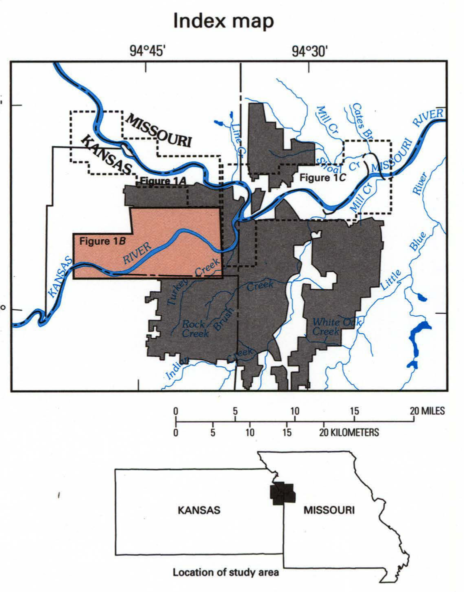
HYDROLOGIC INVESTIGATIONS ATLAS HA 735–E
SHEET 2 OF 3
Perry, Charles A., Clement, Ralph W., and Studley, Seth E., 1997, Delineation of Flooding within the Upper Mississippi River Basin—Floods of July 10 and 27, 1993, in Kansas City, Missouri, and Kansas City, Kansas, and vicinity



FEDERAL EMERGENCY MANAGEMENT AGENCY FLOOD INSURANCE STUDIES

As an investigation of the existence and severity of flood hazards and as an aid in the administration of the Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973, Type 19 Flood Insurance Studies were conducted by FEMA in the Kansas City metropolitan area. Individual studies have been completed for Kansas City, Missouri, and Kansas City, Kansas, surrounding communities, and unincorporated regions within the Missouri counties of Platte, Clay, and Jackson and the Kansas counties of Wyandotte and Johnson. Initial use of this type of study was to revise the Flood Insurance Rate Maps for each of these areas and to promote sound land-use and flood-plain management. The FEMA Flood Insurance Studies for the Kansas City metropolitan area provide a basis for evaluating the severity of the depth and extent of the flood of 1993. The FEMA studies included standard hydrologic frequency analyses to establish peak-discharge/frequency relations for the major streams and rivers in the Kansas City metropolitan area. The FEMA peak-discharge frequency values available at streamflow-gaging stations are listed in table 1 (sheet 1). Recurrence intervals of 100 and 500 years correspond to a chance of occurrence of 1 and 0.2 percent in any given year, or an annual probability of 0.01 and 0.002, respectively. The flood discharges obtained by the frequency analysis are then used to develop water-surface profiles along the stream and river channels and valleys by using various hydraulic analyses. The 100- and 500-year FEMA-modeled water-surface profiles obtained for the Missouri and the Kansas Rivers are shown in fig. 5, sheet 1; fig. 6, sheet 3; fig. 7, sheet 2; and fig. 8, sheet 3.

HIGH-WATER ELEVATION MEASUREMENTS, 1993

High-water elevations of the July 1993 floods in the Kansas City metropolitan area were determined from measurements at streamflow-gaging stations, levee gages, and by surveying high-water marks left after the floodwaters had receded. Each type of high-water elevation measurement has a certain degree of precision, accuracy, and availability.

The most accurate high-water elevations are obtained at streamflow-gaging stations. Water-level sensing equipment is used in these stations and allows measurement of elevation to a precision of 0.01 ft. These accurate measurements are obtained at locations in the stream that are not affected by obstructions, such as bridge piers or trees, that perturb the water surface. The measuring device also dampens waves and surges on the water surface. However, construction and maintenance costs for gaging stations keep their availability and numbers at a minimum. Most streamflow-gaging stations record the water levels at regular intervals, and by utilizing established stage/discharge relations, a continuous record of discharge can be obtained. Discharge hydrographs for June 1 through August 31, 1993, for the Missouri River at Kansas City, Missouri (fig. 9), and for the Kansas River at DeSoto, Kansas (fig. 10), show that discharge peaked on July 27.

Levee gages are staff gages that are read by officials of community levee districts, which are organized for the construction, maintenance, and operation of federally funded levees. The gages have a precision of 0.1 ft and reliable accuracy when maintained and read by trained personnel. The records of the peak water-surface elevations are obtained by diligent manual levee-gage observations. Levee gages generally are inexpensive to install and maintain and can furnish valuable information on flood elevations.

