GAM RUN 11-018: CULBERSON COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Ian C. Jones, Ph.D., P.G.
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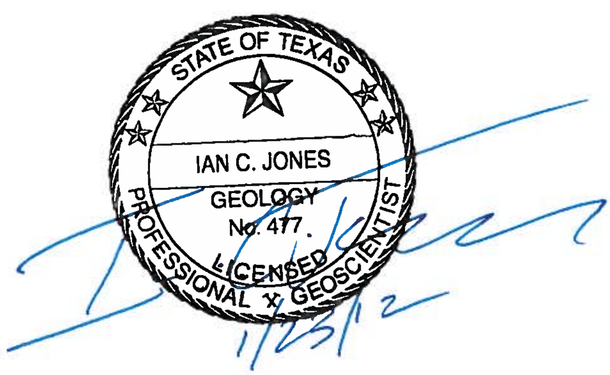
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-6641
January 23, 2012



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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), states that, in developing its groundwater management plan, groundwater conservation districts shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board 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.

The purpose of this report is to provide Part 2 of a two-part package of information from the Texas Water Development Board to Culberson County Groundwater Conservation District management plan to fulfill the requirements noted above.

The groundwater management plan for Culberson County Groundwater Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before January 29, 2013. This report discusses the method, assumptions, and results from the model runs using the groundwater availability models for the Igneous Aquifer and the Red Light Draw, Green River Valley, Eagle Flat, Wild Horse Flat, Michigan Flat and Lobo Flat parts of the West Texas Bolsons Aquifer. Tables 1 and 2 summarize the groundwater availability model data required by the statute, and figures 1 and 2 show the area of each model layer from which the values in the respective tables were extracted. This model run replaces the results of GAM Run 06-02. GAM Run 11-018 meets current standards set after GAM Run 06-02. Differences in the results of the two model runs are due to differences in the method of extracting data from the model(s). If after review of the figures, Culberson 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.

METHODS:

The groundwater availability models for the Igneous Aquifer and the Wild Horse Flat, Michigan Flat and Lobo Flat parts of the West Texas Bolsons Aquifer (1980 through 1999) and the Red Light Draw, Green River Valley, and Eagle Flat parts of the West Texas Bolsons (30-year simulation) were run for this analysis. In the case of the groundwater availability model for the Igneous Aquifer and the Wild Horse Flat, Michigan Flat and Lobo Flat parts of the West Texas Bolsons Aquifer, water budgets for each year of the transient model period were extracted and the average annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow for the portions of the aquifers located within the district are summarized in this report. In the case of the groundwater availability model for the Red Light Draw, Green River Valley, and Eagle Flat parts of the West Texas Bolsons water budget data was extracted from the transient 30-year stress period.

PARAMETERS AND ASSUMPTIONS:

Igneous and West Texas Bolsons Aquifers (Wild Horse Flat, Michigan Flat and Lobo Flat)

- Version 1.01 of the groundwater availability model for the Igneous Aquifer and the Wild Horse Flat, Michigan Flat and Lobo Flat parts of the West Texas Bolsons Aquifer was used for this analysis. See Beach and others (2004) for assumptions and limitations of the groundwater availability model for the Igneous Aquifer and the Wild Horse Flat, Michigan Flat and Lobo Flat parts of the West Texas Bolsons Aquifer.

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

    1 the Wild Horse Flat, Michigan Flat and Lobo Flat parts of the West Texas Bolsons Aquifer,

2 the Igneous Aquifer, and

3 underlying Cretaceous and Permian units.

- Of the three layers listed above, individual water budgets for the district were determined for the West Texas Bolsons Aquifer (Layer 1), and the Igneous Aquifer (Layer 2).

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 35 feet for the West Texas Bolsons Aquifer, and 35 feet for the Igneous Aquifer for the calibration period (1950 to 1990) and 35 and 150 feet for the same aquifers, respectively, in the verification period (1991 to 2000) (Beach and others, 2004). These root mean square errors are between three and five percent of the range of measured water levels (Beach and others, 2004).

