Groundwater Management Plan

Amended and Adopted December 12, 2023
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1.0 DISTRICT MISSION

The Post Oak Savannah Groundwater Conservation District (POSGCD) mission is to adopt and enforce Rules consistent with State law and based on best available science, which provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater, while supporting the ownership of groundwater and the owner's right to assign or produce that property.

2.0 TIME PERIOD OF THIS PLAN

This plan will become effective upon adoption by the POSGCD Board of Directors ("Board") and approval as administratively complete by the Texas Water Development Board. The plan will remain in effect for five (5) years after the date of certification, and thereafter until a revised plan is adopted and approved.

3.0 BACKGROUND

The POSGCD was created in Milam and Burleson counties by HB 1784, 77th Legislature, 2001, and a local confirmation election in November 2002 in both counties. These elections were in accordance with Sections 36.017, 36.018, and 36.019, of the Water Code, and Section 41.001, of the Election Code. POSGCD was codified as Chapter 8865 of Special District Local Laws Code.

The purpose of HB 1784 was to provide a locally controlled groundwater district to conserve and preserve groundwater, protect groundwater users, protect and recharge groundwater, prevent pollution or waste of groundwater in the central Carrizo-Wilcox area, control subsidence caused by withdrawal of water from the groundwater reservoirs in that area, and regulate the transport of water out of the boundaries of the districts. The POSGCD has ten directors, with five from each county. It does not have the power to tax and receives all of its revenue from fees imposed on municipal/commercial pumpers and transporters of groundwater.

The POSGCD is a member of Groundwater Management Area (GMA) 12 and GMA 8, whose areal extents are shown in **Figure 1**. To help establish desired future conditions (DFCs) for the relevant aquifers within the boundaries of GMA 12 and GMA 8, POSGCD will consider groundwater availability models (GAMs) and other data or information. This information can also be found on the Districts website at https://posgcd.halff.com/Map/Public.

4.0 GROUNDWATER RESOURCES

Located within the District's boundaries are portions of the Trinity, Wilcox, Carrizo, Queen City, Sparta, Yegua/Jackson, and the Brazos River Alluvium aquifers. **Figure 2** shows the locations of the outcrops of these aquifers based on the surface geology mapped by Barnes (1992), Young and others (2018), Deeds and others (2010), and Shah and Houston (2007). In Figure 2, the outcrop area for the Carrizo Aquifer includes the outcrop area associated with the Reklaw Formation and the outcrop area for the Queen City Aquifer includes the outcrop area associated with the Weches Formation. Within the District, the Trinity Aquifer does not outcrop and is overlaid primarily by the Midway Formation. **Table 4-1** provides the area associated with each aquifer outcrop.

Table 4-1 Aquifer Outcrop Areas in the District.

Aquifer and/or Geologic Formation	Outcrop Area (square miles)
Midway Formation	346
Wilcox	348
Carrizo/Reklaw	70
Queen City/Weches	159
Sparta	76
Cook Mountain/Yegua-Jackson /Catahoula	321
Brazos River Alluvium	161
Shallow Alluvium	215
Total	1,699

1. **Northern Trinity Aquifer**. The northern Trinity Aquifer is located in the northwest corner of Milam County. The Trinity Aquifer comprises five geological formations considered to be relevant aquifers by GMA 8. These geologic formations are the Paluxy, Glen Rose, Travis Peak, Hensell, and Hosston aquifers. The top and bottom surfaces for these geological formations are defined by the Updated Northern Trinity and Woodbine Aquifers GAM (Kelley and others, 2014).
2. **Wilcox Aquifer.** The Wilcox Aquifer is a regional aquifer system. The outcrop of the Wilcox Aquifer forms a southwest to northeast trending belt through central Milam County; the downdip portion of the Wilcox Aquifer underlies southern Milam County and all of Burleson County. Freshwater exists in the Wilcox Aquifer in both Milam and Burleson counties. The Wilcox Aquifer comprises three geological formations: the Hooper, Simsboro, and Calvert Bluff formations. The Upper Wilcox Aquifer is associated with the Calvert Bluff Formation. The Middle Wilcox Aquifer is associated with the Simsboro Formation. The Lower Wilcox Aquifer is associated with the Hooper Formation.
3. **Carrizo Aquifer.** The Carrizo Aquifer is a regional aquifer system that occurs throughout most of the District. The outcrop of the Carrizo Aquifer has a southwest to northeast orientation through southern Milam County. The confined portion of the Carrizo Aquifer underlies southern Milam County and all of Burleson County. Freshwater exists in the Carrizo Aquifer in both Milam and Burleson counties. The aquifer is a source of groundwater for numerous domestic wells and several large public water supply systems. The areal extent of the Carrizo Aquifer is described by the GAM for the Central portion for the Sparta, Queen City, and Carrizo Wilcox Aquifer (Young and others, 2018).
4. **Queen City.** The Queen City Aquifer outcrops across a 5- to 8-mile-wide zone that is generally aligned along the Milam-Burleson County line. The aquifer extends down dip in Burleson County and is a source of groundwater for domestic wells and some public water supply wells. Freshwater exists in the Queen City Aquifer in both Milam County and Burleson County. The areal extent of the Queen City Aquifer is described by the GAM for the Central portion for the Sparta, Queen City, and Carrizo Wilcox aquifers (Young and others, 2018).
5. **Sparta Aquifer.** The Sparta Aquifer outcrops across a 3- to 5-mile-wide zone trending southwest- northeast just north of Highway 21 in Burleson County. The Sparta extends downdip to the southeast throughout much of Burleson County. Like the Queen City Aquifer, the Sparta is used for numerous domestic water wells and some small public water supply systems in the District. Freshwater exists in the Sparta Aquifer in Burleson County. The areal extent of the Sparta Aquifer is described by the GAM for the Central portion for the Sparta, Queen City, and Carrizo Wilcox aquifers (Young and others, 2018).

6. **Yegua/Jackson Aquifer.** The Yegua/Jackson Aquifer outcrops across a 6- to 10-mile-wide zone trending southwest-northeast south of Highway 21 in Burleson County. The Yegua/Jackson Aquifer extends down-dip to the southeast through much of Burleson County. The Yegua/Jackson Aquifer includes to all four geologic units the upper Yegua, the lower Yegua, the upper Jackson, and the lower Jackson . In Burleson County, the Yegua/Jackson Aquifer provides small to moderate amounts of freshwater to domestic and irrigation wells and to a few public water systems. The areal extent of the Yegua-Jackson Aquifer is described by the Yegua/Jackson GAM (Deeds and others, 2010).
7. **Brazos River Alluvium Aquifer.** The Brazos River Alluvium Aquifer is comprised of floodplain and terrace deposits of the Brazos River along the eastern boundary of Milam and Burleson counties. The Brazos River Alluvium Aquifer occurs only as an unconfined aquifer in POSGCD, and the majority of it exists in Burleson County. The Brazos River Alluvium supplies freshwater to many irrigation wells and several domestic wells. For the most part, the water discharges from the alluvium mainly through flow to the Brazos River, evapotranspiration, and production by wells. The areal extent of the Brazos River Alluvium Aquifer is described by the Brazos River Alluvium GAM (Ewing and Jigmond, 2016).
8. **Shallow Alluvium Aquifers.** Shallow alluvium aquifers have not been completely mapped across POSGCD. The aquifers represent floodplain and terrace deposits near major tributaries to the Brazos River. These aquifers are generally less than 30 feet thick, are characterized by mixtures of coarse sands and fine-grain materials, and are often well connected hydrologically to nearby streams. The areal extent of these aquifers are denoted by alluvium deposits in the Bureau of Economic Geology map of surface geology (Proctor and others, 1974).

5.0 MANAGEMENT ZONES AND MANAGEMENT AREAS

The District is divided into groundwater management zones and management areas for the purpose of evaluating and managing groundwater resources recognizing the different characteristics and anticipated future development of the aquifers in the District. Each of the District Management Zone are associated with a minor or major aquifer for which the TWDB has developed a Groundwater Availability Model (GAM). For the Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper aquifers, the District has partitioned each of the aquifers' Management Zones into two or more Management Areas.

Within each Management Zone, the District will establish and enforce Rules related to spacing of wells, the maximum allowable production of groundwater per acre of land located over an aquifer, require permits for production, regulate drawdown and provide for a reduction in the maximum allowable production and permitted production of groundwater per acre of land based on the different surface and subsurface characteristics and different evaluation and monitoring within the Management Zones.

The Management Zones and Management Areas are as follows:

1. **Brazos River Alluvium Management Zone.** This management zone is located along the eastern boundaries of the District in Milam and Burleson counties and is coterminous with the boundaries of the Brazos River Alluvium (Shah and Houston, 2007). Figure 2 shows the areal extent of the Brazos River Alluvium Management Zone represented in the Brazos River Alluvium GAM (Ewing and Jigmond, 2016). This management zone extends to the bottom of the water bearing alluvial sediments associated with the Brazos River Alluvium.
2. **Trinity Management Zone.** This management zone includes the northern Trinity Aquifer, which is located beneath the footprint of the Midway outcrop shown in Figure 2.
3. **Sparta Management Zone.** The Sparta Management Zone includes all of the water-bearing formations of the Sparta Aquifer found in the District. **Figure 3** shows the areal extent of the

Sparta Management Zone and the two areas that comprise it: Sparta Management Area 1 and Sparta Management Area 2.

4. **Queen City Management Zone.** The Queen City Management Zone includes all of the water-bearing formations of the Queen City Aquifer found in the District. **Figure 4** shows the areal extent of the Queen City Management Zone and the two areas that comprise it: Queen City Management Area 1 and Queen City Management Area 2.
5. **Carrizo Management Zone.** The Carrizo Management Zone includes all of the water-bearing formations of the Carrizo Aquifer found in the District. **Figure 5** shows the areal extent of the Carrizo Management Zone and the three areas that comprise it: Carrizo Management Area 1, Carrizo Management Area 2, and Carrizo Management Area 3.
6. **Calvert Bluff Management Zone.** The Calvert Bluff Management Zone includes all of the water-bearing formations of the Calvert Bluff Formation found in the District. **Figure 6** shows the areal extent of the Calvert Bluff Management Zone and the three areas that comprise it: Calvert Bluff Management Area 1, Calvert Bluff Management Area 2, and Calvert Bluff Management Area 3.
7. **Simsboro Management Zone.** The Simsboro Management Zone includes all of the water-bearing formations of the Simsboro Formation found in the District. **Figure 7** shows the areal extent of the Simsboro Management Zone and the three areas that comprise it: Simsboro Management Area 1, Simsboro Management Area 2, and Simsboro Management Area 3.
8. **Hooper Management Zone.** The Hooper Management Zone includes all of the water-bearing formations of the Hooper Formation found in the District. **Figure 8** shows the areal extent of the Hooper Management Zone and the three areas that comprise it: Hooper Management Area 1, Hooper Management Area 2, and HooperManagement Area 3.
9. **Yegua/Jackson Management Zone.** This zone includes the outcrop and downdip portions of the geologic units of the Yegua and the Jackson formations of the Yegua/Jackson Aquifer, which occur in the southern portion of Burleson County.

6.0 MANAGEMENT OF GROUNDWATER SUPPLIES

The District will evaluate and monitor groundwater conditions and regulate production consistent with this plan and the District Rules. Production will be regulated, as needed, to conserve groundwater, and protect groundwater users, in a manner not to unnecessarily and adversely limit production or impact 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 will identify and engage in activities and practices that will permit groundwater production and, as appropriate, protect the aquifer and groundwater in accordance with this Management Plan and the District's rules. A monitoring well network will be maintained to monitor aquifer conditions within the District. The District will use the monitoring data to support regular assessments of changes in groundwater supply, changes in aquifer water levels, and groundwater storage conditions. The District will report on changes in those conditions, as appropriate, in public meetings of the Board or public announcements. The District will undertake investigations, and cooperate with third-party investigations, of the groundwater resources within the District, and the results of the investigations will be made available to the public upon being presented at a meeting of the Board.

The District will adopt 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 will consider 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 and operating or operating permit or limit groundwater withdrawals will include:

The District Rules and the purpose of the Rules of the District;

1. The equitable distribution of the resource;
2. The economic hardship resulting from grant or denial of a permit, or the terms prescribed by the permit;
3. This Management Plan, the District DFCs as adopted in Joint Planning under Tex. Water Code, Sec. 36.108; the District PDLs, and
4. The potential effect the permit may have on the aquifer, and groundwater users.

The transport of groundwater out of the District will be regulated by the District according to the Rules of the District.

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, including 5 year reviews, 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 Texas Water Code (TWC) Ch. 36.102.

A plan to cope with the effects of water supply deficits due to climatic or other conditions will be developed by the District and will be adopted by the Board after notice and hearing. In developing the plan, the District will consider all relevant factors, including, but not limited to, the economic effect of conservation measures upon all water resource user groups, the local implications of the degree and effect of changes in water storage conditions, the unique hydrogeologic conditions of the aquifers within the District and the conditions under which to implement the plan.

The District will employ reasonable and necessary technical resources, at its disposal, to evaluate the groundwater resources available within the District and to determine the effectiveness of regulatory or conservation measures. A public or private user may appeal to the Board for discretion in enforcement of actions taken by the Board, 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.

7.0 DESIRED FUTURE CONDITIONS

The District shall participate in the joint planning process in GMAs 8 and 12 as defined per TWC §36.108, including establishment of DFCs for management areas within the District. In its evaluation of possible DFCs, the District will consider results from GAMs, scientific reports, and the conditions of the aquifer within the management zones.

1. **DFCs Adopted by GMA 12.** The District's DFCs in GMA 12 are provided in **Tables 7-1**, **7-2**, and **7-3** from the 2022 Joint Planning cycles. GMA 12's explanatory report (DB Stephens and others, 2022) documents the development of the DFCs.

   For the Queen City, Sparta, Carrizo and Wilcox aquifers (Table 7-1), the DFCs are based on simulations using the TWDB GAM for the Central Portion of the Sparta, Queen City and Carrizo-

Wilcox aquifers (Young and others, 2018; 2020). These DFCs are average drawdowns from January 2011 to December 2069.

For the Yegua-Jackson Aquifer (Table 7-2), the DFCs are based on simulations using the TWDB GAM for the Yegua-Jackson Aquifer (Deeds and others, 2010). These DFCs are average drawdowns from January 2010 to December 2069.

For the Brazos River Alluvium Aquifer (Table 7-3), the DFCs are based on simulations using the TWDB GAM for the Brazos River Alluvium (Ewing and Jigmond, 2016). These DFCs are average drawdowns from January 2010 to December 2069.

Table 7-1 Adopted DFCs for the Queen City, Sparta, Carrizo and Wilcox aquifers

Aquifer	2021 Joint Planning Average Drawdown (ft) between January 2011 and December 2069
Sparta	32
Queen City	30
Carrizo	146
Calvert Bluff (Upper Wilcox)	156
Simsboro (Middle Wilcox)	278
Hooper (Lower Wilcox)	178

Table 7-2 Adopted DFCs for the Yegua-Jackson Aquifer

Aquifer	2021 Joint Planning Average Drawdown between January 2010 and December 2069 (ft)
Yegua-Jackson	61

Table 7-3 Adopted DFCs for the Brazos River Alluvium Aquifer

County	2021 Joint Planning Average Decrease in Saturated Thickness between January 2010 and December 2069 (ft)
Milam in GMA 12	5
Burleson in GMA 12	6

2. **DFCs Adopted by GMA 8.** On the date of this Plan's adoption, the District did not have any permitted wells in the portion of the Brazos River Alluvium Aquifer and the Trinity Aquifer in GMA 8. For the purpose of this Plan, the District considers the portion of the Brazos River Alluvium Aquifer within GMA 8 as a non-relevant aquifer. The District will not monitor water levels in the GMA 8 portion of the Brazos River Alluvium until the GMA 8 portion of the Brazos River Alluvium is deemed as a relevant aquifer by the District. The District does not plan to monitor water levels in the Trinity Aquifer until there is at least one permitted well that pumps from the Trinity Aquifer.
3. The District's DFCs for the Trinity Aquifer are provided in **Table 7-4** for the 2021 Joint Planning cycle. These DFCs are average drawdowns for a 71-year period that begins January 2010 and ends December 2080. The average drawdowns are for areas covered by each aquifer in Milam County as defined by the stratigraphy provided by the TWDB GAM for the Northern Trinity Aquifer (Kelley and others, 2014). GMA 8's explanatory report (WSP and others, 2022) documents the development of the Trinity Aquifer DFCs.

Table 7-4 Adopted DFCs for the Trinity Aquifer

Aquifer	2021 Joint Planning Average Drawdown between January 2010 and December 2080 (ft)
Glen Rose	241
Travis Peak	412
Hensell	261
Hosston	412

Protective Drawdown Limits (PDLs) for Shallow Management Zone Water Levels For several management areas, the District has adopted a Protective Drawdown Limit (PDL), which represents an average drawdown across the management area measured from January 2011 to December 2070. The PDLs were adopted to improve the District's ability to manage and regulate water level change across the portion of the District's aquifers where the majority of wells are located. The PDLs were developed using the same GAM run used by GMA 12 to develop the DFCs for each of Management Zones. The PDLs are therefore considered to be physical compatible with all the DFCs adopted by GMA 12. **Table 7-5** lists the PDLs for selected management areas , which are shown in Figures 3 to 8.

Table 7-5 Protective Drawdown Limits for Average Drawdown for the Shallow Management Zones

Aquifer	Average Drawdown Measured from January 2010 to December 2070	
	Management Area 1	Management Area 2
Sparta	28	N/A
Queen City	19	N/A
Carrizo	75	175
Calvert Bluff	88	223
Simsboro	91	335
Hooper	210	N/A

8.0 MODELED AVAILABLE GROUNDWATER

Based on DFCs adopted by GMA 8 and GMA 12, the TWDB is required by TWC § 36.108 9(o) to provide the District with a modeled available groundwater (MAG) for each DFC. **Table 8-1** lists the MAGs received by the District from the TWDB based on DFCs from the 2016 planning cycle. The TWDB has not yet provided GMA 8 nor GMA 12 with revised MAGs based on DFCs from the 2021 joint planning cycle.

Several significant changes are anticipated in the MAGs calculated by the TWDB for the 2022 joint planning cycle from the MAGs calculated for the 2016 joint planning cycles. With regard to implementation of its Rules, the District will consider the MAGs in Table 8-1 and the estimated MAGs in **Table 8-2** until the TWDB determines the District's MAGs for the 2022 joint planning cycle. Table 8-2 provides an estimate of the MAGs that were determined from the GAM runs submitted to the TWDB as part of GMA 12's Explanatory Report (D.B. Stephens & Associates, 2022; Walker, 2022) for the 2021 joint planning cycle.

Table 8-1 Modeled Available Groundwater Values Calculated by the TWDB based on the DFCs adopted by GMA 8 and 12 for the 2016 Joint Planning Cycle*

GAM	Aquifer	Modeled Available Groundwater in acre-ft/year (AFY) based on TWDB GAM runs					
		2020	2030	2040	2050	2060	2070[3]
Brazos River Alluvium	GMA 8: Declared a Non-Relevant Aquifer	N/A	N/A	N/A	N/A	N/A	N/A
	GMA 12: Milam and Burleson County[1]	142,742	138,270	137,714	137,520	137,416	137,351
Aquifers in Trinity GAM	Glen Rose[2]	0	0	0	0	0	0
	Hensell[2]	0	0	0	0	0	0
	Hosston[2]	0	0	0	0	0	0
	Subtotal	0	0	0	0	0	0
Aquifers in the Queen City/ Sparta GAM	Sparta[1]	16,721	19,616	22,167	24,282	24,291	24,292
	Queen City[1]	469	504	504	504	504	504
	Carrizo[1]	34,560	35,616	37,427	40,211	41,167	41,167
	Calvert Bluff[1]	1,036	1,036	1,036	1,036	1,036	1,036

GAM	Aquifer	Modeled Available Groundwater in acre-ft/year (AFY) based on TWDB GAM runs					
		2020	2030	2040	2050	2060	2070[3]
	Simsboro [1]	38,470	37,900	40,042	46,028	48,503	48,503
	Hooper [1]	2,960	4,139	4,433	4,433	4,422	4,422
	Subtotal	94,216	98,811	105,609	116,494	119,923	119,924
Yegua-Jackson Aquifer	Yegua-Jackson Aquifer[1]	14,544	12,576	12,564	12,478	12,326	10,200
	TOTAL	251,502	249,657	255,887	266,492	269,665	267,475

[1] GAM Run 17-030 (Wade and Ballew, 2017)
[2] GAM Run 17-029 MAG (Shi, 2018)
[3] Model year is 2069 for the MAGs calculated for the aquifers in the Queen City/Sparta GAM
NA – not applicable

Table 8-2 Modeled Available Groundwater Values Calculated by the TWDB based on the DFCs adopted by GMA 8 and 12 for the 2021 Joint Planning Cycle* (Shi and Harding, 2022)

GAM	Aquifer	Modeled Available Groundwater in acre-ft/year (AFY) based on TWDB GAM runs					
		2020	2030	2040	2050	2060	2070[3]
Brazos River Alluvium	GMA 8: Declared a Non-Relevant Aquifer	N/A	N/A	N/A	N/A	N/A	N/A
	GMA 12: Milam and Burleson County[1]	63,634	63,582	63,573	63,568	63,565	63,564
Aquifers in Trinity GAM	Glen Rose[2]	0	0	0	0	0	0
	Hensell[2]	0	0	0	0	0	0
	Hosston[2]	0	0	0	0	0	0
	Subtotal	0	0	0	0	0	0
Aquifers in the Queen City/ Sparta GAM	Sparta[1]	1,237	2,840	3,131	3,437	3,760	4,105
	Queen City[1]	513	4,438	5,110	5,886	6,785	7,839
	Carrizo[1]	11,209	17,263	17,486	17,715	17,955	18,206
	Calvert Bluff[1]	2,179	2,940	3,302	3,710	4,175	4,706
	Simsboro [1]	29,953	65,539	74,832	78,742	79,071	79,422
	Hooper [1]	1,806	2,026	2,264	2,523	2,809	3,126
	Subtotal	46,897	95,046	106,125	112,012	114,555	117,404
Yegua-Jackson Aquifer	Yegua-Jackson Aquifer[1]	1,094	5,315	7,004	7,004	7,000	6058
	TOTAL	111,625	163,943	176,702	182,585	185,120	187,026

9.0 WATER WELL INVENTORY

The District will assign permitted wells to a management zone and to an aquifer based on the location of the well's screen or well depth using the Rules of the District. If no well screen information is available, then a permitted well will be assigned to a management zone and to an aquifer based on the total depth of the well. The District will use the best available science to determine the top and bottom surfaces of aquifers that will be used to determine aquifer(s) assignments to wells. The aquifer surfaces will be defined based on the District's evaluation of the aquifer information from the GAMs, geophysical logs, and hydrogeologic reports. The assignment of the permitted well will be made at the time of permit. The District will assign exempt wells to a management zone and to an aquifer based on available information for the exempt well. The District will use the aquifer assignments to help track the permitted pumping and production for each aquifer and for each management zone.

10.0 GROUNDWATER MONITORING

The District will maintain a monitoring well network that will be used by the District to obtain measured water levels. Groundwater monitoring will be designed to monitor changes in groundwater conditions over time. The District encourages well owners to volunteer wells to be used as part of the monitoring network. The District will accept wells into, or replace an existing well in, the monitoring network. The selection process will consider the well proximity to other monitoring wells, to permitted and exempt wells, to streams, and to geographic and political boundaries. If no suitable well locations can be found to meet the monitoring objectives in a specific aquifer or management zone, the District may evaluate the benefits of converting an oil and gas well to a water well, drilling and installing a new well, or using modeled water levels for that area until such time as a suitable well can be obtained for monitoring.

The District shall perform groundwater monitoring. The monitoring of the wells will be performed under the direction of the general manager, by trained personnel using a Standard Operating Procedure adopted by the District. The District may coordinate with the neighboring groundwater conservation districts for the purpose of supplementing its monitoring data and of improving the consistency in the collection, management, and analysis of hydrogeological data in GMA 12.

