7 DROUGHT RESPONSE INFORMATION, ACTIVITIES, AND RECOMMENDATIONS

During the past century, recurring drought has been a natural part of Texas' varying climate, especially in the arid and semi-arid regions of the state. An old saying about droughts in west Texas is that "droughts are continual with short intermittent periods of rainfall." Droughts, due to their complex nature, are difficult to define and understand, especially in a context that is useful for communities that must plan and prepare for drought. Drought directly impacts the availability of ground and surface water supplies for agricultural, industrial, municipal, recreational, and designated aquatic life uses. The location, duration, and severity of drought determine the extent to which the natural environment, human activities, and economic factors are impacted.

Geography, geology, and climate vary significantly from east to west in Region F. Ecoregions within Region F vary from the Edwards Plateau to the east, Central Great and Western High Plains in the central and northern portions of the region, and Chihuahuan Deserts to the west. Annual rainfall in Region F ranges from an average of more than 30 inches in the east to slightly more than 11 inches in the west. Likewise, the annual gross reservoir evaporation rate ranges from 60 inches in the east to approximately 75 inches in the western portion of the region.

Numerous definitions of drought have been developed to describe drought conditions based on various factors and potential consequences. In the simplest of terms, drought can be defined as "a prolonged period of below-normal rainfall." However, the State Drought Preparedness Plan provides more specific and detailed definitions shown in the box below.

These definitions are not mutually exclusive, and provide valuable insight into the complexity of droughts and their impacts. They also help to identify factors to be considered in the development of appropriate and effective drought preparation and contingency measures.

Types of Drought

- **Meteorological Drought.** A period of substantially diminished precipitation duration and/or intensity that persists long enough to produce a significant hydrologic imbalance.

- **Agricultural Drought.** Inadequate precipitation and/or soil moisture to sustain crop or forage production systems. The water deficit results in serious damage and economic loss to plant and animal agriculture. Agricultural drought usually begins after meteorological drought but before hydrological drought and can also affect livestock and other agricultural operations.

- **Hydrological Drought.** Refers to deficiencies in surface and subsurface water supplies. It is measured as streamflow, and as lake, reservoir, and groundwater levels. There is usually a lack of rain or snow and less measurable water in streams, lakes, and reservoirs, making hydrological measurements not the earliest indicators of drought.

- **Socioeconomic Drought.** Occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts have often been described as "insidious by nature." This is mainly due to several factors:

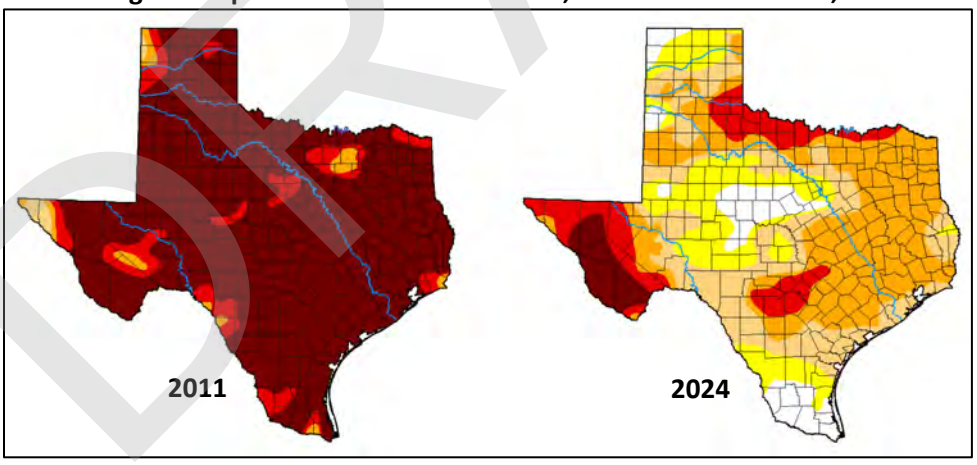
- Droughts cannot be accurately characterized by well-defined beginning or end points.
- Severity of drought-related impacts is dependent on antecedent conditions, as well as ambient conditions such as temperature, wind, and cloud cover.
- Droughts, depending on their severity, may have significant impacts on human activities; and human activities during periods of drought may exacerbate the drought conditions through increased water usage and demand.

Furthermore, the impact of a drought may extend well past the time when normal or above-normal precipitation returns.

7.1 Drought of Record in the Regional Water Planning Area (RWPA)

Various indices have been developed in an attempt to quantify drought severity for assessment and comparative purposes. One numerical measure of drought severity that is frequently used by many federal and state government agencies is the Palmer Drought Severity Index (PDSI). It is an estimate of soil moisture that is calculated based on precipitation and temperature. Another measure is the Drought Monitor that incorporates measurement of climate, hydrologic and soils conditions as well as site specific observations and reports. The Drought Monitor is distributed weekly and is often the tool used to convey drought conditions to the public and water users. In 2011, all counties of Region F experienced at least some periods of severe or extreme drought. Conditions have improved since 2011 but the Region is still experiencing ongoing drought conditions as indicated in Figure 7-1.

Figure 7-1
Drought Comparison between October 4, 2011 and October 29, 2024



7.1.1 Drought of Record in Region F

The drought of record is commonly defined as the worst drought to occur in a region during the entire period of meteorological record keeping. For most of Texas, the drought of record occurred from 1950 to 1957. During the 1950's drought, many wells, springs, streams, and rivers went dry and some cities had to rely on water trucked in from other areas to meet drinking water demands. By the end of 1956, 244 of the 254 Texas counties were classified as disaster areas due to the drought, including all of the counties in Region F.

During the past decade, most regions of Texas have experienced droughts resulting in diminished water supplies for agricultural and municipal use, decreased flows in streams and reservoirs, and significant economic loss. Droughts of severe to extreme conditions occurred in the 1950s, 1990s, 2000s, and 2010s in Region F. The worst year during the recent drought was 2011, when most Region F counties experienced extreme drought. Despite some improvements from the worst part of 2011, drought conditions continue to persist throughout the region today.

For reservoirs, the drought of record is defined as the period that includes the minimum content of the reservoir when a reservoir is diverting its firm yield. The period is recorded from the last time the reservoir was full before reaching its minimum content to the next time the reservoir is full. If a reservoir has reached its minimum content but has not yet filled, then it is considered to still be in drought of record conditions. The droughts of record based on water availability modeling for the reservoirs in Region F are shown below in Table 7-1. The model uses TCEQ's Colorado Basin full authorization run with the "cutoff" subordination of the lower basin, a period of record from 1940 through 2016, and with each reservoir diverting their safe yield. Based on this modeling, most of the reservoirs in Region F are currently experiencing a new drought of record. The minimum content of most of the reservoirs occurs between 2011 and 2015. The drought of record is listed as "ongoing" for 12 of the 19 reservoirs in Table 7-1. The yields of these reservoirs could be further reduced if the reservoirs do not fill and the region experiences further extreme drought conditions.

