1 DESCRIPTION OF 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 water needs of all Texans in the next century. To implement this planning process, the Texas Water Development Board (TWDB) created 16 regional water planning groups across the state and established regulations governing regional planning efforts. The 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, *Water for Texas* 2002. SB1 calls for these plans to be updated every five years.

In 2001, the 77th Texas Legislature passed Senate Bill Two, which included the funding for the first update to the regional water plans. The TWDB refers to the current round of regional planning as SB1, Second Round. This report is the update to the 2002 Region F Plan and will become part of the basis for the next state water plan.

This section of the report is a description of Region F, one of the regions created to implement SB1. Figure 1.1-1 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 this section, and a bibliography is included in Appendix 1A.

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 1.1-1 shows historical populations for these

N

87

SCURRY

BORDEN

Colorado River

LAKE J.B THOMAS

LAKE COLORADO CITY

MITCHELL

CHAMPION CREEK RESERVOIR

HOWARD

MARTIN

ANDREWS

NATURAL DAM LAKE

Beals Creek

MITCHELL COUNTY RESERVOIR

OAK CREEK RESERVOIR

LAKE WINTERS

LAKE COLEMAN

LAKE BROWNWOOD

New Mexico

Texas

Midland

20

Big Spring

RED BLUFF RESERVOIR

Salt Creek

ECTOR

STERLING

E.V SPENCE RESERVOIR

Oak Creek

Valley Creek

Elm Creek

Jim Ned Creek

Pecan Bayou

HORDS CREEK LAKE

LOVING

WINKLER

Odessa

GLASSCOCK

North Concho River

COKE

RUNNELS

MIDLAND

Monahans

LAKE BALLINGER

Colorado River

COLEMAN

BROWN

REEVES

Pecos River

WARD

CRANE

REAGAN

O.C FISHER LAKE

Concho River

San Angelo

O.H IVIE RESERVOIR

UPTON

Middle Concho River

LAKE NASWORTHY

TWIN BUTTES RESERVOIR

CONCHO

IRION

McCULLOCH

Brady Creek

TOM GREEN

BRADY CREEK RESERVOIR

Dove Creek

North Concho River

San Saba River

LAKE BALMORHEA

PECOS

SCHLEICHER

CROCKETT

10

MENARD

MASON

Llano River

James River

Pecos River

SUTTON

Devils River

KIMBLE

Area of Enlargement

Legend

- Interstate
- Counties
- Lakes/Reservoirs
- Cities
- River Basin Boundary
- Streams and Rivers

Texas

Mexico

10 0 10 20 30 Miles

FN JOB NO	CMD01311
FILE	RegionF_Hillshade2.mxd
DATE	January 11, 2005
SCALE	1:1,750,000
DESIGNED	BME
DRAFTED	BME

Figure 1.1-1

Region F

General Location Map

N

W E

S

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Fort Worth, Texas 76109-4895
817-735-7300

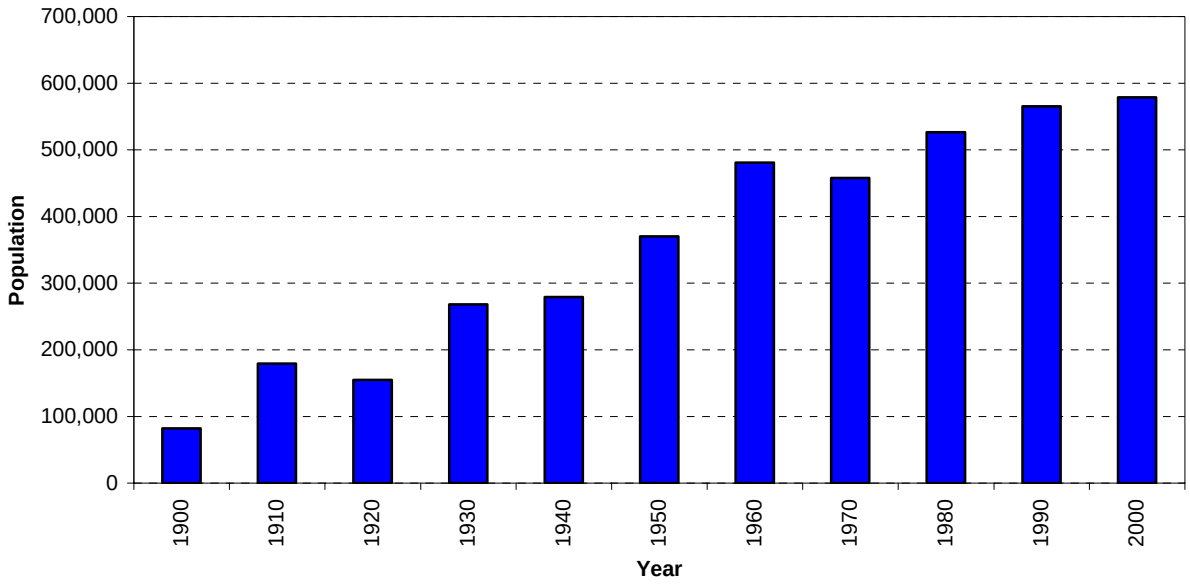
Table 1.1-1
Historical Population of Region F Counties

County	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
Andrews	87	975	350	736	1,277	5,002	13,450	10,372	13,323	14,338	13,004
Borden	776	1,386	965	1,505	1,396	1,106	1,076	888	859	799	729
Brown	16,019	22,935	21,682	26,382	25,924	28,607	24,728	25,877	33,057	34,371	37,674
Coke	3,430	6,412	4,557	5,253	4,590	4,045	3,589	3,087	3,196	3,424	3,864
Coleman	10,077	22,618	18,805	23,669	20,571	15,503	12,458	10,288	10,439	9,710	9,235
Concho	1,427	6,654	5,847	7,645	6,192	5,078	3,672	2,937	2,915	3,044	3,966
Crane	51	331	37	2,221	2,841	3,965	4,699	4,172	4,600	4,652	3,996
Crockett	1,591	1,296	1,500	2,590	2,809	3,981	4,209	3,885	4,608	4,078	4,099
Ector	381	1,178	760	3,958	15,051	42,102	90,995	91,805	115,374	118,934	121,123
Glasscock	286	1,143	555	1,263	1,193	1,089	1,118	1,155	1,304	1,447	1,406
Howard	2,528	8,881	6,962	22,888	20,990	26,722	40,139	37,796	33,142	32,343	33,627
Irion	848	1,283	1,610	2,049	1,963	1,590	1,183	1,070	1,386	1,629	1,771
Kimble	2,503	3,261	3,581	4,119	5,064	4,619	3,943	3,904	4,063	4,122	4,468
Loving	33	249	82	195	285	227	226	164	91	107	67
Martin	332	1,549	1,146	5,785	5,556	5,541	5,068	4,774	4,684	4,956	4,746
Mason	5,573	5,683	4,824	5,511	5,378	4,945	3,780	3,356	3,683	3,423	3,738
McCulloch	3,960	13,405	11,020	13,883	13,208	11,701	8,815	8,571	8,735	8,778	8,205
Menard	2,011	2,707	3,162	4,447	4,521	4,175	2,964	2,646	2,346	2,252	2,360
Midland	1,741	3,464	2,449	8,005	11,721	25,785	67,717	65,433	82,636	106,611	116,009
Mitchell	2,855	8,956	7,527	14,183	12,477	14,357	11,255	9,073	9,088	8,016	9,698
Pecos [c]	2,360	2,071	3,857	7,812	8,185	9,939	11,957	13,748	14,618	14,675	16,809
Reagan [b]		392	377	3,026	1,997	3,127	3,782	3,239	4,135	4,514	3,326
Reeves	1,847	4,392	4,457	6,407	8,006	11,745	17,644	16,526	15,801	15,852	13,137
Runnels	5,379	20,858	17,074	21,821	18,903	16,771	15,016	12,108	11,872	11,294	11,495
Schleicher	515	1,893	1,851	3,166	3,083	2,852	2,791	2,277	2,820	2,990	2,935
Scurry	4,158	10,924	9,003	12,188	11,545	22,779	20,369	15,760	18,192	18,634	16,361
Sterling	1,127	1,493	1,053	1,431	1,404	1,282	1,177	1,056	1,206	1,438	1,393
Sutton	1,727	1,569	1,598	2,807	3,977	3,746	3,738	3,175	5,130	4,135	4,077
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
Upton	48	501	253	5,968	4,297	5,307	6,239	4,697	4,619	4,447	3,404
Ward	1,451	2,389	2,615	4,599	9,575	13,346	14,917	13,019	13,976	13,115	10,909
Winkler	60	442	81	6,784	6,141	10,064	13,652	9,640	9,944	8,626	7,173
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***
% Increase		*119%*	*-14%*	*73%*	*4%*	*32%*	*30%*	*-5%*	*15%*	*7%*	*2%*

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

counties from 1900 through 2000[1]. Figure 1.1-2 shows graphically the total population of the region. The population of Region F has increased from 81,985 in 1900 to 578,814 in 2000. Since 1940, the region's population has increased at a compounded rate of 1.2 percent per year.

Figure 1.1-2
Historical Population of Region F



According to the 2000 census, Region F accounted for 3.0 percent of Texas' total population. Figure 1.1-3 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 59 percent of the region's population. Brown and Howard Counties were the next most populous counties with more than 30,000 people in each. Table 1.1-2 lists the six cities in Region F with a year 2000 population of more than 10,000. These cities included 57 percent of the population in Region F.

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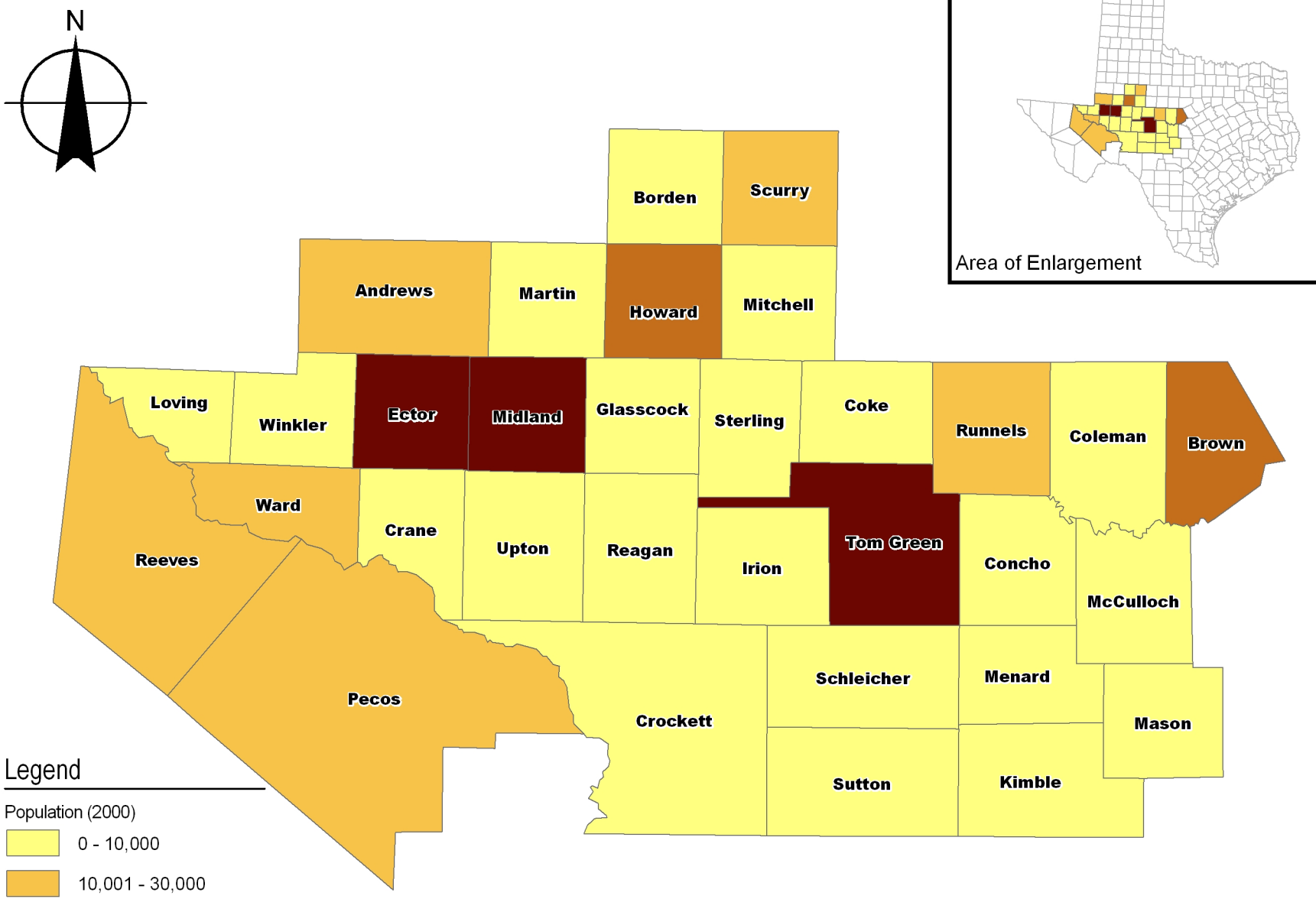
Region F

Population Distribution by County (2000)



FN JOB NO	CMD01311
FILE	RegionF_Population.mxd
DATE	January 13, 2005
SCALE	1:2,421,500
DESIGNED	BME
DRAFTED	BME

FIGURE 1.1-3

Table 1.1-2
Region F Cities with a Year 2000 Population Greater than 10,000

City	Year 2000 Population
Midland	94,996
Odessa	90,943
San Angelo	88,439
Big Spring	25,233
Brownwood	18,813
Snyder	10,783
Total	*329,207*

Data are from the TWDB[9].

1.1.1 Economic Activity in Region F

Region F includes the Midland, Odessa, and San Angelo Metropolitan Statistical Areas (MSAs). The largest employment sector in the Midland MSA is the service industry, followed by wholesale and retail trade and the oil and gas industry. In the Odessa and San Angelo MSAs the largest employment sectors are wholesale and retail trade, services, and manufacturing[2].

Table 1.1-3 summarizes 2002 payroll data for Region F by county and economic sector. Data for certain payroll information are only available on a state-wide basis and are not broken down by counties. One of these categories is mining, which includes the oil and gas industries, a significant economic sector in Region F.

Figure 1.1-4 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 75 percent of the payroll and 70 percent of the employment in the region. Other major centers of economic activity are located in Brown and Howard Counties. The largest business sectors in Region F in terms of payroll in 2002 are healthcare and social assistance, mining and manufacturing, which together account for 41 percent of the region's total payroll.

Table 1.1-3
2002 County Payroll by Category ($1000)

Category	Andrews	Borden	Brown	Coke	Coleman	Concho	Crane	Crockett
Forestry, Fishing, Hunting, and Agricultural Support	(N)	(N)	(D)	(N)	183	(N)	(N)	(N)
Mining	19,984	(D)	1,710	(D)	(D)	281	18,669	4,899
Utilities	601	(N)	3,392	(D)	1,455	(D)	(D)	459
Construction	5,048	(N)	11,038	398	2,280	(D)	1,339	2,327
Manufacturing	9,039	(N)	103,921	(D)	995	(D)	(D)	(N)
Wholesale Trade	2,081	(N)	12,027	(D)	1,024	(D)	389	492
Retail Trade	6,245	(D)	35,902	1,716	3,646	879	1,996	6,465
Transportation and Warehousing	2,270	(N)	1,321	(D)	1,307	(D)	694	982
Information	374	(N)	6,090	127	1,037	(D)	(D)	279
Finance and Insurance	3,338	(N)	10,681	1,108	4,001	1,051	340	(D)
Real Estate, Rental, and Leasing	270	(N)	1,417	(D)	297	(N)	(D)	(D)
Professional, Scientific and Technical Services	(D)	(N)	3,244	(D)	(D)	(D)	(D)	(D)
Management of Companies and Enterprises	(D)	(N)	(D)	(N)	(D)	(N)	(N)	(D)
Admin, Support, Waste Mgmt, Remediation Services	4,845	(N)	5,327	(D)	(D)	(D)	(D)	(N)
Educational Services	177	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Health Care & Social Assistance	12,036	(N)	64,763	(D)	6,583	3,362	3,258	458
Arts, Entertainment, & Recreation	(D)	(N)	599	135	104	(D)	(N)	(D)
Accommodation & Food Services	1,842	(N)	10,595	188	1,362	549	297	1,621
Other Services	5,856	(N)	9,923	255	1,068	(D)	311	215
Total Payroll	*74,006*	*(D)*	*281,950*	*3,927*	*25,342*	*6,122*	*27,293*	*18,197*
Total Employees	*2,876*	*(N)*	*11,842*	*556*	*1,428*	*649*	*878*	*1,017*

Table 1.1-3 (cont.) 2002 County Payroll by Category ($1000)

Category	Ector	Glasscock	Howard	Irion	Kimble	Loving	Martin	Mason
Forestry, Fishing, Hunting, and Agricultural Support	(D)	(D)	(D)	(N)	(N)	(N)	(D)	(D)
Mining	68,491	(D)	16,103	2,836	(D)	(N)	(D)	(D)
Utilities	10,267	(N)	4,353	(D)	(D)	(N)	(D)	(D)
Construction	145,499	(D)	19,619	604	1,823	(N)	(D)	728
Manufacturing	154,211	(N)	39,486	(D)	9,532	(N)	(N)	(D)
Wholesale Trade	136,204	(D)	5,548	910	(D)	(N)	1,652	(D)
Retail Trade	138,317	(D)	27,513	(D)	3,663	(N)	2,789	1,187
Transportation and Warehousing	30,054	(N)	2,107	1,802	354	(N)	(D)	408
Information	23,391	(N)	4,557	(N)	(D)	(N)	(D)	(D)
Finance and Insurance	34,604	(D)	8,678	(D)	1,150	(N)	(D)	(D)
Real Estate, Rental, and Leasing	34,258	(N)	2,532	(D)	(D)	(N)	(N)	24
Professional, Scientific and Technical Services	40,741	(D)	2,807	(D)	(D)	(D)	(D)	(D)
Management of Companies and Enterprises	16,700	(N)	(D)	(N)	(D)	(N)	(D)	(N)
Admin, Support, Waste Mgmt, Remediation Services	37,513	(N)	18,151	(D)	(D)	(N)	(D)	(D)
Educational Services	5,062	(D)	(N)	(D)	(D)	(N)	(D)	(N)
Health Care & Social Assistance	171,575	(N)	82,966	(D)	1,251	(N)	3,905	1,794
Arts, Entertainment, & Recreation	5,531	(N)	586	(D)	(D)	(N)	(D)	(N)
Accommodation & Food Services	43,769	(N)	7,551	(D)	2,155	(N)	(D)	1,222
Other Services	48,528	(D)	7,486	91	1,276	(N)	499	646
Total Payroll	*1,144,715*	*(D)*	*250,043*	*6,243*	*21,204*	*(D)*	*8,845*	*6,009*
Total Employees	*41,306*	*120*	*9,926*	*262*	*1,148*	*(N)*	*575*	*580*

Table 1.1-3 (cont.) 2002 County Payroll by Category ($1000)

Category	McCulloch	Menard	Midland	Mitchell	Pecos	Reagan	Reeves	Runnels
Forestry, Fishing, Hunting, and Agricultural Support	(D)	(D)	293	440	(D)	(N)	(D)	(D)
Mining	(D)	(N)	293,099	(D)	9,899	9,009	3,328	1,272
Utilities	(D)	(D)	23,305	(D)	2,908	(D)	1,456	1,469
Construction	1,011	555	59,979	2,061	2,221	610	985	1,208
Manufacturing	7,138	(D)	46,971	(D)	1,964	(D)	(D)	27,807
Wholesale Trade	(D)	(D)	102,688	530	2,382	529	462	3,003
Retail Trade	6,621	751	120,690	4,114	10,435	1,553	11,116	5,949
Transportation and Warehousing	2,218	(N)	37,432	1,930	3,418	(D)	5,151	1,311
Information	444	(D)	31,220	376	1,326	(D)	873	371
Finance and Insurance	2,364	566	67,685	1,271	3,372	495	1,928	2,792
Real Estate, Rental, and Leasing	1,059	(D)	17,314	(D)	210	(D)	151	120
Professional, Scientific and Technical Services	1,606	(D)	98,245	(D)	(D)	(D)	1,999	1,115
Management of Companies and Enterprises	(N)	(N)	143,404	(N)	(N)	(N)	(N)	(D)
Admin, Support, Waste Mgmt, Remediation Services	182	(N)	46,950	(D)	(D)	(D)	(D)	559
Educational Services	(N)	(D)	12,051	(N)	(D)	(D)	(N)	(D)
Health Care & Social Assistance	6,000	(D)	183,708	7,365	10,564	(D)	5,697	7,511
Arts, Entertainment, & Recreation	(D)	(D)	12,951	(N)	(D)	(D)	237	64
Accommodation & Food Services	1,896	498	50,065	872	3,544	414	2,798	908
Other Services	1,172	58	51,957	780	3,611	673	858	1,626
Total Payroll	*31,711*	*2,428*	*1,400,007*	*19,739*	*55,854*	*13,283*	*37,039*	*57,085*
Total Employees	*1,837*	*254*	*46,328*	*1,129*	*2,824*	*695*	*2,650*	*2,735*

Table 1-3 (cont.) 2002 County Payroll by Category ($1000)

