2026 REGION F WATER PLAN

Initially Prepared Plan / Volume I / Main Report

2026 REGION F INITIALLY PREPARED PLAN

MARCH 2025

Prepared for:

REGION F WATER PLANNING GROUP

DRAFT
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ADVANCED GROUNDWATER SOLUTIONS

RIVULOUS, LLC.

PREFACE

In 1997, the 75th Texas Legislature passed Senate Bill One, legislation designed to address Texas water issues. Senate Bill One put in place a grass-roots regional process to plan for the future water needs of all Texans. To implement this process, the Texas Water Development Board created 16 regional water planning groups across the state and established regulations governing regional planning efforts. This plan presents the results of this process for the Region F Water Planning Area that represents 32 counties in West Texas.

In accordance with the State planning guidelines, the regional water plan includes eleven specific chapters. In addition to the eleven required sections, this report also includes appendices providing more detailed information on the planning efforts. The elements contained in this plan meet Texas Water Development Board regional planning requirements and guidelines.

The *2026 Region F Water Plan* represents the culmination of five years of working together with the regional water planning group (RWPG), regional and local water providers, and the public. As you read this water plan, the RWPG would like you to keep in mind the following points:

- The *2026 Region F Water Plan* presents a comprehensive overview of the water supply issues in the region. It does not predict or forecast future droughts or floods.
- This plan is a living document that will change as new data become available that better represent the demands on our water resources, available supplies from these resources, and the water supply projects that are being pursued.
- The report presents planning level analyses of the recommended water management strategies. Additional engineering studies and design will be needed prior to the implementation of the strategies.
- The specific surpluses and needs shown in the plan should be treated with caution because their development requires certain assumptions that may or may not come to fruition.
- The RWPG has no authority to regulate water supplies or implement water management strategies. The identified water management strategies are assumed to be implemented by the respective water user.

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2026 REGION F PLAN. LIST OF ACROYNMS.

Acronym	Name	Meaning
ASR	Aquifer Storage and Recovery	Aquifer storage and recovery (ASR) is the storage of water in a suitable aquifer through a well during times when water is available, and the recovery of water from the same aquifer during times when it is needed.
BCWID	Brown County Water Improvement District Number One	Owns and operates Lake Brownwood. Wholesale water provider in Brown and Coleman Counties.
CRMWD	Colorado River Municipal Water District	Water district that owns and operates 3 major reservoirs and several well fields. CRMWD is the largest water supplier in Region F and is the political subdivision for the Region F RWPG.
DFC	Desired Future Condition	Criteria for which is used to define the amount of available groundwater from an aquifer.
GAM	Groundwater Availability Model	Numerical groundwater flow model. GAMs are used to determine the aquifer response to pumping scenarios. These are the preferred models to assess groundwater availability.
GCD	Groundwater Conservation District	Generic term for all or individual state recognized Districts that oversee the groundwater resources within a specified political boundary.
GMA	Groundwater Management Area	Sixteen GMAs in Texas. Tasked by the Legislature to define the desired future conditions for major and minor aquifers within the GMA.
gpcd	Gallons per capita per day	Unit of measure that accounts for water use in the number of gallons a person uses each day.
MAG	Modeled Available Groundwater	The MAG is the amount of groundwater that can be permitted by a GCD on an annual basis. It is determined by the TWDB based on the DFC approved by the GMA. Once the MAG is established, this value must be used as the available groundwater in regional water planning.
MWP	Major Water Provider	A water user group or a wholesale water provider of particular significance to the region's water supply as determined by the regional water planning group.
PGMA	Priority Groundwater Management Area	A PGMA is an area designated and delineated by TCEQ that is experiencing or expected to experience, critical groundwater problems. If a study area is designated as a PGMA, TCEQ will make a specific recommendation on groundwater conservation district creation.
RWPG	Regional Water Planning Group	The generic term for the planning groups that oversee the regional water plan development in each respective region in the State of Texas
SB1	Senate Bill One	Legislation passed by the 75th Texas Legislature that is the basis for the current regional water planning process.
TCEQ	Texas Commission on Environmental Quality	Agency charged with oversight of Texas surface water rights and WAM program.

Acronym	Name	Meaning
TMDL	Total Maximum Daily Load	A Total Maximum Daily Load (TMDL) is a regulatory term in the U.S. Clean Water Act, describing a plan for restoring impaired waters that identifies the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.
TWDB	Texas Water Development Board	Texas Agency charged with oversight of regional water plan development and oversight of GCDs
UCRA	Upper Colorado River Authority	Owner of water rights in O.C. Fisher Reservoir and Mountain Creek Lake. Designated WWP.
WAM	Water Availability Model	Computer model of a river watershed that evaluates surface water availability based on Texas water rights.
WMS	Water Management Strategy	Strategies available to RWPG to meet water needs identified in the regional water plan.
WUG	Water User Group	A group that uses water. Six major types of WUGs: municipal, manufacturing, mining, steam electric power, irrigation and livestock.
WWP	Wholesale Water Provider	Entity that has or is expected to have contracts to sell 1,000 ac-ft./yr. or more of wholesale water.

EXECUTIVE SUMMARY

In 1997, the state of Texas began a comprehensive water planning and management effort using a "bottom up" approach to ensure that the water needs of all Texans are met. This process results in 16 unique regional water plans that are compiled into the State Water Plan. Since this planning effort began there have been five State Water Plans developed. This report presents the *Region F Water Plan* developed in the sixth round of the regional water planning process. Region F includes 32 counties in West Texas, as show in Figure ES- 1.

The 2026 Region F Water Plan consists of 10 chapters that identify the water needs in the region and then maps out a path to conserve water supplies, meet future water supply needs, and respond to future droughts. Associated data necessary in developing the plan is included in several appendices. All of the TWDB rules, guidance, and regulations were followed and compliance with them is documented in Appendix A. The plan's required database (DB27) reports can be accessed through the TWDB Database Reports application at https://www3.twdb.texas.gov/apps/SARA/reports/list and following the steps below.

1. Enter '2026 Regional Water Plan' into the "Report Name" field to filter to all DB27 reports associated with the 2026 Regional Water Plans
2. Click on the report name hyperlink to load the desired report
3. Enter the planning region letter parameter, click view report

The tables available for access in DB27 are listed below.

1. WUG Population
2. WUG Water Demand
3. Source Availability
4. WUG Existing Water Supply
5. WUG Needs/Surplus
6. WUG Second-Tier Identified Water Need
7. WUG Data Comparison to 2021 RWP
8. Source Data Comparison to 2021 RWP
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10. Recommended WUG Water Management Strategies
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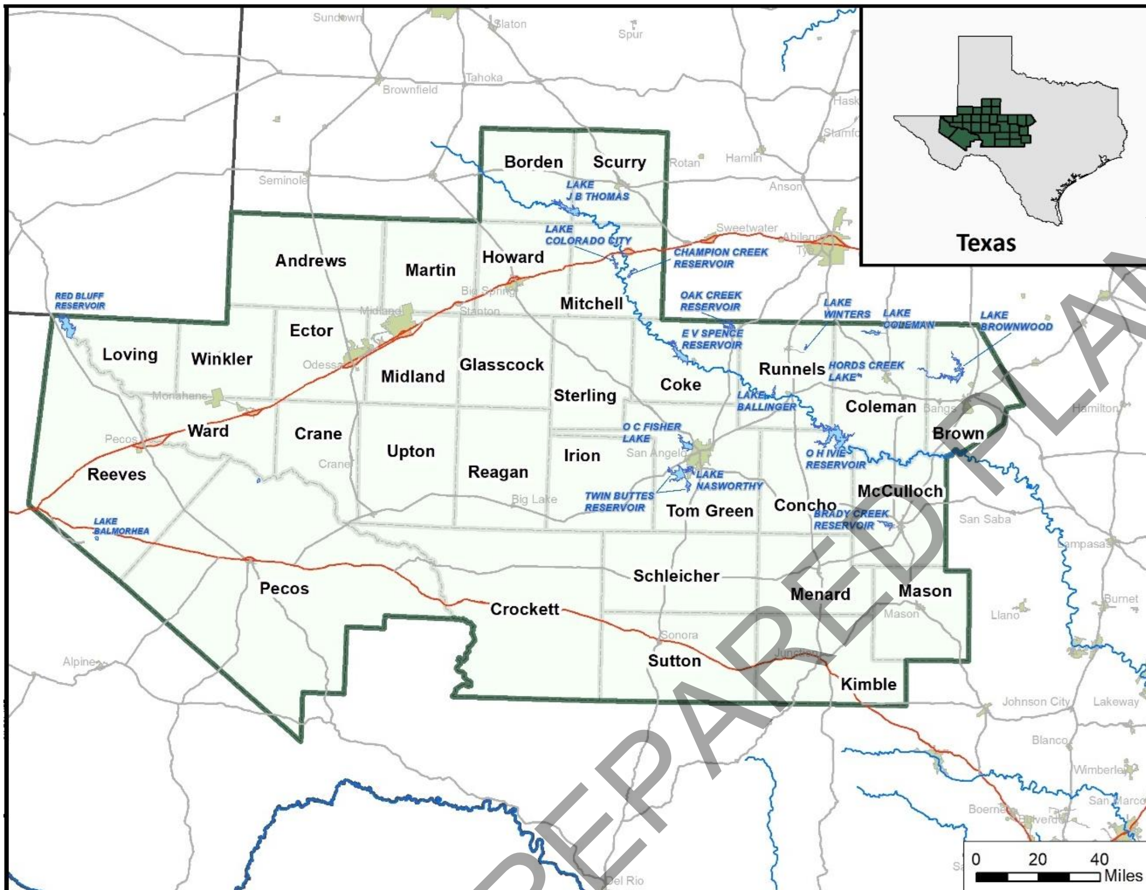
14. WUG Management Supply Factor
15. Recommended water Management Strategy Supply Associated with a new or amended IBT Permit
16. WUG Recommended WMS Supply Associated with a new or amended IBT Permit and Total Recommended conservation WMS Supply
17. Sponsored Recommended WMS Supplies Unallocated to WUGs
18. MWP Existing sales and Transfers
19. MWP WMS Summary

The 2026 Region F Initially Prepared Water Plan was developed under the direction of the Region F Water Planning Group and adopted by the planning group on February 20, 2025. This report presents the results of a five-year planning effort to develop a plan for water supply for the region through 2080.

Figure ES- 1
Region F Area Map



ES.1 Key Findings

The Region F Water Plan projects population and water demands over a fifty-year planning horizon and seeks to identify possible strategies to avoid potential water shortages in the region. Due to drought in the Colorado River Basin, the estimated surface water availability has declined from previous estimates. A new drought of record in the Rio Grande basin resulted in further decreases of surface water supplies for the region. This has resulted in the development of other supplies and reduced reliance on surface water in the region. For some areas, the only source of water is groundwater. Continued and increased demands on groundwater affect the long-term availability of many Region F aquifers. Groundwater availability remained very similar to the availability in the 2021 Water Plan. There continues to be areas with insufficient surface water and groundwater. Also, water quality is significant concern in the region for both surface water and groundwater sources. As entities continue to stress existing water sources, the impacts to quality will increase and the usability of the water will decline. To address this concern, there are several advanced treatment strategies recommended in the region. Irrigation continues to be largest user of water in Region F, but the ability to fully meet this demand during drought is limited. Irrigation conservation provides for some of the need but there is still a regional unmet need of 14,674 acre-feet pear year by 2080. The increased mining activities in the region has had multiple impacts to water demands, including spurring population growth and economic activities in both rural and urban communities, which increase associated water demands. As the region looks to meet its projected needs, conservation, additional groundwater development, and advanced treatment will become greater integral components of the region's water supplies.

ES.2 Current Water Needs and Supplies in Region F

As of the 2020 census, the population of Region F was 694,245. Almost 80 percent of the people in Region F live in urban areas or small- to moderate-sized rural communities. Three counties, Midland, Ector and Tom Green, account for more than half of the region's population. These counties contain the cities of Midland, Odessa and San Angelo, respectively. The Permian and Delaware Basin portions of Region F are experiencing a population increase due to interest in the exploration and production of oil. Because the TWDB population methodology is based on historical growth rates and not economic drivers, population growth is shown to continue throughout the planning horizon despite a reduction in mining demands beginning in 2040. Mining demands may continue as technology improves to make more resources recoverable, the region may diversify its economy overtime, or the population may not grow as projected by TWDB. This should continue to be monitored and updated in future planning cycles.

2.1.1 Physical Setting

Most of Region F is located in the upper portion of the Colorado Basin and in the Pecos portion of the Rio Grande Basin. A small portion of the region is in the Brazos Basin. Figure ES- 1. shows the major streams in Region F. Precipitation increases from west to east across the region, as does the average runoff. Evaporation increases from southeast to northwest. The patterns of rainfall, runoff, and evaporation result in more abundant water supplies in the eastern portion of the region.

Region F includes 17 major water supply reservoirs that provide most of the region's surface water supply. Four major aquifers and ten minor aquifers provide groundwater supplies to Region F. Springs have historically played an important role in water supply; however, over time most of the springs have greatly diminished and only contribute to water supply in specific locations.

ES.2.1 Current Sources of Water

The Region F surface water supplies are associated primarily with major reservoirs. Region F does not import a significant amount of surface water from outside the region. However, Region F exports surface water to the cities of Sweetwater and Abilene, both in the Brazos G Region. The City of Sweetwater owns and operates Oak Creek Reservoir in Region F. The City of Abilene has a contract to purchase water out of O.H. Ivie Reservoir in Region F. Surface water supplies have historically been an important source of water for municipal use and is the primary source for many communities.

Region F has 16 Groundwater Conservation Districts (GCDs) that oversee the use of water from the aquifers in the region. Twelve of these GCDs formed an alliance known as the West Texas Regional Groundwater Alliance that promotes conservation, preservation, and beneficial use of water in Region F.

ES.2.2 Water Providers in Region F

Water providers in Region F are classified by use type and can be grouped into municipal and non-municipal water users. Non-municipal water users are aggregated by county and include irrigation, livestock, manufacturing, mining, and steam electric power. Municipal water user groups are defined by water utilities that provide 100 acre-feet per year or more to retail customers. A major water provider is an entity that provides a significant amount of water in the region. In Region F, there are 95 municipal water user groups and five major water providers. The major water providers include the Colorado River Municipal Water District, Brown County Water Improvement District Number 1, Midland, Odessa, and San Angelo.

ES.3 Projected Need for Water

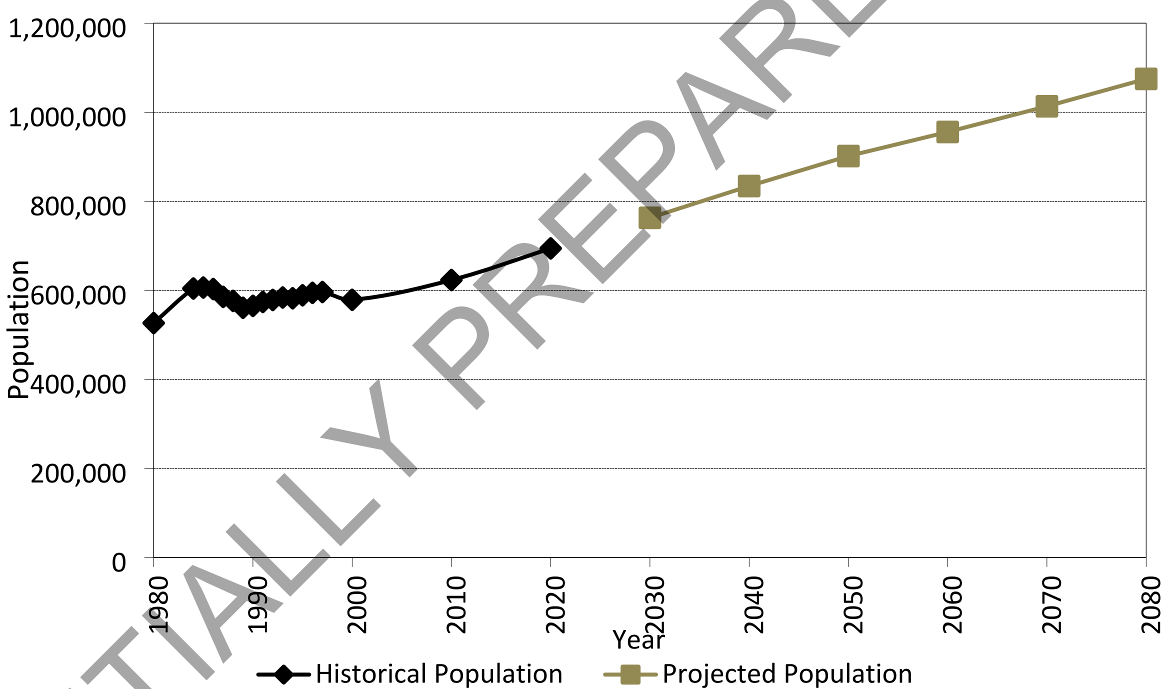
ES.3.1 Population Projections

The population of Region F as shown on Table ES- 1 is projected to grow from 762,985 in the year 2030 to 1,074,918 in 2080, which equates to an average growth rate of 0.70 percent per year. The population projections were developed by the Texas Water Development Board (TWDB). The relative distribution of population in Region F is expected to remain stable throughout the planning period. All but three of the counties are generally rural counties and are expected to remain so into the future. The distribution of the projected population by county and city is discussed in Chapter 2. Figure ES- 2 shows the historical and projected population for Region F.

Table ES- 1
Region F Population Projections

Population Projections	2030	2040	2050	2060	2070	2080
Region F Total	762,985	834,344	901,689	955,743	1,013,398	1,074,918

Figure ES- 2
Historical and Projected Population in Region F



ES.3.2 Demand Projections

Table ES-2 shows the projected demands for water by category of use in Region F. The total historical water use was about 811,000 acre-feet in the year 2021 and is projected to be 859,746 acre-feet in 2030. Irrigated agriculture is the largest water use category in Region F throughout the planning horizon, accounting for approximately 54 percent of the projected water use in 2030. While the demand projections do not decline over the planning period, it is possible that some irrigation water use will be converted to other use types as the need for water increases.

Mining is a significant water user in early decades but is projected to decline over time as oil and gas deposits are fully developed. Municipal water use is also a major water use category and is projected to grow over time, as the population increases, and eventually be the second largest use category.

Manufacturing, livestock, and steam electric power are relatively small use categories In Region F over the planning horizon and are expected to remain steady over the planning period.

Figure ES- 3
Projected Water Demand in Region F by Use Category

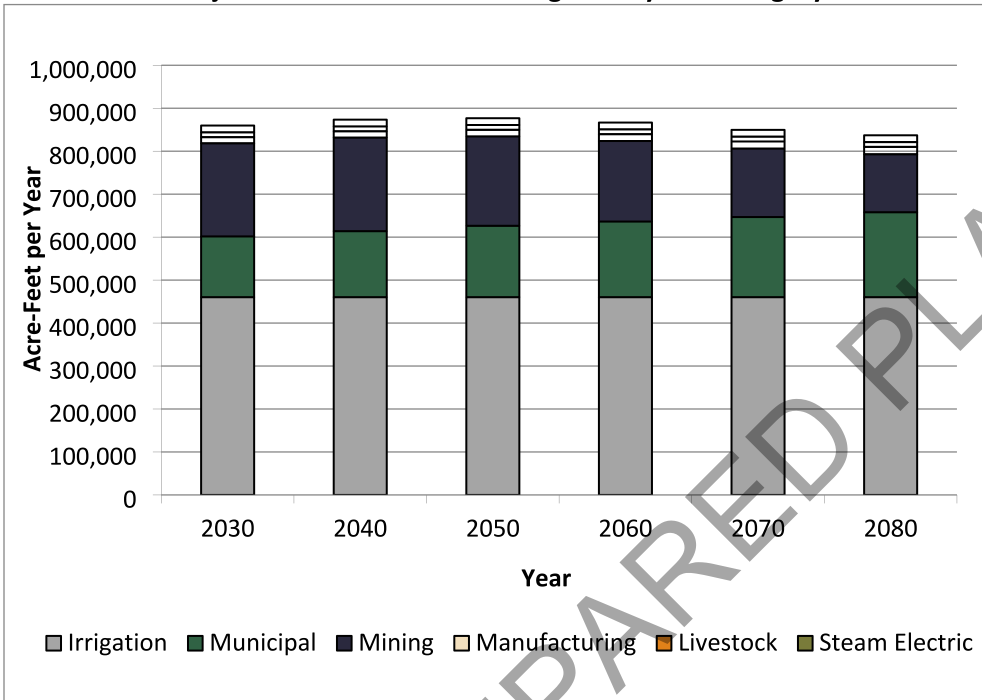


Table ES- 2
Water Demands by Use Type (acre-feet per year)

Use Category	2030	2040	2050	2060	2070	2080
Municipal	141,387	153,631	166,113	175,942	186,455	197,714
Manufacturing	14,276	14,802	15,347	15,913	16,500	17,109
Irrigation	460,341	460,341	460,341	460,341	460,341	460,341
Steam Electric	15,798	15,798	15,798	15,798	15,798	15,798
Mining	216,716	217,652	207,969	187,463	159,337	134,865
Livestock	11,228	11,228	11,228	11,228	11,228	11,228
Region F Total	**859,746**	**873,452**	**876,796**	**866,685**	**849,659**	**837,055**

ES.3.3 Water Supply Analysis

As required by TWDB rules, the available surface water supplies are derived from Water Availability Models (WAMs), Full Authorization Run (Run 3). The WAMs were developed by the Texas Commission on Environmental Quality (TCEQ). Three WAMs are available in Region F: (a) the Colorado WAM, which covers most of the central and eastern portions of the region, (b) the Rio Grande WAM, which covers the Pecos Basin, and (c) the Brazos WAM. The WAMs allocate water based on priority without regard to geographic location, agreements between water right holders, or type of use. As a result, the Colorado WAM significantly underestimates the total surface water supply in Region F as currently operated.

Groundwater provides most of the irrigation water used in the region, as well as a significant portion of the water used for municipal and other purposes. Groundwater is primarily found in four major and ten minor aquifers that vary in quantity and quality (Figure ES- 4 and Figure ES- 5). Total groundwater supply is determined using the Modeled Available Groundwater (MAG) value as determined by the TWDB.

Figure ES- 4
Major Aquifer Map

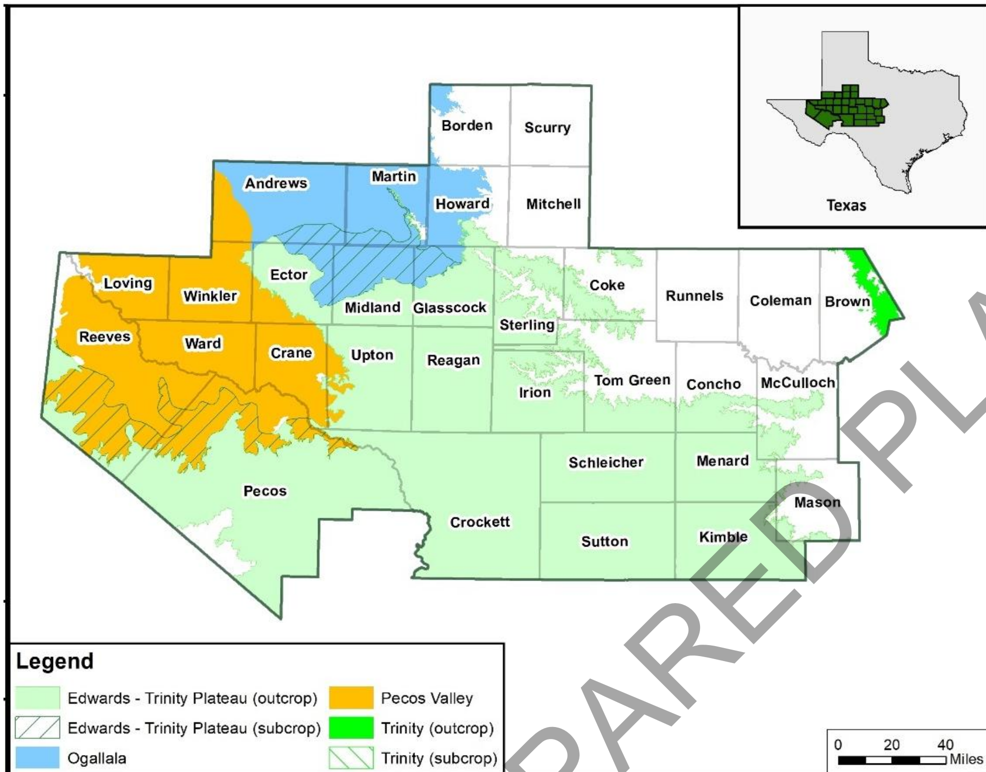
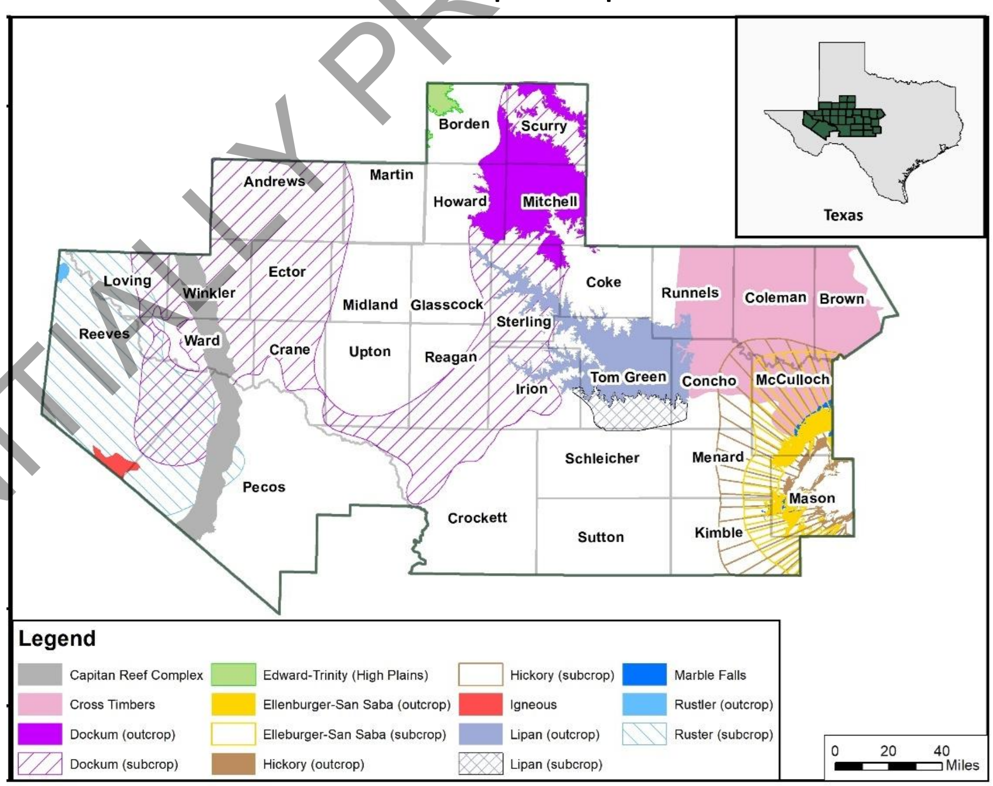


Figure ES- 5
Minor Aquifer Map



The total amount of water available in Region F is approximately 1.3 million acre-feet per year as shown on Figure ES- 6. This includes over 1.1 million acre-feet of groundwater. However, not all the water supplies in the region are currently available and connected to users. Water supply may be limited by the yield of reservoirs, well field capacity, aquifer characteristics, water quality, water rights, permits, contracts, regulatory restrictions, raw water delivery infrastructure or water treatment capacity. Table ES- 3 shows the supplies available to water users by use type. The total amount of water currently available to users in Region F is greater than 827,000 acre-feet per year in 2030 and over 739,000 acre-feet per year by 2080.

Figure ES- 6
Water Availability by Source Type

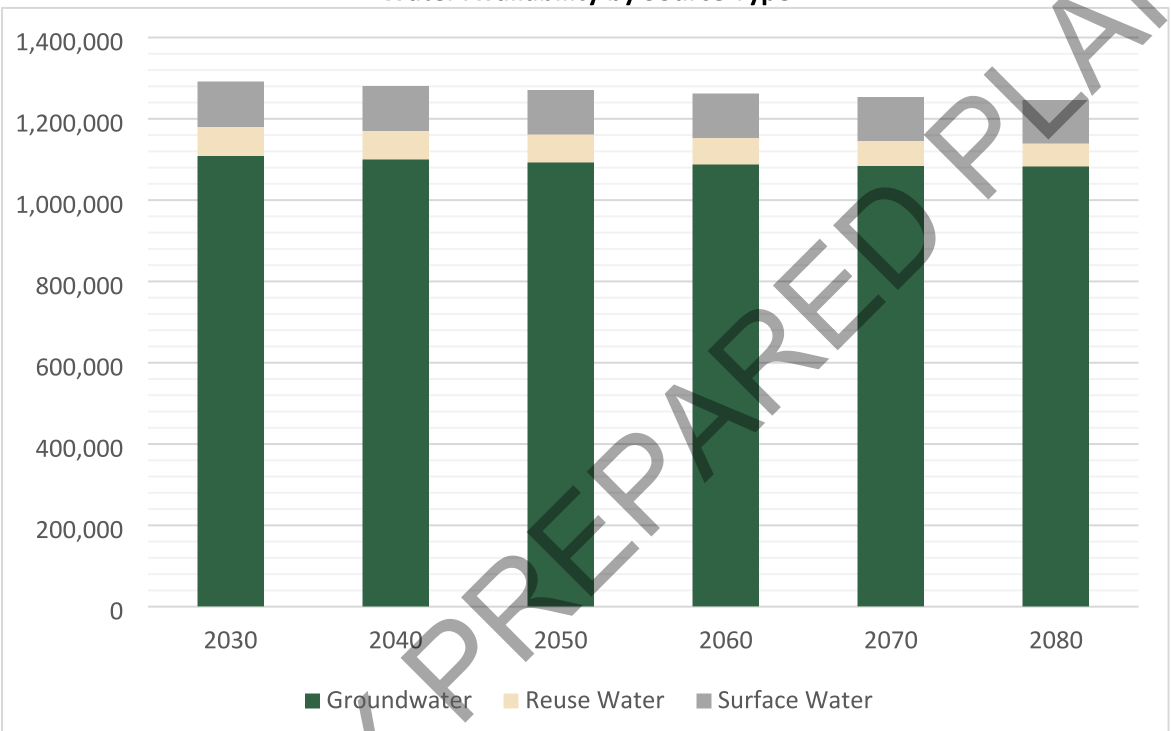


Table ES- 3
Existing Supplies by Use Type (acre-feet per year)

Existing Supplies	2030	2040	2050	2060	2070	2080
Irrigation	449,904	437,440	434,079	432,726	432,651	432,707
Manufacturing	15,193	15,538	15,869	16,265	16,733	17,230
Mining	196,057	195,537	187,209	170,616	147,335	126,237
Municipal	147,286	152,412	151,685	148,560	146,958	144,939
Steam Electric	8,934	8,741	8,491	8,209	8,027	7,858
Livestock	11,212	11,199	11,191	11,186	11,182	11,178
Region F Total	**828,586**	**820,867**	**808,524**	**787,562**	**762,886**	**740,149**

ES.3.4 Comparison of Supply and Demand

Figure ES- 7 illustrates a comparison of the available water supply to Region F and projected demands. Table ES- 4 shows the needs by water use type. With a projected 2080 demand of over 837,000 acre-feet per year and declining water supplies, Region F has a projected regional shortage of nearly 100,000 acre-feet per year by 2080. Most of this need is associated with municipal water use, which some users rely heavily on surface water supplies. The subordination strategy that better reflects current operations in the Colorado River Basin will meet some of the municipal water need but not all of it.

Irrigation, mining, and steam electric power are the other use categories with needs greater than 5,000 acre-feet per year. Irrigation and mining needs are mainly due to limitations in groundwater availability; while the projected steam electric power needs are associated with limitations of the WAM and current unmet needs of Major Water Providers (MWP) that will be met with strategies.

Figure ES- 7
Comparison of Supply and Demand (acre-feet per year)

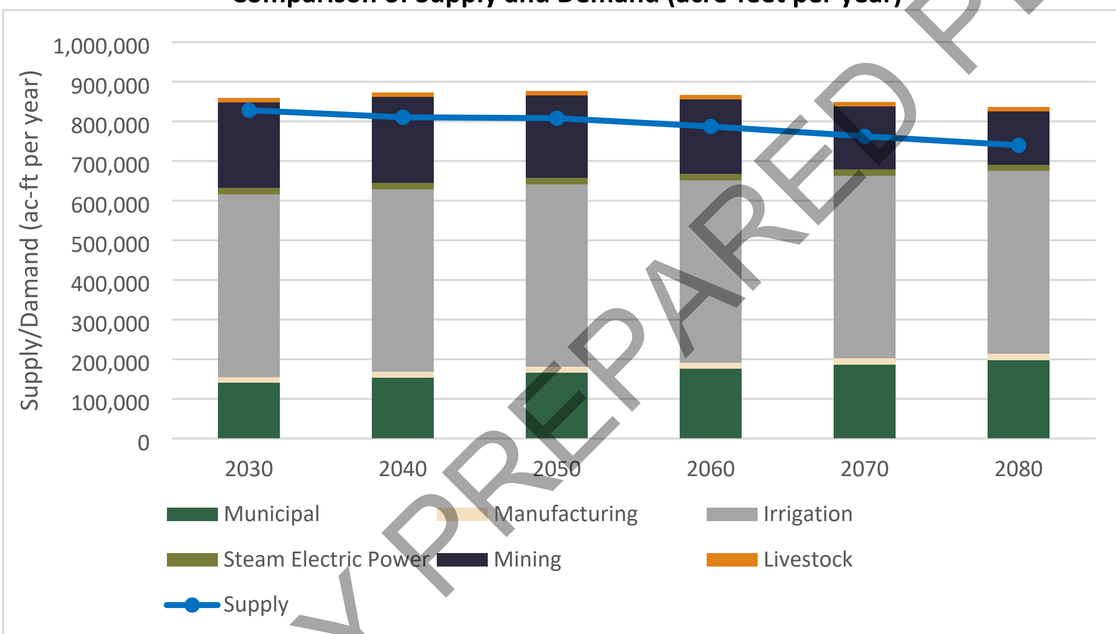


Table ES- 4
Needs by Use Type (acre-feet per year)

Need	2030	2040	2050	2060	2070	2080
Municipal	(8,815)	(12,384)	(21,413)	(29,960)	(40,081)	(53,366)
Manufacturing	(106)	(287)	(501)	(671)	(790)	(902)
Irrigation	(10,564)	(22,968)	(26,262)	(27,615)	(27,690)	(27,634)
Steam Electric Power	(6,864)	(7,057)	(7,307)	(7,589)	(7,771)	(7,940)
Mining	(20,660)	(22,117)	(20,762)	(16,848)	(12,239)	(9,872)
Livestock	(74)	(87)	(95)	(100)	(104)	(108)
Region F Total	(8,815)	(12,384)	(21,413)	(29,960)	(40,081)	(53,366)

ES.3.5 Socio-Economic Impact of Not Meeting Projected Water Needs

According to the comparison of supply and demand, Region F could face significant shortages in water supply over the planning period for some water users. To assess the potential socio-economic impacts of these shortages, the TWDB will conduct an evaluation of failing to meet the projected water needs in Region F after the publication of the initially prepared plan (IPP) and will be included in the final plan. The TWDB's analysis calculated the impacts of a severe drought occurring in a single year at each decadal period in Region F. The findings of this study are summarized below:

- With the projected shortages, the region's projected 2030 population would be reduced by approximately [To be updated in Final Plan] percent.
- The region may experience [To be updated in Final Plan] percent reduction in employment in 2030. The mining sector accounts for [To be updated in Final Plan] percent of these jobs losses in 2030.
- The region's projected annual income in 2030 would be reduced by $[To be updated in Final Plan] billion, approximately [To be updated in Final Plan] percent of which is within the mining industry. This represents nearly [To be updated in Final Plan] percent of the region's current income.
- Economic impacts decline over time as the projected needs decrease. [To be updated in Final Plan]

ES.4 Identification and Selection of Water Management Strategies

The Region F Water Planning Group identified and evaluated a wide variety of potentially feasible water management strategies in developing this plan. Water supply availability, costs and environmental impacts were determined for conservation and reuse efforts, the connection of existing supplies, and the development of new supplies.

As required by the TWDB regulations, the evaluation of water management strategies was an equitable comparison of all feasible strategies and considered the following factors:

- Evaluation of quantity, reliability, and cost of water diverted and treated
- Environmental factors
- Impacts to agricultural and natural resources including impacts of moving water from rural and agricultural areas
- Impacts on key parameters of water quality
- Impacts on other water resources including other water management strategies
- Other factors as deemed relevant by the RWPG

ES.4.1 Water Conservation

The Region F Water Planning Group considered three major categories of water conservation: municipal, mining, and irrigation. Overall, it is estimated that over 67,000 acre-feet of water could be conserved annually by 2080 in Region F.

Municipal water conservation is recommended for all individual municipal water user groups and county-other groups that have a shortage. The total water savings from municipal conservation is estimated to be over 2,800 acre-feet per year in 2030 and is projected to grow to over 4,300 acre-feet per year by 2080. It also places less demand on limited water sources for municipal water users with enough supplies.

The recommended water conservation activities for municipal water users in Region F are:

- Education and outreach programs,
- Reduction of unaccounted for water through water audits and leak repair,
- Water rate structures that discourage water waste,
- Ordinances prohibiting the waste of water

- Landscape ordinances (for entities >20,000), and
- Time of day watering limits (for entities >20,000).

The two other conservation strategies, irrigation and mining conservation, provide nearly 30,800 acre-feet of water savings in 2030 and is projected to increase to 62,700 acre-feet by 2080. The irrigation conservation activities evaluated as part of this plan focus on efficient irrigation practices. Mining conservation focuses on the treatment and reuse of flowback water from fracking operations.

ES.4.2 Water Management Strategies

In addition to conservation, subordination of surface water in the Colorado River Basin and groundwater development are two of the major strategies in Region F. The subordination strategy, which was developed in conjunction with the Lower Colorado Region (Region K), reserves nearly 52,200 acre-feet of surface water for use in Region F in 2080. New groundwater development projects planned in Region F will provide approximately 26,000 acre-feet of additional reliable supply in 2030, increasing to nearly 47,000 acre-feet of supply in 2080. This strategy is recommended for both smaller users as well as major water providers. Figure ES- 8 shows the supplies from water management strategies by type for 2030 and 2080.

Table ES- 5 lists recommended water management strategies for Region F. In total, the Region F plan includes recommended water management strategies to develop or preserve over 215,000 acre-feet per year of additional supplies by 2080, including new well fields, reuse, new or additional treatment, and voluntary redistribution. Alternative water management strategies are included in summary Table ES- 6.

Figure ES- 8
Distribution of Supplies from Recommended Water Management Strategies

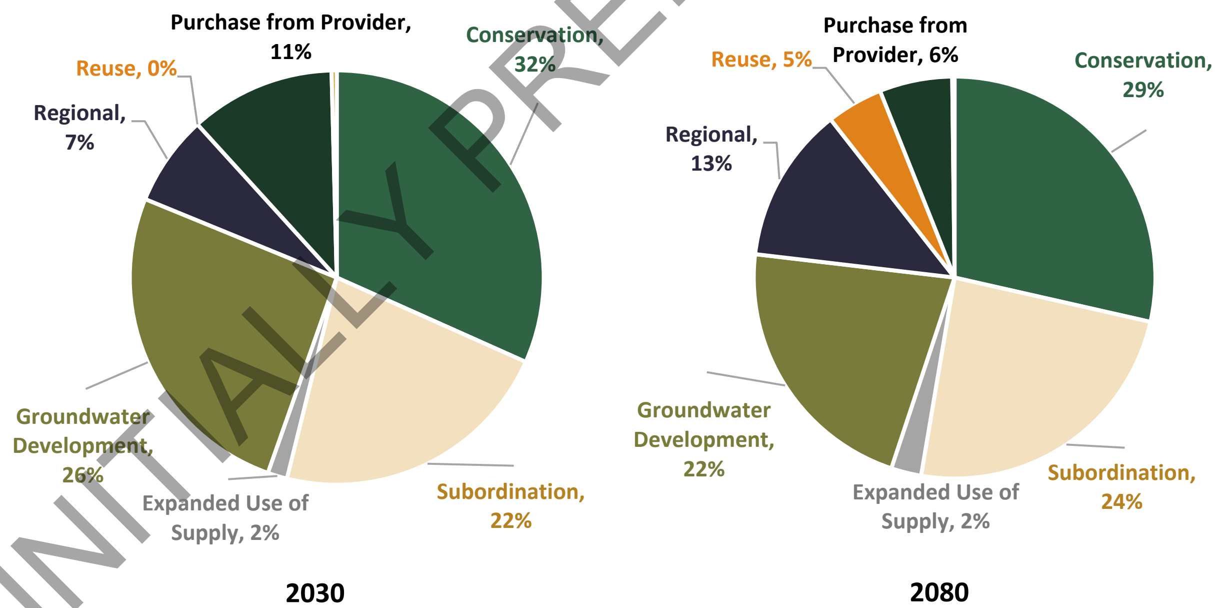


Table ES- 5
Recommended Water Management Strategies

Entity	County Used	Expected Online	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2030	2040	2050	2060	2070	2080	
Brush Control											
BCWID	Multiple	2030	$0	$470	400	400	400	400	400	400	$470
San Angelo	Multiple	2030	$0	$600	90	90	90	90	90	90	$600
Develop Dockum Aquifer Supplies											
Kermit	Winkler	2080	$1,460,000	$480	0	0	0	0	0	250	$68
Develop Edwards-Trinity Plateau Alluvium Aquifer Supplies											
Sterling City	Sterling	2050	$16,804,000	$1,542	0	0	875	875	875	875	$191
Develop Edwards-Trinity Plateau Aquifer Supplies											
County-Other	Andrews	2030	$3,441,000	$306	934	934	934	934	934	934	$47
Livestock	Andrews	2030	$1,018,000	$759	108	108	108	108	108	108	$93
Junction	Kimble	2040	$7,185,000	$1,557	0	370	370	370	370	370	$192
Pecos County WCID #1	Pecos	2030	$16,029,000	$3,063	560	560	560	560	560	560	$1,048
Balmorhea	Reeves	2040	$6,413,000	$4,573	0	110	110	110	110	110	$473
Madera Valley WSC	Reeves	2040	$15,482,000	$3,817	0	333	333	333	333	333	$547
Develop Ellenberger San Saba Aquifer Supplies											
Manufacturing	Kimble	2030	$727,000	$1,900	30	30	30	30	30	30	$200
Develop Lipan Aquifer Supplies											
UCRA	Tom Green	2040	$13,550,000	$313	0	5,000	5,000	5,000	5,000	5,000	$123
Develop Ogallala Aquifer Supplies											
Borden County Water System	Dawson	2060	$24,325,000	$14,127	0	0	0	22	71	134	$1,358
Greenwood Water	Midland	2030	$13,923,000	$1,891	2,420	2,420	2,420	2,420	2,420	2,420	$1,486
Develop Pecos Valley Aquifer Supplies											
Pecos	Reeves	2040	$69,404,000	$638	0	8,960	8,960	8,960	8,960	8,960	$93
Dredging River Intake											
Junction	*Kimble*	*2040*	*$10,439,000*	*$2,936*	*0*	*250*	*250*	*250*	*250*	*250*	*$0*

Entity	County Used	Expected Online	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2030	2040	2050	2060	2070	2080	
Groundwater Strategies											
Borden County Water System	Dawson	2060	$24,325,000	$14,127	0	0	0	22	71	134	$1,358
CRMWD	Ward, Winkler	2030	$299,500,000	$1,224	21,480	20,412	19,319	18,398	17,523	16,735	$245
County-Other	Midland	2030	$136,737,000	$5,531	234	1,401	1,401	1,401	1,401	1,401	$5,743
Increased Runoff Strategies											
UCRA	Tom Green	2040	$178,000	$1,300	0	10	10	10	10	10	$100
Irrigation Conservation											
Irrigation	Andrews	2030	$1,616,000	$32	878	1,756	1,756	1,756	1,756	1,756	$0
Irrigation	Borden	2030	$230,000	$32	125	250	250	250	250	250	$0
Irrigation	Brown	2030	$566,000	$32	384	615	615	615	615	615	$0
Irrigation	Coke	2030	$68,000	$32	31	62	74	74	74	74	$0
Irrigation	Coleman	2030	$39,000	$32	21	42	42	42	42	42	$0
Irrigation	Concho	2030	$526,000	$32	260	520	572	572	572	572	$0
Irrigation	Crockett	2030	$11,000	$32	4	8	12	12	12	12	$0
Irrigation	Ector	2030	$104,000	$32	38	75	113	113	113	113	$0
Irrigation	Glasscock	2030	$1,598,000	$32	1,737	1,737	1,737	1,737	1,737	1,737	$0
Irrigation	Howard	2030	$516,000	$32	255	510	561	561	561	561	$0
Irrigation	Irion	2030	$145,000	$32	53	105	158	158	158	158	$0
Irrigation	Kimble	2030	$287,000	$32	130	260	312	312	312	312	$0
Irrigation	Martin	2030	$4,545,000	$32	1,647	3,293	4,940	4,940	4,940	4,940	$0
Irrigation	Mason	2030	$663,000	$32	240	480	721	721	721	721	$0
Irrigation	McCulloch	2030	$286,000	$32	104	207	311	311	311	311	$0
Irrigation	Menard	2030	$478,000	$32	173	347	520	520	520	520	$0
Irrigation	Midland	2030	$2,483,000	$32	900	1,800	2,699	2,699	2,699	2,699	$0
Irrigation	Mitchell	2030	$239,200	$32	260	260	260	260	260	260	$0
Irrigation	Pecos	2030	$18,999,000	$32	6,884	13,767	20,651	20,651	20,651	20,651	$0
Irrigation	Reagan	2030	$2,967,000	$32	1,075	2,150	3,225	3,225	3,225	3,225	$0
Irrigation	Reeves	2030	$8,284,000	$32	3,001	6,003	9,004	9,004	9,004	9,004	$0

Entity	County Used	Expected Online	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2030	2040	2050	2060	2070	2080	
Irrigation	Runnels	2030	$388,000	$32	176	352	422	422	422	422	$0
Irrigation	Schleicher	2030	$111,000	$32	101	121	121	121	121	121	$0
Irrigation	Scurry	2030	$835,000	$32	349	698	908	908	908	908	$0
Irrigation	Sterling	2030	$118,000	$32	43	86	128	128	128	128	$0
Irrigation	Sutton	2030	$155,000	$32	56	112	168	168	168	168	$0
Irrigation	Tom Green	2030	$5,476,000	$32	2,480	4,960	5,952	5,952	5,952	5,952	$0
Irrigation	Upton	2030	$1,162,000	$32	421	842	1,263	1,263	1,263	1,263	$0
Irrigation	Ward	2030	$598,000	$32	217	433	650	650	650	650	$0
Irrigation	Winkler	2030	$423,000	$32	153	307	460	460	460	460	$0
Mining Conservation (Recycling)											
Mining	Andrews	2030	$4,840,000	$632	242	242	222	182	128	81	$0
Mining	Borden	2030	$2,340,000	$632	117	117	107	88	62	39	$0
Mining	Coke	2030	$40,000	$632	2	2	2	2	2	2	$0
Mining	Crane	2030	$420,000	$632	21	21	21	21	1	1	$0
Mining	Crockett	2030	$8,460,000	$632	423	423	78	63	45	28	$0
Mining	Ector	2030	$480,000	$632	24	24	22	18	12	8	$0
Mining	Glasscock	2030	$9,580,000	$632	479	479	439	359	253	160	$0
Mining	Howard	2030	$8,540,000	$632	427	427	391	320	226	142	$0
Mining	Irion	2030	$12,300,000	$632	615	615	563	92	65	41	$0
Mining	Loving	2030	$13,840,000	$632	692	692	692	692	692	692	$0
Mining	Martin	2030	$11,480,000	$632	574	574	526	143	101	64	$0
Mining	Midland	2030	$10,160,000	$632	508	508	466	381	90	56	$0
Mining	Mitchell	2030	$300,000	$632	15	15	14	12	8	5	$0
Mining	Pecos	2030	$18,620,000	$632	931	931	931	931	186	186	$0
Mining	Reagan	2030	$13,720,000	$632	686	686	628	171	121	76	$0
Mining	Reeves	2030	$40,340,000	$632	2,017	2,017	2,017	2,017	2,017	2,017	$0
Mining	Schleicher	2030	$2,960,000	$632	148	148	136	111	78	49	$0
Mining	Scurry	2030	$360,000	$632	18	18	16	13	9	6	$0
Mining	Sterling	2030	$2,100,000	$632	105	105	97	79	56	35	$0
Mining	Sutton	2030	$20,000	$632	1	1	1	1	1	1	$0

Entity	County Used	Expected Online	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2030	2040	2050	2060	2070	2080	
Mining	Tom Green	2030	$680,000	$632	34	34	31	26	18	11	$0
Mining	Upton	2030	$3,660,000	$632	183	183	168	137	97	61	$0
Mining	Ward	2030	$4,540,000	$632	227	227	227	227	227	227	$0
Mining	Winkler	2030	$2,260,000	$632	113	113	113	113	113	113	$0
Municipal Conservation											
Andrews	Andrews	2030	$0	$1,098	49	60	109	127	147	169	$662
County-Other	Andrews	2030	$0	$824	22	29	38	47	56	80	$712
Borden County Water System	Borden	2030	$0	$5,354	1	1	1	1	1	2	$2,812
Bangs	Brown	2030	$0	$1,379	9	9	9	9	9	9	$1,369
Coleman County SUD	Brown	2030	$0	$1,384	8	8	8	7	7	7	$1,480
Brookesmith SUD	Brown	2030	$0	$877	20	21	21	21	21	21	$853
Brownwood	Brown	2030	$0	$1,087	61	90	90	90	90	91	$852
Early	Brown	2030	$0	$1,321	10	10	10	11	11	11	$1,313
Zephyr WSC	Brown	2030	$0	$1,272	12	13	13	13	13	13	$1,266
Bronte	Coke	2030	$0	$2,076	3	3	3	3	4	4	$1,729
Robert Lee	Coke	2030	$0	$1,985	3	3	3	4	4	5	$1,670
Coleman	Coleman	2030	$0	$1,313	11	9	8	7	5	4	$1,751
Santa Anna	Coleman	2030	$0	$2,034	3	3	3	3	3	3	$2,138
Eden	Concho	2030	$0	$1,567	5	5	5	5	5	5	$1,618
Millersview-Doole WSC	Concho	2030	$0	$1,091	16	18	21	24	27	31	$573
Crane	Crane	2030	$0	$1,312	11	11	11	11	11	11	$1,307
Crockett County WCID 1	Crockett	2030	$0	$1,455	7	6	6	6	5	5	$1,655
Ector County Utility District	Ector	2030	$0	$795	102	128	147	191	209	227	$614
Odessa	Ector	2030	$0	$513	530	637	745	786	838	890	$502
Greater Gardendale WSC	Ector, Midland	2030	$0	$1,175	15	18	21	23	25	27	$662
Big Spring	Howard	2030	$0	$665	118	122	124	121	119	116	$669

Entity	County Used	Expected Online	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2030	2040	2050	2060	2070	2080	
Coahoma	Howard	2030	$0	$2,036	3	3	3	3	3	3	$2,067
Mertzon	Irion	2030	$0	$2,477	2	2	2	2	2	2	$2,596
Junction	Kimble	2030	$0	$1,460	7	7	7	7	7	7	$1,469
Stanton	Martin	2030	$0	$1,386	8	9	10	11	12	14	$1,248
Mason	Mason	2030	$0	$1,471	7	7	7	8	8	8	$1,422
Brady	McCulloch	2030	$0	$1,048	17	17	16	16	15	15	1,191
Richland SUD	McCulloch	2030	$0	$2,606	2	2	2	2	2	2	$2,899
Menard	Menard	2030	$0	$1,883	3	3	3	3	3	3	$2,075
Airline Mobile Home Park	Midland	2030	$0	$1,555	6	6	7	8	8	9	$1,361
Greenwood Water	Midland	2030	$0	$2,122	3	3	3	3	3	3	$2,184
Midland	Midland	2030	$0	$505	646	720	789	877	977	1,092	$490
Colorado City	Mitchell	2030	$0	$884	20	20	20	20	21	21	$862
Corix Utilities Texas Inc	Mitchell	2030	$0	$684	16	34	36	35	35	34	$684
Loraine	Mitchell	2030	$0	$2,649	2	2	1	1	1	1	$3,802
Fort Stockton	Pecos	2030	$0	$624	29	29	29	31	33	35	$515
Iraan	Pecos	2030	$0	$1,953	3	3	3	3	3	4	$1,847
Pecos County Fresh Water	Pecos	2030	$0	$2,439	2	2	2	2	2	3	$2,088
Pecos County WCID #1	Pecos	2030	$0	$1,483	7	7	8	7	7	6	$1,519
Big Lake	Reagan	2030	$0	$1,354	9	9	10	10	10	10	$1,340
Balmorhea	Reeves	2030	$0	$3,456	1	1	1	2	2	2	$2,649
County-Other	Reeves	2030	$0	$1,288	12	12	13	13	14	15	$1,219
Madera Valley WSC	Reeves	2030	$0	$1,535	6	6	7	7	8	8	$1,394
Pecos	Reeves	2030	$0	$587	30	34	38	40	43	46	$393
Ballinger	Runnels	2030	$0	$1,301	11	11	11	11	12	12	$1,286
County-Other	Runnels	2030	$0	$2,007	3	3	3	2	2	2	$2,624
Miles	Runnels	2030	$0	$2,157	3	3	3	3	3	3	$1,960
North Runnels WSC	Runnels	2030	$0	$1,737	4	4	4	5	5	5	$1,594
Winters	Runnels	2030	$0	$1,438	7	7	7	6	6	5	$1,591

Entity	County Used	Expected Online	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2030	2040	2050	2060	2070	2080	
Eldorado	Schleicher	2030	$0	$1,658	5	4	4	3	3	2	$2,468
Snyder	Scurry	2030	$0	$1,120	36	36	37	37	38	38	$1,115
U & F WSC	Scurry	2030	$0	$2,763	2	2	2	2	2	2	$2,720
Sterling City	Sterling	2030	$0	$1,702	4	6	8	10	13	16	$1,106
Sonora	Sutton	2030	$0	$1,474	7	6	6	5	5	4	$1,735
Concho Rural WSC	Tom Green	2030	$0	$771	23	26	29	31	34	37	$480
DADS Supported Living Center	Tom Green	2030	$0	$3,252	1	1	1	1	1	1	$3,252
Goodfellow Air Force Base	Tom Green	2030	$0	$1,444	7	7	7	7	7	7	$1,444
San Angelo	Tom Green	2030	$0	$519	463	507	538	570	605	643	$517
Tom Green County FWSD 3	Tom Green	2030	$0	$2,456	2	2	2	3	3	3	$1,950
McCamey	Upton	2030	$0	$1,599	5	5	6	6	6	6	$1,489
Rankin	Upton	2030	$0	$2,316	2	2	2	3	3	3	$2,093
Barstow	Ward	2030	$0	$4,605	1	1	1	1	1	1	$3,172
Grandfalls	Ward	2030	$0	$3,425	1	1	2	2	2	2	$2,466
Monahans	Ward	2030	$0	$691	26	29	33	36	39	43	$416
Southwest Sandhills WSC	Ward	2030	$0	$1,422	8	9	10	11	12	13	$1,268
Wickett	Ward	2030	$0	$3,148	1	2	2	2	2	2	$2,302
Kermit	Winkler	2030	$0	$812	22	25	29	31	34	38	$476
Wink	Winkler	2030	$0	$2,229	2	2	2	2	2	3	$2,197
New or Additional Treatment											
BCWID #1	*Brown*	*2030*	*$38,124,000*	*$4,045*	*1,529*	*1,529*	*1,529*	*1,529*	*1,529*	*1,529*	*$2,290*
Bronte	*Coke*	*2030*	*$15,000,000*	*$2,536*	*729*	*729*	*729*	*729*	*729*	*729*	*$1,089*
Odessa	*Ector*	*2040*	*$224,032,000*	*$2,145*	*0*	*15,700*	*15,700*	*15,700*	*15,700*	*15,700*	*$1,141*
Big Spring	*Howard*	*2040*	*$165,625,000*	*$1,737*	*0*	*11,210*	*11,210*	*11,210*	*11,210*	*11,210*	*$697*
Brady	*McCulloch*	*2050*	*$97,811,000*	*$7,622*	*0*	*0*	*1,770*	*1,740*	*1,710*	*1,680*	*$3,734*
Pecos	Reeves	2040	$91,236,000	$5,467	0	3,360	3,360	3,360	3,360	3,360	$3,557

Entity	County Used	Expected Online	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2030	2040	2050	2060	2070	2080	
Rehabilitation/Replacement of Infrastructure											
Bronte	*Coke*	*2040*	*$18,637,000*	*$3,225*	*0*	*457*	*457*	*457*	*457*	*457*	*$357*
CRMWD	Ward	2040	$17,868,000	$160	0	1,492	2,831	5,958	7,327	8,674	$15
Reuse											
Pecos	Reeves	2040	$17,953,000	$2,580	0	560	560	560	560	560	$325
Pecos	Reeves	2040	$41,357,000	$6,184	0	925	925	925	925	925	$3,038
San Angelo	Tom Green	2040	$254,550,000	$4,026	0	8,300	8,300	8,300	8,300	8,300	$1,871
Subordination											
BCWID #1	Brown	2030	$0	$0	8,721	8,666	8,611	8,536	8,461	8,386	$0
Coleman County SUD	Brown	2030	$0	$0	78	76	73	70	68	65	$0
Bronte	Coke	2030	$0	$0	199	212	213	215	216	217	$0
County-Other	Coke	2030	$0	$0	49	49	49	49	49	49	$0
Oak Creek	Coke	2030	$0	$0	598	556	513	473	433	393	$0
Robert Lee	Coke	2030	$0	$0	199	212	213	215	216	217	$0
Coleman	Coleman	2030	$0	$0	1,023	1,029	1,035	1,009	954	900	$0
County-Other	Coleman	2030	$0	$0	17	13	10	7	4	2	$0
Irrigation	Coleman	2030	$0	$0	400	400	400	400	400	400	$0
Manufacturing	Coleman	2030	$0	$0	1	1	1	1	1	1	$0
County-Other (Future Sales)	Ector	2030	$0	$0	0	1,200	2,500	2,500	2,500	2,500	$0
Ector County Utility District	Ector	2040	$0	$0	0	289	852	1,387	1,831	2,268	$0
Irrigation	Ector	2040	$0	$0	0	60	150	224	271	308	$0
Manufacturing	Ector	2040	$0	$0	0	26	66	97	119	135	$0
Odessa	Ector	2040	$0	$0	0	1,822	5,642	8,999	11,612	14,024	$0
Steam Electric Power	Ector	2040	$0	$0	0	165	420	625	756	861	$0
Greater Gardendale WSC	Ector	2040	$0	$0	0	18	100	162	216	266	$0
Big Spring	Howard	2040	$0	$0	0	497	1,282	1,866	2,212	2,458	$0
Coahoma	Howard	2040	$0	$0	0	27	72	104	122	134	$0

Entity	County Used	Expected Online	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2030	2040	2050	2060	2070	2080	
Manufacturing	Howard	2040	$0	$0	0	111	281	417	505	576	$0
Steam Electric Power	Howard	2040	$0	$0	1	64	163	240	292	329	$0
Junction	Kimble	2030	$0	$0	269	269	269	269	269	269	$0
Manufacturing	Kimble	2030	$0	$0	8	8	8	8	8	8	$0
Stanton	Martin	2040	$0	$0	0	22	58	85	104	118	$0
Brady	McCulloch	2040	$0	$0	0	0	1,770	1,740	1,710	1,680	$0
Millersview-Doole WSC	Concho	2040	$0	$0	0	43	110	164	198	230	$0
Irrigation	Menard	2030	$0	$0	1,330	1,330	1,330	1,330	1,330	1,330	$0
Menard	Menard	2030	$0	$0	643	643	643	643	643	643	$0
Irrigation	Midland	2040	$0	$0	0	60	153	227	276	314	$0
Midland[a]	Midland	2030	$0	$0	803	1,605	2,860	3,907	4,598	5,149	$0
Steam Electric Power	Mitchell	2030	$0	$0	2,924	2,840	2,756	2,690	2,626	2,560	$0
CRMWD[a]	Multiple	2030	$0	$0	28,060	23,516	15,551	9,011	4,228	0	$0
Ballinger	Runnels	2030	$0	$0	792	822	872	910	935	959	$0
County-Other	Runnels	2030	$0	$0	28	28	28	28	26	23	$0
Miles	Runnels	2030	$0	$0	21	9	8	10	7	8	$0
North Runnels WSC	Runnels	2030	$0	$0	103	109	117	124	132	142	$0
Winters	Runnels	2030	$0	$0	162	155	146	137	128	116	$0
County-Other	Scurry	2040	$0	$0	0	7	17	25	31	34	$0
Snyder	Scurry	2040	$0	$0	0	127	331	498	609	701	$0
U & F WSC	Scurry	2040	$0	$0	0	1	1	2	2	2	$0
County-Other	Tom Green	2030	$0	$0	126	106	102	102	101	99	$0
Goodfellow Air Force Base	Tom Green	2030	$0	$0	93	43	37	34	32	30	$0
Irrigation	Tom Green	2040	$0	$0	0	1,782	1,700	1,643	1,587	1,530	$0
Manufacturing	Tom Green	2030	$0	$0	78	38	34	32	31	29	$0
San Angelo[a]	Tom Green	2030	$0	$0	3,471	1,757	1,604	1,581	1,561	1,534	$0
Concho Rural WSC	Tom Green	2030	$0	$0	35	17	14	13	12	10	$0
Mining	Tom Green	2030	$0	$0	2	1	2	0	0	0	$0

Entity	County Used	Expected Online	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield 2030	Total Yield 2040	Total Yield 2050	Total Yield 2060	Total Yield 2070	Total Yield 2080	Last Decade Unit Cost ($/ac-ft/yr)
Voluntary Transfer (Purchase)											
Bronte, Robert Lee	Coke	2040	$65,724,000	$22,626	0	183	243	334	433	542	$9,075
Greater Gardendale WSC	Ector, Midland	2040	$16,285,000	$10,004	0	18	100	162	216	271	$5,749
Stanton	Martin	2030	$0	$0	43	91	151	215	287	372	$0
Millersview-Doole WSC	McCulloch	2040	$0	$0	0	0	0	73	267	496	$0
Irrigation (to MCUD)	Midland	2030	NA	NA	(293)	(1,751)	(1,751)	(1,751)	(1,751)	(1,751)	NA
Midland	Midland	2030	$0	$0	11,200	11,200	11,200	11,200	11,200	11,200	$0
Concho Rural WSC	Tom Green	2030	$0	$0	100	100	100	100	100	100	$0
Irrigation (to UCRA)	Tom Green	2030	NA	NA	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	$0
Water Audits and Leak Repairs											
Robert Lee	Coke	2030	$1,183,000	$2,234	11	12	13	14	15	17	$1,845
Coleman	Coleman	2030	$2,021,000	$2,209	28	24	21	18	14	11	$3,034
Mertzon	Irion	2030	$754,000	$4,497	4	4	4	4	4	4	$4,350
Junction	Kimble	2030	$1,891,000	$1,211	37	36	36	36	36	36	$1,228
Millersview-Doole WSC	Concho	2030	$5,732,000	$1,619	64	72	81	92	105	121	$1,395
Colorado City	Mitchell	2030	$5,114,000	$1,957	61	61	60	61	61	62	$1,958
Pecos County WCID #1	Pecos	2030	$1,938,000	$3,026	15	16	17	16	15	13	$3,258
North Runnels WSC	Runnels	2030	$1,393,000	$4,350	7	7	7	8	8	8	$4,394
Winters	Runnels	2030	$1,792,000	$2,900	16	15	14	13	12	11	$3,408
Eldorado	Schleicher	2030	$1,090,000	$1,307	24	21	18	16	13	10	$1,981
Concho Rural WSC	Tom Green	2030	$7,416,000	$3,503	41	46	50	55	60	65	$3,151
Weather Modification											
Irrigation	Crockett	2030	$0	$0.64	167	167	167	167	167	167	$0.64
Irrigation	Irion	2030	$0	$0.30	156	156	156	156	156	156	$0.30
Irrigation	Pecos	2030	$0	$0.38	1,807	1,807	1,807	1,807	1,807	1,807	$0.38
Irrigation	Reagan	2030	$0	$1.13	267	267	267	267	267	267	$1.13
Irrigation	Reeves	2030	$0	$0.41	2,176	2,176	2,176	2,176	2,176	2,176	$0.41
Irrigation	Schleicher	2030	$0	$0.38	686	686	686	686	686	686	$0.38
Irrigation	Sterling	2030	$0	$0.45	106	106	106	106	106	106	$0.45

Entity	County Used	Expected Online	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2030	2040	2050	2060	2070	2080	
Irrigation	Tom Green	2030	$0	$0.35	1,550	1,550	1,550	1,550	1,550	1,550	$0.35
Irrigation	Ward	2030	$0	$0.45	53	53	53	53	53	53	$0.45
West Texas Water Partnership[b]											
Abilene					0	8,400	8,400	8,400	8,400	8,400	
Midland	Multiple	2040	$796,828,000	$2,267	0	15,000	15,000	15,000	15,000	15,000	$381
San Angelo					0	5,000	5,000	5,000	5,000	5,000	

Note: Grey italics indicates projects that are needed to access supplies from other strategies and are not included in the total to avoid double counting.

a. Subordination supply is based on a contract for 16.54% of the safe yield of Lake Ivie. This supply changes with the implementation of the West Texas Water Partnership strategy. As part of this strategy, the Lake Ivie supplies may be reallocated among the cities of Abilene, Midland, and San Angelo. However, this has not yet occurred, so the current subordination yields from these contract amounts are shown in the table above. The Partnership will follow up on initial conversations with the CRMWD to explore necessary methodologies and agreements to implement a cooperative use strategy of the Partnership’s collective Ivie supplies. Meetings between the parties are anticipated in the late fall/early winter of 2020/2021.

b. Capital and unit costs for the West Texas Water Partnership will be shared between the partnership (Abilene, Midland, and San Angelo).

Table ES- 6
Alternative Water Management Strategies

Entity	County Used	Expected Implementation Date	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2030	2040	2050	2060	2070	2080	
Desalination											
San Angelo	Tom Green	2040	$186,030,000	$3,071	0	11,200	11,200	11,200	11,200	11,200	$1,902
Develop Dockum Aquifer Supplies											
Colorado City	Mitchell	2030	$11,428,000	$5,335	170	170	170	170	170	170	$606
Develop Edwards-Trinity Plateau Aquifer Supplies											
Andrews	Andrews	2040	$56,814,000	$1,785	0	2,600	2,600	2,600	2,600	2,600	$249
Manufacturing	Andrews	2030	$1,392,000	$412	279	279	279	279	279	279	$61
Bronte, Robert Lee	Coke	2040	$18,305,000	$18,987	0	75	75	75	75	75	$1,813
Robert Lee	Coke	2040	$20,139,000	$9,988	0	160	160	160	160	160	$1,131
San Angelo	Tom Green	2040	$192,701,000	$3,338	0	4,500	4,500	4,500	4,500	4,500	$325
Develop Ellenburger-San Saba Aquifer Supplies											
BCWID #1	Brown	2040	$107,758,000	$3,745	0	3,600	3,600	3,600	3,600	3,600	$1,639
Develop Ogallala Aquifer Supplies											
Andrews	Andrews	2040	$36,022,000	$831	0	3,634	3,634	3,634	3,634	3,634	$135
Texland Great Plains	Andrews, Gaines	2030	$607,000	$263	213	213	213	213	213	213	$61
Develop Additional Groundwater Supplies											
Odessa	Ector	2040	$1,572,207,000	$5,791	0	28,000	28,000	28,000	28,000	28,000	$1,845
CRMWD	Multiple	2040	$551,074,000	$2,604	0	25,000	25,000	25,000	25,000	25,000	$1,055
New or Additional Water Treatment											
Midland	Midland	2030	$192,003,000	$3,441	6,628	7,147	7,514	7,757	7,932	8,065	$1,766
Indirect Potable Reuse with Aquifer Storage and Recovery											
Pecos	Reeves	2040	$49,782,000	$9,252	0	695	695	695	695	695	$4,212
Regional Water Management Strategies											
Bronte, Ballinger, Winters, Robert Lee	Coke, Runnels	2040	$211,788,000	$15,116	0	1,114	1,074	1,033	993	952	$1,739

Note: Grey italics indicates projects that are needed to access supplies from other strategies and are not included in the total to avoid double counting.

ES.4.3 Unmet Needs

No sources were over allocated as a part of this plan. The source balance report that demonstrates this is included in Appendix I.

Despite the best efforts to meet all projected water needs, there are several unmet needs in Region F. Most of these unmet needs are due to limitations of groundwater availability supplies and the lack of cost-effective alternative sources of water, especially in Andrews and Loving Counties. For Andrews County, which does not have a GCD to manage groundwater, water users intend to meet their needs with groundwater. Some irrigation needs may be met in non-drought years or producers will implement changes, such as drought tolerant crops or dryland farming. Unmet water needs for Region F are summarized in Table ES-7 and are discussed in detail in Chapter 6.

Table ES- 7
Unmet Needs Summary (acre-feet per year)

Water User	2030	2040	2050	2060	2070	2080
Municipal	(2,714)	(1,741)	(2,867)	(4,147)	(5,484)	(6,904)
Manufacturing	(70)	(140)	(184)	(218)	(249)	(279)
Livestock	0	0	0	0	0	0
Irrigation	(8,546)	(12,772)	(13,381)	(14,717)	(14,801)	(14,674)
Mining	(18,080)	(19,107)	(18,216)	(15,337)	(11,089)	(8,807)
Steam Electric Power	(3,940)	(3,989)	(3,969)	(4,035)	(4,099)	(4,165)
Total	**(33,350)**	**(37,749)**	**(38,617)**	**(38,454)**	**(35,722)**	**(34,829)**

1 DESCRIPTION OF THE REGION

In 1997, the 75th Texas Legislature passed Senate Bill One (SB1), legislation designed to address Texas water issues. With the passage of SB1, the legislature put in place a grass-roots regional planning process to plan for the future water needs of all Texans. To implement this planning process, the Texas Water Development Board (TWDB) created 16 regional water planning areas across the state and established regulations governing regional planning efforts. The first 16 Regional Water Plans developed as part of the SB1 planning process were submitted to the TWDB in 2001. The TWDB combined these regional plans into one statewide plan. SB1 calls for these plans to be updated every five years. Since 2001, the regional water plans have been updated four times, in 2006, 2011, 2016 and 2021, and then consolidated into the state water plans, Water for Texas 2007, 2012, 2017 and 2022, respectively.

Region F at a Glance:

- 32 Counties
- Major cities include Midland, Odessa, and San Angelo
- Heart of Permian Basin oil & gas activity
- Major economic drivers include agriculture, oil & gas, and service industries
- 64 % of total regional water use came from groundwater in 2021
- 51 % of municipal water supply is from surface water in 2021
- 17 major reservoirs in Region F
- 14 named aquifers
- Wide range of climate variability across region

The TWDB refers to the current round of regional planning as SB1, Sixth Round. This report is the update to the 2021 Region F Water Plan and will become part of the basis for the next state water plan.

This chapter presents a description of Region F, one of the 16 regions created to implement SB1. Figure 1-1 is a map of Region F, which includes 32 counties in West Texas. The data presented in this regional water plan is a compilation of information from previous planning reports, on-going planning efforts and new data. A list of references is found at the end of each chapter.

1.1 INTRODUCTION TO REGION F

Region F includes all of Borden, Scurry, Andrews, Martin, Howard, Mitchell, Loving, Winkler, Ector, Midland, Glasscock, Sterling, Coke, Runnels, Coleman, Brown, Reeves, Ward, Crane, Upton, Reagan, Irion, Tom Green, Concho, McCulloch, Pecos, Crockett, Schleicher, Menard, Sutton, Kimble and Mason Counties. Table 1-1 shows historical populations for these counties from 1900 through 2020[1] and estimated populations for 2023[2].

Figure 1-1
Area Map

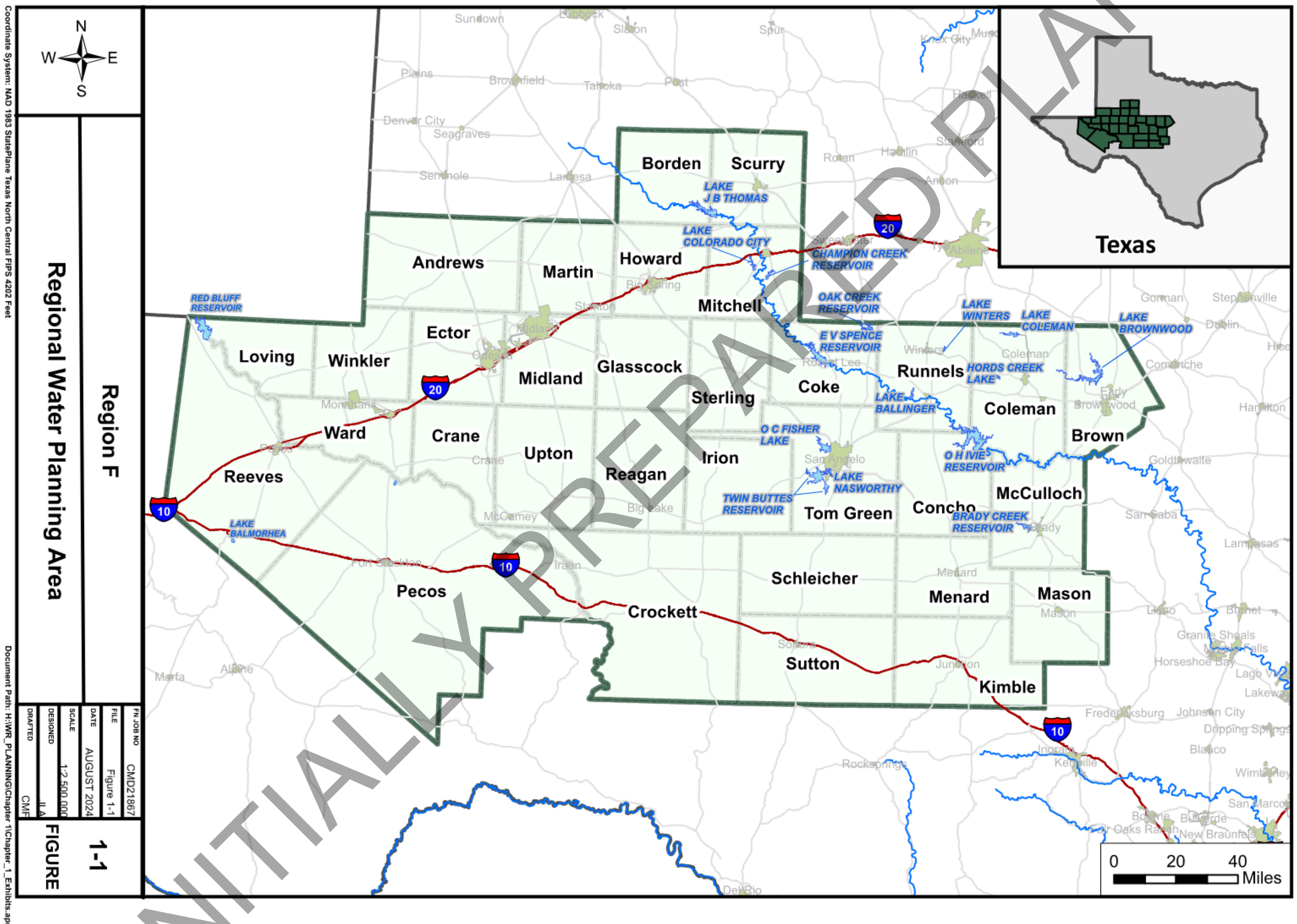


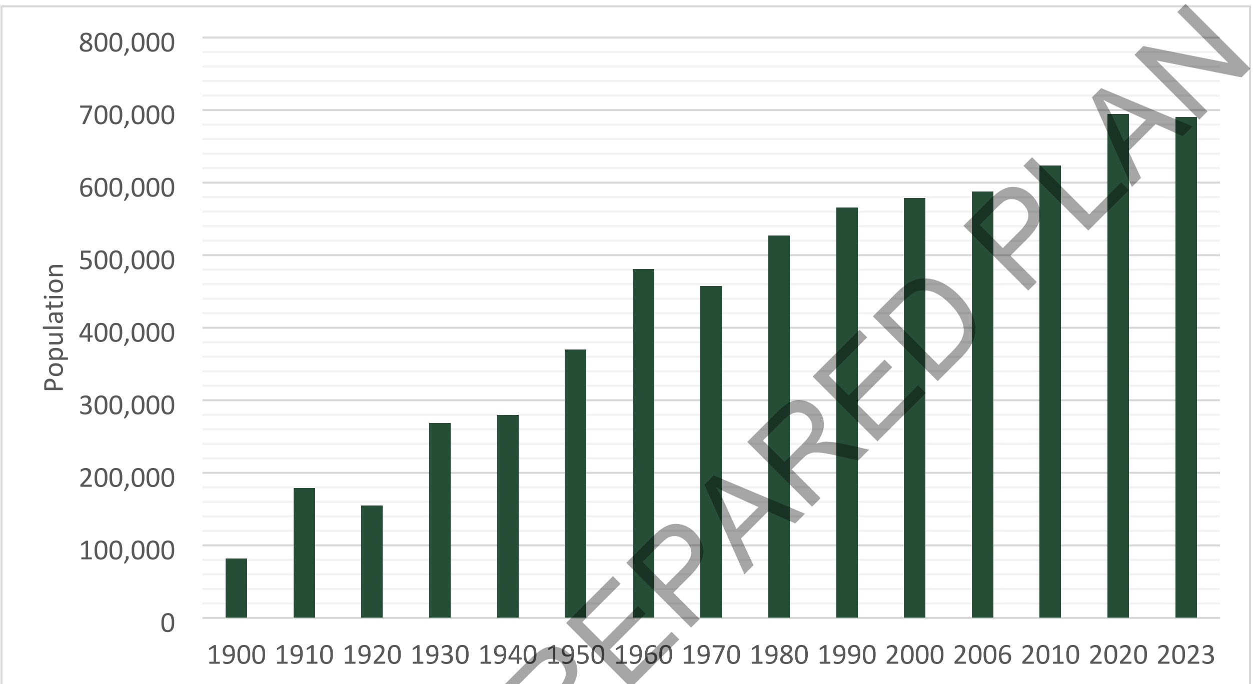
Table 1-1
Historical Population of Region F Counties[a]

County	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2020	2023
Andrews	87	975	350	736	1,277	5,002	13,450	10,372	13,323	14,338	13,004	14,786	18,610	18,664
Borden	776	1,386	965	1,505	1,396	1,106	1,076	888	859	799	729	641	631	572
Brown	16,019	22,935	21,682	26,382	25,924	28,607	24,728	25,877	33,057	34,371	37,674	38,106	38,095	38,709
Coke	3,430	6,412	4,557	5,253	4,590	4,045	3,589	3,087	3,196	3,424	3,864	3,320	3,285	3,352
Coleman	10,077	22,618	18,805	23,669	20,571	15,503	12,458	10,288	10,439	9,710	9,235	8,895	7,684	7,842
Concho	1,427	6,654	5,847	7,645	6,192	5,078	3,672	2,937	2,915	3,044	3,966	4,087	3,303	3,297
Crane	51	331	37	2,221	2,841	3,965	4,699	4,172	4,600	4,652	3,996	4,375	4,675	4,574
Crockett	1,591	1,296	1,500	2,590	2,809	3,981	4,209	3,885	4,608	4,078	4,099	3,719	3,098	2,858
Ector	381	1,178	760	3,958	15,051	42,102	90,995	91,805	115,374	118,934	121,123	137,130	165,171	164,494
Glasscock	286	1,143	555	1,263	1,193	1,089	1,118	1,155	1,304	1,447	1,406	1,226	1,116	1,141
Howard	2,528	8,881	6,962	22,888	20,990	26,722	40,139	37,796	33,142	32,343	33,627	35,012	34,860	30,554
Irion	848	1,283	1,610	2,049	1,963	1,590	1,183	1,070	1,386	1,629	1,771	1,599	1,513	1,549
Kimble	2,503	3,261	3,581	4,119	5,064	4,619	3,943	3,904	4,063	4,122	4,468	4,607	4,286	4,442
Loving	33	249	82	195	285	227	226	164	91	107	67	82	64	43
Martin	332	1,549	1,146	5,785	5,556	5,541	5,068	4,774	4,684	4,956	4,746	4,799	5,237	5,216
Mason	5,573	5,683	4,824	5,511	5,378	4,945	3,780	3,356	3,683	3,423	3,738	4,012	3,953	3,931
McCulloch	3,960	13,405	11,020	13,883	13,208	11,701	8,815	8,571	8,735	8,778	8,205	8,283	7,630	7,452
Menard	2,011	2,707	3,162	4,447	4,521	4,175	2,964	2,646	2,346	2,252	2,360	2,242	1,962	1,958
Midland	1,741	3,464	2,449	8,005	11,721	25,785	67,717	65,433	82,636	106,611	116,009	136,872	169,983	177,108
Mitchell	2,855	8,956	7,527	14,183	12,477	14,357	11,255	9,073	9,088	8,016	9,698	9,403	8,990	9,075
Pecos [c]	2,360	2,071	3,857	7,812	8,185	9,939	11,957	13,748	14,618	14,675	16,809	15,507	15,193	14,623
Reagan [b]		392	377	3,026	1,997	3,127	3,782	3,239	4,135	4,514	3,326	3,367	3,385	3,141
Reeves	1,847	4,392	4,457	6,407	8,006	11,745	17,644	16,526	15,801	15,852	13,137	13,783	14,748	11,770
Runnels	5,379	20,858	17,074	21,821	18,903	16,771	15,016	12,108	11,872	11,294	11,495	10,501	9,900	9,868
Schleicher	515	1,893	1,851	3,166	3,083	2,852	2,791	2,277	2,820	2,990	2,935	3,461	2,451	2,391
Scurry	4,158	10,924	9,003	12,188	11,545	22,779	20,369	15,760	18,192	18,634	16,361	16,921	16,932	16,212
Sterling	1,127	1,493	1,053	1,431	1,404	1,282	1,177	1,056	1,206	1,438	1,393	1,143	1,372	1,397
Sutton	1,727	1,569	1,598	2,807	3,977	3,746	3,738	3,175	5,130	4,135	4,077	4,128	3,372	3,221
Tom Green [b]	6,804	17,882	15,210	36,033	39,302	58,929	64,630	71,047	84,784	98,458	104,010	110,224	120,003	119,057
Upton	48	501	253	Okay.	4,297	5,307	6,239	4,697	4,619	4,447	3,404	3,355	3,308	3,109
Ward	1,451	2,389	2,615	4,599	9,575	13,346	14,917	13,019	13,976	13,115	10,909	10,658	11,644	10,966
Winkler	60	442	81	6,784	6,141	10,064	13,652	9,640	9,944	8,626	7,173	7,110	7,791	7,414
Region F Total	***81,985***	***179,172***	***154,850***	***268,329***	***279,422***	***370,027***	***480,996***	***457,545***	***526,626***	***565,212***	***578,814***	***623,354***	***694,245***	***690,000***
% Change		*119%*	*-14%*	*73%*	*4%*	*32%*	*30%*	*-5%*	*15%*	*7%*	*2%*	*8%*	*11%*	*-1%*

Notes:
a. Historical[1] and estimated population data are from the U.S. Census Bureau[2]
b. Reagan County was formed from part of Tom Green County in 1903
c. Terrell County was formed from part of Pecos County in 1905.

Figure 1-2 shows graphically the total population of the region. The population of Region F has increased from 81,985 in 1900 to 694,245 in 2020. Since the 2020 census, it is estimated that the population of Region F decreased slightly to 690,000 in the year 2023.

Figure 1-2
Historical Population of Region F



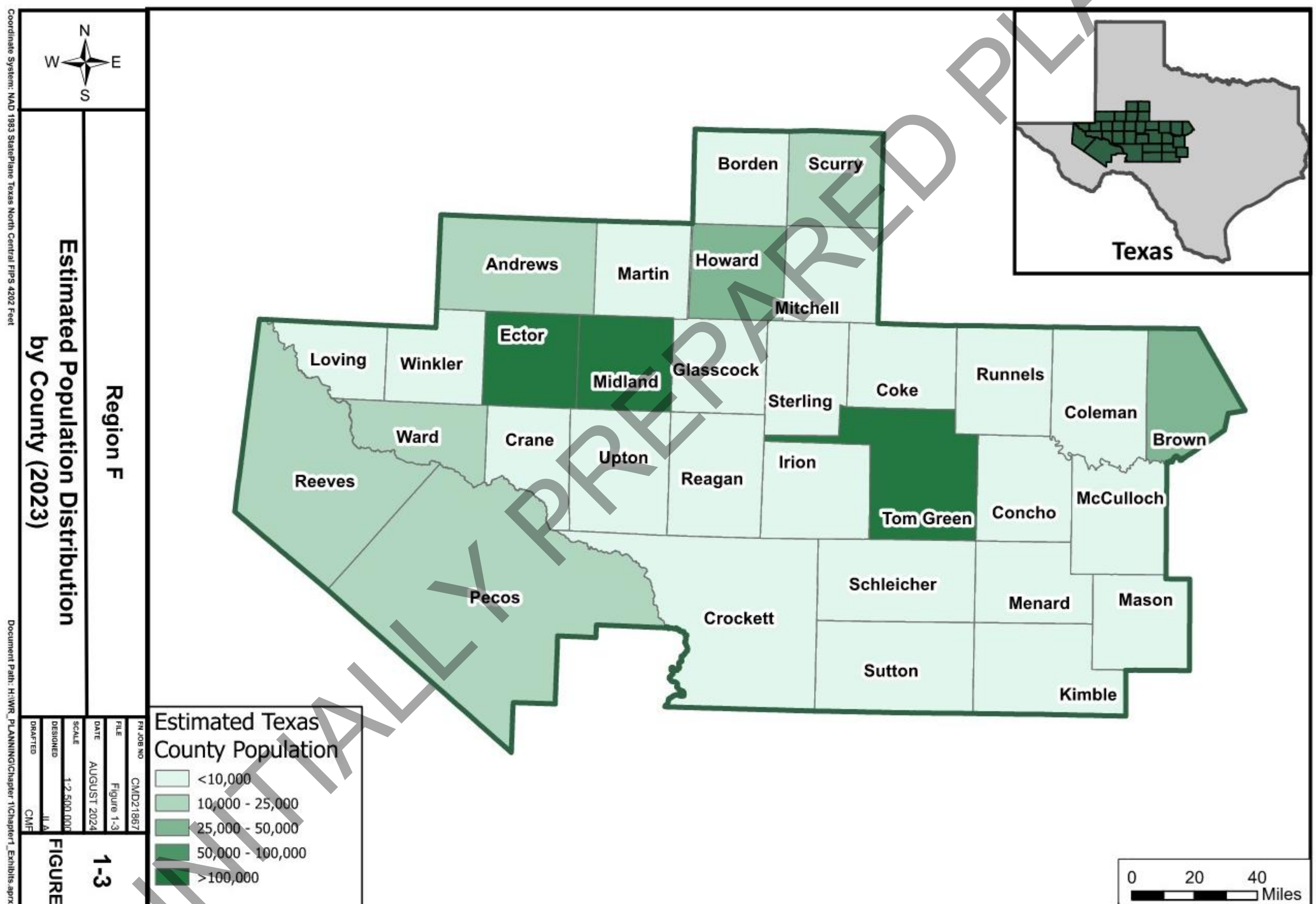
According to 2020 population data by the U.S. Census Bureau, Region F accounted for 2.4 percent of Texas' total population. Figure 1-3 shows the distribution of population in Region F counties based on the census data. Ector, Midland, and Tom Green were the three most populous counties in Region F, accounting for 67 percent of the region's population. Brown and Howard Counties were the next most populous counties with more than 34,000 people in each. Table 1-2 lists the seven cities in Region F with a 2023 population of more than 10,000, which encompass over 60 percent of the population in Region F.

Table 1-2
Region F Cities with a Year 2023 Population Greater than 10,000

City	Year 2023 Population
Midland	138,397
Odessa	115,743
San Angelo	99,262
Big Spring	22,373
Brownwood	18,790
Andrews	13,502
Snyder	11,187
Total	***419,254***

Data are from the 2023 US Census Bureau Estimates[2].

Figure 1-3
Estimated Population Distribution by County (2023)



1.1.1 Economic Activity in Region F

Region F includes the Midland, Odessa, and San Angelo Metropolitan Statistical Areas (MSAs). The largest employment sectors in both the Midland and Odessa MSAs are the oil and gas industry, retail trade, and healthcare services[3]. Educational services, construction, transportation, and leisure and hospitality are also important employment sectors in these areas. In the San Angelo MSA the largest employment sectors are health services and retail trade, followed by educational services and leisure and hospitality.

Table 1-3 summarizes 2022 payroll data for Region F by county and economic sector[4]. Figure 1-4 shows the geographic distribution of total payroll in Region F. This figure shows that Ector, Midland and Tom Green Counties are the primary centers of economic activity in the region. These three counties account for 82 percent of the payroll and 78 percent of the employment in the region. Other major centers of economic activity are located in Brown and Howard Counties. The largest private business sectors in Region F in terms of payroll in 2022 are natural resources and mining, trade, transportation, and utilities, and professional and business services, which together account for 65 percent of the region's total payroll.

The oil and gas industry has been growing rapidly in the Permian Basin, particularly over the last decade (see Section 1.4.3). Since 2007, the payroll for mining and natural resources has more than doubled from $2.0 billion to nearly $6.1 billion in 2022 in Region F[4]. In 2022, Region F counties accounted for over 20% of the total state payroll for natural resources and mining. This increase in production has led to increased population for many cities within the region and subsequently, increased water use. The Permian Basin underlies most of Region F, as shown in Figure 1-5.

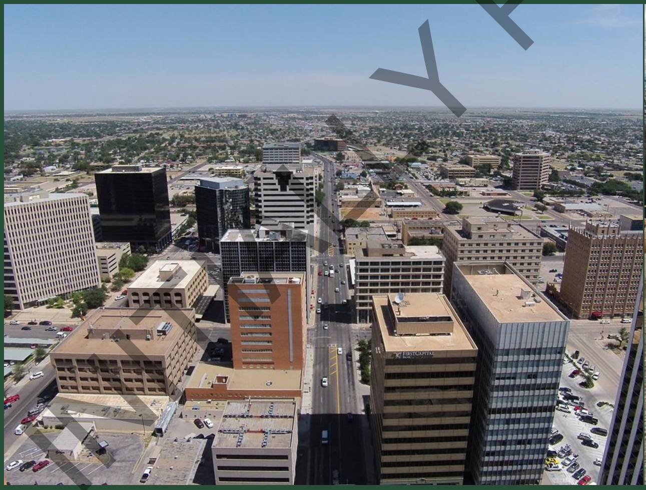


Table 1-3
2022 County Payroll by Category ($1000)

Category	Andrews	Borden	Brown	Coke	Coleman	Concho	Crane	Crockett	Ector	Glasscock	Howard
Federal Government	998	43	6,647	492	1,770	549	310	186	13,733	330	85,514
State Government	2,235	522	41,432	507	1,246	931	794	2,103	101,810	0	30,668
Local Government	82,615	4,136	83,838	10,895	20,494	9,344	17,566	13,808	485,349	0	94,351
Private Industry, Total	474,995	27,517	543,708	38,027	66,124	34,258	69,509	43,245	4,565,103	33,307	521,444
Goods-Producing	283,374	4,610	225,918	4,973	17,188	1,682	38,780	17,591	2,045,469	18,390	189,230
Natural Resources and Mining	153,668	1,172	9,958	452	3,493	1,075	32,913	14,950	1,219,244	16,697	78,005
Construction	121,096	0	23,599	3,706	8,450	0	3,387	1,675	502,761	0	48,274
Manufacturing	8,610	0	192,360	814	5,245	0	2,479	965	323,464	0	62,951
Service Providing	191,621	22,906	317,790	33,054	48,936	32,576	30,729	25,654	2,519,633	14,917	332,214
Trade, Transportation, and Utilities	88,282	11,749	109,591	4,723	13,238	5,908	17,809	13,879	1,211,442	7,136	138,999
Information	3,906	0	4,986	0	2,271	0	0	0	19,470	0	7,268
Financial Activities	25,569	701	39,169	2,907	9,393	4,916	4,704	2,218	270,845	0	22,714
Professional and Business Services	35,628	5,973	24,463	20,665	8,240	14,318	3,305	4,324	323,996	3,125	37,804
Education and Health Services	7,731	663	102,487	0	10,798	5,439	3,839	1,062	315,179	0	87,650
Leisure and Hospitality	18,564	0	27,296	777	4,285	1,211	821	3,026	224,663	0	27,976
Other Services	11,624	175	8,991	0	662	0	250	797	151,119	0	9,412
Unclassified	317	0	807	909	48	0	0	0	2,920	0	392
Total Payroll	***560,843***	***32,218***	***675,625***	***49,920***	***89,633***	***45,082***	***88,179***	***59,342***	***5,165,995***	***33,637***	***731,978***
Total Employees	***7,613***	***544***	***15,670***	***839***	***2,175***	***910***	***1,340***	***1,358***	***77,878***	***677***	***12,605***

Table 1-3 (cont.)
2023 County Payroll by Category ($1000)

Category	Irion	Kimble	Loving	Martin	Mason	McCulloch	Menard	Midland	Mitchell	Pecos	Reagan
Federal Government	125	596	0	946	655	1,212	256	50,095	921	3,538	665
State Government	0	3,573	0	889	1,351	2,755	0	42,157	13,299	21,309	1,146
Local Government	0	9,396	0	34,535	11,155	20,464	0	503,092	28,737	60,277	20,036
Private Industry, Total	51,090	38,200	48,245	103,725	31,824	85,018	5,831	8,748,929	59,153	231,933	106,672
Goods-Producing	39,839	7,096	0	49,528	8,508	24,360	1,306	4,794,711	32,119	81,062	75,116
Natural Resources and Mining	36,855	1,380	6,847	19,817	3,120	16,176	420	3,830,341	27,971	51,428	71,996
Construction	0	2,651	0	23,814	3,210	3,244	0	552,526	0	25,303	0
Manufacturing	0	3,065	3,269	5,897	2,178	4,940	0	411,844	0	4,331	0
Service Providing	11,251	31,104	21,126	54,197	23,316	60,658	4,525	3,954,218	27,034	150,871	31,556
Trade, Transportation, and Utilities	6,780	14,599	17,003	35,200	7,690	29,584	2,325	1,530,362	9,447	76,617	22,778
Information	0	326	0	0	0	1,184	0	46,841	521	1,139	0
Financial Activities	0	2,743	0	3,256	4,238	5,733	723	476,791	5,380	10,327	3,687
Professional and Business Services	1,308	2,229	0	4,154	3,635	3,128	150	1,004,505	4,814	36,020	0
Education and Health Services	127	5,046	0	5,598	3,718	14,251	0	399,347	3,546	8,334	83
Leisure and Hospitality	1,075	5,110	0	1,894	2,799	4,893	662	307,447	2,740	14,210	2,328
Other Services	168	853	0	1,903	1,037	1,884	193	185,175	585	4,217	924
Unclassified	0	198	0	0	0	0	0	3,749	0	8	0
Total Payroll	***51,215***	***51,764***	***48,245***	***140,095***	***44,985***	***109,449***	***6,088***	***9,344,273***	***102,110***	***317,056***	***128,520***
Total Employees	***801***	***1,237***	***774***	***2,243***	***1,167***	***2,388***	***434***	***114,717***	***2,026***	***5,654***	***1,686***

Table 1-3 (cont.)
2023 County Payroll by Category ($1000)

Category	Reeves	Runnels	Schleicher	Scurry	Sterling	Sutton	Tom Green	Upton	Ward	Winkler	Region F Total
Federal Government	5,130	1,892	785	1,810	268	316	81,861	351	679	568	**177,061**
State Government	4,139	2,084	0	10,818	788	2,150	130,731	753	3,243	1,073	**392,692**
Local Government	80,541	37,294	0	65,134	6,144	16,704	233,481	32,184	44,080	32,888	**1,944,150**
Private Industry, Total	413,626	88,856	27,488	308,905	12,696	56,630	2,032,031	175,518	337,392	238,581	**18,991,463**
Goods-Producing	215,582	41,015	12,685	130,034	6,906	33,387	449,773	122,112	224,919	150,900	**9,083,817**
Natural Resources and Mining	143,012	5,919	4,817	92,446	5,634	22,746	94,882	0	155,325	128,558	**6,101,317**
Construction	69,552	11,913	0	19,338	0	5,689	129,006	0	60,569	0	**1,571,488**
Manufacturing	3,019	23,183	0	18,251	0	4,952	225,886	0	9,025	0	**1,253,777**
Service Providing	198,043	47,842	14,804	178,870	5,790	23,243	1,582,258	53,406	112,474	87,681	**9,880,527**
Trade, Transportation, and Utilities	115,587	27,609	4,961	87,061	2,179	13,798	446,776	24,280	52,818	63,622	**4,052,057**
Information	1,786	145	0	1,641	0	0	36,707	0	4,212	0	**125,137**
Financial Activities	23,737	5,015	1,726	9,510	2,308	2,738	157,658	1,670	24,135	9,669	**1,107,781**
Professional and Business Services	26,193	3,193	4,211	49,641	0	623	240,528	5,089	16,653	6,128	**1,856,237**
Education and Health Services	5,634	7,454	0	6,605	0	482	490,789	511	3,027	430	**1,402,097**
Leisure and Hospitality	20,741	3,433	0	11,996	0	4,875	123,957	382	9,393	5,250	**801,498**
Other Services	4,253	0	171	12,270	158	626	85,233	0	2,097	2,128	**476,572**
Unclassified	110	0	265	145	0	0	608	23	138	454	**10,699**
Total Payroll	***503,435***	***130,127***	***28,274***	***386,667***	***19,896***	***75,800***	***2,478,104***	***208,806***	***385,394***	***273,109***	**21,505,366**
Total Employees	***7,564***	***2,994***	***701***	***6,093***	***447***	***1,210***	***49,616***	***3,601***	***5,736***	***3,693***	**322,100**

Notes: Data are from U.S. Bureau of Labor Statistics 2023 Census of Employment and Wages data [4]

Figure 1-4
Estimated Payroll Distribution in Thousands (2022)

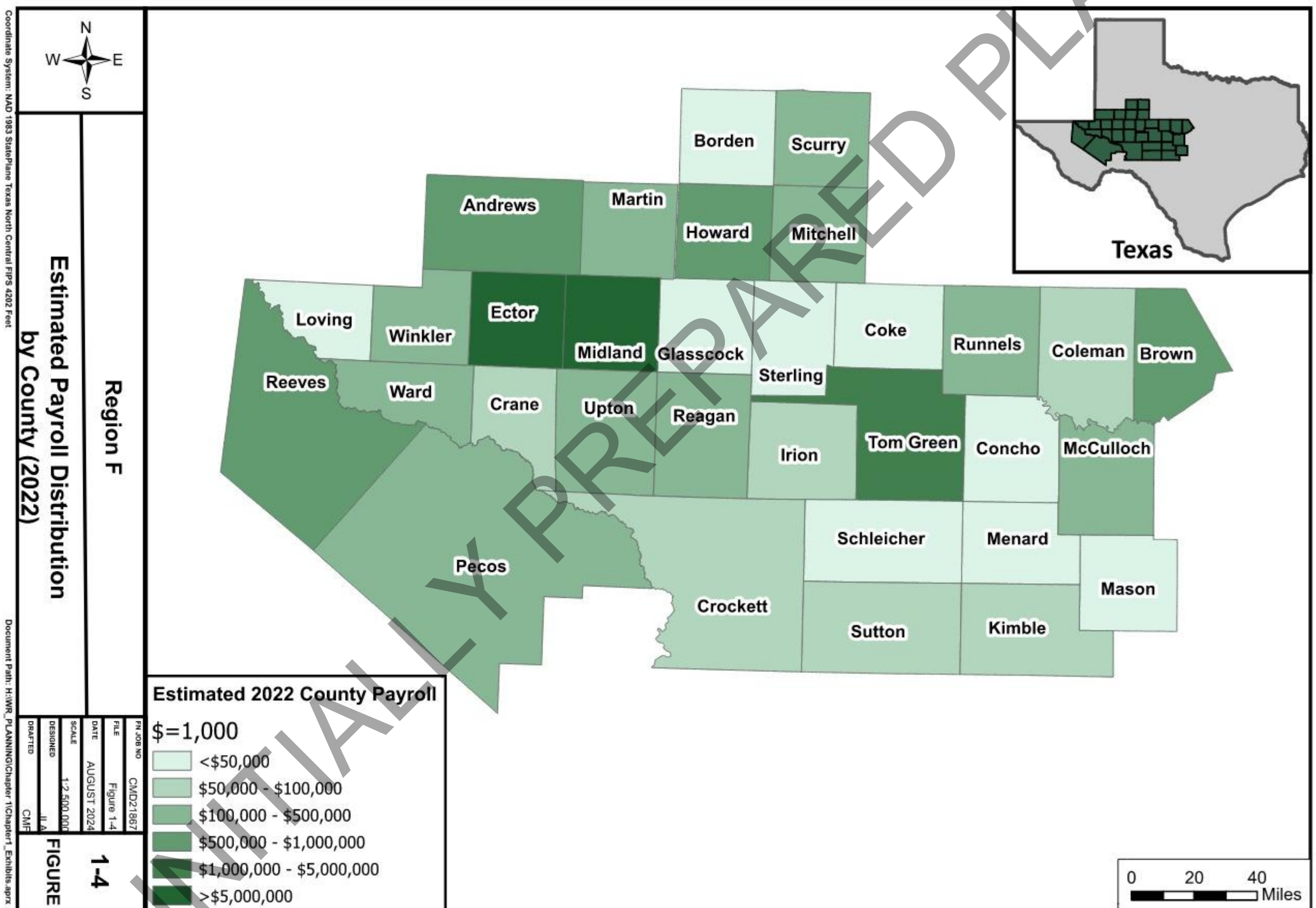
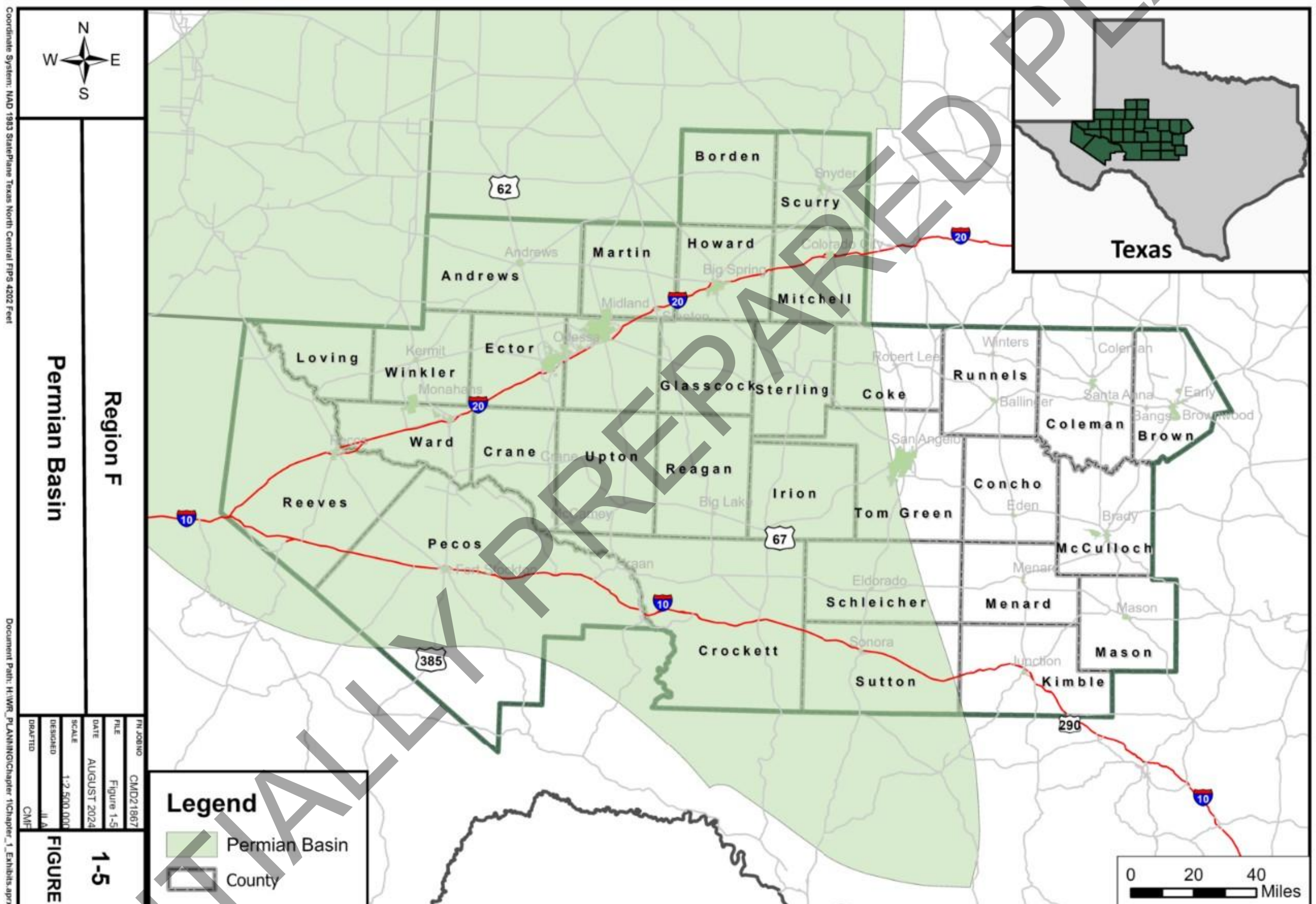


Figure 1-5
Permian Basin in Region F



1.1.2 Water-Related Physical Features and Climate in Region F

Most of Region F is in the upper portion of the Colorado River Basin and in the Pecos River portion of the Rio Grande River Basin. A small part of the region is in the Brazos Basin. Figure 1-6 shows the surface water features in the Region F, which include the Colorado River, Concho River, Pecan Bayou, San Saba River, Llano River, and Pecos River.

Table 1-4 lists the 18 major water supply reservoirs in Region F. These reservoirs provide most of the region's surface water supply. Reservoirs are necessary to provide a reliable surface water supply in this part of the state because of the wide variations in natural streamflow. Reservoir storage serves to capture high flows when they are available and save them for use during times of normal or low flow.

Figure 1-7 shows the average annual precipitation throughout Region F[5]. Average precipitation ranges from slightly more than 11 inches per year in Reeves County to approximately 30 inches per year in Brown County. Precipitation generally increases from the western to the eastern portions of the region. Some of the highest evaporation rates in the state are in Region F, which often exceed rainfall throughout the region. Figure 1-8 illustrates the mean annual temperatures throughout Region F[5]. The mean annual temperatures for the entire region varied from a mean minimum temperature of 46.0 °F in Pecos County to a mean maximum temperature of 81.6 °F in Reeves County. The patterns of rainfall, runoff, evaporation, and temperature result in more abundant water supplies in the eastern portion of Region F.

Figure 1-9 shows the major aquifers in Region F, and Figure 1-10 shows the minor aquifers. There are 14 aquifers that supply water to the 32 counties of Region F. The major aquifers are the Edwards-Trinity Plateau, Ogallala, Pecos Valley, and a small portion of the Trinity. The minor aquifers are the Capitan Reef Complex, Cross Timbers, Dockum, Ellenberger-San Saba, Hickory, Igneous, Lipan, Marble Falls, and the Rustler. A small portion of the Edwards-Trinity High Plains extends into Region F but is not a major source of water. More information on these aquifers may be found in Chapter 3.

Water Related Facts for Region F:

- Three river basins in Region F: Colorado River, Pecos River, Brazos River
- Four major aquifers
- Ten minor aquifers
- Precipitation ranges from 11 inches in the west to 30 inches in the east
- Evaporative losses from area lakes can exceed 5 feet per year

Table 1-4
Major Water Supply Reservoirs in Region F[a,d]

Reservoir Name	Basin	Stream	County(ies)	Water Right Number(s)	Priority Date	Permitted Conservation Storage (Ac-Ft)	Permitted Diversion (Ac-Ft/Yr)	Year 2022 Use (Acre-Feet)	Owner	Water Rights Holder(s)
Lake J B Thomas	Colorado	Colorado River	Borden, Scurry	CA-1002	08/05/1946	204,000	30,000	14,454	CRMWD	CRMWD
Lake Colorado City	Colorado	Morgan Creek	Mitchell	CA-1009	11/22/1948	29,934	5,500	4	Luminant Generation	Luminant Generation
Champion Creek Reservoir	Colorado	Champion Creek	Mitchell	CA-1009	04/08/1957	40,170	6,750		Luminant Generation	Luminant Generation
Oak Creek Reservoir	Colorado	Oak Creek	Coke	CA-1031	04/27/1949	30,000	10,000	159	City of Sweetwater	City of Sweetwater
Lake Coleman	Colorado	Jim Ned Creek	Coleman	CA-1702	08/25/1958	40,000	9,000	1,265	City of Coleman	City of Coleman
E V Spence Reservoir	Colorado	Colorado River	Coke	CA-1008	08/17/1964	488,760	43,000	13,802	CRMWD	CRMWD
Mitchell County Reservoir	Colorado	Off-Channel	Mitchell		2/14/1990	27,266				
Lake Winters	Colorado	Elm Creek	Runnels	CA-1095	12/18/1944	8,374	1,755	1	City of Winters	City of Winters
Lake Brownwood	Colorado	Pecan Bayou	Brown	CA-2454	09/29/1925	114,000	29,712	12,537	Brown Co. WID	Brown Co. WID
Hords Creek Lake	Colorado	Hords Creek	Coleman	CA-1705	03/23/1946	7,959	2,240	No data	COE	City of Coleman
Lake Ballinger	Colorado	Valley Creek	Runnels	CA-1072	10/04/1946	6,850	1,000	268	City of Ballinger	City of Ballinger
O. H. Ivie Reservoir	Colorado	Colorado River	Coleman, Concho & Runnels	A-3866 P-3676	02/21/1978	554,340	113,000	34,677	CRMWD	CRMWD
O. C. Fisher Lake	Colorado	N. Concho River	Tom Green	CA-1190	05/27/1949	80,400	80,400	No data	COE	Upper Colorado River Authority
Twin Buttes Reservoir	Colorado	S. Concho River	Tom Green	CA-1318	05/06/1959	170,000	29,000	11,787	U.S. Bureau of Reclamation	City of San Angelo
Lake Nasworthy	Colorado	S. Concho River	Tom Green	CA-1319	03/11/1929	12,500	25,000	55	City of San Angelo	City of San Angelo
Brady Creek Reservoir	Colorado	Brady Creek	McCulloch	CA-1849	09/02/1959	30,000	3,500	No data	City of Brady	City of Brady
Red Bluff Reservoir	Rio Grande	Pecos River	Loving and Reeves	CA-5438	01/01/1980	300,000	292,500	23,582	Red Bluff Water Power Control District	Red Bluff Water Power Control District
Lake Balmorhea	Rio Grande	Toyah Creek	Reeves	A-0060 P-0057	10/05/1914	13,583	41,400	2,260	Reeves Co WID #1	Reeves Co WID #1
Total						*2,158,136*	*723,757*	*114,850*		

a. A major reservoir has more than 5,000 acre-feet of storage.

b. Total diversions under CA 1002 and CA 1008 limited to 73,000 acre-feet per year. CA 1008 allows up to 50,000 acre-feet per year of diversion. For purposes of this table, the limitation is placed on CA 1008.

c. Permitted storage is reported for water conservation storage. UCRA has permission to use water from the sediment pool.

d. Data are from TCEQ active water rights list[6], TCEQ water rights permits[7], and TCEQ historical water use by water right[8]. Year 2022 use is consumptive.

CA: Certificate of Adjudication; A: Application; P Permit; COE: Corps of Engineers; NA – Data Not Available

Figure 1-6
Surface Water Features in Region F

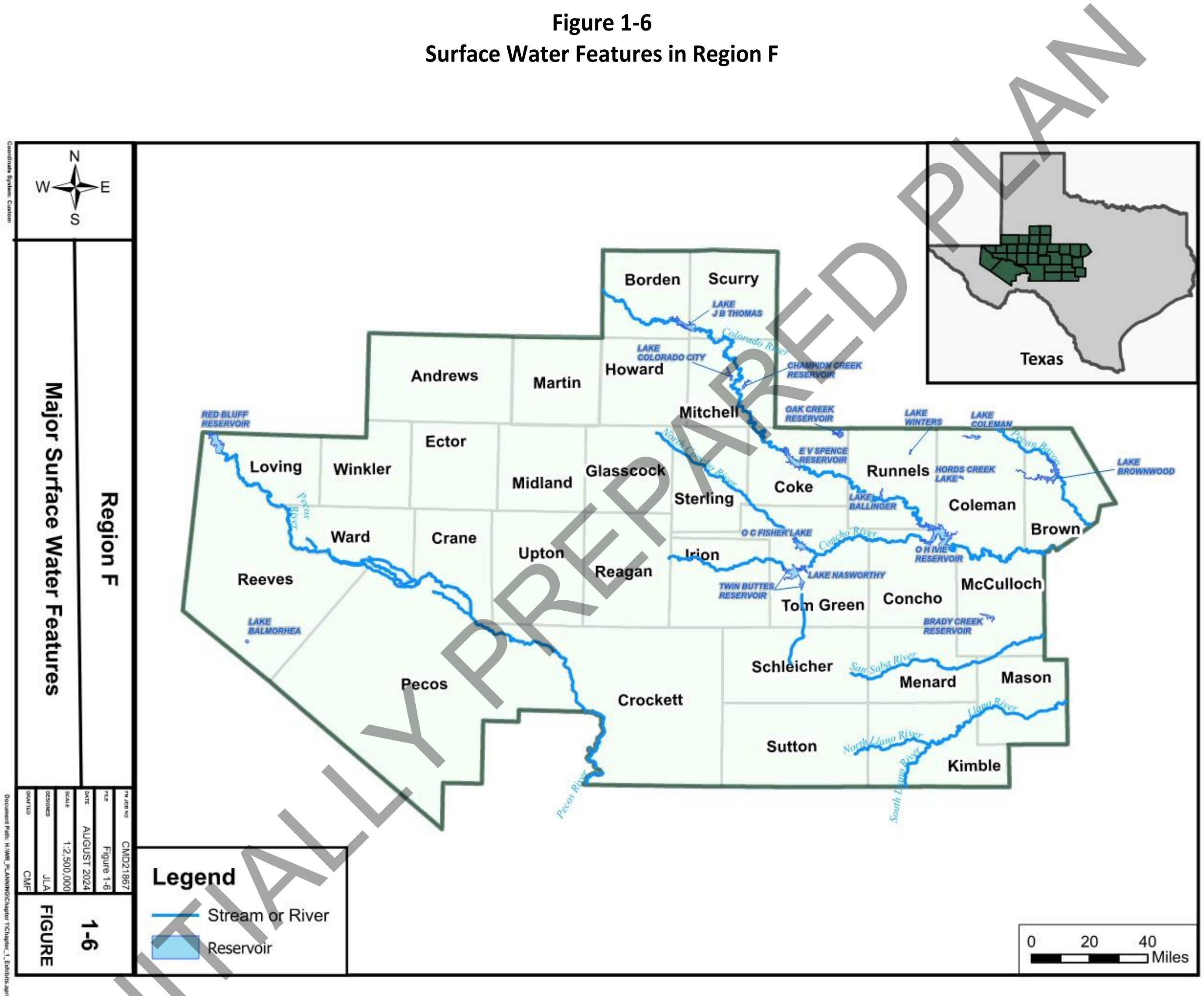


Figure 1-7
Mean Annual Precipitation

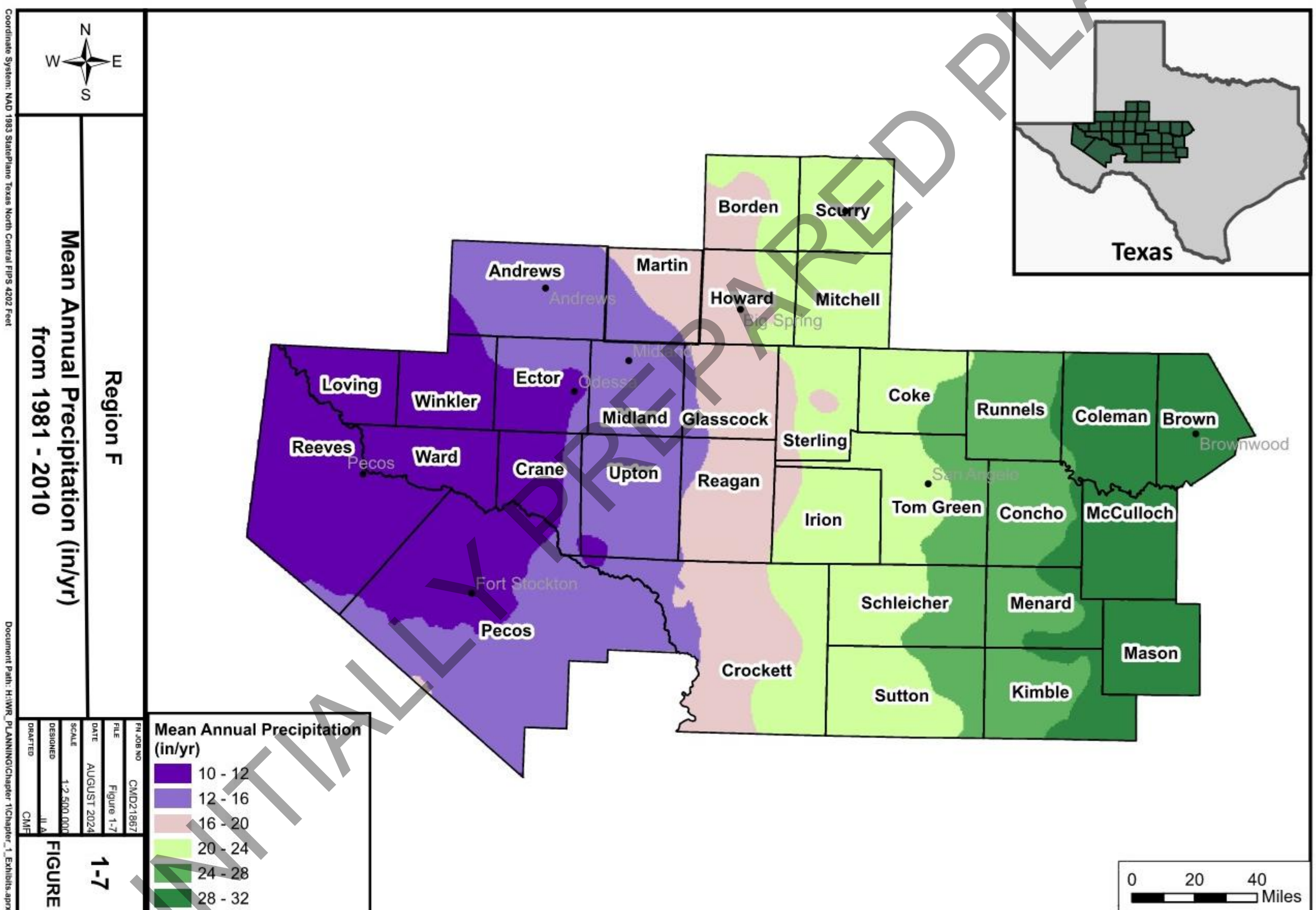


Figure 1-8
Mean Annual Temperature

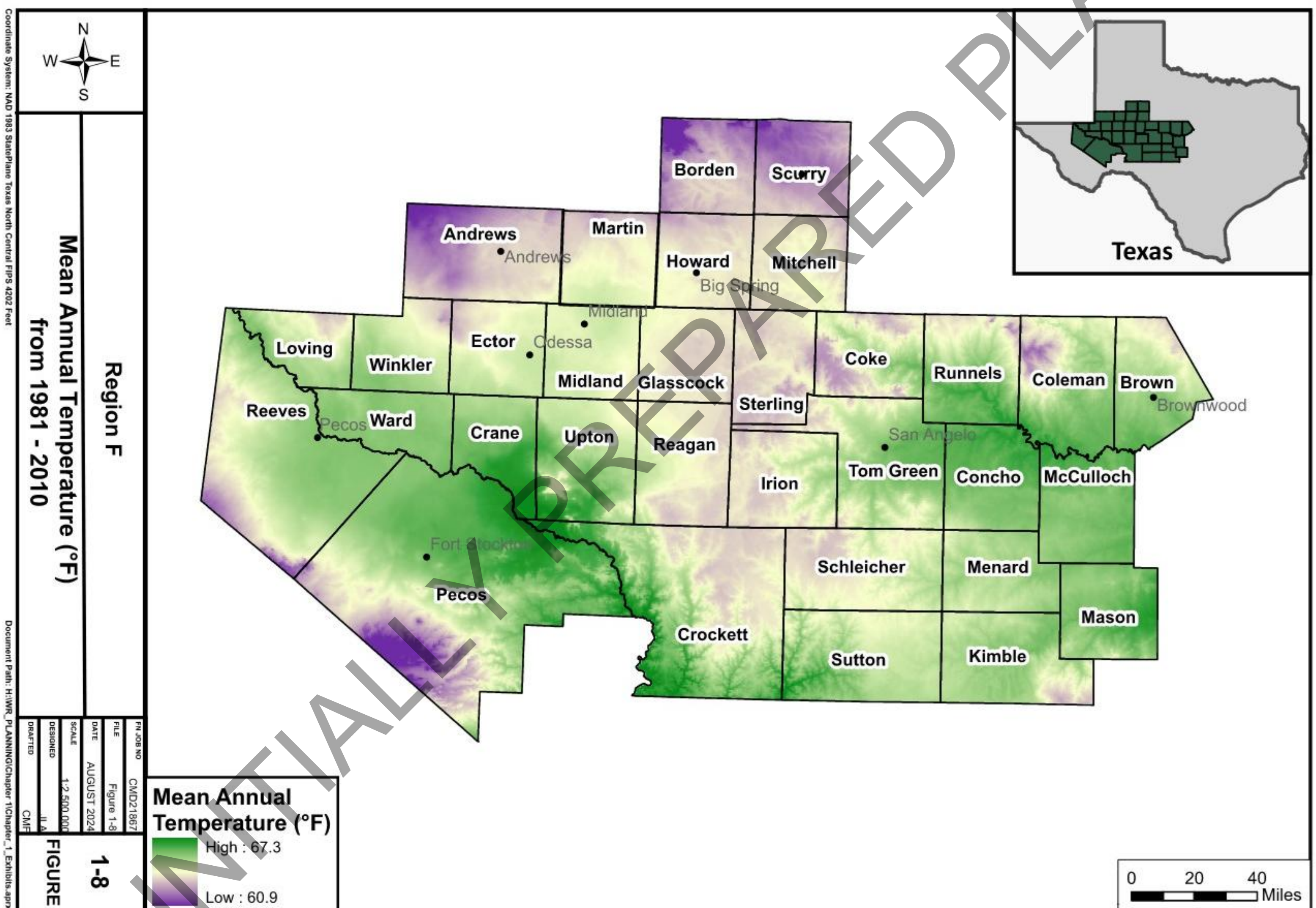


Figure 1-9
Region F Major Aquifer Map

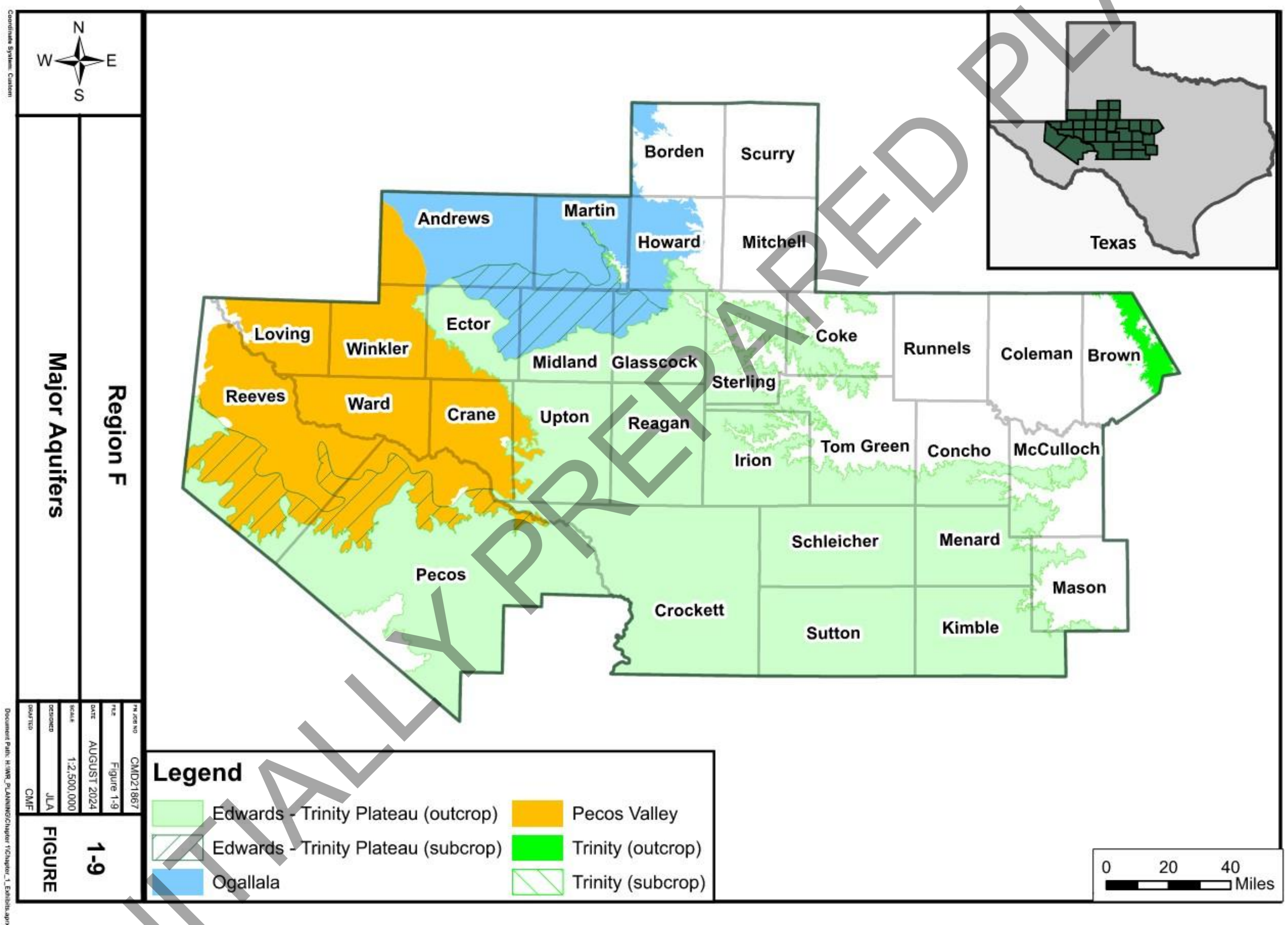
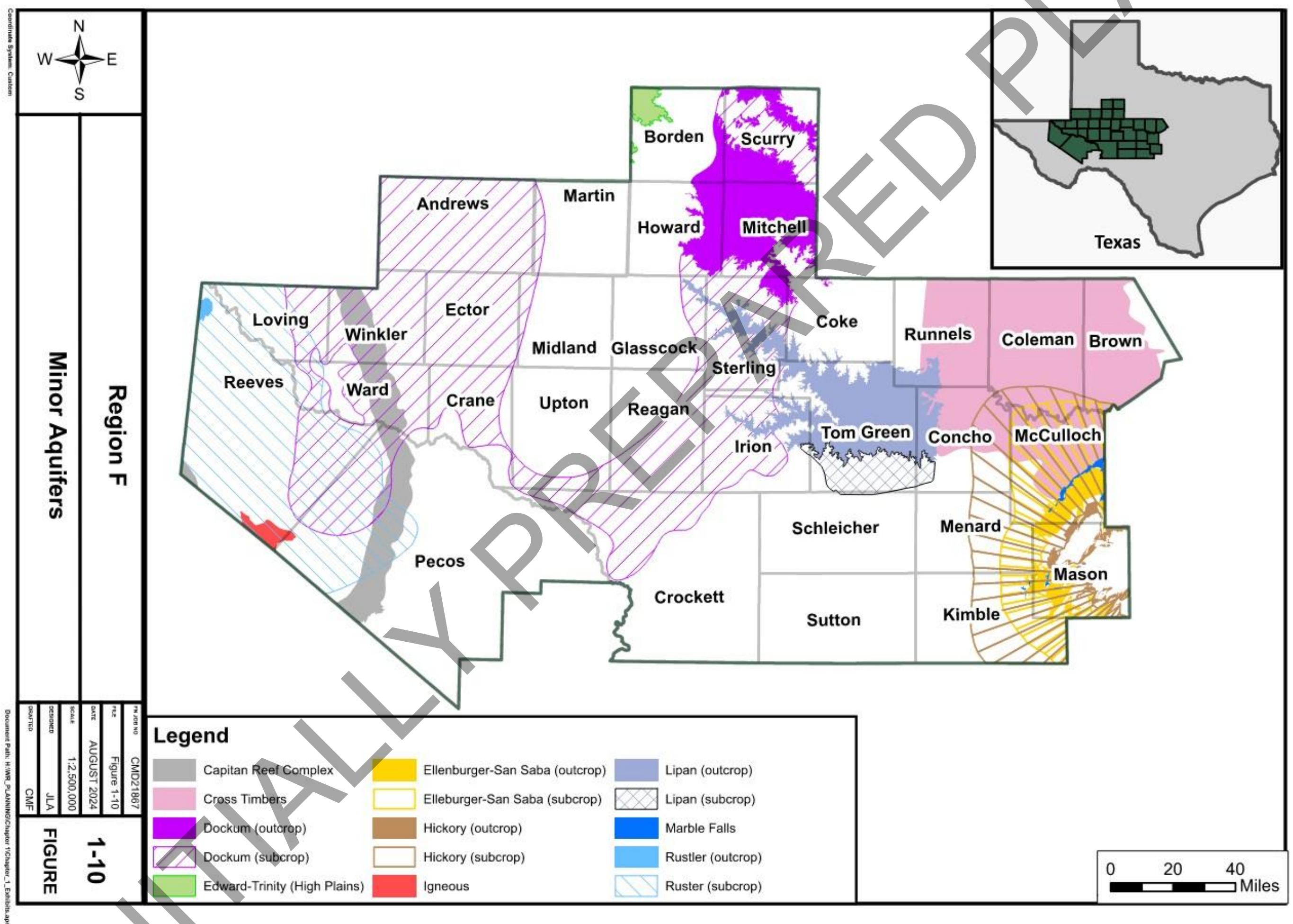


Figure 1-10
Region F Minor Aquifer Map



1.2 CURRENT WATER USES AND DEMAND CENTERS IN REGION F

Table 1-5 shows water use from 2011-2021 by TWDB use category and Figure 1-11 illustrates a graph of the data.[9] Table 1-6 shows the total water use by county in Region F for the same period. Water use in Region F increased between 2011 and 2021 and has generally increased in recent years. Since 2011, mining activity and its associated water use has markedly increased.

