Groundwater Management Plan:
Middle Pecos Groundwater Conservation District

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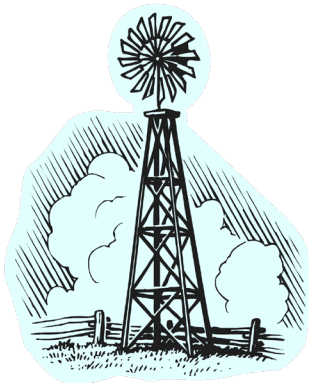

March 27, 2025 (Board Approval Draft)

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1.0 District Mission

The Middle Pecos Groundwater Conservation District (the District) is committed to manage and protect the groundwater resources of The District. The District was created to help maintain a sustainable, adequate, reliable, cost effective and high-quality source of groundwater to promote the vitality, economy, and environment of the District. The District will work with and for the residents of the District and cooperate with other local, regional, and State agencies involved in the study and management of groundwater resources.

2.0 Purpose of Management Plan

In 1997 the 75th Texas Legislature established a statewide comprehensive regional water planning initiative with the enactment of Senate Bill 1 (SB1). Among the provisions of SB1 were amendments to Chapter 36 of the Texas Water Code requiring groundwater conservation districts to develop a groundwater management plan that shall be submitted to the Texas Water Development Board (TWDB) for review of administrative completeness. The groundwater management plan was specified to contain estimates on the availability of groundwater in the district, details of how the district would manage groundwater, and management goals for the district. In 2001 the 77th Texas Legislature further clarified the water planning and management provisions of SB1 with the enactment of Senate Bill 2 (SB2).

The requirements of the Chapter 36 Texas Water Code provisions for groundwater management plan development are specified in 31 Texas Administrative Code Chapter 356 of the TWDB Rules. This plan fulfills all requirements for groundwater management plans in SB1, SB2, Chapter 36 Texas Water Code, and TWDB rules.

3.0 Time Period of Management Plan

This plan shall be in effect for a period of five years from the date of approval by TWDB, unless a new or amended management plan is adopted by the District Board of Directors and approved by TWDB. The management plan will be readopted with or without changes by the District Board and submitted to TWDB for approval at least every five years.

4.0 Middle Pecos Groundwater Conservation District

The District was created in 1999. The creation of the District is recorded in Chapter 1331 of the Acts of the 76th Texas Legislature (SB 1911). This act enabled the District to function in a limited capacity until the creation of the District was fully validated in the 77th Legislature. The validation of the District is recorded in Chapter 1299 of the Acts of the 77th Texas Legislature (HB 1258). The District was confirmed by local election held in Pecos County on November 5, 2002.

The District boundaries are coterminous with the boundaries of Pecos County, Texas. The District is bounded by Reeves, Ward, Crane, Crockett, Terrell, Brewster, and Jeff Davis counties. As of the plan date, groundwater conservation districts (GCDs) that bound the District are in Reeves,

Jeff Davis, Brewster, and Crockett Counties. The GCDs neighboring the District are Brewster County GCD, Jeff Davis County Underground Water Conservation District (UWCD), Terrell County GCD, and Crockett County GCD.

Most of the District is in Groundwater Management Area (GMA) 7, with the northern part of the District in GMA 3. Chapter 36 of the Texas Water Code authorizes the District to co-ordinate its management of groundwater with other GCDs in both GMA 7 and GMA 3. GMA 3 consists of Middle Pecos GCD and Reeves County GCD. The other GCDs that are located in GMA 7 are: Crockett County GCD, Santa Rita UWCD (Reagan), Irion County Water Conservation District (WCD), Glasscock GCD, Sterling County UWCD, Lone Wolf GCD (Mitchell), Terrell GCD, Wes-Tex GCD (Nolan), Coke County UWCD, Lipan-Kickapoo WCD (Tom Green, Concho, and Runnels), Hickory UWCD No. 1 (McCulloch, San Saba, and Mason), Menard County UWD, Hill Country UWCD (Gillespie), Kimble County GCD, Plateau Underground Water Conservation and Supply District (Schleicher), Sutton County UWCD, Real-Edwards Conservation and Reclamation District, Uvalde County UWCD, and Kinney County GCD.

The District Board of Directors is composed of eleven members elected to staggered four-year terms. Two directors are elected from each of the four county precincts, one director is elected at-large, one director is elected from the City of Iraan and one director is elected from the City of Fort Stockton. The Board of Directors holds regular meetings, at least quarterly. Meetings of the Board of Directors are public meetings noticed and held in accordance with public meeting requirements.

4.1 Authority of the District

The District derives its authority to manage groundwater use within the District by virtue of the powers granted and authorized in the District enabling act HB 1258 of the 77th Texas Legislature. The District, acting under authority of the enabling legislation, assumes all the rights and responsibilities of a groundwater conservation district specified in Chapter 36 of the Texas Water Code. The District has developed rules specifying the bounds of due process governing District actions.

4.2 Groundwater Resources of the District

There are six sources of groundwater recognized by TWDB in the District. Two of these sources; the Edwards-Trinity (Plateau) Aquifer and the Pecos Valley Aquifer are classified as major aquifers by TWDB. The other four sources of groundwater; the Rustler Aquifer, the Dockum Aquifer, the Igneous Aquifer and the Capitan Reef Complex Aquifer are classified as minor aquifers by TWDB. A major aquifer produces large amounts of water over larger areas and a minor aquifer produces minor amounts of water over large areas or large amounts of water over small areas.

The groundwater sources in the District produce both fresh and moderately saline (brackish) water. The geologic origins of the groundwater sources of the District cover a broad range of geologic times. Listed in ascending order by geologic age, these sources and their ages are Rustler Formation and Capitan Reef Complex (Permian), Dockum aquifer (Triassic), Edwards-Trinity

(Plateau) aquifer (Cretaceous), and Pecos Valley (Quaternary). The geologic age of the various sources of groundwater in the District and the geologic history of Pecos County have a bearing on the structure of the groundwater sources of the District and their relationships.

4.3 Management Zones

The District has established groundwater management zones in the principal areas of irrigation (or other groundwater demand) and pertinent surrounding areas of Pecos County, as described below:

1) The Leon-Belding Irrigation Area and the vicinity of the City of Fort Stockton to include the outlets of Comanche Springs.
2) The Bakersfield Irrigation Area.
3) The Coyanosa Irrigation Area.

A map that shows the boundaries of the management zones is presented in Figure 1. The District recognizes that groundwater use in the areas of principal groundwater demand in the District has the potential to result in localized aquifer drawdown that could affect the desired future conditions in the District.

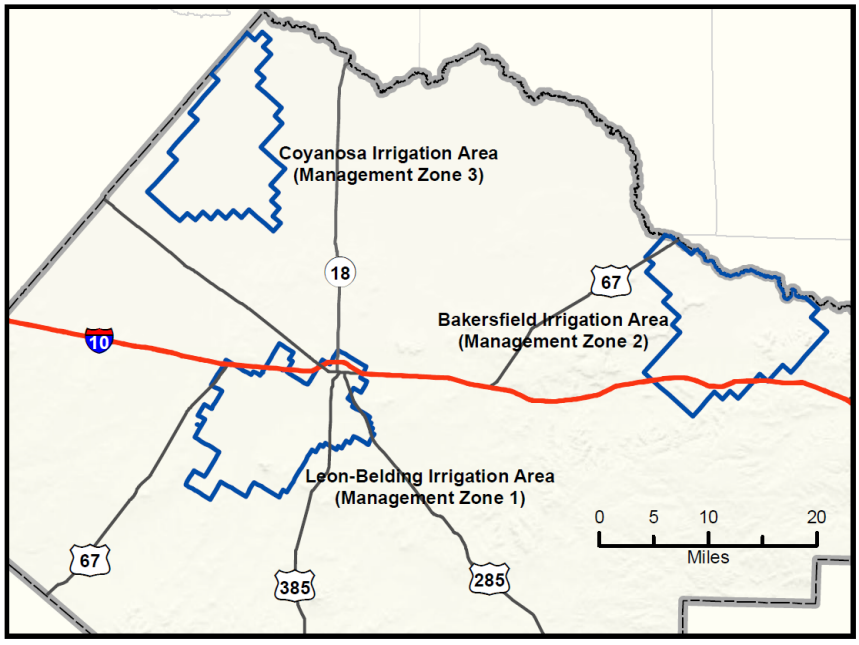

Figure 1. Groundwater Management Zones in MPGCD

5.0 Technical Information Required by Texas Administrative Code

The information in this section is provided pursuant to statutes and rules as summarized in the TWDB Groundwater Conservation District Management Plan Checklist, effective January 6, 2025. The information is organized according to the order in the checklist.

Evidence that the Plan was Adopted after Notice and Hearing: The notice for the public hearing was posted with the Pecos County Clerk on ___, and the management plan was posted on the District's website on ___. The public hearing was held at the Middle Pecos Groundwater Conservation District during the regular Board meeting on May 20, 2025. There were __ comments during the public hearing. The Board approved the plan on ___. Please refer to Appendix A for copies of the notice, agenda, and Board resolution for the public hearing.

Evidence that District Coordinated with Regional Surface Water Management Entities Following Notice and Hearing: Please refer to Appendix B.

5.1 Estimates of Modeled Available Groundwater

Modeled available groundwater is defined in TWC §36.001 as "the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under Section 36.108." The District is within the boundaries of two Groundwater Management Areas (GMAs): GMA 3 and GMA 7.

The Texas Water Development Board website has summaries of desired future conditions and modeled available groundwater estimates for each Groundwater Management Area, including tabulations for each groundwater conservation district in GMAs 3 and 7. These summaries are available at:

http://www.twdb.texas.gov/groundwater/dfc/2021jointplanning.asp

The desired future conditions for Middle Pecos Groundwater Conservation District are presented in Table 1. The modeled available groundwater estimates for Middle Pecos Groundwater Conservation District are presented in Table 2.

The modeled available groundwater estimates for GMA 3 and GMA 7 were developed by TWDB and as noted in Table 2, are documented in GR21-009 MAG for GMA 3 and GR21-012 MAG for GMA 7. These reports can be accessed at the TWDB website:

GMA 3- https://www.twdb.texas.gov/groundwater/docs/GAMruns/GR21-009_MAG.pdf
GMA 7- https://www.twdb.texas.gov/groundwater/docs/GAMruns/GR21-012_MAG.pdf

Table 1. Summary of the Desired Future Conditions for MPGCD

Aquifer	Groundwater Management Area	Desired Future Condition (DFC)	Date DFC Adopted
Capitan Reef Complex	3	Total net drawdown not to exceed 4 feet in Pecos County (Middle Pecos GCD) in 2070 as compared with aquifer levels in 2006	02/17/2021
Capitan Reef Complex	7	Total net drawdown not to exceed 56 feet in 2070 as compared with 2006 aquifer levels.	8/19/2021
Dockum	3	Average drawdown of 52 feet from 2012 to 2070	02/17/2021
Dockum	7	Total net drawdown not to exceed 52 feet in 2070, as compared with 2010 aquifer levels.	8/19/2021
Edwards-Trinity (Plateau) and Pecos Valley	3	Total net drawdown not to exceed 14 feet in 2070, as compared with aquifer levels in 2010	02/17/2021
Edwards-Trinity (Plateau) and Pecos Valley	7	Total net drawdown not to exceed 14 feet in 2070, as compared with aquifer levels in 2010	8/19/2021
Rustler	3	Average drawdown from 2009 to 2070 not to exceed 69 feet	02/17/2021
Rustler	7	Total net drawdown of the Rustler Aquifer in 2070 not to exceed 94 feet as compared with 2009 aquifer levels	8/19/2021

Table 2. Summary of Modeled Available Groundwater for MPGCD

Aquifer	Groundwater Management Area	Modeled Available Groundwater (AF/yr)						TWDB Report
		2020	2030	2040	2050	2060	2070	
Capitan Reef Complex	3	4	4	4	4	4	4	GR 21-009 MAG
Capitan Reef Complex	7	26,164	26,164	26,164	26,164	26,164	26,164	GR 21-012 MAG
Dockum	3	6,142	6,142	6,142	6,142	6,142	6,142	GR 21-009 MAG
Dockum	7	2,022	2,022	2,022	2,022	2,022	2,022	GR 21-012 MAG
Edwards-Trinity (Plateau) and Pecos Valley	3	122,899	122,899	122,899	122,899	122,899	122,899	GR 21-009 MAG
Edwards-Trinity (Plateau) and Pecos Valley	7	117,309	117,309	117,309	117,309	117,309	117,309	GR 21-012 MAG
Rustler	3	3	3	3	3	3	3	GR 21-009 MAG
Rustler	7	7,040	7,040	7,040	7,040	7,040	7,040	GR 21-012 MAG

5.2 Estimates of Annual Groundwater Use within the District

Please refer to Appendix C: TWDB Estimated Historical Groundwater Use and 2022 State Water Plan Datasets: Middle Pecos Groundwater Conservation District (February 28, 2025).

