GTA Aquifer Assessment 10-20 MAG

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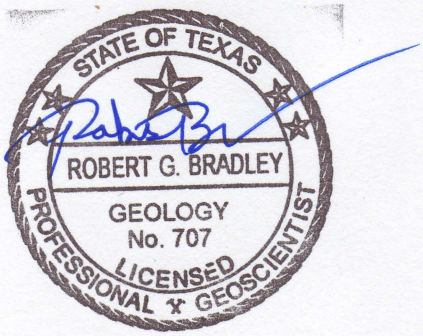

Robert G. Bradley, P.G. 707, authorized the seal appearing on this document on July 9, 2012.

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EXECUTIVE SUMMARY:

The estimated modeled available groundwater from Brazos River Alluvium Aquifer that achieves the desired future condition adopted by members of Groundwater Management Area 12 is approximately 25,138 acre-feet per year and is summarized by county, regional water planning area, and river basin as shown in Table 3. The estimated modeled available groundwater for the Post Oak Savannah Conservation District in Groundwater Management Area 12 for the aquifer is 25,138 acre-feet per year between 2010 and 2060 and is shown in Table 4.

REQUESTOR:

Mr. Gary Westbrook, of the Post Oak Savannah Groundwater Conservation (GCD) acting on behalf of the member groundwater conservation districts of Groundwater Management Area 12.

DESCRIPTION OF REQUEST:

In a letter dated August 12, 2010, Mr. Westbrook provided the Texas Water Development Board (TWDB) with the desired future condition of the Brazos River Alluvium Aquifer within the Post Oak Savannah Groundwater Conservation District (Figure 1) adopted by the members of Groundwater Management Area 12. The desired future condition for the Brazos River Alluvium Aquifer, as described in a resolution and adopted August 11, 2010 by the groundwater conservation districts in Groundwater Management Area 12 is described below:

- Milam County: A decrease of 5 ft in the average saturated thickness over the period from 2010 to 2060. The baseline average saturated thickness for 2010 is estimated at 24.5 feet and is based on an analysis of historical water level data and well depth values.

- Burleson County: A decrease of 6 ft in the average saturated thickness over the period from 2010 to 2060. The baseline average saturated thickness for 2010 is estimated at 38.5 feet and is based on an analysis of historical water level data and well depth values.

- The GMA adopted that the portion of the Brazos River Alluvium Aquifer in the Brazos Valley Groundwater Conservation District (Brazos and Robertson counties) as not relevant at this time for purposes of joint planning.

In response to receiving the adopted desired future condition, TWDB has estimated the modeled available groundwater that achieves the above desired future condition for Groundwater Management Area 12.

METHODS:

A transient hydrologic budget for the saturated portion of an aquifer is described by Freeze and Cherry (1979, p.365):

$$Q(t) = R(t) - D(t) + \frac{dS}{dt}$$

where Q(t)= total rate of groundwater withdrawal
R(t)= total rate of groundwater recharge to the basin
D(t)= total rate of groundwater discharge from the basin
$\frac{dS}{dt}$ = rate of change of storage in the saturated zone of the basin

For this analysis, it is assumed that

$$R(t) = R(r) + R(e)$$

where R(r) = rejected recharge for the basin
R(e) = effective recharge

Effective recharge is the amount of water that enters an aquifer and is available for development (Muller and Price, 1979, p. 5). Rejected recharge is the amount of total (or potential) recharge that discharges from an aquifer because it is overfull and cannot accept more water (Theis, 1940, p. 1).

In addition, it is assumed that

$$R(r) \cong D(t)$$

Therefore, the total rate of groundwater withdrawal equals effective recharge plus the change in storage of the aquifer, or

$$Q(t) = R(e) + \frac{dS}{dt}$$

County and groundwater conservation district boundaries were used to split the aquifer into map areas (Figure 1). The areal extent of each aquifer map area was calculated.

Annual effective recharge was calculated by multiplying the outcrop area by the average precipitation (1971-2000) and an effective recharge rate of 7.5 percent.

To calculate change in aquifer storage based on the desired future condition map areas were multiplied by the estimated aquifer specific yield and then by a uniform saturated thickness decline of 6 feet in Burleson County and 5 feet in Milam County. These volumes were then divided by 50 years to obtain a yearly volume.

The calculations were completed in a Microsoft Excel worksheet.

The Brazos River Alluvium Aquifer within GMA 12 is located entirely within Regional Water Planning Area G and the Brazos River Basin. A regional map of the area is shown in Figure 2.

