GTA Aquifer Assessment 10-11 MAG

by David Thorkildsen, P.G. and Sarah Backhouse
Texas Water Development Board
Groundwater Technical Assistance Section
(512) 936-0871

David Thorkildsen, P.G. 705 authorized the seal appearing on this document on November 1, 2011.

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EXECUTIVE SUMMARY:

The modeled available groundwater for the Hickory Aquifer as a result of the desired future condition adopted by members of Groundwater Management Area 7 is approximately 25,625 acre-feet per year. This is divided by county, regional water planning area, and river basin in Table 2 for use in the regional water planning process. Modeled available groundwater is summarized by county, regional water planning area, river basin, and groundwater conservation district in tables 3 through 6. Parameters and assumptions to determine modeled available groundwater estimates were extracted from GTA Aquifer Assessments 08-07 and 10-05, which Groundwater Management Area 7 used as the basis for developing a desired future condition stating that "total net decline in water levels within the Hickory UWCD No. 1, Hill Country UWCD, Kimble County GCD and Menard County UWD, Llano County and the unprotected areas in McCulloch and San Saba Counties at the end of the fifty-year period shall not exceed seven (7) feet below 2010 water levels in the aquifer" and that "the Hickory aquifer is not relevant for planning purposes in all other areas of Groundwater Management Area 7".

REQUESTOR:

Mr. Allan Lange of the Lipan-Kickapoo Water Conservation District acting on behalf of the member groundwater conservation districts of Groundwater Management Area 7.

DESCRIPTION OF REQUEST:

In a letter received August 16, 2010, Mr. Allan Lange provided the Texas Water Development Board (TWDB) with the desired future condition of the Hickory Aquifer adopted by the members of Groundwater Management Area 7. The desired future condition for the Hickory Aquifer, as described in Resolution No. 07-29-10-3 and adopted July 29, 2010 by the groundwater conservation districts in Groundwater Management Area 7 is described below:

1) *total net decline in water levels within the Hickory UWCD No. 1, Hill Country UWCD, Kimble County GCD and Menard County UWD, Llano County and the unprotected areas in McCulloch and San Saba Counties at the end of the fifty-year period shall not exceed seven (7) feet below 2010 water levels in the aquifer;*
2) *the Hickory aquifer is not relevant for joint planning purposes in all other areas of GMA 7.*

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 7.

METHODS:

Groundwater Management Area 7, located in the Edwards Plateau area of Texas, includes part of the Hickory Aquifer (Figure 1). At the request of Groundwater Management Area 7 the TWDB previously analyzed several water level decline scenarios for the Hickory Aquifer, documented in GTA Aquifer Assessment 08-07 and GTA Aquifer Assessment 10-05. After reviewing GTA Aquifer Assessment 08-07, Hill Country UWCD and Menard County UWD supplied additional water-level and water use data that were incorporated into GTA Aquifer Assessment 10-05. Since neither of the previous assessments included a 7 feet water level decline scenario, new calculations to determine the modeled available groundwater estimates were completed (Table 1).

To calculate modeled available groundwater consistent with the desired future condition of 7 feet of water level decline, parameters and assumptions for the volumetric and recharge calculations, map areas, and areal extent were obtained from GTA Aquifer Assessment 08-07 (Thorkildsen and Backhouse, 2010) and GTA Aquifer Assessment 10-05 (Bradley, 2010). To calculate change in aquifer storage based on the desired future condition map areas were multiplied by the estimated aquifer storativity and then by a uniform water level decline of 7 feet. These volumes were then divided by 50 years to obtain a yearly volume. In cases where unconfined and confined conditions existed, those were calculated separately.

Modeled available groundwater estimates are divided by county, regional water planning area, river basin, and groundwater conservation district. These areas are shown in Figure 2.

