science for a changing world

Prepared in cooperation with the U.S. Army Corps of Engineers, Little Rock and Memphis Districts

Floods of Selected Streams in Arkansas, Spring 2008

Floods can cause loss of life and extensive destruction to property. Monitoring floods and understanding the reasons for their occurrence are the responsibility of many Federal agencies. The National Weather Service, the U.S. Army Corps of Engineers, and the U.S. Geological Survey are among the most visible of these agencies. Together, these three agencies collect and analyze floodflow information to better understand the variety of mechanisms that cause floods, and how the characteristics and frequencies of floods vary with time and location.

The U.S. Geological Survey (USGS) has monitored and assessed the quantity of streamflow in our Nation's streams since the agency's inception in 1879. Because of ongoing collection and assessment of streamflow data, the USGS can provide information about a range of surface-water issues including the suitability of water for public supply and irrigation and the effects of agriculture and urbanization on streamflow. As part of its streamflow-data collection activities, the USGS measured streamflow in multiple streams during extreme flood events in Arkansas in the spring of 2008. The analysis of streamflow information collected during flood events such as these provides a scientific basis for decision making related to resource management and restoration. Additionally, this information can be used by water-resource managers to better define flood-hazard areas and to design bridges, culverts, dams, levees, and other structures.

Water levels (stage) and streamflow (discharge) currently are being monitored in near real-time at approximately 150 locations in Arkansas. The streamflow-gaging stations measure and record hydrologic data at 15-minute or hourly intervals; the data then are transmitted through satellites to the USGS database and displayed on the internet every 1 to 4 hours. Streamflow-gaging stations in Arkansas are part of a network of over 7,500 active streamflow-gaging stations operated by the USGS throughout the United States in cooperation with other Federal, State, and local government agencies. In Arkansas, the major supporters of the streamflow-gaging network are the U.S. Army Corps of Engineers, Arkansas Natural Resources Commission, Arkansas Department of Environmental Quality, and Arkansas Geological Survey. Many other Federal, State, and local government entities provide additional support for streamflow-gaging stations. It is the combined support of the USGS and all funding partners that make it possible to maintain an adequate streamflow-gaging network in Arkansas. Data collected over the years at streamflow-gaging stations can be used to characterize the relative magnitude of flood events and their statistical frequency of occurrence. These analyses provide water-resource manag-

