SUTTON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT

MANAGEMENT PLAN

2019 - 2024

Re-Adopted:
October 9, 2018

301 S. Crockett Avenue
Sonora, Texas 76950

Ph: 325/387-2369 Fax: 325/387-5737
email: opmanager@suttoncountyuwcd.org
website: www.suttoncountyuwcd.org
Meredith Allen, Operations Manager

TABLE OF CONTENTS

CH 1 DISTRICT MISSION & OVERVIEW

1.1 DISTRICT MISSION

It is the Mission of the Sutton County Underground Water Conservation District (the District) to preserve and optimize our groundwater resources for the use by current and future residents of the District. The District also seeks to maintain groundwater ownership and rights of the landowners and their lessees as provided in the Texas Water Code §36.002.

1.2 GUIDING PRINCIPLES

The District, a local government agency, provides for the conservation, preservation, protection, recharge and prevention of waste of the underground water reservoir, Edwards-Trinity (Plateau) Aquifer, located under the District; by consistently adhering to Chapter 36 of the Texas Water Code (TWC). The District conducts administrative and technical activities and programs to achieve these purposes by collecting, archiving water well and aquifer data, regulating water well drilling and production of permitted, non-exempt wells, promoting the capping or plugging of abandoned wells, providing information and educational material to local property owners, interacting with other governmental or organizational entities, and undertaking other groundwater-related activities that may help meet the purposes of the District. The District also strives to maintain groundwater ownership and rights of the landowners as provided in the TWC §36.002. Note: The District is drafting new RULES, which are planned for implementation mid-2019.

1.3 TIME PERIOD FOR THIS PLAN

This plan becomes effective upon adoption by the Board of Directors and approval by the Texas Water Development Board executive administrator. This new plan remains in effect for a five-year period or until a revised plan is approved, whichever is earlier.

1.4 GENERAL DESCRIPTION OF THE DISTRICT

The Sutton County Underground Water Conservation District was created by the 69th Texas Legislature (1985) under the authority of Section 59, Article XVI, of the Texas Constitution, and in accordance with Chapter 51 and 52 of the Texas Water Code. Note, in 1995, by Acts of the 74th Legislature, Chapter 52 of the Texas Water Code was repealed and replaced with Chapter 36 of the Texas Water Code effective September 1, 1995. The District was created to provide for the conservation, preservation, protection, recharge and prevention of waste of the underground water located under the District. The District encompasses all of Sutton County and is governed by a five-member locally-elected board of directors. The board includes four members from individual precincts and one at-large member; with elections being held every two years. Sutton County's economy is primarily based on agriculture, oil and gas, tourism, and recreational hunting.

Location and Extent

The District lies within the Edwards Plateau and consists of approximately 929,920 acres in Sutton County, Texas. Sonora is the county seat and the only city in the county. The population of Sutton County was approximately 4,128 in 2010. Sutton County is bordered by Schleicher County to the north, Kimble County to the east, Edwards and Val Verde Counties to the south and Crockett County to the west.

Topography and Drainage
The land is generally rolling to stony, flat topped hills with elevations from 1,900 to 2,500 feet. The District is included in two different river basins, the Colorado and the Rio Grande. The western half of the county slopes southwestward into the Devils River. The eastern half drains to the North Llano River and a small portion drains northeastward to the San Saba River.

1.5 REGIONAL COOPERATION AND COORDINATION

West Texas Regional Groundwater Alliance
Since 1988 the District has been involved in coordination of district activities with other GCD's managing the Edwards-Trinity (Plateau) Aquifer. In 1988, four groundwater conservation districts; Coke County UWCD, Glasscock County UWCD, Irion County WCD, and Sterling County UWCD signed an original Cooperative Agreement. As new districts were created, they too signed the Cooperative Agreement. In the fall of 1996, the original Cooperative Agreement was redrafted and the West Texas Regional Groundwater Alliance was created. The regional alliance consists of seventeen locally created and locally funded groundwater conservation districts covering all or part of twenty-two counties, which encompass approximately 18.2 million acres or 28,368 square miles, of West Central Texas. This West Texas region is as diverse as the State of Texas. Due to the diversity of this region, each member district provides its own unique programs to best serve its constituents. Current member districts are:

Coke Co. UWCD	Kimble Co. GCD	Plateau UWC & SD
Crockett Co. GCD	Lipan-Kickapoo WCD	Santa Rita UWCD
Glasscock GCD	Lone Wolf GCD	Sterling Co. UWCD
Hickory UWCD # 1	Menard Co. UWD	Sutton Co. UWCD
Hill Country UWCD	Middle Pecos GCD	Wes-Tex GCD
Irion Co. WCD	Permian Basin UWCD	

This Alliance was created because the local districts have a common objective: to facilitate the conservation, preservation and protection of groundwater supplies, protection and enhancement of recharge, prevention of waste and pollution, and beneficial use of water and related resources. Local districts monitor water-related activities which include but are not limited to the State's largest industries of farming, ranching and oil and gas production. The alliance provides coordination essential to the activities of these member districts as they monitor these activities in order to accomplish their objectives.

West Texas Weather Modification Association
In 1996, in response to the resident landowners of seven groundwater conservation districts, the West Texas Weather Modification Association was formed for the purpose of providing weather modification (cloud seeding) for rainfall and recharge enhancement

throughout the geographical region of its members. The target area of the Association includes all of seven counties and part of an 8th for a total area of over 5.8 million acres or 9,000 square miles of West Central Texas. Current membership includes:

City of San Angelo	Irion County WCD	Sterling County UWCD
Crockett Co GCD	Plateau UWC & SD	Sutton County UWCD
	Santa Rita UWCD	

Recognizing the importance of rainfall in the region, this Association was formed to provide benefits from enhanced rainfall which includes a reduction of groundwater withdrawals, increase in runoff, and increase in agricultural productivity with the resulting economic impact for the region, provide additional recharge, and increase spring flow. These benefits are not only realized within the region but also downwind and downstream of the target area.

Regional Water Planning

The District has been active in the Region F, Regional Water Planning Group meetings to provide input in developing and adopting the 2001, 2006, 2011 and 2016 Regional plans. As the Regional Planning Group moves toward adopting future Regional Plans the District will continue to participate in the planning process.

Groundwater Management Area

Groundwater Management Area 7 covers all or part of thirty-three counties and includes twenty groundwater conservation districts. These GCD's manage groundwater resources at the local level in all or part of twenty-four counties within GMA 7 and surrounding areas. The District continues to actively participate in meetings and discussions to determine a feasible future desired condition of the aquifers within the management area and district.

CH 2 GROUNDWATER RESOURCES & MANAGEMENT

2.1 GROUNDWATER RESOURCES

Central Edwards Plateau (Plateau) Geology

The underlying Paleozoic rocks provide a relatively impermeable base for much of the Edwards-Trinity (Plateau) Aquifer (Barker and Ardis, 1992). In the north, the Edwards-Trinity (Plateau) Aquifer overlies Late Triassic age rocks of the Dockum Group (Figure 5-5). The Dockum Group consists of the Santa Rosa, Tecovas, Trujillo, and Cooper Canyon formations that form the Dockum Aquifer (Bradley and Kalaswad, 2003). Hydraulic communication between the Dockum Aquifer and the Trinity hydrostratigraphic unit of the Edwards-Trinity (Plateau) Aquifer is insignificant except where the Trinity Group lies directly over the Santa Rosa Formation (Walker, 1979).

The Trinity hydrostratigraphic unit is composed of the Trinity Group, which consists of the Basal Cretaceous Sand, the Glen Rose Limestone, the Antlers Sand, and the Maxon Sand. The Basal Cretaceous and Maxon sands are sometimes grouped together and are laterally equivalent to the Antlers Sand (sometimes also referred to as Trinity Sands) in the northern plateau area where the Glen Rose Limestone is absent.

The Fredericksburg Group consists of the Fort Terrett Formation and the lower part of the Fort Lancaster Formation, the Devils River Formation within the Devils River Reef Trend, and the West Nueces and McKnight formations within the Maverick Basin. The Lower Washita Group is composed of the Fort Lancaster Formation, the Devils River Formation within the Devils River Reef Trend, and the McKnight and Salmon Peak formations within the Maverick Basin. Locally, these units are combined and referred to as the Edwards Group Limestones (Rose, 1972) and form the Edwards hydrostratigraphic unit of the Edwards-Trinity (Plateau) Aquifer.

The Upper Cretaceous sediments include the uppermost section of the Washita Group sediments (Del Rio Clay and the Buda Limestone). The Boquillas Formation of the Eagle Ford Group and the Austin Chalk Formation of the Austin Group sediments are present only within Val Verde and Terrell counties. The Upper Cretaceous sediments are generally considered confining units to the underlying Edwards hydrostratigraphic unit of the Edwards-Trinity (Plateau) Aquifer.

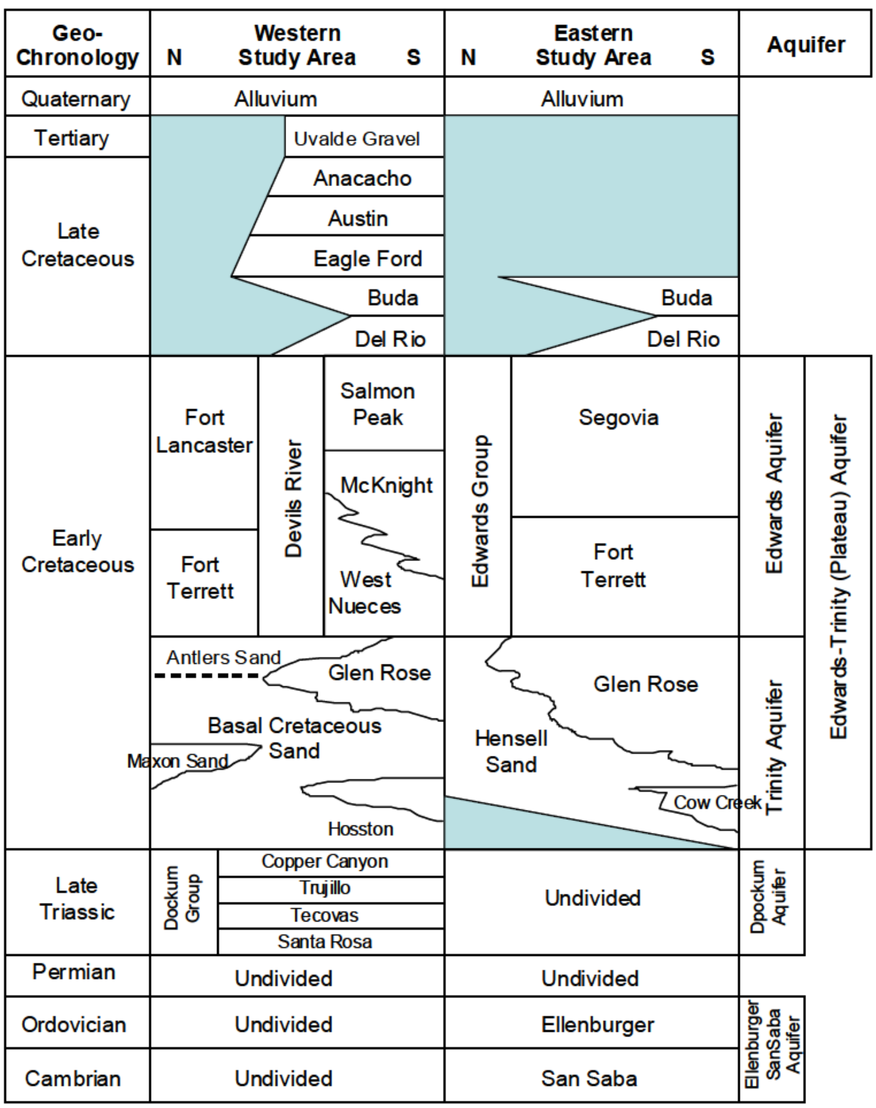


Figure 1 Stratigraphy of Edwards Plateau in the study area (Adapted from Anaya and Jones, 2009).

2.2 MANAGEMENT OF GROUNDWATER SUPPLIES

The District monitors and evaluates groundwater conditions, regulates production and the transport of groundwater out of the District consistent with this plan, the District Rules and TWC Chapter 36. Production is regulated as needed to conserve groundwater, and protect groundwater users, while not unnecessarily or adversely limiting production or impacting the economic viability of the public, landowners and private groundwater users. In consideration of the importance of groundwater to the economy and culture of the District, the District identifies and engages in activities and practices that permit groundwater production and, as appropriate, protects the aquifer and groundwater in accordance with this Management Plan and the District's Rules. A monitoring well network is maintained to monitor aquifer conditions within the District. The District makes a regular assessment of water supply and groundwater storage conditions and reports those conditions as appropriate in public meetings of the Board or public announcements. The District undertakes investigations, and co-operates with third-party investigations, of the groundwater resources within the District, and the results of the investigations are made available to the public when presented at a meeting of the Board.

The District adopts Rules to regulate groundwater withdrawals by means of well spacing and production limits as appropriate to implement this Plan. In making a determination to grant a permit or limit groundwater withdrawals, the District considers the available evidence and, as appropriate and applicable, weigh the public benefit against the individual needs and hardship.

The factors that the District may consider in making a determination to grant a drilling, or operating permit, or limiting groundwater withdrawals include:

1. The purpose of the Rules of the District;
2. The equitable distribution of the resource;
3. The economic hardship resulting from grant or denial of a permit, or the terms prescribed by the permit;
4. This Management Plan and Desired Future Conditions of the District as adopted in Joint Planning under TWC § 36.108; and
5. The potential effect the permit may have on the aquifer, and groundwater users.

In pursuit of the District's mission of protecting the groundwater resources, the District may require adjustment of groundwater withdrawals in accordance with the Rules and Management Plan. To achieve this purpose, the District may, at the Board's discretion after notice and hearing, amend or revoke any permit for non-compliance, or reduce the production authorized by permit for the purpose of protecting the aquifer and groundwater availability. The determination to seek the amendment of a permit will be based on aquifer conditions observed by the District as stated in the District's Rules. The determination to seek revocation of a permit will be based on compliance and non-compliance with the District's Rules and regulations. The District will enforce the terms and conditions of permits and the Rules of the District, as necessary, by fine and enjoining the permit holder in a court of competent jurisdiction as provided for in TWC § 36.102. The District adopted a drought contingency plan (DCP), see Appendix E for managing groundwater resources when collected data indicates water levels are dropping. The DCP contains water level trigger points associated with a drought index well that is sited on the north end of the Sonora Golf Course. These trigger points invoke certain actions in the DCP as conditions worsen, and conversely as they improve.

The District uses reasonable and necessary technical resources at its disposal to evaluate the groundwater resources available within the District and determines the effectiveness of regulatory or conservation measures. A public or private user may appeal to the Board for discretion in enforcement of the provisions contained in the DCP on grounds of adverse economic hardship or unique local conditions. The exercise of discretion by the Board shall not be construed as limiting the power of the Board.

2.3 Estimated Available Groundwater

DFC / MAG

Estimate of modeled available groundwater in the District are based on desired future conditions. Texas Water Code § 36.001 defines modeled available groundwater 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 joint planning process set forth in Texas Water Code § 36.108 must be collectively conducted by all groundwater conservation districts within the same GMA. The District is a member of GMA **7.** GMA 7 adopted DFCs for the Edwards/Trinity (Plateau) Aquifer on March 22, 2018. The adopted DFCs were forwarded to the TWDB for development of the MAG calculations. The submittal package for the DFCs can be found here:
https://www.twdb.texas.gov/groundwater/management_areas/dfc_mag/GMA_7_DFC.pdf

A summary of the desired future conditions and the modeled available groundwater are summarized below.

Edwards/Trinity (Plateau) Aquifer: An average drawdown of 7 feet for the Edwards-Trinity (Plateau) aquifer, except for the Kinney County GCD, based on the GMA 7 Technical Memorandum 18-01.

Estimated Modeled Available Groundwater in acre/feet (ac/ft) for the Edwards/Trinity (Plateau) Aquifer by district from GAM Run 16-026 MAG Version 2.

		Modeled Available Groundwater (year)						
District	**Aquifer**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Sutton	Edwards-Trinity (Plateau)	6,400	6,400	6,400	6,400	6,400	6,400	6,400

2.3.1 Estimate of The Annual Amount of Recharge From Precipitation

Please refer to Appendix C - GAM Run 13-005

2.3.2 Estimate of The Annual Volume of Water That Discharges From The Aquifer To Springs and Any Surface Water Bodies

Please refer to Appendix C - GAM Run 13-005

2.3.3 Estimate of The Annual Volume of Flow Into The District
Please refer to Appendix C - GAM Run 13-005

2.3.4 Estimate of The Annual Volume of Flow Out of The District
Please refer to Appendix C - GAM Run 13-005

2.3.5 Estimate of The Annual Volume of Flow Between Aquifers in the District
Please refer to Appendix C - GAM Run 13-005

2.3.6 Surface Water Resources
Please refer to Appendix B

2.3.7 Projected Total Water Demand
Sutton County's population is projected to increase by approximately 5.2% between 2010 and 2070, according to the Region F Regional Water Plan[vii]. Based on estimated projections, water demands will increase proportionately into the year 2070, at which point the total demand for Sutton County will be approximately 3,926 acre/feet.

Please refer to Appendix B

2.4 Consideration of The Water Supply Needs

Current estimates of supply and demand indicate a projected surplus for irrigation and for the City of Sonora, the only municipality in the District.

