000000	KATHY JAN FREEMAN	DRY CRK	IRRG	1.55	2.32		
1935-000	6	Kerr	9525100000	CHARLES K HICKEY JR ET AL	N FRK GUADALUPE RIVER	IRRG	8	8		
1936-000	6	Kerr	9523000000	WILLIAM H ARLITT JR ET UX	N FRK GUADALUPE RIVER	IRRG	17	6	5	
1936-000	6	Kerr	9523000000	WILLIAM H ARLITT JR ET UX	INDIAN CRK	IRRG	134	48		
1937-000	6	Kerr	9515200000	BOY SCOUTS- ALAMO AREA	BEAR CRK	REC			10	
1938-000	6	Kerr	9515000000	LOUIS H STUMBERG	N FRK GUADALUPE RIVER	IRRG	2	4		
1938-000	6	Kerr	9515000000	LOUIS H STUMBERG	N FRK GUADALUPE RIVER	IRRG	15	22		
1939-000	6	Kerr	9512000000	LOUIS H STRUMBERG	GRAPE CRK	IRRG	3	6	6	
1940-000	6	Kerr	9511000000	B E QUINN III ET AL	N FRK GUADALUPE RIVER	IRRG	32	16	10	
1941-000	6	Kerr	8154502000	DELMAR SPIER AGENT	TURTLE CRK	IRRG	6	9	5	
1943-000	6	Kerr	9505000000	J CONRAD PYLE, ET AL	N FRK GUADALUPE RIVER	MUNI	14			
1945-000	6	Kerr	9485010000	JOHN P HILL	N FRK GUADALUPE RIVER	IRRG	25	20		
1946-000	6	Kerr	9485000000	JOHN P HILL ADMINISTRATOR	N FRK GUADALUPE RIVER	IRRG	11	9		
1947-000	6	Kerr	9480000000	GUAD VALLEY LOT OWNERS ASSN	N FRK GUADALUPE RIVER	IRRG	6	10		AMEND 3/6/91
1947-000	6	Kerr	9480000000	GUAD VALLEY LOT OWNERS ASSN	N FRK GUADALUPE RIVER	MUNI	3			
1948-000	6	Kerr	9489000000	JOHN H DUNCAN	BRUSHY CRK	IRRG	7	7		
1949-000	6	Kerr	9488000000	WILLIAM O CARTER, TRUSTEE	HONEY CRK	IRRG	6	2		OUT OF A 80 ACRE TRACT
1949-000	6	Kerr	9488000000	WILLIAM O CARTER, TRUSTEE	HONEY CRK	IRRG	27	9		

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
1950-000	6	Kerr	9487000000	JOHN H DUNCAN	HONEY CRK	IRRG	6	20	13	ALSO USE 7
1953-000	6	Kerr	9476000000	LAURA B LEWIS ET VIR	N FRK GUADALUPE RIVER	IRRG	40	24		
1956-000	6	Kerr	9897000000	RIVER INN ASSOC OF UNIT OWNERS	S FRK GUADALUPE RIVER	REC			50	
1956-000	6	Kerr	9897000000	RIVER INN ASSOC OF UNIT OWNERS	S FRK GUADALUPE RIVER	MUNI	10			AMEND 4/19/84, 1/4/85
1957-000	6	Kerr	9880000000	BILLIE R VALICEK	S FRK GUADALUPE RIVER	REC			10	
1958-000	6	Kerr	9780000000	T J MOORE ESTATE	CYPRESS CRK	IRRG	20	10	100	
1961-000	6	Kerr	9670000000	LAVERNE CRIDER MOORE ET VIR	S FRK GUADALUPE RIVER	MUNI	3			
1961-000	6	Kerr	9670000000	LAVERNE CRIDER MOORE ET VIR	S FRK GUADALUPE RIVER	IRRG	1	3		
1963-000	6	Kerr	9620000000	LAWRENCE L GRAHAM ET AL	S FRK GUADALUPE RIVER	IRRG	2	12	21	AMEND 9/10/85
1963-000	6	Kerr	9620000000	LAWRENCE L GRAHAM ET AL	S FRK GUADALUPE RIVER	REC			16	AMENDS 5/26/83 CHG PUR USE & ADD RES
1964-000	6	Kerr	9400000000	VIRGINIA MOORE JOHNSTON	TEGENER	IRRG	10	10	12	
1967-000	6	Kerr	9305000000	SARAH HICKS BUSS	UNNAMED TRIB	REC	20			ALSO USE 1, AMEND 3/19/91
1968-000	6	Kerr	9261000000	LOUIS DOMINGUES	GUADALUPE RIVER	IRRG	10	20		
1969-000	6	Kerr	9260000000	TOMMIE SMITH BLACKBURN	GUADALUPE RIVER	INDU	15		15	USE 2: MILLING
1969-000	6	Kerr	9260000000	TOMMIE SMITH BLACKBURN	KELLY CRK	IRRG	49	80		USE 3 - DIVERTING FROM KELLY CREEK
1969-000	6	Kerr	9260000000	TOMMIE SMITH BLACKBURN	GUADALUPE RIVER	IRRG	59			USE 3 - DIVERTING FROM GUADALUPE RIVER
1969-000	6	Kerr	9260000000	TOMMIE SMITH BLACKBURN	GUADALUPE RIVER	HYDRO				USE 5; NONCONSUMPTIVE
1970-000	6	Kerr	9220000000	CARL HAWKINS	GUADALUPE RIVER	MUNI	10			
1970-000	6	Kerr	9220000000	CARL HAWKINS	GUADALUPE RIVER	IRRG	32	25		
1971-000	6	Kerr	9140000000	COUNTY OF KERR	GUADALUPE RIVER	REC			450	
1972-000	6	Kerr	9110000000	WESLEY ELLEBRACHT	WELSH BR	IRRG	0.8	0.8		
1972-000	6	Kerr	9110000000	WELCH CREEK PARTNERS LTD	WELSH BR	IRRG	5.15	5.15		
1972-000	6	Kerr	9110000000	ARANSAS BAY COMPANY	WELSH BR	IRRG	0.05	0.05		
1973-000	6	Kerr	9100000000	SHELTON RANCHES INC	SMITHS BR	IRRG	10	10	6	
1974-000	6	Kerr	9050000000	SHELTON RANCHES INC	SMITHS BR	IRRG	70	35	15	ALSO JOHNSON CREEK
1975-000	6	Kerr	9025000000	TEXAS PARKS & WILDLIFE DEPT	FESSENDEN BR	INDU	400			FISH HATCHERY & GAME PRESERVE
1975-000	6	Kerr	9025000000	TEXAS PARKS & WILDLIFE DEPT	FESSENDEN BR	INDU	5780		72	2 IMP & A POND; USES 3, 1 & 7; EXP 2012
1976-000	6	Kerr	8950000000	F P ZOCH III TRUST & ZEE RANCH	FESSENDEN BR	IRRG	29	14		
1976-000	6	Kerr	8950000000	F P ZOCH III TRUST & ZEE RANCH	FESSENDEN BR	REC			184	

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
1977-000	6	Kerr	8839000000	TEXAS CATHOLIC BOYS' HOME	JOHNSON CRK	IRRG	23	23	23	OUT OF A 111.9 ACRE TRACT
1978-000	6	Kerr	8815000000	A J RUST	JOHNSON CRK	IRRG	33	65		
1979-000	6	Kerr	8808000000	KEITH S MEADOW	BYAS CRK	IRRG	18	6		
1980-000	6	Kerr	8805000000	A L MOORE	JOHNSON CRK	IRRG	12	6		
1981-000	6	Kerr	8800000000	JACK D CLARK JR ET AL	JOHNSON CRK	IRRG	32	16		
1981-000	6	Kerr	8800000000	JACK D CLARK JR ET AL	JOHNSON CRK	IRRG	143	76		
1982-000	6	Kerr	8775000000	LOLA DEAN SMITH	JOHNSON CRK	IRRG	133	50	12	
1983-000	6	Kerr	8770000000	N V MAMIMAR	JOHNSON CRK	IRRG	32	17		
1983-000	6	Kerr	8770000000	N V MAMIMAR	JOHNSON CRK	IRRG	67	35		
1983-000	6	Kerr	8770000000	DAVID J COPELAND ET UX	JOHNSON CRK	IRRG				
1983-000	6	Kerr	8770000000	DAVID J COPELAND ET UX	JOHNSON CRK	IRRG				JOINTLY OWN 32 & 67 AF TO IRR 17 & 35 AC JOINTLY OWN 32 & 67 AF TO IRR 17 & 35 AC JOINTLY OWN 32 & 67 AF TO IRR 17 & 35 AC JOINTLY OWN 32 & 67 AF TO IRR 17 & 35 AC ALSO GILLESPIE CO
1984-000	6	Kerr	8750000000	MICHAEL E & GAIL SEARS	JOHNSON CRK	IRRG	1	2		
1985-000	6	Kerr	8746000000	ROBERT B O'CONNOR JR ET UX	JOHNSON CRK	IRRG	80	31		
1987-000	6	Kerr	8744000000	REGINALD E WARREN JR	JOHNSON CRK	IRRG	90	30		
1988-000	6	Kerr	8720000000	JIMMIE L QUERNER SR ESTATE	FALL BR	IRRG	128	64		
1990-000	6	Kerr	8650000000	DOROTHY L JENKINS ET AL	JOHNSON CRK	IRRG	3	1		
1991-000	6	Kerr	8615001000	LAZY HILLS GUEST RANCH INC	HENDERSON BR	IRRG	21	28		
1992-000	6	Kerr	8600000000	MARK A RYLANDER ET AL	JOHNSON CRK	IRRG	23	15		
1993-000	6	Kerr	8550000000	ROY LITTLEFIELD	JOHNSON CRK	IRRG	50	50	4	
1994-000	6	Kerr	8500000000	M H & MARY FRANCES	GUADALUPE RIVER	IRRG	5	4		
1995-000	6	Kerr	8451000000	MONTGOMERY HENRY GRIFFIN CONSTRUCTION CO	GOAT CRK	IRRG	11	11	6	AMEND 3/19/91, 4/10/98: DIV PT #4.SC. AMEND 3/19/91, 4/10/98: DIV PT #4.SC.
1996-000	6	Kerr	8287000000	KERRVILLE, CITY OF	GUADALUPE RIVER	MUNI	150			
1996-000	6	Kerr	8287000000	KERRVILLE, CITY OF	GUADALUPE RIVER	IRRG	75	44	75	
1997-000	6	Kerr	8310000000	DARRELL G LOCHTE ET AL	GUADALUPE RIVER	MINE	143			
1997-000	6	Kerr	8310000000	DARRELL G LOCHTE ET AL	GUADALUPE RIVER	INDU	2			
1998-000	6	Kerr	8295000000	C W SUNDAY	TOWN CRK	IRRG	22.3	22.3	10	
1998-000	6	Kerr	8295000000	JOSE A LOPEZ ET UX	TOWN CRK	IRRG	4.18	4.18		
1999-000	6	Kerr	8297000000	KERRVILLE STATE HOSPITAL	UNNAMED TRIB	REC	44		44	
					GUADALUPE RIVER					

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
2000-000	6	Kerr	8260010000	RIVERHILL COUNTRY CLUB INC	GUADALUPE RIVER	IRRG	350	160	70	8/31/87
2001-000	6	Kerr	8255000000	CARL D. MEEK	GUADALUPE RIVER	IRRG	295	194		AMEND 4/9/92,5/12/95.DIFF PRIORITY DATES
2002-000	6	Kerr	8230000000	COMANCHE TRACE RANCH & GOLF CL	GUADALUPE RIVER	IRRG	136	99		
2003-000	6	Kerr	8250000000	WHEATCRAFT, INC.	GUADALUPE RIVER	IRRG	42	21		
2003-000	6	Kerr	8250000000	SHELTON RANCH CORPORATION	GUADALUPE RIVER	MINE	10			
2004-000	6	Kerr	8200000000	COUNTY OF KERR	GUADALUPE RIVER	REC			720	ALSO USE 8
2005-000	6	Kerr	8185500000	HARRIET BOCKHOFF ESTATE	GUADALUPE RIVER	IRRG	59	98		
2006-000	6	Kerr	8174000000	FARM CREDIT BANK OF TEXAS	GUADALUPE RIVER	IRRG	179.06	512.55		AMEND 2/3/88,6/18/90. MAX COMB. CFS:4.0
2006-000	6	Kerr	8174000000	FARM CREDIT BANK OF TEXAS	GUADALUPE RIVER	IRRG	83.94			AMEND 2/3/88, 6/18/90
2006-000	6	Kerr	8174000000	1967 SHELTON TRUSTS PART ET AL	GUADALUPE RIVER	IRRG	106.9	78.55		AMEND 2/3/88, 6/18/90
2006-000	6	Kerr	8174000000	1967 SHELTON TRUSTS PART ET AL	GUADALUPE RIVER	IRRG	50.1			AMEND 2/3/88, 6/18/90
2006-000	6	Kerr	8174000000	KENNETH W WHITEWOOD ET UX	GUADALUPE RIVER	IRRG	34.04			AMEND 2/3/88, 6/18/90, 11/22/96
2006-000	6	Kerr	8174000000	KENNETH W WHITEWOOD ET UX	GUADALUPE RIVER	IRRG	15.96			AMEND 2/3/88, 6/18/90, 11/22/96
2006-000	6	Kerr	8174000000	KENNETH W WHITEWOOD ET UX	GUADALUPE RIVER	IRRG	100	76		AMEND 2/3/88, 6/18/90, 11/22/96
2007-000	6	Kerr	8160000000	RAY ELLISON JR	SPRING CRK	IRRG	31	31	50	
2008-000	6	Kerr	8156160000	LUTHERAN CAMP CHRYSALIS	TURTLE CRK	MUNI	11		12	
2009-000	6	Kerr	8155750000	FRANCIS C & WILLADEAN BOLEN	BUSHWACK CRK	IRRG	5	5	5	
2010-000	6	Kerr	8155700000	G ROBERT SWANTNER JR ET UX	BUSHWACK CRK	IRRG	7	5	5	OUT OF 68.8 ACRE TRACT
2011-000	6	Kerr	8155000000	H J GRUY	TURTLE CRK	IRRG	80	50	10	
2012-000	6	Kerr	8154501000	SANDRA BLAIR	TURTLE CRK	IRRG	1	1	5	
2013-000	6	Kerr	8154500000	FELIX R & LILLIAN STEILER REAL	WEST CRK	IRRG	11	12		
2014-000	6	Kerr	8152000000	LEAH MARTHA STEPHENS	TURTLE CRK	IRRG	6.36	5.63		
2014-000	6	Kerr	8152000000	BENNO OOSTERMAN ET UX	TURTLE CRK	IRRG	6.36	5.63		
2014-000	6	Kerr	8152000000	JOHN M LEBOLT TRUSTEE	TURTLE CRK	IRRG	9.02	7.98		
2015-000	6	Kerr	8151000000	JAMES E NUGENT	GUADALUPE RIVER	IRRG	27	21		
2016-000	6	Kerr	8150500000	DORIS J HODGES	GUADALUPE RIVER	IRRG	8	8		
2017-000	6	Kerr	8050000000	COUNTY OF KERR	GUADALUPE RIVER	REC			87	ALSO USE 8
2018-000	6	Kerr	8049000000	LEE ANTHONY MOSTY	GUADALUPE RIVER	IRRG	154	94		
2020-000	6	Kerr	7970000000	ROBERT LEE MOSTY	GUADALUPE RIVER	IRRG	60	30		

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
2021-000	6	Kerr	7940000000	RAYMOND F MOSTY ET AL	GUADALUPE RIVER	IRRG	103	45	5	JOINTLY OWNS 155 AF TO IRR 80 ACRES
2022-000	6	Kerr	7950000000	ROBERT LEE MOSTY	GUADALUPE RIVER	IRRG	17	119	20	
2023-000	6	Kerr	7935000000	ROY A GREEN	GUADALUPE RIVER	IRRG	7	3		
2024-000	6	Kerr	7924990000	CARL E RHODES	GUADALUPE RIVER	IRRG	114	125		
2025-000	6	Kerr	7925000000	HARRY J WRAY	GUADALUPE RIVER	IRRG	155	80		
2025-000	6	Kerr	7925000000	DAVID B WRAY	GUADALUPE RIVER	IRRG				
2025-000	6	Kerr	7925000000	BYNO SALSMAN ET UX	GUADALUPE RIVER	IRRG				
2026-000	6	Kerr	7920000000	ELGIN JUNG	GUADALUPE RIVER	IRRG	3.309	2.118		
2026-000	6	Kerr	7920000000	ZANE H ROBINSON ET UX	GUADALUPE RIVER	IRRG	53.945	34.52		
2026-000	6	Kerr	7920000000	RONNIE W SCHLOTTMAN ET UX	GUADALUPE RIVER	IRRG	17.83	11.41		
2026-000	6	Kerr	7920000000	KENNETH W WHITEWOOD ET UX	GUADALUPE RIVER	IRRG	149.916	44.72		AMENDED 11/22/96
2029-000	6	Kerr	7710000000	ROLAND WALTERS	PRISON CANYON	IRRG	25	200	420	& CO 010, 10/5/82 ADD DIV PT
2030-000	6	Kerr	7704000000	JAMES S ERNST	UNNAMED TRIB VERDE CRK	IRRG	247		120	
2030-000	6	Kerr	7704000000	PETE R SMITH	UNNAMED TRIB VERDE CRK	IRRG	19			AMEND 11/4/85
2031-000	6	Kerr	7701000000	JOSEPH PAUL MILLER ET UX	GUADALUPE RIVER	IRRG	115	80		
2032-000	6	Kerr	7700700000	DAVID M LEIBOWITZ ET UX	GUADALUPE RIVER	IRRG	10	6		
2033-000	6	Kerr	7699900000	JAVIER G REYES ET UX	GUADALUPE RIVER	IRRG	90	90		
2034-000	6	Kerr	7699500000	CHESTER P HEINEN ET AL	GUADALUPE RIVER	IRRG	2	6		
2037-000	6	Kerr	7652500000	GENE ARTHUR ALLERKAMP	CYPRESS CRK	IRRG	5	6.33		
2037-000	6	Kerr	7652500000	JANICE CHARLOTTE BULLARD	CYPRESS CRK	IRRG	5	6.34		
2037-000	6	Kerr	7652500000	ROMAN LUNA ET UX	CYPRESS CRK	IRRG	10	12.67		
2037-000	6	Kerr	7652500000	CURTIS BERNARD ALLERKAMP	CYPRESS CRK	IRRG	5	6.33		
2037-000	6	Kerr	7652500000	WERNER WAYNE ALLERKAMP	CYPRESS CRK	IRRG	5	6.33		
2038-000	6	Kerr	7652000000	HARRY E REEH	CYPRESS CRK	IRRG	15	15		AMEND 2/1/85
2039-000	6	Kerr	7650500000	FRED SAUR	CYPRESS CRK	IRRG	7	7		
2040-000	6	Kerr	7650000000	A C & DOROTHY PFEIFFER	CYPRESS CRK	IRRG	10	5		
2041-000	6	Kerr	7645000000	THOMAS L BRUNDAGE ET AL	CYPRESS CRK	IRRG	134	57		
2042-000	6	Kerr	7644800000	E J & VIRGINIA DOWER	CYPRESS CRK	IRRG	209	125		
2043-000	6	Kerr	7644600000	MARY LEE EDWARDS	CYPRESS CRK	IRRG	19.57	14.68		
2043-000	6	Kerr	7644600000	EDGAR SEIDENSTICKER ET UX	CYPRESS CRK	IRRG	16.85	12.63		

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
2043-000	6	Kerr	7644600000	L J MANNERING ET UX	CYPRESS CRK	IRRG	3.58	2.69		
2437-000	6	Kerr	9550000000	CHLOE CULLUM KEARNEY ET AL	N FRK GUADALUPE RIVER	REC			100	D&L. RESERVOIR JOINTLY OWNED BY SEVERAL.
2437-000	6	Kerr	9550000000	DAN W BACON ET UX	N FRK GUADALUPE RIVER	REC				D&L. RESERVOIR JOINTLY OWNED BY SEVERAL.
2438-000	6	Kerr	9528000000	LUTZ ISSLIEB ET AL	N FRK GUADALUPE RIVER	IRRG	30	18	30	
2439-000	6	Kerr	9510000000	DALE B AND MARSHA G ELMORE	N FRK GUADALUPE RIVER	IRRG	8	8	20	AMEND 10/29/90
2440-000	6	Kerr	9507000000	L F SCHERER	N FRK GUADALUPE RIVER	IRRG	1	1		
2441-000	6	Kerr	9490000000	SILAS B RAGSDALE	N FRK GUADALUPE RIVER	IRRG	21	105		
2442-000	6	Kerr	9486000000	LUTHER GRAHAM	HONEY CRK	IRRG	28	14	17	
2443-000	6	Kerr	9476500000	JOHN H DUNCAN	HONEY CRK	IRRG	40	20	25	
2444-000	6	Kerr	9980000000	BRUCE F. HARRISON	S FRK GUADALUPE RIVER	IRRG	6	3	10	
2444-000	6	Kerr	9980000000	BRUCE F. HARRISON	S FRK GUADALUPE RIVER	REC			17	
2445-000	6	Kerr	9680000000	CAMP MYSTIC INC	CYPRESS CRK	IRRG	12	15		
2445-000	6	Kerr	9680000000	CAMP MYSTIC INC	CYPRESS CRK	MUNI	14		20	
2446-000	6	Kerr	9675000000	BOB/KAT INC	S FRK GUADALUPE RIVER	IRRG	10	10		
2446-000	6	Kerr	9675000000	BOB/KAT INC	S FRK GUADALUPE RIVER	MUNI	10			
2447-000	6	Kerr	9625000000	CAMP LA JUNTA INC	S FRK GUADALUPE RIVER	IRRG	26	15	30	
2447-000	6	Kerr	9625000000	CAMP LA JUNTA INC	S FRK GUADALUPE RIVER	MUNI	14			& RECREATION
2448-000	6	Kerr	9350000000	ALICE CYNTHIA SIMKINS	TEGENER CRK	IRRG	6	5		
2449-000	6	Kerr	9310000000	BILLIE ZUBER ET AL	GUADALUPE RIVER	IRRG	17	25.5		AMEND 9/24/93:ADD ACREAGE.JUNIOR PRIORTY
2450-000	6	Kerr	7999000000	ROBERT L MOSTY ET AL	GUADALUPE RIVER	IRRG	158	117		
3769-000	1	Kerr	8300010000	CITY OF KERRVILLE	GUADALUPE RIVER	MUNI	3603		840	
3769-000	1	Kerr	8300010000	CITY OF KERRVILLE	GUADALUPE RIVER	IRRG		192		USING 2450 AF WASTEWATER FROM SEWAGE.SC
3846-000	1	Kerr	7715000000	T & R PROPERTIES	PALMER CRK	REC	322		322	
3896-000	1	Kerr	8276000000	KENNETH W & MARCIA C MULFORD	RATTLESNAKE	MUNI			13	3 TRACTS 34.55 AC, ALSO REC
3904-000	1	Kerr	8275500000	CITY OF KERRVILLE	QUINLAN CRK	IRRG	80	56	10	& REC-2 RES-146-AC TR-EXPIRES 20 YEARS
4007-000	1	Kerr	7703100000	PECAN VALLEY RANCH OWNERS ASSO	ELM CRK	REC			157	ALSO DOMESTIC & LIVESTOCK
4034-000	1	Kerr	9040000000	SHELTON RANCHES INC	JOHNSON CRK	REC			122	2 RES, SEE FILE, & ADJ 1974
4223-000	1	Kerr	9105000000	SHELTON RANCHES INC	JOHNSON CRK	IRRG	20	14	39	

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
4298-000	1	Kerr	8294800000	ALISON B MENCAROW LIVING TRUST	TOWN CRK	IRRG	12	18		AMEND 12/10/91
4486-000	1	Kerr	7644900000	JAY & HILDA POTH	CYPRESS CRK	IRRG	70	35		RATE SEE 18-2041
5060-000	1	Kerr	8710000000	HORACE COFER ASSOCIATES, INC	FALL BR CRK	IRRG	10	12		
5122-000	1	Kerr	8150800000	JAMES C STORM	GUADALUPE RIVER	IRRG	75	50	8	
5315-000	1	Kerr	8294000000	DANA G KIRK TRUSTEE	E TOWN CRK	OTHER				PRIVATE WATER
5322-000	1	Kerr	8705000000	E RAND SOUTHARD ET UX	FALL BR	REC				
5331-000	1	Kerr	9660000000	KATHLEEN B FLOURNOY, ET AL	S FRK GUADALUPE RIVER	MUNI	15		30	& RECREATION
5331-000	1	Kerr	9660000000	KATHLEEN B FLOURNOY, ET AL	S FRK GUADALUPE RIVER	IRRG	96	30		
5348-000	1	Kerr	9526000000	BRYON DONZIS	N FRK GUADALUPE RIVER	IRRG	5	4		
5352-000	1	Kerr	9650000000	BONITA OWNERS ASSOC INC	S FRK GUADALUPE RIVER	IRRG	2	2		
5394-000	1	Kerr	8300010000	UPPER GUADALUPE RIVER AUTH	GUADALUPE RIVER	MUNI	1661			FIRM YIELD BASIS. AMENDED 4/10/98.
5394-000	1	Kerr	8300010000	UPPER GUADALUPE RIVER AUTH	GUADALUPE RIVER	MUNI	339			SCS. FIRM YIELD BASIS. AMENDED 4/10/98.
5394-000	1	Kerr	8300010000	CITY OF KERRVILLE	GUADALUPE RIVER	MUNI	761			SCS. FIRM YIELD BASIS. AMENDED 4/10/98.
5394-000	1	Kerr	8300010000	CITY OF KERRVILLE	GUADALUPE RIVER	MUNI	339			SCS. RUN OF RIVER BASIS. AMENDED
5394-000	1	Kerr	8300010000	CITY OF KERRVILLE	GUADALUPE RIVER	MUNI	1069			4/10/98.SCS RUN OF RIVER BASIS. AMENDED
5402-000	1	Kerr	8155300000	TURTLE CREEK INDUSTRIES INC	TURTLE CRK	REC				4/10/98.SCS
5444-000	1	Kerr	8490000000	EUGENE D ELLIS ET UX	GUADALUPE RIVER	IRRG	10	25.5		
5479-000	1	Kerr	7701250000	CITY SOUTH MANAGEMENT CORP	GUADALUPE RIVER	IRRG	566	283		AMENDED 3/13/98
5495-000	1	Kerr	9800000000	LOIS & JOSEPH WESSENDORF ET AL	S FRK GUADALUPE RIVER	REC			9	
5521-000	1	Kerr	8300050000	DON D WILSON	GUADALUPE LAKE	IRRG	30	30		GUADALUPE RIVER
5531-000	1	Kerr	8185700000	LEE ROY COSPER ET UX	GUADALUPE RIVER	IRRG	80	40		
5536-000	1	Kerr	7701350000	ROBERT H & CHARLOTTE JENNINGS	GUADALUPE RIVER	IRRG	400	200		
5541-000	1	Kerr	9476150000	BASHARDT LTD	N FRK GUADALUPE RIVER	IRRG	14	15		
5641-000	1	Kerr		MARLIN R MARCUM		IRRG	1	2		SUBJECT TO MAINT OF CONTRACT &
5737-000	1	Kerr		SYLVIA SIEKER		IRRG	1			AGREEMENT
12246-000	1	Kerr		ELIZABETH CARTER		REC			6.84	
2671-000	6	Kinney	4950000000	MAVERICK CO WCID 1	RIO GRANDE	IRRG	134900	45000		& CO 162, AMEND 8/22/86,9/22/88,10/30/98
2671-000	6	Kinney	4950000000	MAVERICK CO WCID 1	RIO GRANDE	MUNI	2049			AMEND 8/22/86,9/22/88,10/30/98

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
2671-000	6	Kinney	4950000000	MAVERICK CO WCID 1	RIO GRANDE	REC	196			AMEND 8/22/86,9/22/88,10/30/98
2671-000	6	Kinney	4950000000	MAVERICK CO WCID 1	RIO GRANDE	HYDRO	1085966			AMEND 8/22/86,9/22/88,10/30/98
2673-000	6	Kinney	4950000000	LENDELL MARTIN ET UX	MUD CRK	IRRG	52	35	16	
2674-000	6	Kinney	4950000000	CLYDE M BRADLEY	MUD CRK	IRRG	20	15		RATE SEE 23-2673
2675-000	6	Kinney	4950000000	SHERWOOD GAINES TRUSTEE	MUD CRK	IRRG	60	30		RATE SEE 23-2673
2676-000	6	Kinney	4950000000	JEWEL FOREMAN ROBINSON	PINTO CRK	IRRG	252	126		
2678-000	6	Kinney	4950000000	JOHNNY E RUTHERFORD	PINTO CRK	IRRG	135	90		
2679-000	6	Kinney	4950000000	CITY OF BRACKETTVILLE	LAS MORAS SPRING	MUNI	3			
2680-000	6	Kinney	4950000000	ELISE AULGUR HUNTSMAN ET AL	LAS MORAS CRK	IRRG	15	15		JOINT OWNER OF 15 AF TO IRR 15 ACRES
2680-000	6	Kinney	4950000000	ANN A LEGG & ERNESTINE A LOPEZ	LAS MORAS CRK	IRRG				JOINT OWNER OF 15 AF TO IRR 15 ACRES
2681-000	6	Kinney	4950000000	EARL H NOBLES	LAS MORAS CRK	IRRG	10	10		
2682-000	6	Kinney	4950000000	BERNARD C MEISCHEN ET AL	LAS MORAS CRK	IRRG	25	25		
2682-000	6	Kinney	4950000000	CHARLES W GAEBLER ET AL	LAS MORAS CRK	IRRG	75	75		+50 AF FROM 7 RES FOR STOCK RAISING
2683-000	6	Kinney	4950000000	ANDREW P MALINOVSKY JR	LAS MORAS CRK	IRRG	60	30		
2684-000	6	Kinney	4950000000	BEN S JONES	ELM CRK	IRRG	47	26	6	
2686-000	6	Kinney	4950000000	ROBERT H MEISCHEN, ET AL	LAS MORAS CRK	IRRG	300	300		
2686-000	6	Kinney	4950000000	ROBERT H MEISCHEN, ET AL	LAS MORAS CRK	MUNI	50			4 RESERVOIRS
2687-000	6	Kinney	4950000000	CELIA R DE PLAZA, ET AL	LAS MORAS CRK	IRRG	110	55		
2913-000	6	Kinney	4950000000	MOODY RANCHES INC	RIO GRANDE	IRRG	5500	3000	17	
2913-000	6	Kinney	4950000000	MOODY RANCHES INC	RIO GRANDE	IRRG	500	250		
3071-000	6	Kinney	7023010000	LLOYD L DAVIS	W NUECES RIVER	OTHER			25	IMPOUNDMENT
4365-000	1	Kinney	7028000000	ROBERT L MOODY JR	SPRING BR	REC	10		42	4 RES
4389-000	1	Kinney	4950000000	FORT CLARK SPRINGS ASSOC INC	LAS MORAS CRK	REC				
4517-000	1	Kinney	4950000000	FORT CLARK SPRINGS ASSOC INC	LAS MORAS CRK	REC			3	
1610-000	9	Medina	5700000000	L KEN EVANS	MEDINA RIVER	IRRG	20			LAKE MEDINA, EXP 2016
3016-000	6	Real	9615000000	JOHN H WATTS III ET UX	E PRONG NUECES RIVER	IRRG	4	2		SC. TWO PRIORITY DATES. AMEND 7/10/98
3016-000	6	Real	9615000000	JOHN H WATTS III ET UX	E PRONG NUECES RIVER	IRRG	54	27		SC. TWO PRIORITY DATES. AMEND 7/10/98
3018-000	6	Real	9450000000	LEWIS CLECKLER ET UX	SPRING CRK	IRRG	22.7	12.1		BULLHEAD HOLLOW
3018-000	6	Real	9450000000	EL CAMINO GIRL SCOUT COUNCIL	SPRING CRK	IRRG	7.3	3.9		BULLHEAD HOLLOW
3019-000	6	Real	9410000000	SARAH M DAVIS	BULLHEAD CRK	IRRG	80	40		

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
3019-000	6	Real	9410000000	SARAH M DAVIS	BULLHEAD CRK	IRRG		13		
3020-000	6	Real	9320000000	H C MCCARTY JR ET UX	BULLHEAD CRK	IRRG	34.736	17.368		
3020-000	6	Real	9320000000	F WALTER CONRAD JR ET UX	BULLHEAD CRK	IRRG	85.264	42.632		
3021-000	6	Real	9198500000	DSD, INC	BULLHEAD CRK	IRRG	418	210		
3022-000	6	Real	9190000000	MARVIN L BERRY	UNNAMED TRIB NUECES RIVER	IRRG	259	300	14	TRIB OF NUECES RIVER
3022-000	6	Real	9190000000	MARVIN L BERRY	UNNAMED TRIB NUECES RIVER	IRRG	485			
3025-000	6	Real	9150000000	WILLIAM C & WANDA LEA LANE	DRY CRK	IRRG	40	20	1	
3026-000	6	Real	9075000000	JOHN A DANIEL ET UX	DRY CRK	IRRG	16	8	90	
3027-000	6	Real	9050000000	J F ALSOP	DRY CRK	IRRG	20	10		
3028-000	6	Real	9040000000	CLARENCE W HARRISON ET UX	DRY CRK	IRRG	15.43	7.72	43	
3028-000	6	Real	9040000000	CLARENCE W HARRISON ET UX	DRY CRK	REC			4	
3028-000	6	Real	9040000000	W THOMAS TAYLOR ET UX	DRY CRK	IRRG	4.36	2.18		
3029-000	6	Real	9008000000	HENRY D ENGELKING	NUECES RIVER	IRRG	43	52		
3034-000	6	Real	9004000000	HERBERT C JEFFRIES ET UX	NUECES RIVER	IRRG		2		SEE ADJ 3030
3036-000	6	Real	9000000000	SALVADOR ORTIZ ET AL	NUECES RIVER	IRRG	125	50		
3037-000	6	Real	8950000000	DAVID WELDON TINDLE	NUECES RIVER	IRRG	25	25		
3050-000	6	Real	8000000000	W A MALEY	E CAMP WOOD CRK	IRRG	28	14		
3051-000	6	Real	7980000000	ROBERT J LLOYD ET UX	E CAMP WOOD CRK	IRRG	1.42	1.42		
3051-000	6	Real	7980000000	WANNA LOU LLOYD	E CAMP WOOD CRK	IRRG	4.08	4.08		
3052-000	6	Real	7970000000	BARRY BLANKS MCHALEK ET UX	E CAMP WOOD CRK	IRRG	5	5		SEE ADJ 3051
3053-000	6	Real	7960000000	BARRY BLANKS MCHALEK ET UX	E CAMP WOOD CRK	IRRG	1	1		SEE ADJ 3051
3054-000	6	Real	7950000000	JOHN CHAMBERS ET AL	E CAMP WOOD CRK	IRRG	10	10		SEE ADJ 3051
3055-000	6	Real	7900000000	WILLIAM C & PATRICIA K SUTTON	E CAMP WOOD CRK	IRRG	105	130	2	
3056-000	6	Real	7810000000	ROY GIBBENS	E CAMP WOOD CRK	IRRG	18	9	4	
3056-000	6	Real	7810000000	ROY GIBBENS	E CAMP WOOD CRK	IRRG	2			
3057-000	6	Real	7800000000	MAGELEE V SWIFT	E CAMP WOOD CRK	IRRG	21	16	8	SEE ADJ 3056
3057-000	6	Real	7800000000	MAGELEE V SWIFT	E CAMP WOOD CRK	IRRG	10	4	4	
3058-000	6	Real	7740000000	DOROTHY MERRITT ANDERSON	NUECES RIVER	IRRG	8	8		
3059-000	6	Real	7730000000	F L JR & CHARLOTTE HATLEY	NUECES RIVER	IRRG	11	7		

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
3060-000	6	Real	7631000000	E E GILDART	NUECES RIVER	IRRG	42	21		
3060-000	6	Real	7631000000	E E GILDART	NUECES RIVER	IRRG	54	26		
3060-000	6	Real	7631000000	E E GILDART	NUECES RIVER	IRRG	35	46		
3061-000	6	Real	7630000000	E E GILDART	NUECES RIVER	IRRG	31	31		
3062-000	6	Real	7550000000	JOANNE FRIEND	NUECES RIVER	IRRG	46	46		
3145-000	6	Real	3900000000	GEORGE S HAWN INTERESTS ET AL	S P/L P W FRIO RIVER	REC			27	
3145-000	6	Real	3900000000	GEORGE S HAWN INTERESTS ET AL	S P/L P W FRIO RIVER	REC			68	
3145-000	6	Real	3900000000	GEORGE S HAWN INTERESTS ET AL	S P/L P W FRIO RIVER	IRRG	156	78		
3146-000	6	Real	3850000000	JAMES W HALE ET AL	W FRIO RIVER	REC			16	
3147-000	6	Real	3810000000	DIAMOND J RANCH INC	W FRIO RIVER	IRRG	165	55		
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	REC	3.5		10	
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	IRRG	6.5	2		UPPER SINGING HILLS RESERVOIR
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	REC	11		11	UNNAMED DOWNSTREAM RESERVOIR (D-0340)
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	IRRG	34.8	12.9		UNNAMED RESERVOIR (D-0340)
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	IRRG	6.7	2.5		UNNAMED RESERVOIR (D-0340)
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	REC	25.08		25.08	LINNET'S WINGS DAM (D-0220);AMEND 3/91
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	IRRG	3.2	1.2		LINNET'S WINGS DAM (D-0220)
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	REC	34		68.7	LAITY LODGE DAM (D-0240):AF/WATERFALL
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	IRRG	4	2		LAITY LODGE DAM (D-0240)
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	REC	5.51		5.51	LOWER SINGING HILLS DAM (D-0280)
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	IRRG	4.1	1.5		LOWER SINGING HILLS DAM (D-0280)
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	REC	2.64		2.64	SILVER CREEK DAM (D-0300)
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	REC	0.24		0.24	LOWER SILVER CREEK DAM (D-0320)
3148-000	6	Real	3750000000	H. E. BUTT FOUNDATION	E FRIO RIVER	REC	17.86		17.86	ECHO VALLEY DAM (D-0360)
3149-000	6	Real	3660000000	ORA L ROGERS ESTATE	E FRIO RIVER	IRRG	30	28		
3150-000	6	Real	3655000000	R F BINDOCK	E FRIO RIVER	IRRG	3	11		
3151-000	6	Real	3620000000	KATHERINE MAXINE MORELAND	E FRIO RIVER	IRRG	67	30		
3152-000	6	Real	3600000000	DAN AULD, JR	E FRIO RIVER	IRRG	324	162		

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
3153-000	6	Real	3490000000	JOHN J BURDITT, ET AL	UNNAMED TRIB E FRIO RIVER	IRRG	15	50		
3153-000	6	Real	3490000000	JOHN J BURDITT, ET AL	UNNAMED TRIB E FRIO RIVER	IRRG	23			
3154-000	6	Real	3430000000	JAMES TREES	YOUNGBLOOD SPRING	IRRG	2	6		
3155-000	6	Real	3420000000	LOTTIE N WRIGHT	FRIO RIVER	IRRG	164	43		
3156-000	6	Real	3400000000	H P COOPER ET AL	FRIO RIVER	IRRG	20	22		
3156-000	6	Real	3400000000	H P COOPER ET AL	FRIO RIVER	IRRG	2			
3157-000	6	Real	3350000000	E F BAYOUTH, MD PENSION PLAN	FRIO RIVER	IRRG	250	125		
3158-000	6	Real	3375000000	LOMBARDY IRRIGATION CO	FRIO RIVER	IRRG	1600	800	6	AMEND 1/9/85. CURRENT OWNER UNKNOWN 5/98 ALSO COUNTY 232
3159-000	6	Real	3294000000	SAM G HARRISON	FRIO RIVER	IRRG	140	70		
3160-000	6	Real	3290000000	GRACIA BASSETT HABY	FRIO RIVER	IRRG	60	100		JOINTLY OWNS 60 AF TO IRR 100 ACRES
3160-000	6	Real	3290000000	THEODORE R REED TRUSTEE	FRIO RIVER	IRRG				JOINTLY OWNS 60 AF TO IRR 100 ACRES
3161-000	6	Real	3289500000	R L HUBBARD	DRY FRIO CRK	IRRG	17	21		
3162-000	6	Real	3287500000	CARL A. DETERING, JR., ET AL	UNNAMED TRIB BUFFALO CRK	IRRG	5	25	15	
3180-000	6	Real	2799000000	LANA J STORMONT	UNNAMED TRIB W SABINAL RIVER	IRRG	5	10		
3878-000	1	Real	3645000000	C B SLABAUGH	CYPRESS CRK	IRRG	40	30		68-AC TR, SC, AMEND 11/12/84
3978-000	1	Real	9421000000	N M FITZGERALD JR ESTATE	FLYNN CRK	IRRG	187	63		156.95-AC TR, SC
4008-000	1	Real	9172500000	DOUGLAS B & MARGARET MARSHALL	NUECES RIVER	IRRG	400	200		AMEND 12/15/81 INCR AC-FT, ACRES, CFS
4094-000	1	Real	3905500000	GEORGE S HAWN INTERESTS ET AL	W FRIO RIVER	IRRG	56	28	9	OUT OF 1118 ACRES
4169-000	1	Real	7910000000	ROARING SPRINGS RANCH INC	CAMP WOOD CRK	IRRG	15	10	41	6 RES & REC
4169-000	1	Real	7910000000	ROARING SPRINGS RANCH INC	CAMP WOOD CRK	MUNI	15			
4405-000	1	Real	7760000000	CITY OF CAMP WOOD	UNNAMED TRIB NUECES RIVER	MUNI	1000			
4405-000	1	Real	7760000000	CITY OF CAMP WOOD	UNNAMED TRIB NUECES RIVER	IRRG	83	16		
4413-000	1	Real	8240000000	WILLIAM C SUTTON ET UX	CAMP WOOD CRK	REC			2	
5009-000	1	Real	3830000000	JACKSON L BABB ET AL	W FRIO RIVER	IRRG	60	30		
2653-000	6	Val Verde	4950000000	PHIL B FOSTER	CIENEGAS CRK &/OR THE RIO GRANDE	IRRG	122.25	61.13		AMEND 10/15/91
2653-000	6	Val Verde	4950000000	DAVID B TERK ET AL	CIENEGAS CRK	IRRG	27.75	13.87		AMEND 10/15/91
2654-000	6	Val Verde	4950000000	THURMAN W OWENS	CIENEGAS CRK	IRRG	26	13		RATE SEE 23-2653

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
2655-000	6	Val Verde	4950000000	JOSE C OVIEDO ET UX	CIENEGAS CRK	IRRG	28	14		RATE SEE 23-2653
2656-000	6	Val Verde	4950000000	RANDOLPH J N & SHARON M ABBEY	CIENEGAS CRK	IRRG	68	43		RATE SEE 23-2653
2657-000	6	Val Verde	4950000000	RONALD J PERSYN ET UX	CIENEGAS CRK	IRRG	150	75		RATE SEE 23-2653
2657-000	6	Val Verde	4950000000	RONALD J. PERSYN, ET UX	CIENEGAS CRK	IRRG	150	68		SEE 23-2653 RATE; AMEND 10/89
2657-000	6	Val Verde	4950000000	RONALD J. PERSYN, ET UX	CIENEGAS CRK	IRRG		89		AMEND 8/2/94
2659-000	6	Val Verde	4950000000	JOHN F QUALIA	CIENEGAS CRK	IRRG	112	56		FOR RATE SEE 23-2653
2660-000	6	Val Verde	4950000000	JOSE A CORTINAS ET AL	CIENEGAS CRK	IRRG	16	5		
2660-000	6	Val Verde	4950000000	LJB ENTERPRISES	CIENEGAS CRK	IRRG	296	99		
2661-000	6	Val Verde	4950000000	BARBARA GULICK RATHKE, ET AL	CIENEGAS CRK	IRRG	120	40	10	
2662-000	6	Val Verde	4950000000	CAPITOL AGGREGATES INC	CIENEGAS CRK	MINE	166	17		AMEND 11/2/87
2663-000	6	Val Verde	4950000000	ALFREDO GUTIERREZ JR	CIENEGAS CRK	IRRG	24	8		
2664-000	6	Val Verde	4950000000	SAN FELIPE A MFG & I COMPANY	SAN FELIPE CRK	IRRG	4950	1700		AMEND 12/16/88, 10/31/94
2664-000	6	Val Verde	4950000000	SAN FELIPE A MFG & I COMPANY	SAN FELIPE CRK	IRRG	6		6	IMPOUNDMENT #1
2664-000	6	Val Verde	4950000000	SAN FELIPE A MFG & I COMPANY	SAN FELIPE CRK	IRRG	6		6	IMPOUNDMENT #2
2664-000	6	Val Verde	4950000000	SAN FELIPE A MFG & I COMPANY	SAN FELIPE CRK	INDU	50			AMENDMENT EXP 12/31/96
2665-000	6	Val Verde	4950000000	JOSE OVIEDO JR ET UX	SAN FELIPE CRK	IRRG	60	40		AMENDED 9/13/96
2666-000	6	Val Verde	4950000000	PETRA ABREGO MUNOZ	SAN FELIPE CRK	IRRG	23.56	7.85		
2669-000	6	Val Verde	4950000000	RODOLFO MOTA	SAN FELIPE CRK	IRRG	6	2		
2670-000	6	Val Verde	4950000000	VICTOR D BOLNER	SAN FELIPE CRK	IRRG	6	3		
2672-000	6	Val Verde	4950000000	CITY OF DEL RIO	SAN FELIPE CRK	MUNI	4416			
2672-000	6	Val Verde	4950000000	CITY OF DEL RIO	SAN FELIPE CRK	MUNI	7000			
2811-000	6	Val Verde	4950000000	RIO BRAVO INC	CIENEGAS CRK &/OR THE RIO GRANDE	IRRG	51.08	997.97	47	& REC/DOM, AMEND 1/84,6/91
2811-000	6	Val Verde	4950000000	DAVID B TERK	CIENEGAS CRK	IRRG	114.64	95.38		
2912-000	6	Val Verde	4950000000	MOODY RANCHES INC	SAN FELIPE CRK	IRRG	800	400	10	

Water Right Number	Type	County	River Order Permit	Name	Stream	Use	Amount in Ac-Ft/Yr	Acreage	Res Cap in Ac-Ft	Remarks
3880-000	1	Val	4950000000	SOUTH TEXAS ELECTRIC CO-OP INC	RIO GRANDE	HYDRO	1500000			AMEND 12/14/87. POWER POOL WITH
3880-000	1	Verde	4950000000	MEDINA ELECTRIC CO-OP INC	RIO GRANDE	HYDRO				MEDINA.
5506-000	1	Val	4950000000	DEL RIO, CITY OF	SAN FELIPE CRK	REC			0.19	AMEND 12/14/87. POWER POOL WITH
		Verde								S.TX.EL.
										WATER PARK LANDING POOL

CHAPTER 4

IDENTIFICATION OF WATER NEEDS

This page intentionally left blank.

4 IDENTIFICATION OF WATER NEEDS

Chapter 4 provides projections (Table 4-1) of water supply surpluses or deficits by decade based on a comparison of projected water demands by decade for each water-use entity from Chapter 2 with water supplies available to meet those demands from Chapter 3. Entities are then identified that, in any decade within the 50-year planning period, develop a water-supply need (deficit) that is greater than that entity's ability to provide a supply to meet that need. A water-supply deficit may develop for individual water-use entities for numerous reasons including supply availability limits, infrastructure limitations, or legal limits. Table 4-2 provides the WUG's needs/surpluses analyses by category of use. Tables 4-3 and 4-4 provide a similar analysis by Major Water Providers (Del Rio Utilities Commission) and by category of use by the Major Water Provider.

Municipal water supply deficits are identified for Bandera County FWSD 1, Camp Wood, City of Del Rio, Laughlin Air Force Base, Rocksprings and County-Other (rural) in Bandera and Kerr Counties. Irrigation shortages are shown in Bandera County; mining shortages in Edwards, Kerr, and Val Verde Counties; and livestock shortages in Bandera, Kerr and Kinney Counties. Water management strategies developed for this *Plan* are intended to meet all projected water supply shortages.

A second tier water needs analysis for all water user groups and major water providers for which conservation or direct reuse water management strategies are recommended is provided in the TWDB Database-22 tables in the Executive Summary Appendix (WUG Second-Tier Identified Water Needs). This second tier water needs analysis calculates the water needs that would remain after assuming all recommended conservation and reuse water management strategies are fully implemented. Del Rio Utilities Commission is listed in these tables as both a WUG and MWP and is therefore listed in the above TWDB table in the Executive Summary. Unmet needs resulting from insufficient supplies to meet certain strategies is also included in the TWDB tables in the Executive Summary.

Water supply strategy recommendations are then made in Chapter 5 for those water users that have projected water supply deficits based on the comparison between demand and supply. In addition, strategies are also developed for specific entities that although they are not projected to have future shortages, they do have anticipated water-supply projects that deserve to be recognized in the *Regional Plan*. A socioeconomic impact of unmet water needs analysis prepared by the Texas Water Development Board is provided in Appendix 6A.

It is important to note that the methodology used to estimate water needs/surpluses for County-Other use depicts water supply available to County-Other (as a whole), except in portions of counties where sub-WUGs have been identified. The methodology assumes that all County-Other water supply is available to satisfy demand, whereas, in reality, County-Other population and water demand are often concentrated in smaller areas of the county such as unincorporated communities, subdivisions and mobile home parks which cannot access water supply available in other areas of the county. The reflected surplus depicted in the tables may or may not be an accurate estimate depending on population densities. Increasing population density increases water demand by straining available local water supply resources though the County-Other (as a whole) reflects adequate supply.

**Table 4-1. Identified Water (Needs)/Surpluses
(Acre Feet per Year)**

	2020	2030	2040	2050	2060	2070
Bandera County						
Guadalupe Basin						
County-Other	21	20	19	19	19	19
Livestock	(2)	(2)	(2)	(2)	(2)	(2)
Nueces Basin						
County-Other	321	308	301	299	297	296
Livestock	(3)	(3)	(3)	(3)	(3)	(3)
Irrigation	102	102	102	102	102	102
San Antonio Basin						
Bandera	192	151	130	121	115	111
Bandera County FWSD 1	(66)	(83)	(92)	(96)	(99)	(100)
County-Other Bandera River Ranch 1	(28)	(39)	(44)	(46)	(48)	(49)
County-Other Lake Medina Shores	(196)	(225)	(239)	(244)	(248)	(251)
County-Other Medina WSC	(35)	(46)	(51)	(53)	(54)	(55)
County-Other	2,970	2,770	2,669	2,633	2,603	2,586
Livestock	11	11	11	11	11	11
Irrigation	(75)	(75)	(75)	(75)	(75)	(75)
Bandera County Total Needs/Surplus	3,212	2,889	2,726	2,666	2,618	2,590
Edwards County						
Colorado Basin						
Rocksprings	673	677	680	681	681	681
County-Other	42	43	43	43	43	43
Mining	(12)	(12)	(12)	(12)	(12)	(12)
Livestock	365	365	365	365	365	365
Irrigation	44	44	44	44	44	44
Nueces Basin						
Rocksprings	(98)	(96)	(94)	(94)	(94)	(94)
County-Other Barksdale WSC	81	82	83	84	84	84
County-Other	120	122	124	124	124	124
Mining	(16)	(16)	(16)	(16)	(16)	(16)
Livestock	14	14	14	14	14	14
Irrigation	114	114	114	114	114	114
Rio Grande Basin						
County-Other	22	22	23	23	23	23
Mining	(31)	(31)	(31)	(31)	(31)	(31)
Livestock	11	11	11	11	11	10
Irrigation	10	10	10	10	10	10
Edwards County Total Needs/Surplus	1,339	1,349	1,358	1,360	1,360	1,360
Kerr County						
Colorado Basin						
County-Other	21	20	20	20	19	18
Mining	(11)	(12)	(15)	(16)	(17)	(19)
Livestock	(119)	(119)	(119)	(119)	(119)	(119)
Irrigation	31	31	31	31	31	31

**Table 4-1. (Continued) Identified Water (Needs)/Surpluses
(Acre Feet per Year)**

	2020	2030	2040	2050	2060	2070
Kerr County						
Guadalupe Basin						
Kerrville	1,551	1,475	1,455	1,396	1,328	1,269
Kerrville South Water	46	41	40	35	29	24
County-Other Center Point	(3)	(3)	(3)	(3)	(3)	(4)
County-Other Center Point North Water System	1	1	1	1	0	0
County-Other Center Point Taylor System	(2)	(2)	(3)	(3)	(4)	(5)
County Other Hills and Dales Estates	1	1	1	0	0	0
County-Other Nickerson Farm Water System	5	5	5	5	4	4
County-Other Oak Forest South Water	24	23	23	22	21	20
County-Other Park Place Subdivision	3	3	3	3	3	2
County-Other Pecan Valley	2	1	1	1	1	1
County-Other Rustic Hills Water	2	2	2	2	2	2
County-Other Verde Park Estates	1	1	1	1	0	0
County-Other Westwood Water System	5	5	5	5	4	4
County-Other	6,525	6,493	6,489	6,458	6,420	6,387
Manufacturing	28	27	27	27	27	27
Mining	60	57	40	39	31	24
Livestock	(173)	(173)	(173)	(173)	(173)	(173)
Irrigation	421	421	421	421	421	421
Nueces Basin						
County-Other	(1)	(1)	(1)	(1)	(1)	(1)
Livestock	(6)	(6)	(6)	(6)	(6)	(6)
San Antonio Basin						
County-Other	238	238	237	237	237	236
Livestock	(27)	(27)	(27)	(27)	(27)	(27)
Irrigation	21	21	21	21	21	21
Kerr County Total Needs/Surplus	8,644	8,523	8,476	8,377	8,249	8,137
Kinney County						
Nueces Basin						
County-Other	23	23	23	23	24	24
Livestock	(27)	(27)	(27)	(27)	(27)	(27)
Irrigation	1,057	1,057	1,057	1,057	1,057	1,057
Rio Grande Basin						
Brackettville	37	43	51	52	53	53
Fort Clark Springs MUD	753	755	759	761	762	762
County-Other	112	113	114	114	114	114
Livestock	197	197	197	197	197	197
Irrigation	5,580	5,580	5,580	5,580	5,580	5,580
Kinney County Needs/Surplus	7,732	7,741	7,754	7,757	7,760	7,760

**Table 4-1. (Continued) Identified Water (Needs)/Surpluses
(Acre Feet per Year)**

	2020	2030	2040	2050	2060	2070
Real County						
Colorado Basin						
County-Other	11	11	12	12	12	12
Livestock	5	5	5	5	5	5
Irrigation	176	176	176	176	176	176
Nueces Basin						
Camp Wood	(143)	(139)	(136)	(135)	(135)	(135)
Leakey	105	112	118	120	121	121
County-Other	352	356	359	361	361	361
Livestock	38	38	38	38	38	38
Irrigation	1,680	1,680	1,680	1,680	1,680	1,680
Real County Total Needs/Surplus	2,224	2,239	2,252	2,257	2,258	2,258
Val Verde County						
Rio Grande Basin						
Del Rio Utilities Commission	(4,423)	(4,918)	(5,419)	(5,995)	(6,598)	(7,191)
Laughlin AFB	(87)	(183)	(284)	(346)	(345)	(345)
County-Other	1,388	1,057	727	362	(12)	(377)
Mining	(151)	(210)	(220)	(184)	(153)	(132)
Livestock	96	96	96	96	96	96
Irrigation	4,267	4,267	4,267	4,267	4,267	4,267
Val Verde County Total Needs/Surplus	1,090	109	(833)	(1,800)	(2,745)	(3,682)
Region J Total Needs/Surplus	24,241	22,850	21,733	20,617	19,500	18,423

Table 4-2. Identified Water (Needs)/Surpluses by Category

WUG COUNTY	WUG CATEGORY	WUG WATER SUPPLY (NEED)/ SURPLUS 2020	WUG WATER SUPPLY (NEED)/ SURPLUS 2030	WUG WATER SUPPLY (NEED)/ SURPLUS 2040	WUG WATER SUPPLY (NEED)/ SURPLUS 2050	WUG WATER SUPPLY (NEED)/ SURPLUS 2060	WUG WATER SUPPLY (NEED)/ SURPLUS 2070
Bandera	Municipal	3,179	2,856	2,693	2,633	2,585	2,557
	Irrigation	27	27	27	27	27	27
	Livestock	6	6	6	6	6	6
Edwards	Municipal	840	850	859	861	861	861
	Irrigation	168	168	168	168	168	168
	Livestock	390	390	390	390	390	390
	Mining	(59)	(59)	(59)	(59)	(59)	(59)
Kerr	Municipal	8,419	8,303	8,276	8,179	8,060	7,957
	Irrigation	473	473	473	473	473	473
	Livestock	(325)	(325)	(325)	(325)	(325)	(325)
	Manufacturing	28	27	27	27	27	27
	Mining	49	45	25	23	14	5
Kinney	Municipal	925	934	947	950	953	953
	Irrigation	6,637	6,637	6,637	6,637	6,637	6,637
	Livestock	170	170	170	170	170	170
Real	Municipal	325	340	353	358	359	359
	Irrigation	1,856	1,856	1,856	1,856	1,856	1,856
	Livestock	43	43	43	43	43	43
Val Verde	Municipal	(3,122)	(4,044)	(4,976)	(5,979)	(6,955)	(7,913)
	Irrigation	4,267	4,267	4,267	4,267	4,267	4,267
	Livestock	96	96	96	96	96	96
	Mining	-151	-210	-220	-184	-153	-132

Table 4-3. Del Rio Major Water Provider Identified Water (Needs)/Surpluses

County	Basin	Major Water Provider	Receiving Entity	2020	2030	2040	2050	2060	2070
Val Verde	Rio Grande	Del Rio Utilities	City of Del Rio	(4,423)	(4,918)	(5,419)	(5,995)	(6,598)	(7,191)
			Laughlin AFB	(87)	(183)	(284)	(346)	(345)	(345)
			County Other	1,388	1,057	727	362	(12)	(377)

Table 4-4. Del Rio Major Water Provider Identified Water (Needs)/Surpluses by Category

County	Basin	Use Category	2020	2030	2040	2050	2060	2070
Val Verde	Rio Grande	Municipal	(3,122)	(4,044)	(4,976)	(5,979)	(6,955)	(7,913)
		Manufacturing	0	0	0	0	0	0
		Irrigation	0	0	0	0	0	0
		Mining	0	0	0	0	0	0
		Livestock	0	0	0	0	0	0

CHAPTER 5

WATER MANAGEMENT STRATEGIES AND CONSERVATION RECOMMENDATIONS

This page intentionally left blank.

5 WATER MANAGEMENT STRATEGIES AND CONSERVATION RECOMMENDATIONS

The Plateau Water Planning Group (PWPG) has identified and evaluated a total of 67 water management strategies for the *2021 Plateau Region Water Plan*. Water management strategies are developed for entities where future water supply needs exist (as required by statute and administrative rules 31 TAC §357.34; 357.35). A need for water is identified when existing water supplies are less than projected water demands for that same WUG within any planning decade. In addition, water management strategies were developed for other entities requesting specific water supply projects, even though these entities did not have a projected water supply shortage.

5.1 IDENTIFICATION OF POTENTIALLY FEASIBLE WATER MANAGEMENT STRATEGIES

The first step in developing a list of recommended water management strategies is to take a “big picture” look at possible projects that could reasonably be expected to result in water-supply improvements. As required by TWC §16.053(e)(3), and 31 TAC §357.34(c) the Regional Water Planning Groups shall consider, **but not be limited to considering**, the following types of water management strategies for all identified water needs:

1. Conservation
2. Drought management
3. Reuse
4. Management of existing water supplies
5. Conjunctive use
6. Acquisition of available existing water supplies
7. Development of new water supplies
8. Developing regional water supply facilities or providing regional management of water supply facilities
9. Developing large-scale desalination facilities for seawater or brackish groundwater that serve local or regional brackish groundwater production zones identified and designated under TWC §16.060(b)(5)34
10. Developing large-scale desalination facilities for marine seawater that serve local or regional entities
11. Voluntary transfer of water within the region using, but not limited to, contracts, water marketing, regional water banks, sales, leases, options, subordination agreements, and financing agreements
12. Emergency transfer of water under TWC §11.139
13. Interbasin transfers of surface water
14. System optimization
15. Reallocation of reservoir storage to new uses
16. Enhancements of yields
17. Improvements to water quality
18. New surface water supply
19. New groundwater supply
20. Brush control
21. Precipitation enhancement
22. Aquifer storage and recovery
23. Cancellation of water rights
24. Rainwater harvesting

Other potential projects considered for the initial list included:

- appropriate strategies from the *2016 Plan*
- water-loss audits and line replacement
- projects suggested by municipalities through a survey
- projects that are currently or have recently applied to the TWDB for funding

The following process was used by the PWPG to identify *potentially feasible water management strategies*.

1. Receive a *Needs Analysis Report* from the TWDB, which provides a comparison of existing water supplies and projected water demands for each water user group (WUG) and wholesale water provider (WWP) in the Region. Based on this comparison, the report identifies WUGs and WWPs that are expected to experience needs for additional water supplies within the 50-year time frame of the *Regional Water Plan*. Using the following process, identify and select potentially feasible water management strategies for each of these entities.
2. Review and consider recommended water management strategies adopted by the water planning group for the *2016 Plateau Region Water Plan*.
3. Review and consider any issues identified in the most current TWDB Water Loss Audit Report, including leak detection and supply side analysis.
4. Solicit current water planning information, including specific water management strategies of interest from WUGs and WWPs with identified needs.
5. Review and consider the most recent Water Supply Management, Water Conservation, and/or Drought Contingency Plans, where available, from WUGs and WWPs with identified needs.
6. Consider potentially feasible water management strategies that may include, but are not limited to (Chapter 357 Subchapter C §357.34):
 - Extended use of existing supplies including:
 - a. System optimization and conjunctive use of water resources
 - b. Reallocation of reservoir storage to new uses
 - c. Voluntary redistribution of water resources including contracts, water marketing, regional water banks, sales, leases, options, subordination agreements, and financing agreements
 - d. Subordination of existing water rights through voluntary agreements
 - e. Enhancement of yields of existing sources
 - f. Improvement of water quality including control of naturally occurring chlorides
 - g. Drought management
 - New supply development including:
 - a. Construction and improvement of surface water and groundwater resources
 - b. Brush control
 - c. Precipitation enhancement
 - d. Desalination
 - e. Water supply that could be made available by cancellation of water rights
 - f. Rainwater harvesting
 - g. Aquifer storage and recovery
 - Conservation and drought management measures including demand management
 - Reuse of wastewater

- Interbasin transfers of surface water
 - Emergency transfers of surface water
7. Consider other potentially feasible water management strategies suggested by planning group members, stakeholders, and the public.
 8. Based on the above reviews and considerations, establish a preliminary list of potentially feasible water management strategies. At a discussion level, consider the following feasibility concerns for each strategy:
 - Water supply source availability during drought-of-record conditions
 - Cost/benefit
 - Water quality
 - Threats to agriculture and natural resources
 - Impacts to the environment, other water resources, and basin transfers
 - Socio-economic impacts
 9. Based on the above discussion level analysis, select a final list of potentially feasible water management strategies for further technical evaluation using detailed analysis criteria.

Using the above criteria and process, the PWPG selected the initial potentially feasible water management strategies listed in Table 5-1 for further detailed analysis. All strategy analyses recognize and protect existing water rights, water contracts, and option agreements. As the water management strategy analysis progressed, it became evident that the initial list would require modification of project descriptive names, and the possible addition of new strategies and the elimination or transfer of others. Much time was spent in communication with individual WUGs (municipalities, irrigation districts, etc.) to ensure that the strategies discussion met with their approval. The evaluation and final recommendation of water management strategies are provided in Appendix 5A at the end of this chapter.

Although these strategy types were considered by the PWPG, not all of them were considered viable options for addressing long-term needs in the region. The PWPG does not consider drought management as a feasible strategy to meet long-term growth in demands or current needs. This strategy is considered a temporary measure aimed at conserving available water supplies during times of drought or emergencies. Drought management is most adequately addressed in the region through the implementation of local drought contingency plans. The PWPG is supportive of the development and use of these plans during periods of drought or emergency water needs.

Table 5-1. Potentially Feasible Water Management Strategies

County	Water User Group	Strategy Source Basin	Water Management Strategy
Bandera	City of Bandera	San Antonio	Reuse treated wastewater effluent for irrigation use
			Promote, design & install rainwater harvesting systems
			Additional Lower Trinity well and lay necessary pipeline
			Additional Middle Trinity wells within city infrastructure
			Surface water acquisition, treatment and ASR
	*Bandera County FWSD#1	San Antonio	Conservation
			New strategy - Additional groundwater well
	*Bandera County Other (Bandera River Ranch #1)	San Antonio	Water loss audit and main-line repair
	*Bandera County Other (Lake Medina Shores)	San Antonio	Conservation
			Additional groundwater wells
	*Bandera County Other (Medina WSC)	San Antonio	Conservation
			Additional groundwater well for the Town of Medina
	Bandera County Other	San Antonio	Drought management (BCRAGD)
			Additional groundwater well for Pebble Beach Subdivision
			Additional groundwater wells to provide emergency supply to VFD
			Water loss audit and main-line repair for Enchanted River Estates
			**Vegetative Management
		Nueces	Drought management (BCRAGD)
	*Bandera County Irrigation	San Antonio	Conservation
			Additional groundwater wells
	*Bandera County Livestock	*Guadalupe	Conservation
			Additional groundwater well
		*Nueces	Conservation
			Additional groundwater well
Edwards	*City of Rocksprings	*Nueces	Conservation
			Additional groundwater well
	Edwards County Other (Barksdale WSC)	Nueces	Additional groundwater well in the Nueces River Alluvium
	Edwards County Other	Nueces	**Vegetative Management
	*Edwards County Mining	*Nueces	Conservation
			Additional groundwater wells
		*Colorado	Conservation
			Additional groundwater wells
		*Rio Grande	Conservation
			Additional groundwater wells
Kerr	*City of Kerrville	Guadalupe	Increase wastewater reuse
			Water loss audit and main-line repair
			Explore and develop potable reuse

Table 5-1. (Continued) Potentially Feasible Water Management Strategies

County	Water User Group	Strategy Source Basin	Water Management Strategy
Kerr	*City of Kerrville	Guadalupe	Explore and develop new Ellenburger Aquifer well supply
			Purchase Guadalupe River water rights
			Increased water treatment and ASR capacity
Kerr	Kerr County Other *(Center Point)	Guadalupe	*** EKCRWSP
	Kerr County Other (Center Point North WS)	Guadalupe	*** EKCRWSP
	Kerr County Other *(Center Point Taylor	Guadalupe	*** EKCRWSP
	Kerr County Other (Hills and Dales Estate)	Guadalupe	*** EKCRWSP
	Kerr County Other (Nickerson Farm WS)	Guadalupe	*** EKCRWSP
	Kerr County Other (Oak Forest South Water)	Guadalupe	*** EKCRWSP
	Kerr County Other (Park Place Subdivision)	Guadalupe	*** EKCRWSP
	Kerr County Other (Pecan Valley)	Guadalupe	*** EKCRWSP
	Kerr County Other (Rustic Hills Water)	Guadalupe	*** EKCRWSP
	Kerr County Other (Verde Park Estates)	Guadalupe	Water loss audit and main-line repair for Verde Park Estates
			*** EKCRWSP
	Kerr County Other (Westwood WS)	Guadalupe	*** EKCRWSP
	*Kerr County Other	*Nueces	Conservation: Public information and education - Water shortage met with Guadalupe Basin strategies
		Guadalupe	Water loss audit and main-line repair for Community Water Group WSC
			**Vegetative management - UGRA
	*Kerr County Irrigation	San Antonio	Conservation
			Additional groundwater well
	*Kerr County Livestock	*Colorado	Conservation
			Additional groundwater wells
		*Guadalupe	Conservation
			Additional groundwater wells
		*San Antonio	Conservation
			Additional groundwater well
		*Nueces	Conservation
			Additional groundwater well
	*Kerr County Mining	Colorado	Conservation
			Additional groundwater well
Kinney	City of Brackettville	Rio Grande	Increase supply to Spofford with new water line
			Increase storage facility
	Fort Clark Springs MUD	Rio Grande	Water loss audit and main-line repair

Table 5-1. (Continued) Potentially Feasible Water Management Strategies

County	Water User Group	Strategy Source Basin	Water Management Strategy
Kinney	Fort Clark Springs MUD	Rio Grande	Increase storage facility
	Kinney County Other	Rio Grande	**Vegetative Management
		Nueces	**Vegetative Management
Real	*City of Camp Wood	Nueces	Conservation: Public information and education - Water shortage met with Guadalupe Basin strategies
			Additional groundwater wells
	*City of Leakey	Nueces	Conservation
			Additional groundwater well
			Develop interconnections between wells within the City
	Real County Other	Nueces	Water loss audit and main-line repair for Real WSC
			**Vegetative Management
			Additional groundwater well for Oakmont Saddle WSC
Val Verde	City of Del Rio	Rio Grande	Water loss audit and main-line repair
			Additional groundwater well
			Water treatment plant expansion
			Develop a wastewater reuse program
	Val Verde County Other	Rio Grande	Water loss audit and main-line repair for Val Verde County WCID Comstock
			Water loss audit and main-line repair for San Pedro Canyon Subdivision (Upper)
			Water loss audit and main-line repair for Tierra Del Lago
			**Vegetative Management
	*Val Verde County Mining	Rio Grande	Conservation
			Additional groundwater well

* WUG with a supply need.