PARAMETERS AND ASSUMPTIONS:

- The areas for each subdivision were calculated from the Texas Water Development Board (TWDB) shapefile for the Brazos River Alluvium, projected into the GAM projection (Anaya, 2001).
- Areas, in acres, were calculated within ArcGIS 9.2.
- Average annual precipitation was used to calculate recharge volumes.
- The average annual precipitation for the aquifer area was determined from the Texas Climatic Atlas (Narasimhan and others, 2008).
- Average annual precipitation was estimated to be 40 inches for Burleson County and 37 inches for Milam County (Table 1).
- Recharge from precipitation is estimated to be 7.5 percent of annual precipitation (Cronin and Wilson, 1967).
- There is sufficient saturated thickness to achieve the desired future condition based on available data (TWDB, 2010; Shaw and Houston, 2007).
- Annual volumes are calculated by dividing the total volume by 50 years.
- Annual modeled available groundwater estimates are calculated by adding the annual volume to the recharge volume.
- Specific yield of the aquifer is estimated to be 0.15 (Cronin and Wilson, 1967, pp.2, 27).

Table 1. Estimated total annual effective recharge volume for the Brazos River Alluvium Aquifer by map area (see Figure 1).

GMA	Aquifer	County	Groundwater Conservation District	Map Area	Areal extent (acres)	Estimated average annual precipitation (inches)	Estimated average annual precipitation (feet)	Effective recharge rate (percent)	Estimated annual effective recharge (ac-ft/yr)
12	Brazos River Alluvium	Burleson	Post Oak Savannah	1	83,073	40	3.3	7.5	20,561
12	Brazos River Alluvium	Milam	Post Oak Savannah	2	12,450	37	3.1	7.5	2,895
								Total	**23,456**

GMA = groundwater management area ac-ft/yr = acre-feet per year

The formula for this table is: areal extent (acres) * estimated average annual precipitation (feet) * effective recharge rate = estimated annual effective recharge (ac-ft/yr).

MODELED AVAILABLE GROUNDWATER AND PERMITTING:

As defined in Chapter 36 of the Texas Water Code, “modeled available groundwater” is the estimated average amount of water that may be produced annually to achieve a desired future condition. This is distinct from “managed available groundwater,” shown in the draft version of this report dated January 5, 2011, which was a permitting value and accounted for the estimated use of the aquifer exempt from permitting. This change was made to reflect changes in statute by the 82nd Texas Legislature, effective September 1, 2011. The previous version of this report was completed prior to the readopting of the desired future conditions.

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. The estimated amount of pumping exempt from permitting, which the Texas Water Development Board is now required to develop after soliciting input from applicable groundwater conservation districts, will be provided in a separate report.

RESULTS:

The estimated modeled available groundwater from the Brazos River Alluvium Aquifer in Groundwater Management Area 12 that achieves the adopted desired future condition is approximately 25,138 acre-feet per year. The volumetric calculations to determine the modeled available groundwater are shown in Table 2.

This pumping has been divided by county, regional water planning area, and river basin for each decade between 2010 and 2060 for use in the regional water

planning process (Table 3). The modeled available groundwater for the Post Oak Savannah GCD is shown in Table 4).

Table 2. Volumetric calculations estimating the annual modeled available groundwater for the Brazos River Alluvium Aquifer in the Post Oak Savannah Groundwater Conservation District summarized by map areas (see Figure 1).

GMA	Aquifer	County	Groundwater Conservation District	Map Areas	Estimated specific yield	Areal extent (acres)	Desired decline in saturated thickness (feet)	Estimated total volume from water level decline (acre-feet)	Estimated annual volume from water level decline (acre-feet)	Estimated annual effective recharge[1] (ac-ft/yr)	Estimated annual total volume (ac-ft/yr)
12	Brazos River Alluvium	Burleson	Post Oak Savannah	1	0.15	83,073	6	74,766	1,495	20,561	22,056
		Milam	Post Oak Savannah	2	0.15	12,450	5	9,338	187	2,895	3,082
									Total	**23,456**	**25,138**

GMA = groundwater management area ac-ft/yr = acre-feet per year

1 - This is the estimated total annual effective recharge volume for the Brazos River Alluvium Aquifer as shown in Table 1.

The formulas for this table are: specific yield * areal extent * desired total decline in saturated thickness = estimated total volume from water level decline/50 = estimated annu volume from water level decline. Estimated annual volume from water level decline + estimated annual effective recharge = estimated annual total volume.

Table 3. Estimated 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 divided by county, regional water planning area, and river basin.

County	Regional Water Planning Area	River Basin	Year					
			2010	2020	2030	2040	2050	2060
Burleson	G	Brazos	22,056	22,056	22,056	22,056	22,056	22,056
Milam	G	Brazos	3,082	3,082	3,082	3,082	3,082	3,082
		Total	25,138	25,138	25,138	25,138	25,138	25,138

Table 4. Estimated modeled available groundwater for the Brazos River Alluvium Aquifer in the Post Oak Savannah Groundwater Conservation District for each decade between 2010 and 2060. Results are in acre-feet per year.

