GAM run 05-22

by Shirley Wade

Texas Water Development Board
Groundwater Availability Modeling Section
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REQUESTOR:

Lonnie Stewart, Live Oak Underground Water Conservation District (LOUWCD).

DESCRIPTION OF REQUEST:

Mr. Stewart requested that we use the groundwater availability models (GAMs) for the central part of the Gulf Coast aquifer and the southern part of the Queen City and Sparta aquifers to help him determine the total useable groundwater for the LOUWCD management plan. The Carrizo-Wilcox aquifers are included in the Queen City and Sparta GAM. The model runs will estimate the amount of pumpage in Live Oak County that will result in the following water-level declines:

- 0 feet
- 10 feet
- 25 feet

METHODS:

To address the request, we:

- extracted the first year pumpage from the transient models (1980);
- ran the steady-state predevelopment GAMs for reference water levels;
- ran the steady-state GAMs using the first year pumpage as a baseline (pre-development steady-state models were chosen for the analysis because they will simulate long-term water level declines);
- calculated water-level declines by subtracting long-term pumped water levels from predevelopment water levels; and
- uniformly adjusted pumping volumes within Live Oak County, for each aquifer layer, until the average water-level decline in the county was 0, 10, and 25 feet for that layer.

PARAMETERS AND ASSUMPTIONS:

- In the analysis, we assumed that the pumpage distribution would remain as it was in the baseline case (1980 spatial and vertical pumpage distribution).
- See Chowdhury and others (2004) for assumptions and limitations of the GAM for the central part of the Gulf Coast aquifer. Root mean squared error for the entire central Gulf Coast aquifer model is up to 46 feet. This error will have more of an effect on model results where the aquifer is thin. In addition, the model assumes that pumping in the Evangeline aquifer only occurs in the upper part of the Evangeline aquifer (Chowdhury and others, 2004).

- See Deeds and others (2003) for additional information concerning the Carrizo-Wilcox aquifer and Kelley and others (2004) for Queen City and Sparta aquifers assumptions and limitations. Root mean squared error for the Sparta layer of the calibrated transient model is 23 feet, for the Queen City it is 18 feet and for the Carrizo layer it is 33 feet. The pre-development steady-state models assume average recharge conditions.

RESULTS:

Table 1 lists the estimated pumping volumes for the central part of the Gulf Coast aquifer located in Live Oak County. Because we referenced water levels to predevelopment, zero water-level declines correspond to zero pumpage. The Chicot aquifer (layer 1) is not active in Live Oak County.

In some model cells the total pumping volume for a given water-level decline was less than the baseline pumpage times the multiplier because some model cells adjacent to the updip outcrop boundary have gone dry. Model cells go dry when the pumpage exceeds the ability of the cell to transmit water and water levels in that cell drop below the base of the aquifer. When a model cell goes dry, the pumpage from that cell turns off in the model. For the 25-foot decline scenario 86 cells go dry in layer 2 (Evangeline aquifer) and 32 cells go dry in layer 3 (Burkeville confining unit). We calculated average water-level declines only for cells that did not go dry.

Table 1 can be used to determine total useable groundwater by deciding on an acceptable average water-level decline per aquifer layer and selecting the total pumping volume for that decline from the table. That pumping volume would be the maximum amount of useable groundwater without exceeding the selected water-level decline. Different acceptable water-level declines may also be selected for each aquifer layer and the individual pumping volumes could then be added together to develop total useable groundwater.

For the Queen City and Sparta aquifers GAM, only the Carrizo aquifer (layer 5) had pumpage in the 1980 baseline pumpage set. Therefore the, baseline pumping volumes in all layers except the Carrizo aquifer (layer 5) is zero. The total pumping volume from the Carrizo aquifer within Live Oak County is about 90 acre-feet per year for 1980. The 1980 pumpage in the Carrizo aquifer for Live Oak County plus pumpage for nearby counties produces 115 feet of average water level decline. For the Sparta aquifer (layer 1), 1980 pumpage from nearby counties produces about 50 feet of average water-level decline in Live Oak County. For the Queen City aquifer (layer 3) the average water-level decline due to pumpage from nearby counties is 72 feet and for the Middle Wilcox (layer 5) the average water-level decline is 111 feet.

When we reduced pumpage in the Carrizo aquifer in Live Oak County to about 18 acre-feet per year (approximately 20 percent of the 1980 baseline pumpage), average water levels within Live Oak County still decline about 113 feet. Therefore, the criteria of 10 feet and 25 feet maximum decline in water levels for the Queen City, Sparta, and Carrizo-Wilcox aquifers cannot be met using the pumping assumptions in the model with any level of pumpage in Live Oak County because of baseline pumping in other counties.

REFERENCES:

Chowdhury, A. H., Wade, S., Mace, R., E., and Ridgeway, C., 2004, Groundwater availability model of the central Gulf Coast Aquifer System: Numerical simulations through 1999, Texas Water Development Board, Model Summary Report, 113 p.

Deeds, N., Kelley, V., Fryar, D., and Jones, T., 2003, Groundwater Availability Model for the Southern Carrizo-Wilcox Aquifer: Final Report prepared for the Texas Water Development Board by INTERA Inc.

Kelley, V. A., Deeds, N. E., Fryar, D. G., Nicot, J. P., Jones, T. L., Dutton, A. R., Bruehl, G., Unger-Holtz, T., and Machin J. L., 2004, Groundwater availability model for the Queen City and Sparta aquifers: Final report prepared for the Texas Water Development Board by INTERA Inc.

Table 1. Estimated pumpage for water-level declines in the GAM for the central part of the Gulf Coast aquifer located in Live Oak County.

Aquifer	Average Water-Level Decline In feet[1]	Pumping (acre-feet per year)	Pumpage Multiplier
Evangeline	0	0	-
Burkeville	0	0	-
Jasper	0	0	-
Total	**0**	**0**	-
Evangeline	10	930	2.5
Burkeville	10	280	1.0
Jasper	10	500	0.2
Total	**10**	**1,710**	-
Evangeline	25	12,440[2]	45.0
Burkeville	25	1,590[3]	6.0
Jasper	25	2,490	1.0
Total	**25**	**16,520**	-

[1]Within one foot – relative to predevelopment water levels

[2] Does not include pumpage from the 86 cells that went dry in the model simulation.

[3] Does not include pumpage from the 32 cells that went dry in the model simulation.