5.3 Estimate of the Annual Amount of Recharge from Precipitation, If Any, To Each Aquifer Within the District

Please refer to Appendix D: GAM Run 19-021: Middle Pecos Groundwater Conservation District Management Plan (February 18, 2020).

5.4 Estimate of the Annual Volume of the Annual Volume of Water That Discharges from Each Aquifer Within the District to Springs and Any Surface Water Bodies, Including Lakes, Streams And Rivers

Please refer to Appendix D: GAM Run 19-021: Middle Pecos Groundwater Conservation District Management Plan (February 18, 2020).

5.5 Estimate of the Annual Volume of Flow a) into the District Within Each Aquifer, b) Out of the District within Each Aquifer, and c) Between Aquifers in the District

Please refer to Appendix D: GAM Run 19-021: Middle Pecos Groundwater Conservation District Management Plan (February 18, 2020).

5.6 Estimate of the Projected Surface Water Supply within the District

Please refer to Appendix C: TWDB Estimated Historical Groundwater Use and 2022 State Water Plan Datasets: Middle Pecos Groundwater Conservation District (February 28, 2025).

5.7 Estimate of the Projected Total Demand for Water within the District

Please refer to Appendix C: TWDB Estimated Historical Groundwater Use and 2022 State Water Plan Datasets: Middle Pecos Groundwater Conservation District (February 28, 2025).

5.8 Details of the District's Consideration of Water Supply Needs Within the District, Emphasizing Those Needs That Impact Groundwater Supply Within The District

Please refer to Appendix C: TWDB Estimated Historical Groundwater Use and 2022 State Water Plan Datasets: Middle Pecos Groundwater Conservation District (February 28, 2025). As noted, there are water supply needs in the Mining User Group from 2020 to 2060 ranging from 600 to 3,500 AF/yr. Two strategies are noted for these needs: additional development of groundwater

from the Edwards-Trinity (Plateau) and Pecos Valley aquifer (3,000 AF/yr) and demand reduction (52 to 539 AF/yr).

5.9 Details of the District's Consideration of Water Management Strategies Sourced From Within The District Boundaries, Emphasizing Strategies that are or Will Be Impacted by District Actions

Please refer to Appendix C: TWDB Estimated Historical Groundwater Use and 2022 State Water Plan Datasets: Middle Pecos Groundwater Conservation District (February 28, 2025).

Page 7 of Appendix C includes six specific water conservation strategies (i.e. demand reduction strategies), and two strategies that call for the development of additional supplies from the Edwards-Trinity (Plateau) and Pecos Valley aquifers. These strategies will yield an additional 11,113 AF/yr of supply in 2020 to an additional 24,978 AF/yr in 2070.

These specific water management strategies were considered and included in the overall preparation of this management plan.

5.10 Details of How the District Will Manage Groundwater Supplies in the District, Including Methodology to Track Progress in Achieving Goals

The Texas Legislature established that groundwater conservation districts are the preferred method of groundwater management in Section 36.0015 of the Texas Water Code. The District will cooperate with the other Groundwater Conservation Districts in the Groundwater Management Areas which Pecos County is located.

The District will manage the supply of groundwater within the District to conserve groundwater while seeking to maintain the economic viability of all resource user groups, public and private. The District seeks to manage the groundwater resources of the District as practicably as possible in a sustainable manner through the development of the Desired Future Conditions of Aquifers within the District.

5.10.1 Sustainable Management

For context, sustainable management of the District is consistent with the definition contained in a report by the Meadows Center for Water and the Environment by Dr. Robert Mace in 2021 (Five Gallons in a Ten Gallon Hat: Groundwater Sustainability in Texas). In this report, groundwater sustainability is defined as the development and use of groundwater for an indefinite period without causing unacceptable environmental, economic, or social consequences. Furthermore, as stated on page 19 of the Mace report, groundwater sustainability must be defined by a decisionmaker, ideally through a stakeholder process.

The Meadows Center report on groundwater sustainability introduced above by Dr. Robert Mace cites the Management Zone 1 (Leon-Belding area) as an example of "desire driven" sustainable

groundwater management. This approach was chosen "to protect the longevity of production from an aquifer".

Rule 10.5(b) of the District links the concept of sustainable groundwater use and the desired future conditions. The District, in essence, has defined sustainable groundwater management as meeting the desired future conditions in this Rule.

5.10.2 Existing and Historic Use

The District will protect the existing and historical use of groundwater that occurred in the District prior to the effective date of the rules establishing the claims process. To obtain a historic use permit, an existing or historic user had to prove the maximum annual amount of groundwater that the user put towards a beneficial use during an existing and historic use period established in the District rules. The protection extended to historic use permit holders is achieved by imposing more restrictive permit conditions on new permit applications. In extending this protection to historic use permit holders the District established limitations that:

a) Apply to all subsequent new applications for the permitted use of groundwater and applications for the increased use of groundwater by holders of historic user permits regardless of the type or location of use
b) Bear a reasonable relationship with the District's management plan
c) Are reasonably necessary to protect existing use and maintain established Desired Future Conditions of aquifers, aquifer subdivisions or management established by the District.

5.10.3 Groundwater Conservation

In consideration of the economic and cultural activities occurring within the District, the District will identify and engage in such activities and practices, that if implemented may result in the conservation of groundwater in the District. The District will manage groundwater resources through rules developed and implemented in accordance with Chapter 36 of the Texas Water Code and the provisions of the District Enabling Act recorded in Chapter 1299 of the Acts of the 77th Texas Legislature (HB 1258).

5.10.4 Converted Wells

The District will require that any well that is constructed as an exempt well under activities regulated by the Texas Railroad Commission (RRC) and later converted to another use not regulated by the RRC will be required to seek a permit for the use of groundwater in the District if the converted use of the well is otherwise not exempted from permitting under the Texas Water Code or Rules of the District.

5.10.5 Management Zones and Desired Future Conditions

In each Management Zone, the District seeks to avoid impairment of the adopted desired future conditions (DFCs) for the District as a whole (within the portions of the District in each of GMAs

3 and 7) by establishing benchmarks of sustainable groundwater use over time in the District Rules. The assessment of the change in average drawdown values over time will be indexed to year 2005 water levels to be consistent with the adopted DFCs of the Edwards-Trinity (Plateau) and Pecos Valley aquifers. By managing the change in aquifer water levels over time in the management zones, the District can provide for the sustainability of the aquifers and avoid impairment of the desired future conditions.

An example of this management activity is when special permit conditions for the Fort Stockton Holdings permit located in Management Zone 1. The thresholds were established based on avoiding groundwater elevations dropping below historic minimum groundwater elevations. This will be accomplished by routine monitoring of groundwater elevations in 11 wells and requiring non-historic use pumping reductions if certain thresholds are exceeded (i.e. groundwater elevations drop below the threshold value set for each well). When developing the thresholds, a comparison was made to evaluate the consistency with the adopted desired future condition. Figure 2 shows the results of the comparison.

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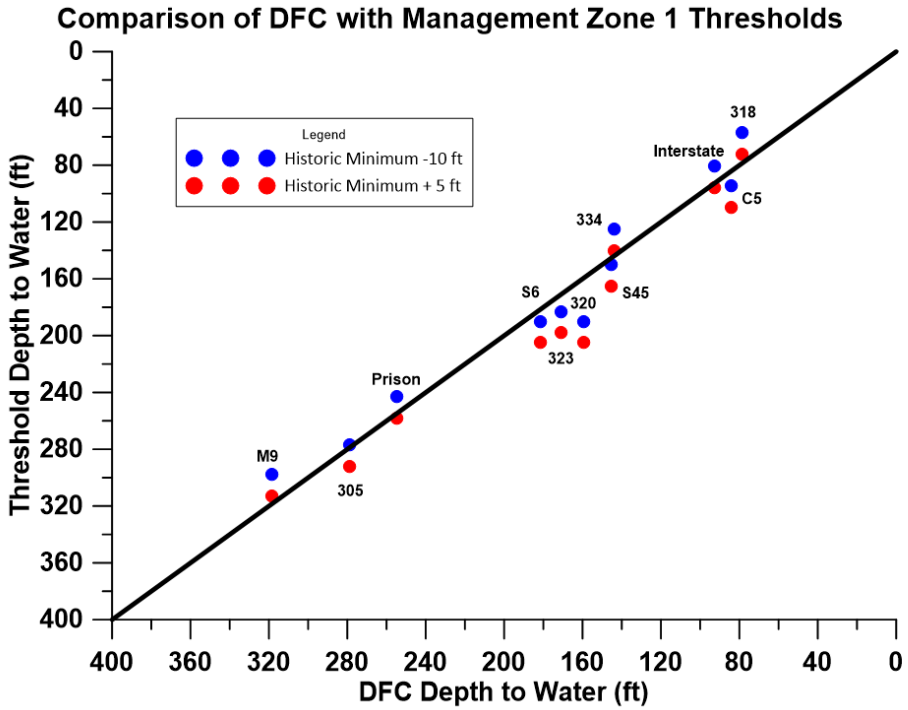

Figure 2. Comparison of DFC with Management Zone 1 Thresholds

Please note that the blue data points represent the groundwater elevation where pumping cutbacks begin for each well. The red dots represent the groundwater elevation where a shut-down in non-historic groundwater pumping would be required, thus providing an opportunity for groundwater elevation recovery. The black line represents a one-to-one line between the desired future condition (DFC) depth to water at each well and the threshold depth to water in each well. The data points generally fall just above or just below the black line demonstrating that the thresholds are consistent with the DFC

5.10.6 Analyses of Regulations and Groundwater Conditions

The District may employ technical resources at its disposal, as needed, to evaluate the resources available within the District and to determine the effectiveness of regulatory or conservation measures. In consideration of individual, localized or District-wide conditions the District may allow the production in a management zone to exceed the sustainable amount for a period considered necessary by the District.

The exercise of this discretion by the District shall not be construed as limiting the authority of the District in any other matter. A public or private user may appeal to the Board for discretion in enforcement of the provisions of a reduction in the permitted use of groundwater on grounds of adverse economic hardship or unique local conditions. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board.

As developed below, tracking the progress of meeting the goal associated with the desired future condition (and, thus, sustainability) relies on monitoring of groundwater elevations in the District.

5.11 Actions, Procedures, Performance, and Avoidance Necessary to Effectuate the Management Plan, Including Specifications and Proposed Rules, All Specified in as Much Detail as Possible

The District will implement the goals and provisions of this Management Plan and will utilize the objectives of this Management Plan as a guideline in its decision-making to be consistent with the provisions of this plan.

