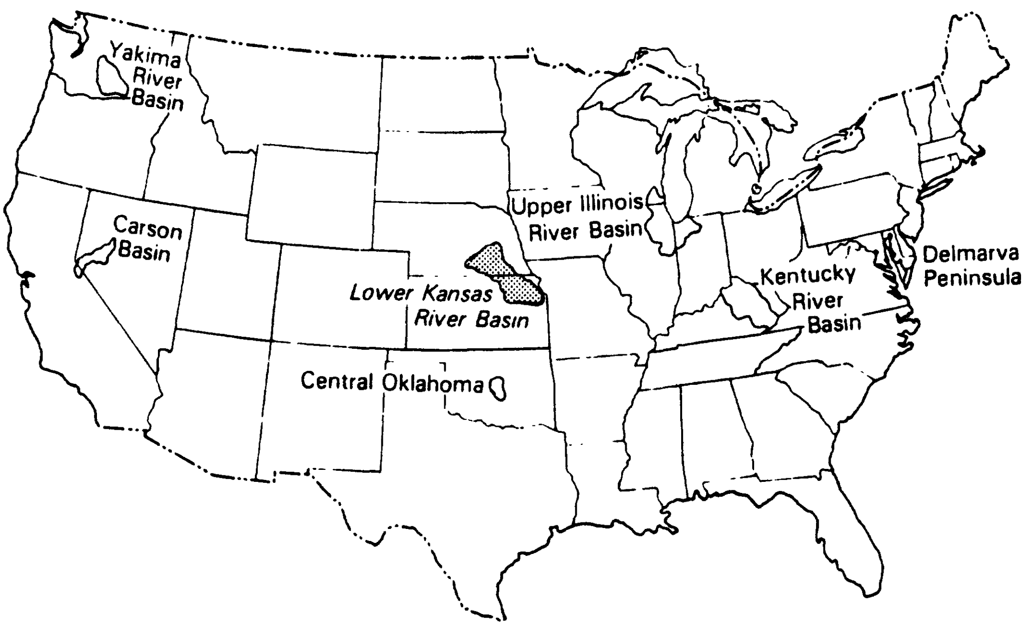
SURFACE WATER-QUALITY ASSESSMENT OF THE LOWER KANSAS RIVER BASIN, KANSAS AND NEBRASKA: PROJECT DESCRIPTION

By J.K. Stamer, P.R. Jordan, R.A. Engberg, and J.T. Dugan



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CONVERSION FACTORS

To aid those readers who are interested in the International System of Units (SI), the factors for converting from the inch-pound units used for the most part in this report to SI units are given below:

Multiply inch-pound unit	By	To obtain SI unit
inch	[1]25.4	millimeter
foot	0.3048	meter
mile	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
acre-foot	1,233	cubic meter
cubic foot per second (ft^3/s)	28.32	liter per second
gallon per minute (gal/min)	0.06309	liter per second
ton (short)	0.9072	megagram
degree Fahrenheit (°F)	[2]	degree Celsius (°C)

[1] Exact conversion factor.

[2] Degree Celsius = (degree Fahrenheit -32)/1.8.

SURFACE WATER-QUALITY ASSESSMENT OF THE LOWER KANSAS RIVER BASIN, KANSAS AND NEBRASKA: PROJECT DESCRIPTION

By J.K. Stamer, P.R. Jordan, R.A. Engberg, and J.T. Dugan

ABSTRACT

In 1986 the U.S. Geological Survey began a National Water-Quality Assessment Program to: (1) Provide nationally consistent descriptions of the current status of water quality for a large, diverse, and geographically distributed part of the Nation's surface-water resources; (2) where possible, define trends in water quality; and (3) identify and describe the relation between water quality and natural and land-use factors. This report describes the pilot study of the lower Kansas River basin, which is one of four surface-water pilot studies that will be used to test, and modify as necessary, assessment concepts and approaches in preparation for future full implementation of the national program.

The lower Kansas River basin drains about 15,300 square miles in eastern Kansas and Nebraska. Three large, multipurpose Federal reservoirs (Tuttle Creek, Perry, and Clinton Lakes) are in the study area. The largest tributary in the study area is the Big Blue River, which drains parts of Nebraska and Kansas. Land use in the study area is predominantly agricultural; principal crops include corn, grain sorghum, soybeans, and wheat. The three major urban areas, Topeka, Lawrence, and Kansas City, Kansas, occupy a very small fraction of the total area.

Water-quality issues in the lower Kansas River basin are dominated by possible nonpoint sources of contamination from agricultural land. Specific water-quality issues include: (1) Large sediment discharge in the streams and sediment deposition in the reservoirs caused by intensive cultivation of row crops and subsequent erosion; (2) occurrence of pesticides in streams and reservoirs that could impair the suitability of water for aquatic life and has the potential for impairing the water's suitability for public supply; (3) bacterial contamination caused by runoff from pastureland and feedlot operations and municipal wastewater discharges; and (4) nutrient enrichment of reservoirs.

The study of the lower Kansas River basin will assess each of the three surface-water components of the basin--the tributaries, the reservoirs, and the main stem of the Kansas River. The approach will use fixed-station, synoptic, and subbasin or river-reach studies. Data from fixed stations will be used to determine frequency distributions of constituent concentrations and mass balances of constituents between stations. Synoptic studies will provide knowledge of the areal variations of water-quality conditions that cannot be assessed through the fixed-station studies. Subbasin or river-reach studies will provide a better understanding of the origin, movement, and fate of potential contaminants.

Quality assurance will be an integral part of the data collection and laboratory analyses of the samples. Coordination of the pilot study will be accomplished, in part, by a local liaison committee consisting of representatives from Federal, State, and local agencies.

INTRODUCTION

Background

Public awareness of the importance of water quality has increased greatly in the past two decades. The Congress has passed such major pieces of water-related legislation as the Federal Water Pollution Control Act Amendments of 1972, the Safe Drinking Water Act of 1974, the Resource Conservation Recovery Act of 1976, and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. State and local governments and industry also have made significant commitments to water-pollution abatement. Through these combined efforts, the quality of many of the Nation's rivers and streams has improved significantly even though industrial activity and population have increased with corresponding increases in water use and in the volume of wastewater discharged. For example, 15 years ago, small dissolved-oxygen concentrations were common in rivers and streams because of the discharge of large volumes of oxygen-demanding carbonaceous and nitrogenous substances. Today, as a result of the construction of new wastewater-treatment plants and the upgrading of existing plants, this is no longer true (Association of State and Interstate Water Pollution Control Administrators, 1984).

Despite significant progress, several water-quality issues still remain. Among them are the possible contamination of surface and ground water from nonpoint-source discharges, acid precipitation, and the disposal of hazardous waste. Cost-effective solutions to many of these potential problems may be difficult because onsite treatment solutions may not be feasible and may involve changes in industrial processes or land-use practices. Additional progress in water-quality improvement will require increased knowledge of the nature and extent of these potential problems, as well as the physical, chemical, and biological processes affecting water quality in streams and aquifers.

National Water-Quality Assessment Program

In response to the need for additional knowledge of the Nation's water resources, the U.S. Geological Survey began a National Water-Quality Assessment Program in 1986 to: (1) Provide nationally consistent descriptions of the current status of water quality for a large, diverse, and geographically distributed part of the Nation's water resources; (2) where possible, define trends in water quality that have occurred over recent decades and provide a baseline for evaluating future trends in water quality; and (3) identify and describe the relations of both the status and the trends in water quality to the relevant natural factors and the history of land use and land- and waste-management practices. This information will be useful for examining the likely consequences of future management actions.

For surface water-quality assessments, study areas will be hydrologic subregions, of which there are 222 in the Nation (Seaber and others, 1984). The program will focus on about 90 of these subregions, selected to account in aggregate for more than 80 percent of the surface-water withdrawals in the Nation.

At the proposed full-implementation level, the surface water-quality assessment program would be conducted on a rotational basis, with about one-third of the designated study areas undergoing intense data acquisition and study at any one time. For any given study area, there would be a 3-year period of concentrated data acquisition and interpretation. At the conclusion of the 3-year period, reports would be written and published that will assess the quality of the water resource. Following this intensive phase, data collection in each study area would be maintained at a smaller scale for 6 years to document any large changes in water quality that may occur. While 60 areas are studied at a smaller scale, major efforts would be concentrated in the other 30 study areas, and thus the level of national effort would remain constant. In any given year, the array of intensive study areas would be dispersed around the Nation.

At present (1986), the National Water-Quality Assessment (NAWQA) Program is in a pilot phase that will be used to test, and modify as necessary, assessment concepts and approaches in preparation for possible full implementation of the program sometime in the future. The pilot phase also provides an opportunity to evaluate the potential benefits and costs of a fully-implemented program. Seven pilot studies (four surface-water studies and three ground-water studies) have been started.

Lower Kansas River Basin Project

The lower Kansas River basin in Kansas and Nebraska is one of the four surface-water pilot-study areas, which also include the Kentucky River basin in Kentucky, the Yakima River basin in Washington, and the Upper Illinois River basin in Illinois, Indiana, and Wisconsin. The lower Kansas River basin was selected as a pilot-study area because it is typical of the very productive midwestern grain belt that includes irrigated and nonirrigated cropland and nonirrigated pasture and rangeland. The basin also includes typical uses of water for irrigation, municipal, and industrial purposes. To achieve the National goals and objectives, the National plan of study has been adapted to the hydrologic and land-use conditions of the lower Kansas River basin.