Please refer to Appendix B

2.4.1 Consideration of The Water Management Strategies
Preservation and protection of groundwater quantity and quality has been the guiding principle of the District since its creation. The goals and objectives of this plan provide guidance in the performance of existing District activities and practices. District Rules address groundwater withdrawals by means of spacing and/or production limits, waste, and well drilling completion as well as capping and plugging of unused or abandoned wells. These Rules are meant to provide equitable conservation and preservation of groundwater resources, protect vested property rights and prevent confiscation of property. The district continues to encourage conservation, reuse and weather modification to meet the projected strategies in the TWDB 2017 State Water Plan and the TWDB Estimated Historical Water Use.

Please refer to Appendix B

2.4.2 Actions, Procedures, Performance, and Avoidance Necessary to Effectuate the Management Plan
The District will implement and utilize the provisions of this plan as a guide for determining the direction and/or priority for District activities. Operations of the District and all agreements entered into by the District will be consistent with the provisions of this plan.

The District has adopted Rules for the management of groundwater resources and will amend those Rules as necessary pursuant to TWC Chapter 36 and the provisions of this plan. Rules will be adhered to and enforced. The promulgation and enforcement of the Rules will be based on the best technical evidence available.

The District shall treat all residents with equality. Residents may apply to the District for discretion in enforcement of the Rules on grounds of adverse economic effect or unique local character. In granting discretion to any rule, the Board shall consider the potential for adverse effect on adjacent landowners. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board. The District will seek cooperation in the implementation of this plan and the management of groundwater supplies within the District.

2.4.3 Methodology for Tracking Progress

The methodology that the District will use to trace the progress in achieving the management goals as prescribed by TWC 36.1071(a) will be as follows:

> The District General Manager will prepare and present an annual report to the Board of Directors on District performance regarding management plan goals and objectives for the preceding year during the first meeting of each year. The annual report will be maintained at the District office.

CH 3 GOALS, MANAGEMENT OBJECTIVES, & PEFORMANCE STANDARDS

The District recognizes the importance of public education to encourage efficient use, implement conservation practices, prevent waste, and preserve the integrity of groundwater. Since the District was formed in 1985, it has provided residents with materials, programs, water analysis, and other information when requested, including requests from the TWDB for water level and analysis data.

3.1 Goal 1 - §36.1071(a)(1) Providing the Most Efficient Use of Groundwater

The District, through programs and its Rules, strives to ensure the most efficient use of groundwater in order to sustain available resources for the future while maintaining the economic growth and respecting private property rights of the District.

Management Objective 1.1
The District will require that all wells be registered in accordance with its current Rules.

Performance Standard 1.1
The Board of Directors will receive quarterly briefings by the General Manager regarding the District's well registration program new wells. The registration data will also be included in the Annual Report to the Board of Directors.

3.2 Goal 2 - §36.1071(a)(2) Controlling and Preventing Waste of Groundwater

An important goal of the District is to implement strategies that will control and prevent the waste of groundwater. The District believes education to its citizens is the best way to prevent waste of groundwater in the District.

Management Objective 2.1

The District will annually provide at least one printed publication, and one public speaking event to provide educational leadership on eliminating and reducing wasteful practices in the use of groundwater.

Performance Standard 2.1

Printed publications and reports of any public speaking events will be included in the District's Annual Report to be provided to the Board of Directors.

Management Objective 2.2

The District will minimize the potential contamination of groundwater by monitoring the spacing and completion of wells.

Performance Standard 2.2

All new registered wells drilled within the District will be in accordance with District Spacing Rules, and maintain information on registered wells to be reported quarterly at regular Board Meetings.

3.3 Goal 3 – §36.1071(a)(5) Addressing Natural Resource Issues

The District understands that the groundwater is a natural resource that must be maintained and researched. The District is committed to continuously learn more about our Edwards-Trinity Aquifer.

Management Objective 3.1

The District will measure monthly wells within the water level monitoring network through steel tape, and electronic sensors.

Performance Standard 3.1

Report at least quarterly to the Board of Directors the measurement of water levels from at least 20 wells monitored in the District's water level monitoring network. The water level report will also be included in the District's Annual Report.

3.4 Goal 4 - §36.1071(a)(6) Addressing Drought Conditions

Groundwater in the District is very affected by drought, and therefore one of the District's main concerns. The Texas Water Development Board provides a very useful website for information on drought called "Water Data for Texas", which can be found here: **waterdatafortexas.org/drought.**

Management Objective 4.1

The District has an approved Drought Contingency Plan compliant with TCEQ standards, it also has a drought index well with trigger levels referenced in the plan (see Appendix E).

Performance Standard
The Drought Contingency Plan is attached as Appendix E. It will also be accessible to the public through the District's website.
Management Objective 4.2
The District will measure its drought index well at least quarterly to monitor drought conditions in Sutton County.

Performance Standard
The Drought Index Well measurements will be presented at the Board Meetings at least quarterly, and included in the Annual Report.

3.5 Goal 5 - §36.1071(a)(7) Addressing Conservation and Precipitation Enhancement

The District will continue to be a source for available informational materials and programs to improve public awareness of efficient use, wasteful practices and conservation measures including the water conservation best management practices guide presented by the Water Conservation Advisory Council: http://www.savetexaswater.org/bmp/.

Management Objective 5.1
The District will maintain a district-wide rainfall event network using voluntary monitors and automatic digital rainfall collectors to help evaluate recharge.

Performance Standard 5.1
The District will report at least quarterly to the Board of Directors rainfall totals collected from at least 20 of the automated rain gauges around the county and ten Stratus Professional rain gauge (Model RG202) located throughout Sonora, TX in the rainfall monitoring network.

Management Objective 5.2
The District will continue to participate in the West Texas Weather Modification Association.

Performance Standard 5.2
Provide West Texas Weather Modification Association Annual Report to the Board of Directors.

Management Objective 5.3
Promote public awareness of the need for water conservation. Present a minimum of one public water conservation show, demonstration, event, or educational talk each year.

Performance Standard 5.3
Report these educational activities to the District Board of directors in the Annual Report.

3.6 Goal 6 - §36.1071(a)(8) Addressing the Desired Future Conditions established under §36.108

The District uses the best available science to establish its DFC. See Appendices A and C.

Management Objective 6.1
The District has an ongoing program using its drought contingency well and monitoring network of water wells to assess groundwater resources; then analyzing changes in the potentiometric surface of the aquifer.
Performance Standard 6.1
The Drought Contingency Plan, Drought Index Well and all of the monitoring network data will be analyzed and reported in the District's Annual Report.

3.7 MANAGEMENT GOALS NOT APPLICABLE

Controlling and Preventing Subsidence (36.1071(a)(3))
The rigid geologic framework of the region precludes significant subsidence from occurring. This management goal is not applicable to the operations of the District.

Addressing Conjunctive Surface Water Management Issues (36.1071(a)(4))
There are no surface water management entities within the District. This management goal is not applicable to the operations of the District.

Addressing Recharge Enhancement (36.1071(a)(7))
The diverse topography and limited knowledge of any specific recharge sites makes any type of recharge enhancement project economically unfeasible. This management goal is not applicable to the operation of the District.

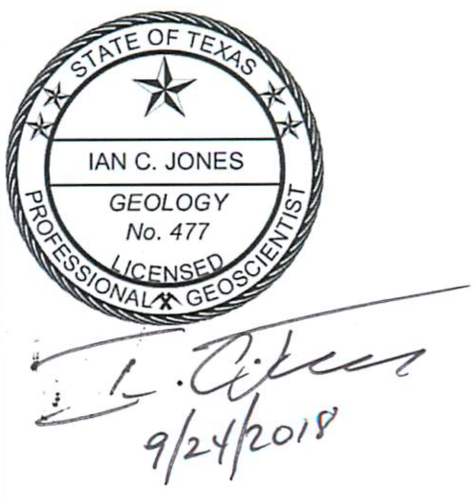
Addressing Rainwater Harvesting (36.1071(a)(7))
The semiarid nature of the area within the District makes the cost of rainwater harvesting projects economically unfeasible. Educational material and programs on rainwater harvesting are provided by the Texas AgriLife Extension Service. This management goal is not applicable to the operations of the District.

Addressing Brush Control (36.1071(a)(7))
The District recognizes the benefits of brush control through increased spring flows and the enhancement of native turf which limits runoff. However, most brush control projects within the District are carried out and funded through the NRCS and ample educational material and programs on brush control are provided by the Texas AgriLife Extension Service. This management goal is not applicable to the operations of the District.

APPENDIX A

GAM Run 16-026 MAG Version 2: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 7

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 463-6641
September 21, 2018



This page is intentionally left blank.

GAM RUN 16-026 MAG VERSION 2: MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 463-6641
September 21, 2018

EXECUTIVE SUMMARY:

We have prepared estimates of the modeled available groundwater for the relevant aquifers of Groundwater Management Area 7—the Capitan Reef Complex, Dockum, Edwards-Trinity (Plateau), Ellenburger-San Saba, Hickory, Ogallala, Pecos Valley, Rustler, and Trinity aquifers. The estimates are based on the desired future conditions for these aquifers adopted by the groundwater conservation districts in Groundwater Management Area 7 on September 22, 2016 and March 22, 2018. The explanatory reports and other materials submitted to the Texas Water Development Board (TWDB) were determined to be administratively complete on June 22, 2018.

The original version of GAM Run 16-026 MAG inadvertently included modeled available groundwater estimates for areas declared not relevant by the groundwater management area and areas that had no desired future conditions for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers. GAM Run 16-026 MAG Version 2 (this report) contains updates that only include relevant portions of these aquifers in the reported total modeled available groundwater estimates and Tables 5 and 6 for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers.

The modeled available groundwater values are summarized by decade for the groundwater conservation districts (Tables 1, 3, 5, 7, 9, 11, 13) and for use in the regional water planning process (Tables 2, 4, 6, 8, 10, 12, 14). The modeled available groundwater estimates are 26,164 acre-feet per year in the Capitan Reef Complex Aquifer; 2,324 acre-feet per year in the Dockum Aquifer; 474,464 acre-feet per year in the undifferentiated Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers; 22,616 acre-feet per year in the Ellenburger-San Saba Aquifer; 49,936 acre-feet per year in the Hickory Aquifer; 6,570 to 8,019 acre-feet per year in the Ogallala Aquifer; and 7,040 acre-feet per year in the Rustler Aquifer. The modeled available groundwater estimates were extracted from results of model runs using the groundwater availability models for the Capitan Reef Complex Aquifer (Jones, 2016); the High Plains Aquifer System (Deeds and Jigmond, 2015); the minor aquifers of the Llano Uplift Area (Shi and others, 2016), and the Rustler Aquifer (Ewing and others, 2012). In addition, the alternative 1-layer model for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers (Hutchison and others, 2011) was used for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers, except for Kinney and Val Verde counties. In these two counties, the alternative Kinney County model (Hutchison and others, 2011) and the model associated with a hydrogeological study for Val Verde County and the City of Del Rio (EcoKai Environmental, Inc. and Hutchison, 2014), respectively, were used to estimate modeled available groundwater. The Val Verde County/Del Rio model covers Val Verde County. This model was used to simulate multiple pumping scenarios indicating the effects of a proposed wellfield. The model indicated the effects of varied pumping rates and wellfield locations. These model runs were used by Groundwater Management Area 7 as the basis for the desired future conditions for Val Verde County.

REQUESTOR:

Mr. Joel Pigg, chair of Groundwater Management Area 7 districts.

DESCRIPTION OF REQUEST:

In letters dated November 22, 2016 and March 26, 2018, Dr. William Hutchison on behalf of Groundwater Management Area 7 provided the TWDB with the desired future conditions for the Capitan, Dockum, Edwards-Trinity (Plateau), Ellenburger-San Saba, Hickory, Ogallala, Pecos Valley, Rustler, and Trinity aquifers in Groundwater Management Area 7. Groundwater Management Area 7 provided additional clarifications through emails to the TWDB on March 23, 2018 and June 12, 2018 for the use of model extents (Dockum, Ellenburger-San Saba, Hickory, Ogallala, Rustler aquifers), the use of aquifer extents (Capitan Reef Complex, Edwards-Trinity [Plateau], Pecos Valley, and Trinity aquifers), and desired future conditions for the Edwards-Trinity (Plateau) Aquifer of Kinney and Val Verde counties.

The final adopted desired future conditions as stated in signed resolutions for the aquifers in Groundwater Management Area 7 are reproduced below:

Capitan Reef [Complex] Aquifer

> Total net drawdown of the Capitan Reef [Complex] Aquifer not to exceed 56 feet in Pecos County (Middle Pecos [Groundwater Conservation District]) in 2070 as compared with 2006 aquifer levels (Reference: Scenario 4, GMA 7 Technical Memorandum 15-06, 4-8-2015).

Dockum Aquifer

Total net drawdown of the Dockum Aquifer not to exceed 14 feet in Reagan County (Santa Rita [Groundwater Conservation District]) in 2070, as compared with 2012 aquifer levels.

Total net drawdown of the Dockum Aquifer not to exceed 52 feet in Pecos County (Middle Pecos [Groundwater Conservation District]) in 2070, as compared with 2012 aquifer levels.

Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers

Average drawdown for [the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers] in the following [Groundwater Management Area] 7 counties not to exceed drawdowns from 2010 to 2070 […].

County	[…] Average Drawdowns from 2010 to 2070 [feet]
Coke	0
Crockett	10
Ector	4
Edwards	2
Gillespie	5
Glasscock	42
Irion	10
Kimble	1
Menard	1
Midland	12
Pecos	14
Reagan	42
Real	4
Schleicher	8
Sterling	7
Sutton	6

Taylor	0
Terrell	2
Upton	20
Uvalde	2

Total net drawdown *[of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers]* in Kinney County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an annual average flow of 23.9 [cubic feet per second] and an annual median flow of 23.9 [cubic feet per second] at Las Moras Springs [...].

Total net drawdown [of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers] in Val Verde County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an average annual flow of 73-75 [million gallons per day] at San Felipe Springs.

Minor Aquifers of the Llano Uplift Area

Total net drawdowns of [Ellenburger-San Saba Aquifer] levels in 2070, as compared with 2010 aquifer levels, shall not exceed the number of feet set forth below, respectively, for the following counties and districts:

County	[Groundwater Conservation District]	Drawdown in 2070 (feet)
Gillespie	Hill Country [Underground Water Conservation District]	8
Mason	Hickory [Underground Water Conservation District] no. 1	14
McCulloch	Hickory [Underground Water Conservation District] no. 1	29
Menard	Menard County [Underground Water District] and Hickory [Underground Water Conservation District] no. 1	46
Kimble	Kimble County [Groundwater Conservation District] and Hickory	18

Ogallala Aquifer

Total net [drawdown] of the Ogallala Aquifer in Glasscock County (Glasscock [Groundwater Conservation District]) in 2070, as compared with 2012 aquifer levels, not to exceed 6 feet […].

Rustler Aquifer

Total net drawdown of the Rustler Aquifer in Pecos County (Middle Pecos GCD) in 2070 not to exceed 94 feet as compared with 2009 aquifer levels.

Additionally, districts in Groundwater Management Area 7 voted to declare that the following aquifers or parts of aquifers are non-relevant for the purposes of joint planning:

- The Blaine, Igneous, Lipan, Marble Falls, and Seymour aquifers.
- The Edwards-Trinity (Plateau) Aquifer in Hickory Underground Water Conservation District No. 1, the Lipan-Kickapoo Water Conservation District, Lone Wolf Groundwater Conservation District, and Wes-Tex Groundwater Conservation District.
- The Ellenburger-San Saba Aquifer in Llano County.
- The Hickory Aquifer in Llano County.
- The Dockum Aquifer outside of Santa Rita Groundwater Conservation District and Middle Pecos Groundwater Conservation District.
- The Ogallala Aquifer outside of Glasscock County.

In response to a several requests for clarifications from the TWDB in 2017 and 2018, the Groundwater Management Area 7 Chair, Mr. Joel Pigg, and Groundwater Management Area 7 consultant, Dr. William R. Hutchison, indicated the following preferences for verifying the desired future condition of the aquifers and calculating modeled available groundwater volumes in Groundwater Management Area 7:

Capitan Reef Complex Aquifer

Calculate modeled available groundwater values based on the official aquifer boundaries.

Assume that modeled drawdown verifications within 1 foot achieve the desired future conditions.

Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers

Calculate modeled available groundwater values based on the official aquifer boundaries.

Assume that modeled drawdown verifications within 1 foot achieve the desired future conditions.

Kinney County

Use the modeled available groundwater values and model assumptions from GAM Run 10-043 MAG Version 2 (Shi, 2012) to maintain annual average springflow of 23.9 cubic feet per second and a median flow of 24.4 cubic feet per second at Las Moras Springs from 2010 to 2060.

Val Verde County

There is no associated drawdown as a desired future condition. The desired future condition is based solely on simulated springflow conditions at San Felipe Spring of 73 to 75 million gallons per day. Pumping scenarios—50,000 acre-feet per year—in three well field locations, and monthly hydrologic conditions for the historic period 1969 to 2012 meet the desired future conditions set by Groundwater Management Area 7 (EcoKai and Hutchison, 2014; Hutchison 2018b).

Minor Aquifers of the Llano Uplift Area

Calculate modeled available groundwater values based on the spatial extent of the Ellenburger-San Saba and Hickory aquifers in the groundwater availability model for the aquifers of the Llano Uplift Area and use the same model assumptions used in Groundwater Management Area 7 Technical Memorandum 16-02 (Hutchison 2016g).

Drawdown calculations do not take into consideration the occurrence of dry cells where water levels are below the base of the aquifer.

