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Estimating the Magnitude of Peak Flows for Streams in Kentucky for Selected Recurrence Intervals

By **Glenn A. Hodgkins** *and* **Gary R. Martin**

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CONTENTS

PLATE

FIGURES

TABLES

CONVERSION FACTORS

Multiply	By	To obtain
inch (in.)	25.4	millimeter
inch per hour (in/h)	0.0254	meter per hour
foot (ft)	0.3048	meter
foot per mile (ft/mi)	0.1894	meter per kilometer
cubic foot (ft^3)	0.02832	cubic meter
cubic foot per second (ft^3)	0.02832	cubic meter per second
mile (mi)	1.606	kilometers
square mile (mi^2)	2.590	square kilometer

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C = (°F - 32) / 1.8$$

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Abstract

This report gives estimates of, and presents techniques for estimating, the magnitude of peak flows for streams in Kentucky for recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years. A flowchart in this report guides the user to the appropriate estimates and (or) estimating techniques for a site on a specific stream.

Estimates of peak flows are given for 222 U.S. Geological Survey streamflow-gaging stations in Kentucky. In the development of the peak-flow estimates at gaging stations, a new generalized skew coefficient was calculated for the State. This single statewide value of 0.011 (with a standard error of prediction of 0.520) is more appropriate for Kentucky than the national skew isoline map in Bulletin 17B of the Interagency Advisory Committee on Water Data.

Regression equations are presented for estimating the peak flows on ungaged, unregulated streams in rural drainage basins. The equations were developed by use of generalized-least-squares regression procedures at 187 U.S. Geological Survey gaging stations in Kentucky and 51 stations in surrounding States. Kentucky was divided into seven flood regions. Total drainage area is used in the final regression equations as the sole explanatory variable, except in Regions 1 and 4 where main-channel slope also was used. The smallest average standard errors of prediction were in Region 3 (from -13.1 to +15.0 percent) and the largest average standard errors of prediction were in Region 5 (from -37.6 to +60.3 percent).

One section of this report describes techniques for estimating peak flows for ungaged sites on gaged, unregulated streams in rural drainage basins. Another section references two previous U.S. Geological Survey reports for peak-flow estimates on ungaged, unregulated, urban streams. Estimating peak flows at ungaged sites on regulated streams is beyond the scope of this report, because peak flows on regulated streams are dependent upon variable human activities.

INTRODUCTION

Estimates of the magnitude of peak streamflows (such as the 50-year-recurrence-interval peak flow) are necessary to safely and economically design bridges, culverts, and other structures that are in or near streams. These estimates also are needed by Federal, State, regional, and local officials for effective flood-plain management. This report, prepared by the U.S. Geological Survey (USGS) in cooperation with the Kentucky Transportation Cabinet (KTC), will help KTC and many others make improved estimates of the magnitude of peak flows for Kentucky streams.

This report gives estimates of, and presents techniques for estimating, the magnitude of peak flows for streams in Kentucky for recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years. Peak flows are listed for USGS streamflow-gaging stations with 10 years or more of recorded annual peak flows through water year[1] 2000.

[1]A water year is the 12-month period from October 1 through September 30, and it is designated by the calendar year in which it ends.

A technique is presented for estimating the peak flows for ungaged, unregulated streams in rural drainage basins. Techniques also are described for estimating peak flows at ungaged sites on gaged streams (for unregulated sites in rural drainage basins). Two reports are referenced for estimating peak flows on ungaged, unregulated streams in urbanized drainage basins. A technique for estimating peak flows for ungaged sites on regulated streams is beyond the scope of this report, although a possible approach is mentioned and cautions about inappropriate approaches are given.

Various peak-flow studies have been published applicable to all or parts of Kentucky since 1958 (McCabe, 1958, 1962; Speer and Gamble, 1964, 1965; Hannum, 1976; Wetzel and Bettandorff, 1986; Choquette, 1988). Each succeeding report generally used more years of hydrologic data and more rigorous statistical techniques. This report supersedes Choquette (1988) and the other reports in that the estimates and estimating techniques described in this report should provide improved estimates of rural peak flows for Kentucky. Advances in techniques for this report included the development of a generalized skew for Kentucky and the use of generalized-least-squares regression (explained later in the report).

The U.S. Army Corps of Engineers (USCOE) and the Tennessee Valley Authority generously provided peak-flow estimates for many regulated rivers. William J. Byron, Jr., USCOE, Louisville office, especially was helpful. This report would not be possible without nearly 100 years of peak-flow data collection, often under hazardous conditions, by USGS hydrologic technicians and hydrologists. This historical-data collection was done by the USGS in cooperation with the Commonwealth of Kentucky.

DESCRIPTION OF STUDY AREA

The Commonwealth of Kentucky encompasses an area of 40,395 mi^2 in the east-central United States. The major drainage basins in Kentucky—Big Sandy, Licking, Kentucky, Salt, Cumberland, Green, and Tennessee Rivers—are tributaries of the Ohio River (fig. 1). Variations in climate, physiography, and geology cause localized variations in streamflow characteristics in Kentucky.

Climate

Kentucky has a moist-continental climate with distinct seasonal variations and changeable weather patterns. Winter temperatures are moderate, rarely below 0°F; typical summer temperatures are warm and rarely above 100°F. Average annual snowfall is about 20 in., but the snow cover rarely remains longer than 3 days at a time. Weather patterns in Kentucky are affected variably by the meeting of cold, continental air masses arriving from the northwest and warm, moist air masses moving up the Mississippi and Ohio River Valleys from the southwest (Conner, 1982).

Annual precipitation in Kentucky averages about 47 in. The distribution of precipitation varies areally, annually, and seasonally. The mean annual precipitation in Kentucky ranges areally from about 41 to 53 in. Rainfall generally decreases to the north, reflecting the increase in distance from the source of moisture, which primarily is the subtropical Atlantic Ocean and Gulf of Mexico. Kentucky has considerable year-to-year variation in precipitation. During the period 1951-80, annual precipitation at reporting stations ranged from 14.5 to 78.6 in. Large amounts of precipitation in Kentucky have been associated with tropical cyclones moving north from the Gulf of Mexico (Conner, 1982).

Precipitation falls throughout the year but the sources and amounts of precipitation vary seasonally. Although March generally is the wettest month of the year, averaging from 4 to 6 in., the precipitation pattern is bimodal with a second peak, averaging from 3.3 to 5.5 in., occurring in July. October generally is the driest month when precipitation averages from 2 to 3 in. Mean seasonal precipitation in Kentucky is about 13.5 in. in spring (March through May), 12.4 in. in summer (June through August), 9.8 in. in fall (September through November), and 11.5 in. in winter (December through February) (Conner, 1982).

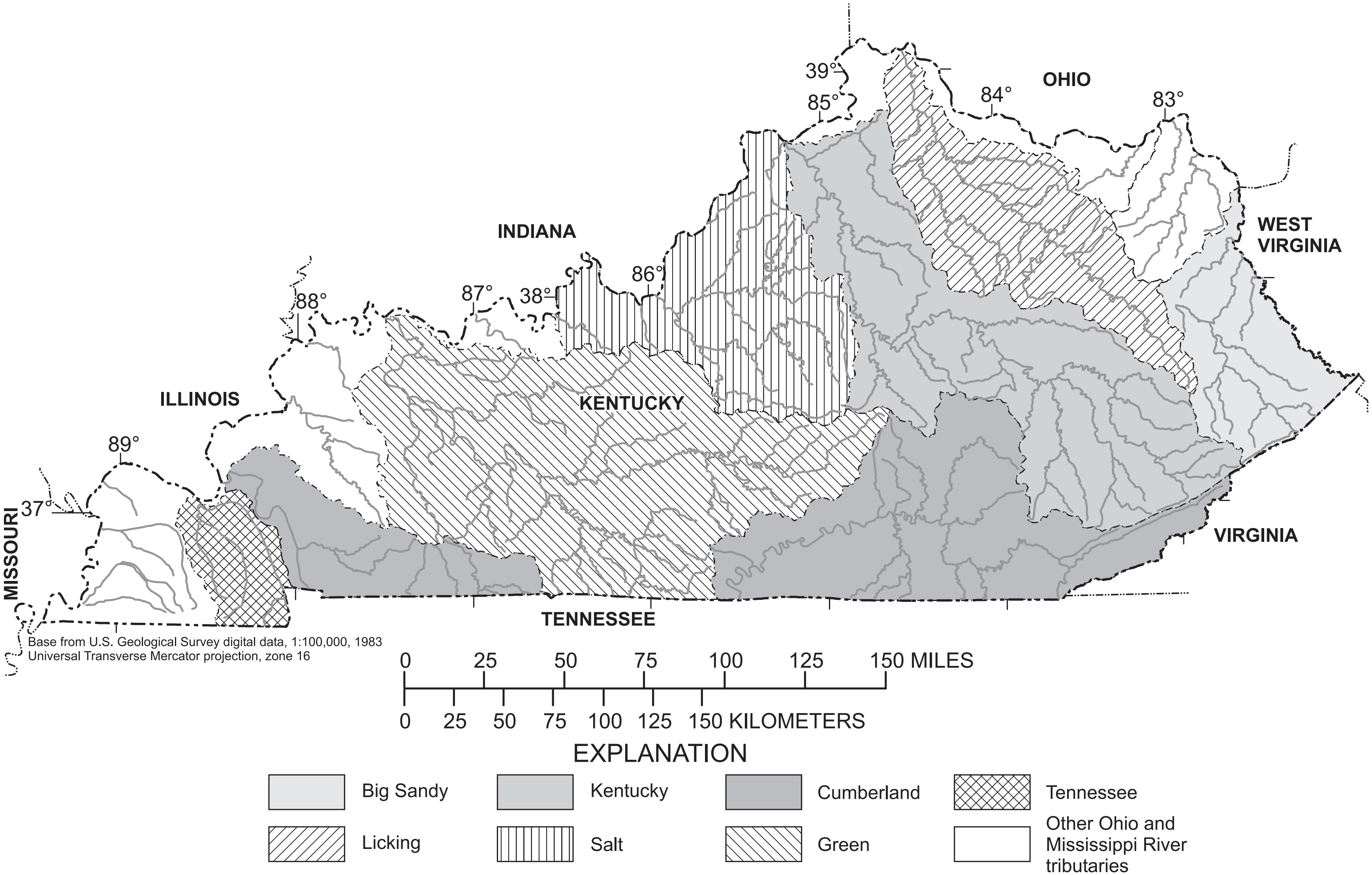


Figure 1. Major drainage basins in Kentucky.

Winter precipitation is characterized by frontal storm systems. Summer precipitation generally results from convective storm activity, commonly in the form of afternoon thunderstorms. Precipitation intensity generally is higher in summer than during other seasons, but the number of days having precipitation is similar in winter and summer. The Bermuda high-pressure system has a strong effect on seasonal precipitation patterns in Kentucky. In the fall, this high-pressure system generally moves inland from the southeastern coast of the United States and is centered over Kentucky and Tennessee, where it inhibits both convective activity and frontal storm movement and produces a dry season (Conner, 1982).

Physiography and Geology

Topographic relief in Kentucky (fig. 2) reflects the results of long-term stream-erosional processes in relation to the character of the rock formations. The upland areas—hills, ridges, mountains, and plateaus—generally consist of formations resistant to erosion. Western and central parts of Kentucky have rolling terrain, whereas the eastern part of Kentucky has rugged terrain with high relief. Land-surface elevations in Kentucky vary by more than 3,500 ft and range from 260 ft above sea level along the Mississippi River to 4,145 ft at the peak of Black Mountain in Harlan County near the Kentucky–Virginia border (McGrain and Currens, 1978).

The physiography of the State reflects the lithology of the surface rocks and largely is defined by the Cincinnati Arch (fig. 3). The axis of the Cincinnati Arch trends northward from south-central Kentucky to just south of the Outer Bluegrass boundary where it divides into two branches—Kankakee and Findlay Arches. The branches approximately are parallel but are separated by approximately 25 mi at the Ohio River (McFarland, 1950). Lithologic units dip away from the axis of the arch—a regional structural high—so that geologic features generally are symmetrical on each side of the arch.

Progressively younger rocks are exposed at the surface both east and west of the Cincinnati Arch. The oldest exposed rocks are part of the Jessamine Dome and adjacent areas; the location of this area corresponds approximately to the Inner Bluegrass region (fig. 3). These rocks consist of limestone, shale, and sandstone of Ordovician age. Narrow bands of shales and limestones of Silurian and Devonian age surround this area and correspond to The Knobs region. An expansive area of limestone of Mississippian age (Mississippian Plateaus Region) is exposed starting at the Ohio River in northeastern Kentucky, extending southwest to the State boundary, and extending northwest in a crescent-shaped area surrounding the Western Kentucky Coal Field. The eastern boundary of this area is the Cumberland Escarpment (fig. 3). Sandstones, shales, siltstones, and coals of Pennsylvanian age in eastern and northwestern Kentucky—the youngest rocks in Kentucky—compose the Eastern and Western Kentucky Coal Fields. Alluvial deposits of Cretaceous and Tertiary age are in extreme western Kentucky in the Mississippi Embayment.

Much of the Mississippian Plateau is characterized by carbonate rock and karst features such as sinkholes, caves, springs, and losing streams. Most well-developed karst features are located in a band originating in west-central Kentucky and extending to south-central Kentucky, southeast to the State boundary, east along the boundary, and then northeast and north (areas shown in black on fig. 4). Less well-developed karst features are in central and south-central Kentucky.

Seasonality of Peak Flows

Precipitation patterns strongly affect the magnitude and timing of peak flows. Seasonally changing conditions, such as evapotranspiration rates, antecedent soil moisture, and the extent, duration, and intensity of storm systems affect flood response in a given drainage basin.

The timing of peak flows varies with drainage-basin size. In basins with drainage areas from 50 to 1,000 mi^2, from 70 to 75 percent of the annual maximum peaks occur between January and April. About 45 percent of the peaks in basins from 0.1 to 10 mi^2 and 58 percent of the peaks in basins from 10 to 50 mi^2 occur between January and April.

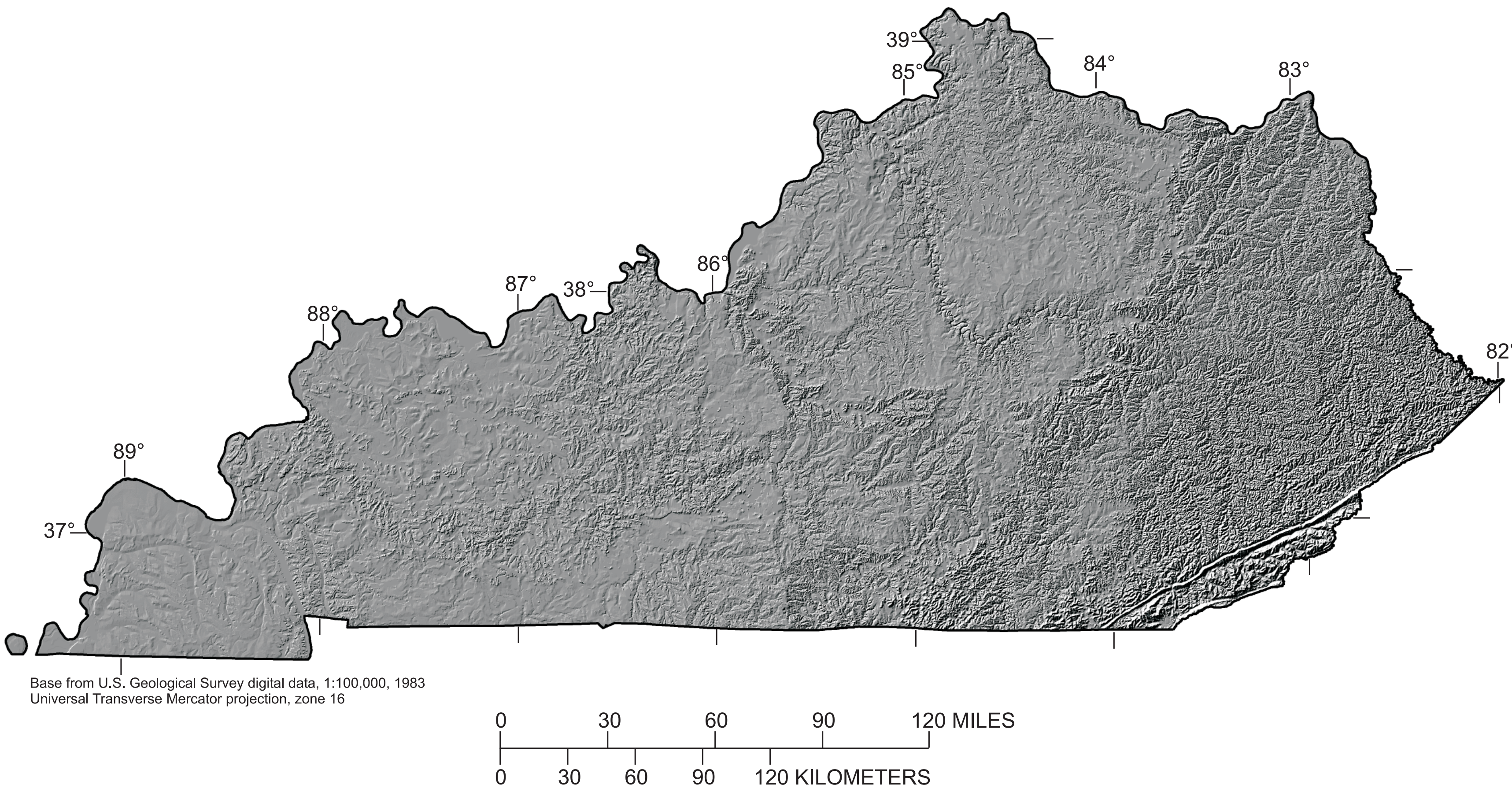
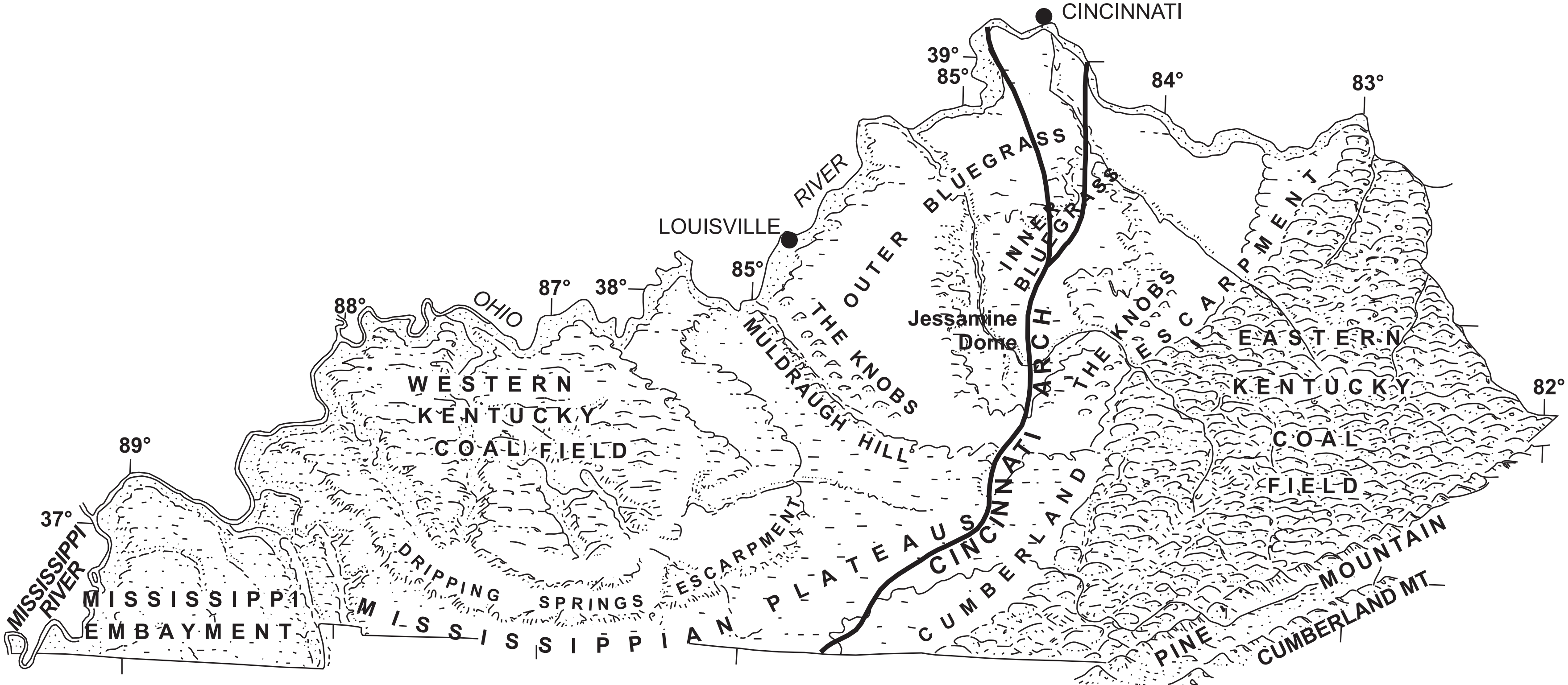


Figure 2. Shaded-relief image of landforms in Kentucky.