11.0 THRESHOLD LEVELS AND ANALYSIS OF GROUNDWATER LEVEL DATA

The District shall use threshold levels to help achieve its DFCs and to conserve and preserve groundwater availability and protect groundwater users. The District shall administer separate threshold levels for each management zone based on the Rules of the District. As part of its evaluation and determinations, the District may also consider the pumping-induced impacts to groundwater resources, including production occurring outside of the District. The District will consider threshold levels based on one or more of the following metrics: estimated total annual production, measured water level change, and predicted water level change.

Among the factors to be considered to guide the District's actions are evaluating thresholds for declines in water levels established in the District's Rules. District actions which can be initiated if a threshold level has been exceeded include: additional aquifer studies to collect and analyze additional information, a re-evaluation of the Management Plan or rules, and/or a change in the Management Plan or rules.

12.0 PRODUCTION AND SPACING OF WELLS

The maximum allowable permitted production and spacing of all wells within the District will be regulated by the District according to the Rules of the District. Well spacing and the rate of production of the well will be dependent on the management zone and the aquifer associated with the well, and other factors included in the Rules of the District. In order to achieve a balance between production and conservation of groundwater resources, the District will establish criteria for evaluating whether the impacts from an aggregate of wells associated with one or more operating permits to be unreasonable. Among the factors that the District will used to evaluate unreasonable impacts is land subsidence, degradation of water quality, reduction of saturated aquifer thickness, and reduction of pressure head in a well.

13.0 ACTIONS, PROCEDURES, PERFORMANCE AND AVOIDANCE FOR PLAN IMPLEMENTATION

The District will implement this plan and utilize it as a guide for the ongoing evaluation, and the planning and establishing, of priorities for all District conservation and regulatory activities. All programs, permits and related operations of the District, and any additional planning efforts in which the District may participate will be consistent with this plan.

The District will adopt rules relating to the permitting of wells, the production and transport of groundwater and reducing permitted production. The rules adopted by the District shall be adopted pursuant to TWC Chapter 36 and provisions of this plan. All rules will be adhered to and enforced. The promulgation and enforcement of the rules will be based on technical data recommended by competent professionals and accepted by the Board. Please follow the link to the most current District Rules, https://posgcd.org/wp-content/uploads/2022/07/Rules.Amended.05102022.pdf.

The District shall treat all citizens equally. Citizens may apply to the District for a variance in enforcement of the rules on grounds of adverse economic effect or unique local conditions. In granting a variance to any rule, the Board shall consider the potential for adverse effect on adjacent landowners and the aquifer(s). The exercise of discretion by the Board shall not be construed as limiting the power of the Board.

The District will endeavor to cooperate with other agencies in the implementation of this plan and the management of groundwater supplies within the District. All activities of the District will be undertaken in a spirit of cooperation and coordination with the appropriate state, regional and local agencies.

14.0 METHODOLOGY FOR TRACKING DISTRICT PROGRESS IN ACHIEVING MANAGEMENT GOALS

The general manager of the District will prepare and present to the Board an annual report on the District's performance and accomplishment of the management goals and objectives. The presentation of the report will occur during the first or second monthly Board meeting following each fiscal year, beginning after the adoption and certification of this plan. The report will include the number of instances in which activities specified in the management objectives was engaged in during the fiscal year. The

Board will maintain the adopted report on file, for public inspection, at the District's offices. This methodology will apply to all management goals contained within this plan.

15.0 AQUIFER STORAGE AND RECOVERY PROJECTS

An Aquifer Storage and Recovery (ASR) project involves the injection of water into a geological formation for subsequent recovery and beneficial use. The District acknowledges that ASR projects can help to improve the overall management of water resources in GMA 12. However, the District also recognizes that poorly designed and instrumented ASR project can be operated in such a manner as to adversely affect the production capacity of existing wells located near the ASR project. As ASR projects are identified, the District will coordinate with the Texas Commission on Environmental Quality to provide data and/or technical expertise that could assist with the evaluation of the proposed ASR project.

16.0 CONJUNCTIVE USE AND CONJUNCTIVE WATER MANAGEMENT

The Texas Water Code §36.001 defines conjunctive use as the combined use of groundwater and surface water sources that optimizes the beneficial characteristics of each source. Conjunctive water use can be considered as the coordinated use of surface water and groundwater to maximum the firm yield. An offspring to conjunctive water use is conjunctive water management. Conjunctive water management engages the principles of conjunctive water use, where surface water and groundwater are used in combination to improve water availability and reliability but also include important components of groundwater management.(Dudley and Fulton, 2005). Examples of conjunctive water management projects includes aquifer storage and recovery, managed aquifer recharge, and joint management of surface water and groundwater supplies. The District encourages permit applicants to include an aspect of conjunctive water management. Among the potential benefits of conjunctive water management is improved reliability of local water supply, increased firm yield from water supplies, reduced groundwater overdraft, increased flood protection, and improved environmental conditions.

17.0 MANAGEMENT GOALS, OBJECTIVES, & PERFORMANCE STANDARDS

17.1 Efficient Use of Groundwater

Management Objectives:

1. The District will maintain a monitoring well network with at least 300 monitoring wells to provide coverage across management zones and aquifers within the District. The District will measure water levels at the monitoring well locations at least once every calendar year. A written analysis of the water level measurements from the monitoring wells will be made available through a presentation to the Board of the District at least once every year.
2. The District will provide educational leadership to citizens within the District concerning this subject. The activity will be accomplished annually through at least one printed publication, such as a brochure, and public speaking at service organizations and public schools as provided for in the District's Public Education Program.

Performance Standards:

1. Maintain a monitoring well network and its criteria, and measure at least 300 monitoring wells at least once every calendar year.
2. Number of monitoring wells measured annually by the District.
3. Written report presented to the Board to document that water levels at these monitoring wells have been measured a minimum of once each year.
4. The number of publications and speaking appearances by the District each year under the District's Public Education Program.

17.2 Controlling and Preventing Waste of Groundwater.

Management Objectives:

1. The District will provide educational leadership to citizens within the District concerning this subject. The activity will be accomplished annually through at least one printed publication, such as a brochure, and public speaking at service organizations and public schools as provided for in the District's Public Education Program. During years when District revenues are sufficient, the District will consider funding a grant to obtain a review, study, or report of pertinent groundwater issues, or to sponsor the attendance of students at summer camps/seminars that place emphasis on the conservation of water resources.
2. Within 3 years of approval of this plan, the District will adopt rules to define "waste" and limit the waste of groundwater resources in the District by users of that groundwater.

Performance Standards:

1. The number of publications and speaking appearances by the District each year, and the number of grants considered and students actually accepting and attending an educational summer camp or seminar.
2. Presence of a section in the District Rules defining "waste" and establishing requirements on permittees to prevent waste of groundwater production in the District.

17.3 Control and Prevent Subsidence

Management Objectives:

1. The District will monitor changes in water levels in its monitoring wells with due consideration to the potential for land subsidence. At least once every three years, the District will assess the potential for land subsidence for areas where water levels have decreased more than 100 feet since the year 2000.
2. The District will review the sections in "*Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping"* report (TWDB Contract Number 1648302062, by LRE Water) when discussing subsidence within the Districts aquifers. Those aquifers can be found on page 4-5, 4-104, 4-187, 4-207, and 4-229 of the report.

Performance Standards:

1. Within three years of the approval of this plan and every three years thereafter, the District will map any region where more than 100 feet of drawdown has occurred since the year 2000 and assess the potential for land subsidence. The results of the assessment will be discussed in a District Board meeting and be document in a presentation or a report.
2. As outlined in TWC Ch. 36.108 (d), The District will take into consideration the "*Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping"* when considering subsidence during GMA 12 joint planning.

17.4 Conservation of Groundwater including Rainwater Harvesting, Precipitation Enhancement, Brush Control, Conjunctive Use, and/or Recharge Enhancement of Groundwater Resources in the District

Management Objectives:

1. The District will provide educational leadership to citizens within the District concerning this subject. The educational efforts will be through at least one printed publication, such as a brochure, and at least one public speaking program at a service organization and/or public school as provided for in the District's Public Education Program. Each of the following topics will be addressed in that program:
    a. Conservation
    b. Rainwater Harvesting
    c. Brush Control
    d. Recharge Enhancement
    e. Conjunctive Use
    f. Precipitation Enhancement

More information can be found at Education – POSGCD.

2. During years when District revenues are sufficient, the District will consider sponsoring the attendance of students and/or teachers at summer camps/seminars that place emphasis on the conservation of groundwater, rainwater harvesting, brush control, groundwater recharge enhancement, conjunctive use, precipitation enhancement of water resources, or a combination of such groundwater management programs.
3. During years when District revenues are sufficient, the District will provide scholarships for students to participate in the programs that place emphasis on the conservation of groundwater,

rainwater harvesting, brush control, groundwater recharge enhancement, conjunctive use, precipitation enhancement of water resources, or a combination of such groundwater management programs, such as the Texas 4-H Water Ambassadors Program.

4. The District will encourage and support projects and programs to conserve and/or preserve groundwater, and/or enhance groundwater recharge, by annually funding District programs, including the Aquifer Conservation Program and the Groundwater Conservation and Enhancement Grant Program, during years when the District's revenues remain at a level sufficient to fund the program. The objective of this program is to obtain the active participation and cooperation of local water utilities, fire departments and public agencies in the funding and successful completion of programs and projects that will result in the conservation of groundwater and the protection or enhancement of the aquifers in the District. The qualifying water conservation projects and programs will include, as appropriate, projects that: result in the conservation of groundwater, reduce the loss or waste of groundwater, recharge enhancement, rainwater harvesting, precipitation enhancement, brush control, or any combination thereof. The District's objective is to benefit the existing and future users of groundwater in the District by providing for the more efficient use of water, increasing recharge to aquifers, reducing waste, limiting groundwater level declines, and maintaining or increasing the amount of groundwater available, by awarding at least one grant under the program in each county annually.

Performance Standards:

1. The number of publications and speaking appearances by the District each year under the District's Public Education Program.
2. The number of students sponsored to attend a summer camp/seminar emphasizing the conservation of water.
3. The number of students receiving scholarships to participate in programs emphasizing the conservation of water, such as the Ambassador 4-H program.
4. Annual funding, when applicable, for the District's Aquifer Conservation Program, Groundwater Conservation and Enhancement Grant Program, and the number of projects and programs reviewed, approved, and funded under that program. A written report providing estimated benefit of the amount of groundwater conserved, of the recharge enhancement, and/or of addition groundwater protection provided by the program.
5. The number and content of reports submitted regarding sponsored programs.

17.5 Conjunctive Use of Surface and Groundwater

Management Objective:

The District will confer annually with the Brazos River Authority (BRA) on cooperative opportunities for conjunctive resource management.

In an effort to enhance long term conservation of groundwater resources, the District encourages conjunctive water use projects to meet future needs and will encourage these water projects through rules, fees or other incentives.

Performance Standard:

1. The number of conferences with the BRA on conjunctive resource management.
2. The number of times each year in which the applicant, general manager or the Board considers conjunctive use in the permitting process.

3. Presence of a section in the District Rules defining "Conjunctive Use" and establish standards for conjunctive use projects.

17.6 Drought Management Strategy

The District is aware that, with climatic changes, the need for groundwater being produced changes. Available tools and information can be found at the TWDB website, https://www.waterdatafortexas.org/drought. The District management strategy is to monitor and review compliance with the District's DFCs and PDLs in response to the changes in groundwater being produced.

Management Objective:

The District, under Section 16 of District Rules, will continue to monitor groundwater, in the different management zones, to maintain compliance with DFCs and PDLs adopted by the District. The District will provide information and tools that can be found at the TWDB website. Performance Standard:

1. Reports to the Board on the number of monitoring wells and the frequency of measurements.
2. Provide information on Drought Status, at a Board Meeting, at least quarterly.

17.7 Natural Resource Issues That Impact the Use and Availability of Groundwater and Which are Impacted by the Use of Groundwater

Management Objectives:

1. The District will confer at least once every two years with appropriate agencies on the impact of groundwater resources in the District.
2. The District will evaluate permit applications for new wells and the information submitted by the applicants on those wells prior to drilling. The District will assess the impact of these wells on the groundwater resources in the District.
3. The District will implement the POSGCD Well Closure Program. The objective of the well closure program is to obtain the closure and plugging of derelict and abandoned wells in a manner that is consistent with state law, for the protection of the aquifers, the environment, and the public safety. The District will conduct a program to identify, inspect, categorize and cause abandoned and derelict water, oil and gas wells to be closed and plugged, by annually funding the program or segments or phases of the program appropriate to be funded in such fiscal year. The District will fund the closure of abandoned wells, according to the most recently adopted District policies, during years when the District's revenues remain at a level sufficient to fund the program.
4. In years when funding is available, the District will enter into interlocal agreements with Milam and Burleson County to protect and preserve groundwater resources from potential contaminants through the County Conservation and Preservation Grant.

Performance Standards:

1. The number of conferences with a representative of appropriate agencies.
2. Reports to the Board on the number of new well permit applications filed, and the possible impacts of those new wells on the groundwater resources in the District.
3. Annual funding, when applicable, for the District's Well Closure Program, and the number of wells closed and plugged as a result of the Well Closure Program.

4. Monthly reports from Milam and Burleson Counties will be provided to the District regarding the requirements of the interlocal agreements.

17.8 Groundwater Well Assistance Program

Management Objective:

The District will maintain a Groundwater Well Assistance Program (GWAP). The purpose of the GWAP is to help restore a water supply to well owners in the District who own wells that have experienced significant groundwater level declines caused by groundwater pumping in GMA 12. Another purpose of the GWAP is to improve the POSGCD monitoring program and the POSGCD's understanding of groundwater aquifer systems in POSGCD by increasing the number of monitoring wells in the monitoring well network.

Performance Standard:

At least once every two years evaluate the number of register wells at risk of their water levels declining below their pump within the next ten years.

17.9 Mitigation

Management Objective:

The District will require filing with the District of mitigation plans required by the District or any State agency regarding impacts caused by groundwater pumping in the District.

Performance Standards:

1. Mitigation plans on file at the District that are related to groundwater pumping in the District.
2. Report of impacts and predicted impacts on well owners in the District on file at the District Offices.

17.10 Desired Future Conditions and Protective Drawdown Limits

Management Objective:

At least once every three years, the District will monitor water levels and evaluate whether the change in water levels addresses the DFCs and PDLs adopted by the District. The District will estimate total annual groundwater production for each aquifer based on the water use reports, estimated exempted use, and other relevant information, and compare these production estimates to the MAGs listed in Table 8-1.

Performance Standards:

1. At least once every three years, the general manager will report to the Board the measured water levels obtained from the monitoring wells within each Management Zone/Area, the average measured drawdown for each Management Zone/Area calculated from the measured water levels of the monitoring wells within the Management Zone/Area, a comparison of the average measured drawdowns for each Management Zone/Area with the DFCs/PDLs for each Management Zone/Area, and the District's progress in conforming with the DFCs/PDLs.

2. At least once every three years, the general manager will report to the Board the total permitted production and the estimated total annual production for each aquifer and compare these amounts to the MAGs listed in Table 8-1 for each aquifer.

17.11 Sustainability of the Groundwater Resource

Management Objective:

Beginning in 2023, the District will evaluate the long-term sustainability of its groundwater supply relative to current production and permitted production. The District will describe the conditions that define sustainability and develop and apply an set of criteria for evaluating the sustainability of the District's aquifers.

Performance Standards:

At least once every three years, the general manager will report to the Board on the sustainability of the groundwater resources. The report will include a definition of groundwater sustainability and the methodology for assessing the sustainability of each relevant aquifer based on current production and projected production.

18.0 PROJECTED WATER DEMANDS

The projected net water demands (in acre-feet) within the District based on the 2022 State Water Plan are compiled in TWDB (2022), provided as **Appendix A**. The District also established future Municipal Groundwater Use Demands in the District for planning purposes. The methodology and results of that effort are as follows:

Method for Establishing Future Municipal Use Demands of Groundwater. The District adopted a resolution, dated March 11, 2003, establishing production rights for Local Water Utilities within the District (water supply corporations, special utility districts, municipal utility districts and cities), as a rule. This rule allowed these Local Water Utilities to obtain a permit to produce a volume of water annually according to one of two methods:

1. An amount equal to the highest annual pumpage it reported from wells within the District in any consecutive twelve months prior to September 31, 2001; or
2. The Local Water Utility could present to the Board a Long-Term Plan prepared by a qualified engineer that projects the annualized long-term water needs as the official projection of the water required by that Local Water Utility in the planning period (for not more than forty [40] years) for providing retail water service within that Local Water Utility's defined service area. If a Local Water Utility adopted this plan on or before March 30, 2004, and the Board found the highest annual pumpage projected in the Long-Term Plan (the "Plan Amount") was not unreasonable, the Local Water Utility was authorized to obtain a permit to pump and produce up to the Plan Amount. **Table 18-1** below contains the results of this effort.

Table 18-1 Municipal Use Groundwater Demands Projected through 2044

Producer	Estimated Acre-Feet per Year
Burleson County	
Apache Hills	11

Producer	Estimated Acre-Feet per Year
Birch Creek	16
Burl. Co. MUD	73
Burl. Investm.	7
Cade Lakes	123
Centerline	21
Caldwell	1,969
Snook	154
Somerville	670
Clara Hills	5
Clay	7
Cooks Point	10
Deanville	350
Lakeview	21
Little Oak Forrest	5
Lyons	106
Post Oak Hill	11
Shupak Utilities	19
Tunis	108
Whispering Woods	7
Wilderness Sound	15
Total for Burleson Co.	3,708
Milam County	
Alcoa	702
Rockdale	2,129
Gause	74
Marlow	108
Milano	673
Minerva	28
North Milam	369
Southwest Milam	2,492
Total for Milam Co.	6,575
DISTRICT TOTALS	10,283

19.0 PROJECTED WATER SUPPLIES WITHIN THE DISTRICT

The projected surface water supplies (in acre-feet) within the District based on the 2022 State Water Plan are compiled in TWDB (2022), provided as **Appendix A**.

Table 19-1 lists the projected groundwater supplies within the District in acre-feet per year according to the 2022 State Water Plan Data. The District has participated and will participate in future regional water planning, and will consider the water supply needs and water management strategies included in the adopted state water plan.

Table 19-1 Projected Groundwater Supplies in acre-feet per year Within the District According the 2022 State Water Plan data

WUG Name	Source Name (aquifer)	Existing WUG Supply					
		2020	2030	2040	2050	2060	2070
Burleson County							
COUNTY-OTHER	CARRIZO-WILCOX	550	550	550	550	550	550
COUNTY-OTHER	QUEEN CITY	250	250	250	250	250	250
DEANVILLE WSC	CARRIZO-WILCOX	659	659	659	659	659	659
IRRIGATION,	BRAZOS RIVER ALLUVIUM	25,189	25,189	25,189	25,189	25,189	25,189
IRRIGATION	CARRIZO-WILCOX	294	294	294	294	294	294
IRRIGATION	YEGUA-JACKSON	974	974	974	974	974	974
MANUFACTURING	SPARTA	111	111	111	111	111	111
MINING	YEGUA-JACKSON	2,018	2,018	2,018	2,018	2,018	2,018
SNOOK	SPARTA	494	494	494	494	494	494
SOMERVILLE	SPARTA	891	891	891	891	891	891
SubTotal		31,430	31,430	31,430	31,430	31,430	31,430
Milam County							
COUNTY-OTHER	BRAZOS RIVER ALLUVIUM	160	160	160	160	160	160
IRRIGATION	BRAZOS RIVER ALLUVIUM	4,422	4,422	4,422	4,422	4,422	4,422
IRRIGATION	CARRIZO-WILCOX	2,224	1,878	1,777	1,986	2,075	2,075
IRRIGATION	QUEEN CITY	53	56	56	56	56	56
MILANO WSC	CARRIZO-WILCOX	255	217	231	230	239	243
MILANO WSC	CARRIZO-WILCOX	265	223	235	235	247	253
MINING	CARRIZO-WILCOX	76	64	61	68	71	71
NORTH MILAM WSC	CARRIZO-WILCOX	423	358	338	378	395	394
ROCKDALE	CARRIZO-WILCOX	1,094	924	624	727	771	771
SOUTHWEST MILAM WSC	CARRIZO-WILCOX	140	113	101	108	114	108
SOUTHWEST MILAM WSC	CARRIZO-WILCOX	1,118	888	795	850	873	839
THORNDALE	CARRIZO-WILCOX	202	202	202	201	201	201
SubTotal		10,272	9,345	8,842	9,261	9,464	9,433
Total		**41,702**	**40,775**	**40,272**	**40,691**	**40,894**	**40,863**

20.0 PROJECTED WATER NEEDS AND WATER STRATEGIES

The projected water supply needs and water management strategies (in acre-feet) within the District based on the 2022 State Water Plan are compiled in TWDB (2022), provided as **Appendix A**.

Milam County:
Projected water supply needs listed in the TWDB estimated historical water use/2022 state water plan data packet are primarily Steam Electric Power. Additional needs exist in irrigation and Municipal. From 2020 to 2070, the total needs in Milam County are projected to increase from 32,333 AF to 33,215 AF, an 882 AF increase.
Projected water management strategies listed in the TWDB estimated historical water use/2022 state water plan data packet and located within Milam County are: Agricultural Conservation (Irrigation), ASR (Thorndale), Corrizo Aquifer Development (Rockdale, Southwest Milam WSC), and Municipal Conservation (Cameron, Rockdale, North Milam WSC). From 2020 to 2070, the total water management strategies in Milam County are projected to increase from 274 AF to 4,690 AF, an increase of 4,416 AF.

Burleson County:
Projected water supply needs listed in the TWDB estimated historical water use/2022 state water plan data packet are primarily Irrigation. Additional needs exist in Municipal. From 2020 to 2070, the total needs in Burleson County are projected to increase from 353 AF to 393 AF.
Projected water management strategies listed in the TWDB estimated historical water use/2022 state water plan data packet and located within Burleson County are: Agricultural Conservation (Irrigation), Sparta Aquifer Development (Manufacturing), Corrizo Aquifer Development (Southwest Milam WSC), Municipal Conservation (Caldwell, Snook, Somerville), and Industrial Water Conservation (Manufacturing). From 2020 to 2070, the total water management strategies in Burleson County are projected to increase from 833 AF to 2,355 AF, an increase of 1,522 AF.

21.0 ESTIMATED GROUNDWATER USE WITHIN THE DISTRICT

The estimated historical water use (in acre-feet) within the District based on the TWDB Historical Water Use Survey is compiled in TWDB (2022), provided as Appendix A.

22.0 ESTIMATED ANNUAL RECHARGE OF GROUNDWATER RESOURCES WITHIN THE DISTRICT

The estimated annual recharge from precipitation to groundwater by aquifer (in acre-feet) within the District is compiled in GAM Run 22-007 (Wade, 2022), provided as **Appendix B**.

23.0 ESTIMATED ANNUAL DISCHARGES FROM THE AQUIFER TO SPRINGS AND ANY SURFACE WATER BODIES, INCLUDING LAKES, STREAMS AND RIVERS

The estimated annual discharges from each aquifer to springs and any surface water bodies, including lakes, streams, and rivers (in acre-feet) within the District are compiled in GAM Run 22-007 (Wade, 2022), provided as Appendix B.

24.0 ESTIMATED ANNUAL GROUNDWATER FLOW INTO AND OUT OF THE DISTRICT WITHIN EACH AQUIFER AND BETWEEN AQUIFERS IN THE DISTRICT

The estimated annual groundwater flow into and out of the District within each aquifer and between aquifers (in acre-feet) within the District is compiled in GAM Run 22-007 (Wade, 2022), provided as Appendix B.