In areas where streamflow or levee gages are not available, measurement of flood elevations is limited to surveying high-water marks left after the floodwater has receded. High-water marks should be identified by trained personnel, surveyed in relation to known reference elevation marks, and then analyzed as a group to determine a "best estimate" of the water-surface profile. High-water marks include debris lines on streambanks or seed, grass, mud, oil, or dust lines on any stationary object that was subjected to the floodwater. Problems arise in the identification of high-water marks because the marks can be difficult to see, multiple lines may be caused by pauses in the recession of the floodwaters, and marks can be washed away by subsequent rainfall.

The accuracy of determining the maximum water-surface level, which can range from 0.01 to poorer than 0.5 ft, depends upon the floodflow characteristics that resulted in the high-water mark. Localized perturbations in the water surface created by the velocity of the floodwaters and by wave action can increase the error in the deter-mination of the floodwater level. Once high-water marks are identified, accuracy of determining their elevation depends on the proximity and accuracy of the elevation reference marks used in the survey.

As a result of the factors that affect the precision and accuracy of the high-water-mark elevation measurements, a rating system was adapted for the elevation measurements shown in this report based on a rating system commonly used for flood mapping. The evaluation of each high-water measurement according to the relative categories of excellent, good, fair, and poor helps the flood analyst determine the most probable water-surface profile. The 1993 flood inundation maps for the Kansas City metropolitan area (figs. 1*A*, sheet 1; *B*, sheet 2; and *C*, sheet 3) indicate whether the high-water-mark elevation measurement is either a stream gage (S) or levee gage (L), which are considered of excellent accuracy, or a surveyed high-water mark, the accuracy of which has been categorized as either excellent (E), good (G), fair (F), or poor (P).

FLOOD PROFILES OF THE MISSOURI AND THE KANSAS RIVERS, 1993

Measured floodwater elevations were used to develop water-surface profiles for the Missouri and the Kansas Rivers (figs. 5, sheet 1; 6, sheet 3; 7, sheet 2; and 8, sheet 3) for the peak flow on July 27, 1993. Floodwater elevations in the inundated areas of the valleys are referenced to river mile along the main channels. Locations of high water elevations away from the main channel are referenced to the river mile where that water elevation is thought to have crossed the main channel. This required an analysis and interpolation of the water-surface elevations in the valleys of the Missouri and the Kansas Rivers. The water surface was contoured on the flood maps of the Missouri and the Kansas River Valleys, taking into consideration the effects of local topography, road embankments, and bridges on flows down the valley. The flood profiles also show the FEMA estimates of the 100- and 500-year water-surface profiles.

Missouri River

The 1993 flood profile of the Missouri River lies between the FEMA 100- and 500-year profiles (fig. 5, sheet 1) from Missouri River mile 390.0 upstream of the I–435 Bridge (Missouri River mile 383.5) to about 3 mi downstream from the I–635 Bridge (Missouri River mile 374.0). All the small agricultural levees in this section of the valley were overtopped, but none of the Federal levees were overtopped. Flow through the main I–635 Bridge and other highway interchange bridges in the area and over the I–635 embankment crossing the Missouri River Valley was quite complex. Also, sections of the I–635 highway were washed away. The 1993 profile was above the FEMA 500-year profile from Missouri River mile 371.0 to just downstream from the Harry S Truman Bridge (Missouri River mile 359.0) (fig. 6, sheet 3). Peak discharge measured on July 27 at the USGS gaging station at the downstream side of the Hannibal Bridge (Missouri River mile 366.1, just downstream from the Broadway Bridge) was 541,000 ft^3/s, 1,000 ft^3/s more than that of the FEMA estimated 500-year flow (table 1, sheet 1, station number 06893000). The resulting 1993 profile was more than 2 ft higher than the FEMA 500-year profile and within 2 ft of the top of the Federal levees within Kansas City. Just downstream from the Missouri State Highway 291 Bridge (Missouri River mile 353.0), the 1993 flood profile dropped to near the 100-year FEMA profile.

