2016 Region F Water Plan

Volume I Main Report

Freese and Nichols, Inc.

LBG - Guyton Associates, Inc.

Region F
Water Planning Group

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2016 Region F Water Plan

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Region F Water Planning Group

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Volume I –Region F Water Plan

LIST OF TABLES

LIST OF FIGURES

ATTACHMENTS

Volume II – APPENDICES

Region F Water Planning Group
List of Acronyms

Acronym	Name	Meaning
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.
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.
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.

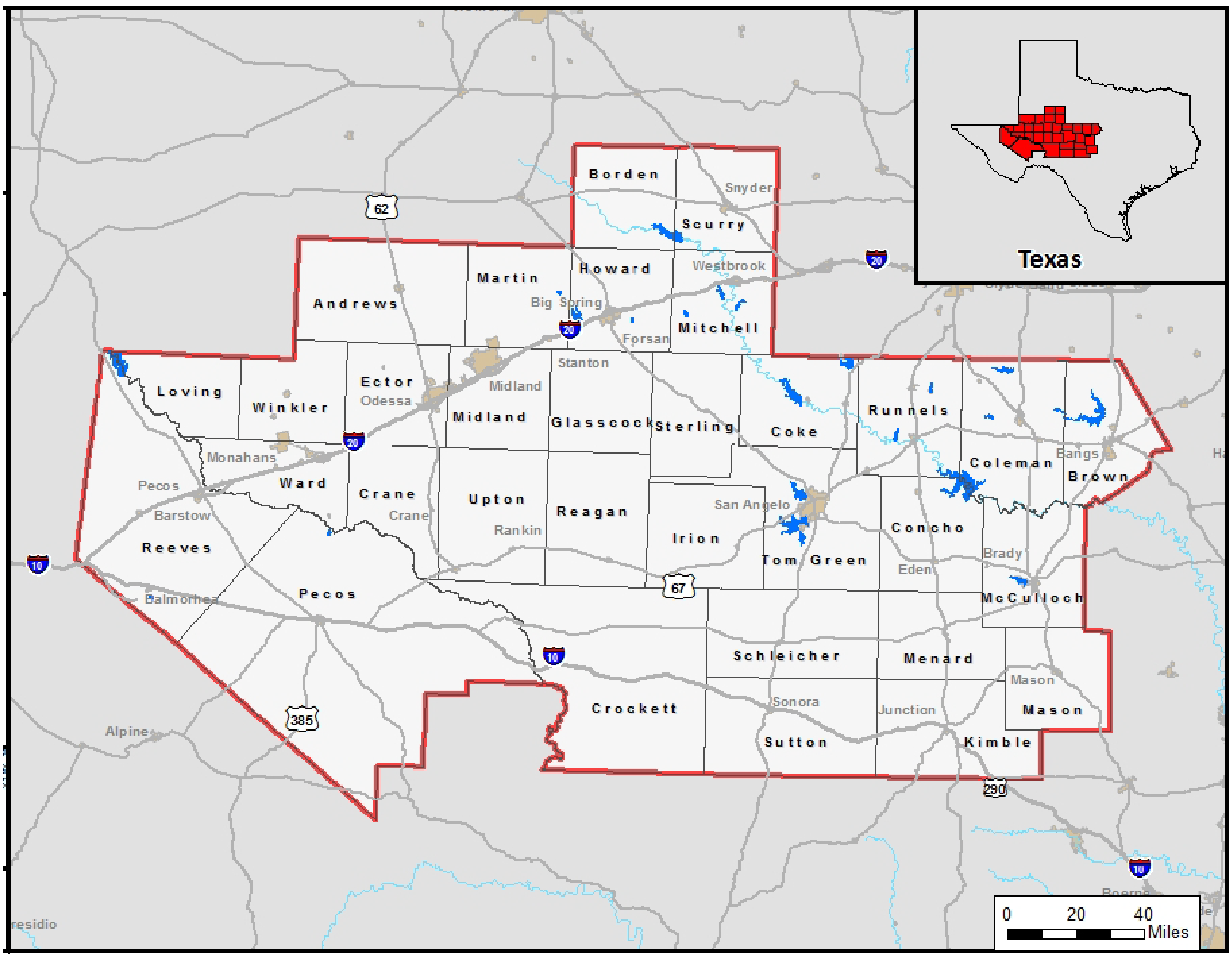
Region F Water Planning Group
List of Acronyms

Acronym	Name	Meaning
TCEQ	Texas Commission on Environmental Quality	Agency charged with oversight of Texas surface water rights and WAM program.
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

This report presents the Region F Water Plan developed in the fourth round of Senate Bill One regional water planning process. Region F includes all of 32 counties in West Texas, as show in Figure ES- 1. This report presents the results of a five-year planning effort to develop a plan for water supply for the region through 2070.

Figure ES- 1
Region F Area Map



The 2016 Region F Water Plan was developed under the direction of the 21- member Region F Water Planning Group and adopted by the planning group on September 17, 2015.

The Region F Plan includes the following chapters:

1. Description of the Region
2. Population and Water Demand Projections
3. Water Supply Analysis
4. Identification of Water Needs
5. Water Management Strategies
6. Impacts of the Regional Water Plan
7. Drought Response Information, Activities, and Recommendations
8. Unique Stream Segments and Reservoir Sites and Other Recommendations
9. Infrastructure Funding Recommendations
10. Adoption of Plan and Public Participation
11. Implementation and Comparison to the Previous Regional Water Plan

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 ongoing severe drought in the Colorado River Basin, the estimated surface water availability has declined significantly for water supply planning. Furthermore, new restrictions on estimated groundwater availability have reduced the estimated recoverable yield. This resulted in increased needs, especially for municipal users, which resulted in over 70 new water management strategies for the region. Conservation comprises 54 percent of the number of recommended strategies and is the only strategy available for some users, such as irrigation. As the region looks to meet its projected needs, conservation, reuse, and desalination of brackish groundwater will become greater integral components of the region's water supplies.

ES.2 Current Water Needs and Supplies in Region F

As of the 2010 census, the population of Region F was 623,354. The three most populous counties in Region F (Ector, Midland, and Tom Green) have 62 percent of the region's population. Seven cities in Region F had a population of more than 10,000 people as of year 2010. These seven cities include 60 percent of the population in Region F.

ES.2.1 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. 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 seven minor aquifers provide groundwater supplies to Region F.

ES.2.2 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 from O.H. Ivie Reservoir in Region F.

Approximately 82 percent of the water used in Region F is supplied by groundwater. Eleven aquifers provide groundwater supplies in Region F. Region F has 16 Underground Water 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.

Region F has identified 13 "major springs" in the region that are important for water supply or other natural resources protection. These major springs include: San Solomon, Giffin, Sandia, Comanche, Diamond Y, Spring Creek, Dove Creek, Rocky Creek, Anson, Lipan, Kickapoo, Clear Creek, and San Saba Springs.

ES.2.3 Water Providers in Region F

Water providers in Region F include 88 water user groups and seven wholesale water providers. The wholesale water providers include the Colorado River Municipal Water District, Brown County Water Improvement District Number 1, Upper Colorado River Authority, the City of Odessa, the City of San Angelo, the Great Plains Water System, and University Lands.

ES.3 Projected Need for Water

ES.3.1 Population Projections

The population of Region F is projected to grow from 623,354 in the year 2010 to 1,003,347 in 2070, an average growth rate of 1.02 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.

Table ES- 1
Region F Population Projections

Population Projections	2020	2030	2040	2050	2060	2070
Region F Total	700,933	766,612	825,381	884,551	943,798	1,003,347

ES.3.2 Demand Projections

Figure ES- 2 shows the projected demands for water by category of use in Region F. The total historical water use was about 625,000 acre-feet in the year 2010 and is projected to be as much as 837,974 acre-feet in 2020 and 853,311 in 2070. The significant increase in water use between the historical year 2010 data and the year 2020 projections is due to irrigation demands. Region F believes that recent historical water use for irrigation is not indicative of the potential for irrigation water use in the region. During the recent drought irrigation demand was suppressed because of low crop prices and reduced water supply. The adopted projections are an estimate of what the irrigation demand could have been with higher crop prices and sufficient water supplies. Irrigation water demands are projected to make up the majority of the water use in Region F.

Steam electric projections are also higher than the historical 2010 use. Several power generation facilities in Region F have recently ceased operation. The future use of these facilities is uncertain. Mining demands have more than doubled from the historical year 2010 data due to the increase in oil and gas exploration in the region.

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

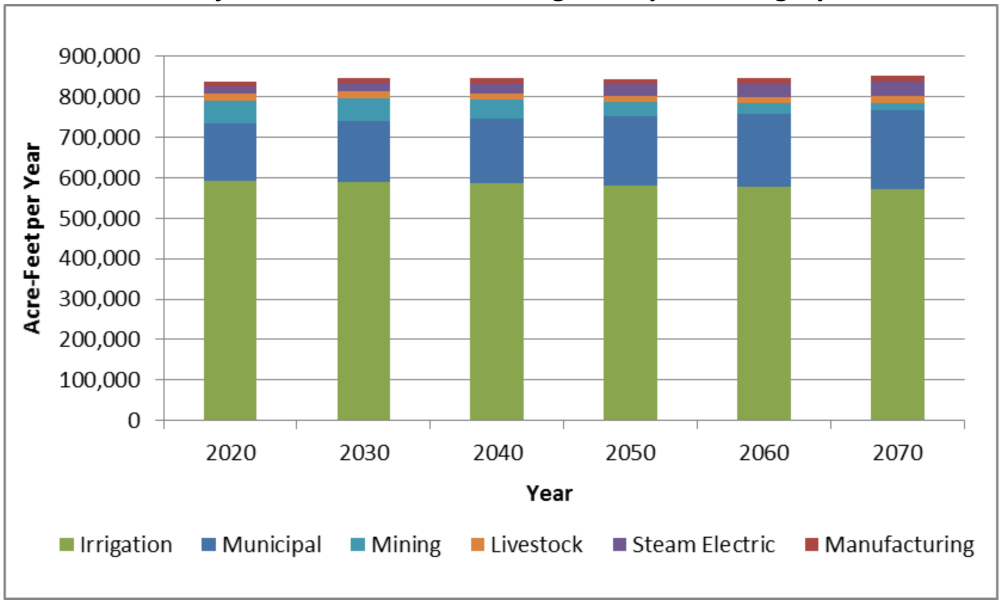


Table ES- 2
Water Demands by Use Type (acre-feet per year)

Demands	2020	2030	2040	2050	2060	2070
Municipal	141,454	151,070	160,417	170,872	182,097	193,585
Manufacturing	11,162	11,879	12,563	13,138	13,934	14,783
Mining	55,657	56,362	46,172	34,381	24,416	18,753
Steam Electric Power	19,085	21,315	24,071	27,472	31,657	36,125
Livestock	16,942	16,942	16,942	16,942	16,942	16,942
Irrigation	593,674	589,525	585,374	581,230	577,147	573,123
Region F Total	**837,974**	**847,093**	**845,539**	**844,035**	**846,193**	**853,311**

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 surface water supply that is currently used in Region F.

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 seven minor aquifers that vary in quantity and quality (Figure ES- 3 and Figure ES- 4). Total groundwater supply is determined using the Modeled Available Groundwater (MAG) value as determined by the TWDB.

Not all of the water supplies in the region are currently available 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
Existing Supplies by Use Type (acre-feet per year)

Existing Supplies	2020	2030	2040	2050	2060	2070
Municipal	105,642	106,440	104,823	101,491	104,824	105,572
Manufacturing	8,714	9,361	9,497	9,558	9,686	9,780
Mining	40,469	41,410	36,000	29,121	21,960	17,614
Steam Electric Power	5,517	5,468	5,511	5,443	5,340	5,339
Livestock	16,718	16,689	16,683	16,666	16,640	16,641
Irrigation	480,375	476,884	474,866	470,524	466,375	463,963
Region F Total	**657,435**	**656,252**	**647,380**	**632,803**	**624,825**	**618,909**

Figure ES- 3
Major Aquifer Map

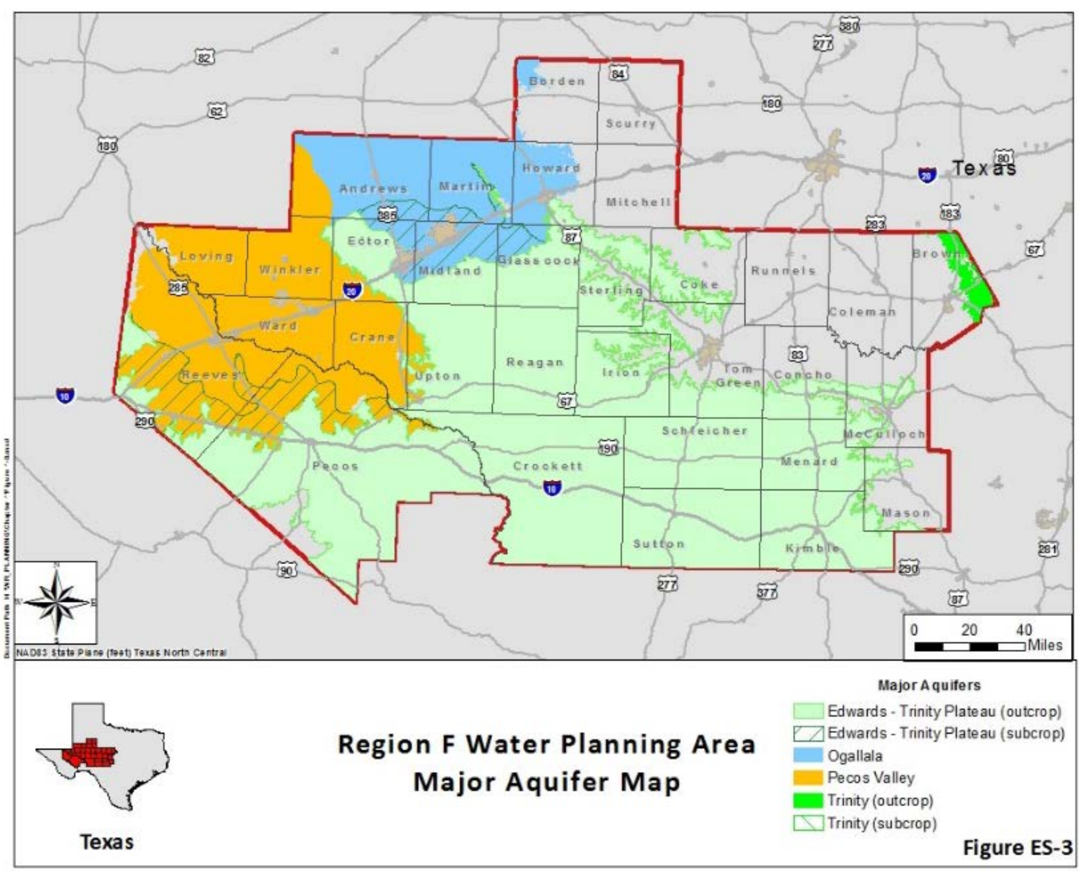
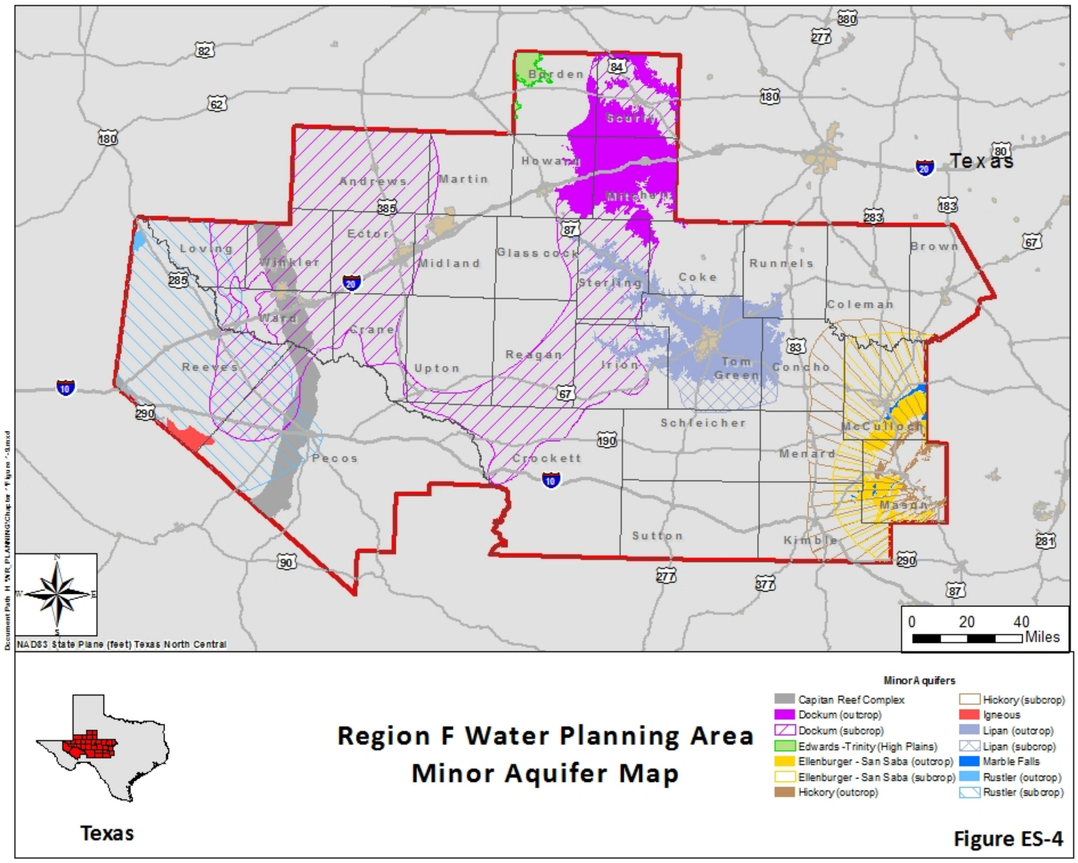


Figure ES- 4
Minor Aquifer Map



ES.3.4 Comparison of Supply and Demand

Figure ES- 5 shows a comparison of the available water supply to Region F and projected demands. With a projected 2070 demand of 853,311 acre-feet per year, Region F has a projected regional shortage of about 236,937 acre-feet per year by 2070.

Irrigation, municipal, and mining demands have the largest shortages. Typically, the counties with the largest irrigation needs are those with large irrigation demands and limited groundwater supplies. Most of the municipal needs are a result of underestimation of available supply according to the Colorado WAM or limited groundwater availability under the MAG. Mining needs are a result of projected growth in demands that exceeds the available supply.

Figure ES- 5
Comparison of Supply and Demand (acre-feet per year)

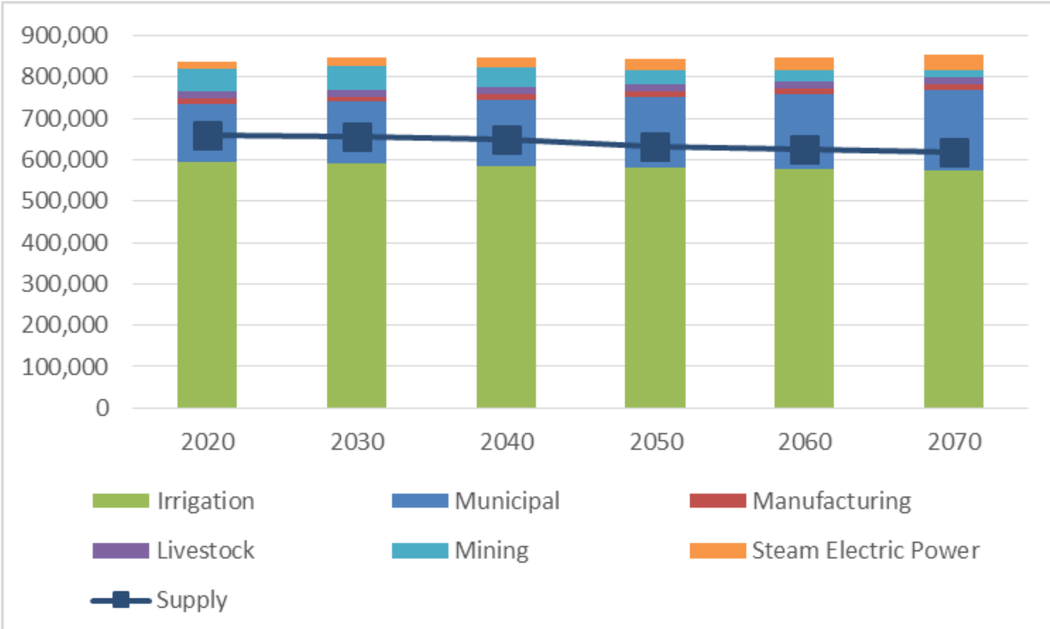


Table ES- 4
Needs by Use Type (acre-feet per year)

Need	2020	2030	2040	2050	2060	2070
Municipal	36,262	45,204	56,120	66,651	77,674	88,349
Manufacturing	3,528	3,718	4,202	4,663	5,277	5,917
Mining	15,516	15,180	10,334	5,402	2,629	1,480
Steam Electric Power	13,568	15,847	18,560	22,029	26,317	30,786
Livestock	368	397	403	420	446	445
Irrigation	113,745	113,158	111,096	111,365	111,501	109,960
Region F Total	**182,987**	**193,504**	**200,715**	**210,530**	**223,844**	**236,937**

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 conducted an evaluation of failing to meet the projected water needs in Region F. The TWDB analysis estimated that without additional supplies, the projected water needs would reduce the region's projected annual income in 2020 by $55.7 billion or about 19 percent. The loss in income reduces to approximately $2.9 billion in 2070, after the mining boom was projected to have ended.

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 on other water resources and on threats to agricultural and natural resources
- Significant issues affecting feasibility
- Consideration of other water management strategies affected

ES.4.1 Water Conservation

The Region F Water Planning Group considered four major categories of water conservation: municipal, mining, irrigation and steam-electric power generation. Overall, in Region F more than 95,000 acre-feet of water could be conserved by 2070.

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).

Irrigation is the largest water user in Region F and the category with the largest needs. 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. Steam Electric Power conservation focuses on alternative cooling technologies such as air cooling.

ES.4.2 Water Management Strategies

Table ES-5 (following page) lists the recommended water management strategies by type for Region F. Alternate water management strategies are included in summary Table ES-6. In total, the Region F plan recommends a number of water management strategies to develop or preserve over 230,000 acre-feet per year of additional supplies by 2070, including new well fields, desalination, reuse, and voluntary redistribution. One of the most significant strategies in the Region F plan is subordination of senior water rights. This strategy, which was developed in conjunction with the Lower Colorado Region (Region K), reserves over 52,000 acre-feet of surface water for use in Region F in 2070. Additional supply is available to wholesale water providers for future customers or use beyond this planning cycle.

No sources were over allocated as a part of this Plan. The source balance report demonstrating this fact is included in Appendix J.

Irrigation demands in some years for 13 counties are not met with this plan due to limited water existing supplies and lack of cost effective alternative sources of water. Mining demands in four counties are not met with this plan due to limited supplies and large demands in early decades. Two municipalities' needs are not met with this plan due to supply availability limitations, however, the municipalities are actively pursuing studies and projects to meet their needs. Unmet water needs for Region F are summarized in Table ES- 7.

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

Water User	2020	2030	2040	2050	2060	2070
Andrews [a]	1,523	2,220	2,748	4,355	6,059	7,316
Midland	0	0	1,910	5,227	8,670	12,081
Manufacturing	399	450	502	550	614	683
Mining	5,679	5,820	2,173	298	103	29
Irrigation	105,296	94,068	87,672	87,839	87,958	86,401
Total	**112,897**	**102,558**	**95,005**	**98,269**	**103,404**	**106,510**

a. Includes Andrews County Manufacturing unmet need.

Water quality is an important factor in Region F water supplies, particularly for municipal use. Communities in Region F are being pressured to expend limited public and private financial resources to meet water quality standards for arsenic, radionuclides, and secondary water constituents. Meeting these standards is particularly difficult for small communities in the region.

Table ES-5
Summary of Recommended Strategies

Entity	County Used	Expected Online Date	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2020	2030	2040	2050	2060	2070	
Additional Treatment											
Big Spring	Howard	2020	$16,345,000	$651	3,677	2,190	2,682	3,115	3,523	3,885	$195
Brady	McCulloch	2020	$20,398,000	$3,013	608	609	614	616	617	616	$246
Bronte	Coke	2020	$6,768,000	$1,603	504	504	504	504	504	504	$480
Mason	Mason	2020	$838,000	$240	703	693	685	680	680	680	$141
Odessa	Ector	2020	$62,309,000	$1,078	7,500	7,500	7,500	7,500	7,500	7,500	$383
Aquifer Storage and Recovery											
CRMWD	Multiple	2030	$10,184,000	$651		5,000	5,000	5,000	5,000	5,000	$480
Brush Control											
San Angelo and UCRA	Multiple	2020	$0	$100	2,240	2,240	2,240	2,240	2,240	2,240	$100
BCWID	Multiple	2020	$0	$857	20,257	20,257	20,257	20,257	20,257	20,257	$857
Desalination											
CRMWD	Multiple	2040	$34,819,000	$1,844			3,360	3,360	3,360	3,360	$977
San Angelo	Tom Green	2050	$57,967,000	$2,142				3,750	3,750	3,750	$703
Develop Other or Local Groundwater Supplies											
Mining	Runnels	2020	$140,000	$211	76	73	46	18	0	0	$55
Mining	Scurry	2020	$140,000	$200	80	80	80	80	80	80	$53
Livestock	Scurry	2020	$143,000	$185	92	92	92	92	92	92	$54
Concho Rural WSC	Tom Green	2020	$5,131,000	$4,673	150	150	150	150	150	150	$1,813
Develop Dockum Aquifer Supplies											
Livestock	Howard	2020	$512,000	$367	150	150	150	150	150	150	$80
Mining	Howard	2020	$989,000	$383	274	274	274	274	274	274	$82
Mining	Irion	2020	$782,000	$520	150	150	150	50	0	0	$87
County-Other	Martin	2020	$4,219,000	$1,636	250	250	250	250	250	250	$224
Livestock	Martin	2020	$339,000	$800	40	40	40	40	40	40	$100
Mining	Martin	2020	$677,000	$348	210	210	210	210	210	210	$76

Table ES-5
Summary of Recommended Strategies

Entity	County Used	Expected Online Date	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2020	2030	2040	2050	2060	2070	
Develop Edwards-Trinity Plateau Aquifer Supplies											
County-Other	Andrews	2020	$3,515,000	$696	500	500	500	500	500	500	$108
Livestock	Andrews	2020	$238,000	$193	150	150	150	150	150	150	$60
Bronte, Robert Lee	Coke	2020	$7,350,000	$8,885	78	78	78	78	78	78	$1,000
Mining	Coke	2020	$678,000	$295	250	250	250	250	250	250	$67
Junction	Kimble	2020	$3,555,000	$1,655	216	220	220	220	220	220	$305
Mining	Irion	2020	$2,057,000	$296	500	500	500	100	0	0	$70
Manufacturing	Kimble	2020	$305,000	$140	300	300	300	300	300	300	$53
Mining	Martin	2020	$2,356,000	$188	1,500	1,500	1,000	1,000	500	500	$57
Livestock	McCulloch	2020	$62,000	$200	30	30	30	30	30	30	$33
Pecos County WCID #1	Pecos	2020	$2,456,000	$988	250	250	250	250	250	250	$164
Steam Electric Power	Crockett	2020	$0	$0	776	907	1,067	1,262	1,500	1,662	$0
Develop Hickory Aquifer Supplies											
Mining	Coleman	2020	$814,000	$1,200	65	65	65	65	65	65	$154
Mining	Concho	2020	$1,626,000	$800	200	200	200	200	200	200	$120
Menard	Menard	2020	$6,120,000	$1,366	500	500	500	500	500	500	$342
Develop Ogallala Aquifer Supplies											
Mining	Howard	2020	$127,000	$419	20	31	31	31	3	3	$67
Develop Pecos Valley Aquifer Supplies											
Livestock	Andrews	2020	$68,000	$160	50	50	50	50	50	50	$40
County Other	Midland	2030	$62,699,000	$5,837		1,000	1,000	1,000	1,000	1,000	$590
Steam Electric Power	Ward	2020	$2,682,000	$89	5,600	5,600	5,600	5,600	5,600	5,600	$49
County Other	Winkler	2020	$1,908,000	$398	500	500	500	500	500	500	$79
Dredging River Intake											
Junction	Kimble	2020	$4,268,000	$867	412	412	412	412	412	412	$0
Expansion of Existing Supplies											
CRMWD	Ward/Winkler	2020	$139,916,000	$1,265	11,200	11,200	11,200	11,200	11,200	11,200	$219
Midland Additional T-Bar	Midland	2030	$52,199,000	$869		10,000	10,000	10,000	10,000	10,000	$432

Table ES-5
Summary of Recommended Strategies

Entity	County Used	Expected Online Date	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield 2020	2030	2040	2050	2060	2070	Last Decade Unit Cost ($/ac-ft/yr)
Irrigation Conservation											
Irrigation	Andrews	2020	$1,894,900	$41,321	1,895	3,758	3,726	3,726	3,726	3,726	$0
Irrigation	Borden	2020	$200,000	$41,321	200	399	399	399	399	399	$0
Irrigation	Brown	2020	$471,750	$41,321	472	752	750	750	750	750	$0
Irrigation	Coke	2020	$48,250	$41,321	48	96	115	115	115	115	$0
Irrigation	Coleman	2020	$38,500	$41,321	39	77	77	77	77	77	$0
Irrigation	Concho	2020	$486,700	$41,321	487	969	1,062	1,062	1,062	1,062	$0
Irrigation	Crane	2020	$0	$41,321	0	0	0	0	0	0	$0
Irrigation	Crockett	2020	$23,950	$41,321	24	47	69	69	69	69	$0
Irrigation	Ector	2020	$71,600	$41,321	72	142	210	210	210	210	$0
Irrigation	Glasscock	2020	$2,268,280	$41,321	2,268	2,250	2,232	2,232	2,232	2,232	$0
Irrigation	Howard	2020	$336,100	$41,321	336	665	722	722	722	722	$0
Irrigation	Irion	2020	$73,350	$41,321	73	144	210	210	210	210	$0
Irrigation	Kimble	2020	$146,950	$41,321	147	283	326	326	326	326	$0
Irrigation	Loving	2020	$0	$41,321	0	0	0	0	0	0	$0
Irrigation	McCulloch	2020	$179,200	$41,321	179	354	524	524	524	524	$0
Irrigation	Martin	2020	$1,816,100	$41,321	1,816	3,567	5,254	5,254	5,254	5,254	$0
Irrigation	Mason	2020	$414,700	$41,321	415	817	1,208	1,208	1,208	1,208	$0
Irrigation	Menard	2020	$126,500	$41,321	127	252	377	377	377	377	$0
Irrigation	Midland	2020	$1,663,800	$41,321	1,664	3,302	4,913	4,913	4,913	4,913	$0
Irrigation	Mitchell	2020	$230,380	$41,321	230	229	228	228	228	228	$0
Irrigation	Pecos	2020	$6,301,150	$41,321	6,301	12,602	18,903	18,903	18,903	18,903	$0
Irrigation	Reagan	2020	$956,500	$41,321	957	1,881	2,773	2,773	2,773	2,773	$0
Irrigation	Reeves	2020	$4,567,850	$41,321	4,568	9,058	13,469	13,469	13,469	13,469	$0
Irrigation	Runnels	2020	$200,450	$41,321	200	399	477	477	477	477	$0
Irrigation	Schleicher	2020	$70,700	$41,321	71	83	81	81	81	81	$0
Irrigation	Scurry	2020	$365,250	$41,321	365	706	885	885	885	885	$0
Irrigation	Sterling	2020	$49,150	$41,321	49	94	135	135	135	135	$0
Irrigation	Sutton	2020	$90,150	$41,321	90	177	260	260	260	260	$0
Irrigation	Tom Green	2020	$4,678,950	$41,321	4,679	9,335	11,175	11,175	11,175	11,175	$0
Irrigation	Upton	2020	$473,650	$41,321	474	934	1,380	1,380	1,380	1,380	$0

Table ES-5
Summary of Recommended Strategies

Entity	County Used	Expected Online Date	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2020	2030	2040	2050	2060	2070	
Irrigation	Ward	2020	$280,650	$41,321	281	554	821	821	821	821	$0
Irrigation	Winkler	2020	$245,600	$41,321	246	491	737	737	737	737	$0
Mining Conservation (Recycling)											
Mining	Andrews	2020	$5,540,000	$124	277	260	222	176	135	104	$0
Mining	Borden	2020	$1,300,000	$716	48	65	55	35	17	8	$0
Mining	Brown	2020	$1,340,000	$149	66	66	67	67	66	66	$0
Mining	Coke	2020	$680,000	$124	34	34	30	26	23	20	$0
Mining	Coleman	2020	$160,000	$124	8	7	7	6	5	5	$0
Mining	Concho	2020	$680,000	$124	34	33	30	26	22	20	$0
Mining	Crane	2020	$1,200,000	$785	43	59	60	48	37	28	$0
Mining	Crockett	2020	$2,580,000	$234	121	129	88	48	14	4	$0
Mining	Ector	2020	$3,020,000	$281	138	151	135	110	89	75	$0
Mining	Glasscock	2020	$4,800,000	$124	240	217	167	118	77	56	$0
Mining	Howard	2020	$3,840,000	$297	174	192	136	80	33	14	$0
Mining	Irion	2020	$4,700,000	$214	223	235	170	104	50	24	$0
Mining	Kimble	2020	$20,000	$124	1	1	1	1	1	1	$0
Mining	Loving	2020	$1,480,000	$702	55	74	65	53	42	33	$0
Mining	Martin	2020	$4,940,000	$124	247	210	158	101	54	29	$0
Mining	Mason	2020	$1,440,000	$124	72	66	50	40	32	26	$0
Mining	McCulloch	2020	$12,500,000	$124	625	584	465	394	339	294	$0
Mining	Menard	2020	$1,520,000	$124	76	75	67	58	50	44	$0
Mining	Midland	2020	$5,460,000	$124	273	239	184	124	74	52	$0
Mining	Mitchell	2020	$1,040,000	$522	42	52	44	35	26	20	$0
Mining	Pecos	2020	$1,500,000	$1,065	48	75	75	60	47	37	$0
Mining	Reagan	2020	$5,900,000	$124	295	238	172	98	37	14	$0
Mining	Reeves	2020	$3,680,000	$1,328	107	184	178	145	114	90	$0
Mining	Runnels	2020	$380,000	$124	19	19	17	15	13	11	$0
Mining	Schleicher	2020	$1,020,000	$435	43	51	39	27	17	10	$0
Mining	Scurry	2020	$680,000	$1,295	20	32	34	25	17	12	$0
Mining	Sterling	2020	$1,340,000	$489	55	67	57	37	19	10	$0
Mining	Sutton	2020	$1,060,000	$1,311	31	50	53	40	27	18	$0

Table ES-5
Summary of Recommended Strategies

Entity	County Used	Expected Online Date	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield 2020	2030	2040	2050	2060	2070	Last Decade Unit Cost ($/ac-ft/yr)
Mining	Tom Green	2020	$1,620,000	$282	74	76	78	78	79	81	$0
Mining	Upton	2020	$5,940,000	$124	297	254	201	135	81	56	$0
Mining	Ward	2020	$1,340,000	$452	56	67	59	45	32	23	$0
Mining	Winkler	2020	$1,640,000	$945	55	82	69	53	37	26	$0
Municipal Conservation											
Andrews	Andrews	2020	$0	$533	82	99	136	157	183	213	$423
Borden County-Other	Borden	2020	$701,400	$1,196	4	4	4	4	4	4	$1,183
Bangs	Brown	2020	$0	$776	9	9	9	9	9	9	$769
Brookesmith SUD	Brown	2020	$0	$398	44	45	45	45	45	45	$388
Brownwood	Brown	2020	$0	$448	126	129	129	129	129	129	$522
Coleman County SUD	Brown	2020	$0	$636	19	19	19	19	19	19	$632
Early	Brown	2020	$0	$661	16	16	16	16	16	16	$657
Santa Anna	Brown	2020	$0	$909	6	6	6	6	6	6	$900
Zephyr WSC	Brown	2020	$0	$602	25	26	26	26	26	26	$600
Bronte	Coke	2020	$900,000	$959	17	17	16	16	16	16	$959
Robert Lee	Coke	2020	$0	$938	6	6	6	6	6	6	$938
Coleman	Coleman	2020	$0	$597	26	27	27	27	27	27	$595
Eden	Concho	2020	$0	$658	16	16	16	16	16	16	$656
Crane	Crane	2020	$0	$628	20	21	23	24	25	26	$600
Crockett County WCID	Crockett	2020	$0	$620	21	23	23	24	24	24	$607
Ector County UD	Ector	2020	$0	$533	83	94	102	135	149	162	$470
Greater Gardendale WSC	Ector	2020	$0	$656	16	19	21	23	26	28	$591
Odessa	Ector	2020	$0	$316	716	825	924	1,026	1,128	1,231	$309
Big Spring	Howard	2020	$0	$399	181	191	193	193	193	193	$444
Coahoma	Howard	2020	$848,000	$1,027	5	5	5	5	5	5	$996
Mertzon	Irion	2020	$0	$1,058	5	5	5	5	5	5	$1,052
Junction	Kimble	2020	$1,891,700	$676	45	46	46	45	45	45	$674
Stanton	Martin	2020	$0	$664	15	17	18	19	20	20	$625
Mason	Mason	2020	$1,568,400	$719	12	12	12	12	12	12	$719
Brady	McCulloch	2020	$0	$555	32	33	33	33	33	33	$523
McCulloch County-Other	McCulloch	2020	$0	$1,286	3	3	3	3	3	3	$1,239

Table ES-5
Summary of Recommended Strategies

Entity	County Used	Expected Online Date	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2020	2030	2040	2050	2060	2070	
Millersview-Doole WSC	McCulloch	2020	$0	$607	24	25	25	26	26	27	$596
Richland SUD	McCulloch	2020	$0	$692	13	14	14	14	14	14	$679
Menard	Menard	2020	$1,183,200	$813	25	25	25	24	24	24	$813
Midland	Midland	2020	$0	$313	813	879	973	1,062	1,150	1,236	$309
Midland County-Other	Midland	2020	$0	$398	145	164	183	202	220	239	$371
Colorado City	Mitchell	2020	$0	$593	28	31	32	32	32	33	$535
Loraine	Mitchell	2020	$0	$1,231	3	4	4	4	4	4	$1,172
Mitchell County-Other	Mitchell	2020	$3,361,800	$597	26	27	28	28	29	29	$589
Fort Stockton	Pecos	2020	$0	$352	50	53	57	60	63	66	$265
Iraan	Pecos	2020	$0	$842	7	8	8	9	9	10	$758
Pecos WCID	Pecos	2020	$0	$635	19	20	22	23	24	25	$602
Big Lake	Reagan	2020	$2,708,800	$638	18	21	22	23	24	24	$605
Madera Valley WSC	Reeves	2020	$1,673,300	$728	11	12	12	13	13	14	$687
Pecos	Reeves	2020	$6,834,400	$332	53	56	59	62	63	64	$272
Reeves County-Other	Reeves	2020	$0	$634	19	20	21	22	23	23	$611
Ballinger	Runnels	2020	$2,669,400	$621	58	59	58	58	58	58	$618
Miles	Runnels	2020	$0	$977	5	6	6	6	6	6	$911
Winters	Runnels	2020	$0	$676	14	15	15	15	15	15	$672
El Dorado	Schleicher	2020	$1,471,200	$736	11	11	11	11	11	11	$736
Snyder	Scurry	2020	$0	$536	75	86	93	100	104	134	$509
Sterling City	Sterling	2020	$0	$986	5	5	5	5	5	5	$963
Sonora	Sutton	2020	$2,486,600	$640	18	20	20	20	21	21	$623
Concho Rural WSC	Tom Green	2020	$0	$523	33	35	37	38	40	41	$427
San Angelo	Tom Green	2020	$0	$319	656	753	793	842	894	949	$317
McCamey	Upton	2020	$1,698,600	$723	11	12	13	13	13	14	$686
Rankin	Upton	2020	$876,900	$1,036	5	5	5	5	6	6	$948
Monahans	Ward	2020	$0	$428	41	43	45	47	48	48	$362
Ward County-Other	Ward	2020	$2,946,700	$617	22	23	24	25	25	26	$599
Kermit	Winkler	2020	$0	$552	32	32	32	33	33	33	$524
Winkler County-Other	Winkler	2020	$1,787,400	$892	6	10	12	15	18	20	$629
Wink	Winkler	2020	$0	$932	6	6	7	7	8	8	$811

Table ES-5
Summary of Recommended Strategies

Entity	County Used	Expected Online Date	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2020	2030	2040	2050	2060	2070	
Rehabilitation of Pipeline											
Bronte	Coke	2020	$1,499,000	$1,370	104	104	104	104	104	104	$164
Reuse											
Bangs	Brown	2020	$422,000	$1,560	25	25	25	25	25	25	$160
Brownwood	Brown	2020	$8,500,000	$1,541	841	841	841	841	841	841	$696
Mining	Mitchell	2020	$932,000	$368	250	250	250	250	250	250	$56
Mining	Crockett	2020	$0	n/a	75	75	75	75	75	75	n/a
Eden	Concho	2020	$485,700	$902	50	50	50	50	50	50	$89
Menard	Menard	2020	$1,288,800	$1,775	67	67	67	67	67	67	$165
Mining	Midland	2020	$3,349,000	$664	500	500	500	500	500	500	$104
Mining	Andrews	2020	$28,197,000	$1,141	2,500	2,500	2,500	2,500	2,500	2,500	$197
Mining	Martin	2020	$17,827,000	$1,187	1,500	1,200	600	500	0	0	$193
Sonora	Sutton	2020	$495,800	$748	62	62	62	62	62	62	$79
Winters	Runnels	2020	$3,354,000	$5,091	83	83	83	83	83	83	$1,685
San Angelo	Multiple	2020	$150,000,000	$2,826	7,000	7,000	7,000	7,000	7,000	7,000	$1,033
Steam Electric Power Conservation (Alternative Cooling Technologies)											
Steam Electric	Coke	2020	$50,490,000	$7,409	247	289	339	401	477	528	$5,057
Steam Electric	Ector	2020	$56,090,000	$836	3,286	4,263	6,165	8,604	11,597	15,033	$541
Steam Electric	Mitchell	2020	$16,830,000	$1,623	1,127	1,030	933	837	740	674	$622

Table ES-5
Summary of Recommended Strategies

Entity	County Used	Expected Online Date	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2020	2030	2040	2050	2060	2070	
Subordination											
Bronte	Coke	2020	$0	$0	400	400	400	400	400	400	$0
Robert Lee	Coke	2020	$0	$0	6	6	6	6	6	6	$0
Mining	Coke	2020	$0	$0	38	36	34	32	30	28	$0
Coleman	Coleman	2020	$0	$0	2,102	2,061	2,024	1,985	1,938	1,891	$0
Coleman County SUD	Brown	2020	$0	$0	214	211	206	202	202	203	$0
Irrigation	Coleman	2020	$0	$0	743	743	743	743	743	743	$0
Odessa	Ector	2020	$0	$0	11,671	7,523	10,146	13,053	16,214	19,491	$0
Irrigation	Ector	2020	$0	$0	189	110	134	156	178	196	$0
Big Spring	Howard	2020	$0	$0	3,677	2,190	2,682	3,115	3,523	3,885	$0
Mining	Howard	2020	$0	$0	1,000	1,000	1,000	982	320	43	$0
Junction	Kimble	2020	$0	$0	412	412	412	412	412	412	$0
Stanton	Martin	2020	$0	$0	253	160	202	249	292	330	$0
Brady	McCulloch	2020	$0	$0	1,892	1,854	1,816	1,778	1,740	1,700	$0
Millersview-Doole WSC	McCulloch	2020	$0	$0	517	302	369	236	267	294	$0
Midland	Midland	2020	$0	$0	8,527	(299)	(298)	(297)	(297)	(296)	$0
Steam Electric Power	Mitchell	2020	$0	$0	1,480	1,460	1,440	1,420	1,400	1,380	$0
Ballinger	Runnels	2020	$0	$0	752	675	693	563	558	554	$0
Miles	Runnels	2020	$0	$0	112	124	121	119	119	119	$0
Winters	Runnels	2020	$0	$0	186	182	178	174	170	165	$0
Manufacturing	Runnels	2020	$0	$0	11	10	10	11	11	11	$0
Snyder	Scurry	2020	$0	$0	1,268	807	1,030	1,280	1,544	1,812	$0
San Angelo	Tom Green	2020	$0	$0	3,271	3,090	2,909	2,737	2,561	2,389	$0
Manufacturing (San Angelo Sales)	Tom Green	2020	$0	$0	428	404	396	378	361	343	$0
BCWID (non-allocated)	Brown	2020	$0	$0	6,981	6,693	6,405	6,117	5,829	5,540	$0
CRMWD (non –allocated)	Multiple	2020	$0	$0	5,527	20,834	17,318	13,566	10,225	6,444	$0

Table ES-5
Summary of Recommended Strategies

Entity	County Used	Expected Online Date	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield						Last Decade Unit Cost ($/ac-ft/yr)
					2020	2030	2040	2050	2060	2070	
Voluntary Transfer (Purchase)											
County-Other	Coke	2020	$11,000	$458	24	22	20	20	20	20	$0
Robert Lee	Coke	2020	$0	$652	176	177	178	178	178	178	$652
County-Other	Ector	2050	$0	$652				221	520	809	$652
Steam Electric Power	Ector	2020	$0	$652	4,000	4,000	4,000	4,000	4,000	4,000	$652
County-Other	Howard	2020	$1,833,000	$1,054	449	485	480	478	475	475	$738
Manufacturing	Howard	2020	$0	$652	614	773	895	998	1,191	1,396	$652
Mining	Howard	2020	$0	$326	238	240	242	0	0	0	$326
Manufacturing	Martin	2020	$14,500	$500	25	26	25	26	28	29	$0
Manufacturing	McCulloch	2020	$142,000	$500	201	217	230	241	261	284	$0
County-Other	McCulloch	2020	$347,000	$1,543	35	35	35	35	35	35	$714
Ballinger	Runnels	2020	$47,093,000	$4,848	990	955	920	886	851	816	$868
Winters	Runnels	2020	$696,000	$950	100	100	100	100	100	100	$370
Midland	Midland	2030	$26,116,800	$1,256	0	4,000	4,000	4,000	4,000	4,000	$710
Midland	Midland	2030	$0	$652	0	4,000	4,000	4,000	4,000	4,000	$652
County-Other	Scurry	2020	$75,000	$500	150	150	150	150	150	150	$0
County-Other	Scurry	2020	$0	$652	158	182	210	250	299	351	$652
UCRA	Tom Green	2020	$32,233,000	$6,116	331	348	404	453	499	543	$722
Manufacturing	Tom Green	2020	$0	$652	320	593	778	983	1,233	1,508	$652
County-Other	Tom Green	2020	$0	$6,116	331	348	404	453	499	543	$722
Weather Modification											
Irrigation	Crockett	2020	$0	$0.69	9	9	9	9	9	9	$0.69
Irrigation	Irion	2020	$0	$0.30	110	110	110	110	110	110	$0.30
Irrigation	Pecos	2020	$0	$4.33	264	264	264	264	264	264	$4.33
Irrigation	Reagan	2020	$0	$0.29	1,469	1,469	1,469	1,469	1,469	1,469	$0.29
Irrigation	Reeves	2020	$0	$2.84	240	240	240	240	240	240	$2.84
Irrigation	Schleicher	2020	$0	$0.35	102	102	102	102	102	102	$0.35
Irrigation	Sterling	2020	$0	$0.71	25	25	25	25	25	25	$0.71
Irrigation	Sutton	2020	$0	$0.66	34	34	34	34	34	34	$0.66
Irrigation	Tom Green	2020	$0	$0.31	4,945	4,945	4,945	4,945	4,945	4,945	$0.31
Irrigation	Ward	2020	$0	$1.21	46	46	46	46	46	46	$1.21

Table ES-6
Summary of Alternate Strategies

Entity	County Used	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield 2020	2030	2040	2050	2060	2070	Last Decade Unit Cost ($/ac-ft/yr)
Aquifer Storage and Recovery										
CRMWD	Multiple	$17,362,890	$189	Included in Develop Additional Groundwater Supplies						$59
Desalination										
CRMWD	Multiple	$65,161,366	$986	Included in Develop Additional Groundwater Supplies						$500
San Angelo	Tom Green	$66,978,000	$827	Included in Develop Additional Groundwater Supplies						$326
Develop Additional Groundwater Supplies										
BCWID	Multiple	$8,436,000	$580	1,680	1,680	1,680	1,680	1,680	1,680	$160
San Angelo	Pecos	$262,726,000	$2,109	12,000	12,000	12,000	12,000	12,000	12,000	$277
Bronte	Coke	$7,468,000	$4,860	200	200	200	200	200	200	$1,735
Bronte	Coke	$2,576,000	$1,780	150	150	150	150	150	150	$340
Midland	Midland	$51,501,000	$2,086	3,000	3,000	3,000	3,000	3,000	3,000	$649
Odessa	Ector	$615,679,000	$5,557	11,200	28,000	28,000	28,000	28,000	28,000	$1,445
Robert Lee	Tom Green	$5,586,000	$3,895	160	160	160	160	160	160	$976
CRMWD	Multiple	$62,668,000	$1,199	30,000	30,000	30,000	30,000	30,000	30,000	$392
Develop Capitan Reef Complex Aquifer Supplies										
San Angelo	Pecos	$389,092,000	$3,360	11,100	11,100	11,100	11,100	11,100	11,100	$427
Odessa	Ward	$134,120,000	$1,801	8,400	8,400	8,400	8,400	8,400	8,400	$465
Develop Dockum Aquifer Supplies										
Colorado City	Mitchell	$6,124,000	$333	2,240	2,240	2,240	2,240	2,240	2,240	$104
Develop Edwards-Trinity Plateau Aquifer Supplies										
San Angelo	Tom Green	$51,891,000	$1,140	4,500	4,500	4,500	4,500	4,500	4,500	$175
Robert Lee	Coke	$5,800,000	$2,832	240	240	240	240	240	240	$811
Develop Hickory Aquifer Supplies										
San Angelo	McCulloch	$27,104,000	$1,016	2,703	6,003	7,970	7,953	7,950	7,953	$468
Develop Lipan Aquifer Supplies										
Concho Rural Water Corporation	Tom Green	$448,000	$285	200	200	200	200	200	200	$100

Table ES-6
Summary of Alternate Strategies

Entity	County Used	Capital Cost	First Decade Unit Cost ($/ac-ft/yr)	Total Yield 2020	2030	2040	2050	2060	2070	Last Decade Unit Cost ($/ac-ft/yr)
Develop Ogallala Aquifer Supplies										
Andrews	Andrews	$18,671,000	$389	1,680	3,360	4,300	4,300	4,300	4,300	$124
Expansion of Existing										
CRMWD	Western Region F Counties	$226,748,000	$1,199	30,000	30,000	30,000	30,000	30,000	30,000	$392
New WTP										
Bronte	Coke	$3,159,000	$4,213	94	94	94	94	94	94	$1,397
Robert Lee	Coke	$7,065,000	$1,666	500	500	500	500	500	500	$484
Off-Channel Reservoir										
San Angelo	Multiple	$23,475,000	$1,791	1,400	1,400	1,400	1,400	1,400	1,400	$389
Steam Electric Power Conservation (Alternative Cooling Technologies)										
Steam Electric	Ward	$56,090,000	$5,644	1,079	1,718	2,496	3,445	4,603	5,569	$1,345
Regional Water Management Strategies										
Bronte, Ballinger, Winters, Robert Lee (Regional System from Brownwood)	Coke & Runnels	$63,166,000	$2,707	2,802	2,802	2,802	2,802	2,802	2,802	$821
Bronte & Robert Lee (Purchase from UCRA)	Coke	$10,691,000	$2,730	500	500	500	500	500	500	$940
Bronte, Ballinger, Winters, Robert Lee (Regional System from Lake Fort Phantom Hill)	Coke & Runnels	$53,591,000	$4,697	1,155	1,155	1,155	1,155	1,155	1,155	$815

Chapter 1 Description of the Region

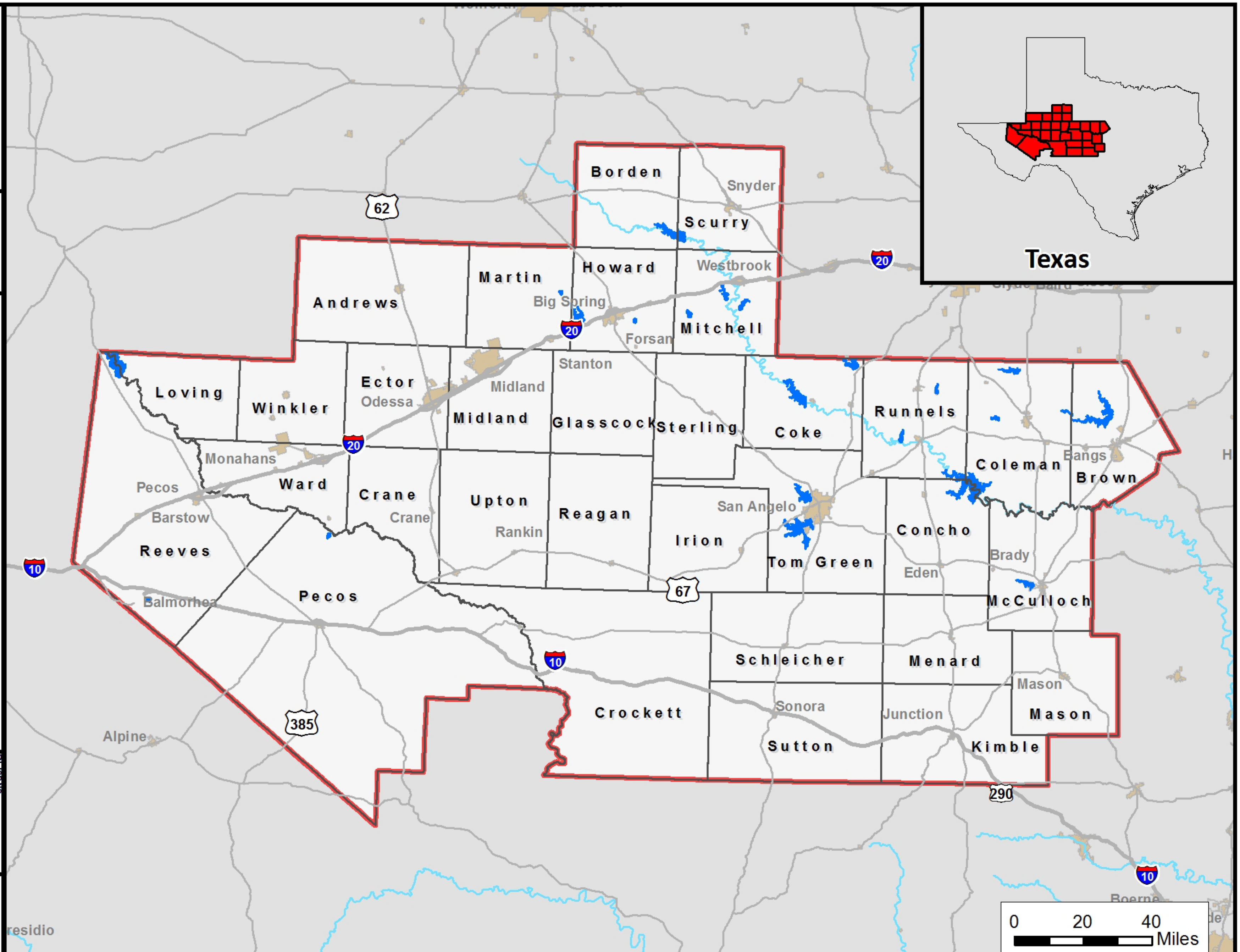
In 1997, the 75th Texas Legislature passed Senate Bill One (SB1), legislation designed to address Texas water issues. With the passage of SB1, the legislature put in place a grass-roots regional planning process to plan for the future water needs of all Texans. To implement this planning process, the 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 twice, in 2006 and 2011, and then consolidated into the state water plans, Water for Texas 2007 and 2012, respectively.

The TWDB refers to the current round of regional planning as SB1, Fourth Round. This report is the update to the 2011 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, and a bibliography is included in Appendix A.

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 2010[1].



Region F

Regional Water Planning Area

Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet

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FIGURE 1-1

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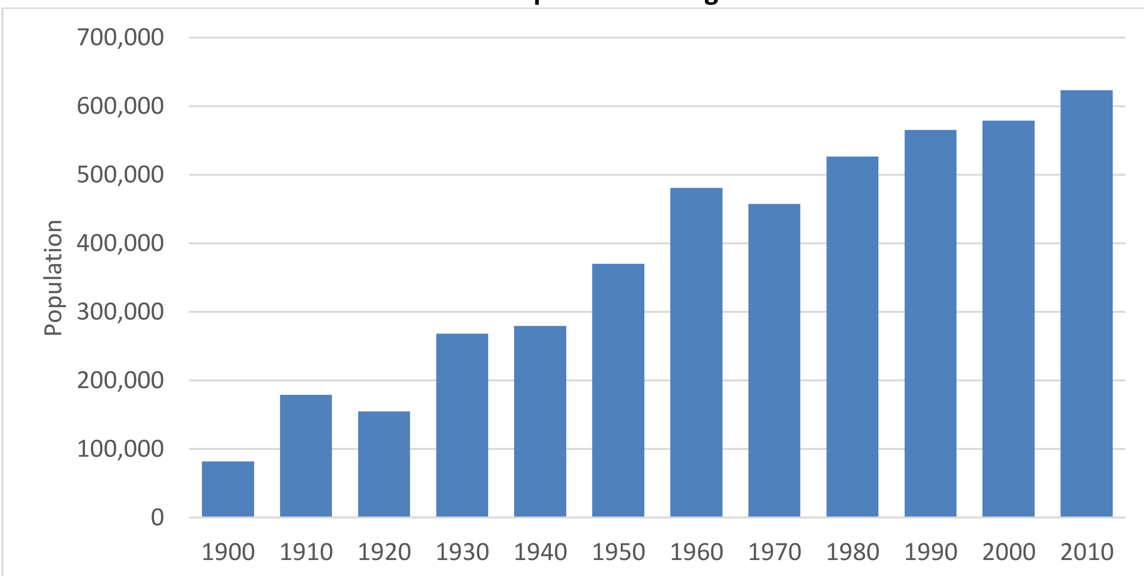
Table 1-1
Historical Population of Region F Counties[a]

County	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
Andrews	87	975	350	736	1,277	5,002	13,450	10,372	13,323	14,338	13,004	14,786
Borden	776	1,386	965	1,505	1,396	1,106	1,076	888	859	799	729	641
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
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
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
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
Crane	51	331	37	2,221	2,841	3,965	4,699	4,172	4,600	4,652	3,996	4,375
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
Ector	381	1,178	760	3,958	15,051	42,102	90,995	91,805	115,374	118,934	121,123	137,130
Glasscock	286	1,143	555	1,263	1,193	1,089	1,118	1,155	1,304	1,447	1,406	1,226
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
Irion	848	1,283	1,610	2,049	1,963	1,590	1,183	1,070	1,386	1,629	1,771	1,599
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
Loving	33	249	82	195	285	227	226	164	91	107	67	82
Martin	332	1,549	1,146	5,785	5,556	5,541	5,068	4,774	4,684	4,956	4,746	4,799
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
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
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
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
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
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
Reagan [b]		392	377	3,026	1,997	3,127	3,782	3,239	4,135	4,514	3,326	3,367
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
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
Schleicher	515	1,893	1,851	3,166	3,083	2,852	2,791	2,277	2,820	2,990	2,935	3,461
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
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
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
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
Upton	48	501	253	5,968	4,297	5,307	6,239	4,697	4,619	4,447	3,404	3,355
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
Winkler	60	442	81	6,784	6,141	10,064	13,652	9,640	9,944	8,626	7,173	7,110
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***
% Change		*119%*	*-14%*	*73%*	*4%*	*32%*	*30%*	*-5%*	*15%*	*7%*	*2%*	*6%*

Notes:
a. Population data are from the U.S. Bureau of Census[1]
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 623,354 in 2010.

Figure 1-2
Historical Population of Region F

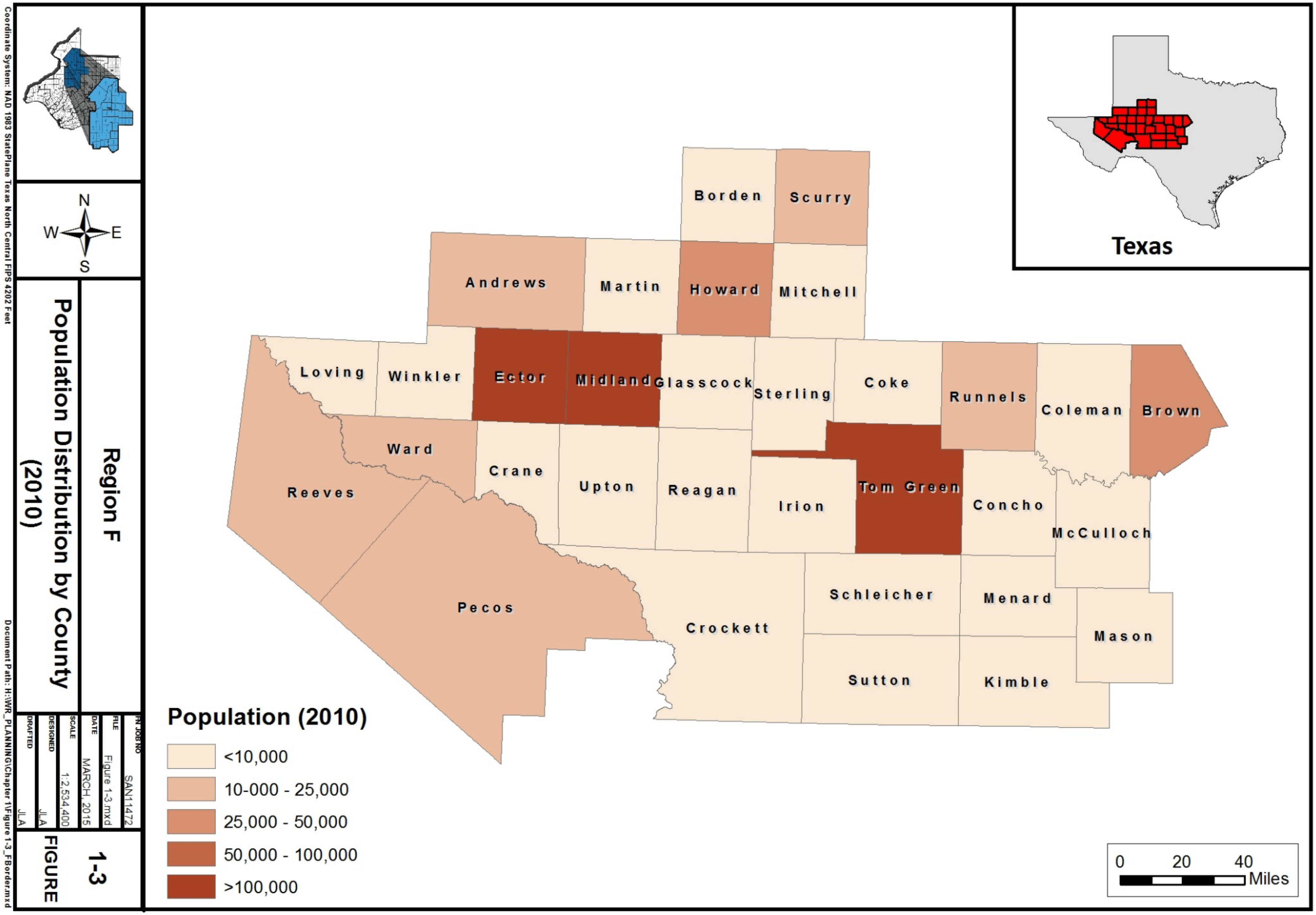


According to the 2010 census, Region F accounted for 2.5 percent of Texas' total population. Figure 1-3 shows the distribution of population in Region F counties based on the census data. Ector, Midland, and Tom Green were the three most populous counties in Region F, accounting for 62 percent of the region's population. Brown and Howard Counties were the next most populous counties with more than 35,000 people in each. Table 1-2 lists the seven cities in Region F with a 2010 population of more than 10,000. These cities included 60 percent of the population in Region F.

Table 1-2
Region F Cities with a Year 2010 Population Greater than 10,000

City	Year 2010 Population
Midland	111,147
Odessa	99,940
San Angelo	93,200
Big Spring	27,282
Brownwood	19,288
Snyder	11,202
Andrews	11,088
Total	***373,147***

Data are from the 2010 US Census[1].


Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet
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Region F
Population Distribution by County
(2010)
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Texas
Borden
Scurry
Andrews
Martin
Howard
Mitchell
Loving
Winkler
Ector
Midland
Glasscock
Sterling
Coke
Runnels
Coleman
Brown
Ward
Crane
Upton
Reagan
Irion
Tom Green
Concho
McCulloch
Reeves
Pecos
Crockett
Schleicher
Menard
Mason
Sutton
Kimble
Population (2010)
<10,000
10-000 - 25,000
25,000 - 50,000
50,000 - 100,000
>100,000
0
20
40
Miles

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, wholesale and retail trade, followed by leisure and hospitality, and professional and business services, and education and health services are also important employment sectors in the area. In the San Angelo MSA the largest employment sectors are education and health services and the wholesale and retail trade, followed by leisure and hospitality, and professional and business services.

Table 1-3 summarizes 2012 payroll data for Region F by county and economic sector. (Data for certain payroll categories are only available on a state-wide basis and are not broken down by counties.)

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 78 percent of the payroll and 73 percent of the employment in the region. Other major centers of economic activity are located in Brown and Howard Counties. The largest business sectors in Region F in terms of payroll in 2012 are healthcare and social assistance, mining and manufacturing, which together account for 45 percent of the region's total payroll.

In recent years, the oil and gas industry has been growing rapidly in the Permian Basin. Since the 2007 Economic Census, the payroll from mining has more than doubled from $1.4 billion to over $3 billion in the 2012 Economic Census. The 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
2012 County Payroll by Category ($1000)

Category	Andrews	Borden	Brown	Coke	Coleman	Concho	Crane	Crockett	Ector	Glasscock	Howard
Forest, Fishing, Hunting, and Agricultural Support	(N)	(N)	(D)	(N)	(D)	(N)	(N)	(N)	(D)	755	(D)
Mining	81,724	(N)	4,039	1,413	619	(D)	24,300	23,307	572,114	(D)	58,620
Utilities	(D)	(N)	3,453	(D)	(D)	(D)	(N)	(D)	7,865	(N)	7,173
Construction	35,948	(D)	16,213	375	1,945	(D)	3,894	(D)	352,708	(D)	28,500
Manufacturing	(D)	(N)	107,611	(D)	7,113	(D)	(D)	(D)	270,807	(D)	43,301
Wholesale Trade	9,843	(N)	17,949	(D)	3,023	(N)	1,471	(D)	377,946	598	14,103
Retail Trade	12,624	(D)	43,045	1,571	5,013	1,179	2,540	4,581	223,186	(D)	32,659
Transportation and Warehousing	28,453	(N)	5,760	(D)	1,039	(D)	13,602	1,341	184,649	(N)	9,626
Information	1,095	(N)	5,018	(D)	1,168	(D)	(D)	298	21,634	(N)	4,232
Finance and Insurance	8,531	(N)	15,438	(D)	3,840	(D)	448	(D)	61,213	(D)	10,980
Real Estate, Rental, and Leasing	8,695	(N)	4,378	(N)	349	(D)	(D)	(D)	100,974	(N)	4,559
Professional, Scientific and Technical Services	6,005	(D)	5,761	(D)	975	(D)	1,013	284	86,727	(D)	7,368
Management of Companies and Enterprises	(D)	(N)	(D)	(D)	(D)	(N)	(N)	(D)	44,029	(N)	(D)
Admin, Support, Waste Mgmt, Remediation Services	18,610	(D)	6,858	611	(D)	(D)	(D)	1,108	83,285	(N)	30,182
Educational Services	(D)	(D)	(D)	(N)	(D)	(N)	(N)	(N)	7,869	(D)	(D)
Health Care & Social Assistance	(D)	(N)	80,975	(D)	8,599	4,791	(D)	1,347	308,536	(N)	51,070
Arts, Entertainment & Recreation	2,278	(N)	1,055	(D)	(D)	(D)	(N)	131	4,223	(N)	806
Accommodation & Food Services	5,047	(N)	15,999	282	1,707	672	440	2,759	93,951	(D)	14,263
Other Services	14,772	(N)	11,344	297	1,237	(D)	(D)	741	107,913	(D)	8,890
Total Payroll	***277,946***	***(D)***	***358,815***	***8,958***	***40,202***	***22,089***	***56,575***	***53,534***	***2,909,698***	***9,830***	***326,654***
Total Employees	***5,253***	***(N)***	***12,945***	***314***	***1,565***	***700***	***1,063***	***1,135***	***57,488***	***184***	***9,090***

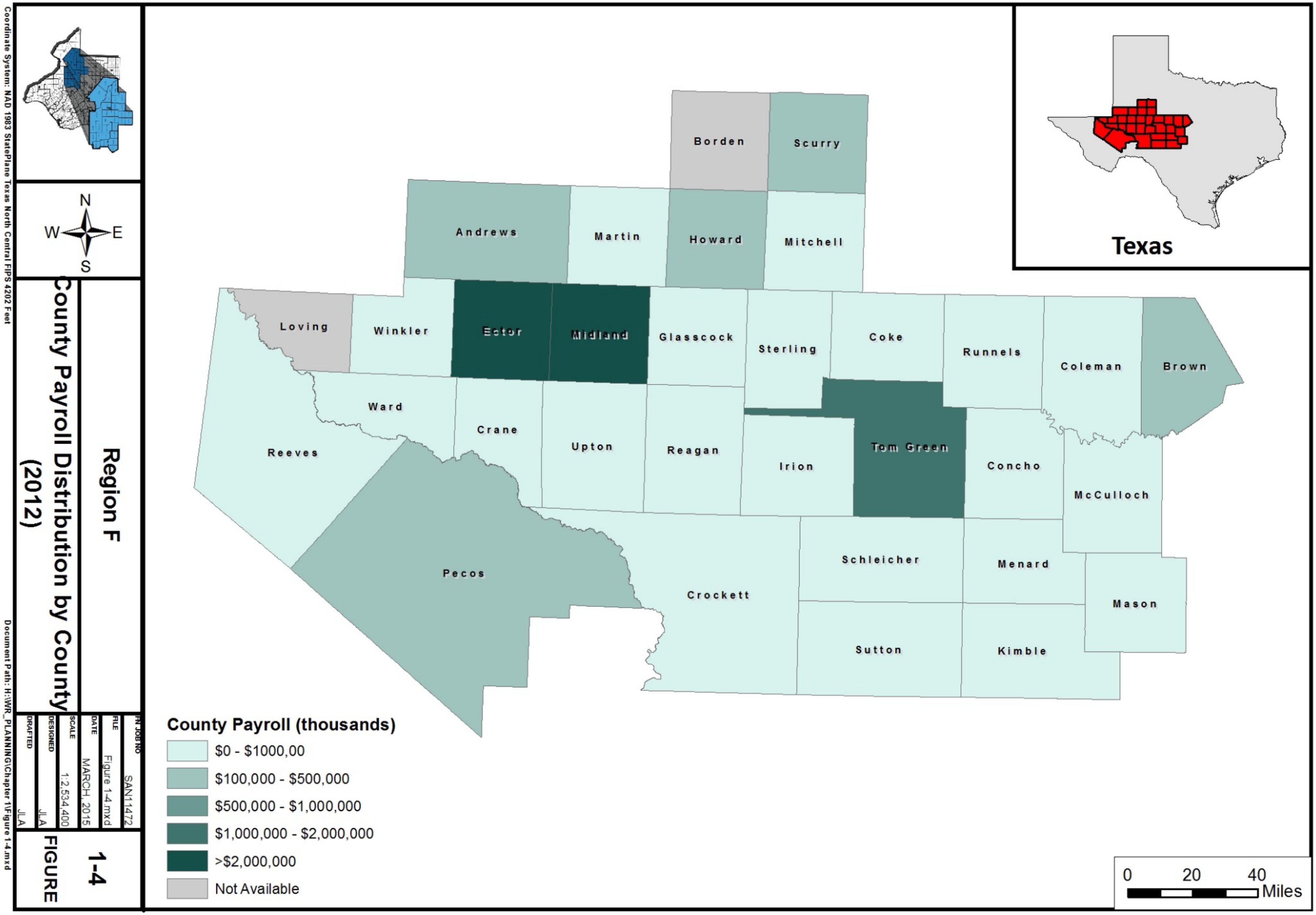
Table 1-3 (cont.) 2012 County Payroll by Category ($1000)

Category	Irion	Kimble	Loving	Martin	Mason	McCulloch	Menard	Midland	Mitchell	Pecos	Reagan
Forest, Fishing, Hunting, and Agricultural Support	(D)	(N)	(N)	(D)	(N)	(N)	(N)	492	294	(D)	(N)
Mining	(D)	(D)	(D)	6,143	(D)	(D)	(D)	1,801,557	20,931	105,010	24,930
Utilities	(N)	(D)	(N)	(D)	(D)	(D)	(D)	31,965	2,676	1,543	(D)
Construction	1,498	2,773	(N)	(D)	807	2,462	(D)	217,118	1,940	10,139	5,808
Manufacturing	(D)	(D)	(N)	(D)	1,188	(D)	(D)	168,332	(D)	322	(D)
Wholesale Trade	783	(D)	(N)	(D)	(D)	10,926	406	337,293	356	9,468	(D)
Retail Trade	(D)	5,199	(N)	5,180	2,635	11,031	748	228,809	5,975	14,730	1,645
Transportation and Warehousing	10,658	(D)	(N)	5,274	680	2,484	(N)	221,148	316	31,734	12,864
Information	(N)	(D)	(N)	(D)	(D)	965	(D)	46,256	(D)	549	(D)
Finance and Insurance	(D)	(D)	(D)	1,243	1,916	3,729	648	115,526	1,632	4,817	(D)
Real Estate, Rental, and Leasing	(N)	(D)	(N)	(N)	(D)	(D)	(N)	91,917	(D)	2,215	(D)
Professional, Scientific and Technical Services	(D)	(D)	(N)	695	2,320	(D)	(D)	261,550	1,437	(D)	578
Management of Companies and Enterprises	(N)	(N)	(N)	(N)	(N)	(D)	(N)	150,776	(N)	(N)	(N)
Admin, Support, Waste Mgmt, Remediation Services	(D)	(D)	(N)	(D)	(D)	(D)	(D)	103,144	(D)	1,918	(D)
Educational Services	(N)	(N)	(N)	(D)	(N)	(N)	(N)	20,350	(N)	(N)	(N)
Health Care & Social Assistance	(D)	(D)	(N)	5,303	2,566	7,368	(D)	298,094	(D)	19,117	(D)
Arts, Entertainment & Recreation	(D)	(D)	(N)	(D)	(D)	(D)	(D)	25,071	(D)	(D)	(D)
Accommodation & Food Services	(D)	2,062	(N)	938	1,146	2,893	309	108,776	1,320	8,169	811
Other Services	(D)	726	(N)	1,063	852	2,381	90	106,332	787	3,773	530
Total Payroll	***23,900***	***22,307***	***(D)***	***42,903***	***20,264***	***82,395***	***3,809***	***4,334,506***	***55,087***	***215,803***	***56,703***
Total Employees	***429***	***836***	***(N)***	***1,005***	***826***	***2,517***	***(N)***	***73,493***	***1,515***	***4,489***	***1,110***

Table 1-3 (cont.) 2012 County Payroll by Category ($1000)

Category	Reeves	Runnels	Schleicher	Scurry	Sterling	Sutton	Tom Green	Upton	Ward	Winkler
Forest, Fishing, Hunting, and Agricultural Support	(D)	(D)	(N)	(D)	(N)	(D)	(D)	(N)	(D)	(N)
Mining	37,503	4,022	3,403	69,649	11,930	31,187	62,435	16,645	44,637	20,606
Utilities	(D)	(D)	(D)	1,776	(D)	(N)	14,398	(D)	5,570	(D)
Construction	5,109	2,462	(D)	30,102	1,382	8,126	86,498	1,567	6,352	8,881
Manufacturing	161	19,305	(D)	5,016	(D)	(D)	130,630	(D)	(D)	(N)
Wholesale Trade	685	1,542	(D)	19,282	(D)	5,704	63,011	(D)	(D)	(D)
Retail Trade	9,041	9,721	1,179	18,397	(D)	2,993	151,674	1,194	5,927	3,672
Transportation and Warehousing	8,602	2,199	(D)	36,042	(D)	5,830	23,626	1,941	7,529	4,183
Information	967	243	(D)	(D)	(N)	(D)	50,793	(D)	688	(D)
Finance and Insurance	776	4,849	840	6,288	(D)	(D)	64,517	(D)	3,178	1,680
Real Estate, Rental, and Leasing	1,900	(D)	(N)	4,293	(D)	(D)	17,090	(D)	4,191	(D)
Professional, Scientific and Technical Services	956	(D)	221	5,636	(D)	375	60,707	(D)	1,590	448
Management of Companies and Enterprises	(N)	(D)	(N)	(D)	(N)	(N)	6,805	(N)	(D)	(N)
Admin, Support, Waste Mgmt, Remediation Services	(D)	234	(D)	3,683	(N)	(D)	67,736	(D)	(D)	(D)
Educational Services	(D)	(D)	(N)	(N)	(N)	(N)	7,153	(D)	(N)	(N)
Health Care & Social Assistance	(D)	(D)	(D)	18,931	(D)	(D)	321,065	(D)	7,825	(D)
Arts, Entertainment & Recreation	(D)	(D)	(D)	224	(D)	295	7,761	(D)	(D)	(D)
Accommodation & Food Services	6,354	1,568	(D)	7,790	(D)	2,791	66,354	515	2,677	1,069
Other Services	992	2,627	225	11,027	507	732	45,890	79	4,244	1,840
Total Payroll	***91,174***	***68,969***	***18,694***	***244,932***	***21,710***	***67,640***	***1,249,284***	***21,941***	***94,408***	***42,379***
Total Employees	***2,305***	***2,296***	***453***	***5,418***	***347***	***1,326***	***37,041***	***822***	***2,390***	***1,203***

Notes: Data are from U.S. Census Bureau 2010 economic data[2]
D = Data withheld to avoid disclosing data for individual companies
N = Data not available



Region F
County Payroll Distribution by County (2012)
FIGURE 1-4
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N
W
E
S
Texas
Borden
Scurry
Andrews
Martin
Howard
Mitchell
Loving
Winkler
Ector
Midland
Glasscock
Sterling
Coke
Runnels
Coleman
Brown
Ward
Crane
Upton
Reagan
Irion
Tom Green
Concho
Reeves
McCulloch
Pecos
Crockett
Schleicher
Menard
Mason
Sutton
Kimble
County Payroll (thousands)
$0 - $1000,00
$100,000 - $500,000
$500,000 - $1,000,000
$1,000,000 - $2,000,000
>$2,000,000
Not Available
0
20
40
Miles

Permian Basin

Region F

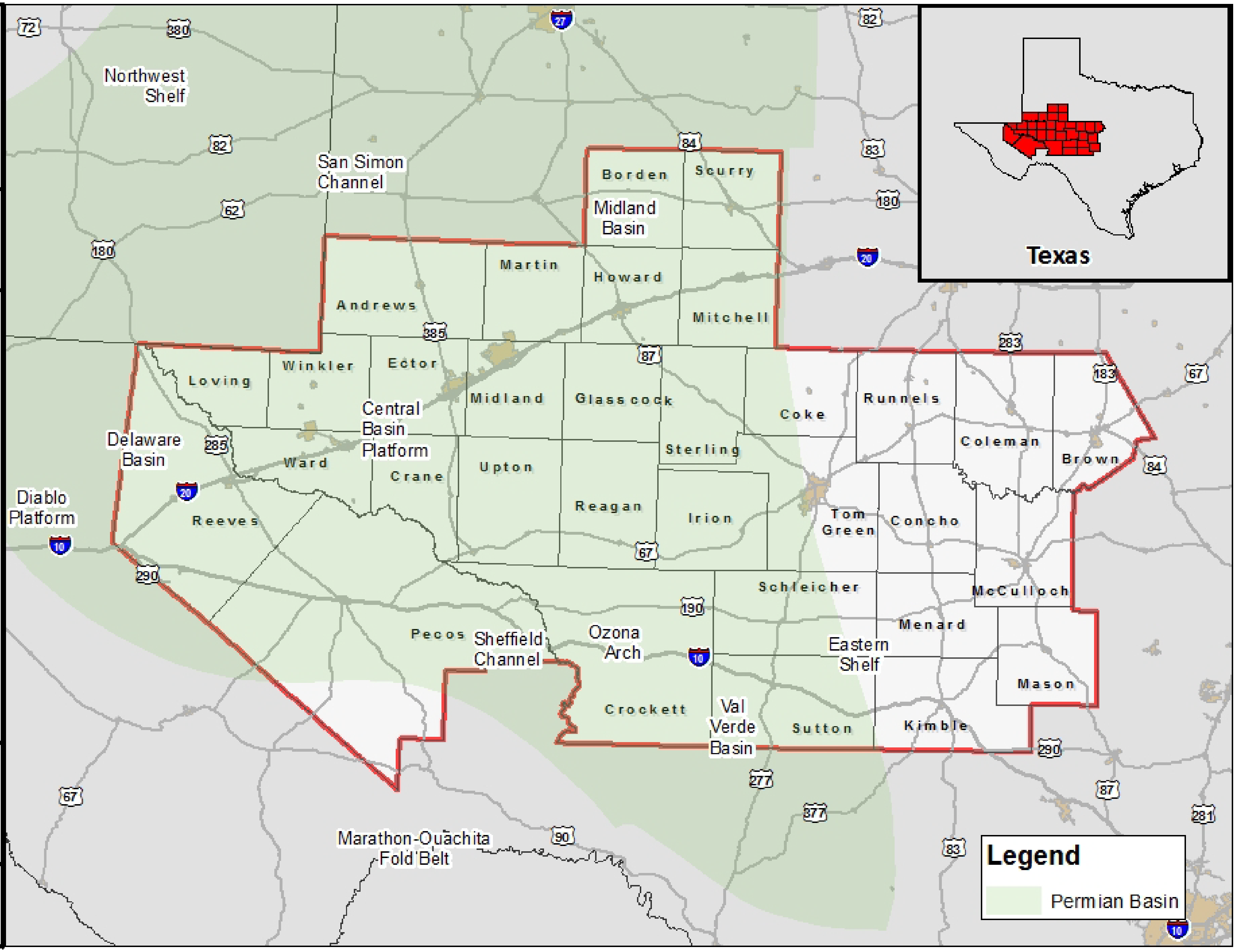


FIGURE 1-5

1.1.2 Water-Related Physical Features 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 17 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.

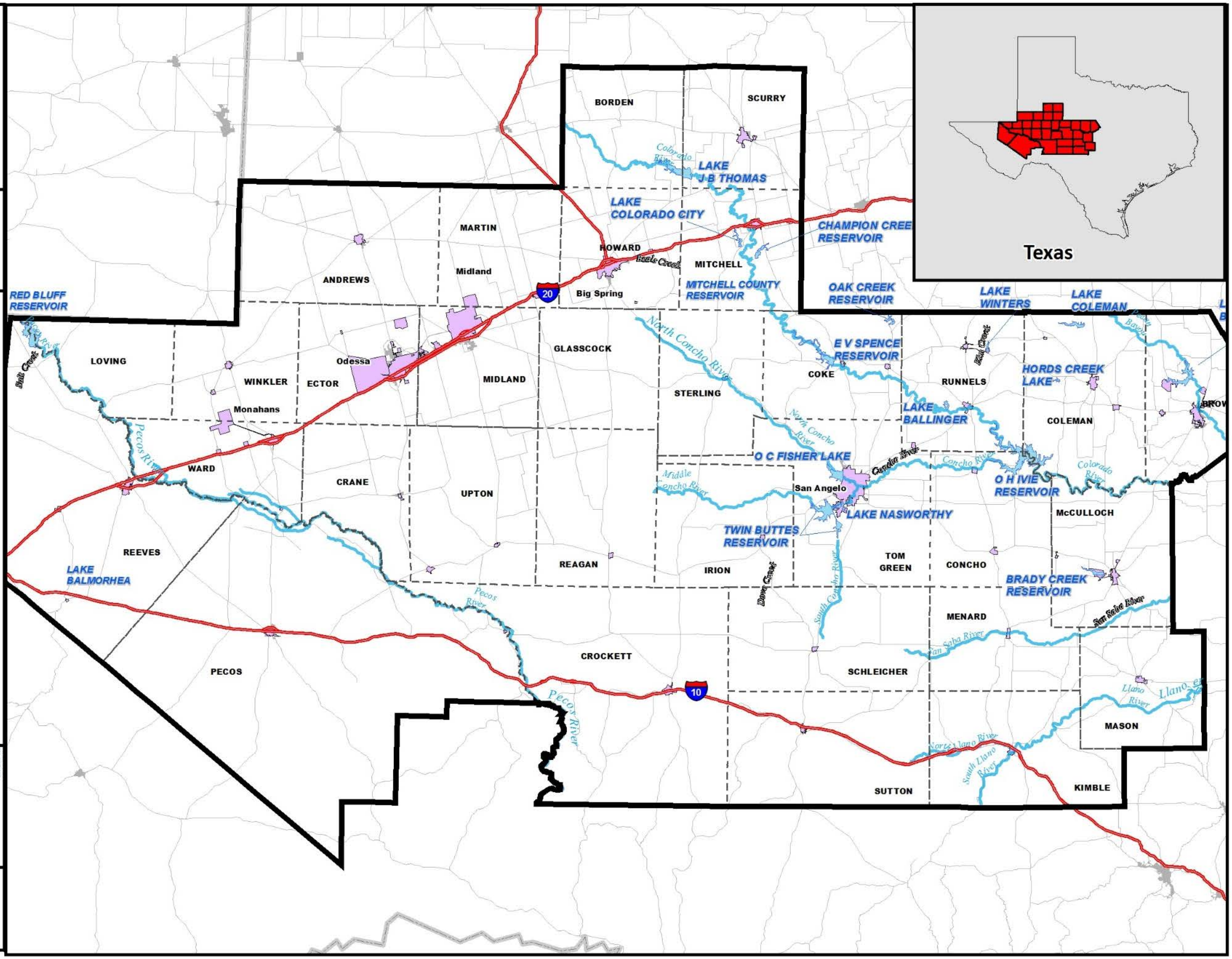
Figure 1-7 shows the average annual precipitation in Texas. In Region F, precipitation increases from slightly more than 11 inches per year in western Reeves County to approximately 30 inches per year in Brown County. Some of the highest evaporation rates in the state are in Region F, exceeding rainfall throughout the region. The patterns of rainfall, runoff, and evaporation result in more abundant water supplies in the eastern portion of Region F.

Figure 1-8 shows the major aquifers in Region F, and Figure 1-9 shows the minor aquifers. There are 11 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 Dockum, Hickory, Lipan, Ellenberger-San Saba, Marble Falls, Rustler and the Capitan Reef Complex. 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.

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

Reservoir Name	Basin	Stream	County(ies)	Water Right Number(s)	Priority Date	Permitted Conservation Storage (Ac-Ft)	Permitted Diversion (Ac-Ft/Yr)	Year 2010 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 [c]	1,907	CRMWD	CRMWD
Lake Colorado City	Colorado	Morgan Creek	Mitchell	CA-1009	11/22/1948	29,934	5,500	3,165[b]	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	426	City of Sweetwater	City of Sweetwater
Lake Coleman	Colorado	Jim Ned Creek	Coleman	CA-1702	08/25/1958	40,000	9,000	1,379	City of Coleman	City of Coleman
E V Spence Reservoir	Colorado	Colorado River	Coke	CA-1008	08/17/1964	488,760	50,000 [c]	14,246	CRMWD	CRMWD
Lake Winters	Colorado	Elm Creek	Runnels	CA-1095	12/18/1944	8,374	1,755	0	City of Winters	City of Winters
Lake Brownwood	Colorado	Pecan Bayou	Brown	CA-2454	09/29/1925	114,000	29,712	10,832	Brown Co. WID	Brown Co. WID
Hords Creek Lake	Colorado	Hords Creek	Coleman	CA-1705	03/23/1946	7,959	2,240	79	COE	City of Coleman
Lake Ballinger	Colorado	Valley Creek	Runnels	CA-1072	10/04/1946	6,850	1,000	233	City of Ballinger	City of Ballinger
O. H. Ivie Reservoir	Colorado	Colorado River	Coleman, Concho and Runnels	A-3866 P-3676	02/21/1978	554,340	113,000	55,360	CRMWD	CRMWD
O. C. Fisher Lake	Colorado	N. Concho River	Tom Green	CA-1190	05/27/1949	80,400	80,400	0	COE	Upper Colorado River Authority
Twin Buttes Reservoir	Colorado	S. Concho River	Tom Green	CA-1318	05/06/1959	170,000	29,000	0	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	0	City of San Angelo	City of San Angelo
Brady Creek Reservoir	Colorado	Brady Creek	McCulloch	CA-1849	09/02/1959	30,000	3,500	341	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	3,358	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	9,436	Reeves Co WID #1	Reeves Co WID #1
Total						*2,130,870*	*730,757*	*100,762*		

a. Data are from TCEQ active water rights list,[6] TCEQ water rights permits,[3] and TCEQ historical water use by water right.[4] Year 2010 use is consumptive.
b. Use is total consumptive use from both Champion Creek Reservoir and Lake Colorado City.
c. Total consumptive use for CA 1002 and CA 1008 limited to 73,000 ac-ft per year.
CA Certificate of Adjudication
A Application
P Permit
COE Corps of Engineers NA – Data Not Available



Coordinate System: Custom

N W E S

Region F
Surface Water Features Reservoirs

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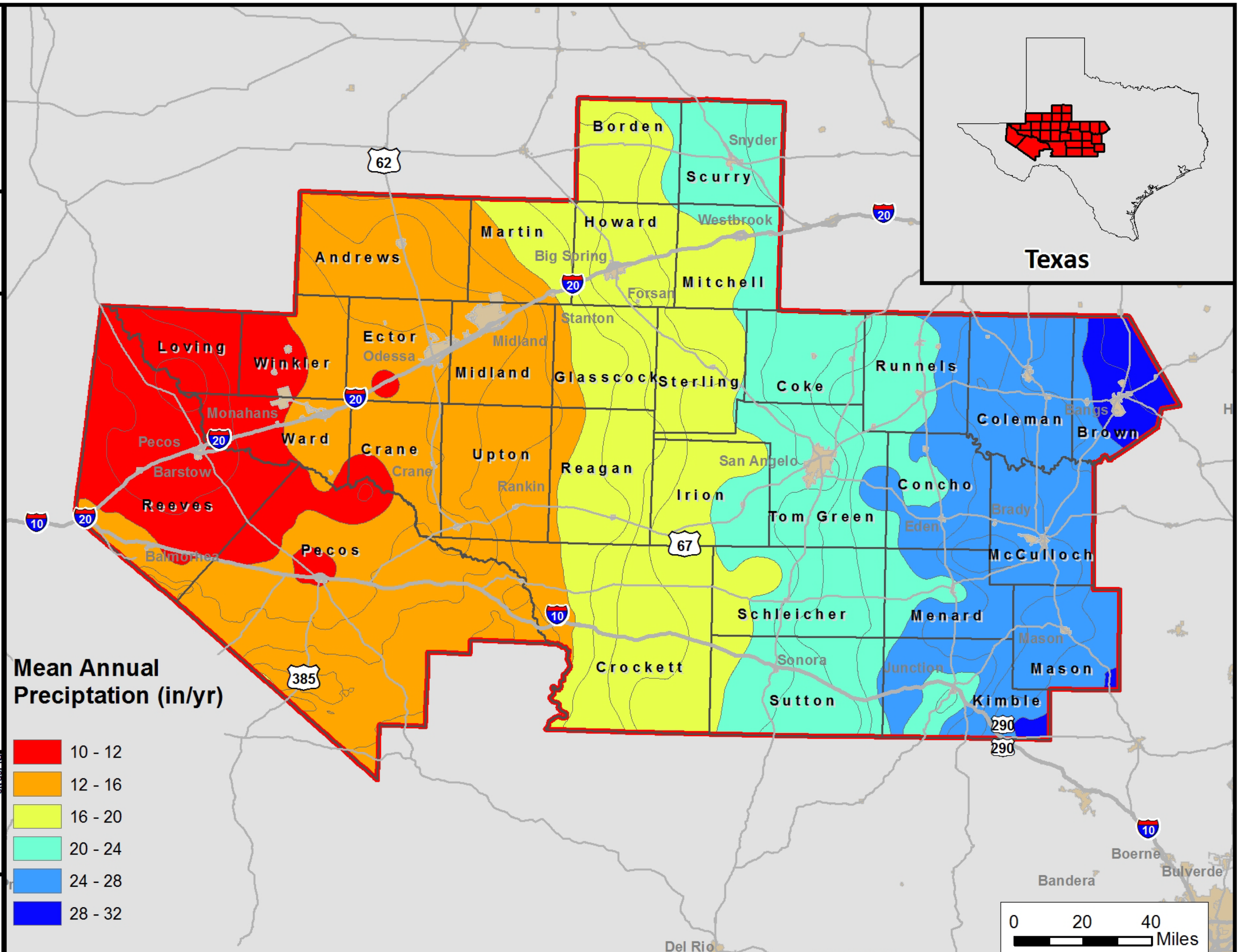
FIGURE 1-6



Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet

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Region F

Mean Annual Preciptation (in/yr)

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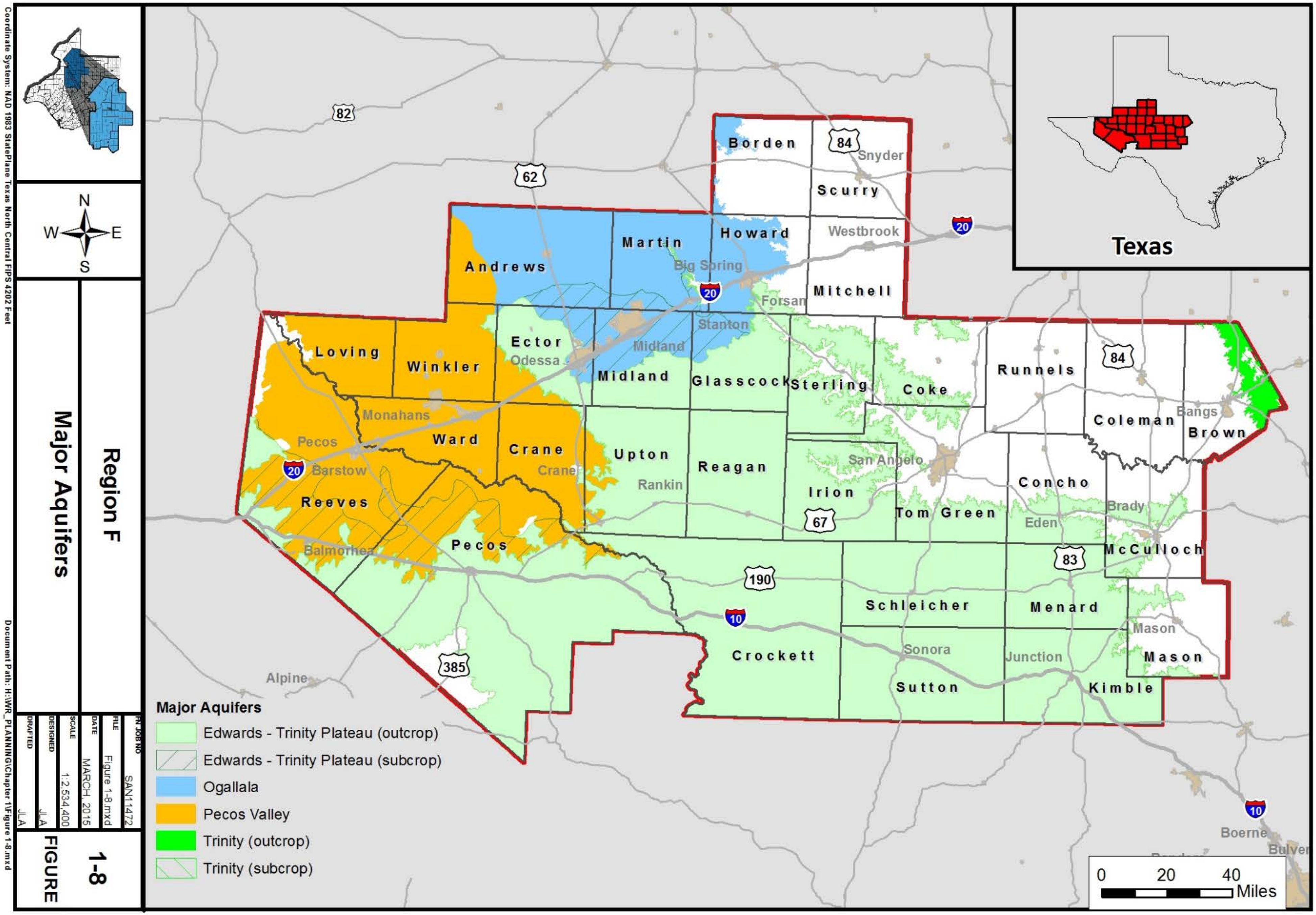
FIGURE 1-7



Region F
Major Aquifers
FIGURE 1-8
Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet
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DATE MARCH, 2015
SCALE 1:2,534,400
DESIGNED JLA
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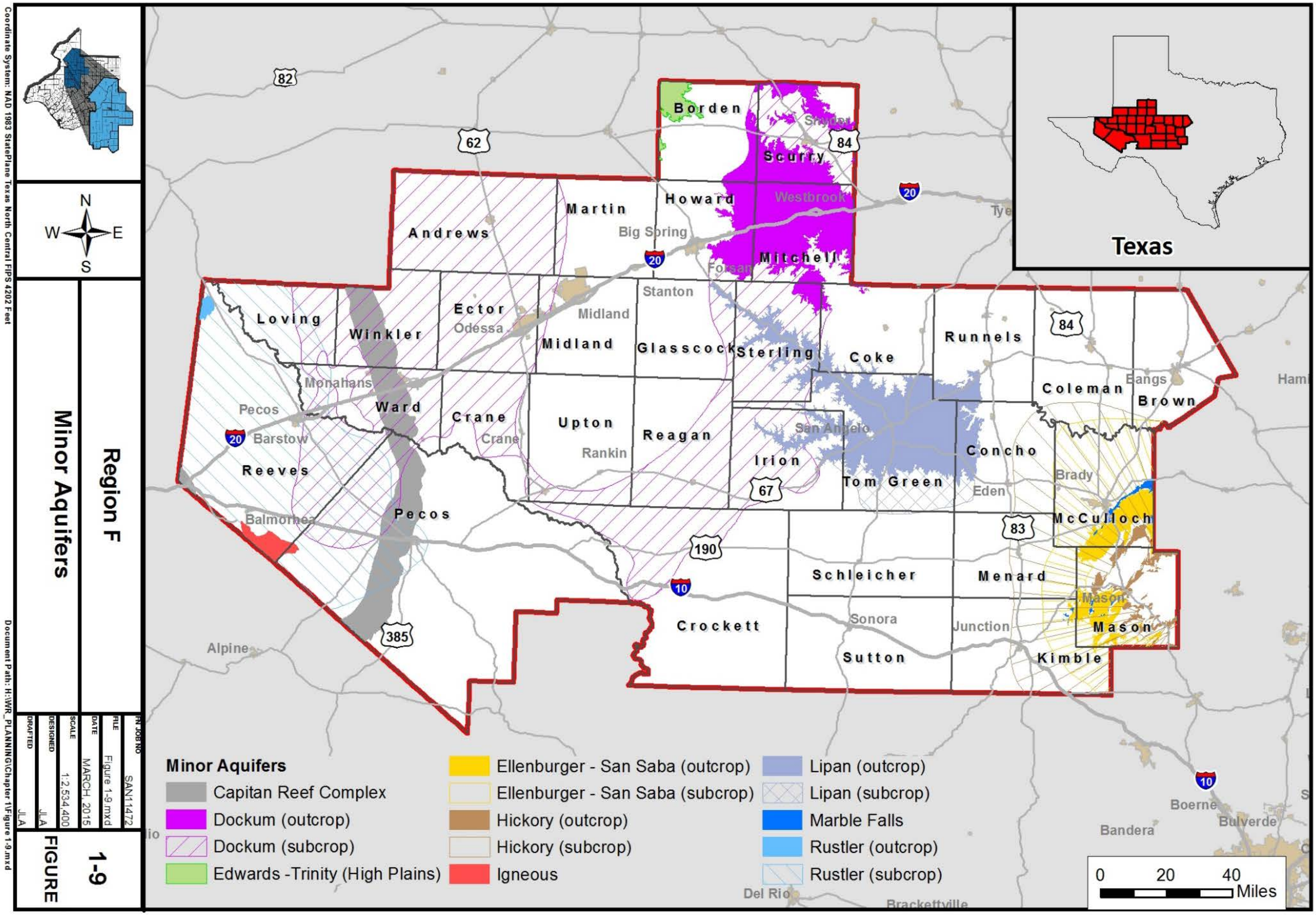
N
S
E
W
Texas
Major Aquifers
Edwards - Trinity Plateau (outcrop)
Edwards - Trinity Plateau (subcrop)
Ogallala
Pecos Valley
Trinity (outcrop)
Trinity (subcrop)
0
20
40
Miles
Borden
Scurry
Howard
Martin
Andrews
Mitchell
Loving
Winkler
Ector
Midland
Glasscock
Sterling
Coke
Runnels
Coleman
Brown
Ward
Crane
Upton
Reagan
Irion
Tom Green
Concho
McCulloch
Reeves
Pecos
Schleicher
Menard
Mason
Crockett
Sutton
Kimble
Snyder
Westbrook
Big Spring
Forsan
Stanton
Odessa
Midland
Monahans
Pecos
Barstow
Crane
Rankin
San Angelo
Bangs
Brady
Eden
Balmorhea
Sonora
Junction
Mason
Alpine
Boerne
82
62
84
20
67
83
190
10
385



Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet
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Region F
Minor Aquifers
PN JOB NO SAN11472
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DATE MARCH, 2015
SCALE 1:2,534,400
DESIGNED JLA
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FIGURE 1-9
N
S
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Texas
Minor Aquifers
Capitan Reef Complex
Dockum (outcrop)
Dockum (subcrop)
Edwards -Trinity (High Plains)
Ellenburger - San Saba (outcrop)
Ellenburger - San Saba (subcrop)
Hickory (outcrop)
Hickory (subcrop)
Igneous
Lipan (outcrop)
Lipan (subcrop)
Marble Falls
Rustler (outcrop)
Rustler (subcrop)
0 20 40 Miles
Borden
Scurry
Howard
Martin
Andrews
Mitchell
Loving
Winkler
Ector
Midland
Glasscock
Sterling
Coke
Runnels
Coleman
Brown
Ward
Crane
Upton
Reagan
Irion
Tom Green
Concho
Reeves
Pecos
McCulloch
Schleicher
Menard
Crockett
Sutton
Kimble
Mason
Snyder
Westbrook
Big Spring
Forsan
Stanton
Odessa
Midland
Monahans
Pecos
Barstow
Crane
Rankin
San Angelo
Eden
Brady
Bangs
Balmorhea
Alpine
Sonora
Junction
Del Rio
Brackettville
Boerne
Bulverde
Bandera
82
62
84
20
67
190
10
385
83

1.2 Current Water Uses and Demand Centers in Region F

Table 1-5 shows water use from 2000-2010 by TWDB use category and Figure 1-10 is a graph of the data.[5] Table 1-6 shows the total water use by county in Region F for the same period. Water use in Region F increased between 2000 and 2010 and has increased in recent years. Most of these trends in water use are associated with increased irrigation and mining activity. This may be attributed in part to changes by the TWDB in the reporting of irrigated agriculture water use after year 2000. Some of these changes include reporting of delivery losses associated with surface water irrigation systems, source of data for irrigated acreages (previous reporting was based on surveys by the Natural Resources Conservation Service and Texas Agricultural Statistics Service, while recent data is provided by the Farm Service Agency and local districts), and types of crops included for water use estimates. In addition to these factors, irrigated agriculture is subject to water use fluctuations due to availability of surface water, economic factors and government programs.

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

Year	Municipal	Manufacturing	Irrigation	SEP	Mining	Livestock	Total
2000	132,251	11,119	378,187	9,152	4,143	17,454	552,306
2001	122,146	9,687	365,952	11,412	4,934	16,523	530,654
2002	121,479	10,098	348,932	12,234	3,635	15,687	512,065
2003	117,582	10,540	289,196	8,418	3,747	13,145	442,628
2004	113,213	11,996	346,643	3,609	3,731	13,249	492,441
2005	116,254	10,002	367,682	3,070	3,110	13,995	514,113
2006	126,687	10,839	418,636	3,731	4,922	15,206	580,021
2007	111,991	12,704	408,888	3,670	4,253	14,690	556,196
2008	116,228	11,718	381,254	6,081	21,136	14,409	550,826
2009	119,702	9,499	446,157	6,010	20,399	14,343	616,110
2010	115,615	9,791	458,658	6,068	22,354	13,905	626,391
State Total in 2010	*4,209,850*	*1,092,358*	*7,603,253*	*416,334*	*227,119*	*300,904*	*13,849,818*
% of State Total in Reg F	*2.75%*	*0.65%*	*4.46%*	*0.76%*	*15.35%*	*4.49%*	*3.79%*

Note: Data are from the Texas Water Development Board.[6]

Figure 1-10
Historical Water Use by Category in Region F

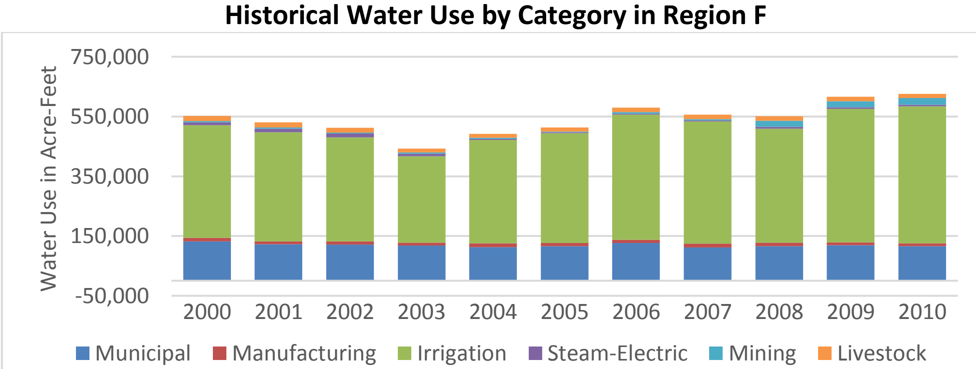

Table 1-6
Historical Total Water Use by County in Region F (Values in acre-feet)

County	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Andrews	23,300	33,662	32,395	37,072	31,490	34,858	34,637	42,249	35,479	29,221	28,083
Borden	2,401	2,498	2,789	2,655	2,890	3,114	2,788	2,951	2,888	4,592	2,180
Brown	21,294	20,127	17,675	16,310	14,160	14,659	18,145	12,380	18,534	16,447	17,592
Coke	2,593	2,517	2,030	1,142	1,515	1,557	1,825	1,392	1,621	1,638	2,028
Coleman	2,894	2,550	2,403	2,888	2,789	3,115	3,461	2,891	3,161	3,244	2,769
Concho	3,757	3,221	4,927	3,763	4,150	4,833	9,009	6,496	10,807	3,667	8,224
Crane	1,984	2,004	2,134	1,466	2,257	1,832	1,869	1,665	2,515	1,768	1,617
Crockett	3,460	3,155	3,158	2,877	2,229	2,433	2,518	2,386	2,646	2,274	2,315
Ector	31,241	28,132	27,902	25,985	25,934	24,914	29,334	25,246	25,788	26,985	28,743
Glasscock	35,813	26,112	26,727	45,380	44,570	44,554	46,925	38,203	43,775	46,868	58,316
Howard	15,379	13,796	13,662	11,748	11,139	14,006	10,285	16,717	14,120	15,329	15,935
Irion	2,606	2,127	2,152	2,859	1,987	1,901	1,120	812	1,308	2,226	2,268
Kimble	2,678	2,087	2,015	3,944	3,564	3,826	4,355	2,744	4054	4693	4812
Loving	405	372	251	43	42	95	108	67	147	209	258
Martin	15,681	16,879	16,885	13,604	15,164	16,636	16,187	26,412	29,740	38,263	37,706
Mason	11,734	11,039	11,331	10,997	11,298	10,125	8,903	4,884	7,811	9,032	5,864
McCulloch	6,978	5,351	5,353	7,573	7,054	7,152	8,685	6,858	10,893	12,095	13,203
Menard	3,922	4,256	4,202	2,429	1,927	2,269	3,228	2,771	1,675	2,471	3,048
Midland	62,210	60,852	60,622	48,547	49,296	50,652	53,624	44,433	53,691	55,170	42,420
Mitchell	7,261	7,183	8,908	8,889	8,297	8,083	9,152	11,622	13,113	16,841	14,832
Pecos	80,353	72,397	67,901	43,392	47,998	52,043	74,827	63,436	63,644	98,399	132,030
Reagan	17,003	12,685	15,836	11,511	11,886	13,822	20,274	17,882	21,047	18,415	21,002
Reeves	79,257	81,620	68,780	38,978	93,831	97,559	94,549	84,066	31,535	63,449	63,896
Runnels	3,377	4,534	6,252	5,536	4,554	4,709	5,922	4,449	6,163	5,607	5,657
Schleicher	3,372	2,416	2,400	1,893	1,737	1,755	2,037	1,536	2,248	2,600	2,587
Scurry	11,781	10,062	6,914	6,397	6,714	6,566	9,005	8,087	8,121	10,586	9,365
Sterling	1,318	1,427	1,408	1,115	1,002	973	1,169	1,005	1,349	1,672	1,337
Sutton	3,411	3,179	3,130	1,965	1,805	3,035	3,295	3,265	2,208	2,210	2,728
Tom Green	53,092	60,473	60,588	57,900	55,900	59,660	70,393	92,453	106,446	92,724	67,915
Upton	13,727	10,014	9,321	9,672	8,869	8,301	8,370	7,156	11,965	10,569	12,014
Ward	23,300	19,261	16,978	8,632	11,231	8,930	12,650	9,895	7,643	11,324	10,747
Winkler	4,724	4,666	5,036	5,466	5,162	6,147	11,372	9,787	4,691	5,522	4,900
Total	***552,306***	***530,654***	***512,065***	***442,628***	***492,441***	***514,114***	***580,021***	***556,196***	***550,826***	***616,110***	***626,391***

Note: Data are from the Texas Water Development Board.[6]
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 2010, and Figure 1-11 shows the distribution of water use by county in the region. About 73 percent of the current water use in Region F is for irrigated agriculture. Municipal supply is the second largest category, followed by mining, livestock watering, manufacturing, and steam electric power generation. The data in Table 1-7 lead to the following observations about year 2010 water use in Region F:

- The areas with the highest water use are Glasscock, 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 2010 these counties accounted for almost 60 percent of the water use in this category. Other significant municipal demand centers include Brown County (Brownwood) and Howard County (Big Spring).
- Manufacturing water use is concentrated in Ector, Howard, and Tom Green Counties, accounting for 71 percent of the total use in this category.
- Glasscock, Reeves and Pecos Counties accounted for most of the reported irrigation water use in 2010, accounting for more than a half of the irrigation water use in the region. However, a large amount 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 much less. Other significant demand centers for irrigation water include Andrews, Martin and Tom Green Counties.
- Steam-electric power generation water use occurred only in Ector, Howard, Mitchell, and Ward Counties. Facilities in other counties have temporarily or permanently ceased operations.
- Most of the water used for mining purposes occurred in McCulloch, Midland, Reeves and Upton Counties, accounting for approximately 53 percent of the total use. Mining activities across the region have increased significantly in recent years.
- Most of the livestock water use occurred in Brown, McCulloch, and Tom Green Counties, accounting for slightly more than a quarter of the total use in this category in the year 2010.

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. 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. However, during the recent drought many of these recreational activities have been impacted by low streamflow, runoff, and lake levels.

Table 1-7
Year 2010 Water Use by Category and County (Values in acre-feet)

County	Municipal	Manu-facturing	Irrigation	Steam-Electric	Mining	Livestock	Total
ANDREWS	3,105	580	23354	0	821	223	28,083
BORDEN	108	0	1616	0	239	217	2,180
BROWN	6,006	505	8901	0	942	1,238	17,592
COKE	635	0	871	0	146	376	2,028
COLEMAN	1,465	1	470	0	42	791	2,769
CONCHO	487	0	7167	0	124	446	8,224
CRANE	1,138	201	0	0	201	77	1,617
CROCKETT	1,419	10	148	0	146	592	2,315
ECTOR	24,669	1,930	1050	0[a]	845	249	28,743
GLASSCOCK	144	3	57164	0	832	173	58,316
HOWARD	5,109	3,055	6721	387	415	248	15,935
IRION	194	1	1386	0	412	275	2,268
KIMBLE	845	518	2975	0	21	453	4,812
LOVING	4	0	0	0	223	31	258
MARTIN	676	0	36160	0	723	147	37,706
MASON	814	0	3922	0	560	568	5,864
MCCULLOCH	1,619	1	2,558	0	7,849	1,176	13,203
MENARD	390	0	2074	0	264	320	3,048
MIDLAND	25,450	152	14,969	0	1,593	256	42,420
MITCHELL	1,462	0	9443	3,179	351	397	14,832
PECOS	4,771	247	126033	0	239	740	132,030
REAGAN	603	0	19385	0	798	216	21,002
REEVES[b]	3,731	286	58,369	0	1,207	303	63,896
RUNNELS	1,618	7	3053	0	77	902	5,657
SCHLEICHER	617	0	1442	0	84	444	2,587
SCURRY	2,576	156	5978	0	107	548	9,365
STERLING	226	0	688	0	173	250	1,337
SUTTON	929	0	1143	0	169	487	2,728
TOM GREEN	19,158	1,966	44366	0	984	1,441	67,915
UPTON	932	126	9,609	0	1,242	105	12,014
WARD	2,891	7	5040	2,502	205	102	10,747
WINKLER	1,824	39	2603	0	320	114	4,900
REGIONAL TOTAL	*115,615*	*9,791*	*458,658*	*6,068*	*22,354*	*13,905*	*626,391*
STATE TOTAL	*4,209,850*	*1,092,358*	*7,603,253*	*416,334*	*227,119*	*300,904*	*13,849,818*

Note: Data are from the Texas Water Development Board.[6]

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.

Region F

2010 Water Use by County (Acre-Feet per Year)

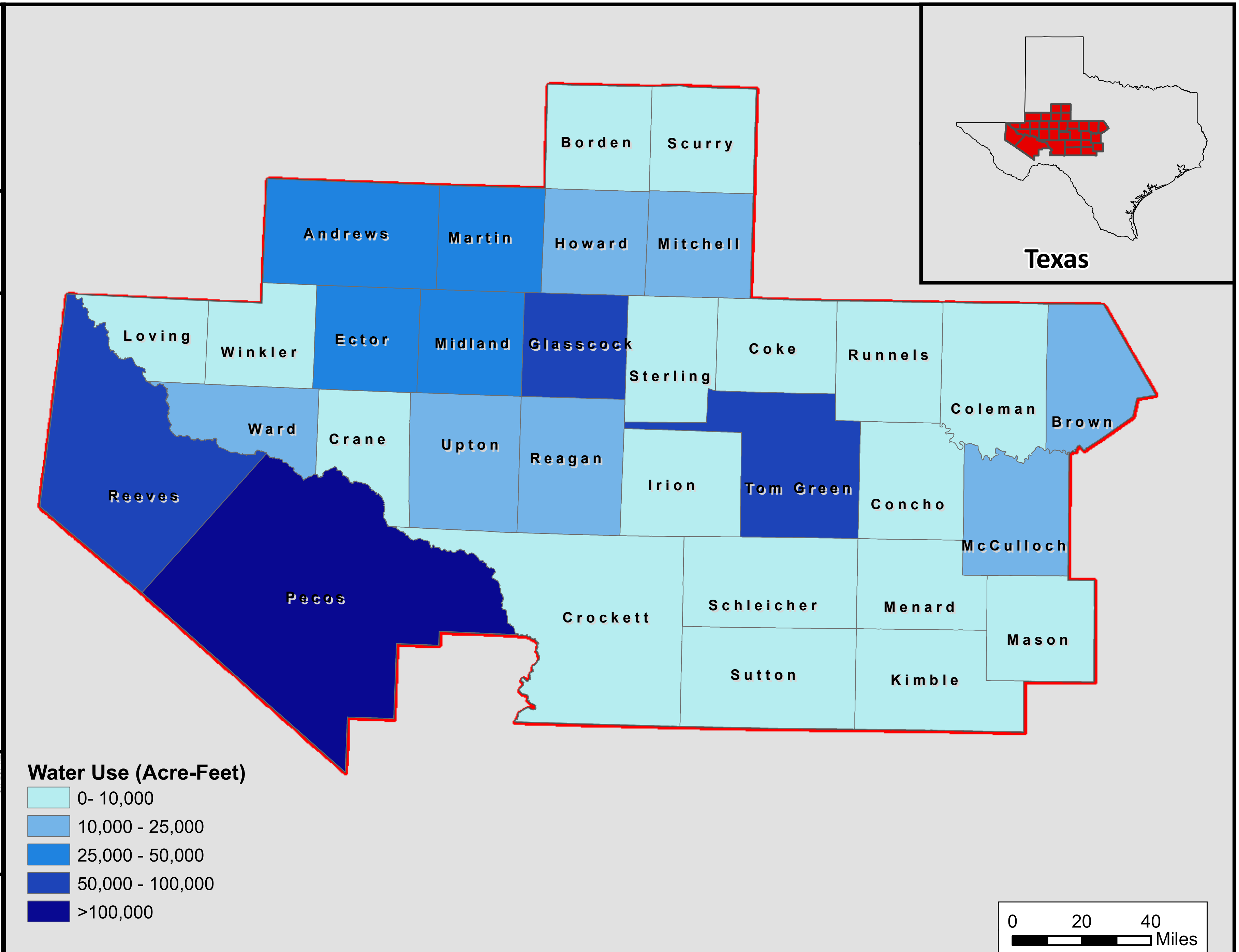

FIGURE 1-11

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Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet

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Table 1-8
Recreational Use of Reservoirs in Region F

Reservoir Name	County	Fishing	Boat Launch	Swimming Area	Marina	Picnic Area	Camping	Hiking Trails	Back-packing	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					
Champion Creek Reservoir	Mitchell											
Oak Creek Reservoir	Coke	X	X	X								
Lake Coleman	Coleman	X	X	X		X	X					
E. V. Spence Reservoir	Coke	X	X		X	X	X					X
Lake Winters/ New Lake Winters	Runnels	X	X	X	X	X	X	X				X
Lake Brownwood	Brown	X	X	X		X	X	X				
Hords Creek Lake	Coleman	X	X	X		X	X	X		X		
Lake Ballinger / Lake Moonen	Runnels	X	X	X		X	X		X			
O. H. Ivie Reservoir	Concho and Coleman	X	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					
Lake Nasworthy	Tom Green	X	X	X	X	X	X			X		X
Brady Creek Reservoir	McCulloch	X	X	X	X	X	X	X	X		X	X
Mountain Creek	Coke											
Red Bluff Reservoir	Reeves and Loving											
Lake Balmorhea	Reeves			X		X	X					

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

1.3 Current Sources of Water

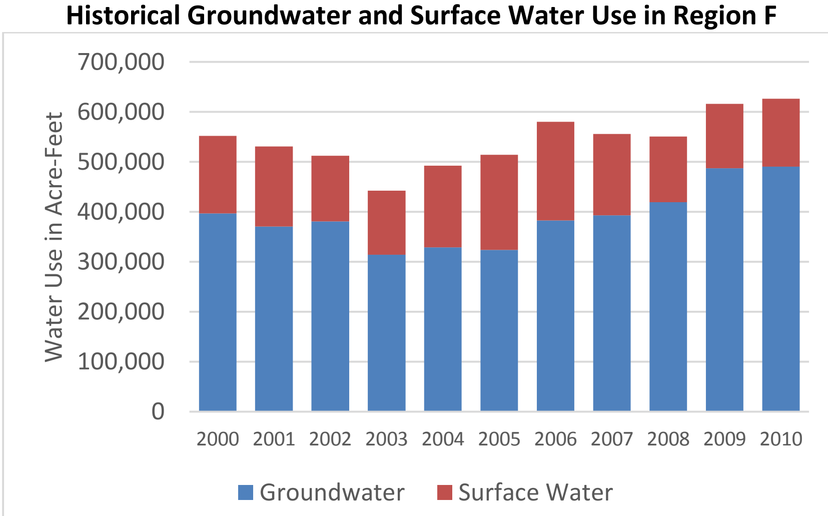
Table 1-9 summarizes the total surface water and groundwater use in Region F from 2000 through 2010, and Figure 1-12 graphically illustrates the same data. Groundwater use has shown an increasing trend ranging from 72 percent of total water use in 2000 to 78 percent in 2010. Total water use increased by approximately 74,000 acre-feet (13.4 percent) between 2000 and 2010. Groundwater use increased by more than 93,000 acre feet (23.6 percent) and surface water use decreased by more than 19,000 acre-feet (12.6 percent) over the same period. Figure 1-13 shows the percentage of supply from groundwater for each county in the region in the same year.