PARAMETERS AND ASSUMPTIONS:

- Parameters, assumptions, volumetric and recharge calculations, and areas were obtained from GTA Aquifer Assessment 08-07 (Thorkildsen and Backhouse, 2010).
- Additional water-level and water use data provide by Hill Country UWCD and Menard County UWD were evaluated in GTA Aquifer Assessment 10-05 (Bradley, 2010).
- Water-level declines of 7 feet were estimated to be uniform across the aquifer.

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 November 18, 2010, 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.

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 for the Hickory Aquifer in Groundwater Management Area 7 consistent with the adopted desired future condition is approximately 25,625 acre-feet per year. The volumetric calculations to determine the estimates are shown in Table 1. Table 2 shows the modeled available groundwater by decade divided by county, regional water planning area, and river basin for use in the regional water planning process.

Modeled available groundwater estimates are also summarized by county, regional water planning area, river basin, and groundwater conservation district and are shown in tables 3, 4, 5, and 6 respectively.

Table 1. Volumetric calculations estimating annual modeled available groundwater for the Hickory Aquifer. Map areas and parameters were obtained from GTA Aquifer Assessment 08-07 (Thorkildsen and Backhouse, 2010) and GTA Aquifer Assessment 10-05 (Bradley, 2010).

GMA	Aquifer	County	GCD	Map Areas	Estimated storage coefficient	Areal extent (acres)	Desired total aquifer water level decline (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)
7	Hickory	Gillespie	Hill Country UWCD	1	0.0001	22,159	7	16	0	0	0
				2	0.0001	594,681	7	416	8	0	8
				3	0.15	9,196	7	9,656	193	1,458	1,651
		Llano	None	4	0.15	39,763	7	41,751	835	1,182	2,017
				5	0.0001	61,617	7	43	1	0	1
		San Saba		6	0.15	3,314	7	3,480	70	239	309
				7	0.0001	289,284	7	202	4	0	4
			Hickory UWCD No. 1	8	0.0001	388,721	7	272	5	0	5
				9	0.15	12,505	7	13,130	263	898	1,161
		McCulloch		10	0.15	12,875	7	13,519	270	6,158	6,428
				11	0.0001	481,896	7	337	7	0	7
			None	12	0.15	1,457	7	1,530	31	684	715
				13	0.0001	176,500	7	124	2	0	2
		Concho	Hickory UWCD No. 1	16	0.0001	64,714	7	45	1	0	1
		Menard		17	0.0001	77,666	7	54	1	0	1
			Menard County UWD	18	0.0001	206,436	7	145	3	1,012	1,015
		Kimble	Kimble County GCD	19	0.0001	433,890	7	304	6	0	6
		Mason	Hickory UWCD No. 1	20	0.0001	20,422	7	14	0	0	0
				21	0.0001	280,610	7	196	4	0	4
				22	0.15	74,827	7	78,568	1,571	10,719	12,290

GMA = groundwater management area GCD = groundwater conservation district UWCD = underground water conservation district
ac-ft/yr = acre-feet per year UWD = underground water district
1 - This is the total groundwater withdrawal (pumping) from GTA Aquifer Assessments 08-07 and 10-05 that resulted in a steady state aquifer condition and was assigned as effective recharge for this calculation.
The formulas for this table are: storage coefficient * areal extent * desired total aquifer water level decline = estimated total volume from water level decline. Estimated total volume from water level decline/50 = estimated annual volume from water level decline. Then estimated annual volume from water level decline + estimated annual effective recharge = estimated annual total volume.

Table 2. Modeled available groundwater by decade for the Hickory Aquifer in Groundwater Management Area 7. Results are in acre-feet per year and are divided by county, regional water planning area, and river basin.

