

**KANSAS GEOLOGICAL SURVEY
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Chloride and Sulfate in the Arkansas River

by

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for the

ARKANSAS RIVER SYMPOSIUM
Wichita, Kansas
September 5-6, 2000

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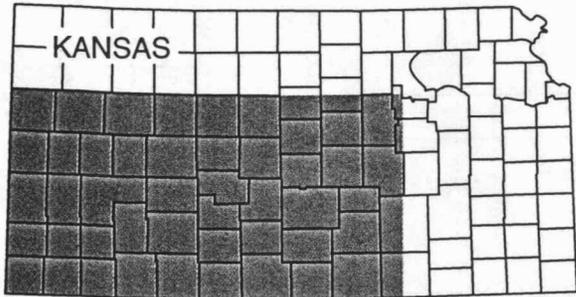
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for the ARKANSAS RIVER SYMPOSIUM, Wichita, Kansas, September 5-6, 2000

Arkansas River water entering Kansas from Colorado is saline. The main dissolved constituents in the water are sulfate and sodium, although high calcium and magnesium contents make the water very hard. The mass source of the dissolved constituents in the river water is primarily soils and bedrock in Colorado. The high salinity of the river water entering Kansas is not natural but the result of consumptive losses of water to evapotranspiration and the retention of the dissolved constituents in the residual water. During some recent years, the Arkansas River becomes dry before Dodge City as the result of seepage into the underlying aquifer and diversion for irrigation use. During the last two decades, the sulfate and chloride concentrations have usually been in the ranges 1,000-2,500 mg/L and 50-200 mg/L, respectively, and have averaged about 1,900 mg/L and 130 mg/L, respectively.

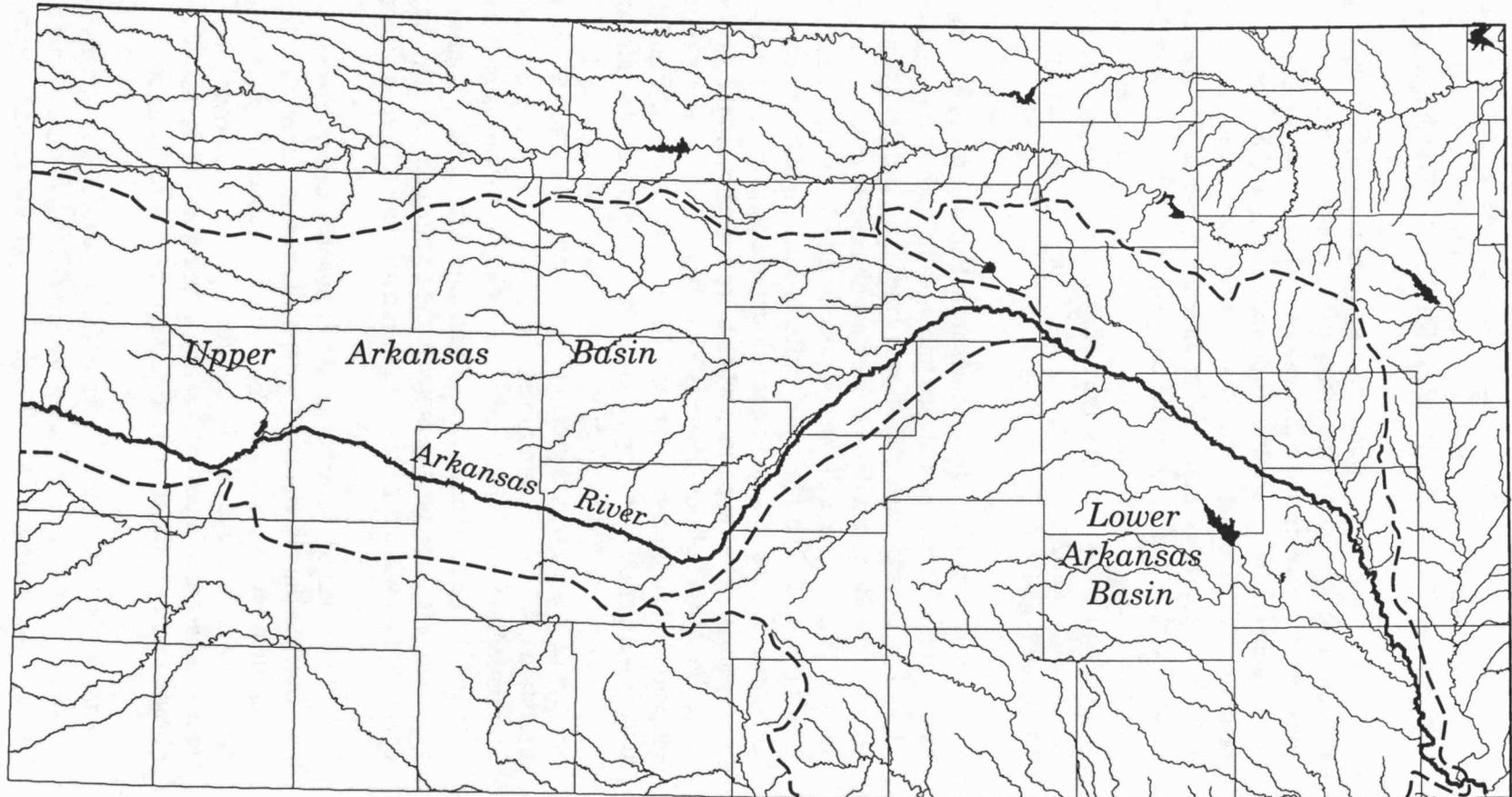
Saltwater naturally intrudes from Permian rocks into the High Plains aquifer in south-central Kansas and thence into streams such as Rattlesnake, Peace, and Salt creeks. The saline ground water and stream water flow into the Arkansas River. The saltwater is high in chloride and sodium contents with smaller amounts of calcium, magnesium, and sulfate. Although there is also some chloride from human activities that enters the river (primarily oil-field brine, water-softener salt in municipal wastewater effluent, and discharges from salt-mining operations), the total percentage effect on the Arkansas River is very small. During periods when there is no flow in the Arkansas River past Dodge City, the salinity of the Arkansas River near Wichita mainly reflects the natural saltwater intrusion in south-central Kansas. The saline input is substantially diluted by runoff during wet periods. During extended dry conditions, chloride concentrations in the river near Maize (just northwest of Wichita) can exceed 700 mg/L. The chloride content and salinity of lower flows is great enough to cause yield reductions to crops if it was used for irrigation. When there are substantial flows in the Arkansas River past Dodge City, the sodium-sulfate water mixes with the sodium-chloride water in south-central Kansas and changes its chemical character. The main effect of the Arkansas River water from Colorado is to substantially increase the sulfate concentration and to dilute the chloride concentration when it mixes with the south-central Kansas discharge.

