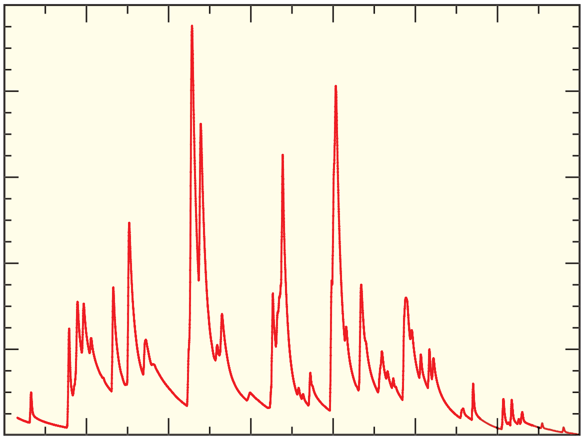
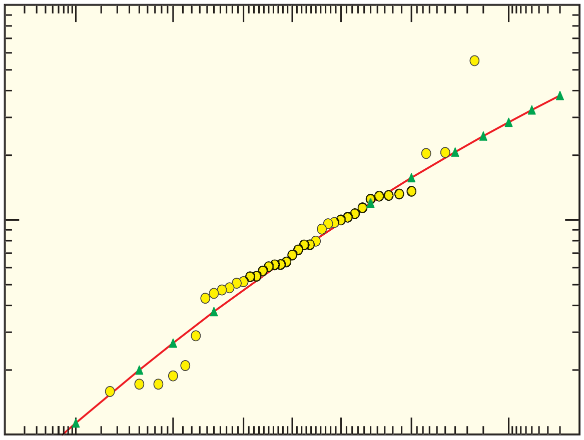
In cooperation with the Illinois Department of Natural Resources, Offices of Water Resources, Realty and Environmental Planning–Conservation 2000 Program, and Resource Conservation; and with the Illinois Department of Transportation

Estimating Flood-Peak Discharge Magnitudes and Frequencies for Rural Streams in Illinois





Scientific Investigations Report 2004-5103

U.S. Department of the Interior
U.S. Geological Survey

Estimating Flood-Peak Discharge Magnitudes and Frequencies for Rural Streams in Illinois

By David T. Soong, Audrey L. Ishii, Jennifer B. Sharpe, and Charles F. Avery

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U.S. Department of the Interior
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Photograph in the upper left shows a bridge over the Fox River near Lotus Woods in Lake County, Illinois (photograph by Gary P. Johnson, U.S. Geological Survey, Illinois Water Science Center). Photograph in the lower right shows a bank-erosion site on Canteen Creek in St. Clair County, Illinois (photograph by Timothy D. Straub and Donald P. Roseboom, U.S. Geological Survey, Illinois Water Science Center).

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Conversion Factors, Symbols, Datums, Abbreviations, and Acronyms

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
	Flow rate	
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
inch per year (in/yr)	25.4	millimeter per year (mm/yr)

<	less than
>	greater than
=	equal to
≤	less than or equal to
≥	greater than or equal to

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). However, gage datum presently (2004) still refers to National Geodetic Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Historical data collected and stored as North American Datum of 1927 (NAD 27).

Other abbreviations used in the report:

AEYR — average equivalent years of record

AMS — annual maximum series

DEM — digital elevation model

EGLS — estimated generalized least squares method

GIS — Geographic Information System

MLR — multiple linear regression

APE — average prediction error of the regional equation, in percent

SEE — standard errors of estimators, in percent

NLCD — National Land Cover Data. The URL is *http://landcover.usgs.gov/nationallandcover.html*

NWIS — National Water Information System

OLS — Ordinary least squares

PDS — partial duration series

STATSGO — State Soil Geographic database

USGS — U.S. Geological Survey

Estimating Flood-Peak Discharge Magnitudes and Frequencies for Rural Streams in Illinois

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Abstract

Flood-peak discharge magnitudes and frequencies at streamflow-gaging sites were developed with the annual maximum series (AMS) and the partial duration series (PDS) in this study. Regional equations for both flood series were developed for estimating flood-peak discharge magnitudes at specified recurrence intervals of rural Illinois streams. The regional equations are techniques for estimating flood quantiles at ungaged sites or for improving estimated flood quantiles at gaged sites with short records or unrepresentative data. Besides updating at-site flood-frequency estimates using flood data up to water year 1999, this study updated the generalized skew coefficients for Illinois to be used with the Log-Pearson III probability distribution for analyzing the AMS, developed a program for analyzing the partial duration series with the Generalized Pareto probability distribution, and applied the BASINSOFT program with digital datasets in soil, topography, land cover, and precipitation to develop a set of basin characteristics. The multiple regression analysis was used to develop the regional equations with subsets of the basin characteristics and the updated at-site flood frequencies. Seven hydrologic regions were delineated using physiographic and hydrologic characteristics of drainage basins of Illinois. The seven hydrologic regions were used for both the AMS and PDS analyses.

