GAM Run 10-052 MAG Version 2: Model Run for the Carrizo-Wilcox Aquifer in Groundwater Management Area 14

by Jerry Shi, Ph.D.
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-5076
November 18, 2011

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EXECUTIVE SUMMARY:

The modeled available groundwater for the Carrizo-Wilcox Aquifer as a result of the desired future conditions adopted by the members of Groundwater Management Area 14 is approximately 10,400 acre-feet per year. This is shown divided by county, river basin, and regional water planning area in Table 1 for use in the regional water planning process. Modeled available groundwater is also summarized by county, regional water planning area, river basin, and groundwater conservation district in tables 2 through 5. The estimates were developed by iteratively adjusting the modeled pumping rate in each county to match the desired future conditions adopted by the members of Groundwater Management Area 14 between 2010 and 2060.

REQUESTOR:

Mr. Lloyd Behm, General Manager of Bluebonnet Groundwater Conservation District, on behalf of Groundwater Management Area 14

DESCRIPTION OF REQUEST:

In a letter dated August 25, 2010, Mr. Behm provided the Texas Water Development Board (TWDB) with the desired future conditions of the Carrizo-Wilcox Aquifer in Groundwater Management Area 14. The desired future conditions for the Carrizo-Wilcox Aquifer, as shown in Resolution No. 2010-01 and adopted August 25, 2010 by the groundwater conservation districts within Groundwater Management Area 14, are described below:

Grimes County: From estimated 2010 conditions, the average drawdown of the Carrizo Sand Aquifer should not exceed approximately 52.8 feet average drawdown across the area of occurrence of the aquifer.

Walker County: From estimated 2010 conditions, the average drawdown of the Carrizo Sand Aquifer should not exceed approximately 45.7 feet average drawdown across the area of occurrence of the aquifer.

METHODS:

As shown in Figure 1, Groundwater Management Area 14 contains a portion of the Carrizo-Wilcox Aquifer, a major aquifer in Texas as defined in the 2007 State Water Plan (TWDB, 2007). Figure 2 shows the location of the Carrizo-Wilcox Aquifer relative to regional water planning areas, river basins, and groundwater conservation districts.

The groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers was used to determine the amount of pumping necessary to achieve the above desired future conditions (Kelley and others, 2004). On November 12, 2010, Randy Williams of Bar-W Groundwater Exploration delivered a MODFLOW pumping file to the Texas Water Development Board containing the pumping distribution considered by the members of Groundwater Management Area 14 when developing desired future conditions. After running the groundwater availability model using this pumping file, the drawdowns in each county did not match the desired future conditions. The submitted pumping file assumed pumping of 7,500 acre-feet per year in Grimes County and 2,300 acre-feet per year in Walker County.

Pumping was adjusted based on the pumping distribution of the submitted file using PEST (Watermark Numerical Computing, 2004), an industry-standard inverse modeling software package, until the drawdowns in the model matched the above desired future conditions (52.8 feet in Grimes County and 45.7 feet in Walker County). As a result of these adjustments, the estimated pumping necessary to achieve the desired future condition in Grimes County is approximately 8,300 acre-feet per year and is approximately 2,100 acre-feet per year in Walker County (Table 2).

Note that pumping from the last year of the historical-calibration portion of the model (1999) was assumed each year during the interim period (2000 to 2009) leading up to the beginning of the predictive simulation (2010).

PARAMETERS AND ASSUMPTIONS:

- Version 2.01 of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers was used for this analysis. See Dutton and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes eight layers which generally correspond to the following units (from top to bottom):

    - the Sparta Aquifer (Layer 1),
    - the Weches Confining Unit (Layer 2),
    - the Queen City Aquifer (Layer 3),
    - the Reklaw Confining Unit (Layer 4),
    - the Carrizo Aquifer (Layer 5),
    - the Upper Wilcox Aquifer (Calvert Bluff Formation; Layer 6),
    - the Middle Wilcox Aquifer (Simsboro Formation; Layer 7), and
    - the Lower Wilcox Aquifer (Hooper Formation; Layer 8).