5.11.1 District Rules

The District has adopted rules, in accordance with Chapter 36 of the Texas Water Code, that implement the Management Plan. The current version of the rules is dated December 1, 2023, 2018, and are available at:

https://www.middlepecosgcd.org/pdf/rules/2023/MPGCD%20Rules%20-%20December%202023.pdf?_t=1701438397

All rules will be followed and enforced. The District will amend the District rules as necessary to comply with changes to Chapter 36 of the Texas Water Code and to ensure the best management of the groundwater within the District. The development and enforcement of the rules of the District will be based on the best scientific and technical evidence available to the District. If, at any point, it appears the District will not be able to achieve the adopted Desired Future Conditions the Board of Directors will amend the rules as necessary to ensure the Desired Future Conditions will be achieved.

5.11.2 Permit Denial

The District may deny a well construction permit or limit groundwater withdrawals in accordance with the guidelines stated in the rules of the District. In deciding to deny a permit or reduce the amount of groundwater withdrawals authorized in an existing permit, the District will weigh the public benefit in managing the aquifer to be derived from the denial of a groundwater withdrawal permit or the reduction of the amount of authorized groundwater withdrawals against the individual hardship imposed by the permit denial or authorization reduction.

The relevant factors to be considered in deciding to deny a permit or limit groundwater withdrawals may include:

- The rules of the District
- The distribution of groundwater resources in the aquifers or aquifer subdivisions of the District or any management zones established by the District
- The economic hardship resulting from grant or denial of a permit or the terms prescribed by the permit

5.11.3 Reductions in Production

In pursuit of the District's mission of protecting the resource, the District may require reduction of groundwater withdrawals. To achieve this purpose, the District may, at the Boards discretion amend or revoke any permits after notice and hearing. The determination to seek the amendment, reduction, or revocation of a permit by the District will be based on aquifer conditions observed by the District. The District will, when necessary, enforce the terms and conditions of permits and the rules of the District by enjoining the permit holder in a court of competent jurisdiction as provided for in Texas Water Code Chapter 36.102.

The District has the authority to establish rules for the proportional reduction of the permitted use of groundwater in the District that will recognize the following priorities of use:

- Exempt users with consideration to livestock and domestic use
- Holders of historic use of groundwater permits
- Holders of non-historic groundwater use permits

5.11.1 General Manager Annual Report

The General Manager of the District will prepare and submit an annual report (Annual Report) to the District Board of Directors. The Annual Report will include an update on the District's performance in achieving the management goals contained in this plan. The general manager will present the Annual Report to the Board of Directors within one hundred twenty (120) days following the completion of the District's Fiscal Year, currently the District fiscal year ends on September 30 of each calendar year. A copy of the annual audit of District financial records will be included in the Annual Report. The District will maintain a copy of the Annual Report on file for public inspection at the District offices, upon adoption by the Board of Directors.

6.0 Management Goals

6.1 Providing the Most Efficient Use of Groundwater

Objective – Each year, the District will require all new exempt or permitted wells that are constructed within the boundaries of the District to be registered with the District in accordance with the District rules.

Performance Standard – Each Year the number of exempt and permitted wells registered by the District for the year will be incorporated into the Annual Report submitted to the Board of Directors of the District.

6.2 Controlling and Preventing Waste of Groundwater

Objective – Each year, the District will provide information to the public on eliminating and reducing wasteful practices in the use of groundwater either by a page on groundwater waste reduction or a link to information on groundwater waste reduction on the District's website or by providing an article on eliminating and reducing wasteful practices to a newspaper of general circulation in the District for potential publication.

Performance Standard – Submit an article annually regarding the elimination of wasteful practices to a local publication for distribution in Pecos County. A copy of the information provided on groundwater waste reduction will be included in the District's Annual Report to be given to the District Board of Directors.

6.3. Controlling and Preventing Subsidence

The subsidence tool developed by the Texas Water Development Board was used to assess the potential for subsidence in the five aquifers in the District using the default values provided. The tool can be accessed at:

http://www.twdb.texas.gov/groundwater/models/research/subsidence/subsidence.asp

The tool provides a numeric total weighted risk factor that ranges from 0 (low risk) to 10 (high risk). The results of applying the default values from the tool yield the following scores:

- Capitan Reef Complex Aquifer: 2.66
- Dockum Aquifer: 3.75
- Edwards-Trinity (Plateau) Aquifer: 2.97
- Pecos Valley Aquifer: 5.78
- Rustler Aquifer: 3.59

Based on applying the tool, this management goal is not applicable to the District due to the low risk of subsidence in Pecos County.

6.4. Addressing Conjunctive Surface Water Management Issues

Objective – The Texas Water Code defines "Conjunctive Use" as the combined use of groundwater and surface water sources that optimizes the beneficial characteristics of each source. As noted in Appendix C, surface water use in Pecos County is projected to be about 21,000 AF/yr through 2070. Because the continued use of surface water in Pecos County are directly linked to other parts of the region, the District will participate in the regional planning process by being represented at the Region F Regional Water Planning Group meetings.

Performance Standard – The attendance of a District representative to at least 50 percent of the Region F Regional Water Planning Group meetings will be noted in the Annual Report presented to the District Board of Directors.

6.5 Addressing Natural Resource Issues That Affect the Use and Availability of Groundwater and which are Impacted by the Use of Groundwater

Objective – Each year the District will monitor the discharge of Comanche and related springs or acquire the monitoring data on spring discharge developed by others.

Performance Standard – Each year, a summary of the collected or gathered spring data will be included in the Annual Report submitted to the District Board of Directors.

Objective - By attending GMA 3 and GMA 7 meetings, there is the opportunity to participate in discussions, planning and education concerning the interrelationship of groundwater with other natural resource issues. The MPGCD designated representative will attend 50% of the GMA 3 and GMA 7 meetings annually.

Performance Standard - The minutes for all attended meetings of GMA 3 and GMA 7 will be maintained in the District 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.

6.6 Addressing Drought Conditions

Objective – Each month, the District will download available drought information, for the District, from available websites on the internet such as (last accessed on February 11, 2025):

https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?TX

Performance Standard – Quarterly, the District will assess the status of drought in the District and prepare a briefing for the Board of Directors. The downloaded maps, reports, and information will be included with copies of the quarterly briefing in the District Annual Report to the Board of Directors.

6.7 Addressing Conservation, Recharge Enhancement, Rainwater Harvesting, Precipitation Enhancement, and Brush Control Where Appropriate and Cost Effective

6.7.1 Addressing Conservation

Objective – The District will submit an article annually, regarding water conservation for publication to at least one newspaper of general circulation in Pecos County.

Performance Standard – A copy of the article submitted by the District for publication to a newspaper of general circulation in Pecos County regarding water conservation will be included in the Annual Report to the Board of Directors.

6.7.2 Recharge Enhancement

This management goal is not applicable to the District due to lack of available surface water of acceptable quality and cost effectiveness.

6.7.3 Rainwater Harvesting

Objective – The District will post an article or a link to an article annually, regarding rainwater harvesting on the District website www.middlepecosgcd.org

Performance Standard – A copy of the article posted on the District website regarding rainwater harvesting will be included in the Annual Report to the Board of Directors.

6.7.4 Precipitation Enhancement

Objective – The District has been participating in a regional program for cloud seeding with Trans Pecos Weather Modification. This effort has been viewed as successful in increasing rainfall.

Performance Standard – Trans Pecos Weather Modification prepares an annual report. This report will be included in the Annual Report to the Board of Directors.

6.7.5 Brush Control

This management goal is not applicable to the District because the objective is not cost effective due to the sparse nature of the vegetation in the District and the fact that much of the recharge to the District's aquifers are outside the boundaries of the District.

6.8 Addressing the Desired Future Conditions Established Under TWC §36.108

Objective – The desired future conditions for the Captain Reef Complex, Dockum, Edwards-Trinity (Plateau), Pecos Valley Alluvium, and Rustler aquifers were adopted after the review of results from Groundwater Availability Model simulations. The model results include cell-by-cell estimates of groundwater elevations and drawdown for each year of the predictive period (through 2070). To assess the desired future condition in the District, these model results are compared annually to groundwater monitoring data that are available from the TWDB groundwater database.

Performance Standard – Each year, the District will download groundwater data from Pecos County from the Texas Water Development Board groundwater database. Based on experience in developing this comparison, it is best to complete this effort in the fall to maximize the available data from the previous year. The comparison of model results will be on a well-by-well basis for data that are available. The data downloaded from the database will be compared to model results each year and presented in a written report that will be presented at a regular Board meeting. These comparisons will be supplemented by data and information related to drought conditions and permitted pumping data. The report will also be included in the Annual Report to the Board of Directors. An example of the most recent analysis completed in 2025 is provided in Appendix E.

Appendix A

Evidence of Notice and Hearing

(to be added after Board approval)

Appendix B

Coordination with Surface Water Entities

(to be added after Board approval)

Appendix C

TWDB Estimated Historic Groundwater Use and 2022 State Water Plan Datasets: Middle Pecos Groundwater District (February 28, 2025)

TWDB Estimated Historical Groundwater Use and 2022 State Water Plan Datasets

Middle Pecos Groundwater Conservation District

Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Department
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(512) 463-7317
February 28, 2025

GROUNDWATER MANAGEMENT PLAN DATA

This set of water data tables (part one of a two-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 table addresses a specific numbered requirement in the Texas Water Development Board's groundwater management plan review checklist. The checklist can be found at this web address:

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

The five tables included in part one of this data package are:

TWDB Historical Water Use Survey (WUS)

- Estimated Historical Water Use (checklist item 2)

State Water Plan (SWP)

- Projected Surface Water Supplies (checklist item 6),
- Projected Water Demands (checklist item 7),
- Projected Water Supply Needs (checklist item 8),
- Projected Water Management Strategies (checklist item 9)

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

DISCLAIMER:

Data presented in these tables are the most up to date WUS and SWP data available as of 2/28/2025. Although it does not happen often, these data are subject to change pending the availability of more accurate WUS data or an amendment to the 2022 SWP. District personnel should review the data table values and correct any discrepancies to ensure approval of their groundwater management plan.

The WUS data can be verified at this web address:

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

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

The values presented in the data tables 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 offer districts the opportunity to review this determination).

The county values in two of the SWP tables (Projected Water Supply Needs and Projected Water Management Strategies) are not apportioned because district-specific values are not required to be presented in the groundwater management plan. However, a district is required to “consider” the county values in these two tables by drafting a short summary of the needs and strategies values in the groundwater management plan.

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

TWDB recognizes that the apportioning formula used is not ideal but it is the best available process with respect to time and staffing constraints. If a district believes it has data that are more accurate, they 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

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

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2021	GW	5,571	11	1,442	0	115,545	550	123,119
	SW	0	0	0	0	2,782	29	2,811
2020	GW	4,638	18	1,587	0	96,846	568	103,657
	SW	0	0	0	0	2,868	30	2,898
2019	GW	4,284	54	3,080	0	92,606	561	100,585
	SW	0	0	0	0	2,318	30	2,348
2018	GW	4,159	54	1,988	0	110,661	561	117,423
	SW	0	0	0	0	516	30	546
2017	GW	5,268	88	1,003	0	137,334	547	144,240
	SW	0	0	0	0	3,146	29	3,175
2016	GW	5,217	221	247	0	147,893	614	154,192
	SW	0	0	0	0	3,910	32	3,942
2015	GW	5,294	142	189	0	151,876	611	158,112
	SW	0	0	0	0	2,972	32	3,004
2014	GW	5,173	133	89	0	159,501	643	165,539
	SW	0	0	0	0	0	34	34
2013	GW	5,635	137	52	0	139,488	601	145,913
	SW	0	0	0	0	0	32	32
2012	GW	4,174	252	5	0	110,247	619	115,297
	SW	0	0	0	0	0	33	33

Projected Surface Water Supplies
TWDB 2022 State Water Plan Data

PECOS COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
F	Irrigation, Pecos	Rio Grande	Red Bluff Lake/Reservoir	2,504	2,498	2,492	2,487	2,481	2,475
F	Irrigation, Pecos	Rio Grande	Rio Grande Run-of-River	18,672	18,672	18,672	18,672	18,672	18,672
F	Livestock, Pecos	Rio Grande	Rio Grande Livestock Local Supply	37	37	37	37	37	37
	Sum of Projected Surface Water Supplies (acre-feet)			**21,213**	**21,207**	**21,201**	**21,196**	**21,190**	**21,184**

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.

