The 1951 Floods in Kansas Revisited

"Measured in terms of human suffering, tremendous losses in property, and extensive disruption of business activities throughout the flooded area, it was the greatest catastrophe within the history of the region. Measured in terms of river stages and discharges, and of extent of the areas inundated, it was the greatest flood in the Kansas River Basin of which there is reliable record." (Veatch, 1952)

—Kyle E. Juracek, Charles A. Perry, and James E. Putnam

Introduction

July 2001 marks the 50th anniversary of the largest floods to occur in Kansas during the 20th century. The 1951 floods, exceeded only in recorded history by the legendary flood of 1844, primarily affected the Kansas, Marais des Cygnes, Neosho, and Verdigris River Basins in eastern Kansas and the Osage and Missouri River Basins in Missouri. According to the American Red Cross, 19 people were killed, directly or indirectly, and about 1,100 people were injured by the 1951 floods in Kansas and Missouri (U.S. Geological Survey, 1952). The most damaging flooding in 1951, and the event that received the most media attention, occurred along the Kansas River where the cities of Manhattan, Topeka, Lawrence, and Kansas City sustained extensive damage (fig. 1).

Total damage from the floods was unprecedented. From the headwaters of the Kansas River to the mouth of the Missouri River at St. Louis, about 2 million acres were flooded, 45,000 homes were damaged or destroyed, and 17 major bridges, some of them weighted with locomotives in an attempt to hold them, were washed away. By October of 1951, estimates of the total damage ranged as high as $2.5 billion (Davis, 1953) (about $17 billion in 2000 dollars).

Within the affected areas, transportation was disrupted as highways and railroads were closed from days to weeks. Damage to municipal water supplies and sewage-treatment works was also extensive. In Kansas, 33 water-supply systems were shut down, requiring that water be brought to the affected communities by tank trucks. At Topeka, the water works were kept in operation thanks to the efforts of as many as 5,000 men at a time that maintained a floodwall during the flood (U.S. Geological Survey, 1952). One of the more unusual damage reports came from Le Roy, Kansas, where the Neosho River had washed caskets from graves at the Le Roy Cemetery (Christy, 1987).

The flood caused significant changes to the affected river and stream channels and the adjacent flood plains. Along the Kansas River, the flooding resulted in substantial bank erosion and channel widening. On the adjoining flood plain, which was submerged to depths of 15 to 20 feet in the vicinity of Lawrence and Topeka, the land surface was scoured to depths of as much as 15 feet in some places and covered by deposits of sand and silt to thicknesses of as much as 4 feet in other places (McCrae, 1954) (fig. 2). Similar changes were noted in the other affected basins.

Cause of the Floods

The July 1951 floods in Kansas were caused by a storm of unusual size and intensity for the Great Plains.

Figure 1. Women and children evacuated from ruined North Topeka were carried ashore at the north end of Topeka Avenue bridge by rescue workers (photograph courtesy of Topeka Capital Journal).

Figure 2. Tractors covered by sand, mud, and debris in the wake of the flood near Lawrence, Kansas, July 1951 (photograph courtesy of U.S. Department of Agriculture, Natural Resources Conservation Service, Lawrence, Kansas).

Above-normal precipitation during May and June 1951 caused some major flooding and established conditions favorable for maximum runoff from subsequent precipitation. These conditions included high streamflows, high ground-water levels, and a minimum capacity for the soil to absorb any additional rainfall (U.S. Geological Survey, 1952).

Then came the great storm of July 9–13, 1951, that was centered near the common divide of the Kansas and Neosho River Basins (fig. 3). Precipitation began during the afternoon of July 9 and continued through the morning of July 10. Following a brief respite, the precipitation began again the evening of July 10 and continued through July 12. Each day was characterized by excessive rainfall during the late afternoon and night with little or no rainfall during the early and mid-afternoon hours. By midnight July 13, almost unprecedented total amounts of rain had fallen since the beginning of the storm. Four areas of particularly excessive rainfall, centered about 27 miles southwest of Manhattan, 36 miles south-southwest of Manhattan, 15 miles southwest of Emporia, and 30 miles west-southwest of Topeka, had total storm amounts of more than 16 inches (fig. 3) (U.S. Geological Survey, 1952).