- The root mean squared error (a measure of the difference between simulated and measured water levels during model calibration) in the groundwater availability model is 22 feet for the Sparta Aquifer, 27 feet for the Queen City Aquifer, 36 feet for the Carrizo Aquifer, and 31 feet for the Simsboro Aquifer for the calibration period (1980 through 1989) and 24, 33, 32, and 43 feet for the same aquifers, respectively, in the verification period (1990 through 1999; Kelley and others, 2004).

- Cells were assigned to individual counties, river basins, regional water planning areas, and groundwater conservation districts as shown in the June 3, 2011 version of the file that associates the model grid to political and natural boundaries for the Carrizo-Wilcox, Queen City, and Sparta aquifers.

- The recharge used for the model run represents average recharge as described in Kelley and others (2004).

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," 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 modeled available groundwater for the Carrizo-Wilcox Aquifer in Groundwater Management Area 14 that achieves the above desired future conditions is approximately 10,400 acre-feet per year between 2010 and 2060. Table 1 contains the modeled available groundwater for the Carrizo-Wilcox Aquifer subdivided by county, regional water planning area, and river basin for use in the regional water planning process. Tables 2, 3, 4, and 5 show the modeled available groundwater for the Carrizo-Wilcox Aquifer summarized by county, regional water planning area, river basin, and groundwater conservation district, respectively, within Groundwater Management Area 14.

LIMITATIONS:

The groundwater model used in developing estimates of modeled available groundwater is the best available scientific tool that can be used to estimate the pumping that will achieve the desired future conditions. Although the groundwater model used in this analysis is the best available scientific tool for this purpose, it, like all models, has limitations. 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 develop estimates of modeled available groundwater is the need to make assumptions about the location in the aquifer where future pumping will occur. As actual pumping changes in the future, it will be necessary to evaluate the amount of that pumping as well as its location in the context of the assumptions associated with this analysis. Evaluating the amount and location of future pumping is as important as evaluating the changes in groundwater levels, spring flows, and other metrics that describe the condition of the groundwater resources in the area that relate to the adopted 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. 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 future groundwater pumping as well as whether or not they are achieving their desired future conditions. 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 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:

Dutton, A.R., Harden, B., Nicot, J.P., and O'Rourke, D., 2003, Groundwater availability model for the central part of the Carrizo-Wilcox Aquifer in Texas: Contract report to the Texas Water Development Board, 295 p.

Kelley, V. A., Deeds, N. E., Fryar, D. G., and Nicot, J. P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: contract report to the Texas Water Development Board, 867 p.

National Research Council, 2007, Models in Environmental Regulatory Decision Making, Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p.

Texas Water Development Board, 2007, Water for Texas – 2007—Volumes I-III; Texas Water Development Board Document No. GP-8-1, 392 p.

Watermark Numerical Computing, 2004, PEST Model-Independent Parameter Estimation User Manual: 5th Edition, variously p.

TABLE 1: MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 14. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, REGIONAL WATER PLANNING AREA, AND RIVER BASIN.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Grimes	G	Brazos	2,850	2,850	2,850	2,850	2,850	2,850
		Trinity	5,424	5,424	5,424	5,424	5,424	5,424
Walker	H	Trinity	2,099	2,099	2,099	2,099	2,099	2,099
Total			**10,373**	**10,373**	**10,373**	**10,373**	**10,373**	**10,373**

TABLE 2: MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX AQUIFER BY COUNTY FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

County	Year					
	2010	2020	2030	2040	2050	2060
Grimes	8,274	8,274	8,274	8,274	8,274	8,274
Walker	2,099	2,099	2,099	2,099	2,099	2,099
Total	**10,373**	**10,373**	**10,373**	**10,373**	**10,373**	**10,373**

TABLE 3: MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX AQUIFER BY REGIONAL WATER PLANNING AREA FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Region	Year					
	2010	2020	2030	2040	2050	2060
G	8,274	8,274	8,274	8,274	8,274	8,274
H	2,099	2,099	2,099	2,099	2,099	2,099
Total	**10,373**	**10,373**	**10,373**	**10,373**	**10,373**	**10,373**

TABLE 4: MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX AQUIFER BY RIVER BASIN FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Basin	Year					
	2010	2020	2030	2040	2050	2060
Brazos	2,850	2,850	2,850	2,850	2,850	2,850
Trinity	7,523	7,523	7,523	7,523	7,523	7,523
Total	**10,373**	**10,373**	**10,373**	**10,373**	**10,373**	**10,373**