Specific objectives of the pilot study in the lower Kansas River basin are to: (1) Define existing surface water-quality conditions; (2) define trends in surface-water quality; (3) calculate average annual constituent transport; (4) evaluate the impact of surface-water impoundments on downstream water quality; and (5) identify stream segments where water quality may be impacted adversely by natural processes or human activities.

Purpose and Scope of Report

This is the first report from the pilot study of the lower Kansas River basin in Kansas and Nebraska. The purpose and scope of this report are to: (1) Describe the study area of the lower Kansas River basin; (2) summarize the general water-quality conditions based on existing reports and data; (3) depict the known water-quality problems and issues; and (4) describe the lower Kansas River basin water-quality assessment.

DESCRIPTION OF LOWER KANSAS RIVER BASIN

The lower Kansas River basin (fig. 1) drains about 15,300 mi^2 and coincides with the area defined by the U.S. Water Resources Council as hydrologic subregion 1027 (Seaber and others, 1984). Although 7.5 mi^2 of the subregion lies within Missouri, drainage from this small area near the mouth of the Kansas River does not impact water use in the study area and will not be included in the study. The study area does include the Big Blue River basin in Nebraska and Kansas, as well as basins of smaller tributaries to the 170-mile Kansas River from Junction City to Kansas City, Kansas.

The Kansas River is formed by the confluence of the Smoky Hill and Republican Rivers at Junction City, Kansas (fig. 1). Three large Federal reservoirs, Tuttle Creek Lake on the Big Blue River, Perry Lake on the Delaware River, and Clinton Lake on the Wakarusa River, lie within the Kansas part of the study area.

Land Forms

Land forms in the lower Kansas River basin are characterized by the four physiographic divisions shown in figure 1 (Fenneman, 1931). Smooth plains with little local relief dominate the High Plains division, and fluvial and eolian deposits comprised of sand, gravel, silt, and clay underlie this part of the study area. Flatness of topography in the High Plains provides gentle stream gradients that contribute to only limited stream dissection and rather broad, poorly defined valleys. The lack of slope has contributed also to a lack of external drainage in some areas.

The Plains Border physiographic division is more dissected than the High Plains and thus has greater local relief. It is underlain by shale, sandstone, and limestone, and minor fluvial and eolian deposits. The drainage pattern in the Plains Border area is more definite than in the High Plains. Stream channels are characteristically narrow, well established, and bounded by a perceptible series of terraces.

The Dissected Till Plains division is characterized by dissected deposits of glacial till comprised of silt, clay, sand, gravel, and boulders that overlie bedrock of primarily shale and limestone with some sandstone. Local relief is from 300 to 500 feet in the downstream part of the Big Blue River basin and generally less than 300 feet elsewhere. Drainage channels are well entrenched by the tributaries flowing south to the Kansas River.

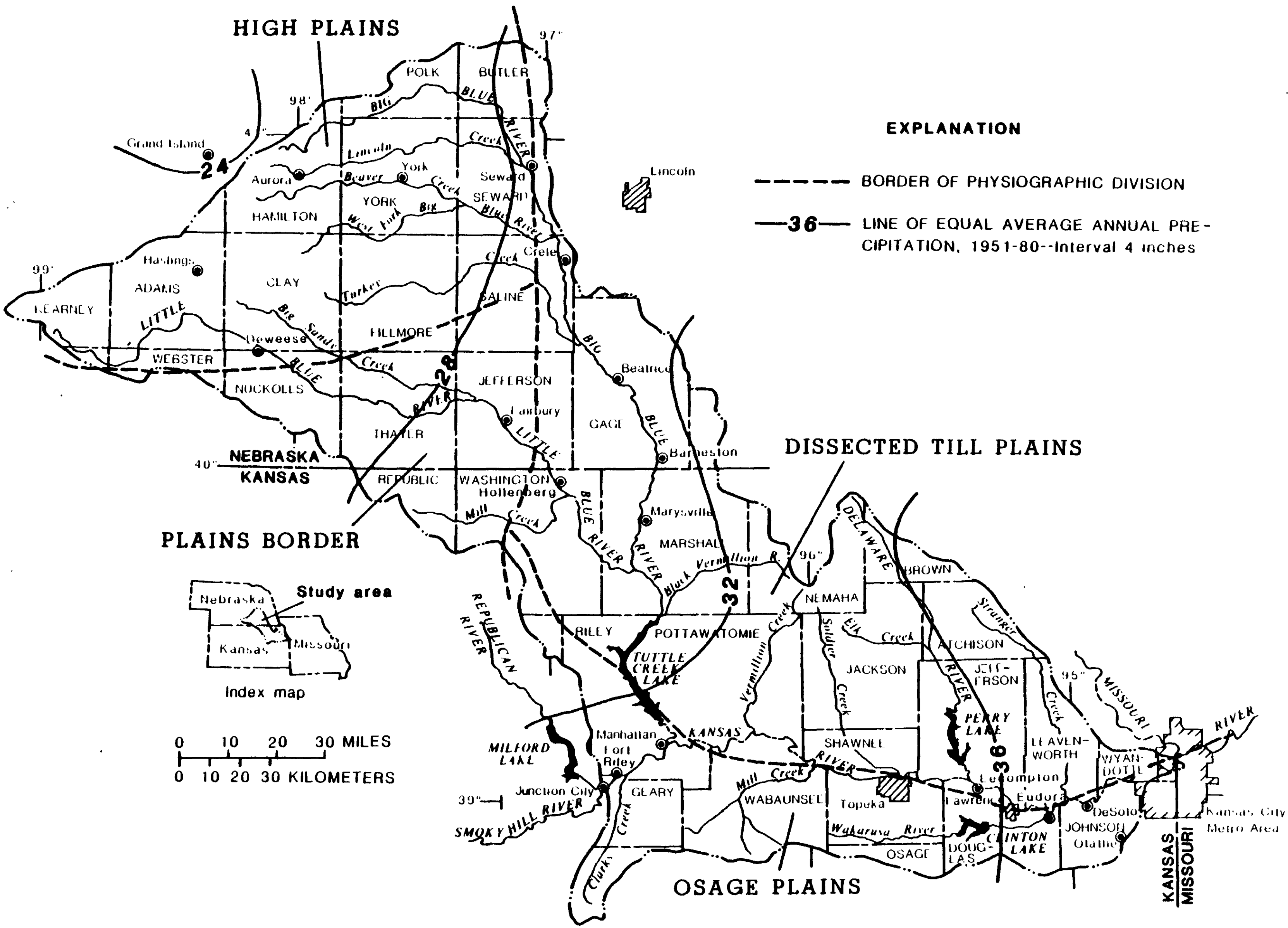

Figure 1.--Location, physiographic divisions, and precipitation in lower Kansas River basin, Kansas and Nebraska.

The Osage Plains are south of the limit of glaciation and are underlain primarily by shale and limestone, with some sandstone. The Osage Plains in Riley, Geary, and Wabaunsee Counties, Kansas, are underlain principally by cherty limestone and are known locally as the Flint Hills. Local relief in the Osage Plains is generally less than 300 feet but exceeds 300 feet in parts of the Flint Hills. Drainage patterns are well defined, although dissection of the land is less than in the Dissected Till Plains.

In both the Osage Plains and the Dissected Till Plains physiographic divisions, alluvial and terrace deposits comprised of sand, gravel, silt, and clay occur in major stream valleys. The Kansas River along its path from Junction City to Kansas City generally separates the Osage Plains from the Dissected Till Plains in a broad, flat alluvial valley bounded by rolling hills.

Land Use

Land use in the lower Kansas River basin is typical of the agricultural region of the midwestern United States. Agriculture accounts for about 95 percent of the land use in the High Plains and Plains Border physiographic divisions. More than 75 percent of the agricultural land in this part of the study area is devoted to cultivated crops, and the balance is devoted principally to grazing. The principal crops in this part of the study area, in acreage order, are corn, grain sorghum, wheat, and soybeans. The most intensely cultivated part of the study area is in the High Plains division, in which about 85 percent of the agricultural land is cultivated. In this area, soils, topography, and ground-water availability are well suited for cultivated and irrigated crops. In the Plains Border division of the study area, about 70 percent of the agricultural land is used for nonirrigated, cultivated crops, and the remainder is used for grazing.

Land use in the Dissected Till Plains and the Osage Plains is also predominantly agricultural. These divisions are characterized by more topographic relief and less ground-water availability than the area of the basin that lies in the High Plains and Plains Border divisions; thus, the area is less suited for cultivated and irrigated crops. Principal crops are grain sorghum, wheat, corn, beans, and hay. The Flint Hills area in Riley, Geary, and Wabaunsee Counties, Kansas, is mostly grazing land, and the remaining area in the Dissected Till Plains and Osage Plains is mixed cropland (30-60 percent) and grazing land.