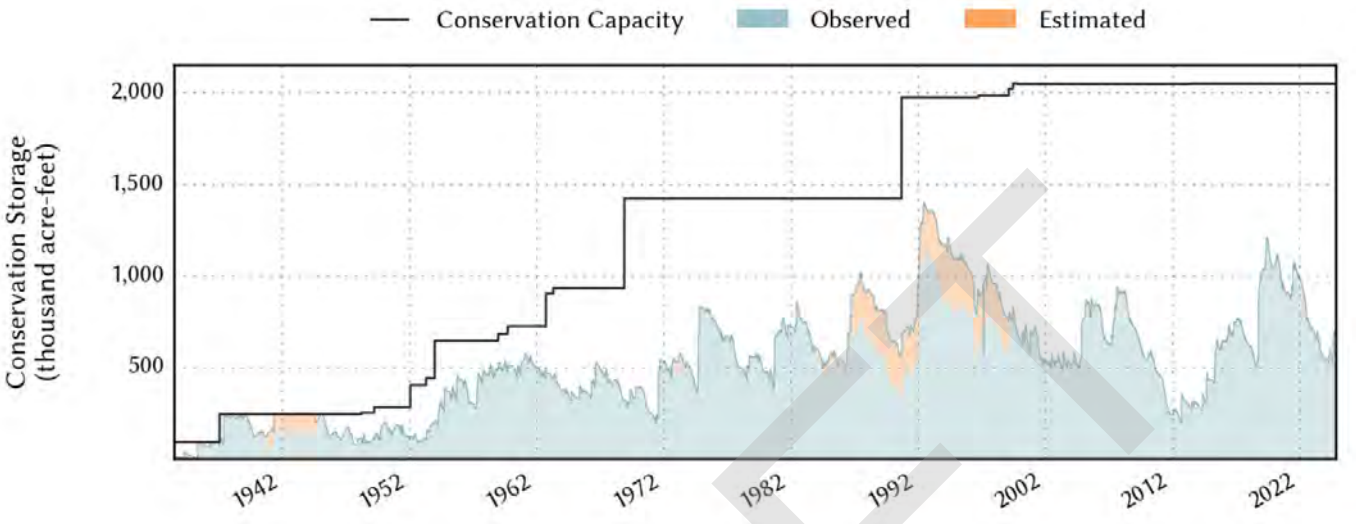
Table 7-1
Modeled Droughts of Record in Region F

Reservoir	Date last full before Minimum in WAM	Date of minimum content in WAM	Drought of Record based on the WAM [a]
Ballinger/Moonen	March 2008	August 2012	2008 – Ongoing
Balmorhea	February 1997	September 2000[b]	1997 – 2000
Brady Creek	March 1998	June 2013	1998 – Ongoing
Brownwood	July 2007	September 2011	2007 – Ongoing
Champion Creek	May 1987	September 2015	1987 – Ongoing
Coleman	August 2007	May 2015	2007 – 2016
Colorado City	May 1994	May 2003	1994 – 2016
Hords Creek	July 2007	May 2015	2007 – 2016
Lake Clyde	September 2007	May 2015	2007 – 2016
Mountain Creek	September 2007	August 2012	2007 – Ongoing
Nasworthy	April 2008	April 2014	2008 – 2014
Oak Creek	June 1997	April 2015	1997 – Ongoing
O.C. Fisher	June 1987	April 2015	1987 – Ongoing
O.H. Ivie	June 1997	April 2014	1997 – Ongoing
Red Bluff	March 1943	September 2000[b]	1943 – 2000
Spence	June 1992[c]	August 2014	1992 – Ongoing
Thomas	July 1987	August 2014	1962 – Ongoing
Twin Buttes	March 1993	April 2014	1993 – Ongoing
Winters	June 1997	August 2012	1997 – Ongoing

a. The period of record for the WAM is 1940-2016. "Ongoing" means, within the simulation, the reservoir had not filled up as of December 31, 2016.
b. Hydrologic input data for the Rio Grande River Basin WAM simulations end in 2000. The hydrology was not extended.
c. Spence reservoir has never filled. The Date Last Full is based on the firm yield analyses.

TWDB generated Figure 7-2, which is another perspective of reservoir storage in the region during the most recent drought[1].

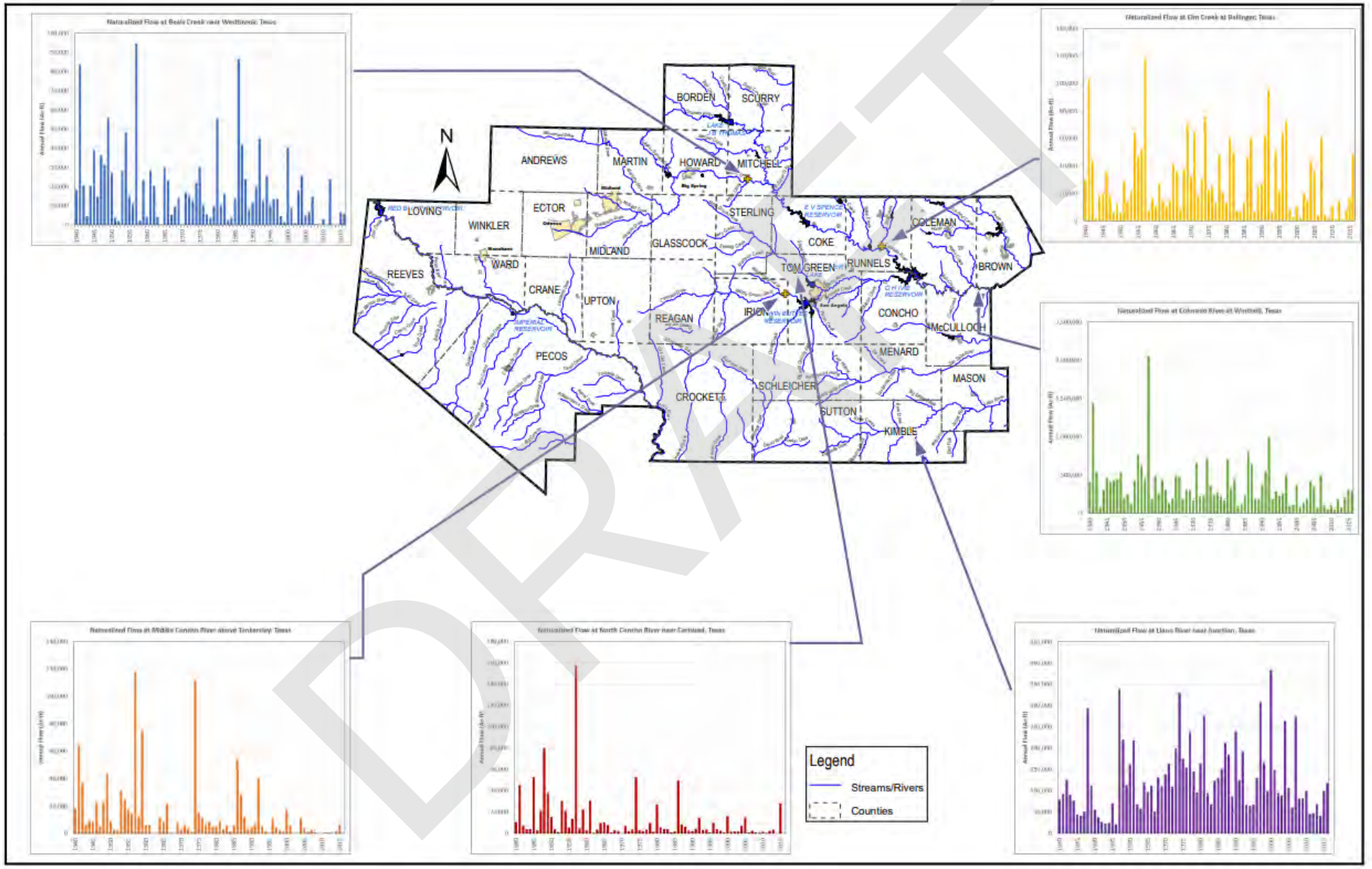
Figure 7-2
TWDB Region-F Planning Region Reservoirs



Drought of record conditions for run of the river supplies are typically evaluated based on minimum annual stream flows. Figure 7-3 shows the variations in naturalized flows from the WAM for seven U.S. Geological Survey (USGS) streamflow gages in Region F.[2] The five gages on tributaries have watersheds with limited development and show the natural variation in streamflows in this region. The Colorado gage near Winchell is the most downstream gage on the main stem of the Colorado River in Region F. Flows at the Pecos River gage near Girvin are largely controlled by releases from Red Bluff Reservoir. Based on the naturalized flows at these locations, the 2011-2015 drought is the drought of record for the run-of-river supplies in the Colorado Basin with the exception of the Llano River where the drought of record is still in the 1950s. The drought of 2011-2015 is also the drought of record for the Rio Grande River Basin in Region F.