TABLE 5: MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX AQUIFER BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

District	Year					
	2010	2020	2030	2040	2050	2060
Bluebonnet GCD	10,373	10,373	10,373	10,373	10,373	10,373
Total	**10,373**	**10,373**	**10,373**	**10,373**	**10,373**	**10,373**

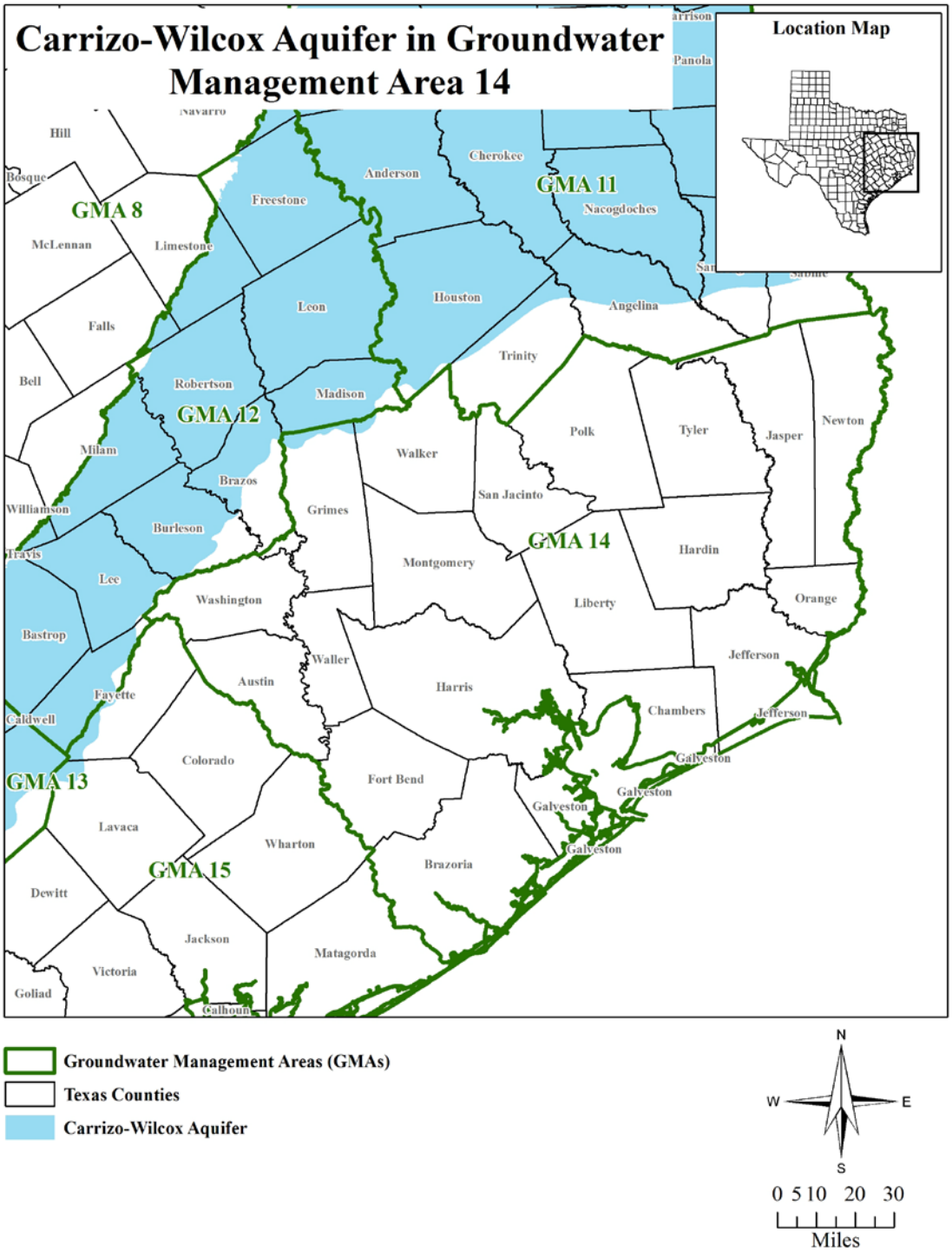

FIGURE 1: MAP SHOWING GROUNDWATER MANAGEMENT AREA 14 AND THE BOUNDARY OF THE CARRIZO-WILCOX AQUIFER ACCORDING TO THE 2007 STATE WATER PLAN (TWDB, 2007).