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

Year	Water Use in Acre-Feet		
	Groundwater	Surface Water	Total
2000	396,962	155,344	552,306
2001	370,328	160,326	530,654
2002	380,906	131,159	512,065
2003	313,828	128,800	442,628
2004	328,601	163,840	492,441
2005	323,550	190,564	514,114
2006	382,461	197,560	580,021
2007	392,721	163,475	556,196
2008	419,370	131,456	550,826
2009	487,538	128,572	616,110
2010	490,590	135,801	626,391

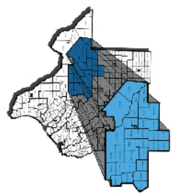
Note: Data are from Texas Water Development Board.[6]

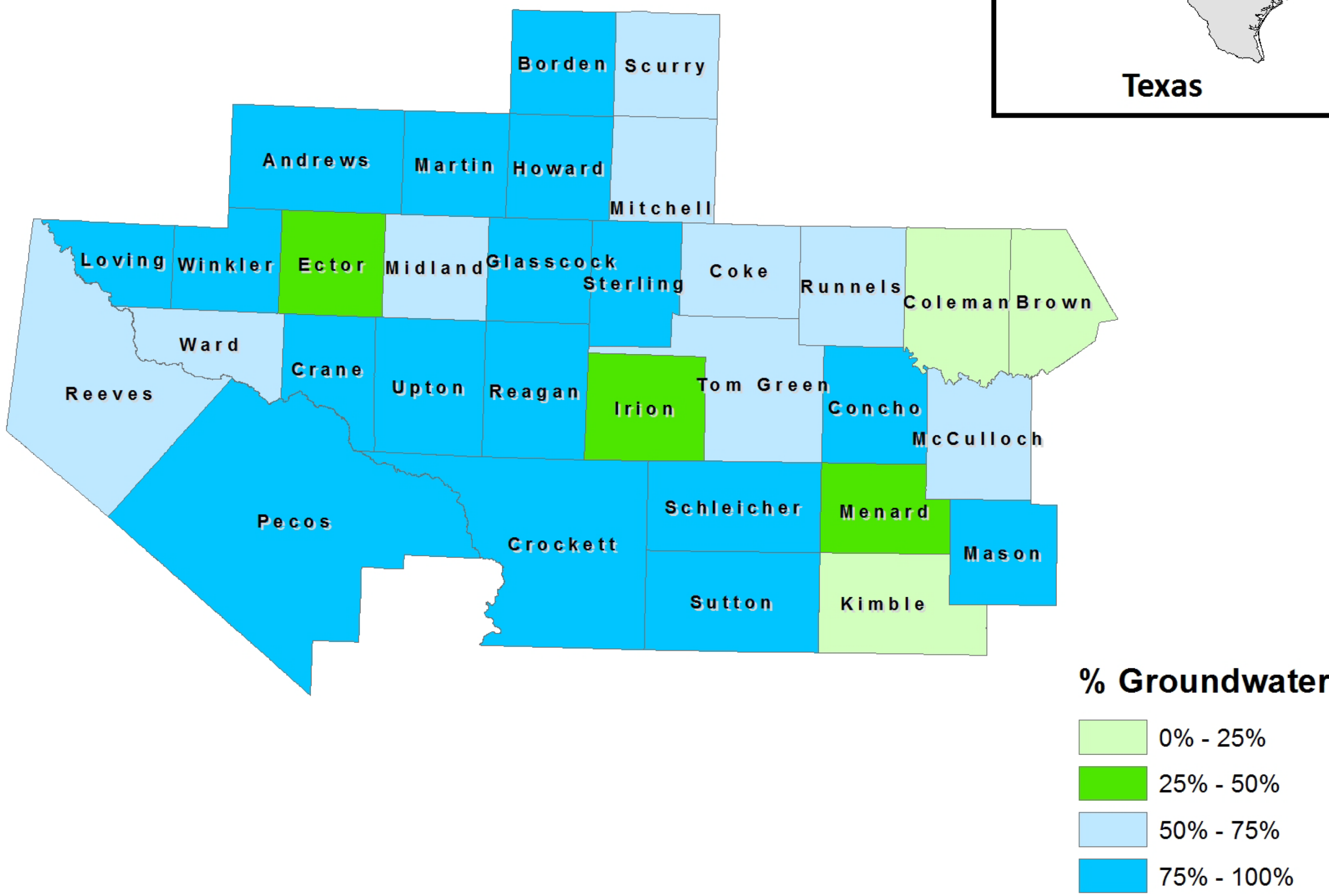
Figure 1-12
Historical Groundwater and Surface Water Use in Region F



Region F

Supplies from Groundwater by County (2010)





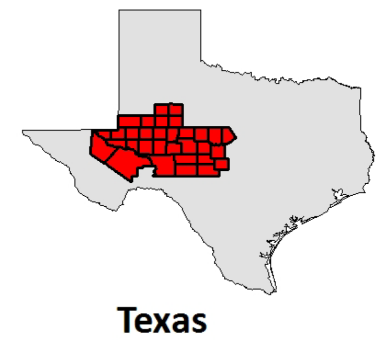


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FIGURE 1-13

Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet

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1.3.1 Surface Water Sources

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.) Table 1-10 does not include non-consumptive use categories such as recreation. Figure 1-14 shows the distribution of permitted diversions by county. 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 2010 water use from major water supply reservoirs in the region.

Region F does not import a significant amount of surface water from other regions. 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 West Central Texas Municipal Water District has a contract with the Colorado River Municipal Water District (CRMWD) for 15,000 acre-feet per year of water from O.H. Ivie Reservoir to supply the City of Abilene. Facilities to transfer water from Lake O.H. Ivie to Abilene became operational in September 2003. Currently Abilene is receiving on average between 5 million to 6 million gallons per day (MGD) (6,700 acre-feet per year) from O.H. Ivie. Small amounts of surface water are also supplied to the Cities of Lawn and Rotan, both of which are in Region G. Several rural water supply corporations also supply small amounts of surface water to neighboring regions.

Table 1-10
Surface Water Rights by County and Category

County	Permitted Surface Water Diversions (Acre-Feet per Year)					
	Municipal	Industrial	Irrigation	Mining	Other	Total
Borden	200	0	63	0	0	263
Brown	29,712	0	8,729	0	0	38,441
Coke	44,865	6,000	969	9,534[a]	0	61,368
Coleman [b]	110,890	14,509	6,362	0	20	131,781
Concho	35	0	2,511	0	16	2,562
Ector	0	0	3,200	0	0	3,200
Howard	1,700	0	89	5,715	0	7,504
Irion	0	0	5,421	0	0	5,421
Kimble	1,000	2,472	8,465	60	14	12,011
Martin	0	2,500	0	0	0	2,500
Mason	0	0	356	0	0	356
McCulloch	3,500	0	2,152	0	0	5,652
Menard	1,016	0	10,597	3	0	11,616
Mitchell	8,200	4,050	123	0	0	12,373
Pecos	0	0	66,902	0	0	66,902
Reeves [c]	0	0	347,366	0	0	347,366
Runnels	2,919	0	7,024	70	0	10,013
Schleicher	0	0	38	3	0	41
Scurry [d]	30,000	0	503	0	0	30,503
Sterling	0	0	168	0	0	168
Sutton	0	0	99	3	0	102
Tom Green	108,069	8,002	40,982	0	23	157,076
Total	***342,106***	***37,533***	***512,119***	***15,388***	***73***	***907,219***

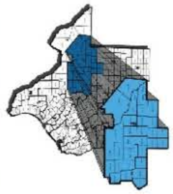
a. Includes up to 6,000 acre-feet per year that can be diverted and used in Mitchell or Howard Counties

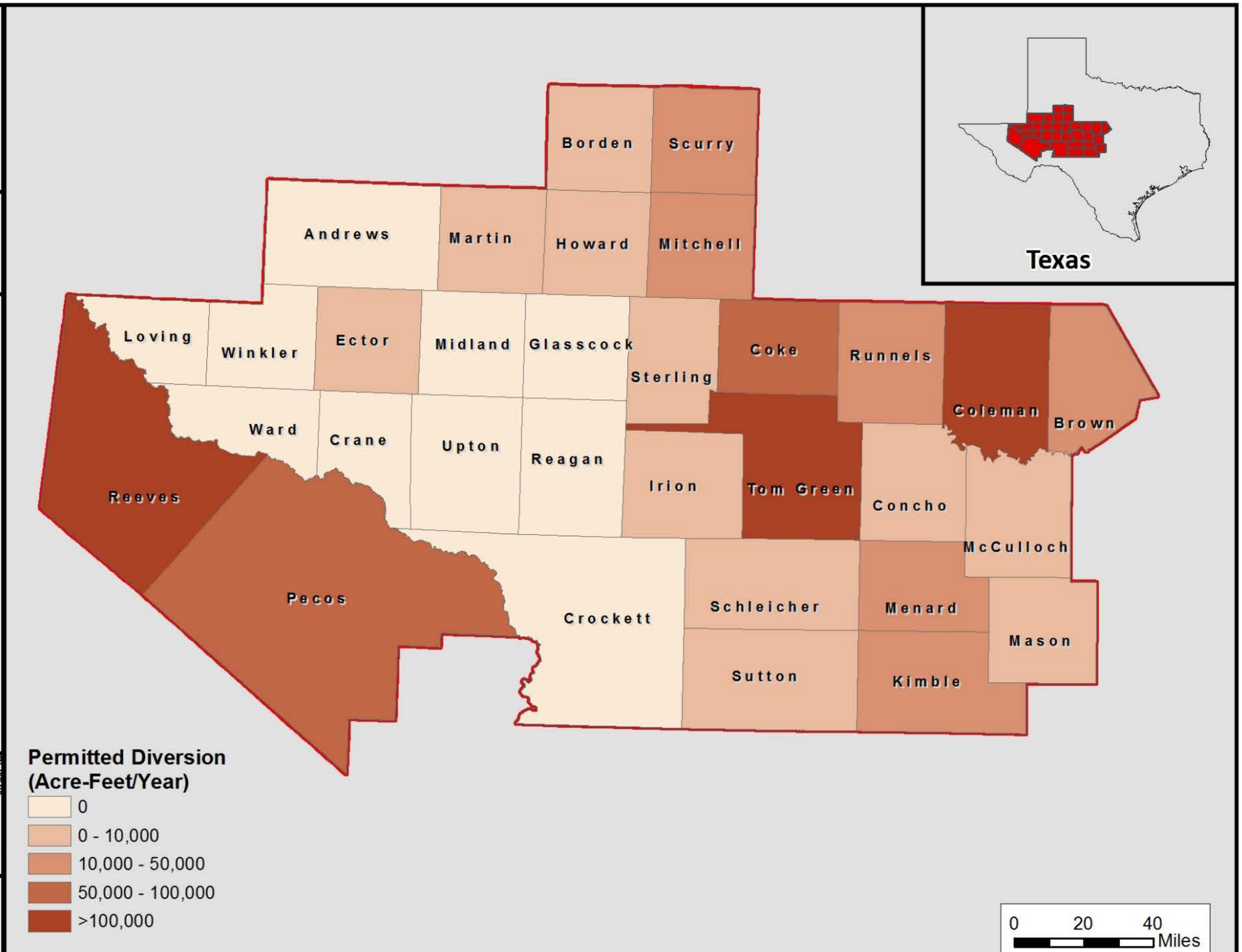
b. Includes water rights for Ivie Reservoir, which is located in Coleman, Concho and Runnels Counties.

c. Includes rights for Red Bluff Reservoir, which is located in Loving and Reeves Counties.

d. 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. Does not include recreation rights.





Region F

Permitted Diversion (Acre - Feet/Year)

Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet

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FIGURE 1-14

1.3.2 Groundwater Sources

As previously discussed in section 1.1.2, there are eleven aquifers that supply water to the 32 counties of Region F: four major aquifers (Edwards-Trinity Plateau, Ogallala, Pecos Valley, and Trinity) and nine minor aquifers (Capitan Reef Complex, 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.[7] 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 2010 groundwater use by county and aquifer[6]. The Edwards-Trinity Plateau, Ogallala and Pecos Valley are the largest sources of groundwater in Region F, providing 39.8 percent, 18.5 percent and 16.6 percent of the total groundwater pumped in 2010, respectively. The Lipan aquifer provided almost 6 percent of the 2010 totals, with all remaining aquifers contributing 19.3 percent combined. Groundwater pumping is highest in Andrews, Glasscock, Martin, Pecos, Reeves, and Tom Green Counties. Approximately 70 percent of the regions 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. 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.[8]

Twelve 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.

Table 1-11
Groundwater Pumping by County and Aquifer 2010 (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	*Total*
Andrews	3	27,000	122	0	0	3	0	0	0	0	0	0	0	656	27,784
Borden	0	1,385	0	0	0	37	0	0	0	15	0	0	0	502	1,939
Brown	0	0	0	0	0	0	639	1	0	0	0	0	0	663	1,303
Coke	160	0	0	0	0	0	0	0	0	0	0	0	0	1244	1,404
Coleman	0	0	0	0	0	0	0	0	0	0	0	0	0	109	109
Concho	203	0	0	3,870	315	0	0	0	0	0	0	0	0	2735	7,123
Crane	0	7	1,372	0	0	75	0	0	0	0	0	0	0	164	1,618
Crockett	2,118	0	0	0	0	2	0	0	0	0	0	0	0	159	2,279
Ector	5,975	926	13	0	0	580	72	0	0	0	0	0	0	515	8,081
Glasscock	49,454	7,411	0	0	0	0	0	0	0	0	0	0	0	1094	57,959
Howard	3,075	5,646	0	0	0	534	0	0	0	0	0	0	0	799	10,054
Irion	437	0	0	0	0	2	0	0	0	0	0	0	0	351	790
Kimble	622	0	0	0	40	0	5	10	0	0	0	0	0	422	1,099
Loving	0	0	16	0	0	16	0	0	0	0	1	0	0	174	207
Martin	0	36,640	0	0	0	0	0	0	0	0	0	0	0	453	37,093
Mason	10	0	0	0	4,803	0	2	67	0	0	0	0	0	487	5,369
McCulloch	11	0	0	0	6,529	0	0	492	46	0	0	0	0	2853	9,931
Menard	585	0	0	0	171	0	0	5	0	0	0	0	0	665	1,426
Midland	9,398	11,122	0	0	0	1	0	0	0	0	0	0	0	640	21,161
Mitchell	0	0	2	0	0	10,907	0	0	0	0	0	0	0	342	11,251
Pecos	79,361	0	33,703	0	0	0	0	0	0	0	3,547	2,664	0	9922	129,197
Reagan	20,030	0	0	0	0	75	0	0	0	0	0	0	0	651	20,756
Reeves	4,932	0	33,339	0	0	1,020	0	0	0	0	2,385	0	291	2056	44,023
Runnels	21	0	0	39	0	0	0	0	0	0	0	0	0	2,894	2,954
Schleicher	2,480	0	0	0	0	0	0	0	0	0	0	0	0	73	2,553
Scurry	0	0	0	0	0	6,806	0	0	0	0	0	0	0	122	6,928
Sterling	456	0	67	0	0	7	0	0	0	0	0	0	0	552	1,082
Sutton	2,363	0	0	0	0	0	0	0	0	0	0	0	0	337	2,700
Tom Green	2,235	0	0	24,333	0	0	0	0	0	0	0	0	0	17,005	43,573
Upton	9,915	167	0	0	0	164	0	0	0	0	0	0	0	821	11,067
Ward	0	0	8,925	0	0	67	0	0	0	0	4	0	0	169	9,165
Winkler	2	0	3,023	0	0	1,649	0	0	0	0	0	0	0	183	4,857
Total	*193,846*	*90,304*	*80,582*	*28,242*	*11,858*	*21,945*	*718*	*575*	*46*	*15*	*5,937*	*2,664*	*291*	*49,812*	*486,835*

Note: Data are from the Texas Water Development Board.[6]

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-4, GMA-2, and GMA-8. 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. Once an area is designated a PGMA, landowners have two years to create a Groundwater Conservation District (GCD). Otherwise, the TCEQ is required to create a GCD or to recommend that the area be added to an existing district. The TWDB works with the TCEQ to produce a legislative report every two years on the status of PGMAs in the state. The PGMA process is completely independent of the current Groundwater Management Area (GMA) process and each process has different goals. The goal of the PGMA process is to establish GCDs in these designated areas so that there will be a 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 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 Santa Rita UWCD (created in 1989) includes all but 65,000 acres of Reagan County, which was incorporated into the existing Glasscock GCD in 1989 and 1990, when landowners petitioned to join the Glasscock GCD. The Reagan, Upton and Midland County PGMA was designated in 1990, essentially at the same time that Reagan County was split into two different GCDs. Therefore, the name of the PGMA is a misnomer as it actually only includes portions of Midland and Upton Counties (Figure 1).

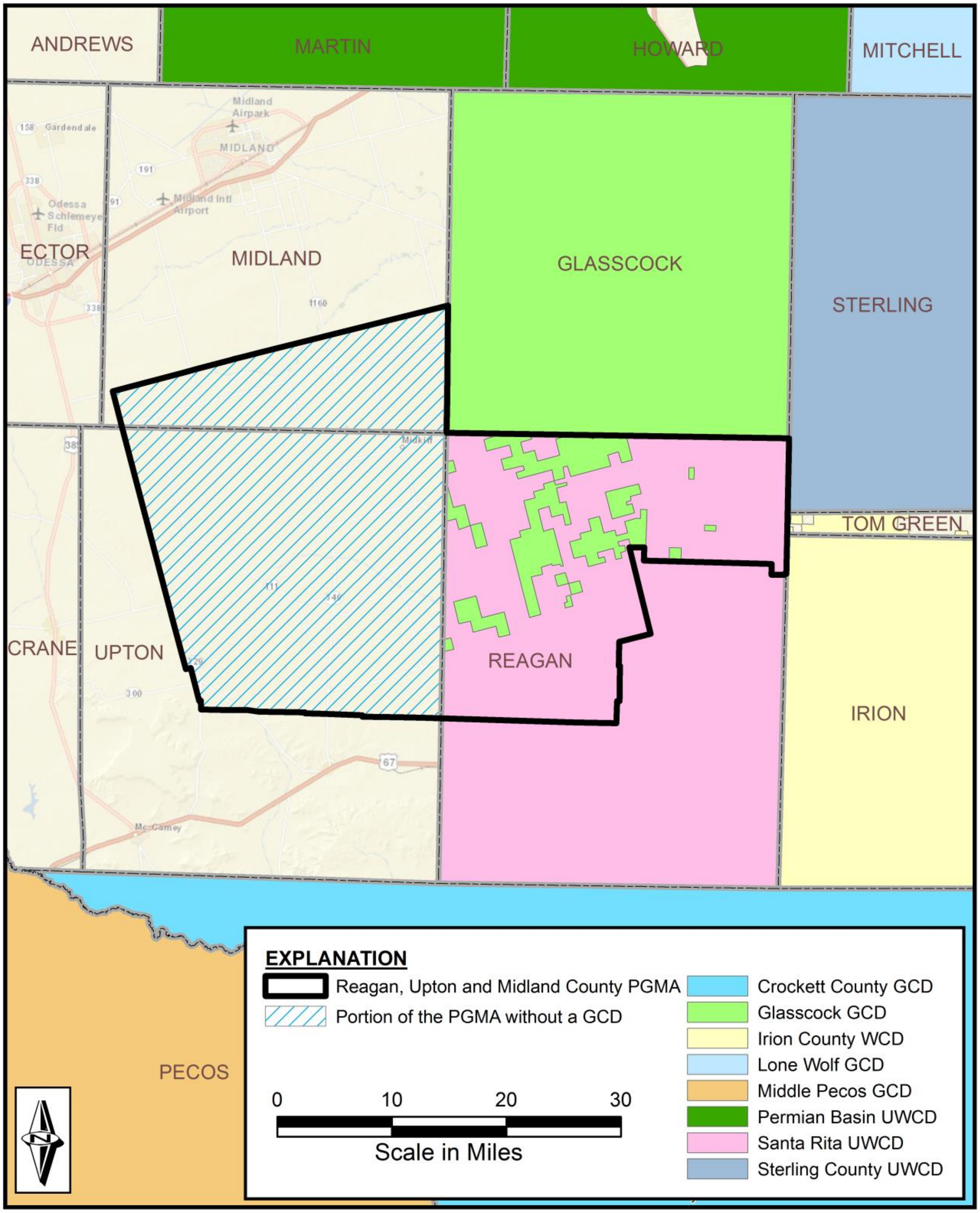
The TCEQ Executive Director is authorized to petition the Commission to establish groundwater management in PGMAs in areas that have no GCD. The Executive Director of the TCEQ issued a draft report in fall 2014 addressing the options available to the portions of Midland and Upton Counties that are located within the PGMA boundary.

These options include:

1. Adding PGMA-bound portions of both counties to the Glasscock GCD,
2. Adding PGMA-bound portions of both counties to the Santa Rita GCD,
3. 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,
4. Create a new and separate GCD for the portions in both counties, or
5. Create two new GCDs for the portions in both counties splitting the GCDs at the county line.

After considering tax base, water demand, and potential fee-based structure, the Executive Director recommended either option 1 or 2, in which the areas are added to one of the existing GCDs. The report indicated that an Order would be issued recommending this action; however, as of August 2015, a final report has not been published and an Order has not been issued. As of this time, no county commissioner's court has promulgated groundwater regulations or availability values for areas within the PGMA that have no GCD.

Figure 1-15
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.

Many springs are also important to the region for natural resources purposes. The Diamond Y Springs in northern Pecos County and 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.

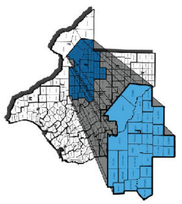
The Region F Planning Group has identified 14 major springs in the region that are important for water supply or natural resources protection (Figure 1-16). These major springs include: San Solomon, Giffin, and Sandia Springs in Reeves County; Comanche and Diamond Y Springs in Pecos County; Spring Creek Springs, Dove Creek Springs, and Rocky Creek Springs in Irion County; Anson Springs, Lipan Spring, and Kickapoo Spring in Tom Green County; Clear Creek Spring in Menard County; Santa Rosa in Pecos County and San Saba Spring in Schleicher County. 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.[9,10].

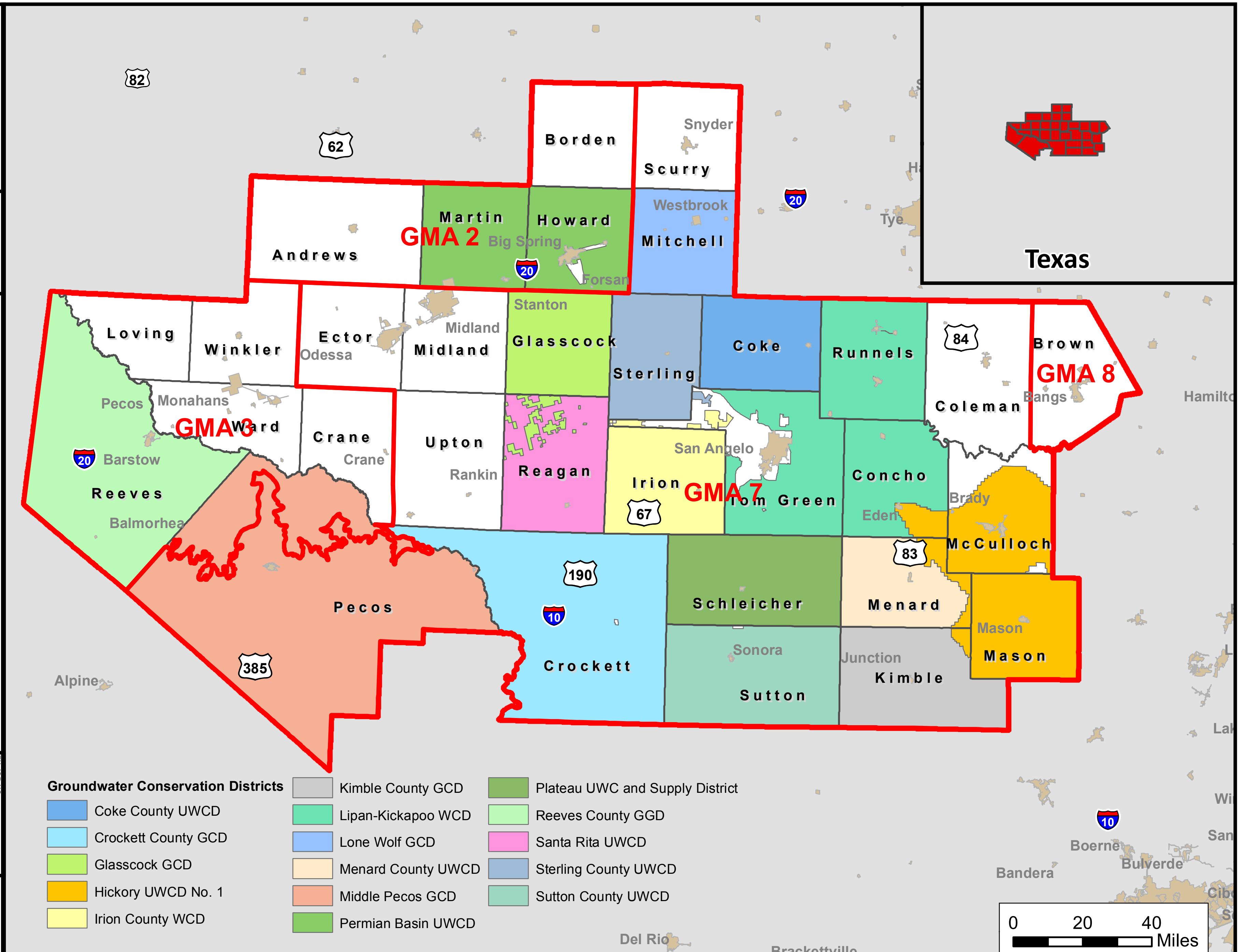
Balmorhea Area Springs

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 in the area over the past decade has resulted in diminishing flows from these springs.

San Solomon Springs are located in the large swimming pool in Balmorhea State Park and are the largest spring in Reeves County. The spring's importance begins with its recreational use in the pool, then its habitat for endangered species in the ditches leading from the pool,[11] 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 gravels in the area. Spring flow is maintained by precipitation recharge in the nearby Davis 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 three and four cubic feet per second. Discharge from Giffin Springs responds much more closely to precipitation than the other Balmorhea-area springs.





Groundwater Conservation Districts and Groundwater Management Areas

Region F

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FIGURE 1-16

Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet

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East and West Sandia Springs are located about one mile east of Balmorhea at an elevation slightly lower than San Solomon and Giffin Springs. Flow from this spring system was classified as a "stream segment with significant natural resources" in the first regional plan. 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.[12] 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.

Fort Stockton Area Springs

Comanche Springs flows 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, since 1987, Comanche Springs has sporadically flowed, primarily during winter months.

Diamond Y Springs (or Deep Springs) is 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.

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 American Indians, 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.

1.4 Agricultural and Natural Resources in Region F

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.[13] There are 15 federally listed endangered species that are known to, or may occur, in counties in Region F. The Black-capped Viero, Interior Least Tern, Whooping Crane and Gray Wolf are the federally endangered species most frequently cited in Table 1-12 for counties 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																																			
American Peregrine Falcon	*Falco peregrinus anatum*		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	S
Bald Eagle	*Haliaeetus leucocephalus*		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
Black-capped Vireo	*Vireo atricapilla*	E	E			B	B	B	B		B				B	B			B	B	B			B	B		B	B		B	B	B			
Common Black-Hawk	*Buteogallus anthracinus*		T																													S			
Golden-cheeked Warbler	*Setophaga chrysoparia*	E	E			B		B	B							B			B	B	B														
Interior Least Tern	*Sterna antillarum athalassos*	E	E		B	B	B	B	B	B	B						B			B			B	B		B	B		B			B		B	
Lesser Prairie-Chicken	*Tympanuchus pallidicinctus*	T		F																															
Mexican Spotted Owl	*Strix occidentalis lucida*	T																						F		F									
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	E	E	B								B					B							B		B								B	B
Peregrine Falcon	*Falco peregrinus*		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	S
Piping Plover	*Charadrius melodus*	T			F																								F						
Reddish Egret	*Egretta rufescens*		T																					S		S									
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*		T																					F		S									
Whooping Crane	*Grus americana*	E	E	B	B	B	B	B	B				B	B	B	B		B	B	B	B	B	B		B		B	B	B	B	B	B			
Zone-tailed Hawk	*Buteo albonotatus*		T								S					S			S	S	S			S		S									
Crustaceans																																			
Pecos amphipod	*Gammarus pecos*	E																						F		F									
Diminutive amphipod	*Gammarus hyalleloides*	E																								F									
Fish																																			
Clear Creek gambusia	*Gambusia heterochir*	E	E																		B														
Comanche Springs pupfish	*Cyprinodon elegans*	E	E																					B		B									
Leon Springs pupfish	*Cyprinodon bovinus*	E	E																					B											
Pecos gambusia	*Gambusia nobilis*	E	E																					B		B									
Pecos pupfish	*Cyprinodon pecosensis*		T							S	S						S							S		S								S	
Proserpine shiner	*Cyprinella proserpina*		T								S													S											
Rio Grande darter	*Etheostoma grahami*		T								S																								
Sharpnose Shiner	*Notropis oxyrhynchus*	E			F																								F						
Smalleye Shiner	*Notropis buccula*	E			F																								F						
Mammals																																			
Black bear	*Ursus americanus*	T	T							B	B					B	B		B					B	B	B		B			B		B	B	
Black-footed ferret	*Mustela nigripes*	E		F	F					F	F	F	F	F			F	F				F	F	F	F	F			F	F			F	F	F
Gray wolf	*Canis lupus*	E	E	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Ocelot	*Leopardus pardalis*	E	E								B																				B				
Palo Duro mouse	*Peromyscus truei comanche*		T		S																														
Red wolf	*Canis rufus*	E	E			B		B	B							B			B	B	B						B	B			B	B			
Reptiles																																			
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	S
Texas tortoise	*Gopherus berlandieri*		T																												S				
Trans-Pecos black-headed snake	*Tantilla cucullata*		T								S													S											
Flowering Plants																																			
Pecos/Puzzle sunflower	*Helianthus paradoxus*	T	T																					B		B									
Texas poppy-mallow	*Callirhoe scabriuscula*	T	E				B																B				B		B						
Tobusch fishhook cactus	*Sclerocactus brevihamatus ssp tobuschii*	E	E													B																			
Snails																																			
Pecos Assiminea Snail	*Assiminea pecos*	E	E																					B		B									

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**
Mussels																																			
Diamond tryonia	*Pseudotryonia adamantina*	E																						F											
False spike mussel	*Quadrula mitchelli*		T			S		S	S	S	S					S	S		S	S	S			S		S						S		S	
Gonzales tryonia	*Tryonia circumstriata*	E																						F											
Pecos assiminea snail	*Assiminea pecos*	E	E																					B		B									
Phantom springsnail	*Pyrgulopsis texana*	E																								F									
Phantom tryonia	*Tryonia cheatumi*	E																								F									
Smooth pimpleback	*Quadrula houstonensis*		T			S		S	S										S	S	S						S								
Texas fatmucket	*Lampsilis bracteata*		T					S	S						S	S			S	S	S						S					S			
Texas fawnsfoot	*Truncilla macrodon*		T			S		S	S							S			S	S	S						S					S			
Texas hornshell	*Popenaias popeii*		T							S	S						S							S		S		S			S			S	
Texas pimpleback	*Quadrula petrina*		T			S		S	S							S			S	S	S						S			S		S			

****Status:***
T - Threatened
E - Endangered

Key:
F - Federal listings only (US Fish and Wildlife Service. 2014. Endangered Species List. http://www.fws.gov/endangered/)
S - State listings only (Texas parks and Wildlife Department. 2014. Annotated County Lists of Rare Species. http://tpwd.texas.gov/gis/rtest/)
B - both Federal and State listings

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 37 species identified by the state as threatened or endangered that are known to, or may potentially occur in Region F.

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.[14] Region F includes approximately 22,313,000 acres in farms and over 2,400,000 acres of potential cropland. In 2012 the market value of agriculture products (crops and livestock) for Region F was over $695,000,000, with livestock accounting for approximately 60 percent of the total.

Figure 1-17 shows the distribution of prime farmland in Region F.[15] 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 1-17 represents the percentage of the total acreage that is considered prime farmland of any kind.

Table 1-13
2012 U.S. Department of Agriculture County Census Data for Region F

Category	Andrews	Borden	Brown	Coke	Coleman	Concho	Crane	Crockett
Farms	169	114	1,918	443	906	401	27	216
Irrigated Land (acres)	4,992	4,958	3,490	967	1,022	2,144	(D)	88
Land in Farms (acres)								
- Crop Land[a]	71,517	63,061	84,641	49,049	135,473	106,618	(D)	7,985
- Pasture Land	(D)	398,814	425,760	421,965	538,289	366,842	237,855	1,513,576
- Other	(D)	2,395	84,911	13,319	51,976	28,137	(D)	24,641
- Total	752,030	464,270	595,312	484,333	725,738	501,597	239,159	1,546,202
Market Value ($1,000)								
- Crops	$5,819	$5,338	$7,527	$2,058	$11,388	$14,229	$23	$45
- Livestock	$6,758	$4,100	$33,151	$4,952	$16,988	$8,601	$1,387	$13,849
- Total	$12,577	$9,438	$40,678	$7,010	$28,376	$22,830	$1,410	$13,894

Category	Ector	Glasscock	Howard	Irion	Kimble	Loving	Martin	Mason
Farms	264	186	475	155	602	10	414	640
Irrigated Land (acres)	771	25,291	4,189	713	8,506	0	17,128	2,975
Land in Farms (acres)								
- Crop Land[a]	3,645	134,675	161,890	10,740	15,535	594	279,609	28,907
- Pasture Land	419,593	275,321	321,415	474,101	622,464	(D)	163,067	463,881
- Other	5,610	23,710	15,167	11,295	56,231	(D)	11,036	58,480
- Total	428,848	433,706	498,472	496,136	694,230	379,524	453,712	551,268
Market Value ($1,000)								
Crops	$634	$23,097	$4,642	$770	(D)	0	$18,002	$4,996
Livestock	$1,556	$2,781	$9,222	$6,693	$6,709	$912	$2,263	$46,453
Total	$2,190	$25,878	$13,864	$7,463	$6,709	$912	$20,265	$51,449

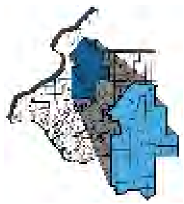
a. Crop land is the land that is currently or recently cultivated for farming. Acreages in active farms may be less.

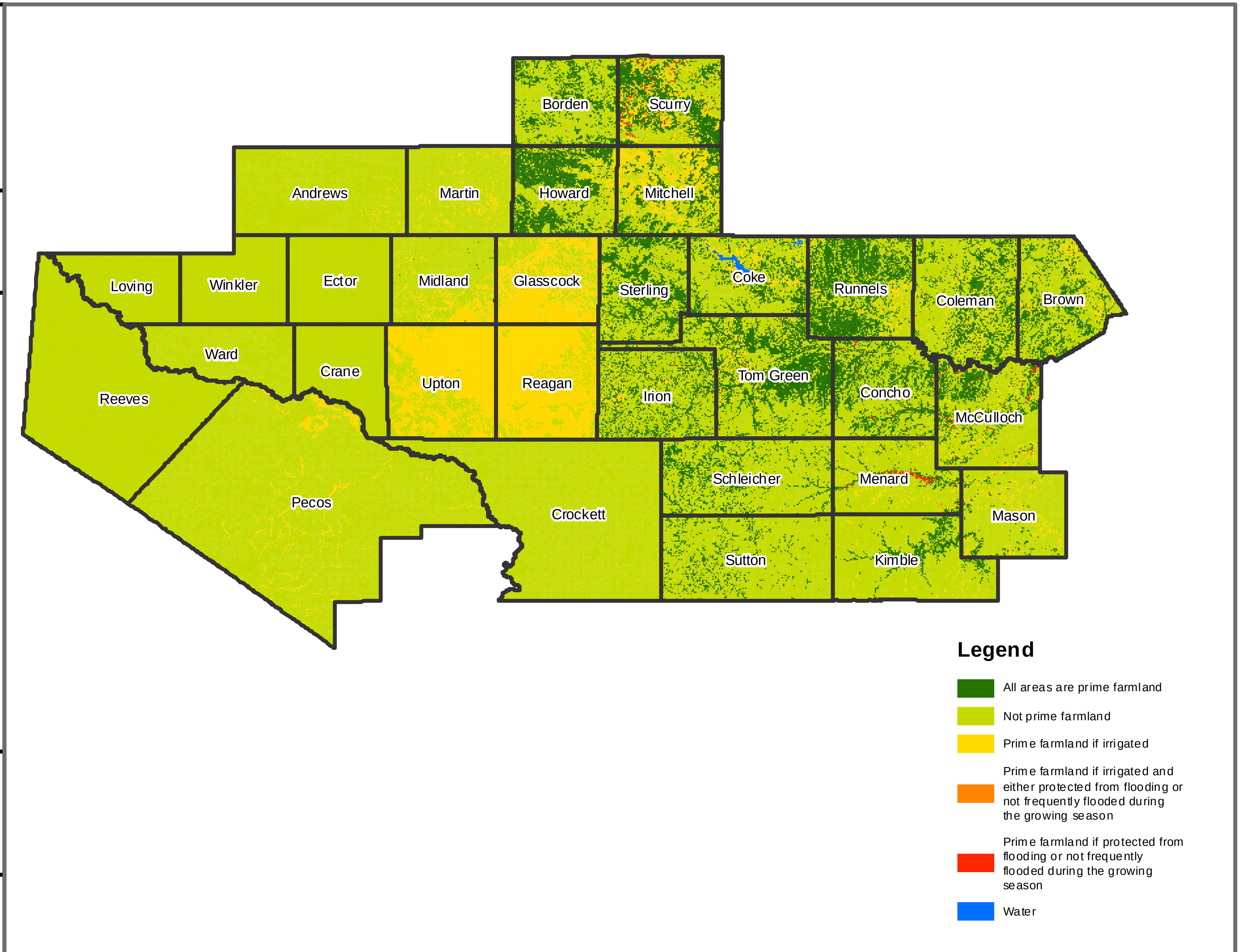
Table 1-13 (Cont'd)
2012 U.S. Department of Agriculture County Census Data for Region F

Category	McCulloch	Menard	Midland	Mitchell	Pecos	Reagan	Reeves	Runnels
Farms	619	325	540	482	291	135	240	925
Irrigated Land (acres)	949	1,534	10,748	4,246	13,918	12,108	10,624	4,505
Land in Farms (acres)								
- Crop Land[a]	90,112	20,653	62,399	146,734	63,668	46,654	98,194	247,945
- Pasture Land	495,221	475,436	332,609	418,107	2,853,067	(D)	1,120,483	389,562
- Other	29,020	40,473	9,353	8,289	31,170	(D)	17,051	28,398
- Total	614,353	536,562	404,361	573,130	2,947,905	698,550	1,235,728	665,905
Market Value ($1,000)								
Crops	$8,622	$1,252	$11,301	$12,918	$27,595	$7,146	$10,864	$29,542
Livestock	$13,943	$8,383	$5,912	$8,269	$19,874	$3,959	$43,342	$17,885
Total	$22,565	$9,635	$17,213	$21,187	$47,469	$11,105	$54,206	$47,427

Category	Schleicher	Scurry	Sterling	Sutton	Tom Green	Upton	Ward	Winkler	Total
Farms	310	677	73	218	1203	101	93	43	13,215
Irrigated Land (acres)	1,424	3,742	622	1,267	31,096	8,876	215	(D)	183,108
Land in Farms (acres)									
- Crop Land[a]	32,505	206,448	12,705	10,958	168,243	46,082	5,882	(D)	2,413,121
- Pasture Land	797,807	273,525	570,990	862,169	762,534	615,897	380,786	(D)	16,991,136
- Other	3,257	14,380	1,371	37,857	26,075	24,252	4,985	(D)	662,839
- Total	833,569	494,353	585,066	910,984	956,852	686,231	391,653	533,464	22,313,203
Market Value ($1,000)									
Crops	$2,808	$13,019	(D)	$495	$32,596	$8,066	$116	(D)	264,908
Livestock	$10,802	$16,008	(D)	$10,378	$98,839	$4,618	$1,656	(D)	430,243
Total	$13,610	$29,027	$0	$10,873	$131,435	$12,684	$1,772	$0	695,151

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, 2012).[14]





Coordinate System: GCS North American 1983

N
W E
S

Region F

Prime Farmland

DRAFTED	JLA
DESIGNED	JLA
SCALE	1:2,824,422
DATE	MARCH, 2015
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FIGURE 1-17

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A number of counties in Region F have significant prime farmland acreage. Those with the largest acreage include Runnels, Glasscock, Upton, Tom Green, Scurry, and Reagan Counties. These six counties accounted for about 30 percent of the total land in farms and 52 percent of the total crop value for Region F in 2012.

It is interesting to note that major agricultural production also occurs in some counties with a relatively small amount of prime farmland. For example, Andrews, Martin, Pecos, and Reeves Counties have 10 percent or less acreage identified as prime farmland. However, these four counties combined accounted for approximately 24 percent of the total land in farms and 24 percent of the crop value for the region in 2012.

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 lignite resources in Brown and Coleman Counties, and stone, sand and gravel in various parts of the region.

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 Wholesale Water Providers

The TWDB defined the term wholesale water provider (WWP) as "any person or entity, including river authorities and irrigation districts, that has contracts to sell more than 1,000 acre-feet of water wholesale in any one year during the five years immediately preceding the adoption of the last Regional Water Plan. The Planning Groups shall include as wholesale water providers other persons and entities that enter or that the Planning Group expects to enter contracts to sell more than 1,000 acre-feet of water wholesale during the period covered by the plan."[16] Region F has identified seven entities that qualify as wholesale water providers:

- Colorado River Municipal Water District
- Brown County Water Improvement District Number One
- Upper Colorado River Authority

- Great Plains Water System, Inc.
- City of Odessa
- City of San Angelo
- University Lands

There are no implications of designation as a "wholesale water provider" except for the additional data required by TWDB. The wholesale 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. Table 1-14 is a list of fiscal year 2010 sales by the CRMWD, which totaled 73,155 acre-feet.

Brown County Water Improvement District Number One (BCWID).

The 2010 sales by the BCWID totaled 10,888 acre-feet and are listed in Table 1-15. 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.

Upper Colorado River Authority (UCRA).

The UCRA is the owner of water rights in O.C. Fisher Reservoir in Tom Green County and Mountain Creek Lake in Coke County. O.C. Fisher supplies are used by the Cities of San Angelo and Miles. The City of Robert Lee uses water from Mountain Creek Lake. Table 1-16 is a list of year 2010 diversions from UCRA sources, which totaled 93 acre-feet.

Table 1-14
Fiscal Year 2010 Sales by the Colorado River Municipal Water District
-Values in Acre-Feet per Year-

Customer	Total Water Sales
Odessa	21,378
Big Spring	7,288
Snyder	2,000
Midland	20,650
Stanton	332
San Angelo	15,806
Robert Lee	315
Grandfalls	34
Pyote/West Tx State School	75
MDWSC (includes Ballinger)	615
West Central Texas MWD	2,893
Non-Municipal Customers	1,769
Total	73,155

Data are from the Colorado River Municipal Water District.[17]

Table 1-15
2010 Sales by the Brown County Water Improvement District Number One
-Values in Acre-Feet-

Customer	2010 Total Water Sales [a]
Bangs	228
Early	886
Brownwood	3,723
Brookesmith WSC	1,533
Santa Anna	(b)
Thunderbird Bay	109
Irrigation	4,409
Total	10,888

a. Data are from the Brown County Water Improvement District No. 1.[18]
b. Santa Anna is served by Brookesmith WSC.

Table 1-16
2010 Diversions from Upper Colorado River Authority Sources
-Values in Acre-Feet per Year-

Customer	2010 Diversions
San Angelo	0
Miles	93
Robert Lee	0
Total	93

Data are from TWDB. [19]

<u>Great Plains Water System, Inc</u>

The Great Plains Water System was initially developed to provide water to oil field operations in the Permian Basin. The System's source of water is the Ogallala aquifer in Andrews County in Region F and Gaines County in Region O. The System's largest customer is the recently established steam electric operation in Ector County. Great Plains has contracts to supply 6,096 acre-feet per year. The System also provides water to the City of Goldsmith in Ector County (43 acre-feet in 2010).

<u>City of Odessa</u>

The City of Odessa is a member city of CRMWD. The City of Odessa sells treated water to the Ector County Utility District, the Odessa County Club, and manufacturing users. Odessa also sells treated wastewater to manufacturing customers. In the year 2010, Odessa purchased 21,378 acre-feet from CRMWD.

<u>City of San Angelo.</u>

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, O.H. Ivie Reservoir (purchased from CRMWD), and E.V. Spence Reservoir (purchased from CRMWD). San Angelo is currently developing a groundwater supply from the Hickory Aquifer near Melvin, Texas (McCullough County). As part of an agreement with UCRA, San Angelo also treats water for customers of UCRA.

<u>University Lands.</u>

University Lands manages property owned by the University of Texas System in West Texas. Although University Lands does not actively provide water, several major water well fields are located on property leased from University Lands, including fields operated by CRMWD, the City of Midland and the City of Andrews. University Lands also provides groundwater for oil and gas activities in Region F.

1.5.2 Retail Water Sales

Cities and towns provide most of the retail water service in Region F, and some cities also serve as retail water providers to connections outside of their city limits or as wholesale water suppliers by selling treated water to other water suppliers. Table 1-17 lists the cities in Region F that had outside sales in 2010.

Table 1-17
Water Supplied by Selected Cities in Region F

Supplier	County	Year 2010 Sales in Acre-Feet		
		Municipal Sales within City	Outside Sales	Total
Andrews	Andrews	2,890	295	3,185
Ballinger	Runnels	1,022	2	1,024
Balmorhea	Reeves	654	361	1,015
Big Spring	Howard	5,312	1,413	6,725
Brownwood	Brown	3,679	531	4,210
Coleman	Coleman	2,589	40	2,629
Colorado City	Mitchell	1,439	715	2,154
Early	Brown	922	92	1,014
Odessa	Ector	18,890	859	19,749
San Angelo	Tom Green	16,951	2,159	19,110
Snyder	Scurry	2,234	434	2,668
Winters	Runnels	741	73	814

Data are from the TWDB [6]

1.6 Existing Plans for Water Supply Development

In 2012, the Texas Water Development Board released the State Water Plan, Water for Texas – 2012, which was a compilation of the 16 regional water plans developed under SB1.[20] The Region F Water Planning Group published the Region F Regional Water Plan in January 2011. Some of the findings of the 2011 Region F plan included:

- Approximately 59 water user groups had projected water shortages over the planning period (through 2060). Many of these shortages were associated with WAM priority analysis of surface water supplies. Water management strategies were developed to address these needs.
- Fifteen counties had a collective irrigation need of over 144,000 acre-feet per year. No water supply is readily available to meet this need. Advanced water conservation irrigation technologies were recommended to reduce the irrigation demands. This strategy would significantly reduce the demands and eliminate projected shortages in several counties. However, some counties in Region F still had significant irrigation water needs.
- Major municipal needs occur with water user groups that rely on the Hickory aquifer. Needs are the result of water quality standards for radionuclides imposed by USEPA and TCEQ. Many of the water management strategies that were developed for the users of Hickory aquifer in the last plan have been implemented.
- General water management strategies recommended in the plan included: subordination, water conservation, brush control, weather modification, wastewater reuse, recharge enhancement, and desalination and chloride control.

The City of San Angelo completed their Long-Range Water Supply Plan in November of 2000.[21] Some of the major recommendations have been implemented including the development of the McCulloch County wellfield and improvements to its surface water delivery system. The city is actively studying wastewater reuse and this strategy is considered in the regional water plan.

Several groundwater districts in Region F (including those located in Crockett, Schleicher, Sutton, Menard, and Kimble Counties) as well as the Real-Edwards district, Val Verde County, and the City of Del Rio collectively funded an independent water budget analysis. The key findings of this study include:

- Groundwater basins and surface water basins do not align and are not equivalent in the area of catchment, nor do they align with geopolitical entity boundaries.
- Groundwater flow rates have less certainty than surface water flow rates.
- The recharge rates derived by this water budget analysis are somewhat greater than previous investigations.
- Downstream users are impacted significantly by upstream users.

The cities of Abilene, Midland and San Angelo have formed the West Texas Water Partnership (the Partnership) to evaluate long-term water supplies the Partnership could develop jointly. The Partnership is conducting a separate study to determine the most feasible water management strategies for these cities, but the results were not available at the writing of this plan.

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 TWDB.

Many entities around the state have already developed conservation plans and/or drought contingency plans. These plans have improved the awareness of the need for water conservation in Texas. In its projections of water use, the TWDB has assumed reductions in per capita municipal use due to the implementation of the plumbing code requiring the use of low flow plumbing fixtures in all new development and renovation. The TWDB also considers expected reductions in municipal water use due to energy efficiency requirements for dish washers and clothes washers.

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. As part of this plan, model water conservation plans can be accessed online at www.regionfwater.org and clicking on the Documents tab (http://regionfwater.org/index.aspx?id=Documents). These models can serve as templates for entities to develop or update their water conservation plan. More information on water 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 Texas Water Development Board every five years. The first water loss audit reports were submitted to the TWDB by March 31, 2006. The water audit reporting requirements follow the International Water Association (IWA) and American Water Works Association (AWWA) Water Loss Control Committee methodology.[22]

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 water loss for a utility.

In the Region F planning area, 46 public water suppliers submitted a water loss audit to TWDB. The average total water loss for Region F is 12.7 percent. The amount of losses in Region F totaled 2.7 billion gallons in 2010. This represents 7.3 percent of the total estimated municipal water demand for the region. This information was used in developing municipal conservation strategies. Table 1-18 summarizes the water loss audit information that was collected by the TWDB for the 2010 year. The region encourages the reduction in water loss where feasible.

Table 1-18
Summary of TWDB Water Loss Audits

Total Water Loss	WUGS	SUDS/WSCs
≤ 10%	10	3
10% - 15%	6	1
15% - 20%	4	3
20% - 25%	1	1
≥ 25%	4	9

Source: 2010 Water Loss Audit Dataset from TWDB

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.[23] In early 2015, the Lower Colorado River Authority (LCRA) announced that preliminary information indicates the current drought has likely surpassed the historic drought-of-record from the 1950s for LCRA's Highland Lakes and the lower basin. 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.

Model drought contingency plans 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.

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. In recent years, TCEQ has increased its scrutiny of the environmental impacts of water supply projects, and permitting has become more difficult and complex. Among its many other provisions, SB1 set out formal criteria for the permitting of interbasin transfers for water supply.

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.[24]

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 recreation in and on the water." [25]

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.[26] 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.

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 six watersheds in the region including Lake Brownwood, O.C. Fisher, O.H. Ivie, E.V. Spence, Lake J.B. Thomas and Twin Buttes Reservoir. Two additional feasibility studies for O.H. Ivie Reservoir (salt cedar specific) and the Upper Llano River are in progress at the time of writing of this plan. 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.

1.7 Summary of Threats and Constraints to Water Supply in Region F

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,
- Changes in groundwater regulation, 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 1-19. 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. 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 and gas production.[27] 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.[28] 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 As a result of this updated plan, continued monitoring of the area should show improving water quality as the I- Plan is implemented.[29]

Infrequent low dissolved oxygen levels have been reported by the TCEQ within the lower 25 miles of Pecan Bayou above Lake Brownwood. There are no known point sources of water pollution within the segment that could be responsible for the problem. Low oxygen levels may be due to natural conditions and/or agricultural non-point source pollution. The TCEQ has not given this a priority ranking on the 303(d) list, instead stating that more data will be collected before a TMDL is scheduled. No impairment to water use as a result of the water quality has been reported.

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.[30]

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.

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.

Other Groundwater Quality Issues

Other groundwater quality issues in Region F include elevated levels of fluoride, nitrate, arsenic and perchlorate. Table 1-20 shows the percentage of water wells sampled by the TWDB that exceed drinking water standards for fluoride, nitrate and arsenic. The largest percentage of wells with excessive fluoride can be found in Andrews and Martin Counties. Elevated nitrate levels can be found throughout Region F, with a high percentage of wells exceeding standards in Ector, Midland, Runnels and Upton Counties. The highest percentages of wells exceeding arsenic standards are found in Borden, Midland and Martin 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.[31]

Table 1-19
Summary of Identified Surface Water Quality Problems in Region F

Segment ID	Segment Name	Concern Location	Water Quality Concern	Status
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	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.
			selenium	Additional data and information will be collected before a TMDL is scheduled.
1413	Lake J. B. Thomas	Entire water body	chloride	Additional data and information will be collected before a TMDL is scheduled.
			sulfate	
			total dissolved solids	
1416	San Saba River	From the confluence with the Colorado River in San Saba County upstream to the US 190	bacteria	Additional data and information will be collected before a TMDL is scheduled.
1416 A	Brady Creek (unclassified water body)	From FM 714 upstream to Brady Lake dam	depressed dissolved oxygen	Additional data and information will be collected before a TMDL is scheduled.
1421	Concho River	North Concho River, from the confluence with the South Concho River upstream to O.C. Fisher dam	bacteria	Additional data and information will be collected before a TMDL is scheduled.
			depressed dissolved oxygen	Additional data and information will be collected before a TMDL is scheduled.
1431	Mid Pecan Bayou	Entire water body	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.
2311	Upper Pecos River	From US Hwy 67 upstream to the Ward Two Irrigation Turnout	depressed dissolved oxygen	Additional data and information will be collected before a TMDL is scheduled.

Source: Data from 2012 Draft 303(d) list (May 9, 2013) [32]

Table 1-20
Percentage of Sampled Water Wells Exceeding Drinking Water Standards for Fluoride, Nitrate and Arsenic (2008)

County	Fluoride	Nitrate	Arsenic
Andrews	27%	54%	36%
Borden	13%	44%	40%
Brown	2%	36%	0%
Coke	1%	39%	0%
Coleman	1%	41%	0%
Concho	1%	56%	0%
Crane	7%	38%	30%
Crockett	0%	15%	0%
Ector	2%	81%	26%
Glasscock	3%	72%	11%
Howard	20%	61%	28%
Irion	0%	22%	0%
Kimble	0%	26%	0%
Loving	0%	41%	5%
Martin	46%	76%	72%
Mason	0%	52%	0%
McCulloch	1%	26%	0%
Menard	0%	19%	0%
Midland	11%	85%	42%
Mitchell	6%	37%	0%
Pecos	2%	31%	5%
Reagan	3%	67%	10%
Reeves	1%	30%	1%
Runnels	10%	94%	0%
Schleicher	0%	22%	0%
Scurry	3%	34%	6%
Sterling	0%	29%	0%
Sutton	0%	18%	0%
Tom Green	0%	52%	0%
Upton	0%	80%	3%
Ward	1%	25%	8%
Winkler	2%	13%	14%

Data are from the Texas Water Development Board 12-2008[33]

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 fresh water 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.

Changes in Groundwater Regulation

Changes in groundwater regulation can have a major impact on water supply in Region F, especially during drought conditions when surface water is not available. The current drought has helped identify how important groundwater supplies are to Region F and how they serve as a critical safety net for several major cities in the region. Many cities and wholesale water providers plan to use surface water and groundwater conjunctively to optimize and maximize water supplies in the region by using as much surface water as possible when it is available in order to reduce evaporation losses and to conserve groundwater. When surface water is not available, groundwater will be used as necessary to meet demands. This shift towards a more fully integrated conjunctive use approach is dependent upon adequate groundwater availability in drought times. If groundwater availability is reduced, the safety net for the region is significantly impaired. Under current law, groundwater availability could be significantly reduced by adoption of more restrictive Desired Future Conditions (DFCs) in areas where current DFCs allow for adequate production of groundwater to meet projected demands.

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 holders, 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 (2011-2013), 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 is 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. More than 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 September 2014, the Executive Director of TCEQ provided a draft 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 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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Chapter 2 Population and Water Demands

2.1 Introduction

In October 2013[1], the Texas Water Development Board (TWDB) approved population and water demand projections for Region F for use in the 2016 Regional Water Plan. As part of the 2016 Regional Water Plan update, these projections were reviewed by the region and revised as needed. During this review process, it was found that the renewed interest in oil and gas production in the Permian Basin and the impacts of the on-going drought may not have been accurately represented in the baseline data. As a result, adjustments to population projections of six cities were made by the RWPG to account for the expected near term growth of the region due to the increased mining activities. These changes resulted in a 5 percent increase in population over the planning horizon. Municipal water demand projections were revised to reflect the new population projections. Due to prolonged extreme drought, some users experienced restricted deliveries during 2011, the base year for water demand projections. As such, the 2011 historical use numbers for those entities were not representative of a dry year demand and were adjusted. This affected both municipal and agricultural users. Overall, water demand projections in Region F are estimated to be 838,000 acre-feet in 2020 and increase to about 853,300 acre-feet in 2070.

The TWDB distributes its population and demand projections into Water User Groups (WUGs). A WUG is defined as one of the following:

- Cities with population of 500 or more,
- Individual utilities providing more than 0.25 million gallons per day (MGD) for municipal use,
- Rural/unincorporated areas of municipal water use, known as County Other (aggregated on a county/basin basis),
- Manufacturing (aggregated on a county/basin basis),
- Steam electric power (aggregated on a county/basin basis),
- Mining (aggregated on a county/basin basis),
- Irrigation (aggregated on a county/basin basis), or
- Livestock (aggregated on a county/basin basis).

Each WUG has an associated water demand. Only municipal WUGs have population projections.

To simplify the presentation of these data, all projections in this chapter are aggregated by county. Projections divided by WUG, county and basin may be found in Attachment 2A at the end of the chapter.

The projections were developed by decade and cover the period from 2020 to 2070.

2.2 Population Projections

Table 2-1 presents the historical year 2010 and projected populations for the counties in Region F. Figure 2-1 compares the region's historical population in 2010 and the projected population through 2070. Figure 2-2 shows the geographical distribution of the population projections for the years 2010 and 2070. Population projections divided by WUG, county and basin are included in the Appendix 2A at the end of this chapter.

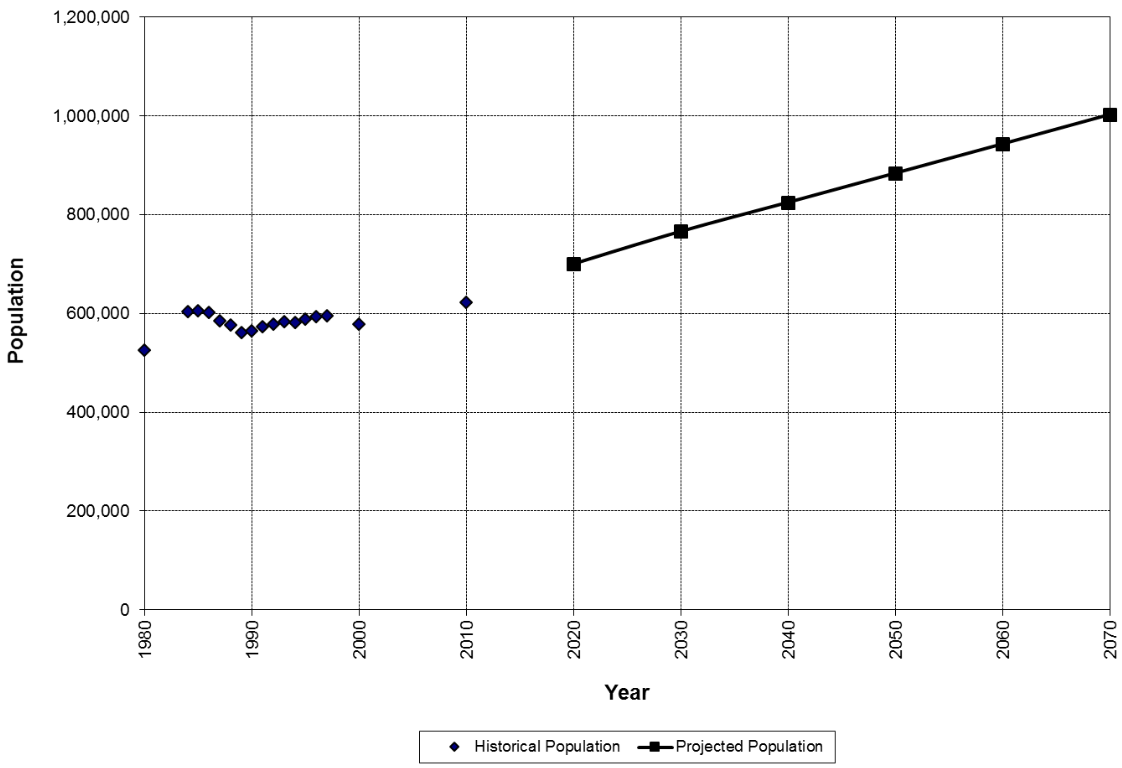
Table 2-1
Historical and Projected Population by County

County	Historical	Projected					
	2010	2020	2030	2040	2050	2060	2070
Andrews	14,786	19,089	22,847	26,246	30,111	34,526	39,574
Borden	641	659	671	671	671	671	671
Brown	38,106	39,761	40,717	40,717	40,717	40,717	40,717
Coke	3,320	3,320	3,320	3,320	3,320	3,320	3,320
Coleman	8,895	9,103	9,307	9,307	9,307	9,307	9,307
Concho	4,087	4,339	4,410	4,410	4,410	4,410	4,410
Crane	4,375	5,056	5,713	6,241	6,737	7,151	7,501
Crockett	3,719	4,111	4,386	4,446	4,486	4,500	4,506
Ector	137,130	156,957	177,157	198,446	220,268	242,371	264,646
Glasscock	1,226	1,341	1,429	1,429	1,429	1,429	1,429
Howard	35,012	37,310	38,936	39,603	39,603	39,603	39,603
Irion	1,599	1,684	1,702	1,702	1,702	1,702	1,702
Kimble	4,607	4,710	4,754	4,754	4,754	4,754	4,754
Loving	82	82	82	82	82	82	82
Martin	4,799	5,433	5,986	6,382	6,735	7,000	7,205
Mason	4,012	4,012	4,012	4,012	4,012	4,012	4,012
McCulloch	8,283	8,635	9,000	9,030	9,125	9,152	9,165
Menard	2,242	2,242	2,242	2,242	2,242	2,242	2,242
Midland	136,872	160,018	173,387	191,665	210,100	228,299	246,134
Mitchell	9,403	10,531	11,329	11,566	11,706	11,826	11,930
Pecos	15,507	16,987	18,257	19,495	20,637	21,657	22,576
Reagan	3,367	3,853	4,303	4,571	4,812	4,980	5,102
Reeves	13,783	15,125	16,193	17,057	17,650	18,106	18,443
Runnels	10,501	10,883	11,300	11,300	11,300	11,300	11,300
Schleicher	3,461	3,811	4,106	4,259	4,350	4,406	4,440

County	Historical	Projected					
	2010	2020	2030	2040	2050	2060	2070
Scurry	16,921	19,911	22,497	24,249	26,236	28,246	30,322
Sterling	1,143	1,215	1,260	1,275	1,275	1,275	1,275
Sutton	4,128	4,526	4,872	4,998	5,096	5,148	5,178
Tom Green	110,224	123,052	137,486	145,685	154,230	163,215	172,642
Upton	3,355	3,690	3,990	4,128	4,272	4,360	4,421
Ward	10,658	11,454	12,144	12,634	13,029	13,329	13,557
Winkler	7,110	8,033	8,817	9,459	10,147	10,702	11,181
Total	*623,354*	*700,933*	*766,612*	*825,381*	*884,551*	*943,798*	*1,003,347*

Source: 2010 Census[2]

Figure 2-1
Historical and Projected Population of Region F



Historical data provided by the Texas Water Development Board.[3] Some historical data are not available. Projected population was approved by TWDB for this round of regional water planning and adopted for this plan.

The population projections for each county are derived from the 2010 U.S. Census. The projections use a standard methodology known as the cohort-component method. This method is based upon historical birth and survival rates of the region's population. More information on the methodology used for the population projections may be found in the TWDB publication Projection Methodology – Draft Population and Municipal Water Demands.[4]

TWDB projects the region's total population to increase from 700,933 in 2020 to 1,003,347 in 2070, an average growth rate of 0.72 percent per year. TWDB projects the total population for Texas to increase from 29,510,184 in 2020 to 51,040,173 in 2070, a growth rate of 1.10 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. Each of these cities had a year 2010 population between 93,000 and 112,000.

Twenty-nine of the thirty-two counties that comprise Region F are generally rural. Twenty 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 Basin and Cline Shale portions of Region F are experiencing or are expected to experience a steep population increase due to the renewed interest in the exploration and production of shale oil. This aggressive population growth is expected to continue as the oil play develops in the near decades (2020-2030) and taper off in subsequent decades. Some counties, particularly those in the eastern portion of Region F, are beginning to see an influx of weekend, recreational and other non-resident population from other parts of the state. Because this population is counted by the census as residing in another region, this population growth and the resulting municipal water demand are not reflected in the TWDB-approved projections.

2.3 Historical and Projected Water Demands

TWDB divides its water demand projections into six water use categories:

- *Municipal* – residential and commercial uses, including landscape irrigation,
- *Manufacturing* – various types of heavy industrial use,
- *Irrigation* - irrigated commercial agriculture,
- *Steam Electric Power Generation* – water consumed in the production of electricity,
- *Livestock Watering* – water used in commercial livestock production, and
- *Mining* – water used in the commercial production of various minerals, as well as water used in the production of oil and gas.

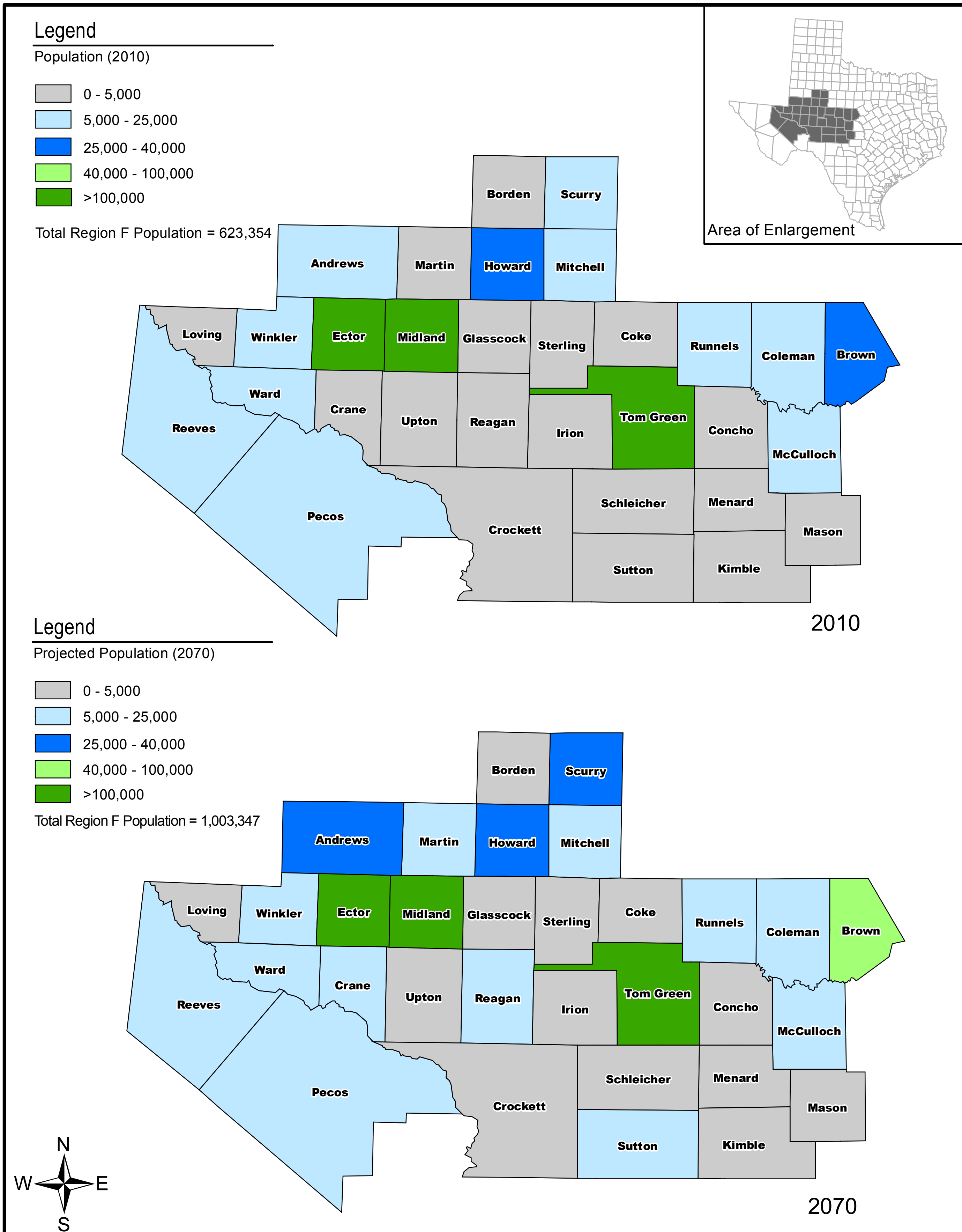
Municipal water use is the only category subdivided into individual entities such as cities and other water providers. All other categories are aggregated into county/basin units.

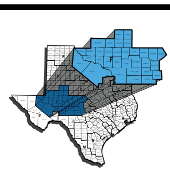
Each category has annual water demand projections for the years 2020, 2030, 2040, 2050, 2060, and 2070. These projections are not the same as the average day and peak-day projections used in planning for municipal water supply distribution systems.

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 volume 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 2016 Regional Water Plan were developed in conjunction with the TWDB and regional stakeholders. The Region F Water Planning Group solicited input from cities, water providers, county judges, and steam electric power generators. 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 2016 Regional Water Plan.

Figure 2.3 and Figure 2.4 present the TWDB-approved total water demand projections for the region by water-use type through 2070.





Region F

Population Distribution by County 2010-2070

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FIGURE

Figure 2-3
Projected 2020 Water Demand in Region F by Use Category

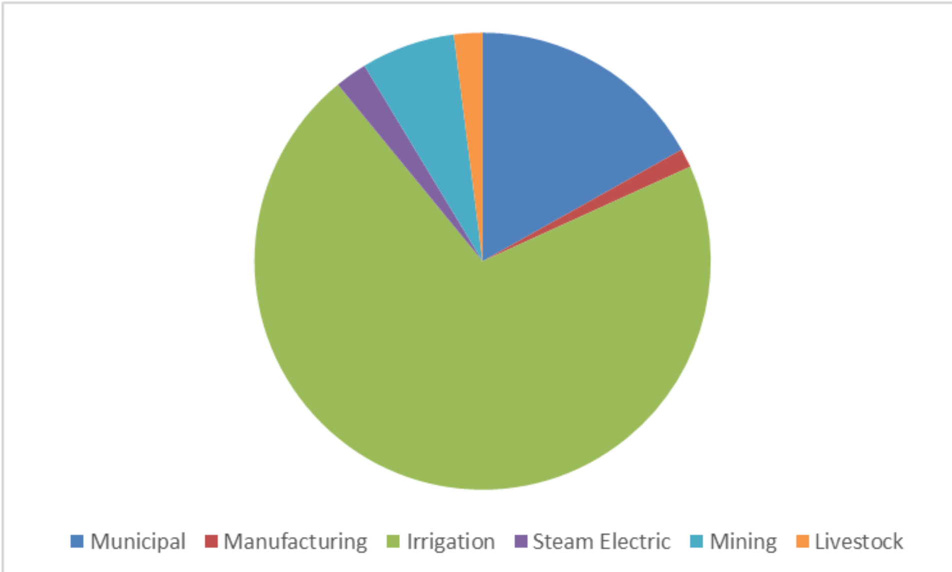


Figure 2-4
Projected 2070 Water Demand in Region F by Use Category

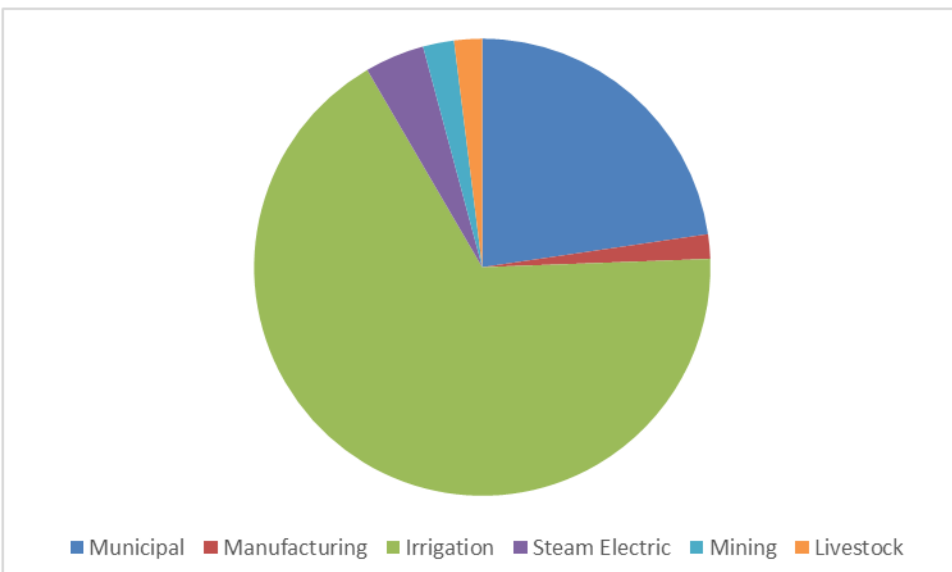


Table 2-3 summarizes the historical year 2010 use and the projected water use by county. Figure 2-6 shows the geographical distribution of the year 2010 historical water use and year 2070 total water demand projections by county. A discussion of the demand projections by each use type is presented in Sections 2.3.1 through 2.3.6.

The significant increase in total water use between the historical year 2010 data and the year 2020 projections is mainly due to irrigation demands. Region F Water Planning Group feels that historical year 2010 water use for irrigation is not indicative of the potential for irrigation water use in the region. More information on the region's projected irrigation demands may be found in Section 2.3.3. Steam electric projects are also higher than the historical 2010 use. Several power generation facilities in Region F have recently ceased operation. The future use of these facilities is uncertain. Mining demands have more than doubled from the historical year 2010 data due to the increase in oil and gas exploration in the region.

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

Use Category	Historical	Projected					
	2010	2020	2030	2040	2050	2060	2070
Municipal	115,407	141,454	151,070	160,417	170,872	182,097	193,585
Manufacturing	9,753	11,162	11,879	12,563	13,138	13,934	14,783
Irrigation	458,658	593,674	589,525	585,374	581,230	577,147	573,123
Steam Electric	6,068	19,085	21,315	24,071	27,472	31,657	36,125
Mining	22,354	55,657	56,362	46,172	34,381	24,416	18,753
Livestock	13,905	16,942	16,942	16,942	16,942	16,942	16,942
Total	*626,145*	*837,974*	*847,093*	*845,539*	*844,035*	*846,193*	*853,311*

Source: Data are from the TWDB[5].

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

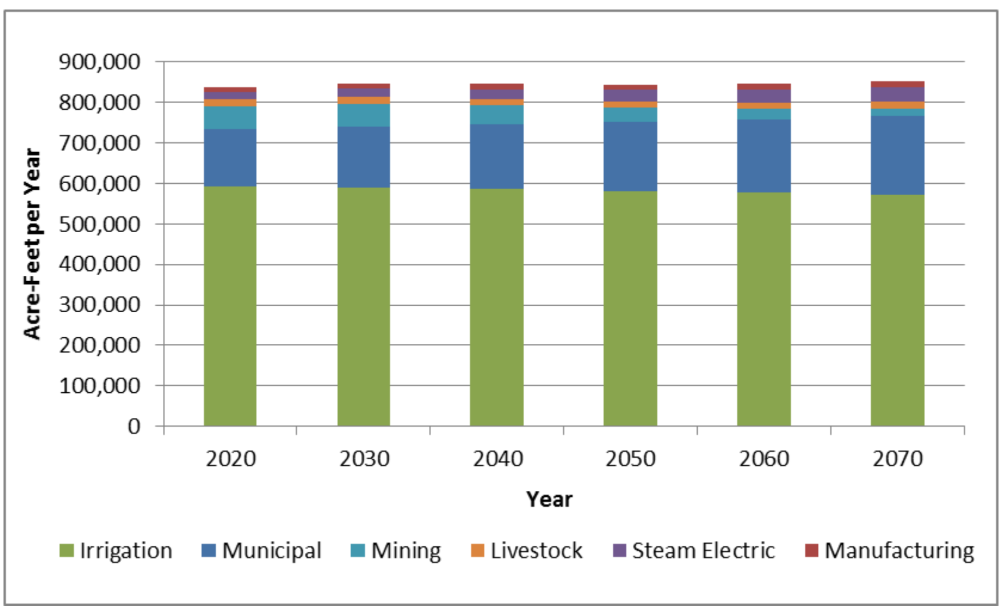
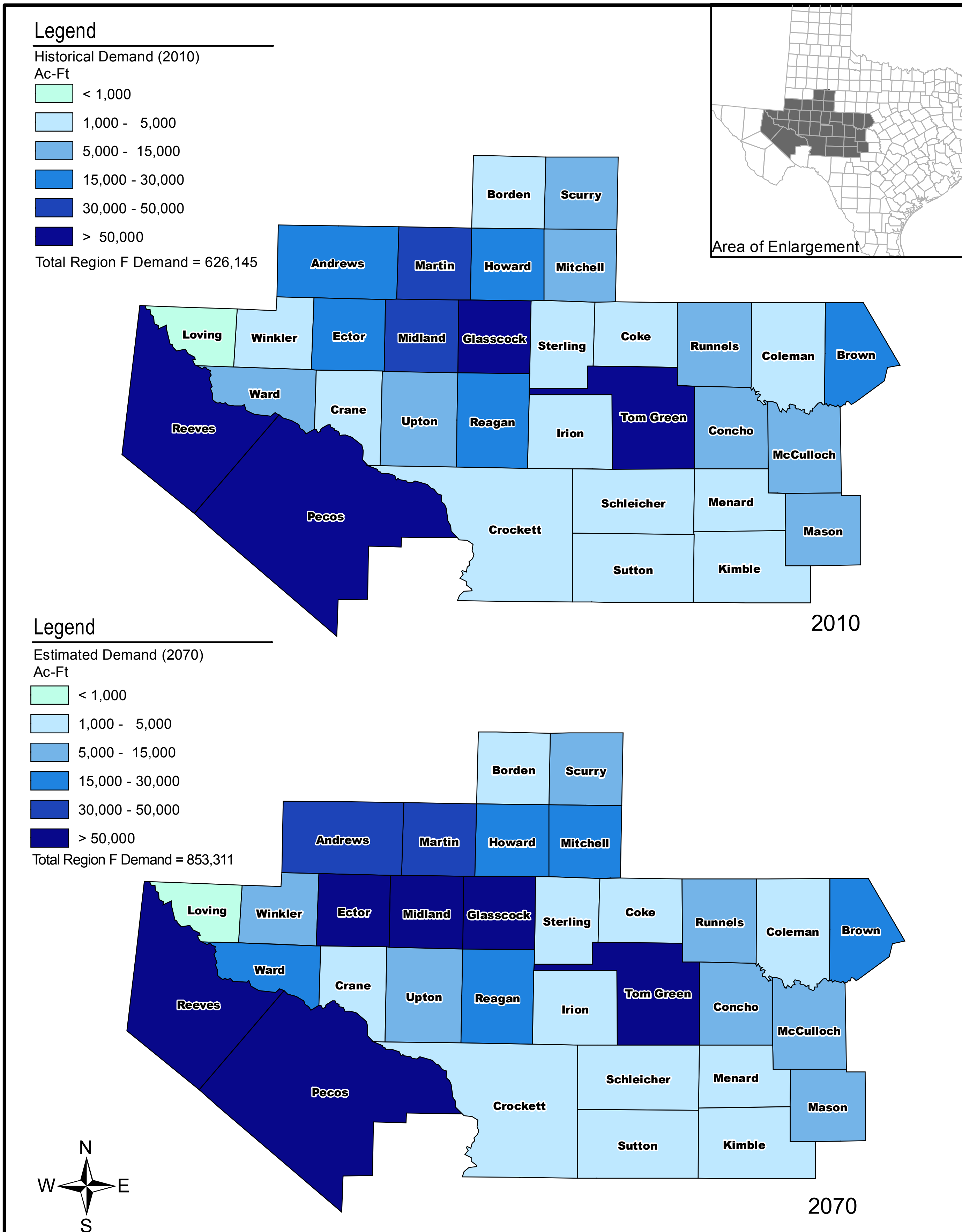
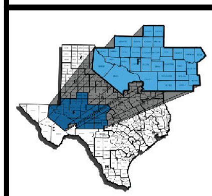


Table 2-3
Total Historical and Projected Water Demand by County
-Values in Acre-Feet per Year-

County	Historical	Projected					
	2010	2020	2030	2040	2050	2060	2070
Andrews	28,083	47,002	47,331	47,290	47,272	47,522	48,090
Borden	2,180	5,107	5,348	5,200	4,903	4,649	4,523
Brown	17,423	18,441	18,446	18,343	18,284	18,299	18,335
Coke	2,028	2,806	2,823	2,808	2,811	2,839	2,848
Coleman	2,769	3,335	3,319	3,274	3,255	3,241	3,233
Concho	8,224	11,586	11,535	11,433	11,335	11,250	11,173
Crane	1,547	2,221	2,559	2,672	2,600	2,523	2,472
Crockett	2,315	5,229	5,563	5,144	4,770	4,529	4,541
Ector	28,743	44,084	48,868	53,855	59,381	65,707	72,767
Glasscock	58,316	60,554	59,780	58,603	57,440	56,409	55,659
Howard	15,934	19,505	19,947	19,192	18,362	17,803	17,654
Irion	2,268	5,134	5,261	4,287	3,317	2,511	2,109
Kimble	4,812	4,943	4,871	4,794	4,722	4,679	4,647
Loving	258	904	1,169	1,045	873	712	585
Martin	37,706	40,899	39,784	38,430	37,021	35,756	34,809
Mason	5,864	11,493	11,274	10,907	10,640	10,412	10,207
McCulloch	13,203	15,535	14,986	13,247	12,230	11,449	10,830
Menard	3,048	4,468	4,434	4,298	4,161	4,043	3,940
Midland	42,420	75,263	76,803	79,343	82,052	85,072	88,465
Mitchell	14,832	19,575	19,622	19,297	18,942	18,611	18,347
Pecos	132,030	133,971	134,725	135,119	135,287	135,455	135,633
Reagan	21,002	24,397	23,330	22,112	20,785	19,624	19,007
Reeves	63,896	98,026	98,561	97,892	96,795	95,712	94,702
Runnels	5,657	6,605	6,581	6,494	6,441	6,399	6,363
Schleicher	2,587	3,453	3,561	3,371	3,179	3,005	2,889
Scurry	9,365	10,891	11,078	11,015	10,884	10,785	10,746
Sterling	1,337	2,394	2,532	2,349	2,018	1,726	1,558
Sutton	2,728	4,134	4,456	4,488	4,284	4,081	3,931
Tom Green	67,915	119,070	120,885	121,841	122,946	124,361	125,908
Upton	12,014	14,974	14,309	13,442	12,399	11,515	11,054
Ward	10,747	13,581	14,451	15,124	15,912	16,893	17,724
Winkler	4,894	8,394	8,901	8,830	8,734	8,621	8,562
Total	*626,145*	*837,974*	*847,093*	*845,539*	*844,035*	*846,193*	*853,311*

Source: Data are from the TWDB.[5]





Region F

Water Demand Distribution by County 2010-2070

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FIGURE

2.3.1 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 city of more than 500 people and water utilities that provide 0.25 MGD or more. TWDB aggregates rural populations and towns of less than 500 people into the County Other classification. The municipal projections are the only projections developed for individual water providers such as cities and other 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.

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.[6])

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.

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[7]. Among other things, the Plumbing Act requires that only water-saving plumbing fixtures may 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 160 gpcd in 2020 to 152 gpcd in 2070, a reduction of 10 percent. This compares to the statewide average of 153 gpcd for the year 2011 declining to 137 gpcd by 2070.

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

Region F	**Base Year (2011)***	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Per Capita Use (gpcd)	169	160	156	153	152	152	152
Decline from Year 2011		9	13	16	17	17	17
% Decline from Year 2011		6%	8%	10%	10%	10%	10%
Statewide	**2011**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Per Capita Use (gpcd)	153	145	141	139	138	137	137
Decline from Year 2011		8	4	2	1	1	0
% Decline from Year 2011		6%	8%	9%	10%	11%	11%

Source: Data are from TWDB.[5]

* In most cases per capita demand projections are based on year 2011 water use. However, in Region F other years were used for select entities that are more indicative of historical water demand trends, particularly for water users under restrictions in the year 2011. This results in a base per capita water use of 169 gpcd.

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 141,454 acre-feet per year in 2020 to 193,585 acre-feet per year in 2070, an increase of 37 percent over the planning period. This compares to an expected 62 percent increase in municipal demand statewide.

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

	Historical	**Projected**					
County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Andrews	3,105	4,771	5,665	6,475	7,441	8,585	9,910
Borden	108	178	178	176	176	175	175
Brown	5,991	6,037	6,016	5,891	5,821	5,806	5,806
Coke	635	675	658	646	641	641	641
Coleman	1,465	1,372	1,357	1,322	1,314	1,309	1,309
Concho	487	673	669	658	651	649	649
Crane	1,138	1,432	1,547	1,639	1,736	1,820	1,893
Crockett	1,419	1,561	1,662	1,674	1,690	1,695	1,698
Ector	24,669	27,520	30,350	33,482	36,879	40,501	44,200
Glasscock	144	162	165	161	160	160	160
Howard	4,992	7,228	7,367	7,375	7,321	7,308	7,307
Irion	194	207	201	194	192	192	192
Kimble	845	882	868	851	843	841	841
Loving	4	11	10	10	10	10	10
Martin	676	881	942	982	1,027	1,064	1,095
Mason	814	928	911	897	889	888	888
McCulloch	1,619	1,810	1,846	1,821	1,830	1,832	1,835
Menard	390	441	430	421	418	418	418
Midland	25,446	37,470	39,725	43,294	47,104	51,076	55,012
Mitchell	1,462	2,203	2,341	2,355	2,371	2,391	2,414
Pecos	4,771	6,223	6,599	6,989	7,368	7,725	8,051
Reagan	603	801	872	914	960	992	1,016
Reeves	3,731	4,079	4,289	4,493	4,642	4,756	4,844
Runnels	1,618	1,396	1,389	1,345	1,337	1,334	1,334
Schleicher	617	883	909	918	925	931	936
Scurry	2,576	2,799	3,059	3,219	3,457	3,714	3,984
Sterling	226	309	315	314	314	314	314
Sutton	929	1,406	1,490	1,513	1,535	1,550	1,559
Tom Green	19,095	20,360	22,152	23,074	24,223	25,606	27,101
Upton	932	1,145	1,218	1,248	1,288	1,314	1,332
Ward	2,891	3,267	3,401	3,490	3,594	3,673	3,735
Winkler	1,815	2,344	2,469	2,576	2,715	2,827	2,926
Total	*115,407*	*141,454*	*151,070*	*160,417*	*170,872*	*182,097*	*193,585*

Source: Data are from the TWDB.[5]

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 almost 19,900 acre-feet per year by 2070.

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

County	2020	2030	2040	2050	2060	2070
Andrews	234	385	514	630	731	844
Borden	7	11	13	13	14	14
Brown	416	590	715	785	800	800
Coke	33	50	62	67	67	67
Coleman	97	145	180	188	193	193
Concho	41	56	67	74	76	76
Crane	57	92	121	138	148	155
Crockett	49	74	90	92	94	93
Ector	1602	2518	3335	3988	4466	4901
Glasscock	15	24	28	29	29	29
Howard	395	589	716	770	783	784
Irion	17	25	32	34	34	34
Kimble	48	70	87	95	97	97
Loving	0	1	1	1	1	1
Martin	62	97	126	142	152	157
Mason	38	55	69	77	78	78
McCulloch	87	132	164	177	179	180
Menard	22	33	42	45	45	45
Midland	1744	2614	3464	4112	4541	4917
Mitchell	115	175	214	227	234	234
Pecos	191	294	372	424	451	473
Reagan	46	73	89	97	101	105
Reeves	167	257	295	313	327	334
Runnels	115	179	223	231	234	234
Schleicher	39	58	72	80	83	83
Scurry	239	381	488	554	605	652
Sterling	14	19	25	25	25	25
Sutton	50	78	95	105	106	107
Tom Green	1372	2189	2734	3120	3358	3597
Upton	42	66	80	86	89	90
Ward	130	201	258	270	280	286
Winkler	90	140	177	192	203	212
Total	7,574	11,671	14,948	17,181	18,624	19,867

Source: Data are from the TWDB.[5]

2.3.2 Manufacturing 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.

To produce the projections used for the 2016 Regional Water Plan, TWDB used an average of 2004-2008 Water Use Survey data as a baseline. In some cases, the baseline was adjusted after comparing the data to employment data from the Bureau of Economic Analysis[8] to adjust for any under-surveyed areas. TWDB then calculated the water demand projections based on the rate of change in the 2011 Regional Water Plan.

Manufacturing water demand accounts for only one percent of the region's total water use and is concentrated in a few counties. Ector, Howard and Tom Green Counties are expected to have the largest manufacturing demands for the region with a combined total use of over 11,000 acre-feet per year by 2070. Total manufacturing water use is expected to increase from 11,162 acre-feet in 2020 to 14,783 acre-feet by 2070, an increase of 3,621 acre-feet (see Table 2-7). Although TWDB projects a 32 percent increase in Region F manufacturing demands from 2020 to 2070, manufacturing is expected to remain a relatively small amount of the region's total demands. Statewide, manufacturing demand is expected to increase by 40 percent over the same period.

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

County	Historical	Projected					
	2010	2020	2030	2040	2050	2060	2070
Andrews	580	49	52	55	58	62	66
Borden	0	0	0	0	0	0	0
Brown	351	673	726	777	820	886	957
Coke	0	0	0	0	0	0	0
Coleman	1	9	9	9	9	9	9
Concho	0	0	0	0	0	0	0
Crane	131	0	0	0	0	0	0
Crockett	10	0	0	0	0	0	0
Ector	1,930	3,454	3,643	3,809	3,936	4,070	4,209
Glasscock	3	0	0	0	0	0	0
Howard	3,171	2,748	2,872	2,994	3,097	3,290	3,495
Irion	1	0	0	0	0	0	0
Kimble	518	701	752	804	852	916	985
Loving	0	0	0	0	0	0	0
Martin	0	41	42	43	44	47	50
Mason	0	0	0	0	0	0	0
McCulloch	1	500	540	578	611	663	719
Menard	0	3	3	3	3	3	3
Midland	156	230	250	269	285	309	335
Mitchell	0	0	0	0	0	0	0
Pecos	247	103	103	103	103	103	103
Reagan	0	0	0	0	0	0	0

County	Historical	Projected					
	2010	2020	2030	2040	2050	2060	2070
Reeves	286	197	201	205	208	220	233
Runnels	7	48	52	56	59	64	69
Schleicher	0	0	0	0	0	0	0
Scurry	156	3	3	3	3	3	3
Sterling	0	0	0	0	0	0	0
Sutton	0	0	0	0	0	0	0
Tom Green	2,029	2,387	2,615	2,839	3,034	3,273	3,531
Upton	126	0	0	0	0	0	0
Ward	7	16	16	16	16	16	16
Winkler	42	0	0	0	0	0	0
Total	***9,753***	***11,162***	***11,879***	***12,563***	***13,138***	***13,934***	***14,783***

Source: Data are from the TWDB.[5]

2.3.3 Irrigation 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. These projections are for dry-year conditions and represent the maximum demand expected during the planning period. During most of the planning period, irrigation demand will probably be less than projected.

The irrigation projections proposed for Region F by the TWDB for 2020 were based on a five year average (2005-2009) of the historical TWDB water use estimates. The estimates were developed by multiplying the number of reported irrigated acres by the water need for each crop-type. The planning group expressed concerns with this approach that some crops are not included in the irrigated acreages and thus the water use may be underestimated. The planning group recommended that the maximum irrigation use from 2005-2010 be used as the 2010 baseline for all counties except for Pecos County. The Middle Pecos Groundwater Conservation District provided 2010 irrigated acreages and application rates. This data was used as the 2010 baseline for Pecos County and the demand was held constant from 2020-2070 based on input from the district. The projected annual water use for irrigation was reduced from the 2020 estimates by the expected savings associated with the implementation of more efficient irrigation practices due to replacement of irrigation equipment with more efficient models. These reductions were determined by TWDB and mirror the rate of change for 2011 Plan projections. Table 2-8 summarizes the reduction in irrigation demand for the region for each decade and compares these reductions to statewide totals. Table 2-9 shows the irrigation water demands by county in Region F. Figure 2-7 compares historical irrigation water use data to the Region F irrigation projections.

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

Region F	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Irrigation (ac-ft)	593,674	589,525	585,374	581,230	577,147	573,123
Decline from Year 2020	0	4,149	8,300	12,444	16,527	20,551
% Decline	0%	1%	1%	2%	3%	3%
Statewide	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Irrigation (ac-ft)	9,437,959	9,138,384	8,799,716	8,431,400	8,067,438	7,778,038
Decline from Year 2020	0	299,575	638,243	1,006,559	1,370,521	1,659,921
% Decline	0%	3%	7%	11%	15%	18%

Source: Data are from the TWDB.[5]

Agricultural use accounted for 73 percent of Region F's total water use in 2010. By 2070, irrigation is expected to continue to be a major water use and could be as much as 71 percent of the region's total water demand. Statewide irrigation demand is projected to be 51 percent of total demand in the year 2020 and 36 percent of statewide demand in 2070. The counties with the largest irrigation water use are Tom Green, Reeves, Pecos, Glasscock, Midland, Reagan and Andrews Counties. These counties are expected to account for 78 percent of the region's irrigation demand in 2070.

Figure 2-7
Comparison of Historical Water Use to Projected Irrigation Water Demand for Region F

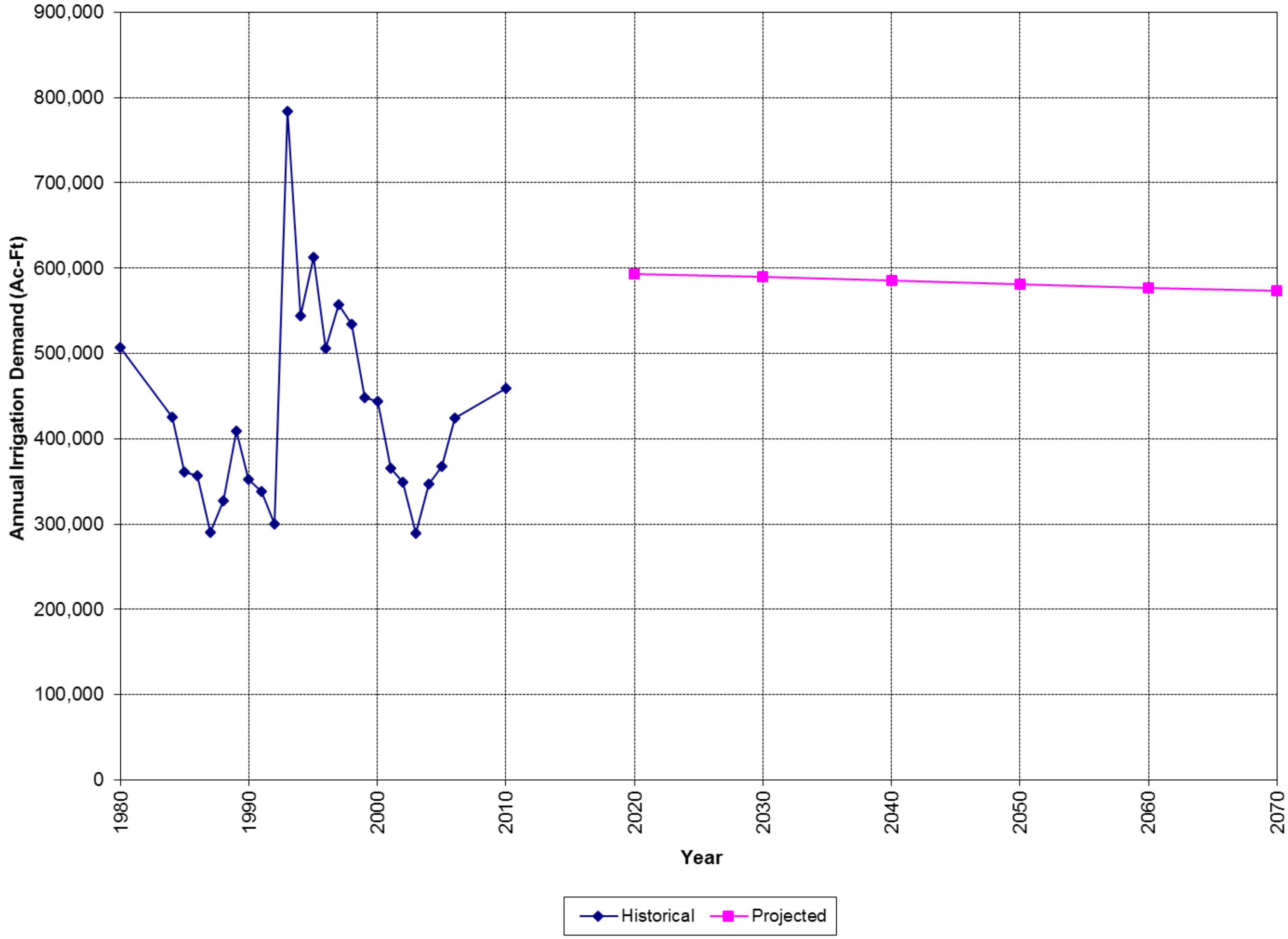


Table 2-9
Irrigation Water Demand Projections for Region F Counties
-Values in Acre-Feet per Year-

	Historical	**Projected**					
County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Andrews	23,354	37,898	37,579	37,258	36,939	36,621	36,306
Borden	1,616	4,000	3,993	3,990	3,983	3,980	3,977
Brown	8,901	9,435	9,403	9,371	9,338	9,306	9,275
Coke	871	965	963	962	962	962	962
Coleman	470	770	770	770	770	770	770
Concho	7,167	9,734	9,693	9,654	9,618	9,582	9,546
Crane	0	0	0	0	0	0	0
Crockett	148	479	470	461	455	446	437
Ector	1,050	1,432	1,415	1,397	1,380	1,362	1,345
Glasscock	57,164	56,707	56,252	55,796	55,339	54,887	54,439
Howard	6,721	6,722	6,645	6,567	6,490	6,413	6,337
Irion	1,386	1,467	1,435	1,402	1,370	1,338	1,307
Kimble	2,975	2,939	2,830	2,718	2,606	2,501	2,400
Loving	0	0	0	0	0	0	0
Martin	36,160	36,322	35,674	35,026	34,381	33,746	33,123
Mason	3,922	8,294	8,174	8,054	7,935	7,816	7,699
McCulloch	2,558	3,584	3,539	3,493	3,448	3,404	3,361
Menard	2,074	2,530	2,522	2,514	2,505	2,497	2,489
Midland	14,969	33,276	33,016	32,756	32,495	32,237	31,981
Mitchell	9,443	11,519	11,460	11,404	11,348	11,292	11,236
Pecos	126,033	126,023	126,023	126,023	126,023	126,023	126,023
Reagan	19,385	19,130	18,808	18,486	18,164	17,848	17,537
Reeves	58,369	91,357	90,577	89,795	89,015	88,242	87,475
Runnels	3,053	4,009	3,991	3,973	3,955	3,937	3,919
Schleicher	1,442	1,414	1,385	1,356	1,327	1,298	1,270
Scurry	5,978	7,305	7,056	6,806	6,557	6,318	6,088
Sterling	688	983	942	901	860	820	782
Sutton	1,143	1,803	1,767	1,733	1,697	1,663	1,629
Tom Green	44,366	93,579	93,350	93,121	92,889	92,660	92,432
Upton	9,609	9,473	9,338	9,202	9,066	8,932	8,800
Ward	5,040	5,613	5,543	5,473	5,403	5,334	5,266
Winkler	2,603	4,912	4,912	4,912	4,912	4,912	4,912
Total	***458,658***	***593,674***	***589,525***	***585,374***	***581,230***	***577,147***	***573,123***

Source: Data are from the TWDB.[5]

2.3.4 Steam Electric Power Generation

The steam electric power generation water demand projections for the 2016 Regional Water Plan were developed by a TWDB-sponsored study by the Bureau of Economic Geology (BEG)[9] . The study, conducted in 2008, developed water demands for steam electric based on state-wide projections of power usage. The water demands needed to produce the projected power were distributed to each county based on existing facilities and information from the 2011 state water plan.

With the current uncertainty in the power industry, it is nearly impossible to accurately predict the location and need for future water demands for steam electric power. The projections developed by the BEG were reviewed and considered by the region. Based on the possibilities for future power development, it was recommended that Region F retain the projections developed for the 2016 Regional Water Plan for all counties except Tom Green County which experienced a plant closure and the demand was reduced to zero.

Based on the adopted projections, steam electric water demand in Region F is expected to almost double, increasing from 19,085 acre-feet per year in 2020 to 36,125 acre-feet per year in 2070. Table 2-10 summarizes the projections for steam electric demands. Statewide, steam electric demand is expected to increase from 939,873 acre-feet per year in 2020 to 1,705,090 acre-feet per year in 2070[4].

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

	Historical	Projected					
County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Andrews	0	0	0	0	0	0	0
Borden	0	0	0	0	0	0	0
Brown	0	0	0	0	0	0	0
Coke	0	247	289	339	401	477	528
Coleman	0	0	0	0	0	0	0
Concho	0	0	0	0	0	0	0
Crane	0	0	0	0	0	0	0
Crockett	0	776	907	1,067	1,262	1,500	1,662
Ector	0	9,436	11,031	12,976	15,347	18,237	21,672
Glasscock	0	0	0	0	0	0	0
Howard	387	0	0	0	0	0	0
Irion	0	0	0	0	0	0	0
Kimble	0	0	0	0	0	0	0
Loving	0	0	0	0	0	0	0
Martin	0	0	0	0	0	0	0
Mason	0	0	0	0	0	0	0

	Historical	Projected					
County	2010	2020	2030	2040	2050	2060	2070
McCulloch	0	0	0	0	0	0	0
Menard	0	0	0	0	0	0	0
Midland	0	0	0	0	0	0	0
Mitchell	3,179	4,847	4,670	4,493	4,317	4,140	3,994
Pecos	0	0	0	0	0	0	0
Reagan	0	0	0	0	0	0	0
Reeves	0	0	0	0	0	0	0
Runnels	0	0	0	0	0	0	0
Schleicher	0	0	0	0	0	0	0
Scurry	0	0	0	0	0	0	0
Sterling	0	0	0	0	0	0	0
Sutton	0	0	0	0	0	0	0
Tom Green	0	0	0	0	0	0	0
Upton	0	0	0	0	0	0	0
Ward	2,502	3,779	4,418	5,196	6,145	7,303	8,269
Winkler	0	0	0	0	0	0	0
Total	***6,068***	***19,085***	***21,315***	***24,071***	***27,472***	***31,657***	***36,125***

Source: Data are from the TWDB.[5]

2.3.5 Mining 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 study conducted by the Bureau of Economic Geology (BEG) Report[10]. The original study was published in 2011 and was updated in 2012 to better account for the increased activities in the oil and gas sector of mining. The BEG reports used data collected from trade organizations, government agencies, and other industry representatives.

The oil and gas industry has played an important role in the development of West Texas and still accounts for a large percentage of its total payroll. Over the past five years there have been considerable changes in the oil and gas industry with renewed interest in production in the Permian Basin due to improved production technologies. This has resulted in an apparent increase in mining activities associated with the oil and gas industry in some parts of Region F. Other mining activities, such as sand, gravel and stone production, represent a small portion of the region's economy and water demands.

The TWDB expected water demand for oil and gas production increases through 2030 as the shale oil plays develop. The expected water demand then begins to decline from 2040-2070. No revisions were made to the mining water use projections that were based on the updated BEG study (BEG, 2012). However, some adjustments to the municipal demands were revised due to increased population growth resulting from the increased oil and gas activity.

The mining demands for Region F are projected to decrease from 55,657 acre-feet in 2020 to 18,753 acre-feet in 2070. This water use represents about 4 percent of the total water demand in Region F. A summary of the projected mining demands by county is presented in Table 2-11. Statewide mining use is expected to account for less than 2 percent of the state's water demands. Table 2-12 compares Region F's mining projections to statewide projections.

Table 2-11
Mining Water Demand Projections for Region F Counties

-Values in Acre-Feet per Year-

County	Historical	Projected					
	2010	2020	2030	2040	2050	2060	2070
Andrews	821	3,959	3,710	3,177	2,509	1,929	1,483
Borden	239	679	927	784	494	244	121
Brown	942	943	948	951	952	948	944
Coke	146	488	482	430	376	328	286
Coleman	42	108	107	97	86	77	69
Concho	124	480	474	422	367	320	279
Crane	201	617	840	861	692	531	407
Crockett	146	1,732	1,843	1,261	682	207	63
Ector	845	1,977	2,164	1,926	1,574	1,272	1,076
Glasscock	832	3,423	3,101	2,384	1,679	1,100	798
Howard	415	2,491	2,747	1,940	1,138	476	199
Irion	412	3,192	3,357	2,423	1,487	713	342
Kimble	21	19	19	19	19	19	19
Loving	223	792	1,058	934	762	601	474
Martin	723	3,527	2,998	2,251	1,441	771	413
Mason	560	1,023	941	708	568	460	372
McCulloch	7,849	8,927	8,347	6,641	5,627	4,836	4,201
Menard	264	1,086	1,071	952	827	717	622
Midland	1,593	3,893	3,418	2,630	1,774	1,056	743
Mitchell	351	593	738	632	493	375	290
Pecos	239	690	1,068	1,072	861	672	524
Reagan	798	4,211	3,395	2,457	1,406	529	199
Reeves	1,207	1,531	2,632	2,537	2,068	1,632	1,288
Runnels	77	272	269	240	210	184	161
Schleicher	84	621	732	562	392	241	148
Scurry	107	280	456	483	363	246	167
Sterling	173	780	953	812	522	270	140
Sutton	169	446	720	763	573	389	264
Tom Green	984	1,056	1,080	1,119	1,112	1,134	1,156

County	Historical	Projected					
	2010	2020	2030	2040	2050	2060	2070
Upton	1,242	4,237	3,634	2,873	1,926	1,150	803
Ward	205	797	964	840	645	458	329
Winkler	320	787	1,169	991	756	531	373
Total	***22,354***	***55,657***	***56,362***	***46,172***	***34,381***	***24,416***	***18,753***

Source: Data are from the TWDB.[5]

Historical data for mining are reported for 2005. In 2006, the TWDB changed the methodology of reporting mining use to include only data provided to the TWDB through the annual survey and other mining use that can be confirmed. This resulted in significantly lower estimates of mining water use across the state.

Table 2-12
Comparison of Region F Mining Projections to Statewide Totals

Region F	2020	2030	2040	250	2060	2070
Mining (ac-ft)	55,657	56,362	46,172	34,381	24,416	18,753
Change from Yr 2020	0	705	-9,485	-21,276	-31,241	-36,904
% Increase	0%	1%	-17%	-38%	-56%	-66%
Statewide [a]	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Mining (ac-ft)	343,393	354,062	326,889	302,776	287,090	292,240
Change from Yr 2020	0	10,669	-16,504	-40,617	-56,303	-51,153
% Change	0%	3%	-5%	-12%	-16%	-15%

Source: Data are from the TWDB.[5]

2.3.6 Livestock Watering

Livestock watering accounted for slightly more than 2 percent of the water use in Region F in 2010. The livestock projections relate 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 Agricultural Statistics Service. Total water use for each county was calculated by multiplying the number of heads by the estimated water demand per head of livestock. TWDB used an average of the 2005-2009 water use estimates as a base. The planning group recommended using the maximum water use from 2005-2009 as the baseline for livestock water demands. Livestock water use was considered to be constant after the year 2010. 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 16,942 acre-feet per year throughout the planning period (see Table 2-13). Statewide livestock demand is expected to be 324,595 acre-feet per year in 2070.

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

County	Historical	Projected					
	2010	2020	2030	2040	2050	2060	2070
Andrews	223	325	325	325	325	325	325
Borden	217	250	250	250	250	250	250
Brown	1,238	1,353	1,353	1,353	1,353	1,353	1,353
Coke	376	431	431	431	431	431	431
Coleman	791	1,076	1,076	1,076	1,076	1,076	1,076
Concho	446	699	699	699	699	699	699
Crane	77	172	172	172	172	172	172
Crockett	592	681	681	681	681	681	681
Ector	249	265	265	265	265	265	265
Glasscock	173	262	262	262	262	262	262
Howard	248	316	316	316	316	316	316
Irion	275	268	268	268	268	268	268
Kimble	453	402	402	402	402	402	402
Loving	31	101	101	101	101	101	101
Martin	147	128	128	128	128	128	128
Mason	568	1,248	1,248	1,248	1,248	1,248	1,248
McCulloch	1,176	714	714	714	714	714	714
Menard	320	408	408	408	408	408	408
Midland	256	394	394	394	394	394	394
Mitchell	397	413	413	413	413	413	413
Pecos	740	932	932	932	932	932	932
Reagan	216	255	255	255	255	255	255
Reeves	303	862	862	862	862	862	862
Runnels	902	880	880	880	880	880	880
Schleicher	444	535	535	535	535	535	535
Scurry	548	504	504	504	504	504	504
Sterling	250	322	322	322	322	322	322
Sutton	487	479	479	479	479	479	479
Tom Green	1,441	1,688	1,688	1,688	1,688	1,688	1,688
Upton	105	119	119	119	119	119	119
Ward	102	109	109	109	109	109	109
Winkler	114	351	351	351	351	351	351
Total	***13,905***	***16,942***	***16,942***	***16,942***	***16,942***	***16,942***	***16,942***

Source: Data are from the TWDB.[5]

2.4 Wholesale Water Providers

As part of the development of the 2016 Regional Water Plan, demands were identified for the wholesale water providers in Region F. A wholesale water provider has wholesale water contracts for 1,000 acre-feet per year or is expected to contract for 1,000 acre-feet per year or more over the planning period. The wholesale water providers in Region F are the Colorado River Municipal Water District (CRMWD), Brown County Water Improvement District Number 1 (BCWID), Upper Colorado River Authority (UCRA), the City of Odessa, the City of San Angelo, the Great Plains Water System, and University Lands.

2.4.1 Colorado River Municipal Water District (CRMWD)

CRMWD provides raw surface and groundwater to both its member cities and to others through various contracts. CRMWD provides all of the water used by its member cities: Odessa, Big Spring and Snyder. The City of Odessa also uses reuse water for potable and non-potable uses. Midland, San Angelo, Robert Lee, Abilene and Millersview-Doole WSC have other sources of water and rely on CRMWD for part of their supply. The remaining municipal contract holders rely entirely on CRMWD for water. Manufacturing water is provided through municipal users. Most mining contracts are for water from CRMWD's chloride control projects. Table 2-14 shows the projected water demands for current CRMWD customers. New customers are discussed in Chapter 5D.

2.4.2 Brown County Water Improvement District No. 1 (BCWID)

BCWID provides both raw and treated water for municipal, manufacturing, and irrigation purposes. Most BCWID customers are located 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 half of the demand for Coleman County SUD will be met by supplies from BCWID. BCWID also currently provides raw water to industries and irrigation.

Table 2-14
Expected Demands for the Colorado River Municipal Water District [a]

-Values in Acre-Feet per Year-

Member City	County(ies)	Basin	2020	2030	2040	2050	2060	2070
Odessa	Ector & Midland	Colorado	21,192	23,401	25,826	28,466	31,288	34,147
Ector County UD	Ector	Colorado	1,856	2,058	2,284	2,521	2,766	3,018
Ector County Other	Ector	Colorado	1,145	1,265	1,397	1,543	1,705	1,883
Manufacturing	Ector	Colorado	665	662	716	719	716	704
Big Spring	Howard	Colorado	6,149	6,288	6,299	6,248	6,238	6,237
Coahoma	Howard	Colorado	183	186	188	187	187	187
Manufacturing	Howard	Colorado	1,500	1,500	1,500	1,500	1,500	1,500
Snyder	Scurry	Colorado	2,222	2,468	2,603	2,797	3,012	3,233
County-Other	Scurry	Colorado	300	300	300	300	300	300
Rotan	Fisher	Brazos	178	170	165	164	163	163
Member Cities Total			***35,390***	***38,298***	***41,278***	***44,445***	***47,875***	***51,372***
Customer	**County(ies)**	**Basin**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Abilene	Jones & Taylor	Brazos	5,959	5,791	5,622	5,453	5,285	5,116
County-Other	Ward	Rio Grande	150	150	150	150	150	150
Midland	Midland	Colorado	24,757	5,791	5,622	5,453	5,285	5,116
Midland	Midland	Colorado	5,959	5,791	5,622	5,453	5,285	5,116
Midland[b]	Midland	Colorado	18,798	0	0	0	0	0
Millersview-Doole WSC[c]	Concho, McCulloch, Runnels, & Tom Green	Colorado	600	600	600	600	600	600
Ballinger	Runnels	Colorado	500	500	500	500	500	500
Robert Lee	Coke	Colorado	296	291	287	287	286	286
County-Other	Coke	Colorado	76	72	69	68	68	68
San Angelo	Tom Green	Colorado	5,959	5,791	5,622	5,453	5,285	5,116
Stanton	Martin	Colorado	539	579	606	635	658	677
Irrigation	Ector	Colorado	400	400	400	400	400	400
Mining	Coke	Colorado	38	36	34	32	30	28
Mining	Howard	Colorado	1,000	1,000	1,000	982	320	43
		Customer Total	***65,031***	***26,792***	***26,134***	***25,466***	***24,152***	***23,216***
		CRMWD Total	***75,664***	***59,299***	***61,790***	***64,458***	***66,742***	***69,472***

a. Does not include potential new customers identified in the planning process or contract renewals.
b. Midland 1966 contract expires in December 2029.
c. Millersview-Doole WSC contract expires in October 2041.

The demands in Table 2-15 are for current BCWID customers. It is likely that BCWID will acquire new customers in the future.

Table 2-15
Expected Demands for the Brown County Water Improvement District No. 1[a]

-Values in Acre-Feet per Year-

Customer	County(ies)	Basin	2020	2030	2040	2050	2060	2070
Bangs	Brown	Colorado	207	204	198	195	194	194
Brookesmith SUD	Brown, Coleman, Mills	Colorado	1,199	1,195	1,170	1,156	1,153	1,153
Santa Anna	Coleman	Colorado	157	155	150	150	149	149
Coleman County SUD	Brown, Coleman, Runnels	Colorado	214	211	206	202	202	203
Brownwood	Brown	Colorado	3,755	3,750	3,677	3,636	3,629	3,629
County-Other	Brown	Colorado	125	125	125	125	125	125
Early	Brown	Colorado	290	285	275	269	268	268
Zephyr WSC	Brown	Colorado	379	374	364	359	357	357
Manufacturing	Brown	Colorado	673	726	777	820	886	957
Irrigation	Brown	Colorado	5,000	5,000	5,000	5,000	5,000	5,000
		BCWID Total	***11,999***	***12,025***	***11,942***	***11,912***	***11,963***	***12,035***

a. Does not include potential new customers identified in the planning process

2.4.3 The Upper Colorado River Authority (UCRA)

UCRA owns the water rights in O.C. Fisher Reservoir and Mountain Creek Reservoir. Water from O.C. Fisher is contracted to the Cities of San Angelo and Miles. The projected demands presented in Table 2-16 are the estimated drought-year supplies available from these sources. Mountain Creek has no reliable supply under these conditions. During normal to wet years, more water may be used from these sources than is indicated in Table 2-16. Potential future customers of UCRA are discussed in Chapter 5D.

