GAM Task 10-026 Model Run Report

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EXECUTIVE SUMMARY:

This report describes the methods and results for a 50-year predictive simulation using pumping from the 2007 State Water Plan applied to the groundwater availability model for the Igneous Aquifer and the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer. Results indicate that this level of pumping results in between 72 and 78 feet of drawdown, on average, for the districts containing the West Texas Bolsons Aquifer. For the Igneous Aquifer, average drawdown ranges from 15 feet in Jeff Davis County Underground Water Conservation District to 65 feet in Culberson County Groundwater Conservation District.

PURPOSE AND DESCRIPTION OF MODEL RUN:

The model run contained in this report was performed using the groundwater availability model for the Igneous Aquifer and the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer to determine how the aquifers respond under pumping from the 2007 State Water Plan (TWDB, 2007) under average recharge conditions. At the June 22, 2010 Groundwater Management Area 4 meeting it was determined that the pumping from previously completed model runs may not be high enough to meet the expected demands on the aquifers. Therefore, a 50-year predictive simulation was run using state water plan pumping – which is higher than the pumping in the previous runs – to provide information to the members of Groundwater Management Area 4 about the effect of state water plan pumping amounts on water levels in the aquifers.

METHODS:

In order to determine the drawdown due to pumping from the 2007 State Water Plan we used the groundwater availability model for the Igneous and parts of the West Texas Bolsons aquifers. It should be noted that the parts of the West Texas Bolsons Aquifer in the groundwater availability model (Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat) are referred to in the model report (Beach and others, 2004) collectively as the Salt Basin Bolson Aquifer.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the model run using the groundwater availability model for the Igneous Aquifer and Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat portions of the West Texas Bolsons Aquifer are described below:

- We used Version 1.01 of the groundwater availability model for the Igneous and parts of the West Texas Bolsons aquifers. See Beach and others (2004) for assumptions and limitations of the model.

- We used Processing MODFLOW for Windows (PMWin) version 5.3 as the interface to process model output (Chiang and Kinzelbach, 2001).

- The model includes three layers representing the Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat portions of the West Texas Bolsons Aquifer (Layer 1), the Igneous Aquifer (Layer 2), and the underlying Cretaceous and Permian units (Layer 3). Also note that some areas of Layer 2 in the model, outside the boundary of the Igneous Aquifer, are active in order to allow flow between the West Texas Bolsons Aquifer of Layer 1 and the underlying Permian units of Layer 3.

- The Igneous Aquifer boundary used in the groundwater availability model run was the boundary around which the model was developed. This boundary is a both a generalized (or smoothed) and slightly smaller version of the official boundary of the Igneous Aquifer according to the 2007 State Water Plan. A comparison of these two boundaries, as well as the boundary for the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer, is shown in Figure 1.

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) of the entire model for the period of 1990 to 2000 is 64 feet, or four percent of the range of measured water levels (Beach and others, 2004).

- The head closure criterion (HCLOSE) in the Strongly Implicit Procedure package was changed from 0.001 ft to 0.005 feet as described in the previously completed Groundwater Availability Model Run 09-025 (Oliver, 2009). This change did not result in any high (greater than 1 percent) water budget imbalances that would indicate a problem with the model run.

- Cells were assigned to individual groundwater conservation districts as shown in the November 18, 2008 version of the model grid file for the Igneous and parts of the West Texas Bolsons aquifers.

- The simulation was set up using average recharge as described in Beach and others (2004).

- The pumping used for the predictive simulation was taken from the 2007 State Water Plan (TWDB, 2007). Details on this pumping area given below.

Pumping

The pumping in the groundwater availability model for each aquifer in each groundwater conservation district was specified to the values in the 2007 State Water Plan (TWDB, 2007). Note that pumping in the state water plan is specified by county. Because the groundwater conservation district boundaries very closely align with the county boundaries, the state water plan pumping by county was considered appropriate to apply to the corresponding groundwater conservation districts. The pumping in the model for the year 2000 (the last year of the historical/calibration portion of the model) was adjusted and applied to each year of the predictive model run. In order to distribute the increase in pumping, the amount of the increase over the pumping for the year 2000 was uniformly spread over all model cells that contained pumping during the year 2000.