Category	Schleicher	Scurry	Sterling	Sutton	Tom Green	Upton	Ward	Winkler
Forestry, Fishing, Hunting, and Agricultural Support	(N)	(D)	(N)	(N)	1,187	(N)	(N)	(N)
Mining	6,738	25,442	2,511	17,208	19,255	8,186	13,800	7,684
Utilities	1,263	(D)	(D)	(D)	12,008	(D)	6,671	(D)
Construction	(D)	9,510	(D)	4,241	52,927	(D)	2,351	1,339
Manufacturing	(D)	4,224	(N)	(D)	136,195	(N)	351	(N)
Wholesale Trade	(D)	6,027	364	2,053	40,728	944	2,819	721
Retail Trade	918	11,354	(D)	2,933	108,477	1,429	5,037	2,885
Transportation and Warehousing	(D)	5,563	(D)	2,471	11,646	(D)	4,150	3,259
Information	(D)	1,582	(N)	105	115,103	(D)	591	246
Finance and Insurance	(D)	4,863	(D)	594	46,276	445	2,824	901
Real Estate, Rental, and Leasing	(D)	3,934	(D)	712	10,396	(N)	2,095	1,266
Professional, Scientific and Technical Services	(D)	(D)	(D)	(D)	42,050	(D)	1,934	(D)
Management of Companies and Enterprises	(N)	(D)	(N)	(D)	12,594	(N)	(D)	(D)
Admin, Support, Waste Mgmt, Remediation Services	(N)	452	(N)	102	35,397	(D)	(D)	(D)
Educational Services	(D)	(N)	(D)	(D)	3,649	(D)	(D)	(N)
Health Care & Social Assistance	(D)	13,276	290	1,124	200,763	2,827	4,994	3,585
Arts, Entertainment, & Recreation	(D)	292	(N)	412	4,976	(D)	(D)	(D)
Accommodation & Food Services	122	3,286	(D)	1,515	37,488	(D)	1,710	638
Other Services	327	5,283	134	(D)	31,250	92	1,811	1,830
Total Payroll	*9,368*	*95,088*	*3,299*	*33,470*	*922,365*	*13,923*	*51,138*	*24,354*
Total Employees	*605*	*4,215*	*214*	*1,196*	*35,429*	*658*	*2,019*	*1,102*

Notes: Data are from U.S. Census Bureau 2002 economic data[3]

D = Data withheld to avoid disclosing data for individual companies

N = Data not available

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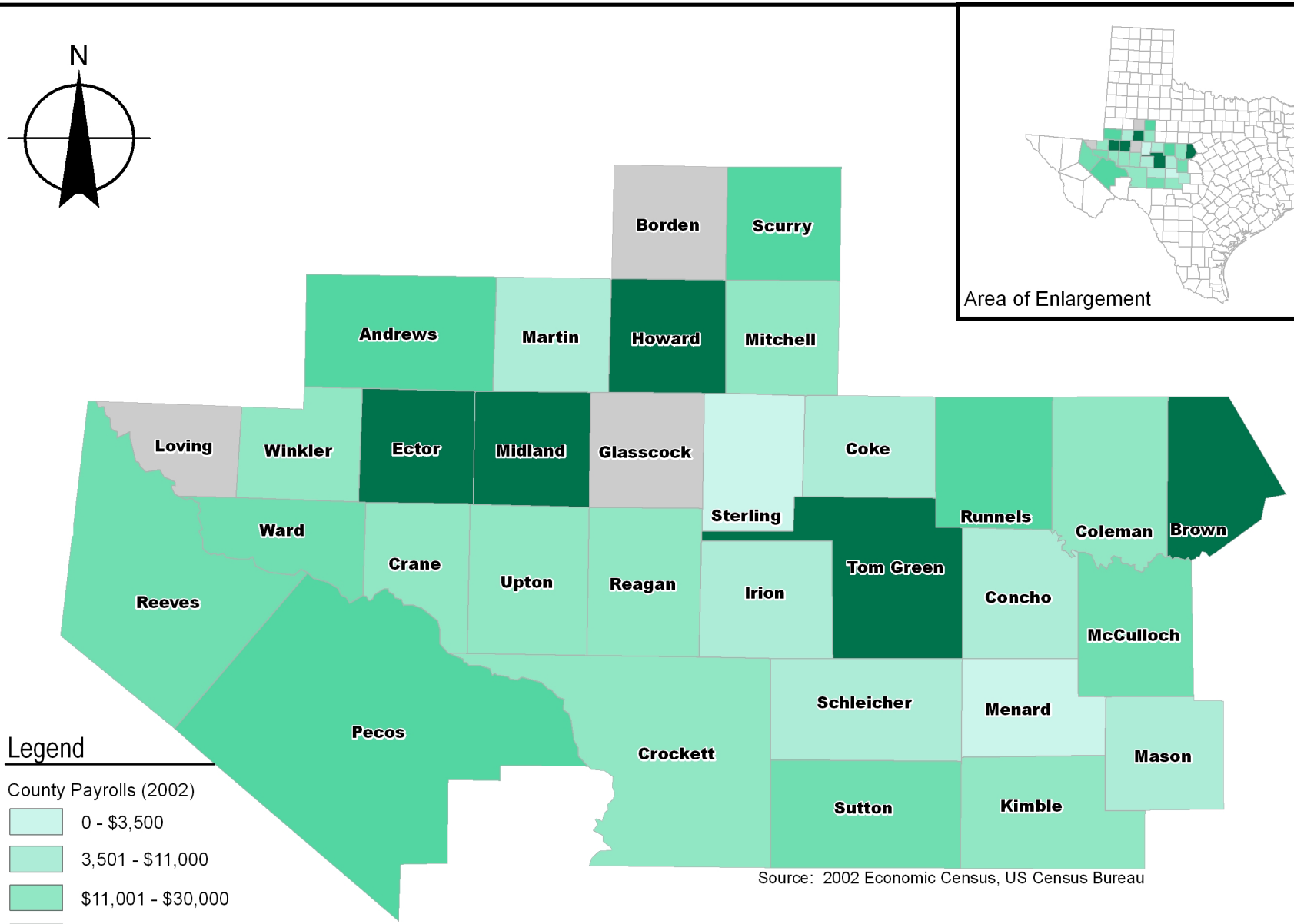
Region F

Total County Payrolls (2002)

FIGURE 1.1-4

FN JOB NO CMD01311
FILE RegionFPayroll.mxd
DATE January 13, 2005
SCALE 1:2,446,400
DESIGNED BME
DRAFTED BME



1.1.2 Water-Related Physical Features in Region F

Most of Region F is in the upper portion of the Colorado Basin and in the Pecos portion of the Rio Grande Basin. A small part of the region is in the Brazos Basin. Figure 1.1-1 shows the major streams in Region F, which include the Colorado River, Concho River, Pecan Bayou, San Saba River, Llano River and Pecos River.

Figure 1.1-5 shows the average annual precipitation in Texas. In Region F, precipitation increases west to east from slightly more than 10 inches per year in western Reeves County to more than 28 inches per year in Brown County. Figure 1.1-6 shows average annual runoff, which follows a similar pattern of increasing from the west to the east[4]. Figure 1.1-7 shows gross reservoir evaporation in Texas, which generally increases from southeast to northwest[5]. (Gross reservoir evaporation is the amount lost to evaporation from the surface of a reservoir.) Some of the highest evaporation rates in the state are in Region F, exceeding rainfall throughout the region. The patterns of rainfall, runoff, and evaporation result in more abundant water supplies in the eastern portion of Region F.

Figure 1.1-8 shows the variations in annual streamflow for seven U.S. Geological Survey (USGS) streamflow gages in Region F[6]. The five gages on tributaries have watersheds with limited development and show the natural variation in streamflows in this region. The Colorado gage near Winchell is the most downstream gage on the main stem of the Colorado River in Region F. Flows at the Pecos River gage near Girvin are largely controlled by releases from Red Bluff Reservoir. Figure 1.1-9 shows seasonal patterns of median streamflows for the same six gages[6].

Table 1.1-4 lists the 18 major water supply reservoirs in Region F, all of which are shown in Figure 1.1-1. 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.

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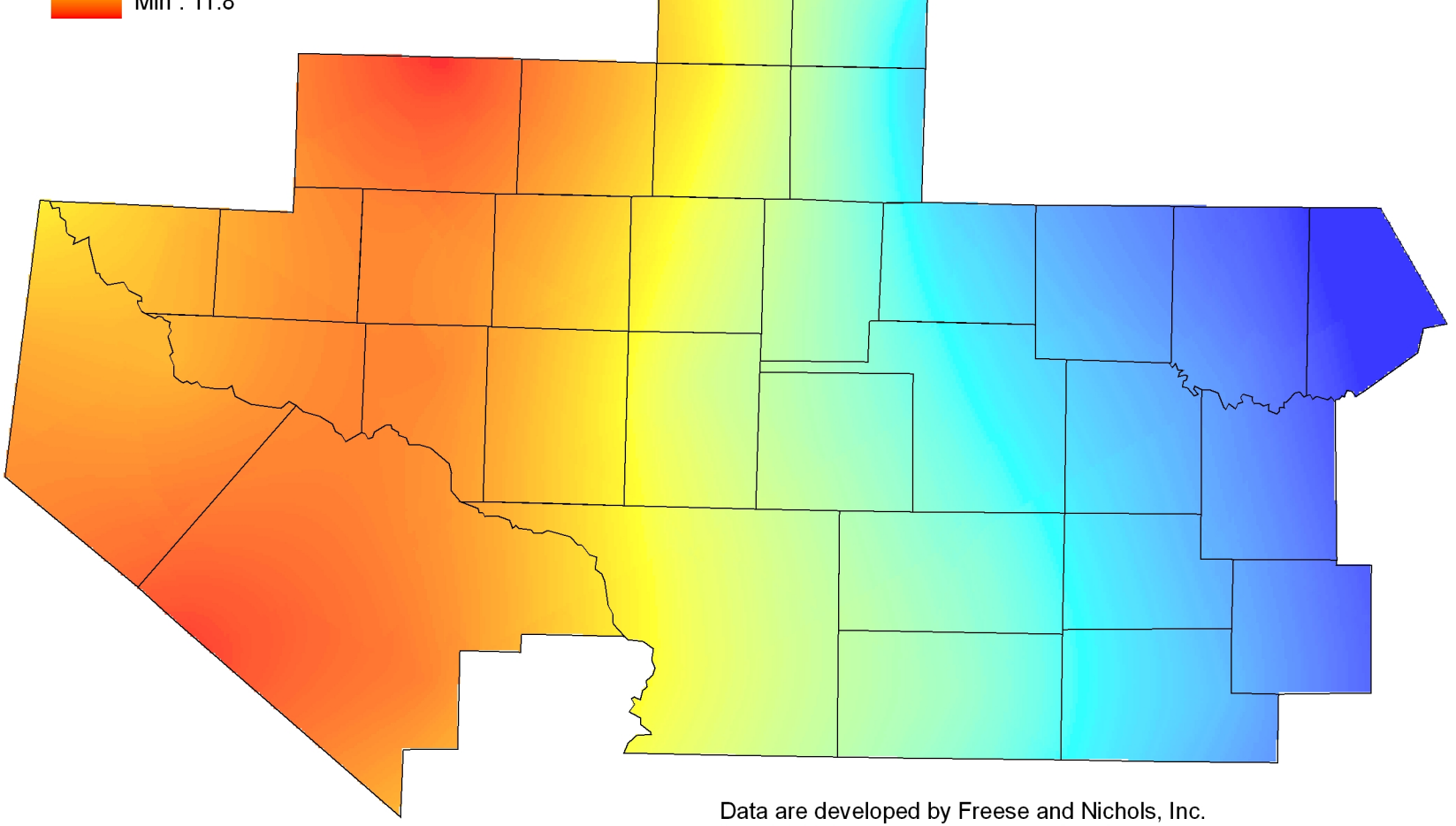

Data are developed by Freese and Nichols, Inc. from TWDB quadrangle precipitation data.

Mean Annual Precipitation

Region F

FN JOB NO	CMD01311
FILE	1-5 RegF Prec.mxd
DATE	July, 2005
SCALE	1:2,400,000
DESIGNED	HEO
DRAFTED	HEO

FIGURE 1.1-5

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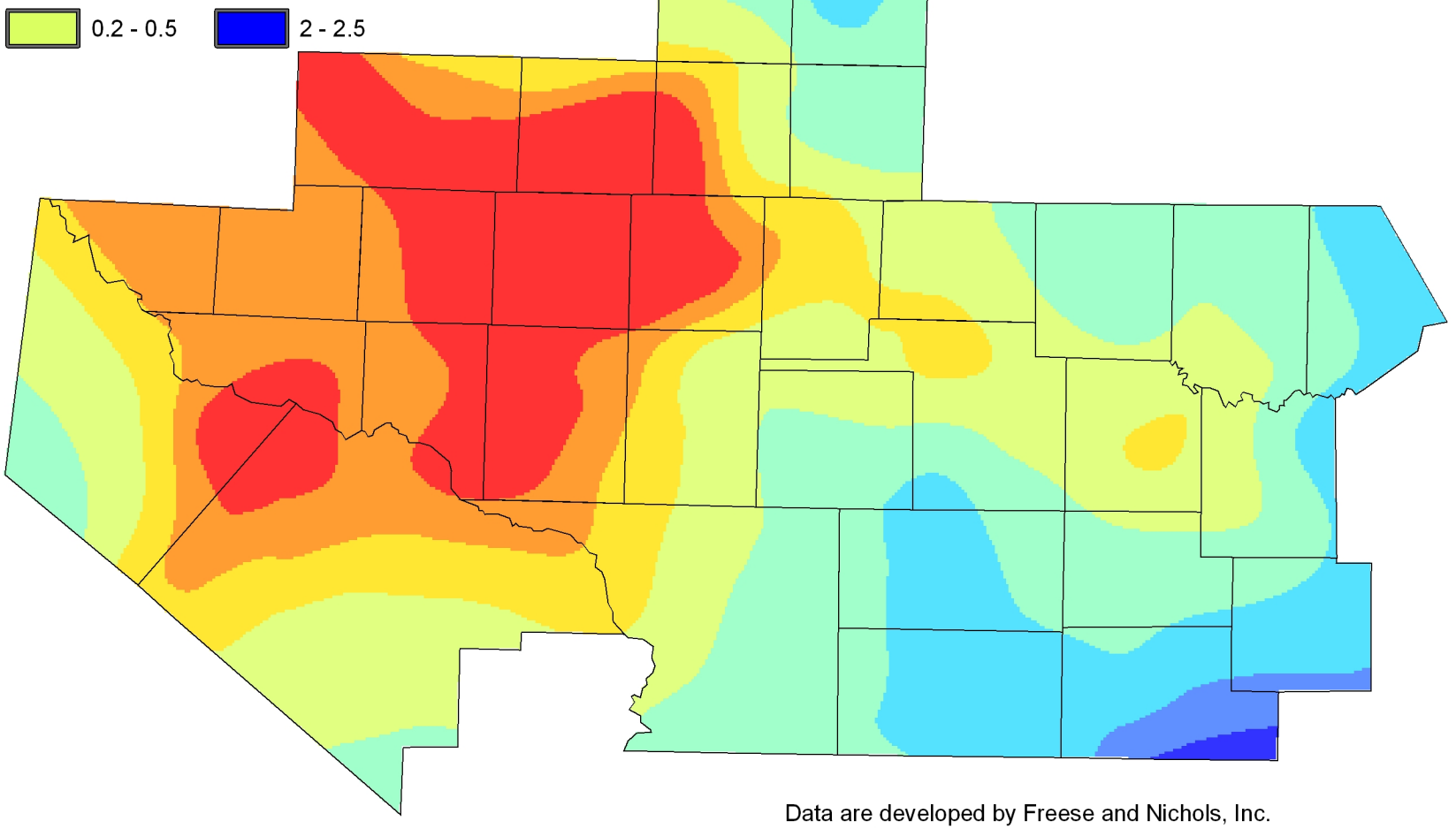

Data are developed by Freese and Nichols, Inc. from USGS stream gage data.

Mean Annual Runoff

Region F

FN JOB NO	CMD01311
FILE	1-6 RegF Runoff.mxd
DATE	July, 2005
SCALE	1:2,400,000
DESIGNED	HEO
DRAFTED	HEO

FIGURE 1.1-6

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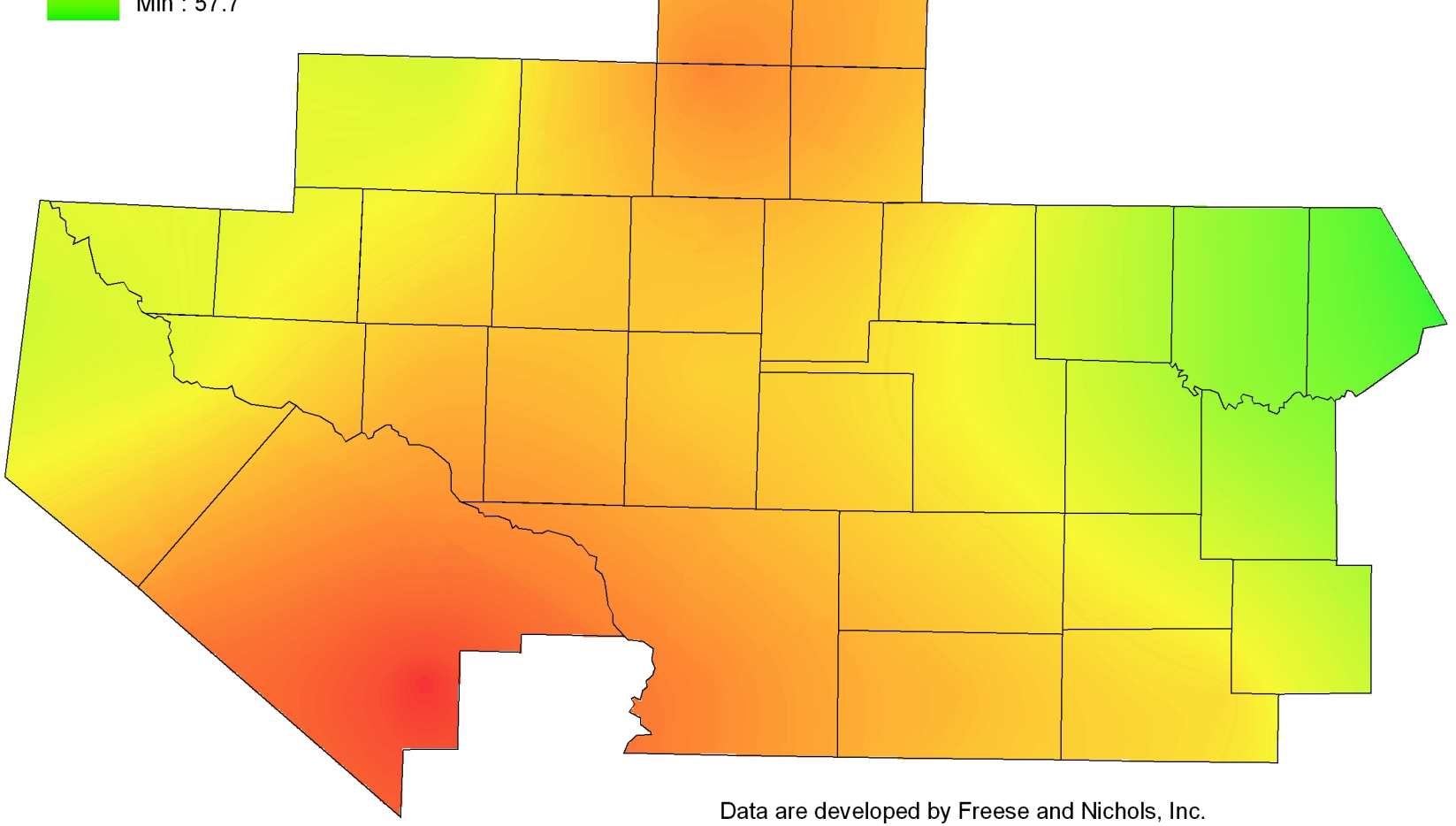


Data are developed by Freese and Nichols, Inc. from TWDB quadrangle evaporation data.