Table 2-16
Expected Demands for the Upper Colorado River Authority

-Values in Acre-Feet per Year-

Customer	County	Basin	Contract Amount	2020	2030	2040	2050	2060	2070
San Angelo[a]	Tom Green	Colorado	80,400	0	0	0	0	0	0
Miles	Runnels	Colorado	200	112	124	121	119	119	119
Red Creek MUD & Concho Rural Water Supply	Tom Green	Colorado	200	200	200	200	200	200	200
Paint Rock	Concho	Colorado	50	25	25	25	25	25	25
		UCRA Total	***80,900***	***337***	***349***	***346***	***344***	***344***	***344***

a. The demand on UCRA from San Angelo is equal to the yield of O.C. Fisher. Under WAM Run 3 analysis, O.C. Fisher has zero reliable yield.

2.4.4 The Great Plains Water Supply System

Table 2-17 shows the expected demands for the Great Plains Water Supply System. Historically, Great Plains provided water for oil field operations in Gaines, Andrews and Ector Counties, as well as a small amount of municipal water in Ector County. A new power generation facility near Odessa is now a major customer.

Table 2-17
Expected Demands for the Great Plains Water Supply System

-Values in Acre-Feet per Year-

Customer	County	Basin	2020	2030	2040	2050	2060	2070
County Other	Ector	Colorado	64	64	64	64	64	64
Steam-Electric	Ector	Colorado	2,800	2,800	2,800	2,800	2,800	2,800
Manufacturing	Ector	Colorado	165	165	165	165	165	165
Mining	Ector	Colorado & Rio Grande	350	300	150	150	150	150
Mining	Andrews	Colorado & Rio Grande	1800	1500	500	500	500	500
Mining	Gaines	Colorado	375	300	150	150	150	150
		Great Plains WSC Total	***5,554***	***5,129***	***3,829***	***3,829***	***3,829***	***3,829***

2.4.5 The City of Odessa

Table 2-18 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 and Ector County Other. The City also provides water for manufacturing in Ector County. A portion of the manufacturing demand is met by treated effluent from the City. Potential future customers are discussed in Chapter 5D.

Table 2-18
Expected Demands for the City of Odessa

-Values in Acre-Feet per Year-

Water User Group	County(ies)	Basin	2020	2030	2040	2050	2060	2070
Odessa	Ector & Midland	Colorado	22,482	24,826	27,400	30,205	33,209	36,269
Ector County UD	Ector	Colorado	1,856	2,058	2,284	2,521	2,766	3,018
Ector County Other	Ector	Colorado	1,145	1,265	1,397	1,543	1,705	1,883
Manufacturing	Ector	Colorado	3,454	3,643	3,809	3,936	4,070	4,209
City of Odessa Total			***28,937***	***31,792***	***34,890***	***38,205***	***41,750***	***45,379***

2.4.6 The 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 UCRA in exchange for UCRA's O.C. Fisher water rights. UCRA then sells to several entities outside of the City. Most of the water used for manufacturing in Tom Green County is also provided by the City. The City has contracted a portion of the supply from Lake Nasworthy to a power generation facility located on the lake. At this time, this facility is shut down, and it is uncertain if or when it will be restarted. It is currently assumed that there is no demand on San Angelo associated with the power plant. The demands shown for Tom Green County irrigation are associated with water for Tom Green County WCID #1. Water is provided to the irrigation district from Twin Buttes Reservoir and the City's wastewater treatment plant.

Table 2-19
Expected Demands for the City of San Angelo

-Values in Acre-Feet per Year-

Water User Group	County	Basin	2020	2030	2040	2050	2060	2070
San Angelo	Tom Green	Colorado	18,244	20,002	20,851	21,930	23,240	24,665
Upper Colorado River Authority	Tom Green	Colorado	1,000	1,000	1,000	1,000	1,000	1,000
Manufacturing	Tom Green	Colorado	2,387	2,615	2,839	3,034	3,273	3,531
Irrigation	Tom Green	Colorado	20,500	20,500	20,500	20,500	20,500	20,500
San Angelo Total			***42,131***	***44,117***	***45,190***	***46,464***	***48,013***	***49,696***

2.4.7 University Lands

University Lands manages the University of Texas System Permanent University Fund lands in West Texas. Several well fields in Region F are located on properties managed by University Lands, including the CRMWD Ward County Well Field (contract expires in 2019), the City of Midland's Paul Davis Well Field in Andrews and Martin Counties (contract expires in 2033), the City of Andrews' well field (contract expires in 2035), and the Upton County Water District's well field. Table 2-20 summarizes the expected demands from leases with University Lands. These demands assume that contracts with University Lands will be renewed for the remainder of the planning period.

Table 2-20
Expected Demands from University Lands[a]
-Values in Acre-Feet per Year-

Recipient	Source County	Basin	2020	2030	2040	2050	2060	2070
CRMWD [b]	Ward	Rio Grande	5,200	5,200	5,200	5,200	5,200	5,200
Andrews [c]	Andrews	Colorado	854	1026	1181	1366	1586	1842
Midland [d]	Andrews & Martin	Colorado	4722	4722	0	0	0	0
Upton County Water District	Upton	Colorado	130	130	130	130	130	130
University Lands Total			***10,906***	***11,078***	***6,511***	***6,696***	***6,916***	***7,172***

a. Demands assume that contracts with University Lands will be renewed for the duration of the planning period.
b. The contract between CRMWD and University Lands will expire in 2019. Contract expected to be renewed.
c. The contract between Andrews and University Lands will expire in 2035. Andrews obtains approximately 20 percent of supply from University Lands. Contract expected to be renewed.
d. The contract between Midland and University Lands will expire in 2033. The City of Midland expects its well field on University Lands will be depleted by 2035. No supply is assumed after this time.

LIST OF REFERENCES

[1] Texas Water Development Board. *Final Historical and Projected Water Use Data for Region F*, October, 2013.

[2] U.S. Census Bureau. *2010 Census Demographic Profile*, August, 2011.

[3] Texas Water Development Board. *Historical Water Use Summary Data for Region F*, June 2014. <www.twdb.texas.gov>.

[4] Texas Water Development Board. *Projection Methodology – Draft Population and Municipal Water Demands*, 2014. <www.twdb.texas.gov>.

[5] Texas Water Development Board. DB17 database, 2014.

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

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

[8] Bureau of Economic Analysis. *State Annual Personal Income & Employment*, 2014. <www.bea.gov>.

[9] Bureau of Economic Geology. *Water Demand Projections for Power Generation in Texas*. Prepared for the Texas Water Development Board, September 2012.

[10] Bureau of Economic Geology. *Oil & Gas Water Use in Texas: Update to the 2011 Mining Water Use Report.* Prepared for Texas Oil & Gas Association, September 2012.

Attachment 2A

Population Projections

Region F Water User Group Population Projections by County and River Basin for 2020-2070

COUNTY	WUG Name	RIVER BASIN	Pop 2020	Pop2030	Pop 2040	Pop 2050	Pop 2060	Pop 2070
ANDREWS	ANDREWS	COLORADO	14,967	18,281	21,239	24,676	28,669	33,309
ANDREWS	COUNTY-OTHER	COLORADO	4,109	4,550	4,989	5,414	5,833	6,238
ANDREWS	COUNTY-OTHER	RIO GRANDE	13	16	18	21	24	27
BORDEN	COUNTY-OTHER	BRAZOS	40	41	41	41	41	41
BORDEN	COUNTY-OTHER	COLORADO	619	630	630	630	630	630
BROWN	BANGS	COLORADO	1,673	1,713	1,713	1,713	1,713	1,713
BROWN	BROOKESMITH SUD	COLORADO	7,947	8,138	8,138	8,138	8,138	8,138
BROWN	BROWNWOOD	COLORADO	20,126	20,610	20,610	20,610	20,610	20,610
BROWN	COLEMAN COUNTY SUD	COLORADO	130	133	133	133	133	133
BROWN	COUNTY-OTHER	BRAZOS	75	76	76	76	76	76
BROWN	COUNTY-OTHER	COLORADO	2,322	2,389	2,389	2,389	2,389	2,389
BROWN	EARLY	COLORADO	2,882	2,952	2,952	2,952	2,952	2,952
BROWN	ZEPHYR WSC	COLORADO	4,606	4,706	4,706	4,706	4,706	4,706
COKE	BRONTE	COLORADO	1,000	1,000	1,000	1,000	1,000	1,000
COKE	COUNTY-OTHER	COLORADO	1,270	1,270	1,270	1,270	1,270	1,270
COKE	ROBERT LEE	COLORADO	1,050	1,050	1,050	1,050	1,050	1,050
COLEMAN	BROOKESMITH SUD	COLORADO	40	41	41	41	41	41
COLEMAN	COLEMAN	COLORADO	4,820	4,928	4,928	4,928	4,928	4,928
COLEMAN	COLEMAN COUNTY SUD	COLORADO	2,925	2,991	2,991	2,991	2,991	2,991
COLEMAN	COUNTY-OTHER	COLORADO	193	197	197	197	197	197
COLEMAN	SANTA ANNA	COLORADO	1,125	1,150	1,150	1,150	1,150	1,150
CONCHO	COUNTY-OTHER	COLORADO	732	744	744	744	744	744
CONCHO	EDEN	COLORADO	2,937	2,985	2,985	2,985	2,985	2,985
CONCHO	MILLERSVIEW-DOOLE WSC	COLORADO	670	681	681	681	681	681
CRANE	COUNTY-OTHER	RIO GRANDE	1,411	1,787	2,089	2,372	2,609	2,809

COUNTY	WUG Name	RIVER BASIN	Pop 2020	Pop2030	Pop 2040	Pop 2050	Pop 2060	Pop 2070
CRANE	CRANE	RIO GRANDE	3,645	3,926	4,152	4,365	4,542	4,692
CROCKETT	COUNTY-OTHER	RIO GRANDE	226	172	160	152	149	147
CROCKETT	CROCKETT COUNTY WCID #1	RIO GRANDE	3,885	4,214	4,286	4,334	4,351	4,359
ECTOR	COUNTY-OTHER	COLORADO	25,374	28,639	32,082	35,609	39,183	42,784
ECTOR	COUNTY-OTHER	RIO GRANDE	1,933	2,181	2,443	2,712	2,984	3,258
ECTOR	ECTOR COUNTY UD	COLORADO	15,197	17,153	19,214	21,327	23,467	25,624
ECTOR	GREATER GARDENDALE WSC	COLORADO	1,974	2,229	2,496	2,771	3,049	3,329
ECTOR	ODESSA	COLORADO	112,479	126,955	142,211	157,849	173,688	189,651
GLASSCOCK	COUNTY-OTHER	COLORADO	1,341	1,429	1,429	1,429	1,429	1,429
HOWARD	BIG SPRING	COLORADO	29,073	30,340	30,860	30,860	30,860	30,860
HOWARD	COAHOMA	COLORADO	871	909	925	925	925	925
HOWARD	COUNTY-OTHER	COLORADO	7,366	7,687	7,818	7,818	7,818	7,818
IRION	COUNTY-OTHER	COLORADO	861	870	870	870	870	870
IRION	MERTZON	COLORADO	823	832	832	832	832	832
KIMBLE	COUNTY-OTHER	COLORADO	2,078	2,097	2,097	2,097	2,097	2,097
KIMBLE	JUNCTION	COLORADO	2,632	2,657	2,657	2,657	2,657	2,657
LOVING	COUNTY-OTHER	RIO GRANDE	82	82	82	82	82	82
MARTIN	COUNTY-OTHER	COLORADO	2,611	2,877	3,067	3,237	3,365	3,463
MARTIN	STANTON	COLORADO	2,822	3,109	3,315	3,498	3,635	3,742
MASON	COUNTY-OTHER	COLORADO	1,898	1,898	1,898	1,898	1,898	1,898
MASON	MASON	COLORADO	2,114	2,114	2,114	2,114	2,114	2,114
MCCULLOCH	BRADY	COLORADO	5,763	6,007	6,027	6,090	6,108	6,117
MCCULLOCH	COUNTY-OTHER	COLORADO	583	608	610	617	619	620
MCCULLOCH	MILLERSVIEW-DOOLE WSC	COLORADO	1,057	1,101	1,105	1,116	1,120	1,121
MCCULLOCH	RICHLAND SUD	COLORADO	1,232	1,284	1,288	1,302	1,305	1,307

COUNTY	WUG Name	RIVER BASIN	Pop 2020	Pop2030	Pop 2040	Pop 2050	Pop 2060	Pop 2070
MENARD	COUNTY-OTHER	COLORADO	770	770	770	770	770	770
MENARD	MENARD	COLORADO	1,472	1,472	1,472	1,472	1,472	1,472
MIDLAND	COUNTY-OTHER	COLORADO	26,537	30,028	33,443	36,888	40,289	43,621
MIDLAND	GREATER GARDENDALE WSC	COLORADO	1,007	1,173	1,335	1,498	1,659	1,818
MIDLAND	MIDLAND	COLORADO	130,267	139,416	153,566	167,838	181,927	195,734
MIDLAND	ODESSA	COLORADO	2,207	2,770	3,321	3,876	4,424	4,961
MITCHELL	COLORADO CITY	COLORADO	5,064	5,686	5,801	5,859	5,918	5,978
MITCHELL	COUNTY-OTHER	COLORADO	4,840	4,996	5,104	5,177	5,231	5,270
MITCHELL	LORAINE	COLORADO	627	647	661	670	677	682
PECOS	COUNTY-OTHER	RIO GRANDE	3,115	3,349	3,574	3,784	3,972	4,141
PECOS	FORT STOCKTON	RIO GRANDE	9,074	9,752	10,414	11,024	11,568	12,059
PECOS	IRAAN	RIO GRANDE	1,347	1,447	1,546	1,636	1,717	1,790
PECOS	PECOS COUNTY WCID #1	RIO GRANDE	3,451	3,709	3,961	4,193	4,400	4,586
REAGAN	BIG LAKE	COLORADO	3,360	3,753	3,986	4,197	4,343	4,449
REAGAN	COUNTY-OTHER	COLORADO	493	550	585	615	637	653
REEVES	COUNTY-OTHER	RIO GRANDE	3,465	3,709	3,907	4,043	4,148	4,225
REEVES	MADERA VALLEY WSC	RIO GRANDE	2,025	2,168	2,284	2,363	2,424	2,469
REEVES	PECOS	RIO GRANDE	9,635	10,316	10,866	11,244	11,534	11,749
RUNNELS	BALLINGER	COLORADO	3,864	3,966	3,966	3,966	3,966	3,966
RUNNELS	COLEMAN COUNTY SUD	COLORADO	110	113	113	113	113	113
RUNNELS	COUNTY-OTHER	COLORADO	2,546	2,633	2,633	2,633	2,633	2,633
RUNNELS	MILES	COLORADO	963	1,119	1,119	1,119	1,119	1,119
RUNNELS	MILLERSVIEW-DOOLE WSC	COLORADO	772	772	772	772	772	772
RUNNELS	WINTERS	COLORADO	2,628	2,697	2,697	2,697	2,697	2,697
SCHLEICHER	COUNTY-OTHER	COLORADO	1,648	1,927	2,072	2,158	2,210	2,243

COUNTY	WUG Name	RIVER BASIN	Pop 2020	Pop2030	Pop 2040	Pop 2050	Pop 2060	Pop 2070
SCHLEICHER	COUNTY-OTHER	RIO GRANDE	211	227	235	240	244	245
SCHLEICHER	ELDORADO	COLORADO	1,952	1,952	1,952	1,952	1,952	1,952
SCURRY	COUNTY-OTHER	BRAZOS	2,053	2,320	2,501	2,706	2,913	3,127
SCURRY	COUNTY-OTHER	COLORADO	4,176	4,439	4,784	5,172	5,564	5,972
SCURRY	SNYDER	COLORADO	13,682	15,738	16,964	18,358	19,769	21,223
STERLING	COUNTY-OTHER	COLORADO	271	281	284	284	284	284
STERLING	STERLING CITY	COLORADO	944	979	991	991	991	991
SUTTON	COUNTY-OTHER	COLORADO	189	203	209	213	215	216
SUTTON	COUNTY-OTHER	RIO GRANDE	1,018	1,096	1,124	1,146	1,158	1,165
SUTTON	SONORA	RIO GRANDE	3,319	3,573	3,665	3,737	3,775	3,797
TOM GREEN	CONCHO RURAL WATER CORPORATIO N	COLORADO	6,116	6,469	6,766	7,027	7,273	7,496
TOM GREEN	COUNTY-OTHER	COLORADO	9,972	10,547	11,031	11,455	11,858	12,222
TOM GREEN	MILLERSVIEW -DOOLE WSC	COLORADO	1,881	1,990	2,081	2,162	2,237	2,306
TOM GREEN	SAN ANGELO	COLORADO	105,083	118,480	125,807	133,586	141,847	150,618
UPTON	COUNTY-OTHER	COLORADO	235	254	263	272	278	281
UPTON	COUNTY-OTHER	RIO GRANDE	523	565	585	606	617	627
UPTON	MCCAMEY	RIO GRANDE	2,076	2,245	2,322	2,403	2,453	2,487
UPTON	RANKIN	RIO GRANDE	856	926	958	991	1,012	1,026
WARD	COUNTY-OTHER	RIO GRANDE	3,981	4,221	4,391	4,529	4,633	4,712
WARD	MONAHANS	RIO GRANDE	7,473	7,923	8,243	8,500	8,696	8,845
WINKLER	COUNTY-OTHER	RIO GRANDE	1,174	1,780	2,275	2,806	3,235	3,604
WINKLER	KERMIT	RIO GRANDE	5,796	5,871	5,933	5,999	6,052	6,098
WINKLER	WINK	RIO GRANDE	1,063	1,166	1,251	1,342	1,415	1,479

Attachment 2B

Water Demands

Region F Municipal Demand Projections by County and River Basin for 2020-2070 (acre-feet per year)

COUNTY	WUG NAME	RIVER BASIN	Demand 2020	Demand 2030	Demand 2040	Demand 2050	Demand 2060	Demand 2070
ANDREWS	ANDREWS	COLORADO	4,270	5,131	5,906	6,832	7,930	9,210
ANDREWS	COUNTY-OTHER	COLORADO	499	532	567	606	652	697
ANDREWS	COUNTY-OTHER	RIO GRANDE	2	2	2	3	3	3
BORDEN	COUNTY-OTHER	BRAZOS	10	11	11	11	10	10
BORDEN	COUNTY-OTHER	COLORADO	168	167	165	165	165	165
BROWN	BANGS	COLORADO	207	204	198	195	194	194
BROWN	BROOKESMITH SUD	COLORADO	1,185	1,181	1,156	1,142	1,139	1,139
BROWN	BROWNWOOD	COLORADO	3,755	3,750	3,677	3,636	3,629	3,629
BROWN	COLEMAN COUNTY SUD	COLORADO	17	16	16	16	16	16
BROWN	COUNTY-OTHER	BRAZOS	7	7	7	7	7	7
BROWN	COUNTY-OTHER	COLORADO	197	199	198	197	196	196
BROWN	EARLY	COLORADO	290	285	275	269	268	268
BROWN	ZEPHYR WSC	COLORADO	379	374	364	359	357	357
COKE	BRONTE	COLORADO	252	248	244	242	242	242
COKE	COUNTY-OTHER	COLORADO	127	120	115	113	113	113
COKE	ROBERT LEE	COLORADO	296	290	287	286	286	286
COLEMAN	BROOKESMITH SUD	COLORADO	6	6	6	6	6	6
COLEMAN	COLEMAN	COLORADO	822	815	796	794	792	792
COLEMAN	COLEMAN COUNTY SUD	COLORADO	363	358	347	341	340	340
COLEMAN	COUNTY-OTHER	COLORADO	24	23	23	23	22	22
COLEMAN	SANTA ANNA	COLORADO	157	155	150	150	149	149
CONCHO	COUNTY-OTHER	COLORADO	96	95	93	91	91	91
CONCHO	EDEN	COLORADO	480	478	471	467	466	466
CONCHO	MILLERSVIEW-DOOLE WSC	COLORADO	97	96	94	93	92	92
CRANE	COUNTY-OTHER	RIO GRANDE	170	208	238	268	294	317

COUNTY	WUG NAME	RIVER BASIN	Demand 2020	Demand 2030	Demand 2040	Demand 2050	Demand 2060	Demand 2070
CRANE	CRANE	RIO GRANDE	1,262	1,339	1,401	1,468	1,526	1,576
CROCKETT	COUNTY-OTHER	RIO GRANDE	28	20	19	18	17	17
CROCKETT	CROCKETT COUNTY WCID #1	RIO GRANDE	1,533	1,642	1,655	1,672	1,678	1,681
ECTOR	COUNTY-OTHER	COLORADO	3,206	3,549	3,932	4,336	4,758	5,191
ECTOR	COUNTY-OTHER	RIO GRANDE	245	271	300	331	363	396
ECTOR	ECTOR COUNTY UD	COLORADO	1,856	2,058	2,284	2,521	2,766	3,018
ECTOR	GREATER GARDENDALE WSC	COLORADO	164	177	192	210	230	251
ECTOR	ODESSA	COLORADO	22,049	24,295	26,774	29,481	32,384	35,344
GLASSCOCK	COUNTY-OTHER	COLORADO	162	165	161	160	160	160
HOWARD	BIG SPRING	COLORADO	6,149	6,288	6,299	6,248	6,238	6,237
HOWARD	COAHOMA	COLORADO	183	186	188	187	187	187
HOWARD	COUNTY-OTHER	COLORADO	896	893	888	886	883	883
IRION	COUNTY-OTHER	COLORADO	105	102	98	97	97	97
IRION	MERTZON	COLORADO	102	99	96	95	95	95
KIMBLE	COUNTY-OTHER	COLORADO	255	248	241	238	237	237
KIMBLE	JUNCTION	COLORADO	627	620	610	605	604	604
LOVING	COUNTY-OTHER	RIO GRANDE	11	10	10	10	10	10
MARTIN	COUNTY-OTHER	COLORADO	342	363	376	392	406	418
MARTIN	STANTON	COLORADO	539	579	606	635	658	677
MASON	COUNTY-OTHER	COLORADO	234	227	221	218	217	217
MASON	MASON	COLORADO	694	684	676	671	671	671
MCCULLOCH	BRADY	COLORADO	1,389	1,418	1,399	1,408	1,410	1,412
MCCULLOCH	COUNTY-OTHER	COLORADO	92	95	94	95	95	95
MCCULLOCH	MILLERSVIEW-DOOLE WSC	COLORADO	153	155	152	151	151	152
MCCULLOCH	RICHLAND SUD	COLORADO	176	178	176	176	176	176

COUNTY	WUG NAME	RIVER BASIN	Demand 2020	Demand 2030	Demand 2040	Demand 2050	Demand 2060	Demand 2070
MENARD	COUNTY-OTHER	COLORADO	95	92	89	87	87	87
MENARD	MENARD	COLORADO	346	338	332	331	331	331
MIDLAND	COUNTY-OTHER	COLORADO	4,232	4,641	5,058	5,520	6,016	6,510
MIDLAND	GREATER GARDENDALE WSC	COLORADO	84	93	103	114	125	137
MIDLAND	MIDLAND	COLORADO	32,721	34,460	37,507	40,746	44,110	47,440
MIDLAND	ODESSA	COLORADO	433	531	626	724	825	925
MITCHELL	COLORADO CITY	COLORADO	1,287	1,417	1,427	1,438	1,451	1,466
MITCHELL	COUNTY-OTHER	COLORADO	843	852	857	861	868	875
MITCHELL	LORAINE	COLORADO	73	72	71	72	72	73
PECOS	COUNTY-OTHER	RIO GRANDE	415	427	453	478	501	522
PECOS	FORT STOCKTON	RIO GRANDE	4,910	5,230	5,548	5,853	6,138	6,398
PECOS	IRAAN	RIO GRANDE	459	486	513	541	567	591
PECOS	PECOS COUNTY WCID #1	RIO GRANDE	439	456	475	496	519	540
REAGAN	BIG LAKE	COLORADO	731	796	835	878	907	929
REAGAN	COUNTY-OTHER	COLORADO	70	76	79	82	85	87
REEVES	COUNTY-OTHER	RIO GRANDE	503	530	553	570	583	594
REEVES	MADERA VALLEY WSC	RIO GRANDE	586	616	644	665	682	694
REEVES	PECOS	RIO GRANDE	2,990	3,143	3,296	3,407	3,491	3,556
RUNNELS	BALLINGER	COLORADO	690	688	671	669	668	668
RUNNELS	COLEMAN COUNTY SUD	COLORADO	14	14	14	13	13	13
RUNNELS	COUNTY-OTHER	COLORADO	252	247	236	235	234	234
RUNNELS	MILES	COLORADO	112	124	121	119	119	119
RUNNELS	MILLERSVIEW-DOOLE WSC	COLORADO	112	109	106	105	105	105
RUNNELS	WINTERS	COLORADO	216	207	197	196	195	195
SCHLEICHER	COUNTY-OTHER	COLORADO	238	272	288	297	304	309

COUNTY	WUG NAME	RIVER BASIN	Demand 2020	Demand 2030	Demand 2040	Demand 2050	Demand 2060	Demand 2070
SCHLEICHER	COUNTY-OTHER	RIO GRANDE	31	32	33	34	34	34
SCHLEICHER	ELDORADO	COLORADO	614	605	597	594	593	593
SCURRY	COUNTY-OTHER	BRAZOS	252	273	286	305	327	351
SCURRY	COUNTY-OTHER	COLORADO	511	523	547	582	625	670
SCURRY	SNYDER	COLORADO	2,036	2,263	2,386	2,570	2,762	2,963
STERLING	COUNTY-OTHER	COLORADO	33	33	33	33	33	33
STERLING	STERLING CITY	COLORADO	276	282	281	281	281	281
SUTTON	COUNTY-OTHER	COLORADO	27	28	28	28	28	28
SUTTON	COUNTY-OTHER	RIO GRANDE	140	145	146	148	150	151
SUTTON	SONORA	RIO GRANDE	1,239	1,317	1,339	1,359	1,372	1,380
TOM GREEN	CONCHO RURAL WATER CORPORATION	COLORADO	538	548	559	572	590	607
TOM GREEN	COUNTY-OTHER	COLORADO	1,306	1,323	1,379	1,428	1,474	1,518
TOM GREEN	MILLERSVIEW-DOOLE WSC	COLORADO	272	279	285	293	302	311
TOM GREEN	SAN ANGELO	COLORADO	18,244	20,002	20,851	21,930	23,240	24,665
UPTON	COUNTY-OTHER	COLORADO	28	30	30	30	31	31
UPTON	COUNTY-OTHER	RIO GRANDE	64	66	67	68	69	70
UPTON	MCCAMEY	RIO GRANDE	776	827	849	878	895	908
UPTON	RANKIN	RIO GRANDE	277	295	302	312	319	323
WARD	COUNTY-OTHER	RIO GRANDE	749	772	786	809	826	840
WARD	MONAHANS	RIO GRANDE	2,518	2,629	2,704	2,785	2,847	2,895
WINKLER	COUNTY-OTHER	RIO GRANDE	210	314	400	492	567	631
WINKLER	KERMIT	RIO GRANDE	1,774	1,766	1,762	1,780	1,793	1,807
WINKLER	WINK	RIO GRANDE	360	389	414	443	467	488
Region F Total			**141,454**	**151,070**	**160,417**	**170,872**	**182,097**	**193,585**

Region F Non-Municipal Demand Projections by County and River Basin for 2020-2070 (acre-feet per year)

COUNTY	WUG NAME	BASIN	Demand 2020	Demand 2030	Demand 2040	Demand 2050	Demand 2060	Demand 2070
ANDREWS	IRRIGATION	COLORADO	36,382	36,076	35,768	35,461	35,156	34,854
ANDREWS	IRRIGATION	RIO GRANDE	1,516	1,503	1,490	1,478	1,465	1,452
ANDREWS	LIVESTOCK	COLORADO	276	276	276	276	276	276
ANDREWS	LIVESTOCK	RIO GRANDE	49	49	49	49	49	49
ANDREWS	MANUFACTURING	COLORADO	49	52	55	58	62	66
ANDREWS	MINING	COLORADO	3,682	3,450	2,955	2,333	1,794	1,379
ANDREWS	MINING	RIO GRANDE	277	260	222	176	135	104
BORDEN	IRRIGATION	BRAZOS	1,120	1,118	1,117	1,115	1,114	1,114
BORDEN	IRRIGATION	COLORADO	2,880	2,875	2,873	2,868	2,866	2,863
BORDEN	LIVESTOCK	BRAZOS	17	17	17	17	17	17
BORDEN	LIVESTOCK	COLORADO	233	233	233	233	233	233
BORDEN	MINING	COLORADO	679	927	784	494	244	121
BROWN	IRRIGATION	BRAZOS	466	464	463	461	459	458
BROWN	IRRIGATION	COLORADO	8,969	8,939	8,908	8,877	8,847	8,817
BROWN	LIVESTOCK	BRAZOS	14	14	14	14	14	14
BROWN	LIVESTOCK	COLORADO	1,339	1,339	1,339	1,339	1,339	1,339
BROWN	MANUFACTURING	COLORADO	673	726	777	820	886	957
BROWN	MINING	COLORADO	943	948	951	952	948	944
COKE	IRRIGATION	COLORADO	965	963	962	962	962	962
COKE	LIVESTOCK	COLORADO	431	431	431	431	431	431
COKE	MINING	COLORADO	488	482	430	376	328	286
COKE	STEAM ELECTRIC POWER	COLORADO	247	289	339	401	477	528
COLEMAN	IRRIGATION	COLORADO	770	770	770	770	770	770
COLEMAN	LIVESTOCK	COLORADO	1,076	1,076	1,076	1,076	1,076	1,076
COLEMAN	MANUFACTURING	COLORADO	9	9	9	9	9	9

COUNTY	WUG NAME	BASIN	Demand 2020	Demand 2030	Demand 2040	Demand 2050	Demand 2060	Demand 2070
COLEMAN	MINING	COLORADO	108	107	97	86	77	69
CONCHO	IRRIGATION	COLORADO	9,734	9,693	9,654	9,618	9,582	9,546
CONCHO	LIVESTOCK	COLORADO	699	699	699	699	699	699
CONCHO	MINING	COLORADO	480	474	422	367	320	279
CRANE	LIVESTOCK	RIO GRANDE	172	172	172	172	172	172
CRANE	MINING	RIO GRANDE	617	840	861	692	531	407
CROCKETT	IRRIGATION	COLORADO	12	12	12	12	12	11
CROCKETT	IRRIGATION	RIO GRANDE	467	458	449	443	434	426
CROCKETT	LIVESTOCK	COLORADO	18	18	18	18	18	18
CROCKETT	LIVESTOCK	RIO GRANDE	663	663	663	663	663	663
CROCKETT	MINING	RIO GRANDE	1,732	1,843	1,261	682	207	63
CROCKETT	STEAM ELECTRIC POWER	RIO GRANDE	776	907	1,067	1,262	1,500	1,662
ECTOR	IRRIGATION	COLORADO	1,289	1,273	1,257	1,242	1,226	1,210
ECTOR	IRRIGATION	RIO GRANDE	143	142	140	138	136	135
ECTOR	LIVESTOCK	COLORADO	225	225	225	225	225	225
ECTOR	LIVESTOCK	RIO GRANDE	40	40	40	40	40	40
ECTOR	MANUFACTURING	COLORADO	3,122	3,293	3,443	3,558	3,679	3,805
ECTOR	MANUFACTURING	RIO GRANDE	332	350	366	378	391	404
ECTOR	MINING	COLORADO	1,325	1,450	1,290	1,055	852	721
ECTOR	MINING	RIO GRANDE	652	714	636	519	420	355
ECTOR	STEAM ELECTRIC POWER	COLORADO	9,436	11,031	12,976	15,347	18,237	21,672
GLASSCOCK	IRRIGATION	COLORADO	56,707	56,252	55,796	55,339	54,887	54,439
GLASSCOCK	LIVESTOCK	COLORADO	262	262	262	262	262	262
GLASSCOCK	MINING	COLORADO	3,423	3,101	2,384	1,679	1,100	798
HOWARD	IRRIGATION	COLORADO	6,722	6,645	6,567	6,490	6,413	6,337
HOWARD	LIVESTOCK	COLORADO	316	316	316	316	316	316

COUNTY	WUG NAME	BASIN	Demand 2020	Demand 2030	Demand 2040	Demand 2050	Demand 2060	Demand 2070
HOWARD	MANUFACTURING	COLORADO	2,748	2,872	2,994	3,097	3,290	3,495
HOWARD	MINING	COLORADO	2,491	2,747	1,940	1,138	476	199
IRION	IRRIGATION	COLORADO	1,467	1,435	1,402	1,370	1,338	1,307
IRION	LIVESTOCK	COLORADO	268	268	268	268	268	268
IRION	MINING	COLORADO	3,192	3,357	2,423	1,487	713	342
KIMBLE	IRRIGATION	COLORADO	2,939	2,830	2,718	2,606	2,501	2,400
KIMBLE	LIVESTOCK	COLORADO	402	402	402	402	402	402
KIMBLE	MANUFACTURING	COLORADO	701	752	804	852	916	985
KIMBLE	MINING	COLORADO	19	19	19	19	19	19
LOVING	LIVESTOCK	RIO GRANDE	101	101	101	101	101	101
LOVING	MINING	RIO GRANDE	792	1,058	934	762	601	474
MARTIN	IRRIGATION	COLORADO	36,322	35,674	35,026	34,381	33,746	33,123
MARTIN	LIVESTOCK	COLORADO	128	128	128	128	128	128
MARTIN	MANUFACTURING	COLORADO	41	42	43	44	47	50
MARTIN	MINING	COLORADO	3,527	2,998	2,251	1,441	771	413
MASON	IRRIGATION	COLORADO	8,294	8,174	8,054	7,935	7,816	7,699
MASON	LIVESTOCK	COLORADO	1,248	1,248	1,248	1,248	1,248	1,248
MASON	MINING	COLORADO	1,023	941	708	568	460	372
MCCULLOCH	IRRIGATION	COLORADO	3,584	3,539	3,493	3,448	3,404	3,361
MCCULLOCH	LIVESTOCK	COLORADO	714	714	714	714	714	714
MCCULLOCH	MANUFACTURING	COLORADO	500	540	578	611	663	719
MCCULLOCH	MINING	COLORADO	8,927	8,347	6,641	5,627	4,836	4,201
MENARD	IRRIGATION	COLORADO	2,530	2,522	2,514	2,505	2,497	2,489
MENARD	LIVESTOCK	COLORADO	408	408	408	408	408	408
MENARD	MANUFACTURING	COLORADO	3	3	3	3	3	3
MENARD	MINING	COLORADO	1,086	1,071	952	827	717	622

COUNTY	WUG NAME	BASIN	Demand 2020	Demand 2030	Demand 2040	Demand 2050	Demand 2060	Demand 2070
MIDLAND	IRRIGATION	COLORADO	33,276	33,016	32,756	32,495	32,237	31,981
MIDLAND	LIVESTOCK	COLORADO	394	394	394	394	394	394
MIDLAND	MANUFACTURING	COLORADO	230	250	269	285	309	335
MIDLAND	MINING	COLORADO	3,893	3,418	2,630	1,774	1,056	743
MITCHELL	IRRIGATION	COLORADO	11,519	11,460	11,404	11,348	11,292	11,236
MITCHELL	LIVESTOCK	COLORADO	413	413	413	413	413	413
MITCHELL	MINING	COLORADO	593	738	632	493	375	290
MITCHELL	STEAM ELECTRIC POWER	COLORADO	4,847	4,670	4,493	4,317	4,140	3,994
PECOS	IRRIGATION	RIO GRANDE	126,023	126,023	126,023	126,023	126,023	126,023
PECOS	LIVESTOCK	RIO GRANDE	932	932	932	932	932	932
PECOS	MANUFACTURING	RIO GRANDE	103	103	103	103	103	103
PECOS	MINING	RIO GRANDE	690	1,068	1,072	861	672	524
REAGAN	IRRIGATION	COLORADO	19,130	18,808	18,486	18,164	17,848	17,537
REAGAN	LIVESTOCK	COLORADO	244	244	244	244	244	244
REAGAN	LIVESTOCK	RIO GRANDE	11	11	11	11	11	11
REAGAN	MINING	COLORADO	3,916	3,157	2,285	1,308	492	185
REAGAN	MINING	RIO GRANDE	295	238	172	98	37	14
REEVES	IRRIGATION	RIO GRANDE	91,357	90,577	89,795	89,015	88,242	87,475
REEVES	LIVESTOCK	RIO GRANDE	862	862	862	862	862	862
REEVES	MANUFACTURING	RIO GRANDE	197	201	205	208	220	233
REEVES	MINING	RIO GRANDE	1,531	2,632	2,537	2,068	1,632	1,288
RUNNELS	IRRIGATION	COLORADO	4,009	3,991	3,973	3,955	3,937	3,919
RUNNELS	LIVESTOCK	COLORADO	880	880	880	880	880	880
RUNNELS	MANUFACTURING	COLORADO	48	52	56	59	64	69
RUNNELS	MINING	COLORADO	272	269	240	210	184	161
SCHLEICHER	IRRIGATION	COLORADO	904	885	867	848	830	812

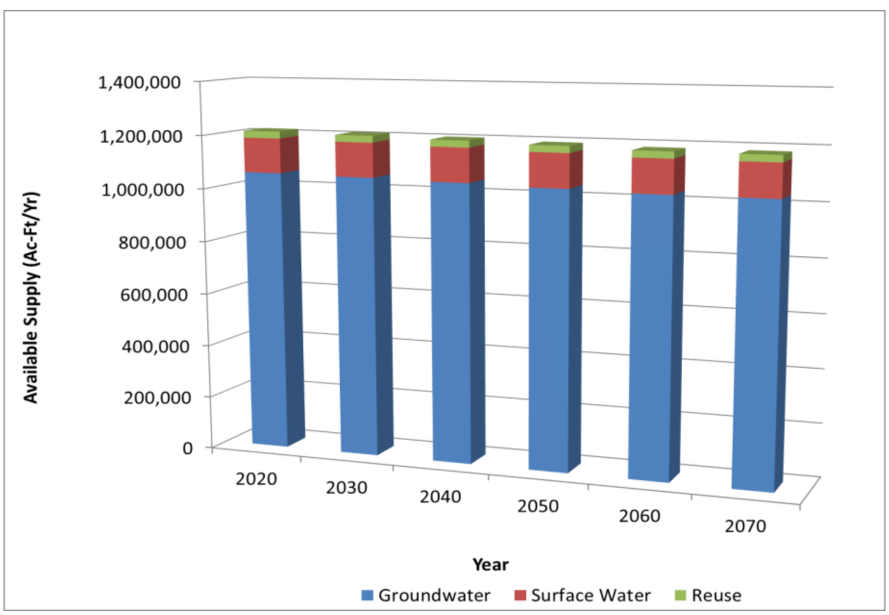
COUNTY	WUG NAME	BASIN	Demand 2020	Demand 2030	Demand 2040	Demand 2050	Demand 2060	Demand 2070
SCHLEICHER	IRRIGATION	RIO GRANDE	510	500	489	479	468	458
SCHLEICHER	LIVESTOCK	COLORADO	403	403	403	403	403	403
SCHLEICHER	LIVESTOCK	RIO GRANDE	132	132	132	132	132	132
SCHLEICHER	MINING	COLORADO	460	542	416	290	178	110
SCHLEICHER	MINING	RIO GRANDE	161	190	146	102	63	38
SCURRY	IRRIGATION	BRAZOS	1,728	1,669	1,610	1,551	1,494	1,440
SCURRY	IRRIGATION	COLORADO	5,577	5,387	5,196	5,006	4,824	4,648
SCURRY	LIVESTOCK	BRAZOS	101	101	101	101	101	101
SCURRY	LIVESTOCK	COLORADO	403	403	403	403	403	403
SCURRY	MANUFACTURING	COLORADO	3	3	3	3	3	3
SCURRY	MINING	BRAZOS	78	128	135	102	69	47
SCURRY	MINING	COLORADO	202	328	348	261	177	120
STERLING	IRRIGATION	COLORADO	983	942	901	860	820	782
STERLING	LIVESTOCK	COLORADO	322	322	322	322	322	322
STERLING	MINING	COLORADO	780	953	812	522	270	140
SUTTON	IRRIGATION	COLORADO	292	286	280	275	269	264
SUTTON	IRRIGATION	RIO GRANDE	1,511	1,481	1,453	1,422	1,394	1,365
SUTTON	LIVESTOCK	COLORADO	214	214	214	214	214	214
SUTTON	LIVESTOCK	RIO GRANDE	265	265	265	265	265	265
SUTTON	MINING	COLORADO	89	144	153	115	78	53
SUTTON	MINING	RIO GRANDE	357	576	610	458	311	211
TOM GREEN	IRRIGATION	COLORADO	93,579	93,350	93,121	92,889	92,660	92,432
TOM GREEN	LIVESTOCK	COLORADO	1,688	1,688	1,688	1,688	1,688	1,688
TOM GREEN	MANUFACTURING	COLORADO	2,387	2,615	2,839	3,034	3,273	3,531
TOM GREEN	MINING	COLORADO	1,056	1,080	1,119	1,112	1,134	1,156
UPTON	IRRIGATION	COLORADO	9,284	9,151	9,018	8,885	8,753	8,624

COUNTY	WUG NAME	BASIN	Demand 2020	Demand 2030	Demand 2040	Demand 2050	Demand 2060	Demand 2070
UPTON	IRRIGATION	RIO GRANDE	189	187	184	181	179	176
UPTON	LIVESTOCK	COLORADO	45	45	45	45	45	45
UPTON	LIVESTOCK	RIO GRANDE	74	74	74	74	74	74
UPTON	MINING	COLORADO	1,610	1,381	1,092	732	437	305
UPTON	MINING	RIO GRANDE	2,627	2,253	1,781	1,194	713	498
WARD	IRRIGATION	RIO GRANDE	5,613	5,543	5,473	5,403	5,334	5,266
WARD	LIVESTOCK	RIO GRANDE	109	109	109	109	109	109
WARD	MANUFACTURING	RIO GRANDE	16	16	16	16	16	16
WARD	MINING	RIO GRANDE	797	964	840	645	458	329
WARD	STEAM ELECTRIC POWER	RIO GRANDE	3,779	4,418	5,196	6,145	7,303	8,269
WINKLER	IRRIGATION	RIO GRANDE	4,912	4,912	4,912	4,912	4,912	4,912
WINKLER	LIVESTOCK	COLORADO	3	3	3	3	3	3
WINKLER	LIVESTOCK	RIO GRANDE	348	348	348	348	348	348
WINKLER	MINING	RIO GRANDE	787	1,169	991	756	531	373
Region F Total			**696,520**	**696,023**	**685,122**	**673,163**	**664,096**	**659,726**

Chapter 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 1.2 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 87 percent of the total water available. Surface water supplies in Figure 3-1 total approximately 130,000 acre-feet per year. 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 relatively small amount of reuse is currently being used in the region for both potable and non-potable uses.

Figure 3-1
Water Availability by Source Type



3.1 Groundwater Supplies

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

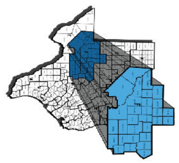
3.1.1 Overview of Groundwater Regulation in Texas and Region F

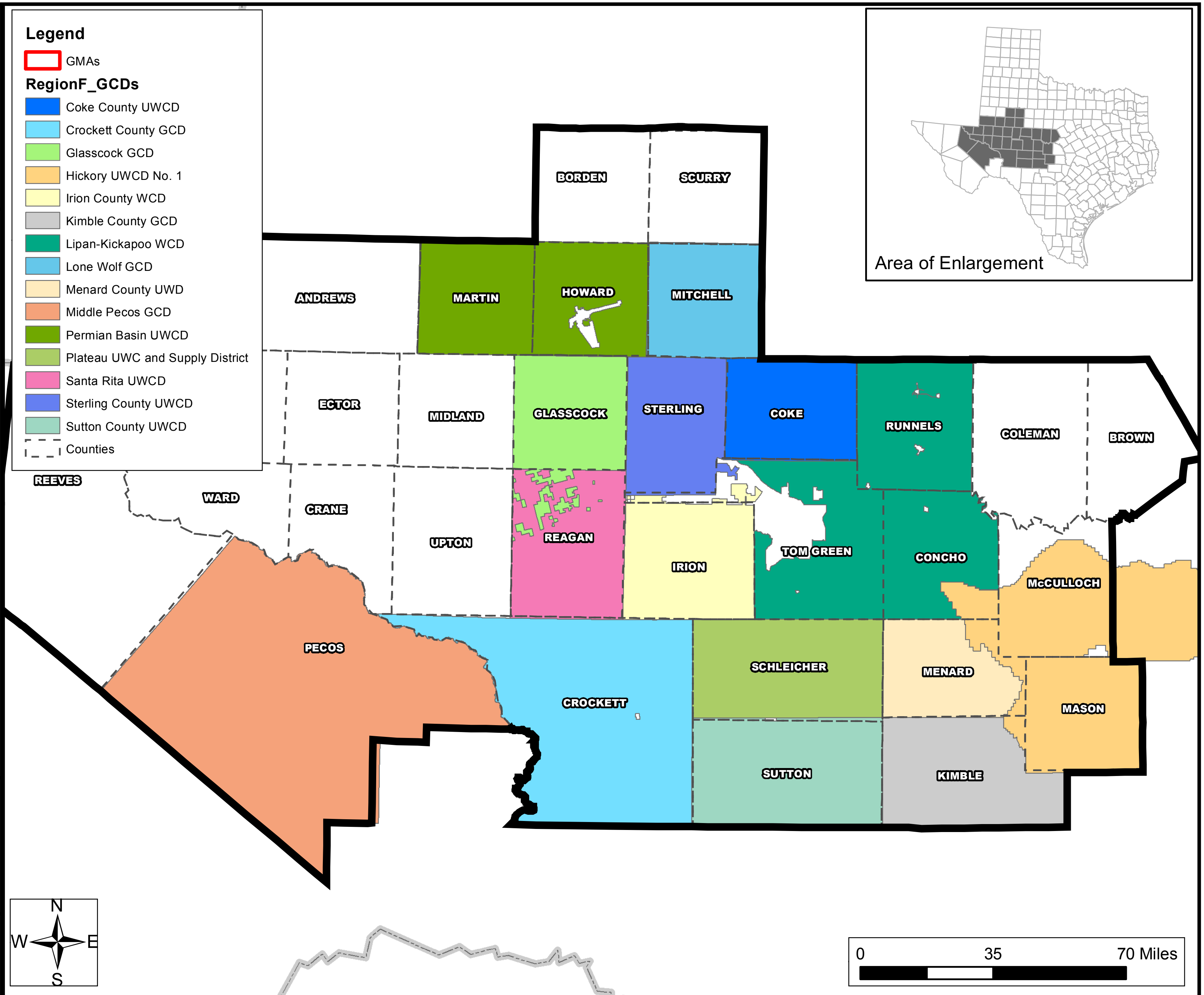
In June 1997, the 75th Texas Legislature enacted Senate Bill 1 (SB 1) to establish a comprehensive statewide water planning process to help ensure that the water needs of all Texans are met. SB1 mandated that representatives serve as members of Regional Water Planning Groups (RWPGs) to prepare regional 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 3-2 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 were 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





Groundwater Conservation Districts & Groundwater Management Areas

Region F

FN JOB NO	SAN11472
FILE	H:\WR_PLANNING\Chapter 2 GCD_GMA.mxd
DATE	AUGUST 2014
SCALE	1:2,217,600
DESIGNED	JJR
DRAFTED	JJR

Figure 3-2

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).

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, another quantitative approach is used to estimate the MAG.

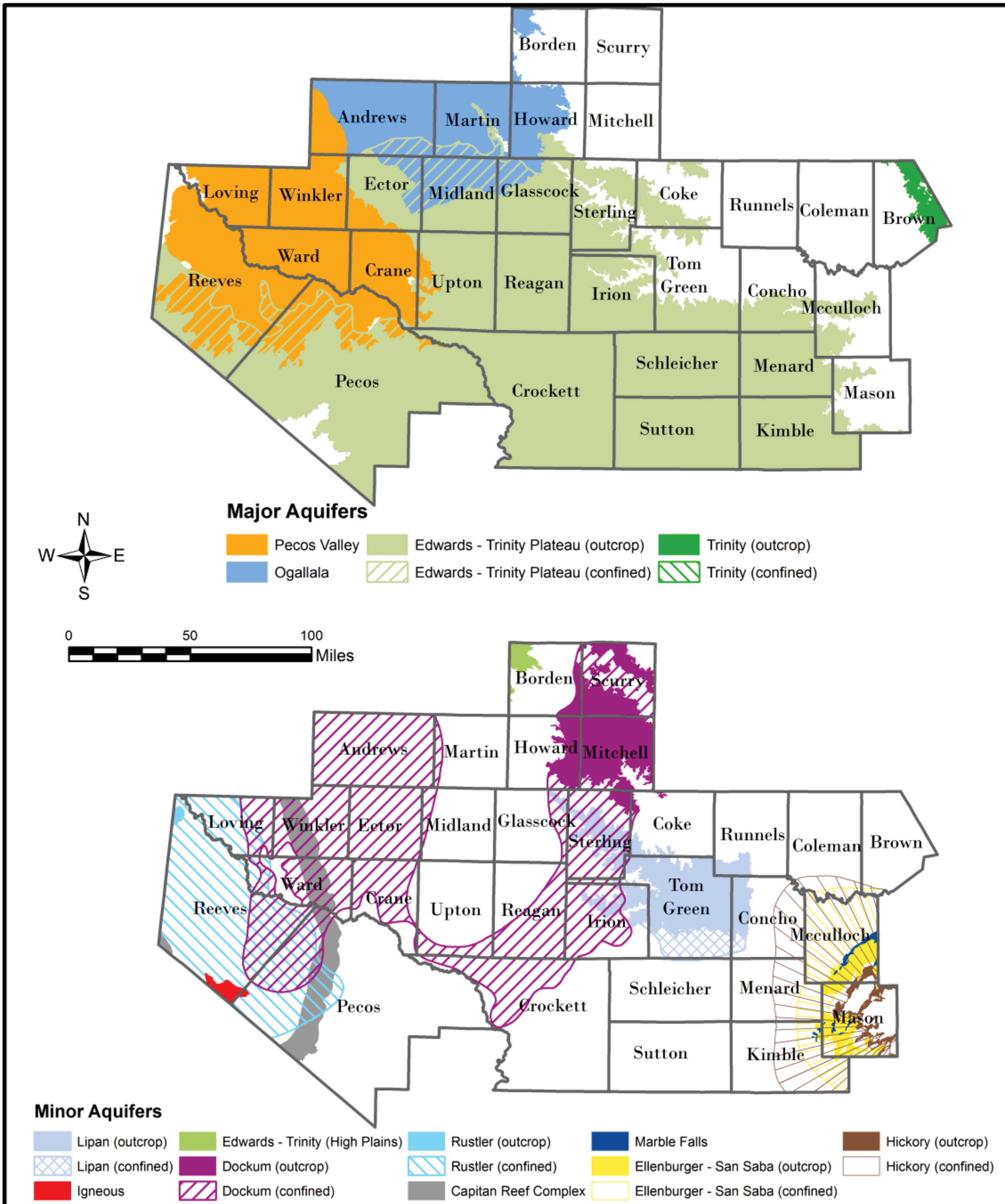
In 2011, Senate Bill 660 required that GMA representatives must participate within each applicable RWPG. It also required the Regional Water Plans be consistent with the DFCs in place when the regional plans are initially developed. TWDB technical guidelines for the current round of planning establishes 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 groundwater production for TWDB planning purposes.

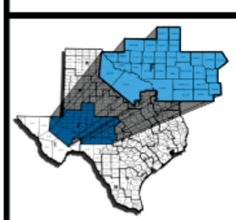
3.1.2 Existing Groundwater Supplies

Based on historic groundwater estimates for years 2007 through 2011, regional groundwater sources supplied an average of 404,000 acre feet of water annually, accounting for 66 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. Groundwater is primarily found in four major and seven minor aquifers in Region F, as shown in Figure 3-3. Wells in the aquifers vary in production capacity and the groundwater quality also varies.

Region F historical groundwater pumping by aquifer for years 2007 through 2011 is shown in Figure 3-4. These data were calculated using the TWDB historical groundwater pumping estimates. The Edwards-Trinity Plateau supplied 41 percent of the region's groundwater, the Ogallala supplied 24 percent, and the Pecos Valley Alluvium provided 16 percent. The minor aquifers provided the remaining 19 percent.

The same historical data set is presented in Figure 3-3 by use category. Irrigation accounted for 84 percent of groundwater pumped in the region. Municipal pumping consumed twelve percent of the groundwater and the remaining use categories collectively accounted for about six percent of total usage in the five-year period.





Region F

Major and Minor Aquifers

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DATE	July, 2014
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FIGURE

Figure 3-4
Historical Groundwater Pumping (2007-2011) by Aquifer

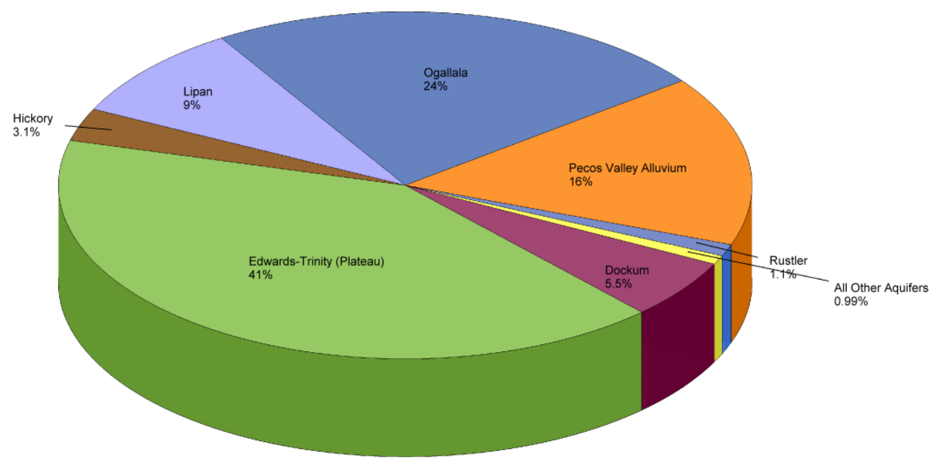


Figure 3-5
Historical Groundwater Pumping (2007-2011) by Use

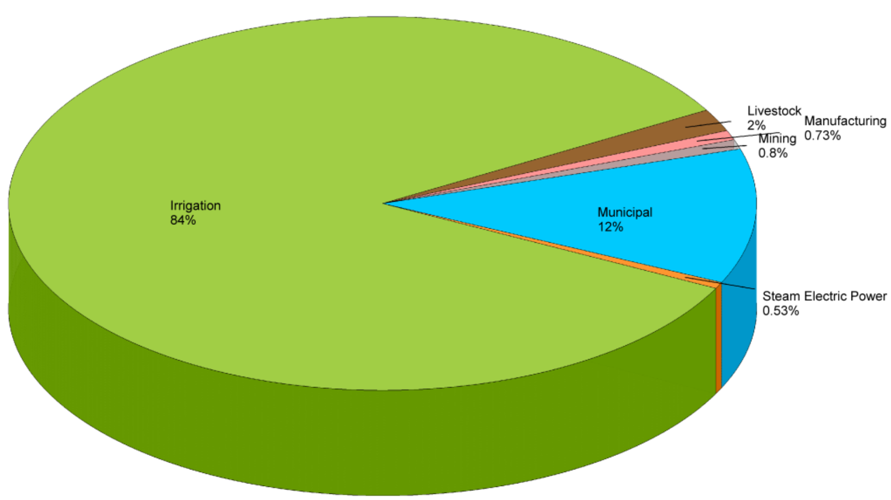


Table 3-1 presents the MAG numbers by county, aquifer and river basin for planning years 2020 through 2070. MAG volumes are the largest amount of water that can be withdrawn from a given source without violating DFCs. Table 3-1 only includes county aquifer combinations where a DFC has been defined by a GCD/ GMA and the MAG subsequently has been determined by the TWDB using the GAM.

Table 3-1
Modeled Available Groundwater in Region F

-Values in Acre-Feet per Year-

County	Aquifer	Basin	2020	2030	2040	2050	2060	2070
Andrews	Dockum	Colorado	715	715	715	715	715	715
		Rio Grande	135	135	135	135	135	135
	Ogallala	Colorado	15,085	13,678	12,014	10,016	7,377	7,377
		Rio Grande	50	41	41	41	41	41
Borden	Dockum	Brazos	33	33	33	33	33	33
		Colorado	482	482	482	482	482	482
	Ogallala	Brazos	292	292	292	292	292	292
		Colorado	107	107	107	107	107	107
Brown	Ellenburger-San Saba	Colorado	131	131	131	131	131	131
	Hickory	Colorado	12	12	12	12	12	12
	Trinity	Brazos	28	28	28	28	28	28
		Colorado	2,017	2,017	2,017	2,017	2,017	2,017
Coke	Edwards-Trinity (Plateau)	Colorado	998	998	998	998	998	998
Concho	Hickory	Colorado	1	1	1	1	1	1
	Lipan	Colorado	1,834	1,834	1,834	1,834	1,834	1,834
Crane	Dockum	Rio Grande	2,000	2,000	2,000	2,000	2,000	2,000
	Edwards-Trinity (Plateau)	Rio Grande	26	26	26	26	26	26
	Pecos Valley	Rio Grande	4,972	4,972	4,972	4,972	4,972	4,972
Crockett	Edwards-Trinity (Plateau)	Colorado	19	19	19	19	19	19
		Rio Grande	5,407	5,407	5,407	5,407	5,407	5,407
Ector	Dockum	Colorado	13	13	13	13	13	13
		Rio Grande	515	515	515	515	515	515
	Edwards-Trinity (Plateau)	Colorado	4,918	4,918	4,918	4,918	4,918	4,918
		Rio Grande	504	504	504	504	504	504
	Pecos Valley	Rio Grande	113	113	113	113	113	113
	Ogallala	Colorado	8,026	7,730	7,171	7,135	6,727	6,727
Glasscock	Edwards-Trinity (Plateau)	Colorado	65,213	65,213	65,213	65,213	65,213	65,213

County	Aquifer	Basin	2020	2030	2040	2050	2060	2070
	Ogallala	Colorado	21,322	20,875	19,691	17,289	14,868	14,868
Howard	Ogallala	Colorado	3,075	2,731	2,731	2,731	2,703	2,703
Irion	Edwards-Trinity (Plateau)	Colorado	2,293	2,293	2,293	2,293	2,293	2,293
Kimble	Edwards-Trinity (Plateau)	Colorado	1,283	1,283	1,283	1,283	1,283	1,283
	Ellenburger-San Saba	Colorado	304	304	304	304	304	304
	Hickory	Colorado	6	6	6	6	6	6
Loving	Dockum	Rio Grande	1,000	1,000	1,000	1,000	1,000	1,000
	Edwards-Trinity (Plateau)	Rio Grande	0	0	0	0	0	0
	Pecos Valley	Rio Grande	2,984	2,984	2,984	2,984	2,984	2,984
	Rustler	Rio Grande	1,183	1,183	1,183	1,183	1,183	1,183
Martin	Ogallala	Colorado	13,570	13,570	13,140	12,299	12,277	12,277
Mason	Ellenburger-San Saba	Colorado	5,801	5,801	5,801	5,801	5,801	5,801
	Hickory	Colorado	12,294	12,294	12,294	12,294	12,294	12,294
McCulloch	Edwards-Trinity (Plateau)	Colorado	4	4	4	4	4	4
	Ellenburger-San Saba	Colorado	5,369	5,369	5,369	5,369	5,369	5,369
	Hickory	Colorado	7,152	7,152	7,152	7,152	7,152	7,152
Menard	Edwards-Trinity (Plateau)	Colorado	2,194	2,194	2,194	2,194	2,194	2,194
	Ellenburger-San Saba	Colorado	791	791	791	791	791	791
	Hickory	Colorado	1,016	1,016	1,016	1,016	1,016	1,016
Midland	Dockum	Colorado	0	0	0	0	0	0
	Edwards-Trinity (Plateau)	Colorado	23,251	23,251	23,251	23,251	23,251	23,251
	Ogallala	Colorado	38,388	36,824	34,623	32,693	31,325	31,325
Mitchell	Dockum	Colorado	14,018	14,018	14,018	14,018	14,018	14,018
Pecos	Capitan Reef	Rio Grande	11,122	11,122	11,122	11,122	11,122	11,122
	Dockum	Rio Grande	13,965	13,965	13,965	13,965	13,965	13,965
	Edwards-Trinity (Plateau)	Rio Grande	115,938	115,938	115,938	115,938	115,938	115,938
	Pecos Valley	Rio Grande	124,182	124,182	124,182	124,182	124,182	124,182
	Rustler	Rio Grande	10,508	10,508	10,508	10,508	10,508	10,508
Reagan	Edwards-Trinity (Plateau)	Colorado	68,250	68,250	68,250	68,250	68,250	68,250
		Rio Grande	28	28	28	28	28	28

County	Aquifer	Basin	2020	2030	2040	2050	2060	2070
Reeves	Capitan Reef	Rio Grande	1,007	1,007	1,007	1,007	1,007	1,007
	Dockum	Rio Grande	5,000	5,000	5,000	5,000	5,000	5,000
	Edwards-Trinity (Plateau)	Rio Grande	3,389	3,389	3,389	3,389	3,389	3,389
	Pecos Valley	Rio Grande	186,722	186,722	186,722	186,722	186,722	186,722
	Rustler	Rio Grande	1,976	1,976	1,976	1,976	1,976	1,976
Runnels	Lipan	Colorado	15	15	15	15	15	15
Schleicher	Edwards-Trinity (Plateau)	Colorado	6,410	6,410	6,410	6,410	6,410	6,410
		Rio Grande	1,640	1,640	1,640	1,640	1,640	1,640
Scurry	Dockum	Brazos	306	306	306	306	306	306
		Colorado	903	903	903	903	903	903
Sterling	Edwards-Trinity (Plateau)	Colorado	2,497	2,497	2,497	2,497	2,497	2,497
Sutton	Edwards-Trinity (Plateau)	Colorado	386	386	386	386	386	386
		Rio Grande	6,052	6,052	6,052	6,052	6,052	6,052
Tom Green	Edwards-Trinity (Plateau)	Colorado	426	426	426	426	426	426
	Lipan	Colorado	39,361	39,361	39,361	39,361	39,361	39,361
Upton	Dockum	Colorado	0	0	0	0	0	0
		Rio Grande	219	219	219	219	219	219
	Edwards-Trinity (Plateau)	Colorado	21,257	21,257	21,257	21,257	21,257	21,257
		Rio Grande	1,122	1,122	1,122	1,122	1,122	1,122
	Pecos Valley	Rio Grande	2	2	2	2	2	2
Ward	Capitan Reef	Rio Grande	1,051	1,051	1,051	1,051	1,051	1,051
	Dockum	Rio Grande	7,000	7,000	7,000	7,000	7,000	7,000
	Edwards-Trinity (Plateau)	Rio Grande	0	0	0	0	0	0
	Pecos Valley	Rio Grande	50,010	50,010	50,010	50,010	50,010	50,010
	Rustler	Rio Grande	555	555	555	555	555	555
Winkler	Capitan Reef	Rio Grande	1,061	1,061	1,061	1,061	1,061	1,061
	Dockum	Colorado	33	33	33	33	33	33
		Rio Grande	9,967	9,967	9,967	9,967	9,967	9,967
	Pecos Valley	Rio Grande	39,984	39,984	39,984	39,984	39,984	39,984

Table 3-2 presents groundwater availability numbers for the non-relevant aquifers (in acre-feet per year). 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).

Some of the availability numbers were published by the TWDB as "DFC-compatible availability values." For the county-aquifer-basin areas that did not have the TWDB DFC-compatible availability values available, the numbers were estimated using various methodologies. Some availability volumes were derived from areal weighting of the non-relevant aquifer area relative to the area of the most proximal relevant aquifer area in the most recent GAM runs (Andrews County, Edwards-Trinity Plateau). Some were based upon well productivity (Brown County, Ellenburger-San Saba and Hickory). Other availabilities are based on historical use with a multiplier (Concho County, Hickory). All of the values that were derived using the various methodologies can be revisited during future planning cycles and revised as needed.

Table 3-2
Non-Relevant Groundwater Supplies in Region F
-Values in Acre-Feet per Year-

County	Aquifer	Basin	2020	2030	2040	2050	2060	2070
Andrews	Edwards-Trinity (Plateau)	Colorado	3,000	3,000	3,000	3,000	3,000	3,000
	Pecos Valley	Rio Grande	1,189	1,189	1,189	1,189	1,189	1,189
Brown	Ellenburger - San Saba	Colorado	4,000	4,000	4,000	4,000	4,000	4,000
	Hickory	Colorado	2,000	2,000	2,000	2,000	2,000	2,000
Coleman	Hickory	Colorado	2,000	2,000	2,000	2,000	2,000	2,000
Concho	Edwards-Trinity (Plateau)	Colorado	487	487	487	487	487	487
	Lipan	Colorado	59	59	59	59	59	59
Crane	Capitan Reef Complex	Rio Grande	1,000	1,000	1,000	1,000	1,000	1,000
	Rustler	Rio Grande	1,000	1,000	1,000	1,000	1,000	1,000
Crockett	Dockum	Colorado	80	80	80	80	80	80
	Dockum	Rio Grande	2	2	2	2	2	2
Ector	Pecos Valley	Rio Grande	113	113	113	113	113	113
Glasscock	Dockum	Colorado	900	900	900	900	900	900
	Lipan	Colorado	10	10	10	10	10	10
Howard	Dockum	Colorado	592	592	592	592	592	592
	Edwards-Trinity (Plateau)	Colorado	1,650	1,650	1,650	1,650	1,650	1,650
Irion	Dockum	Colorado	150	150	150	150	150	150
	Lipan	Colorado	13	13	13	13	13	13

County	Aquifer	Basin	2020	2030	2040	2050	2060	2070
Kimble	Edwards-Trinity (Plateau)	Colorado	104	104	104	104	104	104
	Marble Falls	Colorado	100	100	100	100	100	100
Loving	Capitan Reef Complex	Rio Grande	1,000	1,000	1,000	1,000	1,000	1,000
Martin	Dockum	Colorado	500	500	500	500	500	500
	Edwards-Trinity (Plateau)	Colorado	1,500	1,500	1,500	1,500	1,500	1,500
Mason	Edwards-Trinity (Plateau)	Colorado	18	18	18	18	18	18
	Marble Falls	Colorado	100	100	100	100	100	100
McCulloch	Edwards-Trinity (Plateau)	Colorado	144	144	144	144	144	144
	Marble Falls	Colorado	50	50	50	50	50	50
Menard	Edwards-Trinity (Plateau)	Colorado	377	377	377	377	377	377
Pecos	Pecos Valley	Rio Grande	70	70	70	70	70	70
Reagan	Dockum	Colorado	1,837	1,837	1,837	1,837	1,837	1,837
		Rio Grande	227	227	227	227	227	227
Runnels	Lipan	Colorado	30	30	30	30	30	30
Sterling	Dockum	Colorado	10	10	10	10	10	10
	Lipan	Colorado	50	50	50	50	50	50
Tom Green	Edwards-Trinity (Plateau)	Colorado	2,372	2,372	2,372	2,372	2,372	2,372
	Lipan	Colorado	4,207	4,207	4,207	4,207	4,207	4,207
Upton	Pecos Valley	Rio Grande	2	2	2	2	2	2
Winkler	Rustler	Rio Grande	500	500	500	500	500	500

Note that the Igneous aquifer in Reeves County and the Edwards-Trinity (High Plains) aquifer were not included in Table 3-1 through Table 3-3 even though they appear on the minor aquifer map. Both aquifers underlie major aquifers and any pumping is assumed to be accounted for in the overlying major aquifers.

Historical pumping estimates for years 2007 through 2011 were also utilized for comparison against the MAGs (Table 3-3). The county-aquifer-basin combinations that are highlighted exceed the year 2020 MAG. All pumping was summed by county, basin and aquifer and divided by five to determine average annual use. This was done in an attempt to determine potential needs and conflicts based on where pumping has been occurring.

The pumping estimates are based or reported pumping (from TWDB surveys) as well as non-surveyed estimates. Non-surveyed estimates can comprise a rather 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 upon Texas Agricultural Statistics

Service livestock population statistics with use per animal derived from Texas Agricultural Experiment Station research. TWDB estimates water use for non-surveyed cities with a population greater than 500.

There are two county-aquifer-basin combinations in Table 3-3 that exceed the MAG and do not include any estimated data; they are based on survey data only. The City of Eden (Concho – Hickory – Colorado) has pumped an average of 355 acre-feet per year in years 2007 through 2011. The 2020 MAG is 1 acre-feet per year. This is the largest overdraft that was found in these data. Additionally, Cemex Construction (Ector – Dockum – Colorado) has pumped an average of 36 acre-feet per year in years 2007 through 2011. The 2020 MAG is 13 acre-feet per year.

Borden – Ogallala – Colorado shows an average annual use estimate of 1,686 acre-feet and a MAG of 107 acre-feet. Only 74 acre-feet can be attributed to a particular entity (the City of Gail). The remainder of this is based on non-surveyed estimates of irrigation and livestock use.

Table 3-3
Modeled Available Groundwater and Historical Pumping Estimates (2007 – 2011)
-All Values are in Acre-Feet per Year-

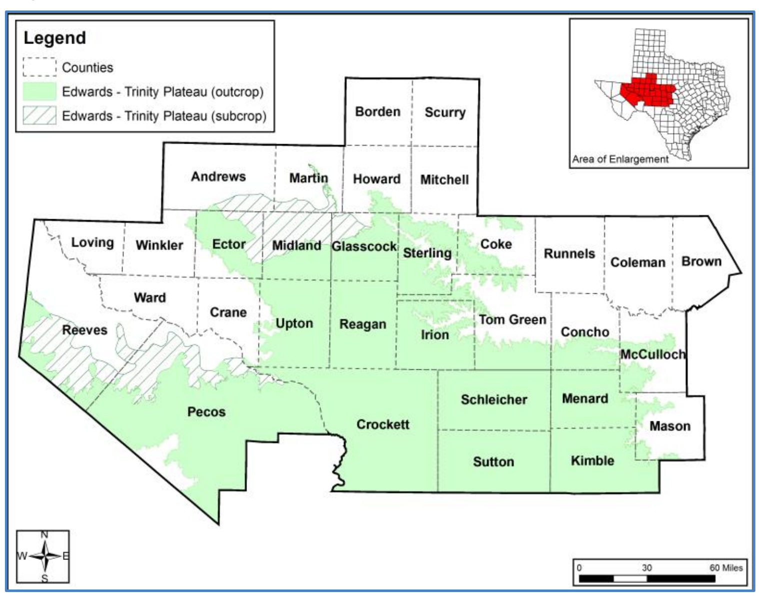
County	Aquifer	Basin	MAG 2020	Historical Pumping Average (2007-2011)
Andrews	Dockum	Colorado	715	3
		Rio Grande	135	0
	Ogallala	Colorado	15,085	31,215
		Rio Grande	50	390
Borden	Dockum	Brazos	33	0
		Colorado	482	42
	Ogallala	Brazos	292	807
		Colorado	107	1,686
Brown	Ellenburger-San Saba	Colorado	131	1
	Hickory	Colorado	12	0
	Trinity	Brazos	28	14
		Colorado	2,017	988
Coke	Edwards-Trinity (Plateau)	Colorado	998	153
Coleman	Hickory	Colorado	500	0
Concho	Hickory	Colorado	1	356
	Lipan	Colorado	1,834	2,970
Crane	Dockum	Rio Grande	2,000	272
	Edwards-Trinity (Plateau)	Rio Grande	26	0
	Pecos Valley	Rio Grande	4,972	1,448
Crockett	Edwards-Trinity (Plateau)	Colorado	19	11
		Rio Grande	5,407	2,239

County	Aquifer	Basin	MAG 2020	Historical Pumping Average (2007-2011)
Ector	Dockum	Colorado	13	50
		Rio Grande	515	526
	Edwards-Trinity (Plateau)	Colorado	4,918	3,380
		Rio Grande	504	1,008
	Pecos Valley	Rio Grande	113	13
	Ogallala	Colorado	8,026	549
Glasscock	Edwards-Trinity (Plateau)	Colorado	65,213	41,044
	Ogallala	Colorado	21,322	6,154
Howard	Ogallala	Colorado	3,075	5,181
Irion	Edwards-Trinity (Plateau)	Colorado	2,293	658
Kimble	Edwards-Trinity (Plateau)	Colorado	1,283	561
	Ellenburger-San Saba	Colorado	304	10
	Hickory	Colorado	6	34
Loving	Dockum	Rio Grande	1,000	22
	Edwards-Trinity (Plateau)	Rio Grande	0	0
	Pecos Valley	Rio Grande	2,984	25
	Rustler	Rio Grande	1,183	1
Martin	Ogallala	Colorado	13,570	34,760
Mason	Ellenburger-San Saba	Colorado	5,801	83
	Hickory	Colorado	12,294	6,058
McCulloch	Edwards-Trinity (Plateau)	Colorado	4	7
	Ellenburger-San Saba	Colorado	5,369	325
	Hickory	Colorado	7,152	5,912
Menard	Edwards-Trinity (Plateau)	Colorado	2,194	678
	Ellenburger-San Saba	Colorado	791	5
	Hickory	Colorado	1,016	122
Midland	Dockum	Colorado	0	0
	Edwards-Trinity (Plateau)	Colorado	23,251	11,136
	Ogallala	Colorado	38,388	14,666
Mitchell	Dockum	Colorado	14,018	11,038
Pecos	Capitan Reef	Rio Grande	11,122	1,958
	Dockum	Rio Grande	13,965	0
	Edwards-Trinity (Plateau)	Rio Grande	115,938	60,041
	Pecos Valley	Rio Grande	124,182	97,068
	Rustler	Rio Grande	10,508	2,606
Reagan	Edwards-Trinity (Plateau)	Colorado	68,250	20,548
		Rio Grande	28	7
Reeves	Capitan Reef	Rio Grande	1,007	0
	Dockum	Rio Grande	5,000	1,024
	Edwards-Trinity (Plateau)	Rio Grande	3,389	3,549
	Pecos Valley	Rio Grande	186,722	24,394
	Rustler	Rio Grande	1,976	1,656
Runnels	Lipan	Colorado	15	37
Schleicher	Edwards-Trinity (Plateau)	Colorado	6,410	1,754
		Rio Grande	1,640	612

County	Aquifer	Basin	MAG 2020	Historical Pumping Average (2007-2011)
Scurry	Dockum	Brazos	306	1,656
		Colorado	903	5,012
Sterling	Edwards-Trinity (Plateau)	Colorado	2,497	507
Sutton	Edwards-Trinity (Plateau)	Colorado	386	208
		Rio Grande	6,052	2,237
Tom Green	Edwards-Trinity (Plateau)	Colorado	426	2,394
	Lipan	Colorado	39,361	33,259
Upton	Dockum	Colorado	0	0
		Rio Grande	219	120
	Edwards-Trinity (Plateau)	Colorado	21,257	9,401
		Rio Grande	1,122	307
	Pecos Valley	Rio Grande	2	0
Ward	Capitan Reef	Rio Grande	1,051	0
	Dockum	Rio Grande	7,000	46
	Edwards-Trinity (Plateau)	Rio Grande	0	0
	Pecos Valley	Rio Grande	50,010	8,241
	Rustler	Rio Grande	555	4
Winkler	Capitan Reef	Rio Grande	1,061	0
	Dockum	Colorado	33	0
		Rio Grande	9,967	1,852
	Pecos Valley	Rio Grande	39,984	4,338
* Average Historical Pumping exceeds 2020 MAG				

The following discussion describes each of these aquifers, including their current use and potential availability. Section 3.4.3 discusses the supply of brackish groundwater potentially available for advanced treatment.

3.1.3 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. More groundwater is produced from the Edwards-Trinity (Plateau) aquifer (approximately 41 percent) than any other aquifer in the region, about 85 percent of which is used for irrigation. Many communities in the region use the aquifer for their public drinking-water supply. Municipal use accounts for ten percent of use.

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 and to rivers in the region. Groundwater flow in the aquifer generally flows in a south-southeasterly direction, but may vary locally. The hydraulic gradient averages about 10 feet/mile.

Long-term water-level declines have been observed in areas of heavy pumping, most notably in the Saint Lawrence irrigation district in Glasscock, Reagan, Upton, and Midland Counties, in the Midland-Odessa area in Ector County, and in the Belding Farm area in Pecos County. Figure 3-6, Figure 3-7, and Figure 3-8 show selected hydrographs for the Edwards-Trinity (Plateau) aquifer in Region F. As noted above, some areas have shown consistent water-level declines, as shown in Figure 3-6. In some cases, these declines have stopped due to cessation or reduction in pumpage, and are currently recovering, as shown by Well 55-08-796 in Menard County. Figure 3-7 shows selected wells showing increases in water levels over time. However, most Edwards-Trinity (Plateau) wells in the region show fairly stable water levels, or are slightly declining, as shown by the hydrographs in Figure 3-8. Well 52-16-802 in Pecos County (Figure 3-8) shows the water level variations throughout the year as pumpage increases in the summer and stops in the winter.

Two GMAs have set collective DFCs for the Edwards-Trinity Plateau and the Pecos Valley Alluvium. In GMA 3, average total net decline in water levels over 50 years shall not exceed 28 feet below water levels in the aquifers in 2010. In GMA 7, average drawdown shall be 7 feet except within Kinney County GCD. Kinney County drawdown will be consistent with maintaining annual average flow of 23.9 cubic feet per second and median flow of 24.4 cubic feet per second at Los Moras Springs.

Edwards Formation

Groundwater is produced from the Edwards Formations portion of the Edwards-Trinity (Plateau) aquifer in a majority 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 pumpage from the Edwards portion of the aquifer in Region F is in the Belding Farms area of 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.

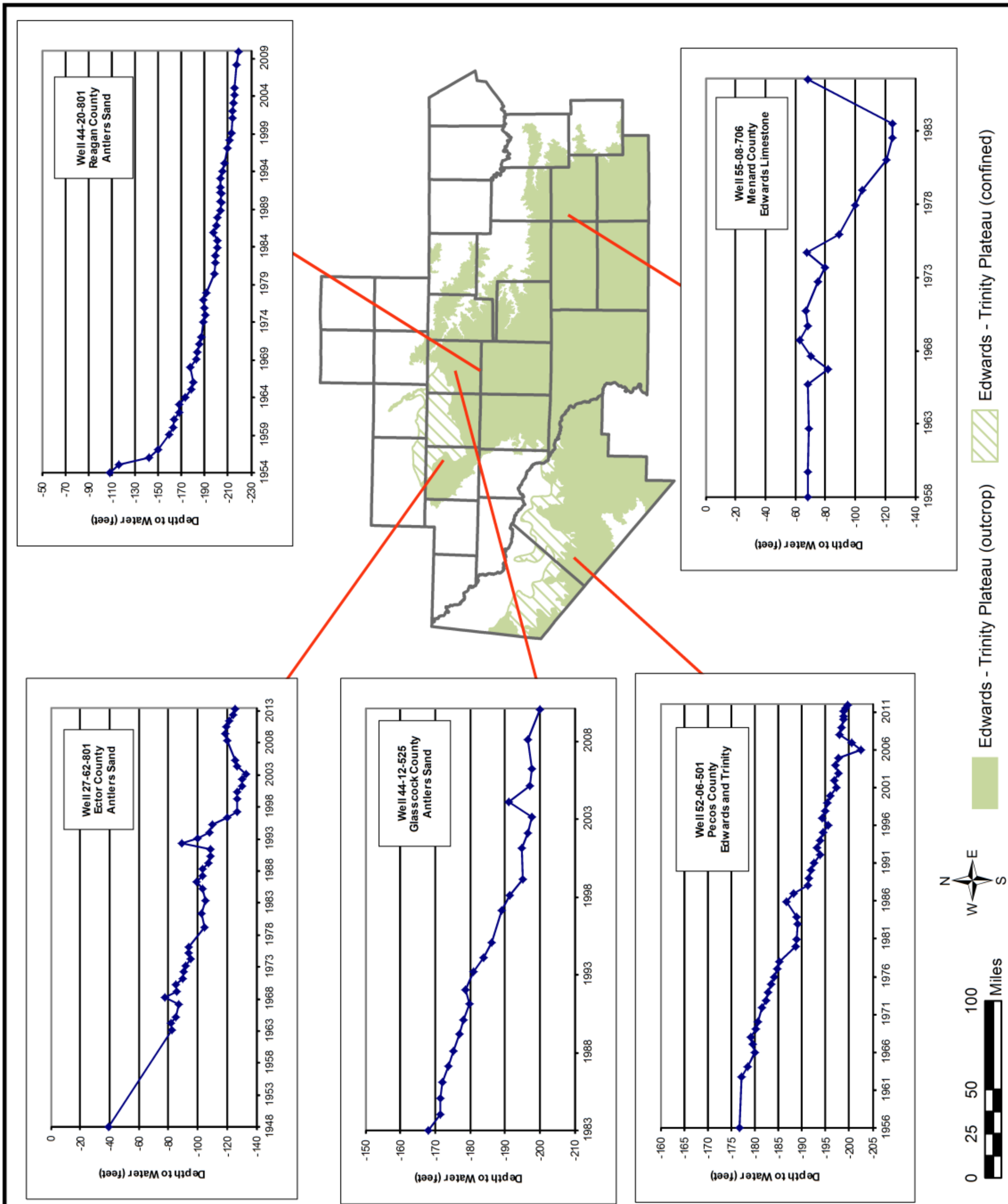
The chemical quality of the Edwards and associated limestones is generally better than that in the underlying Trinity aquifer. Groundwater from the Edwards and associated limestones is fairly uniform in quality, with water being a very hard, calcium bicarbonate type, usually containing less than 500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

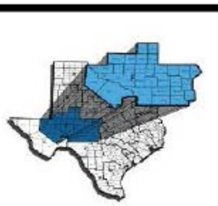
Trinity Group

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 the Saint Lawrence irrigation area 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 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.





Region F

Selected Hydrographs from the Edwards-Trinity (Plateau) Aquifer Showing Declining Water Levels

FN JOB NO	SAN11472
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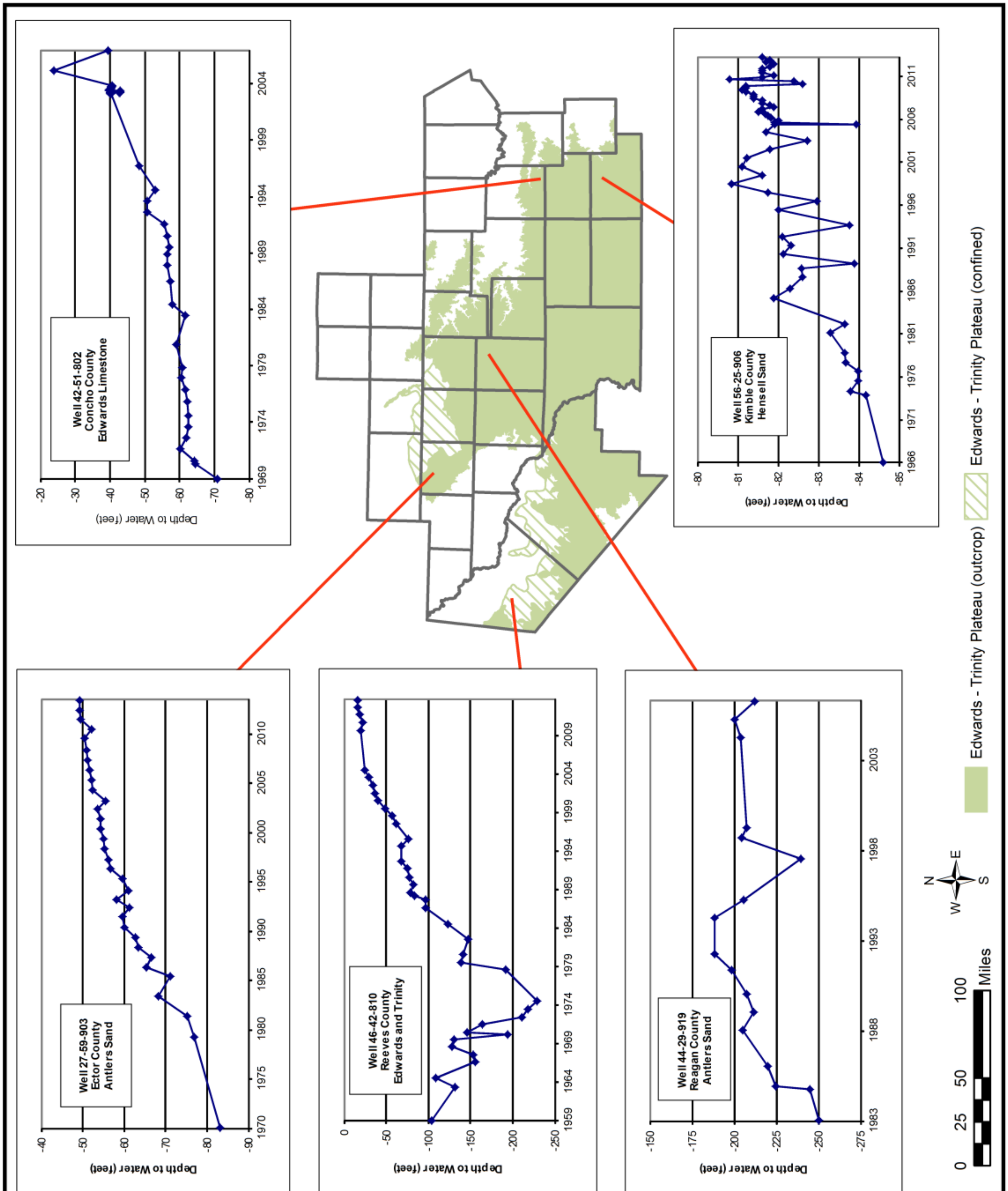
DATE	July, 2014
SCALE	1:0
DESIGNED	JJR
DRAFTED	LAS

3-6

FIGURE



Region F

Selected Hydrographs from the Edwards-Trinity (Plateau) Aquifer Showing Rising Water Levels

FN JOB NO	SAN11472
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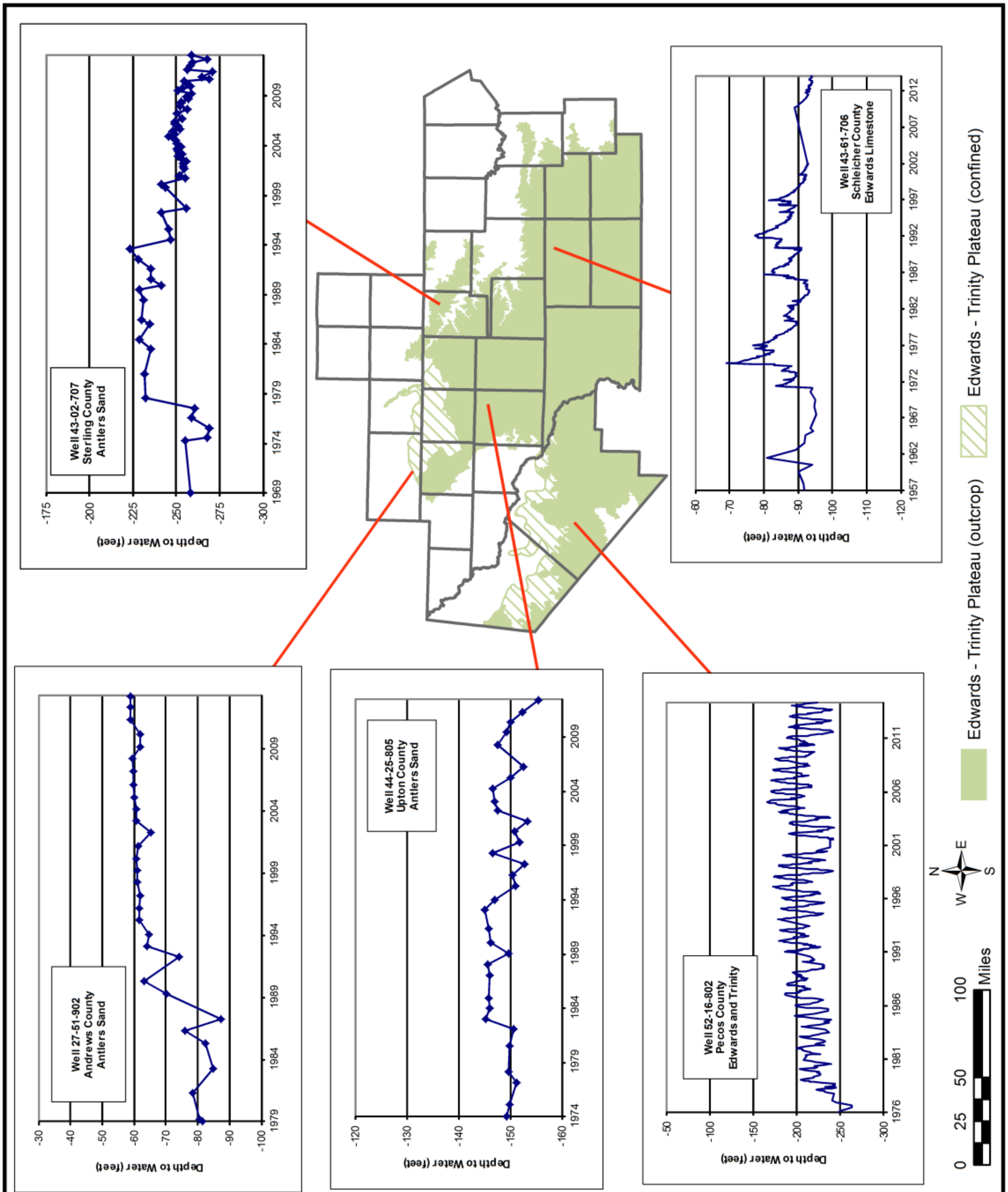
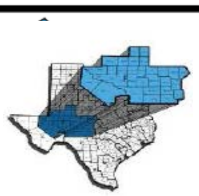
DATE	July, 2014
SCALE	1:0
DESIGNED	JJR
DRAFTED	LAS

3-7

FIGURE





Region F

Selected Hydrographs from the Edwards-Trinity (Plateau) Aquifer Showing Stable Water Levels

FN JOB NO	SAN11472
FILE	TemplateLandscape_LAS.mxd
DATE	July, 2014
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DESIGNED	JJR
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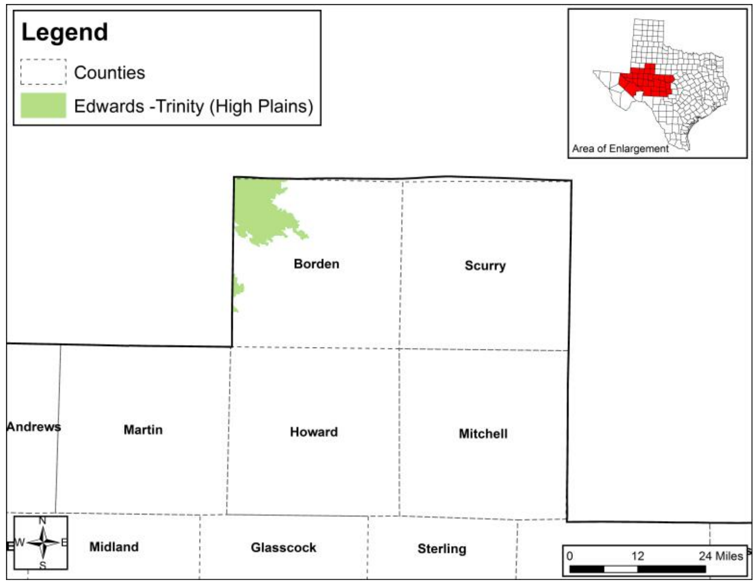
3-8

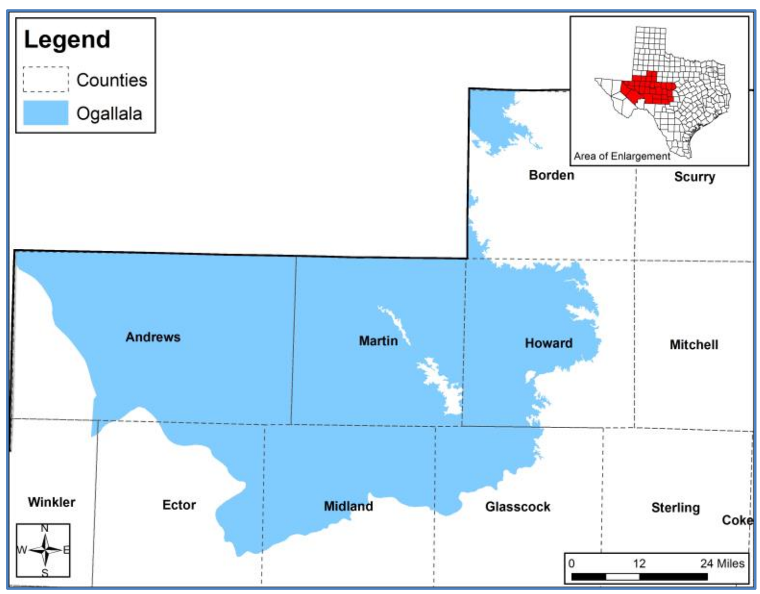
FIGURE

3.1.4 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.

3.1.5 Ogallala Aquifer



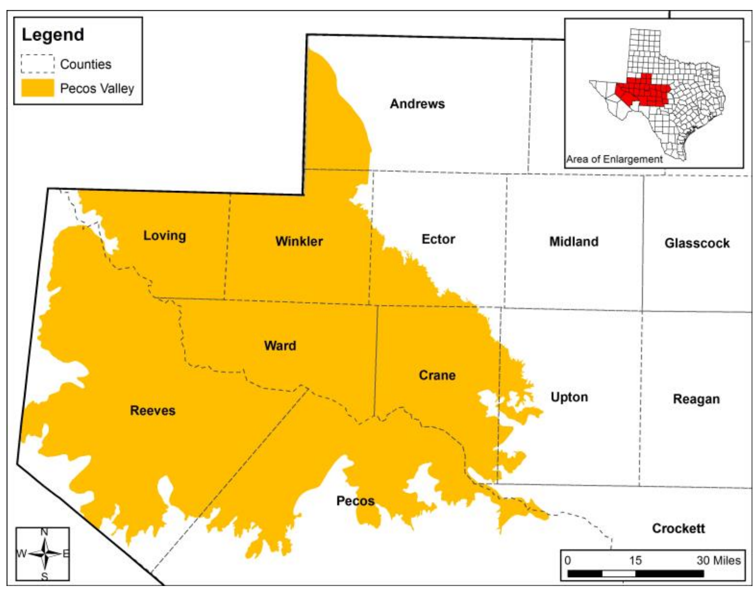
The Ogallala is one of the largest sources of groundwater in the United States, extending from South Dakota to the Southern High Plains of the Texas Panhandle. In Region F, the aquifer occurs in seven counties in the northwestern part of the region including Andrews, Borden, Ector, Howard, Glasscock, Martin and Midland Counties. The aquifer provides approximately 24 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 accounts for approximately 85 percent of the total use of Ogallala groundwater. Municipal use accounts for approximately 12 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.

Two GMAs have defined a DFC for the Ogallala aquifer in Region F. In GMA 7, total decline in volume of water within Ector, Glasscock, and Midland counties over 50 years shall not exceed 50 percent of volume in the aquifer in the year 2010. The Ogallala is not relevant in any other areas of GMA 7. In GMA 2, portions of Andrews, Borden, Martin and Howard counties have DFCs of no more than .675 feet of drawdown per year for the Ogallala aquifer.

3.1.6 Pecos Valley Aquifer



The Pecos Valley aquifer is located in the upper 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.

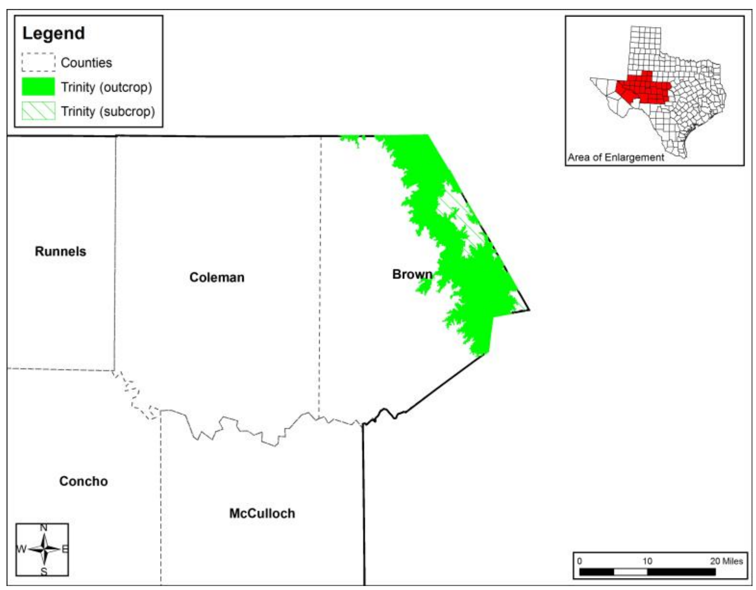
The western basin (Pecos Trough) contains poorer quality water and is used most extensively for irrigation of salt-tolerant crops. The eastern basin (Monument Draw Trough) contains relatively good quality water that is used for a variety of purposes, including industrial use, power generation, and public water supply. Most pumping occurs in Pecos and Reeves Counties for irrigation.

The Pecos Valley is the third most used aquifer in the region, representing approximately 16 percent of total groundwater use. Agricultural irrigation accounts for approximately 80 percent of the total, while municipal consumption and power generation account for about 16 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. However, in Reeves and Pecos Counties water levels have dropped an average of 80 feet.

Two GMAs have set collective DFCs for the Edwards-Trinity Plateau and the Pecos Valley Alluvium. In GMA 3, average total net decline in water levels over 50 years shall not exceed 28 feet below water levels in the aquifers in 2010. In GMA 7, average drawdown shall be 7 feet in counties in Region F.

3.1.7 Trinity Aquifer

The Trinity aquifer is a primary 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) accounts for approximately 80 percent of the total withdrawal from the aquifer.

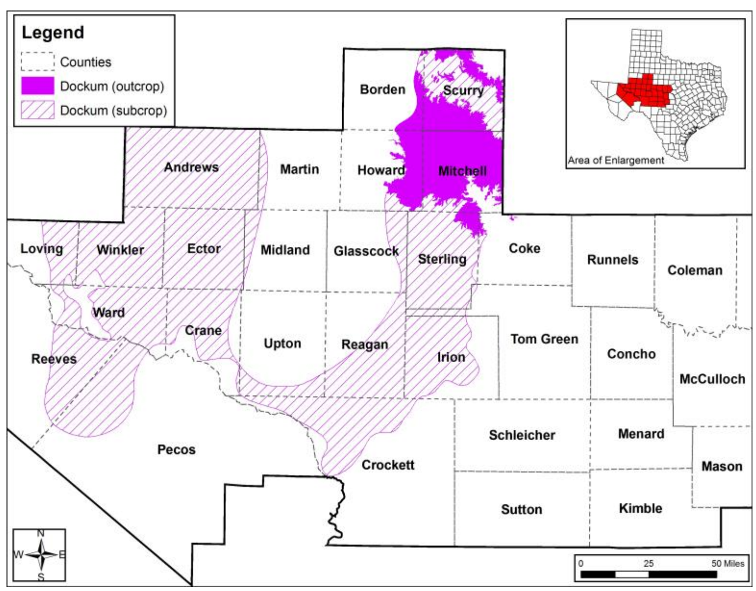


The Trinity was deposited during the Cretaceous Period and is comprised of (from bottom to top) the Twin Mountains, Glen Rose and Paluxy Formations. The Twin Mountains is further divided into the Hosston (lower) and Hensell (upper) with increasing thickness (downdip to the east). In western Brown and 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. 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.

In GMA 8, the Trinity aquifer DFC states that from estimated year 2000 conditions, the average drawdown after 50 years should not exceed (approximately) zero feet in the Paluxy and Glen Rose, and one foot in the Hensell and Hosston in Brown County.

3.1.8 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.

Almost six percent of groundwater withdrawn in the region is from the Dockum. Agricultural irrigation and livestock use account for 75 percent of Dockum pumpage. 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 accounts for about 25 percent of total Dockum use. Mining uses (which include drilling and hydraulic fracking) account for about one percent (based on historical use for years 2007 through 2011).

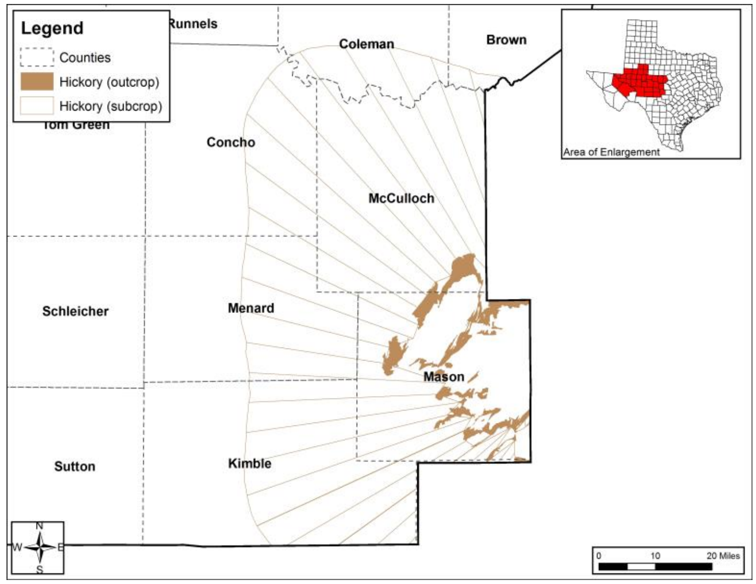
The primary water-bearing zone in the Dockum Group, commonly called the “Santa Rosa”, consists of up to 700 feet of sand and conglomerate interbedded with layers of silt and shale. The Santa Rosa abuts the overlying Trinity aquifer along a corridor that traverses Sterling, Irion, Reagan and Crockett 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 directly from storage and will 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.

Two GMAs in Region F have determined DFCs for the Dockum. In GMA 3, average total net decline in water levels over 50 years shall not exceed 27 feet below water levels in the aquifer in the year 2010. In GMA 7 upper Dockum, the net total drawdown shall not exceed 29 feet in Midland County. In the lower Dockum, net total drawdown shall not exceed four feet in Ector, Mitchell, Pecos, Scurry, and Upton counties (Lone Wolf Groundwater Conservation District, Middle Pecos Groundwater Conservation District); and drawdown not to exceed a net total of 39 feet in Nolan County (West-Tex Groundwater Conservation District). Dockum aquifer determined as not relevant in all other areas of GMA 7 and in GMA 2.

3.1.9 Hickory Aquifer



The Hickory aquifer is located in the eastern portion of Region F and outcrops in Mason and McCulloch Counties. This 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 account for approximately 63 percent of the total pumpage, while municipal water use accounts for approximately 24 percent. Mason County uses the greatest amount of water from the Hickory aquifer, most of which is used for irrigation. McCulloch County pumpage is nearly all for municipal use.

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.

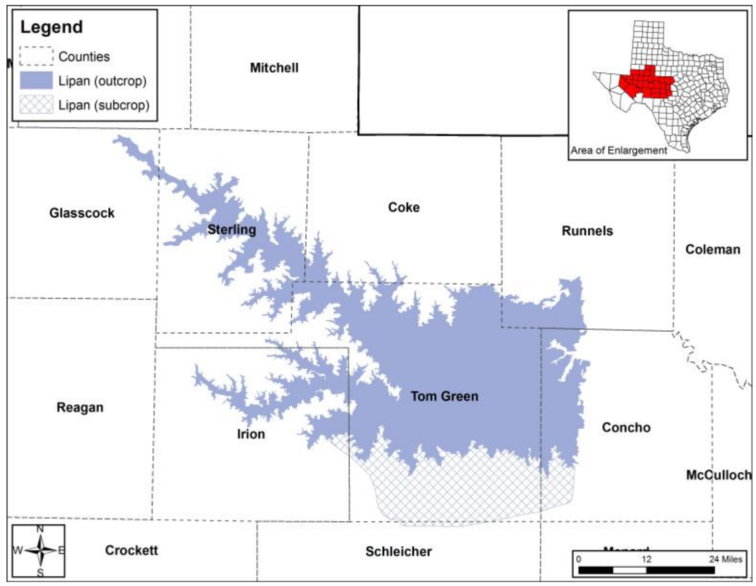
Hickory aquifer water is generally fresh, with dissolved solids concentrations ranging from 300 to 500 mg/l. Much of the water from the Hickory aquifer exceeds drinking water standards for alpha particles, beta particles and radium particles in the downdip portion of the aquifer. The middle Hickory unit 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.

In GMA 7, total net decline in water levels within Hickory Underground Water Conservation District No. 1, Hill Country Underground Water Conservation District, Kimble County Groundwater Conservation District, Menard County Underground Water District, and Llano County and non-district areas in McCulloch and San Saba counties over 50 years shall not exceed seven feet below 2010 levels. The Hickory aquifer is not relevant in all other areas of GMA 7.

3.1.10 Lipan Aquifer

The Lipan aquifer occurs in Concho, Runnels and Tom Green Counties and accounts for about nine percent of regional groundwater use. The aquifer is principally used for irrigation (94 percent) with limited rural domestic and livestock use. Most pumpage 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.



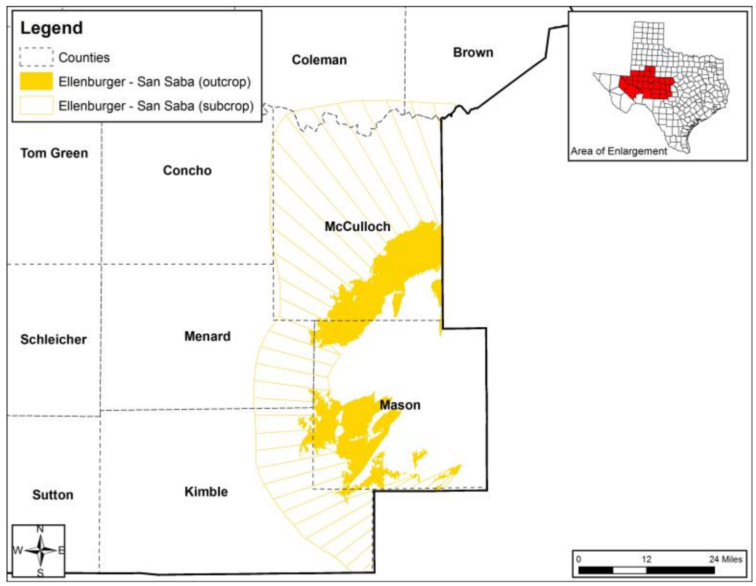
Typical irrigation practice in the area is to withdraw water held in storage in the aquifer during the growing season with expectation of recharge recovery during the winter months. The Lipan-Kickapoo Water Conservation District controls overuse by limiting well density.

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.

The Lipan DFC in GMA 7, states that Lipan-Kickapoo Water Conservation District in Concho, Runnels, and Tom Green counties continue to use 100 percent of all available groundwater annually with annual fluctuations of water levels and zero net drawdown in water levels over the next 50 years. Not relevant outside of district boundaries.

3.1.11 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 one percent of total regional use and most pumpage occurs in McCulloch County. About 80 percent of all use is for livestock and about nine percent is for municipal use. The aquifer is present in only the extreme southern parts of Brown and Coleman counties, and most of the aquifer in this 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.

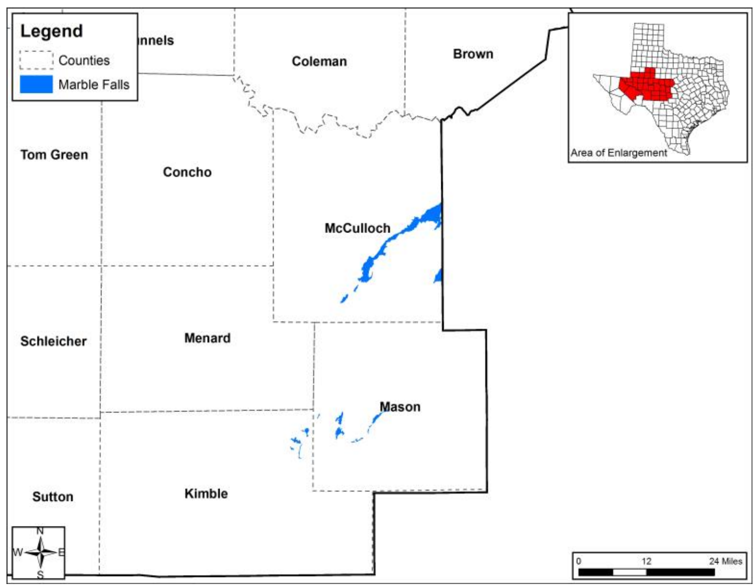
The Ellenburger-San Saba aquifer is comprised of the Cambrian-age San Saba member of the Wilberns Formation and the Ordovician-age Ellenburger Group, which includes the Tanyard, Gorman and Honeycut Formations. Discontinuous outcrops of the aquifer generally encircle older rocks in the core of the Llano 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 Menard County. Maximum yields of large-capacity wells generally range between 200 and 600 gpm, most other wells typically yield less than 100 gpm.

In GMA 7, total net decline in water levels in San Saba County over 50 years shall not exceed seven feet below 2010 water levels in the aquifer. The Ellenburger-San Saba aquifer is determined to be not relevant in all other areas of Groundwater Management Area 7.

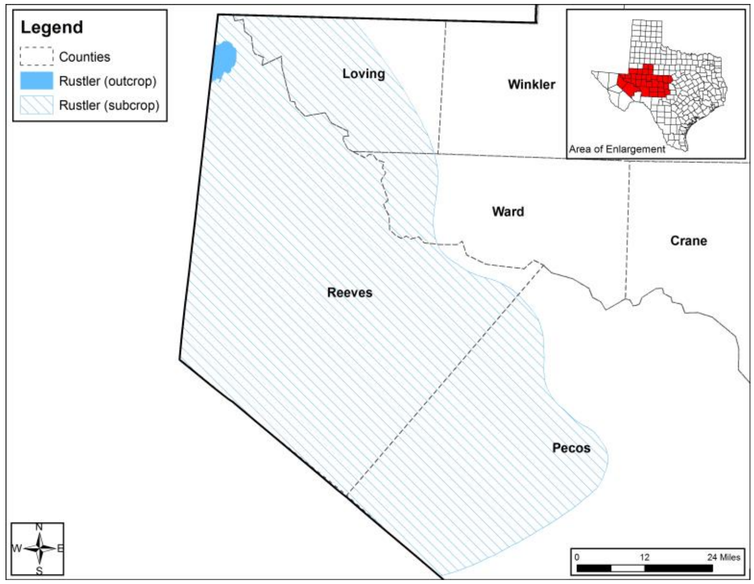
3.1.12 Marble Falls Aquifer



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 one percent of total regional use. Seventy percent is used for irrigation and about 22 percent for livestock. 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, it is the only county with historical pumping estimates in years 2007 through 2011.

3.1.13 Rustler Aquifer



The Rustler Formation outcrops outside of Region F in Culberson County, but the majority of its downdip extent occurs 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.

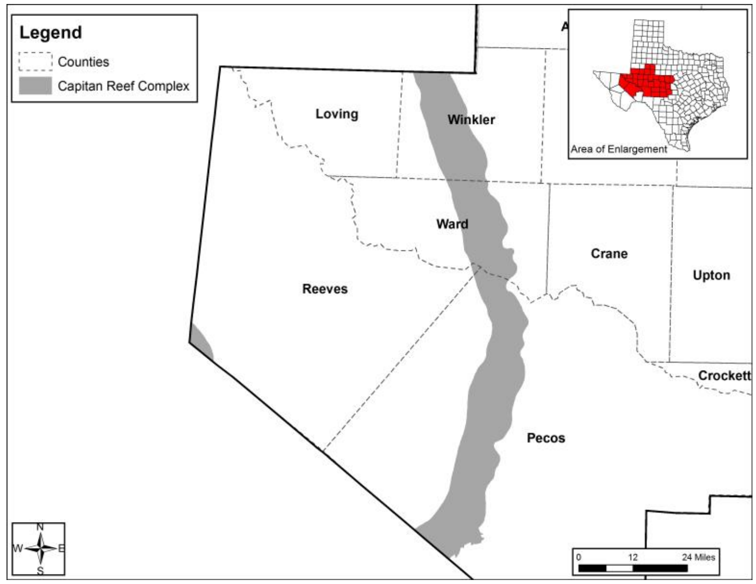
Groundwater from the Rustler Formation may locally migrate upward, impacting water quality in the overlying Edwards-Trinity and Pecos Valley aquifers. The Rustler is the source for about one percent of regional groundwater and is primarily used for irrigation (99 percent), mostly in Pecos and Reeves Counties.

Throughout most of its extent, the Rustler is relatively deep below the land surface, and generally contains water with dissolved constituents (TDS) well in excess of 3,000 mg/l. 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.

Two GMAs have determined DFCs for the Rustler. In GMA 3, the average total net decline in water levels within the unconfined portion in Reeves County over 50 years shall not exceed 15 feet below water levels in the aquifer in 2010; and the average total net decline in water levels within the confined portion in Pecos, Loving, Reeves and Ward counties over 50 years shall not exceed 300 feet below water levels in the aquifer in the year 2010. The aquifer is designated to be not relevant in Crane and Winkler counties.

In GMA 7, the DFC requires that the total net decline in water levels within the Middle Pecos Groundwater Conservation District over 50 years shall not exceed 300 feet below water levels in the aquifer in year 2010. The aquifer was designated as not relevant outside of district boundaries.

3.1.14 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.

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 2007 through 2011 attribute 99 percent of use to irrigation on Pecos County only. The Capitan supplies about 0.5 percent of total groundwater pumpage. 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.

Two GMAs have determined DFCs for the Capitan Reef aquifer. In GMA 3, total net decline in water levels over 50 years shall not exceed 200 feet below water levels in the aquifer in the year 2010. The aquifer was designated to be not relevant in Crane and Loving counties. In GMA 7, total net decline in water levels within the Middle Pecos Groundwater Conservation District over 50 years shall not exceed 15 below water levels in the unconfined portion of the aquifer in the year 2010; and total net decline in water levels over 50 years shall not exceed 200 feet below water levels in the confined portion in the aquifer in year 2010. The aquifer is not relevant outside of district boundaries.

3.1.15 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 outliers of the aquifer in Coke County. Most of the groundwater currently produced from the Blaine is used for 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 quite 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.

3.1.16 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. Table 3-4 includes availability estimates for other aquifers. The 2016 estimates are based upon available historical pumping data for years 2007 through 2011. To derive these estimates, the volume for the year with the highest historical pumping was increased using a multiplier between 1.5 and 3. This methodology was utilized for all but four counties, which are: Menard, Mitchell, Pecos and Tom Green.

For these four counties, reported historical use for "other" aquifer was used as the basis for the reliable supply. However, there is concern that in some cases these historical use amounts may be really associated with a defined major or minor aquifer and misreported as "other" aquifer. For example, it appears evident that pumping in Menard County would only come from the Edwards-Trinity Plateau, Ellenburger-San Saba, or the Hickory, as there is no "other" aquifer in Menard County. In some occurrences this might result in overestimating supplies, as it could likely also be accounted for under the correct aquifer.

Table 3-4
Groundwater Supplies from Other Aquifers

County	Aquifer Name	Basin	2016 Availability(ac-ft/yr)
Borden	Other Aquifer	Colorado	2,598
Brown	Other Aquifer	Colorado	993
Coke	Other Aquifer	Colorado	2,100
Coleman	Other Aquifer	Colorado	217
Concho	Other Aquifer	Colorado	5,964
Crane	Other Aquifer	Rio Grande	606
Irion	Other Aquifer	Colorado	1,731
Mason	Other Aquifer	Colorado	873
McCulloch	Other Aquifer	Colorado	4,279
Menard	Other Aquifer	Colorado	60
Mitchell	Other Aquifer	Colorado	789
Pecos	Other Aquifer	Rio Grande	5
Runnels	Other Aquifer	Colorado	5,001
Scurry	Other Aquifer	Brazos	51
		Colorado	315
Sterling	Other Aquifer	Colorado	1,359
Tom Green	Other Aquifer	Colorado	3,000

3.2 Existing Surface Water Supplies

In the year 2011, approximately 179,000 acre-feet of surface water was used in Region F, supplying 26 percent of the water supply in the region. Surface water from reservoirs provided 52 percent of the municipal water supply in Region F in 2011. Run-of-the-river water rights are used primarily for irrigation.

municipal water supply in Region F in 2011. Run-of-the-river water rights are used primarily for irrigation. Table 3-5 shows information regarding the 17 major reservoirs in Region F. Figure 3-9 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. 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 salt water control. The CRMWD reservoirs are located 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 located 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 droughts have left the two upper reservoirs (J.B. Thomas and E.V. Spence) at storage levels less than 2 percent of conservation capacity prior to capturing some water in 2014 and 2015. O.H. Ivie is currently at less than 15 percent capacity (as of September 2015).

Lake Colorado City/ Champion Creek Reservoir System

Lake Colorado City and Champion Creek Reservoir are located 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.