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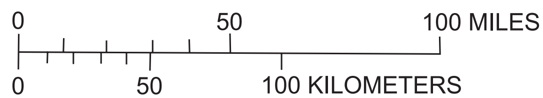
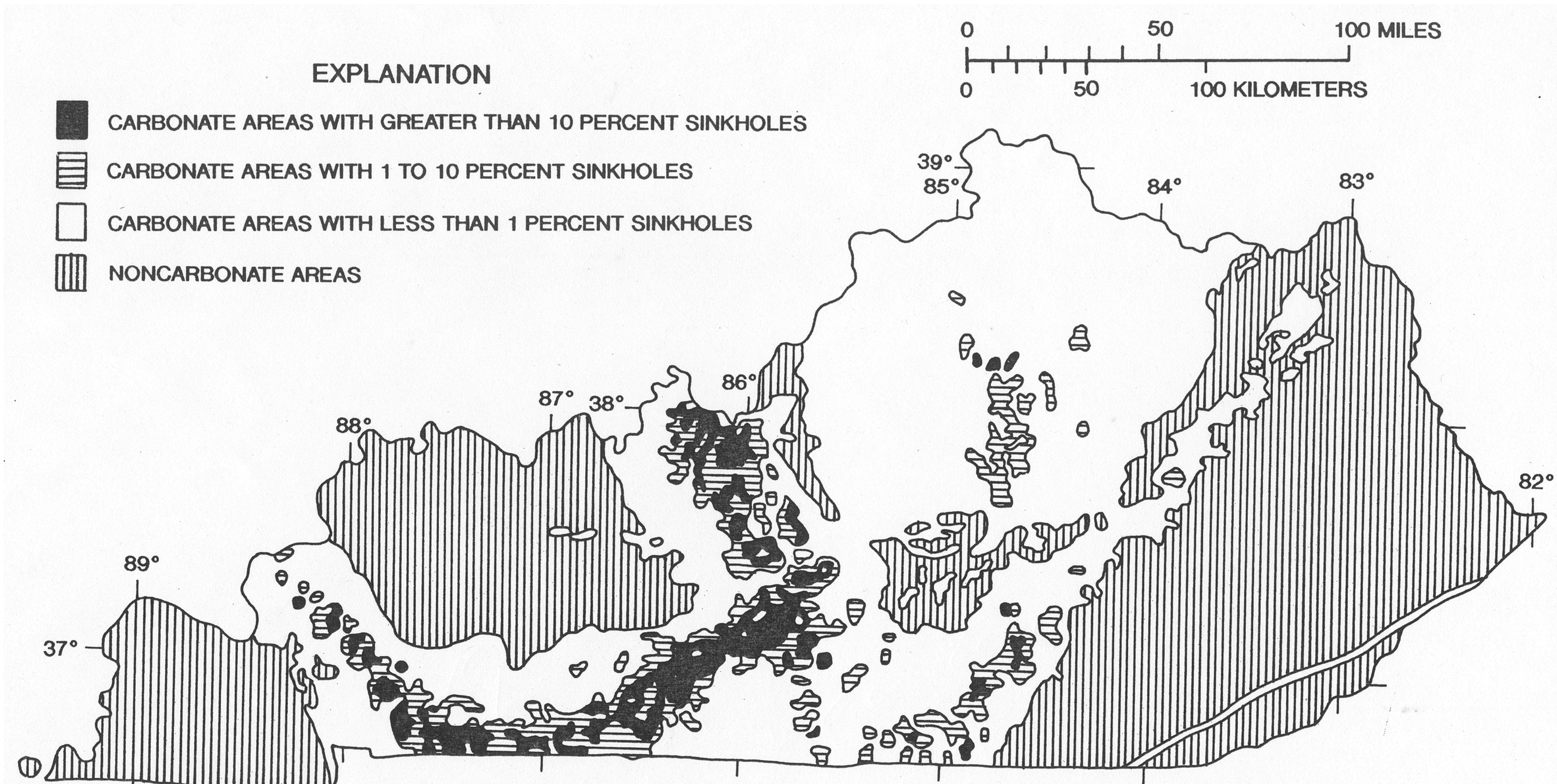


Figure 3. Physiographic regions in Kentucky [from Kentucky Geological Survey, 1980].



(Base credit and projection information unavailable.)

Figure 4. Generalized carbonate areas and surficial karst development in Kentucky [from Crawford and Webster, 1986].

Basins less than 10 mi^2 show a more uniform distribution of peaks throughout the year, with a particularly high percentage of floods occurring from June through September (about 28 percent) in comparison to the basins larger than 50 mi^2, where only about 10 percent of the annual floods occurred during these months. A similar pattern of summer flooding also occurred in the 10- to 50-mi^2 basins where about 20 percent of the peaks occurred from June through September. The annual peaks in small drainages (generally less than 10 mi^2) are more frequently caused by convective summer storms, which generally are of more limited areal extent, shorter duration, and higher intensity than the frontal storms in winter and spring that frequently cause the annual peaks in large basins (generally greater than 50 mi^2) (Choquette, 1988).

DATA USED FOR PEAK-FLOW ESTIMATES AND ESTIMATING TECHNIQUES

The USGS has been collecting and publishing continuous-record streamflow data for gaging stations in Kentucky since 1907 (Beaber, 1970). The data currently (2003) are published by the USGS in the annual report series titled "Water Resources Data—Kentucky." For the section of this report titled "Estimates of Peak Flows at USGS Streamflow-Gaging Stations" (page 19), peak flows are reported for 222 Kentucky stations with 10 or more years of annual peak-flow data that are considered representative of current peak-flow conditions (table 1, page 33). For the section of this report titled "Estimating Peak Flows for Ungaged, Unregulated Streams in Rural Drainage Basins" (page 25), the data for 238 streamflow-gaging stations—187 in Kentucky, 7 in West Virginia, 8 in Virginia, 6 in Ohio, 13 in Indiana, 6 in Illinois, and 11 in Tennessee—with at least 10 years of rural, unregulated, annual peak flows were used (table 2, page 61). These data include the pre-regulation period from various gaging stations where flows currently (2003) are regulated. For both sections of this report, any sites with flow diversions or sites likely to be urbanized were not used. Flow diversions are documented in the annual report series titled "Water Resources Data—Kentucky." Urban drainage basins in Jefferson County were documented in Martin and others (1997). USGS field personnel identified which drainage basins in the rest of Kentucky were likely currently to be urbanized.

The peak flows from various gaging stations were not used for various reasons. The data at two stations were combined into one station if the drainage area for a station was less than 10-percent different from the drainage area of another station and if doing so appeared reasonable based on the data. A drainage-area correction was applied when combining the stations if the drainage areas differed from 3 to 10 percent. Drainage-area corrections were not applied to stations for which the drainage areas differed by less than 3 percent. Data from the following stations were combined: Cumberland River near Pineville, Ky. (USGS gaging-station number 03403000), was combined with Cumberland River at Pine Street Bridge at Pineville, Ky. (03402900).

The peak flows for selected recurrence intervals for Salt River at Glensboro (03295400, 172 mi^2, 11 years of record) are not reported because the annual peak flows at this station appear to have been collected during an unrepresentative short period as compared to Salt River near Van Buren (03295500, 196 mi^2, 44 years of record).

Regression equations are used to estimate a response variable (in this case, a peak flow for a given recurrence interval) for an ungaged drainage basin by measuring explanatory variables (such as drainage area). Explanatory variables should make hydrologic sense, explain a large amount of the variability of the response variable, and be reasonably easy to measure. A set of explanatory variables that were qualitatively judged to best meet these criteria was selected for testing.

For the section of this report titled "Estimating Peak Flows for Ungaged, Unregulated Streams in Rural Drainage Basins" (page 25), the values of 27 explanatory variables were determined for gaged, unregulated streams in rural drainage basins in Kentucky and surrounding States. These 27 explanatory variables were:

total drainage area (TDA), in mi^2, the area measured in a horizontal plane that is enclosed by a drainage divide, measured by planimeter, digitized, or measured by grid method from USGS 7.5-minute topographic quadrangle maps;

contributing drainage area, in mi^2, is the total drainage area excluding any parts characterized by internal drainage, such as by way of sinkholes in karstic terrain;

main-channel length, in mi, the length measured along the main stream channel from the gage to the basin divide (by extension of the mapped main channel up to the divide), following the longest tributary as determined from USGS 7.5-minute topographic quadrangle maps;

main-channel slope (S), in ft/mi, computed as the difference in elevation between points located at 10 and 85 percent of the main-channel length from the gage, divided by the stream length between these two points, as determined from USGS 7.5-minute topographic quadrangle maps;

basin length, in mi, the straight-line distance from the gage to the basin divide (defined by the main-channel length);

mean basin width, in mi, calculated by dividing the total drainage area by basin length;

basin-shape factor, the ratio of basin length, in mi, squared to total drainage area, in mi^2;

main-channel sinuosity, the ratio of main-channel length, in mi, to basin length, in mi;

mean basin elevation, in thousands of ft, computed in ARC/INFO as the average elevation of the basin from a 1:250,000-scale digital elevation model (where elevations are referenced to the National Geodetic Vertical Datum of 1929, NGVD of 1929);

average basin elevation index, in thousands of ft, determined by averaging main-channel elevations at points 10 and 85 percent of the distance from a specified location on the main channel to the topographic divide, as determined from USGS 7.5-minute topographic quadrangle maps (where elevations are referenced to the National Geodetic Vertical Datum of 1929, NGVD of 1929);

storage area, in percent, plus 1.00 percent, that part of the contributing drainage area occupied by lakes, ponds, and swamps, as shown on USGS 7.5-minute topographic quadrangle maps, not including temporary storage as a result of detention basins or ponding at roadway embankments;

mean annual precipitation, in inches, minus 30 in., estimated from Kentucky Department for Natural Resources and Environmental Protection (1979) and Conner (1982);

maximum 24-hour precipitation frequencies, in inches, with recurrence intervals of 25 and 50 years (Hershfield, 1961);

maximum 24-hour precipitation, in inches, occurring during the 30-year interval of 1951-80 (Glenn Conner, Kentucky Climate Center, written commun., 1986);

soils index, in inches ("S"; U.S. Department of Agriculture, 1969), a measure of potential infiltration based on basin vegetative cover, soil infiltration rate, and soil-water storage;

soil infiltration index, in in/h, based on minimum infiltration rates for the U.S. Natural Resources Conservation Service (formerly Soil Conservation Service) hydrologic soil groups (Musgrave, 1955) for soil series in Kentucky (U.S. Department of Agriculture, 1975 and 1984);

forested area, as a percentage of the contributing drainage area, plus 1.00 percent, measured from USGS 7.5-minute topographic quadrangle maps by use of the transparent-grid sampling method;

streamflow-recession index, defined as the number of days it takes base streamflow to decrease one log cycle, or one order of magnitude, as determined graphically from hydrograph plots of daily mean streamflow during representative periods of streamflow recession (Riggs, 1964; Bingham, 1982, Ruhl and Martin, 1991);

streamflow-variability index, (Lane and Lei, 1950) at a station ("station" value) is computed as the standard deviation of the logarithms of the 19 discharges at 5-percent class intervals from 5 to 95 percent on the flow-duration (cumulative-frequency) curve (Searcy, 1959; Dempster, 1990) of daily mean streamflow for the entire period of record;

azimuth, measured in degrees from north to the line defining basin length;

gaging-station latitude, in decimal degrees, minus 36.0º, determined from USGS 7.5-minute topographic quadrangle maps;

gaging-station longitude, in decimal degrees, minus 81.0º, determined from USGS 7.5-minute topographic quadrangle maps.

drainage-basin centroid latitude, in decimal degrees minus 36.0º, determined in a geographic information system (GIS) by means of the "centroidlabels" command as applied to the basin-boundary polygons in ARC/INFO.

drainage-basin centroid longitude, in decimal degrees, minus 81.0º, determined in a GIS as described for centroid latitude.

climate factor for the 2-, 25-, and 100-year recurrence intervals, an index integrating the effects of climate on flood frequency as interpolated from climate factor isolines presented by Lichty and Karlinger (1990).

regional indicator variables X1, X2, ... X7, which were set to a value of 1, if a site was in the selected region, or 0 if the site was not in the selected region.

region, a single regional indicator variable, which was set to integer values 1, 2, ...7 depending on the particular region in which the gaging station was located.

DEVELOPMENT OF PEAK-FLOW ESTIMATES AND ESTIMATING TECHNIQUES

Peak-flow estimates for selected recurrence intervals at gaging stations were developed based on the guidelines of the Interagency Advisory Committee on Water Data (1982) (Bulletin 17B). Peak-flow regression equations for ungaged locations were developed by use of ordinary-least-squares (OLS) and generalized-least-squares (GLS) regression techniques. The peak flows at the gaging stations then were weighted with regression-equation peak-flow estimates at the gaging stations.

Peak Flows at Gaging Stations

The 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year peak flows for individual streamflow-gaging stations discussed in this section were calculated by use of the guidelines of the Interagency Advisory Committee on Water Data (1982) (Bulletin 17B). The calculations involved fitting the Pearson Type III probability distribution to the logarithms (base 10) of the observed annual peak flows at a gaging station. This fitting required computation of the mean, standard deviation, and skew of the logarithms of the annual peak-flow data. The peak flow for any selected recurrence interval was determined from the fitted curve.

Detailed Bulletin 17B Analyses

Bulletin 17B analyses require that the peak-flow data used for statistical analysis at a gaging station be a reliable and representative sample of random, homogeneous events. The annual peak flows at gaging stations described in this report are assumed to be random, reliable, and independent of each other.

The peak flows in a drainage basin will not be homogeneous if the hydrologic conditions in the basin change appreciably over time because of urbanization or other human activities. A two-sided Mann-Kendall trend test (Helsel and Hirsch, 1992) was done on the annual peak flows at gaging stations to test for trends over time. To produce accurate results for the significance of a trend, this test requires that the data have no serial correlation. Serial correlation, in this case, is the dependence or correlation in time sequence between annual peak flows. Annual peak-flow data can exhibit some serial correlation. This correlation can cause the Mann-Kendall trend test to indicate a significant trend when there is none, especially at gaging stations with less than 30 years of peak-flow data (G.D. Tasker, U.S. Geological Survey, written commun., 1997). For this reason, some judgment is necessary to determine whether the results of the Mann-Kendall trend test are significant. The Mann-Kendall test was not done at stations with less than 25 years of peak-flow data because trends cannot be distinguished from serial correlation at stations with this data length. Ten (7 percent) of 142 gaging stations tested had significant trends (at a significance level of 5 percent) over time, with 6 positive trends and 4 negative trends. These trends all had significance levels ranging from 1 to 5 percent. One-hundred two of these sites were located in Kentucky and 40 sites were located in surrounding States. The number of stations with significant trends are close to the number expected simply by chance and are distributed rather uniformly between positive and negative trends. The significant trends are believed to be chance occurrences rather than true trends; no sites were removed from the analyses.

The annual peak flows at all stations were plotted to look for large changes in the distribution of peak flows over time, especially at gaging stations whose basins now are regulated. A station was considered significantly regulated if its drainage basin had more than 4.5 million ft^3 of usable reservoir storage per mi^2 (Benson, 1962) or if pre-regulation peaks were significantly different from post-regulation peaks. The pre- and post-regulation annual peaks from all gaging stations downstream of USCOE dams were tested for significant differences. Significance was established with the Mann-Whitney test (also known as the Wilcoxon rank-sum test) (Helsel and Hirsch, 1992) at a one-sided significance level of 0.05. The results of the regulation analyses are listed in table 1 (page 33). The Cumberland River at Pine Street Bridge at Pineville, Ky. (USGS gaging-station number 03402900), had a *p*-value of 0.075. Given this *p*-value and the fact that the data at both upstream and downstream gaging stations indicated significant regulation, this gaging station also was considered regulated. The section of this report titled “Estimating Peak Flows for Ungaged, Unregulated Streams in Rural Drainage Basins” (page 25), used annual peak flows from pre-regulation time periods only. When peak flows were computed by use of techniques described in Bulletin 17B, only post-regulation data from stations were used (see the section of this report titled “Estimates of Peak Flows at USGS Streamflow-Gaging Stations,” page 19), because the pre-regulation data are no longer representative of current (2003) flows.

Bulletin 17B guidelines were followed for the treatment of high and low outliers, for the conditional probability adjustment, for the adjustment for historical information, and for weighting the station skew coefficient with a generalized skew coefficient. The station skew was not weighted with the generalized skew if the annual peak flows at a gaging station were significantly affected by regulation. The annual peak flows from the gaging stations in this study did not show obvious evidence of being caused by multiple generating mechanisms; therefore, the procedures used to handle this situation were not used. Expected probability adjustments were not made; these adjustments are explained in Bulletin 17B.

Generalized Skew for Kentucky

Four methods were analyzed to find the most accurate generalized skew for Kentucky to use in the Bulletin 17B analyses. The first method was to compute an arithmetic mean of the station skews. To compute this skew coefficient, the station skews from 102 gaging stations in Kentucky were computed by use of the procedures in Bulletin 17B. The stations used all had at least 25 years of unregulated annual peak-flow data. None of these stations were significantly affected by diversions or urbanization. The computed station skews for this method, and the following methods, were adjusted for bias (Tasker and Stedinger, 1986). The 102 stations had an average of 40.4 years of annual peak-flow data.

In the second method, mean skews were calculated for stations that drain karst basins and stations that drain other basins. For this method, the karst stations were defined as stations with total drainage areas that were different from their contributing drainage areas. By this criteria, there were 82 non-karst drainage basins and 20 karst drainage basins. The two samples were different from each other at a significance level of 0.094 when the Mann-Whitney test was applied. The weak *p*-value, combined with mean skews that are similar (0.16 for the karst sites and -0.02 for the non-karst sites), lead to the decision not to separate these two populations of gaging stations in Kentucky.

In the third method of computing a generalized skew, an attempt was made to create a State skew-isoline map by plotting the station skews on a map at the centroid of their drainage basins.

The stations, however, showed no obvious geographic pattern. Positive and negative skew values both were scattered throughout the State.

In the fourth method, an attempt was made to develop a multiple-regression equation with station skew as the response variable and drainage basin characteristics (such as drainage area and stream slope) as the explanatory variables. There were 95 of the 102 gaging stations with the following basin characteristics available for testing as explanatory variables: contributing drainage area, main-channel slope, mean basin elevation, average basin elevation index, forested area, mean annual precipitation, maximum 24-hour precipitation frequencies with recurrence intervals of 25 and 50 years, basin length, and azimuth. All-possible-subsets multiple OLS regression and the Mallow's Cp statistic were used to find the best combinations of variables (Helsel and Hirsch, 1992). Some combinations were eliminated from consideration if individual explanatory variables were not significant. Combinations also were eliminated if they contained both measures of precipitation intensity and each measure had opposite signs. The best remaining regression equation contained the single variable—percent forested area. This regression explained too little of the variation in skew values ($r^2 = 0.076$) to use, given the risk that the form of the regression equation likely is to be imperfect (Helsel and Hirsch, 1992).

It is obvious that the Bulletin 17B generalized skew (the national skew-isoline map) is not representative of station skews in Kentucky. The Bulletin 17B map isolines indicate negative skews for all of Kentucky except the far eastern part. As discussed earlier, both positive and negative computed station skews for 102 sites in Kentucky were scattered throughout the State.

The mean skew for Kentucky was used as the generalized skew in the Bulletin 17B flood-frequency analyses. This new skew coefficient is 0.011, with a standard error of prediction of 0.520.

Peak Flows at Ungaged Locations

Regression equations are used to compute peak flows at ungaged locations. OLS regression techniques (Helsel and Hirsch, 1992) were used in an exploratory data analysis to develop linear regression equations to relate peak flows, Q_T ("response" or "dependent" variable, where T = 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year recurrence intervals), to selected basin characteristics ("independent" or "explanatory" variables). The most appropriate explanatory variables for estimating peak flows were selected in this OLS exploratory phase. The final regression coefficients and regression errors then were computed by use of GLS regression. GLS regression compensates for differences in the reliability of, and correlation among, the Q_T estimates at stations included in the analysis. The regression analysis included the 238 streamflow-gaging stations in Kentucky and nearby in neighboring States with at least 10 years of peak-flow record that was not affected appreciably by regulation (table 2–page 61, and plate 1 at back of report).

Inspection of scatter plots in the OLS exploratory phase, which showed the relations between response and explanatory variables, indicated that logarithmic (base 10) transformations of the response variable and most of the explanatory variables were appropriate. This transformation generally helped make the relations more linear and the residuals (errors) more uniform in variance about the regression line than before transformation. The relations between response and explanatory variables after transformation were consistent with the assumed linear form of the model.

The general form of the regression equations developed in this study is

$$\log(Q_T) = b_o + b_1 \log X_1 + b_2 \log X_2 + \ \dots \\ + b_n \log X_n + \varepsilon \ , \qquad (1)$$

where

Q_T the response variable, is the peak flow of estimated long-term average recurrence interval T,

b_o is a constant,

b_i (i=1 to n) is the regression coefficient for the ith explanatory variable,

X_i (i=1 to n) is the ith explanatory variable,

ε is the random-error component, and

n is the total number of explanatory variables.

The algebraically equivalent form when the equation is retransformed to the original units is

$$Q_T = 10^{bo} X_1^{\,b1} X_2^{\,b2} \ldots X_n^{\,bn} . \qquad (2)$$

Defining Flood Regions

During the exploratory data analysis, the seven peak-flow hydrologic regions defined by Choquette (1988) were assessed based on the updated peak-flow values. The peak-flow characteristics of the seven regions were evaluated graphically and statistically. A statewide OLS regression of log-transformed 50-year peak-flow values with the log-transformed total drainage areas ($log\ Q_{50} = b_0 + b_1\ log\ TDA$) was completed using all 238 gaging stations. Also, this same OLS regression was completed for each of three aggregated regions formed by combining Regions 1 and 2; Regions 3, 4, and 5; and Regions 6 and 7 (plate 1). The geographical distribution of the residuals (errors) from the statewide regression and the residuals from the three regressions for the aggregated regions generally conformed to the regional boundaries defined by Choquette (1988). Residuals from the statewide regression also were grouped by river basin for comparison; however, no distinctive pattern in residuals relative to river basins was apparent. This lack of pattern may be related to the large geologic and physiographic variability and climatic variability spanned by Kentucky drainage basins. Plots of the residuals in downstream order by river basin showed a tendency for the residual signs and magnitudes to vary locally with changes in geologic and physiographic characteristics.

Density plots and box plots of the residuals from the statewide regression (not shown) displayed patterns similar to those described by Choquette (1988) where residuals for Regions 1, 3, 5, and 7 appear similar in sign and magnitude and the residuals for Regions 2, 4, and 6 appear similar in sign and magnitude. A Kruskal-Wallis test indicated that for at least one region, the central tendency of the residuals differ among the seven regions (at an attained significance level (p-value) of less than 0.001). Residuals from the statewide regression were compared to residuals from each region by use of the nonparametric Mann-Whitney U test. The statewide residuals were significantly different ($p<0.05$) from the residuals of all regions except for Region 6, where the test-statistic p-value was 0.076.

Regional location-indicator variables were used in the OLS regressions to test for statistically significant differences among the seven regions. In these statistical tests, a 95-percent confidence level was defined as significant. The location-indicator variables were set either at 1, if the station was in a particular region, or 0, if not. Methods described by Montgomery and Peck (1982) were used to test for significant variations of the slopes (coefficients) and intercepts among regional regressions of the 50-year peak flow with total drainage area. Intercepts for the OLS-regression equations for Regions 2, 4, and 6 differ from those of Regions 1, 3, 5, and 7, and there is variation among slopes of the seven regional regression equations.

Regional location-indicator variables also were used to directly compare regressions for each region to regressions for the group of all the other stations combined (Pope and others, 2001). This comparison was done by adding the location-indicator variable and the product of the location-indicator variable and the total-drainage-area term to the regression. Thus, a three-variable OLS-regression equation to estimate Q_{50}, with all available stations and utilizing (1) total drainage area, (2) location-indicator variable, and (3) the product of the location-indicator variable and total drainage area as explanatory variables, was developed for each of the seven regions. In each regional model, a significant location variable indicates a difference in the regression intercept between the stations in that region and the stations in the rest of the State; a difference in the product of the location variable and total drainage area term indicates a difference in the coefficients for total drainage area between the stations in that region and the stations in the rest of the State. Based on the levels of significance of the indicator-variable terms in these regressions, only the Region 3 regression equation failed to indicate a significant difference (0.05) from the regression for the group of all other stations combined. However, further location-indicator regression comparisons showed that

Region 3 differs from Region 4, Region 3 differs from Region 2, and Region 3 also differs from the group of stations in the neighboring regions combined (Regions 2, 4, and 5).

