7 DROUGHT RESPONSE INFORMATION, ACTIVITIES, AND RECOMMENDATIONS

7.1 Drought Conditions and Droughts of Record

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* [1] provides more specific and detailed definitions:

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

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

- *Hydrological Drought.* Refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, 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 needs 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.

Definitions

Drought of Record: The worst drought to occur in a region during the entire period of hydrologic and/or meteorological record keeping.

Drought Contingency Plan: State mandated plan that identifies different stages of drought and specific triggers and response for each stage. In addition, the plan must specify quantifiable targets for water use reductions for each stage, and a means and method for enforcement.

Run of River Supply: Water right permit that allows the permit holder to divert water directly out of a stream or river." 2012 State Water Plan

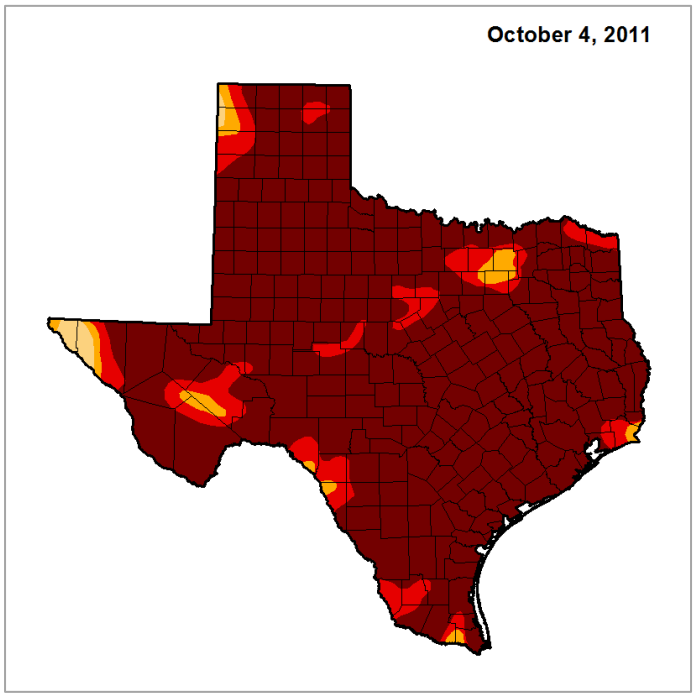
These definitions are not mutually exclusive and provide valuable insight into the complexity of droughts and their impacts. They also help to identify factors to be considered in the development of appropriate and effective drought preparation and contingency measures.

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

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

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

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 is the Drought Monitor that incorporates measurements of climatic, hydrologic and soil 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, most, if not all, of the counties in the PWPA experienced at least some periods of severe or extreme drought. Conditions have improved since 2011 with significant rainfalls in recent years, but some areas in the PWPA are still experiencing hydrological drought conditions. Figure 7-1 shows the historical storage of PWPA reservoirs.



Drought Monitor, October 2011

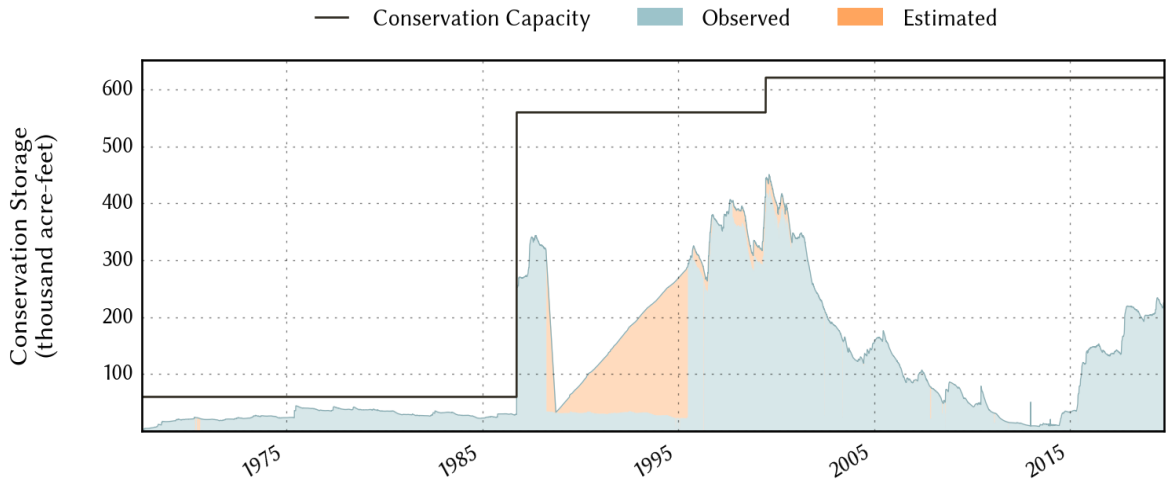


Figure 7-1: Combined Reservoir Storage in the PWPA

Source: Water Data For Texas: https://www.waterdatafortexas.org/reservoirs/region/panhandle

7.1.1 Drought of Record in the Panhandle Water Planning Area

The drought of record is commonly defined as the worst drought to occur in a region during the entire period of hydrologic and/or meteorological record keeping. Historically, for much of Texas the drought of record occurred from 1950 to 1957. During the 1950s 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.

For most of the PWPA, the current drought has eclipsed the drought of the 1950s. This drought has had a substantial impact on surface water supplies within the PWPA. All three major reservoirs in the PWPA are currently in the critical drought period. In 2011, Lake Meredith recorded the lowest historical inflow at approximately 6,300 acre-feet. Both Lake Meredith and Palo Duro Reservoir, which are in the Canadian River Basin, were at less than 10 percent until 2015. As of May 2019, Lake Meredith has improved to approximately 40 percent (Figure 7-2), and Palo Duro Reservoir remains at less than 10 percent (Figure 7-3). Greenbelt Reservoir, located in the Red River Basin, is approximately 20 percent full. (Figure 7-4).

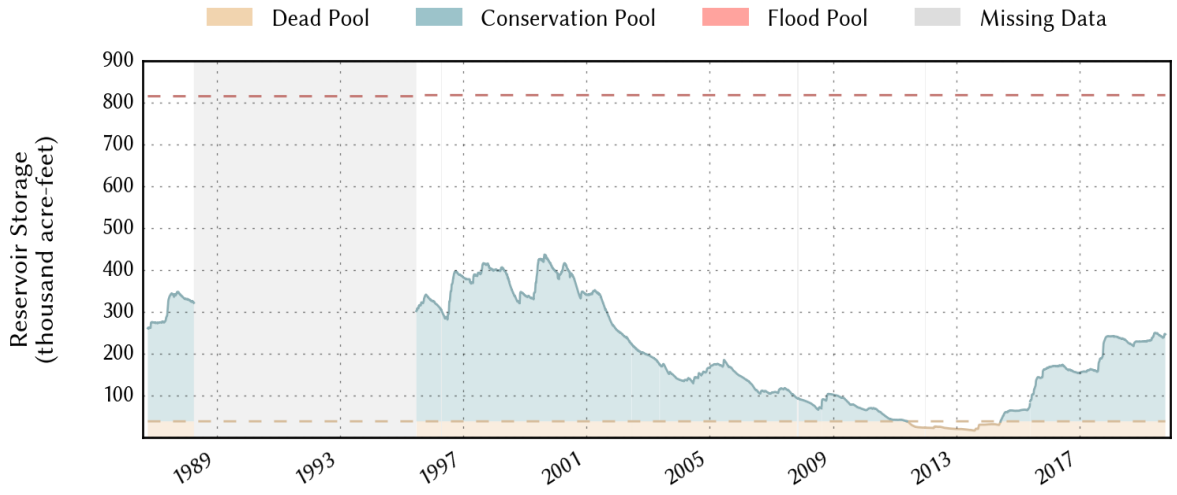


Figure 7-2: Historic Storage in Lake Meredith

Source: Water Data For Texas: https://www.waterdatafortexas.org/reservoirs/individual/meredith

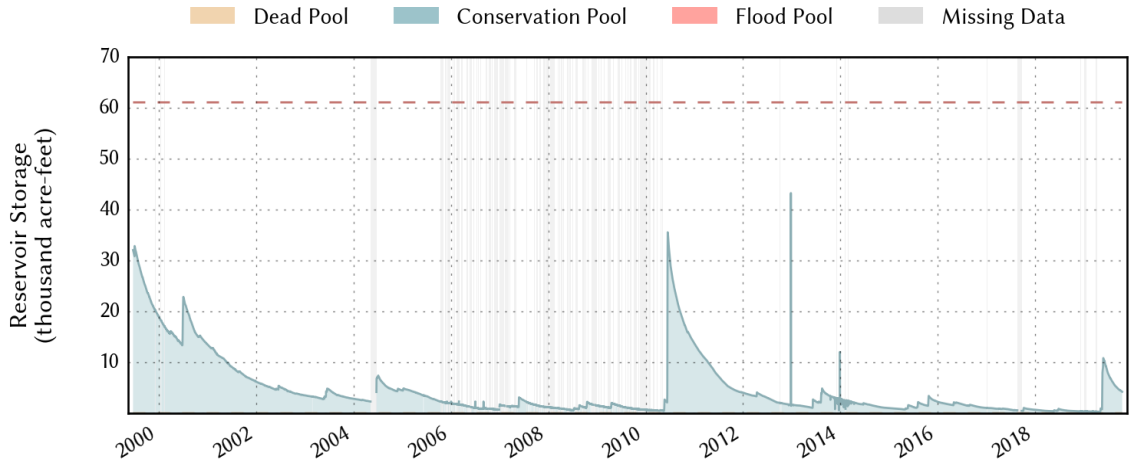


Figure 7-3: Historic Storage in Palo Duro Reservoir

Source: Water Data For Texas: https://www.waterdatafortexas.org/reservoirs/individual/palo-duro