Assume that modeled drawdown verifications within 1 foot achieve the desired future conditions.

Dockum Aquifer

Calculate modeled available groundwater values based on the spatial extent of the groundwater availability model for the Dockum Aquifer.

Modeled available groundwater analysis excludes pass-through cells.

Assume that modeled drawdown verifications within 1 foot achieve the desired future conditions.

Ogallala Aquifer

Calculate modeled available groundwater values based on the official aquifer boundary and use the same model assumptions used in Groundwater Management Area Technical Memorandum 16-01 (Hutchison, 2016f).

Modeled available groundwater analysis excludes pass-through cells.

Well pumpage decreases as the saturated thickness of the aquifer decreases below a 30-foot threshold.

Assume that modeled drawdown verifications within 1 foot achieve the desired future conditions.

Rustler Aquifer

Use 2008 as the baseline year and run the model from 2009 through 2070 (end of 2008/beginning of 2009 as initial conditions), as used in the submitted predictive model run.

Use 2008 recharge conditions throughout the predictive period.

Calculate modeled available groundwater values based on the spatial extent of the groundwater availability model for the Rustler Aquifer.

General-head boundary heads decline at a rate of 1.5 feet per year.

Use the same model assumptions used in Groundwater Management Area 7 Technical Memorandum 15-05 (Hutchison, 2016d).

Assume that modeled drawdown verifications within 1 foot achieve the desired future conditions.

METHODS:

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

For relevant aquifers with desired future conditions based on water-level drawdown, water levels simulated at the end of the predictive simulations were compared to specified baseline water levels. In the case of the High Plains Aquifer System (Dockum and Ogallala aquifers) and the minor aquifers of the Llano Uplift area (Ellenburger-San Saba and Hickory aquifers), baseline water levels represent water levels at the end of the calibrated transient model are the initial water level conditions in the predictive simulation—water levels at the end of the preceding year. In the case of the Capitan Reef Complex, Edwards-Trinity (Plateau), Pecos Valley, and Trinity, and Rustler aquifers, the baseline water levels may occur in a specified year, early in the predictive simulation. These baseline years are 2006 in the groundwater availability model for the Capitan Reef Complex Aquifer, 2010 in the alternative model for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers, 2012 in the groundwater availability model for the High Plains Aquifer System, 2010 in the groundwater availability model for the minor aquifers of the Llano Uplift area, and 2009 in the groundwater availability model for the Rustler Aquifer. The predictive model runs used average pumping rates from the historical period for the respective model except in the aquifer or area of interest. In those areas, pumping rates are varied until they produce drawdowns consistent with the adopted desired future conditions. Pumping rates or modeled available groundwater are reported in 10-year intervals.

Water-level drawdown averages were calculated for the relevant portions of each aquifer. Drawdown for model cells that became dry during the simulation—when the water level dropped below the base of the cell—were excluded from the averaging. In Groundwater Management Area 7, dry cells only occur during the predictive period in the Ogallala Aquifer of Glasscock County. Consequently, estimates of modeled available groundwater decrease over time as continued simulated pumping predicts the development of increasing numbers of dry model cells in areas of the Ogallala Aquifer in Glasscock County. The calculated water-level drawdown averages were compared with the desired future conditions to verify that the pumping scenario achieved the desired future conditions.

In Kinney and Val Verde counties, the desired future conditions are based on discharge from selected springs. In these cases, spring discharge is estimated based on simulated average spring discharge over a historical period maintaining all historical hydrologic conditions—such as recharge and river stage—except pumping. In other words, we assume that past average hydrologic conditions—the range of fluctuation—will continue in the future. In the cases of Kinney and Val Verde counties, simulated spring discharge is based on hydrologic variations that took place over the periods 1950 through 2005 and 1968 through 2013, respectively. The desired future condition for the Edwards-Trinity (Plateau) Aquifer in Kinney County is similar to the one adopted in 2010 and the associated modeled available groundwater is based on a specific model run—GAM Run 10-043 (Shi, 2012).

Modeled available groundwater values for the Ellenburger-San Saba and Hickory aquifers were determined by extracting pumping rates by decade from the model results using

ZONBUDUSG Version 1.01 (Panday and others, 2013). For the remaining relevant aquifers in Groundwater Management Area 7 modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Decadal modeled available groundwater for the relevant aquifers are reported by groundwater conservation district and county (Figure 1; Tables 1, 3, 5, 7, 9, 11, 13), and by county, regional water planning area, and river basin (Figures 2 and 3; Tables 2, 4, 6, 8, 10, 12, 14).

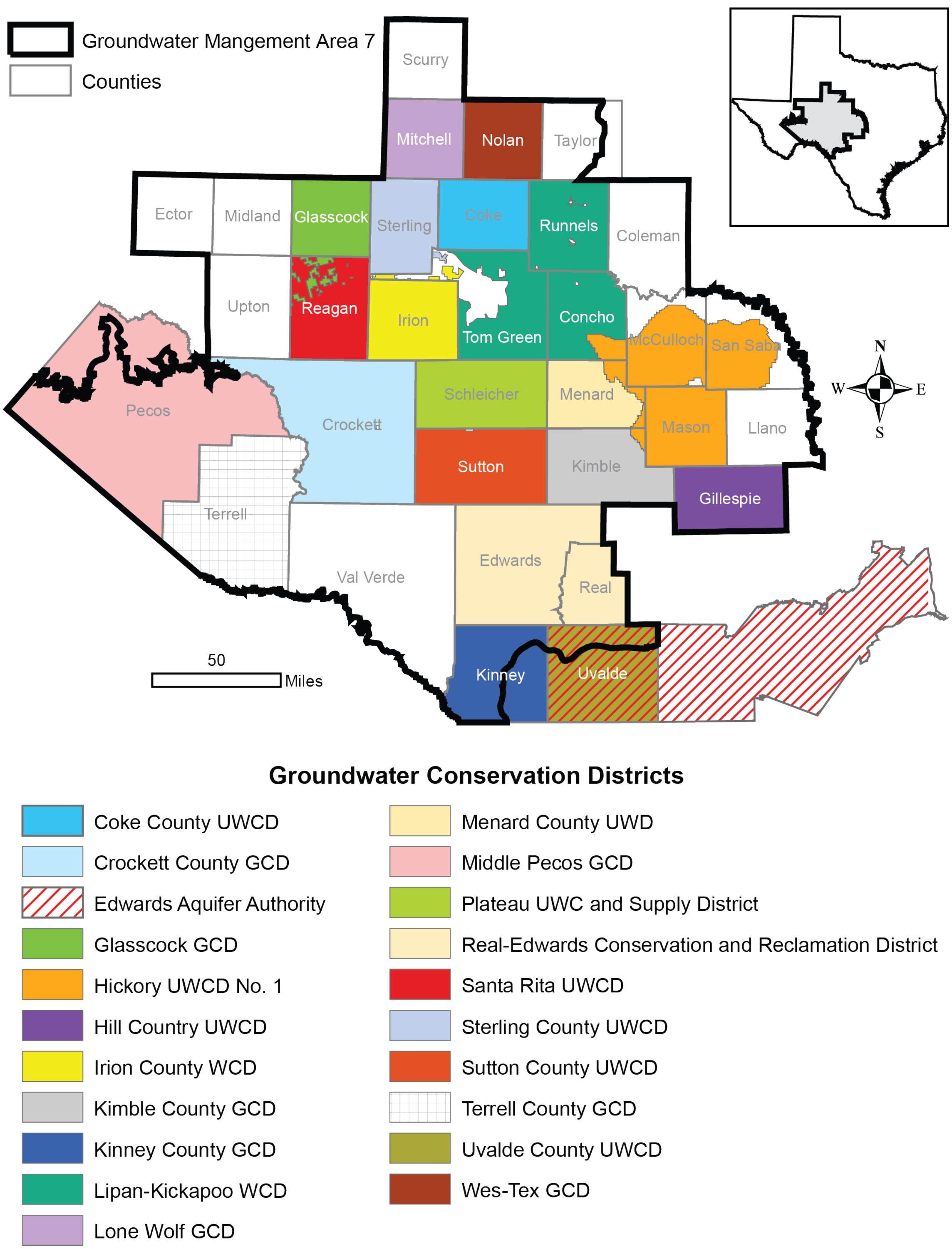


FIGURE 1. MAP SHOWING THE GROUNDWATER CONSERVATION DISTRICTS (GCD) IN GROUNDWATER MANAGEMENT AREA 7. NOTE: THE BOUNDARIES OF THE EDWARDS AQUIFER AUTHORITY OVERLAP WITH THE UVALDE COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (UWCD).

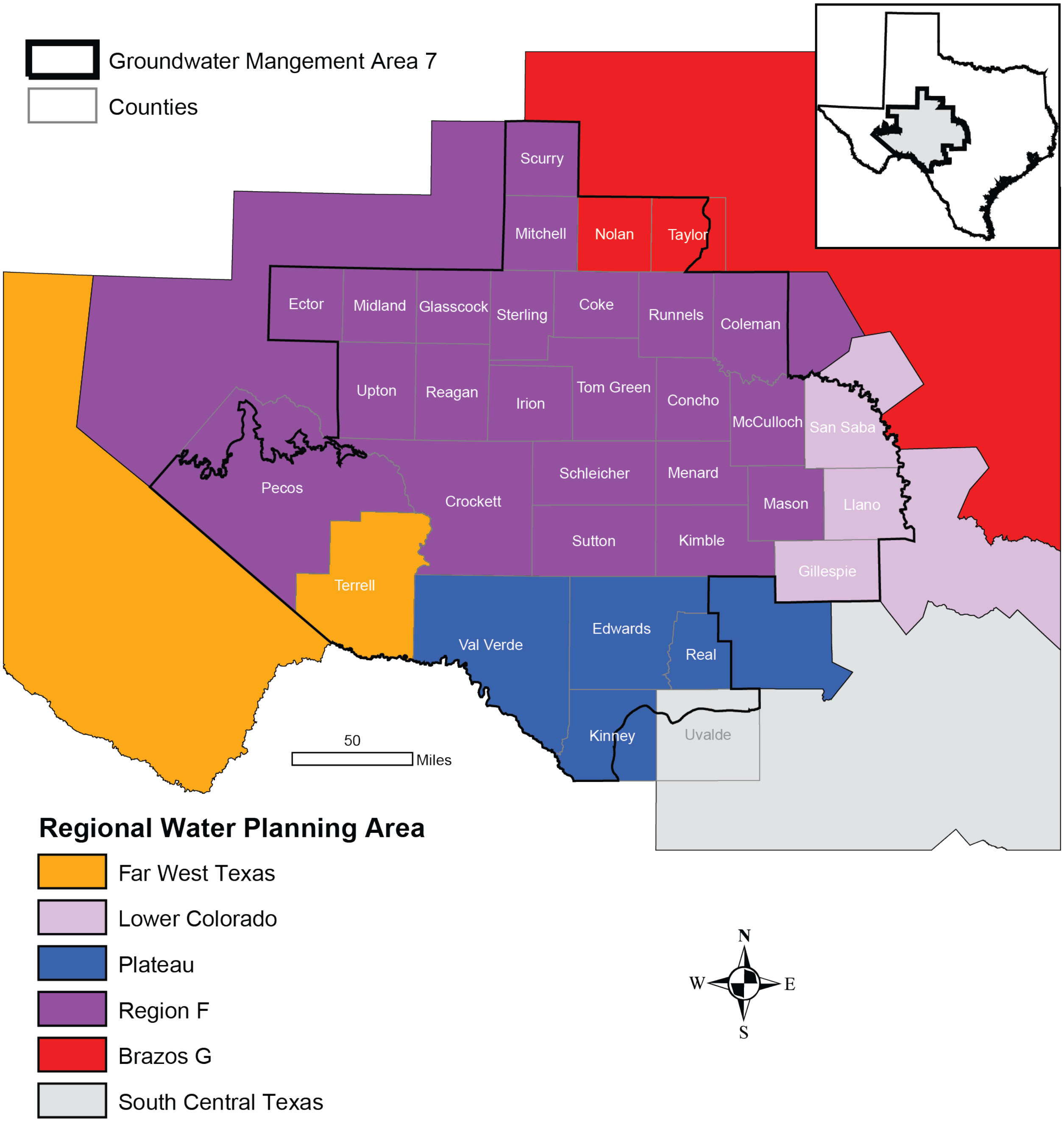


FIGURE 2. **MAP SHOWING REGIONAL WATER PLANNING AREAS IN GROUNDWATER MANAGEMENT AREA 7.**

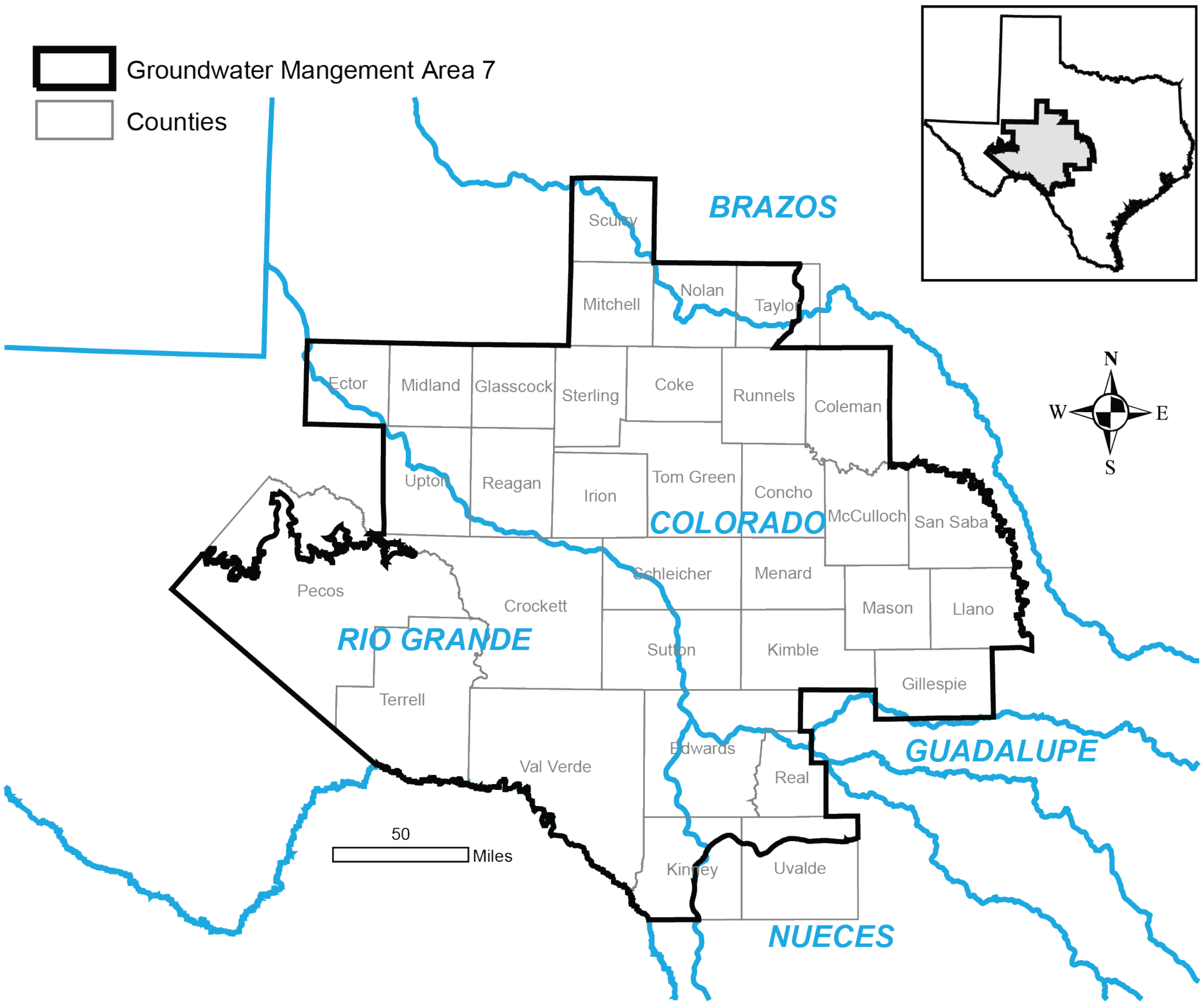


FIGURE 3. MAP SHOWING RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 7. THESE INCLUDE PARTS OF THE BRAZOS, COLORADO, GUADALUPE, NUECES, AND RIO GRANDE RIVER BASINS.

PARAMETERS AND ASSUMPTIONS:

Capitan Reef Complex Aquifer

Version 1.01 of the groundwater availability model of the eastern arm of the Capitan Reef Complex Aquifer was used. See Jones (2016) for assumptions and limitations of the groundwater availability model. See Hutchison (2016h) for details on the assumptions used for predictive simulations.

The model has five layers: Layer 1, the Edwards-Trinity (Plateau) and Pecos Valley aquifers; Layer 2, the Dockum Aquifer and the Dewey Lake Formation; Layer 3, the Rustler Aquifer; Layer 4, a confining unit made up of the Salado and Castile formations, and the overlying portion of the Artesia Group; and Layer 5, the Capitan Reef Complex Aquifer, part of the Artesia Group, and the Delaware Mountain Group. Layers 1 through 4 are intended to act solely as boundary conditions facilitating groundwater inflow and outflow relative to the Capitan Reef Complex Aquifer (Layer 5).

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

The model was run for the interval 2006 through 2070 for a 64-year predictive simulation. Drawdowns were calculated by subtracting 2006 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7.