In 1951, the U.S. Geological Survey (USGS) operated a network of 96 streamflow-gaging stations in Kansas (fig. 3). Of those 96 stations, 36 recorded the highest flows since the time records began through the year 2000 (fig. 3). Most of the record-high flows recorded during the 1951 floods occurred in July, although for a few stations the high flow was recorded in May or June.

The magnitude of the 1951 flood can be put into perspective by comparing the highest flows recorded in that year with the highest flows recorded for the entire period of station operation. For example, information on the highest annual streamflow has been collected for the Kansas River near Lecompton since 1891. As shown in figure 4, the 1951 flood at Lecompton (with an estimated high flow of 483,000 cubic feet per second) was substantially larger than the high flows recorded for the 1903 and 1993 floods. Table 1 lists selected currently (2001) operated USGS streamflow-gaging stations with record flows recorded during 1951. None of the stations shown in table 1 have had flows that exceeded those recorded in 1951.

Comparison to Other Kansas Floods

Even though the floods of 1951 were of epic proportion, there was at least one other flood in eastern Kansas that was larger. On the Kansas River, the largest flood in recorded history occurred in 1844; however, little damage resulted from this flood as it

Can the 1951 Flood Happen Again?

The answer is yes. The occurrence of the 1951 flood helped initiate the construction of numerous flood-control reservoirs and levees that have helped to reduce the inundation by subsequent floods in Kansas. Thus, although a flow of a magnitude comparable to the 1951 flood is certainly possible, the associated flooding would likely be less due to storage of floodwaters in the reservoirs. Damage caused by flooding will vary by location depending on the amount of development in the flood plain. Given the right combination of circumstances and conditions, a flow of equal or greater magnitude is possible. For example, a major flood could result if excessive rainfall occurred at a time when the basin was already saturated and the reservoirs were already full, and (or) if much of the rainfall fell downstream from the reservoirs. Major floods occur occasionally, and the risk of an extraordinary flood like those of 1844 and 1951 will always be with us.