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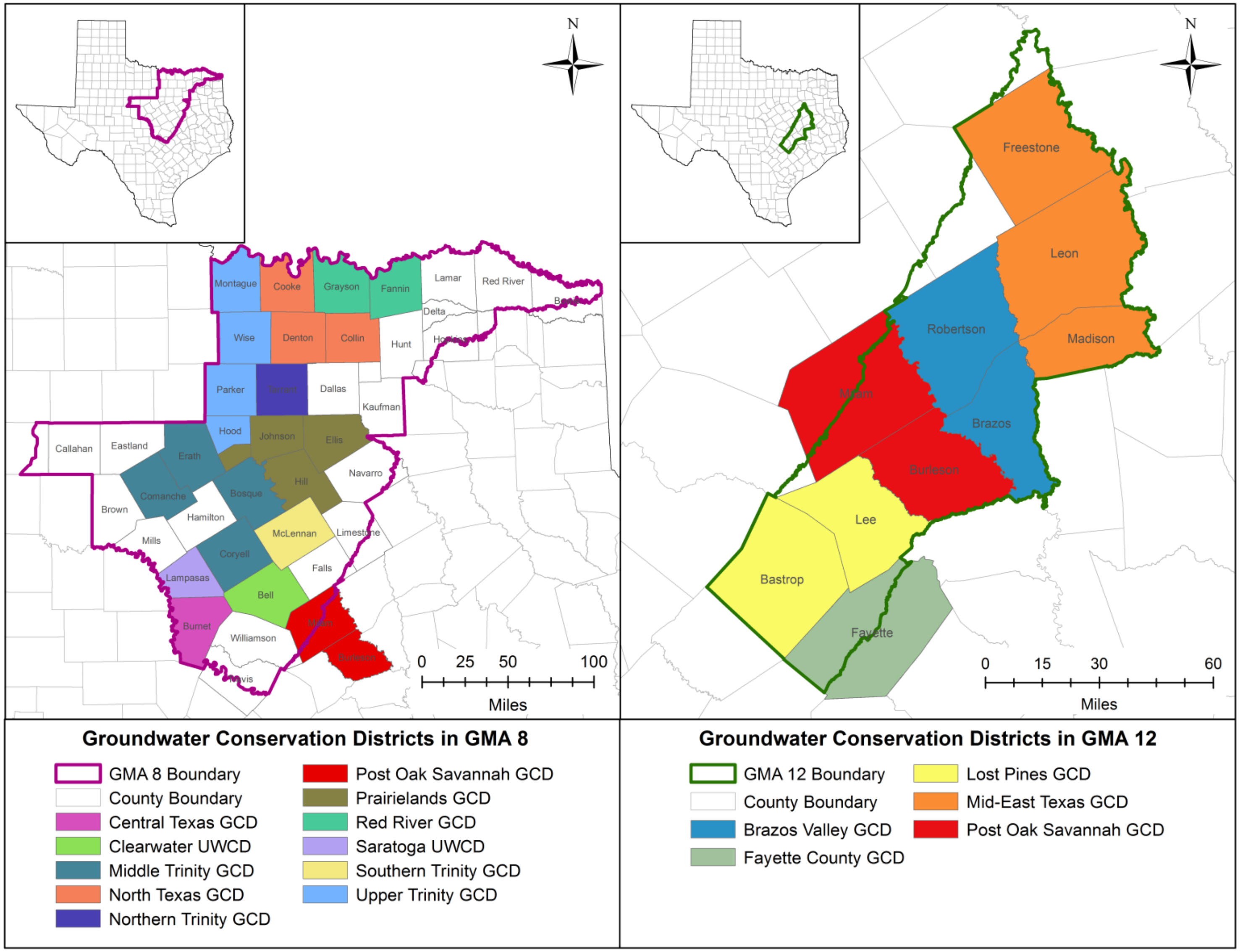


Figure 1 Counties and Groundwater Districts Associated with Groundwater Management Areas 8 and 12

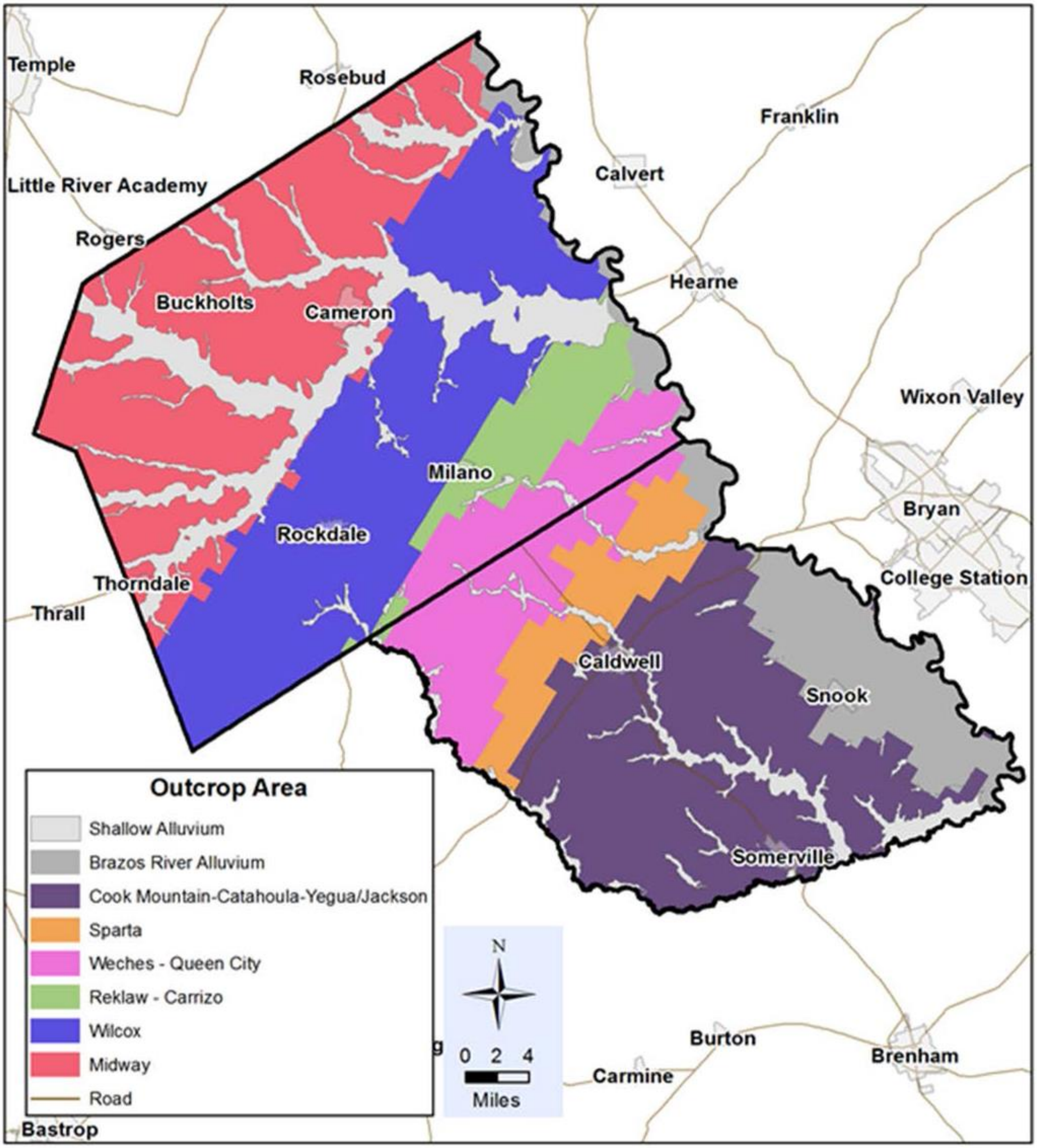


Figure 2 Outcrops Associated with Aquifers and Geological Formations in the District

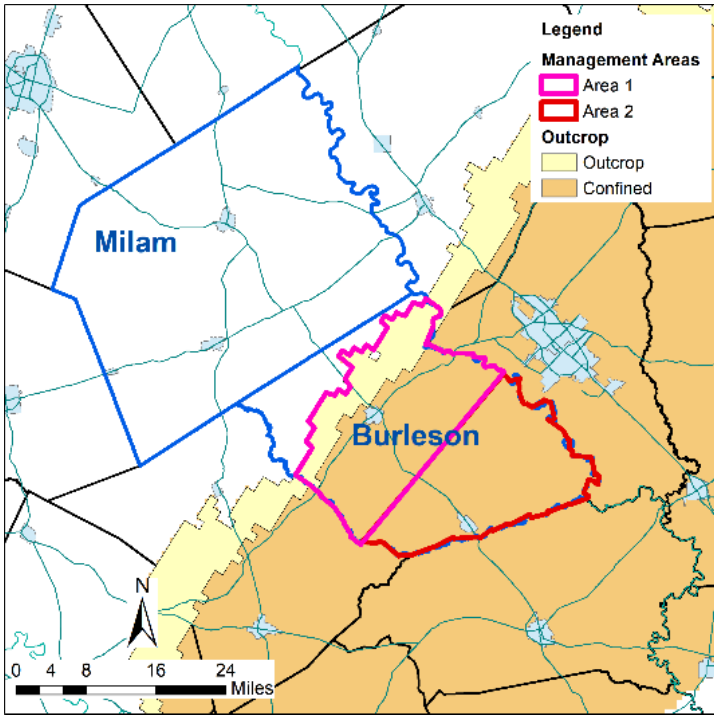


Figure 3 Sparta Management Zone and the Two Management Areas that comprise it: Sparta Management Area 1 and Sparta Management Area 2

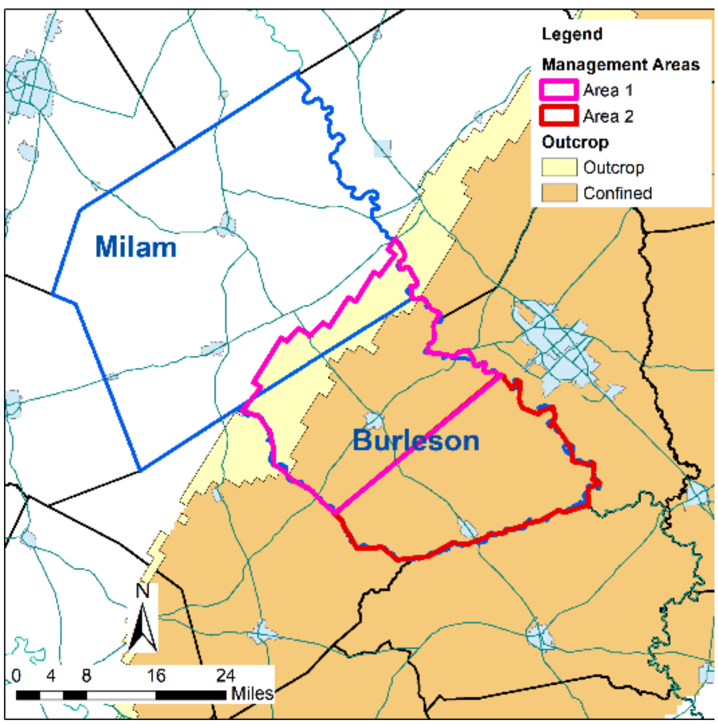


Figure 4 Queen City Management Zone and the Two Management Areas that comprise it: Queen City Management Area 1 and Queen City Management Area 2

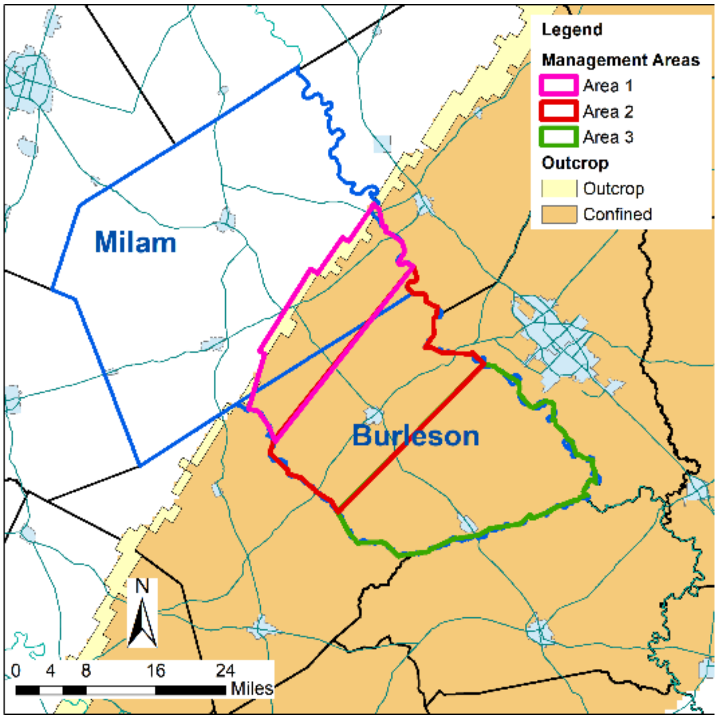


Figure 5 Carrizo Management Zone and the Three Management Areas that comprise it: Carrizo Management Area 1, Carrizo Management Area 2., and Carrizo Management Area 3

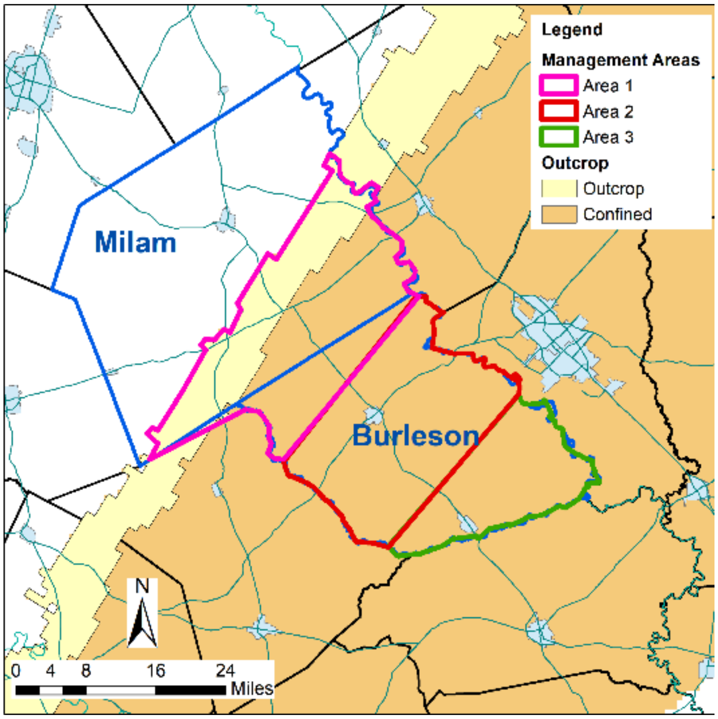


Figure 6 Calvert Bluff Management Zone and the Three Management Areas that comprise it: Calvert Bluff Management Area 1, Calvert Bluff Management Area 2., and Calvert Bluff Management Area 3

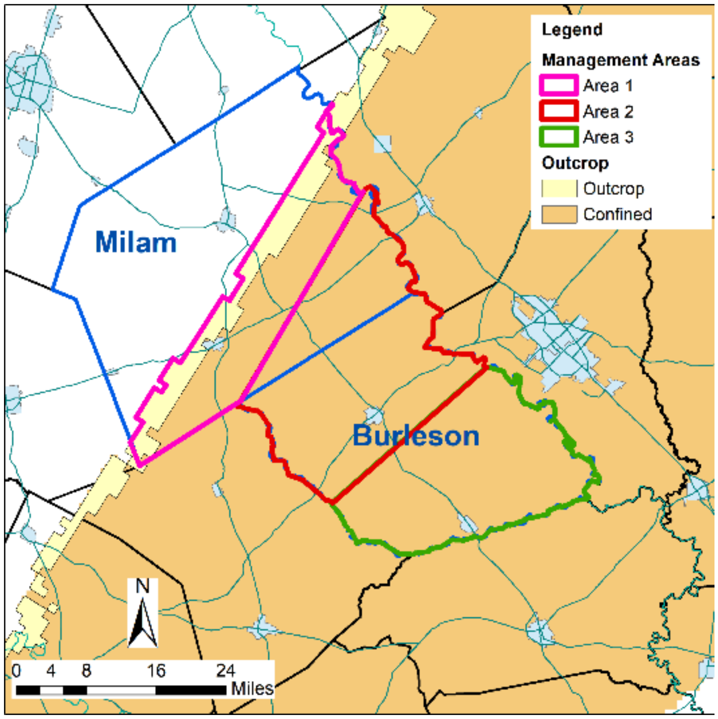


Figure 7 Simsboro Management Zone and the Three Management Areas that comprise it: Simsboro Management Area 1, Simsboro Management Area 2., and Simsboro Management Area 3

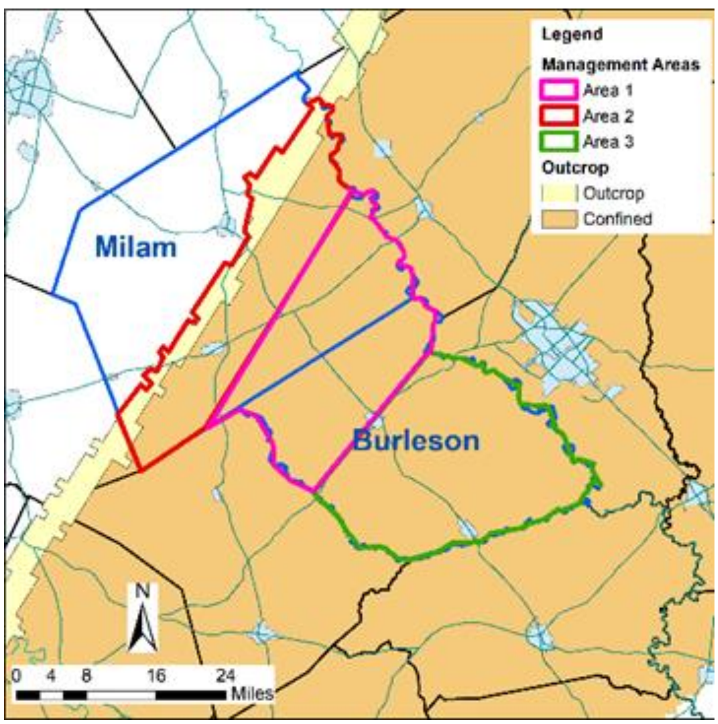


Figure 8 Hooper Management Zone and the Three Management Areas that comprise it: Hooper Management Area 1, Hooper Management Area 2., and Hooper Management Area 3

APPENDIX A

Estimated Historical Water Use And 2022 State Water Plan Datasets:

Post Oak Savannah Groundwater Conservation District

Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
May 23, 2022

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 2022Texas 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 2022 SWP data available as of 5/23/2022. Although it does not happen frequently, either of these datasets are subject to change pending the availability of more accurate WUS data or an amendment to the 2022 SWP. District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

The WUS dataset can be verified at this web address:

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

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

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

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

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

BURLESON COUNTY

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	2,795	8	3,718	0	14,169	317	21,007
	SW	0	0	413	0	531	741	1,685
2018	GW	2,777	21	5,203	0	21,705	317	30,023
	SW	0	0	578	0	728	740	2,046
2017	GW	2,650	35	3,852	0	20,860	308	27,705
	SW	0	0	428	0	604	718	1,750
2016	GW	2,546	111	620	0	15,086	336	18,699
	SW	0	0	69	0	816	784	1,669
2015	GW	2,722	111	2,018	0	8,311	330	13,492
	SW	0	0	224	0	4,351	769	5,344
2014	GW	2,754	111	1,351	0	16,476	319	21,011
	SW	0	0	150	0	2,640	745	3,535
2013	GW	2,935	111	128	0	23,875	304	27,353
	SW	0	0	14	0	3,518	710	4,242
2012	GW	3,299	111	10	0	26,456	320	30,196
	SW	0	0	1	0	4,363	746	5,110
2011	GW	3,549	111	8	0	22,182	579	26,429
	SW	0	0	1	0	7,413	1,350	8,764
2010	GW	2,974	117	17	0	18,749	563	22,420
	SW	0	0	1	0	8,350	1,314	9,665
2009	GW	2,978	117	42	0	22,893	356	26,386
	SW	0	0	2	0	4,695	830	5,527
2008	GW	2,763	117	66	0	15,567	392	18,905
	SW	0	0	4	0	6,868	914	7,786
2007	GW	2,550	117	0	0	5,758	489	8,914
	SW	0	0	0	0	15,313	1,141	16,454
2006	GW	2,877	117	0	0	22,065	505	25,564
	SW	0	0	0	0	2,435	1,178	1,683
2005	GW	2,791	117	0	0	17,060	520	20,488
	SW	0	0	0	0	6,612	1,215	7,827
2004	GW	2,519	117	0	0	20,665	589	23,890
	SW	0	0	0	0	6,106	885	6,991

MILAM COUNTY

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	3,402	0	861	0	4,525	501	9,289
	SW	5,144	0	96	0	520	1,170	6,930
2018	GW	4,543	0	108	0	5,010	500	10,161
	SW	3,225	0	12	421	358	1,167	5,183
2017	GW	4,663	0	103	841	5,208	484	11,299
	SW	4,390	0	11	13,183	308	1,130	19,022
2016	GW	3,040	0	20	6,418	4,281	402	14,161
	SW	1,301	0	2	14,653	133	938	17,027
2015	GW	2,866	0	2	8,968	4,981	398	17,215
	SW	1,356	0	0	12,105	284	928	14,673
2014	GW	3,103	0	25	11,747	5,883	745	21,503
	SW	1,327	0	3	12,962	522	1,739	16,553
2013	GW	3,307	0	140	9,800	6,085	746	20,078
	SW	1,340	0	4	17,712	615	1,740	21,411
2012	GW	6,982	0	121	0	8,844	826	16,773
	SW	7,872	12	1	19,273	446	1,928	29,532
2011	GW	4,228	0	13	13,716	5,273	912	24,142
	SW	1,729	12	1	13,034	1,350	2,127	18,253
2010	GW	3,698	0	15	12,653	1,920	912	19,198
	SW	1,450	12	1	19,601	1,574	2,128	24,766
2009	GW	3,536	11,206	0	0	2,613	552	17,907
	SW	1,470	8,903	0	0	2,155	1,287	13,815
2008	GW	2,890	11,171	0	0	3,099	538	17,698
	SW	1,557	8,876	0	0	1,782	1,257	13,472
2007	GW	2,603	24,678	0	0	4,210	509	32,000
	SW	1,365	4,482	0	0	3	1,188	7,038
2006	GW	3,298	30,116	0	0	5,655	564	39,633
	SW	1,601	12,568	0	0	492	1,315	1,879
2005	GW	3,268	34,762	0	0	4,752	570	43,352
	SW	1,400	11,177	0	0	860	1,329	14,766
2004	GW	2,399	36,435	0	0	3,589	755	43,178
	SW	1,338	11,607	0	0	1,672	1,132	15,749

Projected Surface Water Supplies
TWDB 2022 State Water Plan Data

BURLESON COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
G	Livestock, Burleson	Brazos	Brazos Livestock Local Supply	1,390	1,390	1,390	1,390	1,390	1,390
	Sum of Projected Surface Water Supplies (acre-feet)			**1,390**	**1,390**	**1,390**	**1,390**	**1,390**	**1,390**

MILAM COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
G	Bell Milam Falls WSC	Brazos	Brazos River Authority Little River Lake/Reservoir System	674	662	651	650	637	624
G	Cameron	Brazos	Brazos Run-of-River	2,615	2,615	2,615	2,615	2,615	2,615
G	Irrigation, Milam	Brazos	Brazos Run-of-River	42	42	42	42	42	42
G	Livestock, Milam	Brazos	Brazos Livestock Local Supply	2,761	2,761	2,761	2,761	2,761	2,761
G	Manufacturing, Milam	Brazos	Brazos Run-of-River	14	14	14	14	14	14
G	North Milam WSC	Brazos	Brazos Run-of-River	38	38	38	38	38	37
G	Salem Elm Ridge WSC	Brazos	Brazos River Authority Little River Lake/Reservoir System	297	297	297	297	297	297
G	Salem Elm Ridge WSC	Brazos	Brazos Run-of-River	125	125	125	125	125	125
	Sum of Projected Surface Water Supplies (acre-feet)			**6,566**	**6,554**	**6,543**	**6,542**	**6,529**	**6,515**

