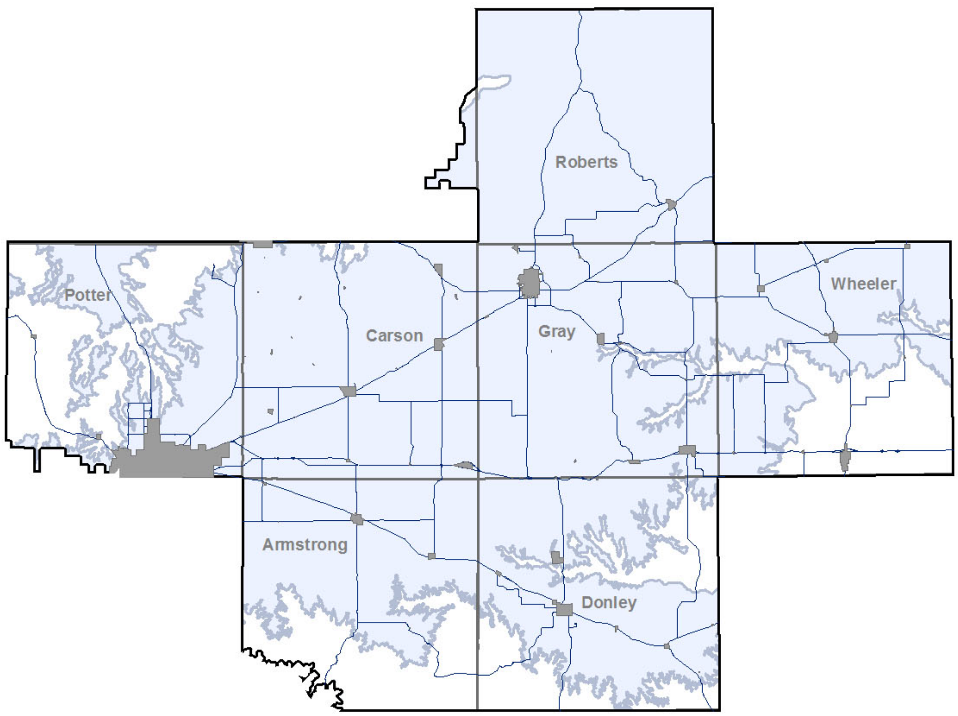
PANHANDLE GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

2024-2029



Amended by the

Panhandle Groundwater Conservation District

Board of Directors

June 6, 2024

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CHAPTER 1 DISTRICT MISSION AND OVERVIEW

The Panhandle Groundwater Conservation District (the District) will strive to develop, promote, and implement water conservation, preservation, recharging, augmentation through precipitation enhancement, prevention of waste, and management strategies to protect water resources for the benefit of the citizens, economy, and environment of the District.

The District seeks cooperation in the implementation of this plan and the management of groundwater supplies within the District. All activities of the District will be undertaken in cooperation and coordination with local owners and the appropriate state, regional, or local water management entities.

The District will work to treat all citizens uniformly. The District will enforce the permit terms and conditions and the District rules by enjoining the permit holder in a court of competent jurisdiction, as provided for in Texas Water Code Section 36.102, if required, after exhausting all other remedies.

The District consists of all of Carson, Donley, Gray, Roberts, and Wheeler counties, along with parts of Armstrong, Hutchinson, and Potter counties. The District was created by the Legislature in 1955 when it began operating in portions of Gray, Carson, Potter, and Armstrong counties. Elections were held in 1988, 1991, 1994, 1997, and 2000 to annex the remaining portions of the District within the present boundaries.

The District's areal extent is 6,410 square miles or approximately four million acres located in the Panhandle region of Texas, extending from west of Amarillo to the Oklahoma border. The Canadian River to the north and the Salt Fork of the Red River to the south generally border the District. The District's economy is dominated by agricultural production and petrochemical production. The agricultural income sources include beef cattle production, wheat, corn, milo, peanuts, soybeans, sunflowers, hay crops, and cotton. Petrochemical production also contributes significantly to the income of the District. There are also chemical, manufacturing, and nuclear weapons industries located in the District.

There are over 3,000 irrigation wells capable of producing water to meet the needs of the agricultural community within District boundaries. The District also has approximately 350 municipal or public supply wells and over 380 wells for industrial use and oil and gas secondary recovery (water flood) operations. The remaining wells are registered wells providing water supplies for household, livestock consumption, and oil and gas exploration.

The area contains rolling plains that are used for cattle production, cultivation, and oil and gas activities. There is a substantial area of flat plains that contain numerous playa basins. This area is used primarily for crop production. The altitude of the land surface ranges from 2,000 feet to 3,800 feet above mean sea level. The District lies within, and between, the drainage systems of both the Canadian River Basin and the Red River Basin.

All statutorily required elements for this Management Plan, as stipulated in Texas Water Code Section 36.1071, have been addressed herein and, for ease of review, are referenced in the Texas Water Development Board's Groundwater Conservation District Management Plan Checklist included as Appendix 1. Documentation that the Management Plan was adopted after public notice is presented in Appendix 2. A copy of the executed Resolution approved by the Panhandle Groundwater Conservation District Board of Directors is included in Appendix 3.

CHAPTER 2 GROUNDWATER MANAGEMENT IN TEXAS

The authority of groundwater conservation districts (GCDs) to conserve, preserve, and protect groundwater through necessary regulation dates to the Underground Water Conservation Districts Act passed by the Texas Legislature in 1949 (Vernon's Civil Statutes, Article 7880-3c). Included in this landmark legislation, which for the most part, remains substantively unchanged today, GCDs receive the following legislative directive, "Such districts shall and are hereby authorized to exercise any one or more of the following:

(8) develop comprehensive plans for the most efficient use of the underground water of the underground reservoir or subdivision thereof and for the control and prevention of waste of such underground water, which plans shall specify in such detail as may be practicable, the acts, procedure, performance, and avoidance which are or may be necessary to effect such plans, including specifications, therefore; to carry out research projects, develop information and determine limitations, if any, which should be made on the withdrawal of underground water from the underground reservoir or subdivision thereof; to collect and preserve information regarding the use of such underground water and the practicability of recharge of the underground water subdivision thereof; to publish such plans and information, bring them to the notice and attention of the users of such underground water within the District, and to encourage their adoption and execution;"

In 1997, the Texas Legislature approved one of the more significant amendments to the Water Code and expanded the groundwater planning process, requiring all GCDs to develop and adopt management plans. Once adopted, management plans will be reviewed and approved by the Executive Administrator at the Texas Water Development Board (TWDB). This review and approval are designed to ensure that certain technical and administrative requirements are met.

Substantial changes in the planning and management of groundwater were put in place in 2005 with the passage of House Bill 1763, which requires GCDs in the same Groundwater Management Area (GMA) to conduct joint planning and establish Desired Future Conditions (DFCs) for all relevant aquifers in the GMA. The first round of joint planning concluded on September 1, 2010. Since the passage of House Bill 1763 in 2005, the District has actively participated in the joint planning process for GMA 1. GMA 1 adopted DFCs for the Ogallala Aquifer on July 7, 2009, and DFCs for the Dockum and Blaine aquifers on June 3, 2010.

No other aquifers were determined to be relevant during the first round of joint planning in the District. By law, GCDs must meet at least annually to continue joint planning and review and readopt (with amendments as necessary) DFCs at least every five years.

In 2011, the Texas Legislature again made significant changes to the planning and management of groundwater resources with the passage of Senate Bill 660 (SB 660). One of the primary elements of SB 660 was the identification of nine specific criteria that must be considered concerning any DFCs being proposed for adoption (Texas Water Code Section 36.108 (d) (1-9). Other changes made by SB 660 included requirements that GCDs in a GMA must provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the GMA (Texas Water Code Section 36.108 (d-2)), development of an explanatory report to accompany adopted DFCs when submitted to the TWDB for review (Texas Water Code Section 36.108 (d-3), and also transfer of the petition process from the TWDB to the State Office of Administrative Hearings (Texas Water Code Section 36.1083). Based on the new requirements of SB 660, the District, along with the other GCDs in GMA 1, adopted updated DFCs on August 26, 2021, as required by Texas Water Code Section 36.108 (d). DFCs were adopted for the Ogallala and Dockum aquifers in the District. In 2016, the Blaine Aquifer, located in Wheeler County in GMA 1, was classified by GMA 1 District Representatives as non-relevant for joint planning.

CHAPTER 3 DESIRED FUTURE CONDITIONS AND THE PANHANDLE GROUNDWATER CONSERVATION DISTRICT

Long before the State of Texas first considered the concept of DFCs in the 2002 State Water Plan[1] or codified the concept in statute in House Bill 1763 in 2005 (Texas Water Code Section 36.108(d)), the District Board of Directors spent countless hours deliberating approaches to better manage and balance current water demands with future water needs. The result of this deliberation that began in 1995 was the District's adoption of the 50/50 Management Standard in 1998. This landmark decision in 1998 to adopt the 50/50 Management Standard represents the first DFC adopted by a GCD anywhere in Texas.

The District's 50/50 Management Standard aims to have at least 50 percent of the current volume in the Ogallala Aquifer still available 50 years after the first certification of this plan (which occurred in 1998). This standard was subsequently adopted for the Ogallala Aquifer for the District during joint planning in 2005-2010 and again in 2010-2015. In the third round of planning (2016-2021), the District decided to extend the planning period beyond 50 years and clarified that it would monitor the 50/50 goal in each 50-year period between 2018 and 2080.

For the purposes of the DFC adopted for the District by the member districts in GMA 1, this Management Plan and District rules, and the 50/50 Management Standard, 50 percent of the current saturated thickness remaining in 50 years, is indistinguishable from 50 percent of the volume of groundwater remaining in the Ogallala Aquifer. The 50/50 Management Standard, originally adopted by the District for the planning period of 1998 – 2048, has now been extended through 2080 to fully represent the current planning horizon (Figure 1). An examination of Figure 1 illustrates that as more time passes during the 50-year planning horizon, the reduction in saturated thickness of the Ogallala Aquifer each year becomes less and less.

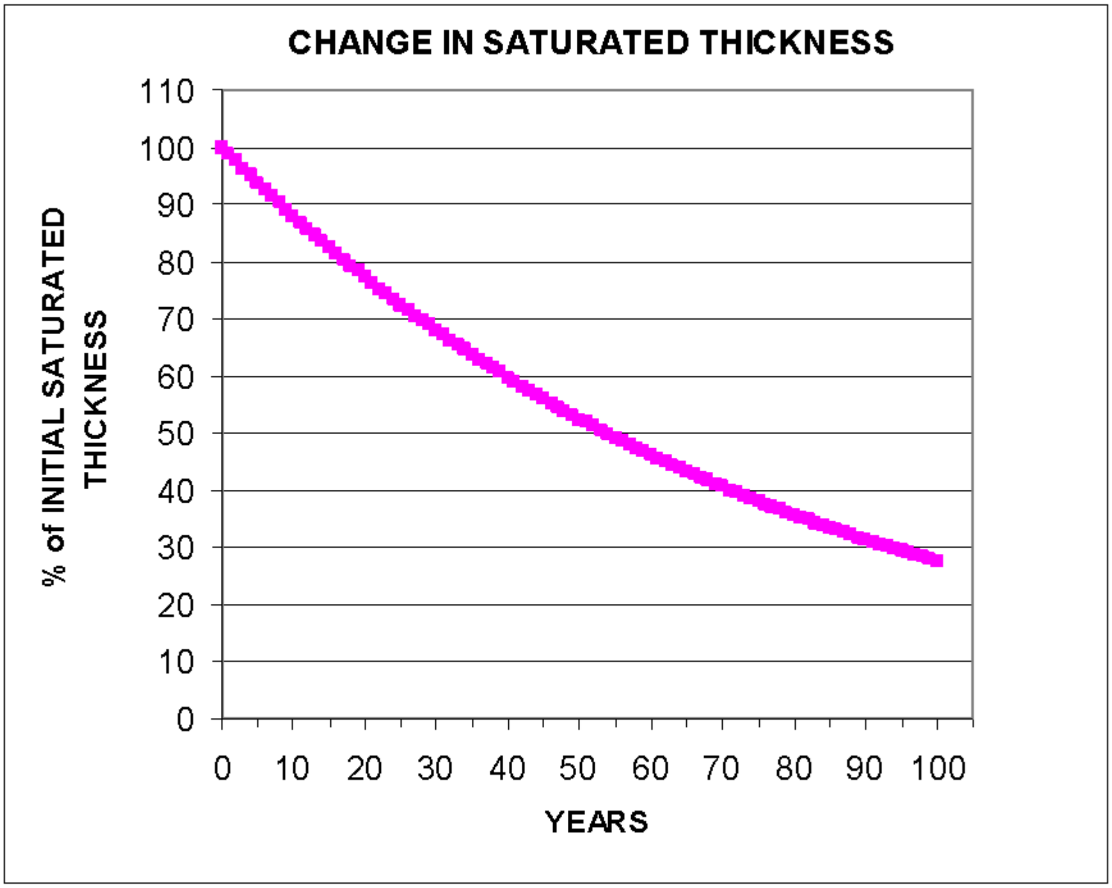


Figure 1 – Illustration of change in saturated thickness as a result of the 50/50 Management Standard.

Texas groundwater law is based on a conceptual three-step sequence that a GCD must follow in accomplishing statutory responsibilities related to conserving and managing groundwater resources within a GCD. The three primary steps, which are to occur at least every five years, are to: (1) adopt DFCs (Texas Water Code Section 36.108(c)€, (2) develop and adopt a management plan that includes goals, management objectives, and performance standards, designed to achieve the DFCs (Texas Water Code Section 36.1071(a)(8), and (3) amend and adopt rules necessary to achieve goals, management objectives, and performance standards, included in the management plan (Texas Water Code Section 36.101(a)(5).

While these three steps are presented as a sequential process, from a practical perspective, all three steps are often ongoing concurrently. This management plan will remain in effect until an amended plan is adopted by the District and approved by the Texas Water Development Board or until five years from the date the Executive Administrator of the Texas Water Development Board approves the plan, whichever is earlier. The Board of Directors will review and adopt the management plan at least every five years, as required by Texas Water Code Section 36.1072(e). The District Management Plan and any amendments thereto shall be forwarded to the Panhandle Water Planning Group for consideration in their regional water planning process.

CHAPTER 4 GOALS, MANAGEMENT OBJECTIVES, AND PERFORMANCE STANDARDS

For nearly 70 years, the District has worked to manage and conserve groundwater resources within its jurisdictional boundaries. With the adoption of the 50/50 Management Standard by the District Board of Directors in 1998, this all-encompassing goal was established for the District to manage and conserve groundwater resources. All other goals, management objectives, and performance standards required for inclusion in this management plan by Texas Water Code Section 36.1071(a) have been developed and adopted to ensure that District programs and activities work directly or indirectly in an integrated and comprehensive manner in order to achieve the 50/50 Management Standard. The 50/50 Management Standard is specifically designed to ensure the management and conservation of the finite water resources within the District while seeking to maintain the economic viability of all water resource user groups, both public and private.

Texas Water Code Section 36.1071(a)(1-9) requires that all management plans address the following management goals, as applicable:

- addressing the desired future conditions adopted by the District,
- providing the most efficient use of groundwater;
- controlling and preventing waste of groundwater;
- controlling and preventing subsidence;
- conjunctive surface water management issues;
- natural resource issues;
- drought conditions, and;
- conservation, recharge enhancement, rainwater harvesting, precipitation enhancement, or brush control, where appropriate and cost-effective.

Goals, management objectives, and performance standards included in this management plan have been developed and adopted to ensure the management and conservation of groundwater resources within the District’s jurisdiction.

SECTION 4.1 ACTIONS, METHODOLOGIES, PROCEDURES, PERFORMANCE, AND AVOIDANCE NECESSARY TO EFFECTUATE THE PLAN

In order to achieve the goals, management objectives, and performance standards adopted in this management plan, the District continually works to develop, maintain, review, and update rules and procedures for the various programs and activities within the management plan. As a means to monitor performance, (a) the General Manager routinely meets with District Staff to track progress on the various management objectives and performance standards adopted in this management plan, and (b) on an annual basis, the General Manager prepares and submits an annual report documenting progress made towards implementation of the management plan to the Board of Directors for their review and approval. In addition, District staff will review District rules to ensure that all provisions necessary to implement the management plan are included in the rules. Reviews of the rules are conducted annually and as needed. The District Board of Directors will amend the rules to manage and conserve groundwater resources more effectively and ensure that the duties prescribed in the Texas Water Code and other applicable laws are carried out. Amendments to District rules adopted on January 11, 2024, and this management plan are the direct result of this review process between the General Manager, District staff, and the District Board of Directors. A copy of this management plan and the District's rules may be found on the District website at www.pgcd.us/rules.

SECTION 4.2 GOAL 1 ADDRESS THE DESIRED FUTURE CONDITIONS ADOPTED BY THE PANHANDLE GCD

The primary purpose of a management plan is to develop goals, management objectives, and performance standards that, when successfully implemented, will work together to achieve the adopted DFCs. Goals 2 through 10 directly and/or indirectly support Goal 1. DFCs adopted for the Ogallala and Dockum aquifers by GMA 1 on August 26, 2021, and by the Panhandle GCD Board of Directors on May 11, 2023, for the District are described below (note: the Blaine Aquifer in Wheeler County is now classified by GMA 1 as non-relevant for joint planning). A 50-year planning horizon was used in setting the DFCs. Throughout the joint planning process, the District actively worked with the other District Representatives and stakeholders within GMA 1 to determine the DFCs for each relevant aquifer located within each district.

Subsection 4.2.1 Ogallala Aquifer DFC

The primary water resource in the District is the Ogallala Aquifer, which is a finite resource and must be managed and conserved for the benefit of future generations. The DFC for the Ogallala Aquifer within the boundaries of the District is to have at least 50 percent of the volume in storage (as discussed above, volume is equivalent to saturated thickness) remaining in each 50-year period between 2018 and 2080 (50/50 DFC). As discussed above, for the District, the 50/50 DFC (goal) is synonymous and interchangeable with the 50/50 Management Standard.

Successful attainment of the 50/50 DFC is accomplished using the District's integrated programs focused on conservation, education, regulation, and permitting, which are designed to achieve this umbrella goal. Texas Water Code Section 36.1132(a) states that "a district, to the extent possible, shall issue permits up to the point that the total volume of exempt and permitted groundwater production will achieve an applicable desired future condition under Section 36.108." The District's permitting program has been designed to achieve this DFC.

The requirement for the inclusion of estimates of modeled available groundwater in the management plan is a requirement resulting from the passage of Senate Bill 660 by the 82nd Texas Legislature in 2011. The term "modeled available groundwater" is defined in Texas Water Code Section 36.001(a)(25) as "the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition…" This change in terms is included to clarify that the estimates presented in Table 1 represent exempt and permitted groundwater production. The modeled available groundwater values for the Ogallala Aquifer range from 981,487 acre-feet per year in 2020 to 736,134 acre-feet per year in 2080 as based on the updated High Plains Aquifer System Groundwater Availability Model by Anaya (2023) [3] in Table 1.

Table 1- Modeled Available Groundwater for the Ogallala Aquifer in the District Summarized by County for Each Decade Between 2020 and 2080. Values are in Acre-Feet per Year. (Anaya, 2023) [3].

Ogallala							
County	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Armstrong	56,940	51,726	45,757	40,241	35,089	30,685	27,137
Carson	163,315	166,024	159,756	149,768	141,251	134,365	121,774
Donley	72,747	78,267	77,157	72,601	67,032	60,915	53,337
Gray	177,633	181,648	173,602	160,382	147,045	133,802	121,936
Hutchinson	8,524	10,589	11,798	11,784	11,427	10,775	9,606
Potter	24,022	22,245	19,590	16,477	13,607	10,990	8,821
Roberts	358,704	409,300	394,930	369,335	344,109	317,529	286,594
Wheeler	119,602	132,615	132,787	128,472	121,852	114,269	106,929
District Total	**981,487**	**1,052,414**	**1,015,377**	**949,060**	**881,412**	**813,330**	**736,134**

4.2.1.1 Management Objective 1.1

The cornerstone of the many programs and activities of the District is the 50/50 Management Standard, which drives its Rules and this Management Plan. The 50/50 Management Standard states that 50 percent of the current volume within the Ogallala Aquifer will remain in 50 years. This 50/50 Management Standard is the tool by which the District will ensure that it meets or exceeds the 50/50 DFC outlined in Rules 1, 3, and 4, which states the maximum allowable volume of pumping from the Ogallala Aquifer is one acre-foot per contiguous acre per year. In order to ensure that the 50/50 Management Standard is being met, the District goes through an annual review process to identify and act upon Contiguous Acreage Tracts exceeding the maximum allowable pumping volume from the Ogallala Aquifer utilizing flow meter data. Management Objective 1.1 is for the District to successfully undergo and complete the annual flow meter data evaluation and review process for each Contiguous Acreage Tract each year by August 31st of the year following the year for which pumping data is collected. The results of this process will be published in the District's Annual Report, which will be published on the District's website upon approval by the District Board of Directors.

The District conducts a systematic winter water level program to collect data necessary to evaluate the achievement of the District's DFCs. Results from the District's winter water level monitoring program are presented to the Board of Directors annually and published in the District's newsletter.

In order to complete Management Objective 1.1, the following Performance Standards will be met. Actions by the District Board of Directors that may result from this review include the enforcement actions stipulated in District Rule 3.3, as required.

4.2.1.1.1 *Performance Standards*

1.1a Based on flow meter readings, quantify all permitted pumping volumes annually for individual Contiguous Acreage Tracts and report results to the Board of Directors in the Annual Report by August 31st of each year.

1.1b Evaluate all Ogallala Aquifer water level measurements collected during the District's annual winter water level monitoring program. This information will be provided to the District Board of Directors at a regularly scheduled meeting by August 31st of each year.

1.1c The District will conduct a Sunset Review of the maximum allowable volume of production contained in Rule 4.2. This review will be concluded no later than January 1, 2025, and the maximum allowable production volume will then be reviewed at least every 5 years thereafter. Using annual production data, the Board will evaluate the effect of Rule 4.2 on the ability to achieve the District's desired future conditions.

4.2.1.2 Management Objective 1.2

The District maintains an integrated geodatabase system based on the District's Observation Well Network and computer mapping programs to track and review changes in water supplies annually.

4.2.1.2.1 *Performance Standards*

1.2a Beginning in 2021, the District will update the Ogallala Aquifer saturated thickness map at least once every five years and publish it on the District's website.

Subsection 4.2.2 Dockum Aquifer DFC

The TWDB classifies the Dockum Aquifer as a minor aquifer that is present primarily in the western portions of the District and is generally under confined (artesian) conditions. Based on our current understanding of water resources in the Dockum Aquifer, DFCs have been adopted for Armstrong, Carson, and Potter counties within the District. Due to the predominantly confined nature of the Dockum Aquifer, a different approach was taken when adopting DFCs for the Dockum Aquifer. The DFCs adopted for the Dockum Aquifer in GMA 1 are that the average decline in water levels will be no more than 30 feet within the District in each 50-year period from 2018 to 2080. The maximum allowable volume of pumping from the Dockum Aquifer is one acre-foot per contiguous acre per year.

The estimates of modeled available groundwater for the Dockum Aquifer were extracted from predictive simulations performed for GMA 1 using the updated High Plains Aquifer System. The modeled available groundwater values for Armstrong, Carson, and Potter counties are based on data by Anaya (2023)[3] and are presented in Table 2.

Table 2- - Modeled Available Groundwater for the Dockum Aquifer in the District Summarized by County for Each Decade Between 2020 and 2080. Values are in Acre-Feet per Year. (Anaya, 2023)[3].

Dockum							
County	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Armstrong	5,313	7,102	8,122	8,601	8,849	8,904	8,914
Carson	6	6	6	6	6	6	6
Potter	30,160	37,699	37,853	36,963	35,881	34,685	33,571
District Total	**35,479**	**44,807**	**45,981**	**45,570**	**44,736**	**43,595**	**42,491**

4.2.2.1 Management Objective 1.3

While there are tens of thousands of data points collected over time relative to the Ogallala Aquifer, the opposite is true for the Dockum Aquifer. This can primarily be attributed to the dominance of the Ogallala Aquifer in the region and the general prevalence of poor water quality and yields from the Dockum Aquifer. Due to declining water levels in the Ogallala Aquifer, there are areas where the Dockum Aquifer is becoming a more important water resource. There are localized areas of good water quality and locations where technological advances are being made using brackish groundwater desalination.

Due to the scarcity of data regarding the Dockum Aquifer, the District primarily focuses on data collection and trend analysis on wells completed in the Dockum Aquifer currently included in the District's Observation Well Network. This management objective is to monitor and report on Dockum Aquifer wells in the District's Observation Well Network that are experiencing declines for which the trend is in excess of the DFC of 30 feet.

4.2.2.1.1 *Performance Standard*

1.3a Evaluate all Dockum Aquifer water level measurements collected during the District's annual winter water level monitoring program. This information will be provided to the District Board of Directors at a regularly scheduled meeting by August 31st of each year.

SECTION 4.3 GOAL 2 PROVIDING FOR THE MOST EFFICIENT USE OF GROUNDWATER

Throughout its history, the District has operated on the core principle (or goal) that groundwater should be used efficiently for beneficial purposes. In order to achieve this goal, the District maintains a qualified staff to assist water users in protecting, managing, and conserving groundwater resources. The Board of Directors has, in the past and continues today, based its decisions on the best data available to treat all water users as equitably as possible. Once data is collected, the District utilizes various forums to provide important information to water users throughout the District so that sound decisions regarding the efficient use of groundwater can be made. The District's Observation Well Network will continuously be reviewed and maintained to monitor changing storage conditions of groundwater supplies within the District. The District will continue to undertake and cooperate with technical investigations of groundwater resources within the District. The following management objectives and performance standards have been developed and adopted to collect needed information, disseminate information, and provide opportunities through the District's Agricultural Water Conservation Equipment Loan Program to ensure the efficient use of groundwater.

