GAM Run 06-05

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Groundwater Availability Modeling Section
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REQUESTOR:

Dr. Robert Mace of the Texas Water Development Board.

DESCRIPTION OF REQUEST:

Dr. Mace requested a Groundwater Availability Model (GAM) run to evaluate the impact of an additional 4,000 acre-feet per year of pumpage from a single cell near Jewett, Texas, located in northwestern Leon County (Figure 1). This request was made to evaluate the potential of the Carrizo-Wilcox aquifer to supply groundwater to a proposed FutureGen power plant, which will be located in or adjacent to the Jewett coal mine (Figure 1).

METHODS:

To determine the impact of an additional 4,000 acre-feet per year of pumpage on water levels in the Jewett area, we used the GAM for the central portion of the Queen City, Sparta, and Carrizo-Wilcox aquifers. We used the 1999 estimated pumpage from the transient calibration-verification model run as the baseline pumpage for the model run. To this baseline pumpage we added 4,000 acre-feet per year to a single cell west of Jewett. A single cell was used because of the desired size of a well field for the proposed site. The additional pumpage was evenly divided between two units for the predictive model run; the Upper Wilcox (Calvert Bluff) and Middle Wilcox (Simsboro). The Upper Wilcox (Calvert Bluff) is not typically considered an aquifer; however, Dutton and others (2003) note that where the sandstones of this formation are present in sufficient thickness, the Calvert Bluff can yield appreciable quantities of water. Based on the parameters used in the GAM, the Calvert Bluff is approximately 1,000 feet thick in the Jewett area, and the Texas Water Development Board (TWDB) Water Information, Integration, and Dissemination (WIID) database indicates that many wells in this area have been completed in this unit. Therefore, the Calvert Bluff Formation was included in the distribution of pumpage. It was assumed that if the well field is located at or near the Jewett coal mine, the Carrizo aquifer will either not be present or will be dewatered due to mining operations, and therefore no pumpage was included for the Carrizo aquifer layer.

PARAMETERS AND ASSUMPTIONS:

- See Dutton and others (2003) and Kelley and others (2004) for assumptions and limitations of the GAM for the central part of the Queen City, Sparta, and Carrizo-Wilcox aquifers.

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) in the GAM for the transient calibration-verification period is 31 feet for the Simsboro Formation, or about seven percent of the range of measured water levels (Kelley and others, 2004).

- The model includes eight layers, representing the Sparta aquifer (Layer 1), the Weches confining unit (Layer 2), the Queen City aquifer (Layer 3), the Reklaw confining unit (Layer 4), the Carrizo aquifer (Layer 5), the Upper Wilcox (Calvert Bluff—Layer 6), the Middle Wilcox (Simsboro—Layer 7), and the Lower Wilcox (Hooper—Layer 8).

- We simulated a 51-year time period for the predictive model run, representing the years 2000 to 2050.

- We added pumpage to a single cell in the model (Row 37, Column 195). As noted above, pumpage was divided equally between two layers: Layer 6 (Calvert Bluff Formation); and Layer 7 (Simsboro Formation).

- We used an average annual recharge based on recharge determined through the calibration of the transient model covering the years 1975 to 2000.

- The GAM uses the MODFLOW stream package to simulate discharge to streams. Streams are included in all layers of the model. Average stream parameters were used for each year in the predictive simulation.

- The GAM uses the MODFLOW reservoir package to simulate the interaction between lakes and surface water reservoirs and aquifers. Average reservoir parameters were used for each year in the predictive simulation.

- The GAM uses the MODFLOW drain package to simulate discharge to springs. Most springs in the study area that are significant in terms of volumetric flow were located in the same cells as streams, and these were handled with the stream package. To handle overland flow in stream valleys, drains were assigned to low-lying stream valleys where the depth to water may be shallow. Average drain parameters were used for each year in the predictive simulation.

- The GAM uses the MODFLOW horizontal flow boundary (HFB) package to simulate the impact of faults on the groundwater flow system.

- The GAM uses general-head boundaries (GHB) to simulate lateral aquifer boundaries. The lateral boundaries of the GAM were not assumed to be no-flow

boundaries, and therefore GHBs were used to simulate the interaction of the aquifer within the model area with areas outside of the model area.

