Hydrologic Responses to Pumping in the Upper Arkansas Basin and Effects of the Conservation Reserve Enhancement Program

Prepared for Hearings of the Kansas Legislature
Senate Natural Resources Committee
House Agriculture and Natural Resources Committee

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The photographs show the Arkansas River northeast of Larned with very low flow in 2002 (left) and dry in 2005 (right). Many of the cottonwood trees along the river channel at this location have since died as a result of declining ground-water levels.

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Sub-regional Areas of the High Plains Aquifer

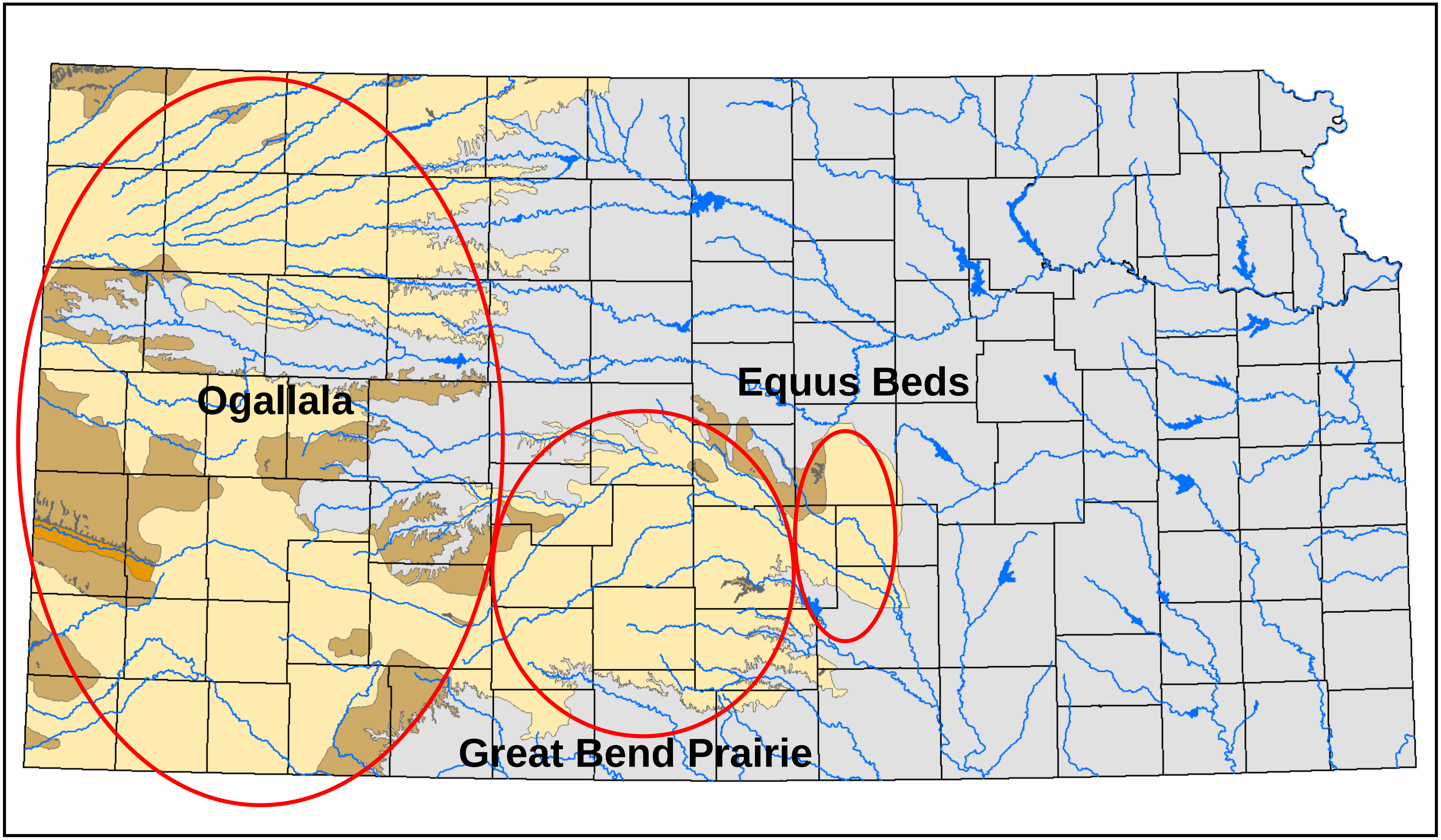


Figure 1 – Sub-Regional Areas of the High Plains Aquifer in Kansas. In Kansas, there are three sub-regions of the High Plains aquifer (the area in yellow) - the Ogallala, the Great Bend Prairie, and the Equus Beds. Ground water in the Great Bend Prairie and Equus Beds sub-regions of the aquifer is generally closer to the land surface (not as deep) and more responsive to recharge. Ground water in the Ogallala sub-region is generally deeper and, with less annual precipitation, has little natural recharge.

