South Plains Underground Water Conservation District

Groundwater Management Plan

2024 - 2029

Effective

May 14, 2024

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District Mission Statement

The South Plains Underground Water Conservation District (the District) will develop, promote, and implement management strategies to provide for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater resources over which it has jurisdictional authority, for the benefit of the people that the District serves.

Time Period for this Plan

This plan becomes effective upon approval by the Executive Administrator of the Texas Water Development Board and remains in effect for a period of five years

Guiding Principles

The District was formed, and has been operated from its inception, with the guiding belief that the ownership and production of groundwater is a private property right. It is understood that, without the District, there is no protection of private property rights. The methods of protecting private property rights in groundwater are implemented using the policies adopted by the locally elected board members.

The Board understands the responsibilities of the District and creates programs necessary for meeting them. The Board believes that the District should be more knowledgeable of its groundwater resources than any other entity.

Additionally, the Board realizes that the aquifer extends beyond the District's boundaries, and the sharing of information, programs and ideas with neighboring districts is important. As a result, the District will consider the joint administration of certain programs when practical.

This management plan is a tool which provides continuity in the management of the District. The District staff uses this guide to ensure that the goals of the District are met. The Board uses it for planning, as well as measuring the performance of the staff.

Conditions change over time, which requires that the Board modify this document. The dynamic nature of this plan shall be maintained such that the District continues serving the needs of the constituents. At the very least, the Board will review and readopt this plan every five years, or as specified by Chapter 36, Texas Water Code.

In the opinion of the Board, the goals, management objectives, and performance standards in this planning document have been set at a reasonable level, considering existing and future fiscal and technical resources. Evolving conditions may change the management objectives defined to reach the stated goals. Whatever the future holds, the following guidelines are used to ensure the management objectives are set at a sufficient level to be realistic and effective:

- The District's constituents will determine if the District's goals are set at a level that is both meaningful and attainable; through their voting right, the public will appraise the District's overall performance in the process of electing or re-electing Board members.
- The duly elected Board will guide and direct the District staff and will gauge the achievement of the goals set forth in this document.
- The interests and needs of the District's constituents shall control the direction of the management of the District.
- The Board will maintain local management of the privately owned resource over which the District has jurisdictional authority, as provided by Chapter 36, Texas Water Code.
- The Board will evaluate District activities on a fiscal-year basis. That is, the District budgets operations on a September 1 – August 31 fiscal year. When considering stated goals, management objectives, and performance standards, any reference to the terms "annual," "annually," or "yearly" will refer to the fiscal year of the District.

General Description, Location and Extent

The District was created by HB 281 (72nd Legislature) during 1991. The District was confirmed by voter approval, the initial Board elected, and an ad valorem tax rate cap of $0.025/$100 valuation was set in an election held in August 1992.Table 1 lists the current Board of Directors, office held, occupation, and term.

Table 1: Board of Directors of the South Plains Underground Water Conservation District

Office	Name	Occupation	Term Ends
President	Matt Hogue	Active Farmer	May 2024
Secretary	Gabe Neill	Active Farmer	May 2024
Member	E. C. Harlan	Active Farmer	May 2026
Member	Barrett Brown	Active Farmer	May 2024
Member	Tye Day	Active Farmer	May 2026

Originally, the jurisdictional extent of the District was the same as Terry County, Texas. However, in 1994, the District annexed about 1,100 acres of Hockley County from individual landowner petitions. As a result, the District includes about .26% of the land area in Hockley County.

The District now covers approximately 902 square miles of the Southern High Plains of Texas (Figure 1). Brownfield, the Terry county seat, is the largest municipality in the District, having a population of about 8717.Meadow (pop. 927), and Wellman (pop. 257), are the other two incorporated communities in the District.

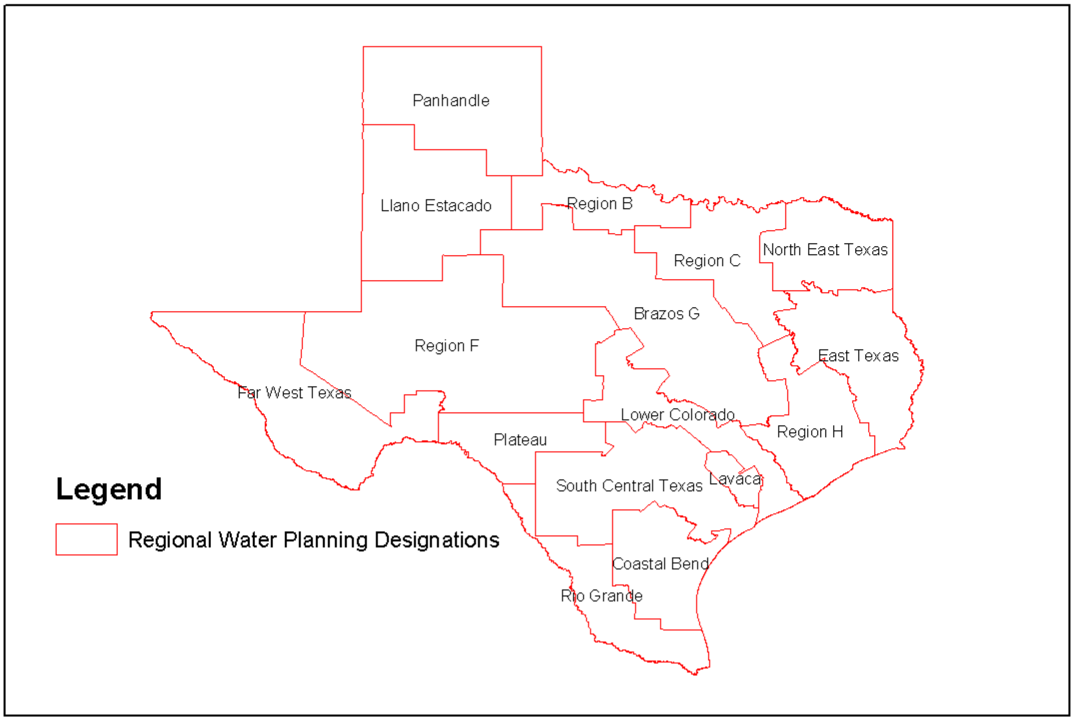
Four other groundwater districts border the South Plains Underground Water Conservation District. These include High Plains UWCD #1, Llano Estacado UWCD, Mesa UWCD and Sandy Land UWCD.

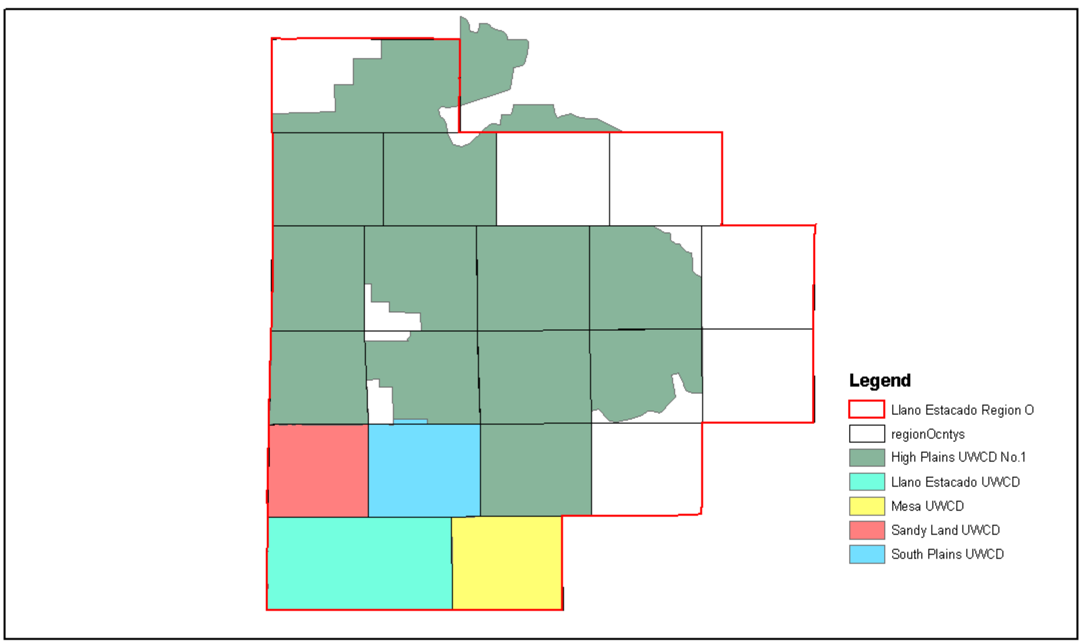
The economy of the District is supported predominately by row crop agriculture. Approximately 105,000 acres of irrigated cropland, out of approximately 500,000 total acres of farmland (USDA National Agriculture Statistic Service 2017), affords economic stability to the area covered by the District. The major crops cultivated within the District include cotton, peanuts, grain sorghum, wheat and, to a lesser extent, grapes, pecans, watermelons, sunflowers, guar and hay crops. Two dairy facilities are located in the District.

Grapes have become an important crop within the last 10 years. Currently, there are approximately 3,500 acres of wine grapes grown in the District. This accounts for 80% of the wine grapes grown in the state. Grapes use less water than other crops and are usually irrigated by drip irrigation during the winter months. Terry County has been designated by the Texas Legislature as the “Grape Capital of Texas”

A significant portion of the District’s tax-based revenues are generated by mineral valuation. Fluctuating oil prices are a challenge to the budgeting process.

Figure 1: Location of the South Plains Underground Water Conservation District





Topography and Drainage

The land surface in the District is a nearly level to a very gently undulating constructional plain that has little dissection. The northwestern part of the District is the most undulating, largely because eolian deposits of sand have been shifted and reworked by wind.

The elevation ranges from about 3150 feet above sea level in the southeastern part of the District to 3600 feet in the northwestern part. Brownfield, which is near the center of the District, has an approximate elevation of 3300 feet. There is a general slope of about 10 feet per mile from the northwest to southeast.

Two relic drainage ways, Sulfur Springs Draw and Lost Draw, cross the District from northwest to southeast. These draws are shallow and are usually dry; they seldom carry runoff water.

Rich Lake and Mound Lake are the largest salt lakes in the District. Around these lakes is the sharpest topographical relief. The eolian hills that border the east sides of these lakes are sometimes 100 feet or more higher than the lakebeds.

Playas, or shallow lakes, are more common in the northeastern part of the district. Playas are not prevalent in the sandier areas. The playas range in size from 2 to 40 acres and provide the only surface drainage in many areas. Aquifer recharge occurs through these playa basins during and after significant rainfall events. Recharge is limited once the clays in the basins swell and effectively stop percolation of groundwater (Sanders, 1961).

Groundwater Resources

The District has jurisdictional authority over all groundwater that lies within the District's boundaries. Three aquifers, the Ogallala, the Cretaceous, and the Dockum occur within the District. The following is a description of these formations that may be beneficial to District constituents by providing usable quantities of groundwater.

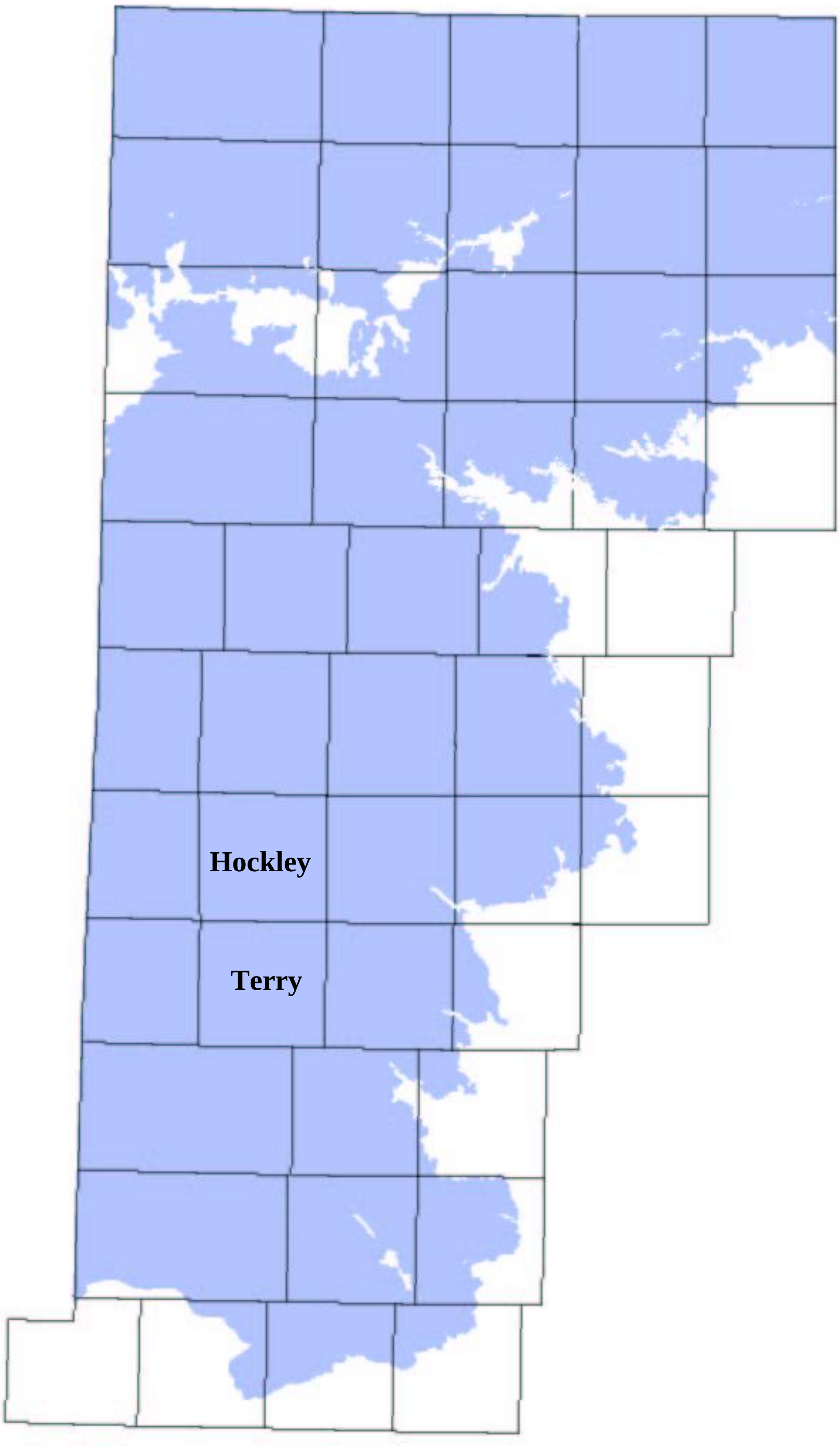
Ogallala Aquifer

The Ogallala Aquifer is the primary source of groundwater in the District (Figure 2). The aquifer extends from the ground surface downward, ranging in thickness from 80 feet to more than 200 feet in the area covered by the District.