Sections of the Arkansas River in south-central Kansas can gain water from or lose water to the alluvial aquifer depending on extended climatic conditions. Flow losses can occur where ground-water pumping has caused declines in aquifer water levels that are below those of the alluvial aquifer adjacent to the river. The water in the alluvial aquifer adjacent to the river is saline in south-central Kansas due to both subsurface flow of saline water to the river in some sections and recharge from the river in other areas.

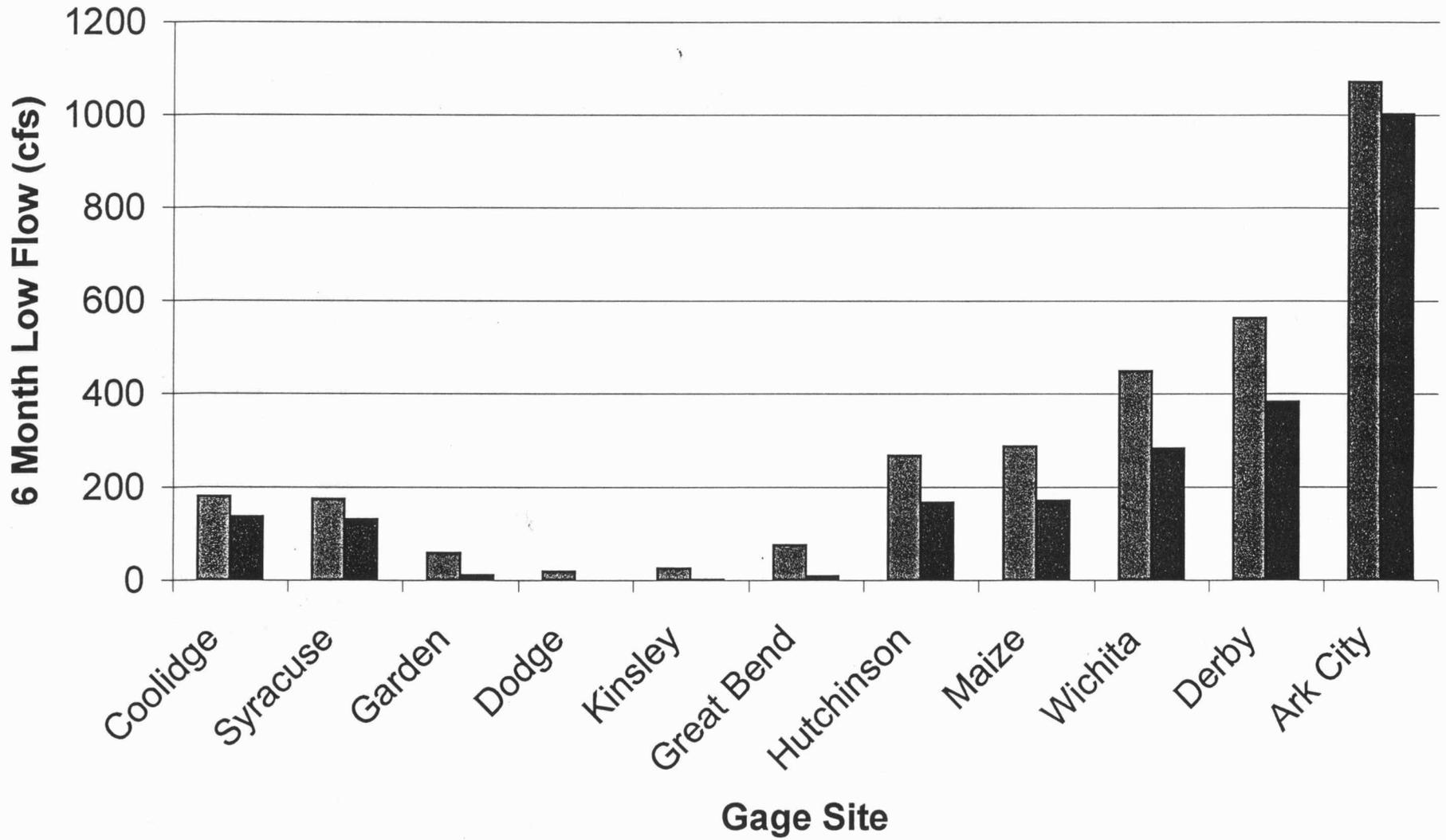
Acknowledgments: Partial support for work related to this document is from the Kansas Department of Health and Environment (TMDL Program) and the Kansas Water Plan (through the Kansas Water Office). Tom Stiles of KDHE prepared the three bar graphs.