** Vegetative Management has an availability of zero.

***** Eastern Kerr County Regional Water Supply Project Strategies**

East Kerr County Regional Water Supply Project	Guadalupe	UGRA acquisition of surface water rights
		KCCC acquisition of surface water rights
		Construction of an off-channel surface water storage
		Construction of surface water treatment facilities and main distribution
		Construction of an ASR facility
		Construction of a wellfield for dense rural areas
		Construction of a brackish groundwater desalination facility
		Construction of an Ellenburger Aquifer water supply source
		Conservation

5.2 EVALUATION AND RECOMMENDATION OF WATER MANAGEMENT STRATEGIES

5.2.1 Strategy Evaluation Procedure

The strategy evaluation procedure is designed to provide a side-by-side comparison such that all strategies can be assessed based on the same quantifiable factors as shown in Tables 5-2, 5-3 and 5-4. An explanation of the qualitative and quantifiable rankings is provided in Appendix 5C. All strategy analyses recognize and protect existing water rights, water contracts, and option agreements. For planning purposes, it is assumed that all strategies experience a two percent water loss over the life of the strategy project. Specific factors considered in each Table were:

Table 5-2

Quantity

Quality

Reliability

Impacts to water, agricultural, and natural resources.

Table 5-3

Financial cost (total capital cost, annual cost, and cost per acre-foot)

Table 5-4

Environmental impacts

- Environmental water needs
- Wildlife habitat
- Cultural resources
- Environmental water quality
- Inflows to bays and estuaries

Cost evaluations for all strategies include capital cost, debt service, and annual operating and maintenance (O&M) expenses. Capital costs are estimated based on September 2018 US dollars. Capital costs consider construction costs, engineering and feasibility studies, legal assistance, financing, bond counsel and contingencies, permitting and mitigation, land purchase not associated with mitigation, easement costs, and purchase of water rights. The length of debt service is 20 years unless otherwise stated. An annual unit cost is also calculated based on the O&M cost per acre-foot of water supplied. The TWDB Unified Costing tool was used for all strategy evaluations except for when specific municipalities provided engineering design studies that included cost estimates.

Water quality is recognized as an important component in this 50-year water plan. To ensure that this *Plan* fully considers water quality, the Federal Clean Water Act and the State Clean Rivers Program were reviewed and considered when developing water management strategies and water quality impacts. Development of water management strategies were also guided by the principal that the designated water quality and related water uses described in the Water Quality Management Plans (WQMPs) of TCEQ and

the Texas State Soil and Water Conservation Board (TSSWCB) were improved or maintained. TCEQ's WQMP is tied to the State's water quality assessments that identify and direct planning for implementation measures that control and/or prevent priority water quality problems. Elements contained in the WQMP include effluent limitations of wastewater facilities, total maximum daily loads (TMDLs), nonpoint source management controls, identification of designated management agencies, and ground water and source water protection planning. TSSWCB's WQMP is a site-specific plan developed through and approved by soil and water conservation districts for agricultural or silvicultural lands. The plan includes appropriate land treatment practices, production practices, management measures, and technologies.

The PWPG relied on Management Supply Factors calculated and supplied by TWDB in the consideration of water-supply needs to be generated in the development of water management strategies. A Management Supply Factor is the combined total of existing and future supply divided by the total projected demand and may be used to consider uncertainties in population, water supply and demand, and other impactful conditions. Management Supply Factors are shown for all WUGs in a table provided in the Executive Summary. Management Supply Factors for Del Rio Utilities, the lone Major Water Provider for this Region is as follows:

MWP Name	Management Supply Factor					
	2020	2030	2040	2050	2060	2070
Del Rio Utilities	1.6	1.6	1.5	1.4	1.4	1.3

The development of water management strategies is intended to assist entities with their future water supply needs based on drought-of-record conditions. Recommendations of the Drought Preparedness Council are considered in this *Plan* and consist of four activities: (1) Drought Monitoring; (2) Impact Assessment; (3) Research and Educational Programs; and (4) Drought Mitigation Strategies. Also, WUGs conservation and drought management plans (see Chapters 6 and 7) were reviewed to identify potential strategies that are currently under consideration by the entity.

Several strategies are considered integral or interconnected to the new supply goal for a specified WUG or cooperation between WUGs. Strategy J-45 lists several projects that may serve the small communities and rural population of eastern Kerr County. Strategies J-64 and J-65 combined will serve to produce a new water supply for the Spoford area of southern Kinney County. These strategies are developed independently, and their interactions do not impact the water supply availability and yield associated with each individual strategy.

5.2.2 Emphasis on Conservation and Reuse

In terms of recommending strategies to meet future water needs, it is most practical and often most economical to consider potential conservation and reuse projects. Conservation generally includes best management practices that are undertaken either voluntarily by water customers or as mandated by a water suppliers. Existing WUG conservation and drought management plans were reviewed, and conservation strategies selected for this *Plan* were often identified from these plans. Water conservation is discussed in further detail in Section 5.3 of this chapter. The following paragraph is assigned to all Public Conservation Education strategies:

Public information programs, even though they may not be directly related to any equipment or operational change, can result in both short- and long-term water savings. Behavioral changes by customers will only occur if a reasonable, yet compelling cause can be presented with sufficient frequency to be recognized and absorbed by the customers. There are many resources that can be consulted to provide insight into implanting effective information programs. Like any marketing or public information program, to be effective, water conservation public information should be planned out and implemented in a consistent and continual manner. A more detailed description of conservation best management practices that might be encouraged is available in TWDB Report 362, Water Conservation Best Management Practices Guide. An updated version of this report is available at: <http://www.twdb.texas.gov/conservation/BMPs/index.asp>.

5.2.3 Water Loss Audit Strategies

In 2003, the 78th Texas Legislature, enacted House Bill 3338 to help conserve the State's water resources by reducing water loss occurring in the systems of drinking water utilities. This statute requires that retail public utilities providing water within Texas file a standardized water audit once every five years with the Texas Water Development Board (TWDB). See Section 1.6 in Chapter 1 of this Plan for a more detailed discussion. Eleven entities reporting more than a 10 percent water loss were selected to receive a water-loss audit and main line repair strategy. Volume of savings is calculated as percent total loss of the true real loss as shown in the graphic below:

Public Water System	Report Year	Reported Breaks Leaks	Unreported Loss	Total Real Losses	Cost of Real Losses	Total Loss Percent	Savings (ac-ft/yr.)
Bandera River Ranch 1	2015	364,487	4,426,897	4,791,384	3,656	27.9	4
City of Kerrville	2017	13,534,319	224,001,131	237,535,450	539,443	18.4	134
Community Water Group WSC	2015	1,252,104	663,788	1,915,892	1,341	20.3	
Del Rio Utilities Commission	2016	1,540,400	33,261,796	34,802,196	144,777	11.4	12
Enchanted River Estates	2015	1,667,400	365,663	2,033,063	1,789	11.7	1
Fort Clark Springs MUD	2015	0	62,273,567	62,273,567	9,341	41.1	79
Real WSC	2015	100,000	1,533,416	1,633,416	1,111	32.3	2
San Pedro Canyon Subdivision - Upper	2016	0	5,394,010	5,394,010	2,551	40.0	7
Tierra Del Lago	2016	0	2,471,426	2,471,426	989	54.9	4
Val Verde County WCID Comstock	2015	20,000	1,534,206	1,554,206	894	16.4	1
Verde Park Estates	2015	32,000	630,140	662,140	2,715	15.5	0

5.2.4 Recommended Water Management Strategies

The strategy evaluation procedure, as described in Section 5.2.1 above, was followed on each of the potentially feasible strategies selected in Table 5-1. Some potential strategies were determined to not meet guideline standards and were thus eliminated. Also, several new strategies were introduced and were subsequently evaluated. Upon completion of the evaluation phase, the PWPG reviewed evaluation criteria and selected the final water management strategies listed in Table 5-2.

Seawater desalination, a major alternative water management solution for the coastal portion of Texas, was not selected for consideration in the Plateau Water Planning Region as the nearest direct point of origin for a seawater source is more than 150 miles from the easternmost border of the Plateau Region, and is thus not rationally economically feasible.

Third-party social and economic impacts resulting from voluntary redistributions of water, including impacts of moving water from rural and agricultural areas were considered; however, no strategies were recommended that resulted in moving water from such areas.

Table 5-2 provides a comparative listing of all the recommended water management strategies that the PWPG subsequently evaluated for inclusion in the *2021 Plateau Region Water Plan*. Table 5-3 provides a breakdown of the cost estimate for each strategy. Where applicable, capital costs, based on September 2018 US dollars, include the following:

- Construction, engineering and feasibility studies, legal assistance, financing, bond council, and contingencies;
- Environmental and archaeology studies and mitigation;
- Land acquisition and surveying; and

Interest during construction. The total capital cost for development of the 67 water management strategies is \$230,456,000. Annual costs (listed in Table 5-3) include operations and maintenance, energy cost at 0.08 \$per kilowatt-hour, and debt service at 3.5 percent over 20 years (40 years for reservoirs).

Table 5-4 shows the potential impacts on the environment of enacting each strategy. Strategy evaluations are presented in Appendix 5A at the end of this chapter. Appendix 5B provides a matrix procedure for measuring the quantitative and qualitative potential for each water management strategy.

Alternate water management strategies are projects that are not part of the package of Recommended strategies but can be substituted for any Recommended strategy that is later determined to be non-viable. Alternate water management strategies are evaluated in the same way as Recommended strategies based on criteria specified in [31 TAC §357.7(a)(7-9, 12)] and are tabulated along with “Recommended” strategies in Tables 5-2, 5-3 and 5-4. Upon conclusion of a thorough evaluation process, the Plateau Water Planning Group identified seven Alternate water management strategies.

5.2.5 Assessment of ASR Potential

Texas Water Code §16.053(e)(10) requires that “if a RWPA has significant identified water needs, the RWPG shall provide a specific assessment of the potential for aquifer storage and recovery (ASR) projects to meet those needs”. The PWPG considers municipal utilities as the only WUGs in the Plateau Region that would have the resources available to initiate an ASR project; and that the threshold for “significant” identified water needs are defined by the PWPG as any municipal utility with greater than 800 acre-feet per year need over the 50-year planning horizon. This horizon only occurs with the City of Del Rio. All other municipal water needs are at a far less significant level. However, the PRPG has recommended ASR water management strategies for the Cities of Bandera and Kerrville, and the Eastern Kerr County Regional Project.

An assessment of ASR potential for Del Rio Utilities considers both source-supply availability and hydrologic capability of the underlying rock formations to perform the necessary storage function of the ASR process. Del Rio Utilities is primarily reliant on its water supply from San Felipe Creek, a tributary of the Rio Grande. The Utility captures its full permitted supply at San Felipe Springs, the principal headwaters of the Creek. Without acquiring additional water rights, the Utility is limited to its current supply availability. The Utility does not have access to water available in nearby Amistad Reservoir on the Rio Grande.

The hydrogeologic nature of the underlying rock units of the Edwards Limestone is only partially understood in the Del Rio area. The upper portion of the formation is highly karstic resulting in the extensive flow paths leading to San Felipe Springs. An ASR reservoir would not likely be feasible in this upper horizon as stored water would not likely remain in place. Lower aquifer reservoirs have not adequately been tested for their ability to store and release injected water. Below the Edwards, the Trinity is likely brackish and probably far less permeable. Depth and reservoir capacity may thus limit the Trinity for its ASR function.

The PWPG considers that there is currently insufficient justification for designating an ASR water management strategy option for Del Rio Utilities in this 2021 Plan. However, the PWPG feels that ASR for the Del Rio area should remain as a research topic worthy of future consideration.

5.2.6 Unqualified Strategies

The TWDB requires that water management strategies listed in regional water plans develop “new” water supplies to be applicable for SWIFT funding. Projects that involve items such as; replacing and/or repairing old infrastructure, and wastewater collection and treatment do not qualify. However, the TWDB offers many other types of financing options. Additional details pertaining to the different types of grants and loans offered can be accessed here: <https://www.twdb.texas.gov/financial/index.asp>.

5.2.7 Vegetative Management and Land Stewardship

Vegetative management and land stewardship are not qualified as water management strategies under regional water planning guidelines as they are not considered to reduce demand. However, the PWPG strongly believes that the concept of properly managing rural range lands is essential in maintaining natural spring flows in the headwaters of surface streams and rivers.

Several invasive species have been recognized in the Plateau Region, as well as elsewhere in the State, that have a negative impact on surface water flow in springs, creeks and rivers, as well as recharge to underlying aquifers. Species of major concern are Giant River Cane (*Arundo donax*) and Elephant Ears (*Colocasia esculenta*) in watersheds, and the encroachment of woody species such as Ashe-juniper and Mesquite. The PRWPG has selected vegetative management as an appropriate water management strategy for each river basin within each county in the Plateau Region.

Vegetative management of Ashe Juniper, also commonly known as “cedar” has become a significant source of discussion and debate as to its impact on water resources on the Edwards Plateau. Ashe Juniper is native to central Texas and was initially controlled through both man-made and natural fires and through foraging. As these events were reduced, cedar returned and has been expanding in the Region. Eradication methods have included controlled burns, use of heavy equipment to pull the plant up by its roots, mechanical cutting and chemical methods. There has been a great deal of debate regarding the impact on water resources by cedar with various groups calculating how much water cedar takes away from both groundwater and surface water sources. In a 2003, report done by A.A. McCole of the University of Texas Geology Department, it was noted that “in late summer and winter the Ashe Juniper obtains approximately between 72% and 100% of its water from groundwater. In contrast, during the wet periods of the year, spring and fall, mass balance calculations indicate that between 45% and 100% of Ashe Juniper's water is derived from soil water. This seasonal shift indicates the presence of Ashe Juniper can appreciably reduce groundwater resources both by lateral roots intercepting potential recharge during the wet season and direct uptake of groundwater by deep roots during the dry season. Ashe

Juniper will directly compete with grasses for soil water during the wet season, limiting herbaceous productivity.”

In 2010, the USGS published a study, “Effects of Brush Management on the Hydrologic Budget and Water Quality In and Adjacent to Honey Creek State Park Natural Area, Comal County, Texas 2001-2010”. The results of this study indicated that brush eradication did not increase runoff to streams but did suggest that clearing brush can result in more infiltration. The study found that before clearing potential groundwater recharge was 17% of the total water budget, but increased to 24% after clearing. The study showed that prior to clearing a rainfall event produced a potential recharge of 5.91 inches of the rain that fell and after clearing, it increased to 7.09 inches; for a difference of 1.18 inches. In terms of actual water, the extra 1.18 inches amounts to approximately 32,042 gallons per acre. Thus, to obtain one acre foot of water, 10 acres will need to be cleared to gain an additional acre foot of water as infiltration. From these and other studies, brush eradication can have a positive impact on groundwater recharge and a limited impact on surface water runoff. However, with increased groundwater recharge it is reasonable to assume that a portion of this groundwater would percolate down to aquifers as well as provide base flow to surface water via springs.

Brush management is a difficult issue to deal with on a planning level since much of the work that needs to be done is on private property with landowners having varied interests. From literature on the subject many authors note that brush management includes both removing the brush, but also providing land management through replacement with other native species that will prevent erosion and hold moisture. However, as a strategy brush management does show potential for enhancing ground water supplies and subsequent base flow to surface water bodies.

Vegetative management of Giant River Cane (*Arundo donax*) has become a significant problem throughout the Plateau Region. The problems with the Giant Cane are a direct result of its incredible growth potential. Individual shoots can grow upwards of 4 inches per day and a mature stand, or River Cane, can be approximately 30 feet tall. To support these high growth rates the plant requires significant amounts of water. When compared to native species, *Arundo donax* requires three times as much water minimum. USDA scientists have calculated that each acre of *Arundo donax* requires approximately 4.37 acre feet of water to support proper growth. Thus, 1,000 acres of *Arundo donax* will consume approximately 4,370 acre feet of water per year.

The eradication methods identified to control the *Arundo donax* are mechanical, chemical and biological. Additionally, any combination of these three treatment protocols can be an effective treatment option. Mechanical control involves removing all portions of the living plant. Due to the plant’s high silicon count, the plant is very flammable and highly susceptible to burning. This approach is not recommended as the burning does not affect the root structure.

Chemical control has proven to be the most effective, which uses glyphosate. Glyphosate interferes with the plants synthesis of nutrients. Biologic control seems to hold promise for eradication. The USDA has been experimenting with using the asexual *Arundo* Wasp, and has received permits to use this wasp in the eradication efforts. Due to the *Arundo donax* being highly invasive, the Texas Legislature passed legislation making it illegal to sell or distribute *Arundo donax* without a permit from the Texas Department of Agriculture.

An HDR consultant memo to the Brazos G Regional Water Plan (2014) provides projected water supply benefits from feasibility studies (Table 2). According to the memo, the increase in in water yield

referenced is an increase in the average annual runoff from the treated watershed and should not be confused with a firm yield supply of water. Under most circumstances, the additional runoff or recharge attained from brush control projects are not sustained during a prolonged drought, and thus the supply benefit under these conditions will be zero. For the Bandera County / Edwards Aquifer / Medina River study, the estimated average annual volume of water supplied is 0.5166 acre-feet per acre.

Table 5-2. Summary of Recommended and Alternate Water Management Strategy Evaluation

County	Water User Group	Strategy Source Basin	Strategy	Source	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost	Quantity ^a	Quality ^b	Reliability ^c	Strategy Impacts ^d		
						Water Resources	Agricultural Resources	Natural Resources										
									2020	2030	2040		2050	2060	2070	(1-3)	(1-3)	(1-3)
Bandera	City of Bandera	San Antonio	Reuse treated wastewater effluent for irrigation of public spaces	Direct Non-Potable Reuse	J-1	0	310	310	310	310	310	\$1,496,000	na	3	1	1	2	2
			Promote, design & install rainwater harvesting systems on public buildings	Demand Reduction	J-2	0	1	1	1	1	1	\$56,000	na	3	2	1	2	1
			Additional Lower Trinity well and lay necessary pipeline ALTERNATE	Lower Trinity Aquifer	J-3	0	403	403	403	403	403	\$3,298,000	na	1	1	4	2	2
			Additional Middle Trinity wells within City water infrastructure area	Middle Trinity Aquifer	J-4	161	161	161	161	161	161	\$625,000	na	1	1	3	2	3
			Surface water acquisition, treatment and ASR	Medina River	J-5	0	1,500	1,500	1,500	1,500	1,500	\$34,188,000	na	2	2	3	2	2
	*Bandera County FWSD #1	San Antonio	Public conservation education	Demand Reduction	J-6	2	2	2	2	2	2	\$0	3	na	na	na	na	na
			Additional groundwater well	Middle Trinity Aquifer	J-7	100	100	100	100	100	100	\$990,000	1	1	1	3	2	3
	*Bandera County Other - Bandera River Ranch #1	San Antonio	Water loss audit and main-line repair for	Demand Reduction	J-8	4	4	4	4	4	4	\$902,000	na	na	na	2	2	2
	*Bandera County Other - Lake Medina Shores	San Antonio	Public conservation education	Demand Reduction	J-9	3	3	3	3	3	3	\$0	3	na	na	na	na	na
			Additional groundwater wells ALTERNATE	Lower Trinity Aquifer	J-10	251	251	251	251	251	251	\$1,477,000	1	1	1	3	2	3
	*Bandera County Other - Medina WSC	San Antonio	Public conservation education	Demand Reduction	J-11	1	1	1	1	1	1	\$0	3	na	na	na	na	na
			Additional groundwater well	Lower Trinity Aquifer	J-12	55	55	55	55	55	55	\$1,417,000	1	1	1	3	2	3
	Bandera County Other	San Antonio	Drought management (BCRAGD)	Demand Reduction	J-14	441	491	516	525	533	537	\$0	na	na	na	2	2	2
	Bandera County Other - Volunteer Fire Dept.	San Antonio	Additional groundwater wells to provide emergency supply ALTERNATE	Trinity Aquifer	J-16	189	189	189	189	189	189	\$4,280,000	na	1	2	3	2	3
	Bandera County Other - Enchanted River Estates	San Antonio	Water loss audit and main-line repair	Demand Reduction	J-17	1	1	1	1	1	1	\$117,000	na	na	na	2	2	2
	Bandera County Other	Nueces	Drought management (BCRAGD)	Demand Reduction	J-18	23	26	27	28	28	28	\$0	na	na	na	2	2	2
	*Bandera County Irrigation	San Antonio	Irrigation scheduling	Demand Reduction	J-20	36	36	36	36	36	36	\$0	3	na	na	2	2	2
			Additional groundwater wells	Trinity Aquifer	J-21	75	75	75	75	75	75	\$291,000	1	3	1	2	2	3
	*Bandera County Livestock	Guadalupe	Livestock conservation	Demand Reduction	J-22	1	1	1	1	1	1	\$0	3	na	na	2	2	2
			Additional groundwater well	Middle Trinity Aquifer	J-23	2	2	2	2	2	2	\$135,000	1	1	1	3	2	3
		Nueces	Livestock conservation	Demand Reduction	J-24	1	1	1	1	1	1	\$0	3	na	na	2	2	2
			Additional groundwater well	Middle Trinity Aquifer	J-25	3	3	3	3	3	3	\$126,000	1	1	1	3	2	3
			Public conservation education	Demand Reduction	J-26	1	1	1	1	1	1	\$0	na	na	na	na	na	na
Edwards	City of Rocksprings	Nueces	Additional groundwater well	Edwards-Trinity (Plateau) Aquifer	J-27	121	121	121	121	121	121	\$681,000	na	1	1	2	2	3

Table 5-2. (continued) Summary of Recommended and Alternate Water Management Strategy Evaluation

County	Water User Group	Strategy Source Basin	Strategy	Source	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost	Quantity ^a	Quality ^b	Reliability ^c	Strategy Impacts ^d		
						Water Resources	Agricultural Resources	Natural Resources										
									2020	2030	2040		2050	2060	2070	(1-3)	(1-3)	(1-3)
Edwards	Edwards County Other (Barksdale WSC)	Nueces	Additional well in the Nueces River Alluvium Aquifer and RO wellhead treatment	Nueces River Alluvium	J-28	54	54	54	54	54	54	\$178,000	na	1	2	3	2	3
	*Edwards County Mining	Nueces	Additional groundwater well	Edwards-Trinity (Plateau) Aquifer	J-31	16	16	16	16	16	16	\$125,000	1	1	1	3	2	3
		Colorado	Additional groundwater well	Edwards-Trinity (Plateau) Aquifer	J-33	12	12	12	12	12	12	\$73,000	1	1	1	3	2	3
		Rio Grande	Additional groundwater wells	Edwards-Trinity (Plateau) Aquifer	J-35	31	31	31	31	31	31	\$132,000	1	1	1	3	2	3
Kerr	*City of Kerrville	Guadalupe	Increase wastewater reuse	Treated wastewater reuse	J-36	2,500	2,500	2,500	2,500	2,500	2,500	\$12,570,000		3	1	1	2	2
			Water loss audit and main-line repair	Conservation	J-37	134	134	134	134	134	134	\$12,636,000	3	na	na	2	2	2
			Explore and develop new Ellenburger Aquifer well supply	Ellenburger-San Saba Aquifer	J-39	1,156	1,156	1,156	1,156	1,156	1,156	\$14,493,000	1	unknown	unknown	unknown	2	2
			Increased water treatment and ASR capacity	Guadalupe River and Trinity Aquifer	J-41	0	3,360	3,360	3,360	3,360	3,360	\$15,393,000	1	2	2	2	2	2
	Kerr County Other -Eastern Kerr County Regional Water Supply Project	Guadalupe	Project 1. Construction of an Ellenburger Aquifer water supply well	Ellenburger-San Saba Aquifer	J-45	0	108	108	108	108	108	\$652,000	na	na	na	unknown	2	2
			Project 2. Construction of off-channel surface water storage	Guadalupe River		0	1,121	1,121	1,121	1,121	1,121	\$25,231,000	na	na	na	2	2	1
			Project 2. Construction of surface water treatment facilities and transmission lines	Guadalupe River								\$22,829,000	na	na	na	2	2	2
			Project 3. Construction of ASR facility	Trinity Aquifer								0	1,124	1,124	1,124	1,124	\$1,461,000	na
			Project 4. Construction of Trinity Aquifer wellfield for dense, rural areas	Trinity Aquifer		0	860	860	860	860	860	\$8,367,000	na	na	na	4	2	2
			Project 4. Construction of desalination plant	Trinity Aquifer								\$21,162,000	na	na	na	na	na	na
	Kerr County Other - *Center Point	Guadalupe	Public conservation education	Demand Reduction	J-54	1	1	1	1	1	1	\$0	na	na	na	na	na	na
			Purchase water from EKCRWSP	Guadalupe River and Trinity Aquifer	J-46	11	11	11	11	11	11	\$0	1	1	1	na	na	na
	Kerr County Other - *Center Point Taylor System	Guadalupe	Public conservation education	Demand Reduction	J-55	1	1	1	1	1	1	\$0	na	na	na	na	na	na
			Purchase water from EKCRWSP	Guadalupe River and Trinity Aquifer	J-47	43	43	43	43	43	43	\$0	1	1	1	na	na	na
	Kerr County Other - Verde Park Estates	Guadalupe	Water loss audit and main-line repair	Demand Reduction	J-42	1	1	1	1	1	1	\$155,000	na	na	na	2	2	2
	*Kerr County Other	Nueces	Public conservation education	Demand Reduction	J-43	1	1	1	1	1	1	\$0	na	na	na	na	na	na
	*Kerr County Livestock	Colorado	Livestock conservation	Demand Reduction	J-56	24	24	24	24	24	24	\$0	3	na	na	2	2	2

Table 5-2. (continued) Summary of Recommended and Alternate Water Management Strategy Evaluation

County	Water User Group	Strategy Source Basin	Strategy	Source	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost	Quantity ^a	Quality ^b	Reliability ^c	Strategy Impacts ^d		
						2020	2030	2040	2050	2060	2070		(1-3)	(1-3)	(1-3)	Water Resources	Agricultural Resources	Natural Resources
																(1-5)	(1-5)	(1-5)
Kerr	*Kerr County Livestock	Colorado	Additional groundwater wells ALTERNATE	Edwards-Trinity (Plateau) Aquifer	J-57	119	119	119	119	119	119	\$985,000	1	3	1	3	2	3
		Guadalupe	Livestock conservation	Demand Reduction	J-58	35	35	35	35	35	35	\$0	3	na	na	2	2	2
			Additional groundwater wells ALTERNATE	Edwards-Trinity (Plateau) Aquifer	J-59	173	173	173	173	173	173	\$370,000	1	3	1	3	2	3
		San Antonio	Livestock conservation	Demand Reduction	J-60	5	5	5	5	5	5	\$0	3	na	na	2	2	2
			Additional groundwater well ALTERNATE	Edwards-Trinity (Plateau) Aquifer	J-61	27	27	27	27	27	27	\$79,000	1	3	1	3	2	3
		Nueces	Livestock conservation	Demand Reduction	J-62	1	1	1	1	1	1	\$0	3	na	na	2	2	2
			Additional groundwater well ALTERNATE	Edwards-Trinity (Plateau) Aquifer	J-63	6	6	6	6	6	6	\$66,000	1	1	1	3	2	3
	*Kerr County Mining	Colorado	Additional groundwater wells	Edwards-Trinity (Plateau) Aquifer	J-65	19	19	19	19	19	19	\$197,000	1	1	1	3	2	3
Kinney	City of Brackettville	Rio Grande	Increase supply to Spofford with new water line	Edwards-Trinity (Plateau) Aquifer	J-66	0	3	3	3	3	3	\$4,271,000	na	1	1	2	2	2
			Increase storage facility	Edwards-Trinity (Plateau) Aquifer	J-67	0	3	3	3	3	3	\$1,272,000	na	na	na	na	2	2
	Fort Clark Springs MUD	Rio Grande	Water loss audit and main-line repair	Demand Reduction	J-68	79	79	79	79	79	79	\$1,531,000	na	na	na	na	na	na
			Increase storage facility	Edwards-Trinity (Plateau) Aquifer	J-69	0	620	620	620	620	620	\$1,501,000	na	na	na	na	2	2
Real	*City of Camp Wood	Nueces	Public conservation education	Demand Reduction	J-72	1	1	1	1	1	1	\$0	3	na	na	na	na	na
			Additional groundwater wells	Edwards-Trinity (Plateau) Aquifer	J-73	143	143	143	143	143	143	\$1,709,000	1	1 or 2	1 or 2	3	2	3
	City of Leakey	Nueces	Additional groundwater well	Lower Trinity Aquifer	J-75	91	91	91	91	91	91	\$189,000	na	1 or 2	1 or 2	3	2	3
			Develop interconnections between wells within the City	Frio River Alluvium Aquifer	J-76	0	81	81	81	81	81	\$202,000	na	na	na	na	2	2
	Real County Other - Real WSC	Nueces	Water loss audit and main-line repair	Demand Reduction	J-77	2	2	2	2	2	2	\$482,000	na	na	na	na	na	na
	Real County Other - Oakmont Saddle Mountain WSC	Nueces	Additional groundwater well	Frio River Alluvium Aquifer	J-79	54	54	54	54	54	54	\$417,000	na	1	1	2	2	3
Val Verde	*City of Del Rio	Rio Grande	Water loss audit and main-line repair	Demand Reduction	J-80	12	12	12	12	12	12	\$5,672,000	3	na	na	na	na	na
			Additional groundwater well	Edwards-Trinity (Plateau) Aquifer	J-81	7,191	7,191	7,191	7,191	7,191	7,191	\$12,695,000	1	1	1	3	2	3
			Water treatment plant expansion	Direct Non-Potable Reuse	J-82	0	943	943	943	943	943	\$8,646,000	3	2	1	3	2	2
			Develop a wastewater reuse program	Direct Non-Potable Reuse	J-83	0	3,092	3,092	3,092	3,092	3,092	\$2,846,000	3	3	1	1	2	2
	Laughlin Air Force Base	Rio Grande	Purchase water from City of Del Rio	Rio Grande Run of River	J-87	87	183	284	346	345	345	\$0	1	1	1	na	na	na

Table 5-2. (continued) Summary of Recommended and Alternate Water Management Strategy Evaluation

County	Water User Group	Strategy Source Basin	Strategy	Source	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost	Quantity ^a	Quality ^b	Reliability ^c	Strategy Impacts ^d		
						2020	2030	2040	2050	2060	2070							
						(1-3)	(1-3)	(1-3)	(1-3)	(1-3)	(1-3)					(1-5)	(1-5)	(1-5)
Val Verde	Val Verde County Other - Val Verde County WCID Comstock	Rio Grande	Water loss audit and main-line repair	Demand Reduction	J-84	1	1	1	1	1	1	\$406,000	na	na	na	na	na	na
	Val Verde County Other - San Pedro Canyon Upper Subdivision	Rio Grande	Water loss audit and main-line repair	Demand Reduction	J-85	7	7	7	7	7	7	\$142,000	na	na	na	na	na	na
	Val Verde County Other - Tierra Del Lago	Rio Grande	Water loss audit and main-line repair	Demand Reduction	J-86	4	4	4	4	4	4	\$146,000	na	na	na	na	na	na
	*Val Verde County Mining	Rio Grande	Additional groundwater wells	Edwards-Trinity (Plateau) Aquifer	J-89	242	242	242	242	242	242	\$1,096,000	2	3	1	3	2	3

* WUGs with a projected future supply deficit. (See Table 4-1 for list of shortages)

See Appendix 5B for quantification description of impact ranges.

- a Quantity Range: 1 = Meets 100% of shortage; 2 = Meets 50 to 99% of shortage; 3 = Meets <50% of shortage (See Table 4-1 for list of shortages)
- b Quality Range: 1 = Meets safe drinking-water standards; 2 = Must be treated or mixed to meet safe drinking-water standards; 3 = Usable for intended use
- c Reliability Range: 1 = Sustainable; 2 = Provides firm supply, but may be partially impacted during drought conditions; 3 = Non-sustainable
- d Strategy Impact Range: 1 = Positive, 2 = No New; 3 = Minimal Negative; 4 = Moderate Negative; 5 = Significant Negative

Table 5-3. Summary of Recommended and Alternate Water Management Strategy Cost

County	Water User Group	Strategy	Strategy ID	Total Capital Cost	Annual Cost/Year						Cost per Acre-Foot/Year					
					2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
Bandera	City of Bandera	Reuse treated wastewater effluent for irrigation	J-1	\$1,496,000	\$0	\$131,000	\$131,000	\$26,000	\$26,000	\$26,000	\$0	\$423	\$423	\$84	\$84	\$84
		Promote, design & install rainwater harvesting systems	J-2	\$56,000	\$0	\$4,000	\$4,000	\$0	\$0	\$0	\$0	\$12	\$12	\$0	\$0	\$0
		Additional Lower Trinity well and lay necessary pipeline ALTERNATE	J-3	\$3,298,000	\$0	\$315,000	\$315,000	\$83,000	\$83,000	\$83,000	\$0	\$782	\$782	\$206	\$206	\$206
		Additional Middle Trinity wells within City water infrastructure	J-4	\$625,000	\$54,000	\$54,000	\$10,000	\$10,000	\$10,000	\$10,000	\$335	\$335	\$62	\$62	\$62	\$62
		Surface water acquisition, treatment and ASR	J-5	\$34,188,000	\$0	\$2,418,000	\$2,418,000	\$12,000	\$12,000	\$12,000	\$0	\$1,612	\$1,612	\$8	\$8	\$8
	*Bandera County FWSD #1	Public conservation education	J-6	\$0	\$340	\$391	\$419	\$431	\$438	\$442	\$170	\$195	\$210	\$216	\$219	\$221
		Additional groundwater well	J-7	\$990,000	\$103,000	\$103,000	\$33,000	\$33,000	\$33,000	\$33,000	\$1,030	\$1,030	\$330	\$330	\$330	\$330
	*Bandera County Other - Bandera River Ranch #1	Water loss audit and main-line repair for Bandera River Ranch #1	J-8	\$902,000	\$71,000	\$71,000	\$7,000	\$7,000	\$7,000	\$7,000	\$17,275	\$17,275	\$1,703	\$1,703	\$1,703	\$1,703
	*Bandera County Other - Lake Medina Shores	Public conservation education	J-9	\$0	\$1,208	\$1,391	\$1,493	\$1,534	\$1,559	\$1,572	\$403	\$464	\$498	\$511	\$520	\$524
		Additional groundwater wells ALTERNATE	J-10	\$1,477,000	\$146,000	\$146,000	\$42,000	\$42,000	\$42,000	\$42,000	\$582	\$582	\$167	\$167	\$167	\$167
	*Bandera County Other - Medina WSC	Public conservation education	J-11	\$0	\$448	\$516	\$554	\$569	\$578	\$583	\$448	\$516	\$554	\$569	\$578	\$583
		Additional groundwater well for the Town of Medina	J-12	\$1,417,000	\$142,000	\$142,000	\$42,000	\$42,000	\$42,000	\$42,000	\$2,582	\$2,582	\$764	\$764	\$764	\$764
	Bandera County Other	Drought Management (BCRAGD)	J-14	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
		Additional wells to provide emergency supply to VFD ALTERNATE	J-16	\$4,280,000	\$358,000	\$358,000	\$57,000	\$57,000	\$57,000	\$57,000	\$1,894	\$1,894	\$302	\$302	\$302	\$302
		Water loss audit and main-line repair for Enchanted River Estates	J-17	\$117,000	\$9,000	\$9,000	\$1,000	\$1,000	\$1,000	\$1,000	\$12,329	\$12,329	\$1,370	\$1,370	\$1,370	\$1,370
		Drought Management (BCRAGD)	J-18	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	*Bandera County Irrigation	Conservation - Irrigation scheduling	J-20	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
		Additional groundwater wells	J-21	\$291,000	\$25,000	\$25,000	\$5,000	\$5,000	\$5,000	\$5,000	\$333	\$333	\$67	\$67	\$67	\$67
	*Bandera County Livestock	Livestock conservation	J-22	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
		Additional groundwater well	J-23	\$135,000	\$10,000	\$10,000	\$1,000	\$1,000	\$1,000	\$1,000	\$5,000	\$5,000	\$500	\$500	\$500	\$500
		Livestock conservation	J-24	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
		Additional groundwater well	J-25	\$126,000	\$10,000	\$10,000	\$1,000	\$1,000	\$1,000	\$1,000	\$3,333	\$3,333	\$333	\$333	\$333	\$333
Edwards	City of Rocksprings	Public conservation education	J-26	\$0	\$208	\$208	\$208	\$208	\$208	\$208	\$208	\$208	\$208	\$208	\$208	\$208
		Additional groundwater well	J-27	\$681,000	\$71,000	\$71,000	\$23,000	\$23,000	\$23,000	\$23,000	\$587	\$587	\$190	\$190	\$190	\$190
	Edwards County Other (Barksdale WSC)	Additional well in the Nueces River Alluvium Aquifer	J-28	\$178,000	\$46,000	\$46,000	\$33,000	\$33,000	\$33,000	\$33,000	\$852	\$852	\$611	\$611	\$611	\$611
	*Edwards County Mining	Additional groundwater wells	J-31	\$125,000	\$11,000	\$11,000	\$2,000	\$2,000	\$2,000	\$2,000	\$688	\$688	\$125	\$125	\$125	\$125
		Additional groundwater wells	J-33	\$73,000	\$6,000	\$6,000	\$1,000	\$1,000	\$1,000	\$1,000	\$500	\$500	\$83	\$83	\$83	\$83
		Additional groundwater wells	J-35	\$132,000	\$12,000	\$12,000	\$3,000	\$3,000	\$3,000	\$3,000	\$387	\$387	\$97	\$97	\$97	\$97
Kerr	*City of Kerrville	Increase wastewater reuse	J-36	\$12,570,000	\$722,000	\$722,000	\$133,000	\$133,000	\$133,000	\$133,000	\$289	\$289	\$53	\$53	\$53	\$53
		Water loss audit and main-line repair	J-37	\$12,636,000	\$984,000	\$984,000	\$95,000	\$95,000	\$95,000	\$95,000	\$3,979	\$3,979	\$384	\$384	\$384	\$384

Table 5-3. (continued) Summary of Recommended and Alternate Water Management Strategy Cost

County	Water User Group	Strategy	Strategy ID	Total Capital Cost	Annual Cost/Year						Cost per Acre-Foot/Year					
					2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
Kerr	*City of Kerrville	Explore and develop new Ellenburger Aquifer well supply	J-39	\$14,493,000	\$1,243,000	\$1,243,000	\$223,000	\$223,000	\$223,000	\$223,000	\$1,075	\$1,075	\$193	\$193	\$193	\$193
		Increased water treatment and ASR capacity	J-41	\$15,393,000	\$0	\$1,943,000	\$1,943,000	\$860,000	\$860,000	\$860,000	\$0	\$578	\$578	\$256	\$256	\$256
	Kerr County Other -Eastern Kerr County Regional Water Supply Project	Project 1. Construction of an Ellenburger Aquifer water supply well	J-45	\$652,000	\$0	\$72,000	\$72,000	\$26,000	\$26,000	\$26,000	\$0	\$667	\$667	\$241	\$241	\$241
		Project 2. Construction of an Off-Channel Surface Water Storage		\$25,231,000	\$0	\$1,327,000	\$1,327,000	\$146,000	\$146,000	\$146,000	\$0	\$1,184	\$1,184	\$130	\$130	\$130
		Project 2. Construction of surface water treatment facilities and transmission lines		\$22,829,000	\$0	\$2,559,000	\$2,559,000	\$953,000	\$953,000	\$953,000	\$0	\$2,283	\$2,283	\$850	\$850	\$850
		Project 3. Construction of ASR facility		\$1,461,000	\$0	\$114,000	\$114,000	\$11,000	\$11,000	\$11,000	\$0	\$101	\$101	\$10	\$10	\$10
		Project 4. Construction of Well field for dense, rural areas		\$8,367,000	\$0	\$842,000	\$842,000	\$253,000	\$253,000	\$253,000	\$0	\$979	\$979	\$294	\$294	\$294
		Project 4. Construction of Desalination plant		\$21,162,000	\$0	\$3,105,000	\$3,105,000	\$1,616,000	\$1,616,000	\$1,616,000	\$0	\$3,610	\$3,610	\$1,879	\$1,879	\$1,879
	Kerr County Other - *Center Point	Public conservation education	J-54	\$0	\$128	\$136	\$141	\$146	\$149	\$152	\$128	\$136	\$141	\$146	\$149	\$152
		Purchase water from EKCRWSP	J-46	\$0	\$4,400	\$4,400	\$4,400	\$4,400	\$4,400	\$4,400	\$400	\$400	\$400	\$400	\$400	\$400
	Kerr County Other - *Center Point Taylor System	Public conservation education	J-55	\$0	\$265	\$282	\$293	\$303	\$310	\$316	\$265	\$282	\$293	\$303	\$310	\$316
		Purchase water from EKCRWSP	J-47	\$0	\$17,200	\$17,200	\$17,200	\$17,200	\$17,200	\$17,200	\$400	\$400	\$400	\$400	\$400	\$400
	Kerr County Other - Verde Park Estates	Water loss audit and main-line repair for Verde Park Estates WWW	J-42	\$155,000	\$12,000	\$12,000	\$1,000	\$1,000	\$1,000	\$1,000	\$12,000	\$12,000	\$1,000	\$1,000	\$1,000	\$1,000
	*Kerr County Other	Public conservation education	J-43	\$0	\$3	\$4	\$4	\$4	\$4	\$4	\$3	\$4	\$4	\$4	\$4	\$4
	*Kerr County Livestock	Livestock conservation	J-56	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
		Additional groundwater wells ALTERNATE	J-57	\$985,000	\$84,000	\$84,000	\$15,000	\$15,000	\$15,000	\$15,000	\$706	\$706	\$126	\$126	\$126	\$126
		Livestock conservation	J-58	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
		Additional groundwater wells ALTERNATE	J-59	\$370,000	\$41,000	\$41,000	\$15,000	\$15,000	\$15,000	\$15,000	\$237	\$237	\$87	\$87	\$87	\$87
		Livestock conservation	J-60	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
		Additional groundwater wells ALTERNATE	J-61	\$79,000	\$9,000	\$9,000	\$3,000	\$3,000	\$3,000	\$3,000	\$333	\$333	\$111	\$111	\$111	\$111
		Livestock conservation	J-62	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
		Additional groundwater wells ALTERNATE	J-63	\$66,000	\$5,000	\$5,000	\$0	\$0	\$0	\$0	\$833	\$833	\$0	\$0	\$0	\$0
	*Kerr County Mining	Additional groundwater well	J-65	\$197,000	\$16,000	\$16,000	\$2,000	\$2,000	\$2,000	\$2,000	\$842	\$842	\$105	\$105	\$105	\$105
Kinney	City of Brackettville	Increase supply to Spoford with new water line	J-66	\$4,271,000	\$0	\$330,000	\$330,000	\$29,000	\$29,000	\$29,000	\$0	\$117,857	\$117,857	\$10,357	\$10,357	\$10,357
		Increase storage facility	J-67	\$1,272,000		\$99,000	\$99,000	\$9,000	\$9,000	\$9,000		\$35,357	\$35,357	\$3,214	\$3,214	\$3,214
	Fort Clark Springs MUD	Water loss audit and main-line repair	J-68	\$1,531,000	\$119,000	\$119,000	\$11,000	\$11,000	\$11,000	\$11,000	\$1,515	\$1,515	\$140	\$140	\$140	\$140
		Increase storage facility	J-69	\$1,501,000	\$0	\$117,000	\$117,000	\$11,000	\$11,000	\$11,000	\$0	\$189	\$189	\$18	\$18	\$18
Real	*City of Camp Wood	Public conservation education	J-72	\$0	\$374	\$374	\$374	\$374	\$374	\$374	\$374	\$374	\$374	\$374	\$374	\$374

Table 5-3. (continued) Summary of Recommended and Alternate Water Management Strategy Cost

County	Water User Group	Strategy	Strategy ID	Total Capital Cost	Annual Cost/Year						Cost per Acre-Foot/Year					
					2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
Real	*City of Camp Wood	Additional groundwater wells	J-73	\$1,709,000	\$139,000	\$139,000	\$19,000	\$19,000	\$19,000	\$19,000	\$972	\$972	\$133	\$133	\$133	\$133
	City of Leakey	Additional groundwater well	J-75	\$189,000	\$34,000	\$34,000	\$21,000	\$21,000	\$21,000	\$21,000	\$374	\$374	\$231	\$231	\$231	\$231
		Develop interconnections between wells within the City	J-76	\$202,000	\$0	\$15,000	\$15,000	\$1,000	\$1,000	\$1,000	\$0	\$185	\$185	\$12	\$12	\$12
	Real County Other	Water loss audit and main-line repair for Real WSC	J-77	\$482,000	\$38,000	\$38,000	\$4,000	\$4,000	\$4,000	\$4,000	\$23,457	\$23,457	\$2,469	\$2,469	\$2,469	\$2,469
		Additional well for Oakmont Saddle WSC	J-79	\$417,000	\$32,000	\$32,000	\$29,000	\$29,000	\$29,000	\$29,000	\$593	\$593	\$56	\$56	\$56	\$56
Val Verde	*City of Del Rio	Water loss audit and main-line repair	J-80	\$5,672,000	\$441,000	\$441,000	\$42,000	\$42,000	\$42,000	\$42,000	\$13,960	\$13,960	\$1,330	\$1,330	\$1,330	\$1,330
		Additional groundwater well	J-81	\$12,695,000	\$1,451,000	\$1,451,000	\$558,000	\$558,000	\$558,000	\$558,000	\$202	\$202	\$78	\$78	\$78	\$78
		Water treatment plant expansion	J-82	\$8,646,000	\$0	\$1,231,000	\$1,231,000	\$623,000	\$623,000	\$623,000	\$0	\$1,305	\$1,305	\$661	\$661	\$661
		Develop a wastewater reuse program	J-83	\$2,846,000	\$0	\$219,000	\$219,000	\$19,000	\$19,000	\$19,000	\$0	\$71	\$71	\$6	\$6	\$6
	Laughlin Air Force Base	Purchase water from City of Del Rio	J-87	\$0	\$326	\$326	\$326	\$326	\$326	\$326	\$616	\$616	\$616	\$616	\$616	\$616
	Val Verde County Other	Water loss audit and main-line repair for Val Verde County WCID Comstock	J-84	\$406,000	\$32,000	\$32,000	\$3,000	\$3,000	\$3,000	\$3,000	\$41,026	\$41,026	\$3,846	\$3,846	\$3,846	\$3,846
		Water loss audit and main-line repair for San Pedro Canyon Subdivision (Upper)	J-85	\$142,000	\$11,000	\$11,000	\$1,000	\$1,000	\$1,000	\$1,000	\$5,500	\$5,500	\$500	\$500	\$500	\$500
		Water loss audit and main-line repair for Tierra Del Lago	J-86	\$146,000	\$11,000	\$11,000	\$1,000	\$1,000	\$1,000	\$1,000	\$2,072	\$2,072	\$188	\$188	\$188	\$188
	*Val Verde County Mining	Additional groundwater well	J-89	\$1,096,000	\$93,000	\$93,000	\$16,000	\$16,000	\$16,000	\$16,000	\$384	\$384	\$66	\$66	\$66	\$66

* WUGs with a projected future supply deficit. (See Table 4-1 for list of shortages)

Where applicable, capital costs include: construction, engineering, and easement, environmental, interest during construction, and purchased water.

Engineering, contingency, construction management, financial and leagal costs are estimated at 30 percent of construction costs for pipelines and 35 percent for pump stations and treatment facilities.

Permitting and mitigation for transmission and treatment projects are estimated at 1 percent of total construction costs.

Surface water treatment costs are estimated at \$0.35 per 1,000 gallons for a conventional plant.

Annual costs include operations and maintenance, power cost, and debt service at 6% over 20 years.

Capital costs are estimated based on September 2018 US dollars.

Table 5-4. Summary of Recommended and Alternate Water Management Strategy Environmental Assessment

County	Water User Group	Water Management Strategy	Strategy ID	Environmental Impact Factor **					Comments
				Envir. Water Needs	Wildlife Habitat	Cultural Resources	Envir. Water Quality	Bays & Estuaries ***	
				(1-5)	(1-5)	(1-5)	(1-5)		
Bandera	City of Bandera	Reuse treated wastewater effluent for irrigation use	J-1	2	2	2	2	na	Reduces dependence on new groundwater.
		Promote, design & install rainwater harvesting systems	J-2	1	1	2	1	na	Provides sustainable supplemental fresh water.
		Additional Lower Trinity well and lay necessary pipeline ALTERNATE	J-3	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
		Additional Middle Trinity wells within City water infrastructure	J-4	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
		Surface water acquisition, treatment and ASR	J-5	4	2	2	2	na	Construction of facilities will displace a small segment of natural habitat. Flow in Medina River would be reduced during periods of diversion.
	*Bandera County FWSD#1	Public conservation education	J-6	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater well	J-7	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
	*Bandera County Other - Bandera River Ranch #1	Water loss audit and main-line repair for Bandera River Ranch #1	J-8	2	2	2	2	na	Reduces water loss.
	*Bandera County Other - Lake Medina Shores	Public conservation education	J-9	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater wells ALTERNATE	J-10	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
	*Bandera County Other - Medina WSC	Public conservation education	J-11	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater well for the Town of Medina	J-12	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
	Bandera County Other	Drought Management (BCRAGD)	J-14	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional wells to provide emergency supply to VFD ALTERNATE	J-16	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
		Water loss audit and main-line repair for Enchanted River Estates	J-17	2	2	2	2	na	Reduces water loss.
		Drought Management (BCRAGD)	J-18	na	na	na	na	na	Reduces dependence on existing supply sources.
	*Bandera County Irrigation	Conservation - Irrigation scheduling	J-20	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater wells	J-21	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
	*Bandera County Livestock	Livestock conservation	J-22	2	1	2	2	na	Reduces dependence on existing supply sources.
		Additional groundwater well	J-23	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
		Livestock conservation	J-24	2	1	2	2	na	Reduces dependence on existing supply sources.
		Additional groundwater well	J-25	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
Edwards	City of Rocksprings	Public conservation education	J-26	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater well	J-27	2	2	2	2	na	Well construction and operation to follow RECRD regulations.
	Edwards County Other (Barksdale WSC)	Additional well in the Nueces River Alluvium Aquifer and treatment plant	J-28	2	2	2	2	na	Caution is necessary to not overexploit the aquifer.
	*Edwards County Mining	Additional groundwater wells	J-31	2	2	2	2	na	Well construction and operation to follow RECRD regulations.
		Additional groundwater wells	J-33	2	2	2	2	na	Well construction and operation to follow RECRD regulations.
Additional groundwater wells		J-35	2	2	2	2	na	Well construction and operation to follow RECRD regulations.	
Kerr	*City of Kerrville	Increase wastewater reuse	J-36	2	2	2	2	na	Reduces dependence on existing supply sources.
		Water loss audit and main-line repair	J-37	2	2	2	2	na	Reduces water loss.
		Explore and develop new Ellenburger Aquifer well supply	J-39	2	2	2	2	na	Well construction and operation to follow HGCD regulations.
		Increased water treatment and ASR capacity	J-41	2	2	2	2	na	Reduces dependence on new groundwater.
	Kerr County Other - EKCRWSP	Project 1. Construction of an Ellenburger Aquifer water supply well	J-45	2	2	2	2	na	Well construction and operation to follow HGCD regulations.
		Project 2. Construction of an off-channel surface water storage		2	1	2	2	na	Provides temporary birding habitat.
		Project 2. Construction of surface water treatment facilities and transmission lines		2	3	2	2	na	Construction of facilities will displace a small segment of natural habitat.
		Project 3. Construction of ASR facility		2	2	2	2	na	Well construction and operation to follow HGCD regulations.

Table 5-4. (continued) Summary of Recommended and Alternate Water Management Strategy Environmental Assessment

County	Water User Group	Water Management Strategy	Strategy ID	Environmental Impact Factor **					Comments
				Envir. Water Needs	Wildlife Habitat	Cultural Resources	Envir. Water Quality	Bays & Estuaries ***	
				(1-5)	(1-5)	(1-5)	(1-5)		
Kerr	Kerr County Other - EKCRWSP	Project 4. Construction of wellfield for dense, rural areas	J-45	2	2	2	2	na	Well construction and operation to follow HGCD regulations.
		Project 4. Construction of desalination plant		2	3	2	2	na	Construction of facilities will displace a small segment of natural habitat.
	*Kerr County Other - Center Point	Public conservation education	J-54	na	na	na	na	na	Reduces dependence on existing supply sources.
		Purchase water from EKCRWSP	J-46	na	na	na	na	na	Efficiency of supply through a regional project
	*Kerr County Other - Center Point Taylor System	Public conservation education	J-55	na	na	na	na	na	Reduces dependence on existing supply sources.
		Purchase water from EKCRWSP	J-47	na	na	na	na	na	Efficiency of supply through a regional project
	*Kerr County Other - Verde Park Estates	Water loss audit and main-line repair for Verde Park Estates WWW	J-42	2	2	2	2	na	Reduces water loss.
	*Kerr County Other	Public conservation education	J-43	na	na	na	na	na	Reduces dependence on existing supply sources.
	*Kerr County Livestock	Livestock conservation	J-56	2	1	2	2	na	Reduces dependence on existing supply sources.
		Additional groundwater wells ALTERNATE	J-57	2	2	2	2	na	Well construction and operation to follow HGCD regulations.
		Livestock conservation	J-58	2	1	2	2	na	Reduces dependence on existing supply sources.
		Additional groundwater wells ALTERNATE	J-59	2	2	2	2	na	Well construction and operation to follow HGCD regulations.
		Livestock conservation	J-60	2	1	2	2	na	Reduces dependence on existing supply sources.
		Additional groundwater wells ALTERNATE	J-61	2	2	2	2	na	Well construction and operation to follow HGCD regulations.
		Livestock conservation	J-62	2	1	2	2	na	Reduces dependence on existing supply sources.
Additional groundwater wells ALTERNATE		J-63	2	2	2	2	na	Well construction and operation to follow HGCD regulations.	
*Kerr County Mining	Additional groundwater well	J-65	2	2	2	2	na	Well construction and operation to follow HGCD regulations.	
Kinney	City of Brackettville	Increase supply to Spoford with new water line	J-66	2	2	2	2	na	Temporary land disturbance during excavation for new pipeline.
		Increase storage facility	J-67	2	3	2	2	na	Temporary land disturbance during facility construction.
	Fort Clark Springs MUD	Water loss audit and main-line repair	J-68	2	2	2	2	na	Reduces water loss.
		Increase storage facility	J-69	2	3	2	2	na	Temporary land disturbance during facility construction.
Real	*City of Camp Wood	Public conservation education	J-72	na	na	na	na	na	Intended to reduce water use.
		Additional groundwater wells	J-73	2	2	2	2	na	Well construction and operation to follow RECRD regulations.
	City of Leakey	Additional groundwater well	J-75	2	2	2	2	na	Well construction and operation to follow RECRD regulations.
		Develop interconnections between wells within the City	J-76	2	2	2	2	na	Temporary land disturbance during excavation for new pipeline.
	Real County Other	Water loss audit and main-line repair for Real WSC	J-77	2	2	2	2	na	Reduces water loss.
		Additional well for Oakmont Saddle WSC	J-79	2	2	2	2	na	Well construction and operation to follow RECRD regulations.

Table 5-4. (continued) Summary of Recommended and Alternate Water Management Strategy Environmental Assessment

County	Water User Group	Water Management Strategy	Strategy ID	Environmental Impact Factor **					Comments
				Envir. Water Needs	Wildlife Habitat	Cultural Resources	Envir. Water Quality	Bays & Estuaries ***	
				(1-5)	(1-5)	(1-5)	(1-5)		
Val Verde	City of Del Rio	Water loss audit and main-line repair	J-80	2	2	2	2	na	Reduces water loss.
		Additional groundwater well	J-81	2	2	2	2	na	Temporary land disturbance during drilling, completion, and pipeline connection.
		Water treatment plant expansion	J-82	2	3	2	2	na	Temporary land disturbance during facility construction.
		Develop a wastewater reuse program	J-83	1	2	2	2	na	Temporary land disturbance during placement of new resue distribution pipelines.
	Val Verde County Other	Water loss audit and main-line repair for Val Verde County WCID Comstock	J-84	2	2	2	2	na	Reduces water loss.
		Water loss audit and main-line repair for San Pedro Canyon Subdivision (Upper)	J-85	2	2	2	2	na	Reduces water loss.
		Water loss audit and main-line repair for Tierra Del Lago	J-86	2	2	2	2	na	Reduces water loss.
	Val Verde County Mining	Additional groundwater well	J-89	2	2	2	2	na	Temporary land disturbance during drilling and completion of well.

* WUGs with a projected future water supply deficit. (See Table 4-1 for list of shortages)

See Appendix 5B for quantification description of impact ranges.

** Strategy impact range: 1 = Positive; 2 = No New; 3 = Minimal Negative; 4 = Moderate Negative; 5 = Significant Negative

*** All strategies occur beyond the distance of potential impact to flows into the coastal bay and estuary systems.

5.3 WATER CONSERVATION

Water conservation is one of the most important components of water supply management. Recognizing its impact, setting realistic goals, and aggressively enforcing implementation may significantly extend the time when new supplies and associated infrastructure are needed. This chapter explores conservation opportunities and best management practices and provides a road map for integrating conservation planning into long-range water supply management goals.

5.3.1 State Water Conservation Overview

The Texas Water Development Board (TWDB) defines “conservation” as those practices, techniques, programs, and technologies that will protect water resources, reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling or reuse of water so that a water supply is made available for future or alternative uses. Water conservation management strategies recommended in Chapter 5 include water loss audits to reduce distribution losses, public conservation awareness, and brush management.

Effective conservation programs implement best management practices to try to meet the targets and goals identified within the *Plan* and are important to water conservation planning for all entities such as: municipal, agricultural, industrial, and commercial. Water conservation management planning currently implemented by municipalities, agricultural and commercial interests, and other water users supersede recommendations in this *Plan* and are considered consistent with this *Plan*.

The TWDB and the Texas State Soil and Water Conservation Board (TSSWCB) jointly conducted a study of ways to improve or expand water conservation efforts in Texas. The results of that study are available in a joint 2018 report titled “An Assessment of Water Conservation in Texas, Prepared for the 85th Texas Legislature”

http://www.twdb.texas.gov/publications/reports/special_legislative_reports/doc/TWDB_TSSWCB_85th.pdf?d=1555509508342 and contains the following:

- An assessment of both agricultural and municipal water conservation issues;
- Information on existing conservation efforts by the TWDB and the TSSWCB;
- Information on existing conservation efforts by municipalities receiving funding from the TWDB, as specified in water conservation plans submitted by the municipalities as part of their applications for assistance;
- A discussion of future conservation needs;
- An analysis of programmatic approaches and funding for additional conservation efforts;
- An assessment of existing statutory authority and whether changes are needed to more effectively promote and fund conservation projects; and
- An assessment of the TWDB’s agricultural water conservation program.

The implementation of water conservation programs that are cost effective, meet state mandates, and result in permanent real reductions in water use will be a challenge for the citizens of the Plateau Region. Smaller communities that lack financial and technical resources will be particularly challenged and will look to the State for assistance.

Since portions of the Region are particularly susceptible to water-supply shortages during periods of drought conditions, these areas are especially encouraged to develop conservation-oriented management

plans. Likewise, water-user entities within these areas should become actively involved in the regional water planning activities associated with this *Plan*.

The PWPG considers all groundwater sources recognized in this *Plan* as being critical to the future health and economic welfare of the Plateau Region. Due to the Region's reliance on groundwater to meet current and future water needs, the PWPG recommends that local groundwater conservation districts be formed throughout the entire Region to administer sound, reasonable, and scientifically-based management objectives; and that these districts play a major role in the regional water planning process.

It is generally recognized that brush infestations are the symptom of deeper ecological disturbances such as fire control, drought, grazing mismanagement, wildlife overpopulations and other causes. Selective Brush Management, as a tool to improve watershed yields and water quality, is a conservation management strategy of great interest in the Plateau Region, as well as in surrounding planning regions. A program is in place and administered through the Texas State Soil and Water Conservation Board to provide a cost-share funding program to landowners in the targeted watersheds for the Selective Brush Management. Funding for this program should be targeted on selected areas identified through modeling.

The PWPG joins with the Rio Grande Region (M) and the Far West Texas Region (E) in encouraging funding for projects aimed at the eradication and long-term suppression of salt cedar and other nuisance phreatophytes in the Rio Grande watershed.

5.3.2 Model Water Conservation Plans

Water Conservation Plan forms are available from TCEQ in WordPerfect and PDF formats. The forms for the following entity types listed below are available at:

https://www.tceq.texas.gov/permitting/water_rights/wr_technical-resources/conserv.html. You can receive a print copy of a form by calling 512/239-4691 or by email to wcp@tceq.texas.gov.

Municipal Use – Utility Profile and Water Conservation Plan Requirements for Municipal Water Use by Public Water Suppliers (TCEQ-10218)

Wholesale Public Water Suppliers – Profile and Water Conservation Plan Requirements for Wholesale Public Water Suppliers (TCEQ-20162)

Industrial – Industrial Water Conservation Plan (TCEQ-20839)

Mining Use – Mining Water Conservation Plan (TCEQ-20840)

Agricultural Uses – Agriculture Water Conservation Plan-Non-Irrigation (TCEQ-10541)

System Inventory and Water Conservation Plan for Individually Operated Irrigation Systems (TCEQ-10238)

System Inventory and Water Conservation Plan for Agricultural Water Suppliers Providing Water to More Than One User (TCEQ-10244)

5.3.3 State Water Conservation Programs and Guides

The TWDB provides a significant amount of information and services pertaining to water conservation that can be accessed at: <http://www.twdb.texas.gov/conservation/municipal/plans/index.asp>

Likewise, water conservation tips developed by the TCEQ and made available through their Take Care of Texas educational campaign can be accessed at the following website:

<http://takecareoftexas.org/conservation-tips/conserve-our-water>

Water-Saving Plumbing Fixture Program

The Texas Legislature created the Water-Savings Plumbing Fixture Program on Jan. 1, 1992 to promote water conservation. Manufacturers of plumbing fixtures sold in Texas must comply with the Environmental Performance Standards for Plumbing Fixtures, which requires all plumbing fixtures such as showerheads, toilets and faucets sold in Texas to conform to specific water use efficiency standards.

As of January 1, 2014, Texas (House Bill 2667) mandates all toilets and urinals sold in Texas must meet new efficiency standards.

- Bath faucets cannot exceed 2.2 gallons per minute (GPM)
- Showerheads cannot exceed 2.5 gallons per minute (GPM)
- Kitchen faucets cannot exceed 2.2 gallons per minute (GPM)
- Toilets cannot exceed 1.28 gallons per flush (GPF)
- Urinals cannot exceed 0.5 gallons per flush (GPF)

Since more water is used in the bathroom than any other place in the home, water-efficient plumbing fixtures play an integral role in reducing water consumption, wastewater production, and consumers' water bills. It is estimated that switching to water-efficient fixtures can save the average household between \$50 and \$100 per year on water and sewer bills. Many hotels and office buildings find that water-efficient fixtures can save 20 percent on water and wastewater costs.

The EPA's WaterSense program labels water-efficient products that meet most of the criteria above, and on average are certified to use at 20 percent less water than legacy fixtures. Their website also provides a product search tool and a rebate finder, and can be accessed here: <https://www.epa.gov/watersense>

Water Conservation Best Management Practices

The 78th Texas Legislature under Senate Bill 1094 created the Texas Water Conservation Implementation Task Force and charged the group with reviewing, evaluating, and recommending optimum levels of water use efficiency and conservation for the state. TWDB Report 362, Water Conservation Best Management Practices Guide was prepared in partial fulfillment of this charge. TWDB Report 362 is now considered outdated and a more current list of BMPs is available at:

<https://www.twdb.texas.gov/conservation/BMPs/index.asp>

Public Water Conservation Education

Public education may be one of the most productive actions that can result in the greatest amount of water savings. Most citizens are willing to actively do their part to conserve water once the need is

communicated and how to accomplish the most benefit is explained. Numerous state, county, and academic agencies provide educational material and demonstrations. Groundwater conservation districts also provide water conservation activities.

The TWDB provides a significant amount of information and services pertaining to water conservation that can be accessed at: <http://www.twdb.texas.gov/conservation/municipal/plans/index.asp>

Likewise, water conservation tips developed by the TCEQ and made available through their Take Care of Texas educational campaign can be accessed at the following website:
<http://takecareoftexas.org/conservation-tips/conserve-our-water>

TPWD also offers programs geared toward the appreciation and conservation of the state's outdoor natural resources (<https://tpwd.texas.gov/landwater/water/conservation/>) which include:

- Freshwater Inflows and Estuaries
- Coastal Studies
- River Studies
- Texas Gulf Ecological Management Sites

Education of our youth may be one of the best ways to spread the word about conservation of water. The TWDB provides excellent educational programs for all grade levels K-12th. Information pertaining to this program can be accessed at: <https://www.twdb.texas.gov/conservation/education/kids/index.asp>.

The Groundwater Conservation Districts in the Plateau Region have water conservation management goals that include:

- Publishing conservation articles in local newspapers;
- Providing conservation presentations and demonstrations at county shows;
- Conducting school programs relating to conservation issues; and
- Working with river authorities to promote the clean rivers program.

Watershed Best Management Practices

Watershed best management practices are activities taken to manage, protect, and restore the quality of water resources. Best management practices are designed to consider a variety of water uses and maximize conservation. The Environmental Protection Agency has put together a list of fourteen recommended BMPs and have developed a siting tool which identifies potential suitable locations for implementing different types of BMPs (<https://www.epa.gov/water-research/best-management-practices-bmps-siting-tool>) that have proven to be helpful in water conservation efforts. Several of these practices are discussed further for being cost effective, practical and efficient for the Plateau Region.