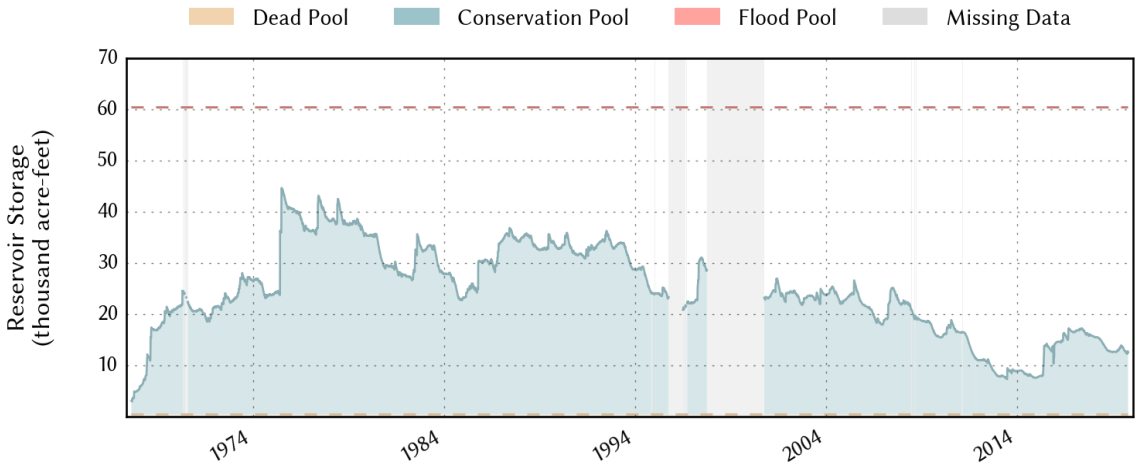


Figure 7-4: Historic Storage in Greenbelt Reservoir

Source: Water Data For Texas: https://www.waterdatafortexas.org/reservoirs/individual/greenbelt

For reservoirs, the drought of record is defined as the period of record that includes the minimum content of the reservoir. The period is recorded from the last time the reservoir spills before reaching its minimum content to the next time the reservoir spills. If a reservoir has reached its minimum content but has not yet filled enough to spill, then it is considered to be still in drought of record conditions. Based on the water availability modeling, the droughts of record for the reservoirs in the PWPA are shown in Table 7-1.

Table 7-1: Droughts of Record for PWPA Reservoirs

Reservoir	Date last full[1]	Date of minimum content	Drought of Record
Meredith	April 2000	March 2012[2]	2000 - Current
Palo Duro	May 1973	June 1996[3]	1973 - Current
Greenbelt	June 1962	June 2011[2]	1962 - Current

[1] None of the PWPA lakes have ever filled. The Date Last Full is based on the firm yield analyses. (Note: Firm yield analyses assume the reservoir is full at the beginning of the simulation.)
[2] Date of the end of the simulation.
[3] Hydrology for WAM simulation for the Palo Duro Reservoir ends in 2004. It was not extended.

For groundwater supplies, meteorological and agricultural conditions were considered for defining the drought of record in the PWPA. The National Atmospheric and Oceanic Administration (NOAA) maintains data on the historical meteorological conditions and drought indices across the country. Figure 7-5 shows the historical precipitation in the High Plains Region of Texas.

Based on this graph, the annual precipitation across the region averages 18.56 inches from 1895 to 2013. The years with the lowest historical precipitation occurred in 1956 and 2011 with 9.57 inches recorded in 1956 and 7.39 inches recorded in 2011. Both years occur during extreme drought.

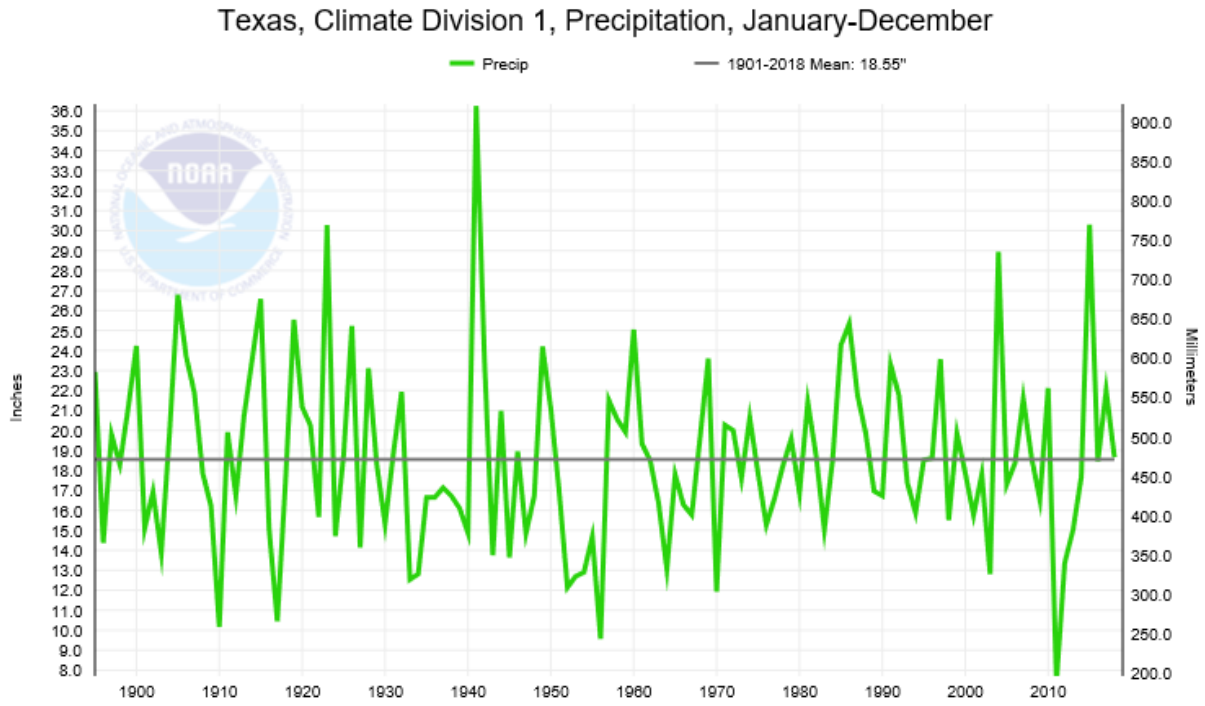


Figure 7-5: Historical Annual Precipitation for the High Plains of Texas

Source: NOAA website (http://www.ncdc.noaa.gov/cag/time-series/us)

Drought of record conditions for run-of-river supplies are typically evaluated based on minimum annual stream flows. Figure 7-6 shows the historical stream flows for selected gages in the PWPA for both the Canadian and Red River Basins. Based on these gages, 2011 was the year with the lowest annual stream flow in the Canadian River Basin. It also was an extreme drought year in the Red River Basin, but there were other years with lower annual flows on the Salt Fork (2013) and North Fork (1996) of the Red River. Considering the overall basin drought, 2011 is the drought of record for the run-of-river supplies in the PWPA.

Drought of Record in PWPA

Reservoir Drought of Record: For reservoirs, the drought of record is defined as the period from the last time the reservoir spills before reaching its minimum content to the next time the reservoir spills. All major reservoirs in PWPA are currently in the Drought of Record.

Run of River Drought of Record: Based on minimum annual stream flows. For both the Canadian River Basin and the Red River Basin, the Drought of Record is considered to be the year 2011.

Groundwater Drought of Record: Generally defined by meteorological and agricultural conditions. In Region A, the years with the lowest recorded precipitation were 1956 and 2011.

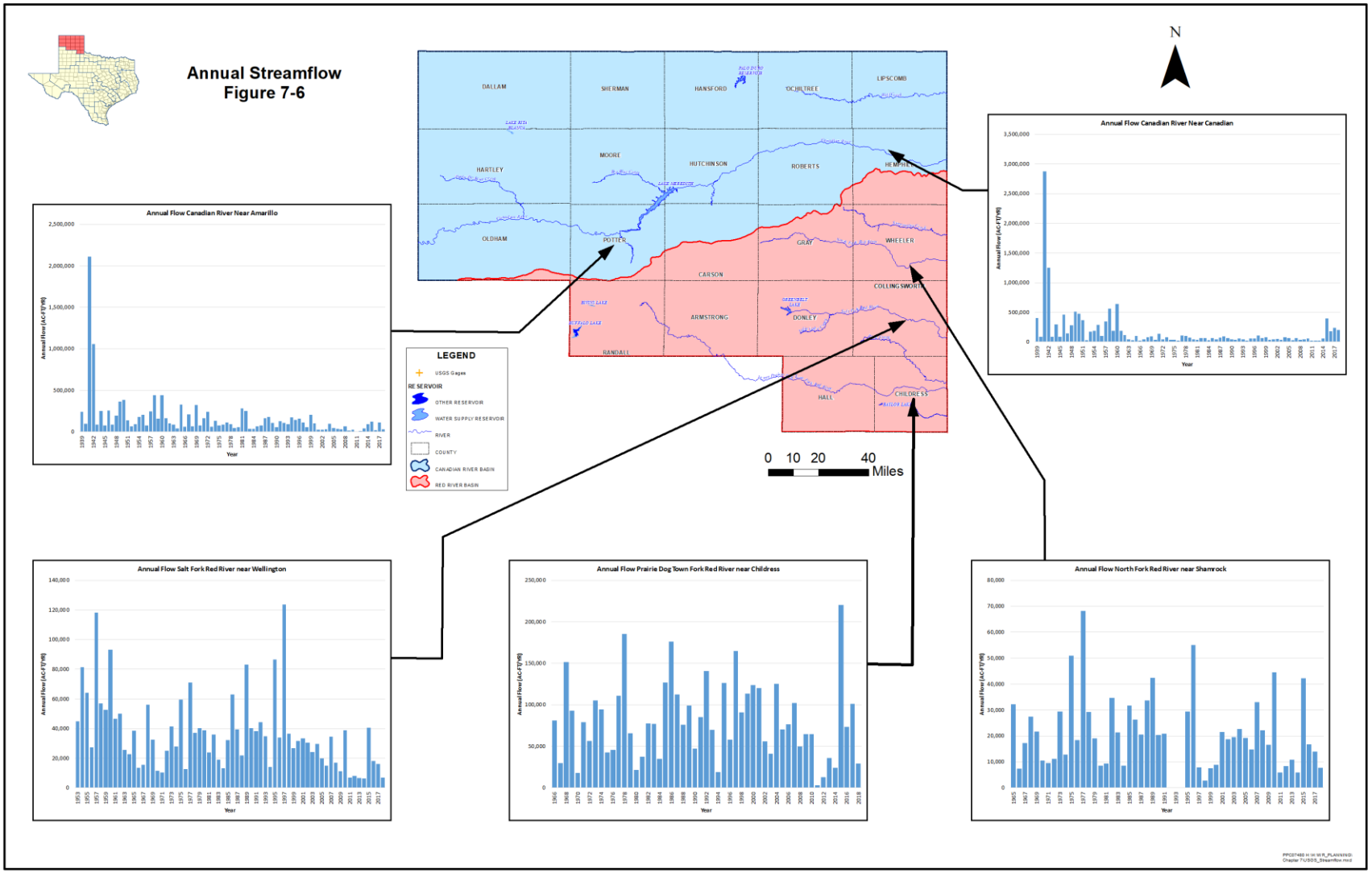


Figure 7-6: Historical Streamflows in the Canadian and Red River Basins

Looking at the PDSI over the same time period, Figure 7-7 clearly shows the drought impacts during the 1950s and again since 2011. The PDSI provides 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 the PWPA, 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 sources is the current drought that started in 2011.