Upper and Lower Arkansas River Basins

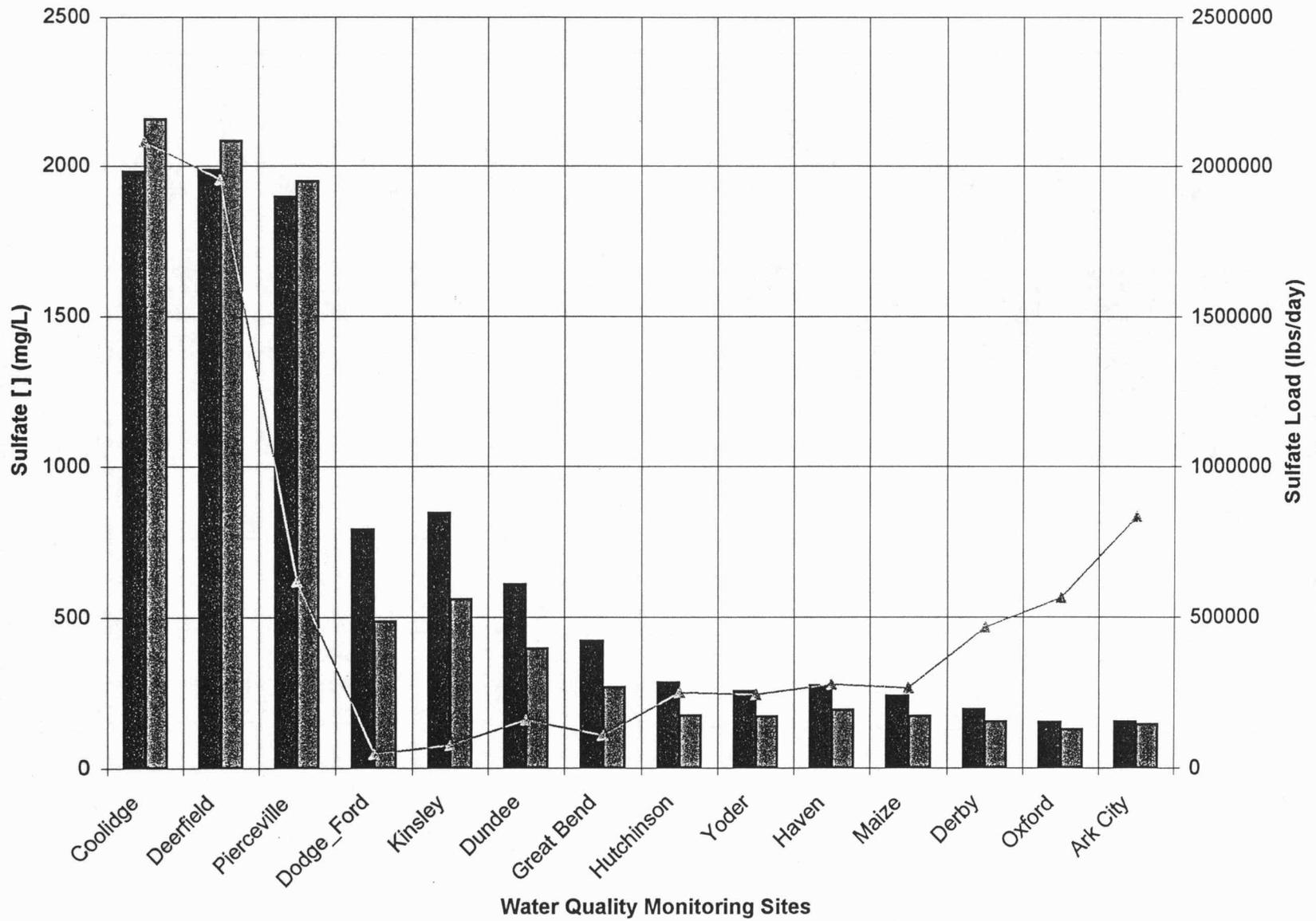


Ark River Flows



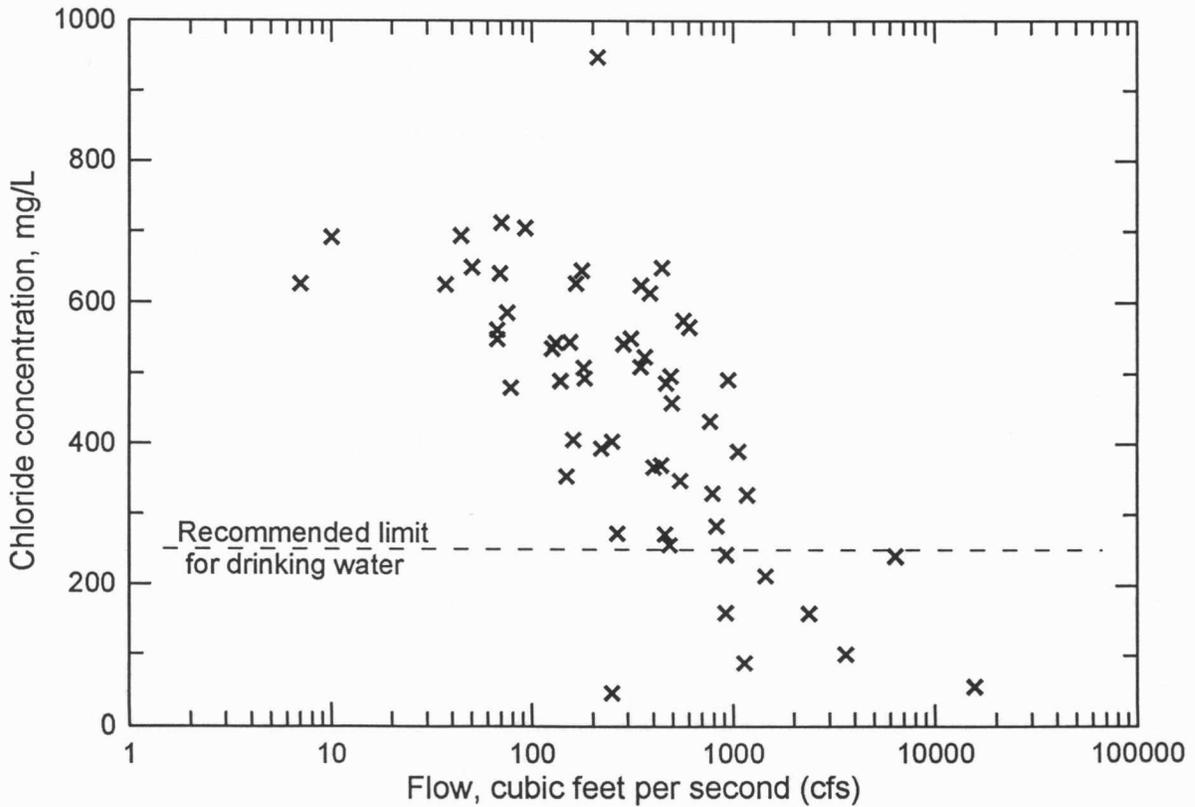