Gross Reservoir Evaporation

Region F

FN JOB NO	CMD01311
FILE	1-7 RegF Eva.mxd
DATE	July, 2005
SCALE	1:2,400,000
DESIGNED	HEO
DRAFTED	HEO

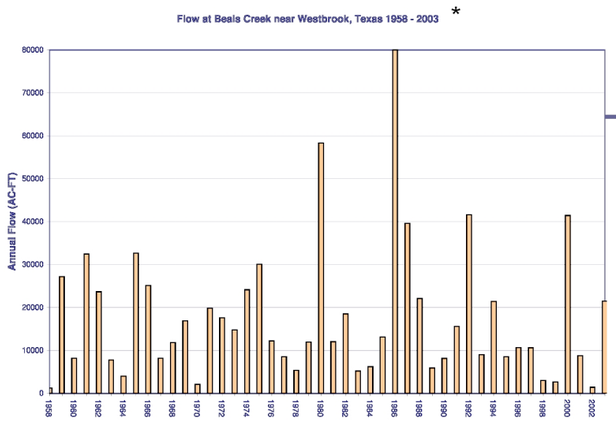
FIGURE 1.1-7

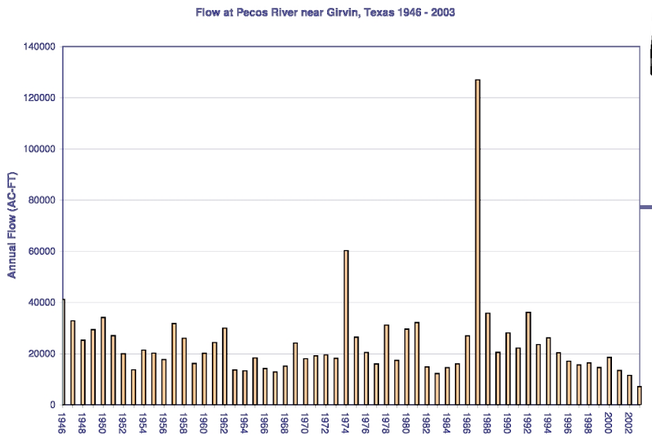
Table 1.1-4
Major Water Supply Reservoirs in Region F [a]

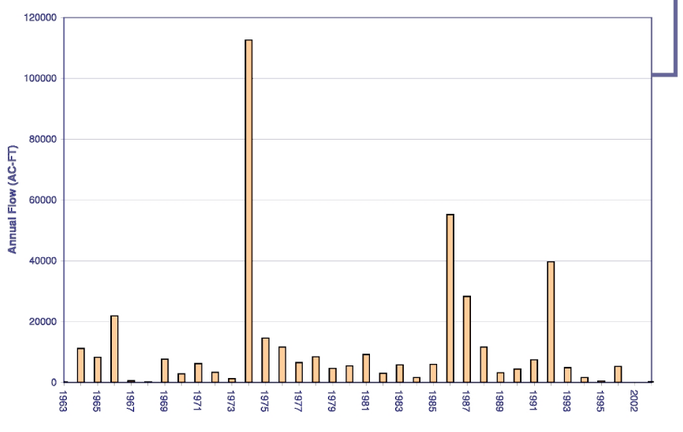
Reservoir Name	Basin	Stream	County(ies)	Water Right Number(s)	Priority Date	Permitted Conservation Storage (Acre-Feet)	Permitted Diversion (Acre-Feet per Year)	Year 2000 Use (Acre-Feet per Year)	Owner	Water Rights Holder(s)
Lake J B Thomas	Colorado	Colorado River	Borden and Scurry	CA-1002	08/05/1946	204,000	30,000 [c]	13,560	CRMWD	CRMWD
Lake Colorado City	Colorado	Morgan Creek	Mitchell	CA-1009	11/22/1948	29,934	5,500	3,690 [b]	TXU	TXU
Champion Creek Reservoir	Colorado	Champion Creek	Mitchell	CA-1009	04/08/1957	40,170	6,750		TXU	TXU
Oak Creek Reservoir	Colorado	Oak Creek	Coke	CA-1031	04/27/1949	30,000	10,000	4,309	City of Sweetwater	City of Sweetwater
Lake Coleman	Colorado	Jim Ned Creek	Coleman	CA-1702	08/25/1958	40,000	9,000	1,651	City of Coleman	City of Coleman
E V Spence Reservoir	Colorado	Colorado River	Coke	CA-1008	08/17/1964	488,760	50,000 [c]	10,932	CRMWD	CRMWD
Mitchell County Reservoir	Colorado	Off-Channel	Mitchell		02/14/1990	27,266				
Lake Winters	Colorado	Elm Creek	Runnels	CA-1095	12/18/1944	8,347	1,755	407	City of Winters	City of Winters
Lake Brownwood	Colorado	Pecan Bayou	Brown	CA-2454	09/29/1925	114,000	29,712	14,113	Brown Co. WID	Brown Co. WID
Hords Creek Lake	Colorado	Hords Creek	Coleman	CA-1705	03/23/1946	7,959	2,260	366	COE	City of Coleman
Lake Ballinger	Colorado	Valley Creek	Runnels	CA-1072	10/04/1946	6,850	1,000	842	City of Ballinger	City of Ballinger
O. H. Ivie Reservoir	Colorado	Colorado River	Coleman, Concho and Runnels	A-3866 P-3676	02/21/1978	554,340	113,000	47,837	CRMWD	CRMWD
O. C. Fisher Lake	Colorado	North Concho River	Tom Green	CA-1190	05/27/1949	119,000	80,400	2,201	COE	Upper Colorado River Authority
Twin Buttes Reservoir	Colorado	South Concho River	Tom Green	CA-1318	05/06/1959	186,000	29,000	NR	U.S. Bureau of Reclamation	City of San Angelo
Lake Nasworthy	Colorado	South Concho River	Tom Green	CA-1319	03/11/1929	12,500	25,000	1,195	City of San Angelo	City of San Angelo
Brady Creek Reservoir	Colorado	Brady Creek	McCulloch	CA-1849	09/02/1959	30,000	3,500	272	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	69,743	Red Bluff Water Power Control District	Red Bluff Water Power Control District
Lake Balmorhea	Rio Grande	Toyah Creek	Reeves	A-0060 P-0057	10/05/1914	13,583	41,400	9,677	Reeves Co WID #1	Reeves Co WID #1
Total						*2,185,443*	*692,400*	*180,429*		

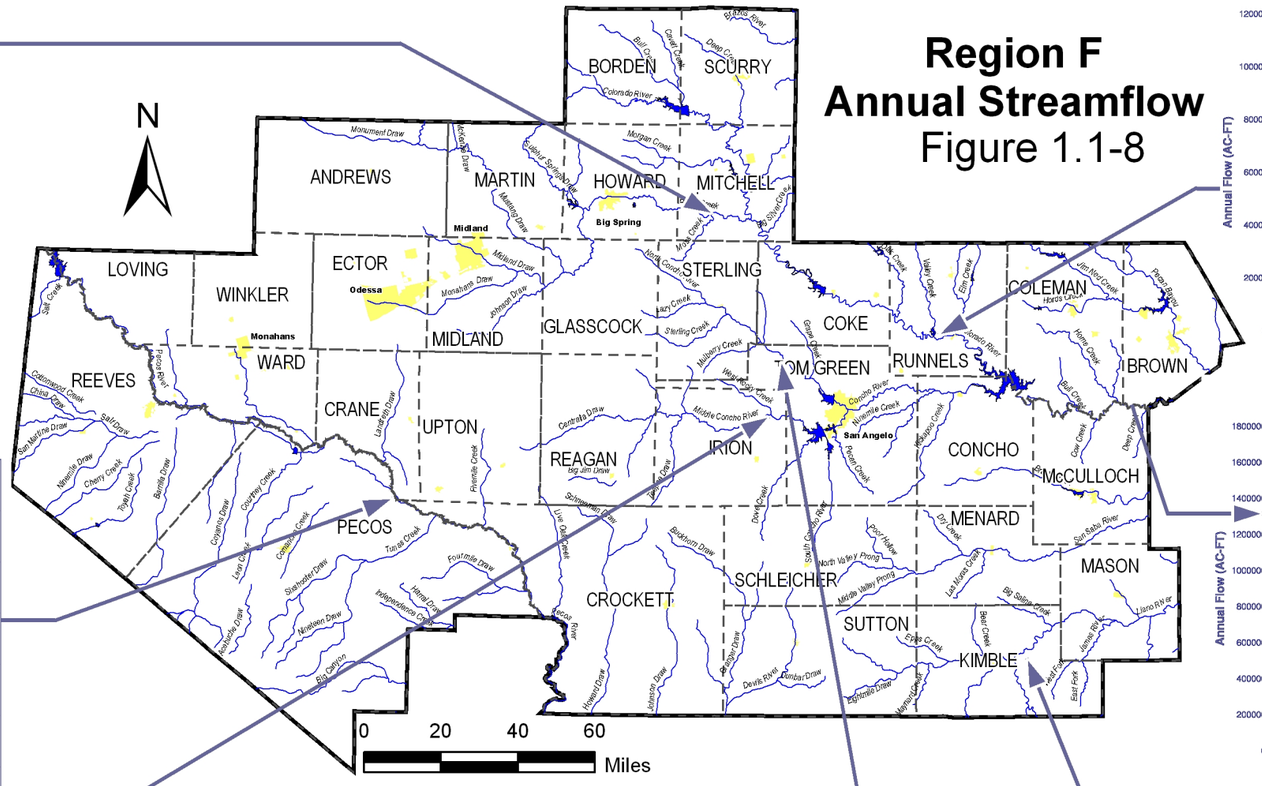
a Data are from TCEQ active water rights list[10], TCEQ water rights permits[7], and TCEQ historical water use by water right[8]. Year 2000 Use is Consumptive Use.
b Use is total consumptive use from both Champion Creek Reservoir and Lake Colorado City.
c Total consumptive use for CA 1002 and CA 1008 limited to 73,000 ac-ft per year.
CA Certificate of Adjudication
A Application
P Permit

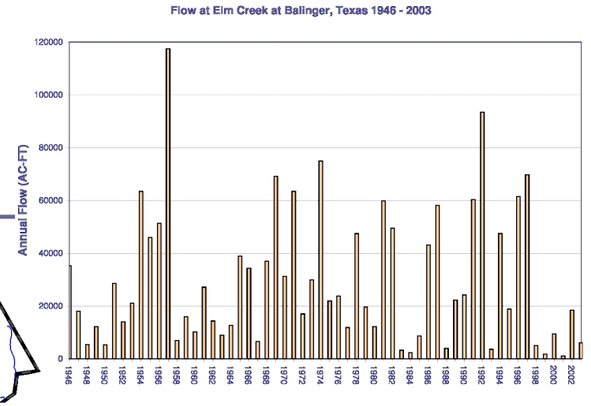
Region F
Annual Streamflow
Figure 1.1-8

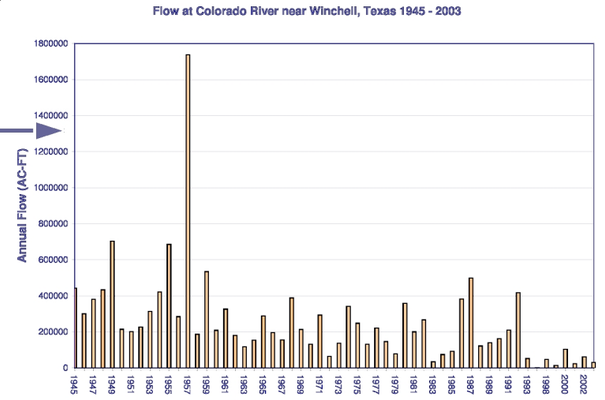


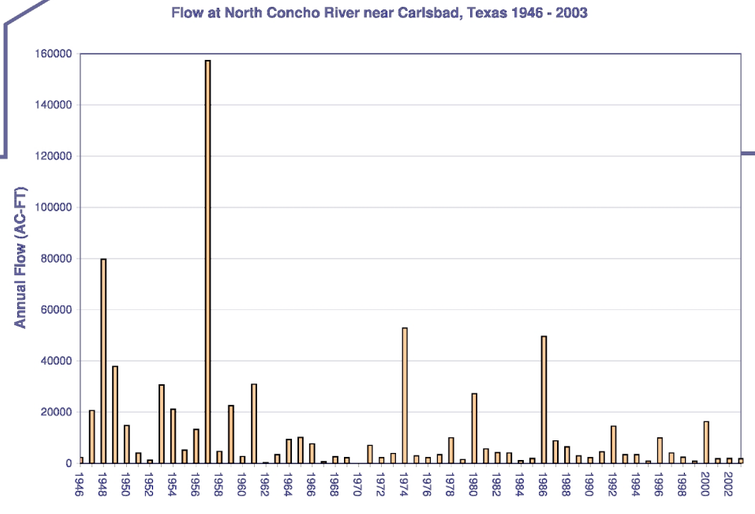


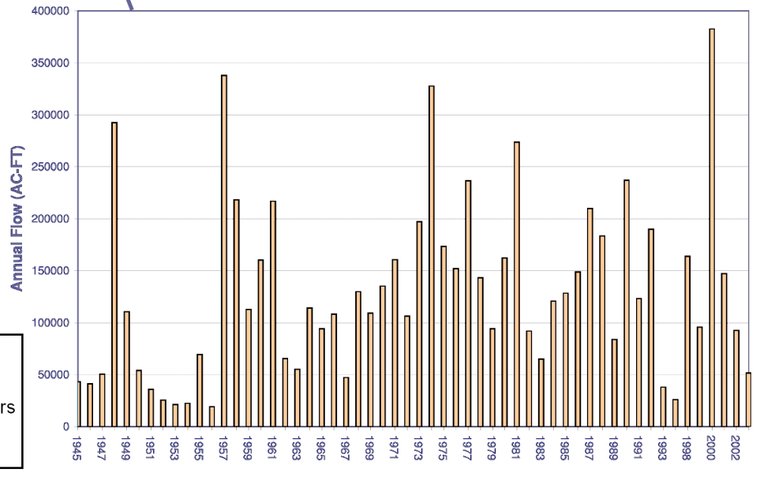


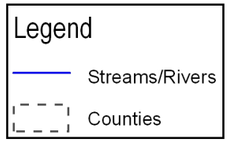








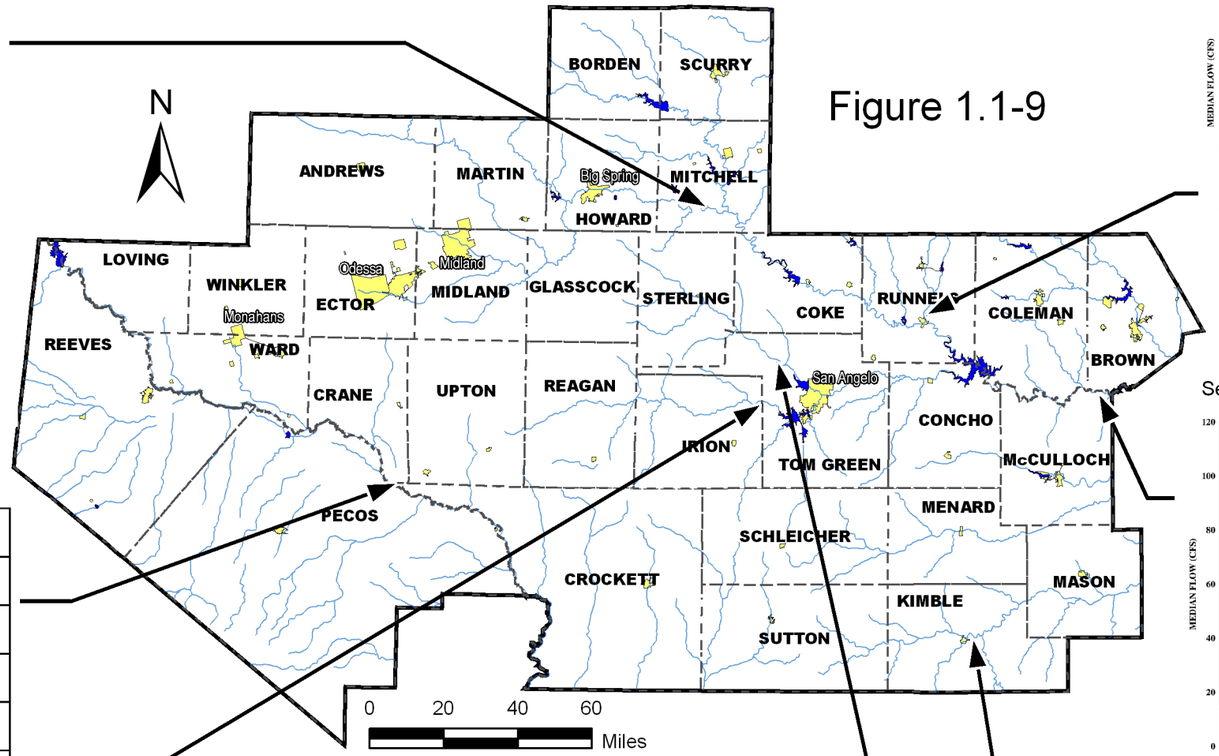




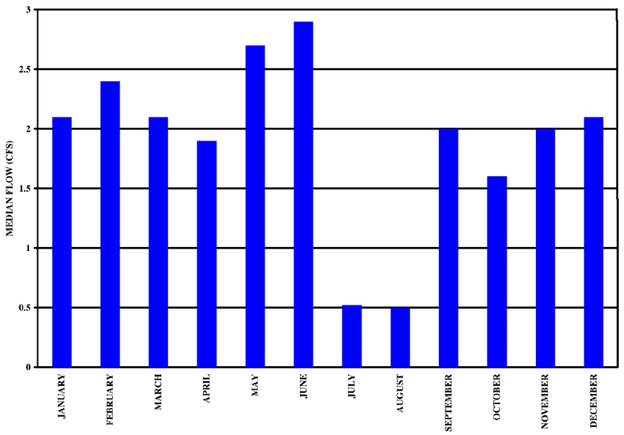
* Natural Dam Lake, which is above the Beals Creek gage, spilled intermittantly during 1986 and 1987. Natural Dam has subsequently been improved so that spills from the lake will not reoccur.

Region F
Median Streamflow

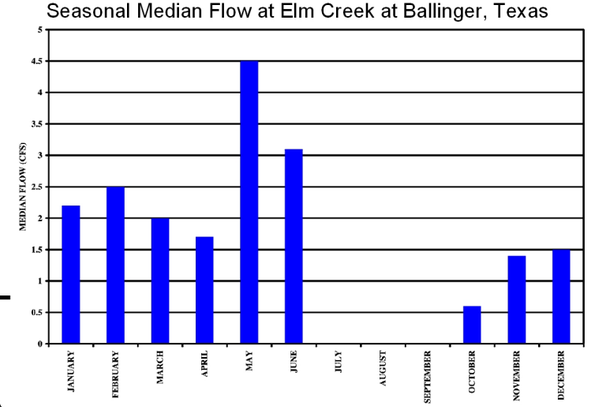
Figure 1.1-9



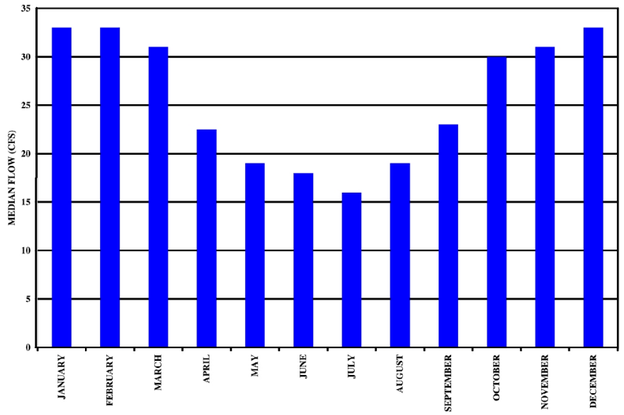
Seasonal Median Flow at Beals Creek near Westbrook, Texas *



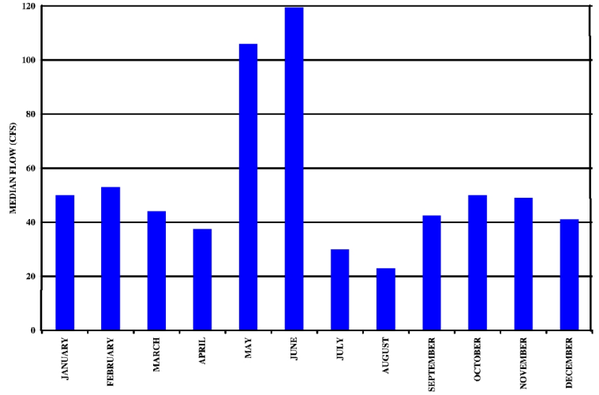
Seasonal Median Flow at Elm Creek at Ballinger, Texas



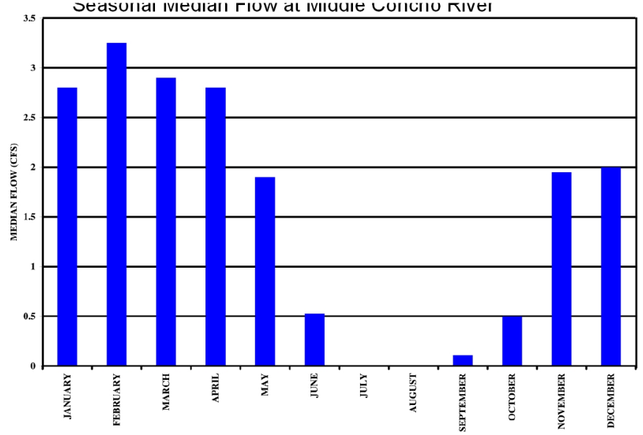
Seasonal Median Flow at Pecos River near Girvin, Texas



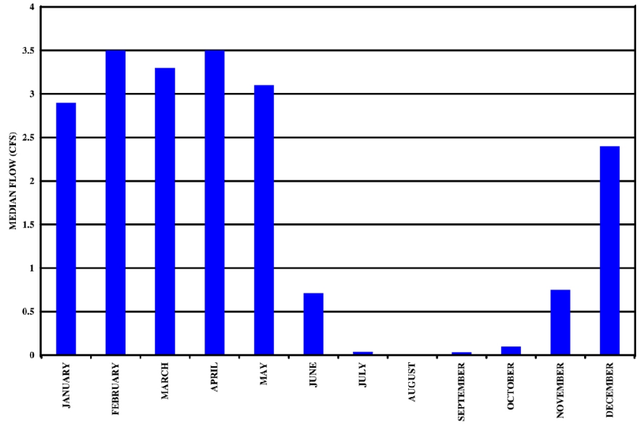
Seasonal Median Flow at Colorado River near Winchell, Texas



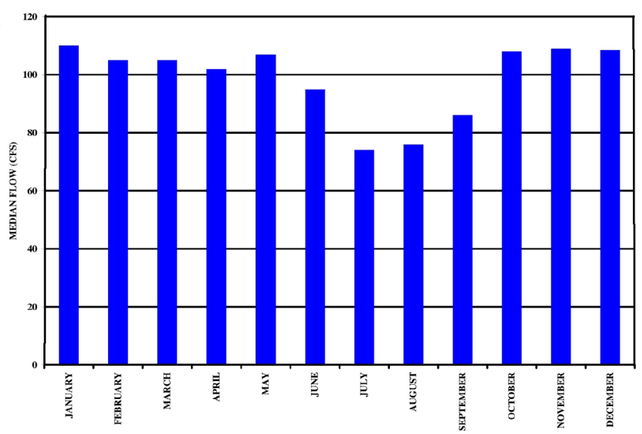
Seasonal Median Flow at Middle Concho River



Seasonal Median Flow at North Concho River near Carlsbad, Texas



Seasonal Median Flow at Llano River near Junction, Texas



Legend

Streams/Rivers

Counties

* Natural Dam Lake, which is above the Beals Creek gage, spilled intermittantly during 1986 and 1987. Natural Dam has subsequently been improved so that spills from the lake will not reoccur.

Figure 1.2-1shows major aquifers in Region F, and Figure 1.2-2 shows the minor aquifers. There are 11 aquifers that supply water to the 32 counties of Region F. The major aquifers are the Edwards-Trinity Plateau, Ogallala, Cenozoic Pecos Alluvium and a small portion of the Trinity. The minor aquifers are Dockum, Hickory, Lipan, Ellenberger-San Saba, Marble Falls, Rustler and the Capitan Reef Complex. A small portion of the Edwards-Trinity High Plains extends into Region F but is not a major source of water. More information on these aquifers may be found in Chapter 3.