PECOS COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
F	County-Other, Pecos	Rio Grande	110	127	147	165	182	197
F	Fort Stockton	Rio Grande	4,841	5,172	5,548	5,813	6,067	6,300
F	Iraan	Rio Grande	458	485	513	540	567	591
F	Irrigation, Pecos	Rio Grande	143,345	143,345	143,345	143,345	143,345	143,345
F	Livestock, Pecos	Rio Grande	687	687	687	687	687	687
F	Manufacturing, Pecos	Rio Grande	413	433	433	433	433	433
F	Mining, Pecos	Rio Grande	7,700	7,700	7,700	6,200	4,800	3,700
F	Pecos County Fresh Water	Rio Grande	201	212	223	235	247	257
F	Pecos County WCID 1	Rio Grande	384	398	415	433	453	472
	Sum of Projected Water Demands (acre-feet)		**158,139**	**158,559**	**159,011**	**157,851**	**156,781**	**155,982**

Projected Water Supply Needs
TWDB 2022 State Water Plan Data

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

PECOS COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
F	County-Other, Pecos	Rio Grande	0	0	0	0	0	0
F	Fort Stockton	Rio Grande	0	0	0	0	0	0
F	Iraan	Rio Grande	0	0	0	0	0	0
F	Irrigation, Pecos	Rio Grande	0	0	0	0	0	0
F	Livestock, Pecos	Rio Grande	0	0	0	0	0	0
F	Manufacturing, Pecos	Rio Grande	0	0	0	0	0	0
F	Mining, Pecos	Rio Grande	-3,500	-3,500	-3,500	-2,000	-600	500
F	Pecos County Fresh Water	Rio Grande	0	0	0	0	0	0
F	Pecos County WCID 1	Rio Grande	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet)		**-3,500**	**-3,500**	**-3,500**	**-2,000**	**-600**	**0**

Projected Water Management Strategies
TWDB 2022 State Water Plan Data

PECOS COUNTY

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

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Fort Stockton, Rio Grande (F)							
Municipal Conservation - Fort Stockton	DEMAND REDUCTION [Pecos]	36	39	42	44	46	48
		36	**39**	**42**	**44**	**46**	**48**
Iraan, Rio Grande (F)							
Municipal Conservation - Iraan	DEMAND REDUCTION [Pecos]	4	4	5	5	5	5
		4	**4**	**5**	**5**	**5**	**5**
Irrigation, Pecos, Rio Grande (F)							
Irrigation Conservation - Pecos County	DEMAND REDUCTION [Pecos]	7,167	14,335	21,502	21,502	21,502	21,502
Weather Modification	Weather Modification [Atmosphere]	106	106	106	106	106	106
		7,273	**14,441**	**21,608**	**21,608**	**21,608**	**21,608**
Mining, Pecos, Rio Grande (F)							
Develop Pecos Valley Aquifer Supplies - Pecos County Mining	Edwards-Trinity-Plateau and Pecos Valley Aquifers [Pecos]	3,000	3,000	3,000	3,000	3,000	3,000
Mining Conservation - Pecos County	DEMAND REDUCTION [Pecos]	539	539	539	434	67	52
		3,539	**3,539**	**3,539**	**3,434**	**3,067**	**3,052**
Pecos County Fresh Water, Rio Grande (F)							
Municipal Conservation - Pecos County Fresh Water	DEMAND REDUCTION [Pecos]	2	2	3	3	3	3
		2	**2**	**3**	**3**	**3**	**3**
Pecos County WCID 1, Rio Grande (F)							
Develop Additional Edwards-Trinity Plateau Aquifer Supplies - Pecos County WCID 1	Edwards-Trinity-Plateau, Pecos Valley, and Trinity Aquifers [Pecos]	250	250	250	250	250	250
Municipal Conservation - Pecos WCID	DEMAND REDUCTION [Pecos]	9	10	11	11	12	12
		259	**260**	**261**	**261**	**262**	**262**
Sum of Projected Water Management Strategies (acre-feet)		**11,113**	**18,285**	**25,458**	**25,355**	**24,991**	**24,978**

Appendix D

GAM Run 19-021: Middle Pecos Groundwater Conservation District (February 18, 2020)

GAM Run 19-021: Middle Pecos Groundwater Conservation District Management Plan

By Grayson Dowlearn
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 475-1552
February 18, 2020

Cynthia K. Ridgeway is the manager of the Groundwater Availability Modeling Department and is responsible for the oversight of work performed by Grayson Dowlearn under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on February 18, 2020.

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GAM RUN 19-021: MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

By Grayson Dowlearn
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 475-1552
February 13, 2020

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), 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 Middle Pecos Groundwater Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan dataset report, which will be provided to you separately by the TWDB Groundwater Technical Assistance Department. Please direct questions about the water data report to Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov. Part 2 is the required groundwater availability modeling information and this information 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 Middle Pecos Groundwater Conservation District should be adopted by the district on or before June 17, 2020 and submitted to the executive administrator of the TWDB on or before July 17, 2020. The current management plan for the Middle Pecos Groundwater Conservation District expires on September 15, 2020.

We used four groundwater availability models to estimate the management plan information for the aquifers within the Middle Pecos Groundwater Conservation District. Information for the Pecos Valley and Edwards-Trinity (Plateau) aquifers is from version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Anaya and Jones, 2009). Information for the Dockum Aquifer is from version 1.01 of the groundwater availability model for the High Plains aquifer system (Deeds and Jigmond, 2015 and Deeds and Hamlin, 2015). Information for the Rustler Aquifer is from version 1.01 of the groundwater availability model for the Rustler Aquifer (Ewing and others, 2012). Information for the Capitan Reef Complex Aquifer is from version 1.01 of the groundwater availability model for the Capitan Reef Complex Aquifer (Jones, 2016). While a small portion of the Igneous Aquifer underlies the district at the western tip of Pecos County, the model for the Igneous Aquifer does not extend into Pecos County. For more information concerning this aquifer, please contact Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov.

This report replaces the results of GAM Run 14-010 (Jones, 2014), as the approach used for analyzing model results has been since refined to more accurately delineate flows between hydraulically connected units and official aquifer boundaries. In addition, this analysis includes results from the groundwater availability model for the Capitan Reef Complex Aquifer and the groundwater availability model for the High Plains Aquifer System, both of which were released since the publication of GAM Run 14-010. Tables 1, 2, 3, 4, and 5 summarize the groundwater availability model data required by statute and Figures 1, 2, 3, 4, and 5 show the area of the models from which the values in the tables were extracted. If, after review of the figures, the Middle Pecos Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models mentioned above were used to estimate information for the Middle Pecos Groundwater Conservation District management plan. Water budgets were extracted for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (1981-2000), Dockum Aquifer (1980-2012), Rustler Aquifer (1980-2008), and

Capitan Reef Complex Aquifer (1980-2005). We used ZONEBUDGET Version 3.01 (Harbaugh, 2009) to extract water budgets from the model results. 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:

Capitan Reef Complex Aquifer

- We used version 1.01 of the groundwater availability model for the Capitan Reef Complex Aquifer. See Jones (2016) for assumptions and limitations of the groundwater availability model.
- The model has five active layers representing the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Layer 1); Dockum Aquifer and Dewey Lake Formation (Layer 2); Rustler Aquifer (Layer 3); Artesia Group, Salado Formation, and Castile Formation (Layer 4); and Capitan Reef Complex Aquifer, Delaware Basin, and San Andres Formation (Layer 5).
- While the model for the Capitan Reef Complex Aquifer includes the Pecos Valley, Edwards-Trinity (Plateau), Dockum, and Rustler aquifers, the focus of the model run was to extract information for the Capitan Reef Complex Aquifer. Thus, model Layer 5 was used for the management plan analysis.
- Water budget terms were averaged for the period 1980 through 2005 (stress periods 50 through 75).
- The model was run with MODFLOW-2005 (Harbaugh, 2005).

Rustler Aquifer

- We used version 1.01 of the groundwater availability model for the Rustler Aquifer. See Ewing and others (2012) for assumptions and limitations of the groundwater availability model.
- The model has two active layers representing the Dewey Lake Formation and Dockum Aquifer (Layer 1) and the Rustler Aquifer (Layer 2). While the model for the Rustler Aquifer includes the Dockum Aquifer, the focus of the model run was to extract information for the Rustler Aquifer. Therefore, model Layer 2 was used for the management plan analysis.

- Water budget terms were averaged for the period 1980 through 2008 (stress periods 63 through 91).

- The model was run with MODFLOW-2000 (Harbaugh and Others, 2000).

Dockum Aquifer

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

- The groundwater availability model for the High Plains Aquifer System contains four layers representing the Ogallala Aquifer and the Pecos Valley Aquifer (Layer 1); the Rita Blanca Aquifer, the Edwards-Trinity (High Plains) Aquifer, and the Edwards-Trinity (Plateau) Aquifer (Layer 2); the upper Dockum Group (Layer 3); and the lower Dockum Group (Layer 4). Layers 3 and 4, representing the Dockum Aquifer, were analyzed together. While the Pecos Valley and Edwards-Trinity (Plateau) aquifers are included in this model, they were not the focus of the model. Therefore, we used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers for analyzing these aquifers,

- 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).

Edwards-Trinity (Plateau) and Pecos Valley Aquifers

- We used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers. See Anaya and Jones (2009) for assumptions and limitations of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers.

- The model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers includes two active layers representing the Pecos Valley Aquifer and the Edwards Group and equivalent limestone hydrostratigraphic units (Layer 1) and the undifferentiated Trinity Group hydrostratigraphic units (Layer 2) in the district.

- A portion of the area underlying the district represents both the Pecos Valley and Edwards-Trinity (Plateau) aquifers within Layer 1 of the model. We assumed certain model cells are assigned to the Pecos Valley Aquifer and the remaining cells are assigned to the Edwards-Trinity (Plateau) Aquifer where this condition exists.

- Water budget terms were averaged for the period 1981 through 2000 (stress periods 2 through 21).

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the model results for the aquifers located within the district and averaged over the historical calibration periods, as shown in Tables 1, 2, 3, 4 and 5.