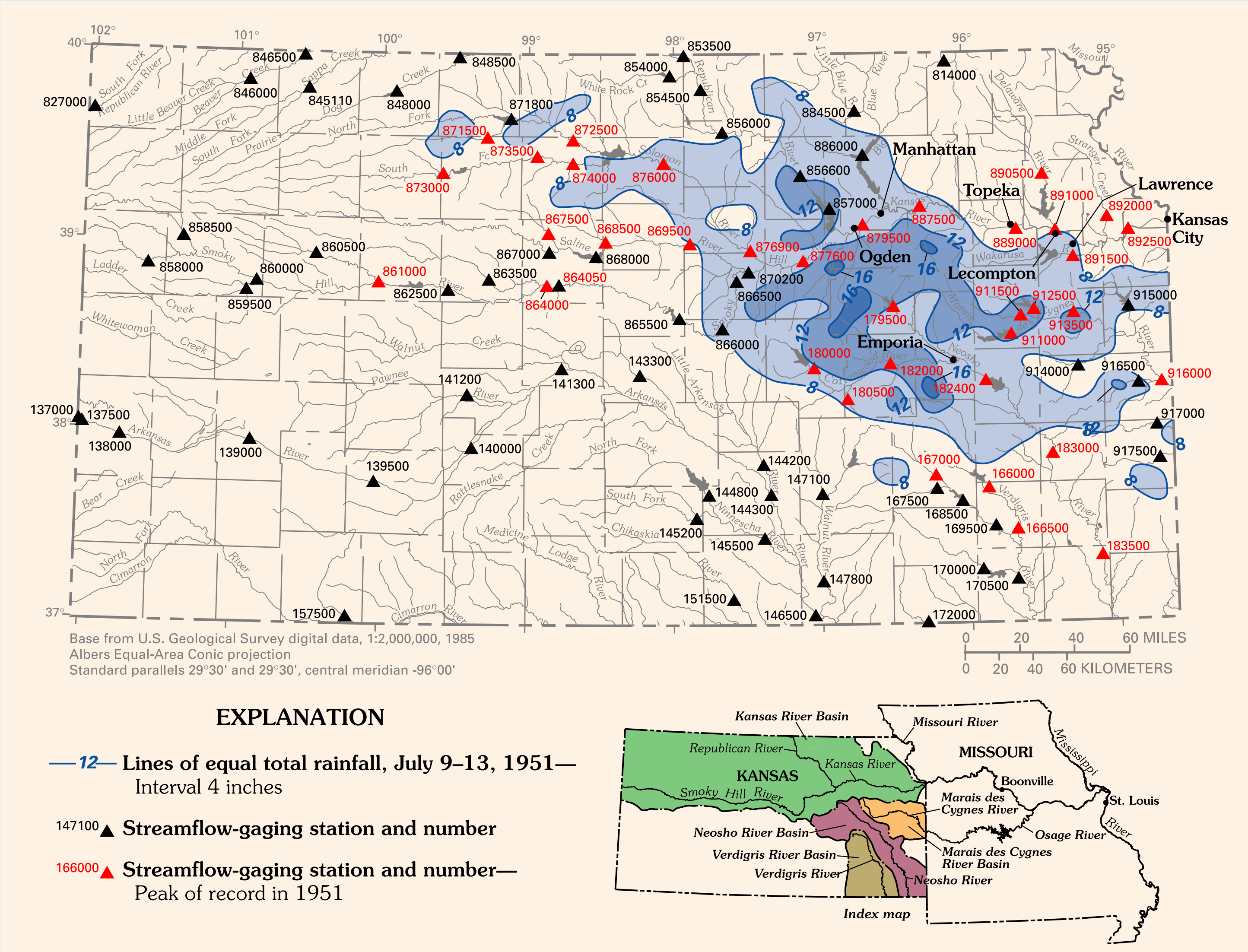

Figure 3. Affected river basins, total rainfall amounts for July 9–13, 1951, and location of U.S. Geological Survey complete-record streamflow-gaging stations in 1951. Stations with the highest flow recorded during 1951 floods are shown in red. Rainfall totals from U.S. Geological Survey (1952, p. 3).

of the region (Flora, 1952). Other significant floods on the Kansas River occurred in 1903 and 1993. These floods, like the 1951 flood, occurred after the flood plains had been extensively developed and thus caused substantial damage.

The flood of 1844 is considered the "maximum" flood on the Kansas River. The 1785 flood on the Mississippi River at St. Louis, Missouri, was approximately 1 foot higher than the 1844 flood (Reed and others, 1993), but accounts are sketchy. Undocumented accounts hint that the 1785 flood also occurred on the Missouri and Kansas Rivers, but no reliable records exist on its magnitude. Reliable data are available for the floods of 1844, 1903, 1951, and 1993, and they can be compared according to relative depth of water and the amount of flow (fig. 5, table 2).

Relative flood depths for 1844, 1903, 1951 and 1993 can be traced along the Kansas River from where it is formed by the confluence of the Smoky Hill and Republican Rivers near Ogden, Kansas, downstream to the Missouri River at Kansas City, and onto the Mississippi River at St. Louis, Missouri. Figure 5 shows the relative depth of water for the different floods at Ogden, Topeka, and Lecompton in Kansas, and Kansas City and St. Louis in Missouri.

From Ogden to Lecompton, Kansas, the 1844 flood along the Kansas River was approximately 5 feet deeper than the 1951 flood. Once the 1951 flood reached Kansas City, water depths were only about 2 feet less than in 1844. Along the Kansas River, the 1951 flood depths were greater than in 1903 and 1993. Along the Missouri River, the 1993 flood depths were greater than in 1844, 1903, and 1951. Upstream from Kansas City, flood depths in 1993 were affected by the flood-control reservoir system which substantially reduced the high flows. However, at locations where levees were built to