- The GAM uses the MODFLOW evapotranspiration package (ET) to simulate discharge of water to evaporation and transpiration. ET parameters were held at average conditions for the predictive simulations.

- The GAM uses the MODFLOW recharge package to simulate precipitation recharge. Initial recharge estimates were based on precipitation, soil/geology, and topography. Recharge parameters were held at average conditions for the predictive simulations.

- The GAM includes pumpage representing rural domestic, municipal, industrial, irrigation, and livestock uses.

RESULTS:

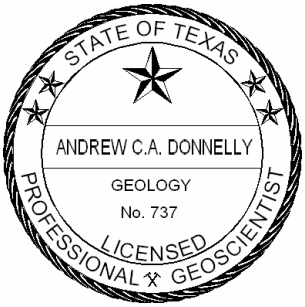
Water levels in the Upper Wilcox (Calvert Bluff) and Middle Wilcox (Simsboro) at the end of 1999 are shown in Figures 2 and 3, respectively. These figures indicate that groundwater generally flows to the east-southeast away from the outcrop areas of each respective formation. Water levels in the Upper Wilcox (Calvert Bluff) and Middle Wilcox (Simsboro) at the end of 2050 with an additional 4,000 acre-feet per year being pumped near Jewett are shown in Figures 4 and 5, respectively. In each of these figures, the impact of the pumpage can be seen on water levels. In both of the producing layers, cones of depression can be observed in the water levels (Figures 4 and 5). The drawdowns in water levels from the end of 1999 to the end of 2050 for the Upper Wilcox (Calvert Bluff) and Middle Wilcox (Simsboro) are shown in Figures 6 and 7, respectively. These figures indicate that the pumpage from each layer causes a cone of depression to form, with maximum amounts of drawdown of 130 feet in the Upper Wilcox (Calvert Bluff) and 42 feet in the Middle Wilcox (Simsboro).

It is important to note that these water levels and drawdowns do not reflect what will occur within an individual well field. Water levels and drawdowns shown in this report are estimates of the impact that this amount of pumpage will have on the aquifers from a regional perspective. Because the GAM has a grid spacing of one mile, this model cannot be used to gage the impacts of pumpage on water levels within individual well fields.

REFERENCES:

Dutton, A. R., Harden, B., Nicot, J. P., O'Rourke, D. O., 2003, Groundwater availability models for the central part of the Carrizo-Wilcox aquifer in Texas: contract report to the Texas Water Development Board, 311 p.

Kelley, V. A., Deeds, N. E., Fryar, D. G., and Nicot, J. P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: contract report to the Texas Water Development Board, 867 p.