County	Regional Water Planning Area	Basin	Year					
			2010	2020	2030	2040	2050	2060
Concho	F	Colorado	1	1	1	1	1	1
Gillespie	K	Colorado	1,659	1,659	1,659	1,659	1,659	1,659
		Guadalupe	0	0	0	0	0	0
Kimble	F	Colorado	6	6	6	6	6	6
Llano	K	Colorado	2,018	2,018	2,018	2,018	2,018	2,018
Mason	F	Colorado	12,294	12,294	12,294	12,294	12,294	12,294
McCulloch	F	Colorado	7,152	7,152	7,152	7,152	7,152	7,152
Menard	F	Colorado	1,016	1,016	1,016	1,016	1,016	1,016
San Saba	K	Colorado	1,479	1,479	1,479	1,479	1,479	1,479
Total			**25,625**	**25,625**	**25,625**	**25,625**	**25,625**	**25,625**

Table 3. Modeled available groundwater for the Hickory Aquifer summarized by county in Groundwater Management Area 7 for each decade between 2010 and 2060. Results are in acre-feet per year.

County	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Concho	1	1	1	1	1	1
Gillespie	1,659	1,659	1,659	1,659	1,659	1,659
Kimble	6	6	6	6	6	6
Llano	2,018	2,018	2,018	2,018	2,018	2,018
Mason	12,294	12,294	12,294	12,294	12,294	12,294
McCulloch	7,152	7,152	7,152	7,152	7,152	7,152
Menard	1,016	1,016	1,016	1,016	1,016	1,016
San Saba	1,479	1,479	1,479	1,479	1,479	1,479
Total	**25,625**	**25,625**	**25,625**	**25,625**	**25,625**	**25,625**

Table 4. Modeled available groundwater for the Hickory Aquifer summarized by regional water planning area in Groundwater Management Area 7 for each decade between 2010 and 2060. Results are in acre-feet per year.

Regional Water Planning Area	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
F	20,469	20,469	20,469	20,469	20,469	20,469
K	5,156	5,156	5,156	5,156	5,156	5,156
Total	**25,625**	**25,625**	**25,625**	**25,625**	**25,625**	**25,625**

Table 5. Modeled available groundwater for the Hickory Aquifer summarized by river basin in Groundwater Management Area 7 for each decade between 2010 and 2060. Results are in acre-feet per year.

Basin	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Colorado	25,625	25,625	25,625	25,625	25,625	25,625
Guadalupe	0	0	0	0	0	0
Total	**25,625**	**25,625**	**25,625**	**25,625**	**25,625**	**25,625**

Table 6. Modeled available groundwater for the Hickory Aquifer summarized by groundwater conservation district in Groundwater Management Area 7 for each decade between 2010 and 2060. Results are in acre-feet per year.

	Year					
Groundwater Conservation District	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Hickory UWCD No. 1	19,897	19,897	19,897	19,897	19,897	19,897
Hill Country UWCD	1,659	1,659	1,659	1,659	1,659	1,659
Kimble County GCD	6	6	6	6	6	6
Menard County UWD	1,015	1,015	1,015	1,015	1,015	1,015
Total (excluding non-district areas)	**22,577**	**22,577**	**22,577**	**22,577**	**22,577**	**22,577**
No District	3,048	3,048	3,048	3,048	3,048	3,048
Total (including non-district areas)	**25,625**	**25,625**	**25,625**	**25,625**	**25,625**	**25,625**

GCD = Groundwater Conservation District UWD = Underground Water District

UWCD = Underground Water Conservation District

LIMITATIONS:

The water budget in this analysis was determined to be the best method to calculate estimates of modeled available groundwater, however this method has limitations and should be replaced with better tools, including groundwater models and additional data that are not currently available, whenever possible.

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:

Bradley, 2010, GTA Aquifer Assessment 10-05: Texas Water Development Board, GTA Aquifer Assessment Report 10-05 Report, 5 p.

Thorkildsen and Backhouse, 2010, GTA Aquifer Assessment 08-07: Texas Water Development Board, GTA Aquifer Assessment 08-07 Report, 13 p.