The formation consists of heterogeneous sequences of clay, silt, sand and gravel. These sediments are thought to have been deposited by eastward-flowing aggrading streams that filled and buried valleys eroded into pre-Ogallala rocks. A resistant layer of calcium carbonate-cemented caliche known locally as the "caprock" occurs near the surface of much of the area. (Ashworth and Hopkins, 1995).

Water levels in the Ogallala Aquifer are influenced by the rate of recharge and discharge. Recharge occurs primarily by infiltration of precipitation. GAM studies show that recharge is

Figure 2: Extent of the Ogallala Aquifer in Texas
(Adapted from Ashworth and Hopkins, 1995)



greater beneath irrigated lands. To a lesser extent, recharge may also occur by upward leakage from underlying Cretaceous units that, in places, have a higher water table elevation than the Ogallala. Generally, only a small percentage of water from precipitation actually reaches the water table due to a combination of limited annual precipitation (17.59 inches per year), high evaporation rate (60-70 inches per year), and slow infiltration rate. However, where deep sands are prevalent and the water table is shallow, precipitation may affect recharge rather quickly.

Groundwater in the aquifer generally flows from northwest to southeast, normally at right angles to water level contours. Velocities of less than one foot per day are typical, but higher velocities may occur along filled erosional valleys where coarser grained deposits have greater permeability.

Discharge from the Ogallala aquifer within the District primarily occurs through the pumping of irrigation wells. Groundwater usage typically exceeds recharge and results in water level declines (Ashworth and Hopkins, 1995).

The chemical quality of Ogallala groundwater varies greatly across the District. Electrical conductance (EC) varies from less than 1.0 dS/m to over 4.0 dS/m. Generally, groundwater in the eastern and southeastern parts of the District exhibits the highest EC. Isolated occurrences of high EC values elsewhere in the District may be due to pollution through oil field saltwater disposal pits or upward leakage and mixing from the underlying Cretaceous aquifer.

The suitability of groundwater for irrigation purposes is largely dependent on the chemical composition of the water and is determined primarily by the total concentration of soluble salts. Some farm acreage in the District is already limited to certain varieties of salt tolerant crops due to limiting or damaging total salt levels.

Cretaceous Aquifer

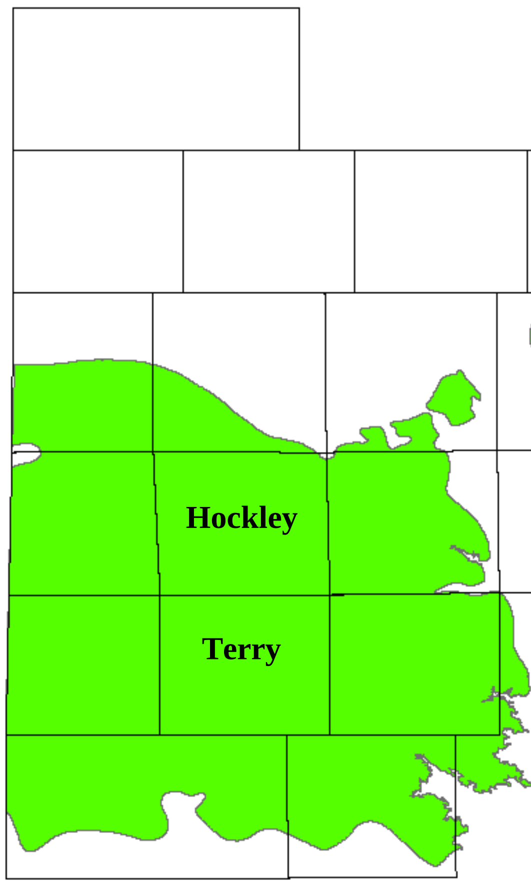
The Edwards-Trinity (High Plains) Aquifer, commonly referred to as the Cretaceous Aquifer, underlies the Ogallala Aquifer throughout the District (Figure 3). In some areas of the District, the Cretaceous and Ogallala aquifers may be hydrologically connected. Groundwater in the Cretaceous is generally fresh to slightly saline. Water quality deteriorates where Cretaceous formations are overlain by saline lakes.

Studies performed by the District suggest that water quality in Cretaceous units is generally similar to that of the Ogallala. However, there are some instances where it has been discovered that lower Cretaceous units have poor quality water. This work is a continual investigation and limited by the sparse locations of Cretaceous water wells. Further work should provide additional understanding of this issue.

As Ogallala water levels decline, it is expected that there will be greater interest in this minor aquifer. The District is implementing a water level measurement program for this minor aquifer and is committing additional resources to the study of Cretaceous units.

Recharge of the Cretaceous occurs directly from the bounding Ogallala formation. Some upward movement of groundwater from the underlying Triassic Dockum formation may also occur, affecting recharge of the Cretaceous (Ashworth and Hopkins, 1995). As mentioned earlier, in some places the potentiometric surface elevation of the Cretaceous Aquifer is higher than the water table elevation of the Ogallala Aquifer, resulting in the upward leakage from the Cretaceous Aquifer. Movement of water in the Cretaceous is generally east to southeast.

Figure 3: Extent of the Edwards-Trinity (High Plains) Aquifer in Texas
(Adapted from Ashworth and Hopkins, 1995)



Dockum Aquifer

The Dockum aquifer underlies the Cretaceous and Ogallala formations throughout the District. The primary water-bearing zone in the Dockum group, commonly called the “Santa Rosa,” consists of up to 700 feet of sand and conglomerate interbedded with layers of silt and shale (Ashworth and Hopkins, 1995). Aquifer permeability is typically low and well yields normally do not exceed 300 gpm.

Water quality in the Dockum is the main limiting factor when considering its use within the District (Ashworth and Hopkins, 1995). EC values for Dockum groundwater range from 15.0 dS/m to over 50.0 dS/m. Even the most salt-tolerant row crops grown cannot withstand such levels of salinity.

Currently, it seems the only practical use of Dockum groundwater may be for make-up water in secondary recovery operations of crude oil. By using water from this aquifer, oil companies could reduce their use of Ogallala and/or Cretaceous groundwater, thereby relieving some pressure from the freshwater sources.

At some point, it may be feasible to treat Dockum water for use as municipal supply. As desalination technology evolves, this process might be feasible for meeting some needs within the District. However, due to the limited productivity of this aquifer, it is likely best suited (using this scenario) for stock or municipal supply. These uses permit a storage system for water that is not available for agricultural irrigation usage.

Surface Water Resources

The only fresh surface water in the District exists as playa lakes. The playas play a significant role in aquifer recharge and support some wildlife when rainfall accumulates in these naturally occurring depressions. Playas are rarely, if ever, used to support irrigation activities.

As previously mentioned, Rich Lake and Mound Lake are naturally occurring salt lakes within the District. Each of these naturally occurring impoundments support limited wildlife populations, primarily migratory waterfowl and opportunistic predators.

Perhaps the most significant surface water resource of benefit to the District is Lake Meredith located on the Canadian River in the Texas Panhandle. The lake is managed by the Canadian River Municipal Water Authority and provides water to the City of Brownfield and, starting 2009, the City of Meadow.

1. Estimates of Modeled Available Groundwater

GMA 2 adopted desired future Conditions for relevant aquifers in October 2022. The relevant aquifers for the District are the Ogallala, Edwards-Trinity (High Plains), and Dockum aquifers.

For the 2013 through 2080 time period, the desired future condition for the Ogalalla and Edwards-Trinity (High Plains) aquifers is a GMA 2-wide average drawdown of 28 feet; for the Dockum, a GMA 2-wide drawdown of 31 feet for the same time period.

As documented in GMA 2 Technical Memorandum 20-01, the average drawdown calculations involve summing the drawdowns in all cells in an identified unit (e.g., county or GCD) and dividing the sum by the number of cells in the unit. Calculated average drawdowns based on the active cells in the model can be different than the calculated average drawdown based on the official aquifer boundary cells, which are often limited to groundwater less than 3,000 mg/l total dissolved solids. Because the GCDs in GMA 2 are actively managing groundwater with total dissolved solids greater than 3,000 mg/l, GMA 2 decided to express the average drawdown desired future conditions based on the active model cell average, not the official aquifer boundary average. Thus, modeled available groundwater values should also include active model area pumping totals, not the official aquifer boundary totals.

For Estimated modeled available groundwater for the South Plains UWCD, refer to the *GMA 2 MAG Report table from the TWDB GAM Run 21-008 MAG Addendum, Appendix C*

2. Estimates of Historical Groundwater Usage

The estimated Historical Water Use from the TWDB Estimated Historical Water Use Survey (WUS) provides estimations of the historical quantity of groundwater used in the area served by the District. It will be used as a guide to estimate future demands on the resource in the District. It should be emphasized that the quantities shown are estimates.

Refer to Estimated Historical Groundwater Use and 2022 State Water Plan Datasets, Appendix B

3. Estimates of Annual Groundwater Recharge from Precipitation

Refer to GAM Run 23-007, Appendix A

4. Estimates of Annual Groundwater Discharge to Springs/Surface Water Bodies

Refer to GAM Run 23-007, Appendix A

5. Estimates of Annual Groundwater Flow Into/Out of the District for the Ogallala; estimates of annual groundwater flow between aquifers in the District

Refer to GAM Run 23-007, Appendix A

6. Estimates of Projected Surface Water Supply

Currently, there are two towns within the District that use surface water. The Canadian River Municipal Water Authority (CRMWA) supplies some water to Brownfield. In 2009, the town of Meadow negotiated the purchase of some CRMWA water with Brownfield. The purchase was necessary for blending the higher quality CRMWA supply with the town's groundwater wells; several of which have elevated arsenic and fluoride. As Lake Meredith has declined, CRMWA has purchased groundwater in Roberts County as a supplement. The town of Wellman is searching for a more stable source of groundwater to supply its municipal water needs.

Refer to Estimated Historical Groundwater Use and 2022 State Water Plan Datasets, Appendix B

7. Estimates of Projected Total Demand for Water in the District

Projecting water demand is a challenging task. Some user group projections are more accurate than others. This is an inherent part of the process. Of particular difficulty is the projection of irrigation water demand. Rainfall, commodity prices, water level changes, and federal farm policy are a few of the factors that complicate the matter.

Refer to Estimated Historical Groundwater Use and 2022 State Water Plan Datasets, Appendix B

8. Water Supply Needs and Water Management Strategies

It is required that the District Management Plan consider the water supply needs and water management strategies included in the 2022 State Water Plan (TWC 36.1071(e)(4). Projected Water Supply Needs TWDB 2022 State Water Plan: Over 98% of the total projected water supply needs for the District, Terry County and 1,100 acres or .26% of Hockley County, is primarily Irrigation. From 2020 to 2070 the total water supply needs are projected to increase 15,408 AF to 42,743 AF. The City of Brownfield shows a need of 49 AF in 2050 increasing to 291 AF in 2070, and mining shows shortages in Terry County decreasing from 230 AF in 2030 to 91 AF in 2027. Water management strategies within the district include City of Brownfield municipal water conservation and additional groundwater supply development, irrigation conservation, and mining conservation and development of new groundwater supplies.

Refer to Estimated Historical Groundwater Use and 2022 State Water Plan Datasets, Appendix B

Projected Water Management Strategies TWDB 2022 State Water Plan:
From 2020 to 2070, the total water management strategies in Hockley County are projected to increase from 4,018 AF to 6,438 AF.

From 2020 to 2070, the total water management strategies in Terry County are projected to increase from 5,857 AF to 10,278 AF.

Actions, Procedures, Performance and Avoidance for Plan Implementation

The District currently employs a set of rules governing the spacing and production of wells, as well as production limitations based on tract size. It is expected that this approach will remain the foundation of the Board's strategies for groundwater management. As conditions dictate, and as the DFC process is completed, it may require that the specific provisions within the existing rules be modified. The District's Board of Directors is responsible for that determination. The District's rules are available on the District web site: https://spuwcd.org/rules/.

Additional water management strategies the District may consider, when applicable, are listed below.

A. Conversion to Dryland Farming—As water supplies decline, there are some landowners that may exercise this option. There are incentive payments available through the USDA NRCS for those interested in this option. The District supports the use of these incentive payments to help those landowners interested in this program.
B. Increased study of Minor aquifers—Some future needs may be addressed using the two minor aquifers, the Cretaceous (Edwards-Trinity High Plains) and the Dockum, within the District. At this time, it is uncertain what additional amount of water may be available from minor aquifers. The District supports the continued and further investigation of these resources and is committed to the monitoring and study of them.
C. Conservation Programs—The implementation of educational programs and resources regarding conservation remains top priority for the District. The Board supports the expansion of resources pertaining to those programs, which include, but are not limited to: maximizing crop water use efficiency, minimizing irrigation water evaporative losses, rainwater harvesting, use of water wise plants and drought tolerant landscaping, wise water use, and device giveaways.

Drought Contingency Plan

Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. Drought is also a temporary aberration, and differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate ("What is Drought?" National Drought Mitigation Center). The South Plains Underground Water Conservation District is in a semi-arid region that also experiences drought. However, even in the midst of a drought, rainfall at crucial times of the growing season may significantly reduce irrigation water demand.

Drought response conservation measures typically used in other regions of Texas (i.e., rationing) cannot and are not used in this region due to extreme economic impact potential. In the District, groundwater conservation is stressed at all times. The Board recognizes that irrigated agriculture provides economic stability to the communities within the District. Therefore, through the notice and hearing provisions required in the development and adoption of this management plan, the Board adopts the official position that, in times of precipitation shortage, irrigated agricultural producers will not be limited to any less usage of groundwater than is provided for by District rules.

In order to treat all other groundwater user groups fairly and equally, the District will encourage more stringent conservation measures, where practical, but likewise, will not limit groundwater use in any way not already provided for by District rules.

Regional Water Planning

The Board of Directors recognizes the regional water plan requirements listed in Ch. 36, TWC, §36.1071. Namely, the District's management plan must be forwarded to the regional water planning group for their consideration in their planning process, and the plan must address water supply needs such that there is no conflict with the approved regional water plan. It is the Board's belief that no such conflict exists.

The Board agrees that the regional water plan should include the District's best data. The Board also recognizes that the regional water planning process provides a necessary overview of the region's water supply and needs. However, the Board also believes it is the duty of the District to develop the best and most accurate information concerning groundwater within the District.

Goals, Management Objectives and Performance Standards

Method for Tracking the District's Progress in Achieving Management Goals

The District Manager will prepare an annual report of the District's performance achieving management goals and objectives. The report will be prepared in a format that will be reflective of the performance standards listed following each management objective. The report will be kept on file in the open records of the District.

The District will actively enforce all rules of the District in order to conserve, preserve, protect and prevent the waste of the groundwater resources over which the District has jurisdictional authority. The Board may periodically review the District's rules, and may modify the rules, with public approval, to better manage the groundwater resources within the District and to carry out the duties prescribed in Chapter 36, Texas Water Code.