4.3.1.1 Management Objective 2.1

The Observation Well Network, with approximately 800 water wells located throughout the District, is continuously maintained and monitored. Wells in the Observation Well Network produce groundwater from the Ogallala Aquifer, the Dockum Aquifer, and other minor aquifers. Water levels are measured by District staff in as many wells as possible, with the management objective being to measure water levels in at least 90 percent of the wells in the Observation Well Network each year. This data is then processed for quality assurance/quality control, entered into the District's geodatabase, analyzed, mapped, and used to calculate decline and update historical trend lines (hydrographs).

Water level measurements from wells in the District's Observation Well Network are used to generate annual decline maps. The District will strive to install additional monitoring wells in locations, when necessary, in order to evaluate the effects of high-impact pumping operations as necessary.

4.3.1.1.1 *Performance Standard*

2.1a Measure water levels in at least 90 percent of the operational water wells in the District's Observation Well Network annually by April 1st.

2.1b Using water level measurements collected from November to April from wells in the Observation Well Network, prepare an annual decline map based on changes in water levels observed in the last 12 months by July 31st and publish it in the next available District newsletter, Panhandle Water News (PWN).

2.1c Using water level measurements collected each year from wells in the Observation Well Network and historical information from the District's geodatabase, prepare an Ogallala Aquifer water table decline map for use in the Internal Revenue Service (IRS) annual depletion program. Provide results of IRS Ogallala Aquifer allowable depletion levels to participating producers by January 31st of each year.

4.3.1.2 Management Objective 2.2

The District encourages efficient groundwater use by promoting low-pressure and other efficient sprinkler systems, drip irrigation systems, and other recognized water conservation measures. This will be accomplished by increasing the use of the District's Agricultural Water Conservation Equipment Loan Program, as long as TWDB Agricultural Loan Program funds are available and economically competitive. The District will enhance awareness of the loan program by utilizing local newspapers and the PWN. The District website will have information on the availability of funds and application guidelines. The District will strive to provide timely responses to loan applicants.

4.3.1.2.1 *Performance Standard*

2.2a The District will include a reminder about the District's Agricultural Water Conservation Equipment Loan Program at least bi-annually in the PWN, as long as funds are available at competitive rates.

2.2b District staff strives to complete the District review process for all loan applications and prepare for Board of Director consideration within 60 days of receipt of administratively complete loan applications.

4.3.1.3 Management Objective 2.3

The District encourages the efficient use of groundwater by disseminating educational information regarding current best management practices and trends in water conservation for agricultural, municipal, and industrial applications. The District publishes a quarterly newsletter containing water conservation resources for water users. In addition, the District also attends and participates in public events throughout the District, including the annual Amarillo Farm and Ranch Show, as often as possible.

4.3.1.3.1 *Performance Standard*

2.3a The District will publish Panhandle Water News (PWN) quarterly.

2.3b Each year, the District will participate in the Amarillo Farm and Ranch Show when held.

4.3.1.4 Management Objective 2.4

In order to ensure that the Board of Directors and District constituents are aware of and informed on the most current information on water conservation, groundwater management, and emerging policy issues related to groundwater resources, District staff actively participate in a broad grouping of professional associations that focus on water resource issues. District staff will report at the next available regularly scheduled Board of Directors meeting in the General Manager's Report on any activities resulting from participation with the following active affiliations:

- Texas Alliance of Groundwater Districts (TAGD)
- Texas Water Conservation Association (TWCA), and,
- Groundwater Management Districts Association (GMDA).

4.3.1.4.1 *Performance Standard*

2.4a District staff will attend and participate in 60 percent of the cumulative number of regularly scheduled TAGD, TWCA, and GMDA general meetings and report on noteworthy presentations and issues from these meetings at the next available regularly scheduled Board of Directors meeting in the General Manager's Report.

4.3.1.5 Management Objective 2.5

The District has adopted rules that require an approved metering method on all wells producing more than 35 gallons per minute. The District believes that when water users understand the volume of groundwater being used, they can better adopt best management practices that result in the efficient use of groundwater. Therefore, the District is committed to continuing the program, which is focused on requiring a metering method for wells pumping more than 35 gallons per minute, flow meter monitoring, and data collection and analysis of water use by crop and irrigation type. To achieve this objective, the District will read and record meter data from installed, registered, and accessible meters within the District annually. The District's metering program information will be published in the District's Annual Report. Additionally, the District will provide water users with meter data production reports. Finally, the Board will consider meter data for individual Contiguous Acreage Tracts to document compliance with the District's maximum allowable production rate.

4.3.1.5.1 *Performance Standard*

2.5a Read and record meter data for 90 percent of approved metering methods at least annually.

2.5b Based on data from the approved metering methods, Production Reports will be generated and sent to water users by August 31st.

2.5c Review and prepare revised estimates for the TWDB annual draft agricultural water use estimates based on District meter data and other relevant information and submit to designated TWDB staff within the timeframe requested.

SECTION 4.4 GOAL 3 CONTROLLING AND PREVENTING WASTE OF GROUNDWATER.

Another core principle adopted by the District since its inception is to conserve the region's groundwater resources by controlling and preventing the waste of groundwater. The following management objectives and performance standards have been developed and adopted as an integral component of the District's umbrella goal to achieve the 50/50 Management Standard.

4.4.1.1 Management Objective 3.1

The District is continuously working to take positive and prompt action to identify and address all reported wasteful practices and instances of waste located by District staff within the District. This effort involves the following actions to be taken by the District.

- Report each complaint to the landowner and/or operator within five business days.
- Resolve the complaint and note the corrective action taken.
- Report the resolution of each complaint to the landowner/operator and the Board at the next regularly scheduled meeting during the General Manager's Report.

4.4.1.1.1 *Performance Standards*

3.1a All notices or complaints will be recorded, investigated, and reported to the landowner/operator within five business days.

3.1b Report each complaint and staff resolution to the Board of Directors at the next regularly scheduled meeting.

SECTION 4.5 GOAL 4 IMPLEMENT STRATEGIES TO ADDRESS DROUGHT CONDITIONS

In order to address drought conditions, the District has implemented numerous programs designed to positively support constituents in the District when drought conditions exist. While one of these efforts is described below in Management Objectives 4.1, others are documented elsewhere in the management plan. For example, the District operates a state-permitted precipitation enhancement program, described below in Goal 8.

4.5.1.1 Management Objective 4.1

In order to provide ongoing information regarding water conditions in the District, establish and maintain links to National Oceanic and Atmospheric Administration Drought Monitor indices on the District website.

4.5.1.1.1 *Performance Standard*

4.1a Annually, the District will update links to the National Oceanic and Atmospheric Administration (NOAA) Drought Monitor indices on the District's website.

SECTION 4.6 GOAL 5 IMPLEMENT STRATEGIES TO ADDRESS CONJUNCTIVE SURFACE WATER MANAGEMENT ISSUES

The Canadian River Municipal Water Authority (CRMWA) supplements member city groundwater allocations with supplies from Lake Meredith. The CRMWA system is the largest conjunctive use water provider in Texas, providing a combination of groundwater and surface water to 11 member cities. All current CRMWA groundwater supplies are produced within the boundaries of the District.

The Greenbelt Water Authority (GWA) is the second surface water user with supplies within the boundaries of the District. GWA is now also utilizing groundwater resources from the Ogallala Aquifer. The District will communicate rules and technical data as it applies to conjunctive use within the District.

4.6.1.1 Management Objective 5.1

In order to continually monitor the impact of declining surface-water availability on groundwater resources within the District, the General Manager or designee will participate in the Panhandle Water Planning Group (PWPG) with the two surface-water entities currently operating within the District. This activity helps facilitate regular communication and cooperation regarding conjunctive use issues in the District.

4.6.1.1.1 *Performance Standard*

5.1a The District General Manager or designee will participate in at least 75 percent of the regularly scheduled PWPG meetings and activities throughout the current regional water planning cycle (2024-2029).

SECTION 4.7 GOAL 6 IMPLEMENT STRATEGIES THAT WILL ADDRESS NATURAL RESOURCE ISSUES

As part of the umbrella goal of achieving the adopted DFCs, the District recognizes that the protection of water quality is equally as important as working to ensure adequate water quantity. In order to protect the District's most important natural resource, the abundant, high-quality groundwater, the District maintains and operates a water quality sampling program. District staff sample different areas within the District each spring/summer, yielding a complete data set biennially.

4.7.1.1 Management Objective 6.1

In order to control and prevent the contamination of groundwater, the District maintains and works to expand the groundwater quality monitoring. As part of this effort, an annual sampling program will be conducted within the District's Water Quality Network. The objective will be to sample at least 80 percent of the wells in the District's Water Quality Network biennially.

4.7.1.1.1 *Performance Standards*

6.1a Sample 80 percent of the wells in the District's Water Quality Network on a biennial basis and report program status to the Board of Directors annually.

6.1b Record all water quality measurement data in the District's water quality database within 30 days of receiving sampling results.

SECTION 4.8 GOAL 7 IMPROVE OPERATING EFFICIENCY AND CUSTOMER SERVICE

4.8.1.1 Management Objective 7.1

Customer service is of great importance to the Board of Directors and Staff of the District. As detailed in the corresponding performance standards, the District will continue to provide timely response to customer assistance requests in the following areas:

- Pump flow tests.
- Processing of well drilling permits and registrations, and operating permits.
- Review and revise District Rules to incorporate revisions required by new legislation and achieve adopted DFCs as necessary.
- Well camera recordings.

4.8.1.1.1 *Performance Standard*

7.1a Provide flow tests within five business days of the landowner's requested date and report to the Board in the Annual Report.

7.1b General Manager's action on administrative completeness of well drilling permits taken and permit returned to the customer within ten business days of approval.

7.1c Provide the well camera service within five business days of the request or the landowner's requested date and return the information to the well operator within five business days.

7.1b General Manager's action on administrative completeness of well drilling permits taken and permit returned to the customer within ten business days of approval.

7.1c Provide the well camera service within five business days of the request or the landowner's requested date and return the information to the well operator within five business days.

SECTION 4.9 GOAL 8 ADDRESSING PRECIPITATION ENHANCEMENT

Texas Water Code Section 36.1071(a)(7) requires groundwater conservation districts to include a goal addressing precipitation enhancement in the management plan. The District has one of the longest continuous precipitation enhancement programs in Texas.

4.9.1.1 Management Objective 8.1

The District will continue to operate its Precipitation Enhancement Program throughout the planning horizon of this management plan. The program will strive to operate within budget. Flight records will be collected and archived.

The program will abide by the Texas Department of Licensing and Regulation requirements for testing, monitoring, and reporting to ensure compliance with permit guidelines. Results of the District's Precipitation Enhancement Program will be presented to the Board of Directors and included in the Annual Report each year.

4.9.1.1.1 Performance Standard

8.1a Annually conduct the Precipitation Enhancement Program from April 1st to September 30th.

8.1b Calculate the baseline costs for the Precipitation Enhancement Program each year.

8.1c Annually, maintain all flight records on all precipitation enhancement operations and make them available for review upon request.

8.1d Annually, provide precipitation enhancement initial and final reports to NOAA.

4.9.1.2 Management Objective 8.2

Educate the public on the benefits of the District's Precipitation Enhancement Program through informational articles in the PWN and local newspapers, public presentations, and program summaries in the District's Annual Report each year.

4.9.1.2.1 Performance Standard

8.2a Publish an article about the Precipitation Enhancement Program in at least 2 of the quarterly issues of PWN.

8.2b Provide at least one article about the Precipitation Enhancement Program to all local newspapers annually.

SECTION 4.10 GOAL 9 ADDRESSING CONSERVATION

Texas Water Code Section 36.0015 states, in part, that "In order to provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater…. Groundwater conservation districts may be created…are the state's preferred method of groundwater management through rules developed, adopted, and promulgated by a district in accordance with the provisions of this chapter." It is noteworthy that in this overview section of Texas water law addressing groundwater management, "conservation" is the first action groundwater conservation districts are to pursue. The 50/50 Management Standard can only be achieved if our groundwater resources are conserved to ensure adequate water resources will be available for future generations. While water conservation is a fundamental component of many of the District's programs, the following represent management objectives most focused on water conservation.

4.10.1.1 Management Objective 9.1

Continue and expand, when possible, the District's Groundwater Conservation Education Program. District staff will make presentations on the importance of water conservation to at least five civic organizations and in at least 30 educational settings. Annually, the District will award at least three college scholarships to students in the District based on participation in a water conservation essay competition. The District will maintain an Internet information page, conduct a conservation education initiative called "Water Warriors," and work with other entities to present an ongoing Panhandle area water conservation symposium.

4.10.1.1.1 Performance Standards

9.1a Annually make a minimum of five civic educational presentations.

9.1b Annually make 30 presentations in educational settings.

9.1c Annually provide at least three scholarships to students residing within the District who have participated in the District's water conservation essay competition.

9.1d Continue the Water Warrior Program as part of the District public relations and education campaign, encouraging all users to prioritize water conservation in at least three public presentations outside of school settings each year.

SECTION 4.11 GOAL 10 RAINWATER HARVESTING

Rainwater harvesting is becoming an increasingly important strategy for meeting water supply needs, especially in the more rural areas of Texas. While rainwater harvesting is one of the many topics in the District's water conservation education programs, the following management objective and performance standards specifically focus on rainwater harvesting.

4.11.1.1 Management Objective 10.1

The District has established and maintains a rainwater harvesting system and provides educational tours to the public regarding the many benefits of the system. Tours of the District office rainwater harvesting system are provided upon request. A link to an informational page highlighting the rainwater harvesting system will be maintained and updated as necessary on the District's website. In addition, a link to the TWDB website on rainwater harvesting will also be maintained on the District's website.

4.11.1.1.1 Performance Standard

10.1a Webpage highlighting the District's rainwater harvesting system and information regarding the availability of tours to the public is maintained and updated as necessary.

10.1b Link to the TWDB Rainwater Harvesting webpage is maintained on the District's website.

CHAPTER 5 GOALS DETERMINED NOT APPLICABLE

SECTION 5.1 GOAL 11 RECHARGE ENHANCEMENT

The District has been a long-standing participant and supporter of recharge enhancement efforts, primarily in partnership with the Texas Water Development Board. However, the lack of financial support from the Texas Legislature for this program has resulted in the suspension of this program indefinitely. Due to the scale and nature of a recharge enhancement program and lack of participating support from either state or federal partners, the District has determined that a program addressing recharge enhancement by the District is not feasible at this time.

SECTION 5.2 GOAL 12 CONTROL AND PREVENTION OF SUBSIDENCE

Although Furnans and others (2017)[4] classified the Ogallala Aquifer in the High Plains as having a high subsidence risk and the Dockum Aquifer as having medium subsidence risk potential, the absence of any measured subsidence in the District over the extensive historical period of pumping and the geologic framework and unconfined nature of the Ogallala Aquifer in the region led to the District's determination that the risk of significant subsidence from occurring due to groundwater pumping is not sufficient to warrant the adoption of a goal, management objective, or performance standard to meet a subsidence goal. However, the District will monitor for indications of subsidence and will respond accordingly to any reports of potential subsidence.

SECTION 5.3 GOAL 13 BRUSH CONTROL

The Canadian River Municipal Water Authority has a large brush control project along the Canadian River in the District, and the District encourages that action; however, the District has determined that a program addressing brush control by the District is not feasible at this time.

CHAPTER 6 POPULATION, WATER USE, AND WATER DEMANDS

Primary activities involved in developing a water resources management plan include the analysis and development of projections of population, historical and current water use, and projections of water demands in the future (for a defined period of time). In order to develop projections for how much water supply we will need in the future, three questions must be answered: (1) how many people are there now and how much water has been used in the recent past, (2) how many people will there be in the future (population projections), and (3) how much water will be required to meet the needs of the projected population and other water use sectors in the future. These analyses to develop water demand projections are primarily conducted in Texas as part of the regional water supply planning process (created by the 75th Texas Legislature through Senate Bill 1 in 1997). Water demand projections are developed for the following water user categories: municipal, rural (county-other), irrigation, livestock, manufacturing, mining, and steam-electric power generation. These three tasks are followed by the evaluation of current water supplies, the comparison of water demands to water supplies in order to determine additional water supply needs, and the identification, evaluation, and selection of water management strategies to meet any water supply needs that are identified. This section addresses population projections, water use, and water demands.

Based on information developed for the 2022 Texas State Water Plan, data in the 2021 Region A Water Plan[5], shows population projections for the District range from 170,045 in 2020 to 264,700 in 2070. This represents a 56 percent increase in population over the 50-year planning horizon.

The next important component in planning for and managing water resources is understanding water use. The methods used to estimate groundwater use in the District have changed and improved over time, so flow meters are now available and allow the District to improve estimates of groundwater use. Groundwater use in the District for the six major water use sectors in 2019 (most currently available year) is estimated to be approximately 260,301 acre-feet (see Table 3– Estimated Historical Water Use TWDB Historical Water Use Survey (WUS) Data).

In 2019, irrigation remained the largest water use sector, representing 87.44 percent of the total groundwater produced. Historic estimates of groundwater and surface water use from 2004-2019 are included in Appendix 4. Throughout the period of record, groundwater for irrigated agriculture in the District has been the largest use of groundwater from the Ogallala Aquifer.

Table 3 - Estimated Historical Water Use TWDB Historical Water Use Survey (WUS) Data in 2019[6] (In acre-feet per year)

County	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
Armstrong	264	0	0	0	5,458	546	6,268
Carson	810	694	0	0	113,138	324	114,966
Donley	80	0	0	0	32,592	798	33,470
Gray	795	314	0	0	41,399	1,379	43,887
Hutchinson	205	446	4	0	2,910	15	3,580
Potter	16,401	5,810	184	883	3,414	386	27,078
Roberts	189	0	32	0	11,638	303	12,162
Wheeler	1,039	0	21	0	17,055	775	18,890
District Total	**19,783**	**7,264**	**241**	**883**	**227,604**	**4,526**	**260,301**

Note - water use estimates for Armstrong, Hutchinson, and Potter counties are proportional to the area of the county within the District. Also, these water use estimates are for water use within the county and not for water pumped within the county and transported outside of a county for use elsewhere. District total represents the sum of water use estimates for Carson, Donley, Gray, Roberts, and Wheeler counties, and the proportional water use estimate based on the proportional amount of area in the county that is within the boundaries for counties partially within the jurisdictional boundaries of the District.

The next step in the planning process is the development of water demand projections for the various water use sectors and water user groups over the course of the 50-year planning horizon. Water demand projections are updated for the regional water planning process every five years and are based on changes in population trends, including information from the most recent U.S. Census, water use patterns, and changes in technology (for example, anticipated savings from drought-tolerant crops in the future). Appendix 4 provides water demand projections for the six water use categories throughout the 50-year planning horizon. Water demands increased from 268,376 acre-feet per year in 2020 to 286,002 acre-feet per year in 2070, representing a 6.5 percent increase in water demands over the 50-year planning horizon.

CHAPTER 7 GROUNDWATER RESOURCES

The District has invested significant time and resources to improve the science and understanding of groundwater resources in the Panhandle of Texas. Most significantly, the District participated in the most recent update of the High Plains Aquifer System Groundwater Availability Model (High Plains GAM), approved by the Texas Water Development Board in 2015. This effort culminated in the publication of the High Plains GAM Report by Deeds and Jigmond (2015)[2]. During this effort, the District worked with the Texas Water Development

Board to update the High Plains GAM through financial support, provision of meter data and new well logs, and technical reviews on draft reports. This updated planning and water resources evaluation tool has significantly improved the science available to the District's Board of Directors and staff, especially regarding improved historical and current pumping estimates, hydro-stratigraphy, and aquifer properties. The updated High Plains GAM was most recently used by District Representatives in Groundwater Management Area 1 to evaluate potential predictive simulation scenarios and to establish estimates of modeled available groundwater resulting from the adoption of the 50/50 Management Standard and the 30-foot decline in the Dockum Aquifer.

The Ogallala Aquifer is the primary aquifer within the District and is located in sediments of the Ogallala Formation of Neogene (Pliocene) Period. The Ogallala Aquifer yields water from the mostly unconsolidated gravels, sands, silts, and clays of the Ogallala Formation. Groundwater movement is generally from the northeast to the southwest, away from groundwater and topographic highs and towards the surface drainage system of the Canadian River basin (Figure 2).

There are localized areas where flow is toward groundwater lows that have developed as a result of production in large well fields. Areas where irrigation wells are co-located with municipal well fields have experienced significant water table declines. Other irrigated areas have demonstrated varying water level declines.

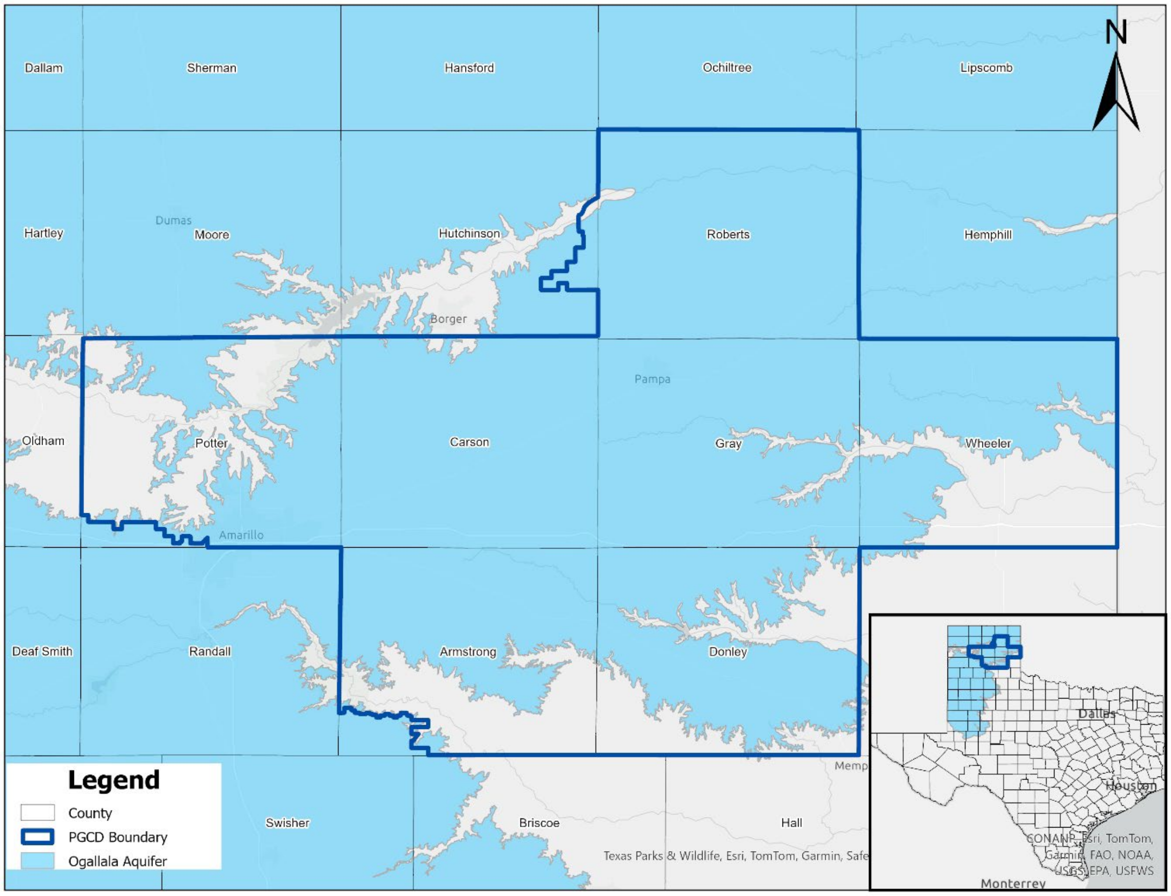


Figure 2 – Map illustrating the areal extent of the Ogallala Aquifer in the District.

In addition to the Ogallala Aquifer, the District has two minor aquifers. The Dockum Aquifer furnishes limited amounts of household, livestock, and irrigation water within the District. The Dockum Aquifer is present in Triassic age shales, sandstones, and siltstones where it is found within the District. Water production from the Dockum Aquifer occurs in Armstrong, Potter, and southwest Carson counties (Figure 3).