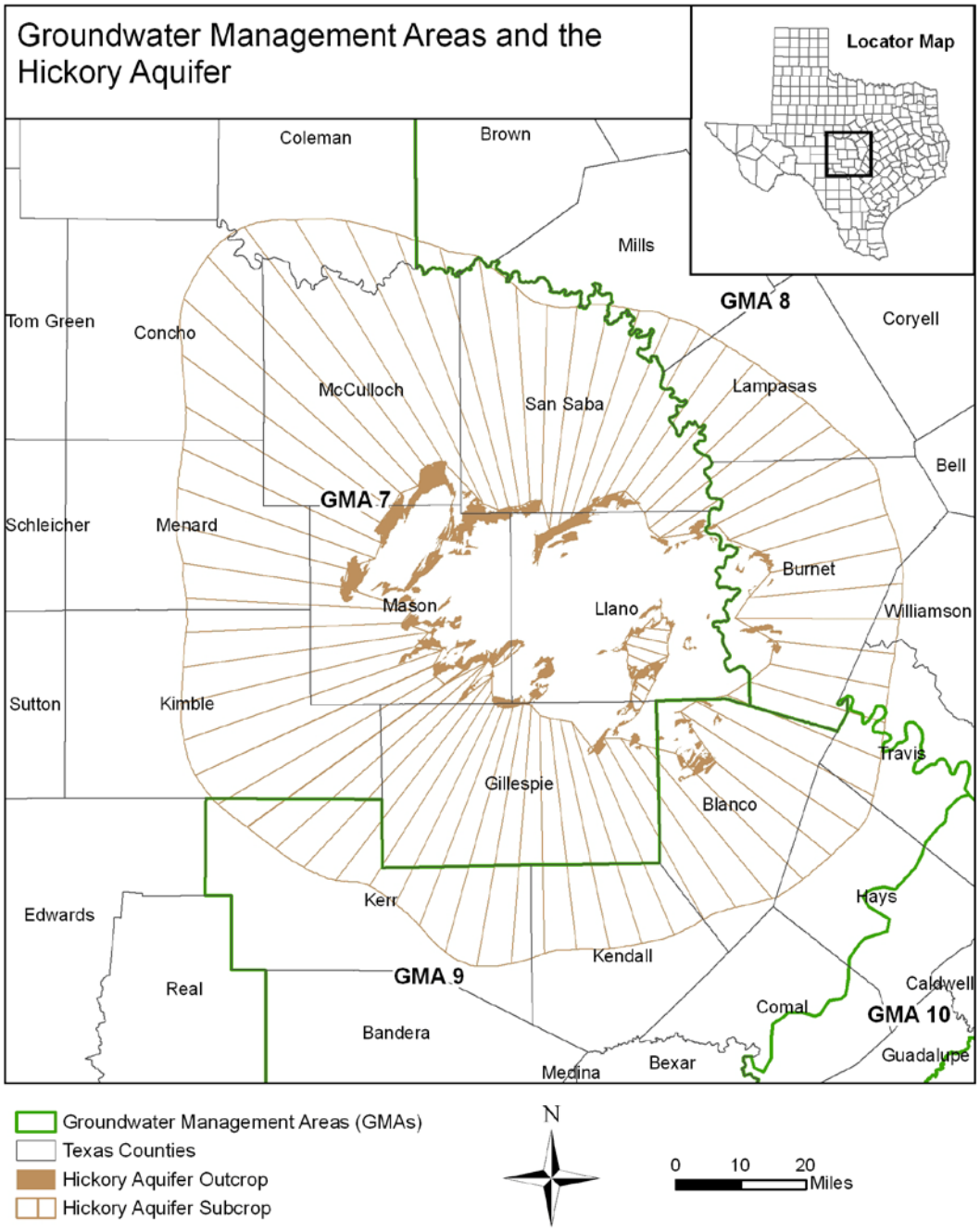

Figure 1. Map showing the areas covered by the Hickory Aquifer.