- Groundwater in the Igneous and West Texas Bolsons aquifers ranges from fresh to brackish in composition (Beach and others, 2004). Groundwater with total dissolved solids of less than 1,000 milligrams per liter are considered fresh and total dissolved solids of 1,000 to 10,000 milligrams per liter are considered brackish.

- Processing MODFLOW for Windows (PMWIN) version 5.3 (Chiang and Kinzelbach, 1998) was used as the interface to process model output.

West Texas Bolsons Aquifers (Red Light Draw, Green River Valley, and Eagle Flat)

- Version 1.01 of the groundwater availability model for the Red Light Draw, Green River Valley, and Eagle Flat parts of the West Texas Bolsons Aquifer was used for this analysis. See Beach and others (2008) for assumptions and limitations of the groundwater availability model for the Red Light Draw, Green River Valley, and Eagle Flat parts of the West Texas Bolsons Aquifer.

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

1 the Red Light Draw, Green River Valley, and Eagle Flat parts of the West Texas Bolsons Aquifer,

2 Cretaceous, Permian and Paleozoic units, and

3 Cretaceous, Paleozoic and basement units.

- Of the three layers listed above, individual water budgets for the district were determined for the West Texas Bolsons Aquifer (Layer 1).

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 56 feet for the West Texas Bolsons Aquifer, and 99 and 119 feet for the underlying layers for the calibration (steady-state) period (Beach and others, 2008). These root mean square errors are between four and eleven percent of the range of measured water levels (Beach and others, 2008).

- Groundwater in the West Texas Bolsons aquifers displays fresh compositions with total dissolved solids of less than 1,000 milligrams per liter (Beach and others, 2008).

- Groundwater Vistas version 5 (Environmental Sciences, Inc., 2007) was used as the interface to process model output.

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability models. Selected components were extracted from the groundwater budget for the aquifers located within the district and averaged over the period 1980 through 1999, as shown in tables 1 and 2. Water budgets for the West Texas Bolsons Aquifer from the two groundwater availability models are combined. The groundwater availability model for the Red Light Draw, Green River Valley, and Eagle Flat extends into Wild Horse Flat where it overlaps with the groundwater availability model for the Igneous Aquifer and the Wild Horse Flat, Michigan Flat and Lobo Flat parts of the West Texas Bolsons Aquifer. Only the water budget from the groundwater availability model for the Igneous Aquifer and the Wild Horse Flat, Michigan Flat and Lobo Flat parts of the West Texas Bolsons Aquifer was used in the overlap area due to limitations in the groundwater availability model for the Red Light Draw, Green River Valley, and Eagle Flat parts of the West Texas Bolsons Aquifer. The components of the modified budget shown in tables1 and 2 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 areas.

- 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 tables 1 and 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 (see figures 1 and 2).

TABLE 1: SUMMARIZED INFORMATION FOR THE WEST TEXAS BOLSONS AQUIFER THAT IS NEEDED FOR CULBERSON 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 INCLUDE BRACKISH WATERS.

Management Plan requirement		
Estimated annual amount of recharge from precipitation to the district	West Texas Bolsons Aquifer	2,107
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	West Texas Bolsons Aquifer	494
Estimated annual volume of flow into the district within each aquifer in the district	West Texas Bolsons Aquifer	7,453
Estimated annual volume of flow out of the district within each aquifer in the district	West Texas Bolsons Aquifer	629
Estimated net annual volume of flow between each aquifer in the district	From the Igneous Aquifer and other underlying units into the West Texas Bolsons Aquifer	5,238*

*Note some of the flow reported in Table 2 is included in this value.