Although population in the study area is about 500,000, urban development represents a very small fraction of the total basin area. The major urban and industrial areas in the basin are the Kansas part of the Kansas City metropolitan area, Topeka, and Lawrence, Kansas. Although the Kansas City metropolitan area is at the downstream end of the basin and has little effect on the Kansas River, some of its water supplies are affected by activities in the basin. Other land uses, such as forest, water, and mining, also occupy a very small part of the total area of the basin.

Climate

Climate in the lower Kansas River basin is characterized by hot, humid summers and cold winters with no particular dry season. July is normally the warmest month in the basin with an average temperature of about 25 °C, and January is normally the coldest month with an average temperature of about -4 °C. The average annual temperature ranges from about 11 °C in the northwestern part of the basin to about 12 °C in the southeast.

The frost-free period, a measure of the growing season, averages from about 150 days in the northwestern part of the basin to about 180 days in the southeast. The last killing frost in spring normally occurs about April 30 in the northwestern part of the basin and about April 20 in the southeast. The first killing frost of autumn generally occurs about October 10 in the northwest and about October 20 in the southeast. The first and last frost dates, however, may vary by as much as a month on either side of the average dates, resulting in considerable variation in the length of the growing season.

Precipitation in the basin is the most significant climatic factor for agriculture and surface-water availability because of both temporal and spatial variability. The 1951-80 average annual precipitation ranged from about 24 inches in the northwestern part of the basin to about 36 inches in the southeast (fig. 1). Extreme variability, however, characterizes annual precipitation patterns. For example, from 1951 to 1980, annual precipitation on large parts of the basin has ranged from less than 15 inches to more than 50 inches. The potential for drought, both short and long term, is always great within this region. The potential for periodic flooding caused by excessive precipitation and runoff is equally great.

About 75 percent of the precipitation in the basin normally occurs during the warm season, April through September, which coincides for the most part with the growing season. Precipitation during the growing season, however, is not always sufficient to provide optimal soil-moisture conditions for most crops grown in the study area. Thus, where water supply is plentiful, irrigation is a common practice.

Potential evapotranspiration ranges from about 49 inches per year in the northwestern part of the basin to about 43 inches per year in the southeast (Farnsworth and others, 1982). During the growing season, potential evapotranspiration normally exceeds precipitation, and during the nongrowing season, evapotranspiration is much less than precipitation. Because of minimal evapotranspiration demands, the nongrowing season is, therefore, the most effective time for precipitation to replenish soil moisture and to recharge the ground-water system.

Surface-Water Features and Runoff

The Republican and Smoky Hill Rivers, which join to form the Kansas River at Junction City, Kansas, both begin in the plains of eastern Colorado and flow about 500 miles eastward to their confluence. Thus, the Kansas River at its beginning receives streamflow from a drainage area of nearly

45,000 mi^2. The Republican River, although it drains more than one-half of the area, provides about one-third of the average flow (about 2,600 ft^3/s) entering the lower Kansas River study area and the Smoky Hill River provides two-thirds of the flow.

The largest tributary downstream from Junction City is the Big Blue River, which originates in Nebraska as does its principal tributary, the Little Blue River. The Big Blue River enters the Kansas River at Manhattan, Kansas. Other principal tributaries that drain from the north to the Kansas River are Vermillion Creek, Soldier Creek, the Delaware River, and Stranger Creek. The drainage to the Kansas River from the south is much smaller than that from the north and includes Mill Creek and the Wakarusa River.

Although the basin contains many ponds and lakes, three large Federal reservoirs provide most of the surface-water storage. Tuttle Creek Lake on the Big Blue River has a sedimentation pool of 211,500 acre-feet, a conservation pool of 177,100 acre-feet, and a flood-control pool of 1,937,000 acre-feet. Tuttle Creek Lake currently is used for flood control, low-flow augmentation, and recreation, but allocations for water supply are being studied. Perry Lake on the Delaware River has a conservation pool of 225,000 acre-feet and a flood-control pool of 517,500 acre-feet. Perry Lake is used for flood control, recreation, and public-water supply. Clinton Lake on the Wakarusa River has a conservation pool of 129,100 acre-feet and a flood-control pool of 268,400 acre-feet. Clinton Lake is used for flood control, recreation, and public-water supply.

Runoff in the study area varies areally as determined by precipitation, vegetation, topography, soils, and geology, and seasonally in response to precipitation and evapotranspiration. The 50-percent increase in average annual precipitation from 24 inches in the northwest to 36 inches in the southeast (fig. 1) is accompanied by a 350-percent increase in average annual runoff from less than 2 inches in the northwestern part of the study area to nearly 9 inches in the southeast (fig. 2). Average monthly streamflow is greatest in the spring and least in the late fall and early winter. The average flow rate of the Kansas River at its mouth during 1971-84 was about 8,800 ft^3/s, of which the Big Blue River contributed about 28 percent; the Smoky Hill River, 19 percent; the Republican River, 12 percent; the Delaware River, 8 percent; and smaller tributaries the remaining 33 percent. Streamflow characteristics (table 1 at the end of this report) were calculated from the entire period of record available at the time of calculation at sites having unregulated flow, and from a period of record representing current (1986) flow conditions at sites where flow is regulated by major reservoirs.

Relation of Surface Water and Ground Water

The upper Big and Little Blue Rivers in the High Plains physiographic division (fig. 1) are generally well sustained during dry weather by discharge from the High Plains aquifer, although intense irrigation development over the past 30 years has caused the base-flow contribution from the

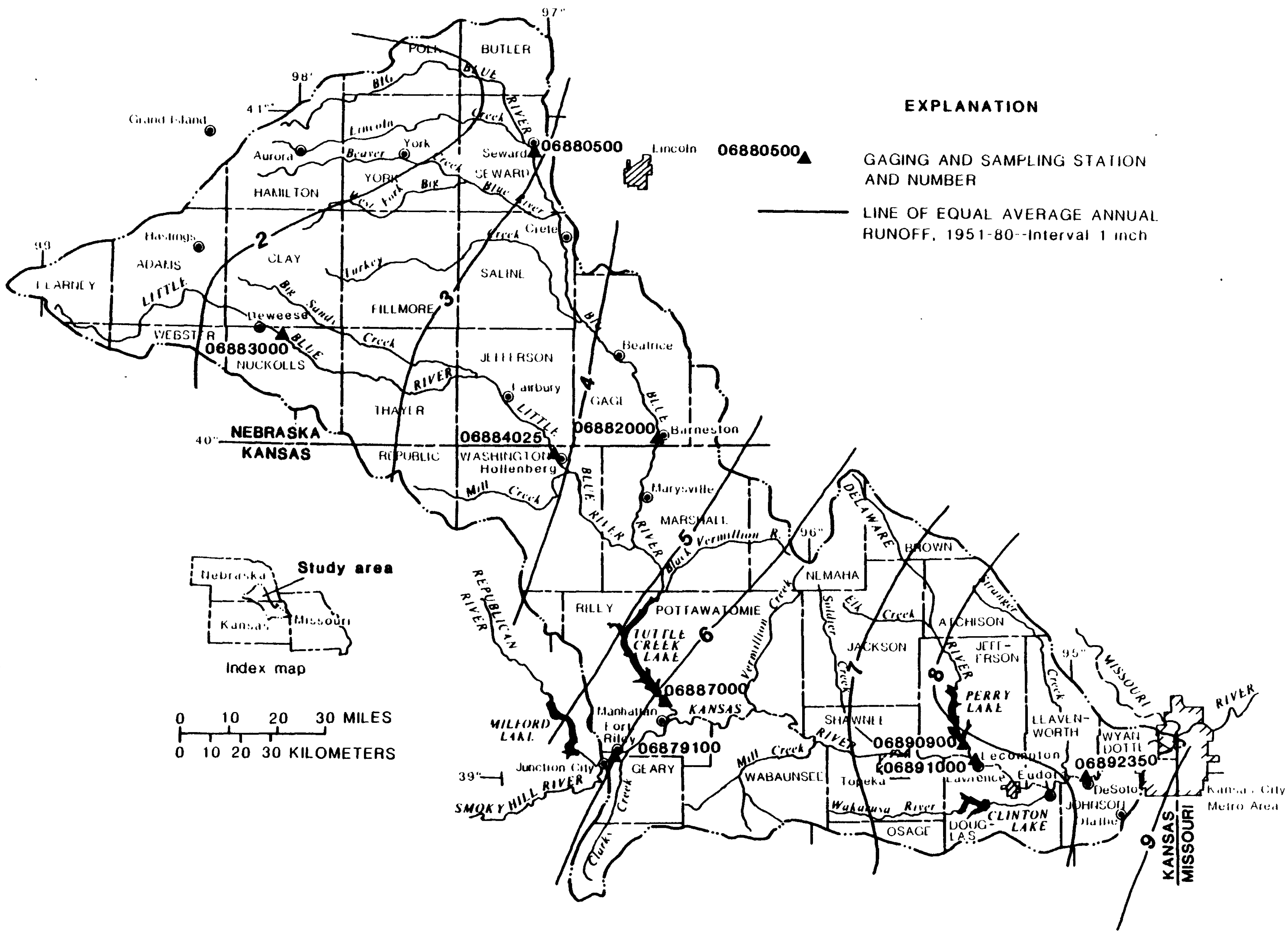

Figure 2.--Average annual runoff and location of gaging and sampling stations.

aquifer to the stream system to be somewhat diminished. Thus, surface-water quality during low flow is affected by ground-water quality, although the effect is not quantitatively known. Ground water from the High Plains aquifer generally contains less that 500 mg/L (milligrams per liter) of dissolved solids, with calcium and bicarbonate as the major constituents.