Goal 1.0 Providing the most efficient use of groundwater.

Management Objective—Water Level Monitoring

1.01 Measure the depth to water in the District's water level monitoring well network.

Performance Standards

1.01a Number of wells measured

1.01b Number of wells added to the network, if required, each year

<u>Management Objective</u>—Technical Field Services

1.02 Provide technical field services including flow testing and drawdown measurement for wells and irrigation systems.

Performance Standards

1.02a Number of field services tests performed each year

<u>Management Objective</u>—Laboratory Services

1.03 Provide basic water quality testing services. Maintain a record of tests performed by entering the results in the District's computer database.

Performance Standards

1.03a Number of laboratory service tests.

1.03b Number of records entered into District's computer database each year

<u>Management Objective</u>—Water Use Monitoring

1.04 Monitor seasonal irrigation applications using a network of cooperative producers.

Performance Standards

1.04a Number of irrigation systems in the cooperative program

1.04b Number and type of crops monitored

1.04c Average irrigation application by crop

<u>Management Objective</u>—Irrigation System Inventory

1.05 Every five years perform a physical inventory of irrigation systems in the District. Enter data in District's database file by block and section.

Performance Standards

1.05a Number of irrigation systems recorded each documenting period

1.05b Number of active irrigation systems by type in District's database

<u>Goal 2.0</u> Controlling and preventing waste of groundwater.

<u>Management Objective</u>—Well Permitting and Well Completion

2.01 Issue temporary water well drilling permits for the drilling and completion of non-exempt water wells. Inspect all well sites to be assured that the District's completion and spacing standards are met.

Performance Standards

2.01a Number of water well drilling permits issued each year

2.01b Number of well sites inspected after well completion each year

<u>Management Objective</u>—Maximum Allowable Production

2.03a The District will investigate reports of usage of groundwater in excess of the maximum production allowable under the District's rules.

Performance Standards

2.03a Number of reports received

<u>Goal 3.0</u> Controlling and preventing subsidence.

<u>Management Objective</u> – Subsidence Vulnerability study of the Ogallala.

3.01 As noted in *Identification of the Vulnerability of the Major and Minor aquifers of Texas to Subsidence with Regard to Groundwater Pumping* – TWDB Contract Number 1648302062, by LRE Water, results of a subsidence vulnerability study on the Ogallala Aquifer suggest that the northern part of the Ogallala has the greatest risk for future subsidence due to pumping. Data from wells in the northern Ogallala tend to show a medium to high subsidence risk. The central and southern portions of the aquifer are at a lower risk with a medium subsidence risk.

Performance Standards

3.01a The District will investigate, and document all reports and concerns of possible subsidence.

<u>Goal 4.0</u> Addressing Conjunctive surface water management issues.

4.01 The only fresh surface water in the District exists as playa lakes. Playas are small shallow depressions which holds rainwater, creating temporary lakes. The playas do play a key role in the natural recharge of the aquifer. There are several organizations in the region working with landowners to incentive the restoration and rejuvenation of healthy playas. The Board does not believe that this activity is cost-effective and applicable for the District currently. Therefore, this goal is not applicable.

<u>Goal 5.0</u> Addressing Natural resource issues.

<u>Management Objective</u> – Investigate all complaints related to the Districts natural resources

5.01 The District will investigate, or refer to the proper agency, any citizen's or District initiated complaint related to surface water, groundwater, or any natural resource within the District.

Performance Standards

5.01a The District will record all complaints and report these annually to the District Board of Directors

<u>Management Objective</u> – Attend GMA2 meetings.

5.02 By attending GMA2 meetings, there is the opportunity to participate in discussions, planning and education concerning the interrelationship of groundwater with other natural resource issues. The Board President or his/her appointed representative will attend 75% of the GMA 2 meetings annually.

Performance Standards

5.02a The minutes for all attended meetings of GMA 2 will be maintained in the District database for a period of three (3) years from their accepted date. A report of all attended meetings will be given to the Board at the regular meeting.

Management Objective—Open, Deteriorated or Uncovered Wells

5.03 If an open, deteriorated or uncovered well is found, the District will ensure that the open hole is properly closed according to District rules and, in so doing, prevent potential contamination of the groundwater resource. The District will contact the party responsible for the open, deteriorated or uncovered. The site will be inspected after notification to ensure the well closure process occurs.

Performance Standards

5.03a Number of open, deteriorated, or uncovered wells

5.03b Number of initial inspections accomplished each year.

Management Objective—Water Quality Monitoring

5.04 Conduct a District-wide water quality testing program. The results will be entered into the District's computer database and will be made available to the public.

Performance Standards

5.04a Number of samples collected and analyzed each year

Goal 6.0 Addressing Drought Conditions

Management Objective—Rain Gages

6.01 Maintain a network of rain gages in the District. Publish rainfall data on the District's web site

Performance Standards

6.01a Number of rain gages in the network

Management Objective – Monitor Statewide Drought Conditions

6.02 **Provide drought condition links (**https://www.waterdatafortexas.org/drought and https://droughtmonitor.unl.edu) on website (www.spuwcd.org) along with monthly rain gauge readings

Performance Standards

6.02a Review and report to the District Board at monthly board meeting statewide and national drought information.
https://www.waterdatafortexas.org/drought and/or
https://droughtmonitor.unl.edu
in addition to monthly rain gauge readings, information and history.

Goal 7.0 **Addressing Conservation**

Management Objective—Classroom Education

7.01 The District will promote water conservation through presentations given at schools within the District.

Performance Standards

7.01a Number of classroom presentations

Management Objective—News Releases

7.02 District staff will prepare news releases addressing groundwater conservation, groundwater quality and District activities.

Performance Standards

7.02a Number of news releases prepared for publication in local newspapers

Management Objective—Public Speaking Engagements

7.03 The District staff and/or directors will present programs addressing groundwater conservation, groundwater quality and District information or activities.

Performance Standards

7.03a Number of programs presented

Management Objective—Saturated Thickness Maps

7.04 Provide a saturated thickness map to show the varying thickness of groundwater remaining in storage. In cooperation with the USGS, a web mapping application is available to users for exploring data, which includes information related to hydrogeologic framework and saturated thickness.
This interactive map is available on the District website, https://webapps.usgs.gov/HDE/SouthernHighPlains/

Performance Standards

7.04a Provide USGS with current data to keep the interactive map as up to date as possible

Goal 8.0 **Addressing Recharge Enhancement**

8.01 A review of past work conducted by others indicates this goal is not appropriate at present. Therefore, this goal is not applicable.

Goal 9.0 **Addressing Rainwater Harvesting**

Management Objective—Public Awareness Program

9.01 The District will conduct an educational program for this conservation strategy at least once a year.

Performance Standards

9.01a Document the type of program conducted (i.e. public presentation, social media, District website, https://spuwcd.org/rainwater-harvesting/)

Goal 10.0 **Addressing Precipitation Enhancement**

10.01 While the District did participate in this program for eleven years, the Board has since determined it is not cost-effective. Therefore, this goal is not applicable.

Goal 11.0 **Addressing Brush Control**

11.01 Existing programs administered by the USDA-NRCS are sufficient for addressing this goal. The Board does not believe that this activity is cost-effective and applicable for the District currently. Therefore, this goal is not applicable.

Goal 12.0 **Addressing Desired Future condition of the aquifers**

Management Objective—Calculate Annual Drawdown

12.01 The District will calculate the average annual drawdown using the results of annual water level measurements each winter.

Performance Standards

12.01a Present the average drawdown results to the District Board each year

12.01b Publish the average drawdown results, plus an interactive water level mapping application on the District website, https://spuwcd.org/

References

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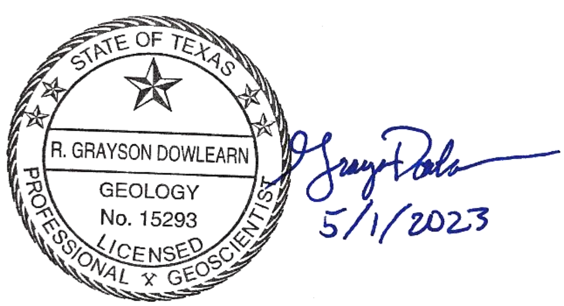
Appendix A

GAM Run 23-007

GAM RUN 23-007: SOUTH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

Dwight Zedric Q. Capus, GIT and Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-936-2404
May 1, 2023



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GAM RUN 23-007: SOUTH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

Dwight Zedric Q. Capus, GIT and Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-936-2404
May 1, 2023

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 South Plains Underground Water 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. 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 groundwater management plan for the South Plains Underground Water Conservation District should be adopted by the district on or before August 16, 2023 and submitted to the TWDB Executive Administrator on or before September 15, 2023. The current management plan for the South Plains Underground Water Conservation District expires on November 14, 2023.

We used version 1.01 of the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015) to estimate the management plan information for the Edwards-Trinity (High Plains) and Ogallala aquifers within South Plains Underground Water Conservation District.

This report replaces the results of GAM Run 18-004 (Ballew, 2018). 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 and 2 summarize the groundwater availability model data required by statute. Figures 1 and 3 show the areas of the respective models from which the values in Tables 1 and 2 were extracted. Figures 2 and 4 provide a generalized diagram of the groundwater flow components provided in Tables 1 and 2. If, after review of the figures, the South Plains Underground Water Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB 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 Texas Water Code § 36.1071(h), the groundwater availability model mentioned above was used to estimate information for the South Plains Underground Water Conservation District management plan. Water budgets were extracted for the historical model period for the Edwards-Trinity (High Plains) and Ogallala aquifers (1980 through 2012), using ZONEBUDGET Version 3.01 (Harbaugh, 2009). 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:

Edwards-Trinity (High Plains) and Ogallala aquifers

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System to analyze the Edwards-Trinity (High Plains) and Ogallala aquifers. See Deeds and others (2015) and Deeds and Jigmond (2015) for assumptions and limitations of the 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 where present.
    - Layer 2 represents the Rita Blanca, Edwards-Trinity (High Plains), and Edwards-Trinity (Plateau) aquifers where present.
    - 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 budget 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 an aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the Edwards-Trinity (High Plains) and Ogallala aquifers located within the South Plains Underground Water Conservation District and averaged over the historical calibration period, as shown in Tables 1 and 2.

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 and 2. Figures 2 and 4 provide a generalized diagram of the groundwater flow components provided in Tables 1 and 2. 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 Edwards-Trinity (High Plains) Aquifer for the South Plains Underground Water 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	Edwards-Trinity (High Plains)	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Edwards-Trinity (High Plains)	0
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (High Plains)	5,619
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (High Plains)	6,750
Estimated net annual volume of flow between each aquifer in the district	To Edwards-Trinity (High Plains) Aquifer from Ogallala Aquifer	338
	To Edwards-Trinity (High Plains) Aquifer from underlying Dockum equivalent units	425

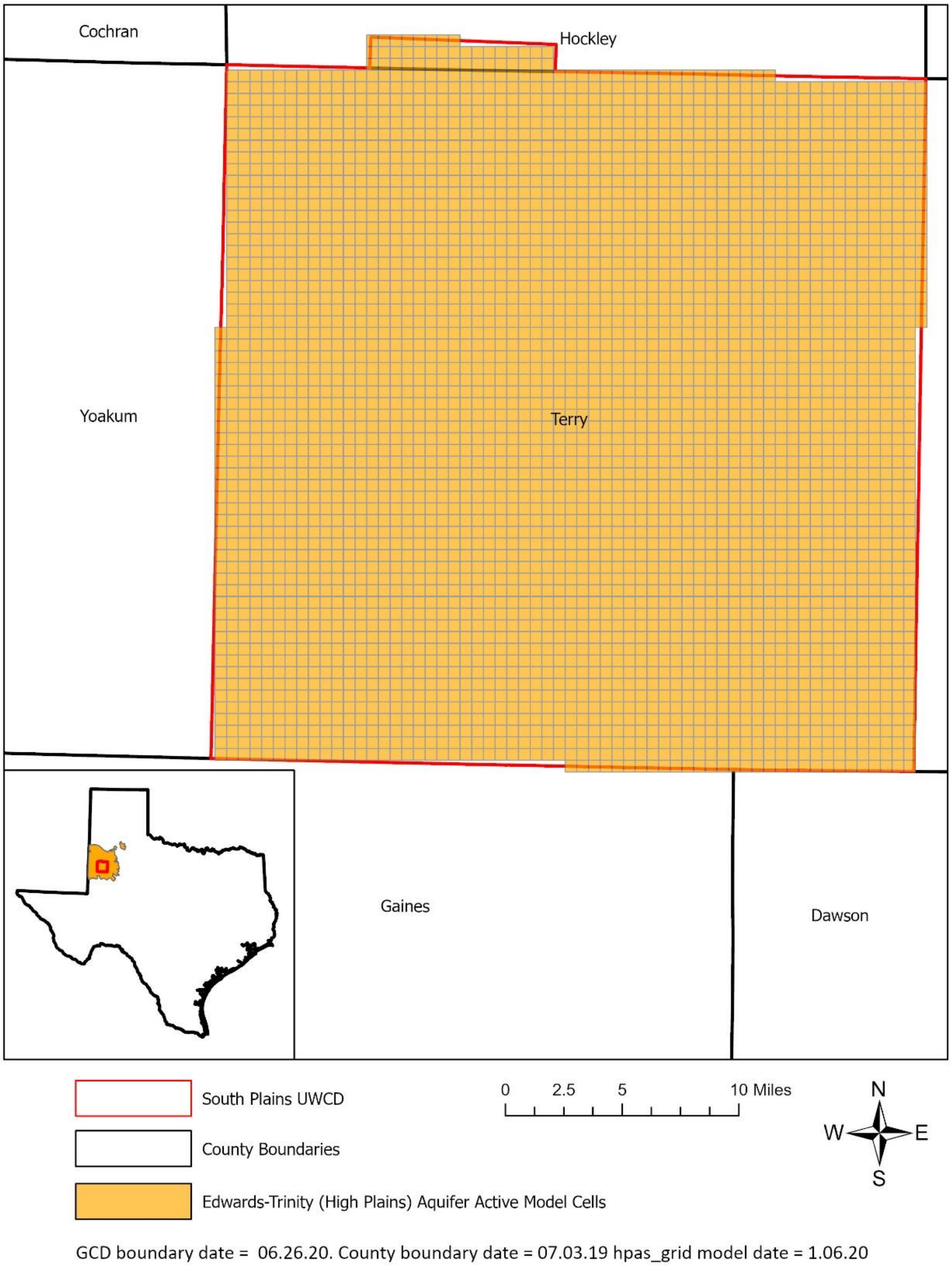
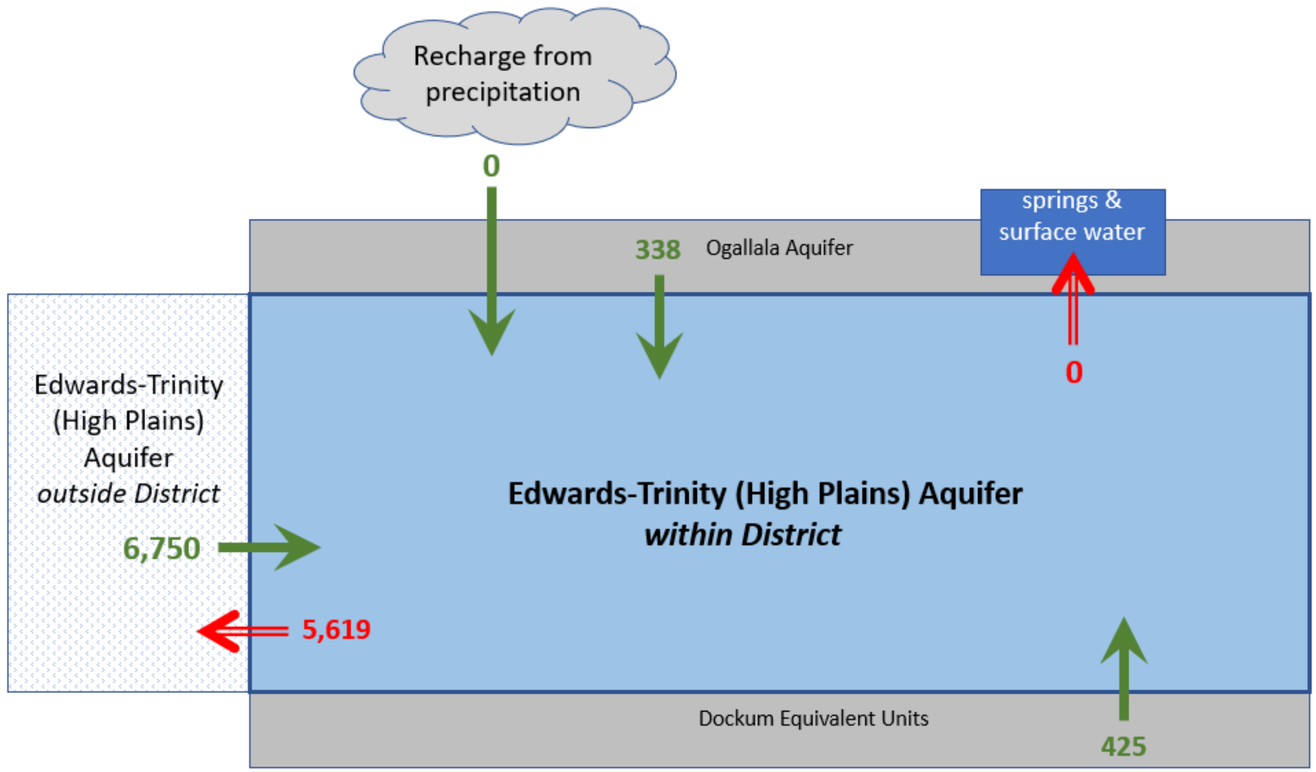