Results of these statistical tests, which cannot be used to statistically verify the seven regions, nonetheless are supportive of the regionalization scheme. The tests, which compare the regional regression characteristics, indicate that each region represents a grouping of stations that is distinguishable from either all the other stations combined as a group or all the stations in the neighboring regions combined. Indeed, the central tendencies (means and medians) of the residuals of the statewide regression in each region are not statistically different from the central tendencies of each and every one of the other regions. As noted previously, the residuals in Regions 1, 3, 5, and 7 appear similar in sign and magnitude, and the residuals in Regions 2, 4, and 6 appear similar in sign and magnitude. However, the odd-numbered regions are geographically separated as are the even-numbered regions. Also, the regression equations for the individual regions (table 3) differ in their coefficients and in their accuracy. Based on the results of the graphical and statistical tests described in this section, the seven-region scheme developed by Choquette (1988) was accepted for the updated peak-flow values presented in this report.

Some minor adjustments in the region boundaries were made to improve alignment with the drainage-basin boundaries and the current residuals: An area of approximately 150 mi^2, which included the basin for the Goose Creek at Manchester station (03281100), was shifted from Region 4 into Region 3. An area of approximately 220 mi^2, which included the basin for the Barren River Tributary near Bowling Green station (03314750), was shifted from Region 6 into Region 5. An area of approximately 50 mi^2 in the lower Green River Basin, just downstream from the confluence with Pond River, was shifted from Region 7 into Region 6.

Choosing Explanatory Variables

OLS-regression equations were developed by all-possible-subsets regression procedures (Statistical Analysis System Institute, Inc., 1985) with the 2-, 50-, and 500-year peak flows for the 238 unregulated stations as response variables, initially utilizing all of the 27 prospective explanatory variables, or transformations thereof, discussed in the section of this report titled “Data Used for Peak-Flow Estimates and Estimating Techniques” (page 8). A subset of 54 of the stations had all of these explanatory variables available, because most of the explanatory variables at these stations were computed in a previous study (Choquette, 1988). The variables out of the 27 prospective variables that least improved the regression model, using data from the 54 stations, were dropped from the analyses. Also, variables were removed if they were highly correlated with a better-performing variable. As the number of explanatory variables was reduced, an increased number of stations had all of the variables. Regression equations were rerun with additional stations and fewer variables than before, and again the variables that least improved the equations were dropped. As more gaging stations were added, regression analyses also were done for individual regions. This iterative process continued as the best explanatory variables were retained, based on both the statewide and regional equations. Total drainage area, instead of contributing drainage area, was selected as the primary explanatory variable. Contributing drainage area was eliminated as an explanatory variable because of (1) the difficulty in determining this basin characteristic accurately from maps that generally are available, (2) the minimal overall improvement in accuracy in most regions, and (3) a reduced accuracy in Region 5. The top four explanatory variables were total drainage area, main-channel slope, main-channel sinuosity, and basin-shape factor. Based on the results from these regressions, it was not considered useful to compute values of the other explanatory variables that had not been determined previously.

Table 3. Regression equations and their accuracy for estimating peak flows for ungaged, unregulated streams in rural drainage basins in Kentucky

[*Q* is peak flow, in cubic feet per second; *TDA* is total drainage area, in square miles; *S* is main-channel slope, in feet per mile]

Peak-flow regression equation for given recurrence interval (recurrence intervals from 2 to 500 years)	Average standard error of prediction (percent)	$(PRESS/n)^{1/2}$ (percent)	Average equivalent years of record	Estimated model-error variance (base-10 logs)	Average sampling-error variance (base-10 logs)
Region 1 – 28 gaging stations					
$Q_2 = 312\ TDA^{0.673}$	49.7 to -33.2	49.9 to -33.3	1.3	0.0277	0.0030
$Q_5 = 493\ TDA^{0.651}$	48.0 to -32.4	48.6 to -32.7	1.9	.0259	.0031
$Q_{10} = 91.5\ TDA^{0.843}\ S^{0.451}$	46.2 to -31.6	47.2 to -32.1	2.8	.0230	.0042
$Q_{25} = 81.2\ TDA^{0.872}\ S^{0.535}$	49.3 to -33.0	51.1 to -33.8	3.6	.0253	.0050
$Q_{50} = 75.8\ TDA^{0.890}\ S^{0.587}$	52.9 to -34.6	55.5 to -35.7	3.9	.0283	.0057
$Q_{100} = 71.4\ TDA^{0.907}\ S^{0.632}$	57.3 to -36.4	61.0 to -37.9	4.1	.0321	.0066
$Q_{200} = 67.8\ TDA^{0.922}\ S^{0.673}$	62.4 to -38.4	67.3 to -40.2	4.2	.0367	.0076
$Q_{500} = 63.6\ TDA^{0.941}\ S^{0.722}$	69.7 to -41.1	76.6 to -43.4	4.3	.0438	.0090
Region 2 – 68 gaging stations					
$Q_2 = 152\ TDA^{0.728}$	44.0 to -30.6	45.1 to -31.1	1.9	.0238	.0013
$Q_5 = 239\ TDA^{0.721}$	39.5 to -28.3	40.8 to -29.0	3.0	.0197	.0012
$Q_{10} = 304\ TDA^{0.715}$	38.6 to -27.9	40.5 to -28.8	4.2	.0188	.0013
$Q_{25} = 393\ TDA^{0.709}$	38.7 to -27.9	41.5 to -29.3	5.8	.0187	.0015
$Q_{50} = 464\ TDA^{0.704}$	39.3 to -28.2	43.0 to -30.1	6.9	.0191	.0016
$Q_{100} = 538\ TDA^{0.699}$	40.4 to -28.8	44.8 to -30.9	7.9	.0199	.0018
$Q_{200} = 615\ TDA^{0.695}$	41.7 to -29.4	47.0 to -32.0	8.7	.0209	.0020
$Q_{500} = 721\ TDA^{0.690}$	43.6 to -30.4	50.2 to -33.4	9.6	.0225	.0022
Region 3 – 24 gaging stations					
$Q_2 = 187\ TDA^{0.748}$	25.9 to -20.6	29.0 to -22.5	5.9	.0081	.0019
$Q_5 = 355\ TDA^{0.712}$	23.7 to -19.1	27.5 to -21.5	9.8	.0064	.0021
$Q_{10} = 498\ TDA^{0.692}$	22.2 to -18.2	27.2 to -21.4	15.1	.0052	.0024
$Q_{25} = 714\ TDA^{0.670}$	20.7 to -17.2	27.5 to -21.5	24.6	.0040	.0027
$Q_{50} = 897\ TDA^{0.656}$	20.4 to -16.9	28.1 to -22.0	32.4	.0034	.0031
$Q_{100} = 1100\ TDA^{0.643}$	20.4 to -16.9	29.1 to -22.5	39.4	.0031	.0034
$Q_{200} = 1320\ TDA^{0.632}$	21.1 to -17.4	30.4 to -23.3	44.5	.0030	.0039
$Q_{500} = 1640\ TDA^{0.620}$	22.6 to -18.4	32.7 to -24.6	47.9	.0033	.0045
Region 4 – 17 gaging stations					
$Q_2 = 39.0\ TDA^{0.923}\ S^{0.204}$	31.4 to -23.9	32.3 to -24.4	3.5	.0112	.0029
$Q_5 = 69.8\ TDA^{0.894}\ S^{0.186}$	25.2 to -20.1	26.0 to -20.7	6.5	.0072	.0023
$Q_{10} = 92.7\ TDA^{0.882}\ S^{0.178}$	24.3 to -19.5	25.6 to -20.4	9.2	.0065	.0024
$Q_{25} = 121\ TDA^{0.873}\ S^{0.173}$	25.5 to -20.3	27.6 to -21.6	11.6	.0068	.0029

Table 3. Regression equations and their accuracy for estimating peak flows for ungaged, unregulated streams in rural drainage basins in Kentucky—*Continued*

[Q is peak flow, in cubic feet per second; TDA is total drainage area, in square miles; S is main-channel slope, in feet per mile]

Peak-flow regression equation for given recurrence interval (recurrence intervals from 2 to 500 years)	Average standard error of prediction (percent)	$(PRESS/n)^{1/2}$ (percent)	Average equivalent years of record	Estimated model-error variance (base-10 logs)	Average sampling-error variance (base-10 logs)
Region 4 – 17 gaging stations—*continued*					
$Q_{50} = 140\ TDA^{0.870}\ S^{0.173}$	27.3 to -21.5	30.2 to -23.2	12.5	0.0077	0.0033
$Q_{100} = 392\ TDA^{0.780}$	31.6 to -24.0	38.4 to -27.7	11.4	.0111	.0031
$Q_{200} = 441\ TDA^{0.778}$	33.8 to -25.3	41.3 to -29.2	11.7	.0125	.0035
$Q_{500} = 510\ TDA^{0.776}$	37.1 to -27.1	45.5 to -31.3	11.9	.0147	.0041
Region 5 – 40 gaging stations					
$Q_{2} = 260\ TDA^{0.704}$	34.5 to -25.7	36.3 to -26.6	3.3	.0151	.0015
$Q_{5} = 437\ TDA^{0.692}$	38.9 to -28.0	41.8 to -29.5	3.8	.0186	.0018
$Q_{10} = 571\ TDA^{0.686}$	43.9 to -30.5	48.0 to -32.4	4.2	.0228	.0022
$Q_{25} = 754\ TDA^{0.682}$	51.1 to -33.8	57.0 to -36.3	4.6	.0293	.0028
$Q_{50} = 901\ TDA^{0.679}$	56.7 to -36.2	64.0 to -39.0	4.7	.0347	.0033
$Q_{100} = 1060\ TDA^{0.677}$	62.4 to -38.4	71.3 to -41.6	4.8	.0405	.0039
$Q_{200} = 1220\ TDA^{0.676}$	68.4 to -40.6	78.7 to -44.0	4.9	.0467	.0045
$Q_{500} = 1450\ TDA^{0.674}$	76.4 to -43.3	89.0 to -47.1	4.9	.0555	.0053
Region 6 – 27 gaging stations					
$Q_{2} = 256\ TDA^{0.600}$	49.9 to -33.3	49.9 to -33.3	1.3	.0280	.0029
$Q_{5} = 397\ TDA^{0.586}$	45.1 to -31.1	46.4 to -31.7	2.0	.0234	.0027
$Q_{10} = 499\ TDA^{0.578}$	43.9 to -30.5	46.5 to -31.7	2.8	.0222	.0028
$Q_{25} = 636\ TDA^{0.569}$	44.1 to -30.6	48.4 to -32.6	3.8	.0221	.0031
$Q_{50} = 740\ TDA^{0.564}$	45.4 to -31.2	50.9 to -33.7	4.4	.0229	.0035
$Q_{100} = 846\ TDA^{0.559}$	47.1 to -32.0	53.9 to -35.0	4.9	.0243	.0038
$Q_{200} = 953\ TDA^{0.555}$	49.6 to -33.2	57.6 to -36.5	5.2	.0263	.0043
$Q_{500} = 1100\ TDA^{0.551}$	53.7 to -34.9	63.1 to -38.7	5.5	.0299	.0049
Region 7 – 34 gaging stations					
$Q_{2} = 293\ TDA^{0.623}$	56.6 to -36.1	58.2 to -36.8	1.4	.0350	.0029
$Q_{5} = 476\ TDA^{0.616}$	55.0 to -35.5	57.5 to -36.5	2.1	.0332	.0030
$Q_{10} = 614\ TDA^{0.613}$	54.5 to -35.3	58.1 to -36.8	3.0	.0325	.0032
$Q_{25} = 804\ TDA^{0.610}$	54.7 to -35.4	59.9 to -37.4	4.1	.0323	.0036
$Q_{50} = 956\ TDA^{0.610}$	55.3 to -35.6	61.6 to -38.1	5.0	.0326	.0039
$Q_{100} = 1110\ TDA^{0.609}$	56.1 to -35.9	63.6 to -38.9	5.8	.0332	.0042
$Q_{200} = 1280\ TDA^{0.610}$	57.3 to -36.4	66.0 to -39.7	6.6	.0342	.0045
$Q_{500} = 1510\ TDA^{0.610}$	59.2 to -37.2	69.5 to -41.0	7.5	.0358	.0050

Various factors were considered in evaluating alternative regression equations with the top four explanatory variables, including (1) the coefficient of determination, a measure of the proportion of the variation in the response variable explained by the regression equation; (2) the standard error of the estimate, a measure of model-fitting error; (3) the prediction sum of squares (PRESS) statistic, a measure of model-prediction error; (4) the statistical significance of each individual explanatory variable; (5) potential multicollinearity as indicated by the correlation of explanatory variables and the value of the variance inflation factor (Montgomery and Peck, 1982); (6) the effort and modeling benefit of determining the values of each additional explanatory variable; and (7) the hydrologic validity of the signs and magnitudes of the explanatory variables.

The best one-, two-, and three-variable regression equations in the final OLS all-possible-subsets regression run were determined for all available gaging stations in each region with the top four explanatory variables. Total drainage area was selected as an explanatory variable in all seven regions. The attained significance levels for the T-statistics on total drainage area were less than 0.0001 in all regions. Main-channel slope was chosen as a second explanatory variable in Regions 1 and 4. Addition of any of the three explanatory variables other than drainage area did not appreciably (more than 3 percentage points) reduce the regression standard errors of estimate in the other five regions. The values of drainage area and main-channel slope for all regions are listed in table 2 (page 61).

Regression diagnostic tools were used to test the adequacy of the final OLS regressions. The OLS-regression coefficients all are statistically different from zero (*p*-values less than 0.05). The influence of individual stations on the regressions was measured by Cook's D statistic (Helsel and Hirsch, 1992). Multicollinearity in the explanatory variables was tested with the variance inflation factor. There were no problems with high-influence points or multicollinearity between variables. Different types of residual plots were analyzed. The regression residuals were plotted against predicted values to look for linearity, homoscedasicity, normality, and the presence of outliers. Normal probability plots of the residuals also were analyzed. Residuals were plotted against the explanatory variables to look for biases in the explanatory variables over their range. All regression diagnostics indicated that the final explanatory variables in each region resulted in satisfactory regression equations.

Determining Final Regression Coefficients

The regression equations (table 3) were finalized by use of GLS-regression techniques (Stedinger and Tasker, 1985; Tasker and Stedinger, 1989), utilizing the computer program GLSNET (G.D. Tasker, K.M. Flynn, A.M. Lumb, and W.O. Thomas, U.S. Geological Survey, written commun., 1995). Two major assumptions of OLS regression commonly are violated in regression of peak flows and explanatory variables: (1) the errors in the computed peak flows of selected recurrence intervals are the same at all gaging stations and (2) the annual flows for overlapping years at different gaging stations are independent of each other (not cross-correlated). Error in the peak flows varies with the length of record, which differs among the gaging stations, and streamflows at gaging stations in a region usually are cross-correlated because the same climatic conditions and weather events can affect most of the streams within a hydrologic region.

Stedinger and Tasker (1985) and Tasker and Stedinger (1986) have shown that where streamflow records are of widely varying length and concurrent flows at different sites are highly correlated, GLS regression provides more accurate estimates of the regression coefficients, better estimates of the accuracy of the regression equations, and better estimates of the model error when compared to OLS regression. GLS regression gives more weight to long-term than short-term gaging stations and less weight to stations where flows are more highly correlated to flows at other gaging stations.

Weighting Gaging-Station Peak-Flow Estimates with Regression-Equation Peak-Flow Estimates

Recorded peak flows at individual gaging stations, especially those with short periods of record, may not be representative of peak flows from long periods of record. Because of this, peak-flow estimates determined by use of the methods in Bulletin 17B at each gaging station (see the section of this report titled "Peak Flows at Gaging Stations," page 10) were combined mathematically with the peak-flow estimates at that station, computed from regression equations (table 3, page 15), to compute the best (weighted) estimate of peak flows for that station (table 1, page 33). If two independent estimates are weighted inversely proportional to their variances, the variance of the weighted average is less than the variance of either estimate (Interagency Advisory Committee on Water Data, 1982). In other words, the weighted average will produce the most accurate peak-flow estimates (number of years of record is inversely proportional to variance, and thus the weighting in equation 3 below becomes direct with years of record). The weighted-average peak flow *(Q_{tw})* was calculated by use of the equation

$$Q_{tw} = 10^{\left(\frac{\log(Q_{to})(\omega) + \log(Q_{tr})(\omega_e)}{\omega + \omega_e}\right)}, \qquad (3)$$

where

Q_{to} is the log-Pearson Type III estimate of the *t*-year peak discharge calculated by the methods described in the section of this report titled "Estimates of Peak Flows at USGS Streamflow-Gaging Stations" (page 19);

Q_{tr} is the regression estimate of the *t*-year peak discharge calculated with the methods described in the section of this report titled "Estimating Peak Flows for Ungaged, Unregulated Streams in Rural Drainage Basins" (page 25);

ω_e is the equivalent years of record for the regression estimate as defined by Hardison (1971); and

ω is either the systematic record length, in years, if no historical peak-discharge data are available for the site, or the effective record length, in years, if historical peak-discharge data are available for the site.

The effective record length is computed as

$$\omega = \omega_s + \left(D\left(0.55 - 0.1\,ln\left(\frac{P}{1-P}\right)\right)\right), \qquad (4)$$

where

D is minimum $(200, (\omega_h - \omega_s))$;

P is $1 - (N_p/(\omega_h + \omega_s))$;

N_p is the number of historic peaks;

ω_h is the historic record length, in years, and

ω_s is the systematic record length, in years.

ESTIMATING THE MAGNITUDE OF PEAK FLOWS FOR SELECTED RECURRENCE INTERVALS

This section describes techniques for estimating the magnitude of peak flows for streams in Kentucky for recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years. A flowchart is provided as a guide to the appropriate estimates and (or) estimating techniques for a site on a specific stream. Example applications of the peak-flow estimating equations also are provided.

Choosing the Appropriate Peak-Flow Estimation Technique

Peak flows in this report refer to peak flows of a specified recurrence interval. The recurrence interval is the average period of time between peak flows that are equal to or greater than a specified peak flow. For example, the 50-year peak flow is the flow that would be exceeded, on a long-term average, once in 50 years. This does not imply, however, that flooding will happen at regular intervals; two 50-year peak flows could occur in the same year. In contrast, a 50-year peak flow might not occur in 100 years. The recurrence interval does not indicate when the estimated flood peak will occur.

The reciprocal of the recurrence interval is called the annual exceedance probability; that is, the probability that a given peak flow will be exceeded in any given year. For example, the annual exceedance probability of the 50-year peak flow would be 0.02. In other words, there is a 2-percent chance that the 50-year peak flow will be exceeded in any given year.

To obtain estimated peak flows for streams in Kentucky, information on the site (site refers to a location on a stream) of interest is needed, including whether the site is at or near (and on the same stream as) a USGS streamflow-gaging station and whether the site drains an urbanized or regulated drainage basin. The different peak-flow estimates and estimating techniques in this report are appropriate to various combinations of these site characteristics.

The flowchart in figure 5 should be used to choose the appropriate method of obtaining estimated peak flows. The boxes in the right column of the flowchart show the appropriate section of this report for obtaining the peak flows. The "Limitations and Accuracy" statements in each section should be read before applying the equations in that section. Although the discussions on limitations are intended to be comprehensive, it is possible that other specific limitations will arise in the application of the equations in these sections.

The following definitions apply to figure 5:

Site at a gaging station—the drainage area of the study site is within 3 percent of the drainage area of a USGS streamflow-gaging station and on the same stream (see plate 1 for a map of the gaging stations);

Regulated—the drainage basin above the site contains more than 4.5 million ft^3 of usable reservoir storage per mi^2 (Benson, 1962) (usable reservoir storage is the volume of water normally available for release from a reservoir, between the minimum and maximum controllable elevations) or peaks have changed significantly following the addition of a reservoir(s) to a drainage basin;

Diversion—the peak flows from a drainage basin are affected by diversion of flow into or out of the basin;

Site near a gaging station—the drainage area of the site ranges from 50 to 200 percent of the drainage area of a USGS gaging station (excluding the plus or minus 3 percent considered "at a gaging station") and on the same stream;

Urbanized—more than 15 percent of the drainage-basin area above the site is covered by some type of commercial, industrial, or residential development.

Estimates of Peak Flows at USGS Streamflow-Gaging Stations

The 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year peak flows for streamflow-gaging stations discussed in this section were calculated by use of the guidelines of the Interagency Advisory Committee on Water Data (1982) (Bulletin 17B). The calculations involved fitting the Pearson Type III probability distribution to the logarithms (base 10) of the observed annual peak flows at a gaging station. This fitting required computation of the mean, standard deviation, and skew of the logarithms of the annual peak-flow data. The peak flow for any selected recurrence interval was determined from the fitted curve.

Presentation of the Estimates

The peak flows for recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years at USGS streamflow-gaging stations in Kentucky with 10 years or more of record (with the exceptions noted in the section of this report titled "Data Used for Peak-Flow Estimates and Estimating Techniques," page 8) are listed in table 1 (page 33). Three different peak flows are given (where appropriate) for unregulated stations: the gaging-station estimate (G), the regression-equation estimate (R), and a weighted average (W) of these two estimates. As discussed in the section of this report titled "Development of Peak-flow Estimates and Estimating Techniques" (page 10), the weighted average is the most accurate peak-flow estimate for each gaging station.

