PRESIDIO COUNTY UNDERGROUND WATER CONSERVATION DISTRICT

GROUNDWATER MANAGEMENT PLAN

Effective 2020-2025

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I. District Mission

The Presidio County Underground Water Conservation District will strive to develop, promote, and implement water conservation and management strategies to protect water resources for the benefit of the citizens, economy, and environment of the District.

II. Purpose of Management Plan

The District's management plan satisfies the requirements of SB 1, SB2, HB 1763, the statutory requirements of Texas Water Code (TWC) Chapter 36, and the rules and requirements of TWDB. This plan further addresses the process established by the District to monitor changes in the aquifer, communicate to the public the findings made by the District, and ensure that the plan can adapt through time to meet the needs of the stakeholders of Presidio County.

III. District Information

A. Creation

The Texas State Legislature in 1949 authorized the creation of Underground Water Conservation Districts to perform certain prescribed duties, functions, and hold specific powers as set forth in Article 7880-3c, Texas Civil Statutes, now codified in Chapter 36 of the Texas Water Code.

This District was legislatively created and confirmed by the citizens of Presidio County through an election on August 31, 1999.

B. Directors

The District's Board of Directors were appointed by the Presidio County Commissioners Court and the present active board of directors is Trey Gerfers, Chair, Virginia Carrasco, Treasurer/Secretary, Brenda Witty, David Williams and Tony Manriquez. The District Manager is Carolyn Macartney

C. Authority

The District derives its authority to manage groundwater within the District by virtue of the powers granted and authorized pursuant to Section 59, Article XVI, Texas Constitution, Chapter 36, Texas Water Code, and the District's enabling act, the Act of May 19, 1995, 74th Leg., R.S., chapter 157, 1995 Tex. Gen. Laws 1007 (See Appendix A). The District, acting under such authority, assumes all the rights and responsibilities of a groundwater conservation district specified in Chapter 36 of the Texas Water Code.

D. Location and Extent

Presidio County is an area of 3,855 square miles, located in the Trans-Pecos region West Texas. The county is bound on the east by Brewster County, on the south by the Rio Grande River, and on the north by Jeff Davis County. Marfa is the county seat, which is in the north portion of the county. Other towns in the county include Presidio and Redford in the south. Candelaria and Ruidoso are in the southwest. All the other towns except Marfa are located near the Rio Grande River.

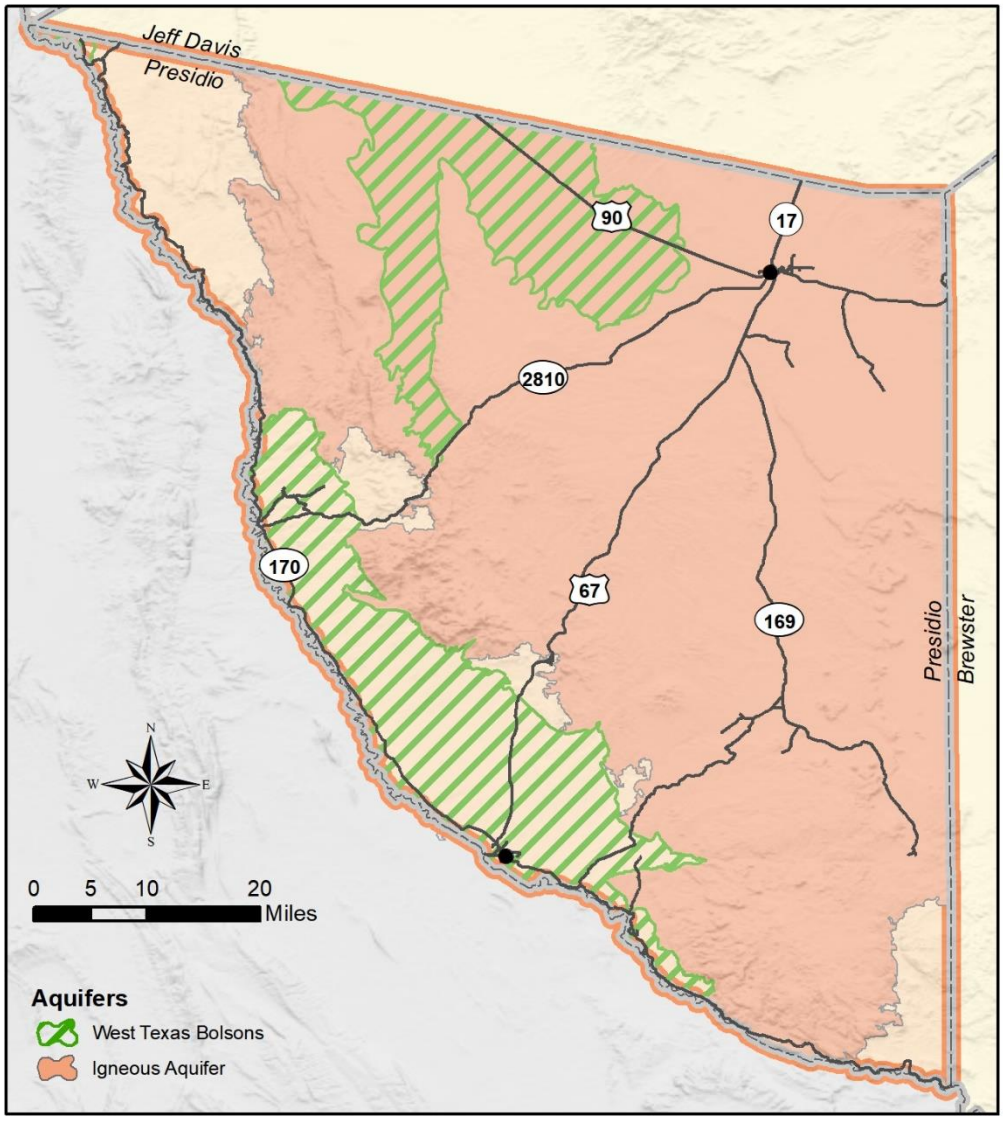


Figure 1 - District and Aquifer Boundaries

County	County Area (acre)	Presidio County UWCD Area (acres)	Percent (%) of County Area
Presidio	2,458,491.65	2,447,785.67	99.56

Table 1 - Presidio County UWCD Area

E. Topography and drainage

The topography of Presidio County is from high plains and plateaus in the north central portion of the county to rugged mountains in the south and southwest. The highest mountain is Chianti Peak, which is 7,730 feet. The farming areas lie in the southern portion of the county, near Presidio and to some extent near Candelaria and Ruidoso in the southwest. The area around Presidio is thought to be the oldest continuously cultivated farmland in Texas. The north central portion of the country or the high plains is the area consisting primarily of ranch land.

F. Groundwater Resources in Presidio County

In the Presidio County Underground Water Conservation District, the known groundwater resources are within the West Texas Bolsons aquifers including the Ryan Flat and Presidio-Redford Bolsons and the Igneous Aquifer.

The West Texas Bolsons are fault-bounded basins filled with sediments eroded from the surrounding highlands. The Presidio-Redford Bolson Aquifer is in the southern portion of Presidio County along the Rio Grande. It is the source of municipal supply for the City of Presidio. Water quality above the Rio Grande flood plain is fresh.

The Ryan Flat Bolson occurs in the northwestern part of Presidio County. Ryan Flat is the southernmost extension of the Salt Basin in Texas. It is bounded by mountains along its western, southern and eastern margins, and is thought to be hydrogeologically connected with Lobo Valley outside the District.

The largest aquifer in the county is the Igneous Aquifer. The Igneous Aquifer consists of many layers of highly fractured and faulted igneous rocks and overlying volcanoclastic alluvial fill. The principal water-bearing volcanic units are the Petan Basalt and the Tascotal Formations. The Igneous Aquifer supplies municipal water to the City of Marfa.

IV. Statement of Guiding Principles

The District recognizes that the groundwater resources of the county are of vital importance. The preservation of this most valuable resource can be managed in a prudent and cost-effective manner through education, regulations, and permitting. The greatest threat to prevent the District from achieving the stated mission is inappropriate management, based in part on the lack of understanding of local conditions. A basic understanding of the aquifers and their hydrogeologic properties, as well as quantification of resources is the foundation from which to build prudent planning measures.

The goals of this plan can best be achieved through guidance from the locally elected board members who understand local conditions as well as technical support from the Texas Water Development Board and qualified consulting agencies. This management plan is intended as a tool to focus the thoughts and actions of those given the responsibility for the execution of the District activities.

V. Criteria for Plan Approval

A. Planning horizon

This plan becomes effective upon adoption by the District's board of directors and approval by the Texas Water Development Board (TWDB) affirming the plan is administratively complete. This District management plan will remain in effect for a period of five (5) years from the date of TWDB's approval, or until a revised plan is approved by the TWDB.

B. Board Resolution

A copy of the Presidio County District's resolution for adopting the 2020 to 2025 management plan is in Appendix A.

C. Plan Adoption

This plan replaces the existing plan adopted by the District's Board of Directors, which was approved by TWDB on January 15, 2015.

D. Coordination with Surface Water Management

There are no irrigation or surface drainage districts within the jurisdiction of this groundwater district.

VI. Technical Information Required by TWC 36.1071/31 TAC 356.52

A. Modeled available groundwater based on Desired Future Conditions (DFC) of aquifers in District.

Section 36.001 of the Texas Water Code defines modeled available groundwater (MAG) 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. House Bill 1763 passed by the 79th Texas Legislature in 2005 provided that the desired future conditions of the aquifer may only be determined through the joint planning process within a groundwater management area (GMA) and must be adopted prior to the statutory deadline of September 1, 2010, and every five years thereafter.

DESIRED FUTURE CONDITIONS ESTABLISHED FOR THE DISTRICT

Aquifer	Amount average drawdown should not exceed after 50 years (feet)
Igneous	14
Salt Basin Portion of the West Texas Bolsons	72
Presidio-Redford Bolson	72

Table 2 - Texas Water Development Board, Groundwater Availability Model (GAM) Run 16-030, listed in "Description of Request", Presidio County, Appendix B

The joint planning process set forth in Section 36.108 of the Texas Water Code must be conducted by all groundwater conservation districts within the same groundwater management area. The District is a member of GMA 4. The groundwater conservation districts adopted desired future conditions prior to the September 1, 2010 deadline and then forwarded them to the TWDB for development of the modeled available groundwater calculations.