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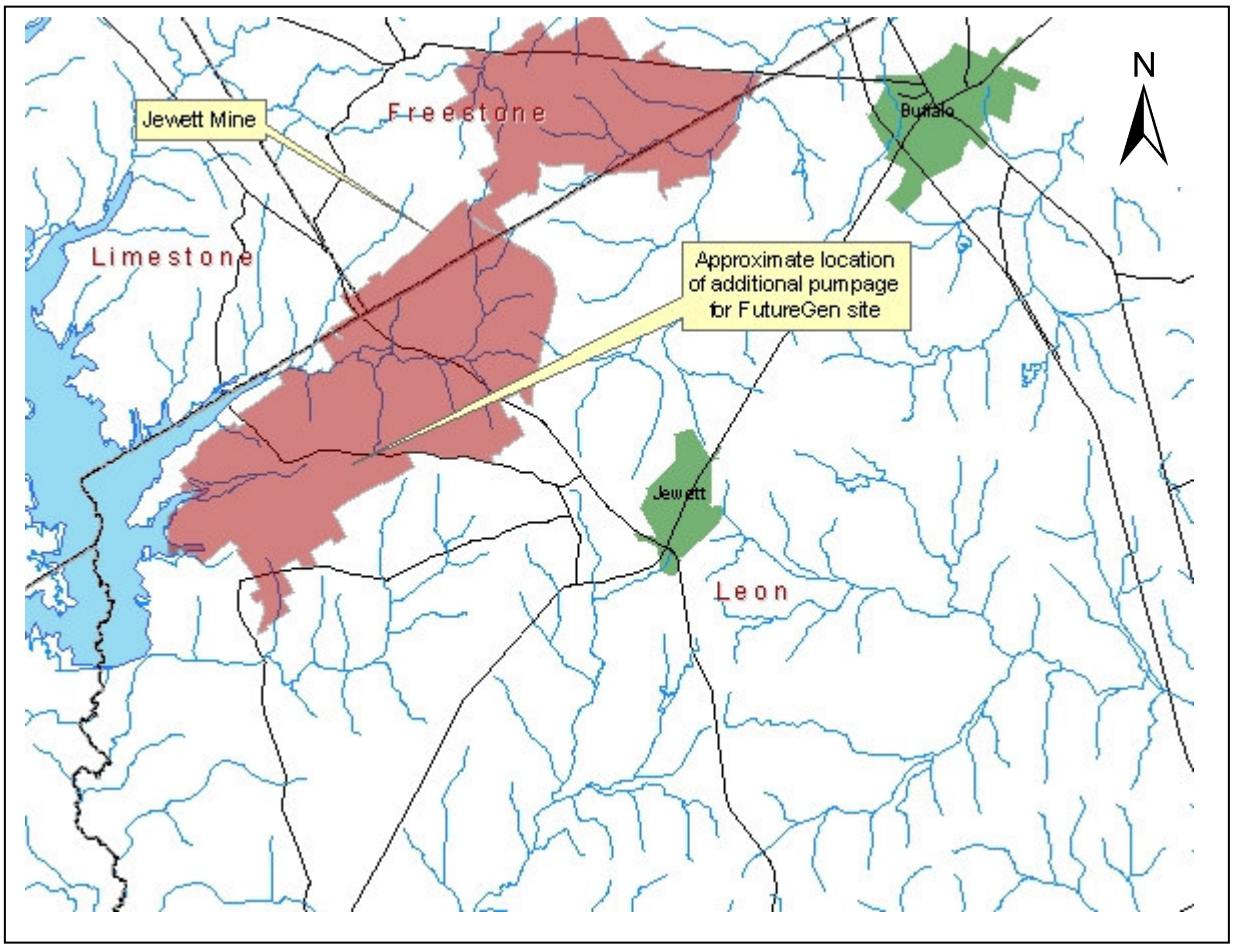

Figure 1. Location of site used in the model run to approximate regional impacts to groundwater due to proposed FutureGen pumpage near Jewett, Texas