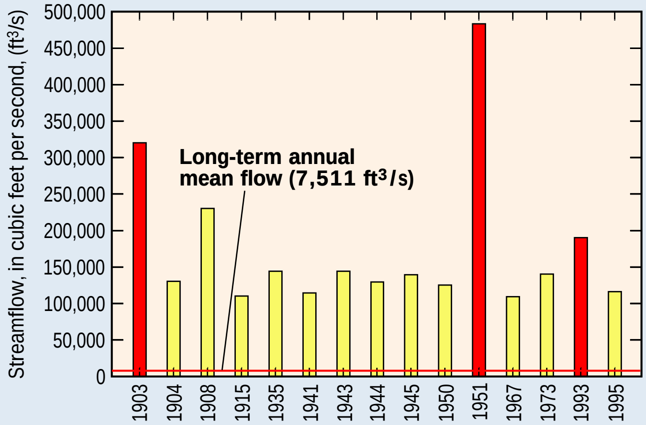

Figure 4. Highest annual flows exceeding 100,000 cubic feet per second for Kansas River at Lecompton (station 891000, fig 3), 1891–2000. The 1903, 1951, and 1993 floods are shown in red.

Table 1. Comparison of 1951 highest flows with more recent highest flows for selected current (2001) U.S. Geological Survey streamflow-gaging stations

[ft^3/s, cubic feet per second]

	Highest flows during 1951		More recent highest flows	
Station name (station number[1], fig 3)	**Date**	**Streamflow (ft^3/s)**	**Date**	**Streamflow (ft^3/s)**
Smoky Hill River near Russell[2] (06864000)	May 23	39,500	July 22, 1993	32,400
Saline River at Testcott (06869500)	July 13	61,400	May 25, 1961	12,900
Solomon River at Niles (06876900)	July 14	178,000	October 11, 1973	52,400
Smoky Hill River at Enterprise (06877600)	July 14	233,000	July 22, 1993	47,600
Kansas River at Wamego (0887500)	July 13	400,000	July 26, 1993	199,000
Kansas River at Topeka (06889000)	July 13	469,000	July 25, 1993	170,000
Kansas River at Lecompton (06891000)	July 13	483,000	July 27, 1993	190,000
Kansas River at Bonner Springs[3] (06892500)	July 13	510,000	July 27, 1993	170,000
Marais des Cygnes River near Ottawa (06913500)	July 11	142,000	November 2, 1998	41,600
Verdigris River near Altoona (07166500)	July 12	71,000	October 3, 1986	48,900
Neosho River at Council Grove (07179500)	July 11	121,000	May 22, 1961	40,000
Neosho River at Iola (07183000)	July 13	436,000	October 3, 1986	64,100
Neosho River near Parsons (07183500)	July 14	410,000	October 5, 1986	92,700

[1]First two digits of the station number have been omitted in figure 3.

[2]Since September 1974, station has been 4.7 miles downstream near Bunker Hill, station number 06864050.

[3]Since September 1973, station has been 9.7 miles upstream at DeSoto, station number 06892350.

protect urban areas, the 1993 flood depth increased substantially within areas bounded by the levees. Flood depths at Kansas City and St. Louis in 1993 were increased by the levees that protected much of the flood plain (fig. 5).

T able 2 lists the highest flows for each of the floods. Estimates for the flood of 1844 are available only for gaging stations on the Missouri and Mississippi Rivers. Along the Kansas River, the highest flows were recorded during the 1951 flood, followed respectively by the 1903 and 1993 floods (table 2). There are no flow estimates for the 1844 flood along the Kansas River. However, documented flood depths would have produced flows greater than the 1951 flood. If the flood-control reservoirs in the Kansas River Basin had not been in place during 1993, the resulting flood flows would have been greater but still not as great as the floods of 1903 or 1951 (Perry, 1994). During the height of the flood on July 13, 1951, almost 90 percent of the flow in the Missouri River at Kansas City came from the Kansas River, a tributary that represents only about 12 percent of the Missouri River's drainage basin.