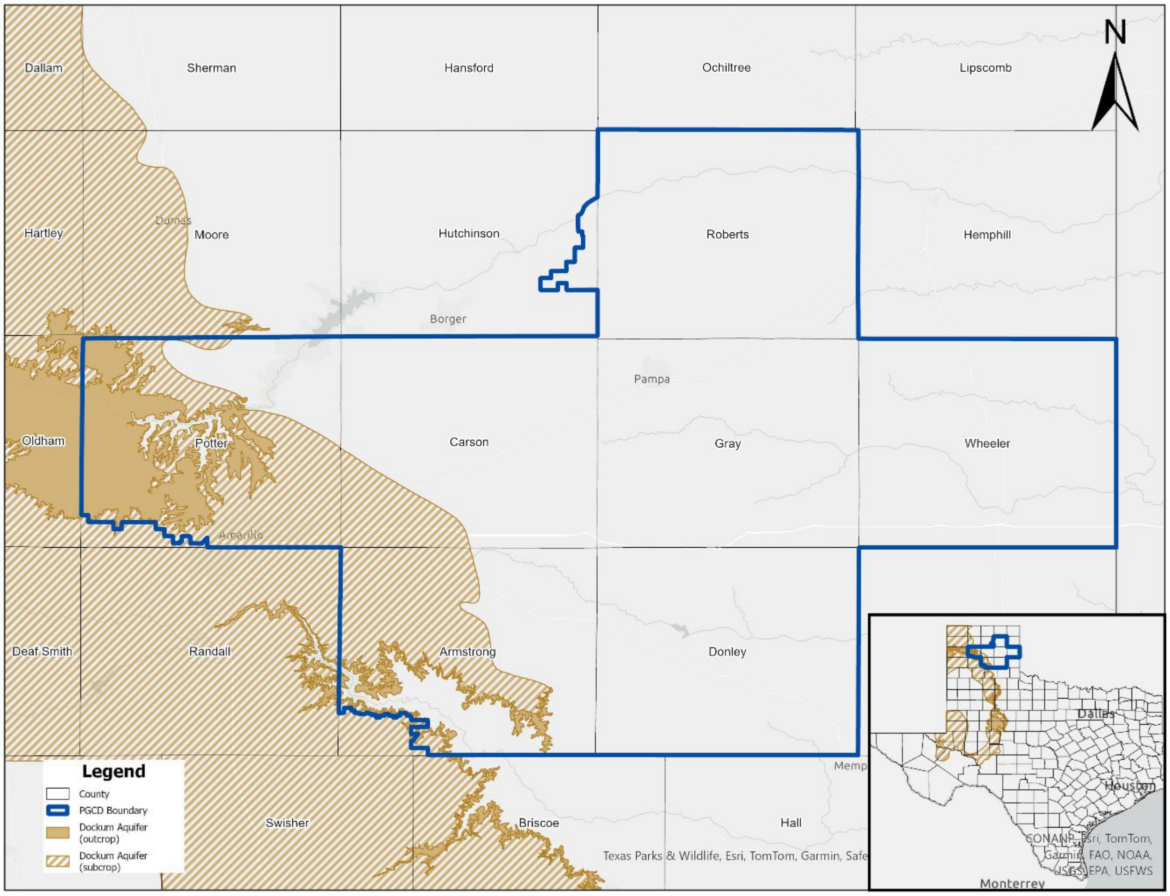


Figure 3 – Map illustrating the areal extent of the Dockum Aquifer in the District.

The Blaine Aquifer is a minor aquifer located in the southern portion of Wheeler County (Figure 4). For the purposes of joint planning, District Representatives classified the Blaine Aquifer as non-relevant. As such, no goals, management objectives, or performance standards are adopted in this management plan for the Blaine Aquifer. The aquifer is contained in the Permian age Blaine Formation. The water is found in solution channels formed by dissolving deposits of anhydrite and halite within the formation. The dissolving salts raise the total dissolved solids to levels above drinking water standards, so the Blaine Aquifer is used mainly for agriculture.

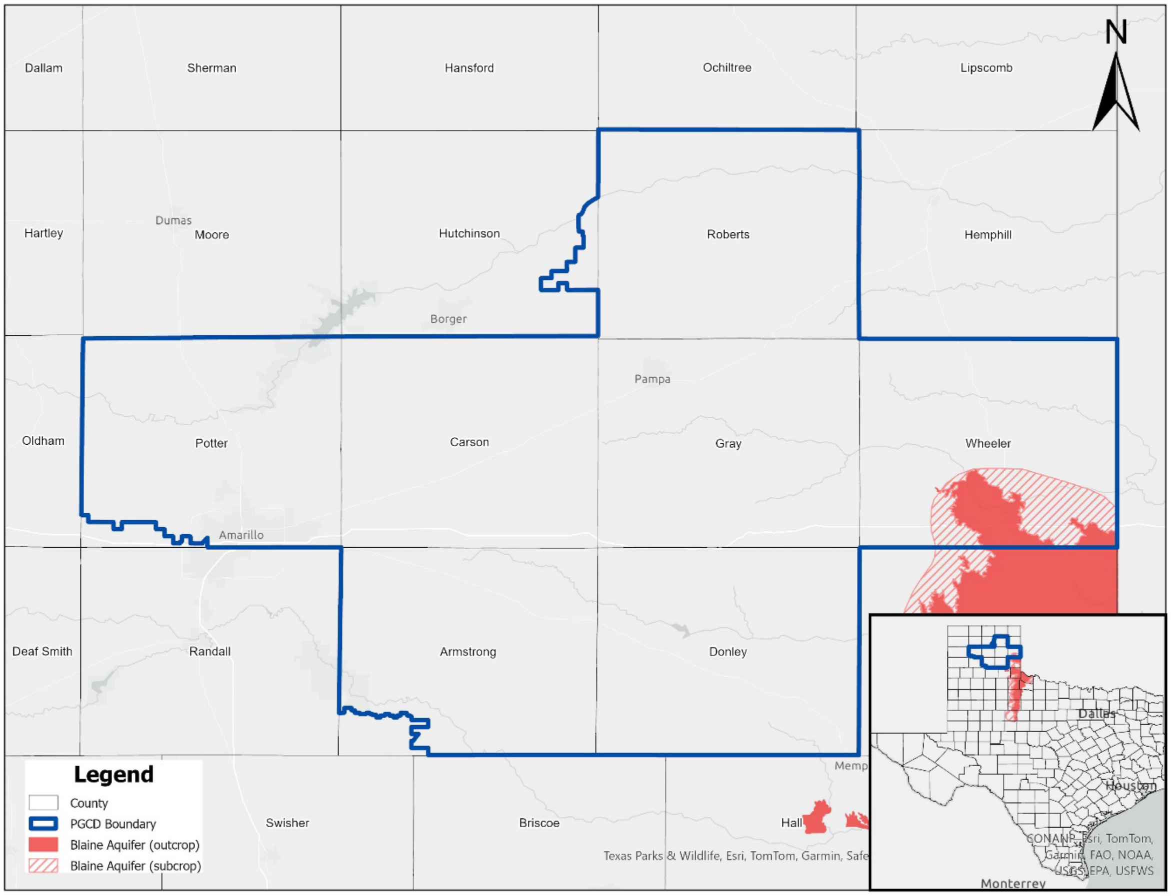


Figure 4 – Map illustrating the areal extent of the Blaine Aquifer in the District.

Texas Water Code Section 36.1071 requires groundwater conservation districts to consider and utilize information from the current groundwater availability model and site-specific information during the development of the management plan. As part of this requirement, groundwater conservation districts are to consider estimates of (1) the annual amount of recharge from precipitation to the groundwater resources within the district, if any; (2) for each aquifer within the district, the annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers; and (3) the annual volume of flow into and out of the district within each aquifer and between aquifers in the District. The Texas Water Development Board provided this information in Cawthon (2024)[7] to the District for this management plan. The required estimates for the Ogallala, Dockum, and Blaine aquifers are included in Appendix 6.

The primary sources of recharge to the Ogallala Aquifer are the infiltration of water from playa lakes and the infiltration of precipitation. Localized water infiltration from playa lakes is the main recharge mechanism in the part of the District located "above the Caprock."

The District has determined that the most feasible method of increasing natural recharge is to increase rainfall by initiating a rainfall enhancement program. The objective of this program is to decrease irrigation demand and increase recharge in those areas where recharge takes place. Precipitation enhancement operations began in May 2000. The purpose of the precipitation enhancement program is to add additional rainfall over an extended period. One additional inch of rainfall could provide 2,300 acre-feet of additional recharge within the District each year (PGCD, 2001)[8].

CHAPTER 8 SURFACE WATER RESOURCES

While groundwater provides the vast majority of water supplies within the District, it is still important to consider surface water resources during the development of this management plan. Also, Texas Water Code §36.1071(e)(3)(F) requires the inclusion of estimates of projected surface water supplies in the District based on the most recently adopted Texas State Water Plan. These estimates summarized at the county level are presented below in Appendix 4 and decreases from 4,578 acre-feet per year in 2020 to 4,348 in 2070. (Readers note – estimates of groundwater resources as represented by estimates of modeled available groundwater (MAG), as determined based on the adopted DFCs, are included in Tables 1 and 2.) Surface water supplies within the District were determined through water availability models (WAM) and other hydrologic modeling of the Red and Canadian Basins. Drought conditions make it challenging to determine a reliable surface water supply within the District.

Lake Meredith and Greenbelt Reservoir are the two major surface impoundments used to supply water to cities inside and outside the District. Numerous other small reservoirs are also used for agricultural purposes and environmental needs. Lake Meredith is located in parts of Hutchinson, Moore, and Potter counties and is operated by the Canadian River Municipal Water Authority (CRMWA) as a municipal and industrial water supply for 11 member cities of the Authority. The lake is owned by the United States Bureau of Reclamation and is operated as a National Recreation Area by the National Park Service. Water rights to impound water in the lake (up to 500,000 acre-feet may be held in conservation storage) and to divert water from it for municipal and industrial uses are held by the Authority under certificates of adjudication issued by the State of Texas. The Ogallala Aquifer now provides most of the water CRMWA delivers to its member cities. Supplemental water is obtained from Lake Meredith to fulfill the annual CRMWA allocations; however, for the first time since opening, there were no deliveries of surface water to member cities from Lake Meredith in 2011– 2013. Water from the lake is blended with local groundwater from individual municipality well fields by several cities. Member cities use the water from CRMWA to supply their base demand and rely upon their localized groundwater supplies to meet their peak demands. Pampa and Amarillo, two of the CRMWA member cities within the boundaries of the District, follow the latter procedure. The second surface impoundment is Greenbelt Reservoir, located in Donley County. Greenbelt Municipal & Industrial Water Authority (Greenbelt) is the proprietor and operator.

CHAPTER 9 WATER MANAGEMENT PLAN

During the regional water planning process in Texas, a water supply need is identified if the projected demands exceed the supply for an individual water user group or wholesale water provider. Water supply needs are quantified on an individual water user group basis, then summarized at the county, groundwater conservation district, regional water planning area, and statewide. If no water user group is determined to need additional water supply during drought conditions, then the need for additional supply will be recorded as "0". A review of summary data for counties in the District documents that seven of the eight counties in the District demonstrate a need for additional water supply throughout the 50-year planning horizon (see Table 4). Within the District, only Roberts County does not have at least some need for additional water supplies during the 50-year planning horizon. Potter County has the most significant need for additional water supplies, projected to be 24,263 acre-feet per year by 2070. For a complete breakdown of water supply needs by water user groups, see Appendix 4.

Table 4 - Projected Water Supply Needs TWDB 2022 State Water Plan Data[6]. (In acre-feet per year).

County	2020	2030	2040	2050	2060	2070
Armstrong	0	0	0	0	0	0
Carson	0	-461	-586	-581	-580	-580
Donley	0	0	0	0	-32	-66
Gray	0	-160	-836	-1,384	-4,569	-5,043
Hutchinson	0	-164	-291	-394	-615	-622
Potter	0	-3,746	-9,043	-15,202	-20,616	-24,263
Roberts	0	0	0	0	0	0
Wheeler	0	0	0	-47	-132	-153
District Total	**0**	**-4,531**	**-10,756**	**-17,608**	**-26,544**	**-30,727**

The final step in the Texas regional water planning process is to identify, evaluate, and then recommend or select water management strategies to meet all identified needs for additional water supply. Any water user group, whether municipal, irrigated agriculture, or mining (at a county aggregate level), for example, that is determined to need additional water supply for any decade during the 50-year planning horizon will go through a deliberate process of identifying all potentially feasible water management strategies to meet the identified need, evaluate the cost, reliability, yield, impact to the environment and water quality, and then recommend the most appropriate strategy or combination of water management strategies to meet the identified needs. A summation by county of the projected volume of water supply that will result from implementing all recommended water management strategies and the individual water management strategies recommended in the 2022 Texas State Water Plan to meet the identified needs for additional water supply may be found in Appendix 4. An examination of more significant water management strategies recommended for water user groups in the District includes:

- Agricultural water conservation strategies,
- Municipal water conservation,
- Development of additional groundwater supplies,
- Weather modification,
- Water audits and leak repairs,
- Conjunctive use, and
- Expand infrastructure capacity (CRMWA II).

References

[1] Texas Water Development Board. (2002). Water for Texas, 2002 State Water Plan (Document Number GP-7-1). https://www.twdb.texas.gov/waterplanning/swp/2002/index.asp#Vol1

[2] Deeds, N. E., & Jigmond, M. (2015). Numerical Model Report for the High Plains Aquifer System Groundwater Availability Model. Texas Water Development Board. https://www.twdb.texas.gov/groundwater/models/gam/hpas/HPAS_GAM_Numerical_Report.pdf

[3] Anaya, R. (2023). GAM RUN 21-007 MAG: Modeled Available groundwater for the High Plains Aquifer System in Groundwater Management Area 1 (No. GR21-007 MAG). Texas Water Development Board. https://www.twdb.texas.gov/groundwater/docs/GAMruns/GR21-007_MAG.pdf

[4] Furnans, J., et al. (2017). Final Report: Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping TWDB Contract Number 1648302062. Texas Water Development Board. https://www.twdb.texas.gov/groundwater/models/research/subsidence/subsidence.asp

[5] Freese and Nichols, Inc., WSP USA, Inc., Texas A&M AgriLife Research and Extension Center in Amarillo. Prepared for the Panhandle Water Planning Group. (2020). 2021 Panhandle Water Plan. https://www.twdb.texas.gov/waterplanning/rwp/plans/2021/index.asp

[6] Allen, S. (2019). Estimated Historical Groundwater Use and 2022 State Water Plan Datasets: Panhandle Groundwater Conservation District. Texas Water Development Board. https://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/

[7] Cawthon, T. (2024). GAM Run 24-003: Panhandle Groundwater Conservation District Management Plan. Texas Water Development Board. https://www.twdb.texas.gov/groundwater/docs/GAMruns/GR24-003.pdf

[8] Panhandle Groundwater Conservation District. (2001). Annual Evaluation Report on the District's Precipitation Enhancement Program.

Appendix 1

Texas Water Development Board Administrative Review Checklist

Texas Water Development Board

Groundwater Conservation District Management Plan Checklist, effective December 6, 2012

District name: Panhandle Groundwater Conservation District

Reviewing staff:	**Date plan received:**
	Date plan reviewed:

A management plan shall contain, unless explained as not applicable, the following elements, 31 TAC §356.52(a):

	Citation of rule	Citation of statute	Present in plan and administratively complete	Source of data	Evidence that best available data was used
Is a paper hard copy of the plan available?	31 TAC §356.53(a)(1)		Yes		
Is an electronic copy of the plan available?	31 TAC §356.53(a)(2)		Yes		
1. Is an estimate of the modeled available groundwater in the District based on the desired future condition established under Section 36.108 included?	31 TAC §356.52(a)(5)(A)	TWC §36.1071(e)(3)(A)	Ogallala Aquifer – Subsection 4.2.1, pg. 7 Dockum Aquifer - Subsection 4.2.2, pg. 9		

2. Is an estimate of the amount of groundwater being used within the District on an annual basis for at least the most recent five years included?	31 TAC §356.52(a)(5)(B); §356.10(2)	TWC §36.1071(e)(3)(B)	See Appendix 6		
For sections 3-5 below, each district must use the groundwater availability modeling information provided by the TWDB in conjunction with available site-specific information provided by the district when developing the required estimates, 31 TAC §356.52(c):					
3. Is an estimate of the annual amount of recharge, from precipitation, if any, to the groundwater resources within the District included?	31 TAC §356.52(a)(5)(C)	TWC §36.1071(e)(3)(C)	See Appendix 6		
4. For each aquifer in the district, is an estimate of the annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams and rivers, included?	31 TAC §356.52(a)(5)(D)	TWC §36.1071(e)(3)(D)	See Appendix 6		
5. Is an estimate of the annual volume of flow	31 TAC §356.52(a)(5)(E)	TWC §36.1071(e)(3)(E)			
a) into the District within each aquifer,			See Appendix 6		
b) out of the District within each aquifer,			See Appendix 6		
c) and between aquifers in the District,			See Appendix 6		
if a groundwater availability model is available, included?					
6. Is an estimate of the projected surface water supply within the District according to the most recently adopted state water plan included?	31 TAC §356.52(a)(5)(F)	TWC §36.1071(e)(3)(F)	Chapter 8, pg. 25, and Appendix 4		

7. Is an estimate of the projected total demand for water within the District according to the most recently adopted state water plan included?	31 TAC §356.52(a)(5)(G)	TWC §36.1071(e)(3)(G)	Chapter 6, pg. 20, and Appendix 4		
8. Did the District consider and include the water supply needs from the adopted state water plan?		TWC §36.1071(e)(4)	Chapter 9, pg. 26 and Appendix 4		
9. Did the District consider and include the water management strategies from the adopted state water plan?		TWC §36.1071(e)(4)	Chapter 9, pg. 26-27 and Appendix 4		
10. Did the district include details of how it will manage groundwater supplies in the district	31 TAC §356.52(a)(4)		Chapter 3, pg. 3-5		
11. Are the actions, procedures, performance, and avoidance necessary to effectuate the management plan, including specifications and proposed rules, all specified in as much detail as possible, included in the plan?		TWC §36.1071(e)(2)	Section 4.1, pg. 6		
12. Was evidence that the plan was adopted, after notice and hearing, included? Evidence includes the posted agenda, meeting minutes, and copies of the notice printed in the newspaper(s) and/or copies of certified receipts from the county courthouse(s).	31 TAC §356.53(a)(3)	TWC §36.1071(a)	Appendix 2		
13. Was evidence that, following notice and hearing, the District coordinated in the development of its management plan with regional surface water management entities?	31 TAC §356.51	TWC §36.1071(a)	Appendix 7		
14. Has any available site-specific information been provided by the district to the executive administrator for review and comment before being used in the management plan when developing the estimates required in subsections 31 TAC §356.52(a)(5)(C),(D), and (E) ?	31 TAC §356.52(c)	TWC §36.1071(h)	No		

Mark an affirmative response with YES
Mark a negative response with NO
Mark a non-applicable checklist item with N/A

Management goals required to be addressed unless declared not applicable	Management goal (time-based and quantifiable) 31 TAC §356.51	Methodology for tracking progress 31TAC §356.52(a)(4)	Management objective(s) (specific and time-based statements of future outcomes) 31 TAC §356.52 (a)(2)	Performance standard(s) (measures used to evaluate the effectiveness of district activities) 31 TAC §356.52 (a)(3)	Notes
Providing the most efficient use of groundwater 31 TAC 356.52(a)(1)(A); TWC §36.1071(a)(1)	15) 4.3	16) 4.1, 4.3, 4.3.1.2, 4.3.1.3, 4.3.1.4, 4.3.1.5,	17) 4.3.1.1, 4.3.1.2, 4.3.1.3, 4.3.1.4, 4.3.1.5	18) 4.3.1.1.1, 4.3.1.2.1, 4.3.1.3.1, 4.3.1.4.1, 4.3.1.5.1	p. 10-13
Controlling and preventing waste of groundwater 31 TAC 356.52(a)(1)(B); TWC §36.1071(a)(2)	19) 4.4	20) 4.4, 4.4.1.1	21) 4.4.1.1	22) 4.4.1.1.1	p. 13
Controlling and preventing subsidence 31 TAC 356.52(a)(1)(C); TWC §36.1071(a)(3)	23) NA	24) NA	25) NA	26) NA	p. 18
Addressing conjunctive surface water management issues 31 TAC 356.52(a)(1)(D); TWC §36.1071(a)(4)	27) 4.6	28) 4.6, 4.6.1.1	29) 4.6.1.1	30) 4.6.1.1.1	p. 14
Addressing natural resource issues that impact the use and availability of groundwater and which are impacted by the use of groundwater 31 TAC 356.52(a)(1)(E); TWC §36.1071(a)(5)	31) 4.7	32) 4.7, 4.7.1.1	33) 4.7.1.1	34) 4.7.1.1.1	p. 14-15
Addressing drought conditions 31 TAC 356.52(a)(1)(F); TWC §36.1071(a)(6)	35) 4.5	36) 4.5, 4.5.1.1,	37) 4.5.1.1,	38) 4.5.1.1.1	p. 13-14
Addressing	39)	40)	41)	42)	
a) conservation,	39a) 4.10	40a) 4.10, 4.10.1.1	41a) 4.10.1.1	42a) 4.10.1.1.1	p. 17
b) recharge enhancement,	39b) NA	40b) NA	41b) NA	42b) NA	p. 18
c) rainwater harvesting,	39c) 4.11	40c) 4.11, 4.11.1.1	41c) 4.11.1.1	42c) 4.11.1.1	p. 17-18
d) precipitation enhancement, and	39d) 4.9	40d) 4.9, 4.9.1.1, 4.9.1.2	41d) 4.9.1.1, 4.9.1.2	42d) 4.9.1.1.1, 4.9.1.2.1	p. 16
e) brush control	39e) NA	40e) NA	41e) NA	42e) NA	p. 18
where appropriate and cost effective 31 TAC 356.52(a)(1)(G); TWC §36.1071(a)(7)					
Addressing the desired future conditions established under TWC §36.108. 31 TAC 356.52(a)(1)(H); TWC §36.1071(a)(8)	43) 4.2	44) 4.2, 4.2.1, 4.2.1.1, 4.2.1.2, 4.2.2, 4.2.2.1	45) 4.2.1.1, 4.2.1.2, 4.2.2.1	46) 4.2.1.1.1, 4.2.1.2.1, 4.2.2.1.1	p. 6-10

Does the plan identify the performance standards and management objectives for effecting the plan? 31 TAC §356.52(a)(2)&(3); TWC §36.1071(e)(1)		47) Chapter 4, pg. 5 - 18	48) Chapter 4, pg. 5 - 18	

Mark required elements that are present in the plan with YES
Mark any required elements that are missing from the plan with NO
Mark plan elements that have been indicated as not applicable to the district with N/A

Appendix 2

Documentation for public notices of Panhandle Groundwater Conservation District Board of Directors on June 6, 2024, during which the Management Plan was adopted

Open Meeting Information

Agency Name:	**Panhandle Ground Water Conservation District Number 3**
Date of Meeting:	06/06/2024
Time of Meeting:	09:00 AM **(Local Time)**
Board:	Panhandle Groundwater Conservation District
Committee:	Board of Directors
Status:	Accepted
Street Location:	201 W 3rd Street
City Location:	White Deer
Meeting State:	TX
TRD:	2024003143
Submit Date:	05/31/2024
Emergency Mtg:	No
Additional Information Obtained From:	Britney Britten, General Manager, 201 W 3rd Street, PO Box 637, White Deer, TX 79097, britney@pgcd.us

PANHANDLE GROUNDWATER
CONSERVATION DISTRICT
BOARD OF DIRECTOR'S PUBLIC HEARING ON AMENDMENTS TO DISTRICT'S MANAGEMENT PLAN AND REGULAR MEETING
DISTRICT OFFICE - Windmill Room
201 W. Third Street, White Deer, Texas
June 6, 2024 – 9:00 a.m.
Agenda

1. CALL PUBLIC HEARING TO ORDER regarding amendments to the District Management Plan and the District's intent to adopt the 2024 Management Plan

2. PUBLIC COMMENT – Public questions and comments on the District's proposed Management Plan amendments (Limited to 3 minutes each, please fill out a "Request to Speak" form prior to the discussion of the agenda item.)

3. CONSIDERATION AND POSSIBLE ACTION TO ADOPT THE AMENDMENTS TO THE DISTRICT'S MANAGEMENT PLAN; AUTHORIZATION TO SUBMIT THE AMENDMENTS TO

THE TEXAS WATER DEVELOPMENT BOARD

4. ADJOURN PUBLIC HEARING

5. CALL REGULAR MEETING TO ORDER

6. PUBLIC COMMENT – Please limit comments to 3 minutes.

7. CONSIDERATION AND POSSIBLE ACTION ON MINUTES FROM MAY 2, 2024

8. CONSIDERATION AND POSSIBLE ACTION ON APRIL 2024 EXPENDITURES

9. CONSIDERATION AND POSSIBLE ACTION ON APPOINTING A GROUNDWATER MANAGEMENT AREA 1 REPRESENTATIVE

10. CONSIDERATION AND POSSIBLE ACTION ON THE ANNUAL REVIEW OF THE INVESTMENT POLICY

11. CONSIDERATION AND POSSIBLE ACTION ON AUTHORIZING THE GENERAL MANAGER TO PARTNER WITH WTAMU FOR RESEARCH OPPORTUNITIES REGARDING CLIMATE STUDIES

12. CONSIDERATION AND POSSIBLE ACTION ON THE RESOLUTION FROM TWDB APPROVING A LOAN IN THE AMOUNT OF $1,000,000.00 TO THE PANHANDLE GROUNDWATER CONSERVATION DISTRICT THROUGH THE AGRICULTURAL WATER CONSERVATION LOAN PROGRAM

Agenda:

13. CONSIDERATION AND POSSIBLE ACTION TO REVIEW THE POSITION OF GENERAL MANAGER AS REQUIRED BY DISTRICT BYLAWS

14. REPORT FROM RULES COMMITTEE AND DISCUSSION OF DISTRICT RULES

15. CONSIDERATION AND POSSIBLE ACTION ON PROPOSED AMENDMENTS TO DISTRICT METER STANDARDS

16. STAFF UPDATES

17. MANAGER'S REPORT
a) Update on 2020-2023 Production
b) GMA 1 Update
c) Review of Region A Water Conservation Strategies for Agriculture

18. CONSIDERATION AND POSSIBLE ACTION TO SET FUTURE MEETING DATES

19. EXECUTIVE SESSION ON LISTED AGENDA ITEMS

20. ADJOURN REGULAR MEETING

At any time during the meeting and in compliance with the Texas Open Meetings Act, Chapter 551, Government Code, Vernon's Texas Codes, Annotated, the Panhandle Groundwater Conservation District Board of Directors may meet in executive session on any of the above agenda items for consultation concerning legal matters (§551.071); deliberation regarding real property (§551.072); deliberation regarding prospective gift (§551.073); personnel matters (§551.074); and deliberation regarding security devices (§551.076), or for any other purpose authorized by Chapter 551 of the Texas Government Code. Any subject discussed in the executive session may be subject to action during an open meeting.