Table 1-5
Historical Water Use by Category in Region F (Values in acre-feet)

Year	Municipal	Manufacturing	Irrigation	Power[a]	Mining	Livestock	Total
2011	135,954	7,123	494,192	3,567	10,136	14,004	664,976
2012	107,716	6,152	447,476	3,747	13,831	11,596	590,518
2013	110,577	5,894	466,502	3,601	27,234	10,094	623,902
2014	117,119	5,507	470,242	3,573	39,072	10,187	645,700
2015	120,779	5,888	438,822	3,202	63,036	10,276	642,003
2016	116,637	5,685	459,192	8,404	75,314	10,417	675,649
2017	119,993	7,422	484,102	8,000	163,536	11,536	794,589
2018	126,001	12,830	422,753	9,232	220,116	11,946	802,878
2019	127,478	11,819	413,831	8,994	236,598	11,979	810,699
2020	141,004	7,061	437,400	7,813	150,408	12,007	755,693
2021	133,726	7,930	450,181	4,516	202,821	11,669	810,843
State Total in 2021	*4,618,597*	*957,199*	*7,566,720*	*532,785*	*334,697*	*285,857*	*14,295,855*
% of State Total in Reg F	*2.90%*	*0.83%*	*5.95%*	*0.85%*	*60.60%*	*4.08%*	*5.67%*

Note: Data are from the Texas Water Development Board.[9]
a. Steam Electric Power

Figure 1-11
Historical Water Use by Category in Region F

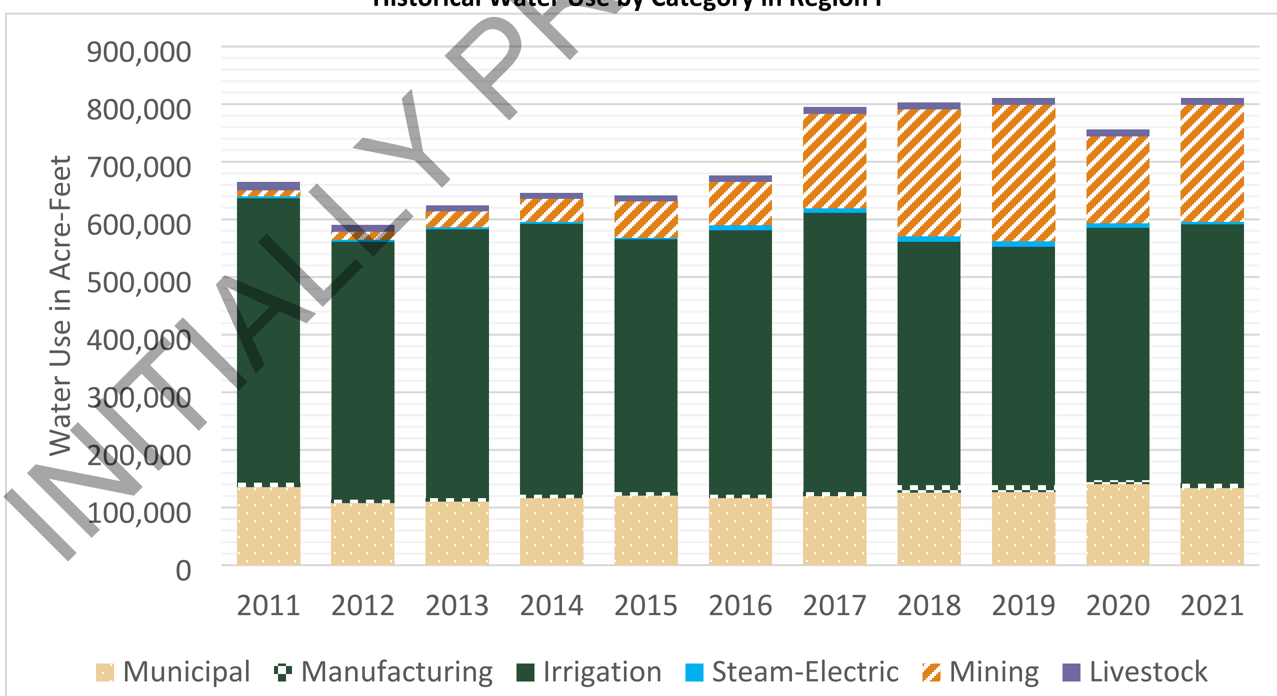


Table 1-6
Historical Total Water Use by County in Region F (Values in acre-feet)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Andrews	27,340	28,839	24,107	20,709	20,853	22,162	21,533	21,950	23,020	21,274	26,861
Borden	4,430	3,788	4,450	2,301	2,238	2,683	3,428	4,814	4,465	3,377	3,066
Brown	17,628	14,763	13,753	12,896	13,660	12,750	12,496	15,627	13,276	15,811	13,707
Coke	1,936	1,453	1,269	1,070	990	1,285	1,365	1,399	1,401	1,882	1,672
Coleman	2,894	2,457	2,223	2,305	2,336	2,711	2,910	2,777	2,872	2,877	2,921
Concho	3,740	5,919	6,121	5,709	5,482	5,562	6,332	7,968	7,658	9,115	7,644
Crane	1,803	1,898	1,960	1,795	2,120	1,315	1,603	2,005	2,785	3,020	3,000
Crockett	2,698	3,468	4,579	4,659	3,657	3,169	4,165	2,696	1,728	1,721	1,715
Ector	32,319	27,105	27,215	25,964	22,012	25,461	26,935	32,568	34,391	37,565	32,894
Glasscock	54,170	47,328	52,337	54,936	30,141	41,498	49,296	48,607	53,203	45,210	44,077
Howard	18,030	13,968	13,282	14,786	15,763	16,742	27,460	30,549	34,235	32,485	39,132
Irion	2,524	2,298	4,235	4,332	3,380	2,873	3,988	6,468	7,134	2,890	2,434
Kimble	4,651	4,367	4,204	3,912	3,933	3,740	3,741	4,171	4,702	5,291	3,815
Loving	66	205	326	548	4,455	6,006	13,039	16,082	17,037	10,936	12,633
Martin	36,948	33,546	44,968	41,754	42,938	35,627	45,106	54,155	57,032	52,827	59,873
Mason	7,505	7,174	6,483	6,880	6,431	6,407	6,089	5,559	6,396	6,170	5,785
McCulloch	7,839	7,527	6,866	8,086	8,472	8,093	6,336	6,491	3,844	4,622	3,876
Menard	5,352	2,621	5,827	5,104	4,770	4,316	2,829	4,431	2,951	3,550	3,448
Midland	69,150	50,755	39,594	46,600	55,177	72,162	85,419	101,876	102,450	93,022	99,902
Mitchell	15,401	21,151	18,671	20,400	17,916	16,831	17,483	15,933	16,323	15,736	15,508
Pecos	188,776	116,318	147,330	166,937	163,262	161,543	154,451	129,393	114,859	112,533	130,065
Reagan	28,760	20,944	24,316	31,378	28,267	26,385	36,540	38,660	38,002	33,668	34,238
Reeves	58,068	58,669	81,800	61,235	62,139	79,545	117,053	96,519	103,819	83,110	99,924
Runnels	4,239	5,599	5,262	5,219	6,235	5,465	5,799	6,379	5,840	6,178	5,956
Schleicher	3,199	3,153	2,833	3,100	2,650	3,041	3,299	3,299	3,301	3,794	3,669
Scurry	10,060	12,680	10,287	10,623	8,926	9,404	10,768	9,651	10,396	12,500	12,058
Sterling	1,575	1,295	1,785	1,678	1,418	1,203	1,173	1,441	1,343	1,518	1,456
Sutton	3,288	2,663	2,460	2,671	2,418	2,449	2,399	2,554	2,392	2,651	2,413
Tom Green	45,410	76,737	56,306	64,204	74,634	64,712	76,616	78,789	80,252	85,898	83,873
Upton	15,942	12,810	12,459	14,763	13,717	15,250	20,243	20,412	21,622	17,967	23,772
Ward	10,159	5,631	5,496	7,761	7,814	9,794	17,455	19,392	18,012	14,192	15,244
Winkler	6,584	6,359	5,180	5,929	3,799	5,465	7,240	10,263	13,958	12,303	14,212
Total	***692,484***	***603,487***	***637,984***	***660,244***	***642,003***	***675,649***	***794,589***	***802,878***	***810,699***	***755,693***	***810,843***

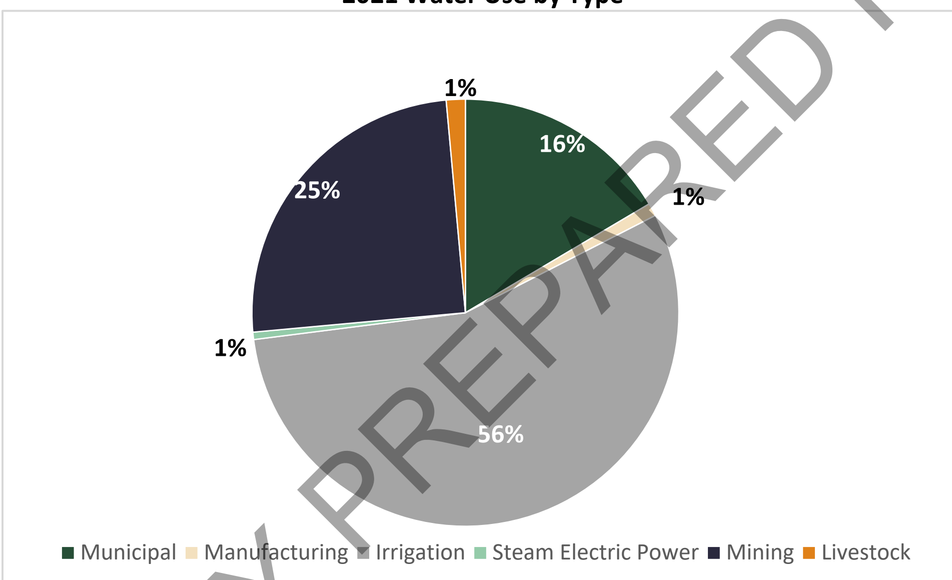
Note: Data are from the Texas Water Development Board.[9]
Data for Reeves County after 2003 includes all water released from the Red Bluff Reservoir. Approximately 25% of this water is delivered to customers in Pecos, Reeves, Ward and Loving Counties. The remaining 75% of the water is lost to evaporation and stream losses.

Table 1-7 shows water use by category and county in 2021, and Figure 1-13 shows the distribution of water use by county.

The areas with the highest water use are Midland, Pecos, Reeves, and Tom Green Counties, accounting for over half of the total water used in the region. Most of the municipal water use occurred in Ector, Midland, and Tom Green Counties, location of the cities of Odessa, Midland, and San Angelo, respectively. In the year 2021, these counties accounted for about 61 percent of the water use in this category. Other significant municipal demand centers include Brown County (Brownwood), Pecos County (Fort Stockton), Reeves County (Pecos), & Howard County (Big Spring).

Manufacturing water use is small in Region F. Use in this category is concentrated in Crane, Ector, Howard, Kimble and Tom Green counties.

Figure 1-12
2021 Water Use by Type



Reeves, Pecos, and Tom Green Counties accounted for most of the reported irrigation water use in 2021, accounting for more than a half of the irrigation water use in the region. However, some of the water reported for irrigation in Reeves County is associated with delivery losses from the Red Bluff Reservoir. The actual use of irrigation water in Reeves County is less than shown. Other significant demand centers for irrigation water include Glasscock, Martin, and Reagan Counties.

2021 Water Use in Region F:

- 2021 water use was highest water use in the decade from 2011 to 2021
- Midland County had the highest total water use in 2018 in the past decade
- Irrigation continues to be the largest water user in the region
- Mining water use has increased more than 20 times since 2011. It is now the second highest water category in Region F

Steam-electric power generation water use occurred only in Ector, Howard, Mitchell, and Ward Counties during the year 2021. Facilities in other counties have temporarily or permanently ceased operations.

Most of the water used for mining purposes occurred in Howard, Martin, Midland, Reeves, and Upton Counties, accounting for approximately 68 percent of the total use. Mining activities across the region have increased significantly since 2011. Region F accounted for nearly 61 percent of the mining water use in the entire state in 2021.

Livestock is a small water use category in Region F. 35% of the livestock water use occurred in Brown, Coleman, Mason, Pecos, and Tom Green Counties.

In addition to the consumptive water uses discussed previously, water-oriented recreation is important in Region F. Table 1-8 summarizes recreational opportunities at major reservoirs in the region[8]. Smaller lakes and streams provide opportunities for fishing, boating, swimming, and other water-related recreational activities. Water in streams and lakes is also important to fish and wildlife in the region, providing a wide variety of habitats.

Table 1-7
Year 2021 Water Use by Category and County (Values in acre-feet)

County	Municipal	Manu-facturing	Irrigation	Steam-Electric	Mining	Livestock	Total
ANDREWS	3,521	202	15,329	0	7,608	201	26,861
BORDEN	133	0	1,700	0	914	319	3,066
BROWN	5,943	357	6,422	0	0	985	13,707
COKE	586	0	750	0	63	273	1,672
COLEMAN	1,636	1	489	0	0	795	2,921
CONCHO	651	0	6,439	0	0	554	7,644
CRANE	1,000	371	0	0	1573	56	3,000
CROCKETT	1,099	0	15	0	82	519	1,715
ECTOR	26,378	449	708	3939	1,256	164	32,894
GLASSCOCK	126	213	36,148	0	7,474	116	44,077
HOWARD	7,044	461	2,937	440	28,065	185	39,132
IRION	158	3	1,475	0	534	264	2,434
KIMBLE	790	31	2,645	0	14	335	3,815
LOVING	75	0	0	0	12513	45	12,633
MARTIN	896	0	27,837	0	31,074	66	59,873
MASON	732	0	4,201	0	176	676	5,785
MCCULLOCH	1,580	0	1,720	0	0	576	3,876
MENARD	337	0	2,794	0	0	317	3,448
MIDLAND	38,707	4893	14,457	0	41,714	131	99,902
MITCHELL	1,520	1	13,588	108	0	291	15,508
PECOS	5,853	11	118,609	0	5,013	579	130,065
REAGAN	507	0	22,549	0	10,795	387	34,238
REEVES[b]	5,350	1	74,793	0	19,577	203	99,924
RUNNELS	1,524	1	3,691	0	0	740	5,956
SCHLEICHER	465	0	2,750	0	0	454	3,669
SCURRY	3,373	50	6,620	0	1,529	486	12,058
STERLING	245	0	963	0	0	248	1,456
SUTTON	901	0	1,121	0	0	391	2,413
TOM GREEN	16,723	862	65,259	0	3	1,026	83,873
UPTON	1,002	15	5,638	0	17,010	107	23,772
WARD	3,018	1	5,318	29	6,804	74	15,244
WINKLER	1,853	7	3,216	0	9,030	106	14,212
REGIONAL TOTAL	*133,726*	*7,930*	*450,181*	*4,516*	*202,821*	*11,669*	*810,843*
STATE TOTAL	*4,618,597*	*957,199*	*7,566,720*	*532,785*	*334,697*	*285,857*	*14,295,855*

Note: Data are from the Texas Water Development Board.[9]

a. Great Plains sells water to a Steam Electric Facility in Ector County

b. Data for Reeves County includes all water released from the Red Bluff Reservoir.

Figure 1-13
2021 Historical Water Use by County

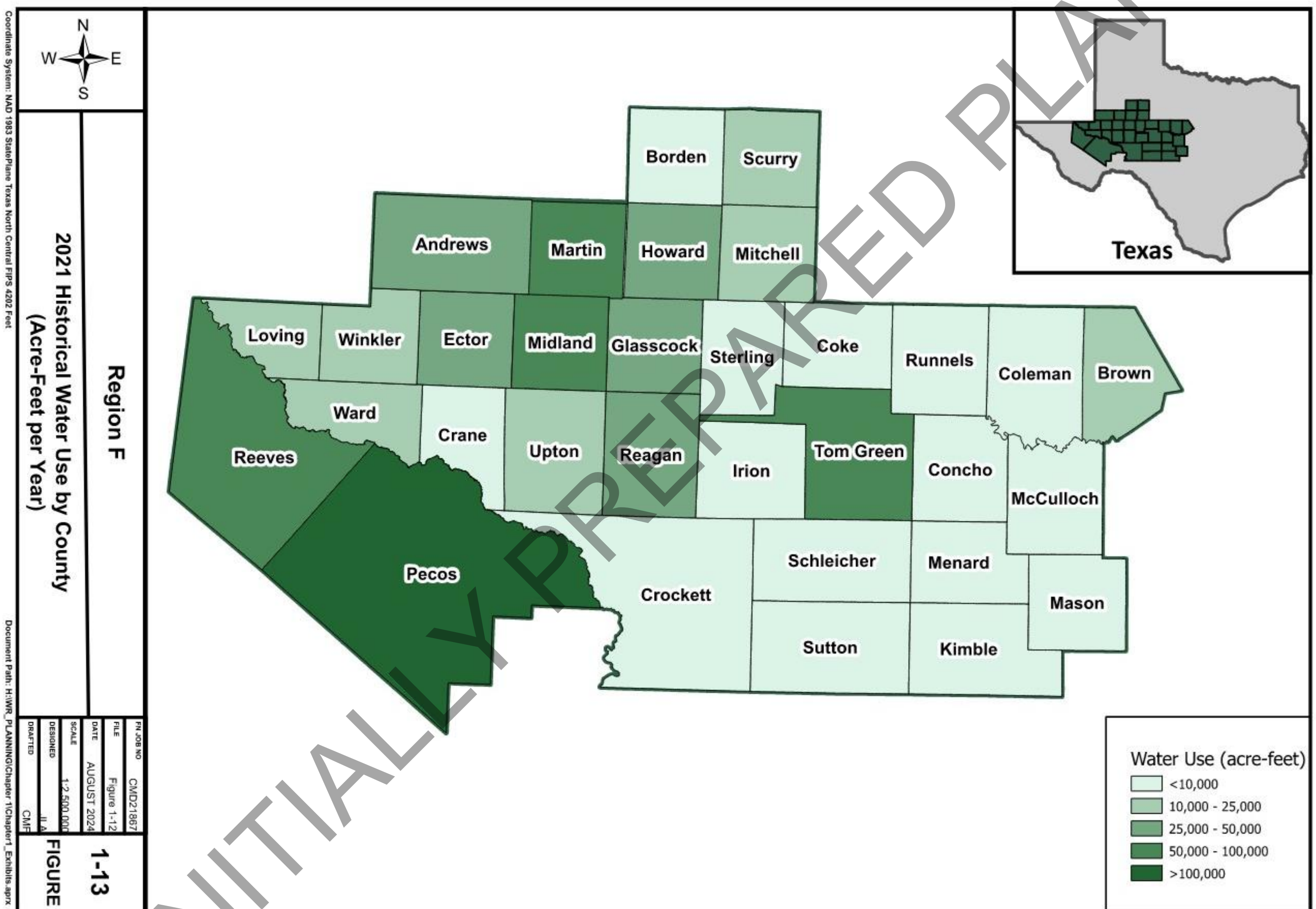


Table 1-8
Recreational Use of Reservoirs in Region F

Reservoir Name	County	Fishing	Boat Launch	Swimming Area	Marina	Picnic Area	Camping	Hiking Trails	Bicycle Trails	Equestrian Trails	Pavilion Area
Lake J. B. Thomas	Borden and Scurry	X	X			X	X				X
Lake Colorado City	Mitchell	X	X	X		X	X	X	X		X
Champion Creek Reservoir	Mitchell	X	X			X	X				
Oak Creek Reservoir	Coke	X	X	X	X	X	X				
Lake Coleman	Coleman	X	X	X	X	X	X				
E. V. Spence Reservoir	Coke	X	X	X	X	X	X				X
Lake Winters/ New Lake Winters	Runnels	X	X	X		X	X	X			X
Lake Brownwood	Brown	X	X	X		X	X	X	X		X
Hords Creek Lake	Coleman	X	X	X		X	X	X	X		X
Lake Ballinger / Lake Moonen	Runnels	X	X	X		X	X				
O. H. Ivie Reservoir	Concho and Coleman	X	X		X	X	X				X
O. C. Fisher Lake	Tom Green	X	X	X		X	X	X	X	X	X
Twin Buttes Reservoir	Tom Green	X	X	X		X	X	X			
Lake Nasworthy	Tom Green	X	X	X	X	X	X	X	X		X
Brady Creek Reservoir	McCulloch	X	X	X	X	X	X	X		X	X
Mountain Creek Lake	Coke										
Red Bluff Reservoir	Reeves and Loving	X	X			X	X				
Lake Balmorhea	Reeves	X	X	X		X	X				

Note: "X" indicates that the activity is available at the specified reservoir.

1.3 CURRENT SOURCES OF WATER

Table 1-9 summarizes the total surface water, groundwater, and reuse water use in Region F from 2011 through 2021, and Figure 1-14 graphically illustrates the same data. Total water use increased by approximately 118,000 acre-feet (17 percent) between 2011 and 2021. Groundwater use increased by more than 24,000 acre-feet (5.0 percent) and surface water use decreased by over 58,000 acre-feet (42.8 percent) over the same period. Estimates of reuse water and brackish water (for mining) use were first recorded by the TWDB on a countywide basis in the year 2015. Between 2015 and 2021, there was an increase of over 125,000 acre-feet (237 percent) of reuse water use.

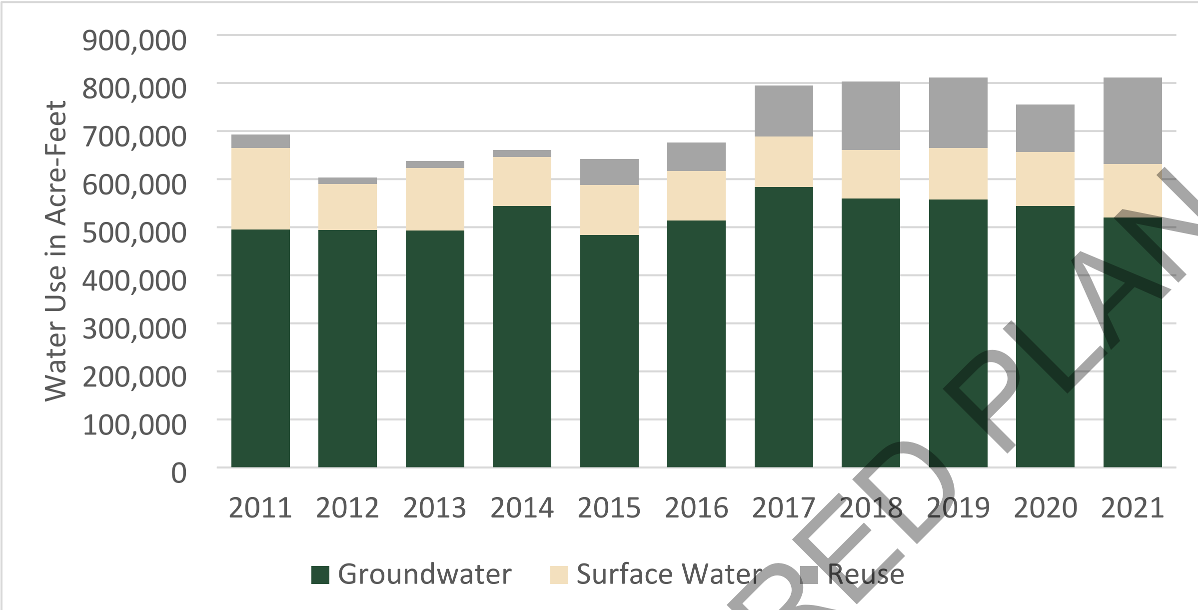
Figure 1-16 shows the percentage of supply from groundwater, broken down by county, in the region in the year 2021. Overall, groundwater use has shown a decreasing trend in recent years ranging from 72 percent of total water use in 2011 to 64 percent in 2021. Surface water use has shown a consistent decreasing trend ranging from 24 percent of total water use in 2011 to 14 percent in 2021.

Table 1-9
Historical Groundwater, Surface Water, and Reuse Water Use in Region F

Year	Groundwater (Acre-Feet)	Surface Water (Acre-Feet)	Reuse[a] Water (Acre-Feet)	Total (Acre-Feet)_
2011	495,423	169,553	27,508	692,484
2012	493,939	96,576	12,969	603,484
2013	493,619	130,279	14,082	637,980
2014	544,024	101,677	14,544	660,245
2015	484,155	104,609	53,239	642,003
2016	513,966	102,629	59,054	675,649
2017	584,176	104,743	105,670	794,589
2018	559,400	101,814	141,664	802,878
2019	558,277	106,692	145,730	810,699
2020	543,760	113,223	98,710	755,693
2021	520,162	111,488	179,193	810,843

Note: Data are from Texas Water Development Board.[9]
a. Values from 2000-2014 only reflect entities that reported water reuse during that year.
Annual reuse and brackish water (for mining) use was not reported through all of Region F until 2015.

Figure 1-14
Historical Groundwater, Surface Water, and Reuse Water Use in Region F*



*Values from 2000-2014 only reflect entities that reported water reuse during that year. Annual water reuse was not reported through all of Region F until 2015.

Figure 1-15
Groundwater, Surface Water, and Reuse Water Use in Region F in 2021

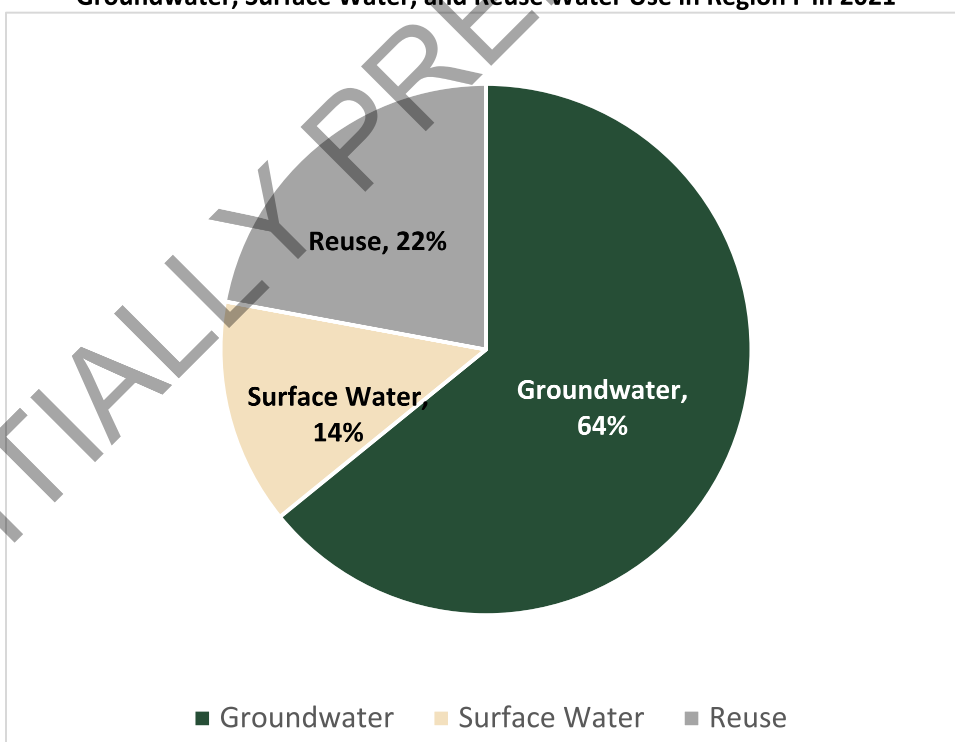
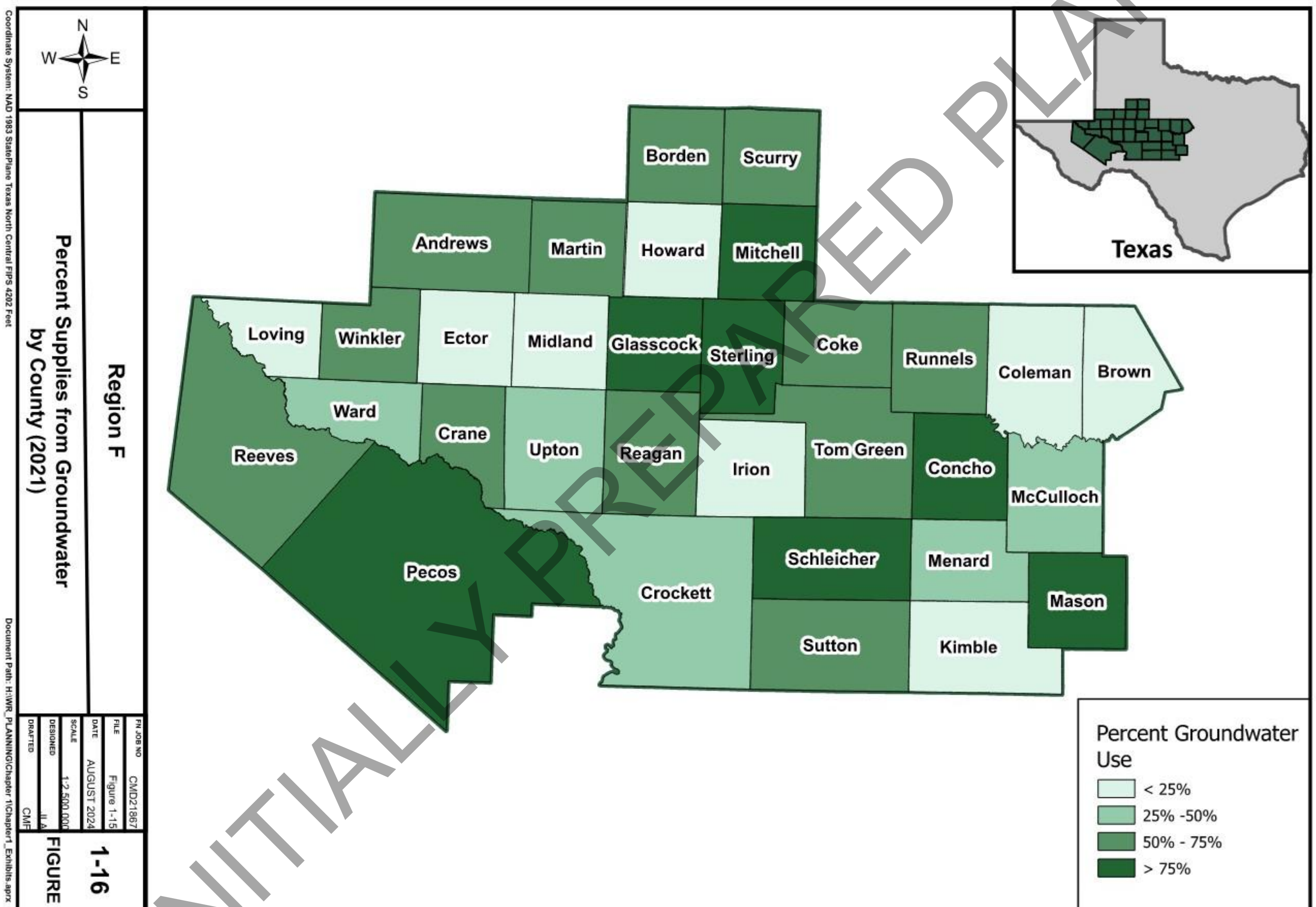


Figure 1-16
Percent Supplies from Groundwater by County (2021)

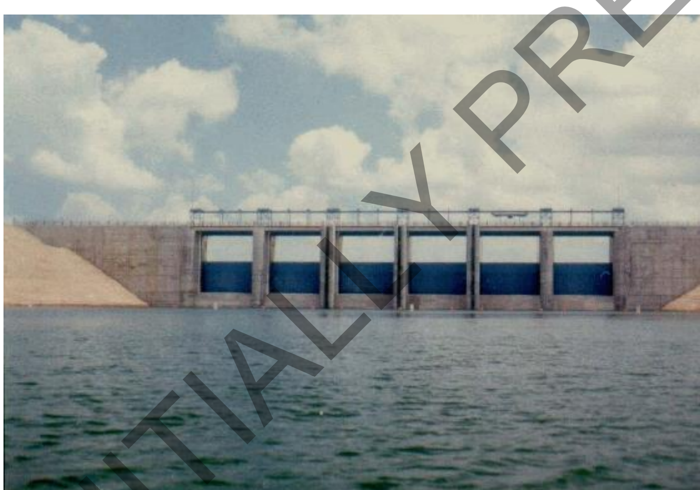


1.3.1 Surface Water Sources

Surface water in Region F is primarily obtained from reservoirs in the Colorado and Rio Grande River Basins. Some water is diverted directly from streams for agricultural and industrial use. Surface water is also used for domestic and livestock use through the development of stock tanks and river diversions.

All surface water, with a few exceptions, is owned by the State and users must have a water right permit to store and/or use this water. Water use permits are generally issued by use type authorized by the State. Table 1-10 summarizes permitted surface water diversions by use category for each county in Region F. (These categories differ slightly from the demand categories used by TWDB for regional water planning.) Figure 1-17 shows the distribution of permitted diversions by county and use type. Most of the large surface water diversions in Region F are associated with major reservoirs. Table 1-4 in Section 1.1.2 lists the permitted diversions and the reported year 2022 water use from major water supply reservoirs in the region.

Region F does not import a significant amount of surface water from other regions (a total of 1,032 acre-feet per year in 2030 from Regions O, G and E). Region F exports water to two cities in Region G: Sweetwater and Abilene. The City of Sweetwater owns and operates Oak Creek Reservoir, a 30,000 acre-feet reservoir in Coke County. The City of Abilene has a contract with the Colorado River Municipal Water District (CRMWD) for 16.54% of the safe yield of O.H. Ivie Reservoir. Facilities to transfer water from Lake O.H. Ivie to Abilene became operational in September 2003. Small amounts of surface water are supplied to the Cities of Lawn and Rotan, which are both in Region G. Several rural water supply corporations also supply small amounts of surface water to neighboring regions.



Lake Ivie
Colorado River Municipal Water District

Lake Brownwood
Brown County Water Improvement District #1

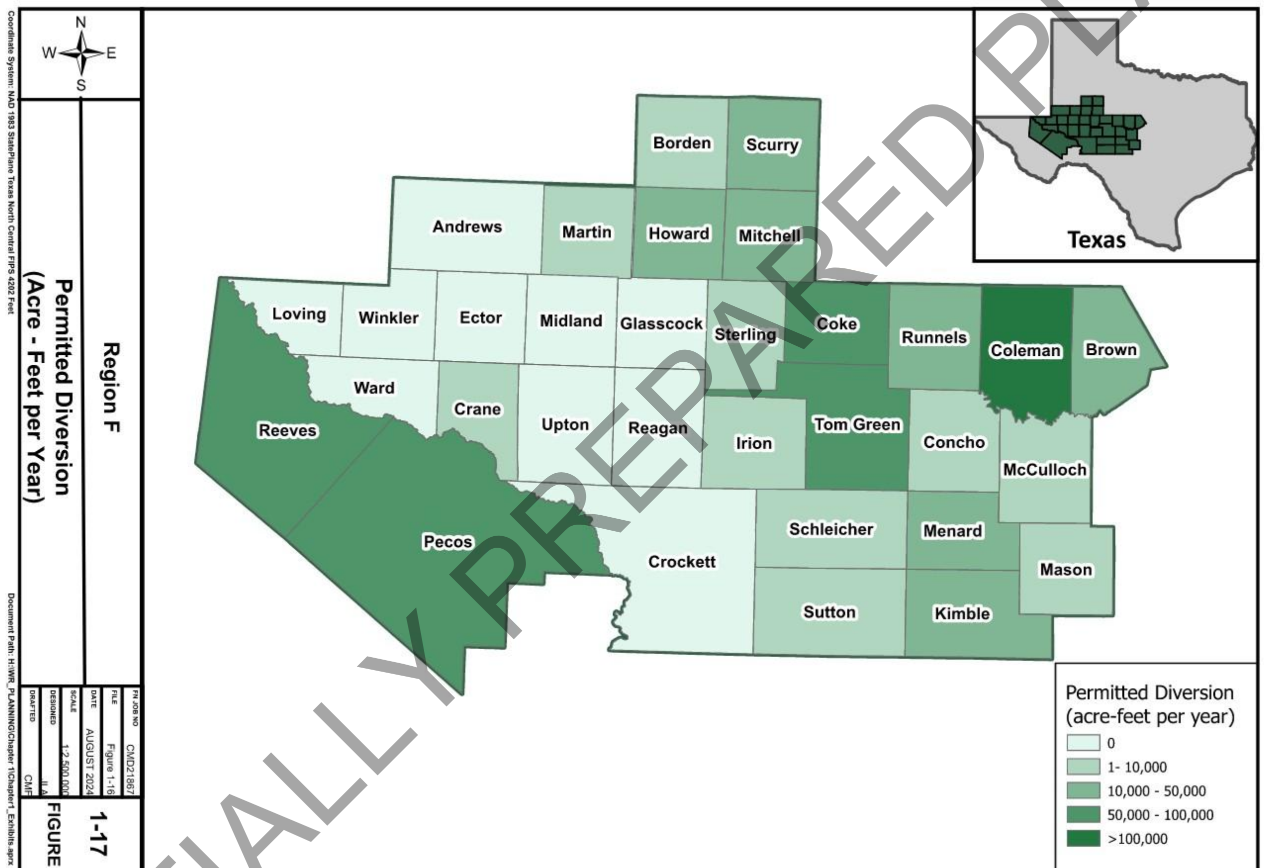
Table 1-10
Surface Water Rights by County and Category

County	Permitted Municipal[a] Surface Water Diversions (Acre-Feet per Year)	Permitted Industrial Surface Water Diversions (Acre-Feet per Year)	Permitted Irrigation Surface Water Diversions (Acre-Feet per Year)	Permitted Mining Surface Water Diversions (Acre-Feet per Year)	Permitted Other[b] Surface Water Diversions (Acre-Feet per Year)	Total Surface Water Diversions (Acre-Feet per Year)
Borden	200	0	63	0	0	**263**
Brown	29,712	0	8,729	0	0	**38,441**
Coke	59,557	6,000	969	1,669	0	**68,195**
Coleman [c]	110,839	14,509	6,522	0	71	**131,941**
Concho	35	0	2,356	0	16	**2,407**
Ector	0	0	3,200	0	0	**3,200**
Howard	1,700	0	89	45,715	0	**47,504**
Irion	0	0	5,734	55	0	**5,789**
Kimble	1,000	2,472	8,450	60	0	**11,982**
Martin	0	0	0	2,500	0	**2,500**
Mason	0	0	356	0	0	**356**
McCulloch	0	0	2,231	0	3,500	**5,731**
Menard	1,016	0	5,597	3	4,892	**11,508**
Mitchell	8,200	4,050	123	0	0	**12,373**
Pecos	0	0	66,902	0	0	**66,902**
Reeves [d]	0	0	54,866	0	0	**54,866**
Runnels	2,919	0	7,073	70	0	**10,062**
Schleicher	0	0	38	3	0	**41**
Scurry [e]	30,000	0	503	0	0	**30,503**
Sterling	0	0	168	0	0	**168**
Sutton	0	0	99	3	0	**102**
Tom Green	27,042	8,002	41,655	0	16	**76,715**
Total	***272,220***	***35,033***	***215,722***	***50,078***	***8,495***	***581,548***

a. Diversion amounts that are permitted for multiple uses, including municipal, are shown under the municipal use category.
b. Other includes domestic and livestock use and recreational use.
c. Includes water rights for Ivie Reservoir, which is located in Coleman, Concho and Runnels Counties.
d. Includes rights for Red Bluff Reservoir, which is located in Loving and Reeves Counties.
e. Includes rights for Lake J.B. Thomas, which is located in Borden and Scurry Counties.

Note: Data are from TCEQ's active water rights list.[6] Other counties have no permitted water rights on the TCEQ list. Additional note, for water rights listed in multiple counties, all of the volume of the water right was assigned to one county.

Figure 1-17
Permitted Diversion by County



1.3.2 Groundwater Sources

As previously discussed in section 1.1.2, there are 14 aquifers that supply water to the 32 counties of Region F: four major aquifers (Edwards-Trinity Plateau, Ogallala, Pecos Valley, and Trinity) and ten minor aquifers (Capitan Reef Complex, Cross Timbers, Dockum, Edwards-Trinity High Plains, Ellenberger-San Saba, Hickory, Igneous, Lipan, Marble Falls, and Rustler). The TWDB defines a major aquifer as an aquifer that supplies large quantities of water to large areas.[10] Minor aquifers supply large quantities of water to small areas, or relatively small quantities of water to large areas. The Trinity aquifer is considered a major aquifer by the TWDB because it supplies large quantities of water in other regions. However, the Trinity aquifer covers only a small portion of Region F in Brown County and supplies a relatively small amount of water in the region.

Table 1-11 shows the 2021 groundwater use by county and aquifer.[9] The Edwards-Trinity Plateau, Pecos Valley, and Ogallala are the largest sources of groundwater in Region F, providing 32.3 percent, 16.2 percent, and 22.9 percent of the total groundwater pumped in 2021, respectively. The Dockum aquifer provided approximately 8.4 percent of the 2021 totals, with all remaining aquifers contributing 20.2 percent combined. Groundwater pumping is highest in Glasscock, Martin, Pecos, Reeves, Reagan, and Tom Green Counties. Approximately 68 percent of the region's total pumping occurs in these six counties.

Groundwater conservation districts are the preferred method for managing groundwater in the State of Texas. There are 16 Underground Water Conservation Districts (GCDs) in Region F (Figure 1-18). These entities are required to develop and adopt comprehensive management plans, permit wells that are drilled, completed or equipped to produce more than 25,000 gallons per day, keep records of well completions, and make information available to state agencies. Other powers granted to GCDs are prevention of waste, conservation, recharge projects, research, distribution and sale of water, and making rules regarding transportation of groundwater outside of the district.[11]

Fifteen of the GCDs in Region F form the West Texas Regional Groundwater Alliance, an organization that promotes the conservation, preservation and beneficial use of water and related resources in the region. Seven of the GCDs are also members of the West Texas Weather Modification Association, a group that performs rainfall enhancement activities in a seven-county area.

The GCDs are also required to participate in joint groundwater planning through Groundwater Management Areas (GMAs). There are 16 GMAs in the State of Texas whose boundaries generally coincide with major aquifers. Each GMA is tasked with determining Desired Future Conditions for the aquifers in the management area for planning purposes. There are four GMAs that include one or more counties in Region F: GMA-7, GMA-3, GMA-2, and GMA-8 (Figure 1-18). Additional information on GCDs, the GMA process, and groundwater availability is included in Chapter 3.

In areas, where no there is no GCD, the state may designate a Priority Groundwater Management Area (PGMA). The Priority Groundwater Management Area (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.

Table 1-11
Groundwater Pumping by County and Aquifer in 2021 (Values in Acre-Feet)

County	Edwards-Trinity Plateau	Ogallala	Pecos Valley	Lipan	Hickory	Dockum	Trinity	Ellen-berger-San Saba	Marble Falls	Edwards-Trinity High Plains	Rustler	Capitan Reef Complex	Igneous	Other[a]	*Total*
Andrews	2	19,911	80	0	0	2	0	0	0	0	0	0	0	2	***19,996***
Borden	0	1,552	0	0	0	233	0	0	0	24	0	0	0	366	***2,174***
Brown	0	0	0	0	0	0	1,172	1	0	0	0	0	0	194	***1,367***
Coke	175	0	0	0	0	0	0	0	0	0	0	0	0	1,019	***1,194***
Coleman	0	0	0	0	0	0	0	0	0	0	0	0	0	121	***121***
Concho	323	0	0	3,624	321	0	0	0	0	0	0	0	0	2,497	***6,764***
Crane	0	0	1,397	0	0	398	0	0	0	0	0	0	0	0	***1,795***
Crockett	1,645	0	0	0	0	2	0	0	0	0	0	0	0	7	***1,654***
Ector	3,556	387	0	0	0	330	7	0	0	0	0	0	0	0	***4,280***
Glasscock	31,535	4,694	0	0	0	1,569	0	0	0	0	0	0	0	369	***38,167***
Howard	1,345	8,609	0	0	0	285*	0	0	0	0	0	0	0	233	***10,473***
Irion	618	0	0	0	0	2	0	0	0	0	0	0	0	62	***682***
Kimble	506	0	0	0	20	0	4	9	0	0	0	0	0	211	***751***
Loving	0	0	2,241	0	0	23	0	0	0	0	1	0	0	1	***2,267***
Martin	2	35,967	0	0	0	0*	0	0	0	0	0	0	0	0	***35,969***
Mason	11	0	0	0	5,273	0	1	73	0	0	0	0	0	231	***5,589***
McCulloch	7	0	0	0	4,303	0	31	247	24	0	0	0	0	104	***4,716***
Menard	512	0	0	0	408	0	0	5	0	0	0	0	0	344	***1,269***
Midland	6,304	14,313	0	0	0	3*	0	0	0	0	0	0	0	0	***20,619***
Mitchell	0	0	2	0	0	15,202	0	0	0	0	0	0	0	20	***15,224***
Pecos	76,337	0	32,452	0	0	0	0	0	0	0	3,338	2,506	0	9,165	***123,799***
Reagan	24,520	0	0	0	0	2,350	0	0	0	0	0	0	0	91	***26,962***
Reeves	7,618	0	55,038	0	0	2,362	0	0	0	0	5,634	0	427	2,457	***73,536***
Runnels	17	0	0	37	0	0	0	0	0	0	0	0	0	3,199	***3,253***
Schleicher	3,647	0	0	0	0	0	0	0	0	0	0	0	0	0	***3,647***
Scurry	0	0	0	0	0	8,119	0	0	0	0	0	0	0	40	***8,159***
Sterling	556	0	88	0	0	220	0	0	0	0	0	0	0	570	***1,434***
Sutton	2,225	0	0	0	0	0	0	0	0	0	0	0	0	180	***2,406***
Tom Green	2,142	0	0	34,713	0	0	0	0	0	0	0	0	0	22,834	***59,690***
Upton	7,456	98	1	0	0	3,676	0	0	0	0	0	0	0	12	***11,243***
Ward	0	0	16,163	0	0	32	0	0	0	0	3	0	0	91	***16,289***
Winkler	2	0	13,896	0	0	9,662	0	0	0	0	0	0	0	0	***23,560***
Total	***171,061***	***85,530***	***121,357***	***38,374***	***10,326***	***44,469***	***1,216***	***336***	***24***	***24***	***8,976***	***2,506***	***427***	***44,422***	***529,049***

a. "Other" aquifer category is the sum of groundwater pumping from aquifers not listed and unknown sources of pumping

*Historical use from the Dockum in Howard, Martin, and Midland counties is likely underestimated by the TWDB. The Dockum is being used for mining purposes in these counites.

Note: Data are from the Texas Water Development Board.[9]

Once an area is designated a PGMA, landowners have two years to create a 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 PGMAs in the state. The PGMA process is completely independent of the current 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 regulating entity to address the identified groundwater issues. PGMAs are still relevant as long as there remain portions within these designated areas without GCDs. There is one PGMA in Region F, the Reagan, Upton, and Midland County PGMA as shown in Figure 1-19.

The Reagan, Upton and Midland County PGMA was designated in 1990. The name of the PGMA is somewhat of a misnomer because it only includes portions of Midland and Upton Counties as shown in Figure 1-19. All portions of Reagan County are included in either Glasscock or Santa Rita GCD.

There have been previous efforts to create GCDs in Upton and Midland Counties. In November 1991, landowners in Midland County attempted to join the Permian Basin UWCD but were unsuccessful. In 1999, House Bill 437 proposed to expand the authority of the existing Upton County Water District, and subsequently failed.

The TCEQ Executive Director is authorized to petition the Commission to establish groundwater management in PGMAs in areas that have no GCD. The Executive Director of the TCEQ published a final report in February 2017 addressing five options available to the portions of Midland and Upton Counties that are located within the PGMA boundary. As of this time, no order has been issued by TCEQ and no county commissioner's court has promulgated groundwater regulations or availability values for areas within the PGMA that have no GCD. TCEQ continues to evaluate groundwater availability and use data within the designated PGMA[10,11].

Options proposed by TCEQ for PGMA Area in Midland and Upton Counties:

- Adding PGMA-bound portions of both counties to the Glasscock GCD (Option 1),
- Adding PGMA-bound portions of both counties to the Santa Rita GCD (Option 2),
- Add the PGMA-bound portion of Midland County to the Glasscock GCD and add the PGMA-bound portion of Upton County to the Santa Rita GCD (Option 3),
- Create a new and separate GCD for the portions in both counties (Option 4), or
- Create two new GCDs for the portions in both counties splitting the GCDs at the county line (Option 4).

Figure 1-18
GCD and GMA Areas in Region F

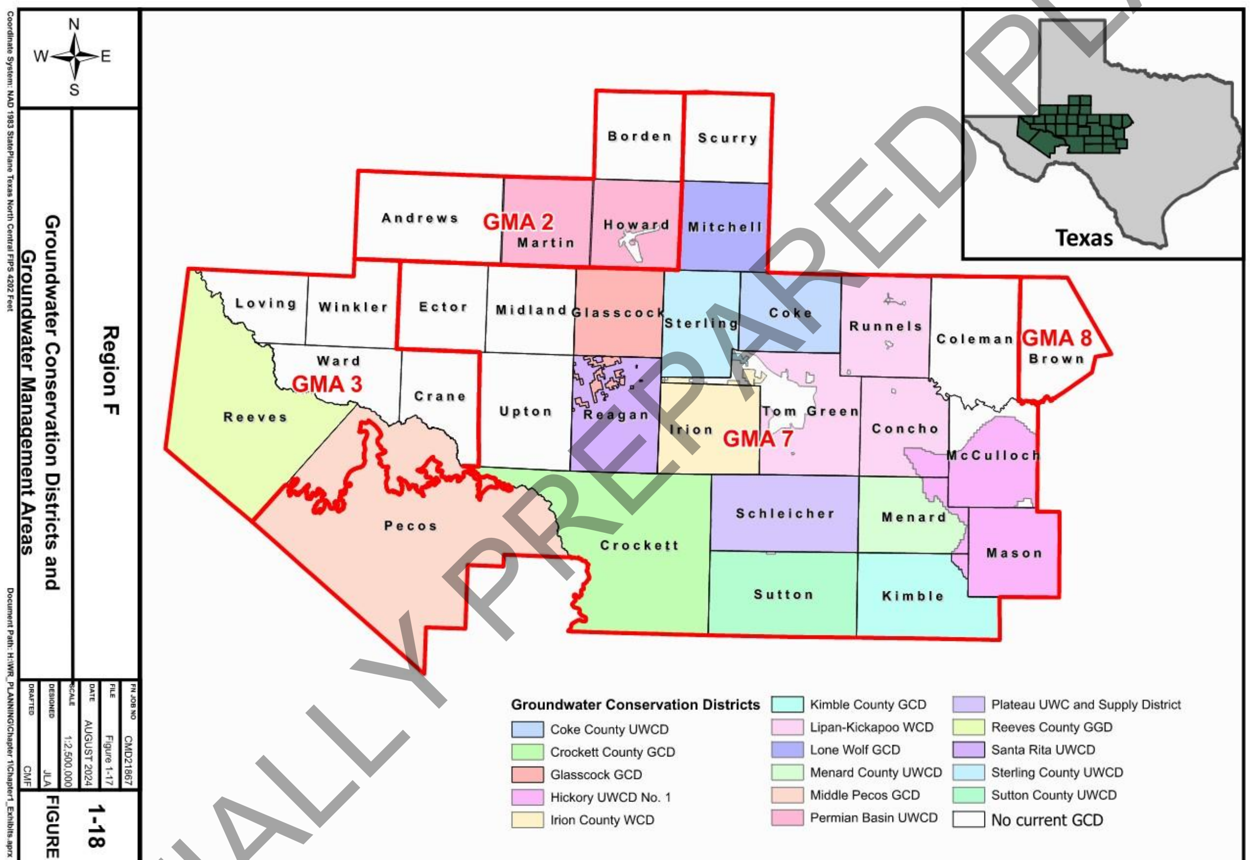
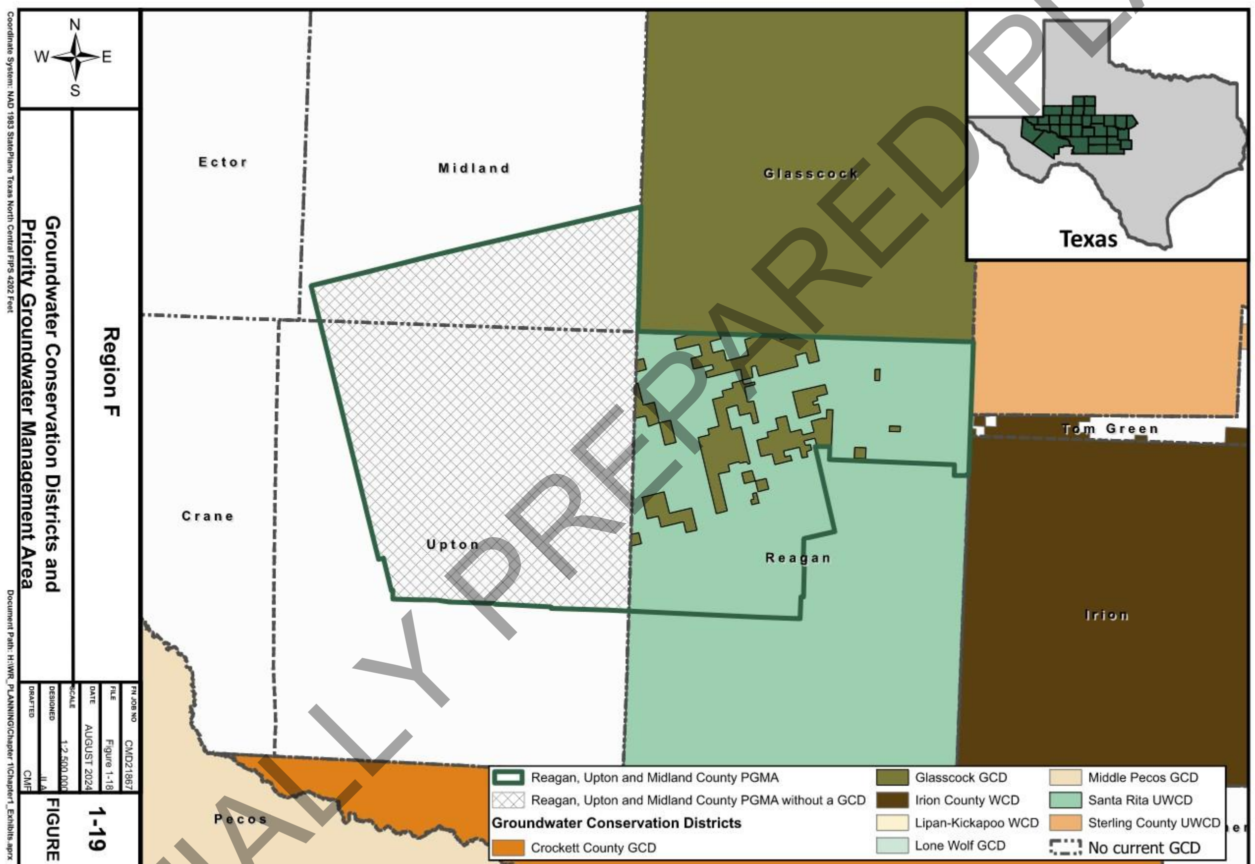


Figure 1-19
Reagan, Upton, and Midland County PGMA Boundary (Source: TCEQ)



1.3.3 Springs in Region F

Springs in Region F have been important sources of water supply since prehistoric times and have had great influence on early transportation routes and patterns of settlement. However, groundwater development and the resulting water level declines have caused some springs to disappear over time and have greatly diminished the flow from many of those that remain. Even though spring flows are declining throughout the region due to groundwater development, brush infestation, and climatic conditions, many springs are still important sources of water. Several rivers in Region F have significant spring-fed flows, including tributary creeks to the Concho and the San Saba Rivers, which are directly or indirectly used for municipal and irrigation purposes in the region.

Region F Springs:

- Anson Springs
- Balmorhea Area Springs
- Clear Creek (or Wilkinson) Springs
- Comanche Springs
- Diamond Y Springs
- Dove Creek Springs
- East Sandia Springs
- Giffin Springs
- Kickapoo Spring
- Lipan Spring
- Rocky Creek Springs
- San Saba Springs
- San Solomon Springs
- Santa Rosa Spring
- Spring Creek Springs
- West Sandia Springs

Many springs are also important to the region for natural resources purposes. The Diamond Y Springs in northern Pecos County stopped flowing in 2018 but have maintained very low discharge volumes since that occurred. The Balmorhea spring complex in southern Reeves County flow continuously and are important habitat for endangered species. Also, in Pecos County, the historically significant Comanche Springs flow occasionally during winter months when there is less stress on the underlying aquifer.

The Region F Planning Group has identified 14 major springs in the region that are important for water supply or natural resources protection. Figure 1-20 contains a map of the major springs in Region F. For convenience, the following spring descriptions are grouped into related geographic areas. Discussions pertaining to the historical significance of these springs are taken from *Springs of Texas*, by Gunner Brune.[12,13]

Balmorhea Area Springs

Springs in the Balmorhea area have supported agricultural cultures for centuries. Early native Americans dug acequias to divert spring-water to crops. In the nineteenth century several mills were powered by water from the springs. The Reeves County Water Control and Improvement District No. 1 was formed in 1915 and provides water, mostly from San Solomon Springs, to irrigated land in the area. The springs are also used for recreational purposes at the Balmorhea State Park, and are the home of rare and endangered species, including the Comanche Springs pupfish, which was transplanted here when flow in Comanche Springs at Fort Stockton became undependable. Three major springs are located in and around the community of Balmorhea: San Solomon Springs, Giffin Springs, and East and West Sandia Springs. A fourth spring, Phantom Spring, is located in Jeff Davis County (Region E) a short distance west of Balmorhea. Below average rainfall has resulted in diminishing flows from these springs.

San Solomon Springs are in Balmorhea State Park and are the largest spring in Reeves County. The spring's importance begins with its recreational use, then its habitat for endangered species in the ditches leading from the pool,[14] and finally its irrigation use downstream, where water from these springs is used to irrigate approximately 10,000 acres of farmland. These springs, which were once known as Mescalero or Head Springs, issue from lower Cretaceous limestones that underlie surface gDavis Mountains to the south. Discharge from San Solomon Springs is typically between 25 and 30 cubic feet per second (cfs). After strong rains, the spring flow often increases rapidly and becomes somewhat turbid. These bursts in spring flow are typically short-lived.

Giffin Springs are located across the highway from Balmorhea State Park and are at the same elevation as San Solomon Springs. Giffin Springs are smaller than, but very similar to, San Solomon Springs. Water discharging from these springs is used for irrigation, and typically averages between 3 and 4 cfs. Discharge from Giffin Springs responds much more closely to precipitation than other Balmorhea-area springs.

East and West Sandia Springs are located about one mile east of Balmorhea at an elevation slightly lower than San Solomon and Giffin Springs. They are ecologically significant due to the presence of the Pecos Gambusia and the Pecos Sunflower, and the only known naturally occurring populations of the Comanche Springs pupfish.[15] East Sandia Springs are about twice as large as the West Sandia Springs located approximately one mile farther up the valley. Together these two springs were called the Patterson Springs in 1915 by the U.S. Army Corps of Engineers. East and West Sandia Springs flow from alluvial sand and gravel, but the water is probably derived from the underlying Cretaceous Comanchean limestone. Discharge is typically between one and three cfs. The Nature Conservancy manages the 246-acre Sandia Springs Preserve to sustain the unique spring habitat and its vulnerable species.

Fort Stockton Area Springs

Comanche Springs flow from a fault fracture in the Comanchean limestone. This complex of springs includes as many as five larger springs and eight smaller springs in and around Rooney Park. These springs were historically very important, serving as a major crossroads on early southwestern travel routes. It is because of their historical significance and their continued ecotourism importance to the City of Fort Stockton, that this spring system is considered a major spring. The development of irrigated farming in the Belding area 12 miles to the southwest has intercepted natural groundwater flow, and by the early 1960s Comanche Springs had ceased to flow continuously. However, flow from Comanche Springs has increased; at first sporadically since 1987, and in the last decade, has flowed regularly in the late winter months after recovering from summer irrigation pumping. A study to restore year-round flow is being conducted by the Meadows Center and Texas Water Trade.

Diamond Y Springs (or Deep Springs) are the largest spring system in Pecos County, and provides aquatic habitat for rare and endangered species. The springs are one of the largest and last remaining cienega (desert marshland) systems in West Texas. These springs are located north of Fort Stockton, and issue from a deep hole in Comanchean limestone, approximately sixty feet in diameter. The chemical quality of the spring water suggests that its origin may be from the deeper Rustler aquifer. This spring is one of the last places the Leon Springs pupfish can be found and is also home for the Pecos Gambusia. The Texas Nature Conservancy maintains conservation management of the Diamond Y Springs. The springs stopped flowing in 2018 but have maintained very low discharge volumes since that occurred.

Santa Rosa Spring is located in a cavern southwest of the City of Grandfalls. At one time this spring provided irrigation water. Spring flow ceased in the 1950s.

San Angelo Area Springs

Six springs/spring-fed creeks located within approximately twenty miles of San Angelo are identified as major springs. Four of these springs, including Dove Creek Springs, Spring Creek Springs, Rocky Creek Springs, and Anson Springs, form the primary tributaries that feed into Twin Buttes Reservoir, which is a water supply source for the City of San Angelo. Two other springs, Lipan Spring and Kickapoo Spring, do not feed into Twin Buttes, but instead flow into the Concho River downstream from San Angelo.

Dove Creek Springs are located at the head of Dove Creek in Irion County about eight miles southwest of Knickerbocker. The perennial springs flow an average of 9 cfs and contribute to surface flow destined for Twin Buttes Reservoir. The landowners of these springs have placed the river corridor surrounding the springs into a Conservation Reserve Program so as to protect aquatic and other wildlife as well as vegetation species.

Anson Springs (or Head of the River Springs) are located on ranchland approximately five miles south of Christoval in Tom Green County. Perennial spring flow in the bed and banks of the South Concho River results in an average discharge of more than 20 cfs. This spring flow sustains the South Concho River, which has major irrigation diversion permits dating back to the early 1900s. The environment surrounding the springs is a sensitive eco-system with diverse flora and fauna found only in this specific location. The landowners of the springs have placed the river corridor of their property where the springs are located into a Conservation Reserve Program to protect vegetation and aquatic life as well as other wildlife.

Spring Creek Springs (also known as Seven, Headwaters, or Good Springs) are located on Spring Creek in eastern Irion County approximately three miles south of the town of Mertzon. Besides evidence of significant occupation by early Native Americans, the U.S. Cavalry also used the springs in the late 1840s. This was the last fresh water spring on the route westward.

Rocky Creek Springs are located on West Rocky Creek in northeastern Irion County, four to five miles northwest of the town of Arden.

Lipan Spring is located approximately 15 miles southeast of San Angelo and was a stop on the old Chihuahua Road. This spring, which issues from Edwards limestone, has historically flowed at less than one cfs.

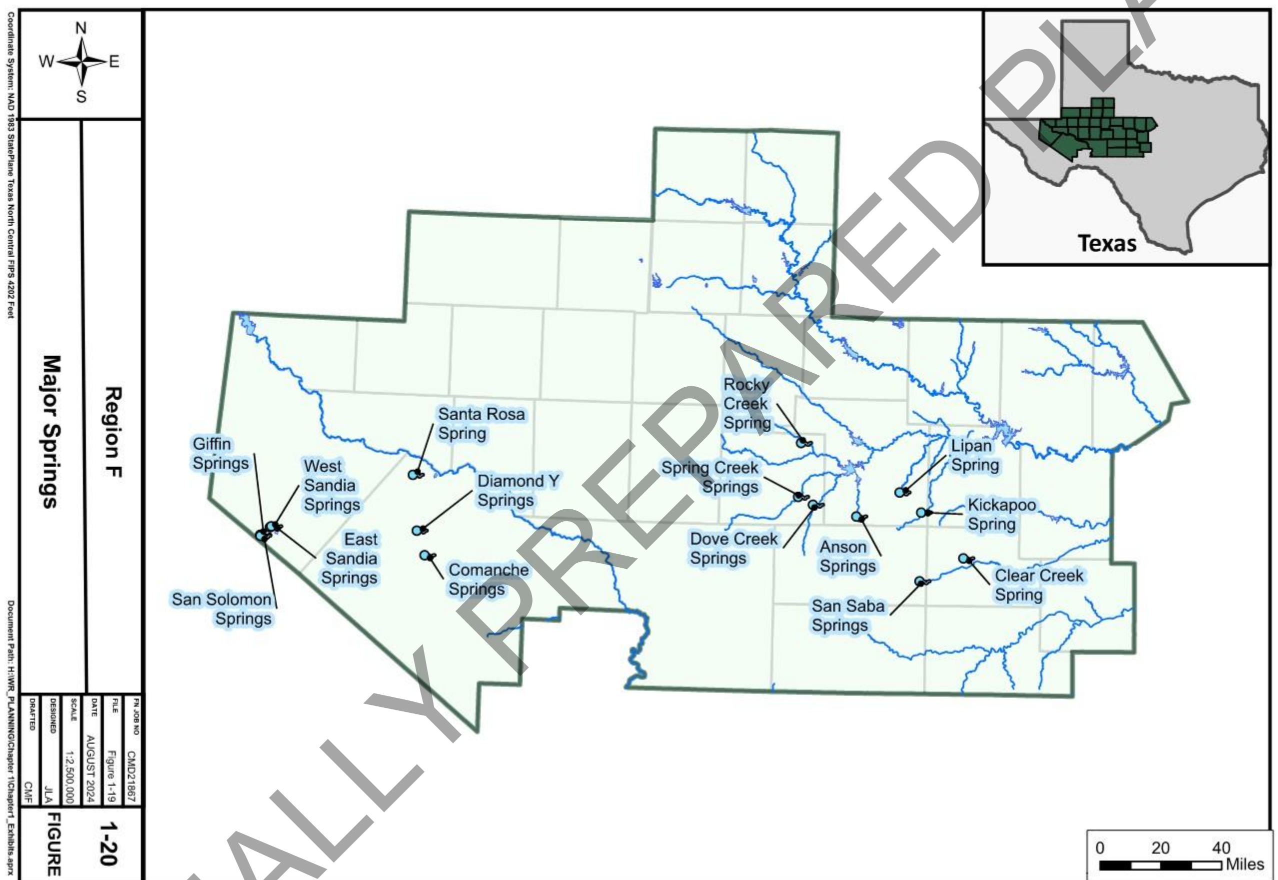
Kickapoo Spring also discharges from Edwards limestone and is located approximately twelve miles south of Vancourt. This spring was used for irrigation in the early days of settlement and historically has flowed between 1 and 4 cfs.

Fort McKavett Area Springs

San Saba Springs (or Government or Main Springs) are located at the headwaters of the San Saba River, were on the Chihuahua Road from the Port of Indianola to Mexico, and were the water supply for Fort McKavett, established in 1852.

Clear Creek Springs (or Wilkinson Springs) form the headwaters of Clear Creek, which contributes significant flow to the upper reaches of the San Saba River in Menard County. The old San Saba Mission was located near these springs from 1756 to 1758. The springs were also a stop on the Chihuahua Road.

Figure 1-20
Springs in Region F



1.4 AGRICULTURAL AND NATURAL RESOURCES IN REGION F

This section describes agricultural and natural resources in Region F. Specifically, it addresses the endangered and threatened species known to be present or potentially present in the region. It also describes the natural resources, including prime farmland, agricultural, and mineral resources.

1.4.1 Endangered or Threatened Species

Table 1-12 is a compilation of federal and state threatened and endangered species found in Region F counties. Section 7 of the Federal Endangered Species Act requires federal agencies to consult with the U.S. Fish and Wildlife Services (USFWS) to ensure that any action they authorize, fund, or carry out will not jeopardize listed species. Under Section 9 of the same act, it is unlawful for a person to "take" a listed species. Under the federal definition "take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect or attempt to engage in any such conduct." Included in the definition of harm are habitat modifications or degradation that actually kills or injures a species or impairs essential behavioral patterns such as breeding, feeding or sheltering. There are nineteen federal and seventeen state species listed as endangered that are known to, or may occur, in counties in Region F. The Northern Aplomado Falcon and Whooping Crane are the federally listed endangered species most frequently cited in Table 1-12 for counties in Region F. The Pecos Gambusia is the state listed endangered species most frequently cited in Table 1-12 for counties in Region F.

The Texas Endangered Species Act gives the Texas Parks and Wildlife Department (TPWD) the authority to establish a list of fish and wildlife that are endangered or threatened with statewide extinction. As defined by the statute, "fish and wildlife" excludes all invertebrates except mollusks and crustaceans. No person may capture, trap, take, or kill or attempt to capture, trap, take, or kill listed fish and wildlife species without a permit. Plants are not protected by these provisions. Endangered, threatened or protected plants may not be taken from public land for commercial sale or taken from private land for commercial purposes without a permit. Laws and regulations pertaining to endangered or threatened animal species are contained in Chapters 67 and 68 of the Texas Parks and Wildlife (TPW) Code and Sections 65.171 - 65.184 of Title 31 of the Texas Administrative Code (T.A.C.). Laws and regulations pertaining to endangered or threatened plant species are contained in Chapter 88 of the TPW Code and Sections 69.01 - 69.14 of the T.A.C.

The Texas Endangered Species Act does not protect wildlife species from indirect take (e.g., destruction of habitat or unfavorable management practices). The TPWD has a Memorandum of Understanding with every state agency to conduct a thorough environmental review of state initiated and funded projects, such as highways, reservoirs, land acquisition, and building construction, to determine their potential impact on state endangered or threatened species. There are 45 species identified by the state as threatened or endangered that are known to, or may potentially occur in Region F.

Table 1-12
Endangered and Threatened Species in Region F

Species		Status		County																															
Common Name	Scientific Name	Federal	State	Andrews	Borden	Brown	Coke	Coleman	Concho	Crane	Crockett	Ector	Glasscock	Howard	Irion	Kimble	Loving	Martin	Mason	McCulloch	Menard	Midland	Mitchell	Pecos	Reagan	Reeves	Runnels	Schleicher	Scurry	Sterling	Sutton	Tom Green	Upton	Ward	Winkler
Birds																																			
Zone-tailed hawk	*Buteo albonotatus*		T								S					S			S					S		S									
Common black-hawk	*Buteogallus anthracinus*		T																													S			
Whooping crane	*Grus americana*	E	E			B		B																											
Black rail	*Laterallus jamaicensis*	T	T		B	B	B	B						B									B				B		B						
White-faced ibis	*Plegadis chihi*		T	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S		S	S	S	S
Golden-cheeked warbler	*Setophaga chrysoparia*	E	E													B			B																
Tropical parula	*Setophaga pitiayumi*		T								S																								
Rufa red knot	*Calidris canutus rufa*	T		F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Piping Plover	*Charadrius melodus*	T			F																								F						
Southwestern willow flycatcher	*Empidonax traillii extimus*	E								F	F						F							F		F		F			F		F	F	
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	E		F								F					F							F		F								F	F
Mexican spotted owl	*Strix occidentalis lucida*	T																						F		F									
Crustaceans																																			
Diminutive amphipod	*Gammarus hyalelloides*	E	E																							B									
Pecos amphipod	*Gammarus pecos*	E	E																					B											
Clear Creek amphipod	*Hyalella texana*		T																		S														
Fish																																			
Proserpine shiner	*Cyprinella proserpina*		T								S													S											
Leon Springs pupfish	*Cyprinodon bovinus*	LE	E																					B											
Comanche Springs pupfish	*Cyprinodon elegans*	LE	E																					B		B									
Pecos pupfish	*Cyprinodon pecosensis*		T							S	S						S							S		S								S	
Red River pupfish	*Cyprinodon rubrofluviatilis*		T			S	S	S	S					S						S			S				S		S						
Roundnose minnow	*Dionda episcopa*		T																					S		S									
Rio Grande darter	*Etheostoma grahami*		T								S																								
Clear Creek gambusia	*Gambusia heterochir*	E	E																		B														
Pecos gambusia	*Gambusia nobilis*	E	E																					B		B									
Headwater catfish	*Ictalurus lupus*		T								S										S			S		S									
Speckled chub	*Macrhybopsis aestivalis*		T								S													S		S								S	
Tamaulipas shiner	*Notropis braytoni*		T								S													S											
Rio Grande Silvery Minnow	*Hybognathus amarus*	E									F													F		F									
Smalleye Shiner	*Notropis buccula*	E																											F						
Sharpnose Shiner	*Notropis oxyrhynchus*	E																											F						
Smalleye Shiner	*Notropis buccula*	E			F																								F						
Mammals																																			
White-nosed coati	*Nasua narica*		T								S					S																			
Black bear	*Ursus americanus*		T						S	S	S				S	S			S	S	S			S	S	S		S				S	S	S	
Reptiles																																			
Texas tortoise	*Gopherus berlandieri*		T					S																											
Brazos water snake	*Nerodia harteri*		T				S	S	S											S			S				S					S			
Texas horned lizard	*Phrynosoma cornutum*		T	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S		S	S	S	S
Trans-Pecos black-headed snake	*Tantilla cucullata*		T																					S											
Dunes sagebrush lizard	*Sceloporus arenicolus*	E		F						F		F																						F	F
Plants																																			
Leoncita false-foxglove	*Agalinis calycina*		T																					S											
Texas poppy-mallow	*Callirhoe scabriuscula*	E	E				B																B				B		B						
Wright's marsh thistle	*Cirsium wrightii*	T	T																					B											
Dune umbrella-sedge	*Cyperus onerosus*		T	S																														S	S

Species		Status		County																															
Common Name	Scientific Name	Federal	State	Andrews	Borden	Brown	Coke	Coleman	Concho	Crane	Crockett	Ector	Glasscock	Howard	Irion	Kimble	Loving	Martin	Mason	McCulloch	Menard	Midland	Mitchell	Pecos	Reagan	Reeves	Runnels	Schleicher	Scurry	Sterling	Sutton	Tom Green	Upton	Ward	Winkler
Pecos sunflower	*Helianthus paradoxus*	T	T																					B		B									
Rock quillwort	*Isoetes lithophila*		T																S																
Tobusch fishhook cactus	*Sclerocactus brevihamatus ssp. tobuschii*	T	E													B																			
Bunched cory cactus	*Coryphantha ramillosa*	T																						F											
Bracted twistflower	*Streptanthus bracteatus*	T				F										F																			
Mollusks																																			
Pecos assiminea snail	*Assiminea pecos*	E	E																					B		B									
Texas pimpleback	*Cyclonaias petrina*	PE	T			B	B	B	B						B	B			B	B	B						B	B		B		B			
False spike	*Fusconaia mitchelli*	PE	T			B										B			B	B	B														
Texas fatmucket	*Lampsilis bracteata*	PE	T			B	B	B	B						B	B			B	B	B						B	B				B			
Texas hornshell	*Popenaias popeii*	E	E							B	B						B							B		B								B	
Diamond Y springsnail	*Pseudotryonia adamantina*	E	E																					B											
Phantom springsnail	*Pyrgulopsis texana*	E	E																							B									
Texas fawnsfoot	*Truncilla macrodon*	PT	T			B		B	B						B	B			B	B	B						B					B			
Phantom tryonia	*Tryonia cheatumi*	E	E																					B		B									
Gonzales tryonia	*Tryonia circumstriata*	E	E																					B											

Status:
T - Threatened
E - Endangered
R - Recovery
C - Candidate
PT - Proposed Threatened
UR - Under Review
PT - Proposed Threatened
PE - Proposed Endangered

Key:
F - Federal listings only (US Fish and Wildlife Service. 2023. Endangered Species List. http://www.fws.gov/endangered/)
S - State listings only (Texas parks and Wildlife Department. 2023. Annotated County Lists of Rare Species. http://tpwd.texas.gov/gis/rtest/)[16]
B - both Federal and State listings

1.4.2 Agriculture and Prime Farmland

Agriculture plays a significant role in the economy of Region F. Table 1-13 provides basic data regarding agricultural production in Region F.[17] Region F includes approximately 22,809,000 acres in farms and over 2,638,000 acres of potential cropland. In 2022, the market value of agriculture products (crops and livestock) for Region F was over $774,000,000, with livestock accounting for approximately 64 percent of the total.

Figure 1-21 shows the distribution of prime farmland in Region F.[18] The National Resources Conservation Service (NRCS) defines prime farmland as "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses". As part of the National Resources Inventory, the NRCS has identified prime farmland throughout the country. Each color in Figure 1-21 represents the percentage of the total acreage that is considered prime farmland of any kind.

A number of counties in Region F have significant prime farmland acreage. Those with the largest acreage include Andrews, Crockett, Pecos, Reeves, Schleicher, Sutton, and Tom Green Counties. These seven counties accounted for about 40 percent of the total land in farms and at least 32 percent of the total crop value for Region F in 2022 (Sutton County did not report their total crop value for 2022).

It is interesting to note that major agricultural production also occurs in some counties with a relatively small amount of prime farmland. For example, Brown, Concho, Glasscock, Howard, Mason, Mitchell, and Scurry Counties account for approximately 17 percent of Region F farmland acreage. However, these seven counties combined accounted for approximately 33 percent of the crop value for the region in 2022.

Texas Criteria for Prime Farmland:

- Moisture Most of Region F lies in Zone 3, which must have water capacity ≥4 inches in the upper 40-inch zone
- Temperature must be > 32 degrees at a depth of 20 inches
- pH should be between 4.5 and 8.4
- Drainage and Water Table characteristics
- Mineral characteristics (salinity and calcium carbonate)
- Flooding occurs less than once in 2 years
- Slope and erosion considerations (including wind erodibility)
- Permeability rate ≥ 0.6 inch per hour
- Rock fragments limited based on size

Table 1-13
2022 U.S. Department of Agriculture County Census Data for Region F

Category	Andrews	Borden	Brown	Coke	Coleman	Concho	Crane	Crockett
Farms	149	102	1680	433	1071	400	44	275
Irrigated Land (acres)	6,709	1,795	1,649	1,423	473	4,372	(D)	2,382
Land in Farms (acres)								
- Crop Land[a]	71,538	76,543	60,660	44,131	145,205	144,536	96	6,604
- Pasture Land	803,982	(D)	342,498	419,734	551,101	466,890	(D)	1,752,234
- Other	4,282	(D)	72,263	14,695	62,413	17,952	(D)	9,996
- Total	879,802	572,829	475,421	478,560	758,719	629,378	291,025	1,768,834
Market Value ($1,000)								
- Crops	$5,343	$14,924	$6,086	$2,753	$6,620	$18,875	(D)	$2,613
- Livestock	$4,400	$12,776	$35,904	$7,933	$37,965	$13,394	(D)	$28,040
- Total	$9,743	$27,700	$41,990	$10,686	$44,585	$32,269	(D)	$30,653

Category	Ector	Glasscock	Howard	Irion	Kimble	Loving	Martin	Mason
Farms	178	188	407	160	619	11	395	650
Irrigated Land (acres)	389	15,617	6,321	1,037	1,329	-	20,914	14,067
Land in Farms (acres)								
- Crop Land[a]	1,934	162,479	237,055	4,432	21,071	783	269,925	38,997
- Pasture Land	406,195	351,938	315,640	662,936	366,985	423,260	295,520	505,965
- Other	9,116	2,660	22,792	4,822	33,435	150	11,406	47,023
- Total	417,245	517,077	575,487	672,190	421,491	424,193	576,851	591,985
Market Value ($1,000)								
Crops	$237	$20,889	$27,807	$172	$264	$274	$20,841	$11,471
Livestock	$3,585	$7,697	$4,824	$9,743	$6,962	$1,273	$1,906	$38,760
Total	$3,822	$28,586	$32,631	$9,915	$7,226	$1,547	$22,747	$50,231

a. Crop land is the land that is currently or recently cultivated for farming. Acreages in active farms may be less.

Table 1-13 (Cont'd)
2022 U.S. Department of Agriculture County Census Data for Region F

Category	McCulloch	Menard	Midland	Mitchell	Pecos	Reagan	Reeves	Runnels
Farms	562	374	349	459	249	91	150	1039
Irrigated Land (acres)	1,072	1,877	6,000	4,181	15,059	6,686	19,783	6,199
Land in Farms (acres)								
- Crop Land[a]	67,529	26,326	67,801	126,283	86,467	40,534	66,694	290,761
- Pasture Land	402,625	538,073	(D)	446,177	2,907,281	700,357	752,689	353,114
- Other	77,805	9,875	(D)	10,015	20,186	3,730	11,274	28,737
- Total	547,959	574,274	560,075	582,475	3,013,934	744,621	830,657	672,612
Market Value ($1,000)								
Crops	$2,345	$481	$8,332	$15,465	$29,294	$1,308	$21,427	$12,869
Livestock	$17,060	$11,594	$10,860	$22,491	$19,647	$7,502	$6,363	$48,740
Total	$19,405	$12,075	$19,192	$37,956	$48,941	$8,810	$27,790	$61,609

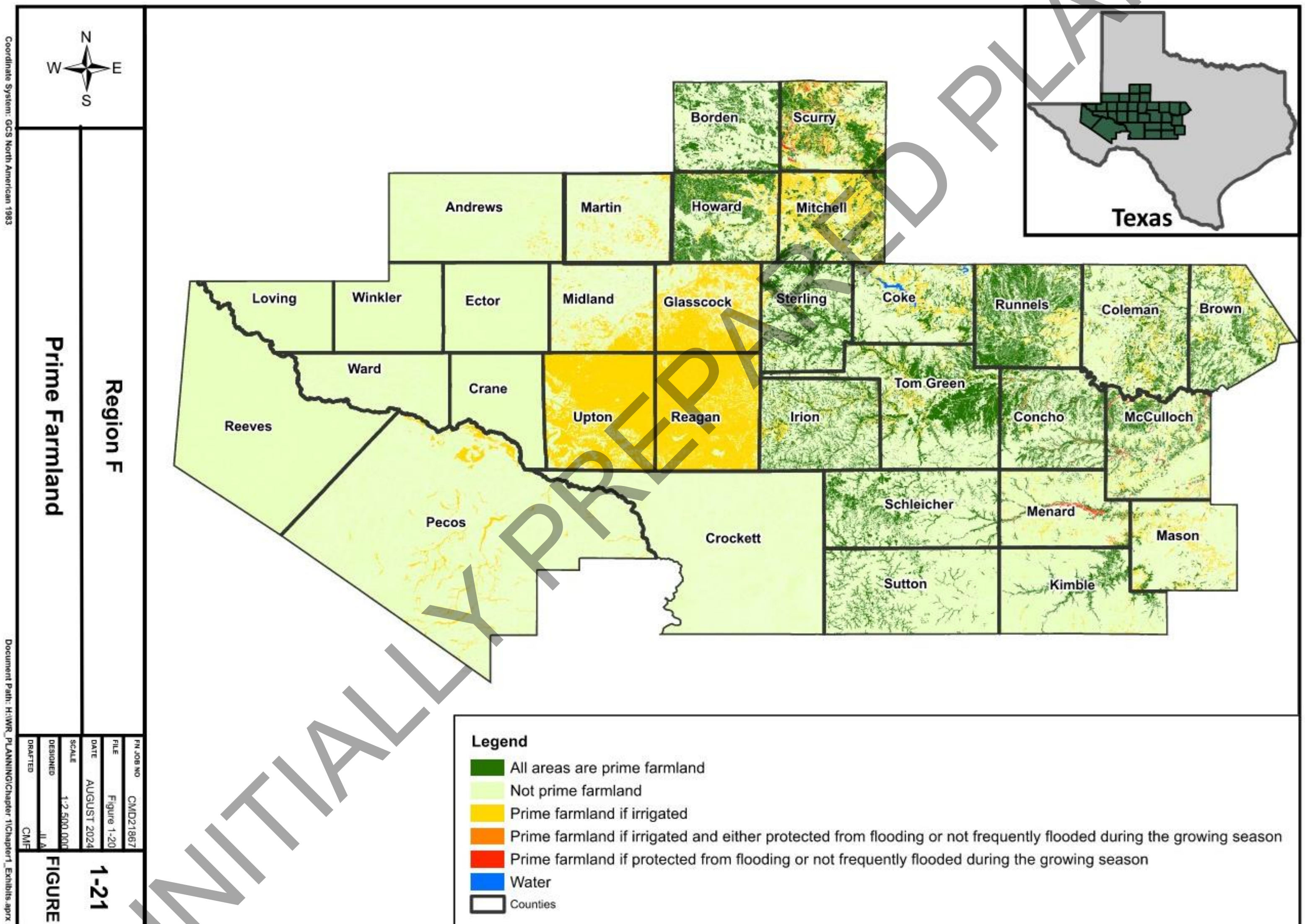
Category	Schleicher	Scurry	Sterling	Sutton	Tom Green	Upton	Ward	Winkler	Total
Farms	353	685	70	289	1392	101	52	38	13,015
Irrigated Land (acres)	5,720	5,342	1,064	(D)	26,497	4,998	530	(D)	183,485
Land in Farms (acres)									
- Crop Land[a]	57,716	234,128	15,761	21,768	189,638	57,289	3,473	(D)	2,638,157
- Pasture Land	773,791	326,093	(D)	847,790	708,815	(D)	437,318	(D)	16,859,001
- Other	5,184	9,725	(D)	40,185	39,260	(D)	982	(D)	569,963
- Total	836,691	569,946	650,960	909,743	937,713	518,980	441,773	365,973	22,809,473
Market Value ($1,000)									
Crops	$5,527	$8,172	$235	(D)	$25,880	$6,355	(D)	(D)	276,859
Livestock	$21,661	$22,433	$10,802	(D)	$76,097	$4,059	$3,034	(D)	497,505
Total	$27,188	$30,605	$11,037	(D)	$101,977	$10,414	$3,034	(D)	774,364

a. Crop land is the land that is currently or recently cultivated for farming. Acreages in active farms may be less.

NOTES: (D) – Data withheld to avoid disclosing data for individual farms.
Total Market Value amounts include value of crops and livestock listed as (D) (data withheld).

Source: Data are from the U.S. Department of Agriculture (USDA, 2022).[17]

Figure 1-21
Prime Farmland Percentage of Total Area



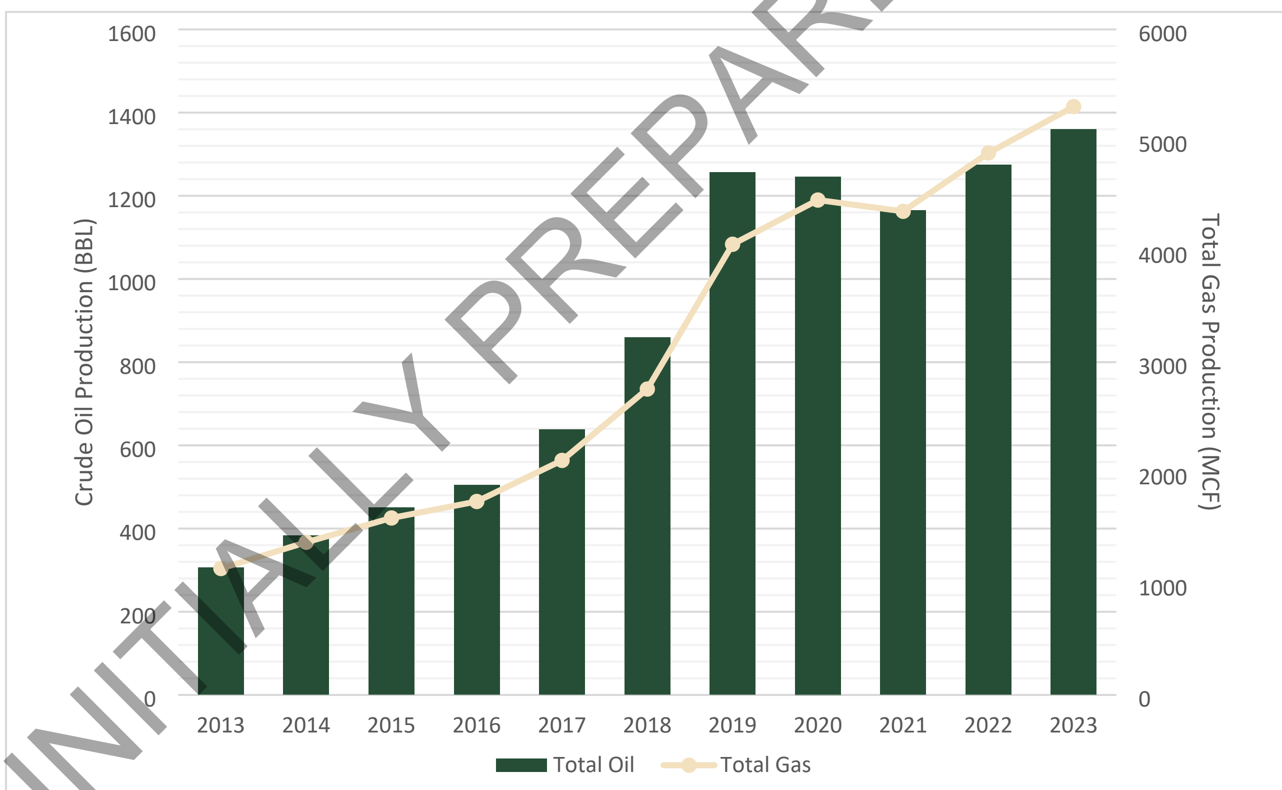
1.4.3 Mineral Resources

Oil and natural gas fields are significant natural resources throughout Region F. Recent developments in drilling technology along with increased commodity prices have led to significant oil and gas production in the Permian Basin. Other significant mineral resources in Region F include bituminous coal resources in Brown, Coleman, and McCulloch Counties, and stone, sand and gravel in various parts of the region.

Petroleum Production

Oil and gas fields are a valuable natural resource throughout most of Region F. As discussed previously in Section 1.1.1, the petroleum industry heavily influences the Region F economy. Over the last decade, Region F has experienced a notable increase in oil and gas production, as technological advancements have made it feasible for companies to develop petroleum in the continental United States. In particular, the Permian Basin (Figure 1-5), which underlies a significant portion of the counties in Region F, has experienced a rapid growth and has become the second largest producer of oil and gas shale in the world[19]. According to data from the Railroad Commission of Texas, annual total oil production (including crude oil and condensate) has increased by over 344% and annual total natural gas (including gas well gas and casinghead gas) production has increased by over 365% in Region F since 2013 (Figure 1-22)[20].

Figure 1-22
Crude Oil and Total Gas Production in Region F



Counties in Region F play an integral role in oil and gas production throughout the state of Texas. In fact, in the year 2023, Region F counties accounted for over 69% of the state's total oil production and over 43% of state's total natural gas production[20]. Nine of the top ten largest total oil producing counties (Andrews, Glasscock, Midland, Reeves, Loving, Martin, Upton, Howard, Ward) and six of the top ten largest total natural gas producing counties (Reeves, Reagan, Loving, Martin, Upton and Midland) in the state of Texas are located in Region F. In 2023, Midland County alone produced 227.9 million barrels (BBL) of crude oil, which accounted for over 13% of the crude oil production in the entire state. In 2023, every county in Region F produced some form of oil (crude oil or condensate). Furthermore, in 2023, every county, with the exception of Kimble and McCulloch Counties, produced some form of natural gas (gas well gas and/or casinghead gas). Figure 1-23 and Figure 1-24 illustrate the distribution of total oil (BBL) and total natural gas (MCF) production in each Region F county during the year 2023, respectively.

Coal Mining

Mining activity for bituminous coal resources have historically occurred in Coleman, Brown, and McCulloch Counties in Region F[21]. The coal resources are historically mined in the Cisco Group, which consists of shale, lenticular sandstone, many thin beds of limestone, and minor amounts of coal. The group has a thickness of about 350 feet in outcrops along the west side of the Llano region in Brown and Coleman Counties. According to the Railroad Commission (RRC), there are a total of seven, five, and three historical mining sites in McCulloch, Coleman, and Brown Counties, respectively. These mining sites are now part of the Abandoned Mine Land (AML) Program, which aims to reclaim and restore the land and water resources within previous mining areas. There are no active coal mining permits in Region F.

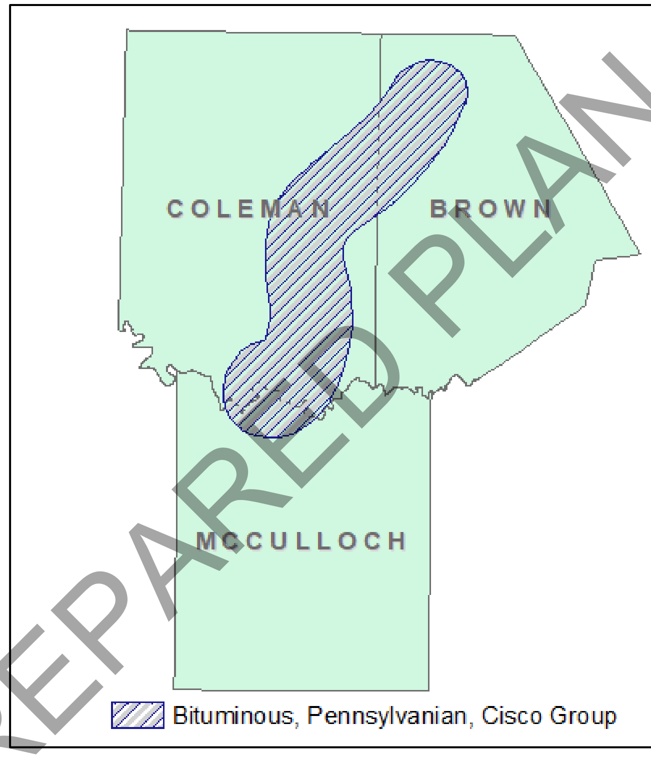


Figure 1-23
Crude Oil Production in Each County (2023)

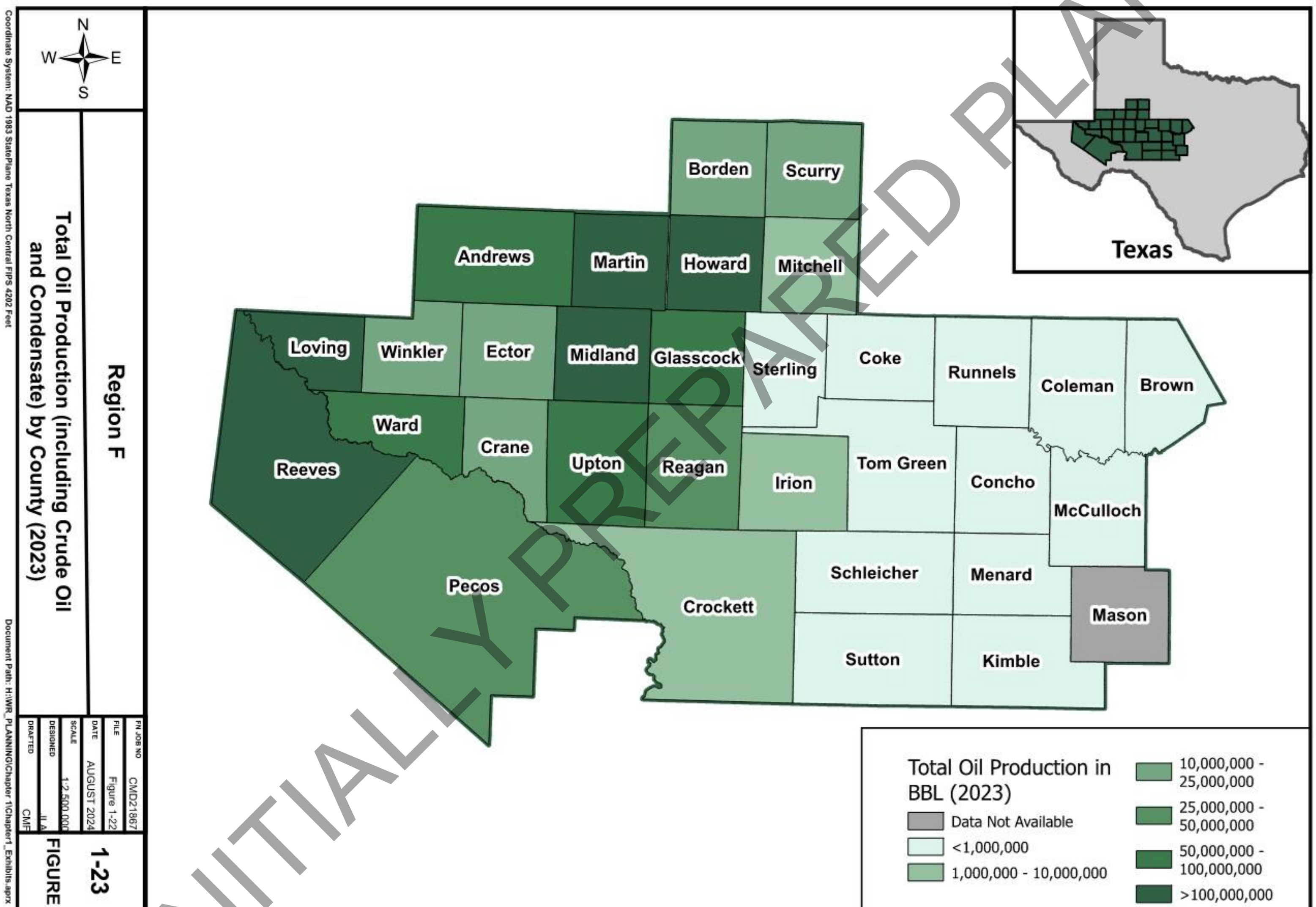
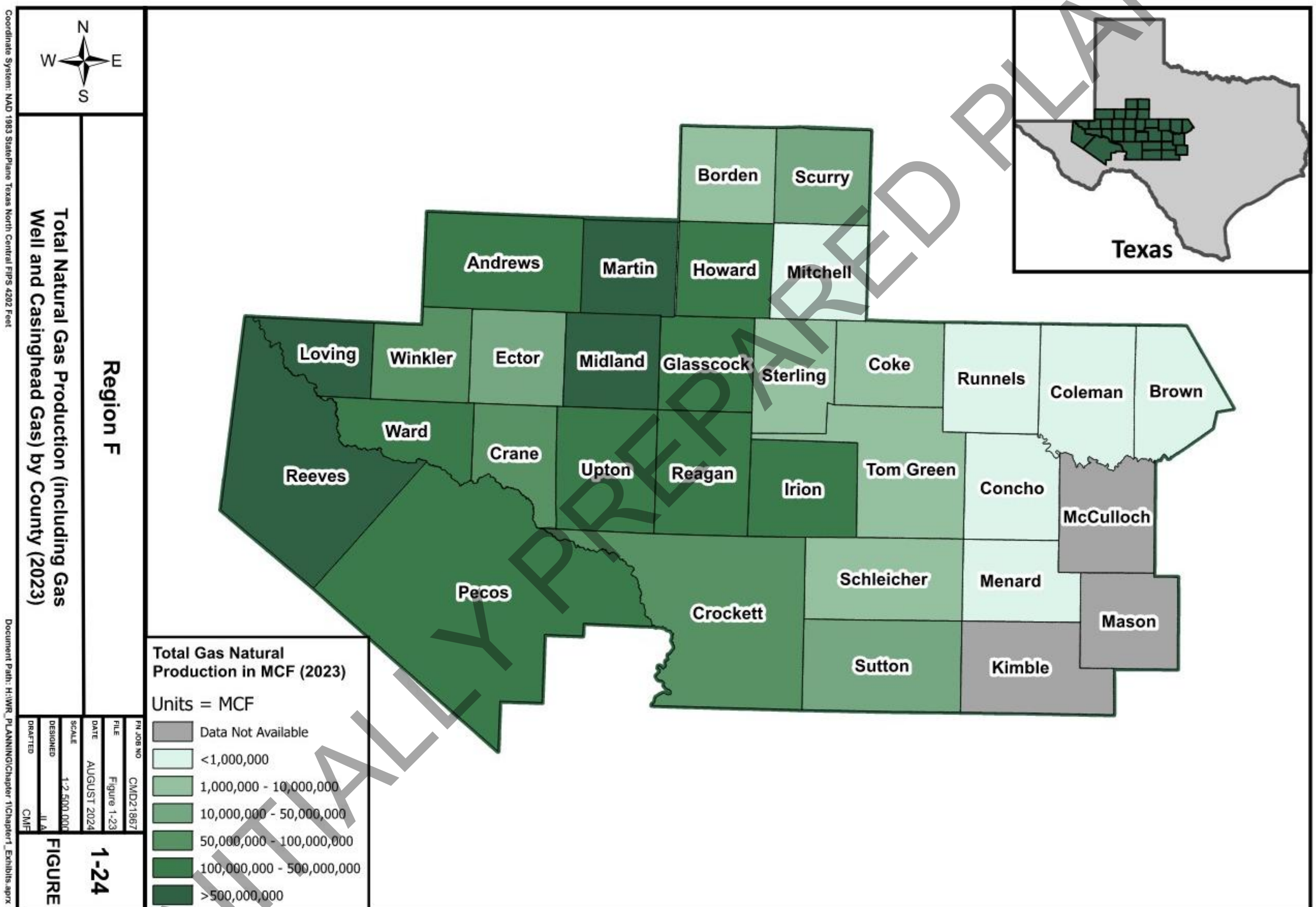


Figure 1-24
Total Gas Production by County (2023)



1.5 WATER PROVIDERS IN REGION F

Water providers in Region F include regional providers and retail suppliers. Regional water providers include river authorities and water districts. Retail water suppliers include cities and towns, water supply corporations, special utility districts, and private water companies.

1.5.1 Major Water Providers

The TWDB defines the term major water provider (MWP) as "a water user group or wholesale water provider of particular significance to the region's water supply as determined by the RWPG."[22] Five major water providers have been identified by the Region F RWPG:

- Colorado River Municipal Water District (CRMWD)
- Brown County Water Improvement District Number One (BCWID)
- City of Odessa
- City of Midland
- City of San Angelo

There are no implications of designation as a "major water provider" except for the additional data required by TWDB. The major water provider designation provides a different way of grouping water supply information.

Colorado River Municipal Water District (CRMWD)

CRMWD is the largest water supplier in Region F. CRMWD member cities include Big Spring, Odessa and Snyder. CRMWD also supplies water to Midland, San Angelo and Abilene, as well as several smaller cities in Ward, Martin, Howard and Coke Counties. CRMWD owns and operates Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir, as well as several chloride control reservoirs. The district's water supply system also includes well fields in Ward, Scurry, Ector and Martin Counties.

Brown County Water Improvement District Number One (BCWID).

BCWID supplies raw water and treated water from Lake Brownwood to the Cities of Brownwood, Early, Bangs and Santa Anna, and rural areas of Brown and Coleman Counties, as well as irrigation water in Brown County.

City of Midland

The City of Midland has several well fields for groundwater supply and purchases water from CRMWD. As the largest city in Region F, Midland provides retail water to over 134,000 municipal users and small quantities of water to manufacturing within city limits. In addition, Midland has a contract to sell treated wastewater effluent to the mining industry. Increased oil and gas activities in the Permian Basin (discussed in Section 1.4.3) around Midland have caused a rapid growth in city population and water service areas.

City of Odessa

The City of Odessa is a member city of CRMWD. Odessa sells retail and wholesale treated water to the Ector County Utility District, Ector County Other, and manufacturing users. In addition, Odessa sells raw wastewater to the Gulf Coast Water Authority to treat and sell to the mining industry, as well as treated wastewater directly to the mining industry.

City of San Angelo

The City of San Angelo's sources of supply are Lake O.C. Fisher (water is purchased from Upper Colorado River Authority), Twin Buttes Reservoir, Lake Nasworthy, local surface water rights, and O.H. Ivie Reservoir (purchased from CRMWD). San Angelo also developed a groundwater supply from the Hickory aquifer near Melvin, Texas (McCullough County). As part of an agreement with UCRA, San Angelo treats water for customers of UCRA. San Angelo also provides water to the Goodfellow Air Force Base.

1.6 Existing Plans for Water Supply Development

In July 2021, the Texas Water Development Board released the State Water Plan, Water for Texas – 2022, which was a compilation of the 16 regional water plans developed under SB1.[23] The Region F Water Planning Group published the Region F Regional Water Plan in January 2021. Some of the findings of the 2021 Region F plan included:

- Approximately 56 water user groups had projected water shortages over the planning period (through 2070). In the event of a drought Region F was projected to have a total water supply shortage of 62,000 acre-feet by 2020 and 103,000 acre-feet by 2070.
- Decreases in surface water availability were attributed to ongoing drought of record conditions, which reduced reservoir yields from the TCEQ WAM priority analysis of surface water supplies. Also, the priority analysis does not reflect actual surface water operation in the Upper Colorado River Basin. Subordination of Lower Colorado River Basin water rights provide a significant amount of surface water supplies to Region F. However, these supplies were less in the 2021 regional plan than previous plans, due to ongoing drought conditions.
- The majority of water supply deficits were associated with mining. About 34% of the water needs for 2020 were from mining needs. However, these needs decrease over time as mining needs comprise only 5% of Region F needs in 2070 due to decreasing mining demands. By 2070 municipal needs account for 54% of the region's needs. Multiple strategies were developed in order to meet these municipal needs, however, there were no strategies proposed to address the mining needs.
- General water management strategies recommended in the plan include: subordination, water conservation, brush control, and weather modification.
- Water conservation (irrigation, mining and municipal) accounts for one fourth to one third of the future water supplies for the region.
- New groundwater development is a major strategy for the region, supplying approximately 20 to 30 percent of the new water supplies.
- Even after accounting for supplies from water management strategies, 18 water user groups had unmet needs during the planning horizon, including three municipal water user groups.

The City of San Angelo in 2018 completed a Water Supply Engineering Feasibility Study.[24] The study considered twenty-four possible water supply options and completed a detailed assessment of four options. One of those options was groundwater and three were different versions of potable reuse. The study recommended a potable reuse strategy termed the "Concho River Water Supply" which entailed potable reuse of Concho River water. This option provided the lowest unit cost, the highest yield, and improves the treatment infrastructure of the City.

The cities of Abilene, Midland, and San Angelo formed the West Texas Water Partnership (the Partnership) to evaluate long-term water supplies the Partnership could develop jointly. The Partnership conducted a separate study to determine the most feasible water management strategies for these cities and ultimately selected to pursue a groundwater development strategy in Pecos County.

There are no known publicly available plans for agricultural, manufacturing, and commercial water users in Region F. To the extent these types of plans are known, they are considered by the Region F Water Planning Group in the development of the Regional Water Plan.

1.6.1 Conservation Planning in Region F

The Texas Water Code requires that certain entities develop, submit, and implement a water conservation plan (Texas Water Code § 11.1271). Those entities include holders of an existing permit, certified filing, or certificate of adjudication for the appropriation of surface water in the amount of 1,000 acre-feet per year or more for municipal, industrial, and other uses, as well as 10,000 acre-feet per year or more for irrigation uses. These plans must be consistent with the appropriate approved regional water plan(s). Water conservation plans must include specific, quantified 5-year and 10-year targets for water savings. Goals must be set for water loss programs and for municipal per capita water use. In 2007, § 13.146 of the Texas Water Code was amended requiring retail public suppliers with more than 3,300 connections to submit a water conservation plan by May 1, 2009, to the TCEQ, and then every five years after. The latest water conservation plans were due to the TCEQ in May 2024. Copies of the plans must also be submitted to the regional water planning groups.

Many cities in Region F have developed water conservation plans. Water conservation education is stressed in most cities. These cities plan to provide educational brochures to new and existing customers. Other measures to conserve water include retrofit programs, leak detection and repair, recycling of wastewater, water conservation landscaping, and adoption of the plumbing code. This plan recommends water conservation for all cities including those without shortages. More information on the water conservation models, conservation planning, including recommended strategies to conserve water may be found in Subchapter 5B.

1.6.2 Water Loss Audits

Retail public water utilities are required to complete and submit a water loss audit form to the TWDB. For entities with more than 3,300 connections this form is to be submitted annually. The water audit reporting requirements follow the International Water Association (IWA) and American Water Works Association (AWWA) Water Loss Control Committee methodology.[25]

The primary purposes of a water loss audit are to account for all of the water being used and to identify potential areas where water can be saved. Water losses are classified as either apparent loss or real loss. Apparent loss is the water that has been used but has not been tracked. It includes losses associated with inaccurate meters, billing adjustment and waivers, and unauthorized consumption. Real loss is the actual water loss of water from the system, and includes main breaks and leaks, customer service line breaks and leaks, and storage overflows. The sum of the apparent loss and the real loss make up the total volume of water lost for a utility. Audits consider the annual water loss volume, the value of annual losses, and the validity of water audit data quality.

In the Region F planning area, 15 public water suppliers submitted a water loss audit to TWDB in 2022[26]. The amount of reported losses in Region F totaled 3.2 billion gallons in 2022. This represents 6.9 percent of the 2030 total estimated municipal water demand for the region. This information was used in developing municipal conservation strategies. Table 1-14 summarizes the water loss audit information that was collected by the TWDB for 2022. The region encourages the reduction in water loss where feasible.

Table 1-14
Summary of TWDB Water Loss Audits

Total Water Loss	WUGS	SUDS/WSCs
≤ 10%	3	0
10% - 25%	6	1
≥ 25%	3	2

Source: 2022 Water Loss Audit Dataset from TWDB[26]

1.6.3 Assessment of Current Preparations for Drought in Region F

Drought is a fact of life in Region F. Periods of low rainfall are frequent and can extend for a long period of time. Most of the area has been in drought-of-record conditions since the mid-1990s. Many Region F water suppliers have already made or are currently making improvements to increase their capacity to deliver raw and treated water under drought conditions. Some smaller suppliers in Region F have faced a shortage of supplies within the last few years and have had to restrict water use. The Lower Colorado River Authority (LCRA) determined that the 2008-2016 drought surpassed the historic drought-of-record from the 1950s for LCRA's Highland Lakes and the lower basin and is now the new drought of record. This is significant for Region F because some of the eastern portion of Region F is in the watershed for the Highland Lakes System, which is located in Region K, east of Region F. The low inflows into the Highland Lakes parallels the lower than normal runoff that has occurred in Region F as well. A detailed discussion of the impact of drought on water supplies and water suppliers is included in Chapter 7.

1.6.4 Other Water-Related Programs

In addition to the SB1 regional planning efforts, there are a number of other significant water-related programs that affect water supply in Region F. Perhaps the most significant are Texas Commission on Environmental Quality's water rights permitting, the Clean Rivers Program, the Clean Water Act, the Safe Drinking Water Act, Water Supply Enhancement Program, and precipitation enhancement programs.

Texas Commission on Environmental Quality (TCEQ) Water Rights Permitting

Surface water in Texas is a public resource, and the TCEQ is empowered to grant water rights that allow beneficial use of that resource. Any major new surface water supply source will require a water right permit. Among its many other provisions, SB1 set out formal criteria for the permitting of interbasin transfers for water supply.

Texas Pollutant Discharge Elimination System (TPDES) Program

The TPDES is the state program to carry out the National Pollutant Discharge Elimination System (NPDES) promulgated under the Clean Water Act. The Railroad Commission of Texas maintains authority in Texas over discharges associated with oil, gas, and geothermal exploration and development activities. The TPDES program covers all permitting, inspection, public assistance, and enforcement associated with:

- discharges of industrial or municipal waste;
- discharges and land application of manure from concentrated animal feeding operations;
- discharges of industrial and construction site storm water;
- discharges of storm water associated with city storm sewers;
- oversight of municipal pretreatment programs; and
- disposal and use of sewage sludge.

Wellhead Protection Areas

The Texas Water Code provides for a wellhead source water protection zone around public water supply wells extending to activities within a 0.25 mile radius. Specific types of sources of potential contamination within this wellhead/source water protection zone may be further restricted by TCEQ rule or regulation. For example, wellhead/source water protection zones have been designated for many public water supply wells within or near Pantex (May and Block, 1997). More specific information on well head protection zones is available from TCEQ.

The Texas Water Code further provides for all wells to be designed and constructed according to TCEQ well construction standards (30 TAC 290). These standards require new wells to be encased with concrete extending down to a depth of 20 feet, or to the water table or a restrictive layer, whichever is the lesser. An impervious concrete seal must extend at least 2 feet laterally around the well head and a riser installed at least 1 foot high above the impervious seal.

Clean Rivers Program

The Texas Clean Rivers Program (CRP) is a state-fee funded water quality monitoring, assessment, and public outreach program. The CRP is a collaboration of 15 partner agencies and the TCEQ. The CRP provides the opportunity to approach water quality issues within a watershed or river basin at the local and regional level through coordinated efforts among diverse organizations. In Region F, the program is carried out by the Lower Colorado River Authority, with assistance from CRMWD and UCRA, in the Colorado Basin, and by the International Boundary and Water Commission in the Rio Grande Basin.[27]

***Clean Water Act* -** The Clean Water Act is a federal law designed to protect water quality. The Act does not directly address groundwater nor water quantity issues. The statute employs a variety of regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water." [28]

The parts of the act which have the greatest impact on water supplies are the NPDES permitting process, which affects water quality, and the Section 404 permitting process for dredging and filling in the waters of the United States, which affects reservoir construction and infrastructure projects that may affect wetlands or rivers. In Texas, the state oversees the NPDES permitting system, which sets the operating requirements for wastewater treatment plants. The Section 404 permitting process is facilitated by the Corps of Engineers.

The TCEQ administers a Total Maximum Daily Load (TMDL) Program for surface water bodies in the state of Texas. TMDL programs are a result of the Clean Water Act. In this program, water quality analyses are performed for water bodies to determine the maximum load of pollutants the water body can handle and still support its designated uses. The load is then allocated to potential sources of pollution in the watershed, and implementation plans are developed which contain measures to reduce the pollutant loads. The Implementation Plan for Sulfate and Total Dissolved Solids (TDS) TMDLs in the E.V. Spence Reservoir (Segment 1411) was established in August 2001. The TCEQ has completed analyzing the Colorado River below E.V. Spence Reservoir (Segment 1426) for chloride, sulfate, and TDS concentrations and updated the Implementation Plan (further information on the updated plan is included in Section 1.7.1).

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) was originally passed by Congress to protect public health by regulating the nation's public drinking water supply. The law requires many actions to protect drinking water and its sources – rivers, lakes, reservoirs, springs, and groundwater wells. To ensure that drinking water is safe, SDWA sets up multiple barriers against pollution including source water protection, treatment, distribution system integrity, and public information.[29] Some of the initiatives that will most likely have significant impacts in Region F are the reduction in allowable levels of trihalomethanes in treated water, the requirement for reduction of total organic carbon levels in raw water, and the reduction in the allowable level of arsenic and radionuclides in drinking water. The allowable limit on arsenic has been reduced from 50 micrograms per liter to 10 micrograms per liter. Other initiatives target per- and polyfluoroalkyl substances (PFAS). EPA issued maximum contaminant limits for six forms of PFAS in April 2024. Water providers have three years to monitor their systems for these chemicals and then will need to start implementing treatment, if needed, by 2029.

Water Supply Enhancement Program

The Water Supply Enhancement Program, formerly known as the State Brush Control Program, was developed pursuant to Chapter 203 of the Texas Agricultural Code. Feasibility studies have been conducted for seven watersheds in the region including Lake Brownwood, O.C. Fisher, O.H. Ivie Lake Basin, E.V. Spence, Lake J.B. Thomas, Twin Buttes Reservoir, and Upper Llano River. These projects are discussed further in Subchapter 5C.

Precipitation Enhancement Programs

In Region F, there are several ongoing weather modification programs, including the West Texas Weather Modification Association (WTWMA) project and the Trans Pecos Weather Modification Association (TPWMA) program. The Southern Ogallala Aquifer Rain (SOAR) program is being conducted in Region O counties bordering Region F to the north. Precipitation enhancement is discussed in more detail in Chapter 5C.

Bio-Terrorism Preparedness and Response Act

Following the events of September 11th, 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 facilities of all sizes. The guidance document for water utilities can be found through the American Water Works Association.

1.7 SUMMARY OF THREATS AND CONSTRAINTS TO WATER SUPPLY

1.7.1 Threats to Water Supply

Threats to water supply in Region F include:

- Water quality concerns in several areas of the region,
- The impact of drought,
- Rainfall/runoff patterns in the upper Colorado River Basin, and
- Strict enforcement of State's Priority System for Surface Water.

Brief discussions of each of these concerns is presented in this section. The water quality concerns are discussed by source. The TCEQ publishes The State of Texas Water Quality Inventory every two years. The Water Quality inventories indicate whether public water supply use is supported in the stream segments designated for public water supply in Region F. Surface water quality concerns identified by the TCEQ within Region F are summarized in Table 1-15. The Region F Plan was developed under the guiding principal that the designated water quality and related water uses shall be improved or maintained.

Rio Grande Basin Water Quality

The high levels of chlorides, sulfates and TDS present in the Pecos River below Red Bluff Reservoir appear to originate from geologic formations and oil and gas production activities. The cause of the toxic algae blooms is unknown. However, their occurrence has been linked to salinity and nutrient concentrations. The elevated levels of arsenic have been attributed to agricultural activities. Red Bluff Reservoir contains elevated levels of mercury, chlorides, and sulfates. The heavy metals present in the surface water in this region represent the most serious public health concern. The high chloride and TDS levels in the surface water preclude most agricultural uses. Instead, agricultural water users rely heavily on the groundwater supply.

Colorado River Basin Water Quality

The high levels of chlorides, sulfates and TDS present in the upper Colorado River above O.H. Ivie Reservoir (including E.V. Spence Reservoir) are thought to originate from geologic formations and oil [30] and gas production. In August 2000, a Total Maximum Daily Load (TMDL) study was completed at E.V. Spence Reservoir. This TMDL study was approved by the Environmental Protection Agency (EPA) in May 2003. In 2007, the TCEQ adopted Two Total Maximum Daily Loads for Chlorides and Total Dissolved Solids for the Colorado River below the E.V. Spence Reservoir. Later that year, the TCEQ approved the Implementation plan (I-plan) to achieve the pollutant reduction identified in the TMDL report.[31] The Railroad Commission has since eliminated many potential sources of contamination and the Texas State Soil and Water Conservation Board removed salt cedar in the watershed. Prior to the current drought, the salinity levels in the segment of stream were improving. However, the drought has lowered water levels in Spence, leading to a re-concentration of chloride and TDS. In 2014, the Upper Colorado River Authority (UCRA) and TCEQ updated the I-plan. In 2016, stakeholders met to discuss progress of the I-Plan to evaluate actions taken, identify actions that may not be working, and make any changes necessary. Continued monitoring of the area should show improving water quality as the I- Plan is implemented.[32]

The high nitrate levels present in the Concho River east of San Angelo and the groundwater water in Runnels, Concho and Tom Green Counties appear to be from a combination of natural conditions, general agricultural activities (particularly as related to wide spread and intense crop production), and locally from confined animal feeding operations and/or industrial activities. Surface waters in the Concho River near Paint Rock have consistently demonstrated nitrate levels above drinking water limits during winter months. This condition has caused compliance problems for the city of Paint Rock, which uses water from the Concho River. It has been determined through studies funded by the Texas Clean Rivers Program that the elevated nitrates in the Concho River result from dewatering of the Lipan aquifer through springs and seeps to the river.[33] Further analysis of data collected near Paint Rock shows an increasing trend in chloride, which is likely attributed to lower inflows from the Lipan aquifer due to drought, increased irrigation withdrawals, and brush infestation.[34]

The North Fork of the Concho River from O.C. Fisher Reservoir Dam to Bell Street in San Angelo is heavily impacted with non-point source urban runoff, which leads to oxygen depletion and a general water quality deterioration. Numerous fish kills have occurred along this 4.75 mile stretch of the Concho River since the late 1960's. In addition, toxics have been reported by the TCEQ within the same stream segment. Both of these problems are believed to result from non-point source water pollution. Since 1994, the Upper Colorado River Authority and the City of San Angelo have been involved in a comprehensive effort to mitigate these problems through the Federal Clean Water Act (CWA) 319(h) program. This program provides grant funds to implement Best Management Practices (BMPs) designed to mitigate non-point source water quality problems. The EPA 319(h) program is administered in Texas through the TCEQ. The implementation of this program has proved to be successful as water quality has shown significant improvement and fish kills have been virtually eliminated. In 2016, water quality data in the North Concho River indicate that concentrations of E. coli have decreased, and TCEQ proposed to remove the bacteria impairment from the list of impaired waters[35].

Table 1-15
Summary of Identified Surface Water Quality Problems in Region F

Segment ID	Segment Name	Concern Location	Water Quality Concern	Status
1411	E.V. Spence Reservoir	From Robert Lee Dam in Coke County to a point immediately upstream of the confluence of Little Silver Creek in Coke County, up to the normal pool elevation of 1898 feet	Chloride	Additional data and information will be collected before a TMDL is scheduled.
1412	Colorado River Below J.B Thomas	From the confluence of Beals Creek upstream to the dam below Barber Reservoir pump station	Bacteria	Additional data and information will be collected before a TMDL is scheduled.
1412 B	Beals Creek (unclassified water body)	From the confluence of Gutherie Draw upstream to the confluence of Mustang Draw and Sulphur Springs Draw in Howard County	Bacteria	A review of the standards for one or more parameters will be conducted before a management strategy is selected, including the possible revision to the water quality standards.
1413	Lake J. B. Thomas	Entire water body	Chloride and total dissolved solids	Additional data and information will be collected before a TMDL is scheduled.
1416	San Saba River	From the confluence with the Colorado River in San Saba County upstream to US 190	Bacteria	Additional data and information will be collected before a TMDL is scheduled.
1416 A	Brady Creek (unclassified water body)	From the confluence of the San Saba River southwest of San Saba County to the Brady Lake Dam west of Brady in McCulloch County	Depressed dissolved oxygen	Additional data and information will be collected before a TMDL is scheduled.
1421	Concho River	From a point 2 km (1.2 mi) above the confluence of Fuzzy Creek in Concho County to San Angelo Dam on the North Concho River in Tom Green County and to Nasworthy Dam on the South Concho River in Tom Green County	Depressed dissolved oxygen	Additional data and information will be collected before a TMDL is scheduled.
1425	O.C. Fisher Lake	From San Angelo Dam in Tom Green County up to normal pool elevation of 1908 feet (impounds North Concho River)	Chloride and total dissolved solids	Additional data and information will be collected before a TMDL is scheduled.
1433	O.H. Ivie Reservoir	From S. W. Freese Dam to a point 3.7 km (2.3 mi) downstream of the confluence of Mustang Creek on the Colorado River Arm and to a point 2.0 km (1.2 mi) upstream of the confluence of Fuzzy Creek on the Concho River Arm, up to the conservation pool level of	Algal growth	Additional data and information will be collected before a TMDL is scheduled.
2311	Upper Pecos River	From a point immediately upstream of the confluence of Independence Creek in Crockett/Terrell County to Red Bluff Dam in Loving/Reeves County	Depressed dissolved oxygen	Additional data and information will be collected before a TMDL is scheduled.
2312	Red Bluff Reservoir	From Red Bluff Dam in Loving/Reeves County to New Mexico State Line in Loving/Reeves County up to normal pool elevation 2842 feet (impounds Pecos River)	Chloride and sulfate	Additional data and information will be collected before a TMDL is scheduled.

Source: Data from 2022 Draft 303(d) list (July 7, 2022)[36]

Hickory Aquifer

Radionuclides present in the Hickory aquifer originate from geologic formations. Several of the public water systems that rely on this aquifer sometimes exceed the TCEQ's radionuclide limits, including limits on radon. Some users are blending water from other sources with Hickory supplies to reduce radionuclide concentrations while other users have implemented radionuclide removal systems. According to local representatives of Hickory aquifer users on the Region F Water Planning Group, water from the Hickory aquifer has been used for decades with no known or identified health risk or problems. Since the radioactive contaminants are similar chemically to water hardness minerals (with the exception of radon), removal techniques are well known within the water industry. Problems that have yet to be resolved in utilizing these techniques are the storage and disposal of the removed radioactive materials left over from the water treatment process, and the funding of treatment improvements for small, rural communities. Generally, agricultural use is not impaired by the presence of the radionuclides.

Dockum Aquifer

Water quality in the Dockum aquifer ranges from fresh (TDS < 1,000 mg/L) in outcrop areas and the edges of the depositional basin to brines with over 50,000 mg/L TDS in the center of the basin. Upward movement of water in some areas, such as Andrews County, can result in poorer water quality in the overlying Ogallala aquifer. In Ector County, Dockum wells produce groundwater with TDS concentrations between 2,000 and 7,000 mg/L and sulfate and chloride concentrations up to 2,500 mg/L from wells that are less than 750 feet deep. The presence of uranium minerals in the Dockum Group has long been recognized and is the source of some radiological constituents (radium-226 and -228) reported in some Dockum aquifer groundwater samples. The concentrations of some trace metals, including antimony, beryllium, cadmium, lead, mercury, selenium, and thallium, were reported to exceed drinking water regulatory limits in several counties.

Other Groundwater Quality Issues

Other groundwater quality issues in Region F include elevated levels of fluoride, nitrate, arsenic and perchlorate.

Table 1-16 shows the percentage of water wells sampled by the TWDB that exceed drinking water standards for dissolved fluoride, dissolved nitrate (nitrogen as NO_3), and dissolved arsenic from 2020-2024. The largest percentage of wells with excessive fluoride found in 4 or more samples can be found in Andrews, Midland, Reagan, Upton, Pecos and Martin Counties. Elevated nitrate levels can be found throughout Region F, with a high percentage of wells (minimum of 4 samples) exceeding standards in Andrews, Crockett, Ector, Martin, Mason, Midland, Pecos, Reeves and Schleicher Counties. The highest percentages of wells (minimum of 3 samples) exceeding arsenic standards are found in Andrews, and Kimble Counties. Perchlorate is a growing water quality concern for water from the Ogallala aquifer in west Texas. Preliminary research found perchlorate levels exceeding drinking water standards in 35 percent of the public drinking water wells.[37] Texas has not established an MCL for perchlorate. However, in 2001, TCEQ did establish an Interim Action Level (IAL) of 0.004 mg/L for perchlorate, and in its 2006 guidance for assessing the health of surface waters for the purposes of drinking water quality, TCEQ required monitoring and reporting of perchlorate levels that exceed 0.022 mg/L.[38] EPA has not set a national limit on perchlorate levels due to the infrequency of occurrence. However, it still may be a concern for some water sources.

Table 1-16
Percentage of Sampled Water Wells Exceeding Drinking Water Standards for Fluoride, Nitrate (as NO_3) and Arsenic

County	Fluoride	Nitrate	Arsenic
Andrews	64%	36%	57%
Borden	0%	0%	0%
Brown	0%	0%	0%
Coke	0%	100%	0%
Coleman	0%	0%	0%
Concho	0%	50%	0%
Crane	67%	33%	0%
Crockett	14%	100%	0%
Ector	25%	100%	25%
Glasscock	17%	0%	0%
Howard	100%	0%	0%
Irion	0%	0%	0%
Kimble	0%	30%	30%
Loving	100%	0%	0%
Martin	100%	100%	25%
Mason	0%	83%	33%
McCulloch	0%	0%	0%
Menard	0%	0%	0%
Midland	55%	64%	0%
Mitchell	0%	0%	0%
Pecos	33%	43%	0%
Reagan	50%	13%	0%
Reeves	18%	40%	0%
Runnels	0%	0%	0%
Schleicher	0%	78%	0%
Scurry	0%	67%	67%
Sterling	0%	100%	100%
Sutton	0%	40%	0%
Tom Green	0%	0%	0%
Upton	80%	0%	0%
Ward	20%	0%	0%
Winkler	20%	0%	0%

Data are from the Texas Water Development Board 2020-2024[39]

Regional Drought

Most of Region F has experienced drought-of-record conditions since the mid-1990s. These conditions have led to reduced inflow, high evaporation and low lake levels limiting the supply. Many suppliers in the region responded by implementing their drought contingency plans and in some cases expedited implementation of water supply strategies. Drought conditions also have a negative impact on water quality. As water levels decline, reservoirs tend to concentrate dissolved materials. Without significant freshwater inflows the water quality in a reservoir degrades. The lack of recharge to aquifers has a similar effect on groundwater. A detailed discussion of the impact of drought on water supplies and water suppliers is included in Chapter 7.

Rainfall and Runoff Patterns in the Upper Colorado River Basin

Region F surface water supply is heavily dependent upon consistent streamflow (runoff) throughout the Colorado River Basin. In 2017, a detailed evaluation of historical rainfall-runoff patterns in the Upper Colorado River Basin determined that observed flow trends have declined over the period of record (1940-2016)[40]. Analysis of naturalized flows from the Colorado Basin WAM indicated that most of this d iminishing trend is likely caused by construction of large reservoir systems and historical water use, which are both associated with existing water rights in the basin area. Additionally, all sites in the study demonstrated some decline in naturalized flow, signifying that activities not accounted for in the naturalization flow process could have impacted observed flows. Further investigations determined that four activities had some effect on the trend of observed and naturalized flows over the study period: (1) the proliferation of noxious brush; (2) the construction of small reservoirs, not accounted for in naturalized flows; (3) groundwater use and aquifer water level declines; and (4) changes in average temperature in drought conditions. If this declining trend of observed and naturalized flows continue, and these activities continue to cause negative effects, then threats to surface water supplies in the Upper Colorado River Basin will likely persist and could potentially magnify.

Strict Enforcement of State's Priority System for Surface Water

Texas surface water is governed by a priority system, which means "first in time, first in right." The TCEQ is charged with regulating the state's surface water, including issuing water rights and enforcing those rights. Historically, the TCEQ has only enforced the priority system when there was a request for water from a senior downstream water right holder, referred to as a priority call. Even then, the TCEQ would consider public health and safety when requiring pass-through of inflows from upstream to downstream users. With the development of the Water Availability Models (WAMs), which models strict interpretation of the priority system, it became apparent that many of the Region F reservoirs have little to no reliable supply, given that assumption. The WAM interpretation applies to the priority system to both storage and diversion that results in more water passed through to downstream water right holders than previously modeled for supply analyses.

During the recent drought (2011-2016), there were several priority calls across the state. As part of the response to these calls, TCEQ considered public health and safety as a factor in requiring pass-throughs. However, recent judicial decisions have stated that the state must enforce the priority system without regard to the type of use. If the state enforces the priority system in accordance with the assumptions in the WAMs, surface water supplies in Region F would be significantly impacted. More discussions on these impacts are included in Chapter 3 and Subchapter 5C.

1.7.2 Constraints

A major constraint to enhancing water supply in Region F is a lack of appropriate locations for new surface water supply development and lack of available water for new and/or existing surface water supply projects. There are few sites in the region that have sufficient runoff to justify the cost of developing a new reservoir without having a major impact on downstream water supplies. Generally, the few locations that do have promise are located far from the areas with the greatest needs for additional water. In addition, the Colorado and Rio Grande WAMs show very little available surface water for new appropriations in Region F. There is very little water available that has not already been allocated to existing water rights.

As previously discussed, much of the surface water and groundwater in the region contains high concentrations of dissolved solids, originating from natural and man-made sources. It is possible to make use of these resources, but the cost to treat this water can be high. Much of the region is rural with limited resources. Therefore, advanced treatment, system improvements or long distance transportation of water may not be economically feasible. Also, many of these smaller communities have experienced declining populations in recent years. One-half of the counties in the region have a population less than 5,000 people.

Finally, many of the municipal water supply needs in Region F are relatively small and are in locations that are far away from reliable water supplies of good quality. Transporting small quantities of water over large distances is seldom cost-effective. Desalination and reuse are good options for these communities. However, the high cost of developing and permitting these types of supplies is a significant constraint on water development. Also, finding a suitable means of disposing the reject concentrate from a desalination project may limit the feasibility of such projects in many locations.

1.8 WATER-RELATED THREATS TO AGRICULTURAL AND NATURAL RESOURCES IN REGION F

Water-related threats to agricultural resources in Region F include water quality concerns and insufficient groundwater supplies. Water-related threats to natural resources include changes to natural flow conditions and water quality concerns.

1.8.1 Water Related Threats to Agriculture

Water quality concerns for agriculture are largely limited to salt water pollution, both from natural and man-made sources. In some cases, improperly abandoned oil and gas wells have served as a conduit for brines originating deep within the earth to contaminate the shallow groundwater supplies. Prior to 1977, the brines associated with oil and gas production were commonly disposed in open, unlined pits. In some cases these disposal pits have not been remediated and remain as sources of salt contamination. Current brine disposal practices involve repressurizing hydrocarbon-producing formations or disposing through deep well injection. These practices lead to the possibility of leaks into water supply aquifers since the hydraulic pressure of the injected water routinely exceeds the pressure needed to raise the water to the ground's surface. In other aquifers, excessive pumping may cause naturally occurring poor quality water to migrate into fresh water zones.

Most of Region F depends on groundwater for irrigation. Based on current use, agricultural demand exceeds the available groundwater supply in several counties. Parts of three counties (Midland, Reagan and Upton) were declared a Priority Groundwater Management Area by the TCEQ in 1990. Since that time the Santa Rita GCD has formed for most of Reagan County with Glasscock GCD covering small portions of the county as well. In February 2017, the Executive Director of TCEQ provided a report for northeastern Upton and southeastern Midland Counties recommending these areas be added to the Glasscock GCD.