Although wells in sandstone underlying parts of the Plains Border, western Dissected Till Plains, and western Osage Plains yield up to 300 gal/min, little is known about the quantity of ground water contributed to streams in these areas. The ground water in these areas generally contains less than 500 mg/L of dissolved solids, with calcium and bicarbonate as the major constituents.

Ground water is scarce in the uplands of the central and eastern parts of the Dissected Till Plains and Osage Plains where bedrock is primarily shale with thin strata of limestone and sandstone. Shallow wells in scattered glacial-drift aquifers north of the Kansas River yield up to 100 gal/min; however, this ground water probably has negligible effect on the quantity or quality of water in the major streams.

Considerable interchange of water occurs between the Kansas River and its alluvial aquifer, which ranges in width from 1 to 2.5 miles. During times of high streamflow and during floods, the river provides recharge to the aquifer. During lengthy dry periods, the alluvial aquifer contributes an estimated 1 to 4 ft^3/s of flow per river mile to the Kansas River (Fader, 1974). The alluvial water generally contains less than 500 mg/L of dissolved solids, with calcium and bicarbonate as the major constituents. The exchange of water probably has a significant effect on quantity and quality of water in both the river and the aquifer; extensive quantitative study of the effects probably would be merited.

Water Use

Water use in the lower Kansas River basin totals about 3,100,000 acre-feet per year. Irrigation withdrawals account for about 1,800,000 acre-feet of the total and are predominantly ground water from the High Plains aquifer and the alluvial aquifer along the Kansas River and partly surface water from the Big and Little Blue Rivers and the Kansas River. Irrigation accounts for more than 90 percent (about 1,600,000 acre-feet) of the net consumptive use of water in the basin. Other major uses having significant consumptive components are self-supplied industry, including thermoelectric power generation (141,000 acre-feet, supplied mainly from the Kansas River), and public supply (134,000 acre-feet, mainly cities along the Kansas River from Topeka to Kansas City).

Surface-water use is about 1,280,000 acre-feet per year, accounting for about 41 percent of the total water use. Surface water is used instream, nonconsumptively, for hydroelectric power (1,000,000 acre-feet per year) and offstream for self-supplied industry (108,000 acre-feet per year), irrigation (85,000 acre-feet per year), and public supplies (79,000 acre-feet per year). Surface-water withdrawals for offstream use are mainly from the Kansas River, and the water is used within a few miles of the river.

Previous Studies

Previous studies have provided a considerable quantity of information on some aspects of surface-water quantity, quality, and related topics for the lower Kansas River basin (see "Selected References"). Studies that include information on quantity or major water-quality characteristics of all or large parts of the lower Kansas River basin, more detailed studies on selected smaller parts of the basin, and other studies that cover selected topics of narrower scope provide important background information and data for this surface water-quality assessment.

A study by the Missouri Basin Inter-Agency Committee (1971) covers the entire lower Kansas River basin and includes information on land use and major water-quality constituents. The studies reported by Colby (1956), the Kansas Water Resources Board (1959), and the U.S. Bureau of Reclamation (1973) cover the Kansas part of the study area and provide valuable information on water quantity but do not include comprehensive information on surface-water quality.

More detailed studies on selected smaller parts of the lower Kansas River basin include a study of fluvial sediment and chemical quality of water in the Little Blue River basin by Mundorff and Waddell (1966). The quality of water in the upper Big Blue River system was studied by Keech and Engberg (1978). A statistical summary and analysis for 29 measures of water quality were performed by Engberg (1983) for 11 sites in the Big Blue and Little Blue River basins in Nebraska for samples collected before 1979.

Studies on selected topics of narrower scope include a study by O'Brien and Angino (1966) of dissolved solids and major ions and their relations to specific conductance and discharge at seven sites on the Kansas River and at sites near the mouths of the Big Blue, Delaware, and Wakarusa Rivers in Kansas. Background concentrations and seasonal variations of selected trace and minor elements at the same sites were analyzed by Angino and others (1969). Analyses of 17 measures of water quality for nearly 600 samples from 14 main-stem and 12 tributary sites in the Kansas River basin were used by McClelland (1974) in studying the responsiveness of the National Sanitation Foundation's Water Quality Index to variations in water quality. Schneider and Angino (1980) studied suspended sediment and selected trace elements transported during floods at nine sites on tributaries in Kansas. Numerous other studies provide additional background information and data on selected surface water-quality topics for the lower Kansas River basin.

Summary of Water-Quality Data for Selected Sites

The principal source of the water-quality data that are presented in this report is computer files of the U.S. Geological Survey in Lawrence, Kansas, and Lincoln, Nebraska. Data availability varies with site, constituent coverage, and periods of collection. Moreover, many of the constituents, such as trace metals and trace organic substances, that potentially have adverse effects on public health and aquatic biota have not been analyzed at many surface-water sites in the basin. Where such data have been collected, they typically represent only one medium, such as the water column which changes with flow and time. Data for long-term integrators of water quality that include streambed sediments and biota generally are lacking.

A summary of readily available information on water quality from the U.S. Geological Survey computer files for five surface-water sites for October 1977 to July 1986 is shown in table 2 at the end of this report. The sites are near the beginning and end of the Kansas River and at major tributary sites that have significant quantities of available data. The period of analysis was selected to provide an overview of recent water-quality conditions. Table 2 shows the name of the constituent or property, the units of measurement, the number of measurements, the 10th-percentile, median (50th-percentile), and 90th-percentile values. The median is a good measure of the central tendency of the data because it is insensitive to extreme values. Similarly, the 10th and 90th percentiles provide a good estimate of the common variation of the data because these percentiles are insensitive to the most extreme values on either side. The number of measurements is important in interpreting these data; for the purpose of this summary, fewer than 30 measurements are insufficient for meaningful 10th and 90th percentiles, and fewer than 10 measurements are insufficient for a meaningful median (standards derived from information presented by Conover, 1980, p. 105-117 and table A-3).

Concentrations of dissolved solids summarized in table 2 were calculated by summing the concentrations of calcium, magnesium, sodium, bicarbonate (with adjustment for volatilization), sulfate, and chloride for each individual analysis. Although no dissolved-solids data were available for the Kansas River at Fort Riley, a median concentration of about 800 mg/L was estimated from data for the Republican and Smoky Hill Rivers. Median calculated dissolved-solids concentrations in the Big Blue River at Barneston, Nebraska, and the Little Blue River at Hollenberg, Kansas, were 320 and 280 mg/L, respectively. Streamflow in the Big Blue River near Manhattan, Kansas, which averaged 28 percent of the flow of the Kansas River at DeSoto and contained a median concentration of 230 mg/L of dissolved solids, contributed to the decrease in dissolved-solids concentrations in the Kansas River downstream from Fort Riley; however, the median concentration in the Kansas River at DeSoto remained larger than 400 mg/L.

The median values of pH ranged from 7.9 to 8.2 standard units (table 2) and indicate moderately alkaline water. A typical range in pH from the 10th to 90th percentile was about 1 standard unit at any given surface-water site.

Concentrations of the nutrients nitrogen and phosphorus were available for some of the sites in table 2. The largest concentrations of nitrogen occurred in the Big Blue River at Barneston, Nebraska, and in the Little Blue River at Hollenberg, Kansas. As noted in the discussion of land use, the land in these drainage areas is used predominantly for row crops, which typically are heavily fertilized. Phosphorus data in table 2 indicate that concentrations of phosphorus were larger in the Big Blue River at Barneston, Nebraska, and in the Little Blue River at Hollenberg, Kansas, than at other sites. Probable effects of Tuttle Creek Lake on concentrations of phosphorus are indicated by the decrease in concentrations in the Big Blue River near Manhattan, Kansas, which may be due in part to sedimentation and in part to assimilation of dissolved phosphorus by lake biota.

Concentrations of total organic carbon were available for four of the sites listed in table 2. The median concentration of total organic carbon is smallest in the Big Blue River near Manhattan, which possibly indicates that deposition and decomposition of organic carbon are occurring in Tuttle Creek Lake. The 90th-percentile values of total organic carbon are largest for the Big Blue River at Barneston, Nebraska, and the Little Blue River at Hollenberg, Kansas, which may reflect the intensity of row crops in the area drained by these two streams.

Available data on dissolved concentrations of eight trace elements (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) were sufficient to summarize for three of the sites in table 2. These elements, when in solution, can pose an immediate toxic problem to aquatic biota if present in large concentrations. Little data exist for total recoverable concentrations of trace elements in the streams. The small median dissolved trace-element concentrations in the limited data reflect the geology and land use in the study area.

Of the seven pesticides listed in table 2, atrazine, silvex, and 2,4-D are herbicides, and endrin, lindane, methoxychlor, and toxaphene are insecticides. In general, there are little or no data on pesticides in either water, suspended sediment, streambed sediment, or biota for many of the pesticides that are used currently in the study area. In the few samples analyzed for pesticides at the sites in table 2, the median concentrations were small; however, analyses at other sites by State agencies have shown significant concentrations of some of these and other pesticides.