The presiding office of the Board, prior to the Board meeting in executive session, will announce that a closed meeting will be held and will publicly identify the section or sections of the Government Code Chapter 551 under which the closed meeting is to be held.

PUBLIC NOTICE

This complies with Section 551.043, of the Open Meetings Act, requiring posting of the items to be considered at least 72 hours prior to the meeting. Notice has been filed with the Secretary of State's office in Austin, at a place convenient to the public in the administrative office of the District and on the District's website, in compliance with Section 551.053 of the Open Meetings Act.

Posted this _______________ 201 W. Third Street, White Deer, Texas at______ a.m.

____

Katie Hodges, Panhandle Groundwater

Meeting Information

2024 Meetings

Agenda 6.6.24 - Public Hearing on District's Management Plan and Regular Meeting

Agenda 6.6.24 - 2nd Meeting to be held at 9:30 or Immediately Upon Adjournment of 1st Meeting

Agenda 5.2.24

Agenda 3.28.24

- Approved Minutes 3.28.24

Agenda 1.11.24

- Approved Minutes 1.11.24

Agenda 1.11.24 - Rules Hearing on Rule 3.3

- Approved Rules Hearing Minutes 1.11.24

2023 Meetings

Agenda 12.14.23

- Approved Minutes 12.14.23

Agenda 11.16.23

PANHANDLE GROUNDWATER CONSERVATION DISTRICT

BOARD OF DIRECTOR'S PUBLIC HEARING ON AMENDMENTS TO DISTRICT'S MANAGEMENT PLAN MINUTES

DISTRICT OFFICE - Windmill Room
201 W. Third Street, White Deer, Texas
June 6, 2024 – 9:00 a.m.

Those Present Were:

Chancy Cruse	President
Lee Peterson	Secretary
Charles Bowers	Director
William Breeding	Director
Wes Stockett	Director
John R. Spearman, Jr.	Director
Britney Britten	General Manager
Julie Bennett	Permitting Administrator
Payton Holtkamp	Education/PR
Rita Poor	Admin Assistant
Jake Robinson	Meter Specialist

Guests Present: Drew Satterwhite, CRMWA; Chad Pernell, CRMWA; Craig Cowden, Hemphill UWCD Board Member

1. CALL PUBLIC HEARING TO ORDER regarding amendments to the District Management Plan and the District's intent to adopt the 2024 Management Plan.

   President Cruse called the Public Hearing on the District's Management Plan to order on 9:02 a.m.

2. PUBLIC COMMENT – Public questions and comments on the District's proposed Management Plan amendments (Limited to 3 minutes each, please fill out a "Request to Speak" form prior to the discussion of the agenda item.)

   No Public Comment.

3. CONSIDERATION AND POSSIBLE ACTION TO ADOPT THE AMENDMENTS TO THE DISTRICT'S MANAGEMENT PLAN; AUTHORIZATION TO SUBMIT THE AMENDMENTS TO THE TEXAS WATER DEVELOPMENT BOARD

   General Manager Britney Britten informed the Directors that due to timing issues with TWDB, the District has not yet received comments from TWDB on a plan it submitted for a pre-review. TWDB has cautioned the District to adopt a plan without pre-review comments. However, legal counsel and the District feel it is in the best interest of the District to follow statute and remain in compliance with the Texas

Commission on Environmental Quality (TCEQ). TCEQ notified the District that it must adopt amendments to its plan by June 17, 2024, and the final plan must be submitted to TWDB by July 17, 2024. Britten has been in ongoing conversations with TWDB and if they deny the final plan, then the District will have 180 days to correct any issues.

Britten reviewed the amendments with the Board.

Director Lee Peterson made the motion to adopt the amendments to the District's Management Plan as presented, subject to amendments necessary to incorporate technical information and non-substantive comments received from TWDB and authorize the Board President and/or General Manager to submit the Management Plan to TWDB for final approval, seconded by Director John R Spearman. The motion passed unanimously.

4. ADJOURN PUBLIC HEARING

Director Charles Bowers motioned to adjourn at 9:11a.m., seconded by Director John R Spearman. The motion passed unanimously.

Chancy Cruse

Lee Peterson

Appendix 3

Resolution adopting the 2024 Panhandle Groundwater Conservation District Management Plan

Panhandle Groundwater Conservation District

P.O. Box 637
White Deer, TX 79097
Resolution No. MP24-01

Management Plan
2024-2029
Adopted June 6, 2024

WHEREAS, the Panhandle Groundwater Conservation District (District) was created by Acts of the 51st Legislature (Texas Civil Statutes, Chapter 3A, Title 128, Article 7880-3c, and currently operates under Chapter 36 of the Texas Water Code); and

WHEREAS, the District is required by SB1, through Chapter 36.1071 of the Texas Water Code, to develop and adopt a new Management Plan each 5 years; and

WHEREAS, under the direction of the Board of Directors of the District (the "Board"), and in accordance with Sections 36.1071, 36.1072 and 36.108 of the Texas Water Code, and 31 Texas Administrative Code Chapter 356, the District has undertaken the amendment of its Management Plan;

WHEREAS, the District issued the notice in the manner required by state law and held a public hearing on June 6, 2024, at 9:00 AM in White Deer, Texas to receive public and written comments on the Amendments to the Management Plan and received written comments at the District's office located at 201 W. Third St., White Deer, Texas;

WHEREAS, the Board finds that the Management plan meets all the requirements of Chapter 36, Water Code, and 31 Texas Administrative Code Chapter 356; and

WHEREAS, these amendments are changes reflective of District Rule revisions and required updates to Texas Water Development Board estimates to the current duly approved Management Plan of September 17, 2019; and

WHEREAS, during the public hearing, which was properly noticed in accordance with state law, the Board of Directors met on June 6, 2024, and considered the adoption of the attached Management Plan, and approval of this resolution after due consideration of all comments received.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE PANHANDLE GROUNDWATER CONSERVATION DISTRICT THAT:

1. The above recitals are true and correct.

2. The Board of Directors of the District hereby adopts the attached Management Plan as the Management Plan for the District, subject to those amendments necessary to incorporate technical information and non-substantive comments received from the Texas Water Development Board;

3. The Board President and the General Manager of the District are further authorized to take all steps necessary to implement this resolution and submit the Management Plan to the TWDB for its approval; and

4. The Board President and General Manager of the District are further authorized to take any and all action necessary to coordinate with the TWDB as may be required in furtherance of TWDB's approval pursuant to the provisions of Section 36.1072 of the Texas Water Code.

AND IT IS SO ORDERED.

PASSED AND ADOPTED on this 6th day of June, 2024.

PANHANDLE GROUNDWATER CONSERVATION DISTRICT

Chancy Cruse
Board President

Lee Peterson
Board Secretary

Appendix 4

Estimated Historical Groundwater Use And 2022 State Water Plan Datasets: Prepared for the Panhandle Groundwater Conservation District

Estimated Historical Groundwater Use And 2022 State Water Plan Datasets:

Panhandle Groundwater Conservation District

Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
May 16, 2024

GROUNDWATER MANAGEMENT PLAN DATA:

This package of water data reports (part 1 of a 2-part package of information) is being provided to groundwater conservation districts to help them meet the requirements for approval of their five-year groundwater management plan. Each report in the package addresses a specific numbered requirement in the Texas Water Development Board's groundwater management plan checklist. The checklist can be viewed and downloaded from this web address:

http://www.twdb.texas.gov/groundwater/docs/GCD/GMPChecklist0113.pdf

The five reports included in this part are:

1. Estimated Historical Groundwater Use (checklist item 2)

   from the TWDB Historical Water Use Survey (WUS)

2. Projected Surface Water Supplies (checklist item 6)
3. Projected Water Demands (checklist item 7)
4. Projected Water Supply Needs (checklist item 8)
5. Projected Water Management Strategies (checklist item 9)

   from the 2022 Texas State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report for the District (checklist items 3 through 5). The District should have received, or will receive, this report from the Groundwater Availability Modeling Section. Questions about the GAM can be directed to Grayson Dowlearn, grayson.dowlearn@twdb.texas.gov, (512) 475-1552.

DISCLAIMER:

The data presented in this report represents the most up to date WUS and 2022 SWP data available as of 5/16/2024. Although it does not happen frequently, either of these datasets are subject to change pending the availability of more accurate WUS data or an amendment to the 2022 SWP. District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

The WUS dataset can be verified at this web address:

http://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/

The 2022 SWP dataset can be verified by contacting Sabrina Anderson (sabrina.anderson@twdb.texas.gov or 512-936-0886).

The values presented in the data tables of this report are county-based. In cases where groundwater conservation districts cover only a portion of one or more counties the data values are modified with an apportioning multiplier to create new values that more accurately represent conditions within district boundaries. The multiplier used in the following formula is a land area ratio: (data value * (land area of district in county / land area of county)). For two of the four SWP tables (Projected Surface Water Supplies and Projected Water Demands) only the county-wide water user group (WUG) data values (county other, manufacturing, steam electric power, irrigation, mining and livestock) are modified using the multiplier. WUG values for municipalities, water supply corporations, and utility districts are not apportioned; instead, their full values are retained when they are located within the district, and eliminated when they are located outside (we ask each district to identify these entity locations).

The remaining SWP tables (Projected Water Supply Needs and Projected Water Management Strategies) are not modified because district-specific values are not statutorily required. Each district should however consider and discuss the county values in these tables.

In the WUS table every category of water use (including municipal) is apportioned. Staff determined that breaking down the annual municipal values into individual WUGs was too complex.

TWDB recognizes that the apportioning formula used is not ideal but it is the best available process with respect to time and staffing constraints. If a district believes it has data that are more accurate it can add those data to the plan with an explanation of how the data were derived. Apportioning percentages used by the TWDB are listed above each applicable table.

For additional questions regarding these data, please contact Stephen Allen (stephen.allen@twdb.texas.gov or 512-463-7317).

Estimated Historical Water Use
TWDB Historical Water Use Survey (WUS) Data

Groundwater and surface water historical use estimates are currently unavailable for calendar year 2020. TWDB staff anticipates the calculation and posting of these estimates at a later date.

ARMSTRONG COUNTY *92.36% (multiplier)* All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	264	0	0	0	5,458	546	6,268
	SW	0	0	0	0	0	61	61
2018	GW	357	0	0	0	5,273	542	6,172
	SW	0	0	0	0	0	60	60
2017	GW	303	0	0	0	4,476	520	5,299
	SW	0	0	0	0	0	58	58
2016	GW	305	0	0	0	6,292	243	6,840
	SW	0	0	0	0	0	27	27
2015	GW	288	0	0	0	4,140	237	4,665
	SW	0	0	0	0	0	27	27
2014	GW	320	0	0	0	5,008	235	5,563
	SW	0	0	0	0	0	26	26
2013	GW	354	0	0	0	7,163	227	7,744
	SW	0	0	0	0	0	25	25
2012	GW	396	0	0	0	8,785	431	9,612
	SW	0	0	0	0	0	48	48
2011	GW	428	0	0	0	7,752	460	8,640
	SW	0	0	0	0	0	51	51
2010	GW	322	0	0	0	4,060	414	4,796
	SW	0	0	0	0	0	46	46
2009	GW	346	0	0	0	5,527	494	6,367
	SW	0	0	0	0	0	54	54
2008	GW	377	0	0	0	6,524	491	7,392
	SW	0	0	0	0	0	54	54
2007	GW	365	0	0	0	5,338	467	6,170
	SW	0	0	0	0	0	53	53
2006	GW	435	0	0	0	6,080	846	7,361
	SW	0	0	0	0	0	94	94
2005	GW	357	0	0	0	7,077	759	8,193
	SW	0	0	0	0	0	84	84
2004	GW	358	0	0	0	6,647	719	7,724
	SW	0	0	0	0	0	179	179

CARSON COUNTY

100% (multiplier)

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	810	694	0	0	113,138	324	114,966
	SW	0	0	0	0	420	36	456
2018	GW	939	831	0	0	110,755	324	112,849
	SW	0	0	0	0	0	36	36
2017	GW	872	762	1	0	91,096	308	93,039
	SW	0	0	0	0	205	34	239
2016	GW	834	990	0	0	104,042	310	106,176
	SW	0	0	0	0	160	34	194
2015	GW	797	957	0	0	78,810	305	80,869
	SW	0	0	0	0	122	34	156
2014	GW	974	949	0	0	91,433	332	93,688
	SW	0	0	0	0	0	37	37
2013	GW	1,090	325	0	0	105,201	318	106,934
	SW	0	0	0	0	0	35	35
2012	GW	1,378	384	0	0	124,090	503	126,355
	SW	0	0	0	0	0	56	56
2011	GW	1,420	908	0	0	95,956	718	99,002
	SW	0	0	0	0	0	80	80
2010	GW	1,622	338	11	0	59,823	631	62,425
	SW	12	0	4	0	246	71	333
2009	GW	1,266	308	38	0	71,965	474	74,051
	SW	2	0	2	0	0	53	57
2008	GW	1,077	365	38	0	88,034	558	90,072
	SW	3	0	0	0	0	62	65
2007	GW	1,108	308	52	0	84,896	571	86,935
	SW	3	0	0	0	0	63	66
2006	GW	1,202	308	43	0	64,707	1,007	67,267
	SW	3	0	0	0	0	112	115
2005	GW	1,141	439	57	0	70,275	586	72,498
	SW	3	0	0	0	0	65	68
2004	GW	1,199	442	65	0	56,545	261	58,512
	SW	4	0	0	0	0	381	385

DONLEY COUNTY

100% (multiplier)

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	80	0	0	0	32,592	798	33,470
	SW	260	0	0	0	0	200	460
2018	GW	49	0	0	0	32,891	798	33,738
	SW	282	0	0	0	0	200	482
2017	GW	44	0	0	0	31,146	766	31,956
	SW	283	0	0	0	0	192	475
2016	GW	78	0	0	0	29,946	692	30,716
	SW	293	0	0	0	0	173	466
2015	GW	92	0	0	0	25,696	686	26,474
	SW	342	0	0	0	0	171	513
2014	GW	111	0	0	0	35,001	732	35,844
	SW	327	0	0	0	0	183	510
2013	GW	162	0	0	0	30,412	671	31,245
	SW	342	0	0	0	0	168	510
2012	GW	208	0	0	0	42,048	711	42,967
	SW	403	0	0	0	0	178	581
2011	GW	250	0	0	0	39,148	770	40,168
	SW	498	0	0	0	0	193	691
2010	GW	209	0	0	0	25,493	696	26,398
	SW	429	0	0	0	30	174	633
2009	GW	203	0	0	0	29,290	726	30,219
	SW	478	0	0	0	0	182	660
2008	GW	211	0	0	0	32,265	835	33,311
	SW	466	0	0	0	46	209	721
2007	GW	190	0	0	0	38,543	943	39,676
	SW	385	0	0	0	37	235	657
2006	GW	231	0	0	0	26,299	862	27,392
	SW	511	0	0	0	48	215	774
2005	GW	216	0	0	0	30,960	942	32,118
	SW	381	0	0	0	70	236	687
2004	GW	198	0	0	0	29,097	110	29,405
	SW	468	0	0	0	64	985	1,517

GRAY COUNTY *100% (multiplier)* All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	795	314	0	0	41,399	1,379	43,887
	SW	2,530	3	0	0	0	460	2,993
2018	GW	1,008	281	0	0	40,832	1,359	43,480
	SW	2,430	3	0	0	0	453	2,886
2017	GW	1,214	305	0	0	38,871	1,313	41,703
	SW	2,009	0	0	0	0	438	2,447
2016	GW	736	264	0	0	41,766	1,501	44,267
	SW	2,339	0	0	0	0	500	2,839
2015	GW	1,676	282	0	0	28,143	1,473	31,574
	SW	1,844	0	0	0	0	491	2,335
2014	GW	1,456	309	0	0	40,664	1,467	43,896
	SW	2,222	0	0	0	0	489	2,711
2013	GW	2,574	287	0	0	39,122	1,428	43,411
	SW	2,187	0	0	0	0	476	2,663
2012	GW	2,251	303	0	0	38,708	1,410	42,672
	SW	2,388	0	0	0	0	470	2,858
2011	GW	2,569	316	0	0	37,285	1,407	41,577
	SW	2,334	0	0	0	8	469	2,811
2010	GW	1,612	459	23	0	22,721	1,184	25,999
	SW	3,080	0	6	0	0	395	3,481
2009	GW	1,794	5,378	21	0	31,276	2,148	40,617
	SW	2,259	0	5	0	0	716	2,980
2008	GW	2,822	3,947	19	0	33,218	1,546	41,552
	SW	1,285	0	5	0	0	516	1,806
2007	GW	2,773	3,921	0	0	32,104	1,449	40,247
	SW	1,285	0	0	0	0	483	1,768
2006	GW	2,821	3,694	0	0	27,181	1,998	35,694
	SW	1,285	0	0	0	0	666	1,951
2005	GW	2,844	3,656	0	0	33,406	1,169	41,075
	SW	1,285	0	0	0	0	390	1,675
2004	GW	2,089	4,030	0	0	35,394	118	41,631
	SW	1,151	0	0	0	0	1,426	2,577

HUTCHINSON COUNTY

4.24% (multiplier)

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	205	446	4	0	2,910	15	3,580
	SW	7	28	0	0	82	5	122
2018	GW	226	440	4	0	2,789	15	3,474
	SW	8	28	0	0	12	5	53
2017	GW	196	464	5	0	2,493	15	3,173
	SW	5	28	0	0	12	5	50
2016	GW	258	415	4	0	2,722	12	3,411
	SW	9	0	0	0	12	4	25
2015	GW	215	652	4	0	2,100	12	2,983
	SW	4	0	0	0	82	4	90
2014	GW	289	673	4	0	2,732	11	3,709
	SW	59	0	0	0	0	4	63
2013	GW	128	638	4	0	2,932	11	3,713
	SW	48	0	0	0	12	4	64
2012	GW	146	684	4	0	3,045	14	3,893
	SW	39	0	0	0	12	5	56
2011	GW	241	720	4	0	3,127	17	4,109
	SW	5	14	0	0	0	6	25
2010	GW	187	1,160	6	0	1,700	16	3,069
	SW	51	39	1	0	12	5	108
2009	GW	153	1,240	6	0	2,255	21	3,675
	SW	9	0	1	0	0	7	17
2008	GW	188	1,104	6	0	2,138	21	3,457
	SW	14	82	5	0	82	7	190
2007	GW	137	1,070	4	0	1,463	16	2,690
	SW	11	114	4	0	12	5	146
2006	GW	138	1,107	4	0	1,735	24	3,008
	SW	13	23	4	0	12	8	60
2005	GW	101	1,028	4	0	1,761	20	2,914
	SW	13	151	0	0	12	7	183
2004	GW	126	1,104	4	0	1,625	3	2,862
	SW	19	110	4	0	12	27	172

POTTER COUNTY

94.12% (multiplier)

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	16,401	5,810	184	883	3,414	386	27,078
	SW	2,583	10	144	0	0	68	2,805
2018	GW	19,807	5,227	104	747	2,252	386	28,523
	SW	3,549	11	51	0	0	68	3,679
2017	GW	19,216	6,034	178	807	1,155	376	27,766
	SW	1,772	9	58	0	0	67	1,906
2016	GW	19,906	6,140	84	811	1,438	379	28,758
	SW	2,657	45	32	0	0	67	2,801
2015	GW	19,154	5,548	151	1,025	492	369	26,739
	SW	2	46	48	0	0	65	161
2014	GW	22,825	5,315	143	1,065	2,451	368	32,167
	SW	1	48	45	0	0	65	159
2013	GW	23,866	4,385	104	1,223	3,854	416	33,848
	SW	0	45	32	0	0	73	150
2012	GW	26,148	3,857	106	742	3,365	523	34,741
	SW	3	44	32	0	0	93	172
2011	GW	26,553	5,174	128	1,321	2,246	680	36,102
	SW	1,520	48	0	0	0	121	1,689
2010	GW	17,695	5,722	417	503	1,121	614	26,072
	SW	6,086	242	464	0	0	109	6,901
2009	GW	16,621	4,965	394	665	3,306	600	26,551
	SW	6,253	380	434	0	0	106	7,173
2008	GW	19,614	5,476	380	1,246	2,923	564	30,203
	SW	4,668	218	404	0	0	100	5,390
2007	GW	16,233	5,473	129	1,331	5,539	596	29,301
	SW	6,294	340	0	181	0	105	6,920
2006	GW	19,554	5,312	137	902	3,958	507	30,370
	SW	8,170	422	6	1,732	0	90	10,420
2005	GW	16,872	4,580	137	1,529	5,180	516	28,814
	SW	9,038	252	0	3,540	0	92	12,922
2004	GW	17,984	5,030	136	1,271	4,639	42	29,102
	SW	7,074	301	0	4,404	0	449	12,228

ROBERTS COUNTY

100% (multiplier)

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	189	0	32	0	11,638	303	12,162
	SW	0	0	8	0	0	53	61
2018	GW	205	0	49	0	10,875	303	11,432
	SW	0	0	12	0	0	53	65
2017	GW	178	0	62	0	8,904	296	9,440
	SW	0	0	15	0	0	52	67
2016	GW	170	0	16	0	9,545	300	10,031
	SW	0	0	4	0	0	53	57
2015	GW	161	0	117	0	7,065	291	7,634
	SW	0	0	29	0	0	51	80
2014	GW	195	0	232	0	9,157	287	9,871
	SW	0	0	58	0	0	50	108
2013	GW	190	0	147	0	8,797	289	9,423
	SW	0	0	37	0	0	52	89
2012	GW	206	0	42	0	9,161	264	9,673
	SW	0	0	10	0	0	46	56
2011	GW	226	0	71	0	13,137	312	13,746
	SW	0	0	18	0	0	55	73
2010	GW	168	0	162	0	7,362	273	7,965
	SW	0	0	77	0	0	48	125
2009	GW	159	0	180	0	6,531	295	7,165
	SW	0	0	85	0	0	52	137
2008	GW	147	0	196	0	8,412	287	9,042
	SW	0	0	94	0	0	52	146
2007	GW	155	0	0	0	16,522	388	17,065
	SW	0	0	0	0	0	69	69
2006	GW	179	0	0	0	14,639	350	15,168
	SW	0	0	0	0	0	62	62
2005	GW	203	0	0	0	13,601	459	14,263
	SW	0	0	0	0	0	81	81
2004	GW	186	0	0	0	14,393	48	14,627
	SW	0	0	0	0	0	468	468

WHEELER COUNTY

100% (multiplier)

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	1,039	0	21	0	17,055	775	18,890
	SW	0	0	4	0	112	258	374
2018	GW	1,669	0	135	0	15,229	775	17,808
	SW	0	0	31	0	115	258	404
2017	GW	1,946	0	181	0	15,307	755	18,189
	SW	0	0	45	0	60	252	357
2016	GW	1,389	0	90	0	17,381	878	19,738
	SW	0	0	22	0	38	292	352
2015	GW	1,395	0	122	0	14,517	868	16,902
	SW	0	0	30	0	679	289	998
2014	GW	1,497	0	697	0	16,580	843	19,617
	SW	0	0	174	0	0	281	455
2013	GW	1,368	0	1,376	0	16,805	837	20,386
	SW	0	0	344	0	369	279	992
2012	GW	1,675	0	993	0	24,070	1,001	27,739
	SW	0	0	248	0	131	334	713
2011	GW	1,586	0	1,192	0	16,601	1,090	20,469
	SW	0	0	298	0	170	364	832
2010	GW	1,228	0	537	0	13,913	994	16,672
	SW	0	0	328	0	0	332	660
2009	GW	1,138	0	674	0	14,277	1,195	17,284
	SW	0	0	411	0	0	398	809
2008	GW	1,260	0	810	0	15,143	1,170	18,383
	SW	0	0	494	0	0	390	884
2007	GW	857	0	0	0	15,370	1,221	17,448
	SW	0	0	0	0	0	407	407
2006	GW	923	0	0	0	13,528	2,112	16,563
	SW	0	0	0	0	0	704	704
2005	GW	890	0	0	0	12,990	1,358	15,238
	SW	0	0	0	0	0	453	453
2004	GW	865	0	0	0	10,441	168	11,474
	SW	0	0	0	0	0	1,508	1,508

Projected Surface Water Supplies
TWDB 2022 State Water Plan Data

ARMSTRONG COUNTY

92.36% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
A	Livestock, Armstrong	Red	Red Livestock Local Supply	113	113	113	113	113	113
	Sum of Projected Surface Water Supplies (acre-feet)			**113**	**113**	**113**	**113**	**113**	**113**

CARSON COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
A	Irrigation, Carson	Red	Red Run-of-River	277	277	277	277	277	277
A	Livestock, Carson	Canadian	Canadian Livestock Local Supply	59	59	59	59	59	59
A	Livestock, Carson	Red	Red Livestock Local Supply	75	75	75	75	75	75
	Sum of Projected Surface Water Supplies (acre-feet)			**411**	**411**	**411**	**411**	**411**	**411**

DONLEY COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
A	Clarendon	Red	GREENBELT LAKE/RESERVOIR	230	234	237	242	225	206
A	County-Other, Donley	Red	GREENBELT LAKE/RESERVOIR	35	36	37	39	36	33
A	Irrigation, Donley	Red	Red Run-of-River	166	166	166	166	166	166
A	Livestock, Donley	Red	Red Livestock Local Supply	283	283	283	283	283	283
A	Red River Authority of Texas	Red	GREENBELT LAKE/RESERVOIR	19	19	20	21	19	18
	Sum of Projected Surface Water Supplies (acre-feet)			**733**	**738**	**743**	**751**	**729**	**706**

GRAY COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
A	Irrigation, Gray	Canadian	Canadian Run-of-River	1	1	1	1	1	1
A	Irrigation, Gray	Red	Red Run-of-River	55	55	55	55	55	55
A	Livestock, Gray	Canadian	Canadian Livestock Local Supply	199	199	199	199	199	199
A	Livestock, Gray	Red	Red Livestock Local Supply	600	600	600	600	600	600
A	Pampa Municipal Water System	Canadian	Meredith Lake/Reservoir	481	570	681	812	935	943

			Sum of Projected Surface Water Supplies (acre-feet)	**1,336**	**1,425**	**1,536**	**1,667**	**1,790**	**1,798**

HUTCHINSON COUNTY

4.24% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
A	Irrigation, Hutchinson	Canadian	Canadian Run-of-River	4	4	4	4	4	4
A	Livestock, Hutchinson	Canadian	Canadian Livestock Local Supply	12	12	12	12	12	12
A	Manufacturing, Hutchinson	Canadian	Canadian Run-of-River	0	0	0	0	0	0
A	Manufacturing, Hutchinson	Canadian	Meredith Lake/Reservoir	73	68	64	61	61	60
			Sum of Projected Surface Water Supplies (acre-feet)	**89**	**84**	**80**	**77**	**77**	**76**

POTTER COUNTY

94.12% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
A	Amarillo	Canadian	Meredith Lake/Reservoir	3,278	3,264	3,125	3,010	3,056	3,072
A	Amarillo	Red	Meredith Lake/Reservoir	2,158	2,149	2,057	1,983	2,012	2,022
A	Livestock, Potter	Canadian	Canadian Livestock Local Supply	471	471	471	471	471	471
A	Livestock, Potter	Red	Red Livestock Local Supply	58	58	58	58	58	58
A	Manufacturing, Potter	Red	Meredith Lake/Reservoir	1,036	1,048	920	816	757	697
			Sum of Projected Surface Water Supplies (acre-feet)	**7,001**	**6,990**	**6,631**	**6,338**	**6,354**	**6,320**

ROBERTS COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
A	Irrigation, Roberts	Canadian	Canadian Run-of-River	72	72	72	72	72	72
A	Livestock, Roberts	Canadian	Canadian Livestock Local Supply	124	124	124	124	124	124
A	Livestock, Roberts	Red	Red Livestock Local Supply	15	15	15	15	15	15
			Sum of Projected Surface Water Supplies (acre-feet)	**211**	**211**	**211**	**211**	**211**	**211**

WHEELER COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
A	Irrigation, Wheeler	Red	Red Run-of-River	603	603	603	603	603	603
A	Livestock, Wheeler	Red	Red Livestock Local Supply	845	845	845	845	845	845
			Sum of Projected Surface Water Supplies (acre-feet)	**1,448**	**1,448**	**1,448**	**1,448**	**1,448**	**1,448**

Projected Water Demands
TWDB 2022 State Water Plan Data

Please note that the demand numbers presented here include the plumbing code savings found in the Regional and State Water Plans.