1.8.2 Water Related Threats to Natural Resources

Reservoir development and invasion by brush and giant reed have altered natural stream flow patterns in Region F. Spring flows in Region F have greatly diminished. Many springs have dried up because of groundwater development, the spread of high water use plant species such as mesquite and salt cedar, or the loss of native grasses and other plant cover. High water use plant species have reduced reliable flows for many tributary streams. Reservoir development also changes natural hydrology by diminishing flood flows and capturing low flows. It is unlikely that future changes to flow conditions in Region F will be as dramatic as those that have already occurred. If additional reservoirs are developed, they will be required to make low flow releases to maintain downstream conditions.

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2 POPULATION AND WATER DEMANDS

In November 2023[1], the Texas Water Development Board (TWDB) approved population and water demand projections for Region F for use in the 2026 Regional Water Plan. The water demand projections include both municipal and non-municipal water use over the planning period of 2030 to 2080. The Region F RWPG reviewed and revised the projections as needed to more accurately reflect the expected water demands for the region.

Continued interest in oil and gas production in the Permian Basin resulted in significant increases in projected mining water demand in parts of Region F over the 2021 Plan. Population projections are slightly lower than in the 2021 Region F Plan but still increase steadily to over 1 million people by 2080. In most cases, the baseline per capita usage from the 2021 Plan was maintained for the 2026 Plan, which was based on 2011 per capita use to represent dry year demands. However, due to prolonged extreme drought, some users experienced restricted deliveries during 2011, and the historical use was not representative of a dry year demand and was thus adjusted. Furthermore, some entities have experienced a declining trend in per capita usage in recent years due to permanent conservation measures implemented as a response to the recent drought. These include conservation-oriented rate structures and changed behavior patterns. These entities' baseline per capita use numbers were adjusted downward to capture the recent trends. Municipal water demands for the region decreased slightly from the previous plan in 2030 but are slightly higher later in the planning horizon.

Overall, water demand projections in Region F are estimated to be roughly 859,700 acre-feet in 2030 and decrease to about 837,100 acre-feet in 2080. Irrigation, steam electric power, and livestock are predicted to remain steady over the planning horizon. Manufacturing demands are projected to slightly increase over the planning horizon. Mining demands start at over 216,000 acre-feet and remain high through 2040. However, mining demand is projected to begin to decline after 2040 as recoverable resources with current technology in the Midland Basin reduce. However, the demand remains sizeable at over 134,800 acre-feet in 2080. Despite the increase in population and municipal demand over the planning horizon, the reduction in heavy mining demand results in an overall slightly decreasing trend in total water demand over the planning horizon.

More detailed discussion of the development of population and water demands is presented in the following subsections. To understand the data development and presentation, it is important to understand the terminology used for regional water planning. The TWDB distributes its population and demand projections into Water User Groups (WUGs). Each WUG has an associated water demand. Only municipal WUGs have population projections.

The Region F Water Plan also recognizes wholesale water providers (WWPs) and major water providers (MWPs). A wholesale water provider is an entity that sells water wholesale to another water provider. These providers are considered in the development and understanding of how water is distributed in the region. However, demands for wholesale water providers are not specifically developed and presented in this chapter unless the WWP is also identified by the region as a MWP. The MWP is an entity selected by the RWPG as having a significant role in providing water in the region. A MWP may be a WUG or WWP. Region F has identified five MWPs for the 2026 Plan. Projected water demands for each MWP are discussed in Section 2.3.

To simplify the presentation of these data, all WUG projections in this chapter are aggregated by county. Projections divided by WUG, county and basin may be found in Appendix I, *Database (DB27) Reports*. The projections were developed by decade and cover the period from 2030 to 2080.

2.1 Population Projections

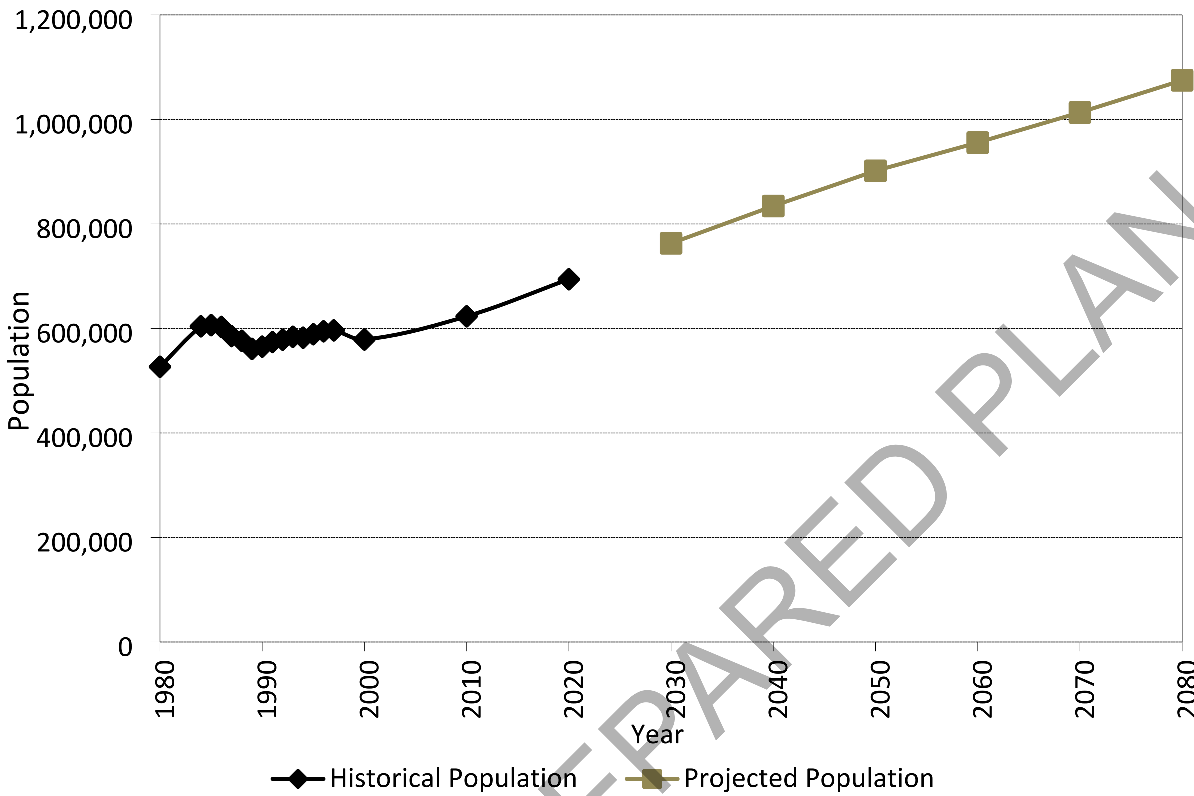
Table 2-1 presents the projected populations for the counties in Region F. Figure 2-1 compares the region's historical population from 1980 to 2020 and the projected population through 2080. Figure 2-2 shows the geographical distribution of the population projections for the years 2030 and 2080. Population projections divided by WUG, county and basin are included in Appendix 2A at the end of this chapter.

Table 2-1
Projected Population by County

County	2030	2040	2050	2060	2070	2080
Andrews	22,997	28,993	35,825	42,717	50,229	58,417
Borden	608	603	601	607	614	622
Brown	39,717	40,383	40,459	40,599	40,752	40,919
Coke	3,454	3,690	3,932	4,317	4,737	5,195
Coleman	7,087	6,424	5,759	5,254	4,724	4,168
Concho	3,905	3,810	3,718	3,629	3,536	3,438
Crane	5,027	5,493	5,887	6,205	6,552	6,930
Crockett	2,845	2,633	2,409	2,250	2,083	1,908
Ector	185,779	207,148	225,963	239,926	254,560	269,935
Glasscock	1,049	985	946	869	788	703
Howard	36,259	37,313	37,885	37115	36276	35361
Irion	1,429	1,357	1,332	1,279	1,223	1,164
Kimble	4,063	3,821	3,650	3,625	3,599	3,572
Loving	64	64	64	64	64	64
Martin	5,543	5,896	6,311	6,530	6,769	7,030
Mason	3,821	3,708	3,666	3,661	3,656	3,651
McCulloch	7,430	7,136	6,817	6,638	6,450	6,253
Menard	1,767	1,637	1,524	1,496	1,467	1,437
Midland	192,470	216,809	241,697	259,762	278,739	298,635
Mitchell	10,837	11,020	11,250	11,361	11,474	11,594
Pecos	15,637	16,195	16,587	16,933	17,296	17,677
Reagan	3,490	3,592	3,633	3,641	3,649	3,657
Reeves	16,015	17,702	19,284	20,384	21,583	22,890
Runnels	9,842	9,786	9,662	9,620	9,576	9,530
Schleicher	2,107	1,806	1,522	1,291	1,049	795
Scurry	17,450	18,006	18,344	18,517	18,699	18,890
Sterling	1,704	2,226	2,923	3,824	4,806	5,876
Sutton	3,067	2,778	2,482	2,266	2,039	1,801
Tom Green	132,573	145,445	156,800	168,070	180,354	193,744
Upton	3,349	3,475	3,550	3,627	3,708	3,793
Ward	12,954	14,666	16,450	18,013	19,717	21,574
Winkler	8,646	9,744	10,757	11,653	12,630	13,695
Total	*762,985*	*834,344*	*901,689*	*955,743*	*1,013,398*	*1,074,918*

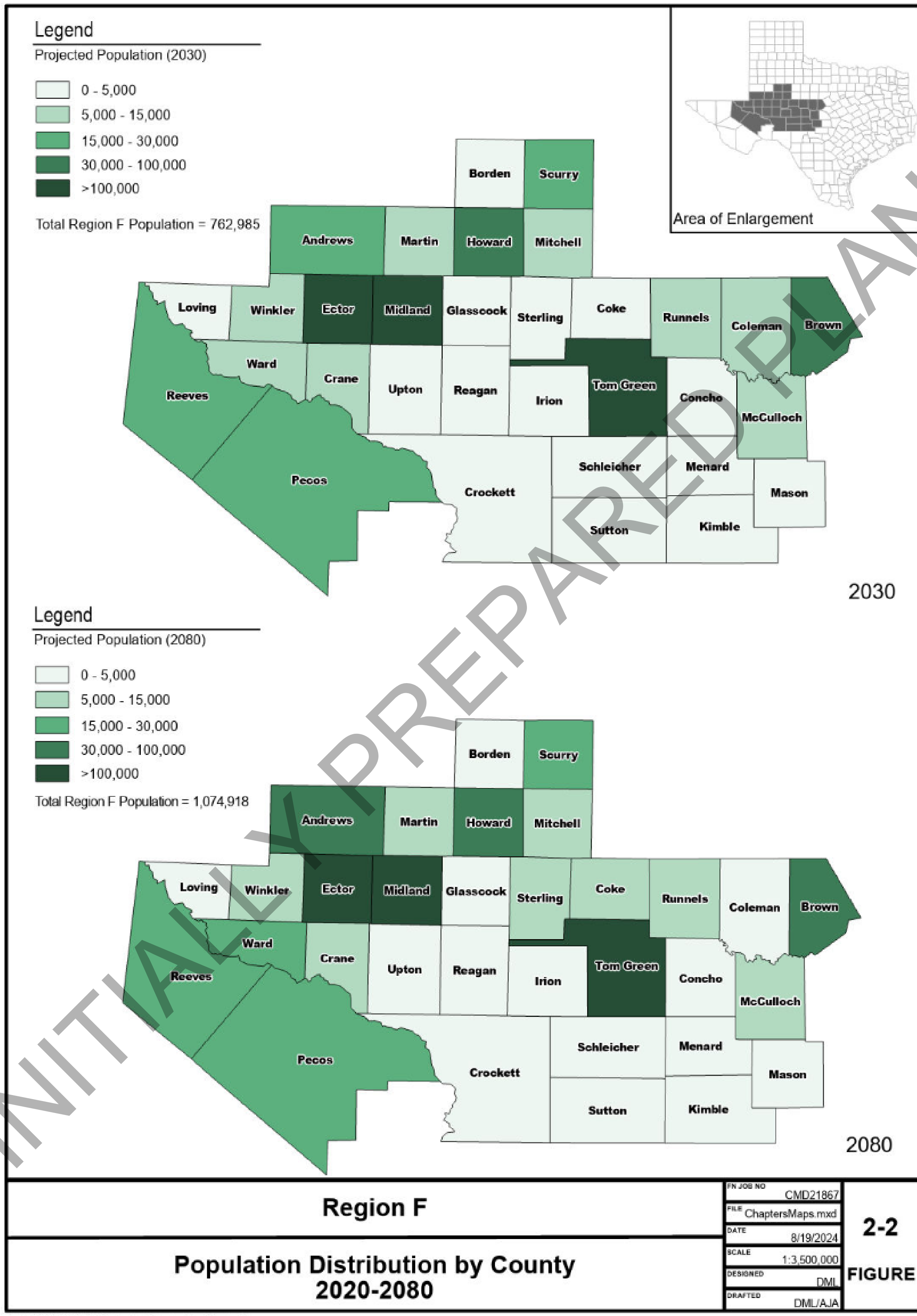
Source: Data are from the TWDB. [3]

Figure 2-1
Historical and Projected Population of Region F



Historical data provided by the Texas Water Development Board[2]. Some historical data are not available. Projected population was approved by TWDB for this round of regional water planning and adopted for this plan.

Figure 2-2
Projected Population Distribution by County 2030 – 2080



For the 2026 regional water plans, municipal water users are defined based on the service area boundary rather than city boundaries. For most of the cities in Region F, the city boundary and service area boundary are the same or very similar. TWDB projects the region's total population to increase from 762,985 in 2030 to 1,074,918 in 2080, an average growth rate of 0.7 percent per year. TWDB projects the total population for Texas to increase from 34.2 million in 2030 to 52.3 million in 2080, an average growth rate of 0.85 percent per year.

The relative distribution of population in Region F is expected to remain stable throughout the 50-year planning period. Almost 80 percent of the people in Region F live in urban areas or small- to moderate-sized rural communities. Three counties, Midland, Ector and Tom Green, account for more than half of the region's population. These counties contain the cities of Midland, Odessa and San Angelo, respectively.

Twenty-nine of the thirty-two counties that comprise Region F are generally rural. Twenty-one counties have populations of less than 10,000. Two of these counties, Loving and Borden, have populations of less than 1,000. These twenty-nine counties are expected to remain primarily rural throughout the planning period. The Permian and Delaware Basin portions of Region F are experiencing or are expected to experience a population increase due to interest in the exploration and production of oil. Because the TWDB population methodology is based on historical growth rates and not economic drivers, population growth is shown to continue throughout the planning horizon despite a reduction in mining demands beginning in 2040. Mining demands may continue as technology improves to make more resources recoverable, the region may diversify its economy overtime, or the population may not grow as projected by TWDB. This should continue to be monitored and updated in future planning cycles.

2.2 Historical and Projected Water Demands

Municipal water use is the only category subdivided into individual water utilities. All other categories are aggregated into county/basin units.

Each category has annual water demand projections for the years 2030, 2040, 2050, 2060, 2070 and 2080. These projections are not the same as the average day and peak-day projections used in planning for municipal water supply distribution systems.

The average day projection is the amount of water expected to be delivered during a normal day. A peak-day projection is the maximum amount of water expected to be delivered during the highest demand day, typically expressed in million gallons per day (MGD). The TWDB water demand projections are the volumes of water expected to be used during a dry year and are usually expressed in acre-feet per year (one acre-foot equals 325,851 gallons). These projections would be comparable to a year's worth of average day deliveries. The water demand projections for the 2026 Region F Plan were developed in conjunction with the TWDB and regional stakeholders. The Region F RWPG solicited input from retail w

Water Demand by Use Category in Region F

Irrigated agriculture is by far the largest water use category in Region F throughout the planning horizon. **Mining** is a significant water use in the early decades but is expected to decline over time as oil and gas deposits are fully developed. **Municipal water** use is also a major water use category, and it is projected to grow over time and eventually be the second largest use category. **Manufacturing, livestock, and steam electric power** are all relatively small use categories in Region F over the planning horizon.

ater providers, including cities, water supply corporations, special utility districts, and other providers identified as a WUG. Region F representatives for non-municipal water use were also contacted for input on non-municipal demands. The projections were then compared to historical data and other projections and evaluated for anomalies such as recent water use exceeding future predictions, changes in trends in per capita water use, etc. The final recommended demands were approved by the region and the TWDB for the 2026 Region F Water Plan.

Figure 2-3 and Figure 2-4 present the TWDB-approved total water demand projections for the region by water-use type for 2030 and 2080. Table 2-2 and Figure 2-5 summarize the water demand projections in the region by use category.

Figure 2-3
2030 Water Demand in Region F by Use

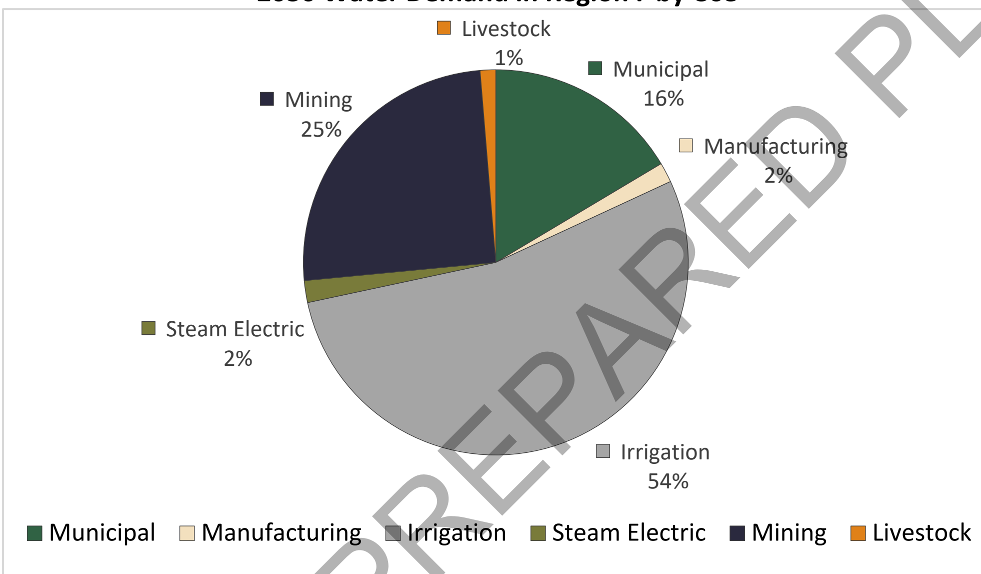


Figure 2-4
2080 Water Demand in Region F by Use

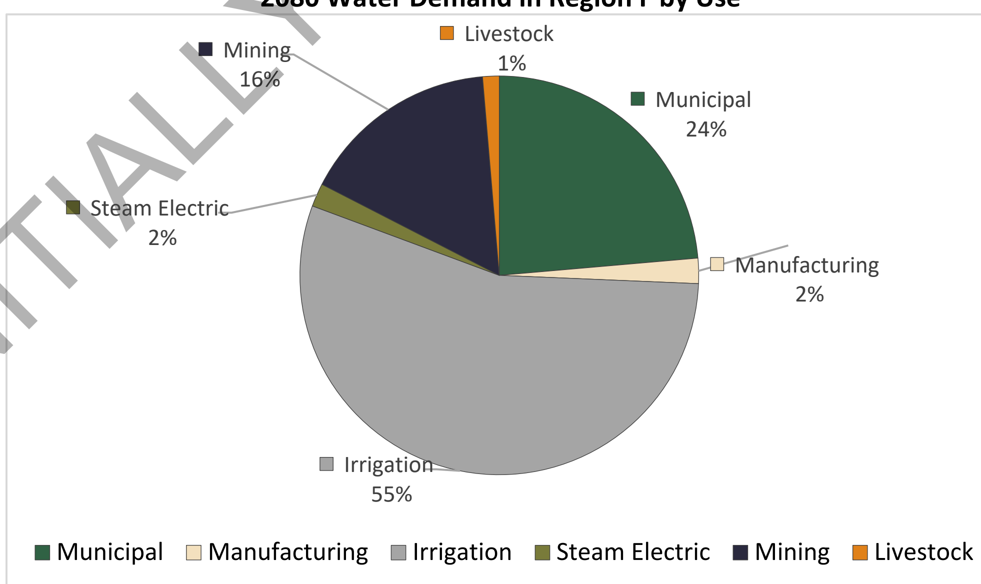


Table 2-2
Water Demand Projections for Region F by Use Category
-Values in Acre-Feet per Year-

Use Category	2030	2040	2050	2060	2070	2080
Municipal	141,387	153,631	166,113	175,942	186,455	197,714
Manufacturing	14,276	14,802	15,347	15,913	16,500	17,109
Irrigation	460,341	460,341	460,341	460,341	460,341	460,341
Steam Electric	15,798	15,798	15,798	15,798	15,798	15,798
Mining	216,716	217,652	207,969	187,463	159,337	134,865
Livestock	11,228	11,228	11,228	11,228	11,228	11,228
Total	*859,746*	*873,452*	*876,796*	*866,685*	*849,659*	*837,055*

Source: Data are from the TWDB[3].

Figure 2-5
Projected Water Demand in Region F by Use Category

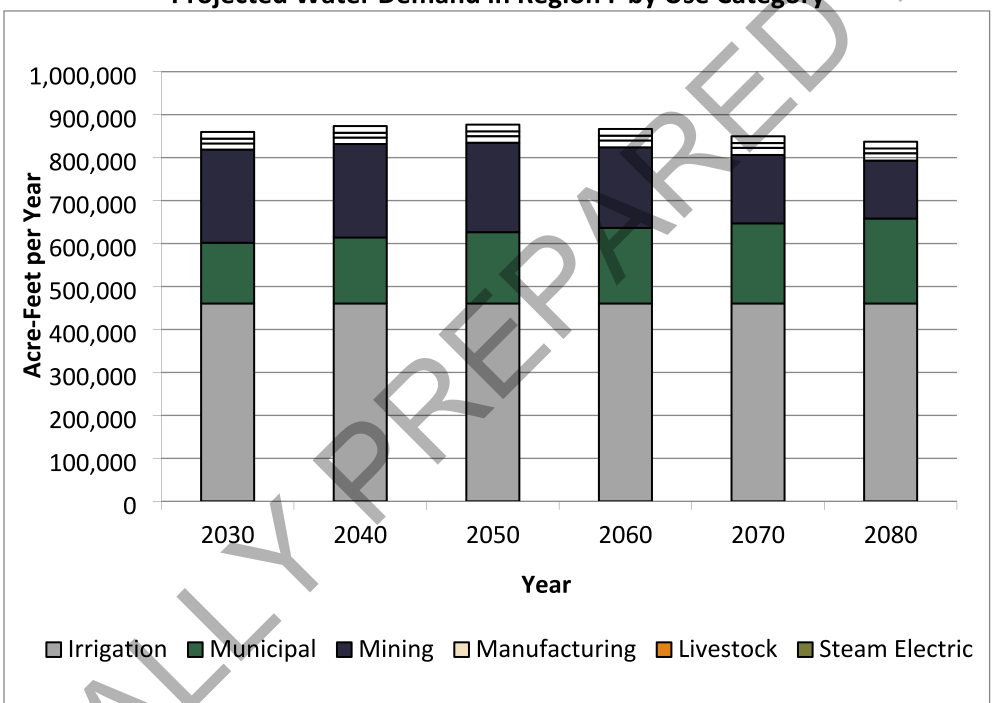


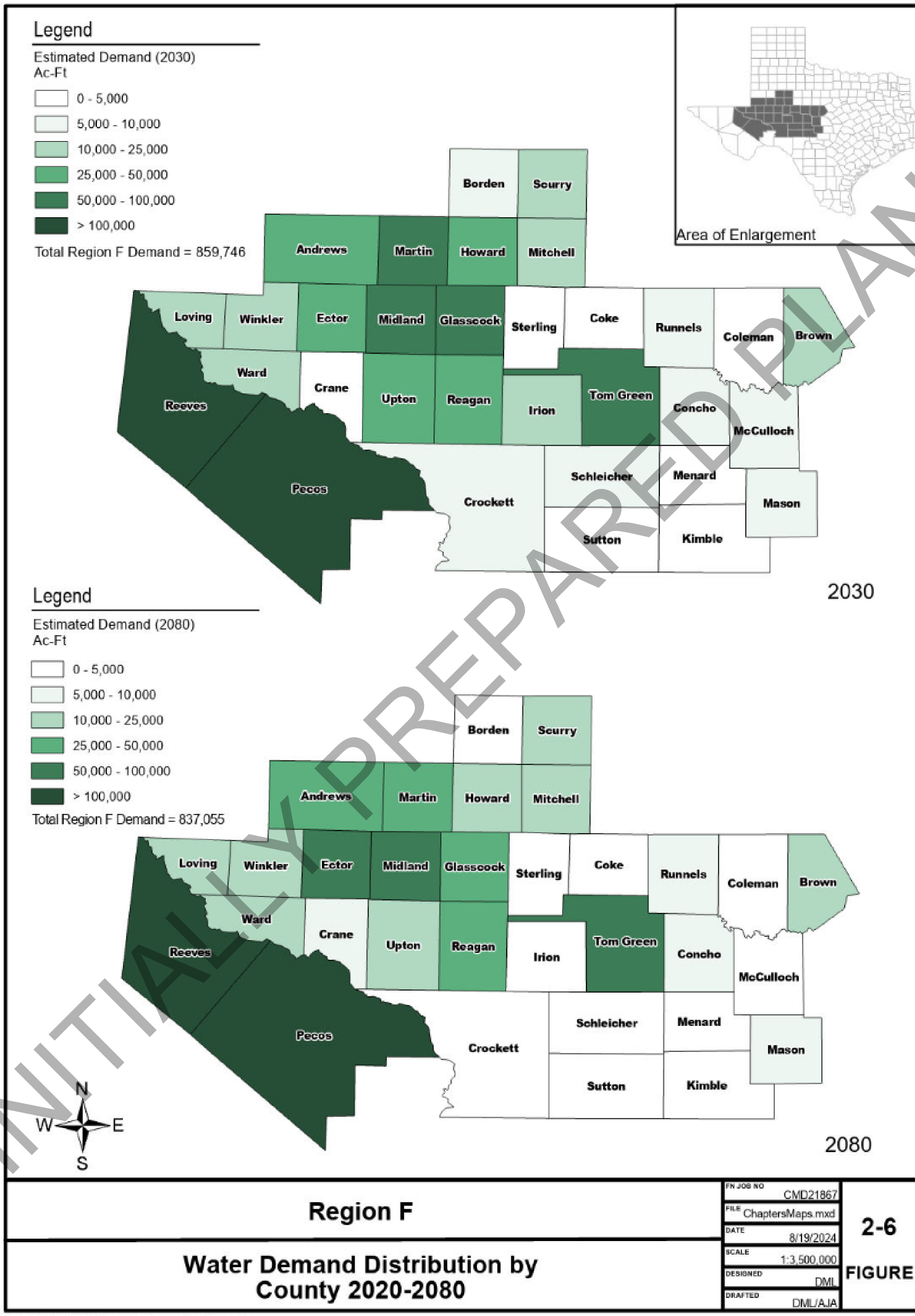
Table 2-3 summarizes the projected water use by county. Figure 2-6 shows the geographical distribution of the years 2030 and 2080 total water demand projections by county from Table 2-3. A discussion of the demand projections by each use type is presented in Sections 2.3.1 through 2.3.6.

Table 2-3
Total Projected Water Demand by County
-Values in Acre-Feet per Year-

County	2030	2040	2050	2060	2070	2080
Andrews	27,876	29,165	30,297	31,094	31,796	32,747
Borden	6,349	6,357	6,092	5,554	4,838	4,217
Brown	16,374	16,447	16,478	16,519	16,563	16,610
Coke	1,691	1,737	1,787	1,864	1,949	2,043
Coleman	2,673	2,528	2,390	2,284	2,176	2,056
Concho	6,664	6,641	6,621	6,601	6,584	6,568
Crane	4,966	5,253	5,516	5,736	5,349	5,525
Crockett	7,734	7,655	7,069	6,004	4,608	3,361
Ector	41,973	45,589	49,078	51,082	53,050	55,154
Glasscock	57,548	57,541	56,385	54,069	51,002	48,281
Howard	30,643	30,990	30,235	28,170	25,427	22,983
Irion	12,133	12,124	11,233	9,450	7,089	4,993
Kimble	3,697	3,661	3,638	3,635	3,632	3,631
Loving	12,050	12,049	12,049	12,049	12,049	12,049
Martin	50,468	50,525	49,216	46,499	42,888	39,700
Mason	6,571	6,581	6,600	6,602	6,604	6,606
McCulloch	5,129	5,054	4,987	4,946	4,906	4,868
Menard	4,113	4,088	4,066	4,062	4,056	4,051
Midland	69,922	73,967	76,995	77,735	77,843	78,487
Mitchell	22,900	22,918	22,903	22,863	22,805	22,758
Pecos	159,999	160,104	160,212	160,421	160,655	160,910
Reagan	42,446	42,467	40,825	37,523	33,147	29,268
Reeves	100,755	101,357	101,933	102,325	102,751	103,218
Runnels	5,748	5,733	5,717	5,712	5,707	5,703
Schleicher	6,521	6,446	6,082	5,436	4,594	3,837
Scurry	10,359	10,425	10,453	10,435	10,401	10,377
Sterling	4,593	4,738	4,672	4,410	4,006	3,707
Sutton	2,737	2,633	2,529	2,451	2,368	2,282
Tom Green	74,043	76,003	77,740	79,388	81,151	83,123
Upton	25,571	25,611	24,325	21,728	18,278	15,232
Ward	16,551	17,121	17,713	18,225	18,772	19,353
Winkler	18,949	19,944	20,960	21,813	22,615	23,357
Total	*859,746*	*873,452*	*876,796*	*866,685*	*849,659*	*837,055*

Source: Data are from the TWDB.[3]

Figure 2-6
Total Water Demands by County 2030-2080



2.2.1 Municipal Water Demand Projections

Municipal water demand consists of both residential and commercial use, including water used for landscape irrigation. Residential use includes water used in single and multi-family households. Commercial use includes business establishments, public spaces and institutions, but does not include most industrial water use. Industrial water demand projections are included in the manufacturing category.

Municipal projections were developed for each retail water provider that provided an average of 100 acre-feet per year or more of municipal water supplies. TWDB aggregates rural populations that use less than 100 acre-feet per year into the County Other classification. The municipal projections are the only projections developed for individual water providers such as cities and other retail water providers. TWDB aggregates all other demand categories by county and river basin.

TWDB used a four-step process to calculate municipal water demands. First, population projections were developed for each municipal WUG. (Population projections are discussed in Section 2.2). Second, per capita water use projections were developed based on historical water use. Third, estimates of water savings associated with implementation of plumbing fixtures were calculated and per capita use was adjusted. Finally, the adjusted per capita water demand projections were multiplied by the population projections to determine the annual municipal water demand for each WUG.

$$\textbf{\textit{Municipal Water Demand}}$$
$$= \textbf{\textit{projected population}} \times (\textbf{\textit{historical gpcd}} - \textbf{\textit{estimated water savings}})$$

Per Capita Water Use Projections

Future water use is calculated by multiplying the population of a region, county or city by a calculated per capita water use. Per capita water use, expressed in gallons per capita per day (gpcd), is the average daily municipal water use divided by the population of the area. It includes the amount of water used by each person in their daily activities, water used for commercial purposes, and landscape watering. This definition of per capita water use does not include water used for manufacturing or other non-municipal purposes (if it can be distinguished from other uses), or water sold to another entity. (This definition of per capita use is not the same as the definition adopted by the Water Conservation Implementation Task Force. The Task Force definition does not differentiate between municipal use and non-municipal use or outside sales.[4])

2011 was the worst single year drought for the State of Texas. The TWDB based the per capita water demand projections on year 2011 annual municipal water use divided by the 2011 population. In some cases, the per capita water use was adjusted if the year 2011 water use was not indicative of historical water use by a WUG. In Region F, some WUGs were under water use restrictions in 2011 and their per capita water use was adjusted based on use in other years. For some WUGs in Region F, the drought of 2011 caused water conservation-oriented behavior changes, resulting in a trend towards lower per capita usage. This trend is even greater than the expected plumbing code savings already incorporated into these plans. This is partially caused by the implementation of increasing rate structures by some providers to encourage water conservation. Thus, in some cases, the base per capita usage was lowered to reflect these changes.

The TWDB assumes that per capita water use will show a downward trend over the planning period as a result of the State Water-Efficiency Plumbing Act[5]. Among other things, the Plumbing Act requires that only water-saving plumbing fixtures be sold in Texas. The TWDB determined the per capita water demand savings based upon the expected rate of replacement of old plumbing fixtures with water-conserving models and the number of new housing units expected in the region. The actual amount of estimated savings can vary somewhat depending upon the age of housing units in a WUG's service area.

Table 2-4 shows the average per capita water use for each decade in Region F and compares these values to average values for the state. Average per capita water use for Region F is expected to decline from 165 gpcd in 2030 to 164 gpcd in 2080. This compares to the statewide average of 156 gpcd in 2030 declining to 151 gpcd by 2080.

Demand

The TWDB calculated the municipal water demand projections by multiplying the population projections by the per capita water use projections. As shown in Table 2-5, the total municipal water demand for Region F is expected to increase from 141,387 acre-feet per year in 2030 to 197,714 acre-feet per year in 2080, an increase of 40 percent over the planning period. This compares to an expected 48 percent increase in municipal demand statewide.

The total estimated water savings associated with the implementation of the State Water-Efficiency Plumbing Act by county is presented in Table 2-6. Water-saving plumbing fixtures are expected to save over 6,200 acre-feet per year by 2080.

Table 2-4
Comparison of Per Capita Water Use and Municipal Conservation Trends

Region F	2030	2040	2050	2060	2070	2080
Per Capita Use (gpcd)	165	164	164	164	164	164
Statewide	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Per Capita Use (gpcd)	156	154	153	152	151	151

Source: Data are from TWDB.[3]

Table 2-5
Municipal Water Demand Projections for Region F Counties
-Values in Acre-Feet per Year-

County	2030	2040	2050	2060	2070	2080
Andrews	5,317	6,584	8,043	9,516	11,120	12,868
Borden	241	249	265	289	319	358
Brown	6,704	6,760	6,774	6,797	6,822	6,850
Coke	703	749	799	876	961	1,055
Coleman	1,513	1,368	1,230	1,124	1,016	896
Concho	981	958	938	918	901	885
Crane	1,366	1,428	1,477	1,513	1,553	1,597
Crockett	1,061	981	898	839	778	714
Ector	30,413	34,002	37,635	39,953	42,346	44,823
Glasscock	123	114	110	101	92	82
Howard	7,951	8,153	8,276	8,112	7,932	7,737
Irion	168	159	156	150	144	136
Kimble	737	701	678	675	672	671
Loving	8	7	7	7	7	7
Martin	870	927	1,000	1,048	1,101	1,162
Mason	903	913	932	934	936	938
McCulloch	1,830	1,753	1,679	1,636	1,595	1,557
Menard	333	308	286	282	276	271
Midland	30,582	34,387	38,392	41,326	44,414	47,661
Mitchell	2,500	2,518	2,534	2,555	2,578	2,603
Pecos	5,323	5,419	5,518	5,717	5,941	6,186
Reagan	827	848	858	860	861	864
Reeves	5,390	5,990	6,564	6,954	7,378	7,843
Runnels	1,548	1,533	1,517	1,512	1,507	1,503
Schleicher	555	480	410	352	290	224
Scurry	2,426	2,485	2,530	2,555	2,581	2,608
Sterling	443	588	776	1,022	1,291	1,588
Sutton	1,169	1,065	961	883	800	714
Tom Green	21,788	23,719	25,508	27,290	29,239	31,371
Upton	1,053	1,088	1,118	1,158	1,203	1,256
Ward	3,935	4,443	4,985	5,458	5,975	6,537
Winkler	2,626	2,954	3,259	3,530	3,826	4,149
Total	*141,387*	*153,631*	*166,113*	*175,942*	*186,455*	*197,714*

Source: Data are from the TWDB.[3]

Table 2-6
Expected Savings from Implementation of Plumbing Code for Region F Counties
-Values in Acre-Feet per Year-

County	2030	2040	2050	2060	2070	2080
Andrews	112	159	197	235	276	321
Borden	3	3	3	3	3	3
Brown	189	250	250	251	252	253
Coke	19	22	24	26	29	31
Coleman	39	40	36	33	29	26
Concho	21	23	22	22	21	20
Crane	25	31	34	36	38	40
Crockett	15	16	15	14	13	12
Ector	931	1,180	1,293	1,372	1,455	1,542
Glasscock	5	6	6	5	5	4
Howard	195	227	230	225	220	215
Irion	8	8	8	8	7	7
Kimble	23	24	23	23	23	22
Loving	0	1	1	1	1	1
Martin	28	33	36	37	38	40
Mason	21	23	23	23	23	23
McCulloch	41	44	42	41	39	38
Menard	10	10	9	9	9	9
Midland	1,037	1,264	1,409	1,518	1,633	1,755
Mitchell	58	65	67	67	68	69
Pecos	82	97	99	101	103	105
Reagan	18	22	22	22	22	22
Reeves	82	104	113	119	126	134
Runnels	53	59	58	58	58	57
Schleicher	11	11	9	8	6	5
Scurry	93	109	111	112	113	114
Sterling	9	12	16	21	26	32
Sutton	17	17	15	14	13	11
Tom Green	707	870	937	1,003	1,076	1,155
Upton	18	21	22	22	23	23
Ward	66	85	95	104	114	125
Winkler	43	56	61	66	72	78
Total	*3,981*	*4,893*	*5,285*	*5,599*	*5,934*	*6,291*

Source: Data are from the TWDB.[3]

2.2.2 Manufacturing Demand Projections

Manufacturing use is the water used by industries in producing various products. In Region F, much of the manufacturing water use is associated with the generation of products from sand and gravel operations and the energy industry. Manufacturing demands for 2030 are estimated by the TWDB based on highest historical reported use from 2015 to 2019 and employment growth data over the last ten years. For each planning decade after 2030, a statewide manufacturing growth rate of 0.37 percent was applied.

Manufacturing water demand accounts for only two percent of the region's total water use and is concentrated in a few counties. Total manufacturing water use is expected to slightly increase from about 14,300 acre-feet in 2030 to about 17,100 acre-feet by 2080, an increase of about 20 percent (see Table 2-7). Ector, Howard, Midland, and Tom Green Counties are expected to have the largest manufacturing demands for the region.

Table 2-7
Manufacturing Water Demand Projections for Region F Counties
-Values in Acre-Feet per Year-

County	2030	2040	2050	2060	2070	2080
Andrews	596	618	641	665	690	716
Borden	0	0	0	0	0	0
Brown	454	471	488	506	525	544
Coke	0	0	0	0	0	0
Coleman	1	1	1	1	1	1
Concho	0	0	0	0	0	0
Crane	469	486	504	523	542	562
Crockett	36	37	38	39	40	41
Ector	719	746	774	803	833	864
Glasscock	42	44	46	48	50	52
Howard	3,916	4,061	4,211	4,367	4,529	4,697
Irion	7	7	7	7	7	7
Kimble	50	50	50	50	50	50
Loving	0	0	0	0	0	0
Martin	0	0	0	0	0	0
Mason	0	0	0	0	0	0
McCulloch	0	0	0	0	0	0
Menard	0	0	0	0	0	0
Midland	6,462	6,701	6,949	7,206	7,473	7,750
Mitchell	4	4	4	4	4	4
Pecos	243	252	261	271	281	291
Reagan	0	0	0	0	0	0
Reeves	45	47	49	51	53	55
Runnels	4	4	4	4	4	4
Schleicher	0	0	0	0	0	0
Scurry	199	206	214	222	230	239
Sterling	0	0	0	0	0	0
Sutton	3	3	3	3	3	3
Tom Green	791	820	850	881	914	948
Upton	128	133	138	143	148	153

County	2030	2040	2050	2060	2070	2080
Ward	0	0	0	0	0	0
Winkler	107	111	115	119	123	128
Total	*14,276*	*14,802*	*15,347*	*15,913*	*16,500*	*17,109*

Source: Data are from the TWDB.[3]

2.2.3 Irrigation Demand Projections

Irrigation use for agriculture is the largest user of water in Region F. Irrigation use can vary substantially from year to year depending on the number of irrigated acres, weather, crop prices, government programs, and other factors.

The irrigation projections proposed for Region F by the TWDB for 2026 were based on a five-year average (2015-2019) of the historical TWDB annual irrigation water use estimates. Region F modified the irrigation demands to be annual average from the past ten years (2010-2019). This period includes years with lower annual rainfall, which are important to consider when estimating future dry year water demands for Regional Water Planning. Table 2-8 summarizes the irrigation demands for the region for each decade and compares these to statewide totals. Table 2-9 shows the irrigation water demands by county in Region F.

In 2080, irrigation is expected to still be a major water use and could be as much as 55 percent of the region's total water demand. The counties with the largest irrigation water use are Andrews, Glasscock, Martin, Midland, Pecos, Reagan, Reeves, and Tom Green. These counties are expected to account for 83 percent of the region's irrigation demand in 2080. Pecos County alone is expected to have 30 percent of the regional irrigation demand.

Table 2-8
Comparison of Region F Irrigation Demand Projections to Statewide Projections

Region F	2030	2040	2050	2060	2070	2080
Irrigation (ac-ft)	460,341	460,341	460,341	460,341	460,341	460,341
Statewide	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Irrigation (ac-ft)	8,375,529	8,001,557	7,313,180	6,642,983	6,384,027	6,187,571
Decline from Year 2030	0	373,972	1,062,349	1,732,546	1,991,502	2,187,958
% Decline	0%	4%	13%	21%	24%	26%

Source: Data are from the TWDB.[3]

Irrigation Water Demand

Irrigation is the largest category of water use in Region F, accounting for over 475,000 acre-feet per year of water demand, which represents over 60 percent of the water demand for the Region. It accounts for over 475,000 acre-feet of water demand. Most of this demand is centered in Andrews, Glasscock, Martin, Midland, Pecos, Reagan, Reeves, and Tom Green counties.

Table 2-9
Irrigation Water Demand Projections for Region F Counties
-Values in Acre-Feet per Year-

County	2030	2040	2050	2060	2070	2080
Andrews	17,563	17,563	17,563	17,563	17,563	17,563
Borden	2495	2495	2495	2495	2495	2495
Brown	7,684	7,684	7,684	7,684	7,684	7,684
Coke	617	617	617	617	617	617
Coleman	418	418	418	418	418	418
Concho	5,204	5,204	5,204	5,204	5,204	5,204
Crane	0	0	0	0	0	0
Crockett	77	77	77	77	77	77
Ector	751	751	751	751	751	751
Glasscock	43,413	43,413	43,413	43,413	43,413	43,413
Howard	5,096	5,096	5,096	5,096	5,096	5,096
Irion	1,054	1,054	1,054	1,054	1,054	1,054
Kimble	2,602	2,602	2,602	2,602	2,602	2,602
Loving	0	0	0	0	0	0
Martin	32,933	32,933	32,933	32,933	32,933	32,933
Mason	4,804	4,804	4,804	4,804	4,804	4,804
McCulloch	2,074	2,074	2,074	2,074	2,074	2,074
Menard	3,465	3,465	3,465	3,465	3,465	3,465
Midland	17,995	17,995	17,995	17,995	17,995	17,995
Mitchell	12,985	12,985	12,985	12,985	12,985	12,985
Pecos	137,672	137,672	137,672	137,672	137,672	137,672
Reagan	21,502	21,502	21,502	21,502	21,502	21,502
Reeves	60,025	60,025	60,025	60,025	60,025	60,025
Runnels	3,517	3,517	3,517	3,517	3,517	3,517
Schleicher	2,015	2,015	2,015	2,015	2,015	2,015
Scurry	6,983	6,983	6,983	6,983	6,983	6,983
Sterling	855	855	855	855	855	855
Sutton	1,123	1,123	1,123	1,123	1,123	1,123
Tom Green	49,600	49,600	49,600	49,600	49,600	49,600
Upton	8,418	8,418	8,418	8,418	8,418	8,418
Ward	4,333	4,333	4,333	4,333	4,333	4,333
Winkler	3,068	3,068	3,068	3,068	3,068	3,068
Total	*460,341*	*460,341*	*460,341*	*460,341*	*460,341*	*460,341*

Source: Data are from the TWDB.[3]

2.2.4 Steam Electric Power Demand Projections

Steam Electric Power demands represent water used for all types of power generation, including other technologies such as combined cycle combustion. The demands are based on the highest use in the five year period from 2015-2019 plus specific projected facilities. In Region F, the RWPG revised the Mitchell County demand to reflect the retired steam generation units at the Morgan Creek Power Plant that were operating during a portion of the historic period used to set the demands.

Table 2-10
Steam Electric Water Demand Projections for Region F Counties
-Values in Acre-Feet per Year-

County	2030	2040	2050	2060	2070	2080
Andrews	0	0	0	0	0	0
Borden	0	0	0	0	0	0
Brown	0	0	0	0	0	0
Coke	0	0	0	0	0	0
Coleman	0	0	0	0	0	0
Concho	0	0	0	0	0	0
Crane	0	0	0	0	0	0
Crockett	0	0	0	0	0	0
Ector	7,889	7,889	7,889	7,889	7,889	7,889
Glasscock	0	0	0	0	0	0
Howard	1,141	1,141	1,141	1,141	1,141	1,141
Irion	0	0	0	0	0	0
Kimble	0	0	0	0	0	0
Loving	0	0	0	0	0	0
Martin	0	0	0	0	0	0
Mason	0	0	0	0	0	0
McCulloch	0	0	0	0	0	0
Menard	0	0	0	0	0	0
Midland	0	0	0	0	0	0
Mitchell	6,725	6,725	6,725	6,725	6,725	6,725
Pecos	0	0	0	0	0	0
Reagan	0	0	0	0	0	0
Reeves	0	0	0	0	0	0
Runnels	0	0	0	0	0	0
Schleicher	0	0	0	0	0	0
Scurry	0	0	0	0	0	0
Sterling	0	0	0	0	0	0
Sutton	0	0	0	0	0	0
Tom Green	0	0	0	0	0	0
Upton	0	0	0	0	0	0
Ward	43	43	43	43	43	43
Winkler	0	0	0	0	0	0
Total	*15,798*	*15,798*	*15,798*	*15,798*	*15,798*	*15,798*

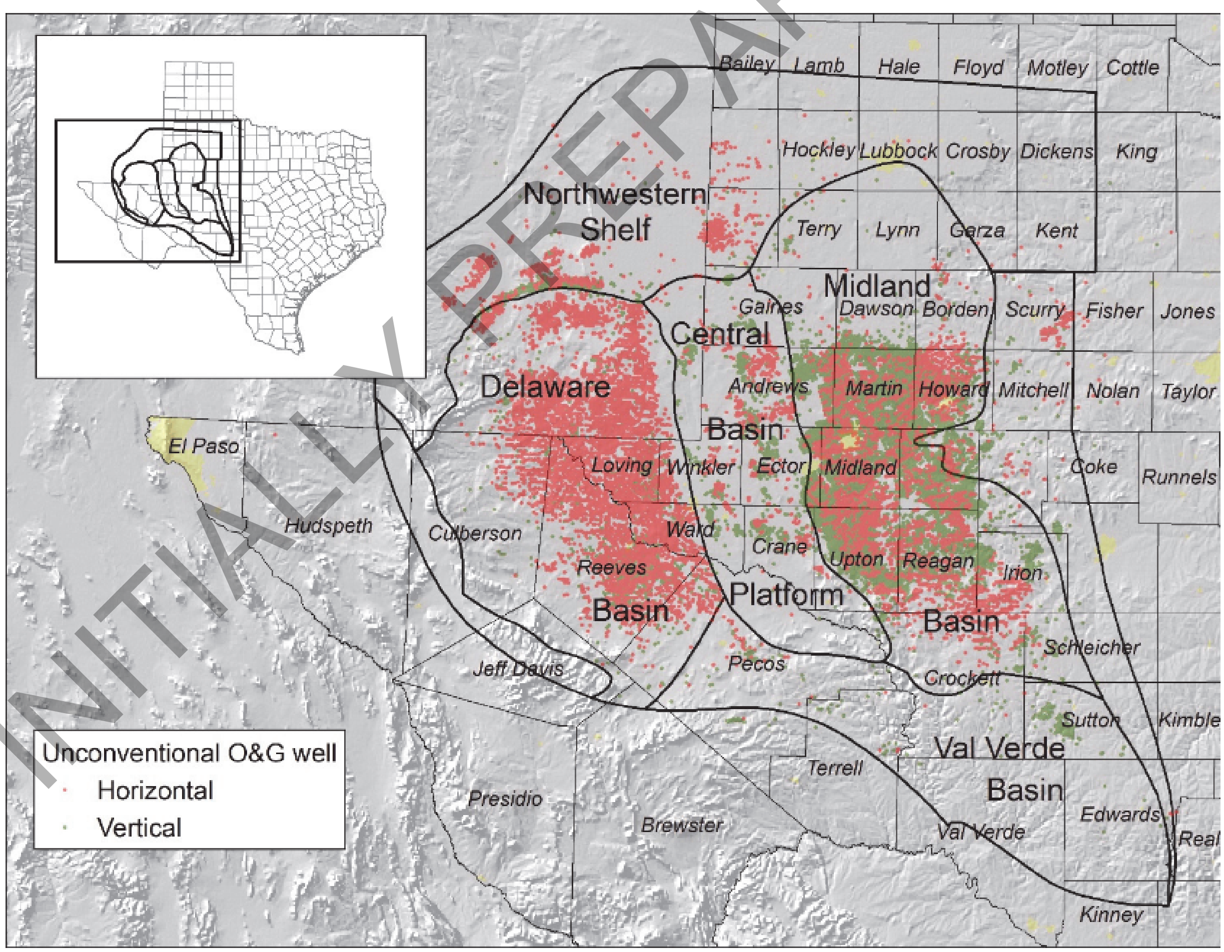
Source: Data are from the TWDB.[3]

2.2.5 Mining Demand Projections

The mining category includes water used in both the production of minerals and the production of oil and gas. (Water used in the processing of minerals or oil and gas into a finished product is considered under the manufacturing use category.) The TWDB mining water demand projections are based on a 2022 study conducted by the Bureau of Economic Geology (BEG) Report[6]. The BEG based its projections on the technically recoverable resources (TRR) measured in the number of wells, the estimated volume of water used per well, and then the number of wells to be drilled per year based on the 2018 to 2019 rate.

Region F lies in the heart of the Permian Basin, which is one of the largest oil and gas shale formations in the country. The Delaware and Midland sub-basins are major oil and gas demand centers in Region F and the state as a whole. Figure 2-7 shows the unconventional oil and gas wells completed from 2005 to 2020 from the BEG report. Based on the initial TWDB projections, the Midland Basin TRR was projected to be exhausted starting in the 2070 decade. This assumed a constant development rate from 2030 to 2060. Region F revised the mining demands to decline more gradually starting in 2040 through 2080 but did not exceed the total TRR projection from the BEG study. The Delaware basin is projected to continue to have development throughout the entire region. The BEG estimate of TRR is based on current technology and may change over time as new mining methods are developed, which could serve to increase the TRR and associated mining demands. This should be monitored and updated as part of future plans.

Figure 2-7: Permian Basin Locations of Unconventional Oil and Gas Wells



Source: Bureau of Economic Geology[6]. Data show unconventional oil and gas wells completed from 2005-2020

Other mining activities, such as sand, gravel and stone production, represent a small portion of the region's economy and water demands.

The mining demands for Region F are projected to be 216,716 acre-feet in 2030 (nearly double the 2030 projection in the 2021 plan), and then decrease to a still substantial amount of 134,865 acre-feet in 2080. This water use represents about 25 percent of the total water demand in Region F in 2030, reducing to 16 percent in 2080. Table 2-11 compares Region F's mining projections to statewide projections. A summary of the projected mining demands by county is presented in Table 2-12.

Table 2-11
Comparison of Region F Mining Projections to Statewide Totals

Region F	2030	2040	2050	2060	2070	2080
Mining (ac-ft)	216,716	217,652	207,969	187,463	159,337	134,865
Change from Year 2030	0	936	-8,747	-29,253	-57,379	-81,851
% Change	0%	0%	-4%	-13%	-26%	-38%
Statewide	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Mining (ac-ft)	410,204	415,411	410,611	398,520	372,722	295,557
Change from Year 2030	0	5,207	407	-11,684	-37,482	-114,647
% Change	0%	2%	0%	-5%	-17%	-53%

Source: Data are from the TWDB.[3]

Table 2-12
Mining Water Demand Projections for Region F Counties
-Values in Acre-Feet per Year-

County	2030	2040	2050	2060	2070	2080
Andrews	4,200	4,200	3,850	3,150	2,223	1,400
Borden	3,374	3,374	3,093	2,531	1,785	1,125
Brown	560	560	560	560	560	560
Coke	106	106	106	106	106	106
Coleman	0	0	0	0	0	0
Concho	0	0	0	0	0	0
Crane	3,071	3,279	3,475	3,640	3,194	3,306
Crockett	6,046	6,046	5,542	4,535	3,199	2,015
Ector	2,061	2,061	1,889	1,546	1,091	687
Glasscock	13,854	13,854	12,700	10,391	7,331	4,618
Howard	12,340	12,340	11,312	9,255	6,530	4,113
Irion	10,662	10,662	9,774	7,997	5,642	3,554
Kimble	1	1	1	1	1	1
Loving	12,002	12,002	12,002	12,002	12,002	12,002
Martin	16,590	16,590	15,208	12,443	8,779	5,530
Mason	176	176	176	176	176	176
McCulloch	673	675	682	684	685	685
Menard	0	0	0	0	0	0
Midland	14,703	14,704	13,479	11,028	7,781	4,901
Mitchell	368	368	337	276	195	123
Pecos	16,152	16,152	16,152	16,152	16,152	16,152
Reagan	19,823	19,823	18,171	14,867	10,490	6,608
Reeves	34,986	34,986	34,986	34,986	34,986	34,986
Runnels	0	0	0	0	0	0
Schleicher	3,529	3,529	3,235	2,647	1,867	1,176
Scurry	306	306	281	230	162	102
Sterling	3,047	3,047	2,793	2,285	1,612	1,016
Sutton	27	27	27	27	27	27
Tom Green	990	990	908	743	524	330
Upton	15,851	15,851	14,530	11,888	8,388	5,284
Ward	8,170	8,232	8,282	8,321	8,351	8,370
Winkler	13,048	13,711	14,418	14,996	15,498	15,912
Total	*216,716*	*217,652*	*207,969*	*187,463*	*159,337*	*134,865*

Source: Data are from the TWDB.[3]

2.2.6 Livestock Watering

Livestock watering accounts for about 1 percent of the projected demand in Region F in 2030 and is predicted to remain the same. The livestock projections are based on the water needs per head for each type of livestock and each type of livestock operation. The number of head in each county was estimated from information provided by the Texas Department of Agriculture and the National Agricultural Statistics Service. TWDB used the average of the 2015-2019 water use estimates as a base. Projections are only available for counties and are not available for specific livestock operations.

Livestock demand in Region F is expected to remain constant at 11,228 acre-feet per year throughout the planning period (see Table 2-13).

Table 2-13
Livestock Water Demand Projections for Region F Counties
-Values in Acre-Feet per Year-

County	2030	2040	2050	2060	2070	2080
Andrews	200	200	200	200	200	200
Borden	239	239	239	239	239	239
Brown	972	972	972	972	972	972
Coke	265	265	265	265	265	265
Coleman	741	741	741	741	741	741
Concho	479	479	479	479	479	479
Crane	60	60	60	60	60	60
Crockett	514	514	514	514	514	514
Ector	140	140	140	140	140	140
Glasscock	116	116	116	116	116	116
Howard	199	199	199	199	199	199
Irion	242	242	242	242	242	242
Kimble	307	307	307	307	307	307
Loving	40	40	40	40	40	40
Martin	75	75	75	75	75	75
Mason	688	688	688	688	688	688
McCulloch	552	552	552	552	552	552
Menard	315	315	315	315	315	315
Midland	180	180	180	180	180	180
Mitchell	318	318	318	318	318	318
Pecos	609	609	609	609	609	609
Reagan	294	294	294	294	294	294
Reeves	309	309	309	309	309	309
Runnels	679	679	679	679	679	679
Schleicher	422	422	422	422	422	422
Scurry	445	445	445	445	445	445
Sterling	248	248	248	248	248	248
Sutton	415	415	415	415	415	415
Tom Green	874	874	874	874	874	874
Upton	121	121	121	121	121	121
Ward	70	70	70	70	70	70
Winkler	100	100	100	100	100	100
Total	*11,228*	*11,228*	*11,228*	*11,228*	*11,228*	*11,228*

Source: Data are from the TWDB.[3]

2.3 Major Water Providers

As part of the development of the 2026 Regional Water Plan, demands were identified for major water providers (MWPs) in Region F. An MWP is defined by the TWDB as a water user group or a wholesale water provider of particular significance to the region's water supply, as determined by the RWPG. The major water providers in Region F are the Colorado River Municipal Water District (CRMWD), the Brown County Water Improvement District Number 1 (BCWID), and the cities of Odessa, Midland, and San Angelo. The sections below contain descriptions of the identified demands and the associated volumes for each Region F MWP. Attachment 2A contains projected water demands for each of these MWPs broken down by category of use for each decade.

2.3.1 Colorado River Municipal Water District

The Colorado Municipal Water District (CRMWD) provides wholesale raw water supplies to multiple member cities and customers. CRMWD's operations and contractual obligations are challenging to represent under the existing regional planning framework required by TWDB rule. For planning purposes, the demands on CRMWD are described as two separate systems: the Lake Ivie Non-System Demands and the CRMWD System demands.

The Lake Ivie Non-System Demands represent contractual demands from Midland, San Angelo, and Abilene for a percentage of the yield of Lake Ivie and an 1,100-acre-foot reservoir contract with Millersview-Doole WSC. These users can only be supplied by Lake Ivie and CRMWD would not provide them other water supplies if supply from Lake Ivie is inadequate. Table 2-14 shows the projected water demands CRMWD's Lake Ivie Non-System customers.

Table 2-14
Lake Ivie Non-System Demands for the Colorado River Municipal Water District
-Values in Acre-Feet per Year-

WUG Name	County(ies)	Basin	2030	2040	2050	2060	2070	2080
Abilene	Jones, Taylor	Brazos	4,721	4,588	4,456	4,324	4,191	4,059
San Angelo	Tom Green	Colorado	4,721	4,588	4,456	4,324	4,191	4,059
Midland	Midland	Colorado	4,721	4,588	4,456	4,324	4,191	4,059
Millersview-Doole WSC[a]	Concho, McCulloch, Runnels, Tom Green	Colorado	600	600	600	600	600	600
Ballinger	Runnels	Colorado	500	500	500	500	500	500
Ivie System Total			***15,263***	***14,864***	***14,468***	***14,072***	***13,673***	***13,277***

[a] Millersview-Doole WSC contract expires in October 2041.

CRMWD's System demands include both its member cities and others through various contracts. CRMWD operates its main system conjunctively using multiple groundwater, surface water, and reuse sources as needed. CRMWD provides all the water used by its member cities: Odessa, Big Spring and Snyder. The remaining municipal contract holders rely entirely on CRMWD for water. Manufacturing water is provided through municipal users. Table 2-15 shows the projected water demands for current CRMWD system customers. Potential future customers are discussed in Chapter 5D.

Table 2-15
Expected Main System Demands for the Colorado River Municipal Water District
-Values in Acre-Feet per Year-

WUG Name	County(ies)	Basin	2030	2040	2050	2060	2070	2080
Odessa	Ector	Colorado	21,766	24,868	28,681	30,457	32,216	33,964
Odessa	Midland	Colorado	1,072	1,636	2,310	2,777	3,261	3,757
Ector County UD	Ector	Colorado	3,277	3,929	4,535	4,975	5,433	5,908
Greater Gardendal WSC	Ector	Colorado	61	140	315	341	368	396
Greater Gardendal WSC	Midland	Colorado	38	93	219	245	270	297
Manufacturing	Ector	Colorado	350	350	350	350	350	350
Irrigation	Ector	Colorado	403	403	403	403	403	403
Irrigation	Midland	Colorado	817	817	817	817	817	817
Steam Electric Power	Ector	Colorado	2,242	2,242	2,242	2,242	2,242	2,242
Big Spring	Howard	Colorado	6,566	6,728	6,826	6,697	6,556	6,402
Coahoma	Howard	Colorado	362	374	381	372	361	351
Manufacturing	Howard	Colorado	1,500	1,500	1,500	1,500	1,500	1,500
Steam Electric Power	Howard	Colorado	858	858	858	858	858	858
Snyder	Scurry	Colorado	1,709	1,738	1,765	1,784	1,804	1,825
County-Other, Scurry	Scurry	Colorado	90	90	90	90	90	90
Rotan	Fisher	Brazos	258	248	241	238	234	230
U and F WSC	Scurry	Colorado	5	5	5	5	5	5
Midland[a]	Midland	Colorado	11,200	11,200	11,200	11,200	11,200	11,200
Stanton[b]	Martin	Colorado	307	307	307	307	307	307
Irrigation	Ector	Colorado	400	400	400	400	400	400
Grandfalls	Ward	Rio Grande	225	255	287	315	344	377
CRMWD Total System Demand			***53,506***	***58,181***	***63,732***	***66,373***	***69,019***	***71,679***
Additional Supply for Odessa (Losses)			0	3,930	3,930	3,930	3,930	3,930
Ector County - Other (ECUD Expanded Service Area, Sales from Odessa)			0	1,200	2,500	2,500	2,500	2,500
Other Potential Future Customers			43	224	338	556	910	1,323
CRMWD Potential Future Demand			***43***	***5,354***	***6,768***	***6,986***	***7,340***	***7,753***
CRMWD Total (Current and Potential Future)			***53,549***	***63,535***	***70,500***	***73,359***	***76,359***	***79,432***

a. Midland 1966 contract expires in December 2029, will continue for 3 months into 2030 but per CRMWD contract renewal is assumed at 10 MGD starting in 2030

b. Contract expires in 2029, assuming renewal for rest of planning period.

2.3.2 Brown County Water Improvement District No. 1

BCWID provides both raw and treated water for municipal, manufacturing, and irrigation purposes. Most BCWID customers are in Brown County. BCWID provides treated water to the Cities of Brownwood, Bangs, and Early and to Brookesmith SUD and Zephyr WSC. BCWID provides water to the City of Santa Anna in Coleman County, Coleman County SUD, and to users in Coleman and Mills Counties through Brookesmith SUD. Coleman County SUD has customers in Coleman, Brown, Runnels, Callahan and Taylor Counties. For the purposes of this plan, it is assumed that 90 percent of the demand for Coleman County SUD will be met by supplies from BCWID. BCWID also currently provides raw water to industries and irrigation. The demands in Table 2-16 are for current BCWID customers.

Table 2-16
Expected Demands for the Brown County Water Improvement District No. 1
-Values in Acre-Feet per Year-

WUG Name	County(ies)	Basin	2030	2040	2050	2060	2070	2080
Bangs	Brown	Colorado	346	347	348	349	350	351
Brookesmith SUD	Brown	Colorado	1,227	1,244	1,247	1,252	1,257	1,262
Brookesmith SUD	Coleman	Colorado	5	4	3	2	2	1
Santa Anna	Coleman	Colorado	128	123	119	116	115	115
Coleman County SUD	Brown	Colorado	30	30	31	31	31	31
Coleman County SUD	Coleman	Colorado	586	551	520	498	477	455
Coleman County SUD	Runnels	Colorado	22	21	18	16	14	13
Coleman County SUD	Callahan	Colorado	40	41	43	45	47	49
Coleman County SUD	Taylor	Colorado	40	41	41	41	41	41
Brownwood	Brown	Colorado	3,827	3,854	3,862	3,875	3,889	3,906
Manufacturing	Brown	Colorado	454	471	488	506	525	544
Early	Brown	Colorado	454	455	455	457	459	460
Zephyr WSC	Brown	Colorado	572	580	581	582	584	587
Mining	Brown	Colorado	560	560	560	560	560	560
Irrigation	Brown	Colorado	6,000	6,000	6,000	6,000	6,000	6,000
		BCWID Total	***14,291***	***14,322***	***14,316***	***14,330***	***14,351***	***14,375***

2.3.3 City of Odessa

Table 2-17 shows the expected demands for the City of Odessa. The City of Odessa is a CRMWD member city. Odessa sells treated water to the Ector County Utility District, Ector County-Other, and manufacturing and steam electric power in Ector County. A portion of the City's wastewater is sold to the Gulf Coast Water Authority (GCA) who treats the effluent and sells the supply to the mining industry. The remainder of the City of Odessa's effluent is treated by the City and sold to Pioneer Natural Resources (manufacturing). The City also provides water for manufacturing in Ector County, which is supplied by raw water. Odessa also provides raw water to irrigation customers in Ector and Midland counties. Potential future customers are discussed in Chapter 5D.

Table 2-17
Expected Demands for the City of Odessa
-Values in Acre-Feet per Year-

WUG Name	County(ies)	Basin	2030	2040	2050	2060	2070	2080
Odessa	Ector	Colorado	21,766	24,868	28,681	30,457	32,216	33,964
Odessa	Midland	Colorado	1,072	1,636	2,310	2,777	3,261	3,757
Ector County UD	Ector	Colorado	3,277	3,929	4,535	4,975	5,433	5,908
Greater Gardendale WSC	Ector	Colorado	61	140	315	341	368	396
Greater Gardendale WSC	Midland	Colorado	38	93	219	245	270	297
Manufacturing	Ector	Colorado	200	200	200	200	200	200
Steam Electric Power	Ector	Colorado	2,242	2,242	2,242	2,242	2,242	2,242
Subtotal Treated Water Demand			*28,656*	*33,108*	*38,502*	*41,237*	*43,990*	*46,764*
Manufacturing (Reuse, Odessa/Pioneer Meter Station)	Ector	Colorado	6,727	6,727	6,727	6,727	6,727	6,727
Mining (Reuse, Gulf Coast Authority)	Ector	Colorado	2,803	2,803	2,803	2,803	2,803	2,803
Subtotal Reuse Demand			*9,530*	*9,530*	*9,530*	*9,530*	*9,530*	*9,530*
Manufacturing	Ector	Colorado	150	150	150	150	150	150
Irrigation	Ector	Colorado	403	403	403	403	403	403
Irrigation	Midland	Colorado	817	817	817	817	817	817
Subtotal Raw Demand			*1,370*	*1,370*	*1,370*	*1,370*	*1,370*	*1,370*
Ector County - Other (ECUD Expanded Service Area)			0	1,200	2,500	2,500	2,500	2,500
Additional Supply for Odessa (Losses)			0	3,930	3,930	3,930	3,930	3,930
Total Future Potable Demand			*0*	*5,130*	*6,430*	*6,430*	*6,430*	*6,430*
City of Odessa Total Current Demand			***39,556***	***49,138***	***55,832***	***58,567***	***61,320***	***64,094***

2.3.4 City of Midland

The City of Midland is the largest city in Region F. It provides retail water service to over 145,000 people, and small quantities of water to manufacturing within the city limits. The City has experienced rapid growth within its service area in recent years, primarily due to increased oil and gas activities within the Permian Basin. The City is also home to many workers that commute from other areas of the State during the work week. While these workers are not considered in Midland's permanent population estimate, they do contribute to the water demands on the City. Recent reports indicate the oil and gas activities will continue in the Permian Basin for several decades, contributing to the expected growth of the City and its water demands. Midland also has a contract to sell treated effluent to Pioneer Resources for mining use. The contract is for up to 15 MGD, but actual wastewater discharges average 10 MGD. As shown in Table 2-18, the expected demands on Midland are 34,386 acre-feet per year in 2030 and increase to 49,306 acre-feet year by 2080.

Table 2-18
Expected Demands for the City of Midland
-Values in Acre-Feet per Year-

WUG Name	County(ies)	Basin	2030	2040	2050	2060	2070	2080
Midland	Midland	Colorado	23,104	25,190	27,583	30,595	34,050	38,024
Manufacturing	Midland	Colorado	72	72	72	72	72	72
Subtotal Treated Water Demand			*23,176*	*25,262*	*27,655*	*30,667*	*34,122*	*38,096*
Mining	Midland	Colorado	2,803	2,803	2,803	2,803	2,803	2,803
Mining	Martin	Colorado	2,803	2,803	2,803	2,803	2,803	2,803
Mining	Reagan	Colorado	2,803	2,803	2,803	2,803	2,803	2,803
Mining	Upton	Colorado	2,801	2,801	2,801	2,801	2,801	2,801
Subtotal Reuse Demand			*11,210*	*11,210*	*11,210*	*11,210*	*11,210*	*11,210*
City of Midland Total			***34,386***	***36,472***	***38,865***	***41,877***	***45,332***	***49,306***

2.3.5 City of San Angelo

Table 2-19 shows the expected demands for current customers of the City of San Angelo. The City provides water to the Upper Colorado River Authority (UCRA) in exchange for UCRA's O.C. Fisher water rights. UCRA then sells to several entities outside of the City. The City also provides water to the Goodfellow Air Force Base located in San Angelo and about half of the water used for manufacturing in Tom Green County. In the near term, San Angelo supplies reuse to Irrigation in Tom Green County. This is anticipated to cease after 2030 when the City plans to repurpose their supplies for municipal use.

Table 2-19
Expected Demands for the City of San Angelo
-Values in Acre-Feet per Year-

WUG Name	County(ies)	Basin	2030	2040	2050	2060	2070	2080
San Angelo	Tom Green	Colorado	17,593	18,903	20,114	21,305	22,606	24,026
UCRA			500	500	500	500	500	500
Goodfellow Air Force Base	Tom Green	Colorado	469	467	467	467	467	467
Manufacturing	Tom Green	Colorado	396	410	425	441	457	474
City of San Angelo Treated Total			***18,958***	***20,280***	***21,506***	***22,713***	***24,030***	***25,467***
Irrigation (Reuse)			***8,300***	***0***	***0***	***0***	***0***	***0***
City of San Angelo Total			**27,258**	**20,280**	**21,506**	**22,713**	**24,030**	**25,467**

ATTACHMENT 2A

WATER DEMANDS BY DECADE AND CATEGORY OF USE FOR MAJOR WATER PROVIDERS

Major Water Provider Demands by Category of Use in Each Decade
(acre-feet per year)

Major Water Provider	Category of Use	2030	2040	2050	2060	2070	2080
BCWID #1	Irrigation	6,000	6,000	6,000	6,000	6,000	6,000
	Livestock	0	0	0	0	0	0
	Manufacturing	454	471	488	506	525	544
	Mining	560	560	560	560	560	560
	Municipal	7,277	7,291	7,268	7,264	7,266	7,271
	Steam Electric Power	0	0	0	0	0	0
	Total	**14,291**	**14,322**	**14,316**	**14,330**	**14,351**	**14,375**
CRMWD[a]	Irrigation	1,620	1,620	1,620	1,620	1,620	1,620
	Livestock	0	0	0	0	0	0
	Manufacturing	1,850	1,850	1,850	1,850	1,850	1,850
	Mining	0	0	0	0	0	0
	Municipal	62,242	71,829	78,398	80,861	83,462	86,139
	Steam Electric Power	3,100	3,100	3,100	3,100	3,100	3,100
	Total	**68,812**	**78,399**	**84,968**	**87,431**	**90,032**	**92,709**
Midland	Irrigation	0	0	0	0	0	0
	Livestock	0	0	0	0	0	0
	Manufacturing	72	72	72	72	72	72
	Mining	11,210	11,210	11,210	11,210	11,210	11,210
	Municipal	23,104	25,190	27,583	30,595	34,050	38,024
	Steam Electric Power	0	0	0	0	0	0
	Total	**34,386**	**36,472**	**38,865**	**41,877**	**45,332**	**49,306**
Odessa[a]	Irrigation	1,220	1,220	1,220	1,220	1,220	1,220
	Livestock	0	0	0	0	0	0
	Manufacturing	7,077	7,077	7,077	7,077	7,077	7,077
	Mining	2,803	2,803	2,803	2,803	2,803	2,803
	Municipal	26,214	35,796	42,490	45,225	47,978	50,752
	Steam Electric Power	2,242	2,242	2,242	2,242	2,242	2,242
	Total	**39,556**	**49,138**	**55,832**	**58,567**	**61,320**	**64,094**
San Angelo	Irrigation	8,300	0	0	0	0	0
	Livestock	0	0	0	0	0	0
	Manufacturing	396	410	425	441	457	474
	Mining	0	0	0	0	0	0
	Municipal	18,562	19,870	21,081	22,272	23,573	24,993
	Steam Electric Power	0	0	0	0	0	0
	Total	**27,258**	**20,280**	**21,506**	**22,713**	**24,030**	**25,467**

[a] Includes potential future demands

LIST OF REFERENCES

[1] Texas Water Development Board. *2026 Regional Water Plan Water Demand Projections,* November, 2023. <http://www.twdb.texas.gov >.

[2] Texas Water Development Board. *Historical Water Use Estimates,* August, 2024. <https://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/>

[3] Texas Water Development Board. DB27 database, 2024.

[4] Texas Water Development Board. *Water Conservation Implementation Task Force Report to the 79th Legislature*, November 2004.

[5] Texas Health and Safety Code. *Water Saving Performance Standards*, Title 5, Subtitle B § 372.002, 2014.

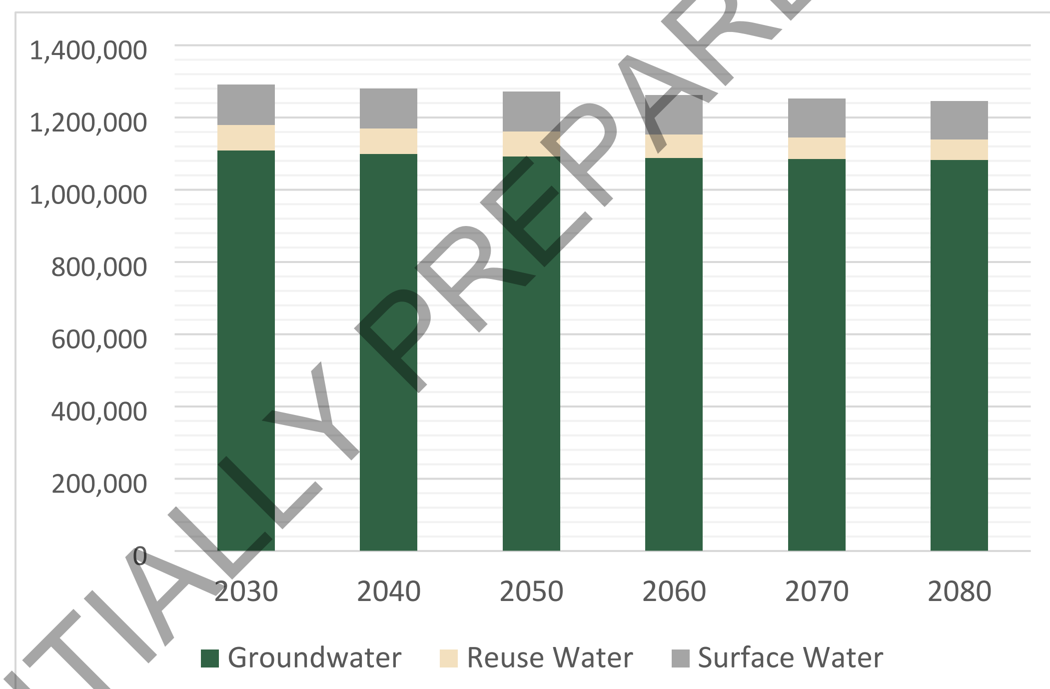
[6] Bureau of Economic Geology. *Water Use by the Mining Industry in Texas Final Report,* August 2022.

3 WATER SUPPLY ANALYSIS

In Region F, water comes from surface water sources such as run-of-the-river supplies and reservoirs, groundwater from individual wells or well fields, and reuse. Figure 3-1 shows that Region F has approximately 1.3 million acre-feet per year of water that is available for use. It includes all developed surface water and reuse supplies and both developed and undeveloped groundwater supplies. Groundwater is the largest source of water supply available in Region F, accounting for 86 percent of the total water available. Surface water supplies in Figure 3-1 total approximately 111,000 acre-feet in 2030. These supplies are lower than historical use, which is partly due to the on-going drought and partly due to the assumptions inherent in the Colorado River Basin Water Availability Model (WAM) (see Section 3.2). In addition to the groundwater and surface water source, a smaller amount of reuse is currently being used in the region for both potable and non-potable uses.

Chapter 3 provides a description of groundwater, surface water, and reuse water supply resources and their overall availability in Region F. The chapter also includes a summary of the supplies currently availability to Water User Groups and Major Water Providers, which are limited by what can be used today under existing contracts, permits, and infrastructure constraints.

Figure 3-1
Water Availability by Source Type



3.1 Groundwater Supplies

Groundwater is primarily found in four major and ten minor aquifers in Region F and is used for municipal, industrial and agricultural purposes. Groundwater represents a major resource in the region. With 14 TWDB designated aquifers and multiple other groundwater sources, the quantity, quality, and reliability of this resource varies across formations and the region.

Based on historic groundwater estimates (2012-2016), regional groundwater sources supplied an average of 478,890 acre-feet of water annually, accounting for 60 percent of all water used in the region. Groundwater provides most of the irrigation water used in the region, as well as a significant portion of the water used for municipal and other purposes.

Region F Aquifers

- Edwards-Trinity (Plateau)
- Edwards-Trinity (High Plains)
- Ogallala
- Pecos Valley
- Trinity
- Dockum
- Hickory
- Lipan
- Ellenburger San Saba
- Marble Falls

Region F historical groundwater pumping by aquifer for years 2017 through 2021 is shown in Figure 3-2. These data were calculated using the TWDB historical groundwater pumping estimates. The Edwards-Trinity (Plateau) supplied 30 percent of the region's groundwater, the Pecos Valley supplied 19 percent, and the Ogallala provided 14 percent. The minor aquifers provided the remaining 37 percent.

The same historical data set is presented in

Figure 3-3 by use category. Irrigation accounted for 70 percent of groundwater pumped in the region. Municipal pumping consumed eleven percent of the groundwater and the remaining use categories collectively accounted for about nineteen percent of total usage in the five-year period.

The following discussion describes each major and minor aquifer in Region F, including their current use and potential availability. Section 3.4.3 discusses the supply of brackish groundwater potentially available for advanced treatment.

Figure 3-2
Historical Groundwater Pumping (2017-2021) by Aquifer

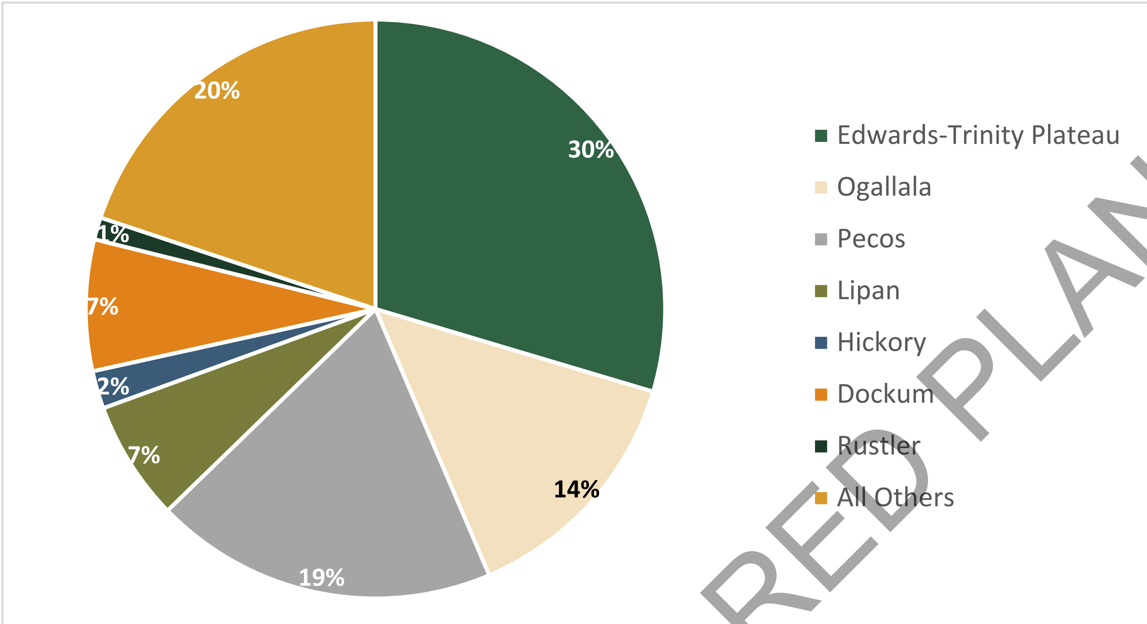


Figure 3-3
Historical Groundwater Pumping (2017-2021) by Use

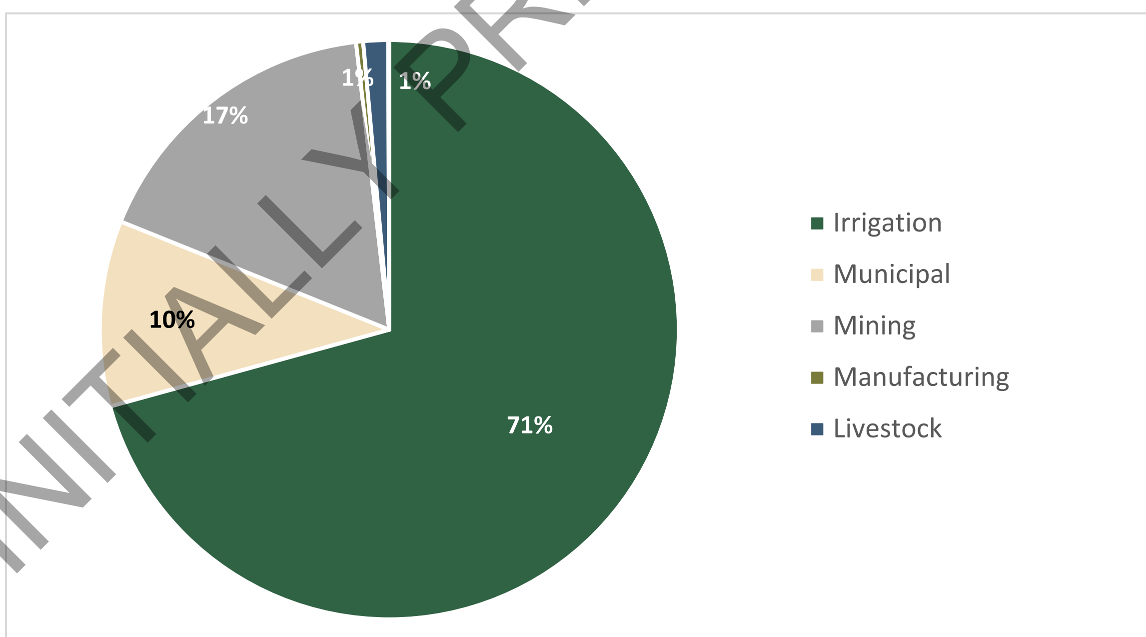
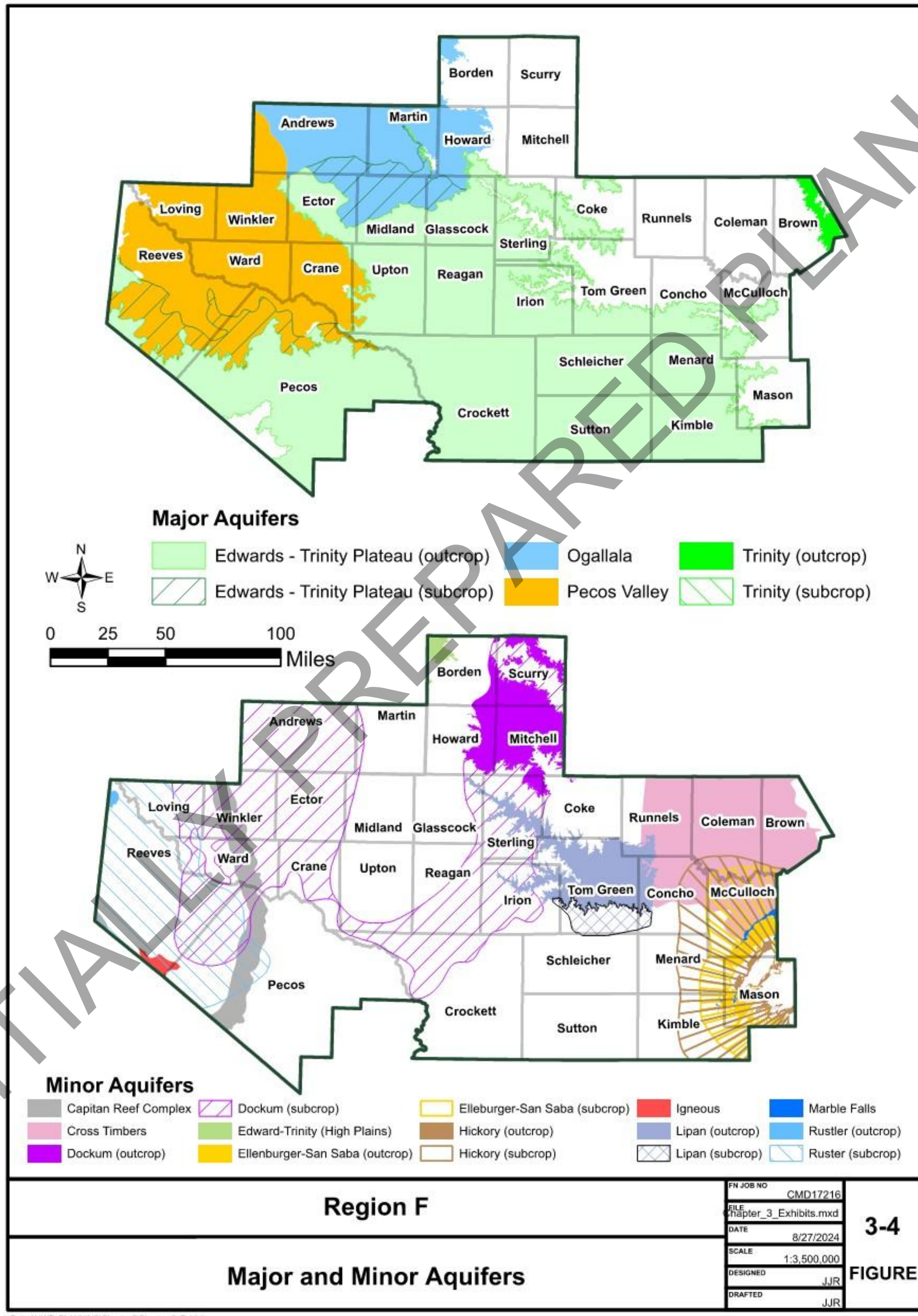
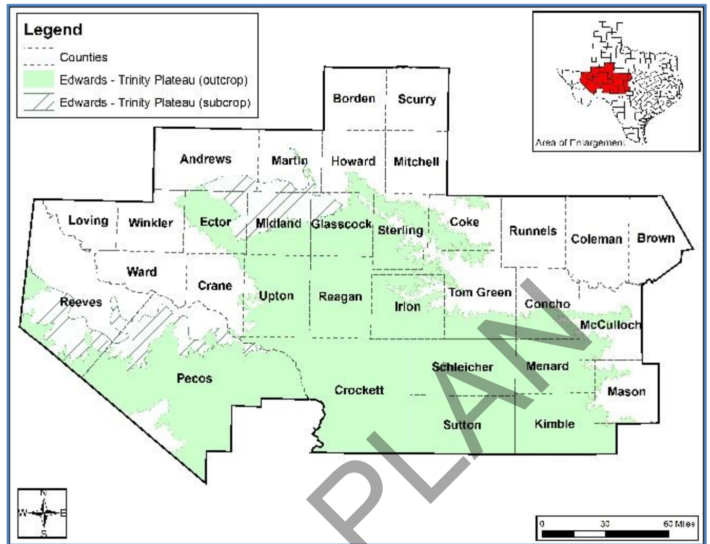


Figure 3-4
Major and Minor Aquifers



3.1.1 Edwards-Trinity (Plateau) Aquifer



Extending from the Hill Country of Central Texas to the Trans-Pecos region of West Texas, the Edwards-Trinity (Plateau) aquifer is the largest aquifer in areal extent in Region F, occurring in 21 of the 32 Region F counties. This aquifer is comprised of water-bearing portions of the Edwards Formation and underlying formations of the Trinity Group and is one of the largest contiguous karst regions in the United States. Regionally, this aquifer is categorized by the TWDB as one aquifer. However, in other parts of the state, the Edwards and Trinity components are not hydrologically connected and are considered separate aquifers. The Trinity aquifer is also present as an individual aquifer in eastern Brown County within Region F and is discussed in Section 3.1.5. More groundwater is produced from the Edwards-Trinity (Plateau) aquifer (approximately 30 percent) than any other aquifer in the region, about 85 percent of which was used for irrigation in 2021. Many communities in the region use the aquifer for their public drinking-water supply. Municipal use accounted for nine percent of use in 2021.

The Edwards-Trinity (Plateau) aquifer is comprised of lower Cretaceous formations of the Trinity Group and limestone and dolomite formations of the overlying Edwards, Comanche Peak, and Georgetown formations. These strata are relatively flat lying and located atop relatively impermeable pre-Cretaceous rocks. The saturated thickness of the entire aquifer is generally less than 400 feet, although the maximum thickness can exceed 1,500 feet. Recharge is primarily through the infiltration of precipitation on the outcrop, in particular where the limestone formations outcrop. Discharge is to wells, evapotranspiration, and rivers in the region. Groundwater flow in the aquifer generally flows in a south-southeasterly direction but may vary locally. The horizontal hydraulic gradient in the aquifer averages about 10 feet/mile.

Edwards Formation

Groundwater is produced from the Edwards Formations portion of the Edwards-Trinity (Plateau) aquifer in most of the region. Groundwater in the Edwards and associated limestones occurs primarily in solution cavities that have developed along faults, fractures, and joints in the limestone. These formations are the main water-producing units in about two-thirds of the aquifer extent. The largest single area of pumping from the Edwards portion of the aquifer in Region F is in the Belding Farms area southwest of Fort Stockton in Pecos County.

Due to the nature of groundwater flow in the Edwards, it is very difficult to estimate aquifer properties for this portion of the Edwards-Trinity (Plateau) aquifer. However, based on aquifer characteristics of the Edwards elsewhere, wells producing from the Edwards portion of the Edwards-Trinity (Plateau) aquifer are expected to be much more productive than from the Trinity portion of the aquifer.

The chemical quality of the Edwards and associated limestones is generally better than that in the underlying Trinity aquifer. Groundwater from the Edwards and associated limestones is fairly uniform in quality, with water being a very hard, calcium bicarbonate type, usually containing less than 500 mg/l total dissolved solids (TDS), although in some areas the TDS can exceed 1,000 mg/l.

Trinity Group

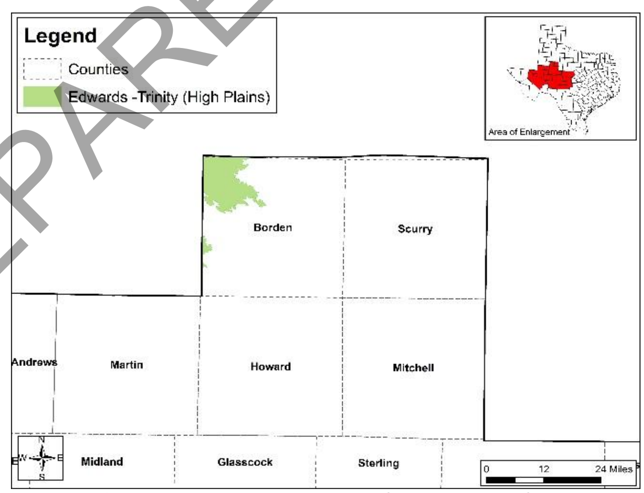
Water-bearing units of the Trinity Group are used primarily in the northern third and on the southeastern edge of the aquifer. In most of the region, the Trinity is seldom used due to the presence of the Edwards above it, which produces better quality water at generally higher rates. In the southeast portion, the Trinity consists of, in ascending order, the Hosston, Sligo, Cow Creek, Hensell and Glen Rose Formations. In the north where the Glen Rose pinches out, all of the Trinity Group is referred to collectively as the Antlers Sand. The greatest withdrawal from the Trinity (Antlers) portion of the aquifer is in Glasscock, Reagan, Upton, and Midland Counties.

Reported well yields from the Trinity portion of the Edwards-Trinity (Plateau) aquifer commonly range from less than 50 gallons per minute (gpm) from the thinnest saturated section to as much as 1,000 gpm. Higher yields occur in locations where wells are completed in jointed or cavernous limestone. Specific capacities of wells range from less than 1 to greater than 20 gpm/ft.

The water quality in the Trinity portion tends to be poorer than in the Edwards. Water from the Antlers is of the calcium bicarbonate/sulfate type and very hard, with salinity increasing towards the west. Salinities in the Antlers typically range from 500 to 1,000 mg/l TDS, although groundwater with greater than 1,000 mg/l TDS is common.

3.1.2 Edwards-Trinity (High Plains) Aquifer

The Edwards-Trinity (High Plains) aquifer underlies the Ogallala aquifer in western Texas and eastern New Mexico and provides water to all or parts of 13 Texas counties. The aquifer's water-producing units include sandstone of the Antlers Formation (Trinity Group) and limestone of the overlying Comanche Peak and Edwards formations. Recharge to the aquifer is primarily due to downward leakage from the younger Ogallala aquifer and typically flows in a southeasterly direction. Water quality found in the Edwards-Trinity (High Plains) aquifer is slightly saline, with total dissolved solids ranging from 1,000 to 2,000 milligrams per liter.



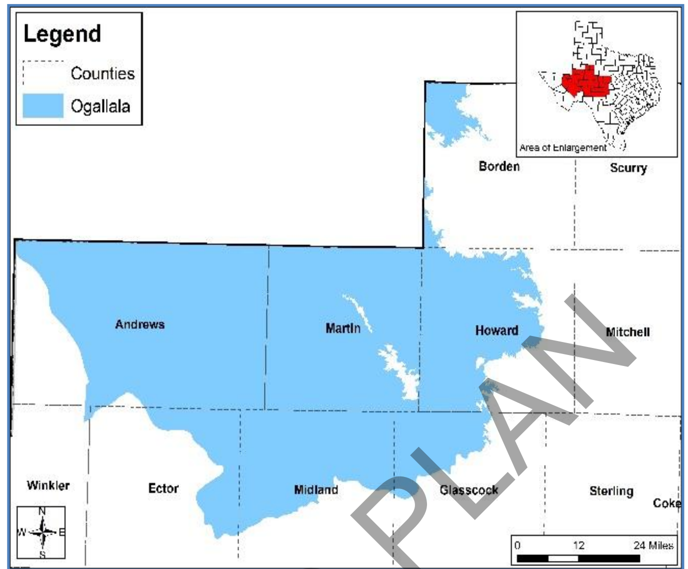
The aquifer extends into the northwestern corner of Borden County where it is a minor source of water used for irrigation purposes.

3.1.3 Ogallala Aquifer

The Ogallala is one of the largest sources of groundwater in the United States, extending from South Dakota to the Southern High Plains of the Texas Panhandle. In Region F, the aquifer occurs in seven counties in the northwestern part of the region including Andrews, Borden, Ector, Howard, Glasscock, Martin and Midland Counties. The aquifer provides approximately 14 percent of all groundwater used in the region. The formation is hydrologically connected to the underlying Edwards-Trinity (Plateau) aquifer in southern Andrews and Martin Counties, and northern Ector, Midland and Glasscock Counties.

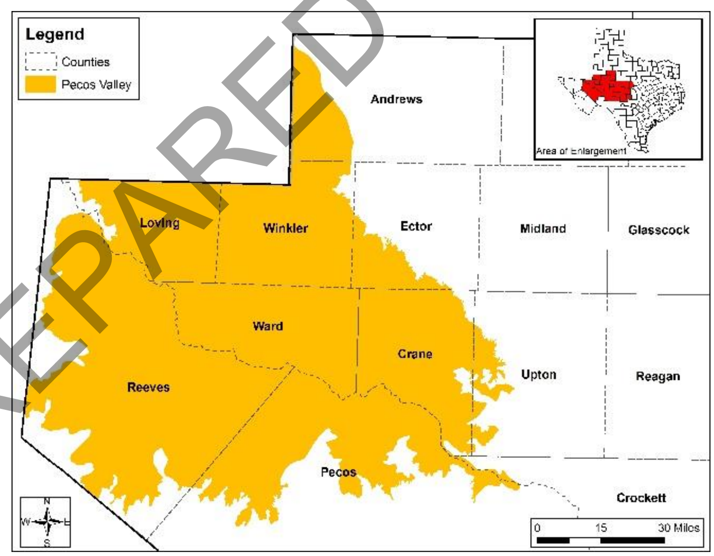
In Region F, agricultural irrigation accounted for approximately 65 percent of the total use of Ogallala groundwater in 2021. Municipal use accounted for approximately 9 percent. Most of the withdrawals from the aquifer occur in Midland, Martin, and Andrews Counties.

The Ogallala is composed of coarse to medium grained sand and gravel in the lower strata grading upward into fine clay, silt and sand. Recharge occurs principally by infiltration of precipitation on the surface and to a lesser extent by upward leakage from underlying formations. Highest recharge infiltration rates occur in areas overlain by sandy soils and in some playa lake basins. Groundwater in the aquifer generally moves slowly in a southeastwardly direction. Water quality of the Ogallala in the Southern High Plains ranges from fresh to moderately saline, with dissolved solids averaging approximately 1,500 mg/l.



3.1.4 Pecos Valley Aquifer

The Pecos Valley aquifer is located in the northern part of the Pecos River Valley of West Texas in Andrews, Crane, Crockett, Ector, Loving, Pecos, Reeves, Upton, Ward and Winkler Counties. Consisting of up to 1,500 feet of alluvial fill, the Pecos Valley occupies two hydrologically separate basins: the Pecos Trough in the west and the Monument Draw Trough in the east. The aquifer is hydrologically connected to underlying water-bearing strata, including the Edwards-Trinity in Pecos and Reeves Counties, the Triassic Dockum in Ward and Winkler Counties, and the Rustler in Reeves County.

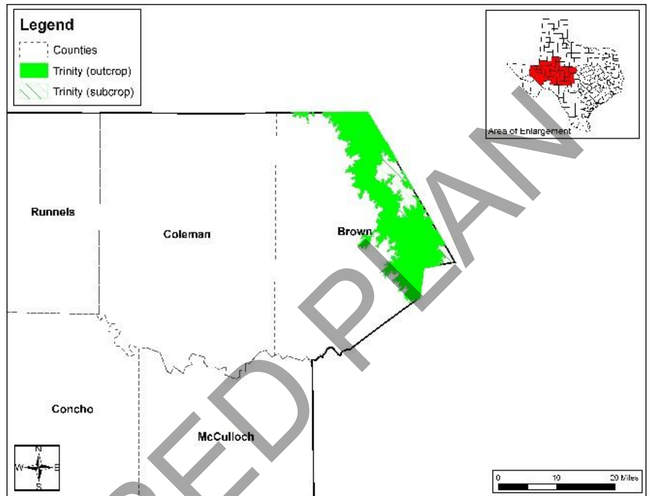


The western basin (Pecos Trough) generally contains poorer quality brackish groundwater and is used most extensively for irrigation of salt-tolerant crops. The eastern basin (Monument Draw Trough) contains relatively good quality water that is used for a variety of purposes, including industrial use, power generation, and public water supply. Most pumping occurs in Pecos and Reeves Counties for irrigation but there are several important wellfields in the Monument Draw Trough that supply water to Midland and the Colorado River Municipal Water District to supply several municipalities in Region F.

The Pecos Valley is the third most used aquifer in the region, representing approximately 19 percent of total groundwater use. Agricultural irrigation accounted for approximately 71 percent of the total in 2021, while municipal consumption and power generation accounted for about 17 percent of aquifer use.

Lateral subsurface flow from the Rustler aquifer into the Pecos Valley has significantly affected the chemical quality of groundwater in the overlying western Pecos Trough aquifer. Most of this basin contains water with greater than 1,000 mg/l TDS, and a significant portion is above 3,000 mg/l TDS. The eastern Monument Draw Trough is underlain by the Dockum aquifer but is not as significantly affected by its quality difference. Water levels in the past fifty years have generally been stable except in areas with significant withdrawals for irrigation or municipal use.

3.1.5 Trinity Aquifer



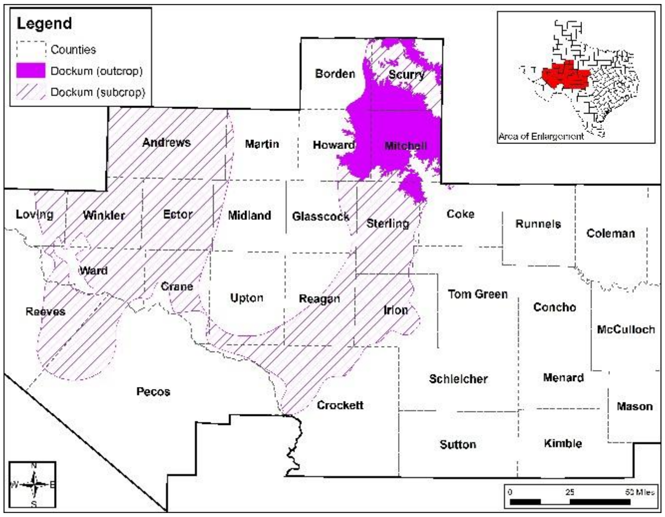
The Trinity aquifer is a groundwater source for eastern Brown County. Small isolated outcrops of Trinity Age rocks also occur in south central Brown County and northwest Coleman County. However, these two areas are not classified as the contiguous Trinity aquifer by the TWDB and the TWDB did not estimate a groundwater availability for the Trinity aquifer in Coleman County. Agricultural related consumption (irrigation and livestock) accounted for approximately 69 percent of the total withdrawal from the aquifer in 2021.

The Trinity was deposited during the Cretaceous Period and is comprised of (from bottom to top) the Twin Mountains, Glen Rose and Paluxy Formations. The Twin Mountains is further divided into the Hosston (lower) and Hensell (upper) with increasing thickness (downdip to the east). In western Brown and Coleman Counties, the Glen Rose is thin or missing and the Paluxy and Twin Mountains coalesce to form the Antlers Sand. The Paluxy consists of sand and shale and is capable of producing small quantities of fresh to slightly saline water. The Twin Mountains formation is composed of sand, gravel, shale, clay and occasional conglomerate, sandstone and limestone beds. It is the principal aquifer and yields moderate to large quantities of fresh to slightly saline water. The maximum thickness of the Trinity aquifer is approximately 200 feet in this area.

Trinity aquifer water quality is acceptable for most municipal, industrial, and irrigation purposes. Dissolved solids range from approximately 150 to over 7,000 mg/l in Brown County; however, most wells have dissolved solids concentrations of less than 1,000 mg/l. The potential for updip movement of poor quality water exists where large and ongoing water level declines have reversed the natural water level gradient and have allowed water of elevated salinity to migrate back updip toward pumpage centers.

3.1.6 Dockum Aquifer

The Dockum aquifer is used for water supply in 12 counties in Region F, including Andrews, Crane, Ector, Howard, Loving, Mitchell, Reagan, Reeves, Scurry, Upton, Ward, and Winkler Counties. The Dockum outcrops in Scurry and Mitchell Counties, and elsewhere underlie rock formations comprising the Ogallala, Edwards-Trinity, and Pecos Valley aquifers. Although the Dockum aquifer underlies much of the region, its low water yield and generally poor quality results in its classification as a minor aquifer.



About seven percent of groundwater withdrawn in the region from the Dockum Aquifer. Agricultural irrigation and livestock use accounted for 45 percent of Dockum pumping in 2021, a decrease from previous years. Most Dockum water used for irrigation is withdrawn in Mitchell and Scurry Counties, while public supply use of Dockum water occurs mostly in Mitchell, Reeves, Scurry and Winkler Counties. Municipal use of Dockum water accounted for about 28 percent of total Dockum use. Mining uses (which include drilling and hydraulic fracking) accounted for 25 percent in 2021, a large jump from the historical use of the Dockum in Region F during 2012-2016, which was less than one percent of total Dockum use.

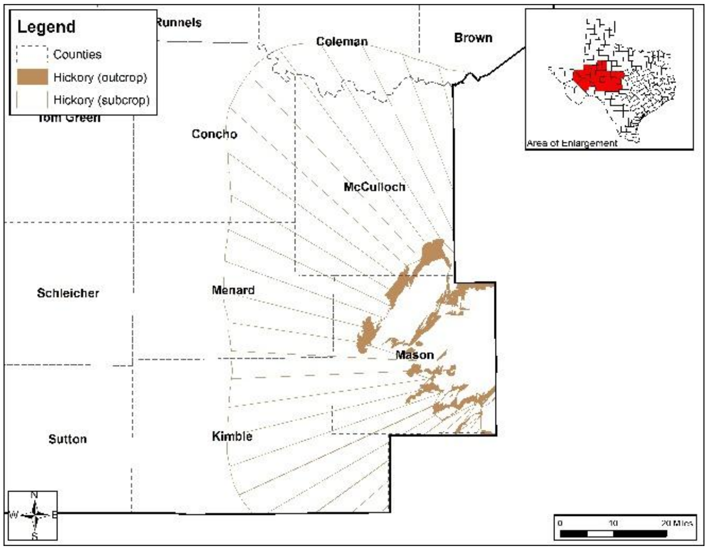
The primary water-bearing zone in the Dockum Group, commonly called the “Santa Rosa”, consists of up to 700 feet of sand and conglomerate interbedded with layers of silt and shale. The Santa Rosa abuts the overlying Trinity aquifer along a corridor that traverses Sterling, Irion, Reagan and Crockett Counties. Within this corridor, the Trinity and Dockum are hydrologically connected, thus forming a thicker aquifer section. A similar hydrologic relationship occurs in Ward and Winkler Counties, where the Santa Rosa unit of the Dockum is in direct contact with the overlying Pecos Valley aquifer. Local groundwater reports use the term “Allurosa” aquifer in reference to this combined section of water-bearing sands.

Recharge to the Dockum primarily occurs in Scurry and Mitchell Counties where the formation outcrops at the land surface. Recharge potential also occurs where water-bearing units of the Trinity and Pecos Valley directly overlie the Santa Rosa portion of the Dockum. Elsewhere, the Dockum is buried deep below the land surface, is finer grained, and receives very limited lateral recharge. Groundwater pumped from the aquifer in these areas will come largely from storage and will generally result in water level declines.

The chemical quality of water from the Dockum aquifer ranges from fresh in outcrop areas to very saline in the deeper central basin area. Groundwater pumped from the aquifer in Region F has average dissolved solids ranging from 550 mg/l in Winkler County to over 2,500 mg/l in Andrews, Crane, Ector, Howard, Reagan and Upton Counties.

3.1.7 Hickory Aquifer

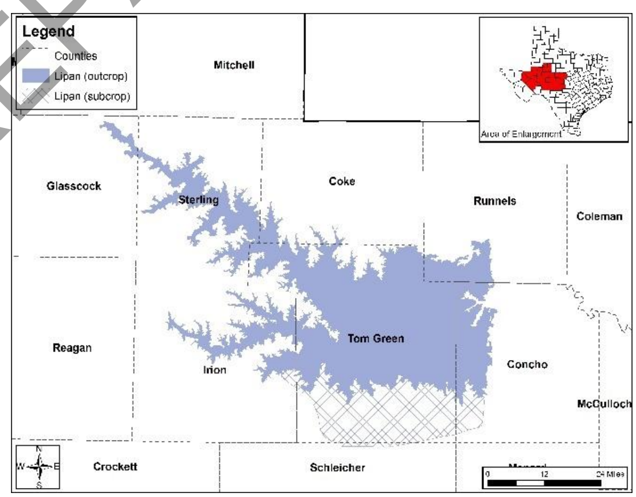
The Hickory aquifer is located in the eastern portion of Region F and outcrops in Mason and McCulloch Counties. The downdip portion of the Hickory aquifer also supplies groundwater to Concho, Kimble and Menard Counties. The Hickory Sandstone Member of the Cambrian Riley Formation is composed of some of the oldest sedimentary rocks in Texas. Irrigation and livestock accounted for approximately 57 percent of the 2021 total pumping, while municipal water use accounts for approximately 41 percent. McCulloch County used the greatest amount of water from the Hickory aquifer, most of which was used for irrigation, while Mason County was close behind, also using most of their Hickory aquifer supply for irrigation.. In most northern and western portions of the aquifer, the Hickory Sandstone Member can be differentiated into lower, middle and upper units, which reach a maximum thickness of 480 feet in southwestern McCulloch County. Block faulting has compartmentalized the Hickory aquifer, which locally limits the occurrence, movement, productivity, and quality of groundwater within the aquifer.



Hickory aquifer water is generally fresh, with dissolved solids concentrations ranging from 300 to 500 mg/l. Much of the water from the Hickory aquifer exceeds drinking water standards for alpha particles, beta particles, and radium particles in the downdip portion of the aquifer. The middle Hickory unit is believed to be the source of alpha, beta, and radium concentrations in excess of drinking water standards. The water may also contain radon gas. The upper unit of the Hickory aquifer produces groundwater containing concentrations of iron in excess of drinking water standards. Wells in the shallow Hickory and the outcrop areas have local concentrations of nitrate in excess of drinking water standards.

Yields of large-capacity wells usually range between 200 and 500 gpm. Some wells have yields in excess of 1,000 gpm. Highest well yields are typically found northwest of the Llano Uplift, where the aquifer has the greatest saturated thickness.

3.1.8 Lipan Aquifer



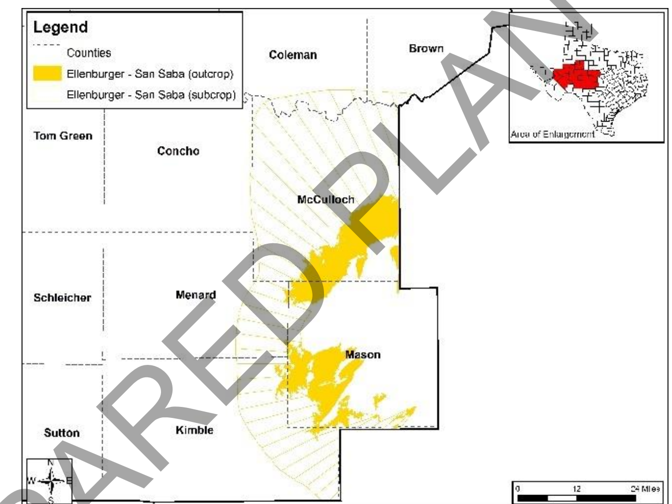
The Lipan aquifer is located primarily in Tom Green County and extends into neighboring counties. The aquifer accounts for about seven percent of regional groundwater use and is principally used for irrigation (95 percent) with limited rural domestic and livestock use. Most pumping occurs in Tom Green County. The Lipan aquifer is comprised of saturated alluvial deposits of the Leona Formation and the updip portions of the underlying Permian-age Choza Formation, Bullwagon Dolomite, and Standpipe Limestone that are hydrologically connected to the Leona. Total thickness of the Leona alluvium ranges from a few feet to about 125 feet. However, most of the groundwater is contained within the underlying Permian units.

Typical irrigation practice in the area is to withdraw water held in storage in the aquifer during the growing season with expectation of recharge recovery during the winter months. The Lipan-Kickapoo Water Conservation District controls overuse by limiting well density.

Groundwater in the Leona Formation ranges from fresh to slightly saline and is very hard, while water in the underlying updip portions of the Choza, Bullwagon and Standpipe tends to be slightly saline. The chemical quality of groundwater in the Lipan aquifer generally does not meet drinking water standards but is suitable for irrigation. In some cases, Lipan water has TDS concentrations in excess of drinking water standards due to influx of water from lower formations. In other cases, the Lipan has excessive nitrates because of agricultural activities in the area. Well yields generally range from 20 to 500 gpm with the average well yielding approximately 200 gpm.

Most of the water in the Lipan aquifer is brackish due to the dissolution of gypsum and other minerals from the aquifer matrix. Additionally, irrigation return flow has concentrated minerals in the water through evaporation and the leaching of natural salts from the unsaturated zone.

3.1.9 Ellenburger San Saba Aquifer



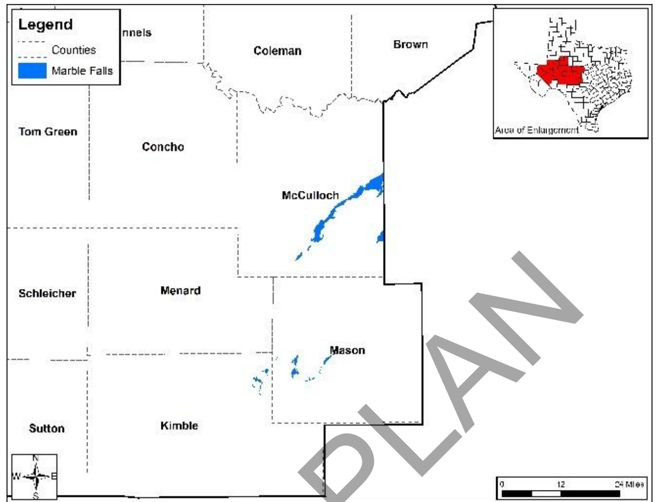
Including the downdip boundary as designated by the TWDB, the Ellenburger-San Saba aquifer occurs in Brown, Coleman, Kimble, Mason, McCulloch and Menard Counties within Region F. Currently, the aquifer supplies less than 0.1 percent of total regional use and most pumping occurs in McCulloch County. About 77 percent of all use was for livestock in 2021 and about 13 percent was for municipal use. Most of the aquifer in the subcrop area contains water in excess of 1,000 mg/l TDS. The downdip boundary of the aquifer, which represents the extent of water with less than 3,000 mg/l TDS, is roughly estimated due to lack of data.

The Ellenburger-San Saba aquifer is comprised of the Cambrian-age San Saba member of the Wilberns Formation and the Ordovician-age Ellenburger Group, which includes the Tanyard, Gorman, and Honeycut Formations. Discontinuous outcrops of the aquifer generally encircle older rocks in the core of the Llano Uplift. The maximum thickness of the aquifer is about 1,100 feet. In some areas, where the overlying beds are thin or absent, the Ellenburger-San Saba aquifer may be hydrologically connected to the Marble Falls aquifer. Local and regional block faulting has significantly compartmentalized the Ellenburger-San Saba, which locally limits the occurrence, movement, productivity, and quality of groundwater within the aquifer.

Water produced from the aquifer has a range in dissolved solids between 200 and 3,000 mg/l, but is usually less than 1,000 mg/l. The quality of water deteriorates rapidly away from outcrop areas. Approximately 20 miles or more downdip from the outcrop, water is typically unsuitable for most uses. All the groundwater produced from the aquifer is inherently hard.

Principal use from the aquifer is for livestock supply in Mason and McCulloch Counties, and a minor amount in Kimble and Menard Counties. Maximum yields of large-capacity wells generally range between 200 and 600 gpm, most other wells typically yield less than 100 gpm.

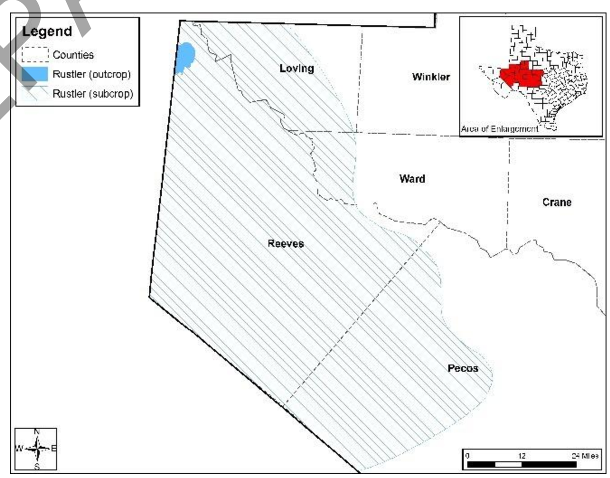
3.1.10 Marble Falls Aquifer



The Marble Falls is the smallest aquifer in the region, occurring in very limited outcrop areas in Kimble, Mason and McCulloch Counties. The aquifer supplies less than 0.01 percent of total regional use, and in recent years (2017-2021) has only reported use in McCulloch County. Irrigation accounted for 60 percent of use and livestock about 25 percent in 2021. Municipal use in 2021 accounted for 15 percent of the total use of the aquifer. Groundwater in the aquifer occurs in fractures, solution cavities, and channels in the limestones of the Marble Falls Formation of the Pennsylvanian-age Bend Group. Where underlying beds are thin or absent, the Marble Falls and Ellenburger-San Saba aquifers may be hydrologically connected.

A limited amount of well data suggests that water quality is acceptable for most uses only in wells located on the outcrop and in wells that are less than 300-feet deep in the downdip portion of the aquifer. The downdip artesian portion of the aquifer is not extensive, and water becomes significantly mineralized within a relatively short distance downdip from the outcrop area. Most water produced from the aquifer occurs in McCulloch County.

3.1.11 Rustler Aquifer

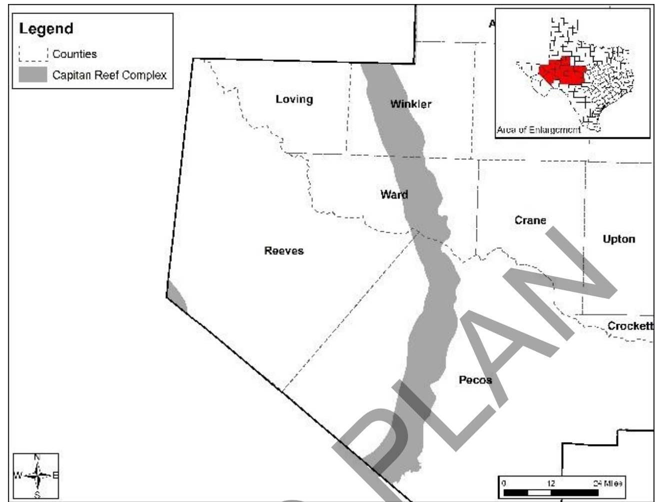


The Rustler Formation outcrops outside of Region F in Culberson County, but the majority of its downdip extent occurs in Region F in Loving, Pecos, Reeves and Ward Counties. The Rustler Formation consists of 200 to 500 feet of anhydrite and dolomite with a basal zone of sandstone and shale deposited in the ancestral Permian-age Delaware Basin. Water is produced primarily from highly permeable solution channels, caverns and collapsed breccia zones.

Groundwater from the Rustler Formation may locally migrate upward, impacting water quality in the overlying Edwards-Trinity and Pecos Valley aquifers. The Rustler is the source for about one percent of regional groundwater and is primarily used for irrigation (77 percent) in Pecos and Reeves Counties.

Throughout most of its extent, the Rustler is relatively deep below the land surface, and generally contains water with dissolved constituents in excess of 3,000 mg/l (TDS). Only in western Pecos, eastern Loving and southeastern Reeves Counties has water been identified that contains less than 3,000 mg/l TDS. The dissolved-solids concentrations increase down gradient, eastward into the basin, with a shift from sulfate to chloride as the predominant anion. No groundwater from the Rustler aquifer has been located that meets drinking water standards

3.1.12 Capitan Reef Aquifer



The Capitan Reef formed along the margins of the ancestral Delaware Basin, an embayment covered by a shallow sea in Permian time. In Texas, the reef parallels the western and eastern edges of the basin in two arcuate strips 10 to 14 miles wide and is exposed in the Guadalupe, Apache and Glass Mountains. From its exposure in the Glass Mountains in Brewster and southern Pecos Counties, the reef plunges underground to a maximum depth of 4,000 feet in northern Pecos County. The reef trends northward into New Mexico where it is a major source of water in the Carlsbad area.

The aquifer is composed of 2,000 feet of massive, vuggy to cavernous dolomite, limestone and reef talus. Water-bearing formations associated with the aquifer system include the Capitan Limestone, Goat Sheep Limestone, and most of the Carlsbad facies of the Artesia Group, which includes the Grayburg, Queen, Seven Rivers, Yates, and Tansill Formations. The Capitan Reef aquifer underlies the Pecos Valley, Edwards-Trinity (Plateau), Dockum, and Rustler aquifers in Pecos, Ward, and Winkler Counties.

In Region F, the aquifer generally contains water of marginal quality, with TDS concentrations ranging between 3,000 and 22,000 mg/l. High salt concentrations in some areas are probably caused by migration of brine waters injected for secondary oil recovery. The freshest water is located near areas of recharge where the reef is exposed at the surface. Yields of wells commonly range from 400 to 1,000 gpm.

Most of the groundwater pumped from the aquifer has historically been used for oil reservoir water-flooding operations in Ward and Winkler Counties. Historical use estimates for years 2017 through 2021 attribute all use of the aquifer to irrigation in Pecos County only. The Capitan supplies less than 0.5 percent of total groundwater pumping in Region F. Very little reliance has been placed on this aquifer due to its depth, limited extent, and marginal quality. The Capitan Reef aquifer may be a potential brackish water supply for desalination and oilfield supply.

3.1.13 Blaine Aquifer

The Blaine aquifer extends from Wheeler County in the Panhandle to Coke County in West-Central Texas. In Region F, there are only isolated portions of the aquifer in Coke County. Most of the groundwater currently produced from the Blaine is used for livestock and irrigation purposes because the water quality is poor. The Permian age Blaine Formation is composed of shale, sandstone, and beds of gypsum, halite, and anhydrite, some of which can be 10 to 30 feet in thickness. Overall, the Blaine Formation can be up to 1,200 feet thick. Groundwater in the Blaine occurs in dissolution channels that have formed in the aquifer matrix.

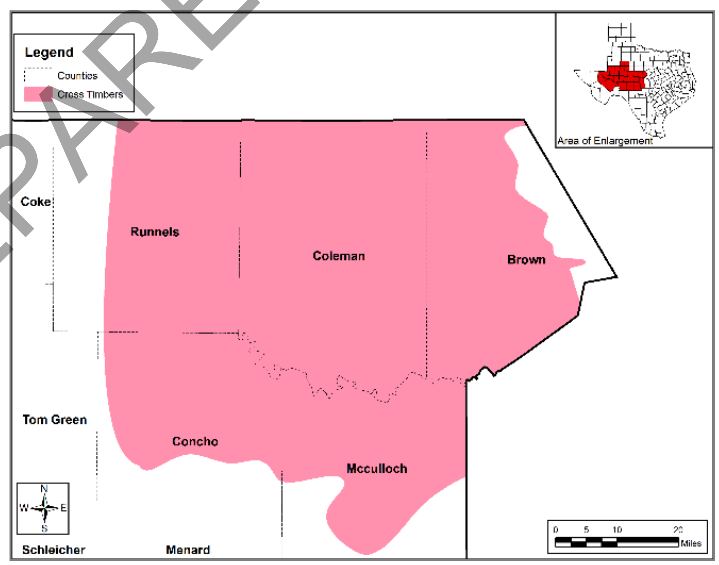
Yields from wells completed in the Blaine aquifer can be relatively high. However, the productivity of a well depends on the number and size of dissolution channels intersected by the well. Because of this, it is very difficult to accurately describe hydraulic characteristics or anticipate potential well yields in the

Blaine. Recharge to the Blaine aquifer is through the infiltration of precipitation on the outcrop. This recharge then moves downdip predominantly along dissolution channels in the gypsum, anhydrite, and halite beds. The recharge water discharges in topographically low areas to salt seeps and springs. As the water moves downdip, it further dissolves the gypsum/anhydrite/ halite beds, increasing the number and size of solution channels that water can move through and also increasing the salinity of the groundwater. The water that discharges into salt seeps and springs tends to be very high in TDS, and will contaminate surface water bodies, which is a long-recognized problem in the area.

The water quality from the Blaine aquifer varies greatly but is generally slightly- to moderately-saline. Most of the groundwater produced from the Blaine is highly mineralized because the water is largely being produced from dissolution channels within gypsum, halite, and anhydrite beds. For this reason, it is largely unsuitable for any purposes except for salt tolerant irrigation. Total dissolved solids range from less than 1,000 to greater than 10,000 mg/L. Fresh groundwater from the Blaine is uncommon and is usually found in topographically higher areas where the formation crops out, and where recharge from precipitation or possibly from overlying alluvium occurs. Groundwater from the Blaine throughout much of the outcrop area typically has between 2,000 and 4,000 mg/L TDS.

3.1.14 Cross Timbers Aquifer

The TWDB recently designated a new minor aquifer known as the Cross Timbers Aquifer. The aquifer has been a source of groundwater mainly in areas northeast of Region F, but it does extend into the northeast portion of Region F as well. The Cross Timbers aquifer consists of Paleozoic-aged formations that have an outcrop area of 11,800 square miles and encompass all or part of 31 counties between the Red and Colorado Rivers. In Region F, the Cross Timbers occurs in Brown, Coleman, Concho, McCulloch, and Runnels Counties. In the southern portion of the aquifer, the formations of the Wichita (Permian), Cisco, Canyon, and Strawn (Pennsylvanian) Groups generally dip to the west, and in the northern portion of the aquifer, where they are overlain by the Cretaceous Trinity Group, they dip to the north and east. The formations predominantly consist of limestone, shale and sandstone.



Groundwater is typically unconfined, shallow, and laterally discontinuous, occurring primarily in the sandstone layers. Aquifer properties, well yields, and water quality are highly variable. Most of the wells that are completed in the Cross Timbers have historically been used for domestic and livestock purposes; however, there are also a few public supply wells.

3.1.15 Groundwater Local Supplies (Other Aquifer)

Groundwater local supplies refer to localized pockets of groundwater that are not classified as either a major or minor aquifer of the state. These areas are termed "other" aquifer. Other aquifer supplies are generally small but can be locally significant.

San Andres Aquifer

The San Andres aquifer is a formation located in norther Pecos County near Imperial, Texas. In 1957, there were at least 27 groundwater wells completed in the San Andres Formation. The wells flowed at [1] the surface when they were drilled but due to continuous discharge and decreasing formation pressure, only about eight of these wells currently flow. In 1957, the withdrawals were estimated to have been 10,000 acre-feet. Additional water may be available from this source, but more studies are needed. Water quality is characterized by total dissolved solid concentrations that exceed 5,000 milligrams per liter, hydrogen sulfide gas presence in the groundwater, and sulfur that precipitates out upon oxidation at the surface.Uses included irrigation, secondary recovery via waterflooding, and livestock. Advanced treatment would be required for municipal use.

Environmental problems created by the flowing wells include sink holes (caused by the dissolution of evaporates by the vertical migration of San Andres waters), malodorous brackish water ponding at the surface, road collapse and reroutes, vegetation kills, potential non-native species encroachment, salt loading of soils, and destruction of land use.

The Capitan Reef Complex is located about four miles to the west of the flowing San Andres Formation wells. The underlying San Andres Formation is structurally high in the area west of Imperial, functions as the base of the backreef sequence, and has good hydrogeological communication with the Capitan Reef Complex [2]. However, the source of water to the flowing wells is the San Andres Formation [3].

3.1.16 Overview of Groundwater Regulation in Texas and Region F

Groundwater supplies are intricately linked to groundwater regulation and permitting throughout Texas and in Region F. It is difficult to discuss availability from groundwater supplies without understanding the basic regulatory framework that controls those supplies. Therefore, the discussion of available regional groundwater supplies begins with a discussion of the regulatory framework for groundwater.

In June 1997, the 75th Texas Legislature enacted Senate Bill 1 (SB 1) to establish a comprehensive statewide water planning process to help ensure that the water needs of all Texans are met. SB1 mandated that representatives serve as members of Regional Water Planning Groups (RWPGs) to prepare regional water plans for their respective areas. These plans map out how to conserve water supplies, meet future water supply needs, and respond to future droughts in the planning areas. Additionally, SB 1 established that groundwater conservation districts (GCDs) were the preferred entities for groundwater management and contained provisions that required the GCDs to prepare management plans.

In 2001, the Texas Legislature enacted Senate Bill 2 (SB 2) to build on the planning requirements of SB 1 and to further clarify the actions necessary for GCDs to manage and conserve groundwater resources. As part of SB 2, the Legislature called for the creation of Groundwater Management Areas (GMAs) which were based largely on hydrogeologic and aquifer boundaries instead of political boundaries. The TWDB divided Texas into 16 GMAs, and most contain multiple GCDs. One of the purposes for GMAs was to manage groundwater resources on a more aquifer-wide basis. Figure 3-5 shows the regulatory boundaries of the GCDs and GMAs within Region F.

The Texas Legislature enacted significant changes to the management of groundwater resources in Texas with the passage of House Bill 1763 (HB 1763) in 2005. A main goal of HB 1763 was intended to clarify the authority and conflicts between GCDs and RWPGs. The new law clarified that GCDs would be responsible for aquifer planning and developing the amount of groundwater available for use and/or development by the RWPGs. To accomplish this, the law directed that all GCDs within each GMA to meet and participate in joint groundwater planning efforts. The focus of joint groundwater planning was to determine the Desired Future Conditions (DFCs) for the groundwater resources within the GMA boundaries (before September 1, 2010, and at least once every 5 years after that).

Desired Future Conditions are defined by statute to be "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 within a groundwater management area as part of the joint groundwater planning process." DFCs are quantifiable management goals that reflect what the GCDs want to protect in their particular area. The most common DFCs are based on the volume of groundwater in storage over time, water levels (limiting decline within the aquifer), water quality (limiting deterioration of quality), or spring flow (defining a minimum flow to sustain). If a GMA determines an aquifer or portion of an aquifer should not be regulated by a DFC, it is declared "non-relevant" and no DFC is set. Table 3-1 summarizes the DFCs for the aquifers in Region F.

After the DFCs are determined by the GMAs, the TWDB performs quantitative analysis to determine the amount of groundwater available for production to meet the DFC. For aquifers where a Groundwater Availability Model (GAM) exists, the GAM is used to develop the Modeled Available Groundwater (MAG). For aquifers without a GAM or non-relevant aquifers, other quantitative approaches may be used to estimate the availability.

In addition to the inclusion of the GAM and MAG water availability limits, the RWPG also considered the water availability requirements per the Priority Groundwater Management Area (PGMA) in Region F. There is one PGMA in Region F called the Reagan, Upton, and Midland County PGMA which was designated by the Texas Water Commission in 1990.

In 2011, Senate Bill 660 required that GMA representatives must participate within each applicable RWPG. It also required the Regional Water Plans be consistent with the DFCs in place when the regional plans are initially developed. TWDB technical guidelines for the current round of planning establishes that the MAG (within each county and basin) is the maximum amount of groundwater that can be used for existing uses and new strategies in Regional Water Plans. In other words, the MAG volumes are a cap on existing and future groundwater production for TWDB planning purposes.

Key Groundwater Terms

Groundwater Management Areas (GMAs)

GMAs provide for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions. Many GMAs contain multiple GCDs.

Groundwater Conservation Districts (GCDs)

Local entity responsible for aquifer planning and developing the amount of groundwater available for use and/or development by the RWPGs.

Desired Future Condition (DFC)

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 within a groundwater management area as part of the joint groundwater planning process.

Groundwater Availability Model (GAM)

Models used by TWDB to perform quantitative analysis to determine the amount of groundwater available for production to meet the DFC. The GAM is used to develop the MAG.

Modeled Available Groundwater (MAG)

The estimated volume of groundwater that can be produced to meet the DFC. It is also the maximum amount of groundwater that can be used for existing uses and new recommended strategies in Regional Water Plans.