Projected Water Demands
TWDB 2022 State Water Plan Data

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

BURLESON COUNTY

All values are in acre-feet

WUG	RWPG	WUG Basin	2020	2030	2040	2050	2060	2070
G	Caldwell	Brazos	1,027	1,043	1,072	1,072	1,091	1,108
G	County-Other, Burleson	Brazos	633	684	705	759	783	798
G	Deanville WSC	Brazos	411	416	433	430	436	441
G	Irrigation, Burleson	Brazos	26,804	26,804	26,804	26,804	26,804	26,804
G	Livestock, Burleson	Brazos	1,390	1,390	1,390	1,390	1,390	1,390
G	Manufacturing, Burleson	Brazos	117	117	117	117	117	117
G	Milano WSC	Brazos	201	209	213	219	225	231
G	Mining, Burleson	Brazos	995	1,923	1,512	1,100	686	428
G	Snook	Brazos	288	305	314	327	337	345
G	Somerville	Brazos	273	292	315	346	378	412
G	Southwest Milam WSC	Brazos	126	132	135	140	144	148
		Sum of Projected Water Demands (acre-feet)	**32,265**	**33,315**	**33,010**	**32,704**	**32,391**	**32,222**

MILAM COUNTY

All values are in acre-feet

WUG	RWPG	WUG Basin	2020	2030	2040	2050	2060	2070
G	Bell Milam Falls WSC	Brazos	225	232	237	246	255	264
G	Cameron	Brazos	1,363	1,413	1,446	1,504	1,561	1,617
G	County-Other, Milam	Brazos	129	134	139	146	151	156
G	Irrigation, Milam	Brazos	6,502	6,502	6,502	6,502	6,502	6,502
G	Livestock, Milam	Brazos	2,761	2,761	2,761	2,761	2,761	2,761
G	Manufacturing, Milam	Brazos	12	13	13	13	13	13
G	Milano WSC	Brazos	209	214	216	224	232	240
G	Mining, Milam	Brazos	14	14	14	14	14	14
G	North Milam WSC	Brazos	249	257	263	273	283	293
G	Rockdale	Brazos	1,173	1,213	1,237	1,285	1,333	1,380
G	Salem Elm Ridge WSC	Brazos	131	135	137	142	148	153
G	Southwest Milam WSC	Brazos	1,002	1,036	1,058	1,100	1,141	1,181
G	Steam-Electric Power, Milam	Brazos	32,254	32,254	32,254	32,254	32,254	32,254
G	Thorndale	Brazos	183	188	190	196	203	211
		Sum of Projected Water Demands (acre-feet)	**46,207**	**46,366**	**46,467**	**46,660**	**46,851**	**47,039**

Projected Water Supply Needs
TWDB 2022 State Water Plan Data

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

BURLESON COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
G	Caldwell	Brazos	1,249	1,233	1,204	1,204	1,185	1,168
G	County-Other, Burleson	Brazos	167	116	95	41	17	2
G	Deanville WSC	Brazos	248	243	226	229	223	218
G	Irrigation, Burleson	Brazos	-347	-347	-347	-347	-347	-347
G	Livestock, Burleson	Brazos	0	0	0	0	0	0
G	Manufacturing, Burleson	Brazos	-6	-6	-6	-6	-6	-6
G	Milano WSC	Brazos	54	8	18	11	14	12
G	Mining, Burleson	Brazos	1,023	95	506	918	1,332	1,590
G	Snook	Brazos	206	189	180	167	157	149
G	Somerville	Brazos	618	599	576	545	513	479
G	Southwest Milam WSC	Brazos	14	-19	-34	-32	-30	-40
	Sum of Projected Water Supply Needs (acre-feet)		**-353**	**-372**	**-387**	**-385**	**-383**	**-393**

MILAM COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
G	Bell Milam Falls WSC	Brazos	551	530	512	502	478	454
G	Cameron	Brazos	1,252	1,202	1,169	1,111	1,054	998
G	County-Other, Milam	Brazos	31	26	21	14	9	4
G	Irrigation, Milam	Brazos	239	-104	-205	4	93	93
G	Livestock, Milam	Brazos	0	0	0	0	0	0
G	Manufacturing, Milam	Brazos	2	1	1	1	1	1
G	Milano WSC	Brazos	56	9	19	11	15	13
G	Mining, Milam	Brazos	62	50	47	54	57	57
G	North Milam WSC	Brazos	212	139	113	143	150	138
G	Rockdale	Brazos	-79	-289	-613	-558	-562	-609
G	Salem Elm Ridge WSC	Brazos	291	287	285	280	274	269
G	Southwest Milam WSC	Brazos	116	-148	-263	-250	-268	-342
G	Steam-Electric Power, Milam	Brazos	-32,254	-32,254	-32,254	-32,254	-32,254	-32,254
G	Thorndale	Brazos	19	14	12	5	-2	-10
	Sum of Projected Water Supply Needs (acre-feet)		**-32,333**	**-32,795**	**-33,335**	**-33,062**	**-33,086**	**-33,215**

BURLESON COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Caldwell, Brazos (G)							
Municipal Water Conservation - Caldwell	DEMAND REDUCTION [Burleson]	0	83	167	239	242	246
		0	**83**	**167**	**239**	**242**	**246**
Irrigation, Burleson, Brazos (G)							
Irrigation Water Conservation	DEMAND REDUCTION [Burleson]	804	1,340	1,876	1,876	1,876	1,876
		804	**1,340**	**1,876**	**1,876**	**1,876**	**1,876**
Manufacturing, Burleson, Brazos (G)							
Industrial Water Conservation	DEMAND REDUCTION [Burleson]	4	6	8	8	8	8
Sparta Aquifer Development	Sparta Aquifer [Burleson]	25	25	25	25	25	25
		29	**31**	**33**	**33**	**33**	**33**
Snook, Brazos (G)							
Municipal Water Conservation - Snook	DEMAND REDUCTION [Burleson]	0	25	50	78	104	129
		0	**25**	**50**	**78**	**104**	**129**
Somerville, Brazos (G)							
Municipal Water Conservation - Somerville	DEMAND REDUCTION [Burleson]	0	20	25	27	29	31
		0	**20**	**25**	**27**	**29**	**31**
Southwest Milam WSC, Brazos (G)							
Carrizo Aquifer Development - Southwest Milam WSC	Carrizo-Wilcox Aquifer [Lee]	0	19	34	32	30	40
		0	**19**	**34**	**32**	**30**	**40**
Sum of Projected Water Management Strategies (acre-feet)		**833**	**1,518**	**2,185**	**2,285**	**2,314**	**2,355**

MILAM COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

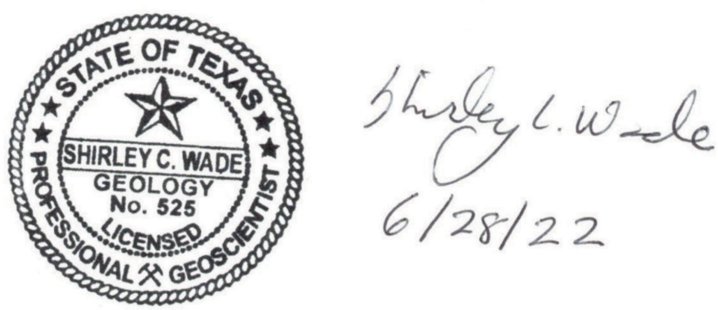
Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Cameron, Brazos (G)							
City of Cameron Little River Intake	Brazos Run-of-River [Milam]	0	2,615	2,615	2,615	2,615	2,615
Municipal Water Conservation - Cameron	DEMAND REDUCTION [Milam]	0	107	218	339	449	465
		0	**2,722**	**2,833**	**2,954**	**3,064**	**3,080**
Irrigation, Milam, Brazos (G)							

Irrigation Water Conservation	DEMAND REDUCTION [Milam]	195	325	455	455	455	455
		195	**325**	**455**	**455**	**455**	**455**
Manufacturing, Milam, Brazos (G)							
City of Cameron Little River Intake	Brazos Run-of-River [Milam]	0	14	14	14	14	14
		0	**14**	**14**	**14**	**14**	**14**
North Milam WSC, Brazos (G)							
City of Cameron Little River Intake	Brazos Run-of-River [Milam]	0	38	38	38	38	37
Municipal Water Conservation - North Milam WSC	DEMAND REDUCTION [Milam]	0	18	19	18	18	18
		0	**56**	**57**	**56**	**56**	**55**
Rockdale, Brazos (G)							
Carrizo Aquifer Development - Rockdale	Carrizo-Wilcox Aquifer [Lee]	79	200	433	360	360	400
Municipal Water Conservation - Rockdale	DEMAND REDUCTION [Milam]	0	89	180	198	202	209
		79	**289**	**613**	**558**	**562**	**609**
Salem Elm Ridge WSC, Brazos (G)							
City of Cameron Little River Intake	Brazos Run-of-River [Milam]	0	125	125	125	125	125
		0	**125**	**125**	**125**	**125**	**125**
Southwest Milam WSC, Brazos (G)							
Carrizo Aquifer Development - Southwest Milam WSC	Carrizo-Wilcox Aquifer [Lee]	0	148	263	250	268	342
		0	**148**	**263**	**250**	**268**	**342**
Thorndale, Brazos (G)							
Lake Granger ASR	Trinity Aquifer ASR [Williamson]	0	0	0	0	2	10
		0	**0**	**0**	**0**	**2**	**10**
Sum of Projected Water Management Strategies (acre-feet)		**274**	**3,679**	**4,360**	**4,412**	**4,546**	**4,690**

APPENDIX B

GAM Run 22-007: Post Oak Savannah Groundwater Conservation District Management Plan

Shirley Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
(512) 936-0883
June 28, 2022



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GAM RUN 22-007: POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Shirley Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
(512) 936-0883
June 28, 2022

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator.

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

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

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

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

The groundwater management plan for the Post Oak Savannah Groundwater Conservation District should be adopted by the district on or before September 30, 2022 and submitted to the executive administrator of the TWDB on or before October 30, 2022. The current management plan for the Post Oak Savannah Groundwater Conservation District expires on December 29, 2022.

We used the groundwater availability models for the northern portion of the Trinity Aquifer and the Woodbine Aquifer (Kelley and others, 2014), the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Young and others, 2018 and Young and Kushnereit, 2020), the Yegua-Jackson Aquifer (Deeds and others, 2010), and the Brazos River Alluvium Aquifer (Ewing and Jigmond, 2016) to estimate the groundwater management plan information for the Post Oak Savannah Groundwater Conservation District. This report replaces the results of GAM Run 16-015 (Ballew, 2017) because it includes results from the updated groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Young and Kushnereit, 2020). Values may also differ from the previous report as a result of routine updates to the spatial grid files used to define county, groundwater conservation district, and aquifer boundaries, which can impact the calculated water budget values. Additionally, the approach used for analyzing model results is reviewed during each update and may have been refined to better delineate groundwater flows. This report also includes a new figure not included in the previous report to help groundwater conservation districts better visualize water budget components. Tables 1 through 6 summarize the groundwater availability model data required by statute and Figures 1, 3, 5, 7, 9, and 11 show the area of the models from which the values in Tables 1 through 6 were extracted. Figures 2, 4, 6, 8, 10, and 12 provide generalized diagrams of the groundwater flow components provided in Tables 1 through 6. If, after review of the figures, the Post Oak Savannah Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models mentioned above were used to estimate information for the Post Oak Savannah Groundwater Conservation District management plan. Water budgets were extracted for the historical model periods for the Trinity Aquifer (1980 through 2012) and the Yegua-Jackson Aquifer (1980 through 1997) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Water budgets were extracted for the historical model periods for the Carrizo-Wilcox, Queen City, and Sparta aquifers (1980 through 2010) and the Brazos River Alluvium Aquifer (1980 through 2012) using

ZONEBUDGET USG Version 1.00 (Panday and others, 2015). The average annual water budget values for recharge, surface-water outflow, inflow to the district, outflow from the district, and the flow between aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Trinity Aquifer

- We used version 2.01 of the groundwater availability model for the northern portion of the Trinity Aquifer and the Woodbine Aquifer. See Kelley and others (2014) for assumptions and limitations of the model.

- The groundwater availability model for the northern portion of the Trinity Aquifer and Woodbine Aquifer contains eight layers that generally represent the following: Layer 1 (the surficial outcrop area of the units in layers 2 through 8 and units younger than Woodbine Aquifer), Layer 2 (Woodbine Aquifer), Layer 3 (Washita and Fredericksburg Groups, and the Edwards [Balcones Fault Zone] Aquifer), and Layers 4 through 8 (Trinity Aquifer). Layers 2 through 7 also include pass-through cells. The Woodbine Aquifer does not occur within the Post Oak Savannah Groundwater Conservation District and therefore no groundwater budget values are included for it in this report.

- Perennial rivers and reservoirs were simulated using the MODFLOW River package. Ephemeral streams, flowing wells, springs, and evapotranspiration in riparian zones along perennial rivers were simulated using the MODFLOW Drain package.

- Water budget terms were averaged for the period 1980 through 2012 (stress periods 92 through 124)

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

Carrizo-Wilcox, Queen City, and Sparta aquifers

- We used version 3.02 of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers. See Young and Kushnereit (2020) and Young and others (2018) for assumptions and limitations of the model.

- The groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers contains ten layers that generally represent the following: Layer 1 (Colorado River and Brazos River alluvium), Layer 2 (shallow flow system of all units in layers 3 through 10), Layer 3 (Sparta Aquifer and equivalent units), Layer 4 (Weches Formation), Layer 5 (Queen City Aquifer and equivalent units), Layer 6 (Reklaw Formation), and Layers 7 through 10 (Carrizo-Wilcox Aquifer and equivalent units).

- The MODFLOW River package was used to simulate groundwater exchange with major rivers and perennial streams. Outflow from ephemeral streams, intermittent streams, and seeps were simulated using the MODFLOW Drain package. The evapotranspiration package was used to simulate groundwater evapotranspiration from the model.
- Water budget terms were averaged for the period 1980 through 2010 (stress periods 52 through 82).
- The model was run with MODFLOW-USG (unstructured grid; Panday and others, 2015).

Yegua-Jackson Aquifer

- We used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes five layers, which all represent the Yegua-Jackson Aquifer in the outcrop. Outside the footprint of the Yegua-Jackson Aquifer the model layers represent the Catahoula Formation and other younger overlying units (Layer 1), the upper portion of the Jackson Group (Layer 2), the lower portion of the Jackson Group (Layer 3), the upper portion of the Yegua Group (Layer 4), and the lower portion of the Yegua Group (Layer 5).
- An overall water budget for the district was determined for the Yegua-Jackson Aquifer (Layer 1 through Layer 5, collectively, for the portions of the model that represent the Yegua-Jackson Aquifer).
- Water budget terms were averaged for the period 1980 through 1997 (stress periods 10 through 27).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

Brazos River Alluvium Aquifer

- We used version 1.01 of the groundwater availability model for the Brazos River Alluvium Aquifer. See Ewing and Jigmond (2016) for assumptions and limitations of the model.
- The groundwater availability model for the Brazos River Alluvium Aquifer contains three layers. Layers 1 and 2 represent the Brazos River Alluvium Aquifer and Layer 3 represents the surficial portions of the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Gulf Coast aquifers as well as various geologic units of the Cretaceous System, including the Edwards and Trinity.
- Perennial rivers and streams were simulated using the MODFLOW Streamflow-Routing package and ephemeral streams were simulated using the MODFLOW River package. Springs were simulated using the MODFLOW Drain package.
- Water budget terms were averaged for the period 1980 through 2012 (monthly stress periods 32 through 427).
- The model was run with MODFLOW-USG (unstructured grid; Panday and others, 2015).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability models results for the Trinity, Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Brazos River Alluvium aquifers located within the Post Oak Savannah Groundwater Conservation District and averaged over the historical calibration period, as shown in Tables 1 through 6.

1. Precipitation recharge—the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.
2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.
3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.
4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative

water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Tables 1 through 6. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

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

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Trinity Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Trinity Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	738
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	399
Estimated net annual volume of flow between each aquifer in the district	From the Trinity Aquifer to Trinity equivalent units	379
	To the Trinity Aquifer from underlying units	Not applicable[1]

[1] The model assumes a no-flow boundary at the base.

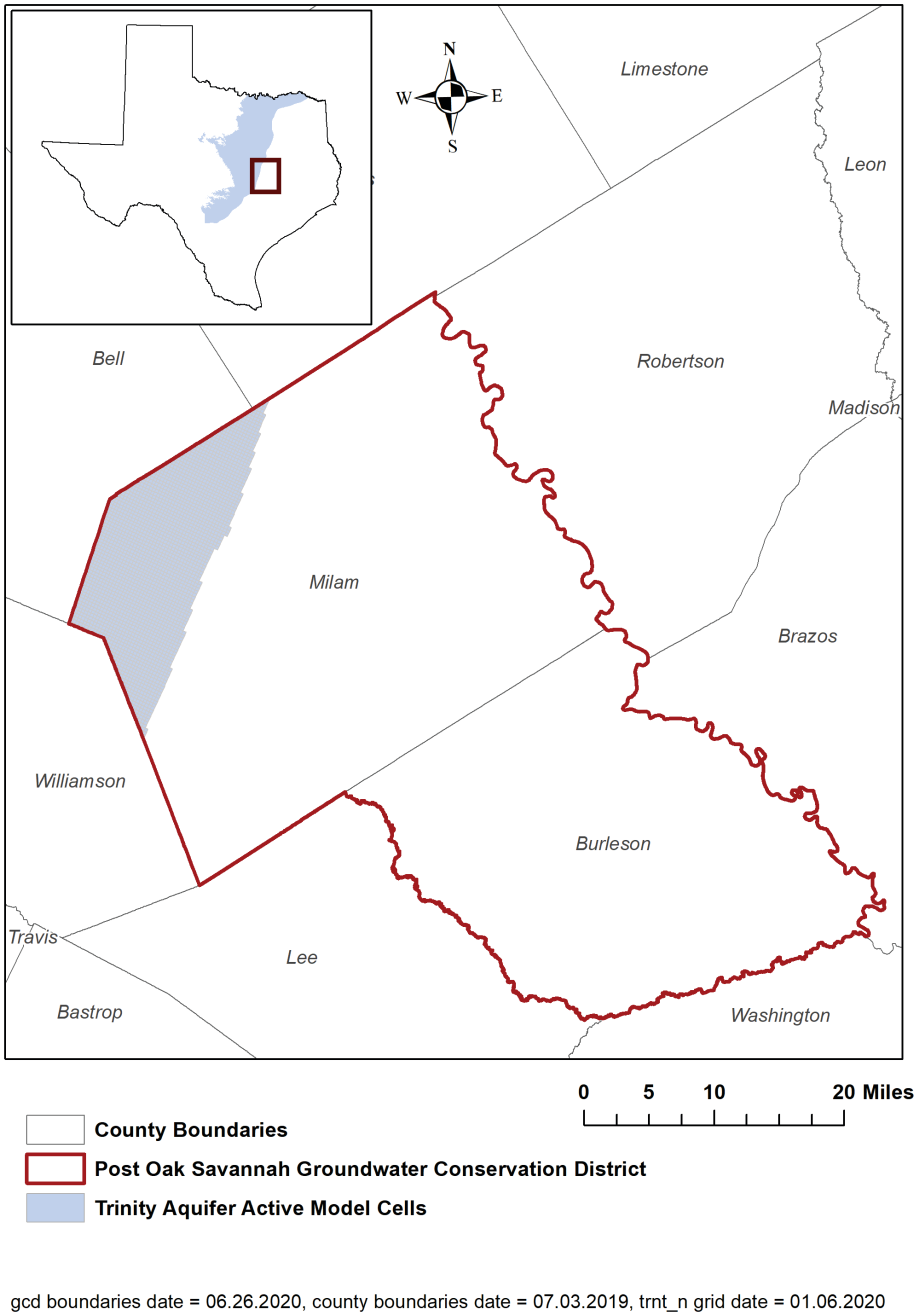


FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE NORTHERN PORTION OF THE TRINITY AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE TRINITY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

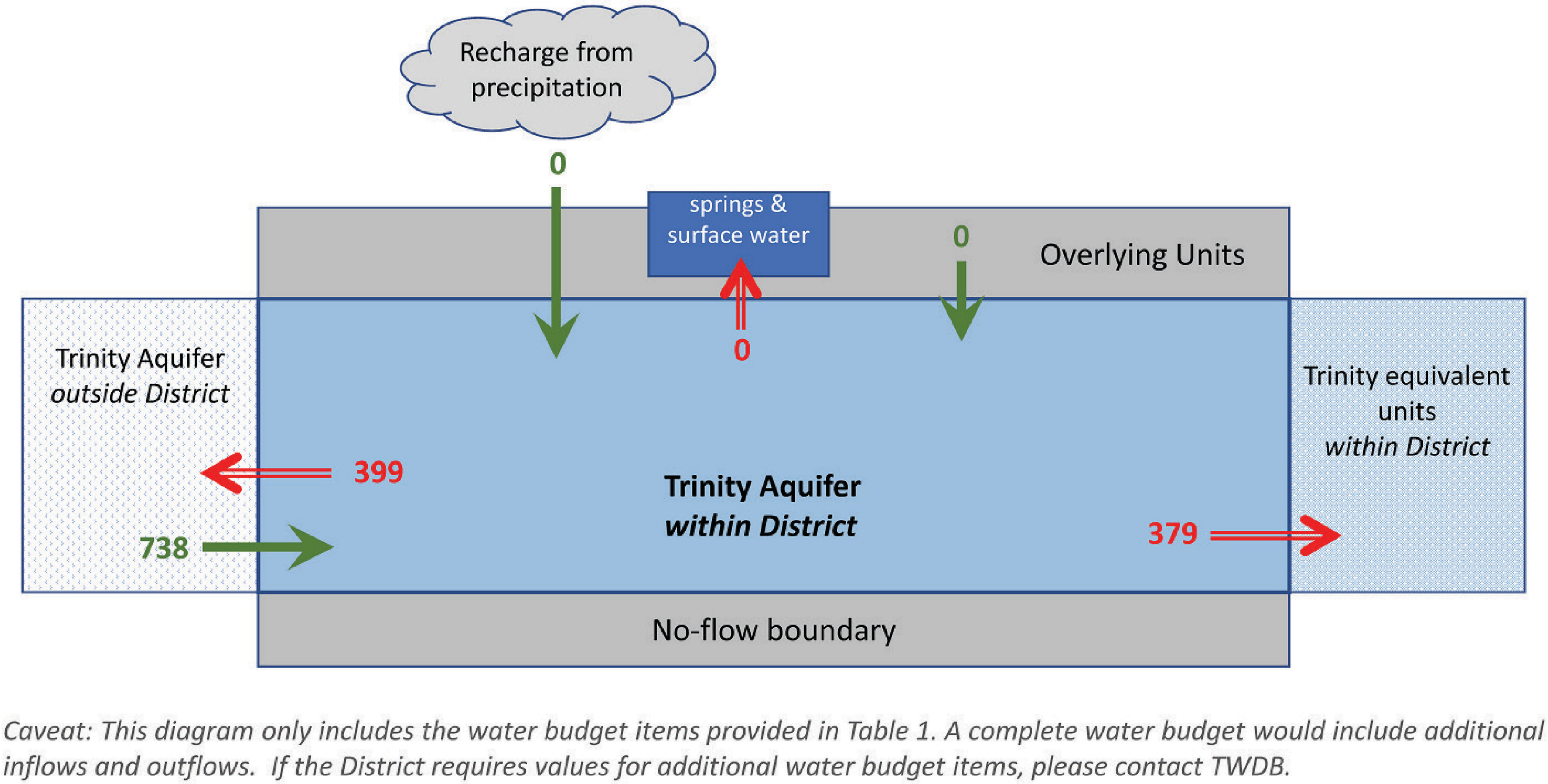


FIGURE 2: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 1, REPRESENTING DIRECTIONS OF FLOW FOR THE TRINITY AQUIFER WITHIN THE POST OAK SAVANNAH GROUNDWATER WATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR (AFY).