Figure 1: Area of the High Plains Aquifer System Groundwater Availability Model from which the information in Table 1 was extracted (the Edwards-Trinity [High Plains] Aquifer extent within the district boundary).



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 Edwards-Trinity (High Plains) Aquifer within South Plains Underground Water Conservation District. Flow values expressed in acre-feet per year.

Table 2: Summarized information for the Ogallala Aquifer that is needed for the South Plains Underground Water 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	53,386
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Ogallala Aquifer	624
Estimated annual volume of flow into the district within each aquifer in the district	Ogallala Aquifer	3,025
Estimated annual volume of flow out of the district within each aquifer in the district	Ogallala Aquifer	5,845
Estimated net annual volume of flow between each aquifer in the district	From Ogallala to Edwards-Trinity (High Plains)	338

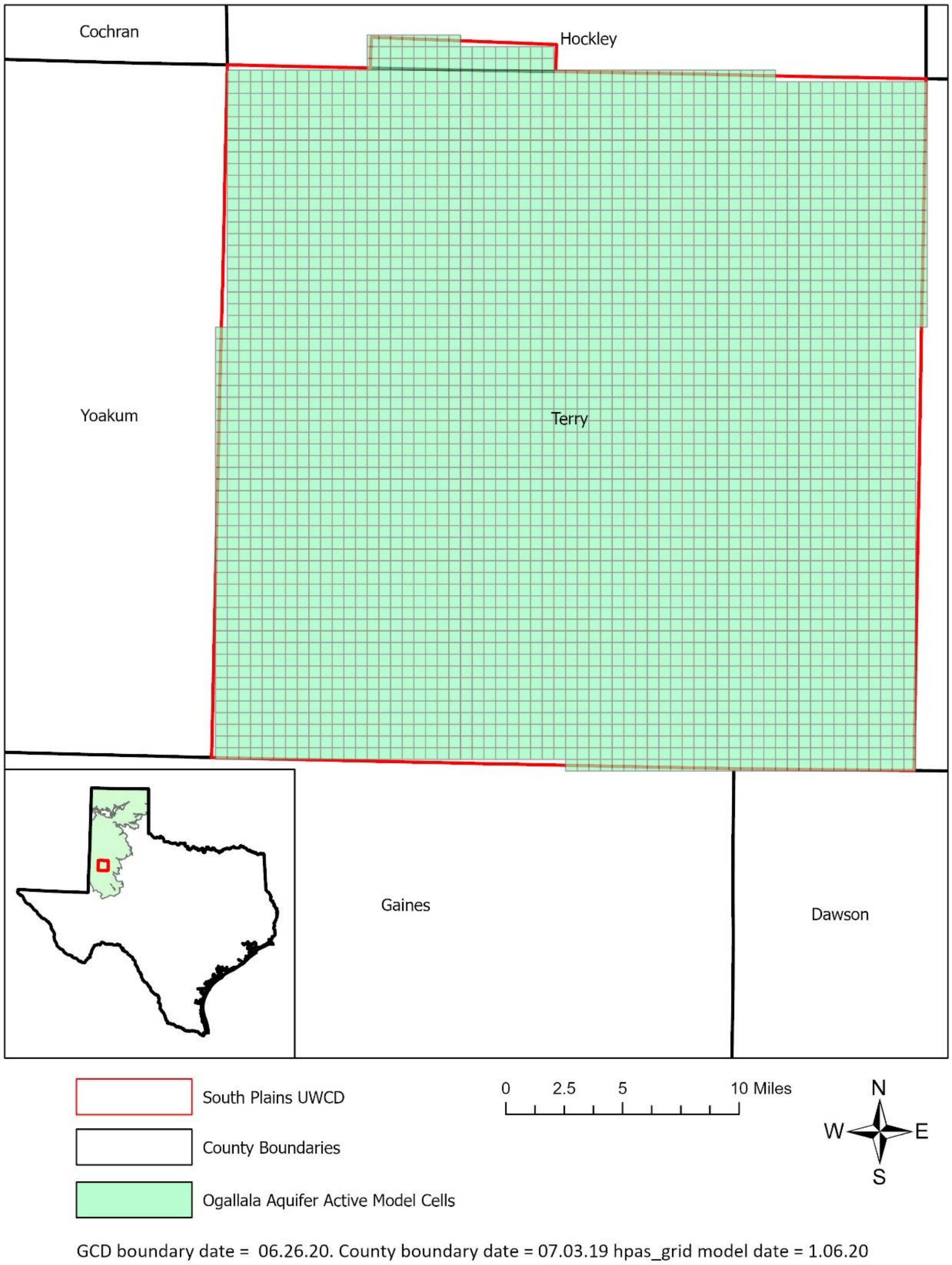
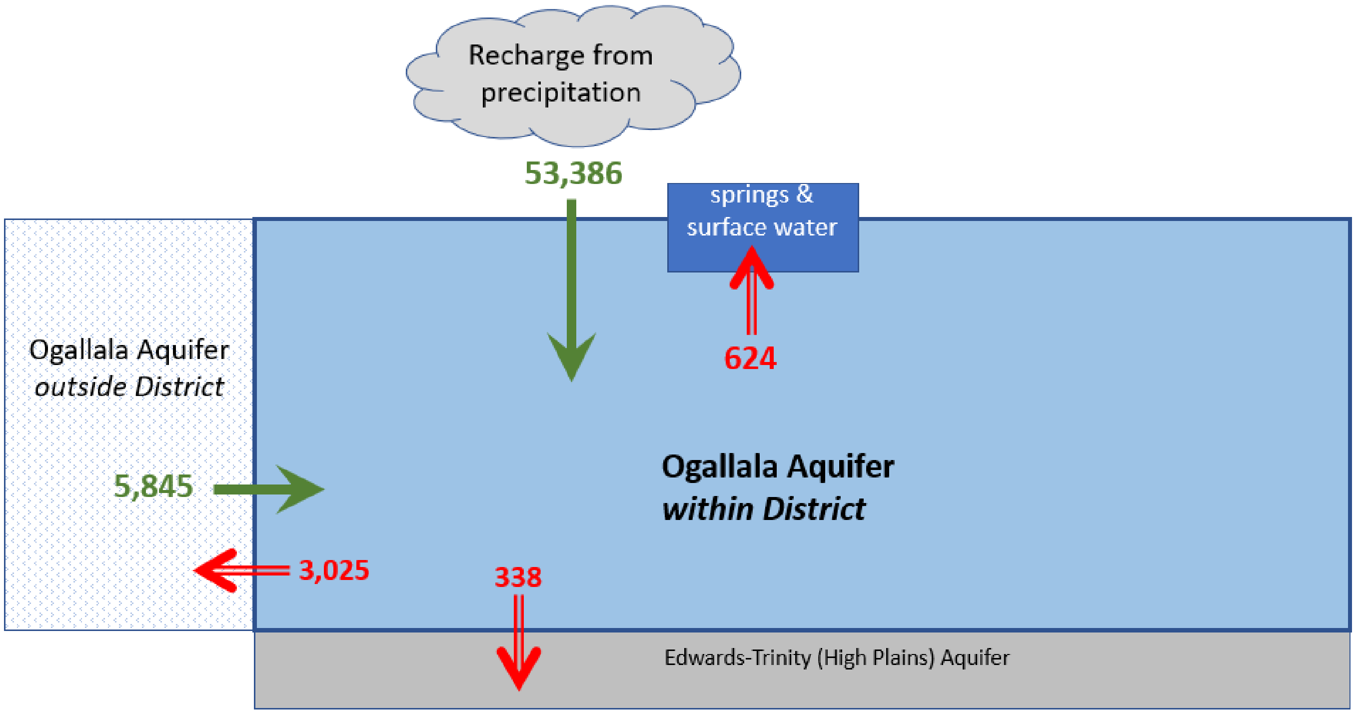


Figure 3: Area of the High Plains Aquifer System Groundwater Availability Model from which the information in Table 2 was extracted (the Ogallala Aquifer extent within the district boundary).



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 Ogallala Aquifer within South Plains Underground Water Conservation District. Flow values 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 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 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 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.

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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 Inc., 640 p. https://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: USGS, Techniques and Methods 6-A37, 44 p.

Texas Water Code § 36.1071

Appendix B

Estimated Historical Groundwater Use And 2022 State Water Plan Datasets

Estimated Historical Groundwater Use And 2022 State Water Plan Datasets:

South Plains Underground Water Conservation District

Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
January 30, 2023

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 1/30/2023. 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 needs only "consider" 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 is more accurate it can add those data to the plan with an explanation of how the data were derived. Apportioning percentages that the TWDB used are listed above each applicable table.

For additional questions regarding this 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.

HOCKLEY COUNTY *1% (multiplier)* All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	8	0	0	0	1,410	2	1,420
	SW	17	0	0	0	0	0	17
2018	GW	9	3	0	0	1,288	2	1,302
	SW	18	0	0	0	0	0	18
2017	GW	8	5	0	0	985	1	999
	SW	18	0	0	0	0	0	18
2016	GW	13	6	0	0	1,367	3	1,389
	SW	16	0	0	0	0	0	16
2015	GW	11	11	0	0	1,143	3	1,168
	SW	19	0	0	0	0	0	19
2014	GW	15	6	1	0	1,099	3	1,124
	SW	18	0	0	0	0	0	18
2013	GW	20	6	0	0	1,383	3	1,412
	SW	16	0	0	0	0	0	16
2012	GW	18	6	0	0	1,603	4	1,631
	SW	15	0	0	0	0	0	15
2011	GW	20	6	0	0	1,499	4	1,529
	SW	18	0	0	0	0	0	18
2010	GW	14	6	0	0	989	4	1,013
	SW	17	0	0	0	0	0	17
2009	GW	14	6	8	0	1,504	3	1,535
	SW	18	0	2	0	0	0	20
2008	GW	14	5	15	0	1,298	3	1,335
	SW	15	1	4	0	0	0	20
2007	GW	23	4	0	0	1,975	3	2,005
	SW	6	0	0	0	0	0	6
2006	GW	16	4	0	0	1,089	4	1,113
	SW	18	0	0	0	0	0	18
2005	GW	16	4	0	0	903	2	925
	SW	18	0	0	0	0	0	18
2004	GW	16	4	0	0	1,856	2	1,878
	SW	15	0	0	0	0	1	16

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

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	215	12	0	0	123,255	349	123,831
	SW	1,272	13	0	0	670	39	1,994
2018	GW	216	12	1	0	116,039	346	116,614
	SW	1,390	13	0	0	685	38	2,126
2017	GW	294	12	4	0	117,927	335	118,572
	SW	1,266	9	0	0	641	37	1,953
2016	GW	706	12	4	0	120,643	385	121,750
	SW	1,326	15	0	0	730	42	2,113
2015	GW	308	12	3	0	88,714	368	89,405
	SW	1,309	12	0	0	828	41	2,190
2014	GW	361	12	5	0	151,201	375	151,954
	SW	1,376	14	0	0	0	42	1,432
2013	GW	421	12	22	0	205,364	358	206,177
	SW	1,381	7	0	0	741	40	2,169
2012	GW	482	14	23	0	159,021	185	159,725
	SW	1,371	4	0	0	0	21	1,396
2011	GW	776	14	0	0	210,380	235	211,405
	SW	1,419	5	0	0	0	26	1,450
2010	GW	558	14	100	0	137,221	208	138,101
	SW	1,302	5	23	0	0	23	1,353
2009	GW	565	2	98	0	183,056	288	184,009
	SW	1,218	76	23	0	0	32	1,349
2008	GW	666	2	96	0	158,840	169	159,773
	SW	1,186	36	22	0	0	19	1,263
2007	GW	674	2	0	0	98,195	245	99,116
	SW	1,116	0	0	0	0	27	1,143
2006	GW	555	2	0	0	176,587	182	177,326
	SW	1,523	0	0	0	733	20	2,276
2005	GW	540	2	0	0	137,895	155	138,592
	SW	1,322	0	0	0	763	17	2,102
2004	GW	633	2	0	0	115,286	80	116,001
	SW	1,190	0	0	0	791	37	2,018

Projected Surface Water Supplies
TWDB 2022 State Water Plan Data

HOCKLEY COUNTY

1% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
O	Levelland	Brazos	Meredith Lake/Reservoir	564	540	532	527	540	553
	Sum of Projected Surface Water Supplies (acre-feet)			**564**	**540**	**532**	**527**	**540**	**553**

TERRY COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
O	Brownfield	Colorado	Meredith Lake/Reservoir	368	349	351	356	353	353
	Sum of Projected Surface Water Supplies (acre-feet)			**368**	**349**	**351**	**356**	**353**	**353**

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.