Figure 3-5
Groundwater Conservation Districts & Management Areas

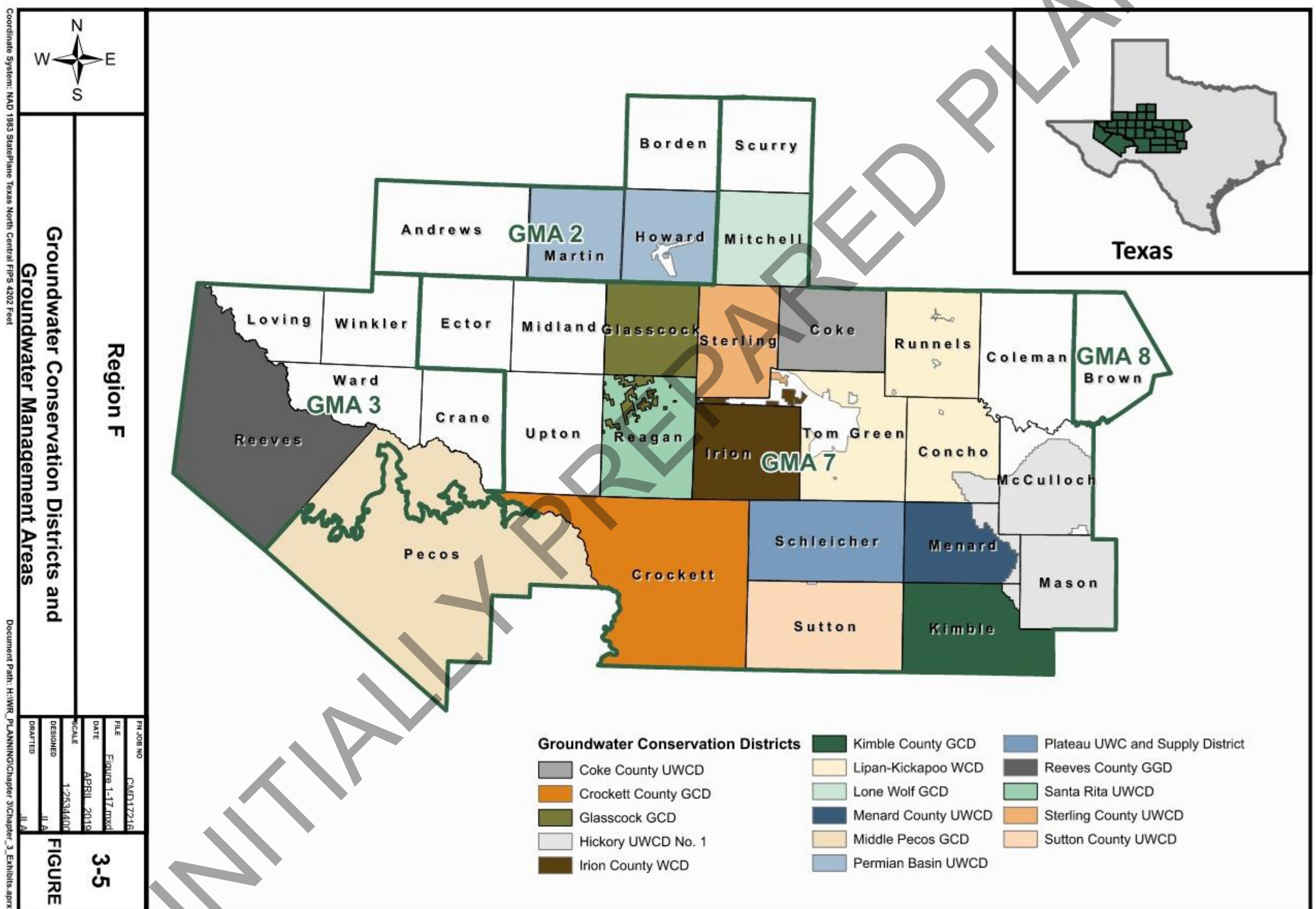


Table 3-1
Desired Future Conditions for Region F Aquifers

Aquifer	Groundwater Management Area[1]	Desired Future Condition (DFC)	Region F Non-Relevant
Edwards-Trinity (Plateau)	2, 3 and 7	Net water level decline by 2070 varies by county from 0 ft. in Coke County to 161 ft. in Winkler County.	Andrews, Howard, Martin Counties (GMA 2) Within Hickory UWCD1, Lipan-Kickapoo WCD, Lone Wolf GCD, and Wes-Tex GCD (GMA 7)
Edwards-Trinity (High Plains)	2	Average drawdown by 2080 is 28 feet for all counties in GMA 2.	None
Ogallala	2, 3 and 7	Net water level declines vary from 6 ft. in Glasscock County by 2070 to 28 ft. for all of GMA 2 by 2080.	Midland, Ector (GMA 7), Winkler (GMA 3)
Pecos Valley	3 and 7	DFC set collectively with Edwards-Trinity (Plateau).	Andrews (GMA 2)
Trinity (Brown County)	8	Set by formation: Average drawdown not to exceed from 148 ft. in Glen Rose and Hensell to 193 ft. in Antlers, to 207 ft. in Travis Peak, and 262 ft. in Hosston.	None
Dockum	2, 3 and 7	Net drawdown by 2080 is 31 ft. for all counties in GMA 2. For GMA 3, net drawdown ranges from 0 ft. (Crane County) to 52 ft. (Pecos County) by 2070. In GMA 7, net drawdown is 14 ft. (Reagan) and 52 ft. (Pecos) by 2070.	Ector, Upton, Crockett, Irion, Midland, Sterling, Coke, Glasscock, Mitchell, Scurry, Nolan, Tom Green
Hickory	7	Total drawdown ranges from 6 ft. in San Saba (Region K) to 53 ft. (Concho County) by 2070 for GMA 7. In GMA 8, average drawdown is 3 ft. (Brown County) through 2080.	Outside of Hickory UWCD, Hill County UWCD, Kimble County GCD, Menard GCD, and Llano County (GMA 7)
Lipan	7	Aquifer determined non-relevant for joint planning purposes and no DFC was established.	All counties
Ellenburger-San Saba	7	Total drawdown ranges from 5 ft. (Region K) to 46 ft. (Menard) by 2070.	Outside of Hickory UWCD, Hill County UWCD, Kimble County GCD, and Menard GCD
Marble Falls	7	None set.	All counties
Rustler	3 and 7	Average water level decline in GMA 3 ranges from 28 ft. (Loving) to 69 ft. (Pecos). For GMA 7, declines not to exceed 94 ft. (Pecos) by 2070.	None
Capitan Reef	3 and 7	Total decline not to exceed 4 ft. in Pecos (GMA 3) and 2 ft. in Ward and Winkler Counties. In GMA 7, decline in Pecos County not to exceed 56 ft by 2070.	Reeves
Blaine	7	None set.	All counties in GMA 7

3.1.17 Existing Groundwater Availability

As discussed in the previous section, the Modeled Available Groundwater (MAG) set through the joint planning process with the Groundwater Management Areas (GMAs), is a cap on the amount of groundwater available for use in the Region F Plan. Table 3-2 presents the MAG numbers by county, aquifer, and river basin for planning years 2030 through 2080. MAG volumes are an estimate of the largest amount of water that can be withdrawn by all users from a given source without violating DFCs. Table 3-2 only includes county aquifer combinations in each basin where a DFC has been defined by a GMA and the MAG subsequently has been determined by the TWDB using the GAM.

Table 3-2
Modeled Available Groundwater in Region F
-Values in Acre-Feet per Year-

County	Aquifer	Basin	2030	2040	2050	2060	2070	2080
Andrews	Dockum	Colorado	1,503	1,503	1,503	1,503	1,503	1,503
		Rio Grande	0	0	0	0	0	0
	Ogallala	Colorado	19,391	17,897	16,937	16,260	15,764	15,378
		Rio Grande	0	0	0	0	0	0
Borden	Dockum	Brazos	323	323	323	323	323	323
		Colorado	703	703	703	703	703	703
	Ogallala and Edwards-Trinity (High Plains)	Brazos	673	615	581	559	543	532
		Colorado	3,759	3,278	3,010	2,834	2,684	2,540
Brown	Ellenburger-San Saba	Colorado	131	131	131	131	131	131
	Hickory	Colorado	12	12	12	12	12	12
	Marble Falls	Colorado	25	25	25	25	25	25
	Trinity	Brazos	51	51	51	51	51	51
		Colorado	1,376	1,376	1,376	1,376	1,376	1,376
Coke	Edwards-Trinity (Plateau)	Colorado	997	997	997	997	997	997
Coleman	---	Colorado	---	---	---	---	---	---
Concho	Hickory	Colorado	27	27	27	27	27	27
Crane	Dockum	Rio Grande	94	94	94	94	94	94
	Edwards-Trinity (Plateau) and Pecos Valley	Rio Grande	4,991	4,991	4,991	4,991	4,991	4,991
Crockett	Edwards-Trinity (Plateau)	Colorado	20	20	20	20	20	20
		Rio Grande	5,427	5,427	5,427	5,427	5,427	5,427
Ector	Edwards-Trinity (Plateau) and Pecos Valley	Colorado	4,925	4,925	4,925	4,925	4,925	4,925
		Rio Grande	617	617	617	617	617	617
Glasscock	Edwards-Trinity (Plateau)	Colorado	65,186	65,186	65,186	65,186	65,186	65,186
	Ogallala	Colorado	7,673	7,372	7,058	6,803	6,570	6,570
Howard	Ogallala	Colorado	15,631	14,818	14,365	14,090	13,915	13,800
	Dockum	Colorado	6,770	6,770	6,770	6,770	6,770	6,770
Irion	Edwards-Trinity (Plateau)	Colorado	3,289	3,289	3,289	3,289	3,289	3,289

County	Aquifer	Basin	2030	2040	2050	2060	2070	2080
Kimble	Edwards-Trinity (Plateau)	Colorado	1,386	1,386	1,386	1,386	1,386	1,386
	Ellenburger-San Saba	Colorado	521	521	521	521	521	521
	Hickory	Colorado	165	165	165	165	165	165
Loving	Dockum	Rio Grande	453	453	453	453	453	453
	Pecos Valley	Rio Grande	2,982	2,982	2,982	2,982	2,982	2,982
	Rustler	Rio Grande	200	200	200	200	200	200
Martin	Ogallala	Colorado	48,293	43,032	39,019	36,358	34,521	33,171
	Dockum	Colorado	11,449	11,449	11,449	11,449	11,449	11,449
Mason	Ellenburger-San Saba	Colorado	3,237	3,237	3,237	3,237	3,237	3,237
	Hickory	Colorado	13,212	13,212	13,212	13,212	13,212	13,212
McCulloch	Ellenburger-San Saba	Colorado	4,364	4,364	4,364	4,364	4,364	4,364
	Hickory	Colorado	24,377	24,377	24,377	24,377	24,377	24,377
Menard	Edwards-Trinity (Plateau)	Colorado	2,597	2,597	2,597	2,597	2,597	2,597
	Ellenburger-San Saba	Colorado	309	309	309	309	309	309
	Hickory	Colorado	2,725	2,725	2,725	2,725	2,725	2,725
Midland	Edwards-Trinity (Plateau)	Colorado	23,233	23,233	23,233	23,233	23,233	23,233
Pecos	Capitan Reef	Rio Grande	26,168	26,168	26,168	26,168	26,168	26,168
	Dockum	Rio Grande	8,164	8,164	8,164	8,164	8,164	8,164
	Edwards-Trinity (Plateau) and Pecos Valley	Rio Grande	240,208	240,208	240,208	240,208	240,208	240,208
	Rustler	Rio Grande	7,043	7,043	7,043	7,043	7,043	7,043
Reagan	Dockum	Colorado	962	962	962	962	962	962
	Edwards-Trinity (Plateau)	Colorado	68,205	68,205	68,205	68,205	68,205	68,205
		Rio Grande	28	28	28	28	28	28
Reeves	Dockum	Rio Grande	2,539	2,539	2,539	2,539	2,539	2,539
	Edwards-Trinity (Plateau) and Pecos Valley	Rio Grande	189,744	189,744	189,744	189,744	189,744	189,744
	Rustler	Rio Grande	2,387	2,387	2,387	2,387	2,387	2,387
Schleicher	Edwards-Trinity (Plateau)	Colorado	6,403	6,403	6,403	6,403	6,403	6,403
		Rio Grande	1,631	1,631	1,631	1,631	1,631	1,631
Sterling	Edwards-Trinity (Plateau)	Colorado	2,495	2,495	2,495	2,495	2,495	2,495
Sutton	Edwards-Trinity (Plateau)	Colorado	388	388	388	388	388	388
		Rio Grande	6,022	6,022	6,022	6,022	6,022	6,022
Upton	Edwards-Trinity (Plateau) and Pecos Valley	Colorado	21,243	21,243	21,243	21,243	21,243	21,243
		Rio Grande	1,126	1,126	1,126	1,126	1,126	1,126

County	Aquifer	Basin	2030	2040	2050	2060	2070	2080
Ward	Capitan Reef	Rio Grande	103	103	103	103	103	103
	Dockum	Rio Grande	2,150	2,150	2,150	2,150	2,150	2,150
	Pecos Valley	Rio Grande	49,976	49,976	49,976	49,976	49,976	49,976
	Rustler	Rio Grande	0	0	0	0	0	0
Winkler	Capitan Reef	Rio Grande	274	274	274	274	274	274
	Dockum	Colorado	13	13	13	13	13	13
		Rio Grande	5,987	5,987	5,987	5,987	5,987	5,987
	Edwards-Trinity (Plateau) and Pecos Valley	Rio Grande	49,949	49,949	49,949	49,949	49,949	49,949

Non-relevant aquifers are areas determined by the GCDs that have aquifer characteristics, groundwater demands, and current groundwater uses that do not warrant adoption of a desired future condition. It is anticipated that there will be no large-scale production from non-relevant aquifers. Additionally, it is assumed that what production does occur will not affect conditions in relevant portions of the aquifer(s).

In the absence of a DFC and a related officially determined MAG developed by the TWDB, the RWPG may use an alternate methodology to estimate availability from the aquifer. In some cases, the TWDB published "DFC-compatible availability values." These estimates typically originate from the DFC/MAG modeling but are not a part of the MAG documentation because a DFC was not established for an area. However, a "DFC-Compatible" pumping is typically assumed for each county and aquifer in the GAM and is a part of the modeling assumptions that define and constrain the DFCs and MAGs in other parts of the model. Therefore, they are considered "compatible" with existing DFCs. For this reason, "DFC-Compatible" values in non-relevant areas are considered appropriate for regional planning purposes because they do not jeopardize or invalidate DFCs or MAGs in nearby relevant areas. For the county-aquifer-basin areas that did not have TWDB DFC-compatible availability values, the volumes were estimated using various methodologies, such as well productivity (Coke County Dockum and Lipan aquifers), historic use, and previous studies. Table 3-3 presents groundwater availability numbers for the non-relevant aquifers in Region F (in acre-feet per year). Table 3-4 includes availability estimates for other aquifers. Other aquifers are localized pockets of water that are not designated by TWDB as a major or minor aquifer. They are generally small but can be locally significant. For many of the non-relevant and other aquifers, the groundwater availability estimates determined for the 2021 Region F Water Plan were retained.

Table 3-3
Non-Relevant Groundwater Supplies in Region F
-Values in Acre-Feet per Year-

County	Aquifer	Basin	2030	2040	2050	2060	2070	2080	Methodology
Andrews	Edwards-Trinity (Plateau) and Pecos Valley	Colorado	1,198	1,198	1,198	1,198	1,198	1,198	Groundwater Availability Model (GAM) Modified
	Pecos Valley	Rio Grande	150	150	150	150	150	150	Estimate based on TCEQ State Well Reports Filed 1968-2000.
Brown	Cross Timbers Aquifer	Colorado	993	993	993	993	993	993	Published Reports/Data
Coke	Dockum	Colorado	100	100	100	100	100	100	Estimate based on Groundwater Assessment
	Lipan	Colorado	160	160	160	160	160	160	Estimate based on Groundwater Assessment
Coleman	Cross Timbers Aquifer	Colorado	108	108	108	108	108	108	Published Reports/Data
	Hickory Aquifer	Colorado	500	500	500	500	500	500	Published Reports/Data
Concho	Edwards-Trinity (Plateau)	Colorado	459	459	459	459	459	459	Published Reports/Data
	Lipan	Colorado	4,000	4,000	4,000	4,000	4,000	4,000	Groundwater Availability Model (GAM)
Crane	Rustler	Rio Grande	1,000	1,000	1,000	1,000	1,000	1,000	Published Reports/Data
Crockett	Dockum	Colorado	4	4	4	4	4	4	Groundwater Availability Model (GAM) Modified
	Dockum	Rio Grande	2	2	2	2	2	2	Groundwater Availability Model (GAM)
Ector	Dockum	Colorado	28	28	28	28	28	28	Published Reports/Data
	Dockum	Rio Grande	721	721	721	721	721	721	Published Reports/Data
	Ogallala	Colorado	206	213	218	222	226	226	Published Reports/Data
Glasscock	Dockum	Colorado	900	900	900	900	900	900	Groundwater Availability Model (GAM) Modified

County	Aquifer	Basin	2030	2040	2050	2060	2070	2080	Methodology
	Lipan	Colorado	10	10	10	10	10	10	Based on Groundwater Analysis
Howard	Edwards-Trinity (Plateau)	Colorado	672	672	672	672	672	672	Groundwater Availability Model (GAM) Modified
Irion	Dockum	Colorado	150	150	150	150	150	150	Groundwater Availability Model (GAM) Modified
	Lipan	Colorado	13	13	13	13	13	13	Estimate Based on Groundwater Analysis
Kimble	Marble Falls	Colorado	100	100	100	100	100	100	Estimate Based on Groundwater Analysis
McCulloch	Cross Timbers Aquifer	Colorado	103	103	103	103	103	103	Max 4-Year Annual Historical Pumpage (2012-2015)
	Edwards-Trinity (Plateau)	Colorado	600	600	600	600	600	600	Groundwater Availability Model (GAM)
	Marble Falls	Colorado	50	50	50	50	50	50	Estimate Based on WSP Groundwater Analysis
Martin	Edwards-Trinity (Plateau)	Colorado	242	242	242	242	242	242	Groundwater Availability Model (GAM) Modified
Mason	Edwards-Trinity (Plateau)	Colorado	18	18	18	18	18	18	Groundwater Availability Model (GAM)
	Marble Falls	Colorado	100	100	100	100	100	100	Estimate Based on Groundwater Analysis
Midland	Dockum	Colorado	1,000	1,000	1,000	1,000	1,000	1,000	Published Reports/Data
	Ogallala	Colorado	15,442	14,369	13,732	13,258	12,745	12,745	Published Reports/Data

County	Aquifer	Basin	2030	2040	2050	2060	2070	2080	Methodology
Mitchell	Dockum	Colorado	14,018	14,018	14,018	14,018	14,018	14,018	Published Reports/Data
	Pecos Valley, Edwards-Trinity (Plateau)	Colorado	0	0	0	0	0	0	No Methodology Selected
Pecos	Igneous	Rio Grande	80	80	80	80	80	80	Estimate Based on Groundwater Analysis
Reeves	Capitan Reef Complex	Rio Grande	1,007	1,007	1,007	1,007	1,007	1,007	Published Reports/Data
	Igneous	Rio Grande	300	300	300	300	300	300	Estimate Based on Groundwater Assessment of TWDB 2016 Groundwater Pumping
Runnels	Cross Timbers Aquifer	Colorado	0	0	0	0	0	0	No Methodology Selected
	Lipan	Colorado	45	45	45	45	45	45	Groundwater Availability Model (GAM)
Schleicher	Lipan	Colorado	0	0	0	0	0	0	No Methodology Selected
Scurry	Dockum	Brazos	2,151	2,151	2,151	2,151	2,151	2,151	Published Reports/Data
	Dockum	Colorado	9,546	9,546	9,335	9,248	9,175	9,175	Published Reports/Data
	Seymour	Brazos	10	10	10	10	10	10	Estimate Based on Groundwater Analysis
Sterling	Dockum	Colorado	300	300	300	300	300	300	Groundwater Availability Model (GAM) Modified
	Lipan	Colorado	850	850	850	850	850	850	Groundwater Availability Model (GAM)

County	Aquifer	Basin	2030	2040	2050	2060	2070	2080	Methodology
Tom Green	Dockum	Colorado	200	200	200	200	200	200	Estimate Based on Groundwater Analysis
	Edwards-Trinity (Plateau)	Colorado	2,797	2,797	2,797	2,797	2,797	2,797	Groundwater Availability Model (GAM)
	Lipan	Colorado	43,568	43,568	43,568	43,568	43,568	43,568	Groundwater Availability Model (GAM)
Upton	Dockum	Rio Grande	1,000	1,000	1,000	1,000	1,000	1,000	Published Reports/Data
Winkler	Ogallala	Rio Grande	40	40	40	40	40	40	Estimate Based on Groundwater Analysis

Table 3-4
Groundwater Supplies from Other Aquifers

County	Aquifer Name	Basin	2026 Availability
Borden	Other Aquifer	Colorado	2,598
Coke	Other Aquifer	Colorado	2,100
Coleman	Other Aquifer	Colorado	109
Concho	Other Aquifer	Colorado	5,964
Mason	Other Aquifer	Colorado	873
McCulloch	Other Aquifer	Colorado	103
Mitchell	Other Aquifer	Colorado	789
Pecos	Other Aquifer |San Andres	Rio Grande	10,000
Runnels	Other Aquifer	Colorado	5,001
Scurry	Other Aquifer	Brazos	74
		Colorado	315

To determine potential needs and conflicts between where pumping has occurred historically and MAG availability, historical pumping estimates for years 2017 through 2021 were compared to the MAGs (Table 3-5). The highlighted county-aquifer-basin combinations represent 5-year average historical use that exceeds the year 2030 MAG.

The pumping estimates are based on reported pumping (from TWDB surveys) as well as non-surveyed estimates. Non-surveyed estimates can comprise a significant portion of the historical estimates data. Irrigation estimates are based on Farm Service Administration crop acreage data and irrigation depths are based on evapotranspiration. Livestock estimates are based on Texas Agricultural Statistics Service livestock population statistics with use per animal derived from Texas Agricultural Experiment Station research. Oilfield surveys help provide estimates for mining use. TWDB estimates water use for non-surveyed cities with a population greater than 500.

Based on the comparison shown in Table 3-5, four county-aquifer-basin combinations have estimated historical use that exceeds the 2020 MAG. These include: Andrews – Ogallala - Rio Grande, Andrews – Dockum - Rio Grande, Concho – Hickory - Colorado, and Crockett – Edwards-Trinity (Plateau) - Colorado.

Table 3-5
Modeled Available Groundwater and Historical Pumping Estimates (2017-2021)
-All Values are in Acre-Feet per Year-

County	Aquifer	Basin	MAG 2030	Historical Pumping Average (2017-2021)
Andrews	Dockum	Colorado	1,503	2
		Rio Grande	0	0
	Ogallala	Colorado	19,391	17,574
		Rio Grande	0	581*
Borden	Dockum	Brazos	323	0
		Colorado	703	121
	Ogallala and Edwards-Trinity (High Plains)	Brazos	673	590
		Colorado	3,759	1,306
Brown	Ellenburger-San Saba	Colorado	131	1
	Hickory	Colorado	12	0
	Marble Falls	Colorado	25	0
	Trinity	Brazos	51	39
		Colorado	1,376	1,015
Coke	Edwards-Trinity (Plateau)	Colorado	997	170
Coleman	---	Colorado	---	0
Concho	Hickory	Colorado	27	298*
Crane	Dockum	Rio Grande	94	341*
	Edwards-Trinity (Plateau) and Pecos Valley	Rio Grande	4,991	1,403
Crockett	Edwards-Trinity (Plateau)	Colorado	20	1,032*
		Rio Grande	5,427	630
Ector	Edwards-Trinity (Plateau) and Pecos Valley	Colorado	4,925	2,001
		Rio Grande	617	474
Glasscock	Edwards-Trinity (Plateau)	Colorado	65,186	33,347
	Ogallala	Colorado	7,673	4,983
Howard	Ogallala	Colorado	15,631	6,490
	Dockum	Colorado	6,770	272
Irion	Edwards-Trinity (Plateau)	Colorado	3,289	607
Kimble	Edwards-Trinity (Plateau)	Colorado	1,386	679
	Ellenburger-San Saba	Colorado	521	7
	Hickory	Colorado	165	20
Loving	Dockum	Rio Grande	453	24
	Pecos Valley	Rio Grande	2,982	917
	Rustler	Rio Grande	200	1
McCulloch	Ellenburger-San Saba	Colorado	4,364	251
	Hickory	Colorado	24,377	5,544
Martin	Ogallala	Colorado	48,293	34,326
	Dockum	Colorado	114,49	0
Mason	Ellenburger-San Saba	Colorado	3,237	73
	Hickory	Colorado	13,212	5,484

County	Aquifer	Basin	MAG 2030	Historical Pumping Average (2017-2021)
Menard	Edwards-Trinity (Plateau)	Colorado	2,597	457
	Ellenburger-San Saba	Colorado	309	4
	Hickory	Colorado	2,725	398
Midland	Edwards-Trinity (Plateau)	Colorado	23,233	5,750
Pecos	Capitan Reef	Rio Grande	26,168	2,399
	Dockum	Rio Grande	8,164	0
	Edwards-Trinity (Plateau) and Pecos Valley	Rio Grande	122,899	72,080
	Rustler	Rio Grande	7,043	3,196
Reagan	Dockum	Colorado	962	1,514*
	Edwards-Trinity (Plateau)	Colorado	68,205	23,441
		Rio Grande	28	63*
Reeves	Dockum	Rio Grande	2,539	3,062*
	Edwards-Trinity (Plateau) and Pecos Valley	Rio Grande	189,744	7,042
	Rustler	Rio Grande	2,387	3,678*
Schleicher	Edwards-Trinity (Plateau)	Colorado	6,403	2,359
		Rio Grande	1,631	1,089
Sterling	Edwards-Trinity (Plateau)	Colorado	2,495	521
Sutton	Edwards-Trinity (Plateau)	Colorado	388	200
		Rio Grande	6,022	2,085
Upton	Edwards-Trinity (Plateau) and Pecos Valley	Colorado	21,243	6,099
		Rio Grande	1,126	346
Ward	Capitan Reef	Rio Grande	103	0
	Dockum	Rio Grande	2,150	36
	Pecos Valley	Rio Grande	49,976	10,674
	Rustler	Rio Grande	0	3*
Winkler	Capitan Reef	Rio Grande	274	0
	Dockum	Colorado	13	5,955*
		Rio Grande	5,987	2,419
	Edwards-Trinity (Plateau) and Pecos Valley	Rio Grande	49,949	2
* Average historical pumping exceeds MAG				

3.2 Existing Surface Water Supplies

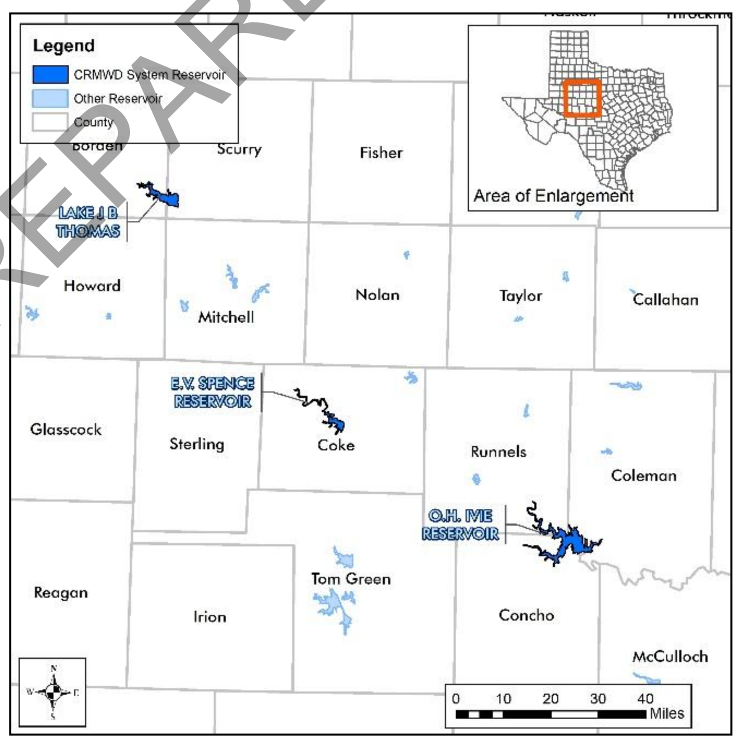
Existing surface water includes supplies from reservoirs, river diversions, and local stock tanks for livestock use. While surface water provides only a fraction of the total water supplies in the region, it is a very important source for municipal and industrial use. In the year 2021, surface water provided only 14 percent of the total water used in the region, yet surface water accounted for 51 percent of the municipal water supply in Region F. Nearly all of the municipal surface water supplies are from reservoirs. Run-of-the-river water rights are used primarily for irrigation. Only the cities of Menard, Paint Rock, San Angelo and Junction use run-of-the-river rights for municipal supply. Table 3-6 shows information regarding the 17 major reservoirs in Region F. Figure 3-6 shows the location of these reservoirs. Additional information regarding water rights and historical water use may be found in Chapter 1.

3.2.1 Description of Major Reservoirs

Fifteen of the 17 major reservoirs in Region F are located in the Colorado River Basin. Two are located in the Pecos River Basin, which is part of the Rio Grande River Basin. Most of the water from the in-region reservoirs are used in Region F, but some water is supplied to users in other regions. A brief description of these reservoirs and/or systems is presented below.

Colorado River Municipal Water District Surface Water System

The Colorado River Municipal Water District (CRMWD) owns and operates three major reservoirs, Lake J.B. Thomas, E.V. Spence Reservoir and O.H. Ivie Reservoir, for water supply. CRMWD also operates several impoundments for saltwater control. The CRMWD reservoirs are in the Upper Colorado River Basin, with Lake J.B. Thomas at the upstream end of the system in Scurry and Borden Counties and O.H. Ivie at the downstream end in Concho and Coleman Counties. E.V. Spence Reservoir is in Coke County near the City of Robert Lee. Water from the reservoir system is supplemented with groundwater from several well fields and is used to supply three-member cities and other customers. Collectively, the three reservoirs are permitted for 1,247,100 acre-feet of storage and 186,000 acre-feet per year of diversions. Recent drought left the two upper reservoirs (J.B. Thomas and E.V. Spence) at storage levels less than 2 percent of conservation capacity in 2013. By 2023, the CRMWD surface water reservoirs were at approximately 31 percent of the combined capacity, with the greatest amount of stored water in O.H. Ivie.



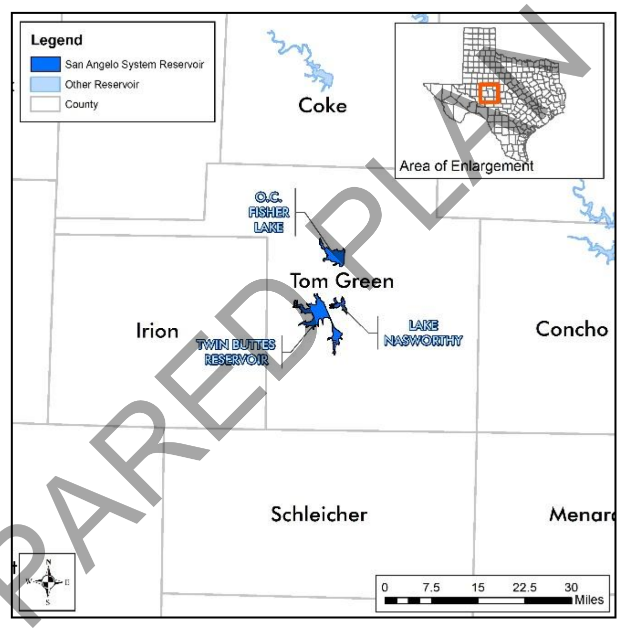
Lake Colorado City/Champion Creek Reservoir System

Lake Colorado City and Champion Creek Reservoir are in Mitchell County, south of Colorado City. Lake Colorado City was built in 1949 on Morgan Creek to supply cooling water for the Morgan Creek Power

Plant and municipal supply to Colorado City. Colorado City no longer receives water from these lakes. Lake Colorado City is permitted to store 29,934 acre-feet and divert 5,500 acre-feet per year for municipal, industrial and steam electric power use. Champion Creek Reservoir was constructed 10 years later in 1959 to supplement supplies from Lake Colorado City. A 30-inch pipeline is used to transfer water from Champion Creek Reservoir to Lake Colorado City when the lake's water levels are low. Champion Creek Reservoir is permitted to store 40,170 acre-feet and divert 6,750 acre-feet per year.

San Angelo System

The San Angelo surface water system, as defined for regional water planning purposes, includes Twin Buttes Reservoir, Lake Nasworthy, and O.C. Fisher Reservoir. These lakes, while owned and operated by different authorities, are used collectively as a system for water supply to San Angelo and its customers.



Twin Buttes Reservoir

Twin Buttes Reservoir is located on the Middle Concho River, Spring Creek and the South Concho River southwest of San Angelo in Tom Green County. The reservoir is owned by the Bureau of Reclamation. The dam was completed in 1963. The reservoir has permitted conservation storage of 170,000 acre-feet and permitted diversion of 29,000 acre-feet per year for municipal and irrigation use. Twin Buttes reservoir is operated with Lake Nasworthy to provide municipal water to San Angelo through the San Angelo Water Supply Corporation. Irrigation water is released directly from the reservoir to a canal system for irrigation use in Tom Green County. Due to recent droughts, little supply has been available for irrigation purposes in recent years.

Lake Nasworthy

Lake Nasworthy is located on the South Concho River, approximately 6 miles southwest of San Angelo in Tom Green County. Lake Nasworthy was completed in 1930 to provide municipal, industrial and irrigation water to the City of San Angelo. The lake is permitted to store 12,500 acre-feet and divert 25,000 acre-feet per year of water for municipal and industrial purposes.

This permitted diversion amount includes water diverted by San Angelo from the Twin Buttes Reservoir for municipal purposes. Lake Nasworthy is operated as a system with Twin Buttes Reservoir.

O.C. Fisher Reservoir

O.C. Fisher Reservoir is on the North Concho River, located northwest of San Angelo in Tom Green County. The reservoir was constructed by the U.S. Army Corps of Engineers for flood control and water supply. The project was fully operational in 1952. The Upper Colorado River Authority (UCRA) holds water rights to impound 80,400 acre-feet and divert 80,400 acre-feet per year for water for municipal, industrial and mining use. The Cities of San Angelo and Miles have contracts for water from this source. During the 2011-2015 drought, there was little to no water available from O.C. Fisher. In August 2024 the reservoir was at 0.8 percent capacity.

Table 3-6 Major Reservoirs in Region F [a]

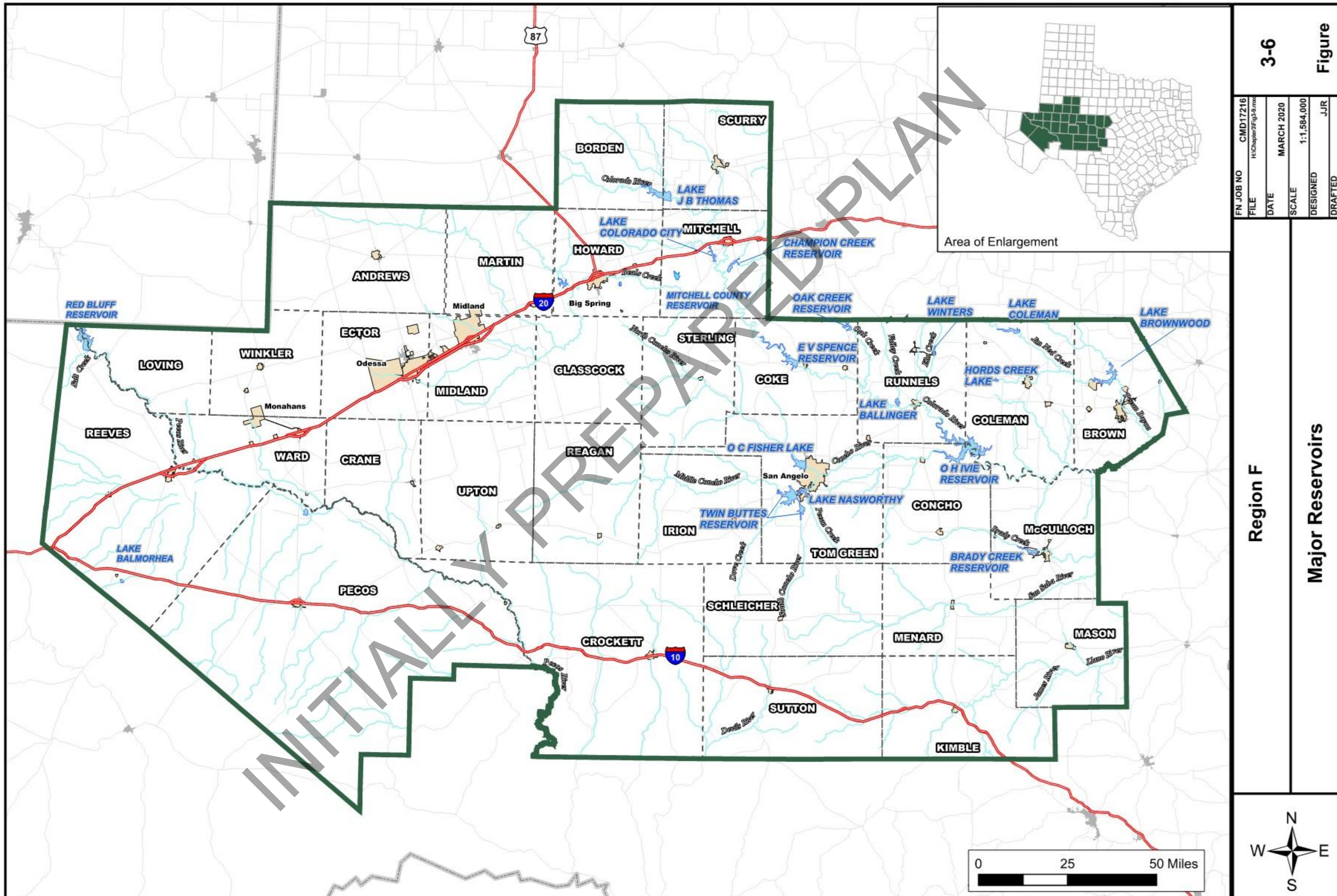
Reservoir Name	Basin	Stream	County(ies)	Water Right Number(s)	Priority Date	Permitted Conservation Storage (Acre-Feet)	Permitted Diversion (Acre-Feet)	2022 Use (Acre-Feet)	Owner	Water Rights Holder(s)
Lake J B Thomas	Colorado	Colorado River	Borden and Scurry	CA-1002	8/5/1946	204,000	30,000	14,454	CRMWD	CRMWD
Lake Colorado City	Colorado	Morgan Creek	Mitchell	CA-1009	11/22/1948	29,934	5,500	4	Luminant	Luminant
Champion Creek Reservoir	Colorado	Champion Creek	Mitchell	CA-1009	4/8/1957	40,170	6,750		Luminant	Luminant
Oak Creek Reservoir	Colorado	Oak Creek	Coke	CA-1031	4/27/1949	30,000	10,000	159	City of Sweetwater	City of Sweetwater
Lake Coleman	Colorado	Jim Ned Creek	Coleman	CA-1702	8/25/1958	40,000	9,000	1,265	City of Coleman	City of Coleman
E V Spence Reservoir	Colorado	Colorado River	Coke	CA-1008	8/17/1964	488,760	43,000	13,802	CRMWD	CRMWD
Mitchell County Reservoir	Colorado	Off-Channel	Mitchell		2/14/1990	27,266				
Lake Winters	Colorado	Elm Creek	Runnels	CA-1095	12/18/1944	8,374	1,755	1	City of Winters	City of Winters
Lake Brownwood	Colorado	Pecan Bayou	Brown	CA-2454	9/29/1925	114,000	29,712	12,537	Brown Co. WID	Brown Co. WID
Hords Creek Lake	Colorado	Hords Creek	Coleman	CA-1705	3/23/1946	7,959	2,240	0	COE	City of Coleman
Lake Ballinger	Colorado	Valley Creek	Runnels	CA-1072	10/4/1946	6,850	1,000	268	City of Ballinger	City of Ballinger
O.H. Ivie Reservoir	Colorado	Colorado River	Coleman, Concho, and Runnels	A-3886 P-3676	2/21/1978	554,340	113,000	34,677	CRMWD	CRMWD
O.C. Fisher Lake	Colorado	North Concho River	Tom Green	CA-1190	5/27/1949	80,400	80,400	0	COE	Upper Colorado River Authority
Twin Buttes Reservoir	Colorado	S. Concho River	Tom Green	CA-1318	5/6/1959	170,000	29,000	11,787	U.S. Bureau of Reclamation	City of San Angelo
Lake Nasworthy	Colorado	S. Concho River	Tom Green	CA-1319	3/11/1929	12,500	25,000	55	City of San Angelo	City of San Angelo
Brady Creek Reservoir	Colorado	Brady Creek	McCulloch	CA-1849	9/2/1959	30,000	3,500	0	City of Brady	City of Brady
Red Bluff Reservoir	Rio Grande	Pecos River	Loving and Reeves	CA-5438	1/1/1980	300,000	292,500	23,582	Red Bluff WCD	Red Bluff WCD
Lake Balmorhea	Rio Grande	Toyah Creek	Reeves	A-0060 P-0057	10/5/1914	13,583	41,400	2,260	Reeves County WID #1	Reeves County WID #1
Total						***2,158,136***	***723,757***	***114,850***		

a. A major reservoir has more than 5,000 acre-feet of storage.

b. Total diversions under CA 1002 and CA 1008 limited to 73,000 acre-feet per year. CA 1008 allows up to 50,000 acre-feet per year of diversion. For purposes of this table, the limitation is placed on CA 1008.

c. Permitted storage reported is for water conservation storage. UCRA has permission to use water from the sediment pool.

Figure 3-6
Major Reservoirs



Oak Creek Reservoir

Oak Creek Reservoir is located on Oak Creek in northeastern Coke County. The reservoir was completed in 1953 and is permitted to store 30,000 acre-feet and divert 10,000 acre-feet per year for municipal and industrial use. The reservoir is owned by the City of Sweetwater, which is in the Brazos G Region. Municipal water from the lake supplies the Cities of Sweetwater, Blackwell, and Bronte Village. In the past, the reservoir also provided cooling water for a power plant. That facility is no longer operating.

Lake Coleman

Lake Coleman is constructed on Jim Ned Creek in Coleman County, approximately 14 miles north of the City of Coleman. It is in the Pecan Bayou watershed of the Colorado River Basin, upstream of Lake Brownwood. The lake was completed in 1966 and has a permitted conservation capacity of 40,000 acre-feet. The City of Coleman holds water rights to use 9,000 acre-feet per year for municipal and industrial purposes.

Lake Brownwood

Lake Brownwood is located on Pecan Bayou, north of the City of Brownwood in Brown County. The lake is owned and operated by the Brown County Water Improvement District #1. Construction was completed on Lake Brownwood in 1933. It is permitted to store 114,000 acre-feet of water and divert 29,712 acre-feet per year for municipal, industrial and irrigation purposes. This lake provides much of the municipal and industrial water supply in Brown County and surrounding areas.

Hords Creek Lake

Hords Creek Lake is located on Hords Creek in western Coleman County. Construction of the dam was completed in 1948, and impoundment of water began. The lake has a permitted conservation capacity of 7,959 acre-feet and a permitted diversion of 2,240 acre-feet per year. The lake is jointly owned by the City of Coleman and the U.S. Army Corps of Engineers and is used for flood control and as a municipal water supply.

Lake Winters

Lake Winters/ New Lake Winters is on Elm Creek, about five miles east of the City of Winters in northeast Runnels County. The City of Winters owns and operates the lake for municipal water supply. The original lake was constructed in 1944 and expanded in 1983. The lake is permitted to store 8,347 acre-feet of water and divert up to 1,755 acre-feet per year.

Lake Ballinger/Lake Moonen

Lake Ballinger is located on Valley Creek in Runnels County. The lake is owned and operated by the City of Ballinger for municipal water supply. The original dam was completed in 1947 (Lake Ballinger). A larger dam was constructed downstream of Lake Ballinger in 1985 (Lake Moonen). The two lakes are permitted to impound 6,850 acre-feet and divert 1,000 acre-feet per year.

Brady Creek Reservoir

Brady Creek Reservoir is located on Brady Creek in central McCulloch County. The lake is owned and operated by the City of Brady for municipal and industrial water supply. Construction of the dam was completed, and impoundment of water began in 1963. The reservoir has a permitted conservation storage capacity of 30,000 acre-feet and a permitted diversion of 3,500 acre-feet per year.

Red Bluff Reservoir

Red Bluff Reservoir is located on the Pecos River in Reeves and Loving counties, approximately 45 miles north of the City of Pecos, and extends into Eddy County, New Mexico. The reservoir is owned and operated by the Red Bluff Water Control District. Construction of the dam was completed in 1936 and water use started in 1937. The reservoir is permitted to store 300,000 acre-feet and divert 292,500 acre-feet per year for irrigation purposes.

Seven water districts form the Red Bluff Water Control District, which supplies irrigation water to Loving, Pecos, Reeves and Ward Counties. Hydropower is no longer generated at the dam. With much of the drainage area of the reservoir in New Mexico, water is released from New Mexico to Red Bluff Reservoir in accordance with the Pecos River Compact.

Water is released from Red Bluff to irrigation users through the bed and banks of the Pecos River and canal systems. Due to high evaporative rates and infiltration, approximately 75 percent of the water released is lost during transport. Naturally occurring salt springs above the reservoir and high evaporative losses contribute to high concentrations of total dissolved solids and chlorides in the water. Irrigation water with total dissolved solids concentrations greater than 1,500 mg/l impacts agricultural production and concentrations greater than 4,500 mg/l damages the land and is not suitable for irrigation. The salinity in Red Bluff Reservoir can exceed these thresholds during dry years, making the available water unusable for its intended purpose.

Lake Balmorhea

Lake Balmorhea is located on Sandia Creek in the Pecos River Basin in southern Reeves County, southeast of the City of Balmorhea. The Reeves County Water Improvement District No. 1 owns and operates the lake. Construction began on the earth fill dam in 1916 and was completed in 1917. The lake is permitted to store 13,583 acre-feet of water and divert 41,400 acre-feet per year for irrigation purposes. The lake is predominantly spring fed. In addition to water from Sandia Creek, Lake Balmorhea receives water from Kountz Draw from the south and Toyah Creek, which receives water from Solomon Springs, through Madera Diversion Dam and its canals. Surplus water from Phantom Lake Canal, which is supplied by several springs, is also stored in Lake Balmorhea until it is needed for irrigation.

3.2.2 Available Surface Water Supply

Surface water supplies in this chapter are derived from Water Availability Models (WAMs) developed by the Texas Commission on Environmental Quality (TCEQ). The TWDB requires the use of the Full Authorization Run (Run 3) of the approved TCEQ WAM for each basin as the basis for water availability in regional water planning[4]. Full Authorization assumes that all water rights will be fully met in priority order. Three WAM models are available in Region F: (a) the Colorado WAM, which covers most of the central and eastern portions of the region, (b) the Rio Grande WAM, which covers the Pecos River Basin, and (c) the Brazos WAM. There are approximately 493,000 acre-feet of permitted diversions in the Colorado Basin in Region F, more than half of the permitted diversions in the region. There are 416,158 acre-feet of permitted diversions in the Rio Grande Basin. There is one water right in the Brazos Basin in Region F with a permitted diversion of 63 acre-feet per year.

After 2013, the TCEQ extended the Colorado WAM through December 2013 to better capture current conditions (previous WAM hydrology only went through 1998). The TCEQ then made other corrections to the model in 2019, including updating to reflect LCRA's 2019 WMP. The updated Colorado River WAM was released in early 2020 and was the basis for surface water supply availability in Region F. Under the updated Colorado WAM, many sources have no yields, and some sources have lower firm and safe yields from the previous estimates due to the drought of record.

Reservoirs lose capacity over time due to sedimentation. For this reason, it is important to update the elevation-area-capacity relationship of the reservoir to reflect future sedimentation prior to calculating the future yield of a reservoir. In Region F, elevation-area-capacity relationships were derived for 2030 and 2080 conditions based on historical sedimentation rates using the average end-area method. More information on the sediment rates and future storage capacities is included in Appendix B.

Table 3-7 and Table 3-8 show the supplies available under the TCEQ WAM Run 3. Additional information on the derivation of the yields using the WAM can be found in Appendix B.

Table 3-7
Region F Reservoir Supplies
-Values in Acre-Feet per Year-

Reservoir Name	Basin	2030 WAM Firm Yield	2030 WAM Safe Yield	2080 WAM Firm Yield	2080 WAM Safe Yield
Lake J. B. Thomas	Colorado	0	0	0	0
E. V. Spence Reservoir	Colorado	0	0	0	0
O. H. Ivie Reservoir	Colorado	33,600	28,540	29,300	24,540
Lake Colorado City	Colorado	0	0	0	0
Champion Creek Reservoir	Colorado	0	0	0	0
Oak Creek Reservoir	Colorado	0	0	0	0
Lake Coleman	Colorado	0	0	0	0
Lake Winters/ New Lake Winters	Colorado	0	0	0	0
Lake Brownwood	Colorado	19,000	15,550	18,300	14,900
Hords Creek Lake	Colorado	0	0	0	0
Lake Ballinger / Lake Moonen	Colorado	0	0	0	0
O. C. Fisher Lake	Colorado	0	0	0	0
Twin Buttes Reservoir	Colorado	0	0	0	0
Lake Nasworthy	Colorado	0	0	0	0
Brady Creek Reservoir	Colorado	0	0	0	0
Red Bluff Reservoir	Rio Grande	20,350	16,180	20,170	16,040
Lake Balmorhea	Rio Grande	19,600	19,600	19,600	19,600
Total		**92,550**	**79,870**	**87,370**	**75,080**

Table 3-8
Region F Run-of-the-River Supplies by County and River Basin[a]
-Values in Acre-Feet per Year-

County	WAM Supplies
Colorado River Basin	
Andrews	0
Borden	0
Brown	162
Coke	8
Coleman	5
Concho	181
Crane	0
Crockett	0
Ector	0
Howard	0
Irion	111
Kimble	902
Loving	0
Martin	0
Mason	0
McCulloch	68
Menard	2,034
Midland	0
Mitchell	8
Reagan	0
Reeves	0
Runnels	236
Schleicher	0
Scurry	0
Sterling	27
Sutton	0
Tom Green	2,117
Upton	0
Ward	0
Winkler	0
Rio Grande River Basin	
Pecos	19,642
Reeves	714
Ward	980
Total	***27,195***

a. Does not include unpermitted supplies for livestock or diverted water from CRMWD chloride projects.

3.2.3 Surface Water Local Supplies

Local surface water supplies generally refer to stock ponds or on-farm supplies used to provide water to livestock. The available supply from these sources is based on the historical usage data collected by the TWDB. The local supply availability estimates are known historical quantities, which represent firm supply during drought conditions for planning purposes. Table 3-9 shows the availability in each county and river basin.

Table 3-9
Local Supplies in Region F
-Values in Acre-Feet per Year-

County	Basin	Local Supply
Borden	Brazos	7
Borden	Colorado	221
Brown	Brazos	78
Brown	Colorado	825
Coke	Colorado	62
Coleman	Colorado	797
Concho	Colorado	287
Crane	Rio Grande	3
Crockett	Colorado	5
Crockett	Rio Grande	22
Ector	Colorado	17
Glasscock	Colorado	24
Howard	Colorado	33
Irion	Colorado	55
Kimble	Colorado	104
Loving	Rio Grande	1
Martin	Colorado	25
Mason	Colorado	176
McCulloch	Colorado	136
Menard	Colorado	49
Midland	Colorado	2
Mitchell	Colorado	266
Pecos	Rio Grande	32
Reagan	Colorado	40
Runnels	Colorado	383
Schleicher	Colorado	15
Schleicher	Rio Grande	9
Scurry	Brazos	129
Scurry	Colorado	241
Sterling	Colorado	26
Sutton	Colorado	4
Sutton	Rio Grande	5
Tom Green	Colorado	209
Ward	Rio Grande	4
Winkler	Rio Grande	2

3.3 Reuse Water Supplies

Reuse water can be defined as any water that has already been used for some purpose and is used again for another purpose instead of being discharged or otherwise disposed.   In Region F, treated wastewater effluent has been used for agricultural irrigation and some industrial purposes for many years. It is also becoming a desired source for mining use. The use of wastewater effluent for other purposes, including municipal, has gained a level of public acceptance that allows water managers to implement other reuse strategies. Although there is still some public resistance to the direct reuse of wastewater effluent for potable water supply, acceptance is growing. There is also increasingly widespread use of reuse water for non-potable municipal uses such as irrigation of parks, golf courses, and landscaping. Reuse water supplies (reclaimed water) requires development of the infrastructure necessary to transport the treated effluent to secondary users and may require additional treatment for the end use.

The use of reclaimed water can occur directly or indirectly. Direct use is typically defined as use of the effluent before it is discharged to a state water course, under arrangements set up by the generator of the wastewater. Indirect reuse occurs when the effluent is discharged to a stream or reservoir and later diverted from the stream for some purpose, such as municipal, agricultural or industrial supply. Indirect reuse is sometimes difficult to quantify because the effluent becomes mixed with the waters of the receiving body. A water rights permit would be needed to transport the reclaimed water by the bed and banks of the stream or reservoir. At this time, there are no indirect reuse supplies in Region F but some are being considered for future development.

A number of communities in Region F have direct non-potable wastewater reuse programs in place, utilizing municipal wastewater effluent for landscape irrigation or for industrial or agricultural purposes. San Angelo has historically used reuse water to irrigate city-owned farms or has sold the effluent to other irrigators but is considering it for municipal use in the future. The Cities of Andrews, Crane, Eden, Monahans, Fork Stockton, and Snyder employ reuse supplies to irrigate golf courses. Midland has implemented a direct non-potable reuse project to supply landscape irrigation water to Midland College. Also, mining has become a prominent recipient of direct reuse in Region F, either through direct purchases of wastewater effluent or recycling produced water. The cities of Kermit, Midland and Odessa have contracts to supply treated wastewater to mining and manufacturing customers that support the mining industry. It is anticipated that over time, mining will utilize the majority of available wastewater from these cities.

The first ever direct potable reuse water supply project was developed in Region F by CRMWD in Big Spring. The Big Spring reuse project utilizes advanced treatment systems to reclaim Big Spring's effluent. After advanced treatment, the water is mixed with other raw water supplies and treated again before distribution throughout the CRMWD system.

Reuse supplies developed beyond what is currently being used may be considered as a water management strategy. A summary of the current reuse supplies for Region F is presented in Table 3-10. The county and basin represent the location of where the reuse water is used, not where it is generated.

In addition to municipal wastewater effluent that is reused for mining purposes, recycling of produced water is becoming increasingly popular. This type of reuse collects the water that flows back to the surface during and after the completion of the hydraulic fracturing or oil field flooding. The TWDB has historical estimates of mining reuse by county, and projected reuse supplies for the 2026 planning period. A summary of the existing recycled water supply used for mining is provided in Table 3-11.

Table 3-10
Reuse Water Supply in Region F
-Values in Acre-Feet per Year-

County	Basin	2030	2040	2050	2060	2070	2080
Andrews	Colorado	709	709	709	709	709	709
Concho	Colorado	187	187	187	187	187	187
Crane	Rio Grande	123	123	123	123	123	123
Howard	Colorado	1,855	1,855	1,855	1,855	1,855	1,855
Midland	Colorado	11,210	11,210	11,210	11,210	11,210	11,210
Pecos	Rio Grande	1,511	1,511	1,511	1,511	1,511	1,511
Scurry	Colorado	1,124	1,124	1,124	1,124	1,124	1,124
Tom Green	Colorado	8,300	8,300	8,300	8,300	8,300	8,300
Ward	Rio Grande	1,017	1,017	1,017	1,017	1,017	1,017

Table 3-11
Recycled Mining Water Supply in Region F
-Values in Acre-Feet per Year-

County	Basin	2030	2040	2050	2060	2070	2080
Andrews	Colorado	741	741	680	556	392	247
Borden	Colorado	596	596	546	447	315	199
Crane	Rio Grande	109	109	109	108	5	5
Ector	Colorado	9,893	9,893	9,862	9,802	9,721	9,650
Glasscock	Colorado	2,445	2,445	2,241	1,833	1,293	815
Howard	Colorado	2,178	2,178	1,997	1,634	1,153	726
Irion	Colorado	1,882	1,882	1,725	1,411	996	627
Loving	Rio Grande	2,118	2,118	2,118	2,118	2,118	2,118
Martin	Colorado	2,928	2,928	2,684	2,196	1,549	976
Midland	Colorado	2,595	2,595	2,379	1,946	1,373	864
Pecos	Rio Grande	2,851	2,851	2,851	2,851	2,851	2,851
Reagan	Colorado	3,499	3,499	3,207	2,624	1,851	1,166
Reeves	Rio Grande	6,175	6,175	6,175	6,175	6,175	6,175
Scurry	Colorado	54	54	50	41	29	18
Sterling	Colorado	538	538	493	403	285	179
Tom Green	Colorado	174	174	160	130	92	58
Upton	Rio Grande	2,798	2,798	2,565	2,098	1,480	933
Ward	Rio Grande	1,159	1,159	1,159	1,159	1,159	1,159
Winkler	Colorado	578	578	578	578	578	578
Winkler	Rio Grande	1,290	1,290	1,290	1,290	1,290	1,290

3.4 Water Quality

Water quality can impact a water source's usability. Many groundwater and surface water sources in Region F contain high levels of salts or other constituents that make them unsuitable for drinking water supplies or for non-potable uses sensitive to salinity. Salinity is not easily removed via conventional treatment and often requires advanced treatment such as reverse osmosis which can greatly increase the cost of a project. For purposes of regional water planning, water with TDS levels less than 1,000 mg/l is considered fresh water. This water meets the secondary standard for drinking water. Water with TDS levels greater than 1,000 mg/l and less than 35,000 mg/l is considered brackish. Water with TDS levels greater than 35,000 mg/l is considered saline. The water quality range for brackish water covers many water supplies in Region F, including both surface water and groundwater.

3.4.1 Groundwater Quality

As shown in Table 3-12, many of the major and minor aquifers in Region F contain significant quantities of brackish groundwater, with deeper units having much greater salinity levels. While the Texas Water Development Board defines brackish water supplies with a wide range of salinity levels (from 1,000 to 35,000 mg/l), the economically feasible range for development is much smaller with TDS concentrations ranging between 1,000 and 5,000 mg/l. While some of this water is currently being used for agricultural and industrial purposes, much of it remains unused. It is unlikely that desalination will be sufficiently economical to be a significant supply for end uses such as irrigated agriculture, but these sources may prove feasible for municipal and industrial purposes.

Although extensive brackish and saline water occurs in the deep, typically hydrocarbon-producing formations throughout Region F, for the most part these formations are not practical water supplies for meeting regional water demands. Many of these formations typically produce groundwater with very high salinities and are found at depths too great to be economically feasible as a water supply. It should be noted that most of the deeper, hydrocarbon-producing formations have some potential to produce brackish groundwater at reasonable rates in and near where they outcrop. The outcrops for many of these units are in the eastern third of the region.

Brackish groundwater desalination has increasingly become a focus of state-wide groundwater research. Notable contributions that have occurred within the previous decade include characterization and quantification of brackish resources (LBG-Guyton Associates, 2003), creation of a state desalination database (Nicot and others, 2005), consideration of concentrate disposal options (Nicot and others, 2004), development of a brackish desalination guidance manual (NRS Consulting Engineers and others, 2008) and creation of the Texas BRACS database (Meyers and others, 2012).

TWDB Report 382 "Pecos Valley Aquifer, West Texas: Structure and Brackish Groundwater" was published in 2012 as the pilot study of the Brackish Resources Aquifer Characterization System (BRACS) Program. The BRACS program was initiated to map and characterize brackish groundwater to facilitate desalination projects. The goals of the study were: mapping of the geologic boundaries of the alluvium, mapping of the distribution of total dissolved solids and other parameters crucial to desalination and estimating brackish reservoir volumes. This report is regional in scale, contains a robust data set from numerous sources, and presents relatively detailed structural and water quality data from an aquifer-wide perspective.

As directed by House Bill 30, additional studies have been completed that designate specific brackish production areas for the Rustler, Blaine, and Lipan aquifers. These studies were completed in 2016 and 2017.

Water Quality

Region F has known some water quality challenges in both groundwater and surface water sources. Some of the Region's groundwater sources are brackish and require blending or advanced treatment before use. The Hickory aquifer can have elevated level of radionuclides. The Lipan aquifer can have elevated nitrates and the Blaine aquifer, in addition to being brackish in some parts, can have elevated levels of gypsum, halite, and anhydrite. Some surface water sources can have elevated TDSs from naturally occurring sources and may be exacerbated by low water levels and high evaporation during drought.

Table 3-12
Summary of Water Quality for Groundwater Sources in Region F

Aquifer	Salinity (TDS)[a]	Other constituents of concern
Edwards-Trinity Plateau	Fresh/Brackish	Hardness
Ogallala	Fresh/Brackish	
Hickory	Fresh	Radionuclides
Pecos Valley	Brackish	
Trinity	Fresh/Brackish	
Dockum	Brackish	
Lipan	Brackish	Nitrates
Ellenberger San Saba	Fresh/Brackish	Hardness
Marble Falls	Fresh/Brackish	
Rustler	Brackish	
Capitan Reef	Brackish	
Blaine	Brackish (small pockets of fresh)	Gypsum, halite, and anhydrite
Cross Timbers	Fresh/Brackish	

a. -Fresh <1,000 mg/l; 1,000 mg/l< Brackish> 35,000 mg/l; Saline > 35,000 mg/l

3.4.2 Surface Water Quality

Surface water quality in Region F can often be poor due to high levels of total dissolved solids (TDS). Contamination from natural mineral deposits and anthropogenic sources both contribute to inferior surface water quality throughout the region. Natural sources of dissolved solids include surface water traveling across mineral beds, dissolution of natural underground mineral deposits, and the concentrating effects of evaporation and transpiration from plants. Improper brine disposal from oil and gas well production, leaking oil well casings and the over pressurization of downhole formations, and municipal wastewater treatment plant discharges are among the human sources of TDS. Within reservoirs, concentration of minerals due to evaporation coupled with low runoff often result in diminished water quality as the reservoir levels decline. In addition, lakes located near urban centers can be impacted by non-point source pollution that can affect the treatability and recreational quality of these water sources. The water quality in most of the lakes in Region F is impacted by high TDS levels during drought. These include lakes within the CRMWD system, Red Bluff Reservoir, O.C. Fisher and many of the smaller reservoirs in the upper Colorado River Basin. (More on surface water quality is discussed in Section 1.7.1).

To help improve surface water quality in the region, CRMWD has developed a chloride control project. This project diverts naturally occurring high saline surface water into off channel reservoirs for evaporation. These diversions help to improve the water quality of the main stem of the Colorado River.

3.4.3 Advanced Treatment

Due to limited amounts of high-quality water supply in the region, poorer quality water sources are increasingly being considered viable. Advanced treatment or desalination processes are used to treat water for use as a public water supply, or for non-potable uses sensitive to lower water quality. Most frequently in Region F, the water quality concern is the salt content of the water. However, in some cases, radionuclides are also a significant issue. Reverse osmosis is commonly used as the advanced treatment technology to remove salts or desalinate the water. The Texas secondary drinking water standard for total dissolved solids (TDS) is 1,000 mg/l. Although secondary standards are recommended limits and not required limits, funding may be limited for municipal projects that use a water source with

TDS greater than 1,000 mg/l unless desalination is part of the planned treatment process, greatly increasing the cost of new water supplies.

Until recently, advanced treatment of brackish waters was too expensive to be a feasible option for most public water suppliers. However, the costs associated with desalination technology have declined significantly in recent years, making it more affordable for communities to implement. If an available source of brackish water is nearby, desalination can be as cost-effective as transporting better quality water a large distance. In some areas, there is less competition for water from brackish sources because very little brackish water is currently used for other purposes, making it easier to develop new brackish sources.

Two factors significantly impact the cost-effectiveness of desalination: initial water quality and concentrate disposal. Treatment costs are directly correlated to the quality of the source water and can vary significantly depending on the constituents in the water. Use of brackish waters with higher ranges of TDS may not be cost-effective. The presence of other constituents, such as calcium sulfate, may also impact the cost-effectiveness of desalination. The disposal of brine waste from the desalination process can be a significant portion of the costs of a project. The options for concentrate disposal include discharge to surface water, existing sewer, evaporation pond (land application) or to an injection well. Most facilities discharge concentrate to either surface water or sanitary sewer[5]. The least expensive option is discharge to a receiving body of water or land application. However, a suitable receiving body with acceptable impacts to the environment may not be available. Disposal of concentrate by deep well injection could be a practical and cost-effective method for large-scale desalination projects in Region F.

Two treatment facilities for brackish water currently operating in Region F are in Fort Stockton. The City of Fort Stockton draws water from the Pecos Alluvium and Edwards-Trinity aquifers that must be treated to reduce TDS to acceptable levels. The main Fort Stockton plant consists of microfiltration (MF) and ultraviolet (UV) disinfection pretreatment, followed by RO and chlorination. Feed water with a TDS concentration of approximately 1,400 mg/l is blended with RO permeate at a ratio of 80:20. The maximum capacity of the RO permeate stream is approximately 3.8 MGD. Currently, the Fort Stockton facility produces approximately 7.0 MGD blended water, at 400-700 mg/l TDS. Concentrate streams are disposed of using evaporation ponds. The City of Fort Stockton also owns and operates a second, smaller desalination facility that uses similar technology. The feed water for the secondary plant has a TDS concentration of approximately 2,200 mg/l and is blended with RO permeate at a ratio of 75:25. Currently, the secondary plant produces approximately 1 MGD of blended water at 450 mg/l TDS. Future plans for the Fort Stockton facility include the possible installation of a dedicated treatment train for the city's industrial customers.[6]

Other current users of desalination facilities include the City of Brady, Midland Country Club, and Water Runner, Inc in Midland. In addition, the Millersview-Doole Water Supply Corporation (MDWSC) operates a RO desalination plant that uses O.H. Ivie Reservoir as a water source, which has TDS levels ranging from <1,000 to 1,500 mg/l. The City of Eden operates a reverse osmosis facility to treat water for high radionuclide levels . Other users within the region are considering advanced treatment to improve water quality. These will be considered water management strategies.

Other industrial and commercial users in the region also desalinate water for various uses. However, the TWDB database does not report any user with a treatment facility smaller than 0.025 million gallons per day. At this time, it is not feasible to estimate how much of the industrial and commercial desalination utilizes a brackish water source.

3.5 Currently Available Supplies for Water User Groups

Unlike the overall water availability presented in Sections 3.1 and 3.2, currently available supplies are limited by the ability to deliver and/or use water. These limitations may include firm yield of reservoirs, well field capacity, aquifer characteristics, water quality, water rights, permits, contracts, regulatory restrictions, raw water delivery infrastructure and water treatment capacities where appropriate. Currently available supplies in each county are shown in Table 3-13. The total of the currently available supply by use type is shown in Figure 3-7. Summary tables included within Appendix I, *Database (DB27) Tables,* present the currently available water available for each water user group (WUG), arranged by county. (Water user groups are water utilities who provide more than 100 acre-feet per year, "county other" municipal uses, and countywide manufacturing, irrigation, mining, livestock, and steam electric uses.)

Historical water use from TWDB provides the basis for livestock water availability. Surface water supplies for livestock in Region F come primarily from private stock ponds, most of which are exempt under §11.142 of the Texas Water Code and do not require a water right. Supplies to mining include contracted sources (limited by current infrastructure), reuse and recycling, and available groundwater. While oil and gas groundwater use are exempt from groundwater permitting, the groundwater availability as determined by the MAGs are considered for regional planning purposes.

A few users in Region F obtain supplies from outside of Region F including Richland SUD whose supply is located in Region K, Balmorhea (Reeves County-Other) whose supply is located in Region E, Madera Valley WSC whose supply is also located in Region E, Borden County Water System (Borden County-Other) whose supply comes from Region O and Steam Electric Power in Ector County whose supply is located in Region O. These supplies represent about 0.6 percent of Region F's current supplies. Region F also provides water to users in Brazos G and Region K. These include the cities of Rotan and Sweetwater (G), and the portions of Richland SUD (K) and Coleman County SUD (G) not located in Region F. Less than 0.1 percent of Region F's current supplies goes to supply users in other regions.

Figure 3-7
Supplies Currently Available to Water User Groups by Type of Use

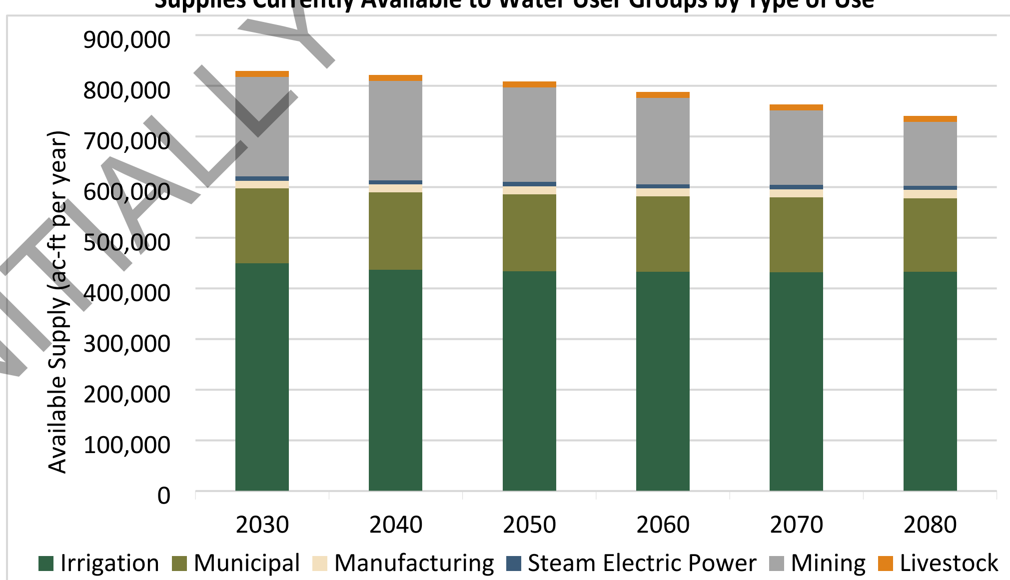


Table 3-13
Summary of Currently Available Supply to Water Users by County [a]
-Values in Acre-Feet per Year-

County	2030	2040	2050	2060	2070	2080
Andrews	19,825	18,635	17,924	17,518	17,324	17,186
Borden	5,874	5,882	5,848	5,586	4,821	4,137
Brown	16,624	16,705	16,737	16,779	16,825	16,875
Coke	1,167	1,177	1,187	1,203	1,221	1,241
Coleman	1,517	1,476	1,440	1,414	1,392	1,369
Concho	6,214	6,206	6,185	6,158	6,131	6,105
Crane	4,966	5,253	5,438	5,437	5,334	5,334
Crockett	5,459	5,459	5,459	5,459	4,608	3,361
Ector	41,961	43,253	42,330	40,391	39,331	38,315
Glasscock	57,548	57,541	56,385	54,069	51,002	48,281
Howard	30,643	30,292	28,438	25,545	22,299	19,416
Irion	5,500	5,500	5,343	5,029	4,614	4,245
Kimble	1,881	1,856	1,839	1,837	1,833	1,827
Loving	5,325	5,325	5,325	5,325	5,326	5,326
Martin	49,836	45,046	41,128	38,200	35,869	34,056
Mason	6,571	6,581	6,600	6,602	6,604	6,606
McCulloch	5,129	5,054	4,984	4,935	4,891	4,847
Menard	3,675	3,669	3,664	3,663	3,662	3,661
Midland	85,077	85,430	83,938	79,912	75,250	70,649
Mitchell	14,312	14,312	14,312	14,312	14,312	14,312
Pecos	159,999	160,104	160,212	160,421	160,655	160,910
Reagan	42,446	42,467	40,825	37,523	33,147	29,268
Reeves	99,400	99,407	99,415	99,424	99,432	99,440
Runnels	4,846	4,821	4,761	4,706	4,663	4,626
Schleicher	6,521	6,446	6,082	5,436	4,594	3,837
Scurry	10,363	10,301	10,125	9,940	9,794	9,681
Sterling	3,056	3,056	2,926	2,604	2,231	1,842
Sutton	2,737	2,633	2,529	2,451	2,368	2,282
Tom Green	70,437	65,765	65,675	65,503	65,333	65,162
Upton	25,571	25,611	24,325	21,728	18,278	15,232
Ward	15,157	15,660	16,185	16,639	17,127	17,647
Winkler	18,949	19,944	20,960	21,813	22,615	23,073
Total	***828,586***	***820,867***	***808,524***	***787,562***	***762,886***	***740,149***

a. Currently available supply reflects the most limiting factor affecting water availability to users in the region. These limitations include firm yield of reservoirs, well field capacity, aquifer characteristics, water quality, water rights, permits, contracts, regulatory restrictions, raw water delivery infrastructure and water treatment capacities.

3.6 Currently Available Supplies for Major Water Providers

There are five designated major water providers in Region F. A major water provider is a water user group or a wholesale water provider of particular significance to the region's water supply as determined by the regional water planning group[4]. Region F considered the quantity of water provided, regional extent, and significance to the region in identifying the major water providers. This identification only provides additional reporting in the regional water plan and does not diminish the planning efforts for other water user groups and wholesale water providers in the region. Similar to the currently available supply for water user groups, the currently available supply for each major water provider is limited by the ability to deliver water to end-users. These limitations include firm yield of reservoirs, well field capacity, aquifer characteristics, water quality, water rights, permits, contracts, regulatory restrictions and infrastructure. A summary of currently available supplies for each major water provider is included in Table 3-14. Brief descriptions of the supply sources are presented below. Attachment 3A contains the water supplies for each of these MWPs broken down by category of use for each decade.

Brown County Water Improvement District No. 1

BCWID owns and operates Lake Brownwood, as well as raw water transmission lines that supply the District's water treatment facilities, irrigation customers and the City of Early. BCWID operates two water treatment facilities in the City of Brownwood which together have a combined capacity of 16.5 million gallons per day (MGD). Other customers divert water directly from the lake.

Colorado River Municipal Water District (CRMWD)

CRMWD existing supplies operate as two basic systems: the Non-System portion of Lake Ivie and the main CRMWD System. The Lake Ivie Non-System includes yield from Lake Ivie that is contracted to Abilene, Midland, and San Angelo. It also includes contractual supplies to Millersview-Doole WSC, who can only access supplies from Lake Ivie. The main CRMWD System includes the remainder of the yield of Lake Ivie, Lake J.B. Thomas, E.V. Spence Reservoir and well fields in Ward and Martin Counties. CRMWD also supplies reclaimed water from its Big Spring reuse project. CRMWD owns and operates more than 600 miles of water transmission lines to provide water to its member cities and customers.

City of Midland

The City of Midland supplies treated water from four main sources: surface water sales from CRMWD, the T-Bar Ranch and Clearwater Well Fields in Winkler and Loving Counties, the Airport Well Field in Midland County, and the Paul Davis Well Field in Andrews and Martin Counties. The City also has a contract to provide up to 15 MGD of wastewater to the mining industry. The actual amount of reuse supply available to mining is limited to the produced wastewater, which is currently about 10 MGD.

City of Odessa

The City of Odessa is a CRMWD member city. As a member city, Odessa's water supplies will be provided from CRMWD sources. The City of Odessa sells treated water to the Ector County Utility District, as well manufacturing and steam electric power users in Ector County. In addition, the City sells treated effluent to mining users and raw water to irrigation and manufacturing users in Ector and Midland Counties.

City of San Angelo

The City of San Angelo's sources of supply are Lake O.C. Fisher (purchased from Upper Colorado River Authority), Twin Buttes Reservoir, Lake Nasworthy, O.H. Ivie Reservoir (purchased from CRMWD), and E.V. Spence Reservoir (purchased from CRMWD). The City also owns several run-of-the river water rights on the Concho River. San Angelo owns a raw water transmission line from Spence Reservoir (currently in need of rehabilitation) and a 5-mile water transmission line from a pump station on the CRMWD Ivie pipeline just north of the City. The City also owns a well field in McCulloch County in the Hickory aquifer. San Angelo provides treated water to the City of Miles and to rural customers in Tom Green County through an agreement with UCRA. Treated wastewater from the City has historically been used for irrigation in exchange for the irrigation share of water in Twin Buttes Reservoir. However, the City is developing a reuse project for municipal purposes (see discussion of the Concho River Water Project in Chapter 5D).

Table 3-14
Currently Available Supplies for Major Water Providers

-Values in Acre-Feet per Year-

Major Water Provider	Source	2030	2040	2050	2060	2070	2080
BCWID	Lake Brownwood [a]	15,550	15,420	15,290	15,160	15,030	14,900
	Subtotal	*15,550*	*15,420*	*15,290*	*15,160*	*15,030*	*14,900*
CRMWD	Lake Ivie [a]	28,540	27,740	26,940	26,140	25,340	24,540
	Lake Ivie Non-System	*15,263*	*14,785*	*14,266*	*13,772*	*13,310*	*12,855*
	System Portion	*13,277*	*12,955*	*12,674*	*12,368*	*12,030*	*[illegible]*
	Spence Reservoir [a]	0	0	0	0	0	0
	Thomas Reservoir [a]	0	0	0	0	0	0
	Big Spring Reuse	1,855	1,855	1,855	1,855	1,855	1,855
	Ward County Well Field [b]	40,055	38,176	36,441	32,970	31,235	29,500
	Martin County Well Field	1,035	922	836	779	740	711
	Subtotal	*71,485*	*68,693*	*66,072*	*61,744*	*59,170*	*56,606*
City of Midland	T- Bar Ranch (Winkler/Loving Counties) Well Field	16,815	16,815	16,815	16,815	16,815	16,815
	CRMWD	4,721	4,588	4,456	4,324	4,191	4,059
	Paul Davis Well Field (Andrews County)[c]	1,087	948	870	819	777	741
	Paul Davis Well Field (Martin County)[c]	3,485	3,105	2,816	2,624	2,491	2,394
	Airport Well Field	0	0	0	0	0	0
	Direct Reuse (mining, non-potable)	11,210	11,210	11,210	11,210	11,210	11,210
	Subtotal	*37,318*	*36,666*	*36,167*	*35,792*	*35,484*	*35,219*
City of Odessa	CRMWD System [a f]	30,026	31,935	32,377	30,735	30,062	29,280
	Direct Reuse (non-potable)	9,530	9,530	9,530	9,530	9,530	9,530
	Subtotal	*39,556*	*41,465*	*41,907*	*40,265*	*39,592*	*38,810*
City of San Angelo	Twin Buttes/Nasworthy [a]	0	0	0	0	0	0
	O.C. Fisher Reservoir [a]	0	0	0	0	0	0
	Spence Reservoir [d]	0	0	0	0	0	0
	Lake Ivie [e]	4,721	4,588	4,456	4,324	4,191	4,059
	Concho River	497	497	497	497	497	497
	Reuse	8,300	8,300	8,300	8,300	8,300	8,300
	McCulloch County Well Field (Hickory aquifer)	10,000	12,200	12,200	12,200	12,200	12,200
	Subtotal	*23,518*	*25,585*	*25,453*	*25,321*	*25,188*	*25,056*
	Total	***187,427***	***187,829***	***184,889***	***178,282***	***174,464***	***170,591***

a. Safe yield from the Colorado WAM. See subordination strategy for actual supply used in planning.
b. Limited by MAG in Ward County. CRMWD existing capacity 50,000 AFY.
c. Contract between University Lands and the City of Midland expires in 2035.
d. Supplies from Spence Reservoir currently not available to the City of San Angelo pending rehabilitation of Spence pipeline.
e. For planning purposes supplies limited to 16.54 percent of the safe yield of Ivie Reservoir.
f. These demands only include current customer demands.

ATTACHMENT 3A

WATER SUPPLIES BY DECADE AND CATEGORY OF USE FOR MAJOR WATER PROVIDERS

Major Water Provider Supplies by Category of Use in Each Decade
(acre-feet per year)

Major Water Provider	Category of Use	2030	2040	2050	2060	2070	2080
BCWID #1	Irrigation	6,000	6,000	6,000	6,000	6,000	6,000
	Livestock	0	0	0	0	0	0
	Manufacturing	454	471	488	506	525	544
	Mining	560	560	560	560	560	560
	Municipal	7,277	7,291	7,268	7,264	7,266	7,271
	Steam Electric Power	0	0	0	0	0	0
	Surplus	1,259	1,098	974	830	679	525
	Total	**15,550**	**15,420**	**15,290**	**15,160**	**15,030**	**14,900**
CRMWD	Irrigation	1,620	1,500	1,317	1,169	1,073	985
	Livestock	0	0	0	0	0	0
	Manufacturing	1,850	1,713	1,503	1,336	1,226	1,125
	Mining	0	0	0	0	0	0
	Municipal	62,199	62,608	60,734	57,003	54,814	52,610
	Steam Electric Power	3,100	2,872	2,518	2,236	2,054	1,885
	Surplus	2,716	0	0	0	0	0
	Total	**71,485**	**68,693**	**66,072**	**61,744**	**59,167**	**56,605**
Midland	Irrigation	0	0	0	0	0	0
	Livestock	0	0	0	0	0	0
	Manufacturing	72	72	72	72	72	72
	Mining	11,210	11,210	11,210	11,210	11,210	11,210
	Municipal	37,236	35,758	33,979	32,591	31,626	30,750
	Steam Electric Power	0	0	0	0	0	0
	Total	**48,518**	**47,040**	**45,261**	**43,873**	**42,908**	**42,032**
Odessa	Irrigation	1,220	1,130	992	880	808	742
	Livestock	0	0	0	0	0	0
	Manufacturing	7,077	7,051	7,011	6,980	6,958	6,939
	Mining	2,803	2,803	2,803	2,803	2,803	2,803
	Municipal	26,214	28,404	29,279	27,985	27,537	26,963
	Steam Electric Power	2,242	2,077	1,822	1,617	1,486	1,363
	Total	**39,556**	**41,465**	**41,907**	**40,265**	**39,592**	**38,810**
San Angelo	Irrigation	8,300	0	0	0	0	0
	Livestock	0	0	0	0	0	0
	Manufacturing	318	350	339	331	321	312
	Mining	0	0	0	0	0	0
	Municipal	14,900	16,935	16,814	16,690	16,567	16,444
	Steam Electric Power	0	0	0	0	0	0
	Total	**23,518**	**17,285**	**17,153**	**17,021**	**16,888**	**16,756**

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3 Standen, 2018. Personal communication.

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5 Shirazi, Saqib, and Arroyo, Jorge. Desalination Database Updates for Texas. Prepared for Texas Water Development Board. 2011. <file:///C:/Users/08288/Downloads/2011_03_desaldb_whitepaper.pdf>

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4 IDENTIFICATION OF WATER NEEDS

Water needs are identified by finding the difference between currently available supplies developed for water users in Chapter 3 and projected demands developed in Chapter 2. Currently available supplies and demands can be defined in multiple ways yielding different levels of water needs. This chapter outlines First, Second, and Third Tier water needs analyses, as defined below, each utilizing different definitions of supplies and demands. The Texas Water Development Board (TWDB) specifies that the currently available supplies to a water user be defined as the most restrictive of current water rights, contracts, infrastructure capacity and available yields for surface water and historical use and/or modeled available groundwater (MAG) for groundwater, henceforth called "current" supplies.

Under the First Tier water needs analysis, current surface water supplies are analyzed using the Water Availability Model (WAM). Assumptions in the WAM, including the use of strict priority order, underestimate the surface water supplies for some sources in the Colorado River Basin in Region F. These WAM supplies are considered as the most restrictive constraint when developing the First Tier water needs. For groundwater users, the most restrictive constraint is commonly infrastructure limitation and/or the MAG values for a specific aquifer. These current supplies are then compared to the full demand scenario outlined in Chapter 2 to yield the First Tier needs analysis.

The Second Tier needs analysis identifies water needs after consideration of reduced demands due to implemented conservation and direct reuse strategies. In some cases, conservation reduces water needs for a particular water user group (WUG) and enables the conserved water to be applied to the needs of others.

The First and Second Tier analyses are required by TWDB. The Third Tier analysis is unique to Region F. This analysis considers surface water supplies, based on a modification to the Colorado River WAM, which subordinates water rights in the lower portion of the Colorado River Basin to those water rights in Region F. These available supplies with subordination are distributed to the water users and incorporated into the entity's total available supplies. This total supply (called "subordination supplies" for the discussion of the Third Tier water needs) is then compared to the demands after conservation and reuse to provide a more realistic assessment of potential water needs. The Third Tier analysis provides an estimate of the amount of additional water needs that may require the development of infrastructure strategies.

This comparison of current water supply to demands is made for the region, county, basin, major water provider, and water user group. If the projected demands for an entity exceed the current supplies, then a shortage is identified (represented by a negative number). For some users, the supplies may exceed the demands (represented by a positive number).

Attachment 4A shows the needs of each Major Water Provider (MWP) in Region F, categorized by water use type, e.g., irrigation, livestock, manufacturing, mining, municipal, steam electric power. Attachment 4B shows a summary of First, Second, and Third Tier needs analyses by each WUG in Region F. Both attachments are provided at the end of this chapter.

4.1 First Tier Water Needs Analysis

The current supply in Region F consists of groundwater, surface water, local supplies and wastewater reuse. There is a small amount of water that comes from outside the region (Regions E, G, and O). The TWDB requires the use of the TCEQ's Water Availability Models (WAM) for regional water planning.

Most of the surface water rights in Region F are in the Colorado River Basin. Chapter 3 discusses the use of the WAM models for water supply estimates and the impacts to the available supplies in the upper Colorado River Basin. Under a WAM analysis, water rights are fully allocated based on strict priority order and thus downstream senior water rights holders continuously make priority calls on major municipal water rights in Region F. Although this does not give an accurate assessment of water supplies based on the way the basin has historically been operated, TWDB requires the regional water planning groups to use the WAM to determine supplies. Therefore, by definition, several sources in Region F have no supply, even though in practice, their supply may be greater than indicated by the WAM.

A similar concern is associated with groundwater supplies. The TWDB requires the use of the MAG values as the cap to groundwater supplies in a county. In some situations, this cap has artificially limited the amount of groundwater that is distributed to existing water users for current supplies and may not be representative of the water that is developed and currently being used. As with the surface water supplies, these restrictions may result in artificially higher water needs.

For the First Tier water needs, the current supplies as evaluated in Chapter 3 are compared to the projected demands from Chapter 2 in accordance with TWDB rules. Considering only the current, connected supplies for Region F, on a regional basis there is a projected regional shortage of over 47,000 acre-feet per year in 2030, increasing to a maximum shortage of over 99,000 acre-feet per year in 2080. This is shown in

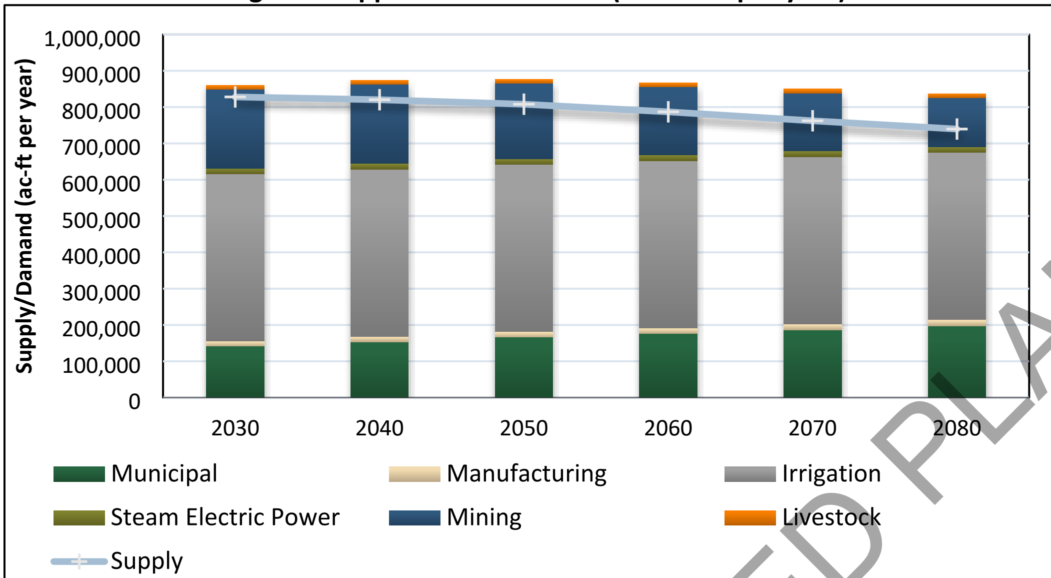
Table 4-1 and graphically in Figure 4-1.

On a county basis, there are twenty-five counties that have a shortage at some point over the planning period. These include Andrews, Borden, Brown, Coke, Coleman, Concho, Crane, Crockett, Ector, Howard, Irion, Kimble, Loving, Martin, McCulloch, Menard, Midland, Mitchell, Reeves, Runnels, Scurry, Sterling, Tom Green, Ward, and Winkler. Based on this analysis, there are significant irrigation, municipal, mining, and steam electric power shortages over the 50-year planning horizon. As previously discussed, some of these shortages are due to limited supply availability either in the surface water modeling (WAM Run 3) or limitations set up by the MAG.

Table 4-1
Comparison of Supplies and Demands for Region F
-Values are in acre-feet per year-

Region F (Acre-feet)	2030	2040	2050	2060	2070	2080
Connected Supply	828,014	820,287	807,943	786,980	762,302	739,562
Demand	859,746	873,452	876,796	866,685	849,659	837,055
Need	-47,083	-64,900	-76,340	-82,783	-88,675	-99,822

Figure 4-1
Region F Supplies and Demands (acre-feet per year)



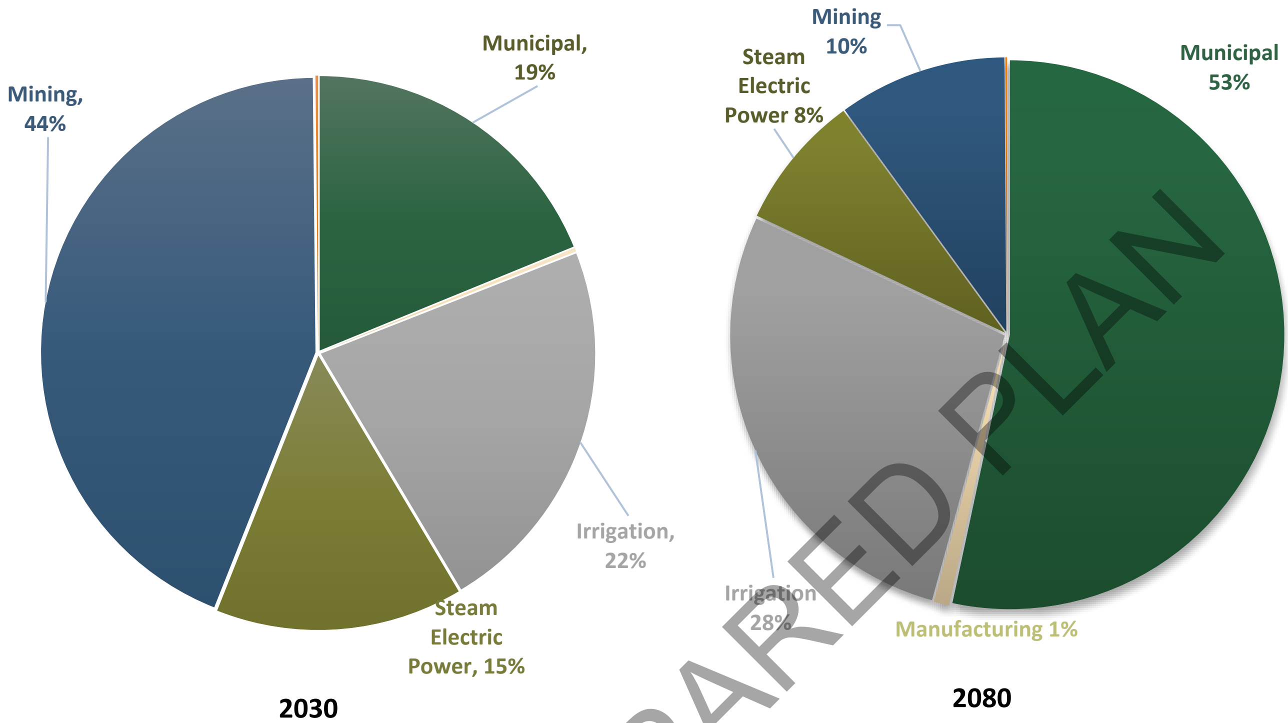
4.1.1 First Tier Water Needs for Water User Groups

A shortage occurs when current supplies are not sufficient to meet projected demands. In Region F there are 65 water user groups with identified shortages over the planning period. Of these, there are 36 municipal utilities and county-other water users spanning 25 counties that are projected to experience a water shortage by 2080.

Of the six use types, mining accounts for the largest percentage of the shortage in the short term. In 2030, mining represents 44 percent of the water needs. As mining demands decline over time, the percentage of water needs attributed to mining falls to 10 percent in 2080. In the short term, irrigation and municipal users account for the next highest portions of needs in Region F. In 2030, irrigation users account for 22 percent of the region's water needs and municipal users account for nearly 19 percent. By 2080, municipal needs account for the highest portion of needs in Region F with 53 percent of needs.

Figure 4-2 graphically illustrates the First Tier water needs in Region F by use type in 2030 and 2080. Table 4-2 and Table 4-3 quantitatively show the water needs by county and use type in 2030 and 2080, respectively.

Figure 4-2
Region F First Tier Needs by Use Type in Year 2030 and 2080



Identified Needs for Municipal Users

Municipal users are shown to have significant water needs throughout the planning period. Thirty-six municipal water user groups, not accounting for river basin splits, show a shortage at some point during the planning horizon. According to the WAM, the cities of Coleman, Junction, and Winters and their customers have no water supply. The cities of Andrews, Ballinger, Balmorhea, Big Spring, Bronte, Coahoma, Coleman, Eden, Junction, Kermit, Menard, Midland, Miles, Odessa, Pecos, Robert Lee, San Angelo, Snyder, Stanton, Sterling City, and Winters do not have sufficient water to meet current demands. Other municipal water suppliers that have a water need include Borden County Water System, Coleman County SUD, Concho Rural Water, Ector County UD, Goodfellow Airforce Base, Greater Gardendale WSC, Madera Valley WSC, Millersview-Doole WSC, North Runnels WSC, U and F WSC, and County-Other users in Andrews, Coke, Coleman, Runnels, and Tom Green counties. The counties with the largest municipal needs are Andrews, Ector, Midland, and Tom Green counties. A significant portion of the needs in these counties are associated with large population centers of Odessa, Midland, and San Angelo.

Identified Needs for Manufacturing Users

There are four counties showing manufacturing needs over the planning period: Andrews, Coleman, Howard, and Kimble counties. Manufacturing needs in Coleman and Howard counties are associated with needs for the cities of Coleman and Big Spring, respectively, and will be met by strategies developed for these cities.

Identified Needs for Irrigation Users

Irrigation water shortages are identified for eleven counties in Region F, including Andrews, Brown, Coleman, Ector, Irion, Kimble, Martin, Menard, Mitchell, Sterling, and Tom Green counties.

Table 4-2
Water Needs by County and Use Type in Year 2030
-Values are in acre-feet per year-

County	Irrigation	Manufacturing	Mining	Municipal	Steam Electric Power	Livestock	Total
Andrews	(5,365)	(70)	(1,990)	(552)	0	(74)	(8,051)
Borden	0	0	(529)	0	0	0	(529)
Brown	(319)	0	0	(3)	0	0	(322)
Coke	0	0	0	(524)	0	0	(524)
Coleman	(361)	(1)	0	(794)	0	0	(1,156)
Concho	0	0	0	(450)	0	0	(450)
Crane	0	0	0	0	0	0	0
Crockett	0	0	(2,275)	0	0	0	(2,275)
Ector	0	0	0	0	(139)	0	(139)
Glasscock	0	0	0	0	0	0	0
Howard	0	0	0	0	0	0	0
Irion	(618)	0	(6,015)	0	0	0	(6,633)
Kimble	(1,258)	(35)	0	(523)	0	0	(1,816)
Loving	0	0	(6,725)	0	0	0	(6,725)
Martin	(437)	0	(144)	(51)	0	0	(632)
Mason	0	0	0	0	0	0	0
McCulloch	0	0	0	0	0	0	0
Menard	(394)	0	0	(44)	0	0	(438)
Midland	0	0	0	0	0	0	0
Mitchell	(1,812)	0	(51)	0	(6,725)	0	(8,588)
Pecos	0	0	0	0	0	0	0
Reagan	0	0	0	0	0	0	0
Reeves	0	0	0	(1,355)	0	0	(1,355)
Runnels	0	0	0	(912)	0	0	(912)
Schleicher	0	0	0	0	0	0	0
Scurry	0	0	0	0	0	0	0
Sterling	0	0	(1,537)	0	0	0	(1,537)
Sutton	0	0	0	0	0	0	0
Tom Green	0	0	0	(3,607)	0	0	(3,607)
Upton	0	0	0	0	0	0	0
Ward	0	0	(1,394)	0	0	0	(1,394)
Winkler	0	0	0	0	0	0	0
Total	**(10,564)**	**(106)**	**(20,660)**	**(8,815)**	**(6,864)**	**(74)**	**(47,083)**

Table 4-3
Water Needs by County and Use Type in Year 2080
-Values are in acre-feet per year-

County	Irrigation	Manufacturing	Mining	Municipal	Steam Electric Power	Livestock	Total
Andrews	(8,982)	(279)	0	(7,417)	0	(108)	(16,786)
Borden	0	0	0	(134)	0	0	(134)
Brown	(319)	0	0	(3)	0	0	(322)
Coke	0	0	0	(802)	0	0	(802)
Coleman	(361)	(1)	0	(325)	0	0	(687)
Concho	0	0	0	(463)	0	0	(463)
Crane	0	0	(191)	0	0	0	(191)
Crockett	0	0	0	0	0	0	0
Ector	(188)	0	0	(15,772)	(879)	0	(16,839)
Glasscock	0	0	0	0	0	0	0
Howard	0	(587)	0	(2,644)	(336)	0	(3,567)
Irion	(618)	0	(130)	0	0	0	(748)
Kimble	(1,258)	(35)	0	(511)	0	0	(1,804)
Loving	0	0	(6,723)	0	0	0	(6,723)
Martin	(4,881)	0	(259)	(504)	0	0	(5,644)
Mason	0	0	0	0	0	0	0
McCulloch	0	0	0	(21)	0	0	(21)
Menard	(394)	0	0	0	0	0	(394)
Midland	0	0	0	(8,861)	0	0	(8,861)
Mitchell	(1,705)	0	(16)	0	(6,725)	0	(8,446)
Pecos	0	0	0	0	0	0	0
Reagan	0	0	0	0	0	0	0
Reeves	0	0	0	(3,778)	0	0	(3,778)
Runnels	0	0	0	(1,077)	0	0	(1,077)
Schleicher	0	0	0	0	0	0	0
Scurry	0	0	0	(718)	0	0	(718)
Sterling	(143)	0	(847)	(875)	0	0	(1,865)
Sutton	0	0	0	0	0	0	0
Tom Green	(8,785)	0	0	(9,177)	0	0	(17,962)
Upton	0	0	0	0	0	0	0
Ward	0	0	(1,706)	0	0	0	(1,706)
Winkler	0	0	0	(284)	0	0	(284)
Total	**(27,634)**	**(902)**	**(9,872)**	**(53,366)**	**(7,940)**	**(108)**	**(99,822)**

Identified Needs for Livestock Users

Livestock needs have been identified for one county within Region F: Andrews County. Needs in Andrews County are due to limited MAG.

Identified Needs for Mining Users

Recent significant growth in demand for mining water, particularly for oil and gas exploration, has created mining shortages throughout Region F, especially in early decades of the planning horizon.

There are ten counties showing mining water shortages over the next fifty years: Andrews, Borden, Crane, Crockett, Irion, Loving, Martin, Mitchell, Sterling, and Ward.

Identified Needs for Steam Electric Power Users

Ector, Howard, and Mitchell counties all show a shortage for steam electric power (SEP) water use. The SEP shortages in Ector County are associated with MAG limitations in Andrews and Gaines (Region O) Counties (one of their sources of supply). The SEP shortage in Mitchell County is attributed to there being no firm yield under WAM Run 3 for Champion Lake, as well as the development of new facilities projected to be brought online by FGE Power. The SEP needs in Howard County are associated with needs of the City of Big Spring and will be met through strategies developed for the Colorado River Municipal Water District (CRMWD), who provides water supplies for Big Spring.

Identified Needs for Major Water Providers

Table 4-4 is a summary of the needs for the five Major Water Providers (MWPs) in Region F. All MWPs have a water shortage at some point over the next fifty years, with the exception of BCWID. Needs for CRMWD, San Angelo, and Odessa are partially the result of using the Colorado WAM for water availability. A summary of the supply, demand, and needs comparison for each designated major provider is included in Attachment 4A.

Table 4-4
Comparison of Supplies and Demands for Major Water Providers
-Values in Acre-Feet per Year-

Major Water Provider	Category	2030	2040	2050	2060	2070	2080
BCWID #1	Supply	15,550	15,420	15,290	15,160	15,030	14,900
	Demand	14,291	14,322	14,316	14,330	14,351	14,375
	Surplus (Need)	1,259	1,098	974	830	679	525
CRMWD	Supply	71,260	68,693	66,072	61,744	59,167	56,605
	Demand	68,769	73,045	78,200	80,445	82,692	84,956
	Surplus (Need)	1,866	(5,007)	(12,815)	(19,416)	(24,269)	(29,128)
City of Midland	Supply	48,518	47,040	45,261	43,873	42,908	42,032
	Demand	34,386	36,472	38,865	41,877	45,332	49,306
	Surplus (Need)	14,132	10,568	6,396	1,996	(2,424)	(7,274)
City of Odessa[a]	Supply	39,556	41,465	41,907	40,265	39,592	38,810
	Demand	39,556	49,138	55,832	58,567	61,320	64,094
	Surplus (Need)	0	(7,673)	(13,925)	(18,302)	(21,728)	(25,284)
City of San Angelo[b]	Supply	23,518	17,285	17,153	17,021	16,888	16,756
	Demand	18,958	20,280	21,506	22,713	24,030	25,467
	Surplus (Need)	(3,740)	(2,995)	(4,353)	(5,692)	(7,142)	(8,711)

a. Includes demands for potential future customers
b. Does not include irrigation demands, only treated water demands

4.1.2 Summary of First Tier Water Needs

The total demands in Region F exceed the total current supply by over 47,000 acre-feet beginning in 2030. The regional need grows to over 99,000 acre-feet by 2080. Most of these needs are associated with either mining, municipal, or irrigation demands. Manufacturing, steam electric power, and livestock needs collectively account for approximately 15 percent of the needs in Region F in 2030 and nine percent in 2080. First Tier water needs are largely attributed to assumptions made in the WAM model and limitations by the MAG in certain counties. Other shortages are due to limitations of infrastructure and/or growth. The First Tier needs report provided by the TWDB is provided in Appendix I and is summarized by WUG in Attachment 4B. Further review of the region's options and strategies to meet shortages is explored in more detail in Chapter 5 and the impacts of these strategies on water quality are discussed in Chapter 6. Second Tier Water Needs Analysis.

The Second Tier water needs analysis compares current supplies with demands after reductions from conservation and direct reuse. Conservation and direct reuse are both considered water management strategies and are discussed further in Chapter 5B. The Second Tier needs report provided by TWDB is provided in Appendix I and is part of the summary provided in Attachment 4B.

4.2 Summary of Second Tier Water Needs

Under the Second Tier water needs analysis, municipal water needs were reduced through conservation, water audit and leak repair savings, and direct reuse supplies. Conservation was considered for all municipal and irrigation water users. Water audits and leak repairs was considered for all municipal users with reported water loss above certain thresholds. Recycling of water was considered for all mining water user groups. More detail on each of these strategies can be found in Chapter 5B and Appendix C. The plan assumes that a significant reduction in water needs could potentially be achieved through conservation. The realization of these water use reductions is contingent upon the implementation of conservation strategies by individual water users and producers. The plan also includes direct reuse supplies for Pecos City.

4.3 Third Tier Water Needs Analysis

The TCEQ WAM does not give an accurate assessment of water supplies based on the way the basin has historically been operated, so Region F has developed a water management strategy called "subordination." Subordination assumes that downstream senior water rights do not make priority calls on Region F water rights in the upper Colorado River Basin, which provides a more realistic assessment of surface water supplies in the upper Colorado River Basin. A full description of the subordination strategy is included in Chapter 5C and Appendix C.

The Third Tier water needs analysis compares the subordination supplies (total current supplies with the subordinated surface water supplies) and the demands after conservation and reuse. The results of the Third Tier water needs analysis is what was used to determine a water user group or major water provider's need for additional water management strategies.

4.3.1 Summary of Third Tier Water Needs

Implementation of the subordination strategy eliminates many of the needs shown in the First and Second Tier needs analyses. Twenty-two water user groups (WUGs) show no needs after conservation and subordination: Ballinger, Big Spring, Bronte, Coahoma, Coleman, Coleman County SUD, Ector County Utility District, Greater Gardendale WSC, Menard, Odessa, Snyder, Coke County-Other, Coleman County-Other, Runnels County-Other, Tom Green County-Other, manufacturing in Coleman County, irrigation in Coleman, Ector, and Menard counties. However, there are ten municipal WUGs that do not have sufficient supplies even after the subordination strategy: Goodfellow Air Force Base, Junction, Midland, Miles, Millersview-Doole WSC, North Runnels WSC, Robert Lee, San Angelo, Stanton, and Winters. There are four non-municipal WUGs for whom subordination does not meet their needs: manufacturing in Howard and Kimble counties and steam electric power in Howard and Mitchell counties. WUGs that do not utilize any surface water sources are not impacted by subordination and continue to show needs throughout the planning period. Figure 4-3 and Table 4-5 compare the First, Second and Third Tier water needs in Region F throughout the planning cycle. The needs are approximately 30 to 54 percent lower after conservation, direct reuse, and subordination (Third Tier needs) than they are under strict WAM analysis (First Tier needs). Attachment 4B shows the summary of each water user group and major water provider's demands, current supplies, conservation supplies, subordination supplies and Third Tier water needs.

Figure 4-3
Comparison of First, Second, and Third Tier Water Needs in Region F

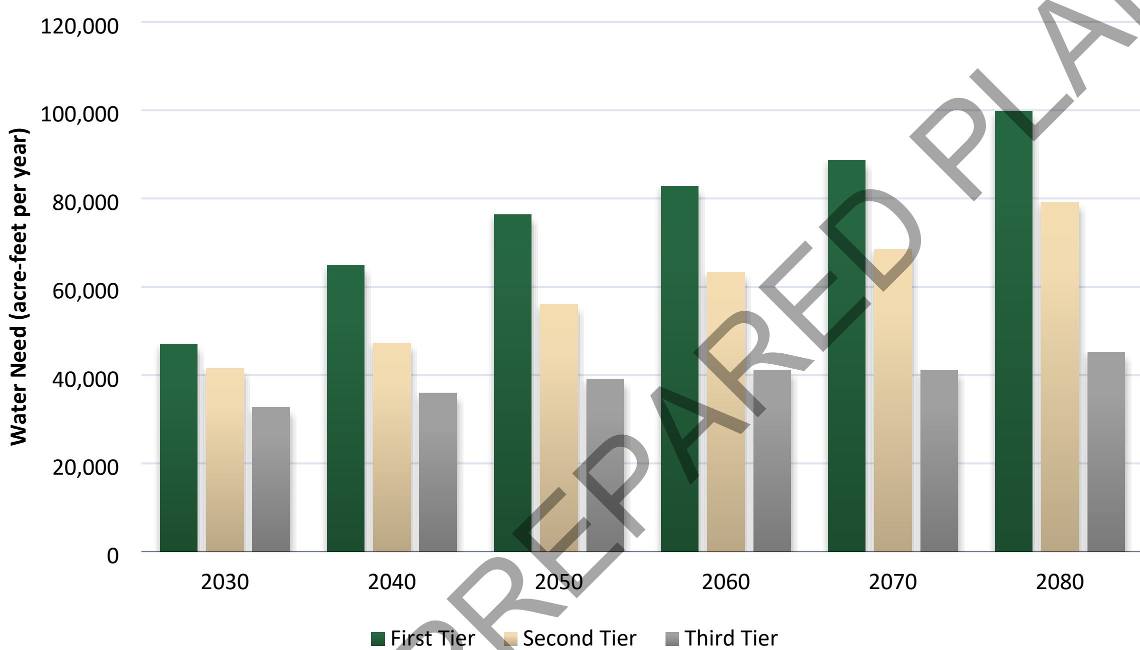


Table 4-5
Comparison of First, Second, and Third Tier Needs in Region F

Tier	2030	2040	2050	2060	2070	2080
First Tier	47,083	64,900	76,340	82,783	88,675	99,822
Second Tier	41,478	47,309	56,058	63,291	68,387	79,209
Third Tier	32,692	35,986	39,143	41,197	41,018	45,132

ATTACHMENT 4A

COMPARISON OF SUPPLY AND DEMAND BY MAJOR WATER PROVIDER

Major Water Provider First Tier Needs by Category of Use in Each Decade (acre-feet per year)

Major Water Provider	Category of Use	2030	2040	2050	2060	2070	2080
BCWID #1	Irrigation	0	0	0	0	0	0
	Livestock	0	0	0	0	0	0
	Manufacturing	0	0	0	0	0	0
	Mining	0	0	0	0	0	0
	Municipal	0	0	0	0	0	0
	Steam Electric Power	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**
CRMWD[a]	Irrigation	0	(120)	(303)	(451)	(547)	(635)
	Livestock	0	0	0	0	0	0
	Manufacturing	0	(137)	(347)	(514)	(624)	(725)
	Mining	0	0	0	0	0	0
	Municipal	(43)	(9,221)	(17,664)	(23,858)	(28,648)	(33,529)
	Steam Electric Power	0	(228)	(582)	(864)	(1,046)	(1,215)
	Total	**(43)**	**(9,706)**	**(18,896)**	**(25,687)**	**(30,865)**	**(36,104)**
Midland	Irrigation	0	0	0	0	0	0
	Livestock	0	0	0	0	0	0
	Manufacturing	0	0	0	0	0	0
	Mining	0	0	0	0	0	0
	Municipal	0	0	0	0	(2,424)	(7,274)
	Steam Electric Power	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**(2,424)**	**(7,274)**
Odessa	Irrigation	0	(90)	(228)	(340)	(412)	(478)
	Livestock	0	0	0	0	0	0
	Manufacturing	0	(26)	(66)	(97)	(119)	(138)
	Mining	0	0	0	0	0	0
	Municipal	0	(7,392)	(13,211)	(17,240)	(20,441)	(23,789)
	Steam Electric Power	0	(165)	(420)	(625)	(756)	(879)
	Total	**0**	**(7,673)**	**(13,925)**	**(18,302)**	**(21,728)**	**(25,284)**
San Angelo	Irrigation	0	0	0	0	0	0
	Livestock	0	0	0	0	0	0
	Manufacturing	(78)	(60)	(86)	(110)	(136)	(162)
	Mining	0	0	0	0	0	0
	Municipal	(3,662)	(2,935)	(4,267)	(5,582)	(7,006)	(8,549)
	Steam Electric Power	0	0	0	0	0	0
	Total	**(3,740)**	**(2,995)**	**(4,353)**	**(5,692)**	**(7,142)**	**(8,711)**

[a]Includes potential future customer demands

Major Water Provider Second Tier Needs (After Conservation and Direct Reuse) by Category of Use in Each Decade

Major Water Provider	Category of Use	2030	2040	2050	2060	2070	2080
BCWID #1	Irrigation	0	0	0	0	0	0
	Livestock	0	0	0	0	0	0
	Manufacturing	0	0	0	0	0	0
	Mining	0	0	0	0	0	0
	Municipal	0	0	0	0	0	0
	Steam Electric Power	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**
CRMWD	Irrigation	0	(120)	(303)	(451)	(547)	(635)
	Livestock	0	0	0	0	0	0
	Manufacturing	0	(137)	(347)	(514)	(624)	(725)
	Mining	0	0	0	0	0	0
	Municipal	0	(7,309)	(15,487)	(21,510)	(26,158)	(30,896)
	Steam Electric Power	0	(228)	(582)	(864)	(1,046)	(1,215)
	Total	**0**	**(7,794)**	**(16,719)**	**(23,339)**	**(28,375)**	**(33,471)**
Midland	Irrigation	0	0	0	0	0	0
	Livestock	0	0	0	0	0	0
	Manufacturing	0	0	0	0	0	0
	Mining	0	0	0	0	0	0
	Municipal	0	0	0	0	(1,447)	(6,182)
	Steam Electric Power	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**(1,447)**	**(6,182)**
Odessa	Irrigation	0	(90)	(228)	(340)	(412)	(478)
	Livestock	0	0	0	0	0	0
	Manufacturing	0	0	0	0	0	0
	Mining	0	0	0	0	0	0
	Municipal	0	(6,755)	(12,466)	(16,454)	(19,603)	(22,899)
	Steam Electric Power	0	(165)	(420)	(625)	(756)	(879)
	Total	**0**	**(7,010)**	**(13,114)**	**(17,419)**	**(20,771)**	**(24,256)**
San Angelo	Irrigation	0	0	0	0	0	0
	Livestock	0	0	0	0	0	0
	Manufacturing	(78)	(60)	(86)	(110)	(136)	(162)
	Mining	0	0	0	0	0	0
	Municipal	(3,192)	(2,421)	(3,722)	(5,005)	(6,394)	(7,899)
	Steam Electric Power	0	0	0	0	0	0
	Total	**(3,270)**	**(2,481)**	**(3,808)**	**(5,115)**	**(6,530)**	**(8,061)**

ATTACHMENT 4B

WATER USER GROUP NEEDS BY TIER

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
IRRIGATION, ANDREWS	IRRIGATION	(5,365)	(6,818)	(7,633)	(8,169)	(8,605)	(8,982)	(4,487)	(5,062)	(5,877)	(6,413)	(6,849)	(7,226)	(4,487)	(5,062)	(5,877)	(6,413)	(6,849)	(7,226)
IRRIGATION, BORDEN	IRRIGATION	0	0	0	0	0	0	125	250	250	250	250	250	125	250	250	250	250	250
IRRIGATION, BROWN	IRRIGATION	(319)	(319)	(319)	(319)	(319)	(319)	65	296	296	296	296	296	65	296	296	296	296	296
IRRIGATION, COKE	IRRIGATION	0	0	0	0	0	0	31	62	74	74	74	74	31	62	74	74	74	74
IRRIGATION, COLEMAN	IRRIGATION	(361)	(361)	(361)	(361)	(361)	(361)	(340)	(319)	(319)	(319)	(319)	(319)	60	81	81	81	81	81
IRRIGATION, CONCHO	IRRIGATION	0	0	0	0	0	0	260	520	572	572	572	572	260	520	572	572	572	572
IRRIGATION, CROCKETT	IRRIGATION	0	0	0	0	0	0	4	8	12	12	12	12	4	8	12	12	12	12
IRRIGATION, ECTOR	IRRIGATION	127	67	(23)	(97)	(144)	(188)	165	142	90	16	(31)	(75)	165	202	240	240	240	233
IRRIGATION, GLASSCOCK	IRRIGATION	0	0	0	0	0	0	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737
IRRIGATION, HOWARD	IRRIGATION	0	0	0	0	0	0	255	510	561	561	561	561	255	510	561	561	561	561
IRRIGATION, IRION	IRRIGATION	(618)	(618)	(618)	(618)	(618)	(618)	(565)	(513)	(460)	(460)	(460)	(460)	(565)	(513)	(460)	(460)	(460)	(460)
IRRIGATION, KIMBLE	IRRIGATION	(1,258)	(1,258)	(1,258)	(1,258)	(1,258)	(1,258)	(1,128)	(998)	(946)	(946)	(946)	(946)	(1,128)	(998)	(946)	(946)	(946)	(946)
IRRIGATION, MARTIN	IRRIGATION	(437)	(4,029)	(6,076)	(6,515)	(5,832)	(4,881)	1,210	(736)	(1,136)	(1,575)	(892)	59	1,210	(736)	(1,136)	(1,575)	(892)	59
IRRIGATION, MASON	IRRIGATION	0	0	0	0	0	0	240	480	721	721	721	721	240	480	721	721	721	721
IRRIGATION, MCCULLOCH	IRRIGATION	0	0	0	0	0	0	104	207	311	311	311	311	104	207	311	311	311	311
IRRIGATION, MENARD	IRRIGATION	(394)	(394)	(394)	(394)	(394)	(394)	(221)	(47)	126	126	126	126	1,109	1,283	1,456	1,456	1,456	1,456

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
IRRIGATION, MIDLAND	IRRIGATION	0	0	0	0	0	0	900	1,800	2,699	2,699	2,699	2,699	900	1,860	2,852	2,926	2,975	3,013
IRRIGATION, MITCHELL	IRRIGATION	(1,812)	(1,829)	(1,819)	(1,788)	(1,742)	(1,705)	(1,552)	(1,569)	(1,559)	(1,528)	(1,482)	(1,445)	(1,552)	(1,569)	(1,559)	(1,528)	(1,482)	(1,445)
IRRIGATION, PECOS	IRRIGATION	0	0	0	0	0	0	6,884	13,767	20,651	20,651	20,651	20,651	6,884	13,767	20,651	20,651	20,651	20,651
IRRIGATION, REAGAN	IRRIGATION	0	0	0	0	0	0	1,075	2,150	3,225	3,225	3,225	3,225	1,075	2,150	3,225	3,225	3,225	3,225
IRRIGATION, REEVES	IRRIGATION	0	0	0	0	0	0	3,001	6,003	9,004	9,004	9,004	9,004	3,001	6,003	9,004	9,004	9,004	9,004
IRRIGATION, RUNNELS	IRRIGATION	0	0	0	0	0	0	176	352	422	422	422	422	176	352	422	422	422	422
IRRIGATION, SCHLEICHER	IRRIGATION	0	0	0	0	0	0	101	121	121	121	121	121	101	121	121	121	121	121
IRRIGATION, SCURRY	IRRIGATION	0	0	0	0	0	0	349	698	908	908	908	908	349	698	908	908	908	908
IRRIGATION, STERLING	IRRIGATION	0	0	0	0	0	(143)	43	86	128	128	128	(15)	43	86	128	128	128	(15)
IRRIGATION, SUTTON	IRRIGATION	0	0	0	0	0	0	56	112	168	168	168	168	56	112	168	168	168	168
IRRIGATION, TOM GREEN	IRRIGATION	0	(7,342)	(7,761)	(8,096)	(8,417)	(8,785)	2,480	(2,382)	(1,809)	(2,144)	(2,465)	(2,833)	2,480	(600)	(109)	(501)	(878)	(1,303)
IRRIGATION, UPTON	IRRIGATION	0	0	0	0	0	0	421	842	1,263	1,263	1,263	1,263	421	842	1,263	1,263	1,263	1,263
IRRIGATION, WARD	IRRIGATION	0	0	0	0	0	0	217	433	650	650	650	650	217	433	650	650	650	650
IRRIGATION, WINKLER	IRRIGATION	0	0	0	0	0	0	153	307	460	460	460	460	153	307	460	460	460	460
LIVESTOCK, ANDREWS	LIVESTOCK	(74)	(87)	(95)	(100)	(104)	(108)	(74)	(87)	(95)	(100)	(104)	(108)	(74)	(87)	(95)	(100)	(104)	(108)
LIVESTOCK, BORDEN	LIVESTOCK	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
LIVESTOCK, BROWN	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, COKE	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, COLEMAN	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, CONCHO	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, CRANE	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, CROCKETT	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, ECTOR	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, GLASSCOCK	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, HOWARD	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, IRION	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, KIMBLE	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, LOVING	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, MARTIN	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, MASON	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, MCCULLOCH	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, MENARD	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
LIVESTOCK, MIDLAND	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, MITCHELL	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, PECOS	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, REAGAN	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, REEVES	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, RUNNELS	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, SCHLEICHER	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, SCURRY	LIVESTOCK	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
LIVESTOCK, STERLING	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, SUTTON	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, TOM GREEN	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, UPTON	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, WARD	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVESTOCK, WINKLER	LIVESTOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, ANDREWS	MANUFACTURING	(70)	(140)	(184)	(218)	(249)	(279)	(70)	(140)	(184)	(218)	(249)	(279)	(70)	(140)	(184)	(218)	(249)	(279)
MANUFACTURING, BROWN	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
MANUFACTURING, COLEMAN	MANUFACTURING	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	0	0	0	0	0	0
MANUFACTURING, CRANE	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, CROCKETT	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, ECTOR	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	26	66	97	119	135
MANUFACTURING, GLASSCOCK	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, HOWARD	MANUFACTURING	0	(111)	(281)	(417)	(505)	(587)	0	(111)	(281)	(417)	(505)	(587)	0	0	0	0	0	(11)
MANUFACTURING, IRION	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, KIMBLE	MANUFACTURING	(35)	(35)	(35)	(35)	(35)	(35)	(35)	(35)	(35)	(35)	(35)	(35)	(27)	(27)	(27)	(27)	(27)	(27)
MANUFACTURING, MIDLAND	MANUFACTURING	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023
MANUFACTURING, MITCHELL	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, PECOS	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, REEVES	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, RUNNELS	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, SCURRY	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, SUTTON	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, TOM GREEN	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	78	38	34	32	31	29

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
MANUFACTURING, UPTON	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MANUFACTURING, WINKLER	MANUFACTURING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINING, ANDREWS	MINING	(1,990)	(2,139)	(1,754)	(899)	235	1,225	(1,748)	(1,897)	(1,532)	(717)	363	1,306	(1,748)	(1,897)	(1,532)	(717)	363	1,306
MINING, BORDEN	MINING	(529)	(529)	(298)	0	0	0	(412)	(412)	(191)	88	62	39	(412)	(412)	(191)	88	62	39
MINING, BROWN	MINING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINING, COKE	MINING	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2
MINING, CRANE	MINING	0	0	(78)	(299)	(15)	(191)	21	21	(57)	(278)	(14)	(190)	21	21	(57)	(278)	(14)	(190)
MINING, CROCKETT	MINING	(2,275)	(2,196)	(1,610)	(545)	0	0	(1,852)	(1,773)	(1,532)	(482)	45	28	(1,852)	(1,773)	(1,532)	(482)	45	28
MINING, ECTOR	MINING	0	0	0	0	0	0	24	24	22	18	12	8	24	24	22	18	12	8
MINING, GLASSCOCK	MINING	0	0	0	0	0	0	479	479	439	359	253	160	479	479	439	359	253	160
MINING, HOWARD	MINING	0	0	0	0	0	0	427	427	391	320	226	142	427	427	391	320	226	142
MINING, IRION	MINING	(6,015)	(6,006)	(5,272)	(3,803)	(1,857)	(130)	(5,400)	(5,391)	(4,709)	(3,711)	(1,792)	(89)	(5,400)	(5,391)	(4,709)	(3,711)	(1,792)	(89)
MINING, KIMBLE	MINING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINING, LOVING	MINING	(6,725)	(6,724)	(6,724)	(6,724)	(6,723)	(6,723)	(6,033)	(6,032)	(6,032)	(6,032)	(6,031)	(6,031)	(6,033)	(6,032)	(6,032)	(6,032)	(6,031)	(6,031)
MINING, MARTIN	MINING	(144)	(1,328)	(1,793)	(1,473)	(784)	(259)	430	(754)	(1,267)	(1,330)	(683)	(195)	430	(754)	(1,267)	(1,330)	(683)	(195)
MINING, MASON	MINING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
MINING, MCCULLOCH	MINING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINING, MIDLAND	MINING	0	0	0	0	0	0	508	508	466	381	90	56	508	508	466	381	90	56
MINING, MITCHELL	MINING	(51)	(52)	(47)	(38)	(26)	(16)	(36)	(37)	(33)	(26)	(18)	(11)	(36)	(37)	(33)	(26)	(18)	(11)
MINING, PECOS	MINING	0	0	0	0	0	0	931	931	931	931	186	186	931	931	931	931	186	186
MINING, REAGAN	MINING	0	0	0	0	0	0	686	686	628	171	121	76	686	686	628	171	121	76
MINING, REEVES	MINING	0	0	0	0	0	0	2,017	2,017	2,017	2,017	2,017	2,017	2,017	2,017	2,017	2,017	2,017	2,017
MINING, SCHLEICHER	MINING	0	0	0	0	0	0	148	148	136	111	78	49	148	148	136	111	78	49
MINING, SCURRY	MINING	0	0	0	0	0	18	18	18	16	13	9	24	18	18	16	13	9	24
MINING, STERLING	MINING	(1,537)	(1,682)	(1,658)	(1,481)	(1,189)	(847)	(1,432)	(1,577)	(1,561)	(1,402)	(1,133)	(812)	(1,432)	(1,577)	(1,561)	(1,402)	(1,133)	(812)
MINING, SUTTON	MINING	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
MINING, TOM GREEN	MINING	1	2	2	1	2	1	35	36	33	27	20	12	37	37	35	27	20	12
MINING, UPTON	MINING	0	0	0	0	0	0	183	183	168	137	97	61	183	183	168	137	97	61
MINING, WARD	MINING	(1,394)	(1,461)	(1,528)	(1,586)	(1,645)	(1,706)	(1,167)	(1,234)	(1,301)	(1,359)	(1,418)	(1,479)	(1,167)	(1,234)	(1,301)	(1,359)	(1,418)	(1,479)
MINING, WINKLER	MINING	0	0	0	0	0	0	113	113	113	113	113	113	113	113	113	113	113	113
AIRLINE MOBILE HOME PARK LTD	MUNICIPAL	0	0	0	0	0	0	6	6	7	8	8	9	6	6	7	8	8	9
ANDREWS	MUNICIPAL	(450)	(1,085)	(2,278)	(3,589)	(4,955)	(6,403)	(401)	(1,025)	(2,169)	(3,462)	(4,808)	(6,234)	(401)	(1,025)	(2,169)	(3,462)	(4,808)	(6,234)

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
BALLINGER	MUNICIPAL	(365)	(390)	(432)	(469)	(499)	(530)	(354)	(379)	(421)	(458)	(487)	(518)	438	443	451	452	448	441
BALMORHEA	MUNICIPAL	(16)	(39)	(62)	(76)	(91)	(109)	(15)	(38)	(61)	(74)	(89)	(107)	(15)	(38)	(61)	(74)	(89)	(107)
BANGS	MUNICIPAL	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9
BARSTOW	MUNICIPAL	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
BIG LAKE	MUNICIPAL	0	0	0	0	0	0	9	9	10	10	10	10	9	9	10	10	10	10
BIG SPRING	MUNICIPAL	0	(497)	(1,282)	(1,865)	(2,211)	(2,507)	118	(375)	(1,158)	(1,744)	(2,092)	(2,391)	118	122	124	122	120	67
BORDEN COUNTY WATER SYSTEM	MUNICIPAL	0	0	0	(22)	(71)	(134)	1	1	1	(21)	(70)	(132)	1	1	1	(21)	(70)	(132)
BRADY	MUNICIPAL	0	0	0	0	0	0	17	17	16	16	15	15	17	17	1,786	1,756	1,725	1,695
BRONTE	MUNICIPAL	(199)	(217)	(237)	(268)	(302)	(339)	(196)	(214)	(234)	(265)	(298)	(335)	3	15	17	18	19	22
BROOKESMITH SUD	MUNICIPAL	0	0	0	0	0	0	20	21	21	21	21	21	20	21	21	21	21	21
BROWNWOOD	MUNICIPAL	0	0	0	0	0	0	61	90	90	90	90	91	61	90	90	90	90	91
COAHOMA	MUNICIPAL	0	(27)	(72)	(104)	(122)	(137)	3	(24)	(69)	(101)	(119)	(134)	3	3	3	3	3	0
COLEMAN	MUNICIPAL	(712)	(616)	(520)	(446)	(365)	(272)	(673)	(583)	(491)	(421)	(346)	(257)	350	446	544	588	608	643
COLEMAN COUNTY SUD	MUNICIPAL	(70)	(66)	(63)	(60)	(58)	(55)	(62)	(58)	(55)	(53)	(51)	(48)	8	8	8	7	7	7
COLORADO CITY	MUNICIPAL	0	0	0	0	0	0	81	81	80	81	82	83	81	81	80	81	82	83
CONCHO RURAL WATER	MUNICIPAL	(5)	4	(7)	(18)	(27)	(36)	59	76	72	68	67	66	94	93	86	81	79	76

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
CORIX UTILITIES TEXAS INC	MUNICIPAL	0	0	0	0	0	0	16	34	36	35	35	34	16	34	36	35	35	34
COUNTY-OTHER, ANDREWS	MUNICIPAL	(102)	(261)	(429)	(601)	(794)	(1,014)	(80)	(232)	(391)	(554)	(738)	(934)	(80)	(232)	(391)	(554)	(738)	(934)
COUNTY-OTHER, BORDEN	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, BROWN	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, COKE	MUNICIPAL	(49)	(49)	(49)	(49)	(49)	(49)	(49)	(49)	(49)	(49)	(49)	(49)	0	0	0	0	0	0
COUNTY-OTHER, COLEMAN	MUNICIPAL	(17)	(13)	(10)	(7)	(4)	(2)	(17)	(13)	(10)	(7)	(4)	(2)	0	0	0	0	0	0
COUNTY-OTHER, CONCHO	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, CRANE	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, CROCKETT	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, ECTOR	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, GLASSCOCK	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, HOWARD	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, IRION	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, KIMBLE	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, LOVING	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, MARTIN	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
COUNTY-OTHER, MASON	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, MCCULLOCH	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, MENARD	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, MIDLAND	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, MITCHELL	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, PECOS	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, REAGAN	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, REEVES	MUNICIPAL	0	0	0	0	0	0	12	12	13	13	14	15	12	12	13	13	14	15
COUNTY-OTHER, RUNNELS	MUNICIPAL	(28)	(28)	(28)	(28)	(26)	(23)	(25)	(25)	(25)	(26)	(24)	(21)	3	3	3	2	2	2
COUNTY-OTHER, SCHLEICHER	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, SCURRY	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	7	17	25	31	34
COUNTY-OTHER, STERLING	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, SUTTON	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, TOM GREEN	MUNICIPAL	(38)	(41)	(39)	(36)	(34)	(31)	(38)	(41)	(39)	(36)	(34)	(31)	88	65	63	66	67	68
COUNTY-OTHER, UPTON	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUNTY-OTHER, WARD	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
COUNTY-OTHER, WINKLER	MUNICIPAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CRANE	MUNICIPAL	0	0	0	0	0	0	11	11	11	11	11	11	11	11	11	11	11	11
CROCKETT COUNTY WCID 1	MUNICIPAL	0	0	0	0	0	0	7	6	6	6	5	5	7	6	6	6	5	5
DADS SUPPORTED LIVING CENTER	MUNICIPAL	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
EARLY	MUNICIPAL	0	0	0	0	0	0	10	10	10	11	11	11	10	10	10	11	11	11
ECTOR COUNTY UTILITY DISTRICT	MUNICIPAL	0	(289)	(852)	(1,386)	(1,831)	(2,314)	102	(161)	(705)	(1,195)	(1,622)	(2,087)	102	128	147	192	209	181
EDEN	MUNICIPAL	(450)	(435)	(421)	(407)	(397)	(390)	(445)	(430)	(416)	(402)	(392)	(385)	(445)	(430)	(416)	(402)	(392)	(385)
ELDORADO	MUNICIPAL	0	0	0	0	0	0	29	25	22	19	16	12	29	25	22	19	16	12
FORT STOCKTON	MUNICIPAL	0	0	0	0	0	0	29	29	29	31	33	35	29	29	29	31	33	35
GOODFELLOW AIR FORCE BASE	MUNICIPAL	(93)	(69)	(94)	(117)	(139)	(160)	(86)	(62)	(87)	(110)	(132)	(153)	7	(19)	(50)	(76)	(100)	(123)
GRANDFALLS	MUNICIPAL	0	0	0	0	0	0	1	1	2	2	2	2	1	1	2	2	2	2
GREATER GARDENDALE WSC	MUNICIPAL	0	(18)	(100)	(162)	(216)	(271)	15	0	(79)	(139)	(191)	(244)	15	18	21	23	25	22
GREENWOOD WATER	MUNICIPAL	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3
IRAAN	MUNICIPAL	0	0	0	0	0	0	3	3	3	3	3	4	3	3	3	3	3	4
JUNCTION	MUNICIPAL	(523)	(512)	(506)	(505)	(506)	(511)	(479)	(469)	(463)	(462)	(463)	(468)	(210)	(200)	(194)	(193)	(194)	(199)
KERMIT	MUNICIPAL	0	0	0	0	0	(284)	22	25	29	31	34	(246)	22	25	29	31	34	(246)

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
LORAINE	MUNICIPAL	0	0	0	0	0	0	2	2	1	1	1	1	2	2	1	1	1	1
MADERA VALLEY WSC	MUNICIPAL	(13)	(91)	(165)	(219)	(277)	(341)	(7)	(85)	(158)	(212)	(269)	(333)	(7)	(85)	(158)	(212)	(269)	(333)
MASON	MUNICIPAL	0	0	0	0	0	0	7	7	7	8	8	8	7	7	7	8	8	8
MCCAMEY	MUNICIPAL	0	0	0	0	0	0	5	5	6	6	6	6	5	5	6	6	6	6
MENARD	MUNICIPAL	(44)	(25)	(8)	(5)	0	4	(41)	(22)	(5)	(2)	3	7	602	621	638	641	646	650
MERTZON	MUNICIPAL	0	0	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6
MIDLAND	MUNICIPAL	14,132	10,568	6,396	1,995	(2,424)	(7,274)	14,778	11,288	7,185	2,872	(1,447)	(6,182)	15,581	12,114	9,291	5,992	2,330	(1,882)
MILES	MUNICIPAL	10	13	8	1	(6)	(14)	13	16	11	4	(3)	(11)	34	25	19	14	4	(3)
MILLERSVIEW-DOOLE WSC	MUNICIPAL	0	0	(122)	(353)	(597)	(878)	80	90	(20)	(237)	(465)	(726)	80	133	90	(73)	(267)	(496)
MONAHANS	MUNICIPAL	0	0	0	0	0	0	26	29	33	36	39	43	26	29	33	36	39	43
NORTH RUNNELS WSC	MUNICIPAL	(158)	(163)	(170)	(178)	(187)	(198)	(148)	(153)	(160)	(167)	(176)	(187)	(45)	(44)	(43)	(43)	(44)	(45)
ODESSA	MUNICIPAL	0	(1,955)	(5,829)	(9,262)	(11,964)	(14,774)	530	(1,318)	(5,084)	(8,476)	(11,126)	(13,884)	530	504	558	523	486	140
PECOS	MUNICIPAL	(1,326)	(1,820)	(2,291)	(2,606)	(2,951)	(3,328)	(1,296)	(301)	(768)	(1,081)	(1,423)	(1,797)	(1,296)	(301)	(768)	(1,081)	(1,423)	(1,797)
PECOS COUNTY FRESH WATER	MUNICIPAL	0	0	0	0	0	0	2	2	2	2	2	3	2	2	2	2	2	3
PECOS COUNTY WCID 1	MUNICIPAL	0	0	0	0	0	0	22	23	25	23	22	19	22	23	25	23	22	19
RANKIN	MUNICIPAL	0	0	0	0	0	0	2	2	2	3	3	3	2	2	2	3	3	3

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
RICHLAND SUD	MUNICIPAL	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2
ROBERT LEE	MUNICIPAL	(276)	(294)	(314)	(344)	(377)	(414)	(262)	(279)	(298)	(326)	(358)	(392)	(53)	0	0	0	0	0
SAN ANGELO	MUNICIPAL	(3,471)	(2,792)	(4,073)	(5,340)	(6,718)	(8,219)	(3,008)	(2,285)	(3,535)	(4,770)	(6,113)	(7,576)	463	(528)	(1,931)	(3,189)	(4,552)	(6,042)
SANTA ANNA	MUNICIPAL	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3
SNYDER	MUNICIPAL	0	(127)	(331)	(497)	(609)	(716)	36	(91)	(294)	(460)	(571)	(678)	36	36	37	38	38	23
SONORA	MUNICIPAL	0	0	0	0	0	0	7	6	6	5	5	4	7	6	6	5	5	4
SOUTHWEST SANDHILLS WSC	MUNICIPAL	0	0	0	0	0	0	8	9	10	11	12	13	8	9	10	11	12	13
STANTON	MUNICIPAL	(51)	(122)	(219)	(311)	(403)	(504)	(43)	(113)	(209)	(300)	(391)	(490)	(43)	(91)	(151)	(215)	(287)	(372)
STERLING CITY	MUNICIPAL	0	0	(88)	(325)	(586)	(875)	4	6	(80)	(315)	(573)	(859)	4	6	(80)	(315)	(573)	(859)
TOM GREEN COUNTY FWSD 3	MUNICIPAL	0	0	0	0	0	0	2	2	2	3	3	3	2	2	2	3	3	3
U & F WSC	MUNICIPAL	0	(1)	(1)	(2)	(2)	(2)	2	1	1	0	0	0	2	2	2	2	2	2
WICKETT	MUNICIPAL	0	0	0	0	0	0	1	2	2	2	2	2	1	2	2	2	2	2
WINK	MUNICIPAL	0	0	0	0	0	0	2	2	2	2	2	3	2	2	2	2	2	3
WINTERS	MUNICIPAL	(359)	(342)	(321)	(303)	(283)	(258)	(336)	(320)	(300)	(284)	(265)	(242)	(174)	(165)	(154)	(147)	(137)	(126)
ZEPHYR WSC	MUNICIPAL	0	0	0	0	0	0	12	13	13	13	13	13	12	13	13	13	13	13
STEAM ELECTRIC POWER, ECTOR	STEAM ELECTRIC POWER	(139)	(269)	(420)	(625)	(756)	(879)	(139)	(269)	(420)	(625)	(756)	(879)	(139)	(104)	0	0	0	(18)

Water User Group	Use Type	Future Unmet Needs/Surplus by Planning Decade (acre-feet/year) - First Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation (acre-feet/year) - Second Tier						Future Unmet Needs/Surplus by Planning Decade After Conservation, Subordination, and Direct Reuse (acre-feet/year) - Third Tier					
		2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
STEAM ELECTRIC POWER, HOWARD	STEAM ELECTRIC POWER	0	(63)	(162)	(239)	(290)	(336)	0	(63)	(162)	(239)	(290)	(336)	1	1	1	1	2	(7)
STEAM ELECTRIC POWER, MITCHELL	STEAM ELECTRIC POWER	(6,725)	(6,725)	(6,725)	(6,725)	(6,725)	(6,725)	(6,725)	(6,725)	(6,725)	(6,725)	(6,725)	(6,725)	(3,801)	(3,885)	(3,969)	(4,035)	(4,099)	(4,165)
STEAM ELECTRIC POWER, WARD	STEAM ELECTRIC POWER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

5 WATER MANAGEMENT STRATEGIES

Chapter 5 identifies and discusses the water management strategies to meet identified water needs as outlined in Chapter 4. These needs are met through a variety of strategies that have been developed through coordination with the water users in Region F.