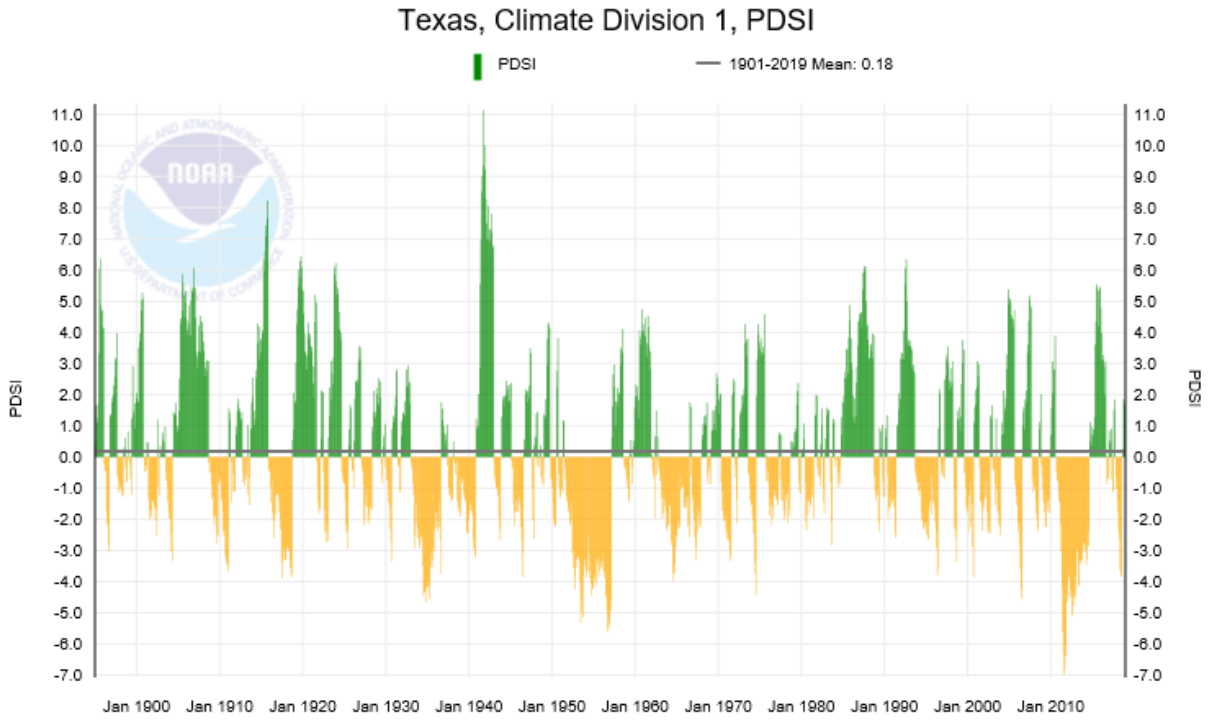


Figure 7-7: Palmer Drought Severity Indices for the High Plains of Texas

Source: NOAA website (http://www.ncdc.noaa.gov/cag/time-series/us)

7.1.2 Impact of Drought on Water Supplies

Drought is a major threat to surface water supplies in the PWPA and groundwater supplies that rely heavily on recharge (such as the Seymour aquifer). The Ogallala aquifer, which provides most of the water supplies in the PWPA, is less impacted by reduced recharge associated with meteorological droughts. However, the Ogallala aquifer is greatly impacted by agricultural droughts (which typically follow meteorological droughts) because the demands on the water source can increase significantly. Over time, the lack of recharge combined with increased demands can impact the amount of storage in the aquifer for future use.

For surface water supplies, hydrological drought is significant because it impacts the yield of water source. Typically, multi-year droughts have the greatest impacts on a reservoir yield. As previously discussed, the Lake Meredith watershed is currently experiencing its lowest inflows since the reservoir was constructed. This impacts water supplies to users in both the PWPA and Llano Estacado Region. To better understand some of the factors contributing to the decline in inflows, a special study on the Lake Meredith watershed was conducted as part of the 2011 regional water plan (Salazar and Schnier, 2010). A concurrent study on drought in the entire Canadian River watershed above Lake Meredith was conducted by the Bureau of Reclamation in conjunction with others (Brauer et al, 2011).

Both studies concluded that it appears there is no one factor or event that appears to be the major contributor to the decline of inflows to Lake Meredith. Annual precipitation, potential evaporation, and changes in irrigation practices do not appear to be contributing factors. The Salazar and Schnier study hypothesized that the combination of factors, including reduced rainfall intensities, increasing shrubland and declining groundwater levels, have resulted in decreased runoff below Ute Reservoir. The Brauer study did not attribute the impacts of increased shrubland to the declining runoff. This conclusion was supported by the continued low stream flows in the watershed following extensive brush control and removal. The Brauer study noted that the entire Canadian River watershed was experiencing drought conditions and reduced reservoir storage. Both studies acknowledged that the activities in the watershed above the Logan gage (Ute Reservoir) may be a significant factor with respect to the total amount of inflow to Lake Meredith. Figure 7-8 shows the historical gage flow at Logan (just below Ute Reservoir) and the historic water levels in Lake Meredith. Most of the flows at the Logan gage are releases from Ute Reservoir.

These studies show that drought can have a significant impact on a water source's reliable supply, but if drought is combined with other factors the results can be catastrophic.

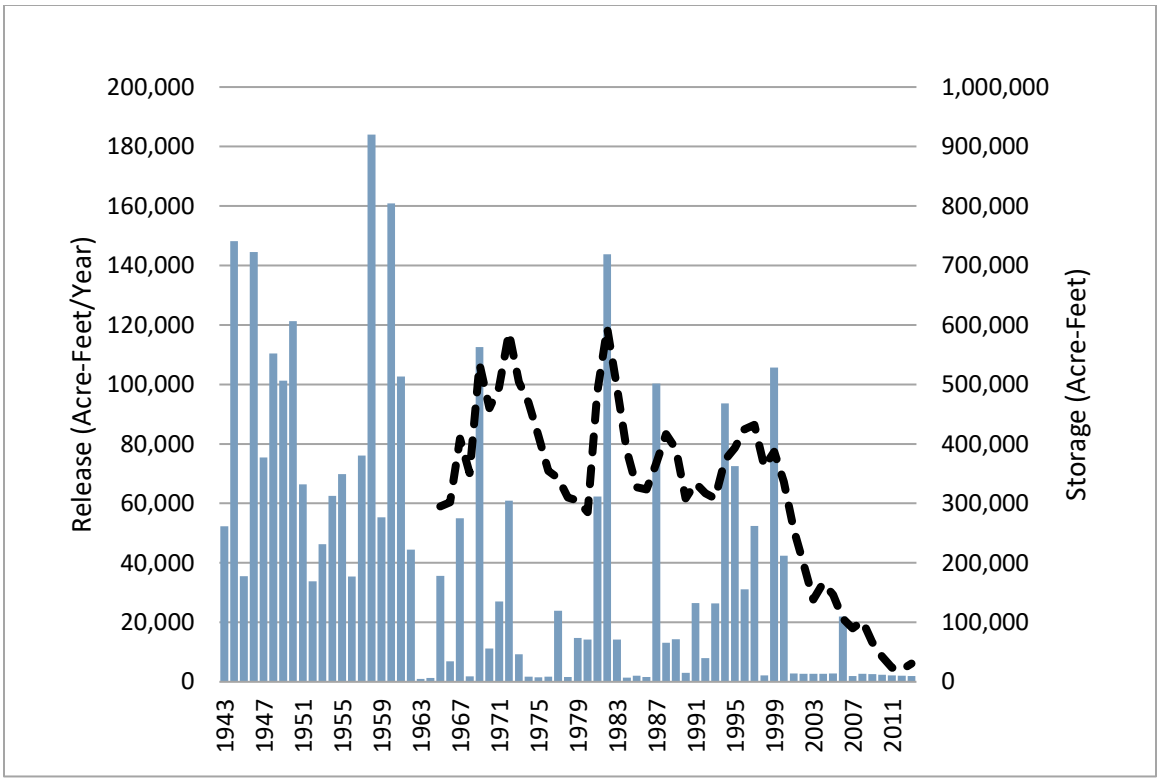


Figure 7-8: Comparison of Lake Meredith Lake Levels to Flows at Logan Gage

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 submit drought contingency plans (DCP). TCEQ now also requires all retail public water suppliers serving less than 3,300 connections to prepare and adopt DCPs by no later than May 1, 2009. All DCPs shall be updated every five years and be available for inspection upon request. The most recent updates were to be submitted to the TCEQ by May 1, 2019.

All wholesale water providers and most municipalities in the PWPA have taken steps to prepare for and respond to drought through efforts including the preparation of individual DCPs and readiness to implement the DCPs as necessary. These drought plans include specific water savings goals and measures associated with multiple drought stages. In addition to these plans, many water providers have a Management Supply Factor (or safety factor) greater than 1.0 for demands that are essential to public health and safety.

DCPs typically identify different stages of drought and specific triggers and response for each stage. In addition, the plan must specify quantifiable targets for water use reductions for each stage, and a means and method for enforcement.

7.2.1 Drought Preparedness

In general, water suppliers in PWPA identify the onset of drought (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 the PWPA, the reservoir operators use a combination of reservoir storage (elevation triggers) and/or demand levels. Triggers for groundwater supplies are commonly determined based on water well elevations or demand. Suppliers set these triggers as needed based on the individual parameters of their system. Customers of a wholesale water provider are subject to the triggers and measures of the providers' DCPs.

Eight DCPs were submitted to the PWPG during this round of planning. Twelve other plans were submitted during the previous planning cycle and are considered in this plan. The majority of the submitted plans use trigger conditions based on the demands placed on the water distribution system. Of the plans reviewed, three users based trigger actions on well levels, eight based actions on storage reservoir levels, and nine based actions on demands/consumption. Table 7-2 summarizes the basis of the drought triggers by provider. Attachment 7-1 summarizes the triggers and actions by water provider for initiation and response to drought. Attachment 7-2 summarizes the DCPs submitted to the PWPG.