1.2 Current Water Uses and Demand Centers in Region F

Table 1.2-1 shows the total water use by county in Region F from 1990 through 2000. (Year 2000 data are the most recent available[9].) Table 1.2-2 shows water use for the same period by TWDB use category and Figure 1.2-3 is a graph of the same data. Water use in Region F increased significantly between 1990 and 1995, primarily due to increases in irrigated agriculture. Total water use has decreased somewhat since the peak in 1995. However, year 2000 water use is still almost 13 percent higher than water use in 1990. Table 1.2-3 shows water use by category and county in 2000, and Figure 1.2-4 shows the distribution of water use by county in the region. About 66 percent of the current water use in Region F is for irrigated agriculture. Municipal supply is the second largest category, followed by mining, steam electric power generation, livestock watering, and manufacturing.

The data in Table 1.2-3 and Figure 1.2-4 lead to the following observations about year 2000 water use in Region F:

- The areas with the highest water use are Reeves, Pecos, Tom Green, Midland and Ector Counties, accounting for over half of the total water used in the region.
- Most of the municipal water use occurred in Midland, Ector and Tom Green Counties, location of the cities of Midland, Odessa and San Angelo, respectively. In the year 2000 these counties accounted for almost 60 percent of the water use in this category. Other significant municipal demand centers include Brown County (Brownwood) and Howard County (Big Spring).

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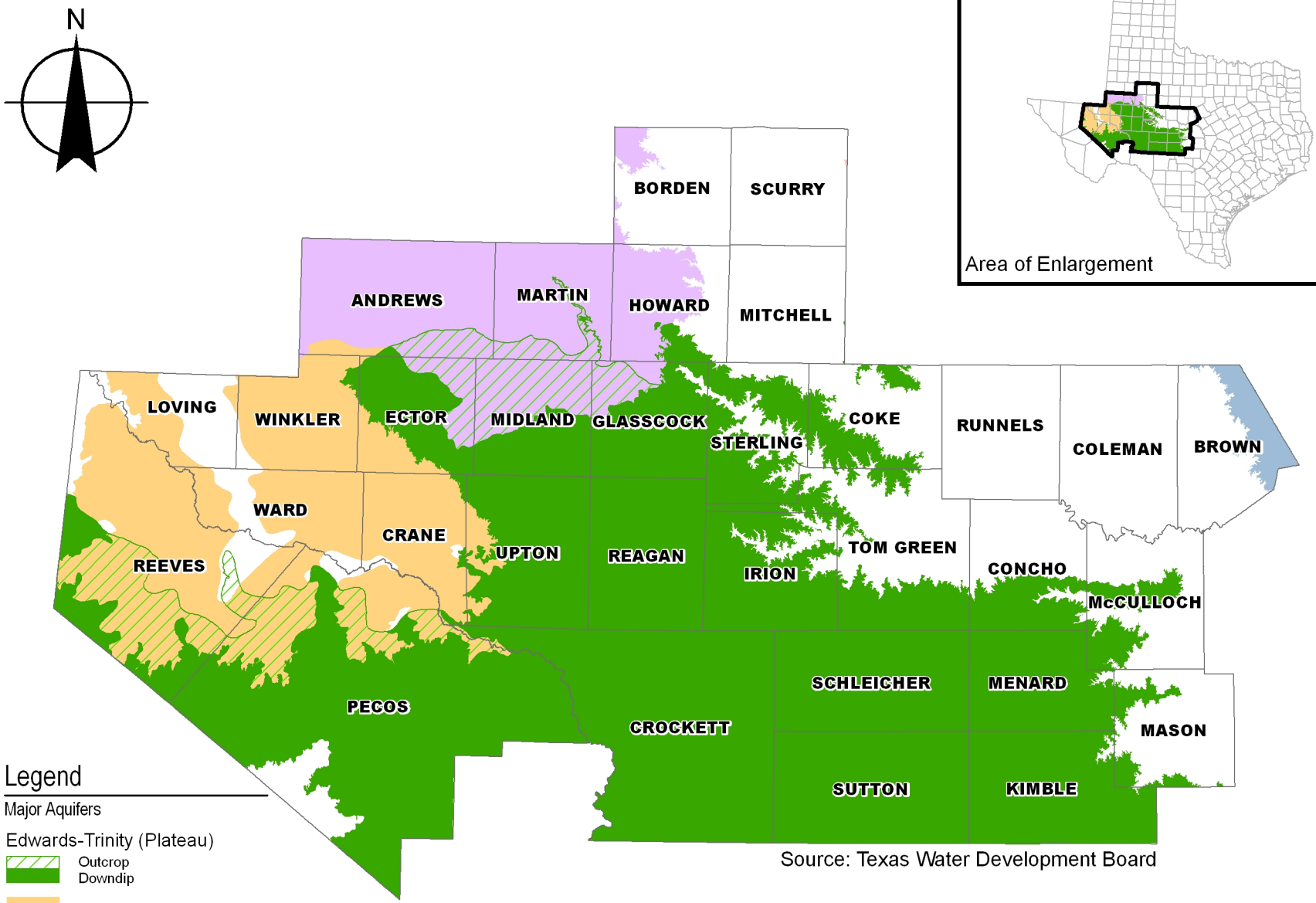
Major Aquifer Map

Region F



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DATE	June 27, 2005
SCALE	1:2,420,500
DESIGNED	BME
DRAFTED	BME

FIGURE 1.2-1

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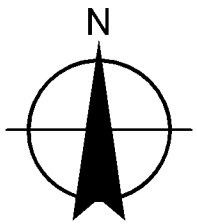
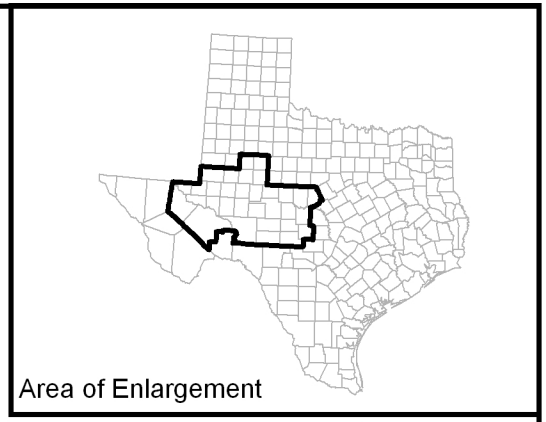
Minor Aquifer Map

Region F





BORDEN
SCURRY
ANDREWS
MARTIN
HOWARD
MITCHELL
LOVING
WINKLER
ECTOR
MIDLAND
GLASSCOCK
STERLING
COKE
RUNNELS
COLEMAN
BROWN
WARD
CRANE
UPTON
REAGAN
IRION
TOM GREEN
CONCHO
REEVES
McCULLOCH
PECOS
CROCKETT
SCHLEICHER
MENARD
MASON
SUTTON
KIMBLE

Source: Texas Water Development Board

Legend

Minor Aquifers

- Dockum: Outcrop, Downdip
- Hickory: Outcrop, Downdip
- Ellenburger - San Saba: Outcrop, Downdip
- Rustler: Outcrop, Downdip
- Marble Falls
- Lipan
- Captain Reef Complex: Outcrop, Downdip

10 0 10 20 30
Miles

FN	J061N0
PLE	CMD01311
DATE	RegionF_MinAquifers.mxd
SCALE	June 27, 2005
DESIGNED	1:2,420,500
DRAFTED	BME
	BME

FIGURE 1.2-2

Table 1.2-1
Historical Total Water Use by County in Region F
(Values in acre-feet)

County	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Andrews	15,177	15,098	16,163	18,350	26,971	22,424	20,988	23,139	18,901	17,633	38,356
Borden	1,153	1,866	1,913	2,307	2,543	3,095	6,505	11,071	4,096	3,547	3,187
Brown	11,053	10,923	10,949	20,722	21,320	24,350	23,121	23,456	27,286	26,161	21,375
Coke	2,333	2,216	2,226	2,799	2,545	2,610	2,788	2,347	3,434	2,525	2,845
Coleman	3,680	3,633	3,779	4,318	4,147	4,016	5,085	4,262	4,222	4,278	2,783
Concho	3,867	4,668	5,033	8,677	5,698	7,757	6,054	3,553	5,473	7,331	3,815
Crane	2,683	3,849	3,651	3,840	4,016	3,828	3,756	4,346	3,947	3,823	3,859
Crockett	4,760	4,801	4,526	4,864	4,820	4,718	4,424	4,032	4,929	4,761	4,032
Ector	35,275	41,673	37,882	40,200	41,659	40,207	42,034	39,242	32,072	32,258	40,501
Glasscock	27,545	36,116	25,139	39,885	58,429	69,096	55,551	52,825	62,642	24,920	35,828
Howard	12,826	14,153	14,068	13,764	15,477	15,706	12,906	14,923	16,129	17,467	15,035
Irion	3,528	3,559	3,544	3,921	3,915	2,836	3,630	3,558	2,493	2,285	2,724
Kimble	4,084	3,970	3,844	5,102	3,354	3,367	3,025	2,712	3,051	3,146	2,754
Loving	151	154	71	652	669	668	652	667	651	638	412
Martin	14,297	7,637	15,101	11,001	9,427	13,535	14,497	16,232	22,214	21,074	16,950
Mason	19,458	19,184	14,312	15,219	14,237	13,238	12,267	10,919	10,716	10,767	11,652
McCulloch	6,203	5,935	5,948	7,241	7,156	6,924	6,021	6,201	6,444	6,036	6,848
Menard	1,635	1,834	2,382	6,898	7,080	5,780	5,048	4,642	4,456	5,045	3,988
Midland	50,921	39,653	45,035	53,948	71,756	95,360	84,290	63,214	70,267	78,372	62, 155
Mitchell	7,459	7,289	6,376	6,720	6,323	5,648	7,386	6,202	7,206	8,610	18,156
Pecos	73,636	66,154	65,246	80,026	78,478	88,947	82,444	85,785	87,948	89,417	79,953
Reagan	39,945	35,153	27,315	26,946	34,080	46,120	46,866	49,463	67,271	23,456	18,769
Reeves	56,705	49,911	50,822	79,080	109,623	113,331	107,007	115,958	113,892	128,338	80,770
Runnels	5,665	8,114	5,570	8,370	6,924	7,986	11,427	9,200	7,975	5,957	3,499
Schleicher	2,233	2,345	2,556	2,836	3,222	2,794	3,010	2,971	3,869	4,405	3,474
Scurry	7,120	10,708	8,151	9,223	8,773	7,374	8,642	8,150	7,513	9,791	9,248
Sterling	1,886	2,139	2,225	1,906	1,958	1,894	1,880	1,918	1,966	1,939	1,886
Sutton	3,067	3,171	2,933	3,449	3,537	3,542	4,227	4,273	2,170	4,276	3,460
Tom Green	66,522	78,821	58,843	131,381	134,530	147,964	79,299	133,483	75,645	63,786	52,750
Upton	16,340	20,434	19,585	18,051	22,488	23,821	22,402	19,462	29,166	10,804	16,138
Ward	22,847	15,212	16,130	30,831	31,108	18,152	18,764	19,391	22,558	19,318	22,971
Winkler	3,176	5,786	5,763	4,430	4,425	3,874	3,796	3,651	3,868	3,411	5,523
Total	*527,230*	*526,159*	*487,081*	*666,957*	*750,688*	*810,962*	*709,792*	*751,248*	*734,470*	*645,575*	*595,696*

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

Table 1.2-2
Historical Water Use by Category in Region F
(Values in acre-feet)

Year	Municipal	Manu-facturing	Irrigation	Steam-Electric	Mining	Livestock	Total
1990	116,551	7,725	352,901	12,075	21,372	16,606	527,230
1991	118,390	7,205	337,813	13,309	32,331	17,111	526,159
1992	113,933	8,329	299,722	12,417	32,256	20,424	487,081
1993	118,009	8,386	471,551	13,933	34,799	20,279	666,957
1994	127,488	7,918	544,511	13,723	36,945	20,103	750,688
1995	125,566	8,241	613,020	12,593	31,410	20,132	810,962
1996	130,198	7,790	505,474	13,243	31,685	21,402	709,792
1997	121,510	7,581	556,928	13,379	31,892	19,958	751,248
1998	134,656	6,661	534,735	13,995	27,985	16,438	734,470
1999	131,308	6,429	448,573	13,840	27,985	17,440	645,575
2000	128,410	8,365	394,362	17,749	29,379	17,431	595,696
State Total in 2000	*4,047,661*	*1,559,912*	*10,228,528*	*561,394*	*278,624*	*300,441*	*16,976,560*
% of State Total in Region F	*3.17%*	*0.54%*	*3.86%*	*3.16%*	*10.54%*	*5.80%*	*3.51%*

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

Figure 1.2-3
Historical Water Use by Category in Region F

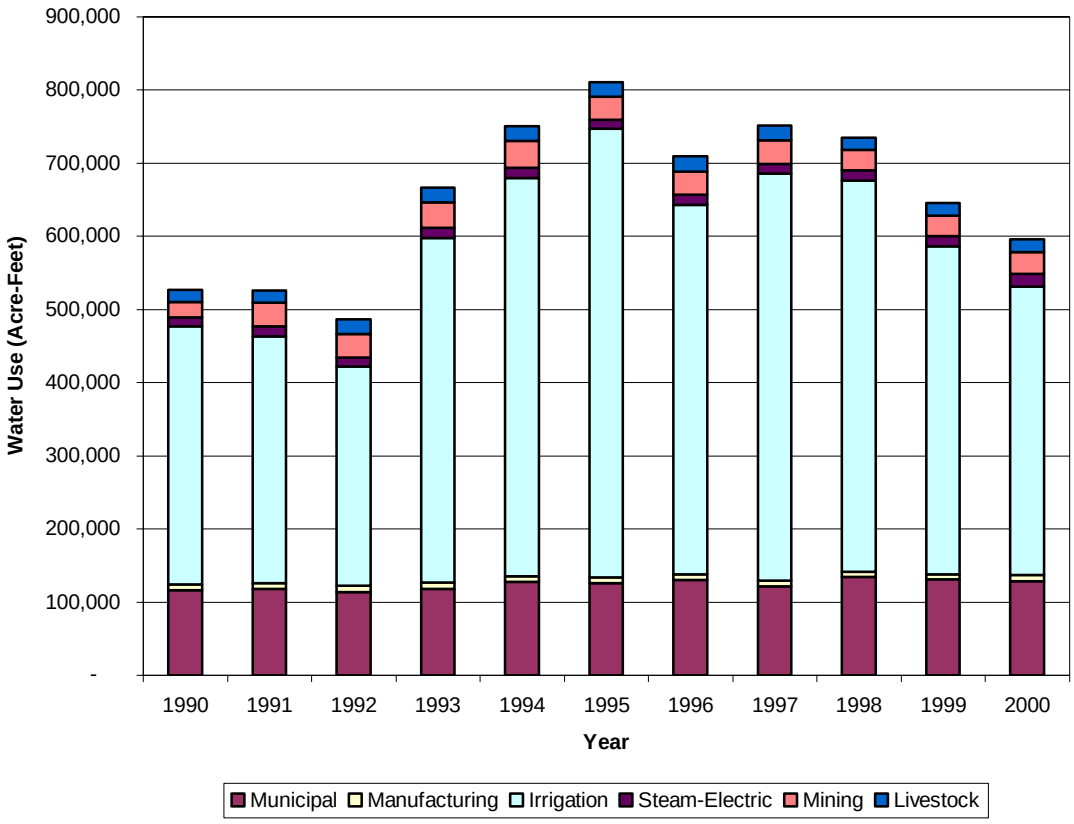


Table 1.2-3
Year 2000 Water Use by Category and County
(Values in acre-feet)

County	Municipal	Manu-facturing	Irrigation	Steam-Electric	Mining	Livestock	Total
Andrews	3,394	0	32,882	0	1,761	319	38,356
Borden	165	0	1,879	0	883	260	3,187
Brown	6,886	479	10,112	0	2,427	1,471	21,375
Coke	757	0	937	372	405	374	2,845
Coleman	1,623	5	0	0	16	1,139	2,783
Concho	699	0	2,574	0	0	542	3,815
Crane	1,138	0	337	0	2,240	144	3,859
Crockett	1,579	0	160	1,171	355	767	4,032
Ector	26,692	2,432	2,694	0	8,481	202	40,501
Glasscock	167	0	35,456	0	7	198	35,828
Howard	6,881	1,453	4,853	0	1,536	312	15,035
Irion	178	0	2,105	0	123	318	2,724
Kimble	972	582	637	0	91	472	2,754
Loving	11	0	358	0	3	40	412
Martin	645	34	14,575	0	845	851	16,950
Mason	889	0	10,223	0	6	534	11,652
McCulloch	2,266	680	2,859	0	140	903	6,848
Menard	427	0	3,143	0	0	418	3,988
Midland	30,627	135	30,483	0	515	395	62,155
Mitchell	1,728	0	5,564	10,280	141	443	18,156
Pecos	4,571	2	74,236	0	163	981	79,953
Reagan	923	0	15,879	0	1,742	225	18,769
Reeves	3,608	644	75,477	0	203	838	80,770
Runnels	1,550	52	920	0	41	936	3,499
Schleicher	671	0	2,150	0	105	548	3,474
Scurry	3,206	0	2,908	0	2,606	528	9,248
Sterling	324	0	637	0	560	365	1,886
Sutton	1,361	0	1,473	0	75	551	3,460
Tom Green	17,963	1,861	30,415	566	59	1,886	52,750
Upton	865	0	12,471	0	2,599	203	16,138
Ward	3,378	6	13,963	5,360	147	117	22,971
Winkler	2,268	0	2,002	0	1,104	149	5,523
Total	*128,412*	*8,365*	*394,362*	*17,749*	*29,379*	*17,429*	*595,696*

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

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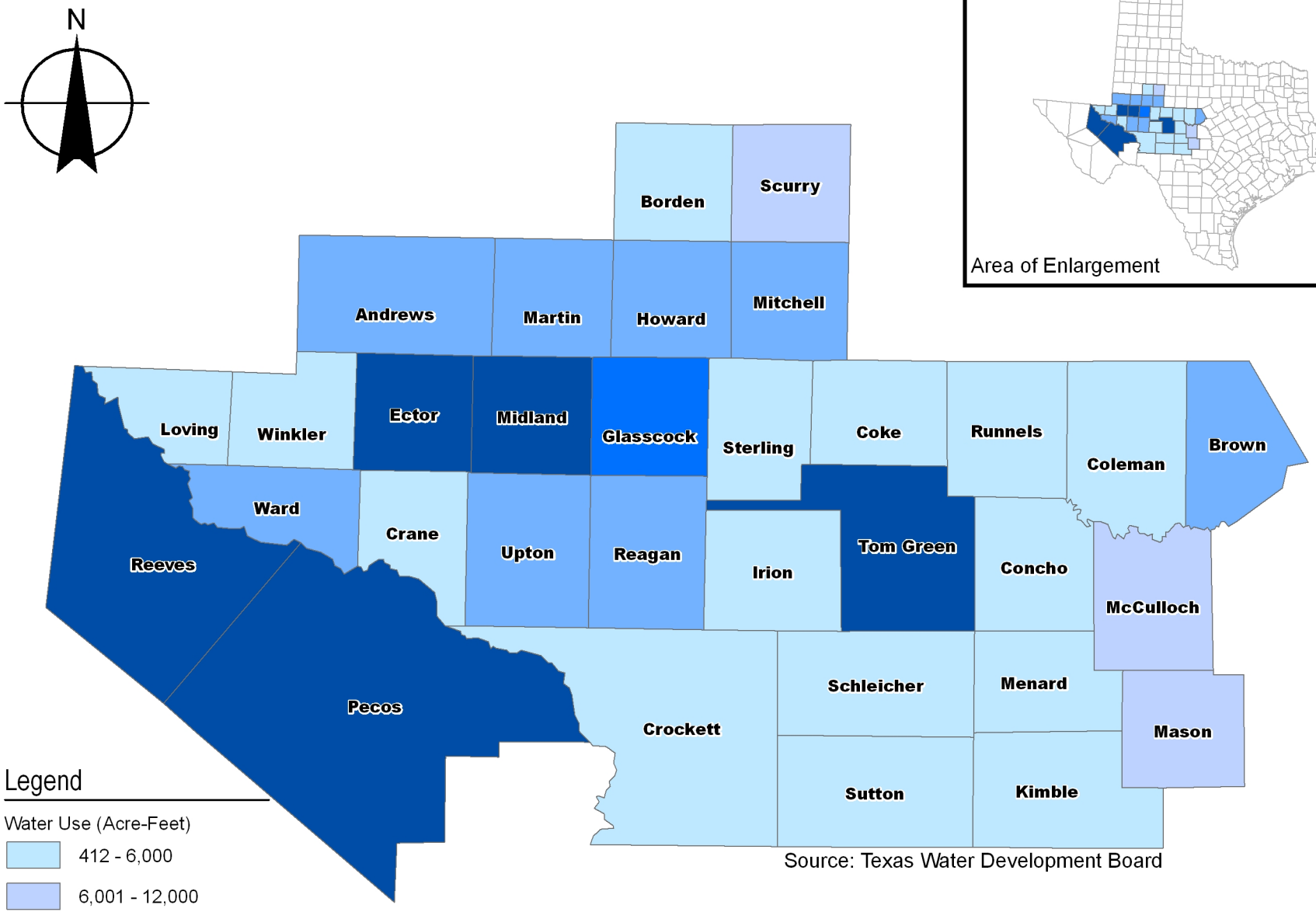
Water Use by County (2000)

Region F



FN JOB NO	CMD01311
FILE	RegionFWaterUse.mxd
DATE	January 13, 2005
SCALE	1:2,401,000
DESIGNED	BME
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FIGURE 1.2-4

- Manufacturing water use is concentrated in Ector, Tom Green and Howard Counties, accounting for almost 70 percent of the total use in this category.
- Reeves and Pecos Counties accounted for most of the irrigation water use in 2000, accounting for more than a third of the irrigation water use in the region. Other significant demand centers for irrigation water include Glasscock, Andrews, Midland and Tom Green Counties.
- Steam-electric power generation water use occurred only in Mitchell, Ward, Crockett, Tom Green and Coke Counties.
- Most of the water used for mining purposes occurred in Ector County, accounting for almost 30 percent of the total use. Other significant areas of mining water use included Scurry, Upton, Brown, Crane, Andrews, Reagan, Howard and Winkler Counties.
- Most of the livestock water use occurred in Tom Green, Brown and Coleman Counties, accounting for slightly more than a quarter of the total use in this category in the year 2000.

