GAM Run 06-08

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Groundwater Availability Modeling Section
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July 6, 2006

REQUESTOR:

Mr. Len Luscomb of the Rusk County Groundwater Conservation District (GCD).

DESCRIPTION OF REQUEST:

Mr. Luscomb requested a groundwater availability model (GAM) run to determine the impact of an additional five million gallons per day (mgd) of pumpage for eight months a year from seven wells near Martin Lake, located near the Rusk-Panola county line (Figure 1).

METHODS:

To determine the effect of an additional five mgd of pumpage on water levels in the Martin Lake area, we used the GAM for the northern 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 pumpage to seven cells in the Martin Lake area, assuming equal pumpage from each of the seven cells (Figure 1). All of the pumpage was added to the Lower Wilcox aquifer model layer (which in this area of the GAM is Layer 7), which is the target aquifer for this project.

PARAMETERS AND ASSUMPTIONS:

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

- The GAM includes eight layers, representing:

  1. Sparta aquifer (Layer 1),
  2. Weches confining unit (Layer 2),
  3. Queen City aquifer (Layer 3),
  4. Reklaw confining unit (Layer 4),
  5. Carrizo aquifer (Layer 5),
  6. Upper Wilcox (Calvert Bluff Formation—Layer 6),
  7. Middle Wilcox (Simsboro Formation—Layer 7), and
  8. Lower Wilcox (Hooper Formation—Layer 8).

- In the Sabine Uplift area (which includes Martin Lake), the Simsboro Formation (Middle Wilcox aquifer) is not distinguishable and the Wilcox is informally divided into the Upper Wilcox and the Lower Wilcox aquifers (Fryar and others, 2003). In the GAM, layers 6 and 7 represent the Upper Wilcox and Lower Wilcox aquifers in this area. Layer 8 is included in the GAM in this area, but it is of nominal thickness and is not intended to represent the Lower Wilcox aquifer. The original Carrizo-Wilcox GAM did not include a third (bottom) layer for the Wilcox aquifer in the Sabine Uplift area.

- 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 26 feet for the Lower Wilcox aquifer (Layer 7) for the calibration period (1980-89) and 29 feet for the verification period (1990-99), or between five and six percent of the range of measured water levels (Kelley and others, 2004).

- Based on data from the GAM, the Lower Wilcox (Layer 7) in the Martin Lake area ranges from 550 to over 700 feet thick (Figure 2). Transmissivities range from approximately 8,500 to over 20,000 gallons per day per foot (Figure 3). Depths to the bottom of the Upper Wilcox range from zero to over 200 feet in the Martin Lake area (Figure 4). Depths to the bottom of the Lower Wilcox range from approximately 500 feet to 850 feet (Figure 5).

- We simulated a 76-year time period for the predictive model run, representing the years 1975 to 2050.

- We used 1999 pumpage to represent the baseline pumpage for each year of the predictive portion of the simulations (2000 to 2050). Pumpage from 1975 through 1999 is based on historical use and remains the same as documented in the GAM reports (Kelley and others, 2004; Fryar and others, 2003).

- We added pumpage to seven cells in the model to represent to proposed well field, as shown in Table 1 below. The amount of pumpage added for the first simulation is the equivalent of five mgd pumped for eight months of the year (October to May) from seven cells. A second model run was also done assuming that the well field would be pumped for the entire year (referred to as the "maximum-drawdown" run). As noted above, pumpage was entirely assigned to the Lower Wilcox aquifer, which in the Martin Lake area is Layer 7. No additional pumpage was added to layer 8 in the model.

Table 1. Pumpage added during the predictive part of the simulations (2000 to 2050) to represent pumpage from a well field in the Martin Lake area.

Layer	Row	Column	Additional pumpage in gallons per minute(gpm)	"Maximum-drawdown" additional pumpage (gpm)
7	85	125	331	497
7	85	126	331	497
7	85	127	331	497
7	86	125	331	497
7	86	126	331	497
7	87	124	331	497
7	87	125	331	497

- 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 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 part of the simulations. Recharge rates in the Martin Lake area are 0.9 to 1.3 inches per year, which are similar to previous recharge estimates (Scanlon and others, 2002). Recharge rates for cells where the Carrizo outcrops to the west of Martin Lake are generally greater than 3 inches per year.

- 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 portion of the simulations.

- 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 portion of the simulations. Martin Lake is included in the reservoir package.

- The GAM uses the MODFLOW drain package to simulate discharge to springs. Average drain parameters were used for each year in the predictive portion of the simulations.

- 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. However, the Martin Lake area is not near any of the GHBs, and therefore they do not impact the results of this study.

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

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

RESULTS:

All reductions in water levels (drawdowns) shown in the results for this report are additional drawdowns from a baseline model run. The baseline model run was a 50-year predictive simulation using 1999 pumpage for each year of the predictive period. By showing additional drawdown from the baseline, we are showing only the effect of the additional proposed pumpage on water levels. These simulations do not reflect estimated trends or strategies from regional water plans or the 2002 State Water Plan.

Additional drawdown in the Lower Wilcox aquifer (Layer 7) after 1, 10, and 50 years of pumping five mgd over a period of eight months each year are shown in Figures 6, 7, and 8, respectively. These figures indicate that the maximum drawdown due to the additional pumpage in the Martin Lake area is approximately 47 feet after one year, 64 feet after ten years, and 94 feet after 50 years. Additional drawdown in the Upper Wilcox aquifer (Layer 6) after 50 years is less than two feet, indicating that there is very little hydraulic communication between the Upper and Lower Wilcox aquifers in this area.

Additional drawdown in the Lower Wilcox aquifer (Layer 7) after 1, 10, and 50 years of pumping five mgd over an entire year are shown in Figures 9, 10, and 11, respectively. This model run was done to show a “maximum-drawdown” scenario, where the capacity of the well field was produced for the entire year in the predictive portion of the simulation. These figures indicate that the maximum drawdown due to the full capacity of the proposed well field being used all of time is approximately 60 feet after one year, 85 feet after ten years, and 135 feet after 50 years. Additional drawdown in the Upper Wilcox aquifer (Layer 6) after 50 years is less than 2.5 feet.

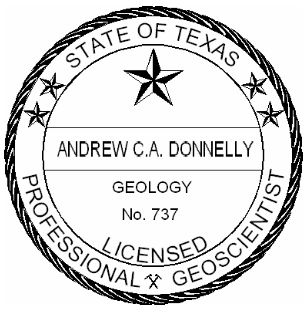
It is important to note that these water levels and drawdowns do not reflect what will occur within the individual well field. Water levels and drawdowns shown in this report are estimates of the impact that this amount of pumpage will have on the aquifers from a regional perspective. Because the GAM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

REFERENCES:

Fryar, D., Senger, R., Deeds, N., Pickens, J., Jones, T., Whallon, A. J., and Dean, K. E., 2003, Groundwater Availability Model for the Northern Carrizo-Wilcox Aquifer: contract report to the Texas Water Development Board, 529 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.

Scanlon, B. R., Dutton, A., and Sophocleous, M., 2002, Groundwater recharge in Texas: contract report to the Texas Water Development Board, 84 p.



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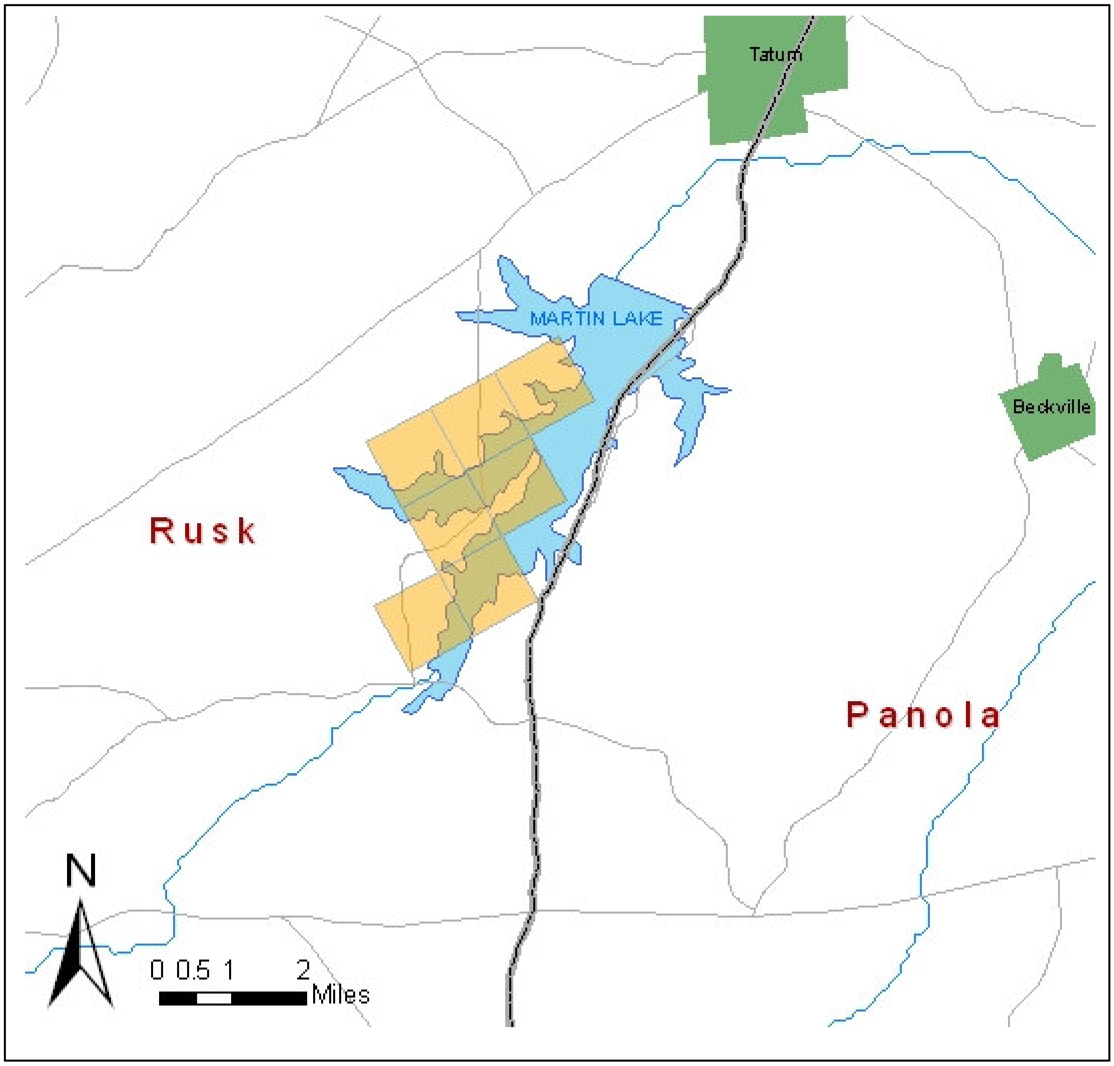

Figure 1. Location of the study area near Martin Lake. The seven GAM model cells where additional proposed pumpage was added are shown in orange.

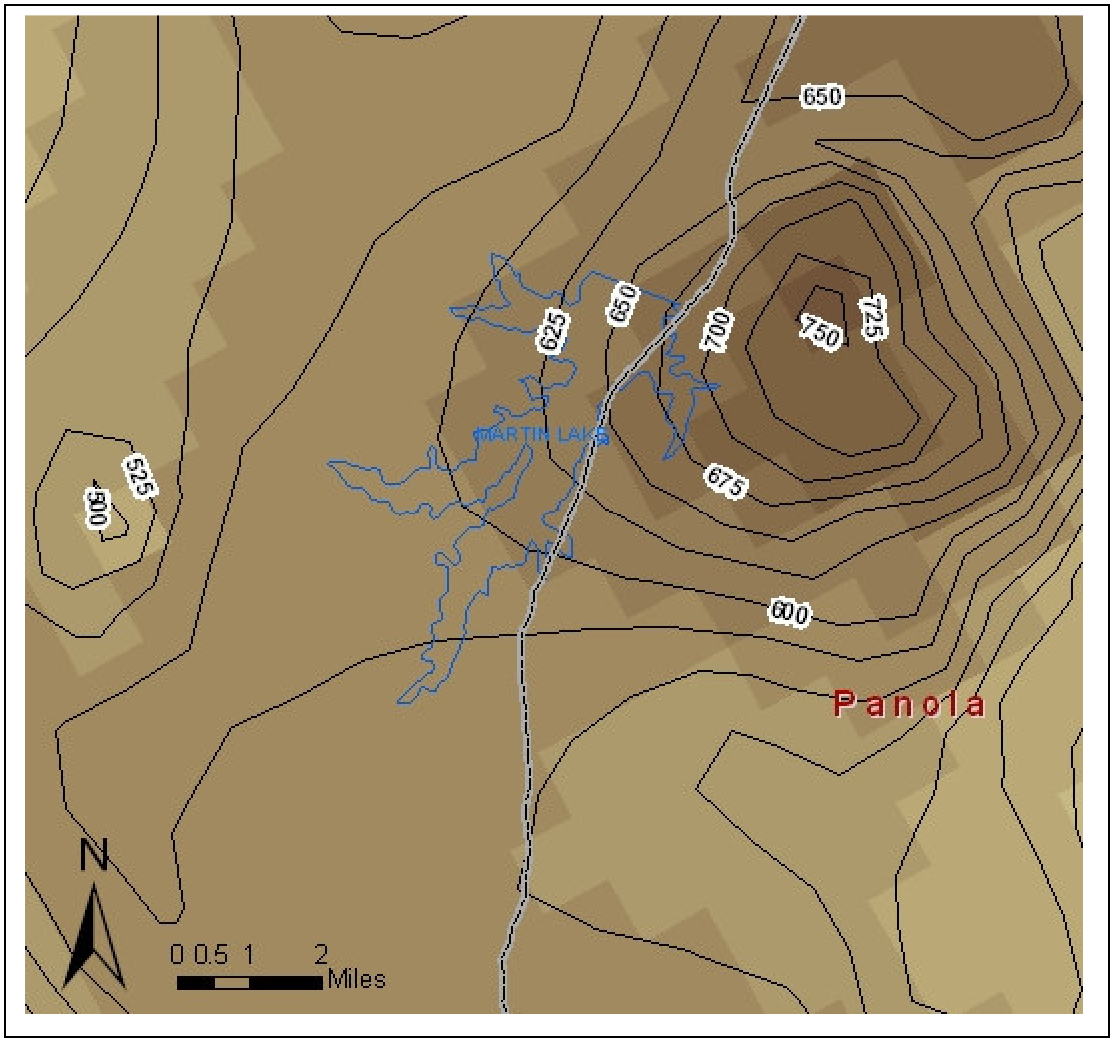

Figure 2. Thickness of the Lower Wilcox aquifer (Layer 7) in the study area based on data from the GAM. The contour interval is 25 feet.

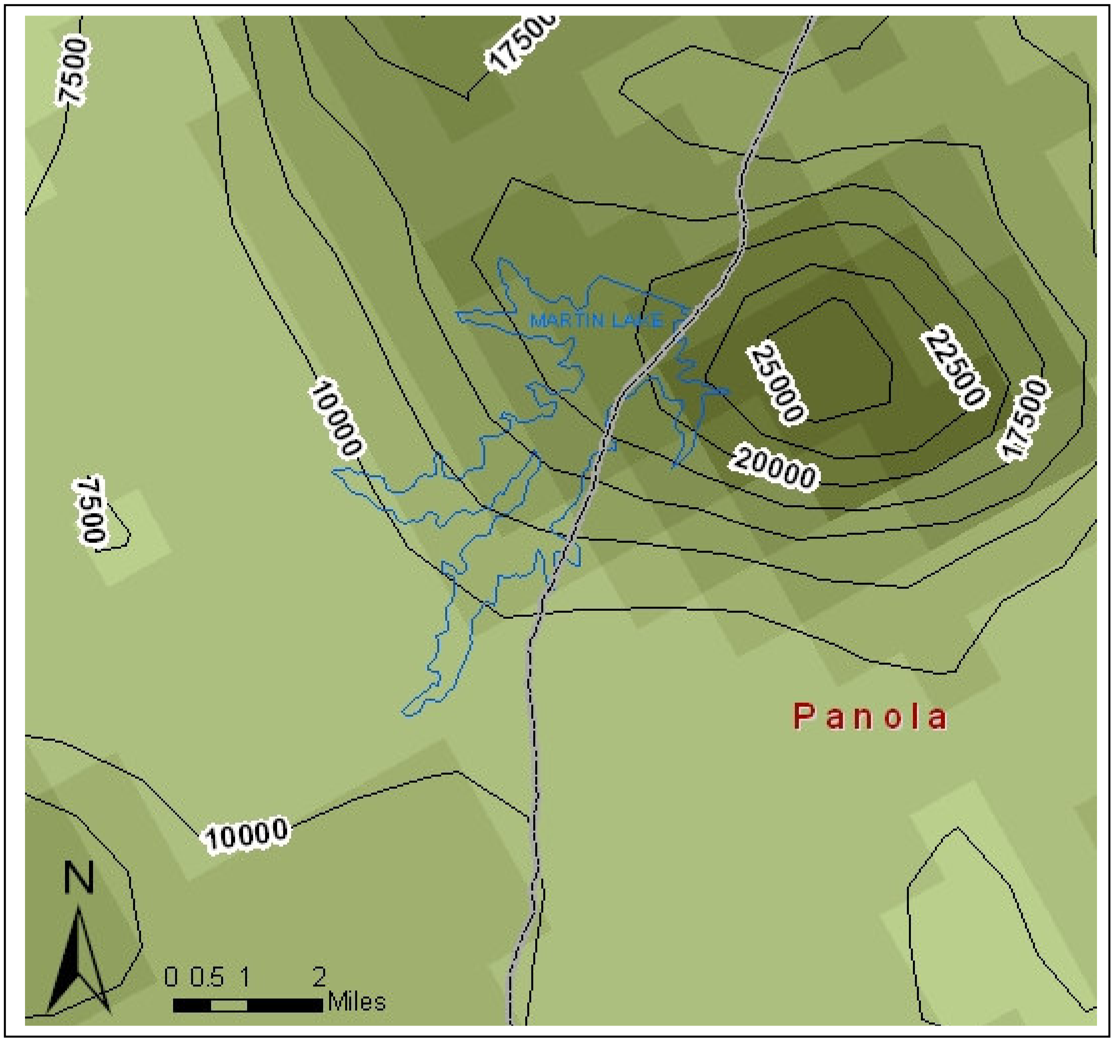

Figure 3. Transmissivity (in gallons per foot per day) of the Lower Wilcox aquifer (Layer 7) in the study area based on data from the GAM. The contour interval is 2,500 gallons per foot per day.

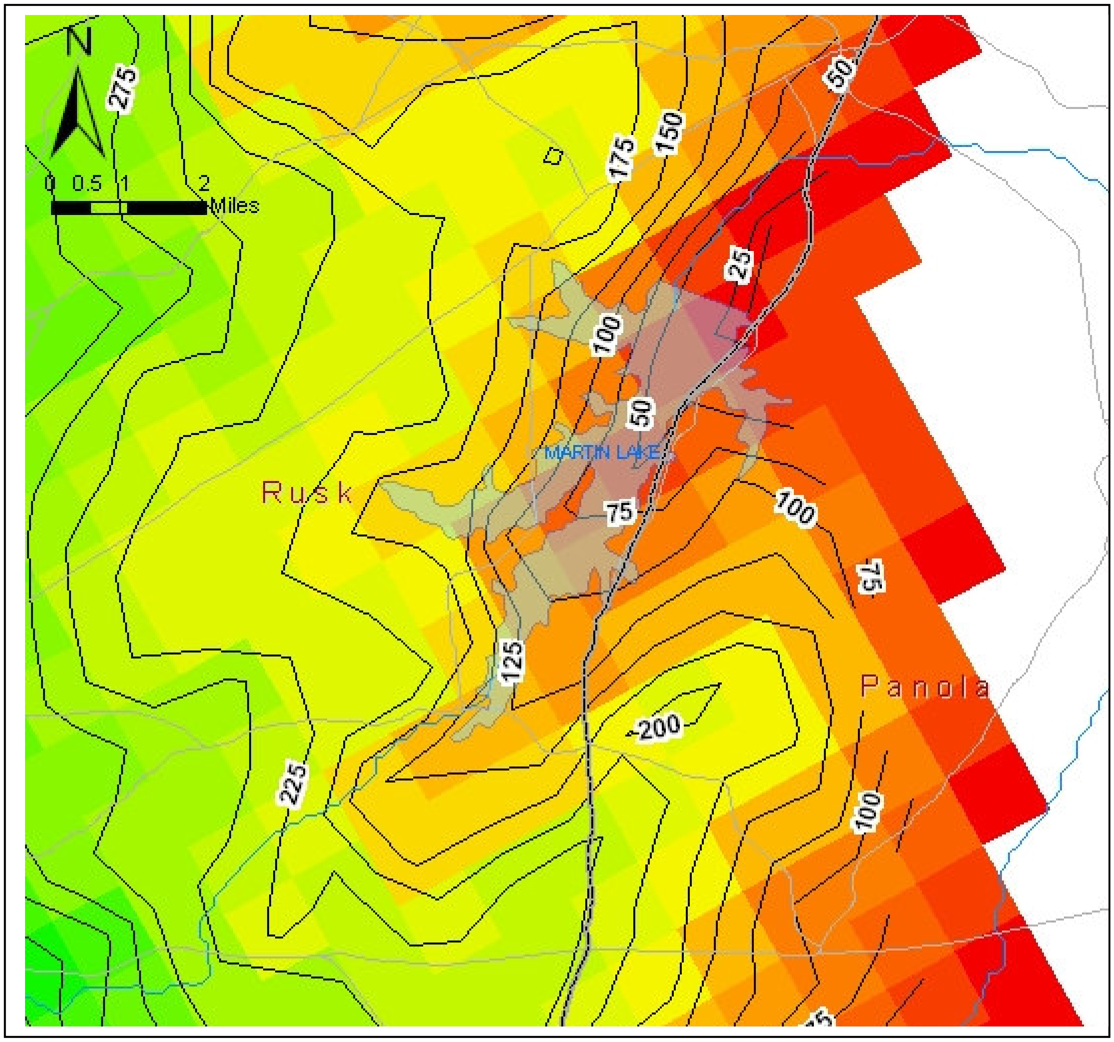

Figure 4. Depth to the bottom of the Upper Wilcox based on data from the GAM. The contour interval is 25 feet. The area to the east of Martin Lake with no color is where the Upper Wilcox is not present and the Lower Wilcox is found at land surface.

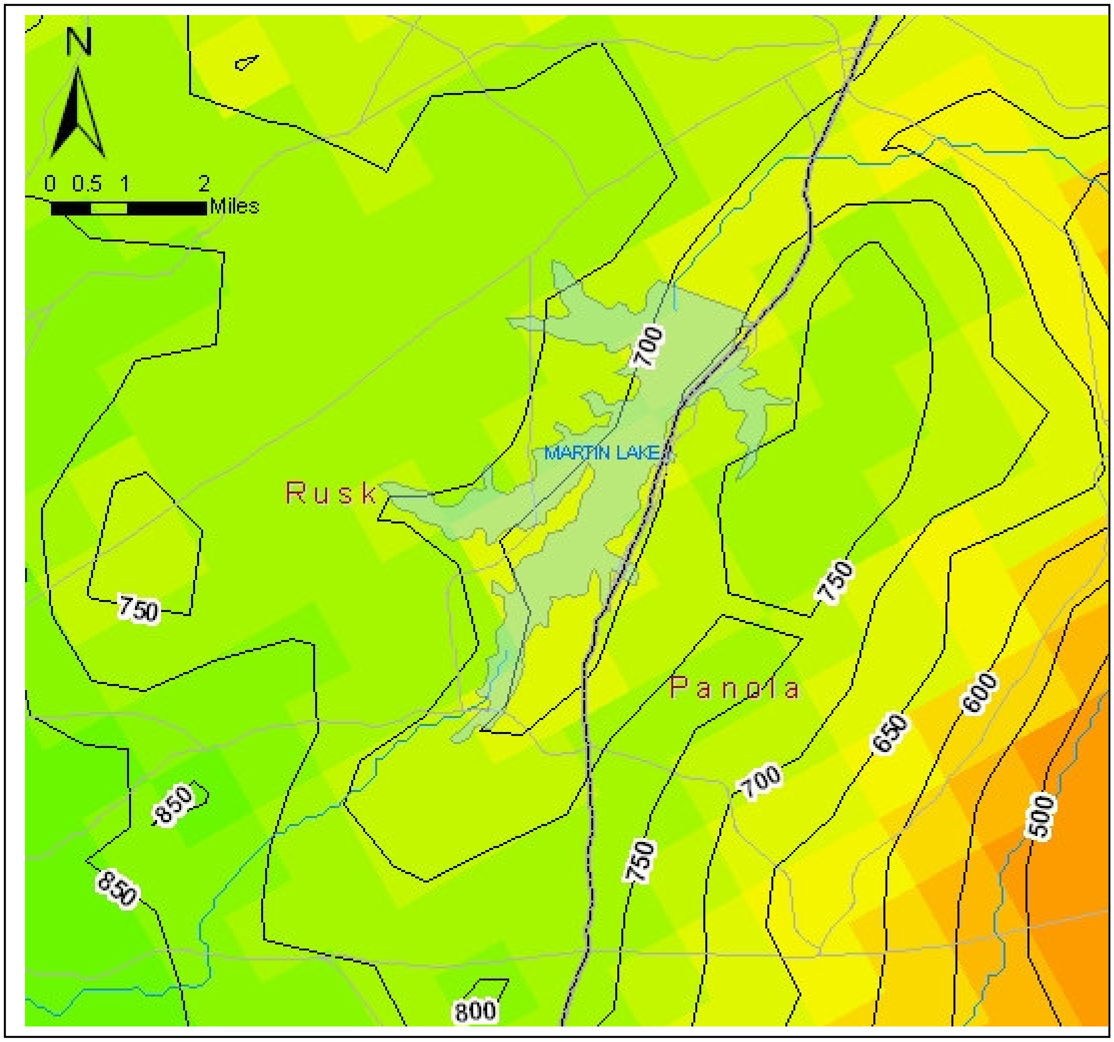

Figure 5. Depth to the bottom of the Lower Wilcox based on data from the GAM. The contour interval is 50 feet.

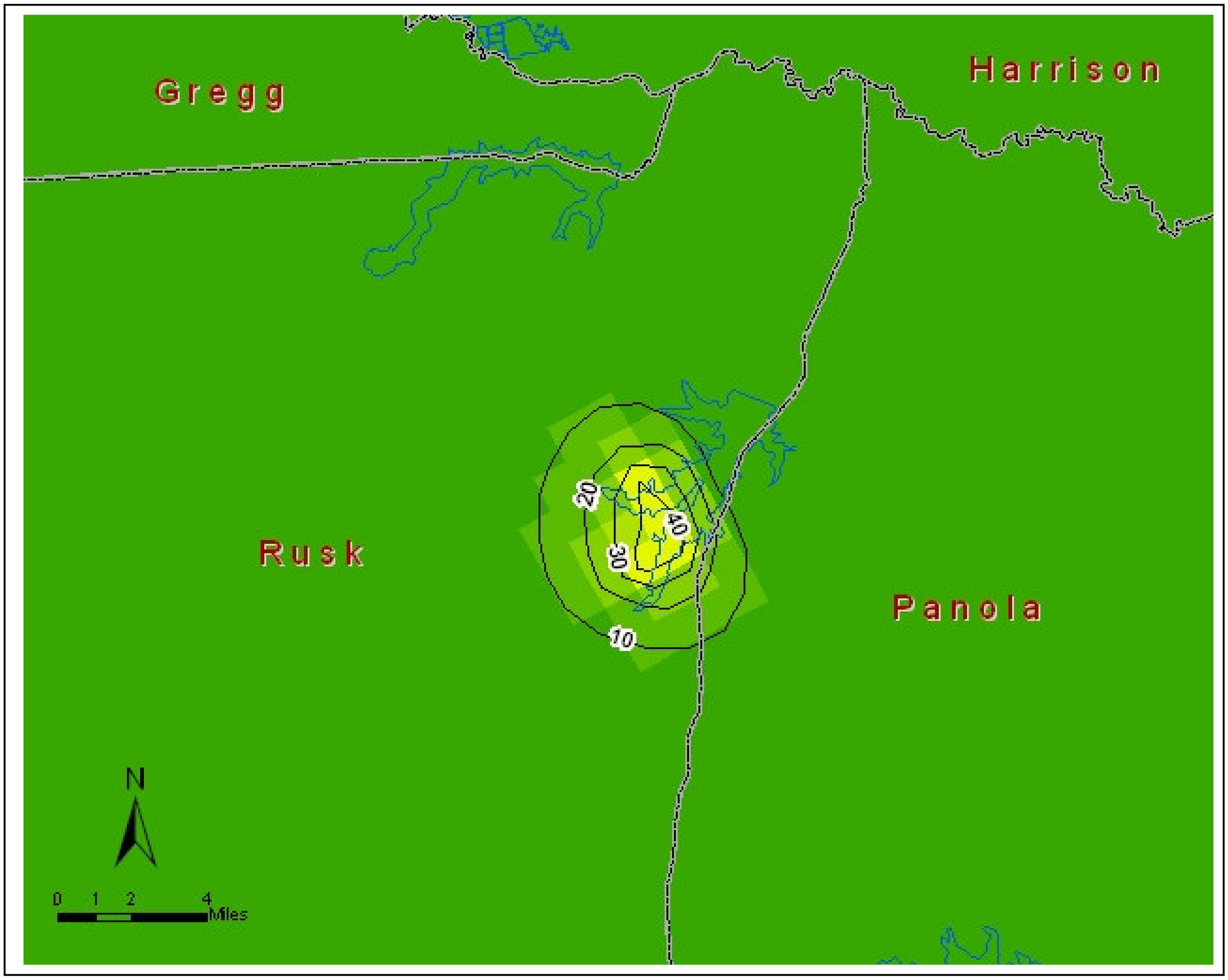

Figure 6. Additional drawdown in the Lower Wilcox aquifer (Layer 7) after one year. The contour interval is ten feet. Additional drawdown is equal to water levels with the baseline pumpage minus water levels with the additional well field pumping.

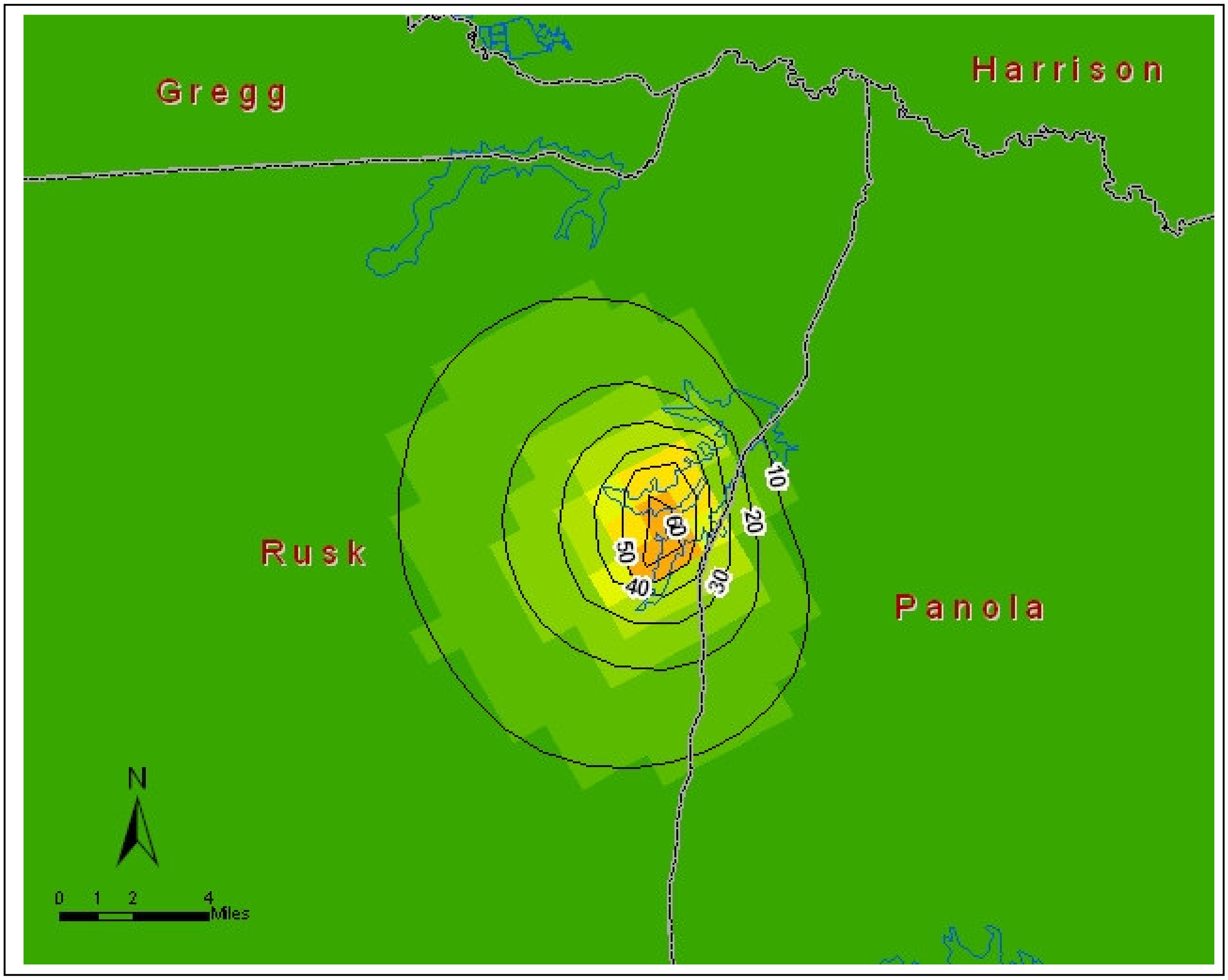

Figure 7. Additional drawdown in the Lower Wilcox aquifer (Layer 7) after ten years. The contour interval is ten feet. Additional drawdown is equal to water levels with the baseline pumpage minus water levels with the additional well field pumping.

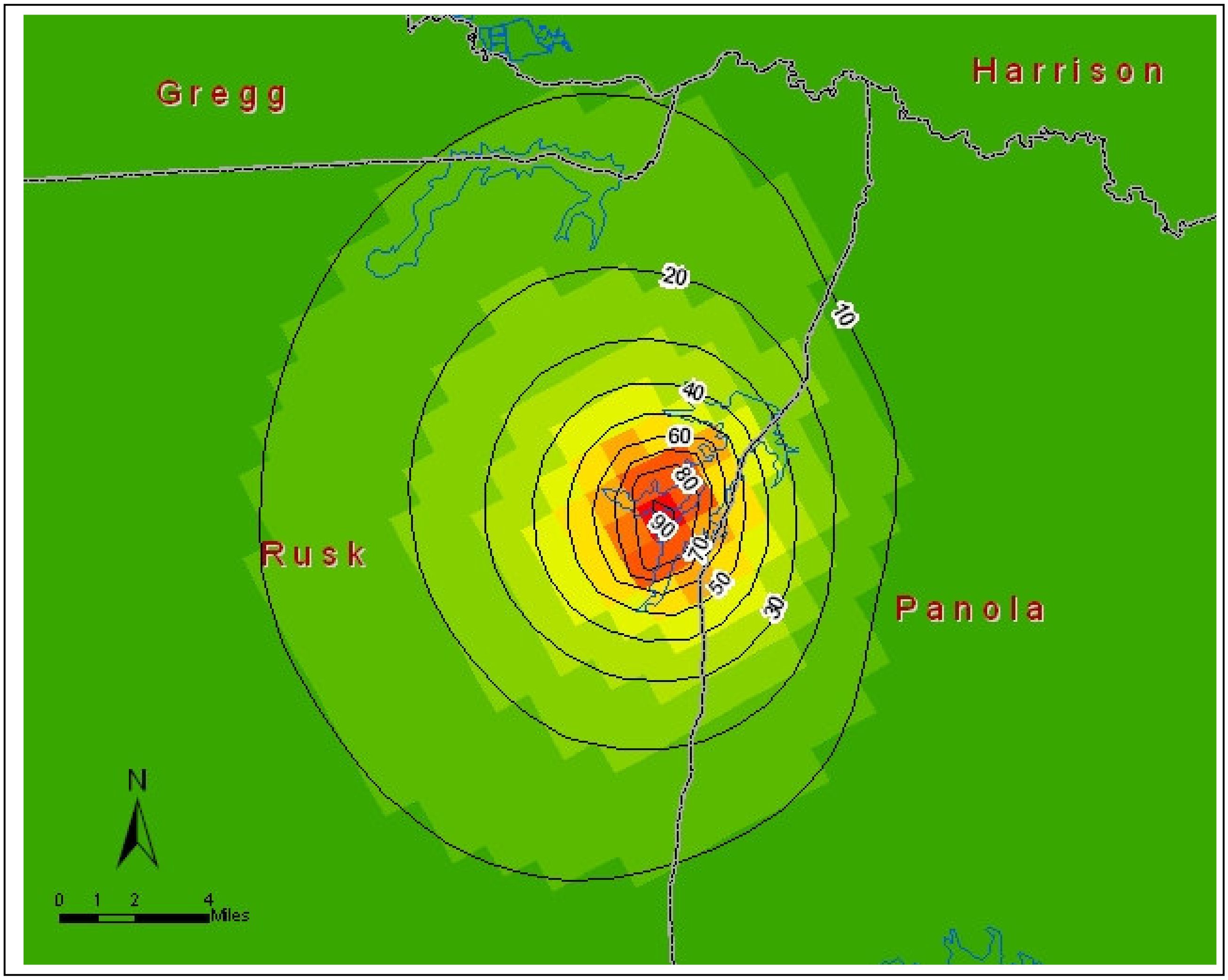

Figure 8. Additional drawdown in the Lower Wilcox aquifer (Layer 7) after fifty years. The contour interval is ten feet. Additional drawdown is equal to water levels with the baseline pumpage minus water levels with the additional well field pumping.

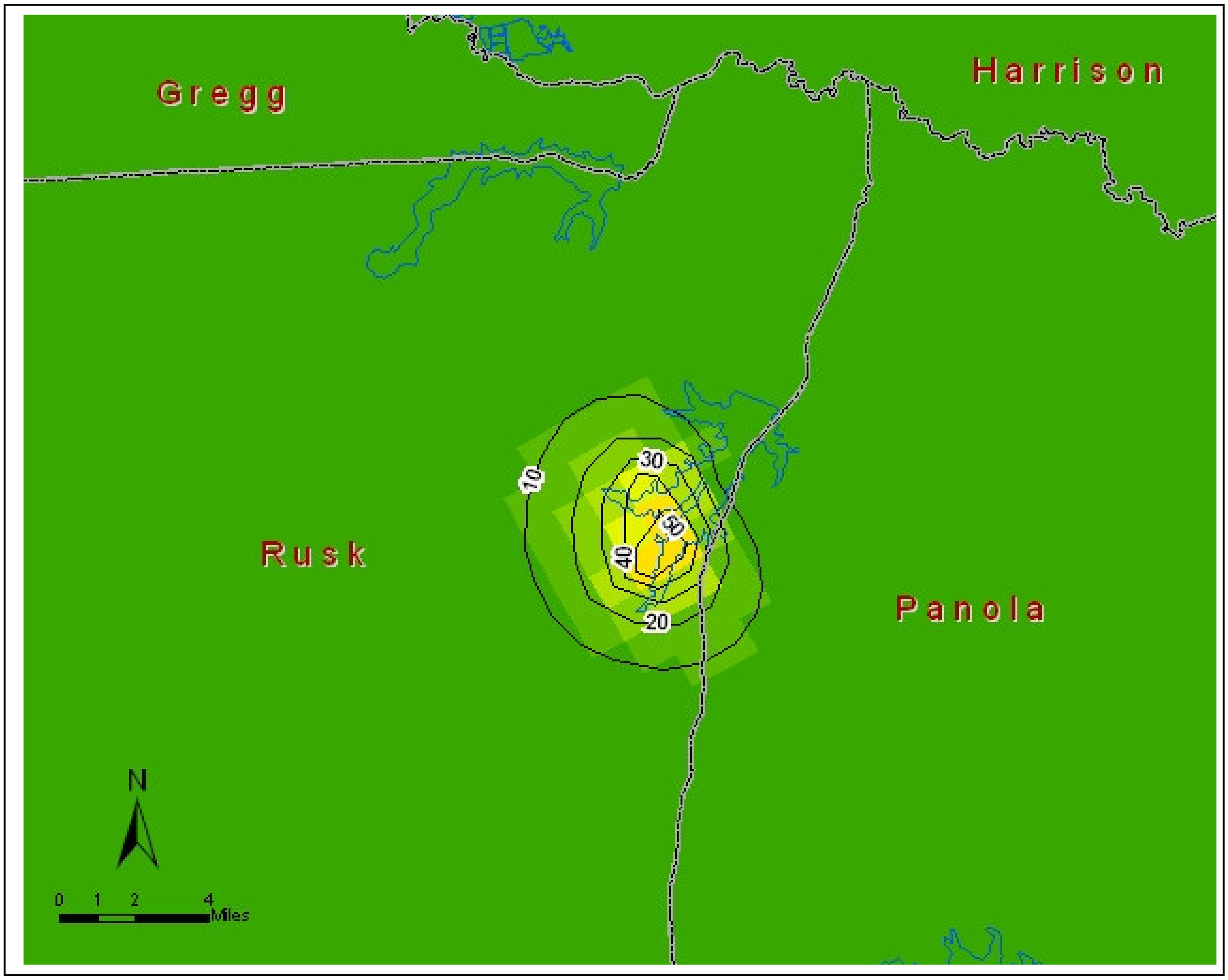

Figure 9. Additional drawdown in the Lower Wilcox aquifer (Layer 7) after one year when pumping the well field for the entire year. The contour interval is ten feet. Additional drawdown is equal to water levels with the baseline pumpage minus water levels with the additional well field pumping.

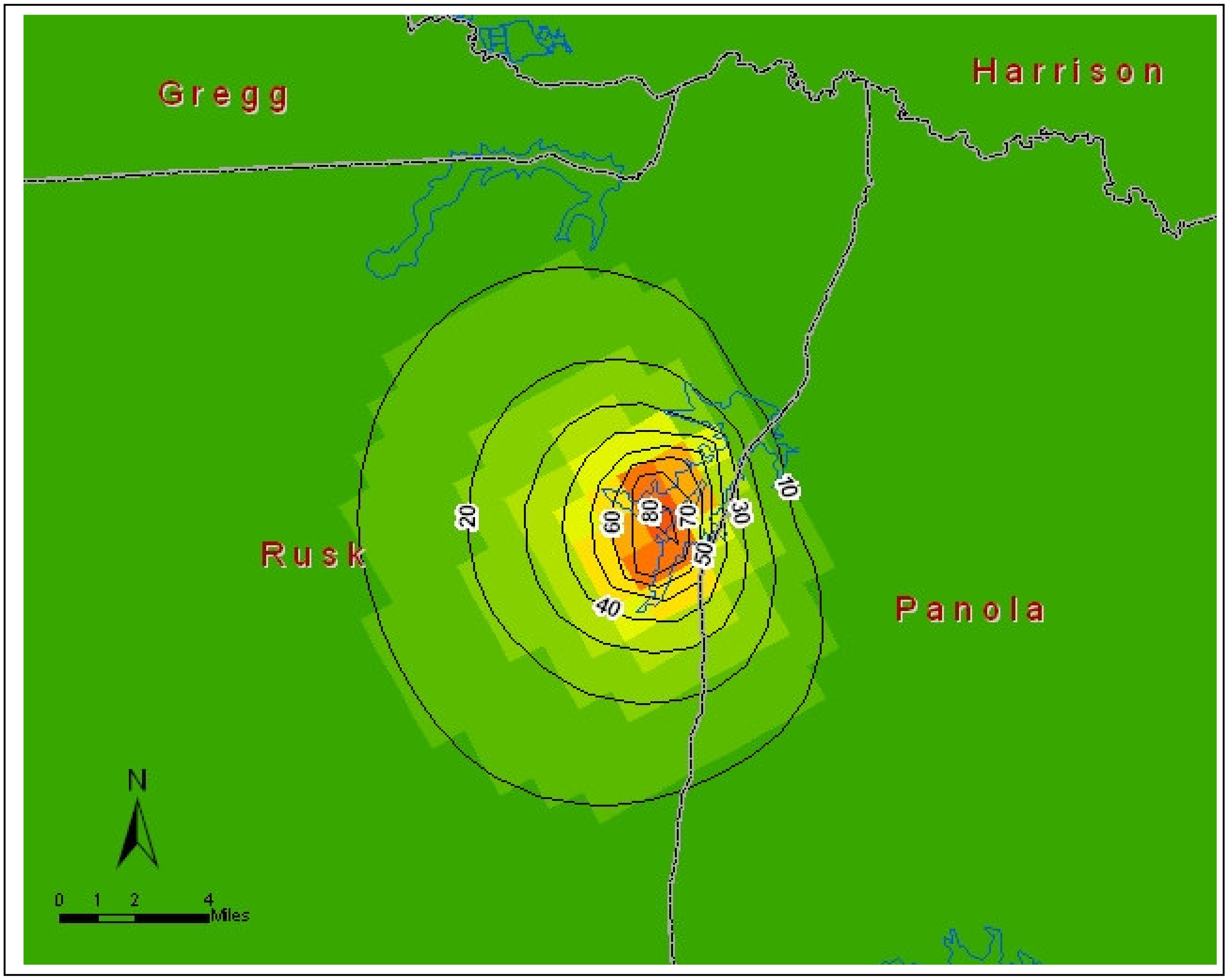

Figure 10. Additional drawdown in the Lower Wilcox aquifer (Layer 7) after ten years when pumping the well field for the entire year for each year of the predictive portion of the simulation. The contour interval is ten feet. Additional drawdown is equal to water levels with the baseline pumpage minus water levels with the additional well field pumping.

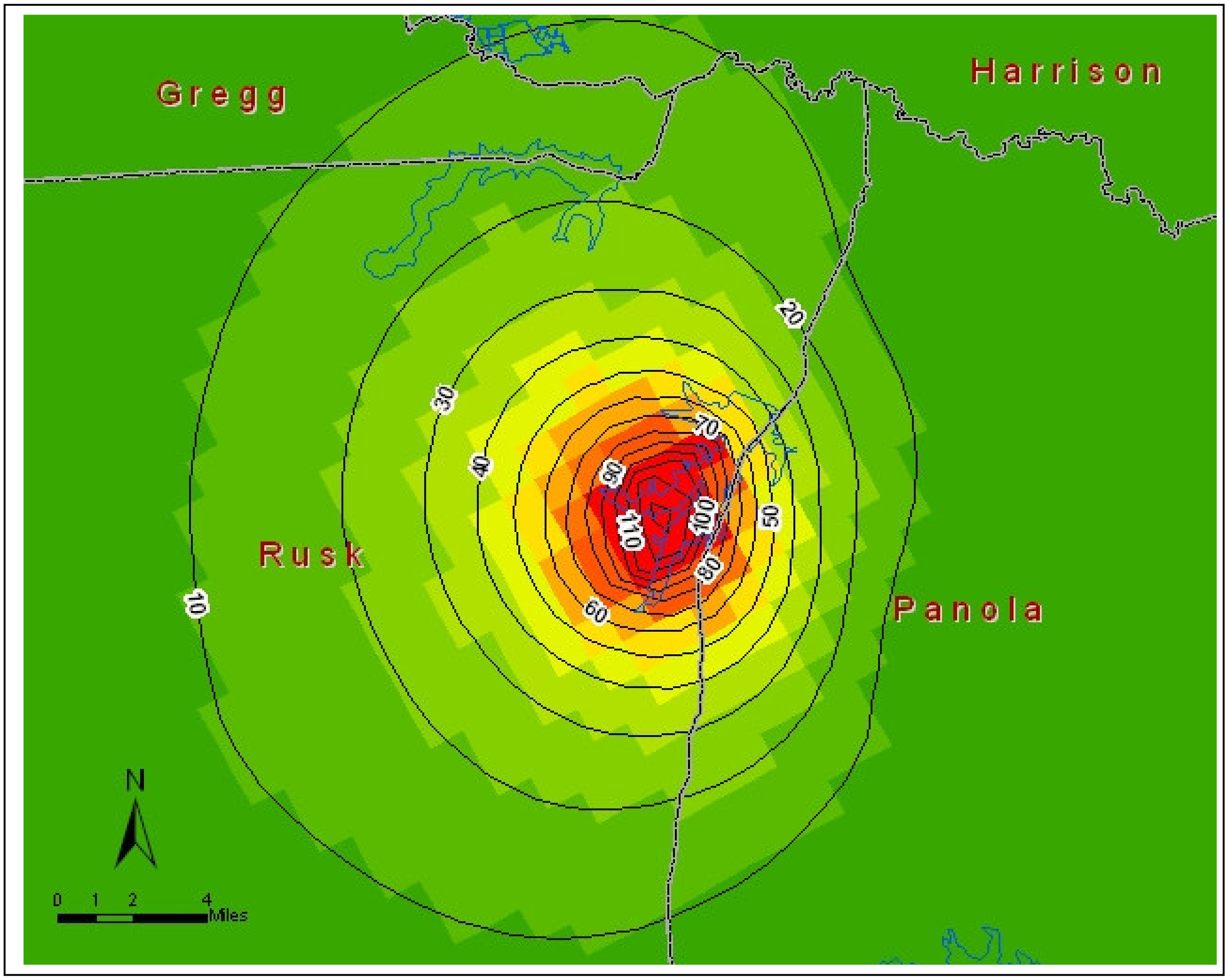

Figure 11. Additional drawdown in the Lower Wilcox aquifer (Layer 7) after fifty years when pumping the well field for the entire year for each year of the predictive portion of the simulation. The contour interval is ten feet. Additional drawdown is equal to water levels with the baseline pumpage minus water levels with the additional well field pumping.