Kansas River

Even though the 1993 peak flow for the Kansas River was 62,000 ft^3/s less than the FEMA 100-year estimated floodflows (232,000 ft^3/s, table 1, sheet 1), backwater from the Missouri River increased water-surface elevations on the Kansas River as far upstream as Kansas River mile 20.5. The 1993 flood elevation of the Kansas River at the Kansas State Highway 7 Bridge (Kansas River mile 20.5) was near the FEMA 100-year level (fig. 7). Proceeding downstream, the 1993 profile maintained a flatter slope than the FEMA profiles; the 500-year FEMA profile was crossed at Kansas River mile 3.0 (fig. 7). Backwater from the Missouri River flood on July 27 caused the Kansas River profile to be several feet above the FEMA 500-year profile and within 2 ft of the top of the Federal levees from Kansas River mile 2.0 to the confluence with the Missouri River.

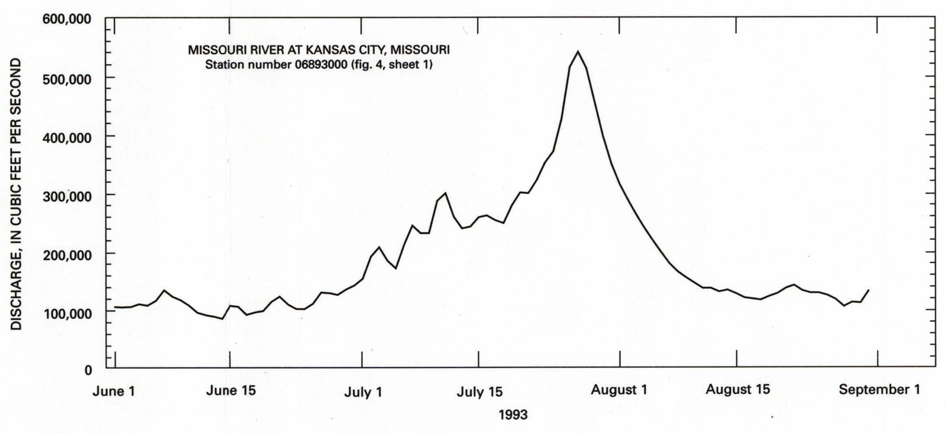


Figure 9. Discharge of the Missouri River at Kansas City, Missouri, for June 1 through August 31, 1993.