ARMSTRONG COUNTY

92.36% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	Claude Municipal Water System	Red	360	354	349	347	347	347
A	County-Other, Armstrong	Red	81	78	76	76	76	76
A	Irrigation, Armstrong	Red	5,767	5,767	5,767	5,767	5,767	5,767
A	Livestock, Armstrong	Red	307	415	431	448	465	484
	Sum of Projected Water Demands (acre-feet)		**6,515**	**6,614**	**6,623**	**6,638**	**6,655**	**6,674**

CARSON COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	County-Other, Carson	Canadian	157	155	155	153	152	152
A	County-Other, Carson	Red	115	113	113	112	112	112
A	Groom Municipal Water System	Red	177	174	172	171	171	171
A	Irrigation, Carson	Canadian	22,518	22,518	22,518	22,518	22,518	22,518
A	Irrigation, Carson	Red	64,771	64,771	64,771	64,771	64,771	64,771
A	Livestock, Carson	Canadian	236	322	334	346	358	372
A	Livestock, Carson	Red	79	108	112	116	120	124
A	Manufacturing, Carson	Canadian	17	18	18	18	18	18
A	Manufacturing, Carson	Red	1,038	1,118	1,118	1,118	1,118	1,118
A	Mining, Carson	Canadian	14	14	14	14	14	14
A	Panhandle Municipal Water System	Red	576	585	586	581	580	580
A	White Deer	Canadian	113	114	114	114	114	114
A	White Deer	Red	147	150	150	149	149	149
	Sum of Projected Water Demands (acre-feet)		**89,958**	**90,160**	**90,175**	**90,181**	**90,195**	**90,213**

DONLEY COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	Clarendon	Red	371	362	354	350	349	349
A	County-Other, Donley	Red	113	94	78	65	52	40
A	Irrigation, Donley	Red	30,910	30,910	30,910	30,910	30,910	30,910
A	Livestock, Donley	Red	971	994	1,019	1,046	1,073	1,102
A	Red River Authority of Texas	Red	234	255	275	296	318	338
	Sum of Projected Water Demands (acre-feet)		**32,599**	**32,615**	**32,636**	**32,667**	**32,702**	**32,739**

GRAY COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	County-Other, Gray	Canadian	472	512	563	634	692	753
A	County-Other, Gray	Red	239	259	285	320	350	381
A	Irrigation, Gray	Canadian	8,395	8,395	8,395	8,395	8,395	8,395
A	Irrigation, Gray	Red	23,894	23,894	23,894	23,894	23,894	23,894
A	Livestock, Gray	Canadian	189	214	224	235	247	259
A	Livestock, Gray	Red	1,706	1,934	2,022	2,117	2,222	2,337
A	Manufacturing, Gray	Canadian	459	502	502	502	502	502
A	McLean Municipal Water Supply	Red	210	227	250	281	307	334
A	Mining, Gray	Canadian	7	7	6	6	5	4
A	Mining, Gray	Red	68	67	61	54	48	43
A	Pampa Municipal Water System	Canadian	3,685	3,964	4,331	4,892	5,341	5,815
		Sum of Projected Water Demands (acre-feet)	**39,324**	**39,975**	**40,533**	**41,330**	**42,003**	**42,717**

HUTCHINSON COUNTY

4.24% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	Borger	Canadian	3,163	3,201	3,182	3,177	3,172	3,172
A	County-Other, Hutchinson	Canadian	11	11	11	11	11	11
A	Fritch	Canadian	592	598	591	589	588	588
A	Irrigation, Hutchinson	Canadian	2,540	2,540	2,540	2,540	2,540	2,540
A	Livestock, Hutchinson	Canadian	25	27	28	30	31	33
A	Manufacturing, Hutchinson	Canadian	1,245	1,329	1,329	1,329	1,329	1,329
A	Mining, Hutchinson	Canadian	8	10	7	5	2	1
A	Stinnett	Canadian	454	460	456	455	454	454
A	TCW Supply	Canadian	690	705	705	701	700	700
		Sum of Projected Water Demands (acre-feet)	**8,728**	**8,881**	**8,849**	**8,837**	**8,827**	**8,828**

POTTER COUNTY

94.12% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	Amarillo	Canadian	16,458	17,919	19,536	21,251	23,234	25,346
A	Amarillo	Red	10,835	11,797	12,863	13,991	15,297	16,687
A	County-Other, Potter	Canadian	1,428	1,554	1,695	1,845	2,015	2,199
A	County-Other, Potter	Red	764	832	908	987	1,080	1,177
A	Irrigation, Potter	Canadian	968	968	968	968	968	968
A	Irrigation, Potter	Red	2,021	2,021	2,021	2,021	2,021	2,021
A	Livestock, Potter	Canadian	398	414	431	449	469	488
A	Livestock, Potter	Red	82	85	88	92	96	101
A	Manufacturing, Potter	Canadian	642	711	711	711	711	711
A	Manufacturing, Potter	Red	6,790	7,515	7,515	7,515	7,515	7,515
A	Mining, Potter	Canadian	602	735	858	930	1,044	1,172

A	Mining, Potter	Red	283	346	404	438	491	552
A	Steam-Electric Power, Potter	Canadian	17,463	17,463	17,463	17,463	17,463	17,463
		Sum of Projected Water Demands (acre-feet)	**58,734**	**62,360**	**65,461**	**68,661**	**72,404**	**76,400**

ROBERTS COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	County-Other, Roberts	Canadian	47	49	47	47	47	47
A	County-Other, Roberts	Red	1	1	1	1	1	1
A	Irrigation, Roberts	Canadian	8,116	8,116	8,116	8,116	8,116	8,116
A	Irrigation, Roberts	Red	427	427	427	427	427	427
A	Livestock, Roberts	Canadian	373	391	411	432	453	477
A	Livestock, Roberts	Red	10	11	11	12	13	13
A	Miami	Canadian	225	226	224	223	223	223
A	Mining, Roberts	Canadian	1,457	1,010	593	183	19	2
A	Mining, Roberts	Red	45	31	18	6	1	0
		Sum of Projected Water Demands (acre-feet)	**10,701**	**10,262**	**9,848**	**9,447**	**9,300**	**9,306**

WHEELER COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	County-Other, Wheeler	Red	296	297	299	309	320	332
A	Irrigation, Wheeler	Red	16,224	16,224	16,224	16,224	16,224	16,224
A	Livestock, Wheeler	Red	1,186	1,321	1,358	1,396	1,436	1,479
A	Mining, Wheeler	Red	3,268	2,329	1,413	503	139	119
A	Shamrock Municipal Water System	Red	350	353	357	369	382	397
A	Wheeler	Red	493	505	517	533	553	574
		Sum of Projected Water Demands (acre-feet)	**21,817**	**21,029**	**20,168**	**19,334**	**19,054**	**19,125**

Projected Water Supply Needs
TWDB 2022 State Water Plan Data

Negative values (in red) reflect a projected water supply need, positive values a surplus.

ARMSTRONG COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	Claude Municipal Water System	Red	224	183	115	55	7	7
A	County-Other, Armstrong	Red	12	16	18	18	18	18
A	Irrigation, Armstrong	Red	54	78	99	119	136	136
A	Livestock, Armstrong	Red	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet)		**0**	**0**	**0**	**0**	**0**	**0**

CARSON COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	County-Other, Carson	Canadian	81	71	63	62	47	25
A	County-Other, Carson	Red	91	83	76	74	60	41
A	Groom Municipal Water System	Red	10	13	15	16	16	16
A	Irrigation, Carson	Canadian	0	0	0	0	0	0
A	Irrigation, Carson	Red	335	336	336	335	335	335
A	Livestock, Carson	Canadian	0	0	0	0	0	0
A	Livestock, Carson	Red	0	0	0	0	0	0
A	Manufacturing, Carson	Canadian	0	0	0	0	0	0
A	Manufacturing, Carson	Red	0	0	0	0	0	0
A	Mining, Carson	Canadian	0	0	0	0	0	0
A	Panhandle Municipal Water System	Red	162	-461	-586	-581	-580	-580
A	White Deer	Canadian	23	23	23	23	23	23
A	White Deer	Red	29	30	30	30	30	30
	Sum of Projected Water Supply Needs (acre-feet)		**0**	**-461**	**-586**	**-581**	**-580**	**-580**

DONLEY COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	Clarendon	Red	0	0	0	0	-32	-66
A	County-Other, Donley	Red	56	56	56	56	51	45
A	Irrigation, Donley	Red	166	166	166	166	166	166
A	Livestock, Donley	Red	0	0	0	0	0	0
A	Red River Authority of Texas	Red	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet)		**0**	**0**	**0**	**0**	**-32**	**-66**

GRAY COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	County-Other, Gray	Canadian	0	0	0	0	0	0
A	County-Other, Gray	Red	0	0	0	0	0	0
A	Irrigation, Gray	Canadian	221	221	221	221	-2,687	-2,687
A	Irrigation, Gray	Red	55	55	55	55	55	55
A	Livestock, Gray	Canadian	71	46	36	25	13	1
A	Livestock, Gray	Red	0	0	0	0	0	0
A	Manufacturing, Gray	Canadian	23	25	25	25	25	25
A	McLean Municipal Water Supply	Red	105	66	16	-40	-88	-115
A	Mining, Gray	Canadian	0	0	0	0	0	0
A	Mining, Gray	Red	0	0	0	0	0	0
A	Pampa Municipal Water System	Canadian	186	-160	-836	-1,344	-1,794	-2,241
		Sum of Projected Water Supply Needs (acre-feet)	**0**	**-160**	**-836**	**-1,384**	**-4,569**	**-5,043**

HUTCHINSON COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	Borger	Canadian	3,436	2,032	1,416	542	-34	-36
A	County-Other, Hutchinson	Canadian	53	46	44	44	42	42
A	Fritch	Canadian	0	0	0	0	0	0
A	Irrigation, Hutchinson	Canadian	96	96	96	96	96	96
A	Livestock, Hutchinson	Canadian	0	0	0	0	0	0
A	Manufacturing, Hutchinson	Canadian	3	-32	-58	-79	-167	-172
A	Mining, Hutchinson	Canadian	0	0	0	0	0	0
A	Stinnett	Canadian	127	78	39	2	-31	-31
A	TCW Supply	Canadian	1	-132	-233	-315	-383	-383
		Sum of Projected Water Supply Needs (acre-feet)	**0**	**-164**	**-291**	**-394**	**-615**	**-622**

POTTER COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	Amarillo	Canadian	662	-1,881	-4,567	-7,764	-10,652	-12,695
A	Amarillo	Red	437	-1,239	-3,005	-5,111	-7,013	-8,359
A	County-Other, Potter	Canadian	900	900	900	900	900	900
A	County-Other, Potter	Red	0	0	0	0	0	0
A	Irrigation, Potter	Canadian	291	291	291	291	291	291
A	Irrigation, Potter	Red	570	570	570	570	570	570
A	Livestock, Potter	Canadian	95	78	60	41	20	0
A	Livestock, Potter	Red	0	0	0	0	0	0
A	Manufacturing, Potter	Canadian	0	-119	-174	-225	-278	-278
A	Manufacturing, Potter	Red	313	-510	-1,297	-2,102	-2,673	-2,931
A	Mining, Potter	Canadian	0	0	0	0	0	0

A	Mining, Potter	Red	0	0	0	0	0	0
A	Steam-Electric Power, Potter	Canadian	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet)		**0**	**-3,749**	**-9,043**	**-15,202**	**-20,616**	**-24,263**

ROBERTS COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	County-Other, Roberts	Canadian	3	1	3	3	3	3
A	County-Other, Roberts	Red	0	0	0	0	0	0
A	Irrigation, Roberts	Canadian	0	0	0	0	0	0
A	Irrigation, Roberts	Red	0	0	0	0	0	0
A	Livestock, Roberts	Canadian	0	0	0	0	0	0
A	Livestock, Roberts	Red	6	5	5	4	3	3
A	Miami	Canadian	73	72	74	75	75	75
A	Mining, Roberts	Canadian	0	0	0	0	0	0
A	Mining, Roberts	Red	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet)		**0**	**0**	**0**	**0**	**0**	**0**

WHEELER COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
A	County-Other, Wheeler	Red	89	88	86	76	65	53
A	Irrigation, Wheeler	Red	290	292	293	294	296	298
A	Livestock, Wheeler	Red	509	374	337	299	259	216
A	Mining, Wheeler	Red	0	0	0	0	0	0
A	Shamrock Municipal Water System	Red	492	489	485	473	460	445
A	Wheeler	Red	211	150	57	-47	-132	-153
	Sum of Projected Water Supply Needs (acre-feet)		**0**	**0**	**0**	**-47**	**-132**	**-153**

Projected Water Management Strategies
TWDB 2022 State Water Plan Data

ARMSTRONG COUNTY

WUG, Basin (RWPG) — All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Claude Municipal Water System, Red (A)							
Municipal Conservation - Claude	DEMAND REDUCTION [Armstrong]	4	4	4	4	4	4
		4	**4**	**4**	**4**	**4**	**4**
Irrigation, Armstrong, Red (A)							
Irrigation Conservation - Armstrong County	DEMAND REDUCTION [Armstrong]	290	542	1,014	1,200	1,314	1,415
		290	**542**	**1,014**	**1,200**	**1,314**	**1,415**
Sum of Projected Water Management Strategies (acre-feet)		**294**	**546**	**1,018**	**1,204**	**1,318**	**1,419**

CARSON COUNTY

WUG, Basin (RWPG) — All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Groom Municipal Water System, Red (A)							
Municipal Conservation - Groom	DEMAND REDUCTION [Carson]	2	2	2	2	2	2
		2	**2**	**2**	**2**	**2**	**2**
Irrigation, Carson, Canadian (A)							
Irrigation Conservation - Carson County	DEMAND REDUCTION [Carson]	1,881	3,203	6,345	7,385	7,877	8,337
		1,881	**3,203**	**6,345**	**7,385**	**7,877**	**8,337**
Irrigation, Carson, Red (A)							
Irrigation Conservation - Carson County	DEMAND REDUCTION [Carson]	5,409	9,213	18,252	21,243	22,658	23,980
		5,409	**9,213**	**18,252**	**21,243**	**22,658**	**23,980**
Panhandle Municipal Water System, Red (A)							
Develop Ogallala Aquifer Supplies - Panhandle	Ogallala Aquifer [Carson]	0	600	600	600	600	600
Municipal Conservation - Panhandle	DEMAND REDUCTION [Carson]	8	8	8	8	8	8
		8	**608**	**608**	**608**	**608**	**608**
White Deer, Canadian (A)							
Municipal Conservation - White Deer	DEMAND REDUCTION [Carson]	2	2	2	2	2	2
		2	**2**	**2**	**2**	**2**	**2**
White Deer, Red (A)							
Municipal Conservation - White Deer	DEMAND REDUCTION	2	2	2	2	2	2

	[Carson]						
		2	2	2	2	2	2
Sum of Projected Water Management Strategies (acre-feet)		**7,304**	**13,030**	**25,211**	**29,242**	**31,149**	**32,931**

DONLEY COUNTY

WUG, Basin (RWPG) All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Clarendon, Red (A)							
Develop Ogallala Aquifer In Donley County - Greenbelt MIWA	Ogallala Aquifer [Donley]	0	0	0	0	32	66
Municipal Conservation - Clarendon	DEMAND REDUCTION [Donley]	6	6	6	6	6	6
		6	**6**	**6**	**6**	**38**	**72**
County-Other, Donley, Red (A)							
Develop Ogallala Aquifer In Donley County - Greenbelt MIWA	Ogallala Aquifer [Donley]	0	0	0	0	5	11
		0	**0**	**0**	**0**	**5**	**11**
Irrigation, Donley, Red (A)							
Irrigation Conservation - Donley County	DEMAND REDUCTION [Donley]	1,115	1,888	3,636	4,301	4,681	5,054
		1,115	**1,888**	**3,636**	**4,301**	**4,681**	**5,054**
Red River Authority of Texas, Red (A)							
Develop Ogallala Aquifer In Donley County - Greenbelt MIWA	Ogallala Aquifer [Donley]	0	0	0	0	3	5
		0	**0**	**0**	**0**	**3**	**5**
Sum of Projected Water Management Strategies (acre-feet)		**1,121**	**1,894**	**3,642**	**4,307**	**4,727**	**5,142**

GRAY COUNTY

WUG, Basin (RWPG) All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Irrigation, Gray, Canadian (A)							
Irrigation Conservation - Gray County	DEMAND REDUCTION [Gray]	1,578	2,979	3,903	4,239	5,420	5,595
		1,578	**2,979**	**3,903**	**4,239**	**5,420**	**5,595**
Irrigation, Gray, Red (A)							
Irrigation Conservation - Gray County	DEMAND REDUCTION [Gray]	644	787	3,417	4,373	3,888	4,386
		644	**787**	**3,417**	**4,373**	**3,888**	**4,386**
McLean Municipal Water Supply, Red (A)							
Develop Ogallala Aquifer Supplies - McLean	Ogallala Aquifer [Gray]	0	150	150	150	150	150
Municipal Conservation - McLean	DEMAND REDUCTION [Gray]	3	3	3	4	4	4
		3	**153**	**153**	**154**	**154**	**154**
Pampa Municipal Water System, Canadian (A)							

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Develop Ogallala Aquifer Supplies - Pampa	Ogallala Aquifer [Gray]	0	0	1,100	1,100	1,100	1,100
Expand Capacity CRMWA 2	Ogallala Aquifer [Roberts]	0	468	285	672	858	759
Municipal Conservation - Pampa	DEMAND REDUCTION [Gray]	59	95	106	121	132	144
Pampa ASR	Ogallala Aquifer ASR [Gray]	0	0	500	500	500	500
Replace Well Capacity	Ogallala Aquifer [Roberts]	0	0	52	172	436	560
		59	**563**	**2,043**	**2,565**	**3,026**	**3,063**
Sum of Projected Water Management Strategies (acre-feet)		**2,284**	**4,482**	**9,516**	**11,331**	**12,488**	**13,198**

HUTCHINSON COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Borger, Canadian (A)							
Expand Capacity CRMWA 2	Ogallala Aquifer [Roberts]	0	1,636	1,678	1,999	1,906	1,728
Municipal Conservation - Borger	DEMAND REDUCTION [Hutchinson]	41	43	43	43	43	43
Replace Well Capacity	Ogallala Aquifer [Roberts]	0	0	116	304	666	846
		41	**1,679**	**1,837**	**2,346**	**2,615**	**2,617**
Fritch, Canadian (A)							
Municipal Conservation - Fritch	DEMAND REDUCTION [Hutchinson]	9	9	10	10	10	10
		9	**9**	**10**	**10**	**10**	**10**
Irrigation, Hutchinson, Canadian (A)							
Irrigation Conservation - Hutchinson County	DEMAND REDUCTION [Hutchinson]	4,432	7,624	15,285	17,656	18,663	19,562
		4,432	**7,624**	**15,285**	**17,656**	**18,663**	**19,562**
Manufacturing, Hutchinson, Canadian (A)							
Expand Capacity CRMWA 2	Ogallala Aquifer [Roberts]	0	32	58	79	167	172
		0	**32**	**58**	**79**	**167**	**172**
Stinnett, Canadian (A)							
Develop Ogallala Aquifer Supplies - Stinnett	Ogallala Aquifer [Hutchinson]	0	0	0	50	50	50
Municipal Conservation - Stinnett	DEMAND REDUCTION [Hutchinson]	6	6	6	6	6	6
		6	**6**	**6**	**56**	**56**	**56**
TCW Supply, Canadian (A)							
Develop Ogallala Aquifer Supplies - TCW Supply	Ogallala Aquifer [Hutchinson]	0	400	400	400	400	400
Municipal Conservation - TCW Supply	DEMAND REDUCTION [Hutchinson]	6	6	6	6	6	6
		6	**406**	**406**	**406**	**406**	**406**
Sum of Projected Water Management Strategies (acre-feet)		**4,494**	**9,756**	**17,602**	**20,553**	**21,917**	**22,823**

POTTER COUNTY

WUG, Basin (RWPG) All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Amarillo, Canadian (A)							
Advanced Metering Infrastructure - Amarillo	DEMAND REDUCTION [Potter]	494	549	608	666	729	796
Amarillo ASR	Ogallala Aquifer ASR [Randall]	0	1,660	2,158	2,155	2,155	2,156
Develop Potter/Carson County Well Field (Ogallala Aquifer) - Amarillo	Ogallala Aquifer [Carson]	0	3,319	3,319	6,631	6,631	6,635
Develop Roberts County Well Field (Ogallala Aquifer) - Amarillo	Ogallala Aquifer [Roberts]	0	0	0	0	0	3,719
Direct Potable Reuse - Amarillo	Direct Reuse [Potter]	0	664	664	663	663	663
Expand Capacity CRMWA 2	Ogallala Aquifer [Roberts]	0	1,633	1,816	2,279	2,186	1,686
Municipal Conservation - Amarillo	DEMAND REDUCTION [Potter]	325	361	399	437	479	522
Replace Well Capacity	Ogallala Aquifer [Roberts]	0	0	271	714	1,563	1,986
Water Audit And Leak Repair - Amarillo	DEMAND REDUCTION [Potter]	691	753	820	893	976	1,065
		1,510	**8,939**	**10,055**	**14,438**	**15,382**	**19,228**
Amarillo, Red (A)							
Advanced Metering Infrastructure - Amarillo	DEMAND REDUCTION [Potter]	326	362	400	438	480	524
Amarillo ASR	Ogallala Aquifer ASR [Randall]	0	1,092	1,420	1,419	1,419	1,420
Develop Potter/Carson County Well Field (Ogallala Aquifer) - Amarillo	Ogallala Aquifer [Carson]	0	2,185	2,185	4,366	4,366	4,368
Develop Roberts County Well Field (Ogallala Aquifer) - Amarillo	Ogallala Aquifer [Roberts]	0	0	0	0	0	2,448
Direct Potable Reuse - Amarillo	Direct Reuse [Potter]	0	437	437	437	437	437
Expand Capacity CRMWA 2	Ogallala Aquifer [Roberts]	0	1,075	1,196	1,501	1,439	1,110
Municipal Conservation - Amarillo	DEMAND REDUCTION [Potter]	214	238	263	288	315	344
Replace Well Capacity	Ogallala Aquifer [Roberts]	0	0	179	470	1,029	1,307
Water Audit And Leak Repair - Amarillo	DEMAND REDUCTION [Potter]	455	496	541	588	642	701
		995	**5,885**	**6,621**	**9,507**	**10,127**	**12,659**
Irrigation, Potter, Canadian (A)							
Irrigation Conservation - Potter County	DEMAND REDUCTION [Potter]	39	88	164	190	204	214
		39	**88**	**164**	**190**	**204**	**214**
Irrigation, Potter, Red (A)							
Irrigation Conservation - Potter County	DEMAND REDUCTION [Potter]	81	184	341	395	427	447
		81	**184**	**341**	**395**	**427**	**447**
Manufacturing, Potter, Canadian (A)							
Develop Ogallala Aquifer Supplies - Potter County Manufacturing	Ogallala Aquifer [Potter]	0	0	13	13	13	13
Expand Capacity CRMWA 2	Ogallala Aquifer [Roberts]	0	119	161	212	265	265
		0	**119**	**174**	**225**	**278**	**278**
Manufacturing, Potter, Red (A)							