Brush Management

A potential means of increasing water supply is to reduce the amount of water consumed by shrubs and trees on rangelands. The density and coverage of shrubs has increased dramatically during the past century as former grasslands have now converted to shrub-lands or closed-canopy woodlands. A total loss of herbaceous vegetation cover will increase water yields in the form of surface runoff. However, this process will accelerate erosion, degrade water quality, and damage aquatic ecosystems. A more

desirable way of increasing water yield is to manage vegetation to decrease evapotranspiration, which will generally increase the amount of water that percolates below the root zone into groundwater and eventually back into streams. Researchers* believe it is appropriate to broaden the issue from solely focusing on “*brush control for increasing water yield*” to “*best management practices for watershed health and sustainability*”. See Section 5.3.9 of this chapter for further discussion on vegetative management as water management strategy.

* Wilcox, B.P., Dugas, W.A., Owens, M.K., Ueckert, D.N., and Hart, C.R., 2005, *Shrub Control and Water Yield on Texas Rangelands, Current State of Knowledge: Texas Agricultural Experiment Station Research Report 05-1*. http://twri.tamu.edu/reports/2005/taesresearchreport_shrub.pdf

Rainwater Harvesting

The following discussion on Rainwater Harvesting is taken from the Texas Water Development Board’s ‘The Texas Manual on Rainwater Harvesting’, 3rd Edition. This manual can be accessed at: http://www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf

Rainwater is valued for its purity and softness. It has a nearly neutral pH, and is free from disinfection by-products, salts, minerals, and other natural man-made contaminants. Plants thrive under irrigation with stored rainwater. Appliances last longer when free from the corrosive or scale effects of hard water. Users with potable systems prefer the superior taste and cleansing properties of rainwater. Rainwater harvesting, in its essence, is the collection, conveyance, and storage of rainwater.

Rainwater harvesting systems can be as simple as a rain barrel for garden irrigation at the end of a downspout, or as complex as a domestic potable system or a multiple end-use system at a large corporate campus. Advantages and benefits of rainwater harvesting are numerous (Krishna, 2003):

- The water is free; the only cost is for collection and use.
- The end use of harvested water is located close to the source, eliminating the need for complex and costly distribution systems.
- Rainwater provides a water source when groundwater is unacceptable or unavailable, or it can augment limited groundwater supplies.
- The zero hardness of rainwater helps prevent scale on appliances, extending their use; rainwater eliminates the need for a water softener and the salts added during the softening process.
- Rainwater is sodium free, important for persons on low sodium diets.
- Rainwater is superior for landscape irrigation.
- Rainwater harvesting reduces flow to storm water drains and reduces non-point source pollution.
- Rainwater harvesting helps utilities reduce the summer demand peak and delay expansion of existing water treatment plants.
- Rainwater harvesting reduces consumers’ utility bills.

The TWDB has a rainwater harvesting webpage that focuses on rainwater projects, training, the Texas Rain Catcher Award and FAQs: <http://www.twdb.texas.gov/innovativewater/rainwater/index.asp>

Landscape Maintenance

A significant amount of water is used each year in the maintenance of residential and non-residential landscapes. Landscape irrigation conservation practices are an effective method of accounting for and reducing outdoor water usage while maintaining healthy landscapes and avoiding runoff. Water wise landscape programs should follow the seven principals of xeriscape:

- Planning and design
- Soil analysis and improvement
- Appropriate plant selection
- Practical turf area
- Efficient irrigation
- Use of mulch
- Appropriate maintenance

Additional detail on this subject is available in TWDB Report 362 ‘Water Conservation Best Management Practices Guide’:

http://www.twdb.texas.gov/publications/reports/numbered_reports/doc/R362_BMPGuide.pdf

Water Loss Audit

Reported municipal use generally includes a variable amount of water that does not reach the intended consumer due to water leaks in the distribution lines, unauthorized consumption, storage tank overflows, and other wasteful factors. For some communities, attending to these issues can be a proactive conservation strategy that may result in significant water savings.

To address the lack of information on water loss, the 78th Texas Legislature passed House Bill 3338, which required retail public utilities that provide potable water to perform and file with the TWDB a water audit computing the utility's most recent annual system water loss every five years. In response to the mandate of House Bill 3338, TWDB developed a water audit methodology for utilities to quantify water losses, standardize water loss reporting and help measure water efficiency. This TWDB report 367 titled ‘Water Loss Audit Manual for Texas Utilities’ can be accessed at:

http://www.twdb.texas.gov/publications/brochures/conservation/doc/WaterLossManual_2008.pdf

The TWDB provides a significant amount of information and services pertaining to water loss audit that can be accessed at: <http://www.twdb.texas.gov/conservation/municipal/waterloss/index.asp>

- Additional resources and appropriate forms provided by TWDB include:
- Water Audit Worksheet Instructions
- Water Loss Guidance
- Guidelines for Setting a Target Infrastructure Leakage Index (ILL)
- Water Loss Manual for Texas Utilities (Updated March 2008)
- Main Line Water Loss Calculator
- Monthly Water Loss Report
- Leak Detection Loan Form
- Ultrasonic Flow Meter Equipment Loan Form

5.3.4 Regional Conservation Water Management Strategies

Many of the recommended water management strategies listed in are classified as “Conservation” and are first to be considered in meeting future water supply needs. These strategies compiled are listed in Table 5-5 and include:

- Water loss audit and main-line repair
- Drought management
- On-site reuse
- Public conservation awareness
- Specified activities for irrigation and livestock use

Table 5-5. Conservation Water Management Strategies

County	Water User Group	Source Basin	Strategy	Strategy ID
	Bandera County FWSD #1	San Antonio	Public conservation education	J-6
	Bandera County Other Bandera River Ranch #1	San Antonio	Water loss audit and main-line repair	J-8
	Bandera County Other Lake Medina Shores	San Antonio	Public conservation education	J-9
	Bandera County Other Medina WSC	San Antonio	Public conservation education	J-11
	Bandera County Other	San Antonio	Drought management	J-14
			Water loss audit and main-line repair	J-17
		Nueces	Drought management	J-18
	Bandera County Irrigation	San Antonio	Irrigation conservation - Irrigation scheduling	J-20
	Bandera County Livestock	Guadalupe	Livestock conservation	J-22
		Nueces	Livestock conservation	J-24
Edwards	City of Rocksprings	Nueces	Public conservation education	J-26
	Edwards County Mining	Nueces	Mining Conservation - On-site reuse	J-30
		Colorado	Mining Conservation - On-site reuse	J-32
		Rio Grande	Mining Conservation - On-site reuse	J-34
Kerr	City of Kerrville	Guadalupe	Water loss audit and main-line repair	J-37
	Kerr County Other: Verde Park Estates	Guadalupe	Water loss audit and main-line repair	J-42
	Kerr County Other	Nueces	Public conservation education	J-43

Table 5-5. (Continued) Conservation Water Management Strategies

County	Water User Group	Source Basin	Strategy	Strategy ID
Kerr	Kerr County Other - Center Point	Guadalupe	Public conservation education	J-54
	Kerr County Other - Center Point Taylor System	Guadalupe	Public conservation education	J-55
	Kerr County Livestock	Colorado	Livestock conservation	J-56
		Guadalupe	Livestock conservation	J-58
		San Antonio	Livestock conservation	J-60
		Nueces	Livestock conservation	J-62
	Kerr County Mining	Colorado	Mining conservation - On-site reuse	J-64
Kinney	Fort Clark Springs MUD	Rio Grande	Water loss audit and main-line repair	J-68
Real	City of Camp Wood	Nueces	Public conservation education	J-72
	City of Leakey	Nueces	Public conservation education	J-74
	Real County Other	Nueces	Water loss audit and main-line repair for Real WSC	J-77
Val Verde	City of Del Rio	Rio Grande	Water loss audit and main-line repair	J-80
	Val Verde County Other	Rio Grande	Water loss audit and main-line repair for Val Verde County WCID Comstock	J-84
			Water loss audit and main-line repair for San Pedro Canyon Subdivision (Upper)	J-85
			Water loss audit and main-line repair for Tierra Del Lago	J-86
	Val Verde County Mining	Rio Grande	Mining conservation - On-site reuse	J-88

5.3.5 Municipal Conservation Programs

Texas Water Code §11.1271 requires water conservation plans for all municipal and industrial water users with surface water rights of 1,000 acre-feet per year or more and irrigation water users with surface water rights of 10,000 acre-feet per year or more. Also, all entities with 3,300 or more connections and/or a financial obligation with TWDB greater than \$500,000 are required to submit water conservation plans. Water conservation plans have been developed for the cities of Kerrville and Del Rio, which meet these criteria. The Upper Guadalupe River Authority, which also has water rights that meet the criteria, is not currently providing water and therefore has not developed a conservation plan under the above TWC requirement. However, UGRA does have a Water Conservation/Drought Management Plan, which was adopted in 1993. Water conservation plans are also required for all other water users applying for a State water right and may also be required for entities seeking State funding for water supply projects.

5.3.6 Gallons Per Capita Daily Goals

Effective municipal conservation can best be monitored in terms of reduction in gallons per day per capita (GPCD). The PWPG recommends the GPCD reduction goals listed in Table 5-6, which provides a listing of projected GPCD reductions anticipated as water efficiency and recommended conservation savings occur on a decadal basis. Entities listed in the table with higher GPCDs than 200 are likely impacted by water loss issues in their distribution systems. It is highly recommended that these entities take advantage of a water-loss audit to guide needed repairs.

Table 5-6. Gallons Per Capita Daily Goals (Source – TWDB Conservation Database)

Water User Group	2020 Adjusted GPCD	2030 Adjusted GPCD	2040 Adjusted GPCD	2050 Adjusted GPCD	2060 Adjusted GPCD	2070 Adjusted GPCD
Bandera	162	158	155	155	154	154
Bandera County FWSD 1	185	180	178	177	177	177
Brackettville	251	247	243	242	242	242
Camp Wood	169	165	161	160	160	160
County-Other, Bandera	93	90	88	87	87	87
County-Other, Edwards	97	93	89	89	88	88
County-Other, Kerr	75	71	69	68	67	67
County-Other, Kinney	120	117	115	114	114	114
County-Other, Real	92	89	87	85	85	85
County-Other, Val Verde	116	113	111	110	110	110
Del Rio Utilities Com.	247	243	240	239	238	238
Fort Clark Springs MUD	438	434	431	430	429	429
Kerrville	172	168	165	163	163	163
Kerrville South Water	107	103	100	99	99	99
Laughlin Air Force Base	514	510	509	509	509	509
Leakey	122	117	114	112	112	112
Rocksprings	209	205	201	201	201	201

Significantly more restrictive measures should be initiated in response to varying degrees of drought conditions such as:

- Mild Drought (Stage 1) – 10% reduction
- Moderate Drought (Stage 2) – 20% reduction
- Severe Drought (Stage 3) – 30% reduction
- Extreme Drought (Stage 4) – 40% reduction

5.3.7 Groundwater Conservation District Management Plans

The Texas Legislature has established a process for local management of groundwater resources through Groundwater Conservation Districts. The districts are charged with managing groundwater by providing for the conservation, preservation, protection, recharging and prevention of waste of groundwater within their jurisdictions. An elected board governs these districts and establishes rules, programs and activities specifically designed to address local problems and opportunities. Texas Water Code §36.0015 states, in part, “Groundwater Conservation Districts created as provided by this chapter are the state’s preferred method of groundwater management.” Four districts are currently in operation within the planning region.

- Bandera County River Authority and Groundwater District
- Headwaters Groundwater Conservation District (Kerr County)
- Kinney County Groundwater Conservation District
- Real-Edwards Conservation and Reclamation District

In recent sessions, the Texas Legislature has redefined the way groundwater is to be managed by establishing a process referred to as Groundwater Management Areas

http://www.twdb.texas.gov/groundwater/management_areas/index.asp. This new process is summarized in Chapter 1, Section 1.1.2. The Real-Edwards and a portion of Kinney districts are in GMA 7; while the Bandera and Kerr (Headwaters) districts are in GMA 9. A portion of the Kinney district is in GMA 10.

As part of the joint planning process, groundwater conservation districts are responsible for determining the *desired future conditions* of principal aquifers within a management area. *Desired future conditions* are defined in Title 31, Part 10, §35601. (6) of the Texas Administrative Code as “the desired, quantified condition of groundwater resources (such as water levels, spring flows, or volumes) within a management area at one or more specified future times as defined by participating groundwater conservation districts.” *Desired future conditions* are implemented to help meet the planning goal for the conservation of water that is to be used for future uses. The following link provides information on desired future conditions: http://www.twdb.texas.gov/groundwater/management_areas/DFC.asp

Based on adopted *desired future conditions*, the TWDB estimates the amount of withdrawals that can occur over a specified time (*modeled available groundwater*) that does not deplete the aquifer beyond the stated *desired future condition*. As of 2018, desired future conditions have been adopted and modeled available groundwater has been determined for the following aquifers in the Plateau Region: Trinity, Edwards Group of the Edwards Trinity (Plateau), Edwards BFZ, and Edwards-Trinity (Plateau).

Bandera County River Authority and Groundwater District

The Bandera County River Authority and Groundwater District <http://www.bcragd.org/> was originally the Bandera County River Authority, created by the Texas legislature in 1971, and the Springhills Water Management District, created by the legislature in 1989. The authority of the Bandera County River Authority was incorporated into the Springhills Water Management District, and in 2003 the TCEQ authorized changing the District’s name to Bandera County River Authority and Groundwater District. The District includes all of Bandera County within its jurisdiction. The mission of the District is to manage, protect and conserve the County’s water and natural resources, while protecting private property rights. The most current District management plan was adopted in April of 2010 and amended in April 2013. The plan can be accessed at:

http://www.twdb.texas.gov/groundwater/docs/GCD/bcragwd/bcragwd_mgmt_plan2013.pdf

Adopted Future Conditions for Bandera County

Aquifer	Edwards Group of the Edwards-Trinity (Plateau)	Trinity
DFC	No net increase in average drawdown through 2070	Increase in average drawdown of approximately 30 feet through 2060

Headwaters Groundwater Conservation District

The Headwaters Groundwater Conservation District <http://www.hgcd.org/> is part of the Hill Country Priority Groundwater Management Area (9) and was created by the Texas legislature in 1991 (HB 1463). The District includes all of Kerr County within its jurisdiction. The District’s revised 2016 Management Plan can be accessed at: <https://hgcd.org/wp-content/uploads/2015/06/District-Management-Plan.pdf>

The purpose of the District is to provide for the conservation, preservation, protection, recharging and prevention of waste of groundwater reservoirs or their subdivisions within the defined boundaries of the District. The District is responsible for registering and permitting wells drilled in the county, along with conducting aquifer analysis to help determine appropriate plans for future development.

Adopted DFCs for the aquifers in Kerr County are shown below. With regards to the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, GMA 9 declares it ‘non-relevant’. Districts in a groundwater management area may, as part of the process for adopting and submitting desired future conditions, propose classification of a portion or portions of a relevant aquifer as non-relevant (31 Texas Administrative Code 356.31 (b)). This classification of an aquifer is made if the districts determine that aquifer characteristics, groundwater demands, and current groundwater uses do not warrant adoption of a desired future condition. Further details explaining ‘non-relevant’ aquifers can be at TWDB website: http://www.twdb.texas.gov/groundwater/docs/How_will_TWDB_Evaluate_DFCs_June_2013.pdf

Adopted Desired Future Conditions for Kerr County

Aquifer	Edwards Group of the Edwards-Trinity (Plateau)	Trinity
DFC	Non-relevant	Increase in average drawdown of approximately 30 feet through 2060.

Kinney County Groundwater Conservation District

The Kinney County Groundwater Conservation District was created by the legislature in 2001 (HB 3243), and was confirmed by the voters of Kinney County in 2002. The District includes all of Kinney County within its jurisdiction. The District was created to develop, promote, and implement water conservation and management strategies to conserve, preserve, protect groundwater supplies within the District, protect and enhance recharge, prevent waste and pollution, and to promote the efficient use of groundwater within the District. The 2018 approved Management Plan includes goals such as: provide the most efficient and sustainable use of groundwater; address conjunctive surface water management issues; address drought conditions and participate in the development of desired future conditions of aquifers.

Adopted Desired Future Conditions for Kinney County (GMA 7)

Aquifer	Edwards-Trinity (Plateau)	Trinity
DFC	Drawdown which is consistent with maintaining an annual flow at Los Moras Springs of 23.9 cfs and median flow of 24.4 cfs.	

Adopted Desired Future Conditions for Kinney County (GMA 10)

Aquifer	Edwards BFZ (GMA10)	Edwards-Trinity (Plateau)
DFC	Water level in well 70-38-902 (J-17) shall not fall below 1,184 feet MSL as mandated by Edwards Aquifer Authority legislation.	

Real-Edwards Conservation and Reclamation District

The Real-Edwards Conservation and Reclamation District <http://www.recrd.org/> was formed by the Texas legislature in 1959 (HB 447) and includes all of Real and Edwards Counties within its jurisdiction. The District was created to provide for the conservation preservation, protection, recharge and prevention of waste of the underground water reservoirs located under the District. The District strives to bring about conservation, preservation and the efficient, beneficial and wise use of water for the benefit of the citizens

and the economy of the District through monitoring and protecting the quantity and quality of the groundwater. The District also aims to maintain groundwater ownership and rights of the landowners.

District activities include regulating groundwater withdrawals by means of spacing and production limits, using the Texas Water Development Board's observation network to monitor changing storage conditions of groundwater supplies within the District, undertaking, as necessary, and cooperating with investigations of the groundwater resources within the District and making the results of investigations available to the public upon adoption by the Board, and potentially requiring reduction of groundwater withdrawals to amounts which will not cause harm to the aquifer.

Adopted Desired Future Conditions for Real and Edwards Counties (GMA 7)

Aquifer	Edwards-Trinity (Plateau)	Trinity (Real County)
DFC	Average drawdown not to exceed 2 feet in Edwards County and not to exceed 4 feet in Real County by 2070. These have been combined into one model so the DFC is for both is 7 feet.	

5.3.8 Upper Guadalupe River Authority Conservation Program

The Upper Guadalupe River Authority (UGRA) provides a significant conservation outreach program serving citizens of Kerr County (<http://www.ugra.org>). Two full-time employees focus on public education programs and activities with emphasis on water conservation. Recent water conservation programs and activities include:

- Working with TPWD on the Healthy Creeks Initiative, assisting landowners with control and management of giant cane (*Arundo doanx*);
- Partnering with the Hill Country Master Gardeners on planning, design, and maintenance of the UGRA EduScape, which is a major landscape project providing educational venues demonstrating water conservation, low maintenance plants, pervious walkway options, and rainwater collection;
- Partnership with the Riverside Nature Center to provide "UGRA 2nd grade Science Day" field trip to all Kerr County 2nd graders;
- Annual River Clean Up event and assistance with cleanups coordinated by other groups;
- Water Enhancement Cost Share Program provides additional reimbursement to landowners enrolled in USDA Natural Resources Conservation Service (NRCS) or Texas State Soil and Water Conservation Board (TSSWCB) brush management programs. Landowners in the Guadalupe River watershed in Kerr County can receive 25% of the amount reimbursed by NRCS or TSSWCB once they have completed brush management activities;
- Water and sediment control basin structures have been constructed at seven locations in the upper Guadalupe River watershed. The structures function to slow runoff during rain events to reduce flooding and sediment loading into the river;
- Rebates up to \$200 are issued to Kerr County residents on their purchases of rainwater catchment system equipment;

- The Rainwater Catchment System Cost Assistance Program annually awards one \$2,500 payment to incentivize the construction of larger rainwater catchment systems. The program is open to anyone in Kerr County, but the applications submitted by entities that promote water conservation education to the public will be given a higher priority;
- Additional opportunities to provide information to the public on water conservation are made available through presentations to students and adults, radio public service announcements, routine newspaper articles, and advertisements in local publications.

This page intentionally left blank.

APPENDIX 5A RECOMMENDED WATER MANAGEMENT STRATEGIES

This page intentionally left blank.

INTRODUCTION

Water Management Strategies described in this appendix are proposed recommended projects to meet projected water supply shortages in future decades, and projects of specific interest by water-user entities participating in this planning process. The strategy evaluation procedure is designed to provide a side-by-side comparison such that all strategies can be assessed based on the same quantifiable factors as shown in Chapter 5 Tables 5-2, 5-3 and 5-4. Specific factors considered in each Table were:

Table 5-2

Quantity adequacy
Quality adequacy
Reliability
Impacts to water, agricultural, and natural resources

Table 5-3

Financial cost (total capital cost, annual cost, and cost per acre-foot)

Table 5-4

Environmental impacts

- Environmental water needs
- Wildlife habitat
- Cultural resources
- Environmental water quality
- Inflows to bays and estuaries

Qualitative and quantifiable impacts resulting from the implementation of projects are an important aspect of the overall analysis of the viability of water management strategies. The Tables above provide a coded ranking of impacts to designated required analysis categories. An explanation of the qualitative and quantifiable rankings listed in the Tables is provided in Appendix 5B. It is recognized that all strategies that require constructed infrastructure, including pipelines, will have either a temporary or permanent land disturbance on the footprint of the project.

Cost evaluations for all strategies include capital cost, debt service, and annual operating and maintenance (O&M) expenses. Capital costs are estimated based on September 2018 US dollars. The length of debt service is 20 years unless otherwise stated. An annual unit cost is also calculated based on the O&M cost per acre-foot of water supplied.

This page intentionally left blank.

5A-1 WATER MANAGEMENT STRATEGIES FOR THE CITY OF BANDERA

The City of Bandera and many other residents of Bandera County rely on the Lower Trinity Aquifer for municipal, domestic, livestock, and irrigation water supply needs, and the demand from the Lower Trinity is projected to increase as the population increases. Because the water level in the Lower Trinity has declined about 350 feet in City of Bandera wells since pumping started in the 1950s, there is concern that continued withdrawals from the Aquifer may negatively impact the Aquifer's ability to meet the long-term water supply needs of the area.

Although the supply-demand analysis does not project a future water supply deficit for the City of Bandera, the following water management strategies are recommended to enhance the reliability of the City's future water supply availability:

- (J-1) Reuse treated wastewater effluent for irrigation of public spaces
- (J-2) Promote, design, and install rainwater harvesting systems on public buildings
- (J-3) Additional Lower Trinity Aquifer well outside the current cone-of-depression and lay necessary pipeline (**ALTERNATE**)
- (J-4) Additional Middle Trinity Aquifer wells within City water infrastructure area
- (J-5) Acquire surface water supply, build required treatment facilities, connect to distribution network, and inject unused supply into underlying Lower Trinity Aquifer (ASR)

The City of Bandera has been active in promoting water conservation during the current drought and has committed to using water conservation as a long-term water management strategy. Conservation practices that the City has adopted include tiered water rates; providing the public with water conservation information; meter change out program and water line replacement program to reduce unaccounted for water loss. The City has also been working with residential and commercial water customers to identify BMPs that can be used to reduce water consumption as well as evaluating the potential for installing rainwater harvesting systems on public buildings. The City of Bandera has adopted the Bandera County River Authority and Groundwater District Drought Contingency Plan. The City has been in drought stage in the past and has implemented various stages of the plan. The various stages of drought management have reduced water use and heightened public awareness of the need to conserve water.

J-1 Reuse Treated Wastewater Effluent for Irrigation of Public Spaces

The City of Bandera has requested funding through the Texas Water Development Board to study the potential of using treated wastewater effluent for irrigation of public parks and athletic fields. The importance of this effort is that the treated wastewater effluent is a known constant and can provide a new source of water for these uses. All current public supplies come predominantly from the Lower Trinity Aquifer, and as a consequence a significant aquifer cone-of-depression has resulted underlying the City of Bandera and surrounding area. If demands can be reduced it will potentially have a positive impact on water levels within the Aquifer.

Quantity, Reliability, and Cost – The quantity and reliability of this source is known through current wastewater discharges allowed under the City's wastewater discharge permit. Average daily flow from

the wastewater plant is approximately 277,000 gallons/day (310 acre-feet/year). Based on the positive recommendation from the feasibility study, construction of this project will include amending the current discharge permit, potentially upgrading the wastewater treatment plant, a pump station, storage tanks and piping to deliver water. Total estimated capital cost for this project is approximately \$1,496,000.

J-2 Promote, Design, and Install Rainwater Harvesting Systems on Public Buildings

Rainwater harvesting is a practical and valuable method for supplying water for multiple uses including household, landscape, livestock and agricultural. A renewed interest in this approach is emerging due to escalating environmental and economic costs associated with the traditional centralized water systems or the drilling of wells. The State has devoted a considerable amount of attention to rainwater harvesting and has enacted many laws regulating this practice. Three specific pieces of legislation support the collection of rainwater: Texas Tax Code 151.355 which allows for a state sales tax exemption on rainwater harvesting equipment, Texas Property Code 202.007 prevents homeowners' associations from banning rainwater harvesting installations, and Texas House Bill 3391 which requires designs of new state buildings to include rainwater harvesting system technology.

The City of Bandera and the Bandera County River Authority and Groundwater District (BCRAGD) is actively involved in the conservation of water through rainwater harvesting. In 2013, Bandera High School was the recipient of the Texas Water Development Board's Texas Rain Catcher Award. This program is established to promote technology, educate the public, and to recognize excellence in the application of rainwater harvesting systems in Texas.

The City of Bandera, with the recommendation from the BCRAGD, has plans to develop a rainwater collection system utilizing rooftops located in the downtown area. This strategy assumes that the system will be gravity fed and used for local irrigation purposes. This project is designed to collect rainwater from two commercial sized roofs and store the water in fiberglass tanks at the respective locations. The strategy includes a fiberglass tank as opposed to a steel tank, since the steel tank would cost considerably more.

Quantity, Reliability, and Cost – This strategy will provide an additional one acre-foot per year. The total estimated capital cost for this project is approximately \$56,000. This project will provide a firm supply of water even though some impact would be expected during drought conditions.

J-3 Additional Lower Trinity Aquifer Well Outside the Current Cone-of-Depression and Lay Necessary Pipeline (ALTERNATE)

The City of Bandera obtains its water from the Trinity Aquifer and serves a growing population. The projected population growth is expected to increase from 1,875 in 2020; to 2,4421 by 2070. In order to keep pace with the growing water demands, the City of Bandera, with the recommendation from the (BCRAGD) has plans to develop additional groundwater from the Lower Trinity Aquifer.

The development of additional supplies from the Lower Trinity Aquifer includes one new well located approximately four miles north of town. It is assumed that the City will purchase the necessary property, costing approximately \$10,000 per acre, along with the associated water rights and develop the

infrastructure needed to pipe the water back to the City. This well will produce water from approximately 800 feet below the surface.

Quantity, Reliability, and Cost – The strategy supply is estimated at 403 acre-feet per year. The Lower Trinity Aquifer has shown that it can be considered reliable as a water supply if properly developed and is not compromised by additional demands. Care will need to be taken to find a suitable site for the new well to prevent any overlapping of existing aquifer cones-of-depression. The cost to develop a water well in the Lower Trinity Aquifer is significant, along with the necessary infrastructure to store and pump the water back to the City of Bandera. The total estimated capital cost for this project is approximately \$3,298,000.

J-4 Additional Middle Trinity Aquifer Wells within City Water Infrastructure Area

The City of Bandera with the recommendation from BCRAGD has identified the Middle Trinity Aquifer as a potential source of supply for meeting future water demands. Currently, this source is not being used for municipal purposes. Development of this Aquifer may provide a source of water that could potentially reduce peak demands on existing wells in the Lower Trinity Aquifer.

The proposed two wells will be located near the Medina River where more recharge might be anticipated and will produce water from approximately 550 feet below the surface. This strategy assumes that the supply from the Middle Trinity Aquifer would require minimal treatment such as chlorine disinfection. In addition, this strategy assumes 1,500 feet of connection piping.

Quantity, Reliability, and Cost – The quantity of water available in the Middle Trinity Aquifer is less than that of the Lower Trinity Aquifer. However, the wells can be pumped at a sustainable rate that does not exceed the MAG allowable. The reliability of water from this source is expected to be approximately 50 gpm. However, the Middle Trinity Aquifer has not been developed for municipal water supply in Bandera. The two wells are expected to yield approximately 161 acre-feet per year. The cost to develop a municipal water well in the Middle Trinity Aquifer is anticipated to be less since the City will not have to drill as deep. Furthermore, this strategy assumes that the new wells will be located within the City limits, minimizing project costs associated with the amount of connection piping required to meet the existing distribution system. The total estimated capital cost for this project is approximately \$625,000.

J-5 Acquire Surface Water Supply, Build Required Treatment Facilities, Connect to Distribution Network, and Inject Unused Supply into Underlying Lower Trinity Aquifer (ASR)

The City of Bandera has considered the feasibility of constructing a water treatment facility to treat surface water from the Medina River. As much of the treated water as is needed will go directly into customer distribution, with the excess being injected into existing public supply wells for future retrieval (ASR). A May 2009 study report titled '*ASR Feasibility in Bandera County*' was prepared for the Plateau Region Water Planning Group and can be accessed at the following link for more strategy detail:

<http://www.ugra.org/pdfs/BanderaReportMay09.pdf>.

https://www.twdb.texas.gov/publications/reports/contracted_reports/doc/0704830695_RegionJ/ASR-Feasibility-Bandera-County_finalreport-August2009.pdf

Bandera County currently has a Water Supply Agreement with Bandera-Medina-Atascosa WCID #1 (BMA WCID#1) for the option of up to 5,000 acre-feet per year. The BMA WCID#1 owns Certificate of Adjudication CA-19-2130, which authorizes the District to divert up to 65,830 acre-feet per year for irrigation, municipal and industrial uses; up to 750 acre-feet per year specifically for domestic and livestock purposes; and up to 170 acre-feet per year specifically for municipal use.

Under CA-19-2130, BMA WCID#1 is authorized to divert water from Medina Lake and Diversion Dam. However, it is anticipated that the surface water purchased by Bandera County for local use and the potential ASR project will be diverted in the vicinity of the City of Bandera, upstream of Medina Lake. As a result, an amendment of the existing water right owned by BMA WCID#1 is required and the addition of an upstream diversion point will likely be subject to additional bypass requirements related to adopted Senate Bill 3 (SB 3) environmental flow standards.

Quantity, Reliability, and Cost – The reliability of the addition of an upstream river diversion was calculated with the official Run 3 version of the Water Availability Model (WAM) of the Guadalupe-San Antonio Basin dated October 2014, provided by the TCEQ. Assumptions of the Run 3 version include adherence to strict prior appropriation; maximum use and storage; no return flows; a hydrologic simulation period of 1934-1989; and application of downstream SB 3 environmental flow standards as adopted and implemented by the TCEQ. The version as received from the TCEQ includes updates for Lake Medina/Diversion Lake and the addition of channel loss factors to all main stem water rights in the Guadalupe and San Antonio River Basins. Based on these modeled characteristics, the average diversion available from the modeled upstream diversion over the historical period (1934-1989) is 4,761 acre-feet per year.

An initial facility will provide 500 acre-feet per year of treated water. As much as is needed will go directly into customer distribution, with the excess being injected into existing public supply wells. In 2040 the facility will increase capacity to 1,000 acre-feet per year, and in 2060 the capacity increases to 1,500 acre-feet per year. To be conservative, a diversion of 85 percent of the average WAM 3 supply or 3,100 acre-feet per year is assumed to be reliably available for planning purposes. The total estimated capital cost for this project is approximately \$34,188,000.

5A-2 WATER MANAGEMENT STRATEGIES FOR BANDERA COUNTY-OTHER

Bandera County-Other has less than 23,000 in population, including individuals living outside of a named water user group. This compilation of users known as County-Other is self-supplied and relies predominately on the Trinity Aquifer for their water supply needs, either on private wells or privately owned water supply systems. In a few locations, the Edwards-Trinity (Plateau) is a modest source of supply.

Although the supply-demand analysis does not project a future water supply deficit for Bandera County-Other, the following water management strategies are recommended to enhance the reliability of the future water supply availability for Bandera County Other:

- (J-6) Public conservation education - Bandera County FWSD #1
- (J-7) Additional groundwater well for Bandera County FWSD #1
- (J-8) Water loss audit and main-line repair for Bandera River Ranch #1
- (J-9) Public conservation education – Lake Medina Shores
- (J-10) Additional groundwater well for Lake Medina Shores (**ALTERNATE**)
- (J-11) Public conservation education – Medina WSC
- (J-12) Additional groundwater well - Medina WSC
- (J-14) Drought management – San Antonio Basin
- (J-16) Additional groundwater wells to provide emergency supply near the volunteer fire department
- (J-17) Water loss audit and main-line repair for Enchanted River Estates
- (J-18) Drought management – Nueces Basin

J-6 Public Conservation Education - Bandera County FWSD #1

Bandera County FWSD#1 is encouraged to emphasize conservation through public information programs. A total of one percent reduction in demand is anticipated, which will result in a water savings of approximately 2 acre-feet per year. The annual cost of this project is estimated to be \$4,949.

J-7 Additional Groundwater Well for Bandera County FWSD #1

This strategy assumes that one new water well be drilled in the Lower Trinity Aquifer, approximately 600 feet in depth. It is anticipated that the well will be cased with either 8- or 12-inch PVC or steel pipe. A 65 gpm electric submersible pump will be installed. In addition, a chlorinator for disinfection purposes will be installed and housed in a small building located on-site. The proposed well-site will include a new 30,000-gallon groundwater storage tank and a dual pump station. A 6-inch water line will be installed to convey water from the well-head to the storage tank, and ultimately to the nearby potable water distribution system.

Quantity, Reliability, and Cost – The quantity of water from the Trinity Aquifer is deemed to be sufficient to meet future demands if a site outside of the existing cone-of-depression can be found. The Aquifer has shown that it can be considered reliable as a water supply if properly developed and is not compromised by additional water demands. It is anticipated that this strategy will provide an additional 100 acre-feet per year. The total estimated capital cost for this project is approximately \$990,000.

J-8 Water Loss Audit and Main-line Repair for Bandera River Ranch #1

According to the 2015 TWDB Public Water System Water Loss Survey, Bandera River Ranch #1 had a total water loss of approximately 791,384 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted-for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of approximately 4 acre-foot per year (338,234 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 3.6 miles of 6-inch diameter main-line will be replaced, with a total project capital cost of approximately \$902,000.

J-9 Public Conservation Education - Lake Medina Shores

Lake Medina Shores is encouraged to emphasize conservation through public information programs. A total of one percent reduction in demand is anticipated, which will result in a water savings of approximately 3 acre-feet per year. The annual cost of this project in 2020 is estimated to be \$1,208.

J-10 Additional Groundwater Well for Lake Medina Shores (ALTERNATE)

This strategy assumes that one new water well be drilled in the Lower Trinity Aquifer, approximately 900 feet in depth. It is anticipated that the well will be cased with either 8- or 12-inch PVC or steel pipe. A 250 gpm electric submersible pump will be installed. In addition, a chlorinator for disinfection purposes will be installed and housed in a small building located on-site. The proposed well site will include a new 30,000-gallon groundwater storage tank and a dual pump station. A 6-inch water line will be installed to convey water from the well head to the storage tank, and ultimately to the nearby potable water distribution system.

Quantity, Reliability, and Cost – The quantity of water from the Trinity Aquifer is deemed to be sufficient to meet future demands if a site outside of the existing cone-of-depression can be found. The Aquifer has shown that it can be considered reliable as a water supply if properly developed and is not compromised by additional water demands. It is anticipated that this strategy will provide an additional 251 acre-feet per year. The total estimated capital cost for this project is approximately \$1,477,000.

J-11 Public Conservation Education - Medina WSC

Medina WSC is encouraged to emphasize conservation through public information programs. A total of one percent reduction in demand is anticipated, which will result in a water savings of approximately 1 acre-feet per year. The annual cost of this project in 2020 is estimated to be \$448.

J-12 Additional Groundwater Well – Medina WSC

This strategy assumes that one new water well be drilled in the Lower Trinity Aquifer, approximately 800 feet in depth. It is anticipated that the well will be cased with either 8- or 12-inch PVC or steel pipe. A 250 gpm electric submersible pump will be installed. In addition, a chlorinator for disinfection purposes will be installed and housed in a small building located on-site. The proposed well-site will include a new 30,000-gallon groundwater storage tank and a dual pump station. A 6-inch water line will be installed to convey water from the well head to the storage tank, and ultimately to the nearby potable water distribution system.

Quantity, Reliability, and Cost – The quantity of water from the Trinity Aquifer is deemed to be sufficient to meet future demands if a site outside of the existing cone-of-depression can be found. The Aquifer has shown that it can be considered reliable as a water supply if properly developed and is not compromised by additional water demands. It is anticipated that this strategy will provide an additional 55 acre-feet per year. The total estimated capital cost for this project is approximately \$1,417,000.

J-14 Drought Management – San Antonio Basin

The Bandera County River Authority and Groundwater District (BCRAGD) has implemented a drought management plan (see Chapter 7 Section 7.2.6.1) to aid in groundwater conservation during declared drought conditions. Stages are triggered by the U.S. Drought Monitor, but can be adjusted at the discretion of the District when aquifer levels, rainfall and river flow conditions warrant. Drought stages are mandated pumping restrictions for permitted wells and recommended restrictions for exempt wells. This strategy recommends that the BCRAGD declare a minimum of Stage 2 (20-percent reduction) on specified wells in the Bandera County San Antonio River Basin to reduce aquifer supply demand by 20 percent. The resulting pumpage reduction will decrease water supply demand in the San Antonio Basin by: 441 acre-feet/year in 2020; 491 acre-feet/year in 2030; 516 acre-feet/year in 2040; 525 acre-feet/year in 2050; 533 acre-feet/year in 2060; and 537 acre-feet/year in 2070.

J-16 Additional Groundwater Wells to Provide Emergency Supply near Volunteer Fire Department

Bandera County River Authority & Groundwater District (BCRAGD) has plans to develop a Regional Project designed to offer relief to residents impacted by severe drought conditions, and to provide a source of water to be potentially used by Fire Departments for emergency firefighting. This strategy assumes that public supply wells will be drilled in strategic locations and outfitted with a 30,000-gallon storage tank per site, which will be connected to the wells by 500 feet of connection piping. In addition, this strategy will be monitored by the BCRAGD to document aquifer conditions, conduct scientific studies such as determining aquifer recharge from rainfall, DFC compliance and regional planning. It is estimated that two new wells will be drilled in the Lower Trinity Aquifer. One well will be drilled in Eastern Bandera County approximately 800 feet in depth, with a capacity of 75 gpm. The second well will be in Western Bandera County approximately 1,100 feet in depth, with a capacity of 100 gpm. The developed water will require minimal treatment such as chlorine disinfection for municipal purposes.

Quantity, Reliability, and Cost – It is anticipated that these two wells will yield a total of 189 acre-feet per year from the Lower Trinity Aquifer. The aquifer has shown that it can be considered reliable as a

water supply if properly developed and is not compromised by additional water demands. The cost to develop water in the Lower Trinity Aquifer is significant. The total estimated capital cost for this project is approximately \$4,280,000.

J-17 Water Loss Audit and Main-line Repair for Enchanted River Estates

According to the 2015 TWDB Public Water System Water Loss Survey, Enchanted River Estates had a total water loss of approximately 2,033,063 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of approximately 1 acre-foot per year (238,072 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 0.5 miles of 6" diameter main-line will be replaced, with a total project capital cost of approximately \$117,000.

J-18 Drought Management – Nueces Basin

The Bandera County River Authority and Groundwater District (BCRAGD) has implemented a drought management plan (see Chapter 7 Section 7.3.6.1) to aid in groundwater conservation during declared drought conditions. Stages are triggered by the U.S. Drought Monitor, but can be adjusted at the discretion of the District when aquifer levels, rainfall and river flow conditions warrant. Drought stages are mandated pumping restrictions for permitted wells and recommended restrictions for exempt wells. Strategy J-69 recommends that the BCRAGD declare a minimum of Stage 2 (20-percent reduction) on specified wells in the Bandera County Nueces River Basin to reduce aquifer supply demand by 20 percent. The resulting pumpage reduction will decrease water supply demand in the Nueces Basin by 23 acre-feet/year in 2020; 26 acre-feet/year in 2030; 27 acre-feet/year in 2040; 28 acre-feet/year in 2050; 28 acre-feet/year in 2060; and 28 acre-feet/year in 2070.

5A-3 WATER MANAGEMENT STRATEGIES FOR BANDERA COUNTY IRRIGATION

Bandera County has approximately 75 acre-feet of irrigation shortage in the San Antonio River Basin over the planning horizon. Irrigation within the Plateau Region is generally limited in most of the counties due to arid conditions and lack of well-developed soils. Low well yields common throughout much of the Region also limit the development of large-scale irrigation. Bandera County generally irrigates less than 200 acres of land with Trinity Aquifer groundwater. In addition to groundwater, most of the diversions by water rights on both the Nueces River and the San Antonio River are used for irrigation purposes. However, surface water is commonly very limited during drought conditions. The following water management strategies are recommended to enhance the reliability of the future water supply availability for the irrigation needs within Bandera County:

- (J-20) Irrigation scheduling
- (J-21) Additional groundwater wells - San Antonio Basin

J-20 Irrigation Scheduling

This strategy is intended for producers with an adequate supply of water throughout the growing season. It involves scheduling the time and amount of water that is applied to a crop based on the amount of water present in the crop root zone, the amount of water consumed by the crop since the last irrigation, and other considerations. Water savings are difficult to quantify and vary from year to year based on cropping practices, water quality, and quantity. It is estimated that 0.3 to 0.5 acre-feet of water per acre may be saved. (Modified from TWDB BMPs at: <http://www.twdb.texas.gov/conservation/BMPs/Ag/index.asp>)

Quantity, Reliability and Cost - According to the 2017 U.S. Ag Census, Bandera County had 55 farms with irrigated land in 2017 and with an average of 22 acres per farm. Assuming that scheduling would conserve 0.3 acre-feet per acre and that only six of the 55 farms in Bandera County might implement this conservation strategy, this results in a conservation savings of approximately six acre-feet per farm, or 36 acre-feet per year total. The estimated quantity of supply for this strategy is uncertain due to variability of potential users who might implement this strategy. The reliability of this supply is low due to uncertainty associated with estimated implementation of BMPs. There is no cost associated with implementing this strategy.

J-21 Additional Groundwater Wells – San Antonio Basin

The Trinity Aquifer has been identified as a potential source of water to meet the irrigation shortages within the County. Water from this source is generally good. TDS levels increase as the depth to the Aquifer increases. The Trinity Aquifer is one of the most extensive and highly used groundwater sources in Texas. This strategy assumes that three new wells will be drilled to provide approximately 75 acre-feet per year. These wells will produce water from approximately 330 feet below the surface.

Quantity, Reliability, and Cost –The three new wells are assumed to supply an additional 75 acre-feet per year. The reliability of this supply is medium, based on competing demands. The total capital cost of this project is approximately \$291,000.

5A-4 WATER MANAGEMENT STRATEGIES FOR BANDERA COUNTY LIVESTOCK

Bandera County has a projected 5 acre-feet per year of livestock water use shortage over the planning horizon. During times of prolonged drought, ranchers often reduce their stock inventory, which will naturally result in decreased supply demand.

Livestock within the County obtain supplies from both surface and groundwater sources. Surface water, such as local-supply tanks, is commonly used, but limited during drought. Groundwater from the Edwards-Trinity (Plateau) Aquifer and Trinity Aquifer are more reliable sources. The following water management strategies are recommended to enhance the reliability of the future water supply availability for livestock needs within Bandera County:

- (J-22) Livestock conservation – Guadalupe Basin
- (J-23) Additional groundwater well - Guadalupe Basin
- (J-24) Livestock conservation – Nueces Basin
- (J-25) Additional groundwater well - Nueces Basin

J-22 Livestock Conservation – Guadalupe Basin

Rotational grazing consists of subdividing grazing pastures and rotating livestock from one pasture to another on a regular interval. This allows the watershed, soils, and vegetation to recover from the stress of continuous livestock grazing. A study by Texas A&M AgriLife Research at Vernon (Ledbetter, 2017) found that changing to a multi-pasture rotational livestock management system reduced surface runoff and sediment load in the local stream by 39 and 34 percent, respectively. The study also found that subsurface flow increased by 48 percent, primarily due to increased infiltration and soil water storage associated with rotational grazing. This strategy assumes a conservative 20 percent reduction of the projected supply need. One acre-foot per year is assumed for the Guadalupe Basin livestock conservation strategy. No capital cost is assigned to this strategy.

J-23 Additional Groundwater Well – Guadalupe Basin

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the livestock shortages within the County and is a recommended strategy. Water from this source ranges from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. This strategy assumes that one new well will be drilled to approximately 700 feet below the surface.

Quantity, Reliability, and Cost –The one new well produce an additional 2 acre-feet per year, with a medium to high reliability based on competing demands. The total cost of this project will be approximately \$135,000.

J-24 Livestock Conservation – Nueces Basin

Rotational grazing consists of subdividing grazing pastures and rotating livestock from one pasture to another on a regular interval. This allows the watershed, soils, and vegetation to recover from the stress of continuous livestock grazing. A study by Texas A&M AgriLife Research at Vernon (Ledbetter, 2017) found that changing to a multi-pasture rotational livestock management system reduced surface runoff

and sediment load in the local stream by 39 and 34 percent, respectively. The study also found that subsurface flow increased by 48 percent, primarily due to increased infiltration and soil water storage associated with rotational grazing. This strategy assumes a conservative 20 percent reduction of the projected supply need. One acre-foot per year is assumed for the Nueces Basin livestock conservation strategy. No capital cost is assigned to this strategy.

J-25 Additional Groundwater Well – Nueces Basin

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the livestock shortages within the County and is a recommended strategy. Water from this source ranges from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. This strategy assumes that one new 20 gpm well will be drilled to approximately 860 feet below the surface.

Quantity, Reliability, and Cost – The one new well is assumed to supply an additional 3 acre-feet per year, with a medium to high reliability based on competing demands. The total cost of this project will be approximately \$126,000.

5A-5 WATER MANAGEMENT STRATEGIES FOR THE CITY OF ROCKSPRINGS

The City of Rocksprings is the county seat for Edwards County, named from the natural springs that occur within the porous limestone rocks in the area. The City and many other residents of Edwards County rely on the Edwards-Trinity (Plateau) Aquifer for municipal, domestic, livestock and irrigation water supply needs. Some local surface water is used by livestock. However, much of the supply from these sources is nearly fully developed for current use.

The City of Rocksprings has no projected water supply deficit for this planning cycle. The following water management strategies are recommended to enhance the reliability of the City's future water supply availability:

- (J-26) Public Conservation Education
- (J-27) Additional Groundwater Wells

J-26 Public Conservation Education

The City of Rocksprings is encouraged to emphasize conservation through public information programs. A total of one percent reduction in demand is anticipated, which will result in a water savings of approximately 1 acre-feet per year. The annual cost of this project in 2020 is estimated to be \$208.

J-27 Additional Groundwater Wells

The City of Rocksprings has recently completed the construction of two new Edwards-Trinity (Plateau) Aquifer wells located approximately six blocks west from the existing overhead storage facility. The City will need to install approximately 500 feet of connection pipe to connect to the wells. This strategy assumes that the new wells will produce water approximately 480 feet below the surface, providing an estimated 121 acre-feet per year. Minimal advance treatment such as chlorine disinfection is required for municipal use.

Quantity, Reliability, and Cost – The two new wells, when brought on line, are assumed to supply an additional 121 acre-feet per year. The reliability of this supply is medium to high, based on competing demands. The total capital cost of this project is approximately \$681,000.

5A-6 WATER MANAGEMENT STRATEGIES FOR BARKSDALE WATER SUPPLY CORPORATION

The Barksdale Water Supply Corporation is a Not for Profit 501 C Corporation that serves the small Community of Barksdale. Currently, the system has two small (40 gpm each) alluvial wells that pump water into the systems pressure tank, and is then distributed to 83 active connections in the system. Due to the small number of connections and relatively low water rates, the income of the system is not adequate to set aside funding for capital improvements. Therefore, over the years the infrastructure of the water supply corporation has deteriorated, and the system is in need of repair and upgrades. The system is currently at peak output, and the projected increase demands from new subdivisions in the area will require extensive upgrades, which will include two additional wells and a new larger capacity pressure tank. In full build-out, the subdivision will add an additional 28 connections or a 34 percent increase in system capacity. Although the supply-demand analysis does not project a future water supply deficit for Barksdale Water Supply Corporation, the following water management strategy is recommended to enhance the reliability of the Community's future water supply availability

J-28 Additional Well in the Nueces River Alluvium Aquifer and RO Wellhead Treatment

Barksdale WSC with the recommendation from Real-Edwards Groundwater Conservation and Reclamation District has plans to drill one additional well in the Nueces River Alluvium Aquifer to help supplement the existing water system. This strategy assumes that the necessary groundwater pumping authorization and property will be obtained for the development of one new well, located a sufficient distance from the other municipal wells in the system to prevent overlapping cones-of-depression. This well is expected to maintain minimum production of 34 gpm. The new well will be drilled at a depth of 50 feet. In addition, this strategy includes 300 feet of six-inch connection pipeline and a reverse osmosis wellhead filter.

Quantity, Reliability, and Cost – The quantity of water from this source is expected to provide up to 54 acre-feet per year. Sufficient groundwater is available from the Nueces River Alluvium Aquifer without causing excessive water-level declines; however, some impact might be expected in a severe drought. The total capital cost for this project is estimated at \$178,000.

5A-7 WATER MANAGEMENT STRATEGIES FOR EDWARDS COUNTY MINING

Edwards County has approximately 59 acre-feet of mining water supply shortage over the planning horizon. Local surface water in conjunction with groundwater from the Edwards-Trinity (Plateau) Aquifer, provide the water needed for industrial use within the County. The following water management strategies are recommended to enhance the reliability of the future water supply availability for the mining water-supply shortages within Edwards County:

- (J-31) Additional groundwater well (Nueces Basin)
- (J-33) Additional groundwater well (Colorado Basin)
- (J-35) Additional groundwater wells (Rio Grande Basin)

J-31 Additional Groundwater Well (Nueces Basin)

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the mining water supply shortages within the County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that one new well will be drilled to produce water from approximately 600 feet below the surface and produce at a rate of 40 gpm.

Quantity, Reliability, and Cost –The one new well is assumed to supply an additional 16 acre-feet per year, with a reliability of medium to high based on competing demands. The total capital cost of this project is approximately \$125,000.

J-33 Additional Groundwater Well – (Colorado Basin)

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the mining water supply shortages within the County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that one new well will be drilled to produce water from approximately 350 feet below the surface and produce at a rate of 15 gpm.

Quantity, Reliability, and Cost – The one new well is assumed to supply an additional 12 acre-feet per year, with a reliability of medium to high based on competing demands. The total capital cost of this project is approximately \$73,000.

J-35 Additional Groundwater Wells (Rio Grande Basin)

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the mining water supply shortages within the County. The Aquifer consists of lower Cretaceous age,

saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that two new wells will be drilled to produce water from approximately 335 feet below the surface and produce at a rate of 10 gpm.

Quantity, Reliability, and Cost – The two new wells are assumed to supply an additional 31 acre-feet per year, with a reliability of medium to high, based on competing demands. The total capital cost of this project is approximately \$132,000.

5A-8 WATER MANAGEMENT STRATEGIES FOR THE CITY OF KERRVILLE

The City of Kerrville has developed a conjunctive-use policy for both surface water and groundwater and passed a comprehensive Water Management Plan in early 2004 (updated 2010). The policy specifies that: (1) surface water will be used to the maximum extent that it is available, (2) groundwater will be a supplemental source of supply, and (3) water consumption will be reduced through conservation.

The TCEQ Guadalupe River WAM 3 drought-of-record analysis yields 150 acre-feet per year of surface water from the Guadalupe River for municipal use and 75 acre-feet per year for irrigation as reliable for the City of Kerrville. For planning purposes, the City proposes to use this estimate of available surface water, even though the estimate is significantly less than the permitted amount based on availability during a drought-of-record. Kerrville will develop additional surface and groundwater supplies, storage options or modifications to the existing permits, and expansion of the aquifer storage and recovery (ASR) system if it can be shown that there are periods when the City will not be able to use the permitted water from the Guadalupe River.

The City of Kerrville has been operating an ASR system for the past several years. In this system, a portion of treated Guadalupe River surface water is injected into the Lower Trinity Aquifer during months of water surplus and recovered from the Aquifer for subsequent use during dry summer months. Currently, the ASR has two wells that serve for both injection and recovery. The capacity of the storage in the ASR is virtually unlimited, but the rates of injection and recovery are limited to 1 MGD in each of the two wells. A third well is in planning stages. As of December 2018, the total storage in the ASR was over 950 million gallons (2,915 acre-feet).

Assuming that a drought-of-record starts immediately, the maximum reliable supply for the City of Kerrville is 150 acre-feet per year using the volume stored in the Aquifer as of June 2010. Permit 1996 would provide an additional 150 acre-feet per year for municipal use, for a total of 300 acre-feet per year. However, the ASR storage does not recover quickly, and if there are multiple drought years, the ASR may not have enough storage for a reliable supply to cover the entire drought period. Therefore, a reliable surface water supply of 150 acre-feet per year for the City of Kerrville is recommended.

Based on current groundwater availability estimates, the firm yield of the Lower Trinity Aquifer is estimated at 4,250 acre-feet per year in the Kerrville area. The City of Kerrville uses approximately 3 MGD, or 3,360 acre-feet per year as an available groundwater supply during a drought year. The City continues to rely on the Lower Trinity Aquifer as a dependable source of water. Through the City's conjunctive use policy, groundwater is reserved for meeting peak demand in a normal year and base demand in a drought year. For planning purposes, the estimates of available groundwater are 5 MGD (5,600 acre-feet per year) for peak demand and 3 MGD (3,360 acre-feet per year) for average demand.

The City has identified the possibility of modifying its own existing water permits. Currently the City's ability to divert under its existing permits is dependent on whether more senior water right holders exercise their rights, and is also affected by the City's Special Conditions written into its permits. If the City had more reliability from the Guadalupe River and more latitude in its ability to divert during certain months of the year, the City could more fully utilize its ASR facility.

The City of Kerrville's water treatment capacity also limits its utilization of its ASR facility. The City needs excess treatment capacity to treat and store 4 MGD during periods of higher streamflow; the current

ASR system is limited to 2 MGD. The City has included the necessary project to increase the ASR system to 4 MGD in the ten-year capital improvement program.

The City is currently exploring the potential of the Ellenburger Aquifer to provide additional water supply. If the aquifer does not prove to be a viable source, the City is considering constructing an RO facility adjacent to the existing reuse pond and treating the water to potable standards.

The availability of water will become a factor limiting the growth of both Kerrville and Kerr County. Currently, the supply-demand analysis for the City of Kerrville projects a water-supply deficit of 874 acre-feet per year in 2020; increasing to 1,156 acre-feet per year by 2070. Water management strategies that the City can consider as possible future sources of supply include:

- (J-36) Increase wastewater reuse
- (J-37) Water loss audit and main-line repair for City of Kerrville
- (J-39) Explore and develop new Ellenburger Aquifer well supply
- (J-41) Increasing water treatment and ASR capacity

J-36 Increase Wastewater Reuse

The City of Kerrville has completed construction of a 98-million-gallon detention pond at the City's existing WWTP to store treated effluent for reuse purposes. The design of this project is to also include a second detention pond to be constructed later when water demands warrant its construction. This strategy focuses solely on the construction of the second pond as a means of expanding the wastewater reuse system capacity.

Quantity, Reliability, and Cost – The quantity and reliability of water from this source is expected to be approximately 2,500 acre-feet per year. The reliability of this source is high. The total capital cost is approximately \$12,570,000.

J-37 Water Loss Audit and Main-line Repair for City of Kerrville

According to the 2017 TWDB Public Water System Water Loss Survey, the City of Kerrville had a water loss of approximately 237,535,450 gallons per year (18.4 percent) due to leaking distribution lines and/or faulty meters. This amount of water loss is the sum of reported breaks and leaks and unreported loss. Currently the City of Kerrville is replacing old inaccurate water meters with new remote read meters. With this increase in accuracy, the City hopes to reduce unaccounted for water, allowing for a more accurate look at water consumption.

Quantity, Reliability, and Cost - This strategy assumes a potential savings of 134 acre-feet per year. It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 51 miles of 6" diameter main-line would be replaced, with a total project capital cost of \$12,636,000.

J-39 Explore and Develop new Ellenburger Aquifer Well Supply

This strategy assumes that two new water wells will be drilled in the Ellenburger-San Saba Aquifer, approximately 1,150 feet in depth. It is anticipated that the well will be cased with either 8- or 12-inch

PVC or steel pipe. A 600 gpm electric submersible pump will be installed. In addition, a chlorinator for disinfection purposes will be installed and housed in a small building located on-site. The proposed well site will include a new 30,000 gallon groundwater storage tank and a dual pump station. An 8-inch water line will be installed to convey water from the wellhead to the storage tank, and ultimately to the nearby potable water distribution system.

The Headwaters Groundwater Conservation District is currently drilling test wells into the Ellenburger-San Saba Aquifer to determine potential yield and chemical quality. The first test well produced favorable results. A second test well will be drilled soon within the City of Kerrville to determine its viability as a municipal source for the City. If the results from this second well are favorable, the City will likely proceed with this strategy.

Quantity, Reliability, and Cost – It is anticipated that this strategy will provide an additional 1,156 acre-feet per year. The total estimated capital cost for this project is approximately \$14,493,000.

J-41 Increasing Water Treatment and ASR Capacity

The City of Kerrville is planning on expanding its existing water treatment plant from its current capacity of 5 MGD to 7 MGD, and the ASR pumping and storage capacity of 2 MGD to 4 MGD. The capacity of the storage in the ASR is virtually unlimited, but the rates of injection and recovery are limited to 1 MGD in each of the two wells. A third and fourth well are in planning stages. As of December 2015, the total storage in the ASR was 600 million gallons (1,841 acre-feet).

The City is also evaluating the possibility of treating wastewater to drinking water standards and storing it in the ASR system. Wastewater is one of the most reliable sources of water during a drought and thus must be considered as a possible water supply. If it were decided to proceed with this project the City would need an additional 2-3 MGD of ASR capacity.

The City's current water treatment capacity limits its utilization of its ASR facility. The City has identified the need for an additional 2 MGD of treatment capacity to take care of peak use; take advantage of periods when higher stream flows occur in the Guadalupe River; and thus, fully utilize its ASR. The increased storage capacity provided by the expanded ASR operation will make available water supplies more reliable. However, during drought-of-record conditions, water available from the upper Guadalupe River may be limited or nonexistent. Treated Guadalupe River water is injected into the aquifer during non-drought conditions when surface water is plentiful and is retrieved at a later time as a supply source during drought-of-record conditions when surface water is scarce.

Quantity, Reliability, and Cost – The treated supply made available through this strategy is estimated to be 3,360 acre-feet per year. Because of the uncertainty involved with the development of this source for municipal use, the reliability of this strategy is considered moderate. The total capital cost is estimated at \$15,393,000.

5A-9 WATER MANAGEMENT STRATEGIES FOR KERR COUNTY-OTHER

Kerr County-Other has a projected population of 24,165, excluding Kerrville and Kerrville South, in 2020, increasing to 28,949 by 2070. This compilation of users known as County-Other is self-supplied and relies predominately on groundwater from the Trinity Aquifer for their water supply needs. Although Kerr County-Other has a projected water supply deficit of only 10 acre-feet per year for the planning horizon, this shortage is spread over the entire County. The rural population is however, concentrated in the eastern portion of the County

Kerr County Commissioners' Court in partnership with the Upper Guadalupe River Authority (UGRA) has plans to develop several Eastern Kerr County Regional Water Supply projects to better serve expanding rural areas. These projects will offer reliable and sustainable sources of water for the growing water demands of numerous small utilities in the service region including Center Point and Center Point Taylor System.

Conservation will be a key factor in developing eastern Kerr County water needs in the future. The mission of UGRA is to "conserve and reclaim surface water through the preservation and distribution of the water resources for future growth to maintain and enhance the quality of life for all Kerr County citizens". Conservation measures are also recommended for Center Point, Center Point Taylor System, and Verde Park Estates.

The following water management strategies are recommended to enhance the reliability of the future water supply availability for Kerr County-Other:

- (J-45) Eastern Kerr County Regional Water Supply Project
- (J-54) Public conservation education – Center Point
- (J-46) Purchase water from EKCRWSP – Center Point
- (J-55) Public conservation education – Center Point Taylor System
- (J-47) Purchase water from EKCRWSP – Center Point Taylor System
- (J-42) Water loss audit and main-line repair for Verde Park Estates
- (J-43) Public conservation education (Nueces River Basin)

J-45 Eastern Kerr County Regional Water Supply Project

Population growth in eastern Kerr County continues to increase, creating genuine concerns pertaining to the water availability needed to meet these growing demands. Kerr County Commissioners' Court (KCCC) in partnership with the Upper Guadalupe River Authority (UGRA) has plans to develop several Eastern Kerr County Regional Water Supply Projects (EKCRWSP) to provide for conjunctive use of surface water and groundwater in high density growth areas of eastern Kerr County outside of the area serviced by the City of Kerrville. A facility plan was completed in 2010 utilizing an EDAP grant from the TWDB for a wholesale surface water supply. Total capital cost for all projects associated with this regional strategy is \$79,702,000. UGRA is the sponsor for this regional project.

The *2021 Plateau Region Water Plan* projects only a limited amount of water-supply shortage for the rural Guadalupe River Basin portion of Kerr County at large; however, it is recognized that a greater percentage of the rural population is concentrated in the eastern portion of the county (see Chapter 2,

Figure 2-3). To prepare for this concentrated water supply need the following water management projects are recommended to develop a regional water management strategy and enhance the reliability of the future water supply availability for the Kerr County Other category:

- Project 1. Ellenburger Aquifer water supply well
- Project 2a. Construction of an off-channel surface water storage
- Project 2b. Construction of surface water treatment facilities and transmission line
- Project 3. Construction of ASR facilities
- Project 4a. Trinity aquifer wellfield
- Project 4b. Construction of a desalination plant

Project 1. Ellenburger Aquifer Water Supply Well

This strategy considers a new water supply well providing water to the Eastern Kerr County Regional Project. The single well will be drilled to a depth of approximately 1,000 feet and will tap the Ellenburger Aquifer. Although there are no Ellenburger supply wells in Kerr County, the aquifer is a significant groundwater source for the City of Fredericksburg immediately to the north in Gillespie County. Subsurface geology suggests that there is a strong potential that usable groundwater will be encountered in the Ellenburger in northern Kerr County. An initial pilot hole will be drilled to total depth to verify the existence of a groundwater supply prior to completing the well to its full capacity. The Headwaters Groundwater Conservation District will provide geotechnical guidance on the drilling of the well. Groundwater supplies produced from this well will be routed to the EKCRWSP distribution network or, if water quality treatment is necessary, to the desalination facility discussed in Project 2b.

Quantity, Reliability, and Cost – The Ellenburger Aquifer has been identified as a viable source, but the quantity and reliability of water from this source is unknown. For this *Plan*, one new well will be drilled at a depth of 1,000 feet below the surface to provide an additional 108 acre-feet per year of water. This strategy includes two miles of six-inch diameter transmission line. Minimal treatment, such as chlorine disinfection, will be required for municipal purposes. The total estimated capital cost for this project is \$652,000.

Project 2a. Construction of an Off-Channel Surface Water Storage

This Regional Project provides for the securing of one or more off-channel ground storage facilities. The strategy assumes that the facility will be lined with impervious material to prevent subsurface seepage loss. Guadalupe River water will be captured during excessive flow episodes. Following a period of time to allow for settling of sediment, the captured water will be diverted for treatment to drinking water quality to a facility site near the Community of Center Point (Project 2b). Water supply generated from this strategy will be combined with water supplies generated in Strategies J-45 and J-46 for public distribution.

Quantity, Reliability, and Cost – The reliability of the river diversion was calculated with the official Run 3 version of the Water Availability Model (WAM) of the Guadalupe-San Antonio Basin dated October 2014, provided by the TCEQ. Assumptions of the Run 3 version include adherence to strict prior

appropriation; maximum use and storage; no return flows; a hydrologic simulation period of 1934-1989; and application of downstream Senate Bill 3 environmental flow standards as adopted and implemented by the TCEQ.

The volume of water this strategy will produce is estimated to average 1,121 acre-feet per year, which will generally only occur during high river flow episodes. During drought-of-record periods, the supply is likely unavailable. Because of the uncertainty involved with the development of this source for municipal use, the reliability of this strategy is considered moderate by itself; however, in combination with other more reliable supplies the project becomes more meaningful.

Total estimated capital cost for this project is \$25,231,000, which includes 1,500-acre land purchase and survey cost of \$5,763,000.

Project 2b. Construction of Surface Water Treatment Facilities and Transmission Line

The construction of a surface water treatment facility to serve the unincorporated community of Center Point and other rural areas in eastern Kerr County includes a 1.8 mgd surface water treatment plant, an intake structure and pumping station, a 500,000 gallon elevated storage tank, and an assumed five miles of 10-inch diameter transmission line. Water supply sources for this facility are generated through Project 2a and possibly Project 1.

Quantity, Reliability, and Cost – In total, this strategy will provide treatment capacity for up to 1,121 acre-feet per year of water. The new supply of water will go directly into customer distribution. The estimated capital cost for a 1.8 MGD capacity source water treatment facility is \$22,829,000. Treated supplies in excess of those that are of immediate use can be made available for storage in an ASR project (Project 3).

Project 3. Construction of ASR Facility

The feasibility of constructing an ASR facility to provide additional water supplies to the eastern portion of Kerr County was evaluated by LBG-Guyton Associates and Freese and Nichols, Inc. during the 2011 planning period (*Water Rights Analysis and ASR Feasibility in Kerr County, 2010*).

Quantity, Reliability, and Cost – This strategy evaluation assumed a facility site near the Community of Center Point. This strategy assumes that 1,124 acre-feet per year of excess treated water from the Project 2b water treatment facility would be injected into the Lower Trinity Aquifer and recovered during times of supply shortage. The cost to construct and equip ASR wells capable of both injection and withdrawal is approximately \$1,461,000. Because of the uncertainty involved with the development of this source for municipal use, the reliability of this strategy is considered moderate.

Project 4a. Trinity Aquifer Wellfield

Part of the Regional Project is to develop a wellfield to provide a water supply to the densely populated rural areas of Eastern Kerr County. This strategy assumes four wells will be drilled in the Trinity Aquifer to provide an additional 860 acre-feet per year. These wells would produce water from 530 feet below the surface. This strategy assumes a five-mile, 10-inch diameter transmission line will transport the water

from the wells to the distribution center. Minimal treatment, such as chlorine disinfection, will be required for municipal purposes. In addition, advanced treatment will be necessary for municipal purposes due to anticipated water quality issues. The wells must be permitted by the Headwaters Groundwater Conservation District and withdrawals must not exceed the Trinity Aquifer MAG limit.

Quantity, Reliability, and Cost – The quantity and reliability of water from this source is expected to be approximately 200 gpm. For this *Plan*, the four new wells are assumed to supply an additional 860 acre-feet per year, beginning in the 2030 decade. The Trinity Aquifer has shown that it can be considered reliable as a water supply if properly developed and is not compromised by additional water demands. The total estimated capital cost for this project is approximately \$8,367,000.

Project 4b Construction of a Desalination Plant

This strategy is contingent on Project 4a. Due to anticipated water quality issues (radon and sulfides) from the groundwater obtained in a newly developed well field or from an Ellenburger Aquifer supply well, advanced treatment will be necessary for municipal purposes. The brine concentrate from the wells will be disposed of using an evaporation pond.

Quantity, Reliability, and Cost – It is assumed that a 1.2 MGD brackish desalination treatment unit (for treatment of elevated TDS levels) as well as a simple filtration unit (for treatment of elevated radon and sulfides) would be necessary to treat the water for municipal use. It is anticipated that this strategy would provide an additional 860 acre-feet per year of water, beginning in the 2030 decade. The reliability of water from this source is expected to be medium to high based on competing demands. The total estimated capital cost for this project is \$21,162,000.