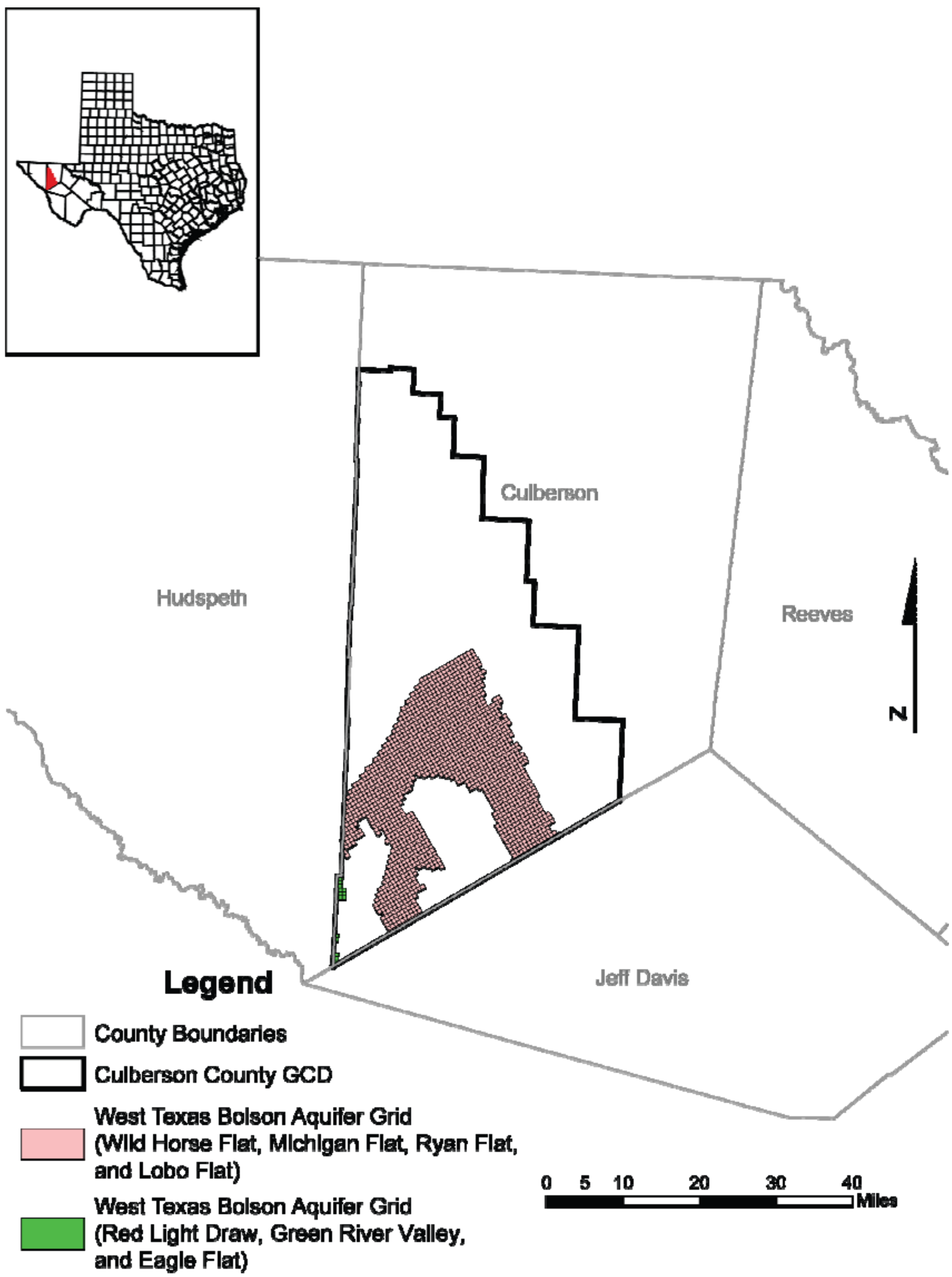

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE WEST TEXAS BOLSONS AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE IGNEOUS AQUIFER THAT IS NEEDED FOR CULBERSON 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 FRESH AND BRACKISH WATERS.

Management Plan requirement		
Estimated annual amount of recharge from precipitation to the district	Igneous Aquifer	671
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Igneous Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Igneous Aquifer	1,037
Estimated annual volume of flow out of the district within each aquifer in the district	Igneous Aquifer	463
Estimated net annual volume of flow between each aquifer in the district	From the Igneous Aquifer into the West Texas Bolsons Aquifer	1,562*

- Some of the flow reported in Table 2 are included in Table 1.