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Develop Ogallala Aquifer Supplies - Potter County Manufacturing	Ogallala Aquifer [Potter]	0	0	137	137	137	137
Expand Capacity CRMWA 2	Ogallala Aquifer [Roberts]	0	524	1,269	2,023	2,540	2,799
		0	**524**	**1,406**	**2,160**	**2,677**	**2,936**
Sum of Projected Water Management Strategies (acre-feet)		**2,625**	**15,739**	**18,761**	**26,915**	**29,095**	**35,762**

ROBERTS COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Irrigation, Roberts, Canadian (A)							
Irrigation Conservation - Roberts County	DEMAND REDUCTION [Roberts]	649	1,100	2,169	2,533	2,712	2,882
		649	**1,100**	**2,169**	**2,533**	**2,712**	**2,882**
Irrigation, Roberts, Red (A)							
Irrigation Conservation - Roberts County	DEMAND REDUCTION [Roberts]	34	58	114	133	143	152
		34	**58**	**114**	**133**	**143**	**152**
Miami, Canadian (A)							
Municipal Conservation - Miami	DEMAND REDUCTION [Roberts]	2	2	2	2	2	2
		2	**2**	**2**	**2**	**2**	**2**
Sum of Projected Water Management Strategies (acre-feet)		**685**	**1,160**	**2,285**	**2,668**	**2,857**	**3,036**

WHEELER COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Irrigation, Wheeler, Red (A)							
Irrigation Conservation - Wheeler County	DEMAND REDUCTION [Wheeler]	895	1,505	3,008	3,493	3,712	3,918
		895	**1,505**	**3,008**	**3,493**	**3,712**	**3,918**
Shamrock Municipal Water System, Red (A)							
Municipal Conservation - Shamrock	DEMAND REDUCTION [Wheeler]	6	6	7	7	7	7
		6	**6**	**7**	**7**	**7**	**7**
Wheeler, Red (A)							
Develop Ogallala Aquifer Supplies - Wheeler	Ogallala Aquifer [Wheeler]	0	0	0	160	160	160
Municipal Conservation - Wheeler	DEMAND REDUCTION [Wheeler]	5	5	5	5	6	6
		5	**5**	**5**	**165**	**166**	**166**
Sum of Projected Water Management Strategies (acre-feet)		**906**	**1,516**	**3,020**	**3,665**	**3,885**	**4,091**

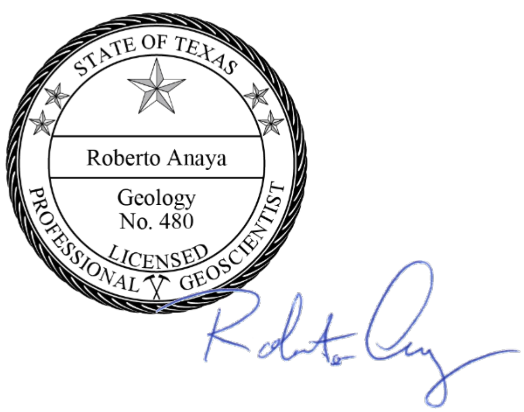
Appendix 5

GAM RUN 21-007 MAG: Modeled Available Groundwater for the High Plains Aquifer System in Groundwater Management Area 1 (Anaya, R., 2023)

GAM RUN 21-007 MAG:
MODELED AVAILABLE GROUNDWATER FOR THE HIGH PLAINS AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 1

Roberto Anaya, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-6115

February 28, 2023



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GAM Run 21-007 MAG:
Modeled Available Groundwater for the High Plains Aquifer System in Groundwater Management Area 1

Roberto Anaya, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-6115

February 28, 2023

EXECUTIVE SUMMARY:

The modeled available groundwater for the High Plains Aquifer System within Groundwater Management Area 1 is summarized by decade for the groundwater conservation districts (Tables 1 and 2) and for use in the regional water planning process (Tables 3 and 4). The modeled available groundwater values for the Ogallala Aquifer (inclusive of the Rita Blanca Aquifer) range from 3,192,963 acre-feet per year in 2020 to 1,991,106 acre-feet per year in 2080 (Table 1). The modeled available groundwater values for the Dockum Aquifer range from 288,052 acre-feet per year in 2020 to 241,087 acre-feet per year in 2080 (Table 2).

The modeled available groundwater values for the Ogallala (inclusive of the Rita Blanca Aquifer) and Dockum aquifers were extracted from results of a model simulation using the groundwater availability model for the High Plains Aquifer System (version 1.01). District representatives in Groundwater Management Area 1 declared the Blaine and Seymour aquifers to be non-relevant for the purposes of joint groundwater planning. The explanatory report and other materials submitted to the TWDB were determined to be administratively complete on December 16, 2022.

REQUESTOR:

Mr. Dustin Meyer, Groundwater Management Area 1 coordinator at the time of the request.

DESCRIPTION OF REQUEST:

District representatives in Groundwater Management Area 1 adopted desired future conditions by resolution for the aquifers in the area on August 26, 2021:

Ogallala (inclusive of the Rita Blanca) Aquifer:

- *"At least 40 percent of volume in storage remaining for each 50-year period between 2018 and 2080 in Dallam, Hartley, Moore, and Sherman Counties"*
- *"At least 50 percent of volume in storage remaining for each 50-year period between 2018 and 2080 in Hansford, Hutchison, Lipscomb, Ochiltree, Carson, Donley, Gray, Roberts, Wheeler, and Oldham Counties; and within the Panhandle District portions of Armstrong and Potter Counties"*
- *"At least 80 percent of volume in storage remaining for each 50-year period between 2018 and 2080 in Hemphill County"*
- *"Approximately 20 feet of total average drawdown for each 50-year period between 2012 and 2080 in Randall County and within High Plains District in Armstrong and Potter Counties".*

Dockum Aquifer:

- *"At least 40 percent of the average available drawdown remaining for each 50-year period between 2018 and 2080 in Dallam, Hartley, Moore, and Sherman Counties"*
- *"No more than 30 feet average decline in water levels for each 50-year period between 2018 and 2080 in Oldham and Carson Counties and the Panhandle District portions of Potter and Armstrong Counties"*
- *"Approximately 40 feet average decline in water levels for each 50-year period between 2012 and 2080 in Randall County and within High Plains District in Armstrong and Potter Counties".*

District representatives in Groundwater Management Area 1 determined the Blaine and Seymour aquifers were not relevant for purposes of joint planning.

On January 4, 2022, Mr. Wade Oliver, on behalf of Groundwater Management Area 1, submitted the Desired Future Conditions Explanatory Report and accompanying files to the TWDB. Groundwater Management Area 1 adopted four geographically defined desired future conditions for the Ogallala (inclusive of the Rita Blanca) Aquifer, and three geographically defined desired future conditions for the Dockum Aquifer, as presented above. TWDB staff reviewed the model files associated with the desired future conditions and some of the desired future conditions were initially not mutually compatible with the groundwater availability model results for the High Plains Aquifer System.

The technical coordinator and consultant for Groundwater Management Area 1 confirmed that the intended desired future conditions required clarification for the assumption of "averaging the 50-year periods," as defined in the resolution adopting desired future conditions. Additionally, the technical coordinator and consultant for the Groundwater Management Area 1 confirmed that a 1 percent tolerance was acceptable for the desired future conditions of both the Ogallala (inclusive of the Rita Blanca) Aquifer and the Dockum Aquifer.

The TWDB received clarifications on procedures and assumptions from the Groundwater Management Area 1 technical coordinator on November 10, 2022, and on November 17, 2022, and a letter of administrative completeness was then provided by the TWDB to Groundwater Management Area 1 on December 16, 2022. All clarifications are included in Appendix A of this report.

METHODS:

The groundwater availability model for the High Plains Aquifer System version 1.01 was run using model files submitted with the explanatory report (Groundwater Management Area 1 and Oliver, 2021) for both the Ogallala (inclusive of the Rita Blanca) Aquifer and the Dockum Aquifer (Figures 1 and 2). Model-simulated water levels were extracted for the years 2019 (stress period 1) through 2080 (stress period 62).

Average percent volumes in storage remaining, total average drawdowns, percent of average drawdowns remaining, and average decline in water levels were calculated according to the Desired Future Conditions Explanatory Report provided by Groundwater Management Area 1 (Groundwater Management Area 1, and Oliver, W., INTERA Inc., 2021). The calculated average percent volumes in storage remaining, total average drawdowns, percent of average drawdowns remaining, and average decline in water level values were then analyzed to verify that the annual pumping scenarios characterized in the submitted model files achieved the desired future conditions within a tolerance of one percent.

The modeled available groundwater values were determined by extracting pumping rates at the end of each decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Annual pumping rates by aquifer are summarized by county and groundwater conservation district, subtotaled by groundwater conservation district, and then summed for Groundwater Management Area 1 (Tables 1 and 2). Annual pumping rates by aquifer are summarized by county, river basin, and regional water planning area within Groundwater Management Area 1 (Tables 3 and 4) to be consistent with the format used in the regional water planning process.

Modeled Available Groundwater and Permitting

As defined in Chapter 36 of the Texas Water Code (2011), "modeled available groundwater" is the estimated average amount of water that may be produced annually to achieve a desired future condition. Groundwater conservation districts are required to consider modeled available groundwater, along with several other factors, when issuing permits to manage groundwater production that achieves the desired future condition(s). The other factors districts must consider include annual precipitation and production patterns, the estimated amount of pumping exempt from permitting, existing permits, and a reasonable estimate of actual groundwater production under existing permits.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the modeled available groundwater values are described below:

Ogallala (inclusive of the Rita Blanca Aquifer) and Dockum aquifers

- We used Version 1.01 of the groundwater availability model for the High Plains Aquifer System. See Deeds and Jigmond (2015) for assumptions and limitations of the groundwater availability model for the Ogallala, Rita Blanca, and Dockum aquifers.
- This groundwater availability model includes four layers, which generally represent the Ogallala Aquifer (Layer 1), the Rita Blanca Aquifer (Layer 2), the Upper Unit of the Dockum Aquifer (Layer 3), and the Lower Unit of the Dockum Aquifer (Layer 4). Since active model cells extend beyond the official TWDB aquifer extents, please note that only active model cells within the official TWDB aquifer extents and within Groundwater Management Area 1 were considered for analysis of the desired future conditions and modeled available groundwater values.
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).
- Although the original groundwater availability model was calibrated only to 2012, an analysis during the current round of joint planning (Groundwater Management Area 1 and Oliver, 2021) verified that the model satisfactorily matched measured water levels for the period from 2012 to 2018. For this reason, the TWDB considers it acceptable to use the end of 2018 as the reference year for initial starting water levels for the predictive model simulation from 2019 to 2080.

- Average percent volumes in storage remaining, total average drawdowns, percent of average drawdowns remaining, and average decline in water levels, as well as modeled available groundwater values were based on the active model cells spatially coincident within the official TWDB defined aquifer boundaries.
- Model cells that became dry (when the water level in a model cell drops below the base of the aquifer) at the start of a simulated 50-year duration cycle were excluded from the desired future conditions analysis. Pumping in dry cells were excluded from the modeled available groundwater values for the decades after the cell went dry.
- A tolerance value of one percent was assumed when comparing desired future conditions to modeled results of average percent volumes in storage remaining, total average drawdowns, percent of average drawdowns remaining, and average decline in water levels. This one percent tolerance was specified by the Groundwater Management Area 1 in clarification statements for their desired future conditions resolution (Appendix A).
- Calculations of modeled available groundwater from the model simulation were rounded to the nearest whole number in units of acre-feet per year.
- The verification calculation for the desired future conditions of average percent volume in storage remaining for each 50-year period between 2018 and 2080 in the Ogallala (inclusive of the Rita Blanca) Aquifer for Dallam, Sherman, Hartley, and Moore counties is based on model layer 1 where the Rita Blanca Aquifer does not exist and on an average of model layers 1 and 2 for the area where the extent of the Rita Blanca Aquifer is spatially coincident with the Ogallala Aquifer within Dallam and Hartley counties.

RESULTS:

The modeled available groundwater values for the Ogallala (inclusive of the Rita Blanca Aquifer) Aquifer range from 3,192,963 acre-feet per year in 2020 to 1,991,106 acre-feet per year in 2080 (Table 1). The modeled available groundwater values for the Dockum Aquifer range from approximately 288,052 acre-feet per year in 2020 to 241,087 acre-feet per year in 2080 (Table 2). The modeled available groundwater is summarized by groundwater conservation district and county for the Ogallala (inclusive of the Rita Blanca Aquifer) and Dockum aquifers (Tables 1 and 2). The modeled available groundwater has also been summarized by county, river basin, and regional water planning area for use in the regional water planning process for the Ogallala (inclusive of the Rita Blanca Aquifer) and Dockum aquifers (Tables 3 and 4).

FIGURE 1. GROUNDWATER MANAGEMENT AREA (GMA) 1 BOUNDARY, RIVER BASINS, COUNTIES, REGIONAL WATER PLANNING AREAS (RWPAS), AND GROUNDWATER CONSERVATION DISTRICTS (GCDS) OVERLAIN ON THE MODEL EXTENT OF THE OGALLALA (INCLUSIVE OF THE RITA BLANCA) AQUIFER.

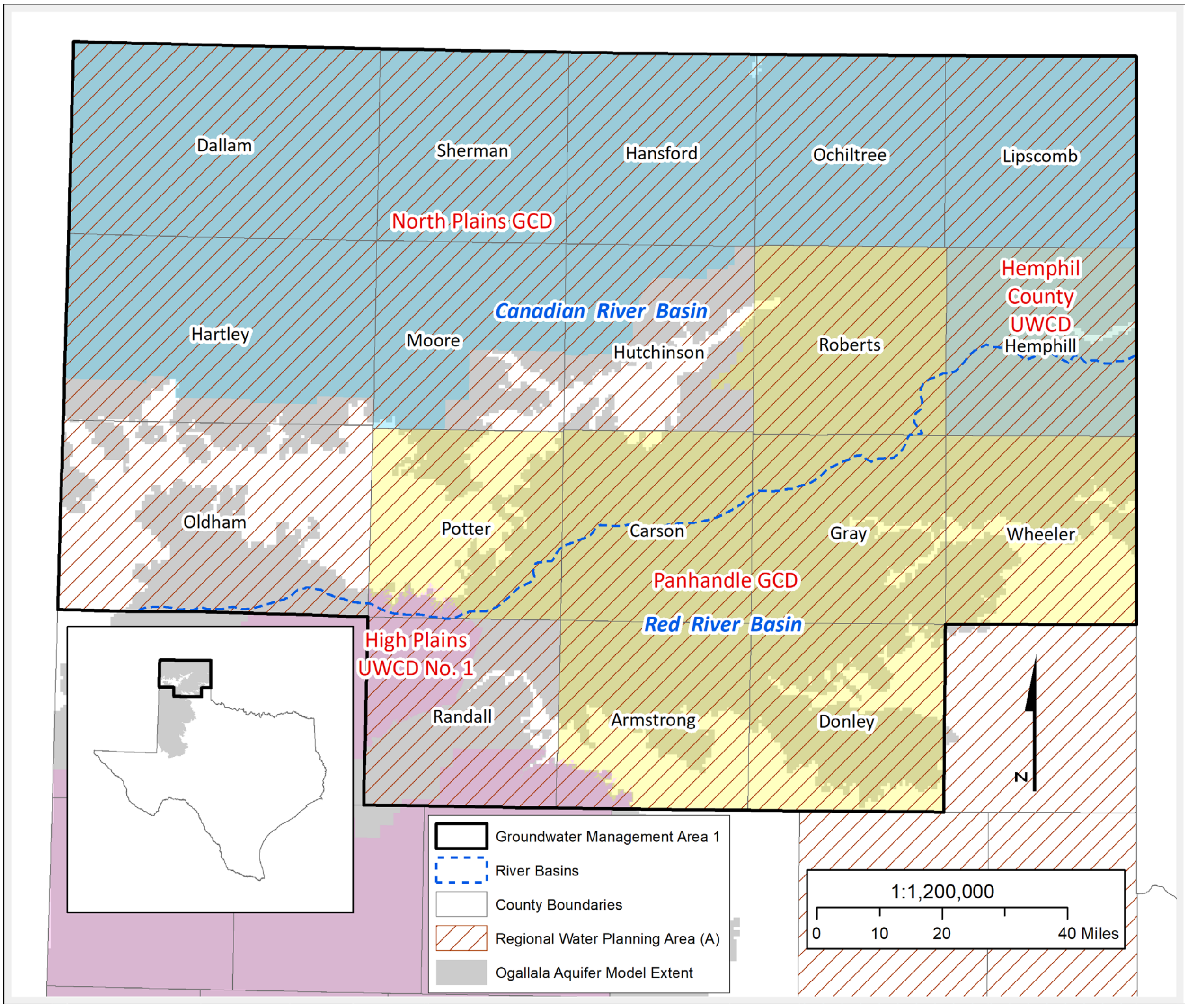

FIGURE 2. GROUNDWATER MANAGEMENT AREA (GMA) 1 BOUNDARY, RIVER BASINS, COUNTIES, REGIONAL WATER PLANNING AREAS (RWPAS), AND GROUNDWATER CONSERVATION DISTRICTS (GCDS) OVERLAIN ON THE MODEL EXTENT OF THE DOCKUM AQUIFER.

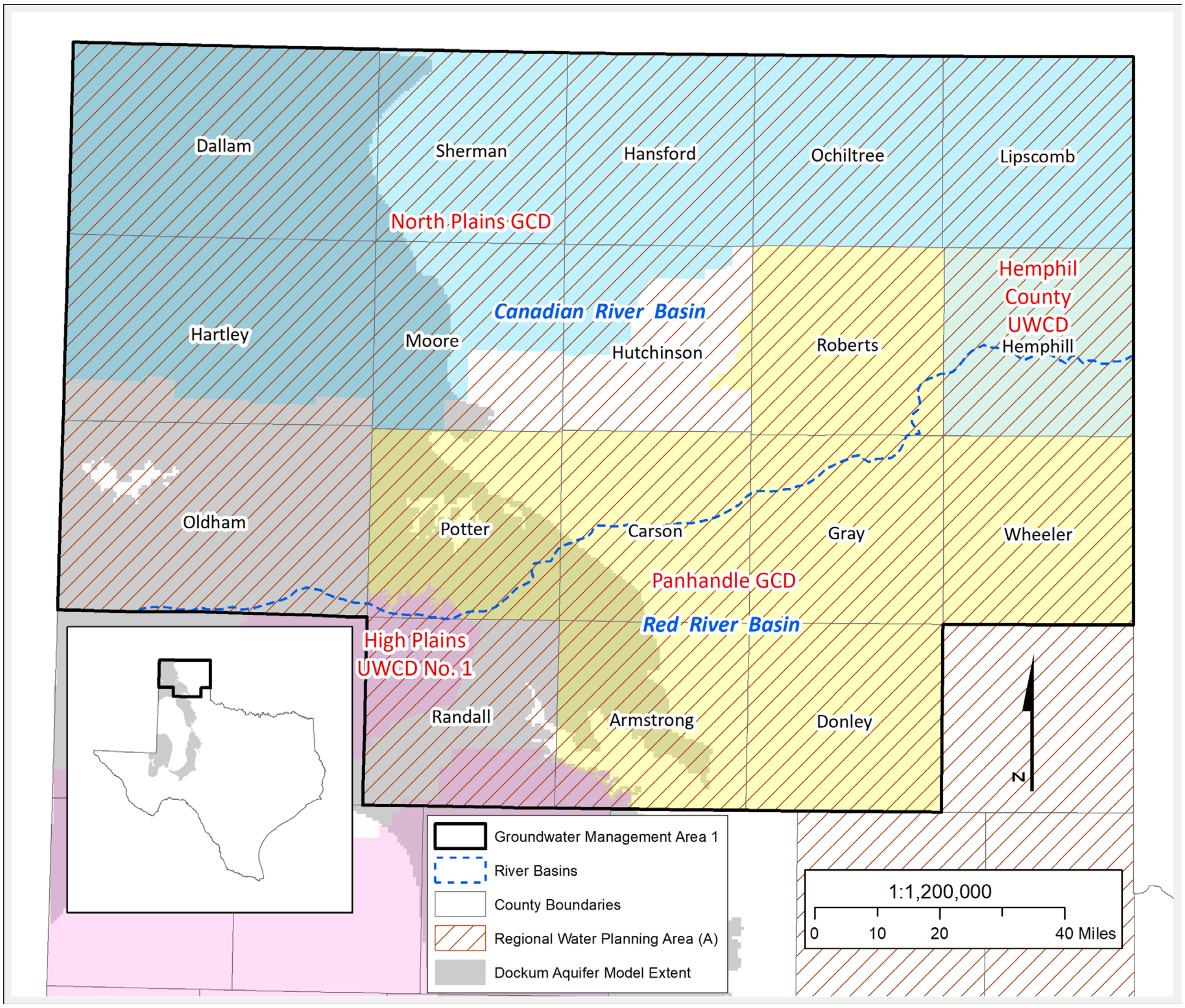

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA (INCLUSIVE OF THE RITA BLANCA AQUIFER) AQUIFER IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2020	2030	2040	2050	2060	2070	2080
Hemphill County UWCD	Hemphill	Ogallala	37,259	45,816	52,208	55,621	58,039	59,257	60,177
Hemphill County UWCD Total		**Ogallala**	**37,259**	**45,816**	**52,208**	**55,621**	**58,039**	**59,257**	**60,177**
High Plains UWCD No.1	Armstrong	Ogallala	5,679	4,713	3,007	1,877	1,181	968	786
High Plains UWCD No.1	Potter	Ogallala	2,348	2,538	2,362	2,049	1,634	1,075	802
High Plains UWCD No.1	Randall	Ogallala	36,992	34,674	29,709	24,585	20,385	17,088	14,559
High Plains UWCD No.1 Total		**Ogallala**	**45,019**	**41,925**	**35,078**	**28,511**	**23,200**	**19,131**	**16,147**
North Plains GCD	Dallam	Ogallala*	319,988	269,575	228,726	194,888	165,787	144,360	128,259
North Plains GCD	Hansford	Ogallala	297,486	295,700	281,612	264,290	247,744	229,800	211,464
North Plains GCD	Hartley	Ogallala†	355,646	270,230	207,754	169,890	144,564	124,366	108,352
North Plains GCD	Hutchinson	Ogallala	77,920	80,189	77,835	74,461	70,609	67,496	64,083
North Plains GCD	Lipscomb	Ogallala	251,489	270,819	263,478	249,968	235,561	218,975	201,984

* Ogallala Aquifer also includes the Rita Blanca Aquifer where they are both spatially coincident within the Dallam County portion of North Plains GCD.
† Ogallala Aquifer also includes the Rita Blanca Aquifer where they are both spatially coincident within the Hartley County portion of North Plains GCD.

TABLE 1 (CONTINUED). MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA (INCLUSIVE OF THE RITA BLANCA AQUIFER) AQUIFER IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2020	2030	2040	2050	2060	2070	2080
North Plains GCD	Ochiltree	Ogallala	259,676	259,973	247,274	231,502	215,617	199,324	181,295
North Plains GCD	Sherman	Ogallala	290,148	287,657	261,521	226,142	198,338	166,675	145,399
North Plains GCD Total		**Ogallala**	**1,992,761**	**1,873,888**	**1,700,937**	**1,532,757**	**1,384,354**	**1,239,161**	**1,113,964**
Panhandle GCD	Armstrong	Ogallala	56,940	51,726	45,757	40,241	35,089	30,685	27,137
Panhandle GCD	Carson	Ogallala	163,315	166,024	159,756	149,768	141,251	134,365	121,774
Panhandle GCD	Donley	Ogallala	72,747	78,267	77,157	72,601	67,032	60,915	53,337
Panhandle GCD	Gray	Ogallala	177,633	181,648	173,602	160,382	147,045	133,802	121,936
Panhandle GCD	Hutchinson	Ogallala	8,524	10,589	11,798	11,784	11,427	10,775	9,606
Panhandle GCD	Potter	Ogallala	24,022	22,245	19,590	16,477	13,607	10,990	8,821
Panhandle GCD	Roberts	Ogallala	358,704	409,300	394,930	369,335	344,109	317,529	286,594
Panhandle GCD	Wheeler	Ogallala	119,602	132,615	132,787	128,472	121,852	114,269	106,929
Panhandle GCD Total		**Ogallala**	**981,487**	**1,052,414**	**1,015,377**	**949,060**	**881,412**	**813,330**	**736,134**
All Districts Total		**Ogallala**	**3,056,526**	**3,014,043**	**2,803,600**	**2,565,949**	**2,347,005**	**2,130,879**	**1,926,422**

TABLE 1 (CONTINUED). MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA (INCLUSIVE OF THE RITA BLANCA AQUIFER) AQUIFER IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2020	2030	2040	2050	2060	2070	2080
No District-County	Hartley	Ogallala‡	15,555	16,380	15,634	14,309	12,989	11,646	10,434
No District-County	Hutchinson	Ogallala	33,955	32,967	28,372	24,059	20,978	18,576	17,204
No District-County	Moore	Ogallala	8,703	9,681	9,415	8,245	7,122	6,198	5,517
No District-County	Oldham	Ogallala	40,496	39,067	36,192	31,219	26,044	21,393	18,041
No District-County	Randall	Ogallala	37,728	35,877	30,800	25,725	20,992	17,103	13,488
No District Total		**Ogallala**	**136,437**	**133,972**	**120,413**	**103,557**	**88,125**	**74,916**	**64,684**
GMA 1 Total		**Ogallala**	**3,192,963**	**3,148,015**	**2,924,013**	**2,669,506**	**2,435,130**	**2,205,795**	**1,991,106**

‡ Ogallala Aquifer also includes the Rita Blanca Aquifer where they are both spatially coincident within Hartley County and outside of any groundwater district.