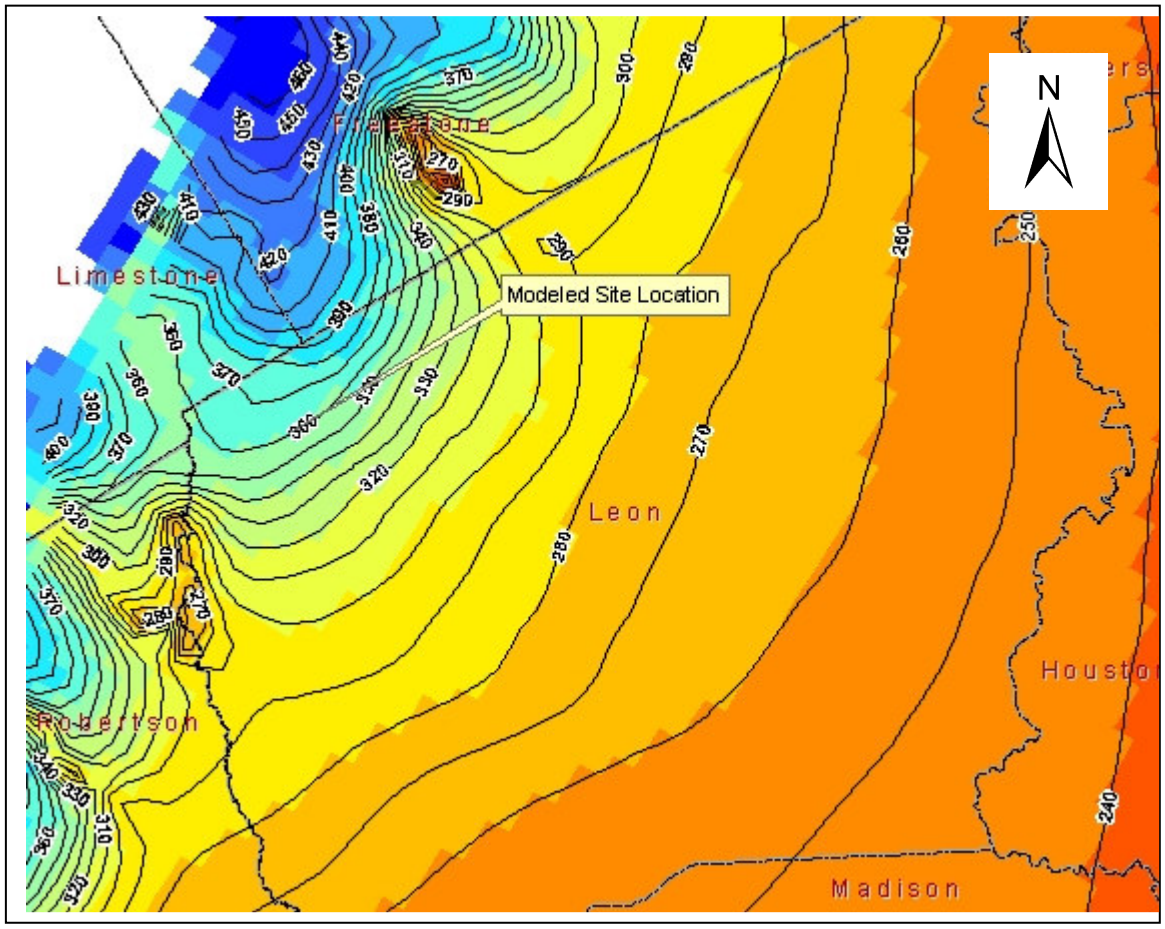

Figure 2. Initial water levels in the Upper Wilcox (Calvert Bluff) aquifer in the year 1999. Contour interval is 10 feet.