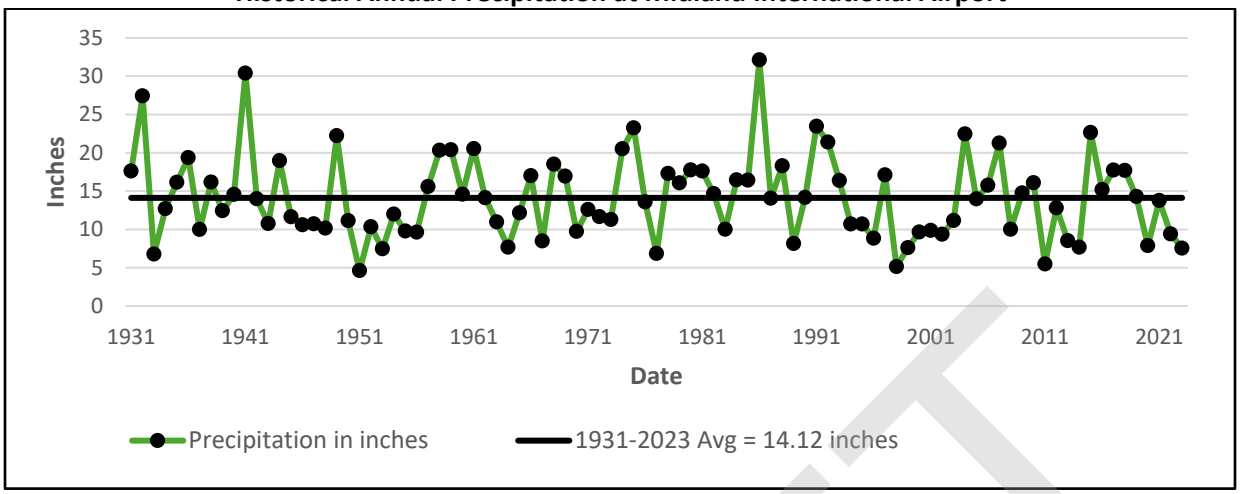
For groundwater, meteorological and agricultural conditions were considered for defining the drought of record in Region F. The National Atmospheric and Oceanic Administration (NOAA) maintains data on the historical meteorological conditions and drought indices across the country. Figure 7-4 shows the historical precipitation for Midland, Texas[3]. As is typical in Texas, the average annual precipitation in Region F increases from west to east. Midland is further west, and averages about 14.12 inches a year over the period shown. The years with the lowest historical precipitation occurred in 1951, 1998, and 2011. In 1951, 4.60 inches were recorded and 5.14 inches were recorded in 1998. In 2011, 5.47 inches were recorded. For both the 1950's drought and the recent drought, annual rainfall was significantly below average for an extended number of years. The current drought rivals the 1950's drought. Seven of the last fifteen years show rainfall less than the historical average. This is similar to the drought of the 1950s.

Figure 7-3
Region F Annual Naturalized Streamflow



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

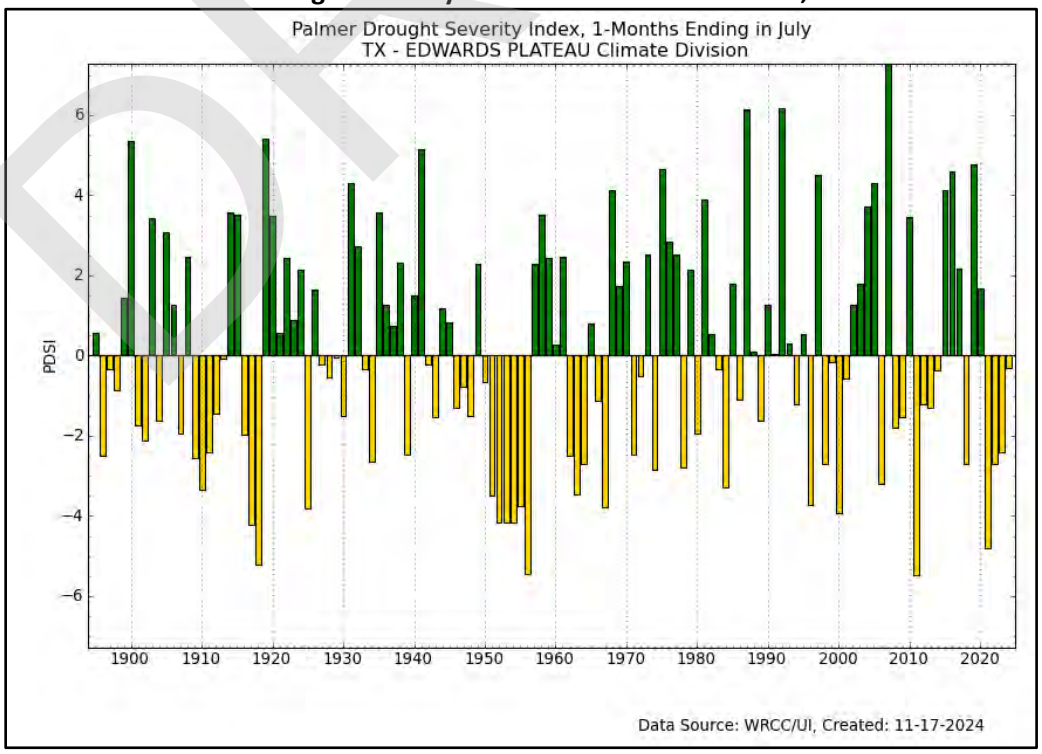
Figure 7-4
Historical Annual Precipitation at Midland International Airport



Looking at the Palmer Drought Severity Indices over the same time period for Climate Region 6 (where most of Region F is located), Figure 7-5 clearly shows the drought impacts during the 1950s and again since 2011[4]. The Palmer Drought Severity Indices (PDSI) provide a measurement of long-term drought based on the intensity of drought during the current month plus the cumulative patterns of previous months. It considers antecedent soil moisture and precipitation. For Region F, these considerations are important in assessing the potential impacts to groundwater sources during drought from increases in water demands and agricultural water needs.

Considering both the annual precipitation and PDSI in the region, the drought of record for groundwater and run of the river sources is still the drought of the 1950s, although the droughts that began in 2011 and 2022 are nearly as severe.

