1 DESCRIPTION OF THE REGION

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

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

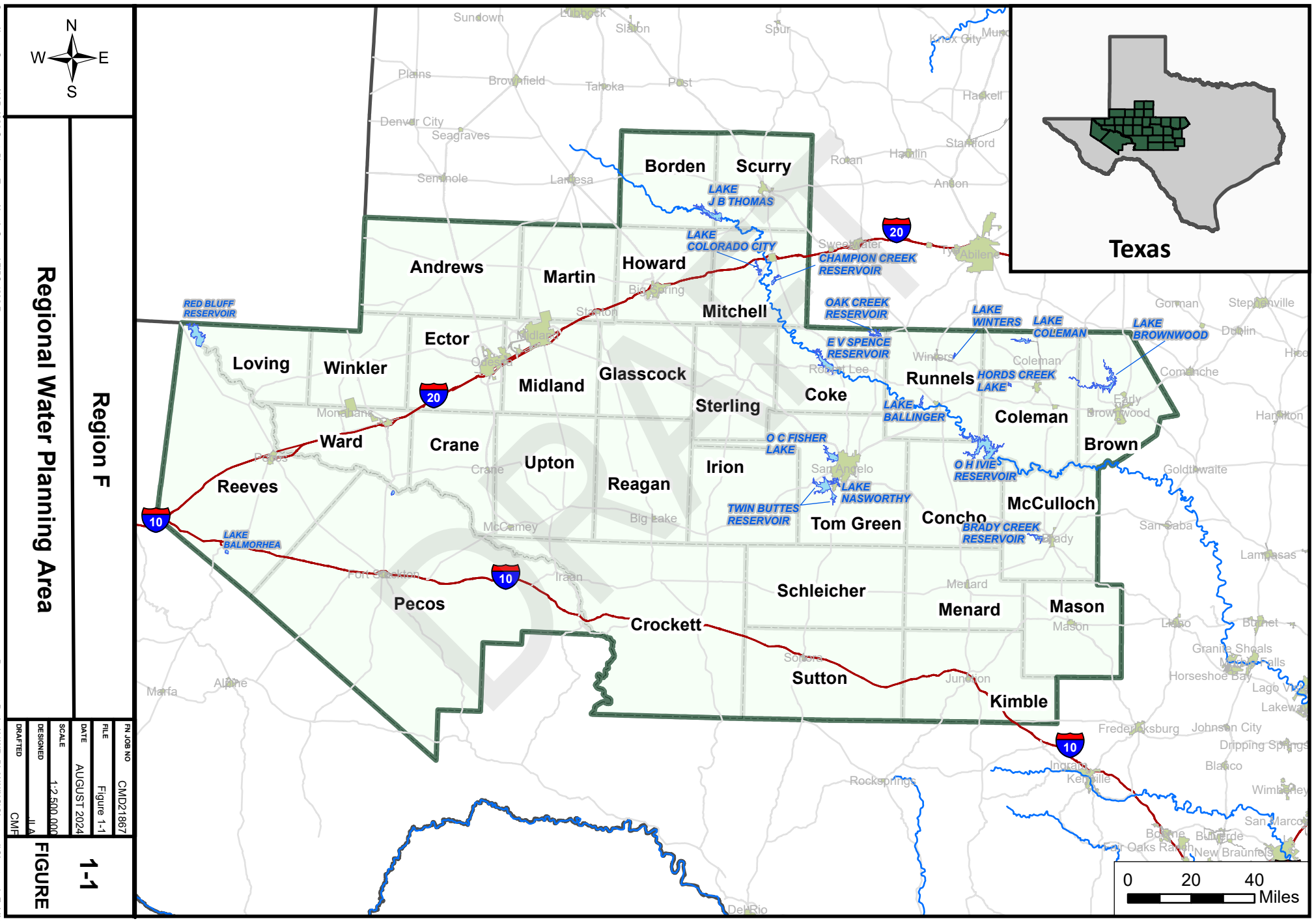
Region F at a Glance:

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

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

1.1 INTRODUCTION TO REGION F

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


Region F
Regional Water Planning Area
FIGURE
1-1
FN JOB NO CMD21867
FILE Figure 1-1
DATE AUGUST 2024
SCALE 1:2,500,000
DESIGNED JLA
DRAFTED CMF
Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet
Document Path: H:\WR_PLANNING\Chapter 1\Chapter_1_Exhibits.aprx
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W
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Texas
Borden
Scurry
Andrews
Martin
Howard
Mitchell
Ector
Loving
Winkler
Midland
Glasscock
Sterling
Coke
Runnels
Coleman
Brown
Ward
Crane
Upton
Irion
Reagan
Concho
McCulloch
Reeves
Pecos
Tom Green
Schleicher
Menard
Mason
Crockett
Sutton
Kimble
LAKE J B THOMAS
LAKE COLORADO CITY
CHAMPION CREEK RESERVOIR
OAK CREEK RESERVOIR
E V SPENCE RESERVOIR
RED BLUFF RESERVOIR
LAKE WINTERS
LAKE COLEMAN
LAKE BROWNWOOD
HORDS CREEK LAKE
LAKE BALLINGER
O C FISHER LAKE
O H IVIE RESERVOIR
LAKE NASWORTHY
TWIN BUTTES RESERVOIR
BRADY CREEK RESERVOIR
LAKE BALMORHEA
20
10
0
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40
Miles
DRAFT

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

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

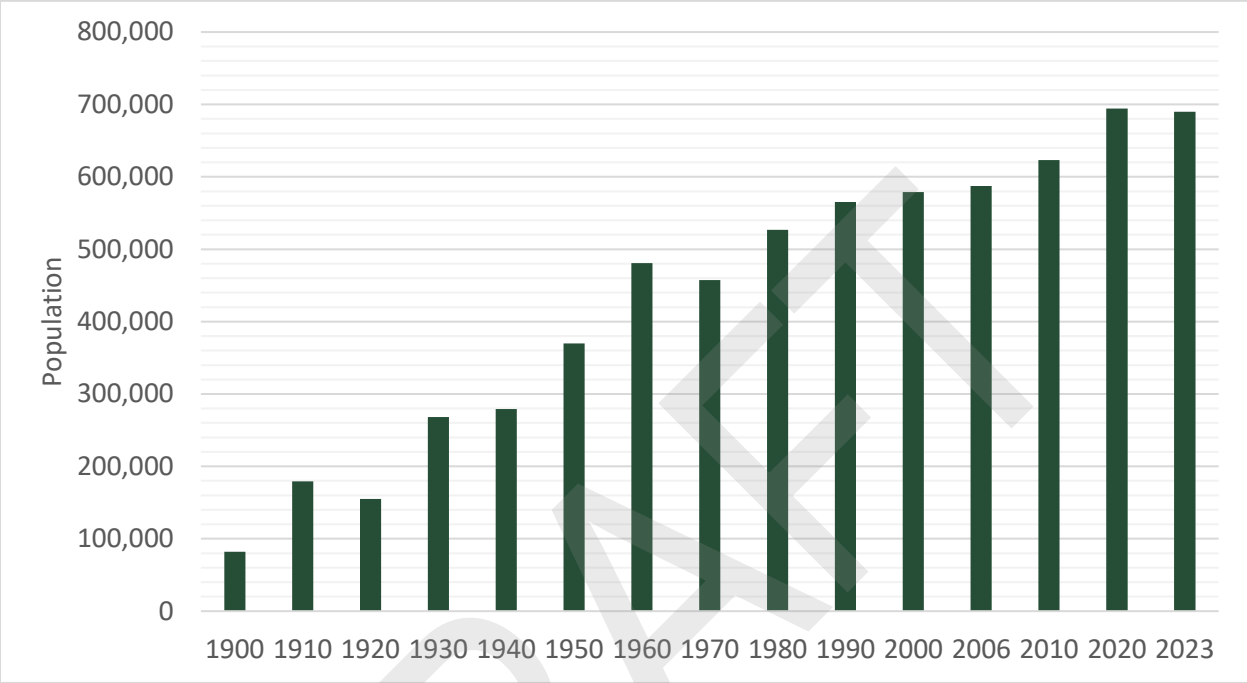
Notes: a. Historical[1] and estimated population data are from the U.S. Census Bureau[2]

b. Reagan County was formed from part of Tom Green County in 1903

c. Terrell County was formed from part of Pecos County in 1905.

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

Figure 1-2
Historical Population of Region F

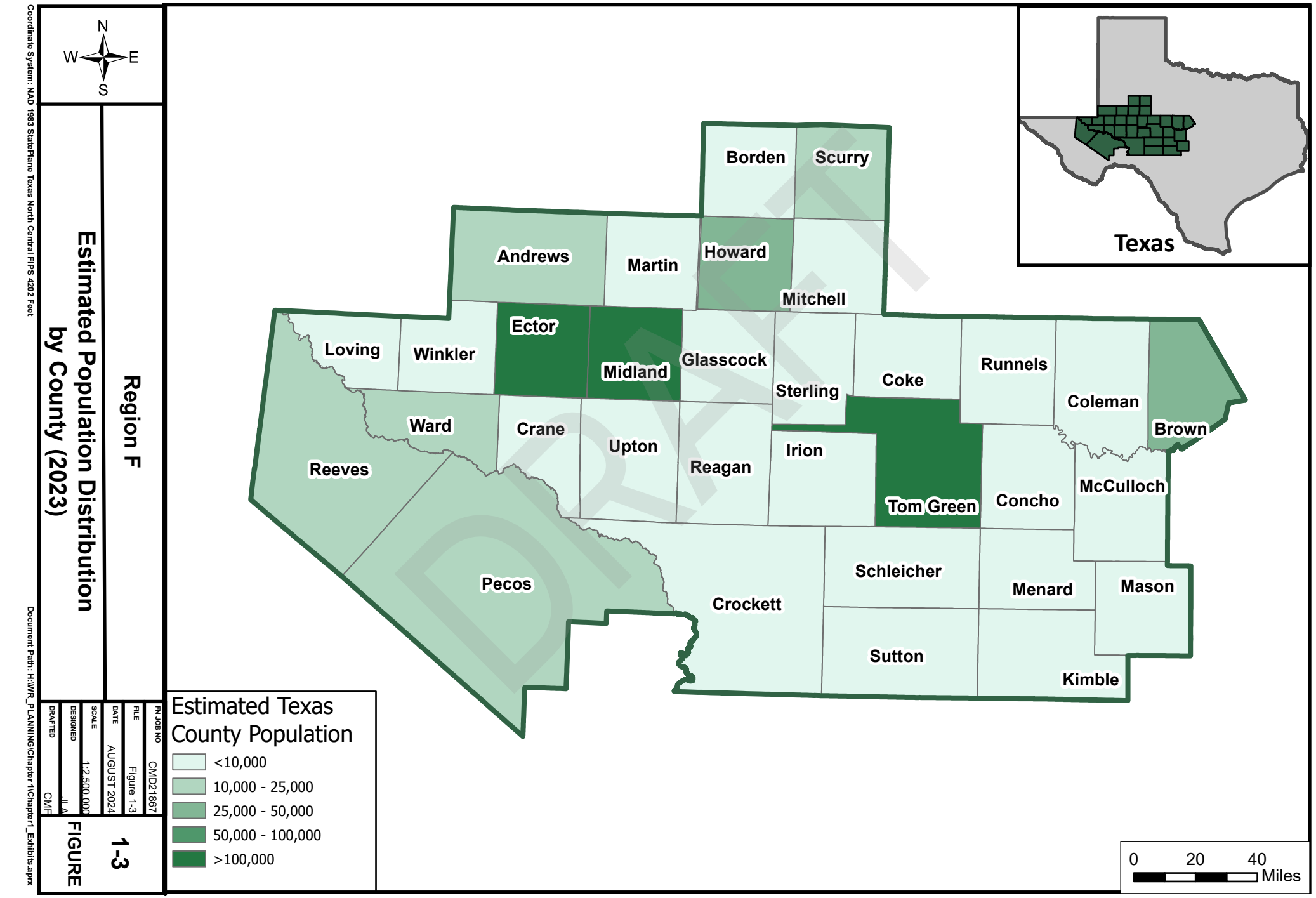


According to 2020 population data by the U.S. Census Bureau, Region F accounted for 2.4 percent of Texas' total population. Figure 1-3 shows the distribution of population in Region F counties based on the census data. Ector, Midland, and Tom Green were the three most populous counties in Region F, accounting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

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

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

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



Region F

Estimated Population Distribution by County (2023)

FIGURE 1-3

FN JOB NO	CMD21867
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DATE	AUGUST 2024
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Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet

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1.1.1 Economic Activity in Region F