This chapter is divided into five main parts. Chapter 5A discusses the types of potentially feasible water management strategies, the process used to develop the strategies, and the factors considered in evaluating the strategies. Chapter 5B discusses the water conservation strategies that were considered and recommended for users in Region F. This includes the identification and evaluation for municipal, irrigation, and mining conservation measures. Chapter 5C discusses regional strategies, including subordination, brush control, and weather modification. Chapter 5D presents the recommended water management strategies for the six major water providers in Region F. Chapter 5E addresses the recommended strategies for each water user group with identified shortages and summarizes the water management plans by county.

Over the planning period there may be additional water users that will need to upgrade or modify their water supply systems or develop new supplies but are not specifically identified in this plan. For aggregated water users, such as County-Other, the identification of needs can be challenging due to the nature of the data evaluation. It is the intent of this plan to include all water systems that may demonstrate a need for water supply. This includes established water providers and new water supply corporations formed by individual users that may need to band together to provide a reliable water supply. In addition, Region F considers water supply projects that do not impact other water users but are needed to meet demands or to meet regulatory requirements for consistency with the regional plan even though not specifically recommended in the plan.

This plan gives a potential approach that water suppliers can take to address their needs. Actual implementation of water management strategies is the responsibility of the water suppliers, and the details of strategies will evolve as they are implemented. The Region F Water Planning Group (RWPG) will not be implementing the strategies and does not want this plan to be an obstacle in the development of needed water supplies.

5A IDENTIFICATION AND EVALUATION OF WATER MANAGEMENT STRATEGIES

This section provides a review of the types of water management strategies (WMS) considered for Region F and the approach for identifying the potentially feasible water management strategies for water users with shortages. Once a list of potentially feasible strategies has been identified, the most feasible strategies are recommended for implementation. The Region F Plan does not recommend any mutually exclusive strategies. Alternative strategies can also be identified in case the recommended strategies become unfeasible. These strategies are discussed in more detail in later subchapters. This subchapter identifies the potentially feasible strategies for water users that were found to have a projected need in Chapter 4. Where applicable the following information was considered when evaluating existing supplies and WMSs:

- Publicly available plans for major agricultural, municipal, manufacturing, and commercial water users
- Local and regional water management plans
- Water availability requirements relating to Priority Groundwater Management Areas
- The Texas Clean Rivers Program
- The U.S. Clean Water Act
- Water management plans
- Other planning goals, including regionalization of water and wastewater services
- Any other information available from local or regional water planning studies

5A.1 Identification of Potentially Feasible Strategies

In accordance with TWDB rules, the Region F RWPG has adopted a standard procedure for identifying potentially feasible strategies. A technical memorandum documenting this procedure can be found in Appendix K. This procedure classifies strategies using TWDB's standard categories developed for regional water planning:

- Water Conservation
- Drought Management Measures
- Wastewater Reuse
- Management and/or Expanded Use of Existing Supplies
    - System Operation
    - Conjunctive Use of Groundwater and Surface Water
    - Reallocation of Reservoir Storage
    - Voluntary Redistribution of Water Resources
    - Voluntary Subordination of Existing Water Rights
    - Yield Enhancement
    - Water Quality Improvement
- New Supply Development
    - Surface Water Resources
    - Groundwater Resources
    - Brush Control
    - Desalination
    - Water Right Cancellation

  - Rainwater Harvesting
  - Aquifer Storage and Recovery (ASR)
  - Precipitation Enhancement
- Interbasin Transfers
- Emergency Transfers of Water

One of the purposes of this chapter is to provide a big picture discussion on the various strategy types that were identified to potentially reduce or meet the identified needs, the applicability of these strategies for users in Region F, and provide documentation of the strategy types that are not appropriate for Region F.

5A.1.1 Strategies Deemed Infeasible in Region F

While each of these strategy types were considered by the RWPG, not all were determined as viable options for addressing shortages in the region. Region F did not consider drought management as a feasible strategy to meet long-term growth in demands or currently identified needs. Drought measure efficacy varies across utilities and even across drought events and strategy is considered a temporary strategy to conserve available water supplies during times of drought or emergencies and acts as a means to minimize the adverse impacts of water supply shortages during drought. Drought management measures are viewed as a vital factor of safety for a drought worse than the drought of record. Drought management will be employed in the region through the implementation of local drought contingency plans. Region F is supportive of the development and use of these plans during periods of drought or emergency water needs.

The RWPG also did not consider water right cancellation to be a feasible strategy. Instead, Region F recommends that a water right holder consider selling water under their existing water right to the willing buyer or sell the water right outright. Emergency transfers of water are considered in Chapter 7. Similar to drought management, this strategy is an emergency response to drought or loss of water supplies and is not appropriate for long-term growth in demands.

Region F frequently experiences periods of low rainfall that can extend for a long period of time. Most of the area has been in drought-of-record conditions since the mid-1990s. As such, rainwater harvesting was not considered by the RWPG to be a feasible strategy due to the inherent lack of reliability.

The opportunities for reallocation of reservoir storage are very limited in Region F. There are only two federal reservoir projects, O.C. Fisher and Hords Creek, with a dedicated flood pool that could potentially be reallocated. Due to the limited surface water supply in Region F, reallocation would not result in additional reliable supply. As such, this strategy type is not considered in Region F.

Seawater desalination was not deemed a feasible strategy type for Region F due to the long transmission distance and considerable cost.

5A.1.2 Potentially Feasible Strategies in Region F

The strategy types (and associated subcategories) that were determined as potentially feasible strategies for entities within Region F are water conservation, wastewater reuse, expanded use of existing supplies (system operation, conjunctive use, voluntary redistribution, subordination, and water quality improvements), new supply development (new surface water, new groundwater, brush control, desalination, and ASR), and precipitation enhancement. All potentially feasibly strategies were evaluated under drought of record conditions.

The sections below include a brief discussion of each of these strategy types and the specific application to the users in Region F.

Water Conservation

Water conservation is defined as methods and practices that 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. Water conservation is typically viewed as long-term changes in water use that are incorporated into daily activities.

Water conservation is a valued water management strategy in Region F because it helps extend the limited water resources in the region. It is recommended for all individual municipal and irrigation water users, whether the user has a defined shortage or not. For rural municipal water users, conservation is recommended for County-Other users with an identified water need.

Conservation is also recommended for all mining users. Water conservation measures for manufacturing users are typically process-centered and difficult to develop at the aggregated county level. Region F does not have the level of detail necessary to develop meaningful conservation measures for manufacturing. Therefore, conservation was not considered feasible for manufacturing water users. However, conservation is encouraged for all users and is supported by Region F.

Wastewater Reuse

Wastewater reuse utilizes treated wastewater effluent as either a direct replacement for an existing water supply (direct reuse) or utilizes treated wastewater that has been returned or converted to a water supply resource (indirect reuse). Wastewater reuse is currently utilized by industry and mining users that purchase wastewater effluent from larger municipalities. It is also used for limited irrigation use. CRMWD has a direct potable reuse project that reuses wastewater from the City of Big Spring for municipal use by CRMWD customers. The largest producers of wastewater effluent are the larger cities, including San Angelo, Odessa and Midland. Currently, Odessa and Midland sell most of their treated wastewater for oil field production. Other entities are considering direct and indirect potable reuse for municipal use. There may be potential to expand wastewater reuse in Region F. Entities considering new or additional wastewater reuse include the City of San Angelo, and several smaller cities.

In addition to the traditional application of wastewater reuse, the mining industry produces millions of gallons of “produced water” a day. This water is impaired with chemicals injected during drilling and hydrocarbons (oil and gas). Much of the produced water is either injected in deep geologic formations or recycled for mining use. There is an interest in Region F to treat the produced water for other beneficial uses. This strategy will be considered for Region F.

Expanded Use of Existing Supplies

Expanded use of existing supplies includes seven subcategories ranging from selling developed water that is not currently used to enhancing existing supplies through operations, storage, treatment or other means. In Region F, five of the seven subcategories were determined potentially feasible. These include:

- subordination of senior water rights
- system operation
- conjunctive use of groundwater and surface water
- water quality improvements
- voluntary transfer (sales or contracts for developed water), and

- the recapturing of storage for surface water use through dredging. (Specifically, this strategy was considered for the City of Junction.)

Subordination of Downstream Water Rights

Texas surface water is governed by a priority system, where water rights are issued based on first in time is first in right. In the Colorado River Basin, there are several very large rights that are located in the lower part of the basin that have older (senior) priority dates. These more senior rights can make priority calls on water right holders in Region F. Under a strict priority analysis, the reliable surface water supply in Region F is very low. For many reservoirs, there is no reliable supply. This strategy assumes that senior right holders in the lower Colorado River Basin subordinate their seniority to upper basin water right holders, therefore this strategy is called subordination. Subordination has occurred for several decades in the basin and this strategy is still a reasonable approach to estimate the reliable supply in Region F rather than developing additional new supplies. Subordination typically involves an agreement between water right holders. Due to the sensitive nature of individual agreements, costs are not assigned to this strategy. This strategy is assessed for all reservoirs in the Colorado Basin in Region F and the run-of- river water rights for the City of Junction.

System Operation

System operation involves optimizing the management of two or more water supplies to maximize the supplies from each source and can result in increased water supplies overall. CRMWD and San Angelo both own and operate multiple surface water systems that could potentially benefit from system operation. In previous planning, system operation analyses of these systems found minimal increases in water supplies from system operation. While this strategy is currently employed by CRMWD and San Angelo and supported by Region F, this strategy type was considered and dismissed for purposes of creating additional supply in Region F.

Conjunctive Use of Groundwater and Surface Water

Conjunctive use is the operation of multiple sources of water to optimize the water resources for additional supply. In Region F, CRMWD, San Angelo, and Brady own and operate both surface water and groundwater sources. All three entities intend to conjunctively use the surface water when available to meet demands and use additional groundwater to supplement surface water supplies during drought when surface water resources are depleted. This will help reduce evaporative losses associated with the surface water reservoirs, while still meeting demands with groundwater when surface water is unavailable, or the quality has deteriorated.

Water Quality Improvements

Water quality improvements allow for the use of impaired water for municipal or other uses. Generally, this strategy is considered for users with sufficient water quantity but impaired water quality. In Region F, there are considerable amounts of brackish surface water and groundwater. Water quality improvements for these sources are typically accomplished through desalination or blending. This is discussed under the strategy type “Desalination”. This strategy type would apply to treatment of other water quality parameters, such as nitrates and radionuclides.

The Hickory aquifer has elevated levels of radionuclides that exceed the drinking water standard. Users of this source include Brady, Eden, Mason, Millersville-Doole WSC, and San Angelo. Additionally, the Lipan aquifer, which serves Concho Rural Water Corporation and rural users in Tom Green County, contains some elevated levels of nitrates.

Voluntary Redistribution

Voluntary redistribution is the transfer of existing water supplies from one user to another through mutually agreeable sales, leases, contracts, options, subordination, or other similar types of agreements. Typically, the entity providing the water has determined that it does not need the water for the duration of the transfer. The transfer of water could be for a set period of years or a permanent transfer. Redistribution of water makes use of existing resources and provides a more immediate source of water. In Region F, there is little to no developed water that is available for redistribution without the development of additional strategies. This strategy is used to represent sales and contracts between a water provider and its customers. It can include current contractual obligations and potential future customers.

New Supply Development

New supply development utilizes water that is not currently being used or generates new supplies through aquifer storage and recovery of water that otherwise would not have been available. This strategy type typically includes substantial infrastructure improvements to develop the new source, transport the water and, if needed, treat the water for its ultimate end use. The subcategories for this strategy type include new surface water development, new groundwater development, brush control, and aquifer storage and recovery.

Surface Water Development

The opportunity for new surface water development is limited in Region F. The Water Availability Model for the Colorado River Basin shows little to no available water for new appropriations. There are existing water rights that are currently not being used but could potentially be further developed. However, there are no identified sponsors for surface water development. New surface water development is not considered in Region F.

Groundwater Development

In parts of the region, there are considerable amounts of groundwater for future development but most of these sources are located far from the identified needs. In other areas, the groundwater is limited or of poor quality. Even with these limitations, groundwater is a viable and cost-effective supply source for some users. Because surface water supplies are so limited in Region F, the vast majority of municipal water users with a need after subordination during the planning period are expected to expand current groundwater use, develop new groundwater supplies, or purchase water from a provider that develops groundwater. Table 5A-1 shows the amount of groundwater that is available for new groundwater development by aquifer in 2030. Counties that have reached or are near capacity in utilizing the fresh groundwater resources allocated by the Modeled Available Groundwater (MAGs) in at least one aquifer are Andrews, Borden, Brown, Howard, Kimble, Martin, Mason, McCulloch, Menard, Pecos, Reagan, Ward, and Winkler counties. In areas where groundwater is not regulated, groundwater development may occur even if the MAG is exceeded. Groundwater production may also exceed the MAGs due to unmetered mining uses such as oil and gas exploration and production and other exempt uses.

Table 5A-1
Available Groundwater Supplies for Strategies

Aquifer	Unallocated Supplies[a] (acre-feet/year)
Capitan Reef Complex Aquifer	25,753
Cross Timbers Aquifer	1,047
Dockum Aquifer	40,053
Edwards-Trinity-Plateau and Pecos Valley Aquifers	222,328
Edwards-Trinity-Plateau Aquifer	1,440
Edwards-Trinity-Plateau, Pecos Valley, and Trinity Aquifers	102,367
Ellenburger-San Saba Aquifer	8,332
Hickory Aquifer	19,200
Igneous Aquifer	84
Lipan Aquifer	2,052
Marble Falls Aquifer	235
Ogallala and Edwards-Trinity-High Plains Aquifers	2,139
Ogallala Aquifer	1,813
Other Aquifer	19,124
Pecos Valley Aquifer	-
Rustler Aquifer	2,031
Seymour Aquifer	10
Trinity Aquifer	15

a. This is the total amount of groundwater that is available for strategies in Region F. These amounts may not necessarily be available in a particular county and/or river basin.

Brush Control

In 1985, the Texas Legislature authorized the Texas State Soil and Water Conservation Board (TSSWCB) to conduct a program for the "selective control, removal, or reduction of … brush species that consume water to a degree that is detrimental to water conservation." In 1999 the TSSWCB began the Brush Control Program. In 2011, the 82nd Legislature replaced the Brush Control Program with the Water Supply Enhancement Program (WSEP). The WSEP's purpose is to increase available surface and groundwater supplies through the selective control of brush species that are detrimental to water conservation[1]. As part of their competitive grant, cost sharing program, WSEP considers

- priority watersheds across the state
- the need for conservation within the territory of a proposed projection based on the State Water Plan
- and if the Regional Water Planning Group has identified brush control as a strategy in the State Water Plan.

WSEP is not a funded program at this time; however, brush control is still identified as a potentially feasible strategy for multiple Region F WUGs.

When funded, there are three primary species of brush in Region F that are eligible for funding from the WSEP. They include juniper, mesquite, and salt cedar.

Feasibility studies have been conducted for seven watersheds in Region F. These studies indicate there is potential for water loss reduction from brush, but these losses have been difficult to quantify during periods of drought. Brush control may be effective as part of a conjunctive use strategy by increasing inflows into surface water sources during times of normal rainfall. Surface water can be heavily relied on when available, allowing groundwater to be conserved for future times of drought. There are several active brush control programs in Region F, including the City of San Angelo's program for brush removal from Twin Buttes and O.C. Fisher Reservoirs and CRMWD's program for salt cedar removal at Lake Spence. Other water providers have partnered with the TSSWCB on brush removal projects in the past. Brush management must be an ongoing strategy to continue to realize water savings. This strategy is a potentially feasible strategy for operators and users of the CRMWD system, San Angelo system, Concho River, and Lake Brownwood.

Desalination

Desalination is the removal of excess salts from either surface water or groundwater for beneficial use. In Region F, most of the fresh groundwater supplies have been developed and are currently being used. The region has an abundant source of brackish water that potentially could be desalinated and used for municipal use. This process tends to require considerable energy and has historically been more costly than conventional treatment. It also produces a waste stream that can vary from about 10 percent to nearly 50 percent of the raw water, depending upon the level of and type of dissolved constituents. Since this strategy is fairly expensive, it is not an economically viable option for agricultural use. This strategy is considered for the municipal development of brackish water.

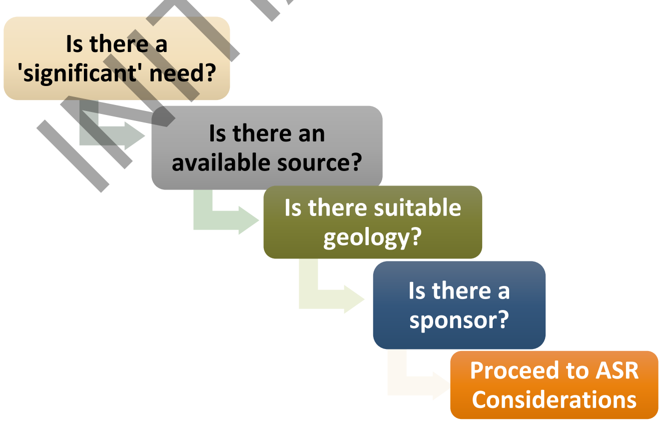
Aquifer Storage and Recovery (ASR)

Aquifer storage and recovery (ASR) involves storing water in aquifers and retrieving this water when needed. The water to be stored can be introduced through enhanced recharge or more commonly injected through a well into the aquifer. If an injection well is used, Texas law requires that the water not degrade the quality of the receiving aquifer. Source water for ASR can include excess surface water, treated wastewater, or groundwater from another aquifer.

To determine the feasibility and applicability of ASR, there are several technical considerations. Specifically,

- ASR requires suitable geological conditions for implementation. Since geologic conditions vary by location, studies must be performed to determine what specific locations would be suitable for ASR.
- Raw surface water and wastewater reuse most likely will require pretreatment prior to injection.
- Operation of an ASR system could significantly impact the amount of water that is retrievable.

Figure 5A-1
ASR Screening Process



Legislation passed by the 86th Texas Legislature and signed by the Governor in 2019 requires the regional water plans to consider ASR and provide a specific assessment of this strategy if the region has significant needs. The definition of significant need is deferred to each region. Region F defined the threshold for significant needs to be 5,000 acre-feet per year. There are five entities that meet the significant need threshold: City of Andrews, City of San Angelo, Irrigation in Andrews County, and Mining in Irion and Loving counties.

There are significant needs for both the City of Andrews and Irrigation in Andrews County. Both are related to a shortage in the Modeled Available Groundwater (MAG). In areas where groundwater is not regulated, like Andrews County, groundwater development may occur even if the MAG is exceeded. It is likely irrigation will meet this need through continued groundwater use beyond the MAG. Irrigators will likely not pursue ASR due to the lack of an identifiable sponsor. The City of Andrews also intends to pursue continued groundwater development. For both entities, there is a lack of water to input into ASR for storage. Therefore, ASR was not considered further for significant needs in Andrews County.

Groundwater production may also exceed the MAGs due to unmetered mining uses such as oil and gas exploration and production and other exempt uses. It is likely that mining users in Irion and Loving counties will continue to pump groundwater beyond the MAG instead of pursuing ASR. Also, there is no identified source for storage in the aquifers. Therefore, ASR was not considered further for mining.

The City of San Angelo considered ASR as part of its Water Supply Engineering Feasibility Study[2] . ASR was ruled out as a potentially feasible strategy due to the lack of suitable geology.

If a sponsor identified ASR as a potentially feasible water management strategy, it was evaluated as part of the Region F Plan. For this plan, ASR is evaluated for the Town of Pecos City.

Strategies were only considered potentially feasible if the strategy:

- Is appropriate for regional planning
- Utilizes proven technology and is technically feasible
- Has an identifiable sponsor
- Could meet the intended purpose for the end user considering water quality, economic feasibility, geographic constraints, and other factors, as appropriate
- Meets existing regulations

5A.1.3 Precipitation Enhancement

Precipitation enhancement introduces seeding agents to stimulate clouds to generate more rainfall. This process is also commonly known as cloud seeding or weather modification. In Region F, there are two ongoing weather modification programs: the West Texas Weather Modification Association (WTWMA) project and the Trans Pecos Weather Modification Association (TPWMA) program. Between these two programs, there are active precipitation enhancement activities occurring in 11 counties in Region F. This strategy was considered for irrigated agriculture in those counties.

According to the WTWMA, their efforts have increased precipitation across their target area by roughly 15 percent from 2004 through 2021, which translates to 2 inches of additional precipitation or around 1.2 million acre-feet of water per year[3]. Precipitation enhancement would be more beneficial during normal and wet years when “cloud targets” are more plentiful.

5A.1.4 Summary of Potentially Feasible Strategies

Potentially feasible water management strategies were identified for water users, wholesale water providers, and major water providers in Region F. These strategies include a wide assortment of strategy types, which were carefully reviewed for entities with identified needs.

Potentially feasible water management strategies were evaluated to identify those that could potentially provide non-trivial flood mitigation benefits, in addition to providing water supply. New surface water supply strategies were the only category deemed appropriate to assess for flood mitigation benefits. However, there are no new surface water strategies in Region F, thus, no strategies that might provide flood mitigation benefits.

While some strategies were determined not to be potentially feasible at this time, the Region F RWPG supports the research and development of new and innovative technologies for water supply. With continued research, new technologies will become more reliable and economical for future users and may be applicable for water suppliers in Region F.

The process for identifying potentially feasible water management strategies was presented at the Region F meeting in Big Spring on October 19, 2023. There were no public comments and Region F approved the methodology. A list of the potentially feasible water management strategies considered for Region F is included in Attachment 5A. The process for strategy development and evaluation is presented in the following sections.

Figure 5A-2
Strategy Development and Evaluation Process

5A.2 Strategy Development

Water management strategies were developed for water user groups to meet projected needs while accounting for their current supply sources, previous supply studies, and available supply within the region. Much of the water supply in Region F is from groundwater, and several of the identified needs could be met by development of new groundwater supplies. Where site-specific data or local aquifer information were available, this information was used. When specific well fields could not be identified, assumptions regarding well capacity, depth of well, lift distance, and associated costs were developed based on county and aquifer estimates. It is important to remember that it is difficult to determine one estimate that is appropriate across an entire county for each aquifer and water user group. The goal was to find average values that were representative for regional planning purposes. In most cases, new surface water supplies are not feasible because of the lack of unappropriated water in the Upper Colorado Basin.

Water transmission lines were assumed to take the shortest route. Profiles were developed using GIS mapping software and Google Earth. Pipes were sized to deliver peak-day flows within reasonable pressure and velocity ranges. Water losses of 25 percent were included for strategies requiring reverse osmosis (RO) treatment (potable reuse or desalination) unless a more specific study was available. Water losses associated with transmission were assumed to be negligible for regional planning purposes.

Municipal and manufacturing strategies were developed to provide water of sufficient quantity and quality that is acceptable for its end use. Water quality issues affect water use options and treatment requirements. For the evaluations of the strategies, it was assumed that the final water product would meet existing state water quality requirements for the specified use. For example, a strategy that provided water for municipal supply would meet existing drinking water standards, while water used for mining may have a lower quality.

In addition to the development of specific strategies to meet needs, there are other water management strategies that are general and could potentially increase water for multiple user groups. These include weather modification and brush control. A brief discussion of each of these general strategies and its applicability to Region F is included in Chapter 5C.

5A.3 Strategy Evaluation Criteria

The consideration and selection of water management strategies for water user groups with needs followed TWDB guidelines and were conducted in open meetings with the Region F RWPG. The potentially feasible strategies were evaluated in accordance with state guidance.

Other relevant factors include regulatory requirements, political and local issues, amount of time required to implement the strategy, recreational impacts of the strategy, and other socio-economic benefits or impacts.

The definition of quantity is the amount of water the strategy would provide to the respective user group in acre-feet per year. This amount is considered with respect to the user's short-term and long-term shortages. Reliability is an assessment of the availability of the specified water quantity to the user over time. If the quantity of water is available to the user all the time, then the strategy has a high reliability. If the quantity of water is contingent on other factors, reliability will be lower. The assessment of cost for each strategy is expressed in dollars per acre-foot per year for water delivered and treated for the end user requirements. Calculations of these costs follow the Texas Water Development Board's guidelines for cost considerations and identify total capital cost and annual costs by decade. Project capital costs are based on September 2023 price levels and include construction costs, engineering, land acquisition, mitigation, right-of-way, contingencies and other project costs associated with the respective strategy. Annual costs include power costs associated with transmission, water treatment costs, water purchase (if applicable), operation and maintenance, and other project-specific costs. Debt service for capital improvements was calculated over 20 years at a 3.5 percent interest rate.

Potential impacts to sensitive environmental factors were considered for each strategy. Sensitive environmental factors may include wetlands, threatened and endangered species, unique wildlife habitats, and cultural resources. In most cases, a detailed evaluation could not be completed because previous studies have not been conducted or the specific location of the new source (such as a groundwater well field) was not identified. Therefore, a more detailed environmental assessment will be required before a strategy is implemented.

The impact on water resources considers the effects of the strategy on water quantity, quality, and use of the water resource. A water management strategy may have a positive or negative effect on a water resource. This review also evaluated whether the strategy would impact the water quantity and quality of other water management strategies identified.

A water management strategy could potentially impact agricultural production or local natural resources. Impacts to agriculture may include reduction in agricultural acreage, reduced water supply for irrigation, or impacts to water quality as it affects crop production. Various strategies may actually improve water quality, while others may have a negative impact. The impacts to natural resources may consider inundation of parklands, impacts to exploitable natural resources (such as mining), recreational use of a natural resource, and other strategy-specific factors.

Strategy evaluations are included in Appendix C and associated infrastructure cost estimates may be found in Appendix D. Appendix E includes a Strategy Evaluation Matrix and Quantified Environmental/Agricultural Impact Matrix.

LIST OF REFERENCES

[1] Texas State Soil and Water Conservation Board: Water Supply Enhancement Program. Available online at https://www.tsswcb.texas.gov/programs/water-supply-enhancement-program.
[2] City of San Angelo. Water Supply Engineering Feasibility Study, October, 2018.
[3] West Texas Weather Modification Association: Analysis and Research. Available online at https://westtxwxmod.com.

5B WATER CONSERVATION

Water conservation is a potentially feasible water savings strategy that can be used to preserve the supplies of existing water resources. For municipalities and manufacturers, advanced drought planning and conservation can be used to protect their water supplies and increase reliability during drought conditions. Some of the demand projections developed for SB1 Planning incorporate an expected level of conservation to be implemented over the planning period. For municipal use, the assumed reductions in per capita water use are the result of the implementation of the State Water-Efficiency Plumbing Act[1]. Among other things, the Plumbing Act specifies that only water-efficient fixtures can be sold in the State of Texas. Savings occur because all new construction must use water-efficient fixtures, and other fixtures will be replaced at a fairly steady rate. On a regional basis, the Plumbing Act results in about a three percent reduction in municipal water use (6,291 acre-feet per year) by year 2080.

Water conservation strategies must be considered for all water users with a need. In Region F, this includes municipal, manufacturing, agricultural, mining, and steam electric power water users. Conservation strategies to reduce industrial (manufacturing, mining, and steam electric power) water use are typically industry and process-specific and cannot be specified to meet county-wide needs. The region recommends that industrial water users be encouraged to develop and implement site-specific water conservation practices. Wastewater reuse is a more general strategy that can be utilized by various industries for process water, and this strategy will be considered where appropriate.

Based on factors developed by the TWDB, irrigation demands are estimated to remain constant over the planning period (2030 to 2080). Reductions in demands due to conservation were not quantified by the TWDB for manufacturing and livestock needs.

Steam electric demands in Region F are estimated to remain constant over the planning period. As an alternative to using water, Region F, in consultation with representatives of the power generators in the area, developed an analysis of alternative cooling technologies that use little or no water. Because these technologies reduce the amount of water needed for power generation, using these technologies can be considered a water conservation strategy and are discussed in this subchapter. Due to the cost of the conversion to this type of technology, this strategy is not considered economically feasible at this time but would be supported by the Region if a power generator chose to pursue the strategy.

Agricultural water shortages include shortages for livestock and irrigation. Most of the livestock demand in Region F is for free-range livestock. Region F encourages individual ranchers to adopt practices that prevent the waste of water for livestock. However, the savings from these practices will be small and difficult to quantify. Therefore, livestock water conservation is not considered in this plan.

For municipal and irrigation users, additional conservation savings can potentially be achieved in the region through the implementation of conservation best management practices (BMPs), as discussed in Section 5B.1.1. These additional conservation measures were considered for all municipal and irrigation water user groups in Region F. Any water conservation plans that were publicly available or submitted to the RWPG were considered when developing and recommending conservation BMPs.

Although water conservation and drought management have proven to be effective strategies in Region F, the RWPG believes that water conservation should not be relied upon exclusively for meeting future needs. The region will need to develop additional surface water, groundwater, and alternative supplies to meet future needs. However, each entity that is considering development of a new water supply should monitor ongoing conservation activities to determine if conservation can delay or eliminate the need for a new water supply project.

The RWPG recognizes that it has no authority to implement, enforce or regulate water conservation and drought management practices. The water conservation practices described in this chapter and elsewhere in this plan are intended only as guidelines. Water conservation strategies determined and implemented by municipalities, water providers, industries or other water users supersede the recommendations in this plan and are considered to be consistent with this plan.

5B.1 Municipal Conservation

Certain public water suppliers are required to update and submit a Water Conservation Plan (WCP) to the Texas Commission on Environmental Quality (TCEQ) every five years. Water suppliers required to submit a WCP are discussed further in Section 5B.5. Per Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.2 of the Texas Administrative Code, some specific conservation strategies are required to be included as part of a water conservation plan.

At a minimum each plan must include:

- Utility Profile that describes the entity, water use data, and water supply and wastewater system
- Record management system that is capable of recording water use by different types of users
- Quantified five-year and ten-year water savings goals
- Metering device with a 5 percent accuracy to measure the amount of water diverted from the source of supply
- A program for universal metering
- Measures to determine and control water loss
- A program of continuing public education and information regarding water conservation
- A non-promotional water rate structure
- A reservoir systems operation plan, if applicable
- Means of implementation and enforcement, as evidenced by: a document indicating the adoption of the WCP, and a description of the authority where the water supplier will implement and enforce the WCP
- Documentation of coordination with the regional water planning group
- Plan review and update, including an implementation report

If a public water supplier serves over 5,000 people, they are additionally required to the have a conservation-oriented rate structure and a program of leak detection, repair, and water loss accounting for the water transmission, delivery, and distribution system.

Both the water conservation plans and water loss audit reports for water suppliers in Region F were reviewed to help identify appropriate municipal water conservation measures. The data from the water loss audit reports for Region F water providers are discussed in more detail in Chapter 1 of this plan.

Twenty-eight water providers in Region F submitted water loss audits in 2023. Based on these reports, the percentage of real water loss for Region F is approximately 14 percent, which is slightly greater than the accepted range of water loss (less than or equal to 12 percent). This is likely due to the large service areas with low population densities characteristic of rural water supply corporations. For the water suppliers that fall under the water supply corporation category, there may be few cost-effective options in reducing water loss.

5B.1.1 Identification of Potentially Feasible Conservation BMPs

To assess the appropriateness of additional conservation BMPs for Region F, 70 potential strategies were identified, and a screening level evaluation was conducted. Due to the differences in the water needs and available resources between the larger municipalities and smaller rural areas, the screening evaluation was performed both for entities with populations less than 20,000 people and entities with populations greater than 20,000.

The evaluation considered six criteria:

- Cost
- Potential Water Savings
- Time to Implement
- Public Acceptance
- Technical Feasibility
- Staff Resources

Each criterion was scored from 1 to 5, with 5 being the most favorable. Scores for all the criteria were then added to create a composite score. The strategies were then ranked and selected based on their composite score.

Selected Strategies for Entities under 20,000

Based on the screening level evaluation and requirements from the TCEQ, the following strategies were selected for consideration for entities in Region F with less than 20,000 people during every decade of the planning period:

- Education and Outreach
- Water Audits and Leak Repair
- Conservation – Oriented Rate Structure
- Water Waste Ordinance

Selected Strategies for Entities over 20,000

Based on the screening level evaluation and requirements from the TCEQ, the following strategies were selected for consideration for entities in Region F with more than 20,000 people during any decade of the planning period:

- Education and Outreach
- Water Audits and Leak Repair
- Conservation – Oriented Rate Structure
- Water Waste Ordinance
- Landscape Ordinance
- Time of Day Watering Limit

Each of the selected strategies above, was considered and evaluated for the appropriate water user groups (greater than or less than 20,000). Details of the strategy evaluation are included in Appendix C.

5B.1.2 Recommended Municipal Conservation Strategies

Published reports and previous studies were used to refine the description for the selected BMPs, including the potential water savings and costs. Water savings for some BMPs are difficult to estimate since there is little data for an extended time period. Also, most entities tend to implement a suite of strategies at the same time, which makes it difficult to estimate the individual water savings. These factors were considered in developing the assumptions defined below for each BMP. As more data becomes available through more rigorous water use tracking, the ability to estimate water conservation savings will improve.

Education and Outreach

Local officials would offer water conservation education to schools, civic associations, include information in water bills, provide pamphlets and other materials as appropriate. It was assumed that the education outreach programs would be needed throughout the planning period to maintain the water savings. It was assumed that education and outreach would save 5,000 gallons per household per year with a 30 percent adoption rate, i.e., assume that 30 percent of the customers respond to this measure by reducing water use. Per person costs were based on data obtained from municipalities and water providers. The costs for entities with populations less than 20,000 are greater on a per person basis than for the larger cities. In this case, education and outreach were assumed to cost $3.19 per person per year with a maximum cost of $15,000 for entities with populations less than 20,000. In contrast, education and outreach were assumed to cost $2.09 per person per year for entities with populations greater than 20,000.

Water Audits and Leak Repairs

Local officials would perform a water audit system wide and create a program of leak detection and repair, including infrastructure replacement as necessary. As part of this type of program, some entities may choose to install Advanced Metering Infrastructure. It was assumed that 20 percent of an entity's losses could be recovered through a water audit and leak repair program, and that the leak detection and repair program would be an ongoing activity to maintain the level of water loss reductions. This strategy was considered for all cities with greater than or equal to 15 percent losses and WSCs with losses greater than or equal to 25 percent. If no water loss data was available for a WUG, this strategy was not considered. Costs were estimated at $12 per person per year. If an entity's population was less than 20,000 people, then an estimated base cost of $5,000 was added to the total cost.

Rate Structure

Local officials would implement an increasing block rate structure where the unit cost of water increases as consumption increases. Increasing block rate structures discourage the inefficient use or waste of water. Many cities already have a non-promotional rate structure. This strategy assumes that the entity adopts a higher level of a non-promotional rate structure. It is assumed that increasing block rates would save 6,000 gallons per household per year and that 10 percent of the households would respond to this measure by reducing water use. Since it is likely that the entity would conduct the rate structure modifications themselves, this BMP has no additional costs to the water provider.

Water Waste Ordinance

Local officials would implement an ordinance prohibiting water waste such as watering of sidewalks and driveways or runoff into public streets. A water waste ordinance saves about 3,000 gallons per household per year. It is assumed that 50 percent of the households in entities with over 20,000 people and 30 percent of the households in entities with less than 20,000 people would respond to this measure by not wasting water. Costs for this strategy would be those costs associated with enforcement. In this case, the costs associated with enforcement was estimated to be $11,600 in entities with over 20,000 people and $2,900 in entities with less than 20,000 people.

Landscape Ordinance (Population over 20,000)

Local officials would implement an ordinance that would promote residential plantings that conserve water for all new construction. This strategy is assumed to be implemented by 2040 and would only apply to new construction for both residential and commercial properties. This BMP would save 1,000 gallons per increased number of households per year. Costs for this strategy would be those costs associated with enforcement, which were estimated to be $11,600.

Time of Day Watering Limit (Population over 20,000)
Local officials would implement an ordinance prohibiting outdoor watering during the hottest part of the day when most of that water is lost (wasted) through evaporation. Many ordinances limit outdoor watering to between 6 p.m. and 10 a.m. on a year-round basis. It is assumed that time of day watering limits save 1,000 gallons/household/year and 75 percent of the population would realize these savings. (The other 25 percent is either not irrigating or already abide by this practice.) Costs for this strategy would be those costs associated with enforcement, which were estimated to be $11,600.

5B.1.3 GPCD Goals

The Region F planning group recognizes that it has no authority to implement, enforce, or regulate water conservation practices. The municipal conservation measures outlined in this chapter are intended as guidelines. Local, entity specific conservation strategies and BMPs are consistent with this plan and encouraged by the RWPG. Entity specific recommendations supersede the recommendations in this Plan.

As part of House Bill (HB) 807, the regional planning groups are required to "set one or more specific goals for gallons water use per capita per day (gpcd) in each decade of the period covered by the plan for the municipal water user groups in the regional water planning area." It should be noted that these goals are different than the goals set by utilities as part of their TCEQ Water Conservation Plans (WCP). WCP goals are often based on multi-year averages. Gpcd goals in this plan are intended as goals for dry year use, and thus, will generally be higher than the gpcd goal shown in an entity's WCP. Gpcd goals for each municipal user Region F are included as Attachment 5B at the end of this chapter.

5B.1.4 Municipal Conservation Summary

It is estimated that the municipal conservation strategy outlined in this plan will save, on a regional basis, over 2,800 acre-feet in 2030 and over 4,300 acre-feet in 2080. The unit costs vary considerably between water user groups depending on the population size, and implementation of a water audit and leak repair program for entities with high water losses. Generally, conservation programs are funded through a city's annual operating budget and are not capitalized. However, in some cases, an entity may choose to capitalize a portion or all of their program. These kinds of costs are difficult to estimate for each individual entity due to the wide variety of factors at play. For this plan, it is assumed that only water audits and leak repairs are capitalized. It was assumed that the repairs would be financed over 20 years in 2030, 2050, and 2070. However, all capital expenditures for conservation are considered consistent with Region F Plan. The savings and costs associated with water audits and leak repairs are shown separately in

Table 5B-3.

Estimates of municipal conservation savings for Region F water users are shown in Table 5B-1. This table shows the amount of water savings that are estimated through conservation water management strategies, which is above the amount assumed to be achieved through the Plumbing Act. Table 5B-1 shows the estimated costs for municipal conservation.

Although water conservation is part of the culture of the region, the challenge for future water conservation activities in Region F will be the development of water conservation programs that are cost-effective, meet state mandates, and result in permanent real reductions in water use. Development of water conservation programs will be a particular challenge for smaller communities, which lack the financial and technical resources needed to develop and implement the programs. Any water conservation activities should consider the potential adverse impacts of lost revenues from water sales and the ability of communities to find alternative sources for those revenues. State financial and technical assistance will be required to meet state mandates for these communities.

Table 5B-1
Estimated Savings from Municipal Conservation (acre-feet per year)

Water User Group	2030	2040	2050	2060	2070	2080
AIRLINE MOBILE HOME PARK	6	6	7	8	8	9
ANDREWS	49	60	109	127	147	169
ANDREWS COUNTY-OTHER	22	29	38	47	56	80
BALLINGER	11	11	11	11	12	12
BALMORHEA	1	1	1	2	2	2
BANGS	9	9	9	9	9	9
BARSTOW	1	1	1	1	1	1
BIG LAKE	9	9	10	10	10	10
BIG SPRING	118	122	124	121	119	116
BORDEN COUNTY WATER SYSTEM	1	1	1	1	1	2
BRADY	17	17	16	16	15	15
BRONTE	3	3	3	3	4	4
BROOKESMITH SUD	20	21	21	21	21	21
BROWNWOOD	61	90	90	90	90	91
COAHOMA	3	3	3	3	3	3
COLEMAN	11	9	8	7	5	4
COLEMAN COUNTY SUD*	8	8	8	7	7	7
COLORADO CITY	20	20	20	20	21	21
CONCHO RURAL WSC	23	26	29	31	34	37
CORIX UTILITIES TEXAS INC*	16	34	36	35	35	34
CRANE	11	11	11	11	11	11
CROCKETT COUNTY WCID 1	7	6	6	6	5	5
DADS SLC	1	1	1	1	1	1
EARLY	10	10	10	11	11	11
ECTOR COUNTY UD	102	128	147	191	209	227
EDEN	5	5	5	5	5	5
ELDORADO	5	4	4	3	3	2
FORT STOCKTON	29	29	29	31	33	35
GOODFELLOW AFB	7	7	7	7	7	7
GRANDFALLS	1	1	2	2	2	2
GREATER GARDENDALE WSC	15	18	21	23	25	27
GREENWOOD WATER	3	3	3	3	3	3
IRAAN	3	3	3	3	3	4
JUNCTION	7	7	7	7	7	7
KERMIT	22	25	29	31	34	38
LORAINE	2	2	1	1	1	1
MADERA VALLEY WSC	6	6	7	7	8	8
MASON	7	7	7	8	8	8
MCCAMEY	5	5	6	6	6	6
MENARD	3	3	3	3	3	3
MERTZON	2	2	2	2	2	2
MIDLAND	646	720	789	877	977	1,092
MILES	3	3	3	3	3	3

Water User Group	2030	2040	2050	2060	2070	2080
MILLERSVIEW-DOOLE WSC	16	18	21	24	27	31
MONAHANS	26	29	33	36	39	43
NORTH RUNNELS WSC*	4	4	4	5	5	5
ODESSA	530	637	745	786	838	890
PECOS	30	34	38	40	43	46
PECOS COUNTY FRESH WATER	2	2	2	2	2	3
PECOS COUNTY WCID 1	7	7	8	7	7	6
RANKIN	2	2	2	3	3	3
REEVES COUNTY-OTHER	12	12	13	13	14	15
RICHLAND SUD	2	2	2	2	2	2
ROBERT LEE	3	3	3	4	4	5
RUNNELS COUNTY-OTHER	3	3	3	2	2	2
SAN ANGELO	463	507	538	570	605	643
SANTA ANNA	3	3	3	3	3	3
SNYDER	36	36	37	37	38	38
SONORA	7	6	6	5	5	4
SOUTHWEST SANDHILLS WSC	8	9	10	11	12	13
STANTON	8	9	10	11	12	14
STERLING CITY	4	6	8	10	13	16
TOM GREEN COUNTY FWSD 3	2	2	2	3	3	3
U AND F WSC	2	2	2	2	2	2
WICKETT	1	2	2	2	2	2
WINK	2	2	2	2	2	3
WINTERS	7	7	7	6	6	5
ZEPHYR WSC	12	13	13	13	13	13
TOTAL	**2,503**	**2,843**	**3,162**	**3,411**	**3,669**	**3,965**

*Conservation volumes for this WUG are split between multiple regions. The amounts shown represent the total conservation volume for the whole WUG.

Table 5B-2
Estimated Costs for Municipal Conservation

	2030	2040	2050	2060	2070	2080
Region F Annual Cost	$1,755,000	$1,952,000	$2,084,000	$2,171,000	$2,279,000	$2,434,000
Annual Cost per acre-foot	$701	$687	$659	$636	$621	$614
Annual Cost per 1,000 gal	$2.15	$2.11	$2.02	$1.95	$1.91	$1.88

Table 5B-3
Estimated Savings and Costs from Water Audits and Leak Repairs

Water User Group	Capital Cost			Savings (acre-feet/year)					
	2030	2050	2070	2030	2040	2050	2060	2070	2080
COLEMAN	$879,000	$668,000	$474,000	28	24	21	18	14	11
COLORADO CITY	$1,697,000	$1,692,000	$1,726,000	61	61	60	61	61	62
CONCHO RURAL WATER	$2,041,000	$2,464,000	$2,911,000	41	46	50	55	60	65
ELDORADO	$446,000	$362,000	$282,000	24	21	18	16	13	10
JUNCTION	$637,000	$625,000	$628,000	37	36	36	36	36	36
MERTZON	$256,000	$251,000	$247,000	4	4	4	4	4	4
MILLERSVIEW-DOOLE WSC	$1,473,000	$1,859,000	$2,400,000	64	72	81	92	105	121
NORTH RUNNELS WSC	$433,000	$461,000	$500,000	7	7	7	8	8	8
PECOS COUNTY WCID #1	$645,000	$691,000	$602,000	15	16	17	16	15	13
ROBERT LEE	$349,000	$388,000	$446,000	11	12	13	14	15	17
WINTERS	$659,000	$599,000	$533,000	16	15	14	13	12	11
TOTAL	**$9,515,000**	**$10,060,000**	**$10,749,000**	**308**	**314**	**321**	**333**	**343**	**358**

5B.2 Irrigation Water Conservation

The agricultural water needs in Region F include livestock and irrigated agriculture. New water supply strategies to meet these needs are limited. For irrigated agriculture, the primary strategies identified to address irrigation shortages are demand reduction strategies (conservation). The agricultural water conservation practices considered include:

- Changes in irrigation equipment
- Crop type changes and crop variety changes
- Conversion from irrigated to dry land farming
- Water loss reduction in irrigation canals

In addition to these practices, the region encourages research into development of drought-tolerant crops, implementation of a region-wide evapotranspiration and soil moisture monitoring network, and, where applicable, water-saving improvements to water transmission systems.

Depending on the method employed to achieve irrigation conservation, the composition of crops grown, sources of water, and method of delivery will impact the potential savings and costs of this strategy. Since Region F does not have data on county-specific irrigation equipment employed by crop type, a general approach to irrigation conservation savings was taken. For planning purposes, a 5 percent increase in irrigation efficiency was assumed in the decades 2030, 2040, and 2050. This efficiency could be achieved through implementation of one or more of the identified practices. The efficiency level was held constant for decades 2060, 2070, and 2080. A maximum efficiency level of 85 percent was assumed. For planning purposes, it was assumed that on average, irrigation conservation would have a capital cost of $920 per acre-foot saved. This is based on the Water Conservation Implementation Task Force Water Conservation Best Management Practices cost per acre for irrigation equipment changes indexed to September 2023 dollars. These costs are based on expenditure for changes in irrigation equipment.

Based on these assumptions, the irrigation conservation strategy is estimated to save around 22,000 acre-feet of supply in 2030 and over 58,000 acre-feet in 2080. The projected savings by county are presented in Table 5B-4. The region-wide capital and annual costs are shown in Table 5B-5.

Table 5B-4
Irrigation Conservation Savings (acre-feet per year)

County Name	2030	2040	2050	2060	2070	2080
ANDREWS	878	1,756	1,756	1,756	1,756	1,756
BORDEN	125	250	250	250	250	250
BROWN	384	615	615	615	615	615
COKE	31	62	74	74	74	74
COLEMAN	21	42	42	42	42	42
CONCHO	260	520	572	572	572	572
CROCKETT	4	8	12	12	12	12
ECTOR	38	75	113	113	113	113
GLASSCOCK	1,737	1,737	1,737	1,737	1,737	1,737
HOWARD	255	510	561	561	561	561
IRION	53	105	158	158	158	158
KIMBLE	130	260	312	312	312	312
MARTIN	1,647	3,293	4,940	4,940	4,940	4,940
MASON	240	480	721	721	721	721
MCCULLOCH	104	207	311	311	311	311
MENARD	173	347	520	520	520	520
MIDLAND	900	1,800	2,699	2,699	2,699	2,699
MITCHELL	260	260	260	260	260	260
PECOS	6,884	13,767	20,651	20,651	20,651	20,651
REAGAN	1,075	2,150	3,225	3,225	3,225	3,225
REEVES	3,001	6,003	9,004	9,004	9,004	9,004
RUNNELS	176	352	422	422	422	422
SCHLEICHER	101	121	121	121	121	121
SCURRY	349	698	908	908	908	908
STERLING	43	86	128	128	128	128
SUTTON	56	112	168	168	168	168
TOM GREEN	2,480	4,960	5,952	5,952	5,952	5,952
UPTON	421	842	1,263	1,263	1,263	1,263
WARD	217	433	650	650	650	650
WINKLER	153	307	460	460	460	460
Total	**22,196**	**42,158**	**58,605**	**58,605**	**58,605**	**58,605**

Table 5B-5
Irrigation Conservation Costs

	2030	2040	2050	2060	2070	2080
Region F Capital Cost	$20,420,000	$18,365,000	$15,131,000	$0	$0	$0
Annual Cost per acre-foot	$32.15	$32.15	$19.97	$9.02	$0.00	$0.00
Annual Cost per 1,000 gal	$0.10	$0.10	$0.06	$0.03	$0.00	$0.00

Irrigation conservation is a strategy that proactively causes a decrease in future water needs by increasing the efficiency of current irrigation practices throughout the region. The adoption of irrigation conservation will help preserve the existing water resources for continued agriculture use and provide for other demands. However, without technical and financial assistance it is unlikely that aggressive irrigation conservation programs will be implemented. Also, increased efficiencies may lead to higher water application rates to increase crop yields, which negates the estimated water savings.

Region F recognizes that it has no authority to implement, enforce, or regulate irrigation conservation practices. These water conservation practices are intended to be guidelines. Water conservation strategies determined and implemented by the individual water user group supersede the recommendations in this plan and are considered to meet regulatory requirements for consistency with this plan. Furthermore, all capital expenditures for conservation are considered to be consistent with the Region F plan.

5B.3 Mining Water Conservation

Most of the mining water use in Region F is used in oil and gas production, and most of the increase in projected future use is associated with the current Permian Basin activities. In accordance with §27.0511 of the Texas Water Code, Region F encourages the use of alternatives to fresh water for oil and gas production whenever it is economically and technically feasible to do so. Furthermore, Region F recognizes the regulatory authority of the Railroad Commission and the TCEQ to determine alternatives to fresh water use in the permitting process.

Due to the limited water resources in the Permian Basin, oil and gas companies have been actively pursuing recycling and reuse of the make-up water. These activities are a form of conservation, which is a demand management strategy that decreases future freshwater needs by treating and reusing water used in mining operations. Mining conservation and recycling is possible for both oil and gas mining as well as sand and gravel mining. Mining recycling and conservation was considered for all oil and gas mining operations in Region F.

Several oil and gas companies are already implementing reuse measures, and the estimated amount is included in the 2026 Region F Plan as existing supplies (Chapter 3). The amount that can potentially be reused as part of a strategy is less the amount of reuse already existing to avoid double counting. The amount of water that can be reused/recycled is also dependent on the amount of water that flows back to the surface during and after the completion of the hydraulic fracturing or oil field flooding. For planning purposes, it is assumed that 20 percent of water used for mining purposes would be available through flow back and can be reused/recycled. The flow back water is of low quality and requires treatment or must be blended with fresh water. An estimated 30% of the flow back water will be lost during the treatment process.

On a regional basis, the amount of water saved through mining recycling and conservation is around 8,600 acre-feet in 2030 and over 4,100 acre-feet in 2080 when demands will have decreased significantly. Estimated savings by county are shown in Table 5B-6. The actual quantity of water available from this strategy will vary. Since this strategy is largely dependent on each individual operator and on economic factors specific to each mining operation, it is difficult to estimate the actual quantity of water that could be made available through this strategy.

The costs associated with this strategy vary based on the amount of flow back, the geographic location of the flow back, the amount of treatment required, and transportation distances required. For the purposes of this plan, a $20,000 per acre-foot capital investment for the maximum amount of water saved over the planning period was assumed. This investment was amortized over 20 years. However, individual operators may plan to invest the capital with no debt service and would likely implement capital improvements at the level needed for each decade. The costs in Table 5B-7 assume a single capital investment beginning in 2030. A 10 cent per barrel ($775 per acre-foot) annual savings from not having to dispose of the brine was assumed for the decades with capital cost. If an operator continued to employ this strategy in the later decades, they may realize net savings over treating and disposing of the brine. However, for planning purposes, the annual cost was assumed to be $0 after the capital investment is paid off.

As competition for water grows, and water resources become more scarce, individual mining operators may find it more attractive to implement a reuse/recycling strategy. Reusing/recycling flow back water may also reduce brine disposal costs for the operator to help offset the cost of treatment and transportation. Ultimately, the decision to implement this strategy will be based on the economics of each individual well field. If brackish water is readily available and not in demand by other users, it may be more attractive to use brackish supplies. For planning purposes, it is assumed that the mining industry will adopt this strategy at the following rates:

- If there is a mining water shortage, mining conservation will be adopted 50 percent of the time
- If there is no mining shortage, mining conservation will be adopted 30 percent of the time
- If there is a surplus of mining water, mining conservation will be adopted 10 percent of the time

This assumption is incorporated into the water savings and costs shown in the previous tables. This strategy is recommended for all counties with a mining demand.

Table 5B-6
Mining Conservation (Recycling) Supplies (acre-feet per year)

Mining Conservation (Recycling) Supplies						
County	**2030**	**2040**	**2540**	**2060**	**2070**	**2080**
Andrews	242	242	222	182	128	81
Borden	117	117	107	88	62	39
Coke	2	2	2	2	2	2
Crane	21	21	21	21	1	1
Crockett	423	423	78	63	45	28
Ector	24	24	22	18	12	8
Glasscock	479	479	439	359	253	160
Howard	427	427	391	320	226	142
Irion	615	615	563	92	65	41
Loving	692	692	692	692	692	692
Martin	574	574	526	143	101	64
Midland	508	508	466	381	90	56
Mitchell	15	15	14	12	8	5
Pecos	931	931	931	931	186	186
Reagan	686	686	628	171	121	76
Reeves	2017	2017	2017	2017	2017	2017
Schleicher	148	148	136	111	78	49
Scurry	18	18	16	13	9	6
Sterling	105	105	97	79	56	35
Sutton	1	1	1	1	1	1
Tom Green	34	34	31	26	18	11
Upton	183	183	168	137	97	61
Ward	227	227	227	227	227	227
Winkler	113	113	113	113	113	113
Total	**8,602**	**8,602**	**7,908**	**6,199**	**4,608**	**4,101**

Table 5B-7
Mining Conservation (Recycling) Costs

Costs	2030	2040	2050	2060	2070	2080
Region F Total Capital Cost	$172,040,000	$0	$0	$0	$0	$0
Region F Annual Cost (ac-ft/yr)	$5,438,000	$5,438,000	$0	$0	$0	$0
Annual Cost per acre-foot	$632	$632	$0	$0	$0	$0
Annual Cost per 1,000 gal	$1.94	$1.94	$0.00	$0.00	$0.00	$0.00

5B.4 Steam Electric Power Conservation

Steam Electric Power is a bit of a misnomer. 'Steam Electric Power' is the official name given by the TWDB for water demands associated with large power generation plants that sell to the open market and use water for cooling, not just facilities that use steam technology. Thus, throughout the Region F Water plan, 'Steam Electric Power' is used to refer to the broader water needs of multiple types of power generation.

By 2080 the region will have water needs for steam electric power generation of over 4,500 acre-feet after subordination. However, some of these needs may not be realized due to changes in technology at the power generation facility that have already reduced water demands or projected new facilities that may not come online.

The projections for steam electric power water use in Region F are based on the highest use in the five-year period from 2015-2019 plus specific projected facilities. The anticipated water use of future facilities listed in state and federal reports is then added to the demand projections from the anticipated operation date to 2080. Subsequent demand projections after 2030 are held constant throughout the planning period. In Region F there are water demands for power generation in four counties: Ector, Howard, Mitchell, and Ward.

The use of alternative cooling technologies (ACT) that generate the same amount of electricity, but use less water is a form of water conservation. One example of an ACT implemented in power generation facilities is air cooling. This type of technology can be very costly to implement, and the adoption of ACT is largely a business decision on the part of the power industry. At this time, no facilities in Region F are currently considering adoption of this technology and is not considered economically feasible. However, the Region F planning group supports all types of water conservation and would support any power generation facility that chooses to implement a technology change that reduces water needs.

5B.5 Water Conservation Plans

The TCEQ defines water conservation as "a strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water."

In §11.1271 of the Texas Water Code, the State of Texas requires water conservation plans for all municipal and industrial/mining 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. Water conservation plans are also required for all water users applying for a state water right and may also be required for entities seeking state funding for water supply projects. Legislation passed in 2003 requires all conservation plans to specify quantifiable five-year and ten-year conservation goals. While achieving these goals is not mandatory, the goals must be identified. In 2007, §13.146 of the Texas Water Code was amended requiring retail public suppliers with more than 3,300 connections to submit a water conservation plan to the TWDB. In addition, any entity that is applying for a new water right or an amendment to an existing water right is required to prepare and implement a water conservation plan.

In Region F, 15 entities hold municipal or industrial rights in excess of 1,000 acre-feet per year and five entities have irrigation water rights greater than 10,000 acre-feet per year. Each of these entities is required to develop and submit to the TCEQ a water conservation plan. In addition, eight retail public suppliers are required to submit conservation plans to the TWDB. A list of the users in Region F which are required to submit water conservation plans is shown in Table 5B-8. All publicly available conservation plans were considered to develop the conservation strategies described in this subchapter.

Many more water users have contracts with regional water providers for 1,000 acre-feet per year or more. Presently, these water users are not required to develop water conservation plans unless the user is seeking state funding. However, TCEQ rules require that a wholesale water provider include contract language requiring water conservation plans or other conservation activities from its customers to assist in meeting the goals of the wholesale water provider's plan.[2]

To assist entities in the Region F area with developing water conservation plans, model plans for municipal water users, industrial users and irrigation districts can be accessed online at www.regionfwater.org and clicking on the Documents tab (https://www.regionfwater.org/index.aspx?id=OtherDocuments). Each of these model plans address the TCEQ requirements and is intended to be modified by each user to best reflect the activities appropriate to the entity. General model water conservation plan forms are also available from TCEQ in Microsoft Word and PDF formats. A printed copy of the form from TCEQ can be obtained by calling TCEQ at 512-239-4691 or by email to wcp@tceq.texas.gov.

Table 5B-8
Water Users in Region F Required to Submit Water Conservation Plans

Municipal/Industrial Water Rights Holders		
Brown County WID #1	City of Menard	City of Coleman
City of Ballinger	City of San Angelo[a]	City of Junction
City of Big Spring[a]	City of Sweetwater[b]	CRMWD
City of Brady	City of Winters	Upper Colorado River Authority
Luminant Generation Co.	Texas Parks and Wildlife	Pax Essential LLC
Retail Public Suppliers		
City of Andrews	City of Midland	City of Pecos
City of Brownwood	City of Odessa	City of Snyder
City of Fort Stockton	Ector County Utility District	
Irrigation Water Rights Holders		
Pecos County WCID #1	Wayne Moore & W H Gilmore	Red Bluff Water Power Control District
Reeves County WID #1	City of San Angelo[a]	

a. These entities are also required to develop a conservation plan as a retail public provider.
b. City of Sweetwater is located in the Brazos G region but holds water rights in Region F.

5B.6 Other Water Conservation Recommendations

Region F encourages all water user groups to practice advanced conservation efforts to reduce water demand, not only during drought conditions, but as a goal in maintaining future supplies. This includes municipal, industrial, mining, and agricultural water users. As appropriate, municipal users should strive to reduce per capita water use to achieve the state-recommended goal of 140 gpcd use. Region F recognizes that some cities and rural communities may not achieve this level of reduction, but many communities have the opportunity to increase their water savings.

With irrigated agriculture being the largest water user in Region F, this sector has the greatest opportunities for water reductions due to conservation. The plan recommends strategies that would reduce the estimated irrigation water use by over 58,000 acre-feet per year by 2080. Region F supports the implementation of any and all measures that effectively reduce water for agricultural purposes.

Region F supports and encourages the collaboration of multiple entities across the region to promote water conservation. This could be accomplished with the assistance of regional organizations, such as the GMAs and GCDs. Consistent messaging is important in continuing to maintain and/or increase conservation levels in the region. 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/.

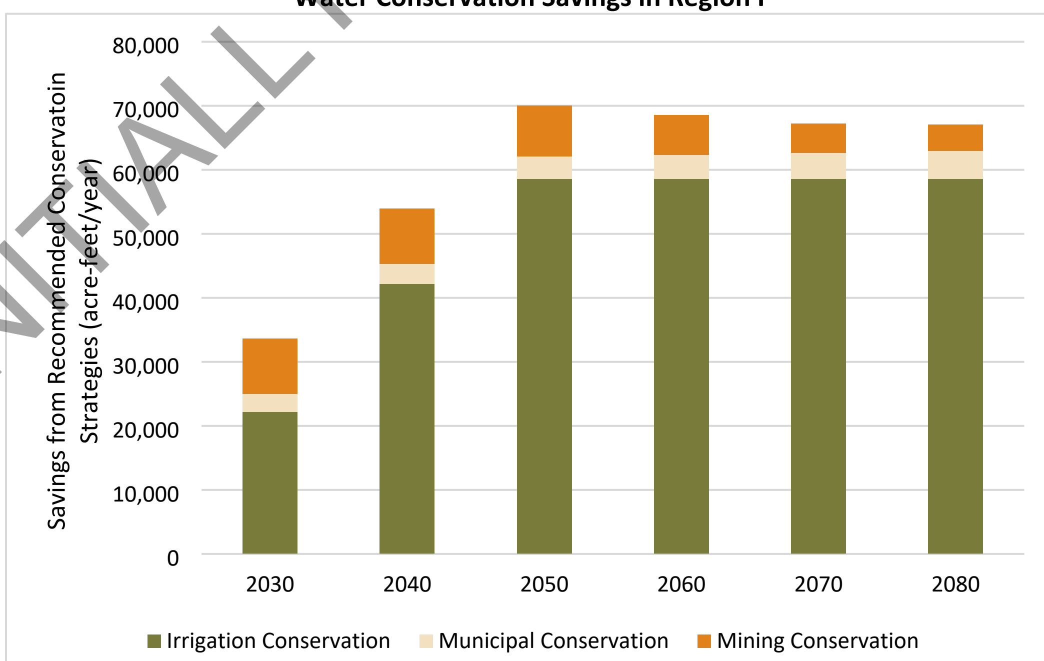
5B.7 Water Conservation Summary

Based on these analyses, it is estimated that implementing water conservation measures for municipal, agricultural, and mining users in Region F could save over 33,000 acre-feet by 2030 and over 67,000 acre-feet of water by 2080. Rising water costs and limited additional supplies will require increased water efficiency for all users and is encouraged by Region F.

Table 5B-9
Water Conservation Savings in Region F
-Values in acre-feet per year-

	2030	2040	2050	2060	2070	2080
Municipal Conservation	2,811	3,157	3,483	3,744	4,012	4,323
Irrigation Conservation	22,196	42,158	58,605	58,605	58,605	58,605
Mining Conservation	8,602	8,602	7,908	6,199	4,608	4,101
Total Conservation Savings	**33,609**	**53,917**	**69,996**	**68,548**	**67,225**	**67,029**

Figure 5B-1
Water Conservation Savings in Region F



ATTACHMENT 5B

GPCD GOALS

Water User Group (WUG) Name	GPCD Goals					
	2030	2040	2050	2060	2070	2080
AIRLINE MOBILE HOME PARK LTD	132	132	131	131	132	131
ANDREWS	249	248	247	247	247	247
BALLINGER	172	172	172	172	172	172
BALMORHEA	421	421	421	419	419	420
BANGS	108	107	107	107	107	107
BARSTOW	516	516	516	516	516	517
BIG LAKE	224	223	223	223	223	223
BIG SPRING	216	216	216	216	216	216
BORDEN COUNTY WATER SYSTEM	558	557	558	559	559	558
BRADY	208	208	208	208	208	208
BRONTE	271	271	271	271	271	271
BROOKESMITH SUD	163	162	162	162	162	162
BROWNWOOD	170	167	167	167	167	167
COAHOMA	338	338	338	338	338	338
COLEMAN	174	174	173	173	174	173
COLEMAN COUNTY SUD	229	228	228	228	228	228
COLORADO CITY	212	212	212	212	212	212
CONCHO RURAL WATER	109	108	108	108	108	108
CORIX UTILITIES TEXAS INC	160	154	154	154	155	155
COUNTY-OTHER, ANDREWS	102	101	101	101	101	101
COUNTY-OTHER, BORDEN	237	237	237	237	237	237
COUNTY-OTHER, BROWN	72	71	71	71	71	71
COUNTY-OTHER, COKE	85	85	85	85	85	85
COUNTY-OTHER, COLEMAN	103	103	103	103	103	103
COUNTY-OTHER, CONCHO	113	113	113	113	113	113
COUNTY-OTHER, CRANE	104	103	103	103	103	103
COUNTY-OTHER, CROCKETT	103	102	102	102	102	102
COUNTY-OTHER, ECTOR	110	109	109	109	109	109
COUNTY-OTHER, GLASSCOCK	104	104	104	104	104	104
COUNTY-OTHER, HOWARD	105	104	104	104	104	104
COUNTY-OTHER, IRION	104	103	103	103	103	103
COUNTY-OTHER, KIMBLE	105	104	104	104	104	104
COUNTY-OTHER, LOVING	106	104	104	104	104	104
COUNTY-OTHER, MARTIN	114	113	113	113	113	113
COUNTY-OTHER, MASON	106	105	105	105	105	105
COUNTY-OTHER, MCCULLOCH	136	135	135	135	135	135
COUNTY-OTHER, MENARD	105	105	105	105	105	105
COUNTY-OTHER, MIDLAND	139	138	138	138	138	138
COUNTY-OTHER, MITCHELL	152	151	151	151	151	151
COUNTY-OTHER, PECOS	115	114	114	114	114	114
COUNTY-OTHER, REAGAN	120	118	118	118	118	118
COUNTY-OTHER, REEVES	122	121	121	121	121	121
COUNTY-OTHER, RUNNELS	81	80	80	81	80	80
COUNTY-OTHER, SCHLEICHER	125	124	124	124	124	124
COUNTY-OTHER, SCURRY	105	105	105	105	105	105
COUNTY-OTHER, STERLING	103	102	102	102	102	102
COUNTY-OTHER, SUTTON	120	119	119	119	119	119
COUNTY-OTHER, TOM GREEN	114	113	113	113	113	113
COUNTY-OTHER, UPTON	104	103	103	103	103	103

Water User Group (WUG) Name	GPCD Goals					
	2030	2040	2050	2060	2070	2080
COUNTY-OTHER, WARD	164	162	162	162	162	162
COUNTY-OTHER, WINKLER	156	154	154	154	154	154
CRANE	303	302	302	302	302	302
CROCKETT COUNTY WCID 1	388	388	388	388	388	388
DADS Supported Living Center	382	381	381	381	381	381
EARLY	118	117	117	116	116	116
ECTOR COUNTY UTILITY DISTRICT	103	102	102	101	101	101
EDEN	329	328	328	328	328	328
ELDORADO	260	260	260	260	260	261
FORT STOCKTON	361	360	360	360	360	360
GOODFELLOW AIR FORCE BASE	177	176	176	176	176	176
GRANDFALLS	506	506	504	505	505	505
GREATER GARDENDALE WSC	68	67	67	67	67	67
GREENWOOD WATER	226	226	226	226	226	226
IRAAN	311	311	311	311	311	311
JUNCTION	190	190	190	190	190	190
KERMIT	267	266	266	266	266	266
LORAINE	282	281	282	282	282	282
MADERA VALLEY WSC	387	387	387	387	386	387
MASON	286	286	286	285	286	286
MCCAMEY	360	359	359	359	359	359
MENARD	203	202	202	202	202	201
MERTZON	104	103	103	103	103	103
MIDLAND	138	138	138	138	138	138
MILES	96	96	96	96	96	96
MILLERSVIEW-DOOLE WSC	156	155	155	155	155	155
MONAHANS	295	294	294	294	294	294
NORTH RUNNELS WSC	99	99	99	99	99	100
ODESSA	167	167	167	167	167	167
PECOS	343	342	342	342	342	342
PECOS COUNTY FRESH WATER	331	330	330	331	331	330
PECOS COUNTY WCID 1	243	242	242	242	242	242
RANKIN	311	310	311	310	310	310
RICHLAND SUD	464	463	463	463	463	463
ROBERT LEE	234	234	234	234	234	233
SAN ANGELO	147	146	146	146	146	146
SANTA ANNA	117	117	116	116	116	116
SNYDER	129	128	128	128	128	128
SONORA	428	428	428	428	428	428
SOUTHWEST SANDHILLS WSC	134	133	133	133	133	133
STANTON	165	164	164	164	164	164
STERLING CITY	255	254	254	255	254	254
TOM GREEN COUNTY FWSD 3	150	150	150	149	149	150
U & F WSC	152	151	151	151	151	151
WICKETT	384	382	382	383	383	383
WINK	381	380	380	380	380	379
WINTERS	127	126	126	126	126	126
ZEPHYR WSC	124	123	123	123	123	123

LIST OF REFERENCES

[1] Texas Health and Safety Code. *Water Saving Performance Standards*, Title 5, Subtitle B § 372.002, 2019.

[2] Texas Administrative Code (TAC). 2018. Title 30, Part 1, Chapter 288, Subchapter A, Subchapter B, and Subchapter C, April 2019, downloaded from: http://texreg.sos.state.tx.us/public/readtac$ext.ViewTAC?tac_view=4&ti=30&pt=1&ch=288

5C REGIONAL WATER MANAGEMENT STRATEGIES

Several strategies have been identified that will benefit multiple user groups across the region. These strategies include: subordination of downstream water rights, brush control, and precipitation enhancement. This subchapter discusses each of these strategies and outlines the recommendations, quantities and costs associated for each user of the strategy. Detailed strategy evaluations are included in Appendix C.

5C.1 Subordination of Downstream Water Rights

The TWDB requires the use of the TCEQ Water Availability Models (WAM) for regional water planning. Most of the water rights in Region F are in the Colorado River Basin. Chapter 3 discusses the use of the WAM models for water supply estimates and the impacts to the available supplies in the Upper Colorado River Basin. The Colorado WAM assumes that senior lower basin water rights would continuously make priority calls on Region F water rights. That assumption is not consistent with the historical operation of the Colorado River Basin and likely underestimates the amount surface water supplies available in Region F.

Although the Colorado WAM does not give an accurate assessment of water supplies based on the way the basin has historically been operated, TWDB requires the regional water planning groups to use the WAM to determine supplies. Using WAM supplies causes several sources in Region F to have no supply by definition, even though in practice their supply may be greater than indicated by the WAM. According to the WAM, the Cities of Coleman, Junction, and Winters and their customers have no surface water supply. The Morgan Creek power plant has no supply to generate power. The Cities of Big Spring, Bronte, Coahoma, Menard, Midland, Miles, Odessa, San Angelo, Snyder and Stanton do not have sufficient water to meet current demands. Overall, the Colorado WAM supplies show shortages that are the result of modeling assumptions and regional water planning rules and are inconsistent with the historical operation of the Colorado Basin. This would indicate Region F needs to immediately spend significant funds on new water supplies, when in reality the magnitude of the indicated water shortages are not justified. Conversely, the WAM model shows more water in Region K (Lower Colorado Basin) than may actually be available.

One way for the planning process to reserve water supplies for these communities and their customers is to assume that downstream senior water rights holders subordinate their priority rights to major Region F municipal water rights, a strategy referred to as subordination in this plan.

Since the subordination strategy impacts water supplies outside of Region F, coordination with the Lower Colorado Regional Water Planning Group (Region K) was conducted. For the development of the 2006 regional water plans, a joint modeling effort was conducted with Region K and an agreement was reached for planning purposes. In subsequent planning cycles, Region K developed its own version of this subordination strategy, called the “cutoff model” that modified the priority dates for all water rights above Lakes Ivie and Brownwood. Region F has adopted the premise of the Region K’s cutoff model with only minor variations for purposes of the subordination strategy in this plan. The Region F model makes two major assumptions: 1) senior water rights in the Lower Colorado Basin (Region K) do not make priority calls on the upper basin, and 2) these upper basin water rights do not make calls on each other. Figure 5C-1 shows the divide between the upper and lower basin and depict which reservoirs were included in the subordination modeling. For the 2026 Region F Plan, the approved TCEQ WAM was used for the subordination modeling and modified to adjust the priority dates in accordance with the cutoff model.

The Region F model differs from the Region K model by including the City of Junction's run-of-river rights and Brady Creek Reservoir in the upper basin. Other refinements to the subordination modeling include modifications for the Pecan Bayou. As discussed above, the assumption that upper basin water rights do not make calls on each other is consistent with general operations in the basin, but it may not be appropriate for determining water supplies during drought in the Pecan Bayou watershed. To better reflect reality, an assumption was made that the upstream reservoirs hold inflows that would have been passed to Lake Brownwood under strict priority analysis if Lake Brownwood is above 50 percent of the conservation capacity. This scenario provides additional supplies in the upper watershed while allowing Lake Brownwood to make priority calls at certain times during drought (i.e. when Lake Brownwood is below 50 percent of the conservation pool).

Two reservoirs providing water to the Brazos G planning region were included in the subordination analysis. Lake Clyde is located in Callahan County and provides water to the City of Clyde. Oak Creek Reservoir is located in Region F and supplies a small amount of water to WUGs within Regions F and G. Oak Creek Reservoir is owned and operated by the City of Sweetwater, which is in the Brazos G Region. Both Clyde and Sweetwater have other sources of water in addition to the supplies in the Colorado Basin.

The subordination strategy modeling was conducted for regional water planning purposes only. By adopting this strategy, the Region F RWPG does not imply that the water rights holders have agreed to relinquish the ability to make priority calls on junior water rights. The Region F RWPG does not have the authority to create or enforce subordination agreements. Such agreements must be developed by the water rights holders themselves. Region F recommends and supports ongoing discussions on water rights issues in the Colorado Basin that may eventually lead to formal agreements that reserve water for Region F water rights.

The modeling shows that over 54,100 acre-feet of additional supply is available through the subordination strategy in 2030 and over 52,100 acre-feet in 2080. Table 5C-1 compares the 2030 and 2080 Region F water supply sources with and without subordination.

The reliability of this strategy is considered to be medium based on the uncertainty of implementing this strategy. The subordination strategy defined for the Region F Water Plan is for planning purposes. If an entity chooses to enter into a subordination agreement with a senior downstream water right holder, the details of the agreement (including costs, if any) will be between the participating parties. Therefore, strategy costs were not determined for the subordination strategy. For planning purposes, capital and annual costs for the subordination strategy are assumed to be $0.

Figure 5C-1
Region F Subordination Strategy: Upper and Lower Colorado River Basins

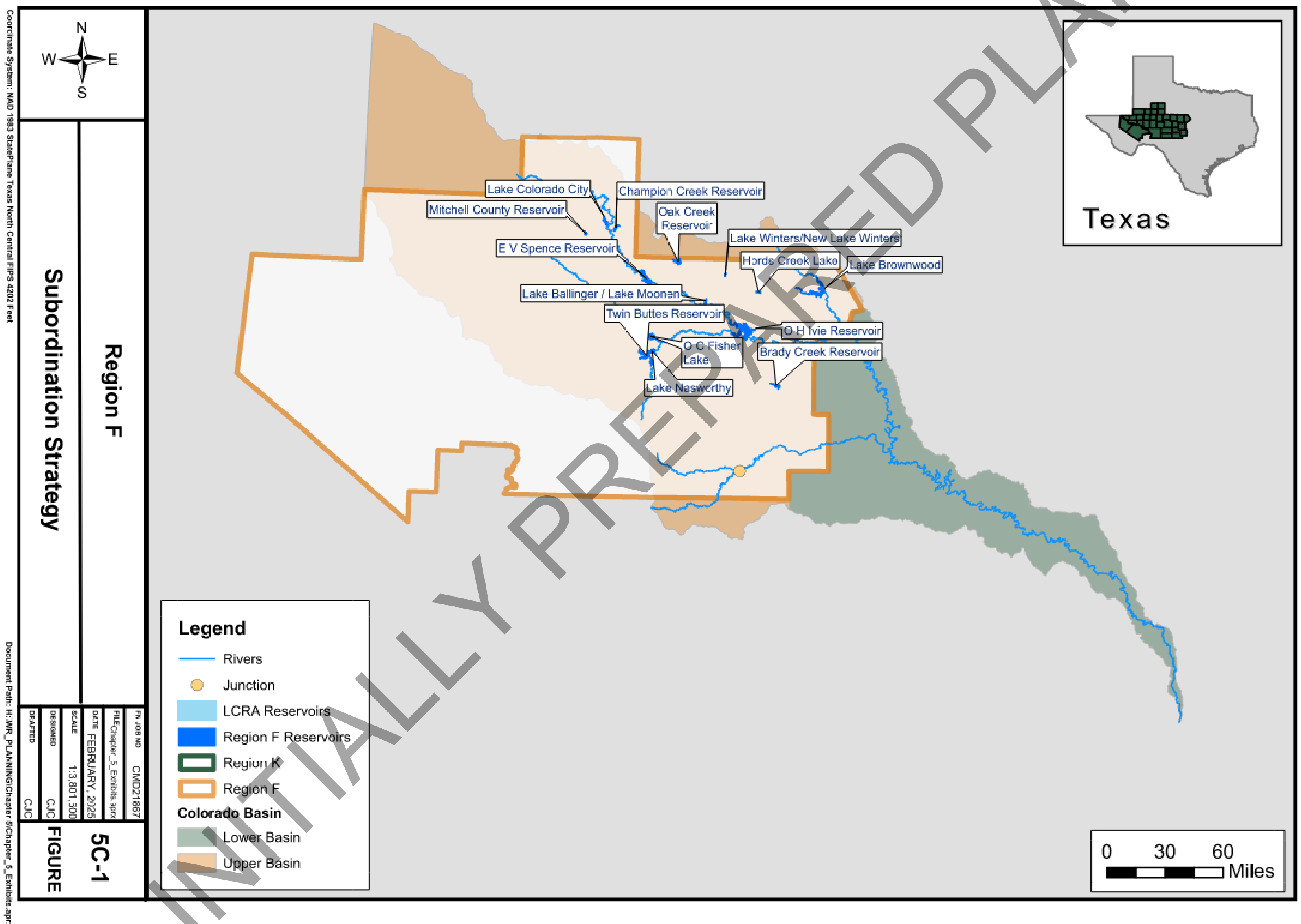


Table 5C-1
Region F Surface Water Supplies with and without Subordination

Reservoir Name	2030 Supply WAM Run 3	2030 Supply Subordination	2080 Supply WAM Run 3	2080 Supply Subordination
Lake Colorado City	0	1,760	0	1,480
Champion Creek Reservoir	0	1,164	0	1,080
Colorado City/Champion System	0	2,924	0	2,560
Lake Coleman	0	1,900	0	1,638
Hords Creek Lake	0	190	0	130
Coleman System	0	2,090	0	1,768
O. C. Fisher Lake[a]	0	0	0	0
Twin Buttes Reservoir[a]	0	1,865	0	1,530
Lake Nasworthy	0	180	0	135
San Angelo System	0	2,045	0	1,665
Lake J. B. Thomas (CRMWD System)	0	3,710	0	3,591
E.V. Spence Reservoir (CRMWD System)	0	21,900	0	21,614
O.H. Ivie Reservoir (CRMWD System)	13,277	15,728	11,685	13,851
O.H. Ivie Reservoir (Non-System)	15,263	17,672	12,855	15,824
O.H. Ivie Reservoir Total	28,540	33,400	24,540	29,675
CRMWD System Total (Thomas, Spence & Ivie)	13,277	41,338	11,685	39,056
Lake Ballinger / Lake Moonen	0	820	0	790
Lake Balmorhea	19,600	19,600	19,600	19,600
Brady Creek Reservoir	0	1,855	0	1,680
Lake Brownwood	15,550	25,800	14,900	24,815
Mountain Creek Reservoir	0	86	0	86
Oak Creek Reservoir	0	1,055	0	850
Red Bluff Reservoir	16,180	16,180	16,040	16,040
Lake Winters/ New Lake Winters	0	265	0	258
Kimble County ROR	902	1,179	902	1,179
Menard County ROR	2,034	4,007	2,034	4,007
TOTAL	***82,806***	***136,916***	***78,016***	***130,178***
Increase with Subordination	***54,110***		***52,162***	

[a] Supplies are less than theoretically available from the subordination model.

A list of the water user groups that could potentially benefit from subordination and the amount assumed for planning are shown in Table 5C-2.

Table 5C-2
Subordination Supplies by WUG

WUG Name	Additional Supplies Made Available through the Subordination Strategy					
	2030	2040	2050	2060	2070	2080
Allocated Subordination Supplies						
Abilene[b]	803	779	754	787	821	849
Ballinger[a]	792	822	872	910	935	959
Big Spring	0	497	1,282	1,866	2,212	2,458
Brady	0	0	1,770	1,740	1,710	1,680
Bronte	199	229	251	283	317	357
Coahoma	0	27	72	104	122	134
Coleman	1,023	1,029	1,035	1,009	954	900
Coleman County SUD	78	76	73	70	68	65
Concho Rural Water	35	17	14	13	12	10
County-Other, Coke	49	49	49	49	49	49
County-Other, Coleman	17	13	10	7	4	2
County-Other, Runnels	28	28	28	28	26	23
County-Other, Scurry	0	7	17	25	31	34
County-Other, Tom Green	126	106	102	102	101	99
Ector County Utility District	0	289	852	1,387	1,831	2,268
Goodfellow Air Force Base	93	43	37	34	32	30
Greater Gardendale WSC	0	18	100	162	216	266
Irrigation, Coleman	400	400	400	400	400	400
Irrigation, Ector[a]	0	60	150	224	271	308
Irrigation, Menard	1,330	1,330	1,330	1,330	1,330	1,330
Irrigation, Midland	0	60	153	227	276	314
Irrigation, Tom Green	0	1,782	1,700	1,643	1,587	1,530
Junction	269	269	269	269	269	269
Manufacturing, Coleman	1	1	1	1	1	1
Manufacturing, Ector	0	26	66	97	119	135
Manufacturing, Howard	0	111	281	417	505	576
Manufacturing, Kimble	8	8	8	8	8	8
Manufacturing, Tom Green	78	38	34	32	31	29
Menard	643	643	643	643	643	643
Midland[a,b]	803	1,605	2,860	3,907	4,598	5,149
Miles	21	9	8	10	7	8
Millersview-Doole WSC	0	43	110	164	198	230
Mining, Tom Green	2	1	2	0	0	0
North Runnels WSC	103	109	117	124	132	142
Odessa	0	1,822	5,642	8,999	11,612	14,024
Robert Lee	199	212	213	215	216	217
Rotan	0	19	46	65	79	88
San Angelo[a,b]	3,471	1,757	1,604	1,581	1,561	1,534
Snyder	0	127	331	498	609	701
Stanton	0	22	58	85	104	118
Steam Electric Power, Ector	0	165	420	625	756	861
Steam Electric Power, Howard	1	64	163	240	292	329
Steam Electric Power, Mitchell	2,924	2,840	2,756	2,690	2,626	2,560
U & F WSC	0	1	1	2	2	2
Winters	162	155	146	137	128	116
Non-Allocated Subordination Supplies						
Brady Creek (non-allocated)	1,855	1,813	0	0	0	0
BCWID (non-allocated)	8,721	8,666	8,611	8,536	8,461	8,386

WUG Name	Additional Supplies Made Available through the Subordination Strategy					
	2030	2040	2050	2060	2070	2080
CRMWD (non-allocated)	28,060	23,516	15,551	9,011	4,228	0
Oak Creek (Sweetwater G)	598	556	513	473	433	393
Lake Coleman (non-allocated)	571	499	427	400	400	400

a. Includes subordination supplies from multiple sources and/or providers.

b. Subordination supply is based on a contract for 16.54% of the safe yield of Lake Ivie. This supply changes with the implementation of the West Texas Water Partnership strategy. As part of this strategy, the Lake Ivie supplies may be reallocated among the cities of Abilene, Midland, and San Angelo. However, this has not yet occurred, so the current subordination yields from these contract amounts are shown in the table above. The Partnership will follow up on initial conversations with the CRMWD to explore necessary methodologies and agreements to implement a cooperative use strategy of the Partnership's collective Ivie supplies.

5C.2 General Water Management Strategies

5C.2.1 Brush Control

Brush control has been identified as a potentially feasible water management strategy for Region F. It has the potential to enhance the existing supply from the region's reservoirs.

In 1999, the Texas State Soil and Water Conservation Board began the Brush Control Program. In 2011, the 82nd Legislature replaced the Brush Control Program with the Water Supply Enhancement Program (WSEP). The WSEP's purpose is to increase available surface and groundwater supplies through the selective control of brush species that are detrimental to water conservation. As part of their competitive grant cost sharing program, the WSEP considers priority watersheds across the State, the need for conservation within the territory of a proposed project, and if the Regional Water Planning Group has identified brush control as a strategy in the State Water Plan. WSEP is not a funded program at this time; however, brush control is still included as a recommended strategy for multiple Region F WUGs that could achieve greater water yields through its implementation. When funded, three primary species are eligible for funding from the WSEP: juniper, mesquite and salt cedar.

For a watershed to be eligible for cost-share funds from the WSEP, a feasibility study must demonstrate increases in projected post-treatment water yield as compared to the pre-treatment conditions. Feasibility studies have been conducted and published for the following watersheds in Region F and are shown on Figure 5C-2:

- Lake Brownwood
- North Concho River (O.C. Fisher Lake)
- O.H. Ivie Reservoir (Lake Basin)
- O.H. Ivie Reservoir (Watershed, Upper Colorado River and Concho River)
- E.V. Spence (Upper Colorado River)
- Lake J.B. Thomas (Upper Colorado River)
- Twin Buttes Reservoir (including Lake Nasworthy)
- Upper Llano River, including South and North Llano Rivers and Junction City Lake

Active brush removal has been implemented in several watersheds, but to be an effective and reliable long-term water production strategy, areas where brush removal has been performed must be maintained. These maintenance activities qualify as brush control for purposes of this plan.

Although many studies have illustrated the benefits of brush control, it is difficult to quantify the amount of water supply created by the strategy for regional water planning. This quantification is important because in most areas where the program is being implemented, hydrologic records indicate long term declines in reservoir watershed yields (some as much as 80%). Region F has been in serious drought conditions during most of the time that the region's brush removal programs have been in place, so the monitoring programs associated with these projects may not have shown significant gains due to the lack of rainfall events. Also, the benefits from brush control are long term; it takes time for aquifers to recharge and it may take some time for watersheds to return to pre-brush conditions.

For purposes of this plan, brush control is recommended for the following sponsors and watersheds designated in Table 5C-3. The quantity of water directly associated with brush removal under drought conditions is limited since it is reliant on rainfall, but it is assumed that this strategy will increase the reliability of the surface water supplies made available through subordination. It may also help increase supplies when employed as part of a conjunctive strategy. By preferentially using surface water when it is available, groundwater is preserved for times of future drought.

Figure 5C-2
Brush Control Watershed Feasibility Studies

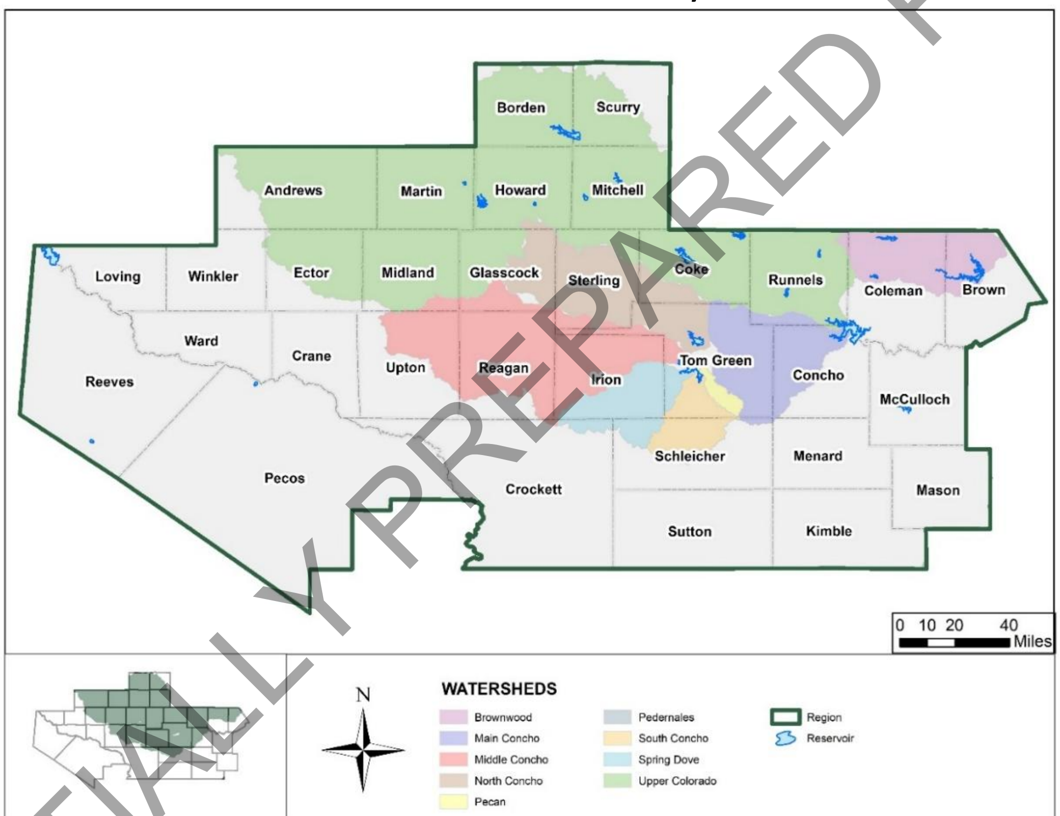


Table 5C-3
Region F Brush Control

Sponsor	Watershed	Annual Cost	Quantity (acre-feet/year)
San Angelo	Twin Buttes Reservoir	$54,000	90
BCWID	Lake Brownwood	$188,000	400

Table is an excerpt from Brush Control section in Appendix C.

5C.2.2 Weather Modification

Weather modification is a water management strategy currently used in Texas to increase precipitation released from clouds over a specified area. The most common form of weather modification or rainfall enhancement is cloud seeding. Early forms of weather modification began in Texas in the 1880s by firing cannons to induce convective cloud formation. Current cloud seeding techniques are used to enhance the natural process for the formation of precipitation in a select group of convective clouds.

Weather modification is most often used to enhance precipitation in West Texas from March through October. The water produced by weather modification augments existing surface and groundwater supplies. It also reduces the reliance on other supplies for irrigation during times of normal and slightly below normal rainfall. However, not all of this water is available for water demands. Some of this precipitation is lost to evaporation, evapotranspiration, and local ponds. During drought years the amount of additional rainfall produced by weather modification may not be significant. However, by using this strategy during normal rainfall years, groundwater is preserved for use during future times of drought.

The amount of water made available to a specific entity from this strategy is difficult to quantify, yet there are regional benefits. Four major benefits associated with weather modification include:

- Improved rangeland and agriculture due to increased precipitation
- Greater runoff to streams and rivers due to higher soil moisture
- Groundwater recharge
- Hail suppression

In Region F, there are two ongoing weather modification programs: the West Texas Weather Modification Association (WTWMA) project and the Trans-Pecos Weather Modification Association (TPWMA) program. Figure 5C-3 shows the counties that are currently participating in weather modification programs.

Based on data collected from the WTWMA program, precipitation increases across participating counties in 2022 varied from slightly 0.46 inches to 1.76 inches throughout the year, averaging 1.30 inches of increased rainfall. [1] According to the WTWMA, this represented a 17 percent increase in rainfall over a non-seeding season. In the Trans-Pecos area, the rainfall increases were less, averaging 1.17 inches of increased rainfall.[2]

While it is difficult to quantify the benefits to individual water user groups, weather modification is a recommended strategy for irrigated agriculture in counties that currently participate in an active program. It is assumed that increases in rainfall will offset irrigation water use. To determine the water savings associated with this strategy, an estimate of the increase in annual rainfall over the typical growing season is applied directly to the irrigated acreages. [3] These savings are shown by county in Table 5C-4.

The reliability of water supplies from precipitation enhancement is considered to be low for two reasons. First, it is uncertain how much water is made directly available per water user. Second, during drought conditions precipitation enhancement may not result in a significant increase in water supply. However, water saved due to precipitation enhancement will preserve local groundwater for future use.

The cost of operating Texas weather modification programs are approximately 4 to 5 cents per acre.[4] For planning purposes, it was assumed that it would cost 4.5 cents per acre. These costs are supported by local municipalities, groundwater districts, irrigation districts, and landowners. The costs shown in

Table 5C-4 are based on the program cost for the irrigated acres. Actual costs would be higher when considering the entire program areas.

Figure 5C-3
Current Weather Modification Programs

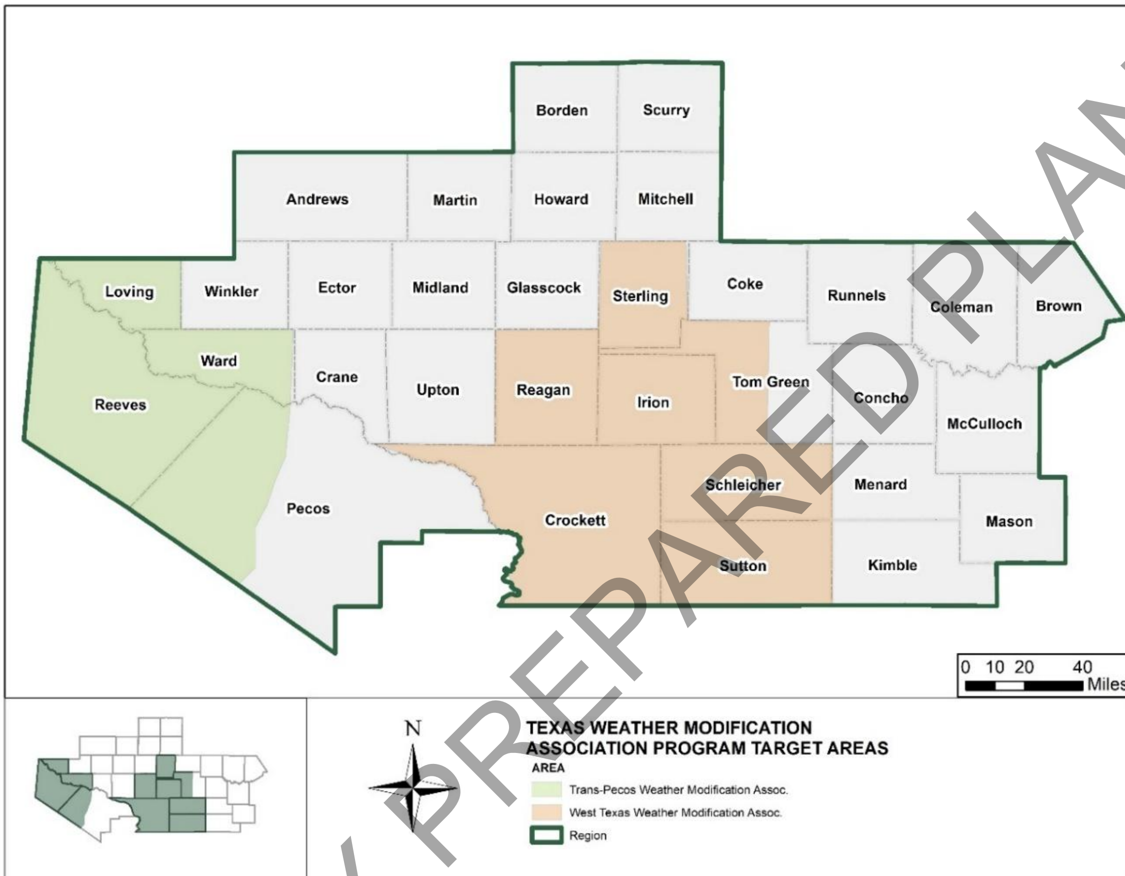


Table 5C-4
Weather Modification Water Savings and Cost

Weather Modification Program	County	Water Savings (acre-feet/yr)	Cost ($)	Cost per Ac-Ft ($/acre-feet)
TPWMA	Pecos	1,807	$678	$0.38
TPWMA	Reeves	2,176	$890	$0.41
TPWMA	Ward	53	$24	$0.45
WTWMA	Crockett	167	$107	$0.64
WTWMA	Irion	156	$47	$0.30
WTWMA	Reagan	267	$301	$1.13
WTWMA	Schleicher	686	$257	$0.38
WTWMA	Sterling	106	$48	$0.45
WTWMA	Tom Green	1,550	$537	$0.35
TOTAL		**6,968**		**$0.41**

Table is an excerpt from Weather Modification section in Appendix C. Water savings based on annual rainfall increase from 2022 annual evaluation reports for the WTWMA and TPWMA.

LIST OF REFERENCES

[1] Arquimedes Ruiz-Columbié. Active Influence & Scientific Management, *Annual Evaluation Report 2022 WTWMA*. Prepared for the West Texas Weather Modification Association.

[2] Arquimedes Ruiz-Columbié. Active Influence & Scientific Management, *Annual Evaluation Report 2022 Trans-Pecos*. Prepared for the Trans-Pecos Weather Modification Association.

[3] United States Department of Agriculture, National Agricultural Statistics Service. "2022 Census of Agriculture, Texas State and County Data." Report. https://www.nass.usda.gov/Publications/AgCensus/2022/index.php

[4] Texas Department of Licensing and Regulation website. https://www.tdlr.texas.gov/weather/summary.htm Accessed 12/31/2024.

5D MAJOR WATER PROVIDER WATER MANAGEMENT STRATEGIES

Region F has five major water providers: Brown County Water Improvement District (BCWID) No. 1, Colorado River Municipal Water District (CRMWD), and the cities of Midland, Odessa, and San Angelo. Among these providers, four are shown to have water supply shortages (see Chapter 4). To better understand the quantity of water that will need to be developed through infrastructure strategies, the needs presented for the major water providers consider supply reductions from municipal conservation and supplies made available through subordination. Both of these strategies are developed and discussed in Chapters 5B and 5C, respectively, and are presented in this chapter for completeness in identifying recommended water management strategies. Discussion of the water needs and recommended water management strategies for each of the major water providers is presented in the following sections. Full strategy evaluations are included in Appendix C.

5D.1 Brown County Water Improvement District No. 1

The Brown County Water Improvement District (BCWID) #1 supplies water to members in Brown, Coleman, and Runnels counties. Major customers include Bangs, Brookesmith SUD, Brownwood, Early, Zephyr WSC, and manufacturers, miners, and irrigators in Brown County. The BCWID currently receives all of its supply from Lake Brownwood. Lake Brownwood has sufficient yield to meet BCWID's needs even without subordination. However, BCWID No. 1 will need a water treatment plant expansion to access additional supply in Lake Brownwood.

BCWID has been experiencing growth in recent years and more development is planned. Due to the timing of population and demand finalization for the regional water plans, this growth may not be fully captured in the 2026 Region F water plan. However, with subordination and conservation, BCWID shows a significant supply surplus throughout the planning horizon, which can help supply growth beyond projections. BCWID has investigated groundwater development as a way to ensure reliable water supplies during times of extreme drought. However, test wells found that the water quality was poor and would be very costly to treat. BCWID does not intend to develop a groundwater source at this time but would consider pursuit of this source if needed under extreme drought conditions. Table 5D-1 shows the comparison of supply and demand for BCWID with subordination and conservation supplies.

Potentially feasible water management strategies for Brown County WID #1 include:

- Municipal Conservation
- Subordination
- Brush Control
- Treatment Plant Expansion
- Develop Groundwater Supplies

Full strategy evaluations are included in Appendix C. The following strategies were recommended for BCWID #1. Both conservation and subordination are discussed in detail in previous chapters, but they are also discussed below as a recommended strategy for completeness.

Table 5D-1
Comparison of Supply and Demand for BCWID

Supplies	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**	**Supply 2080**
Lake Brownwood Safe Supply (with subordination)	25,800	25,615	25,430	25,225	25,020	24,815
Customer Conservation	124	153	152	153	153	153
Total Availability	**25,924**	**25,768**	**25,582**	**25,378**	**25,173**	**24,968**
Demands	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**	**Demand 2080**
City of Bangs	346	347	348	349	350	351
Brookesmith SUD	1,232	1,248	1,250	1,254	1,259	1,263
Coleman County SUD	718	684	653	631	610	589
City of Santa Anna	128	123	119	116	115	115
Brownwood	3,827	3,854	3,862	3,875	3,889	3,906
County-Other, Brown	0	0	0	0	0	0
Early	454	455	455	457	459	460
Zephyr WSC	572	580	581	582	584	587
Manufacturing, Brown	454	471	488	506	525	544
Total Treated Water Demand [a]	**7,731**	**7,762**	**7,756**	**7,770**	**7,791**	**7,815**
Irrigation, Brown	6,000	6,000	6,000	6,000	6,000	6,000
Mining, Brown	560	560	560	560	560	560
Total Raw Water Demand	**6,560**	**6,560**	**6,560**	**6,560**	**6,560**	**6,560**
Total Demand	**14,291**	**14,322**	**14,316**	**14,330**	**14,351**	**14,375**
Surplus (Shortage)	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**	**Surplus (Shortage) 2080**
Surplus (Shortage)	**11,633**	**11,446**	**11,266**	**11,048**	**10,822**	**10,593**

a. Existing treatment capacity limits treated water supply to 9,246 acre-feet per year.

5D.1.1 BCWID No. 1 Recommended Water Management Strategies

Municipal Conservation

This strategy pro-actively reduces municipal retail water demands through public education and outreach, an inclining rate structure to discourage high water use, a water waste ordinance, a landscape ordinance for new construction, and time of day outdoor watering limits. As a wholesale water provider, BCWID #1 cannot carry out this strategy. This strategy will be implemented by each individual member and customer city. These combined efforts are expected to reduce BCWID's demands by about 1 percent throughout the planning horizon. The costs for this strategy are associated with each retail water provider.

Subordination

The subordination strategy increases the supply to Lake Brownwood by changing the strict priority modeling assumptions utilized in WAM Run 3. Under the subordination strategy, Lake Brownwood's supplies increase to over 25,800 acre-feet in 2030. The supplies decrease to nearly 24,800 acre-feet by 2080 due to sedimentation in the reservoir. The subordination strategy is discussed in detail in Chapter 5C and in Appendix C. Region F recognizes that a subordination agreement is not within the authority of the RWPG. Such an agreement must be developed by the water rights holders themselves, including BCWID.

Brush Control

Certain species of brush can drastically reduce the water yield in a watershed. By replacing water intensive brush species with less water intensive native plants, increased runoff to the reservoirs is possible. Funding for this type of project is typically available through the Water Supply Enhancement Program of the Texas State Soil and Water Conservation Board (TSSWCB), though there has been no funding statewide since 2019. The TSSWCB has already completed feasibility studies for the Lake Brownwood watershed. Some of this land has already been treated for brush. However, in order to continue to realize these water savings, brush must be continually retreated. The reservoir yields shown under subordination include hydrology through the end of 2016. Therefore, all savings gained by previous treatment of brush are shown in the modeled yield of these reservoirs. However, any future brush treatments could yield small amounts of additional savings. According to the TSSWCB annual reports, on average, about 1,000 acres of brush per year are treated in this area. Based on this level of brush treatment, around 400 acre-feet of increased supply is estimated.

Treatment Plant Expansion

BCWID will need additional treatment to meet the demands of their treated water customers and to access the available supplies in Lake Brownwood. BCWID has a proposed treatment plant expansion planned to come online in 2030. This expansion will increase the capacity of their membrane WTP by 3 MGD.

5D.1.2 BCWID No. 1 Water Management Plan Summary

Table 5D-2 shows a comparison of supply and demand after recommended strategies are implemented for BCWID No. 1. Subordination and conservation are shown in this table as strategies for completeness. Table 5D-3 shows the capital and annual costs for the recommended plan for BCWID #1.

Figure 5D-1 illustrates the recommended water management plan for BCWID. BCWID currently has a surplus of water available. Recommended strategies are brush control and a water treatment plant expansion.

Table 5D-2
Recommended Water Management Strategies for BCWID #1
-Values are in Acre-Feet per Year-

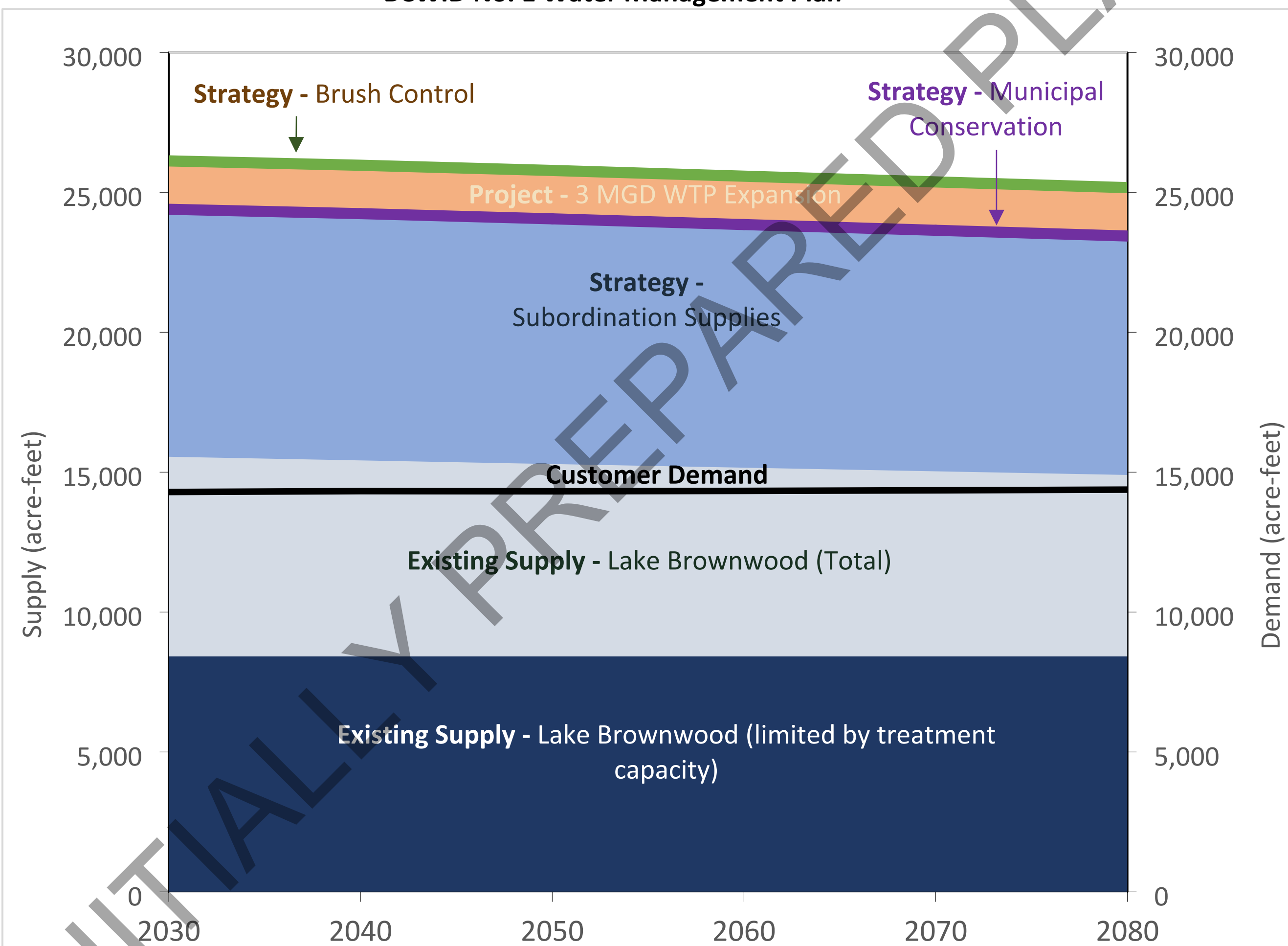
	2030	2040	2050	2060	2070	2080
Surplus (Shortage) before Recommended Strategies	**11,633**	**11,446**	**11,266**	**11,048**	**10,822**	**10,593**
Recommended Strategies (acre-feet per year)	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Subordination	*8,721*	*8,666*	*8,611*	*8,536*	*8,461*	*8,386*
Customer Conservation	*124*	*153*	*152*	*153*	*153*	*153*
Brush Control	400	400	400	400	400	400
Water Treatment Plant Expansion	1,529	1,529	1,529	1,529	1,529	1,529
Surplus (Shortage) after Recommended Strategies	***13,561***	***13,375***	***13,195***	***12,976***	***12,750***	***12,522***
Management Supply Factor	*1.8*	*1.8*	*1.8*	*1.8*	*1.8*	*1.8*

Strategies in grey italics were included in the previous calculation of surplus (shortages). They are included in this table for completeness but are not included in the total to avoid double counting.

Table 5D-3
Cost for Strategies for BCWID #1

Strategy	Capital Cost (Thousand $)	Unit Cost ($/1,000 gal)	
		With Debt Service	After Debt Service
Municipal Conservation of Customers	---	NA	NA
Subordination	---	$0	$0
Brush Control	---	NA	$1.44
Water Treatment Plant Expansion	$38,124	$12.41	$7.03

Figure 5D-1
BCWID No. 1 Water Management Plan



BCWID No. 1 Alternative Water Management Strategies

BCWID No. 1 investigated groundwater development to bolster the security of their water supplies and to serve as a potential backup supply to Lake Brownwood. Based on analysis from their test wells, wells in Brown County can yield supply from deep formations such as the Ellenburger-San Saba Aquifer, however, water quality is poor and contains high total dissolved solids (TDS), requiring advanced treatment. Due to the high cost and currently adequate supplies from Lake Brownwood, BCWID does not intend to pursue a groundwater strategy at this time. However, it is included as an alternative water management strategy should conditions change. Additional information on this strategy is included in Appendix C.

5D.2 Colorado River Municipal Water District (CRMWD)

The Colorado River Municipal Water District (CRMWD), the largest water supplier in Region F, provides raw water from both groundwater and surface water sources to its member cities and customers. CRMWD owns and operates three major reservoirs, Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir, as well as several chloride control reservoirs (diverted water system) for water quality control. Groundwater sources include well fields in Ward and Martin Counties. CRMWD member cities include Big Spring, Odessa and Snyder. CRMWD also supplies water to Midland, San Angelo and Abilene, as well as several smaller water utilities and cities that serve customers in Concho, Howard, Martin, Runnels, and Ward counties.

CRMWD can be thought of as two systems: customers who have contracts only from Lake Ivie (Lake Ivie-non system) and CRMWD member cities and system customers which are supplied from the remaining yield in Ivie, as well as all of CRMWD's other sources of supply. Because the nature of these contractual relationships are different, the needs of each system are evaluated separately. **Table 5D-4** summarizes the supplies and demands for CRMWD's system, which includes subordinated supplies from Lake O.H. Ivie, E.V. Spence Reservoir, Lake J.B. Thomas, potable reuse water from Big Spring, and groundwater. Potential future customers include demands that CRMWD's member cities intend to serve and contractual increase or potential new customers. **Table 5D-5** summarizes the supplies and demands for CRMWD's Lake Ivie non-system portion. Supply from the diverted water system is brackish and cannot be used for municipal purposes in its typical state. Currently, there are no potable or non-potable demands on this water source.

Table 5D-4
Comparison of Supply and Demand for CRMWD System
-Values are in Acre-Feet per Year-

CRMWD System Supplies	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**	**Supply 2080**
Ivie, Spence, Thomas Reservoir System (with subordination)	42,438	41,845	41,252	40,890	40,528	40,156
Lake Ivie (with subordination)	*16,828*	*16,349*	*15,870*	*15,567*	*15,264*	*14,951*
Spence Reservoir (with subordination)	*21,900*	*21,814*	*21,727*	*21,689*	*21,652*	*21,614*
Thomas Reservoir (with subordination)	*3,710*	*3,682*	*3,655*	*3,634*	*3,612*	*3,591*
Big Spring Potable Reuse	1,855	1,855	1,855	1,855	1,855	1,855
Ward County Well Field	40,055	38,176	36,441	32,970	31,235	29,500
Martin County Well Field	1,035	922	836	779	740	711
Customer Conservation	813	956	1,089	1,174	1,245	1,317
Total Availability	**86,196**	**83,754**	**81,473**	**77,668**	**75,603**	**73,539**
CRMWD System Demands	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**	**Demand 2080**
Odessa and Customers	30,026	34,478	39,872	42,607	45,360	48,134
Odessa	22,838	26,504	30,991	33,234	35,477	37,721
Ector County UD	3,277	3,929	4,535	4,975	5,433	5,908
Greater Gardendale WSC (Sales from Odessa)	99	233	534	586	638	693
Manufacturing, Ector County	350	350	350	350	350	350
Irrigation, Ector County	403	403	403	403	403	403
Irrigation, Midland County	817	817	817	817	817	817

Steam Electric Power, Ector County	2,242	2,242	2,242	2,242	2,242	2,242
Big Spring and Customers	9,286	9,460	9,565	9,427	9,275	9,111
Big Spring	6,566	6,728	6,826	6,697	6,556	6,402
Coahoma	362	374	381	372	361	351
Manufacturing, Howard County	1,500	1,500	1,500	1,500	1,500	1,500
Steam Electric Power, Howard County	858	858	858	858	858	858
Snyder and Customers	2,062	2,081	2,101	2,117	2,133	2,150
Snyder	1,709	1,738	1,765	1,784	1,804	1,825
Scurry County-Other	90	90	90	90	90	90
Rotan	258	248	241	238	234	230
U & F WSC	5	5	5	5	5	5
Other Customers	13,232	13,262	13,294	13,322	13,351	13,384
Midland [b]	11,200	11,200	11,200	11,200	11,200	11,200
Stanton	307	307	307	307	307	307
Irrigation, Ector County	400	400	400	400	400	400
Grandfalls	225	255	287	315	344	377
Millersview-Doole WSC	600	600	600	600	600	600
Ballinger	500	500	500	500	500	500
Total Current Demand	**54,606**	**59,281**	**64,832**	**67,473**	**70,119**	**72,779**
CRMWD System Potential Future Customer Demands	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**	**Demand 2080**
Bronte	0	129	156	197	241	294
Robert Lee	0	4	31	71	115	161
Odessa	0	3,930	3,930	3,930	3,930	3,930
ECUD Expansion	0	1,200	2,500	2,500	2,500	2,500
Millersview Doole WSC	0	0	0	73	267	496
Stanton	43	91	151	215	287	372
Total Future Customer Demand	**43**	**5,354**	**6,768**	**6,986**	**7,340**	**7,753**
CRMWD System Surplus (Shortage)	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**	**Surplus (Shortage) 2080**
Current Customer Surplus (Shortage)	31,590	24,473	16,641	10,195	5,484	760
Potential Future Surplus (Shortage)	31,547	19,119	9,873	3,209	(1,856)	(6,993)

[a] Contract is for 16.54% of the safe yield of Ivie.

[b] Midland 1966 Contract expires in 2029. New contract at 10 MGD

Table 5D-5
Comparison of Supply and Demand for Lake Ivie Non-System

Lake Ivie Non-System Supplies	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**	**Supply 2080**
Lake Ivie (with subordination)	17,672	17,201	16,730	16,433	16,136	15,824
Total Availability	**17,672**	**17,201**	**16,730**	**16,433**	**16,136**	**15,824**
Lake Ivie Non-System Demands	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**	**Demand 2080**
Abilene [a]	5,524	5,367	5,210	5,111	5,012	4,908
Midland [a]	5,524	5,367	5,210	5,111	5,012	4,908
San Angelo [a]	5,524	5,367	5,210	5,111	5,012	4,908
Millersview-Doole WSC	600	600	600	600	600	600
Ballinger	500	500	500	500	500	500
Total Current Demand	**17,672**	**17,201**	**16,730**	**16,433**	**16,136**	**15,824**
Lake Ivie Non-System Surplus (Shortage)	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**	**Surplus (Shortage) 2080**
Available Surplus Supply	***0***	***0***	***0***	***0***	***0***	***0***

[a] Contract is for 16.54% of the safe yield of Ivie. This demand reflects Ivie's safe yield with the implementation of the subordination strategy. As part of the West Texas Water Partnership, the Lake Ivie supplies may be reallocated among the cities of Abilene, Midland, and San Angelo. However, this has not yet occurred, so the current contract amounts are shown in the table above. The Partnership will follow up on initial conversations with the CRMWD to explore necessary methodologies and agreements to implement a cooperative use strategy of the Partnership's collective Ivie supplies.

With subordinated supplies, CRMWD can fully meet its current customer demands through 2070 without developing additional supplies. With potential future customers, the need for new water moves up a decade. This projected shortage will need to be met with recommended water management strategies.

While CRMWD is shown to have sufficient water supplies in the early decades, there is some uncertainty associated with the reliability of surface water supplies in the Upper Colorado Basin. CRMWD lakes are still in drought of record conditions and on-going drought will likely continue to decrease the reliable supply from these sources. It is important for CRMWD to develop and maintain their portfolio of water supplies that can be used during drought to increase the reliability of the CRMWD system. Also, as the region continues to respond to the increased oil and gas activities, the demands on CRMWD may increase as new customers request water. Given these unknowns, CRMWD is pursuing water management strategies to meet these future demands and bolster the reliability of their water supply.

The following strategies were identified as potentially feasible for CRMWD:

- Conservation of Wholesale Customers
- Subordination of Senior Downstream Water Rights
- Ward County Well Field Well Replacement
- Ward County Well Field Expansion and the Development of Winkler County Well Field
- Develop Additional Groundwater Supplies in Pecos, Reeves, Ward and Winkler Counties

Full strategy evaluations are included in Appendix C. The following strategies were recommended for CRMWD. Both conservation and subordination are discussed in detail in previous chapters, but they are also discussed below as a recommended strategy for completeness.

5D.2.1 CRMWD Recommended Water Management Strategies

Municipal Conservation

This strategy pro-actively reduces municipal retail water demands through public education and outreach, an inclining rate structure to discourage high water use, a water waste ordinance, a landscape ordinance for new construction, and time of day outdoor watering limits. As a wholesale water provider, CRMWD cannot carry out this strategy. This strategy will be carried out by each individual member and customer city. These combined efforts are expected to reduce CRMWD customer demands by about 2 percent throughout the planning horizon. The costs for this strategy are associated with each retail water provider. CRMWD fully supports the efforts of the cities to implement water education and conservation measures.

Subordination

The subordination strategy increases the supply to CRMWD's reservoirs by changing the strict priority modeling assumptions utilized in WAM Run 3 such that downstream senior water right holders do not make priority calls on upstream users in Region F. Under the subordination strategy, the District's surface water system's supplies increase from about 14,000 acre-feet to over 42,000 acre-feet in 2030. By 2080, the subordination supplies decrease to about 40,000 acre-feet due to sedimentation in the reservoirs. The subordination strategy is discussed in detail in Chapter 5C and in Appendix C. Region F recognizes that a subordination agreement is not within the authority of the RWPG. Such an agreement must be developed by the water rights holders themselves, including CRMWD. CRMWD already has agreements in place with LCRA for Lake Ivie and other surface water sources.

Ward County Well Replacement

CRMWD currently owns and operates a well field in Ward County that produces water from the Pecos Valley aquifer. The integrity of the wells and pipelines that comprise this well field are expected to deteriorate over time, reducing the available supply of the well field. As a result, CRMWD plans to actively rehabilitate and/or replace out-of-service wells to restore the yield of the well field starting in 2040. In this strategy, it was assumed that new water wells and well field piping would be constructed to replace old infrastructure, which would enable CRMWD to withdraw additional groundwater from their Ward County well field that would otherwise be inaccessible. All other infrastructure is in place to transmit and treat the supply from this well field.

Ward County Well Field Expansion and Development of Winkler County Well Field

CRMWD owns and operates a well field in Ward County and owns the rights to an undeveloped well field in southern Winkler County. Both areas produce water from the Pecos Valley aquifer. This strategy involves the development of the Winkler County rights as well as an expansion of their existing Ward County well field. A newly developed pipeline and pump station will deliver supply from the Winkler County well field to the existing Ward County well field. From there, supply from both sources will be transferred to CRMWD's service area using existing transmission lines, as well as new and/or upgraded pump stations along the route. The capacity of the existing transmission system will be upgraded to accommodate the additional supply estimated from this project. This project is expected to come online in 2030.

5D.2.2 CRMWD Water Management Plan Summary

Figure 5D-2 illustrates the recommended water management plan for CRMWD. Major recommended strategies include expansion of the Ward County Well Field and development of the Winkler County Well field, in addition to well replacement at the Winkler County Well Field. CRMWD's development of the recommended strategies will meet the needs identified and increase their reserve supplies throughout the planning horizon. The surplus of supply for CRMWD after the implementation of recommended strategies are shown in Table 5D-6.

The costs for these strategies are summarized in Table 5D-7. The recommended water plan for CRMWD will provide water to meet all current and future customer demands with a reserve.

Figure 5D-2
CRMWD Water Management Plan

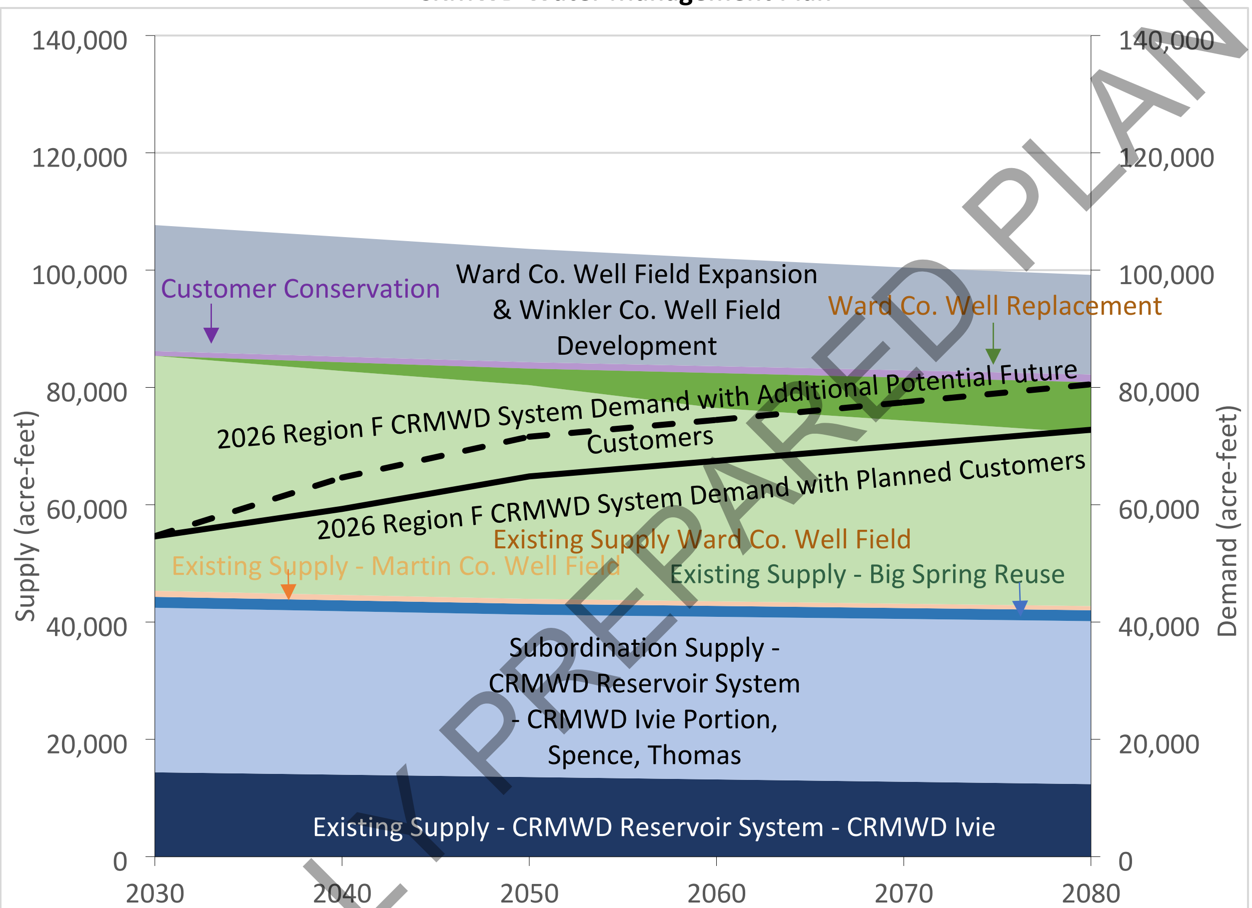


Table 5D-6
Recommended Water Management Strategies for CRMWD
Values are in Acre-Feet per Year-

CRMWD Strategies Summary						
	2030	**2040**	**2050**	**2060**	**2070**	**2080**
Surplus (Shortage) with Potential Future Customers before Water Management Strategies	**31,547**	**19,119**	**9,873**	**3,209**	**(1,856)**	**(6,993)**
Recommended Strategies	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**	**Supply 2080**
Subordination	*28,061*	*27,869*	*27,680*	*27,722*	*27,761*	*27,793*
Customer Conservation	*813*	*956*	*1,089*	*1,174*	*1,245*	*1,317*
Ward County Well Replacement	0	1,492	2,831	5,958	7,327	8,674
Ward and Winkler County Well Field Expansion	21,480	20,412	19,319	18,398	17,523	16,977
Total Supply from Recommended Strategies	**21,480**	**21,904**	**22,150**	**24,356**	**24,850**	**25,651**
Surplus (Shortage) after Recommended Strategies	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Surplus (Shortage) Supply	53,027	41,023	32,023	27,565	22,994	18,658
Management Supply Factor	*2.0*	*1.6*	*1.4*	*1.4*	*1.3*	*1.2*

Strategies in grey italics were included in the previous calculation of surplus (shortages). They are included in this table for completeness but are not included in the total to avoid double counting.

Table 5D-7
Cost of Recommended Water Management Strategies for CRMWD

Strategy	Capital Cost (Million $)	Unit Cost ($/1,000 gal)	
		With Debt Service	After Debt Service
Subordination	$0	$0	$0
Customer Conservation	NA	NA	NA
Ward County Well Replacement	$17.9	$0.49	$0.05
Ward and Winkler County Well Field Expansion	$299.5	$3.76	$0.75

CRMWD Alternative Water Management Strategies

Alternative water management strategies are identified and may be implemented if a recommended strategy is no longer viable or if there is a new need that cannot be met by the recommended water management plan. CRMWD has identified one alternate water management strategy to develop additional groundwater supplies from Pecos, Reeves, Ward and/or Winkler Counties. This strategy is for new groundwater supplies and does not include water rights currently held by CRMWD. Some of these groundwater supplies may require advanced treatment, such as desalination but the development of the treatment facilities would not occur until after 2080. Therefore, costs for advanced treatment were not included. This strategy is described in full and evaluated in Appendix C.

5D.3 Midland

The City of Midland, located in Midland County, is the largest city in Region F and serves as a prominent center for economic, trade, and cultural activities. The City of Midland has experienced rapid population growth in recent years, primarily due to increased oil and gas exploration in the underlying Permian Basin. Over the planning horizon (2030 – 2080), this rapid growth is expected to continue as the City's population and municipal demands are projected to grow by about 65 percent. In addition to the increase in the number of residents in Midland, many workers commute from other areas of the State during the work week. These working commuters are officially counted as residents elsewhere, so they are not considered in the population in this Plan; however, they still contribute to the water demand the City must provide.