Examples are presented to illustrate the use of the AMS regional equations to estimate flood quantiles at an ungaged site and to improve flood-quantile estimates at and near a gaged site. Flood-quantile estimates in four regulated channel reaches of Illinois also are approximated by linear interpolation. Documentation of the flood data preparation and evaluation, procedures for determining the flood quantiles, basin characteristics, generalized skew coefficients, hydrologic region delineations, and the multiple regression analyses used to determine the regional equations are presented in the main text and appendixes.

INTRODUCTION

Knowledge of the frequency and magnitude of flood-peak discharges is essential for water-resources planning, risk management, and project design. The magnitude of flood-peak discharge and associated exceedance probability can be estimated from various approaches (National Research Council, 1988) and flood-frequency analysis is one of them that is based on statistical inference. In flood-frequency analysis, characteristics of the observed instantaneous flood-peak discharge magnitudes from a stream location are analyzed and a probability distribution is selected to fit the observed peak data. The analysis (also termed as at-site analysis because only data at the study site are used) produces a best-fit line (a flood-frequency curve) between the observed flood-peak magnitudes and their estimated exceedance probabilities. From the flood-frequency curve, the magnitude of flood-peak discharge at a specific exceedance probably (a flood quantile) can be estimated for the site. Overall, the advantages of flood-frequency analysis over other approaches are that the flood quantiles are estimated based on observed flood-peak magnitudes and the exceedance probabilities are estimated from actual floods, not from rainfalls as in the design-storm method in the rainfall-runoff modeling approach (where the exceedance probability for a flood-peak discharge is assumed equal to that of the design rainfall). However, data availability and representativeness of the available data also are the limiting factors for the accuracy of quantiles estimated by the flood-frequency analysis. In the flood-frequency curve, the exceedance probability (P) indicates the chances that the magnitude of the corresponding flood peak have been equaled or exceeded by an actual flood peak in a specified time interval. For an easier engineering interpretation, the recurrence interval (T) that has a time unit is used instead of P. Therefore, T is to be used in a probabilistic sense. For a given T, the corresponding flood-peak magnitude is termed as flood quantile (Q_T) in this study. In addition to the "at-site" analysis, the flood-frequency estimates at a number of sites within a hydrologically homogeneous region may be combined and analyzed with explanatory variables taken from physiographic and basin characteristics to improve the at-site estimates by essentially "substituting space for time," effectively extending the length of streamflow records (National Research Council, 1988), and providing a technique for estimating flood-frequency relations at ungaged sites.

Although systematic flow records for Illinois streams have been established since the late-1800's or early-1900's at some streamflow-gagging stations, however, the available flood data at most streamflow-gaging stations generally are insufficient for reliably estimating Q_T for extreme (such as the 100-year flood) events. At-site and regional flood-frequency curves for Illinois were last determined using streamflow data collected through water year[1] (WY) 1985 (Curtis, 1987). Additional flood data, advancements in analytical techniques and geographic information system (GIS) as well as digital databases have became available in the past decade. To provide updated flood-frequency estimates for the State of Illinois, the U.S. Geological Survey (USGS)—in cooperation with the Illinois Department of Natural Resources, Offices of Water Resources, Realty and Environmental Planning–Conservation 2000 Program, and Resource Conservation; and with the Illinois Department of Transportation—began a study in 2000. Flood records collected through WY 1999 were used in this study. Components of the study are briefly introduced as follows.

The annual maximum series (AMS) and partial duration series (PDS) are used in this study for estimating at-site flood frequencies. Up to the present (2004), the AMS has been used in most of the statewide flood-frequency analyses conducted by the USGS throughout the country; the analysis on PDS presented is thought to be the first statewide application of PDS in Illinois. The AMS and PDS represent different ways the instantaneous flood-peak discharge magnitudes are organized from the station records; therefore, these series have different definitions on common terms such as the T and might be fitted with different probability distributions. The AMS and PDS are analyzed and presented separately in this report. Users need to differentiate their definitions and applications.