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

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

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

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

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

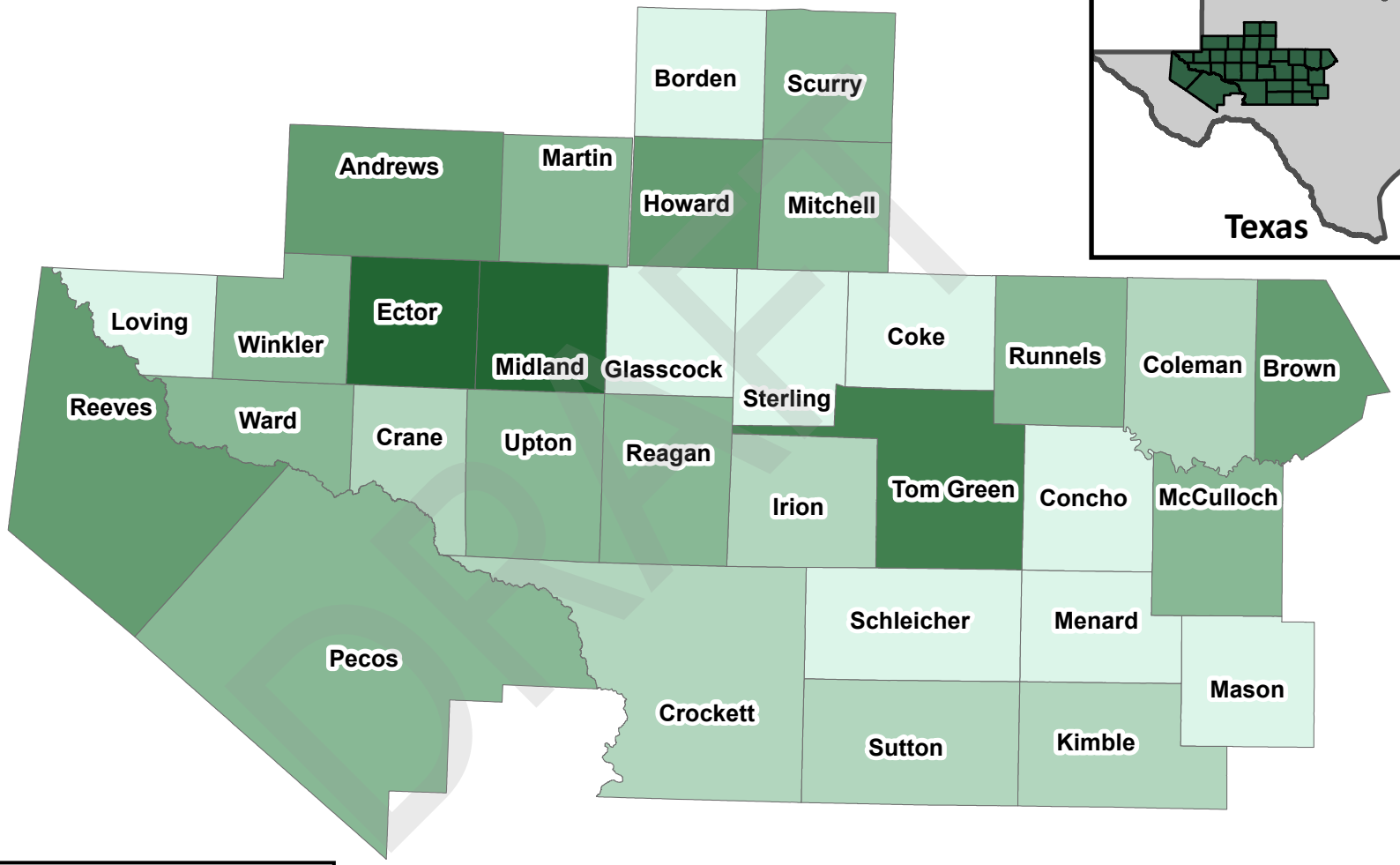
Table 1-3 (cont.)
2023 County Payroll by Category ($1000)

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

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

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

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



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Estimated Payroll Distribution by County (2022)

Region F

FIGURE 1-4

FN JOB NO	CMD21867
FILE	Figure 1-4
DATE	AUGUST 2024
SCALE	1:2,500,000
DESIGNED	JLA
DRAFTED	CMF

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

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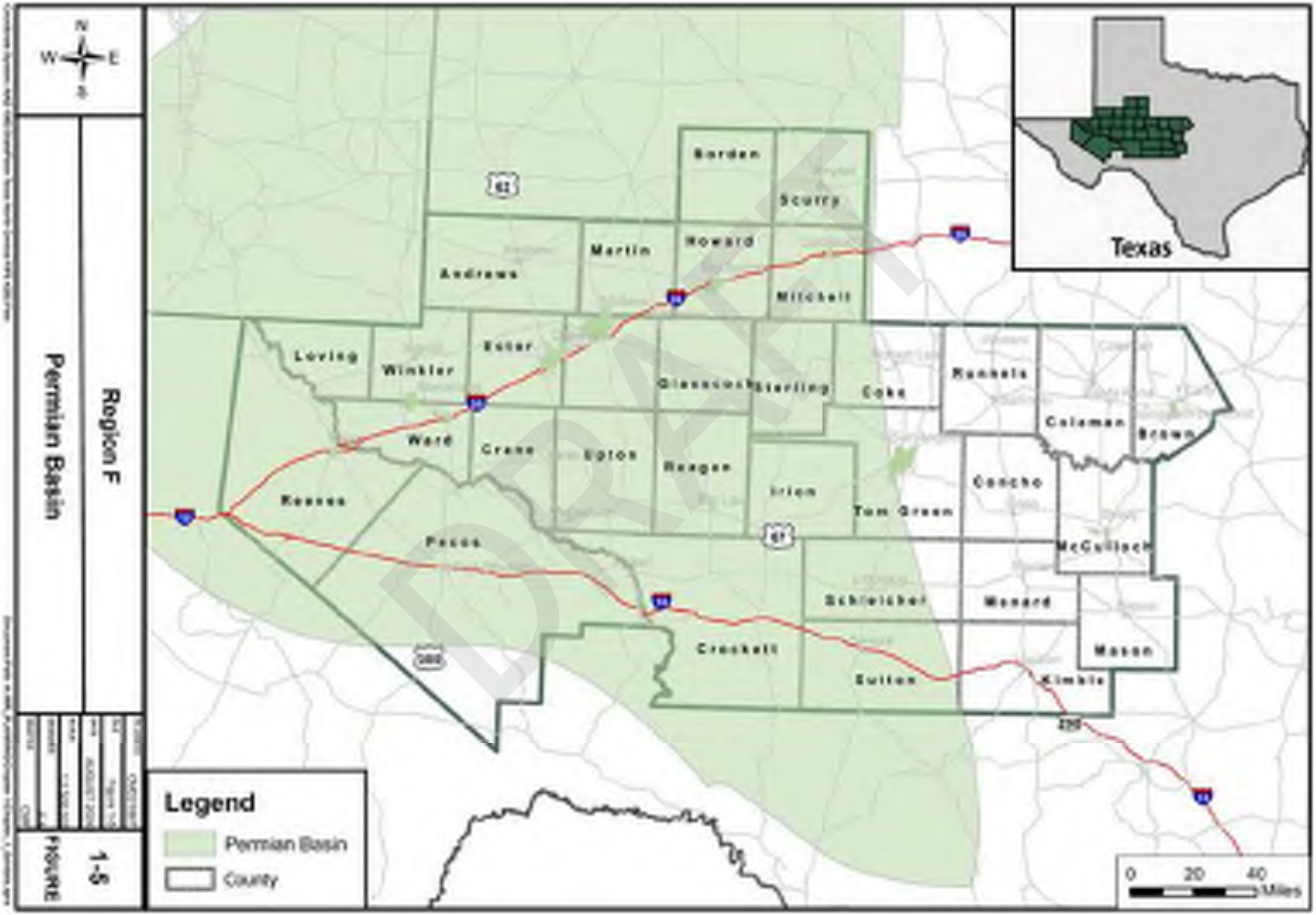
Region F
Permian Basin
FIGURE 1-5
Legend
Permian Basin
County
Texas
Borden
Scurry
Howard
Martin
Andrews
Mitchell
Loving
Winkler
Ector
Glasscock
Sterling
Coke
Runnels
Coleman
Brown
Ward
Crane
Upton
Reagan
Irion
Tom Green
Concho
McCulloch
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1.1.2 Water-Related Physical Features and Climate in Region F

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

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

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

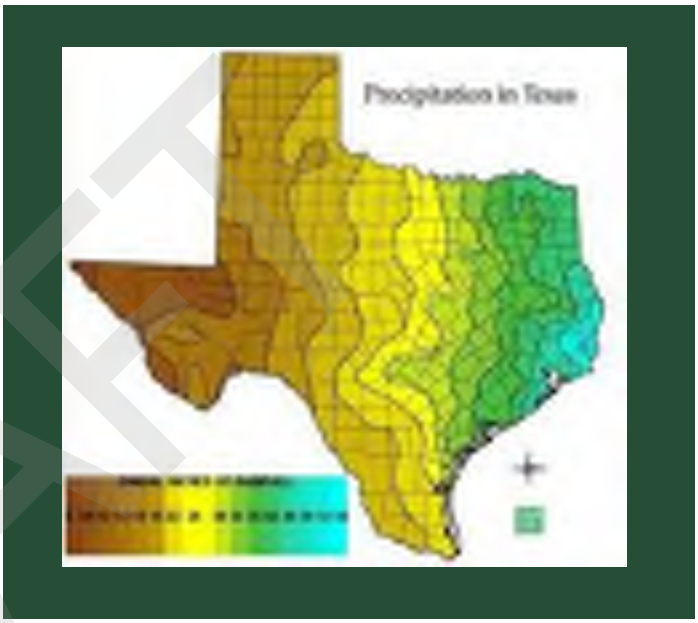


Figure 1-9 shows the major aquifers in Region F, and Figure 1-10 shows the minor aquifers. There are 14 aquifers that supply water to the 32 counties of Region F. The major aquifers are the Edwards-Trinity Plateau, Ogallala, Pecos Valley, and a small portion of the Trinity. The minor aquifers are the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

Water Related Facts for Region F:

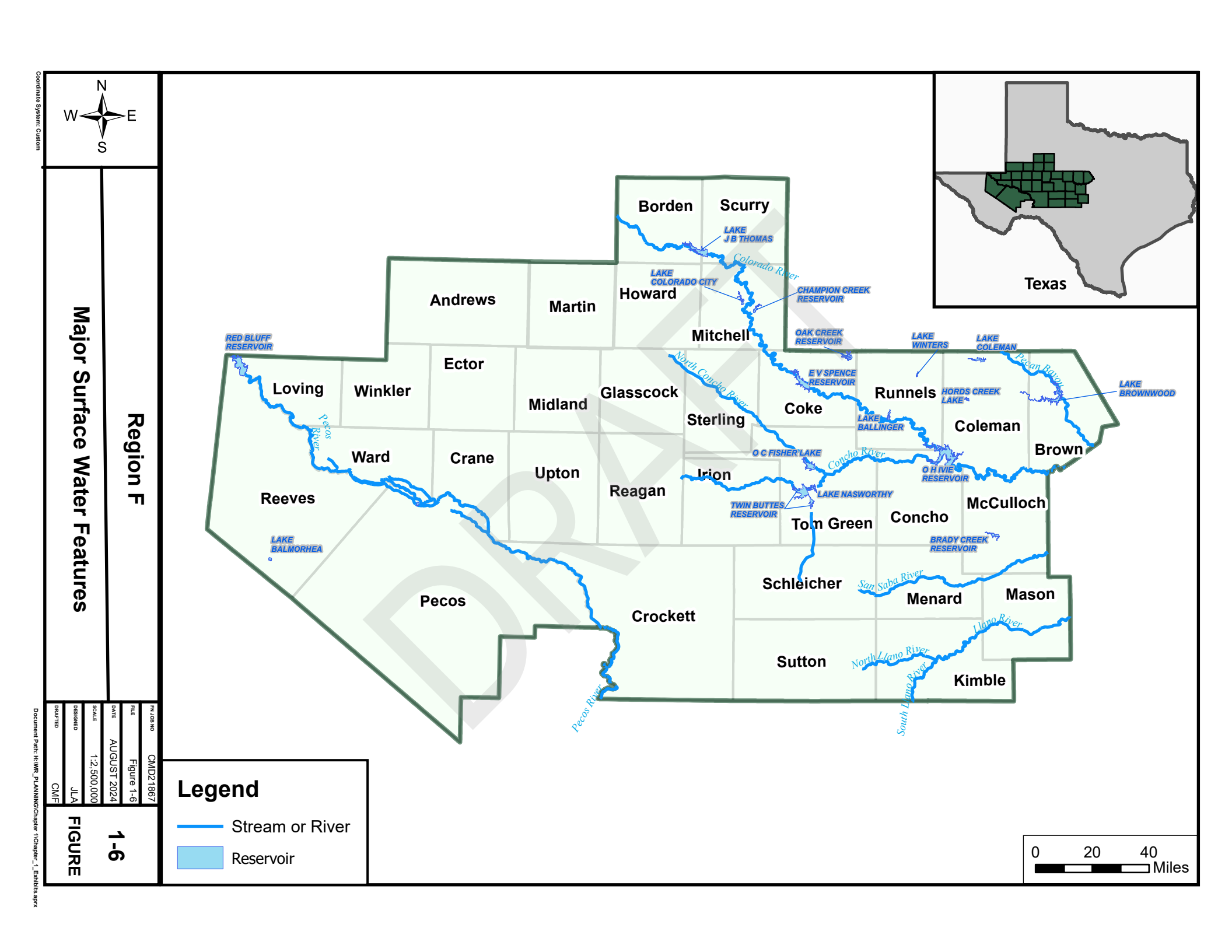
- Three river basins in Region F: Colorado River, Pecos River, Brazos River
- Four major aquifers
- Ten minor aquifers
- Precipitation ranges from 11 inches in the west to 30 inches in the east
- Evaporative losses from area lakes can exceed 5 feet per year

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

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

a. A major reservoir has more than 5,000 acre-feet of storage.
b. Total diversions under CA 1002 and CA 1008 limited to 73,000 acre-feet per year. CA 1008 allows up to 50,000 acre-feet per year of diversion. For purposes of this table, the limitation is placed on CA 1008.
c. Permitted storage is reported for water conservation storage. UCRA has permission to use water from the sediment pool.
d. Data are from TCEQ active water rights list[6], TCEQ water rights permits[7], and TCEQ historical water use by water right[8]. Year 2022 use is consumptive.