HOCKLEY COUNTY

1% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
O	Anton	Brazos	160	164	165	165	171	176
O	County-Other, Hockley	Brazos	9	9	9	9	10	10
O	County-Other, Hockley	Colorado	0	0	0	0	0	0
O	Irrigation, Hockley	Brazos	1,227	1,227	910	779	718	685
O	Irrigation, Hockley	Colorado	92	92	68	58	54	51
O	Levelland	Brazos	2,441	2,520	2,553	2,547	2,654	2,727
O	Livestock, Hockley	Brazos	1	1	1	1	1	1
O	Livestock, Hockley	Colorado	0	0	0	0	0	0
O	Manufacturing, Hockley	Brazos	6	7	7	7	7	7
O	Mining, Hockley	Brazos	0	0	0	0	0	0
O	Mining, Hockley	Colorado	0	0	0	0	0	0
O	Sundown	Colorado	417	435	447	449	469	482
		Sum of Projected Water Demands (acre-feet)	**4,353**	**4,455**	**4,160**	**4,015**	**4,084**	**4,139**

TERRY COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
O	Brownfield	Colorado	1,604	1,665	1,718	1,841	1,919	1,993
O	County-Other, Terry	Brazos	9	9	9	9	9	9
O	County-Other, Terry	Colorado	436	435	456	436	456	478
O	Irrigation, Terry	Brazos	8,639	8,639	7,295	6,735	6,445	6,276
O	Irrigation, Terry	Colorado	164,146	164,146	138,606	127,969	122,446	119,251
O	Livestock, Terry	Brazos	19	20	22	23	25	26
O	Livestock, Terry	Colorado	401	441	470	503	537	560
O	Manufacturing, Terry	Colorado	14	17	17	17	17	17
O	Mining, Terry	Brazos	25	37	38	29	21	15
O	Mining, Terry	Colorado	330	488	505	387	272	191
		Sum of Projected Water Demands (acre-feet)	**175,623**	**175,897**	**149,136**	**137,949**	**132,147**	**128,816**

Projected Water Supply Needs
TWDB 2022 State Water Plan Data

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

HOCKLEY COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
O	Anton	Brazos	675	671	670	670	664	659
O	County-Other, Hockley	Brazos	223	200	192	199	161	135
O	County-Other, Hockley	Colorado	8	7	7	7	6	5
O	Irrigation, Hockley	Brazos	2,037	-43,079	-30,841	-27,041	-25,744	-25,183
O	Irrigation, Hockley	Colorado	4,830	4,830	3,745	-55	-1,352	-1,913
O	Levelland	Brazos	2,773	2,608	2,456	2,333	2,146	2,114
O	Livestock, Hockley	Brazos	236	231	226	221	216	215
O	Livestock, Hockley	Colorado	39	39	38	37	36	36
O	Manufacturing, Hockley	Brazos	124	9	9	9	9	9
O	Mining, Hockley	Brazos	1,295	1,295	1,296	1,296	1,297	1,298
O	Mining, Hockley	Colorado	234	234	234	234	234	234
O	Sundown	Colorado	443	425	413	411	391	378
		Sum of Projected Water Supply Needs (acre-feet)	**0**	**-43,079**	**-30,841**	**-27,096**	**-27,096**	**-27,096**

TERRY COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
O	Brownfield	Colorado	365	236	132	-49	-216	-291
O	County-Other, Terry	Brazos	2	2	2	2	2	2
O	County-Other, Terry	Colorado	109	110	89	109	89	67
O	Irrigation, Terry	Brazos	-351	-1,551	-826	-672	-660	-685
O	Irrigation, Terry	Colorado	15,759	-41,032	-41,757	-42,071	-42,083	-42,058
O	Livestock, Terry	Brazos	9	8	6	5	3	2
O	Livestock, Terry	Colorado	161	121	92	59	25	2
O	Manufacturing, Terry	Colorado	3	0	0	0	0	0
O	Mining, Terry	Brazos	15	3	2	11	19	25
O	Mining, Terry	Colorado	-230	-388	-405	-287	-172	-91
		Sum of Projected Water Supply Needs (acre-feet)	**-581**	**-42,971**	**-42,988**	**-43,079**	**-43,131**	**-43,125**

Projected Water Management Strategies
TWDB 2022 State Water Plan Data

HOCKLEY COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Irrigation, Hockley, Brazos (O)							
Hockley County Irrigation Water Conservation	DEMAND REDUCTION [Hockley]	3,681	6,135	6,367	5,456	5,027	4,794
		3,681	**6,135**	**6,367**	**5,456**	**5,027**	**4,794**
Irrigation, Hockley, Colorado (O)							
Hockley County Irrigation Water Conservation	DEMAND REDUCTION [Hockley]	275	458	475	407	375	358
		275	**458**	**475**	**407**	**375**	**358**
Levelland, Brazos (O)							
CRMWA ASR	Ogallala Aquifer ASR [Lubbock]	0	100	500	500	500	500
Expand Capacity CRMWA 2	Ogallala Aquifer [Roberts]	0	343	298	530	527	441
Hockley County - Levelland Municipal Water Conservation	DEMAND REDUCTION [Hockley]	45	0	0	0	0	0
Replace Well Capacity	Ogallala Aquifer [Roberts]	0	0	41	111	252	328
		45	**443**	**839**	**1,141**	**1,279**	**1,269**
Sundown, Colorado (O)							
Hockley County - Sundown Municipal Water Conservation	DEMAND REDUCTION [Hockley]	17	11	10	11	14	17
		17	**11**	**10**	**11**	**14**	**17**
Sum of Projected Water Management Strategies (acre-feet)		**4,018**	**7,047**	**7,691**	**7,015**	**6,695**	**6,438**

TERRY COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Brownfield, Colorado (O)							
CRMWA ASR	Ogallala Aquifer ASR [Lubbock]	0	100	200	200	200	200
Expand Capacity CRMWA 2	Ogallala Aquifer [Roberts]	0	186	205	314	314	271
Replace Well Capacity	Ogallala Aquifer [Roberts]	0	0	27	75	165	210
Terry County - Brownfield Additional Groundwater Development	Ogallala and Edwards-Trinity-High Plains Aquifers [Terry]	0	0	0	160	160	160
Terry County - Brownfield Municipal Water Conservation	DEMAND REDUCTION [Terry]	30	0	0	0	0	0
		30	**286**	**432**	**749**	**839**	**841**

Irrigation, Terry, Brazos (O)

Terry County Irrigation Water Conservation	DEMAND REDUCTION [Terry]	259	432	511	471	451	439
		259	**432**	**511**	**471**	**451**	**439**
Irrigation, Terry, Colorado (O)							
Terry County Irrigation Water Conservation	DEMAND REDUCTION [Terry]	4,924	8,207	9,702	8,958	8,571	8,348
		4,924	**8,207**	**9,702**	**8,958**	**8,571**	**8,348**
Mining, Terry, Brazos (O)							
Terry County - Mining Water Conservation	DEMAND REDUCTION [Terry]	0	1	2	1	1	1
		0	**1**	**2**	**1**	**1**	**1**
Mining, Terry, Colorado (O)							
Terry County - Mining Additional Groundwater Development	Ogallala and Edwards-Trinity-High Plains Aquifers [Terry]	640	640	640	640	640	640
Terry County - Mining Water Conservation	DEMAND REDUCTION [Terry]	4	15	25	20	14	9
		644	**655**	**665**	**660**	**654**	**649**
Sum of Projected Water Management Strategies (acre-feet)		**5,857**	**9,581**	**11,312**	**10,839**	**10,516**	**10,278**

Appendix C

GMA 2 MAG Report 21-008 Addendum

GAM RUN 21-008 ADDENDUM: MODELED AVAILABLE GROUNDWATER FOR THE HIGH PLAINS AQUIFER SYSTEM (OGALLALA, EDWARDS-TRINITY (HIGH PLAINS), AND DOCKUM AQUIFERS) IN GROUNDWATER MANAGEMENT AREA 2

Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512 475-1552
June 3, 2022

ADDENDUM SUMMARY:

Modeled available groundwater for the Ogallala, Edwards-Trinity (High Plains), and Dockum aquifers in Groundwater Management Area 2 was provided on May 2, 2022 in GAM Run 22-008 (Bond and Dowlearn, 2022). However, after the report was released, errors were identified in Tables 1 and 2. The identified errors are listed below:

1) Tables 1 and 2 were missing a column with the modeled available groundwater for the year 2020, and

2) Table 2 incorrectly included Gaines County and its modeled available groundwater values within the High Plains UWCD No. 1 modeled available groundwater totals.

The errors were addressed with the following corrections:

1) A column with modeled available groundwater values for the year 2020 was added to Tables 1 and 2,

2) Gaines County was removed from the High Plains UWCD No. 1 and the modeled available groundwater values were subtracted from the total for the High Plains UWCD No. 1, and

3) Llano Estacado UWCD, which coincides with Gaines County, was added as a separate groundwater conservation district to Table 2.

This addendum contains the corrected Tables 1 and 2.

TABLE 1: MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AND EDWARDS-TRINITY (HIGH PLAINS) AQUIFERS IN GROUNDWATER MANAGEMENT AREA 2 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR. (UWCD = UNDERGROUND WATER CONSERVATION DISTRICT)

Groundwater Conservation District	County	2020	2030	2040	2050	2060	2070	2080
Garza County UWCD Total	**Garza**	**15,519**	**13,508**	**12,402**	**11,717**	**11,263**	**10,948**	**10,721**
High Plains UWCD No.1	Bailey	88,271	65,138	50,725	42,532	37,743	34,724	32,675
	Castro	228,996	176,186	116,578	68,325	42,856	30,477	23,914
	Cochran	87,584	73,991	62,095	54,265	48,561	43,632	40,036
	Crosby	145,637	105,559	73,026	51,628	39,354	32,169	27,680
	Deaf Smith	162,070	117,359	80,488	56,872	43,574	35,948	31,405
	Floyd	157,164	93,953	65,087	52,305	44,155	39,232	35,987
	Hale	217,265	116,615	75,108	53,298	41,142	34,308	30,298
	Hockley	141,111	96,747	73,687	62,502	56,622	53,198	51,064
	Lamb	204,808	120,172	77,677	60,088	52,063	47,868	45,425
	Lubbock	135,045	110,472	100,950	95,478	91,655	88,877	86,735
	Lynn	99,629	88,768	82,064	77,033	73,324	70,707	68,886
	Parmer	144,423	92,025	63,568	46,835	37,743	32,290	28,757
	Swisher	119,920	73,407	48,754	35,887	28,541	23,972	20,935
High Plains UWCD No.1 Total		**1,931,923**	**1,330,392**	**969,807**	**757,048**	**637,333**	**567,402**	**523,797**
Llano Estacado UWCD Total	**Gaines**	**254,329**	**205,486**	**177,777**	**159,523**	**147,028**	**138,157**	**131,974**
Mesa UWCD Total	**Dawson**	**156,735**	**121,336**	**98,590**	**84,192**	**75,448**	**70,262**	**66,945**

TABLE 1 (CONTINUED): MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AND EDWARDS-TRINITY (HIGH PLAINS) AQUIFERS IN GROUNDWATER MANAGEMENT AREA 2 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR. (UWCD = UNDERGROUND WATER CONSERVATION DISTRICT)

Groundwater Conservation District	County	2020	2030	2040	2050	2060	2070	2080
No District County	Andrews	22,379	19,391	17,897	16,937	16,260	15,764	15,378
	Borden	5,448	4,432	3,893	3,591	3,393	3,227	3,072
	Briscoe	26,813	17,859	12,598	9,600	7,844	6,743	6,016
	Castro	4,726	3,742	2,496	1,874	1,475	1,214	1,039
	Crosby	2,529	2,506	2,276	1,897	1,685	1,562	1,479
	Deaf Smith	20,853	18,024	15,387	13,553	12,267	11,301	10,556
	Floyd	0	0	0	0	0	0	0
	Hockley	15,302	12,402	7,093	3,411	2,028	1,419	1,102
	Howard	483	471	474	483	494	504	513
No District County Total		**98,533**	**78,827**	**62,114**	**51,346**	**45,446**	**41,734**	**39,155**
Permian Basin UWCD	Howard	16,677	15,160	14,344	13,882	13,596	13,411	13,287
	Martin	55,313	48,293	43,032	39,019	36,358	34,521	33,171
Permian Basin UWCD Total		**71,990**	**63,453**	**57,376**	**52,901**	**49,954**	**47,932**	**46,458**
Sandy Land UWCD Total	**Yoakum**	**128,498**	**90,983**	**70,810**	**59,346**	**53,002**	**49,187**	**46,687**
South Plains UWCD	Hockley	4,157	2,638	1,005	493	331	265	234
	Terry	180,555	134,878	108,182	96,190	89,977	86,343	84,043
South Plains UWCD Total		**184,712**	**137,516**	**109,187**	**96,683**	**90,308**	**86,608**	**84,277**
Groundwater Management Area 2 Total		**2,842,239**	**2,041,501**	**1,558,063**	**1,272,756**	**1,109,782**	**1,012,230**	**950,014**

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

Groundwater Conservation District	County	2020	2030	2040	2050	2060	2070	2080
Garza County UWCD Total	**Garza**	**1,038**	**1,038**	**1,038**	**1,038**	**1,038**	**1,038**	**1,038**
High Plains UWCD No.1	Bailey	949	949	949	949	949	949	949
	Castro	484	484	484	484	484	484	484
	Cochran	1,106	1,106	1,106	1,106	1,106	1,106	1,106
	Crosby	4,312	4,312	4,312	4,312	4,312	4,312	4,312
	Deaf Smith	5,006	5,006	5,006	5,006	5,006	5,006	5,006
	Floyd	3,674	3,674	3,674	3,674	3,674	3,674	3,674
	Hale	1,277	1,277	1,277	1,277	1,277	1,277	1,277
	Hockley	1,109	1,109	1,109	1,109	1,109	1,109	1,109
	Lamb	1,051	1,051	1,051	1,051	1,051	1,051	1,051
	Lubbock	1,236	1,236	1,236	1,236	1,236	1,236	1,236
	Lynn	1,039	1,039	1,039	1,039	1,039	1,039	1,039
	Parmer	6,207	6,207	6,207	6,207	5,202	5,188	5,182
	Swisher	1,796	1,796	1,796	1,796	1,796	1,796	1,796
High Plains UWCD No.1 Total		**29,246**	**29,246**	**29,246**	**29,246**	**28,241**	**28,227**	**28,221**
Llano Estacado UWCD	**Gaines**	**880**	**880**	**880**	**880**	**880**	**880**	**880**
Mesa UWCD Total	**Dawson**	**640**	**640**	**640**	**640**	**640**	**640**	**640**