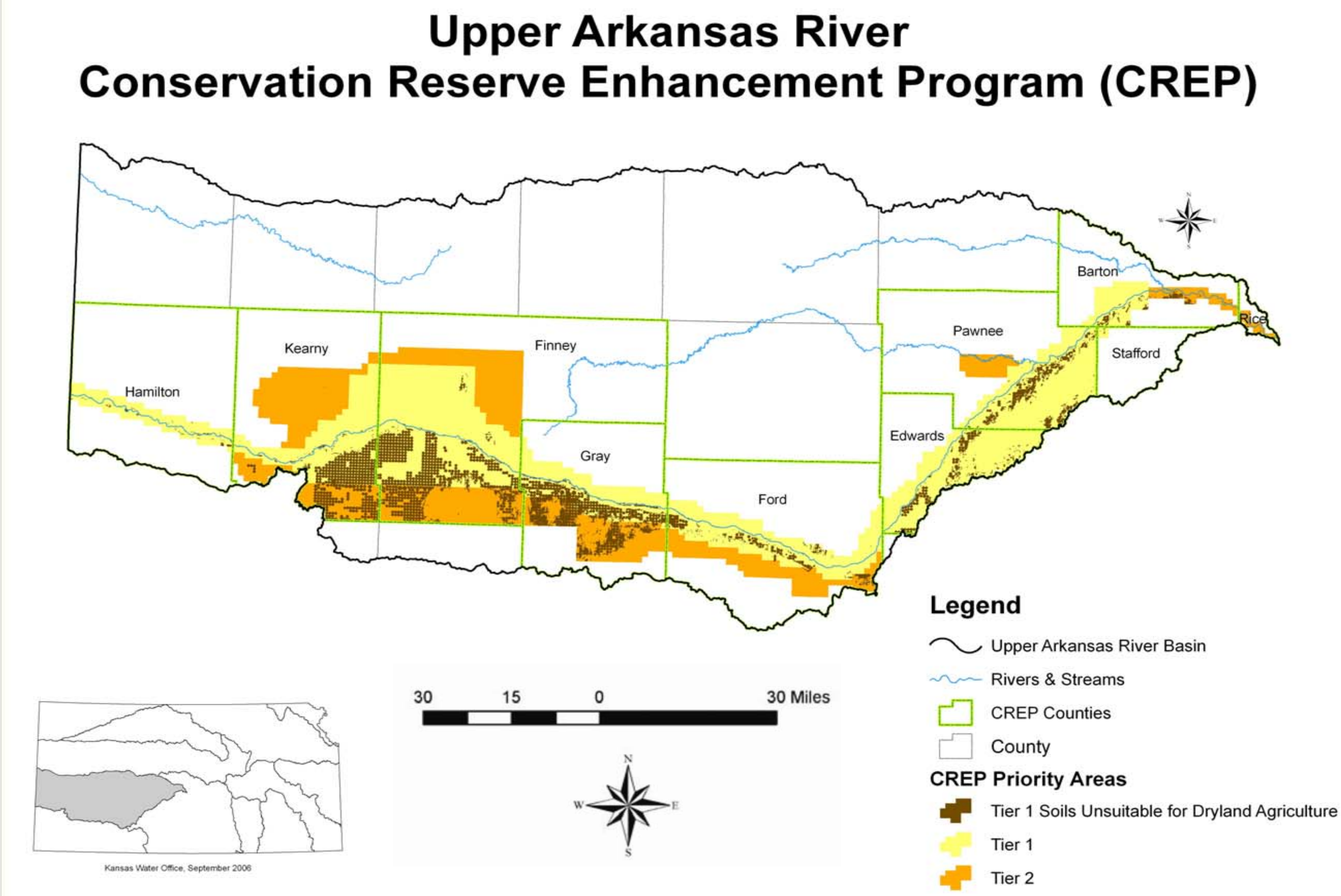


Figure 2 – CREP Area in the Upper Arkansas River Basin. The CREP area extends along the Arkansas River corridor from the Colorado-Kansas border to the southwest corner of Rice County. A large amount of ground water is pumped for irrigation use within the proposed CREP boundaries. Part of the CREP area in Hamilton, Kearny, and Finney counties includes land irrigated with Arkansas River water.

HYDROLOGIC RESPONSES TO FUTURE PUMPING IN THE UPPER ARKANSAS RIVER BASIN

- Ground-water levels will continue to decline unless there are substantial reductions in pumping.
- The aquifer will no longer be usable for large capacity wells in the future if water levels continue to decline at current rates.
- The water-level declines increase the rate of Arkansas River water loss into the aquifer in southwest Kansas and decrease the river flow reaching the Middle Arkansas subbasin.
- The Arkansas river flow from Colorado is saline. Thus, saline river-water seepage is increasing the salinity of the aquifer water.

Figure 3 – Summary of Hydrologic Responses to Future Pumping in the Upper Arkansas River Basin.

