GAM Task 10-028 Model Run Report

by Mr. Wade Oliver
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
July 29, 2010

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on July 29, 2010.

EXECUTIVE SUMMARY:

This report describes the methods and results for a series of five 50-year predictive simulations 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. These simulations are based on the simulation presented in Groundwater Availability Modeling Task 10-026, but achieve between 20 and 25 feet of drawdown in the portion of the Igneous Aquifer in Jeff Davis County Underground Water Conservation District.

In the first two simulations, pumping outside Jeff Davis County Underground Water Conservation District was left at the level from the 2007 State Water Plan. Results indicate that 4,500 to 6,000 acre-feet of pumping per year is necessary to achieve 20 to 25 feet of drawdown in the district.

In the second two simulations, pumping was reduced to 4,000 acre-feet per year in Presidio County Underground Water Conservation District and Brewster County Groundwater Conservation District. This decrease in pumping outside Jeff Davis County Underground Water Conservation District increases the range of pumping necessary to achieve 20 to 25 feet of drawdown to 4,650 to 6,150 acre-feet per year. In each of the simulations, the increase in pumping in the Igneous Aquifer in Jeff Davis County Underground Water Conservation District results in no more than a 2-foot increase in average drawdown in areas outside the district relative to Groundwater Availability Modeling Task 10-026.

The fifth simulation represents pumping in the Igneous Aquifer that is between the levels of pumping described above. For Jeff Davis County Underground Water Conservation District, pumping 5,200 acre-feet per year results in an average drawdown of 22 feet. For Presidio County Underground Water Conservation District, 5,800 acre-feet per year of pumping results in 18 feet of drawdown. For Brewster County Groundwater Conservation District, pumping 4,500 acre-feet per year results in an average drawdown of 24 feet.

PURPOSE AND DESCRIPTION OF MODEL RUN:

The model runs contained in this report were 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. The five model simulations presented here were run in order to determine the pumping required to achieve between 20 and 25 feet of drawdown in the portion of the Igneous Aquifer in Jeff Davis County Underground Water Conservation District over a 50-year predictive simulation.

METHODS:

In order to determine the pumping required to achieve between 20 and 25 feet of drawdown in the portion of the Igneous Aquifer in Jeff Davis County Underground Water Conservation District 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).

Pumping

In the previously completed Groundwater Availability Modeling Task 10-026 (Oliver, 2010), the pumping in the model run for each aquifer in each groundwater conservation district was specified to the values in the 2007 State Water Plan (TWDB, 2007). The runs presented in this report are based on Oliver (2010), but achieve between 20 and 25 feet of drawdown over a 50-year predictive simulation in the portion of the Igneous Aquifer in Jeff Davis County Underground Water Conservation District. This drawdown range was selected because it was discussed as a potential desired future condition by the district at the Groundwater Management Area 4 meeting on July 23rd, 2010 in Van Horn, Texas.

The pumping in scenarios 1 and 2 was determined iteratively to achieve 20 and 25 feet of drawdown, respectively, in the portion of the Igneous Aquifer in Jeff Davis County Underground Water Conservation District. Pumping in other districts and aquifers was set to the levels in the 2007 State Water Plan. All adjustments to pumping were made using the same assumptions and methods described in Oliver (2010).

At the same Groundwater Management Area 4 meeting, representatives of Presidio County Underground Water Conservation District and Brewster County Groundwater Conservation District expressed a willingness to accept pumping as low as 4,000 acre-feet per year from the Igneous Aquifer since changes in pumping in Jeff Davis County Underground Water Conservation District can potentially affect water levels in neighboring areas. In scenarios 3 and 4, pumping in Jeff Davis County Underground Water Conservation District was again determined iteratively to achieve 20 and 25 feet of drawdown, respectively. However, pumping in Presidio County Underground Water Conservation District and Brewster County Groundwater Conservation District was reduced to 4,000 acre-feet per year. Pumping in other areas was kept at the levels in the 2007 State Water Plan.

For Scenario 5, pumping in the portion of the Igneous Aquifer in each of the districts adjusted above was set to a level between the minimum and maximum pumping from the previous four scenarios.

RESULTS:

Table 1 below shows the results of the five scenarios described above. The results include the pumping input to the groundwater availability model for each year of the predictive simulation, the pumping output from the model during the last year of the simulation, and the average drawdown in each groundwater conservation district and aquifer over the period of the simulation. For comparison, the results of Groundwater Availability Modeling Task 10-026, representing pumping from the 2007 State Water Plan, are also shown (Oliver, 2010; TWDB, 2007).

