GAM Run 10-006

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Texas Water Development Board
Groundwater Availability Modeling Section
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July 30, 2012

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 30, 2012.

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EXECUTIVE SUMMARY:

The groundwater availability model for the Nacatoch Aquifer was used to estimate drawdown in the aquifer under five pumping scenarios in Groundwater Management Area 8. In Scenario 1, pumping from the 2007 State Water Plan, approximately 9,400 acre-feet per year, resulted in an average drawdown of 5 feet between 2011 and 2060. In the subsequent four scenarios containing increased pumping, average drawdowns ranged from 6 to 12 feet with pumping ranging from 9,700 to 17,300 acre-feet per year.

REQUESTOR:

The members of Groundwater Management Area 8 at the management area meeting held on March 10, 2010 in Woodway, Texas

DESCRIPTION OF REQUEST:

Desired future conditions for the Nacatoch Aquifer for Groundwater Management Area 8 were adopted on March 16, 2009. Using a water budget approach, AECOM assisted the members of Groundwater Management Area 8 in developing their desired future conditions (Williams, 2009). Subsequent to that work, the groundwater availability model for the Nacatoch Aquifer was completed (Beach and others, 2009). The Texas Water Development Board (TWDB) then completed a preliminary model simulation to estimate the managed available groundwater for the Nacatoch Aquifer based on the desired future conditions. Results from that run yielded pumping numbers in two counties that were less than pumping estimated by AECOM: Delta County had 16 acre-feet pear year instead of 293 acre-feet pear year and Red River County (Sulphur River Basin) had 465 acre-feet pear year instead of 683 acre-feet pear year.

At the March 10, 2010 Groundwater Management Area 8 meeting, the groundwater conservation district members requested that the Texas Water Development Board use the groundwater availability model for the Nacatoch Aquifer to estimate drawdowns associated with higher levels of pumping in these areas.

METHODS:

The groundwater availability model for the Nacatoch Aquifer was used to estimate drawdowns in the aquifer under five pumping scenarios between 2011 and 2060 for Groundwater Management Area 8. Pumping in each county and river basin for each of the scenarios is summarized in Table 1, along with the estimated historical pumping in 1997 as estimated in the groundwater availability model. In Scenario 1, pumping in each county and river basin was set equal to groundwater availability as defined in the 2007 State Water Plan (TWDB, 2007). In three counties, historical pumping was higher than the 2007 State Water Plan groundwater availability estimates. In Scenario 2 pumping was set to the higher of 2007 State Water Plan groundwater availability or estimated 1997 historical pumping. Scenario 3 pumping was set to the greater of the pumping estimated by AECOM (Williams, 2009) or Scenario 2 pumping. In Scenario 4, pumping was increased to a level that achieved an increase in drawdown of approximately three (3) feet as compared to Scenario 2. In Scenario 5, pumping was increased to

a level that achieved an increase in drawdown of approximately six (6) feet as compared to Scenario 2.

The pumping distribution for 1997 in the historical-calibration portion of the model was used as a base for the changes in pumping above. Where a decrease in pumping was required, the pumping in that area was reduced by a uniform factor. Where an increase in pumping was required, the amount of the increase was spread evenly among all active model cells in each zone. See Figure 1 for the location of each of the zones defined by county and river basin.

The end of the historical-calibration period of the model is 1997 while the predictive simulation documented here begins in 2011. A preliminary analysis was performed using several hydrographs (base on observed data) for the Nacatoch Aquifer at various locations within Groundwater Management Area 8. The results of this analysis indicated that there was no consistent trend in the water-levels in those wells. The variation of water level ranges from less than 1 foot to 25 feet. Therefore, it was assumed that pumping from the last year of the historical-calibration period in the model (1997) throughout the interim period leading up to the predictive simulation (1998 to 2010) was appropriate. In areas outside of Texas in the model, 1997 pumping was held constant both during the interim period and throughout the predictive period from 2011 through 2060.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for this model are described below.

- Version 1.01 of the groundwater availability model for the Nacatoch Aquifer was used for these simulations. See Beach and others (2009) for assumptions and limitations of the model.

- The groundwater availability model for the Nacatoch Aquifer includes two layers, which generally represent:
  1. the Kemp Clay and Midway Units (Layer 1)
  2. the Nacatoch Aquifer (Layer 2)

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the Kemp Clay and Midway units and the Nacatoch Aquifer are 4 feet and 30 feet, respectively.

- Groundwater Vistas Version 5.36 Build 10 was used as the interface to process model output (Environmental Simulations, Inc., 2007).

- The average recharge between 1980 and 1997 in the historical-calibration portion of the model was applied each year during the 2011 to 2060 predictive simulation.

- There were a number of dry cells throughout the model domain during the simulations. A model cell goes dry when the water level in the cell falls below the base of the aquifer. In this situation, pumping can no longer occur. In order to account for this, pumping in cells

that went dry during a particular simulation was redistributed to other cells in the zone to keep pumping losses at a minimum.