During predictive simulations, there were no cells where water levels were below the base elevation of the cell (“dry” cells). Therefore, all drawdowns were included in the averaging.

Drawdown averages and modeled available groundwater volumes are based on the official aquifer boundary within Groundwater Management Area 7.

Dockum and Ogallala Aquifers

Version 1.01 of the groundwater availability model for the High Plains Aquifer System by Deeds and Jigmond (2015) was used to construct the predictive model simulation for this analysis. See Hutchison (2016f) 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). Pass-through cells exist in layers 2 and 3 where the Dockum Aquifer was absent but provided pathway for flow between the Lower Dockum and the Ogallala or Edwards-Trinity (High Plains) aquifers vertically. These pass-through cells were excluded from the calculations of drawdowns and modeled available groundwater.

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. It is important for groundwater management areas 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.

The model was run for the interval 2013 through 2070 for a 58-year predictive simulation. Drawdowns were calculated by subtracting 2012 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7.

During predictive simulations, there were no cells where water levels were below the base elevation of the cell ("dry" cells). Therefore, all drawdowns were included in the averaging. Modeled available groundwater analysis excludes pass-through cells.

Drawdown averages and modeled available groundwater volumes are based on the model boundaries within Groundwater Management Area 7 for the Dockum Aquifer and official aquifer boundaries for the Ogallala Aquifer.

Pecos Valley, Edwards-Trinity (Plateau) and Trinity Aquifers

The single-layer alternative groundwater flow model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers used for this analysis. This model is an update to the previously developed groundwater availability model documented in Anaya and Jones (2009). See Hutchison and others (2011a) and Anaya and Jones (2009) for assumptions and limitations of the model. See Hutchison (2016e; 2018c) for details on the assumptions used for predictive simulations.

The groundwater model has one layer representing the Pecos Valley Aquifer and the Edwards-Trinity (Plateau) Aquifer. In the relatively narrow area where both aquifers are present, the model is a lumped representation of both aquifers.

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

The model was run for the interval 2006 through 2070 for a 65-year predictive simulation. Drawdowns were calculated by subtracting 2010 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7. Comparison of 2010 simulated and measured water levels indicate a root mean squared error of 84 feet or 3 percent of the range in water-level elevations.

Drawdowns for cells with water levels below the base elevation of the cell (“dry” cells) were included in the averaging.

Drawdown averages and modeled available groundwater volumes are based on the official aquifer boundaries within Groundwater Management Area 7.

Edwards-Trinity (Plateau) Aquifer of Kinney County

All parameters and assumptions for the Edwards-Trinity (Plateau) Aquifer of Kinney County in Groundwater Management Area 7 are described in GAM Run 10-043 MAG Version 2 (Shi, 2012). This report assumes a planning period from 2010 to 2070.

The Kinney County Groundwater Conservation District model developed by Hutchison and others (2011b) was used for this analysis. The model was calibrated to water level and spring flux collected from 1950 to 2005.

The model has four layers representing the following hydrogeologic units (from top to bottom): Carrizo-Wilcox Aquifer (layer 1), Upper Cretaceous Unit (layer 2), Edwards (Balcones Fault Zone) Aquifer/Edwards portion of the Edwards-Trinity (Plateau) Aquifer (layer 3), and Trinity portion of the Edwards-Trinity (Plateau) Aquifer (layer 4).

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

The model was run for the interval 2006 through 2070 for a 65-year predictive simulation. Drawdowns were calculated by subtracting 2010 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7.

Modeled available groundwater volumes are based on the official aquifer boundaries within Groundwater Management Area 7 in Kinney County.

Edwards-Trinity (Plateau) Aquifer of Val Verde County

The single-layer numerical groundwater flow model for the Edwards-Trinity (Plateau) Aquifer of Val Verde County was used for this analysis. This model is based on the previously developed alternative groundwater model of the Kinney County area documented in Hutchison and others (2011b). See EcoKai (2014) for assumptions and limitations of the model. See Hutchison (2016e; 2018b) for details on the assumptions used for predictive simulations, including recharge and pumping assumptions.

The groundwater model has one layer representing the Edwards-Trinity (Plateau) Aquifer of Val Verde County.

The model was run with MODFLOW-2005 (Harbaugh, 2005).

The model was run for a 45-year predictive simulation representing hydrologic conditions of the interval 1968 through 2013. Simulated spring discharge from San Felipe Springs was then averaged over duration of the simulation. The resultant pumping rate that met the desired future conditions was applied to the predictive period—2010 through 2070—based on the assumption that average conditions over the predictive period are the same as those over the historic period represented by the model run.

Modeled available groundwater volumes are based on the official aquifer boundaries within Groundwater Management Area 7 in Val Verde County.

Rustler Aquifer

Version 1.01 of the groundwater availability model for the Rustler Aquifer by Ewing and others (2012) was used to construct the predictive model simulation for this analysis. See Hutchison (2016d) for details of the initial assumptions, including recharge conditions.

The model has two layers, the top one representing the Rustler Aquifer, and the other representing the Dewey Lake Formation and the Dockum Aquifer.

The model was run with MODFLOW-NWT (Niswonger and others, 2011).

The model was run for the interval 2009 through 2070 for a 61-year predictive simulation. Drawdowns were calculated by subtracting 2009 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7. During predictive simulations, there were no cells where water levels were below the base elevation of the cell (“dry” cells). Therefore, all drawdowns were included in the averaging.

Drawdown averages and modeled available groundwater volumes are based on the model boundaries within Groundwater Management Area 7.

Minor aquifers of the Llano Uplift Area

We used version 1.01 of the groundwater availability model for the minor aquifers in the Llano Uplift Area. See Shi and others (2016) for assumptions and limitations of the model. See Hutchison (2016g) for details of the initial assumptions.

The model contains eight layers: Trinity Aquifer, Edwards-Trinity (Plateau) Aquifer, and younger alluvium deposits (Layer 1), confining units (Layer 2), Marble Falls Aquifer and equivalent units (Layer 3), confining units (Layer 4), Ellenburger-San Saba Aquifer and equivalent units (Layer 5), confining units (Layer 6), Hickory Aquifer and equivalent units (Layer 7), and Precambrian units (Layer 8).

The model was run with MODFLOW-USG beta (development) version (Panday and others, 2013). Perennial rivers and reservoirs were simulated using the MODFLOW-USG river package. Springs were simulated using the MODFLOW-USG drain package.

Drawdown averages and modeled available groundwater volumes are based on the model boundaries within Groundwater Management Area 7.

The model was run for the interval 2011 through 2070 for a 60-year predictive simulation. Drawdowns were calculated by subtracting 2010 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7. During predictive simulations, there were no cells where water levels were below the base elevation of the cell ("dry" cells). Therefore, all drawdowns were included in the averaging.

RESULTS:

The modeled available groundwater estimates are 26,164 acre-feet per year in the Capitan Reef Complex Aquifer, 474,464 acre-feet per year in the undifferentiated Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers, 22,616 acre-feet per year in the Ellenburger-San Saba Aquifer, 49,936 acre-feet per year in the Hickory Aquifer, 6,570 to 7,925 acre-feet per year in the Ogallala Aquifer, 2,324 acre-feet per year in the Dockum Aquifer, and 7,040 acre-feet per year in the Rustler Aquifer.

The modeled available groundwater for the respective aquifers has been summarized by aquifer, county, and groundwater conservation district (Tables 1, 3, 5, 7, 9, 11, and 13). The modeled available groundwater is also summarized by county, regional water planning area, river basin, and aquifer for use in the regional water planning process (Tables 2, 4, 6, 8, 10, 12, and 14). The modeled available groundwater for the Ogallala Aquifer that achieves the desired future conditions adopted by districts in Groundwater Management Area 7 decreases from 7,925 to 6,570 acre-feet per year between 2020 and 2070 (Tables 9 and 10). This decline is attributable to the occurrence of increasing numbers of cells where water levels were below the base elevation of the cell ("dry" cells) in parts of Glasscock County. Please note that MODFLOW-NWT automatically reduces pumping as water levels decline.

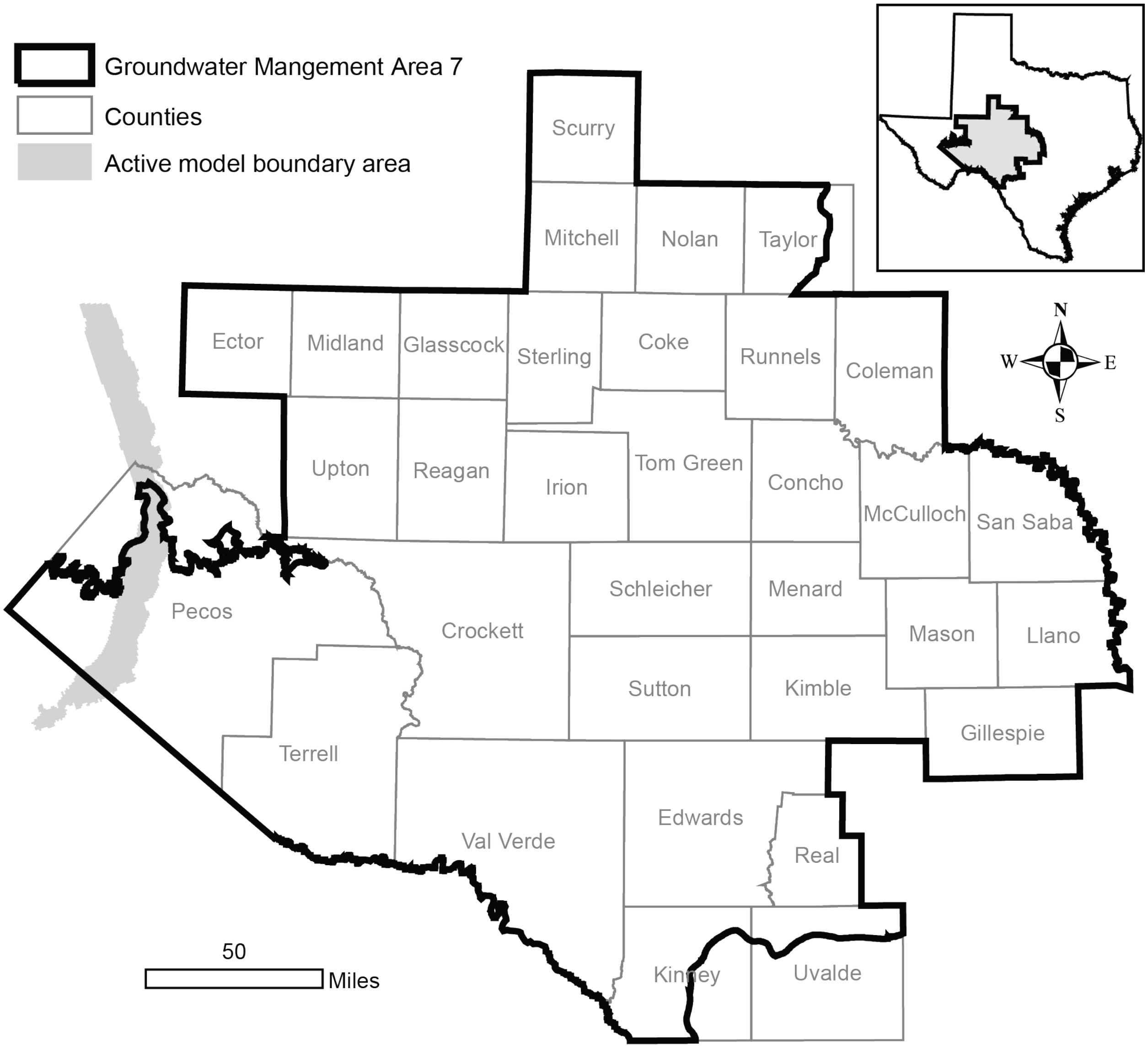


FIGURE 4. MAP SHOWING THE AREAS COVERED BY THE CAPITAN REEF COMPLEX AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE EASTERN ARM OF THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2006 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR. GCD IS THE ABBREVIATION FOR GROUNDWATER CONSERVATION DISTRICT.

District	County	Year							
		2006	2010	2020	2030	2040	2050	2060	2070
Middle Pecos GCD	Pecos	26,164	26,164	26,164	26,164	26,164	26,164	26,164	26,164
	Total	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**
GMA 7		**26,164**	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year					
			2020	2030	2040	2050	2060	2070
Pecos	F	Rio Grande	26,164	26,164	26,164	26,164	26,164	26,164
		Total	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**
GMA 7			**26,164**	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**

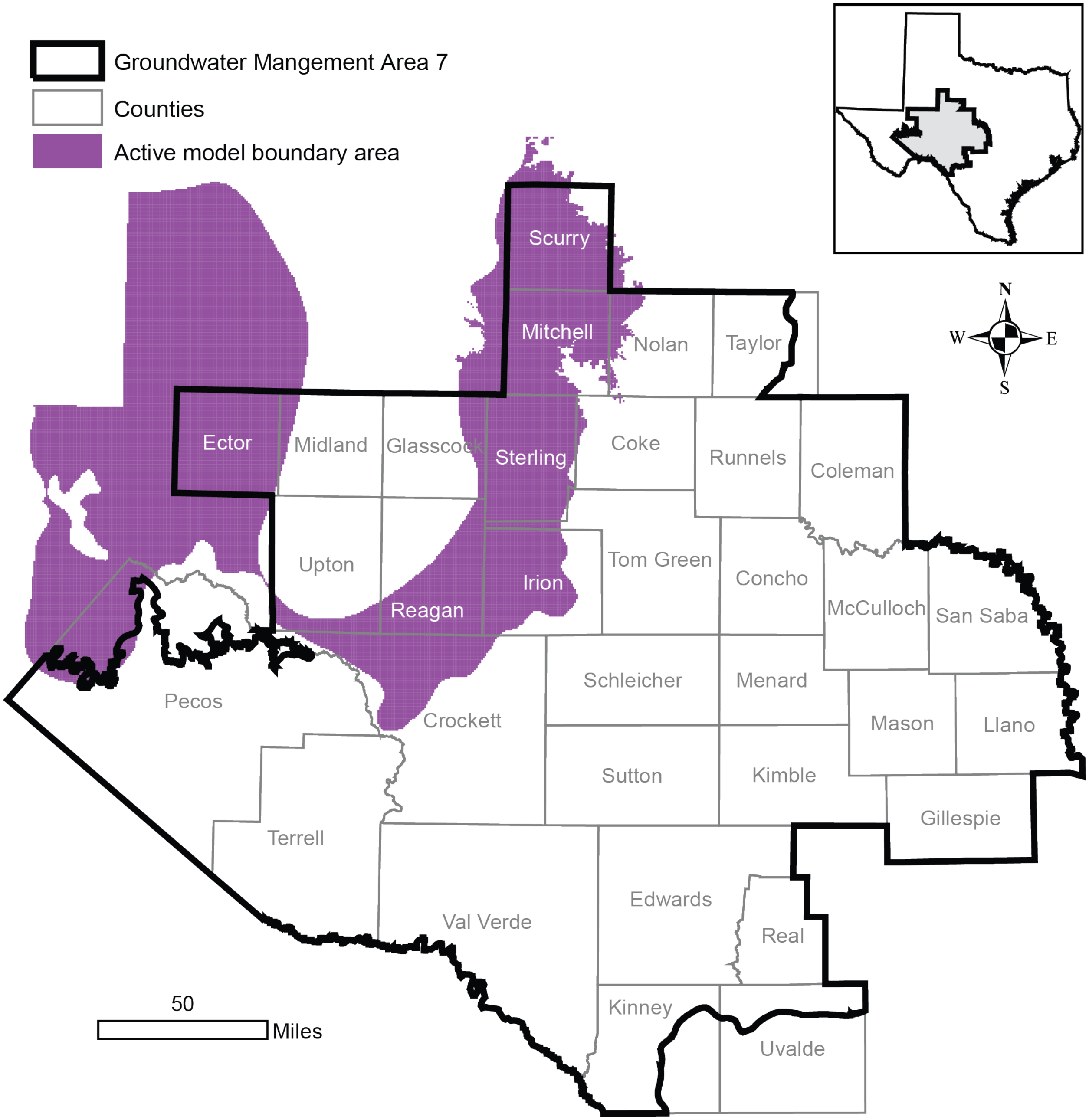


FIGURE 5. **MAP SHOWING AREAS COVERED BY THE DOCKUM AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 7.**

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2013 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR. GCD AND UWCD ARE THE ABBREVIATIONS FOR GROUNDWATER CONSERVATION DISTRICT AND UNDERGROUND WATER CONSERVATION DISTRICT, RESPECTIVELY.

District	County	Year						
		2013	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Middle Pecos GCD	Pecos	2,022	2,022	2,022	2,022	2,022	2,022	2,022
	Total	**2,022**	**2,022**	**2,022**	**2,022**	**2,022**	**2,022**	**2,022**
Santa Rita UWCD	Reagan	302	302	302	302	302	302	302
	Total	**302**	**302**	**302**	**302**	**302**	**302**	**302**
GMA 7		**2324**	**2,324**	**2,324**	**2,324**	**2,324**	**2,324**	**2,324**

Note: The modeled available groundwater for Santa Rita Underground Water Conservation District excludes parts of Reagan County that fall within Glasscock Groundwater Conservation District. The year 2013 is used because the 2012 desired future condition baseline year for the Dockum Aquifer is an initial condition in the predictive model run.