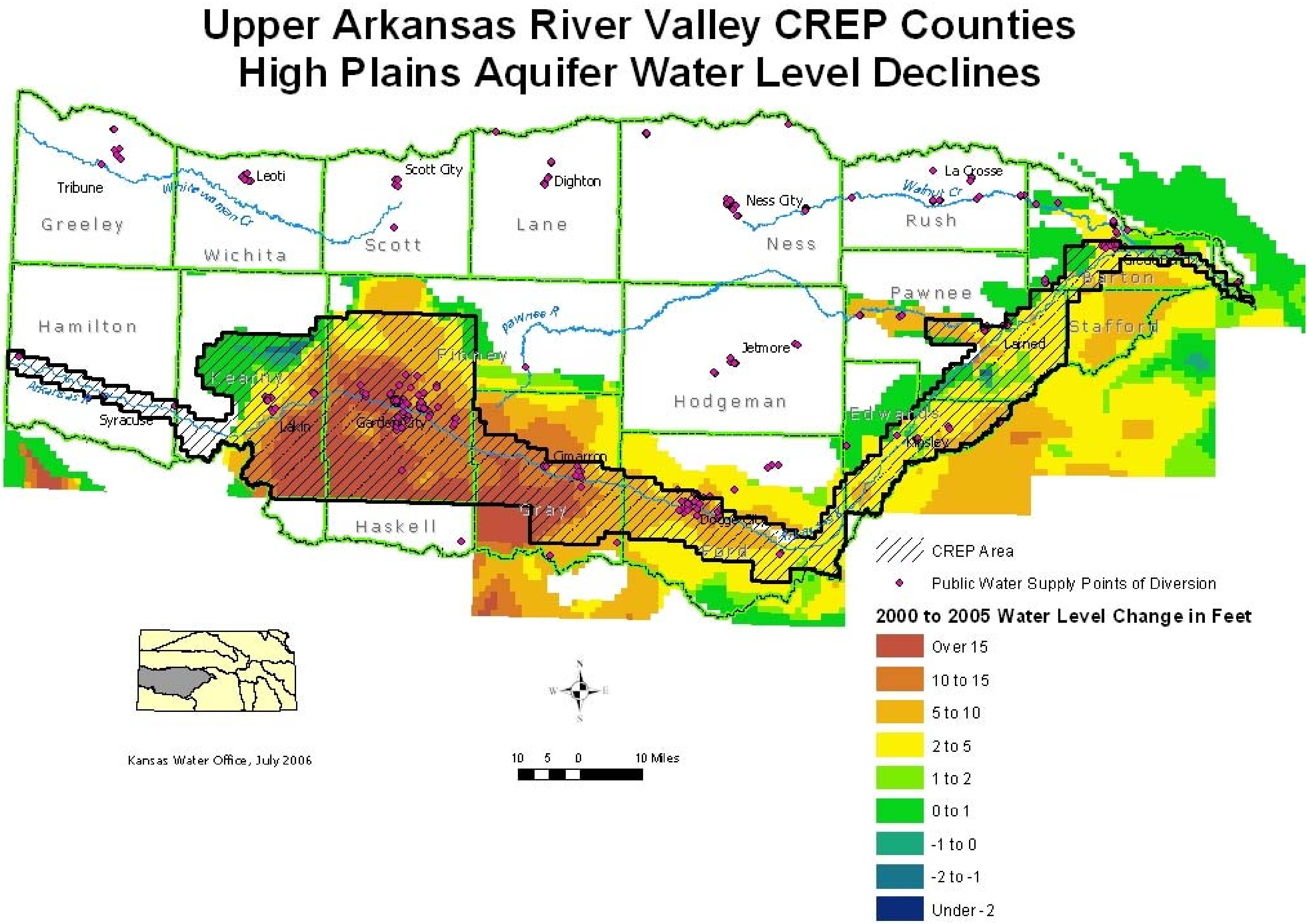
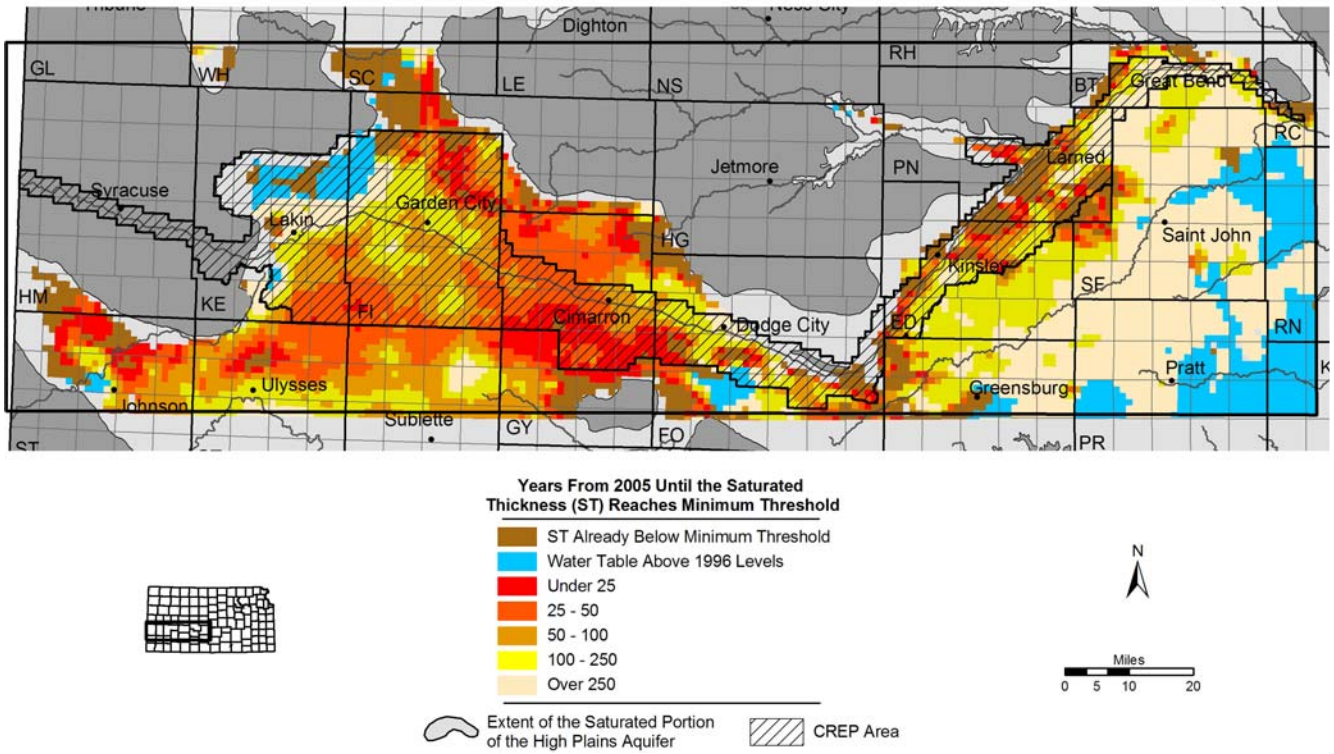


Figure 4 – Change in the Water Table in the High Plains Aquifer in CREP Counties, 2000 to 2005. Water levels in the High Plains aquifer declined in nearly all of the CREP area during the five-year period, including over 15 feet in parts of Kearny, Finney, and Gray counties. These declines are a continuation of long-term water-level declines in the area.

Estimated Usable Lifetime for the High Plains Aquifer in Kansas
(Based on ground water trends from 1996 to 2006 and the minimum saturated thickness required to support well yields at 400 gpm under a scenario of 90 days of pumping with wells on 1/4 section)



CREP would extend the usable lifetime of the aquifer

Figure 5 – Estimated Usable Lifetime of the High Plains Aquifer in the Proposed CREP Region. This map is an estimated projection (not a prediction) of how many years until the High Plains aquifer reaches a point where wells requiring 400 gpm extraction yields will begin to be impaired if ground-water level trends from 1996 to 2006 repeat continuously and unchanged into the future. The border of the CREP area is represented by a heavy black line. The projections based on the last 10 years of water-level records indicate that there are areas with less than 25 years of usable aquifer (the red areas) within the CREP borders. A substantial amount of the CREP area has a usable lifetime of less than 50 years. Some locations within the CREP border have already reached the limits of the usable lifetime based on the procedure used, meaning that pumping is limited to smaller rates than typical for irrigation wells. Where water is currently being pumped from large capacity wells in these locations, future water-level declines will substantially impair the ability to operate these wells as before. The proposed CREP program would reduce the amount of water being pumped from the aquifer, thereby extending the usable lifetime of the aquifer and providing more time for implementation of additional management programs to further extend the aquifer life or achieve sustainable management.