The City of Midland draws its supply from four main sources: sales from CRMWD, the Airport well field in Midland County, the Paul Davis well field in Andrews and Martin Counties, and the T-Bar Ranch and Clearwater Well Fields in Winkler and Loving Counties. Midland purchases water from CRMWD under two contracts: a contract from Lake Ivie for 16.54% of the safe yield and the 1966 Contract which expires in 2029. A new purchase of supplies from CRMWD to replace the 1966 Contract is included as a strategy, and as a result the currently connected supplies for Midland only include the non-system portion of CRMWD's Lake Ivie contract. The City provides water to their municipal customers as well as manufacturing demand within the City. The Airport well field is expected to be depleted before 2030 and the Paul Davis well field is limited by the MAG. **Table 5D-8** shows the City's supplies and demands.

Table 5D-8
City of Midland Water Supplies and Demands

Supplies	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**	**Supply 2080**
CRMWD Contracts with Midland (with Subordination)	5,524	5,367	5,210	5,111	5,012	4,908
CRMWD (Ivie Non-System)	4,721	4,588	4,456	4,324	4,191	4,059
CRMWD (Ivie Non-System) Subordination	803	779	754	787	821	849
T-Bar Ranch/Clearwater Well Field	16,815	16,815	16,815	16,815	16,815	16,815
Paul Davis Well Field (Ogallala Aquifer)	4,572	4,053	3,686	3,443	3,268	3,135
Airport Well Field	0	0	0	0	0	0
Municipal Conservation	646	720	789	877	977	1,092
Total Availability	**27,557**	**26,955**	**26,500**	**26,246**	**26,072**	**25,950**
Demands	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**	**Demand 2080**
City of Midland	23,104	25,190	27,583	30,595	34,050	38,024
Manufacturing, Midland County	72	72	72	72	72	72
Total Raw Water Demands	**23,176**	**25,262**	**27,655**	**30,667**	**34,122**	**38,096**
Surplus (Shortage)	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**	**Surplus (Shortage) 2080**
Surplus (Shortage)	**4,381**	**1,693**	**(1,155)**	**(4,421)**	**(8,050)**	**(12,146)**

[a] As part of the West Texas Water Partnership, the Lake Ivie supplies may be reallocated among the cities of Abilene, Midland, and San Angelo. However, this has not yet occurred, so the current contract amounts are shown in the table above. The Partnership will follow up on initial conversations with the CRMWD to explore necessary methodologies and agreements to implement a cooperative use strategy of the Partnership's collective Ivie supplies.

The City of Midland also has a contract to sell their treated wastewater effluent for mining use. No potable water supplies are used to meet this demand. The treated wastewater is expected to be primarily used for mining in Midland, Martin, Reagan, and Upton Counties. The contract is for up to 15 MGD (16,800 acre-feet per year) but will be limited by actual wastewater flow. Current flows are around 10 MGD (11,200 acre-feet per year). As shown in Table 5D-9, there are no shortages to meet the demand for wastewater for the mining industry over the planning horizon and thus, no strategies were considered for this purpose.

Table 5D-9
City of Midland Wastewater Supplies and Demands

Supplies	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**	**Supply 2080**
Direct Reuse (WW Effluent Sales to Mining)	11,210	11,210	11,210	11,210	11,210	11,210
Total Availability	**11,210**	**11,210**	**11,210**	**11,210**	**11,210**	**11,210**
Recycled Water Demands	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**	**Demand 2080**
Mining, Exxon Contract	11,210	11,210	11,210	11,210	11,210	11,210
Mining, Midland County	2,803	2,803	2,803	2,803	2,803	2,803
Mining, Martin County	2,803	2,803	2,803	2,803	2,803	2,803
Mining, Reagan County	2,803	2,803	2,803	2,803	2,803	2,803
Mining, Upton County	2,801	2,801	2,801	2,801	2,801	2,801
Total Demand	**11,210**	**11,210**	**11,210**	**11,210**	**11,210**	**11,210**
Surplus (Shortage)	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**	**Surplus (Shortage) 2080**
Surplus (Shortage)	0	0	0	0	0	0

However, several water management strategies were considered for Midland to meet the municipal needs of their retail customers.

Potentially Feasible Water Management Strategies Considered for Midland:

- Municipal Conservation
- Subordination
- Purchase from CRMWD
- West Texas Water Partnership
- Advanced Water Treatment and Expanded Use of the Paul Davis Well Field

Full strategy evaluations are included in Appendix C. Both conservation and subordination are discussed in detail in previous sections, but they are also discussed below as a recommended strategy for completeness.

5D.3.1 Midland Recommended Water Management Strategies

Municipal Conservation

Municipal conservation pro-actively reduces municipal water demands through public education and outreach, an inclining rate structure to discourage high water use, a water waste ordinance, a landscape ordinance for new construction, and time of day outdoor watering limits. These efforts are projected to reduce the City of Midland's demands by about 646 to 1,092 acre-feet per year throughout the planning horizon (2030 – 2080).

Subordination

The subordination strategy increases the supply to CRMWD's reservoirs by changing the strict priority modeling assumptions utilized in WAM Run 3 such that downstream senior water right holders do not make priority calls on upstream users in Region F. Some of the subordinated supply goes to supply Midland as a customer city to meet the City's demands on CRMWD. The subordination strategy is discussed in detail in Chapter 5C and in Appendix C.

Purchase from CRMWD

The City of Midland currently receives water from CRMWD through two separate contracts: the Ivie Contract and the 1966 Contract. The 1966 Contract provides around 18,000 acre-feet of supply from any of CRMWDs sources to Midland. This contract will expire by 2029. A recommended strategy involves the City of Midland entering into a new contract agreement with CRMWD for 10 MGD of supply with the ability to purchase up to 12 MGD as needed. Contract negotiations between Midland and CRMWD are close to being finalized, however, the actual contract is dependent upon the two parties reaching mutually agreeable terms that may differ from what is outlined in this plan.

West Texas Water Partnership

The Cities of Midland, San Angelo, and Abilene formed the West Texas Water Partnership (the Partnership or WTWP) to evaluate long-term water supplies the Partnership could develop jointly. The WTWP recently contracted for groundwater from the Edwards-Trinity Plateau Aquifer in Pecos County (GMA 7). The total contracted supply is 28,400 acre-feet per year (15,000 acre-feet per year to Midland, 5,000 acre-feet per year to San Angelo, and 8,400 acre-feet per year to Abilene). Approximately 9 new groundwater supply wells would be drilled in Pecos County to provide 28,400 acre-feet of supply per year. The groundwater would then be transported by pipeline to Midland and San Angelo. Abilene would exchange its share of groundwater from Pecos County for a portion of Midland's and San Angelo's water from Ivie Reservoir. The Partnership will need to reach agreement with CRMWD to implement a cooperative use strategy of the Partnership's collective Ivie supplies. Implementation in such a manner is dependent upon all parties reaching mutually agreeable terms. This results in more groundwater going to Midland and San Angelo by the exchanged amounts. Advanced treatment will be required for a portion of the groundwater flow to meet regulatory standards and recovery stages are anticipated to reduce losses to be comparable to conventional water treatment processes.

5D.3.2 Midland Water Management Plan Summary

Figure 5-3 depicts the recommended water management plan for Midland. Main strategies include Purchase from CRMWD, the West Texas Water Partnership, and Advanced Treatment of Paul Davis Well Field Supplies. The needs for the City of Midland after the implementation of recommended strategies are shown in **Table 5D-9**. **Table 5D-10** shows the capital and annual costs for these strategies. With the recommended water plan, Midland shows no water supply shortages throughout the planning horizon.

Figure 5D-3
Midland Water Management Plan

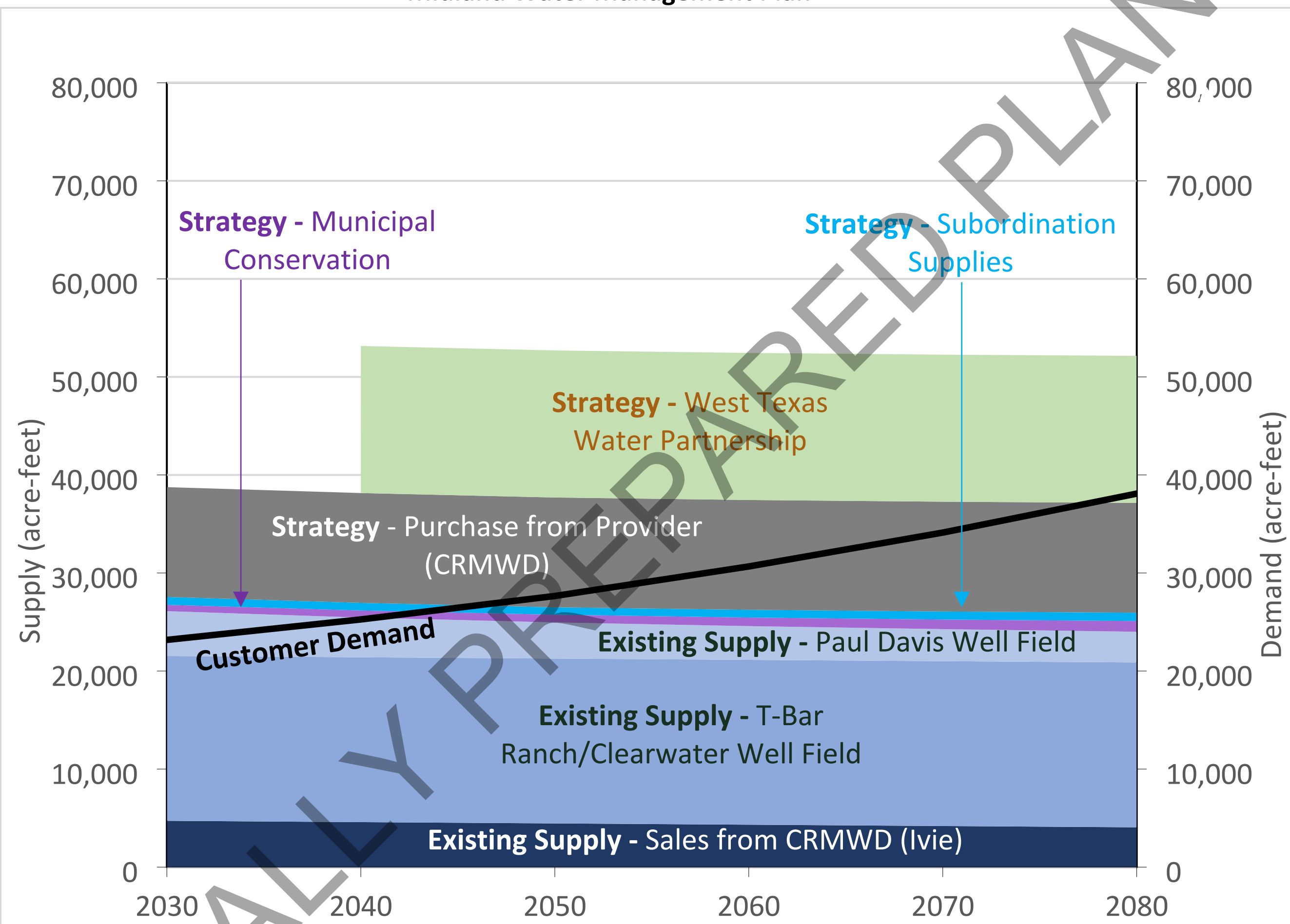


Table 5D-9
Recommended Water Strategies for the City of Midland

Summary before Recommended Strategies	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Supplies	27,557	26,955	26,500	26,246	26,072	25,950
Demand	23,176	25,262	27,655	30,667	34,122	38,096
Surplus (Shortage) with Conservation and Subordination	**4,381**	**1,693**	**(1,155)**	**(4,421)**	**(8,050)**	**(12,146)**
Recommended Strategies (acre-feet per year)	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Subordination (CRMWD Supplies)	*803*	*779*	*754*	*787*	*821*	*849*
Municipal Conservation	*646*	*720*	*789*	*877*	*977*	*1,092*
West Texas Water Partnership	0	15,000	15,000	15,000	15,000	15,000
Purchase from CRMWD	11,200	11,200	11,200	11,200	11,200	11,200
Total Supply from Recommended Strategies	**11,200**	**26,200**	**26,200**	**26,200**	**26,200**	**26,200**
Surplus after Recommended Strategies	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Surplus (Shortage)	**15,581**	**27,893**	**25,045**	**21,779**	**18,150**	**14,054**
Management Supply Factor	*1.7*	*2.1*	*1.9*	*1.7*	*1.5*	*1.4*

Strategies in grey italics were included in the previous calculation of surplus (shortages). They are included in this table for completeness but are not included in the total to avoid double counting.

Table 5D-10
Costs for Recommended Strategies for the City of Midland

Strategy	**Capital Cost (Million $)**	**Unit Cost ($/1,000 gal)**	
		With Debt Service	**After Debt Service**
Municipal Conservation	---	$1.55	$1.50
Subordination	---	NA	NA
Purchase from CRMWD	---	NA	NA
West Texas Water Partnership	$796.8	$6.96	$1.17

Midland Alternative Water Management Strategies

Alternative strategies are included in the plan as additional options that the City may pursue. One alternative strategy the City is interested in pursuing is the development of an advanced treatment (RO) facility to treat Paul Davis Well Field to a higher quality due to current high TDS levels. For planning purposes, it was assumed that the project would generally operate to produce 8,065 acre-feet per year by 2080 to bring the total supply pumped from the Paul Davis Well Field to 11,200 acre-feet per year (10 MGD). MAG limitations in Midland County make accessing this total supply at the proposed volume impossible, leading to this strategy being deemed an alternative rather than recommended water management strategy.

5D.4 Odessa

The City of Odessa is located in Ector County. As one of the largest cities in Region F, it is a major center of employment, trade and cultural activities. The City of Odessa is a member city of CRMWD and receives all of its supply from CRMWD. The City currently sells treated supplies to Ector County Utility District, and some manufacturing operations. The City's raw water is currently contracted for use by manufacturing and irrigation users. Additionally, Odessa produces about 8.5 MGD of wastewater; 2.5 MGD is diverted to the Gulf Coast Authority (GCA), while the other 6 MGD is sold to for mining use. Table 5D-11 shows a comparison of the Region F supply and demand for the City of Odessa, considering subordination of CRMWD's surface water sources. Under these assumptions, the City of Odessa shows a shortage in 2080for current users, and a shortage for future users beginning in 2040. The City is also planning to develop advanced treatment which will increase losses and effectively increase the City's demand. This additional demand will be met by additional supplies from CRMWD.

Table 5D-11
Comparison of Supply and Demand for Treated and Water for Odessa
-Values are in Acre-Feet per Year-

Supplies	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**	**Supply 2080**
CRMWD System Total (without subordination)	30,026	31,935	32,377	30,735	30,062	29,280
Subordination of CRMWD Supplies	0	2,543	7,495	11,878	15,302	18,479
Total Availability	**30,026**	**34,478**	**39,872**	**42,613**	**45,364**	**47,759**
Current Potable Demands	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**	**Demand 2080**
City of Odessa	22,838	26,504	30,991	33,234	35,477	37,721
Ector County UD	3,277	3,929	4,535	4,975	5,433	5,908
Greater Gardendale WSC	99	233	534	586	638	693
Manufacturing, Ector County	200	200	200	200	200	200
Quail Run Power Generation Facility	2,242	2,242	2,242	2,242	2,242	2,242
Total Current Potable Demand	**28,656**	**33,108**	**38,502**	**41,237**	**43,990**	**46,764**
Potential Future Potable Demands	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**	**Demand 2080**
Odessa (Supply for Advanced Treatment)	0	3,930	3,930	3,930	3,930	3,930
Ector County - Other (ECUD Expanded Service Area)	0	1,200	2,500	2,500	2,500	2,500
Total Future Potable Demand	**0**	**5,130**	**6,430**	**6,430**	**6,430**	**6,430**
Raw Water Demands	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**	**Demand 2080**
Irrigation, Ector County	403	403	403	403	403	403
Irrigation, Midland County	817	817	817	817	817	817
Manufacturing, Ector County (Rextac)	150	150	150	150	150	150
Total Current Demand	**1,370**	**1,370**	**1,370**	**1,370**	**1,370**	**1,370**
Surplus (Shortage)	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**	**Surplus (Shortage) 2080**
Current Customers	0	0	0	6	4	(375)
Future Customers	0	(5,130)	(6,430)	(6,430)	(6,430)	(6,430)

Table 5D-12
Comparison of Supply and Demand for Reuse Water for Odessa
-Values are in Acre-Feet per Year-

Supplies	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**	**Supply 2080**
Direct Reuse - Ector County	9,530	9,530	9,530	9,530	9,530	9,530
Total Availability	**9,530**	**9,530**	**9,530**	**9,530**	**9,530**	**9,530**
Demands	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**	**Demand 2080**
Manufacturing, Midland (Exxon)	6,727	6,727	6,727	6,727	6,727	6,727
Mining, Ector and Andrews (GCA)	2,803	2,803	2,803	2,803	2,803	2,803
Total Demand	**9,530**	**9,530**	**9,530**	**9,530**	**9,530**	**9,530**
Surplus (Shortage)	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**	**Surplus (Shortage) 2080**
Surplus (Shortage)	**0**	**0**	**0**	**0**	**0**	**0**

As a member city of CRMWD, CRMWD plans to provide all of Odessa's water needs through development of additional strategies. CRMWD will have sufficient water to meet Odessa's current and future demands. However, should the City of Odessa pursue the development of supplies independently of CRMWD, the following strategies were identified as potentially feasible for the City of Odessa:

- Municipal Conservation
- Subordination (associated with CRMWD sources)
- Additional Supplies from CRMWD
- New Reverse Osmosis Treatment Facility
- Development of Brackish Groundwater in Ward County
- Development of Groundwater near Fort Stockton

Full strategy evaluations are included in Appendix C. Both conservation and subordination are discussed in detail in previous sections, but they are also discussed below as a recommended strategy for completeness.

5D.4.1 Odessa Recommended Water Management Strategies

Municipal Conservation

This strategy pro-actively reduces municipal water demands through public education and outreach, an inclining rate structure to discourage high water use, a water waste ordinance, a landscape ordinance for new construction, and time of day outdoor watering limits. These efforts are expected to reduce the City of Odessa's demands by about 1 to 2 percent throughout the planning horizon.

Subordination

The subordination strategy increases the supply to CRMWD's reservoirs by changing the strict priority modeling assumptions utilized in WAM Run 3 such that downstream senior water right holders do not make priority calls on upstream users in Region F. Some of the subordinated supply goes to supply Odessa as a member city to meet the City's demands. The subordination strategy is discussed in detail in Chapter 5C and in Appendix C. Region F recognizes that a subordination agreement is not within the authority of the RWPG. Such an agreement must be developed by the water rights holders themselves, including CRMWD. CRMWD already has such an agreement in place with LCRA for Lake Ivie and other surface water sources.

Additional Supplies from CRMWD

To meet the additional demands of the City, Ector County UD, manufacturing, irrigation users, or other future customers, Odessa would obtain additional supplies from CRMWD. These supplies would likely come from one or more of the multiple strategies that CRMWD is developing for its member cities and customers. With the development of these strategies, CRMWD is planning to take the new supplies to the Odessa Terminal Storage Reservoir, where Odessa would transport the water to its treatment facilities. It is assumed that all improvements and costs for these additional supplies are included with the development of the CRMWD strategies. Therefore, the capital cost of this water is shown on CRMWD.

Advanced Treatment (RO) Facility

To address water quality concerns associated with existing high TDS levels in CRMWD's surface water system, the City of Odessa is planning to pursue the development of an advanced treatment (RO) facility. For planning purposes, it was assumed that this project would have a peak capacity 20 MGD but would generally operate at around 14 MGD on an average annual basis. This facility is estimated to produce 15,700 acre-feet of finished water per year, based on estimated treatment losses of 20 percent. Finished water would be blended with the rest of the City's supplies to improve the overall drinking water quality. This project is estimated to require a capital investment of $217.4 million.

5D.4.2 Odessa Water Management Plan Summary

The needs for Odessa after the implementation of recommended strategies are shown in Table 5D-13.

Table **5D-14** shows the capital and annual costs for these strategies. Figure 5D-4 demonstrates the recommended water management plan for the City of Odessa. The primary recommended strategy for the City is to improve the water quality of the subordinated surface water supplies with the addition of advanced treatment. This plan indicates the recommended strategies are sufficient to meet Odessa's projected needs.

Table 5D-13
Recommended Strategies for the City of Odessa
-Values are in Acre-Feet per Year-

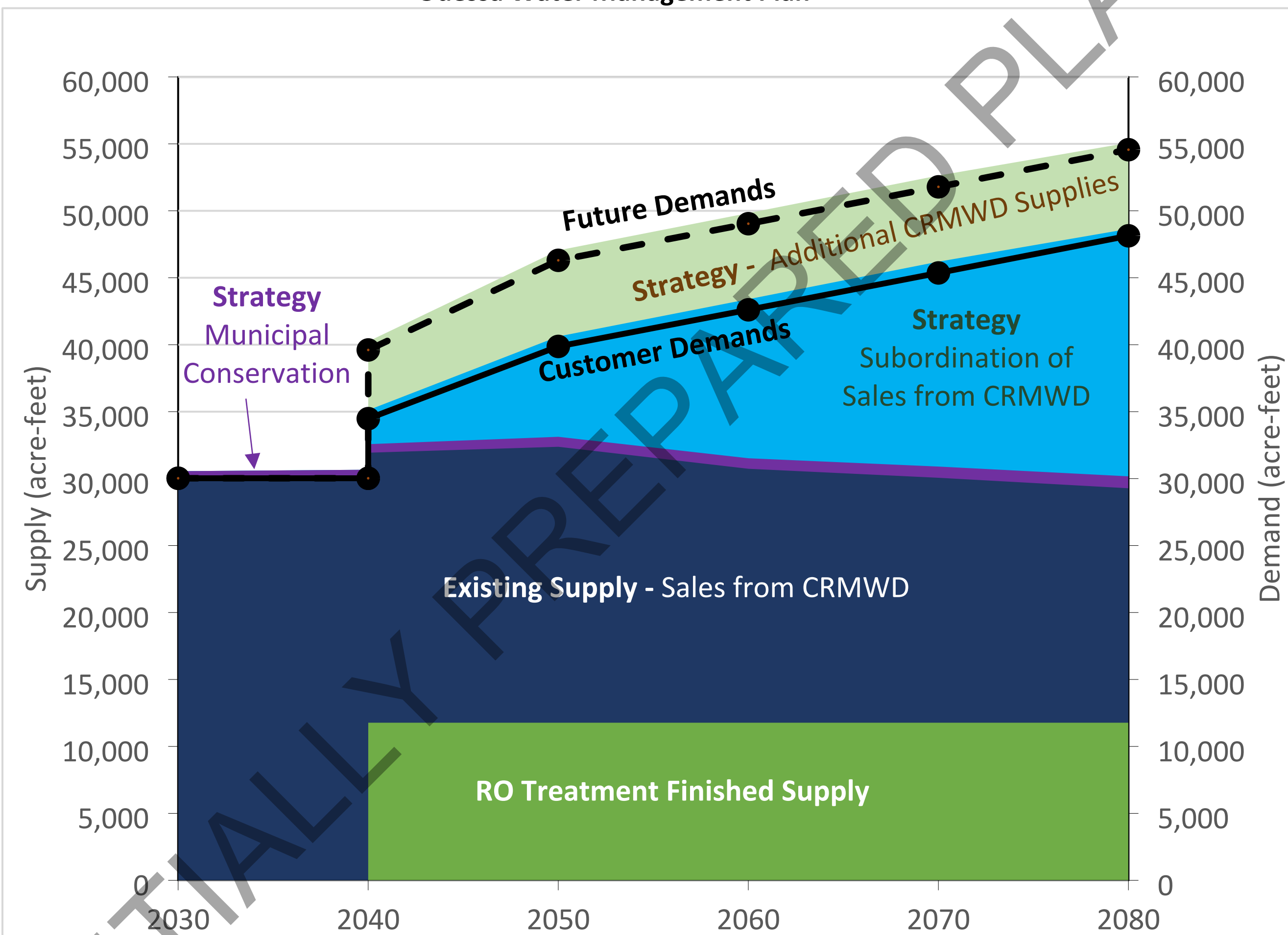
Summary before Recommended Strategies	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Current Surplus (Shortage) After Subordination	**0**	**0**	**0**	**6**	**4**	**(375)**
Future Surplus (Shortage)	**0**	**(5,130)**	**(6,430)**	**(6,430)**	**(6,430)**	**(6,430)**
Recommended Strategies (acre-feet per year)	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Subordination of CRMWD Supplies	*0*	*2,543*	*7,495*	*11,878*	*15,302*	*18,479*
Municipal Conservation	530	637	745	786	838	890
RO Treatment	*0*	*15,700*	*15,700*	*15,700*	*15,700*	*15,700*
Treatment Losses	0	-3,930	-3,930	-3,930	-3,930	-3,930
Additional Supply from CRMWD	0	5,130	6,430	6,430	6,430	6,430
Surplus (Shortage) after Recommended Strategies	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Current Surplus (Shortage)	***530***	***3,180***	***8,240***	***12,670***	***16,144***	***18,994***
Future Surplus (Shortage)	***0***	***0***	***0***	***0***	***0***	***0***
Management Supply Factor	***1***	***1***	***1***	***1***	***1***	***1***

Strategies in grey italics were included in the previous calculation of surplus (shortages). They are included in this table for completeness but are not included in the total to avoid double counting.

Table 5D-14
Costs for the Recommended Strategies for the City of Odessa

Strategy	Capital Cost (Millions $)	Unit Cost ($/1,000 gal)	
		With Debt Service	After Debt Service
Municipal Conservation	---	NA	NA
Subordination	---	NA	NA
Advanced Treatment (RO) Facility	$224	$6.58	$3.50

Figure 5D-4
Odessa Water Management Plan



Odessa Alternative Water Management Strategies

Odessa has identified one alternative strategy, which may be implemented if additional supplies are needed or one of the City's strategies cannot be implemented. The Alternative Water Management Strategy for Odessa is:

- Development of Edwards-Trinity and Capitan Reef Complex Aquifer Supplies in Pecos County

This strategy is described in full and evaluated in Appendix C. The WMS was not selected as recommended because Odessa currently has more cost-effective strategy supplies available to meet their needs. Cost estimates are included in Appendix D.

5D.5 City of San Angelo

The City of San Angelo is located in Tom Green County near the center of Region F. As one of the largest cities in the region, it is a major center of employment, trade and cultural activities in the region. The City currently receives water from six sources: Lake Nasworthy, Twin Buttes Reservoir, the Concho River, O.C. Fisher Reservoir, Ivie Reservoir and a well field in McCulloch County (Hickory aquifer). The city also has a contract with CRMWD for water from the Spence Reservoir, but the pipeline needs rehabilitation and is not currently being used. Tom Green County WCID #1 currently utilizes the City of San Angelo's effluent water prior to taking their water supplies (when available) in Twin Buttes. The City plans to convert this to municipal supply as part of the Concho River Water Project. When this occurs, the Twin Buttes supplies will revert back to the irrigators at Tom Green County WCID #1 and the supplies from the City's surface water reservoirs will decrease.

Table 5D-15 is a comparison of the Region F supply and water demand for the City of San Angelo and its customers. San Angelo supplies all the treated water to Goodfellow Air Force Base and about half of the manufacturing demand in Tom Green County. The City also has a contract with the Upper Colorado River Authority (UCRA) to supply up to 500 acre-feet per year.

There is a small reliable supply from three of the City's run-of- river permits but under strict priority analysis there is no reliable supply from the San Angelo Reservoir system. However, through the subordination strategy, there is a small supply from the San Angelo System that is available as a reliable supply. This supply is expected to decrease over time due to reduction in yield from sedimentation. The City of San Angelo is actively pursuing other strategies to replace supplies from their surface water system. The contracts between the City and CRMWD specify that San Angelo is entitled to 6 percent of the safe yield of Spence Reservoir and 16.54 percent of the safe yield of Ivie. Since the City cannot physically take water from Spence due to the poor condition of the pipeline, San Angelo has no current supply from this source. Due to cost, quality, and reliability concerns, the City of San Angelo does not plan to rehabilitate the Spence Pipeline at this time. The City of San Angelo is currently authorized to divert 10,000 acre-feet per year from the Hickory aquifer which increases to 12,200 acre-feet in 2036. The City already has infrastructure to treat the ultimate supply amount of 12,200 acre-feet per year.

Table 5D-15
Comparison of Supply and Demand for the City of San Angelo
-Values are in Acre-Feet per Year-

Supplies	Supply 2030	Supply 2040	Supply 2050	Supply 2060	Supply 2070	Supply 2080
Concho River	497	497	497	497	497	497
San Angelo System (with subordination)[a]	3,115	1,105	960	898	837	775
Ivie Reservoir[b] (with subordination)	5,524	5,367	5,210	5,112	5,012	4,908
McCulloch County Well Field (Hickory Aquifer)	10,000	12,200	12,200	12,200	12,200	12,200
Municipal Conservation	470	514	545	577	612	650
Total Availability	**19,599**	**19,676**	**19,405**	**19,277**	**19,151**	**19,023**
Demands	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**	**Demand 2080**
City of San Angelo	17,593	18,903	20,114	21,305	22,606	24,026
UCRA	500	500	500	500	500	500
Goodfellow Air Force Base	469	467	467	467	467	467
Manufacturing, Tom Green County	396	410	425	441	457	474
Total Demand	**18,958**	**20,280**	**21,506**	**22,713**	**24,030**	**25,467**
Surplus (Shortage)	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**	**Surplus (Shortage) 2080**
Surplus (Shortage)	**641**	**(604)**	**(2,101)**	**(3,436)**	**(4,879)**	**(6,444)**

[a] Includes Twin Buttes, Lake Nasworthy, and O.C. Fisher; includes contracted portion to UCRA and future contractual increases. Twin Buttes supplies revert to Tom Green County WCID #1 upon implementation of the Concho River Project which is assumed for planning purposes in 2040.
[b] 16.54% of the safe yield of Ivie with subordination. As part of the West Texas Water Partnership, the Lake Ivie supplies may be reallocated among the cities of Abilene, Midland, and San Angelo. However, this has not yet occurred, so the current contract amounts are shown in the table above. The Partnership will follow up on initial conversations with the CRMWD to explore necessary methodologies and agreements to implement a cooperative use strategy of the Partnership's collective Ivie supplies.

Through the standard procedure and discussions with the City of San Angelo, potentially feasible water management strategies were developed for further evaluation. A few strategies were discussed but not considered feasible at this time. These include system optimization and voluntary redistribution through lease or purchase of existing water rights. The system optimization strategy looks at the potential benefit from operating the Twin Buttes, Nasworthy, and O.C. Fisher's reservoirs as a system. The City of San Angelo currently operates its reservoirs in this fashion and likely experiences a small benefit. However, since the yield of the reservoirs under the extended Colorado WAM is negligible, this strategy was not further evaluated. It is recommended however that San Angelo continue to operate their reservoirs as a system to obtain optimal supply. Voluntary redistribution of existing water rights is a strategy where the City would enter into purchase or lease agreements for existing water rights currently held by other users. The City of San Angelo has purchased existing water rights in the past and may continue to purchase other water rights on a willing-buyer willing-seller basis if the cost is not prohibitive. Diversions for these rights could be moved to one of San Angelo's existing diversion points, or the rights could simply not be exercised, eliminating the possibility of a priority call. The City has been approached by individuals wishing to sell their water rights, but the high costs have made this option unfeasible. If there was a cost-effective opportunity to purchase or lease water rights in the future, the City of San Angelo may want to move forward with this strategy. Region F has not identified any specific rights for purchase at this time, so no quantity, costs or impacts can be developed at this time.

The following strategies were identified as potentially feasible for the City of San Angelo:

- Municipal Conservation
- Subordination
- Brush Control
- Indirect reuse for municipal use (Concho River Water Project)
- Development of Edwards-Trinity aquifer supplies in Schleicher County
- Desalination of Additional Groundwater Supplies
- West Texas Water Partnership

Full strategy evaluations are included in Appendix C.

5D.5.1 San Angelo Recommended Water Management Strategies

Municipal Conservation

This strategy pro-actively reduces municipal water demands through public education and outreach, inclining rate structure to discourage high water use, a water waste ordinance, a landscape ordinance for new construction, and time of day outdoor watering limits. These efforts are expected to reduce the City of San Angelo's demands by about 2-3 percent throughout the planning horizon.

Brush Control

Certain species of brush can drastically reduce the water yield in a watershed. By replacing water intensive brush species with less water intensive native plants, increased runoff to the reservoirs is possible during normal and wet periods. Funding for this type of project may be available through the Water Supply Enhancement Program of the Texas State Soil and Water Conservation Board (TSSWCB), though none has been allocated since 2019. The TSSWCB has already completed feasibility studies for the O.C. Fisher, Twin Buttes and Lake Nasworthy watersheds. To date, nearly half of this land has already been treated for brush. However, in order to continue to realize these water savings, brush must be continually retreated. The reservoir yields shown under subordination include hydrology through the end of 2016. Therefore, all savings gained by previous treatment of brush are shown in the modeled yield of these reservoirs under subordination. However, any future brush treatments could yield small amounts of additional savings.

Subordination

The subordination strategy increases the supply to San Angelo's reservoirs by changing the strict priority modeling assumptions utilized in WAM Run 3 such that downstream senior water right holders do not make priority calls on upstream users in Region F. As discussed previously, supplies from the subordination strategy make available supply in the San Angelo system that otherwise would not be deemed reliable. For the purposes of this plan, the subordination strategy for San Angelo increases the City's surface water system (Twin Buttes, Lake Nasworthy, and O.C. Fisher Reservoirs) supplies increase from 0 acre-feet to 2,973 acre-feet in 2030 and decrease to about 775 acre-feet by 2080. A small portion of the decrease is due to sedimentation in the reservoirs. The bigger factor in the decrease in supplies from subordination strategy for the San Angelo system is the loss of Twin Buttes supply (about 1,800 acre-feet) when the Concho River Water Project comes online and the Twin Buttes supplies are returned to the irrigators that form Tom Green County WCID #1. The subordination strategy is discussed in detail in Chapter 5C and in Appendix C. Region F recognizes that a subordination agreement is not within the authority of the Regional Water Planning Group. Such an agreement must be developed by the water rights holders themselves, including the City of San Angelo.

Concho River Water Project

The City of San Angelo completed a long-range water supply study in October 2018 which identified the Concho River Water Project as the next major water supply for the City. The project is an indirect reuse project that will provide approximately 8,300 acre-feet of water as municipal supply. The project will release highly treated wastewater into the Concho River where it will be diverted approximately 8 miles downstream and treated for municipal use. The project includes permitting, and water and wastewater treatment plant upgrades. The City has already applied for the necessary permits from TCEQ for the implementation of this project. The capital costs associated with these upgrades are estimated at nearly $255 million.

West Texas Water Partnership

The Cities of Midland, San Angelo, and Abilene formed the West Texas Water Partnership (the Partnership or WTWP) to evaluate long-term water supplies the Partnership could develop jointly. The WTWP recently contracted for groundwater from the Edwards-Trinity Plateau Aquifer in Pecos County (GMA 7). The total contracted supply is 28,400 acre-feet per year (15,000 acre-feet per year to Midland, 5,000 acre-feet per year to San Angelo, and 8,400 acre-feet per year to Abilene). Approximately 9 new groundwater supply wells would be drilled in Pecos County to provide 28,400 acre-feet of supply per year. The groundwater would then be transported by pipeline to Midland and San Angelo. Abilene would exchange its share of groundwater from Pecos County for a portion of Midland's and San Angelo's water from Ivie Reservoir. The Partnership will need to reach agreement with the CRMWD to explore necessary methodologies and agreements to implement a cooperative use strategy of the Partnership's collective Ivie supplies. Implementation in such a manner is dependent upon all parties reaching mutually agreeable terms. This results in more groundwater going to Midland and San Angelo by the exchanged amounts. Advanced treatment will be required for a portion of the groundwater flow to meet regulatory standards and recovery stages are anticipated to reduce losses to be comparable to conventional water treatment processes.

5D.5.2 San Angelo Water Management Plan Summary

Table 5D-16 shows the supply amounts from each strategy and the needs after implementation of the recommended strategies for San Angelo. The costs for each recommended strategy are summarized in **Table 5D-17**.

Recommended strategies for San Angelo include the Concho River Water Project and the West Texas Water Partnership. Figure 5D-5 illustrates the recommended water management plan for San Angelo. This plan indicates that the recommended strategies will be able to meet all of San Angelo's projected needs throughout the planning horizon.

Table 5D-16
Recommended Water Management Strategies for the City of San Angelo
-Values are in Acre-Feet per Year-

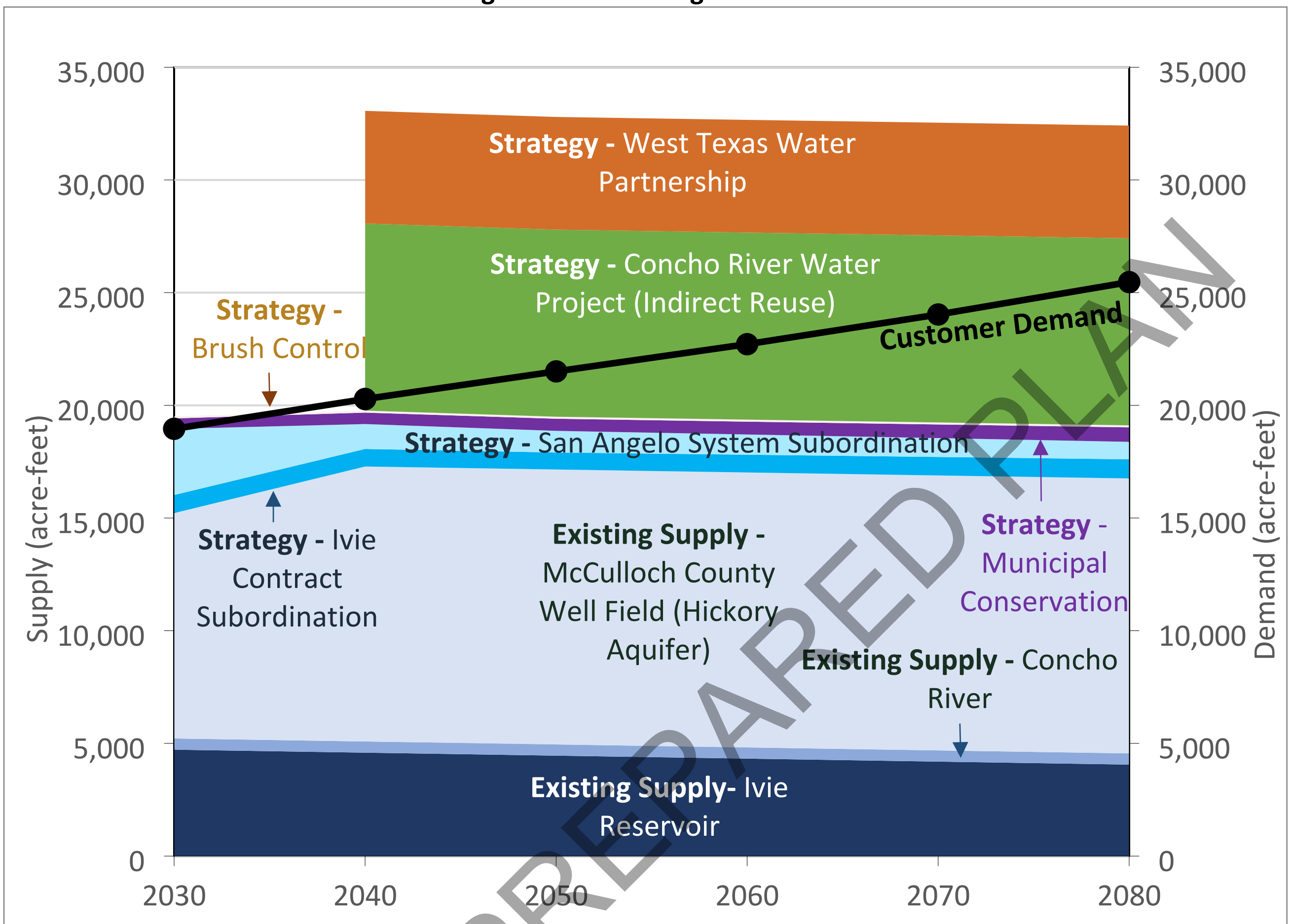
	2030	2040	2050	2060	2070	2080
Surplus (Shortage) before Recommend Strategies	**641**	**(604)**	**(2,101)**	**(3,436)**	**(4,879)**	**(6,444)**
Recommended Strategies	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Subordination - Ivie Contract	*803*	*779*	*754*	*788*	*821*	*849*
Subordination - San Angelo System	*2,937*	*1,105*	*960*	*897*	*837*	*775*
Municipal Conservation	*470*	*514*	*545*	*577*	*612*	*650*
Brush Control	90	90	90	90	90	90
Concho River Project (Indirect Reuse)	0	8,300	8,300	8,300	8,300	8,300
West Texas Water Partnership	0	5,000	5,000	5,000	5,000	5,000
Total Supply from Recommended Strategies	**90**	**13,390**	**13,390**	**13,390**	**13,390**	**13,390**
	2030	**2040**	**2050**	**2060**	**2070**	**2080**
Surplus (Shortage) after Recommended Strategies	**731**	**12,786**	**11,289**	**9,954**	**8,511**	**6,946**
Management Supply Factor	*1*	*1.6*	*1.5*	*1.4*	*1.4*	*1.3*

Strategies in grey italics were included in the previous calculation of surplus (shortages). They are included in this table for completeness but are not included in the total to avoid double counting.

Table 5D-17
Costs for the Recommended Strategies for the City of San Angelo

Strategy	Capital Cost (Million $)	Unit Cost ($/1,000 gal)	
		With Debt Service	After Debt Service
Municipal Conservation	---	NA	NA
Subordination	---	NA	NA
Brush Control	---	NA	$1.84
Concho River Water Project	$254.5	$12.35	$5.74
West Texas Water Partnership	$796.8	$6.96	$1.17

Figure 5D-5
San Angelo Water Management Plan



San Angelo Alternative Water Management Strategies

The City of San Angelo is considering additional strategies which may be implemented if additional supplies are needed or if one or more of the recommended strategies is determined to be no longer feasible. Alternative water management strategies for San Angelo include:

- Development of Edwards-Trinity aquifer supplies in Schleicher County
- Desalination of Additional Groundwater Supplies. This was not selected as recommended WMS because there are more cost-effective strategies available to meet San Angelo's needs.

5D.6 Documentation of Implementation Status and Anticipated Timeline for Certain Types of Recommended Water Management Strategies

This subsection documents the implementation status of certain recommended WMSs. The implementation status must be provided for the following types of recommended WMSs with any online decade:

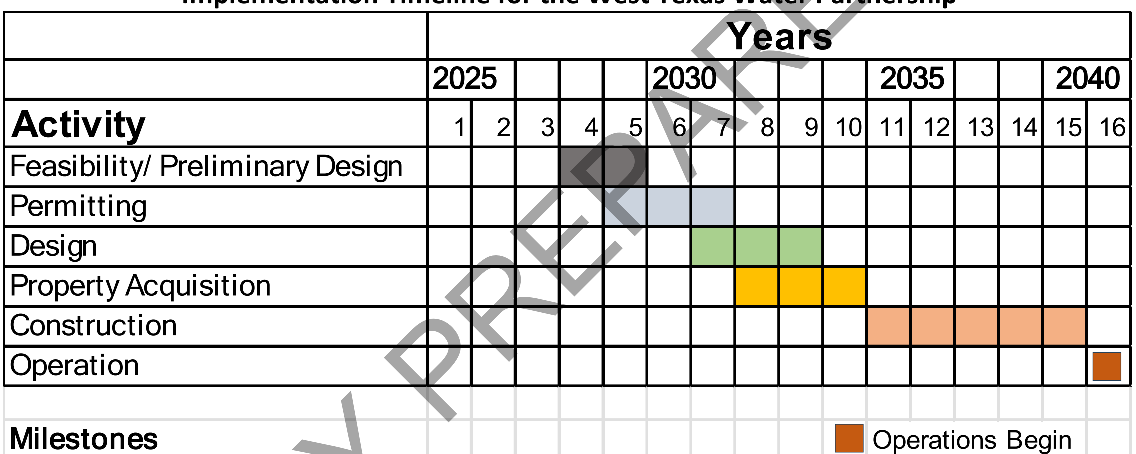
- All reservoir strategies
- All seawater desalination strategies
- Direct potable reuse strategies that provide greater than 5,000 acre-feet per year of supply

- Brackish groundwater strategies that provide greater than 10,000 acre-feet per year of supply
- Aquifer storage and recovery strategies that provide greater than 10,000 acre-feet per year
- All water transfers from out of state
- Any other innovative technology project the RFWPG deems appropriate

Considering these criteria, there is one recommended WMS that requires the development of an implementation schedule, the West Texas Water Partnership because it involves the development of greater than 10,000 acre-feet per year of brackish groundwater supplies. The implementation status of this strategy is documented in the TWDB-required table in Appendix J.

The West Texas Water Partnership is discussed in detail in section 5D.3.1 and is a recommended WMS for Midland, San Angelo, and Abilene (Region G). The recommended implementation decade of 2040 is reasonable and attainable. A simple, conceptual timeline graphic is illustrated in Figure 5D-6. Actual phases, durations, and implementation dates may vary.

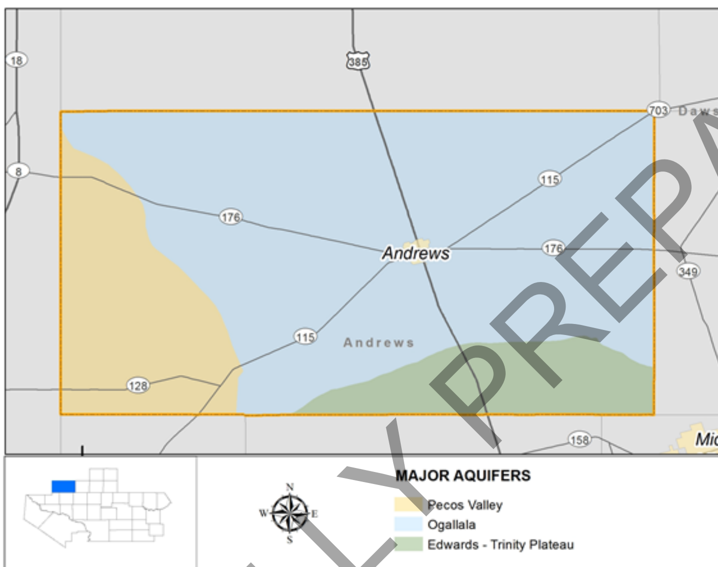
Figure 5D-6
Implementation Timeline for the West Texas Water Partnership



5E COUNTY WATER MANAGEMENT PLANS

There are 32 counties in Region F. This subchapter discusses the water issues of each county and outlines the proposed water management strategies to meet the identified shortages. For some counties, there are projected shortages that cannot be met through an economically viable project or could not reasonably be brought online by 2030. It is important to remember that economic viability of a project is based on the current understanding of the value of water and that maximum cost that can be paid for water in certain industries such as irrigated agriculture. These assumptions of economic viability may change over time and will be reevaluated in the next plan. These "unmet needs" are also identified, if present, by county. Descriptions of water management strategies that are developed by a major water provider are discussed in Chapter 5D and included in the county summary tables for completeness, as appropriate. Detailed evaluations of the potentially feasible water management strategies are included in Appendix C and the detailed costs are presented in Appendix D. A summary evaluation matrix is included in Appendix E.

5E.1 Andrews County



Andrews County has limited surface water and groundwater supplies. Some local surface water is used by livestock, but the majority of water within Andrews County is supplied from the Dockum and Ogallala aquifers. Much of the supply from these sources is nearly fully developed for current use. As a result, there are identified shortages that may not be able to be met by supplies within the county.

The majority of Andrews County's shortages are associated with irrigation, municipal, and mining water needs. Irrigation is the largest water user group within Andrews County, with a water demand at approximately 17,500 acre-feet and current supplies available to meet this need of approximately 12,200 acre-feet in 2030. The only strategy identified for irrigation is conservation. The mining demand in Andrews County is 4,200 acre-feet in 2030, which cannot be met with existing supplies. Strategies identified for mining include utilizing recycled water (conservation). Conservation strategies are discussed in more detail in Chapter 5B.

Most of the municipal shortage within Andrews County is affiliated with the City of Andrews, which has the second largest shortage identified within the county. The City obtains their water from the Ogallala aquifer and plans on expanding their well fields in order to better support their existing supply. Similarly, the Texland Great Plains Water Supply Company (Great Plains), a wholesale water provider (WWP) that operates in Andrews County and Gaines County (Region O), is also identified to have a need and plans to expand their well field. Most strategies for water user groups that have needs in Andrews County are to develop additional groundwater supplies, however, the current MAG volume available in the local aquifers will not support these desired projects. For planning purposes, if a strategy exceeds the MAG availability it does not qualify for state funding and cannot be a recommended strategy, whether or not a GCD is in place. For the purpose of this plan, groundwater strategies developed for water users in Andrews County are not recommended, but are alternative strategies put in place to be recommended only if the DFC and associated MAG were to change in future planning cycles.

5E.1.1 Andrews

The City of Andrews obtains its water from city well fields in the Ogallala aquifer and purchased groundwater from University Lands. The City's contract with University Lands expires in 2035 but has an automatic renewal that extends until 2060. It is assumed that the City will renew this contract for supplies through the planning period. Strategies to develop additional groundwater in the Ogallala aquifer as part of the City's well field expansion project exceed the current MAG availability, and therefore, these strategies are not recommended. However, they can be included as alternative strategies designed to be recommended upon a change in DFC and MAG availabilities in future planning cycles. More information pertaining to these projects are located in Appendix C. For the purpose of this plan, municipal conservation is expected to yield 49 acre-feet in 2030. The preservation of existing supplies through municipal conservation is a recommended strategy.

The City of Andrews has also discussed the possibility of importing additional water from Val Verde County and from the T-Bar well field. However, the small amount of water obtained from these strategies does not outweigh the considerable costs for the necessary infrastructure. These strategies were identified as not being potentially feasible and therefore were not fully evaluated as part of this planning cycle. If part of the infrastructure cost can be shared with others, these strategies may be more feasible in the future.

Potentially Feasible Water Management Strategies Considered for the City of Andrews:

- Municipal Conservation
- Develop Ogallala Aquifer Supplies
- Develop Edwards-Trinity Plateau Aquifer Supplies (Antlers Formation)

Develop Ogallala Aquifer Supplies

This strategy proposes additional groundwater development from the Ogallala aquifer. A total of 17 new wells would be drilled along with associated well field piping. The amount of supply expected is 3,634 acre-feet per year, but there is no water available under the current MAG, causing this strategy to officially be listed as an Alternative strategy. However, there is currently no GCD in Andrews County to manage to the DFC and it is anticipated that users in Andrews County will continue groundwater development and use. Capital costs are estimated at $36 million.

Develop Edwards-Trinity Plateau Aquifer Supplies (Antlers Formation)

This strategy assumes that 38 new wells will need to be constructed at a 200-ft depth to access the additional aquifer supplies needed. Each well is assumed to be operating at a capacity of 50 gpm. A transmission pipe will be constructed to transfer the groundwater. This strategy will cost approximately $56.8 million to implement and is estimated to yield an additional 2,600 acre-feet of water per year.

Table 5E- 1
Recommended and Alternative Water Strategies for Andrews

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		4,507	5,492	6,623	7,766	9,010	10,366
Existing Supply (Groundwater)		4,057	4,407	4,345	4,177	4,055	3,963
Shortage		450	1,085	2,278	3,589	4,955	6,403
Recommended Strategies							
Municipal Conservation	$0	49	60	109	127	147	169
Alternative Strategies							
Develop Ogallala Aquifer Supplies	$36,022,000	0	3,634	3,634	3,634	3,634	3,634
Develop Edwards-Trinity Plateau Aquifer Supplies (Antlers Formation)	$56,814,000	0	2,600	2,600	2,600	2,600	2,600
TOTAL	**$92,836,000**	**0**	**6,234**	**6,234**	**6,234**	**6,234**	**6,234**

5E.1.2 Texland Great Plains Water Supply Co. LLC

The Texland Great Plains Water Supply Company (Great Plains) is a wholesale water provider (WWP) that provides water to customers in Region F and the Llano Estacado Region (Region O). The water supply system operates well fields in the Ogallala aquifer in Andrews County in Region F and Gaines County in Region O. Great Plains owns an extensive pipeline system that has historically provided water primarily for oil and gas operations. In Region F, Great Plains also provides a small amount of municipal water to the City of Goldsmith, manufacturing users and a steam electric operation in Ector County. Due to the limited supplies from the Ogallala aquifer in Andrews and Gaines Counties, Great Plains is shown to have a projected shortage of approximately 213 acre-feet per year in 2030 but decreasing demands show the shortage to be gone starting in 2060, as presented in Table 5E- 2.

Table 5E- 2
Comparison of Supply and Demand for the Great Plains Water Supply System
-Values are in Acre-Feet per Year-

Supplies	2030	2040	2050	2060	2070	2080
Andrews Co. Well Field	1,550	1,236	1,100	1,035	982	937
Gaines Co. Well Field (Region O)	6,582	6,582	6,922	6,970	7,010	7,043
Total Supplies	**8,132**	**7,818**	**8,022**	**8,005**	**7,992**	**7,980**
Demands	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
County-Other, Ector (City of Goldsmith)	68	68	68	68	68	68
Steam Electric Power, Ector County	5,632	5,632	5,632	5,632	5,632	5,632
Manufacturing, Ector County	245	245	245	245	245	245
Mining, Ector County	300	150	100	100	100	100
Mining, Gaines County (Region O)	2,100	2,100	2,100	2,100	2,100	2,100
Total Demand	**8,345**	**8,195**	**8,145**	**8,145**	**8,145**	**8,145**
Shortage	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Shortage	213	377	123	140	153	165

These shortages are associated with the limitations of the MAGs. The existing well fields can produce the required supply but there is competition for water from the Ogallala aquifer. In Andrews County there is no groundwater district to enforce the MAG withdrawal limits, but there is a district in Gaines County. For planning purposes there is no available water from the Ogallala aquifer in Andrews and/or Gaines County for water management strategies. There is a small amount of MAG available in Andrews County from the Dockum aquifer, but the water quality of this supply is poor, and productivity is limited.

In order to meet any potential future needs, Great Plains is planning to expand their well field and drill new wells in northern Andrews County and/or southern Gaines County. Due to limitations of the MAG in both Andrews and Gaines County, this is shown as an alternative strategy in the plan.

Potentially Feasible Water Management Strategies Considered for Texland Great Plains:

- Develop Additional Ogallala Aquifer Supplies in Andrews or Gaines County

Develop Additional Ogallala Aquifer Supplies from Andrews or Gaines County

This strategy is for a small well field expansion at Texland Great Plains existing facilities in Andrews and Gaines counties. This strategy assumes one new well in the Ogallala Aquifer. Due to MAG limitations in these counties, this strategy is classified as alternative.

Table 5E- 3
Alternative Water Strategies for Great Plains

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		8,345	8,195	8,145	8,145	8,145	8,145
Existing Supply (Groundwater)		8,132	7,983	8,102	8,242	8,320	8,398
Shortage		213	212	43	0	0	0
Alternative Strategies							
Develop Additional Supplies in Ogallala Aquifer	$607,000	213	213	213	213	213	213

5E.1.3 Andrews County-Other

Andrews County-Other has less than 8,000 in population in 2030, which consists of individuals living outside of a named water user group. This compilation of users known as County-Other is self-supplied. The shortages for this population stem from limited existing groundwater supply from the Ogallala Aquifer, but there is a small amount of MAG availability in the county from the Edwards-Trinity- Plateau. Development of additional groundwater from the Edwards Trinity Plateau is considered as a recommended water management strategy, though users may continue to develop Ogallala supplies beyond the MAG instead. Municipal conservation was also considered and recommended as a strategy for Andrew County-Other. Conservation strategies are discussed in Chapter 5B.

Potentially Feasible Water Management Strategies Considered for Andrews County-Other:

- Municipal Conservation
- Develop Edwards-Trinity Plateau Aquifer Supplies

Develop Edwards-Trinity Plateau Aquifer Supplies

This strategy assumes that 12 new wells will need to be constructed at a 200-ft depth to access the additional aquifer supplies needed. Each well is assumed to be operating at a capacity of 50 gpm. This strategy will cost approximately $3,441,000 to implement and is estimated to yield an additional 934 acre-feet of water per year.

Table 5E- 4
Recommended and Alternative Water Strategies for Andrews County-Other

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		830	1,112	1,440	1,770	2,130	2,522
Existing Supply (Groundwater)		728	850	1,011	1,169	1,336	1,508
Shortage		102	262	429	601	794	1,014
Recommended Strategies							
Municipal Conservation	**$0**	22	29	38	47	56	80
Develop Edwards-Trinity Plateau Aquifer Supplies	$3,441,000	934	934	934	934	934	934
TOTAL	**$3,441,000**	**956**	**963**	**972**	**981**	**990**	**1,014**

5E.1.4 Andrews County Livestock

Andrews County has approximately 70 to 110 acre-feet of livestock shortages over the planning horizon due to limited existing groundwater supply from the Ogallala aquifer, but there is some Edwards-Trinity Plateau supplies in the county that may potentially be able to meet these needs. A recommended water management strategy is included to provide additional water from the Edwards-Trinity Plateau aquifer though users may continue to develop Ogallala supplies beyond the MAG instead.

Potentially Feasible Water Management Strategies Considered for Andrews County Livestock:

- Develop Edwards-Trinity Plateau Supplies

Develop Edwards-Trinity Plateau Aquifer Supplies

This strategy assumes that 3 new wells will need to be constructed at a 200-ft depth in order to access the additional aquifer supplies needed. Each well is assumed to be operating at a capacity of 50 gpm. This strategy will cost approximately $1,018,000 to implement and is estimated to yield an additional 108 acre-feet of water per year.

Table 5E- 5
Alternative Water Strategies for Andrews County Livestock

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		200	200	200	200	200	200
Existing Supply (Groundwater)		126	113	105	100	96	92
Shortage		74	87	95	100	104	108
Recommended Strategies							
Develop Edwards-Trinity Plateau Aquifer Supplies	$1,018,000	108	108	108	108	108	108

5E.1.5 Andrews County Manufacturing

A small portion of the Andrews County manufacturing demand is supplied through sales from the City of Andrews. The remainder of the manufacturing in the county is self-supplied from the Ogallala aquifer. Due to limited supplies under the MAG, manufacturing in Andrews County also shows a shortage over the planning horizon that cannot be met. An alternative water management strategy for additional groundwater from the Edwards-Trinity Plateau aquifer was developed.

Potentially Feasible Water Management Strategies Considered for Andrews County Manufacturing:

- Develop Edwards-Trinity Plateau Supplies

Develop Edwards-Trinity Plateau Aquifer Supplies

This strategy assumes that 5 new wells operating at 50 gpm constructed at a 200-ft depth to access the additional aquifer supplies needed. This strategy will cost approximately $1,392,000 to implement and is estimated to yield an additional 279 acre-feet of water per year.

Table 5E- 6
Alternative Water Strategies for Andrews County Manufacturing

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		596	618	641	665	690	716
Existing Supply (Groundwater, Purchased from Andrews)		526	478	457	447	441	437
Shortage		70	140	184	218	249	279
Alternative Strategies							
Develop Edwards-Trinity Plateau Aquifer Supplies	$1,392,000	279	279	279	279	279	279

5E.1.6 Andrews County Mining

Andrews County Mining has a projected shortage from 2030 to 2060, with a shortage of nearly 2,140 acre-feet per year in 2040. Region F has identified mining conservation (recycling) as recommended strategy. Additional information on conservation strategies is included in Chapter 5B. The remainder of the need is unmet since the groundwater available under the MAG is limited and mining is an exempt use. However, it is anticipated that the mining industry, as an exempt user, will continue to use groundwater as needed to meet any of their demands.

Table 5E- 7
Recommended Water Strategies for Andrews County Mining

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		4,200	4,200	3,850	3,150	2,223	1,400
Existing Supply (Purchased from Great Plains, Purchased Reuse, Mining Reuse)		2,210	2,061	2,096	2,251	2,458	2,641
Shortage		1,990	2,139	1,754	899	0	0
Recommended Strategies							
Mining Conservation/Recycling	$4,840,000	242	242	222	182	128	81

5E.1.7 Andrews County Summary

Before strategies, Andrews County has a projected shortage of over 14,000 acre-feet per year by 2080 and has limited options under regional planning guidelines to meet these shortages. The MAG in Andrews County is limiting and results in water needs for all users in the county. Most of these needs remain unmet. However, since there is no GCD in Andrews County, users may functionally develop supplies in larger quantities than regional planning recognizes. While the unmet needs are large, some of the need is currently being met by groundwater use above the MAG limits. It is anticipated that the water users in Andrews County will continue to use groundwater at the current levels and possibly expand groundwater use over time. These strategies are included as alternative water management strategies.

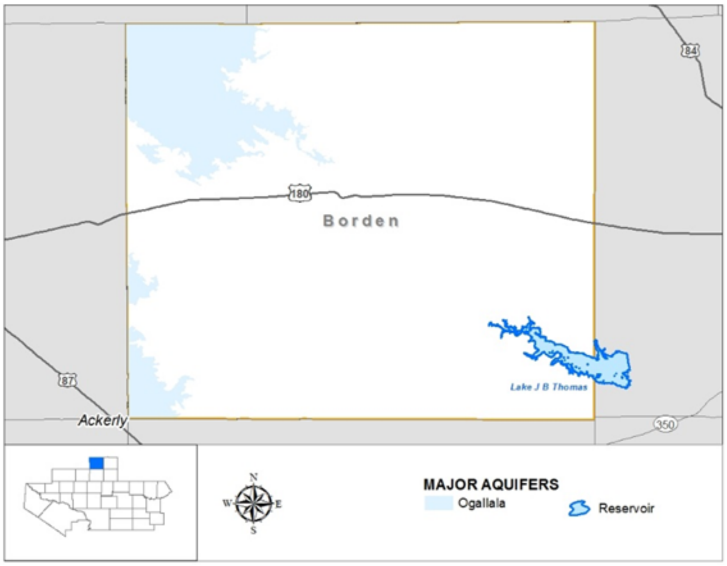
Table 5E- 8
Andrews County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Andrews	Ogallala Aquifer	450	6,403	Municipal Conservation Develop Edwards-Trinity Plateau Supplies (Alternative)
County-Other	Ogallala Aquifer and Pecos Valley	102	1,014	Municipal Conservation Develop Edwards-Trinity Plateau Supplies (Alternative)
Texland Great Plains	Ogallala Aquifer	213	165	Develop Ogallala Aquifer Supplies (Alternative)
Irrigation	Ogallala Aquifer, Edwards-Trinity High Plains Aquifer, Pecos Valley Aquifer, Reuse (Andrews)	5,365	8,982	Irrigation Conservation
Livestock	Dockum Aquifer, Stock Ponds, Ogallala Aquifer, Pecos Valley Aquifer	74	108	Develop Edwards-Trinity Plateau Supplies (Alternative)
Manufacturing	Sales from Andrews, Ogallala Aquifer	70	279	Develop Edwards-Trinity Plateau Supplies (Alternative)
Mining	Mining Reuse (Recycling), Reuse (Ector County)	1,990	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

Table 5E- 9
Unmet Needs in Andrews County
-Values are in Acre Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
Andrews	401	1,025	2,169	3,462	4,808	6,234
Andrews Manufacturing	70	140	184	218	249	279
Irrigation	4,487	5,062	5,877	6,413	6,849	7,226
Mining	1,748	1,897	1,532	717	0	0
TOTAL	**6,706**	**8,124**	**9,762**	**10,810**	**11,906**	**13,739**

5E.2 Borden County



Borden County has limited surface water and groundwater supplies. Some local surface water is used by livestock, but the majority of water within Borden County is supplied from the Ogallala aquifer and Other Aquifer. Much of the supply from these sources is nearly fully developed for current use. Irrigation is the largest water user within the county with a water demand of roughly 2,500 acre-feet per year. Shortages are identified for Borden County Water System in 2060 once the capacity of their existing wells in Dawson County are projected to be exceeded. Mining also shows a shortage in the early decades before the demand is projected to decline. Conservation is recommended for both entities. Conservation strategies are discussed in more detail in Chapter 5B. The Borden County Water System is exploring additional supplies from the Ogallala and Edwards-Trinity-High Plains Aquifer in Dawson County. Dawson County is in Region O, but this strategy will meet their projected needs and is therefore included here. All other water use categories in Borden County, including county-other, and livestock, were identified to not have shortages and therefore no strategies were required.

5E.2.1 Borden County Water System

Borden County Water System is a small regional water system that serves municipal users in Borden County from a small well field in Dawson County, which is in Region O. Their current supplies come from two wells pulling from the Ogallala Aquifer. Their projected demands are expected to exceed the wells' current capacity by 2060. As a result, Borden County Water System is projected to have a shortage from 2060 to 2080, with a shortage of just over 130 acre-feet per year in 2080. Region F has identified municipal conservation as a recommended strategy. Additional information on conservation strategies is included in Chapter 5B. The remainder of the need will be met by a recommended strategy to develop additional Ogallala and Edwards-Trinity-High Plains Aquifer supplies in Dawson County.

Table 5E- 10
Recommended Water Strategies for Borden County Water System

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		138	155	184	223	272	335
Existing Supply (Groundwater, Reuse)		138	155	184	201	201	201
Shortage		0	0	0	22	71	134
Recommended Strategies							
Municipal Conservation	$0	1	1	1	1	1	2
Develop Additional Supplies from Ogallala and Edwards-Trinity-High Plains Aquifer in Dawson County	$24,325,000	0	0	0	22	71	134
TOTAL	**$24,325,000**	**1**	**1**	**1**	**23**	**72**	**136**

5E.2.2 Borden County Mining

Borden County Mining has a projected shortage from 2030 to 2050, with a shortage just over 500 acre-feet per year in 2030. Region F has identified mining conservation (recycling) as a recommended strategy. Additional information on conservation strategies is included in Chapter 5B. The remainder of the need is unmet since the groundwater available under the MAG is limited and mining is an exempt use. However, it is anticipated that the mining industry, as an exempt user, will continue to use groundwater as needed to meet any of their demands.

Table 5E- 11
Recommended Water Strategies for Borden County Mining

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		3,374	3,374	3,093	2,531	1,785	1,125
Existing Supply (Groundwater)		2,845	2,845	2,795	2,531	1,785	1,125
Shortage		529	529	298	0	0	0
Recommended Strategies							
Mining Conservation (Recycling)	$2,340,000	117	117	107	88	62	39
TOTAL	**$2,340,000**	**117**	**117**	**107**	**88**	**62**	**39**

5E.2.3 Borden County Summary

Borden County is projected to have unmet needs for mining through 2050 even after recommended mining conservation (recycling). Borden County-Other does not have a shortage, so municipal conservation was not recommended as a strategy.

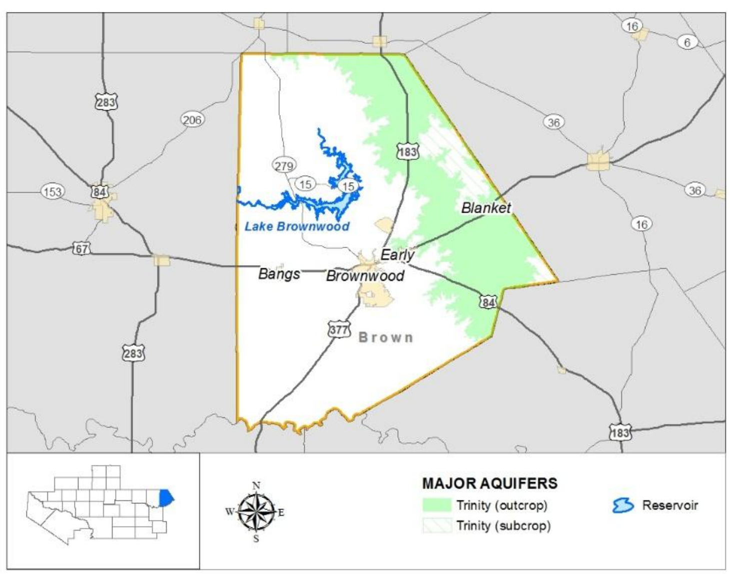
Table 5E- 12
Borden County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Borden County Water System	Ogallala and Edwards-Trinity-High Plains Aquifers (Dawson County)	None	134	Develop Additional Supplies from Ogallala and Edwards-Trinity-High Plains Aquifer in Dawson County
County-Other	Ogallala Aquifer, Local Alluvium Aquifer	None	None	None
Irrigation	Ogallala Aquifer, Local Alluvium Aquifer	0	282	Irrigation Conservation
Livestock	Stock Ponds, Ogallala and Edwards-Trinity-High Plains Aquifers, Dockum Aquifer	None	None	None
Manufacturing	----	----	----	----
Mining	Local Alluvium Aquifer, Mining Reuse	529	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

Table 5E- 13
Unmet Needs in Borden County
-Values are in Acre Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
Mining	412	412	191	0	0	0

5E.3 Brown County



Most of the water supply in Brown County is supplied by Brown County Water Improvement District #1 (BCWID) from Lake Brownwood. None of the entities supplied by BCWID #1 show a water shortage over the planning horizon. BCWID #1 is classified as a major water provider and is discussed further in Chapter 5D. Coleman County SUD, as well as irrigation users, show a water shortage over the planning horizon. The identified shortage for Coleman County SUD is attributed to a lack of firm yield in Lake Coleman. When considering subordination supply from Lake Coleman, the shortages for Coleman County SUD are met. Irrigation users receive their supply through various sources, however, the only recommended strategy in the plan is conservation which is anticipated to fully meet the need in Brown County.

Conservation is recommended as a strategy in Brown County for municipal and irrigation users. All conservation strategies are further discussed in Chapter 5B. County-Other, Livestock and Manufacturing all have no shortages and no recommended strategies.

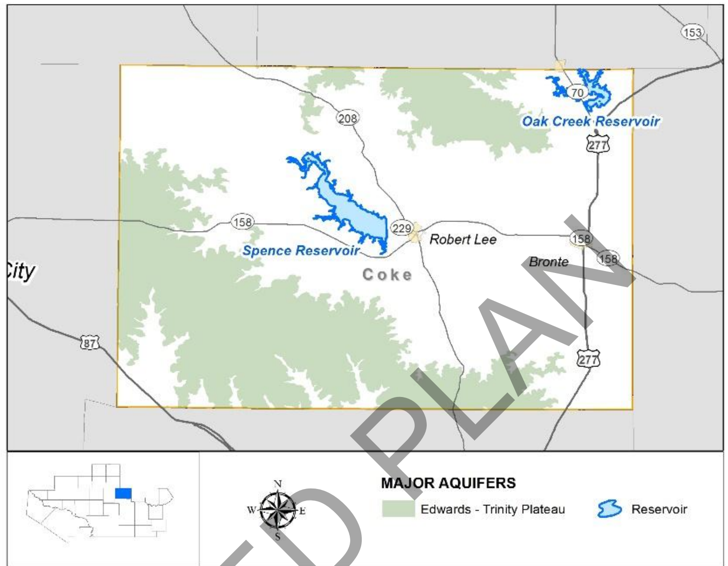
5E.3.1 Brown County Summary

Lake Brownwood (BCWID #1) has sufficient supplies to meet most of the county's demands. Conservation is recommended for all municipal, irrigation, and mining users. No users have needs in Brown County after strategies.

Table 5E- 14
Brown County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Bangs	Sales from BCWID #1	None	None	Municipal Conservation
Brookesmith SUD	Sales from BCWID #1	None	None	Municipal Conservation
Brownwood	Sales from BCWID #1	None	None	Municipal Conservation
Coleman County SUD	Sales from BCWID #1 and City of Coleman	78	65	Municipal Conservation Subordination (through the City of Coleman)
Early	Sales from BCWID #1	None	None	Municipal Conservation
Santa Anna	Sales from BCWID #1	None	None	Municipal Conservation
Zephyr WSC	Sales from BCWID #1	None	None	Municipal Conservation
County-Other	Trinity Aquifer, Cross Timbers Aquifer	None	None	None
Irrigation	Sales from BCWID #1, Run-of-River, Trinity Aquifer, Cross Timbers Aquifer	319	319	Irrigation Conservation
Livestock	Livestock Local Supplies, Trinity Aquifer, Cross Timbers Aquifer	None	None	None
Manufacturing	Sales from BCWID #1	None	None	None
Mining	Trinity and Other Aquifers	None	None	None
Steam Electric	----	----	---	----

5E.4 Coke County



Coke County has very limited groundwater and surface water supplies. Without subordination both E.V. Spence and Oak Creek Reservoir show zero reliable supply. Lake Spence is owned and operated by CRMWD. The subordination supplies from this reservoir go to supply CRMWD customers outside Coke County. Robert Lee previously had a contract with CRMWD and previously received supply from the Spence Reservoir. However, their water treatment plant has been shuttered and their contract has expired. Robert Lee no longer uses this source but there is a strategy considered for Bronte and Robert Lee to begin using Spence supplies again with advanced treatment. Oak Creek Reservoir is owned and operated by the City of Sweetwater (Region G) and is used in conjunction with their other supplies to provide water to Sweetwater and their customers, including Bronte. Groundwater supply in the county is also limited. There are some small alluvium deposits of freshwater, but they are limited and generally not prolific. The Edwards-Trinity Plateau aquifer does have unused availability in the county, but the quality tends to be poor and may require advanced treatment for municipal use. For many of the smaller, rural communities in Coke County, the development of this supply is economically infeasible.

5E.4.1 Bronte

In the past, the City of Bronte relied solely on water from the Oak Creek Reservoir (sales from the City of Sweetwater located in Region G). However, prolonged drought has greatly impacted the supply available from Oak Creek and without subordination, the source shows no supply. As a result, Bronte developed a groundwater supply from ten wells in the vicinity of Oak Creek Reservoir. The groundwater is delivered to the City in the Oak Creek pipeline. The groundwater supply is from an unclassified aquifer and the reliability is not well known. For the purpose of this plan, it is assumed that this source could provide about 80 acre-feet of supply per year.

Bronte provides water for both their retail customers and sells wholesale water to the City of Robert Lee. With the implementation of several water management strategies, Bronte shows no shortages over the planning horizon for their retail needs but will have to limit the sale of water to Robert Lee in 2030. However, if Sweetwater is not able to meet the expected supply amounts, Bronte would show significant shortages for their retail needs also. To ensure the security of their water supply, the City of Bronte is diligently pursuing all options. Several strategies for Bronte in previous plans were evaluated and some were considered economically infeasible. These were not reevaluated for this plan and are listed below.

Previously Evaluated and Dismissed Water Management Strategy:

- Brackish groundwater development with advanced treatment
- Direct Potable Reuse

- Regional System from Lake Brownwood to Runnels and Coke Counties
- Develop Other Aquifer Supplies in Southwest Coke County
- Develop Other Aquifer Supplies in Runnels County

For this plan, several potentially feasible strategies were considered for Bronte including:

- Municipal Conservation
- Subordination (Oak Creek Supplies from Sweetwater)
- Rehabilitation and Upsizing of the Oak Creek Pipeline
- Water Treatment Plant Expansion
- Regional System from Fort Phantom Hill to Runnels and Coke Counties
- Develop Edwards-Trinity Plateau Supplies in Nolan County
- Connect to CRMWD for E.V. Spence Reservoir supplies with Advanced Treatment

Recommended strategies for the City of Bronte are discussed below. Alternate strategies are described further in Appendix C.

Rehabilitation and Upsizing of the Oak Creek Pipeline

The City of Bronte has a 13-mile pipeline to Oak Creek Reservoir. This pipeline is approximately 60 years old and in need of replacement and upsizing to provide adequate capacity. The proposed strategy includes a new 50,000-gallon/ground storage tank, upgrades to the pump station at the intake, and 8 miles of 14-inch pipeline (the remaining five miles of pipeline are being replaced with Bronte's water treatment plant expansion). The additional yield from this strategy represents the additional supplies (subordination sales from Sweetwater) that were previously constrained by the pipeline's capacity. The strategy is estimated to cost nearly $18.6 million.

Water Treatment Plant Expansion

In order to continue supplying Bronte's municipal needs and treated water sales to Robert Lee, the City of Bronte will need a 1.3 MGD water treatment plant expansion by 2030. Bronte is actively working to implement this strategy in conjunction with the rehabilitation of five miles of the Oak Creek Pipeline. This strategy is expected to be completed by 2027 or 2028. Based on an opinion of probable cost provided by Bronte, this project is estimated to cost $15 million.

Connect to CRMWD for E.V. Spence Reservoir Supplies with Advanced Treatment

To ensure the security of their water supply, Bronte is considering connecting to CRMWD's E.V. Spence Reservoir. This strategy would require the construction of a new intake on the reservoir and advancement treatment because of high levels of TDS in the reservoir. The strategy is estimated to cost $65.7 million, with Bronte's portion being $34.8 million and Robert Lee's portion being $30.9 million.

Table 5E- 15
Recommended Water Strategies for Bronte

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		605	641	681	742	809	883
Existing Supply (Groundwater)		81	81	81	81	81	81
Shortage		524	560	600	661	728	802
Recommended Strategies							
Subordination (Oak Creek Reservoir)	$0	457	457	457	457	457	457
Municipal Conservation	$0	3	3	3	3	4	4
*Oak Creek Pipeline Rehabilitation**	*$18,637,000*	*0*	*457*	*457*	*457*	*457*	*457*
*Water Treatment Plant Expansion**	*$15,000,000*	*729*	*729*	*729*	*729*	*729*	*729*
Purchase CRMWD supplies from Spence with Advanced Treatment	$34,844,000	0	100	140	201	267	341
TOTAL	**$68,481,000**	**460**	**560**	**600**	**661**	**728**	**802**

**This strategy is for infrastructure projects required to access the subordination supplies Oak Creek pipeline supplies and is not included in the total to avoid double counting.*

Alternative Water Management Strategies for Bronte include:

- Regional System from Fort Phantom Hill to Runnels and Coke Counties
- Develop Supplies in Nolan County (Region G) - Edwards-Trinity Plateau Supplies or Connect to and Purchase Water from Bitter Creek (Region G)

5E.4.2 Robert Lee

The City of Robert Lee provides water to its current customers and about 50 acre-feet to Coke County WSC (Coke County-Other). It currently purchases all of its supply from the City of Bronte. Robert Lee has a contract with Bronte for 150 acre-feet per year. However, Bronte currently sells more than the contracted amount to Robert Lee and will continue to meet their needs if Bronte has the supply available to do so. The City previously owned and operated a surface water treatment plant for water supplied by Spence and Mountain Creek Reservoirs. However, due to prolonged drought, these water sources became unreliable and the water treatment plant was shuttered. The City is currently pursuing several different water supply options. Additionally, several other strategies have previously been evaluated for Robert Lee that were found to be economically infeasible and are listed below.

Previously Evaluated and Dismissed Water Management Strategies:

- Desalination of Spence Reservoir Water
- Floating pump in Mountain Creek Reservoir
- Direct Potable Reuse
- Regional System from Lake Brownwood to Runnels and Coke Counties

Potentially Feasible Water Management Strategies Considered for Robert Lee:

- Municipal Conservation
- Purchase additional water from Bronte (CRMWD for E.V. Spence Reservoir supplies with Advanced Treatment)

- Regional System from Fort Phantom Hill to Runnels and Coke Counties
- Develop groundwater from Edwards-Trinity Plateau in Nolan County
- Develop groundwater from Edwards-Trinity Plateau in Tom Green County

Recommended strategies for Robert Lee are discussed below. Alternate strategies are described further in Appendix C.

Purchase Additional Water from Bronte (CRMWD E.V. Spence Reservoir supplies with Advanced Treatment)

The City of Robert Lee currently has a contract to purchase 150 acre-feet per year of supply from Bronte. It is recommended that Robert Lee increase this amount to meet their water supply needs. This strategy assumes this is done on a willing buyer, willing seller basis. The supplies from Bronte will be from a strategy to purchase supply from CRMWD from the E.V. Spence Reservoir with advanced treatment and would require significant investment.

The recommended strategies for Robert Lee are shown in the table below. The shortages reported in this table include shortages to County-Other that Robert Lee currently supplies. Water made available to Robert Lee from these strategies will be used to meet the County-Other demands. Because of the time needed to develop the infrastructure to connect to CRMWD Lake Spence supplies, the City of Robert Lee shows an unmet need in 2030.

Table 5E- 16
Recommended Water Strategies for Robert Lee

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		325	343	363	393	426	463
Existing Supply (Purchased)		0	0	0	0	0	0
Shortage		325	343	363	393	426	463
Recommended Strategies							
Municipal Conservation	$0	3	3	3	4	4	5
Subordination (existing contract with Bronte)	$0	258	245	244	242	241	240
Water Audits and Leak Repairs	$349,000	11	12	13	14	15	17
Purchase CRMWD Spence supplies from Bronte	$30,880,000	0	83	103	133	166	201
TOTAL	**$31,229,316**	**272**	**343**	**363**	**393**	**426**	**463**

Alternative Water Management Strategies Considered for Robert Lee:

- Regional Systems from Fort Phantom Hill to Runnels and Coke Counties
- Develop Edwards-Trinity Plateau Aquifer in Nolan County
- Develop Edwards-Trinity Plateau Aquifer in Tom Green County

5E.4.3 Coke County Summary

After subordination of downstream water rights associated with Oak Creek Reservoir, municipal needs in Coke County are greatly reduced. Bronte currently sells to Robert Lee and subordination supplies are not adequate to meet their own needs and the needs of Robert Lee fully. The ability to develop additional water supplies through economically feasible strategies is limited. Both the local groundwater and surface water have known water quantity and quality limitations. The ability to use these sources for municipal purposes would require advanced treatment. Bronte has several strategies currently under development and future plans to connect to the EV Spencer Reservoir and purchase from CRMWD with advanced treatment to meet their needs the needs of Robert Lee. However, due to the time needed to bring such a project online, the City of Robert Lee has an unmet need in 2030. This project will be a challenge due to the significant cost. The entities in Coke County continue to explore their options.

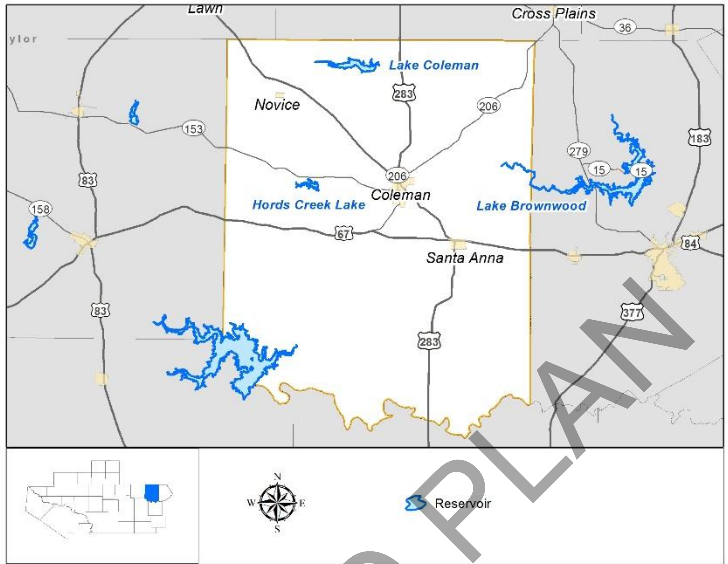
Table 5E- 17
Coke County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Bronte	Sales from Sweetwater, Other Undifferentiated Aquifer	524	802	Municipal Conservation, Subordination, Rehabilitation of Oak Creek Pipeline, Water Treatment Plant Expansion, Purchase CRMWD Supplies from Lake Spence with Advanced Treatment
Robert Lee	Run-of-River, Sales from Bronte	325	463	Municipal Conservation, Subordination (through Bronte), Purchase Additional Supplies from Bronte
County-Other	Edwards-Trinity Plateau Aquifer, Other Undifferentiated Aquifer, Sales from Robert Lee	49	49	Subordination (sales from Robert Lee)
Irrigation	Run-of-River, Edwards-Trinity Plateau Aquifer, Other Undifferentiated Aquifer	None	None	Irrigation Conservation
Livestock	Stock Ponds, Edwards-Trinity Plateau Aquifer, Other Undifferentiated Aquifer	None	None	None
Manufacturing	----	----	----	----
Mining	Edwards-Trinity Plateau Aquifer	None	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

Table 5E- 18
Unmet Needs in Coke County
-Values are in Acre Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
City of Robert Lee	53	0	0	0	0	0

5E.5 Coleman County



Users in Coleman County largely rely on surface water. Many water user groups including Brookesmith SUD, Coleman County SUD, and Santa Anna are supplied by Brown County WID #1 from Lake Brownwood. These entities are discussed further under Brown County. The City of Coleman is supplied by Lake Coleman and Hords Creek. Irrigators in Coleman County rely primarily on Lake Coleman and run-of-river rights for their supply, but also pump some groundwater from the Cross Timbers aquifer. Livestock users utilize local water supplies to meet their demands.

Without subordination, Lake Coleman and Hords Creek show no supply, leaving irrigators, the City of Coleman and the City's customers including Coleman County SUD, County-Other, and manufacturing with shortages. However, when considering conservation and subordination, supplies are adequate to meet all these shortages and no additional infrastructure strategies are needed. Conservation and subordination are discussed further in Chapters 5B and 5C, respectively.

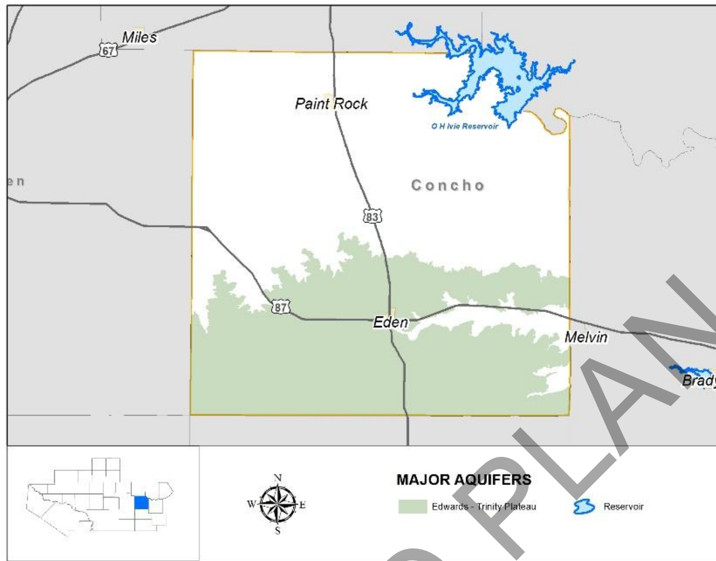
5E.5.1 Coleman County Summary

After subordination of downstream water rights, Coleman County has no water shortages. Although there is no need, conservation is recommended for irrigation users, as well as for municipal users (City of Coleman, Brookesmith SUD, Coleman County SUD, Santa Anna, County-Other). Because of elevated water loss levels reported by the City of Coleman, Water Audits and Leak Repairs are also recommended.

Table 5E- 19
Coleman County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Brookesmith SUD		See Brown County		
Coleman	Lake Coleman, Hords Creek	808	340	Municipal Conservation, Water Audits and Leak Repairs, Subordination
Coleman County SUD		See Brown County		
Santa Anna		See Brown County		
County-Other	Sales from Coleman	17	2	Municipal Conservation, Subordination
Irrigation	Run-of-River, Lake Coleman, Cross Timbers Aquifer	361	361	Irrigation Conservation, Subordination
Livestock	Livestock Local Supplies, Other Aquifer	None	None	None
Manufacturing	Sales from Coleman	1	1	None
Mining	----	----	----	----
Steam Electric	----	----		----

5E.6 Concho County



Concho County is primarily dependent on groundwater supplies from the Hickory, Edwards-Trinity Plateau, Lipan, and other undifferentiated aquifers. The amount of supply available from these sources is shown to be adequate for most users in Concho County. Other sources of water supply in Concho County include run-of-river supplies for irrigators and County-Other users. The City of Eden uses groundwater from the Hickory Aquifer and a small amount of reuse supplies for local golf course. However, the MAG for the Hickory Aquifer in Concho County is severely limited and shows a significant shortage for the City of Eden.

Conservation is recommended for municipal and irrigation users. Conservation is discussed further in Chapter 5B. Millersview-Doole WSC is split between Concho and McCulloch Counties. Further discussion on Millersview-Doole is discussed under McCulloch County.

5E.6.1 City of Eden

The City of Eden has three deep wells in the Hickory Aquifer that functionally provide adequate supplies (over 700 acre-feet per year) for the City's current and projected demands (less than 700 acre-feet per year). However, the MAG in Concho County severely limits the supplies from the Hickory Aquifer to 27 acre-feet per year creating an artificial shortage for regional planning purposes where supplies are not allowed to exceed the MAG. Eden also has reuse supplies, but it is not enough to make up for the MAG shortage. The City of Eden is not planning to pursue any additional strategies since their current wells provide adequate supply for the City. Municipal conservation is the only water management strategy recommended for the City of Eden, leaving an unmet need on paper.

Table 5E- 20
Recommended Water Strategies for the City of Eden

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		664	649	635	621	611	604
Existing Supply (Groundwater, Reuse)		214	214	214	214	214	214
Shortage		450	435	421	407	397	390
Recommended Strategies							
Municipal Conservation	$0	5	5	5	5	5	5
TOTAL		**5**	**5**	**5**	**5**	**5**	**5**

5E.6.2 Concho County Summary

The City of Eden is shown to have an unmet need in Concho County due to artificial MAG limitations on the City's wells. There are no water shortages for any other users in Concho County. Conservation is recommended for irrigation and municipal users in the county, including the City of Eden.

Table 5E- 21
Concho County Summary

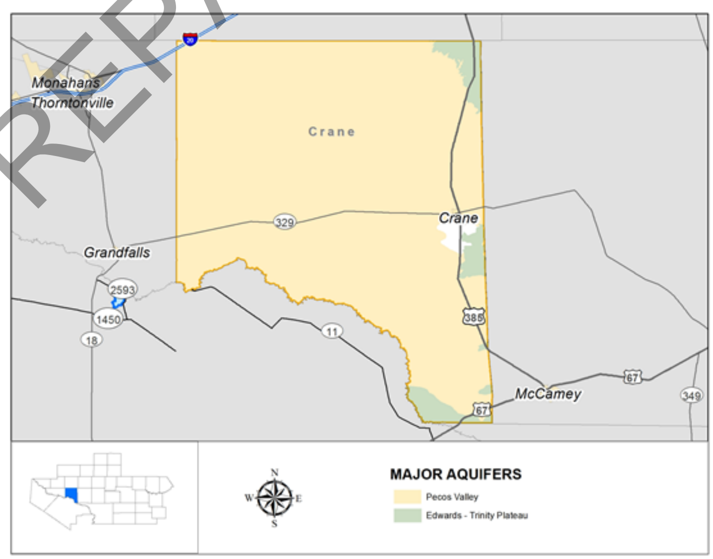
Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
County-Other	Edwards-Trinity Plateau Aquifer, Other Aquifer, Run-of-River	None	None	None
Eden	Hickory Aquifer, Other Aquifers, Reuse	450	390	Municipal Conservation
Millersview-Doole WSC	See McCulloch County			
Irrigation	Run-of-River, Lipan Aquifer, Other Aquifers	None	None	Irrigation Conservation
Livestock	Livestock Local Supplies, Edwards-Trinity Plateau Aquifer, Other Aquifer	None	None	None
Manufacturing	----	----	----	----
Mining	----	----	----	----
Steam Electric	----	----	----	----

Table 5E- 22
Unmet Needs in Concho County
-Values are in Acre Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
City of Eden	445	430	416	402	392	385

5E.7 Crane County

Crane County has limited surface water and groundwater supplies. Some local surface water is used by livestock, but the majority of water within Crane County is supplied from the Pecos Valley and Edwards-Trinity Plateau aquifers. The largest water demand in Crane County is affiliated with the City of Crane and the surrounding rural communities that are classified as County-Other. The City of Crane and County-Other currently obtain water from the Pecos Valley and Edwards-Trinity Plateau aquifers in Crane and Ward counties. In addition, the City of Crane utilizes a small amount of reuse water for golf course irrigation.



Municipal users, livestock, and manufacturing in Crane County were identified to have no water shortages throughout the planning horizon. Municipal and mining conservation (recycling) were identified as viable means of preserving existing supplies and are recommended strategies. These conservation strategies will provide the opportunity to reduce the use of groundwater and local supplies within Crane County and are discussed in more detail in Chapter 5B.

5E.7.1 Crane County Mining

Mining demands in Crane County have historically been met through the use of groundwater and a small amount of sales from Crane and reuse. However, as the needs of other users grow overtime the

MAG for the Edwards-Trintiy-Plateau and Pecos Valley aquifers becomes constraining and there is small need for mining starting in 2050. The mining industry is actively pursuing recycling technologies to help meet its needs. For planning purposes, this is classified as mining conservation and is considered as a recommended strategy, but it is not large enough to meet the entire demand. Conservation is discussed in further detail in Chapter 5B. The modeled available groundwater in Crane County is inadequate to meet the entire demand in later decades and there are few other options to meet the mining shortage. As a result, mining will have an unmet need. Mining is an exempt use, and it is anticipated that mining users will continue to develop groundwater as needed, even if it exceeds the MAG.

Table 5E- 23
Recommended Water Strategies for Crane County Mining

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		3,071	3,279	3,475	3,640	3,194	3,306
Existing Supply (Groundwater, Purchased, Mining Reuse)		3,071	3,279	3,397	3,341	3,179	3,115
Shortage		0	0	78	299	15	191
Recommended Strategies							
Mining Conservation	**$420,000**	21	21	21	21	1	1

5E.7.2 Crane County Summary

The only water shortage identified for water user groups in Crane County was a small amount for mining, some of which cannot be met. Conservation is recommended for irrigation and mining users, as well as municipal users (City of Crane).

Table 5E- 24
Crane County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Crane	Pecos Valley Aquifer, Edwards-Trinity Plateau Aquifer, Reuse	None	None	Municipal Conservation
County-Other	City of Crane	None	None	None
Irrigation	----	----	----	----
Livestock	Pecos Valley Aquifer, Edwards-Trinity Plateau Aquifer, Stock Ponds	None	None	None
Manufacturing	Pecos Valley Aquifer, Edwards-Trinity Plateau Aquifer, Dockum Aquifer	None	None	None
Mining	Pecos Valley Aquifer, Edwards-Trinity Plateau Aquifer, Mining Reuse, Sales from Crane	None	191	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

Table 5E- 25
Unmet Needs in Crane County
-Values are in Acre Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
Mining	0	0	57	278	14	190

5E.8 Crockett County

Almost all of the current water supply in Crockett County is derived from the Edwards-Trinity Plateau aquifer. Mining users in Crockett County are shown to have a shortage in the first four decades of the planning horizon.

5E.8.1 Crockett County Irrigation

Although Crockett County Irrigation shows no shortage, both conservation and weather modification are recommended strategies. Crockett County lies in the West Texas Weather Modification Association program area, where precipitation enhancement is currently active.

Potentially Feasible Water Management Strategies Considered for Crockett County Irrigation:

- Irrigation Conservation
- Weather Modification

Weather Modification

The West Texas Weather Modification Association attributes an annual increase of 0.83 inches of precipitation over Crockett County due to their weather modification efforts in 2022. This strategy assumes that the water savings from precipitation enhancement will be attributed to county irrigation and that irrigation usage occurs predominately during the growing season. Since there are approximately 2,382 irrigated acres in Crockett County, implementation of this strategy is expected to save 167 acre-foot of water per year at a unit cost of $0.64 per acre-foot.

Table 5E- 26
Recommended Water Strategies for Crockett County Irrigation

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		77	77	77	77	77	77
Supply (Groundwater)		77	77	77	77	77	77
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$11,000	4	8	12	12	12	12
Weather Modification	$0	167	167	167	167	167	167
TOTAL	**$11,000**	**171**	**175**	**179**	**179**	**179**	**179**

5E.8.2 Crockett County Mining

Mining demands in Crockett County have historically been met through the use of groundwater. However, in the early decades the MAG availability from the Edwards-Trinity-Plateau, Pecos Valley, and Trinity Aquifers in Crockett County is not adequate to meet the full demand. As the demand declines over time, the groundwater supplies are shown to be sufficient. The mining industry is actively pursuing recycling technologies to help meet its needs. For planning purposes, this is classified as mining conservation and is considered as a recommended strategy, but it is not large enough to meet the entire demand. Conservation is discussed in further detail in Chapter 5B. There are few other options to meet the mining shortage. As a result, mining will have an unmet need. Mining is an exempt use, and it is anticipated that mining users will continue to develop groundwater as needed, even if it exceeds the MAG.

Table 5E- 27
Recommended Water Strategies for Crockett County Mining

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		6,046	6,046	5,542	4,535	3,199	2,015
Existing Supply (Groundwater)		3,771	3,850	3,932	3,990	3,199	2,015
Shortage		2,275	2,196	1,610	545	0	0
Recommended Strategies							
Mining Conservation/Recycling	$8,460,000	423	423	78	63	45	28

5E.8.3 Crockett County Summary

Crockett County shows adequate supplies to meet all users' needs throughout the planning period. Conservation remains recommended for Crockett County WCID #1, Irrigation, and Mining to preserve supplies for future use. Weather modification as part of the West Texas Weather Modification Association is also recommended for irrigators in Crockett County.

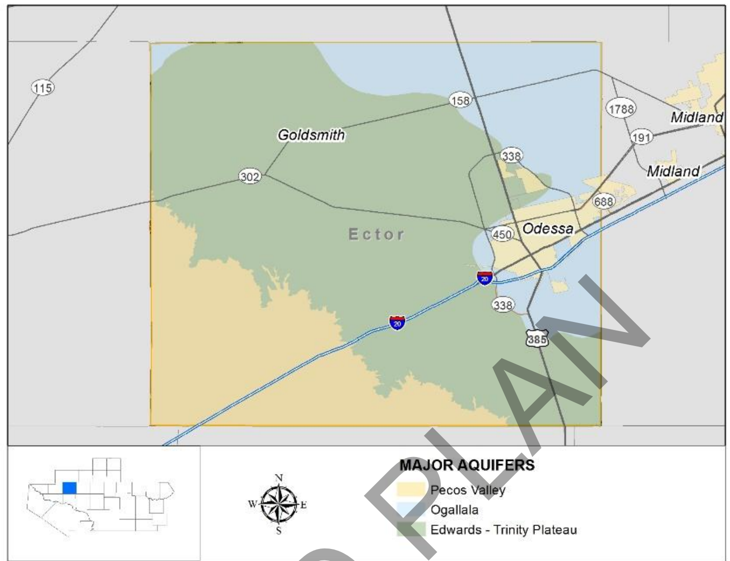
Table 5E- 28
Crockett County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Crockett County WCID #1	Edwards-Trinity Plateau Aquifer	None	None	Municipal Conservation
County-Other	Edwards-Trinity Plateau Aquifer	None	None	None
Irrigation	Edwards-Trinity Plateau Aquifer	None	None	Irrigation Conservation Weather Modification
Livestock	Edwards-Trinity Plateau Aquifer, Livestock Local Supplies	None	None	None
Manufacturing	Sales Crockett County WCID #1	None	None	None
Mining	Edwards-Trinity Plateau Aquifer, Well Field Recycling	None	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

Table 5E- 29
Unmet Needs in Crockett County
-Values are in Acre Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
Mining	1,852	1,773	1,532	482	0	0

5E.9 Ector County



A large portion of the supply and demand in Ector County stems from the City of Odessa. Odessa is a member city of CRMWD and receives all of its supply from their system. Recommended strategies for Odessa include conservation, a new advanced water treatment plant, and subordination of CRMWD's supplies. The City of Odessa is considered a major water provider and is discussed in detail in Chapter 5D. The rest of Ector County is primarily reliant on groundwater from several aquifers, including the Edwards-Trinity Plateau, Pecos Valley, Ogallala, Dockum, and Other aquifers. Shortages in Ector County mostly stem from growth in local municipalities, such as Ector County Utility District (ECUD) and Greater Gardendale Water Supply Corporation (WSC), and from steam electric power generating demands. The remaining water users all show no shortages after subordination.

5E.9.1 Ector County Utility District

The Ector County Utility District (ECUD) receives all of its supplies from the City of Odessa. ECUD has plans to expand their service area and has already received major funding to upgrade and expand their system. Future expansion of ECUD's service is accounted for in regional planning as future sales to the County-Other population they would incorporate. These additional sales are based on a more detailed master plan that ECUD completed in June 2018. The future needs of ECUD were planned for under Odessa as a major provider in Chapter 5D. As a member city of CRMWD, Odessa's needs, including their customers' needs, will be met through additional supplies from CRMWD and their strategies.

5E.9.2 Greater Gardendale WSC

Greater Gardendale WSC is currently reliant on groundwater from the Edwards-Trinity Plateau aquifer and Pecos Valley aquifer. However, this source is not expected to be sustainable at the current withdrawal rate, which will induce shortages after 2030. Consequently, purchasing additional water from the City of Odessa was identified as a recommended strategy for Greater Gardendale WSC to offset the decrease in groundwater supply reliability and to meet growing, future demands. Municipal conservation was also recommended as a strategy for Greater Gardendale WSC. Conservation is discussed further in Chapter 5B.

Potentially Feasible Water Management Strategies Considered for Greater Gardendale WSC:

- Municipal Conservation
- Purchase Water from City of Odessa

Purchase Water from City of Odessa

Greater Gardendale WSC plans to purchase additional water from the City of Odessa in order to compensate for growing water demands and declining groundwater levels. This strategy requires additional infrastructure to connect to Odessa's water distribution system. Details regarding the project for this additional infrastructure are discussed in Appendix C.

Table 5E- 30
Recommended Water Management Strategies for Greater Gardendale WSC

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		393	464	534	586	638	693
Existing Supply (Groundwater, Purchase from Odessa)		393	446	434	424	422	422
Shortage		0	18	100	162	216	271
Recommended Strategies							
Municipal Conservation	$0	15	18	21	23	25	27
Purchase Water from Odessa (CRMWD Supplies)	$16,285,000	0	18	100	162	216	271
TOTAL	**$16,285,000**	**15**	**36**	**121**	**185**	**241**	**298**

5E.9.3 Ector County Steam Electric Power

There are three power plant facilities located in Ector County that use groundwater supplies and supplies from the Great Plains Water System and the City of Odessa. The Invenergy-Ector County Energy Center-Goldsmith Peaking Facility receives its supply from groundwater in the Edwards-Trinity-Plateau and Pecos Valley Aquifers. This facility does not show a shortage during the entire planning period. The Quail Run Energy Center purchases surface water from the City of Odessa. There is a shortage for this facility starting in 2040. However, under subordination, the supplies from Odessa are able to meet the needs for the Quail Run Energy Center. The third facility, Luminant Generation Company LLC, gets its supplies from the Great Plains Water System. The Great Plains Water System has two well fields, one in Gaines County and one in Andrews County. The Andrews County well field has supply limitations due to the MAG that causes a shortage for the Luminant Generation Company LLC beginning in 2030. There are few options to meet this shortage. As a result, steam electric power will have an unmet need due to the shortage from the Luminant power plant. It is anticipated that the Luminant power plant will continue to develop groundwater as needed, even if it exceeds the MAG.

Table 5E- 31
Recommended Water Management Strategies for Steam Electric Power

	Capital Cost (millions)	2030	2040	2050	2060	2070	2080
Demand		7,889	7,889	7,889	7,889	7,889	7,889
Existing Supply (Groundwater, Sales from Great Plains, Sales from Odessa)		7,750	7,620	7,469	7,264	7,133	7,010
Shortage		139	269	420	625	756	879
Recommended Strategies							
Subordination	$0	0	165	420	625	756	879

5E.9.4 Ector County Summary

Ector County has projected shortages of over 20,000 acre-feet by 2080. All of these shortages are associated municipal use from Odessa, ECUD, Greater Gardendale WSC, and steam electric power users. Except for one of the steam electric power users, these can all be met through sales from Odessa, which receives subordinated supplies from CRMWD and other CRMWD system supplies. The steam electric power need is associated with MAG limitations in Andrews and Gaines Counties.

Table 5E- 32
Ector County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Ector County UD	Sales from Odessa	Included in Odessa	Included in Odessa	Municipal Conservation See Odessa
Greater Gardendale WSC	Edwards-Trinity Plateau Aquifer, Sales from Odessa	Included in Odessa	Included in Odessa	Municipal Conservation Purchase Water from Odessa
Odessa	See Major Water Providers Section in Chapter 5D			
County-Other	Edwards-Trinity Plateau Aquifer, Ogallala Aquifer, Dockum Aquifer, sales from Great Plains	None	None	None
Irrigation	Run of River, Edwards-Trinity Plateau Aquifer, Ogallala Aquifer, sales from CRMWD, raw water sales from Odessa	0	188	Irrigation Conservation, Subordination from CRMWD Sales
Livestock	Livestock Local Supplies, Ogallala Aquifer, Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	None
Manufacturing	Raw and Treated Water sales from Odessa, sales from Great Plains Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	Odessa Supplies
Mining	Reuse sales from Odessa, sales from Great Plains, Well Field Recycling, Dockum Aquifer	None	None	Mining Conservation (Recycling)
Steam Electric	Sales from Great Plains (Gaines and Andrews Co.), Sales from Odessa, Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	139	879	Subordination from Odessa Supplies

Table 5E- 33
Unmet Needs in Ector County
-Values are in Acre Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
Ector County - Steam Electric Power	139	104	0	0	0	0

5E.10 Glasscock County

Glasscock County has limited surface water and groundwater supplies. Some local surface water is used by livestock, but nearly all water within Glasscock County is supplied from the Edwards-Trinity Plateau and Ogallala aquifers. Most of the supply from these sources is nearly fully developed for current use. The largest water demand in Glasscock County is for irrigation, with demands at approximately 43,000 acre-feet from 2030 through 2080. Mining use is the second largest water user group, with demands of approximately 13,800 acre-feet in 2030 and 4,600 acre-feet in 2080.

In Glasscock County, groundwater supplies are sufficient to meet demands from all users, so there were no identified water shortages. Irrigation conservation and mining conservation (recycling) were identified as viable means of preserving existing supplies and are recommended strategies. These strategies could potentially reduce demands within Glasscock County and are discussed in more detail in Chapter 5B. Municipal conservation was not recommended for Glasscock County-Other since there was no shortage.

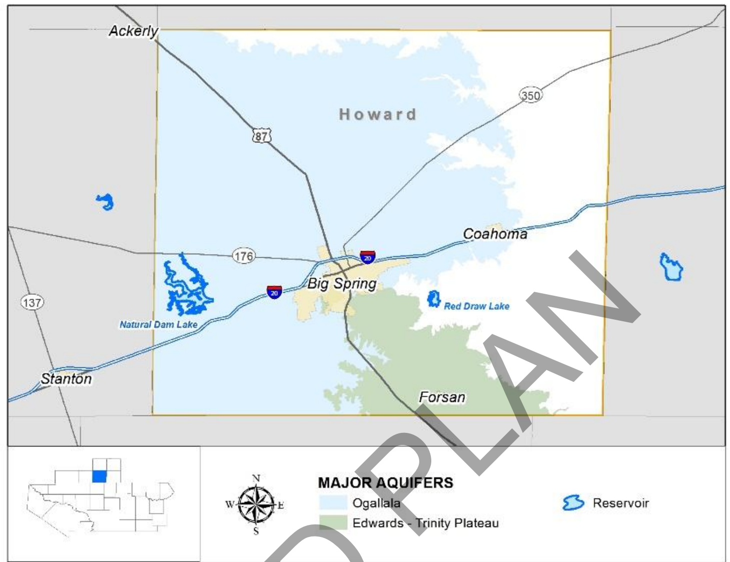
5E.10.1 Glasscock County Summary

No water shortages were identified for any water user groups in Glasscock County. Irrigation and mining conservation are recommended, even though there are no needs.

Table 5E- 34
Glasscock County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
County-Other	Edwards-Trinity Plateau Aquifer	None	None	None
Irrigation	Edwards-Trinity Plateau Aquifer, Ogallala Aquifer	None	None	Irrigation Conservation
Livestock	Stock Ponds, Edwards-Trinity Plateau, Ogallala Aquifer	None	None	None
Manufacturing	Edwards-Trinity Plateau Aquifer	None	None	None
Mining	Edwards-Trinity Plateau Aquifer, Mining Reuse	None	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

5E.11 Howard County



A major source of supply for Howard County is CRMWD's system which supplies Big Spring and its customers: Coahoma, steam electric power, and manufacturing. The shortages for these users can be met through conservation and subordination of CRMWD's supplies. CRMWD is considered a major water provider and is discussed in detail in Chapter 5D. All other water users in Howard County are primarily reliant on groundwater from the Ogallala and Edwards-Trinity High-Plains Aquifer and the Edwards-Trinity Plateau Aquifer. The Dockum Aquifer is also used as a supply by some County-Other, irrigation, livestock, and mining users. However, the Dockum tends to be brackish, limiting the amount and types of use without treatment. Treatment is not economically feasible for many small communities or for agricultural uses.

After considering conservation (municipal, irrigation and mining) and supplies from CRMWD strategies, there is adequate water supply for all users in Howard County. However, a new treatment plant is necessary in Big Spring to treat these raw water supplies to meet current and potential future demands.

5E.11.1 Big Spring

The City of Big Spring is a CRMWD member city. CRMWD supplies one hundred percent of Big Spring and their customers' demand with raw water from their system. The City of Big Spring currently treats and sells water to retail customers within the city limits, Coahoma, steam electric power, and some manufacturing operations in Howard County. The projected needs for Big Spring and their customers can be fully met through conservation and subordination of CRMWD supplies. However, at these projected demand levels, the City will exceed its current water treatment plant capacity by 2030. A new water treatment plant is necessary to make the raw water supplies provided by CRMWD potable for municipal use. This plant will replace the existing facility and provide additional treatment capacity. The recommended strategies for Big Spring include municipal conservation, obtaining the contracted supplies from CRMWD and a new 20 MGD water treatment plant in 2030.

Potentially Feasible Strategies Considered for Big Spring:

- Municipal Conservation
- Subordination (CRMWD supplies)
- New Water Treatment Plant (20 MGD)

Table 5E- 35
Recommended Water Management Strategies for Big Spring

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand (including customers)		9,286	9,460	9,565	9,427	9,275	9,111
Existing Supply (Purchased from CRMWD)		9,286	8,762	7,768	6,802	6,147	5,544
Shortage		0	698	1,797	2,625	3,128	3,567
Recommended Strategies							
Municipal Conservation	$0	118	122	124	121	119	116
*New WTP (20 MGD) **	*$165,625,000*	*0*	*11,210*	*11,210*	*11,210*	*11,210*	*11,210*
Subordination (CRMWD Supplies)	$0	0	698	1,797	2,627	3,130	3,497
TOTAL	**$165,625,000**	**118**	**820**	**1,921**	**2,748**	**3,249**	**3,613**

**This strategy is for infrastructure required to access the subordination supplies and is not included in the total to avoid double counting. The amount shown above is limited to the supply available from the subordination strategy.*

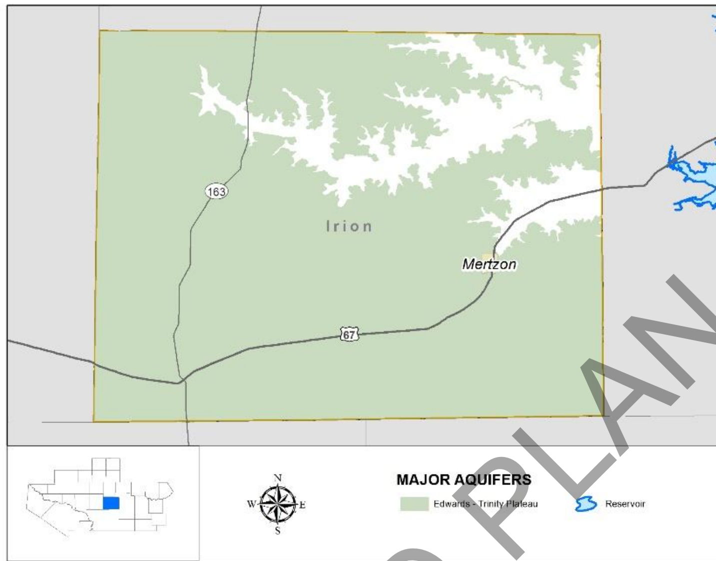
5E.11.2 Howard County Summary

All shortages in Howard County are met after CRMWD strategies. For the CRMWD supplies to be fully utilized, Big Spring will need a new water treatment plant in 2040 to access their subordination supplies. Conservation is also recommended as a strategy for municipal, irrigation, and mining users.

Table 5E- 36
Howard County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Big Spring	Sales from CRMWD	None	3,567	Municipal Conservation Subordination of CRMWD supplies New WTP (20 MGD)
Coahoma	Sales from Big Spring	None	137	Municipal Conservation Supplies from Big Spring
County-Other	Ogallala Aquifer, Dockum Aquifer, Edwards-Trinity Plateau Aquifer	None	None	None
Irrigation	Ogallala Aquifer, Dockum Aquifer, Edwards-Trinity Plateau Aquifer	None	None	Irrigation Conservation
Livestock	Livestock Local Supplies, Ogallala Aquifer, Edwards-Trinity Plateau Aquifer, Dockum Aquifer	None	None	None
Manufacturing	Sales from Big Spring, Ogallala Aquifer, Edwards-Trinity Plateau Aquifer	None	587	Supplies from Big Spring
Mining	Mining reuse, Ogallala Aquifer, Edwards-Trinity-High Plains Aquifer	None	None	Mining Conservation (Recycling)
Steam Electric	Sales from Big Spring, Ogallala Aquifer	None	336	Supplies from Big Spring

5E.12 Irion County



The majority of the water supply for Irion County is derived from the Edwards-Trinity Plateau Aquifer. In addition to this groundwater supply, mining users obtain some water from other aquifers in the county, such as the Dockum and Lipan and reuse some of their supplies. Irrigators also have a small run-of-river supply and livestock has some local supplies. Current sources of supply are shown to be adequate to meet demands for all users throughout the planning horizon, except for irrigation and mining.

5E.12.1 Mertzon

The City of Mertzon obtains most their supplies from the Edwards Trinty Aquifer. The City has is currently drilling two new wells, improving their groundwater treatment plant, and improving their transmission system. All of this work is anticipated to be completed in 2025 and is considered complete for regional planning purposes. While the City's groundwater supplies show to be sufficient, the City is also pursuing water conservation and a water audits and leak repairs program to proactively reduce water losses in their system to preserve their supplies. This includes the replacement of old water lines and water meters.

Table 5E- 37
Recommended Water Management Strategies for Mertzon

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		78	75	75	74	73	72
Existing Supply (Groundwater, Reuse)		78	75	75	74	73	72
Shortage		0	0	0	0	0	0
Recommended Strategies							
Municipal Conservation	$0	2	2	2	2	2	2
Water Audits and Leak Repairs (Line and Meter Replacement)	$754,000	4	4	4	4	4	4
TOTAL	**$754,000**	**6**	**6**	**6**	**6**	**6**	**6**

5E.12.2 Irion County Mining

Mining demands in Irion County have historically been met through the use of groundwater. However, the sharp increase in demands requires the development of additional groundwater supplies. In addition, the mining industry is actively pursuing recycling technologies to help meet its needs. For planning purposes, this is classified as mining conservation and is considered as a recommended strategy. Conservation is discussed in further detail in Chapter 5B. The modeled available groundwater in Irion County is inadequate to meet the entire demand and there are few other options to meet the mining shortage. As a result, mining will have an unmet need. Mining is an exempt use and it is anticipated that mining users will continue to develop groundwater as needed, even if it exceeds the MAG.

Table 5E- 38
Recommended Water Management Strategies for Irion County Mining

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		10,662	10,662	9,774	7,997	5,642	3,554
Existing Supply (Groundwater, Reuse)		4,647	4,656	4,502	4,194	3,785	3,424
Shortage		6,015	6,006	5,272	3,803	1,857	130
Recommended Strategies							
Mining Conservation/Recycling	$12,300,000	615	615	563	92	65	41

5E.12.3 Irion County Irrigation

Irion County Irrigation has an unmet need. This need can be partially alleviated by conservation and weather modification strategies. Irion County lies within the West Texas Weather Modification Association program, where active precipitation enhancement is currently occurring. Both of these strategies are discussed in Chapter 5B.

Potentially Feasible Water Management Strategies Considered for Irion County Irrigation:

- Irrigation Conservation
- Weather Modification

Weather Modification

The West Texas Weather Modification Association attributes an annual increase of 1.76 inches of rainfall over Irion County due to their weather modification efforts in 2022. This strategy assumes that the water savings from precipitation enhancement will be attributed to county irrigation and that irrigation usage occurs predominately during the growing season. Since there are approximately 1,037 irrigated acres in Irion County, implementation of this strategy is expected to save 156 acre-feet of water per year at a unit cost of $0.30 per acre-feet.

Table 5E- 39
Recommended Water Strategies for Irion County Irrigation

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		1,054	1,054	1,054	1,054	1,054	1,054
Existing Supply (Groundwater, Run-of-River Supply)		436	436	436	436	436	436
Shortage		618	618	618	618	618	618
Recommended Strategies							
Irrigation Conservation	$120,000	53	105	158	158	158	158
Weather Modification	$0	156	156	156	1526	156	156
TOTAL	**$120,000**	**209**	**261**	**314**	**314**	**314**	**314**

5E.12.4 Irion County Summary

Needs in Irion County are associated with the mining and irrigation industries. There will be unmet needs for irrigation and mining, even after conservation measures, due to a lack of viable alternatives.

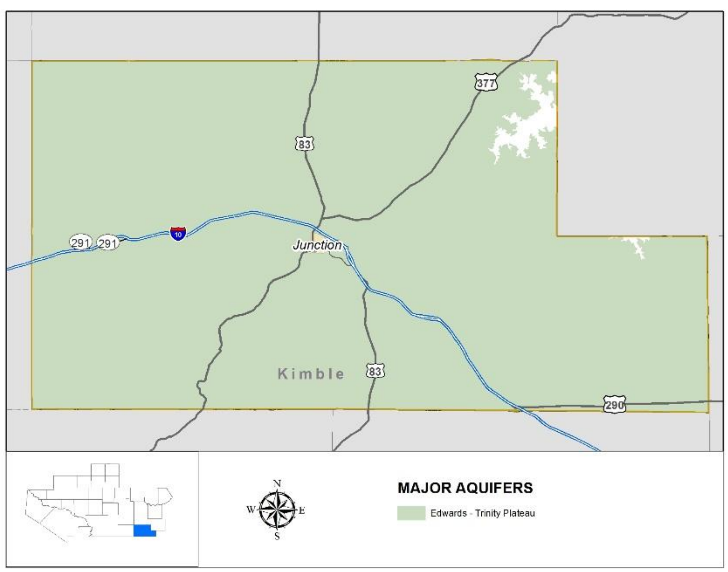
Table 5E- 40
Irion County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Mertzon	Edwards-Trinity Plateau Aquifer	None	None	Municipal Conservation, Water Audits and Leak Repairs (Line and Meter Replacement)
County-Other	Edwards-Trinity Plateau Aquifer	None	None	None
Irrigation	Edwards-Trinity Plateau Aquifer, Run-of-River	618	618	Irrigation Conservation Weather Modification
Livestock	Stock Ponds, Edwards-Trinity Plateau Aquifer	None	None	None
Manufacturing	Edwards-Trinity Plateau Aquifer	None	None	None
Mining	Dockum Aquifer, Lipan Aquifer, Edwards-Trinity Plateau Aquifer, Well Field Recycling	6,015	130	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

Table 5E- 41
Unmet Needs in Irion County
-Values are in Acre Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
Irrigation	409	357	304	304	304	304
Mining	5,693	5,684	5,041	3,775	1,843	123
TOTAL	**6,102**	**6,041**	**5,345**	**4,079**	**2,147**	**427**

5E.13 Kimble County



Kimble County has limited groundwater and surface water supplies. Surface water supplies from the South Llano River are severely limited, even under subordination. Most of the groundwater in Kimble County is derived from the Edwards-Trinity Plateau aquifer. While there is some remaining availability shown for future groundwater development from this source, wells in this area often have low production rates and can be plagued with water quality issues. The majority of Kimble County's shortages are for irrigation and manufacturing. The City of Junction also has a municipal shortage due to limited supplies from their run-of-river right.

5E.13.1 Junction

The City of Junction obtains all of its supply from a run-of-river right on the South Llano River. Under strict priority, this right has no supply. In previous plans, the subordination strategy was enough to meet all of the City's needs. However, the drought has reduced the amount of reliable yield from subordination and other water management strategies must be considered to meet the shortage for the City of Junction. The City is currently undertaking projects to improve their dam and water intake that are anticipated to be completed very soon and considered to be existing for the purposes of regional water planning.

Potentially Feasible Water Management Strategies Considered for Junction:

- Municipal Conservation
- Dredge River Intake to Access Subordination Supplies
- Develop Edwards-Trinity Plateau Aquifer Supplies

Dredge River Intake to Access Subordination Supplies

The City is considering dredging to ensure the ongoing use of their run-of-river supply by removing sedimentation and rocks that have built up over time. This project allows the City of Junction to fully access their subordination supply by increasing the City's storage capacity and improving accessibility to their surface water. This strategy is estimated to cost $10.4 million dollars assuming the dredged material is relatively clean and a suitable location for disposal of the waste material can be found nearby.

Develop Edwards-Trinity Plateau Aquifer Supplies

Water from the Edwards-Trinity Plateau aquifer is not widely used because of low well yields in most areas. Some areas have poor water quality as well. However, there appears to be some areas within the county that have sufficient well yields for supplemental supplies to Junction. This strategy assumes that seven new wells would be drilled to provide approximately 370 acre-feet per year. Water quality from this source is assumed to have elevated salts and would be blended with surface water. However, if it is determined that the water qualities of the two sources are incompatible, the groundwater may require advanced treatment. The capital cost is estimated at $7.2 million. Costs for advanced treatment are not included.

Table 5E- 42
Recommended Water Strategies for Junction

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		523	512	506	505	506	511
Existing Supply (Run-of-River Supply)		0	0	0	0	0	0
Shortage (ac-ft/yr)		523	512	506	505	506	511
Recommended Strategies(ac-ft/yr)							
Municipal Conservation	$0	7	7	7	7	7	7
Water Audits and Leak Repairs	$1,891,000	37	36	36	36	36	36
Subordination (Colorado Run-of-River Supply)	$0	269	269	269	269	269	269
Dredge River Intake*	*$10,439,000*	*0*	*250*	*250*	*250*	*250*	*250*
Develop Edwards-Trinity-Plateau Aquifer Supplies	$7,185,000	0	370	370	370	370	370
TOTAL	**$19,515,000**	**313**	**682**	**682**	**682**	**682**	**682**

**This strategy is for infrastructure required to access the subordination supplies and is not included in the total to avoid double counting.*

5E.13.2 Kimble County Manufacturing

Manufacturing demand in Kimble County is dominated by Grayden Cedarworks. The cedar process plant currently diverts around 500-600 acre-feet per year but can only consume 50 acre-feet per year, per its water right. The quantity of water that can reliably be diverted under subordination was assessed for the Grayden Cedarworks water right. Additional information on subordination can be found in Chapter 5C.

Potentially Feasible Water Management Strategies Considered for Kimble County Manufacturing:

- Subordination
- Develop Ellenburger San Saba Aquifer Supplies

Develop Ellenburger-San Saba Aquifer Supplies

Water from the Ellenburger-San Saba aquifer is not widely used because of low well yields in most areas. Some areas have poor water quality as well. However, there appears to be some areas within the county that have sufficient well yields to meet manufacturing water needs. This strategy assumes that a new well would be drilled to provide approximately 30 acre-feet per year to provide supplies beyond the available surface water in drought of record conditions. The capital costs for this strategy are estimated to be approximately $727,000.

Table 5E- 43
Recommended Water Management Strategies for Kimble County Manufacturing

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		50	50	50	50	50	50
Existing Supply (Groundwater, Run-of-River Supply)		15	15	15	15	15	15
Shortage		35	35	35	35	35	35
Recommended Strategies							
Subordination	$0	8	8	8	8	8	8
Develop Ellenburger-San Saba Aquifer Supplies	$727,000	30	30	30	30	30	30
TOTAL	**$727,000**	**38**	**38**	**38**	**38**	**38**	**38**

5E.13.3 Kimble County Summary

Irrigation accounts for most of the need in Kimble County, with the City of Junction showing a projected need of about 500 acre-feet. The City of Junction has an unmet need in 2030 until additional strategies can be pursued and brought online. Starting in 2040, Junction's needs can be met through conservation, subordination, dredging, and new groundwater. Manufacturing needs can also be met with subordination and new groundwater, but irrigation continues to show a shortage after strategies are implemented.

Table 5E- 44
Kimble County Summary

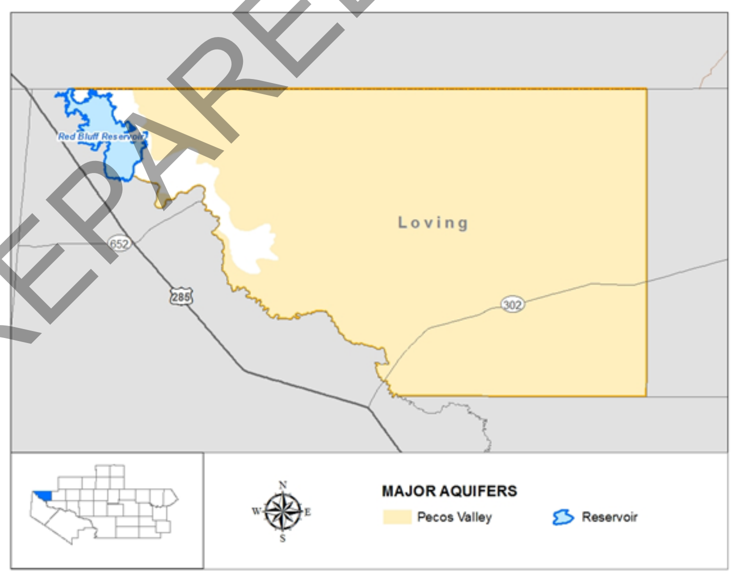
Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Junction	Run-of-River	523	511	Municipal Conservation, Subordination, Develop Edwards-Trinity Aquifer, Dredging
County-Other	Edwards-Trinity Plateau Aquifer	None	None	None

Irrigation	Edwards-Trinity Plateau Aquifer, Hickory Aquifer, Run-of-River	1,258	1,258	Irrigation Conservation
Livestock	Edwards-Trinity Plateau Aquifer, Livestock Local Supplies	None	None	None
Manufacturing	Run-of-River, Edwards-Trinity Plateau Aquifer	35	35	Develop Ellenburger-San Saba Aquifer Supplies, Subordination
Mining	Edwards-Trinity Plateau Aquifer, Run-of-River	None	None	Mining Conservation (Recycling)
Steam Electric	----	----		----

Table 5E- 45
Unmet Needs in Kimble County
-Values are in Acre Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
City of Junction	210	0	0	0	0	0
Irrigation	1,128	998	946	946	946	946
TOTAL	**1,338**	**998**	**946**	**946**	**946**	**946**

5E.14 Loving County



Loving County is solely reliant on local groundwater sources to supply its water users, including the Pecos Valley, Dockum, and Rustler aquifers. Most demands in the county are relatively small (less than 50 ac-ft) and can be met with these supplies. However, mining water demands are about 12,000 acre-feet per year due to oil and gas production.

5E.14.1 Loving County Mining

Due to the limited groundwater supplies available in Loving County, water shortages were identified for mining users throughout the planning horizon. The only recommended strategy in Loving County is conservation/recycling for mining. This strategy is discussed in detail in Chapter 5B. Mining users will still show an unmet need after conservation due to the limited groundwater availability in the county. Since mining is an exempt use, it is likely mining will continue to rely on and develop groundwater, even if it exceeds the MAG.

Table 5E- 46
Recommended Water Management Strategies for Loving County Mining

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		12,002	12,002	12,002	12,002	12,002	12,002
Existing Supply (Groundwater)		5,277	5,278	5,278	5,278	5,279	5,279
Shortage		6,725	6,724	6,724	6,724	6,723	6,723
Recommended Strategies							
Mining Conservation/Recycling	$13,840,000	692	692	692	692	692	692
TOTAL	**$13,840,000**	**692**	**692**	**692**	**692**	**692**	**692**

5E.14.2 Loving County Summary

Mining in Loving County is identified to have a water shortage throughout the planning horizon, particularly in early decades. Mining conservation (well field recycling) is a recommended strategy, however, due to MAG limitations, there are unmet water needs shown for mining users. All other water user groups in Loving County have sufficient water supplies to meet demands and have no shortages.

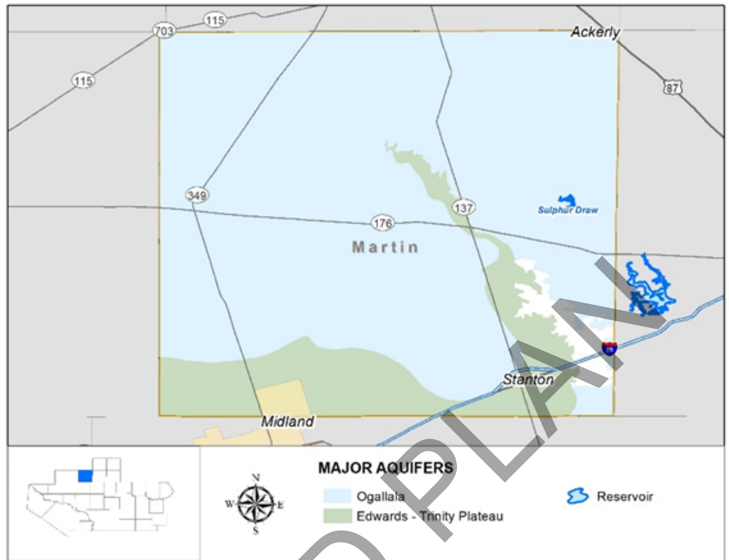
Table 5E- 47
Loving County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
County-Other	Pecos Valley Aquifer	None	None	None
Irrigation	----	----	----	----
Livestock	Livestock Local Supplies, Pecos Valley Aquifer, Dockum Aquifer	None	None	None
Manufacturing	----	----	----	----
Mining	Pecos Valley Aquifer	6,725	6,723	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

Table 5E- 48
Unmet Needs in Loving County
-Values are in Acre Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
Mining	6,033	6,032	6,032	6,032	6,031	6,031

5E.15 Martin County



Martin County has limited surface water and groundwater supplies. Groundwater from the Ogallala aquifer is the primary source for most water users and is increasingly limited by the declining MAG over the planning horizon. Other local groundwater sources include the Dockum and Edwards-Trinity Plateau aquifers, which have diminished water quality and are not currently used in Martin County. Outside of groundwater, Stanton purchases water from CRMWD and mining receives wastewater reuse supplies from Midland.

5E.15.1 Stanton

The City of Stanton's sources of water are groundwater from the Ogallala and Edwards-Trinity-High Plains Aquifers and purchased water from CRMWD. Stanton is shown to have a projected shortage of 51 acre-feet per year in 2030, increasing to 504 acre-feet per year in 2080. The City of Stanton currently has a contract to purchase 307 acre-feet per year of supply from CRMWD. It is recommended that Stanton increase this contract amount and purchase additional water to meet their water supply needs. For purposes of this plan, it is assumed that Stanton's existing infrastructure has the capacity to convey the additional water purchased from CRMWD. The recommended strategies for Stanton are shown in the table below.

Table 5E- 49
Recommended Water Management Strategies for Stanton

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		511	560	621	686	759	843
Existing Supply (Groundwater, CRMWD)		460	438	402	375	356	339
Shortage (ac-ft/yr)		51	122	219	311	403	504
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	8	9	10	11	12	14
Subordination (CRMWD Supplies)	$0	0	22	58	85	104	118
Increase Contract Amount and Purchase from Provider (CRMWD)	$0	43	91	151	215	287	372
TOTAL	**$0**	**51**	**122**	**219**	**311**	**403**	**504**

5E.15.2 Martin County Mining

Martin County Mining has a projected shortage from 2030 to 2080, with a shortage of nearly 1,800 acre-feet per year in 2050. Region F has identified mining conservation (recycling) as recommended strategy. Additional information on conservation strategies is included in Chapter 5B. The remainder of the need is unmet since the groundwater available under the MAG is limited and mining is an exempt use.