TABLE 4. MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year					
			2020	**2030**	**2040**	**2050**	**2060**	**2070**
Pecos	F	Rio Grande	2,022	2,022	2,022	2,022	2,022	2,022
		Total	**2,022**	**2,022**	**2,022**	**2,022**	**2,022**	**2,022**
Reagan	F	Colorado	302	302	302	302	302	302
		Rio Grande	0	0	0	0	0	0
		Total	**962**	**962**	**962**	**962**	**962**	**962**
GMA 7			**2,324**	**2,324**	**2,324**	**2,324**	**2,324**	**2,324**

Note: The modeled available groundwater for Reagan County excludes parts of Reagan County that fall outside of Santa Rita Underground Water Conservation District.

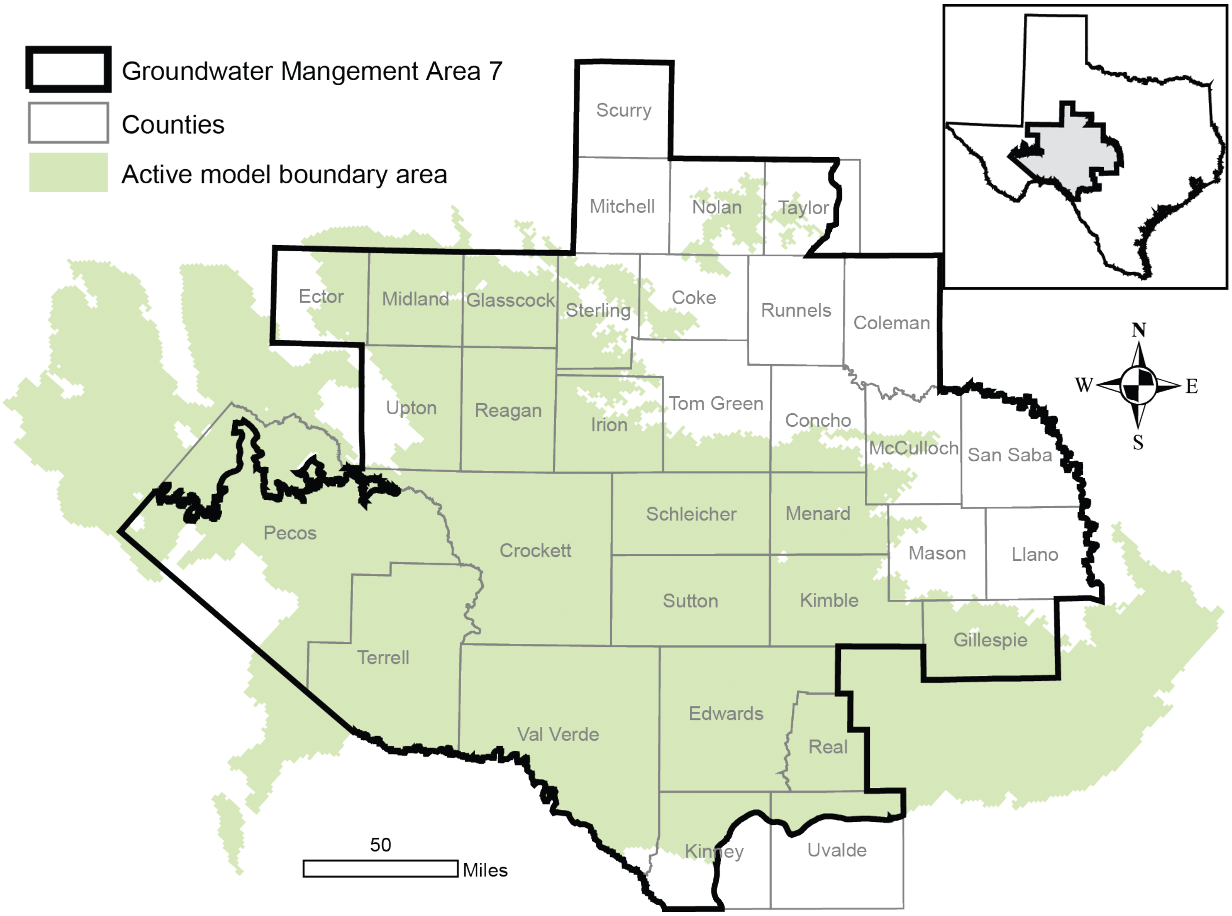


FIGURE 6. **MAP SHOWING THE AREAS COVERED BY THE UNDIFFERENTIATED EDWARDS-TRINITY (PLATEAU), PECOS VALLEY, AND TRINITY AQUIFERS IN THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7.**

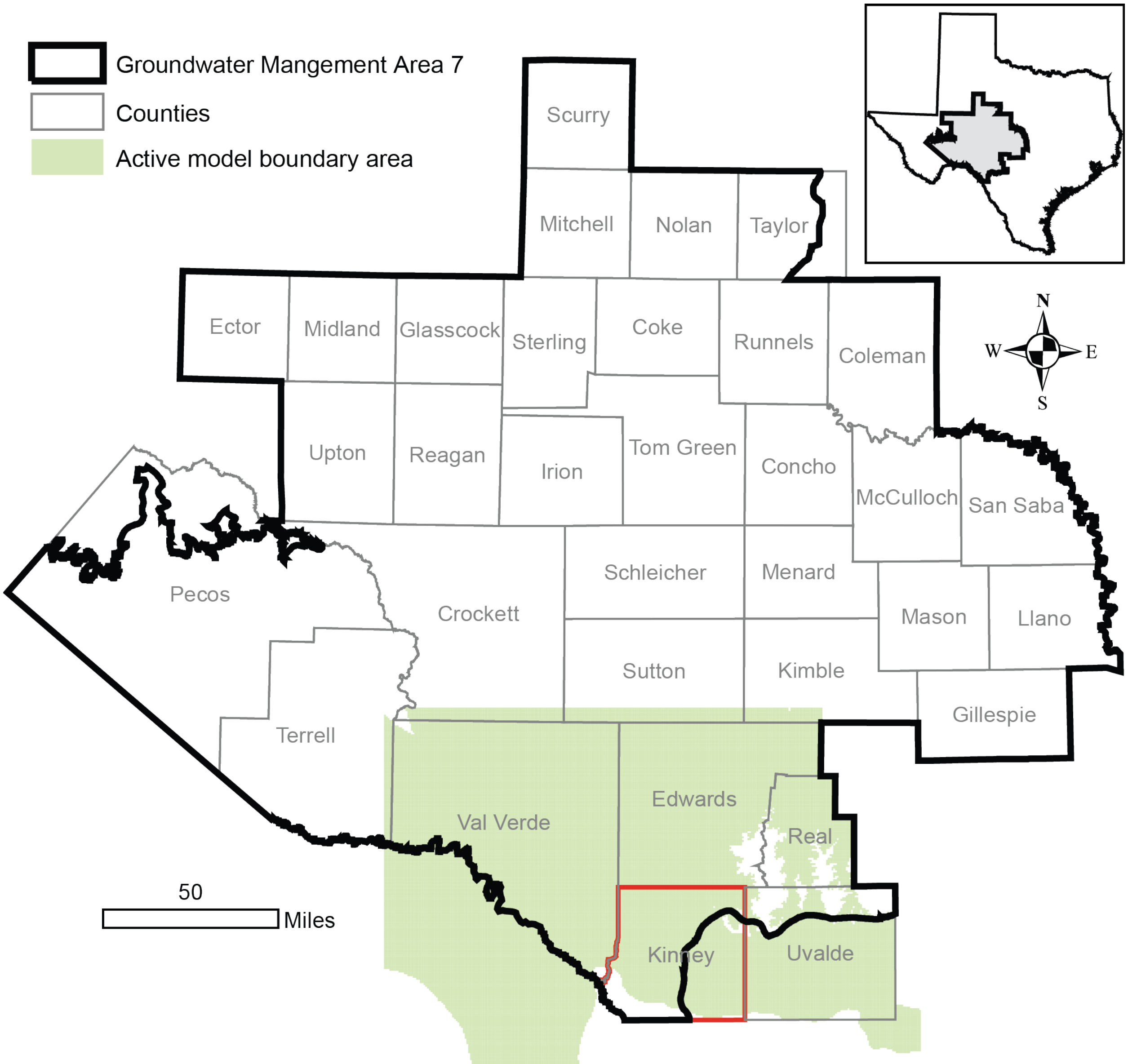


FIGURE 7. **MAP SHOWING THE AREAS COVERED BY THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN THE ALTERNATIVE MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN KINNEY COUNTY.**

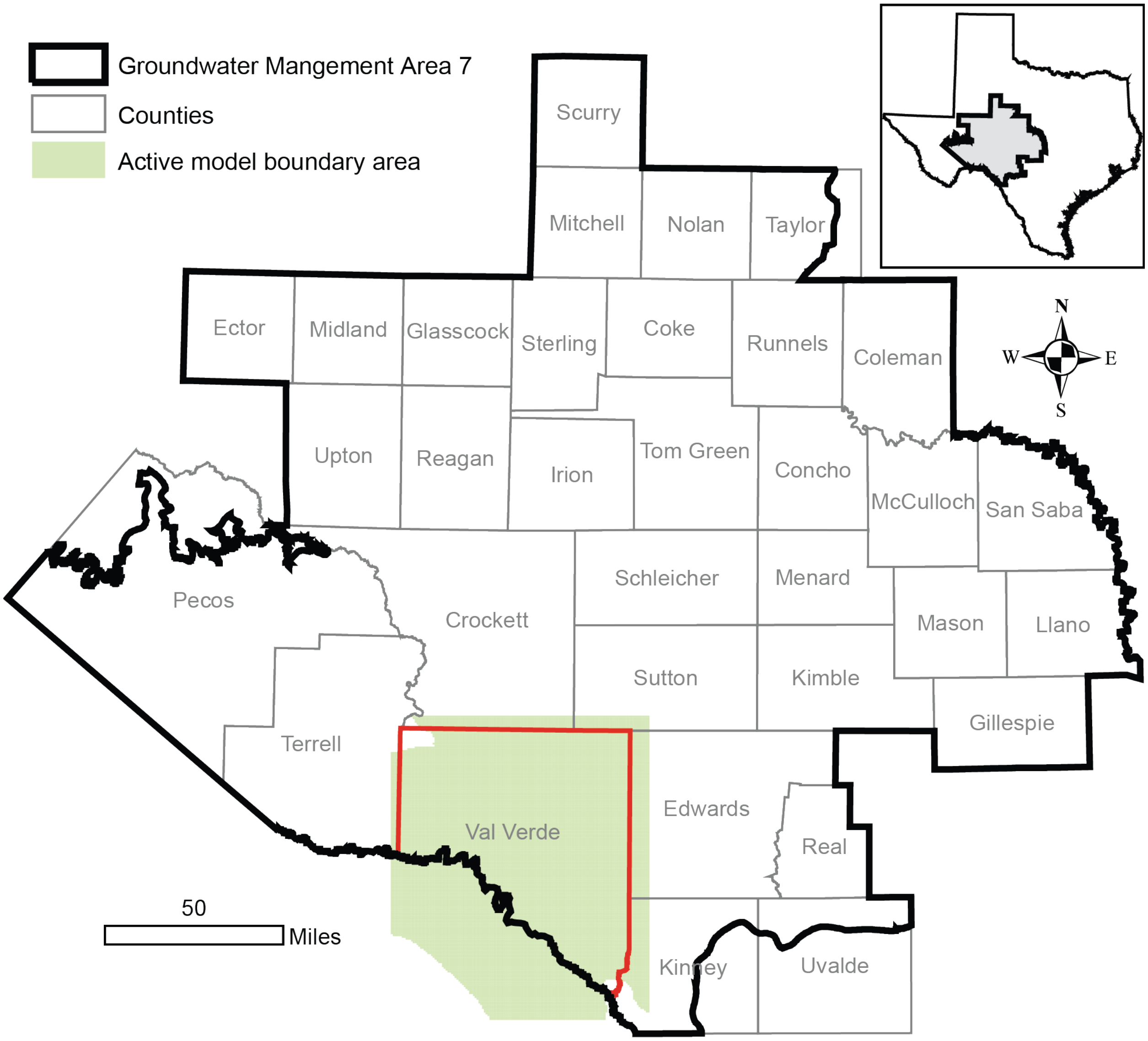


FIGURE 8. **MAP SHOWING THE AREAS COVERED BY THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN THE GROUNDWATER FLOW MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN VAL VERDE COUNTY.**

TABLE 5. MODELED AVAILABLE GROUNDWATER FOR THE UNDIFFERENTIATED EDWARDS-TRINITY (PLATEAU), PECOS VALLEY, AND TRINITY AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY, FOR EACH DECADE BETWEEN 2006 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD IS ABBREVIATION FOR UNDERGROUND WATER CONSERVATION DISTRICT, WCD IS WATER CONSERVATION DISTRICT, UWD IS UNDERGROUND WATER DISTRICT, UWC IS UNDERGROUND WATER CONSERVATION, AND C AND R DISTRICT IS CONSERVATION AND RECLAMATION DISTRICT.

District	County	Year						
		2010	2020	2030	2040	2050	2060	2070
Coke County UWCD	Coke	997	997	997	997	997	997	997
	Total	**997**	**997**	**997**	**997**	**997**	**997**	**997**
Crockett County GCD	Crockett	4,675	4,675	4,675	4,675	4,675	4,675	4,675
	Total	**4,675**	**4,675**	**4,675**	**4,675**	**4,675**	**4,675**	**4,675**
Glasscock GCD	Glasscock	65,186	65,186	65,186	65,186	65,186	65,186	65,186
	Reagan	40,835	40,835	40,835	40,835	40,835	40,835	40,835
	Total	**106,021**	**106,021**	**106,021**	**106,021**	**106,021**	**106,021**	**106,021**
Hill Country UWCD	Gillespie	4,979	4,979	4,979	4,979	4,979	4,979	4,979
	Total	**4,979**	**4,979**	**4,979**	**4,979**	**4,979**	**4,979**	**4,979**
Irion County WCD*	Irion	3,289	3,289	3,289	3,289	3,289	3,289	3,289
	Total	**3,289**	**3,289**	**3,289**	**3,289**	**3,289**	**3,289**	**3,289**
Kimble County GCD	Kimble	1,282	1,282	1,282	1,282	1,282	1,282	1,282
	Total	**1,282**	**1,282**	**1,282**	**1,282**	**1,282**	**1,282**	**1,282**
Kinney County GCD	Kinney	70,341	70,341	70,341	70,341	70,341	70,341	70,341
	Total	**70,341**	**70,341**	**70,341**	**70,341**	**70,341**	**70,341**	**70,341**

TABLE 5. (CONTINUED).

District	County	Year						
		2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Menard County UWD	Menard	2,217	2,217	2,217	2,217	2,217	2,217	2,217
	Total	**2,217**	**2,217**	**2,217**	**2,217**	**2,217**	**2,217**	**2,217**
Middle Pecos GCD	Pecos	117,309	117,309	117,309	117,309	117,309	117,309	117,309
	Total	**117,309**	**117,309**	**117,309**	**117,309**	**117,309**	**117,309**	**117,309**
Plateau UWC and Supply District	Schleicher	8,034	8,034	8,034	8,034	8,034	8,034	8,034
	Total	**8,034**	**8,034**	**8,034**	**8,034**	**8,034**	**8,034**	**8,034**
Real-Edwards C and R District	Edwards	5,676	5,676	5,676	5,676	5,676	5,676	5,676
	Real	7,523	7,523	7,523	7,523	7,523	7,523	7,523
	Total	**13,199**	**13,199**	**13,199**	**13,199**	**13,199**	**13,199**	**13,199**
Santa Rita UWCD	Reagan	27,398	27,398	27,398	27,398	27,398	27,398	27,398
	Total	**27,398**	**27,398**	**27,398**	**27,398**	**27,398**	**27,398**	**27,398**
Sterling County UWCD	Sterling	2,495	2,495	2,495	2,495	2,495	2,495	2,495
	Total	**2,495**	**2,495**	**2,495**	**2,495**	**2,495**	**2,495**	**2,495**
Sutton County UWCD	Sutton	6,400	6,400	6,400	6,400	6,400	6,400	6,400
	Total	**6,400**	**6,400**	**6,400**	**6,400**	**6,400**	**6,400**	**6,400**
Terrell County GCD	Terrell	1,420	1,420	1,420	1,420	1,420	1,420	1,420
	Total	**1,420**	**1,420**	**1,420**	**1,420**	**1,420**	**1,420**	**1,420**
Uvalde County UWCD	Uvalde	1,993	1,993	1,993	1,993	1,993	1,993	1,993
	Total	**1,993**	**1,993**	**1,993**	**1,993**	**1,993**	**1,993**	**1,993**

TABLE 5. (CONTINUED).

District	County	Year						
		2010	2020	2030	2040	2050	2060	2070
No district		102,415	102,415	102,415	102,415	102,415	102,415	102,415
GMA 7		**474,464**	**474,464**	**474,464**	**474,464**	**474,464**	**474,464**	**474,464**

*The modeled available groundwater for Irion County WCD only includes the portion of the district that falls within Irion County.