Aquifer (Rio Grande Basin)	Modeled Available Groundwater Totals for each decade in the planning period, 2020-2050, GAM run 16-030 (in acre-ft. per year)			
	2020	2030	2040	2050
Igneous Aquifer	4,064	4,064	4,064	4,063
Ryan Flat (West Texas Bolsons) Aquifer	9,112	8,982	8,834	8,710
Presidio-Redford (West Texas Bolsons) Aquifer	7,661	7,661	7,661	7,661
Total	20,837	20,707	20,559	20,434

Table 3 - Texas Water Development Board, GAM Run 16-030 MAG, Tables 7 and 11, (Appendix B)

The desired future conditions adopted by Groundwater Management Area 4 represent the quantified, measurable conditions of the groundwater resources of the District over the 50-year planning period (2010-2060). Section 36.001(30) defines desired future conditions as a quantitative description, adopted in accordance with Section 36.108, of the desired condition of the groundwater resources in a management area at one or more specified future times. The desired future conditions provided above demonstrate the maximum amount of water level declines that the District must not exceed over the planning period (2020-2050).

B. Estimate of the amount of groundwater being used within the District

See Appendix C, page 3, 2017 State Water Plan Tables, 1/8/2020

C. Estimate of the amount of recharge from precipitation to the groundwater resources within the District

See Appendix D, GAM Run 19-007

D. Estimate of the amount of discharge from each aquifer to springs and surface water bodies

See Appendix D, GAM Run 19-007

E. Estimate of the amount of flow into and out of the District within each aquifer and between aquifers

See Appendix D, GAM Run 19-007

F. Estimate of the amount of surface water supply within the District

See Appendix C, page 4, 2017 State Water Plan Tables, 1/8/2020

G. Estimate of the amount of total demand for water within the District

See Appendix C, page 5, 2017 State Water Plan Tables, 1/8/2020

VII. Water Supply Needs

A. Water Supply Needs

The District considered the water supply needs covered in the 2017 State Water Plan. According to the projected water supply needs data supplied from the 2017 State Water Plan the urban water needs of the two towns in Presidio County, Marfa and Presidio, will decrease over the next fifty years. The projected water supply needs for irrigation are projected to increase slightly over the next 50 years in Presidio County, while the projected water supply needs for mining in Presidio County, are projected to remain unchanged. The projected water supply needs for county other in Presidio County are projected to decrease over the next 50 years, while the projected needs for livestock will remain at zero according to the 2017 State Water Plan data.

See Appendix C, page 6, 2017 State Water Plan Tables, 1/8/2020

B. Water Management Strategies

The District considered the water management strategies covered in the 2017 State Water

Plan. The city of Marfa has secured funding to create an additional groundwater well to meet future needs. The City of Presidio is actively working to address water loss and will secure funding for an additional groundwater well.

See Appendix C, page 7, 2017 State Water Plan Tables, 1/8/2020

VIII. Management of Groundwater Supplies

The District will manage the supply of groundwater within the District in order to conserve the resource while seeking to maintain the economic viability of all the resource user groups, public and private. In consideration of the economic and cultural activities occurring within the district, the district will identify and engage in such activities and practices, that if implemented would result in a reduction of groundwater use. An observation network shall be established and maintained in order to monitor changing storage conditions of groundwater supplies within the District.

The District will make regular assessments of water supply and groundwater storage conditions and will report those conditions to the Board and to the public. The District will undertake, as necessary, and co-operate with investigations of the groundwater resources within the District and will make the results of investigations available to the public upon adoption of the Board.

The District has rules to regulate groundwater withdrawals by means of production limits. The District may grant or deny a well construction permit application or limit groundwater withdrawals in accordance with the guidelines stated in the rules of the District.

In pursuit of the District's mission of protecting the resource, the district may require reduction of groundwater withdrawals to amounts that will allow the District to achieve the desired future conditions established for the aquifers within the District's boundaries. To achieve this purpose, the District may, at the Boards discretion and in accordance with District's rules, amend or revoke any permit after notice and hearing. The determination to seek such an amendment or revocation of a permit by the District will be based on aquifer conditions observed by the District and as set forth in the District's rules.

Link to District rules (no direct link) http://www.co.presidio.tx.us/ hover over > county offices > Presidio County Underground Water Conservation District > Rules, well permit application, operating permit application, well registration.

IX. Actions, Procedures, Performance and Avoidance for Plan Implementation

The District will implement the provisions of this plan and will utilize the provision of this plan as a guidepost for determining the direction or priority for all District activities. All operations of the District, all agreements entered by the District and any additional planning efforts in which the District may participate will be consistent with the provision of this plan.

The District has adopted and implemented rules that regulate the permitting of wells and the

production of groundwater. The rules adopted by the District were adopted pursuant to TWC 36 and consistent with the provisions of this plan. All 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 citizens with equality. Citizens may apply to the District for discretion in enforcement of the rules on grounds of adverse economic effects or unique local conditions. In granting of discretion to any rule, the Board shall consider the potential for adverse effects 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 the plan and management of groundwater supplies within the District. All activities of the District will be undertaken in cooperation and coordinated with the appropriate state, regional or local water management entity.

X. Methodology for Tracking District Progress in Achieving Management Goals

The District manager will prepare and present an annual report to the Board of Directors on District performance regarding achieving management goals and objectives (during last monthly board of directors meeting each fiscal year. The report will include the number of instances each activity was engaged in during the year, referenced to the expenditure of staff time and budget so that the effectiveness and efficiency of each activity may be evaluated.

The annual report will be maintained on file at the District office.

XI. Goals, Management Objectives and Performance Standards

A. Providing the Most Efficient Use of Groundwater

A.1 Management Objective

Each year require meters to be installed on 100 percent of the new non-exempt production wells.

Performance Standard

Each year provide a report to the Board of Directors indicating the number of meters installed on new non-exempt production wells in the District and the location and ownership.

A.2 Management Objective

All current existing rules and regulations will be reviewed and amended, if necessary, to address the needs of the District at least once every three years.

Performance Standard

Each year, report to the Board of Directors the number of changes required to keep District rules updated to District needs.

B. Controlling and Preventing Waste of Groundwater.

B.1 Management Objective

Each year investigate 100 percent of the reports of wasteful practices within the District.

Performance Standards

a) Each year locate 100 percent of the complaint sites on a District map.

b) Each year provide a report to the Board of Directors indicating the number of wasteful practice reports and the number of those reports that were investigated.

B.2 Management Objective

Each year register 100 percent of the new wells drilled in the District.

Performance Standards

a) District will maintain files including information on the drilling and completion of all new wells in the District.

b) Annually report to the Board of Directors on the number of new wells registered during the year.

B.3 Management Objective

Each year the District will monitor the Railroad Commission of Texas (RCT) website to identify the location and status of all new oil and/or gas production and injection wells.

Performance Standards

Each year, provide a report to the Board of Directors indicating the number, status and type of new RCT wells within the District

C. Controlling and preventing subsidence.

The District considered the final report: “Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping”, TWDB Contract Number 1648302062.

The results from this report suggest that the Igneous Aquifer has a low risk for future subsidence due to pumping and the risk for future subsidence from future pumping is generally low to medium for the West Texas Bolson Aquifer.

D. Addressing conjunctive surface water management issues.

D.1 Management Objective

Each year, the District will participate in the regional planning process by attending the Region E regional water planning group meetings to convey information about groundwater availability and groundwater use within the District and to explore the development of surface water supplies to meet the needs of water user groups in the District.

Performance Standard

The attendance of a District's representative at a minimum of one Region E regional water planning group meeting will be noted in the annual report presented to the District's Board of Directors.

E. Addressing issues related to environmental and other concerns that may be affected by a District's groundwater management plan and rules, such as impacts on endangered species, soils, oil and gas production, mining, air and water quality degradation, agriculture, and plant and animal life.

E.1 Management Objective

To monitor water quality throughout the District

Performance Standard

The District will collect and test groundwater quality samples from newly drilled wells and existing wells.

Every year, the general manager will provide lab analysis reports to the District's Board of Directors for every well sampled

E.2 Management Objective

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

Performance Standard

The District will record all complaints and report these annually to the District's Board of Directors.

E.3 Management Objective

To monitor the Railroad Commission of Texas (RCT) and other appropriate databases to determine: Any new oil and gas operations; any wells that are being hydraulically fracture stimulated; locations of salt water or waste water disposal wells; any new mining operations; report any violations for failure to permit groundwater wells in support of hydraulic fracking operations.

Performance Standard

Obtain operating permits for groundwater wells that support hydraulic fracking operations within the District

Report to the Board at least annually the following activities within the District:

Any new water wells that support hydraulic fracking operations
Location and number of saltwater or wastewater disposal wells
Location and number of new oil and gas operations
Location and number of new mining operations
The number of violations for failure to permit wells being used in support of fracking operations

The District has no documented occurrences of endangered species dependent upon groundwater resources.

F. Addressing drought conditions.

F.1 Management Objective

The District will monitor the Palmer Drought Severity Index (PDSI) by Texas climatic divisions at least once quarterly. If PDSI indicates that the District will experience severe drought conditions, the District will notify all public water suppliers within the District. The District will also monitor the TWDB drought information page, also quarterly, for additional information on drought conditions. The TWDB drought information page is found at: https://www.waterdatafortexas.org/drought

Performance Standard

The District will report in the annual report to the Board of Directors the number of times the District experienced severe drought conditions according to the PDSI and the number of times notification was sent to all public water suppliers within the District.

G. Addressing conservation, recharge enhancement, rainwater harvesting, precipitation enhancement and brush control, where appropriate and cost-effective

G.1 Management Objective – Conservation

Distribute educational information yearly regarding the current conservation practices for efficient use of water resources.

Performance Standard

Each year, the District will include in the annual report to the Board of Directors the number of water conservation literature packets handed out.

G.2 Management Objective - Recharge Enhancement

Not Applicable - not cost effective.

G.3 Management Objective - Rainwater Harvesting

The low rainfall in our district makes this goal unattainable.

G.4 Management Objective - Precipitation Enhancement

Not Applicable - not cost effective.

G.5 Management Objective - Brush Control

Not Applicable - not cost effective

H. Addressing the Desired Future Conditions.

H.1 Management Objective - Desired Future Conditions

The District will establish new monitoring wells within the District to monitor water levels. These measurements and others in the area taken by the TWDB will be used to calculate a five-year average.

The District will monitor non-exempt pumping within the District for use in evaluating District compliance with aquifer desired future conditions.

Performance Standard

The measurement data from the District's wells and other TWDB monitoring wells will be input and managed in purpose specific data management software. Annual reports on this data will be presented to the board. After five years, the average will be used to determine if the District is on track to the meet the DFC.

Annual reporting of groundwater used by nonexempt wells will be included in the annual report provided to the District's Board of Directors.

Appendices

A. Copy of Board Resolution

B. GAM Run 16-030

C. 2017 Provided State Water Plan Tables, 1/8/2020

D. GAM Run 19-007

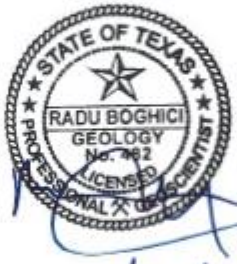
Appendix A – Copy of Board Resolution

Will be updated after TWDB review is completed. District Board will approve a new resolution and place copy here.