Table 3-5 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)	2013 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	0	CRMWD	CRMWD
Lake Colorado City	Colorado	Morgan Creek	Mitchell	CA-1009	11/22/1948	29,934	5,500	3,200	Luminant Generation Company	Luminant Generation Company
Champion Creek Reservoir	Colorado	Champion Creek	Mitchell	CA-1009	4/8/1957	40,170	6,750	No data	Luminant Generation Company	Luminant Generation Company
Oak Creek Reservoir	Colorado	Oak Creek	Coke	CA-1031	4/27/1949	30,000	10,000	500	City of Sweetwater	City of Sweetwater
Lake Coleman	Colorado	Jim Ned Creek	Coleman	CA-1702	8/25/1958	40,000	9,000	900	City of Coleman	City of Coleman
E V Spence Reservoir	Colorado	Colorado River	Coke	CA-1008	8/17/1964	488,760	43,000	8,300	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	400	City of Winters	City of Winters
Lake Brownwood	Colorado	Pecan Bayou	Brown	CA-2454	9/29/1925	114,000	29,712	9,700	Brown Co. WID	Brown Co. WID
Hords Creek Lake	Colorado	Hords Creek	Coleman	CA-1705	3/23/1946	7,959	2,240	46	COE	City of Coleman
Lake Ballinger	Colorado	Valley Creek	Runnels	CA-1072	10/4/1946	6,850	1,000	300	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	49,000	CRMWD	CRMWD
O.C. Fisher Lake	Colorado	North Concho River	Tom Green	CA-1190	5/27/1949	80,400	80,400	No data	COE	Upper Colorado River Authority
Twin Buttes Reservoir	Colorado	S. Concho River	Tom Green	CA-1318	5/6/1959	170,000	29,000	No data	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	No data	City of San Angelo	City of San Angelo
Brady Creek Reservoir	Colorado	Brady Creek	McCulloch	CA-1849	9/2/1959	30,000	3,500	65	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	0	Red Bluff WCD	Red Bluff WCD
Lake Balmorhea	Rio Grande	Toyah Creek	Reeves	A-0060 P-0057	10/5/1914	13,583	41,400	16,650	Reeves County WID #1	Reeves County WID #1
Total						***2,158,136***	***723,757***	***89,061***		

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 3-9

Major Reservoirs

Region F

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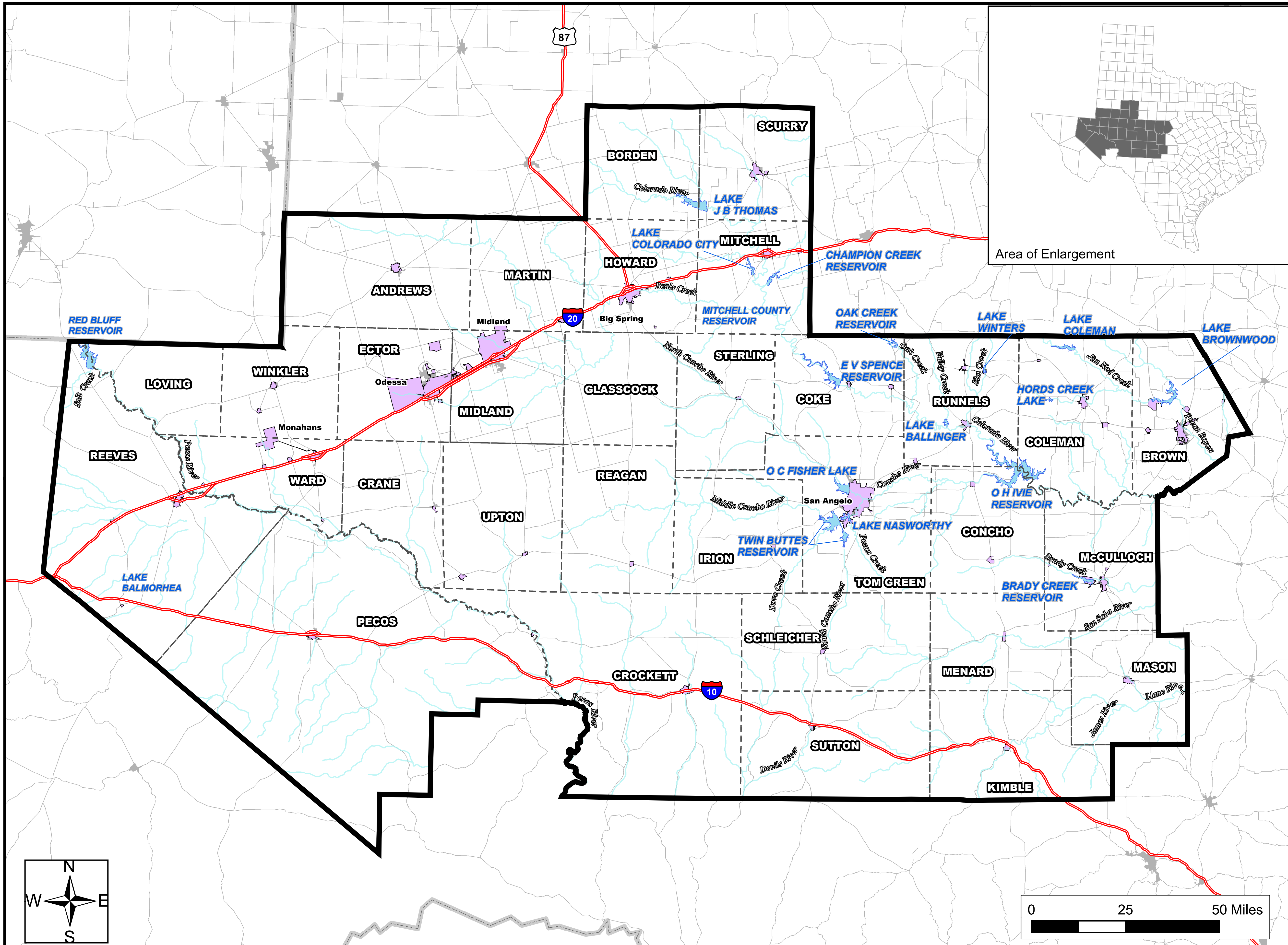


Twin Buttes Reservoir

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.

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 located 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. That facility is currently mothballed, but could be restarted in the future.

Lake Coleman

Lake Coleman is constructed on Jim Ned Creek in Coleman County, approximately 14 miles north of the City of Coleman. It is located 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.

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. At this time, New Mexico has a credit towards its Texas deliveries, which could substantially reduce water supplies to Red Bluff Reservoir during drought.

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. Imperial Lake, which is located in Pecos County and considered part of the Red Bluff system, currently has total dissolved solids concentrations greater than 10,000 mg/l. Other water quality concerns include low dissolved oxygen and golden algae.

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 earthfill 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[1]. 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.

In light of the ongoing drought in the region, the TCEQ recently extended the Colorado WAM through December 2013 to better capture current conditions (previous WAM hydrology only went through 1998). Under the extended Colorado WAM, many sources have significantly lower firm and safe yields due to recent drought worse than the drought of record. Table 3-6 and Table 3-7 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 3-6
Comparison of WAM Firm Yields of Region F Reservoirs under Different Planning Assumptions
-Values in Acre-Feet per Year-

Reservoir Name	Basin	WAM Firm Yield	WAM Safe Yield
Lake J. B. Thomas	Colorado	0	0
E. V. Spence Reservoir	Colorado	0	0
O. H. Ivie Reservoir	Colorado	43,400	36,000
Lake Colorado City	Colorado	0	0
Champion Creek Reservoir	Colorado	0	0
Oak Creek Reservoir	Colorado	0	0
Lake Coleman	Colorado	0	0
Lake Winters/ New Lake Winters	Colorado	0	0
Lake Brownwood	Colorado	24,000	18,760
Hords Creek Lake	Colorado	0	0
Lake Ballinger / Lake Moonen	Colorado	0	0
O. C. Fisher Lake	Colorado	0	0
Twin Buttes Reservoir	Colorado	0	0
Lake Nasworthy	Colorado	0	0
Brady Creek Reservoir	Colorado	0	0
Red Bluff Reservoir	Rio Grande	41,725	33,600
Lake Balmorhea [a]	Rio Grande	21,844	21,844
Total		***130,969***	***110,204***

a. The yield from Lake Balmorhea is assumed to be the minimum annual supply from the springs that feed the reservoir. The yield is not based on the WAM model.

Table 3-7
Region F Run-of-the-River Supplies by County and River Basin[a]
-Values in Acre-Feet per Year-

County	WAM Supplies	County	WAM Supplies
Colorado River Basin		Menard	2,243
Andrews	0	Midland	0
Borden	0	Mitchell	14
Brown	284	Reagan	0
Coke	16	Reeves	0
Coleman	27	Runnels	262
Concho	37	Schleicher	0
Crane	0	Scurry	0
Crockett	0	Sterling	30
Ector	0	Sutton	2
Howard	0	Tom Green	1,969
Irion	221	Upton	0
Kimble	1,148	Ward	0
Loving	0	Winkler	0
Martin	0	*Rio Grande River Basin*	
Mason	0	Pecos [b]	4,444
McCulloch	69	*Total*	*10,766*

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. Table 3-8 shows the availability in each county and river basin.

Table 3-8
Local Supplies in Region F
-Values in Acre-Feet per Year-

County	Basin	Local Supply	County	Basin	Local Supply
Andrews	Colorado	63	Menard	Colorado	86
Andrews	Rio Grande	14	Midland	Colorado	117
Borden	Colorado	251	Mitchell	Colorado	381
Brown	Brazos	27	Pecos	Rio Grande	52
Brown	Colorado	1,296	Reagan	Colorado	41
Coke	Colorado	370	Reagan	Rio Grande	3
Coleman	Colorado	1,081	Reeves	Rio Grande	68
Concho	Colorado	123	Runnels	Colorado	1,148
Crane	Rio Grande	21	Schleicher	Colorado	83
Crockett	Colorado	11	Schleicher	Rio Grande	29
Crockett	Rio Grande	127	Scurry	Brazos	198
Ector	Colorado	11	Scurry	Colorado	336
Glasscock	Colorado	40	Sterling	Colorado	74
Howard	Colorado	62	Sutton	Colorado	46
Irion	Colorado	67	Sutton	Rio Grande	57
Kimble	Colorado	89	Tom Green	Colorado	1,644
Loving	Rio Grande	10	Upton	Colorado	13
Martin	Colorado	67	Upton	Rio Grande	23
Mason	Colorado	984	Ward	Rio Grande	5
McCulloch	Colorado	164	Winkler	Rio Grande	7

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. Although water initially used for agricultural and industrial purposes can be recycled, this discussion will focus on reuse of treated municipal wastewater effluent. In Region F, treated wastewater effluent has been used for agricultural irrigation and some industrial purposes for many years. The use of wastewater effluent for other purposes 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 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 TWDB notes three important advantages of the use of reclaimed water:

- Effluent from municipal wastewater plants is a drought-proof supply.
- Treated effluent is the only source of water that automatically increases as economic and population growth occurs in the community.
- The source of treated effluent is usually located near the intended use, not at some yet-to-be developed, distant reservoir or well field.[2]

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.

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. The City of Odessa provides reuse water for industrial, irrigation and residential irrigation users. San Angelo has historically used reuse water to irrigate city-owned farms or has sold the effluent to other irrigators. The Cities of Andrews, Crane, and Eden employ reuse supplies to irrigate golf courses. Colorado City provides reuse water for irrigation purposes. Midland is in the process of implementing a direct non potable reuse project to supply landscape irrigation water to Midland College.

The first ever direct potable reuse water supply project was recently developed in Region F by the Colorado River Municipal Water District (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 3-9.

Table 3-9
Reuse Water Supply in Region F
-Values in Acre-Feet per Year-

County	Basin	2020	2030	2040	2050	2060	2070
Andrews	Colorado	560	560	560	560	560	560
Concho	Colorado	224	224	224	224	224	224
Crane	Rio Grande	73	73	73	73	73	73
Ector	Colorado	6,720	6,720	6,720	6,720	6,720	6,720
Howard	Colorado	1,855	1,855	1,855	1,855	1,855	1,855
Midland	Colorado	5,987	5,987	5,987	5,987	5,987	5,987
Mitchell	Colorado	552	552	552	552	552	552
Runnels	Colorado	218	218	218	218	218	218
Scurry	Colorado	110	110	110	110	110	110
Tom Green	Colorado	8,500	8,500	8,500	8,500	8,500	8,500
Ward	Rio Grande	670	670	670	670	670	670

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 3-10, 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 purpose.

Table 3-10
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 Aquifer	Fresh/Brackish	
Dockum Aquifer	Brackish	
Lipan Aquifer	Brackish	Nitrates
Ellenberger San Saba Aquifer	Fresh/Brackish	Hardness
Marble Falls Aquifer	Fresh/Brackish	
Rustler Falls Aquifer	Brackish	
Capitan Reef Aquifer	Brackish	
Blaine Aquifer	Brackish (small pockets of fresh)	Gypsum, halite, and anhydrite

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

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.

Two brackish resources within Region F that are currently not used are included in this planning cycle. These resources include the Ellenburger-San Saba and Hickory aquifers in Brown County. These resources were added as a direct result of recent test wells drilled for the City of Brownwood. Availability estimates are based on the production volumes from these wells. TDS concentrations from the test wells in these formations are 2,500 and 76,000, respectively.

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 in order 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.

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 are 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, the Colorado River Municipal Water District (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 (Shirazi and Arroyo, 2011). 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.

A major treatment facility for brackish water currently operating in Region F is at Fort Stockton. The City of Fort Stockton draws water from the Edwards-Trinity aquifer that must be treated to reduce TDS to acceptable levels. The 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 60:40. 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 800 mg/l TDS. Concentrate streams are disposed of using evaporation ponds. Future plans for the Fort Stockton facility include the possible installation of a dedicated treatment train for the city's industrial customers.[3,4]

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 which 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 is constructing a reverse osmosis facility to treat water for high radionuclide levels that is expected to be complete in 2015. 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

Currently available supplies in each county are shown in Table 3-11. The total of the currently available supply by use type is shown in Figure 3-10. Unlike the overall water availability figures 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. Summary tables included within Appendix J present the currently available water available for each water user group (WUG), arranged by county. (Water user groups are cities with populations greater than 500, water suppliers who serve an average of at least 0.25 million gallons per day (MGD) annually, "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. In addition, a significant portion of the mining demand in Brown and Crane Counties appears to be based on recirculated surface water from exempt sources. Therefore, a supply to meet the demand is assumed to come from exempt sources to prevent an unwarranted shortage.

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, and Steam Electric Power in Ector County whose supply is located in Region O. Supply to current users in Region F is from sources located outside of Region F represents about one half of one 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 Abilene (G), Rotan (G), Sweetwater (G), Clyde (G), and the portions of Richland (K) and Coleman County (G) SUDs not located in Region F. A little over one percent of Region F's current supplies goes to supply users in other regions.

Figure 3-10
Supplies Currently Available to Water User Groups by Type of Use

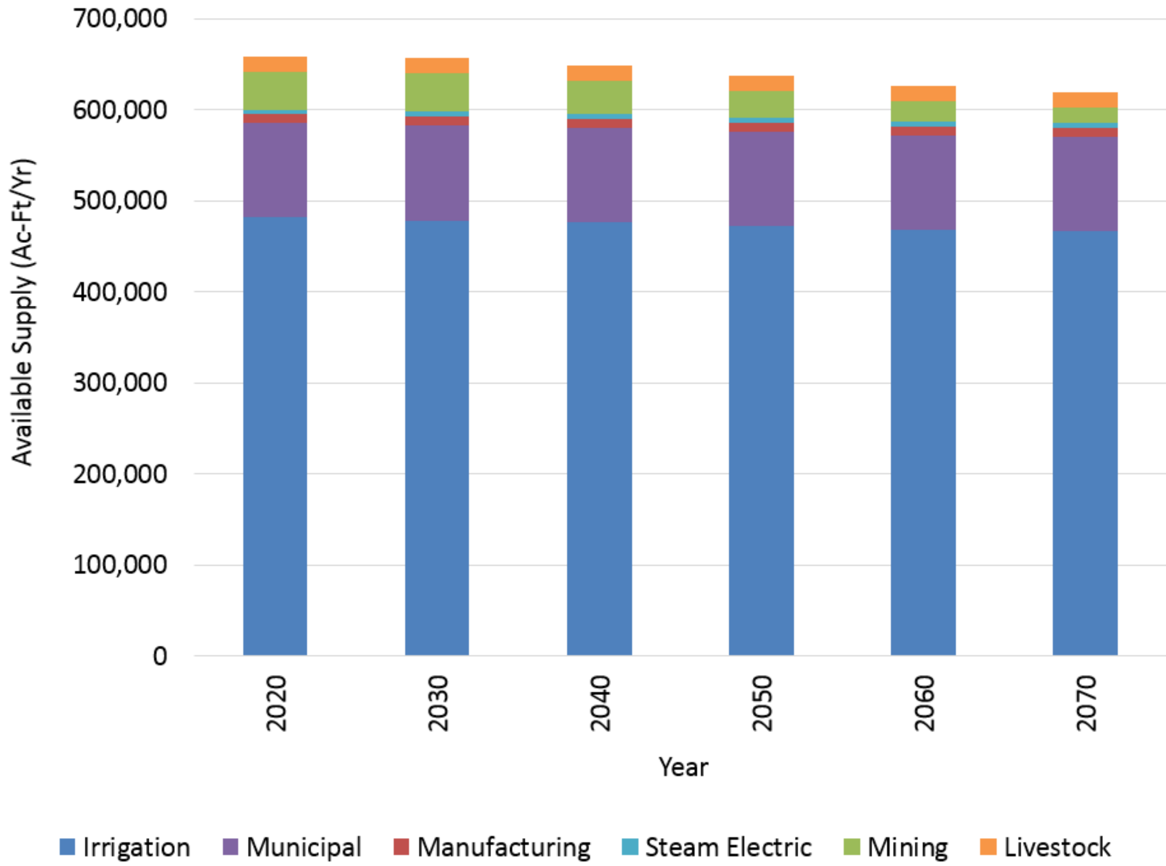


Table 3-11
Summary of Currently Available Supply to Water Users by County [a]
-Values in Acre-Feet per Year-

County	2020	2030	2040	2050	2060	2070
Andrews	14,056	12,898	12,069	10,166	7,670	7,673
Borden	1,864	2,112	1,971	1,681	1,431	1,308
Brown	15,350	15,381	15,308	15,281	15,332	15,403
Coke	1,561	1,554	1,547	1,545	1,545	1,545
Coleman	1,493	1,488	1,478	1,474	1,473	1,474
Concho	6,079	6,092	6,077	6,065	6,058	6,054
Crane	2,221	2,559	2,672	2,600	2,523	2,472
Crockett	3,298	3,390	3,393	3,403	3,056	2,906
Ector	27,686	34,903	35,103	34,934	34,695	34,433
Glasscock	60,554	59,780	58,603	57,440	56,409	55,659
Howard	9,088	10,364	9,885	9,398	8,978	8,618
Irion	2,956	2,918	2,878	2,844	2,152	1,750
Kimble	2,108	2,102	2,095	2,092	2,091	2,091
Loving	904	1,169	1,045	873	712	585
Martin	12,184	12,294	13,167	12,330	12,282	12,256
Mason	11,229	11,010	10,643	10,376	10,148	9,943
McCulloch	9,150	9,171	9,075	9,019	8,405	7,792
Menard	3,850	3,832	3,710	3,583	3,473	3,378
Midland	71,460	61,128	58,394	57,620	57,026	56,832
Mitchell	14,728	14,952	14,804	14,625	14,471	14,353
Pecos	133,976	134,731	135,126	135,295	135,464	135,643
Reagan	24,423	23,356	22,138	20,811	19,650	19,033
Reeves	98,027	98,562	97,893	96,796	95,713	94,703
Runnels	3,714	3,799	3,758	3,730	3,704	3,681
Schleicher	3,533	3,645	3,452	3,255	3,068	2,946
Scurry	2,939	3,612	3,531	3,485	3,446	3,405
Sterling	2,376	2,514	2,331	2,000	1,708	1,540
Sutton	4,225	4,528	4,557	4,366	4,175	4,034
Tom Green	76,524	76,469	76,364	76,175	76,035	75,877
Upton	14,564	13,836	13,007	11,977	11,050	10,625
Ward	12,964	13,294	13,250	13,150	13,034	12,960
Winkler	8,432	8,835	8,678	8,490	8,302	8,179
Total	*657,516*	*656,278*	*648,002*	*636,879*	*625,279*	*619,151*

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 Wholesale Water Providers

There are seven designated wholesale water providers in Region F. A wholesale water provider has wholesale water contracts for 1,000 acre-feet per year or more, or is expected to contract for 1,000 acre-feet per year or more over the planning period. Similar to the currently available supply for water user groups, the currently available supply for each wholesale 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 wholesale water provider is included in Table 3-12. Brief descriptions of the supply sources are presented below.

Table 3-12
Currently Available Supplies for Wholesale Water Providers
-Values in Acre-Feet per Year-

Major Water Provider	Source	2020	2030	2040	2050	2060	2070
BCWID	Lake Brownwood [a]	18,760	18,620	18,480	18,340	18,200	18,060
	Subtotal	*18,760*	*18,620*	*18,480*	*18,340*	*18,200*	*18,060*
CRMWD	Lake Ivie [b]	36,030	35,010	33,990	32,970	31,950	30,930
	Spence Reservoir [b]	0	0	0	0	0	0
	Thomas Reservoir [b]	1855	1855	1855	1855	1855	1855
	Big Spring Reuse						
	Ward County Well Field [c]	9,500	9500	9500	9500	9500	9500
	Martin County Well Field	398	403	441	420	426	433
	Ector County Well Field	0	0	0	0	0	0
	Scurry County Well Field	0	0	0	0	0	0
	Subtotal	*47,783*	*46,768*	*45,786*	*44,745*	*43,731*	*42,718*
Texland Great Plains Water System	Andrews and Gaines Counties Well Fields [d]	4,063	3,616	2,888	2,757	2,558	2,556
	Subtotal	*4,063*	*3,616*	*2,888*	*2,757*	*2,558*	*2,556*
City of Odessa	CRMWD System [b]	13,187	19,863	20,077	20,196	20,261	20,261
	Direct Reuse (Non-potable)	6,720	6,720	6,720	6,720	7,000	7,000

Major Water Provider	Source	2020	2030	2040	2050	2060	2070
	Subtotal	*19,907*	*26,583*	*26,797*	*26,916*	*27,261*	*27,261*
UCRA	O.C. Fisher Reservoir [b]	0	0	0	0	0	0
	Mountain Creek Reservoir [b]	0	0	0	0	0	0
	Subtotal	*0*	*0*	*0*	*0*	*0*	*0*
City of San Angelo	Twin Buttes/Nasworthy [b]	0	0	0	0	0	0
	O.C. Fisher Reservoir [b]	0	0	0	0	0	0
	Spence Reservoir [e]	0	0	0	0	0	0
	Lake Ivie [f]	5,959	5,791	5,622	5,453	5,285	5,116
	Concho River	214	214	214	214	214	214
	Direct Reuse - Irrigation	8,300	8,300	8,300	8,300	8,300	8,300
	McCulloch County Well Field (Hickory Aquifer)	3,997	3,997	4,030	4,047	4,050	4,047
	Subtotal	*18,470*	*18,302*	*18,166*	*18,014*	*17,849*	*17,677*
University Lands	CRMWD Ward Co Well Field [c]	5,200	5,200	5,200	5,200	5,200	5,200
	Midland Paul Davis Well Field [g]	2,057	1,997	0	0	0	0
	City of Andrews Well Field [h]	496	383	359	307	226	225
	Upton County Water District Well Field	130	130	130	130	130	130
	Subtotal	*7,883*	*7,710*	*5,689*	*5,637*	*5,556*	*5,555*
	Total	***116,866***	***121,599***	***117,806***	***116,409***	***115,155***	***113,827***

a. Yield of Lake Brownwood limited by water right.
b. Safe yield from the Colorado WAM. See subordination strategy for actual supply used in planning.
c. Contract between CRMWD and University Lands expires in 2019.
d. Region F supplies only.
e. Supplies from Spence Reservoir currently not available to the City of San Angelo pending rehabilitation of Spence pipeline.
f. For planning purposes supplies limited to 16.54 percent of the safe yield of Ivie Reservoir.
g. Contract between University Lands and the City of Midland expires in 2035. Current supplies estimated at 4,722 acre-feet per year.
h. Contract between University Lands and the City of Andrews expires in 2033. Current supplies estimated at 20% of the city's demands.

Colorado River Municipal Water District (CRMWD).

CRMWD supplies raw water from Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir, and well fields in Ward and Martin Counties. CRMWD is no longer using the well fields in Scurry and Ector Counties due to diminished supplies. CRMWD also supplies reclaimed water from its Big Spring reuse project. Water for oil and gas production, which is classified as a mining use, is supplied from several chloride control projects. CRMWD owns and operates more than 600 miles of 18-inch to 60-inch water transmission lines to provide water to its member cities and customers.[5]

Brown County Water Improvement District Number One (BCWID).

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 mgd. Other customers divert water directly from the lake.

Upper Colorado River Authority (UCRA).

The UCRA owns water rights in O.C. Fisher Reservoir in Tom Green County and Mountain Creek Lake in Coke County. O.C. Fisher supplies are contracted to the Cities of San Angelo and Miles, and Mountain Creek Lake supplies are contracted to the City of Robert Lee.

Great Plains Water Supply System, Ltd.

The Great Plains Water Supply System (Great Plains) provides water to customers in Region F from 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, although a small amount of municipal water has been supplied to rural Ector County as well. The provider's largest customer is a steam electric operation in Ector County.

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, and treated effluent to industrial users and municipal irrigation users.

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, local surface water rights, 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. The City 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 is currently used for irrigation.

University Lands.

University Lands manages properties belonging to the University of Texas System in West Texas. University Lands does not directly supply water; CRMWD, the City of Midland, the City of Andrews, and Upton County Water District have developed water well fields on property managed by University Lands. The well fields produce water from the Pecos Valley aquifer in Ward County, the Ogallala aquifer in Martin and Andrews Counties, and the Edwards Trinity aquifer in Upton County.

LIST OF REFERENCES

1 Texas Water Development Board. *Exhibit C Guideline for Regional Water Plan Development*, October 2012.

2 Krishna, Hari J. "Water Reuse in Texas." Texas Water Development Board, 21 Feb. 2005. <http://www.twdb.state.tx.us/assistance/conservation/Municipal/Reuse/ReuseArticle.asp>.

3 Mickley, Michael C. *Membrane Concentrate Disposal: Practices and Regulations*. Prepared for U.S. Department of Interior, Bureau of Reclamation, Sept. 2001.

4 Phone conversation with Cindy Hollander, City of Fort Stockton, 2/22/05.

5 Colorado River Municipal Water District. *District Operations.* <www.crmwd.org/op.htm>.

Attachment 3A

Existing Water Supplies by Water User Group

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
		2020	2030	2040	2050	2060	2070
ANDREWS COUNTY							
COLORADO BASIN							
ANDREWS	F | OGALLALA AQUIFER | ANDREWS COUNTY	2,683	2,835	3,049	2,358	1,736	1,735
COUNTY-OTHER	F | OGALLALA AQUIFER | ANDREWS COUNTY	291	276	276	252	200	213
MANUFACTURING	F | OGALLALA AQUIFER | ANDREWS COUNTY	31	29	28	20	14	12
MINING	F | DOCKUM AQUIFER | ANDREWS COUNTY	13	13	13	13	13	13
MINING	F | OGALLALA AQUIFER | ANDREWS COUNTY	1,262	979	469	399	293	293
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	63	63	63	63	63	63
LIVESTOCK	F | DOCKUM AQUIFER | ANDREWS COUNTY	9	9	9	9	9	9
LIVESTOCK	F | OGALLALA AQUIFER | ANDREWS COUNTY	139	124	116	99	73	73
IRRIGATION	F | DIRECT REUSE	560	560	560	560	560	560
IRRIGATION	F | OGALLALA AQUIFER | ANDREWS COUNTY	8,870	7,901	7,414	6,323	4,643	4,636
COLORADO BASIN TOTAL EXISTING SUPPLY		**13,921**	**12,789**	**11,997**	**10,096**	**7,604**	**7,607**
RIO GRANDE BASIN							
COUNTY-OTHER	F | OGALLALA AQUIFER | ANDREWS COUNTY	2	2	2	1	1	1
MINING	F | OGALLALA AQUIFER | ANDREWS COUNTY	73	54	17	15	11	11
LIVESTOCK	F | RIO GRANDE LIVESTOCK LOCAL SUPPLY	14	14	14	14	14	14
IRRIGATION	F | OGALLALA AQUIFER | ANDREWS COUNTY	48	39	39	40	40	40
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**137**	**109**	**72**	**70**	**66**	**66**
ANDREWS COUNTY TOTAL EXISTING SUPPLY		**14,058**	**12,898**	**12,069**	**10,166**	**7,670**	**7,673**
BORDEN COUNTY							
BRAZOS BASIN							
COUNTY-OTHER	F | OGALLALA AQUIFER | BORDEN COUNTY	10	11	13	13	12	12
LIVESTOCK	F | BRAZOS LIVESTOCK LOCAL SUPPLY	17	17	17	17	17	17
IRRIGATION	F | OGALLALA AQUIFER | BORDEN COUNTY	259	259	261	261	261	261
BRAZOS BASIN TOTAL EXISTING SUPPLY		**286**	**287**	**291**	**291**	**290**	**290**
COLORADO BASIN							
COUNTY-OTHER	F | OGALLALA AQUIFER | BORDEN COUNTY	22	21	19	19	19	19
COUNTY-OTHER	F | OTHER AQUIFER | BORDEN COUNTY	74	74	74	74	74	74
COUNTY-OTHER	O | OGALLALA AQUIFER | DAWSON COUNTY	72	72	72	72	72	72
MINING	F | OTHER AQUIFER | BORDEN COUNTY	679	927	784	494	244	121
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	233	233	233	233	233	233
IRRIGATION	F | OGALLALA AQUIFER | BORDEN COUNTY	95	95	95	95	96	96
IRRIGATION	F | OTHER AQUIFER | BORDEN COUNTY	403	403	403	403	403	403
COLORADO BASIN TOTAL EXISTING SUPPLY		**1,578**	**1,825**	**1,680**	**1,390**	**1,141**	**1,018**
BORDEN COUNTY TOTAL EXISTING SUPPLY		**1,864**	**2,112**	**1,971**	**1,681**	**1,431**	**1,308**
BROWN COUNTY							
BRAZOS BASIN							
COUNTY-OTHER	F | TRINITY AQUIFER | BROWN COUNTY	7	7	7	7	7	7
LIVESTOCK	F | BRAZOS LIVESTOCK LOCAL SUPPLY	27	27	27	27	27	27
IRRIGATION	F | TRINITY AQUIFER | BROWN COUNTY	21	21	21	21	21	21
BRAZOS BASIN TOTAL EXISTING SUPPLY		**55**	**55**	**55**	**55**	**55**	**55**
COLORADO BASIN							
BANGS	F | BROWNWOOD LAKE/RESERVOIR	207	204	198	195	194	194

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
BROWN COUNTY							
COLORADO BASIN							
BROOKESMITH SUD	F | BROWNWOOD LAKE/RESERVOIR	1,185	1,181	1,156	1,142	1,139	1,139
BROWNWOOD	F | BROWNWOOD LAKE/RESERVOIR	3,755	3,750	3,677	3,636	3,629	3,629
EARLY	F | BROWNWOOD LAKE/RESERVOIR	290	285	275	269	268	268
ZEPHYR WSC	F | BROWNWOOD LAKE/RESERVOIR	379	374	364	359	357	357
COLEMAN COUNTY SUD	F | BROWNWOOD LAKE/RESERVOIR	9	8	8	8	8	8
COLEMAN COUNTY SUD	F | COLEMAN LAKE/RESERVOIR	0	0	0	0	0	0
COLEMAN COUNTY SUD	F | HORDS CREEK LAKE/RESERVOIR	0	0	0	0	0	0
COUNTY-OTHER	F | BROWNWOOD LAKE/RESERVOIR	125	125	125	125	125	125
COUNTY-OTHER	F | TRINITY AQUIFER | BROWN COUNTY	72	74	73	72	71	71
MANUFACTURING	F | BROWNWOOD LAKE/RESERVOIR	673	726	777	820	886	957
MINING	F | OTHER AQUIFER | BROWN COUNTY	31	31	31	31	31	31
MINING	F | TRINITY AQUIFER | BROWN COUNTY	912	917	920	921	917	913
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	1,296	1,296	1,296	1,296	1,296	1,296
LIVESTOCK	F | OTHER AQUIFER | BROWN COUNTY	45	45	45	45	45	45
IRRIGATION	F | BROWNWOOD LAKE/RESERVOIR	5,000	5,000	5,000	5,000	5,000	5,000
IRRIGATION	F | COLORADO RUN-OF-RIVER	284	284	284	284	284	284
IRRIGATION	F | TRINITY AQUIFER | BROWN COUNTY	1,025	1,019	1,017	1,016	1,020	1,024
COLORADO BASIN TOTAL EXISTING SUPPLY		**15,288**	**15,319**	**15,246**	**15,219**	**15,270**	**15,341**
BROWN COUNTY TOTAL EXISTING SUPPLY		**15,343**	**15,374**	**15,301**	**15,274**	**15,325**	**15,396**
COKE COUNTY							
COLORADO BASIN							
ROBERT LEE	F | EV SPENCE LAKE/RESERVOIR NON-SYSTEM PORTION	0	0	0	0	0	0
ROBERT LEE	F | OAK CREEK LAKE/RESERVOIR	0	0	0	0	0	0
ROBERT LEE	F | OTHER AQUIFER | COKE COUNTY	48	47	46	46	46	46
BRONTE	F | OAK CREEK LAKE/RESERVOIR	0	0	0	0	0	0
BRONTE	F | OTHER AQUIFER | COKE COUNTY	68	66	63	62	62	62
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | COKE COUNTY	15	15	15	15	15	15
COUNTY-OTHER	F | OAK CREEK LAKE/RESERVOIR	0	0	0	0	0	0
COUNTY-OTHER	F | OTHER AQUIFER | COKE COUNTY	61	57	54	53	53	53
MINING	F | CRMWD DIVERTED WATER SYSTEM BRACKISH	0	0	0	0	0	0
MINING	F | OTHER AQUIFER | COKE COUNTY	170	170	170	170	170	170
STEAM ELECTRIC POWER		0	0	0	0	0	0
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	370	370	370	370	370	370
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | COKE COUNTY	22	22	22	22	22	22
LIVESTOCK	F | OTHER AQUIFER | COKE COUNTY	39	39	39	39	39	39
IRRIGATION	F | COLORADO RUN-OF-RIVER	11	11	11	11	11	11
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | COKE COUNTY	47	47	47	47	47	47

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
COKE COUNTY							
COLORADO BASIN							
IRRIGATION	F | OTHER AQUIFER | COKE COUNTY	705	705	705	705	705	705
COLORADO BASIN TOTAL EXISTING SUPPLY		**1,556**	**1,549**	**1,542**	**1,540**	**1,540**	**1,540**
COKE COUNTY TOTAL EXISTING SUPPLY		**1,556**	**1,549**	**1,542**	**1,540**	**1,540**	**1,540**
COLEMAN COUNTY							
COLORADO BASIN							
BROOKESMITH SUD	F | BROWNWOOD LAKE/RESERVOIR	6	6	6	6	6	6
COLEMAN	F | COLEMAN LAKE/RESERVOIR	0	0	0	0	0	0
COLEMAN	F | HORDS CREEK LAKE/RESERVOIR	0	0	0	0	0	0
SANTA ANNA	F | BROWNWOOD LAKE/RESERVOIR	157	155	150	150	149	149
COLEMAN COUNTY SUD	F | BROWNWOOD LAKE/RESERVOIR	181	178	173	169	169	170
COLEMAN COUNTY SUD	F | COLEMAN LAKE/RESERVOIR	0	0	0	0	0	0
COLEMAN COUNTY SUD	F | HORDS CREEK LAKE/RESERVOIR	0	0	0	0	0	0
COUNTY-OTHER	F | COLEMAN LAKE/RESERVOIR	0	0	0	0	0	0
COUNTY-OTHER	F | HORDS CREEK LAKE/RESERVOIR	0	0	0	0	0	0
MANUFACTURING	F | COLEMAN LAKE/RESERVOIR	0	0	0	0	0	0
MANUFACTURING	F | HORDS CREEK LAKE/RESERVOIR	0	0	0	0	0	0
MINING	F | OTHER AQUIFER | COLEMAN COUNTY	46	46	46	46	46	46
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	943	943	943	943	943	943
LIVESTOCK	F | OTHER AQUIFER | COLEMAN COUNTY	133	133	133	133	133	133
IRRIGATION	F | COLEMAN LAKE/RESERVOIR	0	0	0	0	0	0
IRRIGATION	F | COLORADO RUN-OF-RIVER	27	27	27	27	27	27
COLORADO BASIN TOTAL EXISTING SUPPLY		**1,493**	**1,488**	**1,478**	**1,474**	**1,473**	**1,474**
COLEMAN COUNTY TOTAL EXISTING SUPPLY		**1,493**	**1,488**	**1,478**	**1,474**	**1,473**	**1,474**
CONCHO COUNTY							
COLORADO BASIN							
EDEN	F | HICKORY AQUIFER | CONCHO COUNTY	480	478	471	467	466	466
EDEN	F | OTHER AQUIFER | CONCHO COUNTY	0	0	0	0	0	0
MILLERSVIEW-DOOLE WSC	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	49	65	59	52	47	43
MILLERSVIEW-DOOLE WSC	F | HICKORY AQUIFER | MCCULLOCH COUNTY	63	61	60	59	58	57
COUNTY-OTHER	F | COLORADO RUN-OF-RIVER	37	37	37	37	37	37
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | CONCHO COUNTY	40	40	40	40	40	40
COUNTY-OTHER	F | HICKORY AQUIFER | CONCHO COUNTY	10	10	9	9	9	9
COUNTY-OTHER	F | MOUNTAIN CREEK LAKE/RESERVOIR	0	0	0	0	0	0
COUNTY-OTHER	F | OTHER AQUIFER | CONCHO COUNTY	9	8	7	5	5	5
COUNTY-OTHER	F | SAN ANGELO LAKES LAKE/RESERVOIR SYSTEM	0	0	0	0	0	0
MINING	F | OTHER AQUIFER | CONCHO COUNTY	268	268	268	268	268	268
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	123	123	123	123	123	123
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | CONCHO COUNTY	213	213	213	213	213	213

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
CONCHO COUNTY							
COLORADO BASIN							
LIVESTOCK	F | OTHER AQUIFER | CONCHO COUNTY	363	363	363	363	363	363
IRRIGATION	F | LIPAN AQUIFER | CONCHO COUNTY	1,893	1,893	1,893	1,893	1,893	1,893
IRRIGATION	F | OTHER AQUIFER | CONCHO COUNTY	2,592	2,592	2,592	2,592	2,592	2,592
COLORADO BASIN TOTAL EXISTING SUPPLY		**6,140**	**6,151**	**6,135**	**6,121**	**6,114**	**6,109**
CONCHO COUNTY TOTAL EXISTING SUPPLY		**6,140**	**6,151**	**6,135**	**6,121**	**6,114**	**6,109**
CRANE COUNTY							
RIO GRANDE BASIN							
CRANE	F | DIRECT REUSE	73	73	73	73	73	73
CRANE	F | PECOS VALLEY AQUIFER | WARD COUNTY	186	203	216	230	242	253
CRANE	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | CRANE COUNTY	1,003	1,063	1,112	1,165	1,211	1,250
COUNTY-OTHER	F | PECOS VALLEY AQUIFER | WARD COUNTY	27	33	39	44	49	53
COUNTY-OTHER	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | CRANE COUNTY	143	175	199	224	245	264
MINING	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | CRANE COUNTY	617	840	861	692	531	407
LIVESTOCK	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | CRANE COUNTY	151	151	151	151	151	151
LIVESTOCK	F | RIO GRANDE LIVESTOCK LOCAL SUPPLY	21	21	21	21	21	21
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**2,221**	**2,559**	**2,672**	**2,600**	**2,523**	**2,472**
CRANE COUNTY TOTAL EXISTING SUPPLY		**2,221**	**2,559**	**2,672**	**2,600**	**2,523**	**2,472**
CROCKETT COUNTY							
COLORADO BASIN							
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	11	11	11	11	11	11
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | CROCKETT COUNTY	7	7	7	7	7	7
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | CROCKETT COUNTY	12	12	12	12	12	12
COLORADO BASIN TOTAL EXISTING SUPPLY		**30**	**30**	**30**	**30**	**30**	**30**
RIO GRANDE BASIN							
CROCKETT COUNTY WCID #1	F | EDWARDS-TRINITY-PLATEAU AQUIFER | CROCKETT COUNTY	1,533	1,642	1,655	1,672	1,678	1,681
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | CROCKETT COUNTY	28	20	19	18	17	17
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | CROCKETT COUNTY	550	550	550	550	207	63
STEAM ELECTRIC POWER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | PECOS COUNTY	0	0	0	0	0	0
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | CROCKETT COUNTY	550	550	550	550	550	550
LIVESTOCK	F | RIO GRANDE LIVESTOCK LOCAL SUPPLY	127	127	127	127	127	127
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | CROCKETT COUNTY	467	458	449	443	434	425
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**3,255**	**3,347**	**3,350**	**3,360**	**3,013**	**2,863**
CROCKETT COUNTY TOTAL EXISTING SUPPLY		**3,285**	**3,377**	**3,380**	**3,390**	**3,043**	**2,893**
ECTOR COUNTY							
COLORADO BASIN							
ODESSA	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	6,625	9,818	9,783	9,739	9,654	9,530
ODESSA	F | DIRECT REUSE	1,964	2,476	2,645	2,830	3,030	3,245

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
		2020	2030	2040	2050	2060	2070
ECTOR COUNTY							
COLORADO BASIN							
ODESSA	F | OGALLALA AQUIFER | MARTIN COUNTY	150	234	262	257	264	275
ODESSA	F | PECOS VALLEY AQUIFER | WARD COUNTY	3,551	5,475	5,610	5,748	5,871	5,978
ECTOR COUNTY UD	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	592	882	885	884	875	864
ECTOR COUNTY UD	F | DIRECT REUSE	62	97	100	103	105	107
ECTOR COUNTY UD	F | OGALLALA AQUIFER | MARTIN COUNTY	13	20	24	22	24	25
ECTOR COUNTY UD	F | PECOS VALLEY AQUIFER | WARD COUNTY	317	492	508	521	532	542
GREATER GARDENDALE WSC	F | EDWARDS-TRINITY-PLATEAU AQUIFER | ECTOR COUNTY	164	177	192	210	230	251
COUNTY-OTHER	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	365	541	542	541	539	539
COUNTY-OTHER	F | DIRECT REUSE	38	60	61	63	65	67
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | ECTOR COUNTY	1,926	1,926	1,926	1,926	1,926	1,926
COUNTY-OTHER	F | OGALLALA AQUIFER | ANDREWS COUNTY	37	33	31	27	20	19
COUNTY-OTHER	F | OGALLALA AQUIFER | ECTOR COUNTY	428	677	700	700	700	700
COUNTY-OTHER	F | OGALLALA AQUIFER | MARTIN COUNTY	8	13	15	14	15	16
COUNTY-OTHER	F | PECOS VALLEY AQUIFER | WARD COUNTY	196	302	311	319	327	338
MANUFACTURING	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	212	284	278	252	227	201
MANUFACTURING	F | DIRECT REUSE	2,623	2,807	2,903	3,013	3,135	3,183
MANUFACTURING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | ECTOR COUNTY	1,152	1,152	1,152	1,152	1,152	1,152
MANUFACTURING	F | OGALLALA AQUIFER | ANDREWS COUNTY	96	85	80	68	50	50
MANUFACTURING	F | OGALLALA AQUIFER | MARTIN COUNTY	5	7	7	7	6	6
MANUFACTURING	F | PECOS VALLEY AQUIFER | WARD COUNTY	114	158	159	149	138	127
MINING	F | DIRECT REUSE	1,060	1,195	1,144	993	806	675
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | ECTOR COUNTY	100	100	73	0	0	0
MINING	F | OGALLALA AQUIFER | ANDREWS COUNTY	218	155	73	62	46	46
STEAM ELECTRIC POWER	F | DIRECT REUSE	500	500	500	500	500	500
STEAM ELECTRIC POWER	F | OGALLALA AQUIFER | ANDREWS COUNTY	667	568	461	393	290	289
STEAM ELECTRIC POWER	O | OGALLALA AQUIFER | GAINES COUNTY	1,650	1,700	1,850	1,850	1,850	1,850
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	11	11	11	11	11	11
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | ECTOR COUNTY	204	204	204	204	204	204
LIVESTOCK	F | OGALLALA AQUIFER | ECTOR COUNTY	10	10	10	10	10	10
IRRIGATION	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	127	171	155	140	126	115
IRRIGATION	F | DIRECT REUSE	13	19	18	16	15	14
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | ECTOR COUNTY	364	364	364	264	120	0
IRRIGATION	F | EV SPENCE LAKE/RESERVOIR NON-SYSTEM PORTION	0	0	0	0	0	0
IRRIGATION	F | OGALLALA AQUIFER | ECTOR COUNTY	400	400	400	400	400	400

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
ECTOR COUNTY							
COLORADO BASIN							
IRRIGATION	F | OGALLALA AQUIFER | MARTIN COUNTY	3	4	4	3	3	3
IRRIGATION	F | PECOS VALLEY AQUIFER | WARD COUNTY	68	96	89	83	77	72
COLORADO BASIN TOTAL EXISTING SUPPLY		**26,033**	**33,213**	**33,530**	**33,474**	**33,343**	**33,330**
RIO GRANDE BASIN							
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | ECTOR COUNTY	250	250	250	250	250	250
MANUFACTURING	F | DIRECT REUSE	187	205	221	233	246	259
MANUFACTURING	F | DOCKUM AQUIFER | ECTOR COUNTY	8	8	8	8	8	8
MANUFACTURING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | ECTOR COUNTY	118	118	118	118	118	118
MANUFACTURING	F | PECOS VALLEY AQUIFER | ECTOR COUNTY	19	19	19	19	19	19
MINING	F | DIRECT REUSE	522	536	397	266	212	186
MINING	F | DOCKUM AQUIFER | ECTOR COUNTY	348	348	348	348	348	349
LIVESTOCK	F | DOCKUM AQUIFER | ECTOR COUNTY	18	18	18	18	18	18
LIVESTOCK	F | PECOS VALLEY AQUIFER | ECTOR COUNTY	25	25	25	25	25	25
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | ECTOR COUNTY	136	136	136	136	136	136
IRRIGATION	F | PECOS VALLEY AQUIFER | ECTOR COUNTY	7	6	4	2	0	0
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**1,638**	**1,669**	**1,544**	**1,423**	**1,380**	**1,368**
ECTOR COUNTY TOTAL EXISTING SUPPLY		**27,671**	**34,882**	**35,074**	**34,897**	**34,723**	**34,698**
GLASSCOCK COUNTY							
COLORADO BASIN							
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | GLASSCOCK COUNTY	160	163	159	158	158	158
COUNTY-OTHER	F | OGALLALA AQUIFER | GLASSCOCK COUNTY	2	2	2	2	2	2
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | GLASSCOCK COUNTY	3,423	3,101	2,384	1,679	1,100	798
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	40	40	40	40	40	40
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | GLASSCOCK COUNTY	198	198	198	198	198	198
LIVESTOCK	F | OGALLALA AQUIFER | GLASSCOCK COUNTY	24	24	24	24	24	24
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | GLASSCOCK COUNTY	49,388	48,933	48,477	48,020	47,568	47,120
IRRIGATION	F | OGALLALA AQUIFER | GLASSCOCK COUNTY	7,319	7,319	7,319	7,319	7,319	7,319
COLORADO BASIN TOTAL EXISTING SUPPLY		**60,554**	**59,780**	**58,603**	**57,440**	**56,409**	**55,659**
GLASSCOCK COUNTY TOTAL EXISTING SUPPLY		**60,554**	**59,780**	**58,603**	**57,440**	**56,409**	**55,659**
HOWARD COUNTY							
COLORADO BASIN							
BIG SPRING	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	1,960	2,695	2,442	2,189	1,974	1,786
BIG SPRING	F | DIRECT REUSE	207	297	276	255	236	221
BIG SPRING	F | OGALLALA AQUIFER | MARTIN COUNTY	44	65	66	58	54	51
BIG SPRING	F | PECOS VALLEY AQUIFER | WARD COUNTY	1,051	1,503	1,400	1,292	1,199	1,121
COAHOMA	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	58	80	73	65	58	53
COAHOMA	F | DIRECT REUSE	6	9	8	8	7	7
COAHOMA	F | OGALLALA AQUIFER | MARTIN COUNTY	1	2	2	2	2	2

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
		2020	2030	2040	2050	2060	2070
HOWARD COUNTY							
COLORADO BASIN							
COAHOMA	F | PECOS VALLEY AQUIFER | WARD COUNTY	31	45	42	38	36	33
COUNTY-OTHER	F | DOCKUM AQUIFER | HOWARD COUNTY	12	12	12	12	12	12
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | HOWARD COUNTY	94	94	94	94	94	94
COUNTY-OTHER	F | OGALLALA AQUIFER | HOWARD COUNTY	341	302	302	302	302	302
MANUFACTURING	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	478	643	581	526	474	430
MANUFACTURING	F | DIRECT REUSE	50	71	66	61	57	52
MANUFACTURING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | HOWARD COUNTY	334	334	334	334	334	334
MANUFACTURING	F | OGALLALA AQUIFER | HOWARD COUNTY	300	265	265	265	265	265
MANUFACTURING	F | OGALLALA AQUIFER | MARTIN COUNTY	11	15	16	14	13	12
MANUFACTURING	F | PECOS VALLEY AQUIFER | WARD COUNTY	256	359	333	310	288	270
MINING	F | CRMWD DIVERTED WATER SYSTEM BRACKISH	0	0	0	0	0	0
MINING	F | DOCKUM AQUIFER | HOWARD COUNTY	106	106	106	106	106	106
MINING	F | OGALLALA AQUIFER | HOWARD COUNTY	57	50	50	50	50	50
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	62	62	62	62	62	62
LIVESTOCK	F | DOCKUM AQUIFER | HOWARD COUNTY	9	9	9	9	9	9
LIVESTOCK	F | OGALLALA AQUIFER | HOWARD COUNTY	131	116	116	116	116	116
IRRIGATION	F | DOCKUM AQUIFER | HOWARD COUNTY	41	41	41	41	41	41
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | HOWARD COUNTY	1,222	1,222	1,222	1,222	1,222	1,222
IRRIGATION	F | OGALLALA AQUIFER | HOWARD COUNTY	2,226	1,967	1,967	1,967	1,967	1,967
COLORADO BASIN TOTAL EXISTING SUPPLY		**9,088**	**10,364**	**9,885**	**9,398**	**8,978**	**8,618**
HOWARD COUNTY TOTAL EXISTING SUPPLY		**9,088**	**10,364**	**9,885**	**9,398**	**8,978**	**8,618**
IRION COUNTY							
COLORADO BASIN							
MERTZON	F | EDWARDS-TRINITY-PLATEAU AQUIFER | IRION COUNTY	102	99	96	95	95	95
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | IRION COUNTY	105	102	98	97	97	97
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | IRION COUNTY	1,373	1,373	1,373	1,373	713	342
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	57	57	57	57	57	57
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | IRION COUNTY	204	204	204	204	204	204
LIVESTOCK	F | OTHER AQUIFER | IRION COUNTY	7	7	7	7	7	7
IRRIGATION	F | COLORADO RUN-OF-RIVER	221	221	221	221	221	221
IRRIGATION	F | OTHER AQUIFER | IRION COUNTY	887	855	822	790	758	727
COLORADO BASIN TOTAL EXISTING SUPPLY		**2,956**	**2,918**	**2,878**	**2,844**	**2,152**	**1,750**
IRION COUNTY TOTAL EXISTING SUPPLY		**2,956**	**2,918**	**2,878**	**2,844**	**2,152**	**1,750**
KIMBLE COUNTY							
COLORADO BASIN							
JUNCTION	F | COLORADO RUN-OF-RIVER	0	0	0	0	0	0
COUNTY-OTHER	F | COLORADO RUN-OF-RIVER	0	0	0	0	0	0
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | KIMBLE COUNTY	242	236	229	226	225	225

Water User Group (WUG) Existing Water Supply

REGION F		EXISTING SUPPLY (ACRE-FEET PER YEAR)					
	SOURCE REGION | SOURCE NAME	2020	2030	2040	2050	2060	2070
KIMBLE COUNTY							
COLORADO BASIN							
MANUFACTURING	F | COLORADO RUN-OF-RIVER	0	0	0	0	0	0
MANUFACTURING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | KIMBLE COUNTY	2	2	2	2	2	2
MINING	F | COLORADO RUN-OF-RIVER	14	14	14	14	14	14
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | KIMBLE COUNTY	5	5	5	5	5	5
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	89	89	89	89	89	89
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | KIMBLE COUNTY	313	313	313	313	313	313
IRRIGATION	F | COLORADO RUN-OF-RIVER	1,134	1,134	1,134	1,134	1,134	1,134
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | KIMBLE COUNTY	309	309	309	309	309	309
COLORADO BASIN TOTAL EXISTING SUPPLY		**2,108**	**2,102**	**2,095**	**2,092**	**2,091**	**2,091**
KIMBLE COUNTY TOTAL EXISTING SUPPLY		**2,108**	**2,102**	**2,095**	**2,092**	**2,091**	**2,091**
LOVING COUNTY							
RIO GRANDE BASIN							
COUNTY-OTHER	F | PECOS VALLEY AQUIFER | LOVING COUNTY	11	10	10	10	10	10
MINING	F | PECOS VALLEY AQUIFER | LOVING COUNTY	792	1,058	934	762	601	474
LIVESTOCK	F | DOCKUM AQUIFER | LOVING COUNTY	22	22	22	22	22	22
LIVESTOCK	F | PECOS VALLEY AQUIFER | LOVING COUNTY	69	69	69	69	69	69
LIVESTOCK	F | RIO GRANDE LIVESTOCK LOCAL SUPPLY	10	10	10	10	10	10
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**904**	**1,169**	**1,045**	**873**	**712**	**585**
LOVING COUNTY TOTAL EXISTING SUPPLY		**904**	**1,169**	**1,045**	**873**	**712**	**585**
MARTIN COUNTY							
COLORADO BASIN							
STANTON	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	172	248	235	223	208	194
STANTON	F | DIRECT REUSE	18	27	27	26	25	24
STANTON	F | OGALLALA AQUIFER | MARTIN COUNTY	14	16	17	16	16	17
STANTON	F | PECOS VALLEY AQUIFER | WARD COUNTY	90	138	134	131	127	122
COUNTY-OTHER	F | OGALLALA AQUIFER | MARTIN COUNTY	131	141	160	159	167	175
MANUFACTURING	F | OGALLALA AQUIFER | MARTIN COUNTY	16	16	18	18	19	21
MINING	F | OGALLALA AQUIFER | MARTIN COUNTY	488	495	541	515	522	531
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	67	67	67	67	67	67
LIVESTOCK	F | OGALLALA AQUIFER | MARTIN COUNTY	23	24	26	25	25	26
IRRIGATION	F | OGALLALA AQUIFER | MARTIN COUNTY	11,165	11,122	11,942	11,150	11,106	11,079
COLORADO BASIN TOTAL EXISTING SUPPLY		**12,184**	**12,294**	**13,167**	**12,330**	**12,282**	**12,256**
MARTIN COUNTY TOTAL EXISTING SUPPLY		**12,184**	**12,294**	**13,167**	**12,330**	**12,282**	**12,256**
MASON COUNTY							
COLORADO BASIN							
MASON	F | HICKORY AQUIFER | MASON COUNTY	0	0	0	0	0	0
COUNTY-OTHER	F | ELLENBURGER-SAN SABA AQUIFER | MASON COUNTY	57	48	48	48	48	48
COUNTY-OTHER	F | HICKORY AQUIFER | MASON COUNTY	132	134	128	125	124	124
COUNTY-OTHER	F | MARBLE FALLS AQUIFER | MASON COUNTY	36	36	36	36	36	36
MINING	F | HICKORY AQUIFER | MASON COUNTY	1,023	941	708	568	460	372

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
MASON COUNTY							
COLORADO BASIN							
MINING	K | HIGHLAND LAKES LAKE/RESERVOIR SYSTEM	2	2	2	2	2	2
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	498	498	498	498	498	498
LIVESTOCK	F | ELLENBURGER-SAN SABA AQUIFER | MASON COUNTY	75	75	75	75	75	75
LIVESTOCK	F | HICKORY AQUIFER | MASON COUNTY	675	675	675	675	675	675
IRRIGATION	F | HICKORY AQUIFER | MASON COUNTY	8,294	8,174	8,054	7,935	7,816	7,699
IRRIGATION	K | HIGHLAND LAKES LAKE/RESERVOIR SYSTEM	59	59	59	59	59	59
COLORADO BASIN TOTAL EXISTING SUPPLY		**10,851**	**10,642**	**10,283**	**10,021**	**9,793**	**9,588**
MASON COUNTY TOTAL EXISTING SUPPLY		**10,851**	**10,642**	**10,283**	**10,021**	**9,793**	**9,588**
MCCULLOCH COUNTY							
COLORADO BASIN							
BRADY	F | BRADY CREEK LAKE/RESERVOIR	0	0	0	0	0	0
BRADY	F | HICKORY AQUIFER | MCCULLOCH COUNTY	0	0	0	0	0	0
MILLERSVIEW-DOOLE WSC	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	77	106	95	86	77	70
MILLERSVIEW-DOOLE WSC	F | HICKORY AQUIFER | MCCULLOCH COUNTY	97	98	97	96	95	94
RICHLAND SUD	K | ELLENBURGER-SAN SABA AQUIFER | SAN SABA COUNTY	117	116	117	118	117	116
RICHLAND SUD	K | MARBLE FALLS AQUIFER | SAN SABA COUNTY	196	195	195	198	196	194
COUNTY-OTHER	F | HICKORY AQUIFER | MCCULLOCH COUNTY	57	59	59	59	59	59
MANUFACTURING	F | HICKORY AQUIFER | MCCULLOCH COUNTY	299	323	348	370	402	435
MINING	F | ELLENBURGER-SAN SABA AQUIFER | MCCULLOCH COUNTY	4,883	4,883	4,883	4,883	4,602	3,998
MINING	F | HICKORY AQUIFER | MCCULLOCH COUNTY	426	398	320	272	234	203
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	164	164	164	164	164	164
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | MCCULLOCH COUNTY	16	16	16	16	16	16
LIVESTOCK	F | ELLENBURGER-SAN SABA AQUIFER | MCCULLOCH COUNTY	355	355	355	355	355	355
LIVESTOCK	F | HICKORY AQUIFER | MCCULLOCH COUNTY	36	36	36	36	36	36
LIVESTOCK	F | MARBLE FALLS AQUIFER | MCCULLOCH COUNTY	15	15	15	15	15	15
LIVESTOCK	F | OTHER AQUIFER | MCCULLOCH COUNTY	104	104	104	104	104	104
IRRIGATION	F | COLORADO RUN-OF-RIVER	69	69	69	69	69	69
IRRIGATION	F | HICKORY AQUIFER | MCCULLOCH COUNTY	1,331	1,332	1,343	1,348	1,349	1,348
COLORADO BASIN TOTAL EXISTING SUPPLY		**8,242**	**8,269**	**8,216**	**8,189**	**7,890**	**7,276**
MCCULLOCH COUNTY TOTAL EXISTING SUPPLY		**8,242**	**8,269**	**8,216**	**8,189**	**7,890**	**7,276**
MENARD COUNTY							
COLORADO BASIN							
MENARD	F | COLORADO RUN-OF-RIVER	136	136	136	136	136	136
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | MENARD COUNTY	72	70	70	69	69	69
COUNTY-OTHER	F | ELLENBURGER-SAN SABA AQUIFER | MENARD COUNTY	5	4	2	1	1	1
COUNTY-OTHER	F | OTHER AQUIFER | MENARD COUNTY	18	18	17	17	17	17
MANUFACTURING	F | COLORADO RUN-OF-RIVER	3	3	3	3	3	3

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR)					
		2020	2030	2040	2050	2060	2070
MENARD COUNTY							
COLORADO BASIN							
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | MENARD COUNTY	786	771	672	577	517	422
MINING	F | ELLENBURGER-SAN SABA AQUIFER | MENARD COUNTY	300	300	280	250	200	200
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	86	86	86	86	86	86
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | MENARD COUNTY	300	300	300	300	300	300
LIVESTOCK	F | ELLENBURGER-SAN SABA AQUIFER | MENARD COUNTY	6	6	6	6	6	6
LIVESTOCK	F | OTHER AQUIFER | MENARD COUNTY	34	34	34	34	34	34
IRRIGATION	F | COLORADO RUN-OF-RIVER	2,104	2,104	2,104	2,104	2,104	2,104
COLORADO BASIN TOTAL EXISTING SUPPLY		**3,850**	**3,832**	**3,710**	**3,583**	**3,473**	**3,378**
MENARD COUNTY TOTAL EXISTING SUPPLY		**3,850**	**3,832**	**3,710**	**3,583**	**3,473**	**3,378**
MIDLAND COUNTY							
COLORADO BASIN							
ODESSA	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	130	215	229	239	246	249
ODESSA	F | DIRECT REUSE	39	54	62	70	77	85
ODESSA	F | OGALLALA AQUIFER | MARTIN COUNTY	3	5	6	6	7	7
ODESSA	F | PECOS VALLEY AQUIFER | WARD COUNTY	70	120	131	141	150	156
MIDLAND	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	5,991	0	0	0	0	0
MIDLAND	F | DIRECT REUSE	763	130	130	130	130	130
MIDLAND	F | EDWARDS-TRINITY-PLATEAU AQUIFER | MIDLAND COUNTY	560	560	0	0	0	0
MIDLAND	F | EV SPENCE LAKE/RESERVOIR NON-SYSTEM PORTION	0	0	0	0	0	0
MIDLAND	F | OGALLALA AQUIFER | ANDREWS COUNTY	718	639	0	0	0	0
MIDLAND	F | OGALLALA AQUIFER | MARTIN COUNTY	1,475	1,358	0	0	0	0
MIDLAND	F | OH IVIE LAKE/RESERVOIR NON-SYSTEM PORTION	5,905	5,755	5,592	5,424	5,257	5,089
MIDLAND	F | PECOS VALLEY AQUIFER | WARD COUNTY	3,212	0	0	0	0	0
MIDLAND	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | WINKLER COUNTY	11,200	11,200	11,200	11,200	11,200	11,200
GREATER GARDENDALE WSC	F | EDWARDS-TRINITY-PLATEAU AQUIFER | ECTOR COUNTY	84	93	103	114	125	137
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | MIDLAND COUNTY	3,033	3,333	3,635	3,968	4,326	4,682
COUNTY-OTHER	F | OGALLALA AQUIFER | MIDLAND COUNTY	1,180	1,296	1,414	1,543	1,682	1,821
COUNTY-OTHER	F | OH IVIE LAKE/RESERVOIR NON-SYSTEM PORTION	19	12	9	9	8	7
MANUFACTURING	F | OGALLALA AQUIFER | MIDLAND COUNTY	195	226	248	265	289	315
MANUFACTURING	F | OH IVIE LAKE/RESERVOIR NON-SYSTEM PORTION	35	24	21	20	20	20
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | MIDLAND COUNTY	2,693	2,218	1,630	974	556	443
MINING	F | OGALLALA AQUIFER | MIDLAND COUNTY	1,200	1,200	1,000	800	500	300
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	117	117	117	117	117	117
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | MIDLAND COUNTY	205	205	205	205	205	205
LIVESTOCK	F | OGALLALA AQUIFER | MIDLAND COUNTY	72	72	72	72	72	72

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
MIDLAND COUNTY							
COLORADO BASIN							
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | MIDLAND COUNTY	12,645	12,546	12,447	12,348	12,250	12,153
IRRIGATION	F | OGALLALA AQUIFER | MIDLAND COUNTY	20,631	20,470	20,309	20,147	19,987	19,828
COLORADO BASIN TOTAL EXISTING SUPPLY		**72,175**	**61,848**	**58,560**	**57,792**	**57,204**	**57,016**
MIDLAND COUNTY TOTAL EXISTING SUPPLY		**72,175**	**61,848**	**58,560**	**57,792**	**57,204**	**57,016**
MITCHELL COUNTY							
COLORADO BASIN							
COLORADO CITY	F | DOCKUM AQUIFER | MITCHELL COUNTY	1,287	1,417	1,427	1,438	1,451	1,466
LORAINE	F | DOCKUM AQUIFER | MITCHELL COUNTY	73	72	71	72	72	73
COUNTY-OTHER	F | DOCKUM AQUIFER | MITCHELL COUNTY	843	852	857	861	868	875
MINING	F | DOCKUM AQUIFER | MITCHELL COUNTY	593	738	632	493	375	290
STEAM ELECTRIC POWER	F | COLORADO CITY-CHAMPION LAKE/RESERVOIR SYSTEM	0	0	0	0	0	0
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	381	381	381	381	381	381
LIVESTOCK	F | DOCKUM AQUIFER | MITCHELL COUNTY	30	30	30	30	30	30
LIVESTOCK	F | OTHER AQUIFER | MITCHELL COUNTY	2	2	2	2	2	2
IRRIGATION	F | COLORADO RUN-OF-RIVER	14	14	14	14	14	14
IRRIGATION	F | DIRECT REUSE	552	552	552	552	552	552
IRRIGATION	F | DOCKUM AQUIFER | MITCHELL COUNTY	10,953	10,894	10,838	10,782	10,726	10,670
COLORADO BASIN TOTAL EXISTING SUPPLY		**14,728**	**14,952**	**14,804**	**14,625**	**14,471**	**14,353**
MITCHELL COUNTY TOTAL EXISTING SUPPLY		**14,728**	**14,952**	**14,804**	**14,625**	**14,471**	**14,353**
PECOS COUNTY							
RIO GRANDE BASIN							
FORT STOCKTON	F | EDWARDS-TRINITY-PLATEAU AQUIFER | PECOS COUNTY	4,910	5,230	5,548	5,853	6,138	6,398
IRAAN	F | EDWARDS-TRINITY-PLATEAU AQUIFER | PECOS COUNTY	459	486	513	541	567	591
PECOS COUNTY WCID #1	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | PECOS COUNTY	439	456	475	496	519	540
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | PECOS COUNTY	378	389	412	435	456	475
COUNTY-OTHER	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | PECOS COUNTY	37	38	41	43	45	47
MANUFACTURING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | PECOS COUNTY	103	103	103	103	103	103
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | PECOS COUNTY	552	854	858	689	538	419
MINING	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | PECOS COUNTY	138	214	214	172	134	105
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | PECOS COUNTY	660	660	660	660	660	660
LIVESTOCK	F | OTHER AQUIFER | PECOS COUNTY	4	4	4	4	4	4
LIVESTOCK	F | PECOS VALLEY AQUIFER | PECOS COUNTY	212	212	212	212	212	212
LIVESTOCK	F | RIO GRANDE LIVESTOCK LOCAL SUPPLY	52	52	52	52	52	52
LIVESTOCK	F | RUSTLER AQUIFER | PECOS COUNTY	4	4	4	4	4	4
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | PECOS COUNTY	74,416	74,416	74,416	74,416	74,416	74,416
IRRIGATION	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | PECOS COUNTY	43,209	43,209	43,209	43,209	43,209	43,209
IRRIGATION	F | RED BLUFF LAKE/RESERVOIR	1,558	1,559	1,560	1,561	1,562	1,563

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
PECOS COUNTY							
RIO GRANDE BASIN							
IRRIGATION	F | RIO GRANDE RUN-OF-RIVER	4,444	4,444	4,444	4,444	4,444	4,444
IRRIGATION	F | RUSTLER AQUIFER | PECOS COUNTY	2,401	2,401	2,401	2,401	2,401	2,401
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**133,976**	**134,731**	**135,126**	**135,295**	**135,464**	**135,643**
PECOS COUNTY TOTAL EXISTING SUPPLY		**133,976**	**134,731**	**135,126**	**135,295**	**135,464**	**135,643**
REAGAN COUNTY							
COLORADO BASIN							
BIG LAKE	F | EDWARDS-TRINITY-PLATEAU AQUIFER | REAGAN COUNTY	731	796	835	878	907	929
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | REAGAN COUNTY	70	76	79	82	85	87
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | REAGAN COUNTY	3,916	3,157	2,285	1,308	492	185
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	41	41	41	41	41	41
LIVESTOCK	F | DOCKUM AQUIFER | REAGAN COUNTY	10	10	10	10	10	10
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | REAGAN COUNTY	204	204	204	204	204	204
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | REAGAN COUNTY	19,130	18,808	18,486	18,164	17,848	17,537
COLORADO BASIN TOTAL EXISTING SUPPLY		**24,102**	**23,092**	**21,940**	**20,687**	**19,587**	**18,993**
RIO GRANDE BASIN							
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | REAGAN COUNTY	310	253	187	113	52	29
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | REAGAN COUNTY	8	8	8	8	8	8
LIVESTOCK	F | RIO GRANDE LIVESTOCK LOCAL SUPPLY	3	3	3	3	3	3
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**321**	**264**	**198**	**124**	**63**	**40**
REAGAN COUNTY TOTAL EXISTING SUPPLY		**24,423**	**23,356**	**22,138**	**20,811**	**19,650**	**19,033**
REEVES COUNTY							
RIO GRANDE BASIN							
MADERA VALLEY WSC	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | REEVES COUNTY	586	616	644	665	682	694
PECOS	F | DOCKUM AQUIFER | REEVES COUNTY	1,281	1,439	1,596	1,711	1,804	1,877
PECOS	F | PECOS VALLEY AQUIFER | WARD COUNTY	1,709	1,704	1,700	1,696	1,687	1,679
COUNTY-OTHER	E | EDWARDS-TRINITY-PLATEAU AQUIFER | JEFF DAVIS COUNTY	198	198	198	198	198	198
COUNTY-OTHER	E | RIO GRANDE OTHER LOCAL SUPPLY	0	0	0	0	0	0
COUNTY-OTHER	F | DOCKUM AQUIFER | REEVES COUNTY	43	45	48	49	50	51
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | REEVES COUNTY	204	226	244	258	268	277
COUNTY-OTHER	F | PECOS VALLEY AQUIFER | WARD COUNTY	58	61	63	65	67	68
MANUFACTURING	F | DOCKUM AQUIFER | REEVES COUNTY	84	86	88	89	94	100
MANUFACTURING	F | PECOS VALLEY AQUIFER | WARD COUNTY	113	115	117	119	126	133
MINING	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | REEVES COUNTY	1,531	2,632	2,537	2,068	1,632	1,288
LIVESTOCK	F | DOCKUM AQUIFER | REEVES COUNTY	40	40	40	40	40	40
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | REEVES COUNTY	279	279	279	279	279	279
LIVESTOCK	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | REEVES COUNTY	438	438	438	438	438	438
LIVESTOCK	F | RIO GRANDE LIVESTOCK LOCAL SUPPLY	66	66	66	66	66	66

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
REEVES COUNTY							
RIO GRANDE BASIN							
LIVESTOCK	F | RUSTLER AQUIFER | REEVES COUNTY	40	40	40	40	40	40
IRRIGATION	F | BALMORHEA LAKE/RESERVOIR	21,844	21,844	21,844	21,844	21,844	21,844
IRRIGATION	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | REEVES COUNTY	60,403	59,623	58,841	58,061	57,288	56,521
IRRIGATION	F | RED BLUFF LAKE/RESERVOIR	9,110	9,110	9,110	9,110	9,110	9,110
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**98,027**	**98,562**	**97,893**	**96,796**	**95,713**	**94,703**
REEVES COUNTY TOTAL EXISTING SUPPLY		**98,027**	**98,562**	**97,893**	**96,796**	**95,713**	**94,703**
RUNNELS COUNTY							
COLORADO BASIN							
BALLINGER	F | BALLINGER/MOONEN LAKE/RESERVOIR	0	0	0	0	0	0
BALLINGER	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	174	237	217	0	0	0
MILES	F | SAN ANGELO LAKES LAKE/RESERVOIR SYSTEM	0	0	0	0	0	0
MILLERSVIEW-DOOLE WSC	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	56	74	66	60	54	49
MILLERSVIEW-DOOLE WSC	F | HICKORY AQUIFER | MCCULLOCH COUNTY	71	69	68	67	66	65
WINTERS	F | WINTERS LAKE/RESERVOIR	0	0	0	0	0	0
COLEMAN COUNTY SUD	F | BROWNWOOD LAKE/RESERVOIR	7	7	7	7	7	7
COLEMAN COUNTY SUD	F | COLEMAN LAKE/RESERVOIR	0	0	0	0	0	0
COLEMAN COUNTY SUD	F | HORDS CREEK LAKE/RESERVOIR	0	0	0	0	0	0
COUNTY-OTHER	F | BALLINGER/MOONEN LAKE/RESERVOIR	0	0	0	0	0	0
COUNTY-OTHER	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	23	31	29	0	0	0
COUNTY-OTHER	F | OTHER AQUIFER | RUNNELS COUNTY	28	23	12	11	10	10
COUNTY-OTHER	F | WINTERS LAKE/RESERVOIR	0	0	0	0	0	0
MANUFACTURING	F | BALLINGER/MOONEN LAKE/RESERVOIR	0	0	0	0	0	0
MANUFACTURING	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	2	3	3	0	0	0
MANUFACTURING	F | WINTERS LAKE/RESERVOIR	0	0	0	0	0	0
MINING	F | OTHER AQUIFER | RUNNELS COUNTY	177	177	177	177	177	177
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	552	552	552	552	552	552
LIVESTOCK	F | LIPAN AQUIFER | RUNNELS COUNTY	26	26	26	26	26	26
LIVESTOCK	F | OTHER AQUIFER | RUNNELS COUNTY	302	302	302	302	302	302
IRRIGATION	F | COLORADO RUN-OF-RIVER	197	197	197	197	197	197
IRRIGATION	F | DIRECT REUSE	218	218	218	218	218	218
IRRIGATION	F | OTHER AQUIFER | RUNNELS COUNTY	1,952	1,952	1,952	1,952	1,952	1,952
COLORADO BASIN TOTAL EXISTING SUPPLY		**3,785**	**3,868**	**3,826**	**3,569**	**3,561**	**3,555**
RUNNELS COUNTY TOTAL EXISTING SUPPLY		**3,785**	**3,868**	**3,826**	**3,569**	**3,561**	**3,555**
SCHLEICHER COUNTY							
COLORADO BASIN							
ELDORADO	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SCHLEICHER COUNTY	614	605	597	594	593	593
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SCHLEICHER COUNTY	252	291	310	321	329	334

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
SCHLEICHER COUNTY							
COLORADO BASIN							
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SCHLEICHER COUNTY	494	583	448	312	192	118
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	83	83	83	83	83	83
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SCHLEICHER COUNTY	337	337	337	337	337	337
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SCHLEICHER COUNTY	904	885	867	848	830	812
COLORADO BASIN TOTAL EXISTING SUPPLY		**2,684**	**2,784**	**2,642**	**2,495**	**2,364**	**2,277**
RIO GRANDE BASIN							
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SCHLEICHER COUNTY	40	39	39	39	39	39
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SCHLEICHER COUNTY	167	190	150	110	65	40
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SCHLEICHER COUNTY	103	103	103	103	103	103
LIVESTOCK	F | RIO GRANDE LIVESTOCK LOCAL SUPPLY	29	29	29	29	29	29
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SCHLEICHER COUNTY	510	500	489	479	468	458
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**849**	**861**	**810**	**760**	**704**	**669**
SCHLEICHER COUNTY TOTAL EXISTING SUPPLY		**3,533**	**3,645**	**3,452**	**3,255**	**3,068**	**2,946**
SCURRY COUNTY							
BRAZOS BASIN							
COUNTY-OTHER	F | DOCKUM AQUIFER | SCURRY COUNTY	34	36	38	42	46	50
MINING	F | DOCKUM AQUIFER | SCURRY COUNTY	12	12	12	12	12	12
LIVESTOCK	F | BRAZOS LIVESTOCK LOCAL SUPPLY	28	28	28	28	28	28
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	47	47	47	47	47	47
LIVESTOCK	F | DOCKUM AQUIFER | SCURRY COUNTY	8	8	8	8	8	7
IRRIGATION	F | DOCKUM AQUIFER | SCURRY COUNTY	249	247	245	241	238	234
BRAZOS BASIN TOTAL EXISTING SUPPLY		**378**	**378**	**378**	**378**	**379**	**378**
COLORADO BASIN							
SNYDER	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	708	1,058	1,009	980	953	926
SNYDER	F | DIRECT REUSE	75	117	114	114	114	113
SNYDER	F | OGALLALA AQUIFER | MARTIN COUNTY	16	25	27	26	26	27
SNYDER	F | PECOS VALLEY AQUIFER | WARD COUNTY	379	590	579	579	580	581
COUNTY-OTHER	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	96	129	115	105	95	86
COUNTY-OTHER	F | DIRECT REUSE	10	14	13	12	11	11
COUNTY-OTHER	F | DOCKUM AQUIFER | SCURRY COUNTY	99	106	113	123	135	148
COUNTY-OTHER	F | OGALLALA AQUIFER | MARTIN COUNTY	2	3	3	3	3	2
COUNTY-OTHER	F | OTHER AQUIFER | SCURRY COUNTY	22	22	22	22	22	22
COUNTY-OTHER	F | PECOS VALLEY AQUIFER | WARD COUNTY	51	72	67	62	58	54
MANUFACTURING	F | DOCKUM AQUIFER | SCURRY COUNTY	3	3	3	3	3	3
MINING	F | DOCKUM AQUIFER | SCURRY COUNTY	36	36	36	35	34	34
LIVESTOCK	F | BRAZOS LIVESTOCK LOCAL SUPPLY	110	110	111	111	111	112
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	187	188	188	189	190	190
LIVESTOCK	F | DOCKUM AQUIFER | SCURRY COUNTY	32	31	30	30	29	29

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
SCURRY COUNTY							
COLORADO BASIN							
IRRIGATION	F | COLORADO RUN-OF-RIVER	0	0	0	0	0	0
IRRIGATION	F | DOCKUM AQUIFER | SCURRY COUNTY	735	730	723	713	703	689
COLORADO BASIN TOTAL EXISTING SUPPLY		**2,561**	**3,234**	**3,153**	**3,107**	**3,067**	**3,027**
SCURRY COUNTY TOTAL EXISTING SUPPLY		**2,939**	**3,612**	**3,531**	**3,485**	**3,446**	**3,405**
STERLING COUNTY							
COLORADO BASIN							
STERLING CITY	F | OTHER AQUIFER | STERLING COUNTY	276	282	281	281	281	281
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | STERLING COUNTY	33	33	33	33	33	33
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | STERLING COUNTY	780	953	812	522	270	140
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	26	26	26	26	26	26
LIVESTOCK	F | DOCKUM AQUIFER | STERLING COUNTY	7	7	7	7	7	7
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | STERLING COUNTY	260	260	260	260	260	260
LIVESTOCK	F | OTHER AQUIFER | STERLING COUNTY	29	29	29	29	29	29
IRRIGATION	F | COLORADO RUN-OF-RIVER	30	30	30	30	30	30
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | STERLING COUNTY	652	611	570	529	489	451
IRRIGATION	F | OTHER AQUIFER | STERLING COUNTY	301	301	301	301	301	301
COLORADO BASIN TOTAL EXISTING SUPPLY		**2,394**	**2,532**	**2,349**	**2,018**	**1,726**	**1,558**
STERLING COUNTY TOTAL EXISTING SUPPLY		**2,394**	**2,532**	**2,349**	**2,018**	**1,726**	**1,558**
SUTTON COUNTY							
COLORADO BASIN							
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SUTTON COUNTY	27	28	28	28	28	28
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SUTTON COUNTY	89	144	153	115	78	53
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	46	46	46	46	46	46
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SUTTON COUNTY	168	168	168	168	168	168
IRRIGATION	F | COLORADO RUN-OF-RIVER	2	2	2	2	2	2
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SUTTON COUNTY	290	284	278	273	267	262
COLORADO BASIN TOTAL EXISTING SUPPLY		**622**	**672**	**675**	**632**	**589**	**559**
RIO GRANDE BASIN							
SONORA	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SUTTON COUNTY	1,239	1,317	1,339	1,359	1,372	1,380
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SUTTON COUNTY	140	145	146	148	150	151
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SUTTON COUNTY	357	576	610	458	311	211
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SUTTON COUNTY	218	218	218	218	218	218
LIVESTOCK	F | RIO GRANDE LIVESTOCK LOCAL SUPPLY	57	57	57	57	57	57
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | SUTTON COUNTY	1,511	1,481	1,453	1,422	1,394	1,365
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**3,522**	**3,794**	**3,823**	**3,662**	**3,502**	**3,382**
SUTTON COUNTY TOTAL EXISTING SUPPLY		**4,144**	**4,466**	**4,498**	**4,294**	**4,091**	**3,941**

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
TOM GREEN COUNTY							
COLORADO BASIN							
SAN ANGELO	F | COLORADO RUN-OF-RIVER	189	189	188	188	188	187
SAN ANGELO	F | HICKORY AQUIFER | MCCULLOCH COUNTY	3,535	3,535	3,547	3,555	3,550	3,540
SAN ANGELO	F | OH IVIE LAKE/RESERVOIR NON-SYSTEM PORTION	5,270	5,122	4,949	4,790	4,632	4,476
SAN ANGELO	F | SAN ANGELO LAKES LAKE/RESERVOIR SYSTEM	0	0	0	0	0	0
MILLERSVIEW-DOOLE WSC	F | COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	136	190	179	166	155	144
MILLERSVIEW-DOOLE WSC	F | HICKORY AQUIFER | MCCULLOCH COUNTY	173	176	182	187	190	193
CONCHO RURAL WATER CORPORATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | TOM GREEN COUNTY	69	69	69	69	69	69
CONCHO RURAL WATER CORPORATION	F | LIPAN AQUIFER | TOM GREEN COUNTY	538	538	538	538	538	538
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | TOM GREEN COUNTY	100	100	100	100	100	100
COUNTY-OTHER	F | LIPAN AQUIFER | TOM GREEN COUNTY	500	500	500	500	500	500
COUNTY-OTHER	F | MOUNTAIN CREEK LAKE/RESERVOIR	0	0	0	0	0	0
COUNTY-OTHER	F | OTHER AQUIFER | TOM GREEN COUNTY	150	150	150	150	150	150
COUNTY-OTHER	F | SAN ANGELO LAKES LAKE/RESERVOIR SYSTEM	0	0	0	0	0	0
MANUFACTURING	F | COLORADO RUN-OF-RIVER	25	25	26	26	26	27
MANUFACTURING	F | HICKORY AQUIFER | MCCULLOCH COUNTY	462	462	483	492	500	507
MANUFACTURING	F | OH IVIE LAKE/RESERVOIR NON-SYSTEM PORTION	689	669	673	663	653	640
MANUFACTURING	F | SAN ANGELO LAKES LAKE/RESERVOIR SYSTEM	0	0	0	0	0	0
MINING	F | LIPAN AQUIFER | TOM GREEN COUNTY	951	975	1,014	1,007	1,029	1,051
MINING	F | OTHER AQUIFER | TOM GREEN COUNTY	105	105	105	105	105	105
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	1,644	1,644	1,644	1,644	1,644	1,644
LIVESTOCK	F | LIPAN AQUIFER | TOM GREEN COUNTY	31	31	31	31	31	31
LIVESTOCK	F | OTHER AQUIFER | TOM GREEN COUNTY	30	30	30	30	30	30
IRRIGATION	F | COLORADO RUN-OF-RIVER	1,755	1,755	1,755	1,755	1,755	1,755
IRRIGATION	F | DIRECT REUSE	8,300	8,300	8,300	8,300	8,300	8,300
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | TOM GREEN COUNTY	520	520	520	520	520	520
IRRIGATION	F | LIPAN AQUIFER | TOM GREEN COUNTY	41,500	41,500	41,450	41,400	41,400	41,400
IRRIGATION	F | OTHER AQUIFER | TOM GREEN COUNTY	9,853	9,853	9,853	9,853	9,853	9,853
IRRIGATION	F | SAN ANGELO LAKES LAKE/RESERVOIR SYSTEM	0	0	0	0	0	0
COLORADO BASIN TOTAL EXISTING SUPPLY		**76,525**	**76,438**	**76,286**	**76,069**	**75,918**	**75,760**
TOM GREEN COUNTY TOTAL EXISTING SUPPLY		**76,525**	**76,438**	**76,286**	**76,069**	**75,918**	**75,760**
UPTON COUNTY							
COLORADO BASIN							
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | UPTON COUNTY	40	41	40	40	40	40
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | UPTON COUNTY	1,610	1,381	1,092	732	437	305
LIVESTOCK	F | COLORADO LIVESTOCK LOCAL SUPPLY	13	13	13	13	13	13

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
UPTON COUNTY							
COLORADO BASIN							
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | UPTON COUNTY	32	32	32	32	32	32
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | UPTON COUNTY	9,284	9,151	9,018	8,885	8,753	8,624
COLORADO BASIN TOTAL EXISTING SUPPLY		**10,979**	**10,618**	**10,195**	**9,702**	**9,275**	**9,014**
RIO GRANDE BASIN							
MCCAMEY	F | EDWARDS-TRINITY-PLATEAU AQUIFER | UPTON COUNTY	776	827	849	878	895	908
RANKIN	F | EDWARDS-TRINITY-PLATEAU AQUIFER | UPTON COUNTY	277	295	302	312	319	323
COUNTY-OTHER	F | EDWARDS-TRINITY-PLATEAU AQUIFER | UPTON COUNTY	100	99	100	100	100	100
MINING	F | EDWARDS-TRINITY-PLATEAU AQUIFER | UPTON COUNTY	2,627	2,253	1,781	1,194	713	498
LIVESTOCK	F | EDWARDS-TRINITY-PLATEAU AQUIFER | UPTON COUNTY	74	74	74	74	74	74
IRRIGATION	F | EDWARDS-TRINITY-PLATEAU AQUIFER | UPTON COUNTY	189	187	184	181	179	176
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**4,043**	**3,735**	**3,290**	**2,739**	**2,280**	**2,079**
UPTON COUNTY TOTAL EXISTING SUPPLY		**15,022**	**14,353**	**13,485**	**12,441**	**11,555**	**11,093**
WARD COUNTY							
RIO GRANDE BASIN							
MONAHANS	F | PECOS VALLEY AQUIFER | WARD COUNTY	2,164	2,259	2,322	2,391	2,444	2,485
MONAHANS	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | WINKLER COUNTY	354	370	382	394	403	410
COUNTY-OTHER	F | DOCKUM AQUIFER | WARD COUNTY	15	15	15	15	15	15
COUNTY-OTHER	F | PECOS VALLEY AQUIFER | WARD COUNTY	790	842	847	861	870	877
COUNTY-OTHER	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | WINKLER COUNTY	24	24	24	24	24	24
MANUFACTURING	F | PECOS VALLEY AQUIFER | WARD COUNTY	16	16	16	16	16	16
MINING	F | PECOS VALLEY AQUIFER | WARD COUNTY	797	964	840	645	458	329
STEAM ELECTRIC POWER	F | PECOS VALLEY AQUIFER | WARD COUNTY	2,700	2,700	2,700	2,700	2,700	2,700
LIVESTOCK	F | DOCKUM AQUIFER | WARD COUNTY	5	5	5	5	5	5
LIVESTOCK	F | PECOS VALLEY AQUIFER | WARD COUNTY	99	99	99	99	99	99
LIVESTOCK	F | RIO GRANDE LIVESTOCK LOCAL SUPPLY	5	5	5	5	5	5
IRRIGATION	F | DIRECT REUSE	670	670	670	670	670	670
IRRIGATION	F | DOCKUM AQUIFER | WARD COUNTY	316	316	316	316	316	316
IRRIGATION	F | RED BLUFF LAKE/RESERVOIR	5,009	5,009	5,009	5,009	5,009	5,009
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**12,964**	**13,294**	**13,250**	**13,150**	**13,034**	**12,960**
WARD COUNTY TOTAL EXISTING SUPPLY		**12,964**	**13,294**	**13,250**	**13,150**	**13,034**	**12,960**
WINKLER COUNTY							
COLORADO BASIN							
LIVESTOCK	F | DOCKUM AQUIFER | WINKLER COUNTY	3	3	3	3	3	3
COLORADO BASIN TOTAL EXISTING SUPPLY		**3**	**3**	**3**	**3**	**3**	**3**
RIO GRANDE BASIN							
KERMIT	F | DOCKUM AQUIFER | WINKLER COUNTY	887	883	881	890	896	903
KERMIT	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | WINKLER COUNTY	887	883	881	890	897	904

Water User Group (WUG) Existing Water Supply

REGION F	SOURCE REGION | SOURCE NAME	EXISTING SUPPLY (ACRE-FEET PER YEAR) 2020	2030	2040	2050	2060	2070
WINKLER COUNTY							
RIO GRANDE BASIN							
WINK	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | WINKLER COUNTY	360	389	414	443	467	488
COUNTY-OTHER	F | DOCKUM AQUIFER | WINKLER COUNTY	51	51	51	51	51	51
COUNTY-OTHER	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | WINKLER COUNTY	159	159	159	159	159	159
MINING	F | DOCKUM AQUIFER | WINKLER COUNTY	394	585	496	378	266	187
MINING	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | WINKLER COUNTY	393	584	495	378	265	186
LIVESTOCK	F | DOCKUM AQUIFER | WINKLER COUNTY	53	53	53	53	53	53
LIVESTOCK	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | WINKLER COUNTY	326	326	326	326	326	326
LIVESTOCK	F | RIO GRANDE LIVESTOCK LOCAL SUPPLY	7	7	7	7	7	7
IRRIGATION	F | PECOS VALLEY/EDWARDS-TRINITY (PLATEAU) AQUIFER | WINKLER COUNTY	4,912	4,912	4,912	4,912	4,912	4,912
RIO GRANDE BASIN TOTAL EXISTING SUPPLY		**8,429**	**8,832**	**8,675**	**8,487**	**8,299**	**8,176**
WINKLER COUNTY TOTAL EXISTING SUPPLY		**8,432**	**8,835**	**8,678**	**8,490**	**8,302**	**8,179**
REGION F TOTAL EXISTING SUPPLY		**657,435**	**656,252**	**647,380**	**636,003**	**624,825**	**618,909**

Chapter 4 Identification of Water Needs

4.1 Introduction

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 frees up water that can be used to meet 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 the lower portion of the Colorado Basin. 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 analyses of 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, wholesale 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 (positive number).

Attachment 4A provides the TWDB required First Tier and Second Tier needs analyses by water user group and river basin. Attachment 4B shows a summary of all three needs analyses by wholesale water provider and water user group. The water supplies and demands shown in Attachment 4B include sales to customers, which differs from the values shown in Attachment 4A. Both attachments are provided at the end of this chapter.

4.2 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 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 several sources in Region F have no supply by definition, even though in practice their supply may be greater than indicated by the WAM.

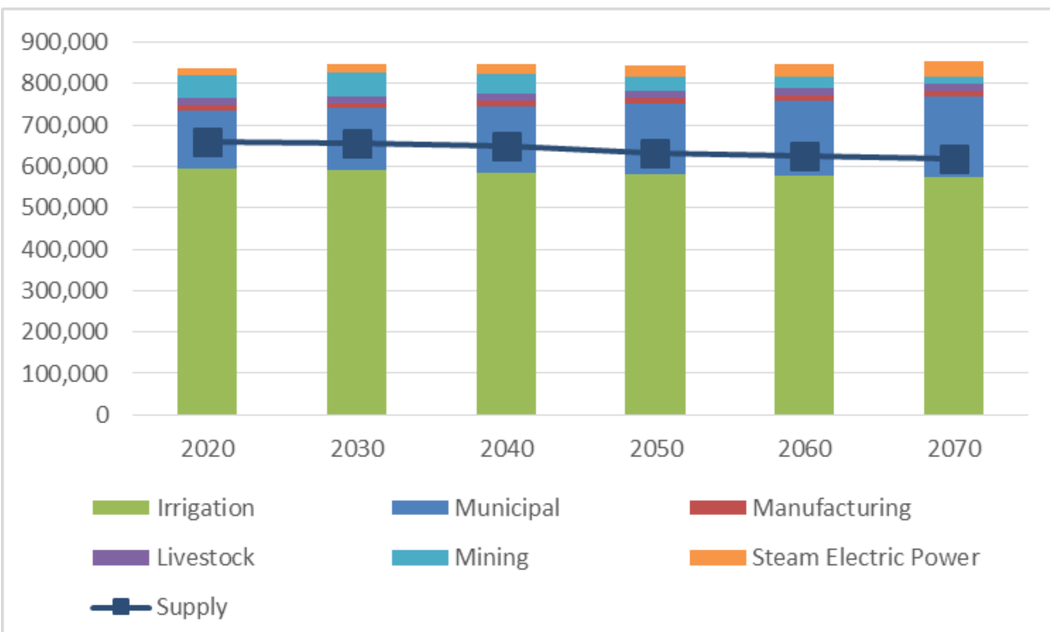
A similar concern is associated with groundwater supplies. The TWDB requires the use of the MAG values as the cap to groundwater supplies in a county. In some situations, this cap has artificially limited the amount of groundwater that is distributed to existing water users for current supplies and may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

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 supplies for Region F, on a regional basis there is a projected regional shortage of over 180,000 acre-feet per year in 2020, increasing to a maximum shortage of nearly 237,000 acre-feet per year in 2070. This is shown in Table 4-1 and graphically in Figure 4-1.

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

Region F (Acre-feet)	2020	2030	2040	2050	2060	2070
Supply	657,435	656,252	647,380	636,003	624,825	618,909
Demand	837,974	847,093	845,539	844,035	846,193	853,311
Need	**-182,987**	**-193,504**	**-200,715**	**-210,530**	**-223,844**	**-236,937**

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



On a county basis, there are twenty counties with shortages over the planning period. These include Andrews, Borden, Coke, Coleman, Concho, Crockett, Ector, Howard, Irion, Kimble, Martin, Mason, McCulloch, Menard, Mitchell, Runnels, Scurry, Tom Green, Ward, and Winkler. Attachment 4A presents First Tier water needs by water user group and county. Based on this analysis, there are significant municipal and irrigation shortages over the 50 year planning horizon. As previously discussed, many 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.

4.2.1 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 70 water user groups with identified shortages over the planning period. Of these, there are 27 cities and county-other water users in 13 counties that are projected to experience a water shortage before 2070. The largest shortages are attributed to assumptions in TCEQ WAM and the Modeled Available Groundwater (MAG).

Of the six use types, irrigation accounts for the largest percentage of the shortage. In 2020, irrigation represents 62 percent of the water needs. This percentage falls to 46 percent by 2070. Municipal users account for the second highest portion of needs in Region F. In 2020, municipal users account for 20 percent of the region's water needs. By 2070, this percentage grows to 46 percent. Figure 4-2 and Figure 4-3 show the First Tier water needs in Region F by use type in 2020 and 2070. Table 4-2 and Table 4-3 show the water needs in 2020 and 2070 quantitatively.

Figure 4-2
Region F First Tier Needs by Use Type in Year 2020

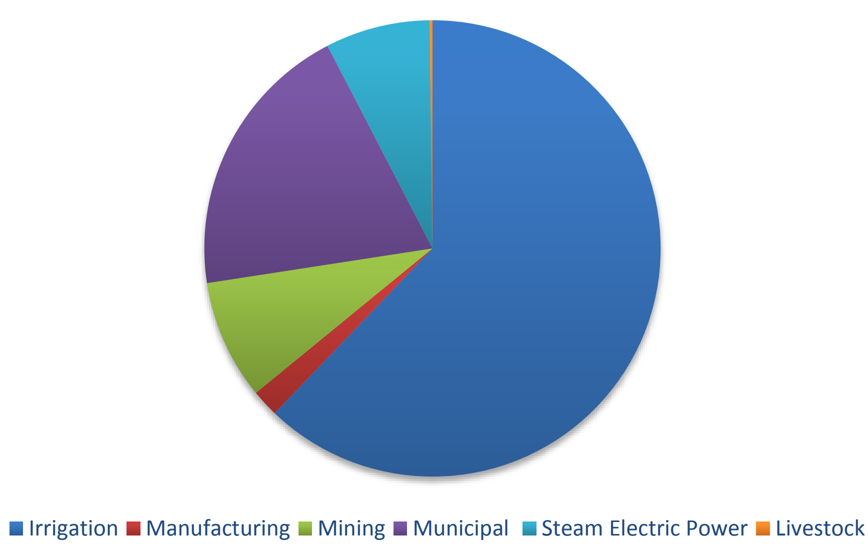


Table 4-2
Water Needs by County and Use Type in Year 2020
-Values are in acre-feet per year-

County	Irrigation	Manufacturing	Mining	Municipal	Steam Electric Power	Livestock	Total
Andrews	(28,420)	(18)	(2,611)	(1,795)	0	(100)	**(32,944)**
Borden	(3,243)	0	0	0	0	0	**(3,243)**
Brown	(3,105)	0	0	(8)	0	0	**(3,113)**
Coke	(202)	0	(318)	(483)	(247)	0	**(1,250)**
Coleman	(743)	(9)	(62)	(1,028)	0	0	**(1,842)**
Concho	(5,249)	0	(212)	0	0	0	**(5,461)**
Crane	0	0	0	0	0	0	**0**
Crockett	0	0	(1,182)	0	(776)	0	**(1,958)**
Ector	(314)	0	0	(10,839)	(6,619)	0	**(17,772)**
Glasscock	0	0	0	0	0	0	**0**
Howard	(3,233)	(1,319)	(2,328)	(3,423)	0	(114)	**(10,417)**
Irion	(359)	0	(1,819)	0	0	0	**(2,178)**
Kimble	(1,496)	(699)	0	(640)	0	0	**(2,835)**
Loving	0	0	0	0	0	0	**0**
Martin	(25,157)	(25)	(3,039)	(456)	0	(38)	**(28,715)**
Mason	0	0	0	(703)	0	0	**(703)**
McCulloch	(2,184)	(201)	(3,618)	(1,424)	0	(24)	**(7,451)**
Menard	(426)	0	0	(210)	0	0	**(636)**
Midland	0	0	0	(3,088)	0	0	**(3,088)**
Mitchell	0	0	0	0	(4,847)	0	**(4,847)**
Pecos	0	0	0	0	0	0	**0**
Reagan	0	0	0	0	0	0	**0**
Reeves	0	0	0	0	0	0	**0**
Runnels	(1,642)	(46)	(95)	(1,052)	0	0	**(2,835)**
Schleicher	0	0	0	0	0	0	**0**
Scurry	(6,321)	0	(232)	(1,307)	0	(92)	**(7,952)**
Sterling	0	0	0	0	0	0	**0**
Sutton	0	0	0	0	0	0	**0**
Tom Green	(31,651)	(1,211)	0	(9,806)	0	0	**(42,668)**
Upton	0	0	0	0	0	0	**0**
Ward	0	0	0	0	(1,079)	0	**(1,079)**
Winkler	0	0	0	0	0	0	**0**
Total	**(113,745)**	**(3,528)**	**(15,516)**	**(36,262)**	**(13,568)**	**(368)**	**(182,987)**

Figure 4-3
Region F First Tier Needs by Use Type in Year 2070

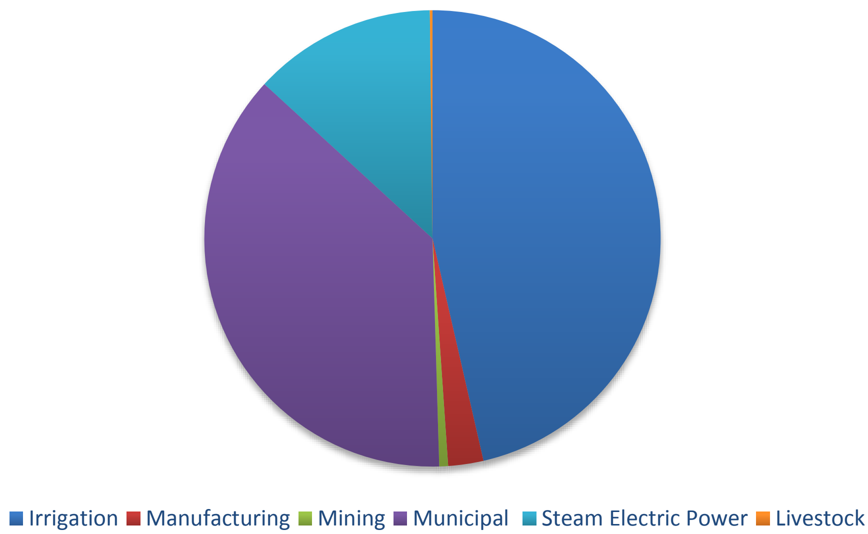


Table 4-3
Water Needs by County and Use Type in Year 2070

-Values are in acre-feet per year-

County	Irrigation	Manufacturing	Mining	Municipal	Steam Electric Power	Livestock	Total
Andrews	(31,070)	(54)	(1,166)	(7,961)	0	(166)	**(40,417)**
Borden	(3,217)	0	0	0	0	0	**(3,217)**
Brown	(2,946)	0	0	(8)	0	0	**(2,954)**
Coke	(199)	0	(116)	(465)	(528)	0	**(1,308)**
Coleman	(743)	(9)	(23)	(984)	0	0	**(1,759)**
Concho	(5,061)	0	(11)	0	0	0	**(5,072)**
Crane	0	0	0	0	0	0	**0**
Crockett	(1)	0	0	0	(1,662)	0	**(1,663)**
Ector	(606)	0	0	(19,528)	(19,033)	0	**(39,167)**
Glasscock	0	0	0	0	0	0	**0**
Howard	(3,107)	(2,132)	(43)	(3,625)	0	(129)	**(9,036)**
Irion	(359)	0	0	0	0	0	**(359)**
Kimble	(957)	(983)	0	(616)	0	0	**(2,556)**
Loving	0	0	0	0	0	0	**0**
Martin	(22,044)	(29)	0	(563)	0	(35)	**(22,671)**
Mason	0	0	0	(680)	0	0	**(680)**
McCulloch	(1,944)	(284)	0	(1,448)	0	(24)	**(3,700)**
Menard	(385)	0	0	(195)	0	0	**(580)**

County	Irrigation	Manufacturing	Mining	Municipal	Steam Electric Power	Livestock	Total
Midland	0	0	0	(31,449)	0	0	**(31,449)**
Mitchell	0	0	0	0	(3,994)	0	**(3,994)**
Pecos	0	0	0	0	0	0	**0**
Reagan	0	0	0	0	0	0	**0**
Reeves	0	0	0	0	0	0	**0**
Runnels	(1,552)	(69)	0	(1,212)	0	0	**(2,833)**
Schleicher	0	0	0	0	0	0	**0**
Scurry	(5,165)	0	(121)	(1,964)	0	(91)	**(7,341)**
Sterling	0	0	0	0	0	0	**0**
Sutton	0	0	0	0	0	0	**0**
Tom Green	(30,604)	(2,357)	0	(17,230)	0	0	**(50,191)**
Upton	0	0	0	0	0	0	**0**
Ward	0	0	0	0	(5,569)	0	**(5,569)**
Winkler	0	0	0	(421)	0	0	**(421)**
Total	**(109,960)**	**(5,917)**	**(1,480)**	**(88,349)**	**(30,786)**	**(445)**	**(236,937)**

Identified Needs for Municipal Users

Municipal users are shown to have significant water needs throughout the planning period. Twenty eight 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 Ballinger, Coleman, Junction, and Winters and their customers have no water supply. The Morgan Creek power plant has no supply to generate power. The cities of Brady, Big Spring, Bronte, Coahoma, Mason, Midland, Miles, Odessa, Robert Lee, San Angelo, Snyder and Stanton do not have sufficient water to meet current demands. The counties with the largest needs are Ector, Midland, and Tom Green counties. Much 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 seven counties showing manufacturing needs over the planning period: Coleman, Howard, Kimble, Martin, McCulloch, Runnels and Tom Green counties. Manufacturing needs in Coleman, Howard, Runnels and Tom Green counties are associated with needs for the cities of Coleman, Big Spring, Ballinger and San Angelo, respectively, and will be met by strategies developed for these cities.

Identified Needs for Irrigation

Irrigation shortages are identified for sixteen counties in Region F including Andrews, Borden, Brown, Coke, Coleman, Concho, Ector, Howard, Irion, Kimble, Martin, McCulloch, Menard, Runnels, Scurry, and Tom Green counties.

Identified Needs for Livestock

Livestock needs have been identified for six counties within Region F. They include Andrews, Howard, Martin, Mason, McCulloch, and Scurry. Needs in Andrews, Martin, McCulloch and Scurry county are due to limited availability of groundwater due to the MAG. Needs in Howard and Mason counties are associated with higher projected water use than historical levels.

Identified Needs for Mining

Recent significant growth in demand for mining water, particularly for oil and gas exploration, has created mining shortages throughout Region F. Andrews, Coke, Coleman, Concho, Crockett, Howard, Irion, Martin, McCulloch, Runnels, and Scurry show mining water needs.

Identified Needs for Steam Electric Power (SEP)

Coke, Crockett, Ector, Mitchell, and Ward counties all show a shortage for steam electric power (SEP) water use. The shortage in Coke County and Mitchell County is due to there being no firm yield under WAM Run 3 for Oak Creek Reservoir and Champion Lake respectively. The steam electric power plant in Crockett County has been retired and no longer operates, therefore no supply has been allocated to this use. The SEP shortages in Ector County are associated with MAG limitations in Andrews County (one of their sources of supply). Ward County SEP shortage is associated with higher projected demands than has been historically used.

Identified Needs for Wholesale Water Providers

Table 4-4 is a summary of the needs for the seven Wholesale Water Providers in Region F. Needs for CRMWD, Odessa and UCRA are primarily the result of using the Colorado WAM for water availability. Needs for University Lands are the result of contract expiration. A summary of the supply and demand comparison for each designated wholesale provider is included in Attachment 4B.

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

Wholesale Water Provider	Category	2010	2020	2030	2040	2050	2060
BCWID	Supply	18,760	18,620	18,480	18,340	18,200	18,060
	Demand	11,999	12,025	11,942	11,912	11,963	12,035
	Surplus (Need)	6,761	6,595	6,538	6,428	6,237	6,025
CRMWD	Supply	47,783	46,768	45,786	44,745	43,731	42,718
	Demand	76,242	59,876	62,368	65,037	67,320	70,051
	Surplus (Need)	-28,459	-13,108	-16,582	-20,292	-23,589	-27,333
City of Odessa	Supply	19,348	26,500	26,785	26,911	27,054	27,161
	Demand	31,019	34,023	36,931	39,964	43,268	46,740
	Surplus (Need)	-11,671	-7,523	-10,146	-13,053	-16,214	-19,579
City of San Angelo[a]	Supply	18,470	22,299	22,196	22,061	21,899	21,724
	Demand	29,131	31,117	32,190	33,464	35,013	36,696
	Surplus (Need)	-11,461	-9,618	-10,794	-12,203	-13,914	-15,772
Great Plains Water	Supply	4,063	3,616	2,888	2,757	2,558	2,556
System	Demand	5,554	5,129	3,829	3,829	3,829	3,829
	Surplus (Need)	-1,491	-1,513	-941	-1,072	-1,271	-1,273
UCRA	Supply	0	0	0	0	0	0
	Demand	337	349	346	344	344	344
	Surplus (Need)	-337	-349	-346	-344	-344	-344
University Lands	Supply	7,883	7,710	5,689	5,637	5,556	5,555
	Demand	10,906	11,078	6,511	6,696	6,916	7,172
	Surplus (Need)	-3,023	-3,368	-822	-1,059	-1,360	-1,617

a. The demands on San Angelo do not include irrigation demands from Twin Buttes Reservoir (26,500 ac-ft/year).

4.2.2 Summary of First Tier Water Needs

The total demands in Region F exceed the total current supply starting in 2020 by over 180,000 acre-feet. The regional need grows to nearly 237,000 acre-feet by 2070. Most of these needs are associated with either irrigation or municipal demands. Manufacturing, mining, steam electric power and livestock needs collectively account for 18 percent of the needs in Region F. 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 J. 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.

4.3 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 J.

4.3.1 Summary of Second Tier Water Needs

Under the Second Tier water needs analysis, municipal water needs were reduced through conservation and direct reuse supplies. Conservation was considered for all municipal and irrigation water users. 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 water needs for irrigation have the greatest potential for needs reduction. The realization of these water use reductions is contingent upon the implementation of conservation strategies by individual water users and producers.

4.4 Third Tier Water Needs Analysis

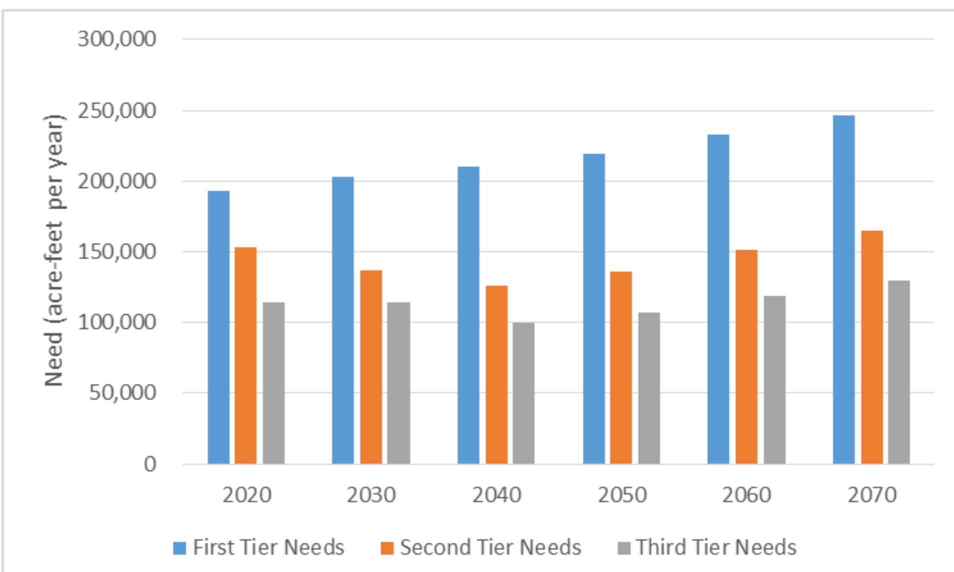
Because the TCEQ WAM does not give an accurate assessment of water supplies based on the way the basin has historically been operated, Region F has developed a water management strategy called subordination. Subordination assumes that downstream senior water rights do not make priority calls on Region F water rights in the upper Colorado 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 wholesale water provider's need for additional water management strategies.

4.4.1 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. Eleven water user groups (WUGs) show no needs after subordination: Brady, Ballinger, Coleman, Coleman County-Other, Coleman County Irrigation, Coleman County Manufacturing, Miles, Odessa, Big Spring, Snyder, and Stanton. However, there are seven municipal WUGs that do not have sufficient supplies even with the subordination strategy: Bronte, Junction, Midland, Millersview-Doole WSC, San Angelo, Robert Lee, and Winters. There are six non-municipal WUGs for whom subordination does not meet their needs: Coke County Mining and Steam Electric Power, Howard County Mining, Mitchell County Steam Electric Power, Runnels County Manufacturing, and Tom Green Manufacturing. WUGs that do not utilize any surface water sources are not impacted by subordination and continue to show needs throughout the planning period. Figure 4-4 compares the First, Second and Third Tier water needs in Region F throughout the planning cycle. The needs are fifty to sixty percent lower after conservation, 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 wholesale provider's demands, current supplies, conservation supplies, subordination supplies and Third Tier water needs.