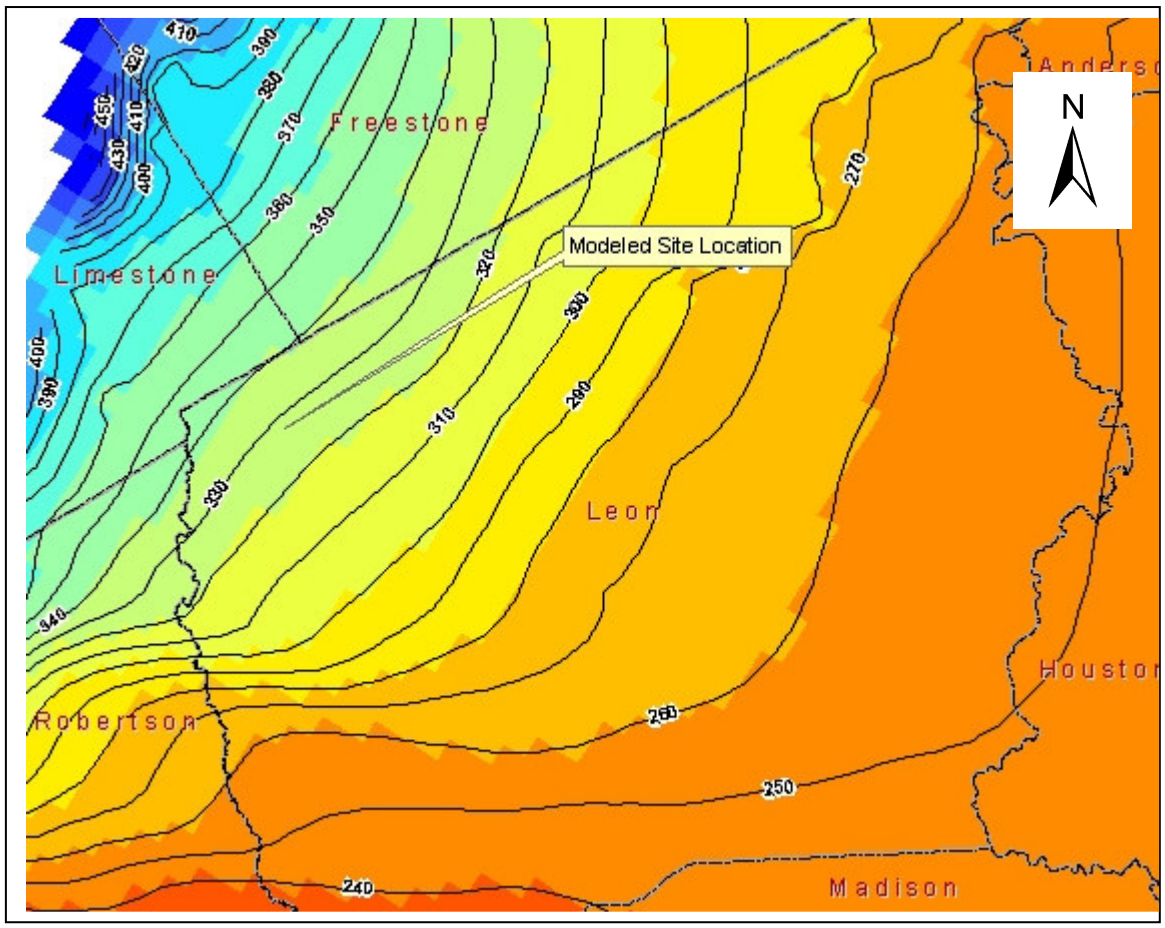

Figure 3. Initial water levels in the Middle Wilcox (Simsboro) aquifer in the year 1999. Contour interval is 10 feet.