J-54 Public Conservation Education – Center Point

The Community of Center Point is encouraged to emphasize conservation through public information programs. A total of one percent reduction in demand is anticipated, which will result in a water savings of approximately 1 acre-feet per year. The annual cost of this project in 2020 is estimated to be \$128.

J-46 Purchase Water from EKRWSWP – Center Point

Center Point is one of several small community utilities in Eastern Kerr County that is expected to benefit from the construction of the Eastern Kerr County Regional Water Supply Project (Strategy J-45). Water supplies provided by the Project are derived from multiple sources and will be more reliable than existing individual sources. Although Center Point is projecting a 4 acre-feet per year water-supply need, the community will likely derive all its supply (11 acre-feet per year) from the Project in the future. The annual supply purchase cost is estimated at \$400 per acre foot for a total annual cost of \$4,400.

J-55 Public Conservation Education – Center Point Taylor System

The Center Point Taylor System is encouraged to emphasize conservation through public information programs. A total of one percent reduction in demand is anticipated, which will result in a water savings of approximately 1 acre-feet per year. The annual cost of this project in 2020 is estimated to be \$265.

J-47 Purchase Water from EKRWSWP – Center Point Taylor System

The Center Point Taylor System is one of several small community utilities in Easter Kerr County that is expected to benefit from the construction of the Eastern Kerr County Regional Water Supply Project (Strategy J-45). Water supplies provided by the Project are derived from multiple sources and will be more reliable than existing individual sources. Although the Center Point Taylor System is projecting a maximum of 5 acre-feet per year water-supply need by 2070, the utility will likely derive all its supply (43 acre-feet per year) from the Project in the future. The annual supply purchase cost is estimated at \$400 per acre foot for a total annual cost of \$17,200.

J-42 Water Loss Audit and Main-line Repair for Verde Park Estates WWW

According to the 2015 TWDB Public Water System Water Loss Survey, Verde Park Estates had a total water loss of approximately 662,140 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss (15.5 percent) is the sum of reported break and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted-for water and get a more accurate look at water consumption.

Quantity, Reliability, and Cost - This strategy assumes a potential savings of approximately 1 acre-foot per year. It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 0.6 miles of 6" diameter main-line would be replaced, with a total project capital cost of \$155,000.

J-43 Public Conservation Education (Nueces Basin)

Kerr County-Other in the Nueces River Basin has a 2020-population of six and a water-supply deficit of one acre-foot per year. This deficit appears because of regional statistics and is inconsistent with the minimal population. A total of one percent reduction in demand is anticipated, which will result in a water savings of approximately 1 acre-feet per year. The annual cost of this project in 2020 is estimated to be \$3.

5A-10 WATER MANAGEMENT STRATEGIES FOR KERR COUNTY LIVESTOCK

Kerr County is projected to have approximately 325 acre-feet of livestock water supply shortage over the planning horizon. Livestock within the County obtains supplies from both surface and groundwater sources. Surface water such as local supply is commonly used, but limited due to the recent drought. Groundwater from the Edwards-Trinity (Plateau) Aquifer and the Trinity Aquifer are more reliable sources.

- (J-56) Livestock conservation – Colorado Basin
- (J-57) Additional groundwater wells - Colorado Basin (ALTERNATE)
- (J-58) Livestock conservation - Guadalupe Basin
- (J-59) Additional groundwater wells - Guadalupe Basin (ALTERNATE)
- (J-60) Livestock conservation - San Antonio Basin
- (J-61) Additional groundwater well - San Antonio Basin (ALTERNATE)
- (J-62) Livestock conservation - Nueces Basin
- (J-63) Additional groundwater wells - Nueces Basin (ALTERNATE)

J-56 Livestock Conservation (Colorado Basin)

Rotational grazing consists of subdividing grazing pastures and rotating livestock from one pasture to another on a regular interval. This allows the watershed, soils, and vegetation to recover from the stress of continuous livestock grazing. A study by Texas A&M AgriLife Research at Vernon (Ledbetter, 2017) found that changing to a multi-pasture rotational livestock management system reduced surface runoff and sediment load in the local stream by 39 and 34 percent, respectively. The study also found that subsurface flow increased by 48 percent, primarily due to increased infiltration and soil water storage associated with rotational grazing. This strategy assumes a conservative 20 percent reduction of the projected supply need. 24 acre-feet per year is assumed for the Colorado Basin livestock conservation strategy. No capital cost is assigned to this strategy.

J-57 Additional Groundwater Wells (Colorado Basin) ALTERNATE

The Trinity Aquifer has been identified as a potential source of water to meet the irrigation shortages within Kerr County. The Aquifer is comprised of five different water-bearing units which are often in hydraulic communication and collectively should be considered a leaky-aquifer system. Water from this source is generally of acceptable quality for irrigation use. Recharge to the Lower Trinity in Kerr County likely occurs primarily by lateral underflow from the north and west. This strategy assumes that one new well will be drilled to approximately 360 feet below the surface. The wells must be permitted by the Headwaters Groundwater Conservation District and withdrawals must not exceed the Trinity Aquifer MAG limit.

Quantity, Reliability, and Cost –Fifteen new wells at 5 gpm each are assumed to supply an additional 119 acre-feet per year. The reliability of this supply is moderate, based on competing demands. The total cost of this project will be approximately \$985,000.

J-58 Livestock Conservation (Guadalupe Basin)

Rotational grazing consists of subdividing grazing pastures and rotating livestock from one pasture to another on a regular interval. This allows the watershed, soils, and vegetation to recover from the stress of continuous livestock grazing. A study by Texas A&M AgriLife Research at Vernon (Ledbetter, 2017) found that changing to a multi-pasture rotational livestock management system reduced surface runoff and sediment load in the local stream by 39 and 34 percent, respectively. The study also found that subsurface flow increased by 48 percent, primarily due to increased infiltration and soil water storage associated with rotational grazing. This strategy assumes a conservative 20 percent reduction of the projected supply need. 35 acre-feet per year is assumed for the Guadalupe Basin livestock conservation strategy. No capital cost is assigned to this strategy.

J-59 Additional Groundwater Wells (Guadalupe Basin) ALTERNATE

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the livestock water supply shortages within the County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that 4 new wells would need to be drilled to approximately 310 feet below the surface. The wells must be permitted by the Headwaters Groundwater Conservation District and withdrawals must not exceed the Trinity Aquifer MAG limit.

Quantity, Reliability, and Cost –Four new 40 gpm wells are assumed to supply an additional 173 acre-feet per year. The reliability of this supply is medium to high, based on competing demands and water quality issues. Total cost of this project will be approximately \$370,000.

J-60 Livestock Conservation (San Antonio Basin)

Rotational grazing consists of subdividing grazing pastures and rotating livestock from one pasture to another on a regular interval. This allows the watershed, soils, and vegetation to recover from the stress of continuous livestock grazing. A study by Texas A&M AgriLife Research at Vernon (Ledbetter, 2017) found that changing to a multi-pasture rotational livestock management system reduced surface runoff and sediment load in the local stream by 39 and 34 percent, respectively. The study also found that subsurface flow increased by 48 percent, primarily due to increased infiltration and soil water storage associated with rotational grazing. This strategy assumes a conservative 20 percent reduction of the projected supply need. Five acre-feet per year is assumed for the San Antonio Basin livestock conservation strategy. No capital cost is assigned to this strategy.

J-61 Additional Groundwater Well (San Antonio Basin) ALTERNATE

The Trinity Aquifer has been identified as a potential source of water to meet the livestock shortages within Kerr County. The Aquifer is comprised of five different water-bearing units which are often in hydraulic communication and collectively should be considered a leaky-aquifer system. Water from this source is generally of sufficient quality to meet Livestock consumption needs. Recharge to the Lower Trinity in Kerr County likely occurs primarily by lateral underflow from the north and west. This strategy assumes that one new well will be drilled to approximately 395 feet below the surface. The wells must be permitted by the Headwaters Groundwater Conservation District and withdrawals must not exceed the Trinity Aquifer MAG limit.

Quantity, Reliability, and Cost – The one new 17 gpm well is assumed to supply an additional 27 acre-feet per year. The reliability of this supply is medium to high, based on competing demands. Total cost of this project will be approximately \$79,000.

J-62 Livestock Conservation (Nueces Basin)

Rotational grazing consists of subdividing grazing pastures and rotating livestock from one pasture to another on a regular interval. This allows the watershed, soils, and vegetation to recover from the stress of continuous livestock grazing. A study by Texas A&M AgriLife Research at Vernon (Ledbetter, 2017) found that changing to a multi-pasture rotational livestock management system reduced surface runoff and sediment load in the local stream by 39 and 34 percent, respectively. The study also found that subsurface flow increased by 48 percent, primarily due to increased infiltration and soil water storage associated with rotational grazing. This strategy assumes a conservative 20 percent reduction of the projected supply need. One acre-foot per year is assumed for the Nueces Basin livestock conservation strategy. No capital cost is assigned to this strategy.

J-63 Additional Groundwater Well (Nueces Basin) ALTERNATE

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the livestock water supply shortages within the County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that 1 new well will be drilled to approximately 360 feet below the surface. The wells must be permitted by the Headwaters Groundwater Conservation District and withdrawals must not exceed the Trinity Aquifer MAG limit.

Quantity, Reliability, and Cost – The one new 5 gpm wells are assumed to supply an additional 6 acre-feet per year. The reliability of this supply is medium to high, based on competing demands and water quality issues. Total cost of this project is approximately \$66,000.

5A-11 WATER MANAGEMENT STRATEGIES FOR KERR COUNTY MINING

Kerr County is projected to have approximately 21 acre-feet of mining water supply shortage over the planning horizon. Water rights diverted from the Guadalupe River in conjunction with groundwater from the Edwards-Trinity (Plateau) and Trinity Aquifers provide the water needed for mining use within the County. The following water management strategies are recommended to enhance the reliability of the future water supply availability for the mining water supply shortages within Kerr County:

- (J-65) Additional groundwater wells (Colorado Basin)

J-65 Additional Groundwater Wells (Colorado Basin)

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the mining water supply shortages within the County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that three new wells will be drilled to produce water from approximately 360 feet below the surface and produce at a rate of 10 gpm.

Quantity, Reliability, and Cost –Historical industrial and agricultural use indicates that the Edwards-Trinity (Plateau) outcrops may be a viable source. The 3 new 5 gpm wells are assumed to supply an additional 19 acre-feet per year. The reliability of this supply is medium to high, based on competing demands and water quality issues. Total cost of this project is approximately \$197,000.

5A-12 WATER MANAGEMENT STRATEGIES FOR THE CITY OF BRACKETTVILLE

The City of Brackettville is the county seat of Kinney County, with a population projected at 1,958 in 2020; increasing to 1,971 by 2070. The City and many other residents of Kinney County rely primarily on groundwater from three different aquifers: Edwards-Trinity (Plateau), Edwards Balcones Fault Zone (BFZ), and the Austin Chalk. Combined, these sources support water use for municipal, domestic, livestock and irrigation purposes. Although the water demand for the City of Brackettville is not projected to increase over the planning horizon, the following water management strategies are recommended to enhance the reliability of the City's future water supply availability:

- (J-66) Increase supply to Spofford with new water line infrastructure
- (J-67) Increase storage facility

J-66 Increase Supply to Spofford with New Water Line Infrastructure

The Kinney County Commissioners Court has plans to provide water through a 10.5-mile pipeline from the City of Brackettville to the Kinney County Union Pacific Facility, of which a portion of the line is already in place. This strategy includes an additional 250,000-gallon storage tank located at the end of the pipeline. The storage tank will provide an additional water supply for municipal and industrial purposes.

Quantity, Reliability, and Cost – This strategy will supply approximately 3 acre-feet of additional water available through transmission to the Kinney County Union Pacific Facility. The reliability of this strategy is high. The total capital cost of this strategy includes the construction of 10.5 miles of six-inch diameter transmission line and a 250,000-gallon storage tank. The total capital cost for this project is estimated at \$4,271,000.

J-67 Increase Storage Facility

The City of Brackettville has plans to construct a 125,000-gallon ground storage facility. This storage facility will ensure that adequate water is available to be piped to the Kinney County Union Pacific Facility in Spofford for municipal and industrial purposes (see Strategy J-66 above).

Quantity, Reliability, and Cost – It is assumed that this strategy will provide an additional 3 acre-feet per year of water. The total estimated capital cost for this project is approximately \$1,272,000.

5A-13 WATER MANAGEMENT STRATEGIES FOR FORT CLARK SPRINGS MUD

Fort Clark Springs MUD is located next to the City of Brackettville and shares the Edwards-Trinity (Plateau) Aquifer for their municipal water supply needs. Although the Fort Clark Springs MUD water demand is not projected to increase over the planning horizon, the following water management strategy is recommended to enhance the reliability of the Community's future water supply availability:

- (J-68) Water Loss Audit and Main-line Repair for Fort Clark Springs MUD
- (J-69) Increase storage facility

Although the project does not meet SWIFT qualification requirements, Fort Clark Springs MUD is in need of repair or upgrade of pumps in existing wells and the distribution network.

J-68 Water Loss Audit and Main-line Repair for Fort Clark Springs MUD

According to the 2015 TWDB Public Water System Water Loss Survey, Fort Clark Springs MUD had a total water loss of approximately 62,273,567 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss (41.1%) is the sum of reported break and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of 79 acre-feet per year (25,594,436 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 6.2 miles of 6" diameter main-line will be replaced, with a total project capital cost of approximately \$1,531,000.

J-69 Increase Storage Facility

The Fort Clark Springs MUD (District) currently has 929 connections, an average daily usage of 0.5 MGD with 660,000 gallons of total storage and a well production capacity of 2 MGD. Additional supply is needed to ensure availability during drought-of-record conditions and to meet peak demands. While the District has the minimum amount of storage available, additional storage will provide the needed water supply. In order to achieve this goal, a 500,000-gallon ground storage tank will provide access to the new supply.

Quantity, Reliability, and Cost – This strategy is assumed to provide an additional 620 acre-feet per year of water. The total estimated capital cost for this project is approximately \$1,501,000.

5A-14 WATER MANAGEMENT STRATEGIES FOR THE CITY OF CAMP WOOD

The City of Camp Wood derives all its municipal water from Old Faithful Spring (also known as Krueger Spring or Camp Wood Spring) that issues from alluvial gravel overlying the Glen Rose Limestone of the Edwards-Trinity (Plateau) Aquifer. The TCEQ Nueces River WAM (Run 3) results indicate that there is no reliable water available from the Spring during a repeat of the drought-of-record. However, Old Faithful did not cease to flow during the drought of the 1950s. Due to the recent drought the discharge from the spring has been insufficient in meeting all the current needs. For this reason, the City of Camp Wood is considering developing an alternate source of supply.

The City of Camp Wood in August of 2014 appeared on the TCEQ's Public Water Supply Limiting Water Use list seeking assistance for emergency funds earmarked for emergency groundwater supply wells. Currently the City remains on this list, which is updated weekly by the TCEQ's Drinking Water Technical Review and Oversight Team and can be found at the following link:
<https://www.tceq.texas.gov/drinkingwater/trot/droughtw.html>.

The City of Camp Wood is projected to have a shortage in 2020 of 134 acre-feet per year; decreasing to 126 acre-feet per year by 2070. The following water management strategies are recommended to enhance the reliability of the City's future water supply availability:

- (J-72) Public conservation education
- (J-73) Additional well in the Edwards-Trinity (Plateau) Aquifer

J-72 Public Conservation Education

The City of Camp Wood is encouraged to emphasize conservation through public information programs. A total of one percent reduction in demand is anticipated, which will result in a water savings of approximately 1 acre-feet per year. The annual cost of this project in 2020 is estimated to be \$374.

J-73 Additional Well in the Edwards-Trinity (Plateau) Aquifer

As Old Faithful Spring can no longer be relied upon to provide a sufficient supply of public drinking water, the City of Camp Wood will need to develop a new water supply source from wells completed into the Edwards-Trinity (Plateau) Aquifer. The potential of constructing wells capable of producing at this desired rate is good, although exploratory drilling and testing will likely be needed before this strategy can be relied upon as a dependable source. Due to high levels of iron and manganese, advanced treatment will likely be required for municipal use. This strategy includes the construction of four new wells to be completed at 1,000 feet below the surface, each operating at a capacity of 40 gpm. The location of the additional wells is assumed to be near the City's current treatment plant. This project will require approximately 500 feet of six-inch diameter connection piping.

Quantity, Reliability, and Cost – Four new wells are assumed to supply an additional 143 acre-feet per year. The reliability of this supply is medium to high, based on competing demands. Total estimated capital cost for this project is \$1,709,000.

5A-15 WATER MANAGEMENT STRATEGIES FOR THE CITY OF LEAKEY

The City of Leakey relies primarily on the Edwards-Trinity (Plateau) Aquifer and the Frio River Alluvium Aquifer for municipal water supply purpose. Small volumes of surface water are used to supplement the irrigation water supply needs of the City. Due to the recent drought, the City of Leakey in August of 2014 appeared on the TCEQ's Public Water Supply Limiting Water Use list, seeking assistance for emergency funds earmarked for emergency groundwater supply wells. Currently, the City remains on this list which is updated weekly by the TCEQ's Drinking Water Technical Review and Oversight Team and can be found at the following link: <https://www.tceq.texas.gov/drinkingwater/trot>

Although the supply-demand analysis does not project a future water supply deficit for the City of Leakey, drought like conditions continues to impact the City's water supplies. The following water management strategy is recommended to enhance the reliability of the City's future water supply availability:

- (J-75) Drill additional well in the Lower Trinity Aquifer
- (J-76) Develop interconnection between wells within the City of Leakey

J-75 Drill Additional Well in the Lower Trinity Aquifer

The City of Leakey currently has a total of six Frio River Alluvium Aquifer wells, with the sixth well recently being completed in 2014. The City has plans to connect all the wells within their system in order for the public water supply system to become a more reliable future source of supply. During the recent drought, it appeared that the water level would drop to the point where one or more of these wells would no longer be viable. In consideration of this limited groundwater availability, the Real Edwards Conservation and Reclamation District passed an emergency rule that allowed for the immediate permitting of an additional well or other potential water source for the City of Leakey. In addition, the City is looking at a solid waste disposal system and it is anticipated that such a system will require additional water.

Sufficient groundwater is available from the Frio River Alluvium Aquifer without causing excessive water-level declines; however, in a severe drought alluvial aquifers are the first to go dry. For this reason, it is recommended that the new well be completed in the Lower Trinity Aquifer.

This strategy assumes that the construction of one new well will be drilled to a depth of 750 feet in order to access the additional aquifer supplies needed. The well is assumed to be operating at a capacity of 75 gpm. In addition, this strategy includes 500 feet of six-inch diameter connection piping. Minimal treatment, such as chlorine disinfection, will be required for municipal purposes.

Quantity, Reliability, and Cost –The Lower Trinity Aquifer is identified as a potential and viable source to meet water supply needs for the City of Leakey; however, water quality issues may require advanced treatment. For this *Plan*, the one new 75 gpm well is assumed to supply an additional 91 acre-feet per year. The reliability of the supply is medium based on water quantity issues. Total estimated capital cost for this project is approximately \$189,000.

J-76 Develop Interconnections between Wells within the City of Leakey

The City of Leakey has developed their current water supply system based on individual wells providing water to sections of the City. The current drought had a significant impact on the City's alluvial wells with some of the wells dropping to levels where they could not be pumped. This experience has demonstrated the need to integrate the system as both a conservation and water supply strategy. By interconnecting the independent systems, an additional 81 acre-feet per year of water can be pumped to other areas, thus reducing the demands on each individual well. This would potentially prevent the over drafting of wells during drought periods. The key well that would be incorporated into the system is Well #5. This strategy assumes approximately 3,500 feet of 6-inch line will need to be installed to connect all wells and the installation of a SCADA system is recommended.

Quantity, Reliability, and Cost – This strategy is assumed to supply an additional 81 acre-feet per year of water. The total estimated capital cost for this project is approximately \$202,000.

5A-16 WATER MANAGEMENT STRATEGIES FOR REAL COUNTY-OTHER

The rural area of Real County Other has less than 1,170 in population including individuals living outside of Leakey and Camp Wood. This compilation of water users known as “County Other” is self-supplied and relies primarily on groundwater from the Nueces River Alluvium and Edwards-Trinity (Plateau) Aquifers for their water supply needs as produced from private domestic wells or by small public systems such as the Real Water Supply Corporation. A modest source of supply is also provided by the Edwards-Trinity (Plateau) Aquifer. Due to the recent drought, there is no availability for planning purposes in the Nueces River.

Much of the rural economy is based on ranching operations, which relies on local surface streams to provide water for their livestock. Natural flow in these streams is negatively influenced by the presence of non-native plant species.

Although the supply-demand analysis does not project a future water-supply deficit for Real County-Other, rural communities within the area have certainly suffered from extreme drought conditions. The following water management strategies are recommended to enhance the reliability of the future water supply for residents within rural Real County:

- (J-77) Water loss audit and main-line repair for Real Water Supply Corporation
- (J-79) Additional well for Oakmont Saddle Mountain Water Supply Corporation

J-77 Water Loss Audit and Main-line Repair for Real Water Supply Corporation

According to the 2015 TWDB Public Water System Water Loss Survey, Real Water Supply Corporation (WSC) had a total water loss of approximately 1,633,416 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss (32.3 percent) is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of 2 acre-feet per year (528,247 gallons/year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 1.9 miles of 6” diameter main-line will be replaced, with a total project capital cost of approximately \$482,000.

J-79 Additional Well for Oakmont Saddle Mountain Water Supply Corporation

Due to the recent drought, Oakmont Saddle Mountain WSC has experienced the loss of production in supply well #1. Currently, the WSC is operating on water well #2, an unapproved temporary shallow well in the Frio River Alluvium Aquifer. Real County received a Disaster Relief Grant from the Texas Department of Agriculture on June 13, 2012 to benefit Oakmont Saddle Mountain WSC for a system improvement project that will replace well #1. Through a series of failed attempts to successfully reach a reliable water supply, the water supply corporation had to abandon efforts on the construction of two wells. Since then, the WSC has drilled an experimental fourth well five feet from one of the previous wells, which involved an excavation three feet in width, 40 feet in depth and 11 feet to bedrock. This was

performed for the purpose of considering a filtration zone constructed through the removal of alluvial gravel and installation of an 8” PVC perforated pipe.

To bring this new supply on-line will require the construction of the well facility and its connection to the distribution system. This strategy assumes a spring water source with the construction of a water tight concrete basin, installation of pump and associated piping, electrical and all appurtenances. Authorization to construct this spring water source well was issued by TCEQ letter dated October 24, 2014.

Quantity, Reliability, and Cost – It is anticipated that this strategy will provide an additional 54 acre-feet per year of water. The total estimated project cost is \$417,000. The reliability of this source is low to medium depending on the surface water availability. Shallow alluvium wells are typically the first water supply to become an unreliable source during drought like conditions.

5A-17 WATER MANAGEMENT STRATEGIES FOR THE CITY OF DEL RIO

The City of Del Rio is the only wholesale water provider in the Plateau Region. In addition to its own use, the City provides water to Laughlin Air Force Base and subdivisions outside of the City. Del Rio also provides water and wastewater services to two colonias: Cienegas Terrace and Val Verde Park Estates.

The City of Del Rio relies primarily on San Felipe Springs, which issues from the Edwards-Trinity (Plateau) Aquifer, but has also been designated as being under the influence of surface water by TCEQ. The water is collected through pumps set in the springs, treated with microfiltration and chlorine and then connected to the distribution system. The City of Del Rio has a water right authorizing it to divert 11,416 acre-feet per year from San Felipe Springs for municipal use. Elsewhere in the County, all known water wells produce water from the Salmon Peak and McKnight Formations of the Edwards Group.

The average discharge of San Felipe Springs since Lake Amistad was filled is about 110 cubic feet per second (cfs), approximately 80,000 acre-feet per year. During recent droughts, the spring discharge has fallen below 50 cfs, approximately 36,000 acre-feet per year. Although the supply-demand analysis does not project a future water supply deficit for the City of Del Rio, the diminished supply availability from the Springs during drought periods requires Del Rio to consider other water supply options. The following water management strategies are recommended to enhance the reliability of the City's future water supply availability:

- (J-80) Water loss audit and main-line repair for the City of Del Rio
- (J-81) Drill and equip new well and connect to distribution system
- (J-82) Water treatment plant expansion
- (J-83) Develop a wastewater reuse program

In addition to the recommended strategies listed above, the City of Del Rio has the following funded, water projects listed with the TWDB as of November 2014:

- Water main replacement
- Collection system reconstruction

J-80 Water Loss Audit and Main-line Repair for the City of Del Rio

The City of Del Rio in 2001 completed a distribution system improvement project funded by the TWDB to replace leaking distribution lines. A 1999 water audit found more than 37 percent of the City's water unaccounted. Since these improvements, per the 2016 TWDB water loss audit, Del Rio has reduced the volume of unaccounted water to 11 percent, approximately 34,802,196 gallons per year total loss. This amount of water loss is the sum of reported breaks and leaks and unreported loss.

This strategy assumes a potential savings of 12 acre-feet per year. It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 22.8 miles of 6" diameter main-line will be replaced, with a total project capital cost of approximately \$5,672,000.

J-81 Drill and Equip a New Well and Connect to Distribution System

The City of Del Rio currently has a total of three wells located north of town; however, due to complications with the production of these wells, all three wells are presently inactive. In order to alleviate the water demand from San Felipe Springs, Del Rio plans to locate an alternate source of supply. The Edwards-Trinity (Plateau) Aquifer has been identified as groundwater source for future water supplies. This source may require minimal treatment such as chlorine disinfection for municipal purposes. As the three existing inactive wells are not classified as being active water supply sources, the addition of a new well is considered a new supply source.

Quantity, Reliability, and Cost – This strategy assumes the development of one new well located near the existing wells, north of town. The well will be drilled at a depth of 650 feet and is anticipated to produce an additional 7,191 acre-feet per year. This strategy includes 0.5 miles of 24-inch diameter transmission line. The total capital cost is estimated to be approximately \$12,695,000.

J-82 Water Treatment Plant Expansion

The City of Del Rio uses a membrane treatment facility, which treats water pumped from San Felipe Springs. The treatment plant is approximately 15 years old and needs two additional pods to keep pace with the communities growing water demands. This strategy assumes costs associated with the 1 MGD treatment plant expansion which is anticipated to come on-line by 2030.

Quantity, Reliability, and Cost – It is expected that this project will supply an additional 943 acre-feet per year. The total capital cost for this project is approximately \$8,646,000 with an estimated annual cost of \$1,231,000.

J-83 Develop a Wastewater Reuse Program

A long-term strategy for the City is to expand its wastewater effluent for irrigation of the municipal golf course, provide reuse water to Laughlin AFB, and eventually to irrigate public parks. Additional treated wastewater will be generated from improvements at the San Felipe and Silver Lake Wastewater Treatment Plants. The primary component of this strategy is the approximate 10-mile extension of the major transmission lines that convey the direct reuse supplies to the intended destinations.

Quantity, Reliability, and Cost – The current wastewater discharge permit for the City of Del Rio is 2.7 MGD (3,092 acre-feet per year). The effluent provided for reuse will be a continual supply available daily for municipal uses. It is expected that this project will supply an additional 3,092 acre-feet per year. The total capital cost for this project is approximately \$2,846,000.

5A-18 WATER MANAGEMENT STRATEGIES FOR VAL VERDE COUNTY-OTHER

The rural area of Val Verde County has a population projected at 15,152 in 2020; increasing to 30,469 by 2070. This population includes individuals living outside of the City of Del Rio and Laughlin AFB. This compilation of water users known as “County Other” is partially supplied by Del Rio, but is mostly self-supplied and relies solely on the Edwards-Trinity (Plateau) Aquifer for their water supply needs either from private domestic wells, or privately owned water supply systems. Much of the rural economy is based on ranching operations, which relies on local surface streams to provide water for their livestock. Natural flow in these streams is negatively influenced by the presence of non-native plant species.

Although the supply-demand analysis does not project a future water supply deficit for Val Verde County-Other, the following water management strategies are recommended to enhance the reliability of the future water supply for residents within Val Verde County Other:

- (J-84) Water loss audit and main-line repair for Val Verde County WCID Comstock
- (J-85) Water loss audit and main-line repair for San Pedro Canyon Subdivision (Upper)
- (J-86) Water loss audit and main-line repair for Tierra del Lago

J-84 Water Loss Audit and Main-line Repair for Val Verde County WCID Comstock

According to the 2015 TWDB Public Water System Water Loss Survey, Val Verde County WCID Comstock had a total water loss of approximately 1,554,206 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss (16.4 percent) is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of 1 acre-foot per year. It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 1.6 miles of 6” diameter main-line will be replaced, with a total project capital cost of approximately \$406,000.

J-85 Water Loss Audit and Main-line Repair for San Pedro Canyon Subdivision (Upper)

According to the 2016 TWDB Public Water System Water Loss Survey, San Pedro Canyon Subdivision (Upper) had a total water loss of approximately 5,394,010 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss (40 percent) is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of 7 acre-feet per year (2,157,604 gallons per year). It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-

line leaks. This strategy assumes 0.6 miles of 6" diameter main-line will be replaced, with a total project capital cost of approximately \$142,000.

J-86 Water Loss Audit and Main-line Repair for Tierra del Lago

According to the 2016 TWDB Public Water System Water Loss Survey, Tierra Del Lago had a total water loss of approximately 2,471,426 gallons per year due to leaking distribution lines and/or faulty meters. This amount of water loss (55 percent) is the sum of reported breaks and leaks and unreported loss. Taking the proper measures to identify and repair old infrastructure and inaccurate water meters, the water supply system can reduce the unaccounted for water and get a more accurate look at water consumption.

This strategy assumes a potential savings of 4 acre-feet per year. It is assumed that a leak testing program will be implemented prior to replacing portions of the existing main-line leaks. This strategy assumes 0.6 miles of 6" diameter main-line will be replaced, with a total project capital cost of approximately \$146,000.

5A-19 WATER MANAGEMENT STRATEGY FOR LAUGHLIN AIR FORCE BASE

The U.S. Laughlin Air Force Base east of Del Rio is a pilot training facility with an average military population of approximately 2,000. The Base maintains a groundwater well which is primarily used for landscape irrigation as most of the facility's treated drinking-water supply is purchased through a long-term contract with Del Rio Utilities Commission (City of Del Rio). The following water management strategy is recommended for Laughlin AFB to insure a continuation of this contracted supply.

- (J-87) Purchase Water from City of Del Rio

J-87 Purchase Water from City of Del Rio

Laughlin Air Force Base is under contract to receive its potable water supply from the City of Del Rio (Del Rio Utilities Commission) at \$1.89 per thousand gallons. Additional supplies needed to meet future projected demand deficits (87 in 2020 increasing to 345 acre-feet per year in 2070) will continue to be delivered by Del Rio and may, on occasion, require contract amendments. Del Rio's available supply will likewise need to increase over time (see Del Rio strategies) to meet Laughlin AFB's need. Under the existing contract, additional cost to purchase future increases are \$53,580 in 2020, increasing to \$212,470 in 2070. There is no capital cost for this strategy.

5A-20 WATER MANAGEMENT STRATEGIES FOR VAL VERDE COUNTY MINING

The mining industry in Val Verde County is projected to have a maximum of 210 acre-feet of mining water supply shortage over the planning horizon. Both surface water and groundwater supplies provide water for mining purposes within the County. The Edwards-Trinity (Plateau) Aquifer is the sole groundwater source used for mining purposes. The following water management strategies are recommended to enhance the reliability of the future water supply availability for the mining water supply shortages within Val Verde County:

- (J-89) Additional Wells in the Edwards-Trinity (Plateau) Aquifer (Rio Grande River Basin)

J-89 Additional Wells – Rio Grande Basin

The Edwards-Trinity (Plateau) Aquifer has been identified as a potential source of water to meet the mining water supply shortage within Val Verde County. The Aquifer consists of lower Cretaceous age, saturated limestones and dolomites of the Edwards and Trinity Groups that occur in the Edwards Plateau. Water from this source can be variable, with water quality ranging from fresh to slightly saline in the outcrop areas, and brine water in subsurface portions. Reported well yields commonly range from less than 50 gpm where saturated thickness is thin; to more than 1,000 gpm where large capacity wells are completed in jointed and cavernous limestone. This strategy assumes that three new wells will be drilled to produce 50 gpm of water from approximately 900 feet below the surface.

Quantity, Reliability, and Cost – The four new wells are assumed to supply an additional 242 acre-feet per year. The reliability of this supply is medium to high, based on competing demands and water quality issues. Total cost of this project will be approximately \$1,100,000.

APPENDIX 5B STRATEGY EVALUATION QUANTIFICATION MATRIX

This page intentionally left blank

STRATEGY EVALUATION QUANTIFICATION MATRIX

The practicality of an implemented water management strategy may be measured in terms of quantity, quality and reliability of water produced and the varying degree of impact (positive or negative) on pre-existing local conditions. The Plateau Region Water Planning Group has adopted a standard procedure for ranking potential water management strategies. Quantitative and qualitative measurements are tabulated in Chapter 5 Tables 5-2 and 5-4. This procedure classifies the strategies using the TWDB's following standard categories developed for regional water planning:

Table 5-2:

Quantity
Quality
Reliability
Impact of Water, Agricultural, and Natural Resources

Table 5-4:

Environmental Impact
Environmental water needs
Wildlife habitat
Cultural resources
Environmental water quality
Bays and estuaries

Quantity, Quality and Reliability

Quantity, quality and reliability are quantitatively assessed and assigned a ranking from 1 to 3 as listed in the Matrix Table below, which shows the correlation between the category and the ranking.

Table 5B-1. Quantity, Quality and Reliability Category Ranking Matrix

Rank	Quantity	Quality	Reliability
1	Meets 100% of shortage	Meets safe drinking water standards	Sustainable
2	Meets 50-99% of shortage	Must be treated or mixed to meet safe drinking water standards	Interruptible
3	Meets < 50% of shortage	Usable for intended non-drinking use only	Un-sustainable

Quantity adequacy is measured as a percent of the volume of water needed to meet the specified water user group's (WUG's) shortage as calculated in Table 4-1 of Chapter 4 that is produced by the water management strategy. Percent volumes are only analyzed for WUGs with projected supply shortages.

Quality adequacy is measured in terms of meeting TCEQ Safe Drinking Water Standards. However, not all strategies are intended for use requiring SDWSs.

Reliability is evaluated based on the expected or potential for the water to be available during drought. Strategies that use water from a source that would not exceed permits or MAGs even during droughts are rated as sustainable. Strategies that use water from a source that is available during normal meteorological conditions, but may not be 100% available during drought are rated as interruptible. Strategies in which 100% of the supply cannot be maintained even during normal meteorological conditions are rated as un-sustainable.

Impact on Water, Agricultural and Natural Resources

Impacts are quantitatively assessed and assigned a ranking from 1 to 5 as listed in the Matrix Table below, which shows the correlation between the category and the ranking.

Table 5B-2. Strategy Impact Category Ranking Matrix

Rank	Water Resources	Agricultural Resources	Natural Resources
1	Positive	Positive	Positive
2	None	None	None
3	Low	Low	Low
4	Medium	Medium	Medium
5	High	High	High

Water Resources impacts refer to the potential for the implemented strategy to compete for water sources shared with adjacent properties. The matrix ranking depicts the potential range of water-level drawdown induced across property boundaries during the life of the strategy project.

- 1 Positive - No aquifer drawdown; increased surface water flow
- 2 None – No new aquifer drawdown; no change to surface water flow
- 3 Low – <10 feet of aquifer drawdown; < 10% reduction in average surface flows
- 4 Medium – 10 to 50 feet of aquifer drawdown; 10 to 30% reduction in average surface flows
- 5 High - > 50 feet of aquifer drawdown; > 30% reduction in surface flows

Agricultural Resources impacts refer to the agricultural economic impact resulting from the loss or gain of water supplies currently in use by the agricultural user as the result of the implementation of a strategy. See Section 1.2.8 in Chapter 1 for a detailed discussion on the Agricultural Resources of the Plateau Region.

- 1 Positive – provides water to agricultural users
- 2 None – does not impact agricultural supplies
- 3 Low – reduces agricultural activity by less than 10%
- 4 Medium – reduces agricultural activity by more than 10%
- 5 High – water rights use changes from agricultural to some other use thus elimination agricultural activity

Natural Resources impacts are those that impact the terrestrial and aquatic habitat of native plant and animal wildlife, as well as the scenic beauty of the Region that is critical to the tourism industry. See Section 1.2.9 in Chapter 1 for a detailed discussion on the Natural Resources of the Plateau Region.

- 1 Positive – provides water to natural resources
- 2 None – does not impact natural resources
- 3 Low – reduces natural resources water supply by less than 10%
- 4 Medium – reduces natural resources water supply by more than 10%
- 5 High – reduces natural resources water supply by more than 50%

Environmental Impacts

Environmental impacts are quantitatively assessed and assigned a ranking from 1 to 5 as listed in the Matrix Table below, which shows the correlation between the category and the ranking. The Environmental Matrix takes into consideration the following categories;

Environmental Water Needs

Wildlife Habitat

Cultural Resources

Environmental Water Quality

Bays and Estuaries

Table 5B-3. Environmental Impact Category Ranking Matrix

Rank	Environmental Water Needs	Wildlife Habitat	Cultural Resources	Environmental Water Quality	Bays and Estuaries
1	Positive	Positive	Positive	Positive	Not applicable
2	No new	No new	No new	No new	
3	Minimal negative	Minimal negative	Minimal negative	Minimal negative	
4	Moderate negative	Moderate negative	Moderate negative	Moderate negative	
5	Significant negative	Significant negative	Significant negative	Significant negative	

Environmental Water Needs impacts refer to how the strategy will impact the area's overall environmental water needs. Water is vital to the environmental health of a region, and so it is important to consider how strategies will impact the amount of water that will be available to the environment.

- 1 Positive – additional water will be introduced for environmental use
- 2 No new – no additional water will be introduced for environmental use
- 3 Minimal negative – environmental water needs will be reduced by <10%
- 4 Moderate negative – environmental water needs will be reduced by 10 to 30%
- 5 Significant negative - environmental water needs will be reduced by >30%

Wildlife Habitat impacts refer to how the strategy will impact the wildlife habitat of the local area. The more area that is impacted due to the implementation of the strategy, the more the area's habitat will be disrupted.

- 1 Positive – additional habitat area for wildlife use will be created
- 2 No new – no additional habitat area for wildlife use will be created or destroyed
- 3 Minimal negative – wildlife habit will be reduced by < 100 acres
- 4 Moderate negative – wildlife habit will be reduced by 100 to 1,000 acres
- 5 Significant negative - wildlife habit will be reduced by > 1,000 acres

Cultural Resources impacts refer to how the strategy will impact cultural resources located within the area. Cultural resources are defined as the collective evidence of the past activities and accomplishments of people. Locations, buildings and features with scientific, cultural or historic value are considered to be cultural resources.

- 1 Positive – cultural resources will be identified and protected
- 2 No new – no impact will occur to local cultural resources
- 3 Minimal negative – disturbance to cultural resources will be < 10%
- 4 Moderate negative – disturbance to cultural resources will be 10 to 20%
- 5 Significant negative - disturbance to cultural resources will be > 20%

Environmental Water Quality impacts refer to the impact that the implementation of the strategy will have on the local area's natural water quality. Negative impacts could include the introduction of poorer quality water, the reduction of the natural flow of water of native quality source water, or the introduction of detrimental chemical elements into the natural water ways.

- 1 Positive – water quality of area streams will be enhanced for existing environmental use
- 2 No new – water quality characteristics of existing environmental habitat will not be changed
- 3 Minimal negative – water quality characteristics of existing environmental habitat will be negatively altered by < 10%
- 4 Moderate negative – water quality characteristics of existing environmental habitat will be negatively altered by < 10 to 30%
- 5 Significant negative - water quality characteristics of existing environmental habitat will be negatively altered by > 30%

Bays and Estuaries – The Plateau Region is located too far away from any bays and estuaries of the Texas coastline to have a quantifiable impact. Therefore, this category was assumed to be non-applicable for every strategy.

This page intentionally left blank

CHAPTER 6

REGIONAL WATER PLAN IMPACTS AND CONSISTENCY WITH PROTECTION OF WATER, AGRICULTURAL AND NATURAL RESOURCES

This page intentionally left blank.

6 REGIONAL WATER PLAN IMPACTS AND CONSISTENCY WITH PROTECTION OF WATER, AGRICULTURAL AND NATURAL RESOURCES

Chapter 6 describes how this *2021 Plan* is consistent with the long-term protection of water resources, agricultural resources, and natural resources that are important to the Plateau Region. All planning analyses applied and recommendations made in the development of this *Plan* honor all existing water rights, contracts, and option agreements; and have no impact on navigation on any of the Region's surface water streams and rivers. Third-party social and economic impacts resulting from voluntary redistributions of water, including impacts of moving water from rural and agricultural areas were considered; however, no strategies were recommended that resulted in moving water from such areas.

The socioeconomic impact of not meeting water supply needs within the Region is discussed in an analysis report prepared by the Texas Water Development Board and presented in Appendix 6A at the end of this chapter. Based on projected water demands and existing water supplies, the Region identified water needs (potential shortages) that could occur under a repeat of the drought of record for five water use categories (irrigation, livestock, manufacturing, mining and municipal). The TWDB then estimated the annual socioeconomic impacts of those needs—if they are not met—for each water use category and as an aggregate for the region.

The report describes that the Plateau Region generated more than \$4.5 billion in gross domestic product (2018 dollars) and supported roughly 68,000 jobs in 2016. It is estimated that not meeting the identified water needs in the Plateau Region would result in an annually combined lost income impact of approximately \$233 million in 2020, increasing to \$257 million in 2070. In 2020, the Region would lose approximately 2,300 jobs, and by 2070 job losses would increase to approximately 3,000 if anticipated needs are not mitigated.

6.1 PROTECTION OF WATER RESOURCES

Water resources in the Plateau Region as described in Chapter 3 include groundwater in numerous aquifers and surface water occurring in five rivers and their tributaries. The numerous springs, which represent an inter-relational transition point between groundwater and surface water, are also recognized in Chapter 1, Section 1.4.3 and Chapter 3, Section 3.3 for their major importance.

The first step in achieving long-term water resources protection was in the process of estimating each source's availability. Surface water estimates are developed through a water availability model process (WAM) and are based on the quantity of surface water available to meet existing water rights during a drought-of-record.

Groundwater availability estimates are based on the Modeled Available Groundwater (MAG) volumes that may be produced on an average annual basis to achieve a Desired Future Condition (DFC) as adopted by Groundwater Management Areas (GMAs). Establishing conservative levels of water source availability, thus results in less potential of over exploiting the supply.

The next step in establishing the long-term protection of water resources occurs in the water management strategies developed in Chapter 5 to meet potential water supply shortages. Each strategy was evaluated for potential threats to water resources in terms of source depletion (reliability), quality degradation, and impact to environmental habitat.

Key parameters of water quality are discussed in Chapter 1 Section 1.4.5. The potential for surface water contamination resulting from urban runoff in rapidly growing population centers is of concern in the Plateau Region. Groundwater contamination most often results from old, poorly constructed or new improperly constructed water wells. In both surface water and groundwater concerns, this *Plan* attempts to (1) provide the reader with information pertaining to best practices to prevent water contamination, (2) recognize local organizational (river authorities, ground water districts, etc.) practices and programs intended to prevent water contamination, and (3) present recommended water management strategies that do not result in potential contamination issues. It is the specific intent of the PWPG that Utilities and WUGs use all necessary precautions and follow all mandated guidelines in the construction of recommended water management strategies. In the analysis of potential water quality impact, no recommended strategies were determined to result in an anticipated water quality degradation.

Water conservation strategies are also recommended for each entity with a supply deficit. Conservation reduces the impact on water supplies by reducing the actual water demand for the supply. Table 5-2 and 5-4 in Chapter 5 provides an overview of these impact evaluations.

Chapters 5 and 7 contain information and recommendations pertaining to water conservation and drought management practices. When enacted, the conservation practices will diminish water demand, the drought management practices will extend supplies over the stress period, and the land management practices will potentially increase aquifer recharge.

6.2 PROTECTION OF AGRICULTURAL RESOURCES

Agriculture in the Plateau Region, as described in Chapter 1, Sections 1.2.7 and 1.3.3, and Chapter 3, Section 3.1.10 includes the raising of crops and livestock, as well as a multitude of businesses that support this industry. Many of the communities in the Region depend on various forms of the agricultural industry for a significant portion of their economy. It is thus important to the economic health and way of life in these communities to protect water resources that have historically been used in the support of agricultural activities.

TWDB's socio-economic analysis (Appendix 6A) reports that a projected water shortages in the irrigated agriculture water use category for one or more decades within the water planning horizon (Chapter 4, Table 4-1) only occurs in Bandera County. Per the TWDB's socio-economic analysis, a negative tax impact was surmised, primarily due to past subsidies from the federal government.

Portions of three of the six counties in the Region (Bandera, Kerr and Kinney) are projected to experience water shortages in the livestock water use category for one or more decades within the water planning horizon (Chapter 4, Table 4-1). Income loss is estimated to be approximately \$11 million, which includes approximately 573 job losses per decade (Table 6-1).

The *2021 Plateau Region Water Plan* provides irrigation strategy recommendations for minor projected shortages in parts of Bandera County in Chapter 5. Also, non-agricultural strategies provided in Chapter 5 include an analysis of potential impact to agricultural interests.

An interim project was performed in 2010 to evaluate the water use by livestock and game animals in the Plateau Region. This report titled "Water Use by Livestock and Game Animals in the Plateau Regional Water Planning Area" is printed in the *2011 Plateau Region Water Plan*.

Table 6-1. Impacts of Water Shortages on Irrigation and Livestock

WUG	2020	2030	2040	2050	2060	2070
Irrigation	\$0	\$0	\$0	\$0	\$0	\$0
Job Losses	0	0	0	0	0	0
Livestock	\$11M	\$11M	\$11M	\$11M	\$11M	\$11M
Job Losses	573	573	573	573	573	573

* Year 2018 dollars rounded. Entries denoted by a zero (\$0) indicate income losses less than \$500,000.

6.3 PROTECTION OF NATURAL RESOURCES

The Plateau Region Water Planning Group has adopted a stance toward the protection of natural resources. Natural resources are defined in Chapter 1, Sections 1.2.6 and 1.2.7 as including terrestrial and aquatic habitats that support a diverse environmental community as well as provide recreational and economic opportunities. Environmental and recreational water needs are discussed in Chapter 2, Section 2.3.

The protection of natural resources is closely linked with the protection of water resources as discussed in Section 6.1 above. Where possible, the methodology used to assess groundwater source availability is based on not significantly lowering water levels to a point where spring flows might be impacted. Thus, the intention to protect surface flows is directly related to those natural resources that are dependent on surface water sources or spring flows for their existence.

Environmental impacts were evaluated in the consideration of strategies to meet water-supply deficits. Table 5-4 in Chapter 5 provides a comparative analysis of all selected strategies. Of prime consideration was whether a strategy potentially could diminish the quantity of water currently existing in the natural environment and if a strategy could impact water quality to a level that would be detrimental to animals and plants that naturally inhabit the area under consideration.

Although the Planning Group chooses to respect the privacy of private lands by not recommending “Ecologically Unique River and Stream Segments” in this *Water Plan*, the Group recognizes and applauds the conservation work that is undertaken on a daily basis by the majority of all landowners in the Region.

6.4 PROTECTION OF PUBLIC HEALTH AND SAFETY

Sufficient water management strategy supplies are recommended in this *2021 Plan* to meet the identified projected needs of all municipal water user groups (WUGs) in the Region except for:

- Bandera River Ranch 1 and Lake Medina Shores in Bandera County
- County Other in Val Verde County
- Livestock in Kerr and Kinney Counties

The public health and safety of meeting municipal water supply needs is of significant concern of the PRWPG in preparing this *2021 Plan*. The unmet needs listed above received attention in terms of considering additional conservation and infrastructure strategies. Insufficient water available to meet the needs of the two entities in Bandera County is the result of GMA limitations placed on groundwater availability. Additional groundwater well strategies can be generated to account for the above needed supplies; however, Bandera River Ranch and Lake Medina Shores must negotiate permit allowances with the Bandera County River Authority and Groundwater Conservation District.

The County Other category in Val Verde County is experiencing a high growth rate with a population expected to double over the 50-year planning horizon. Water use in these rural communities is generally less than the State average and therefore drought management will likely have only a minor impact. Water loss audit and main line repair strategies are presented in this plan to create demand reductions. An unmet need is not projected for this category until the 2070 decade by which time sufficient transitions in

water-supplier opportunities will have occurred. The Del Rio Utilities Commission will likely expand its area of service to incorporate a portion of these communities.

Livestock use shortages in Kerr and Kinney Counties are likewise the result of GMA limitations on groundwater availability. Livestock supply use are considered “Exempt” from permitting but should consult with the local Groundwater Conservation Districts for advice on aquifer supply availability. During drought of record conditions, livestock is typically reduced to a manageable level which would likely eliminate the unmet needs condition. Public health and safety are not at risk as a result of unmet Livestock supply needs.

Conservation was considered and recommended as a strategy to help reduce the unmet municipal needs and protect the human health and safety of the residents of Bandera River Ranch 1 and Lake Medina Shores in Bandera County and County-Other in Val Verde County. Additional conservation is anticipated to be enacted by each entity as described in their Conservation Plans. Drought management was also considered for both entities but was not considered feasible for meeting long-term growth in demands. The Bandera County River Authority and Groundwater Conservation District maintains an active drought management program in which these two entities are monitored and provided the opportunity to learn and experience activities designed to conserve water. Drought management in Valverde County will likely be enacted by the Del Rio Utilities Commission with outreach to County-Other entities.

The PRWPG does not anticipate amending the *2021 Plan* to address these unmet municipal needs but is prepared to do so if conditions cause an entity to request such a change. More likely, it is expected that the entity may choose to wait to incorporate any new information (such as modification of the MAGs) in the *2026 Plateau Region Water Plan*.

This page intentionally left blank.

APPENDIX 6A

SOCIOECONOMIC IMPACT OF UNMET WATER NEEDS

This page intentionally left blank.

Socioeconomic Impacts of Projected Water Shortages for the Plateau (Region J) Regional Water Planning Area

Prepared in Support of the 2021 Region J Regional Water Plan



Dr. John R. Ellis
Water Use, Projections, & Planning Division
Texas Water Development Board

November 2021

Table of Contents

Executive Summary.....	1
1 Introduction.....	3
1.1 Regional Economic Summary	3
1.2 Identified Regional Water Needs (Potential Shortages).....	5
2 Impact Assessment Measures.....	7
2.1 Regional Economic Impacts.....	8
2.2 Financial Transfer Impacts	8
2.3 Social Impacts.....	10
3 Socioeconomic Impact Assessment Methodology.....	11
3.1 Analysis Context	11
3.2 IMPLAN Model and Data	11
3.3 Elasticity of Economic Impacts.....	12
3.4 Analysis Assumptions and Limitations	13
4 Analysis Results.....	17
4.1 Impacts for Irrigation Water Shortages.....	17
4.2 Impacts for Livestock Water Shortages.....	17
4.3 Impacts of Manufacturing Water Shortages	18
4.4 Impacts of Mining Water Shortages	18
4.5 Impacts for Municipal Water Shortages	19
4.6 Impacts of Steam-Electric Water Shortages.....	20
4.7 Regional Social Impacts.....	21
Appendix A - County Level Summary of Estimated Economic Impacts for Region J.....	22

Executive Summary

Evaluating the social and economic impacts of not meeting identified water needs is a required analysis in the regional water planning process. The Texas Water Development Board (TWDB) estimates these impacts for regional water planning groups (RWPGs) and summarizes the impacts in the state water plan. The analysis presented is for the Plateau Regional Water Planning Group (Region J).

Based on projected water demands and existing water supplies, Region J identified water needs (potential shortages) that could occur within its region under a repeat of the drought of record for six water use categories (irrigation, livestock, manufacturing, mining, municipal and steam-electric power). The TWDB then estimated the annual socioeconomic impacts of those needs—if they are not met—for each water use category and as an aggregate for the region.

This analysis was performed using an economic impact modeling software package, IMPLAN (Impact for Planning Analysis), as well as other economic analysis techniques, and represents a snapshot of socioeconomic impacts that may occur during a single year repeat of the drought of record with the further caveat that no mitigation strategies are implemented. Decade specific impact estimates assume that growth occurs, and future shocks are imposed on an economy at 10-year intervals. The estimates presented are not cumulative (i.e., summing up expected impacts from today up to the decade noted), but are simply snapshots of the estimated annual socioeconomic impacts should a drought of record occur in each particular decade based on anticipated water supplies and demands for that same decade.

For regional economic impacts, income losses and job losses are estimated within each planning decade (2020 through 2070). The income losses represent an approximation of gross domestic product (GDP) that would be foregone if water needs are not met.

The analysis also provides estimates of financial transfer impacts, which include tax losses (state, local, and utility tax collections); water trucking costs; and utility revenue losses. In addition, social impacts are estimated, encompassing lost consumer surplus (a welfare economics measure of consumer wellbeing); as well as population and school enrollment losses.

IMPLAN data reported that the Region J generated more than \$4.5 billion in gross domestic product (GDP) (2018 dollars) and supported roughly 68,000 jobs in 2016. The Region J estimated total population was approximately 131,000 in 2016.

It is estimated that not meeting the identified water needs in Region J would result in an annually combined lost income impact of approximately \$233 million in 2020, increasing to \$257 million in 2070 (Table ES-1). In 2020, the region would lose approximately 2,300 jobs, and by 2070 job losses would increase to approximately 3,000 if anticipated needs are not mitigated.

All impact estimates are in year 2018 dollars and were calculated using a variety of data sources and tools including the use of a region-specific IMPLAN model, data from TWDB annual water use

estimates, the U.S. Census Bureau, Texas Agricultural Statistics Service, and the Texas Municipal League.

Table ES-1 Region J socioeconomic impact summary

Regional Economic Impacts	2020	2030	2040	2050	2060	2070
Income losses (\$ millions)*	\$233	\$298	\$316	\$289	\$268	\$257
Job losses	2,272	2,597	2,780	2,850	2,935	3,064
Financial Transfer Impacts	2020	2030	2040	2050	2060	2070
Tax losses on production and imports (\$ millions)*	\$26	\$33	\$35	\$32	\$29	\$28
Water trucking costs (\$ millions)*	\$1	\$1	\$1	\$1	\$1	\$1
Utility revenue losses (\$ millions)*	\$14	\$15	\$17	\$18	\$20	\$22
Utility tax revenue losses (\$ millions)*	\$0	\$0	\$0	\$0	\$0	\$0
Social Impacts	2020	2030	2040	2050	2060	2070
Consumer surplus losses (\$ millions)*	\$5	\$7	\$8	\$10	\$12	\$15
Population losses	417	477	510	523	539	563
School enrollment losses	80	91	98	100	103	108

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero (\$0) indicate estimated income losses less than \$500,000.

1 Introduction

Water shortages during a repeat of the drought of record would likely curtail or eliminate certain economic activity in businesses and industries that rely heavily on water. Insufficient water supplies could not only have an immediate and real impact on the regional economy in the short term, but they could also adversely and chronically affect economic development in Texas. From a social perspective, water supply reliability is critical as well. Shortages could disrupt activity in homes, schools and government, and could adversely affect public health and safety. For these reasons, it is important to evaluate and understand how water supply shortages during drought could impact communities throughout the state.

As part of the regional water planning process, RWPGs must evaluate the social and economic impacts of not meeting water needs (31 Texas Administrative Code §357.33 (c)). Due to the complexity of the analysis and limited resources of the planning groups, the TWDB has historically performed this analysis for the RWPGs upon their request. Staff of the TWDB's Water Use, Projections, & Planning Division designed and conducted this analysis in support of Region J, and those efforts for this region as well as the other 15 regions allow consistency and a degree of comparability in the approach.

This document summarizes the results of the analysis and discusses the methodology used to generate the results. Section 1 provides a snapshot of the region's economy and summarizes the identified water needs in each water use category, which were calculated based on the RWPG's water supply and demand established during the regional water planning process. Section 2 defines each of ten impact assessment measures used in this analysis. Section 3 describes the methodology for the impact assessment and the approaches and assumptions specific to each water use category (i.e., irrigation, livestock, manufacturing, mining, municipal, and steam-electric power). Section 4 presents the impact estimates for each water use category with results summarized for the region as a whole. Appendix A presents a further breakdown of the socioeconomic impacts by county.

1.1 Regional Economic Summary

The Region J Regional Water Planning Area generated more than \$4.5 billion in gross domestic product (2018 dollars) and supported roughly 68,000 jobs in 2016, according to the IMPLAN dataset utilized in this socioeconomic analysis. This activity accounted for 0.3 percent of the state's total gross domestic product of 1.73 trillion dollars for the year based on IMPLAN. Table 1-1 lists all economic sectors ranked by the total value-added to the economy in Region J. The real estate and retail trade sectors generated close to 20 percent of the region's total value-added and were also significant sources of tax revenue. The top employers in the region were in the public administration, retail trade, and health care sectors. Region J's estimated total population was roughly 131,000 in 2016, approximately 0.5 percent of the state's total.

This represents a snapshot of the regional economy as a whole, and it is important to note that not all economic sectors were included in the TWDB socioeconomic impact analysis. Data

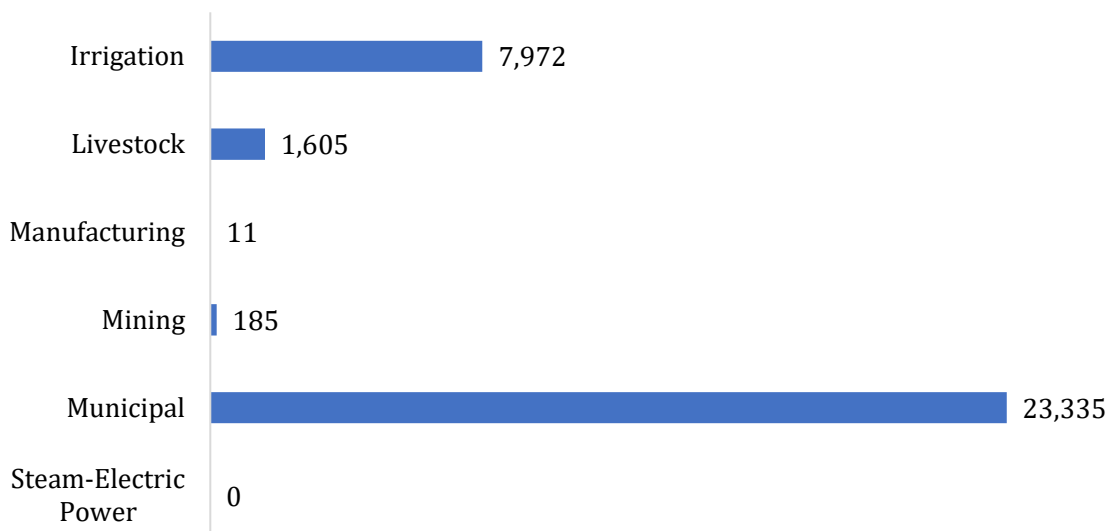
considerations prompted use of only the more water-intensive sectors within the economy because damage estimates could only be calculated for those economic sectors which had both reliable income and water use estimates.

Table 1-1 Region J regional economy by economic sector*

Economic sector	Value-added (\$ millions)	Tax (\$ millions)	Jobs
Public Administration	\$1,098.8	\$(7.7)	10,835
Real Estate and Rental and Leasing	\$511.9	\$91.5	3,031
Retail Trade	\$383.5	\$100.4	7,154
Manufacturing	\$372.0	\$14.1	3,610
Health Care and Social Assistance	\$364.4	\$5.9	7,151
Construction	\$270.8	\$5.6	5,093
Accommodation and Food Services	\$230.2	\$33.8	5,358
Professional, Scientific, and Technical Services	\$189.9	\$6.4	3,150
Other Services (except Public Administration)	\$184.0	\$19.9	4,987
Wholesale Trade	\$171.9	\$65.4	2,211
Administrative and Support and Waste Management and Remediation Services	\$137.6	\$3.4	2,744
Transportation and Warehousing	\$135.8	\$4.2	1,756
Finance and Insurance	\$128.8	\$8.2	2,828
Information	\$91.9	\$32.3	662
Mining, Quarrying, and Oil and Gas Extraction	\$89.9	\$49.8	1,334
Agriculture, Forestry, Fishing and Hunting	\$59.4	\$2.5	3,769
Utilities	\$54.7	\$14.7	218
Arts, Entertainment, and Recreation	\$35.1	\$6.5	1,075
Educational Services	\$28.4	\$1.9	1,025
Management of Companies and Enterprises	\$6.7	\$0.7	251
Grand Total	\$4,545.8	\$459.6	68,241

*Source: 2016 IMPLAN for 536 sectors aggregated by 2-digit NAICS (North American Industry Classification System)

Figure 1-1 illustrates Region J's breakdown of the 2016 water use estimates by TWDB water use category. The categories with the highest use in Region J in 2016 were municipal (70 percent) and irrigation (24 percent).

Figure 1-1 Region J 2016 water use estimates by water use category (in acre-feet)

Source: TWDB Annual Water Use Estimates (all values in acre-feet)

1.2 Identified Regional Water Needs (Potential Shortages)

As part of the regional water planning process, the TWDB adopted water demand projections for water user groups (WUG) in Region J with input from the planning group. WUG-level demand projections were established for utilities that provide more than 100 acre-feet of annual water supply, combined rural areas (designated as county-other), and county-wide water demand projections for five non-municipal categories (irrigation, livestock, manufacturing, mining and steam-electric power). The RWPG then compared demands to the existing water supplies of each WUG to determine potential shortages, or needs, by decade.

Table 1-2 summarizes the region's identified water needs in the event of a repeat of the drought of record. Demand management, such as conservation, or the development of new infrastructure to increase supplies, are water management strategies that may be recommended by the planning group to address those needs. This analysis assumes that no strategies are implemented, and that the identified needs correspond to future water shortages. Note that projected water needs generally increase over time, primarily due to anticipated population growth, economic growth, or declining supplies. To provide a general sense of proportion, total projected needs as an overall percentage of total demand by water use category are also presented in aggregate in Table 1-2. Projected needs for individual water user groups within the aggregate can vary greatly and may reach 100% for a given WUG and water use category. A detailed summary of water needs by WUG and county appears in Chapter 4 of the 2021 Region J Regional Water Plan.

Table 1-2 Regional water needs summary by water use category*

Water Use Category		2020	2030	2040	2050	2060	2070
Irrigation	water needs (acre-feet per year)	75	75	75	75	75	75
	% of the category's total water demand	1%	1%	1%	1%	1%	1%
Livestock	water needs (acre-feet per year)	357	357	357	357	357	357
	% of the category's total water demand	16%	16%	16%	16%	16%	16%
Manufacturing	water needs (acre-feet per year)	-	-	-	-	-	-
	% of the category's total water demand	0%	0%	0%	0%	0%	0%
Mining	water needs (acre-feet per year)	221	281	294	259	229	210
	% of the category's total water demand	62%	67%	66%	63%	58%	55%
Municipal**	water needs (acre-feet per year)	5,956	6,685	7,336	8,143	9,198	10,223
	% of the category's total water demand	23%	24%	26%	28%	30%	32%
Steam-electric power	water needs (acre-feet per year)	-	-	-	-	-	-
	% of the category's total water demand	0%	0%	0%	0%	0%	0%
Total water needs (acre-feet per year)		6,609	7,398	8,062	8,834	9,859	10,865

*Entries denoted by a dash (-) indicate no identified water need for a given water use category.

** Municipal category consists of residential and non-residential (commercial and institutional) subcategories.

2 Impact Assessment Measures

A required component of the regional and state water plans is to estimate the potential economic and social impacts of potential water shortages during a repeat of the drought of record. Consistent with previous water plans, ten impact measures were estimated and are described in Table 2-1.

Table 2-1 Socioeconomic impact analysis measures

Regional economic impacts	Description
Income losses - value-added	The value of output less the value of intermediate consumption; it is a measure of the contribution to gross domestic product (GDP) made by an individual producer, industry, sector, or group of sectors within a year. Value-added measures used in this report have been adjusted to include the direct, indirect, and induced monetary impacts on the region.
Income losses - electrical power purchase costs	Proxy for income loss in the form of additional costs of power as a result of impacts of water shortages.
Job losses	Number of part-time and full-time jobs lost due to the shortage. These values have been adjusted to include the direct, indirect, and induced employment impacts on the region.
Financial transfer impacts	Description
Tax losses on production and imports	Sales and excise taxes not collected due to the shortage, in addition to customs duties, property taxes, motor vehicle licenses, severance taxes, other taxes, and special assessments less subsidies. These values have been adjusted to include the direct, indirect and induced tax impacts on the region.
Water trucking costs	Estimated cost of shipping potable water.
Utility revenue losses	Foregone utility income due to not selling as much water.
Utility tax revenue losses	Foregone miscellaneous gross receipts tax collections.
Social impacts	Description
Consumer surplus losses	A welfare measure of the lost value to consumers accompanying restricted water use.
Population losses	Population losses accompanying job losses.
School enrollment losses	School enrollment losses (K-12) accompanying job losses.

2.1 Regional Economic Impacts

The two key measures used to assess regional economic impacts are income losses and job losses. The income losses presented consist of the sum of value-added losses and the additional purchase costs of electrical power.

Income Losses - Value-added Losses

Value-added is the value of total output less the value of the intermediate inputs also used in the production of the final product. Value-added is similar to GDP, a familiar measure of the productivity of an economy. The loss of value-added due to water shortages is estimated by input-output analysis using the IMPLAN software package, and includes the direct, indirect, and induced monetary impacts on the region. The indirect and induced effects are measures of reduced income as well as reduced employee spending for those input sectors which provide resources to the water shortage impacted production sectors.

Income Losses - Electric Power Purchase Costs

The electrical power grid and market within the state is a complex interconnected system. The industry response to water shortages, and the resulting impact on the region, are not easily modeled using traditional input/output impact analysis and the IMPLAN model. Adverse impacts on the region will occur and are represented in this analysis by estimated additional costs associated with power purchases from other generating plants within the region or state. Consequently, the analysis employs additional power purchase costs as a proxy for the value-added impacts for the steam-electric power water use category, and these are included as a portion of the overall income impact for completeness.

For the purpose of this analysis, it is assumed that power companies with insufficient water will be forced to purchase power on the electrical market at a projected higher rate of 5.60 cents per kilowatt hour. This rate is based upon the average day-ahead market purchase price of electricity in Texas that occurred during the recent drought period in 2011. This price is assumed to be comparable to those prices which would prevail in the event of another drought of record.

Job Losses

The number of jobs lost due to the economic impact is estimated using IMPLAN output associated with each TWDB water use category. Because of the difficulty in predicting outcomes and a lack of relevant data, job loss estimates are not calculated for the steam-electric power category.

2.2 Financial Transfer Impacts

Several impact measures evaluated in this analysis are presented to provide additional detail concerning potential impacts on a portion of the economy or government. These financial transfer impact measures include lost tax collections (on production and imports), trucking costs for

imported water, declines in utility revenues, and declines in utility tax revenue collected by the state. These measures are not solely adverse, with some having both positive and negative impacts. For example, cities and residents would suffer if forced to pay large costs for trucking in potable water. Trucking firms, conversely, would benefit from the transaction. Additional detail for each of these measures follows.

Tax Losses on Production and Imports

Reduced production of goods and services accompanying water shortages adversely impacts the collection of taxes by state and local government. The regional IMPLAN model is used to estimate reduced tax collections associated with the reduced output in the economy. Impact estimates for this measure include the direct, indirect, and induced impacts for the affected sectors.