RESULTS:

The estimated total pumping and associated drawdown for Groundwater Management Area 8 from the Nacatoch Aquifer, summarized by county and river basin, is provided in tables 1 and 2. Scenario 1 assumes pumping is equal to 2007 State Water Plan groundwater availability, and totals about 9,400 acre-feet per year. Drawdown from 2011 to 2060 ranges from a recovery of 6 feet to a drawdown of 14 feet, and averages about 5 feet over Groundwater Management Area 8 Note that groundwater recoveries are predicted in Delta County, Hunt County in the Sulphur River Basin, and Hopkins County in the Sabine River Basin. The recovery is the result of reduced pumping compared to the historical pumping. Scenario 2, assumes the higher amount of pumping between the groundwater availability estimates from the 2007 State Water Plan and estimated 1997 pumping. Drawdown ranges from a drawdown of 1 foot to a drawdown of 14 feet. The average drawdown in Groundwater Management Area 8 is 6 feet with approximately 9,700 acre-feet per year of pumping.

Scenario 3, assumes the higher amount of pumping between the groundwater availability estimated by AECOM and Scenario 2 pumping, water level changes range from a drawdown of 1 foot to a drawdown of 17 feet. The average drawdown in Groundwater Management Area 8 is 7 feet with approximately 10,900 acre-feet per year of pumping. Model results mainly differ from AECOM calculations because their approach did not take into consideration induced lateral and vertical flow caused by increases in pumping.

Pumping in in Scenario 4 was adjusted to achieve an increase of approximately three (3) additional feet of drawdown relative to Scenario 2 as described in the Methods section above. In this scenario, water level changes range from a drawdown of 4 feet to a drawdown of 17 feet in the individual zones. The average drawdown in Groundwater Management Area 8 is 9 feet with approximately 13,800 acre-feet per year of pumping.

Pumping in Scenario 5, was adjusted to achieve an increase of approximately six (6) additional feet of drawdown relative to Scenario 2. In this scenario, the drawdowns range from 7 feet to 20 feet in the individual zones with an average of 12 feet over Groundwater Management Area 8. This corresponds to the applied pumping of approximately 17,300 acre-feet per year.

Notice that, in a number of areas, the drawdowns increase from scenario to scenario though the pumping amount did not change significantly or did not change at all. For example, in Bowie County (Sulphur River Basin), the drawdown increases from 14 feet (Scenario 1) to 17 feet (Scenarios 3 and 4), to 20 feet (Scenario 5) without increasing the amount of pumping (1,968 acre-feet per year). This is due to the significant pumping increases in adjacent areas. In this case, the amount of pumping in Bowie County (Red River Basin) increases significantly between Scenario 2 and scenarios 3, 4 and 5. The pumping also increased significantly in Red River County (Sulphur River Basin) between those two scenarios. Therefore, the drawdown increases in Bowie County (Sulphur River Basin) even with slightly decreased pumping between scenarios.

Table 1: Estimates of pumping for historical and various predictive scenarios using the groundwater availability model for the Nacatoch Aquifer in Groundwater Management Area 8. The pumping amounts are in acre-feet per year.

County	River Basin	Historical (1997) Pumping	AECOM estimated "Managed Available Groundwater" (MAG)	Scenario 1: 2007 State Water Plan (SWP) Pumping	Scenario 2: Higher of 2007 State Water Plan (SWP) Pumping and Historical Pumping	Scenario 3: Higher of AECOM's estimated MAG and Scenario 2 Pumping	Scenario 4: Pumping required to achieve approximately 3 feet higher drawdown than Scenario 2	Scenario 5: Pumping required to achieve approximately 6 feet higher drawdown than Scenario 2
Bowie	Red	341	3,042	1,968	1,968	3,042	3,071	4,175
Bowie	Sulphur	218	899	1,968	1,968	1,968	1,940	1,800
Delta	Sulphur	434	293	282	434	434	574	649
Ellis	Trinity	0	1	0	0	1	20	25
Franklin	Sulphur	4	10	10	10	10	30	38
Hopkins	Sabine	289	not reported	183	289	289	290	300
Hopkins	Sulphur	100	777	732	732	777	916	1,091
Hunt	Sabine	381	2,398	2,491	2,491	2,491	3,302	3,900
Hunt	Sulphur	496	568	465	496	568	490	496
Kaufman	Sabine	10	5	10	10	10	50	160
Kaufman	Trinity	63	304	308	308	308	876	1,240
Lamar	Sulphur	1	45	45	45	45	110	180
Navarro	Trinity	11	234	229	229	234	979	1,600
Rains	Sabine	8	10	10	10	10	0	8
Red River	Red	10	25	35	35	35	58	79
Red River	Sulphur	496	683	665	665	683	1,048	1,523
Rockwall	Trinity	0	1	1	1	1	13	18
Overall GMA 8		2,862	9,295	9,402	9,691	10,906	13,770	17,285

Table 2: Estimates of drawdown for various predictive scenarios using the groundwater availability model for the Nacatoch Aquifer in Groundwater Management Area 8. A negative drawdown indicates water level rise or recovery. The drawdown values are in feet.