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


Region F
Major Surface Water Features
FIGURE 1-6
N
W
E
S
Texas
Borden
Scurry
Howard
Mitchell
Andrews
Martin
Ector
Loving
Winkler
Midland
Glasscock
Sterling
Coke
Runnels
Coleman
Brown
Ward
Crane
Upton
Irion
Reagan
Reeves
Pecos
Crockett
Tom Green
Concho
McCulloch
Schleicher
Menard
Mason
Sutton
Kimble
LAKE J B THOMAS
LAKE COLORADO CITY
CHAMPION CREEK RESERVOIR
OAK CREEK RESERVOIR
LAKE WINTERS
LAKE COLEMAN
E V SPENCE RESERVOIR
HORDS CREEK LAKE
LAKE BROWNWOOD
LAKE BALLINGER
O C FISHER LAKE
O H IVIE RESERVOIR
LAKE NASWORTHY
TWIN BUTTES RESERVOIR
BRADY CREEK RESERVOIR
RED BLUFF RESERVOIR
LAKE BALMORHEA
Colorado River
North Concho River
Concho River
Pecan Bayou
Pecos River
San Saba River
Llano River
North Llano River
South Llano River
Legend
Stream or River
Reservoir
0
20
40
Miles
DRAFT
Coordinate System: Custom
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DRAFTED CMF
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DATE AUGUST 2024
FILE Figure 1-6
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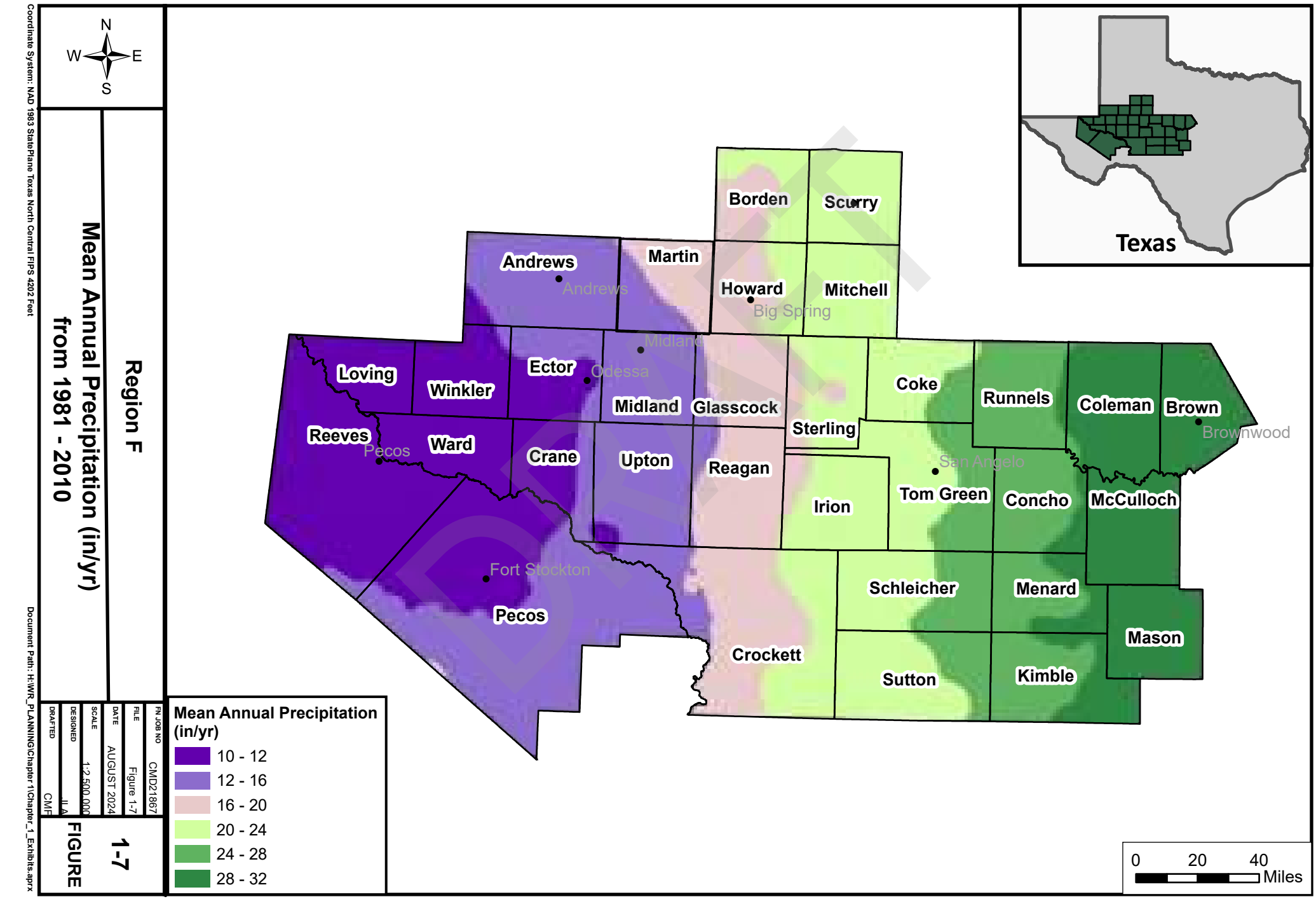
N
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S
Region F
Mean Annual Precipitation (in/yr)
from 1981 - 2010
FIGURE
1-7
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AUGUST 2024
FILE
Figure 1-7
FN JOB NO
CMD21867
Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet
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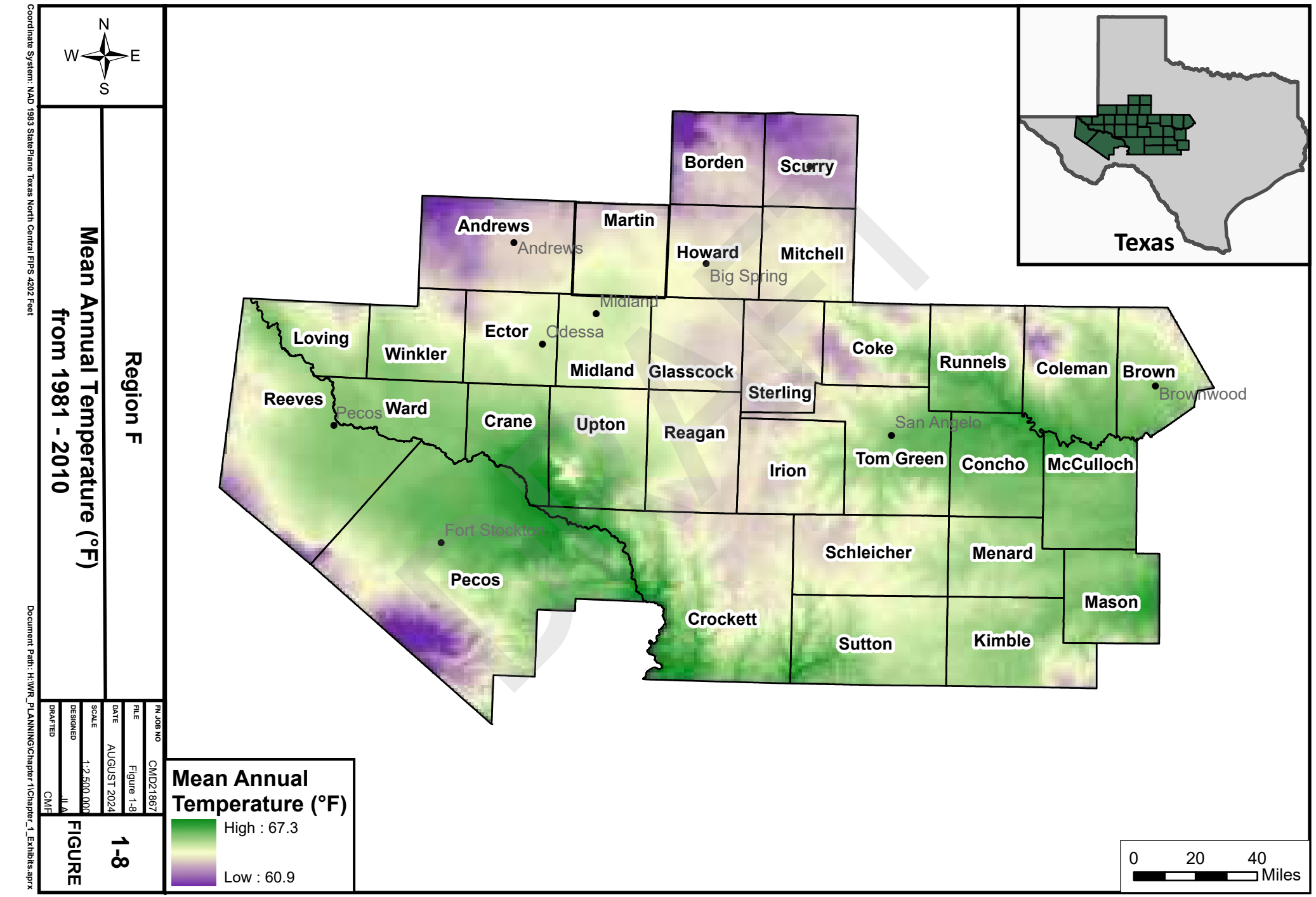
Texas
Borden
Scurry
Andrews
Martin
Howard
Mitchell
Andrews
Big Spring
Midland
Loving
Winkler
Ector
Odessa
Midland
Glasscock
Coke
Runnels
Coleman
Brown
Brownwood
Sterling
Reeves
Pecos
Ward
Crane
Upton
Reagan
San Angelo
Irion
Tom Green
Concho
McCulloch
Fort Stockton
Pecos
Schleicher
Menard
Mason
Crockett
Sutton
Kimble
Mean Annual Precipitation (in/yr)
10 - 12
12 - 16
16 - 20
20 - 24
24 - 28
28 - 32
0
20
40
Miles


Mean Annual Temperature (°F) from 1981 - 2010
Region F
FIGURE 1-8
FN JOB NO CMD21867
FILE Figure 1-8
DATE AUGUST 2024
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Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet
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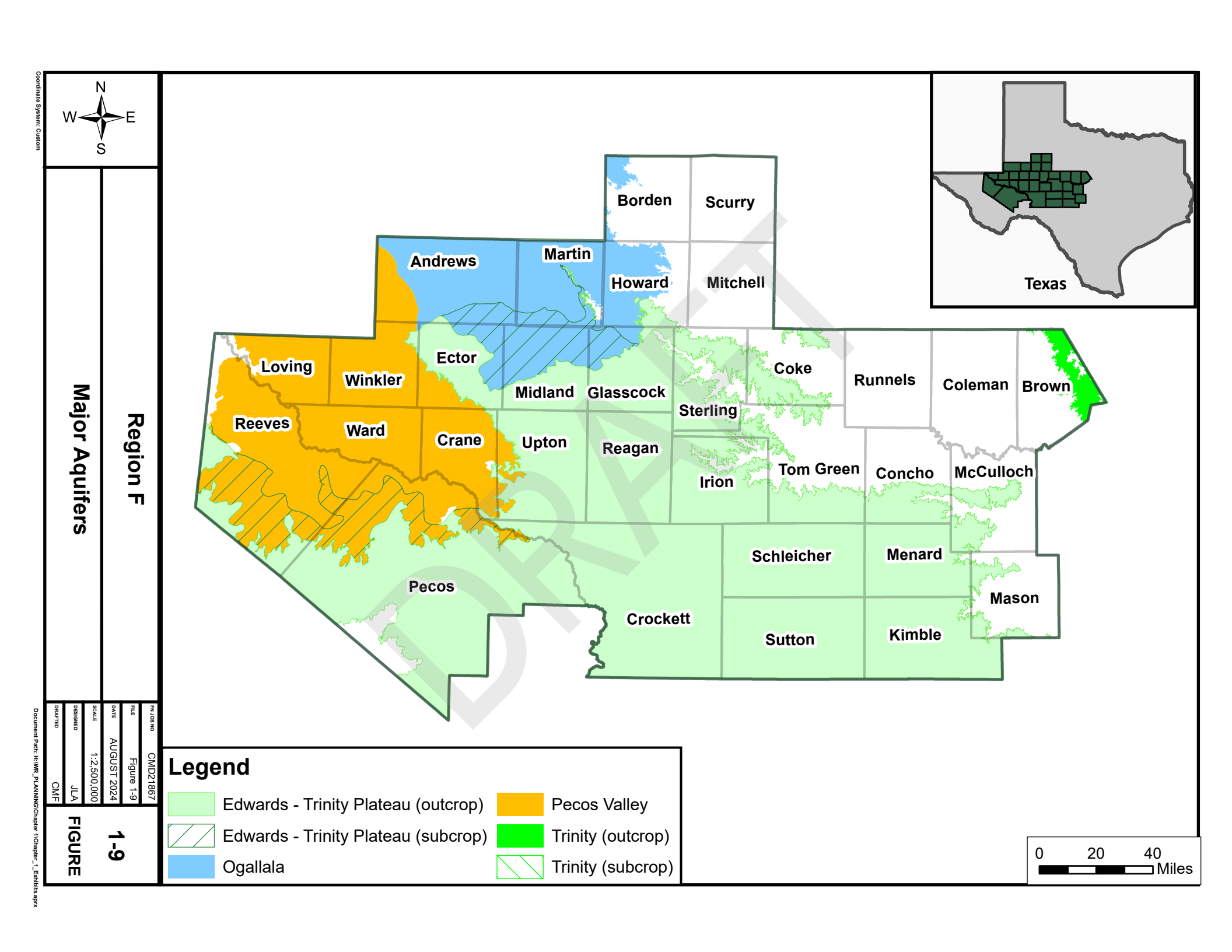
N
W
E
S
Texas
Borden
Scurry
Andrews
Martin
Howard
Mitchell
Big Spring
Midland
Loving
Winkler
Ector
Odessa
Midland
Glasscock
Coke
Runnels
Coleman
Brown
Brownwood
Sterling
Reeves
Pecos
Ward
Crane
Upton
Reagan
San Angelo
Irion
Tom Green
Concho
McCulloch
Fort Stockton
Pecos
Schleicher
Menard
Mason
Crockett
Sutton
Kimble
Mean Annual Temperature (°F)
High : 67.3
Low : 60.9
0
20
40
Miles