In addition to the consumptive water uses discussed above, water-oriented recreation is important in Region F. Table 1.2-4 summarizes recreational opportunities at major reservoirs in the region. Smaller lakes and streams provide opportunities for fishing, boating, swimming, and other water-related recreational activities. Water in streams and lakes is also important to fish and wildlife in the region, providing a wide variety of habitats.

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Table 1.2-4
Recreational Use of Reservoirs in Region F

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

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

1.3 Current Sources of Water

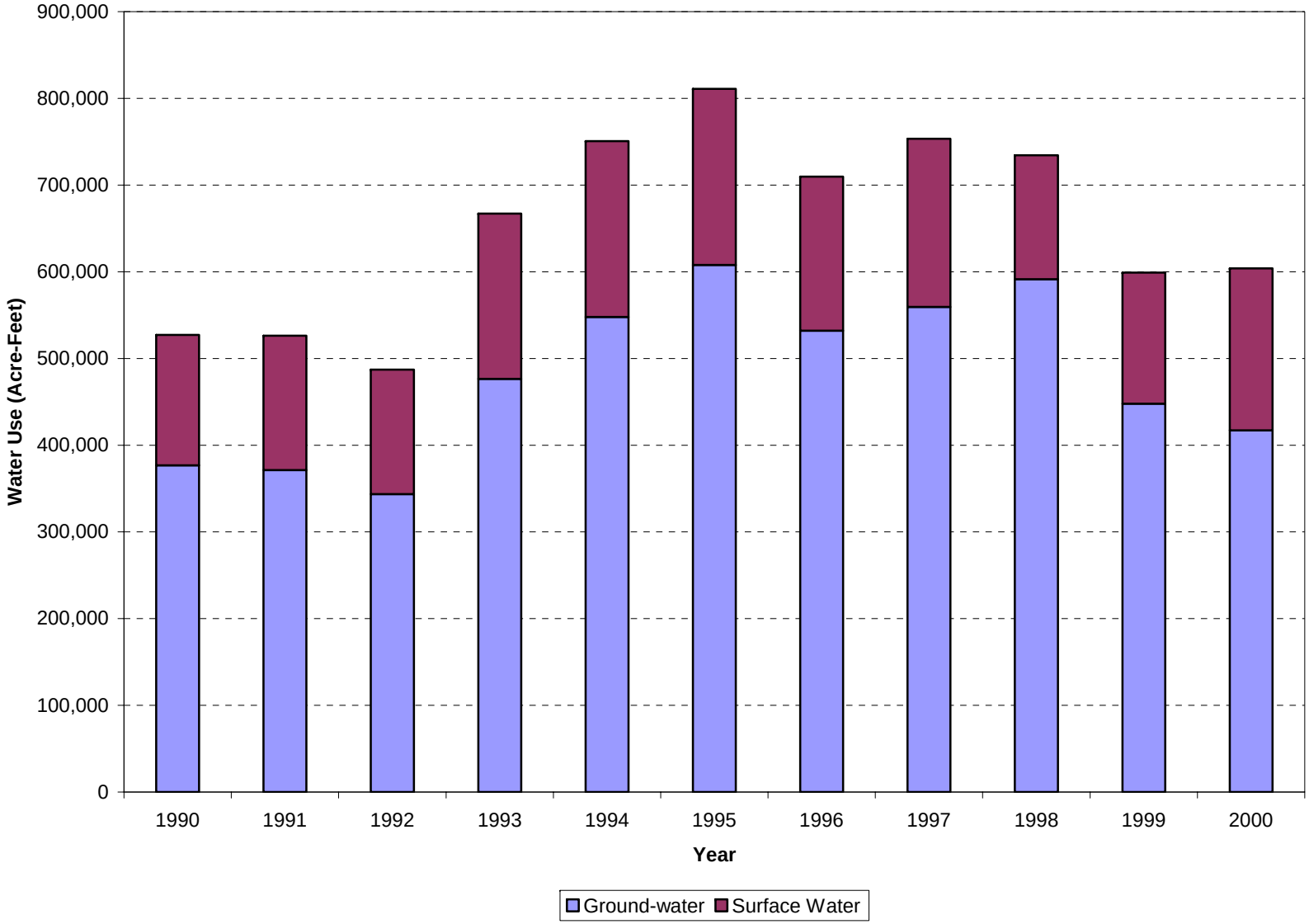
Table 1.3-1 summarizes the total surface water and groundwater use in Region F from 1990 through 2000[9], and Figure 1.3-1 graphically illustrates the same data. Total water use increased by 76,630 acre-feet (14.5 percent) between 1990 and 2000. Groundwater use increased by 40,288 acre feet (10.7 percent) and surface water use increased by 36,342 acre-feet (24 percent) over the same period. Total water use was significantly higher between 1993 and 1998 than the rest of the decade. The reduction in water use at the end of the decade was primarily due to unusually hot, dry weather experienced with the current drought, suppressing the amount of water available for irrigation. Table 1.3-2 shows the distribution of groundwater and surface water use by county and category for 2000, which is the most recent year for which data are available[9]. Figure 1.3-2 shows the percentage of supply from groundwater for each county in the region in the same year.

Table 1.3-1
Historical Groundwater and Surface Water Use in Region F

Year	Water Use in Acre-Feet		
	Ground-water	Surface Water	Total
1990	376,891	150,339	527,230
1991	371,311	154,848	526,159
1992	343,522	143,559	487,081
1993	476,492	190,465	666,957
1994	547,948	202,740	750,688
1995	607,802	203,160	810,962
1996	531,956	177,836	709,792
1997	559,393	193,881	753,274
1998	591,390	143,123	734,513
1999	447,738	151,241	598,979
2000	417,179	186,681	603,860

Note: Data are from Texas Water Development Board. Year 2000 water use for groundwater and surface water based on draft TWDB reported usage and does not match final water use in other tables.[9]

Figure 1.3-1
Historical Groundwater and Surface Water Use in Region F



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Region F

Supplies from Groundwater by County (2000)

FIGURE 1.3-2

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FILE	RegionF_GWUse.mxd
DATE	January 13, 2005
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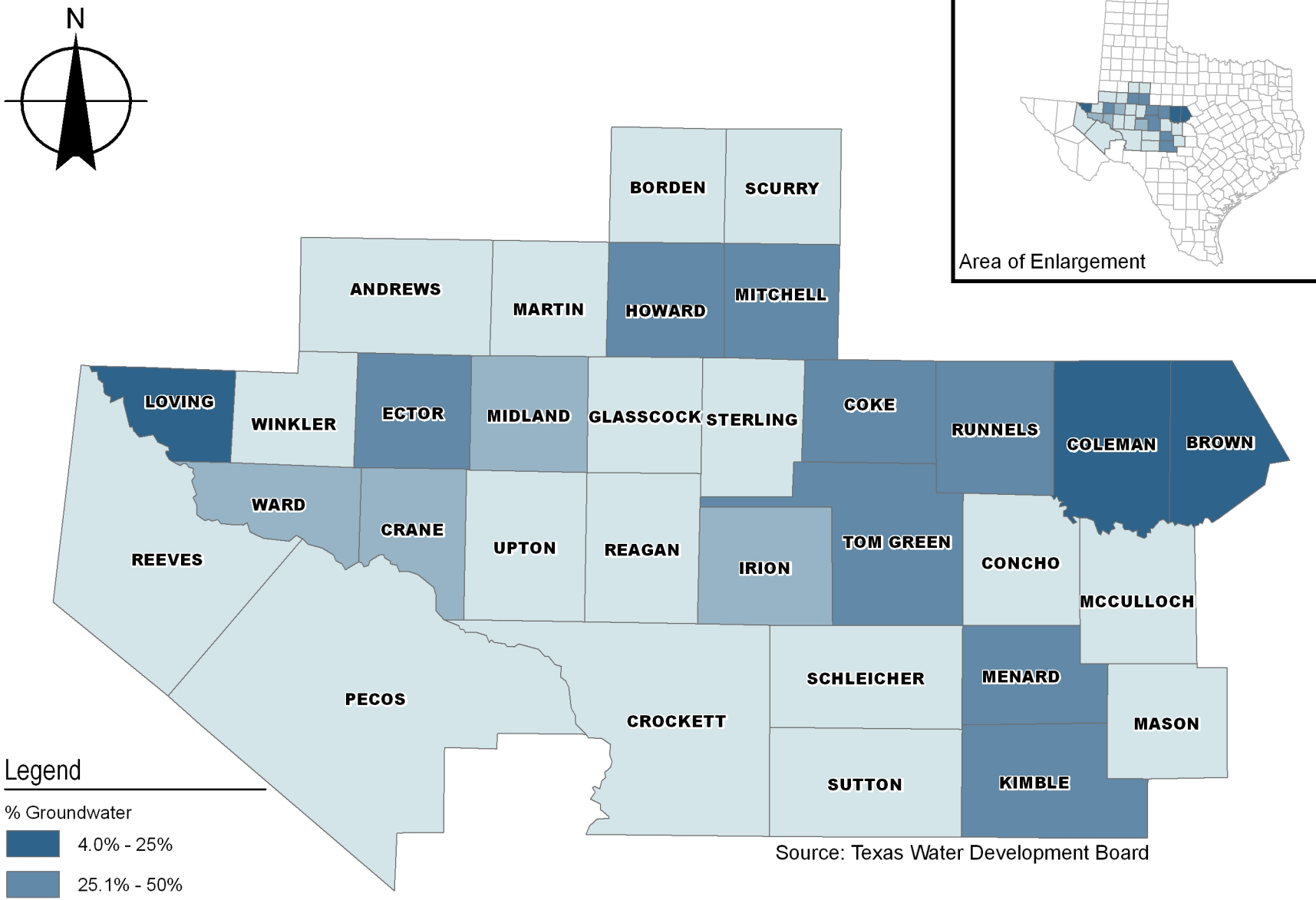

Table 1.3-2
Source of Supply by County and Category in 2000 for Region F
(Values in Acre-Feet)

County	Source of Water	Municipal	Manu-facturing	Irrigation	Steam-Electric	Mining	Livestock	*Total*
Andrews	Ground	3,625	0	18,482	0	1,761	255	*24,123*
	Surface	0	0	0	0	0	64	*64*
	Total	*3,625*	*0*	*18,482*	*0*	*1,761*	*319*	*24,187*
Borden	Ground	163	0	1,879	0	883	26	*2,951*
	Surface	2	0	0	0	0	234	*236*
	Total	*165*	*0*	*1,879*	*0*	*883*	*260*	*3,187*
Brown	Ground	168	0	2,320	0	153	147	*2,788*
	Surface	6,717	479	7,792	0	2,274	1,324	*18,586*
	Total	*6,885*	*479*	*10,112*	*0*	*2,427*	*1,471*	*21,374*
Coke	Ground	60	0	803	0	170	37	*1,070*
	Surface	698	0	134	372	235	337	*1,776*
	Total	*758*	*0*	*937*	*372*	*405*	*374*	*2,846*
Coleman	Ground	0	0	0	0	1	114	*115*
	Surface	1,734	5	0	0	15	1,025	*2,779*
	Total	*1,734*	*5*	*0*	*0*	*16*	*1,139*	*2,894*
Concho	Ground	632	0	2,408	0	0	433	*3,473*
	Surface	66	0	166	0	0	108	*340*
	Total	*698*	*0*	*2,574*	*0*	*0*	*541*	*3,813*
Crane	Ground	1,139	0	0	0	805	137	*2,081*
	Surface	0	0	0	0	1,435	7	*1,442*
	Total	*1,139*	*0*	*0*	*0*	*2,240*	*144*	*3,523*
Crockett	Ground	1,643	0	160	938	21	614	*3,376*
	Surface	0	0	0	0	334	153	*487*
	Total	*1,643*	*0*	*160*	*938*	*355*	*767*	*3,863*
Ector	Ground	4,704	1,545	2,694	0	8,411	192	*17,546*
	Surface	43,184	887	0	0	70	10	*44,151*
	Total	*47,888*	*2,432*	*2,694*	*0*	*8,481*	*202*	*61,697*
Glasscock	Ground	167	0	35,456	0	7	158	*35,788*
	Surface	0	0	0	0	0	40	*40*
	Total	*167*	*0*	*35,456*	*0*	*7*	*198*	*35,828*
Howard	Ground	680	155	4,834	0	184	250	*6,103*
	Surface	6,882	1,298	19	0	1,352	62	*9,613*
	Total	*7,562*	*1,453*	*4,853*	*0*	*1,536*	*312*	*15,716*
Irion	Ground	178	0	987	0	123	254	*1,542*
	Surface	0	0	1,118	0	0	64	*1,182*
	Total	*178*	*0*	*2,105*	*0*	*123*	*318*	*2,724*
Kimble	Ground	189	2	48	0	91	377	*707*
	Surface	780	580	589	0	0	94	*2,043*
	Total	*969*	*582*	*637*	*0*	*91*	*471*	*2,750*
Loving	Ground	11	0	0	0	3	32	*46*
	Surface	0	0	358	0	0	8	*366*
	Total	11	0	358	0	3	40	*412*

Table 1.3-2 (cont.): Source of Supply by County and Category in 2000 for Region F

County	Source of Water	Municipal	Manu-facturing	Irrigation	Steam-Electric	Mining	Livestock	*Total*
Martin	Ground	408	34	14,575	0	132	544	*15,693*
	Surface	278	0	0	0	8	136	*422*
	Total	*686*	*34*	*14,575*	*0*	*140*	*680*	*16,115*
Mason	Ground	889	0	10,223	0	140	350	*11,602*
	Surface	0	0	0	0	0	350	*350*
	Total	*889*	*0*	*10,223*	*0*	*140*	*700*	*11,952*
McCulloch	Ground	2,896	680	2,790	0	23	748	*7,137*
	Surface	27	0	69	0	0	187	*283*
	Total	*2,923*	*680*	*2,859*	*0*	*23*	*935*	*7,420*
Menard	Ground	80	0	370	0	0	335	*1,132*
	Surface*	347	0	2,773	0	0	84	*2,857*
	Total	*427*	*0*	*3,143*	*0*	*0*	*419*	*3,989*
Midland	Ground	7,501	117	24,496	0	515	316	*32,945*
	Surface	23,916	18	5,987	0	0	79	*30,000*
	Total	*31,417*	*135*	*30,483*	*0*	*515*	*395*	*62,945*
Mitchell	Ground	1,369	0	5,549	0	141	44	*7,103*
	Surface	356	0	15	10,280	0	399	*11,050*
	Total	*1,725*	*0*	*5,564*	*10,280*	*141*	*443*	*18,153*
Pecos	Ground	5,054	2	72,412	0	163	932	*78,563*
	Surface	0	0	1,824	0	0	49	*1,873*
	Total	*5,054*	*2*	*74,236*	*0*	*163*	*981*	*80,436*
Reagan	Ground	923	0	15,879	0	1,742	180	*18,724*
	Surface	0	0	0	0	0	45	*45*
	Total	*923*	*0*	*15,879*	*0*	*1,742*	*225*	*18,769*
Reeves	Ground	3,414	644	63,228	0	203	796	*68,285*
	Surface	315	0	10,811	0	0	42	*11,168*
	Total	*3,729*	*644*	*74,039*	*0*	*203*	*838*	*79,453*
Runnels	Ground	357	1	480	0	41	94	*973*
	Surface	1,192	51	440	0	0	842	*2,525*
	Total	*1,549*	*52*	*920*	*0*	*41*	*936*	*3,498*
Schleicher	Ground	671	0	2,150	0	105	438	*3,364*
	Surface	0	0	0	0	0	109	*109*
	Total	*671*	*0*	*2,150*	*0*	*105*	*547*	*3,473*
Scurry	Ground	3,057	0	2,660	0	2,606	53	*8,376*
	Surface	145	0	248	0	0	476	*869*
	Total	*3,202*	*0*	*2,908*	*0*	*2,606*	*529*	*9,245*
Sterling	Ground	324	0	637	0	560	292	*1,813*
	Surface	0	0	0	0	0	73	*73*
	Total	*324*	*0*	*637*	*0*	*560*	*365*	*1,886*
Sutton	Ground	1,385	0	1,473	0	75	440	*3,373*
	Surface	0	0	0	0	0	110	*110*
	Total	1,385	0	1,473	0	75	550	*3,483*

Table 1.3-2 (cont.): Source of Supply by County and Category in 2000 for Region F

County	Source of Water	Municipal	Manu-facturing	Irrigation	Steam-Electric	Mining	Livestock	*Total*
Tom Green	Ground	1,839	0	20,522	0	59	189	*22,609*
	Surface	16,770	1,861	9,893	566	0	1,697	*30,787*
	Total	*18,609*	*1,861*	*30,415*	*566*	*59*	*1,886*	*53,396*
Upton	Ground	866	0	12,471	0	2,599	162	*16,098*
	Surface	0	0	0	0	0	41	*41*
	Total	*866*	*0*	*12,471*	*0*	*2,599*	*203*	*16,139*
Ward	Ground	3,578	6	2,962	5,360	147	111	*12,164*
	Surface	0	0	11,001	0	0	6	*11,007*
	Total	*3,578*	*6*	*13,963*	*5,360*	*147*	*117*	*23,171*
Winkler	Ground	2,268	0	2,002	0	1,104	142	*5,516*
	Surface	0	0	0	0	0	7	*7*
	Total	*2,268*	*0*	*2,002*	*0*	*1,104*	*149*	*5,523*
Total	*Ground*	*50,585*	*3,186*	*324,950*	*6,298*	*22,968*	*9,192*	*417,179*
	Surface	*103,062*	*5,179*	*53,237*	*11,218*	*5,723*	*8,262*	*186,681*
	Total	*153,647*	*8,365*	*378,187*	*17,516*	*28,691*	*17,454*	*603,860*

* The City of Menard's water supply comes from several wells on the banks of the San Saba River. Historically, the city's water supply has been classified as surface water.

Data are based on draft report of year 2000 usage from the Texas Water Development Board[9]. Final breakdown by groundwater and surface water are not available at the time of this report.

1.3.1 Surface Water Sources

Table 1.3-3 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 the regional water planning.) Table 1.3-3 does not include non-consumptive use categories such as recreation. Figure 1.3-3 shows the distribution of permitted diversions by county. Most of the large surface water diversions in Region F are associated with major reservoirs. Table 1.1-4 in Section 1.1.2 lists the permitted diversions and the reported year 2000 water use from major water supply reservoirs in the region.

Region F does not import a significant amount of surface water from other regions. Region F exports a significant amount of 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 Sweetwater used an average of 3,000 acre-feet per year from Oak Creek Reservoir between 1980 and 2000. The West Central Texas Municipal Water District has a

contract with the Colorado River Municipal Water District (CRMWD) for 15,000 acre-feet per year of water from O.H. Ivie Reservoir to supply the City of Abilene. Facilities to transfer water from Lake O.H. Ivie to Abilene became operational in September 2003. The pipeline has an initial peak capacity of 20 million gallons per day (MGD) with an ultimate capacity of 24 MGD. Currently Abilene is receiving an average of approximately 8 MGD (9,000 acre-feet per year) from O.H. Ivie. Small amounts of surface water are also supplied to the Cities of Lawn and Rotan, both of which are in Region G. Several rural water supply corporations also supply small amounts of surface water to neighboring regions.

Table 1.3-3
Surface Water Rights by County and Category

County	Permitted Surface Water Diversions (Acre-Feet per Year)					
	Municipal	**Industrial**	**Irrigation**	**Mining**	**Other**	**Total**
Borden	200	0	63	0	0	263
Brown	15,996	5,004	17,481	0	0	38,481
Coke	44,865	6,000	969	9,534 [a]	0	61,368
Coleman [c]	110,930	14,509	6,245	0	0	131,684
Concho	35	0	2,511	0	16	2,562
Ector	0	0	3,200	0	0	3,200
Howard	1,700	0	89	5,515	0	7,304
Irion	0	0	5,449	0	0	5,449
Kimble	1,000	2,466	8,490	100	0	12,056
Martin	0	0	2,500	0	0	2,500
Mason	0	0	465	0	0	465
McCulloch	3,000	500	2,229	0	0	5,729
Menard	1,016	0	8,935	3	0	9,954
Mitchell	2,700	9,550 [b]	123	0	0	12,373
Pecos	0	0	66,902	0	0	66,902
Reeves [d]	1,890	0	412,352	0	0	414,242
Runnels	2,919	0	6,924	70	0	9,913
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	107,934	8,002	41,019	0	0	156,955
Total	*324,185*	*46,031*	*586,754*	*15,228*	*16*	*972,214*

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

b 5,500 acre-feet per year of this amount is permitted for multiple uses. It is currently being used primarily for steam electric power generation.

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[10]. Other counties have no permitted water rights on the TCEQ list. Does not include recreation rights.