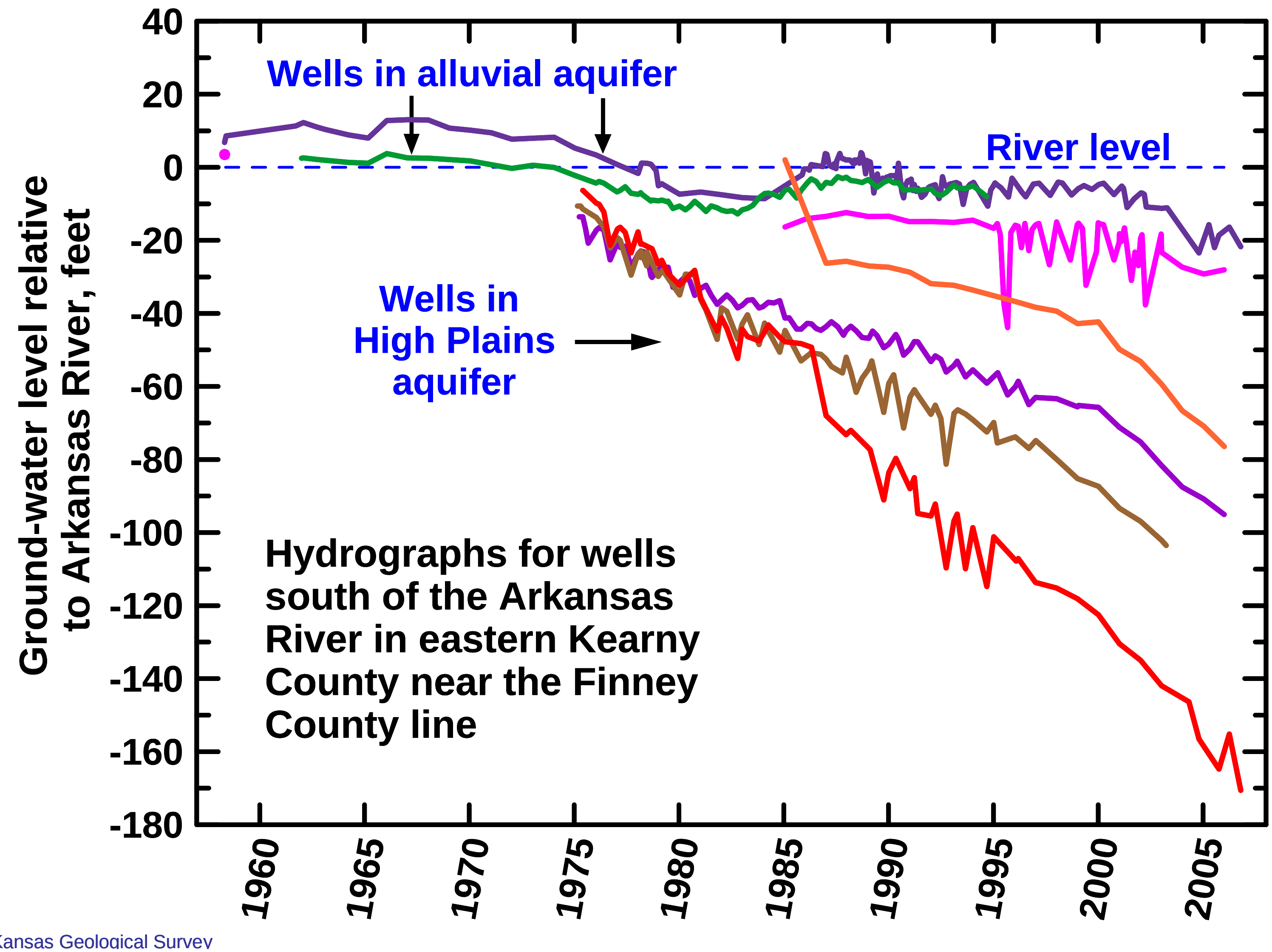


Figure 6 – Water-Level Changes in Wells near the Arkansas River in eastern Kearny County. Water levels have declined in the High Plains aquifer and overlying alluvial aquifer next to the Arkansas River in southwest Kansas, shown here, for example, for eastern Kearny County near the Finney County line. The ground-water levels used to be at or above the water level of the river. In the 1970s the ground-water levels started to decline appreciably below the river level, causing river water to seep into the aquifer thereby decreasing streamflow. Unfortunately, the river water that Colorado sends Kansas is saline, meaning that freshwater in the aquifers is becoming saline. In general, the water-level declines increase in a direction away from the river such that the saline ground water is moving at increasing rates outward from the river.

Sulfate Concentration in Ground Water in the Alluvial Aquifer
in the Upper Arkansas River Corridor, Southwest Kansas