TABLE 2: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR THE POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Carrizo-Wilcox Aquifer	39,740
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Carrizo-Wilcox Aquifer	46,631
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	13,664
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	25,054
Estimated net annual volume of flow between each aquifer in the district	From the Carrizo-Wilcox Aquifer to overlying alluvium	2,943
	To the Carrizo-Wilcox Aquifer from the Queen City Aquifer	989
	From the Carrizo-Wilcox Aquifer to the Reklaw confining unit	73
	From the Carrizo-Wilcox Aquifer to Carrizo-Wilcox equivalent units	196

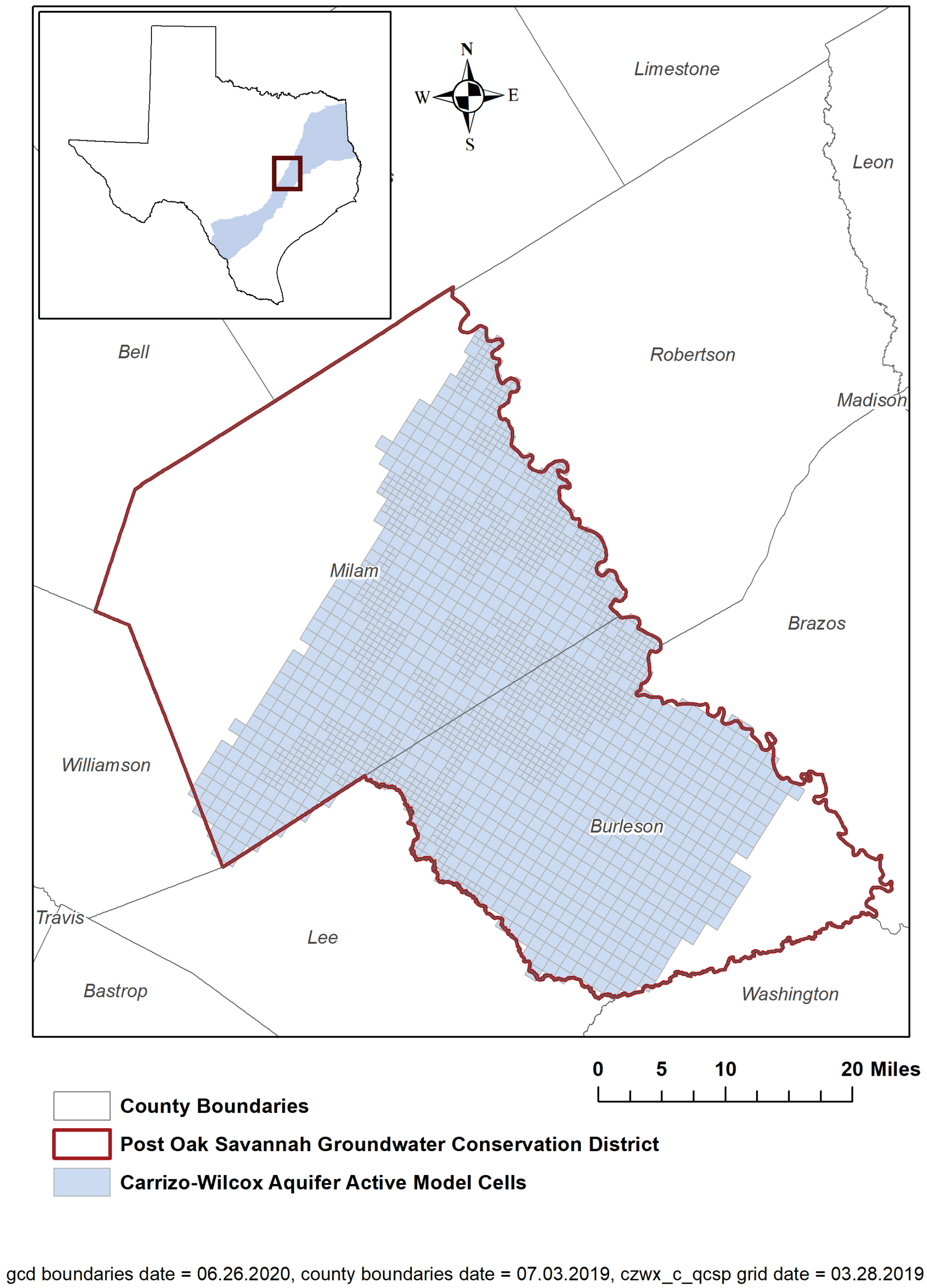
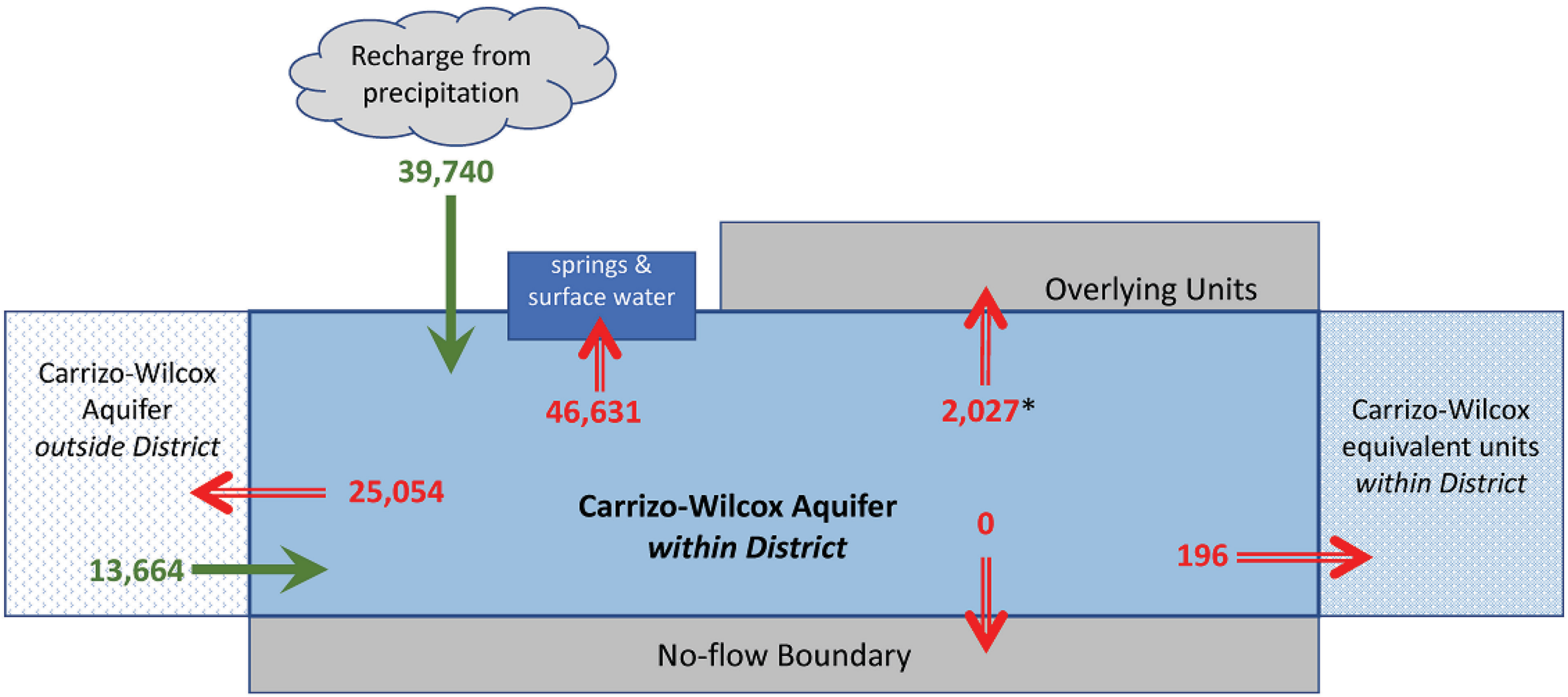


FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE CARRIZO-WILCOX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



* Flow to overlying units includes net outflow of 2,943 acre-feet per year to river alluvium, net inflow of 989 acre-feet per year from the Queen City Aquifer, and net outflow of 73 acre-feet per year to the Reklaw confining unit.

Caveat: This diagram only includes the water budget items provided in Table 2. A complete water budget would include additional inflows and outflows. If the District requires values for additional water budget items, please contact TWDB.

FIGURE 4: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 2, REPRESENTING DIRECTIONS OF FLOW FOR THE CARRIZO-WILCOX AQUIFER WITHIN THE POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR (AFY).

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

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Queen City Aquifer	12,342
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Queen City Aquifer	41,292
Estimated annual volume of flow into the district within each aquifer in the district	Queen City Aquifer	1,307
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	3,291
Estimated net annual volume of flow between each aquifer in the district	From the Queen City to overlying alluvium	2,209
	From the Queen City Aquifer to the Sparta Aquifer	912
	To the Queen City Aquifer from the Weches confining unit	2,098
	To the Queen City Aquifer from Queen City equivalent units	1
	To the Queen City Aquifer from the Reklaw confining unit	1,690
	From the Queen City Aquifer to the Carrizo-Wilcox Aquifer	989

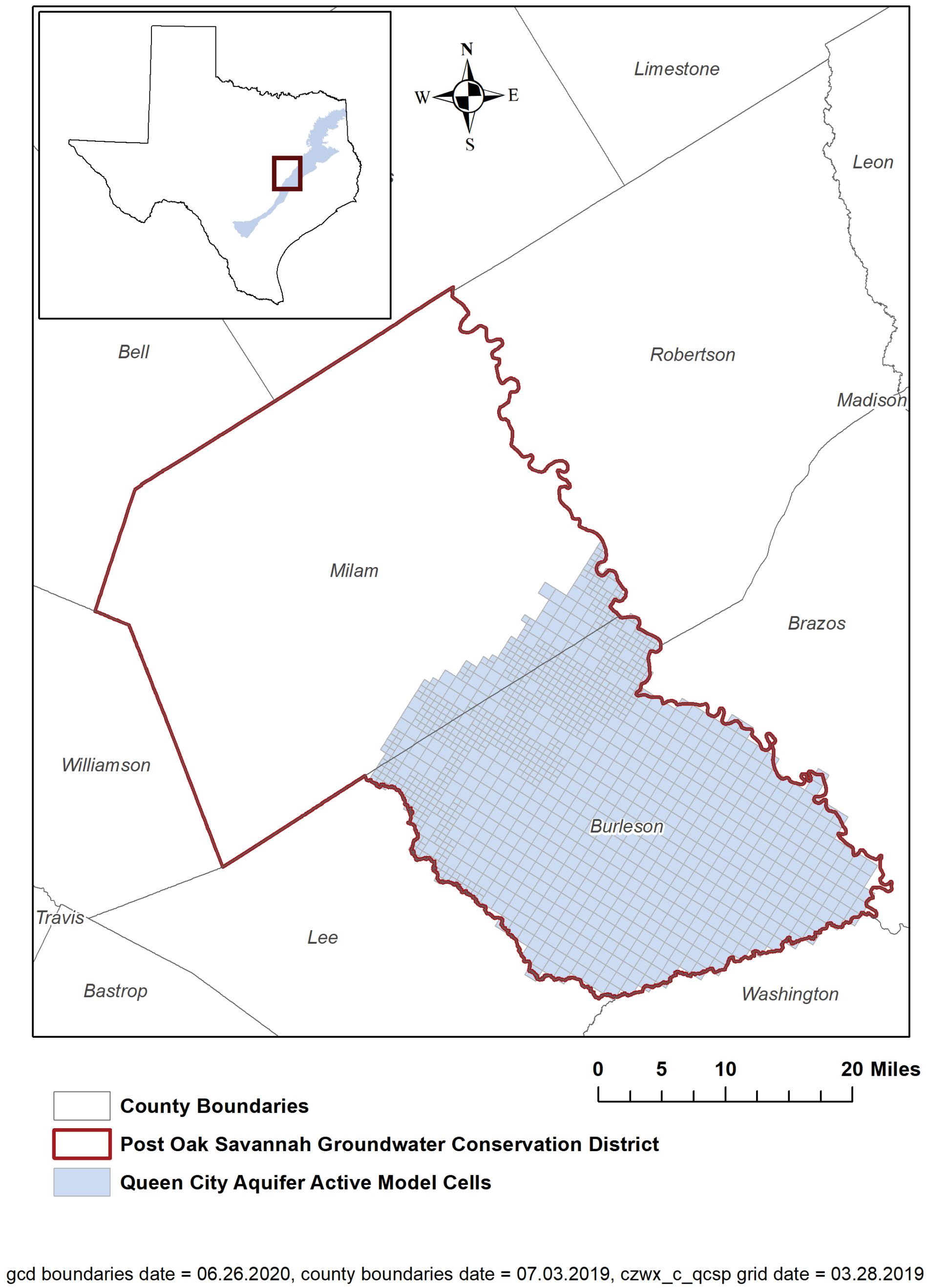
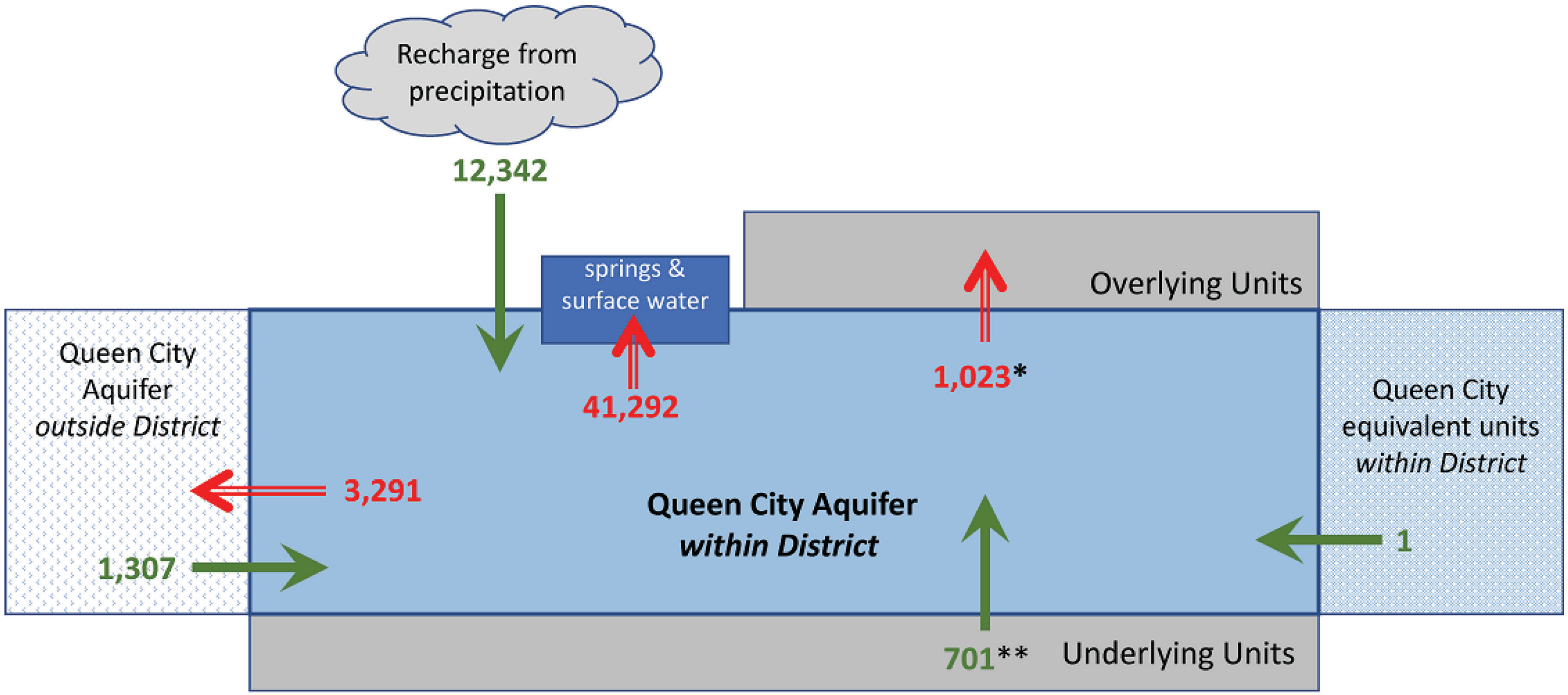


FIGURE 5: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (QUEEN CITY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



* Flow to overlying units includes net outflow of 2,209 acre-feet per year to river alluvium, net outflow of 912 acre-feet per year to the Sparta Aquifer and net inflow of 2,098 acre-feet per year from the Weches confining unit.

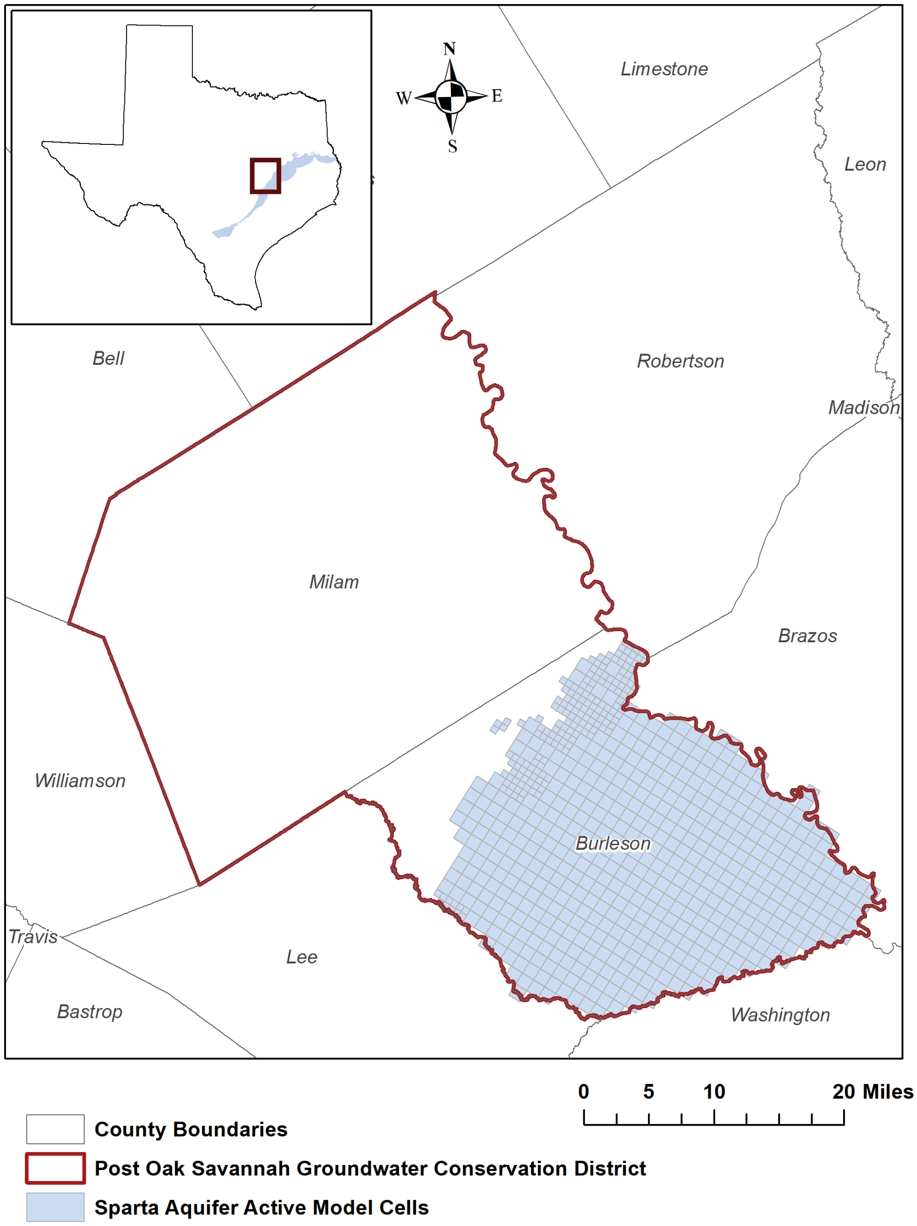
** Flow from underlying units includes net inflow of 1,690 acre-feet per year from the Reklaw confining unit and net outflow of 989 acre-feet per year to the Carrizo-Wilcox Aquifer.

Caveat: This diagram only includes the water budget items provided in Table 3. A complete water budget would include additional inflows and outflows. If the District requires values for additional water budget items, please contact TWDB.

FIGURE 6: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 3, REPRESENTING DIRECTIONS OF FLOW FOR THE QUEEN CITY AQUIFER WITHIN THE POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR (AFY).

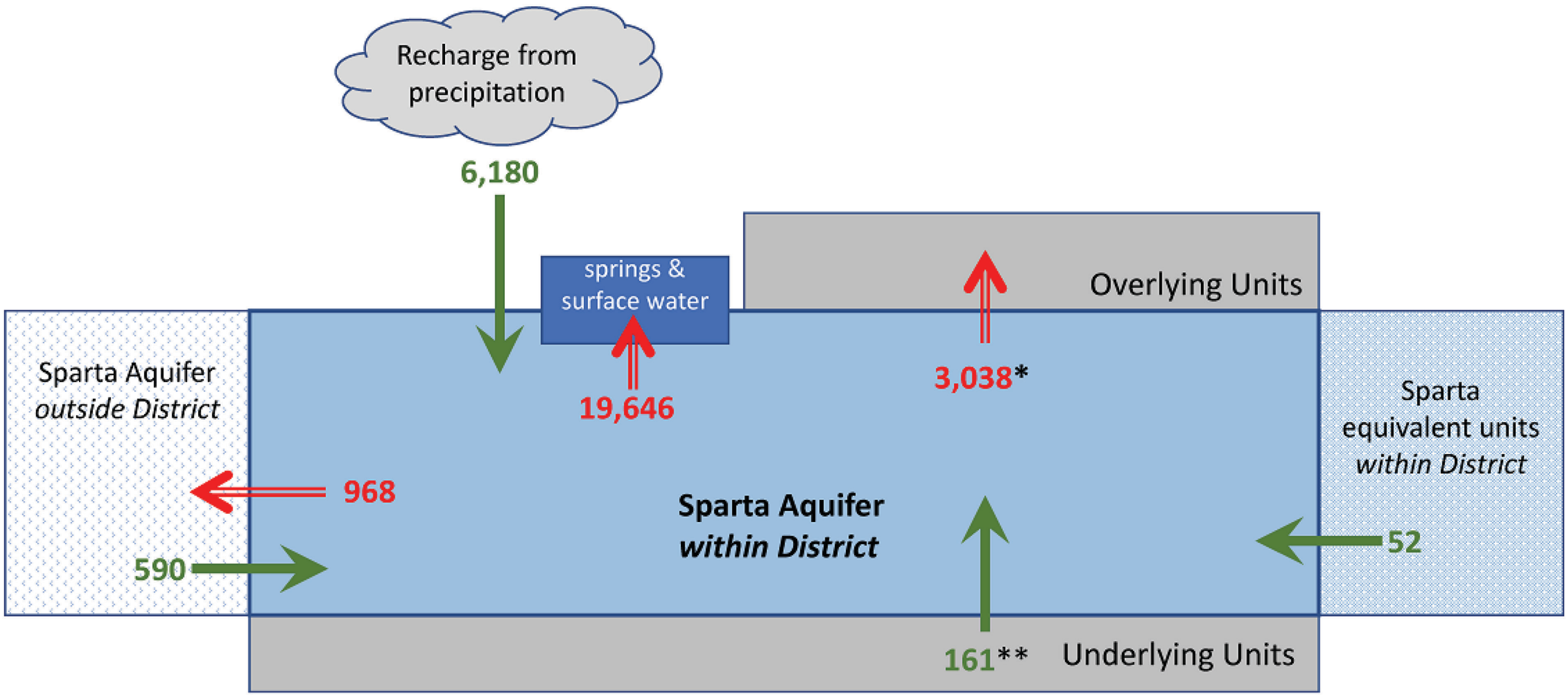
TABLE 4: SUMMARIZED INFORMATION FOR THE SPARTA AQUIFER THAT IS NEEDED FOR THE POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Sparta Aquifer	6,180
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Sparta Aquifer	19,646
Estimated annual volume of flow into the district within each aquifer in the district	Sparta Aquifer	590
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	968
Estimated net annual volume of flow between each aquifer in the district	From the Sparta Aquifer to overlying alluvium	2,230
	From the Sparta Aquifer to the Cook Mountain confining unit	808
	To the Sparta Aquifer from Sparta equivalent units	52
	From the Sparta Aquifer to the Weches confining unit	751
	To the Sparta Aquifer from the Queen City Aquifer	912



gcd boundaries date = 06.26.2020, county boundaries date = 07.03.2019, czwx_c_qcsp grid date = 03.28.2019

FIGURE 7: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED (SPARTA AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



* Flow to overlying units includes net outflow of 2,230 acre-feet per year to river alluvium and net outflow of 808 acre-feet per year to the Cook Mountain confining unit.