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



Attachment 4A

TWDB Water Needs Data Tables

Water User Group (WUG) Needs/Surplus

REGION F	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
ANDREWS COUNTY						
COLORADO BASIN						
ANDREWS	(1,587)	(2,296)	(2,857)	(4,474)	(6,194)	(7,475)
COUNTY-OTHER	(208)	(256)	(291)	(354)	(452)	(484)
MANUFACTURING	(18)	(23)	(27)	(38)	(48)	(54)
MINING	(2,407)	(2,458)	(2,473)	(1,921)	(1,488)	(1,073)
LIVESTOCK	(65)	(80)	(88)	(105)	(131)	(131)
IRRIGATION	(26,952)	(27,615)	(27,794)	(28,578)	(29,953)	(29,658)
RIO GRANDE BASIN						
COUNTY-OTHER	0	0	0	(2)	(2)	(2)
MINING	(204)	(206)	(205)	(161)	(124)	(93)
LIVESTOCK	(35)	(35)	(35)	(35)	(35)	(35)
IRRIGATION	(1,468)	(1,464)	(1,451)	(1,438)	(1,425)	(1,412)
BORDEN COUNTY						
BRAZOS BASIN						
COUNTY-OTHER	0	0	2	2	2	2
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	(861)	(859)	(856)	(854)	(853)	(853)
COLORADO BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	(2,382)	(2,377)	(2,375)	(2,370)	(2,367)	(2,364)
BROWN COUNTY						
BRAZOS BASIN						
COUNTY-OTHER	0	0	0	0	0	0
LIVESTOCK	13	13	13	13	13	13
IRRIGATION	(445)	(443)	(442)	(440)	(438)	(437)
COLORADO BASIN						
BANGS	0	0	0	0	0	0
BROOKESMITH SUD	0	0	0	0	0	0
BROWNWOOD	0	0	0	0	0	0
COLEMAN COUNTY SUD	(8)	(8)	(8)	(8)	(8)	(8)
EARLY	0	0	0	0	0	0
ZEPHYR WSC	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	2	2	2	2	2	2
IRRIGATION	(2,660)	(2,636)	(2,607)	(2,577)	(2,543)	(2,509)
COKE COUNTY						
COLORADO BASIN						
BRONTE	(184)	(182)	(181)	(180)	(180)	(180)
ROBERT LEE	(248)	(243)	(241)	(240)	(240)	(240)
COUNTY-OTHER	(51)	(48)	(46)	(45)	(45)	(45)
MINING	(318)	(312)	(260)	(206)	(158)	(116)
STEAM ELECTRIC POWER	(247)	(289)	(339)	(401)	(477)	(528)
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	(202)	(200)	(199)	(199)	(199)	(199)

Water User Group (WUG) Needs/Surplus

REGION F	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
COLEMAN COUNTY						
COLORADO BASIN						
BROOKESMITH SUD	0	0	0	0	0	0
COLEMAN	(822)	(815)	(796)	(794)	(792)	(792)
COLEMAN COUNTY SUD	(182)	(180)	(174)	(172)	(171)	(170)
SANTA ANNA	0	0	0	0	0	0
COUNTY-OTHER	(24)	(23)	(23)	(23)	(22)	(22)
MANUFACTURING	(9)	(9)	(9)	(9)	(9)	(9)
MINING	(62)	(61)	(51)	(40)	(31)	(23)
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	(743)	(743)	(743)	(743)	(743)	(743)
CONCHO COUNTY						
COLORADO BASIN						
EDEN	0	0	0	0	0	0
MILLERSVIEW-DOOLE WSC	15	30	25	18	13	8
COUNTY-OTHER	0	0	0	0	0	0
MINING	(212)	(206)	(154)	(99)	(52)	(11)
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	(5,249)	(5,208)	(5,169)	(5,133)	(5,097)	(5,061)
CRANE COUNTY						
RIO GRANDE BASIN						
CRANE	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
CROCKETT COUNTY						
COLORADO BASIN						
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	1
RIO GRANDE BASIN						
CROCKETT COUNTY WCID #1	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MINING	(1,182)	(1,293)	(711)	(132)	0	0
STEAM ELECTRIC POWER	(776)	(907)	(1,067)	(1,262)	(1,500)	(1,662)
LIVESTOCK	14	14	14	14	14	14
IRRIGATION	0	0	0	0	0	(1)
ECTOR COUNTY						
COLORADO BASIN						
ECTOR COUNTY UD	(872)	(567)	(767)	(991)	(1,230)	(1,480)
GREATER GARDENDALE WSC	0	0	0	0	0	0
ODESSA	(9,759)	(6,292)	(8,474)	(10,907)	(13,565)	(16,316)
COUNTY-OTHER	(208)	3	(346)	(746)	(1,166)	(1,586)
MANUFACTURING	1,080	1,200	1,136	1,083	1,029	914
MINING	53	0	0	0	0	0
STEAM ELECTRIC POWER	(6,619)	(8,263)	(10,165)	(12,604)	(15,597)	(19,033)
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	(314)	(219)	(227)	(336)	(485)	(606)
RIO GRANDE BASIN						
COUNTY-OTHER	5	(21)	(50)	(81)	(113)	(146)

Water User Group (WUG) Needs/Surplus

REGION F	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
ECTOR COUNTY						
RIO GRANDE BASIN						
MANUFACTURING	0	0	0	0	0	0
MINING	218	170	109	95	140	180
LIVESTOCK	3	3	3	3	3	3
IRRIGATION	0	0	0	0	0	1
GLASSCOCK COUNTY						
COLORADO BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
HOWARD COUNTY						
COLORADO BASIN						
BIG SPRING	(2,887)	(1,728)	(2,115)	(2,454)	(2,775)	(3,058)
COAHOMA	(87)	(50)	(63)	(74)	(84)	(92)
COUNTY-OTHER	(449)	(485)	(480)	(478)	(475)	(475)
MANUFACTURING	(1,319)	(1,185)	(1,399)	(1,587)	(1,859)	(2,132)
MINING	(2,328)	(2,591)	(1,784)	(982)	(320)	(43)
LIVESTOCK	(114)	(129)	(129)	(129)	(129)	(129)
IRRIGATION	(3,233)	(3,415)	(3,337)	(3,260)	(3,183)	(3,107)
IRION COUNTY						
COLORADO BASIN						
MERTZON	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MINING	(1,819)	(1,984)	(1,050)	(114)	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	(359)	(359)	(359)	(359)	(359)	(359)
KIMBLE COUNTY						
COLORADO BASIN						
JUNCTION	(627)	(620)	(610)	(605)	(604)	(604)
COUNTY-OTHER	(13)	(12)	(12)	(12)	(12)	(12)
MANUFACTURING	(699)	(750)	(802)	(850)	(914)	(983)
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	(1,496)	(1,387)	(1,275)	(1,163)	(1,058)	(957)
LOVING COUNTY						
RIO GRANDE BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
MARTIN COUNTY						
COLORADO BASIN						
STANTON	(245)	(150)	(193)	(239)	(282)	(320)
COUNTY-OTHER	(211)	(222)	(216)	(233)	(239)	(243)
MANUFACTURING	(25)	(26)	(25)	(26)	(28)	(29)
MINING	(3,039)	(2,503)	(1,710)	(926)	(249)	118
LIVESTOCK	(38)	(37)	(35)	(36)	(36)	(35)
IRRIGATION	(25,157)	(24,552)	(23,084)	(23,231)	(22,640)	(22,044)

Water User Group (WUG) Needs/Surplus

REGION F	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
MASON COUNTY						
COLORADO BASIN						
MASON	(694)	(684)	(676)	(671)	(671)	(671)
COUNTY-OTHER	(9)	(9)	(9)	(9)	(9)	(9)
MINING	2	2	2	2	2	2
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	59	59	59	59	59	59
MCCULLOCH COUNTY						
COLORADO BASIN						
BRADY	(1,389)	(1,418)	(1,399)	(1,408)	(1,410)	(1,412)
MILLERSVIEW-DOOLE WSC	21	49	40	31	21	12
RICHLAND SUD	137	133	136	140	137	134
COUNTY-OTHER	(35)	(36)	(35)	(36)	(36)	(36)
MANUFACTURING	(201)	(217)	(230)	(241)	(261)	(284)
MINING	(3,618)	(3,066)	(1,438)	(472)	0	0
LIVESTOCK	(24)	(24)	(24)	(24)	(24)	(24)
IRRIGATION	(2,184)	(2,138)	(2,081)	(2,031)	(1,986)	(1,944)
MENARD COUNTY						
COLORADO BASIN						
MENARD	(210)	(202)	(196)	(195)	(195)	(195)
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	18	18	18	18	18	18
IRRIGATION	(426)	(418)	(410)	(401)	(393)	(385)
MIDLAND COUNTY						
COLORADO BASIN						
GREATER GARDENDALE WSC	0	0	0	0	0	0
MIDLAND	(2,897)	(14,818)	(20,585)	(23,992)	(27,523)	(31,021)
ODESSA	(191)	(137)	(198)	(268)	(345)	(428)
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
MITCHELL COUNTY						
COLORADO BASIN						
COLORADO CITY	0	0	0	0	0	0
LORAINE	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
STEAM ELECTRIC POWER	(4,847)	(4,670)	(4,493)	(4,317)	(4,140)	(3,994)
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
PECOS COUNTY						
RIO GRANDE BASIN						
FORT STOCKTON	0	0	0	0	0	0
IRAAN	0	0	0	0	0	0
PECOS COUNTY WCID #1	0	0	0	0	0	0

Water User Group (WUG) Needs/Surplus

REGION F	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
PECOS COUNTY						
RIO GRANDE BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	5	6	7	8	9	10
REAGAN COUNTY						
COLORADO BASIN						
BIG LAKE	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	11	11	11	11	11	11
IRRIGATION	0	0	0	0	0	0
RIO GRANDE BASIN						
MINING	15	15	15	15	15	15
LIVESTOCK	0	0	0	0	0	0
REEVES COUNTY						
RIO GRANDE BASIN						
MADERA VALLEY WSC	0	0	0	0	0	0
PECOS	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MANUFACTURING	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	1	1	1	1	1	1
IRRIGATION	0	0	0	0	0	0
RUNNELS COUNTY						
COLORADO BASIN						
BALLINGER	(516)	(451)	(454)	(669)	(668)	(668)
COLEMAN COUNTY SUD	(7)	(7)	(7)	(6)	(6)	(6)
MILES	(112)	(124)	(121)	(119)	(119)	(119)
MILLERSVIEW-DOOLE WSC	15	34	28	22	15	9
WINTERS	(216)	(207)	(197)	(196)	(195)	(195)
COUNTY-OTHER	(201)	(193)	(195)	(224)	(224)	(224)
MANUFACTURING	(46)	(49)	(53)	(59)	(64)	(69)
MINING	(95)	(92)	(63)	(33)	(7)	16
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	(1,642)	(1,624)	(1,606)	(1,588)	(1,570)	(1,552)
SCHLEICHER COUNTY						
COLORADO BASIN						
ELDORADO	0	0	0	0	0	0
COUNTY-OTHER	14	19	22	24	25	25
MINING	34	41	32	22	14	8
LIVESTOCK	17	17	17	17	17	17
IRRIGATION	0	0	0	0	0	0
RIO GRANDE BASIN						
COUNTY-OTHER	9	7	6	5	5	5
MINING	6	0	4	8	2	2
LIVESTOCK	0	0	0	0	0	0

Water User Group (WUG) Needs/Surplus

REGION F	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
SCHLEICHER COUNTY						
RIO GRANDE BASIN						
IRRIGATION	0	0	0	0	0	0
SCURRY COUNTY						
BRAZOS BASIN						
COUNTY-OTHER	(218)	(237)	(248)	(263)	(281)	(301)
MINING	(66)	(116)	(123)	(90)	(57)	(35)
LIVESTOCK	(18)	(18)	(18)	(18)	(18)	(19)
IRRIGATION	(1,479)	(1,422)	(1,365)	(1,310)	(1,256)	(1,206)
COLORADO BASIN						
SNYDER	(858)	(473)	(657)	(871)	(1,089)	(1,316)
COUNTY-OTHER	(231)	(177)	(214)	(255)	(301)	(347)
MANUFACTURING	0	0	0	0	0	0
MINING	(166)	(292)	(312)	(226)	(143)	(86)
LIVESTOCK	(74)	(74)	(74)	(73)	(73)	(72)
IRRIGATION	(4,842)	(4,657)	(4,473)	(4,293)	(4,121)	(3,959)
STERLING COUNTY						
COLORADO BASIN						
STERLING CITY	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
SUTTON COUNTY						
COLORADO BASIN						
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
RIO GRANDE BASIN						
SONORA	0	0	0	0	0	0
COUNTY-OTHER	0	0	0	0	0	0
MINING	0	0	0	0	0	0
LIVESTOCK	10	10	10	10	10	10
IRRIGATION	0	0	0	0	0	0
TOM GREEN COUNTY						
COLORADO BASIN						
CONCHO RURAL WATER CORPORATION	69	59	48	35	17	0
MILLERSVIEW-DOOLE WSC	37	87	76	60	43	26
SAN ANGELO	(9,250)	(11,156)	(12,167)	(13,397)	(14,870)	(16,462)
COUNTY-OTHER	(556)	(573)	(629)	(678)	(724)	(768)
MANUFACTURING	(1,211)	(1,459)	(1,657)	(1,853)	(2,094)	(2,357)
MINING	0	0	0	0	0	0
LIVESTOCK	17	17	17	17	17	17
IRRIGATION	(31,651)	(31,422)	(31,243)	(31,061)	(30,832)	(30,604)
UPTON COUNTY						
COLORADO BASIN						
COUNTY-OTHER	12	11	10	10	9	9
MINING	0	0	0	0	0	0

Water User Group (WUG) Needs/Surplus

REGION F	WUG (NEEDS)/SURPLUS (ACRE-FEET PER YEAR)					
	2020	2030	2040	2050	2060	2070
UPTON COUNTY						
COLORADO BASIN						
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
RIO GRANDE BASIN						
MCCAMEY	0	0	0	0	0	0
RANKIN	0	0	0	0	0	0
COUNTY-OTHER	36	33	33	32	31	30
MINING	0	0	0	0	0	0
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	0	0	0	0	0	0
WARD COUNTY						
RIO GRANDE BASIN						
MONAHANS	0	0	0	0	0	0
COUNTY-OTHER	80	109	100	91	83	76
MANUFACTURING	0	0	0	0	0	0
MINING	0	0	0	0	0	0
STEAM ELECTRIC POWER	(1,079)	(1,718)	(2,496)	(3,445)	(4,603)	(5,569)
LIVESTOCK	0	0	0	0	0	0
IRRIGATION	382	452	522	592	661	729
WINKLER COUNTY						
COLORADO BASIN						
LIVESTOCK	0	0	0	0	0	0
RIO GRANDE BASIN						
KERMIT	0	0	0	0	0	0
WINK	0	0	0	0	0	0
COUNTY-OTHER	0	(104)	(190)	(282)	(357)	(421)
MINING	0	0	0	0	0	0
LIVESTOCK	38	38	38	38	38	38
IRRIGATION	0	0	0	0	0	0

Attachment 4B

Comparison of Supply and Demand by Wholesale Water Provider and Water User

Wholesale Water Providers

Brown County Water Conservation and Improvement District (BCWID)

	2020	2030	2040	2050	2060	2070
Demands	11,999	12,025	11,942	11,912	11,963	12,035
Current Supply	18,760	18,620	18,480	18,340	18,200	18,060
Conservation Supply	220	225	225	225	225	225
Subordination Supply	6,981	6,693	6,405	6,117	5,829	5,540
Surplus (Need)	13,962	13,513	13,168	12,770	12,291	11,790

Colorado River Municipal Water District (CRMWD)

	2020	2030	2040	2050	2060	2070
Demands	76,242	59,876	62,368	65,037	67,320	70,051
Current Supply	47,783	46,768	45,786	44,745	43,731	42,718
Conservation Supply	1,071	1,213	1,330	1,472	1,593	1,740
Subordination Supply	33,408	33,365	33,322	33,279	33,236	33,198
Surplus (Need)	6,020	21,470	18,070	14,459	11,240	7,605

Great Plains

	2020	2030	2040	2050	2060	2070
Demands	5,554	5,129	3,829	3,829	3,829	3,829
Current Supply	4,063	3,616	2,888	2,757	2,558	2,556
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(1,491)	(1,513)	(941)	(1,072)	(1,271)	(1,273)

Odessa

	2020	2030	2040	2050	2060	2070
Demands	31,019	34,023	36,931	39,964	43,268	46,740
Current Supply	19,348	26,500	26,785	26,911	27,054	27,161
Conservation Supply	799	919	1,026	1,161	1,277	1,393
Subordination Supply	11,671	7,523	10,146	13,053	16,214	19,491
Surplus (Need)	799	919	1,026	1,161	1,277	1,305

San Angelo

	2020	2030	2040	2050	2060	2070
Demands	29,931	31,917	32,990	34,264	35,813	37,496
Current Supply	18,470	18,302	18,166	18,014	17,849	17,677
Conservation Supply	656	753	793	842	894	949
Subordination Supply	3,699	3,494	3,305	3,115	2,922	2,732
Surplus (Need)	(7,106)	(9,368)	(10,726)	(12,293)	(14,148)	(16,138)

University Lands

	2020	2030	2040	2050	2060	2070
Demands	10,906	11,078	6,511	6,696	6,916	7,172
Current Supply	7,883	7,710	5,689	5,637	5,556	5,555
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(3,023)	(3,368)	(822)	(1,059)	(1,360)	(1,617)

Wholesale Water Providers

Upper Colorado River Authority (UCRA)

	2020	2030	2040	2050	2060	2070
Demands	337	349	346	344	344	344
Current Supply	0	0	0	0	0	0
Conservation Supply	5	6	6	6	6	6
Subordination Supply	337	349	346	344	344	344
Surplus (Need)	5	6	6	6	6	6

Andrews County

Andrews

	2020	2030	2040	2050	2060	2070
Demands	4,319	5,183	5,961	6,890	7,992	9,276
Current Supply	2,714	2,864	3,077	2,378	1,750	1,747
Conservation Supply	82	99	136	157	183	213
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(1,523)	(2,220)	(2,748)	(4,355)	(6,059)	(7,316)

Andrews County-Other (Self Supplied)

	2020	2030	2040	2050	2060	2070
Demands	501	534	569	609	655	700
Current Supply	293	278	278	253	201	214
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(208)	(256)	(291)	(356)	(454)	(486)

Andrews County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	37,898	37,579	37,258	36,939	36,621	36,306
Current Supply	9,478	8,500	8,013	6,923	5,243	5,236
Conservation Supply	1,895	3,758	3,726	3,726	3,726	3,726
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(26,525)	(25,321)	(25,519)	(26,290)	(27,652)	(27,344)

Andrews County Livestock

	2020	2030	2040	2050	2060	2070
Demands	325	325	325	325	325	325
Current Supply	225	210	202	185	159	159
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(100)	(115)	(123)	(140)	(166)	(166)

Andrews County Mining

	2020	2030	2040	2050	2060	2070
Demands	3,959	3,710	3,177	2,509	1,929	1,483
Current Supply	1,348	1,046	499	427	317	317
Conservation Supply	277	260	222	176	135	104
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(2,334)	(2,404)	(2,456)	(1,906)	(1,477)	(1,062)

Andrews County Manufacturing

	2020	2030	2040	2050	2060	2070

All manufacturing demand is associated with the City of Andrews. The manufacturing need is included in the City of Andrew's need.

Borden County

Borden County-Other

	2020	2030	2040	2050	2060	2070
Demands	178	178	176	176	175	175
Current Supply	178	178	176	176	175	175
Conservation Supply	13	13	13	13	13	13
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	13	13	13	13	13	13

Borden County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	4,000	3,993	3,990	3,983	3,980	3,977
Current Supply	757	757	759	759	760	760
Conservation Supply	200	399	399	399	399	399
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(3,043)	(2,837)	(2,832)	(2,825)	(2,821)	(2,818)

Borden County Livestock

	2020	2030	2040	2050	2060	2070
Demands	250	250	250	250	250	250
Current Supply	250	250	250	250	250	250
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Borden County Mining

	2020	2030	2040	2050	2060	2070
Demands	679	927	784	494	244	121
Current Supply	679	927	784	494	244	121
Conservation Supply	48	65	55	35	17	8
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	48	65	55	35	17	8

Brown County

Bangs

	2020	2030	2040	2050	2060	2070
Demands	207	204	198	195	194	194
Current Supply	207	204	198	195	194	194
Conservation Supply	9	9	9	9	9	9
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	9	9	9	9	9	9

Brookesmith SUD

	2020	2030	2040	2050	2060	2070
Demands	1,199	1,195	1,170	1,156	1,153	1,153
Current Supply	1,199	1,195	1,170	1,156	1,153	1,153
Conservation Supply	44	45	45	45	45	45
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	44	45	45	45	45	45

Brownwood

	2020	2030	2040	2050	2060	2070
Demands	3,880	3,875	3,802	3,761	3,754	3,754
Current Supply	3,880	3,875	3,802	3,761	3,754	3,754
Conservation Supply	126	129	129	129	129	129
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	126	129	129	129	129	129

Coleman County SUD

	2020	2030	2040	2050	2060	2070
Demands	427	422	411	404	404	405
Current Supply	214	211	206	202	202	203
Conservation Supply	19	19	19	19	19	19
Subordination Supply (Sales from Coleman)	214	211	206	202	202	203
Surplus (Need)	20	19	20	19	19	20

Santa Anna

	2020	2030	2040	2050	2060	2070
Demands	157	155	150	150	149	149
Current Supply	157	155	150	150	149	149
Conservation Supply	6	6	6	6	6	6
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	6	6	6	6	6	6

Early

	2020	2030	2040	2050	2060	2070
Demands	290	285	275	269	268	268
Current Supply	290	285	275	269	268	268
Conservation Supply	16	16	16	16	16	16
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	16	16	16	16	16	16

Brown County

Zephyr WSC

	2020	2030	2040	2050	2060	2070
Demands	379	374	364	359	357	357
Current Supply	379	374	364	359	357	357
Conservation Supply	25	26	26	26	26	26
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	25	26	26	26	26	26

Brown County-Other

	2020	2030	2040	2050	2060	2070
Demands	204	206	205	204	203	203
Current Supply	204	206	205	204	203	203
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Brown County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	9,435	9,403	9,371	9,338	9,306	9,275
Current Supply	6,330	6,324	6,322	6,321	6,325	6,329
Conservation Supply	472	752	750	750	750	750
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(2,633)	(2,327)	(2,299)	(2,267)	(2,231)	(2,196)

Brown County Livestock

	2020	2030	2040	2050	2060	2070
Demands	1,353	1,353	1,353	1,353	1,353	1,353
Current Supply	1,368	1,368	1,368	1,368	1,368	1,368
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	15	15	15	15	15	15

Brown County Mining

	2020	2030	2040	2050	2060	2070
Demands	943	948	951	952	948	944
Current Supply	943	948	951	952	948	944
Conservation Supply	66	66	67	67	66	66
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	66	66	67	67	66	66

Brown County Manufacturing

	2020	2030	2040	2050	2060	2070
Demands	673	726	777	820	886	957
Current Supply	673	726	777	820	886	957
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Coke County

Bronte

	2020	2030	2040	2050	2060	2070
Demands	476	472	468	466	466	466
Current Supply	129	125	121	120	120	120
Conservation Supply	17	17	16	16	16	16
Subordination Supply	176	176	176	176	176	176
Surplus (Need)	(154)	(154)	(155)	(154)	(154)	(154)

Robert Lee

	2020	2030	2040	2050	2060	2070
Demands	360	350	345	343	343	343
Current Supply	61	59	58	58	58	58
Conservation Supply	6	6	6	6	6	6
Subordination Supply	224	224	224	224	224	224
Surplus (Need)	(69)	(61)	(57)	(55)	(55)	(55)

Remaining Coke County-Other

	2020	2030	2040	2050	2060	2070
Demands	114	108	103	101	101	101
Current Supply	63	60	57	56	56	56
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(51)	(48)	(46)	(45)	(45)	(45)

Coke County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	965	963	962	962	962	962
Current Supply	763	763	763	763	763	763
Conservation Supply	48	96	115	115	115	115
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(154)	(104)	(84)	(84)	(84)	(84)

Coke County Livestock

	2020	2030	2040	2050	2060	2070
Demands	431	431	431	431	431	431
Current Supply	431	431	431	431	431	431
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Coke County Mining

	2020	2030	2040	2050	2060	2070
Demands	488	482	430	376	328	286
Current Supply	170	170	170	170	170	170
Conservation Supply	34	34	30	26	23	20
Subordination Supply	38	36	34	32	30	28
Surplus (Need)	(246)	(242)	(196)	(148)	(105)	(68)

Coke County

Coke County Steam Electric Power

	2020	2030	2040	2050	2060	2070
Demands	247	289	339	401	477	528
Current Supply	0	0	0	0	0	0
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(247)	(289)	(339)	(401)	(477)	(528)

Coleman County

Coleman

	2020	2030	2040	2050	2060	2070
Demands	1,052	1,041	1,017	1,011	1,008	1,008
Current Supply	0	0	0	0	0	0
Conservation Supply	26	27	27	27	27	27
Subordination Supply	2,316	2,272	2,230	2,187	2,140	2,094
Surplus (Need)	1,290	1,258	1,240	1,203	1,159	1,113

Coleman County Other

	2020	2030	2040	2050	2060	2070

All county-other demand is associated with the City of Coleman. The county-other need is included in the City of Coleman's need.

Coleman County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	770	770	770	770	770	770
Current Supply	27	27	27	27	27	27
Conservation Supply	39	77	77	77	77	77
Subordination Supply	743	743	743	743	743	743
Surplus (Need)	39	77	77	77	77	77

Coleman County Livestock

	2020	2030	2040	2050	2060	2070
Demands	1,076	1,076	1,076	1,076	1,076	1,076
Current Supply	1,076	1,076	1,076	1,076	1,076	1,076
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Coleman County Manufacturing (All demand associated with City of Coleman)

Coleman County Mining

	2020	2030	2040	2050	2060	2070
Demands	108	107	97	86	77	69
Current Supply	46	46	46	46	46	46
Conservation Supply	8	7	7	6	5	5
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(54)	(54)	(44)	(34)	(26)	(18)

Concho County

Eden

	2020	2030	2040	2050	2060	2070
Demands	490	488	480	476	475	475
Current Supply	490	488	480	476	475	475
Conservation Supply	16	16	16	16	16	16
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	16	16	16	16	16	16

Concho County-Other (Remaining)

	2020	2030	2040	2050	2060	2070
Demands	86	85	84	82	82	82
Current Supply	86	85	84	82	82	82
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Concho County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	9,734	9,693	9,654	9,618	9,582	9,546
Current Supply	4,485	4,485	4,485	4,485	4,485	4,485
Conservation Supply	487	969	1,062	1,062	1,062	1,062
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(4,762)	(4,239)	(4,107)	(4,071)	(4,035)	(3,999)

Concho County Livestock

	2020	2030	2040	2050	2060	2070
Demands	699	699	699	699	699	699
Current Supply	699	699	699	699	699	699
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Concho County Mining

	2020	2030	2040	2050	2060	2070
Demands	480	474	422	367	320	279
Current Supply	268	268	268	268	268	268
Conservation Supply	34	33	30	26	22	20
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(178)	(173)	(124)	(73)	(30)	9

Crane County

Crane

	2020	2030	2040	2050	2060	2070
Demands	1,432	1,547	1,639	1,736	1,820	1,893
Current Supply	1,432	1,547	1,639	1,736	1,820	1,893
Conservation Supply	20	21	23	24	25	26
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	20	21	23	24	25	26

Crane County Other

	2020	2030	2040	2050	2060	2070

All Crane County-Other demand is associated with the City of Crane.

Crane County Livestock

	2020	2030	2040	2050	2060	2070
Demands	172	172	172	172	172	172
Current Supply	172	172	172	172	172	172
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Crane County Mining

	2020	2030	2040	2050	2060	2070
Demands	617	840	861	692	531	407
Current Supply	617	840	861	692	531	407
Conservation Supply	43	59	60	48	37	28
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	43	59	60	48	37	28

Crockett County

Crockett County WCID #1

	2020	2030	2040	2050	2060	2070
Demands	1,533	1,642	1,655	1,672	1,678	1,681
Current Supply	1,533	1,642	1,655	1,672	1,678	1,681
Conservation Supply	21	23	23	24	24	24
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	21	23	23	24	24	24

Crockett County-Other

	2020	2030	2040	2050	2060	2070
Demands	28	20	19	18	17	17
Current Supply	28	20	19	18	17	17
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Crockett County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	479	470	461	455	446	437
Current Supply	479	470	461	455	446	437
Conservation Supply	24	47	69	69	69	69
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	24	47	69	69	69	69

Crockett County Livestock

	2020	2030	2040	2050	2060	2070
Demands	681	681	681	681	681	681
Current Supply	695	695	695	695	695	695
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	14	14	14	14	14	14

Crockett County Mining

	2020	2030	2040	2050	2060	2070
Demands	1,732	1,843	1,261	682	207	63
Current Supply	550	550	550	550	207	63
Conservation Supply	121	129	88	48	14	4
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(1,061)	(1,164)	(623)	(84)	14	4

Crockett Steam Electric Power

	2020	2030	2040	2050	2060	2070
Demands	776	907	1,067	1,262	1,500	1,662
Current Supply	0	0	0	0	0	0
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(776)	(907)	(1,067)	(1,262)	(1,500)	(1,662)

Ector County

Odessa

	2020	2030	2040	2050	2060	2070
Demands	31,019	34,023	36,931	39,964	43,268	46,740
Current Supply	19,348	26,500	26,785	26,911	27,054	27,161
Conservation Supply	716	825	924	1,026	1,128	1,231
Subordination Supply	11,671	7,523	10,146	13,053	16,214	19,491
Surplus (Need)	716	825	924	1,025	1,128	1,143

Greater Gardendale WSC

	2020	2030	2040	2050	2060	2070
Demands	248	270	295	324	355	388
Current Supply	248	270	295	324	355	388
Conservation Supply	16	19	21	23	26	28
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	16	19	21	23	26	28

Ector County-Other (Self-Supplied)

	2020	2030	2040	2050	2060	2070
Demands	2,306	2,555	2,835	3,124	3,416	3,704
Current Supply	2,641	2,886	2,907	2,903	2,896	2,895
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	335	331	72	(221)	(520)	(809)

Ector County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	1,432	1,415	1,397	1,380	1,362	1,345
Current Supply	2,401	2,615	2,740	2,781	2,798	2,862
Conservation Supply	72	142	210	210	210	210
Subordination Supply	189	110	134	157	179	60
Surplus (Need)	1,230	1,452	1,687	1,768	1,825	1,787

Ector County Livestock

	2020	2030	2040	2050	2060	2070
Demands	265	265	265	265	265	265
Current Supply	265	265	265	265	265	265
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Ector County Manufacturing

	2020	2030	2040	2050	2060	2070
Demands	3,454	3,643	3,809	3,936	4,070	4,209
Current Supply	4,534	4,843	4,945	5,019	5,099	5,123
Conservation Supply	0	0	0	0	0	0
Subordination Supply	312	182	240	282	318	345
Surplus (Need)	1,392	1,382	1,376	1,365	1,347	1,259

Ector County

Ector County Mining

	2020	2030	2040	2050	2060	2070
Demands	1,977	2,164	1,926	1,574	1,272	1,076
Current Supply	2,248	2,334	2,035	1,669	1,412	1,256
Conservation Supply	138	151	135	110	89	75
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	409	321	244	205	229	255

Ector County Steam Electric Power

	2020	2030	2040	2050	2060	2070
Demands	9,436	11,031	12,976	15,347	18,237	21,672
Current Supply	2,817	2,768	2,811	2,743	2,640	2,639
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(6,619)	(8,263)	(10,165)	(12,604)	(15,597)	(19,033)

Glasscock County

Glasscock County-Other

	2020	2030	2040	2050	2060	2070
Demands	162	165	161	160	160	160
Current Supply	162	165	161	160	160	160
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Glasscock County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	56,707	56,252	55,796	55,339	54,887	54,439
Current Supply	56,707	56,252	55,796	55,339	54,887	54,439
Conservation Supply	2,268	2,250	2,232	2,232	2,232	2,232
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	2,268	2,250	2,232	2,232	2,232	2,232

Glasscock County Livestock

	2020	2030	2040	2050	2060	2070
Demands	262	262	262	262	262	262
Current Supply	262	262	262	262	262	262
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Glasscock County Mining

	2020	2030	2040	2050	2060	2070
Demands	3,423	3,101	2,384	1,679	1,100	798
Current Supply	3,423	3,101	2,384	1,679	1,100	798
Conservation Supply	240	217	167	118	77	56
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	240	217	167	118	77	56

Howard County

Big Spring

	2020	2030	2040	2050	2060	2070
Demands	7,832	7,974	7,987	7,935	7,925	7,924
Current Supply	4,155	5,783	5,305	4,818	4,401	4,039
Conservation Supply	181	191	193	193	193	193
Subordination Supply	3,677	2,190	2,682	3,115	3,523	3,885
Surplus (Need)	181	190	193	191	192	193

Howard County-Other

	2020	2030	2040	2050	2060	2070
Demands	896	893	888	886	883	883
Current Supply	447	408	408	408	408	408
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(449)	(485)	(480)	(478)	(475)	(475)

Howard County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	6,722	6,645	6,567	6,490	6,413	6,337
Current Supply	3,489	3,230	3,230	3,230	3,230	3,230
Conservation Supply	336	665	722	722	722	722
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(2,897)	(2,751)	(2,615)	(2,538)	(2,461)	(2,385)

Howard County Livestock

	2020	2030	2040	2050	2060	2070
Demands	316	316	316	316	316	316
Current Supply	202	187	187	187	187	187
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(114)	(129)	(129)	(129)	(129)	(129)

Howard Manufacturing (Self-Supplied)

	2020	2030	2040	2050	2060	2070
Demands	1,248	1,372	1,494	1,597	1,790	1,995
Current Supply	634	599	599	599	599	599
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(614)	(773)	(895)	(998)	(1,191)	(1,396)

Howard County Mining

	2020	2030	2040	2050	2060	2070
Demands	2,491	2,747	1,940	1,138	476	199
Current Supply	163	156	156	156	156	156
Conservation Supply	174	192	136	80	33	14
Subordination Supply	1,000	1,000	1,000	982	320	43
Surplus (Need)	(1,154)	(1,399)	(648)	80	33	14

Irion County

Mertzon

	2020	2030	2040	2050	2060	2070
Demands	102	99	96	95	95	95
Current Supply	102	99	96	95	95	95
Conservation Supply	5	5	5	5	5	5
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	5	5	5	5	5	5

Irion County-Other

	2020	2030	2040	2050	2060	2070
Demands	105	102	98	97	97	97
Current Supply	105	102	98	97	97	97
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Irion County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	1,467	1,435	1,402	1,370	1,338	1,307
Current Supply	1,108	1,076	1,043	1,011	979	948
Conservation Supply	73	144	210	210	210	210
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(286)	(216)	(149)	(149)	(149)	(149)

Irion County Livestock

	2020	2030	2040	2050	2060	2070
Demands	268	268	268	268	268	268
Current Supply	268	268	268	268	268	268
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Irion County Mining

	2020	2030	2040	2050	2060	2070
Demands	3,192	3,357	2,423	1,487	713	342
Current Supply	1,373	1,373	1,373	1,373	713	342
Conservation Supply	223	235	170	104	50	24
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(1,596)	(1,749)	(880)	(10)	50	24

Kimble County

Junction

	2020	2030	2040	2050	2060	2070
Demands	640	632	622	617	616	616
Current Supply	0	0	0	0	0	0
Conservation Supply	45	46	46	45	45	45
Subordination Supply	412	412	412	412	412	412
Surplus (Need)	(183)	(174)	(164)	(160)	(159)	(159)

Remaining Kimble County-Other

	2020	2030	2040	2050	2060	2070
Demands	242	236	229	226	225	225
Current Supply	242	236	229	226	225	225
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Kimble County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	2,939	2,830	2,718	2,606	2,501	2,400
Current Supply	1,443	1,443	1,443	1,443	1,443	1,443
Conservation Supply	147	283	326	326	326	326
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(1,349)	(1,104)	(949)	(837)	(732)	(631)

Kimble County Livestock

	2020	2030	2040	2050	2060	2070
Demands	402	402	402	402	402	402
Current Supply	402	402	402	402	402	402
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Kimble County Manufacturing

	2020	2030	2040	2050	2060	2070
Demands	701	752	804	852	916	985
Current Supply	2	2	2	2	2	2
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(699)	(750)	(802)	(850)	(914)	(983)

Kimble County Mining

	2020	2030	2040	2050	2060	2070
Demands	19	19	19	19	19	19
Current Supply	19	19	19	19	19	19
Conservation Supply	1	1	1	1	1	1
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	1	1	1	1	1	1

Loving County

Loving County-Other

	2020	2030	2040	2050	2060	2070
Demands	11	10	10	10	10	10
Current Supply	11	10	10	10	10	10
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Loving County Livestock

	2020	2030	2040	2050	2060	2070
Demands	101	101	101	101	101	101
Current Supply	101	101	101	101	101	101
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Loving County Mining

	2020	2030	2040	2050	2060	2070
Demands	792	1,058	934	762	601	474
Current Supply	792	1,058	934	762	601	474
Conservation Supply	55	74	65	53	42	33
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	55	74	65	53	42	33

Martin County

Stanton

	2020	2030	2040	2050	2060	2070
Demands	539	579	606	635	658	677
Current Supply	294	429	413	397	377	357
Conservation Supply	15	17	18	19	20	20
Subordination Supply	253	160	202	248	291	331
Surplus (Need)	23	27	27	29	30	31

Martin County-Other

	2020	2030	2040	2050	2060	2070
Demands	342	363	376	392	406	418
Current Supply	131	141	160	159	167	175
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(211)	(222)	(216)	(233)	(239)	(243)

Martin County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	36,322	35,674	35,026	34,381	33,746	33,123
Current Supply	11,165	11,122	11,942	11,150	11,106	11,079
Conservation Supply	1,816	3,567	5,254	5,254	5,254	5,254
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(23,341)	(20,985)	(17,830)	(17,977)	(17,386)	(16,790)

Martin County Livestock

	2020	2030	2040	2050	2060	2070
Demands	128	128	128	128	128	128
Current Supply	90	91	93	92	92	93
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(38)	(37)	(35)	(36)	(36)	(35)

Martin County Manufacturing

	2020	2030	2040	2050	2060	2070
Demands	41	42	43	44	47	50
Current Supply	16	16	18	18	19	21
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(25)	(26)	(25)	(26)	(28)	(29)

Martin County Mining

	2020	2030	2040	2050	2060	2070
Demands	3,527	2,998	2,251	1,441	771	413
Current Supply	488	495	541	515	522	413
Conservation Supply	247	210	158	101	54	29
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(2,792)	(2,293)	(1,552)	(825)	(195)	29

Mason County

Mason

	2020	2030	2040	2050	2060	2070
Demands	703	693	685	680	680	680
Current Supply	0	0	0	0	0	0
Conservation Supply	38	38	38	37	37	37
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(665)	(655)	(647)	(643)	(643)	(643)

Remaining Mason County-Other

	2020	2030	2040	2050	2060	2070
Demands	225	218	212	209	208	208
Current Supply	225	218	212	209	208	208
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Mason County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	8,294	8,174	8,054	7,935	7,816	7,699
Current Supply	8,294	8,174	8,054	7,935	7,816	7,699
Conservation Supply	415	817	1,208	1,208	1,208	1,208
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	415	817	1,208	1,208	1,208	1,208

Mason County Livestock

	2020	2030	2040	2050	2060	2070
Demands	1,248	1,248	1,248	1,248	1,248	1,248
Current Supply	1,248	1,248	1,248	1,248	1,248	1,248
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Mason County Mining

	2020	2030	2040	2050	2060	2070
Demands	1,023	941	708	568	460	372
Current Supply	1,025	943	710	570	462	374
Conservation Supply	72	66	50	40	32	26
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	74	68	52	42	34	28

McCulloch County

Brady

	2020	2030	2040	2050	2060	2070
Demands	1,396	1,425	1,406	1,415	1,417	1,419
Current Supply	0	0	0	0	0	0
Conservation Supply	32	33	33	33	33	33
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(1,364)	(1,392)	(1,373)	(1,382)	(1,384)	(1,386)

Richland SUD

	2020	2030	2040	2050	2060	2070
Demands	344	350	345	341	344	348
Current Supply	612	612	612	612	612	612
Conservation Supply	13	14	14	14	14	14
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	281	276	281	285	282	278

Millersview-Doole WSC

	2020	2030	2040	2050	2060	2070
Demands	1,134	1,139	1,137	642	650	660
Current Supply	987	1,202	1,138	773	742	715
Conservation Supply	24	25	25	26	26	27
Subordination Supply	517	302	369	236	267	294
Surplus (Need)	394	390	395	393	385	376

Remaining McCulloch County-Other

	2020	2030	2040	2050	2060	2070
Demands	87	90	89	90	90	90
Current Supply	52	54	54	54	54	54
Conservation Supply	4	3	3	3	3	3
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(31)	(33)	(32)	(33)	(33)	(33)

McCulloch County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	3,584	3,539	3,493	3,448	3,404	3,361
Current Supply	1,400	1,401	1,412	1,417	1,418	1,417
Conservation Supply	179	354	524	524	524	524
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(2,005)	(1,784)	(1,557)	(1,507)	(1,462)	(1,420)

McCulloch County Livestock

	2020	2030	2040	2050	2060	2070
Demands	714	714	714	714	714	714
Current Supply	690	690	690	690	690	690
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(24)	(24)	(24)	(24)	(24)	(24)

McCulloch County

McCulloch County Manufacturing (Self-Supplied)

	2020	**2030**	**2040**	**2050**	**2060**	**2070**
Demands	498	538	576	609	661	717
Current Supply	297	321	346	368	400	433
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(201)	(217)	(230)	(241)	(261)	(284)

McCulloch County Mining

	2020	**2030**	**2040**	**2050**	**2060**	**2070**
Demands	8,927	8,347	6,641	5,627	4,836	4,201
Current Supply	5,309	5,281	5,203	5,155	4,836	4,201
Conservation Supply	625	584	465	394	339	294
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(2,993)	(2,482)	(973)	(78)	339	294

Menard County

Menard

	2020	2030	2040	2050	2060	2070
Demands	349	341	335	334	334	334
Current Supply	139	139	139	139	139	139
Conservation Supply	25	25	25	24	24	24
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(185)	(177)	(171)	(171)	(171)	(171)

Menard County-Other

	2020	2030	2040	2050	2060	2070
Demands	95	92	89	87	87	87
Current Supply	95	92	89	87	87	87
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Menard County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	2,530	2,522	2,514	2,505	2,497	2,489
Current Supply	2,104	2,104	2,104	2,104	2,104	2,104
Conservation Supply	127	252	377	377	377	377
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(300)	(166)	(33)	(24)	(16)	(8)

Menard County Livestock

	2020	2030	2040	2050	2060	2070
Demands	408	408	408	408	408	408
Current Supply	426	426	426	426	426	426
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	18	18	18	18	18	18

Menard County Manufacturing

	2020	2030	2040	2050	2060	2070
Demands	3	3	3	3	3	3
Current Supply	3	3	3	3	3	3
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Menard County Mining

	2020	2030	2040	2050	2060	2070
Demands	1,086	1,071	952	827	717	622
Current Supply	1,086	1,071	952	827	717	622
Conservation Supply	76	75	67	58	50	44
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	76	75	67	58	50	44

Midland County

Midland

	2020	2030	2040	2050	2060	2070
Demands	32,781	34,524	37,574	40,815	44,184	47,518
Current Supply	29,878	19,678	16,952	16,783	16,615	16,446
Conservation Supply	813	879	973	1,062	1,150	1,236
Subordination Supply	8,527	(299)	(298)	(297)	(297)	(296)
Surplus (Need)	6,437	(14,266)	(19,947)	(23,267)	(26,716)	(30,132)

Remaining Midland County-Other

	2020	2030	2040	2050	2060	2070
Demands	4,213	4,629	5,049	5,511	6,008	6,503
Current Supply	4,213	4,629	5,049	5,511	6,008	6,503
Conservation Supply	215	164	183	202	220	239
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	215	164	183	202	220	239

Midland County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	33,276	33,016	32,756	32,495	32,237	31,981
Current Supply	33,276	33,016	32,756	32,495	32,237	31,981
Conservation Supply	1,664	3,302	4,913	4,913	4,913	4,913
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	1,664	3,302	4,913	4,913	4,913	4,913

Midland County Livestock

	2020	2030	2040	2050	2060	2070
Demands	394	394	394	394	394	394
Current Supply	394	394	394	394	394	394
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Midland County Manufacturing

	2020	2030	2040	2050	2060	2070
Demands	230	250	269	285	309	335
Current Supply	230	250	269	285	309	335
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Midland County Mining

	2020	2030	2040	2050	2060	2070
Demands	3,893	3,418	2,630	1,774	1,056	743
Current Supply	3,893	3,418	2,630	1,774	1,056	743
Conservation Supply	273	239	184	124	74	52
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	273	239	184	124	74	52

Mitchell County

Colorado City

	2020	2030	2040	2050	2060	2070
Demands	1,287	1,417	1,427	1,438	1,451	1,466
Current Supply	1,287	1,417	1,427	1,438	1,451	1,466
Conservation Supply	28	31	32	32	32	33
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	28	31	32	32	32	33

Loraine

	2020	2030	2040	2050	2060	2070
Demands	73	72	71	72	72	73
Current Supply	73	72	71	72	72	73
Conservation Supply	3	4	4	4	4	4
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	3	4	4	4	4	4

Mitchell County-Other

	2020	2030	2040	2050	2060	2070
Demands	843	852	857	861	868	875
Current Supply	843	852	857	861	868	875
Conservation Supply	68	70	71	71	72	73
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	68	70	71	71	72	73

Mitchell County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	11,519	11,460	11,404	11,348	11,292	11,236
Current Supply	11,519	11,460	11,404	11,348	11,292	11,236
Conservation Supply	230	229	228	228	228	228
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	230	229	228	228	228	228

Mitchell County Livestock

	2020	2030	2040	2050	2060	2070
Demands	413	413	413	413	413	413
Current Supply	413	413	413	413	413	413
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Mitchell County Mining

	2020	2030	2040	2050	2060	2070
Demands	593	738	632	493	375	290
Current Supply	593	738	632	493	375	290
Conservation Supply	42	52	44	35	26	20
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	42	52	44	35	26	20

Mitchell County

Mitchell County Steam Electric Power

	2020	2030	2040	2050	2060	2070
Demands	4,847	4,670	4,493	4,317	4,140	3,994
Current Supply	0	0	0	0	0	0
Conservation Supply	0	0	0	0	0	0
Subordination Supply	3,720	3,640	3,560	3,480	3,400	3,320
Surplus (Need)	(1,127)	(1,030)	(933)	(837)	(740)	(674)

Pecos County

Fort Stockton

	2020	2030	2040	2050	2060	2070
Demands	4,910	5,230	5,548	5,853	6,138	6,398
Current Supply	4,910	5,230	5,548	5,853	6,138	6,398
Conservation Supply	50	53	57	60	63	66
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	50	53	57	60	63	66

Iraan

	2020	2030	2040	2050	2060	2070
Demands	459	486	513	541	567	591
Current Supply	459	486	513	541	567	591
Conservation Supply	7	8	8	9	9	10
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	7	8	8	9	9	10

Pecos County WCID #1

	2020	2030	2040	2050	2060	2070
Demands	439	456	475	496	519	540
Current Supply	439	456	475	496	519	540
Conservation Supply	19	20	22	23	24	25
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	19	20	22	23	24	25

Pecos County-Other

	2020	2030	2040	2050	2060	2070
Demands	415	427	453	478	501	522
Current Supply	415	427	453	478	501	522
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Pecos County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	126,023	126,023	126,023	126,023	126,023	126,023
Current Supply	126,028	126,029	126,030	126,031	126,032	126,033
Conservation Supply	6,301	12,602	18,903	18,903	18,903	18,903
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	6,306	12,608	18,910	18,911	18,912	18,913

Pecos County Livestock

	2020	2030	2040	2050	2060	2070
Demands	932	932	932	932	932	932
Current Supply	932	932	932	932	932	932
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Pecos County

Pecos County Manufacturing

	2020	2030	2040	2050	2060	2070
Demands	103	103	103	103	103	103
Current Supply	103	103	103	103	103	103
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Pecos County Mining

	2020	2030	2040	2050	2060	2070
Demands	690	1,068	1,072	861	672	524
Current Supply	690	1,068	1,072	861	672	524
Conservation Supply	48	75	75	60	47	37
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	48	75	75	60	47	37

Reagan County

Big Lake

	2020	2030	2040	2050	2060	2070
Demands	769	834	873	916	945	967
Current Supply	769	834	873	916	945	967
Conservation Supply	47	53	55	58	60	61
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	47	53	55	58	60	61

Remaining Reagan County-Other

	2020	2030	2040	2050	2060	2070
Demands	32	38	41	44	47	49
Current Supply	32	38	41	44	47	49
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Reagan County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	19,130	18,808	18,486	18,164	17,848	17,537
Current Supply	19,130	18,808	18,486	18,164	17,848	17,537
Conservation Supply	957	1,881	2,773	2,773	2,773	2,773
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	957	1,881	2,773	2,773	2,773	2,773

Reagan County Livestock

	2020	2030	2040	2050	2060	2070
Demands	255	255	255	255	255	255
Current Supply	266	266	266	266	266	266
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	11	11	11	11	11	11

Reagan County Mining

	2020	2030	2040	2050	2060	2070
Demands	4,211	3,395	2,457	1,406	529	199
Current Supply	4,226	3,410	2,472	1,421	544	214
Conservation Supply	295	238	172	98	37	14
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	310	253	187	113	52	29

Reeves County

Pecos

	2020	2030	2040	2050	2060	2070
Demands	3,288	3,450	3,612	3,729	3,828	3,908
Current Supply	3,288	3,450	3,612	3,729	3,828	3,908
Conservation Supply	210	221	232	240	246	250
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	210	221	232	240	246	250

Madera Valley WSC

	2020	2030	2040	2050	2060	2070
Demands	586	616	644	665	682	694
Current Supply	586	616	644	665	682	694
Conservation Supply	80	85	88	91	93	96
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	80	85	88	91	93	96

Reeves Remaining County-Other

	2020	2030	2040	2050	2060	2070
Demands	402	424	442	456	466	475
Current Supply	402	424	442	456	466	475
Conservation Supply	19	20	21	22	23	23
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	19	20	21	22	23	23

Reeves County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	91,357	90,577	89,795	89,015	88,242	87,475
Current Supply	91,357	90,577	89,795	89,015	88,242	87,475
Conservation Supply	4,568	9,058	13,469	13,469	13,469	13,469
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	4,568	9,058	13,469	13,469	13,469	13,469

Reeves County Livestock

	2020	2030	2040	2050	2060	2070
Demands	862	862	862	862	862	862
Current Supply	863	863	863	863	863	863
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	1	1	1	1	1	1

Reeves County Manufacturing (All demand associated with the City of Pecos)

Reeves County Mining

	2020	2030	2040	2050	2060	2070
Demands	1,531	2,632	2,537	2,068	1,632	1,288
Current Supply	1,531	2,632	2,537	2,068	1,632	1,288
Conservation Supply	107	184	178	145	114	90
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	107	184	178	145	114	90

Runnels County

Ballinger

	2020	2030	2040	2050	2060	2070
Demands	823	825	812	813	817	822
Current Supply	199	272	249	0	0	0
Conservation Supply	58	59	58	58	58	58
Subordination Supply	752	675	693	563	558	554
Surplus (Need)	186	181	188	(192)	(201)	(210)

Miles

	2020	2030	2040	2050	2060	2070
Demands	112	124	121	119	119	119
Current Supply	0	0	0	0	0	0
Conservation Supply	5	6	6	6	6	6
Subordination Supply	112	124	121	119	119	119
Surplus (Need)	5	6	6	6	6	6

Winters

	2020	2030	2040	2050	2060	2070
Demands	355	346	336	335	334	334
Current Supply	0	0	0	0	0	0
Conservation Supply	14	15	15	15	15	15
Subordination Supply	186	182	178	174	170	165
Surplus (Need)	(155)	(149)	(143)	(146)	(149)	(154)

Runnels County-Other (Self-supplied)

	2020	2030	2040	2050	2060	2070
Demands	28	23	12	11	10	10
Current Supply	28	23	12	11	10	10
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Runnels County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	4,009	3,991	3,973	3,955	3,937	3,919
Current Supply	2,367	2,367	2,367	2,367	2,367	2,367
Conservation Supply	200	399	477	477	477	477
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(1,442)	(1,225)	(1,129)	(1,111)	(1,093)	(1,075)

Runnels County Livestock

	2020	2030	2040	2050	2060	2070
Demands	880	880	880	880	880	880
Current Supply	880	880	880	880	880	880
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Runnels County

Runnels County Manufacturing

	2020	**2030**	**2040**	**2050**	**2060**	**2070**
Demands	48	52	56	59	64	69
Current Supply	2	3	3	0	0	0
Conservation Supply	0	0	0	0	0	0
Subordination Supply	11	10	10	11	11	11
Surplus (Need)	(35)	(39)	(43)	(48)	(53)	(58)

Runnels County Mining

	2020	**2030**	**2040**	**2050**	**2060**	**2070**
Demands	272	269	240	210	184	161
Current Supply	177	177	177	177	177	177
Conservation Supply	19	19	17	15	13	11
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(76)	(73)	(46)	(18)	6	27

Schleicher County

Eldorado

	2020	2030	2040	2050	2060	2070
Demands	656	647	639	636	635	635
Current Supply	656	647	639	636	635	635
Conservation Supply	36	35	35	35	35	35
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	36	35	35	35	35	35

Remaining Schleicher County-Other

	2020	2030	2040	2050	2060	2070
Demands	227	262	279	289	296	301
Current Supply	250	288	307	318	326	331
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	23	26	28	29	30	30

Schleicher County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	1,414	1,385	1,356	1,327	1,298	1,270
Current Supply	1,414	1,385	1,356	1,327	1,298	1,270
Conservation Supply	71	83	81	81	81	81
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	71	83	81	81	81	81

Schleicher County Livestock

	2020	2030	2040	2050	2060	2070
Demands	535	535	535	535	535	535
Current Supply	552	552	552	552	552	552
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	17	17	17	17	17	17

Schleicher County Mining

	2020	2030	2040	2050	2060	2070
Demands	621	732	562	392	241	148
Current Supply	661	773	598	422	257	158
Conservation Supply	43	51	39	27	17	10
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	83	92	75	57	33	20

Scurry County

Snyder

	2020	2030	2040	2050	2060	2070
Demands	2,700	2,938	3,068	3,261	3,475	3,696
Current Supply	1,431	2,131	2,038	1,981	1,931	1,884
Conservation Supply	75	86	93	100	104	134
Subordination Supply	1,268	807	1,030	1,280	1,544	1,812
Surplus (Need)	74	86	93	100	104	134

Scurry County-Other (Self-Supplied)

	2020	2030	2040	2050	2060	2070
Demands	463	496	533	587	652	721
Current Supply	155	164	173	187	203	220
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(308)	(332)	(360)	(400)	(449)	(501)

Scurry County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	7,305	7,056	6,806	6,557	6,318	6,088
Current Supply	984	977	968	954	941	923
Conservation Supply	365	706	885	885	885	885
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(5,956)	(5,373)	(4,953)	(4,718)	(4,492)	(4,280)

Scurry County Livestock

	2020	2030	2040	2050	2060	2070
Demands	504	504	504	504	504	504
Current Supply	412	412	412	413	413	413
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(92)	(92)	(92)	(91)	(91)	(91)

Scurry County Manufacturing

	2020	2030	2040	2050	2060	2070
Demands	3	3	3	3	3	3
Current Supply	3	3	3	3	3	3
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Scurry County Mining

	2020	2030	2040	2050	2060	2070
Demands	280	456	483	363	246	167
Current Supply	48	48	48	47	46	46
Conservation Supply	20	32	34	25	17	12
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(212)	(376)	(401)	(291)	(183)	(109)

Sterling County

Sterling City

	2020	2030	2040	2050	2060	2070
Demands	276	282	281	281	281	281
Current Supply	276	282	281	281	281	281
Conservation Supply	5	5	5	5	5	5
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	5	5	5	5	5	5

Sterling County-Other

	2020	2030	2040	2050	2060	2070
Demands	33	33	33	33	33	33
Current Supply	33	33	33	33	33	33
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Sterling County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	983	942	901	860	820	782
Current Supply	983	942	901	860	820	782
Conservation Supply	49	94	135	135	135	135
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	49	94	135	135	135	135

Sterling County Livestock

	2020	2030	2040	2050	2060	2070
Demands	322	322	322	322	322	322
Current Supply	322	322	322	322	322	322
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Sterling County Mining

	2020	2030	2040	2050	2060	2070
Demands	780	953	812	522	270	140
Current Supply	780	953	812	522	270	140
Conservation Supply	55	67	57	37	19	10
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	55	67	57	37	19	10

Sutton County

Sonora

	2020	2030	2040	2050	2060	2070
Demands	1,406	1,490	1,513	1,535	1,550	1,559
Current Supply	1,406	1,490	1,513	1,535	1,550	1,559
Conservation Supply	95	102	103	105	107	107
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	95	102	103	105	107	107

Sutton County-Other

	2020	2030	2040	2050	2060	2070
Demands	167	173	174	176	178	179
Current Supply	167	173	174	176	178	179
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Sutton County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	1,803	1,767	1,733	1,697	1,663	1,629
Current Supply	1,803	1,767	1,733	1,697	1,663	1,629
Conservation Supply	90	177	260	260	260	260
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	90	177	260	260	260	260

Sutton County Livestock

	2020	2030	2040	2050	2060	2070
Demands	479	479	479	479	479	479
Current Supply	548	548	548	548	548	548
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	69	69	69	69	69	69

Sutton County Mining

	2020	2030	2040	2050	2060	2070
Demands	446	720	763	573	389	264
Current Supply	446	720	763	573	389	264
Conservation Supply	31	50	53	40	27	18
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	31	50	53	40	27	18

Tom Green County

San Angelo

	2020	2030	2040	2050	2060	2070
Demands	29,931	31,917	32,990	34,264	35,813	37,496
Current Supply	18,470	18,302	18,166	18,014	17,849	17,677
Conservation Supply	656	753	793	842	894	949
Subordination Supply	3,699	3,494	3,305	3,115	2,922	2,732
Surplus (Need)	(7,106)	(9,368)	(10,726)	(12,293)	(14,148)	(16,138)

Concho Rural WSC

	2020	2030	2040	2050	2060	2070
Demands	538	548	559	572	590	607
Current Supply	607	607	607	607	607	607
Conservation Supply	33	35	37	38	40	41
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	102	94	85	73	57	41

Tom Green County-Other

	2020	2030	2040	2050	2060	2070
Demands	1,081	1,098	1,154	1,203	1,249	1,293
Current Supply	750	750	750	750	750	750
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(331)	(348)	(404)	(453)	(499)	(543)

Tom Green County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	93,579	93,350	93,121	92,889	92,660	92,432
Current Supply	61,928	61,928	61,878	61,828	61,828	61,828
Conservation Supply	4,679	9,335	11,175	11,175	11,175	11,175
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(26,972)	(22,087)	(20,068)	(19,886)	(19,657)	(19,429)

Tom Green County Livestock

	2020	2030	2040	2050	2060	2070
Demands	1,688	1,688	1,688	1,688	1,688	1,688
Current Supply	1,705	1,705	1,705	1,705	1,705	1,705
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	17	17	17	17	17	17

Tom Green County Manufacturing (Sales from San Angelo)

	2020	2030	2040	2050	2060	2070
Demands	2,387	2,615	2,839	3,034	3,273	3,531
Current Supply	1,639	1,618	1,665	1,673	1,679	1,681
Conservation Supply	0	0	0	0	0	0
Subordination Supply	428	404	396	378	361	342
Surplus (Need)	(320)	(593)	(778)	(983)	(1,233)	(1,508)

Tom Green County

Tom Green County Mining

	2020	2030	2040	2050	2060	2070
Demands	1,056	1,080	1,119	1,112	1,134	1,156
Current Supply	1,056	1,080	1,119	1,112	1,134	1,156
Conservation Supply	74	76	78	78	79	81
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	74	76	78	78	79	81

Upton County

McCamey

	2020	2030	2040	2050	2060	2070
Demands	776	827	849	878	895	908
Current Supply	776	827	849	878	895	908
Conservation Supply	50	53	55	57	58	59
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	50	53	55	57	58	59

Rankin

	2020	2030	2040	2050	2060	2070
Demands	277	295	302	312	319	323
Current Supply	277	295	302	312	319	323
Conservation Supply	19	20	20	21	22	22
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	19	20	20	21	22	22

Upton County-Other

	2020	2030	2040	2050	2060	2070
Demands	92	96	97	98	100	101
Current Supply	140	140	140	140	140	140
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	48	44	43	42	40	39

Upton County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	9,473	9,338	9,202	9,066	8,932	8,800
Current Supply	9,473	9,338	9,202	9,066	8,932	8,800
Conservation Supply	474	934	1,380	1,380	1,380	1,380
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	474	934	1,380	1,380	1,380	1,380

Upton County Livestock

	2020	2030	2040	2050	2060	2070
Demands	119	119	119	119	119	119
Current Supply	119	119	119	119	119	119
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Upton County Mining

	2020	2030	2040	2050	2060	2070
Demands	4,237	3,634	2,873	1,926	1,150	803
Current Supply	4,237	3,634	2,873	1,926	1,150	803
Conservation Supply	297	254	201	135	81	56
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	297	254	201	135	81	56

Ward County

Monahans

	2020	2030	2040	2050	2060	2070
Demands	2,685	2,796	2,871	2,952	3,014	3,062
Current Supply	2,685	2,796	2,871	2,952	3,014	3,062
Conservation Supply	41	43	45	47	48	48
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	41	43	45	47	48	48

Ward County-Other

	2020	2030	2040	2050	2060	2070
Demands	749	772	786	809	826	840
Current Supply	749	772	786	809	826	840
Conservation Supply	59	62	63	65	66	68
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	59	62	63	65	66	68

Ward County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	5,613	5,543	5,473	5,403	5,334	5,266
Current Supply	5,995	5,995	5,995	5,995	5,995	5,995
Conservation Supply	281	554	821	821	821	821
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	663	1,006	1,343	1,413	1,482	1,550

Ward County Livestock

	2020	2030	2040	2050	2060	2070
Demands	109	109	109	109	109	109
Current Supply	109	109	109	109	109	109
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Ward County Manufacturing

	2020	2030	2040	2050	2060	2070
Demands	16	16	16	16	16	16
Current Supply	16	16	16	16	16	16
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	0	0	0	0	0	0

Ward County Mining

	2020	2030	2040	2050	2060	2070
Demands	797	964	840	645	458	329
Current Supply	797	964	840	645	458	329
Conservation Supply	56	67	59	45	32	23
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	56	67	59	45	32	23

Ward County

Ward County Steam Electric Power

	2020	2030	2040	2050	2060	2070
Demands	3,779	4,418	5,196	6,145	7,303	8,269
Current Supply	2,700	2,700	2,700	2,700	2,700	2,700
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	(1,079)	(1,718)	(2,496)	(3,445)	(4,603)	(5,569)

Winkler County

Kermit

	2020	2030	2040	2050	2060	2070
Demands	1,831	1,823	1,819	1,837	1,850	1,864
Current Supply	1,831	1,823	1,819	1,837	1,850	1,864
Conservation Supply	32	32	32	33	33	33
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	32	32	32	33	33	33

Wink

	2020	2030	2040	2050	2060	2070
Demands	373	402	427	456	480	501
Current Supply	373	402	427	456	480	501
Conservation Supply	6	6	7	7	8	8
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	6	6	7	7	8	8

Winkler County-Other

	2020	2030	2040	2050	2060	2070
Demands	140	244	330	422	497	561
Current Supply	140	140	140	140	140	140
Conservation Supply	17	26	32	40	46	52
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	17	(78)	(158)	(242)	(311)	(369)

Winkler County Irrigation

	2020	2030	2040	2050	2060	2070
Demands	4,912	4,912	4,912	4,912	4,912	4,912
Current Supply	4,912	4,912	4,912	4,912	4,912	4,912
Conservation Supply	246	491	737	737	737	737
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	246	491	737	737	737	737

Winkler County Livestock

	2020	2030	2040	2050	2060	2070
Demands	351	351	351	351	351	351
Current Supply	389	389	389	389	389	389
Conservation Supply	0	0	0	0	0	0
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	38	38	38	38	38	38

Winkler County Mining

	2020	2030	2040	2050	2060	2070
Demands	787	1,169	991	756	531	373
Current Supply	787	1,169	991	756	531	373
Conservation Supply	55	82	69	53	37	26
Subordination Supply	0	0	0	0	0	0
Surplus (Need)	55	82	69	53	37	26

Chapter 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 wholesale 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 to meet regulatory requirements for consistency with the regional plan even though not specifically recommended in the plan.

This plan assumes that management strategies to meet any identified shortages are employed or implemented by the respective water user. The Region F Water Planning Group (RWPG) does not take responsibility in planning or implementing the strategies.

Subchapter 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 potential 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.

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. This procedure classifies strategies using the TWDB's standard categories developed for regional water planning. These strategy categories include:

- Water Conservation
    - Precipitation Enhancement
- 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. This strategy is considered a temporary strategy to conserve available water supplies during times of drought or emergencies and acts as means to minimize the adverse impacts of water supply shortages during drought. 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. 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 is 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.

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.

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 per capita use above 140 gallons per person per day. This is the State goal for municipal water conservation.

Conservation is also recommended for all mining users that are shown to have a shortage. 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 that purchases wastewater effluent from larger municipalities. It is also used for limited irrigation and mining 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 sells most of its treated wastewater to industrial customers. Several cities are beginning to consider selling their wastewater for oil field production including the City of Midland in Region F. Others are considering direct 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 Cities of Snyder, San Angelo, Midland, Brownwood, and several smaller cities.

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

Subordination of Downstream Senior 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, only 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. For Brady, additional treatment of its groundwater will be needed to use this source when surface water is unavailable.

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 improvement 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.

The Hickory aquifer has elevated levels of radionuclides that exceed the drinking water standard. Users of this source include Brady, Eden, Mason, Millersville-Doole, 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.

5A.1.3 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. A proposed downstream diversion of existing water rights with storage on the Red Arroyo near San Angelo is the only new surface water strategy considered for Region F.

Groundwater Development

After the subordination strategy is implemented, groundwater accounts for approximately 76 percent of the total water use in Region F. 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, approximately 95 percent of municipal water users with a need 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. As shown on Figure 5A-1, there are areas within Region F that have limited available groundwater due to the MAGs as discussed in Chapter 3. Counties that have reached or are near capacity in utilizing the fresh groundwater resources allocated by the MAGs are Andrews, Howard, Martin, McCulloch, and Scurry 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	14,241
Dockum Aquifer	41,840
Edwards Trinity-High Plains	106
Edwards Trinity-Plateau Aquifer	127,106
Ellenburger-San Saba Aquifer	10,790
Hickory Aquifer	7,188
Lipan Aquifer	140
Marble Falls Aquifer	199
Ogallala Aquifer	36,311
Other Aquifer	1,777
Pecos Valley Aquifer	263,487
Rustler Aquifer	11,777
Trinity Aquifer	0

a. This is the amount of groundwater that is available for strategies. 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.

Three primary species of brush in Region F are eligible for funding from the WSEP. They include juniper, mesquite, and salt cedar.

Feasibility studies have been conducted for six watersheds in Region F and there are two ongoing studies. These studies indicate there is potential for water loss reduction from brush, but these losses have been difficult to quantify during periods of drought. However, brush control can still 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. However, 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, including CRMWD's diverted surface water system and brackish groundwater.

Aquifer Storage and Recovery (ASR)

Aquifer storage and recovery is a type of strategy that utilizes suitable geologic formations to store water until needed. It can be used for both treated groundwater and surface water. Two benefits of this strategy are that it can better utilize available treatment capacities during low demand periods and store the treated water to minimize evaporation. This strategy requires the availability of a suitable geologic formation for storage of the water and the infrastructure to place the water into the aquifer and then recover the water when needed. This strategy is considered for CRMWD.

5A.1.4 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.

5A.1.5 Summary of Potentially Feasible Strategies

Potentially feasible water management strategies were identified for water users and wholesale water providers in Region F. These strategies include a wide assortment of strategy types, which were carefully reviewed for entities with identified needs. Strategies were only considered potentially feasible if the strategy:

- Is appropriate for regional planning
- Utilizes proven technology
- 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

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.

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.

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, following existing highways or roads where possible. Profiles were developed using GIS mapping software and USGS topographic maps. 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). 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 all 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. In accordance with state guidance, the potentially feasible strategies were evaluated with respect to:

- Quantity, reliability and cost
- Environmental factors, including effects on environmental water shortages, wildlife habitat and cultural resources
- Impacts on water resources and other water management strategies
- Impacts on agriculture and natural resources
- Other relevant factors

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 capital and annual costs by decade. Project capital costs are based on September 2013 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 5.5 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 for Region F strategies 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 http://www.tsswcb.texas.gov/en/brushcontrol.

Attachment 5A

Water Management Strategies Considered and List of Potentially Feasible Strategies

Every WUG Entity with an Identified Need			WMSs REQUIRED TO BE CONSIDERED BY STATUTE											ADDITIONAL							
Water User Group Name	County	Maximum Need 2020-2070 (acf/yr)	Conservation	Drought Management	Reuse	Reallocation of Storage	Voluntary Transfers	Conjunctive Use	Expansion of Existing	New Supplies	Regional Water Supply	Improvement of Water Quality	Emergency Transfer of Water	System Optimization, Subordination, & Precip. Enhancement	Brush Control	Weather Modification	Desalination	Aquifer Storage and Recovery	Cancellation of Water Rights	Interbasin Transfers
Andrews	Andrews	7,529	■	□	□	□	□	□	□	■	□	□	□	□	□	□	□	□	□	□
County-Other	Andrews	486	□	□	□	□	□	□	□	■	□	□	□	□	□	□	□	□	□	□
Irrigation	Andrews	31,378	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Livestock	Andrews	166	□	□	□	□	□	□	□	■	□	□	□	□	□	□	□	□	□	□
Manufacturing	Andrews	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Mining	Andrews	2,678	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
County-Other	Borden	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	Borden	3,243	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Livestock	Borden	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Mining	Borden	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Bangs	Brown	0	■	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Brookesmith SUD	Brown	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Brownwood	Brown	0	■	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Coleman County SUD	Brown	0	■	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□
County-Other	Brown	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Early	Brown	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	Brown	3,105	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Livestock	Brown	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Manufacturing	Brown	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Mining	Brown	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Santa Anna	Brown	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Zephyr WSC	Brown	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Bronte	Coke	0	■	□	■	□	■	□	■	■	■	□	□	■	□	□	□	□	□	□
County-Other	Coke	51	□	□	□	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	Coke	202	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Livestock	Coke	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Mining	Coke	318	■	□	□	□	□	□	□	■	□	□	□	■	□	□	□	□	□	□
Robert Lee	Coke	299	■	□	□	□	■	□	□	□	□	□	□	■	□	□	□	□	□	□
Steam Electric	Coke	528	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□
Coleman	Coleman	1,052	■	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□
County-Other	Coleman	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	Coleman	743	■	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□
Livestock	Coleman	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Manufacturing	Coleman	9	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Mining	Coleman	62	■	□	□	□	□	□	□	■	□	□	□	□	□	□	□	□	□	□
County-Other	Concho	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Eden	Concho	0	■	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	Concho	5,249	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Livestock	Concho	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Mining	Concho	212	■	□	□	□	□	□	□	■	□	□	□	□	□	□	□	□	□	□
County-Other	Crane	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Crane	Crane	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Livestock	Crane	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Mining	Crane	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□

Every WUG Entity with an Identified Need			WMSs REQUIRED TO BE CONSIDERED BY STATUTE											ADDITIONAL							
Water User Group Name	County	Maximum Need 2020-2070 (acf/yr)	Conservation	Drought Management	Reuse	Reallocation of Storage	Voluntary Transfers	Conjunctive Use	Expansion of Existing	New Supplies	Regional Water Supply	Improvement of Water Quality	Emergency Transfer of Water	System Optimization, Subordination, & Precip. Enhancement	Brush Control	Weather Modification	Desalination	Aquifer Storage and Recovery	Cancellation of Water Rights	Interbasin Transfers
County-Other	Crockett	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Crockett County WCID #1	Crockett	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Crockett	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐
Livestock	Crockett	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Crockett	1,293	■	☐	■	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Steam Electric	Crockett	1,662	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
County-Other	Ector	809	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Greater Gardendale WSC	Ector	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Ector	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
Livestock	Ector	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturing	Ector	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Ector	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Odessa	Ector	19,491	■	☐	☐	☐	☐	☐	■	■	☐	■	☐	■	☐	☐	☐	☐	☐	☐
Steam Electric	Ector	19,033	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
County-Other	Glasscock	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Glasscock	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Livestock	Glasscock	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Glasscock	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Big Spring	Howard	3,885	■	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
Coahoma	Howard	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
County-Other	Howard	485	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Howard	3,415	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Livestock	Howard	129	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturing	Howard	1,396	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Howard	2,591	■	☐	☐	☐	■	☐	☐	■	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
County-Other	Irion	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Irion	359	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐
Livestock	Irion	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mertzon	Irion	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Irion	1,984	■	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
County-Other	Kimble	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Kimble	1,496	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Junction	Kimble	640	■	☐	☐	☐	☐	☐	■	■	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
Livestock	Kimble	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturing	Kimble	983	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Kimble	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
County-Other	Loving	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Livestock	Loving	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Loving	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
County-Other	Martin	243	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Martin	25,157	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Livestock	Martin	38	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturing	Martin	29	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Martin	3,039	■	☐	☐	☐	■	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Every WUG Entity with an Identified Need			WMSs REQUIRED TO BE CONSIDERED BY STATUTE											ADDITIONAL						
Water User Group Name	County	Maximum Need 2020-2070 (acf/yr)	Conservation	Drought Management	Reuse	Reallocation of Storage	Voluntary Transfers	Conjunctive Use	Expansion of Existing	New Supplies	Regional Water Supply	Improvement of Water Quality	Emergency Transfer of Water	System Optimization, Subordination, & Precip. Enhancement	Brush Control	Weather Modification	Desalination	Aquifer Storage and Recovery	Cancellation of Water Rights	Interbasin Transfers
Stanton	Martin	320	■	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□
County-Other	Mason	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	Mason	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Livestock	Mason	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Mason	Mason	703	■	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□	□	□
Mining	Mason	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Brady	McCulloch	1,425	■	□	□	□	□	□	□	□	□	■	□	■	□	□	□	□	□	□
County-Other	McCulloch	36	■	□	□	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	McCulloch	2,184	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Livestock	McCulloch	24	□	□	□	□	□	□	□	■	□	□	□	□	□	□	□	□	□	□
Manufacturing	McCulloch	284	□	□	□	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□
Millersview-Doole WSC	McCulloch	147	■	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□
Mining	McCulloch	3,618	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Richland SUD	McCulloch	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
County-Other	Menard	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	Menard	426	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Livestock	Menard	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Manufacturing	Menard	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Menard	Menard	210	■	□	■	□	□	□	■	■	□	□	□	□	□	□	□	□	□	□
Mining	Menard	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
County-Other	Midland	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	Midland	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Livestock	Midland	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Manufacturing	Midland	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Midland	Midland	31,072	■	□	■	□	■	□	■	■	■	□	□	■	□	□	□	□	□	□
Mining	Midland	0	■	□	□	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□
Colorado City	Mitchell	0	■	□	□	□	□	□	□	■	□	□	□	□	□	□	□	□	□	□
County-Other	Mitchell	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	Mitchell	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Livestock	Mitchell	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Loraine	Mitchell	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Mining	Mitchell	0	■	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Steam Electric	Mitchell	4,847	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□	□	□
County-Other	Pecos	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Fort Stockton	Pecos	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Iraan	Pecos	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	Pecos	0	■	□	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□
Livestock	Pecos	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Manufacturing	Pecos	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Mining	Pecos	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Pecos County WCID #1	Pecos	0	■	□	□	□	□	□	□	■	□	□	□	□	□	□	□	□	□	□
Big Lake	Reagan	0	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
County-Other	Reagan	0	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Irrigation	Reagan	0	■	□	□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	□

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Water User Group Name	County	Maximum Need 2020-2070 (acf/yr)	Conservation	Drought Management	Reuse	Reallocation of Storage	Voluntary Transfers	Conjunctive Use	Expansion of Existing	New Supplies	Regional Water Supply	Improvement of Water Quality	Emergency Transfer of Water	System Optimization, Subordination, & Precip. Enhancement	Brush Control	Weather Modification	Desalination	Aquifer Storage and Recovery	Cancellation of Water Rights	Interbasin Transfers
Livestock	Reagan	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Reagan	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
County-Other	Reeves	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Reeves	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐
Livestock	Reeves	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Madera Valley WSC	Reeves	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturing	Reeves	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Reeves	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pecos	Reeves	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ballinger	Runnels	822	■	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
County-Other	Runnels	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irigation	Runnels	1,642	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Livestock	Runnels	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturing	Runnels	69	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
Miles	Runnels	124	■	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
Mining	Runnels	95	■	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Winters	Runnels	355	■	☐	■	☐	■	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
County-Other	Schleicher	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
El Dorado	Schleicher	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Schleicher	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐
Livestock	Schleicher	0	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Schleicher	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
County-Other	Scurry	501	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Scurry	6,321	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Livestock	Scurry	92	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturing	Scurry	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Scurry	435	■	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Snyder	Scurry	1,812	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
County-Other	Sterling	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Sterling	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐
Livestock	Sterling	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Sterling	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sterling City	Sterling	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
County-Other	Sutton	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Sutton	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐
Livestock	Sutton	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Sutton	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sonora	Sutton	0	■	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Concho Rural Water Corporation	Tom Green	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐
County-Other	Tom Green	543	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Tom Green	31,651	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐
Livestock	Tom Green	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturing	Tom Green	1,850	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
Mining	Tom Green	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Every WUG Entity with an Identified Need			WMSs REQUIRED TO BE CONSIDERED BY STATUTE											ADDITIONAL						
Water User Group Name	County	Maximum Need 2020-2070 (acf/yr)	Conservation	Drought Management	Reuse	Reallocation of Storage	Voluntary Transfers	Conjunctive Use	Expansion of Existing	New Supplies	Regional Water Supply	Improvement of Water Quality	Emergency Transfer of Water	System Optimization, Subordination, & Precip. Enhancement	Brush Control	Weather Modification	Desalination	Aquifer Storage and Recovery	Cancellation of Water Rights	Interbasin Transfers
San Angelo	Tom Green	6,472	■	☐	■	☐	☐	☐	☐	■	☐	☐	☐	■	■	■	■	☐	☐	☐
County-Other	Upton	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Upton	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Livestock	Upton	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
McCamey	Upton	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Upton	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Rankin	Upton	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
BCWID	Varies	0	■	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	■	☐	☐	☐	☐	☐	☐
CRMWD	Varies	26,843	■	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	■	☐	☐	■	■	☐	☐
UCRA	Varies	349	☐	☐	☐	☐	■	☐	☐	■	☐	☐	☐	☐	■	☐	☐	☐	☐	☐
University Lands	Varies	3,368	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
County-Other	Ward	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Ward	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐
Livestock	Ward	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturing	Ward	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Ward	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Monahans	Ward	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Steam Electric	Ward	5,569	☐	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
County-Other	Winkler	421	■	☐	☐	☐	☐	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Irrigation	Winkler	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kermit	Winkler	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Livestock	Winkler	0	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mining	Winkler	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wink	Winkler	0	■	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Region F - Potentially Feasible Water Management Strategies

Sponsor	WMS
Multiple Entities	Municipal conservation
Multiple Entities	Irrigation conservation
Multiple Entities	Steam Electric Power Conservation (Alternate Cooling Techniques)
Multiple Entities	Mining Conservation (Recycling)
Multiple Entities	Subordination of Downstream Water Rights
Multiple Entities	Reuse (Direct and Indirect, Potable and Non-Potable)
Multiple Entities	Purchase from Provider (Voluntary Transfer)
Multiple Entities	Brush control
Multiple Entities	Weather Modification
Andrews	Develop Ogallala Aquifer Supplies
Andrews County Livestock	Develop Edwards-Trinity Plateau Aquifer Supplies
Andrews County Livestock	Develop Pecos Valley Aquifer Supplies
Andrews County-Other	Develop Edwards-Trinity Plateau Aquifer Supplies
Ballinger	Purchase Water Right from Clyde (Fort Phantom Hill Reservoir)
BCWID #1	Develop Groundwater Supplies from Brown County
Big Spring	Water Treatment Plant Expansion
Brady	Advanced Groundwater Treatment
Bronte	Water Treatment Plant Expansion
Bronte	Develop Edwards-Trinity Aquifer Supplies in Nolan County (Region G)
Bronte	Purchase water from UCRA
Bronte	Regional System from Lake Brownwood to Runnels and Coke Counties
Bronte	Regional System from Fort Phantom Hill to Runnels and Coke Counties
Bronte	Direct Potable Reuse
Bronte	Rehabilitation of Oak Creek Pipeline
Bronte	New Water Wells Located Southeast of Bronte
Bronte	New Water Wells Located at Oak Creek Reservoir
Coke County Mining	Develop Additional Edwards Trinity Aquifer Supplies
Coleman County Mining	Develop Additional Hickory Aquifer Supplies
Colorado City	Develop Dockum Aquifer Supplies
Concho County Mining	Develop Additional Hickory Aquifer Supplies
Concho Rural Water Corporation	Develop Lipan Aquifer Supplies
Concho Rural Water Corporation	Desalination of Other Aquifer Supplies in Tom Green County
CRMWD	Desalination of Brackish Groundwater Supplies
CRMWD	Desalination of Brackish Surface Water (CRMWD Diverted Water System)
CRMWD	Ward County Well Field Expansion and Development of Winkler County Well Field
CRMWD	Aquifer Storage and Recovery (ASR) of Existing Surface Water Supplies in Ward County Well Field
CRMWD	Develop Additional Groundwater Supplies from Western Region F Counties
CRMWD	Transmission of Additional Groundwater Supplies from Western Region F Counties
CRMWD	Aquifer Storage and Recovery (ASR) of Brackish Groundwater
Howard County Livestock	Develop Dockum Aquifer Supplies
Howard County Mining	Develop Additional Ogallala Aquifer Supplies
Howard County Mining	Develop Additional Dockum Aquifer Supplies
Irion County Mining	Develop Dockum Aquifer Supplies
Irion County Mining	Develop Edwards-Trinity Plateau Aquifer Supplies
Junction	Dredging River Intake
Junction City	Develop Edwards-Trinity Plateau Aquifer Supplies
Kimble County Manufacturing	Develop Edwards-Trinity Plateau Aquifer Supplies
Martin County Livestock	Develop Dockum Aquifer Supplies
Martin County Mining	Develop Dockum Aquifer Supplies
Martin County Mining	Develop Edwards-Trinity Plateau Aquifer Supplies
Martin County-Other	Develop Dockum Aquifer Supplies
Mason	Advanced Groundwater Treatment
McCulloch County Livestock	Develop Edwards-Trinity Plateau Aquifer Supplies
Menard	Develop Hickory Aquifer Supplies
Midland	Additional T-Bar Ranch Supplies with Treatment
Midland	Development of Groundwater in Midland County (previously used for mining)
Midland County-Other	Development of Groundwater in Winkler County
Odessa	RO Treatment of Existing Supplies
Odessa	Develop Edwards-Trinity and Capitan Reef Complex Aquifer Supplies in Pecos County

Region F - Potentially Feasible Water Management Strategies

Sponsor	WMS
Odessa	Develop Capitan Reef Complex Aquifer Supplies in Ward County
Pecos County WCID No. 1	Develop Edwards-Trinity Plateau Aquifer Supplies
Robert Lee	New Water Treatment Plant
Robert Lee	Develop groundwater from the Edwards Trinity Plateau
Runnels County Mining	Develop Other Undifferentiated Aquifer Supplies
San Angelo	Desalination of Brackish Groundwater Supplies
San Angelo	Red Arroyo Off-Channel Reservoir
San Angelo	Develop Hickory Aquifer Supplies in McCulloch County
San Angelo	Develop Edwards Trinity Plateau Aquifer Supplies in Schleicher County
San Angelo	Develop Capitan Reef Complex Aquifer Supplies in Pecos County
San Angelo	Develop Pecos Valley/ Edwards-Trinity Aquifer Supplies in Pecos County
San Angelo	Desalination of Other Aquifer Supplies in Tom Green County
San Angelo (Region F), Midland	West Texas Water Partnership (WTWP)
Scurry County Livestock	New Groundwater from the Local Alluvium Aquifer
Scurry County Mining	Develop Local Alluvium Aquifer Supplies
UCRA	Purchase Water from San Angelo and Expand Transmission System
Ward County Steam Electric Power	Develop Pecos Valley Aquifer Supplies
Winkler County Other	Develop Pecos Valley Aquifer Supplies

Subchapter 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 seven percent reduction in municipal water use (19,925 acre-feet per year) by year 2070.

Conservation savings are also included in the steam electric power demands. Demands for steam electric power were developed on a state-wide basis and these demands assume that long-term power needs will be met with high water efficient facilities. The estimated water savings associated with the higher efficient power plants is nearly 27 percent of the total demands or 12,300 acre-feet per year in Region F. Based on factors developed by the TWDB, irrigation demands are expected to decline approximately 3.5 percent over the planning period (2020 to 2070), primarily due to conservation. Reductions in demands due to conservation were not quantified by the TWDB for manufacturing and livestock needs.

Water conservation strategies must be considered for all water users with a need. In Region F, this includes municipal, manufacturing, agricultural water, mining, and steam electric power 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.

Steam electric demands in Region F almost double over the planning period. However, there are insufficient water supplies at most existing generation facilities to support the expected growth in demand. 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.

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). These additional conservation measures were considered for all municipal and irrigation water user groups in Region F.

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

Each public water supplier is required to update and submit a Water Conservation Plan (WCP) to the Texas Commission on Environmental Quality (TCEQ) every five years. 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 system and water use data
- 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

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.

Forty-six water providers in Region F submitted water loss audits in 2010. Based on these reports, the percentage of real water loss for Region F is approximately 13 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, 68 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 a 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 2 percent of the total water demands. 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.

Water Audits and Leak Repair

Local officials would perform a water audit system wide and create a program of leak detection and repair including infrastructure replacement as necessary. 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, this strategy was considered for an entity with a gpcd over 140. A constant 5 percent savings rate was assumed until an entity's gpcd was equal to 140. Costs were estimated at $10 per person per year.

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 discourages 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/household/year. It is assumed that 75 percent of the households would respond to this measure by not wasting water. Costs for this strategy would be those costs associated with enforcement.

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 2030 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.

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.

5B.1.3 Municipal Conservation Summary

It is estimated that the municipal conservation strategy outlined in this plan will save, on a regional basis, over 4,300 acre-feet in 2020 and over 6,100 acre-feet in 2070. 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. 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- 2 shows the estimated costs for municipal conservation.

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

Water User Group	2020	2030	2040	2050	2060	2070
Andrews	82	99	136	157	183	213
Ballinger	21	22	22	22	22	22
Bangs	9	9	9	9	9	9
Big Lake	18	21	22	23	24	24
Big Spring	181	191	193	193	193	193
Borden County-Other	4	4	4	4	4	4
Brady	32	33	33	33	33	33
Bronte	5	5	5	5	5	5
Brookesmith SUD	44	45	45	45	45	45
Brownwood	126	129	129	129	129	129
Coahoma	5	5	5	5	5	5
Coleman	26	27	27	27	27	27
Coleman County SUD	19	19	19	19	19	19
Colorado City	28	31	32	32	32	33
Concho Rural WSC	33	35	37	38	40	41
Crockett County WCID	21	23	23	24	24	24
Crane	20	21	23	24	25	26
Early	16	16	16	16	16	16
Ector County UD	83	94	102	135	149	162
Eden	16	16	16	16	16	16
Eldorado	11	11	11	11	11	11
Fort Stockton	50	53	57	60	63	66
Greater Gardendale WSC	16	19	21	23	26	28
Iraan	7	8	8	9	9	10
Junction	14	15	15	15	15	15
Kermit	32	32	32	33	33	33
Loraine	3	4	4	4	4	4
Madera Valley WSC	11	12	12	13	13	14
Mason	12	12	12	12	12	12
McCulloch County-Other	3	3	3	3	3	3
McCamey	11	12	13	13	13	14
Menard	8	8	8	8	8	8
Mertzon	5	5	5	5	5	5
Midland	813	879	973	1,062	1,150	1,236
Midland County-Other	145	164	183	202	220	239
Miles	5	6	6	6	6	6

Water User Group	2020	2030	2040	2050	2060	2070
Mitchell County-Other	26	27	28	28	29	29
Millersview-Doole WSC	24	25	25	26	26	27
Monahans	41	43	45	47	48	48
Odessa	716	825	924	1,026	1,128	1,231
Pecos	53	56	59	62	63	64
Pecos WCID	19	20	22	23	24	25
Reeves County-Other	19	20	21	22	23	23
Rankin	5	5	5	5	6	6
Richland SUD	13	14	14	14	14	14
Robert Lee	6	6	6	6	6	6
San Angelo	656	753	793	842	894	949
Snyder	75	86	93	100	104	134
Santa Anna	6	6	6	6	6	6
Sonora	18	20	20	20	21	21
Stanton	15	17	18	19	20	20
Sterling City	5	5	5	5	5	5
Ward County-Other	22	23	24	25	25	26
Winkler County-Other	6	10	12	15	18	20
Wink	6	6	7	7	8	8
Winters	14	15	15	15	15	15
Zephyr WSC	25	26	26	26	26	26
Total	**3,705**	**4,096**	**4,430**	**4,775**	**5,101**	**5,455**

Table 5B- 2
Estimated Costs for Municipal Conservation

	2020	2030	2040	2050	2060	2070
Region F Annual Cost	$1,503,911	$1,666,784	$1,773,862	$1,879,557	$1,976,548	$2,081,743
Annual Cost per acre-foot	$406	$407	$400	$394	$388	$382
Annual Cost per 1,000 gal	$1.25	$1.25	$1.23	$1.21	$1.19	$1.17

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

Water User Group	Capital Cost	2020	2030	2040	2050	2060	2070
Ballinger	$2,669,400	37	37	36	36	36	36
Big Lake	$2,708,800	29	32	33	35	36	37
Borden County-Other	$701,400	9	9	9	9	9	9
Bronte	$900,000	12	12	11	11	11	11
Coahoma	$848,000	9	9	9	9	9	9
El Dorado	$1,471,200	25	24	24	24	24	24
Junction	$1,891,700	31	31	31	30	30	30
Madera Valley WSC	$1,673,300	69	73	76	78	80	82
Mason	$1,568,400	26	26	26	25	25	25
McCamey	$1,698,600	39	41	42	44	45	45
Menard	$1,183,200	17	17	17	16	16	16
Mitchell County-Other	$3,361,800	42	43	43	43	43	44
Pecos	$6,834,400	157	165	173	178	183	186
Rankin	$876,900	14	15	15	16	16	16
Sonora	$2,486,600	77	82	83	85	86	86
Ward County-Other	$2,946,700	37	39	39	40	41	42
Winkler County-Other	$1,787,400	11	16	20	25	28	32
Total	**$35,607,800**	**641**	**671**	**687**	**704**	**718**	**730**

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 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 take into account 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.

5B.2 Agricultural 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 decades 2020, 2030 and 2040. This efficiency could be achieved through implementation of one or more of the identified practices. The efficiency level was held constant for decades 2050, 2060, and 2070. 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 $650 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 2013 dollars. These costs are based on expenditures for changes in irrigation equipment.

Based on these assumptions, the irrigation conservation strategy is estimated to save around 28,000 acre-feet of supply in 2020 and 73,500 acre-feet in 2070. 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	2020	2030	2040	2050	2060	2070
ANDREWS	1,895	3,758	3,726	3,726	3,726	3,726
BORDEN	200	399	399	399	399	399
BROWN	472	752	750	750	750	750
COKE	48	96	115	115	115	115
COLEMAN	39	77	77	77	77	77
CONCHO	487	969	1,062	1,062	1,062	1,062
CRANE	0	0	0	0	0	0
CROCKETT	24	47	69	69	69	69
ECTOR	72	142	210	210	210	210
GLASSCOCK	2,268	2,250	2,232	2,232	2,232	2,232
HOWARD	336	665	722	722	722	722
IRION	73	144	210	210	210	210
KIMBLE	147	283	326	326	326	326

County Name	2020	2030	2040	2050	2060	2070
LOVING	0	0	0	0	0	0
MCCULLOCH	179	354	524	524	524	524
MARTIN	1,816	3,567	5,254	5,254	5,254	5,254
MASON	415	817	1,208	1,208	1,208	1,208
MENARD	127	252	377	377	377	377
MIDLAND	1,664	3,302	4,913	4,913	4,913	4,913
MITCHELL	230	229	228	228	228	228
PECOS	6,301	12,602	18,903	18,903	18,903	18,903
REAGAN	957	1,881	2,773	2,773	2,773	2,773
REEVES	4,568	9,058	13,469	13,469	13,469	13,469
RUNNELS	200	399	477	477	477	477
SCHLEICHER	71	83	81	81	81	81
SCURRY	365	706	885	885	885	885
STERLING	49	94	135	135	135	135
SUTTON	90	177	260	260	260	260
TOM GREEN	4,679	9,335	11,175	11,175	11,175	11,175
UPTON	474	934	1,380	1,380	1,380	1,380
WARD	281	554	821	821	821	821
WINKLER	246	491	737	737	737	737
Total	**28,771**	**54,417**	**73,499**	**73,499**	**73,499**	**73,499**

Table 5B- 5
Irrigation Conservation Costs

	2020	2030	2040	2050	2060	2070
Region F Capital Cost	$18,701,189	$16,682,536	$12,439,616	$0	$0	$0
Annual Cost per acre-foot	$21.81	$21.81	$13.29	$5.68	$0	$0
Annual Cost per 1,000 gal	$0.07	$0.07	$0.04	$0.02	$0	$0

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 the majority 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 water 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 mining operations in Region F.

The amount of water than can be reused/recycled is 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. Some 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 nearly 7,800 acre-feet in 2020 and around 2,600 acre-feet in 2070 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 2020. A 20 cent per barrel ($1,550 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 a 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 50 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	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Andrews	277	260	222	176	135	104
Borden	48	65	55	35	17	8
Brown	66	66	67	67	66	66
Coke	34	34	30	26	23	20
Coleman	8	7	7	6	5	5
Concho	34	33	30	26	22	20
Crane	43	59	60	48	37	28
Crockett	121	129	88	48	14	4
Ector	138	151	135	110	89	75
Glasscock	240	217	167	118	77	56
Howard	174	192	136	80	33	14
Irion	223	235	170	104	50	24
Kimble	1	1	1	1	1	1
Loving	55	74	65	53	42	33
Martin	247	210	158	101	54	29
Mason	72	66	50	40	32	26
McCulloch	625	584	465	394	339	294
Menard	76	75	67	58	50	44
Midland	273	239	184	124	74	52
Mitchell	42	52	44	35	26	20
Pecos	48	75	75	60	47	37
Reagan	295	238	172	98	37	14
Reeves	107	184	178	145	114	90

Mining Conservation (Recycling) Supplies						
County	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Runnels	19	19	17	15	13	11
Schleicher	43	51	39	27	17	10
Scurry	20	32	34	25	17	12
Sterling	55	67	57	37	19	10
Sutton	31	50	53	40	27	18
Tom Green	74	76	78	78	79	81
Upton	297	254	201	135	81	56
Ward	56	67	59	45	32	23
Winkler	55	82	69	53	37	26
Total	**3,897**	**3,944**	**3,233**	**2,408**	**1,706**	**1,311**

Table 5B- 7
Mining Conservation (Recycling) Costs

County	Capital Cost	Annual Cost Per Acre-Foot					
		2020	2030	2040	2050	2060	2070
Andrews	$5,540,000	$124	$233	$0	$0	$0	$0
Borden	$1,300,000	$716	$124	$0	$0	$0	$0
Brown	$1,340,000	$149	$149	$0	$0	$0	$0
Coke	$680,000	$124	$124	$0	$0	$0	$0
Coleman	$160,000	$124	$363	$0	$0	$0	$0
Concho	$680,000	$124	$174	$0	$0	$0	$0
Crane	$1,200,000	$785	$152	$0	$0	$0	$0
Crockett	$2,580,000	$234	$124	$0	$0	$0	$0
Ector	$3,020,000	$281	$124	$0	$0	$0	$0
Glasscock	$4,800,000	$124	$301	$0	$0	$0	$0
Howard	$3,840,000	$297	$124	$0	$0	$0	$0
Irion	$4,700,000	$214	$124	$0	$0	$0	$0
Kimble	$20,000	$124	$124	$0	$0	$0	$0
Loving	$1,480,000	$702	$124	$0	$0	$0	$0
Martin	$4,940,000	$124	$418	$0	$0	$0	$0
Mason	$1,440,000	$124	$276	$0	$0	$0	$0
McCulloch	$12,500,000	$124	$241	$0	$0	$0	$0
Menard	$1,520,000	$124	$146	$0	$0	$0	$0
Midland	$5,460,000	$124	$362	$0	$0	$0	$0
Mitchell	$1,040,000	$522	$124	$0	$0	$0	$0
Pecos	$1,500,000	$1,065	$124	$0	$0	$0	$0
Reagan	$5,900,000	$124	$524	$0	$0	$0	$0
Reeves	$3,680,000	$1,328	$124	$0	$0	$0	$0
Runnels	$380,000	$124	$124	$0	$0	$0	$0
Schleicher	$1,020,000	$435	$124	$0	$0	$0	$0
Scurry	$680,000	$1,295	$228	$0	$0	$0	$0
Sterling	$1,340,000	$489	$124	$0	$0	$0	$0
Sutton	$1,060,000	$1,311	$224	$0	$0	$0	$0
Tom Green	$1,620,000	$282	$234	$0	$0	$0	$0
Upton	$5,940,000	$124	$407	$0	$0	$0	$0
Ward	$1,340,000	$452	$124	$0	$0	$0	$0
Winkler	$1,640,000	$945	$124	$0	$0	$0	$0
Total	**$84,340,000**	**$261**	**$239**	**$0**	**$0**	**$0**	**$0**

5B.4 Steam Electric Power Conservation

By 2070 the region will have water needs for steam electric power generation of over 25,000 acre-feet after subordination. These shortages are generally the result of increased demands that cannot be met with existing supplies, particularly in Ector County. Some of these needs are proposed to be met by the City of Odessa, but there is still a considerable large quantity of projected steam electric water demands that currently do not have an identified source.

The projections for growth in steam electric power water use in Region F are based on state-wide projections for new generation capacity and do not necessarily reflect site-specific water needs[2]. The expected growth in water demand reflects the expected need for additional electrical generation capacity in Texas, and that additional capacity can be met through a variety of approaches. In Region F, the projected growth in water demand exceeds the water supply currently available to existing generation facilities. Because growth in demand is not site-specific, strategies may include movement of demand to other locations as well as new supply development.

The use of alternative cooling technologies (ACT) that generate the same amount of electricity but use less water is a form of water conservation. An analysis of alternative cooling technologies is included in this plan. However, the actual strategies are largely a business decision on the part of the power industry.

Region F considers alternative cooling technologies on new power generation projects a likely method for developing new generation capacity within Region F. This technology, which uses air for cooling instead of water, can be utilized on any steam cycle based power generation project, for an incremental cost. This cost, calculated on a dollar per installed megawatt basis, would be above the cost of conventional cooling.

This strategy was considered for steam electric power needs in Coke, Ector, Mitchell and Ward counties. For the purposes of this plan, costs have been developed for replacing water demand with the equivalent generation capacity using air-cooled condensers. Details of this strategy are discussed in Appendix C.

For each county, the generation capacity associated with the water shortage was determined and based on estimated power needs that were used to develop the water projections. It was assumed that new generation capacity would be added in each decade in 500 MW blocks (except in Coke and Mitchell Counties where 150 MW blocks are assumed) at a cost of $112.10 per kW, which is the cost of retrofitting existing power generation facilities with an air-cooled condenser. This cost was selected as representative of the incremental difference between a conventional water-cooled facility and one that uses alternative cooling technology.

Table 5B- 8 through Table 5B- 11 show the results of this analysis. Using air-cooled technology, up to 21,276 acre-feet per year of unmet needs can be met by 2070. This technology is currently in use and is very reliable.

Table 5B- 8
Costs of Alternative Cooling Technology to Meet Steam Electric Needs in Coke County

	2020	2030	2040	2050	2060	2070
Steam-Electric Needs (acft)	247	289	339	401	477	528
Equivalent Needs (GWh)	145	178	222	280	355	393
MW Capacity Needed (MW)	24	30	37	47	59	66
Incremental Capacity Installed (MW)	150	150	0	0	150	0
Cumulative Capacity Installed (MW)	150	300	300	300	450	450
Incremental Cost of ACT (million $)	$16.83	$16.83	$0.00	$0.00	$16.83	$0.00
Total Capital Cost (million $)	$16.83	$33.66	$33.66	$33.66	$50.49	$50.49
Amount of Water Saved (acft/yr)	247	289	339	401	477	528
Annual Cost of Water ($ per 1,000 gallons)	$22.74	$38.87	$20.37	$6.43	$17.18	$15.52

Table 5B- 9
Costs of Alternative Cooling Technology to Meet Steam Electric Needs in Ector County

	2020	2030	2040	2050	2060	2070
Steam-Electric Needs (acft)	3,286	4,263	6,165	8,604	11,597	15,033
Equivalent Needs (GWh)	1931	2620	4043	6017	8622	11177
MW Capacity Needed (MW)	322	437	674	1003	1437	1863
Incremental Capacity Installed (MW)	500	0	500	500	0	500
Cumulative Capacity Installed (MW)	500	500	1000	1500	1500	2000
Incremental Cost of ACT (million $)	$56.09	$0.00	$56.09	$56.09	$0.00	$56.09
Total Capital Cost (million $)	$56.09	$56.09	$112.18	$168.27	$168.27	$224.36
Amount of Water Saved (acft/yr)	3,286	4,263	6,165	8,604	11,597	15,033
Annual Cost of Water ($ per 1,000 gallons)	$5.69	$4.38	$3.73	$4.85	$2.36	$2.10

Table 5B- 10
Costs of Alternative Cooling Technology to Meet Steam Electric Needs in Mitchell County

	2020	2030	2040	2050	2060	2070
Steam-Electric Needs (acft)	1,127	1,030	933	837	740	674
Equivalent Needs (GWh)	662	633	612	585	550	501
MW Capacity Needed (MW)	110	106	102	98	92	84
Incremental Capacity Installed (MW)	150	0	0	0	0	0
Cumulative Capacity Installed (MW)	150	150	150	150	150	150
Incremental Cost of ACT (million $)	$16.83	$0.00	$0.00	$0.00	$0.00	$0.00
Total Capital Cost (million $)	$16.83	$16.83	$16.83	$16.83	$16.83	$16.83
Amount of Water Saved (acft/yr)	1,127	1,030	933	837	740	674
Annual Cost of Water ($ per 1,000 gallons)	$4.98	$5.45	$1.38	$1.54	$1.74	$1.91

Table 5B- 11
Cost of Alternative Cooling Technology to Meet Steam Electric Needs in Ward County

	2020	2030	2040	2050	2060	2070
Steam-Electric Needs (acft)	1,079	1,718	2,496	3,445	4,603	5,569
Equivalent Needs (GWh)	634	1056	1637	2409	3422	4140
MW Capacity Needed (MW)	106	176	273	402	570	690
Incremental Capacity Installed (MW)	500	0	0	0	500	0
Cumulative Capacity Installed (MW)	500	500	500	500	1000	1000
Incremental Cost of ACT (million $)	$56.09	$0.00	$0.00	$0.00	$56.09	$0.00
Total Capital Cost (million $)	$56.09	$56.09	$56.09	$56.09	$112.18	$112.18
Annual Cost of Water ($ per acft)	$5,644	$3,545	$561	$406	$1,627	$1,345
Annual Cost of Water ($ per 1,000 gallons)	$17.32	$10.88	$1.72	$1.25	$4.99	$4.13

This strategy is recommended for Coke, Ector and Mitchel Counties. It is an alternate strategy for Ward County. That is because there are sufficient groundwater supplies in Ward County to meet the projected needs. However, the decision on the water source and cooling technologies will be made by the sponsor of the new facilities.

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."

The State of Texas in §11.1271 of the Texas Water Code 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. Recent legislation passed in 2003 requires all conservation plans to specify quantifiable 5-year and 10-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.

Table 5B- 12
Water Users in Region F Required to Submit Water Conservation Plans

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

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.

In the Region F area, 16 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, six 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- 12. 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 (wholesale or retail public water suppliers), industrial users and irrigation districts can be accessed online at www.regionfwater.org and clicking on the Documents tab (http://regionfwater.org/index.aspx?id=Documents). 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 wras@tceq.state.tx.us.

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 73,500 acre-feet per year by 2070. 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/.

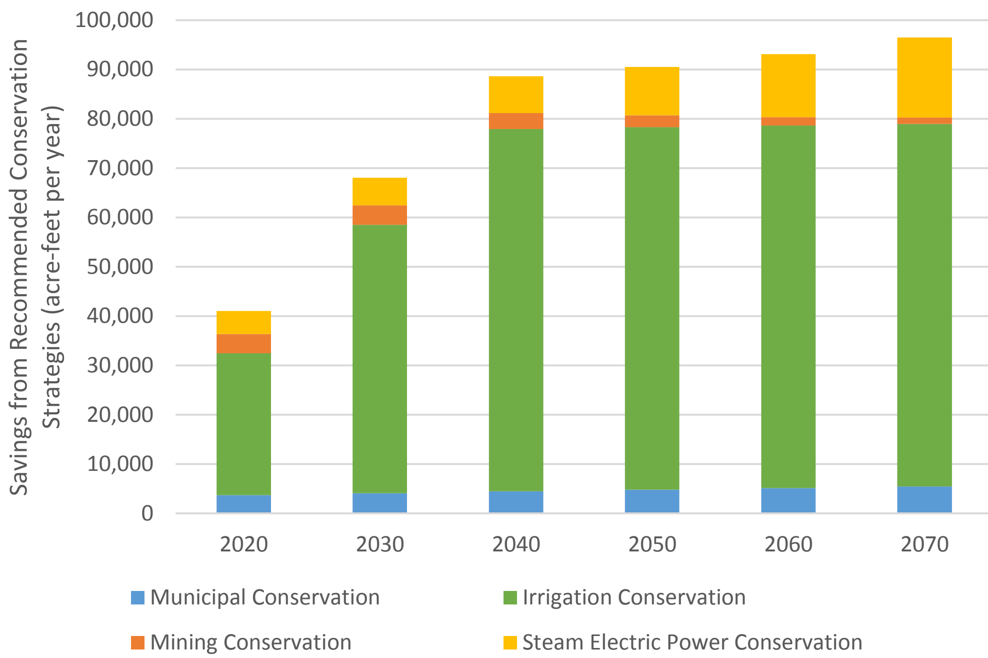
5B.7 Water Conservation Summary

Implementing water conservation measures for municipal, agricultural, mining, and steam electric power users could save over 97,000 acre-feet of water by 2070 in Region F. Rising water costs and limited additional supplies will require increased water efficiency for all users and is encouraged by Region F.

Table 5B- 13
Water Conservation Savings in Region F
-Values in acre-feet per year-

	2020	2030	2040	2050	2060	2070
Municipal Conservation	4,346	4,767	5,117	5,479	5,819	6,185
Irrigation Conservation	28,773	54,417	73,498	73,498	73,498	73,498
Mining Conservation	3,897	3,944	3,233	2,408	1,706	1,311
Steam Electric Power Conservation	4,660	5,582	7,437	9,842	12,814	16,235
Total Conservation Savings	41,676	68,710	89,285	91,227	93,837	97,229

Figure 5B- 1
Water Conservation Savings in Region F



List of References

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

[2] Investor-Owned Utility Companies of Texas. *Power Generation Water use in Texas for the Years 2000 to 2060*. Prepared for the Texas Water Development Board, January 2003.

Subchapter 5C Regional Water Management Strategies

Several strategies have been identified that will benefit multiple user groups across the region. These 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 Senior 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 Ballinger, Brady, Coleman, Junction, and Winters and their customers have no water supply. The Morgan Creek power plant has no supply to generate power. The Cities of Big Spring, Bronte, Coahoma, Midland, Miles, Odessa, Robert Lee, 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.

Because 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 2016 Region F Plan, the hydrology developed by TCEQ through December 2013 was used for the subordination modeling.

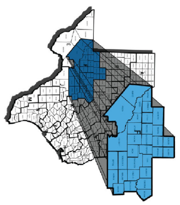
The Region F model differs from the Region K model by including the City of Junction’s run-of-river rights in the upper basin. Other refinements to the subordination modeling include modifications for the Pecan Bayou. As discussed above, the assumption that upper basin water rights do not make calls 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 water user groups 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 56,000 acre-feet of additional supply is available through the subordination strategy in 2020 and over 52,000 acre-feet in 2070. Table 5C- 1 compares the 2020 and 2070 Region F water supply sources with and without subordination.

Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet



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Subordination Strategy

Region F

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JLA	JLA	1:3,801,600	MARCH, 2015	Figure 5C-1.mxd	SAN11472

FIGURE 5C-1

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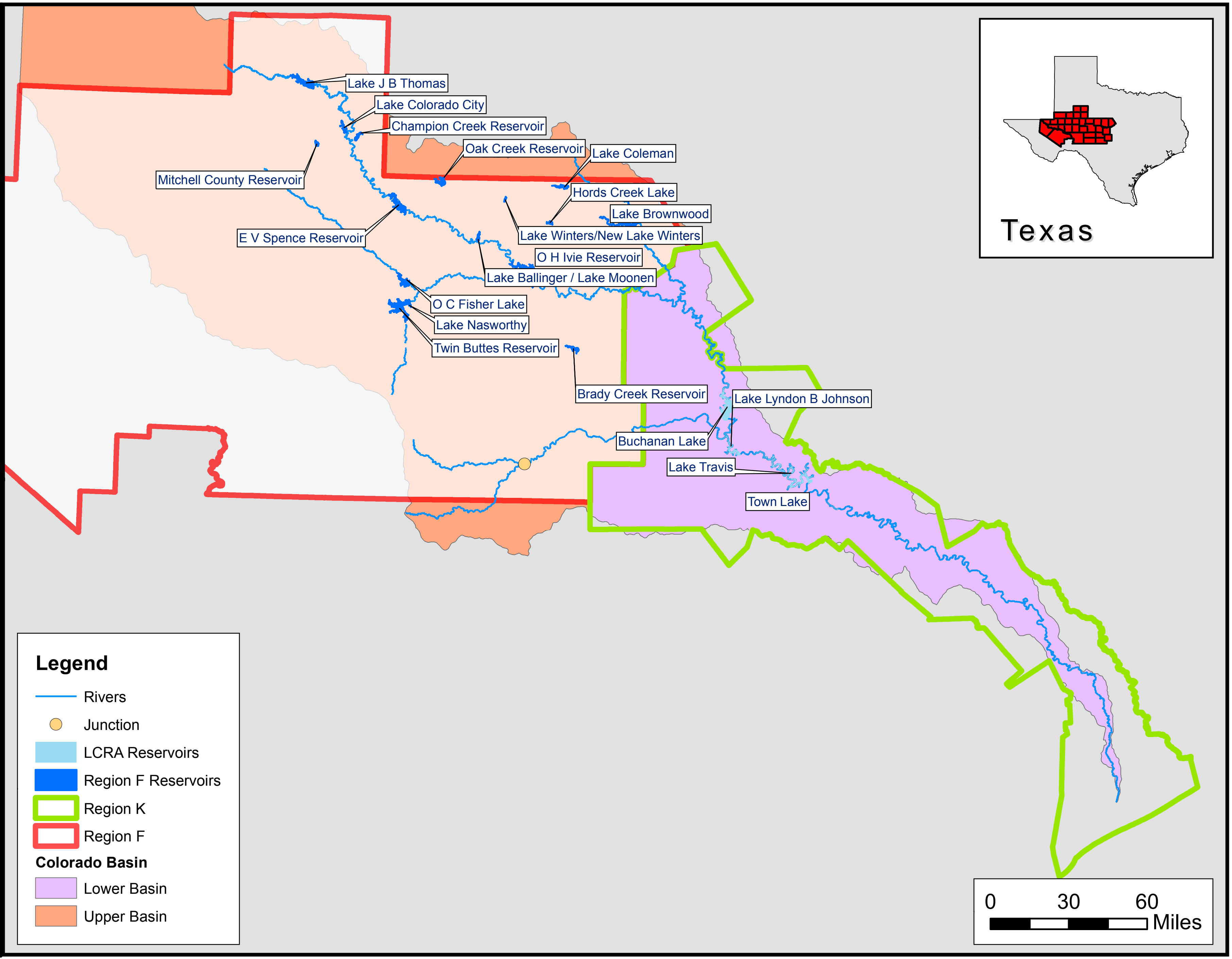


Table 5C- 1
Region F Surface Water Supplies with and without Subordination

Reservoir	2020 Supply WAM Run 3	2020 Supply Subordination	2070 Supply WAM Run 3	2070 Supply Subordination
Lake Colorado City	0	2,240	0	1,940
Champion Creek Reservoir	0	1,480	0	1,380
Colorado City/Champion System	*0*	*3,720*	*0*	*3,320*
Oak Creek Reservoir	0	1,493	0	960
Lake Ballinger	0	779	0	750
Lake Winters	0	191	0	170
Twin Buttes Reservoir/Lake Nasworthy	0	2,797	0	2,342
O.C. Fisher Reservoir	0	1,538	0	1,030
San Angelo System	*0*	*4,335*	*0*	*3,372*
Hords Creek Reservoir	0	358	0	300
Lake Coleman	0	2,915	0	2,740
Coleman System	*0*	*3,273*	*0*	*3,040*
Lake Clyde	0	150		150
Brady Creek Reservoir	0	1,892	0	1,700
Lake Thomas	0	4,864	0	4,779
Spence Reservoir (CRMWD system)	0	23,116	0	22,982
Spence Reservoir (Non-system)	0	1,475	0	1,467
Spence Reservoir Total	*0*	*24,591*	*0*	*24,449*
Ivie Reservoir (CRMWD system)	18,152	17,242	15,583	14,681
Ivie Reservoir (Non-system)	17,878	16,981	15,347	14,459
Ivie Reservoir Total	*36,030*	*34,223*	*30,930*	*29,140*
CRMWD Total (Thomas, Spence & Ivie)	*36,030*	*63,678*	*30,930*	*58,368*
CRMWD Diverted Water System(Brackish)	*0*	*5,760*	*0*	*5,760*
Lake Brownwood	18,760	25,741	*18,060*	23,600
City of Junction	0	412	0	412
Mountain Creek	0	80	0	80
TOTAL	***54,790***	***111,092***	***48,990***	***101,270***
Increase with Subordination	***56,302***		***52,280***	

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. The reduction in supplies shown for Midland is associated with a reduced safe yield of Lake Ivie with the subordination assumptions. These reductions also impact the subordination supplies to San Angelo. The contracts for water for both of these cities is based on a percentage of the safe yield of Lake Ivie.

Table 5C- 2
Subordination Supplies by WUG

WUG Name	Additional Supplies Made Available through the Subordination Strategy					
	2020	2030	2040	2050	2060	2070
Bronte	176	176	176	176	176	176
Robert Lee	224	224	224	224	224	224
Coke County Mining	38	36	34	32	30	28
Coleman	2,102	2,061	2,024	1,985	1,938	1,891
Coleman County SUD	214	211	206	202	202	203
Coleman County Irrigation	743	743	743	743	743	743
Odessa	11,671	7,523	10,146	13,053	16,214	19,491
Ector County Irrigation	189	110	134	157	179	196
Big Spring	3,677	2,190	2,682	3,115	3,523	3,885
Howard County Mining	1,000	1,000	1,000	982	320	43
Junction	412	412	412	412	412	412
Stanton	253	160	202	248	291	331
Brady	1,892	1,854	1,816	1,778	1,740	1,700
Millersview-Doole WSC	782	665	701	236	267	294
Midland [a]	8,527	(299)	(298)	(297)	(297)	(296)
Mitchell County Steam Electric Power	1,480	1,460	1,440	1,420	1,400	1,380
Ballinger	752	675	693	563	558	554
Miles	112	124	121	119	119	119
Winters	186	182	178	174	170	165
Runnels County Manufacturing	11	10	10	11	11	11
Snyder	1,268	807	1,030	1,280	1,544	1,812
San Angelo	4,036	3,843	3,651	3,459	3,266	3,076
Tom Green County Manufacturing (Sales from San Angelo)	467	445	438	420	403	386
BCWID (non-allocated)	6,981	6,693	6,405	6,117	5,829	5,540
CRMWD (non-allocated)	4,949	20,257	16,740	12,987	9,647	5,865
Oak Creek (non-allocated)	104	104	104	104	104	104

a. Due to assumptions concerning the priority date of Lake Ivie in the TCEQ WAM and the subordination model, Lake Ivie has less yield under subordination since it must pass water to other Region F water right holders. Thus, in certain cases, the yield from the subordination strategy is negative.

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.

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 create additional water supply that could be used for some of the unmet needs in the region as well as 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. The 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 as part of their competitive grant, cost sharing program. Three primary species are eligible for funding from the WSEP: juniper, mesquite and salt cedar.

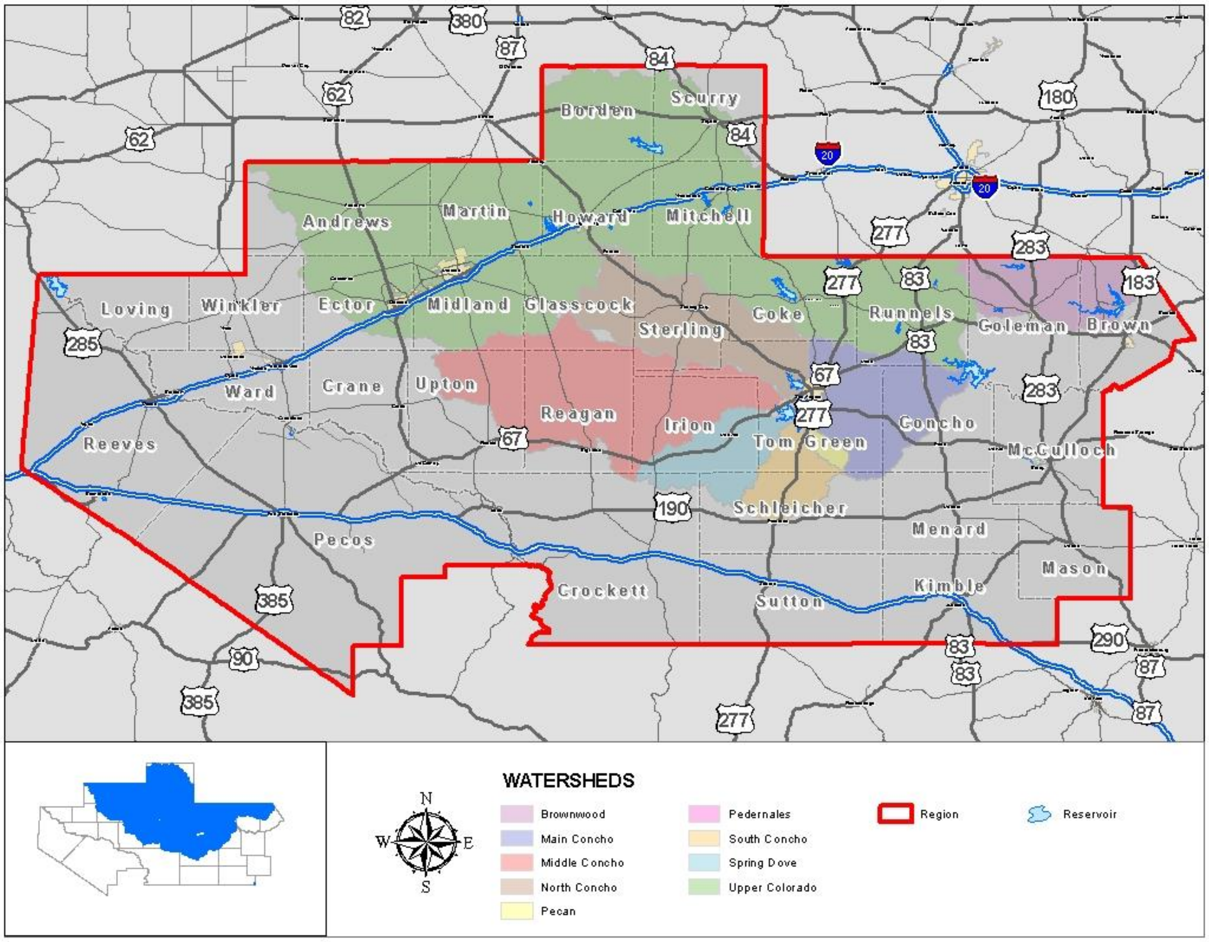
In order for a watershed to be eligible for cost-share funds from the WSEP, a feasibility study must demonstrate increases in projected post-treatment water yield as compared to the pre-treatment conditions. Feasibility studies have been conducted and published for the following watersheds in Region F and are shown on Figure 5C-2:

- Lake Brownwood
- North Concho River (O.C. Fisher Lake)
- O.H. Ivie Reservoir (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)

Feasibility studies within Region F that are in progress at the time of writing of this plan include:

- O.H. Ivie Reservoir lake basin (salt cedar specific)
- Upper Llano River, including South and North Llano Rivers and Junction City Lake

Figure 5C- 2
Brush Control Watershed Feasibility Studies



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, until recently it has been difficult to quantify the amount of water supply created by the strategy for regional water planning. This quantification is very 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. The quantity of water directly associated with brush removal under drought conditions is none, 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 heavily using surface water when it is available, groundwater is preserved for times of future drought.

Table 5C- 3
Region F Brush Control

Sponsor	Watershed	Annual Cost
UCRA	O.H. Ivie	$50,000
San Angelo	North Concho River and Twin Buttes Reservoir	$100,000
BCWID	Lake Brownwood	$300,000

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. Typically, weather modification is practiced during the dry summer months when conditions are most favorable. 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 utilized as a water management strategy during the dry summers in West Texas, with the season beginning in March and ending in 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 in 2014 varied from slightly more than 1 inch to over 2 inches in the year. This represents a 15 percent increase in rainfall.[1] In the Trans Pecos area, the rainfall increases were less, averaging 0.29 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 for counties that currently participate in an active program. It is assumed that the increase in rainfall will offset irrigation water use. To determine the water savings associated with this strategy, an estimate of the increase in rainfall over the growing season (7 months) is applied directly to the irrigated acreages. 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 6 cents per acre. The WTWMA operates at 4 cents per acre. These costs are supported by local municipalities, groundwater districts, irrigation districts, and land owners. 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

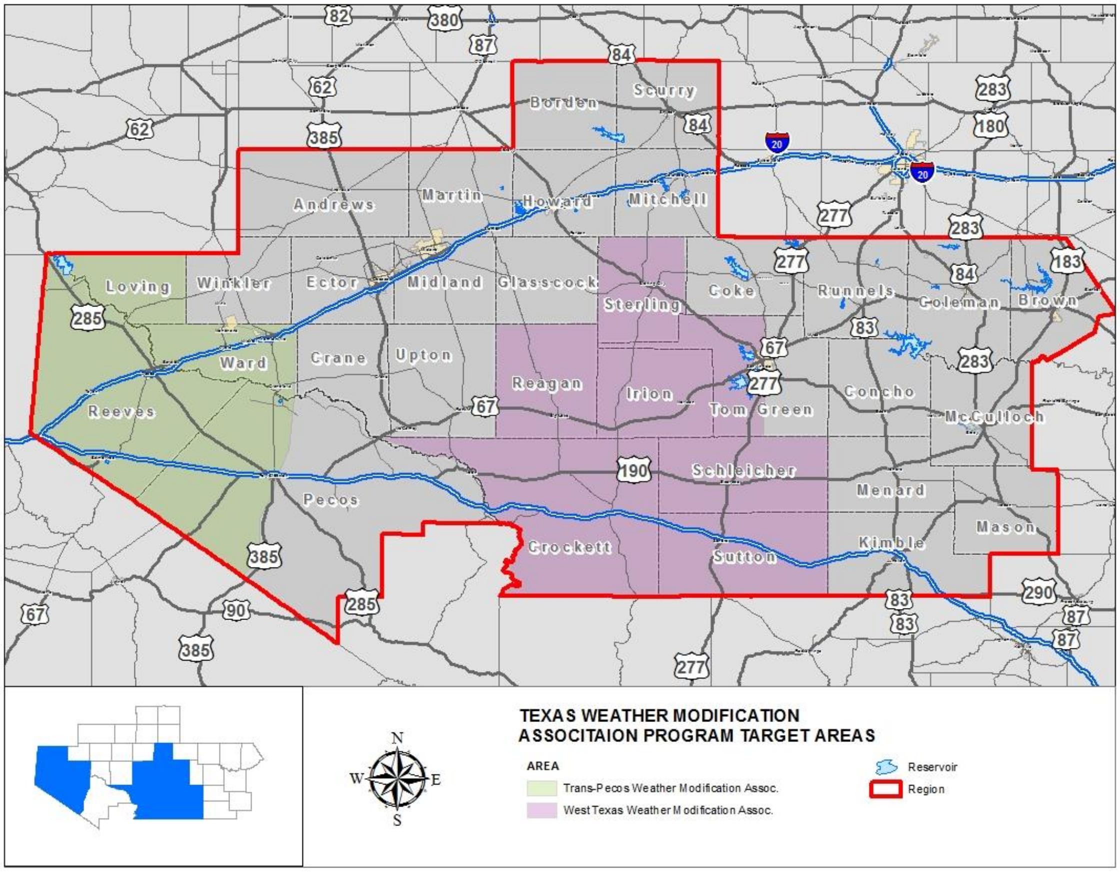


Table 5C- 4
Weather Modification Water Savings and Cost

County	Irrigated Acreage (Acres)	Annual Increase (Feet)	Water Savings (Ac-Ft/Yr)	Cost ($)	Cost per Ac-Ft ($/Ac-Ft)
Crockett	153	0.10	9	$6	$0.69
Irion	829	0.23	110	$50	$0.45
Pecos	28,566	0.02	264	$1,714	$6.50
Reagan	10,793	0.23	1,469	$648	$0.44
Reeves	16,997	0.02	240	$1,020	$4.26
Schleicher	889	0.20	102	$53	$0.53
Sterling	440	0.10	25	$26	$1.06
Sutton	563	0.10	34	$34	$1.00
Tom Green	38,386	0.22	4,945	$2,303	$0.47
Ward	1,381	0.06	46	$83	$1.82

Source: Texas Weather Modification Association[3]

LIST OF REFERENCES

[1] West Texas Weather Modification Association. *2014 Annual Report for West Texas Weather Modification Association*.