Fecal coliform and fecal streptoccoci are bacteria that traditionally have been used as indicators of the sanitary quality of water; these two kinds of bacteria are contained in the intestines of all living, warm-blooded animals. Data in table 2 show the largest median and 90th-percentile concentrations of fecal coliform in the Little Blue River at Hollenberg, Kansas, possibly reflecting effects of cattle feedlots.

Prevalence of problems associated with sediment is reflected in the availability of data on suspended-sediment concentration and particle size at numerous sites in the basin (Jordan, 1985, p. 64-74). Data on concentrations of suspended sediment were available for four of the five sites in table 2. The largest median concentration, 4,700 mg/L, occurred in the Little Blue River at Hollenberg, Kansas, and the smallest median concentration, 33 mg/L, occurred in the Big Blue River near Manhattan, Kansas. The concentration at Hollenberg probably reflects the susceptibility of land predominantly in row crops to erosion processes, whereas the small concentration for the Big Blue River near Manhattan reflects the ability of Tuttle Creek Lake to trap suspended sediment. The variability of suspended-sediment concentrations at each site is large; note that the 90th percentile is about two orders of magnitude larger than the 10th percentile. For the four sites for which suspended-sediment data are summarized in table 2, the median values of percentage of silt- and clay-sized particles (finer than 0.062 millimeters) are 92 to 95 percent.

Available data summarized here, together with the limited data available for other sites, are sufficient only to provide an overview of the general surface-water quality of a few streams in the basin, to indicate some possible problem areas, and to indicate the types of data and areal coverage needed for a more complete understanding of the hydrologic/water-quality system. The following section of this report discusses the major surface water-quality problems and issues that have been indicated by these data, by previous studies, and by other available information.

Water-Quality Problems and Issues

In general, water-quality issues in the lower Kansas River basin are related to identified water-quality problems, which in turn are related to land use. Water-quality problems and issues that are presented in this report have been identified by either published reports, which are referenced, or by written or oral communications in 1986 from members of the lower Kansas River basin Liaison Committee, unless otherwise identified. Committee members who communicated water-quality problems and issues follow: E.E. Angino, Kansas-Lower Republican River Basin Advisory Committee; J.F. Bender, Nebraska Department of Environmental Control; J.J. Brabander, U.S. Fish and Wildlife Service; J.N. Habiger, U.S. Soil Conservation Service, Kansas; K.R. Inglis, U.S. Soil Conservation Service, Nebraska; R.J. Steiert, U.S. Environmental Protection Agency; and T.C. Stiles, Kansas Water Office.

Modern agricultural practices include the intensive cultivation and application of pesticides and fertilizers on the land. Runoff from agricultural land contributes sediment, pesticides and other organic compounds, and nutrients to the reservoirs and the stream system. Reservoir regulation can affect channel geometry and, therefore, erosion and sediment transport, which in turn have an effect on the transport of water-quality constituents that are attached to the sediment.

Intensive cultivation of row crops and precipitation in excess of 24 inches per year promote soil erosion in the lower Kansas River basin, which has contributed to the observed large concentrations and loads of suspended sediment. Large concentrations of suspended sediment commonly occur in the small streams; discharge-weighted mean concentrations range from 2,000 to 6,500 mg/L, and instantaneous concentrations commonly exceed 15,000 mg/L. Average annual yields of suspended sediment range from approximately 500 tons per square mile in the northwestern part of the basin to 6,000 tons per square mile in the east (Missouri Basin Inter-Agency Committee, 1971). The larger yields in the eastern part of the basin result mainly from steeper slopes that characterize the more highly dissected plains and from larger amounts of precipitation as compared to the northwestern part of the basin.

In recognition of the sediment problems, reservoirs have been designed with large storage capacities for sediment accumulation, and watershed districts have been organized to reduce erosion and to trap sediment in small upstream reservoirs. Despite these efforts, the largest reservoir in the study area, Tuttle Creek Lake on the Big Blue River, has experienced sediment problems. A larger percentage of sediment than expected has accumulated in the lake's conservation pool, and increased turbidity in the lake has interfered with aquatic productivity. Sedimentation and turbidity in Tuttle Creek Lake has prevented full attainment of criteria for contact recreational use (Kansas Department of Health and Environment, 1986). The potential effectiveness of land treatment to reduce sediment transport into Tuttle Creek Lake has been raised as an important water-quality issue.

Sediment, furthermore, serves as a vehicle for the transport of phosphorus, ammonia, organic nitrogen, organic carbon, and sparingly soluble pesticides. The transport of these constituents associated with sediment discharge is viewed by Federal and State agencies as an important water-quality issue in the basin. Once these compounds enter the streams, they either can remain on the sediments or enter the solution phase depending on such factors as water temperature, pH, and dissolved-oxygen content. The interaction between these constituents and sediment and the disposition of these constituents once they are deposited in the surface-water system are not well understood. More knowledge regarding the adsorption and desorption phenomena is needed. In addition, more knowledge of the movement of sediment particle sizes dominant in the movement of chemical constituents is needed.

Pesticides that are sparingly soluble in water (less than 5 mg/L), such as most chlorinated organochlorine compounds, can remain attached to streambed sediments for long periods of time, on the order of years. Moderately soluble pesticides (5-50 mg/L), such as some triazine herbicides and organophosphate insecticides, in general remain in the hydrologic system for shorter periods of time, on the order of months to years, depending on environmental conditions. Readily soluble pesticides (greater than 50 mg/L), such as some chlorophenoxy herbicides, tend to remain in the hydrologic system for short periods of time, on the order of weeks to months.

Pesticides belonging to these groups of differing solubility present different environmental problems. For example, readily soluble pesticides tend to wash off agricultural land during periods of substantial runoff. When these compounds enter the streams, they can be acutely toxic to aquatic life. Compounds of moderate solubility tend to chronically affect aquatic life by altering the composition of zooplankton and phytoplankton populations (deNoyelles and Kettle, 1983), and compounds that are sparingly soluble tend to persist and bioaccumulate in the primary, secondary, and tertiary consumers.

Pesticide occurrence in the lower Kansas River basin can impair the suitability of water for aquatic life and has the potential for impairing its suitability for public-water supplies. The Nebraska Department of Environmental Control reports that samples of whole fish collected from selected reaches of the Big and Little Blue Rivers contained concentrations of chlorinated pesticides, such as chlordane, dieldrin, heptachlor, and heptachlor epoxide, whose sum exceeded the guideline of 0.1 parts per million established by the National Academy of Sciences and the National Academy of Engineering (Water Quality Division, 1986). In addition, whole fish collected from the Big Blue River upstream of the Kansas-Nebraska state line contained concentrations of chlordane in excess of the U.S. Food and Drug Administration's standard of 0.3 parts per million for poisonous or deleterious substances in human food or animal feed (Water Quality Division, 1986).

The Kansas Department of Health and Environment analyzed fish collected from the Kansas River at Eudora, Kansas, during 1982 and found that concentrations of chlorinated pesticides in whole, bottom-feeding fish exceeded the guideline of 0.1 parts per million established by the National Academy of Sciences and the National Academy of Engineering. Moreover, during 1985 and 1986, the Kansas Department of Health and Environment in cooperation with the U.S. Environmental Protection Agency, as part of the Regional Ambient Fish Tissue Monitoring Program, analyzed whole, bottom-feeding fish collected from the Kansas River at Lawrence, Kansas. In both years, chlordane concentrations exceeded the U.S. Food and Drug Administration's standard of 0.3 parts per million (Kansas Department of Health and Environment, 1986). The Kansas Department of Health and Environment, the Nebraska Department of Environmental Control, the U.S. Environmental Protection Agency, and the U.S. Fish and Wildlife Service view chlordane contamination of fish in the lower Kansas River basin as a major water-quality issue.

The occurrence of herbicides, such as atrazine, alachlor, metolachlor, 2,4-D, and propachlor, has been documented by the Kansas Department of Health and Environment in streams and reservoirs in the lower Kansas River basin (Kansas Department of Health and Environment, 1986). The largest concentrations of atrazine observed in the Kansas part of the basin occurred in the principal inflow streams to Tuttle Creek Lake, in Tuttle Creek Lake, and in the Big Blue River downstream from Tuttle Creek Lake. Because of their large storage capacity relative to inflows and because of sediment deposition and re-suspension, reservoirs may collect contaminants and then release them downstream over a longer period of time than would occur in the absence of reservoirs.

More knowledge is needed to determine the occurrence and distribution of pesticides transported into the three major reservoirs in the study area, the effect of the reservoirs on pesticide concentrations while in the reservoirs, and the occurrence and distribution of pesticides in the outflow of each reservoir (Kansas Department of Health and Environment, 1986). This information then can be used to better understand the occurrence and distribution of pesticides in the main stem of the Kansas River. For example, concentrations of atrazine exceeding 15 μg/L (micrograms per liter) have occurred in the main stem of the Kansas River during the autumn (Kansas

Department of Health and Environment, written commun., 1985). These concentrations appear large for this time of year because most atrazine is applied in the spring and probably would have been flushed through the basin in the absence of the reservoirs. Ground-water discharges into the main stem of the Kansas River may contribute to the observed large concentrations of atrazine. While this has not been documented, the Kansas Water Office considers the potential effect of ground-water discharge on the quality of the Kansas River as a water-quality issue.