Coordinate System: Custom
N
W
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S
Region F
Major Aquifers
FIGURE
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DATE
AUGUST 2024
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Figure 1-9
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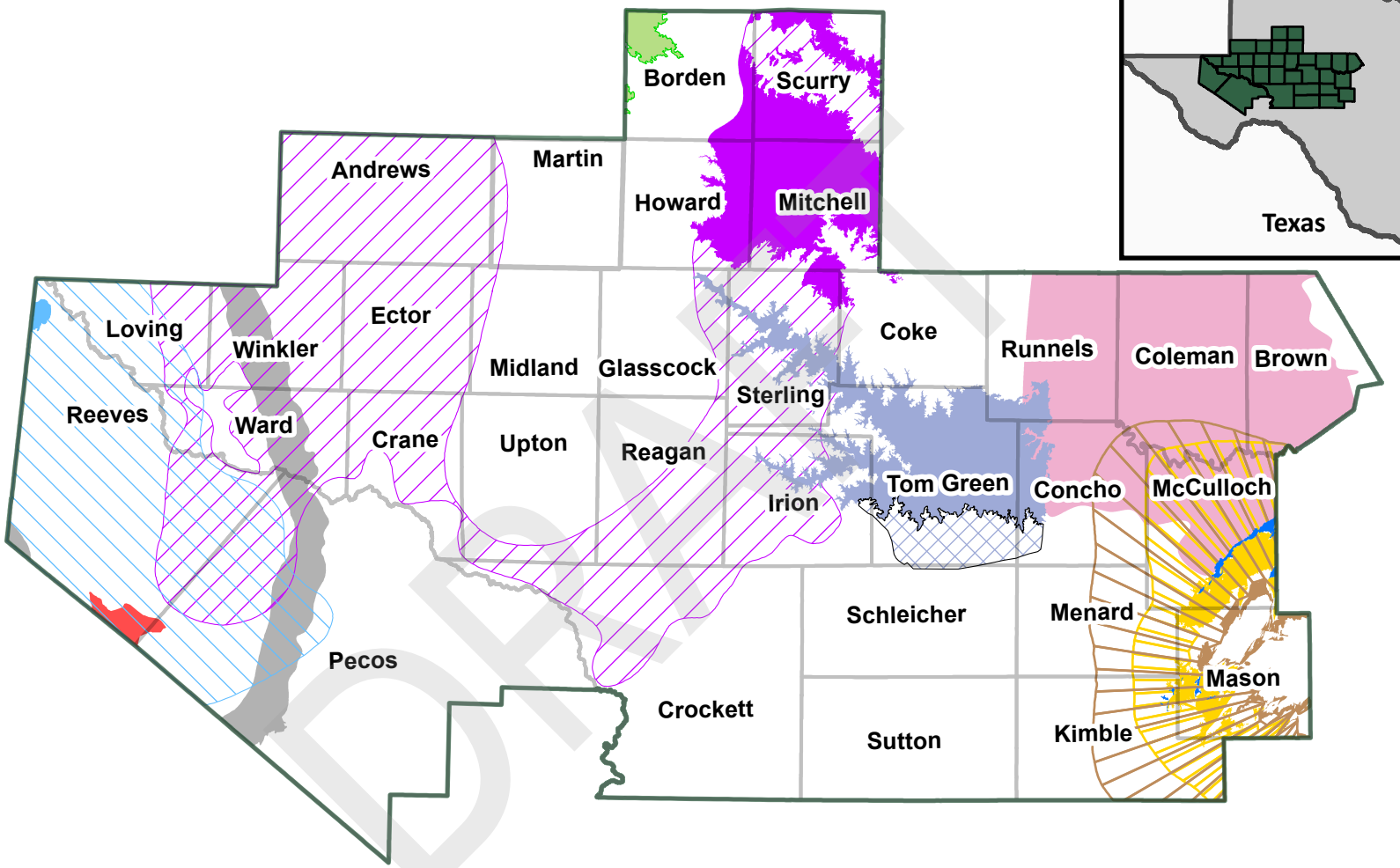
Borden
Scurry
Andrews
Martin
Howard
Mitchell
Texas
Loving
Winkler
Ector
Midland
Glasscock
Coke
Runnels
Coleman
Brown
Reeves
Ward
Crane
Upton
Reagan
Sterling
Irion
Tom Green
Concho
McCulloch
Schleicher
Menard
Mason
Pecos
Crockett
Sutton
Kimble
DRAFT
Legend
Edwards - Trinity Plateau (outcrop)
Edwards - Trinity Plateau (subcrop)
Ogallala
Pecos Valley
Trinity (outcrop)
Trinity (subcrop)
0
20
40
Miles



Legend

- Capitan Reef Complex
- Cross Timbers
- Dockum (outcrop)
- Dockum (subcrop)
- Edward-Trinity (High Plains)
- Ellenburger-San Saba (outcrop)
- Elleburger-San Saba (subcrop)
- Hickory (outcrop)
- Hickory (subcrop)
- Igneous
- Lipan (outcrop)
- Lipan (subcrop)
- Marble Falls
- Rustler (outcrop)
- Ruster (subcrop)

0 20 40 Miles

Region F

Minor Aquifers

FIGURE 1-10

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DATE	AUGUST 2024
FILE	Figure 1-10
FN JOB NO	CMD21867

Coordinate System: Custom

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1.2 CURRENT WATER USES AND DEMAND CENTERS IN REGION F

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

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

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

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

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

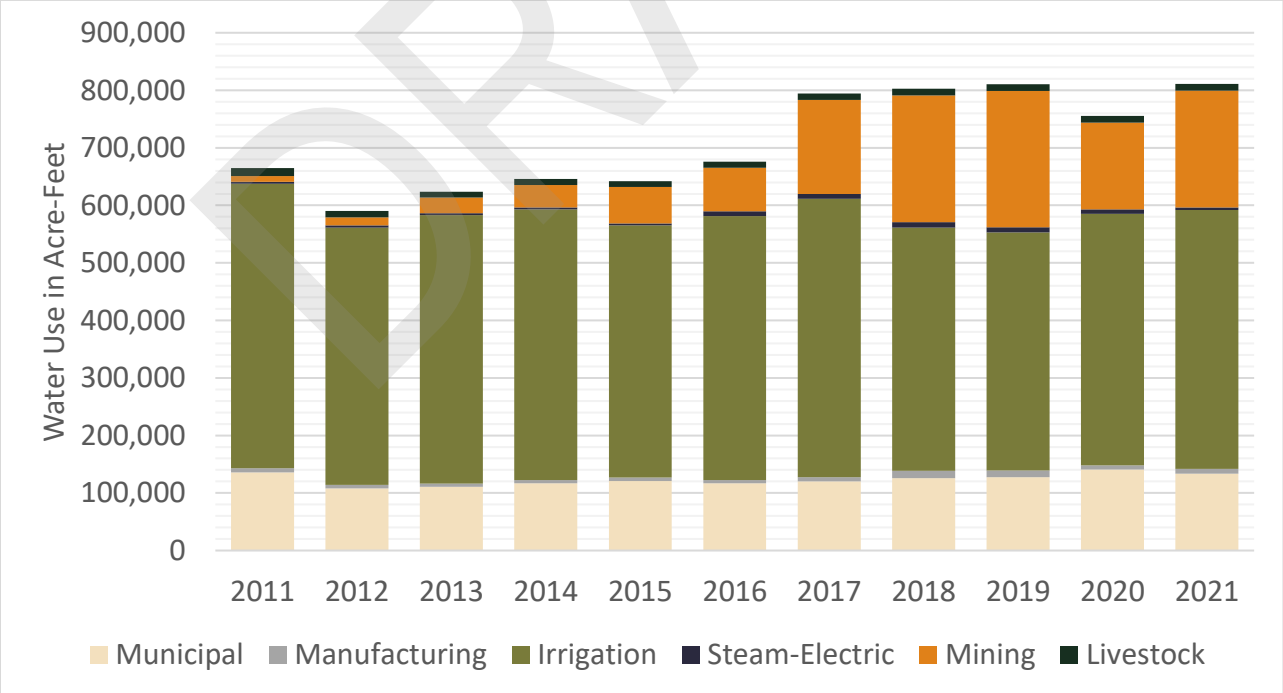


Table 1-6
Historical Total Water Use by County in Region F (Values in acre-feet)

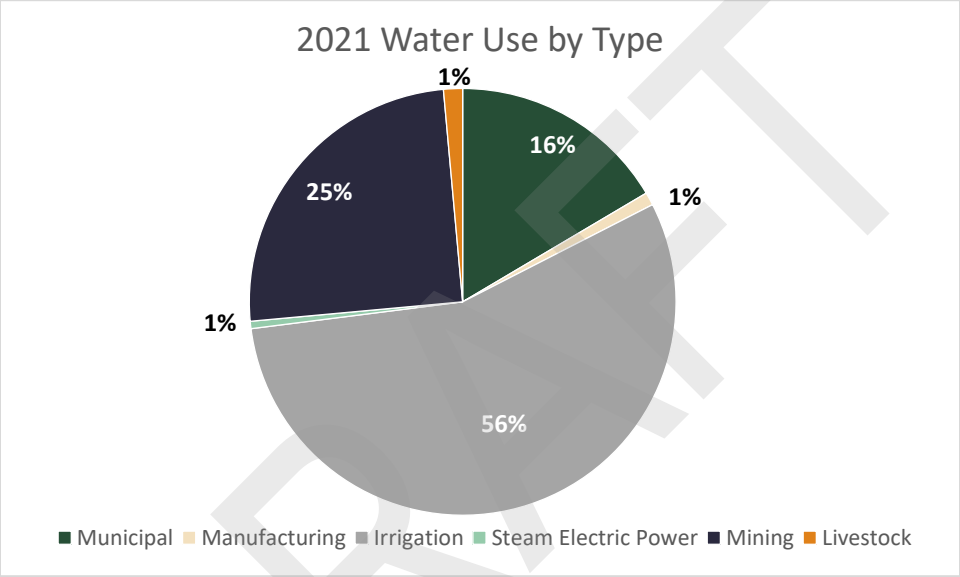
County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Andrews	27,340	28,839	24,107	20,709	20,853	22,162	21,533	21,950	23,020	21,274	26,861
Borden	4,430	3,788	4,450	2,301	2,238	2,683	3,428	4,814	4,465	3,377	3,066
Brown	17,628	14,763	13,753	12,896	13,660	12,750	12,496	15,627	13,276	15,811	13,707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

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

Table 1-7 shows water use by category and county in 2021, and Figure 1-12 shows the distribution of water use by county.

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

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



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

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

2021 Water Use in Region F:

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

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

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

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

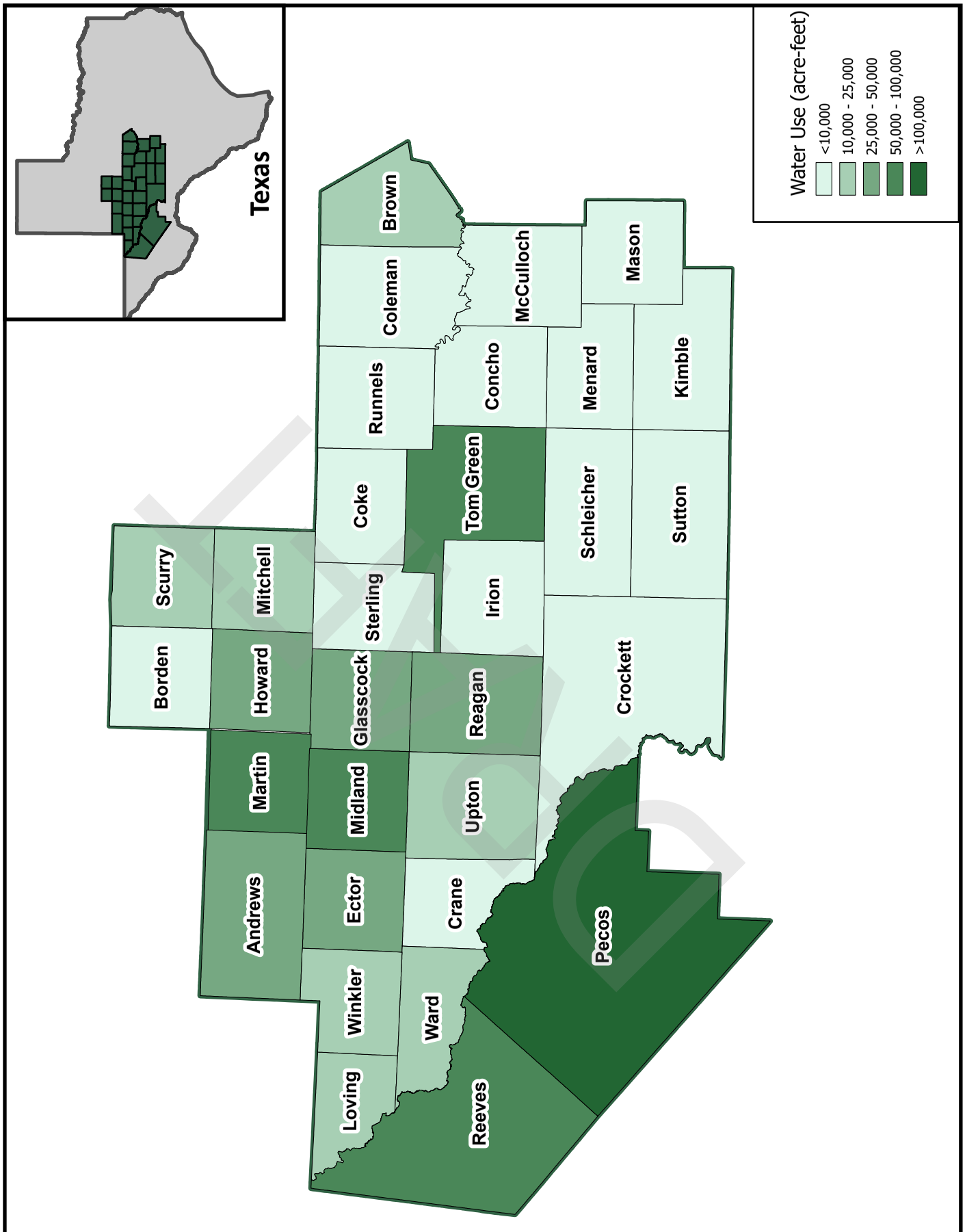
Table 1-7
Year 2021 Water Use by Category and County (Values in acre-feet)

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

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

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

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



Region F

2021 Historical Water Use by County (Acre-Feet per Year)

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DATE	AUGUST 2024
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FIGURE

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

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

1.3 CURRENT SOURCES OF WATER

Table 1-9 summarizes the total surface water, groundwater, and reuse water use in Region F from 2011 through 2021, and Figure 1-13 graphically illustrates the same data. Total water use increased by approximately 118,000 acre-feet (17 percent) between 2011 and 2021. Groundwater use increased by more than 24,000 acre-feet (5.0 percent) and surface water use decreased by over 58,000 acre-feet (42.8 percent) over the same period. Estimates of reuse water and brackish water (for mining) use were first recorded by the TWDB on a countywide basis in the year 2015. Between 2015 and 2021, there was an increase of over 125,000 acre-feet (237 percent) of reuse water use.