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2020	2030	2040	2050	2060	2070	2080
High Plains UWCD No.1	Armstrong	Dockum	1,853	835	221	221	221	221	221
High Plains UWCD No.1	Potter	Dockum	2,663	2,657	2,406	2,315	2,281	2,248	2,172
High Plains UWCD No.1	Randall	Dockum	6,997	8,736	9,703	8,428	7,698	7,610	7,782
High Plains UWCD No.1 Total		**Dockum**	**11,513**	**12,228**	**12,330**	**10,964**	**10,200**	**10,079**	**10,175**
North Plains GCD	Dallam	Dockum	15,969	15,522	14,700	14,019	13,513	12,895	12,415
North Plains GCD	Hartley	Dockum	12,402	11,792	11,051	10,334	9,755	9,234	8,831
North Plains GCD	Moore	Dockum	4,496	5,399	5,409	5,064	4,782	4,474	4,213
North Plains GCD	Sherman	Dockum	445	416	310	288	293	288	291
North Plains GCD Total		**Dockum**	**33,312**	**33,129**	**31,470**	**29,705**	**28,343**	**26,891**	**25,750**
Panhandle GCD	Armstrong	Dockum	5,313	7,102	8,122	8,601	8,849	8,904	8,914
Panhandle GCD	Carson	Dockum	6	6	6	6	6	6	6
Panhandle GCD	Potter	Dockum	30,160	37,699	37,853	36,963	35,881	34,685	33,571
Panhandle GCD Total		**Dockum**	**35,479**	**44,807**	**45,981**	**45,570**	**44,736**	**43,595**	**42,491**
All Districts Total		**Dockum**	**80,304**	**90,164**	**89,781**	**86,239**	**83,279**	**80,565**	**78,416**

TABLE 2 (CONTINUED). MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2020	2030	2040	2050	2060	2070	2080
No District-County	Hartley	Dockum	44,260	52,799	53,096	50,432	46,907	42,974	39,311
No District-County	Moore	Dockum	241	560	594	616	643	645	625
No District-County	Oldham	Dockum	144,234	153,787	145,925	135,393	124,861	114,569	105,341
No District-County	Randall	Dockum	19,013	29,231	32,057	31,502	28,550	21,149	17,394
No District Total		**Dockum**	**207,748**	**236,377**	**231,672**	**217,943**	**200,961**	**179,337**	**162,671**
GMA 1 Total		**Dockum**	**288,052**	**326,541**	**321,453**	**304,182**	**284,240**	**259,902**	**241,087**

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA (INCLUSIVE OF THE RITA BLANCA AQUIFER) AQUIFER IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER FOR EACH DECADE BETWEEN 2030 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River basin	Aquifer	2030	2040	2050	2060	2070	2080
Armstrong	A	RED	Ogallala	56,439	48,764	42,118	36,270	31,653	27,923
Carson	A	CANADIAN	Ogallala	68,193	66,220	62,132	57,975	54,708	49,565
Carson	A	RED	Ogallala	97,831	93,536	87,636	83,276	79,657	72,209
Dallam	A	CANADIAN	Ogallala§	269,575	228,726	194,888	165,787	144,360	128,259
Donley	A	RED	Ogallala	78,267	77,157	72,601	67,032	60,915	53,337
Gray	A	CANADIAN	Ogallala	46,240	43,480	39,643	36,480	33,394	30,628
Gray	A	RED	Ogallala	135,408	130,122	120,739	110,565	100,408	91,308
Hansford	A	CANADIAN	Ogallala	295,700	281,612	264,290	247,744	229,800	211,464
Hartley	A	CANADIAN	Ogallala**	286,610	223,388	184,199	157,553	136,012	118,786
Hemphill	A	CANADIAN	Ogallala	24,975	29,168	32,388	34,729	36,110	37,074
Hemphill	A	RED	Ogallala	20,841	23,040	23,233	23,310	23,147	23,103
Hutchinson	A	CANADIAN	Ogallala	123,745	118,005	110,304	103,014	96,847	90,893
Lipscomb	A	CANADIAN	Ogallala	270,819	263,478	249,968	235,561	218,975	201,984
Moore	A	CANADIAN	Ogallala	149,426	142,152	129,861	113,256	94,363	78,645
Ochiltree	A	CANADIAN	Ogallala	259,973	247,274	231,502	215,617	199,324	181,295
Oldham	A	CANADIAN	Ogallala	34,871	32,845	28,578	23,948	19,789	16,869
Oldham	A	RED	Ogallala	4,196	3,347	2,641	2,096	1,604	1,172
Potter	A	CANADIAN	Ogallala	14,672	13,137	11,036	9,214	7,648	6,337
Potter	A	RED	Ogallala	10,111	8,815	7,490	6,027	4,417	3,286
Randall	A	RED	Ogallala	70,551	60,509	50,310	41,377	34,191	28,047
Roberts	A	CANADIAN	Ogallala	386,950	372,064	346,908	322,461	297,068	267,425
Roberts	A	RED	Ogallala	22,350	22,866	22,427	21,648	20,461	19,169

§ Ogallala Aquifer also includes the Rita Blanca Aquifer where they are both spatially coincident within Dallam County and the Canadian River basin.
** Ogallala Aquifer also includes the Rita Blanca Aquifer where they are both spatially coincident within Hartley County and the Canadian River basin.

TABLE 3 (CONTINUED). MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA (INCLUSIVE OF THE RITA BLANCA AQUIFER) AQUIFER IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER FOR EACH DECADE BETWEEN 2030 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River basin	Aquifer	2030	2040	2050	2060	2070	2080
Sherman	A	CANADIAN	Ogallala	287,657	261,521	226,142	198,338	166,675	145,399
Wheeler	A	RED	Ogallala	132,615	132,787	128,472	121,852	114,269	106,929
GMA 1 Total			**Ogallala**	**3,148,015**	**2,924,013**	**2,669,506**	**2,435,130**	**2,205,795**	**1,991,106**

TABLE 4. MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 1 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER FOR EACH DECADE BETWEEN 2030 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River basin	Aquifer	2030	2040	2050	2060	2070	2080
Armstrong	A	RED	Dockum	7,937	8,343	8,822	9,070	9,125	9,135
Carson	A	CANADIAN	Dockum	0	0	0	0	0	0
Carson	A	RED	Dockum	6	6	6	6	6	6
Dallam	A	CANADIAN	Dockum	15,522	14,700	14,019	13,513	12,895	12,415
Hartley	A	CANADIAN	Dockum	64,591	64,147	60,766	56,662	52,208	48,142
Moore	A	CANADIAN	Dockum	5,959	6,003	5,680	5,425	5,119	4,838
Oldham	A	CANADIAN	Dockum	153,694	145,814	135,269	124,727	114,427	105,188
Oldham	A	RED	Dockum	93	111	124	134	142	153
Potter	A	CANADIAN	Dockum	38,004	38,158	37,268	36,186	34,990	33,815
Potter	A	RED	Dockum	2,352	2,101	2,010	1,976	1,943	1,928
Randall	A	RED	Dockum	37,967	41,760	39,930	36,248	28,759	25,176
Sherman	A	CANADIAN	Dockum	416	310	288	293	288	291
GMA 1 Total			**Dockum**	**326,541**	**321,453**	**304,182**	**284,240**	**259,902**	**241,087**

LIMITATIONS:

The groundwater model used in completing this analysis is the best available scientific tool that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> *"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."*

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historic pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and streamflow are specific to a particular historic time period.
Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and groundwater levels in the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

REFERENCES:

Deeds, Neil E. and Jigmond, Marius, 2015, Numerical Model Report for the High Plains Aquifer System Groundwater Availability Model: Prepared for Texas Water Development Board, 640 p., http://www.twdb.texas.gov/groundwater/models/gam/hpas/HPAS_GAM_Numerical_Report.pdf.

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Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software.

National Research Council, 2007, Models in Environmental Regulatory Decision Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p., http://www.nap.edu/catalog.php?record_id=11972.

Niswonger, R.G., Panday, S., and Ibaraki, M., 2011, MODFLOW-NWT, a Newton formulation for MODFLOW-2005: United States Geological Survey, Techniques and Methods 6-A37, 44 p.

Texas Water Code, 2011, http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf

APPENDIX A

Critical Clarifications requested by the TWDB *(need additional files or potential update to legal DFC Resolutions)***:**

1. Based on TWDB analysis of the High Plains Aquifer System model files provided by the GMA 1 consultant (INTERA, Inc.), some DFCs are unachievable with respect to the current legal phrasing of the DFC Resolution. The TWDB is requesting the following tolerances:
    - A tolerance of 1% for GMA 1 DFCs defined by percent volume in storage remaining in the Ogallala Aquifer (inclusive of Rita Blanca Aquifer).
    - A tolerance of 1% for GMA 1 DFCs defined by percent available drawdown remaining in the Dockum Aquifer.

   Please confirm that the GMA is willing to accept the tolerance clarifications requested above. Alternatively, the GMA or GMA consultant may provide revised High Plains Aquifer System model files for TWDB to review or may revise the DFC Resolution so that the DFCs are achievable without requiring a tolerance.

Other Clarifications requested by the TWDB (*need acknowledgement*)**:**
Note that the tolerances in Clarification #1 were derived from calculations using the following assumptions. If the GMA disagrees with the following assumptions, the requested tolerances may no longer be sufficient for TWDB to declare the DFCs achievable and further action may be required.

Ogallala (inclusive of Rita Blanca) Aquifer:

2. Please confirm that the phrase "percent of volume in storage remaining for each 50-year period between 2018 and 2080" in the DFC Resolution means "the percent of volume remaining in storage averaged over all thirteen 50-year time periods starting from 2018 to 2068 through 2030 to 2080." This interpretation produces calculated storage values consistent with the DFC values provided in the Explanatory Report and supplemental documents provided by the GMA 1 consultant.
3. Please confirm that the phrase "total average drawdown for each 50-year period between 2012 and 2080" in the DFC Resolution means "the total average drawdown averaged over all nineteen 50-year time periods starting from 2012 to 2062 through 2030 to 2080. This interpretation produces calculated drawdown values consistent with the DFC values provided in the Explanatory Report and supplemental documents provided by the GMA 1 consultant.
4. Please confirm that the GMA accepts the following assumptions for calculating modeled drawdown: 1) modeled dry cells are excluded from the calculations, 2) only active model cells within official TWDB aquifer boundaries are included in calculations, and 3) averages are calculated over the entire multi-county area defined

within the resolutions rather than by individual county within those areas. This method produces drawdown values consistent with the DFC values provided in the Explanatory Report and supplemental documents provided by the GMA 1 consultant.

Dockum Aquifer:

5. Please confirm that the phrase "percent of the average available drawdown remaining for each 50-year period between 2018 and 2080" in the DFC Resolution means "the percent of the average available drawdown remaining averaged over all thirteen 50-year time periods starting from 2018 to 2068 through 2030 to 2080." This method produces calculated storage values consistent with the DFC values provided in the Explanatory Report and supplemental documents provided by the GMA 1 consultant.
6. Please confirm that the phrase "average decline in water levels for each 50-year period between 2018 and 2080" in the DFC Resolution means "the average decline in water levels averaged over all thirteen 50-year time periods starting from 2018 to 2068 through 2030 to 2080". This method produces calculated storage values consistent with the DFC values provided in the Explanatory Report and supplemental documents provided by the GMA 1 consultant.
7. Please confirm that the phrase "average decline in water levels for each 50-year period between 2012 and 2080" in the DFC Resolution means "the average decline in water levels averaged over all nineteen 50-year time periods starting from 2012 to 2062 through 2030 to 2080. This method produces calculated storage values consistent with the DFC values provided in the Explanatory Report and supplemental documents provided by the GMA 1 consultant.
8. Please confirm that the GMA accepts the following assumptions for calculating modeled drawdowns: 1) modeled dry cells are excluded from the calculations, 2) only active model cells within official TWDB aquifer boundaries are included in calculations, and 3) averages are calculated over the entire multi-county area defined within the resolutions rather than by individual county within those areas. This method produces drawdown values consistent with the DFC values provided in the Explanatory Report and supplemental documents provided by the GMA 1 consultant.

Optional Clarifications requested by the TWDB *(Typos in Explanatory Report)*[6]:

None

[6] Since the TWDB considers the legal DFC Resolution documents, rather than the Explanatory Report, as the official definition of DFCs, the TWDB does not officially require corrections to the Explanatory Report. However, because the Explanatory Report is often used as a simplified, more-readable summary of the legal DFC Resolution documents, we recommend correcting the Explanatory Report to match the DFC Resolutions in order to avoid confusion.

Informational

For reference, the tables below show the averaged results of DFC analysis calculations provided by the GMA 1 consultant and verified by TWDB for the currently unachievable DFCs:

Bulleted Resolutions	***Percent of volume in storage remaining for each 50-year period between 2018 and 2080***	
	DFC	**Calculated from model**
Ogallala Bullet #2*	>= 50%	49%
Ogallala Bullet #3**	>= 80%	79%

** Refers to Hansford, Hutchinson, Lipscomb, Ochiltree, Carson, Donley, Gray, Roberts, Wheeler, and Oldham counties; and within the Panhandle District portions of Armstrong and Potter counties*
*** refers to Hemphill County*

Resolution Section	***Percent of average available drawdown remaining for each 50-year period between 2018 and 2080***	
	DFC	**Calculated from model**
Dockum Bullet #1*	>= 40%	39%

** Refers to Dallam, Hartley, Moore, and Sherman counties.*

FIGURE A1. LETTER OF AGREEMENT FROM THE GROUNDWATER MANAGEMENT AREA 1 TECHNICAL COORDINATOR FOR CLARIFICATIONS ON PROCEDURES AND ASSUMPTIONS OF THEIR DESIRED FUTURE CONDITIONS RESOLUTION STATEMENTS.

NORTH PLAINS GROUNDWATER Conservation District

November 10, 2022

Robert G. Bradley, PG, CTCM
Groundwater Technical Assistance
Texas Water Development Board
P.O. Box 13231
Austin, Texas 78711

Dear Mr. Bradley,

Thank you for reaching out to clarify the Desired Future Conditions adopted by the groundwater conservation districts in Groundwater Management Area 1 (GMA 1). The GMA 1 technical consultant and the managers from Hemphill County Underground Water Conservation District, High Plains Underground Water Conservation District, and Panhandle Groundwater Conservation District reviewed the clarifications document attached to this correspondence.

The Districts in GMA 1 agree that the approach presented by the TWDB staff including the tolerances below are consistent with our intent when adopting DFCs:

- A tolerance of 1% for GMA 1 DFCs defined by percent volume in storage remaining in the Ogallala Aquifer (inclusive of Rita Blanca Aquifer).
- A tolerance of 1% for GMA 1 DFCs defined by percent available drawdown remaining in the Dockum Aquifer.

We agree with the TWDB staff assumptions presented in the "Other Clarifications" section of your note on November 9, 2022, relating to Ogallala, Rita Blanca and Dockum aquifers.

We look forward to TWDB's determination of administrative completeness and estimation of modeled available groundwater. If there is anything else we can do to help in this process, please let me know.

Sincerely,

Steven D. Walthour, PG
General Manager

CC. Janet Guthrie – Hemphill County Underground Water Conservation District
Britney Britten – Panhandle Groundwater Conservation District
Jason Coleman– High Plains Underground Water Conservation District
Wade Oliver - Intera

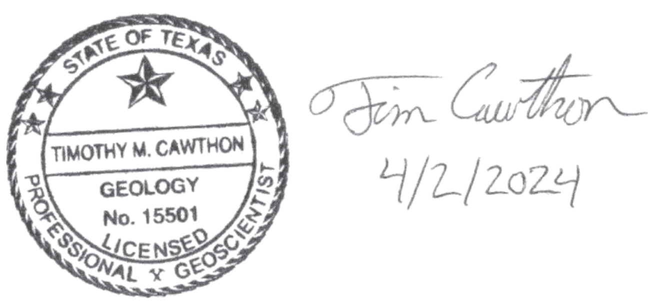
Attachment

Appendix 6

GAM RUN 24-003: Panhandle Groundwater Conservation District Management Plan

GAM Run 24-003: Panhandle Groundwater Conservation District Management Plan

Tim Cawthon, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5076
April 2, 2024



GAM Run 24-003: Panhandle Groundwater Conservation District Management Plan

Tim Cawthon, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5076
April 2, 2024

EXECUTIVE SUMMARY

Texas Water Code § 36.1071(h), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator.

The TWDB provides data and information to the Panhandle Groundwater Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan dataset report, which will be provided to you separately by the TWDB Groundwater Technical Assistance Department. Please direct questions about the water data report to Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov. Part 2 is the required groundwater availability modeling information, which includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;

2. the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers, for each aquifer within the district; and

3. the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The groundwater management plan for the Panhandle Groundwater Conservation District should be adopted by the district on or before June 19, 2024 and submitted to the executive administrator of the TWDB on or before July 19, 2024. The current management plan for the Panhandle Groundwater Conservation District expires on September 17, 2024.

We used two groundwater availability models for the Panhandle Groundwater Conservation District. Information for the Blaine Aquifer is from the groundwater availability model for the Seymour and Blaine aquifers (Ewing and others, 2004). Information for the Dockum and Ogallala aquifers is from version 1.01 of the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015).

This report replaces the results of GAM Run 16-001 (Wade, 2016). Values may differ from the previous report as a result of routine updates to the spatial grid file used to define county, groundwater conservation district, and aquifer boundaries, which can impact the calculated water budget values. Additionally, the approach used for analyzing model results is reviewed during each update and may have been refined to better delineate groundwater flows.

Tables 1 through 3 summarize the groundwater availability model data required by statute. Figures 1, 3, and 5 show the area of the models from which the values in Tables 1 through 3 were extracted. Figures 2, 4, and 6 provide a generalized diagram of the groundwater flow components provided in Tables 1 through 3. If the Panhandle Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions after reviewing the figures, please notify the TWDB Groundwater Modeling Department at your earliest convenience.

The flow components presented in this report do not represent the full groundwater budget. If additional inflow and outflow information would be helpful for planning purposes, the district may submit a request in writing to the TWDB Groundwater Modeling Department for the full groundwater budget.

METHODS

In accordance with the provisions of the Texas Water Code § 36.1071(h), the groundwater availability models mentioned above were used to estimate information for the Panhandle Groundwater Conservation District management plan. Water budgets were extracted for the historical model periods in the respective groundwater availability models. Water budgets were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009) for the Dockum and Ogallala aquifers historical calibration period (1980 through 2012), and for the Blaine Aquifer historical calibration period (1980 through 1999). The average annual water budget values for recharge, surface-water outflow, inflow to the district, outflow from the district, and the flow between aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS

Groundwater availability model for the Seymour and Blaine aquifers

- We used version 1.01 of the groundwater availability model for the Seymour and Blaine aquifers (Ewing and others, 2004) to analyze the Blaine Aquifer. See Ewing and others (2004) for assumptions and limitations of the model.
- The groundwater availability model for the Seymour and Blaine aquifers contains two layers:
    - Layer 1 represents the Seymour Aquifer.
    - Layer 2 represents the Blaine Aquifer.
- In areas where the Blaine Aquifer does not exist the model roughly replicates various Permian units located in the area. The Seymour Aquifer does not occur within the Panhandle Groundwater Conservation District.
- Water budget terms were averaged for the period 1980 through 1999 (stress periods 61 through 300).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

Groundwater availability model for the High Plains Aquifer System

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015) to analyze the Dockum and Ogallala aquifers. See Deeds and Jigmond (2015) for assumptions and limitations of the groundwater availability model.

- The groundwater availability model for the High Plains Aquifer System contains the following four layers:
  - Layer 1 represents the Ogallala and Pecos Valley aquifers.
  - Layer 2 represents the Rita Blanca, Edwards-Trinity (High Plains), and Edwards-Trinity (Plateau) aquifers.
  - Layer 3 represents the upper portion of the Dockum Aquifer and equivalent units.
  - Layer 4 represents the lower portion of the Dockum Aquifer and equivalent units.
- Water budgets for the district were determined for the Ogallala Aquifer (Layer 1) and the Dockum Aquifer (Layers 3 and 4, collectively).
- Water budgets terms were averaged for the period 1980 through 2012 (stress periods 52 through 84).
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).

RESULTS

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the Blaine, Dockum, and Ogallala aquifers located within the Panhandle Groundwater Conservation District and averaged over the historical calibration period, as shown in Tables 1, 2, and 3.

1. Precipitation recharge—the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.
2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.

3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.

4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district’s management plan is summarized in Tables 1 through 3. Figures 1, 3, and 5 show the area of the models from which the values in Tables 1 through 3 were extracted. Figures 2, 4, and 6 provide a generalized diagram of the groundwater flow components provided in Tables 1 through 3. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

Table 1: Summarized information for the Blaine Aquifer that is needed for the Panhandle Groundwater Conservation District groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.