The AMS results have been used for flood prevention and protection. The AMS consists of the list of instantaneous maximum discharge values for each water year. In this report, no streamflow record of shorter duration than 10 years is utilized in determining the flood-frequency relations. The method used to determine flood-peak discharge magnitudes associated with the annual exceedance probabilities from 0.002 to 0.5 (corresponding to 500-year flood to the 2-year recurrence intervals, respectively) at a gaged site is described in the guidelines published as Bulletin 17B of the Interagency Advisory Committee on Water Data, Hydrology Subcommittee (1982). Bulletin 17B recommends the AMS and the Log-Pearson Type III (*LP3*) probability distribution be used in estimating the flood-frequency relations.

Because only one flood peak is chosen per year in AMS, it is not possible to evaluate the magnitudes of secondary flood-peak discharges if the effects of these discharges also are of concern, or to determine flood-peak discharge magnitudes that could occur more than once in a year ($T \leq 1$ year). In recent years, interests on understanding flood-peak discharge of higher frequencies (for example, T equal to 1-3 years) increase because of its potential application to studies of habitat restoration and protection. These more frequent floods can be important in studying channel formation, stability, and migration; and floodplain vegetation and habitat. The PDS, organized from a streamflow record with all instantaneous flood-peak discharges above a threshold magnitude at the site, is suitable for analyzing flood-frequency relations where secondary flood-peak discharges are important (for example, Chow, 1964a). In this study, the Generalized Pareto (*GP*) distribution (for example, Rao and Hamed, 2000) was used to fit the PDS data and for determining the PDS at-site flood-frequency relations.

The regional flood-frequency technique used in this study was based on multiple-regression analysis, with subsets of newly determined explanatory variables from basin characteristics and updated at-site flood frequencies for selected recurrence intervals. Seven hydrologic regions have been delineated in the State of Illinois, and the optimal group of variables was determined using the technique of ordinary least squares (OLS). The technique of generalized least squares (GLS) (Stedinger and Tasker, 1986, 1985; Tasker and Stedinger, 1989) that accounts for unequal record length and concurrent flows in streamflow records was used in developing the final AMS regional equations. However, the OLS technique was used in the regional analysis for PDS.

Although the flood-frequency relations and techniques determined in this study are the latest available (2004), the limitations and assumptions made in deriving the techniques should be understood when using the results.

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[1] A water year is the period from October 1 to September 30 and is designated by the calendar year in which it ends.

Purpose and Scope

This report presents the flood-frequency relations at rural gaged sites for selected recurrence intervals, and regional flood-frequency techniques for seven hydrologic regions in Illinois based on AMS and PDS. The scope of the study included:

1. Compiling the AMS and PDS at streamflow-gaging stations from the USGS peak-flow files available through WY 1999;
2. Deriving the at-site AMS flood quantiles based on Bulletin 17B procedures (Interagency Advisory Committee on Water Data, 1982);
3. Deriving the at-site PDS flood quantiles based on accepted methodologies;
4. Derive physiographic and drainage-basin characteristics using geographic information system (GIS) technology with the updated statewide databases;
5. Updating or developing new hydrologic regions;
6. Updating regional flood-frequency techniques for estimating AMS flood-peak discharge magnitudes using updated at-site flood quantiles and newly developed physiographic and hydrometeorological basin characteristics, and with the multiple regression analysis; and
7. Developing regional flood-frequency techniques for estimating PDS flood-peak discharge magnitudes using newly determined at-site flood quantiles and physiographic and hydrometeorological basin characteristics, and with the multiple regression analysis.

Databases for deriving these basin characteristics included the updated rainfall frequency for Illinois (Huff and Angel, 1992), digital topographic elevation model (DEM), State Soil Geographic (STATSGO) database, (Natural Resources Conservation Service, 1993), and the USGS National Land Cover Data (NLCD). The BASINSOFT program (Harvey and Eash, 1996) and ArcInfo procedures were used for determining basin geometric parameters from the DEM, and basin-weighted soil, land-use, and rainfall variables from the other GIS data layers.

Report Organization

This report contains a main text and eight appendixes. The main text presents the background of the study, definitions of the technical terms, and results of at-site as well as regional flood-frequency analyses. The appendixes are used to document work conducted at various key stages of AMS and PDS analyses of the study. This organization is intended to make the report an efficient reference for the reader, whereas keeping the data, techniques, and documentation available to future flood-frequency or other studies. The tasks and analytical steps of the study are shown in the flowchart (fig. 1). Digital data and images (with zooming capability) are included in the attached CD-ROM that is documented in appendix 8.