The hydrologic conditions prior to each of these floods were similar. A lengthy rainy period prior to the maximum flooding created saturated conditions. Then, a major storm system with excessive precipitation over a large area occurred that simultaneously drove many tributary streams and rivers over their banks. Each of the major floods had storm precipitation totals that were similar, only their duration and location were different. It has been suggested that "...a small difference in the distribution of the heavy rains on July 10–12, 1951, and their continuation for one day longer, would in all probability have produced a flood equal to that of 1844" (Flora, 1952). Had the storm in 1993 occurred over a shorter period of time, flooding probably would have been more extensive.

The rains will come again. When, where, and how much will determine whether the next flood will rival the big ones.

How Are Floods Measured?

When flooding occurs, the USGS mobilizes personnel to collect streamflow data in affected areas. The USGS was out in force during and after the great floods of 1951, collecting streamflow data and documenting high flows that occurred.

Currently (2001), the USGS operates more than 150 streamflow-

The USGS measures streamflow in terms of cubic feet per second. One cubic foot per second is equal to about 448 gallons per minute, 27,000 gallons per hour, or 646,000 gallons per day—close to the amount needed to fill an Olympic-sized swimming pool in 1 day.

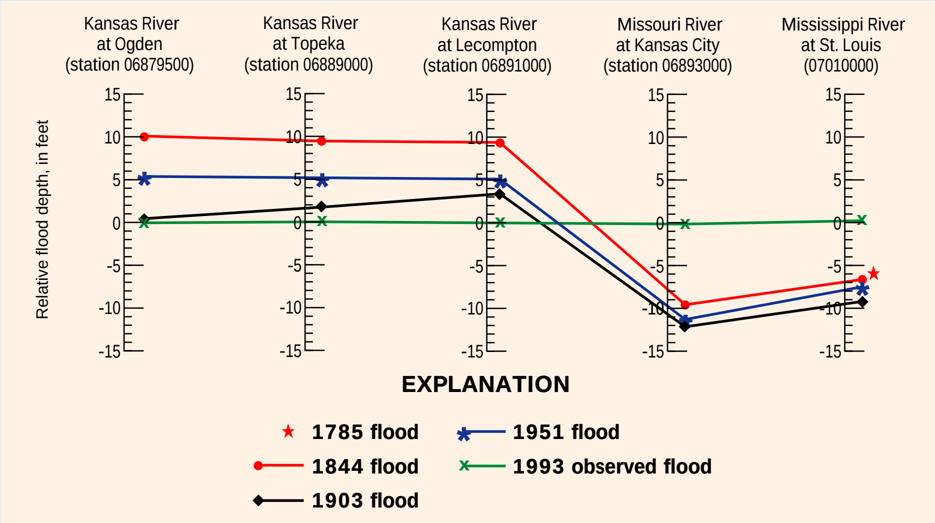

Figure 5. Comparison of relative flood depths from Ogden, Kansas, to St. Louis, Missouri, for floods of 1785, 1844, 1903, 1951, and 1993. Locations of Kansas stations shown in figure 3. [Relative depths are compared with 1993 flood (zero depth). No distance or elevation relations between the individual stations are implied by the graph.]

gaging stations on streams and lakes in Kansas. Although the station equipment has been modernized since 1951, the type of data collected at the gaging stations is the same now as then. Streamflow information collected by the USGS during floods is used for reservoir operations, flood warning and forecasting, design of bridges and flood-control structures, and flood-plain regulation and insurance purposes.

The process of streamflow measurement at USGS gaging stations has not changed significantly since 1951. Where possible, direct measurements of flow during the 1951 floods were made from bridges and boats (fig. 6). However, at most gaging stations in eastern Kansas, the 1951 floods reached such great depths and high velocities that USGS personnel were unable to reach the gaging stations located on some bridges and, therefore, were unable to make direct flow measurements. In some locations, the gaging station was left isolated from the river and, thus, could not be used to record river stage. For example, in the flood analysis for the Kansas River at Ogden, Kansas, R.W. Carter of the USGS wrote that "...the river cut a new channel to the right of the bridge during the flood leaving the gage in the old channel." W.P. Somers of the USGS wrote in the flood analysis for the South Fork Solomon River at Alton, Kansas, that "...the gage was lost during the flood of July 12, before the bridge was destroyed." In such cases, "indirect methods" were used to estimate high flows after floodwaters

Streamflow Measurement

The USGS normally determines streamflow by direct measurement. The USGS measures stage (the height of the water surface, also known as gage height) and streamflow at all gaging stations on a routine schedule. Typically, measurements of water depth and velocity are made at approximately 30 locations across the stream. The distance between measurement locations (width), the speed of the water (velocity), and water depth are multiplied to compute streamflow (discharge) in cubic feet per second. Many streamflow measurements made over the range in stage of the stream are plotted against the corresponding stages to define the stage-discharge relation that is used in conjunction with the continuously recorded stage to determine streamflow throughout the year.