Water Trucking Costs

In instances where water shortages for a municipal water user group are estimated by RWPGs to exceed 80 percent of water demands, it is assumed that water would need to be trucked in to support basic consumption and sanitation needs. For water shortages of 80 percent or greater, a fixed, maximum of \$35,000¹ per acre-foot of water applied as an economic cost. This water trucking cost was utilized for both the residential and non-residential portions of municipal water needs.

Utility Revenue Losses

Lost utility income is calculated as the price of water service multiplied by the quantity of water not sold during a drought shortage. Such estimates are obtained from utility-specific pricing data provided by the Texas Municipal League, where available, for both water and wastewater. These water rates are applied to the potential water shortage to estimate forgone utility revenue as water providers sold less water during the drought due to restricted supplies.

Utility Tax Losses

Foregone utility tax losses include estimates of forgone miscellaneous gross receipts taxes. Reduced water sales reduce the amount of utility tax that would be collected by the State of Texas for water and wastewater service sales.

¹ Based on staff survey of water hauling firms and historical data concerning transport costs for potable water in the recent drought in California for this estimate. There are many factors and variables that would determine actual water trucking costs including distance to, cost of water, and length of that drought.

2.3 Social Impacts

Consumer Surplus Losses for Municipal Water Users

Consumer surplus loss is a measure of impact to the wellbeing of municipal water users when their water use is restricted. Consumer surplus is the difference between how much a consumer is willing and able to pay for a commodity (i.e., water) and how much they actually have to pay. The difference is a benefit to the consumer's wellbeing since they do not have to pay as much for the commodity as they would be willing to pay. Consumer surplus may also be viewed as an estimate of how much consumers would be willing to pay to keep the original quantity of water which they used prior to the drought. Lost consumer surplus estimates within this analysis only apply to the residential portion of municipal demand, with estimates being made for reduced outdoor and indoor residential use. Lost consumer surplus estimates varied widely by location and degree of water shortage.

Population and School Enrollment Losses

Population loss due to water shortages, as well as the associated decline in school enrollment, are based upon the job loss estimates discussed in Section 2.1. A simplified ratio of job and net population losses are calculated for the state as a whole based on a recent study of how job layoffs impact the labor market population.² For every 100 jobs lost, 18 people were assumed to move out of the area. School enrollment losses are estimated as a proportion of the population lost based upon public school enrollment data from the Texas Education Agency concerning the age K-12 population within the state (approximately 19%).

² Foote, Andrew, Grosz, Michel, Stevens, Ann. "Locate Your Nearest Exit: Mass Layoffs and Local Labor Market Response." University of California, Davis. April 2015, <http://paa2015.princeton.edu/papers/150194>. The study utilized Bureau of Labor Statistics data regarding layoffs between 1996 and 2013, as well as Internal Revenue Service data regarding migration, to model the change in the population as the result of a job layoff event. The study found that layoffs impact both out-migration and in-migration into a region, and that a majority of those who did move following a layoff moved to another labor market rather than an adjacent county.

3 Socioeconomic Impact Assessment Methodology

This portion of the report provides a summary of the methodology used to estimate the potential economic impacts of future water shortages. The general approach employed in the analysis was to obtain estimates for income and job losses on the smallest geographic level that the available data would support, tie those values to their accompanying historic water use estimate, and thereby determine a maximum impact per acre-foot of shortage for each of the socioeconomic measures. The calculations of economic impacts are based on the overall composition of the economy divided into many underlying economic sectors. Sectors in this analysis refer to one or more of the 536 specific production sectors of the economy designated within IMPLAN, the economic impact modeling software used for this assessment. Economic impacts within this report are estimated for approximately 330 of these sectors, with the focus on the more water-intensive production sectors. The economic impacts for a single water use category consist of an aggregation of impacts to multiple, related IMPLAN economic sectors.

3.1 Analysis Context

The context of this socioeconomic impact analysis involves situations where there are physical shortages of groundwater or surface water due to a recurrence of drought of record conditions. Anticipated shortages for specific water users may be nonexistent in earlier decades of the planning horizon, yet population growth or greater industrial, agricultural or other sector demands in later decades may result in greater overall demand, exceeding the existing supplies. Estimated socioeconomic impacts measure what would happen if water user groups experience water shortages for a period of one year. Actual socioeconomic impacts would likely become larger as drought of record conditions persist for periods greater than a single year.

3.2 IMPLAN Model and Data

Input-Output analysis using the IMPLAN software package was the primary means of estimating the value-added, jobs, and tax related impact measures. This analysis employed regional level models to determine key economic impacts. IMPLAN is an economic impact model, originally developed by the U.S. Forestry Service in the 1970's to model economic activity at varying geographic levels. The model is currently maintained by the Minnesota IMPLAN Group (MIG Inc.) which collects and sells county and state specific data and software. The year 2016 version of IMPLAN, employing data for all 254 Texas counties, was used to provide estimates of value-added, jobs, and taxes on production for the economic sectors associated with the water user groups examined in the study. IMPLAN uses 536 sector-specific Industry Codes, and those that rely on water as a primary input were assigned to their appropriate planning water user categories (irrigation, livestock, manufacturing, mining, and municipal). Estimates of value-added for a water use category were obtained by summing value-added estimates across the relevant IMPLAN sectors associated with that water use category. These calculations were also performed for job losses as well as tax losses on production and imports.

The adjusted value-added estimates used as an income measure in this analysis, as well as the job and tax estimates from IMPLAN, include three components:

- **Direct effects** representing the initial change in the industry analyzed;
- **Indirect effects** that are changes in inter-industry transactions as supplying industries respond to reduced demands from the directly affected industries; and,
- **Induced effects** that reflect changes in local spending that result from reduced household income among employees in the directly and indirectly affected industry sectors.

Input-output models such as IMPLAN only capture backward linkages and do not include forward linkages in the economy.

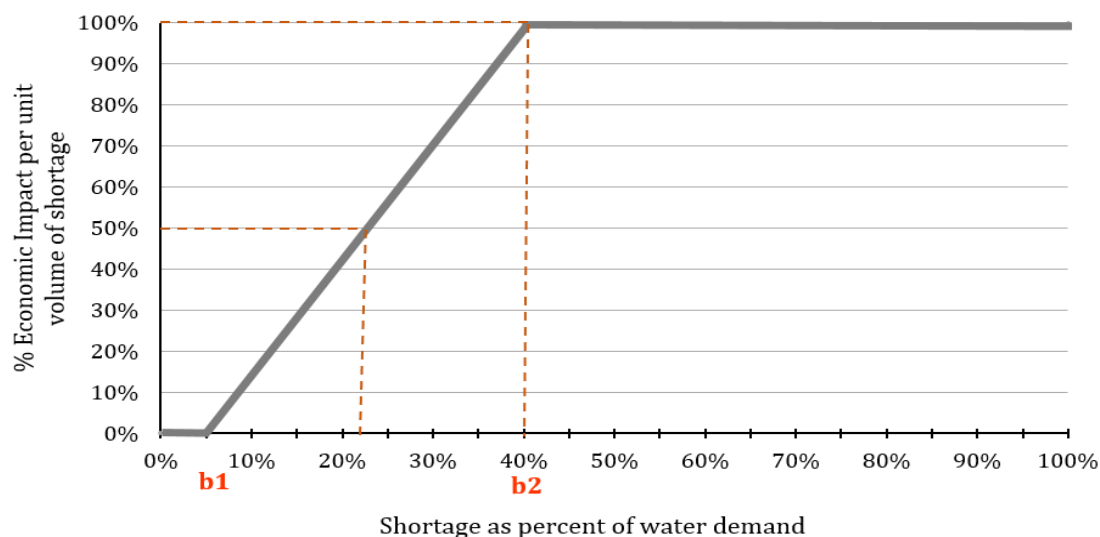
3.3 Elasticity of Economic Impacts

The economic impact of a water need is based on the size of the water need relative to the total water demand for each water user group. Smaller water shortages, for example, less than 5 percent, are generally anticipated to result in no initial negative economic impact because water users are assumed to have a certain amount of flexibility in dealing with small shortages. As a water shortage intensifies, however, such flexibility lessens and results in actual and increasing economic losses, eventually reaching a representative maximum impact estimate per unit volume of water. To account for these characteristics, an elasticity adjustment function is used to estimate impacts for the income, tax and job loss measures. Figure 3-1 illustrates this general relationship for the adjustment functions. Negative impacts are assumed to begin accruing when the shortage reaches the lower bound 'b1' (5 percent in Figure 3-1), with impacts then increasing linearly up to the 100 percent impact level (per unit volume) once the upper bound reaches the 'b2' level shortage (40 percent in Figure 3-1).

To illustrate this, if the total annual value-added for manufacturing in the region was \$2 million and the reported annual volume of water used in that industry is 10,000 acre-feet, the estimated economic measure of the water shortage would be \$200 per acre-foot. The economic impact of the shortage would then be estimated using this value-added amount as the maximum impact estimate (\$200 per acre-foot) applied to the anticipated shortage volume and then adjusted by the elasticity function. Using the sample elasticity function shown in Figure 3-1, an approximately 22 percent shortage in the livestock category would indicate an economic impact estimate of 50% of the original \$200 per acre-foot impact value (i.e., \$100 per acre-foot).

Such adjustments are not required in estimating consumer surplus, utility revenue losses, or utility tax losses. Estimates of lost consumer surplus rely on utility-specific demand curves with the lost consumer surplus estimate calculated based on the relative percentage of the utility's water shortage. Estimated changes in population and school enrollment are indirectly related to the elasticity of job losses.

Assumed values for the lower and upper bounds 'b1' and 'b2' vary by water use category and are presented in Table 3-1.

Figure 3-1 Example economic impact elasticity function (as applied to a single water user's**Table 3-1 Economic impact elasticity function lower and upper bounds**

Water use category	Lower bound (b1)	Upper bound (b2)
Irrigation	5%	40%
Livestock	5%	10%
Manufacturing	5%	40%
Mining	5%	40%
Municipal (non-residential water intensive subcategory)	5%	40%
Steam-electric power	N/A	N/A

3.4 Analysis Assumptions and Limitations

The modeling of complex systems requires making many assumptions and acknowledging the model's uncertainty and limitations. This is particularly true when attempting to estimate a wide range of socioeconomic impacts over a large geographic area and into future decades. Some of the key assumptions and limitations of this methodology include:

1. The foundation for estimating the socioeconomic impacts of water shortages resulting from a drought are the water needs (potential shortages) that were identified by RWPGs as part of the

regional water planning process. These needs have some uncertainty associated with them but serve as a reasonable basis for evaluating the potential impacts of a drought of record event.

2. All estimated socioeconomic impacts are snapshots for years in which water needs were identified (i.e., 2020, 2030, 2040, 2050, 2060, and 2070). The estimates are independent and distinct “what if” scenarios for each particular year, and water shortages are assumed to be temporary events resulting from a single year recurrence of drought of record conditions. The evaluation assumed that no recommended water management strategies are implemented. In other words, growth occurs and future shocks are imposed on an economy at 10-year intervals, and the resulting impacts are estimated. Note that the estimates presented are not cumulative (i.e., summing up expected impacts from today up to the decade noted), but are simply snapshots of the estimated annual socioeconomic impacts should a drought of record occur in each particular decade based on anticipated water supplies and demands for that same decade.
3. Input-output models such as IMPLAN rely on a static profile of the structure of the economy as it appears today. This presumes that the relative contributions of all sectors of the economy would remain the same, regardless of changes in technology, availability of limited resources, and other structural changes to the economy that may occur in the future. Changes in water use efficiency will undoubtedly take place in the future as supplies become more stressed. Use of the static IMPLAN structure was a significant assumption and simplification considering the 50-year time period examined in this analysis. To presume an alternative future economic makeup, however, would entail positing many other major assumptions that would very likely generate as much or more error.
4. This is not a form of cost-benefit analysis. That approach to evaluating the economic feasibility of a specific policy or project employs discounting future benefits and costs to their present value dollars using some assumed discount rate. The methodology employed in this effort to estimate the economic impacts of future water shortages did not use any discounting methods to weigh future costs differently through time.
5. All monetary values originally based upon year 2016 IMPLAN and other sources are reported in constant year 2018 dollars to be consistent with the water management strategy requirements in the State Water Plan.
6. IMPLAN based loss estimates (income-value-added, jobs, and taxes on production and imports) are calculated only for those IMPLAN sectors for which the TWDB’s Water Use Survey (WUS) data was available and deemed reliable. Every effort is made in the annual WUS effort to capture all relevant firms who are significant water users. Lack of response to the WUS, or omission of relevant firms, impacts the loss estimates.

7. Impacts are annual estimates. The socioeconomic analysis does not reflect the full extent of impacts that might occur as a result of persistent water shortages occurring over an extended duration. The drought of record in most regions of Texas lasted several years.
8. Value-added estimates are the primary estimate of the economic impacts within this report. One may be tempted to add consumer surplus impacts to obtain an estimate of total adverse economic impacts to the region, but the consumer surplus measure represents the change to the wellbeing of households (and other water users), not an actual change in the flow of dollars through the economy. The two measures (value-added and consumer surplus) are both valid impacts but ideally should not be summed.
9. The value-added, jobs, and taxes on production and import impacts include the direct, indirect and induced effects to capture backward linkages in the economy described in Section 2.1. Population and school enrollment losses also indirectly include such effects as they are based on the associated losses in employment. The remaining measures (consumer surplus, utility revenue, utility taxes, additional electrical power purchase costs, and potable water trucking costs), however, do not include any induced or indirect effects.
10. The majority of impacts estimated in this analysis may be more conservative (i.e., smaller) than those that might actually occur under drought of record conditions due to not including impacts in the forward linkages in the economy. Input-output models such as IMPLAN only capture backward linkages on suppliers (including households that supply labor to directly affected industries). While this is a common limitation in this type of economic modeling effort, it is important to note that forward linkages on the industries that use the outputs of the directly affected industries can also be very important. A good example is impacts on livestock operators. Livestock producers tend to suffer substantially during droughts, not because there is not enough water for their stock, but because reductions in available pasture and higher prices for purchased hay have significant economic effects on their operations. Food processors could be in a similar situation if they cannot get the grains or other inputs that they need. These effects are not captured in IMPLAN, resulting in conservative impact estimates.
11. The model does not reflect dynamic economic responses to water shortages as they might occur, nor does the model reflect economic impacts associated with a recovery from a drought of record including:
 - a. The likely significant economic rebound to some industries immediately following a drought, such as landscaping;
 - b. The cost and time to rebuild liquidated livestock herds (a major capital investment in that industry);
 - c. Direct impacts on recreational sectors (i.e., stranded docks and reduced tourism); or,
 - d. Impacts of negative publicity on Texas' ability to attract population and business in the event that it was not able to provide adequate water supplies for the existing economy.

12. Estimates for job losses and the associated population and school enrollment changes may exceed what would actually occur. In practice, firms may be hesitant to lay off employees, even in difficult economic times. Estimates of population and school enrollment changes are based on regional evaluations and therefore do not necessarily reflect what might occur on a statewide basis.
13. **The results must be interpreted carefully. It is the general and relative magnitudes of impacts as well as the changes of these impacts over time that should be the focus rather than the absolute numbers.** Analyses of this type are much better at predicting relative percent differences brought about by a shock to a complex system (i.e., a water shortage) than the precise size of an impact. To illustrate, assuming that the estimated economic impacts of a drought of record on the manufacturing and mining water user categories are \$2 and \$1 million, respectively, one should be more confident that the economic impacts on manufacturing are twice as large as those on mining and that these impacts will likely be in the millions of dollars. But one should have less confidence that the actual total economic impact experienced would be \$3 million.
14. The methodology does not capture “spillover” effects between regions – or the secondary impacts that occur outside of the region where the water shortage is projected to occur.
15. The methodology that the TWDB has developed for estimating the economic impacts of unmet water needs, and the assumptions and models used in the analysis, are specifically designed to estimate potential economic effects at the regional and county levels. Although it may be tempting to add the regional impacts together in an effort to produce a statewide result, the TWDB cautions against that approach for a number of reasons. The IMPLAN modeling (and corresponding economic multipliers) are all derived from regional models – a statewide model of Texas would produce somewhat different multipliers. As noted in point 14 within this section, the regional modeling used by TWDB does not capture spillover losses that could result in other regions from unmet needs in the region analyzed, or potential spillover gains if decreased production in one region leads to increases in production elsewhere. The assumed drought of record may also not occur in every region of Texas at the same time, or to the same degree.

4 Analysis Results

This section presents estimates of potential economic impacts that could reasonably be expected in the event of water shortages associated with a drought of record and if no recommended water management strategies were implemented. Projected economic impacts for the six water use categories (irrigation, livestock, manufacturing, mining, municipal, and steam-electric power) are reported by decade.

4.1 Impacts for Irrigation Water Shortages

One of the six counties in the region are projected to experience water shortages in the irrigated agriculture water use category for one or more decades within the planning horizon. Estimated impacts to this water use category appear in Table 4-1. Note that tax collection impacts were not estimated for this water use category. IMPLAN data indicates a negative tax impact (i.e., increased tax collections) for the associated production sectors, primarily due to past subsidies from the federal government. However, it was not considered realistic to report increasing tax revenues during a drought of record.

Table 4-1 Impacts of water shortages on irrigation in Region J

Impact measure	2020	2030	2040	2050	2060	2070
Income losses (\$ millions)*	\$0	\$0	\$0	\$0	\$0	\$0
Job losses	0	0	0	0	0	0

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero (\$0) indicate estimated income losses less than \$500,000.

4.2 Impacts for Livestock Water Shortages

Three of the six counties in the region are projected to experience water shortages in the livestock water use category for one or more decades within the planning horizon. Estimated impacts to this water use category appear in Table 4-2.

Table 4-2 Impacts of water shortages on livestock in Region J

Impact measure	2020	2030	2040	2050	2060	2070
Income losses (\$ millions)*	\$11	\$11	\$11	\$11	\$11	\$11
Jobs losses	573	573	573	573	573	573
Tax losses on production and imports (\$ millions)*	\$1	\$1	\$1	\$1	\$1	\$1

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero (\$0) indicate estimated income losses less than \$500,000.

4.3 Impacts of Manufacturing Water Shortages

None of the six counties in the region are projected to experience water shortages in the manufacturing water use category. Estimated impacts to this water use category appear in Table 4-3.

Table 4-3 Impacts of water shortages on manufacturing in Region J

Impacts measure	2020	2030	2040	2050	2060	2070
Income losses (\$ millions)*	\$-	\$-	\$-	\$-	\$-	\$-
Job losses	-	-	-	-	-	-
Tax losses on production and imports (\$ millions)*	\$-	\$-	\$-	\$-	\$-	\$-

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero (\$0) indicate estimated income losses less than \$500,000.

4.4 Impacts of Mining Water Shortages

Mining water shortages in the region are projected to occur in three of the six counties in the region one or more decades within the planning horizon. Estimated impacts to this water use type appear in Table 4-4.

Table 4-4 Impacts of water shortages on mining in Region J

Impacts measure	2020	2030	2040	2050	2060	2070
Income losses (\$ millions)*	\$162	\$220	\$230	\$195	\$164	\$144
Job losses	495	666	696	592	502	441
Tax losses on production and Imports (\$ millions)*	\$19	\$26	\$27	\$23	\$19	\$17

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero (\$0) indicate estimated income losses less than \$500,000.

4.5 Impacts for Municipal Water Shortages

Five of the six counties in the region are projected to experience water shortages in the municipal water use category for one or more decades within the planning horizon.

Impact estimates were made for two sub-categories within municipal water use: residential, and non-residential. Non-residential municipal water use includes commercial and institutional users, which are further divided into non-water-intensive and water-intensive subsectors including car wash, laundry, hospitality, health care, recreation, and education. Lost consumer surplus estimates were made only for needs in the residential portion of municipal water use. Available IMPLAN and TWDB Water Use Survey data for the non-residential, water-intensive portion of municipal demand allowed these sectors to be included in income, jobs, and tax loss impact estimate.

Trucking cost estimates, calculated for shortages exceeding 80 percent, assumed a fixed, maximum cost of \$35,000 per acre-foot to transport water for municipal use. The estimated impacts to this water use category appear in Table 4-5.

Table 4-5 Impacts of water shortages on municipal water users in Region J

Impacts measure	2020	2030	2040	2050	2060	2070
Income losses¹ (\$ millions)*	\$59	\$67	\$75	\$83	\$92	\$101
Job losses¹	1,204	1,358	1,511	1,686	1,860	2,050
Tax losses on production and imports¹ (\$ millions)*	\$6	\$7	\$8	\$9	\$10	\$11
Trucking costs (\$ millions)*	\$1	\$1	\$1	\$1	\$1	\$1
Utility revenue losses (\$ millions)*	\$14	\$15	\$17	\$18	\$20	\$22
Utility tax revenue losses (\$ millions)*	\$0	\$0	\$0	\$0	\$0	\$0

¹ Estimates apply to the water-intensive portion of non-residential municipal water use.

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero (\$0) indicate estimated income losses less than \$500,000.

4.6 Impacts of Steam-Electric Water Shortages

None of the six counties in the region are projected to experience water shortages in the steam-electric water use category. Estimated impacts to this water use category appear in Table 4-6.

Note that estimated economic impacts to steam-electric water users:

- Are reflected as an income loss proxy in the form of estimated additional purchasing costs for power from the electrical grid to replace power that could not be generated due to a shortage;
- Do not include estimates of impacts on jobs. Because of the unique conditions of power generators during drought conditions and lack of relevant data, it was assumed that the industry would retain, perhaps relocating or repurposing, their existing staff in order to manage their ongoing operations through a severe drought.
- Do not presume a decline in tax collections. Associated tax collections, in fact, would likely increase under drought conditions since, historically, the demand for electricity increases during times of drought, thereby increasing taxes collected on the additional sales of power.

Table 4-6 Impacts of water shortages on steam-electric power in Region J

Impacts measure	2020	2030	2040	2050	2060	2070
Income Losses (\$ millions)*	\$-	\$-	\$-	\$-	\$-	\$-

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero (\$0) indicate estimated income losses less than \$500,000.

4.7 Regional Social Impacts

Projected changes in population, based upon several factors (household size, population, and job loss estimates), as well as the accompanying change in school enrollment, were also estimated and are summarized in Table 4-7.

Table 4-7 Region-wide social impacts of water shortages in Region J

Impacts measure	2020	2030	2040	2050	2060	2070
Consumer surplus losses (\$ millions)*	\$5	\$7	\$8	\$10	\$12	\$15
Population losses	417	477	510	523	539	563
School enrollment losses	80	91	98	100	103	108

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero (\$0) indicate estimated income losses less than \$500,000.

Appendix A - County Level Summary of Estimated Economic Impacts for Region J

County level summary of estimated economic impacts of not meeting identified water needs by water use category and decade (in 2018 dollars, rounded). Values are presented only for counties with projected economic impacts for at least one decade.

(* Entries denoted by a dash (-) indicate no estimated economic impact)

County	Water Use Category	Income losses (Million \$)*						Job losses					
		2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
BANDERA	IRRIGATION	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	0	0	0	0	0	0
BANDERA	MUNICIPAL	\$0.71	\$0.90	\$1.00	\$1.05	\$1.08	\$1.09	14	18	20	21	22	22
BANDERA Total		\$0.71	\$0.91	\$1.01	\$1.05	\$1.08	\$1.10	15	18	21	21	22	22
EDWARDS	MINING	\$14.69	\$14.69	\$14.69	\$14.69	\$14.69	\$14.69	55	55	55	55	55	55
EDWARDS	MUNICIPAL	\$0.31	\$0.30	\$0.29	\$0.29	\$0.29	\$0.29	6	6	6	6	6	6
EDWARDS Total		\$15.00	\$14.99	\$14.98	\$14.98	\$14.98	\$14.98	62	61	61	61	61	61
KERR	LIVESTOCK	\$10.90	\$10.90	\$10.90	\$10.90	\$10.90	\$10.90	527	527	527	527	527	527
KERR	MINING	\$0.36	\$0.41	\$0.52	\$0.59	\$0.60	\$0.71	1	2	2	2	2	3
KERR	MUNICIPAL	\$4.45	\$5.32	\$5.56	\$6.29	\$7.17	\$7.98	90	108	113	127	145	162
KERR Total		\$15.71	\$16.63	\$16.97	\$17.78	\$18.68	\$19.59	618	636	641	656	674	691
KINNEY	LIVESTOCK	\$0.54	\$0.54	\$0.54	\$0.54	\$0.54	\$0.54	46	46	46	46	46	46
KINNEY Total		\$0.54	\$0.54	\$0.54	\$0.54	\$0.54	\$0.54	46	46	46	46	46	46
REAL	MUNICIPAL	\$2.35	\$2.28	\$2.23	\$2.22	\$2.22	\$2.22	48	46	45	45	45	45
REAL Total		\$2.35	\$2.28	\$2.23	\$2.22	\$2.22	\$2.22	48	46	45	45	45	45
VAL VERDE	MINING	\$147.22	\$204.75	\$214.50	\$179.40	\$149.17	\$128.70	438	609	638	534	444	383
VAL VERDE	MUNICIPAL	\$51.61	\$58.21	\$65.51	\$73.36	\$81.04	\$89.62	1,046	1,179	1,327	1,486	1,642	1,816
VAL VERDE Total		\$198.84	\$262.96	\$280.01	\$252.75	\$230.22	\$218.32	1,484	1,789	1,966	2,020	2,086	2,199
REGION J Total		\$233.14	\$298.31	\$315.75	\$289.32	\$267.72	\$256.74	2,272	2,597	2,780	2,850	2,935	3,064

CHAPTER 7

DROUGHT RESPONSE INFORMATION, ACTIVITIES, AND RECOMMENDATIONS

This page intentionally left blank.

7 REGIONAL DROUGHT RESPONSE

Drought is a frequent and inevitable factor in the climate of Texas. Therefore, it is vital to plan for the effect that droughts will have on the use, allocation and conservation of water in the State. Through the regional water planning process, requirements for drought management planning are found in Title 31 of the Texas Administrative Code (TAC), Part 10, Chapter 357, Subchapter D. Texas Statute reference §357.42 includes requirements regarding drought response information, activities, and recommendations. This chapter examines these specific requirements and identifies significant drought impacts within the Region.

7.1 DROUGHT OF RECORD IN THE PLATEAU REGION

The severity of the recent drought significantly impacted the lives of water users, providers and water managers who were hard-pressed to find solutions to critical supply and demand issues. The severity of the impacts varied, but the overriding sense of urgency to create workable strategies and solutions was acknowledged and acted upon Statewide. Therefore, it is critical in this planning cycle to continue to address the impact that drought is currently has had and will have on the future use, allocation and conservation of water in the State.

There are different types of drought that have been defined in various ways; however, these definitions fall into four primary categories: meteorological, agricultural, hydrological and socioeconomic drought. In the most general sense, drought is a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group or environmental purpose. The State Drought Preparedness Plan provides more specific and detailed definitions and is located at the following link:

<https://www.dps.texas.gov/dem/CouncilsCommittees/droughtCouncil/droughtPrepPlan.pdf>.

Meteorological drought is quantified by how dry it is (for example, a rain deficit) compared to normal conditions as well as the duration of the dry period. This is typically a region-specific metric, since factors affecting meteorological drought can vary so much in different regions.

Agricultural drought looks at the effects of meteorological drought in terms of agricultural impacts. For example, evapotranspiration, soil moisture and plant stress are measures of agricultural drought, which account for vulnerability of crops through the various growth stages.

Hydrological drought is measured in terms of effects on surface and subsurface waters, such as reservoir stage and capacity, stream flow or groundwater levels in wells. Hydrological drought is usually defined on a river-basin or watershed scale. Hydrological droughts typically lag behind meteorological and agricultural droughts because it takes more time for the evidence of basin-wide impacts to manifest.

Socioeconomic drought occurs when the demand for an economic product (such as hydroelectric power) exceeds supply due to a weather-related deficit. Typically, demand for a good increases with population growth and per capita consumptions. Supply increases due to efficiency technology and the construction of new water projects. If both are increasing, the rate of change between supply and demand is the key. However, when demand exceeds supply, vulnerability is magnified by water shortages during drought.

Several climatological drought indicators have been formulated in order to quantify drought. The Palmer Drought Severity Index (PDSI) was developed in 1965 and is currently used by many federal and state agencies. The PDSI is a soil moisture index that works best in relatively large regions with uniform topography that don't experience extreme climate shifts. PDSI values can lag oncoming drought by several months. The TWDB uses the PDSI to monitor State drought conditions, which has values ranging between -6.0 (driest) to 6.0 (wettest). "Extreme drought" conditions have a PDSI between -6.0 and -4.0, and "severe drought" conditions have a PDSI between -3.99 and -3.0.

An accumulated area graph of the weekly PDSI categories for the Edwards Plateau region of Texas is included as Figure 7-1. Since 2000, the Plateau region experienced recurring extreme drought conditions in 2006-2007 and 2008-2009.

The Plateau region experienced the longest sustained periods of extreme drought between November, 2010 and May, 2012, and between September, 2012 and May, 2015.

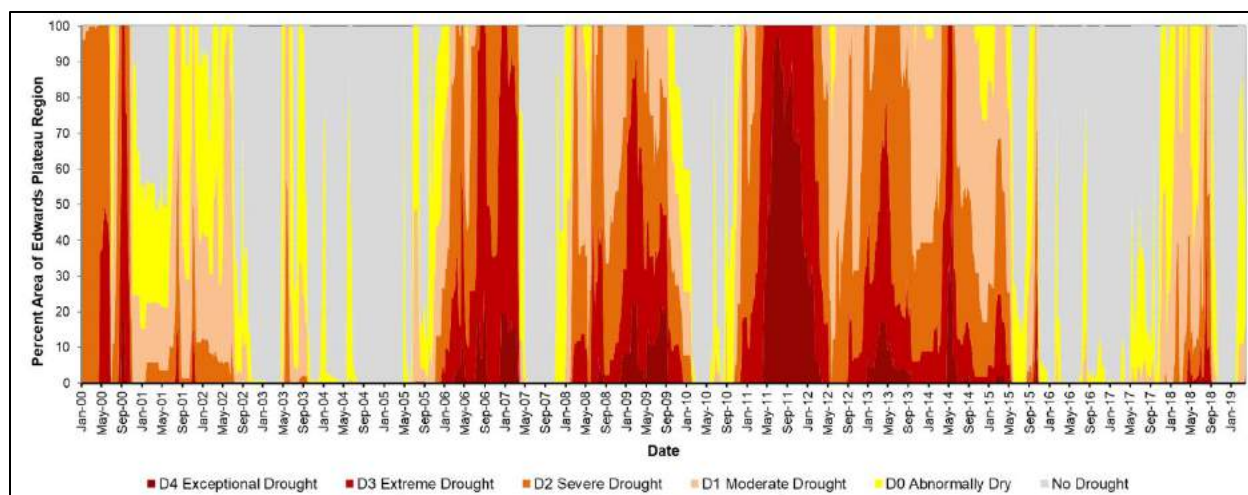


Figure 7-1. Drought in the Edwards Plateau Region of Texas, 2000-2018

Source: U.S. Drought Monitor

The climate of the Plateau Region is intermediate to the more humid climates of regions to the east and drier climates of regions to the west. The combination of high temperatures, high potential evapotranspiration and intermediate rainfall totals combine to produce a semi-arid climate with drought conditions during all or parts of some years (Bomar, 1995).

7.1.1 Precipitation Indicator

Although residents are generally accustomed to the highly variable climatic conditions typical of the Plateau Region, the relatively low rainfall and the accompanying high levels of evaporation underscore the necessity of developing plans that respond to potential disruptions in the supply of groundwater and surface water caused by drought conditions.

Comparing the 1950s DOR and the current drought can be done using historic precipitation, stream flow records, spring discharge and water level measurements in wells for locations that have accumulated data measurements since the 1940s.

Precipitation data for quadrangles 807 (west Plateau Region - portions of Edwards, Kinney and Val Verde Counties) and 808 (east Plateau Region - portions of Bandera, Kerr, Real, and Medina Counties) from 1940 through 2018 are shown on Figure 7-2. Average annual rainfall for these quadrangles is 24.6 and 26.8 inches, respectively. These data indicate that the DOR in the 1950s was associated with seven years of below average rainfall (5-inch deficit per year). The current drought indicates a trend toward below average annual rainfall between 2008 and 2015. Years with below average rainfall have a deficit of about 10 inches for the year.

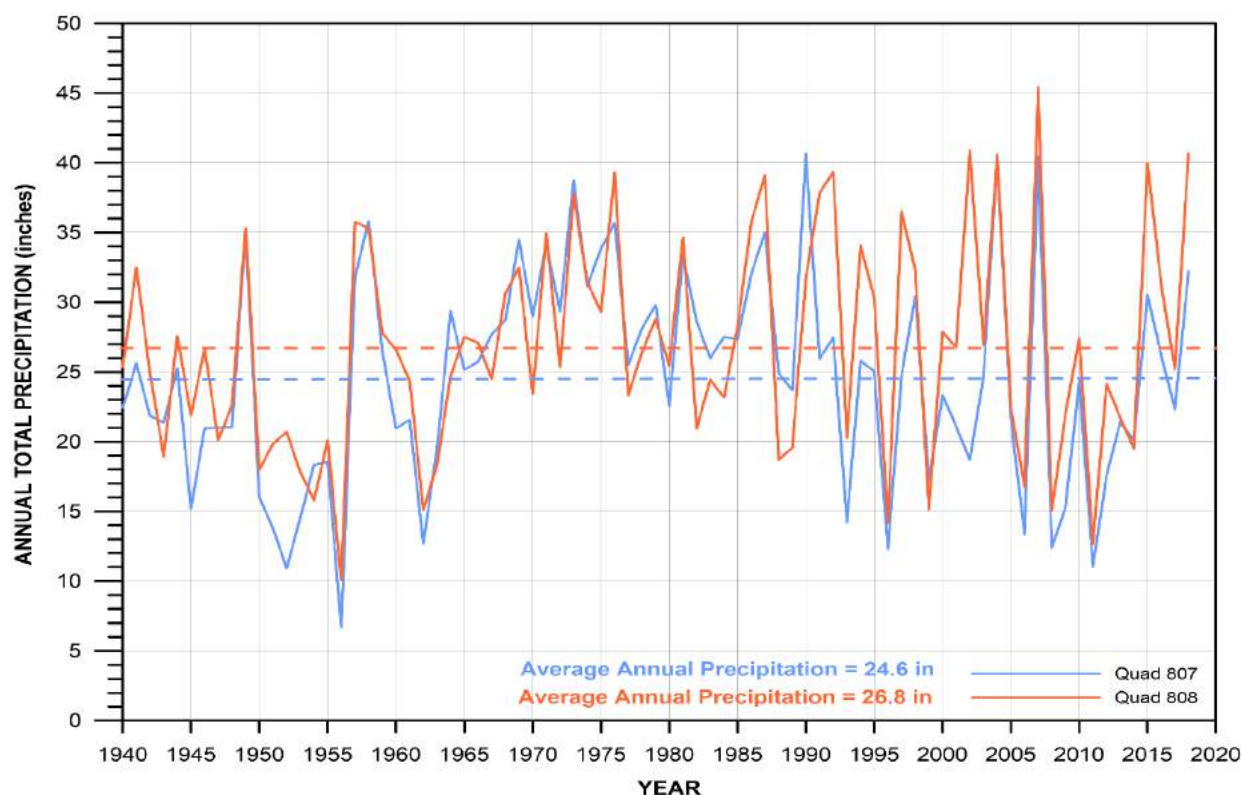


Figure 7-2. Annual Precipitation, 1940-2013

Source: TWDB

7.1.2 Stream Flow Indicator

The U.S. Geological Survey (USGS) has six stream gages located in or proximal to the Plateau Region that have flow data measurements extending back to 1943 (Figure 7-3). Graphs of the annual mean daily discharge (by calendar year) are presented with the average annual mean daily discharge, in cubic feet per second (cfs).

Some general comparisons can be made between the gaging stations during the DOR. It appears that the DOR affected stream flow in the Nueces River basin by 1950, whereas in the Frio and Guadalupe River basins, stream flow was not impacted until after 1950. Since the western counties in the region average about 2 inches of rainfall less than the eastern counties, this impact lag is somewhat intuitive but worth noting nonetheless. The stream flow data in the Frio, Sabinal and Guadalupe River basins illustrate this more readily than the gages located in the Nueces River basin. Additionally, the gaging data highlights the gradual decrease in stream flow that can be seen during the DOR in the 1950s compared to the sudden decrease of flow that is evident in the more recent flow data. These graphs show that recent stream flow in all river basins decreased suddenly compared to the DOR in the 1950s, and that the decreased flow occurred nearly simultaneously in all basins. Generally, it appears that the current drought is having a more intense and rapid impact on stream flow; however, it is uncertain what portion of the decrease in stream flow can be attributed to a decrease in base flow due to increased groundwater pumping. Also, except for perhaps the West Nueces River gaging station near Brackettville (the most arid station location), there does not appear to be a historical decrease in flow since year 2000 as has been observed in the Upper Colorado River basin (Figure 7-4).

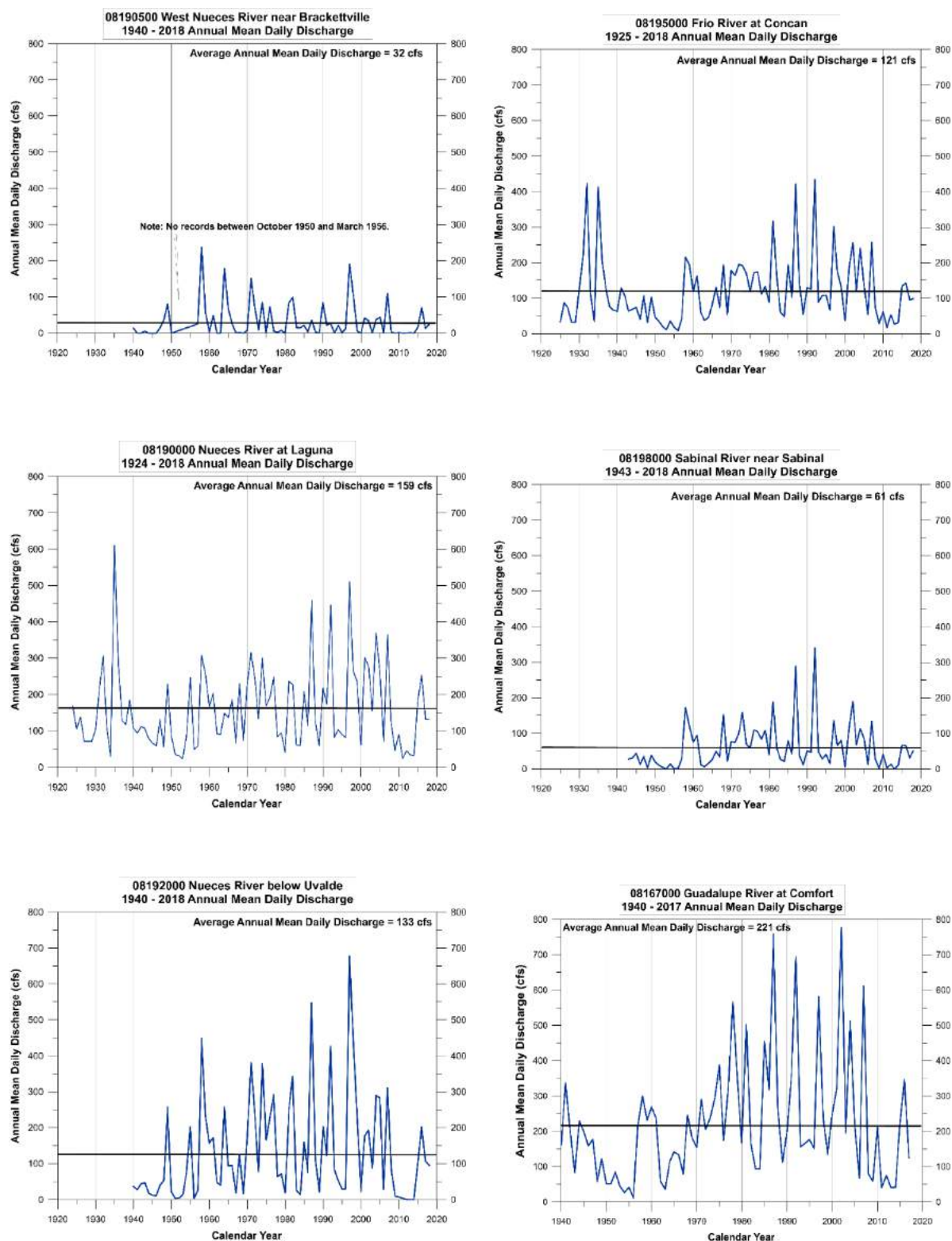


Figure 7-3. Historic Streamflow Gaging Data

Source: USGS

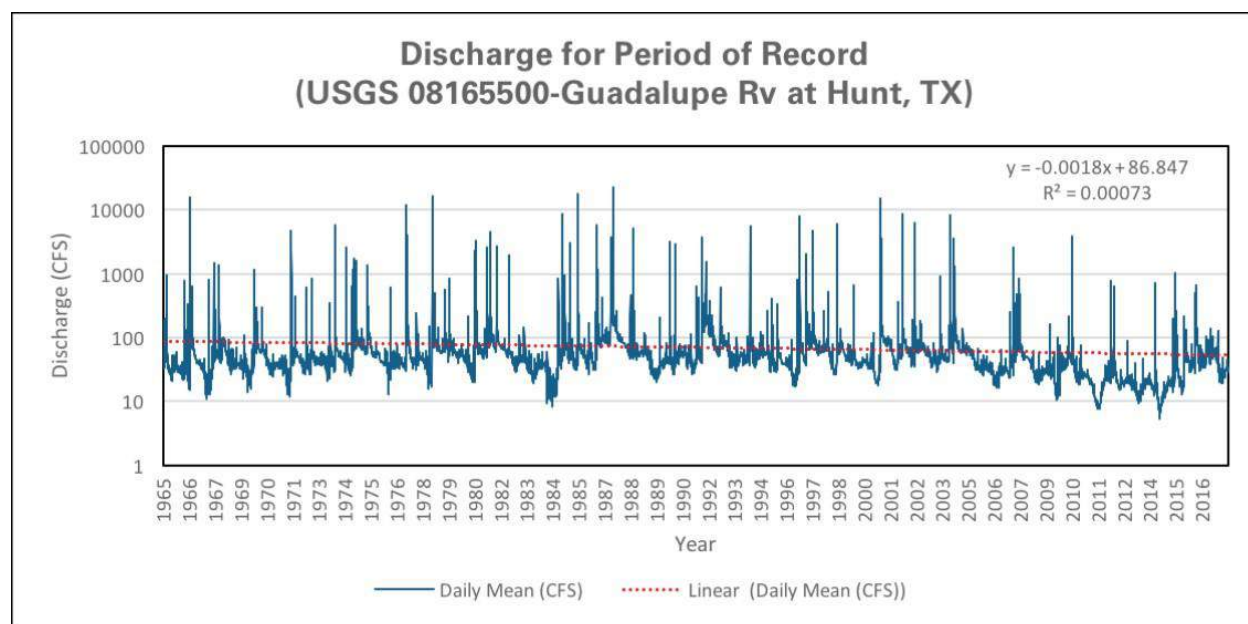


Figure 7-4. Guadalupe River at Hunt Discharge (2000-2017).

Source: Meadows Center, 2019.

7.1.3 Spring Discharge Indicator

Historic spring flow at USGS station 0846300 – Las Moras Springs at Brackettville - is available for years 1895 through 2014. These data are shown on Figure 7-5. The available data are instantaneous discharge measurements which do not necessarily occur on a regularly scheduled interval. Spring discharge has dropped below five cfs numerous times since 1952 (1953, 1956, 1963, 1964, 1966, 1967, 1969, 1971, 1976, 1978, 1980, 1989, 1995, 1996, 2000, 2006, 2011, 2012 and 2014). The periods with flow less than 5 cfs typically lasted for up to 3 months. The only exception is a ten-month period between July 2012 and May 2013. A few zero measurements have also occurred (1964, 1967, 1971 and 1996). Most of these occurrences appear to have lasted less than six weeks.

San Felipe Springs discharge data were not used because the construction of Lake Amistad in 1968 permanently affected the spring discharge measurements and therefore comparison between the current drought and the DOR would be difficult. Flow at the springs has been greater than five cfs since October, 2014.

It is uncertain how much of the low flow at Las Moras can be attributed to the anthropological impacts on drought indicators, such as increased groundwater pumping due to drought conditions and increased demands since the 1950s.

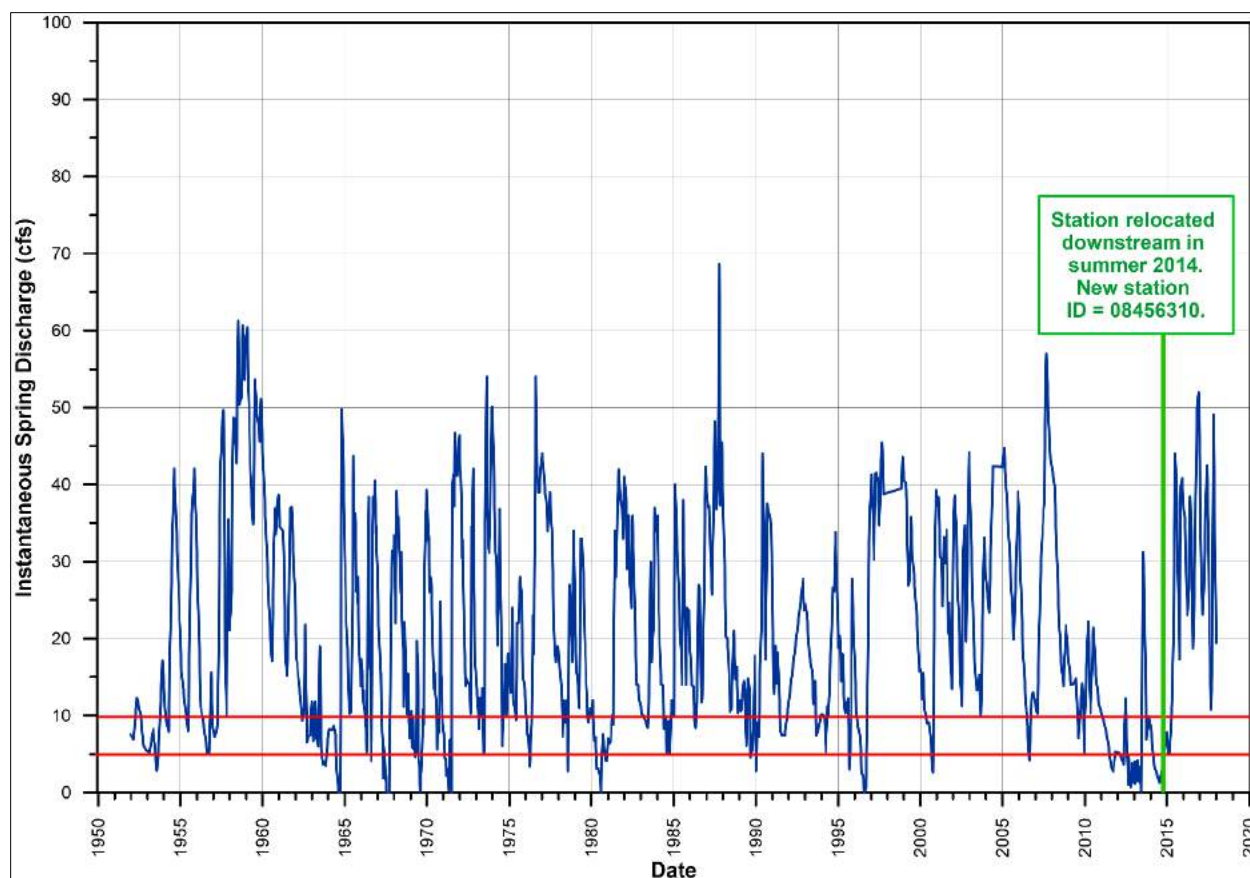


Figure 7-5. Historic Discharge Measurements at Las Moras Springs

Source: U.S. Geological Survey

7.1.4 Groundwater Level Indicator

Figure 7-6 and Figure 7-7 compare daily water level data from existing real-time monitoring wells with daily precipitation data from nearby NWS Cooperative Weather Stations to illustrate aquifer response to precipitation events. Figure 7-6 represents a well in the Edwards-Trinity (Plateau) Aquifer in Val Verde County. The data suggests that response time in the aquifer is quite rapid and occurs within a few days. Note that the water levels in the aquifer remain relatively constant, which suggests that there is not much competition for groundwater near this location. The recent severe drought does not appear to have affected water levels significantly at this location.

Figure 7-7 shows a well completed in the Trinity Aquifer in Real County near Leakey, Texas. The data suggests that response time in the aquifer is quite rapid and occurs within a few days. Total water level decline in the well is over 80 feet in a span of thirteen years. This is likely due to both drought conditions and population growth which both contribute to increased pumping.

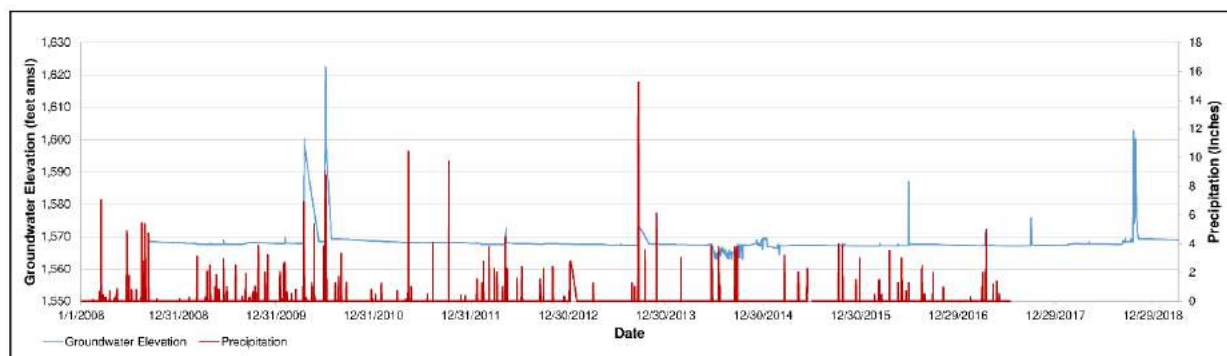


Figure 7-6. Daily Groundwater Elevation and Daily Precipitation, Edwards-Trinity (Plateau), Val Verde County

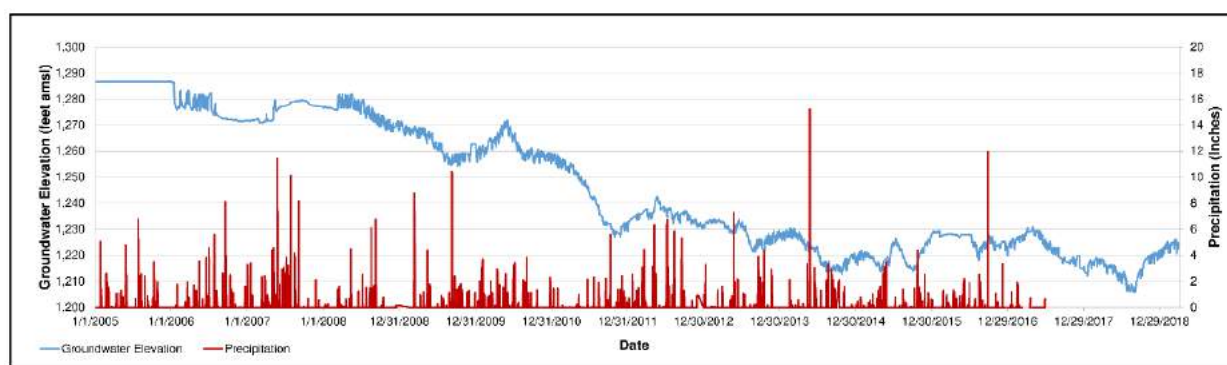


Figure 7-7. Daily Groundwater Elevation and Daily Precipitation, Trinity Aquifer, Real County

7.1.5 Plateau Region Drought of Record

For this planning cycle, the drought of the 1950s is declared the Drought of Record.

The catalyst for the recent drought can be attributed primarily to rainfall deficit (meteorological drought). The hydrological drought that has occurred because of rainfall deficit is evident in the decrease in stream flow and spring discharge data that has been presented. However, the greatest unknown factor that these data collectively point to is the impact that can be attributed to anthropological factors.

The hydrological drought (impact on surface waters and groundwater) is a result of both meteorological and socioeconomic drought. To reiterate, socioeconomic drought occurs when demand exceeds supply due to a weather-related deficit. Typically, demand for a product increases with population growth and per capita consumptions. Supply increases due to efficiency technology and the construction of new water projects. If both are increasing, the rate of change between supply and demand is the key. However, when demand exceeds supply, vulnerability is magnified by water shortages during drought.

In future planning cycles, it would be interesting to attempt to quantify how much anthropological factors exacerbate drought severity. Suggested areas of investigation include: base flow studies, sub-watershed scale water balance calculations, rainfall deficit quantification, and historical pumping.

7.2 CURRENT DROUGHT PREPARATIONS AND RESPONSE

As mandated by 31 TAC 357.42(a)&(b), this section of the RWP summarizes and assesses all preparations and drought contingency plans that have been adopted by municipalities and GCDs within the Plateau Region. The summary includes what specific triggers are used to determine the onset of each defined drought stage and the associated response actions that have been developed by local entities to decrease water demand during the particular drought stage.

Because of the range of conditions that affected the more than 4,000 water utilities throughout the State in 1997, the Texas Legislature directed the TCEQ to adopt rules establishing common drought plan requirements for water suppliers. As a result, TCEQ requires all wholesale public water providers, retail public water suppliers serving 3,300 connections or more, and irrigation districts to submit drought contingency plans (DCPs). In addition, many Groundwater Conservation Districts also have DCPs that provide education and voluntary action recommendations.

Wholesale water providers and retail public water suppliers serving less than 3,300 connections are now required to prepare and administer DCPs no later than May 1, 2014. Plans are required to be made available for inspection upon request. Guidelines as to what should be included in each drought contingency plan can be found on TCEQ's website. at the following link:

http://www.tceq.texas.gov/permitting/water_rights/contingency.html/#contents

DCPs are intended to establish criteria to identify when water supplies may be threatened and the actions that should be taken to ensure these potential threats are minimized. A common feature of drought contingency plans is a structure that allows increasingly stringent drought response measures to be implemented in successive stages as water supply decreases and water demand increases. This measured or gradual approach allows for timely and appropriate action as a water shortage develops. The onset and termination of each implementation stage should be defined by specific "triggering" criteria. Triggering criteria are intended to ensure that: 1) timely action is taken in response to a developing situation, and 2) the response is appropriate to the level of severity of the situation. Each water-supply entity is responsible for establishing its own DCP that includes appropriate triggering criteria and responses.

Figure 7-1 illustrates that drought conditions during this current planning period (2016-2020) were less severe than during the previous planning period (2011-2015). As a result, water utilities and conservation districts implemented less stringent measures during this recent period. Most entities declared no more than a low drought condition with voluntary restrictions throughout the warmer/drier part of the year, and escalating to moderate drought declarations during the dryer than normal summer months of 2018. The Bandera County River Authority and Groundwater District did resort to a severe declaration from December 2019 through January 2020, but is currently back to a moderate condition.

7.2.1 Drought Response Triggers

Drought response triggers should be specific to each water supplier and should be based on an assessment of the water user's vulnerability. In some cases, it may be more appropriate to establish triggers based on a supply source volumetric indicator such as a lake surface elevation or an aquifer static water level. Similarly, triggers might be based on supply levels remaining in an elevated or ground storage tank within the water distribution system; this is not a recommended approach, as the warning of supply depletion would be only three to four days. Triggers based on demand levels can also be effective, if the demands are very closely and frequently monitored. Whichever method is employed, trigger criteria should be

defined on well-established relationships between the benchmark and historical experience. If historical observations have not been made, then common sense must prevail until such time that more specific data can be presented.

7.2.2 Surface Water Triggers

Surface water sources are among the first reliable indicators of the onset of hydrologic drought. Diminished spring discharge and stream flow, for example, can be monitored daily by city, county, and state agencies. Of interest, however, are the levels to which spring discharge and stream flow are reduced before the onset of drought is declared and appropriate response measures are initiated in the region. Cities that rely exclusively on spring flow for municipal water are particularly vulnerable to drought-induced reductions in discharge, especially if alternative sources of supply have not been developed to make up potential shortfalls created by lower discharge. As an operating definition of hydrologic drought, it is recommended that reductions of spring discharge between 25 percent and 33 percent be considered effective hydrologic drought triggers in the Plateau Region.

7.2.3 Groundwater Triggers

Groundwater triggers that indicate the onset of drought are not as easily identified as factors related to surface-water systems. This is attributable to (1) the rapid response of stream discharge and reservoir storage to short-term changes in climatic conditions within a region and within adjoining areas where surface drainage originates, and (2) the typically slower response of groundwater systems to recharge processes. Although climatic conditions over a period of one or two years might have a significant impact on the availability of surface water, aquifers of the same area might not show comparable levels of response for much longer periods of time, depending on the location and size of recharge areas in a basin, the distribution of precipitation over recharge areas, the amount of recharge, and the extent to which aquifers are developed and exploited by major users of groundwater. It is recognized, however, that karstic formations such as the Edwards-Trinity (Plateau) may produce rapid recharge rates in aquifers.

Except for the Trinity Aquifer of Bandera and Kerr Counties, all other aquifers in the rural counties are unlikely to experience significant water-level declines, based on comparisons between projected water demand, aquifer recharge and storage. In these areas, water levels are expected to remain constant or relatively constant over the 50-year planning period (see Figure 7-6). Observation wells in major recharge areas and in areas adjacent to municipal well fields in the rural counties might provide a sufficient number of points to monitor water levels, provided that water-level measurements are made on a regular basis for long periods of time. Water levels below specified elevations for a pre-determined period might be interpreted to be reasonable groundwater indicators of drought conditions in any basin.

Basins that do not receive sufficient recharge to offset natural discharge and pumpage may be depleted of groundwater (e.g., mined). This is especially the case with the Trinity Aquifer of Bandera and Kerr Counties. The rate and extent of groundwater mining in any area are related to the timeframe and the extent to which withdrawals exceed recharge. In such basins, water levels may fall over long periods of time, eventually reaching a point at which the cost of lifting water to the surface becomes an economical concern. Thus, water levels in such areas may not be a satisfactory drought trigger. Instead, communities might consider the rate at which water levels decline in response to increased demand as a sufficient indicator of drought. Entities that utilize groundwater triggers include: Bandera, Rocksprings, Ingram, Loma Vista Water Supply, Brackettville and Fort Clark Springs MUD.

7.2.4 System Capacity Triggers

Because of the above described problems with using water levels as drought-condition indicators, several municipal water-supply entities in the Plateau Region that rely on groundwater generally establish drought-condition triggers based on levels of demand that exceed a percentage of the systems production capacity. Rocksprings, Ingram (Aqua Texas), Loma Vista Water System, Camp Wood, City of Del Rio and City of Kerrville utilize drought triggers that consider demand and system capacity components.

7.2.5 Municipal and Wholesale Water Provider Drought Contingency Plans

The TCEQ requires all retail public water suppliers serving 3,300 connections or more and wholesale public water providers to submit a drought contingency plan to prepare and respond to water shortages. The amended *Title 30, Texas Administrative Code, Chapter 288* became effective on December 6, 2012 addressing TCEQ's guidelines and plan requirements. The forms for wholesale public water providers, retail public water suppliers and irrigation districts are available at:

https://www.tceq.texas.gov/permitting/water_rights/wr_technical-resources/contingency.html Drought contingency plans for municipal uses by public water suppliers must document coordination with the regional water planning groups to ensure consistency with the regional water plans. The following entities have prepared drought contingency plans:

- City of Bandera
- City of Kerrville
- City of Rocksprings
- City of Camp Wood
- Wiedenfeld Water Works
- City of Ingram (Aqua Texas)
- Loma Vista Water System (Aqua Texas)
- City of Brackettville
- Fort Clark Springs Municipal Water District
- City of Del Rio (Wholesale Water Provider)
- City of Leakey

A list of entities, their supply source, specific triggers and actions, for each drought stage is provided in Table 7-1. A DCP was not provided to the Regional Planning Group by Laughlin AFB.

Table 7-1. Municipal Mandated Drought Triggers and Actions

Water Supply Entity	Water Supply Source	Drought Trigger	Drought Stage and Response				
			Mild	Moderate	Severe	Critical	Emergency
City of Bandera	Trinity	Multi-stage drop in water levels in the Dallas Street Municipal Well.	Voluntary conservation May 1 - Sept 30.	Depth to water between 516 and 531 feet.	Depth to water between 532 and 546 feet.	Depth to water between 547 and 566 feet.	Depth to water below 567 feet, or system failure.
			Voluntary usage reduction.	Reduce demand by 20%.	Reduce demand by 35%.	Reduce demand by 50%.	Reduce demand by 90%.
City of Rocksprings	Edwards-Trinity (Plateau)	Based on a comparison of the daily water demand to the static water level of the Sharp Well (55-63-803).	Depth to water reaches 429 feet for 3 consecutive days.	Depth to water reaches 445 feet for 3 consecutive days.	Depth to water reaches 461 feet for 3 consecutive days.	N/A	Depth to water reaches 477 feet for 3 consecutive days.
			Reduce demand by 10%.	Reduce demand by 20%.	Reduce demand by 30%.	N/A	Notify state emergency response officials.
City of Kerrville	Upper Guadalupe River and Trinity Aquifer	Based on a comparison of demand and system's safe operating capacity, which is the maximum amount of water the city can safely deliver to the distribution system. Safe capacity is calculated using the following sources: 1) the WTP, 2) ASR, 3) City wells and 4) other potable sources.	Seven-day average demand exceeds 65% of the system's safe operating capacity.	Seven-day average demand exceeds 75% of the system's safe operating capacity.	Seven-day average demand exceeds 85% of the system's safe operating capacity.	Seven-day average demand exceeds 95% of the system's safe operating capacity.	Seven-day average demand exceeds 100% of the system's safe operating capacity.
			Implement landscape watering schedule; no operation of fountains/pools.	Landscape watering with hand held hose only; non-essential water use prohibited.	No application for new, additional, or expanded water service connections.	Landscape watering with potable water prohibited.	Allocation of available water; notify state emergency response officials.
City of Ingram (Aqua Texas)	Trinity	Demand-based triggers include the following components: 1) percent of water treatment capacity, 2) total daily demand as percent of pumping capacity, 3) storage capacity (tank level) and 4) well pump run time.	Voluntary conservation late Spring and Summer.	75%, tank level within 4 feet of low-level lockout, 16 hours.	85%, tank level within 3 feet of low-level lockout, 20 hours.	95%, tank level reaches low-level lockout, 22 hours.	
			Reduce demand by 5%.	Reduce demand by 10%.	Reduce demand by 20%.	Reduce demand by 40%.	N/A

Table 7-1. (Continued) Municipal Mandated Drought Triggers and Actions

Water Supply Entity	Water Supply Source	Drought Trigger	Drought Stage and Response				
			Mild	Moderate	Severe	Critical	Emergency
City of Ingram (Aqua Texas)	Purchased supply	Supply-based triggers are utilized for systems Aqua provides water from either a district, authority or wholesale supplier.	Upon notification by district, authority, or wholesale supplier, Aqua may implement equivalent stage and restrictions.				
City of Brackettville	Edwards-Trinity (Plateau)	Multi-stage drop in water levels in city well.	Depth to water reaches 50 feet or less while pumping (based on 10-day moving average).	Depth to water reaches 65 feet or less while pumping (based on 10-day moving average).	Depth to water reaches 85 feet or less while pumping (based on 10-day moving average).	Depth to water reaches 110 feet or less while pumping (based on 10-day moving average).	
			Reduce demand by 10%.	Reduce demand by 15%.	Reduce demand by 25%.	N/A	Notify state emergency response officials.
Fort Clark Springs Municipal Water District	Edwards-Trinity (Plateau)	Multi-stage drop in water levels in municipal well.	Depth to water reaches 25 feet or less while pumping (based on 10-day moving average).	Depth to water reaches 35 feet or less while pumping (based on 10-day moving average).	Depth to water reaches 50 feet or less while pumping (based on 10-day moving average).	Depth to water reaches 75 feet or less while pumping (based on 10-day moving average).	
			Voluntary - reduce demand by 10%.	Reduce demand by 15%.	Reduce demand by 25%.	N/A	Notify state emergency response officials.
City of Camp Wood	Spring flow from Edwards-Trinity (Plateau)	Base on system capacity limits.	Low distribution pressure for more than 6 hours.	Demand exceeds 70% of safe operating capacity (based on seven-day average).	Demand exceeds 80% of safe operating capacity (based on seven-day average).	Demand exceeds 90% of safe operating capacity (based on seven-day average).	Major system failures or supply contamination.
			Voluntary - reduce demand by 6%.	Reduce demand by 6%.	Reduce demand by 11%.	Reduce demand by 20%.	Reduce demand by 30%.
City of Leakey	Frio River Alluvium		NO DCP				

Table 7-1. (Continued) Municipal Mandated Drought Triggers and Actions

Water Supply Entity	Water Supply Source	Drought Trigger	Drought Stage and Response				
			Mild	Moderate	Severe	Critical	Emergency
City of Del Rio	San Felipe Springs Edwards-Trinity (Plateau)	Water levels in Bedell Street Storage Reservoirs are less than a designated depth; San Felipe Spring flow drops below a specific flow rate.	Water levels are less than 100 % full; San Felipe Spring flow is less than 40 mgd.	Water levels are less than 30 feet; San Felipe Spring flow is less than 25 mgd.	Water levels are less than 25 feet; San Felipe Spring flow is less than 20 mgd.	Water levels are less than 20 feet; San Felipe Spring flow is less than 15 mgd.	Water levels are less than 15 feet; San Felipe Spring flow is less than 10 mgd.
			Reduce demand to 95% of the 30-day average prior to initiation.	Reduce demand to 90% of the 30-day average prior to initiation.	Reduce demand to 80% of the 30-day average prior to initiation.	Reduce demand to 70% of the 30-day average prior to initiation.	Notify state emergency response officials.
Wiedenfeld Water Works	Trinity (HGCD MW-7, HGCD MW-11, HGCD MW-1SD, Cedar Springs well, 169 Greenwood well, CCGCD Langford, and EAA J17 well).	Cumulative point system based upon water levels and daily pumping time (in minutes) in 7 different wells. Two if the wells monitor both upper and lower Trinity water levels.		3 points	6 points	8 points	
			N/A	Reduce non-essential & outdoor use by 50% of summer water use.	Elimination of non-essential & outdoor use.	Allocation of available water.	N/A
Loma Vista Water Supply (Aqua Texas)	Trinity	Demand-based triggers include the following components: 1) percent of water treatment capacity, 2) total daily demand as percent of pumping capacity, 3) storage capacity (tank level) and 4) well pump run time.	Voluntary conservation late Spring and Summer.	75%, tank level within 4 feet of low-level lock out, 16 hours.	85%, tank level within 3 feet of low-level lock out, 20 hours.	95%, tank level reaches low-level lock out, 22 hours.	
			Reduce demand by 5%.	Reduce demand by 10%.	Reduce demand by 20%.	Reduce demand by 40%.	N/A
	Purchased supply	Supply-based triggers are utilized for systems Aqua provides water from either a district, authority or wholesale supplier.	Upon notification by district, authority, or wholesale supplier, Aqua may implement equivalent stage and restrictions.				

7.2.6 Groundwater Conservation District Drought Contingency Plans

A discussion of the creation and the goals of the four Groundwater Conservation Districts (GCDs) formed in the Plateau Region are discussed in more detail in Chapter 5, Section 5.3.7. This section will focus on summarizing drought management by the Districts.