TABLE 6. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE UNDIFFERENTIATED EDWARDS-TRINITY (PLATEAU), PECOS VALLEY, AND TRINITY AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year					
			2020	2030	2040	2050	2060	2070
Coke	F	Colorado	997	997	997	997	997	997
		Total	**997**	**997**	**997**	**997**	**997**	**997**
Crockett	F	Colorado	20	20	20	20	20	20
		Rio Grande	5,427	5,427	5,427	5,427	5,427	5,427
		Total	**5,447**	**5,447**	**5,447**	**5,447**	**5,447**	**5,447**
Ector	F	Colorado	4,925	4,925	4,925	4,925	4,925	4,925
		Rio Grande	617	617	617	617	617	617
		Total	**5,542**	**5,542**	**5,542**	**5,542**	**5,542**	**5,542**
Edwards	J	Colorado	2,305	2,305	2,305	2,305	2,305	2,305
		Nueces	1,631	1,631	1,631	1,631	1,631	1,631
		Rio Grande	1,740	1,740	1,740	1,740	1,740	1,740
		Total	**5,676**	**5,676**	**5,676**	**5,676**	**5,676**	**5,676**
Gillespie	K	Colorado	4,843	4,843	4,843	4,843	4,843	4,843
		Guadalupe	136	136	136	136	136	136
		Total	**4,979**	**4,979**	**4,979**	**4,979**	**4,979**	**4,979**
Glasscock	F	Colorado	65,186	65,186	65,186	65,186	65,186	65,186
		Total	**65,186**	**65,186**	**65,186**	**65,186**	**65,186**	**65,186**

TABLE 6. (CONTINUED).

County	RWPA	River Basin	Year					
			2020	2030	2040	2050	2060	2070
Irion	F	Colorado	3,289	3,289	3,289	3,289	3,289	3,289
		Total	**3,289**	**3,289**	**3,289**	**3,289**	**3,289**	**3,289**
Kimble*	F	Colorado	1,282	1,282	1,282	1,282	1,282	1,282
		Total	**1,282**	**1,282**	**1,282**	**1,282**	**1,282**	**1,282**
Kinney	J	Nueces	12	12	12	12	12	12
		Rio Grande	70,329	70,329	70,329	70,329	70,329	70,329
		Total	**70,341**	**70,341**	**70,341**	**70,341**	**70,341**	**70,341**
Menard*	F	Colorado	2,217	2,217	2,217	2,217	2,217	2,217
		Total	**2,217**	**2,217**	**2,217**	**2,217**	**2,217**	**2,217**
Midland	F	Colorado	23,233	23,233	23,233	23,233	23,233	23,233
		Total	**23,233**	**23,233**	**23,233**	**23,233**	**23,233**	**23,233**
Pecos	F	Rio Grande	117,309	117,309	117,309	117,309	117,309	117,309
		Total	**117,309**	**117,309**	**117,309**	**117,309**	**117,309**	**117,309**
Reagan	F	Colorado	68,205	68,205	68,205	68,205	68,205	68,205
		Rio Grande	28	28	28	28	28	28
		Total	**68,233**	**68,233**	**68,233**	**68,233**	**68,233**	**68,233**
Real	J	Colorado	277	277	277	277	277	277
		Guadalupe	3	3	3	3	3	3
		Nueces	7,243	7,243	7,243	7,243	7,243	7,243
		Total	**7,523**	**7,523**	**7,523**	**7,523**	**7,523**	**7,523**

TABLE 6. (CONTINUED).

County	RWPA	River Basin	Year					
			2020	2030	2040	2050	2060	2070
Schleicher	F	Colorado	6,403	6,403	6,403	6,403	6,403	6,403
		Rio Grande	1,631	1,631	1,631	1,631	1,631	1,631
		Total	**8,034**	**8,034**	**8,034**	**8,034**	**8,034**	**8,034**
Sterling	F	Colorado	2,495	2,495	2,495	2,495	2,495	2,495
		Total	**2,495**	**2,495**	**2,495**	**2,495**	**2,495**	**2,495**
Sutton	F	Colorado	388	388	388	388	388	388
		Rio Grande	6,022	6,022	6,022	6,022	6,022	6,022
		Total	**6,410**	**6,410**	**6,410**	**6,410**	**6,410**	**6,410**
Taylor	G	Brazos	331	331	331	331	331	331
		Colorado	158	158	158	158	158	158
		Total	**489**	**489**	**489**	**489**	**489**	**489**
Terrell	E	Rio Grande	1,420	1,420	1,420	1,420	1,420	1,420
		Total	**1,420**	**1,420**	**1,420**	**1,420**	**1,420**	**1,420**
Upton	F	Colorado	21,243	21,243	21,243	21,243	21,243	21,243
		Rio Grande	1,126	1,126	1,126	1,126	1,126	1,126
		Total	**22,369**	**22,369**	**22,369**	**22,369**	**22,369**	**22,369**
Uvalde	L	Nueces	1,993	1,993	1,993	1,993	1,993	1,993
		Total	**1,993**	**1,993**	**1,993**	**1,993**	**1,993**	**1,993**
Val Verde	J	Rio Grande	50,000	50,000	50,000	50,000	50,000	50,000
		Total	**50,000**	**50,000**	**50,000**	**50,000**	**50,000**	**50,000**
GMA 7			**474,464**	**474,464**	**474,464**	**474,464**	**474,464**	**474,464**

*The modeled available groundwater for Kimble and Menard counties excludes the parts of the counties that fall within Hickory Underground Water Conservation District No. 1.

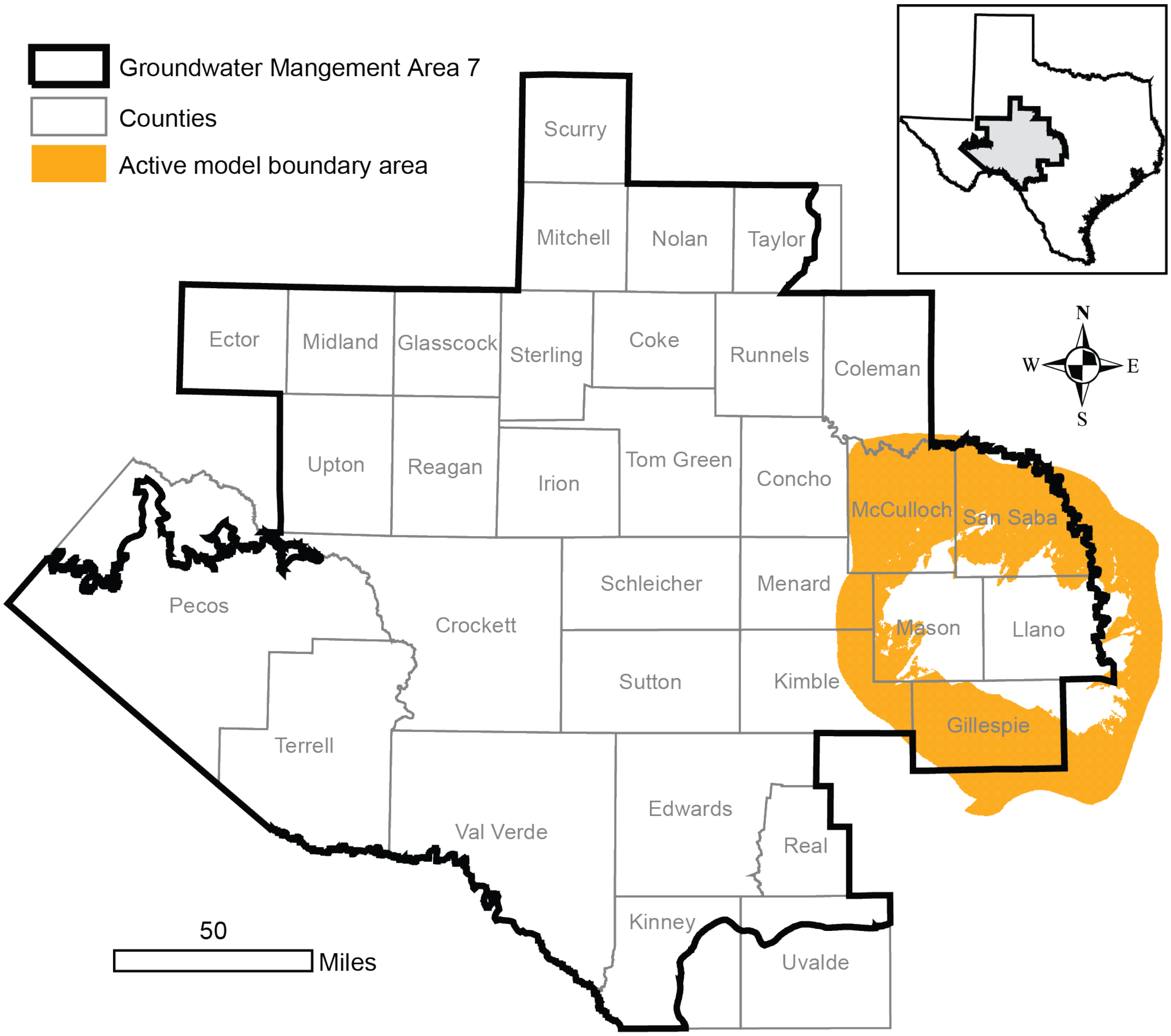


FIGURE 9. **MAP SHOWING THE AREAS COVERED BY THE ELLENBURGER-SAN SABA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS OF THE LLANO UPLIFT AREA IN GROUNDWATER MANAGEMENT AREA 7.**

TABLE 7. MODELED AVAILABLE GROUNDWATER FOR THE ELLENBURGER-SAN SABA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2011 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD IS THE ABBREVIATION FOR UNDERGROUND WATER CONSERVATION DISTRICT AND UWD IS UNDERGROUND WATER DISTRICT.

District	County	Year						
		2011	2020	2030	2040	2050	2060	2070
Hickory UWCD No. 1	Kimble	344	344	344	344	344	344	344
	Mason	3,237	3,237	3,237	3,237	3,237	3,237	3,237
	McCulloch	3,466	3,466	3,466	3,466	3,466	3,466	3,466
	Menard	282	282	282	282	282	282	282
	San Saba	5,559	5,559	5,559	5,559	5,559	5,559	5,559
	Total	**12,887**	**12,887**	**12,887**	**12,887**	**12,887**	**12,887**	**12,887**
Hill Country UWCD	Gillespie	6,294	6,294	6,294	6,294	6,294	6,294	6,294
	Total	**6,294**	**6,294**	**6,294**	**6,294**	**6,294**	**6,294**	**6,294**
Kimble County GCD	Kimble	178	178	178	178	178	178	178
	Total	**178**	**178**	**178**	**178**	**178**	**178**	**178**
Menard County UWD	Menard	27	27	27	27	27	27	27
	Total	**27**	**27**	**27**	**27**	**27**	**27**	**27**
No District	McCulloch	898	898	898	898	898	898	898
	San Saba	2,331	2,331	2,331	2,331	2,331	2,331	2,331
	Total	**3,229**	**3,229**	**3,229**	**3,229**	**3,229**	**3,229**	**3,229**
GMA 7		**22,616**	**22,616**	**22,616**	**22,616**	**22,616**	**22,616**	**22,616**

Note: The year 2011 is used because the 2010 desired future condition baseline year for the Ellenburger-San Saba Aquifer is an initial condition in the predictive model run.

TABLE 8. MODELED AVAILABLE GROUNDWATER FOR THE ELLENBURGER-SAN SABA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year					
			2020	2030	2040	2050	2060	2070
Gillespie	K	Colorado	6,294	6,294	6,294	6,294	6,294	6,294
		Total	**6,294**	**6,294**	**6,294**	**6,294**	**6,294**	**6,294**
Kimble	F	Colorado	521	521	521	521	521	521
		Total	**521**	**521**	**521**	**521**	**521**	**521**
Mason	F	Colorado	3,237	3,237	3,237	3,237	3,237	3,237
		Total	**3,237**	**3,237**	**3,237**	**3,237**	**3,237**	**3,237**
McCulloch	F	Colorado	4,364	4,364	4,364	4,364	4,364	4,364
		Total	**4,364**	**4,364**	**4,364**	**4,364**	**4,364**	**4,364**
Menard	F	Colorado	309	309	309	309	309	309
		Total	**309**	**309**	**309**	**309**	**309**	**309**
San Saba	K	Colorado	7,890	7,890	7,890	7,890	7,890	7,890
		Total	**7,890**	**7,890**	**7,890**	**7,890**	**7,890**	**7,890**
GMA 7			**22,616**	**22,616**	**22,616**	**22,616**	**22,616**	**22,616**

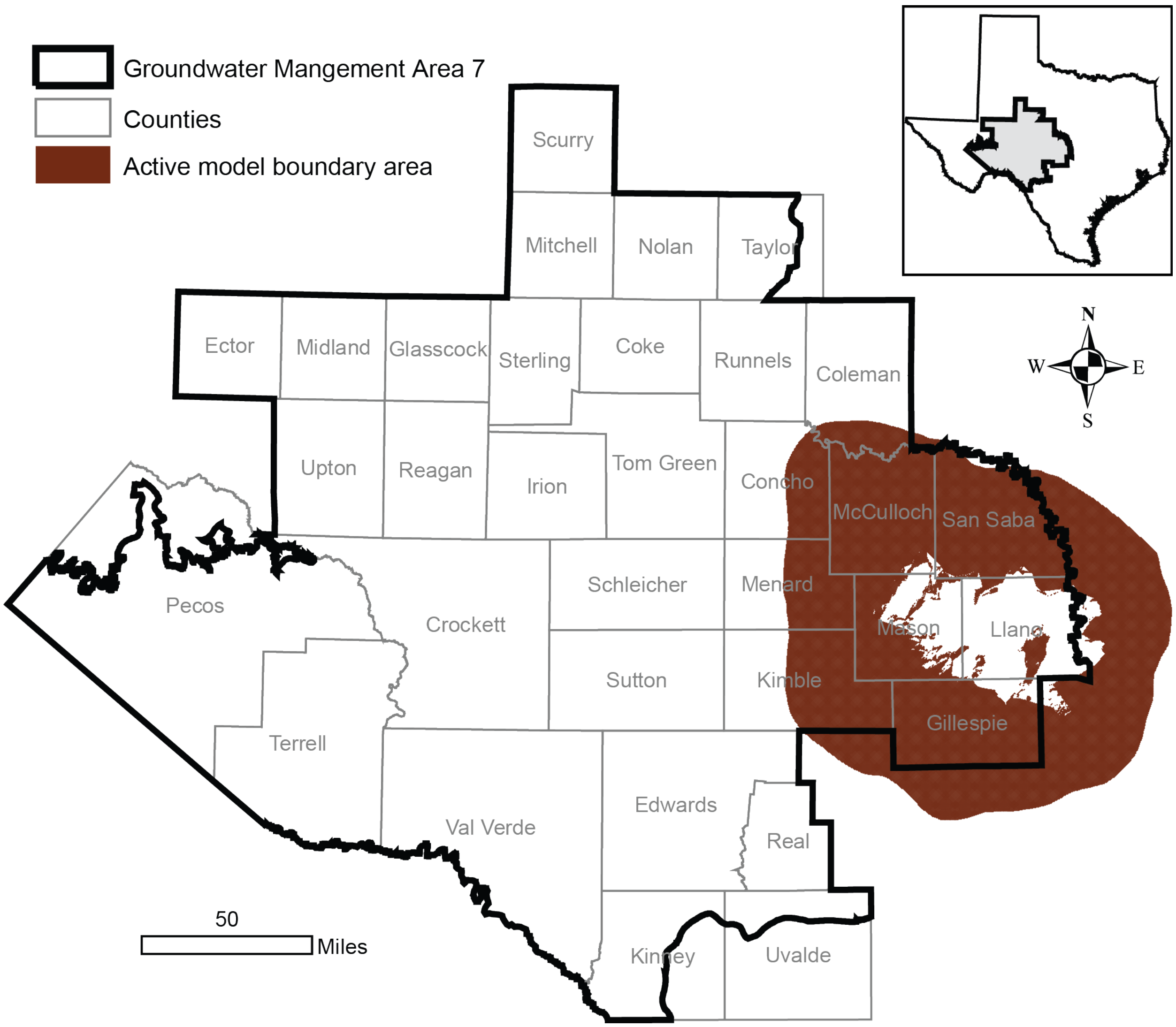


FIGURE 10. **MAP SHOWING AREAS COVERED BY THE HICKORY AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS OF THE LLANO UPLIFT AREA IN GROUNDWATER MANAGEMENT AREA 7.**

TABLE 9. MODELED AVAILABLE GROUNDWATER FOR THE HICKORY AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2011 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD IS THE ABBREVIATION FOR UNDERGROUND WATER CONSERVATION DISTRICT AND UWD IS UNDERGROUND WATER DISTRICT.

District	County	Year						
		2011	2020	2030	2040	2050	2060	2070
Hickory UWCD No. 1	Concho	13	13	13	13	13	13	13
	Kimble	42	42	42	42	42	42	42
	Mason	13,212	13,212	13,212	13,212	13,212	13,212	13,212
	McCulloch	21,950	21,950	21,950	21,950	21,950	21,950	21,950
	Menard	2,600	2,600	2,600	2,600	2,600	2,600	2,600
	San Saba	7,027	7,027	7,027	7,027	7,027	7,027	7,027
	Total	**44,843**	**44,843**	**44,843**	**44,843**	**44,843**	**44,843**	**44,843**
Hill Country UWCD	Gillespie	1,751	1,751	1,751	1,751	1,751	1,751	1,751
	Total	**1,751**	**1,751**	**1,751**	**1,751**	**1,751**	**1,751**	**1,751**
Kimble County GCD	Kimble	123	123	123	123	123	123	123
	Total	**123**	**123**	**123**	**123**	**123**	**123**	**123**
Lipan-Kickapoo WCD	Concho	13	13	13	13	13	13	13
	Total	**13**	**13**	**13**	**13**	**13**	**13**	**13**
Menard County UWD	Menard	126	126	126	126	126	126	126
	Total	**126**	**126**	**126**	**126**	**126**	**126**	**126**
No District	McCulloch	2,427	2,427	2,427	2,427	2,427	2,427	2,427
	San Saba	652	652	652	652	652	652	652
	Total	**3,080**	**3,080**	**3,080**	**3,080**	**3,080**	**3,080**	**3,080**
GMA 7		**49,936**	**49,936**	**49,936**	**49,936**	**49,936**	**49,936**	**49,936**

Note: The year 2011 is used because the 2010 desired future condition baseline year for the Hickory Aquifer is an initial condition in the predictive model run.