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

Groundwater Conservation District	County	2020	2030	2040	2050	2060	2070	2080
No District County	Andrews	1,503	1,503	1,503	1,503	1,503	1,503	1,503
	Borden	1,026	1,026	1,026	1,026	1,026	1,026	1,026
	Briscoe	0	0	0	0	0	0	0
	Castro	0	0	0	0	0	0	0
	Crosby	81	81	81	81	81	81	81
	Deaf Smith	7	7	7	7	7	7	7
	Floyd	0	0	0	0	0	0	0
	Hockley	95	95	95	95	95	95	95
	Howard	134	134	134	134	134	134	134
No District County Total		**2,846**	**2,846**	**2,846**	**2,846**	**2,846**	**2,846**	**2,846**
Permian Basin UWCD	Howard	6,636	6,636	6,636	6,636	6,636	6,636	6,636
	Martin	11,449	11,449	11,449	11,449	11,449	11,449	11,449
Permian Basin UWCD Total		**18,085**	**18,085**	**18,085**	**18,085**	**18,085**	**18,085**	**18,085**
Sandy Land UWCD Total	**Yoakum**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
South Plains UWCD	Hockley	0	0	0	0	0	0	0
	Terry	0	0	0	0	0	0	0
South Plains UWCD Total		**0**	**0**	**0**	**0**	**0**	**0**	**0**
Groundwater Management Area 2 Total		**52,735**	**52,735**	**52,735**	**52,735**	**51,730**	**51,716**	**51,710**

REFERENCES:

Bond, S. and Dowlearn, R. G., 2022, GAM Run 22-008: Modeled Available Groundwater for the High Plains Aquifer System (Ogallala, Edwards-Trinity (High Plains), and Dockum aquifers) in Groundwater Management Area 2, GAM Run Report, 23 p. http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR21-008_MAG.pdf

GAM Run 21-008 MAG: Modeled Available Groundwater for the High Plains Aquifer System (Ogallala, Edwards-Trinity (High Plains), and Dockum aquifers) in Groundwater Management Area 2

Stephen Bond, P.G. and Grayson Dowlearn
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 475-1552

May 2, 2022

STATE OF TEXAS
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GAM Run 21-008 MAG: Modeled Available Groundwater for the High Plains Aquifer System (Ogallala, Edwards-Trinity (High Plains), and Dockum aquifers) in Groundwater Management Area 2

Stephen Bond, P.G. and Grayson Dowlearn
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 475-1552
May 2, 2022

EXECUTIVE SUMMARY:

Modeled available groundwater for the Ogallala and Edwards-Trinity (High Plains) aquifers in Groundwater Management Area 2 decreases from 2,041,501 acre-feet per year in 2030 to 950,014 acre-feet per year in 2080. Modeled available groundwater for the Dockum Aquifer decreases from 52,735 acre-feet per year in 2030 to 51,710 acre-feet per year in 2080. The modeled available groundwater for the Ogallala and Edwards-Trinity (High Plains) aquifers is summarized by groundwater conservation districts and counties in Table 1, and by river basins, regional planning areas, and counties in Table 3. The modeled available groundwater for the Dockum Aquifer is summarized by groundwater conservation districts and counties in Table 2, and by river basins, regional planning areas, and counties in Table 4.

The estimates are based on the desired future conditions for the High Plains Aquifer System (the Ogallala, Edwards-Trinity (High Plains), and Dockum aquifers) adopted by groundwater conservation district representatives in Groundwater Management Area 2 on August 17, 2021. The Pecos Valley Alluvium and Edwards-Trinity (Plateau) aquifers were declared not relevant for the purpose of joint planning. The Texas Water Development Board (TWDB) determined that the explanatory report and other materials submitted by the district representatives were administratively complete on February 25, 2022.

Please note that, for the High Plains Underground Water Conservation District No. 1, only the portion of relevant aquifers within Groundwater Management Area 2 is covered in this report.

REQUESTOR:

Mr. Jason Coleman, General Manager of High Plains Underground Water Conservation District No. 1 and Coordinator of Groundwater Management Area 2.

DESCRIPTION OF REQUEST:

In an email dated August 26, 2021, Dr. William Hutchison, on behalf of Groundwater Management Area (GMA) 2, provided the TWDB with the desired future conditions of the High Plains Aquifer System. The desired future conditions (defined by drawdown) were determined using several predictive groundwater flow simulations (Hutchison, 2021a). The predictive simulations were developed from the groundwater availability model for the High Plains Aquifer System (Version 1.01; Deeds and Jigmond, 2015) from 2013 through 2080 under different pumping scenarios, with an initial water level equal to that of the model's last stress period (i.e., year 2012). The drawdown was calculated as the water level difference between 2012 and 2080.

The desired future conditions for the High Plains Aquifer System, as described in Resolution No. 21-01, were adopted on August 17, 2021 by the groundwater conservation district representatives in Groundwater Management Area 2. The desired future conditions are described below:

Ogallala and Edwards-Trinity (High Plains) Aquifers

- An average drawdown of 28 feet for all of GMA 2 between the years 2013 and 2080.

Dockum Aquifer

- An average drawdown of 31 feet for all of GMA 2 between the years 2013 and 2080.

After review of the submittal, TWDB sent an email on November 16, 2021 to Mr. Jason Coleman, Coordinator of Groundwater Management Area 2, to clarify if Groundwater Management Area 2 accepted the tolerance of three (3) feet and assumptions used to calculate average drawdown. On November 19, 2021 TWDB received the final clarification email from Mr. Jason Coleman confirming the three (3) feet of tolerance and drawdown calculation assumptions, specified in the Methods and Parameters and Assumptions sections below, can be used. TWDB then proceeded with the calculation of the modeled available groundwater which is summarized in the following sections.

METHODS:

To estimate the modeled available groundwater, TWDB used the predictive simulation for Scenario 19 (Hutchison, 2021a). TWDB reviewed the submitted model files and attempted to replicate the adopted desired future conditions using these files. Since groundwater conservation districts in GMA 2 manage groundwater with total dissolved solids concentrations above 3,000 mg/L (Hutchison, 2021b), active model cells, rather than official aquifer boundaries, were used for the basis of the average drawdown calculations. Cell-by-cell drawdowns were calculated based on the difference between modeled head values at the end of 2012 and model heads extracted for the year 2080. Average heads were calculated by summing cell-by-cell heads and dividing by the total number of cells in each aquifer or set of aquifers considered.

Average drawdown results matched the adopted desired future conditions precisely if all active cells were included in the calculations. Excluding cells that went dry during the model run, or cells that were part of the Pecos Alluvium or Edwards-Trinity (Plateau) aquifers changed the results by less than half a foot. Excluding pass-through cells, modeled cells which are not representative of a rock unit but hydraulically connect two model layers when one or more layers between the two is no longer present (for example, the Lower Dockum is connected to the Ogallala Aquifer through two layers of pass-through cells where the Upper Dockum and Edwards-Trinity (High Plains) aquifers are absent) reduced average drawdown for the Ogallala and Edwards-Trinity (High Plains) aquifers from 28 feet to 25 feet.

Modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Annual pumping rates were then divided by county, river basin, regional water planning area, and groundwater conservation district within Groundwater Management Area 2 (Figure 5 and Tables 1 through 4).

Modeled Available Groundwater and Permitting

As defined in Chapter 36 of the Texas Water Code, “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 to achieve the desired future condition(s). The districts must also consider 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 groundwater availability are described below:

- Version 1.01 of the groundwater availability model for the High Plains Aquifer System by Deeds and Jigmond (2015) was revised to construct the predictive model simulation for this analysis. See Hutchison (2021b) for details of the initial assumptions.

- The model has four layers which represent the Ogallala and Pecos Valley Alluvium aquifers (Layer 1), the Edwards-Trinity (High Plains) and Edwards-Trinity (Plateau) aquifers (Layer 2), the Upper Dockum Aquifer (Layer 3), and the Lower Dockum Aquifer (Layer 4). The Pecos Valley Alluvium and Edwards-Trinity (Plateau) aquifers were declared not relevant for the purpose of joint planning and were excluded from the modeled available groundwater calculation. Model layers are shown in Figures 1 through 4.

- Where the Upper Dockum and Edwards-Trinity (High Plains) aquifers are absent in layers 3 and 2, respectively, pass-through cells hydraulically connect the Ogallala Aquifer to the Upper or Lower Dockum, or connect the Edwards-Trinity (High Plains) Aquifer to the Lower Dockum. These pass-through cells contain no pumping and were excluded from the drawdown calculation.

- The model was run with MODFLOW-NWT (Niswonger and others, 2011). The model uses the Newton Formulation and the upstream weighting package which automatically reduces pumping as heads drop in a particular cell as defined by the user. This feature may simulate the declining production of a well as saturated thickness decreases. Deeds and Jigmond (2015) modified the MODFLOW-NWT code to use a saturated thickness of 30 feet as the threshold (instead of percent of the saturated thickness) when pumping reductions occur during a simulation.

- During the predictive model run, some model cells within Groundwater Management Area 2 went dry in each model layer by the end of the simulation in the year 2080.

- Drawdown averages and modeled available groundwater volumes were calculated based on the extent of the model area. The most recent available model grid file (dated January 6,2020) was used to determine which model cells were assigned to specific county, groundwater management area, groundwater conservation district, river basin, or regional water planning area.

- A tolerance of three feet was assumed when comparing desired future conditions to modeled drawdown results.

- For the High Plains Underground Water Conservation District No. 1, only the portion within Groundwater Management Area 2 is covered in this report.

- Estimates of modeled drawdown and available groundwater from the model simulation were rounded to nearest whole numbers.

RESULTS:

The modeled available groundwater for the Ogallala and Edwards-Trinity (High Plains) aquifers combined that achieves the desired future condition adopted by Groundwater Management Area 2 decreases from 2,041,501 to 950,014 acre-feet per year between 2030 and 2080. The modeled available groundwater is summarized by groundwater conservation district and county in Table 1. Table 3 summarizes the modeled available groundwater by county, river basin, and regional water planning area for use in the regional water planning process.

The modeled available groundwater for the Dockum Group and Aquifer that achieves the desired future condition adopted by Groundwater Management Area 2 decreases from 52,735 to 51,710 acre-feet per year between 2030 and 2080. The modeled available groundwater is summarized by groundwater conservation district and county in Table 2. Table 4 summarizes the modeled available groundwater by county, river basin, and regional water planning area for use in the regional water planning process.

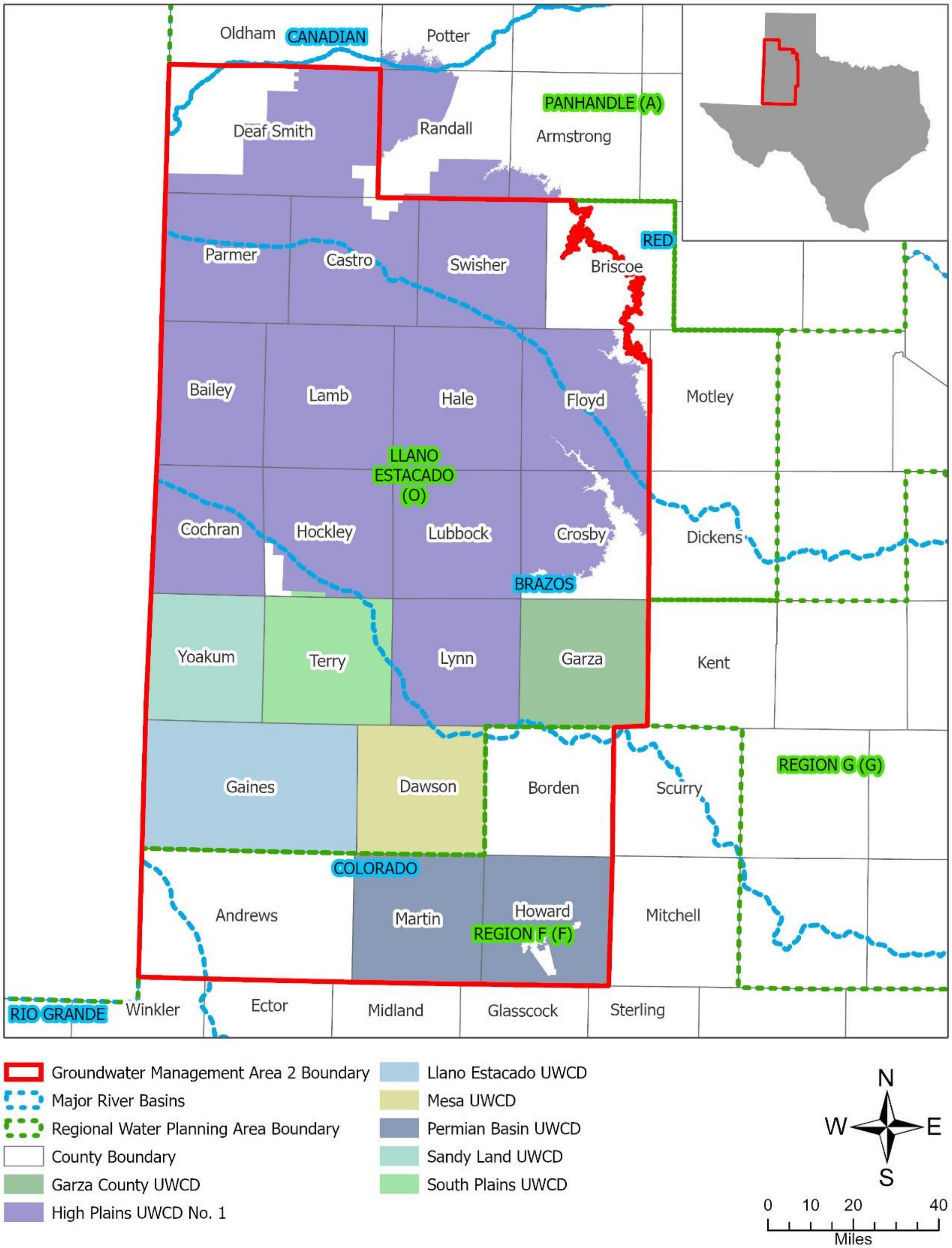

FIGURE 1. MAP SHOWING REGIONAL WATER PLANNING AREAS, GROUNDWATER CONSERVATION DISTRICTS (ALSO KNOWN AS UNDERGROUND WATER CONSERVATION DISTRICT OR UWCD), COUNTIES, AND RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 2