Appendix B – GAM Run 16-030

GAM RUN 16-030 MAG: MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 4

Radu Boghici, P.G. and Robert G. Bradley, P.G.
Texas Water Development Board
Groundwater Division
(512) 463-5808
February 28, 2018



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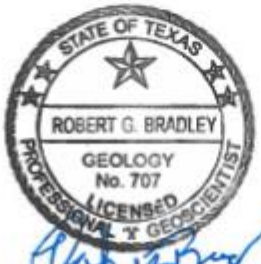

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GAM RUN 16-030 MAG: MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 4

Radu Boghici, P.G. and Robert G. Bradley, P.G.
Texas Water Development Board
Groundwater Division
(512) 463-5808
February 28, 2018

EXECUTIVE SUMMARY:

The modeled available groundwater for the relevant aquifers of Groundwater Management Area 4—the Bone Spring-Victorio Peak, Capitan Reef Complex, Edwards-Trinity (Plateau), Igneous, Marathon, and West Texas Bolsons aquifers—are summarized by decade for use in the regional water planning process (Tables 2, 4, 6, 8, 10, and 12) and for the groundwater conservation districts (Tables 1, 3, 5, 7, 9, and 11). The modeled available groundwater estimates are 101,400 acre-feet per year in the Bone Spring-Victorio Peak Aquifer, 8,163 acre-feet per year in the Capitan Reef Complex Aquifer, 1,394 acre-feet per year in the Edwards-Trinity (Plateau) Aquifer, range from 11,333 to 11,329 acre-feet per year in the Igneous Aquifer, 7,327 acre-feet per year in the Marathon Aquifer, and range from 58,577 to 57,881 acre-feet per year in the West Texas Bolsons Aquifer (Salt Basin and Presidio and Redford Bolsons combined). The modeled available groundwater estimates were extracted from results of model runs using the following groundwater availability models and alternative models: Bone Spring-Victorio Peak, Eastern Arm of the Capitan Reef Complex, Edwards-Trinity (Plateau), Igneous and West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat), and West Texas Bolsons (Presidio and Redford) aquifers. Analytical methods were used to calculate the modeled available groundwater for the Capitan Reef Complex Aquifer in Culberson County and for the Marathon Aquifer. The explanatory report and other materials submitted to the Texas Water Development Board (TWDB) were determined to be administratively complete on October 9, 2017.

Groundwater Management Area 4 responded to a request for clarifications by the TWDB in December 2017 (see the "Description of Request" section below for details).

REQUESTOR:

Ms. Janet Adams, Chair of Groundwater Management Area 4.

DESCRIPTION OF REQUEST:

In a letter dated September 26, 2017, Ms. Janet Adams provided the TWDB with the desired future conditions of the relevant aquifers in Groundwater Management Area 4. The desired future conditions, adopted September 20, 2017 by the groundwater conservation districts within Groundwater Management Area 4, are reproduced below:

Brewster County GCD [Groundwater Conservation District]: for the period from 2010-2060

- 3 feet drawdown for the Edwards-Trinity (Plateau) Aquifer.
- 10 feet drawdown for the Igneous Aquifer.
- 0-foot drawdown for the Marathon Aquifer.
- 0-foot drawdown for the Capitan Reef Complex Aquifer.

Culberson County GCD [Groundwater Conservation District]: for the period from 2010-2060

- 50 feet drawdown for the Capitan Reef Complex Aquifer.
- 78 feet drawdown for the [Salt Basin portion of the] West Texas Bolsons Aquifer.
- 66 feet drawdown for the Igneous Aquifer.

Hudspeth County UWCD [Underground Water Conservation District] No.1

- 0-foot drawdown for the period from 2010 until 2060 for the Bone Spring-Victorio Peak Aquifer, averaged across the portion of the aquifer within the boundaries of the District.

Jeff Davis County UWCD [Underground Water Conservation District]: for the period from 2010-2060

- 20 feet drawdown for the Igneous Aquifer.
- 72 feet drawdown for the [Salt Basin portion of the] West Texas Bolsons Aquifer.

Presidio County UWCD [Underground Water Conservation District]: for the period from 2010-2060

- 14 feet drawdown for the Igneous Aquifer.
- 72 feet drawdown for the [Salt Basin portion of the] West Texas Bolsons Aquifer.
- 72 feet drawdown for the Presidio-Redford Bolson [portion of the West Texas Bolsons].

In response to requests for clarifications from the TWDB on December 5, 2017, December 8, 2017, and February 5, 2018 the Groundwater Management Area 4 Chair, Ms. Janet Adams, indicated the following preferences for calculating modeled available groundwater volumes in Groundwater Management Area 4:

- For the Bone Spring-Victorio Peak Aquifer (Hudspeth County), the TWDB will use the results reported in GAM Run 10-061 and the assumptions described in GAM Task 10-006;
- For the Capitan Reef Complex Aquifer (Brewster and Culberson counties), the TWDB will use the Capitan Reef Complex Aquifer (Eastern Arm) groundwater availability model for Brewster County and the analytical approach (AA 09-08) for Culberson County. For Brewster County we will use 2005 as the baseline year and for Culberson County we will use the assumptions described in AA 09-08. The TWDB will assume the desired future condition in Brewster County is met if the average simulated drawdown value is within 3 feet.
- For the Edwards-Trinity (Plateau) Aquifer (Brewster County), the TWDB will use the single layer groundwater flow model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers, with 2005 as the baseline year and the assumptions described in GR 10-048.
- For the Igneous Aquifer and Salt Basin Portion of the West Texas Bolsons Aquifer (Brewster, Culberson, Jeff Davis, and Presidio counties), the TWDB will use the Igneous and West Texas Bolsons aquifers groundwater availability model, with 2000 as the baseline year and the assumptions described in report GR 10-037 MAG.
- For Presidio and Redford Bolsons portion of the West Texas Bolsons Aquifer, the TWDB will use the West Texas Bolsons Aquifer (Presidio and Redford Bolsons) groundwater availability model, with 2007 as the baseline year.
- The Red Light Draw, Green River Valley, and Eagle Flat portions of the West Texas Bolsons Aquifer are considered non-relevant for the purposes of joint planning because there are no groundwater conservation districts with jurisdiction over this portion of the minor aquifer.

METHODS:

The desired future conditions for the Bone Spring-Victorio Peak, Capitan Reef Complex (Culberson County only), Marathon, Igneous, Edwards-Trinity (Plateau), and West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat) aquifers are identical to the ones adopted in 2011, and the applicable groundwater availability models and

analytical methodology to calculate modeled available groundwater are unchanged. Therefore, the modeled available groundwater volumes presented for those aquifers are the same as those shown in the previous analytical assessments and model runs—GAM Task 10-061 (Oliver, 2011c), AA 09-08 (Wuerch and Davidson, 2010), AA 09-09 (Thorkildsen and Backhouse, 2010), GAM Run 10-048 (Oliver, 2012), and GAM Run 10-037 (Oliver, 2011a), and GAM Run 10-036 (Oliver, 2011b). The TWDB ran two new groundwater availability models, not previously available, for the Capitan Reef Complex (Eastern Arm) and West Texas Bolsons (Presidio and Redford Bolsons) aquifers. The modeled available groundwater volumes for these aquifers differ from the modeled available groundwater volumes previously calculated using analytical assessments.

Where analytical aquifer assessments were used, modeled available groundwater volumes were determined by summing estimates of effective recharge and the change in aquifer storage. See Freeze and Cherry (1979, p.365) for details regarding this analytical method.

Where groundwater availability models were used, the TWDB identified groundwater pumping scenarios that could achieve the adopted desired future conditions in Groundwater Management Area 4. The TWDB extracted simulated water levels for baseline years (see Parameters and Assumptions section for more information) and subsequent decades. The simulated drawdowns in all active model cells were averaged by aquifer for each county and groundwater conservation district. If water levels dropped below the base of the model cells during the predictive simulations, these cells became "dry cells". In some instances, dry cells were included in drawdown averages; in other instances they were not. See the "Parameters and Assumptions" section for more details on the treatment of dry cells in each of the model runs.

The calculated drawdown averages compared well with the desired future conditions and verified that the desired future conditions adopted by the districts can be achieved—within the assumptions and limitations associated with each groundwater availability model. Modeled available groundwater volumes were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Annual pumping rates were divided by county, river basin, regional water planning area, and groundwater conservation district within Groundwater Management Area 4 (Figures 1 through 13 and Tables 1 through 12).

Modeled Available Groundwater and Permitting

As defined in Chapter 36 of the Texas Water Code, "modeled available groundwater" is the estimated average amount of water that may be produced annually to achieve a desired future condition. Groundwater conservation districts are required to consider modeled available groundwater, along with several other factors, when issuing permits 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.

PARAMETERS AND ASSUMPTIONS:

Bone Spring-Victorio Peak Aquifer

- The previous modeled available groundwater (Oliver, 2011c) was calculated using three separate flow models run under a variety of climatic and pumping scenarios. See Hutchison (2008) for assumptions and limitations of the three groundwater flow models.
- The models have one layer representing the Bone Spring-Victorio Peak Aquifer, a portion of the Capitan Reef Complex Aquifer, and the Diablo Plateau.
- Hutchison (2008) ran all three models using pumping ranging from 0 to 125,000 acre-feet per year and climatic information from tree ring data ranging from 1000 to 1988.
- The results of the 144 simulations were plotted to establish a relationship between pumping and drawdown (Hutchison, 2010). Modeled available groundwater was the sum of net pumping and the estimated irrigation return flow (approximately 30 percent of the net pumping, according to the Hudspeth County Underground Water Conservation District No. 1) for each desired future condition. Additional information on the application of irrigation return flow is described in GAM Run 10-061 MAG (Oliver, 2011c).
- Because the analysis used was statistically based, the starting and ending period can apply for any 50-year planning horizon. Therefore, we applied the values to 2020 to 2070.

Capitan Reef Complex Aquifer (Brewster County only)

- Version 1.01 of the groundwater availability model of the Eastern Arm of the Capitan Reef Complex Aquifer was used, with a baseline year of 2005. See Jones (2016) for assumptions and limitations of the groundwater availability model. A new model run simulation was completed to determine modeled available groundwater that achieved the desired future condition.
- 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 recharge used for the model simulation represents average recharge from 1931 through 2005 (last year of model calibration).
- Available water-level data from 2005 to 2010 for the Capitan Reef Complex Aquifer indicates that water level changes have been minimal. Therefore, applying the clarifications received from the Groundwater Management Area 4 on December 7, 2017, we concluded that a 2005-to-2055 predictive simulation is equivalent to a 2010-to-2060 predictive simulation.
- Drawdowns were then averaged in Groundwater Management Area 4 based on the official aquifer boundaries. We assumed the desired future condition was met if the average drawdown value was within 3 feet.