However, it is anticipated that the mining industry, as an exempt user, will continue to use groundwater as needed to meet any of their demands.

Table 5E- 50
Recommended Water Strategies for Martin County Mining

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		16,590	16,590	15,208	12,443	8,779	5,530
Existing Supply (Ogallala Aquifer, City of Midland Reuse, Mining Reuse)		16,446	15,262	13,415	10,970	7,995	5,271
Shortage		144	1,328	1,793	1,473	784	259
Recommended Strategies							
Mining Conservation/Recycling	$11,480,000	574	574	526	143	101	64
TOTAL	**$11,480,000**	**574**	**574**	**526**	**143**	**101**	**64**

5E.15.3 Martin County Summary

Martin County has a total projected shortage of about 3,000 acre-feet in 2060 when the MAG is limited and mining demands are still shown to be relatively high. Most of these shortages are associated with the limitations of the supplies from the Ogallala aquifer based on the adopted MAGs. The projected shortage falls to around 200 acre-feet by 2080 as mining demands are shown to reduce.

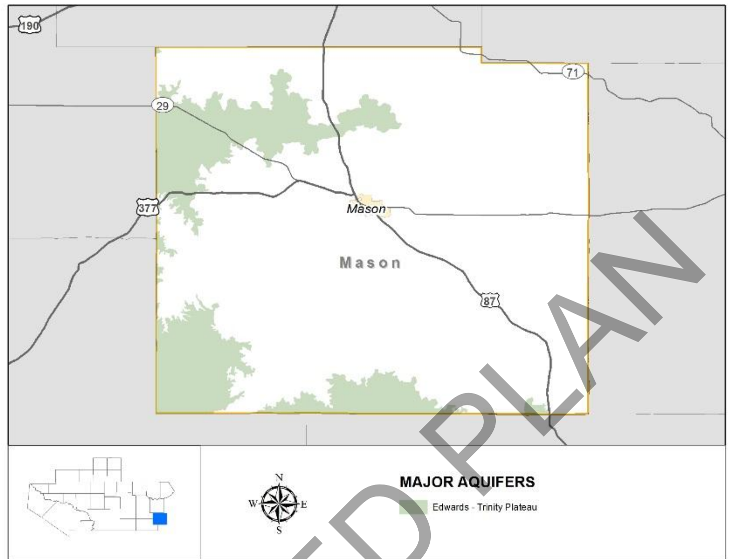
Table 5E- 51
Martin County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Strategies
Stanton	CRMWD supplies, Ogallala Aquifer Edwards-Trinity-High Plains Aquifer	51	504	Municipal Conservation, Subordination, Increase Contract from CRMWD
County-Other	Ogallala Aquifer, Edwards-Trinity-High Plains Aquifer	None	None	None
Irrigation	Ogallala Aquifer, Edwards-Trinity-High Plains Aquifer	437	4,881	Irrigation Conservation
Livestock	Ogallala Aquifer, Edwards-Trinity-High Plains Aquifer, Livestock Local Supplies	None	None	None
Manufacturing	----	----	----	----
Mining	Ogallala Aquifer, Edwards-Trinity-High Plains Aquifer, Mining Reuse, Reuse Sales from City of Midland	144	259	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

Table 5E- 52
Unmet Needs in Martin County
-Values are in Acre-Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
Mining	0	754	1,267	1,330	683	195
Irrigation	0	736	1,136	1,575	892	0

5E.16 Mason County



Mason County is dependent on groundwater supplies from the Hickory, Marble Falls, Ellenburger-San Saba, and undifferentiated Other aquifers. The City of Mason recently implemented a radionuclide reduction system for a portion of their wells and are now shown to have sufficient quantity and quality of water to meet their needs. No other shortages were identified in Mason County. Conservation is recommended for the City of Mason, as well as for irrigation users to preserve water for future and other uses. Conservation is discussed in detail in Chapter 5B. Conservation is not recommended for County-Other since there is no water shortage. Table 5E- 62 shows a summary of supplies, shortages and recommended strategies for Mason County.

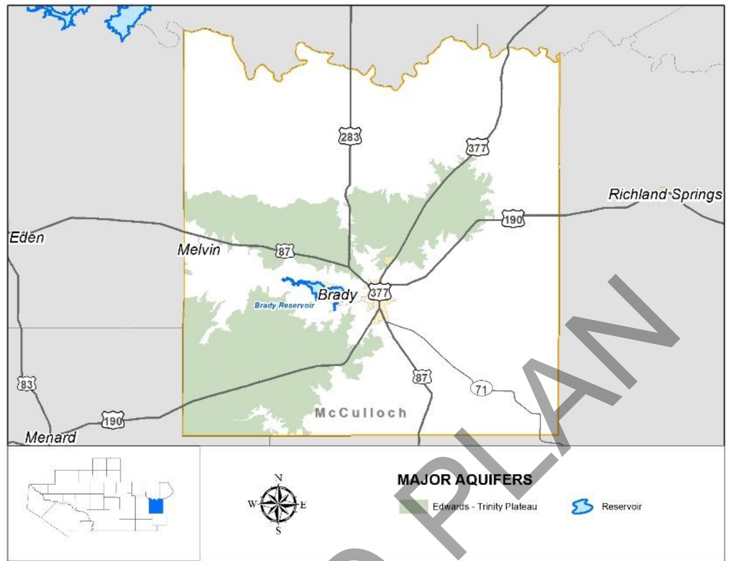
5E.16.1 Mason County Summary

Mason County has no identified shortages, but conservation is still recommended for the City of Mason and irrigation users in Mason County.

Table 5E- 53
Mason County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Mason	Hickory Aquifer	None	None	Municipal Conservation
County-Other	Ellenburger-San Saba Aquifer, Hickory Aquifer, Other Aquifer	None	None	None
Irrigation	Hickory Aquifer	None	None	Irrigation Conservation
Livestock	Livestock Local Supplies, Ellenburger-San Saba Aquifer, Hickory Aquifer	None	None	None
Manufacturing	----	----	----	----
Mining	Hickory Aquifer	None	None	None
Steam Electric	----	----	----	----

5E.17 McCulloch County



McCulloch County has limited surface water and groundwater supplies. Some surface water is available from Lake Brady but is not currently used by the City of Brady. CRMWD surface water supplies Millersview Doole WSC. Water quality from Lake Brady and the Hickory aquifer is impaired and either requires advanced treatment or blending with a high-quality source for municipal use. Groundwater from the Hickory and Ellenburger-San Saba aquifers are the primary sources for other water users. The only shortage identified in McCulloch County is for Millersview-Doole WSC. This shortage will be met with additional water purchased from CRMWD. The City of Brady is also considering some longer-term treatment strategies to increase the resilience of their supplies and restore access to water from Lake Brday. Conservation strategies are also identified for municipal (Brady, Millersview-Doole WSC, Richland SUD) and irrigation users. These strategies are discussed in Chapter 5B.

5E.17.1 Brady

The City of Brady obtains water from groundwater wells in the Hickory aquifer and surface water from Brady Creek Reservoir. The City recently completed a project to treat the groundwater for radium so it can be used without blending and is now using only groundwater supplies.

Historically, however, the City used groundwater conjunctively with their surface water from Brady Creek Reservoir. So, in years when there was sufficient surface water, they may have used little to no groundwater. To address surface water quality concerns, the City constructed one of the first membrane filtration treatment plants in Texas for water from Brady Creek Reservoir in 2000 but it is no longer operational and needs rehabilitation for use. Brady Creek Reservoir has no supplies under WAM Run 3 but subordination does show supplies. While these subordinated supplies may be available in some years, they cannot be accessed without significant improvements to their surface water treatment plant. The recommended strategies for Brady are municipal conservation, subordination and rehabilitation of their surface water treatment plant. Conservation and subordination are discussed in Chapters 5B and 5C respectively.

Potentially Feasible Water Management Strategies Considered for the City of Brady:

- Municipal Conservation
- Subordination (Brady Creek Reservoir)
- Rehabilitate and/or Build New Surface Water Treatment Plant

Rehabilitate and/or Build New Surface Water Treatment Plant

The City of Brady needs to rehabilitate or build a new surface water treatment plant with advanced treatment capabilities including reverse osmosis to access supplies from subordination in Brady Creek reservoir. This project also includes rehabilitation of their existing intake and pump station in Brady Creek reservoir.

Table 5E- 54
Recommended Water Strategies for Brady

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		1,321	1,275	1,229	1,206	1,183	1,160
Supply (Groundwater)		1,321	1,275	1,229	1,206	1,183	1,160
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	17	17	16	16	15	15
Subordination (Brady Creek Reservoir)	$0	0	0	1,770	1,740	1,710	1,680
*Surface Water Treatment for Brady Creek Lake/Reservoir**	*$97,811,000*	*0*	*0*	*1,770*	*1,740*	*1,710*	*1,680*
TOTAL	**$97,811,000**	**17**	**17**	**1,786**	**1,756**	**1,725**	**1,695**

**This strategy is for infrastructure required to access the subordination supplies from Brady Creek Reservoir is not included in the total to avoid double counting.*

5E.17.2 Millersview Doole WSC

Millersview-Doole WSC meets their current water demands with groundwater from the Hickory Aquifer and purchased water from CRMWD. Millersview-Doole WSC is shown to have a projected shortage of 12 acre-feet per year beginning in 2050, increasing to 648 acre-feet per year in 2080. Millersview-Doole WSC currently has a contract to purchase 1,100 acre-feet per year of supply from CRMWD but 500 acre-feet is subsequently contracted to Ballinger, leaving 600 acre-feet per year available for Millersview Doole WSC. It is recommended that Millersview-Doole WSC increase this contract amount and purchase additional water to meet their water supply needs. For purposes of this plan, it is assumed that existing infrastructure has the capacity to convey the additional water purchased from CRMWD. The recommended strategies for Millersview-Doole WSC are shown in the table below.

Table 5E- 55
Recommended Water Strategies for Millersview-Doole WSC

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		1,013	1,138	1,288	1,465	1,675	1,924
Supply (Surface Water, Groundwater)		1,013	1,138	1,166	1,112	1,078	1,046
Shortage (ac-ft/yr)		0	0	122	353	597	878
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	16	18	21	24	27	31
Water Leaks and Audit Repairs	$5,732,000	64	72	81	92	105	121
Subordination (CRMWD Supplies)	$0	0	43	110	164	198	230
Increase Contract Amount and Purchase from Provider (CRMWD)		0	0	0	73	267	496
TOTAL	**$5,732,000**	**80**	**133**	**212**	**353**	**597**	**878**

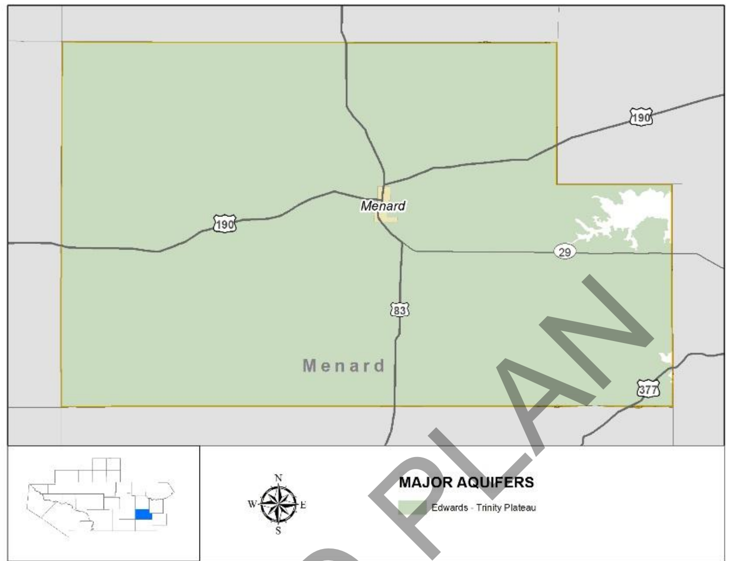
5E.17.3 McCulloch County Summary

McCulloch County has no projected shortages after water management strategies are implemented. Millersview-Doole WSC needs will be met with additional supplies from CRMWD beginning in 2050. The City of Brady has plans to rehabilitate their surface water treatment plant to restore access to their supplies in Brady Creek Reservoir and increase the City's resiliency. Conservation strategies are also recommended for municipal and irrigation users, which will decrease the reliance on current water supplies. These strategies are discussed further in Chapter 5B.

Table 5E- 56
McCulloch County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Strategies
Brady	Hickory Aquifer	None	None	Municipal Conservation, Subordination, Advanced Treatment
Millersview-Doole WSC	CRMWD Supplies, Hickory Aquifer	None	878	Municipal Conservation, Subordination (CRMWD supplies), Purchase Additional Supplies from CRMWD
Richland SUD	Ellenburger-San Saba Aquifer, Marble Falls Aquifer	None	None	Municipal Conservation
Irrigation	Run-of-River, Hickory Aquifer, Marble Falls Aquifer	None	None	Irrigation Conservation
County-Other	Hickory Aquifer, Other Aquifer, Sales from Brady	None	None	None
Livestock	Edwards-Trinity Plateau Aquifer, Ellenburger-San Saba, Hickory Aquifer, Marble Falls Aquifer, Other Aquifer, Local Supplies	None	None	None
Manufacturing	Hickory Aquifer, Edwards-Trinity Plateau Aquifer	None	None	None
Mining	Ellenburger-San Saba Aquifer, Hickory Aquifer	None	None	None
Steam Electric	--	--	--	----

5E.18 Menard County

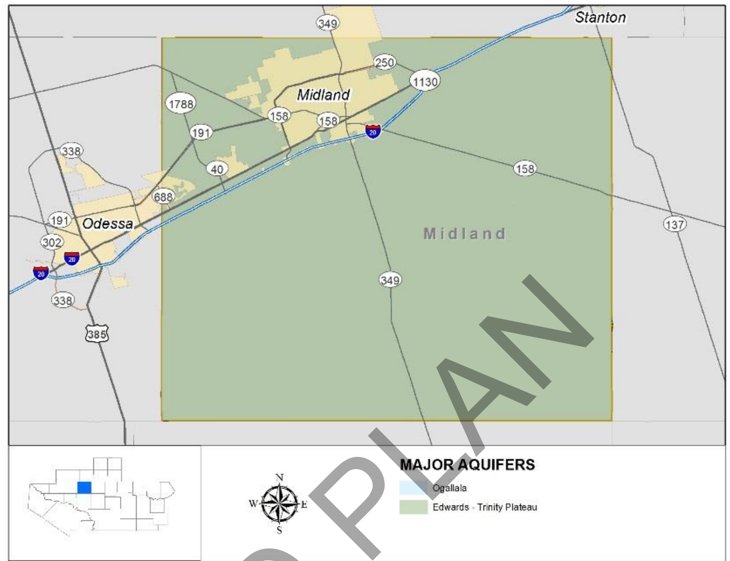


Water users in Menard County obtain their water supplies from the San Saba River and local groundwater, including the Ellenburger-San Saba and Edwards-Trinity Plateau aquifers. The Hickory aquifer also underlies Menard County, but it is not currently used due to the depth of the formation and presence of radionuclides. The ongoing drought has reduced the reliability of the county's surface water supplies, but the County has no shortages after subordination. Conservation is still recommended for the City of Menard despite there being no shortage. County-Other and Livestock show no shortages and have no recommended strategies.

Table 5E- 57
Menard County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Menard	River wells	None	None	Municipal Conservation, Subordination
County-Other	Edwards-Trinity Plateau Aquifer, Ellenburger-San Saba Aquifer, Other Aquifer	None	None	None
Irrigation	Run-of-River, Hickory Aquifer, Edwards-Trinity Plateau Aquifer	None	None	Irrigation Conservation, Subordination
Livestock	Livestock Local Supplies, Edwards-Trinity Plateau Aquifer, Ellenburger-San Saba Aquifer	None	None	None
Manufacturing	----	----	----	----
Mining	----	----	----	----
Steam Electric	----	----	----	----

5E.19 Midland County



Midland County has experienced high population growth in recent years due to the increased interest in oil and gas exploration in the region. Most of the water supply for Midland County comes from sales from the CRMWD system or groundwater. The only shortages in Midland County are associated with the City of Midland. The City of Midland is classified as a major water provider and is discussed in Chapter 5D. While there are no identified needs for County-Other, several local providers are planning new projects to serve the growing rural communities. Greenwood Water Company is also planning to drill new wells in the Ogallala Aquifer. Midland County Utility District (MCUD) is planning to develop a system to serve additional users in the county. Conservation is recommended for municipal, irrigation and mining users, despite there being no shortage for either user. Details on all conservation strategies may be found in Chapter 5B. Livestock and manufacturing show no shortages and have no recommended strategies.

5E.19.1 Midland County-Other

Midland County-Other currently obtains water from local groundwater aquifers, including the Ogallala and Edwards-Trinity Plateau aquifers. The plan assumes that these users will continue to obtain water from these sources to meet the projected demands and Midland County-Other shows no shortage. However, Midland County Utility District (MCUD), which is included in Midland County-Other, is considering developing additional groundwater and advanced treatment to serve growing parts of the county outside of Midland's city limits.

Potentially Feasible Water Management Strategies Considered for Midland County-Other:

- Develop Ogallala Supplies from Midland County with Advanced Treatment

Develop Ogallala Supplies from Midland County with Advanced Treatment (Voluntary Transfer from Irrigation):

MCUD has recently purchased groundwater rights from a private property holder that previously used the water for irrigated agriculture. This strategy will involve drilling several new Ogallala wells for municipal purposes, construction of an advanced water treatment plant, and a brine discharge pipeline to connect to the City of Midland's wastewater treatment facility. This project will likely be implemented in multiple phases over time as the demand develops. For planning purposes, it is conceptually broken into the first phase planned to be online by 2030, which includes 4 wells and a 0.5 MGD WTP. The next phase or phases will include 16 wells and an expansion of the WTP to up to 3 MGD by 2040.

Table 5E- 58
Recommended Strategies for Midland County-Other (MCUD)

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		5,758	6,847	7,715	7,118	6,214	4,934
Supply (Groundwater)		5,758	6,847	7,715	7,118	6,214	4,934
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Develop Ogallala Aquifer Supplies from Midland County with Advanced Treatment (Voluntary Transfer from Irrigation)	$136,737,400	234	1,401	1,401	1,401	1,401	1,401

5E.19.2 Greenwood Water

Greenwood Water receives all of its supply from groundwater, using the Ogallala Aquifer. They currently show no shortages from 2030-2080, but report declining well production. They are pursuing a water management strategy to further expand their groundwater supplies. This new strategy includes drilling 20 new wells to produce 3,226 acre-feet per year from the Ogallala Aquifer. The quality of this water indicates advanced treatment will be needed. Greenwood's existing advanced treatment facility is planned to be used for the supply from the new wells. After treatment losses, this project is anticipated to yield an additional 2,420 acre-feet per year of supply for Greenwood Water. This strategy is expected to come online in 2030 and is considered to be a reliable supply. However, there are MAG limits on the Ogallala Aquifer in Midland County and competition for the supply. Because of the MAG limits, this strategy is considered alternative for the Region F Plan but no groundwater conservation district to enforce these limits. The capital cost of this strategy is $13.9 million, not including the purchase of groundwater rights which is considered complete for the purposes of this plan.

Table 5E- 59
Recommended and Alternative Strategies for Greenwood Water

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		221	216	213	211	209	209
Supply (Groundwater)		221	216	213	211	209	209
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	3	3	3	3	3	3
Alternative Strategies (ac-ft/yr)							
Develop Additional Ogallala Aquifer Supplies	$13,923,000	2,420	2,420	2,420	2,420	2,420	2,420
TOTAL	**$13,923,000**	**2,423**	**2,423**	**2,423**	**2,423**	**2,423**	**2,423**

5E.19.3 Midland County Summary

The total need for Midland County is projected to be around 7,200 acre-feet per year by 2080, which is all associated with the City of Midland. Some of this need will be met with conservation and subordination, but the City of Midland is pursuing multiple other sources of water for development to close the remaining gap. Additional information on the City of Midland and their strategies can be found in Chapter 5D. Greenwood Water has an alternative strategy due to MAG limitations in Midland County for groundwater development. Midland County Utility District (MCUD), which falls under Midland

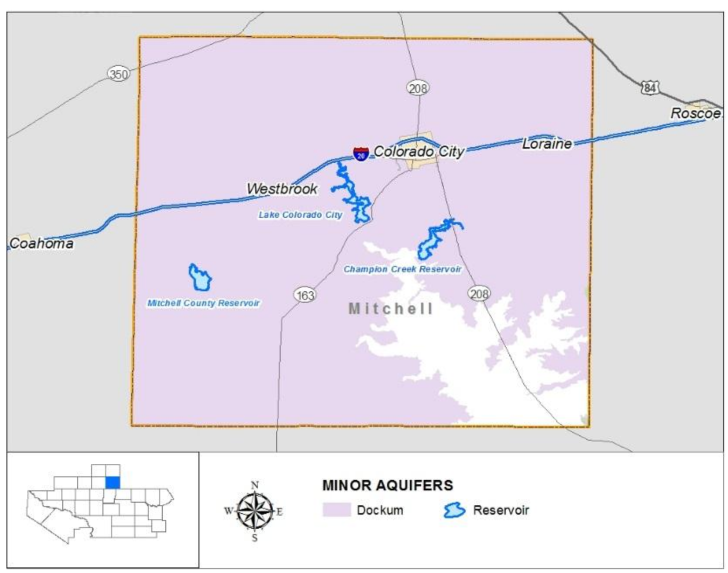
County-Other in this plan, has a recommended strategy to develop groundwater with advanced treatment. This supply is a voluntary transfer from irrigation and is listed as recommended.

Table 5E- 60
Midland County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Airline Mobile Home Park LTD	Edwards-Trinity Plateau, Aquifer, Ogallala Aquifer	None	None	Municipal Conservation
Greenwood Water	Ogallala Aquifer	None	None	Municipal Conservation
Greater Gardendale WSC	See Section 5E.9 for Ector County			
Midland	See Chapter 5D for Major Water Providers			
Odessa	See Chapter 5D for Major Water Providers			
County-Other	Edwards-Trinity Plateau Aquifer, Ogallala Aquifer	None	None	Develop Ogallala Aquifer Supplies from Midland County with Advanced Treatment (Voluntary Transfer from Irrigation)
Irrigation	Edwards-Trinity Plateau Aquifer, Ogallala Aquifer, Sales from Odessa	None	None	Irrigation Conservation, Subordination
Livestock	Livestock Local Supplies, Edwards-Trinity Plateau Aquifer, Ogallala Aquifer	None	None	None
Manufacturing	Sales from Midland, Edwards-Trinity Plateau Aquifer, Ogallala Aquifer, Reuse Sales from Odessa	None	None	None
Mining	Edwards-Trinity Plateau Aquifer, Mining Reuse, Reuse Sales from Midland	None	None	Mining Conservation (Recycling)
Steam Electric	----	----		----

5E.20 Mitchell County

Most of the water users in Mitchell County obtain their water supplies from the Dockum aquifer. The only current surface water supply sources are a small amount of run-of river supplies used for irrigation and the Champion Creek/ Lake Colorado City system, which is used for cooling for a power plant. Mitchell County Reservoir is a brackish lake that is part of the CRMWD diverted water system. Colorado City, irrigation, mining and steam electric power were all identified with a shortage.



5E.20.1 Colorado City

Colorado City supplies their own municipal retail customers, manufacturing, and Westbrook (Mitchell County-Other). Colorado City obtains its water from the Dockum aquifer. The City had 11 active wells with a production capacity of about 2,100 gpm. As water levels decline over time, the capacities also declined. During the last drought, the well field had difficulty in meeting the City's demands. As a result, the City added two wells to increase their system capacities and maintain sufficient supplies during drought. However, one of the new wells produces water high in sulfides and requires blending before use. There are also concerns related to possible oil field contamination. Therefore, Colorado City is planning to pursue additional wells. However, the supply from Dockum in Mitchell County is limited by the MAG. Therefore, the well field expansion strategy is recommended as an alternate strategy until such time that the MAGs increase.

Potentially Feasible Water Management Strategies Considered for Colorado City:

- Municipal Conservation
- Dockum Well Field Expansion

Dockum Well Field Expansion

The total capital cost to develop this strategy amounts to $11.4 million and could potentially yield 170 acre-feet of additional water per year. Total costs include the construction of 2 new wells and the necessary piping infrastructure. It is assumed that the water quality of the new well would be equivalent to the quality of the City's original wells and that no additional treatment will be needed. However, the supply volume of this strategy exceeds the current MAG in the Dockum aquifer. Consequently, this strategy is listed as alternative, rather than recommended, but should be considered for future supplies should the DFC and MAG change in future planning cycles.

Table 5E- 61
Recommended Water Strategies for Colorado City

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		1,657	1,659	1,643	1,659	1,677	1,695
Supply (Groundwater)		1,657	1,659	1,643	1,659	1,677	1,695
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	20	20	20	20	21	21
Water Audits and Leak Repairs	$5,114,000	61	61	60	61	61	62
Alternative Strategies (ac-ft/yr)							
Dockum Well Field Expansion	$11,428,000	170	170	170	170	170	170

5E.20.2 Mitchell County Mining

Mitchell County Mining has a projected shortage from 2030 to 2080, with a shortage of 52 acre-feet per year in 2040. Region F has identified mining conservation (recycling) as recommended strategy. Additional information on conservation strategies is included in Chapter 5B. The remainder of the need is unmet since the groundwater available under the MAG is limited and mining is an exempt use. However, it is anticipated that the mining industry, as an exempt user, will continue to use groundwater as needed to meet any of their demands.

Table 5E- 62
Recommended Water Strategies for Martin County Mining

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		368	368	337	276	195	123
Existing Supply (Dockum Aquifer)		317	316	290	238	169	107
Shortage		51	52	47	38	26	16
Recommended Strategies							
Mining Conservation/Recycling	$300,000	15	15	14	12	8	5
TOTAL	**$300,000**	**15**	**15**	**14**	**12**	**8**	**5**

5E.20.3 Mitchell County Steam Electric Power

Luminant's Morgan Creek Power Plant is located in Mitchell County and obtains water from the Lake Colorado City – Champion Creek Reservoir system, which only has available supply under subordination. There are also two proposed facilities, FGE I and II, that are included in the steam electric power demand in Mitchell County. The proposed facilities would be combined cycle gas turbine plants, which tend to use less water than conventional power generation. However, these facilities are speculative and do not yet exist. The development of these facilities will depend on market conditions and other economic factors, though the facilities have begun the permitting process. If FGE does develop a new power plant in Mitchell County, the source of water supply is unknown as the water supply resources in Mitchell County are limited. In the past, there have been discussions about purchasing wastewater from Colorado City. However, this would be dependent on the power plants coming to fruition and all parties reaching mutually agreeable terms. Because of the uncertainty of the demand and the source of supply, no strategy is recommended. Therefore, a portion of the demand for steam electric power in Mitchell County remains unmet. However, some of this need may never come to fruition if FGE does not move forward with the two new facilities.

5E.20.4 Mitchell County Summary

Mitchell County is projected to have shortages associated with steam electric power, mining and irrigation. Colorado City would like to drill additional wells, though this cannot be fully represented in the regional plan due to MAG limitations. Steam electric power has an unmet need associated with a projected speculative demand for two new CCGT plants that may or may not be developed. Irrigation and mining also have unmet needs despite conservation. County-Other, livestock, and manufacturing show no shortages and have no recommended strategies.

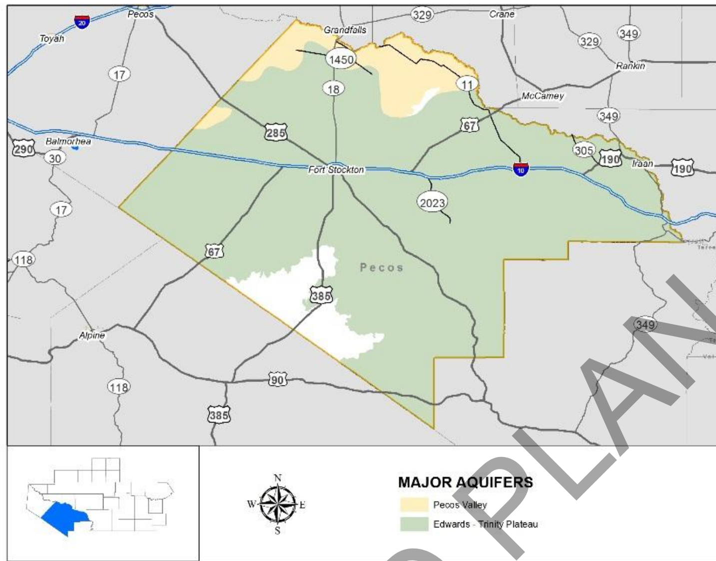
Table 5E- 63
Mitchell County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Colorado City	Dockum Aquifer	None	None	Municipal Conservation, Water Audits and Leak Repairs
Loraine	Dockum Aquifer	None	None	Municipal Conservation
Mitchell County Utility	Dockum Aquifer	None	None	Municipal Conservation
County-Other	Dockum Aquifer, Sales from Colorado City	None	None	None
Irrigation	Run-of-River, Dockum Aquifer	1,812	1,705	Irrigation Conservation
Livestock	Livestock Local Supplies, Dockum Aquifer, Other Aquifer	None	None	None
Manufacturing	Purchase from Colorado City	None	None	None
Mining	Dockum Aquifer	51	16	Mining Conservation (Recycling)
Steam Electric	Champion Lake	6,725	6,725	Subordination

Table 5E- 64
Unmet Needs in Mitchell County
-Values are in Acre-Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
Mining	36	37	33	26	18	11
Irrigation	1,552	1,569	1,559	1,528	1,482	1,445
Steam Electric Power	3,801	3,885	3,969	4,035	4,099	4,165
TOTAL	**5,389**	**5,491**	**5,561**	**5,589**	**5,599**	**5,621**

5E.21 Pecos County



Pecos County relies predominantly on groundwater to meet its water needs. Pecos County is split between two Groundwater Management Areas (GMAs 3 and 7) and therefore, has two modeled available groundwater (MAG) values. Combined, the Edwards-Trinity Plateau and Pecos Valley aquifer system has over 240,000 acre-feet of modeled available groundwater. While the MAG value does not directly correspond to permit limits, the Middle Pecos Groundwater District, which is responsible for managing the aquifer to meet the Desired Future Conditions, has already issued permits in excess of 265,000 acre-feet. Historically, the permit holders have used significantly less than the permitted volume but theoretically could use the entire volume in any given year. There are other districts in Texas who have also permitted larger volumes than the MAG for some aquifers. And similar to Pecos County GCD, the historical pumping in those districts is also less than the MAG. Permits in the Rustler aquifer very slightly exceed the MAG and historical use has been near the permitted amount. The Capitan Reef and Dockum aquifers have both permitted and MAG availability, as shown in the table below.

Table 5E- 65
Modeled Available Groundwater, Permit Authorizations, and Historical Groundwater Use in Pecos Co.

Aquifer	GMA	MAG (acre-feet per year)	Permit Authorizations (ac-ft/yr)	Highest Historical Production (2014-2018) (ac-ft/yr)
Edwards-Trinity Plateau and Pecos Valley Aquifers	3	122,899	146,978	46,567
Edwards-Trinity Plateau and Pecos Valley Aquifers	7	117,309	120,205	71,554
Edwards-Trinity Pecos Valley Subtotal		***240,208***	***267,183***	***118,121***
Capitan Reef	3	4	1,796	564
Capitan Reef	7	26,164	3,347	1,536
Capitan Reef Subtotal		***26,168***	***5,143***	***2,100***
Dockum	3	6,142	0	0
Dockum	7	2,022	0	0
Dockum Subtotal		***8,164***	***0***	***0***
Rustler	3	2,378	2,378	2,378
Rustler	7	7,040	7,291	6,963
Rustler Subtotal		***9,418***	***9,669***	***9,341***

Several water user groups and major water providers in Region F have identified water supplies from Pecos County as an Alternative Water Management Strategy. It may be infeasible to develop all of these strategies, but some subset of them may be considered for implementation if an entity's recommended water management strategies were to become infeasible. However, it is beyond the scope of regional water planning to assess all of the legal, regulatory, and political facets of each Alternative Water Management Strategy.

There are limited surface water supplies within the county, which are used for irrigation purposes. No shortages were identified within the County. In addition, Pecos County WCID #1 expressed interest in developing specific water management strategies to increase the reliability of its supplies by expanding supplies through well conversion for municipal use. Conservation is a recommended strategy for municipal, irrigation and mining use to help preserve the groundwater supplies for future use. Municipal conservation was not specifically recommended for Pecos County-Other because there are no needs.

5E.21.1 Pecos County WCID #1

Pecos County WCID #1 obtains water from the Edwards Trinity Plateau aquifer. Although no shortages were identified, developing additional groundwater supplies is a recommended strategy to increase the reliability of the WCID's current system. Pecos County WCID #1 is actively pursuing the conversion of irrigation wells for municipal wells and the necessary infrastructure to transport and use this water for municipal use.

Potentially Feasible Water Management Strategies Considered for Pecos County WCID #1:

- Develop Edwards-Trinity Plateau Aquifer Supplies

Develop Edwards-Trinity Plateau Aquifer Supplies

Pecos County WCID #1 is in the process of converting two irrigation wells for municipal use. The wells are located in Pecos County and utilize water from the Edwards-Trinity Plateau Aquifer. The implementation of this strategy requires a new 23 mile long 16-inch pipeline, a 45-horsepower pump station, and 0.5 MGD ground storage tank. Pecos County WCID #1 has obtained funding for this project via the United States Department of Agriculture (USDA). They have received a loan and grant for a total of $17 million, which also includes funding for their distribution system. The capital costs estimated for the transmission facilities are $16 million.

Table 5E- 66
Recommended Water Strategies for Pecos County WCID #1

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		384	398	415	433	453	472
Supply (Groundwater)		384	398	415	433	453	472
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	7	7	8	7	7	6
Water Leaks and Audit Repairs	$1,938,000	15	16	17	16	15	13
Develop Edwards-Trinity Plateau Aquifer Supplies	$16,029,000	560	560	560	560	560	560
TOTAL	**$17,967,000**	**582**	**583**	**585**	**583**	**582**	**579**

5E.21.2 Pecos County Irrigation

Although Pecos County Irrigation has no projected shortages, both irrigation conservation and weather modification are recommended as water management strategies. Weather modification is recommended as a strategy because Pecos County lies within the Trans Pecos Weather Modification Association (TPWMA) precipitation enhancement area.

Potentially Feasible Water Management Strategies Considered for Pecos County Irrigation:

- Irrigation Conservation
- Weather Modification

Weather Modification

The TPWMA attributes an annual increase of 1.41 inches over Pecos County due to their weather modification efforts in 2022. This strategy assumes that the water savings from precipitation enhancement will be attributed to county irrigation and that irrigation usage occurs predominately during the growing season. Since there are approximately 15,059 irrigated acres in Pecos County, implementation of this strategy is expected to save 1,807 acre-feet of water per year at a unit cost of $0.38 per acre-foot.

Table 5E- 67
Recommended Water Strategies for Pecos County Irrigation

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		137,672	137,672	137,672	137,672	137,672	137,672
Supply (Groundwater)		137,672	137,672	137,672	137,672	137,672	137,672
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$18,999,000	6,884	13,767	20,651	20,651	20,651	20,651
Weather Modification	$0	1,807	1,807	1,807	1,807	1,807	1,807
TOTAL	**$18,999,000**	**8,691**	**15,574**	**22,458**	**22,458**	**22,458**	**22,458**

5E.21.3 Pecos County Summary

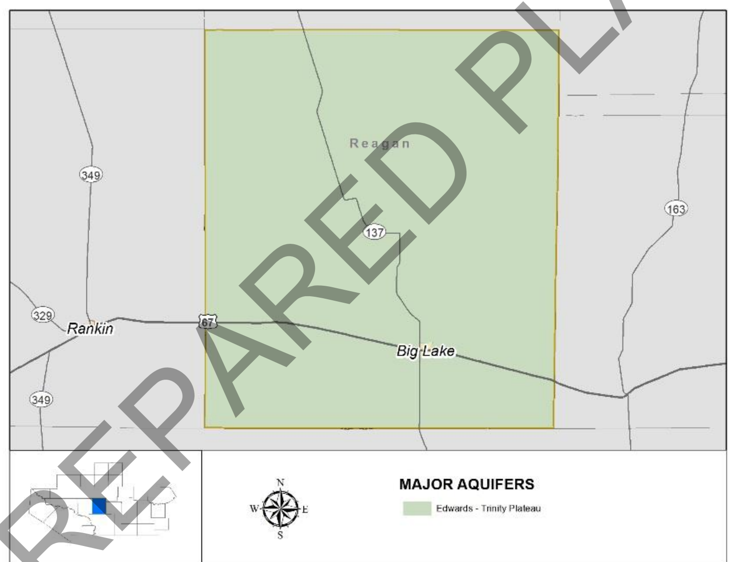
Pecos County is a groundwater rich county, but a considerable amount of the groundwater has diminished water quality. This can limit its viability for some purposes and/or necessitate advanced treatment. No shortages were identified in the county but Pecos County WCID #1 is expanding their water supply sources and has a recommended strategy to develop additional groundwater. Conservation is also considered for municipal (Fort Stockton, Iraan, Pecos County WCID #1), irrigation, and mining users. Conservation is discussed further in Chapter 5B.

Table 5E- 68
Pecos County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Strategies
Fort Stockton	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	Municipal Conservation
Iraan	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	Municipal Conservation
Pecos County WCID #1	Pecos Valley Aquifer, Edwards Trinity Plateau Aquifer, Sales from Fort Stockton	None	None	Municipal Conservation, Water Leaks and Audit Repairs, Develop Edwards Trinity Plateau Aquifer Supplies
Pecos County Fresh Water	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	Municipal Conservation
County-Other	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	None
Irrigation	Red Bluff Reservoir, Run-of-River, Pecos Valley Aquifer, Edwards Trinity Plateau	None	None	Irrigation Conservation Weather Modification

	Aquifer, Capitan Reef Aquifer, Rustler Aquifer, Reuse			
Livestock	Pecos Valley Aquifer, Edwards-Trinity Plateau Aquifer, Capitan Reef Aquifer, Rustler Aquifer, Other Aquifer, Local Livestock Supplies	None	None	None
Manufacturing	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	None
Mining	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer, Mining Reuse	None	None	Mining Conservation (Recycling)
Steam Electric	--	--	----	----

5E.22 Reagan County



Nearly all of the water used in Reagan County is obtained from the Edwards-Trinity Plateau aquifer. Groundwater availability from this aquifer is over 68,000 acre-feet per year. The projected demands in Reagan County are less than 36,000 acre-feet per year in 2030 and are projected to decline to around 25,000 acre-feet per year by 2080. The supply and demand analysis found that Reagan County has no identified water shortages. However, conservation for the City of Big Lake, irrigation, and mining are still recommended as a way to preserve water for future use.

5E.22.1 Reagan County Irrigation

Although Reagan County Irrigation has no projected unmet needs, both irrigation conservation and weather modification are recommended as water management strategies. Weather modification is a recommended strategy because Reagan County lies within the active precipitation enhancement area of the West Texas Weather Modification Association.

Potentially Feasible Water Management Strategies Considered for Reagan County Irrigation:

- Irrigation Conservation
- Weather Modification

Weather Modification

The West Texas Weather Modification Association attributes an annual increase of 0.46 inches over Reagan County due to their weather modification efforts in 2022. This strategy assumes that the water savings from precipitation enhancement will be attributed to county irrigation and that irrigation usage occurs predominately during the growing season. Since there are approximately 6,686 irrigated acres in Reagan County, implementation of this strategy is expected to save 267 acre-feet of water per year at a unit cost of $1.13 per acre-foot.

Table 5E- 69
Recommended Water Strategies for Reagan County Irrigation

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		21,502	21,502	21,502	21,502	21,502	21,502
Supply (Groundwater)		21,502	21,502	21,502	21,502	21,502	21,502
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$2,967,000	1,075	2,150	3,225	3,225	3,225	3,225
Weather Modification	$0	267	267	267	267	267	267
TOTAL	**$2,967,000**	**1,342**	**2,417**	**3,492**	**3,492**	**3,492**	**3,492**

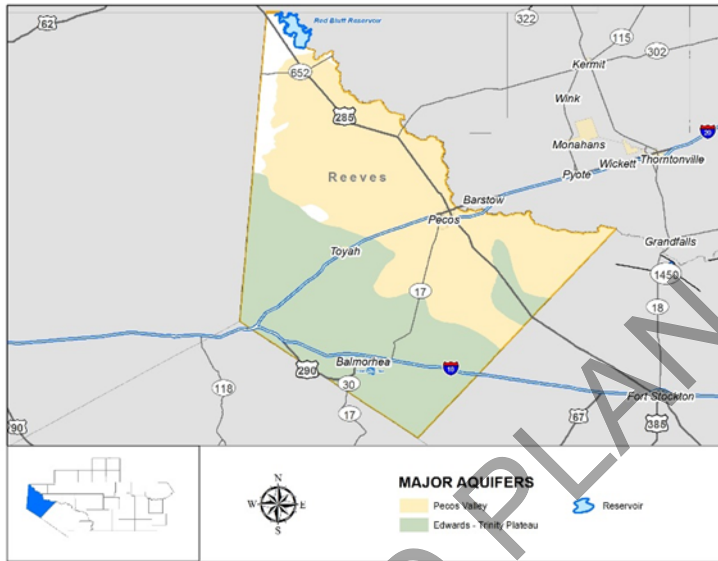
5E.22.2 Reagan County Summary

Reagan County is projected to have no water shortages throughout the planning horizon. However, conservation for municipal (Big Lake), irrigation, and mining users is still recommended as a way to preserve water for future use. In addition, Reagan County lies within the active precipitation enhancement area of the West Texas Weather Modification Association, so weather modification is recommended as a strategy for irrigation users.

Table 5E- 70
Reagan County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Big Lake	Edwards Trinity-Plateau, Pecos Valley, and Trinity Aquifer	None	None	Municipal Conservation
County-Other	Edwards Trinity-Plateau, Pecos Valley, and Trinity Aquifer	None	None	None
Irrigation	Edwards Trinity-Plateau, Pecos Valley, and Trinity Aquifer, Dockum Aquifer	None	None	Irrigation Conservation Weather Modification
Livestock	Edwards Trinity-Plateau, Pecos Valley, and Trinity Aquifer, Local Supply	None	None	None
Manufacturing	----	----	----	----
Mining	Edwards Trinity-Plateau, Pecos Valley, and Trinity Aquifer, Well Field Recycling, Direct Reuse sales from Midland, Mining Reuse	None	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

5E.23 Reeves County



Reeves County relies heavily on groundwater for its water needs. It also uses surface water from Lake Balmorhea and Red Bluff Reservoir for irrigation purposes. Reeves County is another groundwater-rich county in western Region F. There is nearly 200,000 acre-feet per year of groundwater available within the county. However, drought in the Rio Grande Basin, similar to what was experienced in the Colorado Basin, has severely impacted surface water supplies.

Reeves County is in the heart of oil and gas development in West Texas. The county includes portions of the Wolfcamp, Bone Spring, and Wolfbone portions of the Delaware Basin, which are highly prolific, and this area has been the focus of significant oil and gas exploration. Since this formation can be economically produced even when oil prices are lower, exploration is anticipated to remain steady into the future, unlike previous "boom and bust" cycles. As a result, many communities in this county are growing. Shortages were identified for the City of Balmorhea, the Town of Pecos City, and Madera Valley WSC throughout the planning horizon. Recommended strategies to meet these needs include developing additional groundwater supplies. Conservation is also recommended for the municipal, irrigation and mining water users. Livestock and manufacturing users have no recommended strategies.

Water quality, specifically salinity, is a concern throughout the Pecos River Basin. High salinity limits the full use of the Pecos River water resources, including Red Bluff Reservoir.

5E.23.1 Balmorhea

The City of Balmorhea supplies its own municipal users, as well as the City of Toyah (classified under County-Other) and is supplied by groundwater from the Edwards-Trinity Plateau and Pecos Valley Aquifers in Reeves County and Jeff Davis County (Region E). The City also has a small run-of-river water right that provides a small amount of surface water. The currently developed supply from this groundwater source is limited, and therefore, the City is projected to have a shortage of 16 acre-feet per year in 2030 and 109 acre-feet per year in 2080. Municipal conservation and development of additional groundwater supply are recommended strategies that can be implemented to meet the needs in Balmorhea.

Potentially Feasible Water Management Strategies Considered for Balmorhea:

- Municipal Conservation
- Develop Additional Edwards-Trinity Plateau Aquifer Supplies

Develop Edwards-Trinity Plateau Aquifer Supplies

This strategy assumes that one new well will need to be constructed at a 600-ft depth in order to develop the additional groundwater supplies needed in the Edwards-Trinity Plateau aquifer. This well is assumed to be operating at a capacity of 100 gpm. A transmission pipe 6-inches in diameter and 5 miles long is also assumed. This strategy will cost approximately $6.4 million to implement and is estimated to yield an additional 110 acre-feet of water per year. Because this strategy will not be implemented by 2030, Balmorhea has an unmet need in 2030.

Table 5E- 71
Recommended Water Strategies for Balmorhea

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		204	227	250	264	279	297
Supply (Groundwater)		188	188	188	188	188	188
Shortage (ac-ft/yr)		16	39	62	76	91	109
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	1	1	1	2	2	2
Develop Edwards-Trinity Plateau Aquifer Supplies	$6,413,000	0	110	110	110	110	110
TOTAL	**$6,413,000**	**1**	**111**	**111**	**112**	**112**	**112**

5E.23.2 Pecos City

Pecos City is the largest city in Reeves County. In addition to providing water to its own retail customer base, Pecos City also supplies Barstow. Pecos City has three existing well fields: South Worsham, North Worsham, and Ward County Well Field. Water from the North Worsham has elevated levels of TDS and chlorides and must be blended at no more than 5 percent of the total supply.

Due to increased interest in oil and gas exploration in the surrounding area, Pecos City has recently experienced rapid population growth. As a result, the City is pursuing several additional water management strategies that are examined as part of the Region F plan. Potentially Feasible Water Management Strategies Considered for Pecos City:

- Municipal Conservation
- Advanced Water Treatment
- Expand Well Field
- Direct Non-potable Reuse
- Direct Potable Reuse
- Indirect Potable Reuse with ASR

Advanced Groundwater Water Treatment

Poor water quality in the City's existing North Worsham well field severely limits its use. Currently it can only be blended at up to 5 percent of the total supply. This strategy is to develop an 8 MGD advanced treatment plant which will treat blended supplies from all three city well fields. This strategy provides additional water supplies by increasing the usable supply from the North Worsham well field. Costs are estimated at $91.7 million.

Expand Pecos Valley Aquifer Supplies

The Madera Valley WSC had an existing well field and 10-inch transmission line that is now under Pecos City's control via a Certificate of Convenience and Necessity (CCN) transfer. Pecos City is planning to expand the well field yield for an additional 6-8 MGD of average annual supply. The project also includes a 24-inch transmission line for Pecos City to connect to the expanded well field. The total cost for this strategy is estimated at $69.4 million.

Direct Non-Potable Reuse

Pecos City has plans to develop a purple pipe system to supply reuse supplies to irrigation. This would provide peak supplies of 1 MGD or about 560 ac-ft/yr. Costs for this strategy are estimated to be $18 million.

Direct Potable Reuse

Pecos City is considering a direct potable reuse project that would be triggered if the population and demand continues to grow rapidly. The size and timing of this strategy may change. For planning purposes, a 2.2 MGD Advanced Treatment Facility was assumed. Concentrate was assumed to be disposed of in a local stream. If a suitable discharge location cannot be found, injection wells may be needed, which will increase the cost estimated for this project. Cost is estimated at $41.4 million.

Table 5E- 72
Recommended Water Strategies for Pecos City

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand (Includes Sales to Barstow)		3,997	4,491	4,962	5,277	5,622	5,999
Supply (Groundwater)		2,671	2,671	2,671	2,671	2,671	2,671
Shortage (ac-ft/yr)		1,326	1,820	2,291	2,606	2,951	3,328
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	30	34	38	40	43	46
Advanced Groundwater Treatment	$91,236,000	0	3,360	3,360	3,360	3,360	3,360
Expand Pecos Valley Aquifer Supplies	$69,404,000	0	8,960	8,960	8,960	8,960	8,960
Direct Non-Potable Reuse	$17,953,000	0	560	560	560	560	560
Direct Potable Reuse	$41,357,000	0	925	925	925	925	925
TOTAL	**$219,950,000**	**30**	**13,839**	**13,843**	**13,845**	**13,848**	**13,851**

Pecos City is pursuing multiple options for future water supplies but will likely not have any of the recommended water management strategies online by 2030 and therefore shows an unmet need in 2030.

Alternative Water Management Strategies for Pecos City:

- Indirect Potable Reuse with ASR. ASR is a future option for Pecos City if rapid population growth continues and it is needed. However, at this time, there are most cost-effective options available to meet the City's needs and thus, ASR is not ultimately recommended.

5E.23.3 Madera Valley WSC

Madera Valley WSC is supplied by groundwater from the Edwards-Trinity-Plateau Aquifer. Madera Valley WSC recently transferred a portion of their CCN to the City of Pecos. Madera Valley has recently drilled three new wells, two of which collapsed, and one did not provide a substantial enough yield to be considered a productive well. This entity is currently looking into other potential sources of water and is considering drilling additional wells in Reeves County.

Municipal conservation and development of additional groundwater supply are recommended strategies that can be implemented to meet the needs of Madera Valley WSC.

Potentially Feasible Water Management Strategies Considered for Madera Valley WSC:

- Municipal Conservation
- Develop Additional Edwards-Trinity Plateau Aquifer Supplies

Develop Edwards-Trinity Plateau Aquifer Supplies

This strategy assumes that four new wells will be constructed at a 600-ft depth to develop the additional groundwater supplies needed in the Edwards-Trinity Plateau aquifer. These wells are assumed to be operating at a capacity of 100 gpm. A transmission pipe 8-inches in diameter and ten miles long is also assumed. This strategy will cost approximately $15.5 million to implement and is estimated to yield an additional 333 acre-feet of water per year beginning in 2040. Because this strategy will not be implemented until 2040, Madera Valley WSC has an unmet need in 2030.

Table 5E- 73
Recommended Water Strategies for Madera Valley WSC

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		832	910	984	1,038	1,096	1,160
Supply (Groundwater)		819	819	819	819	819	819
Shortage (ac-ft/yr)		13	91	165	219	277	341
Municipal Conservation	$0	6	6	7	7	8	8
Develop Edwards-Trinity-Plateau Aquifer Supplies	$15,482,000	0	333	333	333	333	333
TOTAL	**$15,482,000**	**6**	**339**	**340**	**340**	**341**	**341**

5E.23.4 Reeves County Irrigation

Although Reeves County Irrigation has no projected unmet needs, both irrigation conservation and weather modification are recommended as water management strategies. Weather modification is a recommended strategy because Reeves County lies within the active precipitation enhancement area of the Trans Pecos Weather Modification Association (TPWMA).

Potentially Feasible Water Management Strategies Considered for Reeves County Irrigation:

- Irrigation Conservation
- Weather Modification

Weather Modification

The TPWMA attributes an annual increase of 1.31 inches over Reeves County due to their weather modification efforts in 2022. This strategy assumes that the water savings from precipitation enhancement will be attributed to county irrigation and that irrigation usage occurs predominately during the growing season. Since there are approximately 19,783 irrigated acres in Reeves County, implementation of this strategy is expected to save 2,176 acre-feet of water per year at a unit cost of $0.41 per acre-foot.

Table 5E- 74
Recommended Water Strategies for Reeves County Irrigation

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		60,025	60,025	60,025	60,025	60,025	60,025
Supply (Surface Water, Groundwater)		60,025	60,025	60,025	60,025	60,025	60,025
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$8,284,000	3,001	6,003	9,004	9,004	9,004	9,004
Weather Modification	$0	2,176	2,176	2,176	2,176	2,176	2,176
TOTAL	**$8,284,000**	**5,177**	**8,179**	**11,180**	**11,180**	**11,180**	**11,180**

5E.23.5 Reeves County Summary

Water shortages in Reeves County are identified for the City of Balmorhea, Pecos City, and Madera Valley WSC. Recommended strategies to meet these needs involve developing additional groundwater supplies. Pecos City has several new strategies including groundwater development, advanced treatment, and reuse (potable and non-potable). Additionally, conservation is recommended for municipal (City of Balmorhea, Madera Valley WSC, Pecos City), irrigation, and mining users. Municipal conservation was not considered for County-Other because there was no need. Conservation is discussed in further detail in Chapter 5B.

Table 5E- 75
Reeves County Summary

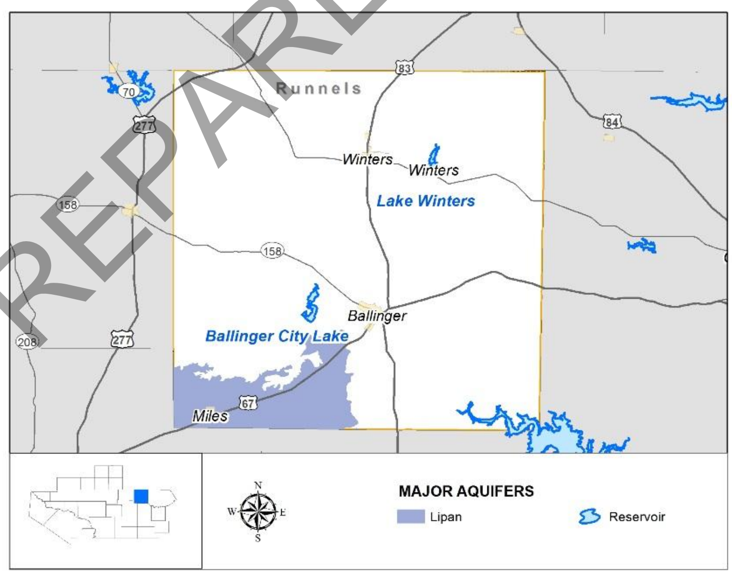
Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Balmorhea	Edwards Trinity Plateau Aquifer, Pecos Valley Aquifer (Jeff Davis and Reeves Counties, Region E), Run-of-River	16	109	Municipal Conservation, Develop Edwards-Trinity Plateau Aquifer Supplies
Madera Valley WSC	Edwards-Trinity Plateau Aquifer, Pecos Velley Aquifers	13	341	Municipal Conservation, Develop Edwards-Trinity-Plateau Aquifer Supplies
Pecos City	Dockum Aquifer, Edwards-Trinity Plateau Aquifer and Pecos Valley Aquifers (Ward County)	1,326	3,328	Municipal Conservation, Advanced Water Treatment, Expand Pecos Valley Aquifer Supplies, Direct Non-Potable Reuse, Direct Potable Reuse
County-Other	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifers, Sales from Balmorhea	None	None	Municipal Conservation
Irrigation	Lake Balmorhea, Red Bluff, Run-of-River, Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer, Rustler Aquifer, Igneous Aquifer	None	None	Irrigation Conservation Weather Modification

Livestock	Local Supplies, Rustler Aquifer, Dockum Aquifer, Igneous Aquifer, Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	None
Manufacturing	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	None
Mining	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer, Mining Reuse	None	None	Mining Conservation (Recycling)
Steam Electric	----	----		----

Table 5E- 76
Unmet Water Needs in Reeves County

Water User Group	2030	2040	2050	2060	2070	2080
Balmorhea	15	0	0	0	0	0
Madera Valley WSC	7	0	0	0	0	0
Pecos City	1,296	0	0	0	0	0
Total	**1,317**	**0**	**0**	**0**	**0**	**0**

5E.24 Runnels County



Water demands in Runnels County are met through in-county groundwater sources, surface water from local lakes and sales from CRMWD and UCRA. Ballinger and Runnels County-Other show no shortages after subordination of Lake Ballinger, Moonen Lake, and Lake Ivie (accessed through contract with Millersview Doole WSC, Abilene, and CRMWD). In previous rounds, Ballinger has considered additional supplies to expand their water portfolio including connecting to Lake Fort Phantom Hill. At this time, the City is not planning to move forward with this strategy, but it may be considered in the future. The largest shortage in Runnels County is associated with the City of Winters. The City of Miles and North Runnels WSC also are identified with shortages during the planning horizon. The options to meet the projected shortages in Runnels County are limited. Nearly all of the available groundwater within the county is allocated to current users. Local surface water lakes are small and susceptible to drought.

5E.24.1 Miles

The City of Miles has a contract with UCRA for water from O.C. Fisher. The water is treated by San Angelo and delivered through UCRA's northeast water supply line. The contract with UCRA expires in 2031, but it is expected to be renewed. UCRA is planning to fully meet Miles' water demands; thus, when considering supplies from UCRA's water management strategies, there are no identified shortages for Miles. The recommended strategies for Miles are conservation, subordination of UCRA's water supplies, and additional supplies from UCRA strategies. Additional information on UCRA strategies can be found in Section 5E.29 Tom Green County.

Table 5E- 77
Recommended Water Strategies for Miles

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		94	96	100	104	108	114
Supply (Groundwater, Purchased from UCRA)		104	109	108	105	102	100
Shortage (ac-ft/yr)		0	0	0	0	6	14
Recommended Strategies (ac-ft/yr)							
Municipal Conservation		3	3	3	3	3	3
Subordination (UCRA)	$0	21	9	8	10	7	8
Supplies from UCRA Strategies	$0	0	0	0	0	0	3
TOTAL	**$0**	**24**	**12**	**11**	**13**	**10**	**14**

5E.24.2 North Runnels WSC

North Runnels Water Supply Corporation (WSC) purchases water from the City of Winters and has an emergency connection with the City of Ballinger. Before subordination, North Runnels WSC is projected to have a shortage of just over 300 acre-feet per year by 2080. When considering conservation and subordination, this shortage decreases to around 160 acre-feet per year in 2080. The recommended strategies for North Runnels WSC include municipal conservation, subordination of Winters and Ballinger's supplies. North Runnels WSC plans to continue purchasing their supplies from the City of Winters. However, the City of Winters supplies are not shown to be adequate during a repeat of the drought of record and therefore, both Winters and North Runnels WSC have a need. The City of Winters is not planning to develop any strategies at this time so there is an unmet need shown. There is no new infrastructure needed for North Runnels WSC to continue receiving supplies from Winters, provided that Winters has adequate supplies to deliver.

Table 5E- 78
Recommended Water Strategies for North Runnels WSC

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		227	241	256	273	292	314
Supply (Purchased from Winters, Ballinger)		0	0	0	0	0	0
Shortage (ac-ft/yr)		227	241	256	273	292	314
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	4	4	4	5	5	5
Water Audits and Leak Repairs	$1,393,000	7	7	7	8	8	8
Subordination (Purchased from City of Winters, Ballinger)	$0	103	109	117	124	132	142
TOTAL	**$1,393,000**	**114**	**120**	**128**	**137**	**145**	**155**

5E.24.3 Winters

The City of Winters' source of water is Lake Winters. This lake was significantly impacted from the last major drought and the reliable supply is estimated at around 250 acre-feet per year with subordination. Winters provides water to its residents and to North Runnels WSC. Considering the City's current customers, Winters is shown to have a projected shortage of 314 acre-feet per year in 2030. To meet this need, Winters could purchase water from another provider, such as Ballinger, Abilene, or CRMWD. The pipeline from Lake Ivie to Abilene runs near Lake Winters, which could provide water from Lake Ivie. Another option would be to construct a new 15-mile pipeline from Ballinger to Winters. These options would be expensive for a small quantity of water. Groundwater options are limited within the County and likely not viable. The City of Winters has no concrete plans to develop additional water supplies and so an unmet need is shown after water conservation and subordination.

Potentially Feasible Water Management Strategies Considered for Winters:

- Municipal Conservation
- Subordination

Table 5E- 79
Recommended Water Strategies for Winters

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand (includes sales to N. Runnels WSC)		586	583	577	576	575	572
Supply (Winters Lake)		0	0	0	0	0	0
Shortage (ac-ft/yr)		586	583	577	576	575	572
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	7	7	7	6	6	5
Water Audits and Leak Repairs	$1,792,000	16	15	14	13	12	11
Subordination (Winters Lake)	$0	265	264	263	261	260	258
TOTAL	**$1,792,000**	**288**	**286**	**284**	**280**	**278**	**274**

5E.24.4 Runnels County Summary

Runnels County has limited options for meeting their water supply needs. Groundwater supplies are extremely limited and surface water supplies are susceptible to drought. Even after subordination and conservation, some municipal entities including Winters and North Runnels WSC (supplied by Winters) have unmet needs. The City of Winters has previously considered purchasing from another provider but currently does not intend to move forward with any of those potential strategies.

Table 5E- 80
Runnels County Summary

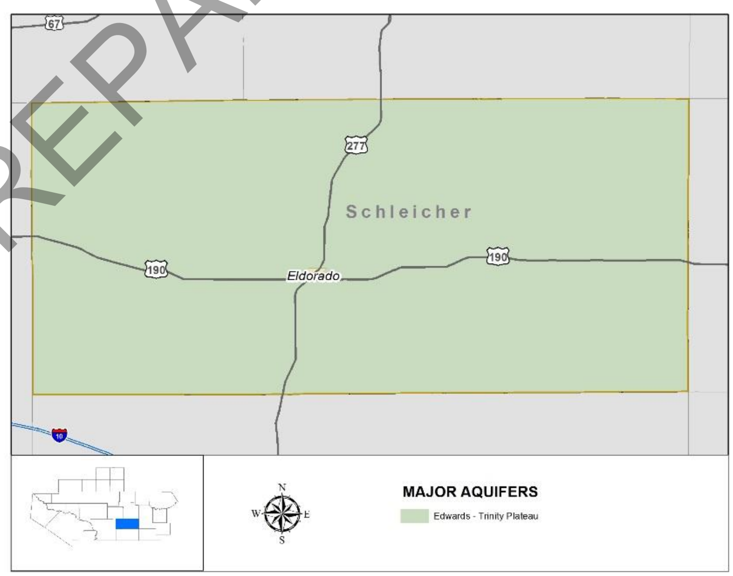
Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Ballinger	Sales from Millersview-Doole (CRMWD Supplies), Ballinger/Moonen Lake	393	553	Municipal Conservation, Subordination
Coleman County SUD	See Coleman County			
Miles	Sales from UCRA, Lipan Aquifer	None	14	Municipal Conservation, Subordination, Supplies from UCRA strategies
Millersview-Doole WSC	See McCulloch County			
North Runnels WSC	Sales from Winters	Included in Winters shortage	Included in Winters shortage	Municipal Conservation, Subordination

Winters	Winters Lake	395	367	Municipal Conservation, Subordination
County-Other	Sales from Ballinger, Other Aquifer	Included in Ballinger shortage	Included in Ballinger shortage	Municipal Conservation, Subordination
Irrigation	Reuse sales from Winters, Other Aquifer, Run-of-River	None	None	Irrigation Conservation
Livestock	Livestock Local Supplies, Other Aquifer, Lipan Aquifer	None	None	None
Manufacturing	Sales from Ballinger	None	None	None
Mining	----	----	----	----
Steam Electric	----	----	----	----

Table 5E- 81
Unmet Needs in Runnels County
-Values are in Acre-Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
North Runnels WSC	113	121	128	136	147	159
Winters	298	297	293	296	297	298
TOTAL	**411**	**418**	**421**	**432**	**444**	**457**

5E.25 Schleicher County



Schleicher County obtains all of its water from the Edwards-Trinity Plateau aquifer. Total demands for the county are less than 6,500 acre-feet per year in 2030 declining to less than 4,000 acre-feet by 2080. There are sufficient groundwater supplies in Schleicher County and the county is shown to have no shortages over the planning period. Conservation is still recommended for the City of Eldorado, Irrigation, and Mining.

5E.25.1 Schleicher County Irrigation

Although Schleicher County Irrigation has no projected unmet needs, both irrigation conservation and weather modification are recommended as water management strategies. Weather modification is a recommended strategy because Schleicher County is located within the active precipitation enhancement area of the West Texas Weather Modification Association.

Potentially Feasible Water Management Strategies Considered for Schleicher County Irrigation:

- Irrigation Conservation
- Weather Modification

Weather Modification

The West Texas Weather Modification Association attributes an annual increase of 1.47 inches over Schleicher County due to their weather modification efforts in 2022. This strategy assumes that the water savings from precipitation enhancement will be attributed to county irrigation and that irrigation usage occurs predominately during the growing season. Since there are approximately 5,720 irrigated acres in Schleicher County, implementation of this strategy is expected to save 686 acre-feet of water per year at a unit cost of $0.38 per acre-foot.

Table 5E- 82
Recommended Water Strategies for Schleicher County Irrigation

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		2,015	2,015	2,015	2,015	2,015	2,015
Supply (Groundwater)		2,015	2,015	2,015	2,015	2,015	2,015
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$111,000	101	121	121	121	121	121
Weather Modification	$0	686	686	686	686	686	686
TOTAL	**$111,000**	**787**	**807**	**807**	**807**	**807**	**807**

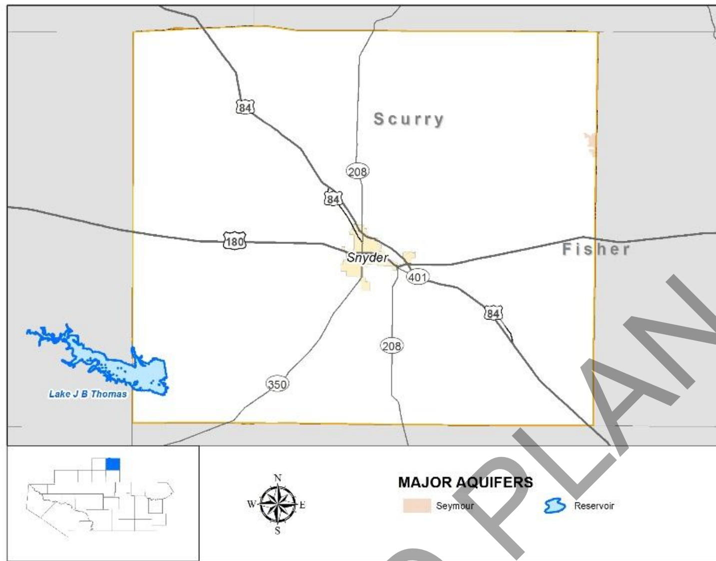
5E.25.2 Schleicher County Summary

There are no shortages over the planning horizon in Schleicher County. Municipal, irrigation, and mining conservation are all recommended to preserve water supplies for future user. Weather modification is also recommended for irrigators as part of the active West Texas Weather Modification Association program.

Table 5E- 83
Schleicher County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Eldorado	Edwards-Trinity Plateau Aquifer	None	None	Municipal Conservation, Water Audits and Leak Repairs
County-Other	Edwards-Trinity Plateau Aquifer	None	None	None
Irrigation	Edwards-Trinity Plateau Aquifer	None	None	Irrigation Conservation Weather Modification
Livestock	Livestock Local Supplies, Edwards-Trinity Plateau Aquifer	None	None	None
Manufacturing	----	----	----	----
Mining	Edwards-Trinity Plateau Aquifer, Mining Reuse	None	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

5E.26 Scurry County



Scurry County has limited surface water and groundwater supplies. Water from CRMWD sources is provided to the City of Snyder and its customers. Groundwater is obtained from the Dockum aquifer and is the primary source of supply for the other water users within the county. There is a small amount of alluvium groundwater (Other aquifer).

5E.26.1 Snyder

The City of Snyder is a member city of CRMWD and obtains all of its water from this wholesale provider. With conservation and subordination, CRMWD can fully meet Snyder's need. In the past, CRMWD and Snyder considered implementing a direct reuse project, similar to the project developed for Big Spring. At this time, there are no plans to move forward with this strategy and therefore it was not evaluated. Recommended strategies for Snyder are municipal conservation and subordination.

Potentially Feasible Water Management Strategies Considered for Snyder:

- Municipal Conservation
- Subordination

Table 5E- 84
Recommended Water Strategies for Snyder

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		2,057	2,076	2,096	2,112	2,128	2,145
Supply (CRMWD)		2,062	1,927	1,706	1,528	1,412	1,307
Shortage (ac-ft/yr)		0	149	390	584	716	838
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	36	36	37	37	38	38
Subordination (CRMWD Supplies)	$0	0	154	395	590	721	825
TOTAL	**$0**	**36**	**190**	**432**	**627**	**759**	**863**

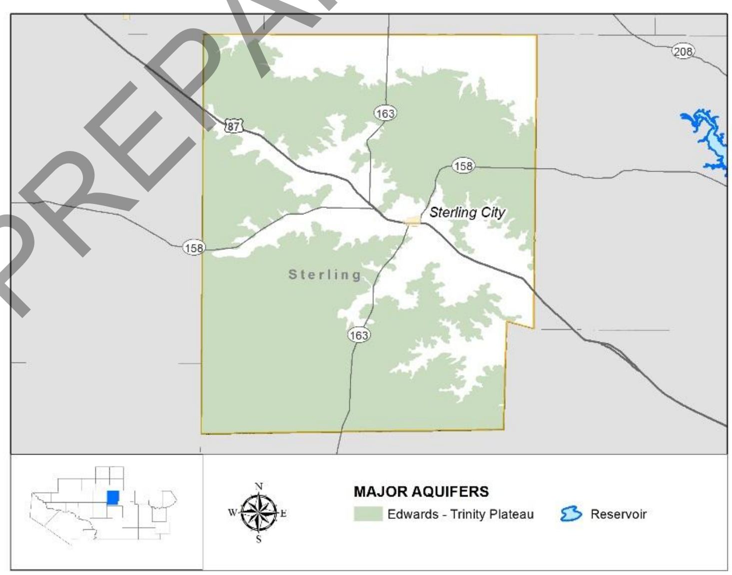
5E.26.2 Scurry County Summary

Before applying potential savings from conservation and subordination, the total need for Scurry County is projected to be about 800 acre-feet in 2080 for the City of Snyder; however, their needs are fully met by CRMWD and municipal conservation. Conservation is also recommended for irrigation and mining users to preserve supplies even though there is no identified need.

Table 5E- 85
Scurry County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Strategies
Snyder	CRMWD Sources	None	838	Municipal Conservation, Subordination
U & F WSC	Dockum Aquifer, Sales from Snyder	None	None	Municipal Conservation
County-Other	CRMWD Sources, Dockum, Local Alluvium Aquifers	None	None	Municipal Conservation, Sales from Snyder
Irrigation	Run-of-River, Dockum Aquifer	None	None	Irrigation Conservation
Livestock	Dockum Aquifer, Other Aquifer, Local Supply	None	None	None
Manufacturing	Dockum Aquifer	None	None	None
Mining	Dockum Aquifer, Mining Reuse	None	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

5E.27 Sterling County



Most of the water supplies for Sterling County are obtained from the Edwards-Trinity Plateau aquifer. There is some supply from the Lipan aquifer but quality limits its use. Projected growth for Sterling City outpaces the capacity of their wells by 2050. There are also shortages identified for mining and irrigation users due to MAG limits.

5E.27.1 Sterling City

The City of Sterling City has significant growth projected over the planning horizon that may or may not come to fruition. If growth is not as large as projected, the City's current supplies are sufficient. If growth continues as projected, the City's supplies will need to be supplemented in 2050. Municipal conservation and development of additional Edwards Trinity Alluvium supplies are recommended as strategies for Sterling City.

Table 5E- 86
Recommended Water Strategies for Sterling City

	Capital Cost	2030	2040	2050	2060	2070	2080
Demands		411	553	732	969	1,230	1,519
Supply (Groundwater)		411	553	644	644	644	644
Shortage (ac-ft/yr)		0	0	88	325	586	875
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	4	6	8	10	13	16
Develop Additional Edwards Trinity Alluvium Supplies	$16,804,000	0	0	88	325	586	875
TOTAL	**$0**	**4**	**6**	**96**	**335**	**599**	**891**

5E.27.2 Sterling County Irrigation

Although Sterling County Irrigation has no projected unmet needs, both irrigation conservation and weather modification are recommended as water management strategies. Weather modification is a recommended strategy because Sterling County is located within the active precipitation enhancement area of the West Texas Weather Modification Association.

Potentially Feasible Water Management Strategies Considered for Sterling County Irrigation:

- Irrigation Conservation
- Weather Modification

Weather Modification

The West Texas Weather Modification Association attributes an annual increase of 1.20 inches over Sterling County due to their weather modification efforts in 2022. This strategy assumes that the water savings from precipitation enhancement will be attributed to county irrigation and that irrigation usage occurs predominately during the growing season. Since there are approximately 1,064 irrigated acres in Sterling County, implementation of this strategy is expected to save 106 acre-feet of water per year at a unit cost of $0.45 per acre-foot.

Table 5E- 87
Recommended Water Strategies for Sterling County Irrigation

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		855	855	855	855	855	855
Supply (Groundwater)		855	855	855	855	855	712
Shortage (ac-ft/yr)		0	0	0	0	0	143
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$118,000	43	86	128	128	128	128
Weather Modification	$0	106	106	106	106	106	106
TOTAL	**$118,000**	**149**	**192**	**234**	**234**	**234**	**234**

5E.27.3 Sterling County Mining

Sterling County Mining has a projected shortage throughout the planning horizon due to MAG limitations for the Edwards Trinity Plateau, Pecos Valley, and Trinity Aquifers. Region F has identified mining conservation (recycling) as a recommended strategy. Additional information on conservation strategies is included in Chapter 5B. The remainder of the need is unmet since the groundwater available under the MAG is limited and mining is an exempt use. However, it is anticipated that the mining industry, as an exempt user, will continue to use groundwater as needed to meet any of their demands.

Table 5E- 88
Recommended Water Strategies for Sterling County Mining

	Capital Cost	2030	2040	2050	2060	2070	2080
Demands		3,047	3,047	2,793	2,285	1,612	1,016
Supply (Groundwater)		1,510	1,365	1,135	804	423	169
Shortage (ac-ft/yr)		1,537	1,682	1,659	1,481	1,189	847
Recommended Strategies (ac-ft/yr)							
Mining Conservation (Recycling)	$2,100,000	105	105	97	79	56	35

5E.27.4 Sterling County Summary

There are sufficient water supplies to meet projected water demands in Sterling County except for mining. New wells in the Edwards Trinity Alluvium are commended for Sterling City if growth continues. Conservation is recommended for municipal (Sterling City), irrigation, and mining water user groups. In addition, the West Texas Weather Modification Association operates in Sterling County, therefore, weather modification is also shown as a recommended strategy for irrigators. The MAG limits the amount shown for mining and there is an unmet need. However, it is anticipated that mining as an exempt use will continue to develop the supplies they need.

Table 5E- 89
Sterling County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Sterling City	Edwards-Trinity Alluvium Supplies	None	875	Municipal Conservation, Develop Additional Edwards-Trintiy Alluvium Supplies
County-Other	Edwards-Trinity Plateau Aquifer	None	None	None
Irrigation	Edwards-Trinity Plateau Aquifer, Run-of-River	None	143	Irrigation Conservation Weather Modification
Livestock	Edwards-Trinity Plateau Aquifer, Livestock Local Supplies	None	None	None
Manufacturing	----	----	----	----
Mining	Edwards-Trinity Plateau Aquifer, Mining Reuse	1,537	847	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

Table 5E- 90
Sterling County Unmet Needs

Water User Group	2030	2040	2050	2060	2070	2080
Mining	1,432	1,577	1,562	1,402	1,133	812

5E.28 Sutton County

The Edwards-Trinity Plateau aquifer is the primary source of water for Sutton County. Small amounts of local surface water supplies for livestock and irrigation are also used. The water demands in the county total about 2,700 acre-feet per year in 2030 and are expected to slightly decrease to about 2,250 acre-feet per year by 2080. Sutton County has sufficient water resources to meet these demands and has no identified shortages. It is recommended that water users in Sutton County implement conservation measures to preserve the water resources in the county, including municipal, irrigation and mining water users.

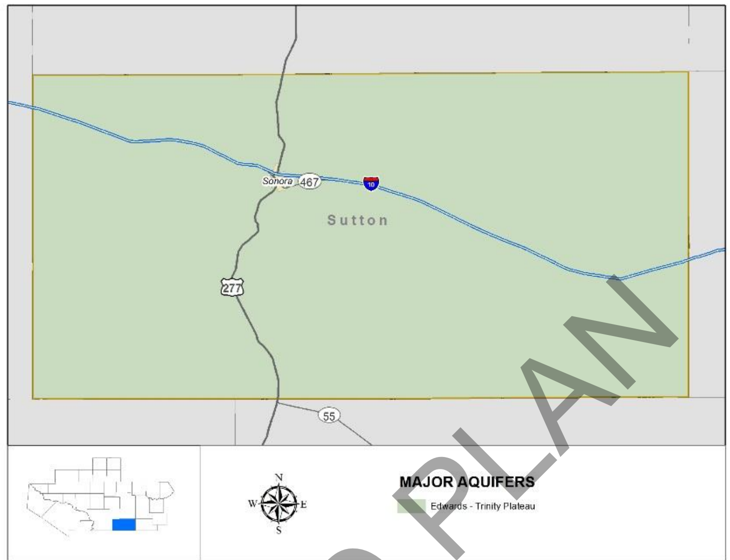
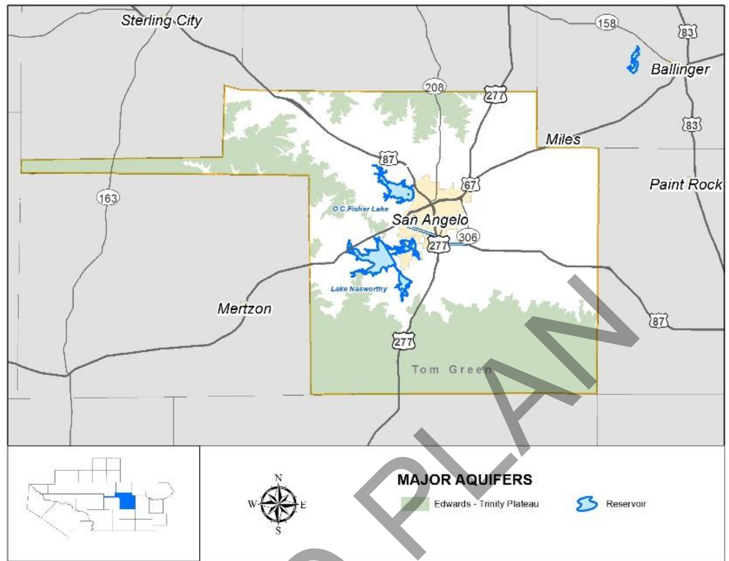


Table 5E- 91
Sutton County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Sonora	Edwards-Trinity Plateau Aquifer	None	None	Municipal Conservation
County-Other	Edwards-Trinity Plateau Aquifer	None	None	None
Irrigation	Edwards-Trinity Plateau Aquifer, Run-of-River	None	None	Irrigation Conservation
Livestock	Edwards-Trinity Plateau Aquifer, Livestock Local Supplies	None	None	None
Manufacturing	Sales from Sonora	None	None	None
Mining	Edwards-Trinity Plateau Aquifer	None	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

5E.29 Tom Green County



Tom Green County is home to the City of San Angelo and a large irrigation district, the Tom Green Water Control and Improvement District 1. Over 60 percent of the water demand in the county is for irrigation water use. Most of the remaining demand is associated with San Angelo, which is classified as a major water provider in Region F. Water supplies in Tom Green County include the Concho River, surface water reservoirs, and local aquifers. The Lipan aquifer, a minor aquifer, provides the greatest amount of groundwater within the county. Due to the drought, the reliable supplies from surface water has been significantly impacted. The remainder of the shortage in the county is associated with San Angelo and its customers. No other water user groups in Tom Green County have identified water shortages. The water management strategies for San Angelo and its customers are discussed in Chapter 5D (Major Water Provider Water Management Strategies).

5E.29.1 Upper Colorado River Authority (UCRA)

The Upper Colorado River Authority (UCRA) is a wholesale water provider in Tom Green County. UCRA owns the water rights in O.C. Fisher Reservoir and Mountain Creek Reservoir. The Authority has an agreement with the City of San Angelo for San Angelo for 500 acre-feet of supply and treatment. The City of Miles and local rural water supply corporations in Tom Green and Concho Counties contract with UCRA to provide treated water which is transmitted through either San Angelo's or the retail customer's systems.

Table 5E- 92
Supply and Demand Summary for UCRA

Supplies	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
San Angelo System Supplies (before Subordination)	402	426	400	375	351	330
Current Demands	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Miles	94	96	100	104	108	114
Concho Rural WSC	100	100	100	100	100	100
Concho Rural WSC (Holscher Farms)	10	10	10	10	10	10
Tom Green County-Other (Red Creek MUD)	100	100	100	100	100	100
Tom Green County-Other (Petrafirma)	145	145	145	145	145	145
Tom Green County-Other (Twin Buttes Water System)	20	20	20	20	20	20
Mining, Tom Green County (Globe Energy)	10	10	10	10	10	10
Total Current Demands	**479**	**481**	**485**	**489**	**493**	**499**
Potential Future Demands	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Concho Rural WC (Potential Future)	50	50	50	50	50	50
Total Future Demands	**50**	**50**	**50**	**50**	**50**	**50**
Shortage	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Current Customers	77	55	85	114	142	169
Current and Future Customers	127	105	135	164	192	219

Due to shortages in the supply from the San Angelo, UCRA shows a shortage for current users; however, San Angelo supplies and subordination will enable them to meet the full current customer planning potential contractual amounts. UCRA is also considering development of independent sources to increase their supplies.

Potentially Feasible Water Management Strategies Considered for UCRA:

- Supply from San Angelo Strategies (up to current contract amount)
- Using Solar Farms for Increased Runoff Near Twin Buttes and O.C. Fisher Lakes
- Develop Lipan Aquifer Groundwater Supplies in Tom Green County

Table 5E- 93
Recommended Water Strategies for UCRA

	Capital Cost	2030	2040	2050	2060	2070	2080
Shortage - Current Customers (ac-ft/yr)		77	55	85	114	142	169
Shortage - Current and Future Customers (ac-ft/yr)		127	105	135	164	192	219
Recommended Strategies (acre-feet per year)							
Municipal Conservation (City of Miles)	$0	3	3	3	3	3	3
San Angelo Supplies (Existing Contract)	$0	98	74	100	125	149	170
Subordination (Mountain Creek Reservoir)	$0	86	86	86	86	86	86
Increased Runoff into Reservoirs (Solar Farms)	$178,000	0	10	10	10	10	10
Develop Lipan Aquifer Supplies in Tom Green County - Voluntary Transfer from Irrigation	$13,550,000	0	5,000	5,000	5,000	5,000	5,000
TOTAL	**$13,728,000**	**187**	**5,173**	**5,199**	**5,224**	**5,248**	**5,269**

5E.29.2 Tom Green County Irrigation

Irrigation in Tom Green County has unmet needs, and both irrigation conservation and weather modification are recommended as water management strategies. Irrigation conservation of water can reduce demands and more efficiently use existing supplies. Tom Green County is also located within the active precipitation enhancement area of the West Texas Weather Modification Association. UCRA is also pursuing a potential project to develop groundwater previously used by irrigation. This strategy would financially benefit irrigators that currently are not using their full amount of allotted groundwater or no longer wish to irrigate. This strategy is for a voluntary transfer only and is dependent upon UCRA and the irrigators reaching mutually agreeable terms for the sale of water. The recommended strategies for irrigation in Tom Green County are conservation, weather modification, and voluntary transfer to UCRA.

Potentially Feasible Water Management Strategies Considered for Tom Green County Irrigation:

- Irrigation Conservation
- Weather Modification
- Voluntary transfer to UCRA

Weather Modification

The West Texas Weather Modification Association attributes an annual increase of 1.59 inches over Tom Green County due to their weather modification efforts in 2022. This strategy assumes that the water savings from precipitation enhancement will be attributed to county irrigation and that irrigation usage occurs predominately during the growing season. Since there are approximately 26,497 irrigated acres in Tom Green County, implementation of this strategy is expected to save 1,550 acre-feet of water per year at a unit cost of $0.35 per acre-foot.

Table 5E- 94
Recommended Strategies for Tom Green County Irrigation

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		49,600	49,600	49,600	49,600	49,600	49,600
Supply (Groundwater, ROR)		49,600	42,258	41,839	41,504	41,183	40,815
Surplus (ac-ft/yr)		0	7,342	7,761	8,096	8,417	8,785
Recommended Strategies (ac-ft/yr)							
Subordination (Twin Buttes Supplies)	$0	0	0	0	0	0	0
Irrigation Conservation	$5,476,000	2,480	4,960	5,952	5,952	5,952	5,952
Weather Modification	$0	1,550	1,550	1,550	1,550	1,550	1,550
Voluntary Transfer to UCRA	$0	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)
TOTAL	**$5,476,000**	**(970)**	**1,510**	**2,502**	**2,502**	**2,502**	**2,502**

5E.29.3 Tom Green County Summary

Tom Green County is the second largest demand county in Region F. As previously discussed, supplies are limited. Most of the shortage is associated with the City of San Angelo, which is discussed in Chapter 5D. Some of this shortage can be reduced through both conservation and subordination. The rest of these shortages can be met through the implementation of infrastructure strategies and transfers between water user groups with the exception of irrigation which shows an unmet need throughout the planning horizon after strategies.

Table 5E- 95
Tom Green County Summary

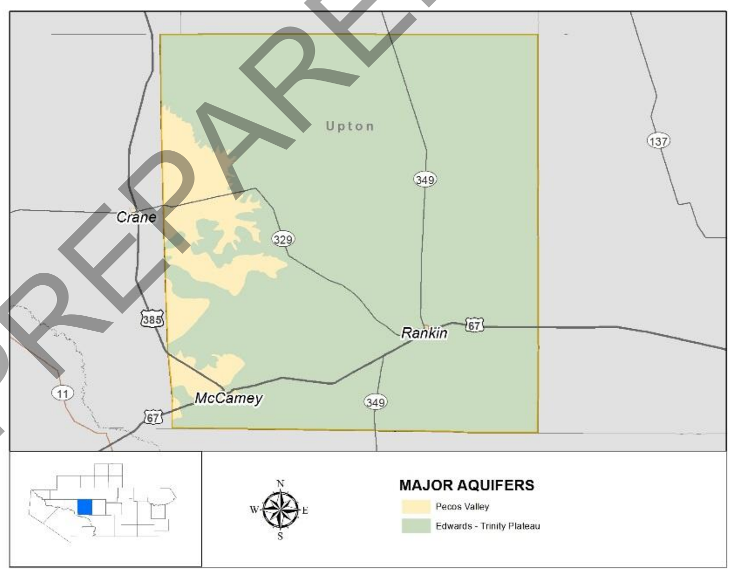
Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Concho Rural WC	Lipan Aquifer, Edwards-Trinity Aquifers, Sales from UCRA	5	36	Municipal Conservation, Water Audits and Leak Repair, UCRA Supplies
DADS Supported Living	Lipan Aquifer	None	None	Municipal Conservation
Goodfellow Air Force Base	Sales from San Angelo	93	160	Municipal Conservation, Supply from San Angelo Strategies
Millersview-Doole WSC	See McCulloch County			
San Angelo	See Chapter 5D for Major Water Providers			
Tom Green County FSD 3	Lipan Aquifer	None	None	Municipal Conservation
County-Other	Lipan Aquifer, Edwards-Trinity Aquifer, Other Aquifers, Sales from UCRA	40	12	Supply from UCRA (San Angelo Strategies)

Irrigation	Lipan Aquifer, Edwards-Trinity Aquifer, Other Aquifers, Reuse, Twin Buttes/Nasworthy, Run-of-River	None	8,785	Irrigation Conservation Weather Modification
Livestock	Lipan Aquifer, Edwards-Trinity Aquifer, Other Aquifers, Livestock Local Supplies	None	None	None
Manufacturing	Lipan Aquifer, Sales from San Angelo	78	29	Supply from San Angelo Strategies
Mining	Lipan Aquifer, Sales from UCRA	None	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

Table 5E- 96
Unmet Needs in Tom Green County
-Values are in Acre-Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
Irrigation, Tom Green	970	5,832	5,259	5,594	5,915	6,283

5E.30 Upton County



Water demands in Upton County are primarily met with groundwater from the Edwards-Trinity Plateau aquifer. Some non-municipal water use groups obtain water from the Dockum aquifer; however, this water is sparsely used due to water quality concerns. In addition to groundwater, mining users in Upton County purchase wastewater from Midland and reuse some of their own supplies to meet their demands. Upton County has sufficient supplies to meet their needs and no water shortages were identified. It is recommended that conservation for McCamey, Rankin, irrigation and mining be implemented as a way to preserve water for future use. County-Other, livestock, and manufacturing have no recommended strategies.

5E.30.1 Upton County Summary

Water user groups in Upton County have ample supply to meet all projected water demands. Conservation is still a recommended strategy for municipal water users, including McCamey and Rankin, as well as irrigators and mining water users.

Table 5E- 97
Upton County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
McCamey	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	Municipal Conservation
Rankin	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	Municipal Conservation
County-Other	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	None
Irrigation	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer, Dockum Aquifer	None	None	Irrigation Conservation
Livestock	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	None
Manufacturing	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer, Dockum Aquifer	None	None	None
Mining	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer, Sales from Midland (Reuse Water), Mining Reuse	None	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

5E.31 Ward County

Ward County is located in the western part of Region F. The county's primary source of water is the Pecos Valley aquifer. There are also smaller quantities of water associated with the Capitan Reef and Dockum aquifers. Most users in Ward County show no shortages. However, the MAG does limit mining use and supplies for CRMWD's Ward County well field.

5E.31.1 Ward County Irrigation

Although Ward County Irrigation has no projected unmet needs, both irrigation conservation and weather modification are recommended as water management strategies. Weather modification is a recommended strategy because Ward County is located within the active precipitation area of the Trans Pecos Weather Modification Association (TPWMA).

Potentially Feasible Water Management Strategies Considered for Ward County Irrigation:

- Irrigation Conservation
- Weather Modification

Weather Modification

The TPWMA attributes an annual increase of 1.17 inches over Ward County due to their weather modification efforts in 2022. This strategy assumes that the water savings from precipitation enhancement will be attributed to county irrigation and that irrigation usage occurs predominately during the growing season. Since there are approximately 530 irrigated acres in Ward County, implementation of this strategy is expected to save 53 acre-feet of water per year at a unit cost of $0.45 per acre-foot.

Table 5E- 98
Recommended Water Strategies for Ward County Irrigation

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		4,333	4,333	4,333	4,333	4,333	4,333
Supply (Groundwater, Reuse, Run of River, Red Bluff)		4,333	4,333	4,333	4,333	4,333	4,333
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$598,000	217	433	650	650	650	650
Weather Modification	$0	53	53	53	53	53	53
TOTAL	**$598,000**	**270**	**486**	**703**	**703**	**703**	**703**

5E.31.2 Ward County Mining

Ward County Mining has a projected shortage over the entire planning horizon. Region F has identified mining conservation (recycling) as a recommended strategy. Additional information on conservation strategies is included in Chapter 5B. The remainder of the need is unmet since the groundwater available under the MAG is limited and mining is an exempt use. However, it is anticipated that the mining industry, as an exempt user, will continue to use groundwater as needed to meet any of their demands.

Table 5E- 99
Recommended Water Strategies for Ward County Mining

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		8,170	8,232	8,282	8,321	8,351	8,370
Supply (Purchased Supply)		6,776	6,771	6,754	6,735	6,706	6,664
Shortage (ac-ft/yr)		1,394	1,461	1,528	1,586	1,645	1,706
Recommended Strategies (ac-ft/yr)							
Mining Conservation (Recycling)	$4,540,000	227	227	227	227	227	227

5E.31.3 Ward County Summary

Ward County has sufficient supplies to meet its needs. The only shortage identified for Ward County is for mining. The MAG also limits supplies for CRMWD's Ward County well field but CRMWD's supplies are still sufficient to meet their member city and customer's needs. Conservation is also recommended for municipal (Barstow, Grandfalls, Monahans, Southwest Sandhills WSC, Wickett), irrigation and mining users. There are no shortages and no strategies for livestock, manufacturing, and steam electric power.

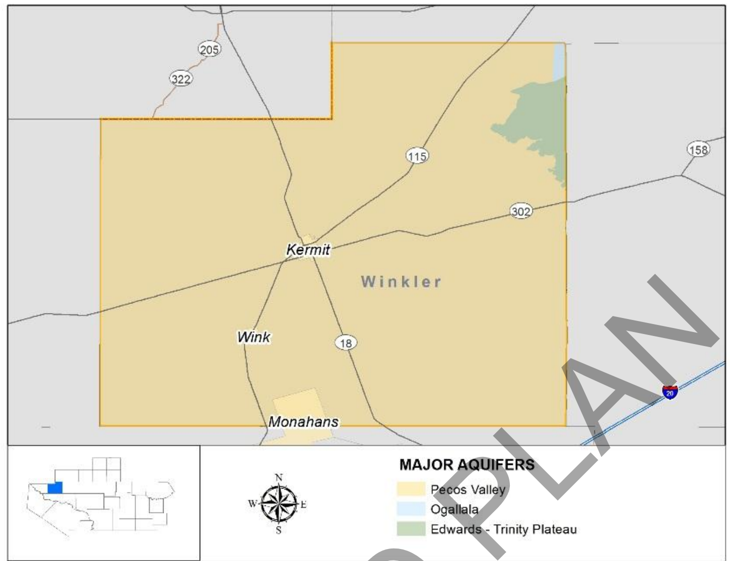
Table 5E- 100
Ward County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Barstow	Dockum Aquifer	None	None	Municipal Conservation
Grandfalls	Sales from CRMWD	None	None	Municipal Conservation
Monahans	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	Municipal Conservation
Southwest Sandhills WSC	Sales from Monahans	None	None	Municipal Conservation
Wickett	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	Municipal Conservation
County-Other	Sales from CRMWD, Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer, Dockum Aquifer	None	None	None
Irrigation	Reuse sales from Monahans, Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer, Dockum Aquifer, Red Bluff Reservoir, Rio Grande Run-of-River	None	None	Irrigation Conservation Weather Modification
Livestock	Livestock Local Supplies, Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer, Dockum Aquifer	None	None	None
Manufacturing	Pecos Valley Aquifer	None	None	None
Mining	Pecos Valley Aquifer, Well Field Recycling	1,394	1,706	Mining Conservation (Recycling)
Steam Electric	Pecos Valley Aquifer	None	None	None

Table 5E- 101
Unmet Needs in Ward County
-Values are in Acre-Feet per Year-

Water User Group	2030	2040	2050	2060	2070	2080
Mining	1,167	1,234	1,301	1,359	1,418	1,479

5E.32 Winkler County



Winkler County is almost entirely supplied by groundwater. Most of the supply originates from the Dockum, Pecos Valley, and Edwards Trinity Plateau aquifers. The City of Kermit shows a shortage in 2080 when their demands are projected to exceed their current well capacities. Some additional water from Winkler County is planned for development by CRMWD for use outside of the county.

Winkler County has ample supply to meet the projected demands. Total demands for the county are less than 9,000 acre-feet per year. However, there are additional demands on the county's groundwater resources from development of Midland's T-Bar Ranch Well Field and the future development of CRMWD's Well Field. Even with these outside demands, there are sufficient supplies to meet them.

5E.32.1 Kermit

The City of Kermit uses groundwater supplies from the Dockum Aquifer in Winkler County. By 2080, their demand projections exceed the capacity of their current wells and a strategy to add an additional well is recommended. Water conservation is also recommended for the City of Kermit.

Table 5E- 102
Recommended Water Strategies for the City of Kermit

	Capital Cost	2030	2040	2050	2060	2070	2080
Demand		2,169	2,494	2,801	3,072	3,367	3,689
Supply (Groundwater)		2,169	2,494	2,801	3,072	3,367	3,405
Shortage (ac-ft/yr)		0	0	0	0	0	284
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	22	25	29	31	34	38
Develop Additional Dockum Aquifer Supplies	$1,460,000	0	0	0	0	0	250
TOTAL	**$1,460,000**	**22**	**25**	**29**	**31**	**34**	**288**

5E.32.2 Winkler County Summary

Winkler County has sufficient groundwater supplies to meet all projected demands for water user groups. The City of Kermit has a recommended strategy to employ conservation and drill additional Dockum wells when the capacity of theirs are projected to be exceeded in 2080. Although there are no shortages, municipal conservation is recommended for Wink and irrigation and mining users.

Table 5E- 103
Winkler County Summary

Water User Group	Current Supplies	2030 Shortage (ac-ft/yr)	2080 Shortage (ac-ft/yr)	Recommended Water Management Strategies
Kermit	Dockum Aquifer	None	284	Municipal Conservation Develop Additional Dockum Aquifer Supplies
Wink	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	Municipal Conservation
County-Other	Dockum Aquifer, Edwards-Trinity Plateau, Pecos Valley Aquifer	None	None	None
Irrigation	Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	Irrigation Conservation
Livestock	Dockum Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifers, Livestock Local Supplies	None	None	None
Manufacturing	Dockum Aquifer	None	None	None
Mining	Dockum Aquifer, Edwards-Trinity Plateau Aquifer, Pecos Valley Aquifer	None	None	Mining Conservation (Recycling)
Steam Electric	----	----	----	----

5E.33 Region F Water Management Strategies Summary

5E.33.1 Unmet Needs Summary

There are some instances in Region F where the recommended water management strategies do not represent enough additional supply to meet the demand associated with the water user group. Table 5E- 104 summarizes all of the remaining unmet needs in Region F. Although there are unmet needs being shown as remaining within Region F, each need is accounted for within the overall plan and is in compliance with state requirements. Chapter 6 discusses the unmet needs in detail and explains how the unmet needs do not affect public health and welfare and are consistent with the long-term protection of the state's resources as embodied in the guidance principles.

Table 5E- 104
Unmet Needs Summary

Water User Group	County	2030	2040	2050	2060	2070	2080
Andrews	Andrews	401	1,025	2,169	3,462	4,808	6,234
Manufacturing	Andrews	70	140	184	218	249	279
Irrigation	Andrews	4,487	5,062	5,877	6,413	6,849	7,226
Mining	Andrews	1,748	1,897	1,532	717	0	0
Mining	Borden	412	412	191	0	0	0
Robert Lee	Coke	53	0	0	0	0	0
Eden	Concho	445	430	416	402	392	385
Mining	Crane	0	0	57	278	14	190
Mining	Crockett	1,852	1,773	1,532	482	0	0
Steam Electric Power	Ector	139	104	0	0	0	0
Irrigation	Irion	409	357	304	304	304	304
Mining	Irion	5,400	5,391	4,709	3,711	1,792	89
Junction	Kimble	210	0	0	0	0	0
Irrigation	Kimble	1,128	998	946	946	946	946
Mining	Loving	6,033	6,032	6,032	6,032	6,031	6,031
Mining	Martin	0	754	1,267	1,330	683	195
Irrigation	Martin	0	736	1,136	1,575	892	0
Mining	Mitchell	36	37	33	26	18	11
Irrigation	Mitchell	1,552	1,569	1,559	1,528	1,482	1,445
Steam Electric Power	Mitchell	3,801	3,885	3,969	4,035	4,099	4,165
Balmorhea	Reeves	15	0	0	0	0	0
Pecos City	Reeves	1,296	0	0	0	0	0
Madera Valley WSC	Reeves	7	0	0	0	0	0
North Runnels WSC	Runnels	113	121	128	136	147	159
Winters	Runnels	174	165	154	147	137	126
Mining	Sterling	1,432	1,577	1,562	1,402	1,133	812
Irrigation	Tom Green	970	4,050	3,559	3,951	4,328	4,753
Mining	Ward	1,167	1,234	1,301	1,359	1,418	1,479
TOTAL		**33,350**	**37,749**	**38,617**	**38,454**	**35,722**	**34,829**

6 IMPACTS OF THE REGIONAL WATER PLAN

The development of viable strategies to meet the demand for water is the primary focus of regional water planning. A part of this goal is the long-term protection of resources that contribute to water availability, and to the quality of life in the State. The purpose of this chapter is to describe how the 2026 update to the Region F Water Plan is consistent with the long-term protection of the State's water resources, agricultural resources, and natural resources. The requirement to evaluate the consistency of the regional water plan with protection of resources is found in 31 TAC Chapter 357.41, which states:

> "RWPGs shall describe how RWPs are consistent with the long-term protection of the state's water resources, agricultural resources, and natural resources as embodied in the guidance principles in §358.3(4) and (8) of this title (relating to Guidance Principles)."

Chapter 6 addresses this issue by providing general descriptions of how the plan is consistent with protection of water resources, agricultural resources, and natural resources. Additionally, the chapter will specifically address consistency of the 2026 Region F Water Plan with the State's water planning requirements. To demonstrate compliance with the State's requirements, the TWDB IPP checklist has been filled out and is included in Appendix A.

The regulations that describe the content and process for the development of regional water plans state that the plan include "a description of the major impacts of recommended water management strategies on key parameters of water quality identified by the regional water planning group pursuant to [31 TAC 357.34(d)(8)]."

This chapter presents an assessment of the water quality parameters that could be affected by the implementation of water management strategies (WMS) for Region F. Based on this assessment, the key water quality parameters for each type of WMS are identified. From this determination, the specific water management strategies selected for Region F were evaluated with respect to potential impacts to the key water quality parameters. In addition, this chapter discusses the potential impacts of moving water from rural areas to urban uses.

6.1 Potential Impacts of Water Management Strategies on Key Water Quality Parameters

The key water quality parameters to be evaluated are dependent on the recommended water management strategy. Table 6-1 summarizes the most pertinent water quality parameters for the types of strategies proposed in this plan.

The implementation of specific strategies can potentially impact both the physical and chemical characteristics of water resources in the region. The following is an assessment of the characteristics of each recommended WMS type that may affect water quality and an identification of the specific water quality parameters that could be affected based on those characteristics. Water management strategy types that were not recommended for Region F, and therefore are not evaluated in this section, include drought management and system operations.

Table 6-1
Key Water Quality Parameters by Water Management Strategy Type

Water Quality Parameter	Water Conservation	Reuse	Subordination	Voluntary Transfer	Conjunctive Use	New/ Expanded Supply Development	Desalination (Advanced Treatment)	Brush Control	Precipitation Enhancement
Total dissolved solids (TDS)	+	+ / -		+ / -	+		-	+ / -	
Alkalinity	+				+				
Hardness	+				+				
Dissolved Oxygen (DO)	+	+ / -		+ / -	+			+ / -	
Nitrogen	+	+ / -		+ / -	+		-	+ / -	
Phosphorus	+	+ / -		+ / -	+			+ / -	
Radionuclides [a]						- [a]	- [a]		
Metals [a]		+		- [a]		- [a]	- [a]		

a. Only for specific constituents where there are significant discharges of the constituent.
\+ Positive Impact - Negative Impact

6.1.1 Water Conservation

The water conservation measure with the greatest potential for water savings to be implemented in Region F is improvements in the efficiency of water used for irrigated agriculture. These recommended strategies are not expected to affect water quality adversely. The results should be beneficial because the demand on surface and groundwater resources will be decreased. Mining conservation also represents the potential for significant reduction in water usage through recycling of flowback water from oil and gas operations in the region. Reducing mining's dependence on other water sources is expected to have a beneficial impact on the water quality of those sources. It also reduces the amount of waste injected underground or to a stream. Municipal conservation is expected to have similar beneficial impacts but on a smaller scale.

6.1.2 Reuse of Treated Wastewaters

In general, there are three possible water quality effects associated with the reuse of treated wastewaters:

- There can be a reduction in instream flow if treated wastewaters are not returned to the stream, which could affect TDS, nutrients, and DO concentrations of the receiving stream.
- Conversely, in some cases, reducing the volume of treated wastewater discharged to a stream could have a positive effect and improve levels of TDS, nutrients, DO, and possibly metals in the receiving stream.
- Reusing water multiple times and then discharging it can significantly increase the TDS concentration in the effluent and in the immediate vicinity of the discharge in the receiving stream.

Total loading to the stream (i.e. the amount of dissolved material in the waste stream) should not change significantly.

These impacts will vary depending on the quality and quantity of treated wastewater that has historically been discharged to the stream and the existing quality and quantity of the receiving stream. For some entities in Region F, wastewater effluent is not discharged to a stream, but is land applied.

In Region F, there is one recommended direct non-potable reuse for the Town of Pecos City. This non-potable strategy involves a small volume of water and is expected to have minimal to no impact on key water quality parameters.

In addition to this project, there is one direct potable reuse project recommended for the Town of Pecos City. Water from this project could potentially be used multiple times, increasing the TDS concentration in the effluent. The water that is discharged and not reused could impact the receiving stream in the immediate vicinity of the discharge. This would be evaluated as part of a discharge permit. Total loading to the stream however should not change significantly.

There is also one indirect potable reuse project recommended for San Angelo, the Concho River Project. The wastewater discharged into the Concho River will be highly treated to state permit requirements and is expected to have minimal impacts on key water quality parameters. Diversion of this water is not expected to significantly change stream flows (and thus water quality) since the water was previously diverted for agricultural use.

6.1.3 Subordination

The plan recommends the subordination of downstream senior water rights holders to major reservoirs in Region F. This reflects the current operation of the basin, so there are no expected changes in water quality associated with this strategy.

6.1.4 Voluntary Transfers

Voluntary redistribution in Region F involves the sales of water from a source to a water user group or wholesale water provider. None of the recommended strategies in Region F involve placing water from one source into another source. The amount of water proposed to be transferred should not significantly impact source reservoir or stream quantities beyond current commitments. Impacts to key water quality parameters are expected to be minimal.

In Region F, most of the surface water is fully utilized and there would not be significant changes to the quantities of surface water diversions and distribution to users within the region. Voluntary transfers are likely to have a neutral impact for surface water users. Drought will have a much greater impact on key water quality parameters.

Voluntary redistribution of groundwater sources will have minimal impacts on water quality parameters assuming there is no relative change in the amount of groundwater pumped. Impacts on key water quality parameters for large increases in groundwater pumping to meet contractual sales are discussed in Section 6.1.6. Depending on the quality of the groundwater, municipal wastewater discharges could have a positive or negative impact to the water quality of the receiving stream.

Depending on the location and use of the water under voluntary redistribution, changes in locations of return flows (if applicable) could impact flows in receiving streams. Such impacts would be site specific and could be positive or negative, depending on the changes.

Generally, these impacts are relative to the quantities of water that are diverted or redistributed. Small quantities are likely to have minimal to no impacts, while large quantities may have measured impacts. In Region F, no large surface water volume transfers are expected.

6.1.5 Conjunctive Use

Conjunctive use allows for surface water sources to be operated in conjunction with groundwater sources such that impacts to key water quality parameters can be minimized while still providing users with sufficient supplies from groundwater. Recommended strategies for CRMWD, San Angelo, Midland, and others in Region F involve conjunctive use of surface water and groundwater supplies. These users' systems already employ conjunctive use and continued and expanded use of this strategy is expected to have minimal to no impacts.

6.1.6 New and/or Expanded Supply Development

Increased use of groundwater can decrease instream flows if the base flow is supported by spring flow. This is not expected to be a concern for the recommended water management strategies in Region F. Most new groundwater development is in areas that have no flowing surface water, such as Winkler County, or from relatively deep portions of aquifers that most likely do not have significant impact on surface flows, such as McCulloch County.

Increased use of groundwater has the potential to increase TDS concentrations in area streams if the groundwater sources have higher concentrations of TDS or hardness than local surface water and are discharged as treated effluent. This is not the case in most areas in Region F. Naturally occurring salt seeps and high TDS waters are common in Region F. The development of new supplies from brackish groundwater is discussed under desalination.

New development of groundwater from the Hickory aquifer could potentially introduce radionuclides to surface water if wastewater is discharged to local streams. San Angelo has already developed treatment systems to remove radionuclides from the Hickory aquifer supplies so large-scale introduction to surface water is not expected. The net concentrations in the receiving streams are expected to be low and should not impact water use from the stream.

6.1.7 Desalination /Advanced Treatment

Advanced treatment of groundwater and/or surface water is a recommended strategy Brady, Bronte, Brown County WID 1, Odessa, Pecos City, and Robert Lee. The West Texas Water Partnership strategy sponsored by Midland, San Angelo and Abilene (Region G) also involves advanced treatment of groundwater. Some of the source water is impaired for TDS, while others are impaired for radionuclides or other constituents. In terms of impacts on water quality, these systems produce a waste stream that may adversely impact waters if discharged to surface waters. Key water quality parameters that may be affected include TDS, nutrients, radionuclides, and metals.

6.1.8 Brush Control

Brush control is a recommended strategy in Region F. Impacts to the water quality of area streams will depend upon the methods employed to control the brush. It is assumed that chemical spraying will not be used near water sources. Mechanical removal, prescribed burns and use of the salt cedar beetle are the preferred methods near water sources. With these assumptions, chemical contamination of water sources is very low. Increases in stream flow due to reduced evapotranspiration associated with the removed brush should improve water quality in watersheds where brush control is employed.

6.1.9 Precipitation Enhancement

Precipitation enhancement is a recommended strategy for irrigators in counties with an active weather modification program, such as the West Texas Weather Modification Association (WTWMA) or the Trans Pecos Weather Modification Program (TPWMA). These operations are already in progress, so there are no expected changes in water quality associated with this strategy.

6.2 Impacts of Moving Water from Rural and Agricultural Areas

The recommended water management strategies that involve taking water from primarily rural areas or water currently used for agricultural purposes for use in primarily urban areas include:

- CRMWD Ward County Well Field Expansion, Winkler County Well Field Development
- City of San Angelo Indirect Reuse
- West Texas Water Partnership

Of these three strategies, all entities already hold the rights to that water. Although all of the proposed well fields are located in rural areas, these strategies are not expected to have significant impact on those areas. The CRMWD well field is located in areas where very little groundwater is used for other purposes. San Angelo's treated wastewater effluent is currently used to supply the local irrigation district as a substitute for Twin Buttes water. However, beginning in 2040 San Angelo will use this wastewater effluent and the implementation of this reuse strategy will make this water unavailable to the irrigation district. The irrigation district will have access to water from Twin Buttes Reservoir to replace this supply from San Angelo. When the City does not need the supply, it will still be available for irrigators, reducing the potential impacts somewhat. During drought times, irrigators may need to plant less water intensive crops, convert to dry land farming, find alternative sources of supply, or reduce the number of irrigated acres. The West Texas Water Partnership has already purchased the groundwater rights and secured necessary permits from the Pecos County GCD.

Smaller municipalities are also planning to develop additional groundwater. These entities are considered rural and therefore do not constitute any movement of water from rural and agricultural areas.

6.3 Socio-Economic Impacts of Not Meeting Water Needs

Region F will face substantial shortages in water supply over the planning period. The TWDB provided technical assistance to regional planning groups in the development of specific information on the socio-economic impacts of failing to meet projected water needs.

The TWDB's analysis calculated the impacts of a severe drought occurring in a single year at each decadal period in Region F. It was assumed that all of the projected shortage was attributed to drought. Under these assumptions, the TWDB's findings can be summarized as follows:

- With the projected shortages, the region's projected 2030 population would be reduced by [Number to be provided by TWDB after IPP], which is approximately [Number to be provided by TWDB after IPP]%.
- Without any additional supplies, the projected water needs would reduce the region's projected 2030 employment by approximately [Number to be provided by TWDB after IPP] jobs ([Number to be provided by TWDB after IPP] percent reduction). This declines to around [Number to be provided by

TWDB after IPP] lost jobs by 2080. The mining sector accounts for [Number to be provided by TWDB after IPP] percent of these jobs losses in 2030 and [Number to be provided by TWDB after IPP] percent in 2080. Municipal and manufacturing sectors are the next biggest contributors, particularly in later decades.

- Without any additional supplies, the projected water needs would reduce the region's projected annual income by $[Number to be provided by TWDB after IPP] billion, approximately [Number to be provided by TWDB after IPP] percent of which is within the mining industry. This represents nearly [Number to be provided by TWDB after IPP] percent of the region's current income. The loss in income reduces to approximately $[Number to be provided by TWDB after IPP] billion in 2080, after the mining boom is projected to decline.

The full analysis performed by the TWDB is included in Appendix H (after the IPP).

6.4 Other Potential Impacts

The U.S. Army Corps of Engineers has published a list of the navigable portions of the rivers in Texas.[1] The Colorado River is considered navigable from the Bastrop-Fayette County line to Longhorn Dam in Travis County. The Rio Grande is considered navigable from the Zapata-Webb County line to the point of intersection of the Texas-New Mexico state line and Mexico. All of these areas are outside of the boundaries of Region F. Therefore, the Region F Plan does not have an impact on navigation.

The Region F Plan protects existing water contracts and option agreements by reserving the contracted amount included in those agreements where the amounts were known. In some cases, there were insufficient supplies to meet existing contracts. In those cases, water was reduced proportionately for each contract holder.

A special water resource is a major water supply source that is committed to provide water outside the region. TWDB has designated two special water resources in Region F: 1) Oak Creek Reservoir, which supplies water to Sweetwater in Brazos G, and 2) Ivie Reservoir, which supplies water to Abilene in Brazos G.

6.5 Consistency with the Protection of Water Resources

The water resources in Region F include three river basins providing surface water, and 14 aquifers providing groundwater. Most of Region F is located in the upper portion of the Colorado River Basin and in the Pecos portion of the Rio Grande River Basin. A small portion of the region is located in the Brazos River Basin. Figure 6-1 shows the major streams in Region F, including the Colorado River, Concho River, Pecan Bayou, San Saba River, Llano River, and Pecos River. TCEQ's Clean Rivers Program was considered when evaluating water management strategies.

The source of most of the region's surface water supply is the upper Colorado River Basin and the Pecos portion of the Rio Grande Basin, which supplies municipal, industrial, mining and irrigation needs in the region. Major reservoirs in Region F include Red Bluff Reservoir, Lake J.B. Thomas, E.V. Spence Reservoir, O.C. Fisher Lake, Twin Buttes Reservoir, O.H. Ivie Reservoir, and Lake Brownwood.

Springs are an important water resource in Region F. They supplement surface water sources and provide water for aquatic and riparian habitats. Region F identified 16 major springs, which are shown on Figure 6-2. Lake Balmorhea, Twin Buttes Reservoir, Concho River and San Saba River are just some of the important water supply sources in Region F that rely on spring-fed streamflow.

Figure 6-1
Major Surface Water Features in Region F

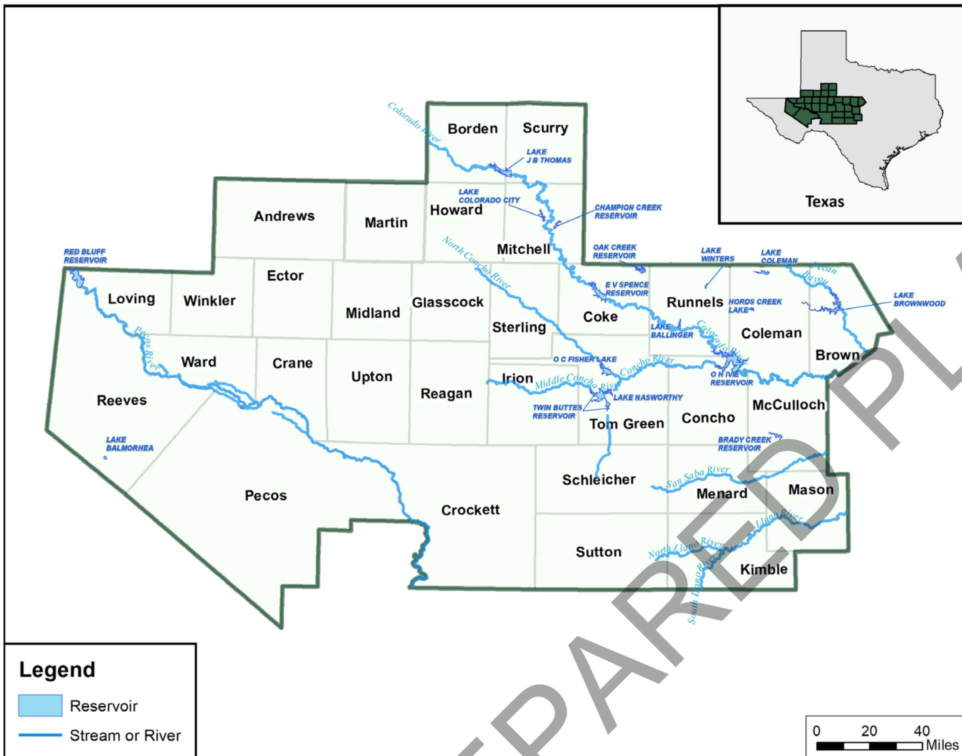


Figure 6-2
Springs in Region F

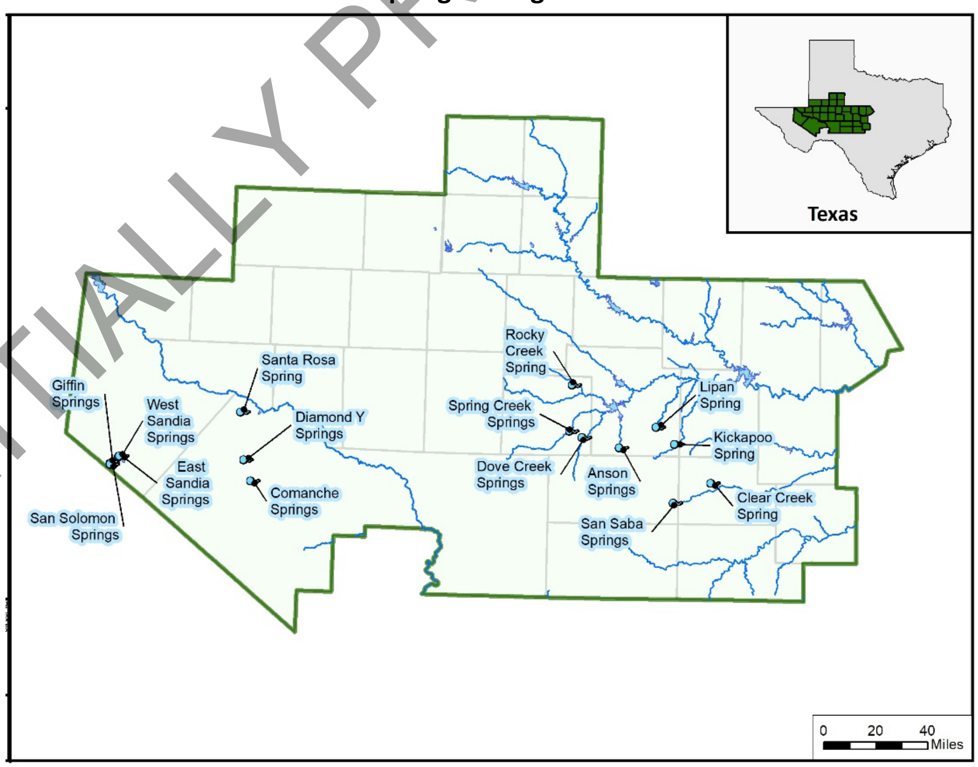


Figure 6-3
Major Aquifers in Region F

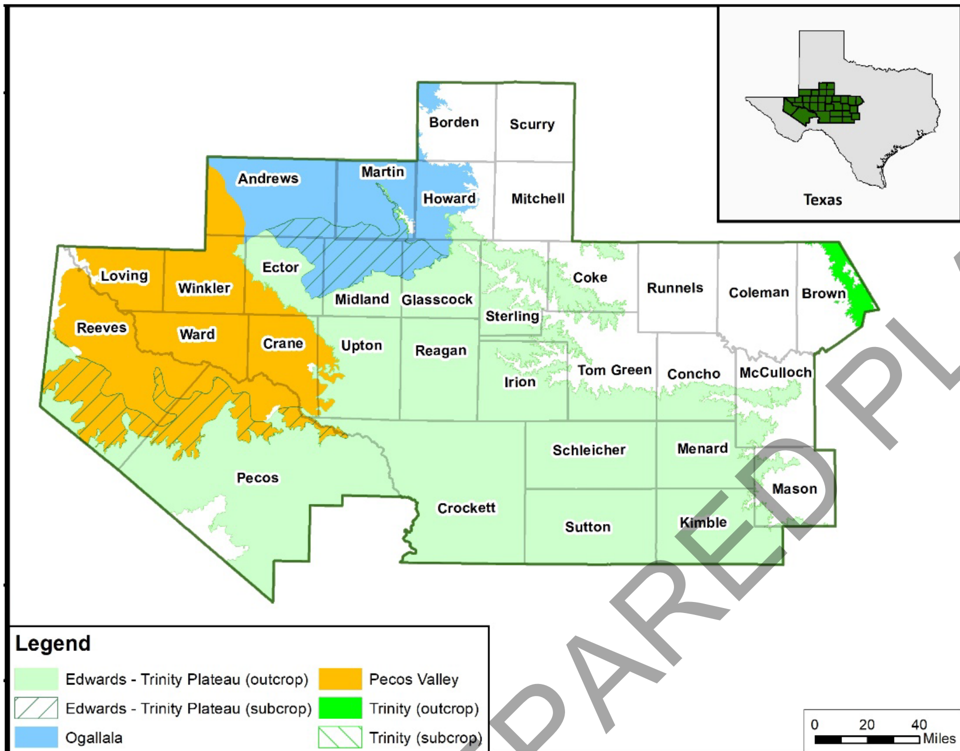


Figure 6-4
Minor Aquifers in Region F

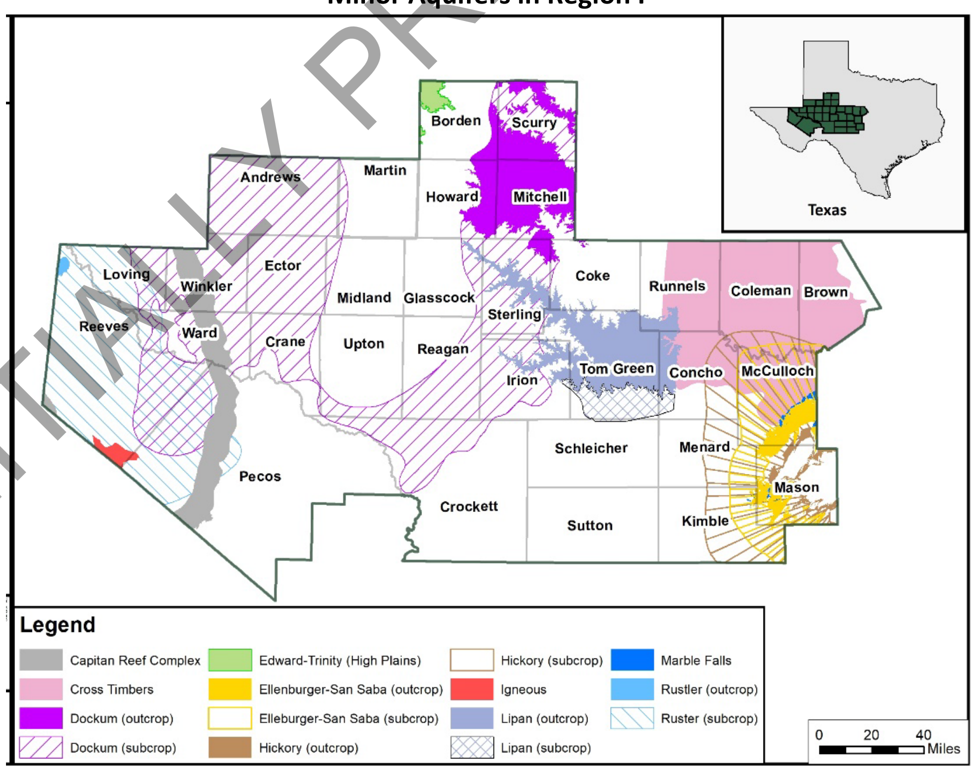


Figure 6-3 shows the major aquifers in Region F, and Figure 6-4 shows the minor aquifers. There are a total of 14 aquifers that supply water to the 32 counties in Region F. Major aquifers include the Edwards-Trinity Plateau, Ogallala, Pecos Valley, and a small portion of the Trinity. Minor aquifers include the Dockum, Hickory, Lipan, Ellenburger-San Saba, Marble Falls, Rustler, Cross Timbers, Igneous and the Capitan Reef Complex. The Edwards-Trinity High Plains is used only on a limited basis. More detailed information on water resources in Region F is presented in Chapters 1 and 3.

The Edwards-Trinity Plateau, Pecos Valley, and Ogallala aquifers are the largest sources of groundwater in Region F, providing 29, 22, and 17 percent of the total groundwater pumped in 2022, respectively. The Lipan, Dockum, and Other aquifers each provided between 9 and 10 percent of the 2022 totals. All remaining aquifers within the region contributed four percent combined.

The protections of water resources were considered through the supply allocation process and the development of water management strategies. For surface water, the distribution of supplies does not exceed the safe yield of the reservoir under subordination. This provides some water in the lakes through the drought of record and provides some protections from future droughts. For groundwater, the desired future conditions, as adopted by the GMAs, were honored for both currently developed supplies and potential future strategies. By not exceeding the modeled available groundwater, long-term effects on groundwater and surface water interrelationships were minimized since these complex relationships are considered by the respective GMA when selecting the DFCs.

To be consistent with the long-term protection of water resources, the plan must recommend strategies that minimize threats to the region's sources of water over the planning period. The water management strategies identified in Chapter 5 were evaluated for threats to water resources. The recommended strategies represent a comprehensive plan for meeting the needs of the region while effectively minimizing threats to water resources. Descriptions of the major strategy types and the ways in which they minimize threats to water resources are outlined in the following sections.

6.5.1 Water Conservation

Strategies for water conservation have been recommended that will reduce the demand for water, thereby reducing the impact on the region's groundwater and surface water sources. Water conservation practices are expected to save over 33,000 acre-feet of water annually by 2030, reducing demands on both groundwater and surface water resources. By 2080, the recommended conservation strategies savings (excluding wastewater reuse) total over 67,000 acre-feet per year. These savings are in addition to the water savings assumed in the demands.

6.5.2 Wastewater Reuse

Strategies involving wastewater reuse will provide high quality treated wastewater effluent for municipal and mining water needs in the region. These strategies will decrease the future demands on surface and groundwater sources and will not have a major impact on water resources. However, at times, San Angelo's reuse project may impact agricultural users that currently rely on the treated effluent for irrigation. In this case, these users may actually increase their demand on other local surface and groundwater sources.

6.5.3 Subordination of Downstream Water Rights

The Colorado WAM Run 3 makes many assumptions that are contrary to the way the Colorado Basin has historically operated, showing that most surface water sources in the region have no supply. In conjunction with the Lower Colorado Region (Region K), a subordination strategy was developed that protects the supply of Region F water rights and the water resources in Region F. This strategy is described in Subchapter 5C.

6.5.4 Voluntary Transfers

Under this strategy, surface and ground water rights holders with water supplies will provide water to areas with current or projected needs. This strategy is for proposed customers of wholesale water providers and expanded sales to entities with a projected future need. Some strategies also include the sale of groundwater rights on a voluntary basis. As proposed, this strategy will only use water that is available on a sustainable basis and will not significantly impact water resources.

6.5.5 Conjunctive Use

Conjunctive use supports the management of surface water and groundwater sources to provide water necessary for beneficial use while protecting the individual water resource during periods of drought.

6.5.6 New or Expanded Use of Groundwater

This strategy is recommended for entities with limited alternative sources and sufficient groundwater supplies to meet needs. Recommended strategies for groundwater supplies do not exceed the MAG values that were determined to meet the desired future conditions of the groundwater source. Large transfers of groundwater may have potential impacts to local surface water and springs. Such impacts were considered during the evaluation of the strategies. Where possible, strategies were selected that minimized impacts to surface water.

While the Region F water plan does not recommend strategies that exceed the MAG, several water providers are planning to develop strategies that would ultimately exceed the MAGs. These strategies are currently permitted or located in counties without GCDs. Based on a technical review of the potential impacts of these strategies, water resources would not be significantly impacted. The need for water and the protections for public health and safety is paramount in this plan.

6.5.7 Desalination/ Advanced Treatment

Desalination and advanced treatment increase the usability of marginal quality water for municipal use. These strategies reduce the need to develop other fresh water supplies.

6.5.8 Brush Control

This strategy will support the surface water supplies in the region by reducing losses associated with evapotranspiration of invasive brush species.

6.5.9 Precipitation Enhancement

This strategy will support the water supplies in the region by increasing streamflows and reducing irrigation demands due to increased rainfall.

6.6 Consistency with Protection of Agricultural Resources

Agriculture is an important economic and cultural cornerstone in Region F. Given the relatively low rainfall rates, irrigation is a critical component for agriculture in the region. The RWPG is recommending improved irrigation efficiency as a strategy to maximize the efficient use of available water supplies and protect current and future agricultural resources in the region. These efficiency increases will reduce the projected deficit in heavily irrigated counties and preserve water supplies for future use in counties with no identified shortage. In some cases, development of additional supplies for irrigated agriculture is not economically feasible. In these cases, the irrigation need is shown as unmet in this plan. However, it is likely that the demands will decrease in response to this economic reality during dry years. Irrigated agriculture is likely to rebound during wet years when supplies are more abundant and economical. A summary of all unmet irrigation needs is shown in the table below.

Table 6-2
Unmet Irrigation Needs in Region F

Water User Group	2030	2040	2050	2060	2070	2080
Andrews	(4,487)	(5,062)	(5,877)	(6,413)	(6,849)	(7,226)
Irion	(409)	(357)	(304)	(304)	(304)	(304)
Kimble	(1,128)	(998)	(946)	(946)	(946)	(946)
Martin	0	(736)	(1,136)	(1,575)	(892)	0
Mitchell	(1,552)	(1,569)	(1,559)	(1,528)	(1,482)	(1,445)
Tom Green	(970)	(4,050)	(3,559)	(3,951)	(4,328)	(4,753)
Total	**(8,546)**	**(12,772)**	**(13,381)**	**(14,717)**	**(14,801)**	**(14,674)**

In addition to irrigated agriculture, dry land agriculture and the ranching industry are important economically and culturally to the region. All livestock demands in the region are met through local surface water (stock ponds) or groundwater supplies and there are no unmet needs in this plan.

All agricultural enterprises depend on the survival of small rural communities and their assurance of a reliable, affordable water supply. These communities increase the local tax base and provide government services, health services, fire protection, education facilities, and businesses where agriculture obtains fuels, crop processing and storage, banking, and general products and supplies. If small rural communities do not have an affordable water supply to sustain themselves and provide for economic stability, agriculture will suffer an increase in the cost of doing business and the loss of services that contribute to its overall well-being and safety. The Governor's Office, the Texas Department of Agriculture, and U.S. Department of Agriculture are working to enhance the validity and sustainability of Texas agriculture and small rural communities.

6.7 Consistency with Protection of Natural Resources

Region F contains many natural resources that must be considered in water planning. Natural resources include threatened or endangered species; local, state, and federal parks and public land; and energy/mineral reserves. The Region F Water Plan is consistent with the long-term protection of these resources. Following is a brief discussion of consistency of the plan with protection of natural resources.

6.7.1 Threatened/Endangered Species

A list of threatened or endangered species potentially present within Region F is contained in Table 1-12, in Chapter 1. Included are twelve species of birds, three crustaceans, sixteen fish, two mammals, five reptiles, ten mollusks, and nine plants that are considered threatened or endangered on a state or federal level in Texas. None of the recommended water management strategies in this plan inherently impact the listed species. However, some strategies may require site-specific studies to verify that threatened or endangered species will not be impacted.

6.7.2 Parks and Public Lands

Seven state parks (Lake Brownwood, Big Spring, Lake Colorado City, Monahans Sandhills, San Angelo, Balmorhea and South Llano River) and one state wildlife management area (Mason Mountain) are located in Region F. The state parks and wildlife management area are not expected to be impacted by the recommended strategies. The subordination strategy simply continues the current operations in the basin and will not change lake or stream operations. There are no new recommended surface water strategies to impact streamflows.

In addition to the state parks, there are several city parks, recreational facilities, and public lands located throughout the region. None of the recommended water management strategies evaluated for the Region F Water Plan are expected to adversely impact these facilities or public land. The development of adequate water supplies would be beneficial for these facilities.