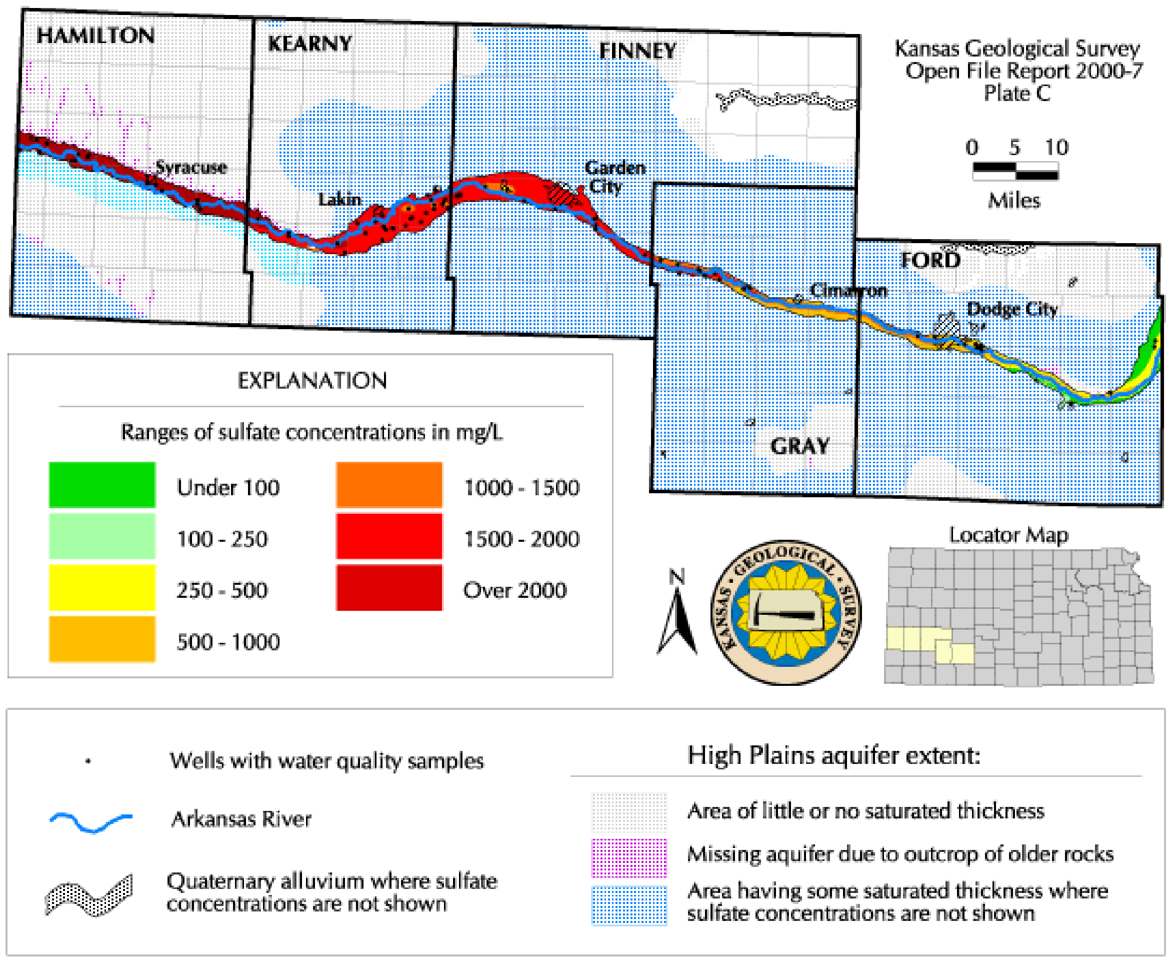


Figure 7 – Sulfate Concentration in Ground Water in the Alluvial Aquifer in the Upper Arkansas River Corridor in Southwest Kansas. The saline river water is very high in sulfate concentration. The recommended or secondary standard for drinking water is 250 mg/L. A substantial portion of the alluvial aquifer along the Arkansas River in southwest Kansas now contains water with over 1,000 mg/L sulfate concentration as a result of saline river water seepage.

Sulfate Concentration in Ground Water in the High Plains Aquifer
in the Upper Arkansas River Corridor, Southwest Kansas