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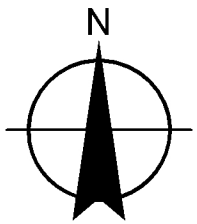
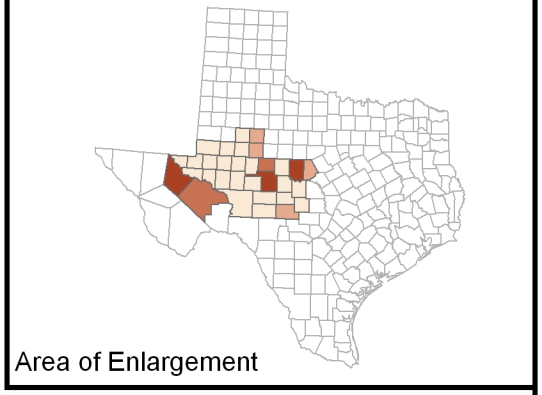
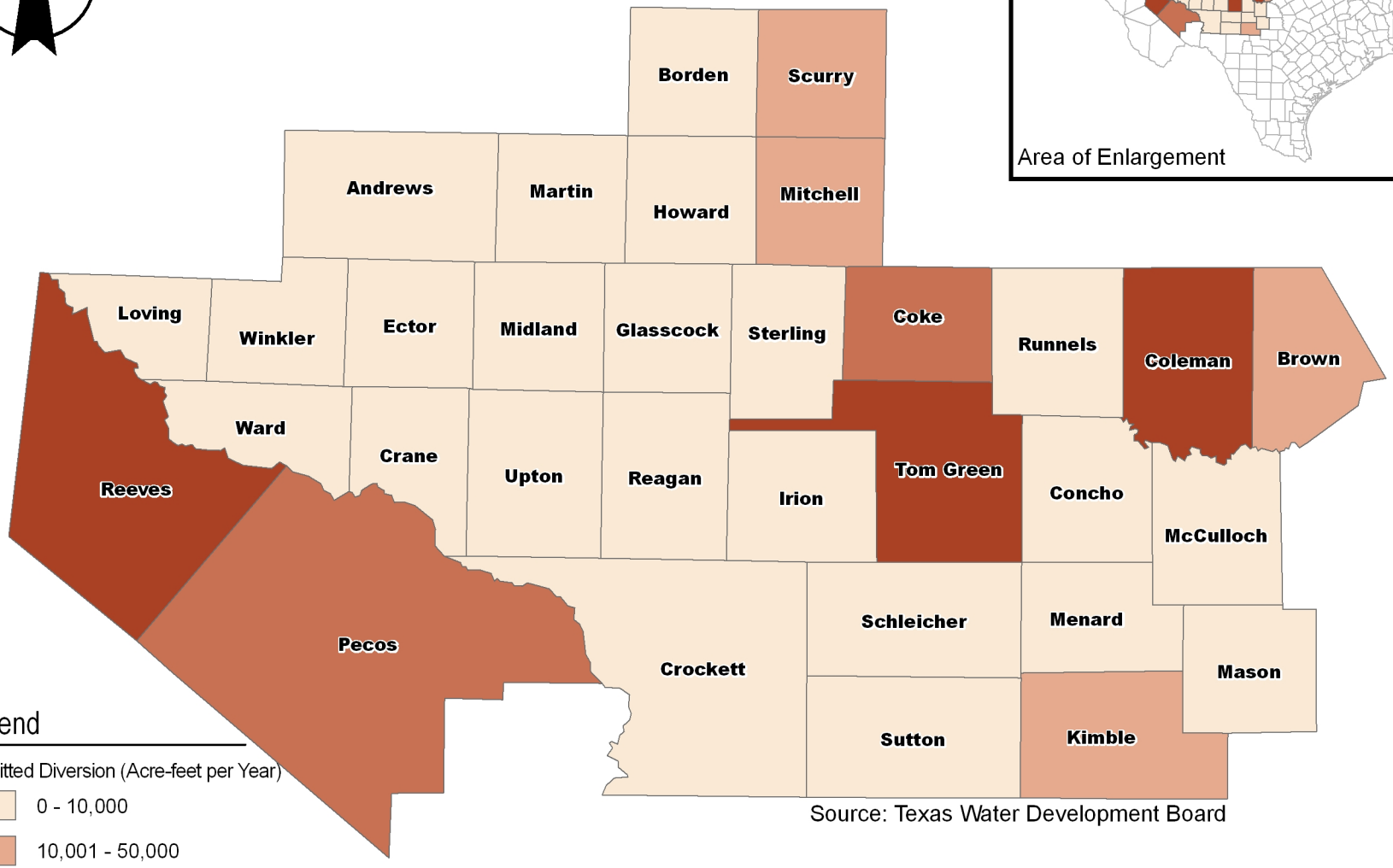
Region F

Total Permitted Surface Water Diversion by County







Legend

Permitted Diversion (Acre-feet per Year)

- 0 - 10,000
- 10,001 - 50,000
- 50,001 - 100,000
- 100,001 - 500,000

Source: Texas Water Development Board

10 0 10 20 30
Miles

FN 30610	CMD01311
FILE	RegionF_Diversion.mxd
DATE	January 13, 2005
SCALE	1:2,420,500
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FIGURE 1.3-3

1.3.2 Groundwater Sources

There are eleven aquifers that supply water to the 32 counties of Region F: four major aquifers (Edwards-Trinity Plateau, Ogallala, Cenozoic Pecos Alluvium, and Trinity) and seven minor aquifers (Dockum, Hickory, Lipan, Ellenberger-San Saba, Marble Falls, Rustler and the Capitan Reef Complex). Figure 1.2-1 shows the major aquifers and Figure 1.2-2 shows the minor aquifers in Region F. The TWDB defines a major aquifer as an aquifer that supplies large quantities of water to large areas[11]. 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 1.3-4 shows the 1999 pumping by county and aquifer, the latest year for which these data are available[9]. The Edwards-Trinity Plateau, Cenozoic Pecos Alluvium and Ogallala are the largest sources of groundwater in Region F, providing 34 percent, 31 percent and 19 percent of the total groundwater pumped in 1999, respectively. The Lipan aquifer provided almost 6 percent of the 1999 totals, with all remaining aquifers contributing 10 percent combined. Groundwater pumping is highest in Reeves, Mitchell, Pecos, Glasscock, Tom Green, and Martin Counties. These six counties account for 68 percent of the region's total pumping.

Groundwater conservation districts are the preferred method for managing groundwater in the State of Texas. There are 15 Underground Water Conservation Districts (GCDs) in Region F. Figure 1.3-4 is a map of the jurisdictional boundaries of the Districts. 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.[12]

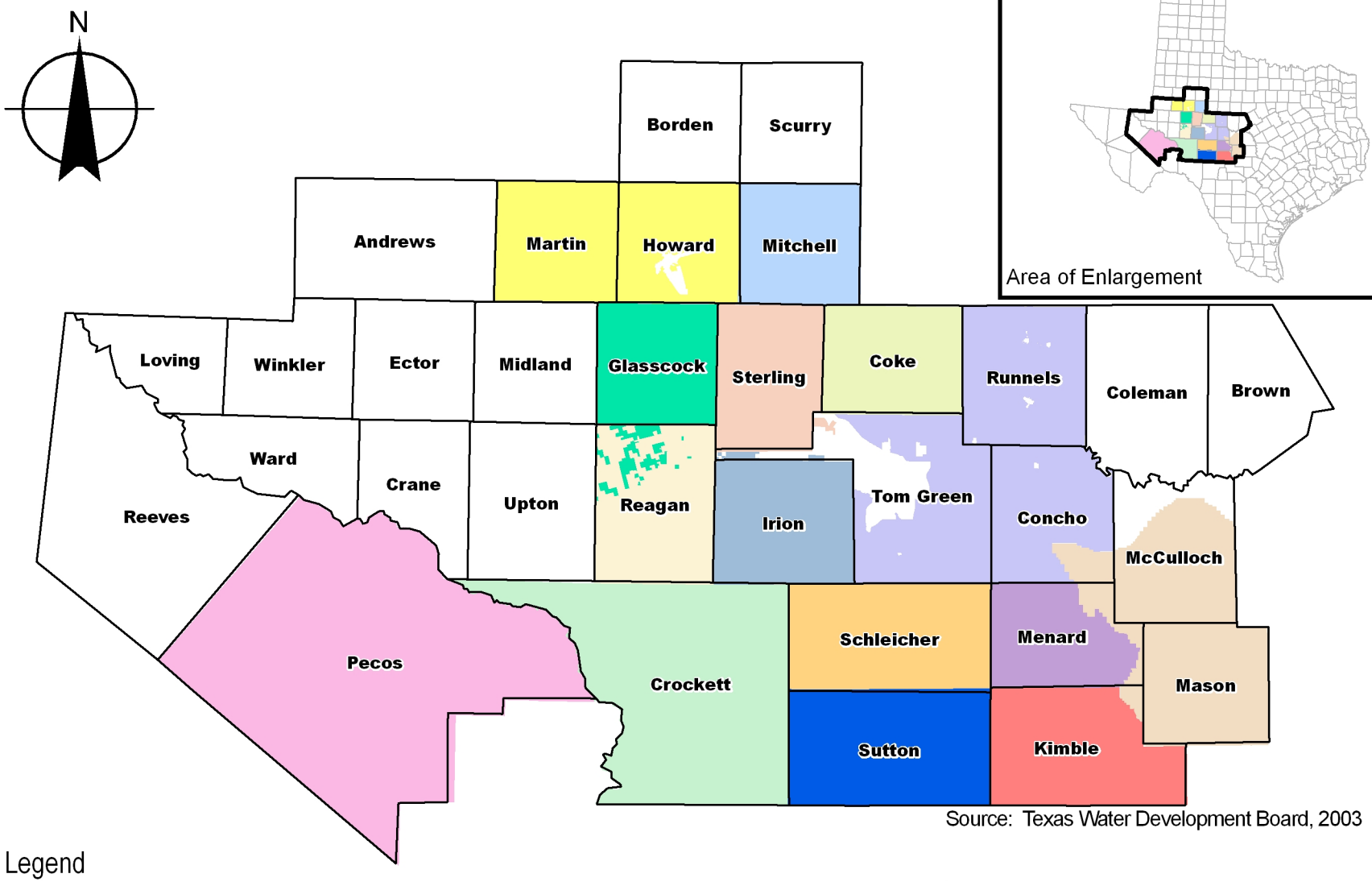
Table 1.3-4
1999 Groundwater Pumping by County and Aquifer
(Values in Acre-Feet)

County	Edwards -Trinity Plateau	Ogallala	Cenozoic Pecos Alluvium	Lipan	Hickory	Dockum	Trinity	Ellen-berger-San Saba	Marble Falls	Edwards -Trinity High Plains	Rustler	Other	*Total*
Andrews	7	17,957	170	0	0	7	0	0	0	0	0	0	*18,141*
Borden	0	2,262	0	0	0	0	0	0	0	4	0	1,021	*3,287*
Brown	0	0	0	0	0	0	3,809	0	0	0	0	69	*3,878*
Coke	26	0	0	0	0	0	0	0	0	0	0	675	*701*
Coleman	0	0	0	0	0	0	29	0	0	0	0	86	*115*
Concho	209	0	0	4,705	523	0	0	0	0	0	0	467	*5,904*
Crane	0	0	2,985	0	0	21	0	0	0	0	52	0	*3,058*
Crockett	3,243	0	0	0	0	0	0	0	0	0	0	0	*3,243*
Ector	10,290	5,687	343	0	0	785	0	0	0	0	0	0	*17,105*
Glasscock	21,342	3,494	0	0	0	0	0	0	0	0	0	0	*24,836*
Howard	819	5,637	0	0	0	125	0	0	0	0	0	0	*6,581*
Irion	569	0	0	0	0	0	0	0	0	0	0	551	*1,120*
Kimble	909	0	0	0	0	0	0	0	0	0	0	0	*909*
Loving	0	0	34	0	0	7	0	0	0	0	0	0	*41*
Martin	0	23,456	0	0	0	0	0	0	0	0	0	0	*23,456*
Mason	0	0	0	0	10,007	0	0	136	130	0	0	0	*10,273*
McCulloch	14	0	0	0	5,254	0	0	301	12	0	0	165	*5,746*
Menard	992	0	0	0	0	0	0	5	0	0	0	30	*1,027*
Midland	18,186	27,394	0	0	0	0	0	0	0	0	0	0	*45,580*
Mitchell	0	0	0	0	0	3,179	0	0	0	0	0	2	*3,181*
Pecos	54,727	0	28,473	0	0	0	0	0	0	0	1,408	5	*84,613*
Reagan	23,184	0	0	0	0	202	0	0	0	0	0	0	*23,386*
Reeves	351	0	95,821	0	0	1,057	0	0	0	0	41	0	*97,270*
Runnels	0	0	0	0	0	0	0	0	0	0	0	1,829	*1,829*
Schleicher	4,301	0	0	0	0	0	0	0	0	0	0	0	*4,301*
Scurry	0	0	0	0	0	6,461	0	0	0	0	0	279	*6,740*
Sterling	937	0	0	0	0	0	0	0	0	0	0	929	*1,866*
Sutton	3,695	0	0	0	0	0	0	0	0	0	0	0	*3,695*
Tom Green	701	0	0	21,076	0	0	0	0	0	0	0	3,698	*25,475*
Upton	10,798	0	0	0	0	16	0	0	0	0	0	0	*10,814*
Ward	0	0	15,197	0	0	204	0	0	0	0	0	0	*15,401*
Winkler	0	0	588	0	0	2,816	0	0	0	0	0	0	*3,404*
Total	*155,300*	*85,887*	*143,611*	*25,781*	*15,784*	*14,880*	*3,838*	*442*	*142*	*4*	*1,501*	*9,806*	*456,976*

Note: Data are from the Texas Water Development Board[9]. Year 2000 Groundwater pumpage was not available.

Freese and Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300

Region F
Underground Water Conservation Districts



Source: Texas Water Development Board, 2003

Legend

UWC Districts

- Sutton County
- Glasscock County
- Sterling
- Santa Rita
- Permian Basin
- Lipan-Kickapoo
- Irion County
- Plateau
- Emerald
- Coke County
- Hickory
- Menard
- Kimble County
- Lone Wolf
- Middle Pecos

10 0 10 20 30 Miles

FN 30610 CMD01311
FILE RegionF_UWCD.mxd
DATE January 13, 2005
SCALE 1:2,421,500
DESIGNED BME
DRAFTED BME

FIGURE 1.3-4

Ten 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. GCDs perform an important role in managing Region F's water supply. 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.

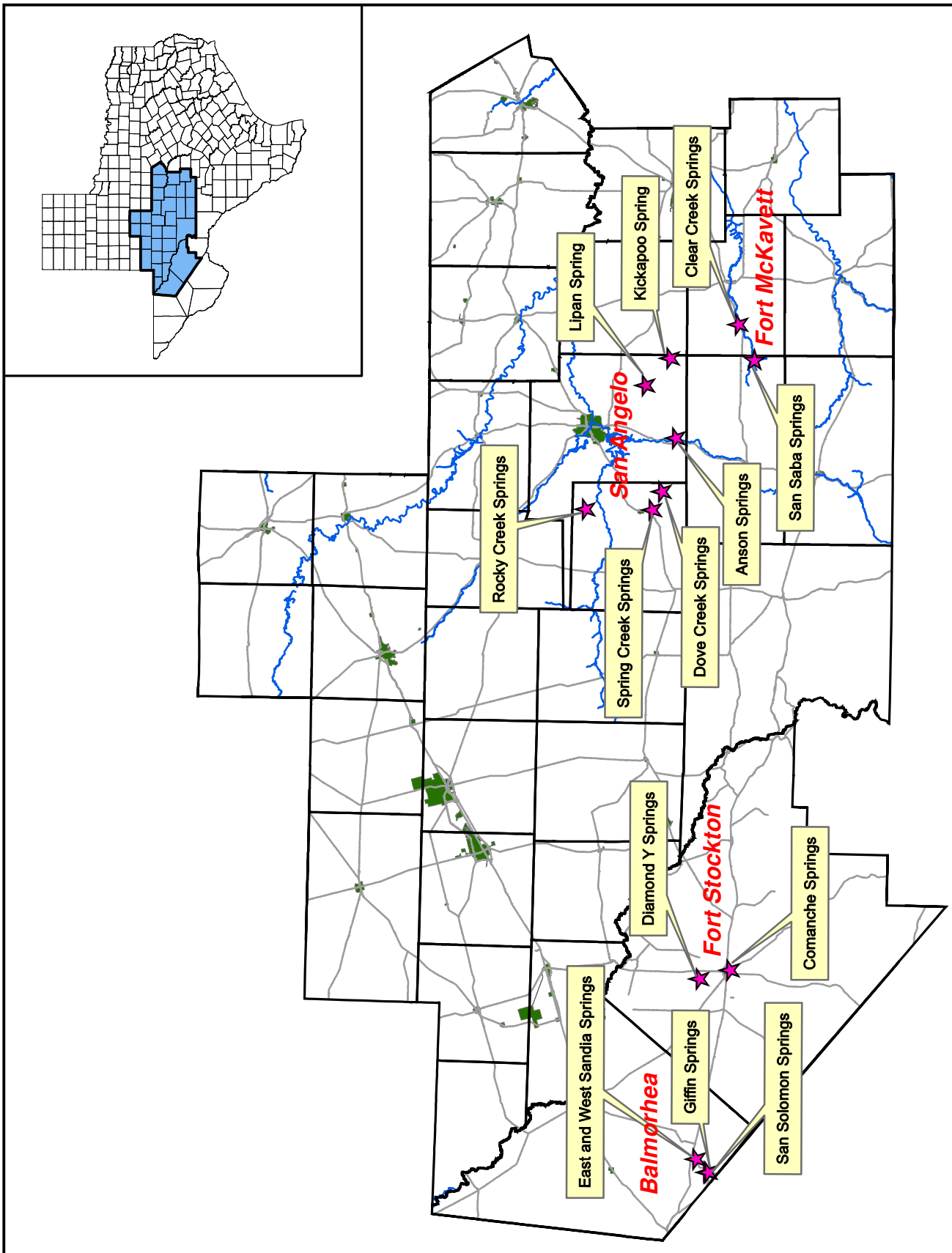
1.3.3 Springs in Region F

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 many springs to disappear over time and have greatly diminished the flow from many of those that remain. Even though springflows are declining throughout the region due to groundwater development, brush infestation, and climatic conditions, many still are important sources of water.

Several rivers in Region F have significant spring-fed flows, including tributary creeks to the Concho and the San Saba Rivers, which are directly or indirectly used for municipal and irrigation purposes in the region.

Many springs are also important to the region for natural resources purposes. The Diamond Y Springs in northern Pecos County and the Balmorhea spring complex in southern Reeves County flow continuously and are important habitat for endangered species. Also in Pecos County, the historically significant Comanche Springs flow occasionally during winter months when there is less stress on the underlying aquifer.

The Region F Planning Group has identified 13 major springs in the region that are important for water supply or natural resources protection (Figure 1.3-5). These major springs include: San Solomon, Giffin, and Sandia Springs in Reeves County; Comanche and Diamond Y Springs in Pecos County; Spring Creek Springs, Dove Creek Springs, and Rocky Creek Springs in Irion County; Anson Springs, Lipan Spring, and Kickapoo Spring in Tom Green County; Clear Creek Spring in Menard County; and San Saba Spring in Schleicher County. For convenience, the following spring descriptions are grouped into related geographic areas. Discussions pertaining to the historical significance of these springs are taken from Gunner Brune[13,14].



LBG-Guyton Associates
1101 S. Capital of Tx. Hwy. B-220
Austin, Texas 78746
Phone - (512) 327 - 9640

N W E S

Region F Water Plan

Identified Major Springs in Region F

FN JOB NO	
FILE	
DATE	July 18, 2005
SCALE	1" = 35 miles
DESIGNED	ACAD
DRAFTED	BJS

1.3-5
FIGURE

Balmorhea Area Springs

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

San Solomon Springs are located in the large swimming pool in Balmorhea State Park and are the largest spring in Reeves County. The spring's importance begins with its recreational use in the pool, then its habitat for endangered species in the ditches leading from the pool[15], 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 cubic feet per second (cfs) and 30 cfs. After strong rains, the springflow often increases rapidly and becomes somewhat turbid. These bursts in springflow are typically short-lived.

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

East and West Sandia Springs are located about one mile east of Balmorhea at an elevation slightly lower than San Salomon and Giffin Springs. Flow from this spring system was

classified as a "stream segment with significant natural resources" in the first regional plan. They are ecologically significant due to the presence of the Pecos Gambusia and the Pecos Sunflower, and the only known naturally occurring populations of the Comanche Springs pupfish[16]. East Sandia Springs are about twice as large as the West Sandia Springs located approximately one mile farther up the valley. Together these two springs were called the Patterson Springs in 1915 by the U.S. Army Corps of Engineers. East and West Sandia Springs flow from alluvial sand and gravel, but the water is probably derived from the underlying Cretaceous Comanchean limestone. Discharge is typically between one and three cfs.

Fort Stockton Area Springs

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

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

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

1.4 Agricultural and Natural Resources in Region F

1.4.1 Endangered or Threatened Species

Table 1-13 is a compilation of federal and state threatened and endangered species found in Region F counties. Table 1-13 also includes species that are designated as rare or "species of concern" by the Texas Parks and Wildlife Department (TPWD). Unless designated as threatened or endangered by either TPWD or the U. S. Fish and Wildlife Service (USFWS), species of concern are not afforded any legal protection.

Section 7 of the Federal Endangered Species Act requires federal agencies to consult with the USFWS to ensure that 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[17].