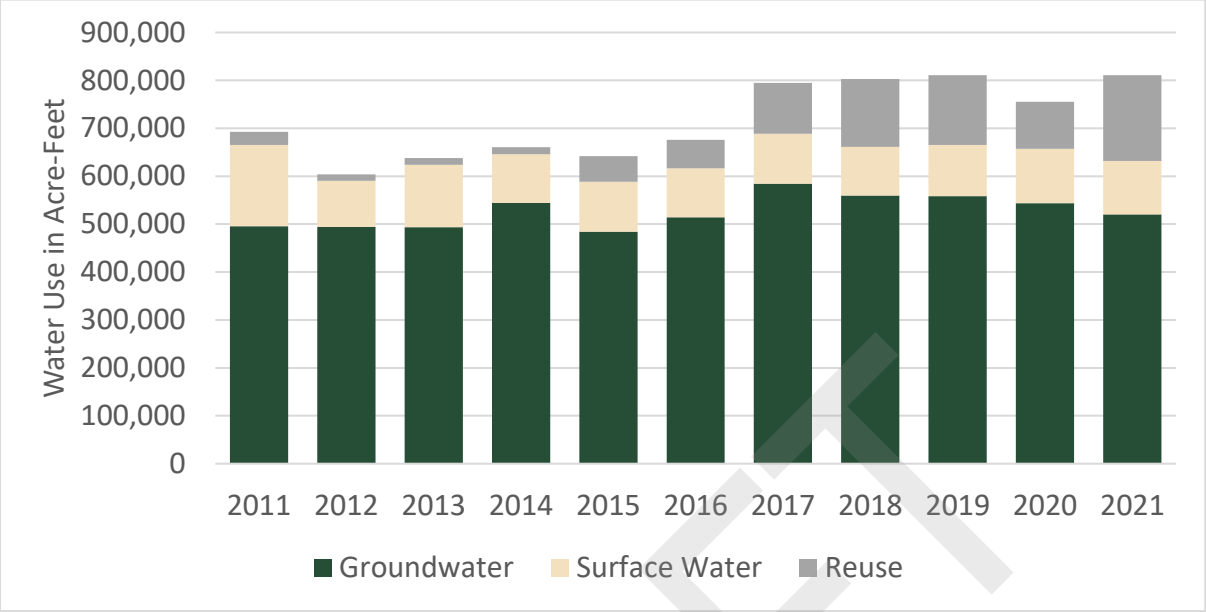
Figure 1-15 shows the percentage of supply from groundwater, broken down by county, in the region in the year 2021. Overall, groundwater use has shown a decreasing trend in recent years ranging from 72 percent of total water use in 2011 to 64 percent in 2021. Surface water use has shown a consistent decreasing trend ranging from 24 percent of total water use in 2011 to 14 percent in 2021.

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

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

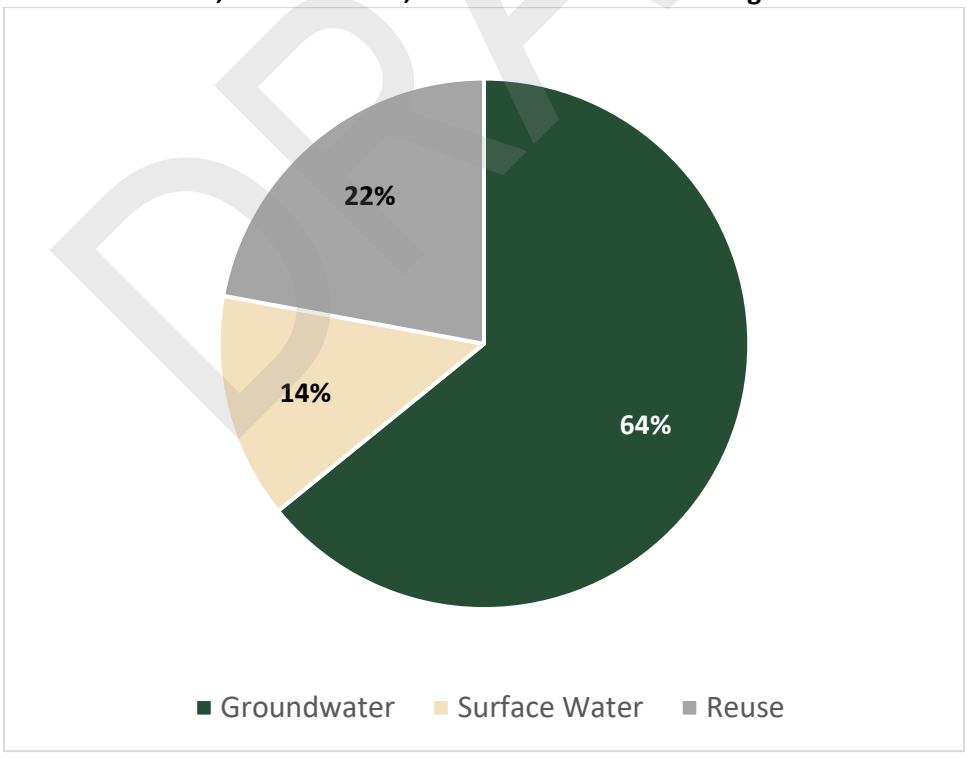
Note: Data are from Texas Water Development Board.[9]
a. Values from 2000-2014 only reflect entities that reported water reuse during that year.
Annual reuse and brackish water (for mining) use was not reported through all of Region F until 2015.

Figure 1-13
Historical Groundwater, Surface Water, and Reuse Water Use in Region F*



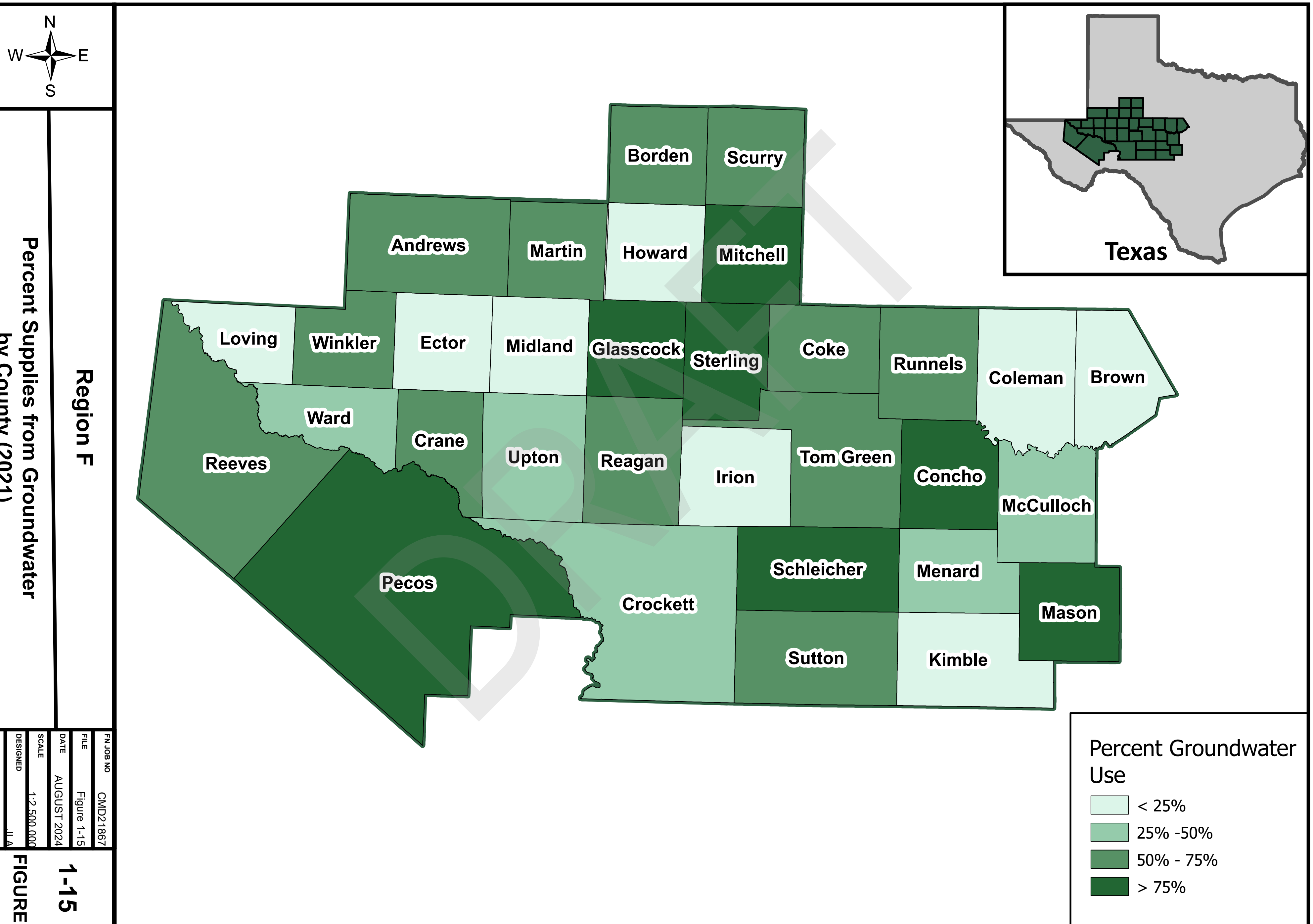
*Values from 2000-2014 only reflect entities that reported water reuse during that year. Annual water reuse was not reported through all of Region F until 2015.

Figure 1-14
Groundwater, Surface Water, and Reuse Water Use in Region F in 2021



Region F

Percent Supplies from Groundwater by County (2021)



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DATE	AUGUST 2024
FILE	Figure 1-15
FN JOB NO	CMD21867

FIGURE 1-15

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

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1.3.1 Surface Water Sources

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

All surface water, with a few exceptions, is owned by the State and users must have a water right permit to store and/or use this water. Water use permits are generally issued by use type authorized by the State. Table 1-10 summarizes permitted surface water diversions by use category for each county in Region F. (These categories differ slightly from the demand categories used by TWDB for regional water planning.) Figure 1-16 shows the distribution of permitted diversions by county and use type. Most of the large surface water diversions in Region F are associated with major reservoirs. Table 1-4 in Section 1.1.2 lists the permitted diversions and the reported year 2022 water use from major water supply reservoirs in the region.

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

Lake Ivie
Colorado River Municipal Water District

Lake Brownwood
Brown County Water Improvement District #1

Table 1-10
Surface Water Rights by County and Category

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

a. Diversion amounts that are permitted for multiple uses, including municipal, are shown under the municipal use category.

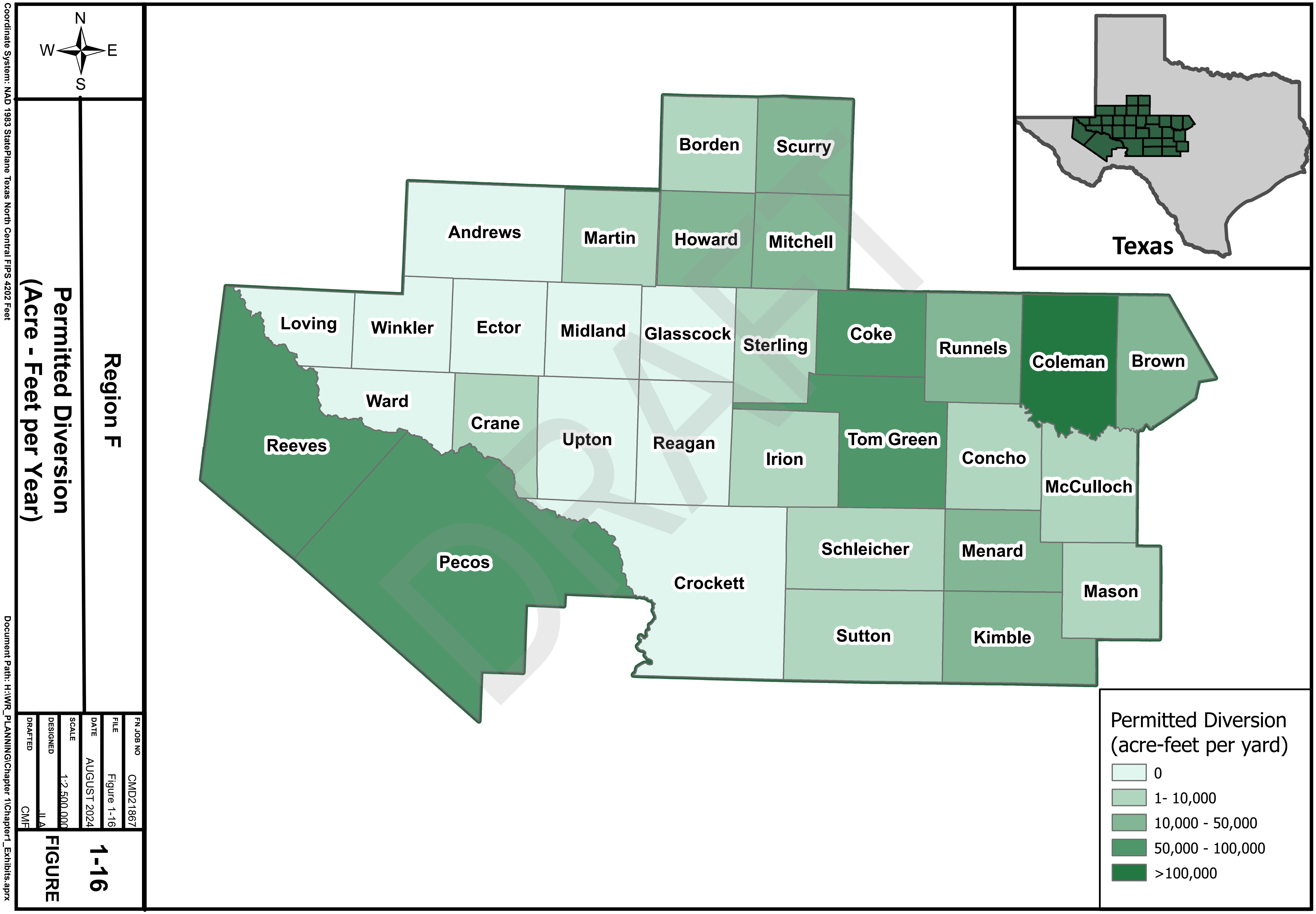
b. Other includes domestic and livestock use and recreational use.