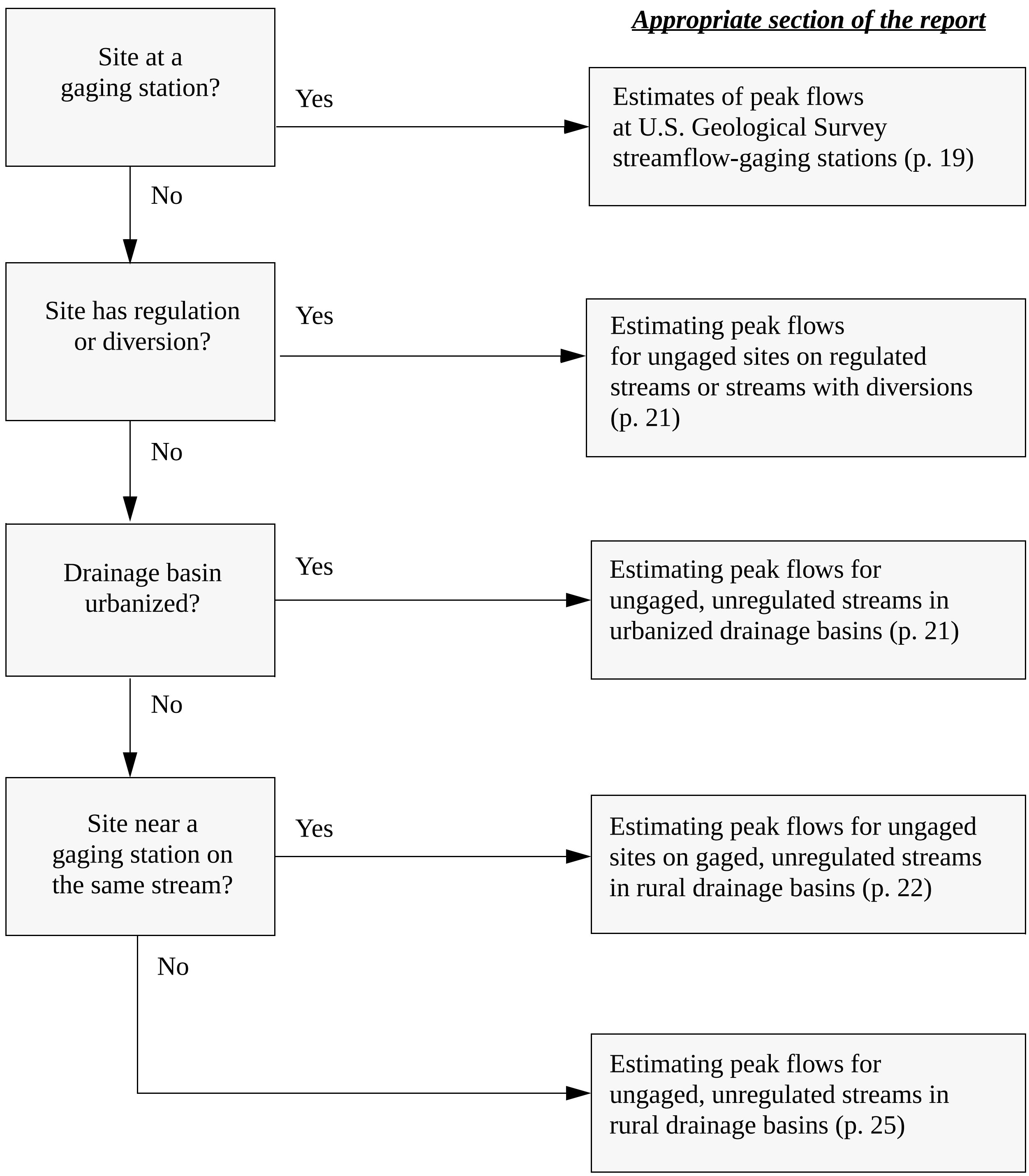


Figure 5. Flowchart for choosing the appropriate means of obtaining estimated peak flows in Kentucky.

For regulated stations, the regression-equation estimate cannot be weighted with the gaging-station estimate because the regression equations do not apply to regulated stations. For sites with drainage-basin characteristics outside the bounds of the drainage-basin characteristics of stations used to create the regression equations, only the gaging-station estimate is presented because the accuracy of the regression-equation estimate is unknown. Also included in table 1 are the USGS gaging-station number and name, the total drainage area, the period of recorded peak flows, the regulation status of the station, and the source of any regulation at a station. Station locations are shown on plate 1.

Limitations and Accuracy of the Estimates

The recorded annual peak flows used to compute the peak flows for given recurrence intervals at gaging stations in this section are assumed to be representative of recorded and unrecorded peaks. Generally, collecting additional years of data at a station provides improved estimates of peak flows. The estimated peak flows at gaging stations will not be reliable if the drainage basin of a station becomes significantly more regulated or urbanized than it was during the period used to calculate the peak flows. In addition, if the flow management at a regulated station changes, the estimated peak flows presented in this section may not apply, depending on the magnitude of the changes. The peak-flow data were analyzed in an attempt to identify significant changes in flow management; subtle or recent changes in flow management may have gone undetected.

If an extreme flood did not occur at a regulated station during the period of streamflow-data collection for that station, the estimated peak flows may underestimate appreciably the true peak flows. This underestimation could result because a large inflow to a reservoir may cause outflows to be regulated differently than at any previous time.

The estimated peak flows in this section do not consider the possibility of dam failures. If a dam failure occurs, the peak flows on streams with dams that store large quantities of water could be much greater than the given peak flows.

Estimating Peak Flows for Ungaged Sites on Regulated Streams or Streams With Diversions

Techniques for estimating peak flows for ungaged, regulated streams or for streams with diversions that will affect peak flows are beyond the scope of this report, because peak flows on these types of streams are dependent on variable human activities. A potential technique for estimating peak flows at ungaged sites on ungaged, regulated streams would be to route peak inflows through the regulated reservoir(s), taking into account regulation practices. The applicable technique of this report could be used to estimate the magnitude of the peak inflows. Physical modeling could be used for sites affected by diversion.

Estimating Peak Flows for Ungaged, Unregulated Streams in Urbanized Drainage Basins

The regression equations presented in the section of this report titled “Estimating Peak Flows for Ungaged, Unregulated Streams in Rural Drainage Basins” (page 25), are not appropriate for urban basins. Peak-flow estimates for ungaged urban basins in Jefferson County, Ky., should be made by use of the methods described in Martin and others (1997). Peak-flow estimates for other urban areas of Kentucky should use the USGS nationwide regression equations contained in Sauer and others (1983).

Martin and others (1997) found that the USGS nationwide urban-regression equations tended to overestimate peak flows for urban streams in Jefferson County. Sherwood (1986) similarly indicated there was positive bias (overestimation) for the USGS nationwide urban-estimating equations when applied in Ohio. It has not been demonstrated that peak-flow estimates from the nationwide urban-regression equations tend to overestimate flows for other urban areas in Kentucky, but such positive bias may well be present.

Sauer and others (1983) presented seven- and three-variable nationwide urban-regression equations in their report. Although the three-variable equations are easier to apply, a later study utilizing new data (Sauer, 1985) showed the three-variable equations to be biased in some areas of the country (mainly in some southeastern States). Only the seven-variable regression equations are recommended for use in Kentucky, because of the potential for biases.

Computed urban peak flows should be compared to the equivalent rural peak flows to make sure that the urban peak-flow estimate is reasonable. The urbanization of a drainage basin generally causes peak flows to increase for those basins that do not have appreciable in-channel or detention storage. The increase in peak flows is usually most dramatic for low recurrence-interval flows, which occur frequently, and less pronounced for high recurrence-interval flows, which occur infrequently (Sauer and others, 1983).

The location of urbanization in a drainage basin may have an effect on peak flows that is not accounted for in the urban-regression equations. For example, if the lower part of a basin is urbanized and the upper part is not, rapid removal of floodwaters from the lower part may occur before the upper part can contribute appreciable runoff. This pattern of urbanization potentially could decrease peak flows from a drainage basin (Sauer and others, 1983).

Estimating Peak Flows for Ungaged Sites on Gaged, Unregulated Streams in Rural Drainage Basins

If an ungaged site is near (see "Limitations of the Technique" later in this section for details) a USGS streamflow-gaging station and on the same stream, a weighted peak flow is calculated. The weights are determined as a function of the difference in drainage area between the ungaged site and the gaging station.

Application of the Technique

Equation 5 (below) provides the means for calculating a final weighted peak flow at an ungaged site on a gaged stream by weighting the peak flow from the gaging station with the peak flow from a regression equation. A different approach is given (equation 9) for sites where the explanatory variables, drainage area (Regions 2, 3, 5, 6, and 7), or drainage area and slope (Regions 1 and 4), are outside the range of the variables used in the development of the regression equations (see table 4 and fig. 6). This range is two-dimensional for Regions 1 and 4. Another approach (equation 10) is provided for ungaged sites located between two gaging stations.

Table 4. Range in values of the basin characteristics used as explanatory variables in the regional peak-flow-regression equations for Kentucky
[--, not applicable]

Region	Total drainage area (square miles)	Main-channel slope (feet per mile)
1	0.16 - 1,197	3.49 - 206
2	.09 - 1,232	--
3	.59 - 722	--
4	.26 - 960	3.60 - 343
5	.24 -1,299	--
6	.22 - 757	--
7	.10 - 706	--

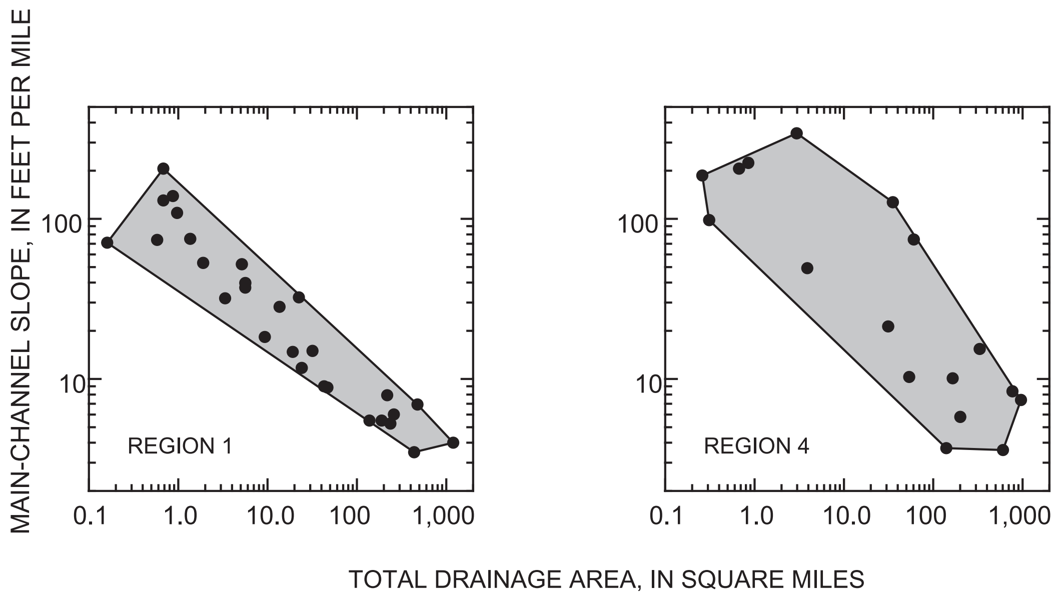


Figure 6. Total drainage area and main-channel slope sampling spaces for the peak-flow regression equations for Regions 1 and 4 in Kentucky.

Application of the equations in this section is based on the assumption that the river is contained completely in one of the seven regions of Kentucky. If a basin spans more than one region, the appropriate equations in this section should be used by computing peak flows, assuming all of the basin is in one of the regions. The peak flows then should be recomputed assuming all of the basin is in the other region (or regions, if there are more than two). Final peak flows should be computed as a weighted average of the peak flows, with weights corresponding to the fraction of the basin in each region. Peak-flow estimates for ungaged sites in basins with drainage from adjacent States can be made similarly by an area weighting of the regression estimate for Kentucky with the regression estimate for the adjacent State. Peak-flow estimating equations for West Virginia (Wiley and others, 2000), Virginia (Bisese, 1995), and Tennessee (Law and Tasker, in press) have been published by the USGS and cooperating agencies.

$$Q_{uf} = Q_r(W_r) + Q_u(1 - W_r)\,, \tag{5}$$

where

Q_{uf} is the final weighted peak flow for a given recurrence interval (for example, the 50-year peak flow) for an ungaged site on a gaged stream, and

Q_r is the regression estimate of the peak flow, at the ungaged site, for a given recurrence interval (for example, the 50-year peak flow) from table 3 in the section of this report titled “Estimating Peak Flows for Ungaged, Unregulated Streams in Rural Drainage Basins” (page 25), for the appropriate region.

W_r is a weighting factor; for

$$A_u > A_g,\ W_r = (A_u/A_g) - 1,\ \text{and for} \tag{6}$$

$$A_u < A_g,\ W_r = (A_g/A_u) - 1\,, \tag{7}$$

where

A_u is the total drainage area at the ungaged site, and

A_g is the total drainage area at the gaging station.

$$Q_u = Q_w(A_u/A_g)^b, \quad (8)$$

where

Q_w is the weighted-average peak flow for a given recurrence interval (such as the 50-year peak flow) for the gaging station from table 1 (page 33) in the section of this report titled “Estimates of Peak Flows at USGS Streamflow-Gaging Stations,” page 19 (or from possible future reports), and

b is the coefficient (exponent) for the drainage-area-only regression equation for the region and for the appropriate recurrence interval (table 5).

If explanatory variables are outside the two-dimensional range of the variables used for the regression equations (Regions 1 and 4; fig. 6), or outside the range of drainage areas (Regions 2, 3, 5, 6, and 7; table 4) then

$$Q_{uf} = Q_w(A_u/A_g)^b, \quad (9)$$

where

Q_{uf} is the final weighted peak flow for a given recurrence interval (for example, the 50-year peak flow) for an ungaged site on a gaged stream, and

Q_w is the weighted-average peak flow for a given recurrence interval (such as the 50-year peak flow) for the gaging station from table 1 (page 33) in the section of this report titled “Estimates of Peak Flows at USGS Streamflow-Gaging Stations,” page 19, (or from possible future reports). If the weighted-average peak flow is not available, the gaging-station peak flow should be used.

A_u, A_g, and b were defined in equations 6, 7, and 8.

If the ungaged site is located between two gaging stations, then the log base-10 interpolated peak-flow estimate may be calculated using equation 10, then detransformed from logs ($Q_{ui} = 10^{\log Q_{ui}}$).

$$\log Q_{ui} = \log Q_{w1} + ((\log Q_{w2} - \log Q_{w1}) (\log A_u - \log A_{g1})/(\log A_{g2} - \log A_{g1})), \quad (10)$$

where

Q_{ui} is the interpolated peak flow for a given recurrence interval (for example, the 50-year peak flow) for an ungaged site located between two gaging stations,

Q_{w1} and Q_{w2} are the weighted-average peak flows for a given recurrence interval (such as the 50-year peak flows) at the upstream and downstream gaging stations, respectively, from table 1 (page 33) discussed in the section of this report titled, “Estimates of Peak Flows at USGS Streamflow-Gaging Stations” (page 19),

A_u is the total drainage area at the ungaged stream site, and

A_{g1} and A_{g2} are the total drainage areas at the upstream and downstream gaging stations, respectively.

Table 5. Coefficients (exponents) of the drainage-area-only regional peak-flow regression equations for Kentucky

Recurrence interval (years)	Region						
	1	2	3	4	5	6	7
2	0.673	0.728	0.748	0.824	0.704	0.600	0.623
5	.651	.721	.712	.803	.692	.586	.616
10	.642	.715	.692	.794	.686	.578	.613
25	.634	.709	.670	.786	.682	.569	.610
50	.629	.704	.656	.783	.679	.564	.610
100	.625	.699	.643	.780	.677	.559	.609
200	.622	.695	.632	.778	.676	.555	.610
500	.618	.690	.620	.776	.674	.551	.610

Limitations of the Technique

This technique is applicable to ungaged sites on gaged, unregulated streams in rural drainage basins that range from 50 to 200 percent of the drainage area of the gaging station(s), except for sites that are plus or minus 3 percent of the drainage area. For ungaged sites within 3 percent of the gaging-station drainage area, the weighted-average peak-flow estimates (table 1, page 33) should be used. If the difference in drainage areas is less than 3 percent and the weighted-average peak-flow estimate is not available for the station, the gaging-station peak-flow estimate from table 1 should be used.

This method is not applicable to urbanized drainage basins, to regulated streams, or to sites affected by diversion (see "Choosing the Appropriate Peak-Flow Estimation Technique," page 18, for definitions of these terms); neither is it applicable if the area between the ungaged site and the gaging station(s) is urbanized nor contains regulation (utilizing the same definitions of urbanized and regulated recently referred to, but using drainage-area difference instead of drainage area in these definitions).

Estimating Peak Flows for Ungaged, Unregulated Streams in Rural Drainage Basins

Peak flows for ungaged drainage basins for selected recurrence intervals generally are estimated by rainfall-runoff procedures or by regression-based procedures. Newton and Herrin (1982) analyzed various procedures of both types. The rainfall-runoff models that they analyzed, including the Natural Resources Conservation Service TR-20 and TR-55 models, the USCOE HEC-1 model, and the rational method, were not calibrated to at-site flow data. Newton and Herrin (1982) concluded that certain regression-based methods (specifically, the USGS State-regression equations and index-flood methods) are the most accurate and reproducible procedures for estimating peak flows for given recurrence intervals.

Regression equations are used in this section of the report to compute peak-flow estimates for ungaged, unregulated streams in rural drainage basins in Kentucky. The response (dependent) variables used in developing the regression equations were the peak flows computed at USGS gaging stations and the explanatory (independent) variables were drainage-basin characteristics such as drainage area and stream slope.

Application of the Technique

Peak-flow regression equations for recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years are presented in table 3 (page 15). The variables used in the equations are described in the text that follows. The average standard error of prediction and other measures of error are discussed in the section of this report titled "Limitations and Accuracy of the Technique."

All of the regression equations in this report are statistical models. These models are not based directly on rainfall-runoff processes. For this reason, when applying these equations, the explanatory variables should be computed by the same techniques that were used in the development of the equations. The use of "more accurate" techniques of computing the explanatory variables will result in peak-flow estimates of unknown accuracy.

Definitions of equation variables in table 3:

Q_T – Peak flow—The calculated peak flow, in ft^3/s, for recurrence interval T (T = 2, 5, 10, 25, 50, 100, 200, or 500 years).

TDA – Total drainage area—The total area, measured in mi^2 on a horizontal plane, of a drainage basin. Total drainage area includes all enclosed subbasins characterized by internal drainage, for example, sinkholes in karst terrain. The drainage area can be determined from a number of sources. Bower and Jackson (1981) lists drainage areas measured from paper USGS topographic quadrangle maps (1:24,000 scale within Kentucky and 1:62,500 scale outside Kentucky) at selected points for many streams in Kentucky. Drainage areas can be computed by digitizing the area of a drainage basin, after delineating the drainage-basin boundaries on 1:24,000-scale topographic quadrangle maps. Drainage areas also can be computed from geographic information system (GIS) 1:24,000-scale map coverages. The drainage areas for the 238 streamflow-gaging stations used in the development of the Kentucky regression equations (table 3) were determined by use of either paper or GIS maps of the resolutions cited previously. These values are listed in table 2 (page 61).

S – Main-channel slope—The slope computed as the difference in elevation between points located at 10 and 85 percent of the main-channel length from the gage, divided by the stream length between these two points (in ft/mi), as determined from USGS 7.5-minute topographic quadrangle maps. The main-channel length is measured along the main-stream channel from the gage to the basin divide, following the longest tributary.

If the drainage basin at a site is located in two (or more) hydrologic regions (plate 1), the peak flow for a given recurrence interval is determined by (1) applying the appropriate estimating equation from table 3 as though the basin is located entirely in each region, and then (2) weighting the two (or more) estimates in proportion to the fraction of the drainage basin in each region (see example 1, page 27).

Limitations and Accuracy of the Technique

The regression equations presented in this section of the report are not applicable to regulated or urbanized drainage basins or drainage basins with diversion. The terms “regulated,” “diversion,” and “urbanized” are defined and the appropriate methodologies for assessing these conditions are described in the section of this report titled “Choosing the Appropriate Peak-Flow Estimation Technique” (page 18).

If the explanatory variables in Regions 1 and 4 (total drainage area and main-channel slope) used in the regression equations in this section are outside the two-dimensional range of the values used to develop the equations (the gray areas on fig. 6, page 23), the accuracy of predictions of peak flows from the equations is unknown and could be reduced substantially. The accuracy of predictions also will be unknown if the total drainage area in Regions 2, 3, 5, 6, and 7 is outside the respective ranges in table 4 (page 22). The further the basin characteristics are outside the sampling space (the gray areas on fig. 6 or the ranges in table 4), the greater the potential for large reductions in the accuracy of the regression equations.

The average standard error of prediction (ASEP) is a measure of how well the regression equations estimate peak flows when they are applied to ungaged drainage basins. The ASEP is the square root of the average variance of prediction at a group of sites with the same basin characteristics as the gaging stations used in development of the regression equations. The standard error of prediction varies from site to site, depending on the values of the explanatory variables (drainage area and main-channel slope for Regions 1 and 4) for each site. The standard error of prediction will be smaller for sites that have explanatory variables near the mean of their range; however, the error associated with the different values of the explanatory variables is a small part of the total standard error of prediction. For this reason, the ASEP can be used as an approximate standard error of prediction for individual sites. The probability that the true value of a peak flow at a study site is between the positive-percent ASEP and the negative-percent ASEP is approximately 68 percent. For example, there is a 68 percent probability that the true 50-year peak flow in Region 1 at an ungaged site ranges from +52.9 to -34.6 percent (table 3, page 15) of the computed peak flow.

The average equivalent years of record is another measure of the overall accuracy of the regression equations. This measure represents the average number of years of gaging-station data needed to determine estimates with accuracy equal to the regression equations. The average equivalent years of record is a function of the accuracy of the regression equations, the recurrence interval, and the average variance and skew of the annual peak flows at gaging stations (Hardison, 1971).

In GLS regression, the average variance of prediction is divided into two parts: the model-error variance and the sampling-error variance. The average standard error of prediction is the square root of the average variance of prediction. The estimated model-error variance and average sampling-error variance from the regression equations in this section of the report are given in table 3. The model-error variance is a measure of the error resulting from an incomplete model if the true values of the estimated peak flows at gaging stations were known at all streams in Kentucky (rather than the sample values that were used). In other words, the explanatory variable (total drainage area and slope for Regions 1 and 4) in the regression equation would not explain all the variation in peak flows from the complete population. The true model-error variance cannot be reduced by additional data collection, although the estimated model-error variance may change if additional data are obtained. The average sampling-error variance for the regression equations is a measure of the error associated with sampling only a subset of the total population of streams in Kentucky (space-sampling error) and sampling only a subset of the total years of data at the gaging stations (time-sampling error). The sampling error can by reduced by collecting more data at existing gaging stations, collecting data at new gaging stations, or some combination of both.

Another overall measure of how well regression equations will estimate flood peaks when applied to ungaged basins is the PRESS statistic. The PRESS statistic is a validation-type statistic. To compute the PRESS statistic, one gaging station is removed from the stations used to develop the regression equation, then the value of the one left out is predicted. The difference between the predicted value from the regression equation and the observed peak flow at that station is computed. The gaging station removed then is changed and the above process repeated until every station has been removed once. The prediction errors then are squared and summed. PRESS/n is analogous to the average variance of prediction, and the square root of PRESS/n is analogous to the average standard error of prediction. Values of the square root of PRESS/n close to the values of the average standard error of prediction provide some measure of validation of the regression equations.

Example Applications of the Estimating Equations

The regional peak-flow estimating equations presented in this report (table 3) can be applied to rural, unregulated streams by (1) determining the basin characteristics required for the appropriate equation, (2) checking to ensure that the basin characteristics are within the range of characteristics used to develop the equations (table 4 and fig. 6), and (3) use of the measured basin-characteristic values with the appropriate equation(s) to compute the estimate.