However, in 1951 the USGS had to rely on indirect measurements to determine high flows after the floodwater receded. Indirect measurement involves the use of field-surveyed high-water marks, information on channel characteristics, and a hydraulic flow model to estimate flows.

Table 2. Comparison of highest flows for floods of 1844, 1903, 1951, and 1993 at selected U.S. Geological Survey streamflow-gaging stations

(e, estimated by U.S. Army Corps of Engineers; --, not determined or not applicable)

	Highest flows, in cubic feet per second			
Station name (station number[1], fig 3)	**1844**	**1903**	**1951**	**1993**
Kansas River Basin				
Kansas River at Ogden (06879500)	(2)	236,000	298,000	85,000
Kansas River at Wamego (06887500)	(2)	280,000	400,000	171,000
Kansas River at Topeka (06889000)	(2)	300,000	469,000	166,000
Kansas River at Lecompton (06891000)	(2)	320,000	483,000	190,000
Kansas River at Desoto (06892350)	(2)	337,000	510,000	170,000
Marais des Cygnes River Basin				
Marais des Cygnes River near Ottawa (06913500)	(2)	13,400	142,000	17,000
Marais des Cygnes River near Kansas-Missouri State line (06916600)	--	--	148,000	40,200
Neosho River Basin				
Neosho River at Strawn (07182400)	--	43,000	400,000	16,000
Neosho River near Parsons (07183500)	--	--	410,000	58,200
Missouri River Basin				
Missouri River at Kansas City (06893000)[3]	e625,000	548,000	573,000	530.000
Mississippi River Basin				
Mississippi River at St. Louis (07010000)[3]	e1,300,000	1,019,000	782,000	1,030,000

[1]First two digits of station number have been omitted in figure 3.
[2]Flow was greater than that of 1951 flood.
[3]Missouri and Mississippi River stations not located in figure 3.

Aerial view of flooding at the confluence of the Kansas and Missouri Rivers in Kansas City looking northeast on July 13, 1951 (photograph courtesy of Warner Studio, Kansas City, Missouri).

detailed description of streamflow conditions during the 1951 flood is provided in a USGS report titled "Kansas-Missouri floods of July 1951" (U.S. Geological Survey, 1952).

The USGS is prepared to document future floods. The streamflow-gaging network in Kansas has grown from 96 stations in 1951 to more than 150 stations in 2001. Streamflow data from the expanded network improve National Weather Service flood forecasting, provide additional data for USGS flood-frequency analysis which is used by the Kansas Department of Transportation for bridge design, and provide information for use by State Emergency Management Agencies and Mitigation Teams before, during, and after flooding.

Most gaging stations in Kansas are now equipped with telemetry equipment that relays stream gage-height data from the gaging stations to USGS offices via satellite. Water-resource managers and the public also have access to this data to make decisions necessary during large floods. Real-time data for Kansas streams are available on the USGS web site at

http://ks.water.usgs.gov/.

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For more information on the 1951 flood, visit the USGS Web site at
http://ks.water.usgs.gov/
to view a collection of 1951 flood photographs and flood hydrographs for selected USGS streamflow-gaging stations

or contact:

District Chief
U.S. Geological Survey
4821 Quail Crest Place
Lawrence, Kansas 66049–3839
(785) 842–9909
email: waucott@usgs.gov

Figure 6. Overflow measurement by motorboat, Solomon River near Bennington, Kansas, July 14, 1951. It was necessary to secure the boat to the utility pole when the motor was turned off.

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