Figure 7-5
Palmer Drought Severity Indices for Edwards Plateau, Texas



7.1.2 Impacts of Drought on Water Supplies

Drought is a major threat to surface water supplies in Region F. For surface water, hydrological drought is significant because it impacts the yield of water sources. Typically, multi-year droughts have the greatest impact on a reservoir yield. Impacts of the new drought on reservoir yields in Region F using WAM Run 3 (no subordination) are negligible in most cases where the yields were already at or near zero. Impacts are more readily seen with the subordination strategy, which is discussed in Chapter 5C. With subordination, the analysis showed that most of the Colorado Basin reservoirs in Region F are currently experiencing new ongoing drought-of-record conditions (as of 2016, the last year of WAM hydrology). As a result of this drought, many reservoirs have shown reductions in yield and may continue to decline if drought persists.

Drought can also be a major threat to groundwater supplies that rely heavily on recharge. While some aquifers are less impacted by reduced recharge, others may be heavily impacted by the ongoing agricultural drought which can increase the demands on these sources. Furthermore, the reduced reliability of surface water sources in the region from the drought has caused many to shift to groundwater sources to secure a more drought-tolerant source of water supply. Over time the increased demands can impact the amount of storage in the aquifers for future use.

7.2 Current Drought Preparations and Response

In 1997, the Texas Legislature directed the TCEQ to adopt rules establishing common drought plan requirements for water suppliers in response to drought conditions throughout the State. Since 1997, the TCEQ has required all wholesale public water suppliers, retail public water suppliers serving 3,300 connections or more, and irrigation districts to develop, implement, and submit Drought Contingency Plans (DCPs) every five years. The most recent updates were to be submitted to the TCEQ by May 1, 2024. Retail public water suppliers serving less than 3,300 connections must prepare and adopt a DCP but are not required to submit plans to TCEQ. All DCPs should be made available for inspection by TCEQ. DCPs typically identify different stages of drought (e.g., mild, moderate, severe) and specific triggers and responses for each stage. In addition, DCPs specify quantifiable targets for water use reductions for each stage, and a means and method for enforcement.

Most wholesale water providers and municipalities in Region F have taken steps to prepare for and respond to drought through efforts, including the preparation of individual DCPs and readiness to implement them as necessary. Region F DCPs include specific water savings goals and drought contingency measures associated with multiple drought stages. In addition to these Plans, many water providers have a Management Supply Factor (i.e., the desired ratio of supplies to demand) greater than 1.0 for demands that are essential to public health and safety.

7.2.1 Drought Preparedness

Frequent recurring drought is a fact of life in Region F. Droughts have occurred in almost every decade since the 1940s. Recent experience with critical drought conditions attests to the effectiveness of drought management in the region. These reductions are at least partially due to the implementation of drought response activities included in the municipality's drought plan. However, according to city officials, the most significant factor in reducing water consumption is public awareness of drought conditions and voluntary reductions in water use. Some cities are pursuing aggressive water conservation programs that include using xeriscaping and efficient irrigation practices for public properties such as parks and buildings, and reuse of treated effluent for municipal and manufacturing supplies.

In general, water suppliers in Region F identify the onset of drought (set drought triggers) based on either their current level of supply or their current level of demand. Often the triggers for surface water reservoirs are based on the current capacity of the reservoir as a percentage of the total reservoir capacity. In Region F, the reservoir operators use a combination of reservoir storage (elevation triggers) and/or demand levels. Triggers for groundwater supplies are commonly determined by demand as a percentage of total supply or total delivery capacity. Suppliers set these triggers as needed based on the individual parameters of their system. Customers of a wholesale water provider (WWP) are subject to the triggers and measures of the WWPs' Drought Plans.

Ten updated Drought Contingency Plans (DCPs) were either submitted to Region F or adopted by an entity during this round of planning. The majority of these DCPs use trigger conditions that are supply-based, while the rest either use triggers that are based on the demands placed on the water system or are a combination of multiple conditions. Table 7-2 summarizes the basis of the drought triggers by provider. Appendix G, Table G-1 summarizes the triggers and actions by water provider for initiation and response to drought.

Table 7-2
Type of Trigger Condition for Entities with Drought Contingency Plans Submitted to the Region F Planning Group

Entity	Type Trigger Conditions	
	Demand	Supply
Balmorhea		X
Big Spring	X	X
Brookesmith SUD	X	
Brownwood	X	X
Brown County WID 1		X
CRMWD		X
Ector County UD[a]		X
Eden[a]		X
Fort Stockton[a]	X	
Grandfalls[a]	X	
Midland	X	X
Red Bluff Power Control District[a]		X
Odessa	X	
San Angelo		X
Snyder	X	X
Sonora[a]	X	X
UCRA[a]		X
Winters		X

a. Data from 2021 RWP

Challenges to the drought preparedness in Region F include the resources available to smaller cities to adequately prepare for drought and respond in a timely manner. Also, for many cities the drought of 2011 truly tested the entity's drought plan and triggers. Some water providers found

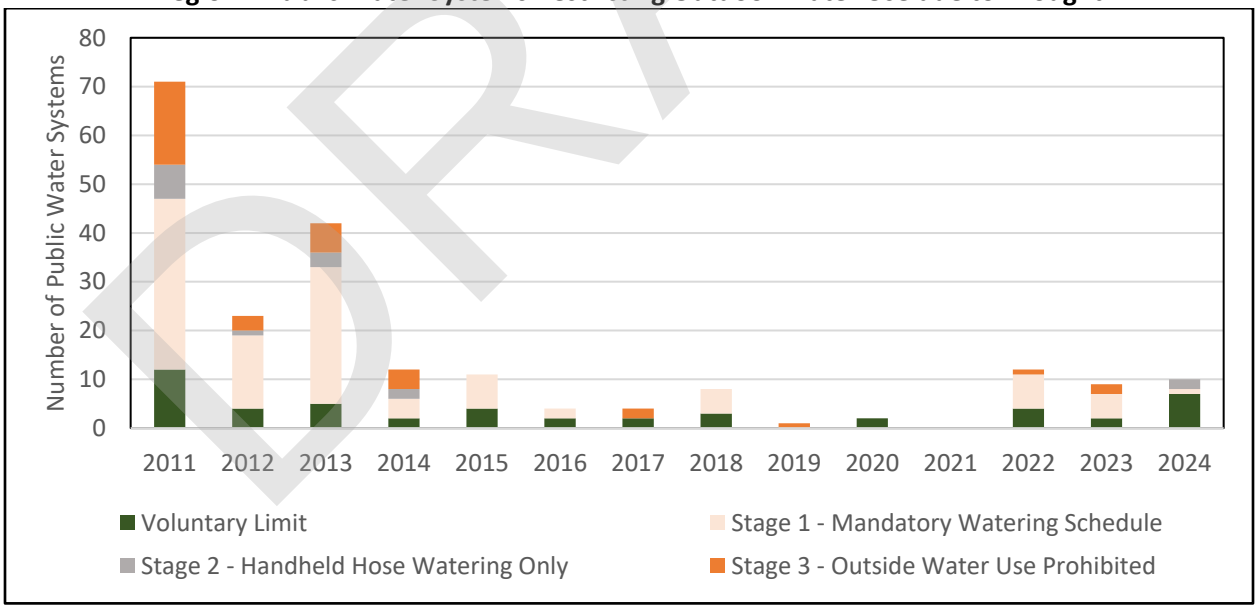
that the triggers were not set at the appropriate level to initiate different stages of the drought plan. The 2011 drought came quickly and was very intense. This increased demands on local resources and for many groundwater users increased competition for the water. Some systems had difficulty meeting demands and little time to make adjustments.