The presence of pesticides in surface water can impair the use of water for public supply. The Kansas Department of Health and Environment has documented the presence of alachlor, atrazine, metolachlor, propachlor, metribuzin, and 2,4-D in surface water used for public supply in the basin (Kansas Department of Health and Environment, written commun., 1985). No criteria or standards for public supply have been established by the U.S. Environmental Protection Agency for these compounds except for 2,4-D and, more recently, atrazine. The apparent reason for the nonexistence of these criteria or standards for public-water supplies is that the long-term adverse effects on human health are not understood. The problem is made more important by the fact that conventional water treatment does not appear to appreciably remove these compounds from the unfinished (raw) water (Joseph Arruda, Kansas Department of Health and Environment, written commun., 1986).

The State of Kansas is in the process of purchasing water storage in Tuttle Creek Lake and additional water storage in Perry and Clinton Lakes to provide for increased demands and to supplement supplies that are periodically inadequate. Planned use of reservoir water to sustain minimum streamflow requirements and to provide water supplies indicates an urgent need to assess the quality characteristics of reservoir inflow, stored water, and water in the main stem of the Kansas River. Because Tuttle Creek Lake is the largest reservoir in the basin and the water quality of its outflow affects about 85 percent of the length of the Kansas River, including nearly all municipal and industrial uses, its water quality is especially important. Also, as is typical of rivers in agricultural areas, the land adjacent to the Kansas River is some of the most productive farmland in the basin. This land overlies the alluvial aquifer, which is as much as 2.5-miles wide and provides base flow that is especially important during periods of no surface runoff. Agricultural chemicals applied to this land have the potential for migration into the Kansas River because of the hydraulic connection between the river and the alluvial aquifer. This could be very significant during low flow, but there are no data to document the migration.

Additional water-quality problems in the basin do not relate to agricultural land use. The Kansas River, upstream of its confluence with the Big Blue River, has large concentrations of dissolved solids, sodium, sulfate, and chloride, all of which affect the suitability of water for such beneficial uses as public-water supply, irrigation, and industrial supply. The suitability of water for present and future municipal and irrigation use along the main stem of the Kansas River is regarded as an important water-quality issue. The lower reach of the Kansas River, from Topeka to its confluence with the Missouri River at Kansas City, serves as both a source of industrial and municipal supply and as a receiving stream for urban effluents. There is a potential for degradation of water quality from urban activities. The importance of this issue has been expressed by the U.S. Fish and Wildlife Service. Although the Kansas City, Kansas, urban area is at the downstream end of the basin and has little effect on the Kansas River, some of its water supplies are affected by activities in the basin.

The sanitary quality of streams in the basin probably is related to both agricultural and urban land use. Bacterial contamination of streams from pastureland, feedlot operations, and municipal wastewater-treatment effluent contributes to commonly observed large counts of fecal coliform and fecal streptococci bacteria. Concentrations in the tens of thousands of colonies per 100 milliliters of both bacteria have occurred in streams upstream of Tuttle Creek Lake (table 2). These observed concentrations may result primarily from agricultural activities. Concentrations of bacteria in the thousands of colonies per 100 milliliters in the lower reach of the Kansas River probably result from a combination of municipal wastewater discharges and agricultural activities. The sanitary quality of streams and lakes probably will become a more important issue as Kansas and Nebraska designate stream segments for such purposes as contact and noncontact recreational use.

While the above discussion is not intended to convey all the possible water-quality problems and issues in the basin, it is intended to provide the reader with the major water-quality problems and issues that have been documented.

DESCRIPTION OF LOWER KANSAS RIVER BASIN WATER-QUALITY ASSESSMENT

In most general terms, the study approach in the lower Kansas River basin, as well as in the other pilot-study areas, will be to make maximum use of existing data to: (1) Provide, to the extent possible, a description of current water-quality conditions and trends in water quality; and (2) formulate conceptual models that relate the observed conditions (concentrations and transport of substances and biological conditions) to the sources and causes, both natural and anthropogenic. New data will be collected to: (1) Verify the description of water-quality conditions obtained from the existing data; (2) define long-term trends in water quality; (3) reduce the uncertainty of the described conditions by intensifying temporal or spatial sampling densities; (4) increase our knowledge of the important water-quality issues in the basin for which the existing data are inadequate in areal or temporal distribution; and (5) improve the understanding of the relations between causative factors and water quality by using statistical methods and studies of physical, chemical, and biological processes.

Determination of proper spatial density and distribution of sampling points gives rise to a difficult decision affecting the design of the pilot study. The main reason for this difficulty is the large discrepancy between the scale of the National program as a whole and the much smaller scale of the lower Kansas River basin assessment. On the one hand, the degree of sampling resolution must be sufficient to adequately characterize the water-quality conditions in the basin and to ensure a good probability of detecting and delineating significant water-quality problem areas. On the other hand, the degree of resolution must not be so fine that the assessment will require unrealistic levels of financial support. As a result, many relatively small, impacted areas may not be detected and characterized as part of the assessment. Even if not essential from the point of view of assessing the current National water-quality situation, these areas may be important. However, they cannot be treated within a broad, nationwide resource-assessment program. Instead, many such areas are within the purview of, and can be addressed by, regulatory agencies (Federal, State, or local) and by nonregulatory local entities. Continual exchange of information between all agencies collecting water-quality data will make it possible for many of the small impacted areas to be taken into account by the assessment. Thus, the lower Kansas River basin assessment must focus on nonpoint-source contamination and those point sources that may significantly impact relatively long reaches of the principal streams.

For consistency with the other basin studies, target water-quality constituents and support variables will be measured in the lower Kansas River basin. Target constituents are those constituents that are of direct relevance to National water-quality issues, such as (1) chemical contamination, (2) nutrient enrichment, (3) acidification, (4) sedimentation, and (5) suitability of water for beneficial uses. A list of target constituents is being developed by a committee of scientists from the U.S. Geological Survey, other Federal agencies, State agencies, and universities. Concentrations of target constituents will be measured during the early phase in each of the study areas for various flow regimes and in various media, such as water, suspended sediment, and streambed sediment. After sufficient data are available, the list of target constituents will be narrowed for each study area to those constituents and compounds important from a public-health or ecological perspective.

Support variables aid in the interpretation of the target constituent data. Streamflow rate, velocity, and other hydraulic characteristics that affect the transport of water-quality constituents are examples of support variables. Support variables also will include descriptive information concerning the characteristics of the watershed, such as climate, geology, soils, land cover and use, population, and known sources of contamination.

After each 3-year intensive phase, the new data will be compared to those from previous intensive phases to identify and explain changes occurring in the study area. Acquisition of 3 years of data is considered necessary because water quality can be affected substantially by hydrologic conditions, such as dry or wet periods, which may persist for 1 or more years. A cyclic approach in which the intensive sampling lasts for only 1 to 2 years may make it difficult to identify trends in water quality because of differences in year-to-year hydrologic conditions. Through a series of 3-year, intensive-phase studies and 6-year periods of data collection, knowledge of the study area will increase in detail and in interpretational quality, such that after several complete cycles a thorough picture of water quality, from a national perspective, can be attained for the study area and from the combined results of the area studies.

Fixed-Station Studies

Three major types of activities will be undertaken to achieve the objectives of the National Water-Quality Assessment Program--fixed-station studies, synoptic studies, and subbasin or river-reach studies. Fixed-station sampling sites will be operated to determine constituent transport and calculate mass balance between sampling sites for selected target constituents, define long-term trends in water quality, and calculate frequency distributions of target-constituent concentrations. Fixed-station sampling will be done at existing and former National Stream Quality Accounting Network stations, the Hydrologic Benchmark Network station, and other selected stations, including some stations operated as part of the U.S. Geological Survey Federal-State Cooperative Program. Special consideration will be given to sampling at or near major public water-supply intakes, sampling streams that drain homogeneous land uses, and sampling upstream and downstream from the largest reservoir. In various small, relatively homogeneous subbasins, information on point- and nonpoint-source discharges, mostly collected by existing programs, will be used to interpret surface-water quality.

The fixed-station studies for the lower Kansas River basin will be used to determine: (1) Average annual and seasonal concentrations and loads of selected constituents that will include trace elements, suspended sediment, nitrogen, phosphorus, and organic carbon, (2) time trends in water quality both historically and as a basis for determining concentration trends for compounds for which little or no data exist, (3) the impact of a reservoir on stream quality, and (4) baseline water quality during each 3-year intensive phase.

Fixed-station sites will be sampled for many of the target constituents at least once a month during the 3-year intensive phase. Monthly sampling will be supplemented with additional high- and low-flow samples as necessary. The need for repetitive sampling arises from the considerable temporal variability of surface-water quality in the lower Kansas River basin. This variability is mainly the result of the seasonality of agricultural practices and the variations in streamflow, wastewater discharges, and temperature. Hypotheses aimed at relating these conditions to causative factors will be developed and tested to draw inferences about water quality on a regional scale and to point out some of the policy implications of the observations.