Capitan Reef Complex Aquifer (Culberson County only)

- There is no groundwater availability model for the Capitan Reef Complex Aquifer in Culberson County.
- The annual total pumping estimates were calculated as the sum of the annual effective recharge amount and the annual volume of water depleted from the aquifer based on the desired future condition.
- Recharge was assumed to be evenly distributed across the outcrop of the aquifer.
- Effective recharge estimates were based on springflow and surface hydrology, groundwater pumpage and water-level changes, and precipitation estimates.
- Annual volumes of water taken from storage were calculated by dividing the total volume of depletion, based on the draft desired future condition, by 50 years. For this report, we assumed the 50 years was 2010 to 2060.
- Calculated water-level declines were assumed to be uniform across the aquifer within its footprint area, and these calculated water-level declines did not exceed aquifer thickness.
- A detailed description of all parameters and assumptions is available in AA 09-08 (Wuerch and others, 2011).

Edwards-Trinity (Plateau) Aquifer (Brewster County)

- The alternate groundwater flow model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers was used with a baseline year of 2005. This model is an update to the previously developed groundwater availability model documented in Anaya and Jones (2009). See Hutchison and others (2011) and Anaya and Jones (2009) for assumptions and limitations of the model.
- 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 recharge used for the model simulation represents average recharge as described in Hutchison and others (2011).
- Drawdowns were calculated by subtracting 2005 simulated water levels from 2060 simulated water levels, which were then averaged based on the official aquifer boundaries in Groundwater Management Area 4. Drawdowns for cells with water levels below the base elevation of the cell (dry cells) were excluded from the averaging.
- A detailed description of all parameters and assumptions is available in GAM Run 10-048 (Oliver, 2012).

Igneous Aquifer

- Version 1.01 of the groundwater availability flow model for the Igneous and parts of the West Texas Bolson aquifers was used for this analysis with year 2000 as baseline. See Beach and others (2004) for assumptions and limitations of the model.
- The model includes three layers representing the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer (Layer 1), the Igneous Aquifer (Layer 2), and the underlying Cretaceous and Permian units (Layer3). Some areas of Layer 2 outside the boundary of the Igneous Aquifer are active in order to allow flow between Layer 1 and Layer 3.
- The averaging of drawdowns and modeled available groundwater calculations were based on model extent as opposed to the official aquifer footprint. The Igneous Aquifer model extent is a smoothed and somewhat smaller version of the official footprint of the Igneous Aquifer. A comparison of these two areas is shown in Figure 8.
- The predictive run was set up using average recharge as described in Beach and others (2004) and was run from 2000 to 2050.

- Cells were assigned to individual counties, river basins, regional water planning areas, and groundwater conservation districts as shown in the August 3, 2010, version of the file that associates the model grid to political and natural boundaries for the Igneous Aquifer. Note that some minor adjustments were made to the file to better reflect the relationship of model cells to political boundaries.
- See GAM Task 10-028 (Oliver, 2010) for a full description of the methods and assumptions used in the groundwater availability model simulations. The predictive model run for this analysis resulted in water levels in some model cells dropping below the base elevation of the cell during the simulation. These cells were excluded from the averaging of drawdowns, which in turn resulted in progressively lower pumping values through time. This is illustrated by the decline in modeled available groundwater (see Tables 7 and 8).

Marathon Aquifer

- The annual total pumping estimates was calculated as the sum of the annual effective recharge amount and the annual volume of water depleted from the aquifer based on the desired future condition.
- Recharge was assumed to occur evenly across the aerial extent of the aquifer.
- Average annual precipitation (1971 through 2000) from the Climatic Atlas of Texas (Larkin and Bomar, 1983) was used to calculate annual effective recharge volumes.
- The draft annual total pumping estimates are the sum of the annual effective recharge amount and the annual volume of water depleted from the aquifer based on the draft desired future condition. Annual volumes were calculated by dividing the total volume by 50 years. For this report, we assumed the 50 years was 2010 to 2060.
- Calculated water level declines were estimated uniformly across the aquifer.
- A detailed description of all parameters and assumptions is available in AA 09-09 (Thorkildsen and Backhouse, 2010).

[Salt Basin portion of the] West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat) Aquifer

- Version 1.01 of the groundwater availability flow model for the Igneous and parts of the West Texas Bolson aquifers was used for this analysis with year 2000 as baseline. See Beach and others (2004) for assumptions and limitations of the model.

- The model includes three layers representing the Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat portions of the West Texas Bolsons Aquifer (Layer 1), the Igneous Aquifer (Layer 2), and the underlying Cretaceous and Permian units (Layer 3).
- The simulation was set up using average recharge as described in Beach and others (2004) and was run from 2000 to 2050.
- Cells were assigned to individual counties, river basins, regional water planning areas, and groundwater conservation districts as shown in the August 3, 2010, version of the file that associates the model grid to political and natural boundaries for the Igneous and West Texas Bolson Aquifers. Note that some minor adjustments were made to the file to better reflect the relationship of model cells to political boundaries.
- See GAM Task 10-028 (Oliver, 2010) for a full description of the methods and assumptions used in the groundwater availability model simulations. The predictive model run for this analysis resulted in water levels in some model cells dropping below the base elevation of the cell during the simulation. These cells have been excluded from the averaging of drawdowns, which in turn resulted in progressively lower pumping values through time. This is illustrated by the decline in modeled available groundwater (see Tables 11 and 12).

West Texas Bolsons (Presidio and Redford) Aquifer

- Version 1.01 of the groundwater availability model of the Presidio and Redford bolsons of the West Texas Bolsons Aquifer was used with a baseline year of 2007. A new model run simulation was completed to determine the modeled available groundwater that achieved the desired future condition.
- See Wade and Jigmond (2013) for assumptions and limitations of the groundwater availability model.
- The model includes three layers representing the Rio Grande Alluvium (Layer 1), West Texas Bolsons (Presidio and Redford) Aquifer (Layer 2), and Tertiary and Cretaceous units (Layer 3).
- The recharge used for the simulation represents average recharge from 1948 through 2007 (end year of model calibration). Pumping was scaled by an equal factor and simultaneously on both the United States and the Mexico sides of the aquifer during the predictive run simulations.
- An analysis of the Presidio and Redford bolsons indicate that the changes in water levels in the few wells with available data from 2007 through 2010 have

been minimal. Therefore, in observance of the clarifications received from the Groundwater Management Area 4 on December 7, 2017, we assumed that a 2007-to-2057 predictive simulation is equivalent to a 2010-to-2060 predictive simulation.

- Drawdowns were calculated by subtracting 2007 simulated water levels from 2057 simulated water levels which were then averaged for all active model cells within the official aquifer boundary in Presidio County. Drawdowns in model cells located in Mexico were excluded from averaging. We assumed the desired future condition was met if the average drawdown value was within 1 foot.

RESULTS:

The results for the groundwater conservation districts (Tables 1, 3, 5, 7, 9, and 11), reflects the ending year discussed in the Parameters and Assumption Section of this report. For planning purposes (Tables 2, 4, 6, 8, 10, and 12), the values may have been populated past the dates noted in Parameters and Assumption Section using the trend of results. Tables 1 through 12 show the combination of modeled available groundwater summarized (1) by groundwater conservation district and county; and (2) by county, river basin, and regional water planning area for use in the regional water planning process.

The modeled available groundwater for the Bone Spring-Victorio Peak Aquifer that achieves the desired future conditions adopted by Groundwater Management Area 4 is 101,400 acre-feet per year from 2020 to 2070 (Tables 1 and 2). These volumes represent total pumping, defined as the sum of net pumping and the irrigation return flow. Hudspeth County Underground Water Conservation District No. 1 estimates that irrigation return flow is about 30 percent of net pumping.

The modeled available groundwater for the Capitan Reef Complex Aquifer that achieves the desired future conditions adopted by Groundwater Management Area 4 is 8,163 acre-feet per year from 2020 to 2060/2070 (Tables 3 and 4). This value includes 583 acre-feet per year in Brewster County; 7,580 acre-feet per year in Culberson County.

The modeled available groundwater for the Edwards-Trinity (Plateau) Aquifer that achieves the desired future conditions adopted by Groundwater Management Area 4 is 1,394 acre-feet per year from 2020 to 2060/2070 (Tables 5 and 6).

The modeled available groundwater for the Igneous Aquifer that achieves the desired future conditions adopted by Groundwater Management Area 4 decreases from 11,333 to 11,329 acre-feet per year between 2020 and 2050 (Tables 7 and 8). In the counties comprising Groundwater Management Area 4, the modeled available groundwater from 2020 to 2060 is as follows: a decline from 2,586 to 2,583 acre-feet per year in Brewster

County; 99 acre-feet per year in Culberson County; 4,584 acre-feet per year in Jeff Davis County; 4,063 acre-feet per year in Presidio County.

The modeled available groundwater for the Marathon Aquifer that achieves the desired future conditions adopted by Groundwater Management Area 4 is 7,327 acre-feet per year from 2020 to 2060/2070 (Tables 9 and 10).

The modeled available groundwater for the West Texas Bolsons (including the Salt Bolson and Presidio and Redford Bolsons) that achieves the desired future conditions adopted by Groundwater Management Area 4 decreases from 58,577 acre-feet per year to 57,881 acre-feet per year between 2020 and 2050 (Tables 11 and 12).

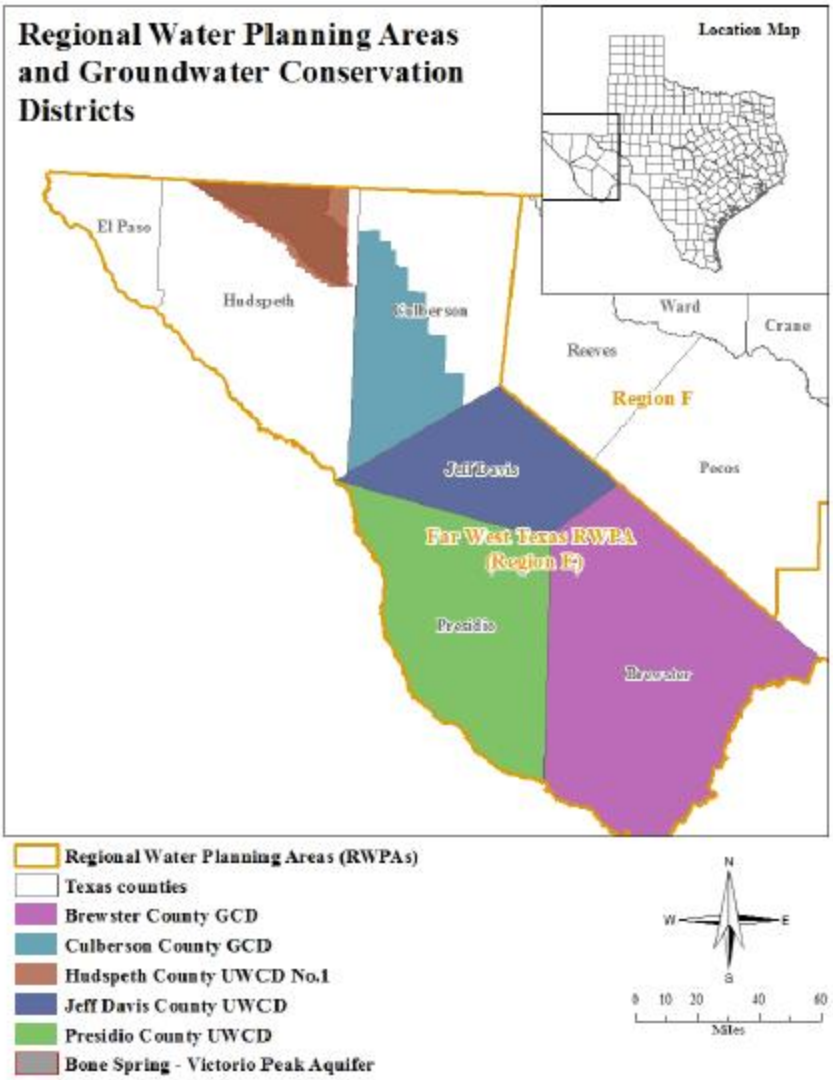

FIGURE 1. **MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES IN THE VICINITY OF THE BONE SPRING–VICTORIO PEAK AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.**

FIGURE 2. MAP SHOWING THE AREAS COVERED BY THE GROUNDWATER AVAILABILITY MODEL FOR THE BONE SPRING-VICTORIO PEAK AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.