Groundwater Conservation District	Year					
	2010	2020	2030	2040	2050	2060
Post Oak Savannah Groundwater Conservation District	25,138	25,138	25,138	25,138	25,138	25,138

LIMITATIONS:

This analysis assumes homogeneous and isotropic aquifers; however, aquifer conditions may not be uniform. The analysis further assumes that precipitation is the only source of aquifer recharge that lateral inflow to the aquifer is equal to lateral outflow from the aquifer, and that future pumping will not alter this balance.

In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in developing modeled available groundwater estimates. These assumptions need to be considered and compared to actual future data when evaluating achievement of the desired future condition.

Given these limitations, users of this information are cautioned that the modeled available groundwater numbers should not be considered a definitive, permanent description of the amount of groundwater that can be pumped to meet the adopted desired future condition. 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 future groundwater pumping and water levels to know if they are achieving their desired future conditions. Because of the limitations and assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine these modeled available groundwater numbers given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future.

REFERENCES:

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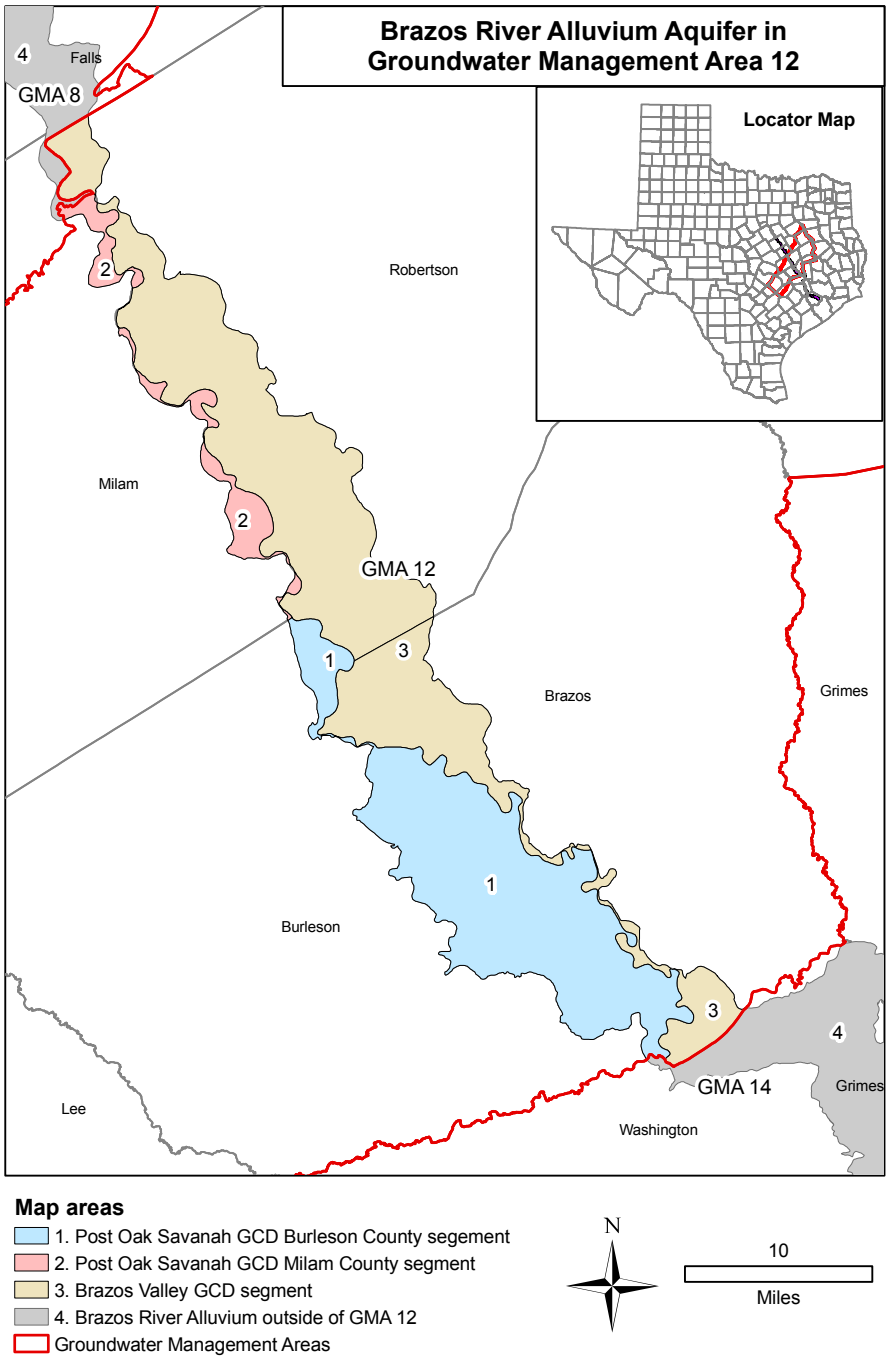

Figure 1. Map showing the map areas for Brazos River Alluvium Aquifer in Groundwater Management Area 12. GCD = Groundwater Conservation District.