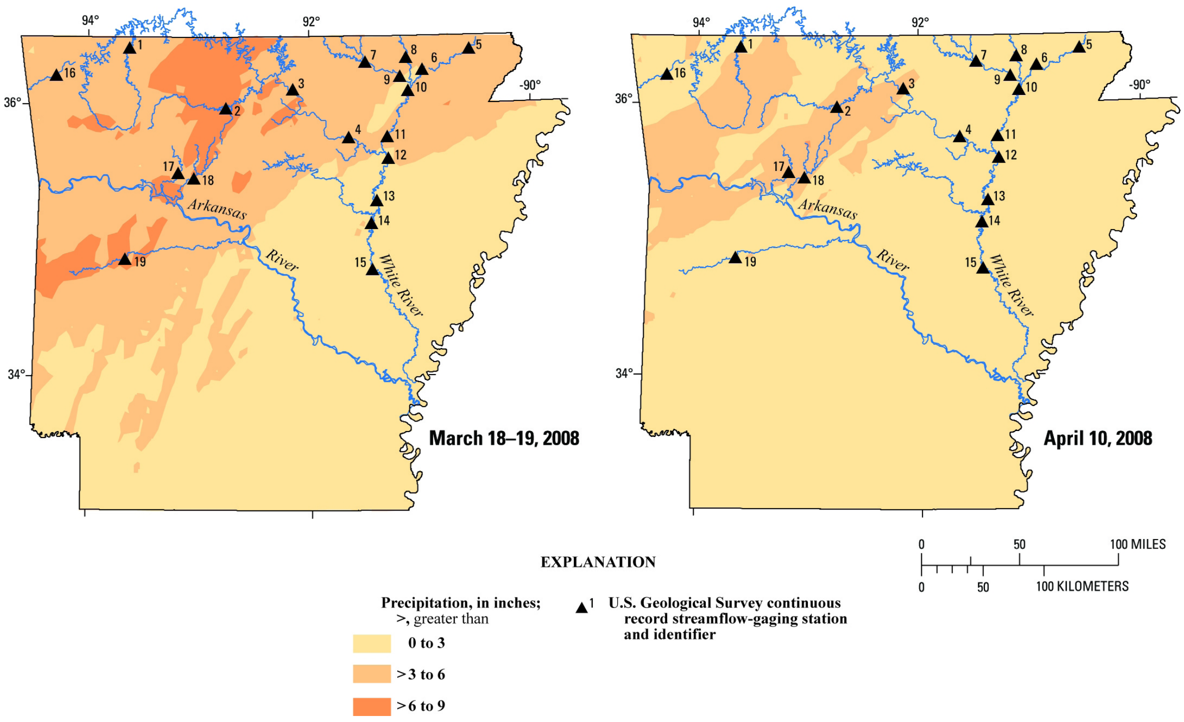

Figure 1. Location of selected U.S. Geological Survey continuous record streamflow-gaging stations and statewide precipitation amounts for March 18-19 and April 10, 2008 (modified from National Weather Service, 2008).

ers with accurate and reliable hydrologic information based on present and historical flow conditions. Continued collection of streamflow data, with consideration of changes in land use, agricultural practices, and climate change, will help scientists to more accurately characterize the magnitude of extreme floods in the future.

Spring 2008 Flood Event

Heavy precipitation fell in northern and western Arkansas during March and April of 2008 (fig. 1). This precipitation caused widespread flooding in the State comparable to the December 1982 flooding in northern Arkansas. Data collected at USGS streamflow-gaging stations show that flooding on several rivers and streams in Arkansas reached magnitudes that have not occurred since the December 1982 floods (table 1). For example, USGS streamflow-gaging station 07060500 White River at Calico Rock reached a stage of 40.27 feet (202,000 cubic feet per second), and 07056000 Buffalo River near St. Joe reached a stage of 49.41 feet (134,000 cubic feet per second). Most of the rivers with drainage areas less than 1,000 square miles experienced rises in stage ranging from 20 feet in less than 24 hours to 47 feet in 30 hours. Rivers with drainage areas greater than 1,000 square miles experienced rises in stage greater than 20 feet over a period of several days to one week.

Flood-frequency analysis provides statistical information about the magnitude and frequency of flood discharge. Flood-frequency statistics describe the chance of a given discharge being exceeded once in any given year (probability) or recurrence interval (reciprocal of probability) of the discharge in years. For example, a flood discharge having a 2-percent chance of being exceeded in any given year has a recurrence interval of 50 years. Flood-frequency analysis commonly is performed on a series of annual peak discharges collected at a streamflow-gaging station over a period of time.

Bulletin 17B of the Hydrology Subcommittee of the Interagency Advisory Committee on Water Data (1982) identifies recommended procedures for consistent determination of flood frequency from peak-discharge records. These procedures were used to compute recurrence intervals for floods that occurred at 19 streamflow-gaging stations in Arkansas during the period between March 18 and April 17, 2008 (table 2).

Table 1. Continuous record streamflow-gaging stations in Arkansas that experienced flooding in spring 2008 and in December 1982.

[n/a, gage was not in operation during this event]

Identifier number (figure 1)	Station number	Station name	Date of peak	Spring 2008 peak stage (feet)	Spring 2008 peak flow (cubic feet per second)	December 1982 peak stage (feet)	December 1982 peak flow (cubic feet per second)
1	07050500	Kings River near Berryville	March 18, 2008	35.29	50,100	30.20	39,400
2	07056000	Buffalo River near St. Joe	March 19, 2008	49.41	134,000	53.75	158,000
3	07060500	White River at Calico Rock	April 11, 2008	40.27	202,000	41.14	201,000
4	07061000	White River at Batesville	March 20, 2008	26.96	208,000	29.27	312,000
5	07064000	Black River at Corning	March 22, 2008	15.92	27,100	14.82	23,400
6	07069000	Black River at Pocahontas	March 22, 2008	26.56	72,200	25.22	66,300
7	07069305	Spring River at Town Branch Bridge at Hardy	March 19, 2008	22.29	80,700	n/a	n/a
8	07069500	Spring River at Imboden	March 19, 2008	29.15	97,300	38.12	244,000
9	07072000	Eleven Point River near Ravenden Springs	March 19, 2008	23.81	69,700	29.06	162,000
10	07072500	Black River at Black Rock	March 20, 2008	29.74	135,000	31.51	190,000
11	07074420	Black River near Elgin Ferry	March 21, 2008	32.57[1]	127,000	27.70[2]	n/a
12	07074500	White River at Newport	March 21, 2008	33.87	266,000	34.00	330,000
13	07074850	White River near Augusta	March 22, 2008	38.41	252,000	38.31[3]	255,000[3]
14	07076750	White River near Georgetown	March 24, 2008	30.18	175,000	28.87	179,000
15	07077000	White River at DeValls Bluff	April 17, 2008	31.41	189,000	30.00[4]	n/a
16	07195000	Osage Creek near Elm Springs	March 18, 2008	15.55	15,800	n/a	n/a
17	07257006	Big Piney at Highway 164 near Dover	March 18, 2008	21.76	73,700	33.87[5]	111,000[5]
18	07257500	Illinois Bayou near Scottsville	April 10, 2008	23.46	77,600	27.49	130,000
19	07261500	Fourche LaFave River near Gravelly	March 19, 2008	30.91	81,500	32.45	162,000