TABLE 10. MODELED AVAILABLE GROUNDWATER FOR THE HICKORY AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year					
			2020	2030	2040	2050	2060	2070
Concho	F	Colorado	27	27	27	27	27	27
		Total	**27**	**27**	**27**	**27**	**27**	**27**
Gillespie	K	Colorado	1,751	1,751	1,751	1,751	1,751	1,751
		Total	**1,751**	**1,751**	**1,751**	**1,751**	**1,751**	**1,751**
Kimble	F	Colorado	165	165	165	165	165	165
		Total	**165**	**165**	**165**	**165**	**165**	**165**
Mason	F	Colorado	13,212	13,212	13,212	13,212	13,212	13,212
		Total	**13,212**	**13,212**	**13,212**	**13,212**	**13,212**	**13,212**
McCulloch	F	Colorado	24,377	24,377	24,377	24,377	24,377	24,377
		Total	**24,377**	**24,377**	**24,377**	**24,377**	**24,377**	**24,377**
Menard	F	Colorado	2,725	2,725	2,725	2,725	2,725	2,725
		Total	**2,725**	**2,725**	**2,725**	**2,725**	**2,725**	**2,725**
San Saba	K	Colorado	7,680	7,680	7,680	7,680	7,680	7,680
		Total	**7,680**	**7,680**	**7,680**	**7,680**	**7,680**	**7,680**
GMA 7			**49,936**	**49,936**	**49,936**	**49,936**	**49,936**	**49,936**

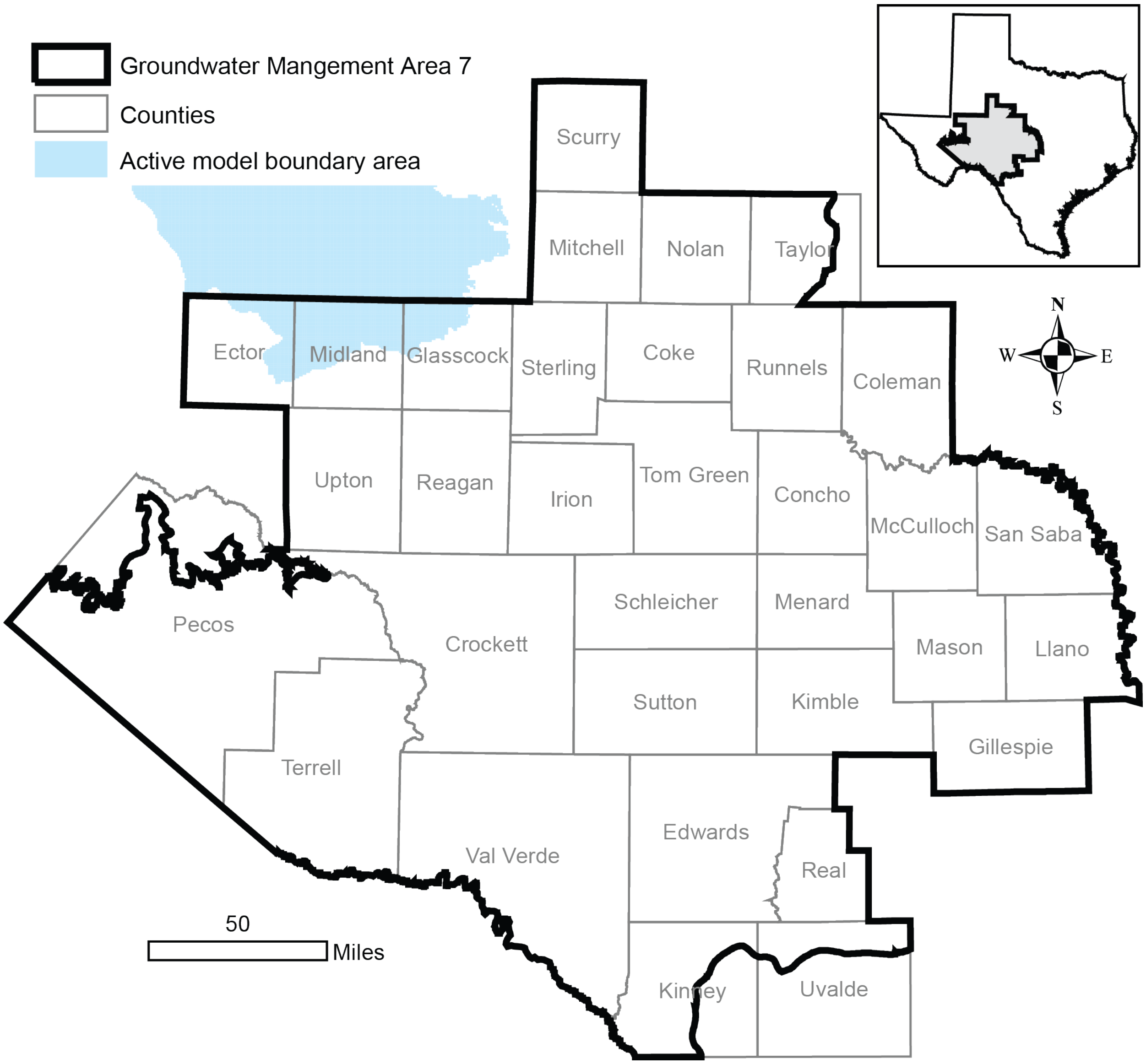


FIGURE 11. MAP SHOWING THE AREAS COVERED BY THE OGALLALA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 11. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2013 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year						
		2013	2020	2030	2040	2050	2060	2070
Glasscock GCD	Glasscock	8,019	7,925	7,673	7,372	7,058	6,803	6,570
	Total	**8,019**	**7,925**	**7,673**	**7,372**	**7,058**	**6,803**	**6,570**
GMA 7		**8,019**	**7,925**	**7,673**	**7,372**	**7,058**	**6,803**	**6,570**

Note: The year 2013 is used because the 2012 desired future condition baseline year for the Ogallala Aquifer is an initial condition in the predictive model run.

TABLE 12. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year					
			2020	2030	2040	2050	2060	2070
Glasscock	F	Colorado	7,925	7,673	7,372	7,058	6,803	6,570
		Total	**7,925**	**7,673**	**7,372**	**7,058**	**6,803**	**6,570**
GMA 7			**7,925**	**7,673**	**7,372**	**7,058**	**6,803**	**6,570**

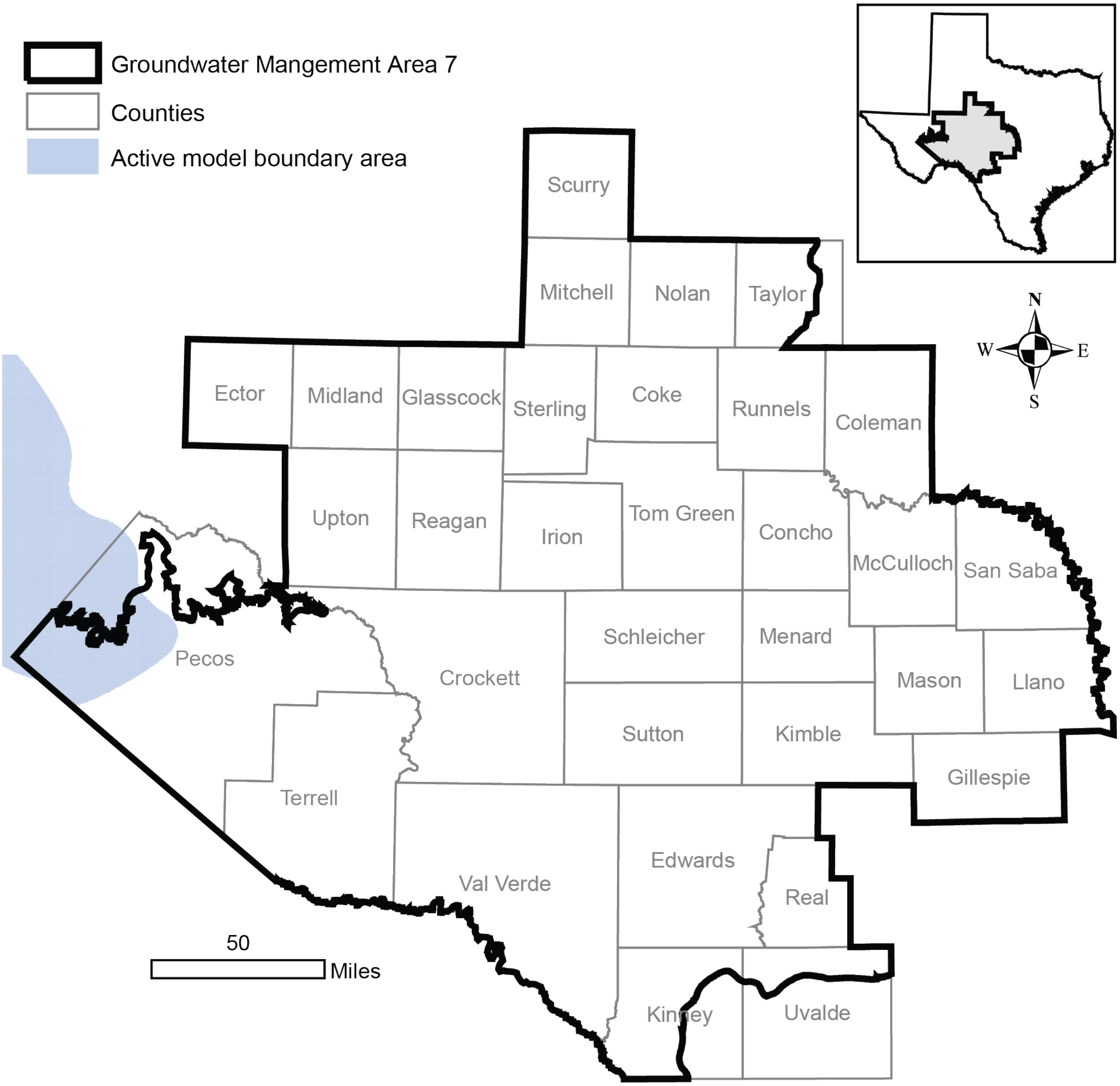


FIGURE 12. MAP SHOWING AREAS COVERED BY THE RUSTLER AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE RUSTLER AQUIFER IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 13. MODELED AVAILABLE GROUNDWATER FOR THE RUSTLER AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2009 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year							
		2009	2010	2020	2030	2040	2050	2060	2070
Middle Pecos GCD	Pecos	7,040	7,040	7,040	7,040	7,040	7,040	7,040	7,040
	Total	**7,040**	**7,040**	**7,040**	**7,040**	**7,040**	**7,040**	**7,040**	**7,040**

TABLE 14. MODELED AVAILABLE GROUNDWATER FOR THE RUSTLER AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year					
			2020	2030	2040	2050	2060	2070
Pecos	F	Rio Grande	7,040	7,040	7,040	7,040	7,040	7,040
		Rio Grande	**7,040**	**7,040**	**7,040**	**7,040**	**7,040**	**7,040**

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 historical 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 streamflow are specific to a particular historical 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.

Model "Dry" Cells

The predictive model run for this analysis results in water levels in some model cells dropping below the base elevation of the cell during the simulation. In terms of water level, the cells have gone dry. However, as noted in the model assumptions the transmissivity of the cell remains constant and will produce water.

REFERENCES:

Anaya, R., and Jones, I. C., 2009, Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas: Texas Water Development Board Report 373, 103p. http://www.twdb.texas.gov/groundwater/models/gam/eddt_p/ET-Plateau_Full.pdf

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

EcoKai Environmental, Inc. and Hutchison, W. R., 2014, Hydrogeological Study for Val Verde and Del Rio, Texas: Prep. For Val Verde County and City of Del Rio, 167 p.

Ewing, J. E., Kelley, V. A., Jones, T. L., Yan, T., Singh, A., Powers, D. W., Holt, R. M., and Sharp, J. M., 2012, Final Groundwater Availability Model Report for the Rustler Aquifer, Prepared for the Texas Water Development Board, 460p. http://www.twdb.texas.gov/groundwater/models/gam/rslr/RSLR_GAM_Report.pdf

Harbaugh, A. W., 2005, MODFLOW-2005, The US Geological Survey Modular Groundwater-Model – the Ground-Water Flow Process. Chapter 16 of Book 6. Modeling techniques, Section A Ground Water: U.S. Geological Survey Techniques and Methods 6-A16. 253p.

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

Harbaugh, A. W., Banta, E. R., Hill, M. C., 2000, MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process: U.S. Geological Survey, Open-File Report 00-92, 121p.

Hutchison, W. R., Jones, I. C, and Anaya, R., 2011a, Update of the Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas, Texas Water Development Board, 61 p. http://www.twdb.texas.gov/groundwater/models/alt/eddt_p_2011/ETP_PV_One_Layer_Model.pdf

Hutchison, W. R., Shi, J., and Jigmond, M., 2011b, Groundwater Flow Model of the Kinney County Area, Texas Water Development Board, 217 p. http://www.twdb.texas.gov/groundwater/models/alt/knny/Kinney_County_Model_Report.pdf

Hutchison, W. R., 2016a, GMA 7 Explanatory Report—Final, Aquifers of the Llano Uplift Region (Ellenburger-San Saba, Hickory, Marble Falls): Prep. For Groundwater Management Area 7, 79 p.

Hutchison, W. R., 2016b, GMA 7 Explanatory Report—Final, Ogallala and Dockum Aquifers: Prep. For Groundwater Management Area 7, 78 p.

Hutchison, W. R., 2016c, GMA 7 Explanatory Report—Final, Rustler Aquifer: Prep. For Groundwater Management Area 7, 64 p.

Hutchison, W. R., 2016d, GMA 7 Technical Memorandum 15-05—Final, Rustler Aquifer: Nine Factor Documentation and Predictive Simulation with Rustler GAM, 27 p.

Hutchison, W. R., 2016e, GMA 7 Technical Memorandum 15-06—Final, Edwards-Trinity (Plateau) and Pecos Valley Aquifers: Nine Factor Documentation and Predictive Simulation, 60 p.

Hutchison, W. R., 2016f, GMA 7 Technical Memorandum 16-01—Final, Dockum and Ogallala Aquifers: Initial Predictive Simulations with HPAS, 29 p.

Hutchison, W. R., 2016g, GMA 7 Technical Memorandum 16-02—Final, Llano Uplift Aquifers: Initial Predictive Simulations with Draft GAM, 24 p.

Hutchison, W. R., 2016h, GMA 7 Technical Memorandum 16-03—Final, Capitan Reef Complex Aquifer: Initial Predictive Simulations with Draft GAM, 8 p.

Hutchison, W. R., 2018a, GMA 7 Explanatory Report—Final, Capitan Reef Complex Aquifer: Prep. For Groundwater Management Area 7, 63 p.

Hutchison, W. R., 2018b, GMA 7 Explanatory Report—Final, Edwards-Trinity, Pecos Valley and Trinity Aquifers: Prep. For Groundwater Management Area 7, 173 p.

Hutchison, W. R., 2018c, GMA 7 Technical Memorandum 18-01—Final, Edwards-Trinity (Plateau) and Pecos Valley Aquifers: Update of Average Drawdown Calculations, 10 p.

Jones, I. C., 2016, Groundwater Availability Model: Eastern Arm of the Capitan Reef Complex Aquifer of Texas. Texas Water Development Board, March 2016, 488p. http://www.twdb.texas.gov/groundwater/models/gam/crcx/CapitanModelReportFinal.pdf

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

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

Panday, S., Langevin, C. D., Niswonger, R. G., Ibaraki, M., and Hughes, J. D., 2013, MODFLOW–USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p.

Shi, J, 2012, GAM Run 10-043 MAG (Version 2): Modeled Available Groundwater for the Edwards-Trinity (Plateau), Trinity, and Pecos Valley aquifers in Groundwater Management Area 7, Texas Water Development Board GAM Run Report 10-043, 15 p. www.twdb.texas.gov/groundwater/docs/GAMruns/GR10-043_MAG_v2.pdf

Shi, J., Boghici, R., Kohlrenken, W., and Hutchison, W., 2016, Numerical model report: minor aquifers of the Llano Uplift Region of Texas (Marble Falls, Ellenburger-San Saba, and Hickory): Texas Water Development Board published report, 400 p. http://www.twdb.texas.gov/groundwater/models/gam/llano/Llano_Uplift_Numerical_Model_Report_Final.pdf

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

APPENDIX B

Estimated Historical Groundwater Use And 2017 State Water Plan Datasets:

Sutton County Underground Water Conservation District

by Stephen Allen
Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
July 18, 2018

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 2017 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 Dr. Shirley Wade, shirley.wade@twdb.texas.gov, (512) 936-0883.

DISCLAIMER:

The data presented in this report represents the most up-to-date WUS and 2017 SWP data available as of 7/18/2018. 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 2017 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 2017 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 perfect 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 2017. TWDB staff anticipates the calculation and posting of these estimates at a later date.