Example 1—Assume that an estimate of the 100-year peak flow, Q_{100}, is needed for an ungaged stream site in Region 3 with a total drainage area of 600 mi^2, the upper 333 mi^2 (55.5 percent of the basin) of which is located in Region 2. The peak-flow estimate for drainage basins located in two regions is determined by (1) applying the estimating equation as though the basin is located entirely in each region, and then (2) weighting the two estimates in proportion to the basin drainage area in each region, as follows:

For the Region 2 estimate,

$$\begin{aligned} Q_{100} &= 538\ TDA^{0.699}, \\ &= 538\ (600)^{0.699}, \\ &= 47{,}100\ ft^3/s. \end{aligned}$$

For the Region 3 estimate,

$$\begin{aligned} Q_{100} &= 1{,}100\ TDA^{0.643}, \\ &= 1{,}100\ (600)^{0.643}, \\ &= 67{,}300\ ft^3/s. \end{aligned}$$

The area-weighted regression estimate for the ungaged site is

$$Q_{100} = 0.555\ (47{,}100) + 0.445\ (67{,}300) = 56{,}100\ \mathrm{ft}^3/\mathrm{s}.$$

Example 2—Assume the 600 mi^2 ungaged, unregulated stream site in example 1 is located downstream from a gaging station with a total drainage area of 466 mi^2. In this case, a weighting of the regression estimate of Q_{100} at the ungaged site with the Q_{100} value at the adjacent gaging station by use of equation 5 is appropriate. The drainage area of the ungaged site is less than 200 percent of the drainage area at the gaging station ((600/466)100 = 129 percent), as required for use of equation 5. Again, when the ungaged drainage basin is located in two or more regions, the peak-flow estimate (using equation 5 in this case) is determined by (1) applying the estimating equation as though the basin is located entirely in each region, and then (2) weighting the two estimates in proportion to the basin drainage area in each region as

$$Q_{uf} = Q_r(W_r) + Q_u(1 - W_r),$$

For the Region 2 estimate,

Q_r = 47,100 ft^3/s, the regression estimate at the ungaged site, as determined in example 1, and

Q_u = $Q_w(A_u / A_g)^b$, where Q_w is the weighted 100-year peak-flow estimate at the gaging station, listed in table 1 (page 33), and b is the exponent of the drainage-area-only regression equation for Region 2 (table 5),

Assume Q_w is 50,700 ft^3/s at the upstream gaging station (table 1) and b is 0.699 for the 100-year peak flow in Region 2 (table 5). Therefore, the gaging station peak-flow estimate “translated” downstream to the ungaged site is

Q_u = 50,700(600/466)$^{0.699}$ = 60,500 ft^3/s.

For $A_u > A_g$, $W_r = (A_u / A_g) - 1$, or

W_r = (600/466)-1 = 1.288 - 1 = 0.288.

The gage-weighted peak-flow estimate at the ungaged site in Region 2 is computed by use of equation 5 as

Q_{uf} = 47,100 (0.288) + 60,500 (1 - 0.288) = 56,600 ft^3/s.

For the Region 3 estimate,

Q_r = 67,300 ft^3/s, the regression estimate at the ungaged site, as determined in example 1, and

Q_u = $Q_w(A_u / A_g)^b$, where Q_w is the weighted 100-year peak-flow estimate at the gaging station (50,700 ft^3/s), and b is the exponent of the drainage-area-only regression equation for Region 3, 0.643 (table 5),

The gage peak-flow estimate “translated” downstream to the ungaged site is

Q_u = 50,700(600/466)$^{0.643}$ = 59,600 ft^3/s.

W_r = 0.288, as determined previously.

The gage-weighted peak-flow estimate at the ungaged site in Region 3 is computed by use of equation 5 as

Q_{uf} = 67,300 (0.288) + 59,600 (1 - 0.288) = 61,800 ft^3/s.

The final estimate is an area-weighted average of these Region 2 and Region 3 estimates,

Q_{uf} = 0.555 (56,600) + 0.445 (61,800) = 58,900 ft^3/s.

Example 3—Assume the 600 mi^2 ungaged, unregulated stream site in example 2 also is located upstream from a gaging station that has a total drainage area of 1,101 mi^2. In this case, a logarithmic interpolation is used between the peak flows at the gaging stations based on the drainage area at the ungaged site and at the two gages. The logarithmically interpolated peak-flow estimate may be calculated by use of equation 10 as

$$\log Q_{ui} = \log Q_{w1} + ((\log Q_{w2} - \log Q_{w1}) (\log A_u - \log A_{g1}) / (\log A_{g2} - \log A_{g1})),$$

log Q_{ui} = log 50,700 + ((log 70,000 - log 50,700) (log 600 - log 466) / (log 1101 - log 466)),

log Q_{ui} = 4.7462

Q_{ui} = $10^{4.7462}$ = 55,700 ft^3/s.

SUMMARY

Estimates of the magnitude of peak streamflows (such as the 50-year recurrence-interval peak flow) are necessary to safely and economically design bridges, culverts, and other structures that are in or near streams. This report, prepared by the U.S. Geological Survey (USGS) in cooperation with the Kentucky Transportation Cabinet (KTC), will help KTC and others better estimate the magnitude of peak flows for streams in Kentucky.

This report gives estimates of, and presents techniques for estimating, the magnitude of peak flows for streams in Kentucky for recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years. The recurrence interval is the long-term average period of time between peak flows that are equal to or greater than a specified peak flow.

Various peak-flow studies have been published for all or parts of Kentucky since 1958 (McCabe, 1958, 1962; Speer and Gamble, 1964, 1965; Hannum, 1976; Wetzel and Bettandorff, 1986; Choquette, 1988). The estimates and estimating techniques in this report should provide more accurate estimates of rural peak flows for Kentucky than previous reports; data through water year 2000 were used. Advances in techniques for this report included the development of a generalized skew for Kentucky and the use of generalized-least-squares (GLS) regression.

Estimates of peak flows are given for 222 USGS streamflow-gaging stations in Kentucky. In the development of the peak-flow estimates at gaging stations, a new generalized skew coefficient was calculated for Kentucky. This single statewide value of 0.011 (with a standard error of prediction of 0.520) is more appropriate for Kentucky than the national skew isoline map in Bulletin 17B of the Interagency Advisory Committee on Water Data.

Regression equations are presented to estimate the peak flows for ungaged, unregulated streams in rural drainage basins. These equations were developed by use of GLS-regression procedures using data from 238 USGS gaging stations in and near Kentucky. The State was divided into seven hydrologic regions; separate regression equations were created for each region. Total drainage area was the final basin characteristic used for five of the regions while total drainage area and main-channel slope were used for the other two regions.

A section of the report describes techniques for estimating peak flows for ungaged sites on gaged, unregulated streams in rural drainage basins. Another section references two previous USGS reports for peak-flow estimates on ungaged, unregulated, urban streams. Estimating peak flows at ungaged sites on regulated streams is beyond the scope of this report, because peak flows on regulated streams are dependent on variable human activities.

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Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval							
							2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03207965	Grapevine Creek near Phyllis	6.20	1974-82, 1989-91, 1995-2000	U	---	G	696	1,090	1,360	1,700	1,940	2,190	2,430	2,740
						R	574	891	1,120	1,430	1,680	1,930	2,190	2,540
						W	678	1,050	1,290	1,610	1,840	2,080	2,320	2,650
03208000	Levisa Fork below Fishtrap Dam, near Millard	392	COE	R6	Fishtrap Lake, 10/68	G	1,500	1,500	1,500	NC	1,500	1,890	NC	NC
03209300	Russell Fork at Elkhorn City	554	COE	R6	Flannagan Lake, 12/63; North Fork Pound Lake, 08/66	G	19,800	29,100	37,600	NC	56,700	66,500	78,200	96,800
03209500	Levisa Fork at Pikeville	1,232	COE	R6	Flannagan Lake, 12/63; North Fork Pound Lake, 08/66; Fishtrap Lake, 10/68	G	21,600	27,400	32,700	NC	51,100	60,900	71,600	88,000
03209575	Bill D. Branch near Kite	3.17	1976-86	U	---	G	282	426	538	698	833	982	1,150	1,390
						R	352	549	694	891	1,050	1,210	1,370	1,600
						W	295	458	589	776	928	1,090	1,260	1,500
03209800	Levisa Fork at Prestonsburg	1,702	COE	R6	Flannagan Lake, 12/63; North Fork Pound Lake, 08/66; Fishtrap Lake, 10/68	G	24,600	31,200	37,000	NC	60,600	74,400	90,000	115,000
03210000	Johns Creek near Meta	56.3	1938-39, 1942-93, 1995-2000	U	---	G	2,630	4,100	5,050	6,220	7,050	7,850	8,620	9,610
						R	2,860	4,370	5,430	6,850	7,920	9,000	10,100	11,600
						W	2,640	4,120	5,090	6,290	7,170	8,030	8,870	9,970
[b]03211500	Johns Creek near Van Lear	206	1951-92	R6	Dewey Lake, 05/50	G	2,900	3,350	3,580	3,820	3,970	NC	NC	NC
03212000	Paint Creek at Staffordsville	103	1950-81	U	---	G	5,200	8,920	11,500	14,900	17,500	20,000	22,500	25,800
						R	4,440	6,760	8,360	10,500	12,100	13,700	15,400	17,700
						W	5,150	8,680	11,100	14,000	16,200	18,400	20,500	23,400

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval							
							2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03212500	Levisa Fork at Paintsville	2,144	COE	R6	Dewey Lake, 05/50; Flannagan Lake, 12/63; North Fork Pound Lake, 08/66; Fishtrap Lake, 10/68; Paintsville Lake, 09/83	G	28,900	34,600	39,000	NC	53,600	61,000	69,800	82,000
03215000	Big Sandy River at Louisa	3,897	COE	R5	Dewey Lake, 05/50; Flannagan Lake, 12/63; North Fork Pound Lake, 08/66; Fishtrap Lake, 10/68	G	48,800	63,800	76,000	NC	104,900	118,700	133,000	152,000
03215500	Blaine Creek at Yatesville	217	1916-20, 1938-84	U	---	G	6,010	8,890	11,100	14,200	16,800	19,700	22,800	27,300
						R	7,630	11,600	14,200	17,800	20,500	23,100	25,900	29,500
						W	6,060	9,010	11,300	14,500	17,200	20,100	23,200	27,600
03216000	Ohio River at Ashland	60,750	COE	NC	Various	G	351,000	410,000	451,000	505,000	545,000	587,000	632,000	697,000
03216350	Little Sandy River below Grayson Dam near Leon	196	1969-92	R6	Grayson Lake, 03/68	G	2,450	3,120	3,590	4,220	NC	NC	NC	NC
03216400	Little Sandy River at Leon	255	COE	R6	Grayson Lake, 03/68	G	2,900	3,100	3,400	NC	4,800	5,850	7,000	9,000
03216500	Little Sandy River at Grayson	400	COE	R6	Grayson Lake, 03/68	G	5,900	7,500	9,300	NC	14,500	16,800	19,100	22,100
03216540	East Fork Little Sandy River near Fallsburg	12.2	1973-91	U	---	G	937	1,300	1,560	1,890	2,140	2,400	2,670	3,040
						R	939	1,450	1,820	2,320	2,700	3,090	3,500	4,050
						W	937	1,320	1,600	1,970	2,270	2,570	2,890	3,320
03216563	Mile Branch near Rush	.94	1976-87	U	---	G	192	273	327	395	445	495	546	613
						R	145	229	291	376	444	515	589	691
						W	185	263	317	389	445	503	563	646
03216564	Mile Branch at Coalton	1.61	1977-86	U	---	G	274	372	435	512	567	621	674	744
						R	215	337	427	551	649	751	856	1,000
						W	263	364	433	526	600	676	754	861

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03216600	Ohio River at Greenup Dam near Greenup	62,000	COE	NC	Various	G	359,000	428,000	477,000	538,000	586,000	633,000	684,000	756,000
03216800	Tygarts Creek at Olive Hill	59.6	1957-94	U	---	G	4,910	7,200	8,660	10,400	11,700	12,900	14,100	15,600
						R	2,980	4,550	5,650	7,130	8,250	9,370	10,500	12,100
						W	4,750	6,880	8,180	9,760	10,900	12,000	13,100	14,600
03216901	Trough Camp Creek Tributary near Olive Hill	1.11	1976-85	U	---	G	192	262	312	379	432	488	548	632
						R	164	258	328	423	499	579	661	775
						W	187	261	317	395	460	528	600	700
03217000	Tygarts Creek near Greenup	242	1941-2000	U	---	G	7,090	11,600	15,200	20,300	24,700	29,400	34,700	42,400
						R	8,270	12,500	15,400	19,300	22,100	24,900	27,900	31,800
						W	7,120	11,700	15,200	20,200	24,400	28,800	33,600	40,700
03237900	Cabin Creek near Tollesboro	22.4	1972-91	U	---	G	4,300	5,700	6,530	7,490	8,140	8,750	9,330	10,000
						R	2,530	3,730	6,030	7,850	9,280	10,800	12,400	14,600
						W	4,150	5,470	6,460	7,540	8,330	9,080	9,820	10,800
03238000	Ohio River at Maysville	70,130	COE	NC	Various	G	373,000	447,000	494,000	558,000	604,000	654,000	705,000	775,000
03238030	Lawrence Creek near Maysville	1.90	1975-86	U	---	G	276	458	602	813	992	1,190	1,410	1,730
						R	481	749	943	1,190	1,380	1,570	1,780	2,050
						W	294	495	665	899	1,090	1,290	1,510	1,820
03248500	Licking River near Salyersville	140	1939-92, 1995-97	U	---	G	4,020	6,310	7,960	10,200	11,900	13,700	15,600	18,200
						R	5,550	8,430	10,400	13,100	15,000	17,000	19,100	21,800
						W	4,060	6,390	8,100	10,400	12,200	14,100	16,000	18,700
03249500	Licking River at Farmers	827	1975-94	R6	Cave Run Lake, 12/73	G	4,150	4,610	4,860	5,140	NC	NC	NC	NC

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03250000	Triplett Creek at Morehead	47.5	1941-80, 1989-92	U	---	G	6,390	10,000	12,600	15,800	18,200	20,700	23,100	26,400
						R	2,530	3,870	4,810	6,070	7,030	7,990	9,000	10,300
						W	6,040	9,190	11,100	13,500	15,200	16,900	18,600	21,000
03250080	Jacks Branch near Morehead	.19	1976-85	U	---	G	37.0	61.7	80.1	106	126	147	170	202
						R	45.4	72.2	92.7	121	144	169	194	229
						W	38.1	63.8	83.4	111	132	156	180	214
03250100	North Fork Triplett Creek near Morehead	84.7	1968-94	U	---	G	6,320	8,080	9,090	10,200	11,000	11,700	12,400	13,200
						R	3,850	5,870	7,270	9,150	10,600	12,000	13,500	15,400
						W	6,110	7,820	8,810	10,000	10,900	11,800	12,600	13,700
03250150	Indian Creek near Owingsville	2.43	1975-86	U	---	G	595	943	1,220	1,620	1,950	2,320	2,730	3,340
						R	290	453	574	738	867	1,000	1,140	1,330
						W	541	819	1,010	1,260	1,470	1,680	1,920	2,250
03250620	Johnson Creek Tributary near Fairview	.33	1976-79, 1981-86	U	---	G	87.0	128	156	192	220	248	277	315
						R	67.8	107	138	179	213	248	285	336
						W	83.6	123	150	188	217	248	280	325
[b]03251000	North Fork Licking River near Lewisburg	119	1947-91	U	---	G	5,700	7,590	8,810	10,300	11,400	12,500	13,600	15,100
						R	4,930	7,500	9,270	11,600	13,400	15,200	17,000	19,500
						W	5,680	7,580	8,840	10,400	11,600	12,800	14,000	15,600
03251008	Wells Creek Tributary near Washington	.96	1977-86	U	---	G	82.7	181	269	404	522	655	803	1,020
						R	148	232	295	382	451	523	598	701
						W	91.7	193	277	395	490	590	695	843

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

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Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu- lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval							
							2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03251015	Lees Creek Tributary at Mays Lick	.45	1975-85	U	---	G	87.1	130	164	212	252	296	344	416
						R	85.0	134	172	223	264	308	353	416
						W	86.8	131	166	215	256	300	348	416
03251500	Licking River at McKinneysburg	2,326	1975-94, 1997	R6	Cave Run Lake, 12/73	G	25,600	36,200	44,400	56,200	NC	NC	NC	NC
03252000	Stoner Creek at Paris	239	1954-91	U	---	G	8,100	11,400	13,700	16,600	18,900	21,200	23,500	26,700
						R	8,190	12,400	15,300	19,100	21,900	24,700	27,700	31,600
						W	8,100	11,500	13,800	16,900	19,200	21,600	24,100	27,400
[b]03252500	South Fork Licking River at Cynthiana	621	1918-94	U	---	G	17,500	23,600	27,300	31,500	34,300	37,000	39,400	42,500
						R	16,400	24,700	30,200	37,600	42,900	48,200	53,700	61,000
						W	17,500	23,700	27,400	31,800	34,900	37,700	40,500	44,000
03253500	Licking River at Catawba	3,300	COE	R6	Cave Run Lake, 12/73	G	48,500	59,100	67,500	78,200	85,800	93,100	100,000	109,000
03254400	North Fork Grassy Creek near Piner	13.6	1968-83	U	---	G	2,620	4,980	7,180	10,900	14,400	18,700	23,900	32,600
						R	1,810	2,700	3,730	4,720	5,500	6,290	7,130	8,270
						W	2,550	4,650	6,460	9,230	11,700	14,700	18,200	23,900
03255000	Ohio River at Cincinnati, Ohio	76,580	COE	NC	Various	G	437,000	488,000	532,000	608,000	663,000	718,000	772,000	842,000
03277185	Craigs Creek Tributary near Warsaw	.68	1976-86	U	---	G	273	491	657	888	1,070	1,270	1,470	1,750
						R	241	384	731	1,000	1,230	1,460	1,710	2,070
						W	268	466	675	921	1,120	1,330	1,550	1,850
03277200	Ohio River at Markland Dam	83,170	COE	NC	Various	G	449,000	510,000	565,000	645,000	705,000	760,000	816,000	890,000

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03277300	North Fork Kentucky River at Whitesburg	66.4	1957-83, 1999-2000	U	---	G	2,020	3,470	4,630	6,310	7,720	9,270	11,000	13,400
						R	3,220	4,920	6,110	7,700	8,900	10,100	11,400	13,000
						W	2,080	3,600	4,810	6,540	7,950	9,450	11,100	13,300
03277400	Leatherwood Creek at Daisy	40.9	1965-83, 1992-98	U	---	G	2,770	4,590	5,880	7,530	8,770	10,000	11,300	12,900
						R	3,000	4,990	6,490	8,580	10,200	12,000	13,800	16,400
						W	2,810	4,710	6,120	8,070	9,620	11,200	12,900	15,200
03277450	Carr Fork near Sassafras	60.6	1983-94	R6	Carr Fork Lake, 01/76	G	664	802	883	NC	NC	NC	NC	NC
[c]03277500	North Fork Kentucky River at Hazard	466	1940-92	R5	Carr Fork Lake, 01/76	G	18,000	27,800	34,200	41,900	47,500	52,800	58,000	64,700
						R	14,800	22,400	27,600	34,500	39,600	44,600	49,800	57,000
						W	17,800	27,300	33,300	40,500	45,700	50,700	55,700	62,400
03277630	Brier Fork near Hazard	1.32	1976-85	U	---	G	245	388	499	659	792	938	1,100	1,340
						R	230	433	603	860	1,080	1,310	1,570	1,950
						W	239	410	558	787	983	1,200	1,430	1,770
03278000	Bear Branch near Noble	2.21	1955-82	U	---	G	243	380	476	603	700	799	900	1,040
						R	271	423	536	690	811	937	1,070	1,250
						W	246	385	486	621	726	834	946	1,100
03278500	Troublesome Creek at Noble	177	1950-81	U	---	G	9,280	15,300	19,400	24,500	28,300	32,000	35,700	40,400
						R	6,580	9,980	12,300	15,400	17,700	20,100	22,500	25,600
						W	9,120	14,700	18,400	22,900	26,200	29,300	32,500	36,600
[c]03280000	North Fork Kentucky River at Jackson	1,101	1905-07, 1917-21, 1927-31, 1935-2000	R5	Carr Fork Lake, 01/76	G	23,800	35,700	43,600	53,400	60,600	67,700	74,700	83,900
						R	28,200	42,000	51,200	63,300	72,100	80,700	89,700	102,000
						W	23,900	36,100	44,200	54,600	62,300	70,000	77,500	87,500

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03280600	Middle Fork Kentucky River near Hyden	202	1957-92	U	---	G	12,600	21,900	29,500	40,600	49,900	60,200	71,600	88,400
						R	9,910	15,500	19,600	25,000	29,200	33,400	37,800	44,100
						W	12,100	20,200	25,800	32,500	37,500	42,600	48,200	56,600
03280700	Cutshin Creek at Wooton	61.3	1958-2000	U	---	G	4,500	7,580	9,940	13,300	16,000	18,900	22,100	26,600
						R	4,060	6,650	8,590	11,300	13,300	15,500	17,800	21,000
						W	4,440	7,360	9,500	12,400	14,600	17,000	19,500	23,100
03280728	Bull Creek near Hyden	1.84	1976-86	U	---	G	270	432	564	761	931	1,120	1,340	1,670
						R	295	548	759	1,070	1,340	1,630	1,940	2,390
						W	279	485	670	956	1,200	1,470	1,760	2,180
03280900	Middle Fork Kentucky River at Buckhorn	420	1962-75	R6	Buckhorn Lake, 12/60	G	4,370	5,320	5,930	6,700	NC	NC	NC	NC
03280935	Stamper Fork at Canoe	1.57	1975-86	U	---	G	154	336	516	824	1,120	1,490	1,940	2,690
						R	262	489	680	966	1,210	1,470	1,760	2,170
						W	184	397	597	909	1,180	1,470	1,810	2,310
03281000	Middle Fork Kentucky River at Tallega	537	COE	R6	Buckhorn Lake, 12/60	G	4,660	5,900	7,040	9,260	11,000	13,400	NC	NC
03281040	Red Bird River near Big Creek	155	1973-2000	U	---	G	11,500	16,700	20,500	25,700	29,800	34,200	38,800	45,300
						R	8,130	12,900	16,300	21,000	24,500	28,200	32,000	37,400
						W	10,600	15,300	18,500	22,800	26,200	29,800	33,700	39,200
[b]03281100	Goose Creek at Manchester	163	1965-2000	U	---	G	8,600	13,600	17,600	23,300	28,100	33,400	39,400	48,200
						R	8,440	13,300	16,900	21,700	25,400	29,100	33,000	38,600
						W	8,570	13,500	17,300	22,500	26,600	30,900	35,400	41,900