[1] Peak stage was caused by backwater from the White River. Backwater adjustments were made to the discharge.

[2] Obtained from surveyed floodmarks.

[3] From the U.S. Army Corps of Engineers, Little Rock District, Post Flood Report for the December 1982 Event.

[4] Estimated value obtained from the U.S. Army Corps of Engineers, Memphis District.

[5] Prior to 1993 water year, gage was located at a different location and datum.

Table 2. Recurrence intervals for select streamflow-gaging stations in Arkansas.

Identifier number (figure 1)	Station number	Station name	Spring 2008 peak flow (cubic feet per second)	Recurrence interval (years)
1	07050500	Kings River near Berryville	50,100	10-25
2	07056000	Buffalo River near St. Joe	134,000	25–50
3	07060500	White River at Calico Rock	202,000	25–50
4	07061000	White River at Batesville	208,000	25–50
5	07064000	Black River at Corning	27,100	10–25
6	07069000	Black River at Pocahontas	72,200	25–50
7	07069305	Spring River at Town Branch Bridge at Hardy	80,700	25–50
8	07069500	Spring River at Imboden	97,300	25–50
9	07072000	Eleven Point River near Ravenden Springs	69,700	100–200
10	07072500	Black River at Black Rock	135,000	25–50
11	07074420	Black River near Elgin Ferry	127,000	50–100
12	07074500	White River at Newport	266,000	25–50
13	07074850	White River near Augusta	252,000	25–50
14	07076750	White River near Georgetown	175,000	25–50
15	07077000	White River at DeValls Bluff	189,000	25–50
16	07195000	Osage Creek near Elm Springs	15,800	10–25
17	07257006	Big Piney at Highway 164 near Dover	73,700	10–25
18	07257500	Illinois Bayou near Scottsville	77,600	50–100
19	07261500	Fourche LaFave River near Gravelly	81,500	50–100

Most of the floods that occurred in Arkansas during the spring of 2008 had recurrence intervals ranging from 25 to 50 years. The largest recorded flood peak occurred in March at streamflow-gaging station 07072000, Eleven Point River near Ravenden Springs; frequency analysis determined that this flood peak had a recurrence interval of 100 to 200 years (table 2). Smaller magnitude floods with recurrence intervals ranging from 10 to 25 years occurred on streams in the upper reaches of the White River and Arkansas River Basins (table 2).

It is important to emphasize that a 100-year (or other T-year) flood does not mean there will be only one occurrence in a 100-year (or other T-year) period. According to the statistical definition, a 100-year flood has a 1-percent chance (probability) of being exceeded in any given year. This concept is illustrated by historical flooding of the Kings River at Berryville. The computed 5-year flood at the Kings River near Berryville streamflow-gaging station (29,500 cubic feet per second) has a 20-percent chance of being exceeded in any given year; in fact, the 5-year flood discharge has been exceeded three times in the 7-year period from 2002 – 2008 (table 3). Flood-insurance studies use these statistics in a slightly different context. For example, a home located in a 100-year flood plain will have a 25-percent chance of experiencing a 100-year flood during a typical 30-year home-mortgage period.