SUTTON COUNTY *99.8% (multiplier)* All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2016	GW	868	1	0	0	1,138	338	2,345
	SW	0	0	0	0	0	7	7
2015	GW	962	1	0	0	1,014	336	2,313
	SW	0	0	0	0	0	7	7
2014	GW	1,121	3	0	0	1,106	428	2,658
	SW	0	0	0	0	0	9	9
2013	GW	1,184	3	16	0	829	416	2,448
	SW	0	0	0	0	0	9	9
2012	GW	1,265	1	12	0	1,020	360	2,658
	SW	0	0	0	0	0	7	7
2011	GW	1,284	0	51	0	1,492	493	3,320
	SW	0	0	6	0	0	11	17
2010	GW	922	5	151	0	1,141	477	2,696
	SW	0	0	18	0	0	9	27
2009	GW	889	0	157	0	676	457	2,179
	SW	0	0	18	0	0	9	27
2008	GW	1,139	0	162	0	407	468	2,176
	SW	0	0	18	0	0	10	28
2007	GW	1,022	0	0	0	1,834	395	3,251
	SW	0	0	0	0	0	8	8
2006	GW	1,246	0	0	0	1,673	363	3,282
	SW	0	0	0	0	0	7	7
2005	GW	1,140	0	0	0	1,487	396	3,023
	SW	0	0	0	0	0	8	8
2004	GW	1,105	1	0	0	347	141	1,594
	SW	0	0	0	0	0	208	208
2003	GW	1,241	1	0	0	347	150	1,739
	SW	0	0	0	0	0	223	223
2002	GW	1,336	0	0	0	1,324	188	2,848
	SW	0	0	0	0	0	277	277
2001	GW	1,334	0	0	0	1,324	208	2,866
	SW	0	0	0	0	0	308	308

Projected Surface Water Supplies
TWDB 2017 State Water Plan Data

SUTTON COUNTY *99.8% (multiplier)* All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
F	IRRIGATION, SUTTON	COLORADO	COLORADO RUN-OF-RIVER	2	2	2	2	2	2
F	LIVESTOCK, SUTTON	COLORADO	COLORADO LIVESTOCK LOCAL SUPPLY	46	46	46	46	46	46
F	LIVESTOCK, SUTTON	RIO GRANDE	RIO GRANDE LIVESTOCK LOCAL SUPPLY	57	57	57	57	57	57
	Sum of Projected Surface Water Supplies (acre-feet)			**105**	**105**	**105**	**105**	**105**	**105**

Projected Water Demands
TWDB 2017 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.

SUTTON COUNTY

99.8% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
F	COUNTY-OTHER, SUTTON	COLORADO	27	28	28	28	28	28
F	COUNTY-OTHER, SUTTON	RIO GRANDE	140	145	146	148	150	151
F	IRRIGATION, SUTTON	COLORADO	291	285	279	274	268	263
F	IRRIGATION, SUTTON	RIO GRANDE	1,508	1,478	1,450	1,419	1,391	1,362
F	LIVESTOCK, SUTTON	COLORADO	214	214	214	214	214	214
F	LIVESTOCK, SUTTON	RIO GRANDE	264	264	264	264	264	264
F	MINING, SUTTON	COLORADO	89	144	153	115	78	53
F	MINING, SUTTON	RIO GRANDE	356	575	609	457	310	211
F	SONORA	RIO GRANDE	1,239	1,317	1,339	1,359	1,372	1,380
		Sum of Projected Water Demands (acre-feet)	**4,128**	**4,450**	**4,482**	**4,278**	**4,075**	**3,926**

Projected Water Supply Needs
TWDB 2017 State Water Plan Data

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

SUTTON COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
F	COUNTY-OTHER, SUTTON	COLORADO	0	0	0	0	0	0
F	COUNTY-OTHER, SUTTON	RIO GRANDE	0	0	0	0	0	0
F	IRRIGATION, SUTTON	COLORADO	0	0	0	0	0	0
F	IRRIGATION, SUTTON	RIO GRANDE	0	0	0	0	0	0
F	LIVESTOCK, SUTTON	COLORADO	0	0	0	0	0	0
F	LIVESTOCK, SUTTON	RIO GRANDE	10	10	10	10	10	10
F	MINING, SUTTON	COLORADO	0	0	0	0	0	0
F	MINING, SUTTON	RIO GRANDE	0	0	0	0	0	0
F	SONORA	RIO GRANDE	0	0	0	0	0	0
		Sum of Projected Water Supply Needs (acre-feet)	**0**	**0**	**0**	**0**	**0**	**0**

Projected Water Management Strategies
TWDB 2017 State Water Plan Data

SUTTON COUNTY

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

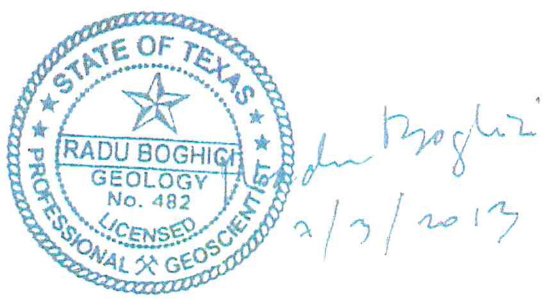
Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
IRRIGATION, SUTTON, COLORADO (F)							
IRRIGATION CONSERVATION - SUTTON COUNTY	DEMAND REDUCTION [SUTTON]	15	29	42	42	42	42
WEATHER MODIFICATION	WEATHER MODIFICATION [ATMOSPHERE]	6	6	5	6	5	6
		21	**35**	**47**	**48**	**47**	**48**
IRRIGATION, SUTTON, RIO GRANDE (F)							
IRRIGATION CONSERVATION - SUTTON COUNTY	DEMAND REDUCTION [SUTTON]	75	148	218	218	218	218
WEATHER MODIFICATION	WEATHER MODIFICATION [ATMOSPHERE]	28	28	29	28	29	28
		103	**176**	**247**	**246**	**247**	**246**
MINING, SUTTON, COLORADO (F)							
MINING CONSERVATION - SUTTON COUNTY	DEMAND REDUCTION [SUTTON]	6	10	11	8	5	4
		6	**10**	**11**	**8**	**5**	**4**
MINING, SUTTON, RIO GRANDE (F)							
MINING CONSERVATION - SUTTON COUNTY	DEMAND REDUCTION [SUTTON]	25	40	42	32	22	14
		25	**40**	**42**	**32**	**22**	**14**
SONORA, RIO GRANDE (F)							
MUNICIPAL CONSERVATION - SONORA	DEMAND REDUCTION [SUTTON]	18	20	20	20	21	21
REUSE - SONORA, DIRECT NON-POTABLE	DIRECT REUSE [SUTTON]	62	62	62	62	62	62
WATER AUDITS AND LEAK - SONORA	DEMAND REDUCTION [SUTTON]	77	82	83	85	86	86
		157	**164**	**165**	**167**	**169**	**169**
Sum of Projected Water Management Strategies (acre-feet)		**312**	**425**	**512**	**501**	**490**	**481**

APPENDIX C

GAM Run 13-005: Sutton County Underground Water Conservation District Management Plan

by Radu Boghici, P.G.
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-5808

July 3, 2013



The seal appearing on this document was authorized by Radu Boghici, P.G. 482 on July 3, 2013.

This page is intentionally blank

GAM RUN 13-005: SUTTON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Radu Boghici, P.G.
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-5808
July 3, 2013

EXECUTIVE SUMMARY:

Texas Water Code, Section 36.1071, Subsection (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. Information derived from groundwater availability models that shall be included in the groundwater management plan includes:

- the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
- 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
- the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

This report (Part 2 of a two-part package of information from the TWDB to Sutton County Groundwater Conservation District) fulfills the requirements noted above. Part 1 of the 2-part package is the Historical Water Use/State Water Plan data report. The District will receive this data report from the TWDB Groundwater Technical Assistance Section. Questions about the data report can be directed to Mr. Stephen Allen, Stephen.Allen@twdb.texas.gov, (512) 463-7317.

The groundwater management plan for the Sutton County Underground Water Conservation District should be adopted by the district on or before November 20, 2013 and submitted to the executive administrator of the TWDB on or before December 20, 2013. The current management plan for Sutton County Underground Water Conservation District expires on February 18, 2014. This report discusses the methods, assumptions, and results from model runs using the groundwater availability model (version 1.01) for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Anaya and Jones, 2009). Table 1 summarizes the groundwater availability model data required by the statute, and Figure 1 shows the area of the model from which the values in the table were extracted. GAM Run 13-005 meets current standards. If after review of the figures, Sutton County Underground Water Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, the District should notify the Texas Water Development Board immediately. Per statute, TWDB is required to provide the districts with data from the official groundwater availability models; however, the TWDB has also approved, for planning purposes, an alternative model that can have water budget information extracted for the district. The alternative model is the 1-layer alternative model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Hutchison and others, 2011). Please contact the author of this report if a comparison table using this model is desired.

METHODS:

In accordance with the provisions of the Texas Water Code, Section 36.1071, Subsection (h), the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers was run for this analysis. Sutton County Underground Water Conservation District Water budgets for the historical model periods were extracted 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, net inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portions of the aquifers located within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Edwards-Trinity (Plateau) Aquifer

- 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 Pecos Valley Aquifer does not occur within Sutton County and therefore no groundwater budget values are included for it in this report.

- This groundwater availability model includes two layers within Sutton County which generally represent the Edwards Group (Layer 1) and the Trinity Group (Layer 2) of the Edwards-Trinity (Plateau) Aquifer. Individual water budgets for the District were determined for the Edwards-Trinity (Plateau) Aquifer (Layer 1 and Layer 2 combined).

- For Sutton County, groundwater in the Edwards-Trinity (Plateau) Aquifer is generally fresh, with total dissolved solids of less than 500 milligrams per liter in nearly 99 percent of the wells in the TWDB groundwater database. (TWDB Groundwater Database, queried in June 2013).

- 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 duration of the calibration and verification portion of the model runs in the district, as shown in Table 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.

- Surface water outflow—The total water discharging from the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).

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

- Flow between aquifers—The net vertical flow between aquifers or confining units. This flow is controlled by the relative water levels in each aquifer or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs. "Inflow" to an aquifer from an overlying or underlying aquifer will always equal the "Outflow" from the other aquifer.

The information needed for the District's management plan is summarized in Table 1. 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 (Figure 1).

TABLE 1: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR THE SUTTON COUNTY UNDERGROUND WATER 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	27,165
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	26,288
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	25,022
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	26,205
Estimated net annual volume of flow between each aquifer in the district	Edwards-Trinity (Plateau) Aquifer into/from adjacent formations	Not Applicable

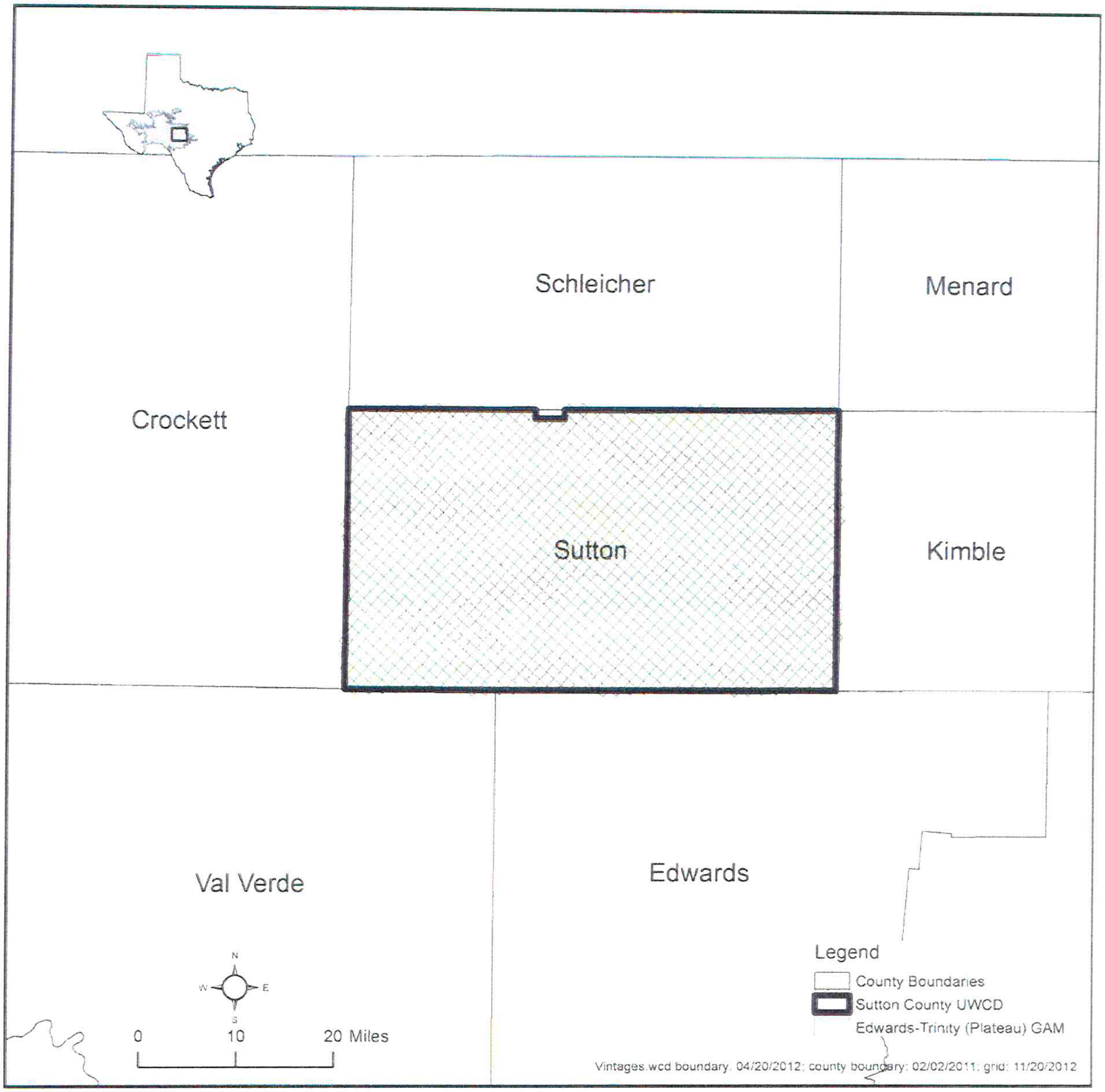


FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL (GAM) FOR THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED FOR THE EXTENT OF THE EDWARDS-TRINITY (PLATEAU) AQUIFER WITHIN THE DISTRICT BOUNDARY.

LIMITATIONS

The groundwater model(s) used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). 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.

REFERENCES:

Anaya, R., and Jones, I., 2009, Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers, 103 p., http://www.twdb.texas.gov/groundwater/models/gam/eddt_p/ET-Plateau_Full.pdf

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

Harbaugh, A. W., and McDonald, M. G., 1996, User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference groundwater-water flow model: U.S. Geological Survey Open-File Report 96-485, 56 p.

Hutchison, W. R., Jones, I., and Anaya, R., 2011, Update of the Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas, 60 p., http://www.twdb.texas.gov/groundwater/models/alt/eddt_p_2011/alt1_eddt_p.asp

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.

TWDB Groundwater Database, 2013, Texas Water Development Board, http://www.twdb.texas.gov/groundwater/data/index.asp.

APPENDIX D

DISTRICT RULES

http://www.suttoncountyuwcd.org/sutton-county-uwcd-rules

APPENDIX E

DROUGHT CONTINGENCY PLAN

http://www.suttoncountyuwcd.org/drought-contingency-plan

APPENDIX F

SUTTON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT
301 S. Crockett Ave Sonora, TX 76950
Office: 325-387-2369 Fax: 325-387-5737 Website: suttoncountyuwcd.org

ADOPTION OF MANAGEMENT PLAN 2019-2024

WHEREAS, The Sutton County Underground Water Conservation District (the District) was created by the 69th Texas Legislature (1985) under the authority of Section 59, Article XVI, of the Texas Constitution, and in accordance with Chapter 51 and 52 of the Texas Water Code, as amended; and

WHEREAS, the District is required by Chapter 36, §36.1071 of the Texas Water Code to develop and adopt a Management Plan; and

WHEREAS, the District is required by Chapter 36, §36.1072 of the Texas Water Code to review and re-adopt the plan with or without revisions at least once every five years and to submit the adopted Management Plan to the Executive Administrator of the Texas Water Development Board for review and approval; and

WHEREAS, the District's readopted revised Management Plan shall be approved by the Executive Administrator if the plan is administratively complete; and

WHEREAS, the District Board of Directors, after reviewing the existing Management Plan, has determined that this plan should be revised and replaced with a new 5-Year Management Plan expiring in 2024; and

WHEREAS, the District Board of Directors has determined that the 5-Year Management Plan addresses the requirements of Chapter 36, §36.1071.

NOW, THEREFORE, be it resolved that the Board of Directors of the Sutton County Underground Water Conservation District, following notice and hearing, hereby adopts this 5-Year Management Plan; and

FUTHER, be it resolved, that this new Management Plan shall become effective immediately upon adoption.

Adopted this 9th day of October, 2018, by the Board of Directors of the Sutton County Underground Water Conservation District.

Attesting Signature

Presiding Officer

APPENDIX G

PUBLIC HEARING
Sutton County Underground Water Conservation District

Tuesday, October 9, 2018
9:30 a.m.
Sutton County UWCD Office
301 S. Crockett Avenue
Sonora, TX 76950

The Sutton County Underground Water Conservation District will hold a Public Hearing at 9:30 a.m. on October 9, 2018, to receive public comments on the District's 5-year Management Plan (2019-2024). The Plan may be reviewed at the District office Monday through Friday during office hours from 8:00 a.m. to 5:00 p.m.