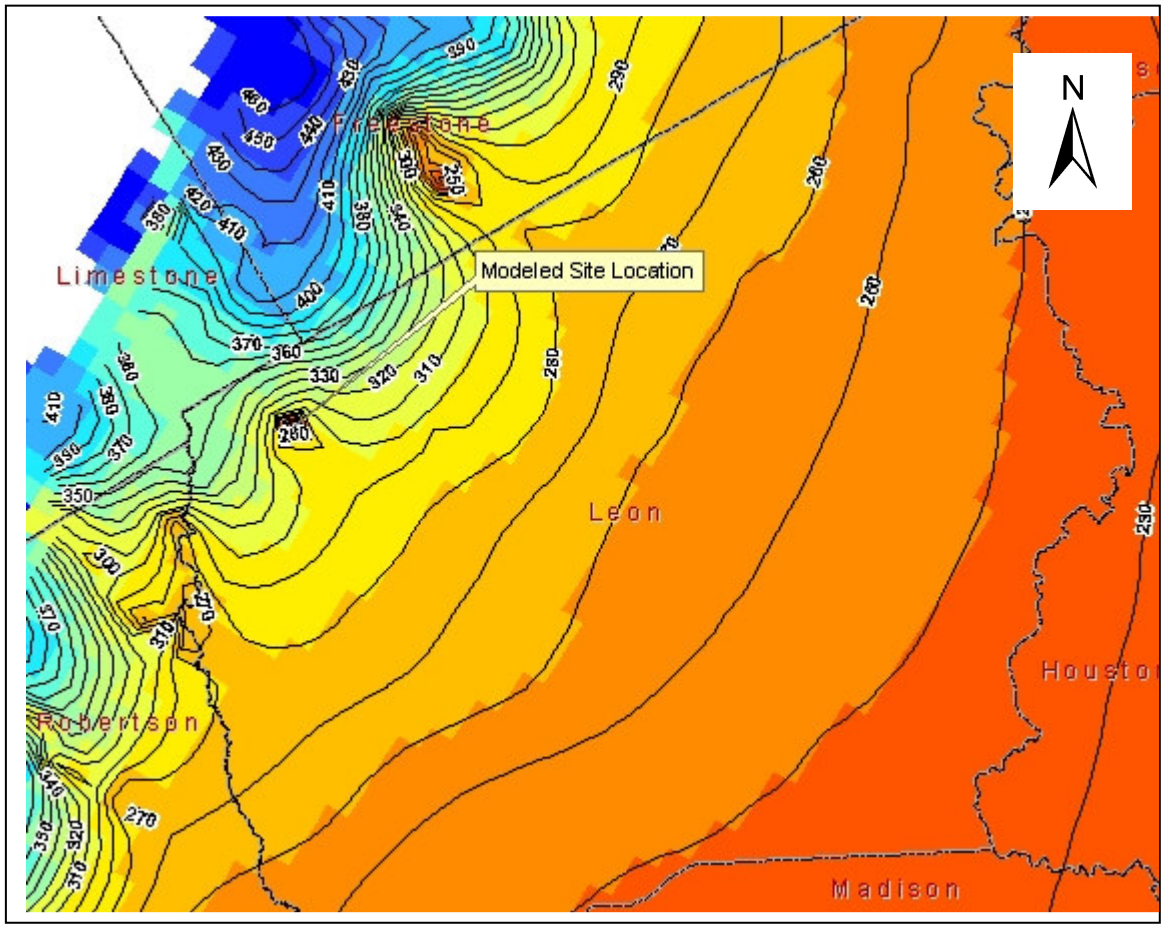

Figure 4. Water levels in the Upper Wilcox (Calvert Bluff) aquifer in the year 2050 after pumping an additional 4,000 acre-feet per year from the Upper Wilcox (Calvert Bluff) and Middle Wilcox (Simsboro) aquifers in the Jewett area for 50 years. Contour interval is 10 feet.

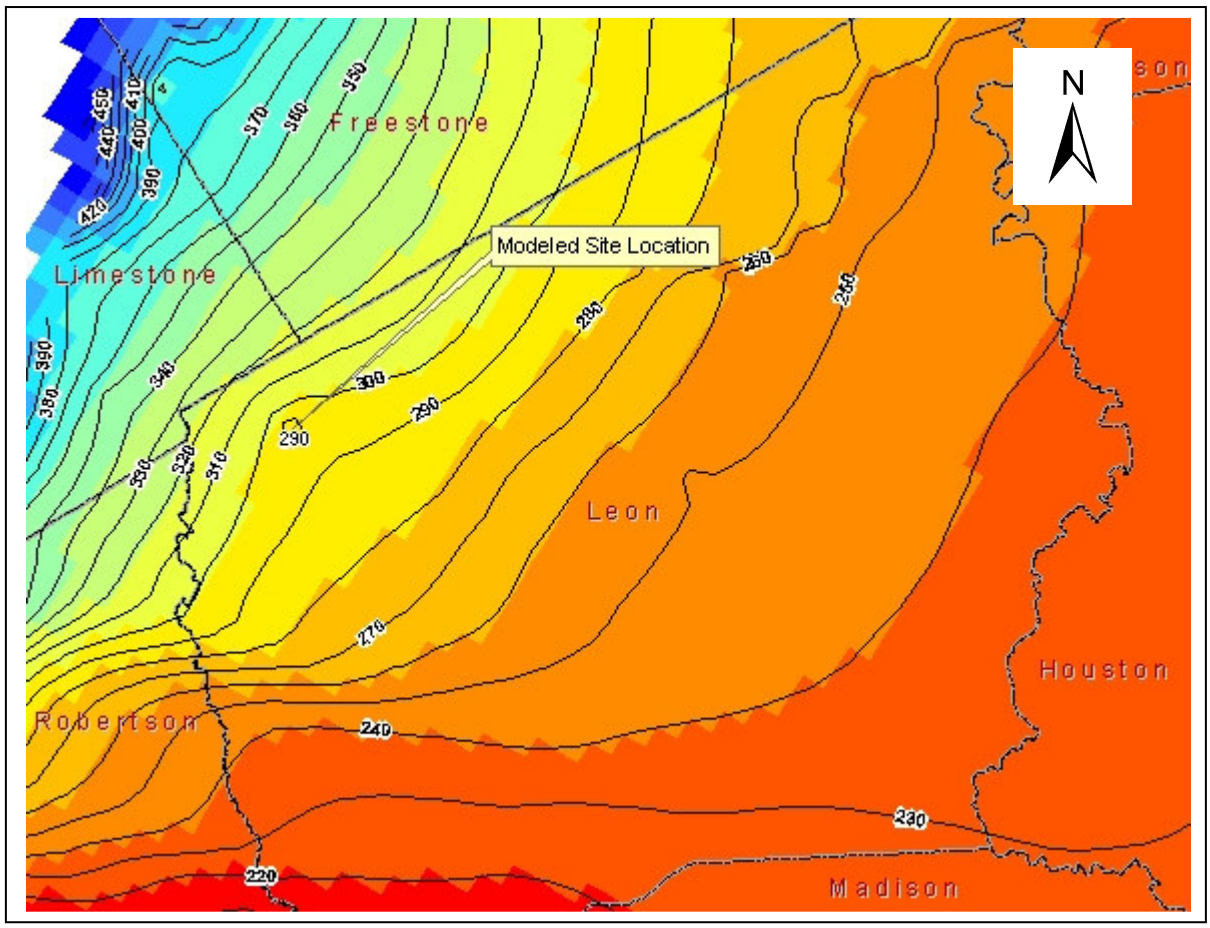

Figure 5. Water levels in the Middle Wilcox (Simsboro) aquifer in the year 2050 after pumping an additional 4,000 acre-feet per year from the Upper Wilcox (Calvert Bluff) and Middle Wilcox (Simsboro) aquifers in the Jewett area for 50 years. Contour interval is 10 feet.