The Texas Endangered Species Act gives the Texas Parks and Wildlife Department 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

Table 1.4-1
Species of Special Concern in Region F

Species	Fed. Status	State Status	County																																					
			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*
AMPHIBIANS																																								
Cascade Caverns Salamander	ND	T													✓																									
Edwards Plateau Spring Salamanders	ND	ND													✓																									
BIRDS																																								
American Peregrine Falcon	DL	E	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Arctic Peregrine Falcon	DL	T	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Baird's Sparrow	ND	ND	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bald Eagle	LT-PDL	T	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Black-capped Vireo	LE	E			✓	✓	✓	✓		✓				✓	✓			✓	✓	✓			✓	✓		✓	✓			✓	✓										
Common Black Hawk	ND	T																													✓									
Ferruginous Hawk	ND	ND	✓	✓		✓			✓		✓	✓	✓	✓		✓	✓				✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Golden-cheeked Warbler	LE	E			✓		✓								✓			✓		✓																				
Henslow's Sparrow	ND	ND																✓																						
Interior Least Tern	LE	E			✓		✓	✓		✓				✓	✓			✓	✓	✓				✓			✓			✓	✓	✓								
Lesser Prairie Chicken	C1	ND	✓	✓		✓			✓		✓	✓	✓	✓		✓	✓				✓	✓		✓				✓	✓		✓	✓	✓	✓						
Mexican Spotted Owl	LT	T																					✓		✓															
Montezuma Quail	ND	ND							✓														✓		✓															
Mountain Plover	ND	ND	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Northern Aplomado Falcon	LE	E																					✓		✓															
Prairie Falcon	ND	ND																					✓		✓															
Snowy Plover	ND	ND	✓	✓					✓		✓	✓	✓	✓		✓	✓				✓	✓		✓				✓	✓		✓	✓	✓	✓						
Southwestern Willow Flycatcher	LE	E								✓													✓		✓															
Western Burrowing Owl	ND	ND	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Whooping Crane	LE	E	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wood Stork	ND	T						✓																															
Yellow-billed Cuckoo	C1;NL	ND																					✓		✓															
Zone-tailed Hawk	ND	T				✓		✓		✓					✓			✓		✓			✓	✓	✓	✓	✓			✓	✓									

Table 1.4-1 (Cont.)
Species of Special Concern in Region F

Species	Fed. Status	State Status	County																																					
			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*
CRUSTACEANS																																								
Clear Creek Amphipod	ND	ND																		✓																					
Pecos Amphipod	ND	ND																					✓																	
FISHES																																								
Chihuahua Catfish	ND	ND																					✓		✓															
Clear Creek Gambusia	LE	E																		✓																				
Comanche Springs Pupfish	LE	E																					✓		✓															
Guadalupe Bass	ND	ND			✓	✓	✓	✓						✓	✓			✓	✓	✓						✓	✓					✓								
Headwater Catfish	ND	ND						✓		✓										✓																				
Leon Springs Pupfish	LE	E																					✓																	
Pecos Gambusia	LE	E																					✓		✓															
Pecos Pupfish	ND	T							✓	✓						✓							✓		✓									✓						
Prosperpine Shiner	ND	T								✓																														
Rio Grande Darter	ND	T								✓																														
Rio Grande Shiner	ND	ND								✓																														
Sharpnose Shiner	C1	ND			✓		✓																																	
INSECTS																																								
Balmorhea Damselfly	ND	ND																							✓															
Balmorhea Saddle-case Caddis fly	ND	ND																							✓															
Leon River Winter Stonefly	C1	ND					✓																																	
MAMMALS																																								
Big Free-tailed Bat	ND	ND								✓					✓								✓		✓															
Black Bear	T/SA; NL	T							✓	✓					✓	✓		✓		✓			✓	✓	✓		✓			✓		✓	✓							
Black-footed Ferret	LE	E	✓	✓					✓	✓	✓	✓	✓			✓	✓				✓	✓	✓	✓	✓			✓	✓			✓	✓	✓						
Black-tailed Prairie Dog	ND	ND	✓	✓		✓			✓	✓	✓	✓	✓	✓		✓	✓				✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓					
Cave Myotis Bat	ND	ND	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓					
Davis Mountains Cottontail	ND	ND																					✓		✓														
Fringed Myotis Bat	ND	ND																					✓		✓														
Ghost-faced Bat	ND	ND								✓					✓								✓																
Gray Wolf	LE	E			✓		✓		✓	✓				✓	✓	✓		✓	✓	✓			✓	✓	✓	✓					✓	✓	✓	✓					
Jones' Pocket Gopher	ND	ND	✓					✓	✓		✓					✓	✓				✓													✓	✓					

Table 1.4-1 (Cont.)
Species of Special Concern in Region F

Species	Fed. Status	State Status	County																																					
			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*
Limpia Creek Pocket Gopher	ND	ND																					✓																		
Limpia Southern Pocket Gopher	ND	ND																					✓																		
Llano Pocket Gopher	ND	ND													✓			✓	✓	✓																					
Pale Townsend's Big-eared Bat	ND	ND								✓					✓								✓		✓																
Pecos River Muskrat	ND	ND								✓													✓		✓																
Plains Spotted Skunk	ND	ND			✓		✓											✓	✓																					
Red Wolf	LE	E			✓		✓								✓			✓	✓	✓			✓		✓		✓													
Swift Fox	ND	ND	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓			✓	✓	✓	✓	✓				✓	✓		✓	✓	✓	✓	✓				
White-nosed Coati	ND	T																					✓																
Yuma Myotis Bat	ND	ND								✓													✓		✓															
MOLLUSKS																																								
Diamond Y Spring Snail	C1	ND																					✓																
Gonzalez Spring Snail	C1	ND																					✓																
Pecos Assiminea Snail	PE	ND																					✓		✓														
Phantom Cave Snail	C1	ND																							✓														
Phantom Cave Spring Tryonia	C1	ND																							✓														
Stockton Plateau Threeband	ND	ND																					✓																
Texas Hornshell	C1	ND																														✓		✓					
REPTILES																																								
Big Bend Blackhead Slider	ND	ND																					✓		✓														
Chihuahuan Desert Lyre Snake	ND	T																					✓		✓														
Chihuahuan Mud Turtle	ND	T								✓													✓		✓														
Concho Water Snake	LT	ND			✓	✓	✓	✓						✓					✓							✓						✓								
Dunes Sagebrush Lizard	C1	ND	✓						✓	✓						✓																		✓	✓					
Reticulated Gecko	ND	T																					✓		✓														
Spot-tailed Earless Lizard	ND	ND	✓			✓		✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓			
Texas Garter Snake	ND	ND			✓		✓	✓										✓	✓	✓		✓																	
Texas Horned Lizard	ND	T	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Texas Tortoise	ND	T							✓														✓		✓														
Trans-Pecos Blackheaded Snake	ND	T							✓														✓		✓														
VASCULAR PLANTS																																								
Alkali Spurge	ND	ND																					✓																
Basin bellflower	ND	ND																✓																					

Table 1.4-1 (Cont.)
Species of Special Concern in Region F

Species	Fed. Status	State Status	County																																					
			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*
Broadpod Rushpea	ND	ND								✓																					✓										
Bushy Wild-Buckwheat	ND	ND																					✓																		
Correll's Green Pitaya	ND	ND				✓																	✓																		
Desert Night-blooming Cereus	ND	ND																					✓		✓																
Dune Umbrella-sedge	ND	ND																																✓	✓						
Dwarf Broomspurge	ND	ND																				✓	✓																		
Enquist's sandmint	ND	ND																✓																						
Granite Spiderwort	ND	ND																✓																						
Grayleaf Rock-daisy	ND	ND																					✓		✓																
Gyp Locoweed	ND	ND																							✓																
Hester's Cory Cactus	ND	ND																					✓																		
Hill Country Wild-Mercury	ND	ND			✓										✓					✓												✓								
Irion Country Wild-buckwheat	ND	ND				✓							✓	✓									✓	✓		✓			✓												
Leoncita false foxglove	ND	ND																					✓																		
Longstock heimia	ND	ND																					✓																		
Mexican mud-plantain	ND	ND																						✓																	
Neglected Sunflower	ND	ND									✓					✓																			✓	✓						
Pecos Sunflower	LT	T																					✓		✓																
Rock Quillwort	ND	ND																✓																							
Texas Poppy-mallow	LE	E				✓																✓				✓														
Tharp's Blue-star	ND	ND																					✓																		
Tobusch Fishhook Cactus	LE	E													✓																										
Two-Bristle Rock-daisy	ND	ND																					✓																		
White Column Cactus	ND	ND																					✓																		
Wright's Trumpets	ND	ND																					✓		✓																
Wright's Water-willow	ND	ND																					✓																		

Status Key:
LE, LT – Federally Listed Endangered/Threatened
PE, PT – Federally Proposed Endangered/Threatened
E/SA, T/SA – Federally Listed Endangered/Threatened by Similarity of Appearance
C1 – Federal Candidate for Listing, Category 1; information supports proposing to list as endangered/threatened
DL, PDL – Federally Delisted/Proposed for Delisting
E, T – State Listed Endangered/Threatened
ND – Rare, but with no regulatory listing status

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.

1.4.2 Agriculture and Prime Farmland

Agriculture plays a significant role the economy of Region F. Table 1.4-2 provides basic data regarding agricultural production in Region F[18]. Region F includes approximately 21,800,000 acres in farms and over 2,800,000 acres of cropland. The market value of agriculture products (crops and livestock), for 2002 for Region F was over $478,000,000, with livestock accounting for about 66 percent and crops accounting for the remaining 34 percent of the total.

Figure 1.4-1 shows the distribution of prime farmland in Region F[19]. 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 1.4-1 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 Runnels, Glasscock, Upton, Tom Green, Scurry, and Reagan Counties. These six counties accounted for about 17 percent of the total land in farms and 39 percent of the total crop value for Region F in 2002.

It is interesting to note that major agricultural production also occurs in some counties with a relatively small amount of prime farmland. For example, Andrews, Martin, Pecos, and Reeves Counties have 10 percent or less acreage identified as prime farmland. However, these four

Table 1.4-2
2002 U.S. Department of Agriculture County Census Data for Region F

Category	Andrews	Borden	Brown	Coke	Coleman	Concho	Crane	Crockett
Farms	169	132	1,347	335	829	411	44	198
Land in Farms (acres)								
- Crop Land	102,488	71,426	131,375	58,729	187,982	142,138	710	1,499
- Pasture Land	654,010	407,875	295,477	416,433	411,024	392,547	(D)	1,724,426
- Other	47,500	714	55,084	10,235	43,257	9,627	(D)	9,551
- Total	803,998	480,015	481,936	485,397	642,263	544,312	(D)	1,735,476
Market Value ($1,000)								
- Crops	$2,240	$3,876	$3,478	$576	$3,432	$6,865	$3	(D)
- Livestock	$6,432	$3,961	$22,251	$12,168	$12,305	$7,444	$1,299	(D)
- Total	$8,672	$7,837	$25,729	$12,744	$15,737	$14,309	$1,302	$10,238

Category	Ector	Glasscock	Howard	Irion	Kimble	Loving	Martin	Mason
Farms	287	199	466	151	528	14	379	633
Land in Farms (acres)								
- Crop Land	4,062	169,845	248,202	10,321	31,180	909	280,977	67,411
- Pasture Land	492,345	317,487	258,722	522,408	535,440	514,207	210,461	445,189
- Other	7,374	5,607	11,445	3,563	48,881	76	34,569	42,997
- Total	503,781	492,939	518,369	536,292	615,501	515,192	526,007	555,597
Market Value ($1,000)								
Crops	$279	$11,412	$11,762	$116	$655	$0	$12,902	$2,367
Livestock	$1,594	$2,225	$3,344	$3,372	$6,702	$523	$1,172	$42,431
Total	$1,873	$13,637	$15,106	$3,488	$7,357	$523	$14,074	$44,798

Table 1.4-2 (Cont'd)
2002 U.S. Department of Agriculture County Census Data for Region F

Category	McCulloch	Menard	Midland	Mitchell	Pecos	Reagan	Reeves	Runnels
Farms	621	336	477	451	270	123	166	897
Land in Farms (acres)								
- Crop Land	144,750	24,771	72,892	171,053	110,235	67,347	89,336	299,223
- Pasture Land	384,025	506,798	279,851	304,714	2,801,801	(D)	915,900	264,813
- Other	17,518	17,269	8,815	12,155	4,034	(D)	4,641	20,842
- Total	546,293	548,838	361,558	487,922	2,916,070	538,285	1,009,877	584,878
Market Value ($1,000)								
Crops	$2,918	$777	$3,994	$7,062	$23,633	$4,398	$7,330	$14,811
Livestock	$10,047	$6,648	$3,407	$5,283	$14,585	$2,170	$11,233	$12,583
Total	$12,965	$7,425	$7,401	$12,345	$38,218	$6,568	$18,563	$27,394

Category	Schleicher	Scurry	Sterling	Sutton	Tom Green	Upton	Ward	Winkler	Total
Farms	307	674	66	191	1,024	83	86	44	11,938
Land in Farms (acres)									
- Crop Land	41,195	240,153	11,227	9,015	212,464	36,282	10,180	1,057	3,050,434
- Pasture Land	725,763	316,818	616,181	868,553	613,446	682,284	445,918	(D)	17,324,916
- Other	11,314	7,842	5,599	2,221	18,785	4,880	9,541	(D)	475,936
- Total	778,272	564,813	633,007	879,789	844,695	723,446	465,639	491,718	21,812,175
Market Value ($1,000)									
Crops	$908	$9,100	$58	$239	$18,851	$2,783	(D)	(D)	$156,825
Livestock	$8,309	$13,926	$5,730	$6,178	$78,372	$2,030	(D)	(D)	$307,724
Total	$9,217	$23,026	$5,788	$6,417	$97,223	$4,813	$1,681	$1,926	$478,394

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). Data are from the U.S. Department of Agriculture (USDA, 2002).

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Fort Worth, TX 76109 - 4895
Phone - (817) 735 - 7300

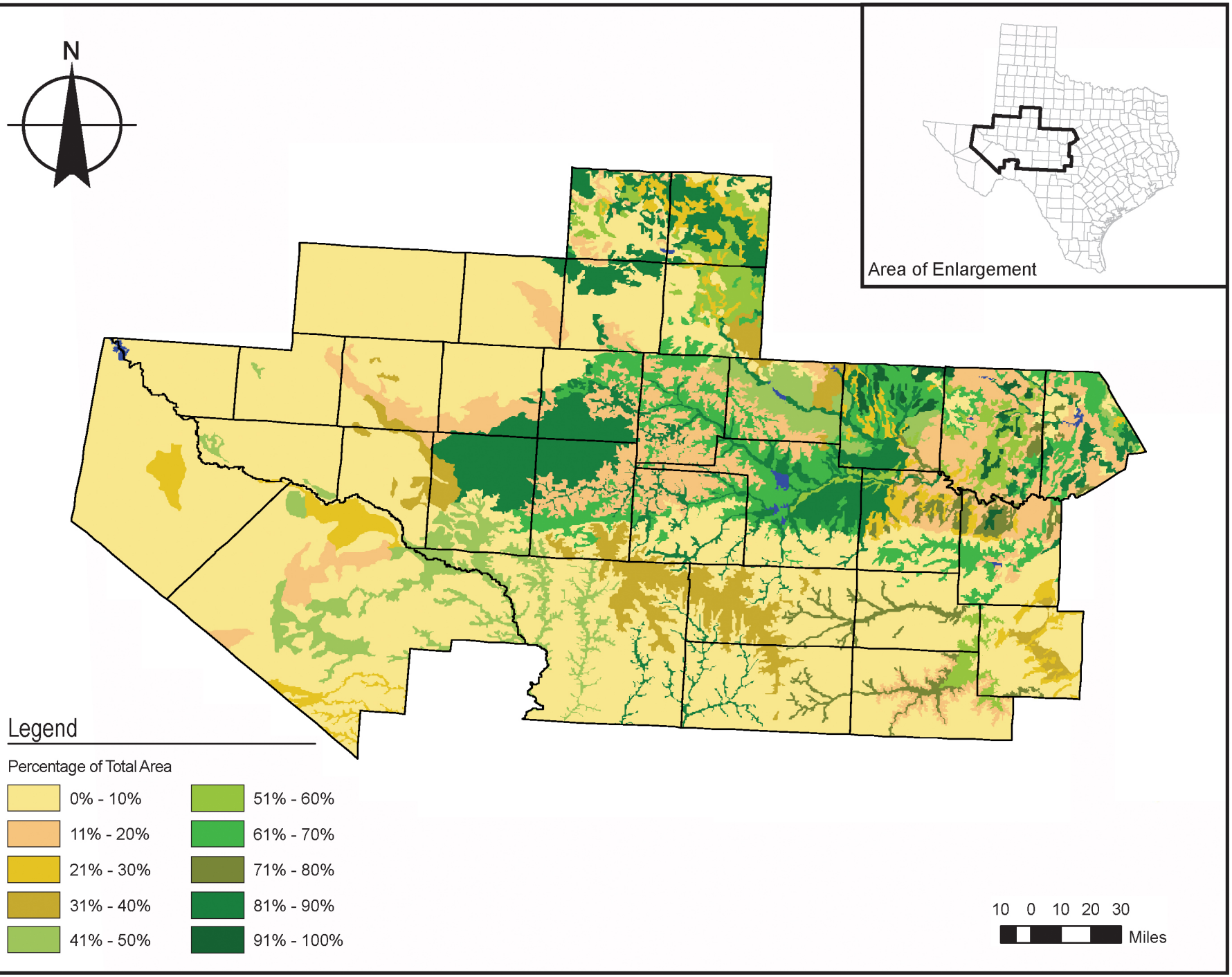
N
W E
S

Region F

Prime Farmland
Percentage of Total Area

FN JOB NO CMD01311
FILE RegionF_Farm.mxd
DATE January 17, 2005
SCALE 1:2,795,000
DESIGNED BME
DRAFTED BME

FIGURE 1.4-1



Prime farmland 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.

counties combined accounted for approximately 24 percent of the total land in farms and 29 percent of the crop value for the region in 2002.

Shrimp farming is a relatively new business in West Texas. Presently, 150 acres of ponds are located in Pecos and Ward Counties with plans to expand at a rate of 12 to 15 percent per year. Estimated water usage is 3,300 acre-feet per year of salt water from the Cenozoic Pecos Alluvium. Because the water used in this industry has a TDS range of 3,000 to 20,000 parts per million, it is not in direct competition with most other uses.

1.4.3 Mineral Resources

Oil and natural gas fields are significant natural resources throughout Region F. Eleven of the top-producing oil fields and seven of the top-producing gas fields are located in Region F[20]. Other significant mineral resources in Region F include lignite resources in Brown and Coleman Counties, and stone, sand and gravel in various parts of the region.

1.5 Water Providers in Region F

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

1.5.1 Wholesale Water Providers

The TWDB defined the term wholesale water provider (WWP) as "any person or entity, including river authorities and irrigation districts, that has contracts to sell more than 1,000 acre-feet of water wholesale in any one year during the five years immediately preceding the adoption of the last Regional Water Plan. The Planning Groups shall include as wholesale water providers other persons and entities that enter or that the Planning Group expects to enter contracts to sell more than 1,000 acre-feet of water wholesale during the period covered by the plan."[21] Region F has identified seven entities that qualify as wholesale water providers:

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

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

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

Colorado River Municipal Water District (CRMWD). CRMWD is the largest water supplier in Region F. CRMWD member cities include Big Spring, Odessa and Snyder. CRMWD also supplies water to Midland, San Angelo and Abilene, as well as several smaller cities in Ward, Martin, Howard and Coke Counties. CRMWD owns and operates Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir, as well as several chloride control reservoirs. The district's water supply system also includes well fields in Ward, Scurry, Ector and Martin Counties. Table 1.5-1 is a list of fiscal year 2003 sales by the CRMWD, which totaled 72,896 acre-feet.

Brown County Water Improvement District Number One (BCWID). The 2000 sales by the BCWID totaled 13,274 acre-feet and are listed in Table 1.5-2. BCWID supplies raw water and treated water from Lake Brownwood to the Cities of Brownwood, Early, Bangs and Santa Anna, and rural areas of Brown and Coleman Counties, as well as irrigation water in Brown County.

Upper Colorado River Authority (UCRA). The UCRA is the owner of water rights in O.C. Fisher Reservoir in Tom Green County and Mountain Creek Lake in Coke County. O.C. Fisher supplies are used by the Cities of San Angelo and Miles. The City of Robert Lee uses water from Mountain Creek Lake. Table 1.5-3 is a list of year 2000 diversions from UCRA sources, which totaled 2,254 acre-feet.

Table 1.5-1
Fiscal Year 2003 Sales by the Colorado River Municipal Water District
(Values in Acre-Feet per Year)

Customer	Total Water Sales
Odessa	21,381
Big Spring	6,317
Snyder	2,416
Midland	24,150
Stanton	184
San Angelo	14,004
Robert Lee	63
Grandfalls	150
Pyote/West Tx State School	201
Ballinger	51
West Central Texas MWD	191
Non-Municipal Customers	3,788
Total	*72,896*

Data are from the Colorado River Municipal Water District[22]

Table 1.5-2
2000 Sales by the Brown County Water Improvement District Number One
(Values in Acre-Feet)

Customer	2000 Treated Water Sales	2000 Raw Water Sales
Bangs	326 [a]	-
Early	-	1,176 [b]
Brownwood	4,324 [a]	-
Brooksmith WSC	924 [a]	
Santa Anna	-	37 [b]
Thunderbird Bay	-	
Other	-	1,766 [a]
Irrigation	-	4,721 [a]
Total	*5,574*	*7,700*

a Data are from the Brown County Water Improvement District No. 1[23]
b Data are from the Texas Water Development Board

Table 1.5-3
2000 Diversions from Upper Colorado River Authority Sources
(Values in Acre-Feet per Year)

Customer	2000 Diversions
San Angelo	2,201
Miles*	-
Robert Lee	53
Total	*2,254*

Data are from the Texas Commission on Environmental Quality. [24]
* UCRA did not begin providing water to Miles until 2004.

Great Plains Water System, Inc. The Great Plains Water System was initially developed to provide water to oil field operations in the Permian Basin. The System's source of water is the Ogallala aquifer in Andrews County in Region F and Gaines County in Region O. The System's largest customer is the recently established steam electric operation in Ector County. The 2010 projected demand for this steam electric operation in Ector County is 6,375 acre-feet, increasing to 17,637 acre-feet by 2060. The System also provides water to the City of Goldsmith (53 acre-feet in 2000) and the Notrees Water Company (2 acre-feet in 2001).

City of Odessa. The City of Odessa is a CRMWD member city. The City of Odessa sells treated water to the Ector County Utility District and the Odessa County Club. In the year 2000, Odessa purchased 24,768 acre-feet from CRMWD. In that same year, Odessa sold 1,098 acre-feet to Ector County Utility District and 405 acre-feet to the Odessa County Club.