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03281200	South Fork Kentucky River at Oneida	486	1957-82	U	---	G	20,800	31,500	38,900	48,500	55,800	63,300	70,800	81,200
						R	19,100	29,000	36,000	45,100	51,900	58,700	65,800	76,000
						W	20,500	30,800	37,800	46,800	53,500	60,400	67,600	77,400
03281500	South Fork Kentucky River at Booneville	722	1926, 1928-31, 1939-2000	U	---	G	22,800	34,800	43,400	54,800	63,600	72,700	82,200	95,200
						R	25,700	38,500	47,400	58,700	67,300	75,800	84,600	97,100
						W	22,900	35,200	44,000	55,700	64,700	73,800	83,100	95,800
03282000	Kentucky River at Lock 14 at Heidelberg	2,657	COE	R6	Buckhorn Lake, 12/60; Carr Fork Lake, 01/76	G	53,400	69,200	79,500	94,000	105,000	116,000	127,000	142,000
03282198	Clear Creek Tributary near West Irvine	.59	1975-85	U	---	G	148	258	343	463	560	663	773	930
						R	126	244	346	501	635	784	946	1,180
						W	140	252	345	485	606	739	884	1,090
03282500	Red River near Hazel Green	65.8	1955-2000	U	---	G	2,060	3,220	4,140	5,490	6,640	7,920	9,340	11,500
						R	3,200	4,890	6,070	7,650	8,840	10,000	11,300	13,000
						W	2,090	3,290	4,260	5,680	6,870	8,170	9,600	11,700
03283000	Stillwater Creek at Stillwater	24.0	1955-83	U	---	G	2,090	3,700	4,930	6,660	8,040	9,510	11,100	13,200
						R	1,540	2,360	2,950	3,740	4,350	4,960	5,600	6,460
						W	2,050	3,540	4,620	6,040	7,130	8,260	9,430	11,100
03283305	Middle Fork Red River at Zachariah	.58	1975-85	U	---	G	144	176	198	225	246	266	287	315
						R	102	161	206	267	316	368	421	495
						W	136	173	200	240	272	307	343	393
03283500	Red River at Clay City	362	1931-32, 1937-2000	U	---	G	8,850	13,600	16,700	20,800	23,700	26,600	29,500	33,400
						R	11,100	16,700	20,500	25,600	29,400	33,100	36,900	42,000
						W	8,900	13,700	17,000	21,100	24,200	27,300	30,300	34,400

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval							
							2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03283610	Lulbegrud Creek Tributary near Westbend	.33	1975-86	U	---	G	49.1	75.9	94.4	118	136	154	172	197
						R	67.8	107	138	179	213	248	285	336
						W	51.2	81.2	104	134	159	184	210	246
03284000	Kentucky River at Lock 10 near Winchester	3,955	COE	R6	Buckhorn Lake, 12/60 Carr Fork Lake, 01/76	G	58,100	69,000	76,100	85,000	91,300	97,200	103,000	109,000
03284300	Silver Creek near Kingston	28.6	1968-83	U	---	G	3,040	5,290	6,940	9,130	10,800	12,600	14,300	16,700
						R	2,300	3,870	5,070	6,750	8,090	9,500	11,000	13,100
						W	2,820	4,690	5,950	7,600	8,910	10,300	11,800	13,900
03284310	Silver Creek near Berea	53.4	1959, 1961-62, 1965-67, 1971-72, 1974-83	U	---	G	3,550	5,860	7,680	10,300	12,500	14,900	17,600	21,500
						R	3,660	6,030	7,810	10,300	12,200	14,200	16,300	19,300
						W	3,580	5,910	7,730	10,300	12,300	14,400	16,700	19,800
03284340	Old Town Branch Tributary near Richmond	1.83	1976-85	U	---	G	297	502	668	913	1,120	1,360	1,620	2,010
						R	294	546	757	1,070	1,330	1,620	1,930	2,390
						W	296	522	715	1,010	1,260	1,540	1,840	2,270
03284500	Kentucky River at Lock 8 near Camp Nelson	4,414	1911-71	R5	Buckhorn Lake, 12/60; Carr Fork Lake, 01/76	G	62,300	79,900	89,600	100,000	107,000	113,000	119,000	126,000
03285000	Dix River near Danville	318	1943-2000	U	---	G	14,000	21,000	26,000	32,900	38,400	44,200	50,300	58,900
						R	13,900	21,500	26,800	33,900	39,300	44,700	50,400	58,400
						W	14,000	21,000	26,200	33,200	38,700	44,400	50,300	58,500
03285500	Dix River near Burgin	395	1912-13, 1915-22	U	Inundated by Herrington Lake, 11/25	G	20,300	26,500	30,500	35,500	39,100	42,700	46,400	51,200
						R	16,400	25,100	31,200	39,200	45,300	51,400	57,800	66,800
						W	18,900	25,800	30,900	38,000	43,600	49,500	55,500	63,600
03287000	Kentucky River at Lock 6 near Salvisa	5,102	COE	R5	Herrington Lake, 11/25; Buckhorn Lake, 12/60; Carr Fork Lake, 01/76	G	68,800	83,100	93,200	106,200	116,000	125,000	134,000	145,000

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval							
							2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03287128	Tanners Creek at Mortonsville	1.26	1976-87	U	---	G	161	292	402	570	717	884	1,070	1,360
						R	180	282	359	463	546	632	722	846
						W	164	290	391	534	652	779	916	1,110
03287500	Kentucky River at Lock 4 at Frankfort	5,411	COE	R5	Herrington Lake, 11/25; Buckhorn Lake, 12/60; Carr Fork Lake, 01/76	G	68,800	80,000	88,200	98,200	105,600	111,800	118,000	126,000
03287534	South Benson Creek near Frankfort	4.47	1976-86	U	---	G	520	670	764	877	958	1,040	1,110	1,210
						R	452	704	887	1,140	1,330	1,530	1,740	2,030
						W	512	676	789	941	1,060	1,180	1,310	1,470
03288000	North Elkhorn Creek near Georgetown	119	1951-83, 1989-98	U	---	G	4,470	6,280	7,570	9,300	10,700	12,100	13,600	15,700
						R	4,930	7,500	9,270	11,600	13,400	15,200	17,000	19,500
						W	4,480	6,330	7,670	9,490	10,900	12,400	14,000	16,200
03288500	Cave Creek near Fort Spring	2.53	1953-79	U	---	G	113	208	288	408	513	630	762	962
						R	299	467	590	759	892	1,030	1,170	1,370
						W	120	224	314	451	569	698	840	1,050
03289000	South Elkhorn Creek at Fort Spring	24	1951-92, 1998-2000	U	---	G	974	1,480	1,830	2,310	2,680	3,060	3,460	4,000
						R	1,540	2,360	2,950	3,740	4,350	4,960	5,600	6,460
						W	991	1,520	1,910	2,430	2,850	3,280	3,720	4,340
03289300	South Elkhorn Creek near Midway	95.0	1983-2000	U	---	G	3,590	6,070	8,020	10,800	13,200	15,800	18,600	22,800
						R	4,180	6,370	7,890	9,920	11,500	13,000	14,600	16,700
						W	3,630	6,100	8,000	10,600	12,800	15,000	17,400	20,700

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
[b]03289500	Elkhorn Creek near Frankfort	473	1916-20, 1940-83, 1989-2000	U	---	G	12,400	17,100	20,600	25,200	28,900	32,800	36,900	42,800
						R	13,500	20,300	24,900	31,000	35,500	39,900	44,500	50,500
						W	12,400	17,200	20,800	25,600	29,400	33,400	37,600	43,500
03290000	Flat Creek near Frankfort	5.63	1952-87	U	---	G	2,000	3,230	4,200	5,600	6,780	8,080	9,510	11,600
						R	998	1,520	2,070	2,630	3,070	3,510	3,980	4,620
						W	1,950	3,090	3,950	5,180	6,190	7,320	8,550	10,400
03290500	Kentucky River at Lock 2 at Lockport	6,180	COE	R5	Herrington Lake, 11/25; Buckhorn Lake, 12/60; Carr Fork Lake, 01/76	G	71,200	84,200	92,700	103,600	111,000	118,000	124,000	132,000
03290580	Town Creek at New Castle	5.62	1976-86	U	---	G	405	687	914	1,250	1,530	1,840	2,190	2,710
						R	997	1,520	2,000	2,530	2,940	3,360	3,800	4,390
						W	449	782	1,090	1,510	1,850	2,210	2,600	3,150
03291000	Eagle Creek at Sadieville	42.9	1941-83	U	---	G	4,260	5,770	6,810	8,180	9,250	10,400	11,500	13,100
						R	3,920	5,700	5,860	6,980	7,810	8,660	9,520	10,700
						W	4,250	5,760	6,760	8,100	9,140	10,200	11,300	12,900
03291050	South Rays Fork near Corinth	.58	1976-86	U	---	G	216	303	366	453	522	596	675	788
						R	216	346	402	505	583	661	743	851
						W	216	310	375	467	540	616	695	807
03291500	Eagle Creek at Glencoe	437	1915-20, 1928-31, 1939-87, 1989-2000	U	---	G	21,200	29,600	35,400	43,000	48,900	54,900	61,100	69,800
						R	18,700	25,800	27,000	31,800	35,300	39,100	42,800	47,900
						W	21,200	29,500	35,200	42,600	48,300	54,200	60,300	68,800

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03292200	Jeff Branch near Sligo	.87	1976-85	U	---	G	437	601	718	876	1,000	1,130	1,270	1,460
						R	284	450	753	1,010	1,210	1,420	1,650	1,970
						W	409	565	728	916	1,070	1,230	1,390	1,630
03292460	Harrods Creek near LaGrange	24.1	1968-94	U	---	G	3,640	4,660	5,280	6,020	6,550	7,050	7,540	8,170
						R	2,660	3,910	4,060	4,860	5,460	6,070	6,680	7,520
						W	3,600	4,610	5,170	5,890	6,420	6,930	7,430	8,090
03292472	South Fork Harrods Creek near Crestwood	.97	1975-87	U	---	G	227	420	578	813	1,010	1240	1,480	1,840
						R	306	483	740	973	1,160	1,350	1,550	1,830
						W	235	430	611	853	1,050	1,270	1,500	1,840
03294500	Ohio River at Louisville	91,170	COE	NC	Various	G	494,000	553,000	605,000	686,000	750,000	812,000	872,000	952,000
03295000	Salt River near Harrodsburg	41.4	1953-83	U	---	G	3,180	4,790	6,050	7,880	9,410	11,100	13,000	15,800
						R	2,290	3,500	4,360	5,510	6,380	7,260	8,180	9,410
						W	3,130	4,680	5,860	7,510	8,860	10,300	11,900	14,200
[b]03295500	Salt River near Van Buren	196	1939-82	U	---	G	8,930	12,100	14,000	16,300	17,900	19,400	20,800	22,700
						R	7,090	10,700	13,200	16,600	19,100	21,500	24,100	27,500
						W	8,880	12,000	14,000	16,300	18,000	19,600	21,200	23,200
03295845	Bradshaw Creek near Shelbyville	1.36	1976-86	U	---	G	257	573	886	1,430	1,960	2,610	3,410	4,730
						R	384	602	832	1,070	1,260	1,450	1,650	1,920
						W	270	578	872	1,310	1,700	2,150	2,680	3,510
03295890	Brashears Creek at Taylorsville	259	1982-2000	U	---	G	12,100	19,700	25,800	34,700	42,400	50,900	60,400	74,700
						R	13,100	18,400	22,200	27,000	30,500	34,300	38,100	43,300
						W	12,100	19,600	25,400	33,600	40,500	48,000	56,400	68,800

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03296500	Plum Creek near Wilsonville	19.1	1954-80	R5	Various	G	2,890	4,210	5,080	6,160	6,960	7,740	8,520	9,550
						R	2,270	3,360	3,700	4,490	5,080	5,680	6,300	7,130
						W	2,860	4,150	4,940	5,950	6,700	7,450	8,190	9,190
03297000	Little Plum Creek near Waterford	5.15	1954-78, 1980-83	U	---	G	1,440	2,350	3,100	4,220	5,180	6,260	7,480	9,340
						R	940	1,430	2,170	2,810	3,320	3,840	4,390	5,160
						W	1,400	2,270	2,990	4,000	4,870	5,830	6,910	8,540
03297500	Plum Creek at Waterford	31.8	1954-77	R5	Various	G	5,850	8,590	10,400	12,600	14,300	15,900	17,400	19,500
						R	3,200	4,690	5,730	7,060	8,070	9,110	10,200	11,600
						W	5,690	8,240	9,780	11,700	13,200	14,600	16,100	18,100
03297845	Floyds Fork near Crestwood	46.7	1980-1991	U	---	G	3,890	4,890	5,560	6,430	7,080	7,750	8,440	9,380
						R	4,150	6,020	6,250	7,440	8,340	9,250	10,200	11,400
						W	3,910	5,010	5,670	6,620	7,340	8,070	8,810	9,820
03298000	Floyds Fork at Fisherville	138	1945-2000	U	---	G	9,270	14,000	17,800	23,600	28,700	34,500	41,200	51,400
						R	8,600	12,200	12,600	14,800	16,500	18,300	20,100	22,500
						W	9,260	13,900	17,600	23,200	28,000	33,400	39,600	49,200
03298500	Salt River at Shepherdsville	1,197	COE	R6	Taylorsville Lake, 01/83	G	23,100	32,900	40,500	51,500	61,000	71,700	83,800	102,000
03298535	Elm Lick Creek near Clermont	.68	1976-85	U	---	G	139	292	442	701	955	1,270	1,660	2,320
						R	241	384	595	786	939	1,090	1,260	1,490
						W	151	309	479	727	949	1,200	1,500	1,980
03299000	Rolling Fork near Lebanon	239	1939-92	U	---	G	14,900	22,300	27,400	34,200	39,400	44,700	50,100	57,700
						R	12,300	19,300	24,400	31,600	37,100	43,200	49,400	58,100
						W	14,800	22,100	27,200	34,000	39,200	44,500	50,100	57,700

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval							
							2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03300000	Beech Fork near Springfield	85.9	1953-83	U	---	G	5,240	7,210	8,550	10,300	11,600	12,900	14,300	16,100
						R	3,890	5,930	7,340	9,240	10,700	12,100	13,600	15,600
						W	5,170	7,110	8,420	10,100	11,400	12,800	14,100	16,000
03300065	North Prong near Willisburg	1.71	1975-87	U	---	G	608	791	899	1,020	1,110	1,190	1,270	1,370
						R	225	352	446	575	677	783	893	1,040
						W	532	674	753	853	932	1,010	1,100	1,220
[b]03300400	Beech Fork at Maud	436	1973-2000	U	---	G	16,500	22,600	27,000	32,800	37,400	42,300	47,500	54,800
						R	12,700	19,100	23,400	29,200	33,500	37,700	42,000	47,800
						W	16,300	22,300	26,600	32,300	36,800	41,500	46,400	53,200
03300990	Town Creek Tributary at Bardstown	.32	1975-86	U	---	G	57.6	86.4	108	137	160	184	211	248
						R	66.3	105	135	175	208	243	279	328
						W	58.7	89.7	114	148	175	204	235	279
03301000	Beech Fork at Bardstown	669	1940-85, 1998-99	U	---	G	20,000	27,200	31,600	36,800	40,500	43,900	47,200	51,400
						R	17,300	26,000	31,800	39,600	45,200	50,800	56,600	64,200
						W	19,900	27,200	31,600	37,100	40,900	44,700	48,300	53,100
03301500	Rolling Fork near Boston	1,299	1939-2000	U	---	G	27,100	38,600	46,800	57,800	66,500	75,500	85,000	98,300
						R	40,500	62,400	78,100	100,000	117,000	136,000	155,000	182,000
						W	27,600	39,600	48,200	59,800	68,900	78,400	88,400	102,000
03302085	Otter Creek Tributary near Vine Grove	.90	1975-78, 1981-86	U	---	G	189	241	270	304	326	347	366	390
						R	241	406	531	702	839	987	1,140	1,350
						W	202	281	335	402	452	500	546	598
03303280	Ohio River at Cannelton Dam	97,000	COE	NC	Various	G	526,000	586,000	640,000	733,000	800,000	865,000	934,000	1,010,000

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03304500	McGills Creek near McKinney	2.14	1952-79	U	---	G	368	735	1,040	1,470	1,840	2,220	2,640	3,240
						R	444	740	962	1,270	1,510	1,770	2,040	2,420
						W	376	736	1,030	1,440	1,780	2,150	2,540	3,090
03305000	Green River near McKinney	22.4	1952-83	U	---	G	3,990	8,230	11,800	17,300	22,000	27,100	32,800	41,100
						R	2,320	3,760	4,820	6,280	7,440	8,700	9,980	11,800
						W	3,790	7,560	10,700	15,200	19,000	23,200	27,900	34,600
03305500	Green River near Mount Salem	36.3	1954-83	U	---	G	5,080	8,960	11,900	16,100	19,400	23,000	26,800	32,100
						R	3,260	5,250	6,710	8,730	10,300	12,100	13,800	16,300
						W	4,860	8,440	11,100	14,800	17,800	21,000	24,400	29,100
03305559	Carpenter Creek Tributary near Hustonville	.88	1976-85	U	---	G	386	547	654	787	885	982	1,080	1,210
						R	238	400	523	691	826	972	1,120	1,330
						W	340	500	610	754	865	977	1,090	1,250
03305835	Gumlick Creek Tributary near Clementsville	.71	1976-86	U	---	G	240	336	405	497	569	644	724	836
						R	204	345	451	597	714	841	968	1,150
						W	231	339	418	525	610	700	794	926
03306000	Green River near Campbellsville	682	1970-94	R6	Green River Lake, 02/69	G	6,070	7,390	8,210	9,200	NC	NC	NC	NC
03306640	White Oak Creek Tributary near Montpelier	.50	1976-85	U	---	G	222	607	1,000	1,670	2,300	3,050	3,930	5,300
						R	160	270	355	470	563	663	764	909
						W	204	481	726	1,100	1,430	1,810	2,230	2,890
03307000	Russell Creek near Columbia	188	1940-2000	U	---	G	8,790	14,700	19,500	26,700	33,000	40,100	48,100	60,300
						R	10,400	16,400	20,700	26,800	31,500	36,700	42,000	49,400
						W	8,870	14,800	19,600	26,700	32,900	39,800	47,600	59,400

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval							
							2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03307100	Russell Creek near Gresham	265	1965-83	U	---	G	11,400	21,800	31,600	47,900	63,600	82,800	106,000	145,000
						R	13,200	20,800	26,200	33,900	39,800	46,300	53,000	62,300
						W	11,700	21,600	30,500	44,800	58,000	73,700	92,300	123,000
03307500	South Fork Little Barren River at Edmonton	18.3	1942-83	U	---	G	1,780	2,650	3,340	4,380	5,270	6,280	7,430	9,180
						R	2,010	3,270	4,190	5,470	6,490	7,590	8,710	10,300
						W	1,800	2,700	3,420	4,480	5,390	6,410	7,560	9,290
03308500	Green River at Munfordville	1,673	COE	R6	Green River Lake, 02/69	G	23,600	30,500	37,500	48,800	57,100	66,500	77,000	92,900
03309500	McDougal Creek near Hodgenville	5.34	1954-82	U	---	G	860	1,500	2,000	2,740	3,350	4,020	4,760	5,830
						R	846	1,390	1,800	2,360	2,810	3,290	3,790	4,480
						W	859	1,480	1,970	2,680	3,260	3,900	4,590	5,600
03310000	North Fork Nolin River at Hodgenville	36.4	1942-78, 1980-82	U	---	G	4,250	6,790	8,530	10,800	12,400	14,100	15,700	17,900
						R	3,270	5,260	6,720	8,750	10,300	12,100	13,900	16,400
						W	4,160	6,640	8,340	10,500	12,200	13,800	15,500	17,700
[c]03310300	Nolin River at White Mills	357	1960-2000	U	---	G	7,400	11,800	15,200	20,100	24,200	28,800	33,800	41,100
						R	14,900	23,200	29,100	37,300	43,600	50,600	57,700	67,500
						W	7,760	12,400	16,100	21,400	25,700	30,500	35,800	43,400
03310385	Bacon Creek Tributary near Upton	.56	1975-85	U	---	G	200	350	462	613	732	854	981	1,160
						R	181	283	357	457	534	612	691	799
						W	198	337	436	564	662	763	867	1,010
03310400	Bacon Creek near Priceville	85.4	1960-94	U	---	G	1,660	3,080	4,210	5,820	7,140	8,560	10,100	12,300
						R	3,690	5,380	6,520	7,990	9,090	10,200	11,200	12,800
						W	1,710	3,170	4,340	6,000	7,340	8,750	10,200	12,300

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
[c]03310500	Nolin River at Wax	600	1937-62	U	---	G	9,130	13,000	15,600	18,600	20,900	23,100	25,200	28,000
						R	17,600	26,500	32,800	41,300	47,900	54,900	62,100	72,000
						W	9,620	14,000	17,000	20,800	23,600	26,500	29,200	32,800
03310880	Brier Creek Tributary near Ollie	.31	1976-85	U	---	G	104	174	229	311	380	456	540	665
						R	127	200	254	327	382	440	498	577
						W	107	179	236	316	381	449	522	626
03311000	Nolin River at Kyrock	703	1964-90, 1998	R6	Nolin Lake, 03/63	G	7,380	9,610	11,000	12,600	13,700	NC	NC	NC
03311500	Green River at Lock 6 at Brownsville	2,762	COE	R6	Nolin Lake, 03/63; Green River Lake, 02/69	G	28,700	35,900	42,700	53,700	62,700	73,000	84,600	102,000
03311600	Beaverdam Creek at Rhoda	10.9	1973-94	U	---	G	1,440	2,420	3,170	4,240	5,130	6,080	7,110	8,600
						R	1,070	1,610	1,980	2,480	2,850	3,220	3,590	4,100
						W	1,410	2,300	2,940	3,800	4,470	5,180	5,940	7,030
03312000	Bear Creek near Leitchfield	30.8	1950-83	U	---	G	4,670	6,140	7,050	8,140	8,910	9,650	10,400	11,300
						R	2,000	2,960	3,620	4,470	5,110	5,750	6,390	7,270
						W	4,460	5,760	6,510	7,410	8,070	8,720	9,390	10,300
03312500	Barren River near Pageville	531	1940-63	U	---	G	19,000	33,100	44,800	62,500	77,800	95,100	115,000	144,000
						R	21,500	33,600	42,300	54,400	63,800	74,200	84,800	99,600
						W	19,300	33,200	44,500	61,200	75,500	91,400	109,000	136,000
03312795	Little Beaver Creek near Glasgow	.89	1976-79, 1981-86	U	---	G	162	246	308	393	462	534	612	723
						R	240	403	527	696	832	980	1,130	1,340
						W	180	283	362	472	560	653	752	894
03313000	Barren River near Finney	942	1965-80, 1983-94	R6	Barren River Lake, 03/64	G	4,790	5,860	6,590	7,510	8,210	NC	NC	NC