The 2007 State Water Plan groundwater availability for Presidio County for the West Texas Bolsons Aquifer is 16,075 acre-feet per year. However, a portion of this is on the Presidio-Redford Bolson, which is outside the model domain, and was assessed separately in GTA Aquifer Assessment 09-10mag (Wuerch and Davidson, 2010). Based on this estimate, 6,282 acre-feet per year of pumping in the Presidio-Redford Bolson was not included in the model, and pumping in Presidio County for the West Texas Bolsons was estimated as 9.793 acre-feet per year.

Two minor changes were made to the original pumping distribution in order to allow the model to perform best during the predictive simulation. The first was that the total pumping in cells in the Igneous Aquifer near the city of Alpine that contained greater than 3 acre-feet per year of pumping was distributed evenly among those cells (20 cells total). This redistribution was done in order to prevent the cells with higher pumping from going dry. The second change was to remove pumping from a model cell that would not converge under the various pumping scenarios described in groundwater availability model run 09-025 (Layer 1, Row 79, Column 64). Because the pumping in this cell was less than 0.1 acre-feet per year, its removal is not considered to have any significant effect on the results below.

RESULTS:

Table 1 below shows the results of the predictive groundwater availability model run for the Igneous Aquifer and Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat portions of the West Texas Bolsons Aquifer. First, for comparison purposes, the pumping in each groundwater conservation district for the year 2000 is shown along with the drawdown that would result if this pumping was held constant through the 50-year predictive period.

Second, the pumping from the 2007 State Water Plan is shown. As described above, these values were input to the model and the simulation was run for 50 years. The pumping in each district at the end of the 50 years is also shown. Note that these are generally less than the state water plan pumping input to the model. This is due to cells becoming inactive (or "dry"). When the water level in a cell drops below the base of the cell, the cell becomes inactive and pumping can no longer occur.

The final column in Table 1 is the average drawdown in each groundwater conservation district over the 50-year simulation for each aquifer. In general, the drawdown is highest in the West Texas Bolsons Aquifer, ranging from 72 to 78 feet on average. In the Igneous Aquifer, average drawdown ranges from 15 feet in Jeff Davis County Underground Water Conservation District to 65 feet in Culberson County Groundwater Conservation District. Notice that the pumping in the Igneous Aquifer in Culberson County, 100 acre-feet per year, is the lowest of the four districts. The high drawdown in this area is not primarily due to the relatively low pumping in the Igneous Aquifer, but is instead due to the much higher level of pumping in the overlying West Texas Bolsons Aquifer.

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 (e.g. a groundwater conservation district) 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 districts, the cell is assigned to the district where the centroid of the cell is located.

REFERENCES AND ASSOCIATED MODEL RUNS:

Beach, J.A., Ashworth, J.B., Finch, Jr., S.T., Chastain-Howley, A., Calhoun, K., Urbanczyk, K.M., Sharp, J.M., and Olson, J., 2004, Groundwater availability model for the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat) aquifers: contract report to the Texas Water Development Board, 208 p.

Chiang, W., and Kinzelbach, W., 2001, Groundwater Modeling with PMWIN, 346 p.

Oliver, W., 2009, GAM run 09-025: Texas Water Development Board, GAM Run 09-025 Report, 26 p.

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

Wuerch, D., and Davidson, S.C., 2010, GTA Aquifer Assessment 09-10: Texas Water Development Board, GTA Aquifer Assessment 09-10 Report, 10 p.

Table 1. Average drawdown by groundwater conservation district (GCD) associated with pumping from the 2007 State Water Plan (TWDB, 2007). The average drawdown associated with pumping from the last year of the historical/calibration period of the model is also shown for comparison. Pumping is in acre-feet per year. Drawdown is in feet. UWCD is Underground Water Conservation District.

Aquifer	GCD	Original 2000 Pumping	Drawdown due to original pumping	State Water Plan (SWP) Pumping	Pumping after 50 years using SWP	Drawdown due to SWP pumping
West Texas Bolsons	Culberson County GCD	30,316	56	38,000	35,504	78
	Jeff Davis County UWCD	135	23	8,075	6,202	72
	Presidio County UWCD	790	7	9,793*	8,382	72
Igneous	Culberson County GCD	0	47	100	99	65
	Jeff Davis County UWCD	932	6	3,000	2,969	15
	Presidio County UWCD	1,985	7	6,500	6,030	19
	Brewster County GCD	2,051	5	5,000	4,735	28

*State water plan pumping for the West Texas Bolsons Aquifer in Presidio County UWCD is 16,075 acre-feet per year. However, a portion of this is in the Presidio-Redford Bolson, which has been assessed in GTA Aquifer Assessment 09-10mag (Wuerch and Davidson, 2010). This yielded 6,282 acre-feet per year of pumping from the Presidio-Redford Bolson, which was subtracted from the state water plan pumping to yield 9,793 acre-feet per year.