Synoptic Studies

The purpose of synoptic sampling is to provide knowledge of the occurrence of certain water-quality conditions over a broad geographical area by making measurements at many sites during a brief period of time, such as 1 or 2 weeks. Synoptic studies will be tailored to specific issues and constituents of interest. Water, suspended sediment, streambed material, and biota will be sampled to provide information on conditions and certain problems that cannot be assessed through the fixed-station approach.

One of the purposes of the synoptic studies in the lower Kansas River basin will be to identify stream segments of about 50 river miles that may have water-quality problems. A second purpose will be to test the sensitivity of the fixed-station network for detecting potential problems, thereby leading to possible adjustments in station location. Such adjustments would occur in cases where the synoptic studies reveal important water-quality problems that are not apparent from the fixed-station data.

Synoptic studies will be conducted specifically during periods of high flow (defined here as flows that are exceeded 20 percent of the time or less) and during extended periods of low flow (defined here as flows that are exceeded 80 percent of the time or more). High-flow synoptic studies will be conducted to determine the concentrations and loads of suspended sediment, pesticides, trace elements, nutrients (defined as nitrogen and phosphorus), and organic carbon and to determine the sanitary quality of the streams using bacteria as indicators.

Low-flow synoptic studies will be conducted to determine concentrations of pesticides, trace elements, nutrients, organic carbon, and bacteria in the water and concentrations of pesticides, trace elements, nutrients, and organic carbon in the streambed sediments. Onsite measurements of water temperature, pH, specific conductance, and streamflow will be made. Particle-size distribution of the streambed sediments will be determined also. Based on additional information on the locations and amounts of wastewater discharge, the need to conduct synoptic studies of dissolved oxygen will be assessed. The low-flow synoptic studies are made more important by the increasing activity of states in adopting minimum-streamflow programs intended to maintain sufficient flow in streams to protect aquatic life and to aid in maintaining an acceptable level of water quality.

Subbasin or River-Reach Studies

During the course of intensive study, certain water-quality problems in specific subbasins or river reaches probably will be identified that require further investigation to better define water-quality conditions and gain an understanding of their causes. Such investigations would be concerned primarily with the origin, movement, and fate of particular contaminants. Subbasin or river-reach studies can be repeated in later study cycles (9 years), if changes occur, to determine whether these changes correspond to a prior understanding of the processes at work. Some subbasin or river-reach studies would be likely candidates for other programs of the Geological Survey, such as the Federal-State Cooperative Program. Selection of subbasins or river reaches for study would be done after initial compilation of information and interpretation of the fixed-station and synoptic data collected during the early part of the study. Several examples of possible studies that relate to water-quality issues follow.

A study could be designed to provide a better understanding of sediment transport, constituents associated with suspended sediment, and dissolved constituents transported into Tuttle Creek Lake. The knowledge could be used to evaluate the effects of changes in agricultural practices and management alternatives--for example, (1) changes in erosion-control measures, such as contour farming and conversion of acreage from tilled to no-till or minimum-tillage farming, with associated changes in the application of pesticides and storage of pesticides in the soil; (2) increases in the number of small upstream reservoirs and farm ponds; and (3) changes in irrigation practices and appropriation for other water uses.

The occurrence and transport of target constituents in streams that drain relatively homogeneous land use could be studied in depth by collecting a sufficiently large number of samples to define variations within and among the subbasins on a seasonal and annual basis. The transport mechanisms could be defined by analyzing filtered-water samples, suspended sediment, and water-sediment mixtures for the target constituents and support variables.

A study of a river reach on the main stem of the Kansas River could focus on the relationship between the stream and its alluvial aquifer. The study could define the movement of water and its constituents from the river during periods of recharge to the alluvial aquifer and the movement of water and its constituents from the aquifer during periods of discharge to the river. Such a study also could take into account the effects of municipal effluents and powerplant discharges on stream quality.

The problem of aquatic biota contaminated with pesticides could be studied with a series of ecological surveys conducted during the course of the study for selected subbasins or river reaches. Physical, chemical, and biological data would be collected for each survey. Physical data would include streamflow rate, water temperature, air temperature, specific conductance, and dissolved oxygen. The chemical composition of pesticides in the streambed sediments, water column, and biota representative of the food web would be defined.

It should be emphasized that the subbasin or river-reach studies briefly discussed in this report are intended to represent some examples for which water-quality issues have been identified; this does not imply a commitment to all of these studies, and it does not preclude the opportunity to conduct studies on other topics that have been identified or that can arise during the course of the intensive phase of the study.

Quality Assurance

Variability in analytical results, caused by errors in the sample-collection and analysis process, always occurs even under rigorously controlled onsite and laboratory conditions. For example, errors can be introduced into sample results through: (1) Selection of a sampling location or method that produces a sample that fails to represent the conditions of interest; (2) improper use of instruments; (3) contamination of the sample; and (4) inappropriate methods of analysis. These errors can be so small that they cannot be measured, or so large that their presence is obvious. Quality-assurance programs are used to detect and control errors and to maintain and document the reliability of results.

A technical quality-assurance plan is being prepared for the National Water-Quality Assessment Program. This plan will address all aspects of sample collection, analysis, and reporting needed to produce reliable and verifiable data in a nationally consistent manner. The plan will include existing U.S. Geological Survey quality-assurance methods and practices described in manuals by the Office of Water Data Coordination (1977) and Friedman and Erdmann (1982).

Agency Coordination

Coordination between U.S. Geological Survey personnel and other interested scientists and water-management personnel is an important component of the National Water-Quality Assessment (NAWQA) Program. Each NAWQA study will have a liaison committee to ensure that the scientific information produced by the program is relevant to local and regional interests. Specific activities will include: (1) Exchanging information about local and regional water-quality and water-data management issues; (2) identifying water-quality constituents and study locations of local and regional interest; (3) exchanging information on NAWQA, other U.S. Geological Survey, and other agencies' sampling-program activities; (4) and providing advice on planning documents and reports from the study.

Organizations currently represented on the liaison committee for the lower Kansas River basin study include: (1) Kansas agencies--Kansas Department of Health and Environment; Kansas Water Office; Kansas State Board of Agriculture, Division of Water Resources; State Conservation Commission; Kansas Fish and Game Commission; University of Kansas, Water Resources Institute; Kansas State University, Kansas Water Resources Research Institute; Kansas-Lower Republican Basin Advisory Committee; (2) Nebraska agencies--Nebraska Department of Environmental Control; Nebraska Department of Water Resources; University of Nebraska, Conservation and Survey Division; Little Blue Natural Resources District; Upper Big Blue Natural Resources District; Lower Big Blue Natural Resources District, and (3) Federal agencies--U.S. Environmental Protection Agency, Region VII; U.S. Army Corps of Engineers, Kansas City District; U.S. Bureau of Reclamation, Missouri Basin Region; U.S. Soil Conservation Service (Kansas); U.S. Soil Conservation Service (Nebraska); U.S. Fish and Wildlife Service; U.S. Bureau of Indian Affairs.

In addition to the local liaison committees, a National Coordinating Work Group has been established by the Director of the U.S. Geological Survey to advise the Survey on the coordination of the NAWQA Program. The work group functions under the general auspices of the Interagency Advisory Committee on Water Data and the Advisory Committee on Water Data for Public Use. The general purposes of the work group are to advise the U.S. Geological Survey on (1) water-quality-information needs of non-Federal and Federal communities of water users and (2) coordination procedures for making the data and information stemming from the NAWQA Program timely and appropriately available. The work group currently consists of the Chief Hydrologist of the U.S. Geological Survey, eight Federal members, seven non-Federal members, and some members from the pilot-study local liaison committees. Organizations represented include: American Water Resources Association, Association of American State Geologists, Association of State and Interstate Water Pollution Control Administrators, Chemical Manufacturers Association, Interstate Conference on Water Programs, National Association of Conservation Districts, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, Council on Environmental Quality, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Forest Service, and U.S. Soil Conservation Service.