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

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

e. Includes rights for Lake J.B. Thomas, which is located in Borden and Scurry Counties.

Note: Data are from TCEQ's active water rights list.[6] Other counties have no permitted water rights on the TCEQ list. Additional note, for water rights listed in multiple counties, all of the volume of the water right was assigned to one county.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N
W
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S
Permitted Diversion
(Acre - Feet per Year)
Region F
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AUGUST 2024
FILE
Figure 1-16
FN JOB NO
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FIGURE
1-16
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
DRAFT
Texas
Permitted Diversion
(acre-feet per yard)
0
1- 10,000
10,000 - 50,000
50,000 - 100,000
>100,000

1.3.2 Groundwater Sources

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

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

Groundwater conservation districts are the preferred method for managing groundwater in the State of Texas. There are 16 Underground Water Conservation Districts (GCDs) in Region F (Figure 1-17). These entities are required to develop and adopt comprehensive management plans, permit wells that are drilled, completed or equipped to produce more than 25,000 gallons per day, keep records of well completions, and make information available to state agencies. Other powers granted to GCDs are prevention of waste, conservation, recharge projects, research, distribution and sale of water, and making rules regarding transportation of groundwater outside of the district.[11]

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

The GCDs are also required to participate in joint groundwater planning through Groundwater Management Areas (GMAs). There are 16 GMAs in the State of Texas whose boundaries generally coincide with major aquifers. Each GMA is tasked with determining Desired Future Conditions for the aquifers in the management area for planning purposes. There are four GMAs that include one or more counties in Region F: GMA-7, GMA-3, GMA-2, and GMA-8 (Figure 1-17). Additional information on GCDs, the GMA process, and groundwater availability is included in Chapter 3.

In areas, where no there is no GCD, the state may designate a Priority Groundwater Management Area (PGMA). The Priority Groundwater Management Area (PGMA) process is initiated by the TCEQ, who designates a PGMA when an area is experiencing critical groundwater problems, or is expected to do so within 25 years. These problems include shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, or contamination of groundwater supplies.

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

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

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

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

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

Once an area is designated a PGMA, landowners have two years to create a GCD. Otherwise, the TCEQ is required to create a GCD or to recommend that the area be added to an existing district. The TWDB works with the TCEQ to produce a legislative report every two years on the status of PGMAs in the state. The PGMA process is completely independent of the current GMA process and each process has different goals. The goal of the PGMA process is to establish GCDs in these designated areas so that there will be a regulating entity to address the identified groundwater issues. PGMAs are still relevant as long as there remain portions within these designated areas without GCDs. There is one PGMA in Region F, the Reagan, Upton, and Midland County PGMA as shown in Figure 1-18.

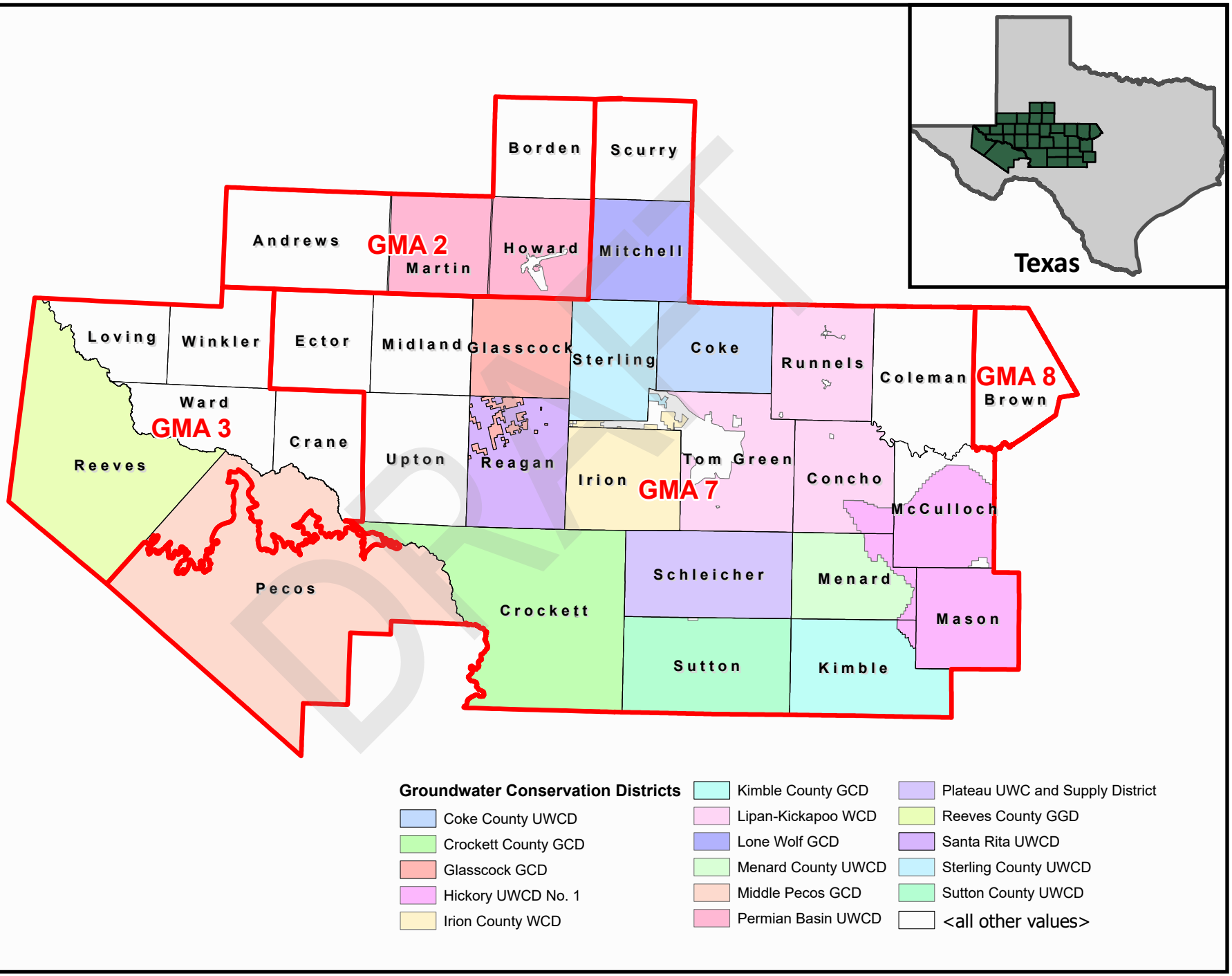
The Reagan, Upton and Midland County PGMA was designated in 1990. The name of the PGMA is somewhat of a misnomer because it only includes portions of Midland and Upton Counties as shown in Figure 1-18. All portions of Reagan County are included in either Glasscock or Santa Rita GCD.

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

The TCEQ Executive Director is authorized to petition the Commission to establish groundwater management in PGMAs in areas that have no GCD. The Executive Director of the TCEQ published a final report in February 2017 addressing five options available to the portions of Midland and Upton Counties that are located within the PGMA boundary. As of this time, no order has been issued by TCEQ and no county commissioner's court has promulgated groundwater regulations or availability values for areas within the PGMA that have no GCD. TCEQ continues to evaluate groundwater availability and use data within the designated PGMA[Error! Bookmark not defined.].

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

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



Region F

Groundwater Conservation Districts and Groundwater Management Areas

FIGURE 1-17

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DATE	AUGUST 2024
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Coordinate System: NAD 1983 StatePlane Texas North Central FIPS 4202 Feet

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Groundwater Conservation Districts and Priority Groundwater Management Area

Region F

FIGURE 1-18

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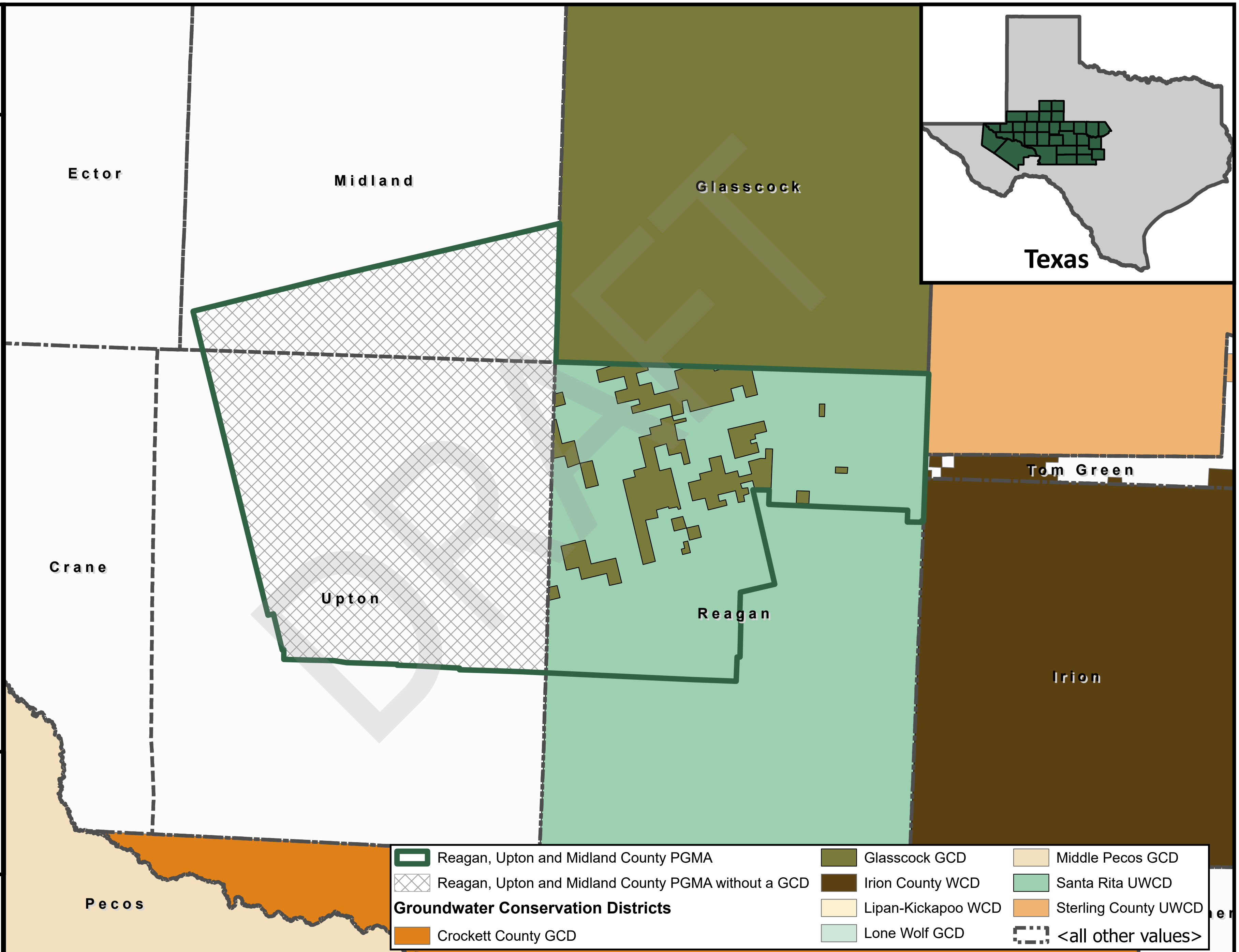

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1.3.3 Springs in Region F

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

Region F Springs:

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

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

The Region F Planning Group has identified 14 major springs in the region that are important for water supply or natural resources protection. Figure 1-19 contains a map of the major springs in Region F. For convenience, the following spring descriptions are grouped into related geographic areas. Discussions pertaining to the historical significance of these springs are taken from *Springs of Texas*, by Gunner Brune.[12,13]

Balmorhea Area Springs

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

San Solomon Springs are in Balmorhea State Park and are the largest spring in Reeves County. The spring's importance begins with its recreational use, then its habitat for endangered species in the ditches leading from the pool,[14] and finally its irrigation use downstream, where water from these springs is used to irrigate approximately 10,000 acres of farmland. These springs, which were once known as Mescalero or Head Springs, issue from lower Cretaceous limestones that underlie surface

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 3 and 4 cfs. Discharge from Giffin Springs responds much more closely to precipitation than other Balmorhea-area springs.

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

Fort Stockton Area Springs

Comanche Springs flow from a fault fracture in the Comanchean limestone. This complex of springs includes as many as five larger springs and eight smaller springs in and around Rooney Park. These springs were historically very important, serving as a major crossroads on early southwestern travel routes. It is because of their historical significance and their continued ecotourism importance to the City of Fort Stockton, that this spring system is considered a major spring. The development of irrigated farming in the Belding area 12 miles to the southwest has intercepted natural groundwater flow, and by the early 1960s Comanche Springs had ceased to flow continuously. However, since 1987, Comanche Springs has sporadically flowed, primarily during winter months.

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

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

San Angelo Area Springs

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

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

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

Spring Creek Springs (also known as Seven, Headwaters, or Good Springs) are located on Spring Creek in eastern Irion County approximately three miles south of the town of Mertzon. Besides evidence of significant occupation by early 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.