Table 7-2: Type of Trigger Condition for Entities with Drought Contingency Plans

Entity	Type of Trigger Condition		Implemented since 2015
	Demand	Supply	
Amarillo	X	X	No
Borger	X	X	No
Canyon		X	No
Childress	X		No
Claude	X		No
CRMWA		X	No
Dalhart	X		No
Dumas	X		No
Greenbelt	X	X	No
Gruver	X		No
Higgins	X	X	No
McLean	X	X	No
Palo Duro RA		X	No
Pampa		X	No
Perryton	X		No
Red River Authority		X	No
Shamrock	X		No
Turkey		X	No
Wellington	X		No
White Deer	X		No

While the DCPs triggers and responses are unique to each entity, they are clear and specific to the entity. Differences between entities should not confuse the public or otherwise impede drought response efforts due to the geographic separation of the entities in the PWPA. Drought responses for Major Water Providers, such as CRMWA, are clearly conveyed to all customers. No entity in the PWPA has implemented their DCP in the last five years.

Challenges to the drought preparedness in the PWPA 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. Also, increased demands placed additional competition for water between agriculture and municipalities leading to lower water levels.

Water providers of surface water sources have proactively developed supplemental groundwater sources, providing additional protections during drought. Many groundwater users expand groundwater production in response to drought. Groundwater in the PWPA provides a more drought-resilient water source, but it needs to be managed to assure future supplies.

7.3 Existing and Potential Emergency Interconnects

According to Texas Statute §357.42(d),(e) [(2)] regional water planning groups are to collect information on existing major water infrastructure facilities that may be used in the event of an emergency need 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 the PWPA.

7.3.1 Existing Emergency Interconnects

Major water infrastructure facilities within the PWPA were identified through a survey process in order to better evaluate existing and potentially feasible emergency interconnects. Several main water suppliers identified were Philips, which obtains water from the Ogallala, Tri-City Water Company, and the Greenbelt MIWA. Table 7-3 presents the survey results for the existing emergency interconnects among water users and neighboring systems.

Table 7-3: Existing Emergency Interconnects to Major Water Facilities in the PWPA

Entity *Providing* Supply	Entity *Receiving* Supply
Phillips County	TCW Supply
Greenbelt Water Authority	City of Memphis
Tri-City Water Company	City of Stinnett
Phillips County	City of Stinnett
Phillips Borger Plant	City of Borger

7.3.2 Potential Emergency Interconnects

Responses to survey questions helped identify other potential emergency interconnects for various WUGs in the PWPA. Table 7-4 presents a list of cities for those receiving and those supplying the potential emergency interconnects.

It was determined that additional emergency interconnects to the CRMWA system are feasible. However, it is assumed that the interconnects are probably limited to those facilities either currently within the CRMWA structure or near existing distribution lines. One of the most limiting factors for developing practical interconnects in the PWPA is the large distance that separates many cities and small towns.

In addition, an assessment was conducted to identify cities within a fifteen-mile radius to existing CRMWA distribution lines. Fifteen miles was assumed to be the farthest distance any system would find feasible for an alternative water supply during an emergency water need. Cities that meet the fifteen-mile radius requirement include: Stinnett, Fritch, TCW Supply Inc., Sanford, and Lake Tanglewood (Table 7-4).

The Greenbelt MIWA was not surveyed but should be included in the discussion of being a potential emergency interconnect. Within the PWPA, Greenbelt MIWA serves customers in the counties of Donley, Collingsworth, Hall and Childress. Only one small community was identified that potentially could interconnect to the Greenbelt MIWA system during an emergency water need. Several other rural communities in the PWPA are already served by this provider. As shown in Table 7-4, the community meeting the maximum 15-mile radius requirement is Lakeview.

Emergency interconnects were found to be not practical for many of the entities that were evaluated for potential emergency water supplies due to the long distance of transmission and size of facilities. The type of infrastructure required between entities to provide or receive water during an emergency need was deemed impractical due to long transmission distances. Furthermore, it was deemed impractical during an emergency situation, to complete the required construction time in a reasonable timeframe.

Table 7-4: Potential Emergency Interconnects to Major Water Facilities in the PWPA

Entity *Providing* Supply	Entity *Receiving* Supply
CRMWA	Stinnett
	Fritch
	TCW Supply Inc.
	Sanford
	Lake Tanglewood
Greenbelt MIWA	Lakeview
WRB Refining	Borger
Amarillo	Borger
Borger	Sanford
	Stinnett
	RBC

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

Texas Statute §357.42(g) [3] requires regional water planning groups to evaluate potential temporary emergency water supplies for all County-Other WUGs and municipalities with 2010 populations less than 7,500 that rely on a sole source of water. The purpose of this evaluation is to identify potential alternative water sources that may be considered for temporary emergency use in the event that the existing water supply sources become temporarily unavailable due to extreme hydrologic conditions such as emergency water right curtailment, unanticipated loss of reservoir conservation storage, or other localized drought impacts.

This section provides potential solutions that should act as a guide for municipal water users that are most vulnerable in the event of a loss of supply. This review was limited and did not require technical analyses or evaluations following in accordance with 31 TAC §357.34.

7.4.1 Emergency Responses to Local Drought Conditions

A survey was conducted to identify and evaluate the municipal water users that are most vulnerable in the event of an emergency water need. The analysis included all 'county-other' WUGs and rural cities with a population less than 7,500 and on a sole source of water that were within 5 miles of another water system.

Figure 7-9 presents a PWPA map delineating municipalities that meet the analysis requirements. Three main reservoirs (Greenbelt, Lake Meredith and Palo Duro) were included on the map, along with the

major water infrastructure facilities (CRMWA and Greenbelt) discussed in Section 7.3. The map illustrates a general proximity to potential alternative water sources that may be considered for temporary emergency use.

Table 7-5 presents 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.

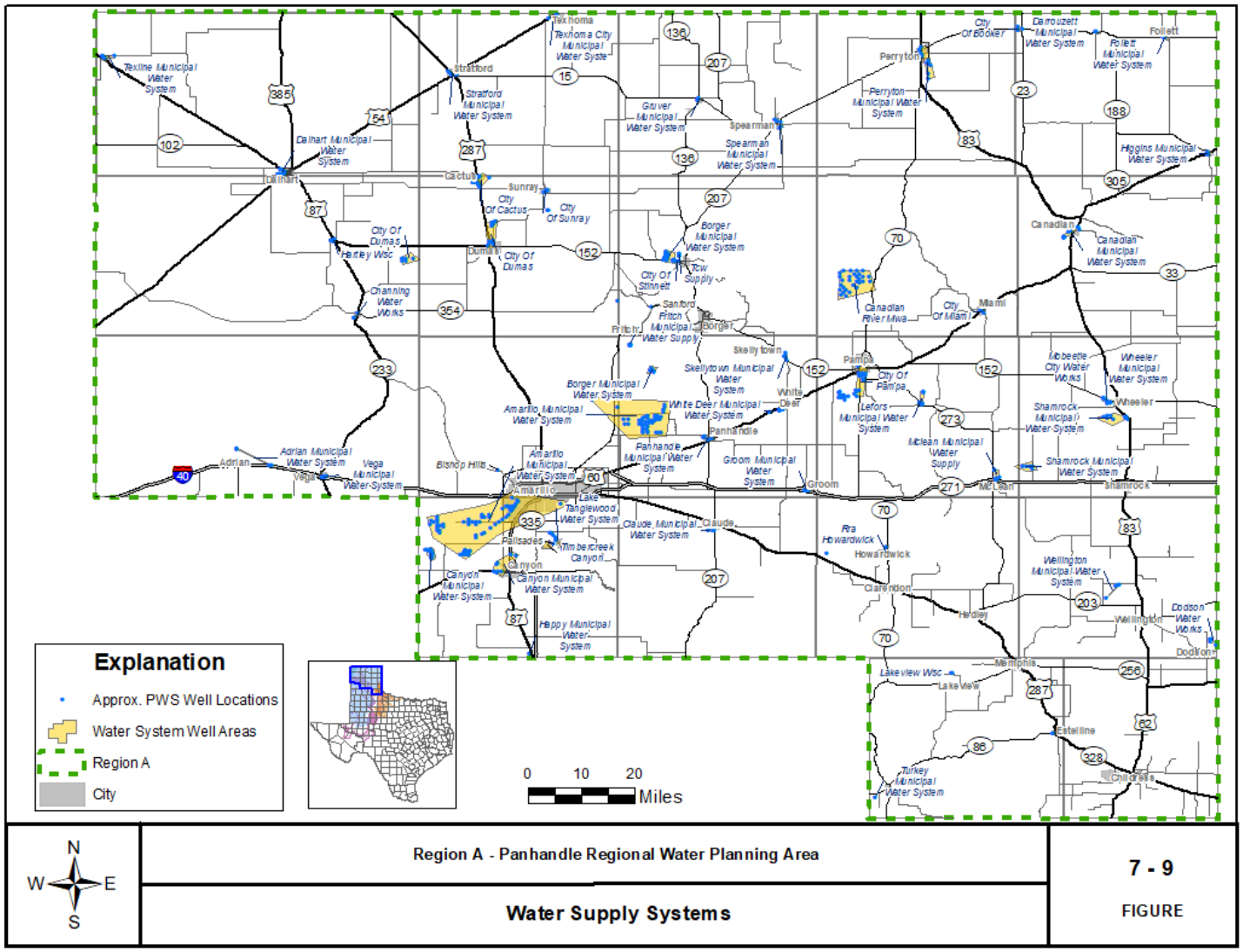


Figure 7-9: Entities Considered for Emergency Supplies

Table 7-5: Emergency Responses to Local Drought Conditions in the PWPA.