County	River Basin	Scenario 1: Drawdown	Scenario 2: Drawdown	Scenario 3: Drawdown	Scenario 4: Drawdown	Scenario 5: Drawdown
Bowie	Red	7	7	10	10	13
Bowie	Sulphur	14	14	17	17	20
Delta	Sulphur	-6	2	2	5	8
Ellis	Trinity	1	1	1	4	7
Franklin	Sulphur	3	3	3	6	9
Hopkins	Sabine	-5	7	7	10	13
Hopkins	Sulphur	8	9	10	12	15
Hunt	Sabine	6	7	7	10	13
Hunt	Sulphur	-4	3	6	6	10
Kaufman	Sabine	4	4	4	7	10
Kaufman	Trinity	1	1	1	4	7
Lamar	Sulphur	2	2	2	5	8
Navarro	Trinity	1	1	1	4	7
Rains	Sabine	9	10	10	13	17
Red River	Red	7	7	8	10	13
Red River	Sulphur	5	5	5	8	11
Rockwall	Trinity	2	2	2	5	8
Overall GMA 8		5	6	7	9	12

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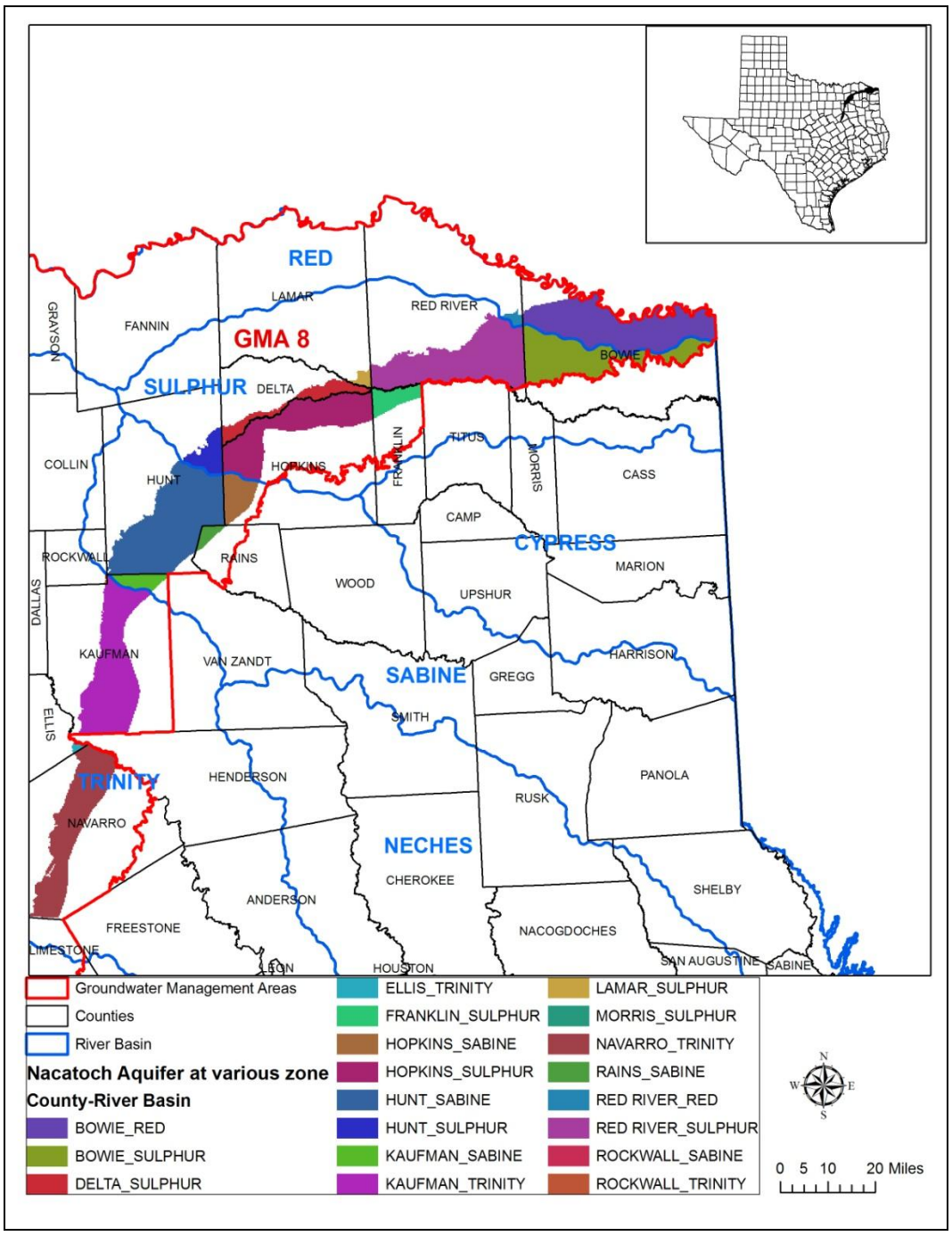

Figure 1: Map showing the zones used to determine the average drawdowns in the Nacatoch Aquifer.

REFERENCES:

Bradley, R. G., 2008, GTA Aquifer Assessment 07-04 managed available groundwater, Texas Water Development Board, 30 p.

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