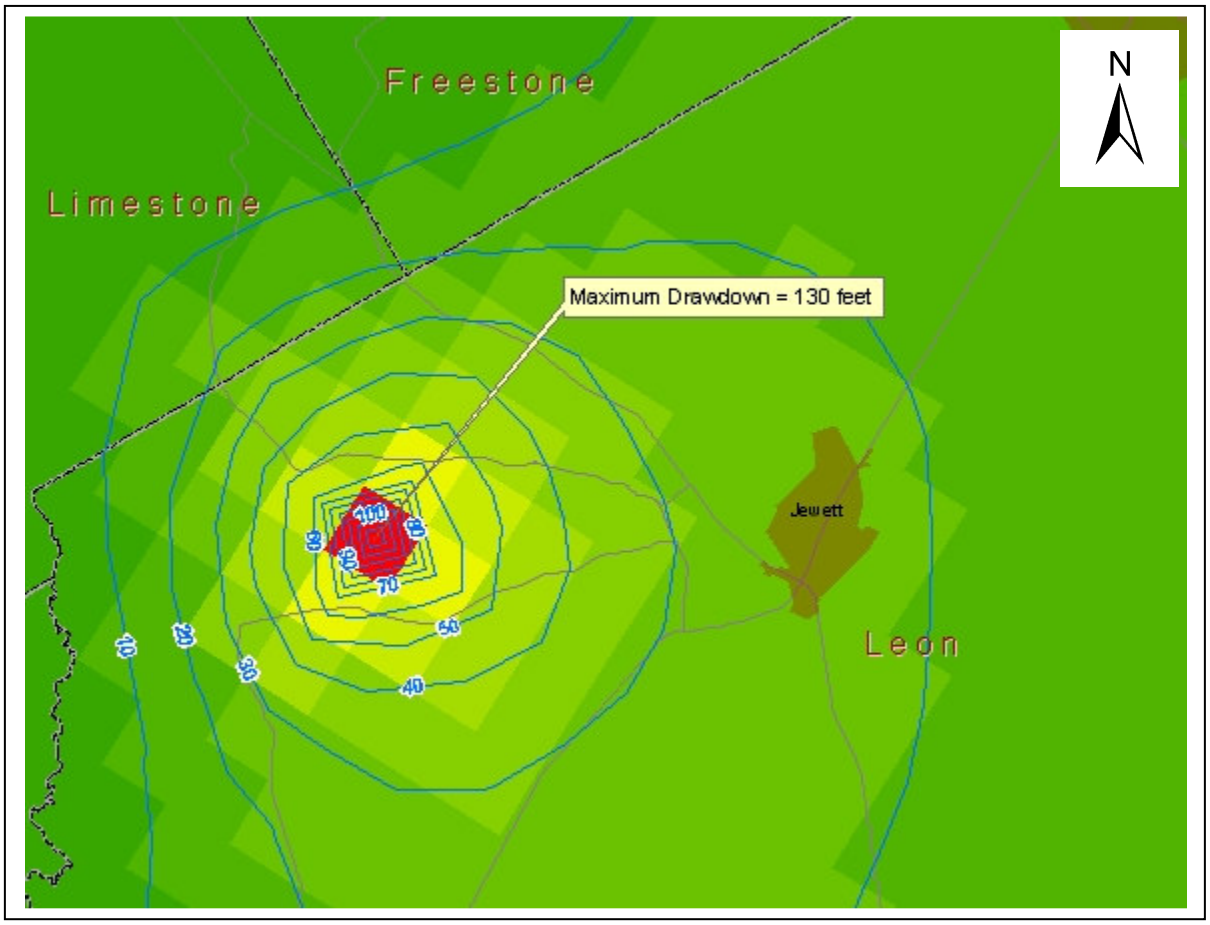

Figure 6. Drawdowns in the Upper Wilcox (Calvert Bluff) aquifer from 1999 to 2050 after pumping an additional 4,000 acre-feet per year from the Upper Wilcox (Calvert Bluff) and Middle Wilcox (Simsboro) aquifers in the Jewett area for 50 years. Contour interval is 10 feet.