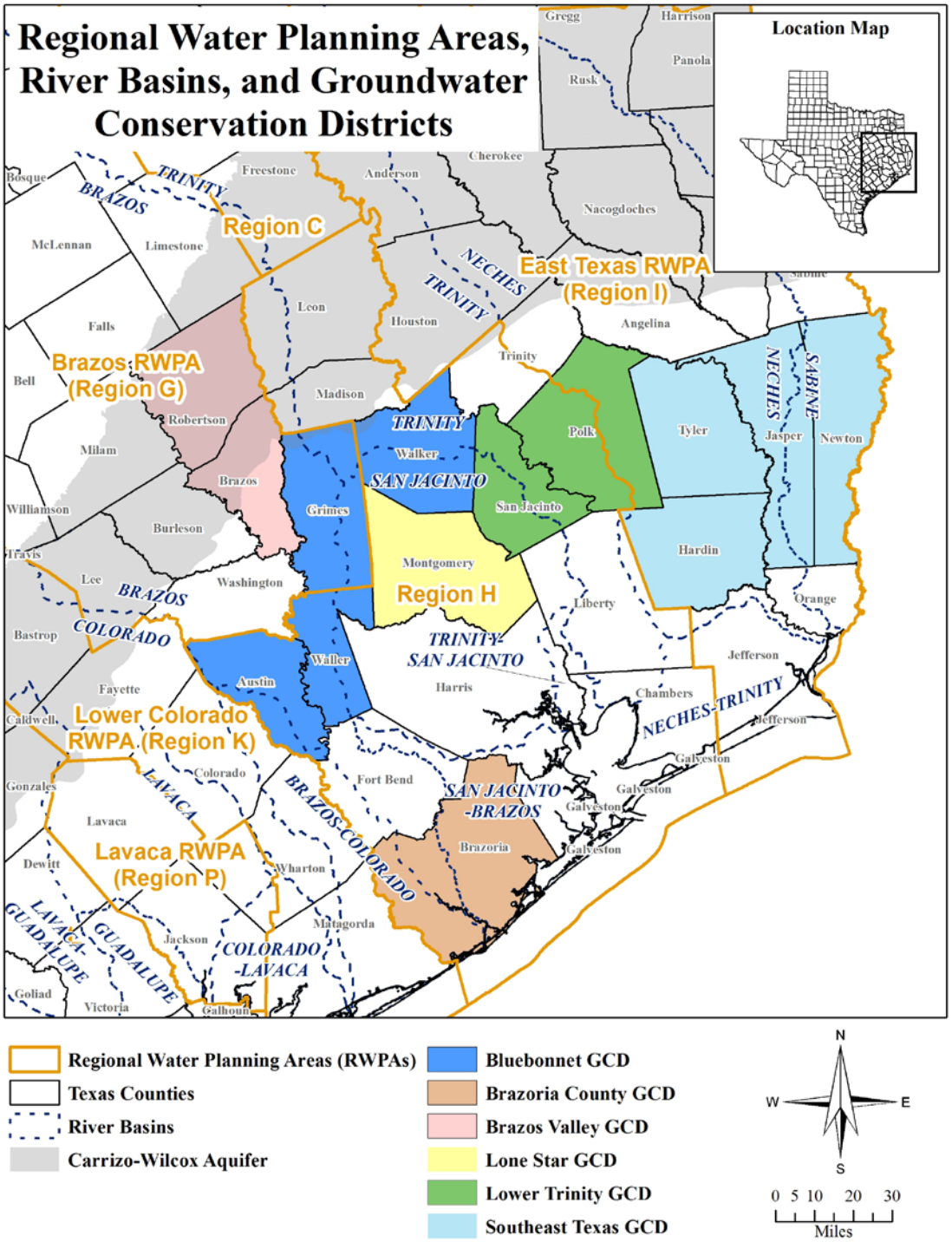

FIGURE 2: MAP SHOWING GROUNDWATER CONSERVATION DISTRICTS, REGIONAL WATER PLANNING AREAS, COUNTIES, AND RIVER BASINS IN AND NEIGHBORING GROUNDWATER MANAGEMENT AREA 14.