Many water providers of surface water sources have proactively developed supplemental groundwater sources, providing additional protections during drought. Many of the groundwater users have expanded groundwater production or are planning to develop additional groundwater in response to the ongoing drought. Groundwater in Region F provides a more drought-resilient water source, but it needs to be managed to assure future supplies.

7.2.2 Recent Implementation of Drought Contingency Measures in Region F

TCEQ collects data on Texas public water systems (PWSs) that reported water use restrictions and priority levels due to drought or emergency conditions. The most recent list of Texas PWSs limiting water use is found here: https://www.tceq.texas.gov/drinkingwater/trot/droughtw.html. The Region F RWPG conducted an analysis of TCEQ records between May 2011 and August 2024 to determine which Region F PWSs implemented water restrictions and to what extent the restrictions were implemented. The results of this analysis are shown in Figure 7-6. The impacts of the 2011 drought and continuing dry conditions through 2013 are apparent, as nearly 150 Region F PWSs reported water use restrictions during that time span. Reports decreased significantly since 2016, with zero reports in 2021, before increasing again in 2022. Between 2022 and August 2024, 14 unique Region F PWSs reported water use restrictions. Two PWSs in 2024 reported that the remaining water supply available to their system was insufficient to meet at least 90 days of demand.

Figure 7-6
Region F Public Water Systems Restricting Outdoor Water Use due to Drought



7.3 Existing and Potential Emergency Interconnects

According to Texas Statute §357.42(d),(e) regional water planning groups are to collect information on existing major water infrastructure facilities that may be used in the event of an emergency shortage of water. Pertinent information includes identifying the potential user(s) of the interconnect, the potential supplier(s), the estimated potential volume of supply that could be provided, and a general description

of the facility. Texas Water Code §16.053(c) requires information regarding facility locations to remain confidential. This section provides general information regarding existing and potential emergency interconnects among water user groups within Region F.

7.3.1 Existing Emergency Interconnects

Major water infrastructure facilities within Region F were identified to better evaluate existing and potentially feasible emergency interconnects. Most interconnections provide water to a specific recipient. Pecos County WCID and the City of Fort Stockton have an interconnection that can move water to or from each entity. In addition, two of the four systems within Concho Rural Water North Concho Lake Estates system are linked. Table 7-3 presents existing emergency interconnects among water users and neighboring systems.

Table 7-3
Existing Emergency Interconnects to Major Water Facilities in Region F

Entity *Providing* Supply	Entity *Receiving* Supply
CRMWD	Monahans[a]
Millersview-Doole WSC	City of Paint Rock[a]
City of San Angelo	Millersview-Doole WSC
City of Fort Stockton	Pecos Co. WCID 1
Pecos Co. WCID #1	City of Fort Stockton
CRWC Grape Creek	Concho Rural Water N. Concho Lake Estates
Concho Rural Water N. Concho Lake Estates	Red Creek MUD
Zephyr WSC	City of Blanket
City of Odessa	Steam Electric Power (Ector County)
City of Ballinger	North Runnels WSC

a. Data from 2021 RWP

7.3.2 Potential Emergency Interconnects

There is potential for other emergency interconnects between various WUGs in Region F. Table 7-4 presents a list of cities for those receiving and those supplying the potential emergency interconnects. Emergency interconnects were found to be not practical for many of the entities that were evaluated for potential emergency water supplies. The type of infrastructure required between entities to provide or receive water during an emergency shortage was deemed impractical due to long transmission distances. Furthermore, it was deemed impractical during an emergency situation, to complete the required construction in a reasonable timeframe.

Table 7-4
Potential Emergency Interconnects to Major Water Facilities in Region F

Entity *Providing* Supply	Entity *Receiving* Supply
CRMWD (O.H. Ivie Lake)	Ballinger
Midland County FWSD#1	Greater Gardendale WSC
Texland Great Plains WSC	City of Andrews
Millersview-Doole WSC	City of Miles
CRMWD	Wickett

7.4 Emergency Responses to Local Drought Conditions or Loss of Municipal Supply

Texas Statute §357.42(g) requires regional water planning groups to evaluate potential temporary emergency water supplies for all County-Other WUGs and municipalities with 2030 populations less than 7,500 that rely on a sole source of water. The purpose of this evaluation is to identify potential alternative water sources that may be considered for temporary emergency use in the event that the existing water supply sources become temporarily unavailable due to extreme hydrologic conditions. This section provides potential solutions that should act as a guide for municipal water users that are most vulnerable in the event of a loss of supply. This review was limited and did not require technical analyses or evaluations in accordance with 31 TAC §357.34.

7.4.1 Emergency Responses to Local Drought Conditions

A survey was conducted to identify and evaluate the municipal water users that are most vulnerable in the event of an emergency water shortage. The analysis included County-Other WUGs and rural cities with a population less than 7,500 and on a sole source of water. A sole source is defined here as a single well field or single surface water source. If an entity receives water from a single wholesale provider with only one source, they were considered as part of this analysis. If an entity receives water from a single wholesale provider who has multiple sources, they were not considered to have a sole source and were not included in this analysis. Additionally, based on the recommendations of the Drought Preparedness Council, Region F included any entities that have been on the 180 days or less of remaining water supply list from TCEQ since 2011. Table 7-5 presents potential temporary responses that may or may not require permanent infrastructure. It was assumed in the analysis that the entities listed would have approximately 180 days or less of remaining water supply.

Releases from Upstream Reservoirs and Curtailment of Rights

Releases from upstream reservoirs and curtailment of water rights was considered as a temporary measure that may help increase water supplies during an emergency water shortage. This response was only considered for those entities who receive surface water and may not be viable for all water right holders. Surface water in Texas is operated on a priority system and the water right holder may have no legal authority on which to request a release from an upstream reservoir or the curtailment of other water rights if their rights are junior. Even if the water user has a senior water right, in some cases, these strategies may result in what is known as a futile call. This occurs if shutting down a junior water right will not actually result in water being delivered to the senior right. In which case, the call will not be enforced.

Brackish Groundwater

Brackish groundwater was evaluated as a temporary source during an emergency water shortage. Some brackish groundwater is found in certain places in the Ogallala, the Dockum, Hickory, Ellenburger-San Saba, Lipan, Capitan Reef, Pecos Valley Alluvium and other formations which underlie shallow aquifers. Required infrastructure would include additional groundwater wells, potential treatment facilities and conveyance facilities. Brackish groundwater at lower TDS concentrations may require only limited treatment. Twelve of the entities listed in Table 7-5 may not be able to potentially use brackish groundwater as a feasible solution to an emergency local drought condition.

Drill Additional Local Groundwater Wells and Trucking in Water

If existing water supply sources become temporarily unavailable, possible solutions include drilling additional groundwater wells or trucking in water. Table 7-5 presents this option as viable for all entities listed.