Four districts are currently in operation within the planning region:

Bandera County River Authority and Groundwater District (<http://bcragd.org>)

Headwaters Groundwater Conservation District (Kerr County) (<http://hgcd.org>)

Kinney County Groundwater Conservation District (<http://kinneycogcd-state-tx.us>)

Real-Edwards Conservation and Reclamation District (<http://recred.org>)

Groundwater Conservation Districts are required to define management goals that specifically address drought conditions within their groundwater management plans. These are delineated via management objectives and performance standards. Drought Contingency Plans have also been adopted by three of the four GCDs in the Plateau region. Following are the District's drought management objectives.

7.2.6.1 Bandera County River Authority and Groundwater District

Management Objective 1 – Record the Palmer Drought Severity Index once at the first of the month and when drought conditions exist, implement to Drought Management Plan as adopted in April 2009.

Management Objective 2 – Evaluate groundwater availability each year by monitoring water levels of the aquifer from at least six monitor wells with continuous recorders within Bandera County.

The District has implemented a drought management plan to aid in groundwater conservation and is designed to reduce pumpage of the aquifer during the different drought stages. The triggers and actions incorporated into the drought plan are summarized below. These five drought stages are mandated restrictions for permitted wells and recommended restrictions for exempt wells.

**Bandera County River Authority and Groundwater District
Drought Triggers and Actions**

Stage & Description	1 – Mild	2 – Moderate	3 – Severe	4 – Extreme	5 – Exceptional
Trigger	Stages are triggered by the U.S. Drought Monitor, but can be adjusted at the discretion of the District when aquifer levels, rainfall and river flow conditions warrant.				
Conservation Goal (percent reduction in pumpage)	10%	20%	30%	40%	50%

7.2.6.2 Headwaters Groundwater Conservation District

Management Objective – Monitor drought conditions by reviewing aquifer data monthly and declaring drought stages based on the District’s defined drought triggers.

The District has implemented a drought management plan to aid in groundwater conservation and is designed to reduce pumpage of the aquifer during the different drought stages. The triggers and actions incorporated into the drought plan are summarized below.

Headwaters Groundwater Conservation District Drought Triggers and Actions

Stage & Description	1 – Mild	2 – Moderate	3 – Severe	4 – Extreme
Trigger	1410 feet amsl	1400 feet amsl	1390 feet amsl	1380 feet amsl
Conservation Goal (percent reduction in pumpage)	10%	20%	30%	40%

The HGCD Drought Index Levels which are the average water level in 4 selected monitor wells (Stonehenge, HGCD MW #11 Middle Trinity, County Agriculture Barn, and HGCD MW # 7 Middle Trinity). The District will also monitor and consider the Palmer Drought Severity Index (PDSI) and the Guadalupe River Flow Rate at Kerrville in initiating drought stages and notices of impending drought or extremely dry conditions. Drought stages may be initiated at the discretion of the District depending on the ability of the City of Kerrville to draw surface water from the Guadalupe River.

These four drought stages invoke mandated restrictions for permitted wells and recommended restrictions for exempt wells.

7.2.6.3 Kinney County Groundwater Conservation District

Management Objective – Once a month, the District will download the latest drought information from the National Weather Service – Climate Prediction Center website. A report on the drought data obtained from the National Weather Service will be included in the regular monthly meeting agenda and retained in the meeting minutes kept at the District office.

7.2.6.4 Real-Edwards Conservation and Reclamation District

Management Objective – Curtailment of Groundwater Withdrawal. To accomplish this objective, the annual amount of groundwater permitted by the District for withdrawal from the portion of the aquifers located within the District may be curtailed during periods of extreme drought in the recharge zones of the aquifers or because of other conditions that cause significant declines in groundwater surface elevations. Such curtailment may be triggered by the District’s Board of Directors based on the groundwater elevation measured in the District’s monitoring well(s) and/or stream flow measurements along with other indices such as rainfall and soil moisture. District staff currently monitors three locations along the Frio River and its tributaries and two locations on the Nueces River. A weir box will

be placed on Old Faithful Spring and measurements will be routinely taken at that location. The triggers and actions incorporated into the drought plan are summarized below.

Real-Edwards Conservation and Reclamation District Drought Triggers and Actions

Stage & Description	1 – Mild	2 – Moderate	3 – Severe	4 – Extreme
Trigger	PDSI -1 or less	PDSI -2 or less	PDSI -3 or less	PDSI -4 or less
Conservation Goal (percent reduction in pumpage)	Voluntary	10%	20%	30%

The Palmer Drought Severity Index, which is an index based on regional meteorological and hydrological data such as rainfall, temperature and soil moisture content will be used as the primary triggering criteria for the initiation and termination of the drought plan.

The four drought stages are mandated restrictions for permitted wells during stages 2, 3, and 4 and recommended restrictions for exempt wells.

7.3 EXISTING AND POTENTIAL EMERGENCY INTERCONNECTS

According to Texas Statute §357.42(d),(e) regional water planning groups are to collect information on existing major water infrastructure facilities that may be used in the event of an emergency shortage of water. Pertinent information includes identifying the potential user(s) of the interconnect, the potential supplier(s), the estimated potential volume of supply that could be provided, and a general description of the facility. Texas Water Code §16.053(c) requires information regarding facility locations to remain confidential. This section provides general information regarding existing and potential emergency interconnects among water user groups within the Plateau Region.

The RWPG is required to gather information pertinent to major water infrastructure facilities that are currently or could potentially be utilized during emergency water shortages. Major water infrastructure facilities within the Plateau Region were identified through a survey process to better evaluate existing and potentially feasible emergency interconnects. There are no existing emergency interconnects. There are only two potential interconnects that have been identified within the Plateau Region in the current planning cycle, as shown below.

Potential Emergency Interconnects to Major Water Facilities

Entity Providing Supply	Entity Receiving Supply
City of Kerrville	Cherokee Mobile Home Park
City of Del Rio	Laughlin AFB and the Landings at Laughlin

7.4 EMERGENCY RESPONSES TO LOCAL DROUGHT CONDITIONS OR LOSS OF MUNICIPAL SUPPLY

Texas Statute §357.42(g) requires regional water planning groups to evaluate potential temporary emergency water supplies for all County-Other WUGs and municipalities with 2010 populations less than 7,500 that rely on a sole source of water. The purpose of this evaluation is to identify potential alternative water sources that may be considered for temporary emergency use in the event that the existing water supply sources become temporarily unavailable due to extreme hydrologic conditions such as emergency water right curtailment, unanticipated loss of reservoir conservation storage, or other localized drought impacts.

This section provides potential solutions that should act as a guide for municipal water users that are most vulnerable in the event of a loss of supply. Entities evaluated for emergency responses to local drought conditions or loss of municipal supply were assumed to have 180 days or less of remaining supply. This review was limited and did not require technical analyses or evaluations following in accordance with 31 TAC §357.34.

In the Plateau Region, there are seven municipal and County-Other WUGs that have a 2010 Census population of less than 7,500 and rely upon a sole source of water. Six of the sole source WUGs rely on groundwater, and one WUG relies on surface water (City of Camp Wood).

Potential emergency water supply sources that might be used by small sole-source municipal WUGs or County-Other WUGs include the following:

- New local groundwater well
- Emergency interconnect
- Use of other named local supply
- Trucked-in water delivery
- Brackish groundwater limited treatment
- Brackish groundwater desalination
- Release from upstream reservoir
- Curtailment of upstream and/or downstream water rights

Based upon personal communication with the WUGs within the Plateau Region, the addition of a new local groundwater well was identified for all entities as a potential emergency water supply source. The Bandera County FWSD #1 (Bandera county-other) would also consider the curtailment of proximal water rights, and the City of Bandera would also consider trucked-in water delivery as a feasible option under emergency conditions. The entities along with feasible potential emergency water supply options have been included in Table 7-2.

Table 7-2. Emergency Responses to Local Drought Conditions

Entity						Implementation Requirements									
Water User Group Name	County	2019 Population Served by Water System (per TCEQ)	2019 Service Connections (per TCEQ)	2020 Population	2020 Demand (AF/year)	Drill additional groundwater wells	Brackish groundwater limited treatment	Brackish groundwater desalination	Emergency interconnect	Other named local supply	Trucked - in water	Type of infrastructure required	Entity providing supply	Other local entities required to participate	Emergency agreements already in place
City of Bandera	Bandera	3,19	1,060	1,875	342	▪			▪		▪	Well	City		
City of Rocksprings	Edwards	1,85	619	1,259	198	▪			▪		▪	Well	City		
Ingram Water Supply	Kerr	5,23	1,746	1,837	165	▪					▪	Well			
City of Brackettville	Kinney	2,42	835			▪					▪	Well			
Fort Clark Springs MUD	Kinney	1,20	989	1,259	618	▪					▪	Well			
City of Camp Wood	Real	1,35	450	747	143	▪			▪		▪	Well	City		
Laughlin Air Force Base	Val	4,01	495	1,767	1,018	▪			▪		▪	Well	City of Del Rio		
County Other															
Bandera County FWSD 1	Bandera	1,04	348	679	141	▪			▪		▪	Well	District		
Bandera River Ranch 1	Bandera	822	274	929	97	▪			▪		▪	Well	WSC		
Barksdale WSC	Edwards	249	83	264	29	▪					▪	Well			
Center Point North Water System	Kerr	237	79	255	22	▪					▪	Well			
Center Point Taylor System	Kerr	492	164	530	45	▪			▪		▪	Well	District		
Center Point Wiedenfeld Works	Kerr	168	56	161	14	▪			▪		▪	Piping	Aqua Texas		
Cedar Springs MHP	Kerr	144	48			▪			▪		▪	Piping	Ingram Oaks Park		
Heritage Park Water System	Kerr	87	29			▪			▪		▪	Piping	Aqua Texas		
Hills & Dales Wiedenfeld Water Works	Kerr	222	74	202	17	▪			▪		▪	Piping	Aqua Texas		
Kerrville South Water	Kerr			2,851	341	▪					▪	Well	Aqua Texas		
Oak Ridge Estates Water System	Kerr	132	44			▪					▪	Well			
Southern Hills Wiedenfeld Water	Kerr	891	297			▪			▪		▪	Piping	Aqua Texas		
Verde Park Estates Wiedenfeld Water	Kerr	210	70	178	15	▪			▪		▪	Piping	Elmwood MHP		
Vista Hills	Kerr	42	14			▪					▪	Well			
Westwood Water System	Kerr	390	130	269	23	▪					▪	Well			
Windwood Oaks Water System	Kerr	57	19			▪			▪		▪	Piping	The Woods Sub.		
Woodhaven Mobile Home Park	Kerr	96	32			▪			▪		▪	Piping	Aqua Texas		
Flying L Ranch PUD	Bandera	903	301			▪					▪	Well			
City of Leahey	Real	1,74	582	1,415	193	▪			▪		▪	System	City		
Medina WSC	Bandera	810	270	895	93	▪					▪	Well			

To qualify for emergency funds that are earmarked for emergency groundwater supply wells, entities must have a drought plan in place and be currently listed as an entity that is limiting water use to avoid shortages. This list is updated weekly by the TCEQ's Drinking Water Technical Review and Oversight Team and can be found at: <https://www.tceq.texas.gov/drinkingwater/trot/droughtw.html>.

There is some assistance available through the Texas Department of Agriculture and the Texas Water Development Board. There are requirements, deadlines, and a specific application process. Contact the TWDB by e-mail, <Financial_Assistance@twdb.texas.gov>, or call 512-463-7853. Contact the Texas Department of Agriculture, Community Development Block Grants, or call 512-936-7891. Funding is limited.

Other TCEQ Guidance resources:

Emergency and Temporary Use of Wells for Public Water Supplies (RG-485)

https://www.tceq.texas.gov/assets/public/comm_exec/pubs/rg/rg-485.pdf

Questions from the TCEQ's Workshops on Drought Emergency Planning: Answers to Help Drinking-Water Systems Prepare for Emergencies <http://www.rgrwa.org/images/pdfs/workshop-questions071312.pdf>

Video: Workshop on Drought Emergency Planning for Public Water Systems in Texas

http://www.youtube.com/watch?v=BdlF9CEcGPI&feature=plcp&context=C34378a7UDOEgsToPDs_kJNYWXf5I3pKq8tW9pkVqQU

7.5 REGION-SPECIFIC DROUGHT RESPONSE RECOMMENDATIONS AND MODEL DROUGHT CONTINGENCY PLANS

As mandated by TAC 357.42(c)&(i), the RWPGs shall develop drought response recommendations regarding the management of existing groundwater and surface water sources in the RWPA designated in accordance with §357.32. The RWPGs shall make drought preparation and response recommendations regarding the development of, content contained within, and implementation of local drought contingency plans. The RWPGs shall develop region-specific model drought contingency plans that shall be presented in the RWP which shall be consistent with 30 TAC Chapter 288 requirements.

Regional drought planning expands the conceptualization and application of drought planning by specific entities to encompass the entire Plateau Region. The approach utilized in developing a region-specific drought plan will consider the following: 1) all regional groundwater and surface water sources, 2) current drought plans that are being utilized by user entities within the region, and 3) current monitoring stations within the region that have evolved since the previous planning cycle.

The goals of this approach are: 1) to gain a comprehensive view of what particular resources are being monitored by entities within the region, 2) determine which resources are not being monitored, 3) determine which users do not fall under the umbrella of existing DCPs, 3) identify potential monitoring stations with publicly accessible real-time data that currently exist, and 4) determine how these data can be utilized for the water user groups that do are not subject to existing DCPs, and ultimately 5) development of a regional model drought contingency plan.

As discussed in Section 7.2, several GCDs, towns/cities and various public supply systems have written drought management / contingency plans and have provided them for inclusion in the *Regional Plan*.

7.5.1 Regional Groundwater Resources and Monitoring

The six groundwater resources identified within the Plateau Region and their contribution to total regional groundwater supply are:

- Edwards-Trinity (Plateau) (61%)
- Trinity (29%)
- Edwards (BFZ) (less than 7%)
- Austin Chalk (less than 3%)
- Frio River Alluvium (less than 1%)
- Nueces River Alluvium (less than 1%)

The aquifer contribution to the regional supply calculation is based upon historical pumping averages for years 2012 through 2016.

Current drought contingency plans were detailed in Section 7.3.5 and Table 7-1. State well numbers of the monitoring wells used by municipal entities that utilize groundwater triggers are shown in Table 7-3. A map of these locations is included as Figure 7-8.

Table 7-3. Current Municipal Trigger Monitoring Wells

Water Supply Entity	County	Water Supply Source	Well ID
City of Rocksprings	Edwards	Edwards-Trinity (Plateau)	55-63-803 Sharp Well
City of Bandera	Bandera	Trinity	69-24-102 Dallas Street Well
Fort Clark Springs MUD	Kinney	Edwards-Trinity (Plateau)	70-45-504 Well #1
City of Brackettville	Kinney	Edwards-Trinity (Plateau)	70-45-601 Well #1

Previous *Plateau Regional Water Plans* identified wells that could potentially be used for drought monitoring.

Table 7-4 provides a selection of groundwater trigger wells included in the *2011 and 2016 Plans*, with an updated status and history of measurements.

Table 7-4. RWP Groundwater Trigger Monitoring Wells

Aquifer	County	Well ID	Monitoring Agency	Period of Record and Measurement Count	Current Status
Trinity	Bandera	69-16-902 (Purple Sage Well)	Unknown	1 measurement	Inactive - Replaced by BCRAGCD network
Edwards-Trinity	Edwards	55-63-803 (City of Rocksprings)	TWDB	1953 - 2019 (39 measurements)	Active
Trinity	Kerr	56-63-916	HGCD (Donna Drive well)	1977 - 2019 (340 measurements)	Currently active in HGCD network
Edwards-Trinity	Kerr	56-53-304	Not being monitored	1966 – 1997 (16 measurements)	Inactive - Replaced by HGCD network
Edwards-Trinity	Kinney	Ring Well	Unknown	Unknown	Unknown
Edwards (BFZ)	Kinney	70-38-902	TWDB	1973 – 2013 (113 measurements)	Active
Austin Chalk	Kinney	70-45-404	TWDB	1937 – 2008 (91 measurements)	Unknown
Frio River Alluvium	Real	69-18-302 (City of Leakey)	Unknown	2 measurements on WIID	Unknown
Edwards-Trinity	Val Verde	Old Y Well	City of Del Rio	2013 - 2014	Inactive
Edwards-Trinity	Val Verde	Agarita Well	City of Del Rio	Unknown	Inactive
Edwards-Trinity	Val Verde	Tiera del Largo Well	City of Del Rio	Unknown	Inactive

The TWDB has a component of their website called Water Data for Texas (similar to the U.S. Geological Survey's NWIS server) that is a collective of real-time monitoring data from both groundwater wells and

reservoir stage-capacity gages. Table 7-5 is a summary of the 24 groundwater wells located within Region J. These locations are included on Figure 7-8.

Table 7-5. Currently Active (Real-Time) Monitoring Wells

Source: Water Data for Texas

County	State Well Number	Aquifer	Aquifer Type	Entity/Cooperator	Data Transmission	Start Date Period of Record
Bandera	6912206	Edwards-Trinity (Plateau)	Unconfined	U.S. Geological Survey	Satellite	11/6/2012
Bandera	6924225	Trinity	Confined	Texas Water Development Board	Satellite	8/11/2008
Kerr	5643901	Trinity	Confined	Headwaters GCD	Satellite	5/6/2009
Kerr	5652704	Trinity	Confined	Headwaters GCD	Satellite	12/9/2010
Kerr	5654106	Trinity	Confined	Headwaters GCD	Satellite	11/29/2010
Kerr	5654405	Trinity	Confined	Texas Water Development Board	Satellite	8/10/2004
Kerr	5655805	Trinity	Confined	Headwaters GCD	Satellite	3/15/2007
Kerr	5659201	Trinity	Confined	Headwaters GCD	Satellite	5/6/2009
Kerr	5661101	Trinity	Confined	Headwaters GCD	Satellite	3/13/2007
Kerr	5663922	Trinity	Confined	Texas Water Development Board	Satellite	12/5/2002
Kerr	5663923	Trinity	Confined	Headwaters GCD	Satellite	7/5/2010
Kerr	5663924	Trinity	Confined	Headwaters GCD	Satellite	7/12/2010
Kerr	5664301	Trinity	Confined	Headwaters GCD	Satellite	3/20/2013
Kerr	5664302	Edwards-Trinity (Plateau)	Unconfined	Headwaters GCD	Satellite	3/20/2013
Kerr	5757805	Trinity	Confined	Headwaters GCD	Satellite	7/16/2008
Kerr	6801703	Trinity	Confined	Headwaters GCD	Satellite	10/5/2009
Kerr	6801704	Trinity	Confined	Headwaters GCD	Satellite	5/14/2009
Kerr	6904503	Trinity	Confined	Headwaters GCD	Satellite	10/6/2009
Kerr	6907107	Trinity	Confined	Headwaters GCD	Satellite	5/8/2008
Kerr	6908304	Trinity	Confined	Headwaters GCD	Satellite	3/2/2008
Kerr	6908305	Trinity	Confined	Headwaters GCD	Satellite	3/2/2008
Real	6919401	Trinity	Confined	Texas Water Development Board	Satellite	2/15/1993
Val Verde	5463401	Edwards-Trinity (Plateau)	Unconfined	Texas Water Development Board	Satellite	9/9/2008
Val Verde	7001707	Edwards-Trinity (Plateau)	Unconfined	Texas Water Development Board	Data Card	8/6/2007

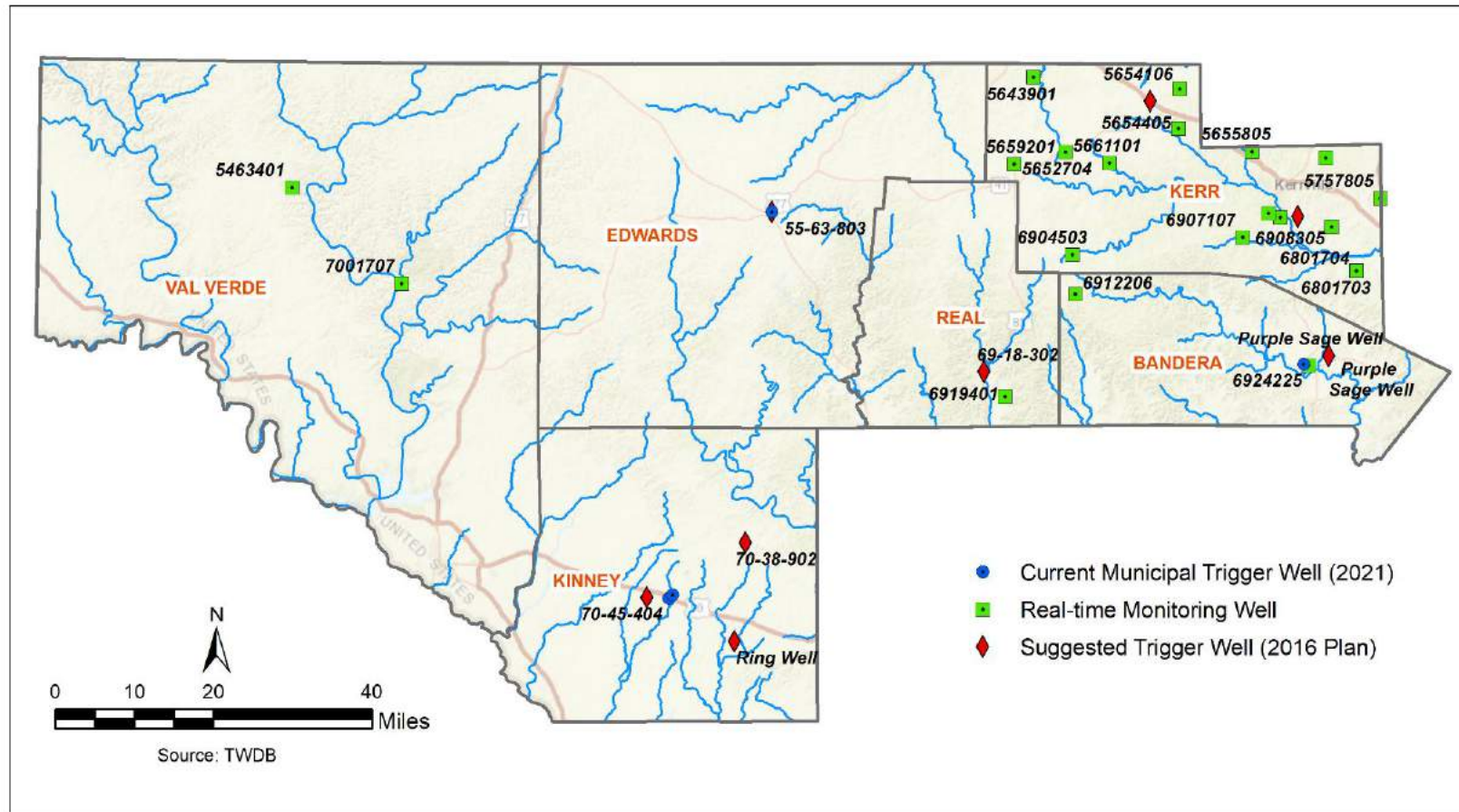


Figure 7-8. Regional Monitoring and Trigger Wells

7.5.2 Regional Surface Water Resources and Monitoring

The five surface water basins identified within the Plateau Region and their contribution to total regional surface water supply are:

- Rio Grande Basin (84%)
- Nueces River Basin (9%)
- Guadalupe River Basin (6%)
- Colorado River Basin (<1%)
- San Antonio River Basin (<1%)

The basin contribution to the regional supply calculation is based upon the WAM Run 3 (Full Authorization) availability numbers. Surface water features that are actively being monitored by an entity within the Plateau Region are detailed in Table 7-6.

Table 7-6. Surface Water Sources Currently Monitored by Regional Entities

Source: Plateau Region Drought Contingency Plans

Entity	County	Water Supply Source	Station ID	Measuring Agency	Period of Record	Current Measurement Frequency
City of Del Rio	Val Verde	San Felipe Springs	08-4530.00 (gage on creek)	IBWC	1931-2019	15 minutes
Headwaters GCD	Kerr	Guadalupe River	08166200 Guadalupe River at Kerrville	USGS	1986 -2019	Daily
Real-Edwards CRD	Real	Frio River	Fulgham's crossing, Leakey Springs crossing, Mill Creek crossing, Frio River Place crossing	RECRD	? – 2019	Monthly
Real-Edwards CRD	Real	Frio River - West Prong	Rancho Real crossing, Kent Creek crossing	RECRD	? – 2019	Monthly
Real-Edwards CRD	Edwards	Nueces River	McDonald's Crossing, Nueces River Dam	RECRD	? – 2019	Monthly
Real-Edwards CRD	Edwards	South Llano River	Telegraph crossing, Hwy 377 at Evergreen School crossing	RECRD	? – 2019	Monthly

The only station that is utilized as an active trigger is San Felipe Springs. The other stations are included in this table to present a complete list of surface water locations that are currently being monitored within the Region. Note that the Guadalupe River is an optional trigger for HGCD. The Frio and Nueces crossings that are measured by the RECRD are posted on their website monthly.

A list of all currently active stream flow, spring flow and reservoir stage gaging stations are listed in Table 7-7. The USGS stations have real-time data that is publicly accessible online. These locations are shown on Figure 7-9.

Table 7-7. Currently Active Surface Water Gaging Locations

Source: Water Data for Texas

County	Station ID	Station Name	Agency
Rio Grande Basin			
Val Verde	8449100	Dolan Creek abv Devils River near Comstock, TX	USGS
Val Verde	8447410	Pecos River near Langtry, TX	USGS
Val Verde	08-3772.00	Rio Grande at Foster Ranch near Langtry, TX	IBWC
Val Verde	08-4508.00	International Amistad Reservoir Storage	IBWC
Val Verde	08-4530.00	San Felipe Creek	IBWC
Kinney	8456300 and 8456310	Las Moras Springs at Brackettville, TX (main channel)	USGS
Nueces River Basin			
Kinney	8190500	W Nueces River near Brackettville, TX	USGS
Edwards	818999010	Nueces River near Barksdale, TX	USGS
Real	8194840	Frio River at Leakey, TX	USGS
Bandera	8197936	Sabinal River below Mill Creek near Vanderpool, TX	USGS
Guadalupe River Basin			
Kerr	8165300	North Fork Guadalupe River near Hunt, TX	USGS
Kerr	8165500	Guadalupe River at Hunt, TX	USGS
Kerr	8166000	Johnson Creek near Ingram, TX	USGS
Kerr	8166140	Guadalupe River above Bear Creek at Kerrville, TX	USGS
Kerr	8166200	Guadalupe River at Kerrville, TX	USGS
Kerr	8166250	Guadalupe River near Center Point, TX	USGS
San Antonio River Basin			
Bandera	817887350	Medina River at Patterson Road at Medina, TX	USGS
Bandera	8178880	Medina River at Bandera, TX	USGS
Bandera	8178980	Medina River above English Creek Spring near Pipe Creek, TX	USGS
Medina	8179500	Medina Lake near San Antonio, TX	USGS

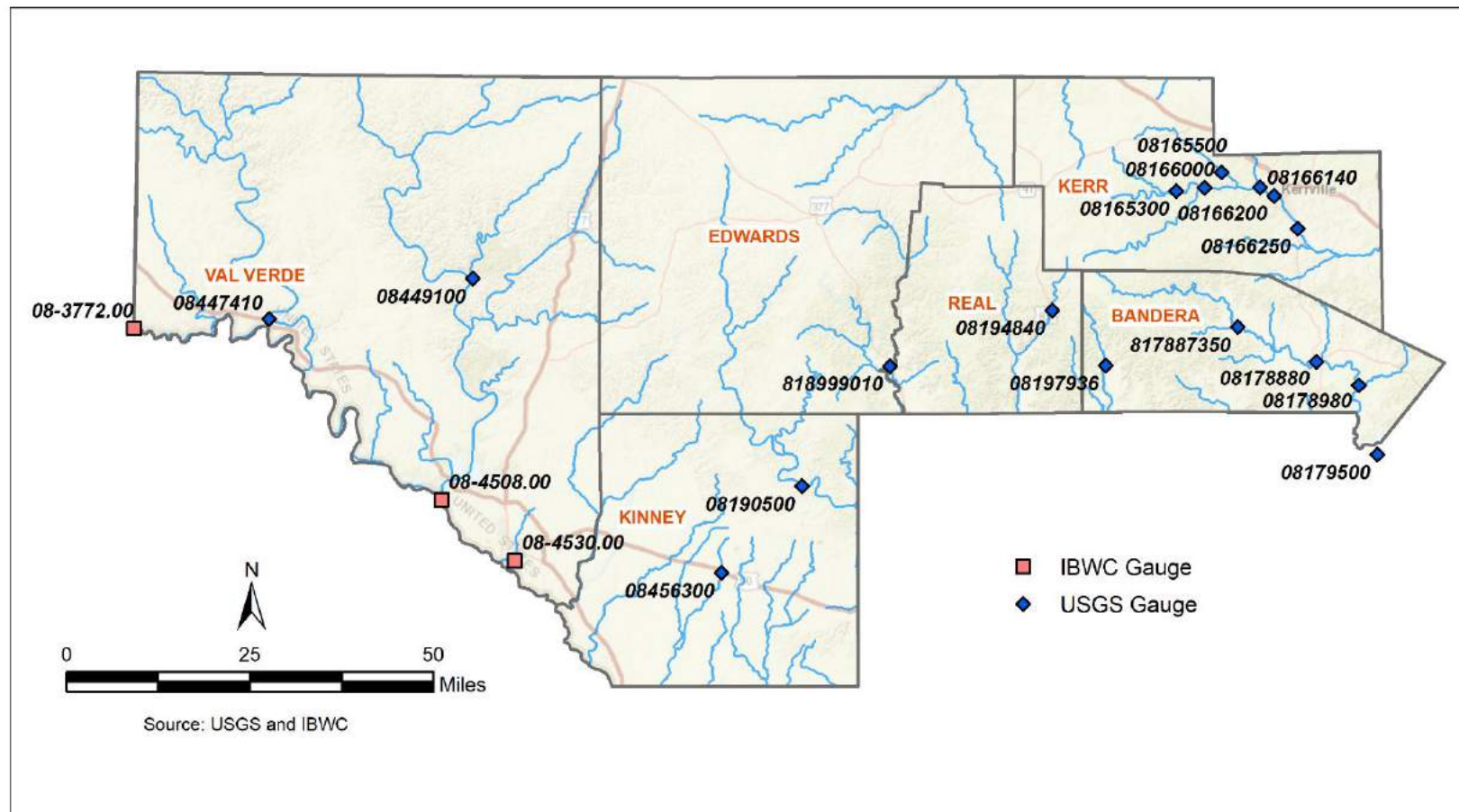


Figure 7-9. Currently Active Surface Water Gaging Locations

7.5.3 Regional Model Drought Contingency Plan

The Regional Model DCP summary table (Table 7-8) provides an overview of all existing regional water sources, WUGs, monitoring wells, gaging stations as well as recommended drought triggers and actions. The intent of including the monitoring wells and stations is to provide a comprehensive region-wide assessment of what current tools are available to WUGs and districts to monitor resources within the Plateau region.

The Regional Model DCP will undoubtedly change over time in order to address particular needs and issues of the Region's users. Therefore, this initial version of the model plan will primarily focus on identifying all sources, users and monitoring tools in order to find the particular components within the Region that are not currently incorporated into any existing drought plan but could potentially utilize existing data resources. Another focus of this first model plan will consider consistency of existing plans within the Region. Entities that have adopted drought plans will only be assessed to this end, therefore fine tuning existing triggers of existing municipal drought plans is not a goal of the model plan beyond an effort toward achieving consistent responses/actions to drought across the Region. Triggers have been recommended that are listed in Table 7-1 that are consistent with existing Municipal and GCD plans. An effort has been made to make the percent reduction of demand/use a little more aggressive and more equitable across the board. Additionally, 'voluntary conservation' has been removed as a stage 1 action. Conservation is a BMP that ideally will ultimately be practiced on a daily basis, and not merely as a reaction to drought conditions, therefore it has been removed as an action in the Regional Model DCP.

Smaller PWS entities (county-other), manufacturing, power, and irrigation water wells that exceed GCD exempt well production thresholds are subject to drought actions imposed by the conservation districts. Exempt well users are requested to voluntarily follow the actions specified by the Districts for non-exempt users. Generally, the water user groups within the Region that are not included in these plans (or included on a voluntary basis) are: 1) all exempt water wells in counties with established GCDs, and 2) all users in Val Verde County except those who are provided water by the City of Del Rio.

This page intentionally left blank

Table 7-8. Recommended Regional Drought Plan Triggers and Actions

Source Name	Source Type (SW or GW)	Source User Entity	Current WUG Monitoring	Real-time Source Monitoring	Factors to be Considered	Recommendations	Specific Triggers								Specific Actions (Percent Reduction Demand/ Use)								
							Source Manager *a				Users *b				Source Manager *c				Users *d				
							1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
							Mild	Mod	Severe	Critical	Mild	Mod	Severe	Critical	Mild	Mod	Severe	Critical	Mild	Mod	Severe	Critical	
Edwards - Trinity (Plateau)	GW	City of Rocksprings	55-63-803 (Sharp well)	---	Plan in place	Add stage 4.	*a	*a	*a	*a					10	20	30	40	10	20	30	40	
		City of Brackettville	70-45-601 (Well #1)	---	Plan in place	Add stage 4.	*a	*a	*a	*a					10	15	25	35	10	15	25	35	
		Fort Clark Springs MUD	70-45-504 (Well #1)	---	Plan in place	Remove voluntary conservation as a stage	*a	*a	*a	*a					10	15	25	35	10	15	25	35	
		City of Del Rio	No groundwater triggers	---	Plan in place	Make stage 1 a 10% demand reduction.	*a	*a	*a	*a					10	20	30	40	10	20	30	40	
		Laughlin AFB									*b	*b	*b	*b									
		County Other	N/A	69-12-206 (Bandera) 56-64-302 (Kerr) 54-63-401 (Val Verde) 70-01-707 (Val Verde)	District plans in place	Make stage 1 a 10% demand reduction (REGRD only).					*b	*b	*b	*b	10	20	30	40	10	20	30	40	
		Irrigation									*b	*b	*b	*b									
		MAN, MIN									*b	*b	*b	*b									
Trinity	GW	City of Bandera	Groundwater triggers	TWDB 69-24-225	Plan in place	Remove voluntary conservation as a stage.	*a	*a	*a	*a					10	20	35	50	10	20	35	50	
		City of Kerrville	Comparison of demand and safe operation capacity	---	Plan in place	No change.	*a	*a	*a	*a					*c	*c	*c	*c					
		City of Ingram	Demand-based triggers	---	Plan in place	Remove voluntary conservation as a stage. Make stage 1 a 10% demand reduction.	*a	*a	*a	*a					10	20	30	40	10	20	30	40	
		County Other	N/A	56-54-405 (Kerr) 56-63-922 (Kerr) 69-19-401 (Real) 16 HGCD wells (Kerr)	District plans in place	No change.					*b	*b	*b	*b	10	20	30	40	10	20	30	40	
		Irrigation																					
		MAN, MIN																					
Edwards (BFZ)	GW	County Other	N/A	70-38-902 (Kinney)	No drought plan	No change.					*b	*b	*b	*b					*d	*d	*d	*d	
		Irrigation																					
		MAN, MIN																					
Austin Chalk	GW	County Other	N/A	---	No drought plan	No change.					*b	*b	*b	*b					*d	*d	*d	*d	
		Irrigation																					
		MAN, MIN																					
Frio River Alluvium	GW	City of Leakey	N/A	---	District plan in place	Remove voluntary conservation as a stage.					*b	*b	*b	*b	10	20	30	40	10	20	30	40	
		Irrigation	N/A																				
		County Other																					
Nueces River Alluvium	GW	Community of Barksdale	Unknown	---	District plan in place	Remove voluntary conservation as a stage.					*b	*b	*b	*b	10	20	30	40	10	20	30	40	
		Irrigation	N/A																				
		County Other																					

*a

Source Manager Triggers – See Table 7-1 for specific triggers in Municipal and GCD drought management plans.

*b

User Triggers – Follow local Municipal or GCD drought management plans as shown in Table 7-1.

*c

Source Manager Action – See Table 7-1 for specific triggers in Municipal and GCD drought management plans.

*d

User Action – Follow local Municipal or GCD drought management plans as shown in Table 7-1.

Table 7-8. (Continued) Recommended Regional Drought Plan Triggers and Actions

Source Name	Source Type (SW or GW)	Source User Entity	Current WUG Monitoring	Real-time Source Monitoring	Factors to be Considered	Recommendations	Specific Triggers								Specific Actions (Percent Reduction Demand/ Use)							
							Source Manager *a				Users *b				Source Manager				Users			
							Mild	Mod	Severe	Critical	Mild	Mod	Severe	Critical	Mild	Mod	Severe	Critical	Mild	Mod	Severe	Critical
Rio Grande Basin	SW																					
Las Moras Springs		City of Brackettville	N/A	USGS station 08456300 and 08456310	Plan in place	Add stage 4.	*a	*a	*a	*a					10	15	25	35	10	15	25	35
San Felipe Springs		City of Del Rio	stages triggered by spring discharge and storage reservoirs	IBWC station 08-4530.00	Plan in place	Increase stage 1 to a 10% demand reduction.	*a	*a	*a	*a					10	20	30	40	10	20	30	40
San Felipe Creek			N/A	IBWC station 08-4530.00	No drought plan						*b	*b	*b	*b					*d	*d	*d	*d
Rio Grande		County Other		IBWC station 08-3772.00																		
Pecos River		Irrigation		USGS station 08447410																		
Devils River		MAN, MIN		USGS station 08449100																		
Amistad Reservoir				IBWC station 08-4508.00																		
Cienegas Creek				---																		
Nueces River Basin	SW																					
Old Faithful Springs		City of Camp Wood	RECRD weir box; based on system capacity limits	RECRD weir box	Plan in place	Remove voluntary conservation as a stage. Make stage 1 a 10% mandated demand reduction.	*a	*a	*a	*a					10	20	30	40	10	20	30	40
West Nueces River			RECRD monitors two gages RECRD monitors six gages	USGS station 08190500	No drought plan						*b	*b	*b	*b					*d	*d	*d	*d
Nueces River Basin		County Other		USGS station 0818999010																		
Frio River		Irrigation		USGS station 08194840																		
Sabinal River		MAN, MIN		USGS station 08197936																		
Hondo Creek				N/A																		
Colorado River Basin	SW																					
Llano River		County Other	RECRD monitors two gages	Telegraph crossing, Hwy 377 at Evergreen School crossing	District plans in place (HGCD and REGRD)	Make stage 1 a 10% demand reduction (REGRD only).					*b	*b	*b	*b	10	20	30	40	10	20	30	40
		Irrigation																				
		MAN, MIN																				
San Antonio River Basin	SW																					
Medina River		County Other	N/A	USGS stations 0817887350, 08178880, and 08178980						*b	*b	*b	*b					*d	*d	*d	*d	
Medina Lake		Irrigation, MAN, Min	N/A	USGS station 08179500																		
Guadalupe River Basin	SW																		*d	*d	*d	*d
Guadalupe River		City of Kerrville	Comparison of demand and safe operation capacity	---	Plan in place	No change.	*a	*a	*a	*a					*c	*c	*c	*c				
		County Other	N/A	USGS stations 08165300, 08165500, 08166000, 08166140, 08166200, and 08166250	District plan in place	No change.					*b	*b	*b	*b	10	20	30	40	10	20	30	40
		Irrigation, MAN, Min	N/A										*b	*b	*b	*b					*d	*d

7.5.4 Model Drought Contingency Plans

In 2019, the Drought Preparedness Council recommended that a model DCP be in place for any water user group that exceeds ten percent of the Region's water demands. For the Plateau Region, these user groups include irrigation and municipal. Based on this recommendation, model DCPs for municipal and irrigation, along with wholesale, are available under the heading of MODEL DROUGHT CONTINGENCY PLANS on the Plateau Region Water Plan website: <http://www.ugra.org/plateau-water-planning-group>.

Public Water Supplier

Drought contingency plans have previously been adopted by the majority of the public suppliers and municipalities in the Plateau Region, although some suppliers did not provide any adopted plans. Current triggers and response actions for participating entities are summarized in Table 7-1.

Irrigation

Irrigation wells located within a municipality are subject to the triggers and response actions designated by the city's drought plan. Non-exempt irrigation wells located outside of a municipality but within a GCD are subject to the triggers and response actions of the GCD. Exempt irrigation wells located within a GCD are requested to comply voluntarily with response actions that have been mandated for non-exempt well owners. No response actions have been designated for irrigators located in Val Verde County except for those located within the City of Del Rio's jurisdictional boundary.

Wholesale Water Provider

The only wholesale water provider in the Plateau Region is the City of Del Rio. Generally, triggers are invoked when water levels in the Bedell Street Storage Reservoirs are less than a designated depth and San Felipe Spring flow drops below a specific flow rate. Currently adopted triggers and actions are summarized below in Table 7-9.

Table 7-9. City of Del Rio Drought Triggers and Response Actions

Stage & Description	1 – Mild	2 – Moderate	3 – Severe	4 – Extreme	5 – Emergency
Trigger	Water levels are less than 100% full; San Felipe Spring flow is less than 40 mgd.	Water levels are less than 30 feet; San Felipe Spring flow is less than 25 mgd.	Water levels are less than 25 feet; San Felipe Spring flow is less than 20 mgd.	Water levels are less than 20 feet; San Felipe Spring flow is less than 15 mgd.	Water levels are less than 15 feet; San Felipe Spring flow is less than 10 mgd.
Conservation Goal (percent reduction in pumpage)	Reduce demand to 95% of the 30-day average prior to initiation	Reduce demand to 90% of the 30-day average prior to initiation	Reduce demand to 80% of the 30-day average prior to initiation	Reduce demand to 70% of the 30-day average prior to initiation	Notify state

7.6 DROUGHT WATER MANAGEMENT STRATEGIES

The PWPG has designated drought management strategies (J-14 and J-18) for the Bandera County Other category to administered by the Bandera County River Authority and Groundwater District. Drought management stages by the District are triggered by the U.S. Drought Monitor and adjusted at the discretion of the District when aquifer levels, rainfall and river flow conditions warrant. Drought management is considered a temporary measure aimed at conserving available water supplies during times of drought or emergencies. Drought management is most adequately addressed in the region through the implementation of local drought contingency plans. The PWPG is supportive of the development and use of these plans during periods of drought or emergency water needs.

7.7 OTHER DROUGHT-RELATED CONSIDERATIONS AND RECOMMENDATIONS

7.7.1 Texas Drought Preparedness Council and Drought Preparedness Plan

In accordance with TWDB rules, all relevant recommendations from the Drought Preparedness Council were considered in the writing of this Chapter. The Texas Drought Preparedness Council is composed of representatives from multiple State agencies and plays an important role in monitoring drought conditions, advising the governor and other groups on significant drought conditions, and facilitating coordination among local, State, and federal agencies in drought-response planning. The Council meets regularly to discuss drought indicators and conditions across the State and releases Situation Reports summarizing their findings. Additionally, the Council has developed the State Drought Preparedness Plan, which sets forth a framework for approaching drought in an integrated manner to minimize impacts to people and resources. Region J supports the ongoing efforts of the Texas Drought Preparedness Council and recommends that water providers and other interested parties regularly review the Situation Reports as part of their drought monitoring procedures. The Council provided two new recommendations in 2019 to all RWPGs which are addressed in this chapter.

- Follow the outline template for Chapter 7 provided to the regions by TWDB staff in April of 2019, making an effort to fully address the assessment of current drought preparations and planned responses, as well as planned responses to local drought conditions or loss of municipal supply.
- Develop region-specific model drought contingency plans for all water use categories in the region that account for more than 10 percent of water demands in any decade over the 50-year planning horizon.

To meet these recommendations, the PWPG has developed this Chapter to correspond with the sections of the outline template, and has provided model DCPs for both municipal and irrigation users.

7.7.2 Other Drought Recommendations

The PWPG recognizes that while drought preparedness, including DCPs, are an important tool, in some instances drought cannot be prepared for, it must be responded to. The PWPG maintains that DCPs developed by the local, individual water providers are the best available tool for drought management. The PWPG fully supports the use and implementation of individual DCPs during times of drought. The PWPG has reviewed provided DCPs and specific drought response strategies proposed in this *Plan* and find no unnecessary or counterproductive variations to exist.

This page intentionally left blank

CHAPTER 8

POLICY AND UNIQUE SITES

RECOMMENDATIONS

This page intentionally left blank.

8 POLICY AND UNIQUE SITES RECOMMENDATIONS

The regional water planning process offers an opportunity to make recommendations pertaining to the development and management of the groundwater and surface water resources of the State of Texas. This chapter contains specific suggestions and decisions made by the Plateau Water Planning Group (PWPG). Regional water planning remains a learning and improving process for the State of Texas. Because of the complex nature of this undertaking, many ideas and approaches to the problems of water-resource management are either refined or changed significantly as all participants in the planning process learn more about the Region's water resources and about what is required to produce a plan that will benefit all areas of the Region. The PWPG supports the continuation of the regional planning process and recommends certain modifications intended to strengthen its effectiveness.

The following recommendations by the PWPG are derived from careful consideration of many issues covered during the course of the planning exercise including needed legislative actions, state funding and assistance, water supply management planning, and needed studies and data. Issues concerning ecologically unique river and stream segments and sites for the construction of reservoirs are covered. The recommendations in the following sections are designed to present new and/or modified approaches to key technical, administrative, institutional, and policy matters that will help to streamline the planning process, and to offer guidance to future planners with regard to specific issues of concern within the Region.

8.1 CONSERVATION RECOMMENDATIONS

1. Watershed Management Practices

Selective vegetative (brush) management, as a tool to improve watershed yields and water quality, is a strategy of great interest in the Plateau Region, as well as in surrounding planning regions. A balanced approach to brush control contributes to the land's ability to absorb, retain, filter, and slow rainfall runoff. However, a narrow goal only to encourage the enhancement of runoff should be avoided.

The State should draft legislation based upon the best available science and input from all stakeholders to provide a cost-share funding program to landowners in the targeted watersheds for selective brush management and required other practices. It is generally recognized that brush infestations are the symptom of deeper ecological disturbances such as fire control, drought, grazing mismanagement, wildlife overpopulations and other causes. As such, the cost-share program should involve a long-range contract between the State and the landowner for at least ten (10) years of post-treatment management with required brush re-invasion treatments. To accurately assess the benefits, treated watersheds will require thorough monitoring of groundwater, springs and surface waters by appropriate state and federal agencies. Information and assistance are available from the USDA Natural Resources Conservation Service (NRCS) and the Texas State Soil and Water Conservation Board.

Currently, Texas Parks & Wildlife Department (TPWD) has a program specifically developed for landowners involving brush management in areas possibly containing endangered species. As has been proven on the Kerr Wildlife Management Area (TPWD) with long-term studies, selective brush management coupled with good rangeland management can benefit endangered species and ranchers as well. It is highly likely that watershed values will fit into the same package to provide a win-win situation for all.

2. Riparian Stewardship

The interaction between soil, water and vegetation in the floodplains and along streambeds constitutes riparian function, which buffers and slows floodwaters, filters sediment, improves natural infiltration and recharge of alluvial aquifers, and enhances water quality. The PWPG encourages riparian landowners to learn and implement land stewardship practices that support healthy riparian function. The PWPG continues to encourage funding for projects aimed at the eradication and long-term suppression of salt cedar, *Arundo donax*, and other nuisance phreatophytes in the Regional watersheds.

3. Conservation Management of State-Owned Lands

All state-owned land should be managed in ways that enhance water conservation. State agencies need to take the lead in water conservation, and it should start on state-owned properties. Unless State agencies set good conservation examples for the public, any public program encouraging such conservation will likely be perceived as “do as I say, not as I do”, something that never plays well. Considering that approximately 95 percent of Texas land is privately owned, the State needs to be convincing when making recommendations to the public if it hopes to be successful.

4. Rainwater Harvesting as an Alternative Source of Water

Rainwater harvesting programs should be supported by the State. Rainwater harvesting is one way to meet rural or urban domestic water demands, as well as use for limited irrigation, such as vineyards, orchards or small farms under drip irrigation. Livestock and wildlife can also be provided supplemental water by rainwater harvesting. This should be widely encouraged by funded education programs and cost-share funding to individual homeowners, farmers, businesses, public entities and ranchers.

5. Conservation and Drought Planning

Because portions of the Plateau Region are particularly susceptible to water-supply shortages during periods of drought conditions, these areas are especially encouraged to develop conservation oriented management plans. Likewise, water-user entities within these areas should become actively involved in the regional water planning activities associated with this Plan.

8.2 WATER MANAGEMENT RECOMMENDATIONS

1. Headwaters GCD Access to Groundwater under State-Owned Land

The Texas Legislature recognizes that a landowner owns the groundwater below the surface of the landowner's land as real property (*Water Code Chapter 36.002 Ownership of Groundwater*). Water Code Chapter 36.104 states that a groundwater district may purchase, sell, transport and distribute surface water or groundwater. For the long-term benefit of meeting the future water demands of the citizens in Kerr County, Texas, the PWPG recommends that the State of Texas enter into a long-term lease agreement or contract that will allow the Headwaters Groundwater Conservation District to retain/acquire the groundwater rights located under all State-owned property within the boundaries of Kerr County. This will provide for:

- better long-term management of local groundwater sources,
- additional drilling sites for test/monitor wells,
- more county-wide data collection and monitoring of aquifer conditions, and
- increased availability of scientific data for local water management planning.

The District's enabling legislation (*Special District Local Laws Code Chapter 8842 Section 102.B*) states that the District may contract with a state agency or another governmental body to carry out any function of the District. The access right to groundwater underlying State-owned land would be included in the District's Management Plan.

2. GCD Management of Brackish Groundwater

Brackish-quality groundwater is recognized State-wide as an underutilized water supply source, and programs are in place in the State's water agencies to encourage the development of this source to meet future water supply shortages. Science recognizes that most of these brackish aquifers represent a down-dip component of an aquifer's freshwater zone, and that the withdrawal of water from the brackish portion may impact the updip fresh-water portion of the same aquifer. The Legislature has declared that groundwater conservation districts are the State's recognized authority to locally manage groundwater sources. The PWPG affirms that local groundwater conservation districts have the authority and should retain the authority to manage the brackish portion of aquifers.

3. Recharge Structures

Recharge structures are a relatively low-cost method of enhancing aquifer recharge if sited to provide adequate streambed water percolation based upon the best available science. Recharge structures such as small dams, gabions, or terraces can provide multiple benefits under ideal conditions as has been proven along the Edwards Aquifer Recharge Zone. This interest in recharge structures should be encouraged, funding provided, and perhaps some streamlining of any required permitting procedures as possible and as advised. Programs and funding should be available to identify appropriate locations for recharge structures and technical assistance provided for construction and maintenance.

8.3 WATER PLANNING RECOMMENDATIONS

1. Transient Population Impact on Water Demand

Municipal water use reports capture the total amount of water produced and distributed by the city. In concept, this volume includes water consumed by both permanent and transient populations within the community. However, the counties of the Plateau Region have a high transient influx of vacationers and hunters that frequent the more remote areas and are not likely included in the water demand estimates. Likewise, there are a high percentage of second-home owners in the rural counties that is also not accounted. Officials in the most rural counties in the Region estimate that as much as 70 percent of landowners are not permanent residents. This transient water demand likely has a significant impact on water demand estimates used by the planning group. The PWPG encourages the TWDB to consider this water-use category and develop a method for estimating its impact.

2. Better Methodologies for Estimating Population and Water Demand

The revision of population and demand estimates should be discussed by regional water planning groups and put before the public for several months, and then be presented to the planning groups for consideration and adoption. This will allow more time for water users within the region to hear about the planning effort and to have input to the revisions of population, water demand, and water supply.

Modification of demand numbers should be allowed further into the planning process. Demand errors may not be discovered until the supply-demand analysis is performed. Some entities or water-use categories may have been overlooked early in the process and their demands need to be added later for the supply-demand analyses to match.

3. County-Other Demand Distribution

In the regional water planning process, water supply demand is determined on a county and river basin basis and is then evenly distributed over the designated area. In some cases, this results in a misrepresentation of the actual rural density within segments of the county-river basin area. The primary disadvantage of this is that a high-density rural area may have a legitimate need of water supply management even though the county-river basin statistical numbers do not indicate a supply shortage. A recommended water management strategy in an area such as this does not register as high of a priority as it realistically should. The PWPG therefore recommends that the TWDB develop a planning process that will justifiably recognize the high-priority needs of relatively higher-density County-Other areas.

4. Irrigation Surveys

Irrigation application is the largest use of water in the State, yet its quantification is probably the least accurate. Irrigation use is only being accurately determined in areas where groundwater conservation districts are requiring the installation of irrigation well flow meters and where irrigation districts record surface water diversions. Elsewhere, planning group members directly involved in the agricultural industry have viewed irrigation surveys with skepticism in many counties. Nursery farms, greenhouse operations, wildlife and exotic animal food plots, and non-municipal golf courses are just a few of the irrigation activities that are often overlooked in the surveys. The TWDB is encouraged to develop a more confident means of estimating actual irrigation use.

5. Peak-Use Management

Drought management plans need to be developed based on peak use demand instead of annual production capabilities. The current Plan is based on drought-of-record conditions on an annual basis. While this is a good starting point in the planning process, it would be beneficial to also plan based on peak demand during a year. For example, current planning does not address water needs during the peak use period of summer months. During the summer, in many areas of the State, severe water problems may exist that are not apparent based on an annual water management plan. This results in a plan that may indicate that water supply needs are satisfied for a region, when in reality such needs may not be satisfied throughout the year. This presents a significant problem in the current planning process.

6. MAG Availability Alternative

Modeled Available Groundwater (MAG) is the quantitative limit set by Groundwater Management Areas for groundwater use in a given area and is the cap for groundwater source use in regional water planning. The PWPG recommends that MAGs be used as the water planning cap unless the Planning Group obtains written permission from a Groundwater Conservation District (GCD) to allow a water management strategy to be recommended that uses more groundwater than the MAG cap. This approach assumes that the strategy is consistent with the GCD Management Plan, but allows for minor supply shortages to be covered without excessive administrative actions and allows the GCD to apply local knowledge to account for variations in permitting approaches and usage patterns. The approach could also be used in areas with no GCDs.

7. Regional Planning Coordination

The two regional planning processes developed by the Legislature (Regional Water Planning and Groundwater Management Areas) have in some cases resulted in conflicting methodologies of reaching long-term planning goals. The PWPG encourages better communication between the stakeholders at earlier stages of both processes in the future. The PWPG also encourages the Legislature to examine ways in which both planning processes can better interact for the good of all citizens and economies in the impacted regions.

8. Training for New Regional Water Planning Group Members

The TWDB is encouraged to continue providing training opportunities for new planning group members. Planning group members provide better input to the planning process when they fully understand the requirements, schedules, and the multitude of internal components of the regional plan.

9. Require Participation of State Agencies Involved with the Planning Process

Representatives of State agencies involved in the regional planning process could effectively derail a regional plan at the end of the planning period - without attending as much as one meeting. The PWPG recommends that nonvoting members of State agencies be required to attend and provide input at every planning group meeting. If an agency's nonvoting representative does not contribute or fails to attend meetings, then that agency should not be permitted to object to or alter contents of a planning group's adopted plan. It should be noted that TWDB, TPWD, and TSSWCB staff were very active (and much appreciated) in the Plateau Region planning process.

8.4 WATER RESEARCH NEEDS

The State should fund or conduct specific studies that will shed more information on specific water-resource issues. The questions unanswered by current sources of information are critical to future PWPG decisions. The following are recommendations pertaining to specific studies and data acquisition that the PWPG believes would provide significant insight into specific planning issues in the Region.

1. Edwards-Trinity (Plateau) Aquifer

All six counties in the Plateau Region are partially or fully underlain by the Edwards- Trinity (Plateau) Aquifer. Even though a groundwater availability model (GAM) has been constructed for this aquifer, there remain many hydrological questions about the aquifer. Specific counties are embroiled in controversy pertaining to groundwater supply availability. At issue is the disagreement about the total amount of water in the county that is available on an annual basis to meet all of the counties projected water demands now and into the future, and the amount of groundwater in excess of that amount that might be available for other purposes other than in-county use. All concerned agree that sound science is needed to assess this quantification.

Specific concern has been voiced by citizens in Val Verde County where the groundwater source availability of the Edwards-Trinity (Plateau) Aquifer changed from 25,000 acre-feet per year in the 2016 Plateau Region Water Plan to 50,000 acre-feet per year in this current Plan. TWDB modelers are particularly critical of the ability of any existing groundwater model to accurately assess Val Verde County groundwater availability as aquifer properties are poorly defined in most of Val Verde County because there are few data on aquifer responses to pumping stresses. In particular, a better understanding is needed of the different geohydrologic environments that exist between the southern San Felipe Springs – Amistad Reservoir area verses the upstream Pecos and Devil’s River area.

A basic, unbiased, scientific study that encompasses the hydrologic characterization of the Edwards-Trinity (Plateau) Aquifer and adjacent associated aquifers (Edwards-BFZ and Austin Chalk) and the inter-formational flow between them, their contribution to surface water flows, and the historical withdrawals from the aquifers is needed in order for the local groundwater management entities and the PWPG to make sound management decisions and recommendations.

2. Unpermitted Withdrawals of Riparian Water

A significant amount of unpermitted riparian water is withdrawn from rivers and their tributaries in the Region. Unpermitted pumping is particularly escalated during drought periods when increased withdrawals occur for irrigation of lawns. This water use is unaccounted for in the Water Availability Models that are developed for these waterways. State water agencies should devise a survey method to establish a reasonable estimate of these diversions.

3. Emphasis on Basic TWDB Water Evaluation Studies

In the past, the TWDB has provided significant knowledge concerning the groundwater resources in the State in the form of basic data and reports. The Board’s current emphasis on groundwater modeling with its intended use as a water management planning tool is recognized as an important advancement in providing planning tools. However, the Board should not abandon its important basic data gathering and

evaluation responsibility. The Board should emphasize more realistic and useful groundwater studies that include the extensive field data collection necessary for such studies.

4. Radionuclides in Trinity Aquifer Groundwater

Recent groundwater sampling by groundwater conservation districts have identified elevated levels of radionuclides in the Trinity Aquifer. Further studies are needed to - identify the specific source of the radionuclides, map their areal distribution and concentration, determine their health concerns, and monitor their changing concentrations over time.

5. Groundwater/Surface Water Relationship

The PWPG defines groundwater availability as a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact such that the base flow in rivers and streams is not significantly affected beyond a level that would be anticipated due to naturally occurring conditions. This water supply policy definition can best be achieved when the relationship between groundwater and surface water is fully understood. The PWPG encourages the State (TWDB) to embrace this concept and focus water availability studies on this topic.

6. Impact of Transient Water Demand in Rural Counties

The concern pertaining to transient population water demand in rural counties was expressed in Section 8.1.8. A study is needed to quantify this impact that is not based solely on the resident population but rather considers the total count of individuals within the respective area.

7. Underestimated Water Demand of Exotic Animals

The PWPG investigated the water use generated by the expanding exotic animal industry within the Region (see Appendix 2B of the *2011 Plan*) and expects to build on this information to generate more accurate water demand estimates in future regional plans. The PWPG encourages the TWDB and other agencies to continue funding for this endeavor in the Plateau Region and throughout the State.

8. Upper Guadalupe River Basin Groundwater/Springflow Analysis

Surface water base flow in the three branches of the upper Guadalupe River in western Kerr County is derived almost exclusively from groundwater discharge through springs. Both the PWPG and members of Groundwater Management Area 9 recognize the need to manage groundwater use in this area where critical surface water/groundwater interaction occurs. However, developing management decisions is impaired by the lack of current understanding of how groundwater level elevations relate to spring flow rates. Only one monitoring well is in place that provides continuous water level readings, and no attempt has thus far been made to relate this recent data to spring flows. A study is needed to evaluate this critical interaction so that future management decisions can be based on a more substantial level of scientific knowledge.

8.5 CONSIDERATION OF ECOLOGICALLY UNIQUE RIVER AND STREAM SEGMENTS

Under regional planning guidelines (§357.43), each planning region may recommend specific river or stream segments to be considered by the legislature for designation as ecologically unique. The legislative designation of a river or stream segment would only mean that the State could not finance the construction of a reservoir that would impact the segment. The intent is to provide a means of protecting the segments from activities that may threaten their environmental integrity.

Texas Parks and Wildlife Department (TPWD) provided a list of stream segments that were identified as meeting ecologically unique criteria. This list and map can be viewed in Appendix 8B of the *2011 Plan*. For each segment, TPWD lists qualities of each segment that support the stream's candidacy. These qualities may include but are not limited to biological function, hydrological function, location with respect to conservation areas, water quality, the presence of state- or federally-listed threatened or endangered species, and the critical habitat for such species.

The Plateau Region contains some of the most ecologically pristine areas in the State. The preservation of this natural environment is an important component of the Region's economy, which is closely tied to these natural resources. The PWPG recognizes the uniqueness of this Region and has followed a policy throughout this planning period of always considering the impact that their decisions have on the area's ecological resources. The PWPG also recognize the extent of Region L designated ecologically unique stream segments that extend upstream to the southern boundary of the Plateau Region.

The PWPG has established the following procedure for public requests for Planning Group consideration of an ecologically unique stream segments:

- PWPG must receive a clearly designated letter and map requesting the EUSS. Letter must be from an individual or entity that resides or principal office is within the geographic boundary of the Plateau Water Planning Region.
- All property owners within the recommended designated area must be provided written notice by certified mail of the proposed designation.
- At least two thirds of the property owners that respond within the recommended area must concur with the proposed EUSS recommended designation.
- The County Commissioners' Court must vote in favor of the recommended designation and submit to the PWPG.

However, because the subsequent ramifications of designation are not fully understood, the PWPG, in keeping its respect toward all individual landowners along these segments and their private property rights, has chosen to refrain from recommending specific segments for designation as "ecologically unique" at this time. The PWPG strongly maintains that all river and stream segments in the Plateau Region are vitally important and their flows constitute a major consideration in adoption of this *2021 Plan*.

The Upper Guadalupe River Authority (UGRA) Board of Directors has presented the following letter in expression of their concern for possible ramifications of RWPGs recommending Ecologically Unique River and Stream Segments:

Based on 31 TAC §357.43 a regional water planning group (RWPG) may recommend a river or stream segment as being of unique ecological value based on the criteria set forth in 31 TAC §358.2(6). Consideration of the designation of stream segments of unique ecological value (unique stream segments) is a component of regional water planning throughout the State. For some, however, including the Plateau Region (J), there is a significant concern about the use of unique stream segments because of a lack of clarity about how the designation might be used in the future. In particular, there are concerns about the provision being used for purposes other than the intent of the legislature, usurping local control, and resulting in the restriction of individual and private property rights for landowners.

31 TAC §358.2(6) states the following: River and stream segments of unique ecological value--Those river or stream segments that may be identified by the Texas Water Development Board in coordination with the Texas Parks and Wildlife Department and the Commission or identified in an approved regional water plan based on the following criteria: (A) Biological function--stream segments which display significant overall habitat value including both quantity and quality considering the degree of biodiversity, age, and uniqueness observed and including terrestrial, wetland, aquatic, or estuarine habitats; (B) Hydrologic function--stream segments which are fringed by habitats that perform valuable hydrologic functions relating to water quality, flood attenuation, flow stabilization, or groundwater recharge and discharge; (C) Riparian conservation areas--stream segments which are fringed by significant areas in public ownership including state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations for conservation purposes, or stream segments which are fringed by other areas managed for conservation purposes under a governmentally approved conservation plan; (D) High water quality/exceptional aquatic life/high aesthetic value--stream segments and spring resources that are significant due to unique or critical habitats and exceptional aquatic life uses dependent on or associated with high water quality; or (E) Threatened or endangered species/unique communities--sites along stream where water development projects would have significant detrimental effects on state or federally listed threatened and endangered species; and sites along streams significant due to the presence of unique, exemplary, or unusually extensive natural communities.

Designation of a river or stream segment as ecologically unique is defined by Chapter 16 of the Texas Water Code §16.051(f) to mean “...that a state agency or political subdivision of the state may not finance the actual construction of a reservoir in a specific river or stream designated by the legislature...”. When the first regional water plans were prepared in 2001, the RWPGs requested clarification of the intent of unique stream segment designations. The legislature addressed that issue in the 77th Legislative Session which is reflected in Chapter 16 of the Texas Water Code §16.051(f) cited earlier. This implies that it would be irrelevant to consider recommending a segment for designation if it does not have potential to be a reservoir site. In other words, no regulatory purpose has been identified that would be served by a unique stream segment designation other than precluding reservoir construction with state funding.

Despite the clarification by the 77th Legislature, many regional water planning groups (including Region J) have struggled with requests for the designation of a stream segment(s) in their respective planning areas based on criteria other than that which was identified by the 77th Legislature. There is considerable concern from some planning group members that using this provision for other than its original intent, which is to prevent a state agency or political subdivision of the state from financing the actual construction of a reservoir in a specific river or stream designated by the

legislature under this provision, will lead to additional unwarranted restrictions on the use of the segment which can negatively impact individual landowners and infringe on private property rights.

Because the subsequent ramifications of unique stream designations are not fully understood, the use of the designation for anything other than the original intent could lead to the impingement of individual and private property rights, and costly litigation. The intent of the Texas Legislature regarding the purpose of the unique stream segment designation is clearly stated in Section 16.051(f) of the Texas Water Code. The current process incorporates considerations made by rule which exceed the legislature's intent and §16.051(f) of the Texas Water Code thereby usurping local control and due process by duly elected local officials.

Recommendation:

The Plateau Water Planning Group recommends the modification of 31 TAC §358.2 by striking subsection 6 (a through e) "Ecologically Unique Stream Segments" and the modification of sections that reference 31 TAC §358.2(6) with the rationale that this section's instruction for unique stream designation supersedes the directive in Texas Water Code 16.051(f). Striking 31 TAC §358.2(6) will additionally preserve and protect local control as well as individual and personal property rights.

8.6 CONSIDERATION OF UNIQUE SITES FOR RESERVOIR CONSTRUCTION

Regional water planning guidelines (§357.43) instruct that planning groups may recommend sites of unique value for construction of reservoirs by including descriptions of the sites, reasons for the unique designation, and expected beneficiaries of the water supply to be developed at the site. The following criteria shall be used to determine if a site is unique for reservoir construction:

1. Site-specific reservoir development is recommended as a specific water management strategy or in an alternative long-term scenario in an adopted plan.
2. The location, hydrologic, geologic, topographic, water availability, water quality, environmental, cultural, and current development characteristics, or other pertinent factors make the site uniquely suited for:
 - reservoir development to provide water supply for the current planning period; or
 - where it might reasonably be needed to meet needs beyond the 50-year planning period.

Following consideration of the above criteria the PWPG makes no recommendation of unique sites for reservoir construction.

CHAPTER 9

WATER INFRASTRUCTURE FINANCING ANALYSIS

This page intentionally left blank.

9 WATER INFRASTRUCTURE FINANCING ANALYSIS

The Infrastructure Financing Report survey presented in this chapter identifies the state financing options proposed by entities in this *Plan* to meet future infrastructure needs. Chapter 5 provides recommended water management strategies for numerous communities in Far West Texas that either have a projected water supply deficit and recommended strategies to meet that need, or have an identified need for a water supply infrastructure project, which may require state financial assistance. These entities were surveyed to determine their proposed method(s) for financing the estimated capital costs involved in implementing the water supply strategies recommended in the *2021 Plateau Region Water Plan*.

Unlike infrastructure financing surveys conducted for previous regional water plans, questions during this planning cycle focused on projected needs for financial assistance from programs administered by the TWDB. The TWDB will aggregate the projected requests for funding from these programs from the 16 water planning regions to provide a picture of estimated long-term infrastructure funding needs to the State Legislature.