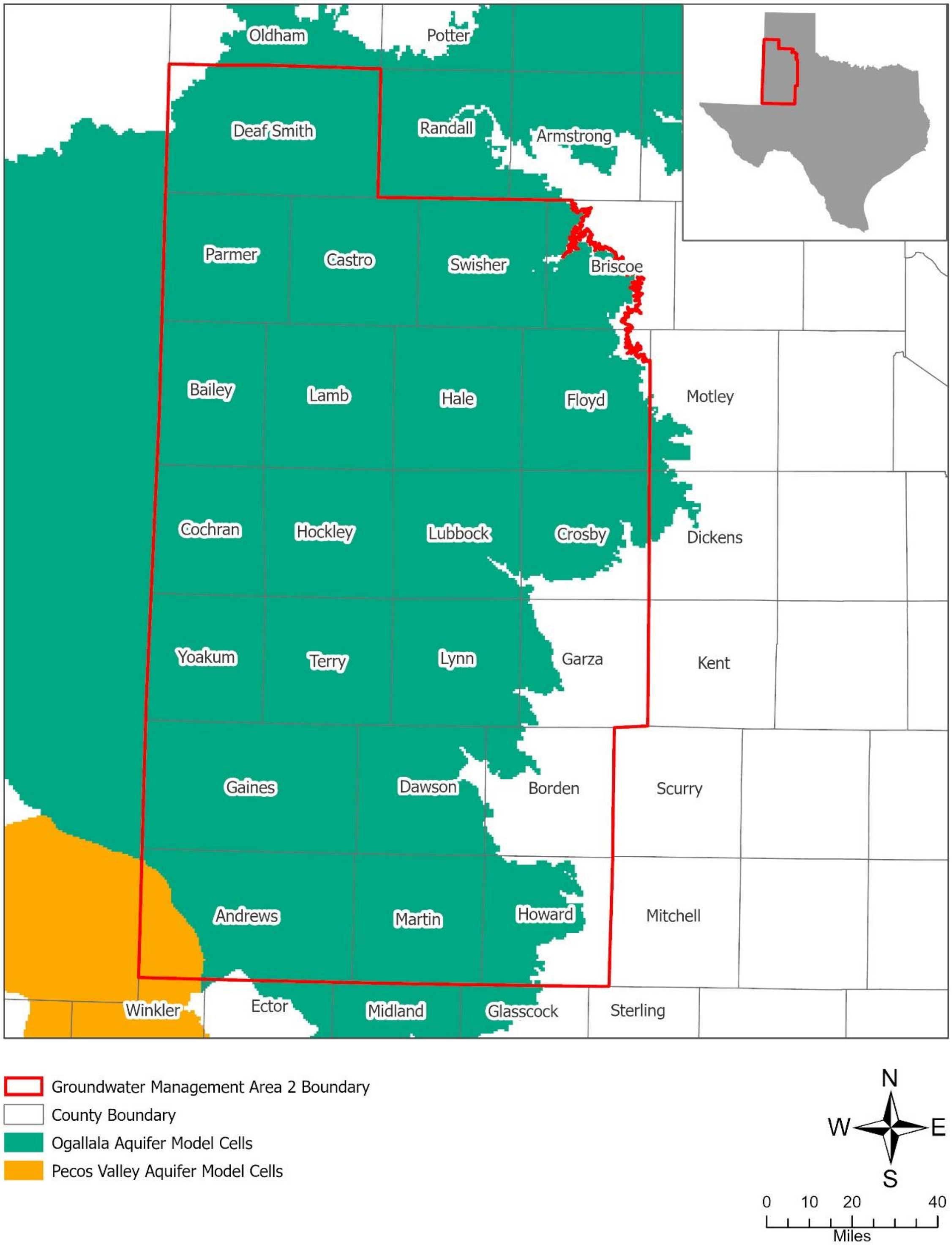

FIGURE 2. MAP SHOWING THE ACTIVE MODEL CELLS REPRESENTING THE OGALLALA AQUIFER AND THE PECOS VALLEY AQUIFER IN LAYER 1 OF THE HIGH PLAINS AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL

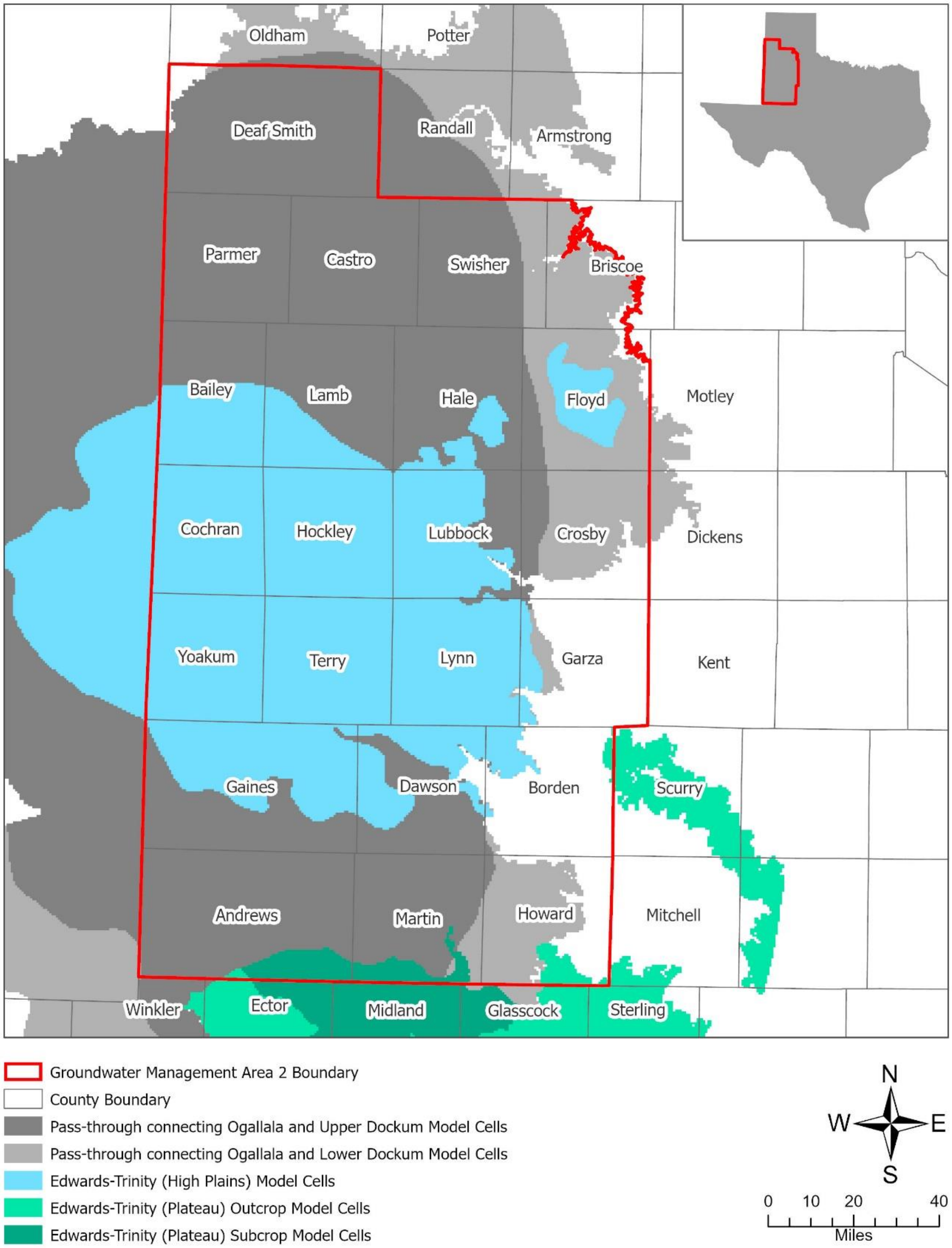

FIGURE 3. MAP SHOWING THE ACTIVE MODEL CELLS REPRESENTING THE EDWARDS-TRINITY (HIGH PLAINS) AQUIFER, THE EDWARDS-TRINITY (PLATEAU) AQUIFER, AND PASS-THROUGH CELLS IN LAYER 2 OF THE HIGH PLAINS AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL

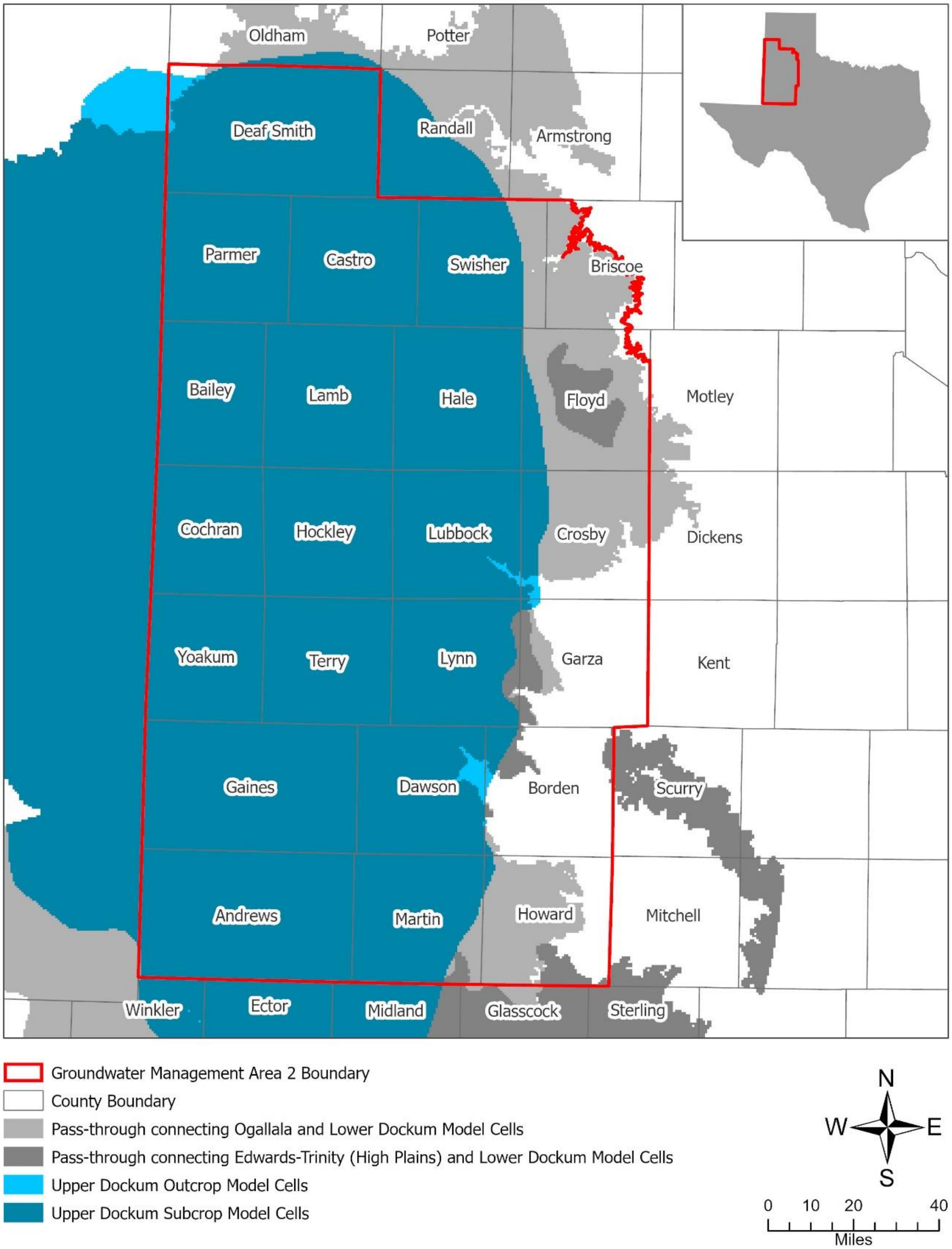

FIGURE 4. MAP SHOWING THE ACTIVE MODEL CELLS REPRESENTING THE UPPER PORTION OF THE DOCKUM AQUIFER AND PASS-THROUGH CELLS IN LAYER 3 OF THE HIGH PLAINS AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL

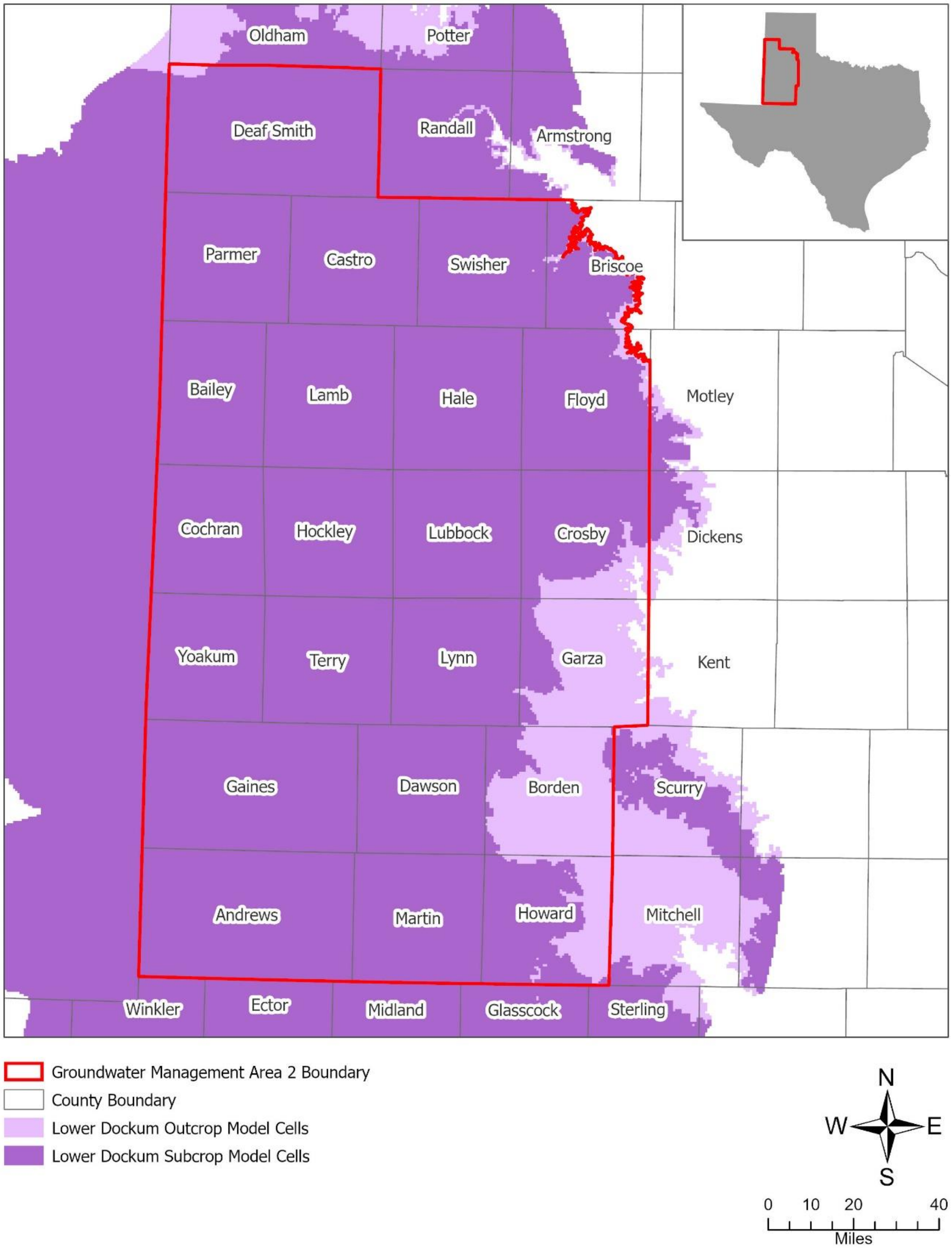

FIGURE 5. MAP SHOWING ACTIVE MODEL CELLS REPRESENTING THE LOWER PORTION OF THE DOCKUM AQUIFER IN LAYER 4 OF THE HIGH PLAINS AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AND EDWARDS-TRINITY (HIGH PLAINS) AQUIFERS IN GROUNDWATER MANAGEMENT AREA 2 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2030 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR. (UWCD = UNDERGROUND WATER CONSERVATION DISTRICT)