Table 7-5
Emergency Responses to Local Drought Conditions in Region F

Entity	Implementation Requirements												
Water User Group	County	2030 Population	2030 Demand (AF/YR)	Release from upstream reservoir	Curtailment of water rights	Local groundwater wells	Brackish groundwater limited treatment	Brackish groundwater desalination	Emergency interconnect	Trucked - in water	Type of infrastructure required	Entity providing supply	Emergency agreements already in place
Bangs	Brown	2,776	346			▪	▪		▪	▪			
Barstow	Ward	265	154			▪				▪			
Big Lake	Reagan	2,996	760			▪	▪	▪		▪			
Colorado City	Mitchell	6,600	1,650			▪	▪			▪			
Coke County WSC[a]	Coke	N/A				▪				▪			
Crockett Co. WCID 1	Crockett	2,270	995			▪	▪			▪			
DADS Supported Living Center	Tom Green	427	183			▪				▪			
Early	Brown	3,352	454			▪	▪		▪	▪	Pipeline	Brownwood	
Eldorado	Schleicher	1,527	474			▪				▪			
Grandfalls	Ward	396	225			▪				▪			
Greater Gardendale WSC	Ector	3,053	242			▪	▪	▪		▪			
	Midland	1,910	151			▪	▪	▪		▪			
Greenwood Water	Midland	872	221			▪	▪			▪			
Iraan	Pecos	1,034	364			▪	▪	▪	▪	▪	Pipeline; PS; Treatment	Pecos Co. Precinct #3	
Junction	Kimble	2,243	523			▪	▪	▪		▪			
Kermit	Winkler	7,184	2,169			▪	▪	▪	▪	▪	Pipeline; PS; Treatment	Midland Freshwater District /WRTA	

Entity	Implementation Requirements												
Water User Group	County	2030 Population	2030 Demand (AF/YR)	Release from upstream reservoir	Curtailment of water rights	Local groundwater wells	Brackish groundwater limited treatment	Brackish groundwater desalination	Emergency interconnect	Trucked - in water	Type of infrastructure required	Entity providing supply	Emergency agreements already in place
Loraine	Mitchell	587	188			▪				▪			
Madera Valley WSC	Reeves	1,905	832			▪	▪	▪		▪			
Mason	Mason	2,189	709			▪				▪			
McCamey	Upton	1,688	685			▪	▪	▪		▪			
Menard	Menard	1,120	257			▪	▪			▪			
Mertzon	Irion	657	78			▪	▪			▪			
Mitchell Co. Utility	Mitchell	2,715	503			▪	▪			▪			
Park Water[a]	Midland	N/A				▪				▪			
Pecos Co. Fresh Water	Pecos	675	252			▪				▪			
Pecos Co. WCID #1	Pecos	2,126	585			▪	▪	▪	▪	▪	Pipeline	Ft. Stockton	▪
Rankin	Upton	740	260			▪				▪			
Santa Anna	Coleman	950	128			▪	▪			▪			
Robert Lee[a]	Coke	999	276			▪				▪			
Sonora	Sutton	2,169	1,048			▪				▪			
Southwest Sandhills WSC	Ward	2,466	378			▪	▪			▪			
Sterling City	Sterling	1,425	411			▪	▪	▪		▪			
Tom Green Co. FWSD 2[a]	Tom Green	N/A				▪				▪			
Tom Green Co. FWSD 3	Tom Green	667	114			▪				▪			
Twin Buttes WS[a]	Tom Green	N/A				▪				▪			

Entity	Implementation Requirements												
Water User Group	County	2030 Population	2030 Demand (AF/YR)	Release from upstream reservoir	Curtailment of water rights	Local groundwater wells	Brackish groundwater limited treatment	Brackish groundwater desalination	Emergency interconnect	Trucked - in water	Type of infrastructure required	Entity providing supply	Emergency agreements already in place
Warren Road Subdivision WS[a]	Midland	N/A				▪				▪			
Wickett	Ward	448	194			▪				▪			
Wink	Winkler	794	341			▪	▪	▪		▪			
Winters	Runnels	2,367	359			▪		▪	▪	▪	Pipeline	Abilene (Ivie Pipeline)	
Zephyr WSC	Brown	4,044	572			▪	▪			▪			▪

a. Entity has reported 180 days or less of remaining water supply to TCEQ since 2011.

7.5 Region Specific Drought Response Recommendations and Model Drought Contingency Plans

As required by the TWDB, the RWPG (Regional Water Planning Group) shall develop drought recommendations regarding the management of existing groundwater and surface water sources. These recommendations must include factors specific to each source as to when to initiate drought response and actions to be taken as part of the drought response. These actions should be specified for the manager of a water source and entities relying on the water source. The RWPG has defined the manager of water sources as the entity that controls the water production and distribution of the water supply from the source. For purposes of this assessment, a manager must also meet the TCEQ requirements for development of a Drought Contingency Plan. Entities that rely on the water sources include customers of the water source manager and direct users of the water sources, such as irrigators.

A list of each surface water and groundwater source in Region F and the associated managers and users of the source is included in Table G-2 in Appendix G.

In addition, the RWPG must identify unnecessary or counterproductive variations in specific drought response strategies, including outdoor watering restrictions, among user groups in the regional water planning area that may confuse the public or otherwise impede drought response efforts. The Region F RWPG recognizes the benefit of additional coordination between drought responses within more urban planning areas where people living in very close proximity to one another may have different outdoor water restrictions. However, this situation does not occur in Region F. Region F maintains that DCPs developed by the local, individual water providers are the best available tool for drought management. Region F fully supports the use and implementation of individual DCPs during times of drought and did not find the differences in local response to be unnecessary or counterproductive.

7.5.1 Drought Trigger Conditions for Surface Water Supply

Drought trigger conditions for surface water supply are customarily related to reservoir levels. Region F acknowledges that the Drought Contingency Plans for the suppliers who have surface water supplies are the best management tool for these water supplies. The RWPG recommends that the drought triggers and associated actions developed by the regional operator of the reservoirs are the Region F regional triggers for these sources. A summary of these triggers and actions for major Region F reservoirs follows as defined by each source manager. Triggers and actions for other reservoirs are included in Table G-3 in Appendix G. The region also recognizes any modification to these drought triggers that are adopted by the regional operator.

Lake Brownwood (Brown County WID #1)

BCWID #1 adopted their current Drought Contingency Plan in April of 2024. The triggers and actions are related to the elevation of Lake Brownwood and are summarized below in Table 7-6.

Table 7-6
Lake Brownwood Triggers and Actions

Drought Stage	Trigger	Action
Mild	Elevation below 1,420 ft. (76% capacity)	Advise customer of early conditions. Initiate Stage I of DCPs. Increase public education. Request voluntary conservation measures.
Moderate	Elevation below 1,417 ft. (64% capacity)	Request decrease in water usage. Implement watering restrictions. Request monitoring of irrigation facilities. District may reduce water delivery in accordance with pro rata curtailment.
Severe	Elevation below 1,414 ft. (52% capacity)	Request to severely reduce water usage. Watering restrictions. May conduct site visits to irrigation facilities. District may reduce water delivery in accordance with pro rata curtailment. May utilize alternative water sources, with TCEQ approval.
Exceptional	Elevation below 1,411 ft. (43% capacity)	District may call an emergency meeting with customers. Completely restrict watering. District may evaluate the need to discontinue delivery of water for second crops and non-essential uses. May reduce water delivery in accordance with pro rata curtailment. May utilize alternate water sources, with TCEQ approval.
Emergency	Elevation below 1,408 ft. (34% capacity)	Same as the Exceptional drought stage. Any other necessary actions.