Entity				Potential Emergency Water Supply Source(s)							Implementation Requirements		
Water User Group Name	County	2020 Population	2020 Demand (ac ft/yr)	Drill additional groundwater wells	Brackish groundwater limit treatment	Brackish groundwater desalination	Emergency interconnect	Other named local supply	Trucked in water	Voluntary transfer from irrigation	Type of infrastructure required	Entity providing supply	Emergency agreements already in place
Booker	Lipscomb	1,740	496	▪					▪	▪			
	Ochiltree	22	6	▪					▪	▪			
Cactus	Moore	3,179	985	▪	▪	▪			▪	▪			
Canadian	Hemphill	2,775	823	▪					▪				
Claude	Armstrong	1,202	360	▪	▪	▪			▪	▪			
Fritch	Hutchinson	2,968	592	▪					▪	▪		CRMWA	
	Moore	14	3	▪					▪				
Groom	Carson	568	177	▪					▪	▪			
Gruver	Hansford	1,353	350	▪					▪	▪			
Happy	Randall	678	10	▪	▪	▪			▪				
Lake Tanglewood	Randall	1,096	438	▪	▪	▪			▪	▪		CRMWA	
McLean	Gray	800	210	▪		▪			▪	▪			
Miami	Roberts	600	225	▪					▪	▪			
Panhandle	Carson	2,470	576	▪					▪	▪			
Shamrock	Wheeler	1,910	350	▪		▪			▪	▪			
Spearman	Hansford	3,364	670	▪					▪	▪			
Stinnett	Hutchinson	1,917	454	▪			▪			▪		Phillips; Tri-City Water Company	Stinnett

Entity				Potential Emergency Water Supply Source(s)							Implementation Requirements		
Water User Group Name	County	2020 Population	2020 Demand (ac ft/yr)	Drill additional groundwater wells	Brackish groundwater limit treatment	Brackish groundwater desalination	Emergency interconnect	Other named local supply	Trucked in water	Voluntary transfer from irrigation	Type of infrastructure required	Entity providing supply	Emergency agreements already in place
Stratford	Sherman	2,134	496	▪					▪	▪			
Sunray	Moore	1,945	450	▪					▪	▪			
TCW Supply Inc.	Hutchinson	1,955	690	▪			▪		▪	▪		Phillips	▪
Texline	Dallam	512	219	▪	▪	▪			▪	▪			
Vega	Oldham	1,036	272	▪	▪	▪			▪				
Wellington	Collingsworth	2,189	524	▪					▪				
Wheeler	Wheeler	1,547	493	▪					▪	▪			
White Deer	Carson	1,068	113	▪					▪	▪	Pump Station & Treatment	Groom	
County-Other[1]		2010 Population											
Skellyton	Carson	619		▪					▪	▪			
Adrian	Oldham	166		▪	▪	▪			▪				
Bishop Hills	Potter	193		▪	▪	▪			▪				
Channing	Hartley	363		▪	▪	▪			▪	▪			
Darrouzett	Lipscomb	350		▪					▪	▪			
Dodson	Collingsworth	109		▪		▪			▪				

Entity				Potential Emergency Water Supply Source(s)							Implementation Requirements		
Water User Group Name	County	2010 Population	2020 Demand (ac ft/yr)	Drill additional groundwater wells	Brackish groundwater limited treatment	Brackish groundwater desalination	Emergency interconnect	Other named local supply	Trucked in water	Voluntary transfer from irrigation	Type of infrastructure required	Entity providing supply	Emergency agreements already in place
Follett	Lipscomb	459		▪					▪	▪			
Hartley	Hartley	540		▪	▪	▪			▪	▪			
Higgins	Lipscomb	397		▪					▪	▪			
Howardwick	Donley	402		▪		▪			▪	▪			
Lakeview	Hall	199		▪					▪			Greenbelt	
Mobeetie	Wheeler	101		▪			▪		▪	▪	Piping from well to treatment plant	Wheeler	
Palisades	Randall	325		▪	▪	▪			▪				
Sanford	Hutchinson	164		▪					▪	▪		CRMWA; Borger	
Texhoma	Sherman	346		▪					▪	▪			
Timbercreek Canyon	Randall	418		▪	▪	▪			▪				
Turkey	Hall	421		▪		▪			▪				
Lefors	Gray	540		▪		▪			▪	▪			
Grandview	Gray			▪					▪		Pump Station & Treatment	Groom	

[1] The analysis included all 'county-other' WUGs and rural cities with a population less than 7,500 and on a sole source of water that were within 5 miles of a potential water system. Figure 7-9 illustrates a general proximity (within 5 miles) to potential alternative water sources that may be considered for temporary emergency use.

7.4.2 Voluntary Transfer of Irrigation Rights

An additional evaluation was conducted which considered voluntary transfer of irrigation rights as an emergency response to local drought conditions. Voluntary transfer of irrigation rights is the payment for temporary transfer of local irrigation supplies for other uses. Voluntary transfer or "irrigation suspension" programs have been implemented successfully by the Edwards Aquifer Authority. The plan is that WUGs would be willing and able to pay for temporary suspension and transfer of irrigation water from local wells to avoid trying to develop more distant sources that may prove impractical. By tapping local sources, WUGs could minimize construction cost and time required to develop infrastructure required for the emergency solution. Table 7-5 presents the entities in the PWPA where voluntary transfer of irrigation rights might be feasible, given their proximity to currently used irrigated areas. Of the 42 entities listed, 31 communities were found to be located in applicable areas, making voluntary transfer of irrigation rights a potential drought management response.

7.4.3 Releases from Upstream Reservoirs and Curtailment of Rights

Releases from upstream reservoirs and the curtailment of upstream/downstream water rights were considered but were not identified as appropriate responses for the rural communities in the PWPA.

7.4.4 Brackish Groundwater

Brackish groundwater was evaluated as a temporary source during an emergency water need. Some brackish groundwater is found in certain places in the Ogallala, but other brackish groundwater supplies can be obtained from the Dockum, Rita Blanca, and other formations which underlie the shallow aquifers found in the PWPA.

Required infrastructure would include additional groundwater wells, potential treatment facilities and conveyance facilities. Brackish groundwater at lower TDS concentrations may require only limited treatment. Eighteen of the 43 entities listed in Table 7-5 will be able to potentially use brackish groundwater as a feasible solution to an emergency local drought condition.

7.4.5 Drill Additional Local Groundwater Wells and Trucking in Water

In the event that the existing water supply sources become temporarily unavailable, drilling additional groundwater wells and trucking in water are optimal solutions. Table 7-5 presents these options as viable for all 43 entities listed.

7.5 Region-Specific Drought Response Recommendations and Model Drought Contingency Plans

As required by the TWDB, the PWPG 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 PWPG 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 DCP. 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 the PWPA and the associated managers and users of the source is included in Attachment 7-1.

7.5.1 Drought Trigger Conditions for Surface Water Supply

Drought trigger conditions for surface water supply are customarily related to reservoir levels. The PWPG acknowledges that the DCPs for the suppliers who have surface water supplies are the best management tool for these water supplies. The PWPG recommends that the drought triggers and associated actions developed by the regional operator of the reservoirs are the PWPA regional triggers for these sources. A summary of these triggers and actions by reservoir as effective October 1, 2019 follows. The region also recognizes any modification to these drought triggers that are adopted by the regional operator.

Lake Meredith (Canadian River Municipal Water Authority)

CRMWA adopted a DCP on July 14, 1999 and the same was revised on January 12, 2011 and reviewed on April 10, 2019. Since CRMWA has multiple sources of water (Lake Meredith and Roberts County groundwater), the drought triggers are based on the Authority's total water supply. Lake Meredith has been in drought conditions for over a decade, with water levels generally declining since 2000. Recent rains have increased the water levels, but the lake is still in drought of record conditions. The triggers and actions for CRMWA are shown in the following table (Table 7-6). These triggers can be implemented at the time of any review of the supply by the CRMWA Board of Directors.

Table 7-6: Lake Meredith Drought Triggers and Actions

Drought Stage	Trigger (No. of Member Cities with Needs):	Action[1]
Mild	1 to 2	Public awareness; Promote conservation; Technical assistance to users; Cities to initiate appropriate stage of DCP
Moderate	3 to 5	Above
Severe	> 5	Above

[1] At any stage, CRMWA may restrict deliveries based on pro rata shares in accordance with State law, if needed.

Greenbelt Reservoir (Greenbelt Municipal and Industrial Water Authority)

The Board of Directors for Greenbelt Municipal and Industrial Water Authority passed a resolution adopting a DCP on August 19, 1999. Triggering criteria are based on water storage levels in the Greenbelt Reservoir and are described as follows:

Table 7-7: Greenbelt Reservoir Drought Triggers and Actions

Drought Stage	Trigger	Action [1]
Mild	Water level = 2,637 feet mean sea level (msl)	Voluntary measures to achieve 10% use reduction
Moderate	Water level = 2,634 feet msl; Demand > 7.5 million gallons per day (MGD)	20% use reduction; reduce customer storage to 75% capacity; initiate customer's Stage 2 of DCP
Severe	Water level = 2,631 feet msl; Demand > 7.5 MGD	30% use reduction; reduce customer storage to 50% capacity; initiate customer's Stage 3 of DCP
Emergency	Water level = 2,628 feet msl; Demand > 7.5 MGD Equipment failure; Water quality impairment	Actions as appropriate

[1] All stages include communications with customers and media.

Palo Duro Reservoir (Palo Duro Water District)

Palo Duro River Authority (now Palo Duro Water District) adopted a conservation plan for Palo Duro Reservoir in May of 1987. Triggering criteria are based on water storage levels in Palo Duro Reservoir and are described as follows:

Table 7-8: Palo Duro Reservoir Drought Triggers and Actions

Drought Stage	Trigger	Action
Mild	Water level = 2,876 feet msl	Communication, voluntary outdoor water schedule
Moderate	2,864 feet msl < Water level < 2,876 feet msl	10% reduction in deliveries, request mandatory limits in outdoor water use
Severe	Water level < 2,864 feet msl	Curtail deliveries as needed, request no outdoor water use, consider alternative supplies
Emergency	Equipment failure	Above

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 7.2.1, some water providers will have developed DCPs that are specific to their water supplies. Other water users, such as agricultural or industrial users, may not have DCPs. To convey drought conditions to all users of these

resources in the PWPA, the PWPG proposes to use the Drought Monitor. This information is easily accessible and updated regularly. It does not require a specific entity to monitor well water levels or stream gages. It is also geographically specific so that drought triggers can be identified on a sub-county level that is consistent with the location of use. The PWPG adopted the same nomenclature for the Drought Monitor for corresponding PWPA drought triggers. Table 7-9 shows the categories adopted by the U.S. Drought Monitor and the associated PDSI.