Management plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Blaine Aquifer	4,080
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Blaine Aquifer	5,165
Estimated annual volume of flow into the district within each aquifer in the district	Blaine Aquifer	0
Estimated annual volume of flow out of the district within each aquifer in the district	Blaine Aquifer	5,096
Estimated net annual volume of flow between each aquifer in the district	To Blaine Aquifer from Permian units	5,977
	To Blaine Aquifer from equivalent units in Oklahoma	16

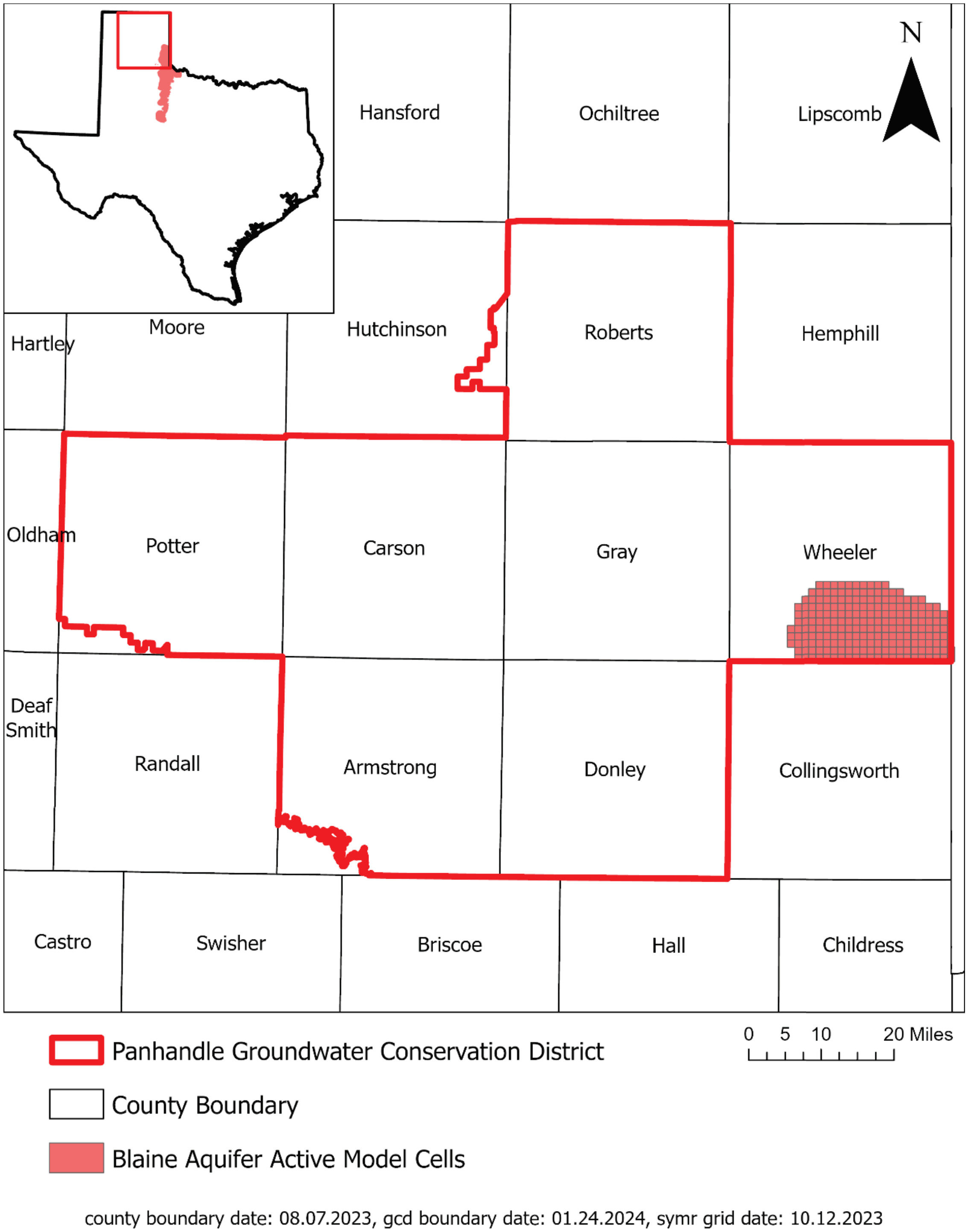
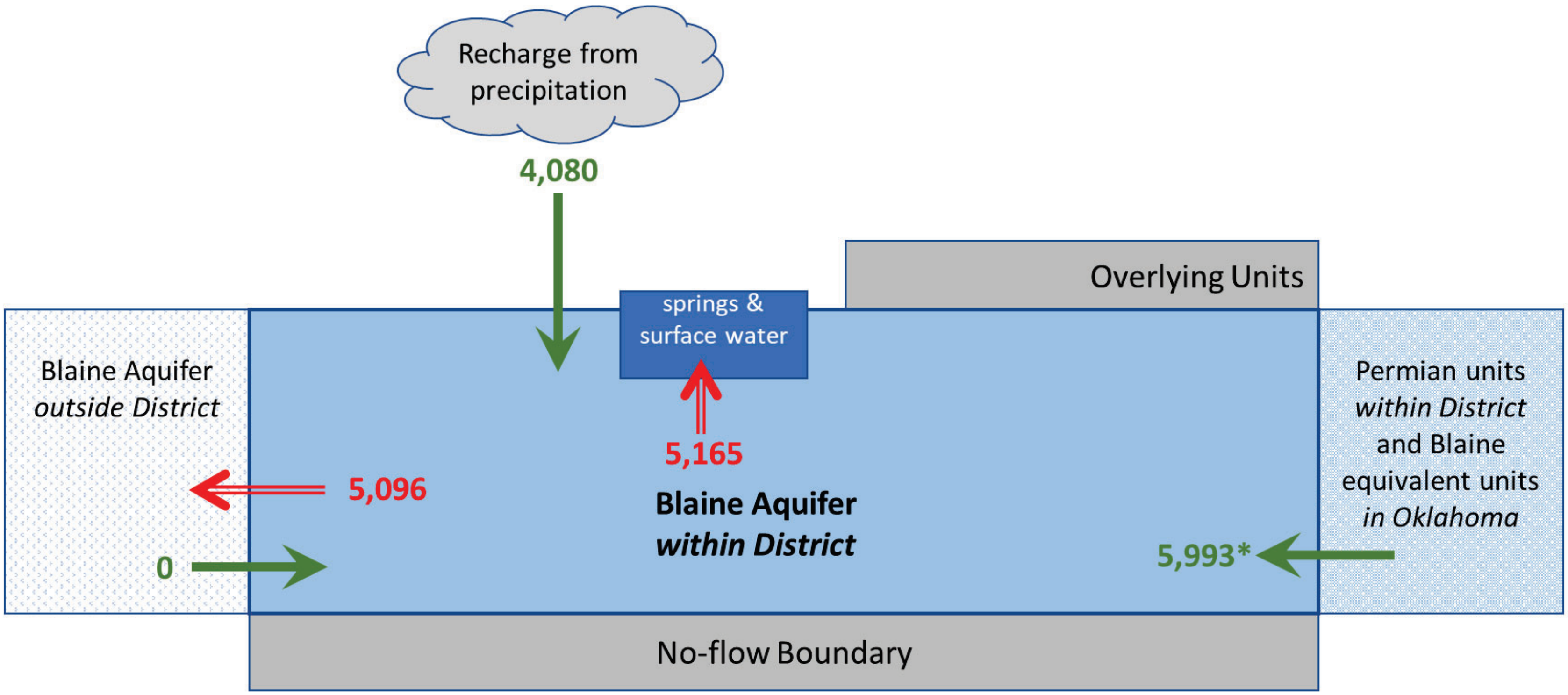


Figure 1: Area of the groundwater availability model for the Seymour and Blaine aquifers from which the information in Table 1 was extracted (the Blaine Aquifer extent within the district boundary).



*Flow from Permian units within District and Blaine equivalent units in Oklahoma includes net inflow of 5,977 acre-feet per year from Permian units within District and net inflow of 16 acre-feet per year from Blaine equivalent units in Oklahoma.

Caveat: This diagram only includes the water budget items provided in Table 1. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 2: Generalized diagram of the summarized budget information from Table 1, representing directions of flow for the Blaine Aquifer within the Panhandle Groundwater Conservation District. Flow values are expressed in acre-feet per year.

Table 2: Summarized information for the Dockum Aquifer that is needed for the Panhandle Groundwater Conservation District groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.

Management plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Dockum Aquifer	2,434
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Dockum Aquifer	8,083
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	3,243
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	729
Estimated net annual volume of flow between each aquifer in the district	From Dockum Aquifer to Dockum equivalent units	51
	To Dockum Aquifer from Ogallala Aquifer	2,733

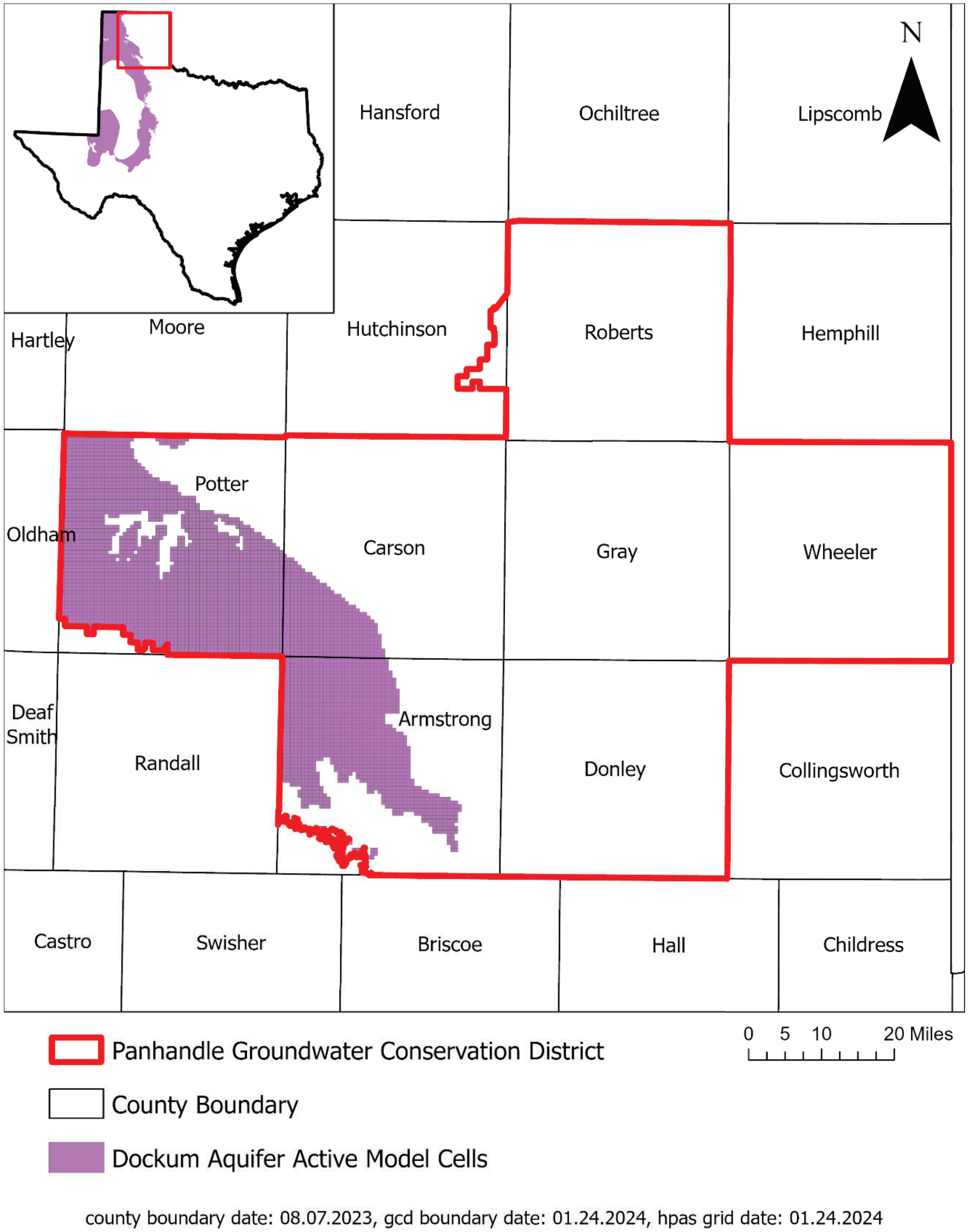
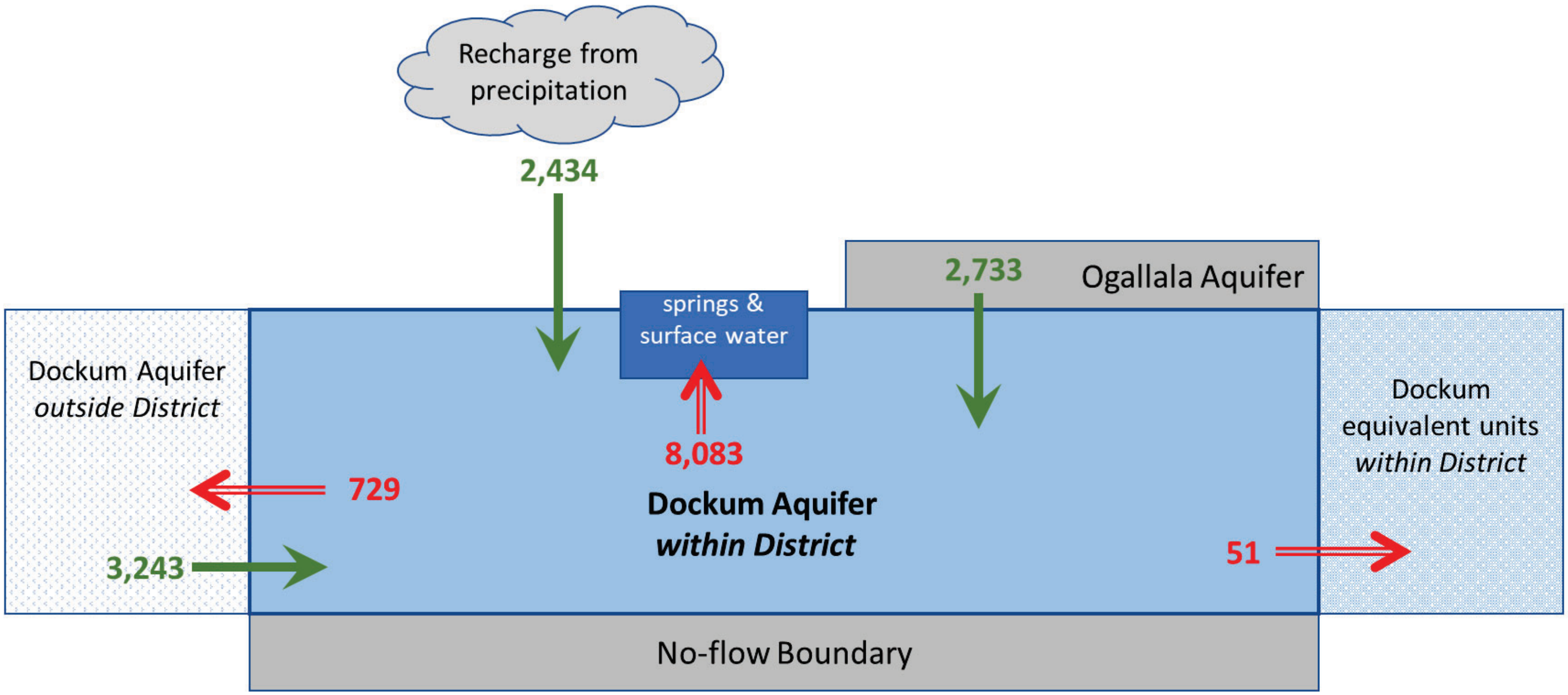


Figure 3: Area of the groundwater availability model for the High Plains Aquifer System from which the information in Table 2 was extracted (the Dockum Aquifer extent within the district boundary).



Caveat: This diagram only includes the water budget items provided in Table 2. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 4: Generalized diagram of the summarized budget information from Table 2, representing directions of flow for the Dockum Aquifer within the Panhandle Groundwater Conservation District. Flow values are expressed in acre-feet per year.

Table 3: Summarized information for the Ogallala Aquifer that is needed for the Panhandle Groundwater Conservation District groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.

Management plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Ogallala Aquifer	114,224
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Ogallala Aquifer	124,574
Estimated annual volume of flow into the district within each aquifer in the district	Ogallala Aquifer	35,249
Estimated annual volume of flow out of the district within each aquifer in the district	Ogallala Aquifer	26,518
Estimated net annual volume of flow between each aquifer in the district	From Ogallala Aquifer to Dockum Aquifer	2,733
	To Ogallala Aquifer from Dockum equivalent units	31
	From Ogallala Aquifer to equivalent units in Oklahoma	1,087

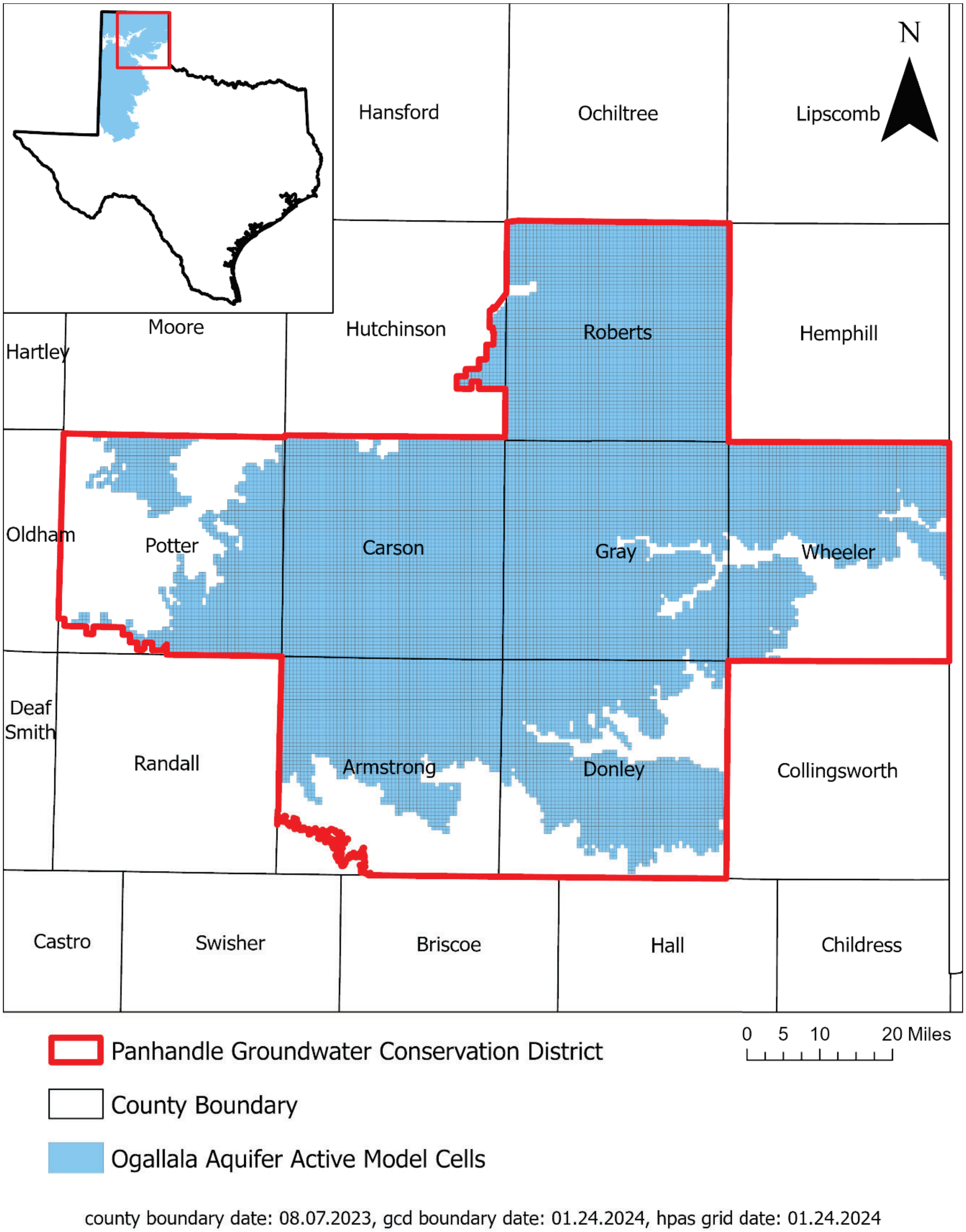
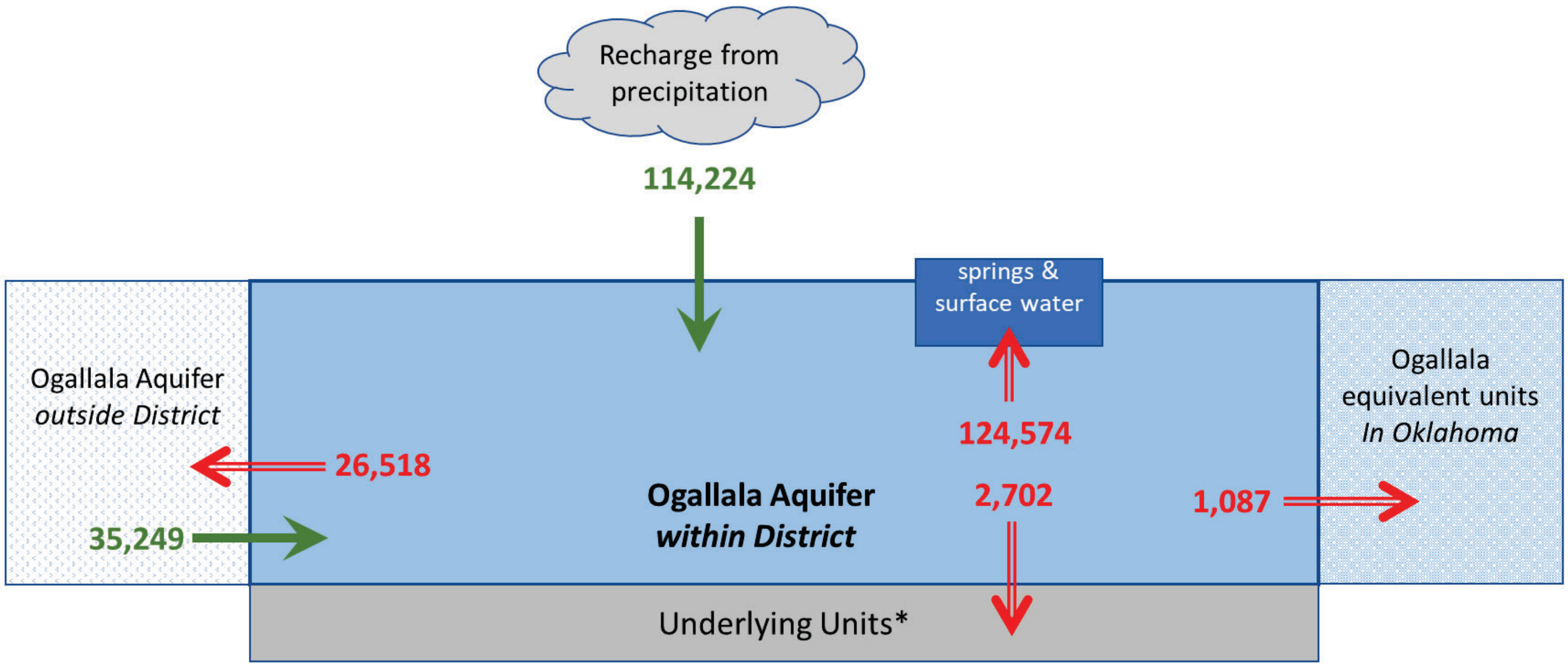


Figure 5: Area of the groundwater availability model for the High Plains Aquifer System from which the information in Table 3 was extracted (the Ogallala Aquifer extent within the district boundary).



*Flow to underlying units includes net outflow of 2,733 acre-feet per year to Dockum Aquifer and net inflow of 31 acre-feet per year from Dockum equivalent units.

Caveat: This diagram only includes the water budget items provided in Table 3. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 6: Generalized diagram of the summarized budget information from Table 3, representing directions of flow for the Ogallala Aquifer within the Panhandle Groundwater Conservation District. Flow values are expressed in acre-feet per year.

LIMITATIONS

The groundwater models used in completing this analysis are the best available scientific tools that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> "Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."

A key aspect of using the groundwater models to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifers where historic pumping was placed. Understanding the amount and location of historical pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and interaction with streams are specific to particular historic time periods.

Because the application of the groundwater models was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater models and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

REFERENCES

Deeds, N. E. and Jigmond, M., 2015, Numerical Model Report for the High Plains Aquifer System Groundwater Availability Model, Prepared for the Texas Water Development Board by INTERA., 640 p., www.twdb.texas.gov/groundwater/models/gam/hpas/HPAS_GAM_Numerical_Report.pdf

Ewing, J.E., Jones, T.L., Pickens, J.F., Chastain-Howley, A., Dean, K.E., Spear, A.A., 2004, Groundwater availability model for the Seymour Aquifer, Prepared for the Texas Water Development Board by INTERA, Inc., 533 p., www.twdb.texas.gov/groundwater/models/gam/symr/SYMR_Model_Report.pdf

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, The U.S. Geological Survey modular ground-water model-User guide to modularization concepts and the ground-water flow process: U.S. Geological Survey, Open-File Report 00-92., 121 p., https://water.usgs.gov/nrp/gwsoftware/modflow2000/ofr00-92.pdf

Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software. https://water.usgs.gov/water-resources/software/ZONEBUDGET/zonbud3.pdf

National Research Council, 2007, Models in Environmental Regulatory Decision Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p., https://nap.nationalacademies.org/catalog/11972/models-in-environmental-regulatory-decision-making

Niswonger, R. G., Panday, S., and Ibaraki, M., 2011, MODFLOW-NWT, A Newton formulation for MODFLOW-2005: U.S. Geological Survey Techniques and Methods 6-A37, 44 p., https://doi.org/10.3133/tm6A37

Texas Water Code § 36.1071

Wade, S. 2016, GAM Run 16-001: Panhandle Groundwater Conservation District Groundwater Management Plan, 15 p., www.twdb.texas.gov/groundwater/docs/GAMruns/GR16-001.pdf

Appendix 7

Coordination letters with regional surface water management entities

PANHANDLE GROUNDWATER CONSERVATION DISTRICT

On June 6, 2024, the Panhandle Groundwater Conservation District sent a copy of the 2024 Amended Management Plan to the following surface water entities in accordance with the statute and TWDB rule requirements.

1. Canadian River Municipal Water Authority – Drew Satterwhite at drew@crmwa.com
2. Red River Authority – Fabian Heaney at fabian.heaney@rra.texas.gov
3. Greenbelt Water Authority – Bobbie Kidd at greenbeltwater@valornet.com

Britney Britten
General Manager

From:	Britney Britten
To:	Drew Satterwhite
Subject:	PGCD - Amended Management Plan
Date:	Thursday, June 06, 2024 3:28:00 PM
Attachments:	Panhandle GCD M-Plan 6-6-24 - Final for TWDB Review.pdf image001.png

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Good Afternoon Drew –

Please see the attached Management Plan the board adopted this morning. Let me know if you have any questions.

PANHANDLE GROUNDWATER CONSERVATION DISTRICT

BRITNEY BRITTEN
General Manager

201 W Third Street, White Deer, TX 79097
Office: 806.883.2501 opt. 2
Cell: 806.898.0128
www.pgcd.us
Conserving Water for Future Generations

From:	Britney Britten
To:	"fabian.heaney@rra.texas.gov"
Subject:	Panhandle GCD - Amended Management Plan
Date:	Thursday, June 06, 2024 3:40:00 PM
Attachments:	image001.png Panhandle GCD M-Plan 6-6-24 - Final for TWDB Review.pdf

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Good Afternoon Mr. Heaney –

Please see the attached Management Plan. PGCD is required to adopt a management plan at least every five years per Chapter 36 of the Texas Water Code Section 36.1071. This email is provided to you as evidence of our coordination with local surface water entities.

If you have any questions, please let me know.

Thanks,

BRITNEY BRITTEN
General Manager
201 W Third Street, White Deer, TX 79097
Office: 806.883.2501 opt. 2
Cell: 806.898.0128
www.pgcd.us
Conserving Water for Future Generations
PANHANDLE GROUNDWATER CONSERVATION DISTRICT

From: Britney Britten
To: Bobbie Kidd
Subject: PGCD - Amended Management Plan
Date: Thursday, June 06, 2024 3:34:00 PM
Attachments: Panhandle GCD M-Plan 6-6-24 - Final for TWDB Review.pdf
image001.png

Good Afternoon –

Please see the attached Management Plan the PGCD Board of Directors adopted this morning. If you have any questions, please let me know.

Thanks,

PANHANDLE GROUNDWATER CONSERVATION DISTRICT

BRITNEY BRITTEN
General Manager

201 W Third Street, White Deer, TX 79097
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