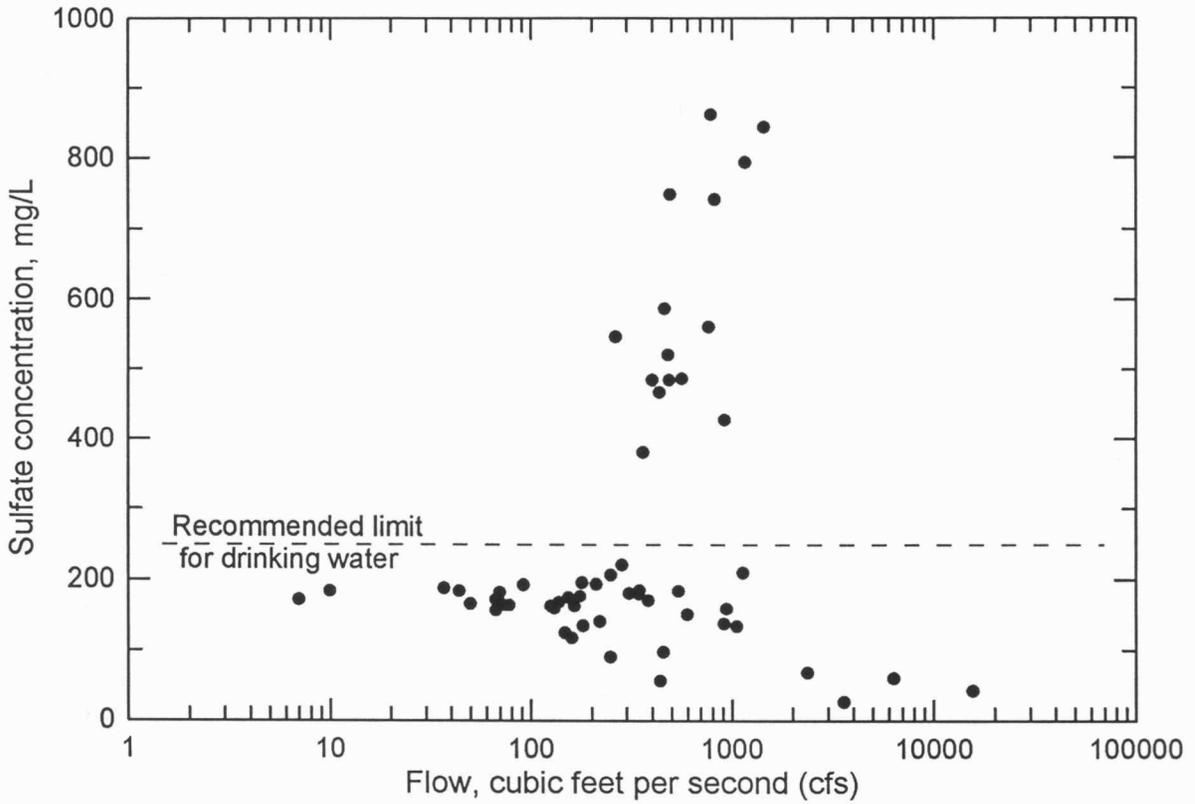
■ Avg 6 Month Low Flow (4/87 - 3/98) ■ Median 6 Month Low Flow (4/87 - 3/98)