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, 2, 3, 4 and 5. 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 CAPITAN REEF COMPLEX AQUIFER THAT IS NEEDED FOR THE MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT'S 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	Capitan Reef Complex Aquifer	4,860
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Capitan Reef Complex Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Capitan Reef Complex Aquifer	29,953
Estimated annual volume of flow out of the district within each aquifer in the district	Capitan Reef Complex Aquifer	2,823
Estimated net annual volume of flow between each aquifer in the district	From Capitan Reef Complex Aquifer to Artesia Group/Salado Formation/Castile Formation	23,463
	From Capitan Reef Complex Aquifer to Capitan Reef Complex and other units	9,085

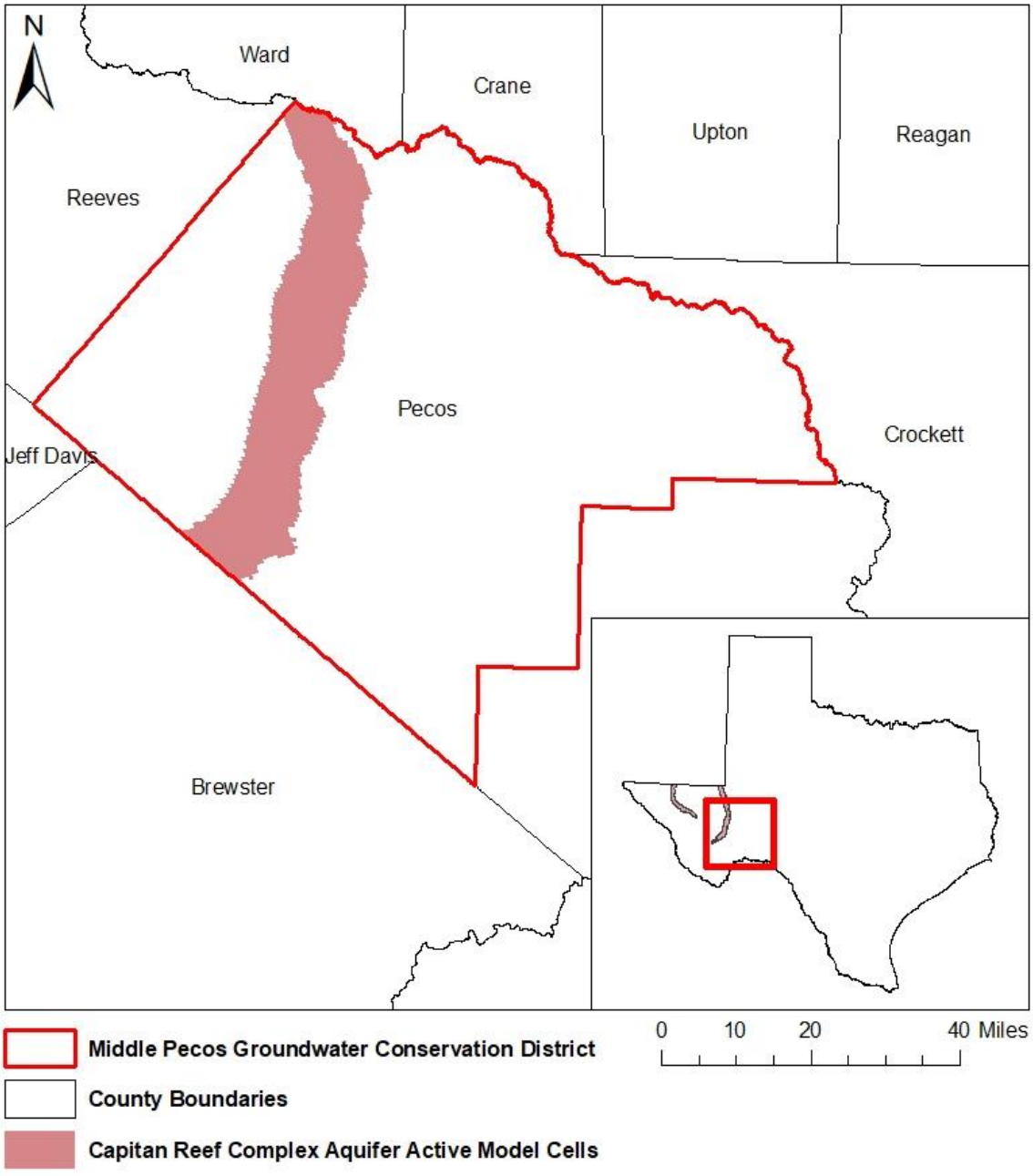

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CAPITAN REEF COMPLEX AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE CAPITAN REEF COMPLEX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE RUSTLER AQUIFER THAT IS NEEDED FOR THE MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT'S 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	Rustler Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Rustler Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Rustler Aquifer	539
Estimated annual volume of flow out of the district within each aquifer in the district	Rustler Aquifer	418
Estimated net annual volume of flow between each aquifer in the district	From the Rustler Aquifer to the Dockum Aquifer	856
	To the Rustler Aquifer from other overlying units	342
	To the Rustler Aquifer from Rustler Formation	532

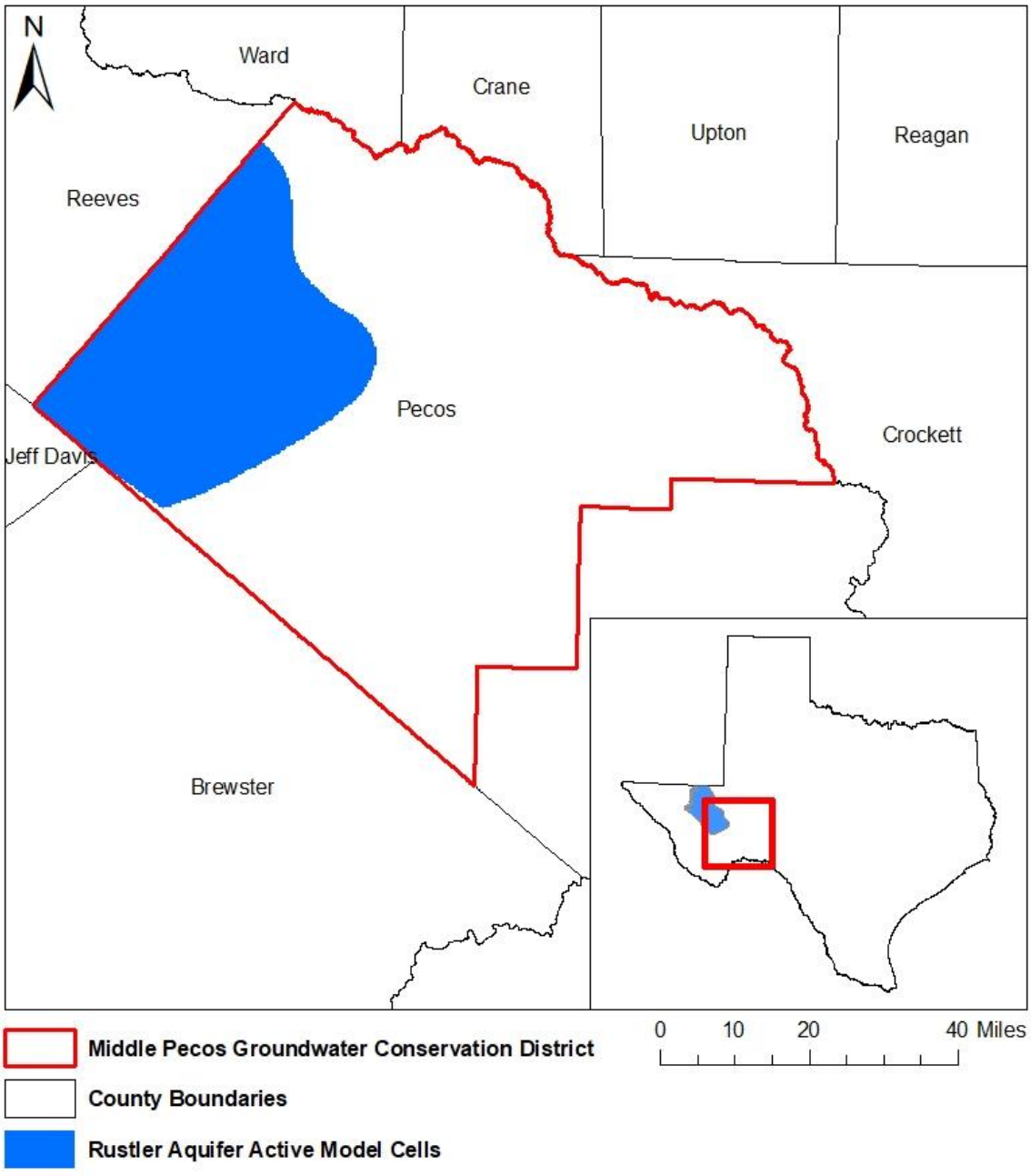

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE RUSTLER AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE RUSTLER AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER THAT IS NEEDED FOR THE MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Dockum Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Dockum Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	511
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	320
Estimated net annual volume of flow between each aquifer in the district	From the Dockum Aquifer to the Pecos Valley Aquifer	118
	To the Dockum Aquifer from the Edwards-Trinity (Plateau) Aquifer	160
	To Dockum Aquifer from Rustler Aquifer	856*
	From Dockum Aquifer to Dockum Formation	87

* Indicates value calculated from the groundwater availability model for the Rustler Aquifer, all other values are from the groundwater availability model for the High Plains Aquifer System.

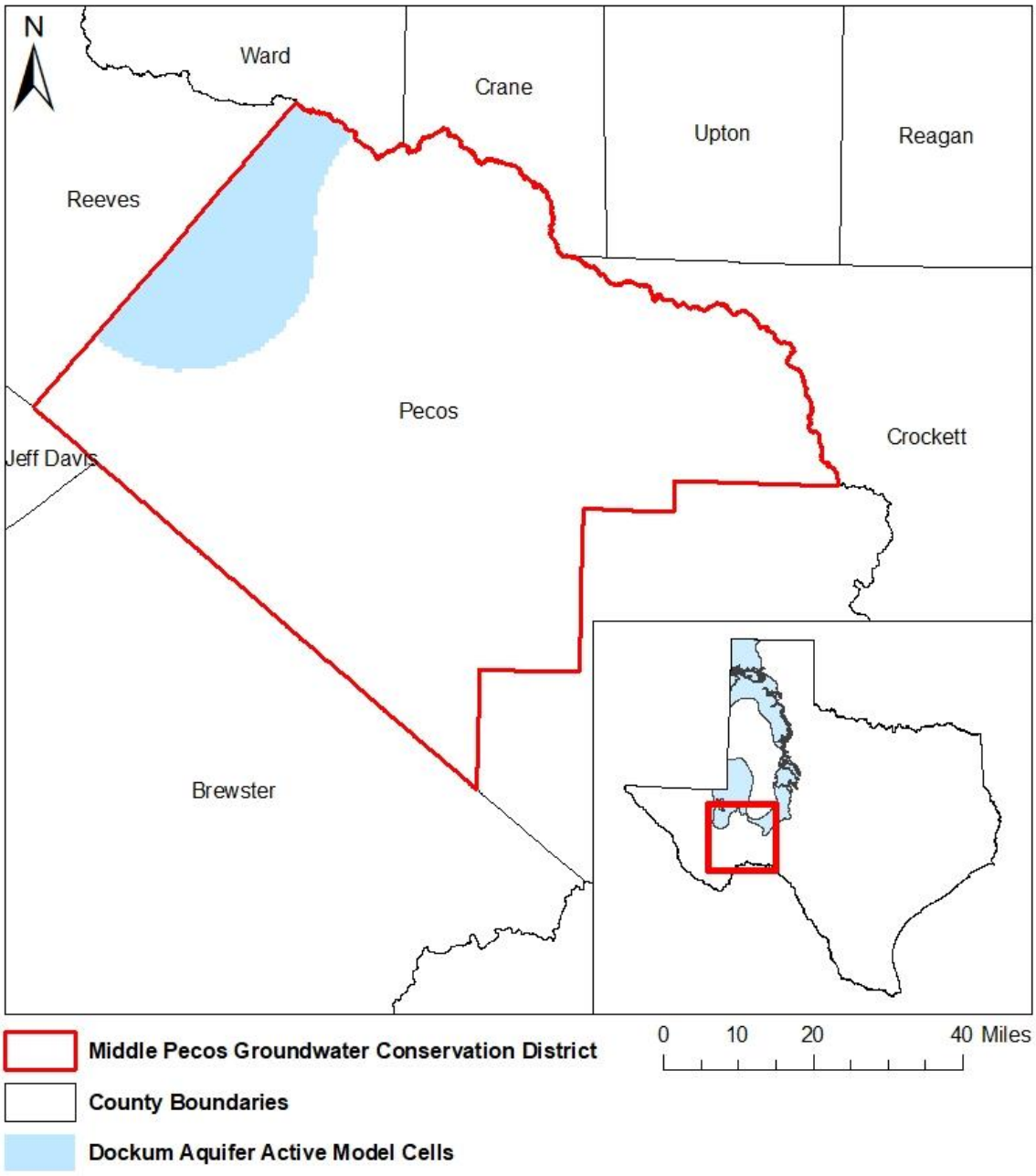

FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE DOCKUM AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 4: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR THE MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT'S 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 (Plateau) Aquifer	141,982
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Edwards-Trinity (Plateau) Aquifer	24,024
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	32,418
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	77,569
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Pecos Valley Aquifer	41,370
	From the Edwards-Trinity (Plateau) Aquifer to the Dockum Aquifer	160*

* Indicates values calculated from the groundwater availability model for the High Plains Aquifer System, all other values are calculated from the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers.