[2] Texas Weather Modification Courier, February 2014. <http://www.texasweathermodification.com>.

[3] Arquimedes Ruiz Columbie. Active Influence & Scientific Management, *Annual Evaluation Report 2014 State of Texas*. Prepared for the Texas Weather Modification Association. <http://www.texasweathermodification.com>.

Subchapter 5D Wholesale Water Providers

There are seven wholesale water providers in Region F. Of these providers, five are shown to have water supply shortages. To better understand the quantity of water that will need to be developed through infrastructure strategies, the needs presented for the wholesale 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 wholesale water providers is presented in the following sections. Full strategy evaluations are included in Appendix C.

5D.1 Brown County WID #1

Brown County Water Improvement District (BCWID) #1 supplies water to members and customers in Brown, Coleman, Mills and Runnels counties. Major customers include Bangs, Brookesmith SUD, Brownwood, Early, Zephyr WSC, and manufacturers 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. With subordination and conservation, BCWID shows a supply surplus of nearly 14,000 acre-feet in 2020. The surplus declines over time to slightly less than 12,000 acre-feet in 2070 due to sedimentation in the reservoir. Despite significant surplus, BCWID is currently pursuing groundwater development as a way to ensure a reliable water supplies during times of extreme drought. Table 5D- 1 shows the comparison of supply and demand for BCWID with subordination and conservation supplies.

Table 5D- 1
Comparison of Supply and Demand for BCWID
-Values are in Acre-Feet per Year-

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Lake Brownwood (with subordination)	25,741	25,313	24,885	24,457	24,029	23,600
Conservation	220	225	225	225	225	225
Total Availability	25,961	25,538	25,110	24,682	24,254	23,825
Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Bangs	207	204	198	195	194	194
Brookesmith SUD	1,199	1,195	1,170	1,156	1,153	1,153
Santa Anna	157	155	150	150	149	149
Coleman County SUD	214	211	206	202	202	203
Brownwood	3,755	3,750	3,677	3,636	3,629	3,629
County-Other	125	125	125	125	125	125
Early	290	285	275	269	268	268
Zephyr WSC	379	374	364	359	357	357
Manufacturing	673	726	777	820	886	957
Irrigation	5,000	5,000	5,000	5,000	5,000	5,000
Total Demand	11,999	12,025	11,942	11,912	11,963	12,035
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage) for BCWID after conservation and subordination	13,962	13,513	13,168	12,770	12,291	11,790

Potentially feasible water management strategies for Brown County WID #1 include:

- Municipal Conservation
- Subordination
- Brush Control
- Groundwater development

Each of these strategies are recommended for the BCWID. While both conservation and subordination are included as supplies in the needs table and are discussed in detail in previous sections, they are also discussed below as a recommended strategy for completeness.

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 carried out by each individual member and customer city. These combined efforts are expected to reduce BCWID's demands by about 2 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 nearly 26,000 acre-feet in 2020. The supplies decrease to 23,600 acre-feet by 2070 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 available through Water Supply Enhancement Program of the Texas State Soil and Water Conservation Board (TSSWCB). 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 2013. Therefore, all savings gained by previous treatment of brush are considered to be 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 350 acre-feet of increased yield can be expected from implementing this strategy.

Groundwater development

BCWID is currently pursuing groundwater development as a way to bolster the security of their water supplies. BCWID previously drilled a test well in the Ellenburger San Saba aquifer but found the water quality was unsuitable for municipal use without additional treatment, which was not cost effective. If water of adequate quality is located in the future, this source could potentially be used. However, to avoid potential additional treatment requirements, BCWID is now pursuing development of the Trinity aquifer in Brown County. Under the modeled available groundwater (MAG), there is no availability from this aquifer for strategy development and therefore, Region F cannot recommended a strategy from the aquifer with a non-zero value. However, that does not mean water is not available from this source. Furthermore, there is no groundwater conservation district in Brown County to enforce the MAG or hinder BCWID from pursuing this source. This strategy is included in this plan as a recommended strategy with no supply. The anticipated supply of 1,680 acre-feet is included as an alternate strategy.

BCWID #1 Water Management Plan Summary

Table 5D- 2 shows the comparison of supply and demand after recommended strategies are implemented for Brown County WID #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.

Table 5D- 2
Recommended Water Management Strategies for BCWID
-Values are in Acre-Feet per Year-

Recommended Strategies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Subordination	6,981	6,693	6,405	6,117	5,829	5,540
Municipal Conservation	220	225	225	225	225	225
Groundwater Development from the Trinity Aquifer	0	0	0	0	0	0
Brush Control	350	350	350	350	350	350
Total WMS Supply (without subordination and conservation)	350	350	350	350	350	350
Surplus (Shortage) after Recommended Strategies	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage) for BCWID after WMS	*14,312*	*13,863*	*13,518*	*13,120*	*12,641*	*12,140*
Alternate Strategies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Groundwater Development from the Trinity Aquifer	1,680	1,680	1,680	1,680	1,680	1,680

Table 5D- 3
Cost for Strategies for BCWID

Strategy	**Capital Cost**	**Annual Cost**					
		2020	**2030**	**2040**	**2050**	**2060**	**2070**
Subordination (Recommended)	$0	$0	$0	$0	$0	$0	$0
Brush Control (Recommended)	$0	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000
Groundwater (Alternate)	$8,436,000	$928,000	$928,000	$222,000	$222,000	$222,000	$222,000
Total	**$8,436,000**	**$1,228,000**	**$1228,000**	**$522,000**	**$522,000**	**$522,000**	**$522,000**

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. 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). Groundwater sources include well fields in Ward, Scurry and Martin Counties. CRMWD member cities include Big Spring, Odessa and Snyder. CRMWD also supplies water to Midland, San Angelo and Abilene (through West Central Texas MWD) as well as several smaller cities in Coke, Howard, Martin, and Ward Counties. Table 5D- 4 shows the projected future potable water shortages for CRMWD after the implementation of subordination and conservation strategies by its customers. The demands shown in Table 5D- 4 include both current and potential future customers. Potential future customers include the future demands that CRMWD's member cities intend to serve and expected renewals of current customer contracts. Some of the potential future demands include aggregated demands for manufacturing and steam electric power that do not have a specified project or sponsor. While the projected manufacturing demands are based on historical trends and expected growth, the steam electric power demands are more speculative regarding the quantity and location of the future water needs. The existing and known future steam electric power needs in Ector County are about one fourth of the projected demands in 2070. Taking into consideration the uncertainty of CRMWD's surface water supplies, possible groundwater regulation and the potential future demand level, there is a moderate level of uncertainty of the projected needs for CRMWD shown in Table 5D- 4. Table 5D- 5 shows CRMWD's diverted water system supplies with subordination and the current mining demands on this source. Supply from the diverted water system is brackish and cannot be used for municipal purposes in its typical state.

Table 5D- 4
Comparison of Supply and Demand for CRMWD

-Values are in Acre-Feet per Year-

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Lake Ivie (with subordination)	34,223	33,206	32,189	31,172	30,155	29,140
Spence Reservoir (with subordination)	24,591	24,562	24,533	24,504	24,475	24,449
Thomas Reservoir (with subordination)	4,864	4,847	4,830	4,813	4,796	4,779
Big Spring Potable Reuse	1,855	1,855	1,855	1,855	1,855	1,855
Ward County Well Field	9,500	9,500	9,500	9,500	9,500	9,500
Martin County Well Field	398	403	441	420	426	433
Municipal Conservation	1,071	1,213	1,330	1,472	1,593	1,740
Total Availability	**76,502**	**75,586**	**74,678**	**73,736**	**72,800**	**71,896**
Current Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Odessa	21,192	23,401	25,826	28,466	31,288	34,147
Ector County UD	1,856	2,058	2,284	2,521	2,766	3,018
Ector County Other	1,145	1,265	1,397	1,543	1,705	1,883
Manufacturing	665	662	716	719	716	704
Big Spring	6,149	6,288	6,299	6,248	6,238	6,237
Coahoma	183	186	188	187	187	187
Manufacturing	1,500	1,500	1,500	1,500	1,500	1,500
Snyder	2,222	2,468	2,603	2,797	3,012	3,233
County-Other	300	300	300	300	300	300
Rotan	178	170	165	164	163	163
Abilene [a]	5,660	5,492	5,324	5,156	4,988	4,820
County-Other	150	150	150	150	150	150
Midland	24,458	5,492	5,324	5,156	4,988	4,820
Midland [a]	5,660	5,492	5,324	5,156	4,988	4,820
Midland [b]	18,798	0	0	0	0	0
Millersview-Doole WSC	600	600	600	600	600	600
Ballinger	500	500	500	500	500	500
Robert Lee [c]	296	291	287	287	286	286
County-Other	76	72	69	68	68	68
San Angelo [a]	5,660	5,492	5,324	5,156	4,988	4,820
San Angelo [d]	1,475	1,474	1,472	1,470	1,469	1,467
Stanton	539	579	606	635	658	677
Irrigation	400	400	400	400	400	400
Total Current Demand	**75,204**	**58,840**	**61,334**	**64,023**	**66,970**	**69,980**

Potential Future Customer Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Midland	0	4,000	4,000	4,000	4,000	4,000
Ector County SEP	4,000	4,000	4,000	4,000	4,000	4,000
Ector County Other	0	0	0	221	520	809
Howard County-Other	249	285	280	278	275	275
Howard County Manufacturing	614	773	895	998	1,191	1,396
Scurry County-Other	158	182	210	250	299	351
Total Future Customer Demand	**5,021**	**9,240**	**9,385**	**9,747**	**10,285**	**10,831**
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Current Customer Demand	1,298	16,746	13,344	9,713	5,830	1,916
Current and Potential Future Customer Demand	*(3,723)*	*7,506*	*3,959*	*(34)*	*(4,455)*	*(8,915)*

[a] Contract is for 16.54% of the safe yield of Ivie.

[b] Midland 1966 Contract expires in 2029.

[c] Robert Lee only receives water from Lake Spence.

[d] This is a contractual demand on CRMWD. The City of San Angelo cannot use this supply without rehabilitation of the Spence pipeline.

Table 5D- 5
Comparison of Supply and Demand for CRMWD Diverted Water System (Brackish)

-Values are in Acre-Feet per Year-

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Diverted Water System (Brackish)	5,760	5,760	5,760	5,760	5,760	5,760
Current Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Coke Co. Mining (Brackish)	38	36	34	32	30	28
Howard Co. Mining (Brackish)	1,000	1,000	1,000	982	320	43
Total Demand	1,038	1,036	1,034	1,014	350	71
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Brackish Surplus (Shortage)	4,722	4,724	4,726	4,746	5,410	5,689

With subordinated supplies, CRMWD can fully meet its current customer demands without developing additional supplies. After the expiration of its contract with Midland in 2029, CRMWD is shown to have a surplus of over 16,000 acre-feet in 2030. However, with the potential future water demands, either served by one of CRMWD's customers or directly by the District, CRMWD is shown to have a shortage beginning in 2050 without developing additional supplies. The shortage shown in 2020, which is the result of potential future steam electric needs, can likely be met with CRMWD existing groundwater supplies. There is sufficient groundwater system capacity for these demands. As previously discussed, there is some uncertainty associated with the reliability of surface water supplies in the Upper Colorado Basin which is currently experiencing an ongoing drought worse than the drought of record. Depending on the duration of the drought, future surface water supplies could be lower than those shown in this plan. There is also uncertainty associated with the level of demands from future customers, especially future steam electric power demands. Given these unknowns, CRMWD is pursuing water management strategies to meet these future demands and bolster the reliability of their water supply.

Several water marketing companies have approached CRMWD with potential water supply scenarios. One of these options was to develop groundwater from the Edwards-Trinity aquifer in Val Verde County (Region J). After supplies were allocated to existing users in Val Verde County, the Modeled Available Groundwater (MAG) only shows 1,873 acre-feet of supply to be available for strategy development. At such a small level of availability, this strategy was deemed not to be potentially feasible. Should the MAG change, this may become a viable option for CRMWD and should be further evaluated at that time. There may also be potential to purchase existing water rights on a willing buyer, willing seller basis from Lake Amistad (Region J) that could be used conjunctively with the groundwater from Val Verde County. This was also not considered potentially feasible for this plan due to the small amount of groundwater shown as available for conjunctive use under the current MAG.

The following strategies were identified as potentially feasible for CRMWD:

- Conservation of Wholesale Customers
- Subordination of Senior Downstream Water Rights
- Ward County Well Field Expansion and the Development of Winkler County Well Field
- Aquifer Storage and Recovery (ASR) of Existing Surface Water Supplies
- Develop Additional Groundwater Supplies from Western Region F Counties
- Transmission of Additional Groundwater Supplies from Western Region F Counties
- Desalination of Brackish Groundwater Supplies
- Aquifer Storage and Recovery (ASR) of Brackish Groundwater Supplies
- Desalination of Brackish Surface Water (CRMWD Diverted Water System)

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.

The following strategies were identified as recommended for CRMWD:

- Conservation
- Subordination
- Ward County Well Field Expansion and the Development of Winkler County Well Field
- Aquifer Storage and Recovery (ASR) of Existing Surface Water Supplies
- Desalination of Brackish Surface Water (CRMWD Diverted Water System)

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 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 36,000 acre-feet to nearly 63,700 acre-feet in 2020. By 2070, the subordination supplies decrease to about 58,400 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 Field Expansion and Development of Winkler County Well Field

CRMWD currently 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. The capacity of the existing transmission system will be upgraded from 46 MGD to 65 MGD to accommodate the additional 20 MGD peak supply estimated from this project. This project is expected to come online in 2020 and cost $139.9 million.

Aquifer Storage and Recovery (ASR) of Existing Surface Water Supplies

CRMWD owns and operates several water supply reservoirs and groundwater well fields. During periods of above normal inflow in the Colorado River Basin, surface water that is not used to meet demands could be treated and stored in CRMWD's existing groundwater well field. This would reduce evaporative losses that would have occurred at the lakes, resulting in increased water supplies available to CRMWD.

This strategy assumes that in years with excess surface water, up to 10,000 acre-feet of water would be treated at the Odessa water treatment plant and pumped to the Ward County well field for storage in the Pecos Valley aquifer. This would likely be done during the winter months, when demands are lower and treatment system has excess capacity. Operation in this manner will require no immediate expansion to the existing water treatment plant in Odessa. As demands increase on Odessa from future customers, the excess treatment capacity will decrease and additional treatment capacity will be needed. It is assumed that Odessa will develop this treatment capacity to serve its future customers. CRMWD will need to construct an additional pump station and piping to facilitate transportation of an additional 5 MGD to and from the Odessa water treatment plant. The existing transmission pipeline and wells would be used to transport, store, and recover the treated surface water. Capital costs for this project are estimated at $10,184,000 and a unit cost of $2.00 per thousand gallons. The project is expected to be in place by 2030.

Desalination of Brackish Surface Water (CRMWD Diverted Water System)

CRMWD currently owns and operates several chloride control reservoirs and associated diversion structures. This part of their system is known as the diverted water system. The firm yield from this system is 5,760 acre-feet per year with subordination. However, the quality of this water is poor and it is unable to be used as potable supply in its typical state. CRMWD sells slightly over 1,000 acre-feet per year to the mining industry without treatment. For the purposes of this plan, it is assumed CRMWD will continue to sell this brackish supply to the mining industry. The remaining 4 MGD would be piped from their diverted water system to the Big Spring Reclamation plant for advanced treatment. To treat this additional supply, a new reverse osmosis (RO) water treatment plant would be needed. The advanced treatment processes required for treating these brackish supplies result in around 25 percent losses. This results in 3 MGD of potable supply. It is assumed for this strategy that the brine concentrate will be discharged to Beals Creek, which has diminished water quality. This project is scheduled to be implemented by 2040 at a capital cost of $35 million and a unit cost of $5.66 per thousand gallons.

CRMWD Water Management Plan Summary

The needs for CRMWD after the implementation of recommended strategies are shown in Table 5D- 6. The recommended water plan for CRMWD will provide water to meet the projected shortages and provide an expected surplus of 10 to 20 percent in most decades. The costs for these strategies are summarized in Table 5D-7.

Alternate water management strategies are identified if a recommended strategy is no longer viable or there is a new need that cannot be met by the recommended water management plan. With the uncertainties of CRMWD's existing supplies and the uncertainty of the water quantity and quality for additional groundwater development, CRMWD has identified four alternate strategies. These strategies are really separate components of a single strategy that would develop new groundwater supplies from the western part of Region F with options for desalination and aquifer storage and recovery. The Alternate Water Management Strategies for CRMWD include:

- Develop Additional Groundwater Supplies from Western Region F Counties
- Transmission of Additional Groundwater Supplies from Western Region F Counties
- Desalination of Brackish Groundwater Supplies
- Aquifer Storage and Recovery (ASR) of Brackish Groundwater Supplies

Each of these strategies is described in full and evaluated in Appendix C.

Table 5D- 6
Recommended Water Management Strategies for CRMWD
-Values are in Acre-Feet per Year-

Recommended Strategies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Subordination	33,408	33,365	33,322	33,279	33,236	33,198
Municipal Conservation	1,071	1,213	1,330	1,472	1,593	1,740
Ward County Well Field Expansion and Development of Winkler County Well Field	11,200	11,200	11,200	11,200	11,200	11,200
Aquifer Storage and Recovery of Existing Surface Water Supplies		5,000	5,000	5,000	5,000	5,000
Desalination of Brackish Surface Water (CRMWD Diverted Water System)			3,360	3,360	3,360	3,360
Total WMS Supply (excluding conservation and reuse)	**11,200**	**16,200**	**19,560**	**19,560**	**19,560**	**19,560**
Surplus (Shortage) after Recommended Strategies						
	2020	**2030**	**2040**	**2050**	**2060**	**2070**
Current Customer Demands	12,498	32,946	32,904	29,273	25,390	21,476
Current and Future Customer Demands	7,241	23,458	23,278	19,267	14,838	10,373

Table 5D- 7
Cost of Recommended Strategies

Strategy	**Capital Cost**	**Annual Cost Per Thousand Gallons**					
		2020	**2030**	**2040**	**2050**	**2060**	**2070**
Subordination	$0	$0	$0	$0	$0	$0	$0
Ward County Expansion	$139,916,000	$14,163,000	$14,163,000	$2,455,000	$2,455,000	$2,455,000	$2,455,000
ASR of Existing Surface Water	$10,184,000		$3,254,000	$3,254,000	$2,402,000	$2,402,000	$2,402,000
Desalination of Brackish Surface Water	$34,819,000			$6,196,000	$6,196,000	$3,282,000	$3,282,000

5D.3 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, entities in Ector County-Other and some manufacturing operations. The City's wastewater is currently contracted for reuse by steam electric power, manufacturing and irrigation. While all of their wastewater return flows are currently contracted, they are not always fully utilized. As excess supplies are available, Odessa plans to sell the remainder of their reuse supply to mining operations. The City also plans to supply the steam electric power needs identified for current and planned facilities in Ector County as they arise.

Table 5D- 8 shows a comparison of the Region F supply and demand for the City of Odessa, considering municipal conservation and subordination of CRMWD's surface water sources. Under these assumptions, the City of Odessa does not show a shortage over the planning horizon for current users. The City has been approached about providing water to a proposed future steam electric power facility. The facility will need up to 4.2 MGD for peak water use. Assuming the City would supply this water need along with the potential shortage for current facilities, it is estimated that Odessa would provide an additional 4,000 acre-feet per year of water to steam electric power in Ector County. With these additional demands, Odessa shows a shortage of 3,284 acre-feet per year.

However, due to the ongoing drought and increased development of oil and gas from the Permian Basin, the City of Odessa is experiencing additional demands on their supplies. The growth in population and demands has largely occurred after the development of the population and demand projections and may not be fully represented in the projections shown here. Furthermore, due to prolonged drought in the region, many homeowners in the area have drilled private wells for lawn irrigation. The City expects that if adequate supplies were available, much of this demand would revert back to the City.

Another consequence of the ongoing drought is reduced reliability from surface water in the Upper Colorado Basin. If the drought persists, the reliable yield may decrease, potentially reducing CRMWD's surface water supplies shown in this plan.

Table 5D- 8
Comparison of Supply and Demand for Treated Water for Odessa

-Values are in Acre-Feet per Year-

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
CRMWD System Total (with subordination)	24,858	27,386	30,223	33,249	36,475	39,752
Municipal Conservation	716	825	924	1,026	1,128	1,231
Total Availability	25,574	28,211	31,147	34,275	37,603	40,983
Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Odessa	21,192	23,401	25,826	28,466	31,288	34,147
Ector County UD	1,856	2,058	2,284	2,521	2,766	3,018
Ector County Other	1,145	1,265	1,397	1,543	1,705	1,883
Manufacturing	665	662	716	719	716	704
Subtotal Treated Water Demand	24,858	27,386	30,223	33,249	36,475	39,752
Potential Future Customer Demand	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Ector County Steam Electric Power	4,000	4,000	4,000	4,000	4,000	4,000
Ector County – Other	0	0	0	221	520	809
Subtotal Potential Future Customer Demand	4,000	4,000	4,000	4,221	4,520	4,809
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Current Customers	716	825	924	1,025	1,128	1,231
Current and Potential Future Customers	(3,201)	(3,081)	(2,974)	(3,060)	(3,243)	(3,416)

Table 5D- 9
Comparison of Supply and Demand for Reuse Water for Odessa
-Values are in Acre-Feet per Year-

Supplies	Supply 2020	Supply 2030	Supply 2040	Supply 2050	Supply 2060	Supply 2070
Direct Reuse (non-potable)	6,720	6,720	6,720	6,720	6,800	7,000
Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Steam Electric/Reuse	500	500	500	500	500	500
Manufacturing/Reuse	2,789	2,981	3,093	3,217	3,354	3,505
Irrigation/Reuse	1,290	1,425	1,574	1,739	1,921	2,122
Future Mining/Reuse	1,582	1,731	1,541	1,259	1,018	861
Total Reuse Demand	**6,161**	**6,637**	**6,708**	**6,715**	**6,793**	**6,988**
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage) for Odessa Reuse Supplies	559	83	12	5	7	12

As a member city of CRMWD, CRMWD plans to provide all of Odessa's water needs through development of additional strategies. CRMWD has 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 included as supplies in the needs table and are discussed in detail in previous sections, but they are also discussed below as a recommended strategy for completeness.

The following strategies were identified as recommended for the City of Odessa:

- Municipal Conservation
- Subordination(associated with CRMWD sources)
- Additional Supplies from CRMWD
- New Reverse Osmosis Treatment Facility

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 2.5 to 3 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. Under the subordination strategy, the District's surface water system's supplies increase from about 48,000 acre-feet to just over 81,000 acre-feet in 2020. 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 and Ector County steam electric power use, Odessa would obtain up to 4,809 acre-feet per year of 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.

New Reverse Osmosis Treatment 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 produce 10 MGD of finished water at peak capacity. Using a peaking factor of 1.5, this facility is estimated to produce 7,500 acre-feet of finished water per year. Treatment losses were estimated at 25 percent. This water would then be blended with the rest of their supplies to improve the overall drinking water quality. This project is estimated to require a capital investment of $62,309,000.

City of Odessa Water Management Plan Summary

The needs for Odessa after the implementation of recommended strategies are shown in Table 5D- 10. Table 5D- 11 shows the capital and annual costs for these strategies. The recommended water plan indicates the recommended strategies will be able to meet Odessa's projected needs. The City is planning to improve the water quality of the subordinated surface water supplies with the addition of advanced treatment.

Odessa has identified two alternate strategies, which may be implemented if additional supplies are needed or one of the City's strategies cannot be implemented. The Alternate Water Management Strategies for Odessa include:

- Development of Brackish Groundwater in Ward County
- Development of Groundwater near Fort Stockton

Both of these strategies are described in full and evaluated in Appendix C.

Table 5D- 10
Recommended Strategies for the City of Odessa
-Values are in Acre-Feet per Year-

Recommended Strategies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Subordination	11,825	9,960	12,152	14,544	17,117	19,757
*RO Treatment**	*7,500*	*7,500*	*7,500*	*7,500*	*7,500*	*7,500*
Treatment Losses	-2,500	-2,500	-2,500	-2,500	-2,500	-2,500
Municipal Conservation	799	919	1,026	1,161	1,277	1,393
Additional Supply from CRMWD	6,119	6,340	6,583	7,068	7,649	8,224
Total WMS Supply (excluding subordination and conservation)	3,619	3,840	4,083	4,568	5,149	5,724
Surplus (Shortage) after Recommended Strategies	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Current Customer Demands	*4,418*	*4,759*	*5,109*	*5,729*	*6,426*	*7,117*
Current and Potential Future Customer Demands	*418*	*759*	*1,109*	*1,508*	*1,906*	*2,308*

**This strategy is for infrastructure required to access the subordination supplies and is not included in the total to avoid double counting. The value shown is the maximum capacity of the 10 MGD treatment facility based on a 1.5 peaking factor.*

Table 5D- 11
Costs for the Recommended Strategies for the City of Odessa

Strategy	Capital Cost	Annual Cost					
		2020	**2030**	**2040**	**2050**	**2060**	**2070**
Conservation	$0	$226,435	$263,505	$291,958	$321,105	$350,602	$380,302
RO Treatment	$62,309,000	$8,084,000	$8,084,000	$2,870,000	$2,870,000	$2,870,000	$2,870,000
Additional Supply from CRMWD	$0	$3,910,000	$3,910,000	$3,910,000	$4,126,000	$4,419,000	$4,701,000
Total Costs		**$12,220,000**	**$12,258,000**	**$7,072,000**	**$7,317,000**	**$7,640,000**	**$7,951,000**

5D.4 Great Plains Water Supply System, Ltd.

Great Plains Water Supply System (Great Plains) 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 rural Ector County, 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 1,500 acre-feet per year as presented in Table 5D- 12.

Table 5D- 12
Comparison of Supply and Demand for the Great Plains Water Supply System
-Values are in Acre-Feet per Year-

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Andrews Co. Well Field	2,063	1,616	888	757	558	556
Gaines Co. Well Field	2,000	2,000	2,000	2,000	2,000	2,000
Total Supplies	4,063	3,616	2,888	2,757	2,558	2,556
Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Ector County-Other (Goldsmith)	64	64	64	64	64	64
Ector County SEP	2,800	2,800	2,800	2,800	2,800	2,800
Ector Manufacturing	165	165	165	165	165	165
Gaines Mining	350	300	150	150	150	150
Andrews Mining	1,800	1,500	500	500	500	500
Ector Mining	375	300	150	150	150	150
Total Demand	5,554	5,129	3,829	3,829	3,829	3,829
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Current Customers	(1,491)	(1,513)	(941)	(1,072)	(1,271)	(1,273)

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 water from the Edwards-Trinity, Pecos Valley and Dockum aquifers, but the water quality of this supply is poor and productivity is limited. Due to the expense associated with obtaining and treating this water, Great Plains is not planning on developing additional supplies from these sources. Therefore, Great Plains is shown to have an unmet need.

5D.5 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 receives water from seven sources: Lake Nasworthy, Twin Buttes Reservoir, the Concho River, O.C. Fisher Reservoir, Ivie Reservoir, Spence Reservoir and a well field in McCulloch County (Hickory aquifer). San Angelo's wastewater is currently under contract with the Tom Green County WCID #1 in exchange for raw water from Twin Buttes. However, there has been little water in Twin Buttes in recent years to provide additional supplies to San Angelo. Other possible uses for this reuse water are currently being studied and it may be converted to municipal use in the future. The City has also recently developed a well field in the Hickory aquifer in McCulloch County.

Table 5D- 13 is a comparison of the Region F supply and treated water demand for the City of San Angelo, considering municipal conservation and subordination of the City's surface water sources. For this analysis, it was assumed that San Angelo supplies all of the manufacturing demand in Tom Green County. 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. For the purposes of this plan, it was assumed that CRMWD will reduce available supplies to San Angelo based on the Region F safe yield of each source. 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. The City does not plan to rehabilitate the pipeline, therefore it was not considered a feasible source or strategy. The water availability model shows a small reliable supply from three of the City's run-of- river permits.

Table 5D- 13
Comparison of Supply and Demand for the City of San Angelo
-Values are in Acre-Feet per Year-

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Concho River	214	214	214	214	214	214
San Angelo System (with subordination)[a]	4,335	4,142	3,949	3,756	3,563	3,372
Ivie Reservoir[b]	5,660	5,492	5,324	5,156	4,988	4,820
Hickory Aquifer	3,997	3,997	4,030	4,047	4,050	4,047
Municipal Conservation	656	753	793	842	894	949
Reuse (non-potable)	8,300	8,300	8,300	8,300	8,300	8,300
Total Availability	23,162	22,898	22,610	22,315	22,009	21,702
Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
San Angelo	18,244	20,002	20,851	21,930	23,240	24,665
UCRA	1,000	1,000	1,000	1,000	1,000	1,000
Manufacturing	2,387	2,615	2,839	3,034	3,273	3,531
Irrigation[c]	8,300	8,300	8,300	8,300	8,300	8,300
Total Demand	30,131	32,117	33,190	34,464	36,013	37,696
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Total Shortage for San Angelo	*(6,769)*	*(9,019)*	*(10,380)*	*(11,949)*	*(13,804)*	*(15,794)*

[a] Includes Twin Buttes, Lake Nasworthy, and O.C. Fisher; includes contracted portion to UCRA and future contractual increases

[b] 16.54% of the safe yield of Ivie

[c] Tom Green County WCID #1 Reuse

In compliance with the guidance and rules for regional planning, the TWDB requires the use of the MAG in regional water planning. The MAG for the Hickory aquifer in McCulloch County is severely limiting and causes the supplies from San Angelo's well field to be artificially shorted. The City of San Angelo has a binding agreement with the Hickory Underground Water Conservation District for 6,700 acre-feet per year of water. This amount increases to 10,000 acre-feet in 2026 and to 12,000 acre-feet in 2036. However, due to the constraints of the MAG, only around 4,000 acre-feet of total supply can be shown from this source. The ability to pump the remaining 8,000 acre-feet or so to reach their ultimate capacity is shown as an alternate strategy in this plan due to the combination of a low MAG and constraints created by regional water planning rules. Despite having to be shown as an alternate strategy in this plan, the City is currently moving forward with this strategy. The Hickory UWCD has indicated that the intention is to increase the MAG to cover the binding agreement with the City.

Using these supplies, the City of San Angelo has needs for over 6,000 acre-feet of water in 2020 which increases to over 15,000 acre-feet by 2070. A portion of these are artificial due to the constraints created by the MAG in McCulloch County. If it is assumed the well field can operate at its current agreement amount of 6,700 acre-feet per year, the City's needs are around 3,400 acre-feet in 2020 and just over 12,400 acre-feet in 2070. These are the volumes of needs that were used to plan additional water management strategies for the City of San Angelo.

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 their reservoir in this fashion and likely experiences a small benefit. However, since the yield of the reservoirs under the extended Colorado WAM is small, 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
- Direct and/or indirect reuse for municipal use
- Hickory Well Field Expansion in McCulloch County
- Desalination of Other aquifer supplies in Tom Green County
- Development of Capitan Reef aquifer supplies in Southwest Pecos County
- Development of Pecos Valley –Edwards-Trinity aquifer supplies in Southwest Pecos County

- Development of Edwards-Trinity aquifer supplies in Schleicher County
- Desalination of additional groundwater supplies
- Red Arroyo Off Channel Storage
- West Texas Water Partnership

Full strategy evaluations are included in Appendix C and the following strategies were recommended for the City of San Angelo. Both municipal conservation and subordination are included as supplies in the needs table and are discussed in detail in previous sections, but they are also discussed below as a recommended strategy for completeness.

- Municipal Conservation
- Subordination
- Brush Control
- Direct and/or Indirect Reuse for Municipal Use
- Hickory Well Field Expansion in McCulloch County
- Desalination of Other aquifer supplies in Tom Green County
- West Texas Water Partnership Project

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 4 percent throughout the planning horizon.

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. Under the subordination strategy, the city's surface water system's (Twin Buttes, Lake Nasworthy, and O.C. Fisher Reservoirs) supplies increase from 0 acre-feet to almost 4,000 acre-feet in 2020. Subordination supplies decrease to about 3,000 acre-feet by 2070 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 Regional Water Planning Group. Such an agreement must be developed by the water rights holders themselves, including the City of San Angelo.

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 available through Water Supply Enhancement Program of the Texas State Soil and Water Conservation Board (TSSWCB). 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 2013. Therefore, all savings gained by previous treatment of brush are considered to be 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 2,000 to 3,000 acres of brush per year are treated in this area. Based on this level of brush treatment, around 1,000 acre-feet of increased yield can be expected from implementing this strategy.

Direct and/or Indirect Reuse for Municipal Use

Currently, the City of San Angelo contracts approximately 8,300 acre-feet per year of reuse water to Tom Green County WCID #1 for irrigation purposes. The City is currently involved in an ongoing study examining other potential uses for this water, including municipal use. At the writing of this plan, the study is not complete. Although it has not been determined whether the reuse will be implemented directly or indirectly, for planning purposes it was assumed to be a direct reuse project. After treatment losses, this strategy is expected to provide around 7,000 acre-feet per year and require about $150 million in capital investment.

Desalination of Other Aquifer Supplies in Tom Green County

The City of San Angelo and UCRA have identified several potential brackish groundwater sources north and west of the City. An initial investigation into one of these sources, the Whitehorse formation, did not yield water of sufficient quality or quantity and has been dropped from consideration. A test of the Clear Fork formation was more promising and merits additional investigation. The City plans to continue investigating sources of saline water for long-term future water supplies. For the purposes of this plan, a conceptual design was developed for a 7 MGD project starting in 2050, yielding an average supply of 3,750 acre-feet per year. The most likely location for a desalination facility is on the northwest side of the City. The conceptual design for this strategy calls for disposal of brine reject through deep-well injection. Estimated capital costs for this strategy are $79.1 million.

Hickory Aquifer Well Field Expansion in McCulloch County

The City recently completed the first phase of its Hickory well field project. This project included 15 wells and a transmission system. The Phase 1 project can provide up to 6,700 acre-feet per year according to their agreement with the Hickory Underground Water District. Starting in 2026, the City can increase this supply by 3,300 acre-feet to a total capacity of 10,000 acre-feet. The project will reach its ultimate capacity of 12,000 acre-feet by 2036. In order to reach full capacity, the City will need to add additional wells, increase their radium treatment capacity, and upgrade some pump stations along the pipeline route. No additional pipelines or increases in pipeline capacity are required. The capital costs associated with these upgrades are estimated at $27 million. At this time, due to limitations by the MAG in McCulloch County, this recommended strategy officially shows no supply. However, the full supply amount expected from this strategy is included as an alternate strategy.

West Texas Water Partnership

The Cities of San Angelo, Midland and Abilene have formed the West Texas Water Partnership (the Partnership) to evaluate long-term water supplies the Partnership could develop jointly. The Partnership is conducting a separate study to determine the most feasible water management strategies for these cities, but the results were not available at the writing of this plan. For planning purposes, it is assumed that the Partnership would provide 10,000 acre-feet per year from sources in Region G (City of Abilene), transmitted back through Abilene's existing O.H. Ivie pipeline to a delivery point near San Angelo. The City of San Angelo would receive 6,000 acre-feet per year, and the remaining 4,000 acre-feet would supply Midland. These sources in Region G include current supplies to the City of Abilene and future supplies from the proposed Cedar Ridge Reservoir. The total project costs for the infrastructure improvements necessary to transmit water back through Abilene's Ivie pipeline and tie into existing CRMWD facilities are estimated to be $65,292,000, with a unit cost of $1,256 per acre-foot. The portion of the capital cost attributable to San Angelo would be 60% of the total capital cost, or $39,175,200. The unit costs are identical for both cities for delivery to the CRMWD pipeline, however, there would likely be additional operating costs for Midland to pump supply through the CRMWD facilities to Midland. For planning purposes the Partnership has included a concept strategy in the Region F Plan for San Angelo and Midland. The Partnership has not approached the Colorado River Municipal Water District with any plans to use CRMWD facilities and CRMWD facilities are already fully contractually committed. If and when the Partnership has developed a firmer concept strategy, they should contact CRMWD to see if their option(s) are feasible and beneficial to both the Partnership and CRMWD. Discussions between the Partnership and CRMWD are outside the scope of regional water planning.

Table 5D- 14 shows the supply amounts from each strategy and the needs after implementation of recommended strategies for the City of San Angelo. Table 5D- 15 shows the needs for the City of San Angelo if the full amount of expected supply from the Hickory Well Field Expansion was able to be shown.

The costs for each recommended strategy is summarized in Table 5D- 16. The total capital cost for the recommended water plan for San Angelo is $198 million.

Table 5D- 14
Recommended Water Management Strategies for the City of San Angelo

-Values are in Acre-Feet per Year-

Recommended Strategies	Supply 2020	Supply 2030	Supply 2040	Supply 2050	Supply 2060	Supply 2070
Subordination	3,699	3,494	3,305	3,115	2,922	2,732
Municipal Conservation	656	753	793	842	894	949
Hickory Well Field Expansion	0	0	0	0	0	0
Reuse	7,000	7,000	7,000	7,000	7,000	7,000
Desalination (Other Aquifer)	0	0	0	3,750	3,750	3,750
Brush Control	1,000	1,000	1,000	1,000	1,000	1,000
West Texas Water Partnership	0	6,000	6,000	6,000	6,000	6,000
Total WMS Supply	**7,000**	**13,000**	**13,000**	**16,500**	**16,500**	**16,500**
Surplus (Shortage) after Recommended Strategies	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage) for San Angelo	*1,231*	*4,981*	*3,620*	*5,801*	*3,946*	*1,956*

Table 5D- 15
Needs after Expansion of Hickory Well Field (Full Supply Amount – Alternative WMS)

-Values are in Acre-Feet per Year-

Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage) after Recommended Strategies	*1,231*	*4,981*	*3,620*	*5,801*	*3,946*	*1,956*
Supply	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Hickory Well Field Expansion (Full Supply Amount - Alternative WMS)	2,703	6,003	7,970	7,953	7,950	7,953
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage) after Hickory Well Field Expansion	*3,934*	*10,984*	*11,590*	*13,754*	*11,896*	*9,909*

Table 5D- 16
Costs for the Recommended Strategies for the City of San Angelo

Strategy	**Capital Cost**	**Annual Cost**					
		2020	**2030**	**2040**	**2050**	**2060**	**2070**
Conservation	$0	$209,149	$243,264	$256,453	$270,455	$285,325	$301,112
Hickory Well Field Expansion	$27,104,000	$4,063,000	$4,063,000	$1,873,000	$1,873,000	$1,873,000	$1,873,000
Reuse	$150,000,000	$6,744,000	$6,744,000	$2,342,000	$2,342,000	$2,342,000	$2,342,000
Desalination (Other Aquifer)	$57,967,000				$10,267,000	$10,267,000	$3,646,000
Brush Control	$0	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000
West Texas Water Partnership	$39,175,200		$7,536,000	$7,536,000	$3,581,000	$3,581,000	$3,581,000
Total Costs	**$274,246,200**	**$11,116,149**	**$18,686,264**	**$12,107,453**	**$18,433,455**	**$18,448,325**	**$11,843,112**

Alternate Water Management Strategies for San Angelo include:

- Expansion of Hickory aquifer well field in McCulloch County (full supply amount)
- Additional supplies from the West Texas Partnership
- Development of Edwards-Trinity aquifer supplies in Schleicher County
- Development of Pecos Valley – Edwards-Trinity aquifer supplies in Southwest Pecos County
- Development of Capitan Reef Complex aquifer Supplies in Pecos County
- Desalination of Brackish Groundwater
- Red Arroyo Off Channel Storage

The alternate strategies may be implemented if one or more of the recommended strategies is determined to be no longer feasible.

5D.6 Upper Colorado River Authority (UCRA)

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 to treat up to 500 acre-feet per year of water from any of San Angelo's sources in return for water from O.C. Fisher. The City of Miles and local rural water supply corporations contract with UCRA to provide treated water which is transmitted through either San Angelo's or the retail customer's systems. It also has a lease agreement securing groundwater rights in Coke County that UCRA intends to develop for the City of Robert Lee.

Table 5D- 17 shows a comparison of the Region F supply and demand for UCRA, considering subordination of its surface water sources. Under these assumptions, UCRA does not show a shortage for current users. UCRA has been approached about providing water to a proposed new development near San Angelo for 150 acre-feet per year. Also, other rural users in Tom Green County are seeking additional water supplies. UCRA would like to increase its contract with San Angelo from 500 acre-feet per year to 1,000 acre-feet per year to serve rural customers in Tom Green County.

UCRA continues to work with San Angelo on evaluating the potential strategy for surface water storage and diversion from the Red Arroyo near San Angelo. This strategy, while not recommended for San Angelo, could be a potential source of water for the additional 500 acre-feet per year contract with San Angelo. UCRA has been monitoring flows in the Red Arroyo over the past five years and found that even under drought conditions, the watershed produces 5,000 acre-feet per year or more of storm water flow. Some of this flow may be associated with increased urbanization in the greater San Angelo area, which has resulted in increased runoff. Further study is needed of this strategy to determine if this is a viable water source for San Angelo and UCRA.

Table 5D- 17
Comparison of Supply and Demand for UCRA
-Values are in Acre-Feet per Year-

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Mountain Creek Lake	0	0	0	0	0	0
OC Fisher Reservoir (with subordination)	500	500	500	500	500	500
Total Availability	500	500	500	500	500	500
Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Miles	112	124	121	119	119	119
Tom Green County-Other	200	200	200	200	200	200
Concho County-Other (Paint Rock)	25	25	25	25	25	25
Total Current Demand	337	349	346	344	344	344
Potential Future Customers:						
Tom Green County Other	306	323	379	428	474	518
Total Demand with Future Customers	643	672	725	772	818	862
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Total Shortage for UCRA with current customers	*0*	*0*	*0*	*0*	*0*	*0*
Total Shortage for UCRA with future customers	*(143)*	*(172)*	*(225)*	*(272)*	*(318)*	*(362)*

The following strategies were recommended for UCRA. Water from subordination is included as supplies in the needs table and is discussed in detail in Chapter 5C, but it is included below as a recommended strategy for completeness. Full strategy evaluations are included in Appendix C

- Subordination
- Purchase water from San Angelo (Voluntary Transfer)
- New groundwater in Coke County
- Brush Control within OH Ivie Reservoir basin and watershed

Purchase water from San Angelo (Voluntary Transfer)

This strategy involves a contract amendment to increase the amount of water that San Angelo will treat for UCRA in return for water from O.C. Fisher. The cost for additional supply from San Angelo will need to be negotiated at the time of the contractual changes and will reflect San Angelo’s wholesale water rates at that time. Currently, these costs are unknown and therefore not included in the plan. This strategy also includes additional infrastructure to move the treated water to rural customers in Tom Green County. A study was recently completed for UCRA that looked at the infrastructure needs to serve customers to the northwest and south of San Angelo. Based on this study, the capital costs for this strategy are estimated at $32.2 million.

Brush Control within O.H. Ivie watershed

UCRA has been active with the TSSWCB on brush control in the Concho River Basin. Feasibility studies and active brush management has been conducted in the O.H. Ivie watershed. However, in order to continue to realize water savings from brush management, brush must be continually retreated. The City of San Angelo and UCRA have performed brush control in the watersheds of its reservoirs, including O.C. Fisher and Twin Buttes Reservoir. Brush control within each watershed and reservoir basins within the Upper Colorado and Concho River is a recommended strategy for San Angelo and the costs and water savings are shown for this wholesale water provider. San Angelo also holds water rights in O.H. Ivie and UCRA is interested in securing additional supplies from San Angelo through brush control in the Ivie watershed.

Table 5D- 18 shows the supply amounts from each strategy and the needs after implementation of recommended strategies for UCRA. The costs for each recommended strategy is summarized in Table 5D-19. The total capital cost for the recommended water plan for UCRA is $32.2 million.

Table 5D- 18
Recommended Strategies for UCRA
-Values are in Acre-Feet per Year-

Recommended Strategies	Supply 2020	Supply 2030	Supply 2040	Supply 2050	Supply 2060	Supply 2070
Increase contract with San Angelo	500	500	500	500	500	500
Brush Control – O.H. Ivie	Included with Increase contract with San Angelo					
Total WMS Supply	500	500	500	500	500	500
Surplus (Shortage) after Recommended Strategies	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage) for UCRA	*357*	*328*	*275*	*228*	*182*	*138*

Table 5D- 19
Costs of Recommended Strategies for UCRA

Strategy	Capital Cost	Annual Cost					
		2020	2030	2040	2050	2060	2070
Increase contract with San Angelo	$32,233,000	$3,058,140	$3,058,140	$361,140	$361,140	$361,140	$361,140
Develop Edwards-Trinity in Coke County	Included with Robert Lee's Strategy in Coke County						
Brush Control - O.H. Ivie	$0	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000
Total Costs	**$32,233,000**	**$3,108,140**	**$3,108,140**	**$411,140**	**$411,140**	**$411,140**	**$411,140**

Alternate Water Management Strategies for UCRA include:

- New groundwater in Coke County

5D.7 University Lands

University Lands manages the University of Texas System Permanent University Fund lands in West Texas. Several well fields in Region F are located on properties managed by University Lands, including the CRMWD Ward County Well Field (contract expires in 2019), the City of Midland's Paul Davis Well Field in Andrews and Martin Counties (contract expires in 2033), the City of Andrews' well field (contract expires in 2035), and the Upton County Water District's well field. As a manager of property, University Lands typically does not actively develop new projects if supplies beneath the lands diminish. Contracts are developed based on expected supplies. However, due to the limitations of the MAGs in Martin and Andrews Counties, University Lands is showing a projected shortage of over 3,000 acre-feet per year in 2020 and 2030. After the expiration of Midland's contract, the shortage decreases. There are no recommended strategies for University Lands. Therefore, University Lands has an unmet water need.

Table 5D- 20
Comparison of Supply and Demand for University Lands
-Values are in Acre-Feet per Year-

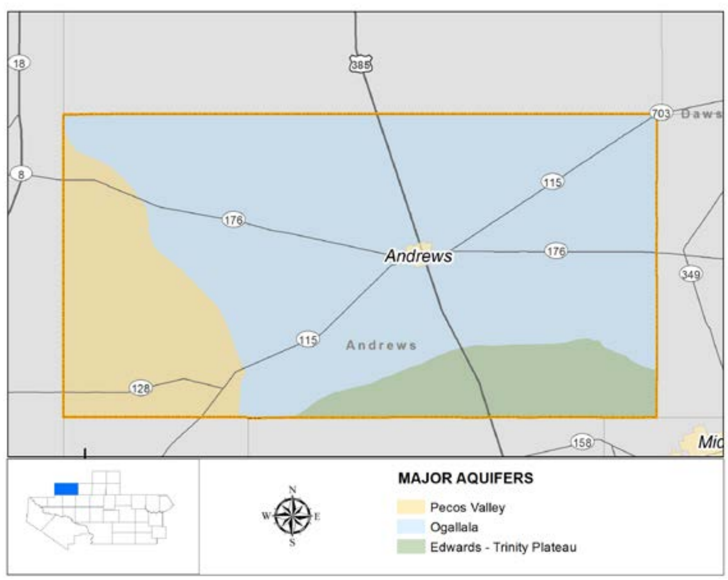
Well Field Supplies	***Aquifer***	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Ward Co. - CRMWD	Pecos Valley	5,200	5,200	5,200	5,200	5,200	5,200
Martin Co. - Midland	Ogallala	718	639	0	0	0	0
Andrews Co. - Midland	Ogallala	1,339	1,358	0	0	0	0
Andrews Co. - Andrews	Ogallala	496	383	359	307	226	225
Upton Co. - WSD	Edwards-Trinity	130	130	130	130	130	130
Total Supply		**7,883**	**7,710**	**5,689**	**5,637**	**5,556**	**5,555**
Demands		**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
CRMWD		5,200	5,200	5,200	5,200	5,200	5,200
Midland		4,722	4,722	0	0	0	0
Andrews		854	1,026	1,181	1,366	1,586	1,842
Upton County Water District		130	130	130	130	130	130
Total		10,906	11,078	6,511	6,696	6,916	7,172
Surplus (Shortage)		**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Total Shortage for University Lands		*(3,023)*	*(3,368)*	*(822)*	*(1,059)*	*(1,360)*	*(1,617)*

Subchapter 5E County Water Management Plans

There are 32 counties in Region F, of which ten show no shortages after conservation and subordination. 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. 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 wholesale 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 and municipal water needs. Irrigation is the largest water user group within Andrews County, with a water demand at approximately

37,898 acre-feet in 2020. Current supplies available to meet this need are approximately 9,478 acre-feet. Municipal shortages within Andrews County are 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. However, the current MAG volume available in the Ogallala aquifer 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, the strategies developed for the City of Andrews are not recommended, but are alternate strategies put in place to be recommended only if the DFC and associated MAG were to change in future planning cycles.

In addition, the mining demand in Andrews County is 3,959 acre-feet in 2020, which cannot be met with existing supplies. The only strategy identified for irrigation is conservation. Conservation strategies are discussed in more detail in Chapter 5B.

City of 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. 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 alternate 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 approximately 82 acre-feet in 2020. 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 seem to outweigh the considerable costs involved in 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

Alternate Water Management Strategies for the City of Andrews:

- Develop Ogallala Aquifer Supplies

<u>Develop Ogallala Aquifer Supplies</u>

This strategy proposes three phases of groundwater development. A total of 23 new wells would be drilled along with associated well field piping. The amount of supply expected from all phases combined is 4,300 acre-feet per year, but there is no water available under the current MAG. Capital costs are estimated at $18.67 million.

Table 5E- 1
Recommended Water Strategies for Andrews

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		1,605	2,319	2,884	4,512	6,242	7,529
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	82	99	136	157	183	213
Alternate Strategies (ac-ft/yr)							
Develop Ogallala Supplies	$18,671,000	1,680	3,360	4,300	4,300	4,300	4,300

Andrews County Other

Andrews County Other has less than 4,122 in population including individuals living outside of a named water user group. This compilation of users known as County-Other is self-supplied. A strategy to meet their needs was developed using additional groundwater in the Edwards-Trinity Plateau aquifer due to limited availability under the MAG in the Ogallala aquifer. However, in this area, the geology is complex and changes significantly across the county. In many areas, the Edwards-Trinity aquifer does not exist and in other areas, water from the Ogallala aquifer is found mostly in channels. The Edwards-Trinity aquifer may provide small volumes in the southern portion of Andrews County, but it is not available in all areas of the county. For the plan, it is assumed that any necessary treatment would occur at the point of use and a water treatment facility is not included in the costs. Further study would be needed on this formation prior to pursuing this strategy. These new groundwater wells are a recommended strategy. Municipal conservation was not recommended for Andrews County Other because their per capita use was below 140 gpcd.

Potentially Feasible Water Management Strategies Considered for Andrews County Other:

- Develop Edwards-Trinity Plateau Aquifer Supplies

<u>Develop Edwards-Trinity Plateau Aquifer Supplies</u>

This strategy assumes that 38 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 20 gpm. This strategy will cost approximately $3.5 million to implement and is estimated to yield an additional 500 acre-feet of water per year.

Table 5E- 2
Recommended Water Strategies for Andrews County Other

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		210	258	293	357	455	487
Recommended Strategies (ac-ft/yr)							
Develop Edwards-Trinity Plateau Aquifer Supplies	$3,515,000	500	500	500	500	500	500

Andrews County Livestock

Andrews County has approximately 100 acre-feet of livestock shortages over the planning horizon. In order to provide additional water to their existing supply, development of the Edwards-Trinity Plateau and Pecos Valley aquifer supplies are recommended strategies.

Potentially Feasible Water Management Strategies Considered for Andrews County Livestock:

- Develop Edwards-Trinity Plateau Aquifer Supplies
- Develop Pecos Valley Aquifer Supplies

<u>Develop Edwards-Trinity Plateau Aquifer Supplies</u>

The Edwards-Trinity Plateau aquifer in Andrews County may be a viable source, however, it is unclear if this water is truly fed by the overlaying Ogallala aquifer. Furthermore, it may only be found in certain areas of the county and may be in isolated pockets. Localized characterization studies are recommended prior to pursuing this strategy. This strategy assumes that five 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 20 gpm. This strategy will cost approximately $238,000 to implement and is estimated to yield an additional 150 acre-feet of water per year.

<u>Develop Pecos Valley Aquifer Supplies</u>

This strategy assumes that one new well will need to be constructed at a 230-ft depth in order to access the additional aquifer supplies needed. The well is assumed to be operating at a capacity of 40-gpm. This strategy will cost approximately $68,000 to implement and is estimated to yield an additional 50 acre-feet of water per year.

Table 5E- 3
Recommended Water Strategies for Andrews County Livestock

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		100	100	100	100	100	100
Recommended Strategies (ac-ft/yr)							
Develop Edwards-Trinity Plateau Aquifer Supplies	$238,000	150	150	150	150	150	150
Develop Pecos Valley Aquifer Supplies	$68,000	50	50	50	50	50	50
TOTAL	**$306,000**	**200**	**200**	**200**	**200**	**200**	**200**

Andrews County Manufacturing

The City of Andrews supplies all of Andrews' county manufacturing demand. The manufacturing need is included in the City of Andrews' need. A portion of the supply from the City of Andrews strategies would go to supply the manufacturing demands in Andrews County. Since the City of Andrews shows an unmet need due to the MAG, manufacturing also has an unmet need. This near-term unmet need is expected to be met with the development of the City of Andrews well field expansion.

Andrews County Mining

Andrews County Mining has a projected shortage of over 2,600 acre-feet per year. Region F has identified mining conservation and use of non-potable water as potential strategies to meet mining needs in Andrews County. Potential non-potable sources include reuse water from Midland and brackish groundwater.

Potentially Feasible Water Management Strategies Considered for Andrews County Mining:

- Purchase Midland wastewater effluent

<u>Purchase Midland Wastewater Effluent</u>

This is a proposed regional strategy that utilizes treated wastewater for mining needs in Andrews, Martin and Midland counties. The amount of supply assumed available to Andrews County is 2,500 acre-feet per year. The overall strategy includes improvements at the wastewater treatment plant and approximately 37 miles of distribution system. The proportional cost for Andrews County is $28 million.

Table 5E- 4
Recommended Water Strategies for Andrews County - Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		2,611	2,664	2,678	2,082	1,612	1,166
Recommended Strategies (ac-ft/yr)							
Mining Conservation/Recycling	$5,540,000	277	260	222	176	135	104
Non-Potable Reuse	$28,197,000	2,500	2,500	2,500	2,500	2,500	2,500
TOTAL	**$33,737,000**	**2,777**	**2,760**	**2,722**	**2,676**	**2,635**	**2,604**

Andrews County Summary

Andrews County has a projected shortage of over 40,000 acre-feet per year and has limited options to meet these shortages. As a result, the county is shown to have nearly 29,000 acre-feet per year of unmet water needs. These needs are associated with the City of Andrews and irrigation. Mining is able to meet its projected needs through the development of a direct reuse project that uses treated wastewater from Midland and conservation/recycling. While the unmet needs are large, some of the needs 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.

Table 5E- 5
Andrews County Summary

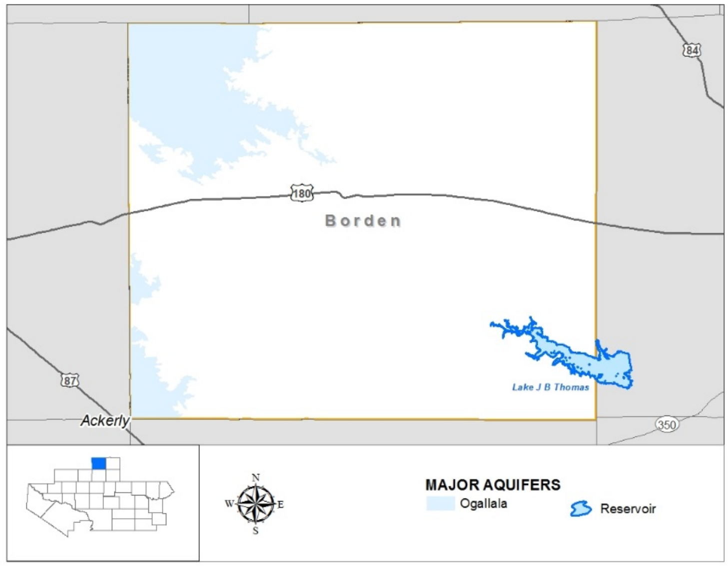
Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Andrews	Ogallala Aquifer	7,529	Municipal Conservation Renew Existing Contract with University Lands
County-Other	Ogallala Aquifer	487	Develop Edwards-Trinity Plateau and Pecos Valley Aquifer Supplies
Irrigation	Ogallala Aquifer, Reuse (City of Andrews)	31,377	Irrigation Conservation
Livestock	Dockum Aquifer, Stock Ponds, Ogallala Aquifer	166	Develop Edwards-Trinity Plateau and Pecos Valley Aquifer Supplies
Manufacturing	Sales from Andrews	Included in Andrew's shortage	See Andrews
Mining	Ogallala Aquifer, Dockum Aquifer	2,678	Mining Conservation/Recycling
Steam Electric	----	----	----

Table 5E- 6
Unmet Needs in Andrews County
-Values are in Acre Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Andrews[1]	(1,523)	(2,220)	(2,748)	(4,355)	(6,059)	(7,316)
Irrigation	(26,525)	(25,319)	(25,517)	(26,289)	(27,651)	(27,343)
TOTAL	**(28,048)**	**(27,539)**	**(28,266)**	**(30,644)**	**(33,710)**	**(34,660)**

[1]Manufacturing unmet need in included in the City of Andrew's unmet need.

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. As a result, there are identified shortages that may not be able to be met by supplies within the county. All of Borden County's shortages are for irrigation. Irrigation is the largest water user within the county, having a water demand of roughly 4,000 acre-feet per year. The only strategies identified for irrigation are conservation. These strategies are discussed in more detail in Chapter 5B. The following water use categories were identified to not have shortages, therefore no strategies were required: county-other, livestock and mining.

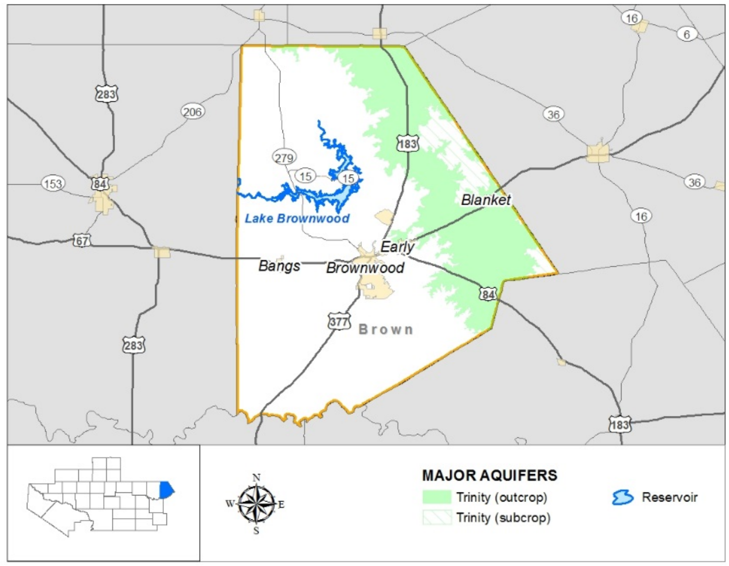
Table 5E- 7
Borden County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
County-Other	Ogallala Aquifer, Local Alluvium Aquifer	None	Municipal Conservation
Irrigation	Ogallala Aquifer, Local Alluvium Aquifer	3,243	Irrigation Conservation
Livestock	Stock Ponds	None	None
Manufacturing	----	----	----
Mining	Local Alluvium Aquifer	None	None
Steam Electric	----	----	----

Table 5E- 8
Unmet Needs in Borden County
-Values are in Acre Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(3,043)	(2,837)	(2,832)	(2,825)	(2,821)	(2,818)

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. BCWID #1 is a wholesale provider and is discussed further in Chapter 5D. None of the entities supplied by BCWID #1 show a water shortage over the planning horizon. Conservation is recommended as strategy for both their municipal and irrigation customers. Conservation is also recommended for mining despite showing no shortage. All conservation strategies are further discussed in Chapter 5B. Bangs and Brownwood plan to pursue reuse strategies. County-Other, Livestock and Manufacturing all have no shortages and no recommended strategies.

Bangs

Bangs is a customer of BCWID and has no shortages over the planning horizon. However, Bangs plans to pursue a small scale direct non-potable reuse project for irrigation at a golf course.

Potentially Feasible Water Management Strategies Considered for Bangs:

- Municipal Conservation
- Direct Non-Potable Reuse

<u>Direct Non-Potable Reuse</u>

For the purposes of this plan, it was assumed that minor improvements would need to be made at the wastewater treatment facility as well as additional piping to transport the water from the plant to the golf course. This strategy will provide approximately 25 acre-feet per year and is estimated to cost approximately $422,000.

Table 5E- 9
Recommended Water Strategies for Bangs

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	9	9	9	9	9	9
Reuse	$422,000	25	25	25	25	25	25
TOTAL	**$422,000**	**34**	**34**	**34**	**34**	**34**	**34**

Brownwood

The City of Brownwood is supplied by BCWID. Lake Brownwood shows adequate supplies over the planning period. However, the ongoing drought has placed a strain on the lake and has caused some concern over the reliability of the water supply. To bolster the security of their water supplies, Brownwood is pursuing a 1.5 MGD direct potable reuse project.

Potentially Feasible Water Management Strategies Considered for Brownwood:

- Municipal Conservation
- Direct Potable Reuse

Direct Potable Reuse

The City of Brownwood is currently considering a direct potable reuse project that would reclaim water from the wastewater treatment plant and treat the effluent for 1.5 MGD potable supply. Brownwood was approved for funding by the TWDB in 2012 and received preliminary approval for the design of the plant from TCEQ in 2013. At the writing of this plan, Brownwood has chosen not to construct the project at this time and withdrew their loan application from TWDB. However, this project may be pursued at a later date. While direct potable reuse is technically feasible, public opposition to the idea can be strong. Furthermore, after the plant is built, the reclamation plant will still need to perform full scale rigorous testing before it could be approved by the TCEQ to be used as part of the City's drinking water supply. The estimated capital cost for this facility is $8.5 million.

Table 5E- 10
Recommended Water Strategies for Brownwood

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	126	129	129	129	129	129
Reuse	$8,500,000	841	841	841	841	841	841
TOTAL	**$8,500,000**	**966**	**970**	**969**	**969**	**969**	**969**

Brown County Summary

Lake Brownwood (BCWID #1) has sufficient supplies to meet most of the county's demands. However, uncertainty caused by the drought has led some to develop strategies to increase the security of their water supply. Bangs and Brownwood both plan to pursue direct reuse projects. Conservation is recommended for all municipal users in the county except County-Other that already has low per capita water use. Conservation is also recommended for irrigation. Irrigation is the only entity that has unmet needs over the planning horizon.

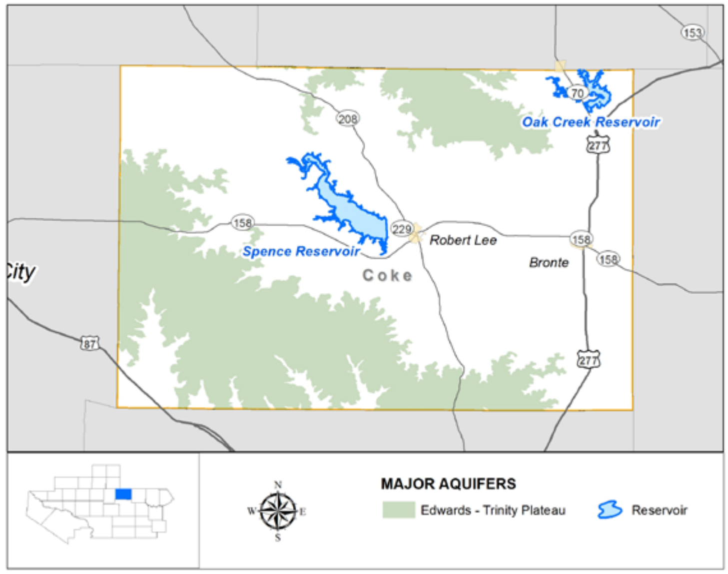
Table 5E- 11
Brown County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Bangs	Sales from BCWID #1	None	Municipal Conservation Direct Non-potable Reuse
Brookesmith SUD	Sales from BCWID #1	None	Municipal Conservation
Brownwood	Sales from BCWID #1	None	Municipal Conservation Direct Potable Reuse
Coleman County SUD	Sales from BCWID #1 and City of Coleman	None	Municipal Conservation
Early	Sales from BCWID #1	None	Municipal Conservation
Santa Anna	Sales from BCWID #1	None	Municipal Conservation
Zephyr WSC	Sales from BCWID #1	None	Municipal Conservation
County-Other	Sales from Brownwood, Trinity Aquifer	None	None
Irrigation	Sales from BCWID #1, Run-of-River, Trinity Aquifer	3,098	Irrigation Conservation
Livestock	Livestock Local Supplies, Other Aquifer	None	None
Manufacturing	Sales from BCWID #1	None	None
Mining	Trinity and Other Aquifers	None	Mining Conservation/Recycling
Steam Electric	----	----	----

Table 5E- 12
Unmet Needs in Brown County
-Values are in Acre Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(2,626)	(2,320)	(2,292)	(2,260)	(2,224)	(2,189)

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 has a contract with CRMWD and previously received supply from the Spence Reservoir. However, their water treatment plant has been shuttered and they no longer use this source. 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.

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 130 acre-feet of supply per year. Assuming the City of Sweetwater is able to meet their full obligation to Bronte, they show no shortages over the planning horizon. However, if Sweetwater is not able to meet this amount, Bronte would show significant shortages. 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 at least one was considered economically infeasible. This was not reevaluated for this plan and is listed below.

Previously Evaluated and Dismissed Water Management Strategy:

- Brackish groundwater development with advanced treatment

For this plan, several potentially feasible strategies were considered for Bronte including:

- Municipal Conservation
- Subordination (Oak Creek Supplies from Sweetwater)
- Rehabilitation of the Oak Creek Pipeline
- Water Treatment Plant Expansion
- Regional System from Lake Brownwood to Runnels and Coke Counties
- Regional System from Fort Phantom Hill to Runnels and Coke Counties
- Develop groundwater from Edwards-Trinity Plateau in Nolan County
- Develop additional groundwater near Oak Creek Reservoir
- Develop new groundwater SE of Bronte
- Direct Potable Reuse
- Purchase treated water from UCRA

Recommended strategies for the City of Bronte are discussed below. Alternate strategies are described further in Appendix C.

Rehabilitation 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 rehabilitation. All but approximately five miles of the pipeline has been replaced or rehabilitated. The remaining five miles of pipe need to be replaced. The proposed strategy includes a new 50,000-gallons/ground storage tank and 5 miles of 10-inch pipeline. 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 $1.5 million dollars.

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 MGD water treatment plant expansion in 2020. This is estimated to cost $6.8 million.

Develop Edwards-Trinity Aquifer Supplies in Nolan County (Region G)

The City of Bronte is considering developing new groundwater wells in south central Nolan County, which is in Region G. These wells produce water from the Edwards Trinity aquifer. The City of Bronte estimates this strategy to provide 200 acre-feet per year, however, the MAG in Nolan County, limits this strategy to

78 acre-feet per year. It is possible that not all users will utilize all the supply allocated to them from this source in the Region G plan. In this case, additional water may be available for Bronte. Additionally, Robert Lee may partner with Bronte to develop this strategy. This is included as an alternate strategy for Robert Lee.

Table 5E- 13
Recommended Water Strategies for Bronte

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		347	347	347	346	346	346
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	5	5	5	5	5	5
Water Audit and Leak Repairs	$900,000	12	12	11	11	11	11
Subordination	$0	400	400	400	400	400	400
Rehabilitation of Oak Creek Pipeline	$1,499,000	104	104	104	104	104	104
*Water Treatment Plant Expansion**	*$6,768,000*	*504*	*504*	*504*	*504*	*504*	*504*
Develop Edwards-Trinity Aquifer Supplies in Nolan County	$7,350,000	78	78	78	78	78	78
TOTAL	**$16,517,000**	**599**	**599**	**598**	**598**	**598**	**598**

**This strategy is for infrastructure required to access the subordination supplies Oak Creek pipeline supplies and is not included in the total to avoid double counting.*

Alternate Water Management Strategies for Bronte include:

- Develop additional groundwater near Oak Creek Reservoir
- Develop new groundwater southeast of Bronte
- Regional System from Lake Brownwood to Runnels and Coke Counties
- Regional System from Fort Phantom Hill to Runnels and Coke Counties
- Direct Potable Reuse
- Purchase treated water from UCRA

Robert Lee

The City of Robert Lee provides water to its current customers and about half of the County-Other demands. It currently purchases all of its supply from the City of Bronte. 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:

- Regional System from Lake Brownwood to Runnels and Coke Counties
- Desalination of Spence Reservoir Water
- Floating pump in Mountain Creek Reservoir
- Direct Potable Reuse

Potentially Feasible Water Management Strategies Considered for Robert Lee:

- Municipal Conservation
- Purchase additional water from Bronte
- Regional System from Fort Phantom Hill to Runnels and Coke Counties
- New water treatment plant to utilize supply from Spence and Mountain Creek Reservoirs
- Develop groundwater from Edwards-Trinity Plateau in Coke County
- Develop groundwater from Edwards-Trinity Plateau in Nolan County
- Develop groundwater from Edwards-Trinity Plateau in Tom Green County
- Purchase water from UCRA

Purchase additional water from Bronte

The City of Robert Lee currently has a contract to purchase 224 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 willing buyer, willing seller basis. The recommended strategies for Robert Lee are shown in Table 5E- 14. 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.

Table 5E- 14
Recommended Water Strategies for Robert Lee

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		136	126	121	119	119	119
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	6	6	6	6	6	6
Purchase additional supply from Bronte	$0	176	177	178	178	178	178
TOTAL	**$0**	**182**	**183**	**184**	**184**	**184**	**184**

Alternate Water Management Strategies Considered for Robert Lee:

- New water treatment plant to utilize supply from Spence and Mountain Creek Reservoirs
- Regional Systems from Fort Phantom Hill to Runnels and Coke Counties
- Develop groundwater from Edwards-Trinity Plateau in Coke County
- Develop groundwater from Edwards-Trinity Plateau in Nolan County
- Develop groundwater from Edwards-Trinity Plateau in Tom Green County
- Purchase water from UCRA

Coke County Other

Coke County Other is shown to have a small shortage due to the limited availability of groundwater. The demands for this user group decline over time. Due to the high costs associated with development and treatment of brackish water from the Edwards-Trinity Plateau, it is recommended that rural municipal water users acquire additional groundwater rights in the Other-aquifer to secure reliable supplies. For purposes of this plan, these rights are shown to transfer from irrigation use to municipal use. Since there is sufficient infrastructure to use the water, no new infrastructure is identified. Capital costs are associated only with water right purchase. Municipal conservation is not recommended because the per capita water use is less than 140 gallons per day.

Potentially Feasible Water Management Strategies Considered for Coke County Other:

- Voluntary Transfer from Irrigation to County-Other

Table 5E- 15
Recommended Water Strategies for Coke County Other

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage		24	22	20	20	20	20
Recommended Strategies							
Voluntary Transfer from Irrigation	$11,000	24	22	20	20	20	20
TOTAL	**$11,000**	**24**	**22**	**20**	**20**	**20**	**20**

Coke County Mining

Region F has identified mining conservation, subordination and additional groundwater development as potential strategies to meet mining needs in Coke County. Most of the water used for mining purposes in Region F is for enhanced oil and gas production. According to the §27.0511 of the Texas Water Code, the oil and gas industry is required by law to use non-potable supplies whenever possible for enhanced production. For the purpose of the plan, it is assumed that mining conservation will yield approximately 34 acre-feet in 2020. It is also assumed that subordination will yield approximately 38 acre-feet in 2020. The remaining shortage can be met by additional development of the Edwards-Trinity aquifer. These strategies combined will surpass the water shortage of Coke County's Mining industry.

Potentially Feasible Water Management Strategies Considered for Coke County Mining:

- Mining Conservation (Recycling)
- Development of Additional Edwards-Trinity Aquifer Supplies

<u>Development of Additional Edwards-Trinity Aquifer Supplies</u>

This strategy assumes that five wells will need to be constructed at a 350-ft depth in order to access the additional aquifer supplies needed. The well is assumed to be operating at a capacity of 100-gpm. This strategy will cost approximately $700,000 to implement, and is estimated to yield an additional 250 acre-feet of water per year.

Table 5E- 16
Recommended Water Strategies for Coke County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		318	312	260	206	158	116
Recommended Strategies (ac-ft/yr)							
Mining Conservation/Recycling	$680,000	34	34	30	26	23	20
Additional Development of the Edwards-Trinity Aquifer Supplies	$678,000	250	250	250	250	250	250
Subordination	$0	38	36	34	32	30	28
TOTAL	**$1,358,000**	**322**	**320**	**314**	**308**	**303**	**298**

Coke County Irrigation

Irrigation shortages are approximately 200 acre-feet in 2020 in Coke County. Conservation of water will help preserve existing supplies and is recommended. The remainder of the need will be unmet due to lack of economically viable strategies. Also, it is recommended that Coke County Other purchase additional groundwater rights. This voluntary transfer of water is shown for Coke County Irrigation.

Potentially Feasible Water Management Strategies Considered for Coke County Mining:

- Irrigation Conservation

Table 5E- 17
Recommended Water Strategies for Coke County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		202	200	199	199	199	199
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$75,000	48	96	115	115	115	115
Voluntary Transfer to Coke County-Other	-$11,000	(24)	(22)	(20)	(20)	(20)	(20)
Subordination	$0	0	0	0	0	0	0
TOTAL	**$64,000**	**24**	**74**	**95**	**95**	**95**	**95**

Coke County Steam Electric Power

Coke County is shown to have a steam electric power shortage that is associated with the former power plant on Oak Creek Reservoir. This power plant has closed and is no longer using water from Oak Creek Reservoir. Due to the prolonged drought, reliable supplies from the reservoir even with subordination are severely limited and unlikely. Instead, the steam electric power need is being proposed to be met through Alternative Cooling Technologies. This strategy is discussed in detail in Chapter 5B, Section 5B.4.

Table 5E- 18
Recommended Water Management Strategies for Coke County SEP

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		247	289	339	401	477	528
Recommended Strategies (ac-ft/yr)							
Conservation (ACT)	$50,490,000	247	289	339	401	477	528
TOTAL	**$50,490,000**	**247**	**289**	**339**	**401**	**477**	**528**

Coke County Summary
After subordination of downstream water rights associated with Oak Creek Reservoir, Coke County has a total water need of less than 1,000 acre-feet per year. However, the ability to meet this need 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 likely require advanced treatment. The entities in Coke County continue to explore their options.

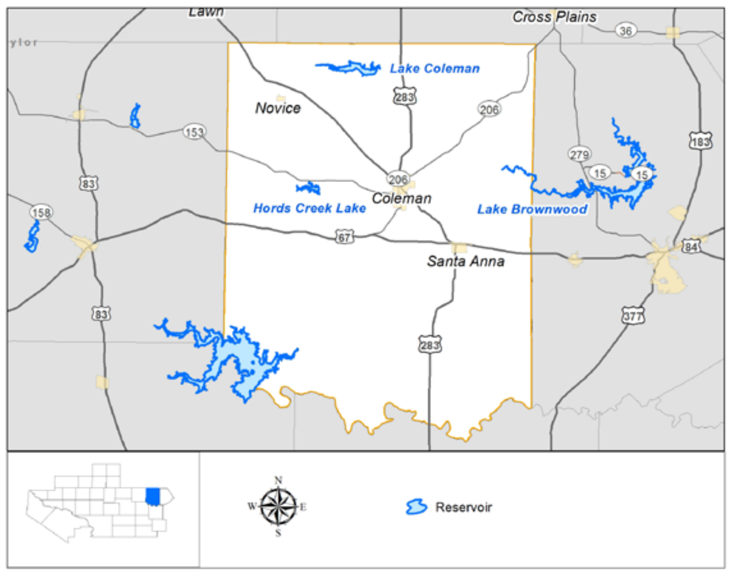
Table 5E- 19
Coke County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Bronte	Sales from Sweetwater, Other Undifferentiated Aquifer	347	Municipal Conservation, Subordination, Rehabilitation of Oak Creek Pipeline, Nolan County Groundwater
Robert Lee	CRMWD, Run-of-River, Sales from Bronte	136	Municipal Conservation, Purchase Additional Supplies from Bronte
County-Other	Edwards-Trinity Plateau Aquifer, Other Undifferentiated Aquifer	24	Voluntary Transfer from Irrigation
Irrigation	Irrigation Local Supplies, Edwards-Trinity Plateau and Other Undifferentiated Aquifer	202	Irrigation Conservation
Livestock	Stock Ponds, Edwards-Trinity Plateau Aquifer, Other Undifferentiated Aquifer	None	None
Manufacturing	----	----	----
Mining	CRMWD, Other Undifferentiated Aquifer	318	Mining Conservation/Recycling, Development of Additional Edwards-Trinity Aquifer Supplies
Steam Electric	Oak Creek Reservoir	528	Conservation (Alternative Cooling Technologies)

Table 5E- 20
Unmet Needs in Coke County
-Values are in Acre Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(176)	(124)	(102)	(102)	(102)	(102)

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 also rely on Lake Coleman and run-of-river rights. 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. Conservation and subordination however are adequate to meet all of these shortages and no additional infrastructure strategies are needed. Conservation and subordination are discussed further in Chapters 5B and 5C respectively.

Coleman County Mining

The only water user group in Coleman County with a water shortage is mining. The current source of water for this use is groundwater from Other aquifer. However, this source is fully utilized in the county. Region F has identified mining conservation and additional groundwater development from the Hickory aquifer as potential strategies to meet mining needs in Coleman County. There may be other non-potable supplies, either brackish groundwater or reuse, that could be used by mining. For the purpose of the plan, it is assumed that mining conservation will yield approximately 8 acre-feet in 2020. The remaining shortage can be met by additional development of the Hickory aquifer.

Potentially Feasible Water Management Strategies Considered for Coleman County Mining:

- Mining Conservation/Recycling
- Development of Additional Hickory Aquifer Supplies

Development of Additional Hickory Aquifer Supplies

This strategy assumes that one well will need to be constructed at a 2,000-ft depth in order to access the additional aquifer supplies needed. The well is assumed to be operating at a capacity of 300-gpm. This strategy will cost approximately $814,000 to implement, and is estimated to yield an additional 65 acre-feet of water per year.

Table 5E- 21
Recommended Strategies for Coleman County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		62	61	51	40	31	23
Recommended Strategies (ac-ft/yr)							
Mining Conservation/Recycling	$160,000	8	7	7	6	5	5
Additional Hickory Aquifer	$814,000	65	65	65	65	65	65
TOTAL	**$974,000**	**73**	**72**	**72**	**71**	**70**	**70**

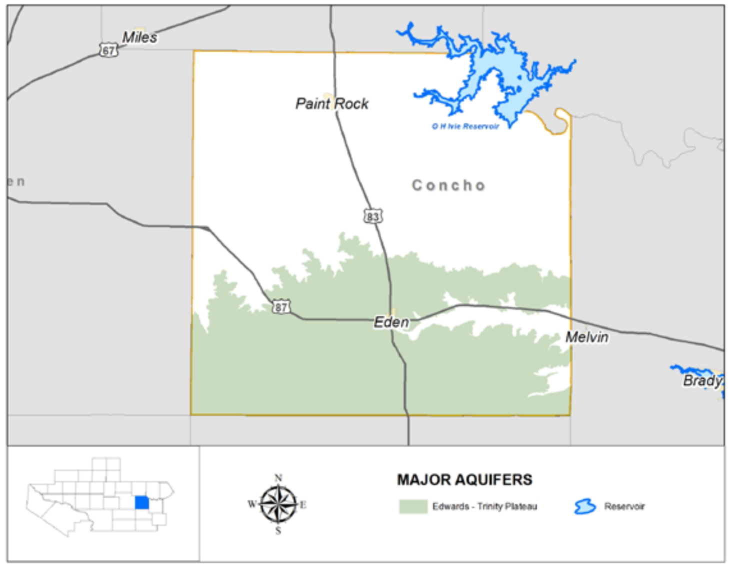
Coleman County Summary

After subordination of downstream water rights, Coleman County has a total water need of less than 100 acre-feet per year, which is all associated with mining use. This need can be met through the recommended strategies. In addition, conservation is recommended for irrigation and the City of Coleman.

Table 5E- 22
Coleman County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Brookesmith SUD	See Brown County		
Coleman	Lake Coleman, Hords Creek, Sales from BCWID #1 though Brookesmith SUD	1,052	Municipal Conservation, Subordination
Coleman County SUD	See Brown County		
Santa Anna	See Brown County		
County-Other	Sales from Coleman	None	None
Irrigation	Run-of-River, Lake Coleman	743	Irrigation Conservation, Subordination
Livestock	Livestock Local Supplies, Other Aquifer	None	None
Manufacturing	Sales from Coleman	None	None
Mining	Other Aquifer	62	Mining Conservation/Recycling, Development of Hickory Supplies
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. The City of Eden is pursuing a direct non-potable reuse supply for outdoor irrigation of golf courses and public parks. Irrigation and mining are the only water users with a shortage. Conservation is recommended for both users and is discussed further in Chapter 5B. The remaining shortage is an unmet need. Millersview-Doole WSC is split between Concho and McCulloch Counties. Further discussion on Millersview-Doole is discussed under McCulloch County.

Eden

Current supplies for Eden result in no water supply shortage. However, municipal conservation was still considered as a way to preserve and extend water supplies. To address water quality issues, the City of Eden recently constructed a radium removal system that implements water remediation technology. This system is currently operational. The City of Eden is also considering a small direct non-potable reuse project to provide irrigation water for golf courses and public parks.

Potentially Feasible Water Management Strategies Considered for Eden:

- Municipal Conservation
- Direct Non-potable reuse

Direct Non-potable Reuse

For the purposes of this plan, it was assumed that minor improvements would need to be made at the wastewater treatment facility as well as additional piping to transport the water from the plant to the golf courses and public parks. This strategy is estimated to yield 50 acre-feet per year and cost approximately $485,700.

Table 5E- 23
Recommended Water Strategies for Eden

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (a-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	16	16	16	16	16	16
Reuse	$485,700	50	50	50	50	50	50
TOTAL	**$485,700**	**66**	**66**	**66**	**66**	**66**	**66**

Concho County Mining
The Concho County Mining water needs can be met through mining conservation/recycling and development of Hickory aquifer supplies.

Potentially Feasible Water Management Strategies Considered for Concho County Mining:
- Mining Conservation/Recycling
- Development of Hickory Aquifer Supplies

Development of Hickory Aquifer Supplies
This strategy assumes that two wells will need to be constructed at a 2,000-ft depth in order to access the additional aquifer supplies needed. The wells are assumed to be operating at a capacity of 300-gpm each. This strategy will cost approximately $1.6 million to implement, and is estimated to yield an additional 200 acre-feet of water per year.

Table 5E- 24
Recommended Water Strategies for Concho County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		212	206	154	99	52	11
Recommended Strategies (ac-ft/yr)							
Mining Conservation/Recycling	$680,000	34	33	30	26	22	20
Development of Hickory Aquifer	$1,626,000	200	200	200	200	200	200
TOTAL	**$2,306,000**	**234**	**233**	**230**	**226**	**222**	**220**

Concho County Summary
The total shortage for Concho County is projected to be approximately 5,500 acre-feet in 2020. The entire shortage is associated with irrigation and mining demands. Some of this need is met through conservation which is discussed in detail in Chapter 5B. Beyond conservation, the remaining water need for Concho County Mining can be met through the development of the Hickory aquifer supplies. However, the remaining 4,762 acre-feet of shortage for irrigation will remain unmet due to a lack of viable options.

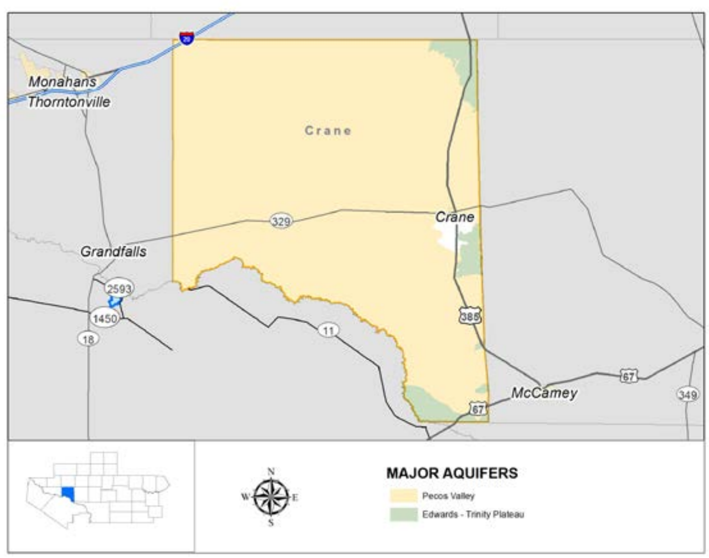
Table 5E- 25
Concho County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
County-Other	Edwards-Trinity Plateau and Other Aquifers, Run-of-River	None	None
Eden	Hickory and Other Aquifers	None	Municipal Conservation Direct Non-potable Reuse
Millersview-Doole WSC	See McCulloch County		
Irrigation	Run-of-River, Lipan and Other Aquifers	5,249	Irrigation Conservation
Livestock	Livestock Local Supplies, Edwards-Trinity Plateau and Other Aquifers	None	None
Manufacturing	----	----	----
Mining	Other Aquifer	212	Mining Conservation/Recycling Development of Hickory Aquifer Supplies
Steam Electric	----	----	----

Table 5E- 26
Unmet Needs in Concho County
-Values are in acre-feet per year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(4,762)	(4,239)	(4,107)	(4,071)	(4,035)	(3,999)

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 Pecos Valley-Edwards-Trinity Plateau aquifers. Much of the supply from these sources is nearly fully developed for current use under the current MAGs. The largest water demand in Crane County is affiliated with the City of Crane and the surrounding rural communities known as County-Other. Crane County-Other has less than 1,500 in population including individuals living outside of a named water user group. This compilation of users has no identified water shortages. The City of Crane and County-Other currently obtain water from the Pecos Valley and Pecos Valley-Edwards-Trinity Plateau aquifers. Municipal conservation and mining recycling were identified as viable means of preserving existing supplies and are recommended strategies. These strategies will meet the current needs within Crane County and are discussed in more detail in Chapter 5B. No other shortages were identified.

Table 5E- 27
Crane County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Crane	Pecos Valley Edwards-Trinity Plateau, Reuse	None	Municipal Conservation
County-Other	City of Crane	None	None
Irrigation	----	----	----
Livestock	Pecos Valley Edwards-Trinity Plateau, Stock Ponds	None	None
Manufacturing	----	----	----
Mining	Pecos Valley Edwards-Trinity Plateau Aquifer	None	Mining Conservation/Recycling
Steam Electric	----	----	----

5E.8 Crockett County

Almost all of the current water supply in Crockett County is derived from the Edwards-Trinity Plateau aquifer. The only shortages in Crockett County are associated with mining and steam electric power. Crockett County WCID #1 is planning to begin selling about 75 acre-feet of treated wastewater effluent to the oil and gas industry (mining). However, this alone will not be enough to meet the identified shortage for mining and the remainder will be an unmet need. The steam electric power demands in Crockett County are speculative as no power plant currently operates there.

Crockett County WCID #1
Current supplies for Crockett County WCID #1 result in no water supply need. However, municipal conservation was still considered as a way to preserve and extend their water supply. The district will also

begin selling approximately 75 acre-feet of treated wastewater effluent to the mining industry. It is assumed that no wastewater treatment plant improvements will be required to meet Type II reuse standards and therefore will impose no capital investment or additional annual costs on Crockett County WCID #1.

Crockett County Mining
Much of the mining demand in West Texas is cyclical and fluctuates based on the oil market. Therefore, there is significant uncertainty surrounding the magnitude of the shortages and the means in which these shortages may be met. It is assumed that the mining industry will develop supply as the need arises but specific strategies beyond those already known were not developed. In the case of Crockett County, it is known that Crockett County WCID #1 has plans to begin selling a portion of their effluent to mining which will meet a portion of the shortage shown in this plan. Mining conservation/recycling will meet some of the remaining shortage, but about 1,000 acre-feet of shortage will be left unmet in the near term for planning purposes.

Potentially Feasible Water Management Strategies Considered for Crockett County Mining:

- Mining Conservation (Recycling)
- Reuse sales from Crockett County WCID #1

<u>Reuse sales from Crockett County WCID #1</u>
Crockett County WCID #1 plans to sell about 75 acre-feet per year of treated wastewater effluent to the oil and gas industry. For planning purposes it was assumed that the mining industry would not invest capital in permanent infrastructure such as a pipeline. Instead it was assumed that the purchaser would transport the water via truck from the wastewater plant to the specific well field. While this would incur some annual costs for the mining operator, it is difficult to develop a meaningful cost estimate because of the uncertainty regarding the way in which this strategy would actually be implemented. It is assumed the mining operator will incur all of the annual costs.

Table 5E- 28
Recommended Water Management Strategies for Crockett County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		1,182	1,293	711	132	0	0
Recommended Strategies (ac-ft/yr)							
Mining Conservation/Recycling	$2,580,000	121	129	88	48	14	4
Reuse sales from Crockett County WCID #1	$0	75	75	75	75	75	75
TOTAL	**$2,580,000**	**196**	**204**	**163**	**123**	**89**	**79**

Crockett County Steam Electric Power

The steam electric power demands in Crockett are associated with the American Electric Power (AEP) Rio Pecos Plant. This plant has been retired and is no longer operating. Thus, no supply was allocated to this use. If this plant were to come back online, groundwater supplies that were used for cooling for this facility would be sufficient to meet the projected demands.

Table 5E- 29
Recommended Water Strategies for Crockett County Steam Electric Power

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		776	907	1,067	1,262	1,500	1,662
Recommended Strategies (ac-ft/yr)							
Edwards-Trinity Aquifer	$0	776	907	1,067	1,262	1,500	1,662

Crockett County Irrigation

Although Crockett County Irrigation shows no shortage, both conservation and weather modification are recommended strategies. Crockett County lies in the WTWMA program area, where precipitation enhancement is currently active.

Potentially Feasible Water Management Strategies Considered for Crockett County Irrigation:

- Irrigation Conservation
- Weather Modification

<u>Weather Modification</u>

The WTWMA attributes an annual increase of 1.19 inches of precipitation over Crockett County due to their weather modification efforts in 2014. 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 153 irrigated acres in Crockett County, implementation of this strategy is expected to save 9 acre-feet of water per year at a unit cost of $0.69 per acre-foot.

Table 5E- 30
Recommended Water Strategies for Crockett County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$45,000	24	47	69	69	69	69
Weather Modification	$0	9	9	9	9	9	9
TOTAL	**$45,000**	**33**	**56**	**78**	**78**	**78**	**78**

Crockett County Summary

The shortages in Crockett County are associated with irrigation and mining and much of the shortage remains unmet. All other water user groups in Crockett County show adequate supplies to meet their needs throughout the planning period.

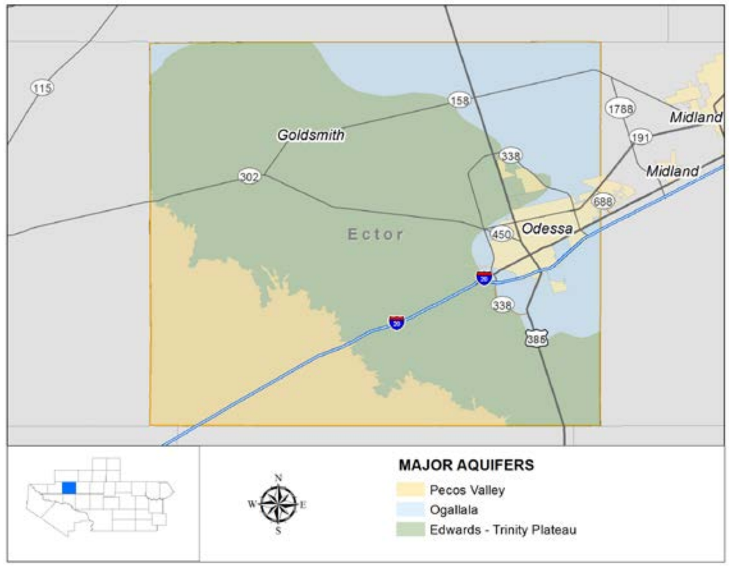
Table 5E- 31
Crockett County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Crockett County WCID #1	Edwards-Trinity Plateau Aquifer	None	Municipal Conservation
County-Other	Edwards-Trinity Plateau Aquifer	None	None
Irrigation	Edwards-Trinity Plateau Aquifer	None	Irrigation Conservation Weather Modification
Livestock	Edwards-Trinity Plateau Aquifer	None	None
Manufacturing	----	----	----
Mining	Edwards-Trinity Plateau Aquifer	1,293	Mining Conservation/Recycling Reuse sales from Crockett County WCID #1
Steam Electric	None	1,662	Edwards-Trinity Plateau Aquifer

Table 5E- 32
Unmet Needs in Crockett County
-Values are in Acre Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Mining	(986)	(1,089)	(548)	(9)	None	None

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 wholesale 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, the Ogallala, the Pecos Valley and the Dockum. Shortages in Ector County mostly stem from growth in Ector County-Other and from steam electric power generating needs. The remaining water users all show no shortages after subordination.

Ector County UD

The Ector County Utility District (UD) receives all of its supplies from the City of Odessa. The needs of Ector County UD were planned for under the Odessa as a wholesale provider in Chapter 5D. A portion of the supply from any of Odessa's water management strategies will help meet any potential future needs of Ector County UD.

Ector County Other

Ector County-Other currently receives supply from the City of Odessa, the Edwards-Trinity Plateau and Ogallala aquifers in Ector County. The City of Goldsmith (part of Ector County-Other) currently receives water from Great Plains from the Ogallala aquifer in Andrews County. The supply from Great Plains is not fully represented due to MAG limitations that do not allow for the actual amount of production from this source to be shown as a current supply. It is likely that Great Plains will continue to provide water at its current levels and no shortage will occur. However, if Great Plains were unable to provide adequate water, Goldsmith could purchase additional water supply from Odessa. The remainder of the shortage for County-Other could also be provided through the purchase of additional supplies from Odessa.

Potentially Feasible Water Management Strategies Considered for Ector County Other:

- Purchase additional water from City of Odessa

Purchase additional supply from City of Odessa

Ector County-Other currently receives water supply from the City of Odessa, and if needed, could purchase more in order to compensate for any shortage. This strategy requires no additional infrastructure and thus has no capital cost associated with it.

Table 5E- 33
Recommended Water Management Strategies for Ector County-Other

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	221	520	809
Recommended Strategies (ac-ft/yr)							
Purchase additional supply from Odessa	$0	0	0	0	221	520	809

Ector County Steam Electric Power

Steam electric power demands in Ector County are currently met through sales of treated effluent from the City of Odessa and groundwater from Great Plains well fields in Andrews and Gaines counties. Odessa and Great Plains are considered wholesale water providers and are discussed in Chapter 5D. Andrews County has limited groundwater availability and the Modeled Available Groundwater (MAG) does not support the amount of water that is currently being produced there. Therefore, a portion of the shortage in this plan is somewhat artificial since it does not represent the actual current production amounts from Andrews County. This accounts for between 1,000 and 1,500 acre-feet of the overall shortage throughout the planning period. The remainder of the shortage is associated with large speculative steam electric power demands. A proposed plant requiring 4.2 MGD of peak supply is considering locating in Ector County. The remainder of the demand is highly uncertain.

For purposes of this plan, approximately 4,000 acre-feet per year of new supply for steam electric power would be provided through the City of Odessa. This amount would provide for the current and planned facilities. The remaining demands would be associated with new facilities, and is proposed to be met through Alternative Cooling Technology. This strategy is discussed in detail in Chapter 5B, Section 5B.4.

Table 5E- 34
Recommended Water Strategies for Ector County Steam Electric Power

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		7,286	8,263	10,165	12,604	15,597	19,033
Recommended Strategies (ac-ft/yr)							
Sales from City of Odessa (CRMWD Supplies)	$0	4,000	4,000	4,000	4,000	4,000	4,000
Conservation (ACT)	$224,360,000	3,286	4,263	6,165	8,604	11,597	15,033
TOTAL	**$224,360,000**	**7,286**	**8,263**	**10,165**	**12,604**	**15,597**	**19,033**

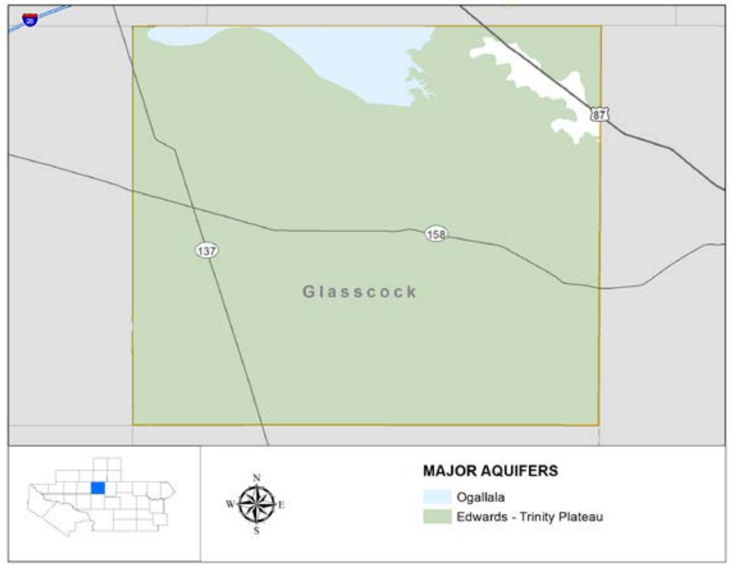
Ector County Summary

Ector County has a total projected shortage of over 19,800 acre-feet per year after subordination. All but about 800 acre-feet per year is associated with prospective steam electric demands that may or may not be located in Ector County. Of the demands that can be justifiably assigned to Ector County, all of these needs can be met through available supplies. This includes existing groundwater sources, Odessa reuse, CRMWD supplies and potential future supplies developed by CRMWD.

Table 5E- 35
Ector County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Ector County UD	Sales from Odessa	Included in Odessa	Municipal Conservation See Odessa
Greater Gardendale WSC	Edwards-Trinity Plateau Aquifer	None	Municipal Conservation
Odessa	See Wholesale Water Provider Section		
County-Other	Edwards-Trinity Plateau Aquifer, Ogallala Aquifer, sales from Odessa, sales from Great Plains (Ogallala Aquifer - Andrews Co.)	809	Purchase additional supply from Odessa
Irrigation	Edwards-Trinity Plateau, Ogallala Aquifer, sales from CRMWD, reuse sales from Odessa	None	Irrigation Conservation
Livestock	Livestock Local Supplies and Dockum, Ogallala, Pecos Valley, and Edwards-Trinity Plateau	None	None
Manufacturing	Reuse and Treated Water sales from Odessa, sales from Great Plains (Ogallala Aquifer – Andrews Co.), and Edwards-Trinity Plateau, Pecos Valley and Dockum Aquifers	None	None
Mining	Reuse sales from Odessa, sales from Great Plains (Ogallala Aquifer – Andrews Co.), Edwards-Trinity Plateau, Dockum	None	Mining Conservation/Recycling
Steam Electric	Sales from Great Plains (Gaines and Andrews Co.), Reuse sales from Odessa	19,033	Sales from City of Odessa SEP Conservation

5E.10 Glasscock County

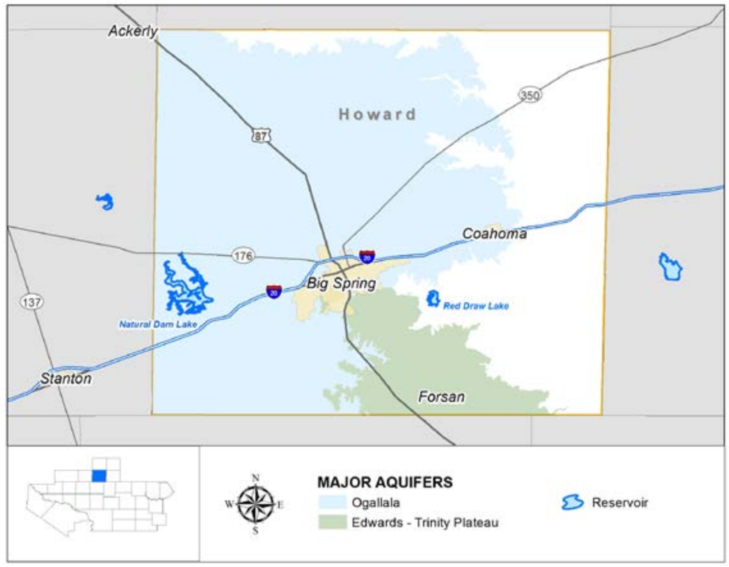


Glasscock County has limited surface water and groundwater supplies. Some local surface water is used by livestock, but the majority of water within Glasscock County is supplied from the Ogallala and Edwards-Trinity Plateau aquifers. Much of the supply from these sources is nearly fully developed for current use. The largest water demand in Glasscock County is for irrigation purposes, at approximately 56,707 acre-feet in 2020 from the Edwards-Trinity Plateau aquifer. Mining use is approximately 3,423 acre-feet in 2020, making it the second largest water user group. Irrigation conservation and mining recycling were identified as viable means of preserving existing supplies and are recommended strategies. These strategies will meet the current needs within Glasscock County and are discussed in more detail in Chapter 5B. Municipal conservation was not recommended for Glasscock County-Other because their per capita use was below 140 gpcd. No shortages were identified within Glasscock County.

Table 5E- 36
Glasscock County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
County-Other	Edwards-Trinity Plateau Aquifer, Ogallala Aquifer	None	None
Irrigation	Edwards-Trinity Plateau Aquifer, Ogallala Aquifer	None	Irrigation Conservation
Livestock	Stock Ponds, Edwards-Trinity Plateau Aquifer, Ogallala Aquifer	None	None
Manufacturing	----	----	----
Mining	Edwards-Trinity Plateau Aquifer	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 consequently, Coahoma, and a portion of County-Other and manufacturing. The shortages for these users can be met through conservation and subordination of CRMWD's supplies. Other water users in the county are reliant on groundwater from the Ogallala and Edwards-Trinity Plateau aquifers. The amount of supply available from these aquifers is almost entirely developed for current use. As a result, the identified shortages in Howard County may not be able to be met through additional groundwater development of these aquifers. The Dockum aquifer is also used some for irrigators, livestock, and mining. 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. The self-supplied portions of Howard County-Other and manufacturing are also shown to have shortages over the planning horizon. These shortages are proposed to be met through additional purchase of supplies from the City of Big Spring (CRMWD sources). Mining may be able to purchase additional brackish supplies from CRMWD's diverted water system. The remaining mining shortage can be met with additional development of the Ogallala aquifer supplies. The remaining shortage associated with irrigation after conservation is unmet.

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, and some manufacturing operations in Howard County. The City plans to begin supplying additional water to manufacturing and Howard County-Other by 2020. 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 12 MGD water treatment plant by 2020. This water treatment plant is necessary to make the raw water supplies provided by CRMWD potable and fit for municipal use. The recommended strategies for Big Spring include municipal conservation, obtaining the contracted supplies from CRMWD and a 5.5 MGD water treatment plant expansion of their existing 12 MGD facility in 2020. The supplies shown in Table 5E-37 represent the amount of supplies Big Spring will receive from CRMWD to meet their need only. Additional supplies needed from CRMWD to meet the needs of Big Spring's customers are shown in this section in each respective entity's table.

Table 5E- 37
Recommended Water Management Strategies for Big Spring

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage		3,677	2,191	2,682	3,117	3,524	3,885
Recommended Strategies							
Municipal Conservation	$0	181	191	193	193	193	193
*WTP Expansion (5.5 MGD)**	*$16,930,000*	*3,000*	*2,190*	*2,682*	*3,000*	*3,000*	*3,000*
Subordination (CRMWD Supplies)	$0	3,677	2,190	2,682	3,115	3,523	3,885
CRMWD Strategies	see CRMWD	186	206	228	252	277	302
TOTAL	**$16,930,000**	**4,044**	**2,587**	**3,103**	**3,560**	**3,993**	**4,380**

**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 the maximum capacity of the treatment facility or the supply available from the subordination strategy.*

Howard County-Other

It is recommended that the shortage for Howard County-Other be met through the purchase of additional supply from the City of Big Spring (CRMWD sources) starting in 2020. This strategy assumes that an additional 2 miles of 8-inch pipeline and one small pump station will be needed to facilitate this sale. The capital cost is estimated at $1.8 million dollars. Conservation was not recommended for Howard County-Other since their per capita use was not above the 140 gpcd goal.

Table 5E- 38
Recommended Water Management Strategies for Howard County-Other
-Values are in Acre Feet per Year-

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage		449	485	480	478	475	475
Recommended Strategies							
Purchase from Big Spring	$1,833,000	449	485	480	478	475	475

Howard County Livestock

At current supply levels, Howard County livestock shows a projected shortage of almost 130 acre-feet per year. It is recommended that this shortage be met through an additional ten wells in the Dockum aquifer.

Table 5E- 39
Recommended Water Management Strategies for Howard County Livestock

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		114	129	129	129	129	129
Recommended Strategies (ac-ft/yr)							
Develop Dockum Aquifer Supplies	$512,000	150	150	150	150	150	150

Howard County Manufacturing
To meet the projected shortages for manufacturing in Howard County, it is recommended that additional supply be purchased from the City of Big Spring (CRMWD sources) starting in 2020 and increasing as necessary. There is no infrastructure required for this strategy so the implementation cost is zero.

Table 5E- 40
Recommended Water Management Strategies for Howard County Manufacturing

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		614	773	895	998	1,191	1,396
Recommended Strategies (ac-ft/yr)							
Purchase from Big Spring	$0	614	773	895	998	1,191	1,396

Howard County Mining
Mining in Howard County is currently partially supplied by brackish water from CRMWD's diverted water system. Without subordination, this source has zero supply. Subordination of this source is a recommended strategy for Howard County Mining. CRMWD is considering a strategy to desalinate a portion of the diverted water system yield for potable use. However, there is a small additional amount that would still be available for sales to mining operators in the county. It is recommended that mining purchase this remaining additional amount as needed. There is also a small amount of groundwater available from the Dockum and Ogallala aquifer. Employing all of these strategies will leave mining with an unmet need from 2020 to 2040.

Potentially Feasible Water Management Strategies Considered for Howard County Mining:
- Subordination of CRMWD's Diverted Water System (Current Purchase Level)
- Purchase of Additional Brackish Water from CRMWD's Diverted Water System
- Additional groundwater from Ogallala Aquifer
- Additional groundwater from Dockum Aquifer

Purchase of Additional Brackish Water from CRMWD's Diverted Water System

As mentioned above, CRMWD is considering a strategy to desalinate a portion of the diverted water system yield and will have a small amount available for sale to mining operators in the county. There is no capital cost associated with this strategy, and up to 242 acre-feet per year is available.

Development of Additional Groundwater from the Ogallala Aquifer

This strategy assumes that one well will need to be constructed at a 300-ft depth in order to access the additional aquifer supplies needed. The well is assumed to be operating at a capacity of 100-gpm. This strategy will cost approximately $127,000 to implement, and is estimated to yield an additional 31 acre-feet of water. The yield of this strategy is limited by the MAG of the Ogallala aquifer in Howard County. Public health and safety is considered paramount in this plan, so the municipal needs of the aquifer took precedence over mining, leaving only the amount unallocated as shown in Table 5E- 41. This strategy is considered recommended, regardless of low yield, because in actuality water used for the oil and gas industry is exempt from GCD regulation. Therefore, this is still a viable strategy since operators may exceed the MAG availability.

Development of Additional Groundwater from Dockum Aquifer

This strategy assumes that six wells will need to be constructed at a 550-ft depth in order to access the additional aquifer supplies needed. The wells are assumed to be operating at a capacity of 100-gpm. This strategy will cost approximately $1 million to implement, and is estimated to yield an additional 274 acre-feet of water.

Table 5E- 41
Recommended Water Management Strategies for Howard County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		2,328	2,591	1,784	982	320	43
Recommended Strategies (ac-ft/yr)							
Subordination of CRMWD's Diverted Water System (Current Purchase Level)	$0	1,000	1,000	1,000	982	320	43
Purchase Additional Brackish Water from CRMWD's Diverted Water System	$0	238	240	242	0	0	0
Additional GW from Ogallala	$127,000	20	31	31	31	3	3
Additional GW from Dockum	$989,000	274	274	274	274	274	274
TOTAL	**$1,116,000**	**1,532**	**1,545**	**1,547**	**1,287**	**597**	**320**

Howard County Summary

Howard County has little high quality groundwater available for development. As such, much of the shortages in the county are proposed to be met through the sales from the City of Big Spring (CRMWD sources). For this supply to be fully utilized, the Big Spring water treatment plant will need to be expanded in 2020. Irrigation and mining have unmet needs remaining due to a lack of viable options.

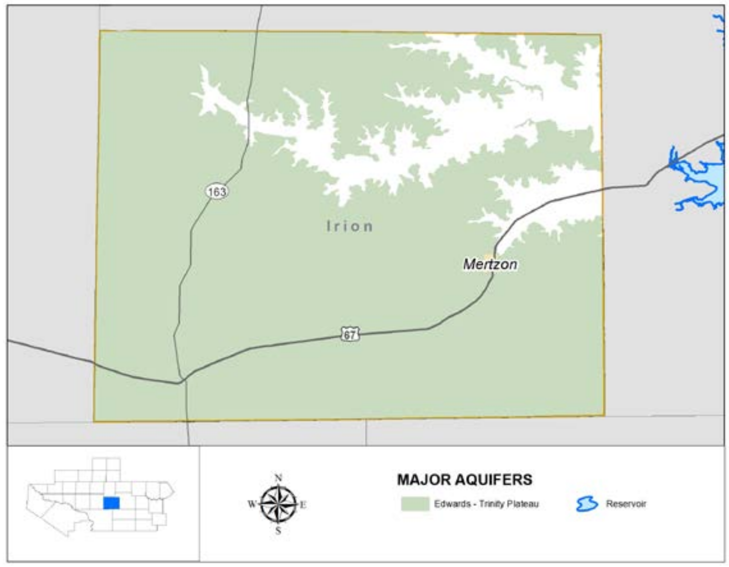
Table 5E- 42
Howard County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Big Spring	Sales from CRMWD	3,885	Municipal Conservation Subordination of CRMWD supplies WTP Expansion (5.5 MGD)
Coahoma	Sales from Big Spring	None	Municipal Conservation Obtain contractual supplies from Big Spring
County-Other	Ogallala, Dockum, and Edwards-Trinity Plateau Aquifers	485	Purchase from Big Spring
Irrigation	Ogallala, Dockum, and Edwards-Trinity Plateau Aquifers	3,415	Irrigation Conservation
Livestock	Livestock Local Supplies, Ogallala and Dockum Aquifers	129	Develop Dockum Aquifer Supplies
Manufacturing	Sales from Big Spring, Ogallala and Edwards-Trinity Plateau Aquifers	1,396	Purchase from Big Spring
Mining	Brackish sales from CRMWD, Ogallala and Dockum Aquifers	2,591	CRMWD's Diverted Water System, Develop Additional Groundwater from Dockum and Ogallala Aquifers
Steam Electric	----	----	----

Table 5E- 43
Unmet Needs in Howard County
-Values are in Acre Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(2,897)	(2,751)	(2,615)	(2,538)	(2,461)	(2,385)
Mining	(796)	(1,046)	(237)	0	0	0

5E.12 Irion County



The majority of the water supply for Irion County is derived from the Edwards-Trinity Plateau and Other Undifferentiated aquifers. Irrigators also have a small run-of-river supply. Current sources of supply are shown to be adequate for all users except irrigation and mining.

Irion County Mining

Mining demands in Irion County have historically been met through the use of groundwater. However, the sharp increase in demands in early decades requires the development of additional groundwater supplies. The available groundwater in Irion County is inadequate to meet the entire demand in early decades. The mining industry is actively pursuing recycling technologies to help meet its needs. This is a recommended strategy and 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.

Potentially Feasible Water Management Strategies Considered for Irion County Mining:

- Mining Conservation/Recycling
- Develop additional groundwater supply from Edwards-Trinity Plateau Aquifer
- Develop additional groundwater supply from Dockum Aquifer

<u>Develop additional groundwater from the Edwards-Trinity Plateau Aquifer</u>

This strategy assumes that 32 wells will need to be constructed at a 350-ft depth in order to access the additional aquifer supplies needed. The wells are assumed to be operating at a capacity of 20-gpm. This strategy will cost approximately $2.06 million to implement, and is estimated to yield an additional 500 acre-feet of water per year.

<u>Develop additional groundwater from the Dockum Aquifer</u>

This strategy assumes that 10 wells will need to be constructed at a 550-ft depth in order to access the additional aquifer supplies needed. The wells are assumed to be operating at a capacity of 20-gpm. This strategy will cost approximately $780,000 and is estimated to yield an additional 150 acre-feet of water per year.

Table 5E- 44
Recommended Water Management Strategies for Irion County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		1,819	1,984	1,050	114	0	0
Recommended Strategies (ac-ft/yr)							
Mining Conservation/Recycling	$4,700,000	223	235	170	104	50	24
Develop Additional GW from Edwards-Trinity Plateau	$2,057,000	500	500	500	100	0	0
Develop Additional GW from Dockum	$782,000	150	150	150	50	0	0
TOTAL	**$7,539,000**	**873**	**885**	**820**	**254**	**50**	**24**

Irion County Irrigation
Irion County Irrigation has an unmet need. This need can be alleviated by conservation and weather modification strategies. Irion County lies within the WTWMA 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 WTWMA attributes an annual increase of 2.74 inches over Irion County due to their weather modification efforts in 2014. 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 829 irrigated acres in Irion County, implementation of this strategy is expected to save 110 acre-feet of water per year at a unit cost of $0.30 per acre-feet.

Table 5E- 45
Recommended Water Strategies for Irion County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		359	359	359	359	359	359
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$137,000	73	144	210	210	210	210
Weather Modification	$0	110	110	110	110	110	110
TOTAL	**$137,000**	**184**	**254**	**321**	**321**	**321**	**321**

Irion County Summary

The total need for Irion County is associated with the mining and irrigation industry. In the early decades, the mining need is nearly 2,000 acre-feet. By 2040, the demand and the projected shortage drop significantly. A portion of this shortage is met through the development of additional groundwater supplies from the Edwards-Trinity Plateau and Dockum aquifers. However, due to availability limitations in these aquifers in Irion County, there will be an unmet need of about 1,000 acre-feet in 2020 and 2030 for the mining industry. There will be an unmet need in irrigation as well, even after conservation measures, due to a lack of viable alternatives.

Table 5E- 46
Irion County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Mertzon	Edwards-Trinity Plateau Aquifer	None	Municipal Conservation
County-Other	Edwards-Trinity Plateau Aquifer	None	None
Irrigation	Other Aquifer, Run-of-River	359	Irrigation Conservation Weather Modification
Livestock	Stock Ponds, Other Aquifer, Edwards-Trinity Plateau Aquifer	None	None
Manufacturing	----	----	----
Mining	Edwards-Trinity Plateau Aquifer	1,984	Mining Conservation/Recycling Develop additional GW from Edwards-Trinity Develop GW from Dockum
Steam Electric	----	----	----

Table 5E- 47
Unmet Needs in Irion County
-Values are in Acre Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(175)	(105)	(38)	(38)	(38)	(38)
Mining	(946)	(1,099)	(230)	0	0	0

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 due to the ongoing drought. Much 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. Manufacturing shortages are mainly due to artificially inflated demands caused by the difference in diversion rates and actual consumptive use. The City of Junction also has a municipal shortage due to limited supplies from their run-of-river right.

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 ongoing 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.

Potentially Feasible Water Management Strategies Considered for Junction:

- Municipal Conservation
- Subordination of downstream water rights
- Dredge river intake
- Develop of Edwards-Trinity Plateau Aquifer Supplies

<u>Dredge River Intake</u>

The City is considering dredging their river intake 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 $4.3 million dollars assuming the dredged material is relatively clean and a suitable location for disposal of the waste material can be found nearby.

Develop of 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 nine new wells would be drilled to provide approximately 220 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 $3.6 million. Costs for advanced treatment are not included.

Table 5E- 48
Recommended Water Strategies for Junction

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		640	632	622	617	616	616
Recommended Strategies(ac-ft/yr)							
Municipal Conservation	$0	14	15	15	15	15	15
Water Audit and Leak Repairs	$1,891,700	31	31	31	30	30	30
Subordination	$0	412	412	412	412	412	412
Dredge River Intake*	$4,268,000	*412*	*412*	*412*	*412*	*412*	*412*
Develop Edwards-Trinity (Plateau) Aquifer Supplies	$3,555,000	216	220	220	220	220	220
TOTAL	**$9,714,700**	**673**	**678**	**678**	**677**	**677**	**677**

**This strategy is for infrastructure required to access the subordination supplies and is not included in the total to avoid double counting.*

Kimble County Manufacturing

Manufacturing demand in Kimble County is dominated by Grayden Cedarworks. The cedar process plant currently diverts around 600 acre-feet per year but can only consume 50 acre-feet per year. The remainder of the diversions must be returned to the streams for downstream water-right holders. This difference in diversions and consumptive use artificially inflates the manufacturing demands in Kimble County. Thus, strategies were only developed to meet the consumptive shortage for Grayden Cedarworks and other manufacturers in Kimble County. This amounts to about 300 acre-feet of shortage throughout the planning period. The remainder of the need (400 to 700 acre-feet per year) will be unmet since the demand is artificial.