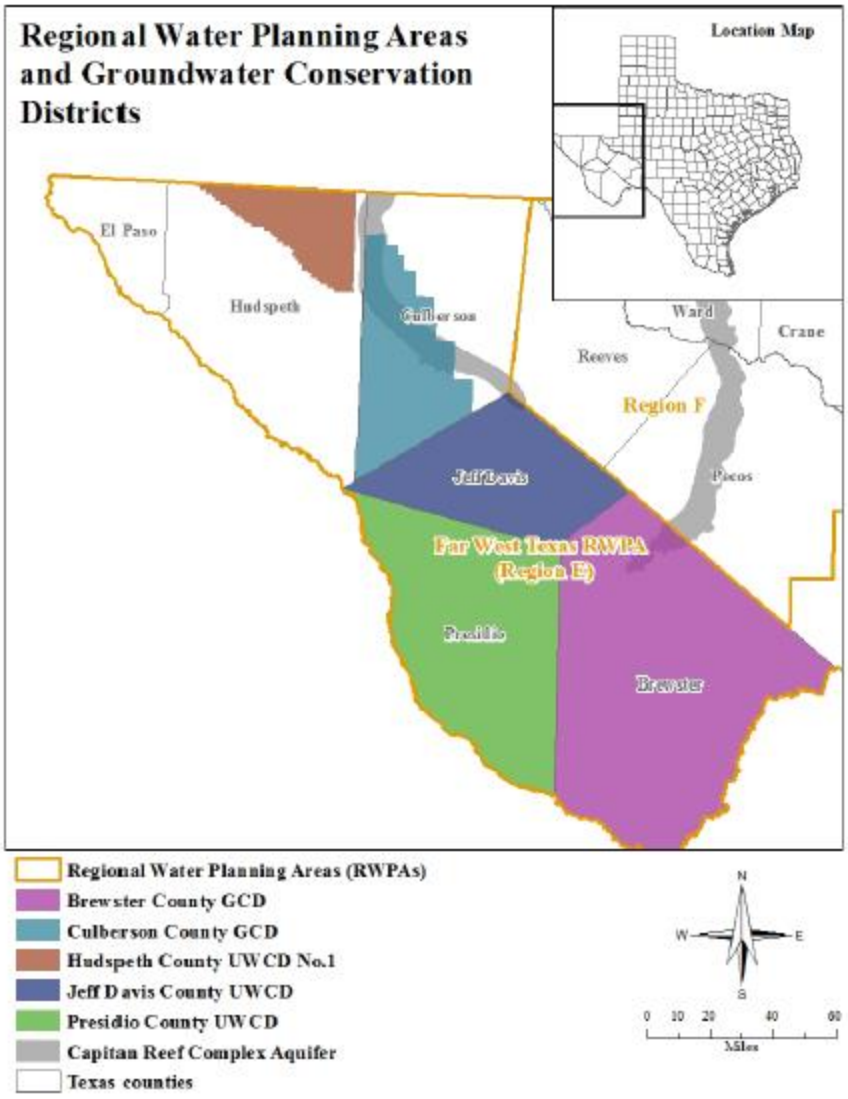

FIGURE 3. MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATIONDISTRICTS (GCDS), AND COUNTIES IN THE VICINITY OF THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.

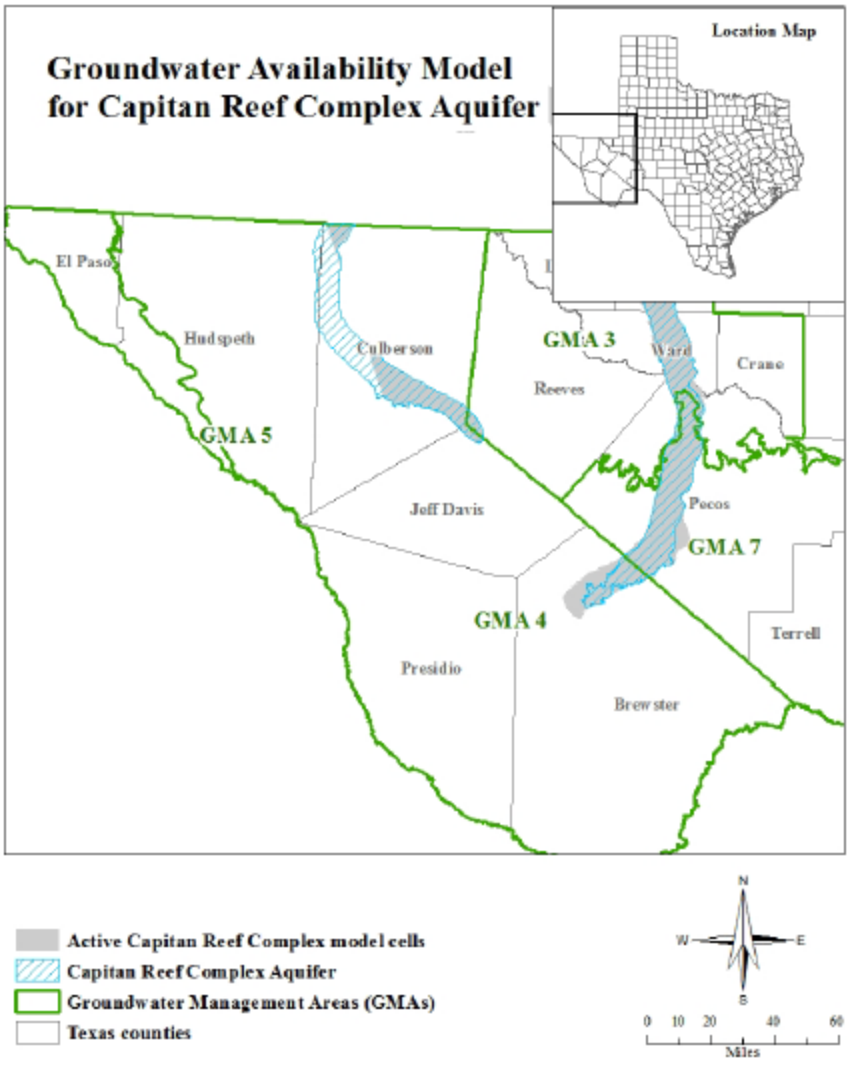

FIGURE 4. **MAP SHOWING THE AREAS COVERED BY THE GROUNDWATER AVAILABILITY MODEL FOR THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.**

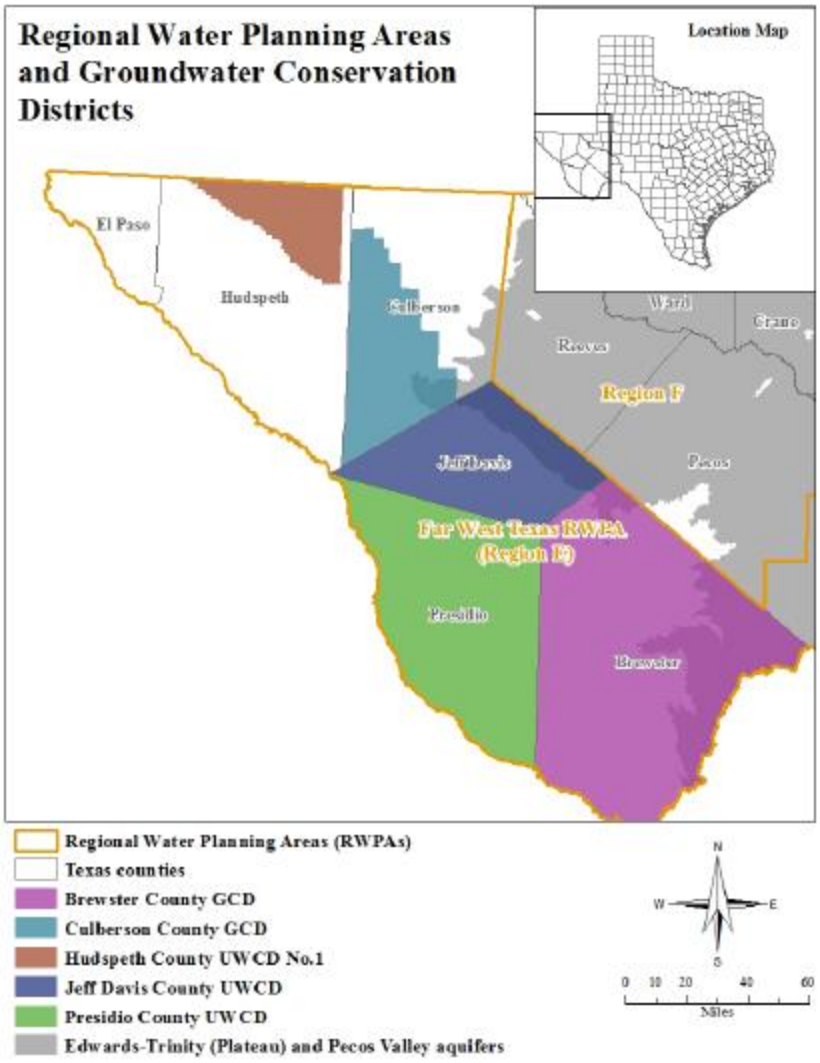

FIGURE 5. **MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATIONDISTRICTS (GCDS), AND COUNTIES IN THE VICINITY OF THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.**