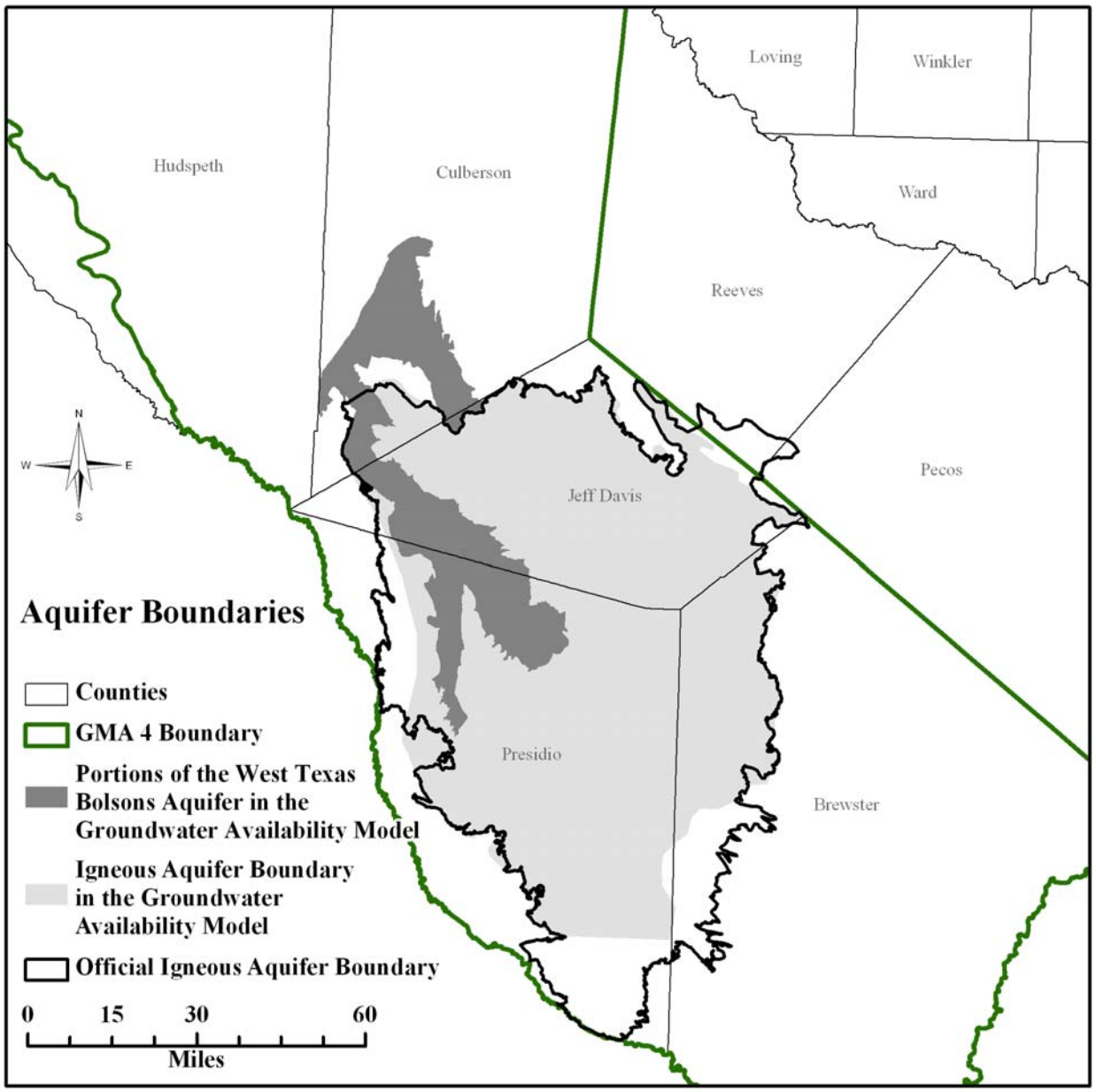

Figure 1. Aquifer boundaries for the Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat portions of the West Texas Bolsons Aquifer and the Igneous Aquifer used in the groundwater availability model run. The official boundary of the Igneous Aquifer is also included for comparison.