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Table 1.--*Streamflow characteristics for selected streamflow-gaging stations*

Station number (fig. 2)	Station name	Period of analysis	Streamflow rate, in cubic feet per second					
			7-day minimum	10th percentile	Median	Mean	90th percentile	1-day maximum
06879100	Kansas River at Fort Riley, Kans.	1968-85	217	424	1,290	2,680	6,480	56,600
06880500	Big Blue River at Seward, Nebr.	1955-84	.8	10.5	24	126	210	13,400
06882000	Big Blue River at Barneston, Nebr.	1933-84	15	92	245	817	1,700	50,000
06883000	Little Blue River near Deweese, Nebr.	1954-84	6.7	42	70	147	198	14,700
06884025	Little Blue River at Hollenberg, Kans.	1975-84	45	100	195	531	963	25,500
06887000	Big Blue River near Manhattan, Kans.	1964-85	6.1	147	867	2,420	6,110	25,800
06890900	Delaware River below Perry Dam, Kans.	1970-84	0	22	91	730	2,270	11,900
06891000	Kansas River at Lecompton, Kans.	1971-84	721	1,120	3,640	7,790	20,500	129,000
06892350	Kansas River at DeSoto, Kans.	1971-84	754	1,220	4,040	8,760	22,800	127,000

Table 2.--*Summary of selected chemical, physical, and biological data from U.S. Geological Survey computer files for five surface-water sites in the lower Kansas River basin, October 1977 to July 1986*

[Abbreviations: A = based on colony count outside the acceptable range; mL = milliliters; mm = millimeters; mg/L = milligrams per liter; μg/L = micrograms per liter]

Constituent or property	Units of measurement	Number of measurements	10th percentile	Median	90th percentile
Station 06879100 Kansas River at Fort Riley, Kansas					
Solids, dissolved, sum of major constituents	mg/L	0	--	--	--
pH	standard units	5	--	--	--
Nitrogen, total, as N	mg/L	0	--	--	--
Phosphorus, total, as P	mg/L	0	--	--	--
Carbon, organic, total	mg/L	0	--	--	--
Arsenic, dissolved	μg/L	0	--	--	--
Barium, dissolved	μg/L	0	--	--	--
Cadmium, dissolved	μg/L	0	--	--	--
Chromium, dissolved	μg/L	0	--	--	--
Lead, dissolved	μg/L	0	--	--	--
Mercury, dissolved	μg/L	0	--	--	--
Selenium, dissolved	μg/L	0	--	--	--
Silver, dissolved	μg/L	0	--	--	--
Atrazine, total	μg/L	0	--	--	--
Silvex, total	μg/L	0	--	--	--
2,4-D, total	μg/L	0	--	--	--
Endrin, total	μg/L	0	--	--	--
Lindane, total	μg/L	0	--	--	--
Methoxychlor, total	μg/L	0	--	--	--
Toxaphene, total	μg/L	0	--	--	--
Coliform, fecal	colonies/100 mL	0	--	--	--
Streptococci, fecal	colonies/100 mL	0	--	--	--
Sediment, suspended	mg/L	467	61	520	3,100
Sediment, suspended, finer than 0.062 mm	percent	386	79	95	100

Table 2.--*Summary of selected chemical, physical, and biological data from U.S. Geological Survey computer files for five surface-water sites in the lower Kansas River basin, October 1977 to July 1986*--Continued

Constituent or property	Units of measurement	Number of measurements	10th percentile	Median	90th percentile
Station 06882000 Big Blue River at Barneston, Nebraska					
Solids, dissolved, sum of major constituents	mg/L	14	--	320	--
pH	standard units	74	7.3	8.0	8.5
Nitrogen, total, as N	mg/L	72	3.1	4.2	6.2
Phosphorus, total, as P	mg/L	71	.42	.66	.99
Carbon, organic, total	mg/L	71	5.2	9.5	41
Arsenic, dissolved	μg/L	4	--	--	--
Barium, dissolved	μg/L	3	--	--	--
Cadmium, dissolved	μg/L	3	--	--	--
Chromium, dissolved	μg/L	4	--	--	--
Lead, dissolved	μg/L	4	--	--	--
Mercury, dissolved	μg/L	4	--	--	--
Selenium, dissolved	μg/L	4	--	--	--
Silver, dissolved	μg/L	4	--	--	--
Atrazine, total	μg/L	0	--	--	--
Silvex, total	μg/L	0	--	--	--
2,4-D, total	μg/L	0	--	--	--
Endrin, total	μg/L	0	--	--	--
Lindane, total	μg/L	0	--	--	--
Methoxychlor, total	μg/L	0	--	--	--
Toxaphene, total	μg/L	0	--	--	--
Coliform, fecal	colonies/100 mL	73	A 48	A 600	A 14,000
Streptococci, fecal	colonies/100 mL	74	A 66	A 940	45,000
Sediment, suspended	mg/L	0	--	--	--
Sediment, suspended, finer than 0.062 mm	percent	0	--	--	--

Table 2.--*Summary of selected chemical, physical, and biological data from U.S. Geological Survey computer files for five surface-water sites in the lower Kansas River basin, October 1977 to July 1986*--Continued

Constituent or property	Units of measure-ment	Number of meas-ure-ments	10th percent-ile	Median	90th percent-ile
Station 06884025 Little Blue River at Hollenberg, Kansas					
Solids, dissolved, sum of major constituents	mg/L	71	82	280	350
pH	standard units	104	7.3	7.9	8.4
Nitrogen, total, as N	mg/L	100	1.3	2.6	8.5
Phosphorus, total, as P	mg/L	100	.28	.43	1.4
Carbon, organic, total	mg/L	71	2.5	10	66
Arsenic, dissolved	µg/L	21	--	3	--
Barium, dissolved	µg/L	8	--	--	--
Cadmium, dissolved	µg/L	21	--	<1	--
Chromium, dissolved	µg/L	21	--	<20	--
Lead, dissolved	µg/L	20	--	<2	--
Mercury, dissolved	µg/L	21	--	< .1	--
Selenium, dissolved	µg/L	21	--	1	--
Silver, dissolved	µg/L	18	--	<1	--
Atrazine, total	µg/L	0	--	--	--
Silvex, total	µg/L	8	--	--	--
2,4-D, total	µg/L	8	--	--	--
Endrin, total	µg/L	8	--	--	--
Lindane, total	µg/L	8	--	--	--
Methoxychlor, total	µg/L	6	--	--	--
Toxaphene, total	µg/L	8	--	--	--
Coliform, fecal	colonies/100 mL	103	A 100	A 1,600	A 25,000
Streptococci, fecal	colonies/100 mL	103	A 120	A 2,000	A 51,000
Sediment, suspended	mg/L	14	--	4,700	--
Sediment, suspended, finer than 0.062 mm	percent	14	--	95	--

Table 2.--*Summary of selected chemical, physical, and biological data from U.S. Geological Survey computer files for five surface-water sites in the lower Kansas River basin, October 1977 to July 1986*--Continued

Constituent or property	Units of measurement	Number of measurements	10th percentile	Median	90th percentile
Station 06887000 Big Blue River near Manhattan, Kansas					
Solids, dissolved, sum of major constituents	mg/L	61	150	230	340
pH	standard units	87	7.6	8.2	8.4
Nitrogen, total, as N	mg/L	42	1.6	2.2	3.7
Phosphorus, total, as P	mg/L	74	.12	.19	.31
Carbon, organic, total	mg/L	35	4.3	6.7	14
Arsenic, dissolved	μg/L	35	2	3	4
Barium, dissolved	μg/L	35	<100	130	200
Cadmium, dissolved	μg/L	35	<1	<1	<2
Chromium, dissolved	μg/L	35	<1	<1	<10
Lead, dissolved	μg/L	35	<1	<1	18
Mercury, dissolved	μg/L	32	< .1	< .1	.4
Selenium, dissolved	μg/L	35	<1	<1	2
Silver, dissolved	μg/L	35	<1	<1	<1
Atrazine, total	μg/L	7	--	--	--
Silvex, total	μg/L	0	--	--	--
2,4-D, total	μg/L	0	--	--	--
Endrin, total	μg/L	7	--	--	--
Lindane, total	μg/L	7	--	--	--
Methoxychlor, total	μg/L	7	--	--	--
Toxaphene, total	μg/L	7	--	--	--
Coliform, fecal	colonies/100 mL	71	A 3	A 46	A 560
Streptococci, fecal	colonies/100 mL	72	A 4	A 68	560
Sediment, suspended	mg/L	75	11	33	200
Sediment, suspended, finer than 0.062 mm	percent	27	--	95	--

Table 2.--*Summary of selected chemical, physical, and biological data from U.S. Geological Survey computer files for five surface-water sites in the lower Kansas River basin, October 1977 to July 1986*--Continued

Constituent or property	Units of measurement	Number of measurements	10th percentile	Median	90th percentile
Station 06892350 Kansas River at DeSoto, Kansas					
Solids, dissolved, sum of major constituents	mg/L	54	210	420	570
pH	standard units	124	7.8	8.2	8.6
Nitrogen, total, as N	mg/L	40	1.4	2.3	3.9
Phosphorus, total, as P	mg/L	72	.21	.32	.49
Carbon, organic, total	mg/L	31	5.1	11	41
Arsenic, dissolved	μg/L	33	2	3	4
Barium, dissolved	μg/L	32	100	130	280
Cadmium, dissolved	μg/L	32	<1	<1	3
Chromium, dissolved	μg/L	32	<1	<10	17
Lead, dissolved	μg/L	32	<1	1	7
Mercury, dissolved	μg/L	30	< .10	< .10	.29
Selenium, dissolved	μg/L	31	<1	1	2
Silver, dissolved	μg/L	32	<1	<1	1
Atrazine, total	μg/L	2	--	--	--
Silvex, total	μg/L	6	--	--	--
2,4-D, total	μg/L	6	--	--	--
Endrin, total	μg/L	15	--	< .01	--
Lindane, total	μg/L	15	--	< .01	--
Methoxychlor, total	μg/L	15	--	< .01	--
Toxaphene, total	μg/L	15	--	<1	--
Coliform, fecal	colonies/100 mL	73	A 98	A 880	A 3,500
Streptococci, fecal	colonies/100 mL	73	<100	A 400	A 7,900
Sediment, suspended	mg/L	1,308	51	340	2,100
Sediment, suspended, finer than 0.062 mm	percent	1,138	69	92	98