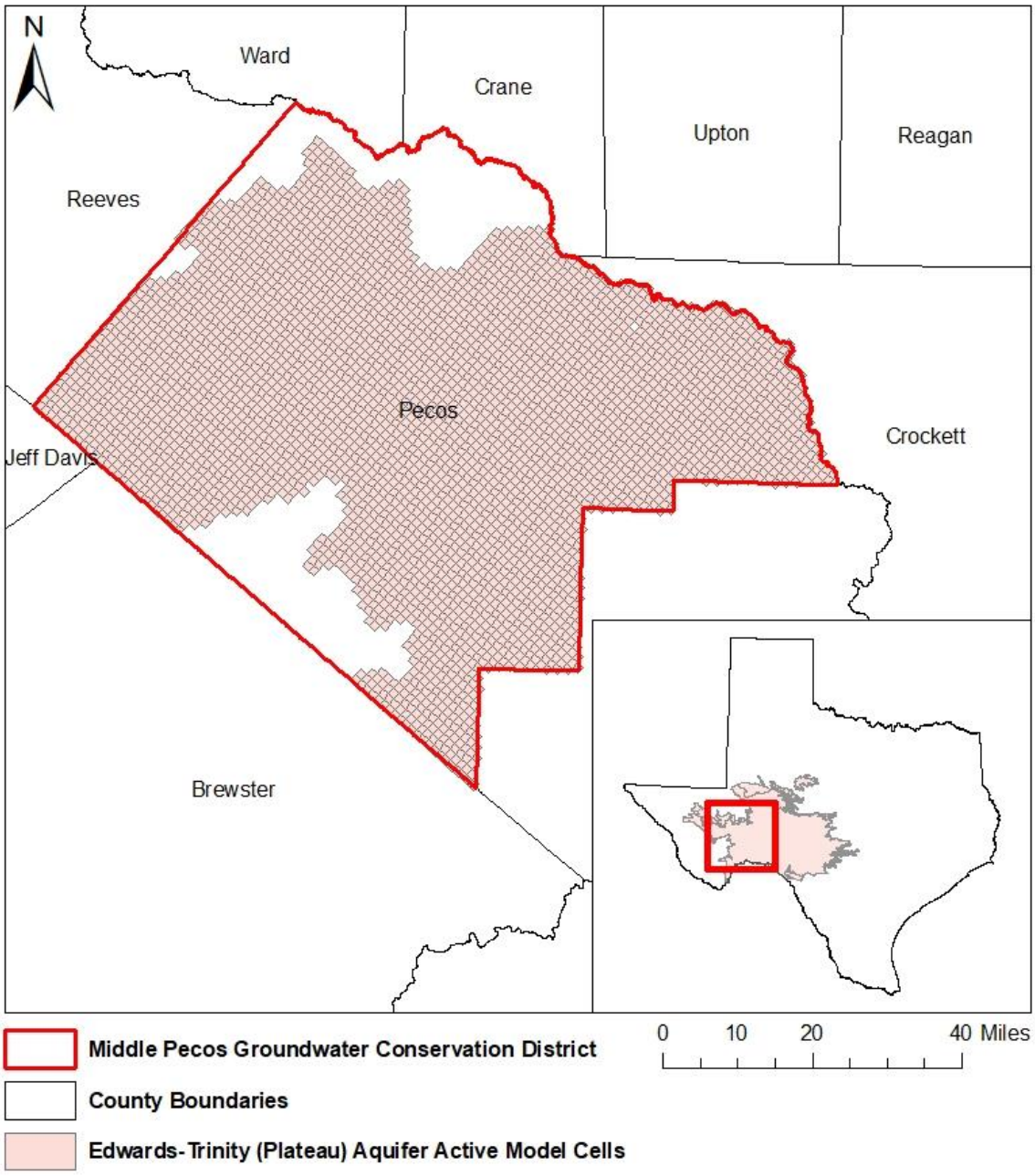

FIGURE 4: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED (THE EDWARDS-TRINITY (PLATEAU) AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 5: SUMMARIZED INFORMATION FOR THE PECOS VALLEY AQUIFER THAT IS NEEDED FOR THE MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT'S 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	Pecos Valley	35,919
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Pecos Valley	23,989
Estimated annual volume of flow into the district within each aquifer in the district	Pecos Valley	3,225
Estimated annual volume of flow out of the district within each aquifer in the district	Pecos Valley	15,118
Estimated net annual volume of flow between each aquifer in the district	To the Pecos Valley Aquifer from the Edwards-Trinity (Plateau) Aquifer	41,370
	To the Pecos Valley Aquifer from the Dockum Aquifer	118*

* Indicates values calculated from the groundwater availability model for the High Plains Aquifer System, all other values are calculated from the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers.

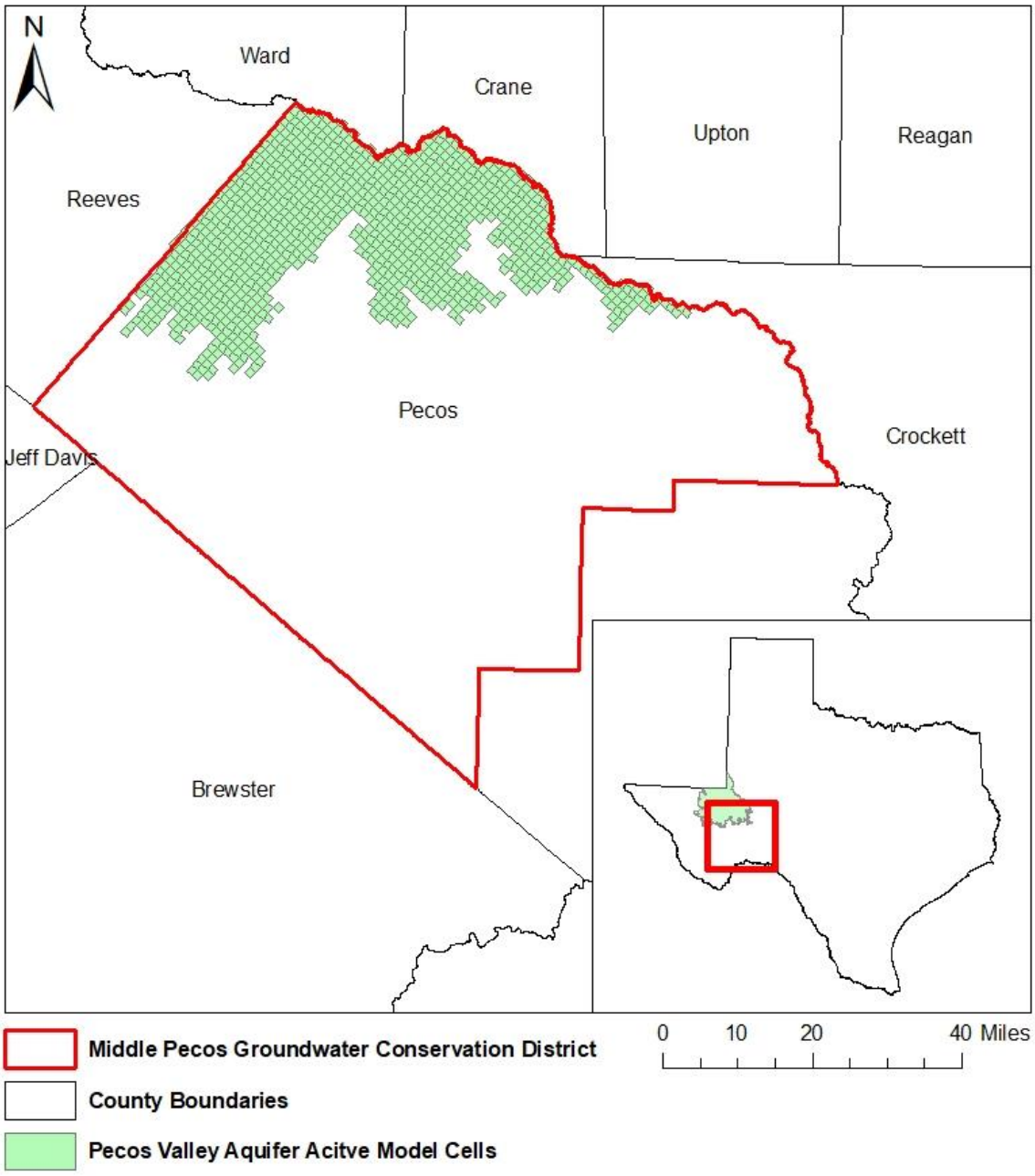

FIGURE 5: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS FROM WHICH THE INFORMATION IN TABLE 5 WAS EXTRACTED (THE PECOS VALLEY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

The groundwater models 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 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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Appendix E

Comparison of Groundwater Elevations and Drawdowns: GAM DFC Simulation and Measured Data from TWDB

Final Report

2024 Update:
Comparison of Groundwater Elevations and Drawdowns: GAM DFC Simulation and Measured Data from TWDB

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February 13, 2025

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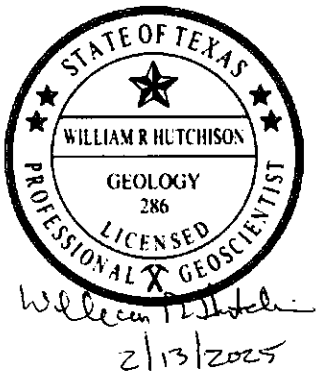

1.0 Introduction

One of the required goals (Goal 8) of the Middle Pecos Groundwater Conservation District Management Plan is a how the District addresses the desired future conditions in a quantitative manner. This report:

- Summarizes the available data from the TWDB Groundwater Database
- Describes the analyses that were completed to select monitoring wells for the comparison with the simulations that are the basis for the desired future condition
- Provides a comparison of model simulated groundwater elevations and drawdowns with actual data and provides some context to the results with an analysis of precipitation in the area.

The 2020 management plan included an appendix providing documentation of this comparison (Hutchison, 2020). An update was completed as documented in Hutchison (2023). This report contains an update through 2023 for inclusion in the 2025 management plan. The analysis ends in 2023 because complete groundwater level and precipitation data for 2024 are not yet available on the TWDB website.

2.0 TWDB Data

2.1 Groundwater Level Data

The TWDB groundwater database includes a site for water levels by county:

https://www3.twdb.texas.gov/apps/reports/GWDB/WaterLevelsByCounty

Data for Pecos County were downloaded on January 21, 2025 for use in this report. The raw data were filtered to only include records with water level data after 2005 (the base year for the desired future condition). Sorting the data by date resulted in the identification of 38 wells that could be used for this analysis.

The Fortran program *TWDBData.exe* was written to read the list of wells, read the water level data, and return end-of-year water levels. For purposes of this selection, the monthly priority of groundwater levels to assign an end-of-year groundwater level was:

1. December of the current year
2. January of the next year
3. November of the current year
4. February of the next year

This effort yielded 503 groundwater level records for the 38 wells. As noted in Hutchison (2020 and 2023), the water level data in the TWDB database can only be used to compare the DFCs in the Edwards-Trinity (Plateau) and Pecos Valley Alluvium. Data are not available to evaluate the DFCs for the Capitan Reef Complex, Dockum, and Rustler aquifers.

The Fortran program *etppvrowcol.exe* was written to locate each well on the grid of the Groundwater Availability Model used as the basis for the desired future conditions (DFC) in GAM 3 and GAM 7. The results are expressed in terms of the model row and column.