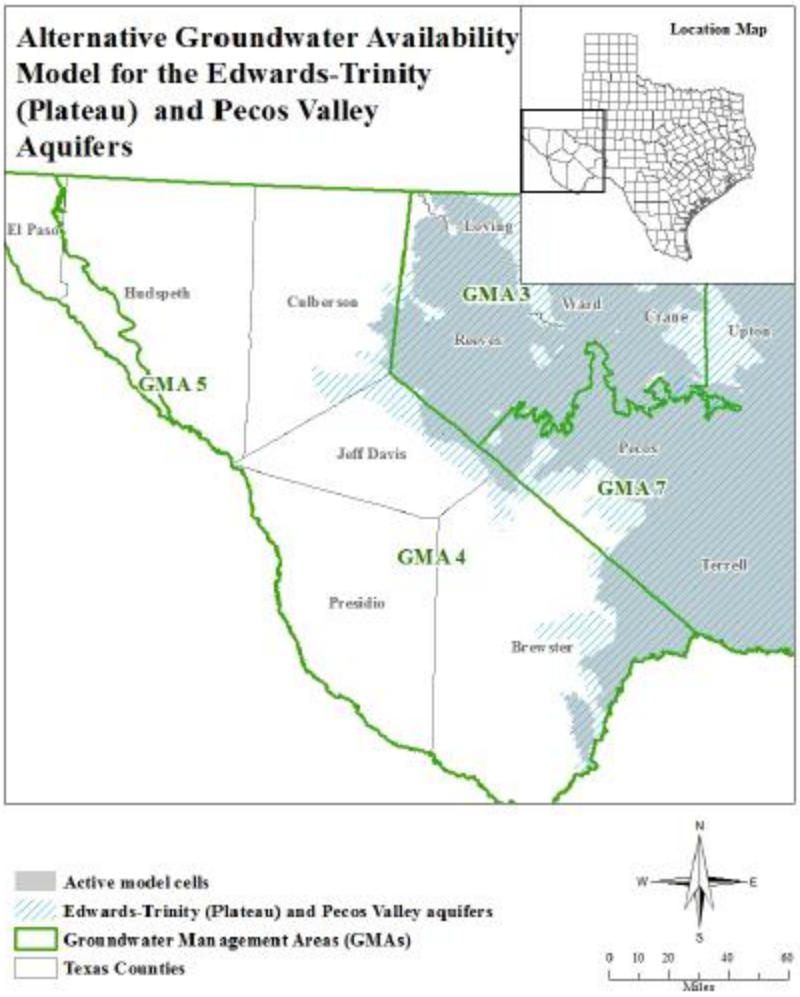

FIGURE 6. **MAP SHOWING THE AREAS COVERED BY THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.**

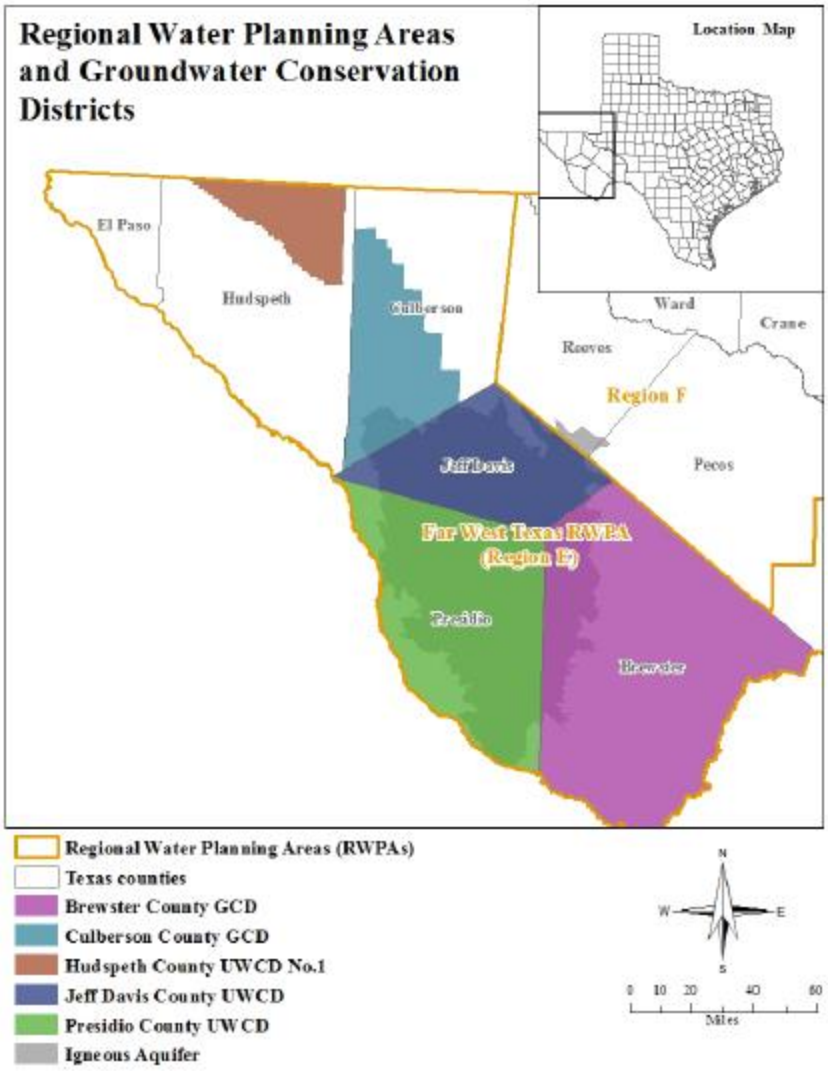

FIGURE 7. **MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES IN THE VICINITY OF THE IGNEOUS AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.**

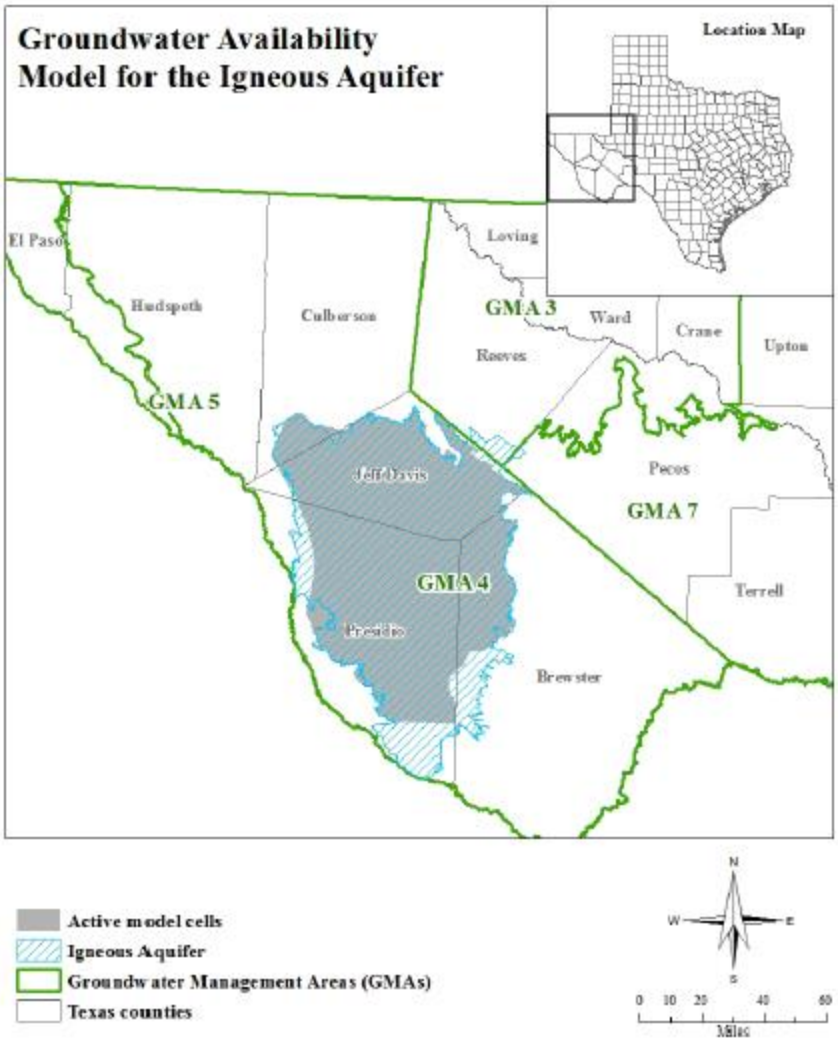

FIGURE 8. MAP SHOWING THE AREAS COVERED BY THE GROUNDWATER AVAILABILITY MODEL FOR THE IGNEOUS AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.

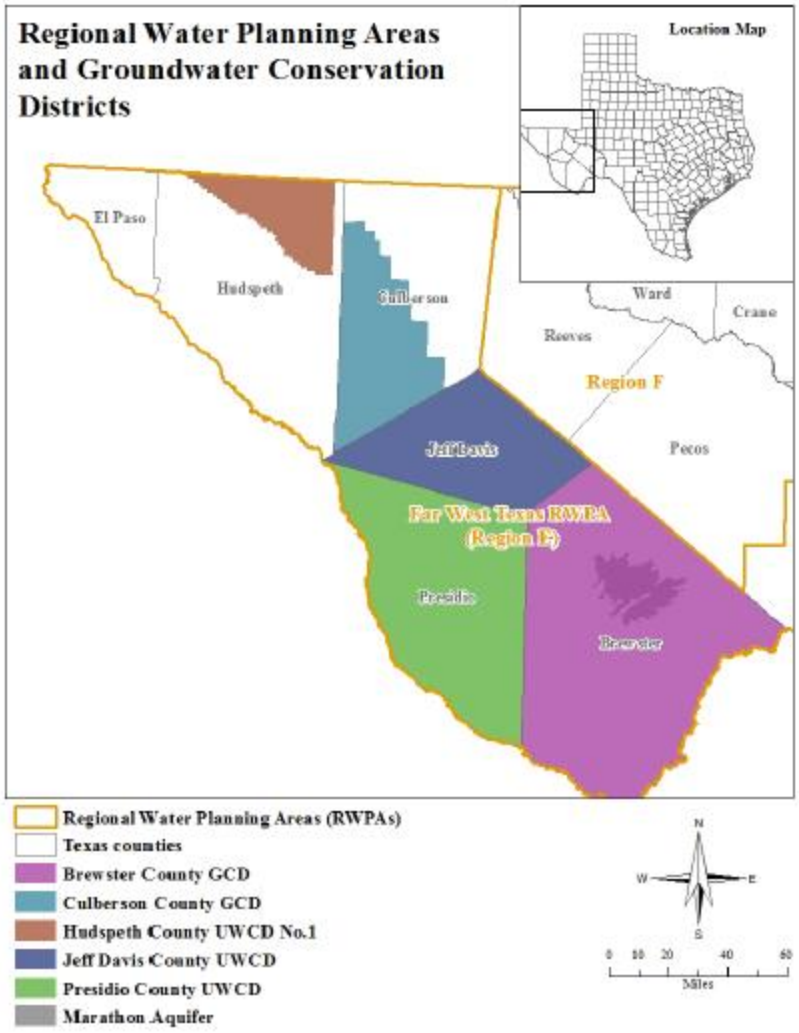

FIGURE 9. MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES IN THE VICINITY OF THE MARATHON AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.