For Scenario 1, 4,500 acre-feet of pumping was required to achieve 20 feet of drawdown in the portion of the Igneous Aquifer in Jeff Davis County Underground Water Conservation District with state water plan pumping elsewhere. The impact of this increase in pumping to other areas is a 1-foot increase in drawdown in the Igneous Aquifer in both Culberson County and Presidio County groundwater conservation districts compared to Oliver (2010).

For Scenario 2, 6,000 acre-feet of pumping was required to achieve 25 feet of drawdown in the portion of the Igneous Aquifer in Jeff Davis County Underground Water Conservation District with state water plan pumping elsewhere. The only impact of this increase in pumping to other areas over Scenario 1 is another 1-foot increase in drawdown in the portion of the Igneous Aquifer in Culberson County Groundwater Conservation District.

In scenarios 3 and 4, pumping in the Igneous Aquifer was lowered to 4,000 acre-feet per year in Presidio County Underground Water Conservation District and Brewster County Groundwater Conservation District as described above. Just as in scenarios 1 and 2, pumping in the Igneous Aquifer in Jeff Davis County Underground Water Conservation District was then adjusted in scenarios 3 and 4 to achieve 20 and 25 feet of drawdown, respectively. The pumping required to achieve these drawdowns was 4,650 acre-feet per year for Scenario 3 and 6,150 acre-feet per year for Scenario 4. Each of these represents an increase of 150 acre-feet per year relative to the corresponding scenarios 1 and 2.

In Scenario 5, pumping was set to 5,200 acre-feet per year (between 4,500 and 6,150) for the portion of the Igneous Aquifer in Jeff Davis County Underground Water Conservation District. This achieved 22 feet of drawdown.

Outside of the Igneous Aquifer in the districts with reduced pumping, average drawdown for scenarios 3 and 4 is the same as shown in scenarios 1 and 2. In Presidio County Underground Water Conservation District, the reduction in pumping from 6,500 acre-feet per year to 4,000 acre feet per year results in a decrease in drawdown from 20 feet to 14 feet for both scenarios 3 and 4. In Scenario 5, pumping set to 5,800 acre-feet per year resulted in an average drawdown of 18 feet in the district.

In Brewster County Groundwater Conservation District, the reduction in pumping from 5,000 acre-feet per year to 4,000 acre-feet per year results in a decrease in drawdown from 28 feet to 20 feet for both scenarios. In Scenario 5 for the district, pumping set to 4,500 acre-feet per year resulted in an average drawdown of 24 feet.

The pumping output from the model in each district at the end of each of the 50-year simulations is also shown. Note that these are generally less than the 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.

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.

Oliver, W., 2010, GAM Task 10-026: Texas Water Development Board, GAM Task 10-026 Model Run Report, 7 p.

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

Table 1. Average drawdown by groundwater conservation district (GCD) associated with pumping from the five scenarios described above. The average drawdown associated with pumping from Groundwater Availability Modeling Task 10-026 is also shown for comparison (Oliver, 2010). Pumping is in acre-feet per year. Drawdown is in feet. UWCD is Underground Water Conservation District.

		Input pumping (acre-feet per year)					
Aquifer	**District**	**Task 10-026**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**
West Texas Bolsons	Culberson County GCD	38,000	38,000	38,000	38,000	38,000	38,000
	Jeff Davis County UWCD	8,075	8,075	8,075	8,075	8,075	8,075
	Presidio County UWCD	9,793	9,793	9,793	9,793	9,793	9,793
Igneous	Culberson County GCD	100	100	100	100	100	100
	Jeff Davis County UWCD	3,000	4,500	6,000	4,650	6,150	5,200
	Presidio County UWCD	6,500	6,500	6,500	4,000	4,000	5,800
	Brewster County GCD	5,000	5,000	5,000	4,000	4,000	4,500
		Pumping after 50 years (acre-feet per year)					
West Texas Bolsons	Culberson County GCD	35,504	35,504	35,504	35,504	35,504	35,504
	Jeff Davis County UWCD	6,202	6,202	6,202	6,202	6,202	6,202
	Presidio County UWCD	8,382	8,382	8,382	8,382	8,382	8,382
Igneous	Culberson County GCD	99	99	99	99	99	99
	Jeff Davis County UWCD	2,969	4,449	5,928	4,597	6,076	5,139
	Presidio County UWCD	6,030	6,030	6,030	3,783	3,783	5,400
	Brewster County GCD	4,735	4,735	4,735	3,823	3,823	4,281
		Average drawdown (feet)					
West Texas Bolsons	Culberson County GCD	78	78	78	78	78	78
	Jeff Davis County UWCD	72	72	72	72	72	72
	Presidio County UWCD	72	72	72	72	72	72
Igneous	Culberson County GCD	65	66	67	66	67	66
	Jeff Davis County UWCD	15	20	25	20	25	22
	Presidio County UWCD	19	20	20	14	14	18
	Brewster County GCD	28	28	28	20	20	24