Table 1 summarizes information on the 38 wells, and Figure 1 presents their locations. Please note that the Well ID from Table 1 is used to identify each well location in Figure 1.

Table 1. Summary of Well Information

Well ID	TWDB Well Number	Number of Records (2005 to 2022)	GAMx	GAMy	Well Depth (ft)	Reference Point Elevation (ft MSL)	GAM Row	GAM Col	Distance to Nearest Cell Center (ft)
1	4562402	14	4180198	19622464	120	2,533	169	141	1,198
2	4562901	16	4215270.5	19605324	190	2,302	167	148	1,794
3	4563701	5	4221824	19602964	138	2,298	166	150	3,170
4	4648502	17	3969727	19718808	724	2,525	182	99	2,007
5	4648503	17	3971253.8	19725630	625	2,513	181	99	1,570
6	4648604	7	3975771	19716692	425	2,528	182	100	3,498
7	4648801	3	3968880.3	19702396	400	2,578	184	101	2,971
8	4655603	16	3943139.8	19674652	600	2,694	192	101	2,374
9	4656201	16	3964642.3	19690156	865	2,623	187	102	2,188
10	4656301	8	3974916.3	19685516	568	2,618	186	104	1,762
11	4656306	17	3984143.3	19690126	615	2,594	184	105	1,293
12	4656401	5	3947945.8	19675934	400	2,686	191	102	1,623
13	5206501	12	3881571	19588218	351	3,077	212	104	3,353
14	5206701	10	3871409.3	19565630	510	3,237	216	105	363
15	5207302	4	3938322.8	19599728	501	2,964	203	110	1,237
16	5207502	12	3924182.8	19585546	280	3,020	207	110	2,446
17	5207901	17	3937220.5	19567040	612	3,081	208	114	2,586
18	5208302	9	3975494.3	19595652	310	3,018	199	116	2,206
19	5208801	16	3959985.3	19562958	200	3,086	205	118	1,659
20	5216202	14	3963653.8	19554044	666	3,098	206	119	2,137
21	5216302	4	3973889.5	19552850	320	3,080	205	121	730
22	5216505	9	3962363.8	19545166	246	3,141	207	120	2,815
23	5216609	5	3973211.8	19534436	1,975	3,192	208	123	2,730
24	5216802	18	3967842.3	19530824	448	3,201	209	123	1,474
25	5221301	11	3853462.8	19511174	350	3,512	226	109	1,735
26	5301707	14	3986188.8	19573280	98	2,969	200	120	2,374
27	5301805	14	4000338.3	19572294	341	3,029	199	122	1,802
28	5301902	16	4018509.5	19565434	180	2,981	197	126	2,849
29	5302708	17	4030551.5	19560160	227	3,025	197	128	1,853
30	5303901	17	4092037	19559444	462	2,876	189	137	1,129
31	5306501	17	4196969.5	19581700	425	2,410	173	149	2,839
32	5307202	14	4234979	19591762	Unknown	2,425	166	153	1,855
33	5307203	11	4241304	19590826	Unknown	2,354	166	154	2,181
34	5307601	6	4243929	19582876	931	2,978	166	155	2,422
35	5309105	3	3982084.3	19550196	200	3,087	204	122	2,770
36	5309301	18	4015507.3	19553902	210	3,012	199	127	2,749
37	5309306	13	4018967.8	19559648	235	2,971	198	126	2,728
38	5312702	15	4108293.3	19521890	Unknown	2,916	192	144	1,307

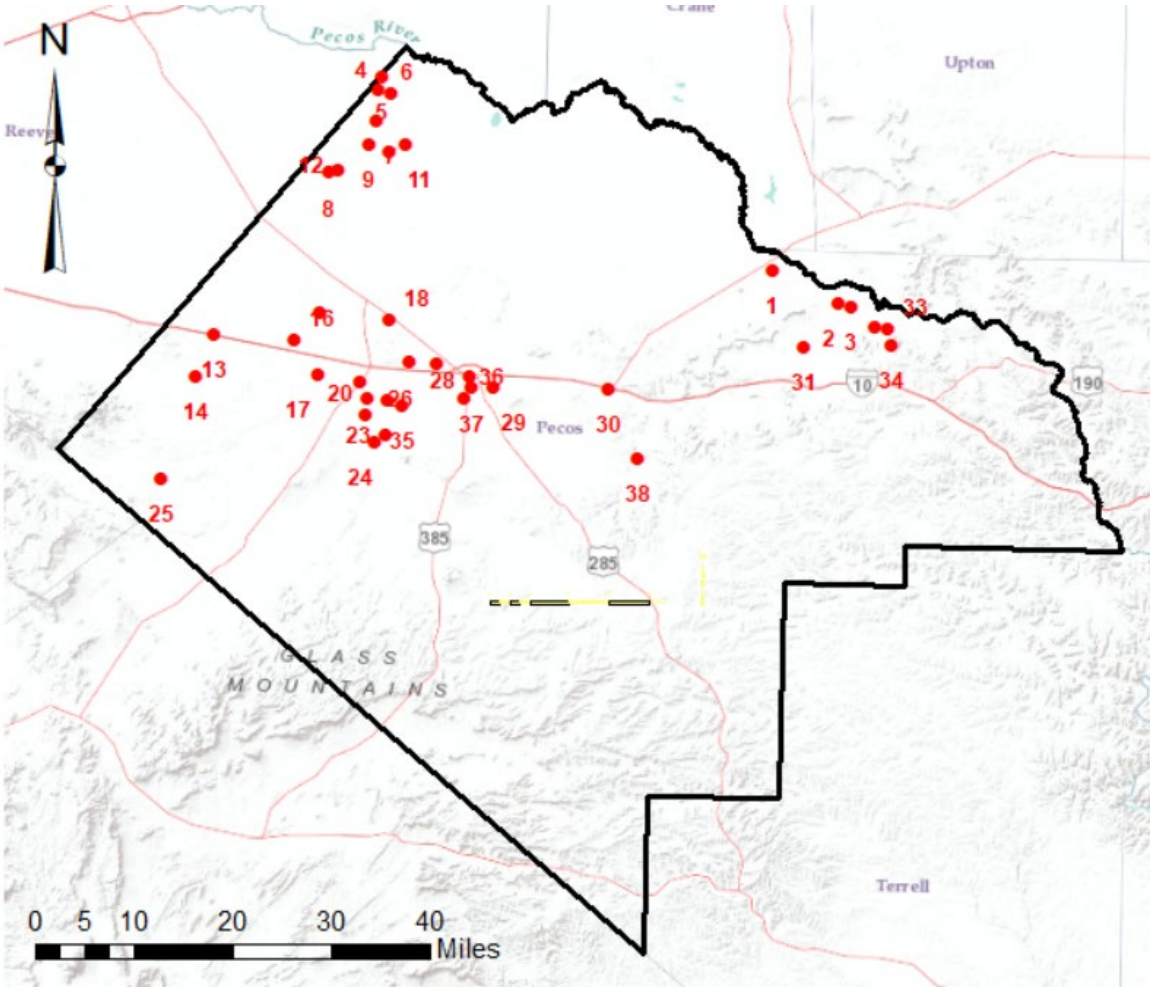

Figure 1. Well Locations

2.2 Precipitation Data

Precipitation data were downloaded from the TWDB website:

https://waterdatafortexas.org/lake-evaporation-rainfall

As seen in Figure 2, Pecos County is in parts of four quadrangles (604, 605, 704, and 705). The available data for the four quadrangles include monthly totals of precipitation from 1940 to 2023. Data for 2024 are limited to the first quarter (January, February, and March). These data were saved to the file *MPGCD Pcp.xlsx.* The monthly data were averaged across all four quadrangles, the annual totals for each year were calculated and presented in Column M. The annual rainfall was also expressed in terms of a percent average for the entire period in Column N. The average rainfall from 1940 to 2023 was 13.36 inches. Annual departures from the average are presented in Column O. The pertinent data for the years of interest (2005 to 2023) are summarized in Table 2.

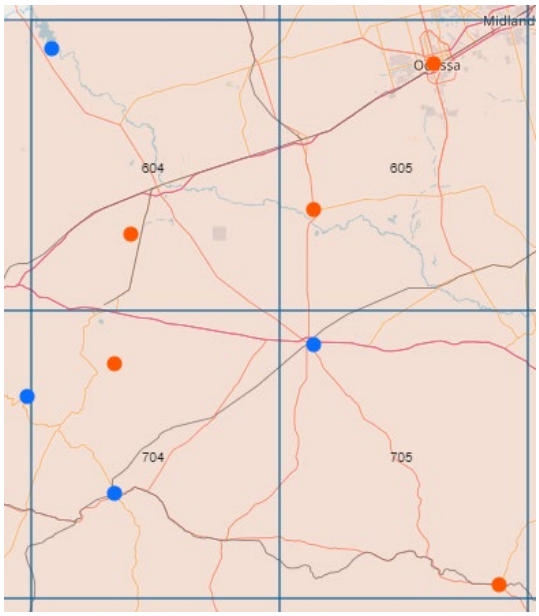

Figure 2. Location of Precipitation Quads

Table 2. Precipitation for Quadrangles 604, 605, 704, and 705: 2005 to 2023

Year	Annual Precipitation (in)	Annual Precipitation (% of Average)	Annual Difference from Average (in)
2005	15.60	116.75	2.24
2006	11.17	83.59	-2.19
2007	18.79	140.66	5.43
2008	12.02	89.99	-1.34
2009	12.00	89.82	-1.36
2010	16.60	124.27	3.24
2011	3.08	23.07	-10.28
2012	12.32	92.18	-1.05
2013	10.53	78.80	-2.83
2014	11.58	86.70	-1.78
2015	19.41	145.30	6.05
2016	13.32	99.70	-0.04
2017	13.39	100.24	0.03
2018	14.85	111.13	1.49
2019	14.30	107.04	0.94
2020	7.76	58.07	-5.60
2021	10.37	77.62	-2.99
2022	12.50	93.53	-0.87
2023	9.26	69.27	-4.11

Annual departures from the long term mean precipitation is presented in Figure 3 and highlights the current drought (2020 to 2023). Please note that the last wet year was 2015. Since then, there were three near-average years (2016, 2017, and 2018) followed by four dry years (2020, 2021, 2022, and 2023).

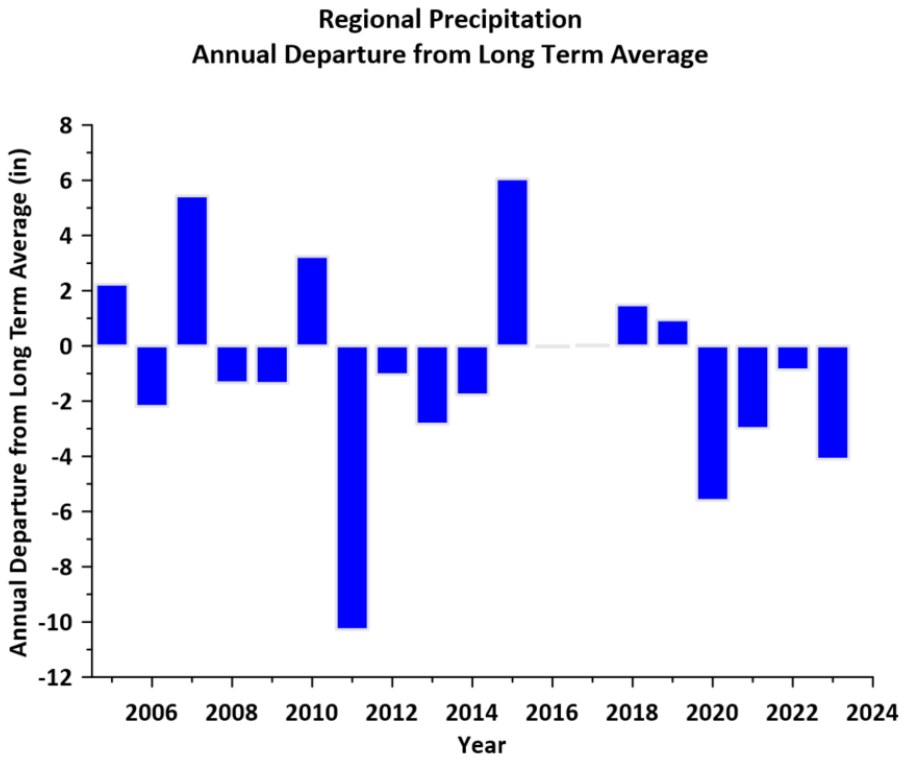

Figure 3. Regional Precipitation Annual Departures from Average

3.0 GAM Results and Comparison to Actual Data

The Fortran program *getDFCdd.exe* reads the actual drawdown data described above (503 records) and extract the groundwater elevations from those same points and years from the calibrated model (2005) and the DFC simulation (2006 to 2070). The results are saved in the Excel spreadsheet *ActualDD Sim DD 2005 to 2024.xlsx*. Also included in these results are the precipitation data for the years 2005 to 2023. Table 3 presents the annual summary included in the Excel file.

