GAM run 07-38 (Revised)

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EXECUTIVE SUMMARY:

We ran groundwater availability models for the northern and southern segments of the Ogallala Aquifer in order to produce a baseline volume of groundwater in each grid cell in the models. We extracted average annual recharge for each grid cell from the models. First we calculated the total volume of groundwater in each grid cell using an assumed porosity value. We then calculated the pumping rate for each cell that would result in the retention of 50 percent of the initial volume of groundwater after fifty years with average annual recharge. We used these results to generate a new well file for both models in Groundwater Management Area 1. Pumping rates varied according to aquifer thickness. After the model runs, we generated saturated thickness maps for each decade from 2000 through 2050. By 2050, some areas of northern Dallam, a small area in western Sherman, south central Moore, south central Hansford, and north central Hutchinson counties became inactive. Based on this model run, it is possible to achieve a fifty percent reduction of the saturated thickness in fifty years without widespread areas of the aquifer becoming inactive.

REQUESTOR:

Mr. C.E. Williams with the Panhandle Groundwater Conservation District on behalf of Groundwater Management Area 1.

DESCRIPTION OF REQUEST:

Based on the pumping rates established in GAM run 07-31 (Smith, November 8, 2007) it was requested that the area-wide pumping rates be applied to the groundwater availability models for the northern and southern segments of the Ogallala Aquifer for a fifty year period with 2000 as the baseline year.

METHODS:

To address the request, we did the following steps:

- We calculated annual pumping rates as the percentage change in total storage plus the average recharge for each year from 2000 to 2050 in each grid cell (one square mile) of the two models.
- We used the pumping rates per grid cell to create new well files which were then used as input to the two models.

- We ran both models for the projected fifty years.
- The results are presented as a series of maps showing the saturated thickness from the baseline of year 2000 through 2050 on a decade-by-decade basis.

PARAMETERS AND ASSUMPTIONS:

- We used version 2.01 of the groundwater availability model for the northern part of the Ogallala Aquifer (Dutton, 2004) and version 1.01 of the groundwater availability model for the southern part of the Ogallala Aquifer (Blandford and others, 2003),
- See Dutton and others (2001) and Dutton (2004) for assumptions and limitations of the model for the northern part of the Ogallala Aquifer. Root mean squared error for this model is 53 feet. This error has more of an effect on model results where the aquifer is thin.
- See Blandford and others (2003) for assumptions and limitations of the model for the southern part of the Ogallala Aquifer. Root mean squared error for this model is 47 feet. This error will have more of an effect on model results where the aquifer is thin.
- Recharge was reappraised in the updated model of the northern part of the Ogallala Aquifer (Dutton, 2004).
- Average recharge used in both of the models was based on a percentage of average precipitation for the 1950 through 1990 period of record. This period includes the 1950s drought of record, consequently the average recharge used for this analysis is considered a conservative estimate.
- For Randall, Potter, and Armstrong counties, which are partially included in both the northern and southern parts of the Ogallala Aquifer groundwater availability models, we combined the results of the volume calculation from each model to get full county totals. However, we used the groundwater volume calculated from each model for that segment of the county covered as the starting point for the annual pumping rate calculation which would result in a fifty percent decline over a fifty year period.

RESULTS:

Figures 1 through 3 show the baseline saturated thickness for Groundwater Management Area 1 as calculated from the year 2000 values. Figures 4 through 6 show the saturated thickness in 2010; Figures 7 through 9 are for 2020; Figures 10 through 12 are for 2030; Figures 13 through 15 are for 2040; and Figures 16 through 18 are for 2050.

The changes in saturated thickness are most evident in Dallam and Moore counties as illustrated in Figure 4. All white areas have been rendered inactive in the model. This in effect occurs when the water level intersects the bottom elevation of the aquifer (model layer) and the model cell is no longer an active element in the model. No pumping, no recharge and no groundwater flow are associated with the inactive grid cells.

Although the pumping in the model run is distributed on a cell-by-cell basis for all years after 2000, the presence of active pumping centers prior to 2000 leads to the existence of zones of slightly thinner saturated thicknesses than surrounding cells in the year 2000 calculations. However, the overall result of maintaining fifty percent of the aquifer after fifty years appears possible based on this model run. For example, Hartley County in 2000 has saturated thicknesses of 100 to 300 feet (Figure 1). In 2050, these same areas are reduced to 50 to 150 feet (Figure 16). Moore County has saturated thicknesses ranging from close to zero to over 300 feet thick in 2000 (Figure 1). By 2050, the thinnest areas are inactive and the thicker areas are reduced by about fifty percent (Figure 16). Randall and Potter counties have saturated thicknesses in 2000 of 100 to 150 (Figure 2) feet which are reduced to less than 50 to 100 by 2050 (Figure 17). Sherman and Hansford counties indicate saturated thicknesses of 100 to over 400 feet in 2000 (Figure 2). However, although most of the two counties had their respective saturated thickness reduced by fifty percent, some areas which were thinner became inactive (Figure 17). Carson and Armstrong counties have saturated thickness from over 350 feet in Carson County to about 50 to 100 feet in Armstrong County at the baseline in 2000 (Figure 2). By 2050, both counties have a fifty percent reduction in saturated thickness with no addition of inactive cells. Ochiltree and Lipscomb counties follow the same pattern as the foregoing counties. About half the saturated thickness remains after fifty years (Figures 3 and 18). Hemphill County has a range of saturated thicknesses in 2000 from less than fifty feet to over 300 feet (Figure 3). By 2050, the range is less than fifty to a high of about 150 feet (Figure 18). Roberts County has the thickest saturated zone at over 500 feet in 2000 (Figure 3). In 2050, this thickness has been reduced to 250 feet (Figure 18). Finally, Gray, Wheeler, Donley and Armstrong counties have saturated thicknesses ranging from near zero to over 300 feet in 2000 (Figure 3). By 2050, the saturated thickness has been reduced by fifty percent with no change in inactive cells.

It would appear, based on this GAM run, that a “fifty-fifty” solution can be reached with the pumping spread across the areal extent of the aquifer. This prevents widespread swaths of grid cells from becoming inactive.

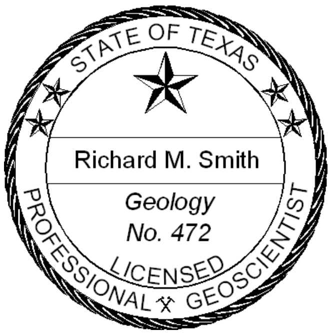
REFERENCES:

Dutton, A., 2004, Adjustments of parameters to improve the calibration of the Og-N model of the Ogallala aquifer, Panhandle Water Planning Area: Bureau of Economic Geology, The University of Texas at Austin, 9 p

Blandford, T.N., Blazer, D.J., Calhoun, K.C., Dutton, A.R., Naing, T., Reedy, R.C., and Scanlon, B.R., 2003, Groundwater availability of the southern Ogallala aquifer in Texas and New Mexico—Numerical Simulations Through 2050: Final Report prepared for the Texas Water Development Board by Daniel B. Stephens & Associates, Inc., 158 p.

Dutton, A., Reedy, R., and Mace, R., 2001, Saturated thickness of the Ogallala aquifer in the Panhandle Water Planning Area—Simulation of 2000 through 2050

Withdrawal Projections: prepared for the Panhandle Water Planning Group by the Bureau of Economic Geology, The University of Texas at Austin, 54 p.
Smith, R, 2006, GAM Run 06-25, Texas Water Development Board, 28 p.
Smith, R, 2007, GAM Run 07-31, Texas Water Development Board, 23 p.



The seal appearing on this document was authorized by Richard M. Smith, P.G. on January 15, 2008.

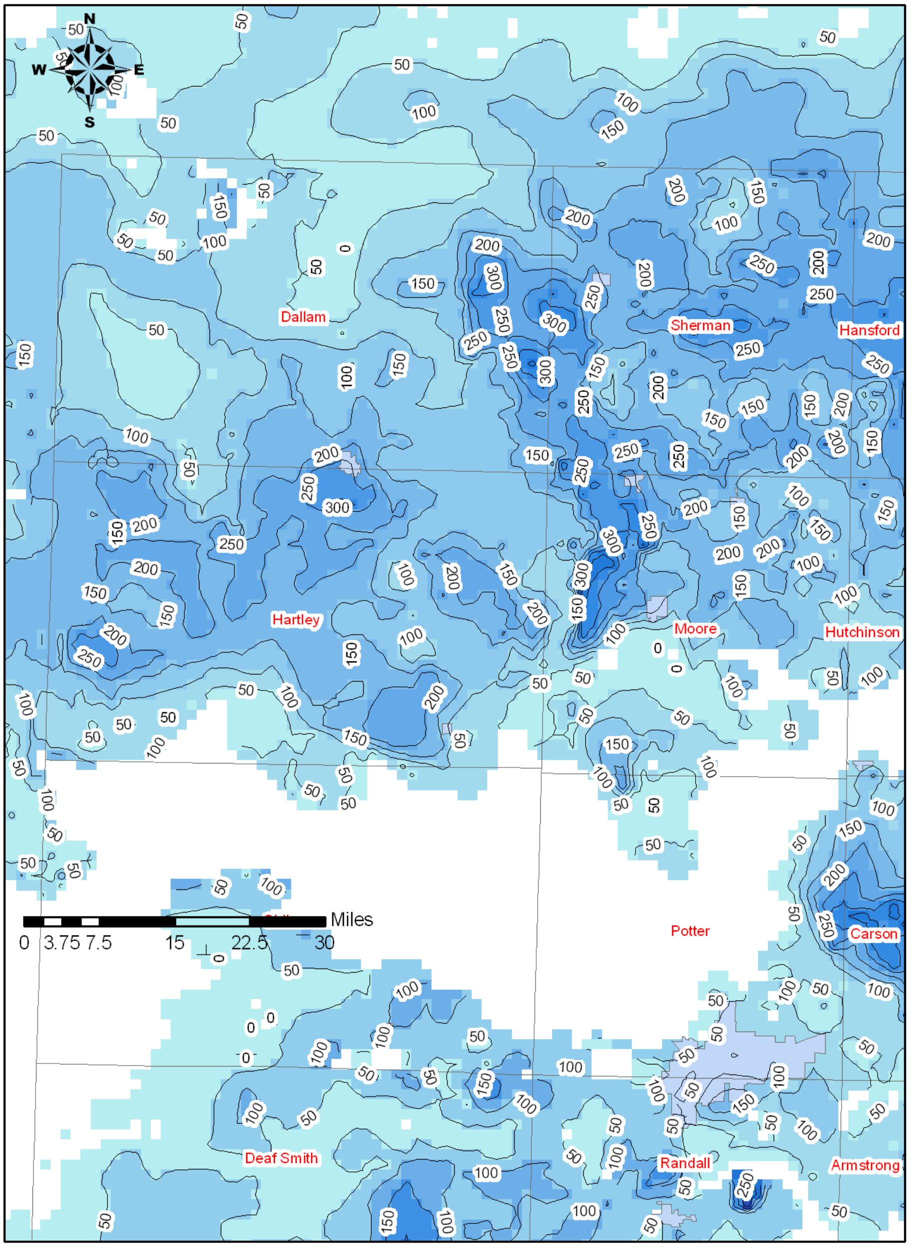


Figure 1: Baseline year 2000 saturated thickness in Dallam, Hartley, Sherman, Oldham, Potter and Moore counties. White cells are inactive. The contour interval is 50 feet.

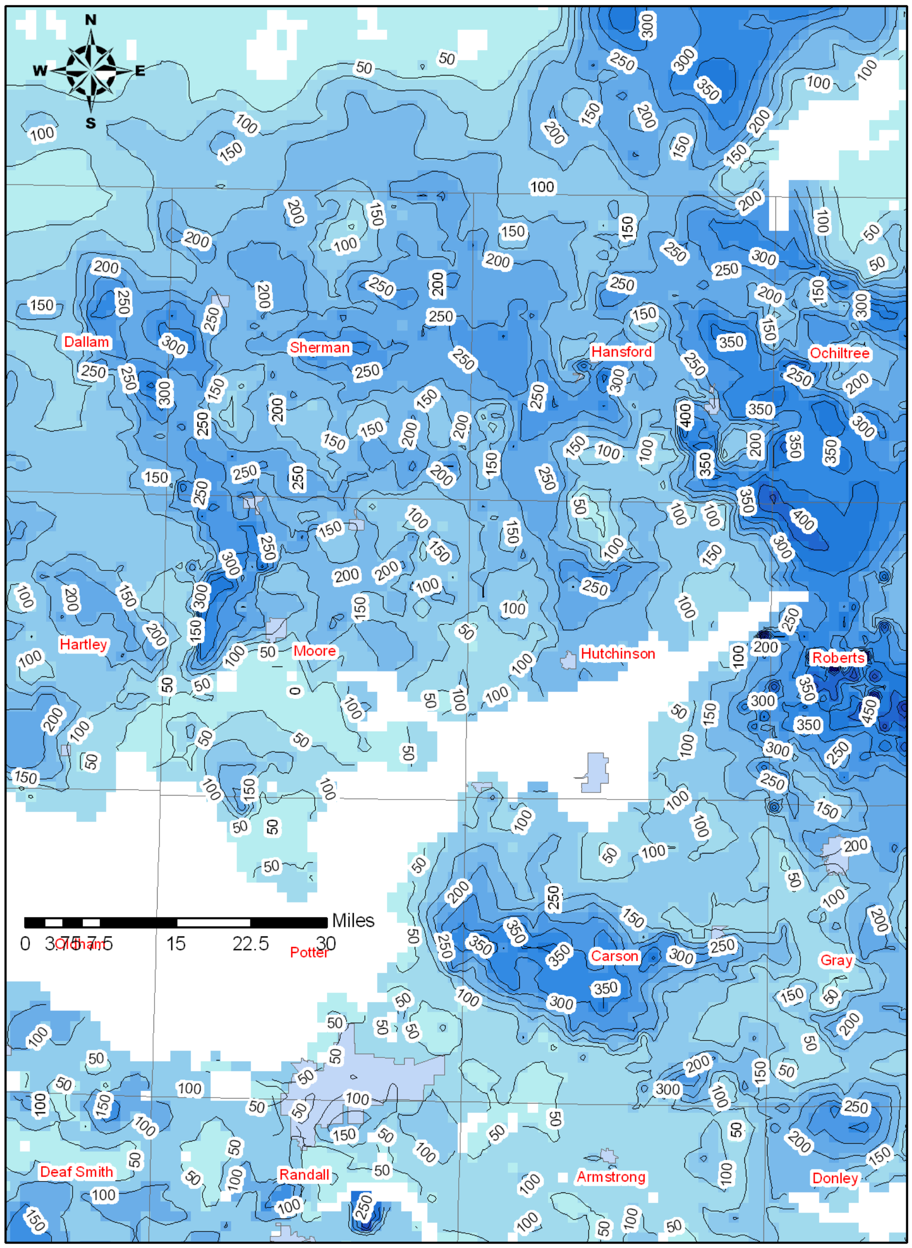


Figure 2: Baseline year 2000 saturated thickness in Sherman, Hansford, Moore, Hutchinson, Potter, Carson, and parts of Ochiltree, Roberts, and Gray counties. White cells are inactive. The contour interval is 50 feet.

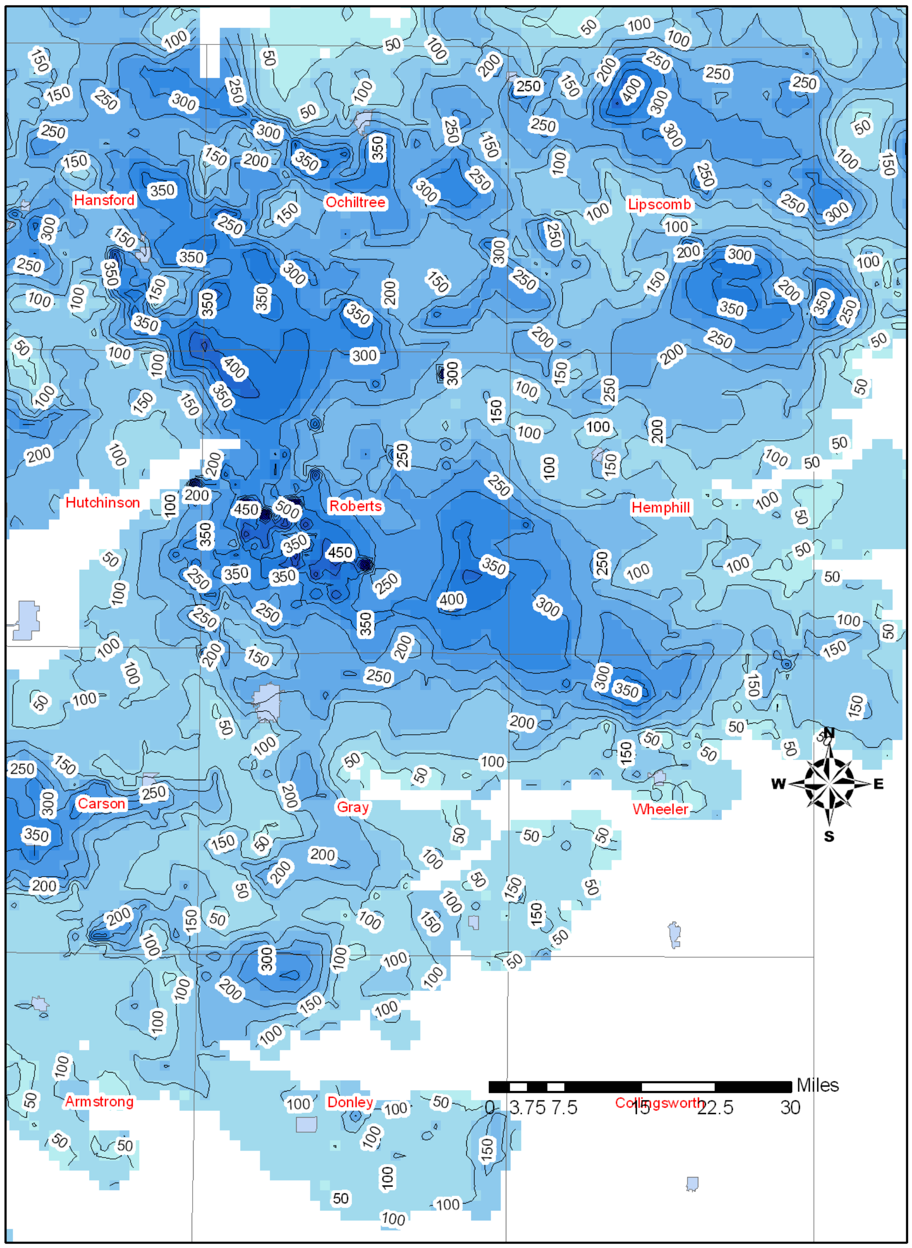


Figure 3: Baseline year 2000 saturated thickness in Lipscomb, Hemphill, Roberts, Gray, Donley, Wheeler and Ochiltree counties. White cells are inactive. The contour interval is 50 feet.

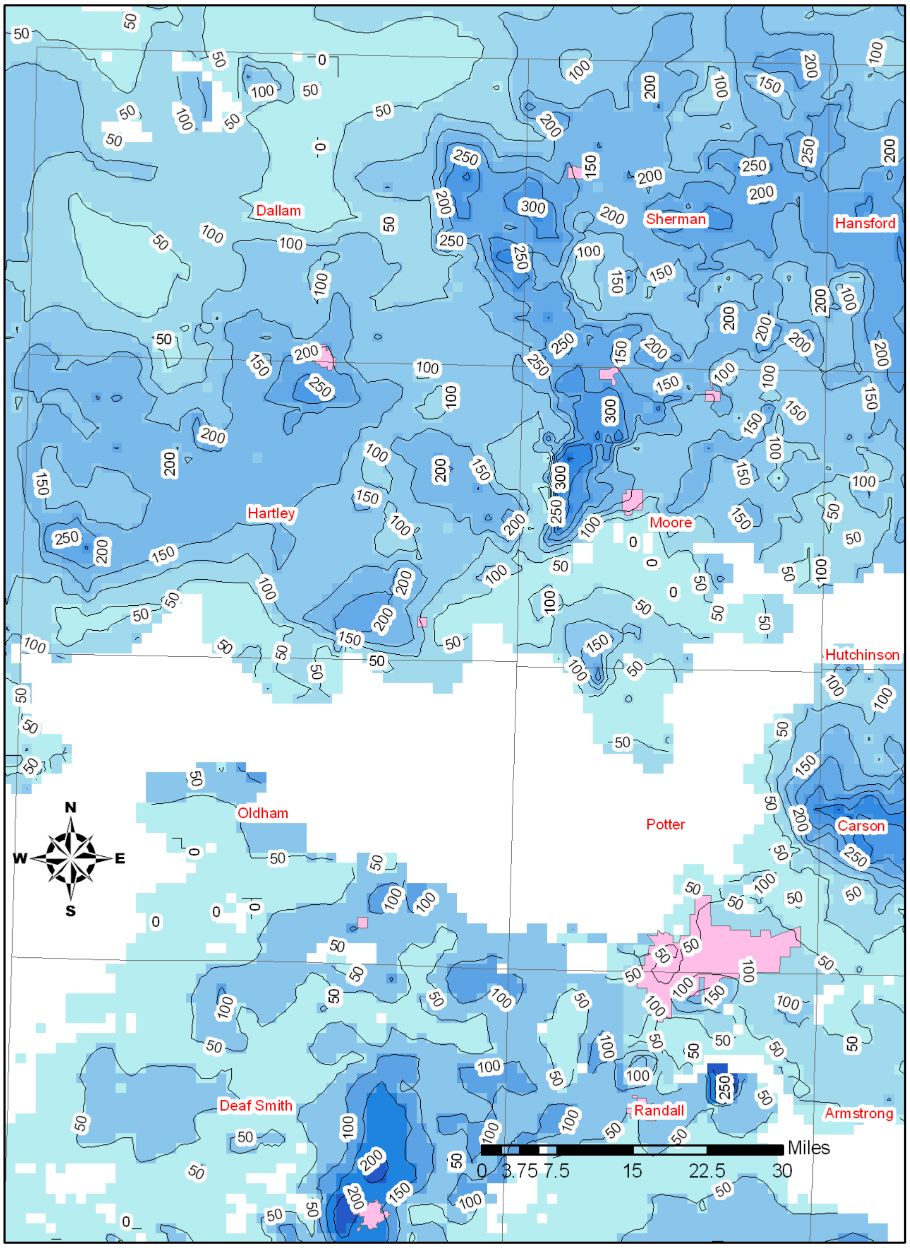


Figure 4: Saturated thickness in 2010 for Dallam, Hartley, Sherman, Oldham, Potter, Moore counties and parts of Deaf Smith and Randall counties. White cells are inactive. The contour interval is 50 feet.

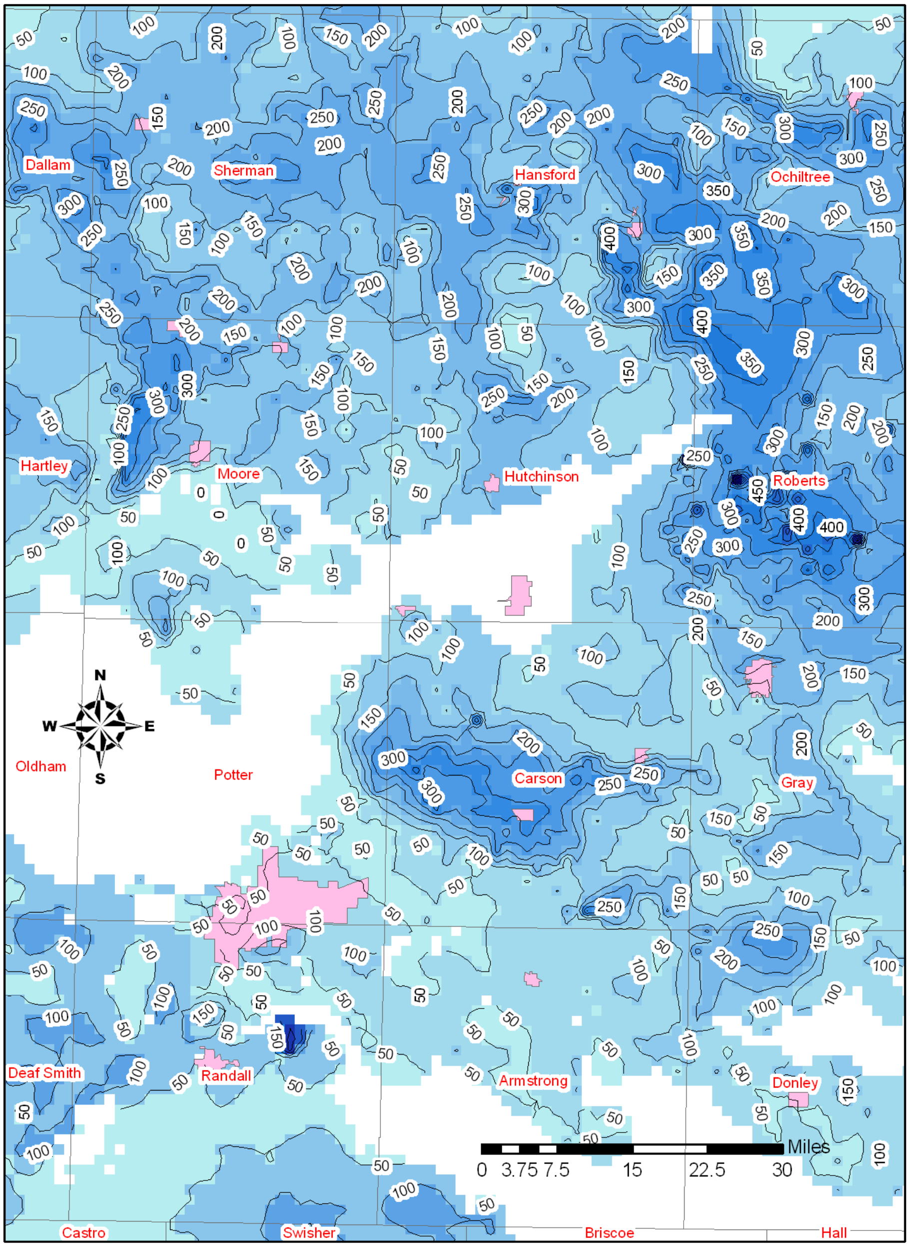


Figure 5: Saturated thickness in 2010 for Hansford, Hutchinson, Ochiltree, Roberts, Carson, and Gray counties. White cells are inactive. The contour interval is 50 feet.

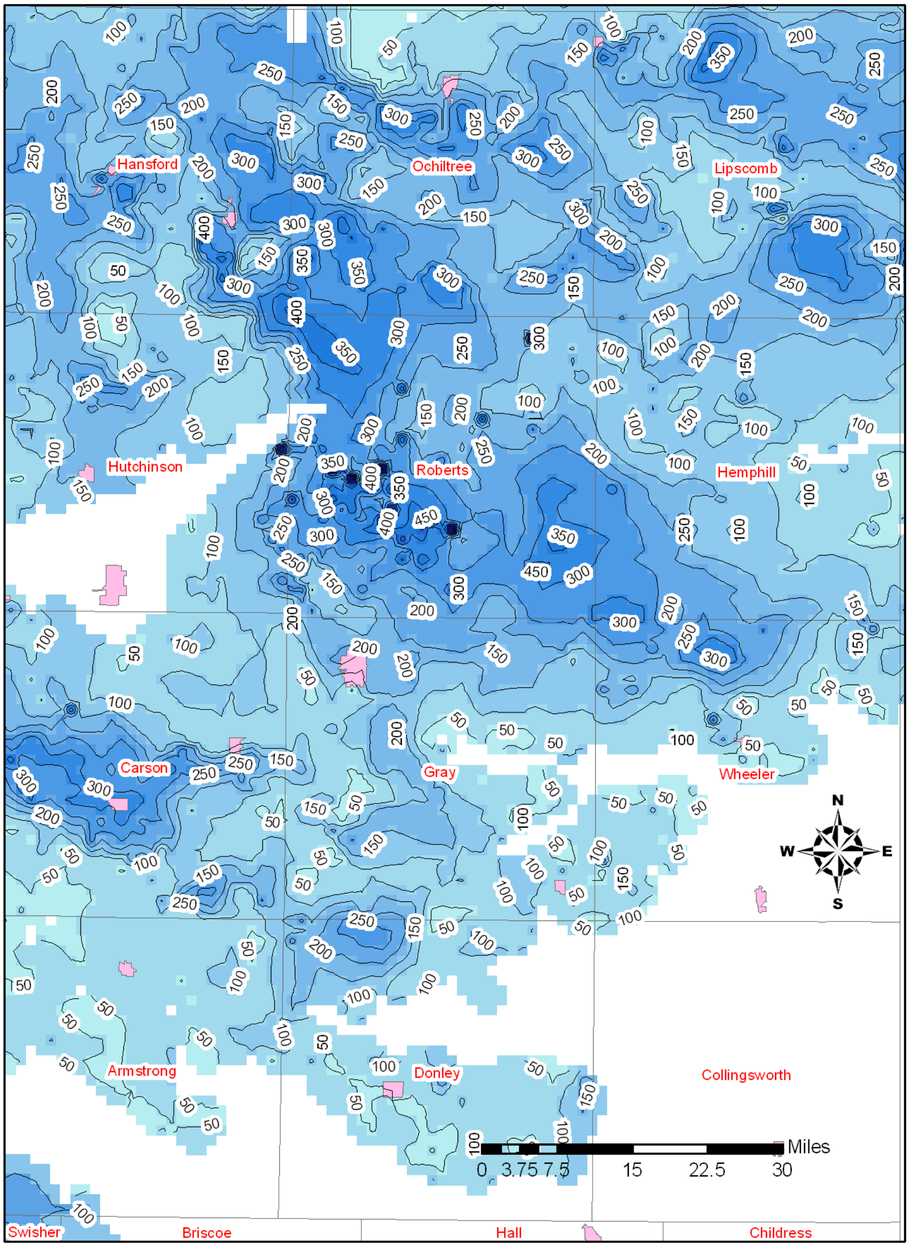


Figure 6: Saturated thickness in 2010 for Ochiltree, Lipscomb, Roberts, Gray, Wheeler, and Hemphill counties. White cells are inactive. The contour interval is 50 feet.

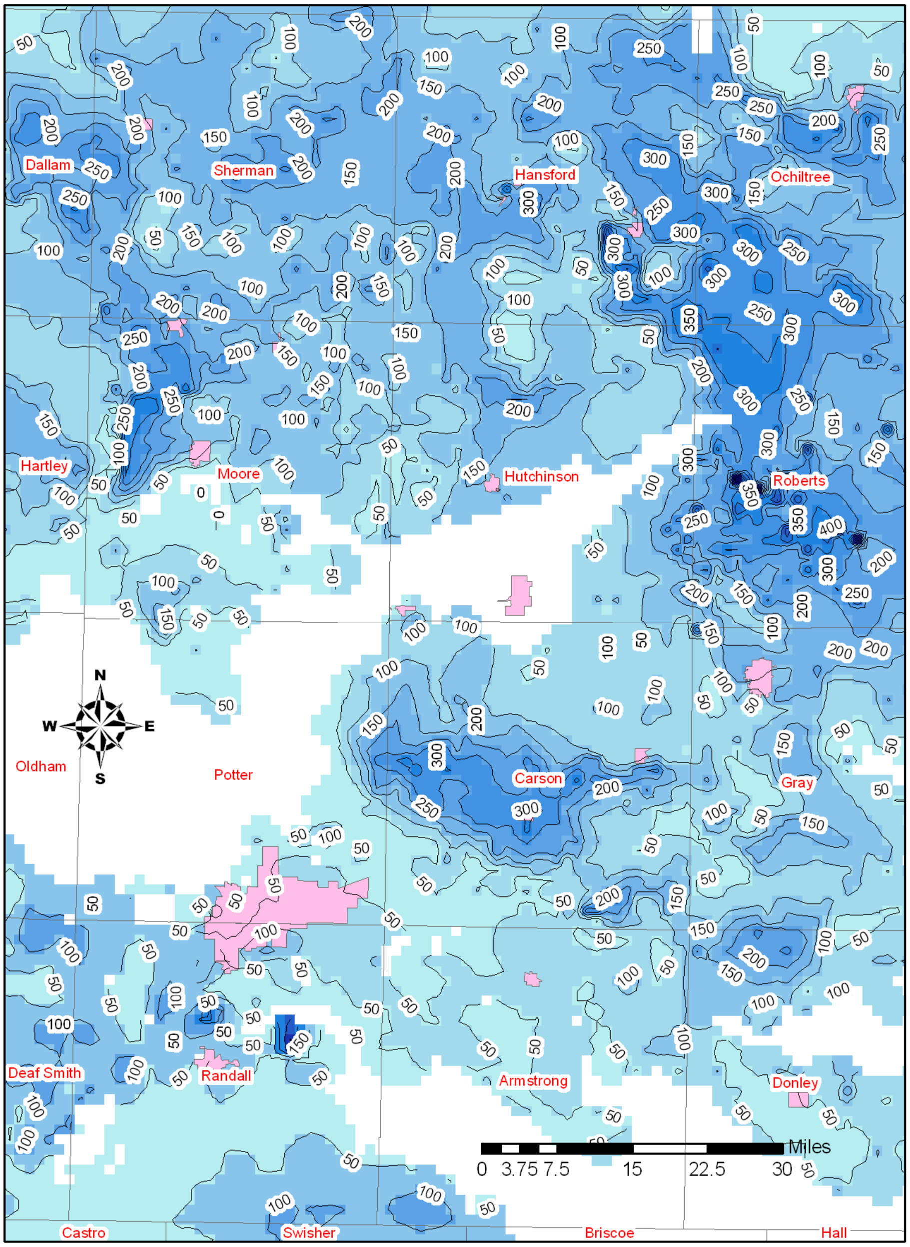


Figure 7: Saturated thickness in 2020 in Moore, Hutchinson, Potter, Carson, Armstrong, and Randall counties. White cells are inactive. The contour interval is 50 feet.

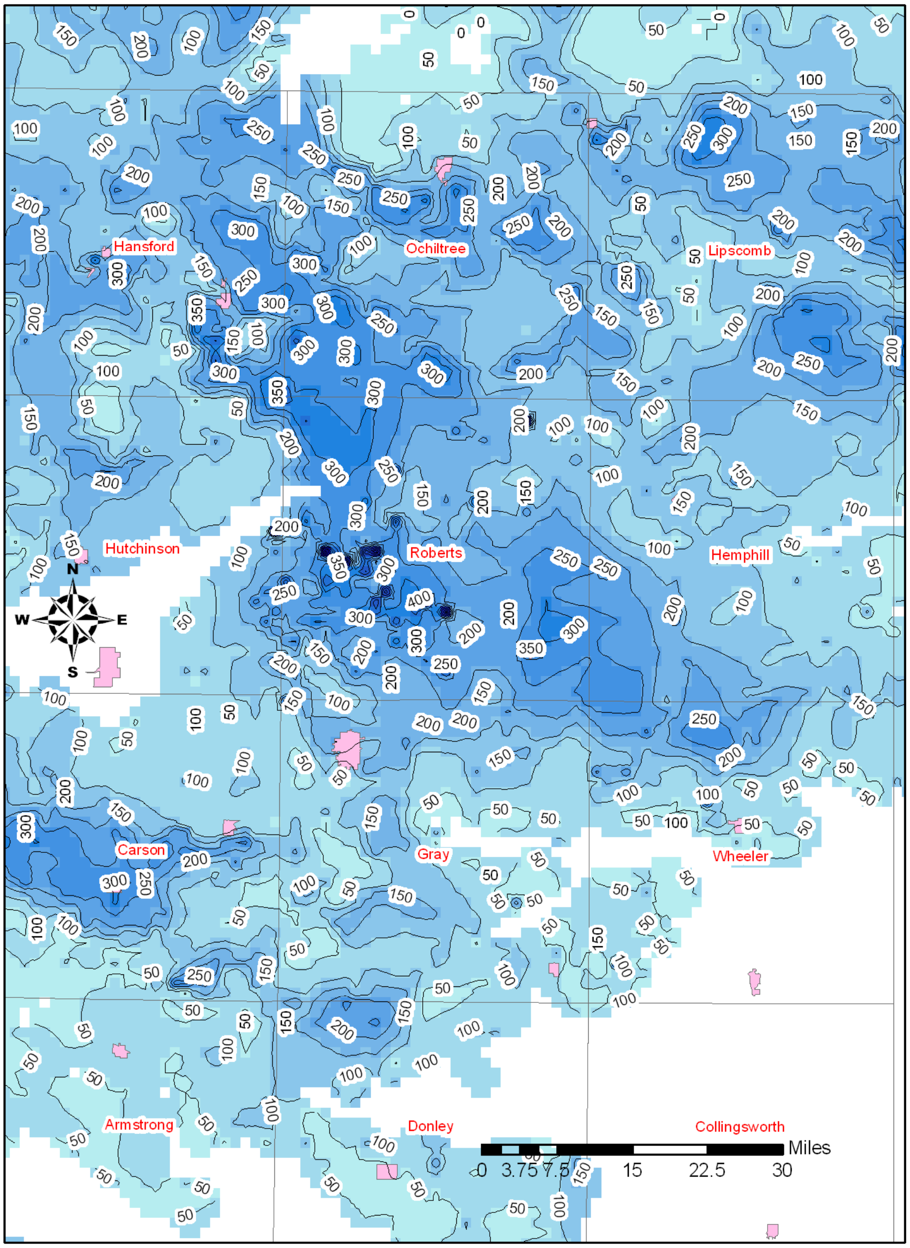


Figure 8: Saturated thickness in 2020 for Gray, Wheeler, Ochiltree, Lipscomb, Roberts, and Hemphill counties. White cells are inactive. The contour interval is 50 feet.

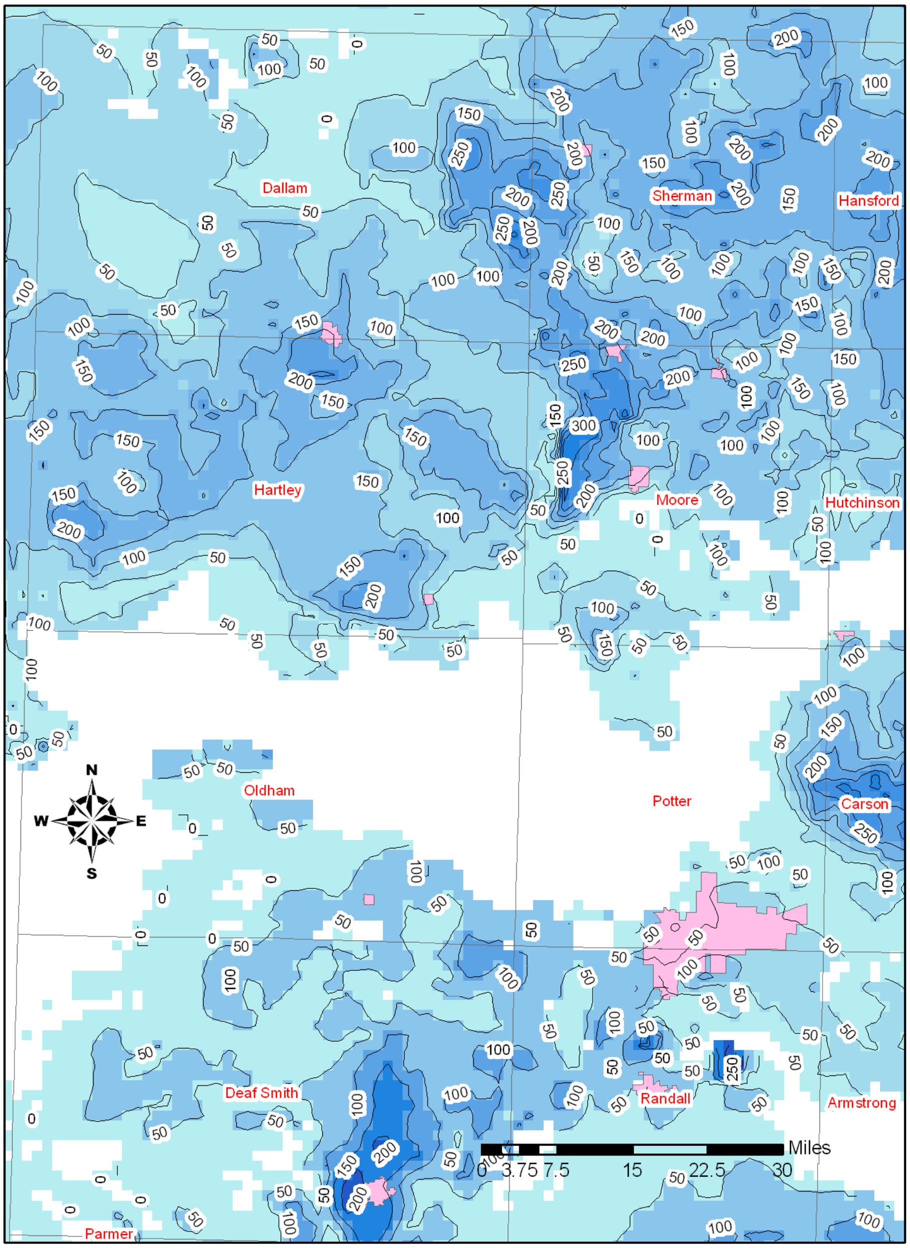


Figure 9: Saturated thickness in 2020 for Dallam, Hartley, Sherman, Potter, Randall and Moore counties. White cells are inactive. The contour interval is 50 feet.

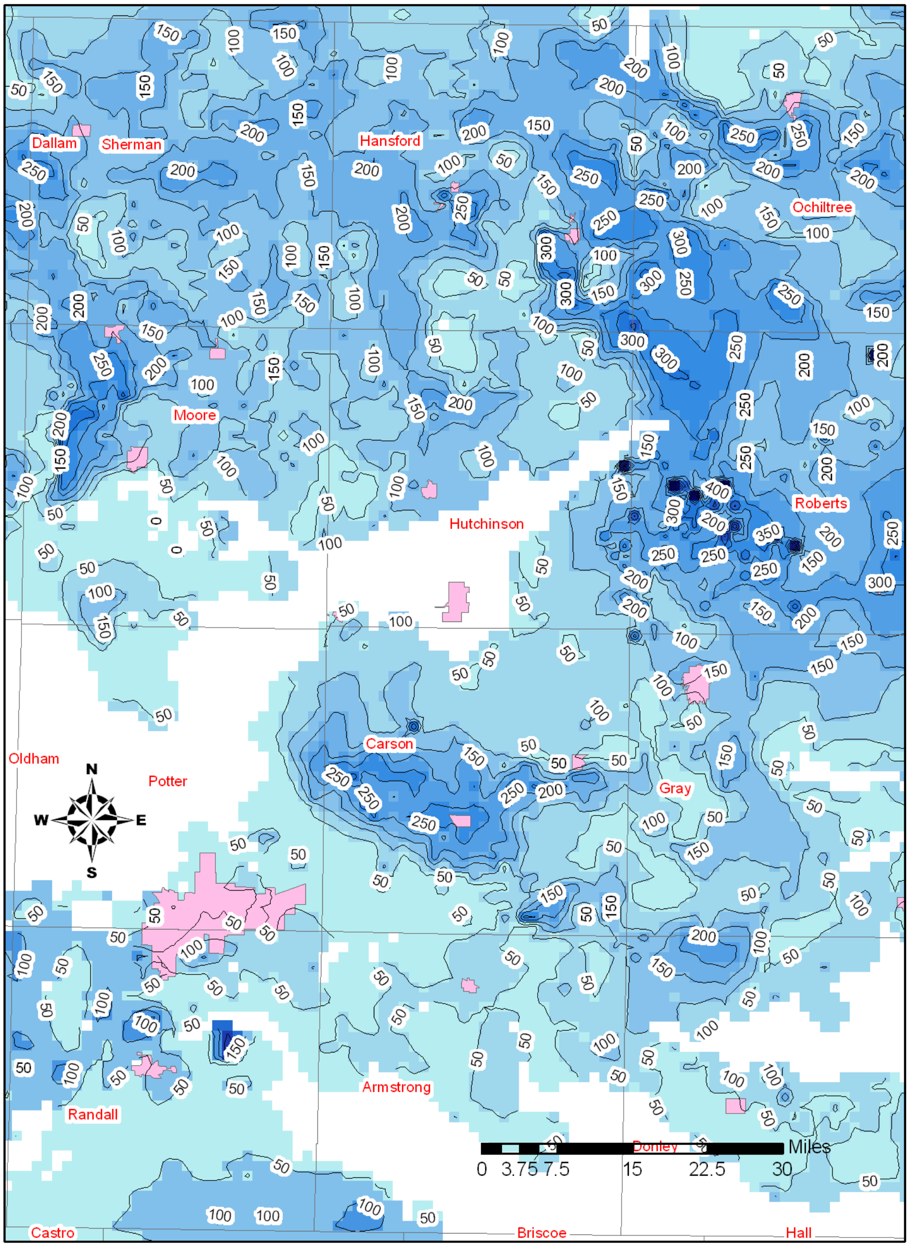


Figure 10: Saturated thickness in 2030 in Sherman, Moore, Hutchinson, Potter, Carson, Armstrong, and Randall counties. White cells are inactive. The contour interval is 50 feet.

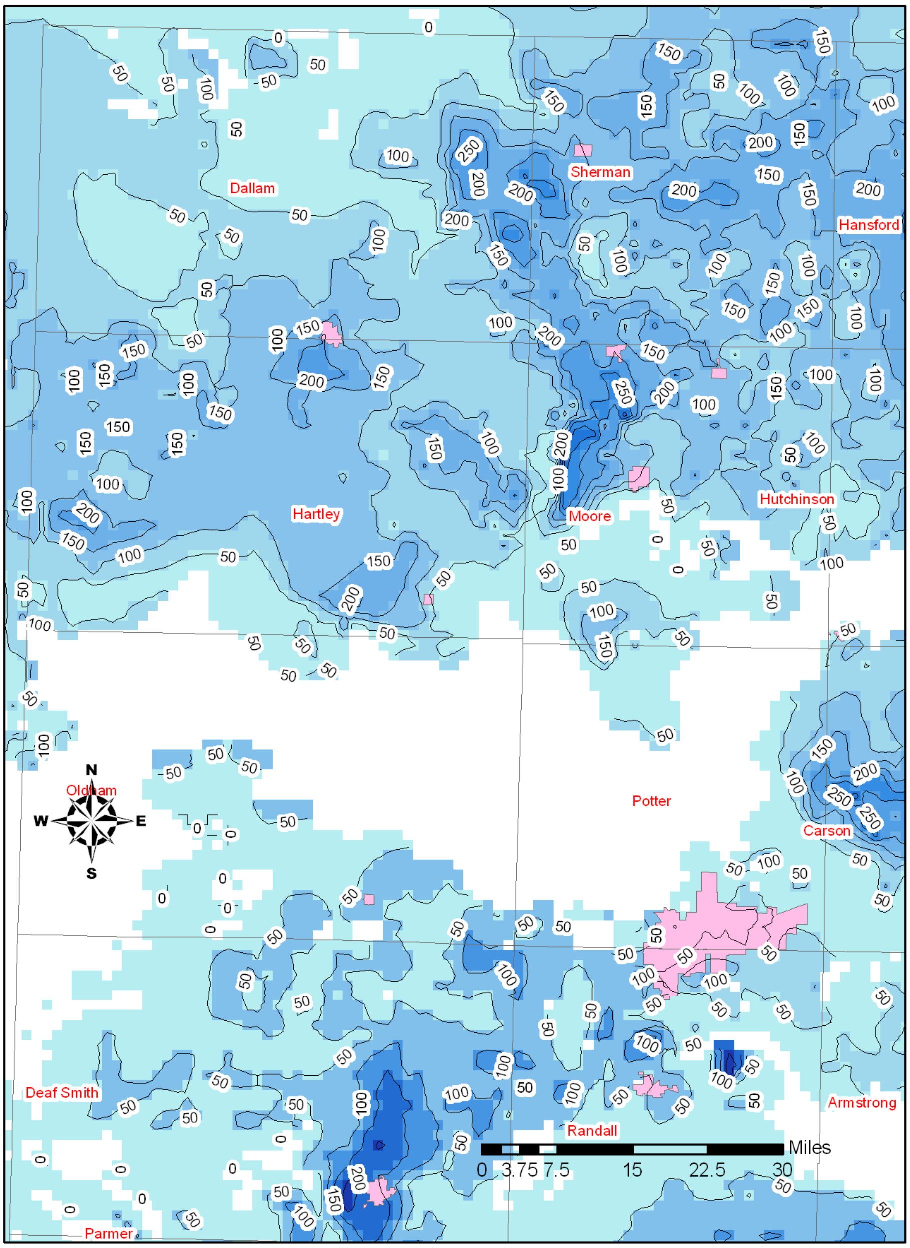


Figure 11: Saturated thickness in 2030 for Dallam, Hartley, Sherman, Potter, Randall and Moore counties. White cells are inactive. The contour interval is 50 feet.

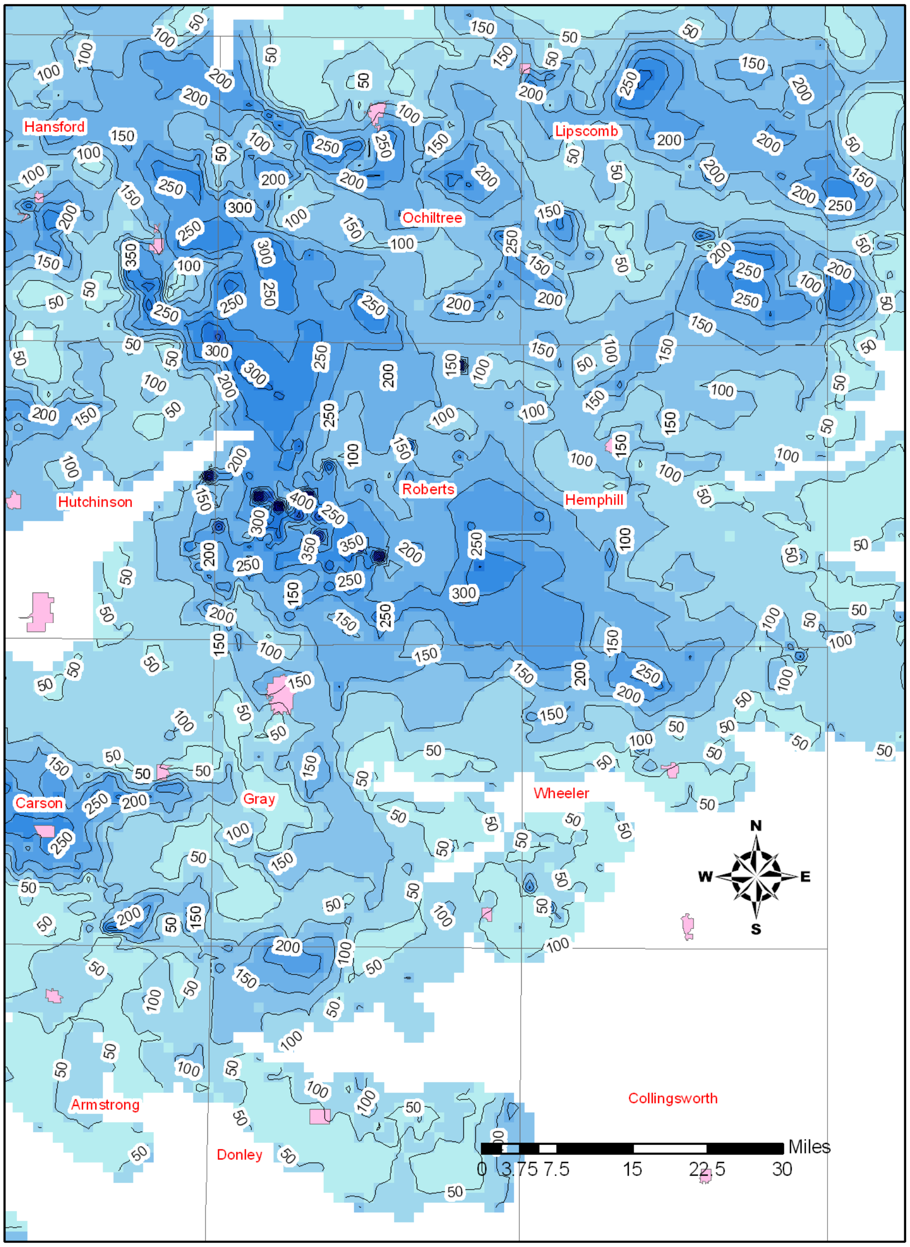


Figure 12: Saturated thickness in 2030 for Ochiltree, Lipscomb, Roberts, Gray, Wheeler, Donley, and Hemphill counties. White cells are inactive. The contour interval is 50 feet.

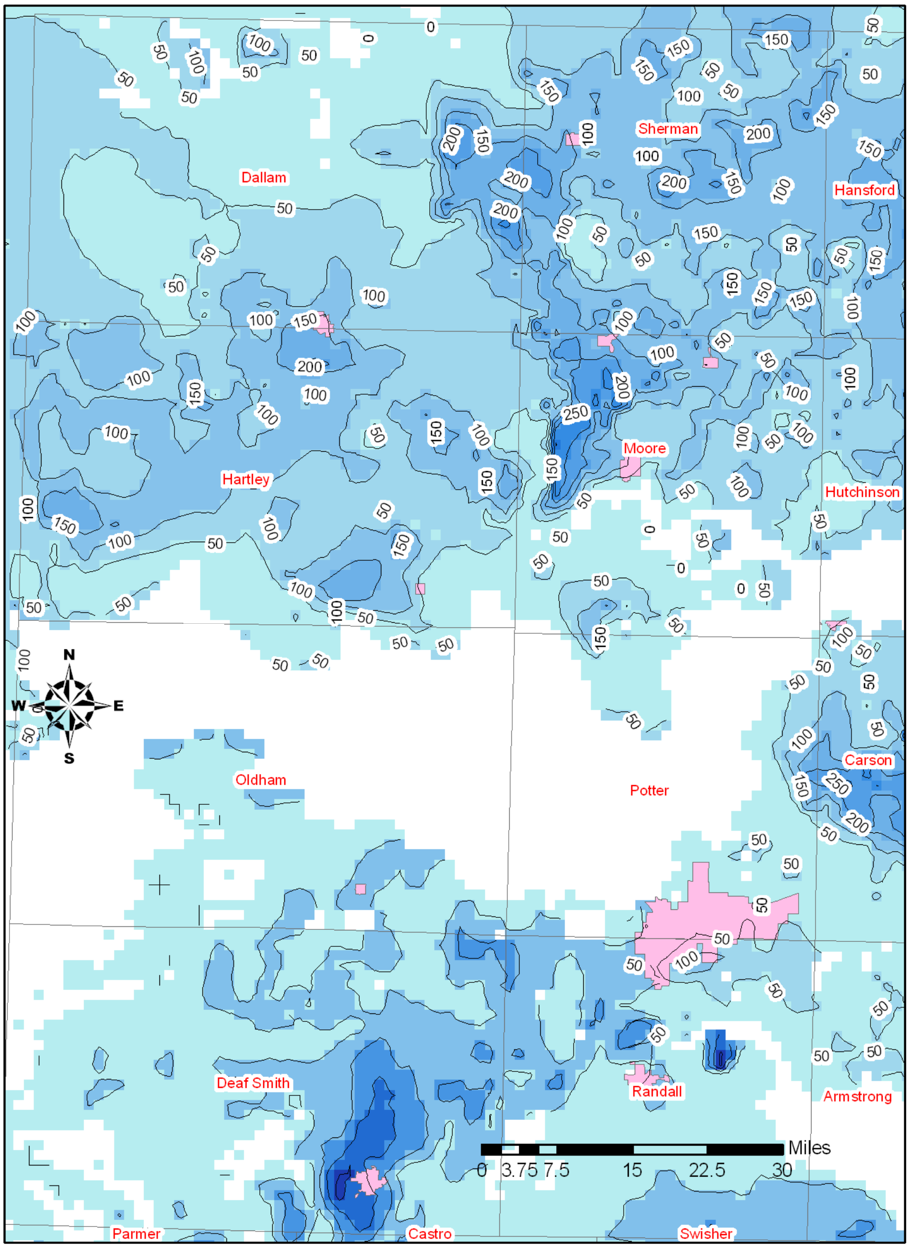


Figure 13: Saturated thickness in 2040 for Dallam, Hartley, Sherman, Oldham, Potter, Randall, and Moore counties. White cells are inactive. The contour interval is 50 feet.

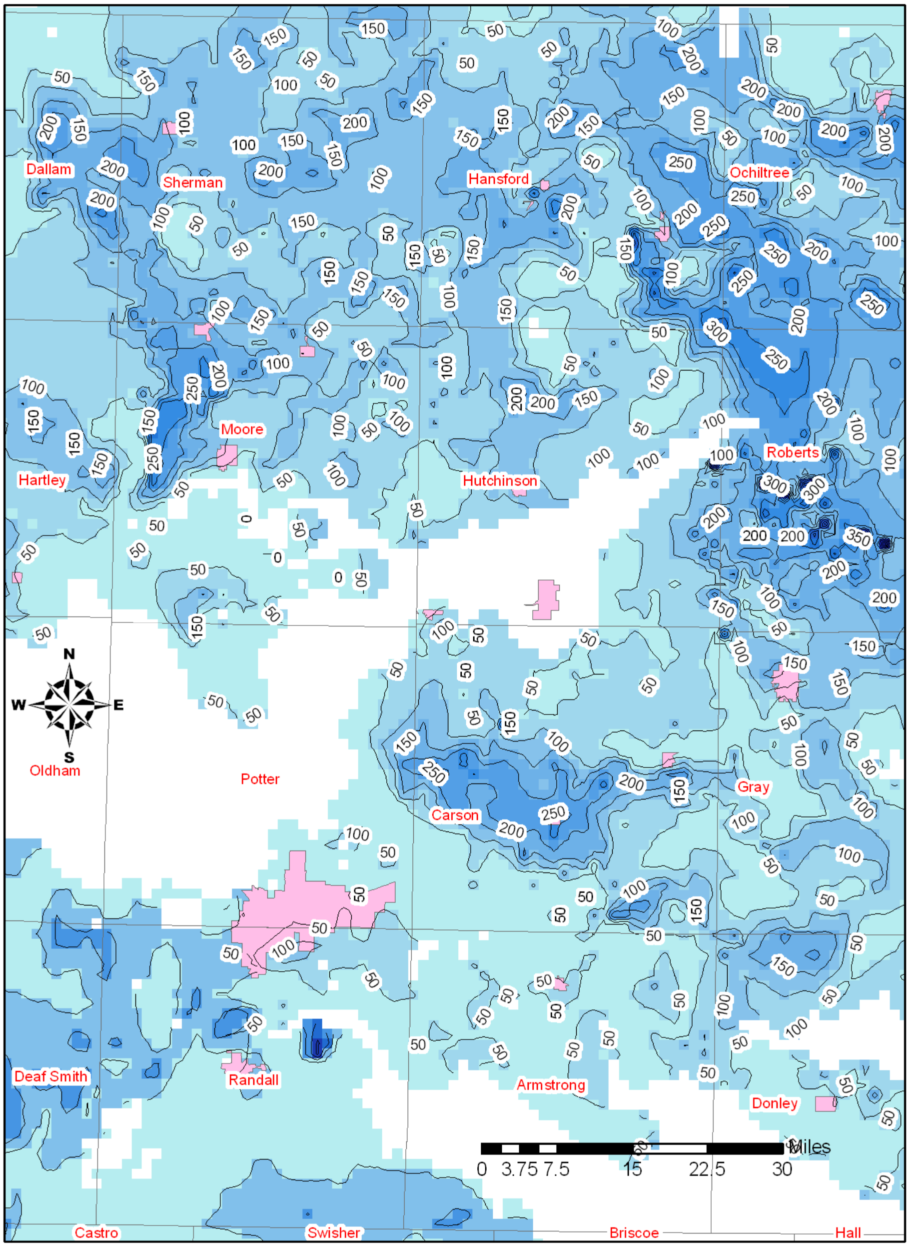


Figure 14: Saturated thickness in 2040 for Sherman,Hansford, Hutchinson, Ochiltree, Moore, Roberts, Potter, Carson, and Gray counties. White cells are inactive. Contour interval is 50 feet.

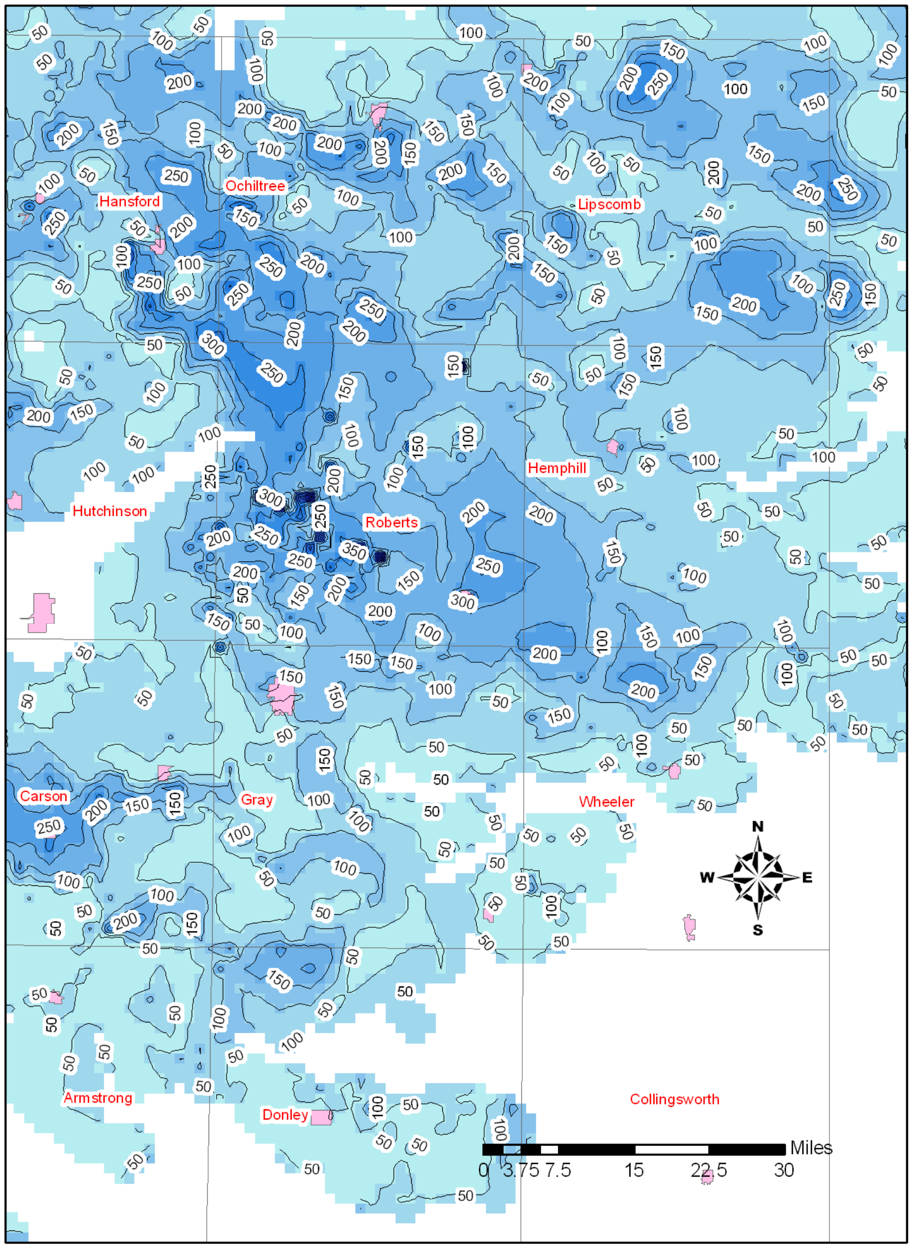


Figure 15: Saturated thickness in 2040 for Gray, Wheeler, Ochiltree, Lipscomb, Roberts, Donley, and Hemphill counties. White cells are inactive. Contour interval is 50 feet.

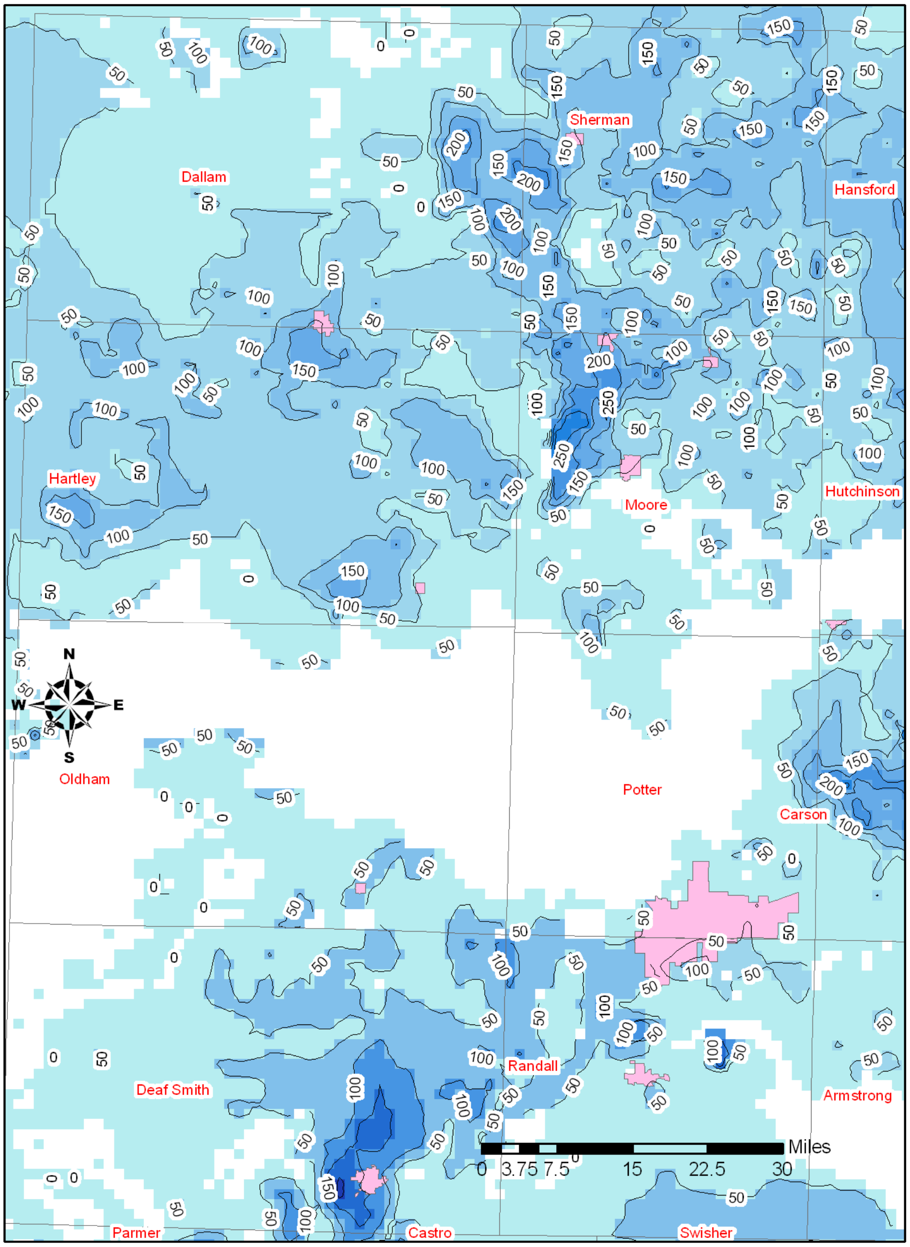


Figure 16: Saturated thickness in 2050 for Dallam, Hartley, Sherman, Oldham, Potter, Randall and Moore counties. White cells are inactive. Contour interval is 50 feet.

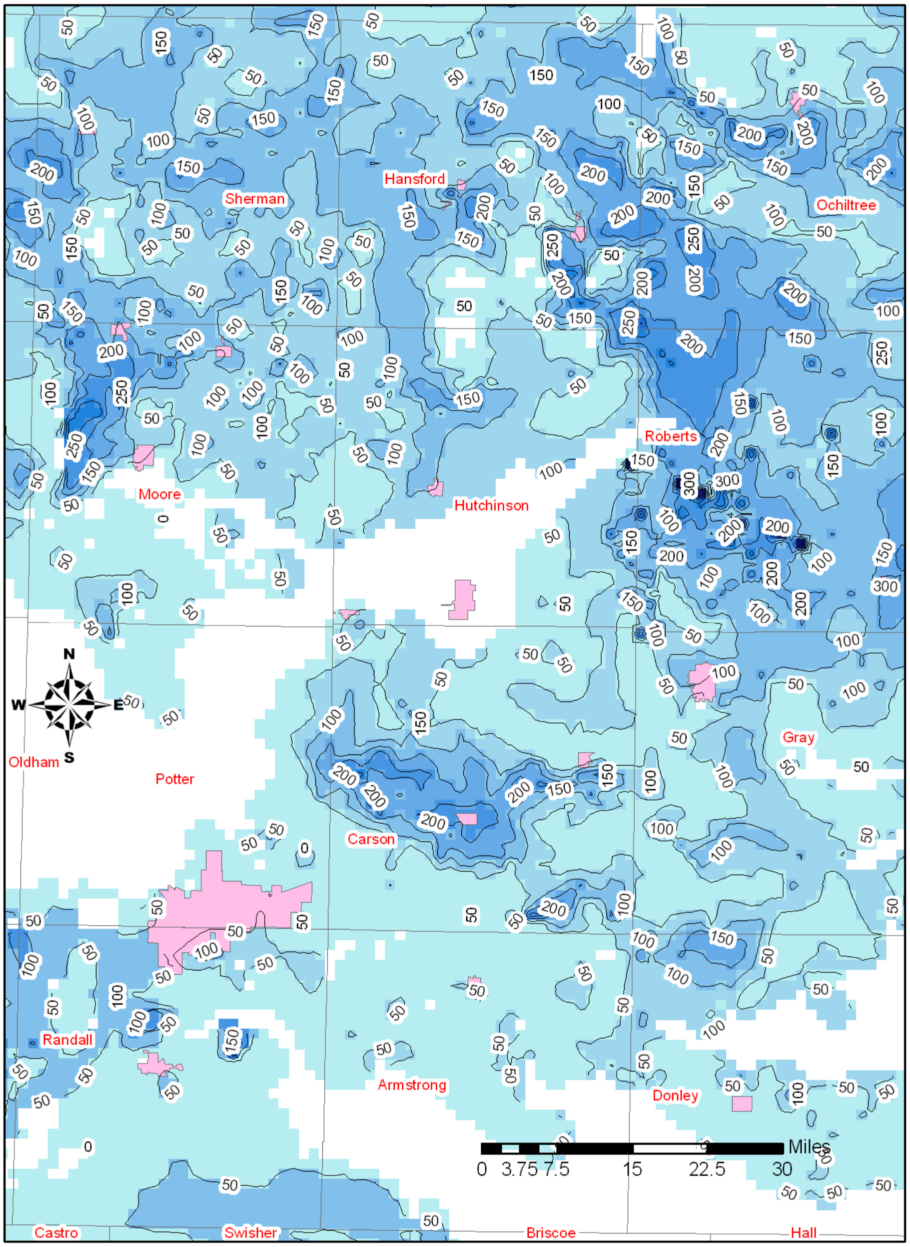


Figure 17: Saturated thickness in 2050 for Sherman, Hansford, Hutchinson, Ochiltree, Roberts, Carson, and Gray counties. White cells are inactive. Contour interval is 50 feet.

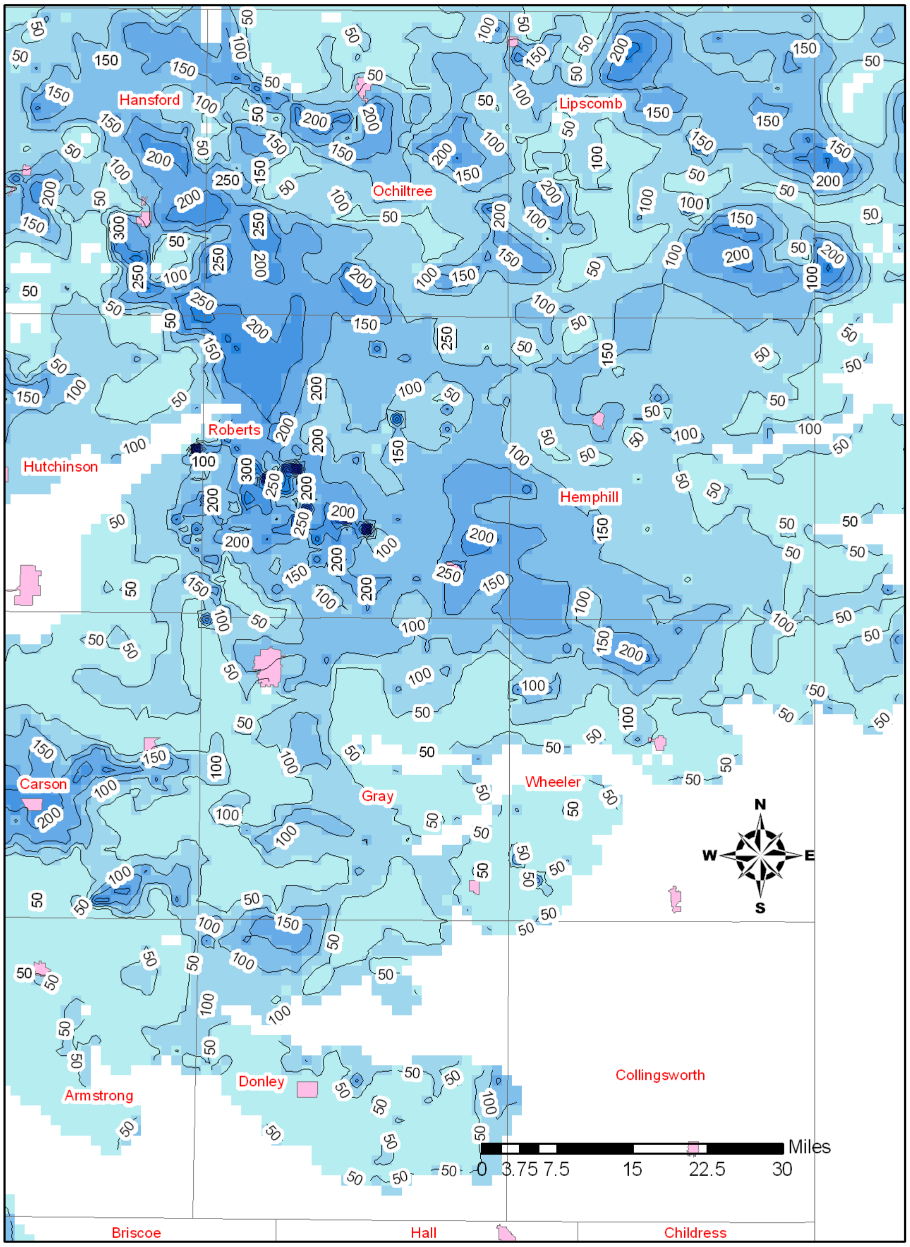


Figure 18: Saturated thickness in 2050 for Gray, Wheeler, Ochiltree, Lipscomb, Roberts, Donley, and Hemphill counties. White cells are inactive. Contour interval is 50 feet.