O.H. Ivie Reservoir (CRMWD)

The Board of Directors of CRMWD adopted their current Drought Contingency Plan in April 2024. In CRMWD's DCP, drought contingency triggers and actions are separated into two categories: the non-system portion of the O.H. Ivie Reservoir (Ivie) and the remaining CRMWD System. Triggers for these two categories are associated with their respective storage capacities. The triggers and actions related to the capacities of the O.H. Ivie Reservoir are outlined below in Table 7-7.

Table 7-7
O.H. Ivie Reservoir Drought Triggers and Actions

Drought Stage	Trigger	Action[a]
Mild	Capacity below 184,936 ac-ft.	Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on Ivie water to implement Stage 1 of their DCP.
Moderate	Capacity below 138,702 ac-ft.	Continue or initiate actions under Stage 1. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 2 of their DCP.
Severe	Capacity below 92,468 ac-ft.	Continue or initiate actions under Stage 1 and 2. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 3 of their DCP.
Critical	Pipeline break, equipment failure, or source contamination that severely limits distribution capacity.	Assess the severity of the problem and identify actions and time needed to resolve it. Inform responsible officials for each wholesale water customer and suggest actions to alleviate problems. If appropriate, notify city, county, and/or state emergency response officials. Undertake necessary actions. Prepare a post-event assessment report.

a. During each stage, the following actions may be implemented by the District:
(1) Contact wholesale water customers monthly to discuss water supply and/or demand actions.
(2) Requesting wholesale water customers to reduce non-essential water use.
(3) Discussing the possibility of pro rata curtailment of water diversions and/or deliveries.
(4) Preparing a monthly water usage allocation baseline for each wholesale customer.

CRMWD System (CRMWD)

The CRMWD System includes supplies from Lake J.B. Thomas, E.V. Spence Reservoir, O.H. Ivie Reservoir, North Ward County Well Field, and the Big Spring Raw Water Production Facility. The triggers and actions related to the capacity of the CRMWD System are outlined below in Table 7-8.

Table 7-8
CRMWD System Drought Triggers and Actions

Drought Stage	Trigger	Action[a]
Mild	System capacity below 92,122 ac-ft.	Initiate studies to evaluate alternative actions if conditions worsen. Begin 'pump back' operation as needed. Request any WUG solely dependent on Ivie water to implement Stage 1 of their DCP.
Moderate	System capacity below 69,092 ac-ft.	Continue or initiate actions under Stage 1. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 2 of their DCP.
Severe	System capacity below 46,061 ac-ft.	Continue or initiate actions under Stage 1 and 2. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 3 of their DCP. Initiate Ward County Well Field System pipeline expansion project. Implement viable alternative water supplies.
Critical	Pipeline break, equipment failure, or source contamination that severely limits distribution capacity.	Assess the severity of the problem and identify actions and time need to resolve it. Inform responsible officials for each wholesale water customer and suggest actions to alleviate problems. If appropriate, notify city, county, and/or state emergency response officials. Undertake necessary actions. Prepare a post-event assessment report.

a. During each stage, the following actions may be implemented by the District:
(1) Contact wholesale water customers monthly to discuss water supply and/or demand actions.
(2) Requesting wholesale water customers to reduce non-essential water use.
(3) Discussing the possibility of pro rata curtailment of water diversions and/or deliveries.
(4) Preparing a monthly water usage allocation baseline for each wholesale customer.

O.C. Fisher, Twin Buttes, Nasworthy (San Angelo)

O.C. Fisher, Twin Buttes, and Nasworthy are all operated by the City of San Angelo. The City of San Angelo adopted their most recent Drought Contingency Plan in September of 2024. The triggers and actions in the City's DCP are based on combined storage and supply from all of the City's sources, which includes these reservoirs, as well as groundwater. These are outlined in Table 7-9 below.

Table 7-9
O.C Fisher, Twin Buttes and Nasworthy Drought Triggers and Actions

Drought Stage	Trigger	Action
Mild	Less than 24-month supply	Outdoor watering restrictions, watering schedule, water usage fees.
Moderate	Less than 18-month supply	Same as Stage 1 ("Mild" drought stage).
Critical/Emergency	Less than 12-month supply	Outdoor watering, filling of fountains or swimming pools, and/or washing of vehicles are all prohibited, water usage fees.

7.5.2 Drought Trigger Conditions for Run-of-River and Groundwater Supply

Both run-of-river and groundwater supplies are more regional than reservoirs and typically there are many users of these sources. As noted in Section 7.2, some water providers have developed Drought Contingency Plans that are specific to their water supplies. Other water users, such as agricultural or industrial users, may not have Drought Contingency Plans. To convey drought

conditions to all users of these resources in Region F, the RWPG proposes to use the Drought Monitor[5]. This information is easily accessible and updated regularly. It does not require a specific entity to monitor well water levels or stream gages. It is also geographically specific so that drought triggers can be identified on a sub-county level that is consistent with the location of use. Region F has adopted the same nomenclature as the Drought Monitor for corresponding Region F drought triggers. Table 7-10 shows the categories adopted by the U.S. Drought Monitor and the associated values for the Standardized Precipitation Index (SPI) and the Standardized Precipitation-Evapotranspiration Index (SPEI).

Table 7-10
Drought Severity Classification

Category	Description	Possible Impacts	Values for SPI and SPEI
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered	-0.5 to -0.79
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested	-0.8 to -1.29
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed	-1.3 to -1.59
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions	-1.6 to -1.99
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies	-2.0 or less

SPI= Standardized Precipitation Index
SPEI= Standard Precipitation-Evaporation Index

For groundwater and run-of-river supplies, Region F recognizes that the initiation of drought response is the decision of the manager of the source and/or user of the source. Region F recommends the following actions based on each of the drought classifications listed above:

- *Abnormally Dry* – Entities should begin to review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage is necessary.
- *Moderate Drought* – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage is necessary.
- *Severe Drought* – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point if the review indicates current supplies may not be sufficient to meet reduced demands the entity should begin considering alternative supplies.
- *Extreme Drought* – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point if the review indicates current supplies may not be sufficient to meet reduced demands the entity should consider alternative supplies.
- *Exceptional Drought* – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point if the review indicates current supplies are not sufficient to meet reduced demands the entity should implement alternative supplies

7.5.3 Model Drought Contingency Plans

Model Drought Contingency Plans (DCPs) were developed for Region F and can be accessed online at www.regionfwater.org. Each plan identifies four drought stages: mild, moderate, severe and emergency. The recommended responses range from notification of drought conditions and voluntary reductions in the "mild" stage to mandatory restrictions during an "emergency" stage. Entities using the model plan can select the trigger conditions for the different stages and appropriate responses for each stage.

The Drought Preparedness Council recommended that a model DCP be in place for any water user group that exceeds ten percent of the Region's water demands. For Region F, these user groups include irrigation, municipal, and mining. Region F developed Model DCPs for municipal and irrigation users, which can be accessed at http://regionfwater.org/index.aspx?id=Documents. The TCEQ does not require a DCP for mining users since mining is a private industry and is not subject to TCEQ enforcement. Thus, no model DCP was developed for mining.

7.6 Drought Management Water Management Strategies

Drought management is a temporary strategy to conserve available water supplies during times of drought or emergencies. This strategy is not recommended to meet long-term growth in demands, but rather acts as a means to minimize the potential for adverse impacts or water supply shortages during drought. The TCEQ requires Drought Contingency Plans (DCPs) for wholesale and retail public water suppliers and irrigation districts. A DCP may also be required for entities seeking state funding for water projects. Region F does not recommend specific drought management strategies. Region F recommends the implementation of DCPs by suppliers when appropriate to reduce demand during drought and prolong current supplies.