Table 3. Summary of Annual Drawdown Comparison

Year	Record Count	Average Actual Drawdown (ft)	Average Simulated Drawdown (ft)	Precipitation (in)	Precipitation (% of Average)
2005	38	0.00	0.00	15.60	116.75
2006	27	-0.05	2.18	11.17	83.59
2007	26	-1.25	3.32	18.79	140.66
2008	22	5.28	4.21	12.02	89.99
2009	31	-0.24	4.71	12.00	89.82
2010	25	2.16	4.93	16.60	124.27
2011	30	8.93	5.46	3.08	23.07
2012	29	13.39	5.99	12.32	92.18
2013	29	15.37	6.45	10.53	78.80
2014	29	12.56	6.91	11.58	86.70
2015	28	4.25	7.32	19.41	145.30
2016	27	4.13	7.80	13.32	99.70
2017	22	6.17	8.57	13.39	100.24
2018	23	4.83	9.00	14.85	111.13
2019	23	17.13	9.41	14.30	107.04
2020	23	15.39	9.82	7.76	58.07
2021	23	14.46	10.22	10.37	77.62
2022	23	12.24	10.62	12.50	93.53
2023	23	13.46	11.02	9.26	69.27
2024	2	25.23	18.42	NA	NA

Figure 4 presents a hydrograph of actual average drawdown and simulated average drawdown from 2005 to 2023. Please note that the blue numbers represent the annual precipitation for each year expressed as a percentage of long-term average, and the red numbers represent the numbers of records that were compared in each year.

Please note that the simulated drawdown is declining from 2005 to 2021 with only slight variations from a linear trend. The linear trend is expected because the simulation assumed constant and average rainfall and recharge conditions.

Based on the last few years, it is expected that the TWDB precipitation data for 2024 will be posted in April or May 2025. The groundwater level data for 2024 does not yet appear complete. This may suggest that this analysis be completed later in the calendar year in the future to get a more complete picture in the annual assessment.

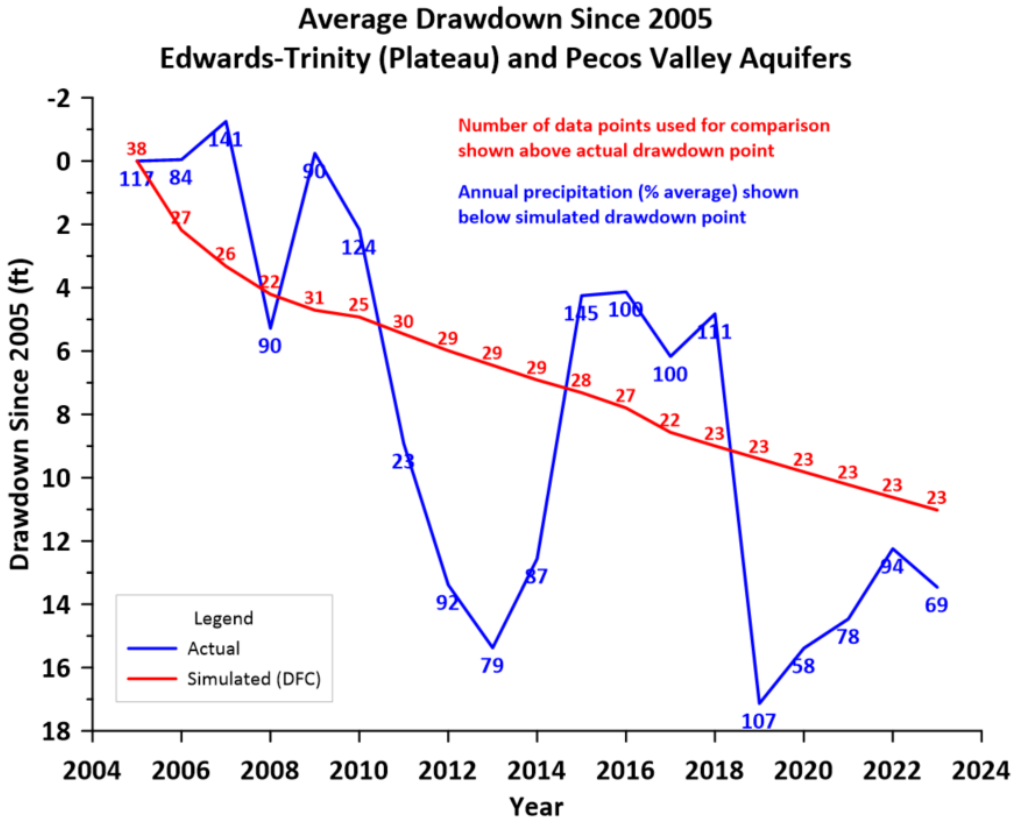

Figure 4. Average Drawdown Comparison (2005 to 2023)

The actual drawdown appears to rise and fall generally with precipitation (wet years yield low drawdowns and dry years yield higher drawdowns). This is expected since pumping generally increases during drought years as irrigation demands are higher.

A more complete analysis of this observation is presented in Figure 5, which presents a plot of annual precipitation vs. measured average drawdown, along with the best-fit line based on a second-order polynomial regression of drawdown in feet (DD) and annual precipitation in inches (PCP):

$$DD = 9.86 + (0.70*PCP) - 0.063*PCP^2)$$

The 98% confidence of the linear regression is also shown.

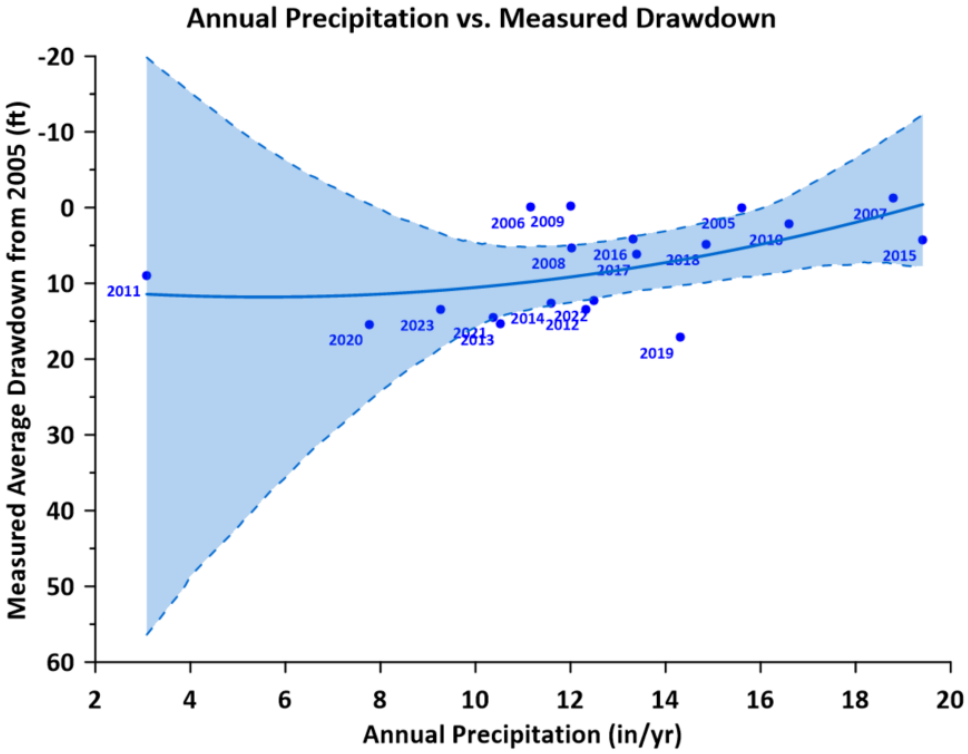

Figure 5. Annual Precipitation vs. Measured Drawdown

Please note that the year is also shown on each data point. As expected, the higher the rainfall, the lower the drawdown. However, the plot shows considerable scatter. During dry years, the confidence band is wider due to that general lack of data (2011 was an exceptionally dry year with only about 3 inches of precipitation).

The correlation is not particularly strong, which means that there are several influences and factors that are not considered in this simple analysis. A cursory review of the figure also shows that 2019 is anomalous. In 2019, the average drawdown is greater than expected given the precipitation that year. Pumping from exempt oil and gas operations was unusually high in 2019 (about 11,000 AF/yr), which could explain the high drawdown in 2019 compared to the other years if the monitoring wells that were used for this analysis were located near the pumping. Please note that since the subsequent years generally fall within the confidence band, there is little need to delve into this issue further for purposes of comparing actual and simulated drawdowns.

4.0 Discussion and Recommendations

The TWDB database was sampled to find wells with groundwater elevation measurements in Pecos County. The analysis showed that the TWDB database did not have sufficient groundwater elevation data to complete a comparison with simulated drawdowns for the Capitan Reef Complex, Dockum, and Rustler aquifers. It is recommended that monitoring of wells completed in these aquifers be identified and data collection from these wells improved, or the aquifers be classified as not relevant for purposes of joint planning. Such a classification would result in no desired

future condition for that aquifer in Pecos County and would result in no modeled available groundwater calculation by the Texas Water Development Board. The Regional Planning Group (Region F) would be responsible for establishing groundwater availability if an aquifer is classified as not relevant for purposes of joint planning.

The analysis showed that the TWDB database had sufficient groundwater elevation data to complete a comparison with simulated drawdown for the Edwards-Trinity (Plateau) and Pecos Valley aquifers. The database was sampled to find wells in Pecos County with groundwater elevation measurements in 2005 to compare with simulated drawdowns from the GAM simulation that was the basis for the desired future condition.

The comparison of measured drawdowns with simulated drawdowns showed that, in general, when annual precipitation is higher than average, measured drawdown is less than simulated drawdown and when annual precipitation is less than average, measured drawdown is higher than simulated drawdown. In general, lower than average precipitation correlates with lower-than-average recharge and higher than average pumping. However, this relationship is complex and other factors are important. This analysis shows a weak correlation between annual precipitation and measured drawdown, but the analysis also shows that the measured drawdowns are consistent with the simulation that was the basis for the desired future condition.

Based on this analysis, it is recommended that the future annual updates to this analysis be delayed until later in the year to provide more groundwater level data. If the analysis were completed in the fall, more data from the end of the previous year will be available for analysis.

5.0 References

Hutchison, W.R., 2020. Comparison of Groundwater Elevations and Drawdowns: GAM DFC Simulation and Measured Data from TWDB. Report to Middle Pecos Groundwater Conservation District, Fort Stockton, Texas. June 8, 2020, 50p.

Hutchison, W.R., 2023. 2024 Update: Comparison of Groundwater Elevations and Drawdowns: GAM DFC Simulation and Measured Data from TWDB. Report to Middle Pecos Groundwater Conservation District, Fort Stockton, Texas. May 11, 2023, 11p.