9.1 TWDB FUNDING PROGRAMS

The TWDB offers financial assistance for the planning, design and construction of projects identified in Regional Water Plans or the State Water Plan. Programs available include the State Water Implementation Fund for Texas (SWIFT), Water Infrastructure Fund (WIF), the State Participation Fund (SP), and the Economically Distressed Areas Program (EDAP). To be eligible to apply for funding from the SWIFT source, the applicant must be a political subdivision of the state, or in some cases a water supply corporation and the proposed project must be a recommended water management strategy in the most recent approved Regional Water Plan or State Water Plan.

9.1.1 State Water Implementation Fund for Texas (SWIFT)

The Texas Legislature created the SWIFT to provide affordable, ongoing state financial assistance for projects in the state water plan. Passed by the Legislature and approved by Texas voters through a constitutional amendment, the SWIFT helps communities develop and optimize water supplies at cost-effective rates. The program provides low-interest loans, extended repayment terms, deferral of loan repayments, and incremental repurchase terms for projects with state ownership aspects. Recognizing the benefit of conservation and the needs of rural Texas, the legislation directed that not less than 10% of the SWIFT funding should support projects for rural communities and agricultural water conservation; and not less than 20% of the funds should support water conservation and reuse projects.

9.1.2 Water Infrastructure Fund (WIF)

The Water Infrastructure Fund (WIF) provides subsidized interest rate loans for planning, design and construction. The WIF-Deferred fund offers the option of deferring all interest and principal payments for up to 10 years for planning, design and permitting costs, while the WIF-Construction fund offers subsidized interest for all construction costs including planning, acquisition, design, and construction.

9.1.3 State Participation Fund (SP)

The State Participation Fund (SP) is geared towards large projects which are regional in scope and meant to capitalize on economies of scale in design and construction, but where the local project sponsors are unable to assume the debt for an optimally sized facility. The TWDB assumes a temporary ownership interest in the project, and the local sponsor repays the cost of the funding through purchase payments on a deferred schedule. The goal of the program is to build a project that will be the right size for future needs, even if that results in the short term in building excess capacity, rather than constructing one or more smaller projects now.

9.1.4 Rural and Economically Distressed Areas (EDAP)

Both grants and zero percent interest loans for planning, design and construction costs are offered through these programs, which are available to eligible small, low-income communities. Rural and economically distressed areas that meet population, income and other criteria are eligible to apply for these funds. EDAP funding eligibility also requires adoption of the Texas Model Subdivision Rules by the applicant planning entities.

9.2 INFRASTRUCTURE FINANCE SURVEY

The survey instrument is prefaced with an explanation of its purpose in identifying the need for financial assistance programs offered by the State of Texas and administered by the TWDB. The available funding programs (SWIFT, WIF, SP and EDAP) are summarized, and the survey participant is asked to: 1) identify the amounts they might request from each funding source for each identified project or strategy; and 2) the earliest date the funds would be needed, by fund type. Water user groups with multiple strategies to meet future water needs are only surveyed for strategies with a capital cost.

All communities listed in Chapter 5 water management strategies were presented with surveys provided by the TWDB. The survey along with supporting documentation that summarized the water management strategies included in the *Regional Plan* for that entity were delivered to the mayor or the city/utility manager and follow-up contacts were made with each entity to encourage response to the survey. Table 9-1 presents the surveys responses.

Table 9-1. Infrastructure Finance Report Survey

CITY OF BANDERA - ADDITIONAL MIDDLE TRINITY WELLS WITHIN CITY WATER INFRASTRUCTURE	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING		Completed
CITY OF BANDERA - ADDITIONAL MIDDLE TRINITY WELLS WITHIN CITY WATER INFRASTRUCTURE	CONSTRUCTION FUNDING	\$244,500	Completed
CITY OF BANDERA - ADDITIONAL MIDDLE TRINITY WELLS WITHIN CITY WATER INFRASTRUCTURE	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	\$0	
CITY OF BANDERA - PROMOTE, DESIGN AND INSTALL RAINWATER HARVESTING SYSTEMS	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING		Not considered
CITY OF BANDERA - PROMOTE, DESIGN AND INSTALL RAINWATER HARVESTING SYSTEMS	CONSTRUCTION FUNDING		Not considered
CITY OF BANDERA - PROMOTE, DESIGN AND INSTALL RAINWATER HARVESTING SYSTEMS	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY		Not considered
CITY OF BANDERA - REUSE TREATED WASTEWATER EFFLUENT FOR IRRIGATION	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING		Not considered
CITY OF BANDERA - REUSE TREATED WASTEWATER EFFLUENT FOR IRRIGATION	CONSTRUCTION FUNDING		Not considered
CITY OF BANDERA - REUSE TREATED WASTEWATER EFFLUENT FOR IRRIGATION	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY		Not considered
CITY OF BANDERA - SURFACE WATER ACQUISITION, TREATMENT AND ASR	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING		Not considered
CITY OF BANDERA - SURFACE WATER ACQUISITION, TREATMENT AND ASR	CONSTRUCTION FUNDING		Not considered
CITY OF BANDERA - SURFACE WATER ACQUISITION, TREATMENT AND ASR	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY		Not considered
CITY OF KERRVILLE - EXPLORE AND DEVELOP NEW ELLENBURGER AQUIFER WELL SUPPLY	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	\$3,998,750	2021
CITY OF KERRVILLE - EXPLORE AND DEVELOP NEW ELLENBURGER AQUIFER WELL SUPPLY	CONSTRUCTION FUNDING	\$11,996,250	2021
CITY OF KERRVILLE - EXPLORE AND DEVELOP NEW ELLENBURGER AQUIFER WELL SUPPLY	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	\$0	
CITY OF KERRVILLE - INCREASE WASTEWATER REUSE	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	\$0	NA
CITY OF KERRVILLE - INCREASE WASTEWATER REUSE	CONSTRUCTION FUNDING	\$0	NA
CITY OF KERRVILLE - INCREASE WASTEWATER REUSE	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	\$0	
CITY OF KERRVILLE - INCREASED WATER TREATMENT AND ASR CAPACITY	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	\$3,059,100	2030
CITY OF KERRVILLE - INCREASED WATER TREATMENT AND ASR CAPACITY	CONSTRUCTION FUNDING	\$7,137,900	2031
CITY OF KERRVILLE - INCREASED WATER TREATMENT AND ASR CAPACITY	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	\$0	
CITY OF KERRVILLE - WATER LOSS AUDIT AND MAIN-LINE REPAIR	PLANNING, DESIGN, PERMITTING & ACQUISITION FUNDING	\$789,750	2022
CITY OF KERRVILLE - WATER LOSS AUDIT AND MAIN-LINE REPAIR	CONSTRUCTION FUNDING	\$9,477,000	2023
CITY OF KERRVILLE - WATER LOSS AUDIT AND MAIN-LINE REPAIR	PERCENT STATE PARTICIPATION IN OWNING EXCESS CAPACITY	\$0	

CHAPTER 10

PUBLIC PARTICIPATION AND PLAN ADOPTION

This page intentionally left blank.

10 PUBLIC PARTICIPATION AND PLAN ADOPTION

Chapter 10 contains an overview of the Plateau Water Planning Group (PWPG) representation, administrative planning process, specific activities that insured that the public was informed and involved in the planning process, and the implementation of the *Plan*. Chapter 10 appendices contain comments and responses on the Initially Prepared Plan by the Public (Appendix 10A), TWDB (Appendix 10B), and TPWD (Appendix 10C).

10.1 PLATEAU WATER PLANNING GROUP

The TWDB appointed an initial coordinating body or PWPG for the original Region J based on names submitted by the public for consideration. The PWPG then voted to change its name to Plateau and expanded its membership based on their knowledge of additional persons who could appropriately represent water user groups (Table 10-1). Non-voting members representing interested state agencies and adjacent planning regions are listed in Table 10-2. State planning provisions mandate that one or more representatives of the following water user groups be seated on each planning group: agriculture, counties, electric generating utilities, environment, industries, municipalities, river authorities, public, small business, water districts, and water utilities. An electric generating utility does not exist within the Plateau Region and is therefore not represented. In addition to the other 10 categories, the PWPG chose to appoint a member to represent the tourism industry because of its prevalence in the Region. Also, to insure adequate geographic representation, the PWPG made sure that at least one member was selected from each of the six counties. Membership was also extended to represent the three Groundwater Management Areas within the Region. Staff persons from both the Texas Parks and Wildlife Department and the Texas Department of Agriculture were also appointed as non-voting members. The PWPG members voluntarily devote considerable amounts of their time to the planning process.

**Table 10-1. Plateau Water Planning Group Voting Members
(Effective March 3, 2020)**

Name	Water-use Category	County
Jonathan Letz, <i>Chair</i>	Small Businesses	Kerr
Genell Hobbs, <i>Vice Chair</i>	GMA 10	Kinney
Gene Williams, <i>Secretary</i>	Water Districts	Kerr
Ray Buck, <i>Political Entity</i>	River Authorities	Kerr
Jerry Simpton	Other	Val Verde
William Feathergail Wilson	Other	Bandera
Joseph McDaniel	Industries	Kerr
Homer T. Stevens, Jr.	Tourism	Bandera
Charlie Wiedenfeld	Water Utilities	Kerr
David Maulk	Water Districts	Bandera
Roland Trees	Water Districts	Real
Rene Villareal	Water Districts	Kinney
Wes Robinson	Agriculture	Kinney
Tully Shahan	Environment	Kinney
Lee Sweeten	Counties	Edwards
Scott Loveland	Municipalities	Kerr
Otila Gonzalez	Municipalities	Val Verde
Dell Dickinson	Public	Val Verde
Max Martin	Public	Edw/VV/Kin
Charlie Flatten	Public	Kerr/Ban/Real
Genell Hobbs	GMA7	Kinney
David Jeffery	GMA9	Bandera

**Table 10-2. Plateau Water Planning Group Non-Voting Members
(Effective March 3, 2020)**

Name	Organization
William Alfaro	Texas Water Development Board
Robin Barthen	Texas Department of agriculture
Chad Norris	Texas Parks and Wildlife Department
Rusty Ray	Texas State Soil & Water Conservation Board
Kenn Norris	Region E Liaison
Paul Tybor	Region K Liaison
Con Mims	Region L Liaison
Thomas Rodriquez	Region M Liaison
Carl Schwing	Region J Liaison to Region M

Interregional Planning Council

The TWDB is required by Texas Water Code Section 16.052 to appoint an Interregional Planning Council made up of one member from each regional water planning group (RWPG). The purpose of the Council is to:

- Improve coordination among the RWPGs, and between the RWPGs and the TWDB in meeting goals of the state water planning process;
- Facilitate dialogue regarding regional water management strategies; and
- Share operational best practices of the regional water planning process.

The PWPG has appointed Ray Buck to this position.

10.2 ADMINISTRATIVE PROCESS AND PROJECT MANAGEMENT

The PWPG functions through procedures set forth in their adopted bylaws and follow planning guidelines establish by Legislative rule and TWDB contractual guidelines. With planning funds administered through TWDB, the PWPG then hires technical consultants to perform the work of preparing the regional plan for planning group review and adoption. Work required completing the Plan follows well-defined guidelines intended to meet the mandated legislation and to establish a degree of format uniformity between plans submitted by all 16 planning regions. The PWPG operates its administrative function through the Upper Guadalupe River Authority (UGRA), which oversees contractual and budgetary obligations. All meetings of the PWPG are open to the public and meet Open Meetings Act requirements.

10.3 PLANNING GROUP MEETINGS AND PUBLIC HEARINGS

All activities associated with the Regional Water Planning Process were performed in accordance with the State Open Meetings Act. All meetings of the PWPG, including committee meetings, are open to the public where visitors are afforded the opportunity and encouraged to voice their opinions, concerns, or suggestions. Meetings are primarily held in Leakey Texas so that all citizens within the Region have an equal opportunity to attend. Meeting notices are posted with the County Commissioners' Courts of each county.

All material to be presented at public meetings and all draft and final *Plan* documents were made available for public inspection on the Planning Group's website hosted by the UGRA in accordance with the Texas Public Information Act.

A public hearing was held virtually on April 23, 2020 to receive comments on the *2021 Initially Prepared Plan*. Notice of the Public Hearings was sent to 334 down-river water rights holders as well as to each county commissioner's court and designated libraries. Hard copies of the *Initially Prepared Plan* were placed in the courthouse and a designated library in each of the Regions' six counties listed below, and an electronic copy of the draft *Plan* was made available on the Upper Guadalupe River Authority web site <http://www.ugra.org/waterdevelopment.html>. The public was given a full month prior to the hearing to review the document.

- Bandera County Library
- Butt-Holdsworth Memorial Library (Kerr County)
- Claud H. Gilmer Memorial Library (Edwards County)
- Kinney County Public Library
- Real County Public Library
- Val Verde County Library

Prior to receiving official comments during the public hearing, a question and answer session was held so that the public attendees would have an opportunity to gain a better understanding of how the draft *Plan* was formulated. X people representing the public attended the hearing, along with several planning group members. At the conclusion of the hearing, the public was notified that there would be a 60-day period in which the PWPG would continue to receive written comments. The TWDB and TPWD also reviewed the *Initially Prepared Plan* and provided comments. Responses to agency and public comments are provided in Appendix 10A, Appendix 10B and Appendix 10C. On October 22, 2020, the PWPG met in a public forum and approved the final *2021 Plateau Region Water Plan* for submittal to the TWDB.

10.4 COORDINATION WITH OTHER REGIONS

Coordination with other regions was accomplished through liaisons shared with adjacent regions (Regions E, F, K, L and M) and through active participation in Chairs Conferences scheduled by the TWDB.

10.5 PLAN IMPLEMENTATION

Following final adoption of the *2021 Plateau Region Water Plan*, copies of the *Plan* were provided to each municipality and county commissioners' court in the Region. An electronic copy of the *Plan* is also available on the UGRA and TWDB web sites.

This page intentionally left blank

APPENDIX 10A

RESPONSE TO PUBLIC COMMENTS

This page intentionally left blank

PUBLIC COMMENTS

The Plateau Water Planning Group (PWPG) hosted a virtual (in response to COVID 19) Public Hearing on the Plateau Water Initially Prepared Plan (IPP) on April 23, 2020. The Planning Group received one comment from Mr. Skip Newson, a resident of Val Verde County and an owner of property abutting the Devil's River.

Skip Newsom
793 Diablo Road
Del Rio, Texas 78840
(830) 775-7838 Home/Office
(512) 431-9511 Mobile
skipnewsom@fnlawtx.com

June 20, 2020

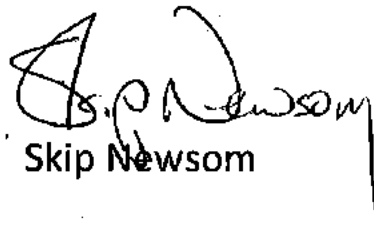
Mr. Jonathon Letz
Chairman
Plateau Water Planning Group (Region J)
700 Main Street, Ste. 101
Kerrville, TX 78028

Re: Initially Prepared Plan for the Plateau Region 2021 Regional Water Plan

Dear Chairman Letz,

Enclosed for filing and consideration by you and your Voting Members please find my written Comments to the Initially Prepared Plan for the Plateau Region 2021 Regional Water Plan prepared on behalf of Region J by Carollo Engineers. Should you, your staff, representatives, or any of Region J's Members have any questions regarding these Comments or require additional information, please feel free to contact me directly. Please also put me on your notification list for any and all notifications or announcements respecting the proposed Water Plan.

Respectfully yours,


Skip Newsom

To: Plateau Water Planning Group (Region J)
From: Skip Newsom
Date: June 20, 2020
Re: Comments to Plateau Region Initially Prepared Water
Plan (March 2020)

Introduction to Plan Comments

As a resident of Val Verde County and an owner of property abutting the Devils River, I offer these comments to (a) compliment the draft Plan's explanatory detail relating to necessary conservation measures and costs to meet present and future water needs, (b) address what I see as significant shortcomings in Region J's proposed 2021 Plan relating to Val Verde County, the Devils River and its underlying aquifer, and (c) offer my own perspective as to how such issues may be resolved in keeping with the Plateau Group's overall mission. More specifically:

1. The draft Plan employs a self-described "conservative methodology" to quantify sustainable groundwater supplies protective of the County's natural resources; however, it actually imposes an assumed, but wholly unsubstantiated, "zero" flow on drought period Devils River spring flows and declares groundwater availability values and a hydrogeological spring flow "trigger" derived from a "one size fits all" modeling extrapolation which, if adopted, invites habitat demise and excessive Devils River area pumping without County or stakeholder consent.
2. The draft Plan claims the intention of protecting surface water and spring flows directly related to the preservation of natural resources which are dependent on such surface water sources or spring flows for their existence. Yet, such Plan neither conducts nor relies upon any riverine or other environmental assessment to identify, quantify or correlate how such habitat, species and spring flow resources would be protected by the adoption of the proposed Plan.

3. The draft Plan's groundwater availability assessment doubles County-wide groundwater availability from Region J's previous 2016 Water Plan without explanation and adopts a County-wide hydrogeological "trigger" based strictly upon estimated pumping impacts from three southeast County wells upon southeast County spring flows measured at San Felipe Springs. Such approach reveals nothing about upgradient groundwater availability or potential pumping impacts upon any of the springs which actually contribute to the base flow of either the Devils or Pecos Rivers. The failure to provide any correlation between southeast County groundwater and spring flow conditions and Devils River or Pecos River area groundwater conditions and spring flows corrupts the County-wide water availability conclusions set forth in the draft Plan and precludes their applicability to any portion of Val Verde County other than, at best, the southeast. The Plan should be revised to reflect the Texas Water Development Board's own conclusion that no properly developed quantitative groundwater availability model currently exists for Val Verde County and no such model is available due to current data deficiencies.

4. The draft Plan recommends the creation of a groundwater conservation district for Val Verde County without delineating any reasons, consequences or costs associated with such an effort, and without any discussion of the availability or adequacy of water data details to support such creation, much less the promulgation of a groundwater management plan and the issuance or denial of pumping permits by such district once created. Unless the Plan is modified to accountably provide a detailed and reasoned explanation underlying such recommendation, accompanied by a realistic assessment of foreseeable costs associated with such undertaking, the Plan should explicitly state that it takes no position relative to such creation.

I am neither a groundwater hydrologist nor a habitat biologist, but I am passionate about protecting the unique and pristine character of the Devils River, having fished and paddled it over the course of the past five decades. I am also a member of the Devils River Conservancy and

am the Chairman of the Devils River Association Water Committee, although these comments are strictly my own. In addition to being a dearly interested landowner, I have been a Texas water law specialist throughout my legal career, focusing on all facets and tangents of Texas water law across the State on behalf of landowners, water suppliers and customers, corporations, water districts and municipalities since my years in the Texas Attorney General's Office in the 1970's, where I represented the Texas Water Development Board, Texas Parks & Wildlife Department, and the predecessor agencies to the current Texas Commission on Environmental Quality. I am pleased to have this opportunity to contribute to Region J's Planning efforts and hope that these comments may prove helpful in fulfilling the Plateau Group's mission to safeguard the Devils River and its source artesian springs for future generations.

For clarity of the information and observations presented herein, a locational map of most all Val Verde County springs is appended at the end of these comments.¹

I **PROTECTION OF NATURAL RESOURCES**

The Devils River has long been considered to be "the most unspoiled, pristine and ecologically intact river in Texas."² There are a number of threatened and endangered species that inhabit springs or spring-fed streams in Val Verde County. The Devils River supports five listed species, with a sixth being currently evaluated for list inclusion by the

¹ Spring location map is derived from the Texas Water Development Board publication "Overview of Groundwater Conditions in Val Verde County, Texas", Dec. 2018, Figure 4-12 at p. 46

² Birdwatchersdigest.com, "Devils River State Natural Area"; Texas Parks & Wildlife Magazine, "Falling Water," Emily Moskai, June 2017; Wikipedia.com, "Devils River"

U.S. National Park Service and the U.S. Fish and Wildlife Service.³ The draft Plan, however, devotes little actual attention to the Devils River or its protection and, in fact, expressly declines to recommend any declaration of “ecologically unique river or stream segments” which could lend an additional level of protection for such species and habitats beyond the remarkable stewardship historically exercised by most Devils River watershed landowners in their continued efforts to preserve precious riverine habitats and species.⁴

Despite such omission, the draft Plan appears to provide an encouraging commitment to the protection of spring flows and riverine habitats found in the Devils River:

The long-term protection of the Plateau Region’s water resources, agricultural resources, and natural resources is an important component of this 2021 update of the *Plateau Region Water Plan*. Long-term water resources protection occurs in the conservative methodology of estimating water supply availability...The methodology adopted to assess groundwater source availability is based on not significantly impacting spring flows that contribute to base flows in area rivers. Thus, the intention to protect surface flows is directly related to those natural resources that are dependent on surface water sources (or spring flows) for their existence...Of prime consideration was whether a strategy potentially could diminish the quantity of water currently existing in the natural environment and if a strategy could impact water quality to a level that would be detrimental to

³ Texas Water Development Board, “Overview of Groundwater Conditions in Val Verde County, Texas, Dec. 2018, at p. 8, Table 2-1.

⁴ Plateau Region Initially Prepared Water Plan, March 2020, Corollo Engineers, *Supra* at pp. ES-12 and 6-4

animals and plants that naturally inhabit the area under consideration.⁵

Unfortunately, and while no doubt well intended, scrutiny of the proposed Plan's textual detail and other related documents on file at the Texas Water Development Board reveals the Plan's commitment to be more platitude than certitude.

Indeed, rather than utilizing its self-described "conservative methodology" to quantify sustainable groundwater supplies protective of the County's natural resources, the draft Plan doubles projected groundwater availability from Region J's previous 2016 Water Plan without explanation, imposes an assumed, but unsubstantiated, "zero" flow on drought period Devils River spring flows and employs groundwater availability values derived from a faulty "one size fits all" modeling extrapolation inviting potentially excessive pumping without County or stakeholder consent.

Val Verde County Groundwater Availability Modeling

In the past decade alone, there have been no less than four notable groundwater modeling efforts, each employing distinctly different methodologies and developing vastly different water availability assessments for Val Verde County.⁶

⁵ Id.

⁶ See: (1) Anaya and Jones, 2009, "Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas", Texas Water Development Board Report 373, April 2009; (2) Wet Rock Groundwater Services, L.L.C, 2010a, "Water Resources Evaluation of the Edwards-Trinity (Plateau) Aquifer, Weston Ranch - Val Verde County, Texas", report of findings for Western Water Division, Grass Valley Water L.P.; Wet Rock Groundwater Services, L.L.C, 2010b, "Groundwater Modeling of the Grass Valley Water Project: Weston Ranch - Val Verde County, Texas", report of findings for Western Water

Reviewing these models generally, the Texas Water Development Board staff has explained the limitations currently inherent in any Val Verde County groundwater availability model as follows:

Numerical groundwater models are computer tools used to represent and understand aquifer flow systems. When properly calibrated, models may also be used to simulate groundwater conditions for a given set of assumptions. The level of complexity and usefulness of groundwater flow models are generally constrained by the availability of data and the range of conditions reflected in the available data. The relative scarcity of historical measurements for much of Val Verde County constitutes a challenge for modeling the Edwards-Trinity (Plateau) Aquifer groundwater flow system.⁷

Indeed, the Water Development Board staff has been particularly critical of the ability of any existing groundwater model to accurately assess Val Verde County groundwater availability:

Aquifer properties are poorly defined in most of Val Verde County because there are few data on aquifer responses to pumping stresses. These data are needed to estimate critical parameters such as aquifer hydraulic conductivity and storage. Preferably, aquifer tests could be designed and

Division, Grass Valley Water L.P.; (3) Eco-Kai Environmental Inc. and Hutchison, W. R., 2014, "Hydrogeological study for Val Verde County and City of Del Rio, Texas", report prepared for Val Verde County and City of Del Rio; and (4) Toll, N., Fratesi, S.B., Green, R.T., Bertetti, F.P., and Nunu, R., 2017, "Water resource management of the Devils River watershed", final report, Southwest Research Institute

⁷Texas Water Development Board (TWBD) "Overview of Groundwater Conditions in Val Verde County, Texas", Dec. 2018, p. 66

conducted on wells constructed for this purpose and located where data are most needed.⁸

Quantitative evaluation of the effects of potential future pumping on recharge, streamflow, and groundwater-surface water interaction requires an appropriately scaled, calibrated, and validated numerical model of coupled groundwater and surface water processes. Such a model is not currently available and key inputs needed to develop one are not well constrained.⁹

Water level measurements are the fundamental record required to assess groundwater resources. The current network of observation wells does not provide adequate spatial or temporal detail over the extent of Val Verde County.¹⁰

Models need to incorporate higher temporal and spatial resolution than the regional Edwards-Trinity (Plateau) Aquifer GAM to assess compliance with desired future conditions, but data to support more detailed models are generally lacking.¹¹

Several lines of evidence suggest that a large part of the Val Verde water budget actually originates outside the model domain; if so, these models are not properly calibrated and estimates of aquifer properties and the groundwater volumes available for use are likely in error.¹²

⁸Id, at p. 76

⁹Id at p. 56

¹⁰Id. at p. 75

¹¹Id at p. 66

¹²Id at pp. 66

Despite such severe model and data limitations inherent in the Plateau Region's GAM (Groundwater Availability Model) and underlying Eco-Kai and W. R. Hutchison, 2014 model for Del Rio and Val Verde County noted by the Water Development Board, together with the Board's express concerns as to likely calibration errors presented by such modeling efforts, the draft Plan's groundwater availability projection relies exclusively upon GMA7's 2018 Desired Future Condition (DFC) and Modeled Available Groundwater (MAG) determinations. Those determinations double the previously declared groundwater availability for Val Verde County from 25k AF to 50k AF, without any explanation, articulated rationale or model changes from that previously employed in GMA7's 2015 DFC Resolution and Region J's adopted 2016 Plan.¹³ Such "doubled" modeled groundwater availability, although wholly unexplained in the proposed Plan or GMA7's 2018 Resolution adopting DFCs or even W.R. Hutchison's 2018 "GMA7 Explanatory Report, is entirely based upon the same W.R. Hutchison's Eco Kai 2014 model relied upon for the previous GMA7 Val Verde County DFC and Plateau Group 2016 Water Plan for Val Verde County which generated a DFC or groundwater availability of 25k AF, not 50k AF.¹⁴ Notably, however, Mr. Hutchison's own 2018 GMA7 Explanatory Report, in a number of instances, continues to reference a Val Verde County groundwater availability of 25k AF, not 50k AF.¹⁵ Such unexplained doubling and inconsistent presentation

¹³ See, Plateau Region Initially Prepared Water Plan, *Supra*, at p. 11-6, Table 11-3); Compare: Eco Kai Environmental and WR Hutchison, "Val Verde County/City of Del Rio Hydrogeological Study", May, 2014) with WR Hutchison, "GMA7 Explanatory Report, Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers", March 2018

¹⁴ Compare: Eco Kai Environmental and WR Hutchison, "Val Verde County/City of Del Rio Hydrogeological Study", May, 2014) with WR Hutchison, "GMA7 Explanatory Report, Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers", March 2018).

¹⁵ See, e.g., "GMA7 Explanatory Report", Table 1, p. 17

presents an unanswered question as to the cause and source of such change, suggesting a predetermined quantitative assessment of County-wide groundwater availability. When the same modeling results are used to support a 100% increase in modeled water availability, with absolutely no supporting explanation, something is clearly amiss, but both the draft Plan and GMA7's declared groundwater availability determinations ignore such dichotomy.

Notwithstanding the notable lack of professional consensus in approach or results presented by the various Val Verde County groundwater models reviewed by the Water Development Board, their poorly defined Aquifer properties, lack of available data necessary to accurately estimate critical aquifer parameters, and the great likelihood of calibration error in their assessments of groundwater available for use, GMA7's DFC determination is wholly irrelevant to Val Verde County. Unlike the case for every other county within GMA7, no statutorily required public hearing was conducted in Val Verde County to support any water availability assessment or DFC adopted by GMA7 for the County.¹⁶ Likewise by statute, Groundwater Management Authorities, such as GMA7, are exclusively composed of groundwater conservation districts which set their own DFCs based upon modeled water availability within their jurisdiction.¹⁷ Val Verde County has no such groundwater conservation district and therefore had no representation, voice or vote in any GMA7 groundwater management decisions or availability assessments declared on behalf of the County.

The draft Plan's groundwater water availability assessment for Val Verde County, based upon GMA7's adopted DFC, is an erroneous over-reach and not binding upon the County as GMA7 does not regulate Val Verde County and such adoption lacks the consent of the County and its landowning stakeholders who, as emphatically stated by our Texas Supreme Court, are the actual owners of the affected groundwater in

¹⁶ Texas Water Code §38.108 (d-2)

¹⁷ Texas Water Code §36.108(c).

place, not the State of Texas or its legislative creations.¹⁸ Since a determined volume of groundwater in place and actually available for capture and use beneath a surface estate can dramatically affect the value of such property, it cannot be artificially or arbitrarily increased or reduced by regulatory decree without notice to the landowners affected thereby and a fair opportunity for hearing thereon. To so decree without such notice invites litigation for a regulatory taking without due process or compensation.

The proposed Plan's implicit embrace of W.R. Hutchison's Eco Kai 2014 groundwater availability model and GMA7's Desired Future Condition is especially egregious when applied to the entire County, and the Devils River in particular, because it is based solely upon estimated pumping impacts from only three southeast County well fields upon San Felipe Springs, located in southeast Val Verde County below Amistad Reservoir. Indeed, such limited scope may have been by design since such modeling effort appears to have been directed under a City and County Partnership primarily to determine the impact of well fields proposed by the San Antonio Water System upon San Felipe Springs for a then proposed out of county export project.¹⁹ The model was not intended to quantify groundwater conditions needed to sustain contributing spring flows to either the Devils or the Pecos River systems as those systems are not affected by San Felipe Spring flows or pumping from the southeast county wells simulated in the model. The process employed by the Hutchison/Eco Kai 2014 model is best explained by the Water Development Board staff as follows:

The model associated with a hydrogeological study for Val Verde County and the City of Del Rio (Eco Kai Environmental, Inc. and Hutchison, 2014), was used ...

¹⁸*Edwards Aquifer Authority vs. Day*, 369 S.W.3d 814(Tex. 2012)

¹⁹Hutchison/Eco Kai Environmental 2014 Hydrogeological Study, *Supra* at p. 46; See also, San Antonio Express News, Nolan Hicks, Jan. 12, 2014, "Opposition Grows to Val Verde Water Plan

to simulate multiple pumping scenarios indicating the effects of a proposed well field. The model indicated the effects of varied pumping rates and well field locations. These model runs were used by Groundwater Management Area 7 as the basis for the desired future conditions for Val Verde County. * * *

There is no associated drawdown as a desired future condition. The desired future condition is based solely on simulated spring flow conditions at San Felipe Spring of 73 to 75 million gallons per day. Pumping scenarios—50,000 acre-feet per year—in three well field locations, and monthly hydrologic conditions for the historic period 1969 to 2012 meet the desired future conditions set by Groundwater Management Area 7, Eco Kai and Hutchison, 2014; Hutchison 2018b.²⁰

Notably, this is the same model run and Plateau Region Edwards-Trinity Aquifer GAM which the Water Development Board has stated needed to incorporate higher temporal and spatial resolution to assess compliance with desired future conditions and may have substantive calibration errors due to out of County sourced groundwater flows.²¹

Not only is the limited four year period of hydrological conditions utilized by the model and proposed by the Plan to simulate DFC compliance and future conditions for up to fifty years an inordinately restricted time period upon which to premise long term availability estimates, such approach tells us absolutely nothing about upgradient

²⁰ Texas Water Development Board, I. Jones, “GAM RUN 16-026, MAG Version 2: Modeled Available Groundwater for the Aquifers in GMA7, Sept. 2018, at pp. 4 and 9; Hutchison/Eco Kai Environmental 2014 Hydrogeological Study, Supra at Table 12, p. 45

²¹ Texas Water Development Board “Overview of Groundwater Conditions in Val Verde County, Texas”, Dec. 2018, Supra at pp. 66

groundwater availability or potential pumping impacts upon any of the springs which actually contribute to the base flow of the Devils River. San Felipe Springs and the southeast portion of the County generally receive abundant groundwater flows from Edwards and Kinney Counties to the northeast and significant down pressure surface water infiltration and groundwater displacement from Amistad Reservoir's surface water storage.²² Neither the karst conduits transmitting Edwards and Kinney County groundwater flows into southeast Val Verde County nor Amistad Reservoir's forced surface water intrusions into the underlying aquifer influence Devils River springs above Pafford Crossing. Notably, the Water Development Board has documented Amistad Reservoir's "dominating" influence on San Felipe Springs as having sizably increased southeast County groundwater elevations and San Felipe Springs flows since the Reservoir began impounding water,²³ and the Hutchison/Eco Kai 2014 model itself estimated groundwater flows to the area emanating from Edwards and Kinney County in volumes in excess of 200k AF per year.²⁴

While the San Felipe Springs flow hydrologic trigger of 73-75 mgd, established by GMA7 from the Hutchison/Eco Kai 2014 groundwater availability model, may serve to protect San Felipe spring flows used by the City of Del Rio as its primary municipal water supply, such DFC spring flow trigger has no relevance to and offers no protection for Devils River or Pecos River spring flows. Indeed, the Water Development Board has expressly stated that the DFC for Val Verde County does not reflect groundwater conditions in the Devils River or Pecos River drainage basins:

²² Texas Water Development Board "Overview of Groundwater Conditions in Val Verde County, Texas", Dec. 2018, Supra at pp. 52, 73-74, and Figures 4-18, 5-3 and 5-4

²³ Id at p. 52; See also, W.R. Hutchison/Eco Kai 2014 Hydrogeological Study, Supra at p.50

²⁴ Hutchison/Eco Kai Environmental 2014 Hydrogeological Study, Supra at Table 12, p. 45

Because the currently adopted desired future condition focuses on San Felipe Springs, it may not adequately address all potential groundwater management concerns in Val Verde County. As noted previously in this report, San Felipe Springs discharge is strongly influenced by water levels in Amistad Reservoir, such that spring flow is a poor indicator of overall groundwater conditions in the county. In addition, the drainage basin contributing to flow from San Felipe Springs may represent only a small part of Val Verde County. Groundwater management decisions based solely on San Felipe Springs discharge will not reflect groundwater conditions in the Devils River or Pecos River drainage basins.²⁵

The draft Plan's recommended groundwater assessment and management for Val Verde County relies entirely upon the Hutchison/Eco Kai 2014 model for both availability and DFC hydrogeological trigger. That model, however, does "not reflect groundwater conditions in the Devils River or Pecos River drainage basins," and "is a poor indicator of overall groundwater conditions in the county."²⁶ The Plan should instead reflect the Water Development Board's resolute conclusion that no properly developed quantitative groundwater availability model currently exists for Val Verde County and no such model is available due to existing data deficiencies.

Devils River Spring Flows

The draft Plan additionally declares that its "intention to protect surface flows is directly related to those natural resources that are dependent on

²⁵ Texas Water Development Board "Overview of Groundwater Conditions in Val Verde County, Texas", Dec. 2018, Supra at p. 98

²⁶ Id.

surface water sources or spring flows for their existence,”²⁷ despite having neither conducted nor relied upon any riverine or other environmental assessment to actually determine or correlate such resources and the essential spring flows upon which they are dependent. Unlike the proposed Plan, the Texas Water Development Board has specifically addressed the frail relationship between Devils River listed species, their habitat and spring flows:

Streamflow requirements for these species are linked to spring discharges and therefore are tied to groundwater conditions. Aquatic habitats for these species depend upon groundwater inflows to maintain sufficient, good quality river flows, particularly during droughts and summer low-flows when surface runoff is minimal and water quality begins to deteriorate. Water quality can be compromised during low flow events if water temperatures rise and dissolved oxygen decreases, further impacting these rare aquatic organisms. *** The threat of worsening drought in concert with the potential for groundwater development could exacerbate the loss of species habitat, thereby increasing the rate of species decline and leading to critical groundwater problems in the future.²⁸

The proposed Plan unaccountably makes no effort to mention, much less address, such potential habitat loss, species decline or critical future groundwater problems or how the Plan’s stated “intention” to protect the spring flows upon which the Region’s riverine habitat resources depend is to be carried out. As such, the Plan’s declared “intention” is, unfortunately, wholly unsupported and self-serving and should be retracted or revised to provide appropriate documentation to support such assertion.

²⁷ Plateau Region Initially Prepared Water Plan, Supra, at p. 6-4

²⁸ Texas Water Development Board “Overview of Groundwater Conditions in Val Verde County, Texas”, Dec. 2018, Supra at p. 11

More significantly, the proposed Plan's declared intent to protect habitat spring flows is expressly belied by its own invented characterization of Devils River flows as "generally low and undependable" as well as its unsubstantiated assumption that "zero" flows dominate during a drought-of-record:

In absence of data for the 1950s-drought period, and considering the generally low and undependable flows within the Devils River, a realistic estimate of the drought-of-record amount of supply from the Devils River within the Plateau Region is zero.²⁹

Such unfounded assertions equate to an "intermittent" stream status declaration for the Devils River and could be foreseeably used to garner regulatory support for aquifer drawdowns during periods of drought or low precipitation, thereby resulting in a self-fulfilling prophecy of truly zero spring flows. Indeed, such assertions manifest the Water Development Board's worst critical habitat fears for an unsustainable habitat condition. Yet, such assertions are not only wholly without foundation, they are expressly contrary to the drought-of-record history of the River as reported by long time Devils River area ranchers having personal knowledge and recollection of such drought-of-record conditions.³⁰ Quizzically, however, such area landowners were never consulted in the preparation of the proposed Plan. The draft Plan's assertions are likewise not supported by the Texas Water Development Board's own studies of the River's "continuous perennial" nature

²⁹ Plateau Region Initially Prepared Plan, *Supra*, at p. 3-23.

³⁰ The author personally consulted with a number of such long time area ranchers, each of whom confirmed such draft Plan assertions to be factually erroneous.

downstream of where the River's spring-fed base flow begins at Pecan Springs.³¹

Wholly unsustainable habitat conditions in the Devils River during future periods of drought or low precipitation could potentially result from a regulatory adoption of the draft Plan's unsubstantiated "generally low and undependable" characterization and "zero" drought flow assumption for the River. Such result would be greatly catastrophic to one of the State's natural resource gems. The draft Plan's unsupported and greatly disputed contentions of "low" "undependable" and drought derived "zero" Devils River spring flows are unacceptable and factually incorrect and should be rejected and retracted in their entirety.

II

GROUNDWATER CONSERVATION DISTRICT CREATION

The creation of a groundwater conservation/management district for Val Verde County has been the topic of considerable debate since the passage of Texas Water Code Chapter 36's enabling legislation.³² A groundwater conservation district creation for Val Verde County has been repeatedly presented and rejected at the Texas Legislature over the last several legislative sessions. What such a district would cost and how it would protect either private property rights or potentially at risk water resources has beguiled stakeholders ever since such questions first arose. The lack of consensus among geohydrology professionals as to Val Verde County's aquifer recharge, conductivity and storage properties, complicated by an inadequate level of recorded water data details has

³¹ Texas Water Development Board "Overview of Groundwater Conditions in Val Verde County, Texas", Dec. 2018, Supra at pp. 43-51, and see Figures 6-2 and 6-7 at pp. 79 and 86

been and continues to be a serious obstacle to any appropriate groundwater management effort.³³ The costs and legal consequence uncertainties posed by such a proposed creation additionally confound the proposition.

While the Region's proposed 2021 Plan advocates for such creation,³⁴ it is notably silent about any reasoned basis for such recommendation. Indeed, no aspect of such proposed district's governance, costs, funding, permit standards, underlying policies or resulting legal or environmental consequences is addressed by the draft Plan's recommendation. In order to embrace the Plan's proposed recommendation that a groundwater conservation district for the entire County be created, however, we must first understand why such recommendation may be perceived necessary. Such understanding should be accompanied by a realistic assessment of the likely consequences associated with such creation. It is beyond the scope of these brief comments to argue definitively in favor of or in opposition to the ultimate creation of a conservation/management district for Val Verde County. It must nonetheless be noted that, at least at this time, the creation of a groundwater conservation district is premature as neither the modeling nor aquifer defining characteristics upon which such modeling would depend are currently available, and, at present, there is no viable threat of groundwater depletion from out-of-county exportation. Indeed, the required time and expense necessary to accurately conduct a properly validated assessment of groundwater availability for Val Verde County under Texas Water Development Board standards would be significant. Even so, none of the foundational features of a district creation decision, such as cost, governance structure or policies, or legal and environmental consequences of district management and permitting decisions are presented in the proposed

³⁰ Creation of water district remains a controversial topic, Del Rio News Herald, Ruben Cantu, Mar. 8, 2020

³³ Texas Water Development Board, "Overview of Groundwater Conditions in Val Verde County," Texas, Supra

³⁴ Plateau Region Initially Prepared Water Plan, March, 2020, p. 8-4

Plan. Such features must be accountably addressed in order to provide context to any responsible recommendation that a groundwater conservation district be created.

I do not believe that anyone legitimately fears that either our property rights or water resources in Val Verde County are threatened by future water uses within the County. However, the same cannot be said for potential water exportation projects serving municipal type uses beyond our County's boundaries. If properly presented by a reasonably prepared permit application, a groundwater conservation district has little discretion but to grant a groundwater development and use permit for export for out-of-county uses. Texas Water Code §36.122 (g) provides:

The district may not deny a permit based on the fact that the applicant seeks to transfer groundwater outside of the district.
³⁵

Additionally, to avoid a takings claim and contentious, expensive, litigation, the permit granted for such export must provide for a time period sufficient to allow recovery of all transmission and facility development costs. If construction has already commenced on the transmission conduit, the minimum time period for the permit is thirty years.³⁶

Numerous proposals have been considered to export Val Verde County groundwater for municipal type purposes.³⁷ None of such proposals are

³⁵ Texas Water Code §36.122 (g)

³⁶ Id., at §36.122 (h and i)

³⁷ See, cf., Eco Kai Environmental and W.R. Hutchison, Final Draft Report, Val Verde County/City of Del Rio Hydrogeological Study, May 2014, p. 46; Joe Hyde, San Angelo Live, Sept. 22, 2013, "A Water Pipe to San Angelo will make Del Rio Howl"; San Antonio Express News,

currently active, however, and nearly all the major potential buyers -- the cities of San Antonio, San Angelo, Abilene and Midland -- have now secured large, long term water supply contractual commitments to meet their foreseeable needs.³⁸ Nonetheless, it should be recognized that in order to make any such trans-regional Val Verde County water transmission project financially feasible, the volume of water to be delivered would need to be substantial, as would the financing necessary to such a project. Such funding and financing of a trans-region scale water project requires a level of certainty and security which, in part, only the creation of a regulatory and tax empowered governmental entity, such as a groundwater conservation district, can offer. Without the certainty afforded by a groundwater conservation district permit stipulating availability, volume and duration, it is questionable whether any such trans-region transmission project could secure adequate funding as both equity investment and bond markets are historically and inherently risk averse, requiring a reasonable degree of success assurance to advance.

In short, the creation of a conservation district may, in fact, be an indispensable *sin qua non* to the financial viability of any potential regional groundwater export project. If true, such recognition creates the ironic paradox that, in order to protect our groundwater resources from depletion due to large scale out-of-county export, we must create a groundwater conservation district permitting authority to assure availability for such project, and then authorize and oversee such export,

Nolan Hicks, Jan. 12, 2014, "Opposition Grows to Val Verde Water Plan

³⁸ San Antonio Express-News, "Like it or not, Vista Ridge pipeline now delivering water to San Antonio", Scott Huddleston, May 11, 2020; Hill Country Alliance, "SAWS Vista Ridge Pipeline Project"; Go San Angelo, "San Angelo negotiates 50-year contract to buy 1.5 billion more gallons of water per year", John Tufts, San Angelo Standard Times, May 12, 2020

when such export would not even have been financially feasible in absence of such conservation district's creation.

It should be also recognized that a groundwater conservation district is statutorily obligated to issue permits for reasonable uses of water determined to be available in nearly all instances:

A district, to the extent possible, shall issue permits up to the point that the total volume of exempt and permitted groundwater production will achieve an applicable desired future condition under Section 36.108.)³⁹

As previously noted, currently available Val Verde County groundwater models and water data details are inadequate to determine the point at which total groundwater production will achieve any declared DFC. In light of such inadequacies, a district attempting to balance the exercise of private property rights with public resource conservation goals currently would face the extreme likelihood of liability for “regulatory taking” claims and compensation for property rights taken in whole or in part as the result of licensing or other regulatory processes.⁴⁰ Indeed, in the *Bragg* case, such a “takings” judgment was issued against the Edwards Aquifer Authority for over \$4.5 million.⁴¹ Unfortunately, in these litigious times, groundwater conservation districts, can be easy targets for takings claims, particularly when, as will most often be the case, the interests of property owners wishing to maximize their business

³⁹ Texas Water Code §36.1132(a)

⁴⁰ *Edwards Aquifer Authority vs. Day*, 369 S.W.3d 814(Tex. 2012); *Edwards Aquifer Authority v. Bragg*, 421 S.W.3d 118, 126–131 (Tex. App.—San Antonio 2013, pet. Denied; See also, *Stratta vs. Brazos Valley Groundwater Conservation District*, No. 18-50994, U.S Court of Appeals, 5th Cir., May 29, 2020

⁴¹ *Stratta vs. Brazos Valley Groundwater Conservation District*, Supra at p. 14)

opportunities collide with the public goal of resource conservation.⁴² On the other hand, it is also entirely possible that a district, mindful of its potential liability to pay takings judgment awards with taxpayer funds, would shy away from litigation and simply capitulate to the drawdown demands of well-represented applicants.

In order for a Val Verde County groundwater conservation district to comply with Water Code §36.1131(a) and accurately and reliably ascertain “the point that the total volume of exempt and permitted groundwater production will achieve an applicable desired future condition”, such district will have to perform a “quantitative evaluation of the effects of potential future pumping on recharge, streamflow, and groundwater-surface water interaction (requiring) an appropriately scaled, calibrated, and validated numerical model of coupled groundwater and surface water processes” as plainly set out the Water Development Board’s Overview of Groundwater Conditions in Val Verde County.⁴³ Significantly, the same Texas Water Development Board that instructs us as what such a reliable quantitative groundwater evaluation must consist of also advises us that “such a model is not currently available and key inputs needed to develop one are not well constrained.”⁴⁴

The bottom line here is simply that, at least with respect to that portion of the Edwards aquifer underlying the Devils River watershed and the focus of these comments, (1) there is no consensus among hydrogeological professionals as to critical aquifer properties or spring flow parameters, (2) a properly scaled, calibrated and validated numerical model of such parameters does not exist, and (3) such model is not presently available since currently existing data is inadequate to

⁴² See, e.g. *Statta vs Brazos Valley Groundwater Conservation District*, Supra)

⁴³ Texas Water Development Board “Overview of Groundwater Conditions in Val Verde County, Texas”, Dec. 2018, Supra at p. 56.

⁴⁴ Id.

such purpose. The creation of a groundwater conservation district in such a vacuum of aquifer defining quantitative data and lack of reliable, validated modeling assessments would be sheer folly where permit approvals or denials can be legitimately challenged based upon the quality of evidence presented or lack thereof.⁴⁵ The lack of available data to support a district's regulatory decisions will not qualify as a rational or evidentiary defense of such decisions, but that lack of evidence could readily support claims that such decisions are arbitrary or capricious.

It goes without saying that litigation can be quite costly to landowner parties, as well as to the district and its taxpayers, but win or lose it will be a long-term field day for lawyers and their consulting witnesses. A judicial takings award constitutes a judgment for debt. As statutorily provided in Texas Water Code 36.066(b):

Any court in the state rendering judgment for debt against a district may order the board to levy, assess, and collect taxes or assessments to pay the judgment.⁴⁶

Indeed, that is exactly what the Court in *Bragg* ordered against the largest and best funded conservation district in the State – the Edwards Aquifer Authority.⁴⁷

⁴⁵ See, e.g., the long standing central Texas disputes over the Carrizo-Wilcox Simsboro formation over groundwater availability, whose aquifer properties are much more clearly defined than the Edwards-Trinity Aquifer in Val Verde County: Austin American Statesman, “LCRA declines to reveal science behind Bastrop County groundwater case,” Christopher De Los Santos, Dec. 28, 2018); Reporting Texas, “Bastrop Water Conflict Turns on Competing Assessments of Aquifer Volume,” Christopher De Los Santos, Dec. 17, 2018; Corridor News, “Judge Rules for Local Landowners in Groundwater Export Dispute,” Jan. 5, 2018).

⁴⁶ Texas Water Code §36.066(b)

The recommendations of the Plateau Group should not invite litigation. However, the proposed recommendation that a groundwater conservation district be created in the near or foreseeable future, in the absence of coherent and well supported quantitative assessments of groundwater availability, will likely do just that.

While aquifer tests could be designed and conducted on wells constructed to provide the much needed numerical inputs required for an accurate quantitative assessment of groundwater availability, such a district endeavor would take considerable time and extensive funds which the proposed Plan neither identifies nor allocates as part of its Water Management Strategies and Conservation Recommendations. If the Plan is to seriously recommend the creation of a groundwater conservation district for Val Verde County, it should tabulate all foreseeable costs and include them in the Plan's Recommended Strategies. It should be recognized, however, that even once such additional data collection and availability assessments are conducted, there may be no assurance that such efforts will be sufficient to generate the substantive quantitative groundwater assessment described by the Water Development Board and invariably necessary to minimize the threat of litigation over the district's management and permitting processes.⁴⁸

Under the totality of circumstances here presented, since neither a quantitative availability assessment of groundwater underlying the Pecos and Devils River Watersheds nor a Desired Future Condition for such areas has been, and presently cannot be, accurately or reliably determined, and no imminent threat of Val Verde County aquifer

⁴⁷ *Edwards Aquifer Authority v. Bragg*, Supra

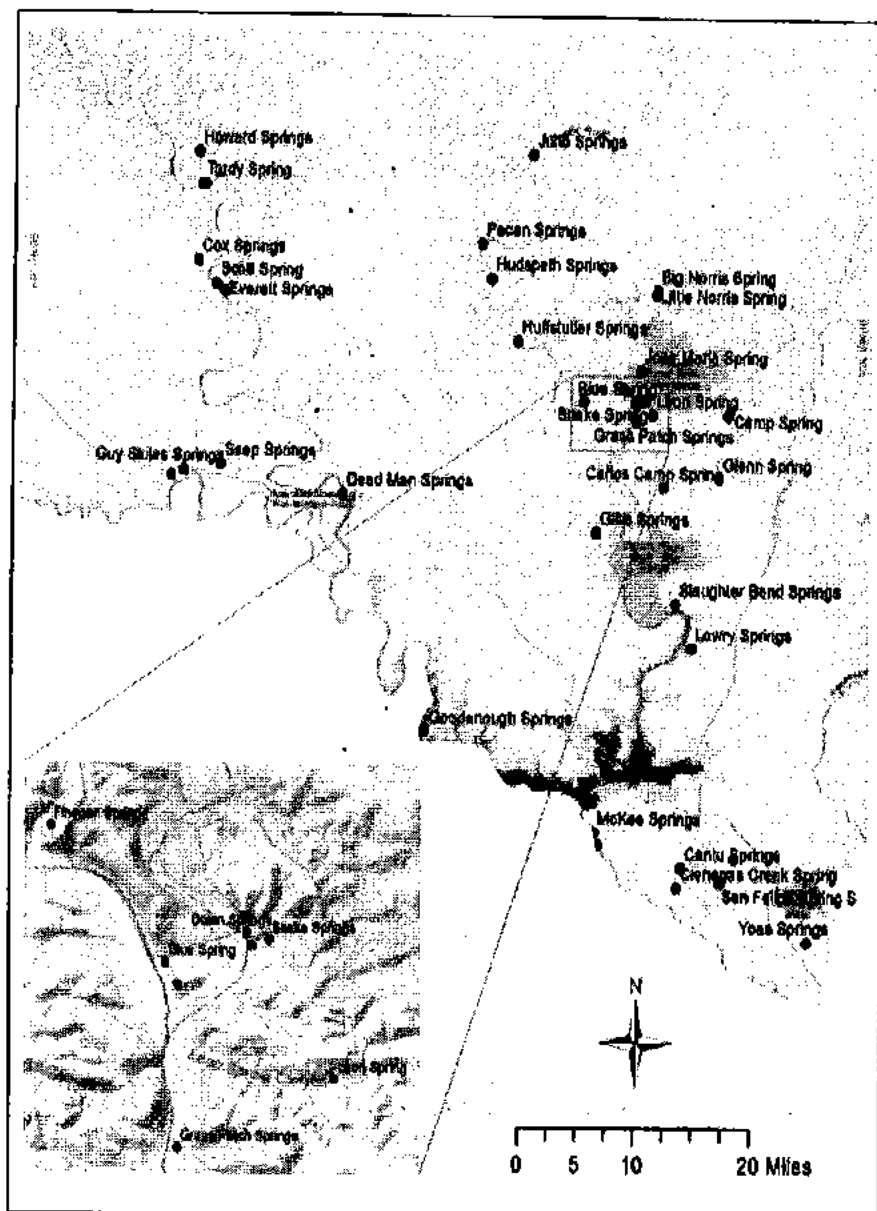
⁴⁸ Texas Water Development Board "Overview of Groundwater Conditions in Val Verde County, Texas", Dec. 2018, Supra at p 56

drawdowns from out-of-county groundwater export projects is currently presented, the facts simply do not support the creation of a groundwater conservation district for Val Verde County at this time. The proposed Plan should be modified to expressly state that the Plateau Group makes no recommendation as to the creation of a groundwater conservation district for Val Verde County.

AFTERTHOUGHTS

I stated at the outset that I am passionate about protecting the Devils River, its springs and its habitat. I am also a realist, so while I am hopeful that these comments will prompt further examination and reformation of the currently proposed Plan as relevant to Val Verde County and the Devils River, as a practical matter, that may be unduly optimistic. Although Val Verde County, as reported by the draft Plan's demographics, maintains the largest population in the Region, represents the majority of the Region's municipal water use, is reported to have the highest volume of retrievable groundwater in the Region and has the greatest socio-economic risk associated with potential fresh water shortages, the County has been relegated to only 3 voting directors (15%) on the 20 member Region J Board. Likewise, because Groundwater Management Areas are comprised of and governed solely by groundwater conservation districts, Val Verde County has no seat at the table for water availability and DFC determinations of Groundwater Management Area 7 simply because it has, to date, not elected to undertake the costs or uncertainties commensurate with the creation of a groundwater conservation district within its boundaries. Hence, given that Val Verde County has very limited voice or influence in the decisions of the Plateau Group or GMA7, I can only hopefully ask that your adoption of a 2021 Water Plan for Region J be driven by the power of persuasion and documentary support presented in these comments, not the power of politics in the Plateau Group's representative make-up or that of GMA7. I urge that your acceptance of the proposed Plan, as it relates to the Devils River and its underlying aquifer, be conditioned

upon reformation of the proposed Plan consistent with the comments and proposals here presented.



RESPONSES TO PUBLIC COMMENTS

The Plateau Water Planning Group appreciates the well-written comment / position paper presented by Mr. Skip Newsom and, in response, the PWPG has eliminated their recommendation pertaining to the creation of a Val Verde Groundwater Conservation District (Chapter 8). The Group has also added the following language to the recommendation pertaining to water research needs for the Edwards-Trinity (Plateau) Aquifer:

Specific concern has been voiced by citizens in Val Verde County where the groundwater source availability of the Edwards-Trinity (Plateau) Aquifer changed from 25,000 acre-feet per year in the 2016 Plateau Region Water Plan to 50,000 acre-feet per year in this current Plan. TWDB modelers are particularly critical of the ability of any existing groundwater model to accurately assess Val Verde County groundwater availability as aquifer properties are poorly defined in most of Val Verde County because there are few data on aquifer responses to pumping stresses. In particular, a better understanding is needed of the different geohydrologic environments that exist between the southern San Felipe Springs – Amistad Reservoir area verses the upstream Pecos and Devil's River area.

This page intentionally left blank

APPENDIX 10B

RESPONSE TO TWDB COMMENTS

This page intentionally left blank

TWDB comments on the Initially Prepared 2021 Plateau (Region J) Regional Water Plan.

Level 1: Comments, questions, and data revisions that must be satisfactorily addressed in order to meet statutory, agency rule, and/or contract requirements.

1. Chapter 5 and the State Water Planning Database (DB22). The plan includes the following recommended water management strategies (WMS) by WMS type, providing supply in 2020 (not including demand management): 24 *groundwater wells & other*, one *other direct reuse*, three *aquifer storage and recovery*, and three *other surface water*. **Strategy supply with an online decade of 2020 must be constructed and delivering water by January 5, 2023.**
 - a) Please confirm that all strategies shown as providing supply in 2020 are expected to be providing water supply by January 5, 2023. [31 § TAC 357.10(21); Contract Exhibit C, Section 5.2]
 - b) Please provide the specific basis on which the planning group anticipates that it is feasible that the three *aquifer storage and recovery*, and three *other surface water* WMSs will all actually be online and providing water supply by January 5, 2023. For example, provide information on actions taken by sponsors and anticipated future project milestones that demonstrate sufficient progress toward implementation. [31 § TAC 357.10(21); Contract Exhibit C, Section 5.2]
 - c) In the event that the resulting adjustment of the timing of WMSs in the plan results in an increase in near-term unmet water needs, please update the related portions of the plan and DB22 accordingly, and also indicate whether ‘demand management’ will be the WMS used in the event of drought to address such water supply shortfalls or if the plan will show these as simply ‘unmet’. If municipal shortages are left ‘unmet’ and without a ‘demand management’ strategy to meet the shortage, please also ensure that adequate justification is included in accordance with 31 TAC § 357.50(j). [TWC § 16.051(a); 31 § TAC 357.50(j); [31 TAC § 357.34(i)(2); Contract Exhibit C, Section 5.2]
 - d) **Please be advised that, in accordance with Senate Bill 1511, 85th Texas Legislature, the planning group will be expected to rely on its next planning cycle budget to amend its 2021 Regional Water Plan during development of the 2026 Regional Water Plan, if recommended WMSs or projects become infeasible, for example, do to timing of projects coming online.** Infeasible WMSs include those WMSs where proposed sponsors have not taken an affirmative vote or other action to make expenditures necessary to construct or file applications for permits required in connection with implementation of the WMS on a schedule in order for the WMS to be completed by the time the WMS is needed to address drought in the plan. [Texas Water Code § 16.053(h)(10); 31 TAC § 357.12(b)]

2. ES Appendix. The plan includes some DB22 reports that appear blank due to the region not having relevant data for these reports. Please provide a cover page to the DB22 report appendix indicating the reason for these report contents being blank.
3. Chapter 1. Please include a discussion of the current preparation for drought within the planning area in Chapter 1 of the final, adopted regional water plan. *[31 TAC § 357.30(10)]*
4. Chapter 3, page 3-7 and ES Appendix. The total existing water supplies presented in Table 3-2 appear to be inconsistent with existing supplies reported in DB22. For example, Table 3-2 shows a total of 62,846 acre-ft/year from 2020 to 2060 and 62,845 for 2070. DB22 reports the total existing supply as 61,578 acre-ft/year from 2020 to 2070. Please reconcile this information as necessary in the final, adopted regional water plan. *[31 TAC § 357.32(e)]*
5. Chapter 3, page 3-8, Table 3-3. Please revise the Table 3-3 header and column header from 'Wholesale Water Provider' to 'Major Water Provider' in the final, adopted regional water plan. *[31 TAC § 357.32(g)]*
6. Section 3.1.1, Table 3-4, page 3-11. Please update Table 3-4 to include Guadalupe Basin, Real County for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers. *[Contract Exhibit C, Section 3.5.2]*
7. Section 3.4, page 3-30. It is not clear what methodology was used to calculate direct reuse supplies discussed in Section 3.4. Please provide a more detailed explanation of the methodology used to calculate reuse supplies, including as relates to existing treatment capacity, in the final, adopted regional water plan. *[Contract Exhibit C, Section 3.4]*
8. Chapter 3. Please include a summary of the Water Availability Models (WAM) used, including any modification to the models approved by the TWDB's Executive Administrative in the final, adopted regional water plan. The summary of WAM models used should include information on WAM version/date, WRAP version used for simulation, and the date of the simulation. *[Contract Exhibit C, Section 3.2.1]*
9. Chapter 4, page 4-4, Table 4-2. Please revise the Table 4-2 header and column header from 'Wholesale Water Provider' to 'Major Water Provider' in the final, adopted regional water plan. *[31 TAC § 357.33(b)]*
10. Page 4-5. The plan includes blank spaces for Table 4.3 (Second -Tier Identified Water Needs) and Table 4.4 (WUG Unmet Needs). Please either include this information or refer the reader to the applicable DB22 reports in the final, adopted regional water plan. Additionally, unmet needs should be presented in Chapter 6. *[31 TAC § 357.33(e); 31 TAC § 357.40(c)]*
11. Chapter 4. The plan does not appear to include a secondary needs analysis for major water providers (MWP). If the region does not include a separate table for Del Rio, please indicate where the reader can find the secondary needs for Del Rio (the

region's MWP), in the DB22 reports in the final, adopted regional water plan. [31 TAC § 357.33(e)]

12. Section 5.2.5, page 5-10. Del Rio is identified as having significant water needs; however, the plan does not appear to provide a specific assessment of aquifer storage and recovery (ASR) for the identified needs for Del Rio. Please present information on the assessment of ASR for Del Rio in the final, adopted regional water plan. [TWC § 16.053(e)(10); 31 TAC § 357.34(h)]
13. Table 5-2 and Appendix 5A. Vegetative Management is presented in the plan as a recommended WMS with a zero supply yield in all decades in Table 5-2 and is included as the strategy evaluations J-13, J-29; J-44, J-70, J-71, J-78, J-87. Please remove Vegetative Management from the list of recommended WMSs, and present information on Vegetative Management in a separate section in the final, adopted regional water plan. [31 TAC § 357.34(d)]
14. Page 5A-3. The strategy evaluation for J-1 appears to describe a reuse WMS used for irrigation at a resort. These projects are not appropriate for inclusion in the regional water plans per Contract Exhibit C, Section 5.5.3. Reuse WMSs may not include distribution lines directly to residences or commercial businesses. Please ensure projects not required to increase the volume of water supply are omitted from the final, adopted regional water plan. [Contract Exhibit C, Section 5.5.3]
15. Pages 5A-4, 5A-16, and 5A-42. The evaluation for strategy J-28 states that in a severe drought, alluvial aquifers are the first to go dry and the evaluation for strategy J-75 states that reliability of supply is low to medium based on water quantity issues. Additionally, the evaluation for J-2 indicates a seasonal supply based on rainfall. Please remove these strategies from the final, adopted regional water plan since the IPP indicates that the strategy supplies presented in for strategy J-2, J-28, and J-75 will not be available as firm supplies under drought of record conditions. In the event that the resulting adjustment of the timing of WMSs in the plan results in an increase in near-term unmet water needs, please update the related portions of the plan and DB22 accordingly. [31 TAC § 357.34(b)]
16. Page 5A-26, Strategy J45, project 1. The plan does not appear to present separately the reservoir associated land costs. Please include separated reservoir-associated land costs or indicate land costs are not applicable to this strategy in the final, adopted regional water plan. [Contract Exhibit C, Section 5.5]
17. Page 5A-26, Strategy J-45, project 2. The plan indicates that the Kerr County Commissioners Court would negotiate diversion rights up to 6,000 acre-feet/year of water. Please clarify whether the region coordinated with Region L on the yield for this WMS, as the 2021 Region L IPP indicated a potential commitment of 2,000 acre-feet/year from Canyon Reservoir. After confirmation or coordination with Region L/GBRA, please adjust the anticipated yield, if necessary, in the final, adopted regional water plan to reflect the expected supply volume. In the event that the resulting adjustment of the timing of WMSs in the plan results in an increase in

near-term unmet water needs, please update the related portions of the plan and DB22 accordingly. [31 TAC § 357.35(f)]

18. Page 5A-46. It is not clear from the evaluation for J-83 what reuse project components are included for this WMS. Please ensure that reuse WMSs do not include distribution lines directly to residences or commercial businesses and ensure projects not required to increase the volume of water supply are omitted from the final, adopted regional water plan. [Contract Exhibit C, Section 5.5.3]
19. Chapter 5B. The plan includes *brush control* and *rainwater harvesting* recommendations in the *conservation* recommendation subchapter. For planning purposes, these strategy types may not be considered demand reduction and must be presented separately from conservation, in addition, they are reported separately in DB22. Please remove the Vegetative Management and Rainwater Harvesting recommendations from the conservation subchapter in the final, adopted regional water plan. [31 TAC § 357.34(h); Contract Exhibit C, Section 5.10]
20. Chapter 5 and DB22. From the information presented in the plan, it is not clear that all required capital cost components were evaluated for each strategy. For example, capital costs should consider the following as applicable: construction costs, engineering and feasibility studies, legal assistance, financing, bond counsel and contingencies, permitting and mitigation, land purchase not associated with mitigation, easement costs, and purchases of water rights. Please clarify the cost elements considered in strategy evaluations in the final, adopted regional water plan. [Contract Exhibit C, Section 5.5]
21. Units costs reported in DB22 appear notably high for the City of Brackettville - Increase Supply to Spofford with New Water Line and Storage and the Val Verde County Other - Val Verde County WCID - Water Loss Audit and Main-Line Repair WMSs. For example, unit costs are reported as \$153,214 per acre-foot in 2020 and 2030 for the City of Brackettville - Increase Supply to Spofford with New Water Line and Storage WMS, and unit costs are reported as \$41,026 in 2020 and 2030 for the Val Verde County Other - Val Verde County WCID - Water Loss Audit and Main-Line Repair WMS. Please confirm that the calculated unit costs are correct in DB22 and that costs were considered in WMS recommendations in the final, adopted regional water plan. [31 TAC § 357.34(e)(2)]
22. Appendix 5A. The plan in several instances, for example, evaluations J-30, J-32, J-34, J-64, J-88, presents mining conservation strategies with zero costs and yet notes an assumption that there are strategy costs that are assumed to be paid back within a year. Please report the initial one-time costs for these strategies against which cost savings are based in the final, adopted regional water plan. [31 TAC § 357.34(e)(3)(A); Contract Exhibit C, Section 5.5]
23. Appendix 5A. The plan does not clearly state if or how TCEQ adopted environmental flow standards were taken into account in calculation of yield for the following WMSs: Acquire Surface Water Supply (J-5) and Eastern Kerr County Regional Water

Supply Project (J-45, Project 1). The evaluation for J-5 states that 7Q2 was used, however the Chapter 298 environmental flow standards for the San Antonio Basin should be used. If the diversion associated with J-45, Project 1 isn't already permitted, Chapter 298 environmental flow standards should be used. Please clarify the application of environmental flow standards for these WMSs and reevaluate the WMSs using the required environmental standards if they were not applied in the final, adopted regional water plan. *[31 TAC § 357.34(e)(3)(B); 31 TAC § 358.3(22); 31 TAC § 358.3(23)]*

24. Chapter 5. The plan does not include the WMS project costing tool's output report for projects or analogously present the capital cost for each project component. Please submit the costing tool's standardized cost output report or present capital cost estimates for each project component for each WMS evaluated in the final, adopted regional water plan. *[31 TAC § 357.34(f); 31 TAC § 358.3(21); Contract Exhibit C, Section 5.5.1; Contract Exhibit C, Section 5.7]*
25. Chapter 5. The plan presents the documented process for identifying potentially feasible WMSs but does not appear to include the process of selecting recommended WMSs and projects. Please include documentation of the process of selecting recommended WMSs and projects in the final, adopted regional water plan. *[Contract Scope of Work, Task 5A subtask 5]*
26. Chapter 5. Please include documentation of why seawater desalination was not selected as a recommended WMS in the final, adopted regional water plan. *[TWC § 16.053(e)(5)(j); Contract Exhibit C, Section 5.2; 31 TAC § 357.34(g)]*
27. Chapter 5. It is not clear if third-party social and economic impacts resulting from voluntary redistributions of water, including impacts of moving water from rural and agricultural areas, were considered in the evaluation of potentially feasible WMSs. Please clarify how these impacts were considered (or clarify if there are no impacts) in the final, adopted regional water plan. *[31 TAC § 357.34(e)(7)]*
28. Chapter 6. The plan does not appear to include a description of third-party social and economic impacts resulting from voluntary redistributions of water, including analysis of third-party impacts of moving water from rural and agricultural areas. Please include this information (or clarify if there are no impacts) in the final, adopted regional water plan. *[31 TAC § 357.40(b)(4)]*
29. Chapter 6. Please include a description of major impacts of recommended WMSs on key parameters of water quality in Chapter 6 of the final, adopted regional water plan. *[31 TAC § 357.40(b)(5)]*
30. Chapter 6. The plan states that there are no identified unmet water needs in Chapter 5 (page 5-11), however data reported in DB22 shows unmet water needs for the following WUGs: Laughlin Air Force Base, County-other sub-WUGs: Bandera River Ranch 1, Lake Medina Shores, Center Point, Center Point Taylor System, Val Verde County-Other, and Livestock Kerr County, and Livestock Kinney County. Please reconcile this information and provide documentation that all potentially feasible

WMSs were considered to meet identified needs. Additionally, please include a summary of unmet water needs in Chapter 6 and provide an adequate justification of unmet needs for municipal WUGs as specified in rule and contract guidance, in the final, adopted regional water plan. [31 TAC § 357.40(c); 31 TAC § 357.50(j); *Contract Exhibit C, Section 6.3*]

31. Section 7.4, page 7-19. Please confirm whether the entities evaluated for emergency responses to local drought conditions or loss of municipal supply were assumed to have 180 days or less of remaining supply. [*Contract Exhibit C, Section 7.4*]
32. Section 7.5.3. Table 7-8 appears to include recommended drought triggers and actions; however, the table is blank for all columns associated with triggers. Please include specific drought response triggers in Table 7-8 in the final, adopted regional water plan. [31 TAC § 357.42(c)(1)]
33. Section 7.5.4, page 7-32. The plan does not appear to include copies of the model drought contingency plans as referenced in Attachment 7-1. Please include the model plans (two plans minimum) in the final, adopted regional water plan. [31 TAC § 357.42(j)]
34. Chapter 7. Model drought contingency plans were not provided for review. Please ensure that model drought contingency plans submitted with the final, adopted regional water plan at a minimum have triggers and responses to 'severe' and 'critical/emergency' drought conditions. [*Contract Exhibit C, Section 7.6*]
35. Page 7-33. Section 7.6 states that "The PWPG does not consider drought management as a feasible strategy to meet long-term growth in demands or current needs." However, Drought Management is presented as a recommended WMS for Bandera County-Other in Table 5-2 and as reported in DB22. Please reconcile this information as appropriate, including references the associated triggers to initiate each of the recommended drought management strategies, if any, throughout the final, adopted regional water plan. [31 TAC § 357.42(f)(2)]
36. Chapter 7. The plan does not appear to include a discussion of whether drought contingency measures have been recently implemented (for example, since the adoption of the last regional water plan) in response to drought conditions. Please include this information in the final, adopted regional water plan. [*Contract Scope of Work, Task 7, subtask 3*]
37. Chapter 10. The plan notes that all meetings were held in accordance with the Texas Open Meetings Act but does not discuss compliance with the Texas Public Information Act. Please address how the planning group complied with the Texas Public Information Act in the final, adopted regional water plan. [31 TAC § 357.21; 31 TAC § 357.50(f)]
38. Chapter 11, Table 11-1. The plan did not include implementation survey data collected to date. Please ensure that the template and data used for the implementation survey in the final, adopted regional water plan are based on the

survey template and data that the TWDB provided in June 2019. [31 TAC § 357.45(a)]

39. Chapter 11, Table 11-9. Please remove the Vegetative Management zero yield WMSs from Table 11-9. Additionally, please provide a brief summary of how the 2016 Plan differs from the 2021 Plan with regards to recommended and alternative WMS projects in the final, adopted regional water plan. [31 TAC § 357.45(b)(4)]

Level 2: Comments and suggestions for consideration that may improve the readability and overall understanding of the regional water plan.