Previous Flood-Frequency Analyses for Illinois

The first statewide flood-frequency estimating techniques for Illinois were developed based on 108 stations with drainage areas greater than 10 mi^2 (Mitchell, 1954). Mitchell graphically fitted the distribution curves to station data and applied a technique (index flood procedure, Dalrymple, 1960) to conduct the regional analysis. The hydrologic regions were modified slightly from the physiographic divisions outlined by Leighton and others (1948), and the index mean annual flood ($Q_{2.33}$) for each region was estimated using (1) drainage area, (2) volume per area (related to the climatological factors), and (3) a lag index (measure of time lag because of storage that is related to physiographic factors). Mitchell then derived regional flood-frequency curves for three hydrologic divisions of Illinois; the regional frequency curves were used to estimate flood quantiles at ungaged sites for T between 1.1 and 50 years.

Using the procedures in Bulletin 15 (that is, fitted with the *LP3* distribution) (U.S. Water Resource Council, 1967), Carns (1973) presented regression equations for estimating flood quantiles at T of 1.25, 2, 5, 10, 25, 50, and 100 years. The equations were derived using 172 stations with at least 10 years of record at the end of WY 1967. Carns (1973) analyzed residuals to delineate four hydrologic regions for Illinois. The multiple regression analysis evaluated nine basin-characteristic parameters and derived the regional equations using *TDA* (drainage area, in