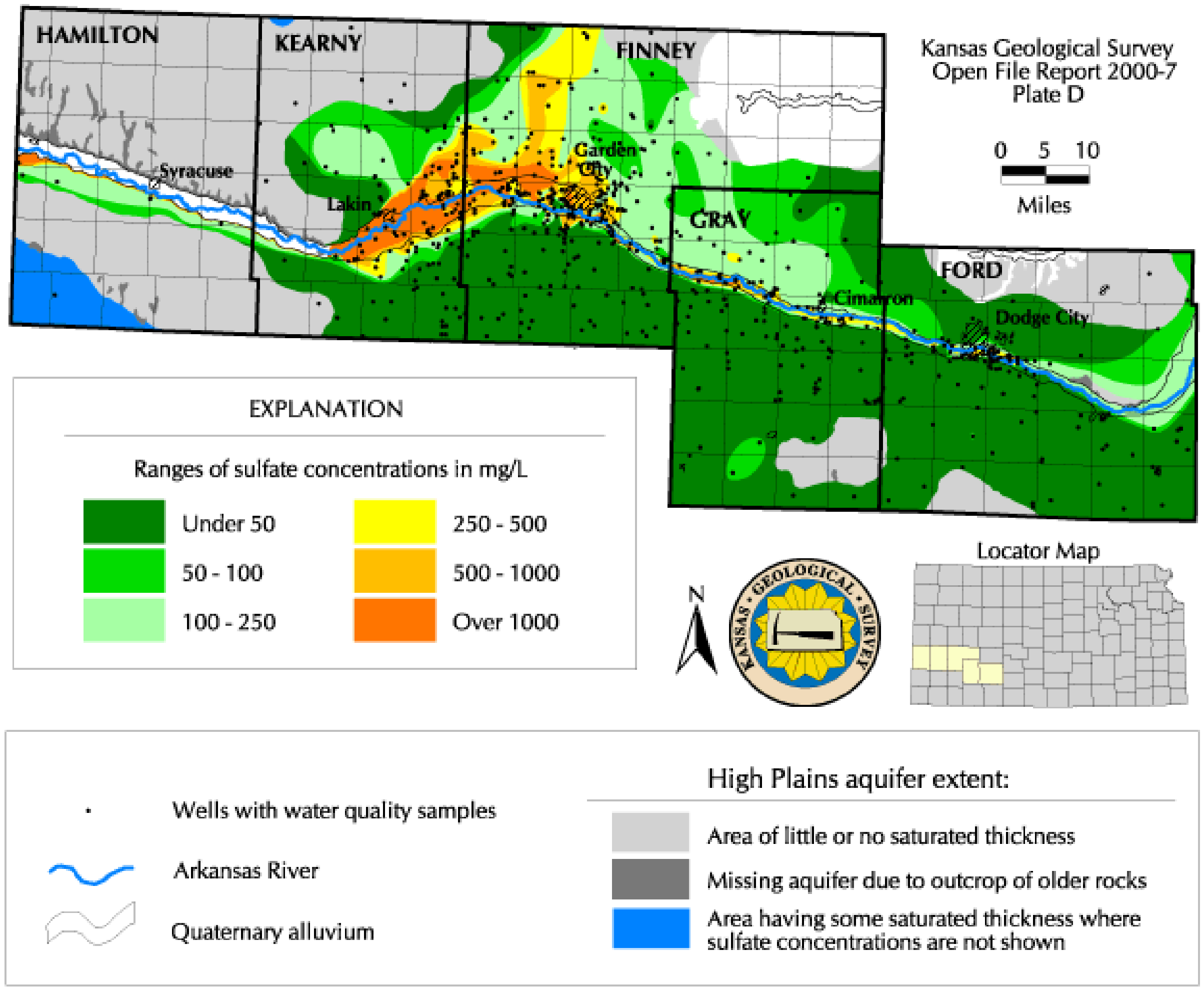
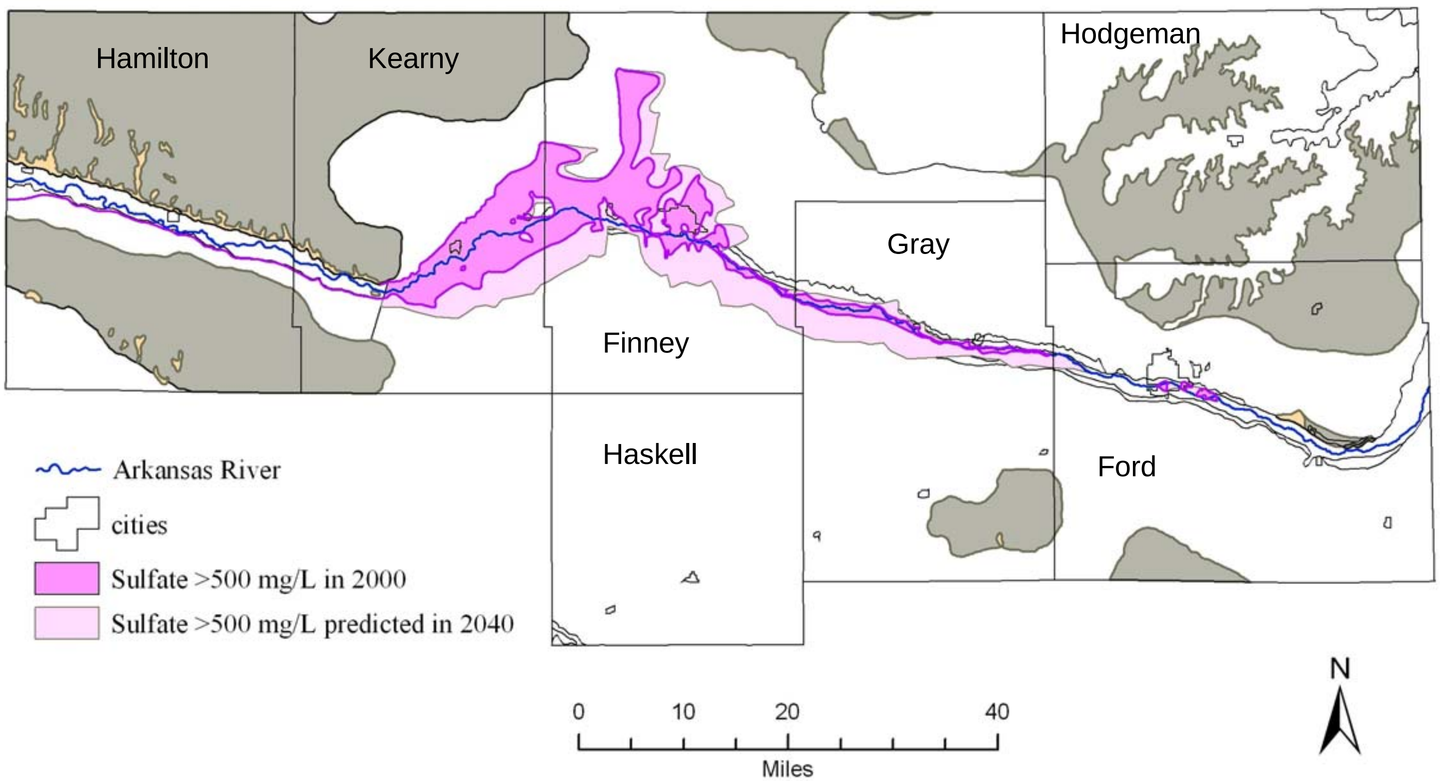