7.7 Other Drought-Related Considerations and Recommendations

7.7.1 Texas Drought Preparedness Council and Drought Preparedness Plan

In accordance with TWDB rules, relevant recommendations from the Drought Preparedness Council were considered in the writing of this Chapter. The Texas Drought Preparedness Council is composed of representatives from multiple State agencies and plays an important role in monitoring drought conditions, advising the governor and other groups on significant drought conditions, and facilitating coordination among local, State, and federal agencies in drought-response planning. The Council meets regularly to discuss drought indicators and conditions across the State and releases Situation Reports summarizing their findings. Additionally, the Council has developed the State Drought Preparedness Plan, which sets forth a framework for approaching drought to minimize impacts to people and resources. Region F supports the efforts of the Texas Drought Preparedness Council and recommends that water providers regularly review the Situation Reports as part of their drought monitoring.

The Council provided three new recommendations in 2024 to all RWPGs:

- The regional water plans and state water plan shall serve as water supply plans under drought of record conditions. The DPC encourages regional water planning groups to consider planning for drought conditions worse than the drought of record, including scenarios that reflect greater rainfall deficits and/or higher surface temperatures.
- The Drought Preparedness Council encourages regional water planning groups to incorporate projected future reservoir evaporation rates in their assessments of future surface water availability.

- The Drought Preparedness Council encourages regional water planning groups to identify in their plans utilities within their boundaries that reported having less than 180 days of available water supply to the Texas Commission on Environmental Quality during the current or preceding planning cycle. For systems that appeared on the 180-day list, RWPGs should perform the evaluation required by Texas Administrative Code Section 357.42(g), if it has not already been completed for that system.

Region F considers uncertainty and planning for a drought worse than the drought of record in the next section, Section 7.7.2. Additionally, Region F added entities from the 180-day list from TCEQ to Table 7-5 which includes the evaluation required by TAC Section 357.4(g).

7.7.2 Uncertainty and Drought Worse Than Drought of Record

The Region F Regional Water Plan addresses water supply needs during a hypothetical repeat of the worst drought on record. A new drought of record, or drought worse than the current drought of record (DWDOR), is a constant threat in Region F. The regional water planning process relies on input variables (such as hydrology, supplies, demands and population) that each have their own associated ranges of uncertainty. For example, the future population served by a WUG could be more or less than projected by TWDB. A multi-scenario approach could be used to estimate yield under drought conditions worse than the drought of record. While it is possible to quantitatively assess a range of input variables including hydrology worse than the drought of record, limited regional planning resources do not support evaluating a range of possible futures (e.g. future evaporation rates) for the 2026 RWP.

The 2026 RWP has addressed known but unquantified uncertainty associated with variability in hydrology and water demands in the following ways:

- Surface water supplies are determined using a one-year safe yield for planning purposes, which is more conservative than a firm yield. In a simulation where a reservoir is diverting its safe yield, the minimum simulated storage is equal to the annual diversion; in other words, the amount of water left in the reservoir at its lowest point is equal to a one-year supply. This applies to the surface water supplies from reservoirs listed in Table 7-1. The WUGs relying on water supplies from these reservoirs are listed in Table G-2 of Appendix G.
- The Water Availability Model (WAM) used to determine surface water supplies for the region has a number of conservative assumptions built into it including full consumptive use (no return flows). In reality, some percentage of the water diverted is returned to the river in the form of wastewater discharges. Another assumption is that water rights holders attempt to divert their full permitted amounts, however water users typically do not divert 100 percent of their permitted amounts, which leaves more water available for others. This applies to surface water supplies from reservoirs and run-of-river water rights. The WUGs relying on these supplies are listed in Table G-2.
- Some WUGs and Major Water Providers (MWPs) in Region F use conjunctive use to help address uncertainty in planning for water supplies. They use surface water supplies when they are available and then use groundwater supplies during times of drought when surface water supplies are more limited. This applies to CRMWD, Midland, San Angelo, Bronte, Brady, Balmorhea and any customers of the entities listed.
- Some WUGs and Major Water Providers (MWPs) in Region F have a management supply (safety) factor greater than 1, meaning supply is developed in excess of demand. Supply factors greater than 1 provide a cushion against uncertainty in both supplies and demands. The following Major Water Providers have surplus supplies (i.e., management supply factors greater than one)

following implementation of the recommended water management strategies: Brown County WID1, CRMWD, Midland, and San Angelo.

- There are existing and potential emergency interconnects in the region detailed in Section 7.3 that could be used in the event of a drought worse than the drought of record or other emergency situations.
- The regional water planning process assumes full, unrestricted dry year demands in each decade from 2030 to 2080. However, the water user groups in Region F implement Drought Contingency Plans (DCPs) during the recurring droughts in the region. In most cases, the "severe" or "critical" drought stage would be triggered during a drought worse than the drought of record and water demand would be substantially reduced through stringent drought response measures.
- Water user groups in Region F submit updated DCPs every five years to TCEQ with evolving drought triggers and measures refined on their experience dealing with drought. Compared to the 2021 RWP, several DCPs show more sensitivity to drought for surface supply triggers, more conservative water reduction goals and additional measures for drought response. For example, the storage triggers shown in Table 7-7 and Table 7-8 increased compared to the 2021 RWP, meaning the reservoir is storing more water when the same drought stage is triggered. Table G-1 in Appendix G examines the DCPs of 19 WUGs in Region F.
- In case of a drought worse than the drought of record, the recommended water management strategies (WMSs) in the 2026 Regional Water Plan could be brought on earlier than recommended in the plan.
- The region already makes significant use of reuse water, primarily for direct non-potable uses but is also home to the first and only active direct potable reuse project in Texas. New Direct Potable Reuse projects could be pursued to extend existing supplies during an unprecedented drought. Direct Potable Reuse projects would likely only be feasible for MWPs.
- Strategies that are currently impractical for some MWPs, such as desalination of brackish groundwater, may become feasible responses to DWDOR conditions.

7.7.3 Other Drought Recommendations

Region F recognizes that while drought preparedness, including DCPs, are an important tool, in some instances drought cannot be prepared for, it must be responded to. Region F recognizes the Drought Preparedness Council's ability to assist with drought response when needed. Region F, however, maintains that DCPs developed by the local, individual water providers are the best available tool for drought management. Region F fully supports the use and implementation of individual DCPs during times of drought.

To better prepare for future droughts, Region F makes the following recommendations:

- That the Regional Water Plans remain a separate process for developing long-term water supply solutions for increased growth. The Regional Water Plans should not be the resource for times of emergency drought.
- The Drought Preparedness Council should increase coordination with local providers regarding drought conditions and potential implementation of drought stages, particularly during times of limited precipitation.

LIST OF REFERENCES

[1] Texas Water Development Board "Water Data for Texas" <https://www.waterdatafortexas.org/reservoirs/region/region-f>

[2] Naturalized flow for seven points from the WAM <https://www.tceq.texas.gov/permitting/water_rights/wr_technical-resources/wam.html>

[3] Historical Annual Precipitation for Midland International Airport < https://www.ncei.noaa.gov/cdo-web>

[4] PDSI data https://wrcc.dri.edu/wwdt/time

[5] U.S. Drought Monitor <https://droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx>