Ground-Water Model and Pumping Scenarios for the Middle Arkansas River Subbasin

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Hydrologic Responses to Changes in and outside of the Middle Arkansas Subbasin

- Ground-water levels have declined in the Middle Arkansas subbasin in response to consumptive pumping from the alluvial and High Plains aquifers. (See Figures 1 and 2.)
- Water-level declines have decreased the discharge of ground water into the Arkansas River. Where water levels have declined below the bottom of the river bed, river water seeps into the underlying aquifer and decreases the downstream flow. As a result, river flows have decreased and a dry river bed has been present over much of the subbasin during the last few years. (See Figure 3.)
- Long-term declines in the flow of the Arkansas River from southwest Kansas and of the Pawnee River into the subbasin have contributed to decreases in Arkansas River flow in the subbasin.

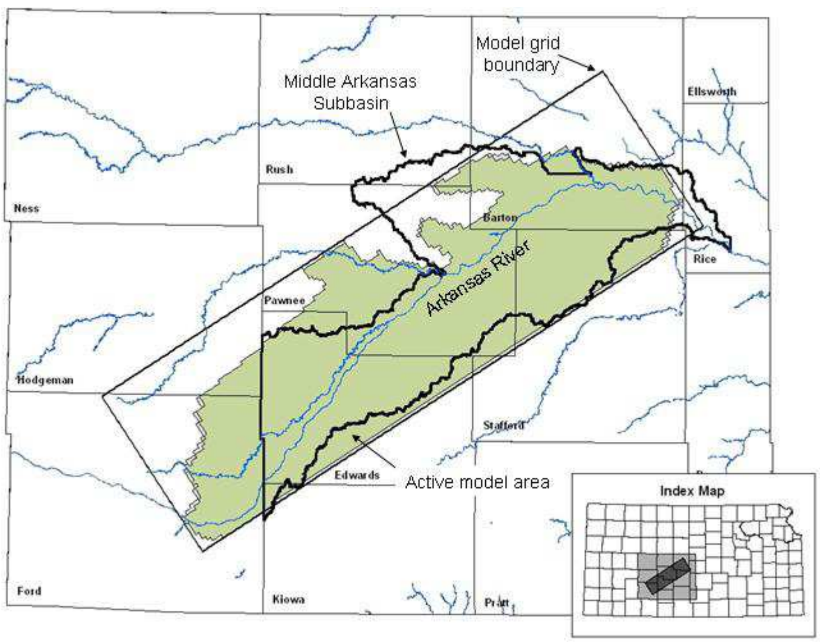

Figure 1. Location of the Middle Arkansas subbasin in Kansas, and the grid boundary and active area (color shaded) of the ground-water flow model prepared by the Kansas Geological Survey for the Division of Water Resources, Kansas Department of Agriculture and the Kansas Water Office.

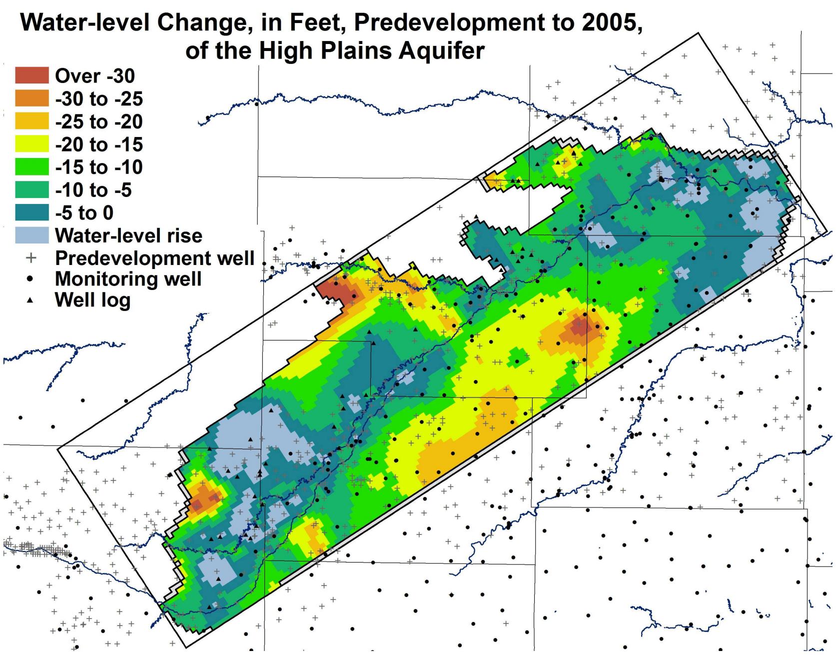

Figure 2. Change in ground-water levels from predevelopment (1940-1945) to 2005 within the active area of the ground-water flow model of the Middle Arkansas subbasin. Ground-water levels have declined the most in the High Plains aquifer within the active model area in northeast Edwards, southeast Pawnee, and west-central Stafford counties, and in the alluvial aquifer of the Pawnee River valley in central Pawnee County.

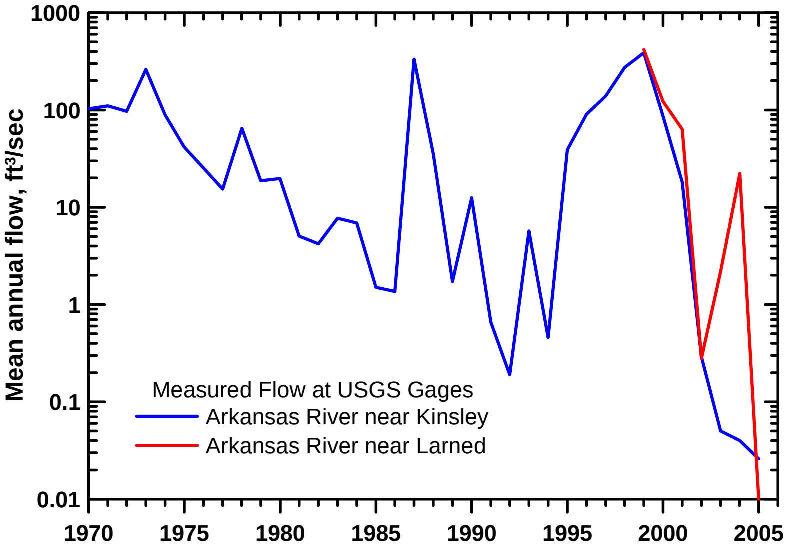

Figure 3. Change in the mean annual flow of the Arkansas River at the gaging stations of the U.S. Geological Survey near Kinsley and Larned. The gage near Larned began operating during 1998. The flow in the graph is shown using a logarithmic axis to better display the decreases in low flows during recent years. The high flows in 1985 and 1995-2001 were caused mainly by flow from Colorado. During the last few years the river has been nearly dry to dry essentially all of the time near Kinsley and dry most of the time near Larned. The only flow in the Arkansas River near Larned since the fall of 2002 has resulted from high flows from the Pawnee River.

Water-Quality Responses to Changes in and outside of the Middle Arkansas Subbasin

- Long-term increases in the salinity of Arkansas River water from Colorado have increased the salinity of high flows that enter the Middle Arkansas subbasin.
- The salinity of ground water in the Arkansas River valley in the subbasin increases when saline flow passing through southwest Kansas from Colorado seeps into the aquifer underlying the river. The saline ground water is moving outward from the river in response to ground-water level declines.
- Long-term decreases in Pawnee River flow have decreased freshwater flow entering the Arkansas River at Larned thereby decreasing the amount of downstream freshwater in the river or recharging the aquifer.

Hydrologic and Salinity Responses to Future Changes in the Arkansas River Corridor

- Ground-water levels will continue to decline in the Middle Arkansas subbasin unless there are substantial reductions in consumptive pumping.
- Continuing water-level declines will increase the seepage rate of high flows in the Arkansas River from southwest Kansas (when they occur) into the alluvial aquifer and underlying High Plains aquifer. This will decrease the amount of river flow reaching the Lower Arkansas basin for a similar, past high flow entering the subbasin. More saline water from high Arkansas River inflows will enter the alluvial and High Plains aquifers.
- Continuing water-level declines will increase the movement of saline ground water in the aquifer outward from the river valley.
- Continuing decreases in Pawnee River flow will decrease the amount of freshwater flow entering the Arkansas River at Larned and flowing downstream or recharging the aquifer.

Ground-Water Flow Model of the Middle Arkansas Subbasin

The numerical model simulated historical conditions for 1944-2004 and a series of future scenarios for 2005-2054. The model indicated that aquifer storage declined substantially in the High Plains aquifer starting in the late 1970s and was accompanied by a decrease in streamflow and a reduction in ground-water flow out of the subbasin. A model scenario in which pumping continued at current levels showed that ground-water levels continue to decline, causing further decreases in streamflow and lateral outflow of ground water. A scenario in which all pumping ceased showed that the long-term water-level declines in the aquifer that began in the late 1970s start to reverse within a few years, and the change from streamflow loss to gain starts after several years after the pumps are shut off. A reduced pumping scenario based on the proposed Conservation Reserve Enhancement Program (CREP) area for the subbasin showed that losses in aquifer storage, streamflow, and lateral ground-water outflow were not as great as in the continued-pumping scenario. However, those losses continued during the 2005-2054 simulation. The report on the model and presentations given at Basin Advisory Committee meetings can be obtained on the web at http://www.kgs.ku.edu/HighPlains/mid_ark_model.htm.