Table 7-9: Drought Severity Classification

Category	Description	Possible Impacts	Palmer Drought Severity Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered	-1.0 to -1.9
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water needs developing or imminent; voluntary water-use restrictions requested	-2.0 to -2.9
D2	Severe Drought	Crop or pasture losses likely; water needs common; water restrictions imposed	-3.0 to -3.9
D3	Extreme Drought	Major crop/pasture losses; widespread water needs or restrictions	4.0 to 4.9
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; needs of water in reservoirs, streams, and wells creating water emergencies	5.0 or less

Source: U.S. Drought Monitor: http://droughtmonitor.unl.edu/AboutUs/ClassificationScheme.aspx

For groundwater and run-of-river supplies, the PWPG recognizes that the initiation of drought response is the decision of the manager of the source and/or user of the source. The PWPG 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 DCPs were developed for the PWPG and are available online through the PWPG website (http://www.panhandlewater.org/). Each plan identifies four drought stages: mild, moderate, severe and emergency. Some plans also include a critical drought stage. The recommended responses range from notification of drought conditions and voluntary reductions in the "mild" stage to mandatory restrictions during an "emergency" stage. Each entity will select the trigger conditions for the different stages and the appropriate response. Entities should use the TAC 228 rules mandated by the TCEQ as the guideline in development of these plans.

7.6 Drought 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 means to minimize the adverse impacts of water supply needs during drought. The TCEQ requires drought contingency plans for wholesale and retail public water suppliers and irrigation districts. A drought contingency plan may also be required for entities seeking State funding for water projects. The PWPG does not recommend specific drought management strategies. The PWPG recommends the implementation of DCPs by suppliers when appropriate to reduce demand during drought and prolong current supplies. The PWPG also recommends the implementation of conservation measures for all users to conserve its water resources for the future.

7.7 Other Drought-Related Considerations

7.7.1 Texas Drought Preparedness Council and Drought Preparedness Plan

In accordance with TWDB rules, all relevant recommendations from the Drought Preparedness Council were considered in the writing of this Chapter. The Texas Drought Preparedness Council is composed of representatives from multiple State agencies and plays an important role in monitoring drought conditions, advising the governor and other groups on significant drought conditions, and facilitating coordination among local, State, and federal agencies in drought-response planning. The Council meets regularly to discuss drought indicators and conditions across the state and releases Situation Reports summarizing their finding.

Additionally, the Council has developed the State Drought Preparedness Plan, which sets forth a framework for approaching drought in an integrated manner in order to minimize impacts to people and resources. The PWPG supports the ongoing efforts of the Texas Drought Preparedness Council and recommends that water providers and other interested parties regularly review the Situation Reports as part of their drought monitoring procedures. The Council provided two recommendations to all RWPGs which are addressed in this chapter:

1. Follow the outline template for Chapter 7 provided to the regions by Texas Water Development Board staff in April of 2019, making an effort to fully address the assessment of current drought preparations and planned responses, as well as planned responses to local drought conditions or loss of municipal supply.

2. Develop region-specific model drought contingency plans for all water use categories in the region that account for more than 10 percent of water demands in any decade over the 50-year planning horizon.

To meet these recommendations, the PWPG has developed this chapter to correspond with the sections of the outline template. The PWPG has also developed a model DCP for water use categories that exceed 10 percent of the demands. For the PWPA, these use categories include irrigation only. A model DCP for irrigation is included in the 2021 Plan (see Section 7.5.3).

The PWPG does not recommend any drought management strategies as a long-term supply solution. Instead, it reserves these types of strategies for unanticipated emergency situations only.

7.7.2 Other Drought Recommendations

One of the challenges with drought in the PWPA is that the response to drought and associated impacts can vary depending upon the timing of the drought. Droughts that occur during the agricultural growing season can have a greater impact than if it occurs at other times. Since irrigated agriculture accounts for such a large percent of the water use in the region, the impacts of agricultural droughts on water supplies can be significant because it not only affects agricultural producers but also

impacts other users that rely on those supplies.

To be better prepared for future droughts, the PWPG has the following recommendations:

- Municipal water users that rely on groundwater should consider protecting its water supplies from competition through the acquisition of additional water rights and/or expansion of current well fields. Municipalities should take advantage of such opportunities if they become available.
- To minimize potential catastrophic failure of an entity's water system, the entity should provide sufficient resources to maintain its infrastructure in good condition. The PWPG recognizes that water main breaks and system failures do occur, but with proper maintenance these may be able to be reduced.
- Water users should continue to use water efficiently to conserve limited resources.

List of References

(1) Texas Water Development Board: *Chapter 357, Regional Water Planning Guidelines*, Austin, August 12, 2012.

(2) Texas Water Development Board: *Chapter 357, Regional Water Planning Guidelines*, *Rule 357.42 Drought Response Information, Activities, and Recommendations,* Austin, August 12, 2012.

(3) Drought Preparedness Council: *State Drought Preparedness Plan*, January 2001.

ATTACHMENT 7-1

SOURCES, SOURCE MANAGER, AND DROUGHT CONTINGENCY PLAN TRIGGERS

Sources, Source Manager, Drought Contingency Plan Triggers

Source	Manager[1]	PWPA User
Lake Meredith	CRMWA	Amarillo
		Borger
		Pampa
		Manufacturing (Potter County)
		Canyon
		County-Other (Randall County)
		Manufacturing (Randall County)
		Manufacturing (Hutchison County)
Greenbelt Lake	GMIWA	Childress County-Other
		Childress
		Donley County-Other
		Clarendon
		Hall County-Other
		Red River Authority (Childress County)
		Red River Authority (Collingsworth County)
		Red River Authority (Donley County)
		Red River Authority (Hall County)
		Memphis
Palo Duro Reservoir	PDRA	
Canadian River Run-of-River - Gray County		Irrigation (Gray County)
Canadian River Run-of-River - Hutchinson County		Irrigation (Hutchinson County)
Canadian River Run-of-River - Lipscomb County		Irrigation (Lipscomb County)
Canadian River Run-of-River - Moore County		Irrigation (Moore County)
Canadian River Run-of-River - Roberts County		Irrigation (Roberts County)
Canadian River Run-of-River - Hansford County		Irrigation (Hansford County)
Canadian River Run-of-River - Hutchinson County		Manufacturing (Hutchinson County)
Canadian River Run-of-River - Sherman County		Irrigation (Sherman County)
Red River Run-of-River - Carson County		Irrigation (Carson County)
Red River Run-of-River - Childress County		Irrigation (Childress County)
Red River Run-of-River - Collingsworth County		Irrigation (Collingsworth County)
Red River Run-of-River - Donley County		Irrigation (Donley County)
Red River Run-of-River - Gray County		Irrigation (Gray County)
Red River Run-of-River - Hall County		Irrigation (Hall County)
Red River Run-of-River - Randall County		Irrigation (Randall County)
Red River Run-of-River - Wheeler County		Irrigation (Wheeler County)
Blaine Aquifer - Hall County		Livestock (Hall County)
Blaine Aquifer - Collingsworth County		County-Other (Collingsworth County)
		Irrigation (Collingsworth County)
		Livestock (Collingsworth County)
Blaine Aquifer - Wheeler County		County-Other (Wheeler County)
		Irrigation (Wheeler County)
		Livestock (Wheeler County)
Blaine Aquifer - Childress County		Irrigation (Childress County)
		Livestock (Childress County)
Dockum Aquifer - Armstrong County		County-Other (Armstrong County)
		Irrigation (Armstrong County)
Dockum Aquifer - Dallam County		Irrigation (Dallam County)
Dockum Aquifer - Hartley County		Livestock (Hartley County)
		Irrigation (Hartley County)
Dockum Aquifer - Moore County		Irrigation (Moore County)
Dockum Aquifer - Sherman County		Irrigation (Sherman County)
Dockum Aquifer - Oldham County		County-Other (Oldham County)
		Irrigation (Oldham County)
		Livestock (Oldham County)
		Mining (Oldham County)
Dockum Aquifer - Potter County		County-Other (Potter County)
		Irrigation (Potter County)
		Manufacturing (Potter County)
		Livestock (Potter County)
Dockum Aquifer - Randall County	Happy	County-Other (Randall County)
		Canyon
		Lake Tanglewood
		Irrigation (Randall County)
		Livestock (Randall County)

Sources, Source Manager, Drought Contingency Plan Triggers

Source	Manager[1]	PWPA User
Ogallala Aquifer - Armstrong County	Claude	County-Other (Armstrong County)
		Irrigation (Armstrong County)
		Livestock (Armstrong County)
Ogallala Aquifer - Carson County	Amarillo	County-Other (Carson County)
	Groom	Irrigation (Carson County)
	Panhandle	Livestock (Carson County)
	Skellytown	Manufacturing (Carson County)
		Fritch
		Manufacturing (Hutchinson County)
	White Deer	Mining (Carson County)
Ogallala Aquifer - Dallam County	Dalhart	County-Other (Dallam County)
	Texline	Irrigation (Dallam County)
		Manufacturing (Dallam County)
		Livestock (Dallam County)
Ogallala Aquifer - Donley County		County-Other (Donley County)
		Red River Authority (Childress County)
		Red River Authority (Collingsworth County)
		Red River Authority (Donley County)
		Red River Authority (Hall County)
		Childress
		Clarendon
		Memphis
		Irrigation (Donley County)
		Livestock (Donley County)
Ogallala Aquifer - Gray County	Lefors	County-Other (Gray County)
	McLean	Irrigation (Gray County)
	Pampa	Mining (Gray County)
		Livestock (Gray County)
		Manufacturing (Gray County)
Ogallala Aquifer - Hansford County	Gruver	County-Other (Hansford County)
	Spearman	Irrigation (Hansford County)
		Livestock (Hansford County)
		Manufacturing (Hansford County)
		Mining (Hansford County)
Ogallala Aquifer - Hartley County		County-Other (Hartley County)
		Irrigation (Hartley County)
		Hartley WSC
		Mining (Hartley County)
		Dumas
		County-Other (Moore County)
		Livestock (Hartley County)
Ogallala Aquifer - Hemphill County	Canadian	County-Other (Hemphill County)
		Irrigation (Hemphill County)
		Livestock (Hemphill County)
		Manufacturing (Hemphill County)
		Mining (Hemphill County)
Ogallala Aquifer - Hutchinson County	Borger	County-Other (Hutchinson County)
		Irrigation (Hutchinson County)
	Stinnett	Livestock (Hutchinson County)
	TCW Supply Inc	Manufacturing (Hutchinson County)
		Mining (Hutchinson County)
Ogallala Aquifer - Lipscomb County	Booker	County-Other (Lipscomb County)
		Darrouzett
		Follett
		Higgins
		Irrigation (Lipscomb County)
		Livestock (Lipscomb County)
		Manufacturing (Lipscomb County)
		Mining (Lipscomb County)
Ogallala Aquifer - Moore County	Cactus	County-Other (Moore County)
	Dumas	Irrigation (Moore County)
	Fritch	Livestock (Moore County)
	Sunray	Manufacturing (Moore County)
		Mining (Moore County)

Sources, Source Manager, Drought Contingency Plan Triggers

Source	Manager[1]	PWPA User
Ogallala Aquifer - Ochiltree County	Booker	County-Other (Ochiltree County)
	Perryton	Irrigation (Ochiltree County)
		Livestock (Ochiltree County)
		Manufacturing (Ochiltree County)
		Mining (Ochiltree County)
Ogallala Aquifer - Oldham County	Vega	County-Other (Oldham County)
		Irrigation (Oldham County)
		Livestock (Oldham County)
Ogallala Aquifer - Potter County	Amarillo	County-Other (Potter County)
		Irrigation (Potter County)
		Livestock (Potter County)
		Mining (Potter County)
Ogallala Aquifer - Randall County	Amarillo	County-Other (Randall County)
	Canyon	Irrigation (Randall County)
	Lake Tanglewood	Livestock (Randall County)
		Manufacturing (Randall County)
Ogallala Aquifer - Roberts County	CRMWA	Amarillo
	Miami	Borger
		Pampa
		Canyon
		Manufacturing (Hutchinson County)
		Manufacturing (Potter County)
		Manufacturing (Randall County)
		County-Other (Roberts County)
		Irrigation (Roberts County)
		Livestock (Roberts County)
		Mining (Roberts County)
Ogallala Aquifer - Sherman County	Stratford	County-Other (Sherman County)
		Texhoma
		Manufacturing (Sherman County)
		Irrigation (Sherman County)
		Livestock (Sherman County)
		Mining (Sherman County)
Ogallala Aquifer - Wheeler County	Shamrock	County-Other (Wheeler County)
	Wheeler	Irrigation (Wheeler County)
		Livestock (Wheeler County)
		Mining (Wheeler County)
Other Aquifer - Armstrong County		Livestock (Armstrong County)
Other Aquifer - Childress County		Irrigation (Childress County)
		County-Other (Childress County)
Other Aquifer - Collingsworth County		Irrigation (Collingsworth County)
		Livestock (Collingsworth County)
Other Aquifer - Donley County		Livestock (Donley County)
Other Aquifer - Hall County		Livestock (Hall County)
		Irrigation (Hall County)
Other Aquifer - Wheeler County		County-Other (Wheeler County)
		Irrigation (Wheeler County)
		Livestock (Wheeler County)
Seymour Aquifer - Childress County		County-Other (Childress County)
		Irrigation (Childress County)
		Livestock (Childress County)
Seymour Aquifer - Collingsworth County	Wellington	County-Other (Collingsworth County)
		Irrigation (Collingsworth County)
		Livestock (Collingsworth County)
Seymour Aquifer - Hall County		County- Other (Hall County)
		Irrigation (Hall County)
		Turkey
		Red River Authority (Hall County)
		Livestock (Hall County)

1. Muncipalities that are shown as Manager of a source are also a User of the source. CRMWA and Greenbelt MIWA are the only entities that are only Managers of a source.

Summary of Drought Triggers and Action Recommendations

Source Name	Type (sw/gw)	Factor considered	TRIGGERS						ACTIONS					
			Source Manager			Users			Source Manager			Users		
			Mild	Severe	Critical/ Emergency	Mild	Severe	Critical/ Emergency	Mild	Severe	Critical/ Emergency	Mild	Severe	Critical/ Emergency
Lake Meredith	sw	Cities with shortages	1 to 2	> 5	> 5	Approaching shortage	shortage	shortage	Public awareness; Promote conservation; Technical assistance to affected customers			Implement appropriate stage of DCP		
Greenbelt Lake	sw	Water level	2637 msl	2631 msl	2628 msl	Same as Manager			Request users to reduce use by 10%	30% use reduction; customer storage reduced to 50%	Actions as appropriate	Voluntary reduction by 10%; review DCP	30% use reduction; Implement Stage 3 of DCP	Actions as appropriate
		Demand		> 7.5 MGD	> 7.5 MGD									
Palo Duro Reservoir	sw	Water level	2876 msl	< 2864 msl	equipment failure	NA	NA	NA	Voluntary outdoor water reductions	Limit deliveries; no outdoor water use	Limit deliveries; no outdoor water use	NA	NA	NA
Red River	sw	Drought Monitor	D1 (Moderate)	D2 (Severe)	D4 (Critical)	D1 (Moderate)	D2 (Severe)	D4 (Critical)	Review DCP; Initiate actions if appropriate	Review DCP; Initiate actions; consider additional supplies		Review DCP and implement ,if appropriate; consider voluntary demand reductions	Review DCP; Initiate actions; consider additional supplies	
Canadian River	sw	Drought Monitor	D1 (Moderate)	D2 (Severe)	D4 (Critical)	D1 (Moderate)	D2 (Severe)	D4 (Critical)	Review DCP; Initiate actions if appropriate	Review DCP; Initiate actions; consider additional supplies		Review DCP and implement ,if appropriate; consider voluntary demand reductions	Review DCP; Initiate actions; consider additional supplies	
Ogallala Aquifer	gw	Drought Monitor	D1 (Moderate)	D2 (Severe)	D4 (Critical)	D1 (Moderate)	D2 (Severe)	D4 (Critical)	Review DCP; Initiate actions if appropriate	Review DCP; Initiate actions; consider additional supplies		Review DCP and implement ,if appropriate; consider voluntary demand reductions	Review DCP; Initiate actions; consider additional supplies	
Seymour Aquifer	gw	Drought Monitor	D1 (Moderate)	D2 (Severe)	D4 (Critical)	D1 (Moderate)	D2 (Severe)	D4 (Critical)	Review DCP; Initiate actions if appropriate	Review DCP; Initiate actions; consider additional supplies		Review DCP and implement ,if appropriate; consider voluntary demand reductions	Review DCP; Initiate actions; consider additional supplies	
Blaine Aquifer	gw	Drought Monitor	D1 (Moderate)	D2 (Severe)	D4 (Critical)	D1 (Moderate)	D2 (Severe)	D4 (Critical)	Review DCP; Initiate actions if appropriate	Review DCP; Initiate actions; consider additional supplies		Review DCP and implement ,if appropriate; consider voluntary demand reductions	Review DCP; Initiate actions; consider additional supplies	
Dockum Aquifer	gw	Drought Monitor	D1 (Moderate)	D2 (Severe)	D4 (Critical)	D1 (Moderate)	D2 (Severe)	D4 (Critical)	Review DCP; Initiate actions if appropriate	Review DCP; Initiate actions; consider additional supplies		Review DCP and implement ,if appropriate; consider voluntary demand reductions	Review DCP; Initiate actions; consider additional supplies	
Other Aquifer	gw	Drought Monitor	D1 (Moderate)	D2 (Severe)	D4 (Critical)	D1 (Moderate)	D2 (Severe)	D4 (Critical)	Review DCP; Initiate actions if appropriate	Review DCP; Initiate actions; consider additional supplies		Review DCP and implement ,if appropriate; consider voluntary demand reductions	Review DCP; Initiate actions; consider additional supplies	

NA - Not Applicable. Currently there are no users of Palo Duro Reservoir

ATTACHMENT 7-2

SUMMARY OF DROUGHT CONTINGENCY PLANS IN PWPA

Summary of Current Drought Triggers and Responses in PWPA

		Onset of Drought						Severe Drought	
Water Provider	**Water Sources**	**Stage 1 Trigger**	**Response**	**Stage 2 Trigger**	**Response**	**Stage 3 Trigger**	**Response**	**Stage 4 Trigger**	**Response**
Amarillo	Ogallala, CRMWA	Demand>70% production capacity for 5 consecutive days	Request voluntary Watering Schedules and encourage other Conservation measures	Demand>80% production capacity for 5 consecutive days	Require mandatory Watering Schedule and other Conservation Methods as ordered by the Director	Demand>85% production capacity for 5 consecutive days	Require mandatory Watering Schedule between 8PM and 6AM and may prohibit nonessential water use	Demand>90% production capacity for 5 consecutive days	All nonessential watering prohibited. All commercial, institutional, industrial, and wholesale users shall be notified to initiate appropriate stage. Washing of mobile equipment is permitted only to a commercial vehicle washing facility. Director shall begin preparations for implementation of pro rata curtailment.
Borger	Ogallala, CRMWA	Total supply<6,240 AF/Y and supplies from CRMWA < 3,600 AF/Y	Achieve a voluntary 10% reduction in total water use. Best management practices for supply management. Voluntary water use restrictions for retail customers. Voluntary water use restrictions for wholesale and industrial customers.	Total supply<6,420 AF/Y and supplies from CRMWA <3,080 AF/Y	Achieve a 20% reduction in total water use. Best management practices for supply management. Water use restrictions for retail customers. Water use restrictions for wholesale and industrial customers.	Total supply<6,356 AF/Y and supplies from CRMWA <2,524 AF/Y	Achieve a 30% reduction in total water use. Best management practices for supply management. Water use restrictions for retail customers. Water use restrictions for wholesale and industrial customers.	Total supply<6,471AF/Y and supplies from CRMWA <1,967AF/Y	Achieve a 35% reduction in total water use. Best management practices for supply management. Water use restrictions for retail customers. Water use restrictions for wholesale and industrial customers.
Canyon	Ogallala, Dockum, Amarillo	Supply=<72.5% full	Achieve voluntary 5% reduction in use of total contracted water from storage. Implementation of supply management and demand measurement measures.	Supply=< 64% full	Achieve 10% voluntary reduction in uses of total contracted water from storage. Implementation of supply management and demand measurement measures.	Supply =< 56% full	Achieve 15% voluntary reduction in use of total contracted water from storage. Implementation of supply management and demand measurement measures.	Mechanical or system failures. Natural or man-made contamination.	Assess severity of emergency. Inform the utility director of each wholesale water customer. Undertake necessary actions for cleanup.
Childress	Ogallala	Supply and demand (Non Specified)	Voluntary 10% reduction in use	Supply and demand (Non Specified)	20% reduction in demand	Supply and demand (Non Specified)	30% reduction in water use	Supply and demand (Non Specified)	Initiate emergency response procedures.
Claude	Ogallala	Dry weather conditions before and during then normal landscape growing season	Voluntary 15% reduction in use	Demand>0.55 MGD for 3 consecutive days	Voluntary 25% reduction in use	Demand>0.575 MGD for 3 consecutive days	Voluntary 35% reduction in use	Water supply emergency such as major water line breaks, pump system failures	Voluntary 15% reduction in use
CRMWA	Ogallala, Meredith	One or two members cities cannot meet actual or expected demand	CRMWA will issue a press release in the cities affected, describing the initiation of Stage 1 of the Drought Contingency Plan and the general condition of water supply. Work with affected city(s) to promote water conservation. Provide technical help for affected city(s).	Three to five members cities cannot meet actual or expected demand.	Continue Stage 1 Responses. Work with additional affected cities to promote water conservation to the public. Work with additional affected cities to provide technical and request cities to initiate appropriate stage of DCP.	More than five members cities cannot meet actual or expected demand	Continue Stage 1 & Stage 2 Responses. Work with additional affected cities to promote water conservation to the public. Work with additional affected cities to provide technical and request cities to initiate appropriate stage of DCP.	N/A	