FIGURE 10. MAP SHOWING GROUNDWATER MANAGEMENT AREAS (GMAS) AND COUNTIES IN THE VICINITY OF THE MARATHON AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.

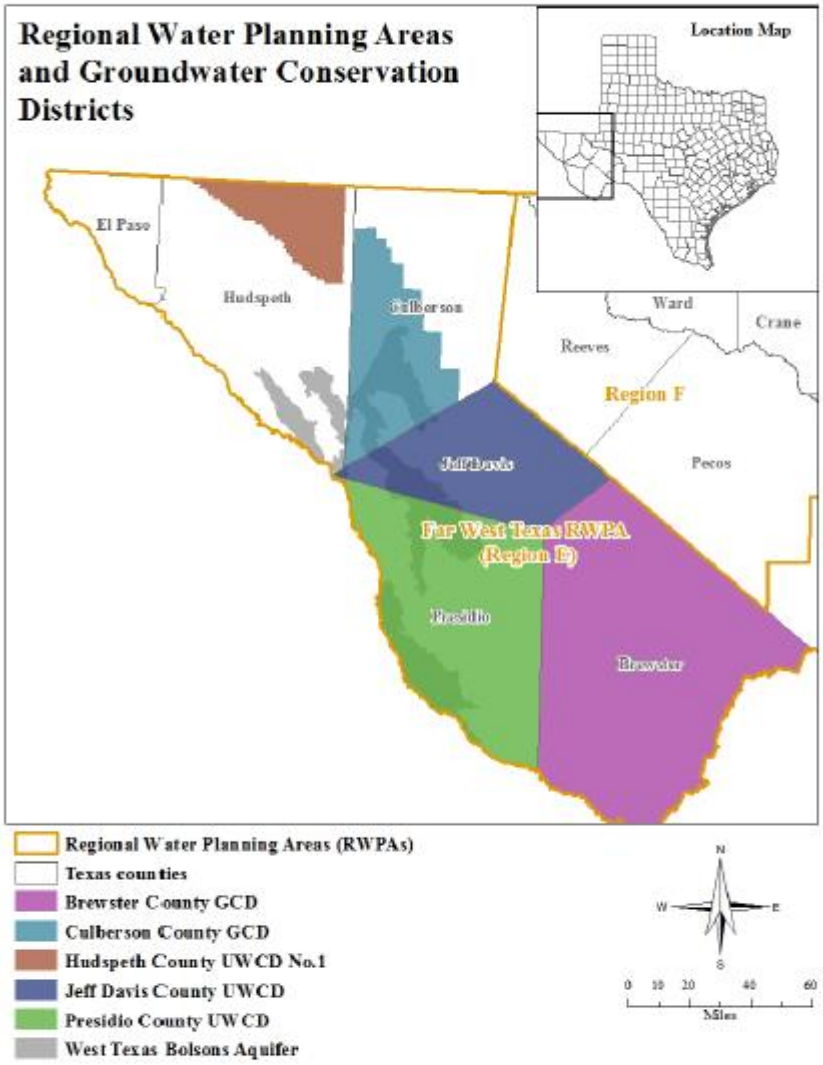

FIGURE 11. MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATIONDISTRICTS (GCDS), AND COUNTIES IN THE VICINITY OF THE WEST TEXAS BOLSONS AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.

FIGURE 12. MAP SHOWING THE AREAS COVERED BY THE GROUNDWATER AVAILABILITY MODEL FOR PORTIONS OF THE WEST TEXAS BOLSONS AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.

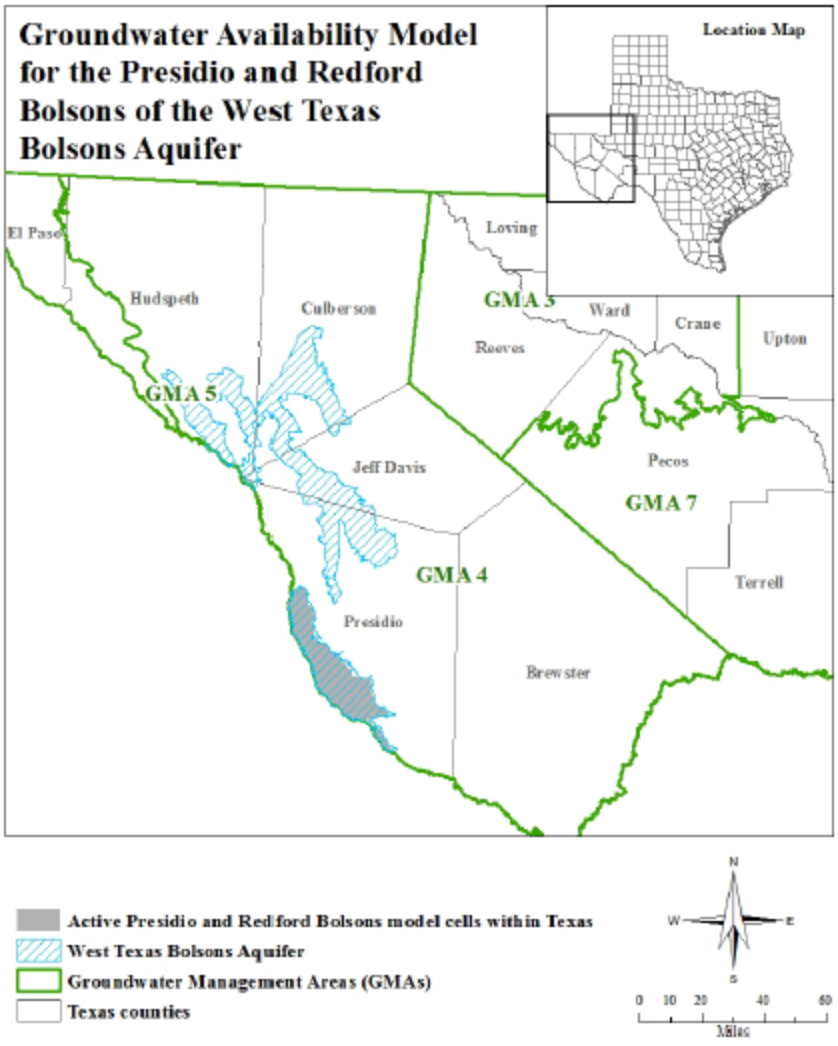

FIGURE 13. MAP SHOWING THE AREAS COVERED BY THE GROUNDWATER AVAILABILITY MODEL FOR THE PRESIDIO AND REDFORD PORTIONS OF THE WEST TEXAS BOLSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 4.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE BONE SPRING-VICTORIO PEAK AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (UWCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	2020	2030	2040	2050	2060	2070
Hudspeth County UWCD	Hudspeth	101,400	101,400	101,400	101,400	101,400	101,400
No district-County	Hudspeth	0	0	0	0	0	0
Total		**101,400**	**101,400**	**101,400**	**101,400**	**101,400**	**101,400**

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE BONE SPRING-VICTORIO PEAK AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	2020	2030	2040	2050	2060	2070
Hudspeth	E	Rio Grande	101,400	101,400	101,400	101,400	101,400	101,400
Total			**101,400**	**101,400**	**101,400**	**101,400**	**101,400**	**101,400**

TABLE 3. **MODELED AVAILABLE GROUNDWATER FOR THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2060. VALUES ARE IN ACRE-FEET PER YEAR.**

Groundwater Conservation District	County	2020	2030	2040	2050	2060
Brewster County GCD	Brewster	583	583	583	583	583
Culberson County GCD	Culberson	7,580	7,580	7,580	7,580	7,580
Total		8,163	8,163	8,163	8,163	8,163

TABLE 4. **MODELED AVAILABLE GROUNDWATER FOR THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR. NOTE: THE VALUES LISTED IN THIS TABLE HAVE BEEN POPULATED PAST THE DATES NOTED IN PARAMETERS AND ASSUMPTIONS SECTION (SEE TABLE 3) USING THE TREND OF RESULTS.**

County	RWPA	River Basin	2020	2030	2040	2050	2060	2070
Brewster	E	Rio Grande	583	583	583	583	583	583
Culberson	E	Rio Grande	7,580	7,580	7,580	7,580	7,580	7,580
Total			8,163	8,163	8,163	8,163	8,163	8,163

TABLE 5. **MODELED AVAILABLE GROUNDWATER FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2060. VALUES ARE IN ACRE-FEET PER YEAR.**

Groundwater Conservation District	County	2020	2030	2040	2050	2060
Brewster County GCD	Brewster	1,394	1,394	1,394	1,394	1,394
Total		1,394	1,394	1,394	1,394	1,394

TABLE 6. **MODELED AVAILABLE GROUNDWATER FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR. NOTE: THE VALUES LISTED IN THIS TABLE HAVE BEEN POPULATED PAST THE DATES NOTED IN PARAMETERS AND ASSUMPTIONS SECTION (SEE TABLE 5) USING THE TREND OF RESULTS.**

County	RWPA	River Basin	2020	2030	2040	2050	2060	2070
Brewster	E	Rio Grande	1,394	1,394	1,394	1,394	1,394	1,394
Total			1,394	1,394	1,394	1,394	1,394	1,394

TABLE 7. MODELED AVAILABLE GROUNDWATER FOR THE IGNEOUS AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD, UWCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2050. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	2020	2030	2040	2050
Brewster County GCD	Brewster	2,586	2,586	2,585	2,583
Culberson County GCD	Culberson	99	99	99	99
Jeff Davis County UWCD	Jeff Davis	4,584	4,584	4,584	4,584
Presidio County UWCD	Presidio	4,064	4,064	4,064	4,063
Total		11,333	11,333	11,332	11,329

TABLE 8. MODELED AVAILABLE GROUNDWATER FOR THE IGNEOUS AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR. NOTE: THE VALUES LISTED IN THIS TABLE HAVE BEEN POPULATED PAST THE DATES NOTED IN PARAMETERS AND ASSUMPTIONS SECTION (SEE TABLE 7) USING THE TREND OF RESULTS.

County	RWPA	River Basin	2020	2030	2040	2050	2060	2070
Brewster	E	Rio Grande	2,586	2,586	2,585	2,583	2,583	2,582
Culberson	E	Rio Grande	99	99	99	99	99	99
Jeff Davis	E	Rio Grande	4,584	4,584	4,584	4,584	4,584	4,584
Presidio	E	Rio Grande	4,064	4,064	4,064	4,063	4,063	4,063
Total			11,333	11,333	11,332	11,329	11,329	11,327

TABLE 9. MODELED AVAILABLE GROUNDWATER FOR THE MARATHON AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2060. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	2020	2030	2040	2050	2060
Brewster County GCD	Brewster	7,327	7,327	7,327	7,327	7,327
Total		7,327	7,327	7,327	7,327	7,327

TABLE 10. MODELED AVAILABLE GROUNDWATER FOR THE MARATHON AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR. NOTE: THE VALUES LISTED IN THIS TABLE HAVE BEEN POPULATED PAST THE DATES NOTED IN PARAMETERS AND ASSUMPTIONS SECTION (SEE TABLE 9) USING THE TREND OF RESULTS.