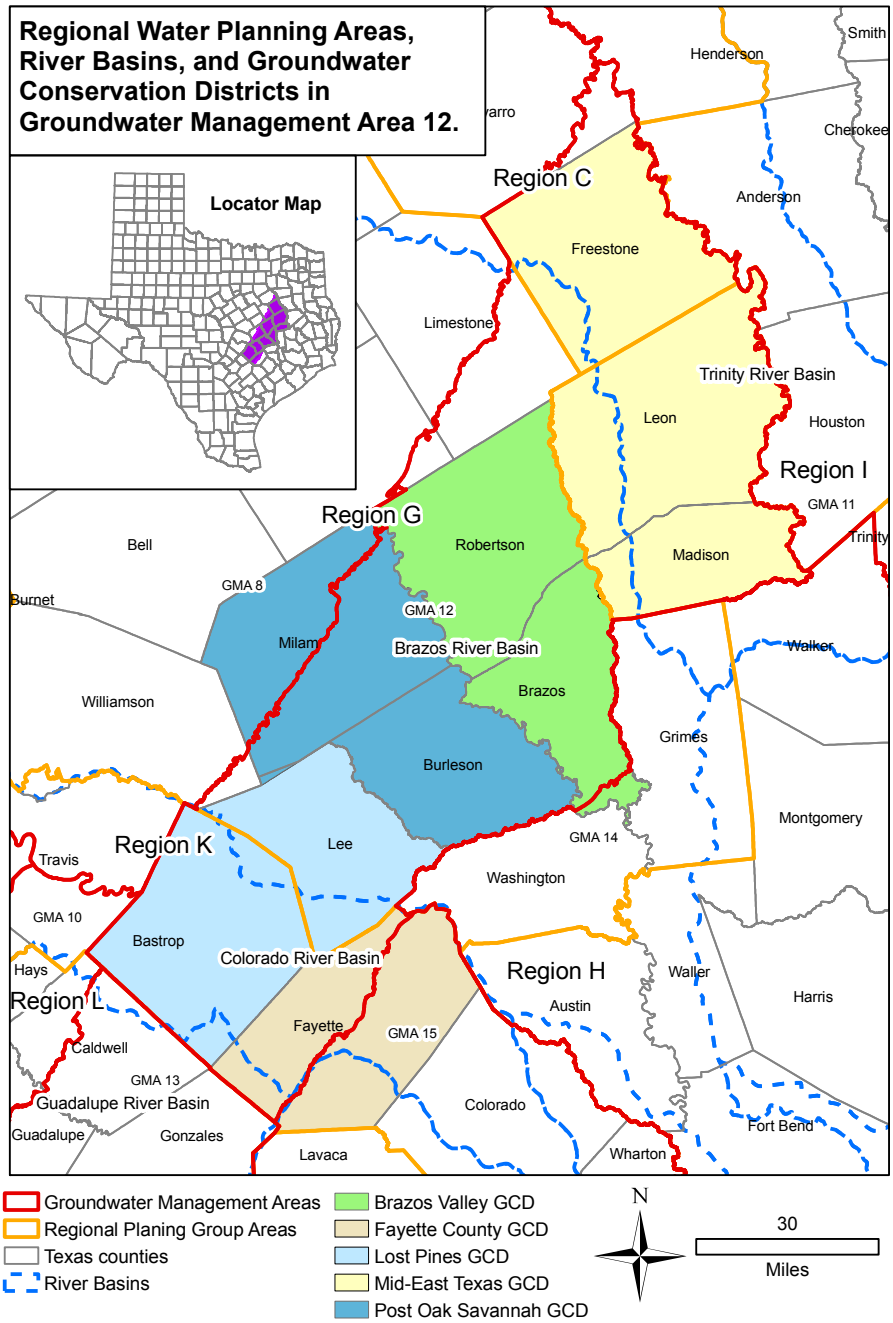

Figure 2. Map showing regional water planning areas, river basins, groundwater conservation districts, and counties in and neighboring the Groundwater Management Area 12. GCD = Groundwater Conservation District