Potentially Feasible Water Management Strategies Considered for Kimble County Manufacturing:

- Develop new groundwater from the Edwards-Trinity Plateau Aquifer

<u>Develop Edwards-Trinity Plateau Aquifer Supplies</u>

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 to meet manufacturing water needs. This strategy assumes that five new wells would be drilled to provide approximately 300 acre-feet per year. The capital costs for this strategy are estimated to be $305,000.

Table 5E- 49
Recommended Water Management Strategies for Kimble County Manufacturing

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		699	750	802	850	914	983
Recommended Strategies (ac-ft/yr)							
Develop Edwards-Trinity Plateau	$305,000	300	300	300	300	300	300

Kimble County Summary

Kimble County has a projected need of just over 2,400 acre-feet per year after subordination of downstream water rights. Irrigation and manufacturing account for most of this need, with the City of Junction showing a projected need of 228 acre-feet per year. All of Junction's needs can be met through conservation and new groundwater, but manufacturing and irrigation will continue to show a shortage after strategies are implemented. Most of the unmet need for manufacturing is a paper shortage associated with the methodologies used to develop demands and the supplies. The consumptive use for manufacturing can be met through new groundwater.

Table 5E- 50
Kimble County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Junction	Run-of-River	640	Municipal Conservation, Subordination, Develop Edwards-Trinity Aquifer, Dredging
County-Other	Edwards-Trinity Plateau	None	None
Irrigation	Edwards-Trinity Plateau Aquifer, Run-of-River	1,496	Irrigation Conservation
Livestock	Edwards-Trinity Plateau, Livestock Local Supplies	None	None
Manufacturing	Run-of-River, Edwards-Trinity Plateau Aquifer	300*	Develop Additional Edwards Trinity Plateau Aquifer Supplies
Mining	Edwards-Trinity Plateau Aquifer, Run-of-River	None	Mining Conservation/Recycling
Steam Electric	----	----	----

*This is the consumptive use need. Recirculating water use need is 983 acre-feet per year. Most of this is met through surface water.

Table 5E- 51
Unmet Needs in Kimble County
-Values are in Acre Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(1,349)	(1,104)	(949)	(837)	(732)	(631)
Manufacturing	(409)	(460)	(512)	(560)	(624)	(693)

5E.14 Loving County

Loving County has no identified water shortages. The only recommended strategy in Loving County is conservation/recycling for mining as a way to responsibly conserve water for future or other uses. It is discussed in detail in Chapter 5B.

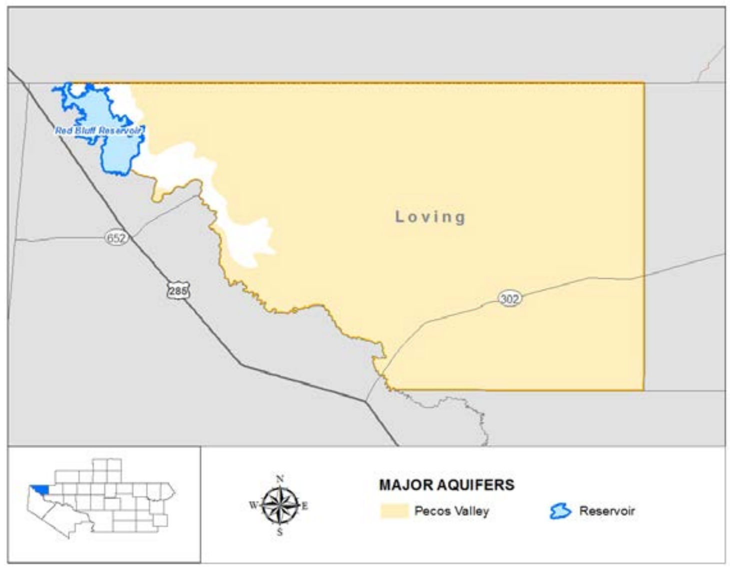
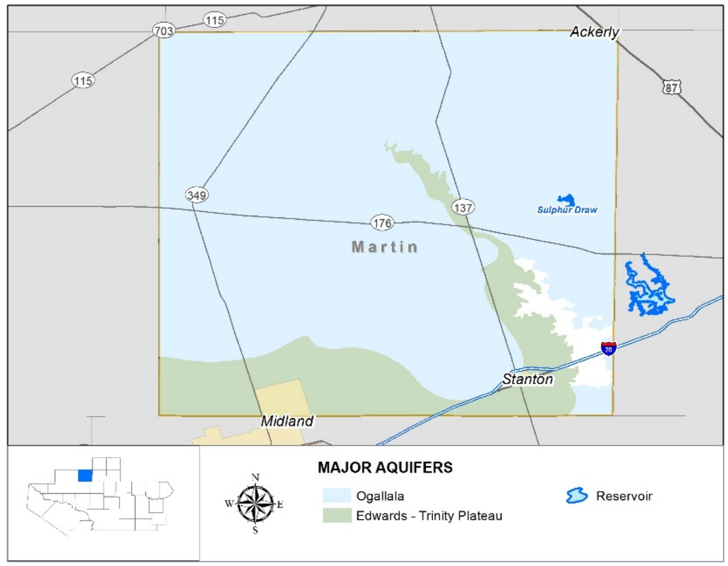


Table 5E- 52
Loving County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
County-Other	Pecos Valley Aquifer	None	None
Irrigation	----	----	----
Livestock	Livestock Local Supplies, Pecos Valley Aquifer, Dockum	None	None
Manufacturing	----	----	----
Mining	Pecos Valley Aquifer	None	Mining Conservation/Recycling
Steam Electric	----	----	----

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. However, the amount of supply from this aquifer is fully developed for current use. The other local groundwater sources are the Dockum and Edwards-Trinity Plateau, which have diminished water quality and are not currently used in Martin County. As a result, there are identified shortages that may not be able to be met by supplies within the county. The majority of Martin County's shortages are associated with irrigation. Mining was identified as having the second largest water shortage. The primary strategy for irrigation is conservation, which is discussed in Chapter 5B. Livestock and county-other have modest water shortages and may be met with the development of additional Dockum aquifer supplies.

Stanton

Stanton is a customer of CRMWD. The projected needs for Stanton can be fully met through conservation and subordination of CRMWD supplies. The recommended strategies for Stanton are municipal conservation and obtaining the contracted supplies from CRMWD.

Table 5E- 53
Recommended Water Strategies for Stanton

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		245	150	193	238	281	320
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	15	17	18	19	20	20
Subordination	$0	253	160	202	248	291	331
TOTAL	**$0**	**268**	**177**	**220**	**267**	**311**	**351**

Martin County Other

Martin County Other is comprised of entities with less than 500 in population and individuals living outside of a named water user group. This compilation of users known as county-other will meet their needs by drilling supplemental groundwater wells in the Dockum aquifer. Municipal conservation was not recommended for Martin County Other because their per capita use was below 140 gpcd.

Potentially Feasible Water Management Strategies Considered for Martin County Other:

- Develop Dockum Aquifer Supplies with Treatment

Develop Dockum Aquifer Supplies:

This strategy assumes eight new wells would be constructed to produce 250 acre-feet per year. Due to the poor water quality of the Dockum aquifer, this water would need additional treatment. For purposes of this strategy, it is assumed that the treatment would occur at the point of use and a water treatment facility is not included in the costs. The capital cost for this strategy is $4.2 million, which provides a unit cost of $5.02 per thousand gallons of raw water. Treated water costs would be higher.

Table 5E- 54
Recommended Water Strategies for Martin County Other

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		211	222	216	233	239	243
Recommended Strategies (ac-ft/yr)							
Develop Dockum Aquifer	$4,219,000	250	250	250	250	250	250

Martin County Irrigation

Irrigation shortages are over 25,000 acre-feet in 2020 in Martin County. Conservation of water will help preserve existing supplies and is recommended. The remainder of the need will be unmet due to lack of economically viable strategies. Also, it is recommended that Martin County Manufacturing purchase additional groundwater rights. This voluntary transfer of water is shown for Martin County Irrigation.

Table 5E- 55
Recommended Water Strategies for Martin County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		25,157	24,552	23,084	23,231	22,640	22,044
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$3,415,000	1,816	3,567	5,254	5,254	5,254	5,254
Voluntary Transfer	-$14,500	(25)	(26)	(25)	(26)	(28)	(29)
TOTAL	**$3,400,500**	**1,791**	**3,541**	**5,229**	**5,228**	**5,226**	**5,225**

Martin County Livestock

Martin County has roughly 38 acre-feet of livestock shortages over the planning horizon. In order to provide additional water to their existing supply, development of the Dockum aquifer supplies is a recommended strategy.

Potentially Feasible Water Management Strategies Considered for Martin County Livestock:

- Develop Dockum Aquifer Supplies

Develop Dockum Aquifer Supplies:

This strategy assumes one new well would be constructed to produce 40 acre-feet per year. The capital cost for this strategy is $339,000, which provides a unit cost of $2.30 per thousand gallons.

Table 5E- 56
Recommended Water Strategies for Martin County Livestock

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		38	37	35	36	36	35
Recommended Strategies (ac-ft/yr)							
Develop Dockum Aquifer Supplies	$339,000	40	40	40	40	40	40

Martin County Manufacturing

Martin County is shown to have a shortage of less than 30 acre-feet per year for manufacturing due to limited groundwater supplies from the Ogallala aquifer. Since the demands for this use are small, it is likely that this shortage will be met from current supplies. Development of brackish water for such a small supply may be economically infeasible. A small package desalination plant could potentially be utilized. However, for planning purposes, if additional supplies are needed, it assumed that additional groundwater rights would be purchased from willing sellers.

Potentially Feasible Water Management Strategies Considered for Martin County Manufacturing:

- Obtain additional groundwater rights

Obtain Additional Groundwater Rights:

This strategy assumes industrial users would purchase additional groundwater rights from willing sellers to ensure adequate supplies. For this plan, it is assumed that additional groundwater rights would be obtained from irrigators. Since there is sufficient capacity to use this water, no additional infrastructure was assumed. The only costs are associated with the water right purchase.

Table 5E- 57
Recommended Water Strategies for Martin County Manufacturing

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		25	26	25	26	28	29
Recommended Strategies (ac-ft/yr)							
Purchase Groundwater Rights	$14,500	25	26	25	26	28	29

Martin County Mining

Region F has identified the development of additional water supplies in both the Dockum and Edwards-Trinity Plateau aquifers and recycling water as potential strategies to meet mining needs in Martin County. Most of the water used for mining purposes in Region F is for enhanced oil and gas production. Although some availability has been identified in subsurface areas of both the Dockum and Edwards-Trinity Plateau aquifers, local groundwater cannot meet all of the county's mining need. Furthermore, the water quality is generally poor, with brine water in much of the subsurface portions. This will pose a significant challenge and may cause the groundwater strategies to not be economically feasible. Mining companies have approached the City of Midland to purchase the City's wastewater. This water could be used for mining demands across multiple counties, including Martin County.

Potentially Feasible Water Management Strategies Considered for Martin County Mining:

- Develop Dockum Aquifer Supplies
- Develop Edwards – Trinity Plateau Supplies
- Direct Reuse from City of Midland
- Recycle Mining Wastewater (Conservation, see Chapter 5B)

Develop Dockum Aquifer Supplies:

This strategy assumes two new wells would be constructed to produce 210 acre-feet per year. The capital cost for this strategy is $677,000, which provides a unit cost of $1.07 per thousand gallons.

Develop Edwards-Trinity Plateau Aquifer Supplies:

The Edwards Trinity Plateau Aquifer is only available in Martin County and may not yield economically viable volumes of water in all locations where it is present. It is unclear if this supply is truly from the Edwards Trinity or if it is fed by the overlaying Ogallala aquifer. Further localized study is recommended to assess local hydrogeologic conditions prior to pursuing this strategy. This strategy assumes 47 new wells would be constructed to produce 1,500 acre-feet per year. The capital cost for this strategy is $2,356,000, which provides a unit cost of $0.58 gal per thousand gallons.

Purchase of Wastewater from Midland

This strategy assumes that up to 9 MGD of treated wastewater from the City of Midland would be sold directly to mining companies. Improvements to the City's wastewater treatment plant and the construction of a 37 mile transmission system to move the water to Andrews and Martin Counties would be needed. The total average annual supply from this strategy to mining in Martin County is assumed to be 4,500 acre-feet per year, with 1,500 acre-feet per year used in Martin County. The proportional cost for Martin County are estimated at $17.8 million.

Table 5E- 58
Recommended Water Strategies for Martin County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		3,039	2,503	1,710	926	249	0
Recommended Strategies (ac-ft/yr)							
Develop Edwards-Trinity Plateau	$2,356,000	1,500	1,500	1,000	1,000	500	500
Develop Dockum Aquifer Supplies	$677,000	210	210	210	210	210	210
Purchase Reuse from Midland	$17,827,000	1,500	1,200	600	500	0	0
Conservation	$4,940,000	247	210	158	101	54	29
TOTAL	**$25,800,000**	**3,457**	**3,120**	**1,968**	**1,811**	**764**	**739**

Capital cost shown in this table is the total capital cost. The annual costs will be proportioned to each county that uses water from this strategy based on annual quantities.

Martin County Summary

Martin County has a total projected shortage of about 28,700 acre-feet per year. Most of these shortages are associated with the limitations of the supplies from the Ogallala and Pecos Valley aquifers based on the adopted MAGs. Approximately 8 percent of the projected shortage can be met through conservation, subordination and development of brackish groundwater sources. There is nearly 23,500 acre-feet of unmet water needs. All of the unmet need is associated with irrigated agriculture.

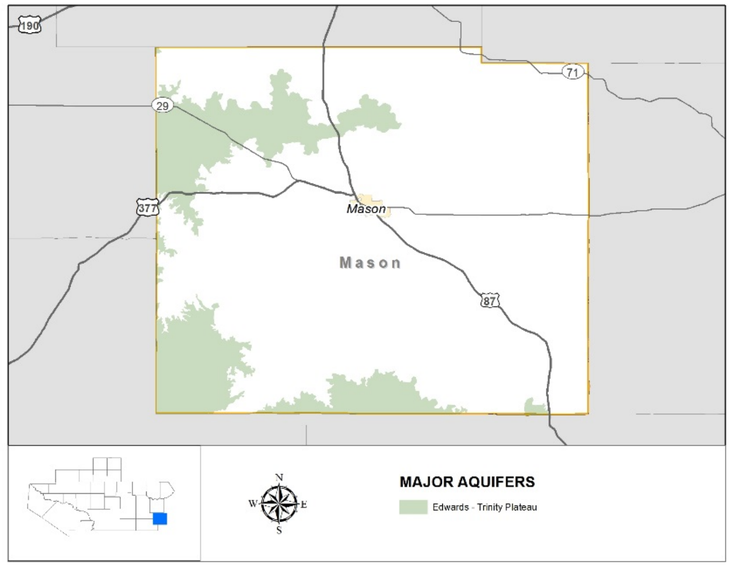
Table 5E- 59
Martin County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Strategies
Stanton	Run-of-River, Direct Reuse, Ogallala and Pecos Aquifers	320	Municipal Conservation Subordination
County-Other	Ogallala Aquifer	243	Develop Dockum Aquifer Supplies with Treatment
Irrigation	Ogallala Aquifer	25,157	Irrigation Conservation
Livestock	Ogallala Aquifer, Livestock Local Supplies	38	Develop Dockum Aquifer Supplies
Manufacturing	Ogallala Aquifer	29	Purchase Additional Groundwater Rights
Mining	Ogallala Aquifer	3,039	Develop Dockum and Edwards-Trinity Plateau Aquifers; Direct Reuse; Conservation
Steam Electric	----	----	----

Table 5E- 60
Unmet Needs in Martin County
-Values are in Acre-Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(23,366)	(22,762)	(21,293)	(21,441)	(20,852)	(20,257)

5E.16 Mason County



Mason County is dependent on groundwater supplies from the Hickory, Marble Falls, and Ellenburger-San Saba aquifers. The only need identified over the planning horizon in Mason County is for the City of Mason. The City of Mason has experienced issues related to quality and will need to pursue additional treatment to be in compliance with TCEQ regulations. Conservation is recommended for the City of Mason, Irrigation and Mining to preserve water for future and other uses. Conservation is discussed in detail in Chapter 5B. Conservation is not recommended for County-Other since their per capita use is not above the 140 gpcd target. Table 5E- 62 shows a summary of supplies, shortages and recommended strategies for Mason County.

Mason

The City of Mason is supplied by groundwater from the Hickory aquifer. While, there is enough quantity of groundwater available, due to naturally occurring radioactive materials, the quality suffers and the supply exceeds the Maximum Contaminant Level (MCL) for gross alpha particles. In order for the City to continue to use this source, additional treatment will be necessary. For planning purposes it was assumed that half of the water will be treated using ion exchange technology and blended with the remaining groundwater to ensure compliance with the MCL.

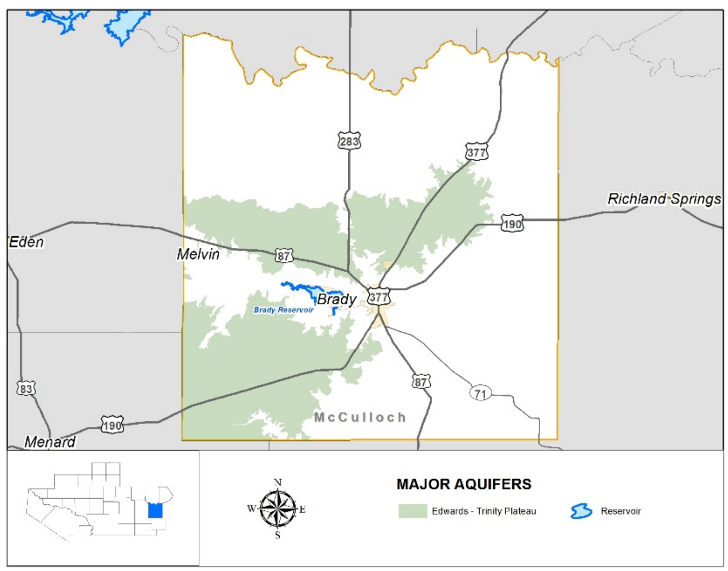
Table 5E- 61
Recommended Water Management Strategies for Mason

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		703	693	685	680	680	680
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	12	12	12	12	12	12
Water Audits and Leak Repair	$1,568,400	26	26	26	25	25	25
Additional Water Treatment	$838,000	703	693	685	680	680	680
TOTAL	**$2,406,400**	**741**	**731**	**723**	**717**	**717**	**717**

Table 5E- 62
Mason County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Mason	Hickory Aquifer	350	Municipal Conservation Additional Water Treatment
County-Other	Sales from Mason, Marble Falls, Ellenburger-San Saba, and Hickory Aquifers	None	None
Irrigation	Hickory Aquifer	None	Irrigation Conservation
Livestock	Livestock Local Supplies, Ellenburger-San Saba and Hickory Aquifers	None	None
Manufacturing	----	----	----
Mining	Hickory Aquifer	None	Mining Conservation/Recycling
Steam Electric	----	----	----

5E.17 McCulloch County



McCulloch County has limited surface water and groundwater supplies. Some surface water is used by the City of Brady and Millersview-Doole WSC but this water must be treated for municipal use. Groundwater from the Hickory and Ellenburger-San Saba aquifers are the primary sources for other water users. However, the amount of supply from these aquifers 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 McCulloch County's shortages are for irrigation and mining. The City of Brady and Millersview-Doole WSC also have municipal shortages. The only strategies identified for irrigation and mining are conservation and/or recycling of water. These strategies are discussed in Chapter 5B.

Brady

The City of Brady obtains water from groundwater wells in the Hickory aquifer and surface water from Brady Creek Reservoir. The City has capacity to produce about 1,200 acre-feet of groundwater per year.

However, due to MAG limitations in McCulloch County, only about 600 acre-feet per year can be shown in the regional plan. When used conjunctively with surface water, some years the City may rely heavily on groundwater and exceed this amount; in other years they may use 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. Water from the reservoir was then blended with Hickory groundwater to reduce radium levels. 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, drought has severely impacted Brady Creek Reservoir and it is unable to be used at this time. Without surface water supplies to blend with the Hickory supplies, the City is above the TCEQ requirements for radionuclides and gross alpha particles. In order to conjunctively use the supplies made available through subordination with groundwater from the Hickory, new advanced treatment will be required. The recommended strategies for Brady are municipal conservation, subordination and advanced treatment. Conservation and subordination are discussed in Chapters 5B and 5C respectively.

Potentially Feasible Water Management Strategies Considered for the City of Brady:

- Advanced Groundwater Treatment

<u>Advanced Groundwater Treatment</u>

To address water quality issues when surface water from Brady Creek Reservoir is not available, the City plans to pursue the development of an advanced groundwater treatment facility to come into compliance with TCEQ water quality requirements. This facility is sized to treat the full capacity of Brady's groundwater well field (1,200 acre-feet per year).

Table 5E- 63
Recommended Water Strategies for Brady

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		1,396	1,425	1,406	1,415	1,417	1,419
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	32	33	33	33	33	33
Subordination	$0	1,892	1,854	1,816	1,778	1,740	1,700
Advanced Treatment	$20,398,000	608	609	614	616	617	616
Voluntary Transfer to McCulloch County Manufacturing	($142,000)	(201)	(217)	(230)	(241)	(261)	(284)
TOTAL	**$20,256,000**	**2,331**	**2,279**	**2,233**	**2,186**	**2,129**	**2,065**

Millersview-Doole WSC

Millersview-Doole WSC obtains its water supplies from the Hickory aquifer and Lake Ivie. The WSC sells a portion of its contracted water from Lake Ivie to the City of Ballinger. The projected needs for Millersview-Doole WSC can be fully met through conservation and subordination of CRMWD supplies. The recommended strategies for Millersview-Doole WSC are municipal conservation and subordination of the contracted supplies from CRMWD. In addition, it is recommended that Millersview-Doole provide a small quantity of water to County-Other.

Table 5E- 64
Recommended Water Strategies for Millersview-Doole WSC

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		147	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	24	25	25	26	26	27
Subordination	$0	517	302	369	236	267	294
Voluntary Transfer to McCulloch County Other	$0	(35)	(35)	(35)	(35)	(35)	(35)
TOTAL	**$0**	**506**	**292**	**359**	**227**	**258**	**286**

McCulloch County Other

McCulloch County-Other obtains water through sales from local cities or directly from the Hickory aquifer. There is a shortage of about 35 acre-feet per year for McCulloch County-Other. This shortage is due to the limits of the MAG for the Hickory aquifer in McCulloch County, and is likely not a real shortage. Rural domestic water use is not subject to the MAG limits and these users would likely continue to use this source. If rural water users begin to show a need of additional water, one option is to purchase water from a local municipality or WSC. Both the City of Brady and Millersview-Doole WSC have supplies in excess of their projected demands after conservation and subordination. For planning purposes, it is recommended that McCulloch County-Other purchase additional water from Millersview-Doole WSC. However, Region F considers contracting with any water provider as consistent with this strategy.

Potentially Feasible Water Management Strategies Considered for McCulloch County-Other:

- Purchase Water from Millersview-Doole WSC

<u>Purchase Water from Millersview-Doole WSC (Voluntary Transfer):</u>

This strategy assumes a small pipeline connection up to 2 miles in length. It is assumed that the system has sufficient pressures such that no other infrastructure is required.

Table 5E- 65
Recommended Water Strategies for McCulloch County Other

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		35	36	35	36	36	36
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	**0**	3	3	3	3	3	3
Purchase from Millersview-Doole	$347,000	35	35	35	35	35	35
TOTAL	**$347,000**	**38**	**38**	**38**	**38**	**38**	**38**

McCulloch County Livestock
McCulloch County has roughly 25 acre-feet of livestock shortages over the planning horizon. Drilling additional groundwater wells in the Edwards-Trinity Plateau aquifer will provide additional water to their existing supply. It is recommended that additional groundwater be developed for livestock use.

Potentially Feasible Water Management Strategies Considered for McCulloch County Livestock:

- Develop Edwards-Trinity Plateau Aquifer Supplies

Develop Edwards-Trinity Plateau Aquifer Supplies:

This strategy assumes one new well would be constructed to produce 30 acre-feet per year. The capital cost for this strategy is $62,000, which provides a unit cost of $0.61 per thousand gallons.

Table 5E- 66
Recommended Water Strategies for McCulloch County Livestock

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		24	24	24	24	24	24
Recommended Strategies (ac-ft/yr)							
Develop Edwards-Trinity Plateau Aquifer Supplies	$62,000	30	30	30	30	30	30

McCulloch County Manufacturing
McCulloch County is shown to have a shortage between 200 and 300 acre-feet per year for manufacturing due to limited groundwater supplies from the Hickory aquifer. It is likely that the industrial users in McCulloch County will continue to use water from the Hickory aquifer to meet their needs. If the MAG limits are not adjusted in the future and additional supplies are needed, manufacturers could contract for water from the City of Brady or a local WSC. While the recommended strategy identifies a specific seller, Region F considers contracting with any water provider as consistent with this strategy.

Potentially Feasible Water Management Strategies Considered for McCulloch County Manufacturing:

- Purchase Water from Brady

Purchase Water from Brady (Voluntary Transfer):

This strategy assumes a small pipeline connection up to 2 miles in length. It is assumed that the system has sufficient pressures such that no other infrastructure is required.

Table 5E- 67
Recommended Water Strategies for McCulloch County Manufacturing

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		201	217	230	241	261	284
Recommended Strategies (ac-ft/yr)							
Purchase from Brady (Voluntary Transfer)	$142,000	201	217	230	241	261	284

McCulloch County Mining

Mining water use in McCulloch County has historically been provided by groundwater. However, with the increased demands for mining and the reduced availability from groundwater, McCulloch County has a projected shortage of over 3,000 acre-feet per year for mining use in 2020 and 2030. After 2030 this shortage decreases substantially. The mining industry is actively pursuing recycling technologies to help meet its needs. There are few other options to meet the mining shortage. As a result, mining will have an unmet need. The recommended strategy for McCulloch County mining is conservation. This is discussed in Chapter 5B.

Table 5E- 68
Recommended Water Strategies for McCulloch County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		3,618	3,066	1,438	472	0	0
Recommended Strategies (ac-ft/yr)							
Conservation	$12,500,000	625	584	465	394	339	294

McCulloch County Summary

The total need for the county is projected to be nearly 7,000 acre-feet a year. Some of this need will be met with conservation and subordination, but there is still a projected shortage of 5,255 acre-feet per year in 2020. The opportunity to meet this need with strategies is limited because nearly all of the available water in McCulloch County is currently being used. As a result of these limitations, the county is shown is to have an unmet need of nearly 5,000 acre-feet per year in 2020 and reducing to 1,420 acre-feet per year by 2070. Much of the reduction is associated with declining mining demands that cannot be met with in-county sources.

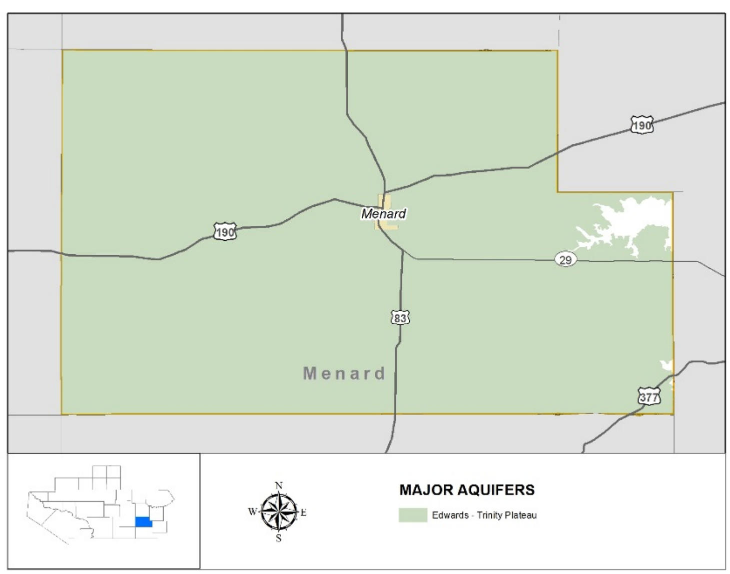
Table 5E- 69
McCulloch County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Strategies
Brady	Brady Reservoir, Hickory Aquifer	816	Municipal Conservation, Subordination, Treatment
Millersview-Doole WSC	Run-of-River, Hickory Aquifer	147	Municipal Conservation, Subordination (CRMWD supplies)
Richland SUD	Ellenburger-San Saba Aquifer, Marble Falls	None	Municipal Conservation
Irrigation	Run-of-River, Hickory Aquifer	2,184	Irrigation Conservation
County-Other	Hickory Aquifer	36	Municipal Conservation, Purchase from Millersview-Doole
Livestock	Edwards-Trinity Plateau, Ellenburger-San Saba, Hickory, Marble Falls , Local Alluvium aquifers, Local	24	Develop Edwards-Trinity Plateau Aquifer Supplies
Manufacturing	Hickory Aquifer	284	Purchase from Brady (Voluntary Transfer)
Mining	Ellenburger-San Saba, Hickory Aquifers	3,618	Mining Conservation/Recycling
Steam Electric	--	--	----

Table 5E- 70
Unmet Needs in McCulloch County
-Values are in Acre-Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(2,005)	(1,784)	(1,557)	(1,507)	(1,462)	(1,420)
Mining	(2,993)	(2,482)	(973)	(78)	0	0
TOTAL	**(4,998)**	**(4,266)**	**(2,530)**	**(1,585)**	**(1,462)**	**(1,420)**

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, resulting in shortages for the City of Menard and Irrigation.

Menard

The City of Menard has several wells near the banks of the San Saba River that produce water from the San Saba River Alluvium. Reduced flows in the San Saba River during a severe drought have the potential to reduce the City's available supply. For the purposes of this plan, supplies for the City of Menard are considered to be surface water. However, recent actions by state agencies have re-classified the City's supply as groundwater. Based on the Colorado WAM through 2013, Menard is shown to have a shortage of about 200 acre-feet per year under drought of record conditions.

During the recent drought the City relied on water conservation and drought management to prevent shortages. Although this strategy proved successful, the City desires to increase the reliability of its supplies by developing a groundwater source. The City is currently considering developing a well in the Hickory aquifer. In addition the City is interested in developing a direct reuse project for agricultural irrigation of the City Farm.

Previously Evaluated and Dismissed Water Management Strategies:

- San Saba Off-Channel Reservoir

Potentially Feasible Water Management Strategies Considered for Menard:

- Direct Non-Potable Reuse
- Develop Hickory Aquifer Supplies

<u>Direct Non-Potable Reuse</u>

The City is interested in developing a direct reuse project for agricultural irrigation of the City Farm. This strategy assumes that the current WWTP will need to construct the necessary improvements in order to bring a portion of the plant's effluent to Type 1 standards. This strategy will cost approximately $1.3 million, and will yield 67 additional acre-feet per year.

<u>Develop Hickory Aquifer Supplies</u>

The City is planning to drill one well near its existing storage tank to provide approximately 500 acre-feet per year. This strategy also includes one 8-inch diameter five mile transmission line and assumes that the source can be blended with the City's other sources to meet safe drinking water standards. This strategy will cost approximately $6.1 million, and will yield 500 additional acre-feet per year.

Table 5E- 71
Recommended Water Strategies for Menard

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		210	202	196	195	195	195
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	8	8	8	8	8	8
Water Audit and Leak Repairs	$1,183,200	17	17	17	16	16	16
Reuse	$1,288,800	67	67	67	67	67	67
Develop Hickory Aquifer Supplies	$6,120,000	500	500	500	500	500	500
TOTAL	**$8,592,000**	**592**	**592**	**592**	**591**	**591**	**591**

Menard County Summary

Menard County is projected to have a shortage of 618 acre-feet per year. This shortage is associated with the City of Menard and irrigation. The City can meet its projected needs with the recommended water management strategies. Irrigation will have an unmet need after conservation. Conservation is also recommended for Mining despite there being no shortage. County-Other, Livestock and Manufacturing show no shortages and have no recommended strategies.

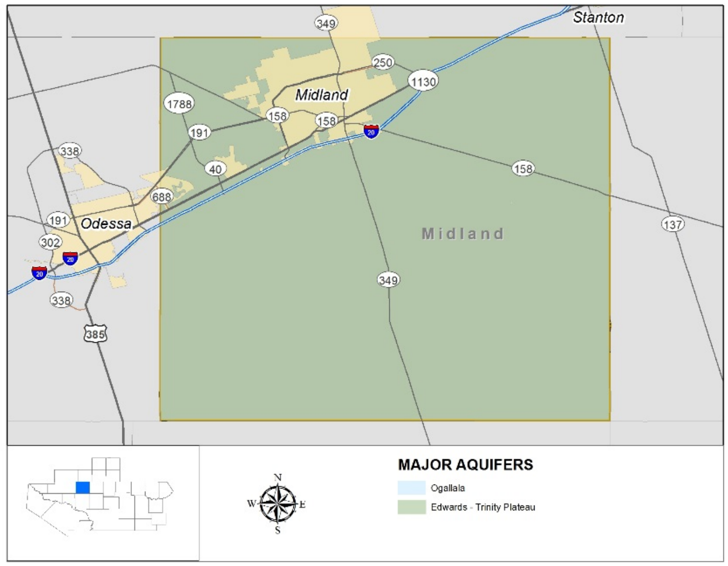
Table 5E- 72
Menard County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Menard	River wells	210	Municipal Conservation, Hickory Aquifer, Direct Non-Potable Reuse
County-Other	Edwards-Trinity, Ellenburger-San Saba, and Other Aquifers	None	None
Irrigation	Run-of-River	426	Irrigation Conservation
Livestock	Livestock Local Supplies, Edwards-Trinity, Ellenburger-San Saba, and Other Aquifers	None	None
Manufacturing	Sales from Menard	None	None
Mining	Edwards-Trinity and Ellenburger-San Saba Aquifers	None	Mining Conservation/Recycling
Steam Electric	----	----	----

Table 5E- 73
Unmet Needs in Menard County
-Values are in Acre-Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(300)	(166)	(33)	(24)	(16)	(8)

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. A small portion of County-Other's demand is associated with the City of Midland and is included in the City's shortage. Conservation is recommended for Irrigation and Mining 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.

Midland
The City of Midland has experienced rapid population growth in recent years due to increased oil and gas exploration in the Permian Basin. 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 commuters are officially counted as residents elsewhere. This kind of worker is not considered in the population and water demands projections 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 recently completed T-Bar Ranch and Clearwater Well Fields in Winkler and Loving Counties. The City has also recently completed a small direct reuse project that provides about 130 acre-feet per year of water to Midland College for outdoor irrigation. The City begins to experience shortages in 2030 after the expiration of one its contracts with CRMWD in 2029. The Paul Davis Well Field is expected to be depleted by 2035, deepening their shortage in 2040. Table 5E- 74 shows the supplies and demands for the City of Midland.

Table 5E- 74
City of Midland Supplies and Demands

Supply	Supply 2020	Supply 2030	Supply 2040	Supply 2050	Supply 2060	Supply 2070
T-Bar Ranch/ Clearwater Well Field	11,200	11,200	11,200	11,200	11,200	11,200
CRMWD (Ivie)	5,959	5,791	5,622	5,453	5,285	5,116
CRMWD (1966 contract)	9,972	0	0	0	0	0
University Lands	2,057	1,997	0	0	0	0
Airport Well field	560	560	0	0	0	0
Direct reuse	130	130	130	130	130	130
Total	**29,878**	**19,678**	**16,952**	**16,783**	**16,615**	**16,446**
Demand	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
City of Midland	32,721	34,460	37,507	40,746	44,110	47,440
Industrial Sales	39	43	46	48	53	57
Municipal Sales	21	21	21	21	21	21
Total	**32,781**	**34,524**	**37,574**	**40,815**	**44,184**	**47,518**
Need	**-2,903**	**-14,846**	**-20,622**	**-24,032**	**-27,569**	**-31,072**

Potentially Feasible Water Management Strategies Considered for Midland:

- Municipal Conservation
- Direct Potable Reuse
- Purchase from CRMWD
- Additional T-Bar groundwater with Treatment
- West Texas Water Partnership
- Development of Groundwater in Midland County (previously used for mining)

<u>Additional T-Bar Groundwater with Treatment</u>

Water from the T-Bar Ranch is provided to Midland through the Midland Fresh Water District. Some of the water has elevated arsenic levels and is currently blended with water from the Clearwater Well Field to meet drinking water standards. The well field capacity and limitations associated with the blend ratio limits the annual average supply from this source to 10 MGD (11,200 acre-feet per year). The transmission capacity of the pipeline to Midland is 38 MGD. This strategy would fully develop the T-Bar Well Field to provide a peak capacity of 38 MGD. It would require approximately 25 additional wells, two new pump stations, and treatment for arsenic. It is assumed that the treatment facilities would be located at the well field, but the final location would be determined during design. The average annual supply from this strategy is 10,000 acre-feet. The capital costs are estimated at $52.2 million.

Purchase Water from CRMWD

The City of Midland currently receives water from CRMWD through two separate contracts: the Ivie Contract and the 1966 Contract. The Ivie Contract is for 16.54 percent of the safe yield of Lake Ivie. The supply from this contract for this plan has been adjusted to reflect the current safe yield of Ivie as computed through 2013. The 1966 Contract provides around 18,000 acre-feet of supply from any of CRMWDs sources to Midland. This contract will expire in 2029[1]. This strategy involves entering into a new contract agreement with CRMWD to replace the 1966 Contract. The purchase water costs are based on CRMWD's current customer contracts. The terms and conditions of the contract for this strategy will be negotiated between the two parties. The supply amount and cost in this plan are best estimates and do not reflect the final agreement that may be reached.

West Texas Water Partnership

The Cities of Midland, San Angelo and Abilene have formed the West Texas Water Partnership (the Partnership) to evaluate long-term water supplies the Partnership could develop jointly. The Partnership is conducting a separate study to determine the most feasible water management strategies for these cities, but the results were not available at the writing of this plan. For planning purposes, it is assumed that the Partnership would provide 10,000 acre-feet per year from current City of Abilene sources (Region G) and future supplies from the proposed Cedar Ridge Reservoir. The Partnership plans to develop additional supplies in excess of 10,000 acre-feet to meet Midland's long-term needs. The Partnership is currently evaluating a variety of sources including new groundwater supplies and reuse. However, the sources of supplies above 10,000 acre-feet are confidential and are not officially included in the 2016 Regional Water Plan. The additional strategies developed as part of the Partnership would be available prior to the City of Midland's need in 2040.

Supplies from this strategy would be transmitted back through Abilene's existing O.H. Ivie pipeline to a delivery point near San Angelo. Midland would receive 4,000 acre-feet per year, and the remaining 6,000 acre-feet would supply San Angelo. The total project costs for the infrastructure improvements necessary to transmit water back through Abilene's Ivie pipeline and tie into existing CRMWD facilities are estimated to be $65,292,000, with a unit cost of $1,256 per acre-foot. The portion of the capital cost attributable to

[1] Supplies from this contract vary yearly. The values specified in this plan are based on the quantities specified for the decadal year.

Midland would be 40% of the total capital cost, or $26,116,800. The unit costs are identical for both cities for delivery to the CRMWD pipeline, however, there would be additional operating costs for Midland to pump supply through the CRMWD facilities to Midland. For planning purposes, the Partnership has included a concept strategy in the Region F Plan for San Angelo and Midland. The Partnership has not approached the Colorado River Municipal Water District with any plans to use CRMWD facilities and CRMWD facilities are already fully contractually committed. If and when the Partnership has developed a firmer concept strategy they should contact CRMWD to see if their option(s) are feasible and beneficial to both the Partnership and CRMWD. Discussions between the Partnership and CRMWD are outside the scope of regional water planning.

Table 5E- 75
Recommended Water Strategies for Midland

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		2,903	14,846	20,622	24,032	27,569	31,072
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	813	879	973	1,062	1,150	1,236
Purchase from CRMWD	$0	0	4,000	4,000	4,000	4,000	4,000
Additional T-Bar groundwater w/ Treatment	$52,199,000	0	10,000	10,000	10,000	10,000	10,000
West Texas Water Partnership	$26,116,800	0	4,000	4,000	4,000	4,000	4,000
Subordination	$0	8,527	-299	-298	-297	-297	-296
TOTAL	**$78,315,800**	**9,340**	**18,580**	**18,675**	**18,765**	**18,853**	**18,940**

Midland is also considering utilizing fresh and/or brackish groundwater supplies in Midland County that are currently being used for mining purposes. These supplies may become available after Midland completes its sale of wastewater to the mining industry and as the mining demands decrease in the county. Due to the uncertainty of this supply, these sources are considered alternate strategies for the City. Complete evaluation of these strategies will be conducted as more information becomes available.

Potential Future Water Management Strategies for Midland include:

- Development of Groundwater in Midland County (previously used for mining)
- Additional supplies from the West Texas Water Partnership

The alternate strategies may be implemented if one or more of the recommended strategies is determined to be no longer be feasible.

With the recommended water plan, Midland shows a water supply shortage after 2030. It is likely that this shortage would be met with additional supplies from the West Texas Water Partnership projects. However, these new supplies have not been identified at this time and cannot be included in this water plan. As the projects for the Partnership become better defined, this plan will be updated. For the 2016 Water Plan, Midland shows an unmet water need after 2030.

Midland County Other

Midland County-Other currently obtains water from local groundwater aquifers, including the Ogallala and Edwards-Trinity Plateau aquifer. The plan assumes that these users will continue to obtain water from these sources to meet the projected demands. Midland County-Other shows no shortage except for the small portion of the demand that is associated with sales from Midland. This shortage will be addressed through municipal conservation and a portion of the supply from Midland's strategies. While the plan shows no shortages, Midland County Utility District is considering developing additional groundwater in conjunction with the Midland County Fresh Water District (FWD). In March 2015, the FWD entered into an agreement to purchase the land contingent upon the groundwater quality and quantity tests. This strategy would expand groundwater supplies from the Pecos Valley aquifer in Winkler County and would be transported by the Midland County Fresh Water District pipeline to the greater Midland area. This strategy is a recommended strategy for Midland County Utility District (County-Other).

<u>New Groundwater in Winkler County</u>

At this time it is unclear how much water could be available through this strategy or how it will ultimately be transported. For planning purposes, the strategy was assumed to provide up to 1,000 acre-feet of additional water to County-Other in Midland County. It is assumed that three new wells would be drilled in Winkler County and connected to the T-Bar infrastructure, if agreements can be reached with the Midland County Freshwater Supply District No. 1 and the City of Midland to provide this capacity in the transmission line from the T-Bar Well Field. For this strategy, no treatment is included. This supply is considered reliable, but the use of the T-Bar infrastructure may limit the supplies when Midland is using the full capacity of the system. The capital cost of this strategy is $62 million, not including the purchase of the land which is considered complete for the purposes of this plan.

Table 5E- 76
Recommended Strategies for Midland County-Other

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Conservation	$0	145	164	183	202	220	239
Develop Winkler County Groundwater	$62,699,000	1,000	1,000	1,000	1,000	1,000	1,000
TOTAL	**$62,699,000**	**1,145**	**1,164**	**1,183**	**1,202**	**1,220**	**1,239**

Midland County Mining

Midland County Mining shows no shortage, but mining companies have expressed interest in purchasing wastewater effluent from the City of Midland for mining purposes. It is uncertain whether this water would be used in Midland County or adjacent areas. For purposes of this plan, the use of the reuse water is assumed to occur in Midland, Andrews and Martin Counties. In addition, it is recommended that Mining implement conservation/recycling of the process water.

Potentially Feasible Water Management Strategies Considered for Midland County Mining:

- Mining Conservation/Recycling
- Direct Reuse from City of Midland

<u>Direct Reuse from City of Midland</u>

This strategy assumes that up to 9 MGD of treated wastewater from the City of Midland would be sold directly to mining companies. This strategy includes improvements to the City's wastewater treatment plant and the construction of a 37 mile transmission system to move the water to Andrews and Martin Counties. The total average annual supply from this strategy is assumed to be 4,500 acre-feet per year. The proportional cost for Midland County is estimated at $3.3 million or $2.04 per thousand gallons. Only the supply amount for Midland County Mining is shown in Table 5E- 77. Supplies from this strategy that are transported to Andrews and Martin Counties are shown in their respective counties.

Table 5E- 77
Recommended Water Strategies for Midland County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Mining Conservation/Recycling	$5,460,000	273	239	184	124	74	52
Purchase Reuse Water from Midland	$3,349,000	500	500	300	200	0	0
TOTAL	**$8,809,000**	**773**	**739**	**484**	**324**	**74**	**52**

Midland County Summary

The total need for the county is projected to be 31,000 acre-feet a year, which is all associated with the City of Midland. Some of this need will be met with conservation and subordination, but there is still a projected shortage beginning in 2030. The City of Midland is actively identifying and pursuing new water supplies, but these strategies are still in development and are not available for this water plan. Strategies have been identified that will meet the projected shortages through 2030. After 2030, the City of Midland shows a maximum shortage of 12,132 acre-feet per year.

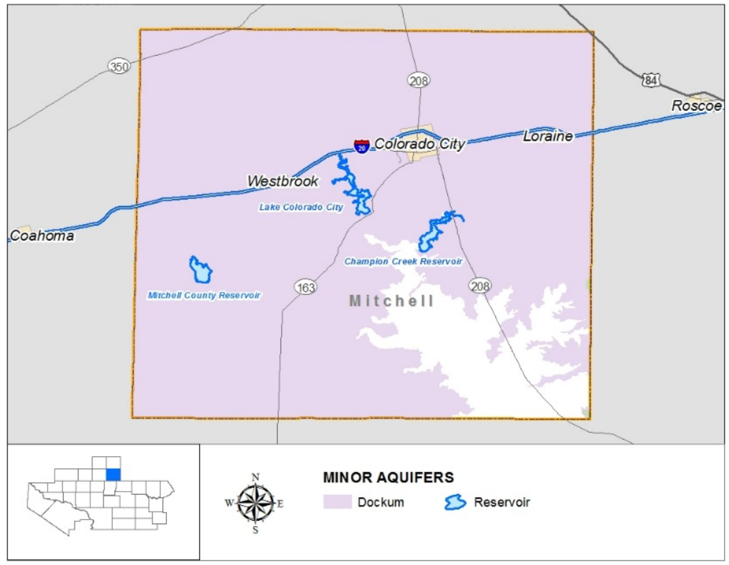
Table 5E- 78
Midland County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Greater Gardendale WSC	See Ector County		
Midland	T-Bar Ranch (Pecos Valley-Edwards Trinity Plateau Winkler Co), sales from CRMWD, Paul Davis Well Field (Ogallala Andrews and Martin Cos)	31,498	Municipal Conservation Subordination, Purchase from CRMWD West Texas Water Partnership, Additional Groundwater from T-Bar with Treatment
Odessa	See Wholesale Water Provider Section		
County-Other	Sales from Midland, Edwards-Trinity Plateau and Ogallala Aquifers	Incorporated in Midland shortage	Municipal Conservation New Groundwater from Winkler County
Irrigation	Edwards-Trinity Plateau and Ogallala Aquifers	None	Irrigation Conservation
Livestock	Livestock Local Supplies, Edwards-Trinity Plateau and Ogallala Aquifers	None	None
Manufacturing	Sales from Midland	None	None
Mining	Edwards-Trinity Plateau and Ogallala Aquifers	None	Mining Conservation/Recycling Direct Reuse from Midland
Steam Electric	----	----	----

Table 5E- 79
Unmet Needs in Midland County
-All Values are in Acre-feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Midland	0	0	(1,947)	(5,267)	(8,716)	(12,132)

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 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. The only water user with an identified shortage is steam electric power. However, Colorado City is considering expanding its water supplies to increase the reliability during drought.

Colorado City

Colorado City obtains its water from the Dockum aquifer. The City has 11 active wells with a production capacity of about 2,100 gpm. As water levels decline over time, the capacities will also decline. During the latest drought, the well field had difficulty in meeting the City's demands. As a result, the City plans to expand its current well fields by 2 MGD to increase the system capacities and ensure sufficient supplies during drought. However, the available supply from Dockum in Mitchell County is fully utilized by current users. Therefore, the well field expansion strategy is recommended as an alternate strategy until such time that the MAGs increase. The City is also planning to expand its wastewater reuse for irrigation and possibly sell wastewater to mining interests for oil field fracking. Dockum water that is not being used for irrigation or mining as the result of the wastewater reuse will become available to Colorado City.

Potentially Feasible Water Management Strategies Considered for Colorado City:

- Direct Reuse
- Dockum Well Field Expansion

<u>Direct Reuse for Mining or Irrigation</u>

This strategy assumes that the current wastewater treatment plant would need no improvements to utilize the water for the intended purpose, and two miles of transmission pipeline would need to be constructed to convey the reuse water from the plant to the end users. The amount of supply planned is about 250 acre-feet per year. The capital costs are estimated at $932,000. This strategy is included in the Mining water plan.

Table 5E- 80
Recommended Water Strategies for Colorado City

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)[a]							
Municipal Conservation	$0	28	31	32	32	32	33
TOTAL	**$0**	**28**	**31**	**32**	**32**	**32**	**33**

a. Reuse for mining is shown is Table 5E-81.

Recommended Alternate Water Management Strategies for Colorado City:

- Dockum Well Field Expansion

<u>Dockum Well Field Expansion</u>

This strategy's total capital costs amount to $6 million and could potentially yield 2,240 acre-feet of additional water per year. This strategy's total cost includes the construction of 14 new wells and the necessary piping infrastructure. However, the supply volume exceeds the current MAG in the Dockum aquifer. This strategy is not currently recommended, but should be considered for future supplies should the DFC and MAG change in future planning cycles.

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. Mitchell County steam electric power is projected to have a shortage of just over 1,100 acre-feet per year in 2020 after subordination. The options to meet this need are limited since the existing plant is designed to use water from the lakes. There is little available groundwater in the county that is not already being used by another entity. One option is alternative cooling technologies that use less water than conventional cooling. The costs for this strategy indicate that the strategy may be feasible to retrofit an existing plant. Therefore, the recommended strategies for Mitchell County Steam Electric Power are subordination and alternative cooling technology. The discussion of the alternative cooling technology is presented in subchapter 5B.

Table 5E- 81
Recommended Water Strategies for Mitchell County Steam Electric Power

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		4,847	4,670	4,493	4,317	4,140	3,994
Recommended Strategies (ac-ft/yr)							
Alternative Cooling	$16,830,000	1,127	1,030	933	837	740	674
Subordination	$0	3,720	3,640	3,560	3,480	3,400	3,320
TOTAL	**$16,830,000**	**4,847**	**4,670**	**4,493**	**4,317**	**4,140**	**3,994**

Mitchell County Mining

Mitchell County does not show a mining shortage over the planning period. However, the City of Colorado City is planning on selling some of its treated wastewater to mining. This strategy is discussed under Colorado City. However, the development and costs would be by the mining industry.

Table 5E- 82
Recommended Water Strategies for Mitchell County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Direct Reuse	$932,000	250	250	250	250	250	250
Conservation/ Recycling	$1,040,000	42	52	44	35	26	20
TOTAL	**$1,972,000**	**342**	**352**	**344**	**335**	**326**	**320**

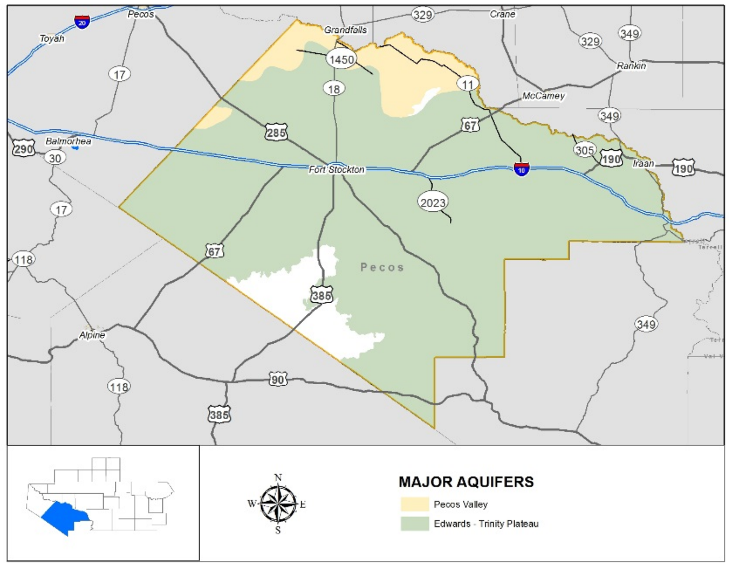
Mitchell County Summary

The projected water demands in Mitchell County can be fully met through the recommended strategies.

Table 5E- 83
Mitchell County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Colorado City	Dockum Aquifer	None	Municipal Conservation
Loraine	Dockum Aquifer	None	Municipal Conservation
County-Other	Dockum Aquifer	None	Municipal Conservation
Irrigation	Reuse from Colorado City, Run-of-River, Dockum Aquifer	None	Irrigation Conservation
Livestock	Livestock Local Supplies, Dockum and Other Aquifers	None	None
Manufacturing	----	----	----
Mining	Dockum Aquifer	None	Mining Conservation/Recycling Direct Reuse
Steam Electric	Champion Lake	3,367	Subordination Alternative Cooling

5E.21 Pecos County



Pecos County relies predominantly on groundwater to meet its water needs. The county has over 275,000 acre-feet per year of total available groundwater from five different aquifers. There are limited surface water supplies within the county, which are used for irrigation purposes. No shortages were identified for any water user group within Pecos County. However, Pecos County WCID #1 expressed interest in developing specific water management strategies to increase the reliability of its supplies by diversifying their sources. 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 and the per capita use was below 140 gpcd.

Pecos County WCID #1

Pecos County WCID #1 obtains water from the Pecos Valley-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. For this planning purpose, it is assumed that Pecos County WCID #1 will drill additional wells in the Edwards-Trinity Plateau aquifer to back up current supplies. The exact location is not known.

Potentially Feasible Water Management Strategies Considered for Pecos County WCID #1:

- Develop Edwards-Trinity Plateau Aquifer Supplies

<u>Develop Edwards-Trinity Plateau Aquifer Supplies</u>

This strategy assumes that two new wells will be drilled within 0.5 mile of the current well field or distribution system and could supply up to 250 acre-feet per year. The capital costs are estimated at $2.5 million, with a unit cost of $2.85 per thousand gallons.

Table 5E- 84
Recommended Water Strategies for Pecos County WCID #1

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	19	20	22	23	24	25
Develop Edwards-Trinity Plateau Aquifer Supplies	$2,456,000	250	250	250	250	250	250
TOTAL	**$2,456,000**	**269**	**270**	**272**	**273**	**274**	**275**

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 0.19 inches over Pecos County due to their weather modification efforts in 2014. 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 28,556 irrigated acres in Pecos County, implementation of this strategy is expected to save 264 acre-feet of water per year at a unit cost of $4.33 per acre-foot.

Table 5E- 85
Recommended Water Strategies for Pecos County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$12,287,000	6,301	12,602	18,903	18,903	18,903	18,903
Weather Modification	$0	264	264	264	264	264	264
TOTAL	**$12,287,000**	**6,565**	**12,866**	**19,167**	**19,167**	**19,167**	**19,167**

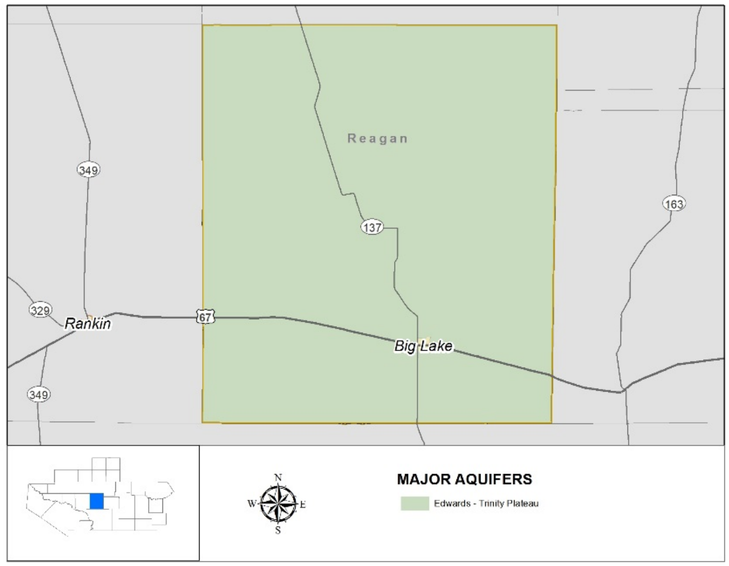
Pecos County Summary

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. Pecos County does not have a projected shortage over the planning period. Considering conservation and the strategy for Pecos County WCID #1, the total amount of water from recommended strategies in Pecos County is approximately 20,000 acre-feet per year.

Table 5E- 86
Pecos County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Strategies
Fort Stockton	Edwards-Trinity Plateau Aquifer	None	Municipal Conservation
Iraan	Edwards-Trinity Plateau Aquifer	None	Municipal Conservation
Pecos County WCID #1	Pecos Valley-Edwards Trinity Plateau Aquifer	None	Develop Edwards-Trinity Plateau Aquifer Supplies
County-Other	Edwards-Trinity Plateau and Pecos Valley-Edwards Trinity Plateau Aquifers	None	None
Irrigation	Red Bluff Reservoir, Run-of-River, Edwards-Trinity Plateau, Pecos Valley-Edwards Trinity Plateau and Rustler Aquifers	None	Irrigation Conservation Weather Modification
Livestock	Edwards-Trinity Plateau, Pecos Valley, Rustler and Local Alluvium Aquifers, Local Supply	None	None
Manufacturing	Edwards-Trinity Plateau Aquifer	None	None
Mining	Edwards-Trinity Plateau and Pecos Valley-Edwards Trinity Plateau Aquifers	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 and the projected demands in Reagan County are less than 25,000 acre-feet per year. The supply and demand analysis found that Reagan County has no identified water shortages. However, conservation for Big Lake, Irrigation and Mining are still recommended as a way to preserve water for future use. The total amount of expected water savings from conservation is estimated at 3,000 acre-feet per year.

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 (WTWMA).

Potentially Feasible Water Management Strategies Considered for Reagan County Irrigation:

- Irrigation Conservation
- Weather Modification

Weather Modification

The WTWMA attributes an annual increase of 2.80 inches over Reagan County due to their weather modification efforts in 2014. 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 10,793 irrigated acres in Reagan County, implementation of this strategy is expected to save 1,469 acre-feet of water per year at a unit cost of $0.29 per acre-foot.

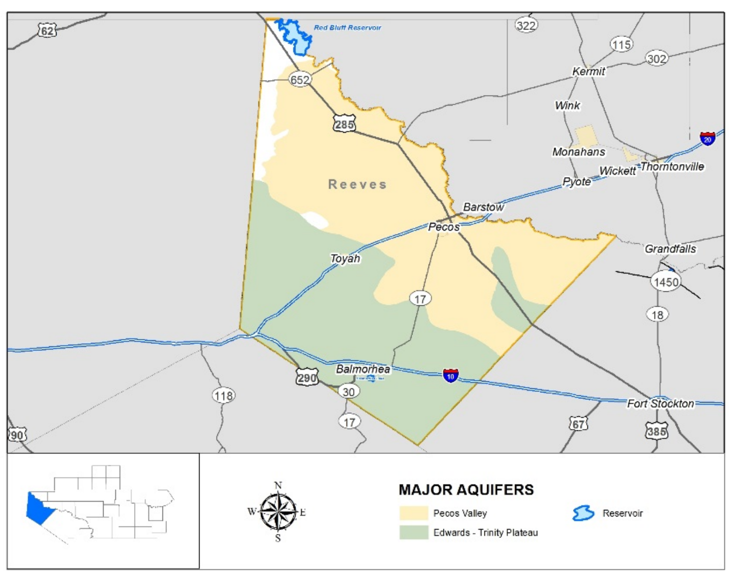
Table 5E- 87
Recommended Water Strategies for Reagan County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$1,802,000	957	1,881	2,773	2,773	2,773	2,773
Weather Modification	$0	1,469	1,469	1,469	1,469	1,469	1,469
TOTAL	**$1,802,000**	**2,426**	**3,350**	**4,242**	**4,242**	**4,242**	**4,242**

Table 5E- 88
Reagan County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Big Lake	Edwards Trinity-Plateau Aquifer	None	Municipal Conservation
County-Other	Edwards Trinity-Plateau Aquifer	None	None
Irrigation	Edwards Trinity-Plateau Aquifer	None	Irrigation Conservation Weather Modification
Livestock	Livestock Local Supplies, Edwards Trinity-Plateau Aquifer, Dockum Aquifer	None	None
Manufacturing	----	----	----
Mining	Edwards Trinity-Plateau Aquifer	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, recent ongoing drought in the Rio Grande Basin, similar to what was experienced in the Colorado Basin, has severely impacted surface water supplies. The hydrology in the Rio Grande WAM has not been extended, and thus current surface water supply estimates for Red Bluff Reservoir may be overestimated. Conservation is recommended for the municipal, irrigation and mining water users.

Livestock and manufacturing users have no recommended strategies. The total amount of expected water savings from conservation is estimated at 14,000 acre-feet per year.

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. In May 2014, a collaborative effort between the Pecos River Commission, Pecos River Water Quality Coalition, US Army Corps of Engineers (USACE), Texas Water Development Board (TWDB), Texas Commission on Environmental Quality (TCEQ), and the U.S. Geological Survey (USGS) commenced to conduct a comprehensive review of existing studies, identify data gaps, and recommended projects to reduce salinity in the region[1]. This study is called the Pecos River Watershed Assessment and is ongoing at the writing of this plan. Since these projects are not yet defined, they cannot be fully evaluated as part of the Region F Plan. However, the projects identified as a result of this study may result in increased usable water supplies for agricultural, urban, and environmental purposes and are considered to be consistent with this plan.

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

<u>Weather Modification</u>

The TPWMA attributes an annual increase of 0.29 inches over Reeves County due to their weather modification efforts in 2014. 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 16,997 irrigated acres in Reeves County, implementation of this strategy is expected to save 240 acre-feet of water per year at a unit cost of $2.84 per acre-foot.

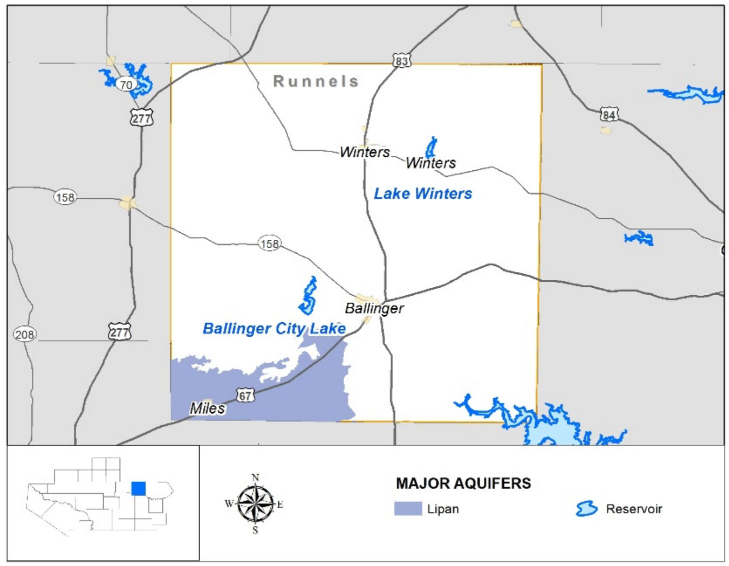
Table 5E- 89
Recommended Water Strategies for Reeves County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$8,755,000	4,568	9,058	13,469	13,469	13,469	13,469
Weather Modification	$0	240	240	240	240	240	240
TOTAL	**$8,755,000**	**4,807**	**9,297**	**13,709**	**13,709**	**13,709**	**13,709**

Table 5E- 90
Reeves County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Madera Valley WSC	Pecos Valley-Edwards-Trinity Plateau Aquifer	None	Municipal Conservation
Pecos	Dockum Aquifer, Pecos Valley Aquifer (Ward County)	None	Municipal Conservation
County-Other	Edwards-Trinity Plateau Aquifer, Run-of-River	None	Municipal Conservation
Irrigation	Lake Balmorhea, Red Bluff, Pecos Valley-Edwards-Trinity Plateau Aquifer	None	Irrigation Conservation Weather Modification
Livestock	Local Supplies, Rustler, Dockum, Edwards-Trinity Plateau, Pecos Valley-Edwards-Trinity Plateau Aquifers	None	None
Manufacturing	Sales from Pecos	None	None
Mining	Pecos Valley-Edwards-Trinity Plateau Aquifer	None	Mining Conservation/Recycling
Steam Electric	----	----	----

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. After subordination and conservation, there is a projected shortage of about 1,700 acre-feet per year. The largest shortage in Runnels County is associated with irrigation demands. Both Ballinger and Winters show projected shortages over the planning period due to the reduced surface water supplies. Some of the shortages for County-Other and manufacturing are associated with the shortages for Ballinger and Winters and will be addressed through strategies by the respective seller. 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. As a result, Ballinger is looking at obtaining water supplies from outside of the county.

Ballinger

The City of Ballinger obtains water from Lake Ballinger and Lake Ivie through a contract with Millersview-Doole WSC. This contract is to expire after 2040 and Ballinger is considering not renewing the contract because of their concerns about the reliability of Lake Ivie. Presently, Ballinger takes water from Lake Ivie from the Abilene pipeline. If the lake drops below elevation 1490 ft msl, the ability to pump water through the Abilene pipeline is greatly impeded. To shore up the City's supplies, several other strategies were considered, including direct potable reuse, conjunctive use of groundwater in Coke County with advanced treatment, and purchase water rights from the City of Clyde. Previous evaluations of the Coke County groundwater by Ballinger found this strategy to be cost prohibitive due to the level of treatment required and the limited groundwater supplies. Direct potable reuse was considered to be cost prohibitive at this time. The recommended strategies for Ballinger include conservation, subordination, and purchase water rights from Clyde.

Previously Evaluated and Dismissed Strategies:

- Direct Potable Reuse
- Conjunctive use of groundwater in Coke County with advanced treatment

Potentially Feasible Water Management Strategies Considered for Ballinger:

- Municipal Conservation
- Subordination
- Purchase from Millersview-Doole (CRMWD)
- Purchase water rights from Clyde (Fort Phantom Hill Reservoir)

<u>Purchase water from Clyde</u>

The City of Clyde has purchased the industrial water right for Lake Fort Phantom Hill that was previously used for the steam electric power plant. This water right has a permitted diversion of 2,500 acre-feet per year and has been amended for multi-purpose use. Ballinger proposes to purchase between 1,000 and 1,750 acre feet of the water right from Clyde. For planning purposes, it was assumed that Ballinger purchases 1,500 acre-feet of the water right from Clyde. Based on the reliability of this water, the estimated supply available to Ballinger is 990 acre-feet per year in 2020. This strategy assumes that the water would be transported via a new pipeline. If other delivery options prove to be feasible, the costs of this strategy could be impacted. The capital costs are estimated at $47 million, with a unit cost of $14.88 per thousand gallons. Ballinger is also considering partnering with other rural entities in the region to build a regional system and sell a portion of this supply. However, this may change as this strategy is further developed and defined. This will impact the costs and evaluation of the strategy.

Table 5E- 91
Recommended Water Strategies for Ballinger

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		589	514	520	767	766	766
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	21	22	22	22	22	22
Water Audits and Leak Repair	$2,669,400	37	37	36	36	36	36
Subordination	$0	752	675	693	563	558	554
Fort Phantom Hill supplies	$47,093,000	990	955	920	886	851	816
TOTAL	**$49,762,400**	**1,800**	**1,689**	**1,671**	**1,506**	**1,467**	**1,428**

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 and there are no identified shortages for Miles. The recommended strategies for Miles are conservation and subordination of UCRA's water supplies.

Winters

The City of Winters' source of water is Lake Winters. This lake was significantly impacted from the recent drought and the reliable supply is estimated at less than 200 acre-feet per year with subordination. Winters provides water to its residents and rural customers in Runnels County, as well as a small amount of water to manufacturing. Considering the City's current customers, Winters is shown to have a projected shortage of 164 acre-feet per year. To meet this need, Winters could implement direct potable reuse and/or 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. This option would be expensive for such a small quantity of water. For purposes of this plan, the recommended strategies for Winters are to implement direct reuse and purchase water from Abilene.

Potentially Feasible Water Management Strategies Considered for Winters:

- Direct Potable Reuse
- Purchase from Abilene

<u>Direct Potable Reuse</u>

This strategy assumes that Winters would implement a direct reuse project where the City's wastewater effluent would be treated with microfiltration and reverse osmosis and then blended back with its raw water sources at the water treatment plant. For purposes of this plan, this strategy would provide 83 acre-feet per year of potable supply after 25 percent treatment losses associated with RO. This is slightly less than one third of the City's demands. The capital costs are estimated at $3.35 million.

<u>Purchase water from a Provider</u>

There are multiple water providers that utilize the Abilene pipeline from Lake Ivie. It is assumed that the City would purchase up to 100 acre-feet per year of Lake Ivie water from one of the providers. It would require a valve and short pipeline, where the water would then be discharged to a tributary of Lake Winters. The capital cost of the strategy is $696,000 with a unit cost of $2.92 per thousand gallons for raw water.

Table 5E- 92
Recommended Water Strategies for Winters

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		355	346	336	335	334	334
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	6	6	7	7	8	8
Subordination	$0	186	182	178	174	170	165
Direct Reuse	$3,354,000	83	83	83	83	83	83
Purchase from Provider	$696,000	100	100	100	100	100	100
TOTAL	**$4,050,000**	**375**	**371**	**368**	**364**	**361**	**356**

Runnels County Irrigation

Runnels County Irrigation uses water from local alluvium aquifers, a small amount of river water and wastewater effluent from Ballinger and Winters. There is a projected water shortage of 1,424 acre-feet per year for mining after conservation. If Winters elects to implement a direct potable reuse strategy to serve the city's projected needs, the projected water shortage for irrigation would increase. The following table shows the recommended strategy for Runnels County Irrigation and the reduction in current supplies.

Table 5E- 93
Recommended Water Strategies for Runnels County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		1,642	1,624	1,606	1,588	1,570	1,552
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$310,000	200	399	477	477	477	477
Winters Reuse		(110)	(110)	(110)	(110)	(110)	(110)
TOTAL	**$310,000**	**90**	**289**	**367**	**367**	**367**	**367**

Runnels County Mining

There is a projected water shortage of 76 acre-feet per year for mining after conservation. This need could potentially be met through the development of groundwater from local alluvium aquifers.

Potentially Feasible Water Management Strategies Considered for Runnels County Mining:

- Develop Other Aquifer Supplies

<u>Develop Other Aquifer Supply</u>

There is available supply from Other aquifer in Runnels County. The water quality is uncertain, but this is not a factor for mining use. This strategy assumes that two wells would be developed to produce up to 76 acre-feet per year. The supplies shown in the summary table represent the amount needed to meet the need. The capital cost of the strategy is $140,000.

Table 5E- 94
Recommended Water Strategies for Runnels County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		95	92	63	33	7	0
Recommended Strategies (ac-ft/yr)							
Mining Conservation/ Recycling	$380,000	19	19	17	15	13	11
Other Undifferentiated Aquifer	$140,000	76	73	46	18	0	0
TOTAL	**$520,000**	**95**	**92**	**63**	**33**	**13**	**11**

Runnels County Summary
Runnels County is able to meet its projected water demands through a suite of strategies that include conservation, subordination for surface water lakes, purchase water from other providers and a small groundwater development project. There is an unmet need for Irrigation due to a lack of viable alternatives.

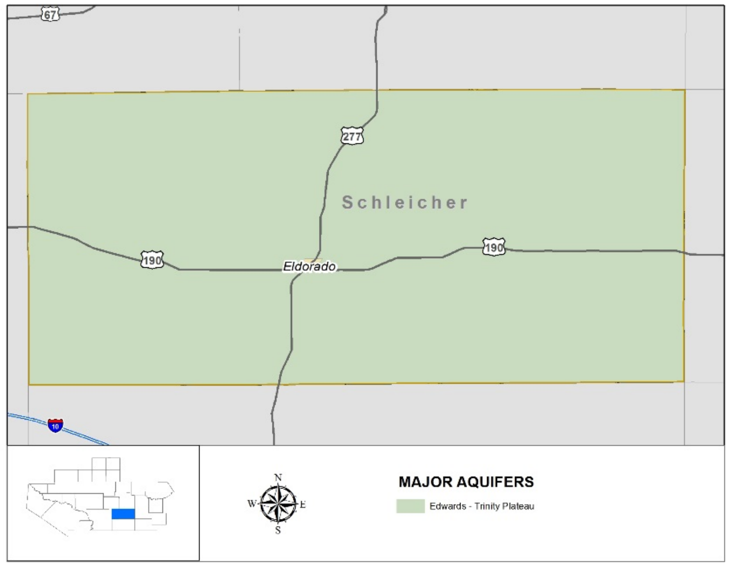
Table 5E- 95
Runnels County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Ballinger	Sales from Millersview-Doole, Ballinger/Moonen Lk	766	Municipal Conservation, Subordination, Purchase from Clyde
Coleman County SUD	See Coleman County		
Miles	Sales from UCRA	None	Municipal Conservation, Subordination
Millersview-Doole WSC	See McCulloch County		
Winters	Winters Lake	355	Municipal Conservation, Subordination, Reuse, Purchase from Provider
County-Other	Sales from Ballinger, Sales from Winters, Other Aquifer	Included in Ballinger & Winters shortage	See Ballinger and Winters
Irrigation	Reuse sales from Ballinger, Reuse sales from Winters, Other Aquifer, Run-of-River	1,642	Irrigation Conservation
Livestock	Livestock Local Supplies, Other Aquifer, Lipan Aquifer	None	None
Manufacturing	Sales from Ballinger, Sales from Winters	58	See Ballinger and Winters
Mining	Other Aquifer	76	Mining Conservation/Recycling Other Aquifer
Steam Electric	----	----	----

Table 5E- 96
Unmet Water Needs in Runnels County
-Values are in Acre-Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(1,552)	(1,335)	(1,239)	(1,221)	(1,203)	(1,185)

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 3,500 acre-feet per year. There is 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.

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 (WTWMA).

Potentially Feasible Water Management Strategies Considered for Schleicher County Irrigation:

- Irrigation Conservation
- Weather Modification

<u>Weather Modification</u>

The WTWMA attributes an annual increase of 2.35 inches over Schleicher County due to their weather modification efforts in 2014. 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 889 irrigated acres in Schleicher County, implementation of this strategy is expected to save 102 acre-feet of water per year at a unit cost of $0.35 per acre-foot.

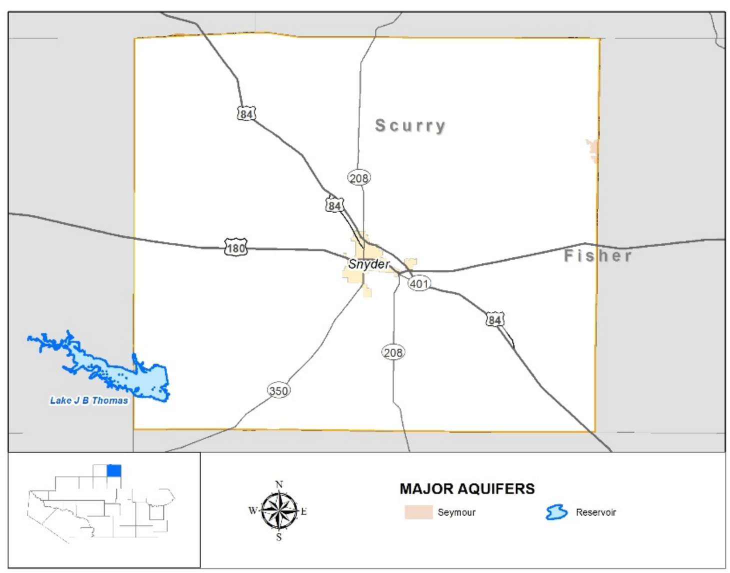
Table 5E- 97
Recommended Water Strategies for Schleicher County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$54,000	71	83	81	81	81	81
Weather Modification	$0	102	102	102	102	102	102
TOTAL	**$54,000**	**172**	**185**	**183**	**183**	**183**	**183**

Table 5E- 98
Schleicher County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Eldorado	Edwards Trinity Plateau Aquifer	None	Municipal Conservation
County-Other	Edwards Trinity Plateau Aquifer	None	None
Irrigation	Edwards Trinity Plateau Aquifer	None	Irrigation Conservation Weather Modification
Livestock	Livestock Local Supplies, Edwards Trinity Plateau Aquifer	None	None
Manufacturing	----	----	----
Mining	Edwards Trinity Plateau Aquifer	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) and this source is only used by rural municipal users. The current demands on the Dockum aquifer exceed the availability (MAG values). As a result, there are identified shortages that may not be able to be met by supplies within Scurry County.

City of Snyder

The City of Snyder is a member city of CRMWD and obtains all of its water from this wholesale provider. The City is projected to have a shortage of about 1,800 acre-feet in 2070. This shortage is the result of limited surface water supplies associated with the availability modeling. With conservation and subordination, CRMWD can fully meet Snyder's need. The recommended strategies for Snyder are municipal conservation and subordination.

Potentially Feasible Water Management Strategies Considered for Snyder:

- Municipal Conservation
- Subordination
- Direct Reuse

Table 5E- 99
Recommended Water Strategies for Snyder

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		1,269	807	1,030	1,280	1,544	1,812
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	75	86	93	100	104	134
Subordination	$0	1,268	807	1,030	1,280	1,544	1,812
TOTAL	**$0**	**1,343**	**893**	**1,123**	**1,380**	**1,648**	**1,946**

Scurry County Other

Scurry County Other includes rural water users living outside of a named water user group. Most of these users obtain their water from groundwater and will continue to use groundwater. However, due to the MAG limits, there is no available water from the Dockum aquifer. For purposes of this plan, this water user group is expected to meet some of their needs with water supplied by the City of Snyder, which will come from strategies developed by CRMWD. The costs for this strategy are assumed to be only the purchase cost of the water. The remaining needs will be met through Voluntary Transfer of Dockum groundwater from irrigation use to municipal use. Since this water is already being used at the proposed level, no additional infrastructure is assumed for this strategy. Municipal conservation is not a recommended strategy because the per capita water use is less than 140 gallons per day.

Potentially Feasible Water Management Strategies Considered for Scurry County Other:

- Purchase water from City of Snyder (Voluntary Transfer)
- Voluntary Transfer from Irrigation to Municipal Use

Table 5E- 100
Recommended Water Strategies for Scurry County-Other

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		308	332	360	400	449	501
Recommended Strategies (ac-ft/yr)							
Purchase from Snyder	$0	158	182	210	250	299	351
Voluntary Transfer from Irrigation	$75,000	150	150	150	150	150	150
TOTAL	**$75,000**	**308**	**332**	**360**	**400**	**449**	**501**

Scurry County Irrigation
Irrigation shortages are over 5,900 acre-feet in 2020 in Scurry County. Conservation of water will help preserve existing supplies and is recommended. Some of the current supply is proposed for transfer to municipal County-Other needs. This will reduce the impacts from conservation. The remainder of the need will be unmet due to a lack of economically viable strategies.

Table 5E- 101
Recommended Water Strategies for Scurry County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		6,321	6,079	5,838	5,603	5,377	5,165
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$575,000	365	706	885	885	885	885
Transfer to Municipal Use	-$75,000	(150)	(150)	(150)	(150)	(150)	(150)
TOTAL	**$500,000**	**215**	**556**	**735**	**735**	**735**	**735**

Scurry County Livestock
Scurry County has roughly 92 acre-feet of livestock shortages over the planning horizon. Drilling supplemental groundwater wells in the local alluvium associated with the Dockum aquifer will provide additional water to their existing supply. Water from this source has been identified as being suitable for agricultural use and is a recommended strategy.

Potentially Feasible Water Management Strategies Considered for Scurry County Livestock:

- New Groundwater from the Local Alluvium Aquifer

<u>New Groundwater from Local Alluvium Aquifer</u>
This strategy assumes three new wells would be constructed to produce 92 acre-feet per year. The capital cost for this strategy is $102,000, which provides a unit cost of $0.57 per thousand gallons of water.

Table 5E- 102
Recommended Water Strategies for Scurry County Livestock

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		92	92	92	91	91	91
Recommended Strategies (ac-ft/yr)							
Other Aquifer	$143,000	92	92	92	92	92	92

Scurry County Mining

Scurry County is projected to have an increase in mining demands over the planning period. Currently water from the Dockum aquifer is used for mining purposes, but due to limitations of the MAGs there is less supply available. Potentially feasible strategies to meet the projected mining demands include conservation/recycling and developing groundwater from Other aquifer. Even with these strategies, Mining is shown to have an unmet need.

Potentially Feasible Water Management Strategies Considered for Scurry County Mining:

- New Groundwater from the Local Alluvium Aquifer

<u>New Groundwater from the Local Alluvium Aquifer</u>

There is a small amount of water available from Other aquifer that currently is not used. This strategy proposes to develop two wells at 75 gpm each to produce 80 acre-feet per year of water for mining use. The capital cost for this strategy is $140,000, which provides a unit cost of $0.61 per thousand gallons of water.

Table 5E- 103
Recommended Water Strategies for Scurry County Mining

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		232	408	435	316	200	121
Recommended Strategies (ac-ft/yr)							
Mining Conservation	$680,000	20	32	34	25	17	12
Develop Other Aquifer	$140,000	80	80	80	80	80	80
TOTAL	**$820,000**	**100**	**112**	**114**	**105**	**97**	**92**

Scurry County Summary

The total need for Scurry County is projected to be 8,222 acre-feet in 2020. The majority of Scurry County's shortages are for irrigation. The other larger shortages are for Snyder and will be met with conservation and subordination of CRMWD supplies. The shortages for County-Other are shown to be met through sales from Snyder. However, much of the County-Other demand will likely continue to be met through local groundwater supplies. The majority of mining demands can likely be met through additional groundwater development and direct reuse from Snyder, but a small need will remain unmet. The only strategy identified for irrigation is conservation and/or recycling of water. There were no shortages identified for Manufacturing that were not provided by a water provider. Due to the limitations of the groundwater supplies in Scurry County, the county is shown to have an unmet need for irrigation.

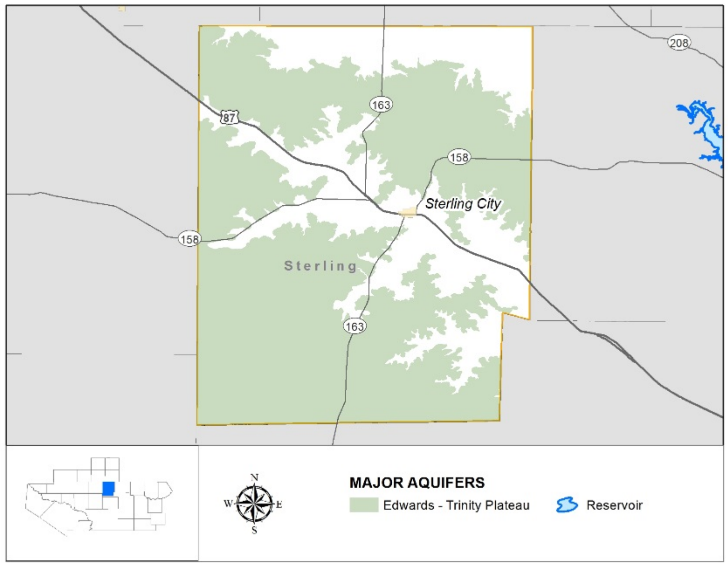
Table 5E- 104
Scurry County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Strategies
Snyder	CRMWD Sources	None	Municipal Conservation, Subordination
County-Other	CRMWD Sources, Dockum, Local Alluvium Aquifers	501	Sales from Snyder Voluntary Transfer from Irrigation
Irrigation	Run-of-River, Dockum Aquifer	6,321	Irrigation Conservation
Livestock	Dockum and Local Supply	92	New Groundwater from the Local Alluvium Aquifer
Manufacturing	Dockum Aquifer	None	None
Mining	Dockum Aquifer	435	Mining Conservation, Reuse, New Groundwater from the Local Alluvium Aquifer
Steam Electric	--	--	----

Table 5E- 105
Unmet Needs in Scurry County
-Values in Acre-Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(6,106)	(5,523)	(5,103)	(4,868)	(4,642)	(4,430)
Mining	(132)	(296)	(321)	(211)	(103)	(29)
TOTAL	**(6,238)**	**(5,819)**	**(5,424)**	**(5,079)**	**(4,745)**	**(4,459)**

5E.27 Sterling County



Most of the water supplies for Sterling County are obtained from the Edwards-Trinity Plateau aquifer. There is about 1,000 acre-feet per year of supply from local alluvium aquifers (Other aquifer), which is used by Sterling City and agricultural users. Total demands in Sterling County are about 2,500 acre-feet per year. There are sufficient supplies to meet these demands and Sterling County has no shortages. Other than conservation, no strategies were developed for water user groups in Sterling County. The recommended strategies in Sterling County include municipal, irrigation and mining conservation.

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 (WTWMA).

Potentially Feasible Water Management Strategies Considered for Sterling County Irrigation:

- Irrigation Conservation
- Weather Modification

Weather Modification
The WTWMA attributes an annual increase of 1.16 inches over Sterling County due to their weather modification efforts in 2014. 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 440 irrigated acres in Sterling County, implementation of this strategy is expected to save 25 acre-feet of water per year at a unit cost of $0.71 per acre-foot.

Table 5E- 106
Recommended Water Strategies for Sterling County Irrigation

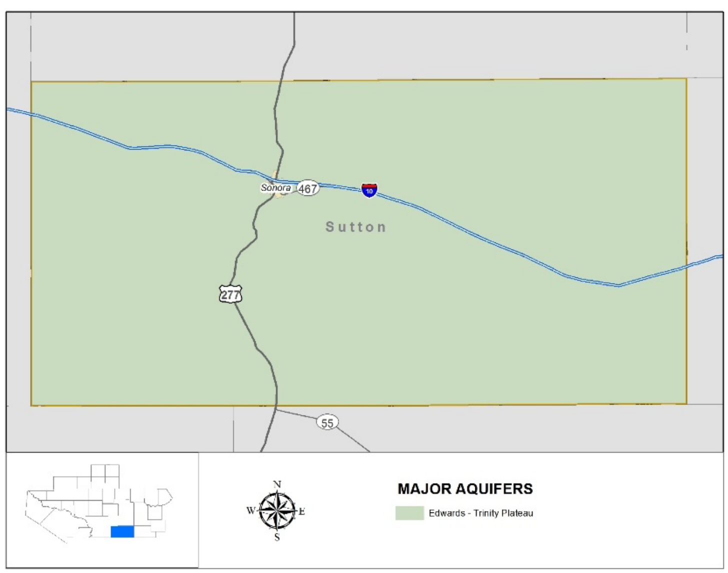
	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$88,000	49	94	135	135	135	135
Weather Modification	$0	25	25	25	25	25	25
TOTAL	**$88,000**	**74**	**119**	**160**	**160**	**160**	**160**

Table 5E- 107
Sterling County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr))	Recommended Water Management Strategies
Sterling City	Other Aquifer	None	Municipal Conservation
County-Other	Edwards-Trinity Plateau Aquifer	None	None
Irrigation	Edwards-Trinity Plateau Aquifer, Other Aquifer, Run-of-River	None	Irrigation Conservation Weather Modification
Livestock	Edwards-Trinity Plateau, Dockum and Other Aquifers, Livestock Local Supplies	None	None
Manufacturing	----	----	----
Mining	Edwards-Trinity Plateau Aquifer	None	Mining Conservation/Recycling
Steam Electric	----	----	----

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 4,300 acre-feet per year in 2020 and are expected not to exceed 4,700 acre-feet per year over the planning period. Sutton County has sufficient water resources to meet these demands and has no identified shortages. The City of Sonora is considering developing a direct reuse project for municipal irrigation. This will continue to conserve water for the City of Sonora.



Sonora

The City of Sonora has no water shortages over the planning horizon. Municipal conservation is still recommended as a way to preserve water for future or other uses. The City is also planning to begin implementing a small scale direct reuse project to provide water to industry and municipal parks for irrigation. This is expected to come online sometime between 2020 and 2030.

Potentially Feasible Water Management Strategies Considered for Sonora:

- Direct Reuse for Municipal Irrigation

<u>Direct Reuse for Municipal Irrigation</u>

This strategy is based on a generalized direct non-potable reuse strategy developed for the Region F plan. It assumes that the current wastewater treatment plant would need improvements to utilize the water for the intended purpose, and two miles of transmission pipeline would need to be constructed to convey the reuse water from the plant to the end users. The amount of supply planned is about 55,000 gallons per day or 62 acre-feet per year. The capital costs are estimated at $500,000.

Table 5E- 108
Recommended Water Strategies for Sonora

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	18	20	20	20	21	21
Water Audit and Leak Repairs	$2,486,600	77	82	83	85	86	86
Direct Reuse for Irrigation	$495,800	62	62	62	62	62	62
TOTAL	**$2,982,400**	**157**	**164**	**165**	**167**	**169**	**169**

Sutton County Irrigation

Although Sutton 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 Sutton County is located within the active precipitation enhancement area of the West Texas Weather Modification Association (WTWMA).

Potentially Feasible Water Management Strategies Considered for Sutton County Irrigation:

- Irrigation Conservation
- Weather Modification

Weather Modification

The WTWMA attributes an annual increase of 1.24 inches over Sutton County due to their weather modification efforts in 2014. 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 645 irrigated acres in Sutton County, implementation of this strategy is expected to save 34 acre-feet of water per year at a unit cost of $0.66 per acre-foot.

Table 5E- 109
Recommended Water Strategies for Sutton County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$169,000	90	177	260	260	260	260
Weather Modification	$0	34	34	34	34	34	34
TOTAL	**$169,000**	**124**	**211**	**294**	**294**	**294**	**294**

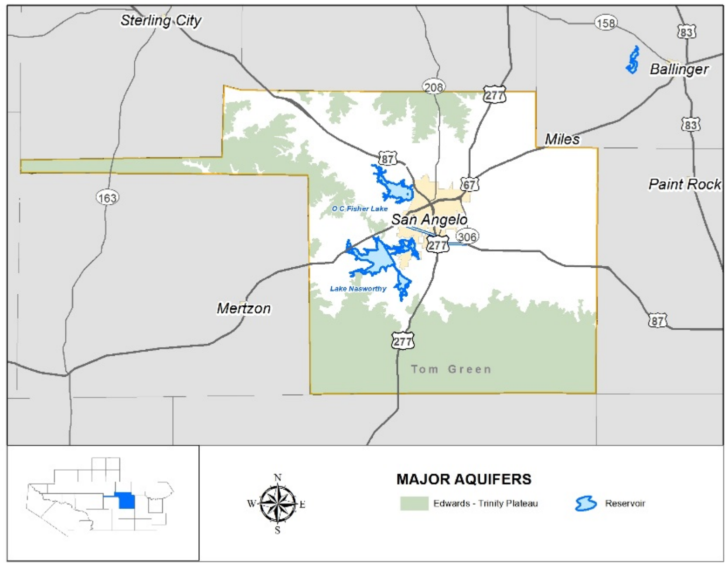
Sutton County Summary

Sutton County has no identified shortages. It is recommended that water users in Sutton County implement conservation measures to preserve the water resources in the county. This includes direct non-potable reuse for the City of Sonora, and conservation for municipal, irrigation and mining water users. Municipal conservation is not recommended specifically for County-Other users because the per capita water user is less than 140 gallons per day.

Table 5E- 110
Sutton County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Sonora	Edwards-Trinity Plateau Aquifer	None	Municipal Conservation Direct Reuse for Irrigation
County-Other	Sales from Sonora	None	None
Irrigation	Edwards-Trinity Plateau Aquifer, Run-of-River	None	Irrigation Conservation Weather Modification
Livestock	Edwards-Trinity Plateau Aquifer, Livestock Local Supplies	None	None
Manufacturing	----	----	----
Mining	Edwards-Trinity Plateau Aquifer	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 demands in Tom Green County total over 130,000 acre-feet per year, of which about 70 percent is for irrigation water use. Most of the remaining demand is associated with San Angelo. 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 ongoing drought, the reliable supplies from surface water has been significantly impacted. After conservation and subordination, the county is shown to have a shortage of about 34,000 acre-feet per year in 2020. Slightly more than half of this shortage is associated with irrigation. The other half is identified for San Angelo and its customers. Concho Rural Water Corporation, Livestock and Mining have no identified water shortages. The water management strategies for San Angelo and its customers, including Manufacturing, are discussed in subchapter 5D.

Concho Rural Water Corporation

Concho Rural Water Corporation supplies several small communities in Tom Green County. All of their current supply is derived from the Lipan aquifer. The current analysis shows them to have no shortages but the Concho Rural WC is seeking to develop an additional four wells to ensure continued reliable supplies from the Lipan aquifer.

Potentially Feasible Water Management Strategies Considered for Concho Rural Water Corporation:

- Municipal Conservation
- Direct Reuse for Municipal Irrigation
- Develop Lipan Aquifer Supplies
- Desalination of Other Aquifer Supplies

<u>Develop Lipan Aquifer Supplies</u>

This strategy includes an additional four 50 gpm wells to be connected to their current transmission infrastructure. Under the current MAG availability, there is not enough supply for the current strategy to develop 200 acre-feet per year. Therefore, this strategy is being included as an alternate strategy should the MAG limitations change.

<u>Desalination of Other Aquifer Supplies</u>

Beneath the Lipan aquifer, lies brackish water in an undefined Other aquifer. Concho Rural plans to pursue development of this source and use reverse osmosis technology to desalinate the supply for municipal use. This strategy would provide 150 acre-feet of finished supply after treatment losses.

Table 5E- 111
Recommended Water Strategies for Concho Rural Water Corporation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Municipal Conservation	$0	33	35	37	38	40	41
Desalination of Other Aquifer Supplies in Tom Green County	$5,131,000	150	150	150	150	150	150
TOTAL	$5,131,000	**183**	**185**	**187**	**188**	**190**	**191**
Alternate Strategies (ac-ft/yr)							
Develop Lipan Aquifer Supplies	$448,000	200	200	200	200	200	200

Tom Green County Other

Tom Green County-Other is comprised of small utilities with less than 500 people and individuals living outside of a named water user group. This compilation of users known as County-Other is projected to have a shortage of about 300 acre-feet per year in 2020, increasing to over 500 acre-feet by 2070. To meet these shortages, UCRA is planning to serve several smaller communities south of San Angelo with water from strategies developed by the wholesale provider. The recommended strategy for County-Other is to purchase water through UCRA. Municipal Conservation was not recommended for Tom Green County-Other because their per capita use was below 140 gpcd.

Potentially Feasible Water Management Strategies Considered for Tom Green County Other:

- Purchase water through UCRA

<u>Purchase water through UCRA</u>

UCRA would develop additional infrastructure to deliver treated water to communities south and southwest of San Angelo. The capital cost of this project are included under the UCRA strategy to increase their contract amount from San Angelo and expand their transmission system. Details on this strategy are located in Chapter 5D.

Table 5E- 112
Recommended Water Strategies for Tom Green County-Other

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		306	323	379	428	474	518
Recommended Strategies (ac-ft/yr)							
Purchase Water through UCRA		306	323	379	428	474	518

Tom Green County Irrigation

Irrigation shortages are projected to be over 31,000 acre-feet in 2020 in Tom Green County. Options for meeting this shortage are limited. 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 (WTWMA). The recommended strategy for Irrigation is conservation and weather modification.

Irrigation in Tom Green County currently receives 8,300 acre-feet of treated effluent from the City of San Angelo. The City of San Angelo is considering using this effluent for a direct potable reuse project and ceasing their sales to irrigation. This results in an even greater shortage for irrigation of 39,000 acre-feet in 2020. The remaining need after conservation and weather modification will be unmet due to lack of economically viable strategies.

Potentially Feasible Water Management Strategies Considered for Tom Green County Irrigation:

- Irrigation Conservation
- Weather Modification

<u>Weather Modification</u>

The WTWMA attributes an annual increase of 2.65 inches over Tom Green County due to their weather modification efforts in 2014. 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 38,386 irrigated acres in Tom Green County, implementation of this strategy is expected to save 4,945 acre-feet of water per year at a unit cost of $0.31 per acre-foot.

Table 5E- 113
Recommended Water Strategies for Tom Green County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		31,451	31,222	31,043	30,861	30,632	30,404
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$7,263,000	4,679	9,335	11,175	11,175	11,175	11,175
Weather Modification	$0	4,945	4,945	4,945	4,945	4,945	4,945
Transfer to San Angelo		-8,300	-8,300	-8,300	-8,300	-8,300	-8,300
TOTAL	**$7,263,000**	**1,324**	**5,980**	**7,819**	**7,819**	**7,819**	**7,819**

Tom Green County Manufacturing

Most of the manufacturing demand in Tom Green County is centered in the City of San Angelo. The City already provides water to individual manufacturers and plans to continue to do so as demands grow. Purchasing water from San Angelo is the only potentially feasible and recommended strategy for Tom Green County Manufacturing. A portion of the supply from San Angelo's strategies would go to meet the manufacturing demand in Tom Green County. San Angelo's strategies are discussed in Subchapter 5D.

Table 5E- 114
Recommended Water Strategies for Tom Green County Manufacturing

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		1,211	1,459	1,657	1,853	2,094	2,357
Recommended Strategies (ac-ft/yr)							
Purchase from San Angelo	$0	744	1,014	1,219	1,433	1,691	1,971
Subordination	$0	467	445	438	420	403	386
TOTAL	$0	**1,211**	**1,459**	**1,657**	**1,853**	**2,094**	**2,357**

Tom Green County Summary

Tom Green County is the second largest demand county in Region F. As previously discussed supplies are limited and the county shows a total shortage of over 50,000 acre-feet per year by 2070. Some of this shortage is met through conservation and subordination, but the county still shows a shortage of nearly 37,000 acre-feet per year. Some of this shortage can be met through the implementation of infrastructure strategies and voluntary transfers, but the county will still have an unmet need of approximately 25,000 acre-feet per year for irrigation use.

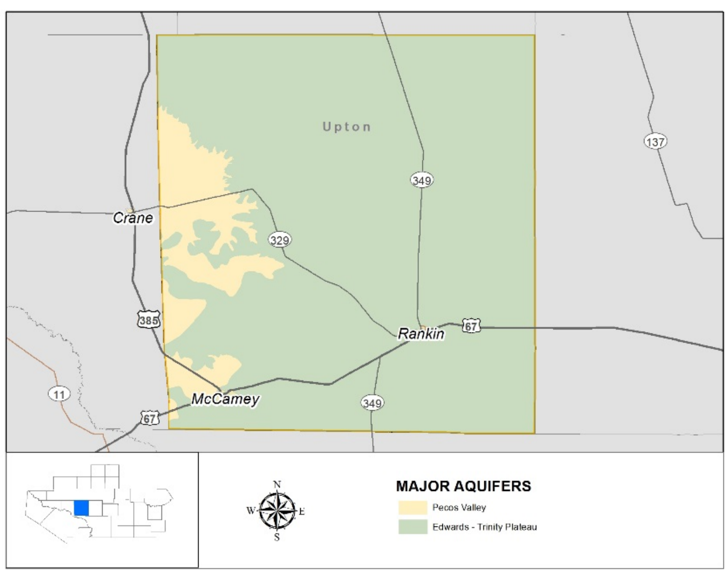
Table 5E- 115
Tom Green County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Concho Rural Water Corporation	Lipan and Edwards-Trinity Aquifers	None	Municipal Conservation
Millersview-Doole WSC	See McCulloch County		
San Angelo	San Angelo System, Ivie Reservoir, Concho River, Hickory Aquifer	16,597	Subordination, Municipal Conservation, Hickory Well Field Expansion , Reuse, Desalination (Other Aquifer), Brush Control, West Texas Water Partnership
County-Other	Lipan, Edwards-Trinity, and Other Aquifers	518	Purchase water through UCRA
Irrigation	Lipan, Edwards-Trinity, and Other Aquifers, Reuse, Twin Buttes/Nasworthy, Run-of-River	31,451	Irrigation Conservation Weather Modification
Livestock	Lipan, Edwards-Trinity, and Other Aquifers and Livestock Local Supplies	None	None
Manufacturing	Sales from San Angelo	2,014	Purchase from San Angelo
Mining	Lipan and Other Aquifers	None	Mining Recycling
Steam Electric	----	----	----

Table 5E- 116
Unmet Needs in Tom Green County
-Values in Acre Feet per Year-

Water User Group	2020	2030	2040	2050	2060	2070
Irrigation	(30,127)	(25,242)	(23,224)	(23,042)	(22,813)	(22,585)

5E.30 Upton County



All of the water demands in Upton County are currently met with groundwater from the Edwards-Trinity Plateau aquifer. There is a small amount of groundwater in the Dockum and Pecos Valley aquifers but this water is unused due to water quality and quantity concerns. The total water demands for the county are about 15,000 acre-feet per year. Upton

County has sufficient supplies to meet these 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 and Livestock have no recommended strategies.

Table 5E- 117
Upton County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
McCamey	Edwards-Trinity Plateau Aquifer	None	Municipal Conservation
Rankin	Edwards-Trinity Plateau Aquifer	None	Municipal Conservation
County-Other	Edwards-Trinity Plateau Aquifer, Sales from Upton County Water District	None	None
Irrigation	Edwards-Trinity Plateau Aquifer	None	Irrigation Conservation
Livestock	Edwards-Trinity Plateau Aquifer, Livestock Local Supplies	None	None
Manufacturing	----	----	----
Mining	Edwards-Trinity Plateau Aquifer	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, Dockum and Rustler aquifers. Based on developed supplies, all water users in Ward County can meet the projected demands except steam electric power. The steam electric power demands are higher than current use and are projected to more than double over the 50-year planning period. There are sufficient supplies to meet this demand in Ward County, if needed.

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

<u>Weather Modification</u>
The TPWMA attributes an annual increase of 0.68 inches over Ward County due to their weather modification efforts in 2014. 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 1,381 irrigated acres in Ward County, implementation of this strategy is expected to save 46 acre-feet of water per year at a unit cost of $1.21 per acre-foot.

Table 5E- 118
Recommended Water Strategies for Ward County Irrigation

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		0	0	0	0	0	0
Recommended Strategies (ac-ft/yr)							
Irrigation Conservation	$534,000	281	554	821	821	821	821
Weather Modification	$0	46	46	46	46	46	46
TOTAL	**$534,000**	**326**	**600**	**867**	**867**	**867**	**867**

Ward County Steam Electric Power

The current steam electric power demand in Ward County is associated with the Luminant Permian Basin Power Plant. This facility uses groundwater from the Pecos Valley aquifer. Over the past five years, the average water use was about 2,700 acre-feet per year. The projected future water demands for steam electric power are over 8,200 acre-feet per year. These demands are speculative and may never develop. The power industry is not actively developing steam electric facilities, but should these demands occur it is assumed that they are associated with a new facility. To meet these demands, development of the Pecos Valley aquifer and alternative cooling technologies for new facilities were considered. Alternative cooling technology is recommended as an alternate strategy.

Potentially Feasible Water Management Strategies Considered for Ward County Steam Electric Power:

- Develop Pecos Valley Aquifer Supplies
- Alternative Cooling Technologies

<u>Additional Groundwater from Pecos Valley Aquifer Supplies</u>

This strategy assumes that six new wells would need to be drilled to provide approximately 5,600 acre-feet per year. Since this strategy would likely be for a new facility, it is assumed that the facility would be sited near the water supply. The capital cost for this strategy is estimated at $2.7 million.

Table 5E- 119
Recommended Water Strategies for Ward County Steam Electric Power

	Capital Cost	2020	2030	2040	2050	2060	2070
Shortage (ac-ft/yr)		1,079	1,718	2,496	3,445	4,603	5,569
Recommended Strategies (ac-ft/yr)							
Develop Pecos Valley Aquifer Supplies	$2,682,000	5,600	5,600	5,600	5,600	5,600	5,600
TOTAL	**$2,682,000**	**5,600**	**5,600**	**5,600**	**5,600**	**5,600**	**5,600**

Alternate Water Management Strategy for Ward County Steam Electric Power:

- Alternative Cooling Technologies

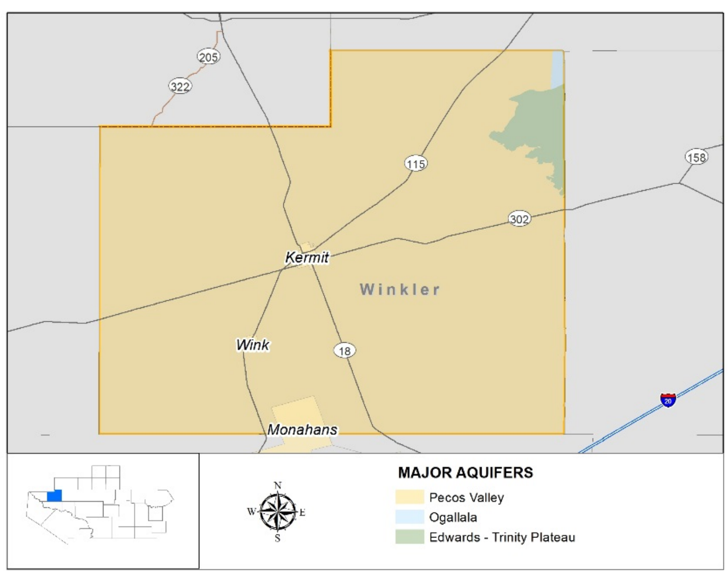
Ward County Summary

Ward County has sufficient supplies to meet its needs. The only shortage identified for Ward County is for steam electric power. It is recommended that development of the Pecos Valley aquifer supplies be implemented to meet this shortage. Conservation is also recommended for Monahans, County-Other, Irrigation and Mining. There are no shortages and no strategies for Livestock and Manufacturing.

Table 5E- 120
Ward County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Monahans	Pecos Valley Aquifer	None	Municipal Conservation
County-Other	Sales from Monahans, Pecos Valley and Dockum Aquifers	None	Municipal Conservation
Irrigation	Reuse sales from Monahans, Dockum Aquifer, Red Bluff Reservoir	None	Irrigation Conservation Weather Modification
Livestock	Livestock Local Supplies, Cenozoic Pecos Alluvium, Dockum Aquifer	None	None
Manufacturing	Pecos Valley Aquifer	None	None
Mining	Pecos Valley Aquifer	None	Mining Conservation/Recycling
Steam Electric	Pecos Valley Aquifer	5,569	Develop Pecos Valley Aquifer Supplies

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 only water user with an identified shortage in Winkler County is Winkler County-Other. There is over 30,000 acre-feet per year of groundwater in Winkler County that is not currently developed and could be used for strategies. Some of this water is planned for development by CRMWD for use outside of the county.

Winkler County Other

Winkler County-Other is comprised of small utilities with less than 500 people and individuals living outside of a named water user group. This compilation of users known as County-Other is projected to have a shortage of about 80 acre-feet per year in 2020, increasing to nearly 400 acre-feet by 2070. To meet these shortages, it is recommended that new groundwater be developed from the Pecos Valley Alluvium.

Potentially Feasible Water Management Strategies Considered for Winkler County Other:

- New Groundwater from Pecos Valley Aquifer

New Groundwater from Pecos Valley Aquifer

This strategy assumes that three new wells would be developed to produce 500 acre-feet per year of additional supply. Since there is no information on the locations of the source or use of this water, no other infrastructure was considered. The capital costs are estimated at $2 million.

Table 5E- 121
Recommended Water Strategies for Winkler County Other

	Capital Cost	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Shortage (ac-ft/yr)		0	104	190	282	357	421
Recommended Strategies (ac-ft/yr)							
Conservation	$0	6	10	12	15	18	20
Water Audit and Leak Repairs	$1,787,400	11	16	20	25	28	32
Pecos Valley Aquifer	$1,908,000	500	500	500	500	500	500
TOTAL	**$3,695,400**	**517**	**526**	**532**	**540**	**546**	**552**

Winkler County Summary

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. As the county grows, it is recommended that new groundwater be developed to meet the increasing municipal demands of County-Other. Kermit, Wink, Irrigation, and Mining have no identified shortages but it is still recommended that they employ conservation strategies as appropriate. Livestock has no needs or recommended strategies.

Table 5E- 122
Winkler County Summary

Water User Group	Current Supplies	Shortage (ac-ft/yr))	Recommended Water Management Strategies
Kermit	Dockum Aquifer	None	Municipal Conservation
Wink	Pecos Valley-Edwards-Trinity Plateau Aquifer	None	Municipal Conservation
County-Other	Dockum and Pecos Valley-Edwards-Trinity Plateau Aquifers	395	Municipal Conservation Additional Pecos Valley aquifer
Irrigation	Pecos Valley-Edwards-Trinity Plateau Aquifer	None	Irrigation Conservation
Livestock	Dockum and Pecos Valley-Edwards-Trinity Plateau Aquifers, Livestock Local Supplies	None	None
Manufacturing	----	----	----
Mining	Dockum and Pecos Valley-Edwards-Trinity Plateau Aquifer	None	Mining Conservation/Recycling
Steam Electric	----	----	----

5E.33 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- 123 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 remain in consistency with the long-term protection of the state's resources as embodied in the guidance principles.

Table 5E- 123
Unmet Needs Summary Table

Water User Group	County	2020	2030	2040	2050	2060	2070
Andrews	Andrews	(26,525)	(25,319)	(25,517)	(26,289)	(27,651)	(27,343)
Irrigation	Andrews	(28,048)	(27,539)	(28,266)	(30,644)	(33,710)	(34,660)
Irrigation	Borden	(3,043)	(2,837)	(2,832)	(2,825)	(2,821)	(2,818)
Irrigation	Brown	(2,626)	(2,320)	(2,292)	(2,260)	(2,224)	(2,189)
Irrigation	Coke	(176)	(124)	(102)	(102)	(102)	(102)
Irrigation	Concho	(4,762)	(4,239)	(4,107)	(4,071)	(4,035)	(3,999)
Mining	Crockett	(986)	(1,089)	(548)	(9)	89	79
Irrigation	Howard	(2,897)	(2,751)	(2,615)	(2,538)	(2,461)	(2,385)
Mining	Howard	(796)	(1,046)	(237)	0	0	0
Irrigation	Irion	(175)	(105)	(38)	(38)	(38)	(38)
Mining	Irion	(946)	(1,099)	(230)	0	0	0
Irrigation	Kimble	(1,349)	(1,104)	(949)	(837)	(732)	(631)
Manufacturing	Kimble	(409)	(460)	(512)	(560)	(624)	(693)
Irrigation	Martin	(23,366)	(22,762)	(21,293)	(21,441)	(20,852)	(20,257)
Irrigation	McCulloch	(2,005)	(1,784)	(1,557)	(1,507)	(1,462)	(1,420)
Mining	McCulloch	(2,993)	(2,482)	(973)	(78)	0	0
Irrigation	Menard	(300)	(166)	(33)	(24)	(16)	(8)
Midland	Midland	0	0	(1,947)	(5,267)	(8,716)	(12,132)
Irrigation	Runnels	(1,552)	(1,335)	(1,239)	(1,221)	(1,203)	(1,185)
Irrigation	Scurry	(6,106)	(5,523)	(5,103)	(4,868)	(4,642)	(4,430)
Mining	Scurry	(132)	(296)	(321)	(211)	(103)	(29)
Irrigation	Tom Green	(30,127)	(25,242)	(23,224)	(23,042)	(22,813)	(22,585)
Total		**(139,318)**	**(129,621)**	**(123,935)**	**(127,832)**	**(134,116)**	**(136,825)**

List of References

[1] 31, 2014 July. "Pecos River Water Quality Coalition Fact Sheet." Pecos River Water Quality Coalition (n.d.): n. pag. Texas Commission on Environmental Quality, 31 July 2014. Web. 26 Mar. 2015.

Chapter 6 Impacts of the Regional Water Plan

6.1 Introduction

The development of viable strategies to meet the demand for water is the primary focus of regional water planning. However, another important goal of water planning 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 2016 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 2016 Region F Water Plan with the State's water planning requirements. To demonstrate compliance with the State's requirements, a matrix has been developed and is included in Appendix G.

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.

6.2 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)	Aquifer Storage and Recovery (ASR)	Brush Control	Precipitation Enhancement
Total dissolved solids (TDS)	+	+ / -		+ / -	+		-	+	+ / -	
Alkalinity	+				+			+		
Hardness	+				+			+		
Dissolved Oxygen (DO)	+	+ / -		+ / -	+			+	+ / -	
Nitrogen	+	+ / -		+ / -	+		-	+	+ / -	
Phosphorus	+	+ / -		+ / -	+			+	+ / -	
Radionuclides						-				
Metals [a]		+		- [a]		- [a]	- [a]			

a. Only for specific metals where there are significant discharges of the metal.
\+ Positive Impact - Negative Impact

6.2.1 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. Steam electric power conservation proposes to use alternative cooling technologies when generating power. This will also alleviate demand on water sources in the region and can be expected to have a positive impact on water quality. Municipal conservation is expected to have similar beneficial impacts but on a smaller scale.

6.2.2 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 discharge is not discharged to a stream, but is land applied.

In Region F, there are eight recommended direct non-potable reuse strategies including:

- Bangs (Direct Non-Potable)
- Brady (Direct Non-Potable)
- Crockett County Mining (Direct Non-Potable)
- Eden (Direct Non-Potable)
- Menard (Direct Non-Potable)

- Midland, Martin, and Andrews County Mining (Direct Non-Potable)
- Mitchell County Mining (Direct Non-Potable)
- Sonora (Direct Non-Potable)

All of these non-potable strategies involve small volumes of water and are expected to have minimal to no impacts on key water quality parameters. In addition to these projects, there are three direct potable reuse projects that have been recommended in Region F including:

- Brownwood (Direct Potable)
- San Angelo (Direct Potable)
- Winters (Direct Potable)

For these direct potable reuse projects, the water 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. Total loading to the stream however should not change significantly.

6.2.3 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.

6.2.4 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 pumpage to meet contractual sales are discussed in Section 6.2.6. 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.

6.2.5 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. This strategy is being recommended for CRMWD, San Angelo, and others in Region F.

6.2.6 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 wastewaters are discharged to local streams. San Angelo is developing treatment systems to remove radionuclides and is planning to reuse their wastewater effluent 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.

6.2.7 Desalination (Advanced Treatment)

Desalination of brackish groundwater is a recommended strategy for several entities in Region F. With new technologies, desalination has become a potentially viable option for the treatment of brackish and high nitrate source waters. However, 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, and metals.

There are two recommended desalination water management strategies:

- City of San Angelo, treatment of Other Aquifer supplies from Tom Green County
- CRMWD treatment of the surface water desalination of their diverted water system

The San Angelo groundwater strategy proposes to dispose of the waste stream through deep well injection. The surface water desalination strategy (CRMWD) discharges the waste stream back into the diverted water system which is already brackish. The proposed treatment process will treat brackish water and make it suitable for municipal use. The finished water will be of comparable or higher quality than existing supplies and will have minimal impacts to area surface water.

6.2.8 Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) is a strategy that treats surface water or brackish groundwater to drinking water standards and then pumps this water into an aquifer for storage. The water is later recovered from the aquifer for use. This allows for optimal sizing of treatment systems and reduces evaporative losses associated with reservoir storage, preserving water resources for future use. ASR, if used as part of a conjunctive use strategy, may allow a reservoir operator to minimize impacts to key water quality parameters while still providing users with sufficient supplies from stored groundwater. ASR is expected to have minimal impacts on key water quality parameters of water in the aquifer because the treated water being pumped into the aquifer will be of equal or great quality than the supply already in the aquifer. This strategy is recommended for CRMWD.

6.2.9 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.

6.2.10 Precipitation Enhancement

Precipitation enhancement is a recommended strategy for irrigators in counties with an active weather modification program. These operations are already in progress, so there are no expected changes in water quality associated with this strategy.

6.3 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/Winkler County Well Field Expansion
- Midland T-Bar Well Field Expansion
- City of San Angelo McCulloch County Well Field Phase 2
- San Angelo Brackish Groundwater Development
- San Angelo Reuse

Of these five strategies, four already hold the rights to that water. Only San Angelo brackish groundwater development would require obtaining new water rights. 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 and Midland well fields are located in areas where very little groundwater is used for other purposes. The San Angelo well field may impact wells in rural communities that also depend on the Hickory aquifer. However, pumping and well spacing limits set by the Hickory Underground Water Conservation District should minimize the potential impacts. Further studies may be required to determine the potential impacts of the San Angelo well field.

Another strategy that involves moving water from rural to urban areas is the San Angelo brackish groundwater strategy. This strategy proposes to use water that is not currently usable for rural and agricultural purposes. This strategy would have little to no impacts on rural communities.

San Angelo's treated wastewater effluent is currently used to supply the local irrigation district as a substitute for Twin Buttes water. Implementation of this reuse strategy will make this water unavailable to the irrigation district and will likely impact these users. Irrigators may have to plant less water intensive crops, convert to dry land farming, find alternative sources of supply, or reduce the number of irrigated acres.

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.

6.4 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 2020 population would be reduced by 5,773, which is approximately 0.8%.
- Without any additional supplies, the projected water needs would reduce the region's projected 2020 employment by 31,500 jobs (8 percent reduction). This declines to 29,400 lost jobs by 2070. Most of this reduction occurs in the mining sector. Manufacturing and municipal sectors are the next biggest contributors.
- Without any additional supplies, the projected water needs would reduce the region's projected annual income in 2020 by approximately $5.8 billion. This represents about 19 percent of the region's current income. The loss in income reduces to approximately $2.9 billion in 2070, after the mining boom was projected to have ended.

The full analysis performed by the TWDB is included in Appendix I.

6.5 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 those 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 of the region. TWDB has designated two special water resources in Region F: 1) Oak Creek Reservoir, which supplies water to the City of Sweetwater in Brazos G, and 2) Ivie Reservoir, which supplies water to the City of Abilene in Brazos G. Supplies to these entities are included in the Region F Plan.

6.6 Consistency with the Protection of Water Resources

The water resources in Region F include three river basins providing surface water, and 11 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.