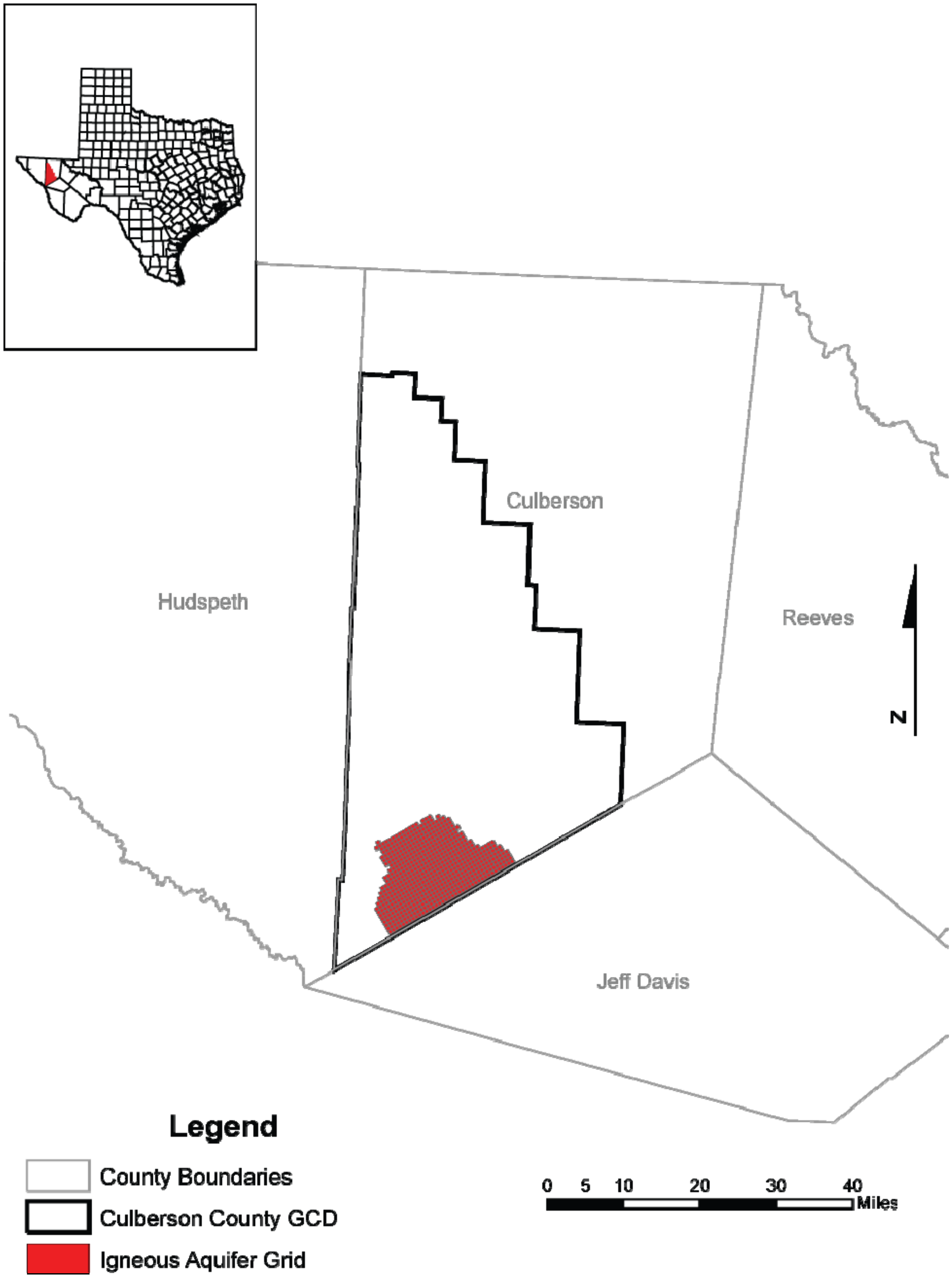

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE IGNEOUS AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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.

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