GAM Run 12-018 (Version 2): Goliad County Groundwater Conservation District Management Plan

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Groundwater Availability Modeling Section
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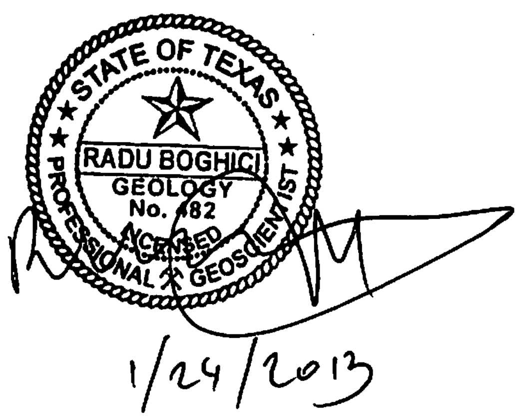
January 24, 2013



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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), 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. Information derived from groundwater availability models that shall be included in the groundwater management plan includes:

- the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
- 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
- the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

This report is a revision to the GAM Run 12-018 report dated November 30, 2012. We have included an updated water budget to fulfill the requirements noted above (Table 1) and an addendum requested by the district on December 18, 2012. GAM Run 12-018 (Version 2) is Part 2 of a two-part package of information from the TWDB to Goliad County Groundwater Conservation District management plan to fulfill the requirements noted above. The groundwater management plan for the Goliad Groundwater Conservation District is due for approval by the executive administrator of the TWDB before November 14, 2013.

This report discusses the method, assumptions, and results from model runs using the groundwater availability model for the central portion of the Gulf Coast. Table 1 summarizes the groundwater availability model data required by the statute, and Figure 1 shows the area of the model from which the values in the table was extracted. This model run replaces the results of GAM Run 12-018. GAM Run 12-018 (Version 2) meets current standards. If after review of the figure, Goliad County Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the Texas Water Development Board immediately. The TWDB has also approved, for planning purposes, alternative models that can have water budget information extracted for the district. These alternative models include the Groundwater Management Area 16 model and the fully penetrating alternative model for the central portion of the Gulf Coast. Please contact the author of this report if a comparison report using these models is desired.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability model for the central portion of the Gulf Coast Aquifer was run for this analysis. Goliad County Water budgets for 1981 through 1999 were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009) The average annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portions of the aquifers located within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Gulf Coast Aquifer

- Version 1.01 of the groundwater availability model for the central portion of the Gulf Coast Aquifer was used for this analysis. See Chowdhury and others (2004) and Waterstone and others (2003) for assumptions and limitations of the groundwater availability model.

- The model for the central section of the Gulf Coast Aquifer assumes partially penetrating wells in the Evangeline Aquifer due to a lack of data for aquifer properties in the lower section of the aquifer.

- This groundwater availability model includes four layers, which generally correspond to (from top to bottom):

1. the Chicot Aquifer,
2. the Evangeline Aquifer,
3. the Burkeville Confining Unit, and
4. the Jasper Aquifer including parts of the Catahoula Formation.

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 model results for the aquifers located within the district and averaged over the duration of the calibration and verification portion of the model runs in the district, as shown in Table 1. The components of the modified budget shown in Table 1 include:

- 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.
- Surface water outflow—The total water discharging from the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).
- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—The net vertical flow between aquifers or confining units. This flow is controlled by the relative water levels in each aquifer or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs. "Inflow" to an aquifer from an overlying or underlying aquifer will always equal the "Outflow" from the other aquifer.

The information needed for the District's management plan is summarized in Table 1. In addition, we have provided a detailed water budget that averages the Gulf Coast Aquifer inflows and outflows for Goliad County by each model layer from 1981 to 1999 (Addendum, Table 2). 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 (Figure 1).

TABLE 1: SUMMARIZED INFORMATION FOR THE GULF COAST AQUIFER THAT IS NEEDED FOR GOLIAD COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT. THESE FLOWS MAY INCLUDE BRACKISH WATERS.

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Gulf Coast Aquifer	16,603
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Gulf Coast Aquifer	21,645
Estimated annual volume of flow into the district within each aquifer in the district	Gulf Coast Aquifer	4,665
Estimated annual volume of flow out of the district within each aquifer in the district	Gulf Coast Aquifer	14,872
Estimated net annual volume of flow between each aquifer in the district	Not Applicable	Not Applicable