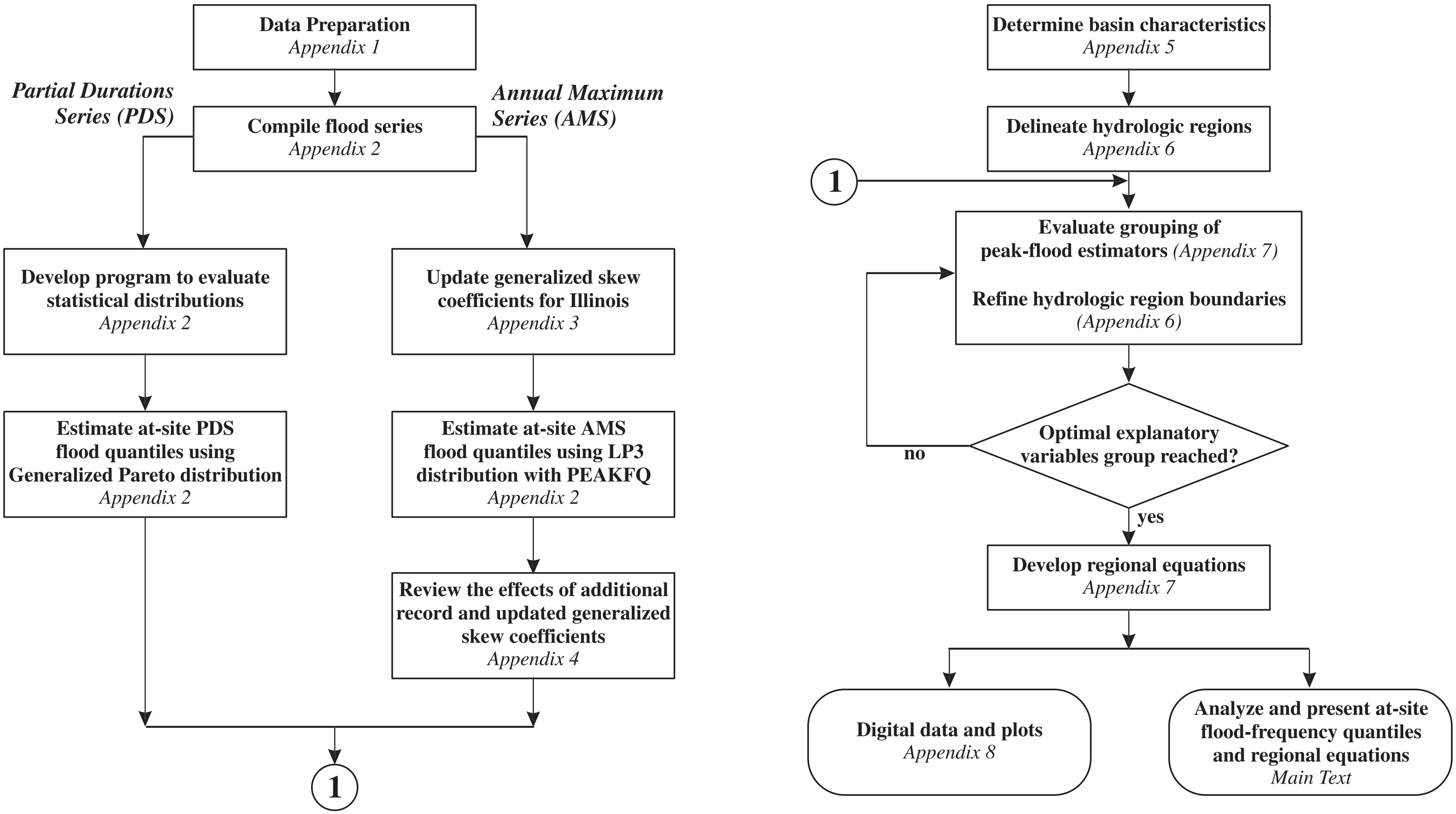


Figure 1. Development of flood-frequency relations and regional flood-frequency techniques for rural streams in Illinois (Text in italics indicates the part of the report where the listed components are fully described).

square miles, mi^2), *MCS* (main-channel slope, in feet per mile, ft/mi), *TTF* (precipitation index, using the 2-year, 24-hour, rainfall depth per 24 hours, in inches), and *RF* (a regional factor). Note that the abbreviations are cited differently from their original reports in order to maintain consistency with variables used in this report. The *RF* was determined in each region by averaging the residuals in that region and the *RF* was used in all Q_T equations. The *RF* was adjusted when streams crossed regional boundaries, or when sites were close to the boundary between regions. The applicability of the regression equations for *TDA* ranged from 0.02 mi^2 (Bear Creek tributary near Reeders, Ill.) to 28,600 mi^2 (Wabash River at Mount Carmel, Ill.), and for *MCS* from 0.7 ft/mi (Wabash River at Mount Carmel, Ill.) to 269.81 ft/mi (Big Muddy River Tributary near Gorham, Ill.). The *TTF*, which ranged from 2.6 to 3.6 in, was obtained from the U.S. Weather Bureau (Technical Paper 40, Hershfield, 1961). Concerning the lack of data in representing the variable *TDA* in the group of 25 mi^2 or less, Carns (1973) developed a separate set of equations based on the index flood method to estimate the magnitudes of 50- and 100-year flood-peak discharges for drainage basins in this group. Carns also summarized PDS data for streamflow-gaging stations with 5 or more years of record.

Curtis (1977b) estimated the flood quantiles for *T* ranged from 2 to 500 years at 303 gaging stations based on using the procedures outlined in Bulletin 17 (U.S. Water Resources Council, 1976). All these stations had at least 10 years of record by the end of WY 1975. The weighted skew method was applied to all stations except for stations with less than 25 years of record, where the generalized skew coefficient was used instead. Regional equations for rural streams were developed based on 241 sites not affected by urbanization or regulation. Among these 241 stations, 87 were from the USGS Small Stream Network (drainage area ranging from 0.02 to 10.2 mi^2). Curtis (1977b) also examined nine basin characteristics in developing the regional equations but selected the same explanatory variables used by Carns (1973). A constant 2.5 was subtracted from *TTF* to decrease the range and the magnitude of the regression coefficients for each *T*. The boundaries of four hydrologic regions were modified slightly with the consideration of physiographic characteristics, river-basin boundaries, and regression residuals. The *RF* values were different from those determined in 1973 but the differences were not appreciable. In his analysis, Curtis concluded that the *RF* reduced the standard error by about 3 percent, and stratifying the drainage area by size did not improve the standard errors significantly. The range of explanatory variables for *TDA* was from 0.02 (05586850, Bear Creek tributary near Reeders, Ill.) to 9,551 mi^2 (05446500, Rock River near Joslin, Ill.), for *MCS* was from 0.69 (05526000, Iroquois River near Chebanse, Ill.) to 228.6 ft/mi (05558050, Coffee Creek tributary near Florid, Ill.), and the rainfall depth remained the same (Hershfield, 1961).

Curtis (1987) updated frequency analysis using station data ending in WY 1985 and procedures outlined in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982). At-site flood quantiles for $T = 2$, 5, 10, 25, 50, 100, and 500 years were evaluated at 394 streamflow-gaging stations with 10 or more years of data. Among the 394 gaging stations, 268 stations were on rural streams suitable for regression analysis. In developing regional equations, the same hydrologic regions and explanatory variables were retained but the GLS method (Stedinger and Tasker, 1986, 1985) was used. The *RF*s were defined for each *T* in each region. The range of explanatory variables remained the same as those defined in 1977 except *TDA* for station 05446500 (Rock River near Joslin, Ill.) was reported as 9,549 mi^2.