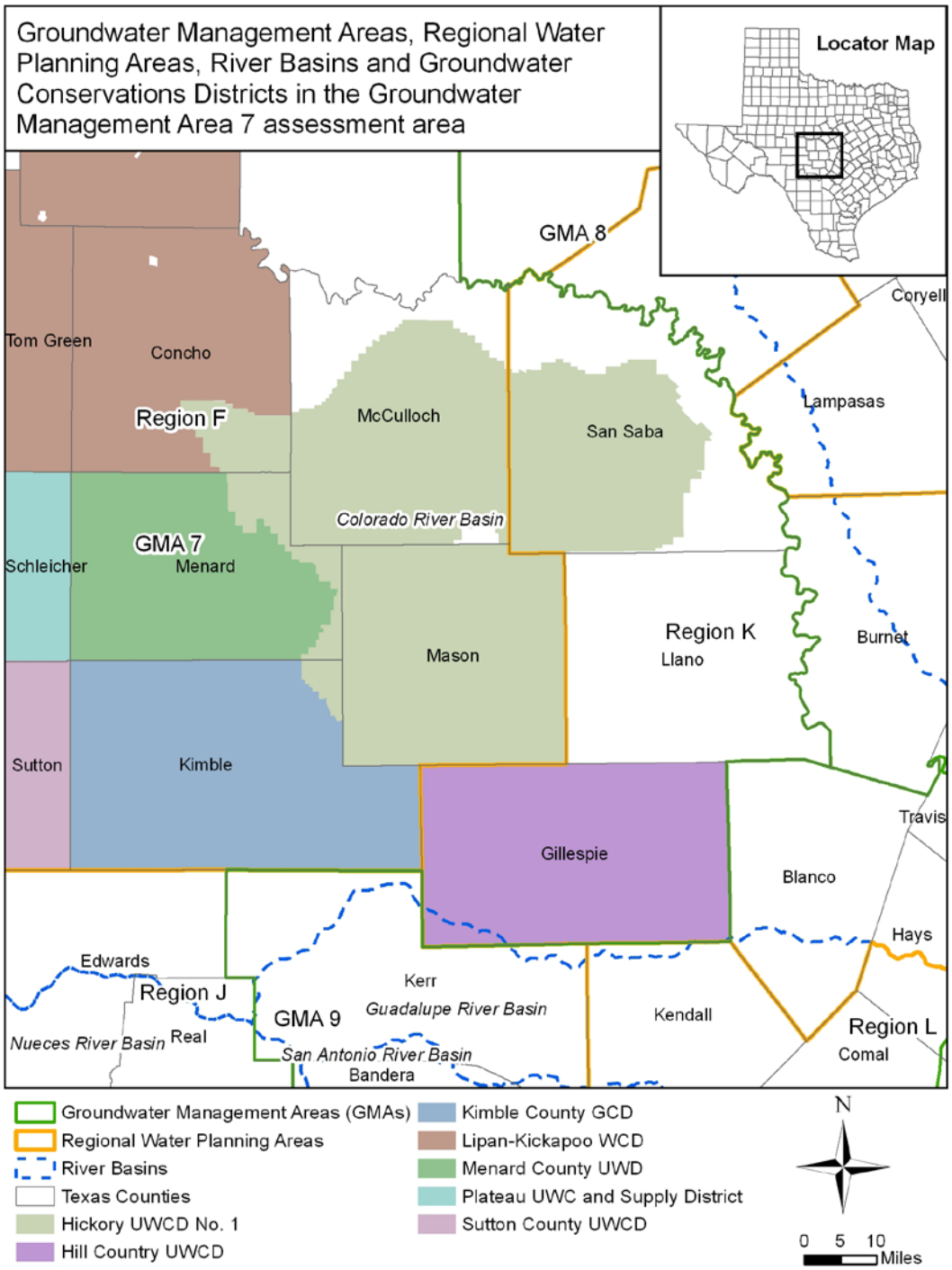

Figure 2. Map showing regional water planning areas, river basins, groundwater conservation districts and counties in and neighboring the Groundwater Management Area 7 assessment area. GCD = Groundwater Conservation District, UWCD = Underground Water Conservation District, WCD = Water Conservation District, UWD = Underground Water District