Bankfull discharge, defined as the amount of water flowing in a stream that completely fills the channel to the top of one or both banks, can be expected to occur for most streams, on average, approximately once every 1.5 years (Leopold, 1994). Out-of-bank flooding, when the water breaches the stream's banks and flows into the flood plain, is inferred from flood-frequency analyses to occur, on average, approximately once every 2.3 years; this equates to a 43-percent chance of occurring in any given year (U.S. Geological Survey, 2008). Larger floods, such as those that occurred in Arkansas during the spring of 2008, increase the risk of flood-related damages to property and infrastructure when development occurs in flood-prone areas (such as in flood plains).

Collecting streamflow information during extreme flooding events is an important mission for the USGS. Streamflow measurements made during flood conditions (fig. 2) are critical

Figure 2. *A*, U.S. Geological Survey hydrographer making a discharge measurement on March 18, 2008, at the Buffalo River Highway 65 bridge crossing near St. Joe, Arkansas. Photograph by William Baldwin, U.S. Geological Survey. *B*, U.S. Geological Survey hydrographers making a discharge measurement on March 25, 2008, at the White River U.S. Highway 64 bridge crossing near Augusta, Arkansas. Photograph by Reed Green, U.S. Geological Survey.

Table 3. Peak streamflow data collected at the Kings River near Berryville streamflow-gaging station (07050500).

[Red numbers indicate a flow greater than or equal to the 5-year flood event]

Water year	Yearly peak streamflow (cubic feet per second)
2002	32,300
2003	11,300
2004	39,000
2005	8,370
2006	8,290
2007	17,000
2008	50,100

to the documentation of peak flows. These measurements also are needed to define or verify the high flow of the stage-discharge relation maintained by the USGS at most streamflow-gaging stations so that recorded stream stage data can be converted to streamflow in near real-time. During the spring 2008 floods, the USGS made over 60 discharge measurements at nearly two dozen streamflow-gaging stations in Arkansas. These measurements were made using Acoustic Doppler Current Profilers (fig. 3) to measure discharge by using sound waves transmitted through the water to determine the velocity, and the depth and the width of the water that is flowing in the stream to determine the area. At most sites, high-water marks (leaf litter, trash, other floating debris) left behind on the banks after the flooding were marked with flagging, and altitudes were determined by standard surveying methods at a later date. Altitudes of the surveyed high-water marks were used to verify the peaks recorded by equipment in the streamflow-gaging stations.

Figure 3. An Acoustic Doppler Current Profiler and a global positioning system mounted to a tethered boat used for measuring the discharge of a stream. Photograph by Reed Green, U.S. Geological Survey.

Important Uses for Continuous-Streamflow Data

There are many important uses for continuous-streamflow data. Water-level forecasts for streams in Arkansas are produced by the National Weather Service and the U.S. Army Corps of Engineers (USACE). Used in conjunction with accurate and timely weather data, weather forecasts, and precipitation data, continuous-streamflow data form the foundation for reliable water-level forecast models that help the USACE make important decisions. The USACE uses water-level forecasts to help determine which reservoir to release water from and how much water to release.

USACE reservoir releases (fig. 4) during and after the spring 2008 floods along the White River were made in an effort to help lower the pool elevation of each reservoir. During the spring 2008 floods, the levels of all five of the U.S. Army Corps of Engineers' reservoirs in the White River Basin experienced record pool elevations (Kevin Fagot, U.S. Army Corps of Engineers, oral commun., 2008). Without accurate continuous-streamflow information at the streamflow-gaging stations on the major inflow streams, reservoir pool elevation prediction and subsequent decisions about reservoir releases would have been difficult to make, and the effects of these releases would have been difficult to predict.

Figure 4. Spillway releases from Table Rock Dam, April 2008. Photograph from the U.S. Army Corps of Engineers, Little Rock District.

USGS Monitoring is for Assessment Only

The USGS has no regulatory responsibilities within its mission scope and focuses strictly on scientific evaluation of the water resource, whether it is being used as a source of drinking water or for industry, irrigation, or recreation. USGS water-quantity data complement water-resource management activities of State and other Federal agencies such as the USACE, which is responsible for investigating, developing, and maintaining the Nation's water and related environmental resources.

Visit ***http://ar.water.usgs.gov*** for access to online data (real-time and historical) and reports, including current streamflow, rainfall, and water-quality data for the State of Arkansas. Links from the website also provide access to the National Water Information System for real-time and historical water data and online reports for other States.

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