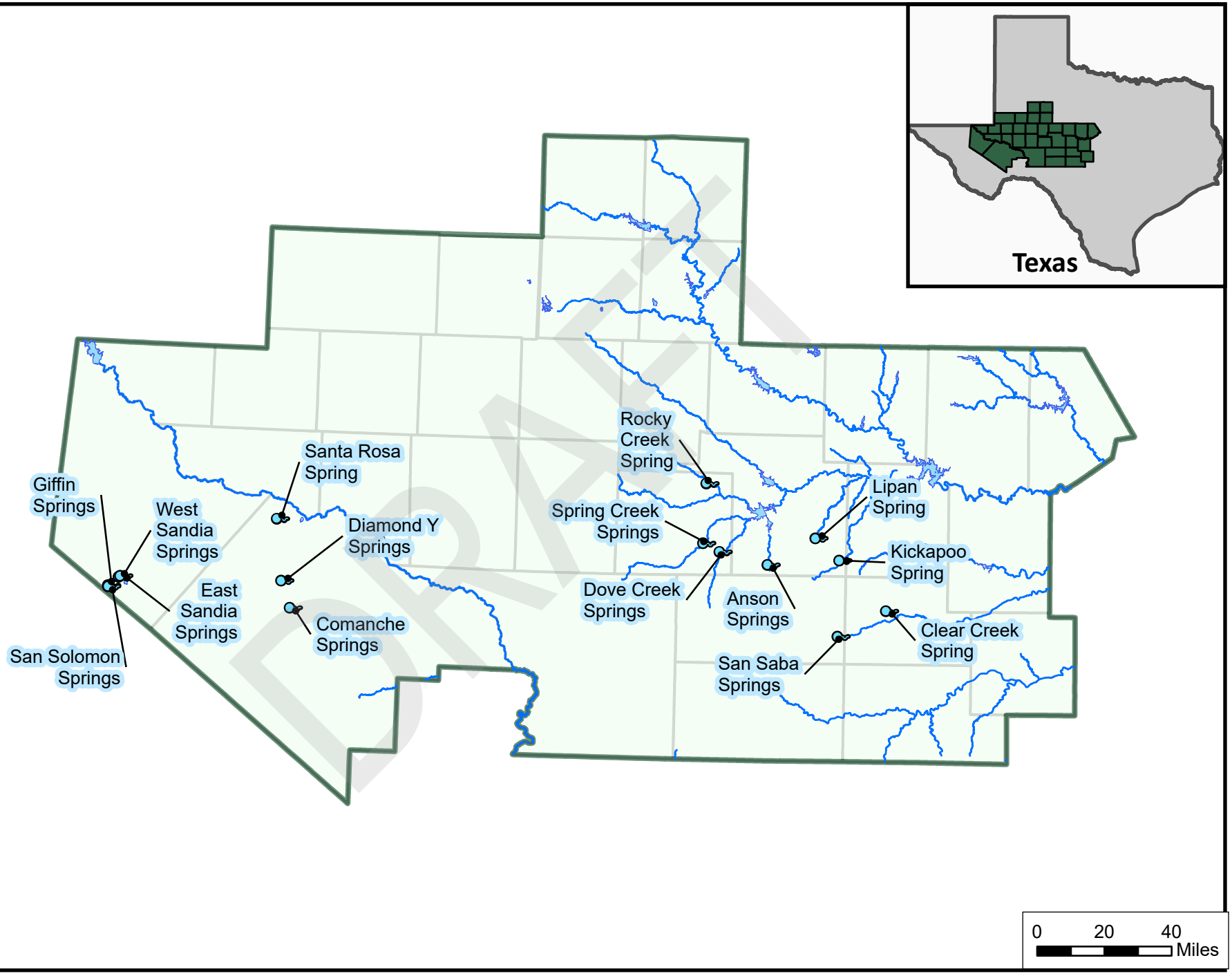
Lipan Spring is located approximately 15 miles southeast of San Angelo and was a stop on the old Chihuahua Road. This spring, which issues from Edwards limestone, has historically flowed at less than one cfs.

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.



Region F

Major Springs

FIGURE 1-19

FN JOB NO	CMD21867
FILE	Figure 1-19
DATE	AUGUST 2024
SCALE	1:2,500,000
DESIGNED	JLA
DRAFTED	CMF

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

Document Path: H:\WR_PLANNING\Chapter 1\Chapter_1_Exhibits.aprx

1.4 AGRICULTURAL AND NATURAL RESOURCES IN REGION F

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

1.4.1 Endangered or Threatened Species

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

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

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

Table 1-12
Endangered and Threatened Species in Region F

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

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

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

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

1.4.2 Agriculture and Prime Farmland

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

Figure 1-20 shows the distribution of prime farmland in Region F.[18] The National Resources Conservation Service (NRCS) defines prime farmland as "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses". As part of the National Resources Inventory, the NRCS has identified prime farmland throughout the country. Each color in Figure 1-20 represents the percentage of the total acreage that is considered prime farmland of any kind.

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

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

Texas Criteria for Prime Farmland:

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

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

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

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

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

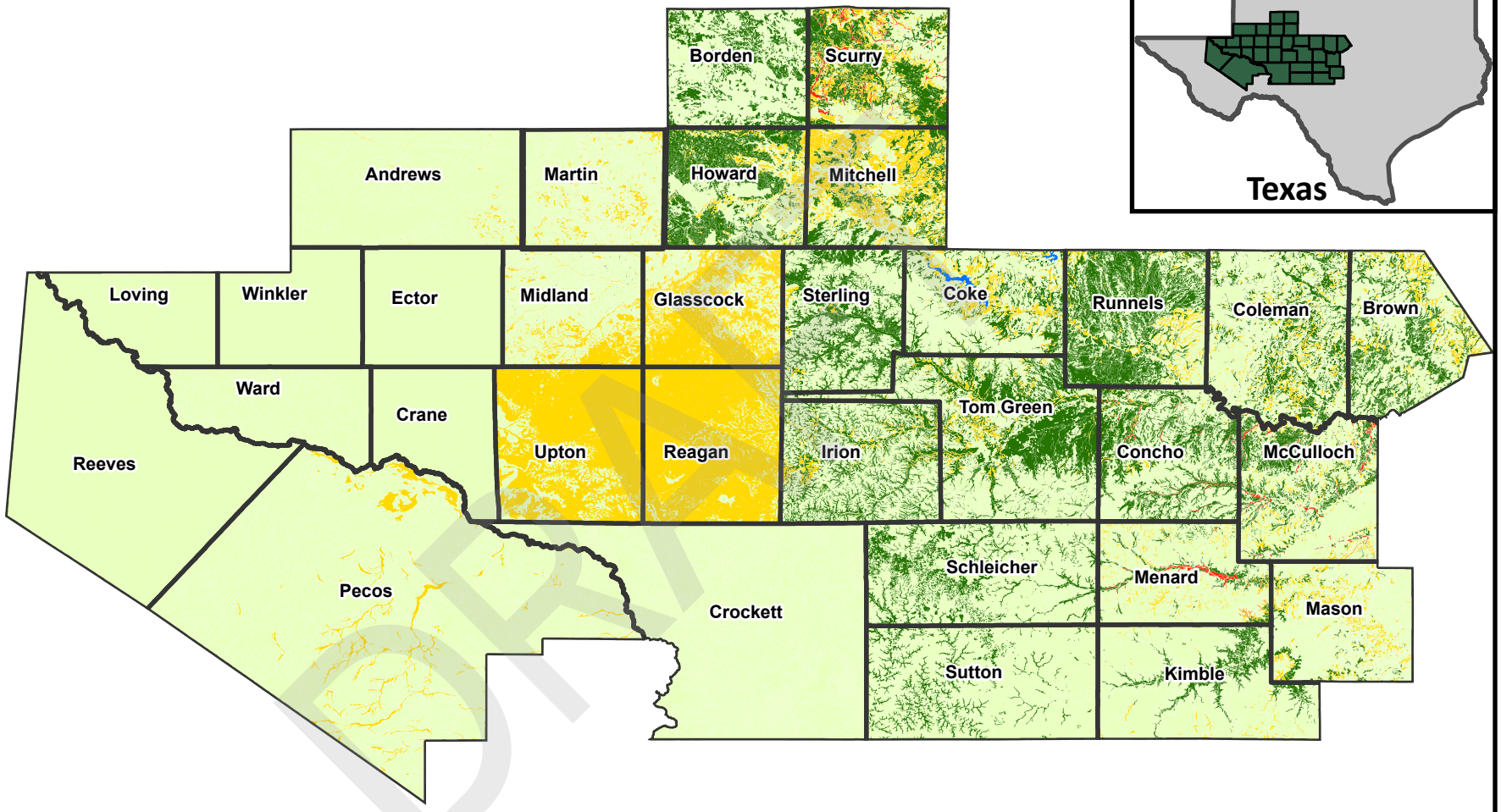
Table 1-13 (Cont'd)
2022 U.S. Department of Agriculture County Census Data for Region F

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

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

a. Crop land is the land that is currently or recently cultivated for farming. Acreages in active farms may be less.
NOTES: (D) – Data withheld to avoid disclosing data for individual farms.
Total Market Value amounts include value of crops and livestock listed as (D) (data withheld).

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



Legend

- All areas are prime farmland
- Not prime farmland
- Prime farmland if irrigated
- Prime farmland if irrigated and either protected from flooding or not frequently flooded during the growing season
- Prime farmland if protected from flooding or not frequently flooded during the growing season
- Water
- Counties

N
W E
S

Prime Farmland

Region F

FN JOB NO	CMD21867
FILE	Figure 1-20
DATE	AUGUST 2024
SCALE	1:2,500,000
DESIGNED	JLA
DRAFTED	CMF

FIGURE 1-20

Coordinate System: GCS North American 1983

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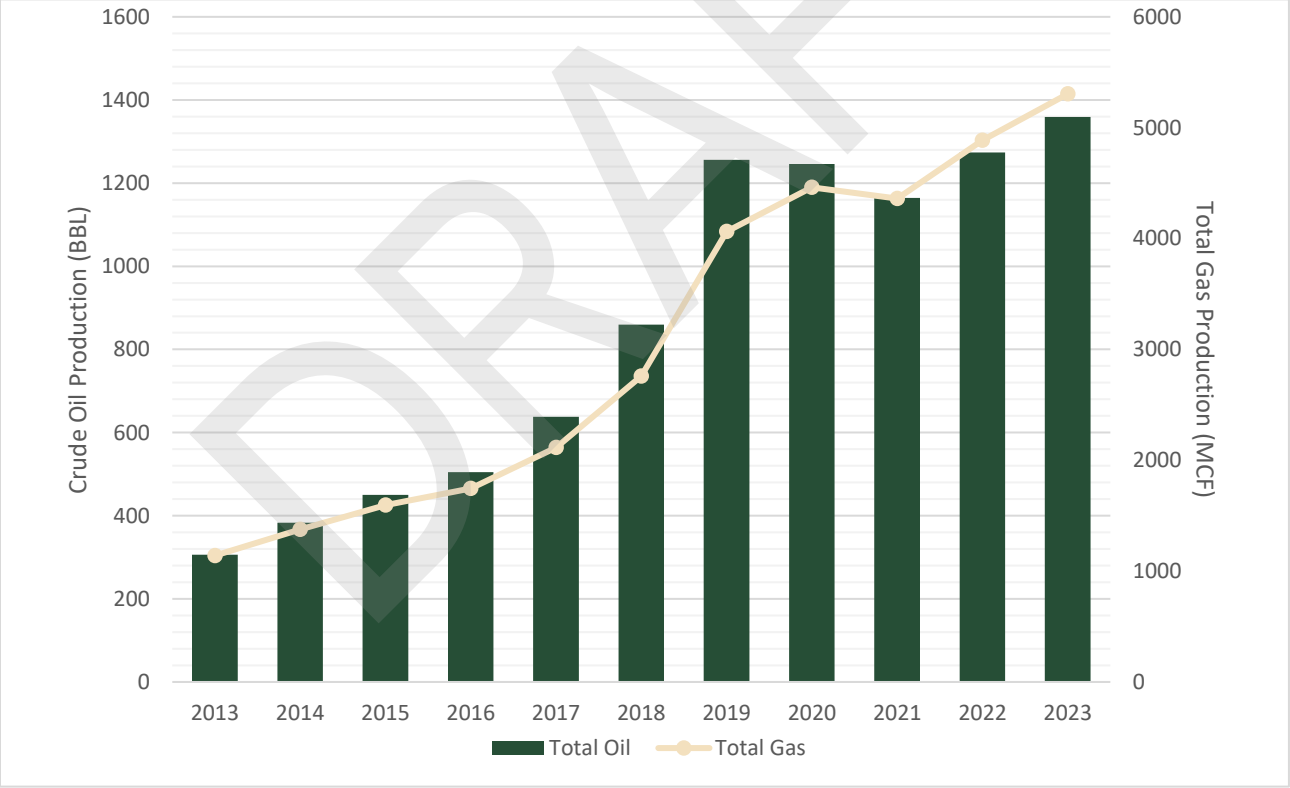
1.4.3 Mineral Resources

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

Petroleum Production

Oil and gas fields are a valuable natural resource throughout most of Region F. As discussed previously in Section 1.1.1, the petroleum industry heavily influences the Region F economy. Over the last decade, Region F has experienced a notable increase in oil and gas production, as technological advancements have made it feasible for companies to develop petroleum in the continental United States. In particular, the Permian Basin (Figure 1-5), which underlies a significant portion of the counties in Region F, has experienced a rapid growth and has become the second largest producer of oil and gas shale in the world[19]. According to data from the Railroad Commission of Texas, annual total oil production (including crude oil and condensate) has increased by over 344% and annual total natural gas (including gas well gas and casinghead gas) production has increased by over 365% in Region F since 2013 (Figure 1-21)[20].

Figure 1-21
Crude Oil and Total Gas Production in Region F



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

every county, with the exception of Kimble and McCulloch Counties, produced some form of natural gas (gas well gas and/or casinghead gas). Figure 1-22 and Figure 1-23 illustrate the distribution of total oil (BBL) and total natural gas (MCF) production in each Region F county during the year 2023, respectively.