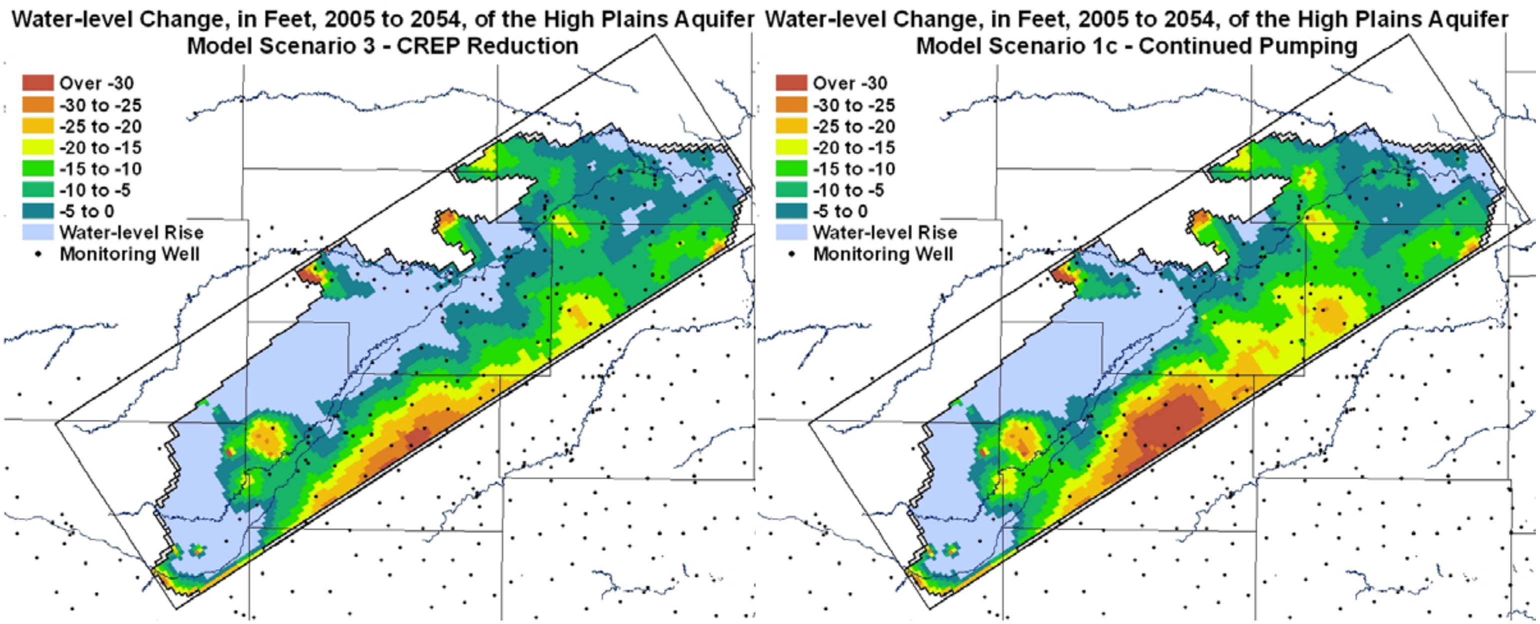
Figure 8 – Sulfate Concentration in Ground Water in the High Plains Aquifer in the Upper Arkansas River Corridor in Southwest Kansas. A substantial portion of the High Plains aquifer in the Arkansas River corridor in Kearny and Finney counties now contains water with over 500 mg/L sulfate concentration as a result of saline river water seepage.



Predicted migration of saline ground water in the High Plains aquifer along the Arkansas River corridor in 2040 based on average 1990s water use

CREP would slow the rate of saline water migration

Figure 9 – Predicted Migration of Saline Ground Water in the High Plains Aquifer along the Arkansas River Corridor in Southwest Kansas. The prediction is based on a numerical model run in 2000 for the year 2040 based on average 1990s water use. The aquifer area with over 500 mg/L sulfate concentration in 2000 is shown in the darker pink shade. The additional aquifer area predicted to have greater than 500 mg/L sulfate by 2040 is represented in lighter pink. This area is expected to completely cover the freshwater well field of Garden City south of the river. The proposed CREP would slow the rate of saline ground-water migration.



Comparison of CREP Pumping and Continued-Pumping Scenarios for Numerical Modeling of the Middle Arkansas River Subbasin

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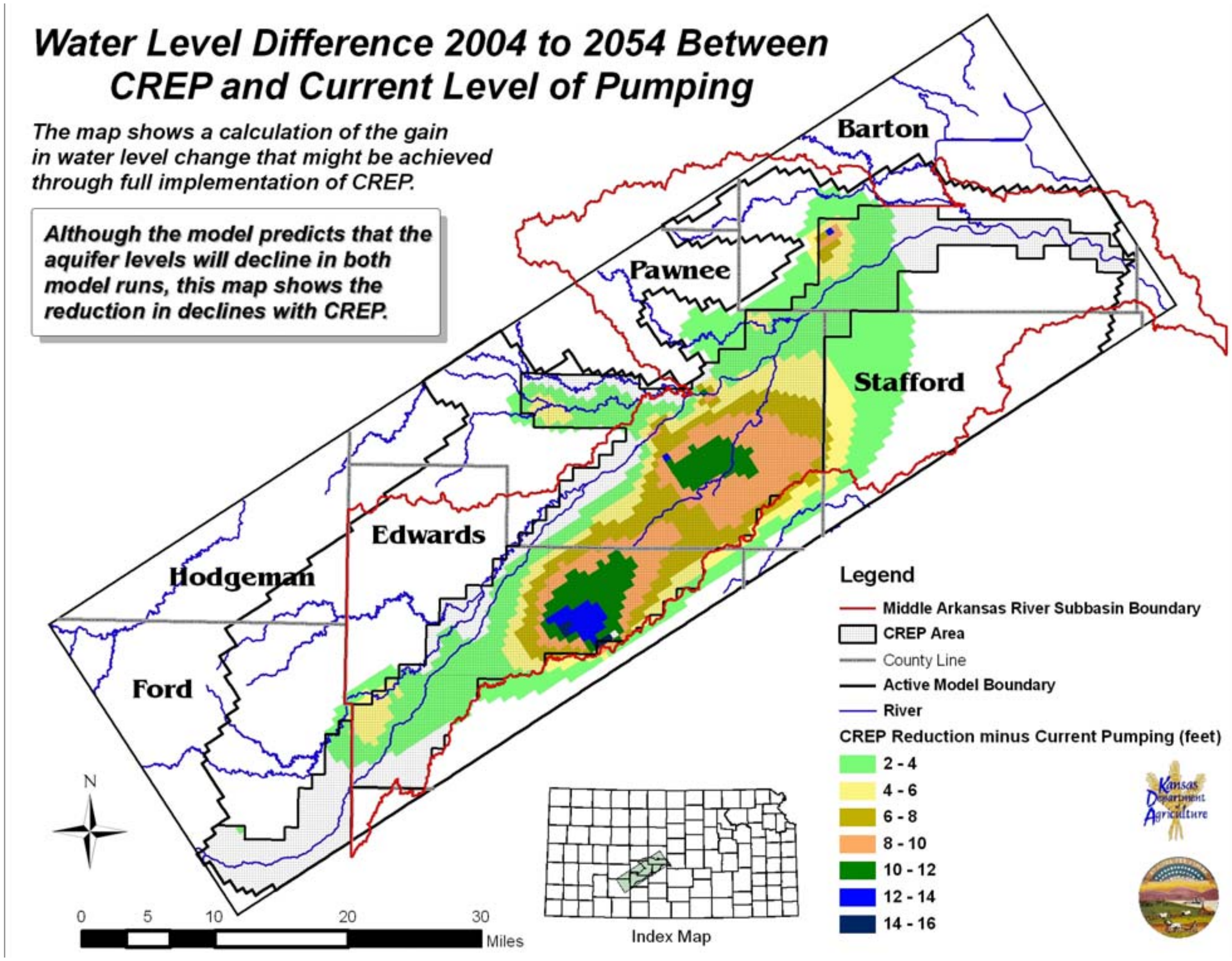
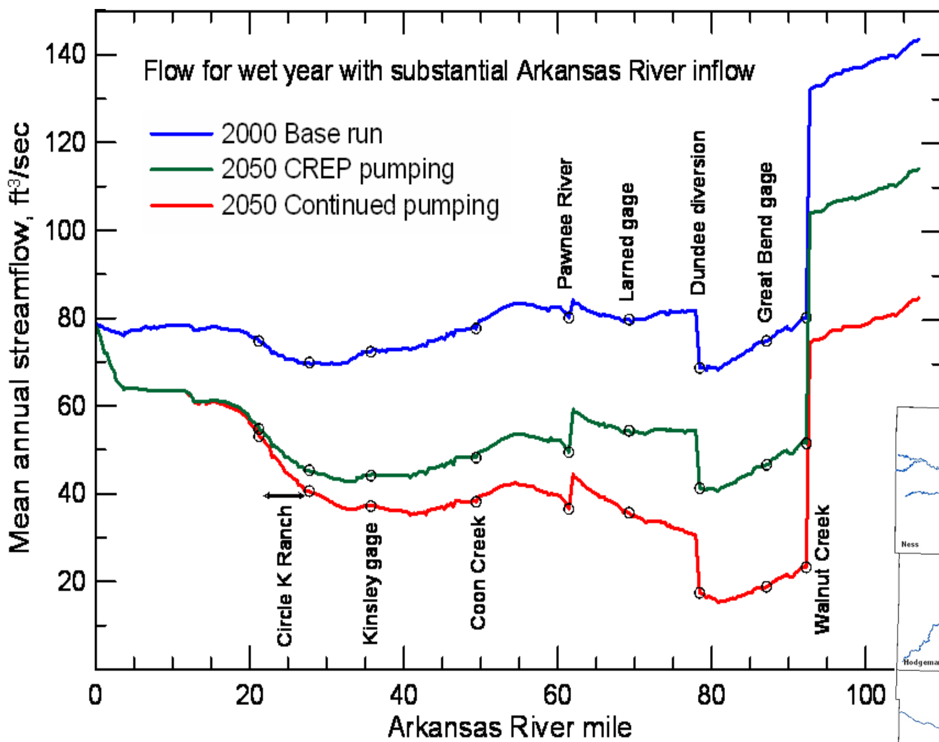
Figure 10 - Comparison of CREP Pumping and Continued-Pumping Scenarios for Numerical Modeling of the Middle Arkansas River Subbasin. The Middle Arkansas River subbasin is located primarily in Edwards, Pawnee, Stafford, and Barton counties. A recent numerical model for the subbasin developed by the Kansas Geological Survey for the Kansas Water Office and the Kansas Department of Agriculture shows that water-level declines in the High Plains aquifer predicted for a CREP scenario (the left-hand figure) will be less than those for a scenario based on continued pumping at current rates. Note the smaller areas with large predicted water-level declines (areas in red and orange shades) in the CREP scenario in comparison with the continued-pumping scenario. Figure 11 shows the water-level difference between these two figures.