Ark River Sulfate

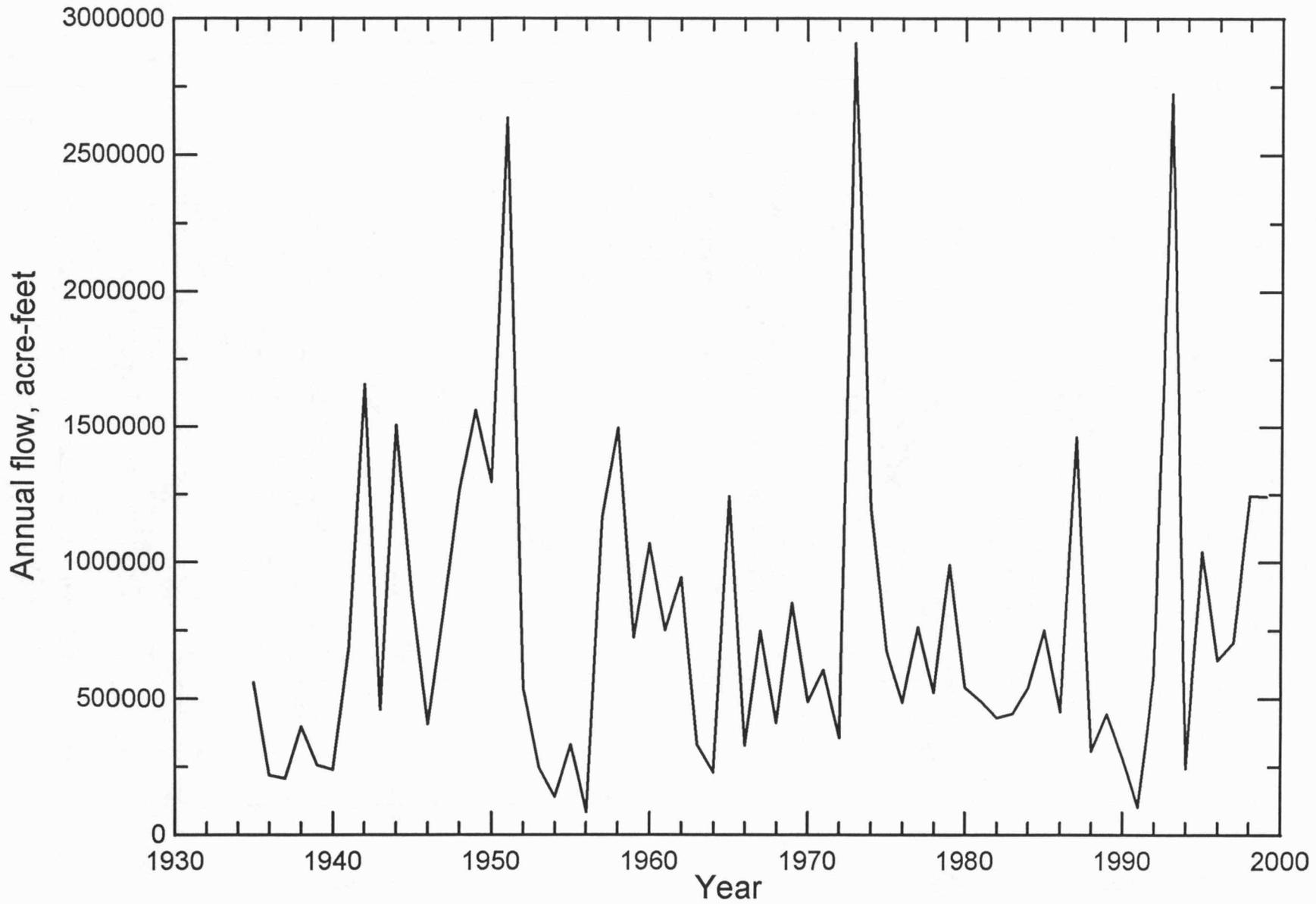


Avg SO4 [] (4/87-3/98)
 Median SO4 [] (4/87-3/98)

▲ SO4 Load @ Avg 6 month low flow and Median []