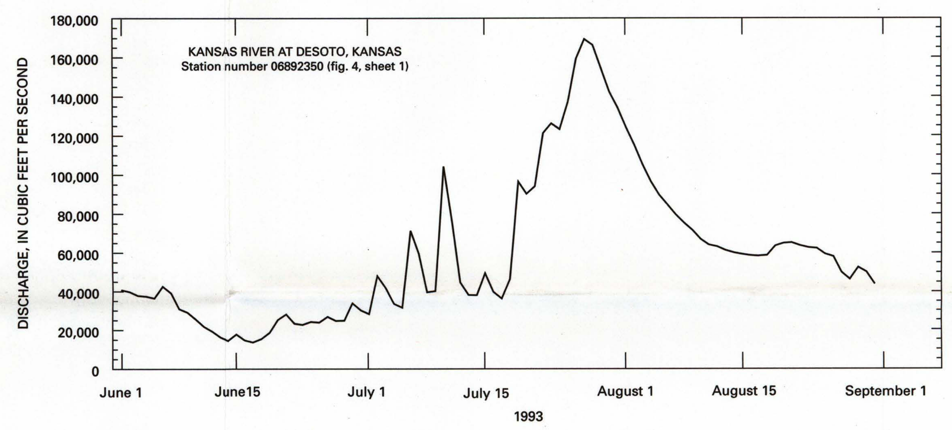
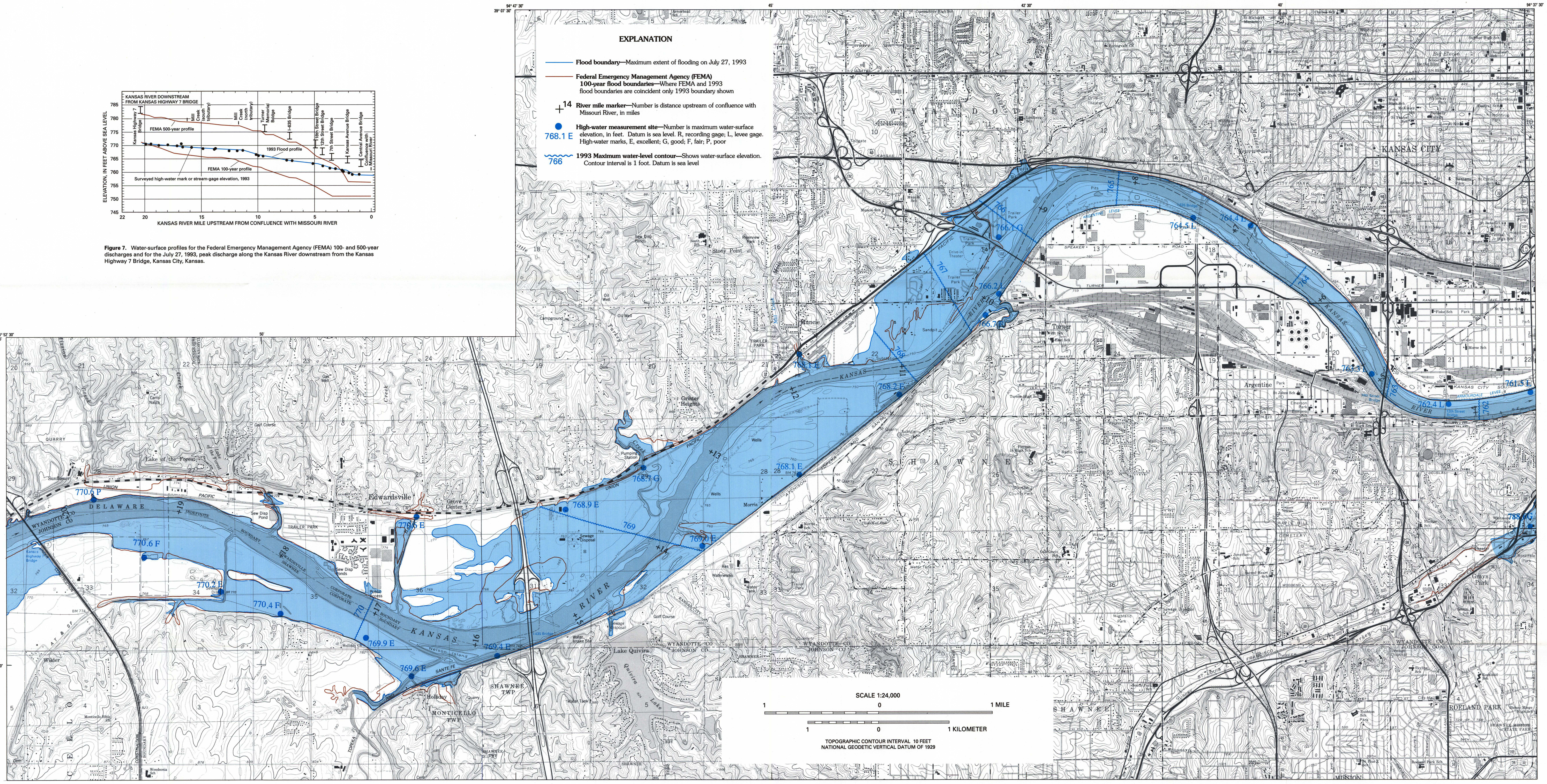


Figure 10. Discharge of the Kansas River at DeSoto, Kansas, for June 1 through August 31, 1993.

Figure 7. Water-surface profiles for the Federal Emergency Management Agency (FEMA) 100- and 500-year discharges and for the July 27, 1993, peak discharge along the Kansas River downstream from the Kansas Highway 7 Bridge, Kansas City, Kansas.



Base maps from U.S. Geological Survey.
North Kansas City, MO-KS, 1:24,000, 1964, Photorevised 1970, 1975
Parkville, MO-KS, 1:24,000, 1964, Photorevised 1970, 1975
Kansas City, MO-KS, 1:24,000, 1964, Photorevised 1970, 1975
Wolcott, MO-KS, 1:24,000, 1948, Photorevised 1970, 1975
Independence, MO, 1:24,000, 1964, Photorevised 1970, 1975
Liberty, MO, 1:24,000, 1965, Photorevised 1970, 1975
Edwardsville, KS, 1:24,000, 1984
Shawnee, KS, 1:24,000, 1964, Photorevised 1970, 1975
Interstates revised, 1985

Figure 1*B*. Flood boundaries, water-elevation measurements, and water-level contours for 1993 and Federal Emergency Management Agency 100-year-flood boundaries for the Kansas City metropolitan area from about Kansas River miles 20 to 4.

DELINEATION OF FLOODING WITHIN THE UPPER MISSISSIPPI RIVER BASIN—FLOODS OF JULY 10 AND 27, 1993, IN KANSAS CITY, MISSOURI, AND KANSAS CITY, KANSAS, AND VICINITY

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