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval							
							2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03313020	Solomon Creek Tributary near Scottsville	.24	1976-84, 1986	U	---	G	86.5	136	172	218	254	291	328	379
						R	95.2	163	215	285	342	403	465	554
						W	88.8	144	185	240	283	327	374	435
03313500	West Bays Fork at Scottsville	7.47	1951-83	U	---	G	1,450	2,090	2,580	3,300	3,910	4,580	5,320	6,430
						R	1,070	1,760	2,270	2,970	3,530	4,140	4,750	5,620
						W	1,400	2,040	2,540	3,250	3,840	4,500	5,220	6,280
03313700	West Fork Drakes Creek near Franklin	110	1969-2000	U	---	G	6,170	9,730	12,500	16,400	19,600	23,100	27,000	32,500
						R	7,110	11,300	14,400	18,600	21,900	25,500	29,300	34,500
						W	6,270	9,920	12,700	16,700	20,000	23,500	27,300	32,900
03313800	Lick Creek near Franklin	21.6	1959-83	U	---	G	2,080	3,780	5,200	7,340	9,200	11,300	13,600	17,200
						R	2,260	3,660	4,700	6,130	7,260	8,490	9,740	11,500
						W	2,100	3,770	5,120	7,130	8,840	10,700	12,900	16,000
03314000	Drakes Creek near Alvaton	478	1940-82	U	---	G	16,100	27,200	36,800	51,800	65,300	81,200	99,800	129,000
						R	20,000	31,200	39,300	50,700	59,400	69,100	79,000	92,700
						W	16,400	27,500	37,000	51,700	64,800	80,000	97,600	125,000
03314500	Barren River at Bowling Green	1,849	COE	R6	Barren River Lake, 03/64	G	19,200	28,100	34,900	45,000	53,100	62,300	72,700	88,500
03314750	Barren River Tributary near Bowling Green	.50	1976-84, 1986	U	---	G	207	357	480	663	820	997	1,190	1,490
						R	160	270	355	470	563	663	764	909
						W	194	331	438	594	725	869	1,030	1,260
03315500	Green River at Lock 4 at Woodbury	5,404	COE	R6	Nolin Lake, 03/63; Barren River Lake, 03/64; Green River Lake, 02/69	G	50,000	60,200	70,300	85,900	98,000	112,000	126,000	148,000

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03316000	Mud River near Lewisburg	90.5	1940-83	U	---	G	5,210	7,290	8,720	10,600	12,000	13,500	15,000	17,100
						R	3,820	5,560	6,750	8,260	9,390	10,500	11,600	13,200
						W	5,160	7,200	8,570	10,400	11,700	13,100	14,500	16,500
03316500	Green River at Paradise	6,183	1970-81, 1992-2000	R6	Nolin Lake, 03/63; Barren River Lake, 03/64; Green River Lake, 02/69	G	44,100	56,900	65,800	77,500	NC	NC	NC	NC
03317000	Rough River near Madrid	225	1937-59	U	---	G	8,790	11,900	13,700	15,900	17,400	18,700	20,100	21,700
						R	6,600	9,490	11,400	13,900	15,700	17,500	19,300	21,700
						W	8,670	11,700	13,500	15,600	17,100	18,500	19,900	21,700
03317500	North Fork Rough River near Westview	42.0	1955-76, 1978-80, 1982-83	U	---	G	2,000	2,840	3,380	4,060	4,550	5,030	5,510	6,140
						R	2,410	3,550	4,330	5,330	6,090	6,840	7,590	8,630
						W	2,020	2,880	3,470	4,210	4,750	5,300	5,830	6,530
03318000	Rough River near Falls of Rough	454	1940-56	U	---	G	8,920	11,600	13,200	15,000	16,200	17,200	18,300	19,600
						R	10,100	14,300	17,100	20,700	23,300	25,900	28,400	32,000
						W	8,990	11,800	13,600	15,800	17,300	18,800	20,100	21,800
03318200	Rock Lick Creek near Glen Dean	20.1	1957-78	U	---	G	2,940	4,480	5,650	7,330	8,720	10,200	11,900	14,400
						R	1,550	2,300	2,830	3,510	4,020	4,530	5,040	5,750
						W	2,830	4,190	5,150	6,440	7,480	8,590	9,800	11,600
03318500	Rough River at Falls of Rough	504	COE	R6	Rough River Lake, 10/59	G	4,120	4,810	5,680	6,900	7,570	8,360	NC	NC
03318505	Pleasant Run Tributary near Falls of Rough	.22	1975-81, 1983-85, 1987	U	---	G	134	209	261	328	378	429	480	549
						R	103	163	208	269	315	363	411	478
						W	130	200	247	309	356	405	454	521

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03318800	Caney Creek near Horse Branch	124	1957-92	U	---	G	5,650	7,910	9,450	11,400	13,000	14,500	16,100	18,200
						R	4,620	6,690	8,090	9,880	11,200	12,500	13,800	15,700
						W	5,610	7,840	9,340	11,300	12,700	14,200	15,800	17,900
03319000	Rough River near Dundee	757	COE	R6	Rough River Lake, 10/59	G	7,900	10,800	13,900	17,900	21,000	24,500	28400	34,400
03319520	West Fork Adams Tributary near Fordsville	.26	1976-86	U	---	G	102	150	181	219	248	275	303	339
						R	114	180	229	296	346	398	451	524
						W	104	154	190	237	273	309	345	392
03320000	Green River at Lock 2 at Calhoun	7,566	COE	R6	Rough River Lake, 10/59; Nolin Lake, 03/63; Barren River Lake, 03/64; Green River Lake, 02/69	G	48,200	55,100	62,900	73,100	80,700	88,800	97,500	110,000
03320500	Pond River near Apex	194	1941-2000	U	---	G	6,990	12,400	16,800	23,300	28,800	35,000	41,800	52,000
						R	7,800	12,200	15,500	20,000	23,800	27,500	31,800	37,500
						W	7,010	12,400	16,700	23,000	28,400	34,300	40,700	50,200
03321465	Rhodes Creek Tributary near Owensboro	.29	1975-79, 1982-86	U	---	G	97.2	159	206	275	331	393	459	557
						R	122	192	244	314	368	423	479	556
						W	100	164	214	284	341	402	466	556
03322000	Ohio River at Evansville, Ind.	107,000	COE	NC	Various	G	593,000	660,000	708,000	785,000	853,000	920,000	989,000	1,080,000
03322360	Beaverdam Creek near Corydon	14.3	1973-82, 1984-87, 1989-94	U	---	G	2,230	2,650	2,870	3,100	3,250	3,380	3,500	3,650
						R	1,260	1,890	2,320	2,890	3,320	3,740	4,170	4,760
						W	2,140	2,550	2,780	3,060	3,260	3,460	3,660	3,900
03382975	Ward Creek at Lewiston	.91	1975-79, 1981-86	U	---	G	337	628	862	1,200	1,490	1,800	2,130	2,620
						R	276	449	580	759	903	1,050	1,210	1,430
						W	326	584	772	1,020	1,220	1,430	1,640	1,940

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval							
							2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
[b]03383000	Tradewater River at Olney	255	1941-83, 1986-2000	U	---	G	3,810	6,080	7,900	10,600	13,000	15,600	18,600	23,100
						R	9,250	14,500	18,300	23,600	28,100	32,400	37,600	44,400
						W	3,900	6,290	8,270	11,300	13,900	16,800	20,100	25,100
03384000	Rose Creek at Nebo	2.10	1952-81	U	---	G	593	847	1,010	1,210	1,350	1,480	1,620	1,790
						R	465	752	968	1,260	1,500	1,740	2,010	2,370
						W	586	840	1,010	1,210	1,370	1,530	1,690	1,900
03384500	Ohio River at Dam 51, at Golconda, Ill.	143,900	COE	NC	Various	G	622,000	762,000	855,000	974,000	1,057,000	1,143,000	1,230,000	1,345,000
03400500	Poor Fork at Cumberland	82.3	1940-92, 2000	U	---	G	3,520	5,680	7,240	9,330	11,000	12,600	14,400	16,800
						R	3,770	5,750	7,120	8,960	10,400	11,700	13,200	15,100
						W	3,530	5,680	7,230	9,290	10,900	12,500	14,200	16,500
03400700	Clover Fork at Evarts	82.4	1960-78, 1981-86	U	---	G	5,720	9,650	12,700	17,000	20,600	24,500	28,700	34,700
						R	5,070	8,210	10,500	13,700	16,200	18,800	21,500	25,300
						W	5,570	9,160	11,700	15,100	17,700	20,500	23,400	27,600
03400800	Martins Fork near Smith	55.8	1980-2000	R6	Martins Fork Lake, 11/78	G	675	983	1,220	1,570	NC	NC	NC	NC
03400990	Clover Fork at Harlan	222	COE	R6	Martins Fork Lake, 11/78	G	4,750	NC	10,400	NC	16,700	19,800	NC	27,700
03401000	Cumberland River near Harlan	374	COE	R6	Martins Fork Lake, 11/78	G	NC	NC	34,700	NC	48,700	53,200	NC	65,800
03401500	Yellow Creek Bypass at Middlesboro	35.3	1941-65, 1967-83	U	---	G	3,150	4,650	5,750	7,280	8,510	9,820	11,200	13,200
						R	2,810	4,160	5,090	6,280	7,190	6,320	7,060	8,100
						W	3,120	4,590	5,640	7,070	8,230	8,900	10,100	11,900
03402000	Yellow Creek near Middlesboro	60.6	1941-2000	R5	Fern Lake	G	4,180	6,260	7,780	9,870	11,500	13,300	15,200	17,900
						R	4,150	6,100	7,450	9,180	10,500	9,630	10,700	12,300
						W	4,180	6,240	7,740	9,760	11,400	12,600	14,300	16,800

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03402020	Shillalah Creek near Page	2.96	1976-86	U	---	G	517	723	851	1,000	1,110	1,210	1,310	1,430
						R	349	545	682	857	988	914	1,030	1,180
						W	468	648	766	923	1,040	1,040	1,140	1,290
03402900	Cumberland River at Pine Street Bridge at Pineville	770	COE	R6	Martins Fork Lake, 11/78; Fern Lake	G	NC	NC	56,300	NC	71,100	76,000	NC	84,800
03403500	Cumberland River at Barbourville	960	COE	R6	Martins Fork Lake, 11/78; Fern Lake	G	NC	NC	47,000	NC	61,800	66,200	NC	74,700
03403910	Clear Fork at Saxton	331	1969-90, 1996-2000	U	---	G	11,100	16,200	19,600	24,000	27,200	30,400	33,600	38,000
						R	14,400	20,800	25,200	30,800	35,000	36,200	40,300	46,000
						W	11,400	17,000	20,800	25,700	29,400	31,900	35,400	40,000
03404000	Cumberland River at Williamsburg	1,607	COE	R5	Martins Fork Lake, 11/78; Fern Lake	G	NC	NC	41,900	NC	54,300	57,400	NC	65,000
03404500	Cumberland River at Cumberland Falls	1,977	COE	R5	Martins Fork Lake, 11/78; Fern Lake	G	NC	NC	51,100	NC	66,700	71,100	NC	80,600
03404820	Laurel River at Municipal Dam near Corbin	140	1974-2000	U	---	G	4,950	7,920	10,200	13,200	15,800	18,400	21,300	25,300
						R	4,870	7,380	9,140	11,300	12,900	18,500	20,600	23,600
						W	4,940	7,830	9,910	12,700	14,900	18,400	21,100	24,800
03404867	Gozey Hollow near Corbin	.31	1976-85	U	---	G	34.0	49.5	59.5	71.6	80.3	88.7	96.8	107
						R	33.7	57.5	74.7	96.3	112	157	177	206
						W	33.9	52.8	66.7	84.4	97.3	123	137	158
03404900	Lynn Camp Creek at Corbin	53.8	1957-2000	U	---	G	2,220	3,470	4,460	5,920	7,160	8,540	10,100	12,400
						R	2,480	3,800	4,720	5,870	6,720	8,780	9,790	11,200
						W	2,250	3,520	4,520	5,910	7,040	8,610	10,000	12,100

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03405000	Laurel River at Corbin	201	1923-24, 1943-73	U	---	G	6,620	10,300	13,000	16,700	19,500	22,400	25,500	29,800
						R	7,460	11,100	13,600	16,800	19,100	24,500	27,300	31,300
						W	6,690	10,500	13,200	16,700	19,400	23,000	26,000	30,200
03405854	Big Hurricane Branch at Conway	1.91	1976-85	U	---	G	523	1,000	1,380	1,920	2,370	2,840	3,350	4,060
						R	303	563	779	1,100	1,370	1,670	1,990	2,450
						W	426	757	996	1,330	1,620	1,930	2,270	2,780
03406000	Wood Creek near London	3.89	1954-86	U	---	G	304	468	572	695	780	860	936	1,030
						R	303	485	615	777	896	1,130	1,270	1,460
						W	304	472	582	718	816	931	1,020	1,150
[c]03406500	Rockcastle River at Billows	604	1937-2000	U	---	G	21,500	30,700	36,700	44,100	49,400	54,600	59,700	66,300
						R	19,200	28,100	34,300	42,100	47,900	59,200	65,900	75,300
						W	21,300	30,500	36,400	43,700	49,100	55,400	60,900	68,100
03407100	Cane Branch near Parkers Lake	.67	1957-86	U	---	G	80.7	157	221	317	400	491	593	744
						R	79.9	131	168	214	248	287	323	374
						W	80.6	151	205	279	340	416	490	596
03407200	West Fork Cave Branch near Parkers Lake	.26	1957-86	U	---	G	39.5	64.2	82.9	109	130	152	176	211
						R	32.7	55.4	71.7	92.2	107	137	155	179
						W	38.6	62.2	79.7	103	122	148	169	200
03407300	Helton Branch at Greenwood	.85	1956-86	U	---	G	51.3	104	145	202	247	294	342	407
						R	101	165	210	268	310	345	389	450
						W	55.9	115	160	221	267	308	355	421

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03407500	Buck Creek near Shopville	165	1953-91	U	---	G	9,230	14,200	17,500	21,700	24,800	27,800	30,900	34,900
						R	6,960	10,300	12,600	15,600	17,700	21,000	23,400	26,800
						W	9,040	13,600	16,500	20,100	22,900	26,200	29,100	33,000
03410500	South Fork Cumberland River near Stearns	954	1943-2000	U	---	G	44,200	61,000	72,000	85,600	95,600	106,000	115,000	128,000
						R	32,600	50,400	63,200	81,200	95,000	110,000	126,000	148,000
						W	43,500	60,400	71,500	85,300	95,600	106,000	116,000	130,000
03411000	South Fork Cumberland River at Nevelsville	1,271	1916-31, 1933-50	U	---	G	50,100	72,200	87,200	106,000	121,000	135,000	150,000	170,000
						R	39,800	61,500	76,900	98,700	115,000	134,000	153,000	179,000
						W	49,200	71,300	86,200	106,000	120,000	135,000	150,000	171,000
03412500	Pitman Creek at Somerset	31.3	1954-83	U	---	G	2,070	2,730	3,120	3,590	3,910	4,210	4,500	4,860
						R	1,750	2,680	3,330	4,150	4,750	5,750	6,430	7,380
						W	2,030	2,720	3,170	3,750	4,170	4,610	5,000	5,500
03413200	Beaver Creek near Monticello	43.4	1969-83, 1990-2000	U	---	G	2,680	4,400	5,760	7,730	9,390	11,200	13,200	16,200
						R	3,700	5,940	7,580	9,870	11,700	13,600	15,600	18,400
						W	2,790	4,580	6,000	8,030	9,730	11,600	13,600	16,600
03413202	Elk Spring Creek near Spann	.57	1976-86	U	---	G	137	279	416	649	875	1,150	1,500	2,070
						R	175	296	388	514	615	724	834	993
						W	145	283	408	606	787	999	1,250	1,630
03413425	Williams Creek Tributary near Cartwright	.76	1976-86	U	---	G	158	193	215	240	258	276	293	315
						R	214	361	473	625	748	880	1,010	1,210
						W	170	228	268	320	359	396	434	485

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval							
							2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03414000	Cumberland River near Rowena	5,790	COE	R6	Cumberland Lake, 12/50; Laurel River Lake, 10/73; Martins Fork Lake, 1/79; Fern Lake	G	NC	NC	40,000	NC	42,500	50,000	NC	90,000
03414102	Bear Creek near Burksville	3.52	1976-86	U	---	G	537	986	1,360	1,910	2,380	2,900	3,480	4,340
						R	631	1,040	1,350	1,780	2,120	2,480	2,860	3,390
						W	558	1,000	1,360	1,870	2,290	2,760	3,260	4,010
03435140	Whippoorwill Creek near Claymour	20.8	1973-91	U	---	G	3,250	4,950	6,230	8,010	9,450	11,000	12,700	15,100
						R	1,940	3,090	3,950	5,120	6,090	7,050	8,150	9,620
						W	3,130	4,720	5,860	7,390	8,610	9,910	11,300	13,300
03437490	South Fork Little River Tributary near Hopkinsville	2.62	1977-86	U	---	G	256	430	560	741	886	1,040	1,200	1,430
						R	534	862	1,110	1,450	1,720	2,000	2,300	2,720
						W	283	489	660	910	1,120	1,340	1,580	1,910
03437500	South Fork Little River at Hopkinsville	46.5	1950-83	U	---	G	2,770	4,380	5,610	7,360	8,800	10,400	12,100	14,500
						R	3,200	5,070	6,460	8,360	9,940	11,500	13,300	15,700
						W	2,790	4,420	5,680	7,470	8,950	10,500	12,300	14,800
03438000	Little River near Cadiz	244	1940-2000	U	---	G	6,520	10,500	13,700	18,700	23,100	28,100	33,800	42,700
						R	9,000	14,100	17,900	23,000	27,300	31,600	36,600	43,200
						W	6,570	10,600	13,900	18,900	23,400	28,400	34,100	42,800
03438070	Muddy Fork Little River near Cerulean	30.5	1969-83	U	---	G	3,530	4,560	5,280	6,210	6,940	7,700	8,480	9,570
						R	2,460	3,910	4,990	6,470	7,690	8,900	10,300	12,100
						W	3,430	4,480	5,230	6,260	7,100	8,000	8,960	10,300

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval							
							2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03438120	North Fork Dryden Creek Tributary near Confederate	.10	1975-85	U	---	G	21.7	31.3	38.2	47.4	54.8	62.5	70.6	82.0
						R	69.8	115	150	197	235	273	314	371
						W	24.7	38.4	50.4	68.7	84.5	102	120	147
03438220	Cumberland River near Grand Rivers	17,600	COE	NC	Various	G	NC	NC	165,000	NC	230,000	260,000	NC	325,000
03610000	Clarks River at Murray	89.7	1952-83	U	---	G	5,830	10,600	14,700	21,300	27,200	34,200	42,400	55,300
						R	4,820	7,590	9,670	12,500	14,800	17,200	19,900	23,500
						W	5,780	10,400	14,200	20,100	25,200	30,900	37,500	47,400
03610200	Clarks River at Almo	134	1983-2000	U	---	G	9,380	14,100	17,600	22,300	26,000	30,000	34,200	40,200
						R	6,200	9,730	12,400	16,000	19,000	21,900	25,400	30,000
						W	9,100	13,600	16,700	21,000	24,300	27,800	31,600	36,900
03610470	York Creek near Benton	.96	1975-87	U	---	G	358	575	731	939	1,100	1,270	1,440	1,670
						R	286	464	599	784	932	1,080	1,250	1,470
						W	350	558	705	900	1,050	1,210	1,370	1,600
03610500	Clarks River near Benton	227	1939-83	U	---	G	9,850	16,800	22,200	29,700	35,900	42,400	49,400	59,500
						R	8,600	13,500	17,100	22,000	26,200	30,200	35,000	41,300
						W	9,810	16,700	21,900	29,100	34,900	41,000	47,500	56,800
03610503	Chestnut Creek near Benton	.82	1975-79, 1981-86	U	---	G	729	1,100	1,340	1,650	1,870	2,090	2,300	2,590
						R	259	421	544	712	847	984	1,130	1,340
						W	644	936	1,100	1,310	1,450	1,600	1,760	1,980
03610545	West Fork Clarks River near Brewers	68.7	1969-83, 1989-94	U	---	G	5,100	7,720	9,480	11,700	13,300	14,900	16,400	18,500
						R	4,090	6,440	8,210	10,600	12,600	14,600	16,900	19,900
						W	5,030	7,610	9,320	11,500	13,200	14,800	16,500	18,900

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
03610820	Clarks River Tributary near Reidland	.13	1975-79, 1981-86	U	---	G	71.4	138	200	301	396	509	644	863
						R	82.2	135	176	232	275	320	369	435
						W	72.8	138	194	278	349	427	512	638
03611260	Massac Creek near Paducah	14.6	1972-2000	U	---	G	1,980	3,260	4,240	5,630	6,770	8,010	9,340	11,300
						R	1,560	2,480	3,180	4,130	4,910	5,680	6,570	7,750
						W	1,960	3,190	4,120	5,410	6,450	7,550	8,730	10,400
07022500	Perry Creek near Mayfield	1.72	1953-65, 1968-87	U	---	G	676	1,060	1,360	1,770	2,100	2,460	2,840	3,400
						R	411	665	856	1,120	1,330	1,540	1,780	2,100
						W	661	1,030	1,300	1,670	1,970	2,280	2,610	3,090
07023000	Mayfield Creek at Lovelaceville	212	1937-77	U	---	G	6,820	9,810	12,000	15,100	17,600	20,200	23,100	27,200
						R	8,240	12,900	16,400	21,100	25,100	29,000	33,600	39,600
						W	6,870	9,930	12,300	15,500	18,200	21,100	24,300	28,800
07023040	Lick Creek Tributary near Kirbyton	.53	1975-85, 1987	U	---	G	193	277	338	419	483	549	619	718
						R	197	322	416	546	649	754	869	1,030
						W	193	284	352	449	528	612	701	826
07023500	Obion Creek at Pryorsburg	36.8	1952-83	U	---	G	3,780	4,950	5,670	6,530	7,140	7,730	8,300	9,040
						R	2,770	4,390	5,600	7,250	8,620	9,980	11,500	13,600
						W	3,730	4,910	5,660	6,610	7,320	8,050	8,780	9,780
07023935	South Fork Bayou De Chien Tributary at Water Valley	.23	1975-87	U	---	G	104	157	192	237	270	303	336	379
						R	117	193	249	328	390	454	522	616
						W	105	162	203	258	301	346	393	457

Table 1. Estimated peak flows for 222 selected U.S. Geological Survey streamflow-gaging stations in Kentucky—*Continued*

[U, unregulated; ---, none known; G, estimate computed from analysis of the observed annual peak flows at the gaging stations; R, estimate computed from regression equation (table 3); W, estimate computed as a weighted average of the gage estimate (G, upper row) and the regression estimate (R, middle row); COE, gaging-station flows computed by the U.S. Army Corps of Engineers; R6, significant regulation (see report for definition); NC, not computed; R5, insignificant regulation (see report for details)]

Station number	Station name	Total drainage area (square miles)	Period of record used (water years[a])	Regu-lation	Source of regulation and start date or type of diversion and location	Code	Peak flow (cubic feet per second) for given recurrence interval: 2 years	5 years	10 years	25 years	50 years	100 years	200 years	500 years
07024000	Bayou De Chien near Clinton	68.7	1940-82, 1985-2000	U	---	G	3,180	4,690	5,700	6,950	7,880	8,790	9,700	10,900
						R	4,090	6,440	8,210	10,600	12,600	14,600	16,900	19,900
						W	3,200	4,750	5,800	7,150	8,170	9,210	10,300	11,700
07024070	Mississippi River at Hickman	922,500	COE	NC	Various	G	996,000	1,260,000	1,415,000	1,587,000	1,719,000	1,798,000	NC	NC

[a]Water year refers to the 12-month period from October 1 through September 30. The water year is designated by the calendar year in which it ends. Periods of systematic record are identified. Information on historic peaks outside the period of systematic record was used at selected stations (see note b).