Coal Mining

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

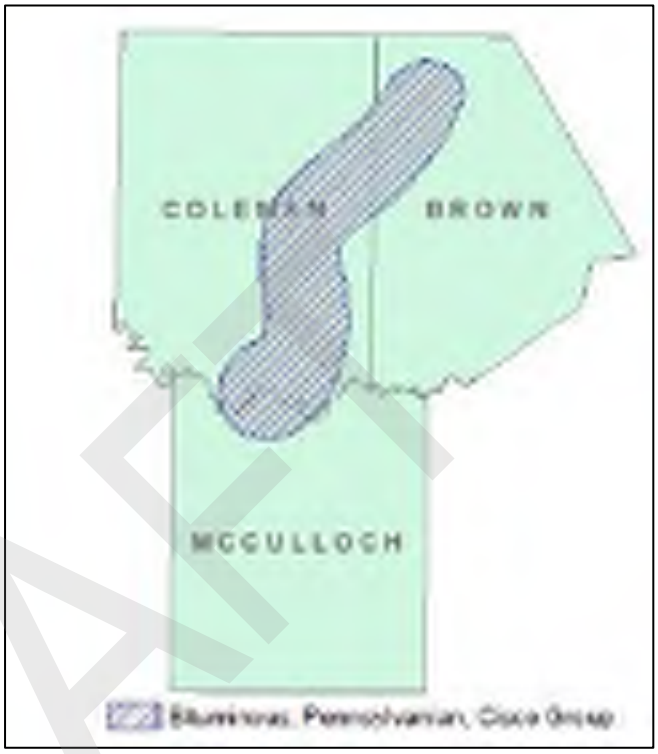
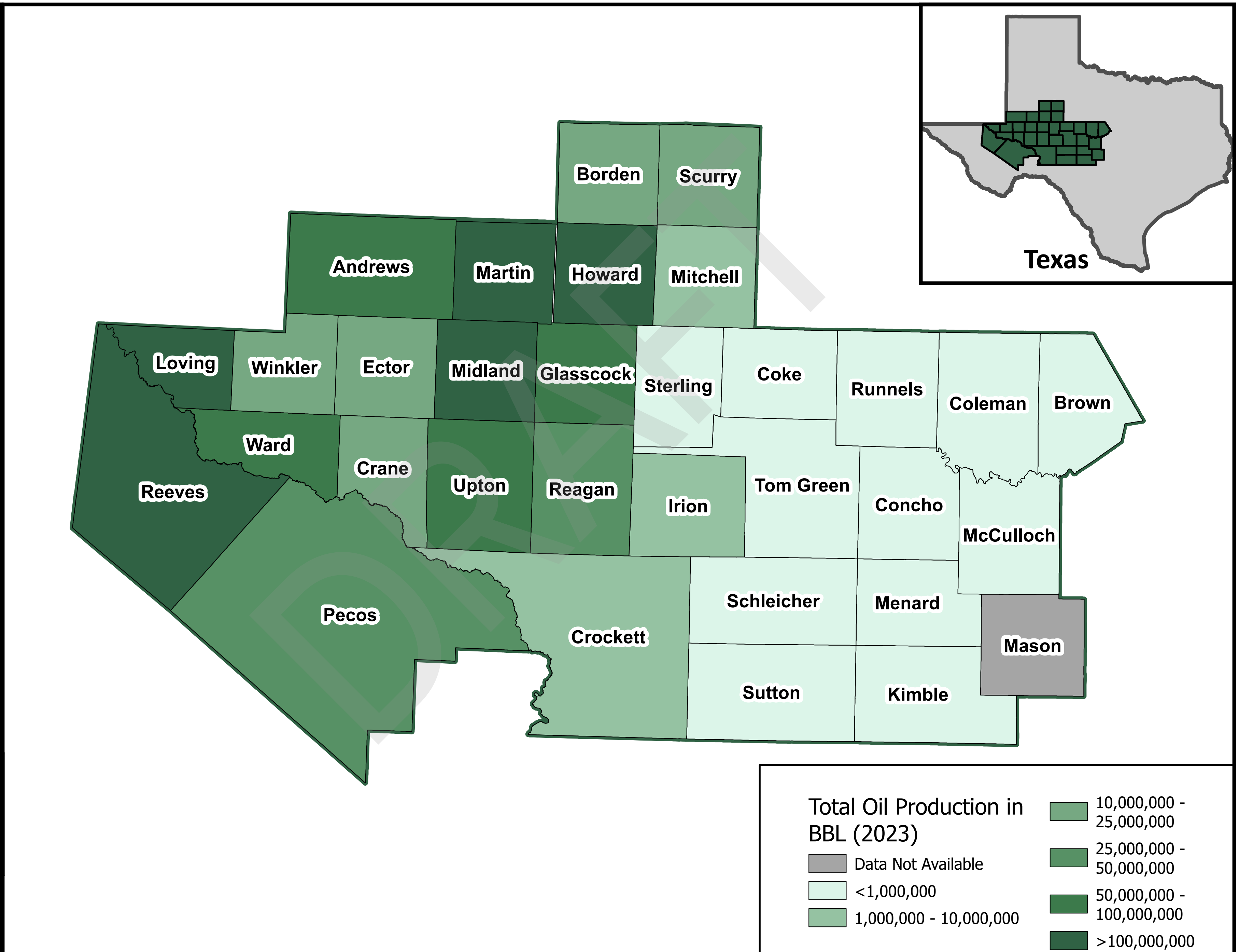


FIGURE 1-22

Region F

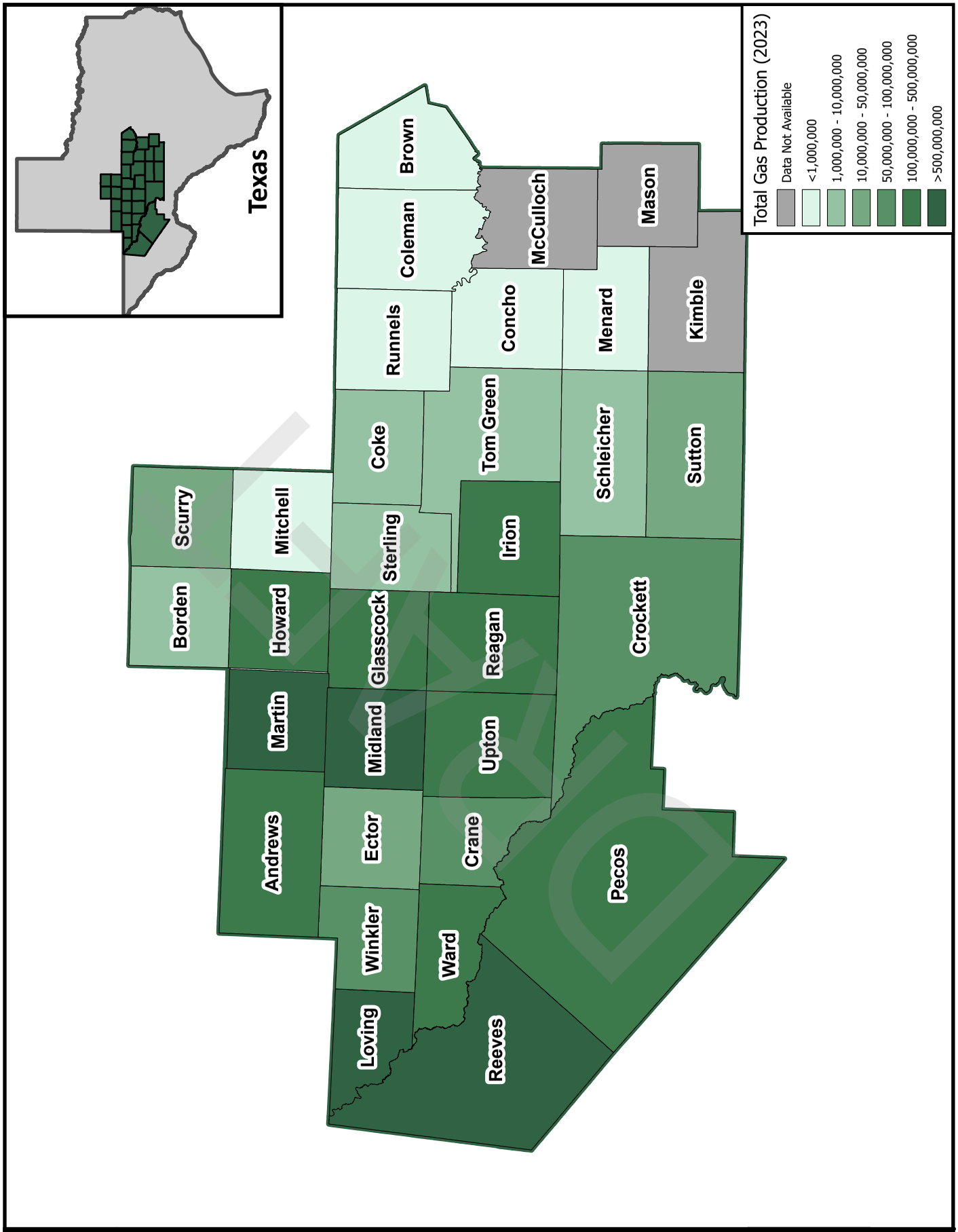
Total Oil Production (including Crude Oil and Condensate) by County (2023)

FN JOB NO	CMD21867
FILE	Figure 1-22
DATE	AUGUST 2024
SCALE	1:2,500,000
DESIGNED	JLA
DRAFTED	CMF



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

Document Path: H:\WR_PLANNING\Chapter 1\Chapter1_Exhibits.aprx



Region F

Total Natural Gas Production (including Gas Well and Casinghead Gas) by County (2023)

FN JOB NO	CMD21867
FILE	Figure 1-23
DATE	AUGUST 2024
SCALE	1:2,500,000
DESIGNED	JLA
DRAFTED	CMF

1-23

FIGURE

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

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1.5 WATER PROVIDERS IN REGION F

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

1.5.1 Major Water Providers

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

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

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

Colorado River Municipal Water District (CRMWD)

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

Brown County Water Improvement District Number One (BCWID).

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

City of Midland

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

City of Odessa

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

City of San Angelo

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

1.6 Existing Plans for Water Supply Development

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

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

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

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

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

1.6.1 Conservation Planning in Region F

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

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

1.6.2 Water Loss Audits

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

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

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

Table 1-14
Summary of TWDB Water Loss Audits

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

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

1.6.3 Assessment of Current Preparations for Drought in Region F

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

1.6.4 Other Water-Related Programs

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

Texas Commission on Environmental Quality (TCEQ) Water Rights Permitting

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

Texas Pollutant Discharge Elimination System (TPDES) Program

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

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

Wellhead Protection Areas

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

The Texas Water Code further provides for all wells to be designed and constructed according to TCEQ well construction standards (30 TAC 290). These standards require new wells to be encased with concrete extending down to a depth of 20 feet, or to the water table or a restrictive layer, whichever is

the lesser. An impervious concrete seal must extend at least 2 feet laterally around the well head and a riser installed at least 1 foot high above the impervious seal.

Clean Rivers Program

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

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

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

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

Safe Drinking Water Act

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

Water Supply Enhancement Program

The Water Supply Enhancement Program, formerly known as the State Brush Control Program, was

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

Precipitation Enhancement Programs

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

Bio-Terrorism Preparedness and Response Act

Following the events of September 11th, Congress passed the Bio-Terrorism Preparedness and Response Act. Drinking water utilities serving more than 3,300 people were required and have completed vulnerability preparedness assessments and response plans for their water, wastewater, and stormwater facilities. The U.S. Environmental Protection Agency (EPA) funded the development of three voluntary guidance documents, which provide practical advice on improving security in facilities of all sizes. The guidance document for water utilities can be found through the American Water Works Association.

1.7 SUMMARY OF THREATS AND CONSTRAINTS TO WATER SUPPLY

1.7.1 Threats to Water Supply

Threats to water supply in Region F include:

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

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

Rio Grande Basin Water Quality

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

Colorado River Basin Water Quality

The high levels of chlorides, sulfates and TDS present in the upper Colorado River above O.H. Ivie Reservoir (including E.V. Spence Reservoir) are thought to originate from geologic formations and oil

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

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

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

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

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

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

Hickory Aquifer

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

Dockum Aquifer

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

Other Groundwater Quality Issues

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

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

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

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

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

Regional Drought

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

Rainfall and Runoff Patterns in the Upper Colorado River Basin

Region F surface water supply is heavily dependent upon consistent streamflow (runoff) throughout the Colorado River Basin. In 2017, a detailed evaluation of historical rainfall-runoff patterns in the Upper Colorado River Basin determined that observed flow trends have declined over the period of record (1940-2016)[40]. Analysis of naturalized flows from the Colorado Basin WAM indicated that most of this

diminishing trend is likely caused by construction of large reservoir systems and historical water use, which are both associated with existing water rights in the basin area. Additionally, all sites in the study demonstrated some decline in naturalized flow, signifying that activities not accounted for in the naturalization flow process could have impacted observed flows. Further investigations determined that four activities had some effect on the trend of observed and naturalized flows over the study period: (1) the proliferation of noxious brush; (2) the construction of small reservoirs, not accounted for in naturalized flows; (3) groundwater use and aquifer water level declines; and (4) changes in average temperature in drought conditions. If this declining trend of observed and naturalized flows continue, and these activities continue to cause negative effects, then threats to surface water supplies in the Upper Colorado River Basin will likely persist and could potentially magnify.

Strict Enforcement of State's Priority System for Surface Water

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

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

1.7.2 Constraints

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

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

Finally, many of the municipal water supply needs in Region F are relatively small and are in locations that are far away from reliable water supplies of good quality. Transporting small quantities of water over large distances is seldom cost-effective. Desalination and reuse are good options for these communities. However, the high cost of developing and permitting these types of supplies is a

significant constraint on water development. Also, finding a suitable means of disposing the reject concentrate from a desalination project may limit the feasibility of such projects in many locations.

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

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

1.8.1 Water Related Threats to Agriculture

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

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

1.8.2 Water Related Threats to Natural Resources

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

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