** Flow from underlying units includes net outflow of 751 acre-feet per year to the Weches confining unit and net inflow of 912 acre-feet per year from the Queen City Aquifer.

Caveat: This diagram only includes the water budget items provided in Table 4. A complete water budget would include additional inflows and outflows. If the District requires values for additional water budget items, please contact TWDB.

FIGURE 8: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 4, REPRESENTING DIRECTIONS OF FLOW FOR THE SPARTA AQUIFER WITHIN THE POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR (AFY).

TABLE 5: SUMMARIZED INFORMATION FOR THE YEGUA-JACKSON AQUIFER THAT IS NEEDED FOR THE POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Yegua-Jackson Aquifer	22,416
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Yegua-Jackson Aquifer	12,860
Estimated annual volume of flow into the district within each aquifer in the district	Yegua-Jackson Aquifer	3,922
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua-Jackson Aquifer	8,624
Estimated net annual volume of flow between each aquifer in the district	To Yegua-Jackson Aquifer from younger units	69
	To the Yegua-Jackson Aquifer from Yegua-Jackson equivalent units	56
	To the Yegua-Jackson Aquifer from underlying units	Not applicable[1]

[1] The model assumes a no-flow boundary at the base.

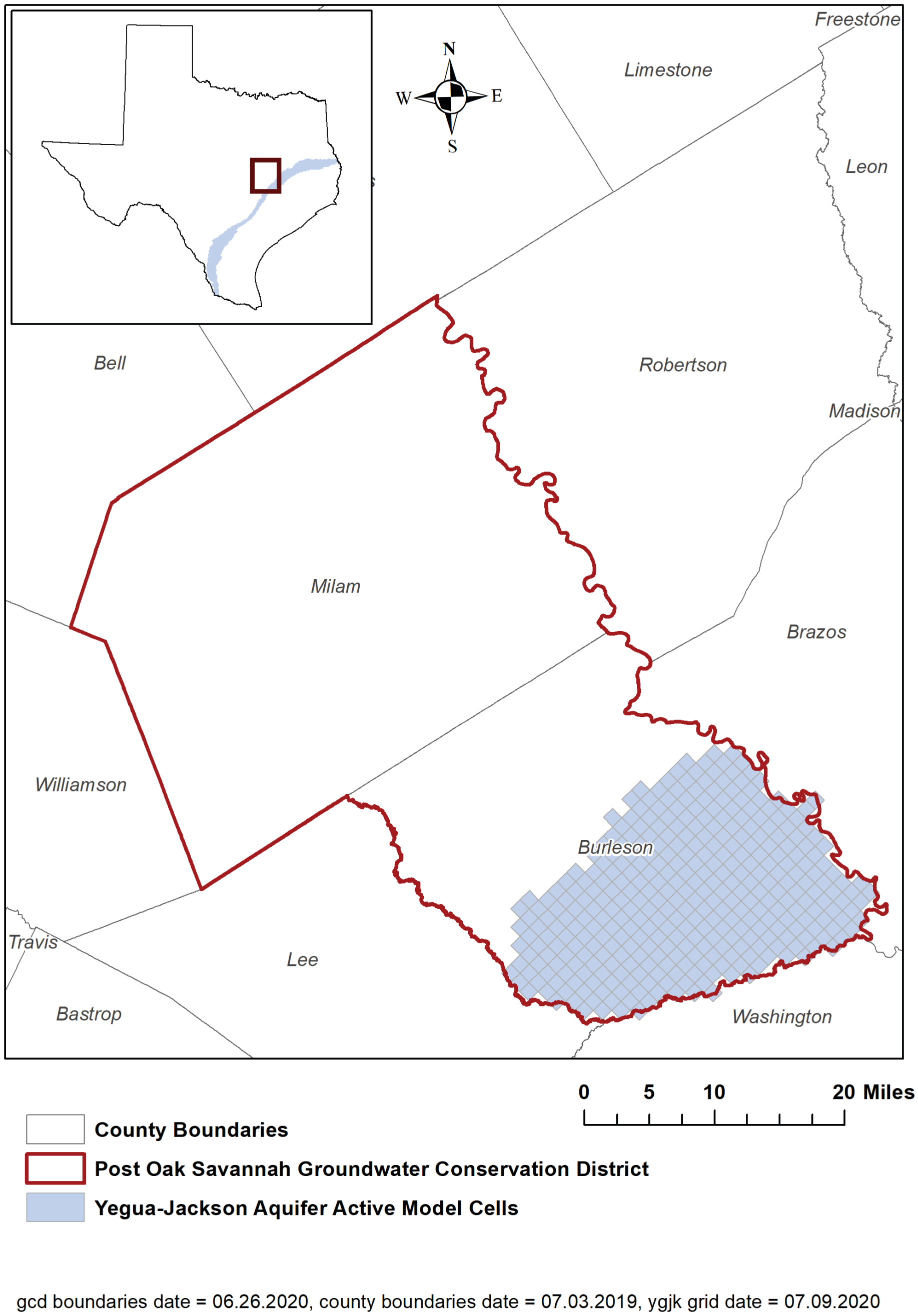
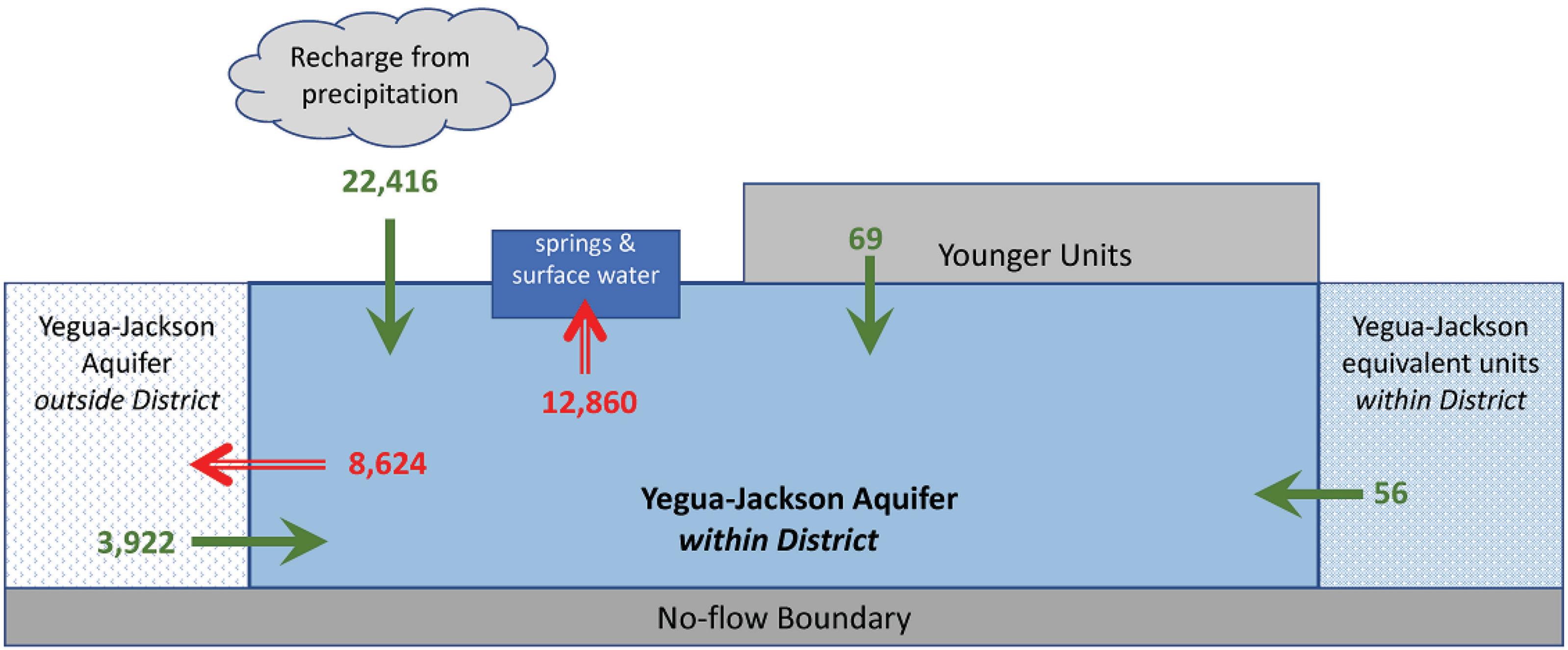


FIGURE 9: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE YEGUA-JACKSON AQUIFER FROM WHICH THE INFORMATION IN TABLE 5 WAS EXTRACTED (YEGUA-JACKSON AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



Caveat: This diagram only includes the water budget items provided in Table 5. A complete water budget would include additional inflows and outflows. If the District requires values for additional water budget items, please contact TWDB.

FIGURE 10: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 5, REPRESENTING DIRECTIONS OF FLOW FOR THE YEGUA-JACKSON AQUIFER WITHIN THE POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR (AFY).

TABLE 6: SUMMARIZED INFORMATION FOR THE BRAZOS RIVER ALLUVIUM AQUIFER THAT IS NEEDED FOR THE POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Brazos River Alluvium Aquifer	15,433
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Brazos River Alluvium Aquifer	25,412
Estimated annual volume of flow into the district within each aquifer in the district	Brazos River Alluvium Aquifer	16,937
Estimated annual volume of flow out of the district within each aquifer in the district	Brazos River Alluvium Aquifer	20,194
Estimated net annual volume of flow between each aquifer in the district	To the Brazos River Alluvium Aquifer from the Yegua-Jackson Aquifer	2,802
	To the Brazos River Alluvium Aquifer from the Sparta Aquifer	3,760
	To the Brazos River Alluvium Aquifer from the Queen City Aquifer	1,669
	To the Brazos River Alluvium Aquifer from the Carrizo-Wilcox Aquifer	645
	To the Brazos River Alluvium Aquifer from confining units	504

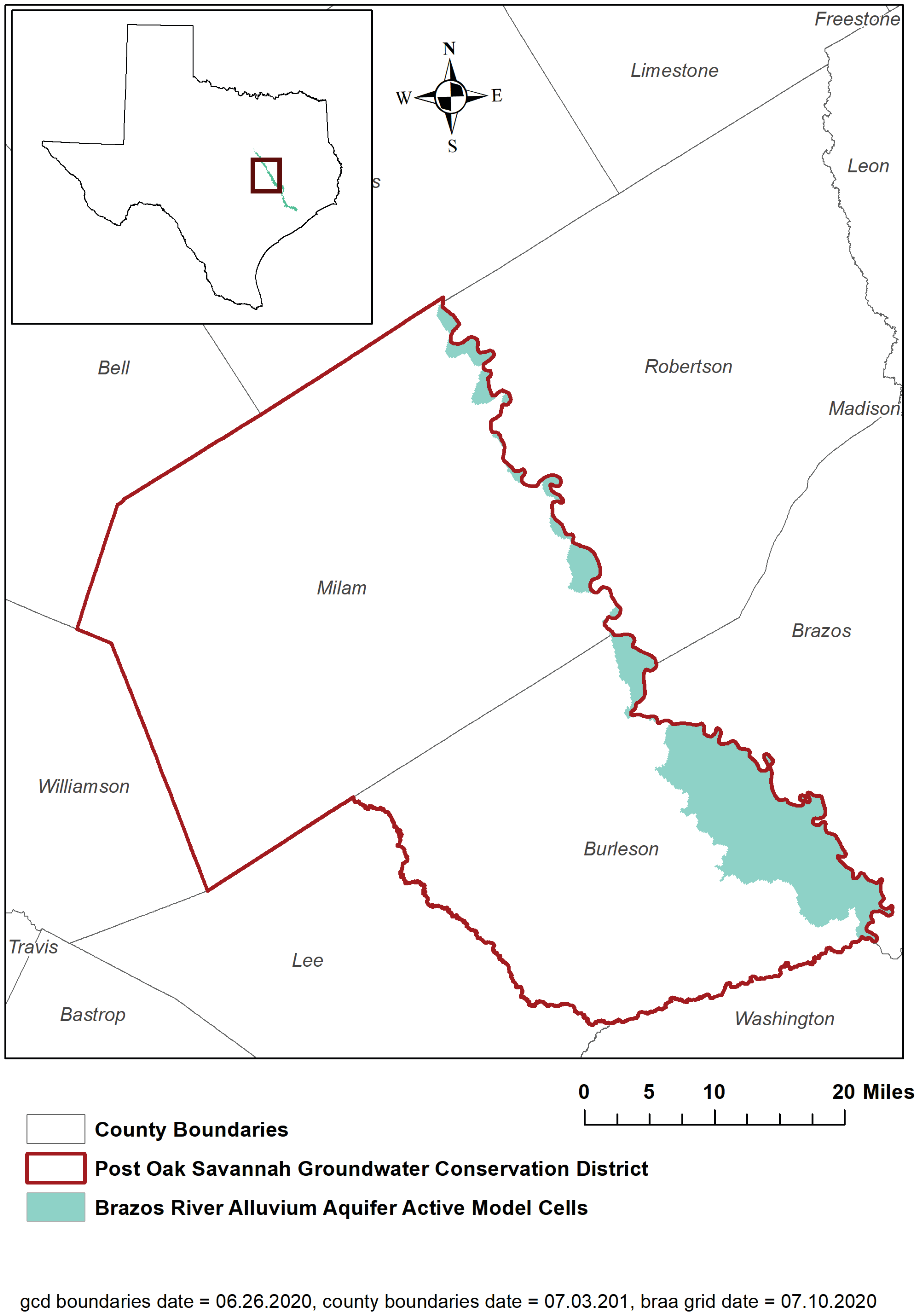
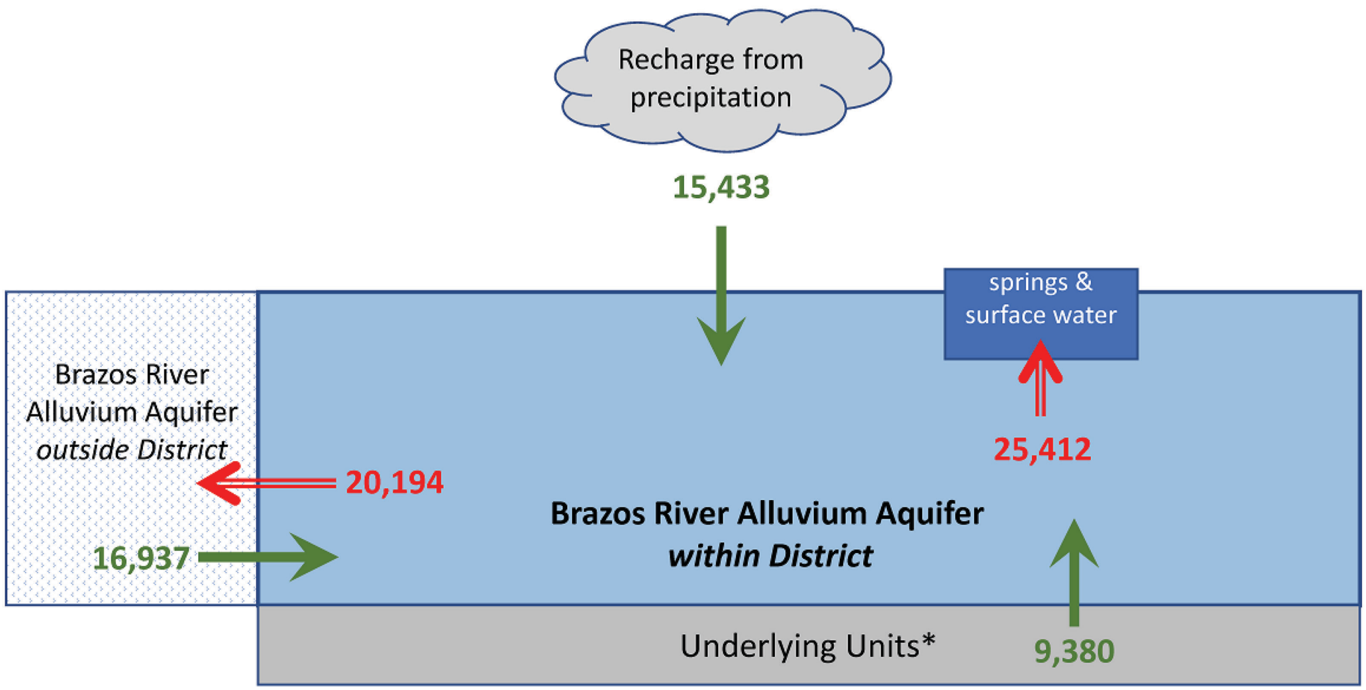


FIGURE 11: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE BRAZOS RIVER ALLUVIUM AQUIFER FROM WHICH THE INFORMATION IN TABLE 6 WAS EXTRACTED (BRAZOS RIVER ALLUVIUM AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



* Flow from underlying units includes net inflows of 2,802 acre-feet per year from the Yegua-Jackson Aquifer, 3,760 acre-feet per year from the Sparta Aquifer, 1,669 acre-feet per year from the Queen City Aquifer, 645 acre-feet per year from the Carrizo-Wilcox Aquifer and 504 acre-feet per year from confining units.

Caveat: This diagram only includes the water budget items provided in Table 6. A complete water budget would include additional inflows and outflows. If the District requires values for additional water budget items, please contact TWDB.

FIGURE 12: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 6, REPRESENTING DIRECTIONS OF FLOW FOR THE BRAZOS RIVER ALLUVIUM AQUIFER WITHIN THE POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR (AFY).

LIMITATIONS:

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

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

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

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

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

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APPENDIX C

GAM RUN 21-017 MAG:
MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 12

Jerry Shi, Ph.D., P.G. and Jevon Harding, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5076
November 1, 2022

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Geoscientist Seals

The following professional geoscientists contributed to this conceptual model report and associated data compilation and analyses:

Jianyou (Jerry) Shi, Ph.D., P.G.

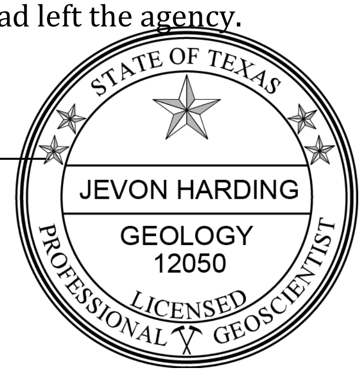
Dr. Shi was responsible for the calculations to verify the attainability of desired future conditions and the calculations of modeled available groundwater values. He was the primary author of the report.

Signature   11/10/2022 Date

Jevon Harding, P.G.

Ms. Harding was responsible for editing the report and adding additional documentation as necessary to meet TWDB standards after Dr. Shi had left the agency.

Signature   11/3/2022 Date



GAM RUN 21-017 MAG: MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 12

Jerry Shi, Ph.D., P.G. and Jevon Harding, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5076
November 1, 2022

EXECUTIVE SUMMARY:

Groundwater Management Area 12 submitted a desired future conditions explanatory report and associated predictive groundwater availability model files to the Texas Water Development Board (TWDB) on February 2, 2022. The TWDB Executive Administrator determined that the explanatory report and other materials submitted to the TWDB were administratively complete on July 1, 2022.

The TWDB calculated modeled available groundwater in Groundwater Management Area 12 for the Sparta, Queen City, Yegua-Jackson, and Brazos River Alluvium aquifers, as well as for the following formations of the Carrizo-Wilcox Aquifer: Carrizo, Calvert Bluff (upper Wilcox), Simsboro (middle Wilcox), and Hooper (lower Wilcox) formations.

Modeled available groundwater is summarized by decade, county, and groundwater conservation district (Tables 4 through 11) and by county, regional water planning area, and river basin for use in the regional water planning process (Tables 12 through 19). Modeled available groundwater for each aquifer in Groundwater Management Area 12 is summarized below.

Carrizo-Wilcox, Queen City, and Sparta aquifers
Sparta Aquifer: Modeled available groundwater ranges from approximately 11,530 to 26,210 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 4) and by county, regional water planning area, and river basin (Table 12).
Queen City Aquifer: Modeled available groundwater ranges from approximately 5,650 to 15,310 acre-feet per year during the period from 2020 to 2070. Values are summarized by

groundwater conservation district and county (Table 5) and by county, regional water planning area, and river basin (Table 13).

Carrizo-Wilcox Aquifer (Carrizo Formation): Modeled available groundwater ranges from approximately 27,460 to 52,370 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 6) and by county, regional water planning area, and river basin (Table 14).

Carrizo-Wilcox Aquifer (Calvert Bluff Formation): Modeled available groundwater ranges from approximately 7,160 to 16,450 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 7) and by county, regional water planning area, and river basin (Table 15).

Carrizo-Wilcox Aquifer (Simsboro Formation): Modeled available groundwater ranges from approximately 129,990 to 314,460 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 8) and by county, regional water planning area, and river basin (Table 16).

Carrizo-Wilcox Aquifer (Hooper Formation): Modeled available groundwater ranges from approximately 7,420 to 14,440 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 9) and by county, regional water planning area, and river basin (Table 17).

Yegua-Jackson Aquifer

Modeled available groundwater for the Yegua-Jackson Aquifer ranges from approximately 17,070 to 25,860 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 10) and by county, regional water planning area, and river basin (Table 18).

Brazos River Alluvium Aquifer

Modeled available groundwater for the Brazos River Alluvium Aquifer ranges from approximately 194,220 to 197,360 acre-feet per year during the period from 2020 to 2070. Values are summarized by county and groundwater conservation districts (Table 11) and by county, regional water planning area, and river basin (Table 19).

REQUESTOR:

Mr. Gary Westbrook, Groundwater Management Area 12 Coordinator.

DESCRIPTION OF REQUEST:

The groundwater conservation districts (Figure 1) in Groundwater Management Area 12 adopted desired future conditions for the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Brazos River Alluvium aquifers on November 30, 2021.

Carrizo-Wilcox, Queen City, and Sparta Aquifers

The desired future conditions for the Carrizo-Wilcox, Queen City, and Sparta aquifers, described in the resolution adopted by Groundwater Management Area 12 on November 30, 2021, are listed in Table 1. The desired future conditions are the average water level drawdowns in feet measured from January 2011 through December 2070.

TABLE 1. ADOPTED DESIRED FUTURE CONDITIONS FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS IN GROUNDWATER MANAGEMENT AREA 12.

Groundwater Conservation District (GCD) or County	Sparta Aquifer	Queen City Aquifer	Carrizo-Wilcox Aquifer			
			Carrizo Formation	Wilcox (Calvert Bluff Formation)	Wilcox (Simsboro Formation)	Wilcox (Hooper Formation)
Brazos Valley GCD*	53	44	84	111	262	167
Fayette County GCD**	43	73	140	NR	NR	NR
Lost Pines GCD	22	28	134	132	240	138
Mid-East Texas GCD	25	20	48	57	76	69
Post Oak Savannah GCD	32	30	146	156	278	178
Falls County	NP	NP	NP	NP	7	3
Limestone County	NP	NP	NP	2	3	3
Navarro County	NP	NP	NP	0	1	0
Williamson County	NP	NP	NP	NR	31	24

** Brazos Valley GCD desired future conditions are for 2000 through 2070*
***Fayette County GCD desired future conditions are for all of Fayette County*
NR: non-relevant for the purposes of joint planning; NP: not present

Yegua-Jackson Aquifer

The desired future conditions for the Yegua-Jackson Aquifer, described in the resolution adopted by Groundwater Management Area 12 on November 30, 2021, are listed in Table 2. The desired future conditions are the average water level drawdowns in feet measured from January 2010 through December 2069.