Summary of Current Drought Triggers and Responses in PWPA

		Onset of Drought						Severe Drought	
Water Provider	**Water Sources**	**Stage 1 Trigger**	**Response**	**Stage 2 Trigger**	**Response**	**Stage 3 Trigger**	**Response**	**Stage 4 Trigger**	**Response**
Dalhart	Ogallala	Dry weather conditions before and during then normal landscape growing season	Achieve 10% voluntary reduction in water use.	Demand>5.7 MGD for 3 consecutive days or equals 6 MGD on a single day	Achieve 20% reduction in daily demand.	Demand>6 MGD for 3 consecutive days or equals 6.3 MGD on a single day	Achieve 30% reduction in daily water demand.	Water supply emergency such as major water line breaks, pump system failures	Initiate emergency response procedures.
Dumas	Ogallala	Demand>85% production capacity of 3 consecutive days	Achieve a voluntary 10% reduction in daily water demand. Voluntary limit irrigation of landscaped areas by street address. Request practice of water conservation and nonessential water use.	Demand>90% production capacity for 3 consecutive days	Achieve a 15% reduction in daily water demand. Irrigation to be limited to two days a week. Use of water to wash a moto vehicle is prohibited except on watering days at designated hours. Water will be served at restaurants only when requested.	Demand=100% production capacity for 3 consecutive days	Achieve a 20% reduction in daily water demand. All Stage 2 requirements except irrigation of landscapes is prohibited by hose-end sprinklers. The watering of golf courses is prohibited and use of water for construction purposes from designated fire hydrants under special permit is to be discontinued.	Demand>=100% production capacity for 3 consecutive days	Achieve a 25% reduction in daily water demand. Irrigation of landscapes is limited to designated watering days and prohibited by used of hose-end sprinklers or permanently installed automatic sprinkler systems. Use of water to wash any motor vehicle, motorbike, boat, trailer or other vehicle not occurring on the premises of a commercial car or truck wash and not in immediate interest of public health/welfare is prohibited.
Greenbelt		Reservoir Elevation Level=2,367.00	Achieve a voluntary 10% reduction in total water use.	Reservoir Elevation Level=2,634.00 or Demand>=7.5MGD	Achieve a 20% reduction in total water use. Water authority would lower the level in all storage tanks to no more than 75% of capacity. Implement demand management measures.	Reservoir Elevation Level=2,631.00 or Demand>=7.5MGD	Achieve a 30% reduction in total water use. Water authority would lower the level in all storage tanks to no more than 50% of capacity. Implement demand management measures.	Reservoir Elevation Level=2,628.00 or Demand>=7.5MGD. Event of major water line water or pump or system failures occur. Natural or man-made contamination of water supply	Assess severity of the emergency and identify actions needed and time required to solve the problem. Inform all necessary parties and notify parties for assistance.
Gruver	Ogallala	Consumption reached 65% total production capacity for 5 consecutive days	Public notification of Stage 1 condition and encouragement of voluntary water conservation measures	Consumption reached 75% total production capacity for 5 consecutive days	City may require even/odd watering days or other restrictions on non-essential water uses	Consumption reached 80% total production capacity for 5 consecutive days	Restrictions for non-essential water uses and may require odd/even water days	Consumption reached 90% total production capacity for 5 consecutive days	Restrictions for non-essential water uses and may require odd/even water days
Higgins	Ogallala	Supply<= 90% of wells capacity or Demand>0.3 MGD for 3 consecutive days	Request voluntary water restrictions	Supply>90% of original well capacity for 3 consecutive days	Comply with requirements and restrictions on certain non-essential water use	Supply>95% of original well capacity for 3 days	Comply with requirements for Stage 3 non-essential water usages	Water supply outage	Comply with requirements for Stage 4
McLean	Ogallala	Consumption reached 65% total production capacity for 5 consecutive days	Public notification of Stage 1 condition and encouragement of voluntary water conservation measures	Consumption reached 75% total production capacity for 5 consecutive days	City may require even/odd watering days or other restrictions on non-essential water uses	Consumption reached 80% total production capacity for 5 consecutive days	Restrictions for non-essential water uses and may require odd/even water days	Consumption reached 90% total production capacity for 5 consecutive days	Restrictions for non-essential water uses and may require odd/even water days
Pampa	Ogallala, CRMWA	CRMWA provides that all or part of the city supply has initiated Stage 1. CRMWA informs member cities that the Reservoir Operation Model projections shows a projected three year future supply in Lake Meredith. City wells, supply lines, pumps or storage where continuously falling water storage levels do not refill above 70%.	Reduce water use by 5%. May implement the following: notify major water users of the situation and request voluntary water use reductions, review Stage 1 cause, and intensify leak detection and repair efforts.	CRMWA provides that all or part of the city supply has initiated Stage 2. CRMWA informs member cities that the Reservoir Operation Model projections shows a projected two year future supply in Lake Meredith. City wells, supply lines, pumps or storage where continuously falling water storage levels do not refill above 50%.	Reduce water by 10%. May implement the following: irrigation utilizing sprinkler systems, notify major users of the situation and should reduce water usage, car wash shall use minimum practical water settings,etc.	CRMWA provides that all or part of the city supply has initiated Stage 3 .CRMWA informs member cities that the Reservoir Operation Model projections shows a projected 1.5 year future supply in Lake Meredith. City wells, supply lines, pumps or storage where continuously falling water storage levels do not refill above 40%.	Reduce water by 15%. Prohibited allowing irrigation water to run off into gutter, ditch, or drain, failure to repair a controllable leak, and washing sidewalks driveways, parking areas, tennis courts, or other paved areas, except to alleviate immediate fire or health hazards.	CRWS provides that all or part of the city supply has initiated Stage 4. CRMWA inform Pampa that a water line fails or pump or system failures occur which cause unprecedented loss of capability to provide water services or natural or man-made contamination of the water supply source occurs.	Reduce water by 30%. Outdoor irrigation of vegetation shall be allowed only between hours of 8PM to 2AM on designated days. Washing of automobiles, trucks, trailers, boats, airplane, etc. is prohibited unless on premises of commercial car washes and commercial service stations.
Panhandle	Ogallala	Demand =90% system capacity	Request voluntary Watering Schedules and encourage other Conservation measures	N/A	N/A	Demand reaches safe limit of 2.5 MGD system capacity for 15 consecutive days	Request voluntary Watering Schedules and encourage other Conservation measures	Demand reaches safe limit of 2.5 MGD system capacity for 10 consecutive days	Request voluntary Watering Schedules and encourage other Conservation measures
Perryton		Dry weather conditions before and during then normal landscape growing season	Achieve a voluntary 10% reduction in total water use. Request voluntary water conservation and prescribed restrictions on certain water uses.	Daily demand>= 4.9 MGD for 3 consecutive days	Achieve a 20% reduction in total water use. Comply with requirements and restrictions on certain non-essential water uses	Daily demand>= 5.25 MGD for 3 consecutive days	Achieve a 30% reduction in total water use. Comply with requirements and restrictions on certain non-essential water use for Stage 3	Water supply emergencies	Initiate emergency response procedures. Mandatory water use restrictions such as prohibited landscape irrigation and filling of swimming pools.
Red River Authority	Ogallala	System Water production capacity drops 20% and remains consistent for a period of at least 60 consecutive days.	Raise public awareness. Achieve up to 20% reduction in demand.	System water production capacity drops by 30% and remains consistent for a period of at least 30 consecutive days.	Increase public awareness. Achieve a 30% reduction in demand.	System water production capacity drops by 40% and remains consistent for a period of at least 20 consecutive days.	Inform public of critical situation. Reduce demand by 40%.	System water production capacity drops by 50% and remains consistent for a period of at least 10 consecutive days.	Inform public of critical and possible hazardous situation. Reduce demand to a level necessary to maintain public health and safety.

Summary of Current Drought Triggers and Responses in PWPA

		Onset of Drought						Severe Drought	
Water Provider	**Water Sources**	**Stage 1 Trigger**	**Response**	**Stage 2 Trigger**	**Response**	**Stage 3 Trigger**	**Response**	**Stage 4 Trigger**	**Response**
Shamrock	Ogallala	Consumption reached 65% total production capacity for 5 consecutive days	Public notification of Stage 1 condition and encouragement of voluntary water conservation measures	Consumption reached 75% total production capacity for 5 consecutive days	City may require even/odd watering days or other restrictions on non-essential water uses	Consumption reached 80% total production capacity for 5 consecutive days	Restrictions for non-essential water uses and may require odd/even water days	Consumption reached 90% total production capacity for 5 consecutive days	Restrictions for non-essential water uses and may require odd/even water days
Turkey	Ogallala	Supply>= 75% capacity	Voluntary 25% reduction in use	Supply>= 50% capacity	50% reduction in water use	Supply>= 25% capacity	75% reduction in water use	Water supply emergency	Identify action needed, inform wholesale water supply customers, and if appropriate notify city/country emergency response officials
Wellington	Ogallala	Demand >=90% system capacity for 5 consecutive days	Voluntary 10% reduction in use	Demand >=95% system capacity for 3 consecutive days	15% reduction in demand	Demand >=100% system capacity for 3 consecutive days	20% reduction in water use	Water supply emergency	20% reduction in water use
White Deer	Ogallala	Dry weather conditions before and during then normal landscape growing season	Request voluntary water conservations	Demand>0.55 MGD for 3 consecutive days	Comply with requirements and restrictions on certain non-essential water use	Demand>0.575 MGD for 3 consecutive days	Comply with requirements and restrictions on certain non-essential water use	Water supply emergency such as major water line breaks, pump system failures	Comply with requirements for Stage 4