City of San Angelo. The City of San Angelo's sources of supply are Lake O.C. Fisher (purchased from Upper Colorado River Authority), Twin Buttes Reservoir, Lake Nasworthy, local surface water rights, O.H. Ivie Reservoir (purchased from CRMWD), and E.V. Spence Reservoir (purchased from CRMWD). San Angelo supplies water to the power plant located on Lake Nasworthy as well as to Millersview-Doole WSC. San Angelo also treats and delivers O.C. Fisher water to the City of Miles.

University Lands. University Lands manages property owned by the University of Texas System in West Texas. Although University Lands does not actively provide water, several major water well fields are located on property leased by University Lands, including fields operated by CRMWD, the City of Midland and the City of Andrews.

1.5.2 Retail Water Sales

Cities and towns provide most of the retail water service in Region F, and some cities also serve as retail water providers to connections outside of their city limits or as wholesale water suppliers by selling treated water to other water suppliers. Table 1.5-4 lists the cities in Region F that had significant outside sales in 2000.

Table 1.5-4
Water Supplied by Selected Cities in Region F

Supplier	County	Year 2000 Sales in Acre-Feet		
		Municipal Sales within City	Outside Sales	Total
Odessa	Ector	21,189	3,579	24,768
San Angelo	Tom Green	16,048	1,861	17,909
Big Spring	Howard	5,596	645	6,241
Brownwood	Brown	3,604	2,574	6,178
Snyder	Scurry	2,343	484	2,827
Fort Stockton	Pecos	3,102	415	3,517
Pecos	Reeves	2,575	315	2,890
Andrews	Andrews	2,876	365	3,141
Coleman	Coleman	1,017	658	1,675
Sonora	Sutton	1,104	129	1,233
Colorado City	Mitchell	1,012	83	1,095
Crane	Crane	886	294	1,180
Ballinger	Runnels	713	270	983
Early	Brown	774	379	1,153
Winters	Runnels	329	78	407
Balmorhea	Reeves	96	324	420

Data are from the TWDB [9]

1.6 Existing Plans for Water Supply Development

Prior to SB1 regional water plans and water availability models, the most comprehensive study of water availability in the basin was published in 1978 by the Texas Department of Water Resources (TDWR). This study, titled *Present and Future Water Availability in the Colorado River Basin, Texas, Report LP-60,* was a detailed analysis of water availability and needs for the years 1980 and 2030[25]. According to this report, in 1980 there would be sufficient supplies in

the basin to meet demands. By 2030, there would only be minor shortages in the upper basin provided that Ivie Reservoir was constructed. In the same period the middle and lower basins could experience significant shortages. The report recommended the construction of new reservoirs to meet needs in the lower basin.

In 2002, the Texas Water Development Board released the State Water Plan, *Water for Texas – 2002*, which was a compilation of the 16 regional water plans developed under SB1[26]. The Region F Water Planning Group published the *Region F Regional Water Plan* in January 2001. Some of the findings of the 2001 Region F plan included:

- Approximately 40 water user groups had projected water shortages over the planning period (through 2050). Water management strategies were developed to address these needs.
- Ten counties had a collective irrigation need of over 200,000 acre-feet per year. No water supply is readily available to meet this need. Advanced water conservation irrigation technologies were recommended to reduce the irrigation demands. This strategy would significantly reduce the demands and eliminate projected shortages in several counties. However, some counties in Region F still had significant irrigation water needs.
- Major municipal needs occur with water user groups that rely on the Hickory aquifer. Needs are the result of water quality standards for radionuclides imposed by USEPA and TCEQ. Four water management strategies were developed for the users of Hickory aquifer:
    - Brady Creek Reservoir water treatment plant
    - Lake Ivie water treatment plant
    - New Ellenberger well field
    - New Hickory well field (in area with low radionuclides)
- General water management strategies recommended in the plan included: water conservation and drought response, brush control, weather modification, wastewater reuse, recharge enhancement, and desalination and chloride control.

The City of San Angelo completed their *Long-Range Water Supply Plan* in November of 2000[27]. Major recommendations from the plan include:

- *Improve delivery system from Fisher, Ivie and Spence.* At that time, the City was unable to receive water from both Lake Spence and Lake Ivie concurrently and was limited to a maximum delivery capacity of 18 mgd. The proposed improvements included a parallel pipeline and a new pump station, increasing the delivery capacity to 50 mgd. The new pipeline has been constructed.

- *Increase water treatment capacity*. The City's water treatment plant should have adequate capacity through about 2031. Expansion may be delayed by using water from the McCulloch County Well Field even during times when the local reservoirs are full (Groundwater from McCulloch County does not require the level of treatment as surface water supplies).
- *Pursue trade of treated effluent for irrigation supplies.* The City can gain additional supply and reduce pumping costs by trading irrigation supply from Twin Buttes and Nasworthy for treated effluent from the City's wastewater plant. Effluent is available even during droughts and increases over time as municipal demands increase. To implement this option, additional wastewater storage ponds will be needed. Construction is recommended in the years 2002, 2015 and 2032 at a cost of $7 million per pond or expansion.
- *Add the McCulloch County well field to the system.* Two options were considered to bring McCulloch County water to the City:
    - Constructing a pipeline directly from the well field to San Angelo or
    - Constructing a pipeline to Ivie Reservoir and using CRMWD facilities to transport the water the remaining distance (San Angelo already has such a right by its contract with CRMWD to do so under specific circumstances).

Although the capital costs of the Ivie option are much lower, the direct option was recommended because:

- The operational savings of the direct pipeline offset most of the increased capital costs, and
- The Ivie option impacts other users of the CRMWD system by adding radionuclides to the Ivie pipeline.

The City of San Angelo is currently studying several water supply options, including desalination of brackish groundwater, reuse, alternative sources of groundwater and other options. Identified goals for the city include:

- Development of groundwater resources in the Edwards-Trinity south of San Angelo,
- Acquisition of additional surface water rights in the Concho watershed, and
- Continuation brush control efforts on O.C. Fisher Reservoir and Twin Buttes Reservoir.

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). Additional requirements effective May 1, 2005 state that 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.

Many entities around the state have already developed conservation plans and/or drought contingency plans. These plans have improved the awareness of the need for water conservation in Texas. In its projections of water use for SB1 Second Round, the Texas Water Development Board has assumed reductions in per capita municipal use due to the implementation of the plumbing code requiring the use of low flow plumbing fixtures in all new development and renovation.

Many cities in Region F have compiled water conservation plans to ensure that they will be able to meet the future water demands of their constituents. 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. As part of SB1 Second Round, model water conservation plans have been developed and are included in Appendix 6A. These models can serve as templates for entities to develop or update their water conservation plan.

1.6.2 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[28].

The Texas Water Code requires that wholesale and retail public water suppliers and irrigation districts develop drought contingency plans (Texas Water Code § 11.1272). These plans must

also be consistent with the appropriate approved regional water plan(s). In addition, all drought contingency plans must include specific, quantified targets for water use reductions to be achieved during periods of water shortages and drought.

Most of the conservation plans that have been developed in response to state requirements also include a drought contingency plan. The purpose of the drought contingency plan is to address circumstances that could affect a water supplier's ability to supply water to the customer due to transmission line failures, water treatment plant failures, prolonged emergency demand, or acts of God. The drought contingency plans for each area have established trigger conditions that indicate when to take demand management measures. These trigger conditions range from mild to emergency. As part of SB1 Second Round, model drought contingency plans have been developed and are included in Appendix 6B. These models can serve as templates for entities to develop or update their drought contingency plan.

1.6.3 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, the Texas Brush Control Plan, and precipitation enhancement programs.

Texas Commission on Environmental Quality (TCEQ) Water Rights Permitting. Water in Texas is a public resource, and the TCEQ is empowered to grant water rights that allow beneficial use of that resource. Any major new surface water supply source will require a water right permit. In recent years, TCEQ has increased its scrutiny of the environmental impacts of water supply projects, and permitting has become more difficult and complex. Among its many other provisions, SB1 set out formal criteria for the permitting of interbasin transfers for water supply.

Clean Rivers Program. The Texas Clean Rivers Program (CRP) is a state-fee funded water quality monitoring, assessment, and public outreach program. The CRP is a collaboration of 15 partner agencies and the TCEQ. The CRP provides the opportunity to approach water quality issues within a watershed or river basin at the local and regional level through coordinated

efforts among diverse organizations. In Region F, the program is carried out by the Lower Colorado River Authority, with assistance from CRMWD and UCRA, in the Colorado Basin, and by the International Boundary and Water Commission in the Rio Grande Basin[29].

Clean Water Act. The Clean Water Act is a federal law designed to protect water quality. The Act does not deal directly with groundwater nor with water quantity issues. The statute employs a variety of regulatory and non-regulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water." [30]

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. In Texas, the state has recently taken over the NPDES permitting system, which sets the operating requirements for wastewater treatment plants. The Section 404 permitting process is handled by the Corps of Engineers and is an important step in the development of a new reservoir.

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, and the TCEQ is currently analyzing the Colorado River below E.V. Spence Reservoir (Segment 1426) for chloride, sulfate, and TDS concentrations. Additional information may be found in Section 1.7.

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 dinking 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[31]. 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.

Texas Brush Control Plan. The Texas Brush Control Plan was developed pursuant to Chapter 203 of the Texas Agricultural Code. There are seven Brush Control Projects currently underway in Region F, including the North Concho River Pilot Brush Control Project, Twin Buttes Reservoir/Lake Nasworthy Brush Control Projects, Lake Ballinger Brush Control Project, Mountain Creek Reservoir Brush Control Project, Oak Creek Reservoir Brush Control Project, Pecos River/Upper Colorado River Salt Cedar Project, and Champion Creek Reservoir Brush Control Project. These projects are discussed further in Chapter 4. In these programs, cost share funds are administered at the local level by soil and water conservation districts based on allocations made by the State Board. Acreages of land are treated to eliminate the amount of water being used by brush.

Precipitation Enhancement Programs. In Region F, there are several ongoing weather modification programs, including the Colorado River Municipal Water District (CRMWD) rain enhancement project, the West Texas Weather Modification Association (WTWMA) project, and the Trans Pecos Weather Modification Association (TPWMA) program. Another weather modification program, conducted by the West Central Texas Weather Modification Association (WCTWMA), was started in 2001, but due to budgetary issues, stopped cloud seeding after the 2003 season. 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 4.

Partial funding for weather modification programs was provided by the Texas Department of Licensing and Regulation, and its predecessor agencies for many years. This funding ended in October, 2004.

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

1.7.1 Threats to Water Supply

Threats to water supply in Region F include:

- Use of the TCEQ Water Availability Model (WAM) Run 3 for regional water planning;
- Water quality concerns in several areas of the region; and
- The impact of on-going drought.

Water quality problems identified by the TWDB, TCEQ, TPWD, EPA and others (River Authorities, etc.) within Region F are summarized in Table 1-19.

Use of TCEQ WAM Run 3 for Regional Water Planning

The TWDB requires the use of the TCEQ Water Availability Models (WAM) Run 3 as the definition of water availability for regional water planning[21]. WAM Run 3 has the following major assumptions:

- Full use of permitted diversion and storage
- 100 percent reuse of return flows (except return flows specified within the water right permit)
- Allocation of water according to priority date regardless of geographic location or type of use

The Colorado WAM Run 3 has significantly different results than previous assessments of water availability in the basin. Previous studies by the State of Texas and others showed sufficient reliable supplies from reservoirs in Region F to meet current and projected demands, including the 1978 Report LP-60[25], the 1990 state water plan[32], the 1997 state water plan[33], and the 2002 state water plan[26]. Recent experience of critical drought conditions in the upper basin show that supplies are available from the region's reservoirs under drought-of-record conditions. However, because of its assumptions the Colorado WAM indicates that almost all of the major reservoirs in Region F have little or no reliable supply. This result is contrary to previous water plans and recent historical experience.

Table 1.7-1
Summary of Identified Surface Water Quality Problems in Region F

Segment ID	Segment Name	Concern Location	Water Quality Concern	Status
1416A	Brady Creek (unclassified water body)	From FM 714 upstream to Brady Lake dam	depressed dissolved oxygen	Additional information needed before a TMDL is scheduled
1420	Pecan Bayou Above Lake Brownwood	Lower 25 miles	depressed dissolved oxygen	Additional information needed before a TMDL is scheduled
1420	Concho River	Loop 306 to end of segment, including both North and South forks	impaired macrobenthos community	Additional information needed before a TMDL is scheduled
1425	O. C. Fisher Lake	Entire reservoir	chloride	Additional information needed before a TMDL is scheduled
			total dissolved solids	Additional information needed before a TMDL is scheduled
1426	Colorado River Below E. V. Spence Reservoir	Coke County line to SH 208	chloride	TMDL underway
			total dissolved solids	TMDL underway
		Country Club Lake to Coke County line	chloride	TMDL underway
			total dissolved solids	TMDL underway
		Lower end of segment to Country Club Lake	chloride	TMDL underway
			total dissolved solids	TMDL underway
		SH 208 to dam	chloride	TMDL underway
			total dissolved solids	TMDL underway

Data from 2004 Draft 303(d) list (May 13, 2005) [34]

The WAM was developed by TCEQ to process new water rights and amendments to existing water rights. The WAM operates in a theoretical legal space that is different from the way that the Colorado Basin has historically been operated. The WAM does not include return flows, which can be a significant source of water in many areas. Many run-of-the-river irrigation rights depend on these return flows for reliable supplies. Until such time as return flows are claimed for reuse, water rights holders can legally make use of these return flows. The WAM also assumes that storage in a reservoir has the same weight as diversion. A downstream reservoir with a senior priority date can appropriate all of the available water just to fill storage, often leaving upstream junior water rights with no available water for use.

WAMs are a new tool available to state agencies for planning, permitting and making policy decisions. Care must be used when using these models without modifications to set state water policies for existing and future water users. In some cases, modifications to the assumptions used in TCEQ WAM Run 3 would make these models more appropriate for other purposes. As presently used, the WAM adversely impacts water availability in Region F.

The development of water supplies in the Colorado Basin has a long history of conflict and resolution over the impact upstream development may have on downstream water rights. Requiring the use of the WAM for planning purposes without modification has reopened these issues and thus poses a policy threat to existing water rights in Region F. It also forces an overestimation of water needs within Region F, and a corresponding underestimation of the future water needs downstream in Region K.

Rio Grande Basin Water Quality

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

Colorado River Basin Water Quality

The high levels of chlorides, sulfates and TDS present in the Upper Colorado River above O.H. Ivie Reservoir (including E.V. Spence Reservoir) are thought to originate from geologic formations and oil and gas production[35]. 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. As a result of the TMDL study, a Watershed Action Plan was developed which provides a comprehensive strategy for restoring and maintaining water quality in the area. Continued monitoring of the area should show improving water quality as the Action Plan is implemented.

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

The high nitrate levels present in the Concho River east of San Angelo and the groundwater water in Runnels, Concho and Tom Green Counties appear to be from a combination of natural conditions, general agricultural activities (particularly as related to wide spread and intense crop production), and locally from confined animal feeding operations and/or industrial activities. Surface waters in the Concho River near Paint Rock have consistently demonstrated nitrate levels above drinking water limits during winter months. This condition has caused compliance problems for the city of Paint Rock, which uses water from the Concho River. It has been determined through studies funded by the Texas Clean Rivers Program that the elevated nitrates in the Concho River result from dewatering of the Lipan aquifer through springs and seeps to the river[36].

The North Fork of the Concho River from O.C. Fisher Reservoir Dam to Bell Street in San Angelo is heavily impacted with non-point source urban runoff, which leads to oxygen depletion and a general water quality deterioration. Numerous fish kills have occurred along this 4.75 mile stretch of the Concho River since the late 1960's. In addition, toxics have been reported by the

TCEQ within the same stream segment. Both of these problems are believed to result from non-point source water pollution. Since 1994, the Upper Colorado River Authority and the City of San Angelo have been involved in a comprehensive effort to mitigate these problems through the Federal Clean Water Act (CWA) 319(h) program. This program provides grant funds to implement Best Management Practices (BMPs) designed to mitigate non-point source water quality problems. The EPA 319(h) program is administered in Texas through the TCEQ.

Hickory Aquifer

Radionuclides present in the Hickory aquifer originate from geologic formations. Several of the public water systems that rely on this aquifer regularly exceed the TCEQ's radionuclide limits, including limits on radon. Treatment of this water by water supply providers in this area has not been attempted to date. 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. Removal techniques for radon are well known and should not present any major problems to suppliers in implementation. Generally, agricultural use is not impaired by the presence of the radionuclides.

Other Groundwater Quality Issues

Other groundwater quality issues in Region F include elevated levels of fluoride, nitrate, arsenic and perchlorate. Table 1.7-2 shows the percentage of water wells sampled by the TWDB that exceed drinking water standards for fluoride, nitrate and arsenic. The largest percentage of wells with excessive fluoride can be found in Andrews and Martin Counties. Elevated nitrate levels can be found throughout Region F, with a high percentage of wells exceeding standards in Ector, Midland, Runnels and Upton Counties. The highest percentages of wells exceeding arsenic standards are found in Borden, Howard and Martin Counties. Perchlorate is a growing water quality concern for water from the Ogallala aquifer in west Texas. Preliminary research found perchlorate levels exceeding drinking water standards in 35 percent of the public drinking water wells[37].

Table 1.7-2
Percentage of Sampled Water Wells Exceeding Drinking Water Standards for Fluoride, Nitrate and Arsenic

County	Fluoride	Nitrate	Arsenic
Andrews	27%	54%	3%
Borden	13%	44%	10%
Brown	2%	36%	0%
Coke	1%	39%	0%
Coleman	1%	41%	0%
Concho	1%	56%	0%
Crane	7%	38%	0%
Crockett	0%	15%	0%
Ector	2%	80%	3%
Glasscock	3%	71%	2%
Howard	20%	61%	25%
Irion	0%	22%	0%
Kimble	0%	26%	0%
Loving	0%	41%	0%
Martin	45%	75%	10%
Mason	0%	52%	0%
McCulloch	1%	25%	0%
Menard	0%	19%	0%
Midland	11%	85%	0%
Mitchell	6%	37%	0%
Pecos	2%	31%	0%
Reagan	3%	67%	3%
Reeves	0%	30%	0%
Runnels	3%	94%	0%
Schleicher	0%	23%	0%
Scurry	3%	35%	0%
Sterling	0%	29%	0%
Sutton	0%	18%	0%
Tom Green	0%	51%	0%
Upton	0%	80%	0%
Ward	1%	25%	0%
Winkler	2%	13%	0%

Data are from the Texas Water Development Board[38]

Current and Proposed TMDL Studies in Region F

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. The TCEQ has also established a list of stream segments for which it intends to develop Total Maximum Daily Load (TMDL) evaluations to address water quality concerns[39], which is summarized in Table 1.7-1. Two

TMDLs have been proposed for Region F: one for E.V. Spence Reservoir and one for the Colorado River downstream of E.V. Spence Reservoir. The E.V. Spence TMDL was adopted by TCEQ in June 2002 and approved by the EPA in May 2003. The Colorado River TMDL is currently underway. In December 2003, the TCEQ presented the results of the 2003 monitoring effort for the Colorado River TMDL to project stakeholders. Monitoring is scheduled to run through December 2004. The projected completion date for the Colorado River TMDL is March 2007.

Regional Drought

Most of Region F has experience drought-of-record conditions since the mid 1990s. Although extensive rains at the end of 2004 brought some relief to the drought conditions, there remains a large volume of empty reservoir storage in the region. In October 2004, the capacity of Lake J.B. Thomas, Champion Creek Reservoir, E.V. Spence Reservoir, and O.C. Fisher Lake was less than 15 percent. O.H. Ivie was at 30 percent of capacity. Hords Creek Lake had less than 50 percent of its capacity. In June 2004, Twin Buttes Reservoir was only at 3 percent of capacity. Red Bluff Reservoir was the only major reservoir in Region F that is almost full, at 95 percent of capacity in October 2004. Aquifers generally respond more slowly to drought conditions than surface water supplies. However, without significant rainfall, little recharge will be available to replace water currently being pumped from these aquifers.

Drought conditions also have a negative impact on water quality. As water levels decline, reservoirs tend to concentrate dissolved materials. Without significant fresh water inflows the water quality in a reservoir degrades. The lack of recharge to aquifers has a similar effect on groundwater.

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 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.

Much of the surface water and groundwater water 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 economically distressed due to downturns in the petroleum industry and agriculture. Therefore, advanced treatment, system improvements or long distance transportation of water may not be economically feasible. Also, many of these smaller communities have experienced declining populations in recent years. More than one-half of the counties in the region have a population less than 5,000 people. These smaller counties lost 2.2 percent of their population between 1990 and 2000. Thus they are ill equipped to afford the high cost of advanced water treatment techniques, given their declining revenue base.

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 water supplies. Water-related threats to natural resources include changes to natural flow conditions and water quality concerns. In most cases, groundwater water supplies in Region F associated with irrigated agriculture have little impact on natural resources.

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 many 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 water for irrigation. According to the 2001 *Region F Regional Water Plan*[40], agricultural demand may exceed the available groundwater water supply. Parts of three counties (Midland, Reagan and Upton) have already been declared Priority Groundwater Water Management Area by the TCEQ in response to excessive drawdown in the aquifer.

1.8.2 Water Related Threats to Natural Resources

Reservoir development and invasion by brush have altered natural stream flow patterns in Region F. Spring flows in Region F have greatly diminished. Many springs have dried up because of groundwater development, the spread of high water use plant species such as mesquite and salt cedar, or the loss of native grasses and other plant cover. Such 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 stream conditions.

1.9 Navigation in Region F

The U.S. Army Corps of Engineers has published a list of the navigable portions of the rivers in Texas[41]. The Colorado River is considered navigable from the Bastrop-Fayette County line to Longhorn Dam in Travis County. The Rio Grande is considered navigable from the Zapata-Webb County line to the point of intersection of the Texas-New Mexico state line and Mexico.

All of these areas are outside of the boundaries of Region F. The Pecos River segment is not specifically included.

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