1. Page ES-9 references tables ES-2 through ES-6, however these tables do not appear to be in the plan. Please consider updates these table references.
2. Page ES-12. Please correct spelling of "Agricultural" in bold heading text.
3. Chapter 3. Please consider adding table numbers to the tables on pages 3-12 and 3-16.
4. Section 3.1, page 3-9. The study Occurrence of Significant River Alluvium Aquifers in the Plateau Region, 2010 does not appear to be linked on the Plateau RWPG's webpage, as indicated on page 3-9. Please provide an active link to the webpage with the final plan.
5. Section 3.1.1, Table 3-4, page 3-11. For the groundwater availability methodology listed as "GMA9 Non-Relevant, TWDB modeled". Please consider clarifying which model runs were used and if this includes pumping from the associated modeled available groundwater run that was compatible with the DFC, which was provided to planning groups for consideration.
6. Page 3-11, Table 3-4. Please consider adding a source for the Austin Chalk Aquifer methodology presented.
7. Page 3-11, Table 3-4. Please consider revising the terminology of "hydraulic conductivity" to 'Annual availability' in reference to the Ellenburger/San Saba Aquifer.
8. Section 5.3.4, page 5-29. Please correct the first sentence that states, "Many of the recommended water management strategies listed in Error! Reference source not found.2 are...".
9. Section 5.3.5. Please consider including that all entities with 3,300 or more connections and/or a financial obligation with TWDB greater than \$500,000 are also required to submit WCPs.

10. Section 5.3.3, page 216. The reference to Report 362 is outdated. A current list of BMPs is available at <https://www.twdb.texas.gov/conservation/BMPs/index.asp>.
11. Page 5A-44. The plan states that the Oakmont Saddle Mountain WSC has applied to the TWDB for SWIFT funding for an additional well. To date, the TWDB has not received a SWIFT application from Oakmont Saddle Mountain WSC. Please reconcile this statement in the final plan.
12. Page 7-22. The plan states that this is the first cycle regional drought planning was required. Please consider updating this statement, as regional model drought contingency plans were required in the previous planning cycle.
13. The GIS files submitted for WMS projects do not adhere to the contractually required naming convention. Please rename the GIS files following the naming convention outlined in Exhibit D, Section 2.4.5 in the final GIS files submitted. *[Contract Exhibit D, Section 2.4.5]*
14. The GIS files submitted for WMS projects do not include all of the required attribute fields listed in Table 1 of Exhibit D, Section 2.4.5. Please include the following attribute fields in all submitted WMS project GIS data: Project ID, Sponsor, Name, Location Description, Project Components, and Datum, with the final GIS files submitted. *[Contract Exhibit D, Section 2.4.5]*

RESPONSE TO TWDB COMMENTS**LEVEL 1:**

1a. The following ten strategies listed in the IPP have been changed to a starting decade of 2030 (See response 1b below).

- City of Bandera – Reuse treated wastewater effluent for irrigation ---
- City of Bandera – Promote, design and install rainwater harvesting systems ---
- City of Bandera – Additional Lower Trinity well ---
- City of Bandera – Surface water acquisition, treatment and ASR
- City of Kerrville – Increase water treatment and ASR capacity
- EKCRWSP Project 1 – Construction of an Ellenburger Aquifer water supply well
- EKCRWSP Project 2 – Construction of off-channel surface water storage
- EKCRWSP Project 3 – Construction of an ASR facility
- EKCRWSP Project 4 – Construction of a wellfield and desalination plant
- City of Brackettville – Increased supply to Spofford with new water line and increased storage facility
- Fort Clark Springs MUD – Increased storage facility
- City of Leakey – Develop interconnection between city wells
- City of Del Rio – Water treatment plant expansion
- City of Del Rio – Develop a wastewater reuse program

1b. The remaining strategies listed as starting in the 2020 decade could feasibly be implemented by January 5, 2023.

- All conservation strategies can be implemented immediately at the discretion and need of the WUG.
- All water loss audit and main-line repairs can be implemented in a very short time at the discretion of the WUG.
- Groundwater well projects can feasibly be implemented within approximately one year at the discretion of the WUG.

1c. There are no increases in unmet needs resulting from changing the starting decade of implementation of the above strategies to 2030.

1d. The Plateau Region Water Planning Group acknowledges that they will be expected to rely on its next planning cycle budget for any required Plan amendments.

2. DB22 report appendix page now contains listing of TWDB provided tables and notations on tables with no relevant data.

3. Current preparation for drought in the region is discussed in Chapter 1, Section 1.2.5, final paragraph.

4. Tables 3-1, 3-2 and 3-3 in the Plan now match Ex Sum TWDB tables.

5. Table 3.2 headers are corrected to show “Major Water Provider”.

6. Guadalupe Basin is added in Table 3-4.

7. Reuse source supply methodology is provided in Chapter 3 Section 3.4.

8. River Basin WAM summary information is provided in Chapter 3 Section 3.2.
9. Table 4.2 headers are corrected to show “Major Water Provider”.
10. Tables 4-3 and 4-4 are eliminated and reference is made to the appropriate tables in the Executive Summary Database-22 Appendix.
11. The second-tier needs analysis for WUGs and MWPs is referenced to the appropriate TWDB DB22 table in the Executive Summary Appendix in the third paragraph of Ch 4 Sec 4. Text is revised to specifically explain that Del Rio Utilities Commission, the Region’s only Major water Provider, is listed in this table.
12. An ASR discussion is added to Chapter 5 Section 5.2.5.
13. Vegetative Management strategies have been eliminated from Chapter 5 Tables 5-2, 5-3, 5-4 and Appendix 5A; and is discussed as a recommended conservation practice in Chapter 5 Section 5-2-8.
14. Discussion pertaining to Flying L Resort is eliminated from Strategy J-1.
15. PWPG considers strategies J-2, J-28 and J-75 capable of producing firm yields during drought conditions and desires to retain all three strategies. Strategy discussions are altered to eliminate confusion and the “Reliability” factor index definition at the end of Table 5-2 is changed to read “2 = Provides firm supply, but may be partially impacted during drought conditions”. Strategy J-75 was incorrectly titled and is corrected to read “Drill Additional Well in the Lower Trinity Aquifer”.
16. Land purchase and survey cost is shown in Chapter 5 Appendix 5A Strategy J-45 Project 2a.
17. This strategy has been eliminated.
18. Strategy J-83 discussion is revised to describe the infrastructure component of the project as a 10-mile long major transmission pipeline. Reference to the TWDB funded project has been deleted.
19. Brush Control and Rainwater Harvesting are not intended as “recommendations”, but are presented in the conservation subchapter as “State Water Conservation Programs and Guides”. This material is presented solely for reader education and not intended as a water management strategy discussion. Rainwater Harvesting is removed from the list of conservation strategies in Ch 5 Sec 5.3.4.
20. A description of capital cost elements are included in Ch 5 Sec 5.2.1.
21. Unit costs in Strategy J-66 (Brackettville-Spoford) and J-84 (Val Verde County Other) have been verified and are in agreement with DB22.
22. Strategies J-30, J-32, J-34, J-64 and J-88 have been eliminated and a discussion pertaining to mining conservation has been added in Chapter 5 Section 5.2.2.
23. Strategies J-5 and J-45 Project 2a have been revised to include environmental flow standards.
24. The costing tool’s output report is provided for all required projects and capital costs are presented for all project strategies in Chapter 5 Tables 5-2 and 5-3.

25. An explanation of the process of selecting recommended strategies is added in the first paragraph of Chapter 5 Section 5.2.4.
26. The reasoning for not including seawater desalination is included in the second paragraph of Chapter 5 Section 5.2.4.
27. Third-party social and economic impacts of moving water from rural and agricultural areas is addressed in the third paragraph of Chapter 5 Section 5.2.4.
28. Third-party social and economic impacts of moving water from rural and agricultural areas is addressed in the first paragraph of Chapter 6 Section 6.
29. Chapter 1 Section 1.4.5 describes water quality issues relevant to the Plateau Region. Major impacts of recommended water management strategies on key parameters of water quality are discussed in the fifth paragraph of Chapter 6 Section 6.1.
30. Chapter 6 Section 6.4 is added to discuss unmet water needs that match the final DB22 report. Center Point and Center Point Taylor were corrected in the database to not show as having unmet needs. A new strategy was generated for Laughlin AFB to take care of their needs.
31. Entities evaluated for emergency response with 180 days or less of remaining supply is stated in the second paragraph of Chapter 7 Section 7.4.
32. Chapter 7 Table 7-8 is revised to include drought triggers and actions. No new triggers and actions were generated, so table shows that recommendations are to follow existing triggers and actions noted in Table 7-1.
33. Model drought contingency plans are discussed in Chapter 7 Section 7.5.4 and provided by link to the Plateau Region Water Plan website.
34. Model drought contingency plans are discussed in Chapter 7 Section 7.5.4 and provided by link to the Plateau Region Water Plan website.
35. Chapter 7 Section 7.6 is modified to recognize drought management strategies J-14 and J-18 for Bandera County-Other.
36. A discussion pertaining to recent implementation of drought contingency measures is added as the fifth paragraph of Chapter 7 Section 7.2.
37. The Texas Public Information Act is added to the first paragraph of Chapter 10 Section 10.3.
38. Chapter 11 Table 11-1 implementation survey report has been added.
39. Chapter 11 Table 11-6 has been replaced and does not contain Vegetative Management strategies. Chapter 11 Tables 11-7 and 11-8 have been added and a narrative has been added in Sec 11.2.6 that compare recommended and alternate WMS *projects*.

LEVEL 2:

1. Text on page ES-9 is revised to not show table numbers. A listing of all TWDB tables are now provided on the ES Appendix cover page.
2. The spelling of Agriculture is corrected on page ES-12 of the Executive Summary.
3. The table on Chapter 3 Page 3-12 has been redesigned as a bulleted list. The table on page 3-16 is made into Table 3-5, which results in renumbering the previous Table 3-5 on page 3-26 to Table 3-6.
4. Alluvial Aquifers Report (2010) has been sent to UGRA for posting on PWPG website.
5. Corrections made in Chapter 3 Table 3-4.
6. Corrections made in Chapter 3 Table 3-4.
7. Corrections made in Chapter 3 Table 3-4.
8. “Error! Reference source not found.2” is corrected in Chapter 5 Section 5.3.4.
9. Additional entities required to submit WCPs are added to Chapter 5 section 5.3.5.
10. Conservation BMPs reference is replaced with new website in Chapter 5 Section 5.3.3.
11. Statement pertaining to Oakmont Saddle Mountain funding has been removed from Chapter 5 Strategy J-79.
12. Reference to first planning period has been deleted in Chapter 7 Section 7.5.
13. An attempt has been made to properly rename GIS files according to the naming convention outlines in the Guidelines.
14. An attempt has been made to include all required attribute fields in the GIS data.

APPENDIX 10C

RESPONSE TO TPWD COMMENTS

This page intentionally left blank



Life's better outside.®

June 22, 2020

Commissioners

S. Reed Morian
Chairman
Houston

Arch "Beaver" Aplin, III
Vice-Chairman
Lake Jackson

James E. Abell
Kilgore

Oliver J. Bell
Cleveland

Anna B. Galo
Laredo

Jeffery D. Hildebrand
Houston

Jeanne W. Latimer
San Antonio

Robert L. "Bobby" Patton, Jr.
Fort Worth

Dick Scott
Wimberley

Lee M. Bass
Chairman-Emeritus
Fort Worth

T. Dan Friedkin
Chairman-Emeritus
Houston

Carter P. Smith
Executive Director

Mr. Jonathan Letz, Chairman
Plateau Water Planning Group (Region J)
700 Main Street, Suite 101
Kerrville, Texas 78028

Dear Mr. Letz:

Thank you for seeking review and comment from the Texas Parks and Wildlife Department ("TPWD") on the 2021 Initially Prepared Regional Water Plan (IPP) for the Plateau Region J Water Planning Area. Water impacts every aspect of TPWD's mission to manage and conserve the natural and cultural resources of Texas. Although TPWD has limited regulatory authority over the use of state waters, we are the agency charged with primary responsibility for protecting the state's fish and wildlife resources. To that end, TPWD offers these comments intended to help avoid or minimize impacts to state fish and wildlife resources.

TPWD understands that regional water planning groups are guided by 31 TAC §357 when preparing regional water plans. These water planning rules spell out requirements related to natural resource and environmental protection. Accordingly, TPWD staff reviewed the IPP with a focus on the following questions:

- Does the IPP include a quantitative reporting of environmental factors including the effects on environmental water needs and habitat?
- Does the IPP include a description of natural resources and threats to natural resources due to water quantity or quality problems?
- Does the IPP discuss how these threats will be addressed?
- Does the IPP describe how it is consistent with long-term protection of natural resources?
- Does the IPP include water conservation as a water management strategy?
- Does the IPP include Drought Contingency Plans?
- Does the IPP recommend any stream segments be nominated as ecologically unique?
- Does the IPP address concerns raised by TPWD in connection with the 2016 Water Plan?

TPWD appreciates the Plateau Water Planning Group's (PWPG) response to the Department's comments regarding the 2016 plan and acknowledgement of staff support during the current and previous planning cycles. It is clear the PWPG recognizes the importance of protecting the natural and ecological resources of the Region as they are important economic drivers for the area.

The 2021 IPP is a refinement of the 2016 Regional Water Plan. Projected population has not changed significantly with the population of the 6 county Plateau Water Planning Area estimated to grow by 52 percent from 141,176 in 2020 to about 185,000 by 2070. Approximately 45 percent of the total population of the area is located in the two largest cities, Del Rio and Kerrville. The forecasted total demand for water needed in the Region will increase from the year 2020 by 44,937 acre-feet (13 percent) by the year 2070. Municipal and irrigation combined represent 93 percent of all water used in the Region.

Recommended Water Management Strategies (WMS) for meeting future water needs include water conservation, reuse, additional groundwater development, expansion of an existing aquifer storage and recovery (ASR) project and construction of a new ASR project, a new off-channel reservoir, rainwater harvesting and vegetative management. TPWD commends the Plateau Region J Water Planning Group for its emphasis on water conservation and reuse. In addition each WMS was evaluated to determine whether a strategy potentially could diminish the quantity of water currently existing in the natural environment and if a strategy could impact water quality to a level that would be detrimental to animals and plants that naturally inhabit the area under consideration.

The Plateau Region J IPP includes thorough descriptions of natural resources and acknowledges the importance of protecting those resources. Section 1.2.6 describes the Native Vegetation and Ecology but does not include a list of threatened and endangered species found in the Region. There have been recent updates (March 30, 2020) to the list of federal and state listed species and Species of Greatest Conservation need, including species in Region J counties. We recommend that you include a table with the latest information that is available at, https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/listed-species/.

Environmental and recreational water needs are discussed in Sections 1.35 and 2.3 and elsewhere in the document. Even though environmental and recreational water uses are not quantified, they are recognized as being an important consideration. It would be appropriate to mention the Senate Bill 3 environmental flows process in this discussion.

Table 5-4 provides an analysis of environmental impacts related to each WMS. TPWD appreciates the inclusion of Appendix 5B in response to our comments in 2015. Appendix 5B provides both quantitative and qualitative descriptions of impact ranges as well as a quantification of threatened and endangered species found in the county where the WMS is located. Each Recommended and Alternate WMS is given an Environmental Impact Factor score based on impacts to environmental water needs, wildlife habitat, cultural resources, environmental water quality and bays and estuaries. Environmental Impact Factors range from 1-5 where a score of 1 represents a positive impact and a score of 5 represents a significantly

negative impact. For the most part each WMS scored 1 (positive impact) or 2 (no new impact impact). Two strategies received scores of 3 based on the potential to cause minimal habitat impacts. One strategy, the City of Bandera's Aquifer Storage and Recovery Project received a score of 4 (moderate negative) due to potential instream flow impacts. There appears to be a typo in the title for Table 5B-3. Environmental Impact Category *Ranting* Matrix.

As in previous plans, the IPP includes a good discussion of major springs and seeps that occur in the region and recognizes the important ecological water supply function that all springs perform. The PWPG defines groundwater availability as a maximum level of aquifer withdrawal that results in an acceptable level of long-term aquifer impact such that the base flow in rivers and streams is not significantly affected beyond a level that would be anticipated due to naturally occurring conditions. TPWD applauds this approach to defining groundwater availability and supports the PWPG recommendation for more groundwater/surface water interaction studies such as streamflow gain/loss studies and is interested in assisting regional entities in developing and implementing such studies.

TPWD appreciates the PWPG's efforts this planning cycle regarding nomination of ecologically unique stream segments. During this planning cycle the PWPG created a new process with six required steps for nominating stream segments. Even though the planning group ultimately decided not to nominate any segments at this time, the PWPG strongly maintains that all river and stream segments in the Plateau Region are vitally important and their flows constitute a major consideration in adoption of this 2021 Plan. If the PWPG chooses to recommend any of these stream segments in the future TPWD stands ready to provide any additional supporting information necessary to designate these segments as unique. It would be helpful for future discussions to include a description of the nomination process in the final regional water plan.

Thank you for your consideration of these comments. TPWD appreciates recognition in the IPP of our participation in the planning process. We look forward to continuing to work with the planning group to develop water supply strategies that not only meet the future water supply needs of the region but also preserve the ecological health of the region's aquatic resources. Please contact me at (512) 389-8715 or Cindy.Loeffler@TPWD.Texas.gov if you have any questions or comments.

Sincerely,

Cindy Loeffler

Cindy Loeffler, Chief
Water Resources Branch

CL:lc

RESPONSES TO TPWD COMMENTS

The Plateau Water Planning Group (PWPG) thanks the TPWD staff for their technical review and comments on the 2020 Plateau IPP and wish to express their appreciation for the agencies active role in the Plateau Regional Water Planning process. The PWPG would also like to thank the TPWD staff for recognizing the concerted effort that the Planning Group has made to include environmental needs in the develop of this regional water plan as shown in the following key phrases contained in the agency's comments:

- *It is clear the PWPG recognizes the importance of protecting the natural and ecological resources of the Region as they are important economic drivers for the area.*
- *TPWD commends the Plateau Region J Water Planning Group for its emphasis on water conservation and reuse.*
- *The Plateau Region J IPP includes thorough descriptions of natural resources and acknowledges the importance of protecting those resources.*
- *As in previous plans, the IPP includes a good discussion of major springs and seeps that occur in the region and recognizes the important ecological water supply function that all springs perform.*
- *TPWD applauds this approach to defining groundwater availability and supports the PWPG recommendation for more groundwater/surface water interaction studies such as streamflow gain/loss studies and is interested in assisting regional entities in developing and implementing such studies.*
- *TPWD appreciates the PWPG's efforts this planning cycle regarding nomination of ecologically stream segments.*

Following are responses to TPWD comments on the 2020 Plateau IPP:

1. TPWD - Suggestion to include a table listing federal and state listed species and species of greatest conservation need.
PWPG – The list is quite extensive, so a discussion is provided in Chapter 1 Section 1.2.7 that discusses the list, and the link taking the reader to the TPWD website is updated.
2. TPWD – Suggestion to mention the Senate Bill 3 environmental flows process.
PWPG – A discussion pertaining to the environmental flows process is added in the last paragraph of Chapter 2 Section 2.3.
3. TPWD – Suggestion to correct a typo in the title of Table 5B-3.
PWPG – Typo has been corrected.
4. TPWD – Suggestion to include a description of the ecologically unique stream segment nomination process.
PWPG – The nomination process has been added to the discussion in Chapter 8 Section 8.5.

CHAPTER 11

IMPLEMENTATION AND COMPARISON TO THE PREVIOUS REGIONAL WATER PLAN

This page intentionally left blank.

11 IMPLEMENTATION AND COMPARISON TO THE PREVIOUS REGIONAL WATER PLAN

Chapter 11 provides a survey of the level of implementation and identified impediments to the development of previously (*2016 Plan*) recommended Water Management Strategies that have affected progress in meeting projected water-supply needs. To best appreciate the continued improvements to the Plateau Region water planning process, this Chapter offers a comparison of key components in the *2016 Plateau Region Water Plan* to those in this current *2021 Plateau Region Water Plan*. This Chapter also assesses the progress of the Plateau planning area in encouraging cooperation between water user groups for achieving economies of scale and otherwise incentivizing strategies that benefit the entire Region.

11.1 IMPLEMENTATION OF PREVIOUS REGIONAL WATER PLAN

Information needed to report on the level of implementation and identified impediments to the development of previously (*2016 Plan*) recommended Water Management Strategies that have affected progress in meeting projected water-supply needs was collected through an emailed survey and follow-up messages were delivered one month after first delivery and in a subsequent message to the PRWPG to encourage further responses. Additional methods that were considered for identifying projects that may potentially have been implemented include:

- Tracking changes since the last Plan;
- Using TWDB funding records; and
- Using conservation implementation reports submitted to the TWDB.

A summary of the survey results are provided in Table 11-1 and the entire populated spreadsheet is returned to the TWDB.

Table 11-1. 2021 Plateau Region Strategy Implementation Survey

WMS or WMS Project Name	Implementation Survey Record Type	Has Sponsor taken affirmative vote or actions?* (TWC 16.053(h)(10))	If yes, in what year did this occur?	If yes, by what date is the action on schedule for implementation?	At what level of implementation is the project currently?*	If not implemented, why?* (When "If other, please describe" is selected, please add the descriptive text to that field)	What impediments presented to implementation?* (When "If other, please describe" is selected, please add the descriptive text to that field)	Current water supply project yield (ac-ft/yr)	Funds expended to date (\$)	Project Cost (\$)	Year the project is online?*	Is this a phased project?*	(Phased) Ultimate volume (ac-ft/yr)	(Phased) Ultimate project cost (\$)	Year project reaches maximum capacity?*	What is the project funding source(s)?*	Funding Mechanism if Other?	Included in 2021 plan?*	Does the project or WMS involve reallocation of flood control?*	Does the project or WMS provide any measurable flood risk reduction?*	Optional Comments
CITY OF KERRVILLE - INCREASE WASTEWATER REUSE	RECOMMENDED WMS PROJECT	Yes	2018	Completed	Currently operating		Political support/governance	3,069	\$23 million	\$23 million	2019	No			2019	Other	Kerrville Public Utility Board	Yes	No	No	
CITY OF KERRVILLE - INCREASED WATER TREATMENT AND ASR CAPACITY	RECOMMENDED WMS PROJECT	Yes	2016	2017	Under construction		Access to funding	1,120	\$1,750,000	Undetermined	2023	Yes	Undetermined	Undetermined	2025	Market		Yes	No	No	Wells are currently being drilled which will eventually be converted from production to ASR. Planning for treatment expansion has not started.
CITY OF KERRVILLE - WATER LOSS AUDIT AND MAIN-LINE REPAIR	RECOMMENDED WMS PROJECT	Yes	Ongoing annually	See comments at end	Under construction		Access to funding	4% reduction in loss	\$350,000	\$750,000	2023	Yes	7% total reduction in losses	\$750,000	2025	Other	Operational funds (utility rates)	Yes	No	No	Annually 750-1,000 feet replaced, 15-20 meters replaced, 3-yr phase in of an AMI meter read system being developed.
CITY OF KERRVILLE - PURCHASE WATER FROM UGRA	RECOMMENDED WMS SUPPLY WITHOUT WMS PROJECT	No			Not implemented	Too soon	Not applicable	NA	NA	NA	2023	No			2030	Other	None identified	No	No	No	

11.2 COMPARISON TO PREVIOUS PLAN

The following section includes a summary that shows how the *2021 Water Plan* differs from the *2016 Water Plan*. Comparisons include:

- Water demand projections;
- Drought of record and the hydrologic and modeling assumptions on which plans are based;
- Water availability at the source;
- Existing water supplies of WUGs;
- WUG and WWP needs;
- Recommended and alternative water management strategies; and
- Any other aspects of the plans that the PWPG chooses to compare.

11.2.1 Water Demand Projections

Table 11-2 provides a comparison between *2016* and *2021 Plan* water demand projections. The more populated counties show slight increases in demand, while rural counties show a slight decrease. The largest percentage change between the two *Plans* is in Kinney County where a significant decrease in irrigation demand in the *2021 Plan* results in a county total demand decrease of 38 percent.

Table 11-2. Water Demand Projections Comparison by County (Acre-Feet per Year)

County	Plan	2020	2030	2040	2050	2060	2070
Bandera	2016	3,413	3,717	3,872	3,928	3,972	3,998
	2021	4,007	4,330	4,493	4,553	4,601	4,629
Edwards	2016	1,230	1,211	1,193	1,184	1,173	1,166
	2021	1,092	1,082	1,073	1,071	1,071	1,071
Kerr	2016	9,063	9,154	9,171	9,242	9,343	9,433
	2021	9,659	9,780	9,827	9,926	10,054	10,166
Kinney	2016	8,406	8,397	8,384	8,380	8,378	8,378
	2021	5,227	5,218	5,204	5,201	5,199	5,199
Real	2016	913	890	870	855	843	835
	2021	881	866	853	848	847	847
Val Verde	2016	16,777	17,664	18,519	19,398	20,262	21,127
	2021	16,471	17,452	18,394	19,361	20,306	21,243
Total	2016	39,802	41,033	42,009	42,987	43,971	44,937
	2021	37,337	38,728	39,844	40,960	42,078	43,155

11.2.2 Drought of Record and Hydrologic and Modeling Assumptions

The drought of record consideration for water supply analysis for both the *2016* and *2021 Plans* is the drought of the 1950s. The *2016 Plan* recognized that the current drought conditions, as particularly witnessed in the summer of 2011, was having a significant impact on local water supply sources. Surface water availability for both the *2016* and *2021 Plans* is based on Run 3 of the TCEQ Water Availability Models (WAMs) for the five river basins within the Plateau Region.

Groundwater availability in the *2016 and 2021 Plans* is based on the Modeled Available Groundwater (MAG) volumes that may be produced on an average annual basis to achieve a Desired Future Condition (DFC) as adopted by Groundwater Management Areas (GMAs) (per Texas Water Code 36.001). Aquifers recognized in both *Plans* that are not included in the GMA-MAG process are termed “non-

relevant” and “other aquifer”. Groundwater availability for these sources is calculated by modeling or standard geohydrologic methods.

11.2.3 Source Water Availability

Total water supply from the source increased from 169,608 acre-feet per year in the *2016 Plan* to 194,942 acre-feet per year in the *2021 Plan*, with groundwater increasing by 17.5 percent and surface water increasing by 5.4 percent. A Source Data Comparison table is provided in the Executive summary of this *Plan*.

11.2.4 Existing Water Supplies of WUGs

A WUG Data Comparison Table is provided in the Executive Summary of this *Plan* which compares *2016 Plan* and *2021 Plan* water supplies available to cities and general water use categories based on the current infrastructure ability of each to obtain water supplies. These abilities primarily include existing infrastructure, water-rights limitations, and groundwater conservation district permit limitations.

11.2.5 WUG and WWP Needs

Water supply needs occur when an entity’s (WUG’s) projected water demand exceeds its supply availability. Table 11-3 and 11-4 compare entities in the *2016 Plan* and *2021 Plan* that are projected to experience a water supply need at some decade in the next 50 years. The dramatic difference between WUG needs in the two *Plans* is primarily the result of the decreased supply source availability shown in the *2021 Plan*.

Table 11-3. 2016 WUG and WWP Needs (Acre-Feet per Year)

County	WUG/WWP	Source Basin	2020	2030	2040	2050	2060	2070
Bandera	Irrigation	San Antonio	129	129	129	129	129	129
	Livestock	Guadalupe	12	12	12	12	12	12
	Livestock	San Antonio	1	1	1	1	1	1
Edwards	Rocksprings	Nueces	98	96	94	94	94	94
	Livestock	Nueces	16	16	16	16	16	16
	Mining	Rio Grande	22	22	22	22	22	22
Kerr	Kerrville	Guadalupe	3,194	3,263	3,281	3,334	3,396	3,450
	Loma Vista WS	Guadalupe	30	37	38	44	51	57
	County Other	Colorado	5	5	5	5	6	7
	County Other	Nueces	1	1	1	1	1	1
	Livestock	Colorado	106	106	106	106	106	106
	Livestock	Nueces	6	6	6	6	6	6
	Livestock	San Antonio	18	18	18	18	18	18
	Irrigation	San Antonio	14	14	13	13	12	12
	Mining	Colorado	12	13	17	17	19	21
Kinney	Livestock	Rio Grande	22	22	22	22	22	22
Real	Camp Wood	Nueces	134	131	128	127	126	126
	Livestock	Nueces	33	33	33	33	33	33
Val Verde	Mining	Rio Grande	4	63	73	37	6	

Table 11-4. 2021 WUG and MWP Needs (Acre-Feet per Year)

County	WUG/MWP	Source Basin	2020	2030	2040	2050	2060	2070
Bandera	Livestock	Guadalupe	2	2	2	2	2	2
	Livestock	Nueces	3	3	3	3	3	3
	Bandera County FWSD 1	San Antonio	66	83	92	96	99	100
	County-Other Bandera River Ranch 1	San Antonio	28	39	44	46	48	49
	County-Other Lake Medina Shores	San Antonio	196	225	239	244	248	251
	County-Other Medina WSC	San Antonio	35	46	51	53	54	55
	Irrigation	San Antonio	75	75	75	75	75	75
Edwards	Mining	Colorado	12	12	12	12	12	12
	Rocksprings	Nueces	98	96	94	94	94	94
	Mining	Nueces	16	16	16	16	16	16
	Mining	Rio Grande	31	31	31	31	31	31
Kerr	Mining	Colorado	11	12	15	16	17	19
	Livestock	Colorado	119	119	119	119	119	119
	County-Other Center Point	Guadalupe	3	3	3	3	3	4
	County-Other Center Point Taylor System	Guadalupe	2	2	3	3	4	5
	Livestock	Guadalupe	173	173	173	173	173	173
	County-Other	Nueces	1	1	1	1	1	1
	Livestock	Nueces	6	6	6	6	6	6
	Livestock	San Antonio	27	27	27	27	27	27
Kinney	Livestock	Nueces	27	27	27	27	27	27
Real	Camp Wood	Nueces	143	139	136	135	135	135
Val Verde	Del Rio Utilities Commission	Rio Grande	4,423	4,918	5,419	5,995	6,598	7,191
	Laughlin Air Force Base	Rio Grande	87	183	284	346	345	345
	County-Other	Rio Grande					12	377
	Mining	Rio Grande	151	210	220	184	153	132

11.2.6 Recommended Water Management Strategies and Projects

A total of 67 water management strategies (Table 11-5) for 27 water user groups (WUGs) were recommended in the *2016 Plan*, with a total capital cost of \$146,202,577. As a result of more WUGs projecting a water supply need (Table 11-3) in the *2021 Plan*, a total of 67 strategies (Table 11-5) for 35 WUGs were recommended with a total capital cost of \$230,456,000. Tables 11-7 and 11-8 provide a similar comparison between strategy projects in the *2016 and 2021 Plans*. The *2016 Plan* contains 57 projects for 25 WUGs, while the *2021 Plan* contains 52 projects for 29 WUGs. The principal change in the two *Plans* centers around how the *2021 Plan* designates the Eastern Kerr County Regional Water Supply Project as a single strategy with multiple project components.

Table 11-5. 2016 Summary of Recommended Water Management Strategies

County	Water User Group	Strategy Source Basin	Water Management Strategy	2016 Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
					2020	2030	2040	2050	2060	2070	
Bandera	City of Bandera	San Antonio	Reuse treated wastewater effluent for irrigation use	J-1	310	310	310	310	310	310	\$450,000
			Promote, design & install rainwater harvesting systems	J-2	1	1	1	1	1	1	\$56,000
			Additional Lower Trinity well and lay necessary pipeline	J-4	323	323	323	323	323	323	\$2,284,000
			Additional Middle Trinity wells within City water infrastructure	J-5	161	161	161	161	161	161	\$779,000
	*Bandera County Other		Water loss audit and main-line repair for Bandera County FWSD #1	J-6	1	1	1	1	1	1	\$163,000
			Water loss audit and main-line repair for Bandera River Ranch #1	J-7	1	1	1	1	1	1	\$463,000
			Water loss audit and main-line repair for Medina Water Supply Corporation	J-8	1	1	1	1	1	1	\$447,000
			**Vegetative Management	J-9	0	0	0	0	0	0	\$0
			Drought Management (BCRAGD)	J-68	467	519	546	556	563	568	\$0
			Additional well for Pebble Beach Subdivision	J-10	161	161	161	161	161	161	\$3,717,000
			Additional wells to provide emergency supply to VFD	J-11	189	189	189	189	189	189	\$2,824,000
			Additional wells to help Medina Lake area	J-12	27	27	27	27	27	27	\$1,377,000
		Nueces	Drought Management (BCRAGD)	J-69	29	32	34	34	35	35	\$0
	* Bandera County Irrigation	Nueces	Additional groundwater wells	J-13	130	130	130	130	130	130	\$244,000
	* Bandera County Livestock	San Antonio	Additional groundwater well	J-14	20	20	20	20	20	20	\$103,000
Edwards	* City of Rocksprings	Colorado	Water loss audit and main-line repair	J-15	1	1	1	1	1	1	\$129,000
		Nueces	Additional groundwater well	J-16	121	121	121	121	121	121	\$650,000
	Edwards County Other	Nueces	Water loss audit and main-line repair for Barksdale WSC	J-17	1	1	1	1	1	1	\$203,000
			Additional well in the Nueces River Alluvium Aquifer	J-18	54	54	54	54	54	54	\$114,000
			**Vegetative Management	J-19	0	0	0	0	0	0	\$0

Table 11-5. (Continued) 2016 Summary of Recommended Water Management Strategies

County	Water User Group	Strategy Source Basin	Water Management Strategy	2016 Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
					2020	2030	2040	2050	2060	2070	
Edwards	* Edwards County Livestock	Nueces	Additional groundwater wells	J-20	20	20	20	20	20	20	\$105,000
	* Edwards County Mining	Rio Grande	Additional groundwater wells	J-21	30	30	30	30	30	30	\$109,000
Kerr	* City of Kerrville	Guadalupe	Increase wastewater reuse	J-22	5,041	5,041	5,041	5,041	5,041	5,041	\$23,000,000
			Water loss audit and main-line repair	J-23	147	147	147	147	147	147	\$9,339,000
			Purchase water from UGRA	J-24		0	0	0	0	0	\$4,103,791
			Increased water treatment and ASR capacity	J-25	3,360	3,360	3,360	3,360	3,360	3360	\$11,543,000
	* Loma Vista WSC	Guadalupe	Conservation: Public information	J-26	4	4	4	4	4	4	\$0
			Additional groundwater well	J-27	57	57	57	57	57	57	\$728,000
	* Kerr County Other	Guadalupe	Water loss audit and main-line repair for Center Point WWW	J-28	1	1	1	1	1	1	\$33,000
			Water loss audit and main-line repair for Hills and Dales WWW	J-29	1	1	1	1	1	1	\$138,000
			Water loss audit and main-line repair for Rustic Hills Water	J-30	1	1	1	1	1	1	\$99,000
			Water loss audit and main-line repair for Verde Park Estates WWW	J-31	1	1	1	1	1	1	\$102,000
			Conservation: Public information	J-32	9	9	9	10	9	8	\$0
		Colorado	Conservation: Public information - Water shortage met with J-32	J-32A	5	5	5	5	6	7	\$0
		Nueces	Conservation: Public information - Water shortage met with J-32	J-32B	1	1	1	1	1	1	\$0
		Guadalupe	**Vegetative management - UGRA	J-33	0	0	0	0	0	0	\$0
			UGRA Acquisition of Surface Water Rights ² (EKCRWSP)	J-34	1,029	1,029	1,029	1,029	1,029	1029	\$1,087,367
			KCCC Acquisition of Surface Water Rights ² (EKCRWSP)	J-35	6,000	6,000	6,000	6,000	6,000	6,000	\$6,342,000
			Construction of an Off-Channel Surface Water Storage ² (EKCRWSP)	J-36	1,121	1,121	1,121	1,121	1,121	1,121	\$7,534,303

Table 11-5. (Continued) 2016 Summary of Recommended Water Management Strategies

County	Water User Group	Strategy Source Basin	Water Management Strategy	2016 Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
					2020	2030	2040	2050	2060	2070	
Kerr	*Kerr County-Other	Guadalupe	Construction of surface water treatment facilities and transmission lines ² (EKCROWSP)	J-37	149	149	149	149	149	149	\$25,581,000
			Construction of ASR facility ² (EKCROWSP)	J-38	1,124	1,124	1,124	1,124	1,124	1,124	\$1,258,000
			Construction of Well field for dense, rural areas ² (EKCROWSP)	J-39	860	860	860	860	860	860	\$4,357,000
			Construction of Desalination plant ² (EKCROWSP)	J-40	860	860	860	860	860	860	\$14,539,000
			Construction of an Ellenburger Aquifer water supply well ² (EKCROWSP)	J-41	108	108	108	108	108	108	\$567,000
	*Kerr County Irrigation	San Antonio	Additional groundwater well	J-42	20	20	20	20	20	20	\$78,000
	* Kerr County Livestock	Colorado	Additional groundwater wells	J-43	108	108	108	108	108	108	\$667,000
	* Kerr County Livestock	Guadalupe	Additional groundwater wells	J-44	20	20	20	20	20	20	\$190,000
	* Kerr County Livestock	San Antonio	Additional groundwater well	J-45	20	20	20	20	20	20	\$65,000
	* Kerr County Mining	Guadalupe	Additional groundwater well	J-46	30	30	30	30	30	30	\$132,000
Kinney	City of Brackettville	Rio Grande	Water loss audit and main-line repair	J-47	58	58	58	58	58	58	\$1,116
			Increase supply to Spoford with new water line	J-48	3	3	3	3	3	3	\$751,000
			Increase storage facility	J-49	3	3	3	3	3	3	\$288,000
	Fort Clark Springs MUD		Increase storage facility	J-50	620	620	620	620	620	620	\$1,033,000
	Kinney County Other		**Vegetative Management	J-51	0	0	0	0	0	0	\$0
	* Kinney County Livestock		Additional groundwater wells	J-52	22	22	22	22	22	22	\$55,000

Table 11-5. (Continued) 2016 Summary of Recommended Water Management Strategies

County	Water User Group	Strategy Source Basin	Water Management Strategy	2016 Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
					2020	2030	2040	2050	2060	2070	
Real	* City of Camp Wood	Nueces	Conservation: Public information	J-53	1	1	1	1	1	1	\$0
	Additional groundwater wells		J-54	172	172	172	172	172	172	\$1,887,000	
	City of Leakey (Real County Other)		Water loss audit and main-line repair	J-55	1	1	1	1	1	1	\$52,000
			Additional groundwater well	J-56	91	91	91	91	91	91	\$156,000
			Develop interconnections between wells within the City	J-57	81	81	81	81	81	81	\$200,000
	Real County Other		Water loss audit and main-line repair for Real WSC	J-58	2	2	2	2	2	2	\$199,000
			**Vegetative Management	J-59	0	0	0	0	0	0	\$0
			Additional well for Oakmont Saddle WSC	J-60	54	54	54	54	54	54	\$420,000
	* Real County Livestock		Additional groundwater wells	J-61	40	40	40	40	40	40	\$74,000
Val Verde	City of Del Rio	Rio Grande	Water loss audit and main-line repair	J-62	119	119	119	119	119	119	\$8,673,000
			Drill & equip new well, connect to distribution system	J-63	850	850	850	850	850	850	\$2,937,000
			Water treatment plant expansion	J-64		943	943	943	943	943	\$1,841,000
			Develop a wastewater reuse program	J-65	3,092	3,092	3,092	3,092	3,092	3,092	\$1,700,000
	Val Verde County Other		**Vegetative Management	J-66	0	0	0	0	0	0	\$0
	* Val Verde County Mining		Additional groundwater well	J-67	80	80	80	80	80	80	\$235,000

*WUGs with projected water supply needs (deficits).

Table 11-6. 2021 Summary of Recommended and Alternate Water Management Strategies

County	Water User Group	Strategy	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
				2020	2030	2040	2050	2060	2070	
Bandera	City of Bandera	Reuse treated wastewater effluent for irrigation of public spaces	J-1	0	310	310	310	310	310	\$1,496,000
		Promote, design & install rainwater harvesting systems on public buildings	J-2	0	1	1	1	1	1	\$56,000
		Additional Lower Trinity well and lay necessary pipeline ALTERNATE	J-3	0	403	403	403	403	403	\$3,298,000
		Additional Middle Trinity wells within City water infrastructure area	J-4	161	161	161	161	161	161	\$625,000
		Surface water acquisition, treatment and ASR	J-5	0	1,500	1,500	1,500	1,500	1,500	\$34,188,000
	*Bandera County FWSD #1	Public conservation education	J-6	2	2	2	2	2	2	\$0
		Additional groundwater well	J-7	100	100	100	100	100	100	\$990,000
	*Bandera County Other - Bandera River Ranch #1	Water loss audit and main-line repair for	J-8	4	4	4	4	4	4	\$902,000
	*Bandera County Other - Lake Medina Shores	Public conservation education	J-9	3	3	3	3	3	3	\$0
		Additional groundwater wells ALTERNATE	J-10	251	251	251	251	251	251	\$1,477,000
	*Bandera County Other - Medina WSC	Public conservation education	J-11	1	1	1	1	1	1	\$0
		Additional groundwater well	J-12	55	55	55	55	55	55	\$1,417,000
	Bandera County Other	Drought management (BCRAGD)	J-14	441	491	516	525	533	537	\$0
	Bandera County Other - Volunteer Fire Dept.	Additional groundwater wells to provide emergency supply ALTERNATE	J-16	189	189	189	189	189	189	\$4,280,000
	Bandera County Other - Enchanted River Estates	Water loss audit and main-line repair	J-17	1	1	1	1	1	1	\$117,000
	Bandera County Other	Drought management (BCRAGD)	J-18	23	26	27	28	28	28	\$0
	*Bandera County Irrigation	Irrigation scheduling	J-20	36	36	36	36	36	36	\$0
		Additional groundwater wells	J-21	75	75	75	75	75	75	\$291,000

Table 11-6. (continued) 2021 Summary of Recommended and Alternate Water Management Strategies

County	Water User Group	Strategy	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
				2020	2030	2040	2050	2060	2070	
Bandera	*Bandera County Livestock	Livestock conservation	J-22	1	1	1	1	1	1	\$0
		Additional groundwater well	J-23	2	2	2	2	2	2	\$135,000
		Livestock conservation	J-24	1	1	1	1	1	1	\$0
		Additional groundwater well	J-25	3	3	3	3	3	3	\$126,000
Edwards	City of Rocksprings	Public conservation education	J-26	1	1	1	1	1	1	\$0
		Additional groundwater well	J-27	121	121	121	121	121	121	\$681,000
	Edwards County Other (Barksdale WSC)	Additional well in the Nueces River Alluvium Aquifer and RO wellhead treatment	J-28	54	54	54	54	54	54	\$178,000
	*Edwards County Mining	Additional groundwater well	J-31	16	16	16	16	16	16	\$125,000
		Additional groundwater well	J-33	12	12	12	12	12	12	\$73,000
		Additional groundwater wells	J-35	31	31	31	31	31	31	\$132,000
Kerr	*City of Kerrville	Increase wastewater reuse	J-36	2,500	2,500	2,500	2,500	2,500	2,500	\$12,570,000
		Water loss audit and main-line repair	J-37	134	134	134	134	134	134	\$12,636,000
		Explore and develop new Ellenburger Aquifer well supply	J-39	1,156	1,156	1,156	1,156	1,156	1,156	\$14,493,000
		Increased water treatment and ASR capacity	J-41	0	3,360	3,360	3,360	3,360	3,360	\$15,393,000
	Kerr County Other -Eastern Kerr County Regional Water Supply Project	Project 1. Construction of an Ellenburger Aquifer water supply well	J-45	0	108	108	108	108	108	\$652,000
		Project 2. Construction of off-channel surface water storage		0	1,121	1,121	1,121	1,121	1,121	\$25,231,000
		Project 2. Construction of surface water treatment facilities and transmission lines								\$22,829,000
		Project 3. Construction of ASR facility		0	1,124	1,124	1,124	1,124	1,124	\$1,461,000

Table 11-6. (continued) 2021 Summary of Recommended and Alternate Water Management Strategies

County	Water User Group	Strategy	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
				2020	2030	2040	2050	2060	2070	
Kerr	Kerr County Other -Eastern Kerr County Regional Water Supply Project	Project 4. Construction of Trinity Aquifer wellfield for dense, rural areas	J-45	0	860	860	860	860	860	\$8,367,000
		Project 4. Construction of desalination plant								\$21,162,000
	Kerr County Other - *Center Point	Public conservation education	J-54	1	1	1	1	1	1	\$0
		Purchase water from EKRWSP	J-46	11	11	11	11	11	11	\$0
	Kerr County Other - *Center Point Taylor System	Public conservation education	J-55	1	1	1	1	1	1	\$0
		Purchase water from EKRWSP	J-47	43	43	43	43	43	43	\$0
	Kerr County Other - Verde Park Estates	Water loss audit and main-line repair	J-42	1	1	1	1	1	1	\$155,000
	*Kerr County Other	Public conservation education	J-43	1	1	1	1	1	1	\$0
	*Kerr County Livestock	Livestock conservation	J-56	24	24	24	24	24	24	\$0
		Additional groundwater wells ALTERNATE	J-57	119	119	119	119	119	119	\$985,000
		Livestock conservation	J-58	35	35	35	35	35	35	\$0
		Additional groundwater wells ALTERNATE	J-59	173	173	173	173	173	173	\$370,000
		Livestock conservation	J-60	5	5	5	5	5	5	\$0
		Additional groundwater well ALTERNATE	J-61	27	27	27	27	27	27	\$79,000
		Livestock conservation	J-62	1	1	1	1	1	1	\$0
		Additional groundwater well ALTERNATE	J-63	6	6	6	6	6	6	\$66,000
	*Kerr County Mining	Additional groundwater wells	J-65	19	19	19	19	19	19	\$197,000
Kinney	City of Brackettville	Increase supply to Spofford with new water line	J-66	0	3	3	3	3	3	\$4,271,000
		Increase storage facility	J-67	0	3	3	3	3	3	\$1,272,000
	Fort Clark Springs MUD	Water loss audit and main-line repair	J-68	79	79	79	79	79	79	\$1,531,000

Table 11-6. (continued) 2021 Summary of Recommended and Alternate Water Management Strategies

County	Water User Group	Strategy	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
				2020	2030	2040	2050	2060	2070	
Kinney	Fort Clark Springs MUD	Increase storage facility	J-69	0	620	620	620	620	620	\$1,501,000
Real	*City of Camp Wood	Public conservation education	J-72	1	1	1	1	1	1	\$0
		Additional groundwater wells	J-73	143	143	143	143	143	143	\$1,709,000
	City of Leakey	Additional groundwater well	J-75	91	91	91	91	91	91	\$189,000
		Develop interconnections between wells within the City	J-76	0	81	81	81	81	81	\$202,000
	Real County Other - Real WSC	Water loss audit and main-line repair	J-77	2	2	2	2	2	2	\$482,000
	Real County Other - Oakmont Saddle Mountain WSC	Additional groundwater well	J-79	54	54	54	54	54	54	\$417,000
Val Verde	*City of Del Rio	Water loss audit and main-line repair	J-80	12	12	12	12	12	12	\$5,672,000
		Additional groundwater well	J-81	7,191	7,191	7,191	7,191	7,191	7,191	\$12,695,000
		Water treatment plant expansion	J-82	0	943	943	943	943	943	\$8,646,000
		Develop a wastewater reuse program	J-83	0	3,092	3,092	3,092	3,092	3,092	\$2,846,000
	Laughlin Air Force Base	Purchase water from City of Del Rio	J-87	87	183	284	346	345	345	\$0
	Val Verde County Other - Val Verde County WCID Comstock	Water loss audit and main-line repair	J-84	1	1	1	1	1	1	\$406,000
	Val Verde County Other - San Pedro Canyon Upper Subdivision	Water loss audit and main-line repair	J-85	7	7	7	7	7	7	\$142,000
	Val Verde County Other - Tierra Del Lago	Water loss audit and main-line repair	J-86	4	4	4	4	4	4	\$146,000
	*Val Verde County Mining	Additional groundwater wells	J-89	242	242	242	242	242	242	\$1,096,000

Table 11-7. 2016 Summary of Recommended Water Management Projects

County	Water User Group	Strategy Source Basin	Water Management Strategy	2016 Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
					2020	2030	2040	2050	2060	2070	
Bandera	City of Bandera	San Antonio	Reuse treated wastewater effluent for irrigation use	J-1	310	310	310	310	310	310	\$450,000
			Promote, design & install rainwater harvesting systems	J-2	1	1	1	1	1	1	\$56,000
			Additional Lower Trinity well and lay necessary pipeline	J-4	323	323	323	323	323	323	\$2,284,000
			Additional Middle Trinity wells within City water infrastructure	J-5	161	161	161	161	161	161	\$779,000
	*Bandera County Other		Water loss audit and main-line repair for Bandera County FWSD #1	J-6	1	1	1	1	1	1	\$163,000
			Water loss audit and main-line repair for Bandera River Ranch #1	J-7	1	1	1	1	1	1	\$463,000
			Water loss audit and main-line repair for Medina Water Supply Corporation	J-8	1	1	1	1	1	1	\$447,000
			Additional well for Pebble Beach Subdivision	J-10	161	161	161	161	161	161	\$3,717,000
			Additional wells to provide emergency supply to VFD	J-11	189	189	189	189	189	189	\$2,824,000
			Additional wells to help Medina Lake area	J-12	27	27	27	27	27	27	\$1,377,000
	* Bandera County Irrigation	Nueces	Additional groundwater wells	J-13	130	130	130	130	130	130	\$244,000
	* Bandera County Livestock	San Antonio	Additional groundwater well	J-14	20	20	20	20	20	20	\$103,000
Edwards	* City of Rocksprings	Colorado	Water loss audit and main-line repair	J-15	1	1	1	1	1	1	\$129,000
		Nueces	Additional groundwater well	J-16	121	121	121	121	121	121	\$650,000
	Edwards County Other	Nueces	Water loss audit and main-line repair for Barksdale WSC	J-17	1	1	1	1	1	1	\$203,000
			Additional well in the Nueces River Alluvium Aquifer	J-18	54	54	54	54	54	54	\$114,000

Table 11-7. (continued) 2016 Summary of Recommended Water Management Projects

County	Water User Group	Strategy Source Basin	Water Management Strategy	2016 Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
					2020	2030	2040	2050	2060	2070	
Edwards	* Edwards County Livestock	Nueces	Additional groundwater wells	J-20	20	20	20	20	20	20	\$105,000
	* Edwards County Mining	Rio Grande	Additional groundwater wells	J-21	30	30	30	30	30	30	\$109,000
Kerr	* City of Kerrville	Guadalupe	Increase wastewater reuse	J-22	5,041	5,041	5,041	5,041	5,041	5,041	\$23,000,000
			Water loss audit and main-line repair	J-23	147	147	147	147	147	147	\$9,339,000
			Purchase water from UGRA	J-24		0	0	0	0	0	\$4,103,791
			Increased water treatment and ASR capacity	J-25	3,360	3,360	3,360	3,360	3,360	3360	\$11,543,000
			Additional groundwater well	J-27	57	57	57	57	57	57	\$728,000
	* Kerr County Other	Guadalupe	Water loss audit and main-line repair for Center Point WWW	J-28	1	1	1	1	1	1	\$33,000
			Water loss audit and main-line repair for Hills and Dales WWW	J-29	1	1	1	1	1	1	\$138,000
			Water loss audit and main-line repair for Rustic Hills Water	J-30	1	1	1	1	1	1	\$99,000
			Water loss audit and main-line repair for Verde Park Estates WWW	J-31	1	1	1	1	1	1	\$102,000
			UGRA Acquisition of Surface Water Rights ² (EKCRWSP)	J-34	1,029	1,029	1,029	1,029	1,029	1029	\$1,087,367
			KCCC Acquisition of Surface Water Rights ² (EKCRWSP)	J-35	6,000	6,000	6,000	6,000	6,000	6,000	\$6,342,000
			Construction of an Off-Channel Surface Water Storage ² (EKCRWSP)	J-36	1,121	1,121	1,121	1,121	1,121	1,121	\$7,534,303

Table 11-7. (continued) 2016 Summary of Recommended Water Management Projects

County	Water User Group	Strategy Source Basin	Water Management Strategy	2016 Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
					2020	2030	2040	2050	2060	2070	
Kerr	*Kerr County-Other	Guadalupe	Construction of surface water treatment facilities and transmission lines ² (EKCRWSP)	J-37	149	149	149	149	149	149	\$25,581,000
			Construction of ASR facility ² (EKCRWSP)	J-38	1,124	1,124	1,124	1,124	1,124	1,124	\$1,258,000
			Construction of Well field for dense, rural areas ² (EKCRWSP)	J-39	860	860	860	860	860	860	\$4,357,000
			Construction of Desalination plant ² (EKCRWSP)	J-40	860	860	860	860	860	860	\$14,539,000
			Construction of an Ellenburger Aquifer water supply well ² (EKCRWSP)	J-41	108	108	108	108	108	108	\$567,000
	*Kerr County Irrigation	San Antonio	Additional groundwater well	J-42	20	20	20	20	20	20	\$78,000
	* Kerr County Livestock	Colorado	Additional groundwater wells	J-43	108	108	108	108	108	108	\$667,000
	* Kerr County Livestock	Guadalupe	Additional groundwater wells	J-44	20	20	20	20	20	20	\$190,000
	* Kerr County Livestock	San Antonio	Additional groundwater well	J-45	20	20	20	20	20	20	\$65,000
	* Kerr County Mining	Guadalupe	Additional groundwater well	J-46	30	30	30	30	30	30	\$132,000
Kinney	City of Brackettville	Rio Grande	Water loss audit and main-line repair	J-47	58	58	58	58	58	58	\$1,116
			Increase supply to Spoford with new water line	J-48	3	3	3	3	3	3	\$751,000
			Increase storage facility	J-49	3	3	3	3	3	3	\$288,000
	Fort Clark Springs MUD		Increase storage facility	J-50	620	620	620	620	620	620	\$1,033,000
	* Kinney County Livestock		Additional groundwater wells	J-52	22	22	22	22	22	22	\$55,000

Table 11-7. (continued) 2016 Summary of Recommended Water Management Projects

County	Water User Group	Strategy Source Basin	Water Management Strategy	2016 Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
					2020	2030	2040	2050	2060	2070	
Real	* City of Camp Wood	Nueces	Additional groundwater wells	J-54	172	172	172	172	172	172	\$1,887,000
	City of Leakey (Real County Other)		Water loss audit and main-line repair	J-55	1	1	1	1	1	1	\$52,000
			Additional groundwater well	J-56	91	91	91	91	91	91	\$156,000
			Develop interconnections between wells within the City	J-57	81	81	81	81	81	81	\$200,000
	Real County Other		Water loss audit and main-line repair for Real WSC	J-58	2	2	2	2	2	2	\$199,000
			Additional well for Oakmont Saddle WSC	J-60	54	54	54	54	54	54	\$420,000
	* Real County Livestock		Additional groundwater wells	J-61	40	40	40	40	40	40	\$74,000
Val Verde	City of Del Rio	Rio Grande	Water loss audit and main-line repair	J-62	119	119	119	119	119	119	\$8,673,000
			Drill & equip new well, connect to distribution system	J-63	850	850	850	850	850	850	\$2,937,000
			Water treatment plant expansion	J-64		943	943	943	943	943	\$1,841,000
			Develop a wastewater reuse program	J-65	3,092	3,092	3,092	3,092	3,092	3,092	\$1,700,000
	* Val Verde County Mining		Additional groundwater well	J-67	80	80	80	80	80	80	\$235,000

Table 11-8. 2021 Summary of Recommended and Alternate Water Management Projects

County	Water User Group	Strategy	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
				2020	2030	2040	2050	2060	2070	
Bandera	City of Bandera	Reuse treated wastewater effluent for irrigation of public spaces	J-1	0	310	310	310	310	310	\$1,496,000
		Promote, design & install rainwater harvesting systems on public buildings	J-2	0	1	1	1	1	1	\$56,000
		Additional Lower Trinity well and lay necessary pipeline ALTERNATE	J-3	0	403	403	403	403	403	\$3,298,000
		Additional Middle Trinity wells within City water infrastructure area	J-4	161	161	161	161	161	161	\$625,000
		Surface water acquisition, treatment and ASR	J-5	0	1,500	1,500	1,500	1,500	1,500	\$34,188,000
	*Bandera County FWSD #1	Additional groundwater well	J-7	100	100	100	100	100	100	\$990,000
	*Bandera County Other - Bandera River Ranch #1	Water loss audit and main-line repair for	J-8	4	4	4	4	4	4	\$902,000
	*Bandera County Other - Lake Medina Shores	Additional groundwater wells ALTERNATE	J-10	251	251	251	251	251	251	\$1,477,000
	*Bandera County Other - Medina WSC	Additional groundwater well	J-12	55	55	55	55	55	55	\$1,417,000
	Bandera County Other - Volunteer Fire Dept.	Additional groundwater wells to provide emergency supply ALTERNATE	J-16	189	189	189	189	189	189	\$4,280,000
	Bandera County Other - Enchanted River Estates	Water loss audit and main-line repair	J-17	1	1	1	1	1	1	\$117,000
	*Bandera County Irrigation	Additional groundwater wells	J-21	75	75	75	75	75	75	\$291,000
	*Bandera County Livestock	Additional groundwater well	J-23	2	2	2	2	2	2	\$135,000
		Additional groundwater well	J-25	3	3	3	3	3	3	\$126,000
Edwards	City of Rocksprings	Additional groundwater well	J-27	121	121	121	121	121	121	\$681,000
	Edwards County Other (Barksdale WSC)	Additional well in the Nueces River Alluvium Aquifer and RO wellhead treatment	J-28	54	54	54	54	54	54	\$178,000
	*Edwards County Mining	Additional groundwater well	J-31	16	16	16	16	16	16	\$125,000
		Additional groundwater well	J-33	12	12	12	12	12	12	\$73,000

Table 11-8. (continued) 2021 Summary of Recommended and Alternate Water Management Projects

County	Water User Group	Strategy	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
				2020	2030	2040	2050	2060	2070	
Edwards	*Edwards County Mining	Additional groundwater wells	J-35	31	31	31	31	31	31	\$132,000
Kerr	*City of Kerrville	Increase wastewater reuse	J-36	2,500	2,500	2,500	2,500	2,500	2,500	\$12,570,000
		Water loss audit and main-line repair	J-37	134	134	134	134	134	134	\$12,636,000
		Explore and develop new Ellenburger Aquifer well supply	J-39	1,156	1,156	1,156	1,156	1,156	1,156	\$14,493,000
		Increased water treatment and ASR capacity	J-41	0	3,360	3,360	3,360	3,360	3,360	\$15,393,000
	Kerr County Other - Eastern Kerr County Regional Water Supply Project	Project 1. Construction of an Ellenburger Aquifer water supply well	J-45	0	108	108	108	108	108	\$652,000
		Project 2. Construction of off-channel surface water storage		0	1,121	1,121	1,121	1,121	1,121	\$25,231,000
		Project 2. Construction of surface water treatment facilities and transmission lines		0	1,124	1,124	1,124	1,124	1,124	\$22,829,000
		Project 3. Construction of ASR facility		0	1,124	1,124	1,124	1,124	1,124	\$1,461,000
		Project 4. Construction of Trinity Aquifer wellfield for dense, rural areas		0	860	860	860	860	860	\$8,367,000
		Project 4. Construction of desalination plant								\$21,162,000
	Kerr County Other - Verde Park Estates	Water loss audit and main-line repair	J-42	1	1	1	1	1	1	\$155,000
	*Kerr County Livestock	Additional groundwater wells ALTERNATE	J-57	119	119	119	119	119	119	\$985,000
		Additional groundwater wells ALTERNATE	J-59	173	173	173	173	173	173	\$370,000
		Additional groundwater well ALTERNATE	J-61	27	27	27	27	27	27	\$79,000
		Additional groundwater well ALTERNATE	J-63	6	6	6	6	6	6	\$66,000
	*Kerr County Mining	Additional groundwater wells	J-65	19	19	19	19	19	19	\$197,000
Kinney	City of Brackettville	Increase supply to Spofford with new water line	J-66	0	3	3	3	3	3	\$4,271,000
		Increase storage facility	J-67	0	3	3	3	3	3	\$1,272,000

Table 11-8. (continued) 2021 Summary of Recommended and Alternate Water Management Projects

County	Water User Group	Strategy	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost
				2020	2030	2040	2050	2060	2070	
Kinney	Fort Clark Springs MUD	Water loss audit and main-line repair	J-68	79	79	79	79	79	79	\$1,531,000
		Increase storage facility	J-69	0	620	620	620	620	620	\$1,501,000
Real	*City of Camp Wood	Additional groundwater wells	J-73	143	143	143	143	143	143	\$1,709,000
	City of Leakey	Additional groundwater well	J-75	91	91	91	91	91	91	\$189,000
		Develop interconnections between wells within the City	J-76	0	81	81	81	81	81	\$202,000
	Real County Other - Real WSC	Water loss audit and main-line repair	J-77	2	2	2	2	2	2	\$482,000
	Real County Other - Oakmont Saddle Mountain WSC	Additional groundwater well	J-79	54	54	54	54	54	54	\$417,000
Val Verde	*City of Del Rio	Water loss audit and main-line repair	J-80	12	12	12	12	12	12	\$5,672,000
		Additional groundwater well	J-81	7,191	7,191	7,191	7,191	7,191	7,191	\$12,695,000
		Water treatment plant expansion	J-82	0	943	943	943	943	943	\$8,646,000
		Develop a wastewater reuse program	J-83	0	3,092	3,092	3,092	3,092	3,092	\$2,846,000
	Val Verde County Other - Val Verde County WCID Comstock	Water loss audit and main-line repair	J-84	1	1	1	1	1	1	\$406,000
	Val Verde County Other - San Pedro Canyon Upper Subdivision	Water loss audit and main-line repair	J-85	7	7	7	7	7	7	\$142,000
	Val Verde County Other - Tierra Del Lago	Water loss audit and main-line repair	J-86	4	4	4	4	4	4	\$146,000
	*Val Verde County Mining	Additional groundwater wells	J-89	242	242	242	242	242	242	\$1,096,000

11.3 PROGRESS OF REGIONALIZATION

Five of the six counties that comprise the Plateau Region are highly rural with each county containing only one or two communities of significant size. Generally, these rural communities are totally self-supportive without need or justification for regional / shared water supply projects.

The *2021 Plateau Region Water Plan* projects only a limited amount of water-supply shortage for the rural Guadalupe River Basin portion of Kerr County at large; however, it is recognized that a greater percentage of the rural population is concentrated in the eastern portion of the county (see Chapter 2, Figure 2-3). Population growth in eastern Kerr County continues to increase, creating genuine concerns pertaining to the water availability needed to meet these growing demands.

To meet this anticipated need, the Kerr County Commissioners' Court (KCCC) in partnership with the Upper Guadalupe River Authority (UGRA) has plans to develop the Eastern Kerr County Regional Water Supply Project (EKCRWSP) to provide for conjunctive use of surface water and groundwater in high density growth areas of eastern Kerr County outside of the area serviced by the City of Kerrville. The EKCRWSP includes both water and wastewater facilities, and will draw on several proposed strategies to tap multipole water-supply sources (see Chapter 5, Strategy J-45).

Regionalization thus plays a key role in moving both surface water and groundwater supplies to the numerous end-users in the County. This *2021 Plateau Region Water Plan* continues to support regionalization by recognizing that future water supplies can best be shared in this high-growth community through cooperative management.