Figure 6-1
Regional Water Planning Area Map

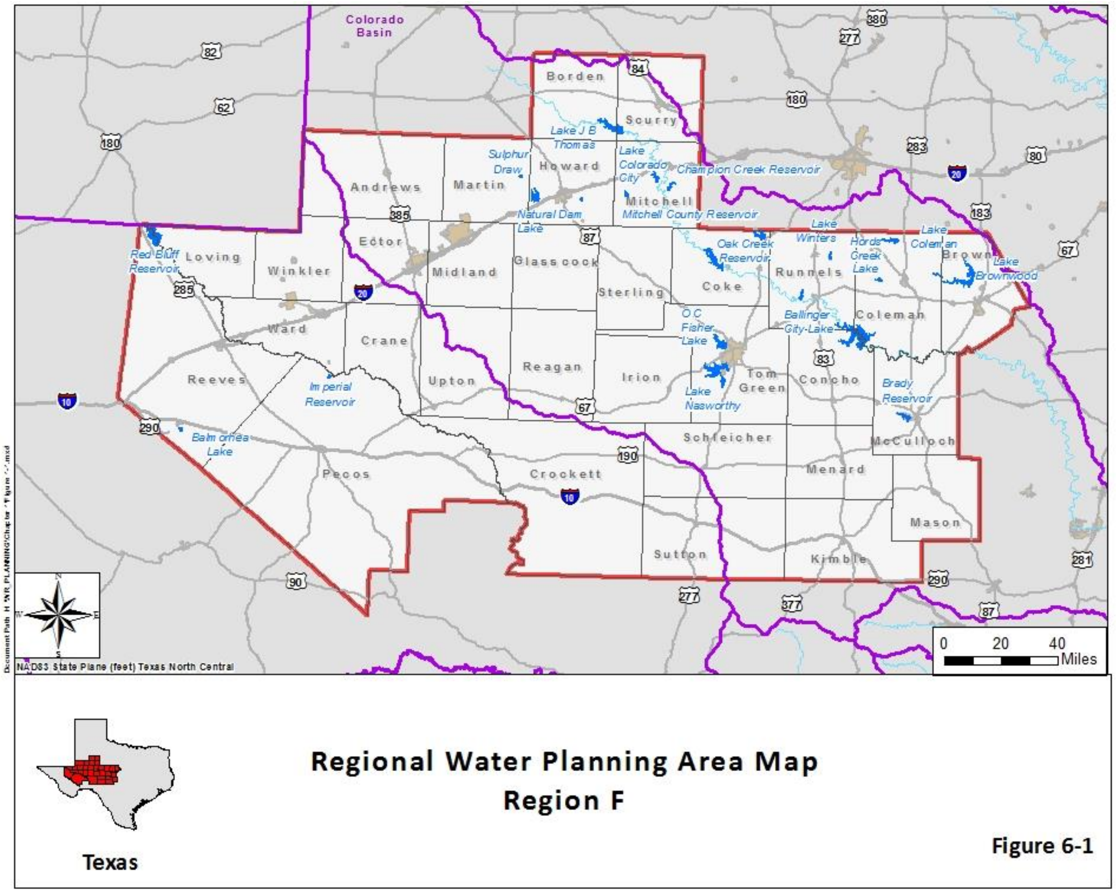


Figure 6-2 shows the major aquifers in Region F, and Figure 6-3 shows the minor aquifers. There are a total of 11 aquifers that supply water to the 32 counties in Region F. The major aquifers are the Edwards-Trinity Plateau, Ogallala, Pecos Valley, and a small portion of the Trinity. The minor aquifers are Dockum, Hickory, Lipan, Ellenburger-San Saba, Marble Falls, Rustler, 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.

Figure 6-2
Major Aquifers in Region F

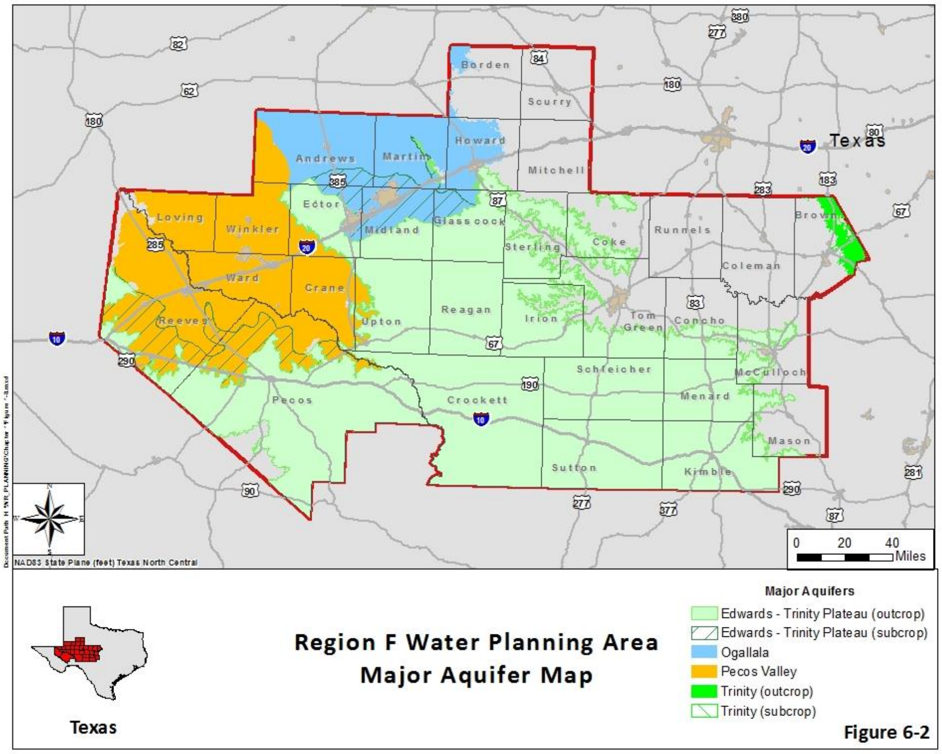
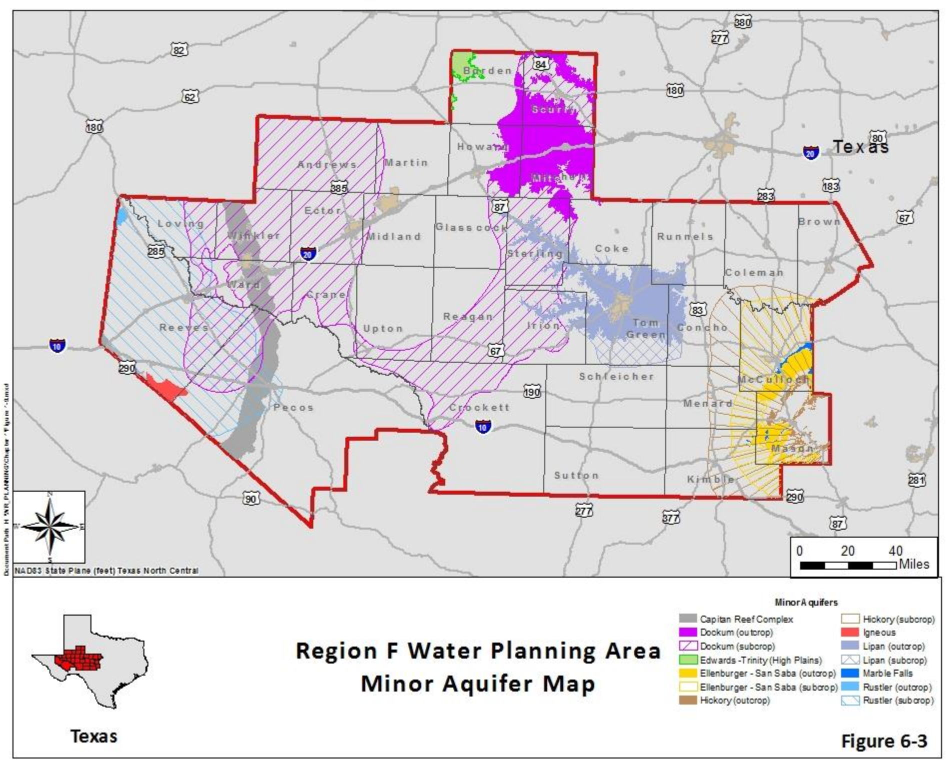


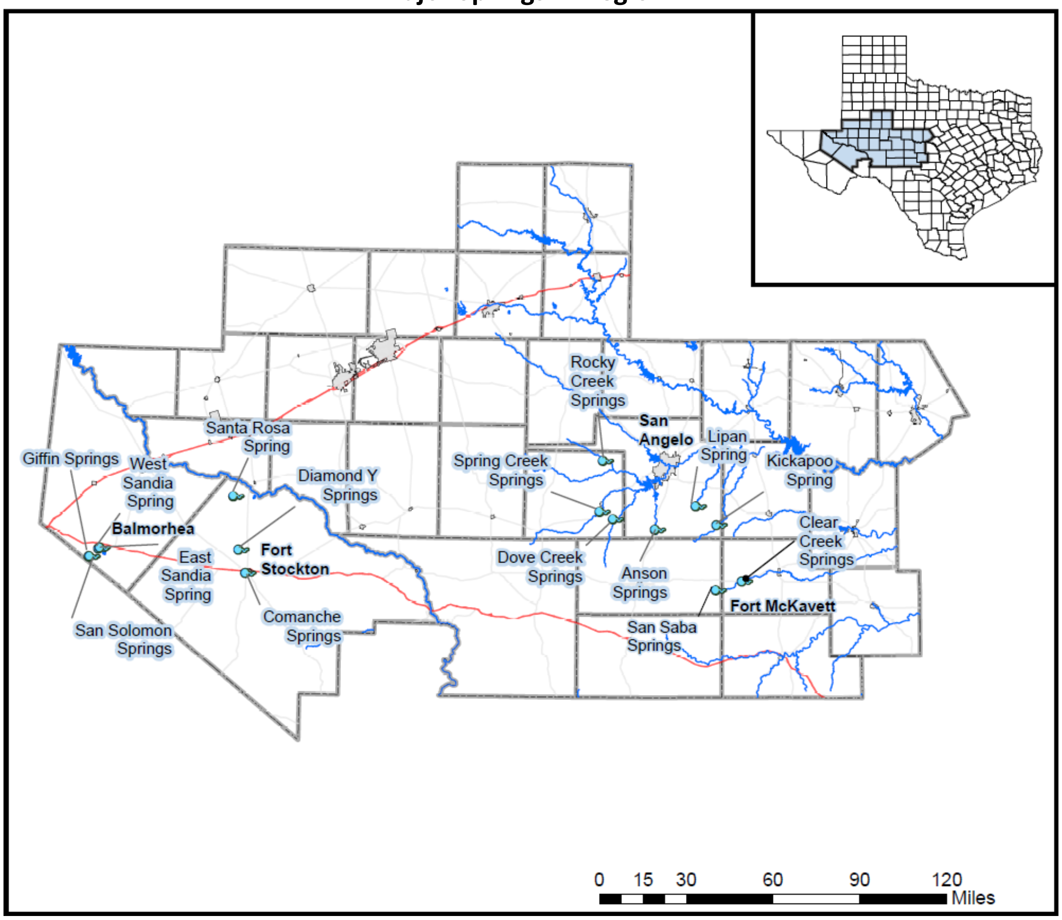
Figure 6-3
Minor Aquifers in Region F



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 supply 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 habitat. Region F identified 14 major springs, which are shown on Figure 6-4. 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 6-4
Major Springs in Region F



The Edwards-Trinity Plateau and Ogallala aquifers are the largest sources of groundwater in Region F, providing 32 percent and 21 percent of the total groundwater pumped in 2008, respectively. The Lipan aquifer provided 13 percent of the 2008 totals. The Pecos Valley and Other Undifferentiated aquifers each provided 12 percent of the 2008 total pumpage, with all other aquifers contributing less than 10 percent. (Note: 2008 is the last year that the TWDB provided data on pumpage by aquifer.)

The protections of water resources were considered through the supply allocation process and the development of water management strategies. For surface water, the distributions 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 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.

6.6.1 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 41,000 acre-feet of water annually by 2020, reducing impacts on both groundwater and surface water resources. By 2070, the recommended conservation strategies savings (excluding wastewater reuse) total over 96,000 acre-feet per year. These savings are in addition to the water savings assumed in the demands.

6.6.2 Wastewater Reuse

This strategy will provide high quality treated wastewater effluent for municipal and mining water needs in the region. This strategy will decrease the future demands on surface and groundwater sources and will not have a major impact on water resources. However, 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.

6.6.3 Subordination of Downstream Water Rights

The Colorado WAM 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.

6.6.4 Voluntary Transfers

Under this strategy, surface and ground water rights holders with surplus 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 manufacturing, irrigation, and County-Other users. Additionally, in some cases, this strategy is proposed for a transfer from irrigation users to municipal users on a willing buyer, willing seller basis. As proposed, this strategy will only use water that is available on a sustainable basis and will not significantly impact water resources.

6.6.5 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.

6.6.6 New or Expanded Use of Groundwater

This strategy is recommended for entities with limited alternative sources and sufficient groundwater supplies to meet needs. 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 technical review of the potential impacts of these strategies, water resources would not be significantly impacted. The protections for public health and safety is paramount in this plan.

6.6.7 Desalination

The City of San Angelo, Concho Rural WSC, and CRMWD have recommended long-term strategies to desalinate brackish groundwater. Desalination represents an important additional source of water that could be used to augment existing freshwater sources.

6.6.8 Aquifer Storage and Recovery (ASR)

Aquifer Storage and Recovery represents an important solution to high evaporative losses from reservoirs during drought. CRMWD is also proposing to use ASR to store treated surface water from their existing lakes and/or diverted water system. This will preserve otherwise unusable water for times when it is needed most. ASR may also make brackish groundwater desalination more viable by reducing the need for peak time treatment capacity. ASR strategy is not expected to threaten water resources of the State, but rather to preserve surface water resources for future use and allow increased use of brackish groundwater in a more economical manner.

6.6.9 Brush Control

This strategy will support the surface water supplies in the region by reducing losses associated with evapotranspiration of invasive brush species.

6.6.10 Precipitation Enhancement

This strategy will support the water supplies in the region by increasing streamflows and reducing irrigation demands due to increased rainfall.

6.7 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 aspect of agriculture for 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. The transfer of agricultural water for other purposes would only occur on a willing buyer, willing seller basis. In some cases, development of additional supplies for irrigated agriculture are 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	2020	2030	2040	2050	2060	2070
Andrews	(26,525)	(25,321)	(25,519)	(26,290)	(27,652)	(27,344)
Borden	(3,043)	(2,837)	(2,832)	(2,825)	(2,821)	(2,818)
Brown	(2,633)	(2,327)	(2,299)	(2,267)	(2,231)	(2,196)
Coke	(176)	(124)	(102)	(102)	(102)	(102)
Concho	(4,762)	(4,239)	(4,107)	(4,071)	(4,035)	(3,999)
Ector	(80)	0	0	(6)	(136)	(241)
Howard	(2,897)	(2,750)	(2,615)	(2,538)	(2,461)	(2,385)
Irion	(176)	(105)	(39)	(39)	(39)	(39)
Kimble	(1,349)	(1,104)	(949)	(837)	(732)	(631)
Martin	(23,366)	(21,011)	(17,855)	(18,003)	(17,414)	(16,819)
McCulloch	(2,005)	(1,784)	(1,557)	(1,507)	(1,462)	(1,420)
Menard	(299)	(166)	(33)	(24)	(16)	(8)
Runnels	(1,552)	(1,335)	(1,239)	(1,221)	(1,203)	(1,185)
Scurry	(6,106)	(5,523)	(5,103)	(4,868)	(4,642)	(4,430)
Total	**(105,296)**	**(94,068)**	**(87,672)**	**(87,839)**	**(87,958)**	**(86,401)**

In addition to irrigated agriculture, dry land agriculture and the ranching industry are important economically and culturally to the region. 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 area's 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.

6.8 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.

6.8.1 Threatened/Endangered Species

A list of threatened or endangered species located within Region F is contained in Table 1-13, in Chapter 1. Included are fifteen species of birds, two crustaceans, nine fishes, six mammals, three reptiles, one snail, eleven mussels, and two flowering plants. 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.

6.8.2 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 a number of 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.

6.8.3 Energy Reserves

Thousands of producing oil and gas wells are located within Region F, representing an important economic base for the region. The 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 in actuality operators may exceed the MAG availability. The mining industry is not expected to be adversely impacted by this plan.

Table 6-3 below summarizes the unmet mining needs in Region F.

Table 6-3
Unmet Mining Needs in Region F

Water User Group	2020	2030	2040	2050	2060	2070
Crockett	(986)	(1,089)	(548)	(9)	0	0
Howard	(622)	(854)	(101)	0	0	0
Irion	(946)	(1,099)	(230)	0	0	0
McCulloch	(2,993)	(2,482)	(973)	(78)	0	0
Scurry	(132)	(296)	(321)	(211)	(103)	(29)
Total	**(5,679)**	**(5,820)**	**(2,173)**	**(298)**	**(103)**	**(29)**

6.9 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 the City of Andrew's future groundwater development strategy because of this limitation. As a result, the City of Andrews shows an unmet municipal need in this plan. However, the city is planning to pursue the development of additional groundwater above the MAG to protect the public health and safety of their residents. The City is able to do this because there is no GCD limit groundwater production.

The City of Midland also shows an unmet municipal need in this plan beginning in 2040. The City of Midland is part of the West Texas Water Partnership. The Partnership is actively pursuing the study of potential options for future water supplies. However, the study is not complete and specific sources of supply have not been explicitly identified and therefore cannot be included in the plan at this time. However, the needs of the City of Midland are expected to be fully met through this Partnership before an unmet need arises. The City has provided a letter to this effect which is included in Appendix L. The public health and safety of the residents of Midland will not be compromised.

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 and Midland. Drought management was also considered for both 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 6-4 below summarizes all municipal unmet needs in Region F.

Table 6-4
Municipal Unmet Needs

Water User Group	2020	2030	2040	2050	2060	2070
Andrews [a]	(1,523)	(2,220)	(2,748)	(4,355)	(6,059)	(7,316)
Midland	0	0	(1,910)	(5,227)	(8,670)	(12,081)
Total	**(1,523)**	**(2,220)**	**(4,658)**	**(9,582)**	**(14,729)**	**(19,397)**

a. Includes Andrews County Manufacturing unmet need.

6.10 Consistency with Economic Development

Consistent with the guiding principles for regional water planning, the Region F Water Plan provides for the 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.

There is one unmet manufacturing need in the region in Kimble County. The manufacturing demand in Kimble County is dominated by Grayden Cedarworks. The cedar processing plant currently diverts around 600 acre-feet per year but can only consume 50 acre-feet per year. The remainder of the diversions must be returned to the streams for downstream water-right holders. This difference in diversions and consumptive use artificially inflates the manufacturing demands in Kimble County. Thus, strategies were only developed to meet the consumptive shortage for Grayden Cedarworks and other manufacturers in Kimble County. This amounts to about 400 to 700 acre-feet of unmet need throughout the planning period. However, this shortage is artificial and the economic development of Kimble County and Region F has been ensured by this plan. Table 6-5 shows the manufacturing unmet need in Region F.

Table 6-5
Manufacturing Unmet Needs

Water User Group	2020	2030	2040	2050	2060	2070
Manufacturing Kimble County	(399)	(450)	(502)	(550)	(614)	(683)

6.11 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 358.3

The information, data, evaluation, and recommendations included in the Region F Water Plan collectively comply with these regulations. To assist with demonstrating compliance, Region F has developed a matrix addressing the specific recommendations contained in the above referenced regulations.

The matrix is a checklist highlighting each pertinent paragraph of the regulations. The content of the Region F Water Plan has been evaluated against this matrix. Appendix G contains a completed matrix.

6.12 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 were considered through assessment of environmental impacts, impacts to agricultural and rural areas and impacts to natural resources.

In this plan, existing in-basin or region supplies were utilized as feasible before recommendations for new water supply projects. Wastewater reuse is 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 and steam electric power 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*, March 20, 1999.

Chapter 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 28 inches in the east to slightly more than 10 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:

- *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.

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.

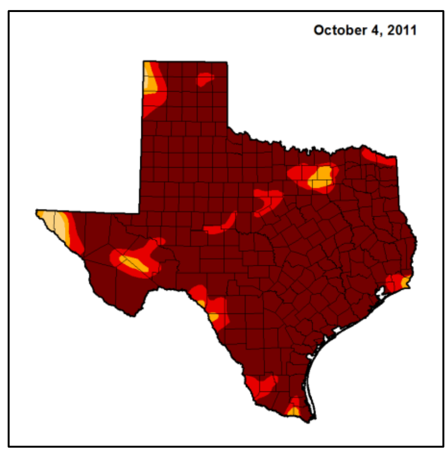
Droughts have often been described as "insidious by nature." This is mainly due to several factors:

- 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 Conditions and Drought of Records

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.



Drought Monitor, October 2011

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 of record that includes the minimum content of the reservoir. The period is recorded from the last time the reservoir spills before reaching its minimum content to the next time the reservoir spills. If a reservoir has reached its minimum content but has not yet filled enough to spill, then it is considered to be still in drought of record conditions. Based on the water availability modeling, most of the reservoirs in Region F are currently experiencing a new drought of record. The minimum content of many reservoirs in the Colorado River Basin occurs at or near the end of the modeling simulation in December 2013. If the drought continues, the minimum content of the reservoir could continue to decrease, reducing the firm yield of the reservoirs. The drought of records for the reservoirs in Region F are shown below in Table 7-1.

Table 7-1
Droughts of Record in Region F

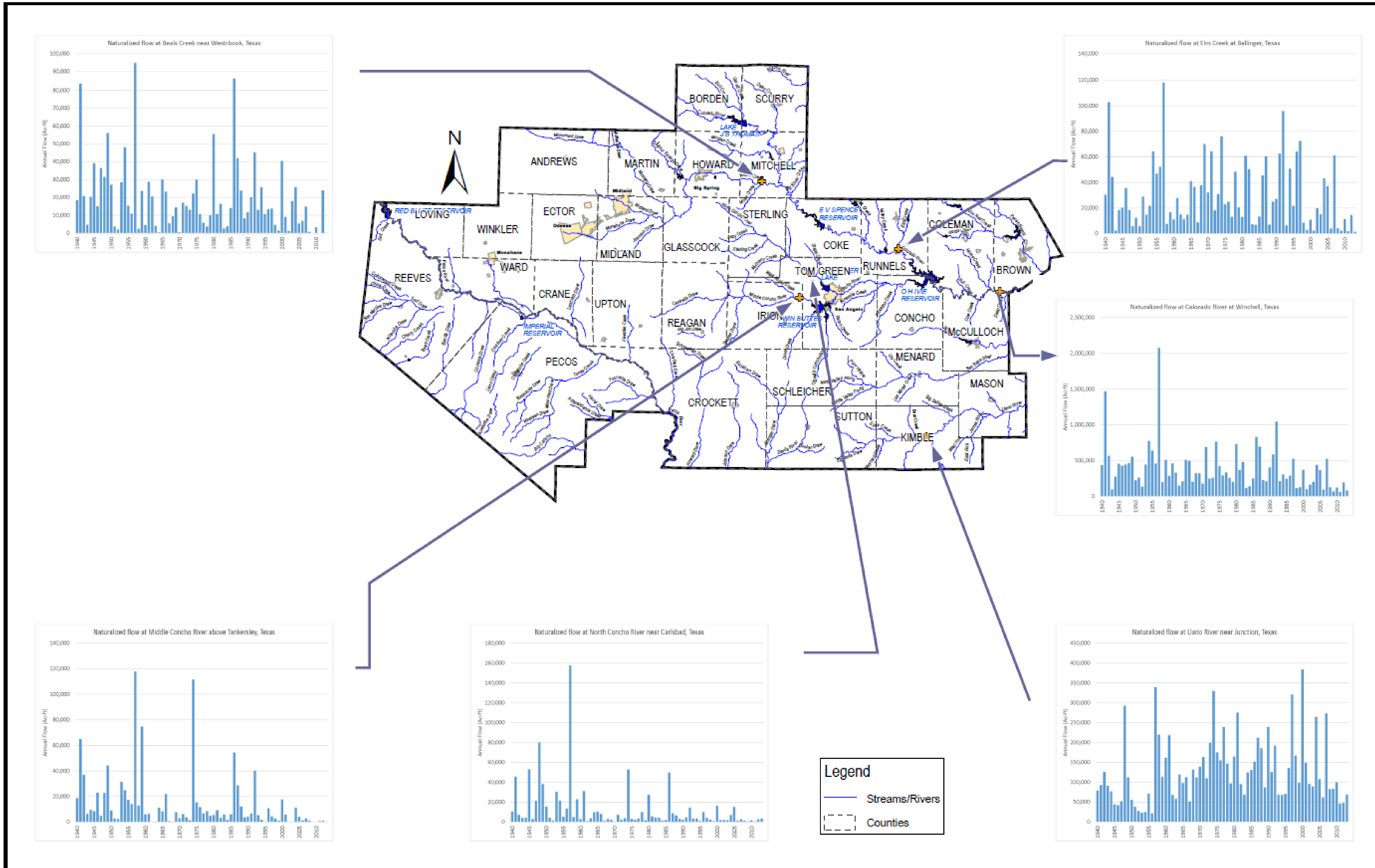
Reservoir	Date last full	Date of minimum content	Drought of Record
Ballinger/Moonen	March 2008	August 2012	2008 – Current
Balmorhea	February 1997	September 2000	1997 – 2000
Brady Creek	March 1998	June 2013	1998 – Current
Brownwood	July 2007	September 2013	2007 – Current
Champion Creek	May 1987	August 2012	1987 – Current
Coleman	August 2007	December 2013[b]	2007 – Current
Colorado City	May 1994	May 2003	1994 – Current
Hords Creek	July 2007	December 2013[b]	2007 – Current

Reservoir	Date last full	Date of minimum content	Drought of Record
Lake Clyde	August 2007	December 2013[b]	2007 – Current
Mountain Creek	May 2008	August 2012	2008 – Current
Nasworthy	April 2008	October 2013	2008 – Current
Oak Creek	June 1997	August 2012	1997 – Current
O.C. Fisher	June 1987	September 2013	1987 – Current
O.H. Ivie	June 1997	December 2013[b]	1997 – Current
Red Bluff	March 1943	September 2000[b,c]	1943 – 2000
Spence	June 1992[a]	August 2012	1992 – Current
Thomas	September 1962[a]	December 2013[b]	1962 – Current
Twin Buttes	March 1993	December 2013[b]	1993 – Current
Winters	June 1997	August 2012	1997 – Current

a. This reservoir has never filled. The Date Last Full is based on the firm yield analyses. (Note: Firm yield analyses assume the reservoir is full at the beginning of the simulation.)
b. Date of the end of the simulation.
c. Hydrology for WAM simulations for the Rio Grande River Basin end in 2000. It was not extended.

Drought of record conditions for run of the river supplies are typically evaluated based on minimum annual stream flows. Figure 7-1 shows the variations in naturalized flows from the WAM for seven U.S. Geological Survey (USGS) streamflow gages in Region F.[1] The five gages on tributaries have watersheds with limited development and show the natural variation in streamflows in this region. The Colorado gage near Winchell is the most downstream gage on the main stem of the Colorado River in Region F. Flows at the Pecos River gage near Girvin are largely controlled by releases from Red Bluff Reservoir. Based on the naturalized flows at these locations, the 2011 drought is the drought of record for the run-of-river supplies in the Colorado Basin with the exception of the Llano River where the drought of record is still in the 1950s. The drought of 2011 is also the drought of record for the Rio Grande River Basin in Region F.

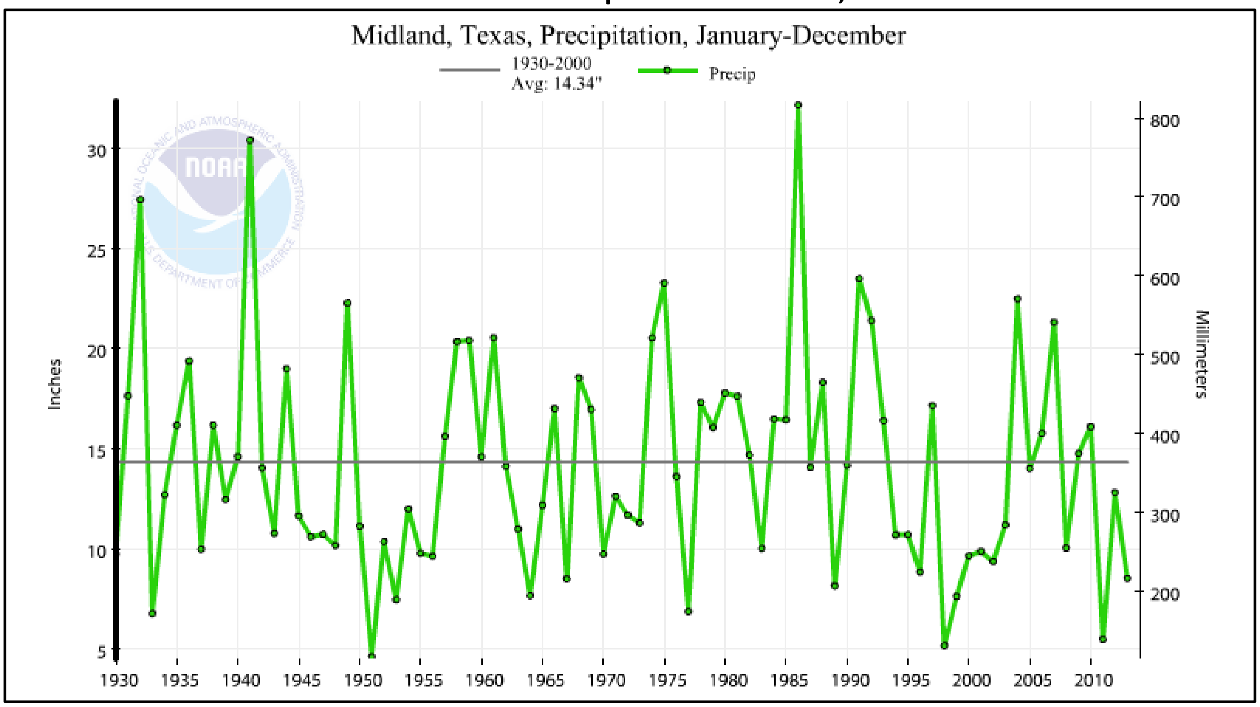
Figure 7-1
Region F Annual Streamflow



* Natural Dam Lake, which is above the Beals Creek gage, spilled intermittantly during 1986 and 1987. Natural Dam has subsequently been improved so that spills from the lake will not reoccur.

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 7-2 shows the historical precipitation for Midland, Texas. 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 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 5.16 inches were recorded in 1998. In 2011, 5.47 inches were recorded. For both the 1950's drought and the recent drought, annual rainfall is significantly below average for an extended number of years. The current drought rivals the 1950's drought. Ten of the last fifteen years show rainfall less than the historic average. This is similar to the drought of the 1950s.

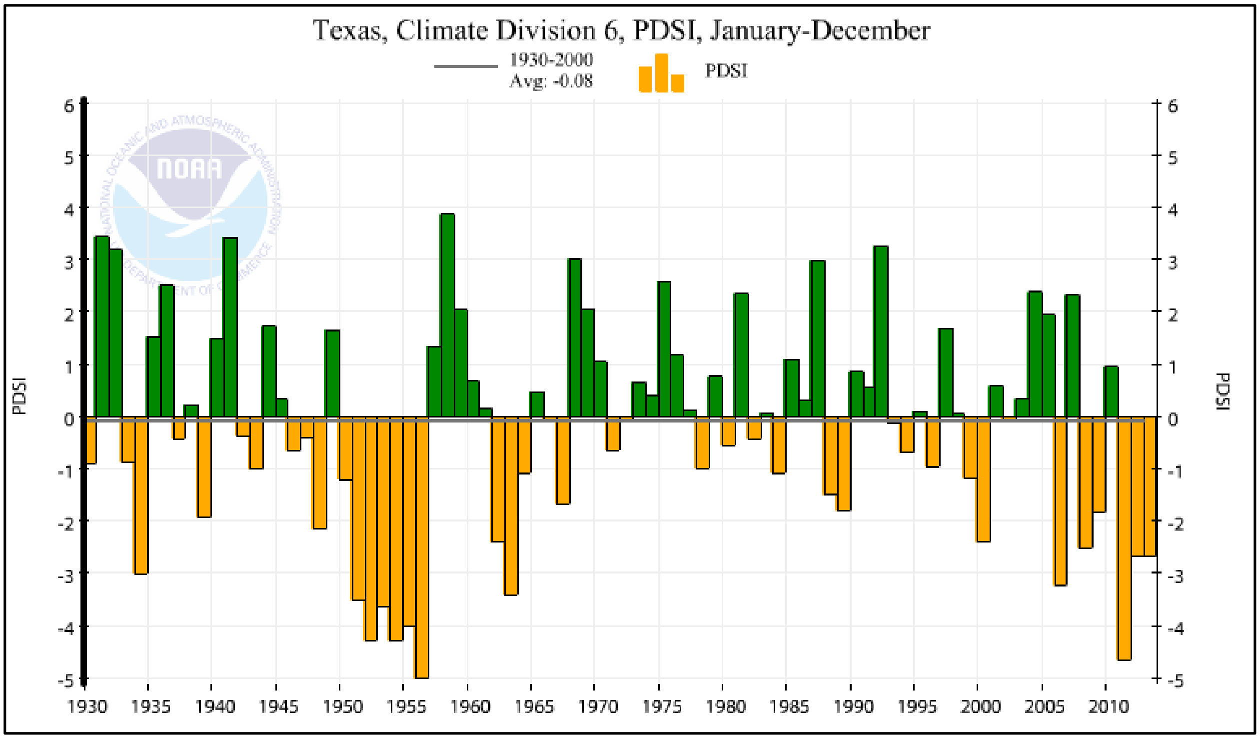
Figure 7-2
Historical Annual Precipitation in Midland, Texas



Looking at the Palmer Drought Severity Indices over the same time period for Climate Region 6 (where most of Region F is located), Figure 7-3 clearly shows the drought impacts during the 1950s and again since 2011. 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 current drought that began in 2011 is nearly as severe.

Figure 7-3
Palmer Drought Severity Indices for Edwards Plateau, Texas



7.2 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 a result of this current drought, many reservoirs have shown reductions in yield of about 50 percent. These yields may continue to decline if the 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, many have been 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 as a way 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.

7.2.1 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 submit Drought Contingency Plans. TCEQ now also requires all retail public water suppliers serving less than 3,300 connections to prepare and adopt Drought Contingency Plans by no later than May 1, 2009. All Drought Contingency Plans shall be updated every five years and be available for inspection upon request. The most recent updates were to be submitted to the TCEQ by May 1, 2014. Drought Contingency Plans typically identify different stages of drought and specific triggers and responses for each stage. In addition, the plan must 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 Drought Contingency Plans and readiness to implement the Drought Contingency Plans as necessary. These drought plans include specific water savings goals and measures associated with multiple drought stages. In addition to these plans, many water providers have a Management Supply Factor (or safety factor) greater than 1.0 for demands that are essential to public health and safety.

7.2.2 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. Other cities, such as Midland, 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 based on water well elevations or 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.

Seventeen Drought Contingency Plans were submitted to Region F during this round of planning. Half of the submitted plans use trigger conditions based on the demands placed on the water distribution system. The other half are supply based. Table 7-2 summarizes the basis of the drought triggers by provider. Appendix H, Table H-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

Entity	Type Trigger Conditions	
	Demand	Supply
Ballinger		X
Balmorhea		X
Big Spring		X
Brookesmith	X	X
Brown County WID	X	
Brownwood	X	X
CRMWD		X
Early City	X	
Fort Stockton	X	
Menard City		X
Midland	X	

Entity	Type Trigger Conditions	
	Demand	**Supply**
Mitchell County Utility Co		X
Monahans	X	X
Odessa	X	
Robert Lee	X	X
Snyder	X	
Upton County WD	X	X

As of February 18, 2015, there are 53 entities that have initiated their Drought Contingency Plan. These include all the customers of BCWID #1, CRMWD, San Angelo, and several smaller independent communities.

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 current drought. Groundwater in Region F provides a more drought-resilient water source, but it needs to be managed to assure future supplies.

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 through a survey process in order to better evaluate existing and potentially feasible emergency interconnects. Pecos County WCID and the City of Fort Stockton were described in the survey to have reverse capabilities of who could provide and who could receive. In addition, two of the four systems within Concho Rural Water North Concho Lake Estates system are linked. Table 7-3 presents the survey results for the 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
Millersview-Doole WSC	City of Paint Rock
City of San Angelo	Millersview-Doole WSC
City of Fort Stockton	Pecos Co. Water District
Pecos Co. WCID #1	City of Fort Stockton
Concho Rural Water N. Concho Lake Estates	CRWC Grape Creek
Zephyr WSC	City of Blanket

7.3.2 Potential Emergency Interconnects

Responses to survey questions helped identify other potential emergency interconnects for various WUGs in Region F. Table 7-4 presents a list of cities for those receiving and those supplying the potential emergency interconnects.

Table 7-4
Potential Emergency Interconnects to Major Water Facilities in Region F

Entity ***Providing*** **Supply**	Entity ***Receiving*** **Supply**
Millersview-Doole WSC	City of Miles
CRMWD	Wickett

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 time in a reasonable timeframe.

7.4 Emergency Responses to Local Drought Conditions or Loss of Municipal Supply

Texas Statute §357.42(g) requires regional water planning groups to evaluate potential temporary emergency water supplies for all County-Other WUGs and municipalities with 2010 populations less than 7,500 that rely on a sole source of water. The purpose of this evaluation is to identify potential alternative water sources that may be considered for temporary emergency use in the event that the existing water supply sources become temporarily unavailable due to extreme hydrologic conditions such as emergency water right curtailment, unanticipated loss of reservoir conservation storage, or other localized drought impacts.

This section provides potential solutions that should act as a guide for municipal water users that are most vulnerable in the event of a loss of supply. This review was limited and did not require technical analyses or evaluations following 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 all 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.

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, but other brackish groundwater supplies can be obtained from the Hickory, Ellenburger-San Saba, Lipan, Capitan Reef and other formations which underlie the shallow aquifers found in Region F.

Required infrastructure would include additional groundwater wells, potential treatment facilities and conveyance facilities. Brackish groundwater at lower TDS concentrations may require only limited treatment. All but four of the entities listed in Table 7-5 will 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

In the event that the existing water supply sources become temporarily unavailable, drilling additional groundwater wells and trucking in water are possible solutions. 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 Name	County	2020 Population	2020 Demand (AF/year)	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	1,673	207	▪	▪	▪	▪		▪	▪			
Early	Brown	2,882	290	▪	▪	▪	▪		▪	▪	Pipeline	City of Brownwood	
Zephyr WSC	Brown	4,606	379	▪	▪	▪	▪			▪			▪
Santa Anna	Coleman	1,125	157	▪	▪	▪	▪			▪			
Greater Gardendale WSC	Ector	1,974	164			▪	▪	▪		▪			
	Midland	1,007	84			▪	▪	▪		▪			
Mertzon	Irion	823	102			▪	▪	▪		▪			
Junction	Kimble	2,632	627	▪	▪	▪	▪	▪		▪			
Mason	Mason	2,114	694			▪				▪			
Menard	Menard	1,472	346			▪	▪	▪		▪			
Colorado City	Mitchell	5,064	1,287			▪	▪			▪			
Loraine	Mitchell	627	73			▪				▪			

Entity				Implementation Requirements									
Water User Group Name	County	2020 Population	2020 Demand (AF/year)	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
Iraan	Pecos	1,347	459			▪	▪	▪	▪	▪	Pipeline; Pump Station; Treatment	Pecos Co. Precinct #3	
Pecos County WCID #1	Pecos	3,451	439			▪	▪	▪	▪	▪	Pipeline	City of Ft. Stockton	▪
Big Lake	Reagan	3,360	731			▪	▪	▪		▪			
Madera Valley WSC	Reeves	2,025	586			▪	▪	▪		▪			
Winters	Runnels	2,628	216	▪	▪	▪		▪	▪	▪	Pipeline	City of Abilene (Ivie Pipeline)	
Eldorado	Schleicher	1,952	614			▪				▪			
Sterling City	Sterling	944	276			▪	▪	▪		▪			
Sonora	Sutton	3,319	1,239			▪				▪			
McCamey	Upton	2,076	776			▪	▪	▪		▪			
Rankin	Upton	856	277			▪	▪			▪			
Wink	Winkler	1,063	360			▪	▪	▪		▪			

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 H-2 in Appendix H.

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 H-3 in Appendix H. The region also recognizes any modification to these drought triggers that are adopted by the regional operator.

Lake Brownwood (Brown County WCID #1)

BCWID #1 adopted their current Drought Contingency Plan in June of 2014. 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 1420 ft. (76% capacity)	Advise customer of early conditions. Initiate Stage I of DCPs. Increase public education. Request voluntary conservation measures.
Moderate	Elevation below 1417 ft. (64% capacity)	Request decrease in water usage. Implement watering restrictions.
Severe	Elevation below 1414 ft. (52% capacity)	Request to severely reduce water usage. Watering restrictions. District may reduce water delivery in accordance with pro rata curtailment.
Exceptional	Elevation below 1411 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.
Emergency	Elevation below 1408 ft. (34% capacity)	Above. Any other necessary actions.

O.H. Ivie Reservoir (CRMWD)

The Board of Directors of CRMWD adopted their current Drought Contingency Plan in 2009. The triggers are associated with each reservoir's elevation level. The actions for each reservoir are similar but also unique. The triggers and actions related to the elevation of O.H. Ivie are outlined below in Table 7-7.

Table 7-7
O.H. Ivie Drought Triggers and Actions

Drought Stage	Trigger	Action[a]
Mild	Elevation below 1,517.73 ft.	Request any customer that CRMWD finds to be dependent on this source to implement Stage 1 of their DCP.
Moderate	Elevation below 1,512.07 ft.	Request all customers that CRMWD finds to be dependent on this source to implement Stage 2 it their DCPs. Refrain from making any large-scale releases from Ivie Reservoir for water quality purposes.
Severe	Elevation below 1,504.46 ft.	Request all customers that CRMWD finds to be dependent on this source to implement Stage 3 it their DCP.

a. All stages include initiation of engineering studies to evaluate alternative actions if conditions worsen and the implementation of viable alternative water supplies.

E.V. Spence Reservoir (CRMWD)

The Board of Directors of CRMWD adopted their current Drought Contingency Plan in 2009. The triggers are associated with each reservoir's elevation level. The actions for each reservoir are similar but also unique. The triggers and actions related to the elevation of E.V. Spence are outlined below in Table 7-8.

Table 7-8
E.V. Spence Drought Triggers and Actions

Drought Stage	Trigger	Action [a]
Mild	Elevation below 1,846.67 ft.	Request the Cities of Robert Lee and San Angelo and any other customers that CRMWD finds to be dependent on this source to implement Stage 1 of their DCP. Refrain from any large releases from Spence Reservoir for water quality purposes.
Moderate	Elevation below 1,842.18 ft.	Request the Cities of Robert Lee and San Angelo and any other customers that CRMWD finds to be dependent on this source to implement Stage 2 of their DCP.
Severe	Elevation below 1,836.52 ft.	Request the Cities of Robert Lee and San Angelo and any other customers that CRMWD finds to be dependent on this source to implement Stage 3 of their DCP. Refrain from transferring water from Spence Reservoir to any other source.

a. All stages include initiation of engineering studies to evaluate alternative actions if conditions worsen and the implementation of viable alternative water supplies.

J.B. Thomas Reservoir (CRMWD)

The Board of Directors of CRMWD adopted their current Drought Contingency Plan in 2009. The triggers are associated with each reservoir's elevation level. The actions for each reservoir are similar but also unique. The triggers and actions related to the elevation of J.B. Thomas are outlined below in Table 7-9.

Table 7-9
J.B. Thomas Drought Triggers and Actions

Drought Stage	Trigger	Action [a]
Mild	Elevation below 2,216.32 ft.	Request the City of Snyder and any other customers that CRMWD finds to be dependent on this source to implement Stage 1 of their DCP. Discontinue pumping operations at the Big Spring/Odessa intake.
Moderate	Elevation below 2,213.90 ft.	Request the City of Snyder and any other customers that CRMWD finds to be dependent on this source to implement Stage 2 of their DCP. Begin operation of the Snyder Well Field.
Severe	Elevation below 2,211.10 ft.	Request the City of Snyder and any other customers that CRMWD finds to be dependent on this source to implement Stage 3 of their DCP. Begin "pump back" operation with water from Ivie or Spence Reservoirs, if available.

a. All stages include initiation of engineering studies to evaluate alternative actions if conditions worsen and the implementation of viable alternative water supplies.

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 2014. The triggers and actions for these reservoirs are based on combined storage and supply from all of the City's sources (including non-reservoir sources). These are outlined in Table 7-10 below.

Table 7-10
O.C Fisher, Twin Buttes and Nasworthy Drought Triggers and Actions

Drought Stage	Trigger	Action
Mild	Less than 24 months supply	Water restrictions; water usage fee.
Moderate	Less than 18 months supply	Above.
Critical/Emergency	Less than 12 months supply	Above.

7.5.2 Drought Trigger Conditions for Run-of-River and Ground Water Supply

Both run-of-river and ground water supplies are more regional than reservoirs and typically there are many users of these sources. As noted in Section 7.2.1, some water providers will 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. 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 for the Drought Monitor for corresponding Region F drought triggers. Table 7-11 shows the categories adopted by the U.S. Drought Monitor and the associated Palmer Drought Index.

Table 7-11
Drought Severity Classification

Category	Description	Possible Impacts	Palmer Drought Index
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	-1.0 to -1.9
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested	-2.0 to -2.9
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed	-3.0 to -3.9
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions	-4.0 to -4.9
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less

U.S. Drought Monitor: http://droughtmonitor.unl.edu/AboutUs/ClassificationScheme.aspx

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 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.

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 for wholesale and retail public water suppliers and irrigation districts. A Drought Contingency Plan 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 Drought Contingency Plans by suppliers when appropriate to reduce demand during drought and prolong current supplies.

7.7 Other Drought Recommendations

7.7.1 Texas Drought Preparedness Council and Drought Preparedness Plan

In accordance with TWDB rules, all relevant recommendations from the Drought Preparedness Council were considered in the writing of this Chapter. The Texas Drought Preparedness Council is composed of representatives from multiple State agencies and plays an important role in monitoring drought conditions, advising the governor and other groups on significant drought conditions, and facilitating coordination among local, State, and federal agencies in drought-response planning. The Council meets regularly to discuss drought indicators and conditions across the State and releases Situation Reports summarizing their finding.[2]

Additionally, the Council has developed the State Drought Preparedness Plan, which sets forth a framework for approaching drought in an integrated manner in order to minimize impacts to people and resources. Region F supports the ongoing efforts of the Texas Drought Preparedness Council and recommends that water providers and other interested parties regularly review the Situation Reports as part of their drought monitoring procedures. The Council provided two recommendations to all RWPGs which are addressed in this chapter.

- Follow the outline template for Chapter 7 provided to the regions by the Texas Water Development Board.
- Evaluate the drought preparedness impacts of unanticipated population growth or industrial growth within the region over the planning horizon.

To meet these recommendations, Region F has developed this Chapter to correspond with the sections of the outline template. The planning group has also considered unanticipated population or industrial growth over the planning period in the development of this plan. Region F anticipates uncertainty through the use of safe yield instead of firm yield in its subordination strategies and includes safety factors for water suppliers where possible. Furthermore, Region F does not recommend any drought management strategies as a long term supply solution. Instead, it reserves these types of strategies for unanticipated emergency situations only. Lastly, this kind of uncertainty was accounted for in the Region F plan through extensive coordination with local water providers.

7.7.2 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 follow 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] U.S. Geological Survey. "Streamflow Gage Records." <http://waterdata.usgs.gov/tx/nwis.>.

[2] State Drought Preparedness Council. *Situation Reports*. Texas Department of Public Safety. <https://www.txdps.state.tx.us/dem/CouncilsCommittees/droughtCouncil/stateDroughtPrepCouncil.htm>.

Chapter 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.

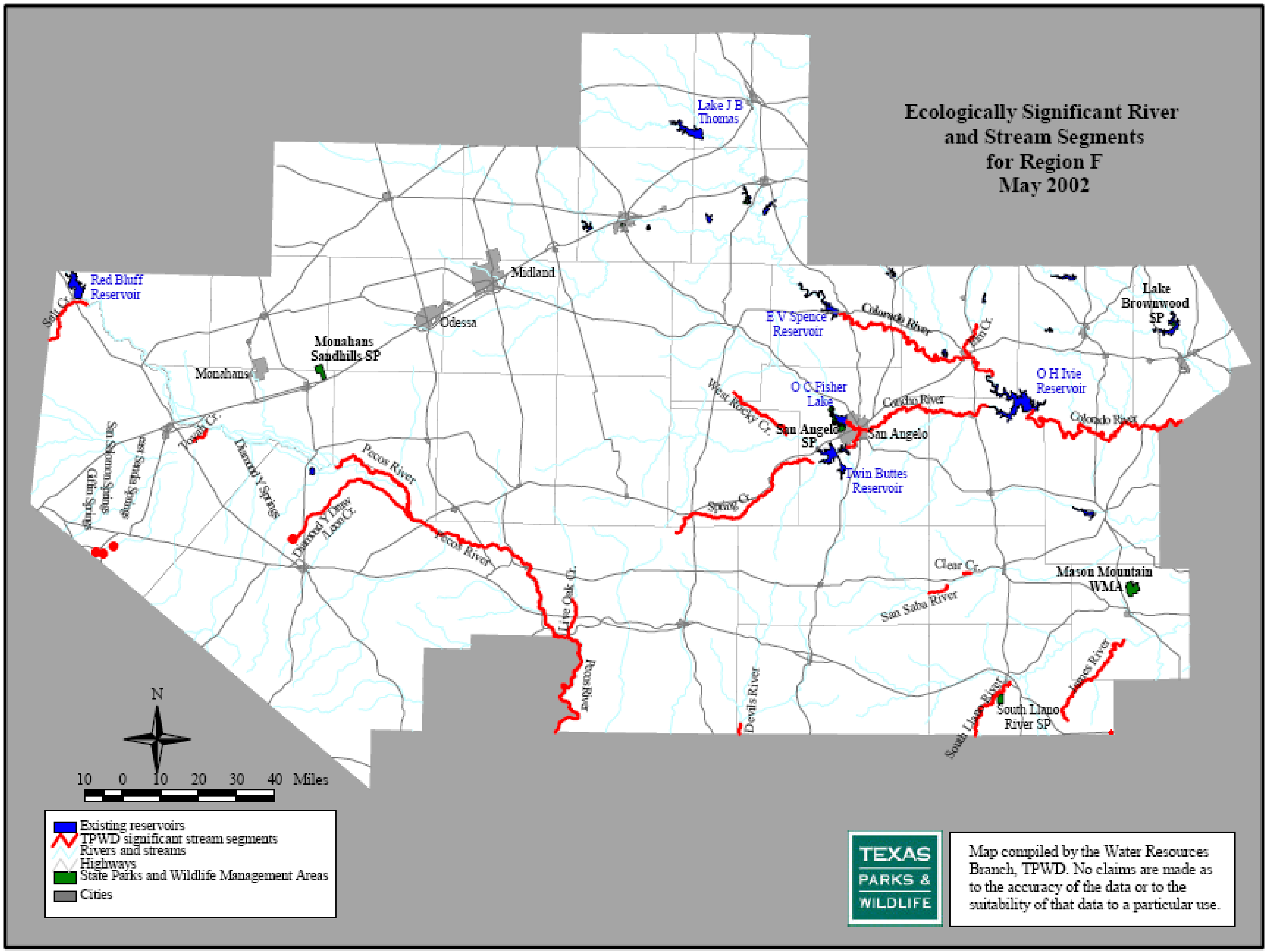
Table 8-1
Texas Parks and Wildlife Department Ecologically Significant River and Stream Segments

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
San Saba River	From FM 864 upstream to Fort McKavett	Colorado	Menard			X		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 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



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 major water source for the City of San Angelo. The Region F Water Planning Group will reconsider the possible designation of unique streams for the 2021 Water Plan.

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. At this time, 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 (512,000 people) in 2020 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.

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, while providing encouragement and incentives for cooperation among the groundwater conservation districts 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 Regional Water Planning Group.
- All state agencies with land within groundwater conservation districts must be subject to groundwater district rules and production limits, and must provide information on existing and proposed groundwater projects to the relevant Regional Water Planning Group.

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 priority 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 2070; 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 priority strategies to provide optimum conditions for most efficient utilization of the region's limited rainfall. These practices should receive top priority for funding from the Texas legislature and State agencies charged with protecting and developing our water resources. Whereas Texas is a leading user of compost, utilizing soil biology to conserve the infiltration of water.

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 streamflows with many streams being intermittent, having water only part of the year. During drought, streamflows can be very low, but this is a natural occurrence and the ecological environment in Region F has developed under these conditions. State agencies have been engaged in studies of the requirements for instream flows since the late 1960s, particularly with regard to freshwater inflows to bays and estuaries. Some cities and municipalities are concerned that a significant portion of their water supply could be reallocated to meet instream flow demands. 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. However, Region F believes it is imperative that existing water rights are protected.

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 Texas Commission on Environmental Quality 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, areas of the region with the highest rainfall per year. Region F recognizes that the key to water 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.

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

Recommendations include:

- TCEQ authorize small, rural water suppliers who currently cannot afford the necessary capital improvements to their existing water systems and who have no reasonable available alternate water source to utilize bottled water options to the fullest extent possible and apart from the threat of TCEQ enforcement. The alternative is for the water supplier to receive grants, not loans, to construct, operate, and maintain a treatment system to reduce drinking water constituents that exceed the established MCLs of the federal drinking water standard level.

- TCEQ develop rules for the disposal of constituent residuals that result from water treatment processes for radionuclides. Without such rules, the accurate cost of water treatment cannot be computed, viable treatment options cannot be assessed, and water suppliers cannot be assured that their water system meets the standards.
- The State of Texas sponsor an oral ingestion study to determine the epidemiology of radium in potable water before enforcing minimum MCLs for radium. Region F is concerned about enforcement of State and federal regulations for radium in drinking water. A cluster cancer investigation was conducted by the Texas Cancer Registry of the Texas Department of Health and found that the cancer incidence and mortality in the area were within ranges comparable to the rest of the State. The Texas Radiation Advisory Board also expressed concern that EPA rules are "unwarranted and unsupported by public health information (specifically epidemiological data)".
- TCEQ revise its policy on requiring the use of secondary water standards, particularly TDS, when granting permits. Meeting secondary water standards should be the option of local water suppliers who must consider local conditions such as the economy, availability of water, community concerns for the aesthetics of water, and the volunteer use of technologies such as point-of-use.

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. The Task Force indicated that these goals are voluntary, and recognized that a statewide per capita water use value is not appropriate for the State of Texas, with its wide variation in rainfall, economic development, and other factors. Considering the drought-prone nature of Region F and the recommendations of the Water Conservation Task Force, the Region F Water Planning Group:

- Supports that conservation targets should be voluntary rather than mandatory goals.
- Recommends State participation in water conservation be increased by providing monetary incentives in the form of grants or low interest loans to municipal, industrial and agricultural interest for the implementation of advanced conservation technologies.
- Recommends the State encourage conservation by providing technical assistance to water users and not force conservation through mandatory targets and 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 development 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 Conjunctive Use

The definition of conjunctive use must include "surface water, groundwater, water education and conservation, demineralization, reclaimed treated wastewater effluent, aquifer storage and recovery, land management, blending water from different sources and quality, regulatory impacts (State and federal) on water supplies and environmental needs".

8.3.14 Groundwater Conservation Districts

There are 16 established groundwater conservation districts 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.
- Rules and regulations must respect property rights and protect the right of the landowners to capture and market water within or outside of district boundaries.
- The region does not support the use of historical use limits in granting permits.

- The region does not support the use of groundwater fees for wells used exclusively for dewatering purposes.
- The legislature should support the 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.

8.3.15 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 adequate personnel and funding to the Railroad Commission to carry out its mandated responsibility to protect water supplies affected by oil and gas industry activities.
- The Texas Legislature restore funds to the industry-initiated and industry-funded well plugging account, which were transferred to the general revenue following the 2003 budget crisis. The well plugging fund is not tax money but industry funds contributed for a specific purpose.
- The 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 Electric Generation Industry

The steam electric power water demands in Region F account for 8 percent of the year 2020 non-agricultural demands in the region and are projected to increase by 89 percent over the planning period.

The planning group has concerns of how the statewide demand for steam electric generation was allocated to Region F given the current drought situation in our region. Existing steam electric plants have closed over the past ten years, with many of them disassembled. The trend for future steam electric plants is to develop combined combustion units that use considerably less water than traditional steam electric power facilities. Region F recommends that the TWDB and the electric generating industry reevaluate the volume of water demands associated with electric generation as well as the location of these demands.

Electric utilities have a duty to plan for the long-term needs of our customers, and the utilities have made substantial investments to secure water contracts/rights and groundwater resources in advance of actual use. All of these water contracts/rights and groundwater resources have been or are held for a substantial period of time in advance of actual use – not only for future generating units but also during drought periods for existing power plants. In order for the electric utility industry to effectively provide service to existing and future customers, the industry opposes:

- Any attempt to cancel uncommitted water contracts/rights.
- Establishing historical use limits for groundwater.

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.

8.4 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. However, due to the intense competition for the limited funds, many entities are still struggling with financing water projects. The Region F Water Planning Groups recommends:

- The State provides increased appropriations to the water infrastructure fund for implementation of strategies in the regional water plans.
- 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 Planning Schedule

The current 5-year schedule for joint groundwater planning is not synchronized very well with the 5-year schedule for developing the State Water Plan. The managed available groundwater (MAG) volumes determined in the joint groundwater planning process for each aquifer are to be incorporated into groundwater conservation district management plans, and are required in the regional water planning process for assessing water supply availability during the next regional planning period. By modifying the due dates in the GMA process, MAG data can be better integrated into the overall state water planning program to better reflect the most recent demand projections and future strategies. Presently, the GMA process uses superseded data in formulating the DFC and MAG. The following table provides a suggested timeline for coordinating the interrelated water planning functions that will provide a more synchronized and orderly development of planning information.

Table 8-2
Proposed Planning Schedule

Planning Process	Current Due Dates	Next Planning Cycle Due Dates	Proposed Due Dates
GMAs deliver proposed DFC to TWDB	2016	2020	**2017**
TWDB establishes MAG	2016	2021	**2018**
GCD Management Plans	2017	2022	**2019**
Regional Water Plans	2016	2021	**2021**
State Water Plans	2017	2022	**2022**

Note: Currently local plans are submitted on staggered 5-year intervals; because most GCDs resubmitted their plans in 2012, the next deadline is 2017.

8.4.3 Frequency of State Water Plan Development

The State is required by law to develop and update the State Water Plan every five years. The 2017 State Water Plan will be the fourth 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. It is recommended 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. This would allow full updates of the State Water Plan following updated population census. It also may better align the regional water plans with the schedule specified for the GMA process, which is critical to defining the amount of groundwater supplies that are available for regional planning purposes. The special studies can be tailored to provide updated data necessary to better define water demands, supplies or strategies as needed by the regions.

8.4.4 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.

8.4.5 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.

8.4.6 Allow Groundwater Supplies in the Regional Water Plans to exceed the Modeled Available Groundwater (MAG) with GCD Approval

The TWDB policy currently states that the MAG values are a cap for water supply and strategy development, while the MAG is not necessarily considered a cap for permitting purposes by groundwater districts according to Chapter 36 of the Water Code. The MAGs are also unenforceable in areas with no groundwater regulation. Chapter 36 describes the process of managing to Desired Future Conditions (DFC). The MAG is an estimate of the groundwater availability based on the DFC but Chapter 36 provides flexibility for districts to permit above or below the MAG based on local knowledge, usage patterns, and other factors. The Region F Water Planning Group recommends that the TWDB should allow groundwater supplies in the regional water plans to exceed the MAG if the planning group obtains written permission from a groundwater district. This approach assumes that the strategy is consistent with the management plan of the GCD, but allows for minor shortages to be covered without excessive administrative actions, such as alternate strategies that would ultimately require a plan amendment. It also allows a GCD to apply local knowledge to account for variations in permitting approaches and usage patterns, while honoring the DFCs of the aquifer. This approach could also be used in areas with no GCDs if the RWPG demonstrates compliance with the DFCs.

8.4.7 Allow Adjustments of MAG Values Across River Basins and County Boundaries with GCD Approval

The Groundwater Availability Models are developed based on the location of existing wells. In the predictive model runs, pumping is generally “ramped up,” i.e. existing wells are assumed to pump a certain percentage over their current pumping level. Locations of future demands and potential new wells are generally not considered in the current MAG model runs. This method of applying an equal percentage increase to existing wells can create skewed distributions of availability to locations with existing wells. This type of "ramping" is adequate and perhaps even preferable for the purposes of estimating a DFC on a regional/aquifer basis. However, because the TWDB planning process requires that groundwater availability be split by county and basin, the resulting TWDB MAG values along county and basin boundaries may not be representative of the true location of the water but instead reflect the location of existing wells. This can cause artificial needs since the requirement to split MAGs along basin boundaries was not anticipated in the DFC process since it has no physical relevance to the DFC and is a constraint of the regional water planning process. In reality, groundwater is not constrained by river basin or county lines and will be used in the areas with increasing demands, even if that area has limited existing use. Region F recommends that adjustments of MAG values across river basins and county boundaries be allowed with GCD approval. This will help eliminate artificial shortages that have no physical meaning and are purely a consequence of TWDB's application of modeling results in a way that may not have been intended.

8.4.8 Expand Consistency with the State Water Plan for SWIFT Funding to Include Adopted Regional Water Plans

The current legislation specifies that a water supply project must be in the adopted State Water Plan for eligibility for SWIFT funds. To allow the TWDB sufficient time to develop the State Water Plan, there is a one year period between when a regional water plan is adopted and when the TWDB approves the corresponding State Water Plan. During this year period the State Water Plan is based on recommended projects in a superseded regional water plan. Under current law, if a project is included in the current regional water plan but not in the superseded plan, the project sponsor must amend the superseded plan to receive SWIFT funding. This could mean that the regions and project sponsors are expending funds for a process that has already been completed for the current regional water plan. It is recommended that the consistency requirement with the State Water Plan for eligibility for SWIFT funds be expanded to include the currently adopted regional water plan.

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 protection of 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 modification of the planning cycles as related to the timing of due dates in the Groundwater Management Area (GMA) process, groundwater conservation district management plans, and regional and state water plans.
- Recommends the State allow the regions to adopt an existing water plan to meet the Legislative requirements for 5-year updates if there are no significant changes to the region's recommended water management strategies.
- 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 project 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 appropriations for implementation of strategies in the regional water plans, and 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 TCEQ consider alternative programs (such as bottled water) to meet water quality standards for radionuclides and other constituents that are very costly to treat.
- Recommends that TCEQ develop rules for the disposal of constituent residuals from the treatment of radionuclides.
- Recommends the State of Texas sponsor an oral ingestion study to determine the epidemiology of radium in potable water before enforcing minimum MCLs for radium.
- Recommends that TCEQ revise its policy on requiring the use of secondary water standards, particularly TDS, when granting permits.
- Recommends 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 development 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.
- Recommends a definition of conjunctive use that includes surface water, groundwater, water education and conservation, desalination, reuse, aquifer storage and recovery, land management, blending of water supplies, regulatory impacts on water supplies and environmental needs.
- 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.
    - Rules and regulations must respect property rights and protect the right of the landowners to capture and market water within or outside of district boundaries.
    - Historical use limits should not be used in granting permits.

- Groundwater fees should not be applied to wells used exclusively for dewatering purposes.
- 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.
- Recommends that the Legislature continue to support the principal of basing groundwater supplies used for regional water planning on the governing water conservation districts' management goals and regulatory requirements.
- 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 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.
- Recommends the Legislature restore funds to the well plugging account, which were transferred to the general revenue fund in 2003.
- Recommends the clean-up and remediation of all contamination related to the processing and transportation of oil and gas.
- Encourages the use of higher TDS water for stream-electric generation.
- Encourages the continued assessment of generation technologies that use less water.
- Recommends the following changes to the Regional Water Planning process:
    - Clarification of the roles of the TWDB and the Regional Water Planning Groups in regards to data collection and quality control of data
    - Simplification of rules governing the regional water planning process
    - Provision of clear guidance on resolving consistency issues
    - Reduction of the frequency of regional plan updates to once every ten years
    - Waivers of the requirement to amend the regional water plan for small entities
    - Use of groundwater supplies in the regional plans exceeding the MAG with GCD approval
    - Adjustments of MAG values across river basin and county boundaries with GCD approval
    - Coordination between TWDB and TCEQ regarding the use of WAMs for regional water planning, and

- Expansion of Consistency with State Water Plan for SWIFT Funding to Include Adopted Regional Water Plans.

Chapter 9 Infrastructure Funding Recommendations

The Region F Water Planning Group surveyed thirty one wholesale water suppliers or water user groups. Each entity projected a water supply deficit and recommended strategies to meet that need, or they have an identified need for a water supply infrastructure project that might be eligible for state financial assistance. Five of the thirty one entities surveyed submitted responses regarding future state funding. Six others responded to the survey but did not indicate they would seek state funding.

The entities were surveyed to determine how much funding they anticipate requesting from the Texas Water Development Board for pre-construction activities such as planning, design, permitting, and acquisition as well as the amount they anticipate requesting for construction of the project included in the 2016 Region F Water Plan. The survey also collected information on the percent share of the total project capacity that will not be needed within the first 10 years of the project life.

9.1 State Water Planning Funding

The TWDB offers financial assistance for the planning, design and construction of projects identified in the regional water plans or State Water Plan. Programs available include the State Participation Program (SP), the Rural and Economically Distressed Areas Program (EDAP), and the recently adopted State Water Implementation Fund for Texas (SWIFT). In order to be eligible to apply for funding from the SP and EDAP, the applicant must be a political subdivision of the State, or in some cases a water supply corporation, and the proposed project must be a recommended water management strategy in the most recent approved regional plan or State Water Plan. To be eligible for SWIFT the proposed project must be a recommended strategy in the adopted State Water Plan. The results of the current surveys carried out by each of the planning regions will be used to identify the amount of additional funds that will be needed for water supply projects through the end of the 2070 planning horizon.

9.1.1 State Participation Program (SP)

The State Participation Program (SP) is geared towards large projects which are regional in scope and meant to capitalize on economies of scale in design and construction, but where the local project sponsors are unable to assume the debt for an optimally sized facility. The TWDB assumes a temporary ownership interest in the project, and the local sponsor repays the cost of the funding through purchase payments on a deferred schedule. The goal of the program is to build a project that will be the right size for future needs, even if that results in the short term in building excess capacity, rather than constructing one or more smaller projects now. On new water supply projects, the TWDB can fund up to 80 percent of the costs, provided that the applicant can fund the other 20 percent through an alternate source and that at least 20 percent of the total capacity of the project serves current needs.

9.1.2 Rural and Economically Distress Areas (EDAP)

Both grants and 0% to low interest loans for planning, design and construction costs are offered through these programs, which are available to eligible small, low-income communities. Rural and economically distressed areas that meet population, income and other criteria are eligible to apply for these funds. EDAP funding eligibility also requires adoption of the Texas Model Subdivision Rules by the applicant planning entities.

9.1.3 State Water Implementation Fund for Texas (SWIFT)

SWIFT is a new funding vehicle passed by the Legislature and approved by Texas voters through a constitutional amendment in 2014 which aims to fund the State Water Plan through low-interest loans, extended repayment terms, deferral of loan repayments, and incremental repurchase terms for projects with state ownership aspects (similar to the SP fund discussed above). The legislation outlines that no less than 10 percent of SWIFT funding should go towards projects for rural communities and agricultural water conservation, and not less than 20 percent of the fund should support water conservation and reuse projects. Funds can be used for planning, acquisition, design, and construction costs. Only projects included in the most recently adopted State Water Plan are eligible for funds.

9.2 Infrastructure Financing Survey

The surveys were distributed via mail. Each survey was prefaced with an explanation of its purpose in identifying the need for financial assistance programs offered by the State of Texas and administered by the TWDB. The surveys listed each recommended strategy and its total capital cost. Following this basic data, the water user group or wholesale water provider was asked: 1) to enter the portion of the total costs associated with the planning and acquisition phase of the project and the year needed; 2) to enter the portion of the total costs associated with the construction phase of the project and the year needed; and 3) to enter the percent share of the total project capacity that will not be needed within the first 10 years of the project life.

Political subdivisions of the State whose water supply strategies were noted in the regional plan as having zero capital costs were not surveyed. Where a water user group with needs and strategies to meet those needs have multiple water management strategies, some of which have capital costs and others that have no capital costs, those water user groups were only surveyed for the strategies with a capital cost. Surveys were delivered the second week in July and received until September 10, 2015. Several entities that were surveyed did not respond. The results of this survey represent the best effort of the group to complete the survey.

Table 9-1 summarizes the capital costs for all recommended strategies in Region F.

Table 9-1
Summary of Total Capital Costs by Entity

Entity	Total Capital Cost for Recommended Strategies
Ballinger	$49,762,400
Bangs	$422,000
Big Lake	$2,708,800
Big Spring	$16,930,000
Brady	$20,398,000
Bronte	$16,517,000
Brownwood	$8,500,000
Coahoma	$848,000
Colorado River Municipal Water District	$184,919,000
Concho Rural Water Corporation	$5,131,000
County-Other	$83,404,300
Eden	$485,700
Eldorado	$1,471,200
Irrigation	$47,823,341
Junction	$9,714,700
Livestock	$1,362,000
Madera Valley WSC	$1,673,300
Manufacturing	$461,500
Mason	$2,406,400
McCamey	$1,698,600
Menard	$8,592,000
Midland	$78,315,800
Mining	$145,031,000
Odessa	$62,309,000
Pecos	$6,834,400
Pecos County WCID #1	$2,456,000
Rankin	$876,900
San Angelo	$274,246,200
Sonora	$2,982,400
Steam Electric Power	$126,092,000
Upper Colorado River Authority	$32,233,000
Winters	$4,050,000
Region F Total	**$1,200,655,941**

9.3 Summary of Responses to Surveys

Eleven of the thirty one entities surveyed responded. The total funding required by the responding entities was about $592 million dollars, which accounts for about 49 percent of the total costs for recommended strategies in Region F. Of the responding entities about 16 percent of the funds will be needed for planning and acquisition. The remaining 84 percent of the funds will be needed for construction. Responses to the surveys were recorded in a spreadsheet and submitted to the Texas Water Development Board and are also included in Appendix M.

Chapter 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
- Environmental
- Small businesses
- Electric generating utilities
- 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. 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.

Table 10-1
Voting Members of the Region F Water Planning Group

Name	Interest	County
Len Wilson	Public	Andrews
Wendell Moody	Public	Concho
Jerry Bearden	Counties	Mason
Robert Moore	Counties	Runnels
Will Wilde (Ret) Ricky Dickson	Municipalities	Tom Green
Merle Taylor	Municipalities	Scurry
John Shepard	Municipalities	Winkler
Ben Shepperd	Industries	Midland
Kenneth Dierschke	Agricultural	Tom Green
Terry Scott (Ret)	Agricultural	Coleman
Woody Anderson	Agricultural	Mitchell
Gilbert Van Deventer	Environmental	Midland
Caroline Runge	Environmental	Menard
Charles Hagood	Small Business	Kimble
Tim Warren	Elec. Gen. Util.	Mitchell
Stephen Brown	River Authorities	Tom Green
John Grant	Water Districts	Howard
Larry Turnbough (Ret)	Water Districts	Reeves
Richard Gist	Water Utilities	Brown
Raymond Straub, Jr.	GMA 2	Martin
Paul Weatherby	GMA 3	Pecos
Scott Holland	GMA 7	Irion

(Ret) – Retired during this planning cycle.

Table 10-2
Non-Voting Members of the Region F Water Planning Group

Name	County/ Agency
Slate Williams	Crocket
Tom Hoysa	Coleman
Winton Milliff	Coke
Gordon Hooper	Crane
Debbie McReynolds	Ector
Rick Harston	Glasscock
Todd Darden	Howard
Billy Hopper	Loving
Sue Young	Mitchell
Michael McCulloch	Pecos
Cindy Weatherby	Reagan
Jon Cartwright	Schleicher
Gary Foster	Sterling
Joe David Ross	Sutton
Lynn Halfmann John Evridge	Upton
Nathan Rains	Texas Parks and Wildlife
William Rice (Ret)	Texas Department of Agriculture
Vacancy	Texas Commission on Environmental Quality

(Ret) – Retired during this planning cycle.

10.2 Outreach to Water Suppliers, Water User Groups and Adjacent Regions

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.

Region F continued to coordinate with adjacent regions that provide and/or receive water from Region F. This included coordination with the Llano- Estacado, Brazos G, and Far West Texas (Region E) regions.

10.3 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 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.

10.4 Public Meetings and Public Hearings

As required by SB1 rules, the Region F Water Planning Group held an initial public hearing to discuss the planning process and the scope of work for the region on July 21, 2011. Presentations were made on the planning process and input was solicited from participants. Public meetings were held approximately every quarter throughout the planning process.

On April 26, 2015 copies of the Initially Prepared Region F Water Plan were mailed to Region F county courthouses and libraries for public review. Copies of the Initially Prepared Plan were 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.

On June 11, 2015, the Region F Water Planning Group held a public hearing in Big Spring to present the draft Initially Prepared Region F Water Plan and seek public input. Oral comments were requested following the presentation and written comments were accepted through August 10, 2015. There were no oral comments at the public hearing. Public comments received during the comment period are documented in Appendix K. Where appropriate, modifications to the plan were made and incorporated into the adopted Regional Water Plan. Responses to the public comments are also included in Appendix K.

10.5 Comments from State and Federal Agencies

Appendix L contains comments on the Initially Prepared Region F Water Plan from the Texas Water Development Board and the Texas Parks and Wildlife Department. No other comments were received from other state or federal agencies. Responses to agency comments are documented in Appendix L. Where appropriate, modifications to the plan were made and incorporated into the adopted Region F Water Plan.

10.6 Comments from Water Providers

As part of the region's outreach efforts, a survey on water management strategies was sent to water user groups after the publication of the Initially Prepared Plan. Reponses to this survey resulted in changes to plans for eight water providers as outlined below.

10.6.1 Andrews

The City of Andrews requested adjustments to the cost, structure, and timing of their strategy to develop supplies from the Ogallala Aquifer in Andrews County.

10.6.2 Brady

The City of Brady requested that their direct non-potable reuse strategy be removed from the plan and an advanced groundwater treatment strategy be added in its place.

10.6.3 Bronte

Several strategies that were previously evaluated and dismissed for the City of Bronte were requested to be fully evaluated for the 2016 Plan. These strategies included a Regional Water System from Lake Brownwood and direct potable reuse. Both strategies are now included as alternate strategies. The City also requested five new additional strategies be added including a regional system from Ballinger's purchase of water rights from Clyde in Lake Fort Phantom Hill, purchasing supply from UCRA, development of groundwater from the Edwards-Trinity Aquifer in Nolan County (with Robert Lee) and a water treatment plant expansion. Development of groundwater in Nolan County and a water treatment plant expansion are now recommended strategies. The remaining strategies are included as alternates.

10.6.4 Brownwood

Brownwood requested that minor adjustments to the write up of their direct potable reuse project be made. Also, more detailed cost information was provided and the cost estimate was adjusted accordingly.

10.6.5 Concho Rural Water Corporation

Concho Rural Water Corporation requested that a brackish groundwater desalination strategy be included in addition to the current strategy to provide supplies from the Lipan aquifer.

10.6.6 Mason

The City of Mason requested that a new advanced treatment strategy be included in their plan to treat radionuclides.

10.6.7 Midland County-Other

Midland County-Other had no new strategies but provide more detailed cost estimates that were adopted.

10.6.8 Robert Lee

The City of Robert Lee has recently completed additional investigation of groundwater in Coke County with UCRA and the potential well field did not prove to be a reliable source of supply. Therefore this strategy was changed from a recommended strategy to an alternate one. Several additional potential strategies were also evaluated and included in the Region F Water Plan. These strategies include the participation in a regional system from Ballinger's purchase of water rights from Clyde in Lake Fort Phantom Hill and development of groundwater from Nolan County (with Bronte).

10.7 Plan Implementation Issues

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.

10.7.1 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 cost increases the customer base can assume. Some strategies may not be able to be implemented without state assistance.

10.7.2 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.

10.7.3 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 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.

10.7.4 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 due to TWDB rules. 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 83rd Texas Legislative Session[1], there was a general consensus that brackish groundwater needs to be incorporated as a new water-supply strategy whenever feasible, but ultimately no legislation was passed. It is possible that legislation will be passed in the near future concerning the desalination of brackish groundwater that may result in differences in brackish groundwater strategies and/or the evaluation criteria of these sources.

LIST OF REFERENCES

[1] Texas Alliance of Groundwater Districts. 83rd Legislative Session Wrap-Up, 2013.

Chapter 11 Implementation and Comparison to Previous Regional Water Plan

11.1 Introduction

One of the new requirements for the 2016 Regional Water Plans is the inclusion of a chapter providing a comparison of the current Regional Water Plan to the previous plan, and a discussion of the differences between the two. This chapter includes that discussion, as well as a description of strategies that have been implemented since the publication of the 2011 plan.

11.2 Differences Between Previous and Current Regional Water Plan

The following sections provide a discussion of changes from the 2011 plan to the 2016 plan. Specifically, these sections address differences in:

- Water demand projections
- Drought of record and hydrologic modeling and assumptions
- Groundwater and surface water availability
- Existing water supplies for water users
- Identified water needs for WUGs and WWPs
- Recommended and alternative water management strategies

11.2.1 Water Demand Projections

The total projected water demand in Region F is about 3.5 to 4.5 percent higher for the 2016 plan than in the 2011 plan. This equates to about 30,000 to 37,000 acre-feet per year of increased demands over the planning horizon. This is displayed in Figure 11-1 below.

The increase in projected demands for the region was mainly driven by increased irrigation and mining demands. For the 2016 plan, irrigation baseline demands were based on the historical maximum usage between 2005 and 2010. Irrigation demands for the 2011 plan were not changed from the 2006 plan. The 2011 demands were based on average historical use. More recent irrigation usage is higher likely due to persistent drought conditions throughout the region. Mining demands were also significantly higher in the 2016 plan than in the 2011 plan. This is largely due to the recent renewed interest in oil and gas exploration in the Permian Basin. Manufacturing demands are only slightly higher in the 2016 plan.

Livestock and steam electric power demands are both slightly lower in the 2016 plan. Table 11-1 shows the change in demands from the 2011 plan to the 2016 plan by use type.

Figure 11-1
Comparison of Region F Water Demand in 2011 and 2016 Plans

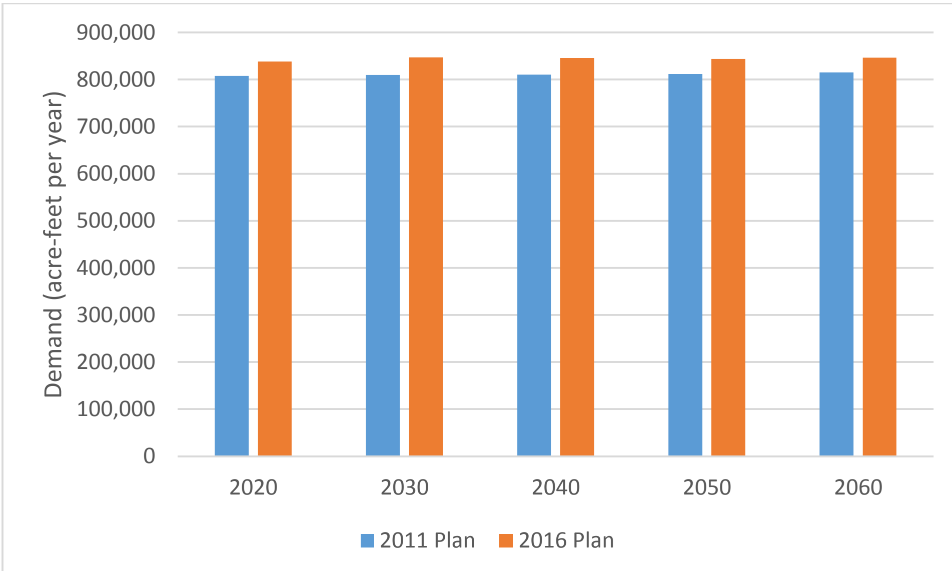


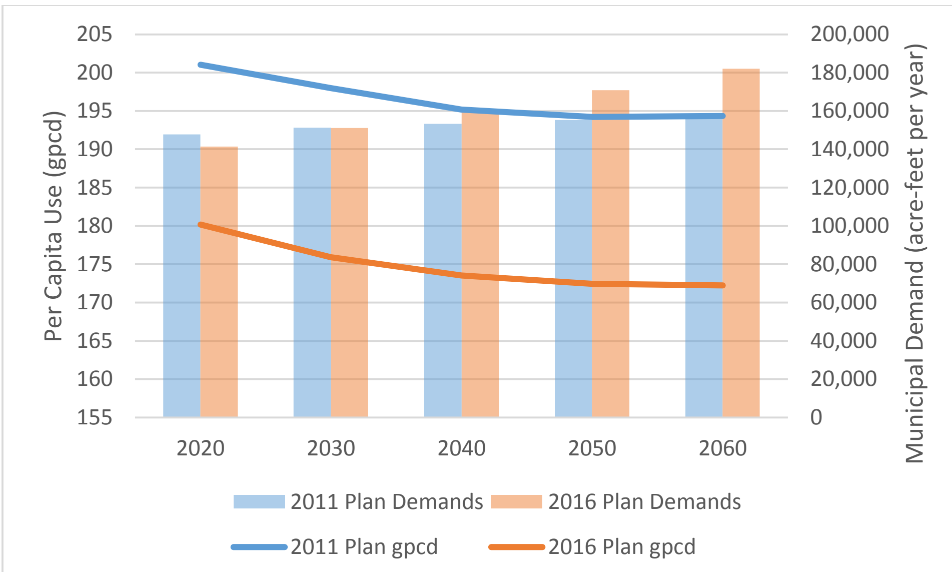
Table 11-1
Changes in Projected Demands from the 2011 Plan to the 2016 Plan by Use Type

Use Type	Change in Projected Water Demand (acre-feet per year)				
	2020	**2030**	**2040**	**2050**	**2060**
Irrigation	20,447	21,679	22,913	24,150	25,373
Livestock	-6,118	-6,118	-6,118	-6,118	-6,118
Manufacturing	567	585	603	614	621
Mining	22,560	22,567	11,693	-773	-11,378
Municipal	-6,374	-210	7,211	15,532	24,465
Steam Electric Power	-910	-1,065	-1,253	-1,482	-1,761
Region F Total	**30,172**	**37,438**	**35,049**	**31,923**	**31,202**

Total municipal demand is slightly lower in the 2016 plan until 2030. By 2040, the municipal demand in the 2016 plan is higher than in the 2011 plan. Municipal demands in both plans were developed by estimating a dry year per capita demand. The per capita demand was then multiplied by the projected population of each entity to determine the total demand in acre-feet per year. The per capita use for the previous plan was based on the year 2000. The per capita water use for the 2016 plan was based on the year 2011. In both cases, some WUGs were under water use restrictions during the base year and their per capita use was adjusted upwards. Furthermore, the population projections for the 2011 plan were based on the 2000 census. The population projections for the 2016 plan were developed based on the

2010 census. For some users, the 2016 plan population projections were updated to reflect population growth caused by increased oil and gas exploration that was not captured in the 2010 Census. In addition to these factors, the TWDB used higher estimates of savings from the plumbing code for the 2016 plan than in the 2011 plan. As shown in Figure 11-2, the per capita use for the region is considerably less in the 2016 plan than it was in the 2011 plan. However, higher population projections outpace these savings and result in higher municipal demands starting in 2040.

Figure 11-2
Comparison of the 2011 and 2016 Plan Projected Per Capita Use and Municipal Demand



11.2.2 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 plan. Only Lake Brownwood still had a drought of record during the 1950s. However, with record low inflows in 2011, Lake Brownwood has experienced a new drought of record as well. The extreme drought conditions are ongoing and may continue to impact the availability of surface water supplies in the region in future plans. The impacts of the drought on surface water availability under 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 over.

WAM Run 3 (Strict Priority Analysis)

In the 2011 plan, the TCEQ Colorado WAM used naturalized flows from 1940 to 1998. This period of record did not include the ongoing drought in Region F. To assess the potential impacts of the drought in the 2011 plan, the period of record was extended through 2004 by using historical gage flows at key locations. These flows were incorporated into a special simplified version of the Colorado WAM (the MiniWAM). The MiniWAM only included major reservoirs and Junction's run-of-river right. This analysis showed that most reservoirs were experiencing a new drought of record as a result of the drought at that time and surface water supplies were less than previously estimated. Drought conditions, however, have continued in the region, deepening the impacts of the new drought of record shown in the MiniWAM analysis used in the 2011 plan. In 2013, the TCEQ recognized the new drought of record in this region and updated the full Colorado WAM to include naturalized flows from 1940 through the end of 2013. This updated version of the Colorado WAM was used for the 2016 plan analysis and included all water rights in the 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.

The 2011 Region F Plan used the modeling approach developed in 2006. This approach was a joint effort with Region K (the Lower Colorado River Basin). This modeling had two major assumptions: 1) Water rights in Region K do not make priority calls on major upper basin water rights located in Region F, and 2) These upper basin rights do not make calls on each other (with the exception of reservoirs in the Pecan Bayou watershed, which operate in priority order under certain conditions). Only selected Region K water rights with a priority date before May 8, 1938 were subjected to subordination. All other water rights were assumed to operate as originally modeled in the Colorado WAM. The hydrology for the subordination strategy in 2011 plan was also extended through 2004 using the MiniWAM. For the 2011 Region K Plan, Region K developed its own version of the subordination strategy, called the "cutoff model" that modified the priority dates for all water rights above Lakes Ivie and Brownwood. For the 2016 plan, Region F has adopted the premise of the Region K cutoff model for the subordination strategy. The Region F Plan cutoff model differs slightly from the Region K model by including Junction's run-of-river right and Brady Creek Reservoir, and it includes priority operation only under certain conditions for the Pecan Bayou watershed. The new Colorado WAM with hydrology through 2013 was used for the subordination strategy in the 2016 plan. More information on the subordination strategy is included in Chapter 5C.

11.2.3 Groundwater and Surface Water Availability

Groundwater and surface water availability (not considering infrastructure or permit constraints) in Region F is significantly lower in the 2016 plan than in the previous plan. Major differences in groundwater availability stem from a new definition of groundwater availability, as described below. Differences in surface water availability were caused by the new drought of record conditions that reduced the amount of reliable yield. Overall, there was about a 15 percent decline in water availability throughout the region between the 2011 and 2016 plans. Figure 11-3 and Figure 11-4 show the differences in groundwater and surface water availability respectively.

Figure 11-3
Comparison of Groundwater Availability in the 2011 and 2016 Plans

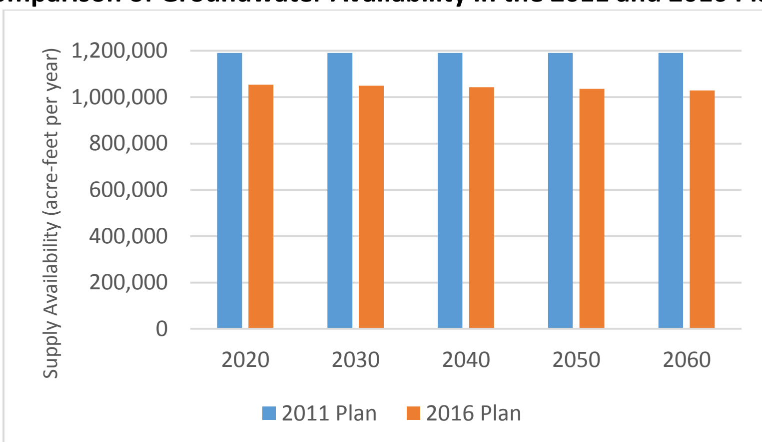
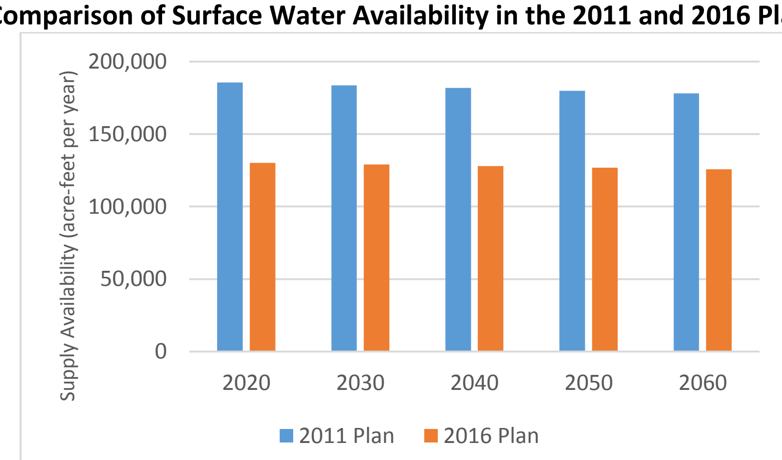
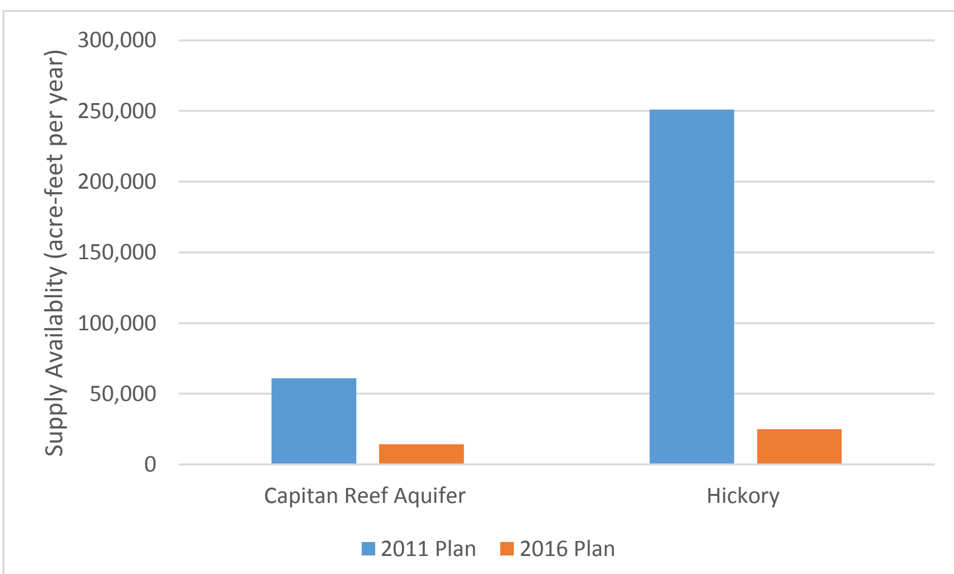


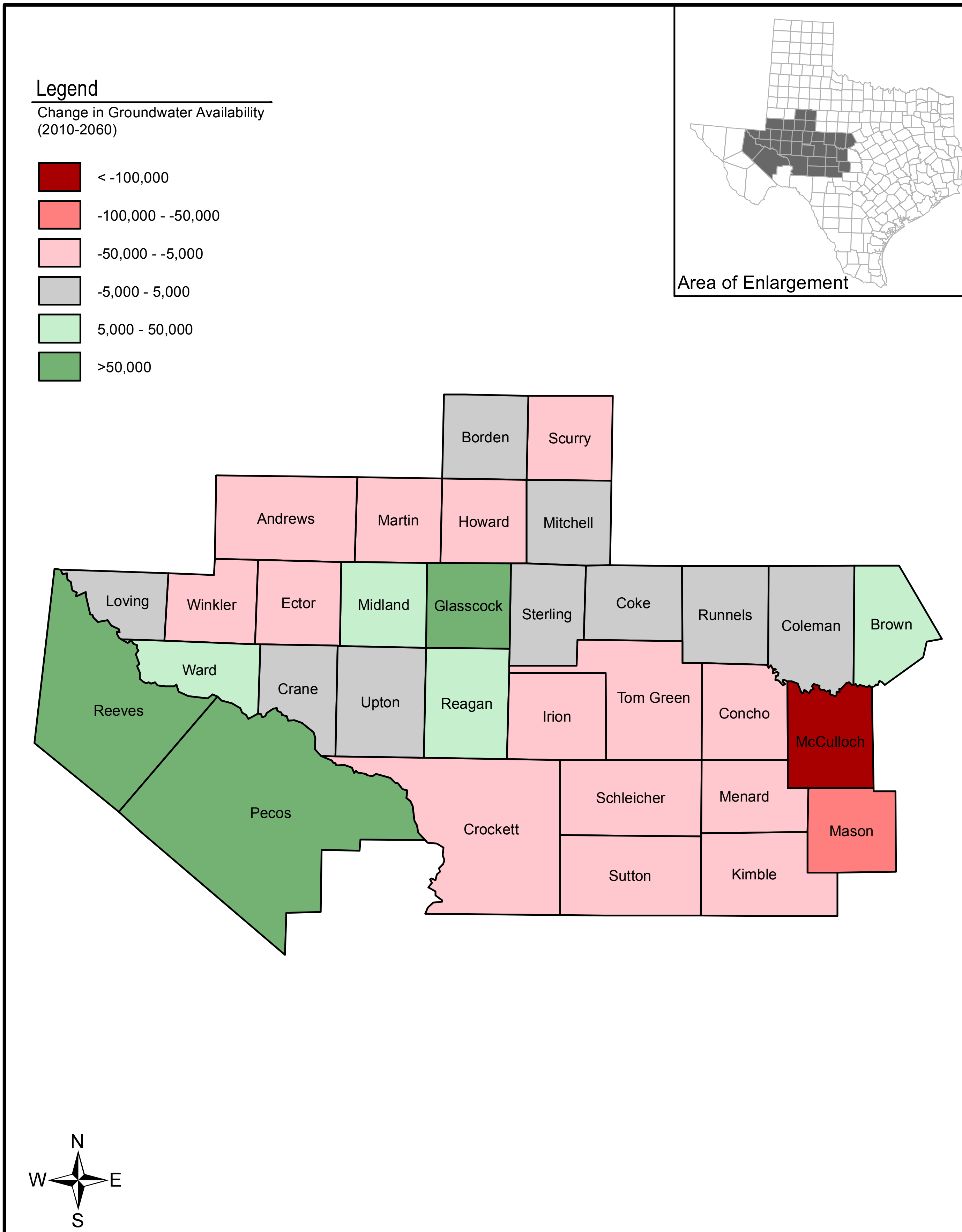
Figure 11-4
Comparison of Surface Water Availability in the 2011 and 2016 Plans



In accordance with TWDB rules, the groundwater availability in the 2016 plan is determined by the Modeled Available Groundwater (MAG) estimate. This is the first plan 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. In previous rounds of planning, the RWPG with technical input from its consultants developed availability estimates for groundwater based on recharge and/or acceptable levels of storage depletion. In Region F, the assumptions and approaches for the 2011 plan differ from the Desired Future Conditions (DFCs) adopted by the Groundwater Management Areas (GMAs) in the joint planning process. Most of the difference centered on the acceptable amount of water depleted from storage. This resulted in overall lower groundwater availability in the 2016 plan than in the 2011 plan. This is especially evident in the Capitan Reef and Hickory aquifers as shown in Figure 11-5. The Edwards Trinity Plateau and Ogallala aquifers show slightly lower volumes available but are fairly similar to the values estimated for the 2011 plan. The Pecos Valley aquifer actually shows an increase in supply from the previous plan. Figure 11-6 shows the differences in groundwater available by county. Seven counties show significant increases in availability. Nine counties do not have significant changes in overall groundwater availability between the two plans. The remaining sixteen counties show decreases in availability.

Figure 11-5
Difference in Supply Availability in the 2011 and 2016 Plans for the Capitan Reef and Hickory Aquifers





Region F

2060 Groundwater Availability Difference From 2011 Plan to 2016 Plan

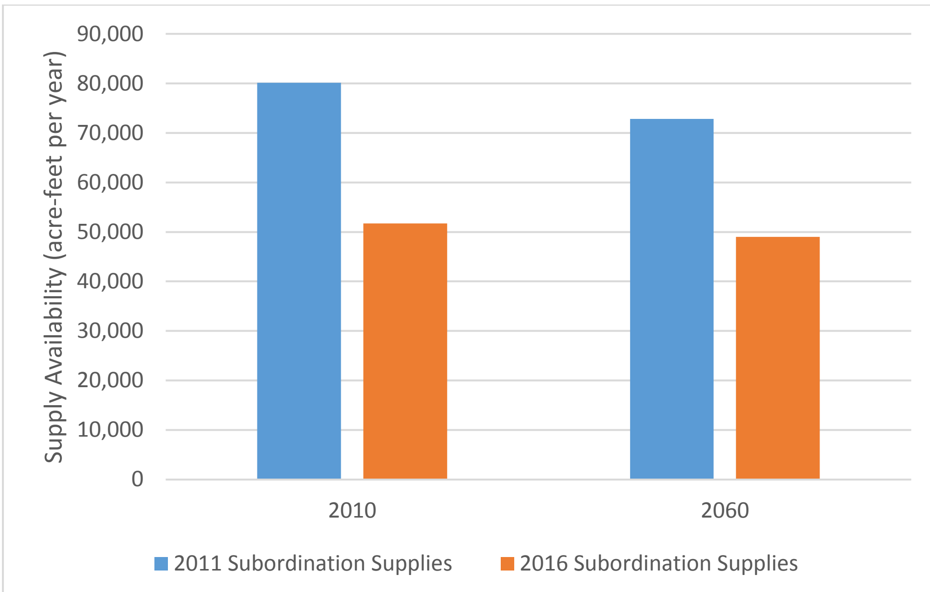
FN JOB NO	SAN11472
FILE	H:\WR_PLANNING\Chapter 2\Compare_GWAvail.mxd
DATE	MARCH 2015
SCALE	1:3,000,000
DESIGNED	JLA
DRAFTED	JLA

11-6

FIGURE

The impacts of the drought on surface water supplies in Region F have been substantial. The amount of surface water supply shown in the 2016 plan is about 30 percent lower than amount of surface water shown in the 2011 plan. However, the impacts are not fully captured when looking at the overall availability under WAM Run 3 (strict priority analysis) because many reservoirs already showed zero supply. The impacts are more fully shown in the reduction of supplies available through the subordination strategy, where the reduction is closer to 40 percent. This is shown in Figure 11-7.

Figure 11-7
Comparison of Subordination Supplies in the 2011 Plan and the 2016 Plan



11.2.4 Existing Water Supplies of Water Users

New Sources of Existing Supply for Water Users

The new drought of record conditions in Region F not only reduced the yield from each source, but it also greatly impacted the quality of the supplies from those sources. In many cases, the water quality became too poor to use the remaining dwindling supply. As a result, many communities began seeking more drought tolerant sources of water including reuse and groundwater. Table 11-2 shows users in Region F that have new sources of supply in the 2016 plan that were not included in the 2011 plan. Of these new supplies, three were recommended strategies in the 2011 plan that have since been implemented and are discussed in Section 11.3. This changes the status of these supplies from "new supplies" to "existing supplies". The other strategies not considered in the 2011 plan were developed in response to the significant drought and are now new sources of existing supply.

Table 11-2
Entities with New Sources of Existing Supply in the 2016 Plan

Entity	New Existing Supply
CRMWD	Big Spring Reuse
	Ward County Well Field
Midland	Indirect Reuse
	Local groundwater (Airport well field)
	T-Bar Well Field
Robert Lee	Purchase from Bronte
San Angelo	Hickory Well Field
Ward County-Other	Purchase from CRMWD
Zephyr WSC	Purchase from Early (BCWID supply)

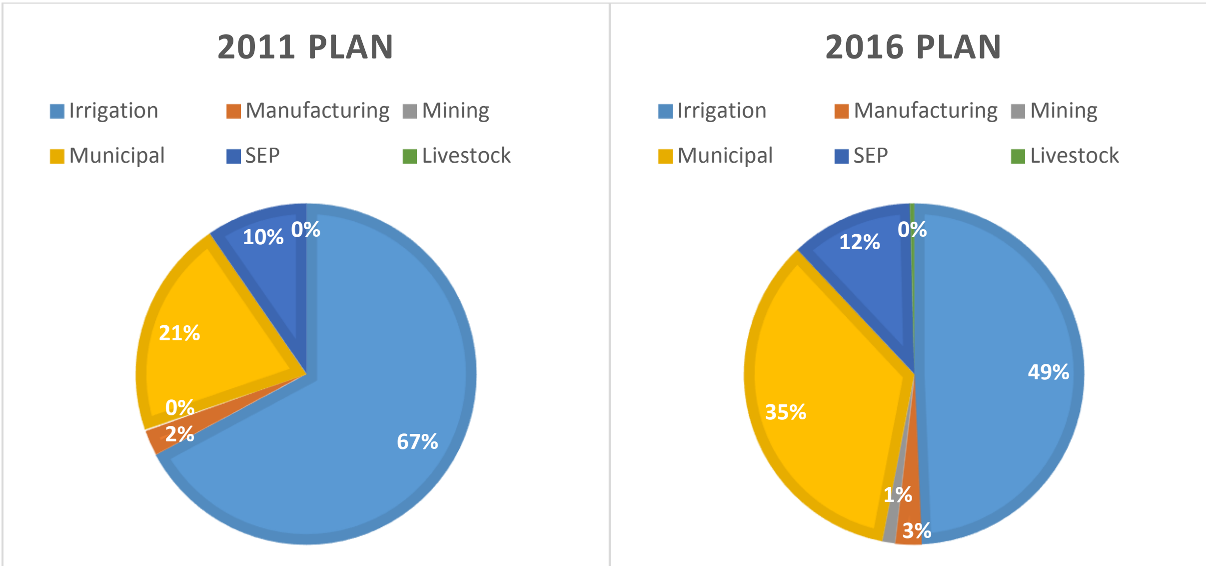
Reduced Existing Groundwater Supplies

The reduction in overall groundwater source availability caused the existing supplies for groundwater users in the region to also be reduced, in some cases very significantly. In the 2011 plan, if the supply in a county was not sufficient to meet the county's needs, it was assumed that municipal needs would be met first. Then supply was allocated to manufacturing, steam electric power, livestock, irrigation and mining. As a result, most shortages affected only mining and irrigated agriculture in most counties. This type of tiered shortages by usage type may not be very realistic when shortages are significant. It is unlikely, for example, that irrigators will cease to use groundwater due to a drought. It is more likely that everyone reliant on that source will suffer to some extent. In order to more accurately reflect this reality, when current demands exceeded available supply in the 2016 plan, mining and irrigation supplies were first reduced by up to 20 percent. If demands were still in excess of supply, all users were shorted by an equal percentage in order not to exceed the source's availability. Mining and irrigation were cut by this percentage in addition to the original 20 percent reduction. Due to the significant reduction of MAG values for some aquifers in certain counties, reductions of allocated supplies at times reached upwards 70 percent over the planning horizon in the 2016 plan.

11.2.5 Identified Water Needs

Due to increased demands and diminishing groundwater and surface water supplies, needs across Region F increased five to ten percent from the 2011 plan to the 2016 plan. The composition of these needs also changed significantly. Figure 11-8 below highlights the differences in need by use type in the two plans in the year 2060.

Figure 11-8
2060 Need by Use Type in the 2011 and 2016 Plans



Total Need = 215,000 acre-feet per year Total Need = 223,800 acre-feet per year

In the previous plan, irrigation made up 67 percent of the total need in 2060. In the current plan, irrigation represents only half of the total need in 2060. Despite an increase in irrigation demands, the overall needs for irrigation were reduced. This is mainly due to increased groundwater availability in Glasscock and Upton Counties and decreased demands in Tom Green and Ward Counties where there were previously large shortages.

Mining needs also greatly increased especially during the early decades. In the previous plan, mining needs in 2020 were only 660 acre-feet per year. In the current plan, mining needs are over 15,000 acre-feet in 2020. This represents over a 2000 percent increase. The changes in mining needs were primarily fueled by increased demand associated with renewed interest in oil and gas exploration in the region.

In the 2011 plan, there were no livestock needs in any decade. In the 2016 plan, livestock does show a small shortage (less 1,000 acre-feet total). This is mainly due to counties in which all users were shorted due to limited groundwater availability under the MAG.

Manufacturing needs are actually very similar, ranging from around 3,500 acre-feet to 5,500 acre-feet throughout the planning horizon, in both plans.

Steam electric power needs in the 2016 plan are slightly higher than in the 2011 plan. Many steam electric power plants in Region F have shut down in recent years. However, the TWDB still includes the demands associated with these facilities in their projections in case the plant should be reopened. In many cases, these demands may not be realistic as the trend in Region F has been to shut down steam electric power generation plants, not open new ones. If the RWPG had knowledge that a plant no longer operated in a specific county where the demand was located, no water was allocated to this use in order to reserve this availability for more realistic demands. This resulted in higher needs for steam electric power.

Municipal needs in 2060 are over 75 percent higher than they were in the same decade in the last plan. Municipal needs represented 21 percent of the 2060 need in the 2011 plan. In the 2016 plan, municipal needs represent 35 percent of the need in the region. This is mainly due to reduced groundwater availability from the MAG, and a differing approach to allocation of existing supplies in counties with severe shortages as previously explained in Section 11.2.4. The increases in municipal needs after subordination are also much greater in the 2016 plan than in the 2011 plan. This is mainly due to reduced yields from the reservoirs due to the new drought of record conditions present in the region.

11.2.6 Recommended and Alternative Water Management Strategies

New Water Management Strategies

Increased needs across the region resulted in many water user groups having new shortages in the 2016 plan. Furthermore, several entities previously had their entire need met through subordination. Due to the diminishing surface water supplies under new drought of record conditions, this is no longer the case for many users. As a result, new strategies had to be developed to meet these needs. There are over 70 new infrastructure strategies in the 2016 plan that were not included in the 2011 plan. This does not include the new conservation strategies for municipal, irrigation or mining use. The new recommended strategies are outlined in Table 11-3. New alternate strategies are included in Table 11-4.

Table 11-3
New Recommended Water Management Strategies in the 2016 Plan

Water User Group or Wholesale Provider	New Recommended Water Management Strategy
Andrews County Livestock	Develop Edwards Trinity Plateau Supplies
Andrews County Livestock	Develop Pecos Valley Supplies
Andrews County Mining	Direct Reuse from the City of Midland
Andrews County Mining	Develop Edwards Trinity Plateau Supplies
Andrews County-Other	Develop Edwards Trinity Plateau Supplies
Ballinger	Purchase water right from Clyde
Bangs	Direct Non Potable Reuse
Big Spring	Water Treatment Plant Expansion

Water User Group or Wholesale Provider	New Recommended Water Management Strategy
Brady	Advanced Groundwater Treatment
Brown County WCID #1	Develop Groundwater in Brown County
Brownwood	Direct Potable Reuse
Bronte	Water Treatment Plant Expansion
Bronte	Develop Groundwater in Nolan County
Coke County Mining	Develop Edwards Trinity Plateau Supplies
Coke County-Other	Voluntary Transfer from Irrigation
Coleman County Mining	Develop Hickory Aquifer Supplies
Colorado City	Direct Reuse for Sale to Mining or Irrigation
Concho County Mining	Develop Hickory Aquifer Supplies
Concho Rural WC	Groundwater Desalination
CRMWD	Aquifer Storage and Recovery (ASR) of Existing Surface Water Supplies
CRMWD	Desalination of Brackish Surface Water (CRMWD Diverted System)
Crockett County Mining	Reuse Sales from Crockett County WCID #1
Crockett SEP	Groundwater supply from the Edwards Trinity
Ector County-Other	Purchase Additional Supply from Odessa
Ector SEP	Purchase Supply from Odessa
Ector SEP	Alternative Cooling Technologies
Eden	Direct Non-Potable Reuse
Howard County Livestock	Develop Dockum Aquifer Supplies
Howard County Manufacturing	Purchase from Big Spring
Howard County Mining	Develop Dockum Aquifer Supplies
Howard County Mining	Develop Ogallala Aquifer Supplies
Howard County Mining	Purchase brackish supplies from CRMWD diverted water system
Howard County-Other	Purchase from Big Spring
Irion County Mining	Develop Dockum Aquifer Supplies
Irion County Mining	Develop Edwards Trinity Plateau Supplies
Junction	Develop Edwards Trinity Plateau Supplies
Martin County Livestock	Develop Dockum Aquifer Supplies
Martin County Manufacturing	Purchase additional groundwater rights (from irrigation)
Martin County Mining	Develop Dockum Aquifer Supplies
Martin County Mining	Develop Edwards Trinity Plateau Supplies
Martin County Mining	Direct Reuse from the City of Midland
Martin County-Other	Develop Dockum Aquifer Supplies
Mason	Advanced Groundwater Treatment
McCulloch County Livestock	Develop Edwards Trinity Plateau Supplies
McCulloch County Manufacturing	Purchase water from Brady
McCulloch County-Other	Purchase from Millersview-Doole WSC
Midland	West Texas Water Partnership
Midland	Additional T-Bar with Treatment
Midland County Mining	Direct Reuse from the City of Midland
Midland County-Other	New Groundwater from Winkler County
Mining, All Counties	Mining Conservation/Recycling
Mitchell County SEP	Alternative Cooling Technologies
Odessa	Reverse Osmosis Treatment
Pecos WCID #1	Develop Additional Edwards Trinity (Plateau) Supplies
Runnels County Mining	Develop Other Aquifer Supplies

Water User Group or Wholesale Provider	New Recommended Water Management Strategy
San Angelo	West Texas Water Partnership
Scurry County Livestock	Develop New Groundwater from Local Alluvium Supplies
Scurry County Mining	Develop Local Alluvium Aquifer Supplies
Scurry County-Other	Purchase from Snyder
Sonora	Direct Non Potable Reuse
Tom Green County-Other	Purchase through UCRA
UCRA	Purchase Water from San Angelo and Expand Transmission System
Ward County Steam Electric Power	Develop Pecos Valley Supplies
Winkler County-Other	Develop Pecos Valley Supplies
Winters	Purchase water from Abilene

Table 11-4
New Alternate Water Management Strategies

Water User Group or Wholesale Provider	New Alternate Water Management Strategy
Ballinger, Bronte, Winters, Robert Lee	Regional System from Fort Phantom Hill to Runnels and Coke Counties
Concho Rural Water Corporation	Develop Lipan Aquifer Supplies
CRMWD	Develop Additional Groundwater Supplies from Western Region F Counties
CRMWD	Transmission of Additional Groundwater Supplies from Western Region F Counties
CRMWD	Desalination of Brackish Groundwater Supplies
CRMWD	Aquifer Storage and Recovery (ASR) of Brackish Groundwater Supplies
Junction	Dredge River Intake
Midland	Brackish groundwater development
Midland	Additional Supplies from the West Texas Water Partnership
Odessa	Development of Brackish Groundwater in Ward County
Odessa	Development of Groundwater near For Stockton
San Angelo	Red Arroyo OCR
San Angelo	Additional Supplies from the West Texas Water Partnership
Ward County Steam Electric Power	Alternative Cooling Technologies

Altered Water Management Strategies

Several strategies in the current plan 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 either due to major conceptual changes, better available data, or considerable changes in assumptions used to calculate the water available from the strategy. The changes to these strategies are outlined below. 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.

Municipal Conservation

In the 2011 plan, additional municipal conservation measures were only considered for entities with needs. In the 2016 plan, this strategy was considered for all named municipal WUGs, regardless of if they had a need. Municipal conservation was considered for County-Other entities if their gpcd was over the state goal of 140. The 2011 plan municipal conservation strategy included savings from the federal clothes washer rules. This was incorporated as part of the plumbing code savings built into the 2016 plan demands. As such, it was not included in the 2016 plan conservation strategy to avoid double counting. The 2016 municipal conservation strategy for entities great than 20,000 people also included additional BMPs not in the 2011 plan including a landscape ordinance and time of day water limits. More information of the municipal conservation strategy can be found in Subchapter 5B.

Irrigation Conservation

In the previous plan, irrigation savings were based solely on the installation of new, more efficient irrigation equipment. In the 2016 plan, the methods by which conservation savings were achieved were not specified. Instead a 5 percent increase in irrigation efficiency was assumed to be possible in decades 2020, 2030, and 2040. These savings can be achieved through a combination of water saving measures including changes in irrigation equipment, crop type changes and crop variety changes, conversion from irrigated to dry land farming, and water loss reduction in irrigation canals.

Weather Modification

In the previous plan, data from the WTWMA's 2008 growing season estimated a 20 percent increase in rainfall. This was the basis for the water savings calculations in the 2011 plan. More updated information from the 2013 growing season for the WTWMA estimated a 9.6 percent increase in rainfall. This more recent data was used for the water savings calculations associated with this strategy in the 2016 plan.

CRMWD Winkler County Well Field

In the previous plan, the development of the Winkler County well field was a standalone strategy to develop and transport water to the CRMWD system. Since the publication of the 2011 plan, CRMWD has expanded their well field in Ward County as well as the transmission system from Ward County. CRMWD plans to expand the Ward County well field again in conjunction with development of the Winkler County well field. A new transmission line from the Winkler County well field to the Ward County well field will be needed. However, the existing transmission line from Ward County to the rest of the CRMWD's system is already in place and can be used with some minor pump station upgrades that are now included as part of this strategy.

CRMWD Groundwater Desalination

In the previous plan, this was a standalone strategy to develop and treat brackish groundwater from the Capitan Reef aquifer. In the current plan, this is part of a suite of strategies for CRMWD that includes development, transmission, treatment and potential ASR of groundwater. Each piece of this large project was broken out as an individual strategy for CRMWD as some or all of these pieces may be implemented depending on the results of future studies to determine the most feasible and economical combination of components.

No Longer Considered Water Management Strategies

In addition to new and altered strategies, some strategies included in the 2011 plan are no longer being considered for the entity for various reasons. These are outlined in Table 11-5.

Table 11-5
Strategies No Longer Considered in the 2016 Plan

Water User Group or Wholesale Provider	Strategies from the 2011 Plan No Longer in the 2016 Plan
Ballinger	Direct Potable Reuse
CRMWD	Drought Management
CRMWD	Snyder Reuse Project
CRMWD	Midland-Odessa Reuse Project
CRMWD	Water Marketing - Water from Roberts County
Eden	Bottled Water Programs
Menard	Drought Management
Menard	ASR
Richland SUD	Well Replacement and Advanced Treatment
Richland SUD	Bottled Water Programs
Robert Lee	Desalination of Spence Reservoir Water
Robert Lee	New floating pump in Mountain Creek Reservoir
Robert Lee	Expansion of WTP and storage facilities
Robert Lee	Direct Potable Reuse
San Angelo	System Optimization

11.3 Implementation of Previously Recommended Water Management Strategies

The following sections discuss those WMSs that were recommended in the 2011 Regional Water Plan, and have been partially or completely implemented since that plan was published. These WMSs are included in the 2016 plan as currently available supply. Information was collected on the implementation status of projects in the 2011 plan via an implementation survey. The full results of this survey are included in

Appendix N.

11.3.7 City of Eden

Advanced Treatment

One of the proposed WMSs for the City of Eden in the previous regional water plan included the replacement of a well in the Hickory aquifer, the construction of an advanced treatment facility to treat radionuclides in the Hickory aquifer water, and the construction of additional storage facilities. The City of Eden has since built a Water Remediation, Radium Removal System and it is currently in operation.

11.3.8 City of Midland

T-Bar Well Field

The City of Midland purchased the T-Bar Well Field in 1965, which consists of approximately 20,230 acres in northwestern Winkler County and northeastern Loving County. The WMS from the 2011 plan included the installation of 43 wells and the construction of a transmission pipeline. The City of Midland has implemented this strategy at a cost of approximately $209 million.[1] The City currently obtains about 11,200 acre-feet of supply per year from the well field. The system has a peak capacity of 20 MGD and contains 45 wells, a network of well field piping, and a 48 inch 59 mile transmission pipeline.[2]

11.3.9 CRMWD

Big Spring Reuse

The Big Spring Reclamation Project was proposed in the previous regional water plan to provide additional water for CRMWD customers through potable reuse. Wastewater reuse provides a reliable source that remains available even during a drought. This WMS included the treatment of approximately 2.3 MGD of wastewater effluent with advanced treatment methods (membrane filtration, reverse osmosis and UV oxidation), and the blending of this treated water with raw water from Spence Reservoir directly in the CRMWD Spence Pipeline. The raw water/effluent blend would then be treated at the Big Spring water treatment plant for municipal and industrial use. In May 2013, the $14 million dollar reclamation plant was opened.[3] It provides an additional 1,855 acre-feet per year for the customers of CRMWD.

11.3.10 City of San Angelo

McCulloch County Well Field Phase I

One of the strategies for the City of San Angelo included the development of a well field owned by the

City. The well field is located on the border of McCulloch and Concho Counties, and produces water from the Hickory aquifer. In 2014, the first phase of this project was put in place. At the writing of this plan, 9.5 miles of well field piping and 62 miles of transmission piping and associated pump stations have been installed. A groundwater treatment facility and additional wells are under construction. Another expansion of well field capacity is expected and is included as a recommended strategy in the current 2016 plan. The entire project is estimated to cost $120 million.[4] Phase I of the project will provide 6,700 acre-feet per year for the City of San Angelo through 2029. The supply from this source will be increased by 3,300 acre-feet per year in 2030 and again in 2040 by 2,000 acre-feet in accordance with their permit.

11.4 Conclusion

Overall the 2016 Region F Water Plan is very different from the 2011 Region F Water Plan. Surface water supplies are substantially lower due to the new drought of record conditions in the region. Groundwater supplies were reduced due to fundamental differences in determining availability, specifically the use of the MAG as a ceiling. Diminishing supplies coupled with higher demands in the region resulted in needs for many water users that previously showed no needs and greater needs for many other entities. Consequently, over 70 new strategies were developed for the 2016 plan.

LIST OF REFERENCES

[1] "Well Field Project Provides Relief to Drought-Stricken Texas." *American Water Works Association Opflow* July 2013: 36. Web. 5 Mar. 2015.

[2] "T-Bar Well Field Development and Delivery Project Midland, Texas." *T-Bar Well Field Development and Delivery Project*. Parkhill Smith & Cooper, n.d. Web. 06 Mar. 2015.

[3] Wythe, Kathy. "Reclaiming a Valuable, Clean Resource." Texas Water Resources Institute. Tx H20, Summer 2013. Web. 06 Mar. 2015.

[4] "Hickory Aquifer." City of San Angelo, TX. City of San Angelo, TX, n.d. Web. 06 Mar. 2015.