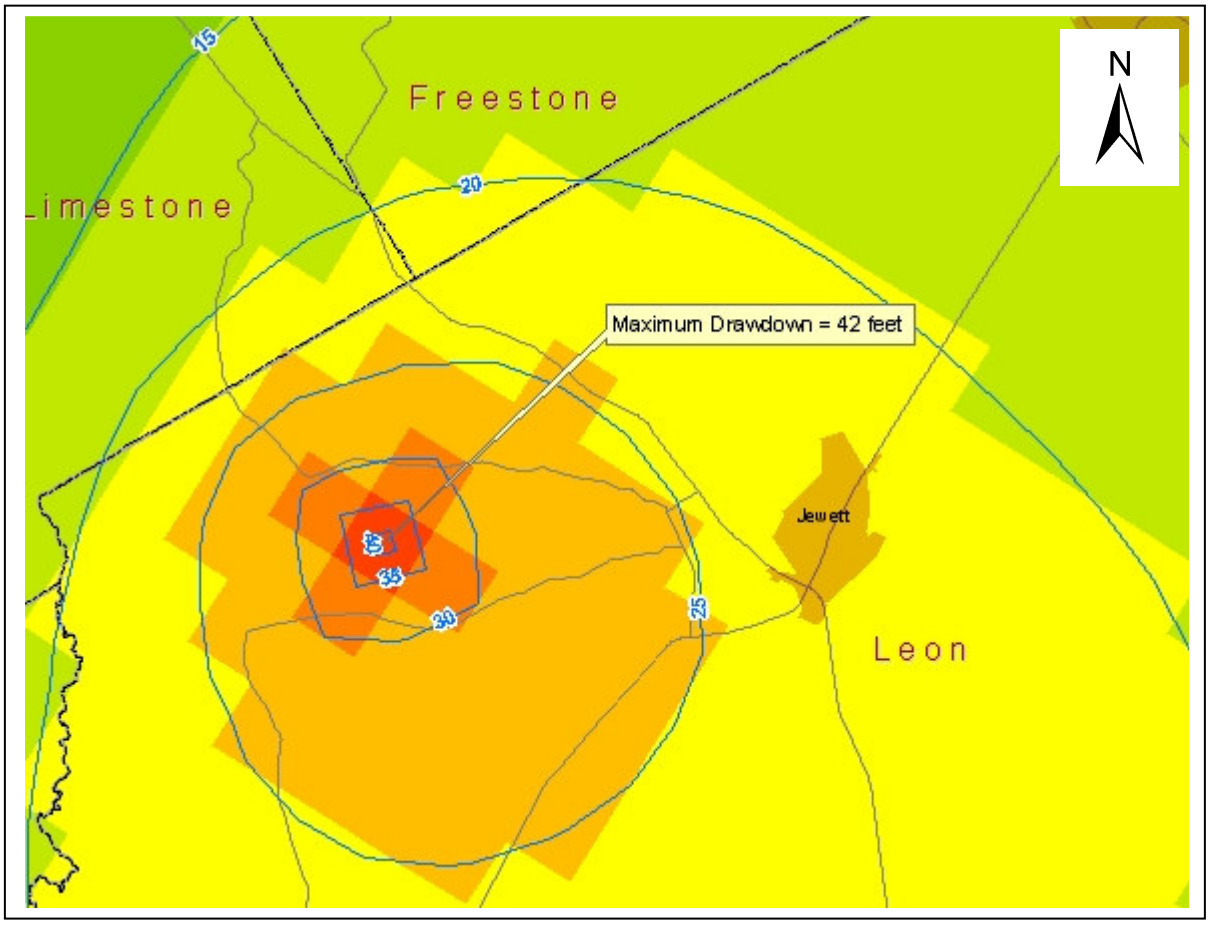

Figure 7. Drawdowns in the Middle Wilcox (Simsboro) aquifer from 1999 to 2050 after pumping an additional 4,000 acre-feet per year from the Upper Wilcox (Calvert Bluff) and Middle Wilcox (Simsboro) aquifers in the Jewett area for 50 years. Contour interval is 5 feet.