County	RWPA	River Basin	2020	2030	2040	2050	2060	2070
Brewster	E	Rio Grande	7,327	7,327	7,327	7,327	7,327	7,327
Total			7,327	7,327	7,327	7,327	7,327	7,327

TABLE 11. MODELED AVAILABLE GROUNDWATER FOR THE WEST TEXAS BOLSONS AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD, UWCD), COUNTY, AND AQUIFER SEGMENT FOR EACH DECADE BETWEEN 2020 AND 2050. VALUES ARE IN ACRE-FEET PER YEAR. THE SALT BASIN PORTION OF THE WEST TEXAS BOLSONS AQUIFER INCLUDES WILD HORSE, MICHIGAN, LOBO FLATS, AND RYAN FLAT.

Groundwater Conservation District	County	Aquifer Segment	2020	2030	2040	2050
Culberson County GCD	Culberson	Wild Horse, Michigan, and Lobo Flats	35,749	35,678	35,601	35,550
Jeff Davis County UWCD	Jeff Davis	Ryan Flat	6,055	6,055	5,989	5,960
Presidio County UWCD	Presidio	Ryan Flat	9,112	8,982	8,834	8,710
Presidio County UWCD	Presidio	Presidio and Redford Bolsons	7,661	7,661	7,661	7,661
Total			58,577	58,376	58,085	57,881

TABLE 12. MODELED AVAILABLE GROUNDWATER FOR THE WEST TEXAS BOLSONS AQUIFER IN GROUNDWATER MANAGEMENT AREA 4 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER SEGMENT FOR EACH DECADE BETWEEN 2020 AND 2070. NOTE: THE VALUES LISTED IN THIS TABLE HAVE BEEN POPULATED PAST THE DATES NOTED IN PARAMETERS AND ASSUMPTIONS SECTION (SEE TABLE 11) USING THE TREND OF RESULTS. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Aquifer Segment	2020	2030	2040	2050	2060	2070
Culberson	E	Rio Grande	Wild Horse, Michigan, and Lobo Flats	35,749	35,678	35,601	35,550	35,476	35,409
Jeff Davis	E	Rio Grande	Ryan Flat	6,055	6,055	5,989	5,960	5,927	5,892
Presidio	E	Rio Grande	Ryan Flat	9,112	8,982	8,834	8,710	8,571	8,436
Presidio	E	Rio Grande	Presidio and Redford Bolsons	7,661	7,661	7,661	7,661	7,661	7,661
Total				58,577	58,376	58,085	57,881	57,635	57,397

LIMITATIONS:

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

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

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

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

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

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Appendix C – 2017 Provided State Water Plan Tables, 1/8/2020

Estimated Historical Water Use And 2017 State Water Plan Datasets:

Presidio 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
January 8, 2020

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 Water 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 1/8/2020. 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).

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 2018. TWDB staff anticipates the calculation and posting of these estimates at a later date.

PRESIDIO COUNTY

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2017	GW	3,470	0	0	0	1,790	427	5,687
	SW	0	0	0	0	1,339	47	1,386
2016	GW	3,307	0	0	0	1,873	233	5,413
	SW	0	0	0	0	1,698	26	1,724
2015	GW	2,857	0	0	0	1,836	230	4,923
	SW	0	0	0	0	1,168	26	1,194
2014	GW	3,301	0	0	0	1,691	226	5,218
	SW	0	0	0	0	1,565	25	1,590
2013	GW	1,517	0	0	0	1,806	274	3,597
	SW	0	0	0	0	758	30	788
2012	GW	1,573	0	0	0	1,246	302	3,121
	SW	0	0	0	0	1,300	34	1,334
2011	GW	1,415	0	0	0	1,210	339	2,964
	SW	0	0	0	0	6,140	38	6,178
2010	GW	1,293	0	0	0	2,712	336	4,341
	SW	0	0	0	0	1,600	37	1,637
2009	GW	1,198	0	0	0	2,861	355	4,414
	SW	0	0	0	0	1,314	40	1,354
2008	GW	1,222	0	0	0	2,318	367	3,907
	SW	0	0	0	0	1,648	41	1,689
2007	GW	1,230	0	0	0	1,501	285	3,016
	SW	0	0	0	0	2,800	32	2,832
2006	GW	1,392	0	0	0	3,247	315	4,954
	SW	0	0	0	0	3,461	35	3,496
2005	GW	1,375	0	0	0	3,738	331	5,444
	SW	0	0	0	0	3,204	37	3,241
2004	GW	1,358	0	0	0	4,395	324	6,077
	SW	0	0	0	0	2,855	17	2,872
2003	GW	1,592	0	0	0	4,110	340	6,042
	SW	0	0	0	0	4,442	18	4,460
2002	GW	1,590	0	0	0	5,132	516	7,238
	SW	0	0	0	0	29,081	27	29,108

Projected Surface Water Supplies
TWDB 2017 State Water Plan Data

PRESIDIO COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
E	IRRIGATION, PRESIDIO	RIO GRANDE	RIO GRANDE RUN-OF-RIVER	6,140	6,140	6,140	6,140	6,140	6,140
E	LIVESTOCK, PRESIDIO	RIO GRANDE	RIO GRANDE LIVESTOCK LOCAL SUPPLY	41	41	41	41	41	41
	Sum of Projected Surface Water Supplies (acre-feet)			**6,181**	**6,181**	**6,181**	**6,181**	**6,181**	**6,181**

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.

PRESIDIO COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
E	COUNTY-OTHER, PRESIDIO	RIO GRANDE	249	267	287	313	338	361
E	IRRIGATION, PRESIDIO	RIO GRANDE	4,630	4,539	4,450	4,363	4,278	4,197
E	LIVESTOCK, PRESIDIO	RIO GRANDE	408	408	408	408	408	408
E	MARFA	RIO GRANDE	589	627	667	718	764	808
E	MINING, PRESIDIO	RIO GRANDE	403	0	0	0	0	0
E	PRESIDIO	RIO GRANDE	659	689	721	764	808	851
	Sum of Projected Water Demands (acre-feet)		**6,938**	**6,530**	**6,533**	**6,566**	**6,596**	**6,625**

Projected Water Supply Needs
TWDB 2017 State Water Plan Data

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

PRESIDIO COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
E	COUNTY-OTHER, PRESIDIO	RIO GRANDE	339	321	301	275	250	227
E	IRRIGATION, PRESIDIO	RIO GRANDE	4,371	4,462	4,551	4,638	4,723	4,804
E	LIVESTOCK, PRESIDIO	RIO GRANDE	0	0	0	0	0	0
E	MARFA	RIO GRANDE	1,185	1,147	1,107	1,056	1,010	966
E	MINING, PRESIDIO	RIO GRANDE	0	403	403	403	403	403
E	PRESIDIO	RIO GRANDE	2,930	2,900	2,868	2,825	2,781	2,738
	Sum of Projected Water Supply Needs (acre-feet)		**0**	**0**	**0**	**0**	**0**	**0**

Projected Water Management Strategies
TWDB 2017 State Water Plan Data

PRESIDIO COUNTY

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

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
MARFA, RIO GRANDE (E)							
CITY OF MARFA - ADDITIONAL GROUNDWATER WELL	IGNEOUS AQUIFER [PRESIDIO]	785	785	785	785	785	785
		785	**785**	**785**	**785**	**785**	**785**
PRESIDIO, RIO GRANDE (E)							
CITY OF PRESIDIO - ADDITIONAL GROUNDWATER WELL IN THE WEST TEXAS BOLSONS AQUIFER	WEST TEXAS BOLSONS AQUIFER [PRESIDIO]	120	120	120	120	120	120
CITY OF PRESIDIO - WATER LOSS AUDIT AND MAIN-LINE REPAIR	DEMAND REDUCTION [PRESIDIO]	9	9	9	9	9	9
		129	**129**	**129**	**129**	**129**	**129**
Sum of Projected Water Management Strategies (acre-feet)		**914**	**914**	**914**	**914**	**914**	**914**

Appendix D – GAM Run 19-007

Estimated Annual Recharge, Discharge to Springs and Surface Water Bodies and Flow into and out of Each Aquifer

Management Plan requirement	Aquifer or confining unit	Results*
Estimated annual amount of recharge from precipitation to the district	West Texas Bolsons Aquifer	14,031
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	West Texas Bolsons Aquifer	9,117
Estimated annual volume of flow into the district within each aquifer in the district	West Texas Bolsons Aquifer	22,275
Estimated annual volume of flow out of the district within each aquifer in the district	West Texas Bolsons Aquifer	37,465
Estimated net annual volume of flow between each aquifer in the district	Net flow from West Texas Bolsons Aquifer into overlying Rio Grande alluvium	838
	Net flow from Igneous Aquifer and other underlying units into West Texas Bolsons Aquifer	12,965

*Due to changes to the model grid attributes for the West Texas Bolsons (Presidio and Redford) Aquifer Groundwater Availability Model since the previous management plan report (2013), the groundwater flow volumes have also changed.

TWDB, GAM Run 19-007

SUMMARY DEFINITIONS

“Board” - the Board of Directors of the Presidio County Underground Water Conservation District. “District” - the Presidio County Underground Water Conservation District. “TWDB” - Texas Water Development Board. “Waste” - as defined by Chapter 36 of the Texas Water Code means anyone or more of the following:

1. Withdrawal of groundwater from a groundwater reservoir at a rate and in an amount that causes or threatens to cause intrusion into the reservoir of water unsuitable for agricultural, gardening, domestic, or stock raising purposes.

2. The flowing or producing of wells from a groundwater reservoir if the water produced is not used for a beneficial purpose.

3. Escape of groundwater from a groundwater reservoir to any other reservoir or geologic strata that does not contain groundwater.

4. Pollution or harmful alteration of groundwater in a groundwater reservoir by saltwater or by other deleterious matter admitted from another stratum or from the surface of the ground.

5. Willfully or negligently causing, suffering, or allowing groundwater to escape into a river, creek, natural watercourse, depression, lake, reservoir, drain, sewer, street, highway, road, or road ditch, or onto any land other than that of the owner of the well unless such discharge is authorized by permit, rule, or order issued by the commission under Chapter 26 of the Texas Water Code.

6. Groundwater pumped for irrigation that escapes as irrigation tail water onto land other than that of the owner of the well unless permission has been granted by the occupant of the land receiving the discharge.

7. For water produced from an artesian well "waste" has the meaning assigned by Section 11.205 of the Texas Water Code.