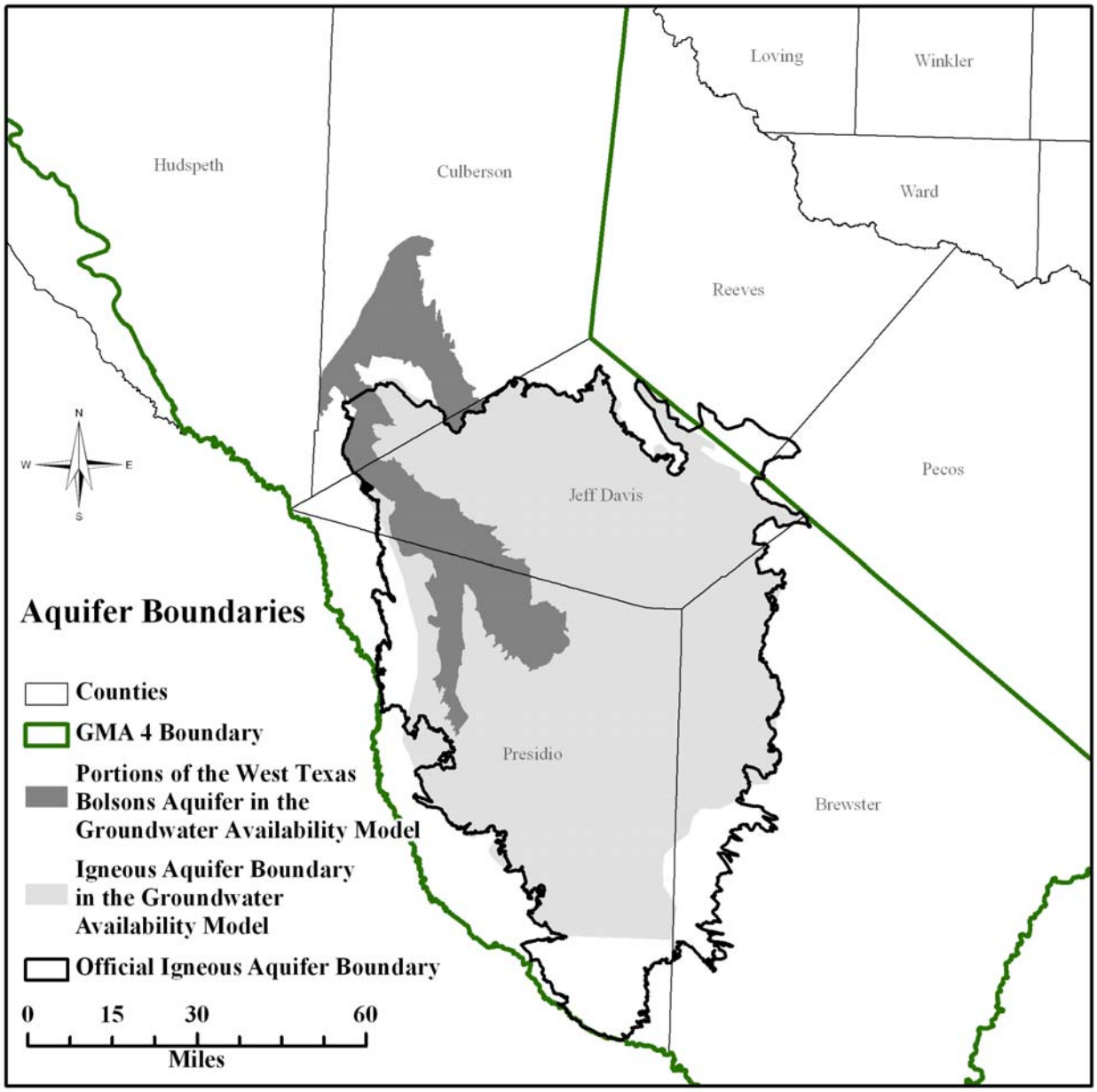

Figure 1. Aquifer boundaries for the Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat portions of the West Texas Bolsons Aquifer and the Igneous Aquifer used in the groundwater availability model run. The official boundary of the Igneous Aquifer is also included for comparison.