[b]Station record contains historic peak(s).

[c]Stations having drainage area extending into two or more hydrologic regions. The regression estimates for these stations are obtained by weighting the estimates from the regional equations in proportion to the percentage of the total drainage area in each hydrologic region.

Table 2. Total drainage areas and main-channel slopes for 238 streamflow-gaging stations used to develop the peak-flow regression equations for Kentucky

U.S. Geological Survey gaging-station number	U.S. Geological Survey gaging-station name	Region	Total drainage area (square miles)	Main-channel slope (feet per mile)
03202400	Guyandotte River near Baileysville, West Virginia	2	306	35.2
03203000	Guyandotte River at Man, West Virginia	2	758	12.9
03203600	Guyandotte River at Logan, West Virginia	2	836	10.4
03204500	Mud River near Milton, West Virginia	2	256	4.10
03206600	East Fork Twelvepole Creek near Dunlow, West Virginia	2	38.5	21.7
03207020	Twelvepole Creek Below Wayne, West Virginia	2	300	5.70
03207400	Prater Creek at Vansant, Virginia	2	19.8	119
03207500	Levisa Fork near Grundy, Virginia	2	235	36.6
03207965	Grapevine Creek near Phyllis, Kentucky	2	6.20	129
03208000	Levisa Fork Below Fishtrap Dam, Kentucky	2	392	16.9
03208500	Russell Fork at Haysi, Virginia	2	286	19.3
03208950	Cranes Nest River near Clintwood, Virginia	2	66.5	42.5
03209500	Levisa Fork at Pikeville, Kentucky	2	1,232	11.5
03209575	Bill D Branch near Kite, Kentucky	2	3.17	181
03210000	Johns Creek near Meta, Kentucky	2	56.3	24.3
03211500	Johns Creek near Van Lear, Kentucky	2	206	6.40
03212000	Paint Creek at Staffordsville, Kentucky	2	103	8.25
03213700	Tug Fork at Williamson, West Virginia	2	936	10.2
03215500	Blaine Creek at Yatesville, Kentucky	2	217	3.50
03216500	Little Sandy River at Grayson, Kentucky	2	400	3.70
03216540	East Fork Little Sandy River near Fallsburg, Kentucky	2	12.2	18.3
03216563	Mile Branch near Rush, Kentucky	2	.94	85.0
03216564	Mile Branch at Coalton, Kentucky	2	1.61	74.0
03216800	Tygarts Creek at Olive Hill, Kentucky	2	59.6	17.8
03216901	Trough Camp Creek Tributary near Olive Hill, Kentucky	2	1.11	104
03217000	Tygarts Creek near Greenup, Kentucky	2	242	4.60
03237280	Upper Twin Creek at Mcgaw, Ohio	2	12.2	67.0
03237500	Ohio Brush Creek near West Union, Ohio	2	387	8.30
03237900	Cabin Creek near Tollesboro, Kentucky	1	22.4	32.4
03238030	Lawrence Creek near Maysville, Kentucky	1	1.90	53.1
03238500	White Oak Creek near Georgetown, Ohio	1	218	7.92
03246500	East Fork Little Miami River at Williamsburg, Ohio	1	237	5.27

Table 2. Total drainage areas and main-channel slopes for 238 streamflow-gaging stations used to develop the peak-flow regression equations for Kentucky—*Continued*

U.S. Geological Survey gaging-station number	U.S. Geological Survey gaging-station name	Region	Total drainage area (square miles)	Main-channel slope (feet per mile)
03247100	Paterson Run near Owensville, Ohio	1	3.34	31.9
03247500	East Fork Little Miami River at Perintown, Ohio	1	476	6.93
03248500	Licking River near Salyersville, Kentucky	2	140	4.70
03249500	Licking River at Farmers, Kentucky	2	827	3.29
03250000	Triplett Creek at Morehead, Kentucky	2	47.5	29.4
03250080	Jacks Branch near Morehead, Kentucky	2	.19	164
03250100	North Fork Triplett Creek near Morehead, Kentucky	2	84.7	15.8
03250150	Indian Creek near Owingsville, Kentucky	2	2.43	45.5
03250620	Johnson Creek Tributary near Fairview, Kentucky	2	.33	130
03251000	North Fork Licking River near Lewisburg, Kentucky	2	119	2.60
03251008	Wells Creek Tributary near Washington, Kentucky	2	.96	123
03251015	Lee Creek Tributary at Mays Lick, Kentucky	2	.45	81.2
03252000	Stoner Creek at Paris, Kentucky	2	239	2.40
03252500	South Fork Licking River at Cynthiana, Kentucky	2	621	2.41
03254400	North Fork Grassy Creek near Piner, Kentucky	1	13.6	28.2
03277185	Craigs Creek Tributary near Warsaw, Kentucky	1	.68	206
03277300	North Fork Kentucky River at Whitesburg, Kentucky	2	66.4	19.5
03277400	Leatherwood Creek at Daisy, Kentucky	3	40.9	51.2
03277450	Carr Fork near Sassafras, Kentucky	2	60.6	17.1
03277500	North Fork Kentucky River at Hazard, Kentucky	3	466	7.40
03277630	Brier Fork near Hazard, Kentucky	3	1.32	188
03278000	Bear Branch near Noble, Kentucky	2	2.21	125
03278500	Troublesome Creek at Noble, Kentucky	2	177	8.80
03280000	North Fork Kentucky River at Jackson, Kentucky	2	1,101	4.60
03280600	Middle Fork Kentucky River near Hyden, Kentucky	3	202	24.5
03280700	Cutshin Creek at Wooton, Kentucky	3	61.3	44.6
03280728	Bull Creek near Hyden, Kentucky	3	1.84	203
03280935	Stamper Fork at Canoe, Kentucky	3	1.57	129
03281000	Middle Fork Kentucky River at Tallega, Kentucky	3	537	4.70
03281040	Red Bird River near Big Creek, Kentucky	3	155	16.4
03281100	Goose Creek at Manchester, Kentucky	3	163	13.7
03281200	South Fork Kentucky River at Oneida, Kentucky	3	486	7.60
03281500	South Fork Kentucky River at Booneville, Kentucky	3	722	5.10

Table 2. Total drainage areas and main-channel slopes for 238 streamflow-gaging stations used to develop the peak-flow regression equations for Kentucky—*Continued*

U.S. Geological Survey gaging-station number	U.S. Geological Survey gaging-station name	Region	Total drainage area (square miles)	Main-channel slope (feet per mile)
03282198	Clear Creek Tributary near West Irvine, Kentucky	3	0.59	149
03282500	Red River near Hazel Green, Kentucky	2	65.8	9.90
03283000	Stillwater Creek at Stillwater, Kentucky	2	24.0	23.6
03283305	Middle Fork Red River at Zachariah, Kentucky	2	.58	160
03283500	Red River at Clay City, Kentucky	2	362	6.00
03283610	Lulbegrud Creek Tributary near Westbend, Kentucky	2	.33	105
03284300	Silver Creek near Kingston, Kentucky	3	28.6	22.2
03284310	Silver Creek near Berea, Kentucky	3	53.4	11.0
03284340	Old Town Branch Tributary near Richmond, Kentucky	3	1.83	61.9
03285000	Dix River near Danville, Kentucky	3	318	4.10
03285500	Dix River near Burgin, Kentucky	3	395	5.34
03287128	Tanners Creek at Mortonsville, Kentucky	2	1.26	58.0
03287534	South Benson Creek near Frankfort, Kentucky	2	4.47	12.1
03288000	North Elkhorn Creek near Georgetown, Kentucky	2	119	3.80
03288500	Cave Creek near Fort Spring, Kentucky	2	2.53	38.5
03289000	South Elkhorn Creek at Fort Spring, Kentucky	2	24.0	16.5
03289300	South Elkhorn Creek near Midway, Kentucky	2	95.0	5.17
03289500	Elkhorn Creek near Frankfort, Kentucky	2	473	3.60
03290000	Flat Creek near Frankfort, Kentucky	1	5.63	39.8
03290580	Town Creek at New Castle, Kentucky	1	5.62	37.2
03291000	Eagle Creek at Sadieville, Kentucky	1	42.9	9.00
03291050	South Rays Fork near Corinth, Kentucky	1	.58	73.9
03291500	Eagle Creek at Glencoe, Kentucky	1	437	3.49
03292200	Jeff Branch near Sligo, Kentucky	1	.87	139
03292460	Harrods Creek near Lagrange, Kentucky	1	24.1	11.7
03292472	South Fork Harrods Creek near Crestwood, Kentucky	1	.97	109
03294000	Silver Creek near Sellersburg, Indiana	1	189	5.50
03295000	Salt River near Harrodsburg, Kentucky	2	41.4	8.50
03295400	Salt River at Glensboro, Kentucky	2	172	3.83
03295500	Salt River near Van Buren, Kentucky	2	196	3.70
03295845	Bradshaw Creek near Shelbyville, Kentucky	1	1.36	75.1
03295890	Brashears Creek at Taylorsville, Kentucky	1	259	6.01
03296500	Plum Creek near Wilsonville, Kentucky	1	19.1	14.8

Table 2. Total drainage areas and main-channel slopes for 238 streamflow-gaging stations used to develop the peak-flow regression equations for Kentucky—*Continued*

U.S. Geological Survey gaging-station number	U.S. Geological Survey gaging-station name	Region	Total drainage area (square miles)	Main-channel slope (feet per mile)
03297000	Little Plum Creek near Waterford, Kentucky	1	5.15	52.1
03297500	Plum Creek at Waterford, Kentucky	1	31.8	15.0
03297845	Floyds Fork at Crestwood, Kentucky	1	46.7	8.85
03298000	Floyds Fork at Fisherville, Kentucky	1	138	5.50
03298500	Salt River at Shepherdsville, Kentucky	1	1,197	4.16
03298535	Elm Lick near Clermont, Kentucky	1	.68	130
03299000	Rolling Fork near Lebanon, Kentucky	5	239	9.05
03300000	Beech Fork near Springfield, Kentucky	2	85.9	5.80
03300065	North Prong near Willisburg, Kentucky	2	1.71	75.6
03300400	Beech Fork at Maud, Kentucky	2	436	3.76
03300990	Town Creek Tributary at Bardstown, Kentucky	2	.32	106
03301000	Beech Fork at Bardstown, Kentucky	2	669	3.70
03301500	Rolling Fork near Boston, Kentucky	5	1,299	3.50
03302085	Otter Creek Tributary near Vine Grove, Kentucky	5	.90	60.5
03302220	Buck Creek near New Middletown, Indiana	5	65.2	18.6
03302300	Little Indian Creek near Galena, Indiana	5	16.1	19.0
03302350	Georgetown Creek Tributary near Georgetown, Indiana	5	.56	140
03303000	Blue River near White Cloud, Indiana	6	476	3.80
03303300	Middle Fork Anderson River at Bristow, Indiana	6	39.8	15.4
03303400	Crooked Creek near Santa Claus, Indiana	6	7.86	23.7
03303440	Crooked Creek Tributary near Fulda, Indiana	6	.26	104
03303900	Little Red Creek Tributary near Heilman, Indiana	6	.25	82.0
03304500	Mcgills Creek near Mckinney, Kentucky	5	2.14	150
03305000	Green River near Mckinney, Kentucky	5	22.4	32.1
03305500	Green River near Mount Salem, Kentucky	5	36.3	28.4
03305559	Carpenter Creek Tributary near Hustonville, Kentucky	5	.88	105
03305835	Gumlick Creek Tributary near Clementsville, Kentucky	5	.71	154
03306500	Green River at Greensburg, Kentucky	5	736	3.50
03306640	White Oak Creek Tributary near Montpelier, Kentucky	5	.50	125
03307000	Russell Creek near Columbia, Kentucky	5	188	9.38
03307100	Russell Creek near Gresham, Kentucky	5	265	5.10
03307500	South Fork Little Barren River at Edmonton, Kentucky	5	18.3	16.4
03309500	Mcdougal Creek near Hodgenville, Kentucky	5	5.34	24.0

Table 2. Total drainage areas and main-channel slopes for 238 streamflow-gaging stations used to develop the peak-flow regression equations for Kentucky—*Continued*

U.S. Geological Survey gaging-station number	U.S. Geological Survey gaging-station name	Region	Total drainage area (square miles)	Main-channel slope (feet per mile)
03310000	North Fork Nolin River at Hodgenville, Kentucky	5	36.4	20.0
03310300	Nolin River at White Mills, Kentucky	6	357	4.20
03310385	Bacon Creek Tributary near Upton, Kentucky	6	.56	117
03310400	Bacon Creek near Priceville, Kentucky	6	85.4	7.99
03310500	Nolin River at Wax, Kentucky	6	600	2.60
03310880	Brier Creek Tributary near Ollie, Kentucky	6	.31	310
03311000	Nolin River at Kyrock, Kentucky	6	703	3.20
03311600	Beaverdam Creek at Rhoda, Kentucky	6	10.9	23.8
03312000	Bear Branch near Leitchfield, Kentucky	6	30.8	26.8
03312500	Barren River near Pageville, Kentucky	5	531	4.30
03312795	Little Beaver Creek near Glasgow, Kentucky	5	.89	186
03313000	Barren River near Finney, Kentucky	5	942	3.70
03313020	Solomon Creek Tributary near Scottsville, Kentucky	5	.24	122
03313500	West Bays Fork at Scottsville, Kentucky	5	7.47	47.2
03313700	West Fork Drakes Creek near Franklin, Kentucky	5	110	9.06
03313800	Lick Creek near Franklin, Kentucky	5	21.6	19.5
03314000	Drakes Creek near Alvaton, Kentucky	5	478	6.60
03314750	Barren River Tributary near Bowling Green, Kentucky	5	.50	227
03316000	Mud River near Lewisburg, Kentucky	6	90.5	7.10
03317000	Rough River near Madrid, Kentucky	6	225	4.90
03317500	North Fork Rough River near Westview, Kentucky	6	42.0	15.3
03318000	Rough River near Falls of Rough, Kentucky	6	454	3.40
03318200	Rock Lick Creek near Glen Dean, Kentucky	6	20.1	31.3
03318500	Rough River at Falls of Rough, Kentucky	6	504	2.43
03318505	Pleasant Run Tributary near Falls of Rough River, Kentucky	6	.22	246
03318800	Caney Creek near Horse Branch, Kentucky	6	124	3.00
03319000	Rough River near Dundee, Kentucky	6	757	2.90
03319520	West Fork Adams Tributary near Fordsville, Kentucky	6	.26	122
03320500	Pond River near Apex, Kentucky	7	194	4.63
03321465	Rhodes Creek Tributary near Owensboro, Kentucky	6	.29	62.1
03322360	Beaverdam Creek near Corydon, Kentucky	6	14.3	13.5
03366200	Herberts Creek near Madison, Indiana	1	9.31	18.3
03366400	Lewis Creek Tributary near Kent, Indiana	1	.16	71.0

Table 2. Total drainage areas and main-channel slopes for 238 streamflow-gaging stations used to develop the peak-flow regression equations for Kentucky—*Continued*

U.S. Geological Survey gaging-station number	U.S. Geological Survey gaging-station name	Region	Total drainage area (square miles)	Main-channel slope (feet per mile)
03378550	Big Creek near Wadesville, Indiana	6	104	3.80
03378590	Olive Creek Tributary near Solitude, Indiana	6	.32	79.5
03381600	Little Wabash River Tributary near New Haven, Illinois	7	.16	89.8
03382520	Black Branch Tributary near Junction, Illinois	7	1.10	28.2
03382975	Ward Creek at Lewiston, Kentucky	7	.91	10.7
03383000	Tradewater River at Olney, Kentucky	7	255	2.00
03384000	Rose Creek at Nebo, Kentucky	7	2.10	28.8
03385000	Hayes Creek at Glendale, Illinois	7	19.1	21.4
03385500	Lake Glendale Inlet near Dixon Springs, Illinois	7	1.05	145
03400500	Poor Fork at Cumberland, Kentucky	2	82.3	28.1
03400700	Clover Fork at Evarts, Kentucky	3	82.4	38.8
03400800	Martins Fork near Smith, Kentucky	3	55.8	33.0
03401000	Cumberland River near Harlan, Kentucky	3	374	13.0
03401500	Yellow Creek Bypass at Middlesboro, Kentucky	4	35.3	127
03402000	Yellow Creek near Middlesboro, Kentucky	4	60.6	74.4
03402020	Shillalah Creek near Page, Kentucky	4	2.96	343
03402900	Cumberland River Pine Street Bridge at Pineville, Kentucky	4	770	8.38
03403500	Cumberland River at Barbourville, Kentucky	4	960	7.40
03403910	Clear Fork at Saxton, Kentucky	4	331	15.4
03404820	Laurel River at Municipal Dam near. Corbin, Kentucky	4	140	3.70
03404867	Gozey Hollow near Corbin, Kentucky	4	.31	98.3
03404900	Lynn Camp Creek at Corbin Kentucky	4	53.8	10.3
03405000	Laurel River at Corbin, Kentucky	4	201	5.80
03405854	Big Hurricane Branch at Conway, Kentucky	3	1.91	103
03406000	Wood Creek near London, Kentucky	4	3.89	49.2
03406500	Rockcastle River at Billows, Kentucky	4	604	3.60
03407100	Cane Branch near Parkers Lake, Kentucky	4	.67	206
03407200	West Fork Cane Branch near Parkers Lake, Kentucky	4	.26	187
03407300	Helton Branch at Greenwood, Kentucky	4	.85	224
03407500	Buck Creek near Shopville, Kentucky	4	165	10.1
03408500	New River at New River, Tennessee	5	382	7.06
03409000	White Oak Creek at Sunbright, Tennessee	5	13.5	54.5
03410500	South Fork Cumberland River near Stearns, Kentucky	5	954	9.00

Table 2. Total drainage areas and main-channel slopes for 238 streamflow-gaging stations used to develop the peak-flow regression equations for Kentucky—*Continued*

U.S. Geological Survey gaging-station number	U.S. Geological Survey gaging-station name	Region	Total drainage area (square miles)	Main-channel slope (feet per mile)
03411000	South Fork Cumberland River at Nevelsville, Kentucky	5	1,271	8.00
03412500	Pitman Creek at Somerset, Kentucky	4	31.3	21.3
03413200	Beaver Creek near Monticello, Kentucky	5	43.4	20.2
03413202	Elk Spring Creek near Spann, Kentucky	5	.57	333
03413425	Williams Creek Tributary near Cartwright, Kentucky	5	.76	190
03414102	Bear Creek near Burksville, Kentucky	5	3.52	49.4
03414500	East Fork Obey River near Jamestown, Tennessee	5	202	37.0
03415000	West Fork Obey River near Alpine, Tennessee	5	115	33.6
03415700	Big Eagle Creek near Livingston, Tennessee	5	7.98	68.5
03416000	Wolf River near Byrdstown, Tennessee	5	106	12.3
03418000	Roaring River near Hilham, Tennessee	5	78.7	14.6
03435140	Whippoorwill Creek near Claymour, Kentucky	7	20.8	13.8
03435500	Red River near Adams, Tennessee	7	706	4.44
03436000	Sulphur Fork Red River near Adams, Tennessee	7	186	6.56
03436700	Yellow Creek near Shiloh, Tennessee	7	124	12.3
03437490	South Fork Little River Tributary near Hopkinsville, Kentucky	7	2.62	27.1
03437500	South Fork Little River at Hopkinsville, Kentucky	7	46.5	7.10
03438000	Little River near Cadiz, Kentucky	7	244	3.60
03438070	Muddy Fork Little River near Cerulean, Kentucky	7	30.5	20.0
03438120	North Fork Draydon Creek Tributary near Confederate, Kentucky	7	.10	157
03529500	Powell River at Big Stone Gap, Virginia	2	112	41.2
03530000	South Fork Powell River at Big Stone Gap, Virginia	2	40.0	156
03530500	North Fork Powell River at Pennington Gap, Virginia	3	70.0	59.4
03531500	Powell River near Jonesville, Virginia	3	319	16.8
03610000	Clarks River at Murray, Kentucky	7	89.7	8.59
03610200	Clarks River at Almo, Kentucky	7	134	7.45
03610470	York Creek near Benton, Kentucky	7	.96	57.7
03610500	Clarks River near Benton, Kentucky	7	227	6.20
03610503	Chestnut Creek near Benton, Kentucky	7	.82	52.9
03610545	West Fork Clarks River near Brewers, Kentucky	7	68.7	11.6
03610820	Clarks River Tributary near Reidland, Kentucky	7	.13	75.2
03611260	Massac Creek near Paducah, Kentucky	7	14.6	17.8

Table 2. Total drainage areas and main-channel slopes for 238 streamflow-gaging stations used to develop the peak-flow regression equations for Kentucky—*Continued*

U.S. Geological Survey gaging-station number	U.S. Geological Survey gaging-station name	Region	Total drainage area (square miles)	Main-channel slope (feet per mile)
03612200	Q Ditch Tributary near Choat, Illinois	7	0.27	141
03614000	Hess Bayou Tributary near Mound City, Illinois	7	1.95	23.9
07022500	Perry Creek near Mayfield, Kentucky	7	1.72	28.1
07023000	Mayfield Creek at Lovelaceville, Kentucky	7	212	5.30
07023040	Lick Creek Tributary near Kirbyton, Kentucky	7	.53	58.6
07023500	Obion Creek at Pryorsburg, Kentucky	7	36.8	10.9
07023935	South Fork Bayou de Chien Tributary at Water Valley, Kentucky	7	.23	59.3
07024000	Bayou de Chien near Clinton, Kentucky	7	68.7	8.00
07026500	Reelfoot Creek near Samburg, Tennessee	7	110	3.72

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