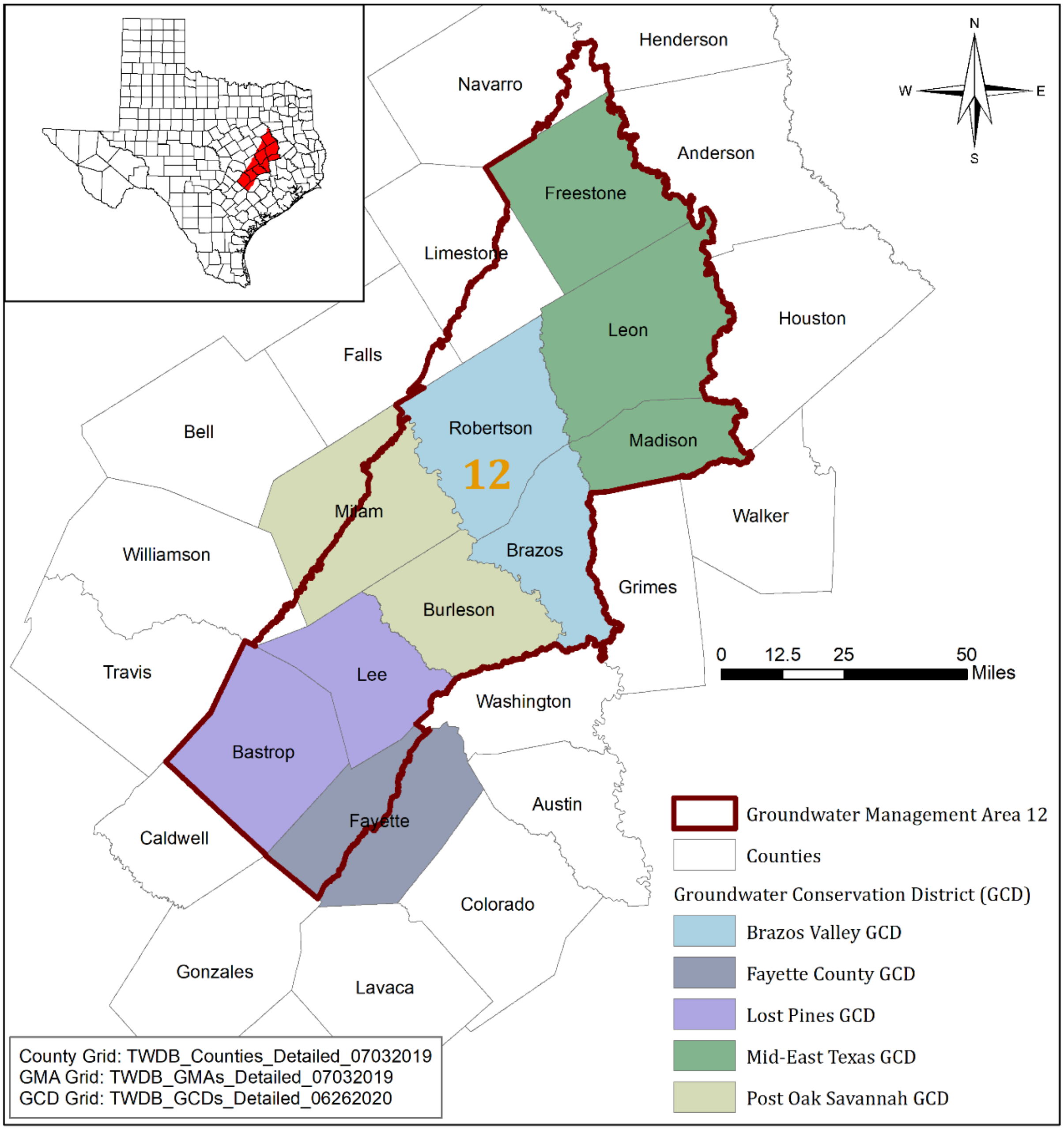


Figure 1. GROUNDWATER CONSERVATION DISTRITS IN GROUNDWATER MANAGEMENT AREA 12.

TABLE 2. ADOPTED DESIRED FUTURE CONDITIONS FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 12.

Groundwater Conservation District (GCD)	Desired Future Condition
Brazos Valley GCD	67
Fayette County GCD*	81
Lost Pines GCD	NR
Mid-East Texas GCD	8
Post Oak Savannah GCD	61

* *Fayette County GCD desired future conditions are for all of Fayette County*
NR: non-relevant.

Brazos River Alluvium Aquifer

The desired future conditions for the Brazos River Alluvium Aquifer, described in the resolution adopted by Groundwater Management Area 12 on November 30, 2021, are presented in Table 3. The desired future conditions for Brazos Valley Groundwater Conservation District are defined in terms of an average percent saturation and the desired future conditions for Post Oak Savannah Groundwater Conservation District are defined in terms of a decrease in the average saturated thickness.

TABLE 3 ADOPTED DESIRED FUTURE CONDITIONS FOR THE BRAZOS RIVER ALLUVIUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 12.

<table>
<tr><th>Groundwater Conservation District (GCD)</th><th>County</th><th>Desired Future Condition</th></tr>
<tr><td>Brazos Valley GCD</td><td>Brazos and Robertson</td><td>North of State Highway 21: Percent saturation shall average at least 30% of total well depth from January 2013 to December 2069.

South of State Highway 21: Percent saturation shall average at least 40% of total well depth from January 2013 to December 2069.</td></tr>
<tr><td rowspan="2">Post Oak Savannah GCD</td><td>Burleson</td><td>A decrease in 6 feet in the average saturated thickness over the period from January 2010 to December 2069.</td></tr>
<tr><td>Milam</td><td>A decrease of 5 feet in average saturated thickness over the period from January 2010 to December 2069.</td></tr>
</table>

All desired future conditions in Groundwater Management Area 12 are based on modeled extent, which may contain portions of an aquifer that do not fall within the official TWDB aquifer boundary. In addition, the desired future conditions for Fayette County Groundwater Conservation District are based on the entire county, although only part of the district is within Groundwater Management Area 12.

Groundwater Management Area 12 provided the TWDB with the desired future conditions, associated predictive groundwater availability model files, and supporting documents on February 2, 2022 (Daniel B. Stephens & Associates and others, 2022).

TWDB staff reviewed the materials submitted by Groundwater Management Area 12 and requested clarifications on several items on April 21, 2022. On May 6, 2022, Groundwater Management Area 12 met to discuss the TWDB clarifications request and reviewed and approved two response documents titled "Calvert Bluff Aquifer Memo-Draft-20220503" and "Memo on TWDB Items-Draft-2022050". The response is summarized in Appendix A.

METHODS:

Carrizo-Wilcox, Queen City, and Sparta aquifers

The desired future conditions for the Carrizo-Wilcox, Queen City, and Sparta aquifers in Groundwater Management Area 12 are based on the predictive model files for "Scenario 19" submitted with the desired future conditions explanatory report (Daniel B. Stephens & Associates and others, 2022). This predictive simulation was constructed as an extension of the calibrated groundwater availability model (Version 3.02) for the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox aquifers (INTERA Incorporated and others, 2020).

The desired future conditions for each aquifer by groundwater conservation district or county are expressed as average drawdown between 2010 and 2070. The modeled available groundwater values were determined by extracting pumping rates by decade from the MODFLOW cell-by-cell budget files using custom Fortran scripts developed by the TWDB.

Yegua-Jackson Aquifer

The desired future conditions for the Yegua-Jackson Aquifer in Groundwater Management Area 12 are based on the predictive model files for "Scenario 2 (PS2)" submitted with the desired future conditions explanatory report (Daniel B. Stephens & Associates and others, 2022). Stress periods 1 through 27 in this predictive model represent the original calibrated groundwater availability model (Version 1.01; Deeds and others, 2010) and stress periods 28 through 100 represent the predictive simulation for the desired future conditions.

The desired future conditions for the Yegua-Jackson Aquifer are expressed as average drawdown between 2009 and 2069. The modeled available groundwater values were determined by extracting pumping rates by decade from the MODFLOW cell-by-cell budget files using custom Fortran scripts developed by the TWDB.

Brazos River Alluvium Aquifer

The desired future conditions for the Brazos River Alluvium Aquifer in Groundwater Management Area 12 are based on the predictive model files for "Scenario 2 (PS2)" submitted with the explanatory report (Daniel B. Stephens & Associates and others, 2022).

Stress periods 1 through 427 in this predictive model represent the original calibrated groundwater availability model (Version 1.01; Ewing and Jigmond, 2016) and stress periods 428 through 485 represent the predictive simulation for the desired future conditions.

BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT

The desired future conditions for the Brazos Valley Groundwater Conservation District are expressed as percent saturation of total well depth at the end of 2069. The modeled available groundwater values were determined by extracting pumping rates by decade from the MODFLOW cell-by-cell budget files using custom Fortran scripts developed by the TWDB.

POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT

The desired future conditions for the Post Oak Savannah Groundwater Conservation District are expressed as a decrease in saturated thickness between 2009 and 2069. The modeled available groundwater values were determined by extracting pumping rates by decade from the MODFLOW cell-by-cell budget files using custom Fortran scripts developed by the TWDB.

MODELED AVAILABLE GROUNDWATER AND PERMITTING

As defined in Chapter 36 of the Texas Water Code (2011), "modeled available groundwater" is the estimated average amount of water that may be produced annually to achieve a desired future condition. Groundwater conservation districts are required to consider modeled available groundwater, along with several other factors, when issuing permits 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:

The parameters and assumptions for the groundwater availability simulations are described below:

Carrizo-Wilcox, Queen City, and Sparta aquifers

- Version 3.02 of the updated groundwater availability model for Central Portion of the Sparta, Queen City, and Carrizo-Wilcox aquifers was the base model for this analysis. See INTERA Incorporated and others (2020) for the assumptions and limitations of the historical calibrated model. Groundwater Management Area 12 constructed a predictive model simulation to extend the base model to 2070 for planning purposes. See Groundwater Management Area 12 explanatory report (Daniel B. Stephens & Associates and others, 2022) for the assumptions of this predictive model simulation.

- The predictive model was run with MODFLOW-USG (Panday and others, 2015).
- The model has ten layers that represent alluvium (Layer 1), the surficial layer of all aquifers (Layer 2), the Sparta Aquifer (Layer 3), the Weches confining unit (Layer 4), the Queen City Aquifer (Layer 5), the Reklaw confining unit (Layer 6), and the subunits that comprise the Carrizo-Wilcox Aquifer (Layers 7 to 10).
- The most recent TWDB model grid file, dated October 9, 2020 (*czwx_v3_01_MFUSG_ModelGrid100920.csv*), was used to assign model cells to counties, groundwater management areas, groundwater conservation districts, river basins, and regional water planning areas. This grid was also used to assign model grid cells to aquifer layers.
- Drawdown was calculated as the difference in modeled water levels between the baseline date of January 1, 2011 (initial water levels) and the final date of December 31, 2070 (stress period 60) using an area-weighted averaging methodology.
- During the predictive simulation model run, some model cells went dry, meaning the modeled water level fell below the bottom of the cell. Pumping in dry cells was excluded from the modeled available groundwater calculations.
- The drawdown averages and modeled available groundwater values were calculated using the modeled extent of aquifers, rather than the official TWDB boundaries for the Carrizo-Wilcox, Queen City, and Sparta Aquifers. Note that the TWDB does not maintain official boundaries for the Carrizo-Wilcox subunits.
- The drawdown calculations and modeled available drawdown values for Fayette County Groundwater Conservation District was based on all of Fayette County, including areas in both Groundwater Management Areas 12 and 15.
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

Yegua-Jackson Aquifer

- Version 1.01 of the updated groundwater availability model for the Yegua-Jackson Aquifer was the base model for this analysis. See Deeds and others (2010) for the assumptions and limitations of the historical calibrated model. Groundwater Management Area 12 constructed a predictive model simulation to extend the base model to 2070 for planning purposes. See Groundwater Management Area 12 explanatory report (Daniel B. Stephens & Associates and others, 2022) for the assumptions of this predictive model simulation.

- The predictive model was run with MODFLOW 2000 (Harbaugh and others, 2000).
- The model has five layers that represent the Yegua-Jackson Aquifer and younger overlying units—the Catahoula Formation (Layer 1), the upper portion of the Jackson Group (Layer 2), the lower portion of the Jackson Group (Layer 3), the upper portion of the Yegua Group (Layer 4), and the lower portion of the Yegua Group (Layer 5).
- The most recent TWDB model grid file, dated July 9, 2020 (*ygjk_07092020.csv*), was used to assign model cells to counties, groundwater management areas, groundwater conservation districts, river basins, and regional water planning areas. This grid was also used to assign model grid cells to aquifer layers.
- Although the original groundwater availability model was only calibrated to 1997, a TWDB analysis (Oliver, 2010) verified that the model satisfactorily matched measured water levels for the period from 1997 to 2009. For this reason, the TWDB considers it acceptable to use the January 2010 as the reference date for drawdown calculations.
- Drawdown was calculated as the difference in modeled water levels between the baseline date of January 1, 2010 (stress period 39) and the final date of December 31, 2069 (stress period 99).
- During the predictive simulation model run, some model cells went dry, meaning the modeled water level fell below the bottom of the cell. Pumping in dry cells was excluded from the modeled available groundwater calculations.
- The drawdown averages and modeled available groundwater values were calculated using the modeled extent of aquifers, rather than the official TWDB boundaries for the Yegua-Jackson Aquifer.
- The drawdown calculations and modeled available drawdown values for Fayette County Groundwater Conservation District was based on all of Fayette County including areas in both Groundwater Management Areas 12 and 15.
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

Brazos River Alluvium Aquifer

- Version 1.01 of the updated groundwater availability model for the Brazos River Alluvium Aquifer was the base model for this analysis. See Ewing and Jigmond

(2016) for the assumptions and limitations of the historical calibrated model. Groundwater Management Area 12 constructed a predictive model simulation to extend the base model to 2070 for planning purposes. See Groundwater Management Area 12 explanatory report (Daniel B. Stephens & Associates and others, 2022) for the assumptions of this predictive model simulation.

- The predictive model was run with MODFLOW-USG beta (development) version (Panday and others, 2013).
- The model has three layers that represent the Brazos River Alluvium Aquifer (Layers 1 and 2) and the surficial portions of the underlying Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Gulf Coast aquifers as well as various geologic units of the Cretaceous System (Layer 3).
- The most recent TWDB model grid file, dated July 10, 2020 (*bra_grid_poly071020.csv*), was used to assign model cells to counties, groundwater management areas, groundwater conservation districts, river basins, and regional water planning areas.
- In Brazos Valley Groundwater Conservation District, the calculation was for the average percent saturation on December 31, 2069 (stress period 484). In Post Oak Savannah Groundwater Conservation District, the calculation was for the decrease in average saturated thickness from January 1, 2013 (stress period 391) to December 31, 2069 (stress period 484).
- The drawdown averages and modeled available groundwater values were calculated using the modeled extent of the aquifer, which is coincident with the official TWDB boundary for the Brazos River Alluvium Aquifer.
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

RESULTS:

The modeled available groundwater values that achieve the desired future conditions adopted by Groundwater Management Area 12 are described below:

Carrizo-Wilcox, Queen City, and Sparta Aquifers

Sparta Aquifer: The modeled available groundwater ranges from approximately 11,530 to 26,210 acre-feet per year during the period from 2020 to 2070 (Tables 4 and 12).
Queen City Aquifer: The modeled available groundwater ranges from approximately 5,650 to 15,310 acre-feet per year during the period from 2020 to 2070 (Tables 5 and 13).

Carrizo-Wilcox Aquifer (Carrizo Formation): The modeled available groundwater ranges from approximately 27,460 to 52,370 acre-feet per year during the period from 2020 to 2070 (Tables 6 and 14).

Carrizo-Wilcox Aquifer (Calvert Bluff Formation): The modeled available groundwater ranges from approximately 7,160 to 16,450 acre-feet per year during the period from 2020 to 2070 (Tables 7 and 15).

Carrizo-Wilcox Aquifer (Simsboro Formation): The modeled available groundwater ranges from approximately 129,990 to 314,460 acre-feet per year during the period from 2020 to 2070 (Tables 8 and 16).

Carrizo-Wilcox Aquifer (Hooper Formation): The modeled available groundwater ranges from approximately 7,420 to 14,440 acre-feet per year during the period from 2020 to 2070 (Tables 9 and 17).

Yegua-Jackson Aquifer

The modeled available groundwater for the Yegua-Jackson Aquifer ranges from approximately 17,070 to 25,860 acre-feet per year during the period from 2020 to 2070 (Tables 10 and 18).

Brazos River Alluvium Aquifer

The modeled available groundwater for the Brazos River Alluvium Aquifer ranges from approximately 194,220 to 197,360 acre-feet per year during the period from 2020 to 2070 (Tables 11 and 19).

TABLE 4 MODELED AVAILABLE GROUNDWATER FOR THE SPARTA AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District (GCD)	County	Aquifer	2020	2030	2040	2050	2060	2070
Brazos Valley GCD	Brazos	Sparta	4,483	6,014	7,545	9,076	10,607	12,138
	Robertson	Sparta	167	338	509	680	851	1,022
Brazos Valley GCD Total		**Sparta**	**4,650**	**6,352**	**8,054**	**9,756**	**11,458**	**13,160**
Fayette County GCD	Fayette	Sparta	2,765	2,779	2,783	2,796	2,828	2,853
Fayette County GCD Total*		**Sparta**	**2,765**	**2,779**	**2,783**	**2,796**	**2,828**	**2,853**
Lost Pines GCD	Bastrop	Sparta	368	437	529	644	788	972
	Lee	Sparta	674	809	975	1,181	1,434	1,751
Lost Pines GCD Total		**Sparta**	**1,042**	**1,246**	**1,504**	**1,825**	**2,222**	**2,723**
Mid-East Texas GCD	Leon	Sparta	249	248	249	251	253	254
	Madison	Sparta	1,589	1,900	2,211	2,523	2,834	3,115
Mid-East Texas GCD Total		**Sparta**	**1,838**	**2,148**	**2,460**	**2,774**	**3,087**	**3,369**
Post Oak Savannah GCD	Burleson	Sparta	1,237	2,840	3,131	3,437	3,760	4,105
Post Oak Savannah GCD Total		**Sparta**	**1,237**	**2,840**	**3,131**	**3,437**	**3,760**	**4,105**
GMA 12 Total		**Sparta**	**11,532**	**15,365**	**17,932**	**20,588**	**23,355**	**26,210**

** Fayette County GCD values are for all of Fayette County.*

TABLE 5 MODELED AVAILABLE GROUNDWATER FOR THE QUEEN CITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District (GCD)	County	Aquifer	2020	2030	2040	2050	2060	2070
Brazos Valley GCD	Brazos	Queen City	133	245	357	469	582	694
	Robertson	Queen City	36	144	252	359	467	575
Brazos Valley GCD Total		**Queen City**	**169**	**389**	**609**	**828**	**1,049**	**1,269**
Fayette County GCD	Fayette	Queen City	2,694	2,715	2,737	2,761	2,786	2,813
Fayette County GCD Total*		**Queen City**	**2,694**	**2,715**	**2,737**	**2,761**	**2,786**	**2,813**
Lost Pines GCD	Bastrop	Queen City	469	519	573	632	698	771
	Lee	Queen City	640	700	767	839	917	1,000
Lost Pines GCD Total		**Queen City**	**1,109**	**1,219**	**1,340**	**1,471**	**1,615**	**1,771**
Mid-East Texas GCD	Freestone	Queen City	77	77	77	77	77	77
	Leon	Queen City	871	919	967	1,014	1,063	1,106
	Madison	Queen City	221	264	308	351	394	433
Mid-East Texas GCD Total		**Queen City**	**1,169**	**1,260**	**1,352**	**1,442**	**1,534**	**1,616**
Post Oak Savannah GCD	Burleson	Queen City	366	3,090	3,467	3,883	4,344	4,863
Post Oak Savannah GCD	Milam	Queen City	147	1,348	1,643	2,003	2,441	2,976
Post Oak Savannah GCD Total		**Queen City**	**513**	**4,438**	**5,110**	**5,886**	**6,785**	**7,839**
GMA 12 Total		**Queen City**	**5,654**	**10,021**	**11,148**	**12,388**	**13,769**	**15,308**

** Fayette County GCD values are for all of Fayette County.*

TABLE 6 **MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.**

Groundwater Conservation District (GCD)	County	Aquifer	2020	2030	2040	2050	2060	2070
Brazos Valley GCD	Brazos	Carrizo	864	1,444	2,023	2,603	3,183	3,763
	Robertson	Carrizo	81	412	743	1,074	1,405	1,736
Brazos Valley GCD Total		**Carrizo**	**945**	**1,856**	**2,766**	**3,677**	**4,588**	**5,499**
Fayette County GCD	Fayette	Carrizo	5,155	5,155	5,155	5,155	5,155	5,155
Fayette County GCD Total*		**Carrizo**	**5,155**	**5,155**	**5,155**	**5,155**	**5,155**	**5,155**
Lost Pines GCD	Bastrop	Carrizo	2,591	3,451	4,416	5,533	6,873	8,534
	Lee	Carrizo	2,125	2,452	2,821	3,255	3,783	4,446
Lost Pines GCD Total		**Carrizo**	**4,716**	**5,903**	**7,237**	**8,788**	**10,656**	**12,980**
Mid-East Texas GCD	Freestone	Carrizo	79	79	79	79	79	79
	Leon	Carrizo	5,356	6,396	7,435	8,474	9,514	10,450
	Madison	Carrizo	0	0	0	0	0	0
Mid-East Texas GCD Total		**Carrizo**	**5,435**	**6,475**	**7,514**	**8,553**	**9,593**	**10,529**
Post Oak Savannah GCD	Burleson	Carrizo	10,669	16,656	16,806	16,956	17,108	17,261
Post Oak Savannah GCD	Milam	Carrizo	540	607	680	759	847	945
Post Oak Savannah GCD Total		**Carrizo**	**11,209**	**17,263**	**17,486**	**17,715**	**17,955**	**18,206**
GMA 12 Total		**Carrizo**	**27,460**	**36,652**	**40,158**	**43,888**	**47,947**	**52,369**

** Fayette County GCD values are for all of Fayette County.*

TABLE 7 MODELED AVAILABLE GROUNDWATER FOR THE CALVERT BLUFF FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District (GCD)	County	Aquifer	2020	2030	2040	2050	2060	2070
Brazos Valley GCD	Brazos	Calvert Bluff	0	0	0	0	0	0
	Robertson	Calvert Bluff	252	546	841	1,136	1,430	1,725
Brazos Valley GCD Total		**Calvert Bluff**	**252**	**546**	**841**	**1,136**	**1,430**	**1,725**
Lost Pines GCD	Bastrop	Calvert Bluff	1,837	2,419	3,010	3,609	4,217	4,834
	Lee	Calvert Bluff	318	395	475	557	642	729
Lost Pines GCD Total		**Calvert Bluff**	**2,155**	**2,814**	**3,485**	**4,166**	**4,859**	**5,563**
Mid-East Texas GCD	Freestone	Calvert Bluff	590	613	637	661	685	706
	Leon	Calvert Bluff	1,832	2,176	2,519	2,863	3,206	3,515
	Madison	Calvert Bluff	0	0	0	0	0	0
Mid-East Texas GCD Total		**Calvert Bluff**	**2,422**	**2,789**	**3,156**	**3,524**	**3,891**	**4,221**
Post Oak Savannah GCD	Burleson	Calvert Bluff	117	129	140	152	163	174
	Milam	Calvert Bluff	2,062	2,811	3,162	3,558	4,012	4,532
Post Oak Savannah GCD Total		**Calvert Bluff**	**2,179**	**2,940**	**3,302**	**3,710**	**4,175**	**4,706**
No District	Limestone	Calvert Bluff	140	153	168	184	202	222
	Navarro	Calvert Bluff	7	7	7	8	8	9
No District Total		**Calvert Bluff**	**147**	**160**	**175**	**192**	**210**	**231**
GMA 12 Total		**Calvert Bluff**	**7,155**	**9,249**	**10,959**	**12,728**	**14,565**	**16,446**