6.7.3 Energy Reserves

Thousands of producing oil and gas wells are located within Region F, representing an important economic base for the region. The RWPG is recommending recycling of flowback water from oil and gas operations (otherwise referred to in the plan as "mining conservation") as a strategy for all mining entities in the region, as it has the potential to significantly reduce water usage. Mining conservation, as well as all other recommended water management strategies for mining are expected to positively impact oil or gas production in the region. Some counties in Region F still show an unmet mining need, especially in counties with limited availability under the MAG, since water used for the protection of public health and safety is considered paramount in this plan. Advances in technology to reuse fracking water may help to close this gap. Furthermore, water used for the oil and gas industry is exempt from GCD regulation, and operators may exceed the MAG availability. The mining industry is not expected to be adversely impacted by this plan. Table 6-3 summarizes the unmet mining needs.

Table 6-3
Unmet Mining Needs in Region F

Water User Group	2030	2040	2050	2060	2070	2080
Andrews	(1,748)	(1,897)	(1,532)	(717)	0	0
Borden	(412)	(412)	(191)	0	0	0
Crane	0	0	(57)	(278)	(14)	(190)
Crockett	(1,852)	(1,773)	(1,532)	(482)	0	0
Irion	(5,400)	(5,391)	(4,709)	(3,711)	(1,792)	(89)
Loving	(6,033)	(6,032)	(6,032)	(6,032)	(6,031)	(6,031)
Martin	0	(754)	(1,267)	(1,330)	(683)	(195)
Mitchell	(36)	(37)	(33)	(26)	(18)	(11)
Sterling	(1,432)	(1,577)	(1,562)	(1,402)	(1,133)	(812)
Ward	(1,167)	(1,234)	(1,301)	(1,359)	(1,418)	(1,479)
Total	**(18,080)**	**(19,107)**	**(18,216)**	**(15,337)**	**(11,089)**	**(8,807)**

6.7.4 Power Generation

Four counties in Region F are projected to have a steam electric power water demand over the next fifty years, including Ector, Howard, Mitchell, and Ward Counties. Steam electric power users in Ector and Mitchell Counties are identified to have an unmet need. Table 6-4 summarizes the unmet steam electric power needs in the 2026 Region F Plan.

The Luminant Generation Company, LLC in Ector County, gets its supplies from the Great Plains Water System. The Great Plains Water System has two well fields, one in Gaines County and one in Andrews County. The Andrews County well field has supply limitations due to the MAG that causes a shortage for the Luminant Generation Company, LLC beginning in 2030. There are few options to meet this shortage. As a result, steam electric power will have an unmet need due to the shortage from the Luminant power plant. It is anticipated that the Luminant power plant will continue to develop groundwater as needed, even if it exceeds the MAG.

Unmet steam electric power needs in Mitchell County are associated with two proposed FGE Texas Power facilities. These facilities do not currently exist, and development is dependent upon market conditions and other economic factors. If FGE does develop a new power plant in Mitchell County, the source of water supply is unknown as the water supply resources in Mitchell County are limited. In the past, there have been discussions about purchasing wastewater from Colorado City. However, this would be dependent on the power plants coming to fruition and all parties reaching mutually agreeable terms. Because of the uncertainty of the demand and the source of supply, no strategy is recommended. Therefore, a portion of the demand for steam electric power in Mitchell County remains unmet. However, some of this need may never come to fruition if FGE does not move forward with the two new facilities.

Table 6-4
Unmet Steam Electric Power Needs in Region F

Water User Group	2030	2040	2050	2060	2070	2080
Ector	(139)	(104)	0	0	0	0
Mitchell	(3,801)	(3,885)	(3,969)	(4,035)	(4,099)	(4,165)
Total	**(3,940)**	**(3,989)**	**(3,969)**	**(4,035)**	**(4,099)**	**(4,165)**

6.8 Consistency with Protection of Public Health and Safety

Consistent with the guiding principles for regional water planning, the Region F Water Plan protects the public health and safety of current and future residents in the region.

The City of Andrews has limited supplies to serve future municipal water needs without exceeding the MAG. This plan is unable to show the full supply amount expected from future groundwater development strategies for this entity because of this limitation. As a result, the City of Andrews shows an unmet municipal need in this plan. However, the City of Andrews is planning to pursue the development of additional groundwater above the MAG in order to protect the public health and safety of their residents. Andrews is able to do this because there is no GCD limit on groundwater production within Andrews County.

The City of Eden shows an unmet need because the MAG in Concho County severely limits the supplies from the Hickory Creek Aquifer creating an artificial shortage for regional planning purposes where supplies are not allowed to exceed the MAG. This may represent an error in the estimated pumping used when developing the MAG. The City of Eden is not planning to pursue any additional strategies since their current wells provide adequate supply for the city.

Several smaller WUGs in Region F are currently considering multiple options to meet future water supplies but have no concrete plans or timelines to do so. These WUGs include Winters and North Runnels WSC (who purchases all of their water from Winters). Other municipal water providers are in the process of evaluating potential plans for additional water supplies, but it is unlikely the strategies would be implemented by 2030, leading to an unmet need in that decade. These entities include Balmorhea, Junction, Madera Valley WSC, Pecos City, and Robert Lee.

The Region F RWPG is unaware of any plans to amend the plan to address these unmet municipal needs. However, conditions may change and cause an entity to request such a change, or the entity may choose to wait to incorporate any new information (such as modification of the MAGs) in the 2031 Regional Water Plans.

Conservation was considered and recommended as a strategy to help reduce the unmet needs and protect the human health and safety of the residents of Andrews, Balmorhea, Eden, Junction, Madera Valley WSC, North Runnels WSC, Pecos City, Robert Lee, and Winters. Drought management was also considered for all entities but was not considered feasible for meeting long-term growth in demands. Instead, it is intended and encouraged to be used as means to reduce water usage during drought emergencies through the implementation of the entity's Drought Contingency Plan. Table 6-5 below summarizes all municipal unmet needs in Region F.

Table 6-5
Municipal Unmet Needs

Water User Group	2030	2040	2050	2060	2070	2080
Andrews	(401)	(1,025)	(2,169)	(3,462)	(4,808)	(6,234)
Balmorhea	(15)	0	0	0	0	0
Eden	(445)	(430)	(416)	(402)	(392)	(385)
Junction	(210)	0	0	0	0	0
Madera Valley WSC	(7)	0	0	0	0	0
North Runnels WSC	(113)	(121)	(128)	(136)	(147)	(159)
Pecos City	(1,296)	0	0	0	0	0
Robert Lee	(53)	0	0	0	0	0
Winters	(174)	(165)	(154)	(147)	(137)	(126)
Total	**(2,714)**	**(1,741)**	**(2,867)**	**(4,147)**	**(5,484)**	**(6,904)**

6.9 Consistency with Economic Development

Consistent with the guiding principles for regional water planning, the Region F Water Plan provides for further economic development of the region through water supply development for manufacturing and industrial use as well as increasing municipal demands associated with economic growth. The only unmet manufacturing need in Region F is in Andrews County. Similar to other entities in Andrews County, limited groundwater supplies under the MAG prohibit showing groundwater development as a recommended strategy, thus causing this unmet need. However, manufacturing users in Andrews County can pursue groundwater development of additional supplies above the MAG to meet all future water needs since production is not limited by a GCD. Table 6-6 shows the manufacturing unmet need in Region F.

Table 6-6
Manufacturing Unmet Needs

Water User Group	2030	2040	2050	2060	2070	2080
Andrews	(70)	(140)	(184)	(218)	(249)	(279)

6.10 Consistency with State Water Planning Guidelines

To be considered consistent with long-term protection of the State's water, agricultural, and natural resources, the Region F Water Plan must be determined to be in compliance with the following regulations:

- 31 TAC Chapter 357.35
- 31 TAC Chapter 357.40
- 31 TAC Chapter 357.41
- 31 TAC Chapter 357.50
- 31 TAC Chapter 358.3

The information, data, evaluation, and recommendations included in the 2026 Region F Water Plan collectively comply with these regulations. To assist with demonstrating compliance, Region F has completed the TWDB IPP checklist, which addresses the specific recommendations contained in the above referenced regulations. The content of the Region F Water Plan has been evaluated against this checklist and the results are presented in Appendix A.

6.11 Summary of the Protections of the State's Resources

The RWPG balanced meeting water shortages with good stewardship of water, agricultural, and natural resources within the region. During the strategy selection process, long-term protection of the State's resources was considered through assessment of environmental impacts, impacts to agricultural and rural areas and impacts to natural resources. These evaluations are documented in Appendices C and E.

In this plan, existing in-basin or regional surface water and groundwater supplies were utilized as feasible before recommendations for new water supply projects. Wastewater reuse is also an active water source to meet long-term needs in Region F. The plan assumes that this resource will be fully utilized to meet the growing demands in the region. The proposed conservation measures for municipalities, irrigators, and mining operators will continue to protect and conserve the State's resources for future water use.

LIST OF REFERENCES

[1] U.S. Army Corps of Engineers. *Fort Worth District: Navigable Waters of the United States in the Fort Worth, Albuquerque, and Tulsa Districts within the State of Texas*, December 20, 2011.

7 DROUGHT RESPONSE INFORMATION, ACTIVITIES, AND RECOMMENDATIONS

During the past century, recurring drought has been a natural part of Texas' varying climate, especially in the arid and semi-arid regions of the state. An old saying about droughts in west Texas is that "droughts are continual with short intermittent periods of rainfall." Droughts, due to their complex nature, are difficult to define and understand, especially in a context that is useful for communities that must plan and prepare for drought. Drought directly impacts the availability of ground and surface water supplies for agricultural, industrial, municipal, recreational, and designated aquatic life uses. The location, duration, and severity of drought determine the extent to which the natural environment, human activities, and economic factors are impacted.

Geography, geology, and climate vary significantly from east to west in Region F. Ecoregions within Region F vary from the Edwards Plateau to the east, Central Great and Western High Plains in the central and northern portions of the region, and Chihuahuan Deserts to the west. Annual rainfall in Region F ranges from an average of more than 30 inches in the east to slightly more than 11 inches in the west. Likewise, the annual gross reservoir evaporation rate ranges from 60 inches in the east to approximately 75 inches in the western portion of the region.

Numerous definitions of drought have been developed to describe drought conditions based on various factors and potential consequences. In the simplest of terms, drought can be defined as "a prolonged period of below-normal rainfall." However, the State Drought Preparedness Plan provides more specific and detailed definitions shown in the box below.

These definitions are not mutually exclusive, and provide valuable insight into the complexity of droughts and their impacts. They also help to identify factors to be considered in the development of appropriate and effective drought preparation and contingency measures.

Types of Drought

- **Meteorological Drought.** A period of substantially diminished precipitation duration and/or intensity that persists long enough to produce a significant hydrologic imbalance.

- **Agricultural Drought.** Inadequate precipitation and/or soil moisture to sustain crop or forage production systems. The water deficit results in serious damage and economic loss to plant and animal agriculture. Agricultural drought usually begins after meteorological drought but before hydrological drought and can also affect livestock and other agricultural operations.

- **Hydrological Drought.** Refers to deficiencies in surface and subsurface water supplies. It is measured as streamflow, and as lake, reservoir, and groundwater levels. There is usually a lack of rain or snow and less measurable water in streams, lakes, and reservoirs, making hydrological measurements not the earliest indicators of drought.

- **Socioeconomic Drought.** Occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts have often been described as "insidious by nature." This is mainly due to several factors:

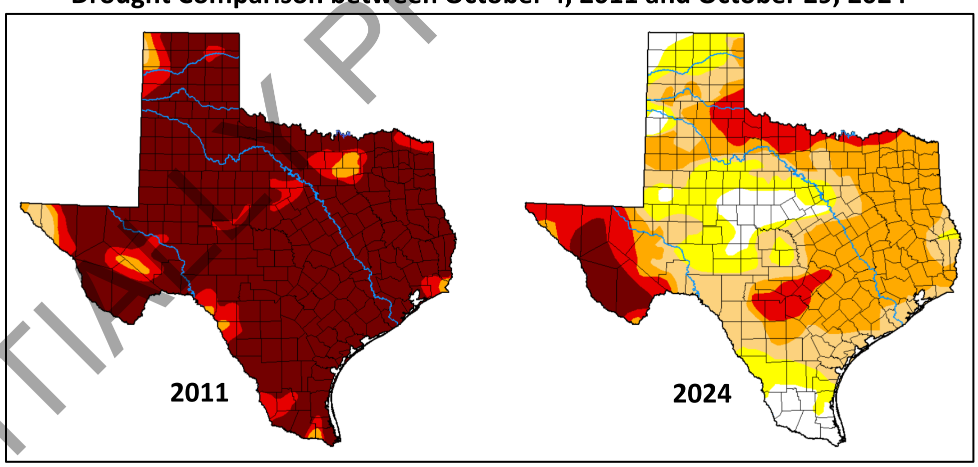
- Droughts cannot be accurately characterized by well-defined beginning or end points.
- Severity of drought-related impacts is dependent on antecedent conditions, as well as ambient conditions such as temperature, wind, and cloud cover.
- Droughts, depending on their severity, may have significant impacts on human activities; and human activities during periods of drought may exacerbate the drought conditions through increased water usage and demand.

Furthermore, the impact of a drought may extend well past the time when normal or above-normal precipitation returns.

7.1 Drought of Record in the Regional Water Planning Area (RWPA)

Various indices have been developed in an attempt to quantify drought severity for assessment and comparative purposes. One numerical measure of drought severity that is frequently used by many federal and state government agencies is the Palmer Drought Severity Index (PDSI). It is an estimate of soil moisture that is calculated based on precipitation and temperature. Another measure is the Drought Monitor that incorporates measurement of climate, hydrologic and soils conditions as well as site specific observations and reports. The Drought Monitor is distributed weekly and is often the tool used to convey drought conditions to the public and water users. In 2011, all counties of Region F experienced at least some periods of severe or extreme drought. Conditions have improved since 2011 but the Region is still experiencing ongoing drought conditions as indicated in Figure 7-1.

Figure 7-1
Drought Comparison between October 4, 2011 and October 29, 2024



7.1.1 Drought of Record in Region F

The drought of record is commonly defined as the worst drought to occur in a region during the entire period of meteorological record keeping. For most of Texas, the drought of record occurred from 1950 to 1957. During the 1950's drought, many wells, springs, streams, and rivers went dry and some cities had to rely on water trucked in from other areas to meet drinking water demands. By the end of 1956, 244 of the 254 Texas counties were classified as disaster areas due to the drought, including all of the counties in Region F.

During the past decade, most regions of Texas have experienced droughts resulting in diminished water supplies for agricultural and municipal use, decreased flows in streams and reservoirs, and significant economic loss. Droughts of severe to extreme conditions occurred in the 1950s, 1990s, 2000s, and 2010s in Region F. The worst year during the recent drought was 2011, when most Region F counties experienced extreme drought. Despite some improvements from the worst part of 2011, drought conditions continue to persist throughout the region today.

For reservoirs, the drought of record is defined as the period that includes the minimum content of the reservoir when a reservoir is diverting its firm yield. The period is recorded from the last time the reservoir was full before reaching its minimum content to the next time the reservoir is full. If a reservoir has reached its minimum content but has not yet filled, then it is considered to still be in drought of record conditions. The droughts of record based on water availability modeling for the reservoirs in Region F are shown below in Table 7-1. The model uses TCEQ's Colorado Basin full authorization run with the "cutoff" subordination of the lower basin, a period of record from 1940 through 2016, and with each reservoir diverting their safe yield. Based on this modeling, most of the reservoirs in Region F are currently experiencing a new drought of record. The minimum content of most of the reservoirs occurs between 2011 and 2015. The drought of record is listed as "ongoing" for 12 of the 19 reservoirs in Table 7-1. The yields of these reservoirs could be further reduced if the reservoirs do not fill and the region experiences further extreme drought conditions.

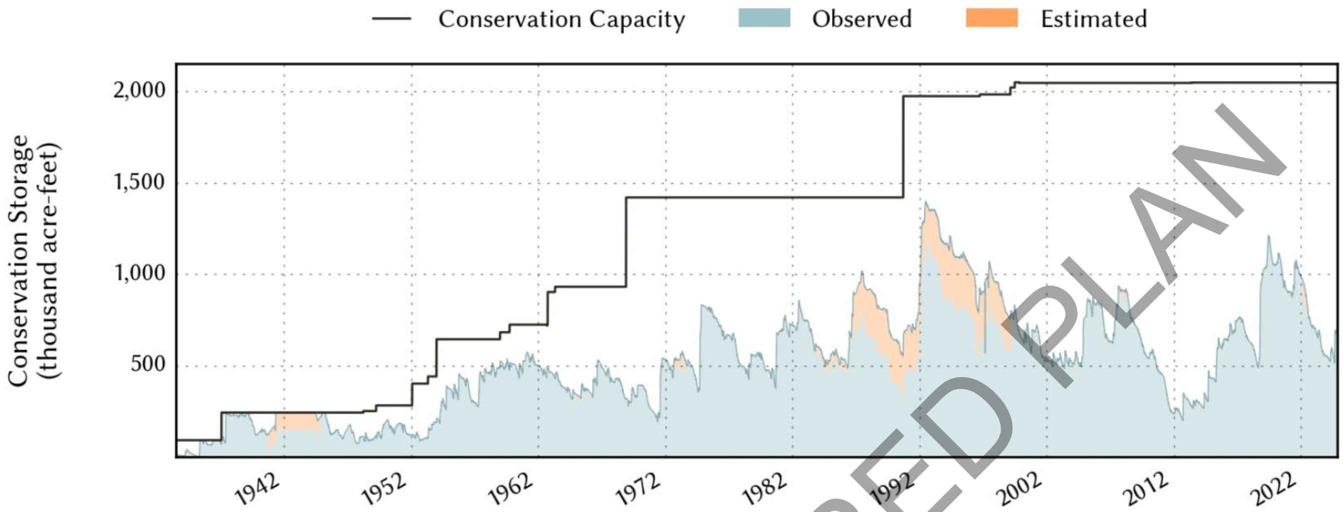
Table 7-1
Modeled Droughts of Record in Region F

Reservoir	Date last full before Minimum in WAM	Date of minimum content in WAM	Drought of Record based on the WAM [a]
Ballinger/Moonen	March 2008	August 2012	2008 – Ongoing
Balmorhea	February 1997	September 2000[b]	1997 – 2000
Brady Creek	March 1998	June 2013	1998 – Ongoing
Brownwood	July 2007	September 2011	2007 – Ongoing
Champion Creek	May 1987	September 2015	1987 – Ongoing
Coleman	August 2007	May 2015	2007 – 2016
Colorado City	May 1994	May 2003	1994 – 2016
Hords Creek	July 2007	May 2015	2007 – 2016
Lake Clyde	September 2007	May 2015	2007 – 2016
Mountain Creek	September 2007	August 2012	2007 – Ongoing
Nasworthy	April 2008	April 2014	2008 – 2014
Oak Creek	June 1997	April 2015	1997 – Ongoing
O.C. Fisher	June 1987	April 2015	1987 – Ongoing
O.H. Ivie	June 1997	April 2014	1997 – Ongoing
Red Bluff	March 1943	September 2000[b]	1943 – 2000
Spence	June 1992[c]	August 2014	1992 – Ongoing
Thomas	July 1987	August 2014	1962 – Ongoing
Twin Buttes	March 1993	April 2014	1993 – Ongoing
Winters	June 1997	August 2012	1997 – Ongoing

a. The period of record for the WAM is 1940-2016. "Ongoing" means, within the simulation, the reservoir had not filled up as of December 31, 2016.
b. Hydrologic input data for the Rio Grande River Basin WAM simulations end in 2000. The hydrology was not extended.
c. Spence reservoir has never filled. The Date Last Full is based on the firm yield analyses.

TWDB generated Figure 7-2, which is another perspective of reservoir storage in the region during the most recent drought[1].

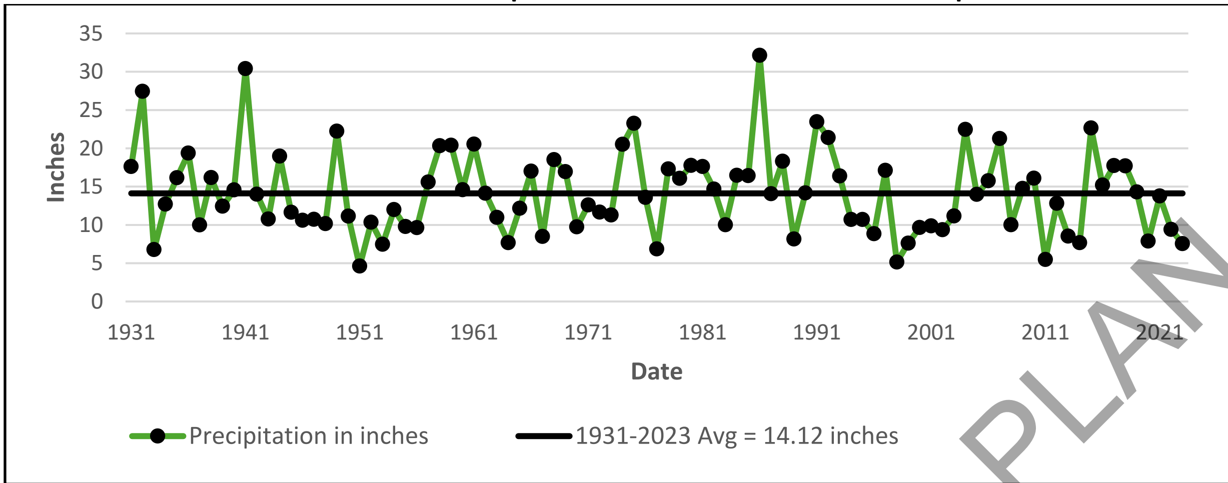
Figure 7-2
TWDB Region-F Planning Region Reservoirs



Drought of record conditions for run of the river supplies are typically evaluated based on minimum annual stream flows.

For groundwater, meteorological and agricultural conditions were considered for defining the drought of record in Region F. The National Atmospheric and Oceanic Administration (NOAA) maintains data on the historical meteorological conditions and drought indices across the country. Figure 7-4 shows the historical precipitation for Midland, Texas[3]. As is typical in Texas, the average annual precipitation in Region F increases from west to east. Midland is further west, and averages about 14.12 inches a year over the period shown. The years with the lowest historical precipitation occurred in 1951, 1998, and 2011. In 1951, 4.60 inches were recorded and 5.14 inches were recorded in 1998. In 2011, 5.47 inches were recorded. For both the 1950's drought and the recent drought, annual rainfall was significantly below average for an extended number of years. The current drought rivals the 1950's drought. Seven of the last fifteen years show rainfall less than the historical average. This is similar to the drought of the 1950s.

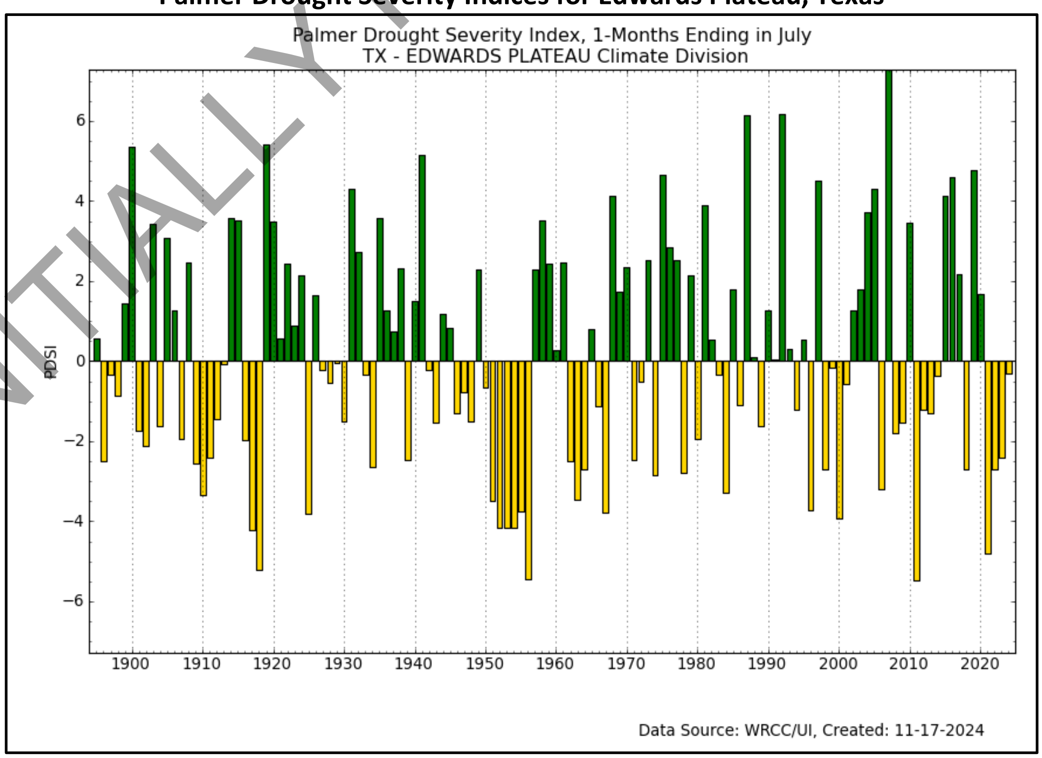
Figure 7-3
Historical Annual Precipitation at Midland International Airport



Looking at the Palmer Drought Severity Indices over the same time period for Climate Region 6 (where most of Region F is located), Figure 7-5 clearly shows the drought impacts during the 1950s and again since 2011[4]. The Palmer Drought Severity Indices (PDSI) provide a measurement of long-term drought based on the intensity of drought during the current month plus the cumulative patterns of previous months. It considers antecedent soil moisture and precipitation. For Region F, these considerations are important in assessing the potential impacts to groundwater sources during drought from increases in water demands and agricultural water needs.

Considering both the annual precipitation and PDSI in the region, the drought of record for groundwater and run of the river sources is still the drought of the 1950s, although the droughts that began in 2011 and 2022 are nearly as severe.

Figure 7-4
Palmer Drought Severity Indices for Edwards Plateau, Texas



7.1.2 Impacts of Drought on Water Supplies

Drought is a major threat to surface water supplies in Region F. For surface water, hydrological drought is significant because it impacts the yield of water sources. Typically, multi-year droughts have the greatest impact on a reservoir yield. Impacts of the new drought on reservoir yields in Region F using WAM Run 3 (no subordination) are negligible in most cases where the yields were already at or near zero. Impacts are more readily seen with the subordination strategy, which is discussed in Chapter 5C. With subordination, the analysis showed that most of the Colorado Basin reservoirs in Region F are currently experiencing new ongoing drought-of-record conditions (as of 2016, the last year of WAM hydrology). As a result of this drought, many reservoirs have shown reductions in yield and may continue to decline if drought persists.

Drought can also be a major threat to groundwater supplies that rely heavily on recharge. While some aquifers are less impacted by reduced recharge, others may be heavily impacted by the ongoing agricultural drought which can increase the demands on these sources. Furthermore, the reduced reliability of surface water sources in the region from the drought has caused many to shift to groundwater sources to secure a more drought-tolerant source of water supply. Over time the increased demands can impact the amount of storage in the aquifers for future use.

7.2 Current Drought Preparations and Response

In 1997, the Texas Legislature directed the TCEQ to adopt rules establishing common drought plan requirements for water suppliers in response to drought conditions throughout the State. Since 1997, the TCEQ has required all wholesale public water suppliers, retail public water suppliers serving 3,300 connections or more, and irrigation districts to develop, implement, and submit Drought Contingency Plans (DCPs) every five years. The most recent updates were to be submitted to the TCEQ by May 1, 2024. Retail public water suppliers serving less than 3,300 connections must prepare and adopt a DCP but are not required to submit plans to TCEQ. All DCPs should be made available for inspection by TCEQ. DCPs typically identify different stages of drought (e.g., mild, moderate, severe) and specific triggers and responses for each stage. In addition, DCPs specify quantifiable targets for water use reductions for each stage, and a means and method for enforcement.

Most wholesale water providers and municipalities in Region F have taken steps to prepare for and respond to drought through efforts, including the preparation of individual DCPs and readiness to implement them as necessary. Region F DCPs include specific water savings goals and drought contingency measures associated with multiple drought stages. In addition to these Plans, many water providers have a Management Supply Factor (i.e., the desired ratio of supplies to demand) greater than 1.0 for demands that are essential to public health and safety.

7.2.1 Drought Preparedness

Frequent recurring drought is a fact of life in Region F. Droughts have occurred in almost every decade since the 1940s. Recent experience with critical drought conditions attests to the effectiveness of drought management in the region. These reductions are at least partially due to the implementation of drought response activities included in the municipality's drought plan. However, according to city officials, the most significant factor in reducing water consumption is public awareness of drought conditions and voluntary reductions in water use. Some cities are pursuing aggressive water conservation programs that include using xeriscaping and efficient irrigation practices for public properties such as parks and buildings, and reuse of treated effluent for municipal and manufacturing supplies.

In general, water suppliers in Region F identify the onset of drought (set drought triggers) based on either their current level of supply or their current level of demand. Often the triggers for surface water reservoirs are based on the current capacity of the reservoir as a percentage of the total reservoir capacity. In Region F, the reservoir operators use a combination of reservoir storage (elevation triggers) and/or demand levels. Triggers for groundwater supplies are commonly determined by demand as a percentage of total supply or total delivery capacity. Suppliers set these triggers as needed based on the individual parameters of their system. Customers of a wholesale water provider (WWP) are subject to the triggers and measures of the WWPs' Drought Plans.

Ten updated Drought Contingency Plans (DCPs) were either submitted to Region F or adopted by an entity during this round of planning. The majority of these DCPs use trigger conditions that are supply-based, while the rest either use triggers that are based on the demands placed on the water system or are a combination of multiple conditions. Table 7-2 summarizes the basis of the drought triggers by provider. Appendix G, Table G-1 summarizes the triggers and actions by water provider for initiation and response to drought.

Table 7-2
Type of Trigger Condition for Entities with Drought Contingency Plans Submitted to the Region F Planning Group

Entity	Type Trigger Conditions	
	Demand	Supply
Balmorhea		X
Big Spring	X	X
Brookesmith SUD	X	
Brownwood	X	X
Brown County WID 1		X
CRMWD		X
Ector County UD[a]		X
Eden[a]		X
Fort Stockton[a]	X	
Grandfalls[a]	X	
Midland	X	X
Red Bluff Power Control District[a]		X
Odessa	X	
San Angelo		X
Snyder	X	X
Sonora[a]	X	X
UCRA[a]		X
Winters		X

a. Data from 2021 RWP

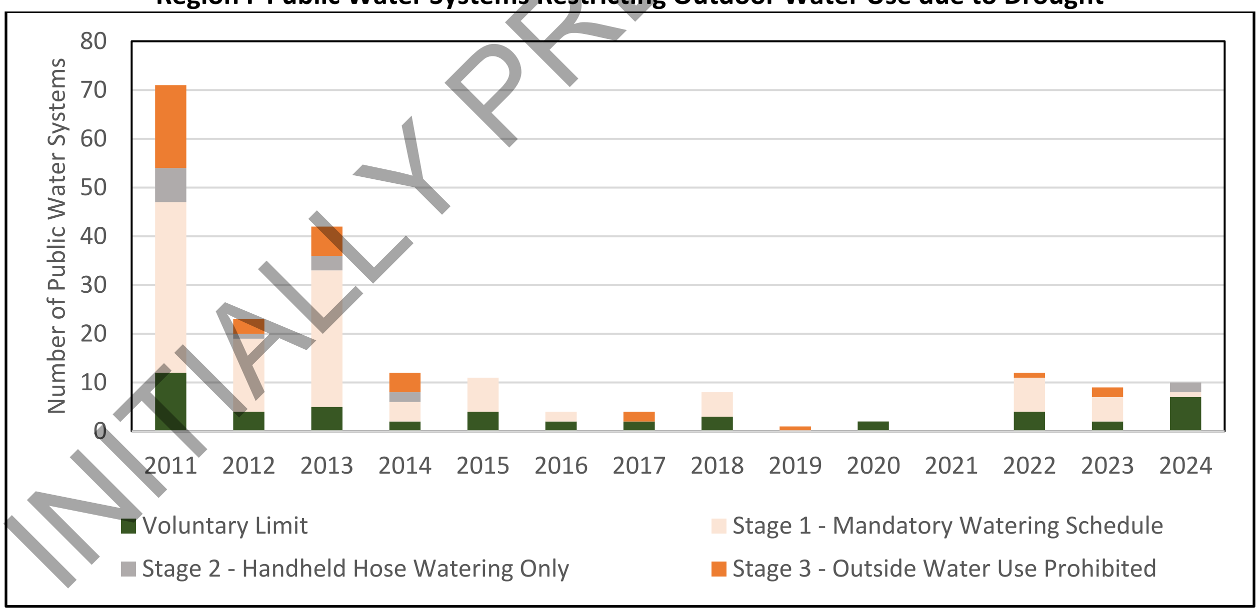
Challenges to the drought preparedness in Region F include the resources available to smaller cities to adequately prepare for drought and respond in a timely manner. Also, for many cities the drought of 2011 truly tested the entity's drought plan and triggers. Some water providers found that the triggers were not set at the appropriate level to initiate different stages of the drought plan. The 2011 drought came quickly and was very intense. This increased demands on local resources and for many groundwater users increased competition for the water. Some systems had difficulty meeting demands and little time to make adjustments.

Many water providers of surface water sources have proactively developed supplemental groundwater sources, providing additional protections during drought. Many of the groundwater users have expanded groundwater production or are planning to develop additional groundwater in response to the ongoing drought. Groundwater in Region F provides a more drought-resilient water source, but it needs to be managed to assure future supplies.

7.2.2 Recent Implementation of Drought Contingency Measures in Region F

TCEQ collects data on Texas public water systems (PWSs) that reported water use restrictions and priority levels due to drought or emergency conditions. The most recent list of Texas PWSs limiting water use is found here: https://www.tceq.texas.gov/drinkingwater/trot/droughtw.html. The Region F RWPG conducted an analysis of TCEQ records between May 2011 and August 2024 to determine which Region F PWSs implemented water restrictions and to what extent the restrictions were implemented. The results of this analysis are shown in Figure 7-6. The impacts of the 2011 drought and continuing dry conditions through 2013 are apparent, as nearly 150 Region F PWSs reported water use restrictions during that time span. Reports decreased significantly since 2016, with zero reports in 2021, before increasing again in 2022. Between 2022 and August 2024, 14 unique Region F PWSs reported water use restrictions. Two PWSs in 2024 reported that the remaining water supply available to their system was insufficient to meet at least 90 days of demand.

Figure 7-5
Region F Public Water Systems Restricting Outdoor Water Use due to Drought



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 Region F.

7.3.1 Existing Emergency Interconnects

Major water infrastructure facilities within Region F were identified to better evaluate existing and potentially feasible emergency interconnects. Most interconnections provide water to a specific recipient. Pecos County WCID and the City of Fort Stockton have an interconnection that can move water to or from each entity. In addition, two of the four systems within Concho Rural Water North Concho Lake Estates system are linked. Table 7-3 presents existing emergency interconnects among water users and neighboring systems.

Table 7-3
Existing Emergency Interconnects to Major Water Facilities in Region F

Entity *Providing* Supply	Entity *Receiving* Supply
CRMWD	Monahans[a]
Millersview-Doole WSC	City of Paint Rock[a]
City of San Angelo	Millersview-Doole WSC
City of Fort Stockton	Pecos Co. WCID 1
Pecos Co. WCID #1	City of Fort Stockton
CRWC Grape Creek	Concho Rural Water N. Concho Lake Estates
Concho Rural Water N. Concho Lake Estates	Red Creek MUD
Zephyr WSC	City of Blanket
City of Odessa	Steam Electric Power (Ector County)
City of Ballinger	North Runnels WSC

a. Data from 2021 RWP

7.3.2 Potential Emergency Interconnects

There is potential for other emergency interconnects between various WUGs in Region F. Table 7-4 presents a list of cities for those receiving and those supplying the potential emergency interconnects. Emergency interconnects were found to be not practical for many of the entities that were evaluated for potential emergency water supplies. The type of infrastructure required between entities to provide or receive water during an emergency shortage was deemed impractical due to long transmission distances. Furthermore, it was deemed impractical during an emergency situation, to complete the required construction in a reasonable timeframe.

Table 7-4
Potential Emergency Interconnects to Major Water Facilities in Region F

Entity *Providing* Supply	Entity *Receiving* Supply
CRMWD (O.H. Ivie Lake)	Ballinger
Midland County FWSD#1	Greater Gardendale WSC
Texland Great Plains WSC	City of Andrews
Millersview-Doole WSC	City of Miles
CRMWD	Wickett

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 2030 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. 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. This review was limited and did not require technical analyses or evaluations in accordance with 31 TAC §357.34.

7.4.1 Emergency Responses to Local Drought Conditions

A survey was conducted to identify and evaluate the municipal water users that are most vulnerable in the event of an emergency water shortage. The analysis included County-Other WUGs and rural cities with a population less than 7,500 and on a sole source of water. A sole source is defined here as a single well field or single surface water source. If an entity receives water from a single wholesale provider with only one source, they were considered as part of this analysis. If an entity receives water from a single wholesale provider who has multiple sources, they were not considered to have a sole source and were not included in this analysis. Additionally, based on the recommendations of the Drought Preparedness Council, Region F included any entities that have been on the 180 days or less of remaining water supply list from TCEQ since 2011. Table 7-5 presents potential temporary responses that may or may not require permanent infrastructure. It was assumed in the analysis that the entities listed would have approximately 180 days or less of remaining water supply.

Releases from Upstream Reservoirs and Curtailment of Rights

Releases from upstream reservoirs and curtailment of water rights was considered as a temporary measure that may help increase water supplies during an emergency water shortage. This response was only considered for those entities who receive surface water and may not be viable for all water right holders. Surface water in Texas is operated on a priority system and the water right holder may have no legal authority on which to request a release from an upstream reservoir or the curtailment of other water rights if their rights are junior. Even if the water user has a senior water right, in some cases, these strategies may result in what is known as a futile call. This occurs if shutting down a junior water right will not actually result in water being delivered to the senior right. In which case, the call will not be enforced.

Brackish Groundwater

Brackish groundwater was evaluated as a temporary source during an emergency water shortage. Some brackish groundwater is found in certain places in the Ogallala, the Dockum, Hickory, Ellenburger-San Saba, Lipan, Capitan Reef, Pecos Valley Alluvium and other formations which underlie shallow aquifers. Required infrastructure would include additional groundwater wells, potential treatment facilities and conveyance facilities. Brackish groundwater at lower TDS concentrations may require only limited treatment. Twelve of the entities listed in Table 7-5 may not be able to potentially use brackish groundwater as a feasible solution to an emergency local drought condition.

Drill Additional Local Groundwater Wells and Trucking in Water

If existing water supply sources become temporarily unavailable, possible solutions include drilling additional groundwater wells or trucking in water. Table 7-5 presents this option as viable for all entities listed.

Table 7-5
Emergency Responses to Local Drought Conditions in Region F

Entity				Implementation Requirements									
Water User Group	County	2030 Population	2030 Demand (AF/YR)	Release from upstream reservoir	Curtailment of water rights	Local groundwater wells	Brackish groundwater limited treatment	Brackish groundwater desalination	Emergency interconnect	Trucked - in water	Type of infrastructure required	Entity providing supply	Emergency agreements already in place
Bangs	Brown	2,776	346			▪	▪		▪	▪			
Barstow	Ward	265	154			▪				▪			
Big Lake	Reagan	2,996	760			▪	▪	▪		▪			
Colorado City	Mitchell	6,600	1,650			▪	▪			▪			
Coke County WSC[a]	Coke	N/A				▪				▪			
Crockett Co. WCID 1	Crockett	2,270	995			▪	▪			▪			
DADS Supported Living Center	Tom Green	427	183			▪				▪			
Early	Brown	3,352	454			▪	▪		▪	▪	Pipeline	Brownwood	
Eldorado	Schleicher	1,527	474			▪				▪			
Grandfalls	Ward	396	225			▪				▪			
Greater Gardendale WSC	Ector	3,053	242			▪	▪	▪		▪			
	Midland	1,910	151			▪	▪	▪		▪			
Greenwood Water	Midland	872	221			▪	▪			▪			
Iraan	Pecos	1,034	364			▪	▪	▪	▪	▪	Pipeline; PS; Treatment	Pecos Co. Precinct #3	
Junction	Kimble	2,243	523			▪	▪	▪		▪			
Kermit	Winkler	7,184	2,169			▪	▪	▪	▪	▪	Pipeline; PS; Treatment	Midland Freshwater District /WRTA	

Entity	Implementation Requirements												
Water User Group	County	2030 Population	2030 Demand (AF/YR)	Release from upstream reservoir	Curtailment of water rights	Local groundwater wells	Brackish groundwater limited treatment	Brackish groundwater desalination	Emergency interconnect	Trucked - in water	Type of infrastructure required	Entity providing supply	Emergency agreements already in place
Loraine	Mitchell	587	188			▪				▪			
Madera Valley WSC	Reeves	1,905	832			▪	▪	▪		▪			
Mason	Mason	2,189	709			▪				▪			
McCamey	Upton	1,688	685			▪	▪	▪		▪			
Menard	Menard	1,120	257			▪	▪			▪			
Mertzon	Irion	657	78			▪	▪			▪			
Mitchell Co. Utility	Mitchell	2,715	503			▪	▪			▪			
Park Water[a]	Midland	N/A				▪				▪			
Pecos Co. Fresh Water	Pecos	675	252			▪				▪			
Pecos Co. WCID #1	Pecos	2,126	585			▪	▪	▪	▪	▪	Pipeline	Ft. Stockton	▪
Rankin	Upton	740	260			▪				▪			
Santa Anna	Coleman	950	128			▪	▪			▪			
Robert Lee[a]	Coke	999	276			▪				▪			
Sonora	Sutton	2,169	1,048			▪				▪			
Southwest Sandhills WSC	Ward	2,466	378			▪	▪			▪			
Sterling City	Sterling	1,425	411			▪	▪	▪		▪			
Tom Green Co. FWSD 2[a]	Tom Green	N/A				▪				▪			
Tom Green Co. FWSD 3	Tom Green	667	114			▪				▪			
Twin Buttes WS[a]	Tom Green	N/A				▪				▪			

Entity	Implementation Requirements												
Water User Group	County	2030 Population	2030 Demand (AF/YR)	Release from upstream reservoir	Curtailment of water rights	Local groundwater wells	Brackish groundwater limited treatment	Brackish groundwater desalination	Emergency interconnect	Trucked - in water	Type of infrastructure required	Entity providing supply	Emergency agreements already in place
Warren Road Subdivision WS[a]	Midland	N/A				▪				▪			
Wickett	Ward	448	194			▪				▪			
Wink	Winkler	794	341			▪	▪	▪		▪			
Winters	Runnels	2,367	359			▪		▪	▪	▪	Pipeline	Abilene (Ivie Pipeline)	
Zephyr WSC	Brown	4,044	572			▪	▪			▪			▪

a. Entity has reported 180 days or less of remaining water supply to TCEQ since 2011.

7.5 Region Specific Drought Response Recommendations and Model Drought Contingency Plans

As required by the TWDB, the RWPG (Regional Water Planning Group) shall develop drought recommendations regarding the management of existing groundwater and surface water sources. These recommendations must include factors specific to each source as to when to initiate drought response and actions to be taken as part of the drought response. These actions should be specified for the manager of a water source and entities relying on the water source. The RWPG has defined the manager of water sources as the entity that controls the water production and distribution of the water supply from the source. For purposes of this assessment, a manager must also meet the TCEQ requirements for development of a Drought Contingency Plan. Entities that rely on the water sources include customers of the water source manager and direct users of the water sources, such as irrigators.

A list of each surface water and groundwater source in Region F and the associated managers and users of the source is included in Table G-2 in Appendix G.

In addition, the RWPG must identify unnecessary or counterproductive variations in specific drought response strategies, including outdoor watering restrictions, among user groups in the regional water planning area that may confuse the public or otherwise impede drought response efforts. The Region F RWPG recognizes the benefit of additional coordination between drought responses within more urban planning areas where people living in very close proximity to one another may have different outdoor water restrictions. However, this situation does not occur in Region F. Region F maintains that DCPs developed by the local, individual water providers are the best available tool for drought management. Region F fully supports the use and implementation of individual DCPs during times of drought and did not find the differences in local response to be unnecessary or counterproductive.

7.5.1 Drought Trigger Conditions for Surface Water Supply

Drought trigger conditions for surface water supply are customarily related to reservoir levels. Region F acknowledges that the Drought Contingency Plans for the suppliers who have surface water supplies are the best management tool for these water supplies. The RWPG recommends that the drought triggers and associated actions developed by the regional operator of the reservoirs are the Region F regional triggers for these sources. A summary of these triggers and actions for major Region F reservoirs follows as defined by each source manager. Triggers and actions for other reservoirs are included in Table G-3 in Appendix G. The region also recognizes any modification to these drought triggers that are adopted by the regional operator.

Lake Brownwood (Brown County WID #1)

BCWID #1 adopted their current Drought Contingency Plan in April of 2024. The triggers and actions are related to the elevation of Lake Brownwood and are summarized below in Table 7-6.

Table 7-6
Lake Brownwood Triggers and Actions

Drought Stage	Trigger	Action
Mild	Elevation below 1,420 ft. (76% capacity)	Advise customer of early conditions. Initiate Stage I of DCPs. Increase public education. Request voluntary conservation measures.
Moderate	Elevation below 1,417 ft. (64% capacity)	Request decrease in water usage. Implement watering restrictions. Request monitoring of irrigation facilities. District may reduce water delivery in accordance with pro rata curtailment.
Severe	Elevation below 1,414 ft. (52% capacity)	Request to severely reduce water usage. Watering restrictions. May conduct site visits to irrigation facilities. District may reduce water delivery in accordance with pro rata curtailment. May utilize alternative water sources, with TCEQ approval.
Exceptional	Elevation below 1,411 ft. (43% capacity)	District may call an emergency meeting with customers. Completely restrict watering. District may evaluate the need to discontinue delivery of water for second crops and non-essential uses. May reduce water delivery in accordance with pro rata curtailment. May utilize alternate water sources, with TCEQ approval.
Emergency	Elevation below 1,408 ft. (34% capacity)	Same as the Exceptional drought stage. Any other necessary actions.

O.H. Ivie Reservoir (CRMWD)

The Board of Directors of CRMWD adopted their current Drought Contingency Plan in April 2024. In CRMWD's DCP, drought contingency triggers and actions are separated into two categories: the non-system portion of the O.H. Ivie Reservoir (Ivie) and the remaining CRMWD System. Triggers for these two categories are associated with their respective storage capacities. The triggers and actions related to the capacities of the O.H. Ivie Reservoir are outlined below in Table 7-7.

Table 7-7
O.H. Ivie Reservoir Drought Triggers and Actions

Drought Stage	Trigger	Action[a]
Mild	Capacity below 184,936 ac-ft.	Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on Ivie water to implement Stage 1 of their DCP.
Moderate	Capacity below 138,702 ac-ft.	Continue or initiate actions under Stage 1. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 2 of their DCP.
Severe	Capacity below 92,468 ac-ft.	Continue or initiate actions under Stage 1 and 2. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 3 of their DCP.
Critical	Pipeline break, equipment failure, or source contamination that severely limits distribution capacity.	Assess the severity of the problem and identify actions and time needed to resolve it. Inform responsible officials for each wholesale water customer and suggest actions to alleviate problems. If appropriate, notify city, county, and/or state emergency response officials. Undertake necessary actions. Prepare a post-event assessment report.

a. During each stage, the following actions may be implemented by the District:
(1) Contact wholesale water customers monthly to discuss water supply and/or demand actions.
(2) Requesting wholesale water customers to reduce non-essential water use.
(3) Discussing the possibility of pro rata curtailment of water diversions and/or deliveries.
(4) Preparing a monthly water usage allocation baseline for each wholesale customer.

CRMWD System (CRMWD)

The CRMWD System includes supplies from Lake J.B. Thomas, E.V. Spence Reservoir, O.H. Ivie Reservoir, North Ward County Well Field, and the Big Spring Raw Water Production Facility. The triggers and actions related to the capacity of the CRMWD System are outlined below in Table 7-8.

Table 7-8
CRMWD System Drought Triggers and Actions

Drought Stage	Trigger	Action[a]
Mild	System capacity below 92,122 ac-ft.	Initiate studies to evaluate alternative actions if conditions worsen. Begin 'pump back' operation as needed. Request any WUG solely dependent on Ivie water to implement Stage 1 of their DCP.
Moderate	System capacity below 69,092 ac-ft.	Continue or initiate actions under Stage 1. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 2 of their DCP.
Severe	System capacity below 46,061 ac-ft.	Continue or initiate actions under Stage 1 and 2. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 3 of their DCP. Initiate Ward County Well Field System pipeline expansion project. Implement viable alternative water supplies.
Critical	Pipeline break, equipment failure, or source contamination that severely limits distribution capacity.	Assess the severity of the problem and identify actions and time need to resolve it. Inform responsible officials for each wholesale water customer and suggest actions to alleviate problems. If appropriate, notify city, county, and/or state emergency response officials. Undertake necessary actions. Prepare a post-event assessment report.

a. During each stage, the following actions may be implemented by the District:
(1) Contact wholesale water customers monthly to discuss water supply and/or demand actions.
(2) Requesting wholesale water customers to reduce non-essential water use.
(3) Discussing the possibility of pro rata curtailment of water diversions and/or deliveries.
(4) Preparing a monthly water usage allocation baseline for each wholesale customer.

O.C. Fisher, Twin Buttes, Nasworthy (San Angelo)

O.C. Fisher, Twin Buttes, and Nasworthy are all operated by the City of San Angelo. The City of San Angelo adopted their most recent Drought Contingency Plan in September of 2024. The triggers and actions in the City's DCP are based on combined storage and supply from all of the City's sources, which includes these reservoirs, as well as groundwater. These are outlined in Table 7-9 below.

Table 7-9
O.C Fisher, Twin Buttes and Nasworthy Drought Triggers and Actions

Drought Stage	Trigger	Action
Mild	Less than 24-month supply	Outdoor watering restrictions, watering schedule, water usage fees.
Moderate	Less than 18-month supply	Same as Stage 1 ("Mild" drought stage).
Critical/Emergency	Less than 12-month supply	Outdoor watering, filling of fountains or swimming pools, and/or washing of vehicles are all prohibited, water usage fees.

7.5.2 Drought Trigger Conditions for Run-of-River and Groundwater Supply

Both run-of-river and groundwater supplies are more regional than reservoirs and typically there are many users of these sources. As noted in Section 7.2, some water providers have developed Drought Contingency Plans that are specific to their water supplies. Other water users, such as agricultural or industrial users, may not have Drought Contingency Plans. To convey drought conditions to all users of these resources in Region F, the RWPG proposes to use the Drought Monitor[5]. This information is easily accessible and updated regularly. It does not require a specific entity to monitor well water levels or stream gages. It is also geographically specific so that drought triggers can be identified on a sub-county level that is consistent with the location of use. Region F has adopted the same nomenclature as the Drought Monitor for corresponding Region F drought triggers. Table 7-10 shows the categories adopted by the U.S. Drought Monitor and the associated values for the Standardized Precipitation Index (SPI) and the Standardized Precipitation-Evapotranspiration Index (SPEI).

Table 7-10
Drought Severity Classification

Category	Description	Possible Impacts	Values for SPI and SPEI
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered	-0.5 to -0.79
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested	-0.8 to -1.29
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed	-1.3 to -1.59
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions	-1.6 to -1.99
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies	-2.0 or less

SPI= Standardized Precipitation Index
SPEI= Standard Precipitation-Evaporation Index

For groundwater and run-of-river supplies, Region F recognizes that the initiation of drought response is the decision of the manager of the source and/or user of the source. Region F recommends the following actions based on each of the drought classifications listed above:

- *Abnormally Dry* – Entities should begin to review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage is necessary.
- *Moderate Drought* – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage is necessary.
- *Severe Drought* – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point if the review indicates current supplies may not be sufficient to meet reduced demands the entity should begin considering alternative supplies.
- *Extreme Drought* – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point if the review indicates current supplies may not be sufficient to meet reduced demands the entity should consider alternative supplies.
- *Exceptional Drought* – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point if the review indicates current supplies are not sufficient to meet reduced demands the entity should implement alternative supplies

7.5.3 Model Drought Contingency Plans

Model Drought Contingency Plans (DCPs) were developed for Region F and can be accessed online at www.regionfwater.org. Each plan identifies four drought stages: mild, moderate, severe and emergency. The recommended responses range from notification of drought conditions and voluntary reductions in the "mild" stage to mandatory restrictions during an "emergency" stage. Entities using the model plan can select the trigger conditions for the different stages and appropriate responses for each stage.

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 Region F, these user groups include irrigation, municipal, and mining. Region F developed Model DCPs for municipal and irrigation users, which can be accessed at http://regionfwater.org/index.aspx?id=Documents. The TCEQ does not require a DCP for mining users since mining is a private industry and is not subject to TCEQ enforcement. Thus, no model DCP was developed for mining.

7.6 Drought Management Water Management Strategies

Drought management is a temporary strategy to conserve available water supplies during times of drought or emergencies. This strategy is not recommended to meet long-term growth in demands, but rather acts as a means to minimize the potential for adverse impacts or water supply shortages during drought. The TCEQ requires Drought Contingency Plans (DCPs) for wholesale and retail public water suppliers and irrigation districts. A DCP may also be required for entities seeking state funding for water projects. Region F does not recommend specific drought management strategies. Region F recommends the implementation of DCPs by suppliers when appropriate to reduce demand during drought and prolong current supplies.

7.7 Other Drought-Related Considerations and Recommendations

7.7.1 Texas Drought Preparedness Council and Drought Preparedness Plan

In accordance with TWDB rules, 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 to minimize impacts to people and resources. Region F supports the efforts of the Texas Drought Preparedness Council and recommends that water providers regularly review the Situation Reports as part of their drought monitoring.

The Council provided three new recommendations in 2024 to all RWPGs:

- The regional water plans and state water plan shall serve as water supply plans under drought of record conditions. The DPC encourages regional water planning groups to consider planning for drought conditions worse than the drought of record, including scenarios that reflect greater rainfall deficits and/or higher surface temperatures.
- The Drought Preparedness Council encourages regional water planning groups to incorporate projected future reservoir evaporation rates in their assessments of future surface water availability.

- The Drought Preparedness Council encourages regional water planning groups to identify in their plans utilities within their boundaries that reported having less than 180 days of available water supply to the Texas Commission on Environmental Quality during the current or preceding planning cycle. For systems that appeared on the 180-day list, RWPGs should perform the evaluation required by Texas Administrative Code Section 357.42(g), if it has not already been completed for that system.

Region F considers uncertainty and planning for a drought worse than the drought of record in the next section, Section 7.7.2. Additionally, Region F added entities from the 180-day list from TCEQ to Table 7-5 which includes the evaluation required by TAC Section 357.4(g).

7.7.2 Uncertainty and Drought Worse Than Drought of Record

The Region F Regional Water Plan addresses water supply needs during a hypothetical repeat of the worst drought on record. A new drought of record, or drought worse than the current drought of record (DWDOR), is a constant threat in Region F. The regional water planning process relies on input variables (such as hydrology, supplies, demands and population) that each have their own associated ranges of uncertainty. For example, the future population served by a WUG could be more or less than projected by TWDB. A multi-scenario approach could be used to estimate yield under drought conditions worse than the drought of record. While it is possible to quantitatively assess a range of input variables including hydrology worse than the drought of record, limited regional planning resources do not support evaluating a range of possible futures (e.g. future evaporation rates) for the 2026 RWP.

The 2026 RWP has addressed known but unquantified uncertainty associated with variability in hydrology and water demands in the following ways:

- Surface water supplies are determined using a one-year safe yield for planning purposes, which is more conservative than a firm yield. In a simulation where a reservoir is diverting its safe yield, the minimum simulated storage is equal to the annual diversion; in other words, the amount of water left in the reservoir at its lowest point is equal to a one-year supply. This applies to the surface water supplies from reservoirs listed in Table 7-1. The WUGs relying on water supplies from these reservoirs are listed in Table G-2 of Appendix G.
- The Water Availability Model (WAM) used to determine surface water supplies for the region has a number of conservative assumptions built into it including full consumptive use (no return flows). In reality, some percentage of the water diverted is returned to the river in the form of wastewater discharges. Another assumption is that water rights holders attempt to divert their full permitted amounts, however water users typically do not divert 100 percent of their permitted amounts, which leaves more water available for others. This applies to surface water supplies from reservoirs and run-of-river water rights. The WUGs relying on these supplies are listed in Table G-2.
- Some WUGs and Major Water Providers (MWPs) in Region F use conjunctive use to help address uncertainty in planning for water supplies. They use surface water supplies when they are available and then use groundwater supplies during times of drought when surface water supplies are more limited. This applies to CRMWD, Midland, San Angelo, Bronte, Brady, Balmorhea and any customers of the entities listed.
- Some WUGs and Major Water Providers (MWPs) in Region F have a management supply (safety) factor greater than 1, meaning supply is developed in excess of demand. Supply factors greater than 1 provide a cushion against uncertainty in both supplies and demands. The following Major Water Providers have surplus supplies (i.e., management supply factors greater than one)

following implementation of the recommended water management strategies: Brown County WID1, CRMWD, Midland, and San Angelo.

- There are existing and potential emergency interconnects in the region detailed in Section 7.3 that could be used in the event of a drought worse than the drought of record or other emergency situations.
- The regional water planning process assumes full, unrestricted dry year demands in each decade from 2030 to 2080. However, the water user groups in Region F implement Drought Contingency Plans (DCPs) during the recurring droughts in the region. In most cases, the "severe" or "critical" drought stage would be triggered during a drought worse than the drought of record and water demand would be substantially reduced through stringent drought response measures.
- Water user groups in Region F submit updated DCPs every five years to TCEQ with evolving drought triggers and measures refined on their experience dealing with drought. Compared to the 2021 RWP, several DCPs show more sensitivity to drought for surface supply triggers, more conservative water reduction goals and additional measures for drought response. For example, the storage triggers shown in Table 7-7 and Table 7-8 increased compared to the 2021 RWP, meaning the reservoir is storing more water when the same drought stage is triggered. Table G-1 in Appendix G examines the DCPs of 19 WUGs in Region F.
- In case of a drought worse than the drought of record, the recommended water management strategies (WMSs) in the 2026 Regional Water Plan could be brought on earlier than recommended in the plan.
- The region already makes significant use of reuse water, primarily for direct non-potable uses but is also home to the first and only active direct potable reuse project in Texas. New Direct Potable Reuse projects could be pursued to extend existing supplies during an unprecedented drought. Direct Potable Reuse projects would likely only be feasible for MWPs.
- Strategies that are currently impractical for some MWPs, such as desalination of brackish groundwater, may become feasible responses to DWDOR conditions.

7.7.3 Other Drought Recommendations

Region F recognizes that while drought preparedness, including DCPs, are an important tool, in some instances drought cannot be prepared for, it must be responded to. Region F recognizes the Drought Preparedness Council's ability to assist with drought response when needed. Region F, however, maintains that DCPs developed by the local, individual water providers are the best available tool for drought management. Region F fully supports the use and implementation of individual DCPs during times of drought.

To better prepare for future droughts, Region F makes the following recommendations:

- That the Regional Water Plans remain a separate process for developing long-term water supply solutions for increased growth. The Regional Water Plans should not be the resource for times of emergency drought.
- The Drought Preparedness Council should increase coordination with local providers regarding drought conditions and potential implementation of drought stages, particularly during times of limited precipitation.

LIST OF REFERENCES

[1] Texas Water Development Board “Water Data for Texas” <https://www.waterdatafortexas.org/reservoirs/region/region-f>

[3] Historical Annual Precipitation for Midland International Airport < https://www.ncei.noaa.gov/cdo-web>

[4] PDSI data https://wrcc.dri.edu/wwdt/time

[5] U.S. Drought Monitor <https://droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx>

8 UNIQUE STREAM SEGMENTS, RESERVOIR SITES, AND LEGISLATIVE RECOMMENDATIONS

The Texas Water Development Board (TWDB) regional water planning rules require that a regional water plan include recommendations for regulatory, administrative, legislative or other changes that:

"the regional water planning group believes are needed and desirable to achieve the stated goals of the state and regional water planning, including to facilitate the orderly development, management, and conservation of water resources and preparation for and response to drought conditions." [357.43(d)]

The rules also call for regional water planning groups to make recommendations on the designation of ecologically unique river and stream segments and unique sites for reservoir development and encourage the planning groups to consider recommendations that would facilitate more voluntary transfers. This section presents the regulatory, administrative, legislative, and other recommendations of the Region F Water Planning Group and the reasons for the recommendations.

8.1 Recommendations for Ecologically Unique River and Stream Segments

For each planning region, the Texas Parks and Wildlife Department (TPWD) developed a list of river and stream segments that meet one or more of the criteria for being considered ecologically significant. In Region F, TPWD identified 20 segments as listed in Table 8-1 and shown in red on Figure 8-1 as ecologically significant.

In previous planning cycles, the Region F Water Planning Group decided not to recommend any river or stream segments as ecologically unique because of unresolved concerns regarding the implications of such a designation. The Texas legislature has since clarified that the only intended effect of the designation of a unique stream segment was to prevent the development of a reservoir on the designated segment by a political subdivision of the State. However, the TWDB regulations governing regional water planning require analysis of the impact of water management strategies on unique stream segments, which implies some level of protection beyond the mere prevention of reservoir development.

Considering the remaining uncertainty for designation and the regional consensus that there are no new reservoirs recommended for development, the Region F Water Planning Group is not recommending the designation of any river or stream segment as ecologically unique at this time.

The Region F Water Planning Group recognizes the ecological benefits of major springs, which are discussed in Chapter 1, and the benefits of possible protection for these important resources. Several of the potential ecologically significant streams identified by TPWD are springs or spring-fed streams. The list includes springs that provide water to water supply reservoirs and/or ecologically sensitive species. The South Llano River in Kimble County, which is spring-fed, is an important water supply source for the City of Junction and Kimble County water users and may warrant additional protections. Other important stream segments include the South Concho River and Dove Creek. Both are spring-fed streams that flow into Twin Buttes Reservoir, which is a water source for the City of San Angelo and Tom Green County WCID No. 1. The Region F Water Planning Group will reconsider the possible designation of unique streams for the 2031 Water Plan.

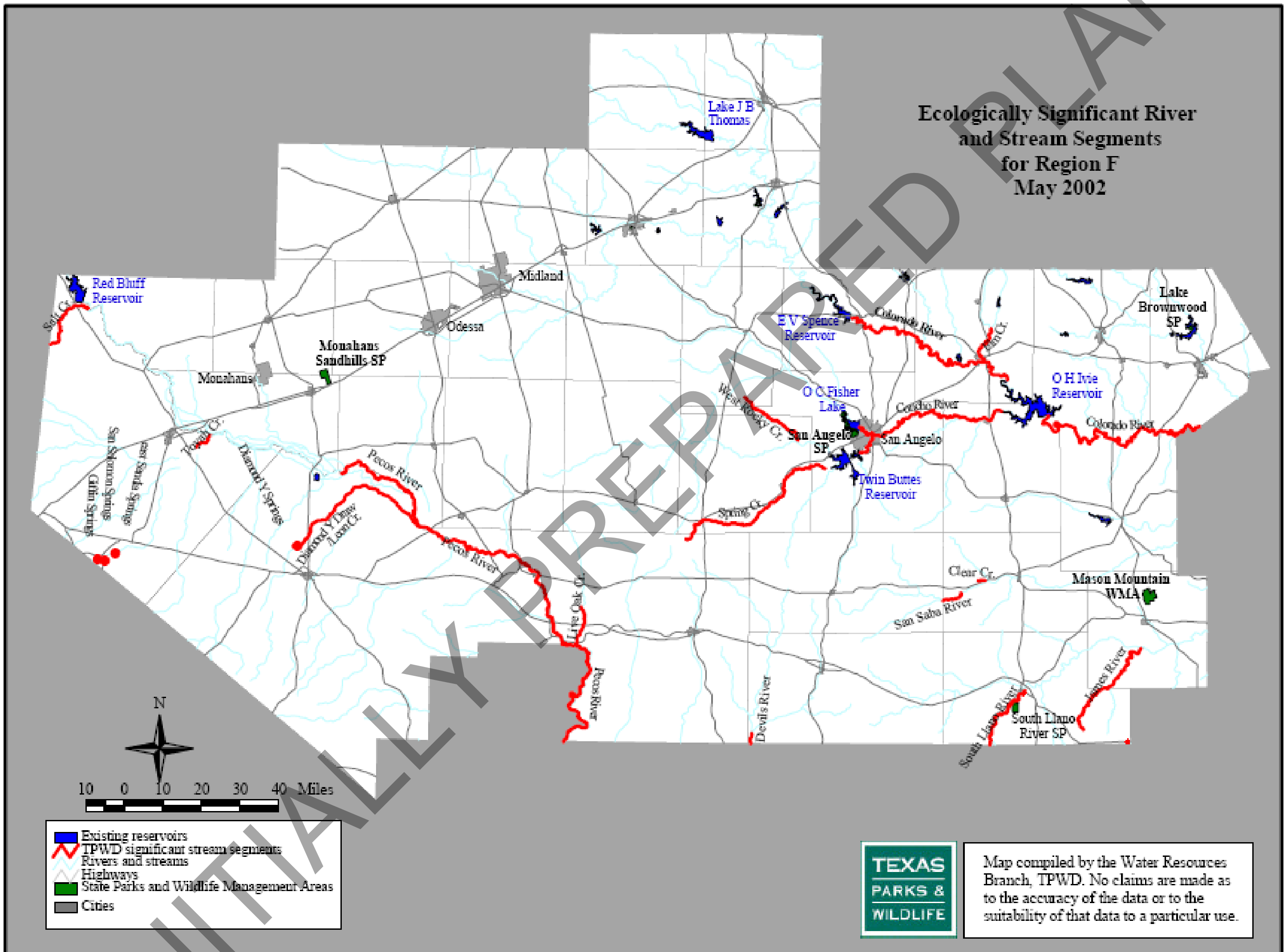
Table 8-1
Texas Parks and Wildlife Department Ecologically Significant River and Stream Segments

River or Stream Segment	Description	Basin	County	TPWD Reasons for Designation[a]				
				Biological Function	Hydrologic Function	Riparian Conservation Area	Water Quality/ Aesthetic Value	Endangered Species/ Unique Communities
Clear Creek	Impounded headwater springs	Colorado	Menard					X
Colorado River	Regional boundary upstream to E.V. Spence Reservoir dam, excluding O.H. Ivie Reservoir	Colorado	Multiple	X			X	X
Concho River	Above O.H. Ivie Reservoir to San Angelo Dam on North Concho River and Nasworthy Dam on South Concho River	Colorado	Concho, Tom Green				X	X
Devils River	Sutton/Val Verde County line upstream to Dry Devils River	Rio Grande	Sutton				X	X
Diamond Y Springs	Headwaters to confluence with Leon Creek	Rio Grande	Pecos					X
East Sandia Springs	Springs in Reeves County	Rio Grande	Reeves					X
Elm Creek	Elm Creek Park Lake to FM 2647 bridge	Colorado	Runnels				X	X
Giffen Springs	Springs in Reeves County	Rio Grande	Reeves					X
James River	Headwaters to confluence with Llano River	Colorado	Mason, Kimble				X	
Diamond Y Draw	Headwaters to confluence with Pecos River	Colorado	Pecos					X
Live Oak Creek	Headwaters to confluence with Pecos River	Colorado	Crockett				X	X
Pecos River	Val Verde/Crockett County line upstream to FM 11 bridge on Pecos/Crane County line	Rio Grande	Multiple	X			X	X
Pedernales River	Kimble/Gillespie County line upstream to FM 385	Colorado	Kimble	X			X	
Salt Creek	Confluence with Pecos River upstream to Reeves/ Culberson County line	Rio Grande	Reeves					X

River or Stream Segment	Description	Basin	County	TPWD Reasons for Designation[a]				
				Biological Function	Hydrologic Function	Riparian Conservation Area	Water Quality/ Aesthetic Value	Endangered Species/ Unique Communities
San Saba River	From FM 864 upstream to Fort McKavett	Colorado	Menard			X		X
San Solomon Springs	Spring in Reeves County	Rio Grande	Reeves			X		X
South Llano River	Confluence with North Llano River upstream to Kimble/ Edwards County line	Colorado	Kimble			X	X	X
Spring Creek	Headwaters to FM 2335 crossing in Tom Green County	Colorado	Crockett, Irion, Tom Green				X	X
Toyah Creek	Confluence with Pecos River upstream to FM 1450	Rio Grande	Reeves					X
West Rocky Creek	Headwaters to confluence with Middle Concho River	Colorado	Irion, Tom Green, Sterling				X	X

[a] The criteria listed are from Texas Administration Code Section 357.8. The Texas Parks and Wildlife Department feels that their recommended stream reaches meet those criteria marked with an X.

Figure 8-1
Texas Parks and Wildlife Department Ecologically Significant River and Stream Segments



8.2 Recommendations for Unique Sites for Reservoir Construction

Section 357.43(c) of the Texas Water Development Board regional water planning rules allows a regional water planning group to recommend unique stream sites for reservoir construction:

> *Unique Sites for Reservoir Construction. A RWPG 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. [357.43(c)]*

Evaluations of available water supply in the upper Colorado River Basin show limited availability for new surface water supplies. The Region F Water Planning Group does not recommend any unique sites for new reservoir development.

8.3 Policy and Legislative Recommendations

The Region F Water Planning Group has identified specific water policy topics relevant to the development and management of water supplies in the region. The following is a synopsis of the recommendations presented by the Region F Water Planning Group.

8.3.1 Surface Water Policies

In Region F, over 70 percent of the population in 2030 will depend on surface water from the upper Colorado River Basin for all or part of their municipal water needs. Making sure that this water remains a dependable part of Region F's existing supplies is crucial.

Surface water in the Colorado River Basin is over appropriated and became that way in about 1938. This was well before there was any substantial population in Region F. Most of the "senior water rights" are in the lower Colorado Basin. The majority of these water rights are held by the Lower Colorado River Authority, City of Austin, and City of Corpus Christi. It is imperative that any changes to water rights, such as a change in use, change in point of diversion, transfers of water or transfer of water rights out of the Colorado Basin do not impair existing water rights even if they are junior in priority.

Surface water policy recommendations include the following:

- Require that any time a request is made to amend a water right, if the change involves an increase in the quantity, a change in the purpose of use or a change in the place of use, all water rights holders in the basin must be notified.

- The water availability models show that the Colorado River Basin is over appropriated. Region F opposes any legislation that would repeal or modify the "junior priority provision" for interbasin transfers from the Colorado River Basin (Water Code 11.085 (t)).

- Review the State's surface water policy of prior appropriation to see if this is a policy that will work in Texas over the next 50 years.

- Recommend that State water law be amended to incorporate river basin subordinations as set forth in regional water plans.

8.3.2 Groundwater Policies

Groundwater policy recommendations include the following:

- To support retention of the Rule of Capture while encouraging fair treatment of all stakeholders, and the State's policy that groundwater districts are the preferred method for managing Texas' groundwater resources.
- To support local control and management of groundwater through confirmed groundwater conservation districts (GCD), while providing encouragement and incentives for cooperation among the GCDs within the region.
- That all persons or entities seeking to export a significant amount of water from a groundwater district must submit notice of their plan to the affected GCD and the RWPG.
- All state agencies must be subject to GCD rules and production limits and must provide information on existing and proposed groundwater projects to the relevant RWPG.

8.3.3 Environmental Policies

Region F believes in good stewardship of the region's water and natural resources. Environmental policy recommendations include the following:

- That brush control and desalination are Region F strategies for protecting environmental values while developing new water supply for municipal and other economic purposes.

- That because of the very limited water resources in this region, there must be a carefully managed balance in the development, allocation and protection of water supplies, between supporting population growth and economic enterprise and maintaining environmental values. Consequently, while recognizing the need for, and importance of, reservations of adequate water resources for environmental purposes, the RWPG will not designate any special stream segments until the Texas Parks and Wildlife Department, working in cooperation with local entities such as groundwater districts, county soil and water conservation districts, local conservation groups and landowners, completes comprehensive studies identifying and quantifying priority environmental values to be protected within the region and the quantification of minimum stream flows necessary to maintain those environmental values.

- To support legislative funding and diversion of TPWD resources, for undertaking the studies described above; and

- To support the creation of cooperative local stakeholder groups to assist the TPWD in studies described above.

- There are insufficient water supplies within Region F to meet projected municipal, agricultural and environmental needs through 2080; therefore, Region F RWPG opposes the export of surface water outside of the region except for existing contracts for such export, and will give priority consideration to needs within the region, including protection of environmental values, in evaluating any future proposed contracts for export.

- Land (range and cropland) conservation and management practices (including brush management and proper follow-up grazing and burn management) are strategies to provide optimum conditions for most efficient utilization of the region's limited rainfall. These practices should target areas that will have the greatest effectiveness for enhancing water supplies in the region and these efforts should be eligible for funding from the Texas legislature and State agencies charged with protecting and developing our water resources.

8.3.4 Instream Flows

Region F is located in an arid area with much of the rainfall occurring in short bursts. This results in widely varying stream flows with many streams being intermittent, having water only part of the year. During drought, stream flows can be very low, but this is a natural occurrence and the ecological environment in Region F has developed under these conditions. Region F recognizes that future flow conditions in Texas' rivers and streams must be sufficient to support a sound ecological environment that is appropriate for the area. As required under Senate Bill 3, TCEQ has established instream flow requirements for the Colorado River Basin and Brazos River Basin. No instream flow requirements have been established to date for the Pecos River Basin. Under current policy, these standards apply only to new water rights and some amendments to existing water rights. Region F supports this policy and believes it is imperative that existing water rights are protected now and in the future.

8.3.5 Interbasin Transfers

The State of Texas has 23 river basins that provide surface water to users in 16 regions. The current statutes require any new water right diverted from one river basin to another to become "junior" in priority to other rights in that basin. Also, as part of the water rights application, an economic impact analysis is required for both basins involved in the transfer. These requirements are aimed at protecting the basin of origin while allowing transfers of water to entities with needs. The Region F Water Planning Group:

- Supports retention of the junior water rights provision (Water Code 11.085(s) and (t)).
- Urges the legislature and TCEQ to study and develop mechanisms to protect current water rights holders.

8.3.6 Uncommitted Water

The Texas Water Code currently allows the TCEQ to cancel any water right, in whole or in part, for ten consecutive years of non-use. This rule inhibits long-term water supply planning. Water supplies are often developed for ultimate capacity to meet needs far into the future. Some entities enter into contracts for supply that will be needed long after the first ten years. Many times, only part of the supply is used in the first ten years of operation.

The regional water plans identify water supply projects to meet water needs over a 50-year use period. In some cases, there are water supplies that are not currently fully utilized or new management strategies that are projected to be used beyond the 50-year planning period. To support adequate supply for future needs and encourage reliable water supply planning policy recommendations include the following:

- Opposes cancellation of uncommitted water contracts/rights.
- Supports long term contracts that are required for future projects and drought periods.

- Supports shorter term "interruptible" water contracts as a way to meet short term needs before long-term water rights are fully utilized.

8.3.7 Brush Control

Brush control is recognized as an important tool in the management and maintenance of healthy rangelands that can allow for more efficient circulation of rainfall into the soil profile. This in turn can add to the effectiveness of aquifer recharge and restoration of streams and springs.

Region F supports brush control where it has the greatest effect on rivers, streams, and springflow, such as riparian zones, and areas of the region with the highest rainfall per year. Region F recognizes that the key to watershed restoration is managing the land to promote a healthy and vigorous soil and vegetative condition, of which brush control can play an important part.

Region F supports legislative efforts to promote funding for brush control activities for the purpose of river, stream, and spring enhancement in those areas that allow for the greatest success. The Region F Water Planning Group recommends the Texas legislature continue to support the State Water Supply and Enhancement Program through:

- Funding for on-going maintenance of brush removal in the region, and
- Continued cooperation with federal agencies to secure funds for brush control projects that will improve water quality.

8.3.8 Desalination

There are significant reserves of brackish groundwater in Region F. Region F Planning Group recommends the Texas Legislature continue to provide funds to assist local governments in the implementation of development of these water resources.

8.3.9 Weather Modification

There are currently two operational weather modification programs in the region – the West Texas Weather Modification Association (WTWMA) and the Trans Pecos Weather Modification Association (TPWMA). The WTWMA estimated a 15% increase in rainfall in their targeted area during 2014 due to their rain enhancement efforts, while the TPWMA estimated a 6.8% increase. Weather modification is one of the region's recommended strategies, together with brush control and desalination, for augmenting water supply. Recommendations include:

- Support legislative funding for operational programs, research, and evaluation of impact on rainfall.
- Support the creation of additional programs.

8.3.10 Water Quality

Region F has multiple water sources that are impaired for water quality. Local geologic formations contribute salts and total dissolved solids to streams and reservoirs. Some groundwater sources are affected by elevated minerals (including arsenic and fluoride), nitrates, and radionuclides. For many smaller communities, these impaired water sources are the only available water supply. Region F recognizes the challenges in developing new water supplies and/or treating the impaired water supply for these communities. To provide greater certainty in supply development and use of impaired water sources, Region F recommends

- The state provide funding for grants, not loans, to construct, operate, and maintain treatment systems (including waste disposal) to reduce drinking water constituents that exceed the established MCLs of the federal drinking water standard level.

8.3.11 Municipal Conservation

The Region F Water Planning Group recognizes the importance of water conservation as a means to prolong existing water supplies that have shown to be vulnerable under drought conditions. The Water Conservation Task Force presented to the Texas legislature a summary of conservation recommendations, including statewide municipal conservation goals. Since that time, the legislature has created the Water Conservation Advisory Council which was given multiple duties including monitoring new technologies for inclusion by the TWDB as best management practices. Considering the drought-prone nature of Region F and the role of the Water Conservation Advisory Council, the Region F Water Planning Group:

- Supports that conservation targets should be voluntary.
- Supports the State's efforts to encourage conservation by providing technical assistance to water users and not force conservation through mandatory goals for water use.
- Recommends the State continue participation in research and demonstration projects for the development of new conservation ideas and technologies.
- Supports the funding of a statewide public information and education program to promote water conservation. Water conservation can only be successful with the willing support of the general public.
- Recommends consideration of excess use rates, water budget rates and seasonal rates that encourage water conservation, and recognition of water conservation as an appropriate goal in determining water rates.

8.3.12 Reuse

Reuse of water is a major source of "new water" especially in Region F. Reclaimed or new water developed from a demineralization or reclamation project can be stored for use in aquifers that have been depleted. Region F Water Planning Group recognizes the importance of reuse for the region and State, and recommends the following:

- Support legislation that will encourage and allow the reuse of water in a safe and economical manner.
- Work with the State's congressional delegation and federal agencies to develop procedures that will allow reject water from demineralization and reclamation projects to be disposed of in a safe and economical manner.

- Support legislation that will encourage and allow aquifer storage and recovery projects to be developed and managed in an economical manner.

- Support legislation at both the State and federal levels to provide funding for demineralization, reclamation and aquifer storage and recovery pilot projects.

8.3.13 Groundwater Conservation Districts

There are 16 established GCDs in Region F that oversee groundwater production in more than half of the region. Region F recognizes and supports the State's preferred method of managing groundwater resources through locally controlled groundwater districts. In areas where groundwater management is needed, existing districts could be expanded or new districts could be created taking into consideration hydrological units (aquifers), sociological conditions, and political boundaries. Recommendations include:

- Legislation developed for managing the beneficial use and conservation of groundwater must be fair for all users.
- R regulations must respect property rights and protect the right of the landowners to capture and market water within or outside of district boundaries and follow the rules set by the groundwater conservation district.
- The legislature should support the expanded collection of groundwater data that would be used to carry out regional water planning.

The region also recognizes that the State has groundwater resources associated with state lands that may or may not be governed by local groundwater districts. Region F encourages the State to review its groundwater resources on all state-owned land and how those resources should be managed to the benefit of all of Texas.

8.3.14 Abandoned Water Wells

Water wells are abandoned when they become inoperable, or are no longer needed, and not properly plugged. Landowners may be unaware that these wells exist on their property or do not possess the funds to properly plug the well. These wells can function as a surface contaminant conduit to groundwater bearing production zones. Abandoned wells located within zones of high subsurface artesian pressures may also flow to land surface, allowing for deeper groundwater to comingle with shallow groundwater systems. To provide for expedited and increased closure of abandoned water wells, Region F recommends:

- Continued and increased financial support for the Leaking Water Wells Grant Program (H.B. No. 4256).
- The State of Texas consider the development of a water well plugging fund that provides landowner incentives and funding for the closure of abandoned water wells.
- Increased educational outreach so that landowners are better aware of the threat that abandoned water wells pose to groundwater resources.

8.3.15 Oil and Gas Operations

Protection of the quality of the region's limited groundwater resources is very important within Region F. Prevention of groundwater contamination from oil and gas well operations requires constant vigilance on the part of the Railroad Commission rules. Orphan oil and gas wells that need proper plugging have become a problem and a liability for the State, the oil and gas industry as a whole, and the Texas Railroad Commission. In response to this problem, the State initiated a well plugging program that is directed by the Railroad Commission. This program enables a large number of abandoned wells to be properly plugged each year and has accomplished much by preventing water pollution.

In light of the importance of local groundwater supplies to users in Region F and the vulnerability of these supplies to contamination, the Region F Water Planning Group recommends:

- Stringent enforcement of the oil and gas operations rules and supports the levy of fines by the Commission against operators who violate the rules.
- Continuing support for the industry funded, Commission supported abandoned well and plugging program.
- The Legislative Budget Board and the Texas Legislature provide additional personnel and funding to the Railroad Commission to carry out its mandated responsibility to protect water supplies affected by oil and gas industry activities.
- Provide incentives and funding for the proper clean-up and remediation of all contamination related to the processing and transportation of oil and gas. This includes operational or abandoned gas processing plants, oil refineries, and product pipelines.

8.3.16 Produced Water

Produced water is byproduct from oil and gas production that returns to the surface. Some of the produced water is currently recycled by oil and gas producers but much of the produced water is injected back into the ground for disposal. Using produced water for other beneficial uses is currently being studied. Region F recommends:

- A more comprehensive data collection program on produced water.
- Continued study and robust testing of treatment alternatives to treat water to sufficient standards for other beneficial uses.
- Continued monitoring and robust testing of a pilot project to discharge produced water into the Pecos River to supplement low streamflows.

8.3.17 Electric Generation Industry

Region F encourages the use of higher TDS water for electric generation, when possible, to conserve available fresh water sources within the region. In addition, Region F encourages the continued assessment of generation technologies that use less water.

8.3.18 Hydrogen Production

Hydrogen can be used as an energy source and can be created through a number of different processes. Often times producers use a color-coding system to describe the process used to create the hydrogen. Green hydrogen uses electrolysis to separate hydrogen from water and can therefore be very water intensive. The demands for the 2026 Regional Water Plans and the 2027 State Water Plan did not consider hydrogen production as a potential source of water demand. However, there are several green hydrogen proposals within Region F. Region F recommends:

- TWDB considers hydrogen production water demands in the development of water demand projections for future planning cycles.
- The legislature considers policies that promote hydrogen production and economic activity but also protect the limited fresh water resources in Region F and the State of Texas.

8.4 Regional Planning Process

8.4.1 Funding

The Region F Water Planning Group recognizes that the ability to implement the water plan will depend in part on the ability to fund the recommended projects. The TWDB and Texas Legislature have responded to this concern by providing different funding vehicles for water projects, including the State Water Implementation Fund that is specifically dedicated to implementing projects identified in the State Water Plan. However, many entities are still struggling with financing water projects. For many of these entities, the regional water planning process is essential in identifying water needs and potential strategies. The Region F Water Planning Group recommends:

- The State provides increased grant funding to smaller communities with limited financial resources for implementation of strategies in the regional water plans.
- The State should continue to fund the regional water planning process at a sufficient level to adequately address the Legislative requirements and provide a planning assessment for the many smaller communities in rural Texas.
- Consider providing adequate funds for the administration of the regional water planning process since the TWDB and the Legislature has continued to increase the responsibilities of the administrator.

8.4.2 Frequency of State Water Plan Development

The State is required by law to develop and update the State Water Plan every five years. The 2027 State Water Plan will be the sixth plan since the passage of SB1. Over the past 20 years, the regional and state water plans have captured the local water supply issues and a comprehensive path forward has been developed. In response to recommendations that the development of the State Water Plan be conducted every 10 years instead of every five years, with funding of special studies between planning cycles, the Texas Legislature provided a simplified planning option for non-census planning cycles. The simplified planning option still requires the planning groups to develop and independently verify most, if not all, of the data required under the standard methodology. The simplified planning option does not meet the intent of changing the planning cycle from every five years to ten years. It also does not provide a funding mechanism to conduct more in-depth region-specific special studies. Region F recommends that the Texas Legislature reconsider changing the planning cycle from five years to ten years with the opportunities for regions to apply for funding for special studies during non-regional planning periods.

8.4.3 Allow Waivers of Plan Amendments for Entities with Small Strategies

Region F recommends that the Texas Water Development Board (TWDB) allow waivers for consistency issues for plan amendments that involve projects resulting in small amounts of additional supply rather than requiring the regional water planning groups to grant consistency waivers. With the change in structure of the TWDB, TWDB Directors are fully capable of making such decisions.

8.4.4 Coordination between TWDB and TCEQ Regarding Use of the WAMs for Planning

The TWDB requires that the Water Availability Models (WAMs) developed under the direction of TCEQ be used in determining available surface water supplies. The models were developed for the purpose of evaluating new water rights permit applications and are not appropriate for water supply planning. The TWDB and TCEQ should coordinate their efforts to determine the appropriate data and tools available through the WAM program for use in regional water planning. The TWDB should allow the regional water planning groups some flexibility in applying the models made available for planning purposes.

8.4.5 Enhanced Joint Planning Efforts

The TWDB requires that the Modeled Available Groundwater (MAG) developed under the Joint Groundwater Planning process be used as a cap on groundwater availability in regional water planning. Region F recommends that the TWDB consider ways to enhance the coordination between the Joint Groundwater Planning and Regional Water Planning processes and bring the assumptions used in each into better alignment.

8.4.6 Interregional Planning Council

The TWDB received the Interregional Planning Council report on March 4, 2024. The council report makes several recommendations regarding project coordination, stakeholder engagement, and other regional and state water planning tasks. Region F has considered the recommendations presented by the council and has taken steps to implement those recommendations. Region F prepares interregional memos related to split WUGs and shares those with adjacent regions early in the planning process. Regions G and O have interregional liaisons that attend the Region F Water Planning Group meetings on a regular basis. The Region F Water Planning Group has no comments related to the recommendations presented in the Interregional Planning Council report.

8.5 Summary of Recommendations

The following is a summary of the region's policy and legislative recommendations as agreed to by the Region F Regional Water Planning Group. The region:

- Does not recommend the designation of any ecologically unique stream segments or unique reservoir sites.
- Supports recognition of the importance of springs and spring-fed streams.
- Supports protection of existing water rights and encourages review and study of mechanisms to protect rights, including potential modification of the prior appropriation doctrine.
- Supports the protection of environmental values and developing water supply using brush control and desalination.
- Supports state funding for environmental studies with local stakeholder input.
- Supports existing TCEQ policy to protect existing water rights when considering instream flows.
- Recommends that state water law be amended to incorporate river basin subordinations as set forth in regional water plans.
- Supports state funding of land management activities to promote conservation of the region's natural resources.
- Supports a requirement for notification of all water rights holders in a basin any time a request is made to amend a water right if the change involves an increase in the quantity, a change in the purpose of use or a change in the place of use.
- Opposes any legislation that would repeal or modify the "junior priority provision" for interbasin transfers (Water Code 11.085 (t)) from the Colorado River Basin.
- Opposes cancellation of uncommitted or unused water contracts or water rights.
- Supports long-term contracts as a means for reliable water supply planning and shorter-term "interruptible" water contracts as a way to meet short-term needs before long-term water rights are fully utilized.
- Recommends the State change the Legislative requirements to update the regional water plans from every five years to ten years and provide interim funding for special studies that would benefit the regional water planning process.
- Supports continued and future funding of the Water Supply Enhancement Program, including but not limited to:
- Funding for on-going maintenance of brush removal in the region, and

- Continued cooperation with federal agencies to secure funds for brush control projects that will improve water quality such as salt cedar control.
- Supports state funding for desalination projects of brackish groundwater.
- Recommends the State provide increased grant funding for smaller communities with limited financial resources and adequately fund the regional water planning process, including funding the administration of the process.
- Supports state funding for existing weather modification programs and the creation of new programs.
- Recommends that the state provide grant funding to help small communities to meet water quality standards for radionuclides and other constituents that are very costly to treat.
- Supports continued State participation in water conservation through technical assistance to water users and monetary incentives to entities that implement advanced conservation.
- Opposes mandatory targets and goals for water use.
- Supports continued State participation in research and demonstration projects for conservation.
- Supports the funding of a statewide public information and education program to promote water conservation.
- Supports the use of water conservation pricing and recognition of water conservation as an appropriate goal when setting rates.
- Supports legislation that would allow the reuse of water in a safe and economical manner.
- Supports the development of procedures for disposal of waste streams from desalination and reclamation projects in a safe and economical manner.
- Supports legislation that will encourage and allow aquifer storage and recovery projects to be developed in an economical manner.
- Supports state funding of pilot projects for desalination, reclamation and aquifer storage and recovery projects.
- Supports the use of groundwater conservation districts to manage groundwater resources, and recommends that:
- The legislation for managing the beneficial use and conservation of groundwater must be fair for all users.
- Regulations must respect property rights and protect the right of the landowners to capture and market water within or outside of district boundaries and follow the rules set by the groundwater conservation district.

- Encouragement and incentives for cooperation among groundwater conservation districts be provided.
- All state lands within a groundwater conservation district be subject to that district's rules.
- Supports retention of the Rule of Capture while encouraging fair treatment of all stakeholders.
- Supports a requirement for notification of Regional Water Planning Groups and GCDs whenever a significant amount of water is being exported from a groundwater conservation district.
- Supports the expanded collection of groundwater data that would be used to carry out the intent of Regional Water Planning and Joint Planning for Groundwater.
- Supports the protection of groundwater resources through the current oil and gas operation rules and the state-initiated well plugging program.
- Encourages the Legislature to adequately fund and staff the Railroad Commission to carry out its mandated responsibility to protect water supplies affected by oil and gas operations.
- Continued and increased financial support for the Leaking Water Wells Grant Program (H.B. No. 4256).
- The State of Texas consider the development of a water well plugging fund that provides landowner incentives and funding for the closure of abandoned water wells.
- Increased educational outreach so that landowners are better aware of the threat that abandoned water wells pose to groundwater resources.
- Recommends incentives and funding for the proper clean-up and remediation of all contamination related to the processing and transportation of oil and gas.
- Supports a more comprehensive data collection program on produced water.
- Supports the continued study and robust testing of treatment alternatives to treat water to sufficient standards for other beneficial uses.
- Supports continued monitoring and robust testing of a pilot project to discharge produced water into the Pecos River to supplement low streamflows.
- Encourages the use of higher TDS water for stream-electric generation.
- Encourages the continued assessment of generation technologies that use less water.
- Recommends that TWDB consider hydrogen production water demands in the development of demand projections for future planning cycles.
- Recommends the legislature consider policies that promote hydrogen production and economic activity but also protect the limited freshwater resources in Region F and the State of Texas.

- Recommends the following changes to the Regional Water Planning process:
- Provision of clear guidance on resolving consistency issues,
- Waivers of the requirement to amend the regional water plan for small entities, and
- Coordination between TWDB and TCEQ regarding the use of WAMs for regional water planning.
- Region F recommends that the TWDB consider ways to enhance the coordination between the Joint Groundwater Planning and Regional Water Planning processes and bring the assumptions used in each into better alignment.

9 IMPLEMENTATION AND COMPARISON TO THE PREVIOUS REGIONAL WATER PLAN

The Regional and State Water Planning process administered by the Texas Water Development Board (TWDB) operates on a five-year cycle. Inherently, this cycle enables continual refinements and changes to major components of the planning process, such as water demands, supplies, and recommended water management strategies. This chapter assesses the changes between cycles of Regional Water Plans (RWPs), in accordance with TWDB requirements for the development of the 2026 RWP. Specifically, this chapter contains a discussion of the implementation of previously recommended water management strategies (WMS) (Section 9.1), as well as a summary of how various components of the current 2026 RWP compare to the previously adopted 2021 RWP (Section 9.2). In addition, this chapter addresses the progress of the Region F Water Planning Group in encouraging cooperation between entities for the purpose of achieving economies of scales and otherwise incentivizing strategies that benefit the region as a whole (Section 9.3).

9.1 Implementation of Previously Recommended Water Management Strategies

The following sections discuss those WMSs that were recommended in the 2021 Regional Water Plan and have been partially or completely implemented since that plan was published. These WMSs are included in the 2026 plan as currently available supply. Information was collected on the implementation status of strategies and projects in the 2026 plan via an implementation survey (Appendix J).

9.1.1 Mining Conservation – Well Field Recycling/Reuse

In at least 19 counties across Region F, more recent TWDB water use survey data showed that mining operators have been employing the 2021 plan mining conservation strategy to reuse and recycle water used for fracking operations. This is an increase from 11 counties in the 2021 Plan.

9.1.2 Brady – Advanced Groundwater Treatment

The City of Brady had a strategy to bring online an advanced groundwater treatment facility to address radium issues. Construction is now complete, and the water treatment plant is operational.

9.1.3 Mason – Additional Treatment

The City of Mason recently implemented an advanced treatment system to remove radium for their groundwater supplies. This project has been implemented and is now operational.

9.1.4 San Angelo – Hickory Well Field Expansion

The City of San Angelo had a strategy to add additional wells and expand their treatment and transmission capacity from their Hickory Aquifer well field. This project is now complete and can be operated in accordance with their groundwater permits. This project serves more than one Water User Group (WUG).

9.1.5 Sonora – Develop Additional Edwards-Trinity Aquifer Supplies

The City of Sonora recently completed two additional wells for additional water supplies. These supplies are complete and included in the plan as existing supplies.

9.2 Differences Between Previous and Current Regional Water Plan

The following sections provide a discussion of changes from the previous 2021 plan to the current 2026 plan. Specifically, these sections address differences in:

- Water demand projections
- Drought of record and hydrologic modeling and assumptions
- Source water availabilities
- Existing water supplies for water users
- Identified water needs for WUGs and WWPs
- Recommended and alternative water management strategies and projects

9.2.1 Water Demand Projections

The total projected water demand in Region F is about 10 to 14 percent higher for the 2026 plan than in the 2021 plan. This is displayed in Figure 9-1. Table 9-1 shows the differences in demand by use type. These differences and their causes are explored more fully in the following sections.

Figure 9-1
Comparison of Region F Water Demand in 2021 and 2026 Plans

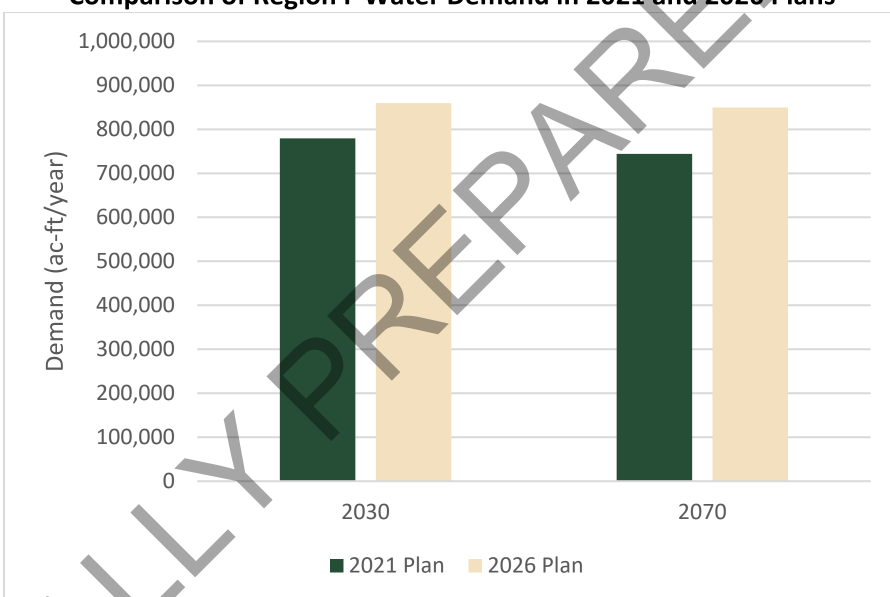


Table 9-1
Changes in Projected Demands from the 2021 Plan to the 2026 Plan by Use Type

Use Type	2030 Percent Change in Water Demand	2070 Percent Change in Water Demand
Municipal	-5.8%	-2.0%
Manufacturing	13.2%	30.9%
Mining	97.3%	362.1%
Livestock	-6.1%	-6.1%
Irrigation	-3.5%	-3.5%
Steam Electric Power	-12.7%	-12.7%
Region F Total	**10.3%**	**14.1%**

Municipal Demands

One of the changes for this round of planning is the declining population for some water user groups. In the previous round of regional planning, even if a water user group had experienced loss of population, the population was held steady throughout the entire planning horizon. In this round of regional planning, if a water user experienced a population between the 2010 and 2020 census, the population was projected to decline. This resulted in lower population and demands for some WUGs. Another difference was the use of new data from the 2020 census. The methodology for development of the municipal demands in both plans were similar. A dry year per capita demand was estimated for each entity. Then, the per capita demand was multiplied by the projected population of each entity to determine the total demand in acre-feet per year. Overall municipal demands were about 5.8 percent lower in 2030 and about 2 percent lower in 2070.

Non-Municipal Demands

Irrigation and livestock demands were slightly lower than in the 2026 plan but overall, very similar.

Steam electric power demand decreased by about 13 percent due to the conversion of some existing plants from higher water use technologies to lower water use power generation methods.

Manufacturing demand increased by about 13 percent in 2030 and by about 31 percent by 2070. This is largely due to a methodology change where growth was assumed to continue over the entire planning horizon (2026 plan) instead of only allowing for manufacturing growth in the first decade of the planning cycle (2021 plan). While the percentage increase is notable, because manufacturing demand in the region is generally small, the volumetric change in demand was also small. In total, the changes in manufacturing demand projections made a very small difference in the regional demand.

In contrast, mining demands nearly doubled in 2030 in the 2026 plan compared to the 2021 plan. By 2080, the projected demand in the 2026 plan is more than 3.5 times the projections in the 2021 plan. This is largely due to the renewed interest in oil and gas development in the Permian Basin and a new 2022 study developed by the Bureau of Economic Geology for TWDB as the basis of the projections. This is by far the biggest contributor to the overall increase in demand for the region between the 2021 and 2026 plans.

9.2.2 Drought of Record and Hydrologic Modeling Assumptions

In general, the drought of record is defined as the worst drought to occur in a region during the period of available meteorological records. For most of Texas, the drought of record began around 1950 and continued through early 1957. In Region F, most surface water sources were in drought-of-record conditions as of the publication of the 2011, 2016, and 2021 plans. The extreme drought conditions have lessened since the 2016 plan, but many reservoirs have never filled and the availability of surface water supplies in the region may still be impacted in future plans. The impacts of the drought on surface water availability under Water Availability Model (WAM) Run 3 (strict priority analysis) does not show the full impact of the drought since many of the reservoirs already had little to no yield. The impacts are more fully shown in the subordination strategy. However, the full impact of ongoing drought conditions cannot be fully evaluated until the current drought is officially over (which is defined by the refilling of the reservoir).

Colorado River Basin WAM Run 3 (Strict Priority Analysis)

For the 2026 plan, an updated version of the TCEQ Colorado WAM was available and used. In the 2021 Plan, the model only included hydrology through the year 2013. For the 2026 Plan, the model's hydrology was extended through 2016. This change resulted in relatively small changes in surface water availability under WAM Run 3 since many of the reservoirs in the Colorado River Basin do not have a yield prior to subordination.

Colorado River Basin Subordination

The subordination strategy changes key assumptions in the WAM such that downstream water rights do not constantly make priority calls on the upstream rights in Region F. This is consistent with the historical operation of the basin.

For both the 2021 and 2026 plans, Region F adopted the premise of the Region K cutoff model for the subordination strategy. The cutoff model modifies priority dates for all water rights above Lakes Ivie and Brownwood. The cutoff model used in both the 2021 and 2026 plans includes the same period of hydrology (1940 – 2016). The Region F Plan cutoff model differs slightly from the Region K model by including Junction's run-of-river right, Brady Creek Reservoir, and including priority operation only under certain conditions for the Pecan Bayou watershed. The Region F adjustments to the Region K cutoff model were the same for the 2021 and 2026 plans. The updated version of the model was also used for the subordination model and resulted in small changes in availability in the Colorado Basin. More information on the subordination strategy is included in Chapter 5C.

Rio Grande River Basin WAM Run 3

While the approach and modifications made to the Rio Grande WAM were the same in the 2021 and 2026 Plans, TCEQ released a new extended version of the WAM. In the 2021 Plan, the model only included hydrology through the year 2000. For the 2026 Plan, the model's hydrology was extended through 2018. This resulted in significant reductions in availability in surface water sources in the Rio Grande, recognizing the impacts of the more recent drought of record in the basin.

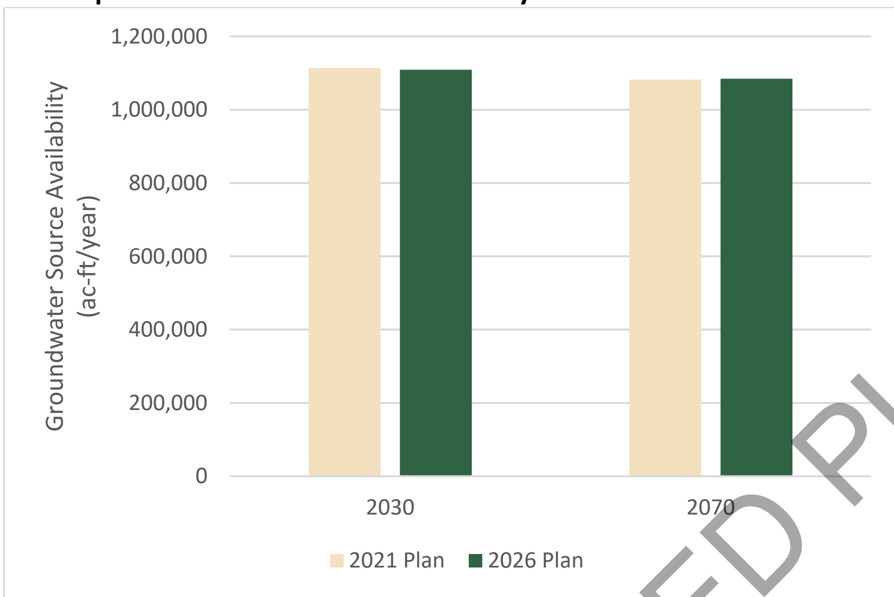
9.2.3 Source Water Availability

The total source water availability (not considering infrastructure or permit constraints) in Region F is less in the 2026 plan than in the previous 2021 plan. The decrease is largely attributed to a new drought of record reflected in extended hydrology in the Rio Grande WAM. Reuse supplies in the 2026 plan increased mostly due to an increase in reuse water supplied to mining entities in the region but it was not enough to offset the loss in surface water availability. Groundwater supplies stayed near constant between the two plans. Overall, there was about a 1.5 go 2 percent decrease in water availability throughout the region between the 2021 and 2026 plans.

Groundwater

In accordance with TWDB rules, the groundwater availability in the 2021 and 2026 plans are determined by the Modeled Available Groundwater (MAG) estimate. These plans were both required to use groundwater estimates developed through the state-sponsored groundwater joint planning process, which is discussed in further detail in Chapter 3, Section 3.1.1. Small adjustments were made to the non-MAG availabilities (also discussed further in Chapter 3) but overall, the groundwater availability between the two plans was nearly constant (less than 1 percent difference).

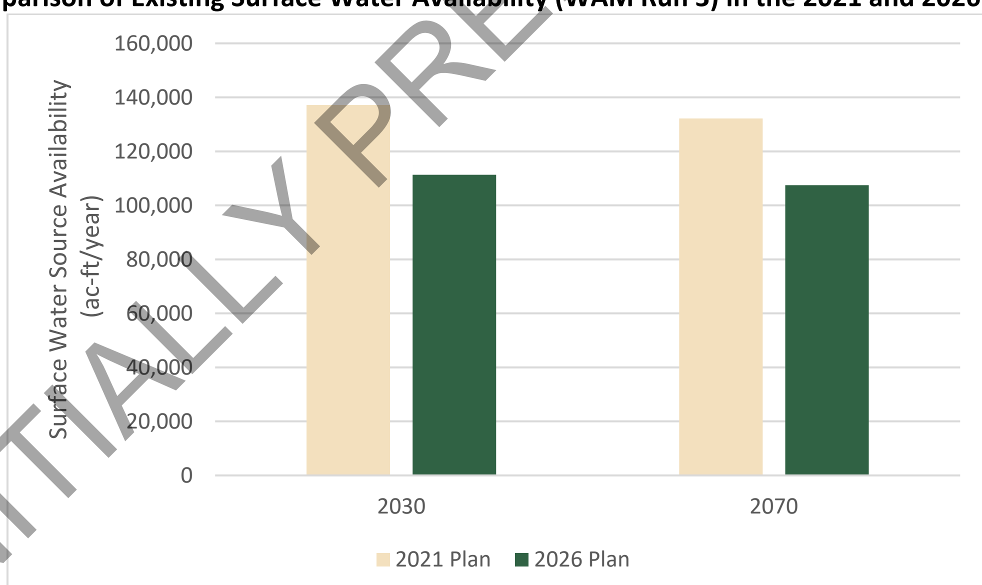
Figure 9-2
Comparison of Groundwater Availability in the 2021 and 2026 Plans



Surface Water

As previously discussed, for the 2026 plan, new versions of the TCEQ WAM were used. This resulted in a decrease in surface water availability in the region under WAM Run 3 of about 18 percent. This is largely attributed to the extended hydrologic period in the Rio Grande basin.

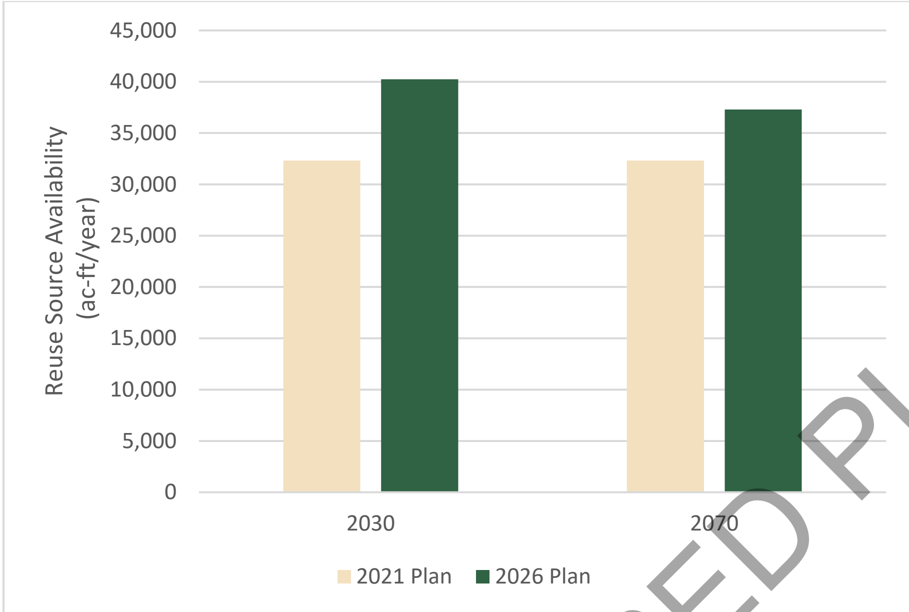
Figure 9-3
Comparison of Existing Surface Water Availability (WAM Run 3) in the 2021 and 2026 Plans



Reuse

Existing reuse source availability went up from the 2021 plan to the 2026 plan, as shown in Figure 9-4. This is largely attributed to the increase in oil and gas well field recycling and reuse that was observed in several counties.

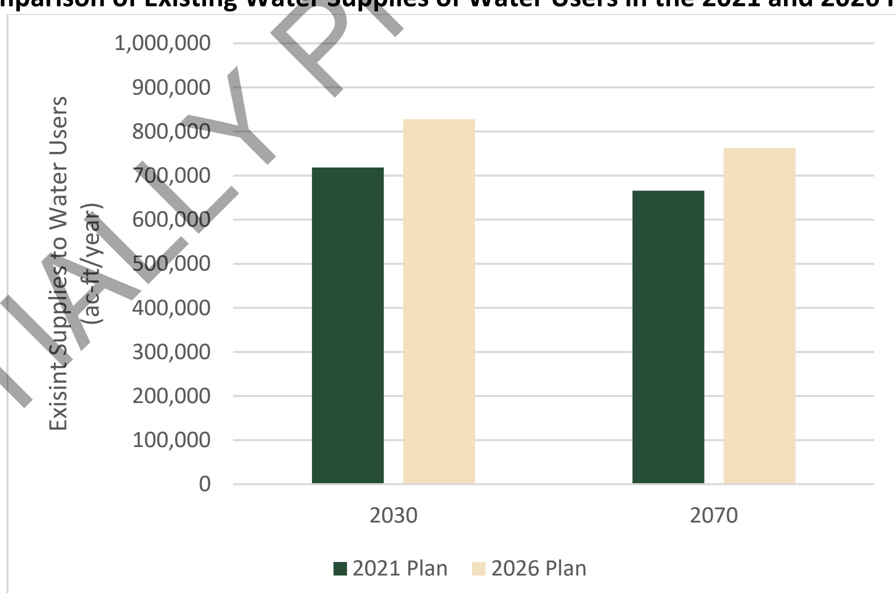
Figure 9-4
Comparison of Reuse Water Availability in the 2021 and 2026 Plans



9.2.4 Existing Water Supplies of Water Users

While the overall source availability decreased from the 2021 plan, the supply to users (which is limited by infrastructure constraints) increased. This is largely attributed to the implementation of additional reuse and recycling supplies for mining operation and the implementation of projects for individual water users as discussed in Section 9.1.

Figure 9-5
Comparison of Existing Water Supplies of Water Users in the 2021 and 2026 Plans



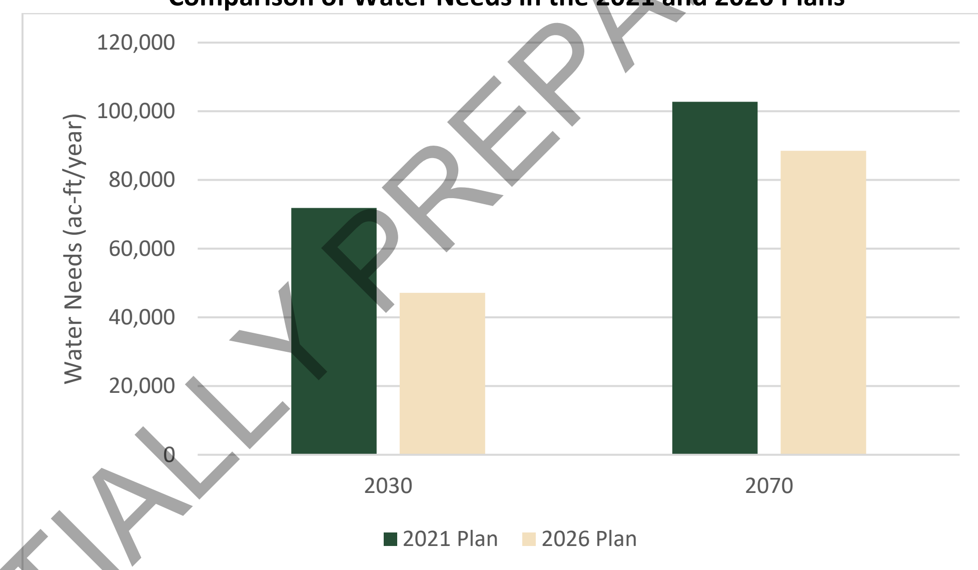
9.2.5 Identified Water Needs

Due to increases in existing water supplies to water users, needs across Region F decreased approximately 35 in 2030 and 15 percent in 2070 from the 2021 plan to the 2026 plan. The composition of these needs also changed significantly. Table 9-2 highlights the differences in need by use type between the two plans in the years 2030 and 2070. In 2030, the decrease in water needs is largely driven by reductions in needs for municipal, irrigation, and steam electric power water users. In 2070, the decrease is largely due to a reduction in the needs for municipal water users. In both the 2021 and 2026 Plans, much of the municipal water needs are driven by limited existing surface water availability in the Colorado River Basin prior to subordination. In 2070, mining represents the greatest increase in water needs due to increases in projected demands.

Table 9-2
Changes in Water Needs from the 2021 Plan to the 2026 Plan by Use Type

Use Type	2030 Percent Change in Water Need	2070 Percent Change in Water Need
Municipal	-52.8%	-28.1%
Manufacturing	-90.0%	-53.8%
Mining	-3.3%	126.4%
Livestock	335.3%	73.3%
Irrigation	-41.2%	2.3%
Steam Electric Power	-45.9%	-40.4%
Region F Total	**-34.4%**	**-13.9%**

Figure 9-6
Comparison of Water Needs in the 2021 and 2026 Plans



9.2.6 Recommended and Alternative Water Management Strategies and Projects

New Water Management Strategies and Projects

New water management strategies and associated infrastructure projects were developed to meet new shortages or better represent entities' current plans that have changed since the previous round of planning. There are 13 new strategies and/or projects in the 2026 plan that were not included in the 2021 plan. This does not include the new conservation strategies. The new recommended strategies and projects are outlined in Table 9-3. There are no new alternative strategies or projects for the 2026 Plan. Two strategies were previously recommended and are now considered alternative due to MAG limitations: Midland's advanced RO treatment and expanded use of their Paul Davis Well Field (Midland County) and Bronte and/or Robert Lee's development of groundwater supplies from Nolan County (Region G).

Table 9-3
New Recommended Water Management Strategies and Projects in the 2026 Plan

Water User Group or Wholesale Provider	New Recommended Water Management Strategy and/or Project
Borden County Water System	Develop Additional Supplies from Ogallala and Edwards-Trinity-High Plains Aquifer in Dawson County
Brown County Water Improvement District (BCWID) No. 1	Treatment Plant Expansion
Brady	Surface Water Treatment for Brady Creek Lake/Reservoir
Bronte and Robert Lee	Connect to CRMWD for Lake Spence with Advanced Treatment
Greenwood Water	New Groundwater Wells
Kermit	Develop Additional Dockum Aquifer Supplies
Madera Valley WSC	Develop Edwards-Trinity Plateau Aquifer Supplies
Midland County-Other -- Midland County Utility District (MCUD)	Develop Ogallala Aquifer Supplies from Midland County with Advanced Treatment (Voluntary Transfer from Irrigation)
Millersview-Doole WSC	Purchase from Provider (CRMWD)
Stanton	Purchase from Provider (CRMWD)
Sterling City	Develop Additional Edwards-Trinity Alluvium Supplies
Upper Colorado River Authority (UCRA)	Develop Lipan Aquifer Supplies in Tom Green County (Voluntary Transfer from Irrigation)
Upper Colorado River Authority (UCRA)	Increased Runoff into Reservoirs (Solar Farms)

Altered Water Management Strategies and Projects

This section covers any strategies and associated infrastructure projects in the current plan that were also in the previous plan but have been altered in some way. This section focuses on strategies that were significantly changed from the last plan. This section is meant to highlight the differences, not give a full description of the strategy. More information on these strategies can be found in Chapter 5 and Appendix C. Strategies with only minor adjustments that did not change the spirit of the strategy are considered to be the same and are not discussed in this section.

West Texas Water Partnership (Midland, San Angelo, Abilene)

Midland, San Angelo, and Abilene have reached an agreement to develop 28,400 acre-feet of new supply from the Edwards-Trinity Plateau Aquifer in Pecos County (15,000 acre-feet per year to Midland, 5,000 acre-feet per year to San Angelo, and 8,400 acre-feet per year to Abilene). In the 2021 Plan, new pipeline infrastructure from Pecos County to both Midland and San Angelo were included. In the 2026 Plan, only a pipeline to Midland is considered and use of the existing CRMWD pipeline is contemplated to move water to San Angelo, if needed. The details of the strategy are still being worked out and new agreements with CRMWD and between the parties will be needed to finalize the ultimate approach for implementation.

Pecos County WCID #1 – Develop Edwars Trintiy Plateau Aquifer Supplies and Transmission Replacement Pipeline

In the last plan, Pecos County WCID #1 had two recommended water management strategies. Since that time, they have obtained funding and have begun implementation of these strategies as one combined project. To match that approach, Region F similarly combined these two strategies for the 2026 Plan.

Town of Pecos City – Partner with Madera Valley WSC & Expand Well Field

In the 2021 plan, the Town of Pecos City and Madera Valley WSC had a well field expansion as a partnership project. Since that time, Pecos City has acquired some of Madera Valley WSC's Certificate of Convenience and Necessity (CCN) and is now pursuing this project independently. The project sponsor was updated to only show Pecos City for the 2026 plan.

Removed Water Management Strategies and Projects

In addition to new and altered strategies, some strategies and associated projects included in the 2021 plan are no longer being considered for the entity for various reasons. Changes in water user groups that have conservation recommended due to the same set of methodology used to identify them are considered non substantive and not included. These are outlined in Table 9-4.

Table 9-4
Strategies and Projects No Longer Considered in the 2026 Plan

Water User Group or Wholesale Provider	Strategies from the 2021 Plan No Longer in the 2026 Plan
Brown County Mining	Develop Cross Timbers Aquifer Supplies
Bronte	Develop Other Aquifer Supplies in Runnels County
Bronte	Develop Other Aquifer Supplies in Southwest Coke County
Bronte, Ballinger, Winters, Robert Lee	Regional System from Lake Brownwood
Odessa	Develop Capitan Reef Complex Aquifer Supplies in Ward County
Greater Gardendale WSC	Purchase from Provider (Midland FWSD)
Grandfalls	Develop Pecos Valley Aquifer Supplies
Grandfalls	Purchase from Provider (CRMWD)
Menard	Develop Alluvial Well Supplies/Purchase Supplies from Irrigation, Menard
Menard	Develop Hickory Aquifer Supplies
Midland County-Other Midland County Utility District (MCUD)	Develop Pecos Valley Aquifer Supplies from Roark Ranch in Winkler County
Midland, San Angelo, Abilene (G)	West Texas Water Partnership - Alternative Version
Mitchell County Steam Electric Power	Indirect Non-Potable Reuse (Sales from Colorado City)
Odessa	Develop Capitan Reef Complex Aquifer Supplies in Ward County
Pecos County Mining	Develop Pecos Valley Aquifer Supplies
Reeves County Mining	Develop Pecos Valley Aquifer Supplies
Robert Lee	Repair and Expand Water Treatment Plant
Scurry County Other	Purchase from Provider (Snyder)
Scurry County Manufacturing	Develop Dockum Aquifer Supplies
Sutton County Irrigation	Weather Modification
Sonora	Develop Additional Edwards-Trinity Aquifer Supplies
Upper Colorado River Authority (UCRA)	Brush Control
Winters	Purchase from Provider (Abilene)

9.3 Assessment of Regionalization Across Region F

As a part of the regional planning process, regional water planning groups (RWPGs) are required to prepare long-term plans that consider ongoing local and regional planning efforts and are consistent with other regional plans across the state. In addition, regional water plans are required to meet the projected needs of water user groups (WUGs) with strategies that, among other requirements, are cost-effective. Regional water management strategies, or strategies that meet needs of multiple WUGs, can be more cost-effective than localized strategies due to economies of scale and potential reductions in the unit cost of planning, design, and construction of one, regionalized infrastructure project in densely populated areas. However, in more sparsely populated areas, the cost of long transmission lines can outweigh the potential benefits and cost savings from the economies of scale of a regional project.

In Region F, regional strategies that meet the needs of multiple WUGs and achieve economies of scale are implemented in areas where it is cost-effective and technically feasible. For example, the Colorado River Municipal Water District (CRMWD) sells and distributes water to multiple water users in Region F, including other major water providers (Midland, Odessa, and San Angelo) that distribute water to their own customers. Strategies implemented by CRMWD are inherently regional as they provide for the needs of their customers and any potential future customers. In addition, the cities of Midland, San Angelo, and Abilene (Region G) are collaborating and considering the development of a regional water supply strategy (referred to as the "West Texas Water Partnership") that could provide for the growing needs of their customers. Growing communities outside Midland (Midland County Utility District) and San Angelo (UCRA) are considering regional solutions to meet their needs. Another potential regional strategy in Region F includes the development of a regional system between the cities of Bronte, Ballinger, Winters, and Robert Lee that would transport water from Lake Fort Phantom Hill. However, regional strategies for Bronte, Ballinger, Winters, and Robert Lee have not been found to be cost effective due to the long distances of transmission pipeline that is needed for relatively small amounts of water and are included as an alternative WMS.

Table 9-5
Comparison of Recommended Water Management Strategies Serving More than one Water User Group (WUG) in the 2021 and 2026 Plans

2021 Regional Plan	2026 Regional Plan
Subordination	Subordination
Weather Modification	Weather Modification
Concho River Water Project (San Angelo)	Concho River Water Project (San Angelo)
Hickory Aquifer Expansion (San Angelo)	*Implemented*
----	Brown County WID Treatment Plant Expansion
Ward County Well Field Replacement (CRMWD)	Ward County Well Field Replacement (CRMWD)
Ward County Well Field Expansion and Development of Winkler County Well Field (CRMWD)	Ward County Well Field Expansion and Development of Winkler County Well Field (CRMWD)
Purchase from CRMWD (Midland)	Purchase from CRMWD (Midland)
West Texas Water Partnership (Midland, San Angelo, Abilene)	West Texas Water Partnership (Midland, San Angelo, Abilene)
----	Purchase from CRMWD Lake Spence with Advanced Treatment (Bronte, Robert Lee)
Partner with Madera Valley WSC to Expand Well Field (Pecos City)	----
-----	Develop Lipan Aquifer Supplies (UCRA)
-----	Increase Runoff from Solar Farms (UCRA)
9 Recommended WMS Serving More than one WUG	**11 Recommended WMS Serving More than one WUG**

Regional strategies can achieve economies of scales and be cost-effective, particularly for centralized areas that have a large water need. However, in comparison to other regions across Texas, Region F has demographic and geographic characteristics that limit the advantages of regional strategies. With the exception of a few metropolitan areas, the majority of Region F is rural, and demands are primarily met with local water supplies, such as groundwater or local reservoirs. Furthermore, Region F is geographically expansive, as it encompasses 32 counties and spans across nearly half the state of Texas. Region F encourages regional strategies and projects when they can make sense and can be developed in a cost-effective manner. However, the need for large-scale projects in Region F is limited since many communities already have local supplies available. Also, unless water user groups are relatively nearby, regional projects can be cost-prohibitive due to long transmission distances.

9.4 Conclusion

Overall, the 2026 Region F Water Plan has changed in various ways from the 2021 Region F Water Plan. Water demands in the 2026 Plan are slightly higher than the 2021 Plan largely due to increases in projected mining water demands. Surface water supplies are slightly lower due to changes to the extended Water Availability Model for the Rio Grande Basin. However, supplies to users were generally higher and overall water needs were slightly lower. The region removed 24 strategies and added 13 strategies, resulting in a net decrease of 10 strategies in the 2026 plan.

10 PUBLIC PARTICIPATION AND PLAN ADOPTION

This section describes the plan approval process for the Region F Water Plan and the efforts made to encourage public participation in the planning process. During the development of the regional water plan, special efforts were made to inform the general public, water suppliers, and others with special interest in the planning process and to seek their input.

10.1 Regional Water Planning Group

As part of SB1, regional water planning groups were formed to guide the planning process. These groups were comprised of local representatives of twelve specific interests:

- General public
- Counties
- Municipalities
- Industrial
- Agricultural
- Electric generating utilities
- Small businesses
- Environmental
- River authorities
- Water districts
- Water utilities
- Groundwater Management Areas

Table 10-1 lists the voting members of the Region F Water Planning Group, the interests they represent, and their counties as of February 20, 2025. The Region F Water Planning Group also has non-voting members to represent counties that are not otherwise represented by voting members.

Table 10-2 lists the non-voting members. The Region F Water Planning Group held regular meetings during the development of the plan, receiving information from the region's consultants and making decisions on planning efforts. These meetings were open to the public, and proper notice was made under SB1 and Texas Government Code Chapter 551 guidelines.

10.2 Outreach to the Public

The public were given opportunities to participate throughout the regional water planning process, including the following:

Regional water planning group meetings held throughout the planning process presented opportunities for dissemination of information to the public and receiving public comments. Notices for the meetings were posted in accordance with TWDB rules and the Texas Open Meetings Act.

A website specific to Region F was developed to provide information on the planning process to the public and planning group members. This website can be accessed at www.regionfwater.org.

Scope of Work, meeting minutes and other information were available on the Region F and TWDB websites. Materials are also available for public request in accordance with TWDB rules and the Texas Public Information Act.

Table 10-1
Voting Members of the Region F Water Planning Group

Name	Interest	County
Vacancy	Public	
Vacancy	Public	
Vacancy	Counties	
John Allen	Counties	Brown
Shane Kelton	Municipalities	Tom Green
Eli Torres	Municipalities	Scurry
Vacancy	Municipalities	
Vacancy	Industries	
Kenneth Dierschke	Agricultural	Tom Green
Vacancy	Agricultural	
Schuyler Wight	Agricultural	Ector
Gilbert Van Deventer	Environmental	Midland
Vacancy	Environmental	
Tommy Ervin	Small Business	Ector
Gene Carter	Elec. Gen. Util.	Mitchell
Scott McWilliams	River Authorities	Tom Green
Ben Deishler	Water Districts	Reeves
Cole Walker	Water Districts	Howard
Richard Gist	Water Utilities	Brown
Raymond Straub, Jr.	GMA 2	Martin
Ty Edwards	GMA 3	Pecos
Rhetta Hector	GMA 7	Glasscock

Table 10-2
Non-Voting Members of the Region F Water Planning Group

Name	County/ Agency
Dale Adams	Region G liaison
Melanie Barnes	Region O liaison
Rodney Taylor	Taylor
Lee Sweeten	Region J liaison
Heather Rose	Texas Water Development Board
Nathan Rains	Texas Parks and Wildlife
JD Lawrence	Texas Department of Agriculture
Ben Wilde	Texas State Soil and Water Conservation Board

10.3 Outreach to Water Suppliers and Water User Groups

The Region F Water Planning Group made special efforts to contact municipalities, water districts, and rural water supply corporations and others in the region and obtain their input in the planning process. Outreach included both questionnaires and meetings with selected water user groups and wholesale water providers. The questionnaires sought information on water use projections, current sources of water and supplies, drought planning, water quality issues, water management strategies, and other water supply issues. Particular emphasis was placed on receiving input from water user groups with water supply needs.

10.4 Rural Outreach Efforts

The Region F Water Planning Group made special efforts to contract rural entities in the planning area to support plan development. TWDB provided a list of 129 entities which qualify as rural political subdivisions per definition per Texas Water Code 15.001(14) in Region F. 70 of these entities are already named water user groups and were surveyed and called as described in Section 10.3. In accordance with TWDB guidelines, outreach for the remaining entities was prioritized for those entities which have:

1. Self-reported water use restriction to TCEQ due to water supply issues during the current planning cycle,
2. self-report to TCEQ having less than 180 days of water supply remaining during the current planning cycle,
3. have not previously engaged in the regional planning process, and
4. have already been identified as facing significant near-term shortages under drought conditions in previous regional water plans.

Appendix L documents the prioritization and outreach measures performed in Region F.

10.5 Interregional Coordination

Region F continued to coordinate with adjacent regions that provide and/or receive water from Region F. This included regional liaisons who attended planning group meetings and coordination with the Llano- Estacado (Region O), Brazos G, Region J, Region K, and Far West Texas (Region E) regions. Additionally, Region F developed interregional coordination memos that document demands, existing and future sources that cross regional planning group boundaries. The interregional coordination memo was sent to each of the adjacent regions' technical consultant for review and coordination.

10.6 Public Meetings and Public Hearings

As required by rule, the Region F Water Planning Group held an initial public meeting to discuss the planning process and the scope of work for the region on November 18, 2021. Presentations were made on the planning process and input was solicited from participants. Public meetings were held approximately three to four times per year throughout the planning process.

According to the capabilities of the facility, copies of the Initially Prepared Region F Water Plan were provided electronically via web link or were mailed to Region F County courthouses and libraries for public review 30 days in advance of the Public Hearing. Copies of the Initially Prepared Plan were also posted on the Region F website. Notices of the upcoming public meetings were sent to the Secretary of State, all voting and non-voting planning group members, county clerks, county judges, regional legislators, groundwater and irrigation districts, and regional newspapers along with a description of how to obtain copies of the draft plan for review.

The Region F Water Planning Group will also hold a public hearing to present the draft Initially Prepared Region F Water Plan and seek public input. Oral comments will be accepted following the presentation and written comments will be accepted for a period after the public hearing in accordance with TWDB rules and guidelines. A summary of public comments received during the comment period will be added for the final plan. Appendix M will include responses to all comments received on the plan.

10.7 Comments from State and Federal Agencies

Comments from state and federal agencies and responses to agency comments will be documented in Appendix M. Where appropriate, modifications to the plan will be made and incorporated into the adopted Region F Water Plan.

10.8 Plan Implementation Issues

As part of the development of the 2026 Region F Water Plan, implementation issues were identified for some providers and specific water management strategies. These issues are documented in the descriptions and evaluations of the strategies (Chapters 5B through 5E and Appendix C). This section summarizes the issues for users in Region F. The implementation issues identified for the Region F Regional Water Plan include:

1) financial issues associated with paying for the proposed capital improvements,
2) additional studies associated with subordination of Colorado Basin water rights,
3) implementation of conservation measures that were assumed in this plan, and
4) groundwater issues.

10.8.1 Financial Issues

It is assumed that the entities for which strategies were developed will utilize existing financial resources, incur debt through bond sales and/or receive state-supported financial assistance. Most likely the funding of identified strategies will increase the cost of water to the customers. The economic feasibility to implement the strategies will depend on the economic burden to the customer base. Especially for small rural communities with limited resources, some strategies may not be able to be implemented without state assistance.

10.8.2 Additional Water Rights Studies in the Colorado Basin

The subordination strategy described in Chapter 5C was developed for regional water planning to better represent surface water supplies that are currently in use within Region F. The results are for planning purposes only and do not represent legal findings or recommendations. Should entities in Region F choose to enter into subordination agreements with downstream water right holders, additional studies will be required. Further study may still be needed to clarify water rights issues in the Colorado Basin.

10.8.3 Water Conservation

The water conservation plans and water loss audit reports were reviewed to help identify appropriate municipal water conservation measures and identify suggested Best Management Practices (BMPs). Water savings achieved through these BMPs can be difficult to estimate since there is little data over an extended time period. Also, entities normally implement multiple strategies at once making it difficult to estimate individual water savings. Savings associated with irrigation conservation are based on aging TWDB datasets and strategies that must be implemented by the irrigator. There is no confirmation that irrigation water saved will be available for future use.

Experience during the recent droughts has demonstrated that significant savings can be made through water conservation and drought management. However, without specific data, it is difficult to quantify the potential long-term savings for water conservation activities and rely on these savings to meet future needs.

10.8.4 Groundwater Issues

The Modeled Available Groundwater (MAG) was considered to be a cap for allocating groundwater supplies in the current plan. For counties without a GCD, this limit is unenforceable and will likely be exceeded in reality. Furthermore, in some cases, a GCD has already issued permits that exceed the MAG. However, these strategies cannot be included in this plan if existing use exceeds the MAG. This makes these strategies ineligible for certain state funding programs until the MAG values are changed and may make implementation more difficult.

Also, desalination of brackish groundwater is becoming an increasingly popular water supply alternative for regions heavily affected by drought. Although brackish groundwater is plentiful in Texas, additional understanding about this historically underutilized source is needed. For example, no legal definition currently exists in the State of Texas for 'brackish groundwater'. During the 86th Texas Legislative Session[1], House Bill 722 passed which created a separate GCD permitting system for the production of brackish groundwater in "Brackish Groundwater Production Zones".

LIST OF REFERENCES

[1] Texas Alliance of Groundwater Districts. 86th Legislative Session Wrap-Up, 2019.