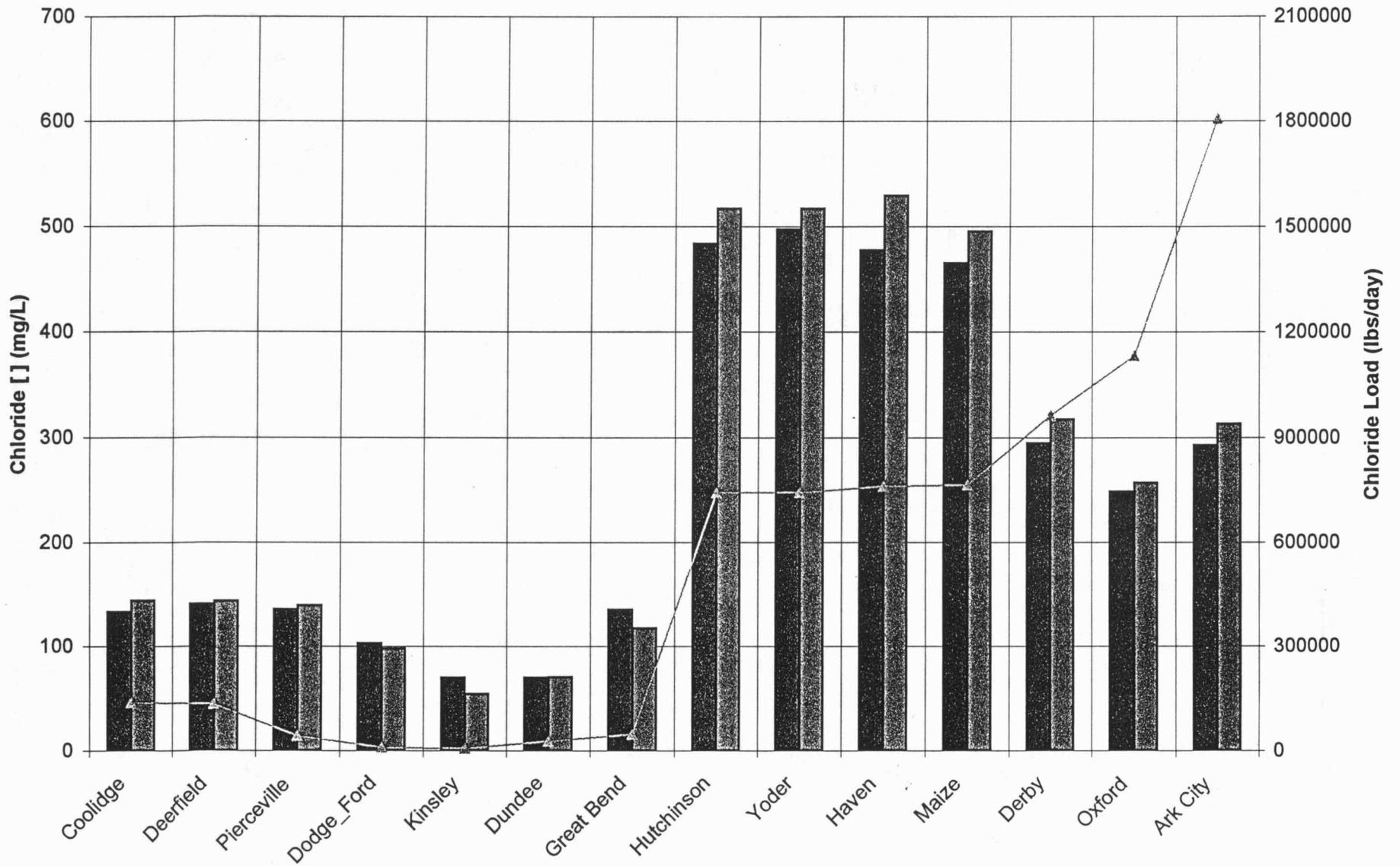


Sulfate and chloride concentration in the Arkansas River near Maize (northwest of Wichita) during 1990-1999. The high sulfate concentration occurs for substantial flows past Dodge City.