** Fayette County GCD values are for all of Fayette County.*

TABLE 8 **MODELED AVAILABLE GROUNDWATER FOR THE SIMSBORO FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.**

Groundwater Conservation District (GCD)	County	Aquifer	2020	2030	2040	2050	2060	2070
Brazos Valley GCD	Brazos	Simsboro	37,282	42,709	48,137	53,565	58,993	64,421
	Robertson	Simsboro	38,219	47,140	56,061	64,982	73,903	82,824
Brazos Valley GCD Total		**Simsboro**	**75,501**	**89,849**	**104,198**	**118,547**	**132,896**	**147,245**
Lost Pines GCD	Bastrop	Simsboro	16,424	38,836	41,484	43,946	46,429	48,977
	Lee	Simsboro	3,940	26,406	27,620	28,836	30,052	30,968
Lost Pines GCD Total		**Simsboro**	**20,364**	**65,242**	**69,104**	**72,782**	**76,481**	**79,945**
Mid-East Texas GCD	Freestone	Simsboro	2,843	3,371	3,900	4,429	4,958	5,434
	Leon	Simsboro	733	876	1,020	1,163	1,307	1,436
	Madison	Simsboro	0	0	0	0	0	0
Mid-East Texas GCD Total		**Simsboro**	**3,576**	**4,247**	**4,920**	**5,592**	**6,265**	**6,870**
Post Oak Savannah GCD	Burleson	Simsboro	27,267	39,656	48,662	52,267	52,273	52,278
	Milam	Simsboro	2,686	25,883	26,170	26,475	26,798	27,144
Post Oak Savannah GCD Total		**Simsboro**	**29,953**	**65,539**	**74,832**	**78,742**	**79,071**	**79,422**
No District	Falls	Simsboro	10	11	12	14	15	17
	Limestone	Simsboro	555	612	676	746	824	910
	Navarro	Simsboro	11	12	13	14	15	16
	Williamson	Simsboro	19	21	23	25	28	31
No District Total		**Simsboro**	**595**	**656**	**724**	**799**	**882**	**974**
GMA 12 Total		**Simsboro**	**129,989**	**225,533**	**253,778**	**276,462**	**295,595**	**314,456**

** Fayette County GCD values are for all of Fayette County.*

TABLE 9 **MODELED AVAILABLE GROUNDWATER FOR THE HOOPER FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.**

Groundwater Conservation District (GCD)	County	Aquifer	2020	2030	2040	2050	2060	2070
Brazos Valley GCD	Brazos	Hooper	0	0	0	0	0	0
	Robertson	Hooper	798	1,066	1,334	1,603	1,871	2,139
Brazos Valley GCD Total		**Hooper**	**798**	**1,066**	**1,334**	**1,603**	**1,871**	**2,139**
Lost Pines GCD	Bastrop	Hooper	1,664	1,957	2,259	2,572	2,897	3,234
	Lee	Hooper	27	30	32	35	40	44
Lost Pines GCD Total		**Hooper**	**1,691**	**1,987**	**2,291**	**2,607**	**2,937**	**3,278**
Mid-East Texas GCD	Freestone	Hooper	2,642	3,140	3,639	4,138	4,637	5,085
	Leon	Hooper	85	102	118	135	152	167
	Madison	Hooper	0	0	0	0	0	0
Mid-East Texas GCD Total		**Hooper**	**2,727**	**3,242**	**3,757**	**4,273**	**4,789**	**5,252**
Post Oak Savannah GCD	Burleson	Hooper	25	27	30	32	35	37
	Milam	Hooper	1,781	1,999	2,234	2,491	2,774	3,089
Post Oak Savannah GCD Total		**Hooper**	**1,806**	**2,026**	**2,264**	**2,523**	**2,809**	**3,126**
No District	Falls	Hooper	31	35	38	42	47	52
	Limestone	Hooper	176	195	215	238	262	290
	Navarro	Hooper	79	86	94	103	113	124
	Williamson	Hooper	108	119	132	146	161	177
No District Total		**Hooper**	**394**	**435**	**479**	**529**	**583**	**643**
GMA 12 Total		**Hooper**	**7,416**	**8,756**	**10,125**	**11,535**	**12,989**	**14,438**

** Fayette County GCD values are for all of Fayette County.*

TABLE 10 **MODELED AVAILABLE GROUNDWATER FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.**

Groundwater Conservation District (GCD)	County	Aquifer	2020	2030	2040	2050	2060	2070
Brazos Valley GCD	Brazos	Yegua-Jackson	4,207	6,270	7,092	7,091	7,091	7,091
Brazos Valley GCD Total		**Yegua-Jackson**	**4,207**	**6,270**	**7,092**	**7,091**	**7,091**	**7,091**
Fayette County GCD	Fayette	Yegua-Jackson	9,984	9,984	9,984	9,983	9,983	9,983
Fayette County GCD Total*		**Yegua-Jackson**	**9,984**	**9,984**	**9,984**	**9,983**	**9,983**	**9,983**
Mid-East Texas GCD	Leon	Yegua-Jackson	0	0	0	0	0	0
	Madison	Yegua-Jackson	1,122	1,122	1,122	1,122	1,122	1,122
Mid-East Texas GCD Total		**Yegua-Jackson**	**1,122**	**1,122**	**1,122**	**1,122**	**1,122**	**1,122**
Post Oak Savannah GCD	Burleson	Yegua-Jackson	1,094	5,315	7,004	7,004	7,000	6,058
Post Oak Savannah GCD Total		**Yegua-Jackson**	**1,094**	**5,315**	**7,004**	**7,004**	**7,000**	**6,058**
GMA 12 Total		**Yegua-Jackson**	**16,407**	**22,691**	**25,202**	**25,200**	**25,196**	**24,254**

** Fayette County GCD values are for all of Fayette County.*

TABLE 11 **MODELED AVAILABLE GROUNDWATER FOR BRAZOS RIVER ALLUVIUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR. GCD = GROUNDWATER CONSERVATION DISTRICT.**

GCD	County	Aquifer	2020	2030	2040	2050	2060	2070
Brazos Valley GCD	Brazos	Brazos River Alluvium	77,816	76,978	76,393	76,195	76,100	76,039
	Robertson	Brazos River Alluvium	55,907	55,424	55,157	54,839	54,723	54,618
Post Oak Savannah GCD	Burleson	Brazos River Alluvium	32,222	32,207	32,207	32,206	32,206	32,206
	Milam	Brazos River Alluvium	31,412	31,375	31,366	31,362	31,359	31,358
Total			**197,357**	**195,984**	**195,123**	**194,602**	**194,388**	**194,221**

TABLE 12 **MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE SPARTA AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WAER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.**

County	RWPA	River Basin	Aquifer	2030	2040	2050	2060	2070
Bastrop	K	Brazos	Sparta	60	71	86	103	125
		Colorado	Sparta	370	450	547	672	830
		Guadalupe	Sparta	7	8	11	13	17
Brazos	G	Brazos	Sparta	6,014	7,545	9,076	10,607	12,138
Burleson	G	Brazos	Sparta	2,840	3,131	3,437	3,760	4,105
Fayette*	K	Colorado	Sparta	1,618	1,617	1,617	1,640	1,657
		Guadalupe	Sparta	1,161	1,166	1,179	1,188	1,196
		Lavaca	Sparta	0	0	0	0	0
Lee	G	Brazos	Sparta	694	833	1,003	1,212	1,472
		Colorado	Sparta	115	142	178	222	279
Leon	H	Brazos	Sparta	97	97	97	97	97
		Trinity	Sparta	151	152	154	156	157
Madison	H	Brazos	Sparta	238	277	316	355	390
		Trinity	Sparta	1,662	1,934	2,207	2,479	2,725
Robertson	G	Brazos	Sparta	338	509	680	851	1,022
GMA 12 Total			**Sparta**	**15,365**	**17,932**	**20,588**	**23,355**	**26,210**

** Fayette County GCD values are for all of Fayette County.*

TABLE 13 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE QUEEN CITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.

County	RWPA	River Basin	Aquifer	2030	2040	2050	2060	2070
Bastrop	K	Brazos	Queen City	45	49	54	60	66
		Colorado	Queen City	410	453	500	552	610
		Guadalupe	Queen City	64	71	78	86	95
Brazos	G	Brazos	Queen City	245	357	469	582	694
Burleson	G	Brazos	Queen City	3,090	3,467	3,883	4,344	4,863
Fayette*	K	Colorado	Queen City	1,879	1,891	1,905	1,919	1,935
		Guadalupe	Queen City	836	846	856	867	878
		Lavaca	Queen City	0	0	0	0	0
Freestone	C	Trinity	Queen City	77	77	77	77	77
Lee	G	Brazos	Queen City	601	656	717	783	854
		Colorado	Queen City	99	111	122	134	146
Leon	H	Brazos	Queen City	408	451	493	536	575
		Trinity	Queen City	511	516	521	527	531
Madison	H	Brazos	Queen City	132	154	175	197	216
		Trinity	Queen City	132	154	176	197	217
Milam	G	Brazos	Queen City	1,348	1,643	2,003	2,441	2,976
Robertson	G	Brazos	Queen City	144	252	359	467	575
GMA 12 Total			**Queen City**	**10,021**	**11,148**	**12,388**	**13,769**	**15,308**

** Fayette County GCD values are for all of Fayette County.*

TABLE 14 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE CARRIZO FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.

County	RWPA	River Basin	Aquifer	2030	2040	2050	2060	2070
Bastrop	K	Brazos	Carrizo	189	241	314	417	565
		Colorado	Carrizo	3,000	3,853	4,815	5,937	7,289
		Guadalupe	Carrizo	262	322	404	519	680
Brazos	G	Brazos	Carrizo	1,444	2,023	2,603	3,183	3,763
Burleson	G	Brazos	Carrizo	16,656	16,806	16,956	17,108	17,261
Fayette*	K	Colorado	Carrizo	4,875	4,875	4,875	4,875	4,875
		Guadalupe	Carrizo	280	280	280	280	280
		Lavaca	Carrizo	0	0	0	0	0
Freestone	C	Trinity	Carrizo	79	79	79	79	79
Lee	G	Brazos	Carrizo	1,680	1,942	2,269	2,690	3,246
		Colorado	Carrizo	772	879	986	1,093	1,200
Leon	H	Brazos	Carrizo	1,258	1,457	1,656	1,855	2,035
		Trinity	Carrizo	5,138	5,978	6,818	7,659	8,415
Madison	H	Brazos	Carrizo	0	0	0	0	0
		Trinity	Carrizo	0	0	0	0	0
Milam	G	Brazos	Carrizo	607	680	759	847	945
Robertson	G	Brazos	Carrizo	412	743	1,074	1,405	1,736
GMA 12 Total			**Carrizo**	**36,652**	**40,158**	**43,888**	**47,947**	**52,369**

** Fayette County GCD values are for all of Fayette County.*

TABLE 15 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE CALVERT BLUFF FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.

County	RWPA	River Basin	Aquifer	2030	2040	2050	2060	2070
Bastrop	K	Brazos	Calvert Bluff	29	32	36	40	44
		Colorado	Calvert Bluff	2,390	2,978	3,573	4,177	4,790
		Guadalupe	Calvert Bluff	0	0	0	0	0
Brazos	G	Brazos	Calvert Bluff	0	0	0	0	0
Burleson	G	Brazos	Calvert Bluff	129	140	152	163	174
Freestone	C	Brazos	Calvert Bluff	100	101	103	104	105
		Trinity	Calvert Bluff	513	536	558	581	601
Lee	G	Brazos	Calvert Bluff	395	475	557	642	729
		Colorado	Calvert Bluff	0	0	0	0	0
Leon	H	Brazos	Calvert Bluff	806	925	1,044	1,163	1,270
		Trinity	Calvert Bluff	1,370	1,594	1,819	2,043	2,245
Limestone	G	Brazos	Calvert Bluff	153	168	184	202	222
Madison	H	Brazos	Calvert Bluff	0	0	0	0	0
		Trinity	Calvert Bluff	0	0	0	0	0
Milam	G	Brazos	Calvert Bluff	2,811	3,162	3,558	4,012	4,532
Navarro	C	Trinity	Calvert Bluff	7	7	8	8	9
Robertson	G	Brazos	Calvert Bluff	546	841	1,136	1,430	1,725
GMA 12 Total			**Calvert Bluff**	**9,249**	**10,959**	**12,728**	**14,565**	**16,446**

TABLE 16 **MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE SIMSBORO FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.**

County	RWPA	River Basin	Aquifer	2030	2040	2050	2060	2070
Bastrop	K	Brazos	Simsboro	9,215	9,327	9,439	9,552	9,664
		Colorado	Simsboro	29,621	32,157	34,507	36,877	39,313
		Guadalupe	Simsboro	0	0	0	0	0
Brazos	G	Brazos	Simsboro	42,709	48,137	53,565	58,993	64,421
Burleson	G	Brazos	Simsboro	39,656	48,662	52,267	52,273	52,278
Falls	G	Brazos	Simsboro	11	12	14	15	17
Freestone	C	Brazos	Simsboro	461	525	589	653	710
		Trinity	Simsboro	2,910	3,375	3,840	4,305	4,724
Lee	G	Brazos	Simsboro	26,405	27,619	28,835	30,051	30,967
		Colorado	Simsboro	1	1	1	1	1
Leon	H	Brazos	Simsboro	519	604	689	774	850
		Trinity	Simsboro	357	416	474	533	586
Limestone	G	Brazos	Simsboro	612	676	746	824	910
Madison	H	Brazos	Simsboro	0	0	0	0	0
		Trinity	Simsboro	0	0	0	0	0
Milam	G	Brazos	Simsboro	25,883	26,170	26,475	26,798	27,144
Navarro	C	Trinity	Simsboro	12	13	14	15	16
Robertson	G	Brazos	Simsboro	47,140	56,061	64,982	73,903	82,824
Williamson	G	Brazos	Simsboro	21	23	25	28	31
GMA 12 Total			**Simsboro**	**225,533**	**253,778**	**276,462**	**295,595**	**314,456**

TABLE 17 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE HOOPER FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.

County	RWPA	River Basin	Aquifer	2030	2040	2050	2060	2070
Bastrop	K	Brazos	Hooper	0	0	0	0	0
		Colorado	Hooper	1,957	2,259	2,572	2,897	3,234
		Guadalupe	Hooper	0	0	0	0	0
Brazos	G	Brazos	Hooper	0	0	0	0	0
Burleson	G	Brazos	Hooper	27	30	32	35	37
Falls	G	Brazos	Hooper	35	38	42	47	52
Freestone	C	Brazos	Hooper	696	806	917	1,027	1,126
		Trinity	Hooper	2,444	2,833	3,221	3,610	3,959
Lee	G	Brazos	Hooper	18	19	21	24	26
		Colorado	Hooper	12	13	14	16	18
Leon	H	Brazos	Hooper	0	0	0	0	0
		Trinity	Hooper	102	118	135	152	167
Limestone	G	Brazos	Hooper	190	210	232	256	283
		Trinity	Hooper	5	5	6	6	7
Madison	H	Brazos	Hooper	0	0	0	0	0
		Trinity	Hooper	0	0	0	0	0
Milam	G	Brazos	Hooper	1,999	2,234	2,491	2,774	3,089
Navarro	C	Trinity	Hooper	86	94	103	113	124
Robertson	G	Brazos	Hooper	1,066	1,334	1,603	1,871	2,139
Williamson	G	Brazos	Hooper	118	130	144	159	175
		Colorado	Hooper	1	2	2	2	2
GMA 12 Total			**Hooper**	**8,756**	**10,125**	**11,535**	**12,989**	**14,438**

TABLE 18 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.

County	RWPA	River Basin	Aquifer	2030	2040	2050	2060	2070
Brazos	G	Brazos	Yegua-Jackson	6,270	7,092	7,091	7,091	7,091
Burleson	G	Brazos	Yegua-Jackson	5,315	7,004	7,004	7,000	6,058
Fayette*	K	Colorado	Yegua-Jackson	7,644	7,644	7,643	7,643	7,643
		Guadalupe	Yegua-Jackson	727	727	727	727	727
		Lavaca	Yegua-Jackson	1,613	1,613	1,613	1,613	1,613
Leon	H	Trinity	Yegua-Jackson	0	0	0	0	0
Madison	H	Brazos	Yegua-Jackson	11	11	11	11	11
		Trinity	Yegua-Jackson	1,111	1,111	1,111	1,111	1,111
GMA 12 Total			**Yegua-Jackson**	**22,691**	**25,202**	**25,200**	**25,196**	**24,254**

** Fayette County GCD values are for all of Fayette County.*

TABLE 19 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE BRAZOS RIVER ALLUVIUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.

County	RWPA	River Basin	Aquifer	2030	2040	2050	2060	2070
Brazos	G	Brazos	Brazos River Alluvium	76,978	76,393	76,195	76,100	76,039
Burleson	G	Brazos	Brazos River Alluvium	32,207	32,207	32,206	32,206	32,206
Milam	G	Brazos	Brazos River Alluvium	31,375	31,366	31,362	31,359	31,358
Robertson	G	Brazos	Brazos River Alluvium	55,424	55,157	54,839	54,723	54,618
GMA 12 Total			**Brazos River Alluvium**	**195,984**	**195,123**	**194,602**	**194,388**	**194,221**

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 A

Summary of Groundwater Management Area 12 Response to the TWDB's Review of the Desired Future Condition Deliverable

After reviewing the initial Groundwater Management Area 12 submittal, the TWDB sent an email on April 21, 2022, requesting clarifications on the desired future condition definitions. In response, Groundwater Management Area 12 consultants produced two memorandums dated May 5, 2022, that were presented and approved at the May 6, 2022, Groundwater Management Area 12 meeting. One memo provides the responses to the TWDB clarifications and is reproduced in Figure A1. Numbered entries represent the TWDB clarification questions and the entries beginning in "RESPONSE:" represent Groundwater Management Area 12's responses. This document is also available on the Post Oak Savannah Groundwater Conservation district website. The second memo provides a non-relevant statement for the Calvert Bluff Aquifer that was missing in the original submittal package (see Clarification #1 under Carrizo-Wilcox, Queen City, and Sparta aquifers). This document is not reproduced here.

Memorandum

To: Texas Water Development Board

From: GMA 12

Date: May 5, 2022

Subject: Items to address prior to calculating DFCs

GMA 12 has reviewed the email from the TWDB dated April, 21, 2022 regarding items that need to be addressed before calculating modeled available groundwater. The following is a summary of these items and GMA 12's response to them.

Carrizo-Wilcox, Queen City, and Sparta aquifers

1) Our analysis does not achieve the DFC for the Calvert Bluff Aquifer in Williamson County. There is only one active model cell for this aquifer in Williamson County and the cell goes dry around 2065 in the DFC predictive model. We suggest declaring the Calvert Bluff Aquifer as non-relevant in Williamson County. Please consider declaring the Calvert Bluff Aquifer non-relevant in Williamson County or provide additional information for our DFC analysis.

RESPONSE: GMA 12 will declare the Calvert Bluff Aquifer non-relevant in Williamson County at a GMA meeting on May 6, 2022. A memorandum providing the required documentation for this declaration will be submitted to the TWDB.

2) Please confirm that the DFCs for the Carrizo-Wilcox are calculated using a cell count averaging method, rather than an area-weighted averaging method.
   a. If a cell count averaging method is used, the current DFC error tolerance of 10% is good enough to make all DFCs compliant with our calculation, except the Calvert Bluff Aquifer in Williamson County (See Note #1 above).
   b. If an area-weighted averaging method is used, we recommend clarifying a tolerance of 11% for the GMA-wide Simsboro Aquifer DFC in order to be compliant with our calculation.

RESPONSE: GMA 12 uses an area-weighted averaging method. However, GMA 12 did not adopt a GMA-wide DFC for any of these aquifers. GMA-wide averages were erroneously included in the DFC summary tables in the Explanatory Report. The GMA 12 DFC resolution, dated November 30, 2022 and for which the Explanatory Report was submitted in support of, does not contain any GMA-wide DFCs. Therefore, no tolerance changes are needed to be compliant with TWDB calculations other than the declaration of the Calvert Bluff in Williamson County as a non-relevant aquifer

Yegua-Jackson Aquifer

1) Please confirm that the reference time period for the Yegua-Jackson Aquifer DFCs only goes to the end of December 2069 (stress period 99), even though the predictive model goes to December 2070 (stress period 100).

RESPONSE: The Yegua-Jackson DFCs are specified as from January 2010 (the end of Stress Period 39) through December 2069 (the end of Stress Period 99), for a total of 60 years.

2) Since there are no monthly stress periods, please confirm that the baseline year of "January 2010" refers to the end of 2009/beginning of January 2010 (stress period 39), rather than the end of 2010 (stress period 40).

RESPONSE: That is correct. The beginning of the GMA 12 predictive model runs is Stress Period 40, so the baseline year is the end of Stress Period 39.

Figure A1. Response Memorandum from Groundwater Management Area 12 to clarifications requested from the Texas Water Development Board.

3) Our analysis results in a 1-foot difference in the GMA-wide DFC for the Yegua-Jackson Aquifer. We recommend clarifying a tolerance of 1 foot for the GMA-wide Yegua-Jackson DFC in order to be compliant with the TWDB-calculated value.

RESPONSE: As with the Carrizo-Wilcox Aquifer, GMA 12 did not adopt a GMA-wide DFC for the Yegua-Jackson Aquifer. GMA averages were erroneously included in the DFC summary tables in the Explanatory Report. The actual GMA 12 DFC resolution, dated November 30, 2022 and for which the Explanatory Report was submitted in support of, does not contain any GMA-wide DFCs. Therefore, no tolerance changes are needed to be compliant with TWDB for the Yegua-Jackson Aquifer.

Brazos River Alluvium Aquifer

1) Please confirm that the reference time period for the Brazos River Alluvium Aquifer DFCs only goes to the end of December 2069 (stress period 484), even though the predictive model goes to the end of 2070 (stress period 485).

RESPONSE: The reference time period for the BRAA DFCs only extents to the end of December 2069 (Stress Period 484).

2) Since there are no monthly stress periods in 2013, please confirm that the Brazos Valley GCD baseline of "January 2013" refers to the end of 2012/beginning of January 2013 (stress period 427), rather than the end of 2013 (stress period 428).

RESPONSE: The baseline "January 2013" refers to the end of 2012/beginning of January 2013 (Stress Period 427).

3) Since there are monthly stress periods in 2010, please clarify whether the Post Oak Savannah GCD baseline of "January 2010" refers to the end of 2009/beginning of January 2010 (stress period 391) or the end of January 2010 (stress period 392).

RESPONSE: The baseline "January 2010" refers to the end of 2009/beginning of January 2010 (Stress Period 391).

4) For Brazos Valley GCD, please clarify how average percent saturation was defined by GMA 12. Is the average of only the final stress period (2069) or the average over the entire period from 2013 through 2069?

RESPONSE: The average percent saturation is for the final stress period (2069) and not for the entire period from 2013 through 2069.

5) The drawdown values calculated using the official TWDB grid shapefile and TWDB methodology are not compliant with the provided GMA 12 county-specific DFCs in the Brazos River Alluvium Aquifer. We recommend adopting the tolerances listed below in order to be compliant with the TWDB methodology. Alternatively, please provide the detailed methodology and zoned grid shapefile used to define the GMA 12 county-specific DFCs in the Brazos River Alluvium Aquifer, as these are not provided in the explanatory report or accompanying files:
   a. For Brazos Valley GCD, we suggest replacing the current tolerance of "1 foot or 5 percent (whichever was greater)" with "10% of total well depth" as the error tolerance for the DFC evaluation of the percent saturation. This will make the DFC compliant with our calculation regardless how the percent saturation is calculated (see Note #4 above).
   b. For Post Oak Savannah GCD, we suggest replacing the current tolerance of "1 foot or 5 percent (whichever was greater)" with "3 feet or 10 percent (whichever is greater)" as the error tolerance for the DFC evaluation of the decrease in average saturated thickness. This modification will make the DFC compliant with our calculation regardless of which baseline year is used (see Note #3 above).

RESPONSE: GMA 12 will adopt tolerances for the DFC evaluation of the percent saturation for the Brazos River Alluvium Aquifer as proposed by the TWDB.

Figure A1 (Cont). **Response Memorandum from Groundwater Management Area 12 to clarifications requested from the Texas Water Development Board.**