CREP would slow ground-water declines

Figure 11 – Water-Level Difference between the CREP Pumping and Continued-Pumping Scenarios for Numerical Modeling of the Middle Arkansas River Subbasin. The differences in the water-level declines for the CREP and continued-pumping scenarios are especially important where the aquifer has currently reached the limit of its usable lifetime or is projected to reach its usable lifetime within 50 years for typical high capacity wells (see Figure 5). The slowing of water-level declines in the High Plains aquifer within the CREP area will also be important to ground-water management in the adjacent Rattlesnake Creek subbasin to the southeast of the Middle Arkansas subbasin.

CREP would slow streamflow declines in the Middle Arkansas River subbasin



Middle Arkansas subbasin and model area

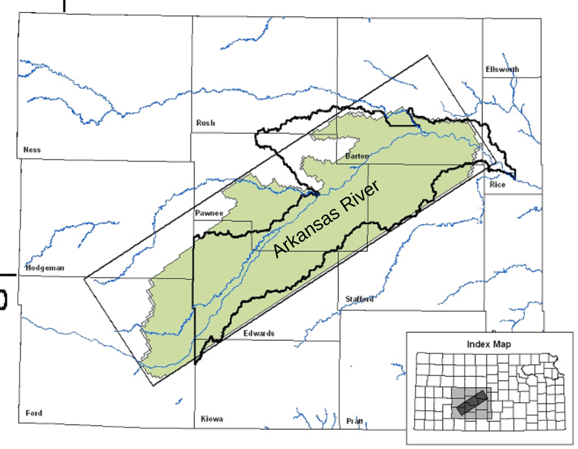


Figure 12 – Decrease in Streamflow along the Arkansas River for the CREP and Continued-Pumping Scenarios Compared to a Wet Year with Substantial Flow. Arkansas River mile in the graph refers to the distance along the river channel starting at the beginning of the numerical model area (shaded in green in the inset map) in northeast Ford County and extending downstream to the end of the model area in southeast Barton County. The smaller streamflow declines in the CREP scenario would mean more water that could be diverted at the Dundee diversion to Cheyenne Bottoms during wet years than if current ground-water pumping continues in the subbasin. As shown in the right-hand photo on the title page, the Arkansas River is now usually dry upstream of the Dundee diversion.

Questions???

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High Plains/Ogallala Aquifer Information
http://www.kgs.ku.edu/HighPlains/index.htm

Upper Arkansas River Corridor Study
http://www.kgs.ku.edu/Hydro/UARC/index.html

Numerical Model of the Middle Arkansas River Basin
http://www.kgs.ku.edu/HighPlains/mid_ark_model.htm

Upper Arkansas Basin CREP Education
http://www.kgs.ku.edu/HighPlains/wraps_crep.htm

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