Groundwater Conservation District	County	2030	2040	2050	2060	2070	2080
Garza County UWCD Total	**Garza**	**13,508**	**12,402**	**11,717**	**11,263**	**10,948**	**10,721**
High Plains UWCD No.1	Bailey	65,138	50,725	42,532	37,743	34,724	32,675
	Castro	176,186	116,578	68,325	42,856	30,477	23,914
	Cochran	73,991	62,095	54,265	48,561	43,632	40,036
	Crosby	105,559	73,026	51,628	39,354	32,169	27,680
	Deaf Smith	117,359	80,488	56,872	43,574	35,948	31,405
	Floyd	93,953	65,087	52,305	44,155	39,232	35,987
	Hale	116,615	75,108	53,298	41,142	34,308	30,298
	Hockley	96,747	73,687	62,502	56,622	53,198	51,064
	Lamb	120,172	77,677	60,088	52,063	47,868	45,425
	Lubbock	110,472	100,950	95,478	91,655	88,877	86,735
	Lynn	88,768	82,064	77,033	73,324	70,707	68,886
	Parmer	92,025	63,568	46,835	37,743	32,290	28,757
	Swisher	73,407	48,754	35,887	28,541	23,972	20,935
High Plains UWCD No.1 Total		**1,330,392**	**969,807**	**757,048**	**637,333**	**567,402**	**523,797**
Llano Estacado UWCD Total	**Gaines**	**205,486**	**177,777**	**159,523**	**147,028**	**138,157**	**131,974**
Mesa UWCD Total	**Dawson**	**121,336**	**98,590**	**84,192**	**75,448**	**70,262**	**66,945**

Groundwater Conservation District	County	2030	2040	2050	2060	2070	2080
No District County	Andrews	19,391	17,897	16,937	16,260	15,764	15,378
	Borden	4,432	3,893	3,591	3,393	3,227	3,072
	Briscoe	17,859	12,598	9,600	7,844	6,743	6,016
	Castro	3,742	2,496	1,874	1,475	1,214	1,039
	Crosby	2,506	2,276	1,897	1,685	1,562	1,479
	Deaf Smith	18,024	15,387	13,553	12,267	11,301	10,556
	Floyd	0	0	0	0	0	0
	Hockley	12,402	7,093	3,411	2,028	1,419	1,102
	Howard	471	474	483	494	504	513
No District County Total		**78,827**	**62,114**	**51,346**	**45,446**	**41,734**	**39,155**
Permian Basin UWCD	Howard	15,160	14,344	13,882	13,596	13,411	13,287
	Martin	48,293	43,032	39,019	36,358	34,521	33,171
Permian Basin UWCD Total		**63,453**	**57,376**	**52,901**	**49,954**	**47,932**	**46,458**
Sandy Land UWCD Total	**Yoakum**	**90,983**	**70,810**	**59,346**	**53,002**	**49,187**	**46,687**
South Plains UWCD	Hockley	2,638	1,005	493	331	265	234
	Terry	134,878	108,182	96,190	89,977	86,343	84,043
South Plains UWCD Total		**137,516**	**109,187**	**96,683**	**90,308**	**86,608**	**84,277**
Groundwater Management Area 2 Total		**2,041,501**	**1,558,063**	**1,272,756**	**1,109,782**	**1,012,230**	**950,014**

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 2 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2030 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR. (UWCD = UNDERGROUND WATER CONSERVATION DISTRICT)

Groundwater Conservation District	County	2030	2040	2050	2060	2070	2080
Garza County UWCD Total	**Garza**	**1,038**	**1,038**	**1,038**	**1,038**	**1,038**	**1,038**
High Plains UWCD No.1	Bailey	949	949	949	949	949	949
	Castro	484	484	484	484	484	484
	Cochran	1,106	1,106	1,106	1,106	1,106	1,106
	Crosby	4,312	4,312	4,312	4,312	4,312	4,312
	Deaf Smith	5,006	5,006	5,006	5,006	5,006	5,006
	Floyd	3,674	3,674	3,674	3,674	3,674	3,674
	Hale	1,277	1,277	1,277	1,277	1,277	1,277
	Hockley	1,109	1,109	1,109	1,109	1,109	1,109
	Lamb	1,051	1,051	1,051	1,051	1,051	1,051
	Lubbock	1,236	1,236	1,236	1,236	1,236	1,236
	Lynn	1,039	1,039	1,039	1,039	1,039	1,039
	Parmer	6,207	6,207	6,207	5,202	5,188	5,182
	Swisher	1,796	1,796	1,796	1,796	1,796	1,796
	Gaines	880	880	880	880	880	880
High Plains UWCD No.1 Total		**30,126**	**30,126**	**30,126**	**29,121**	**29,107**	**29,101**
Mesa UWCD Total	**Dawson**	**640**	**640**	**640**	**640**	**640**	**640**

Groundwater Conservation District	County	2030	2040	2050	2060	2070	2080
No District County	Andrews	1,503	1,503	1,503	1,503	1,503	1,503
	Borden	1,026	1,026	1,026	1,026	1,026	1,026
	Briscoe	0	0	0	0	0	0
	Castro	0	0	0	0	0	0
	Crosby	81	81	81	81	81	81
	Deaf Smith	7	7	7	7	7	7
	Floyd	0	0	0	0	0	0
	Hockley	95	95	95	95	95	95
	Howard	134	134	134	134	134	134
No District County Total		**2,846**	**2,846**	**2,846**	**2,846**	**2,846**	**2,846**
Permian Basin UWCD	Howard	6,636	6,636	6,636	6,636	6,636	6,636
	Martin	11,449	11,449	11,449	11,449	11,449	11,449
Permian Basin UWCD Total		**18,085**	**18,085**	**18,085**	**18,085**	**18,085**	**18,085**
Sandy Land UWCD Total	**Yoakum**	**0**	**0**	**0**	**0**	**0**	**0**
South Plains UWCD	Hockley	0	0	0	0	0	0
	Terry	0	0	0	0	0	0
South Plains UWCD Total		**0**	**0**	**0**	**0**	**0**	**0**
Groundwater Management Area 2 Total		**52,735**	**52,735**	**52,735**	**51,730**	**51,716**	**51,710**

TABLE 3. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE OGALLALA AND EDWARDS-TRINITY (HIGH PLAINS) AQUIFERS IN GROUNDWATER MANAGEMENT AREA 2. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN.

County	RWPA	River Basin	2030	2040	2050	2060	2070	2080
Andrews	Region F	Colorado	19,391	17,897	16,937	16,260	15,764	15,378
Andrews	Region F	Rio Grande	0	0	0	0	0	0
Bailey	Llano Estacado	Brazos	65,138	50,725	42,532	37,743	34,724	32,675
Borden	Region F	Brazos	673	615	581	559	543	532
Borden	Region F	Colorado	3,759	3,278	3,010	2,834	2,684	2,540
Briscoe	Llano Estacado	Red	17,859	12,598	9,600	7,844	6,743	6,016
Castro	Llano Estacado	Brazos	106,971	71,565	40,493	24,591	17,282	13,530
Castro	Llano Estacado	Red	72,957	47,509	29,706	19,740	14,409	11,423
Cochran	Llano Estacado	Brazos	20,220	18,297	17,034	16,204	15,655	15,283
Cochran	Llano Estacado	Colorado	53,771	43,798	37,231	32,357	27,977	24,753
Crosby	Llano Estacado	Brazos	105,148	72,526	50,976	38,890	31,952	27,655
Crosby	Llano Estacado	Red	2,917	2,776	2,549	2,149	1,779	1,504
Dawson	Llano Estacado	Brazos	1,390	1,294	1,230	1,187	1,156	1,134
Dawson	Llano Estacado	Colorado	119,946	97,296	82,962	74,261	69,106	65,811
Deaf Smith	Llano Estacado	Canadian	0	0	0	0	0	0
Deaf Smith	Llano Estacado	Red	135,383	95,875	70,425	55,841	47,249	41,961

County	RWPA	River Basin	2030	2040	2050	2060	2070	2080
Floyd	Llano Estacado	Brazos	73,465	45,024	32,571	24,708	20,244	17,492
Floyd	Llano Estacado	Red	20,488	20,063	19,734	19,447	18,988	18,495
Gaines	Llano Estacado	Colorado	205,486	177,777	159,523	147,028	138,157	131,974
Garza	Llano Estacado	Brazos	13,508	12,402	11,717	11,263	10,948	10,721
Garza	Llano Estacado	Colorado	0	0	0	0	0	0
Hale	Llano Estacado	Brazos	116,240	74,782	53,039	40,940	34,150	30,172
Hale	Llano Estacado	Red	375	326	259	202	158	126
Hockley	Llano Estacado	Brazos	84,987	67,316	58,259	53,255	50,258	48,358
Hockley	Llano Estacado	Colorado	26,800	14,469	8,147	5,726	4,624	4,042
Howard	Region F	Colorado	15,631	14,818	14,365	14,090	13,915	13,800
Lamb	Llano Estacado	Brazos	120,172	77,677	60,088	52,063	47,868	45,425
Lubbock	Llano Estacado	Brazos	110,472	100,950	95,478	91,655	88,877	86,735
Lynn	Llano Estacado	Brazos	82,425	76,194	71,817	68,689	66,499	64,962
Lynn	Llano Estacado	Colorado	6,343	5,870	5,216	4,635	4,208	3,924
Martin	Region F	Colorado	48,293	43,032	39,019	36,358	34,521	33,171
Parmer	Llano Estacado	Brazos	51,129	37,132	28,030	22,549	19,129	16,878

County	RWPA	River Basin	2030	2040	2050	2060	2070	2080
Parmer	Llano Estacado	Red	40,896	26,436	18,805	15,194	13,161	11,879
Swisher	Llano Estacado	Brazos	11,508	6,845	4,598	3,421	2,759	2,360
Swisher	Llano Estacado	Red	61,899	41,909	31,289	25,120	21,213	18,575
Terry	Llano Estacado	Brazos	6,825	6,322	5,998	5,776	5,612	5,487
Terry	Llano Estacado	Colorado	128,053	101,860	90,192	84,201	80,731	78,556
Yoakum	Llano Estacado	Colorado	90,983	70,810	59,346	53,002	49,187	46,687
Groundwater Management Area 2 Total			**2,041,501**	**1,558,063**	**1,272,756**	**1,109,782**	**1,012,230**	**950,014**

TABLE 4. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 2. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN.

County	RWPA	River Basin	2030	2040	2050	2060	2070	2080
Andrews	Region F	Colorado	1,503	1,503	1,503	1,503	1,503	1,503
Andrews	Region F	Rio Grande	0	0	0	0	0	0
Bailey	Llano Estacado	Brazos	949	949	949	949	949	949
Borden	Region F	Brazos	323	323	323	323	323	323
Borden	Region F	Colorado	703	703	703	703	703	703
Briscoe	Llano Estacado	Red	0	0	0	0	0	0
Castro	Llano Estacado	Brazos	0	0	0	0	0	0
Castro	Llano Estacado	Red	484	484	484	484	484	484
Cochran	Llano Estacado	Brazos	118	118	118	118	118	118
Cochran	Llano Estacado	Colorado	988	988	988	988	988	988
Crosby	Llano Estacado	Brazos	4,393	4,393	4,393	4,393	4,393	4,393
Crosby	Llano Estacado	Red	0	0	0	0	0	0
Dawson	Llano Estacado	Brazos	0	0	0	0	0	0
Dawson	Llano Estacado	Colorado	640	640	640	640	640	640
Deaf Smith	Llano Estacado	Canadian	0	0	0	0	0	0
Deaf Smith	Llano Estacado	Red	5,013	5,013	5,013	5,013	5,013	5,013
Floyd	Llano Estacado	Brazos	3,389	3,389	3,389	3,389	3,389	3,389
Floyd	Llano Estacado	Red	285	285	285	285	285	285
Gaines	Llano Estacado	Colorado	880	880	880	880	880	880
Garza	Llano Estacado	Brazos	1,038	1,038	1,038	1,038	1,038	1,038
Garza	Llano Estacado	Colorado	0	0	0	0	0	0
Hale	Llano Estacado	Brazos	1,244	1,244	1,244	1,244	1,244	1,244
Hale	Llano Estacado	Red	33	33	33	33	33	33
Hockley	Llano Estacado	Brazos	1,013	1,013	1,013	1,013	1,013	1,013
Hockley	Llano Estacado	Colorado	191	191	191	191	191	191

County	RWPA	River Basin	2030	2040	2050	2060	2070	2080
Howard	Region F	Colorado	6,770	6,770	6,770	6,770	6,770	6,770
Lamb	Llano Estacado	Brazos	1,051	1,051	1,051	1,051	1,051	1,051
Lubbock	Llano Estacado	Brazos	1,236	1,236	1,236	1,236	1,236	1,236
Lynn	Llano Estacado	Brazos	901	901	901	901	901	901
Lynn	Llano Estacado	Colorado	138	138	138	138	138	138
Martin	Region F	Colorado	11,449	11,449	11,449	11,449	11,449	11,449
Parmer	Llano Estacado	Brazos	3,590	3,590	3,590	2,585	2,571	2,565
Parmer	Llano Estacado	Red	2,617	2,617	2,617	2,617	2,617	2,617
Swisher	Llano Estacado	Brazos	29	29	29	29	29	29
Swisher	Llano Estacado	Red	1,767	1,767	1,767	1,767	1,767	1,767
Terry	Llano Estacado	Brazos	0	0	0	0	0	0
Terry	Llano Estacado	Colorado	0	0	0	0	0	0
Yoakum	Llano Estacado	Colorado	0	0	0	0	0	0
Groundwater Management Area 2 Total			**52,735**	**52,735**	**52,735**	**51,730**	**51,716**	**51,710**

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.

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