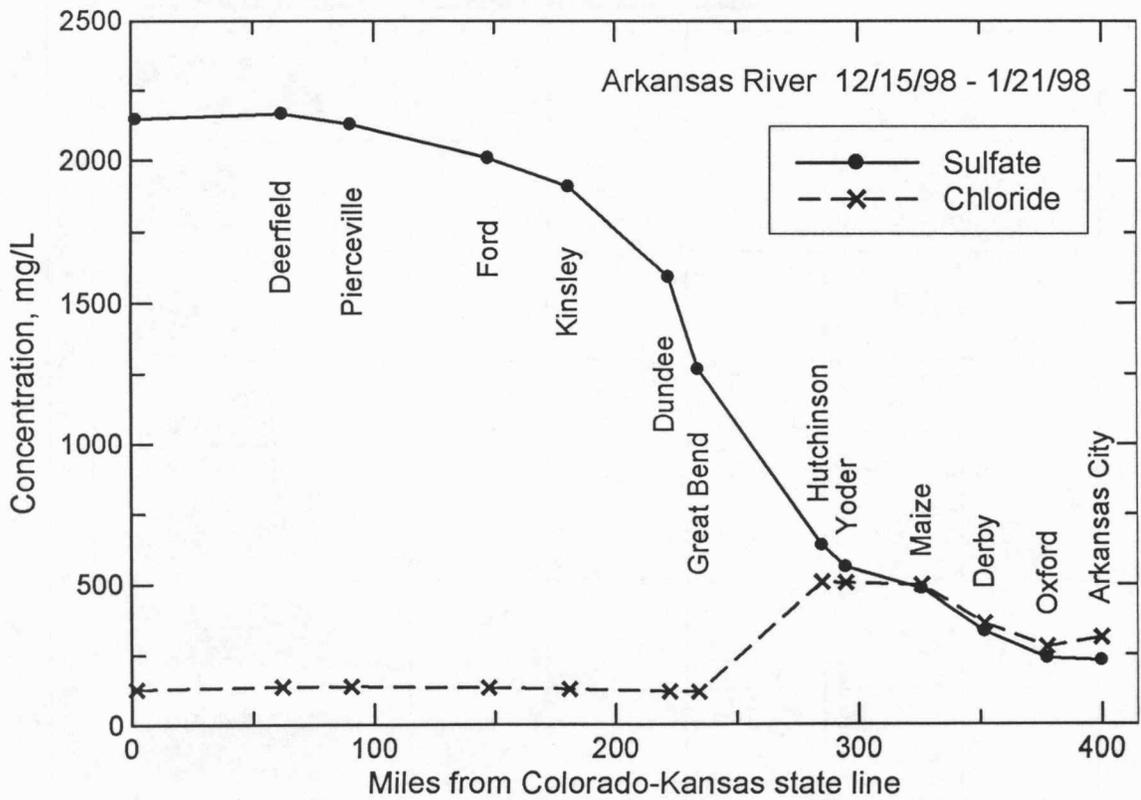
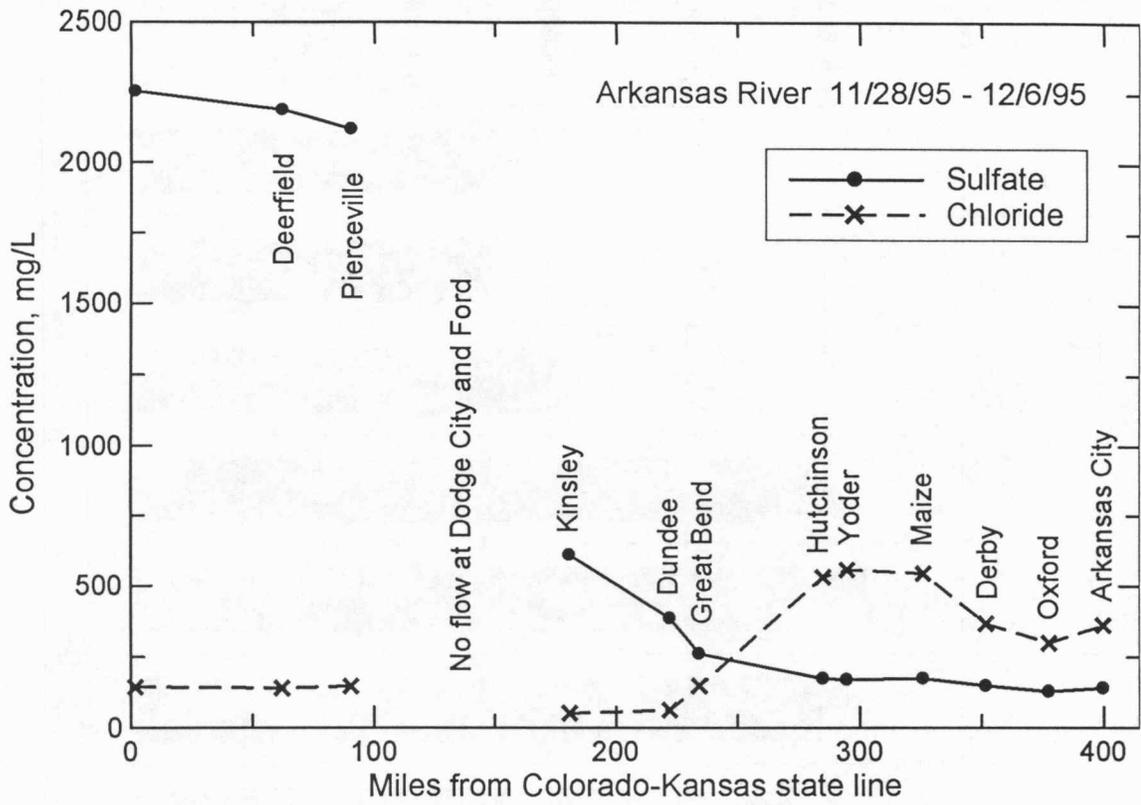


Annual volume of flow in the Arkansas River at Wichita

Ark River Chloride



Avg Cl [] (4/87 - 3/98)
 Median Cl [] (4/87 - 3/98)
 Cl Load @ Avg 6 month low flow and Median []



Profiles of sulfate and chloride concentrations in the Arkansas River across Kansas during periods of no flow (top) and flow (bottom) across Ford County in southwest Kansas.