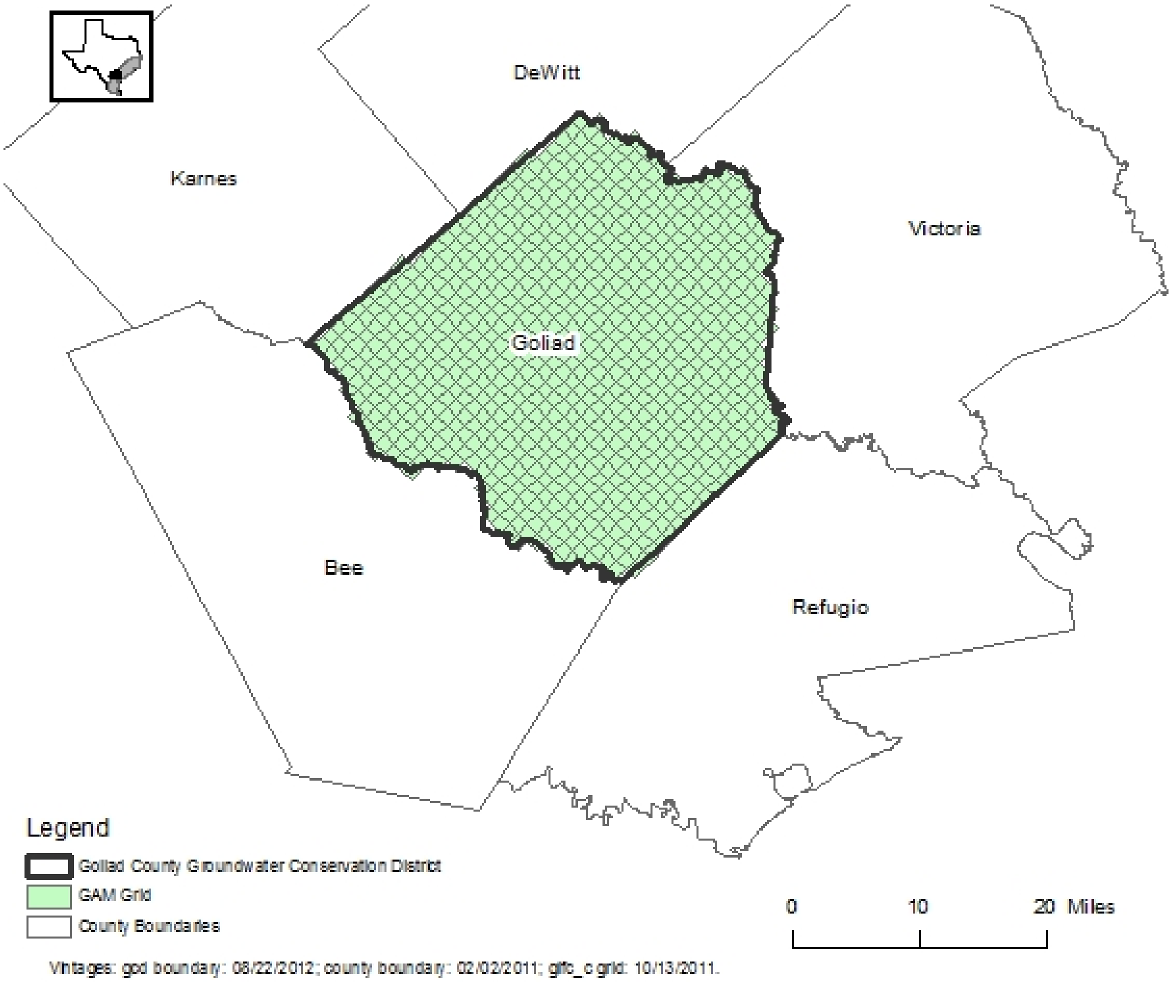

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE GULF COAST AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE GULF COAST AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS

The groundwater model(s) used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). 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 interaction with streams are specific to particular historic time periods.

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 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.

REFERENCES:

Chowdhury, Ali. H., Wade, S., Mace, R.E., and Ridgeway, C., 2004, Groundwater Availability Model of the Central Gulf Coast Aquifer System: Numerical Simulations through 1999- Model Report, 114 p., http://www.twdb.texas.gov/groundwater/models/gam/glfc_c/TWDB_Recalibration_Report.pdf.

Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software.

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.

Tu, K., 2008, GAM Run 08-09: Texas Water Development Board, GAM Run 08-09 Report, 7 p., http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR08-09.pdf.

Waterstone Environmental Hydrology and Engineering Inc. and Parsons, 2003, Groundwater availability of the Central Gulf Coast Aquifer: Numerical Simulations to 2050, Central Gulf Coast, Texas Contract report to the Texas Water Development Board, 157 p.

GAM Run 12-018 Addendum

TABLE 2. GROUNDWATER FLOW BUDGET FOR EACH AQUIFER, INTO AND OUT OF, GOLIAD GROUNDWATER CONSERVATION DISTRICT, IN THE GROUNDWATER AVAILABLILITY MODEL OF THE CENTRAL PART OF THE GULF COAST AQUIFER. FLOWS ARE IN ACRE-FEET PER YEAR. VALUES HAVE BEEN ROUNDED TO WHOLE NUMBERS.

	Central Gulf Coast GAM 1981-99				
	Chicot	Evangeline	Burkeville	Jasper	**Total Gulf Coast Aquifer**
Inflow					
Lakes	1,510	0	0	0	**1,510**
Recharge	9,440	7,163	0	0	**16,603**
Streams/Rivers	1,935	11,879	0	0	**13,815**
Vertical Leakage Upper	0	1,430	285	290	**-**
Vertical Leakage Lower	666	575	440	0	**-**
Lateral Flow	684	3,375	39	565	**4,665**
Total Inflow	14,235	24,422	764	855	**36,593**
Outflow					
Wells	122	1,068	0	0	**1,191**
Springs	11	1	0	0	**13**
Evapotranspiration	706	74	0	0	**780**
Streams/Rivers	8,153	13,479	0	0	**21,632**
Vertical Leakage Upper	0	666	575	440	**-**
Vertical Leakage Lower	1,430	285	290	0	**-**
Lateral Flow	4,438	9,722	57	656	**14,872**
Total Outflow	14,860	25,295	922	1,096	**38,488**
Inflow - Outflow	-625	-873	-158	-241	**-1,895**
Storage Change	-626	-873	-155	-241	**-1,896**
Model Error	1	0	-3	0	**1**
Model Error (percent)	0.01%	0.00%	0.31%	0.00%	**0.00%**