FLOOD-PEAK DISCHARGE MAGNITUDES AND FREQUENCIES AT GAGED SITES

Data Availability

Both AMS and PDS were retrieved from the peak-flow files in the National Water Information System (NWIS) of the USGS. The instantaneous peak discharges also are part of streamflow record published annually by USGS Science Center offices, for example, LaTour and others (1996) or at URL: *http://il.water.usgs.gov/nwis-w/IL/* for Illinois. Secondary instantaneous peak discharges above a selected base discharge and associated stages are reported if the flow above the gaging station is not appreciably regulated. The base discharge generally is selected such that, on average, three independent flood-peak discharges, including the annual maximum peak discharge, exceed the base discharge each water year. Criteria for selecting peak discharges, concerning the selection of independent events, secondary peaks, base discharge at the gaging station, and others are given in Novak (1985).

The AMS series were compiled for streamflow-gaging stations with a minimum of 10 years of records. There were 419 streamflow-gaging stations – including both rural and urban watersheds as well as active and inactive stations – used in at-site AMS analysis. Out of the 419 records, 288 were identified as rural streamflow records that are suitable for developing the regional equations. Descriptions of data preparation for AMS data are described in appendix 1 (Data Preparation). The locations of the 419 and 288 streamflow-gaging stations are shown in figures 2A, b.

The PDS series were first retrieved from all stations with available records and examined. Gage operations could create breaks in a station's continuous record for both AMS and PDS, and also could create records having combined continuous and one record per year (when the gage was operated as a crest-stage gage (CSG)) for a period of time. The CSG data were included as part of the PDS data if they did not constitute a major portion of the record. The missing data (secondary peaks) in the CSG operation period may not be a major concern in this study because the emphasis of PDS analysis is on estimating flood quantiles at smaller *T*'s. The effect of missing data on estimating flood quantiles at larger *T*'s should be investigated, however. A general rule used for selecting systematic PDS data in this study was that the record had adequate coverage of large and small flood events and, generally, had 15 or more data points (an average of 5 years or more of record). With 15 or more data points and 5 years in time span, the magnitudes of smaller flood peak discharges generally are sufficiently represented in the PDS dataset. As the result of record examination, there were 222 streamflow-gaging station records in Illinois suitable for the PDS analysis of which 142 stations were in rural watersheds suitable for developing the PDS regional equations. The PDS station locations are shown in figure 3. Descriptions of data preparation for the PDS and other potential sources for organizing PDS data also are described in appendix 1 (Data Preparation).

Determination of Recurrence Intervals

For AMS, the recurrence interval, *T*, has a time unit, year, and is defined as the inverse of exceedance probability *P*. The *T* for AMS is easy to understand because these data are taken at yearly intervals. For a 100-year flood, it means that there is a 0.01 probability or 1-percent chance, on average, that the flood-peak discharge magnitude will be exceeded (an exceedance) in any and each year, including successive years. For PDS, because multiple flood peak-discharges are counted in a year, the definition of *T* for PDS is the expected time between exceedances, on average, in which a flood-peak discharge (no implication of annual maximum) exceeds the specified flood magnitude. The methods for approximating *T*'s for the AMS and the PDS are discussed below.

Because each observed flood-peak discharge in a flood series is necessarily a limited sample of the full range of possible events, the exceedance probability *P* for each flood sample in the series is approximated by using the plotting position formula (Chow, 1964b). Chow (1964b) or others have discussed various formulas for this purpose. In this study, the Weibull plotting position formula is used for approximating the *T* for the AMS (Interagency Advisory Committee on Water, 1982). The Weibull formula is specified in equation 1 below as

$$T = \frac{1}{P} = \frac{N+1}{m}, \qquad (1)$$

where *T* is the recurrence interval, *P* is the exceedance probability, *N* is the total number of observed events (samples), and *m* is the rank of the event in ascending order. Note that here the number of observed data is equal to the number of years in the flood series. For a flood series with 20 samples, for example, the highest ranked flood event has *T* equal to 21 years ($P = 0.0476$), and the lowest event has *T* equal to 1.05 ($P = 0.952$, *P* cannot exceed 1.0).

Equation 1 also is used to estimate the *T* for each sample in the PDS. Dalrymple (1960) considered that equation 1 would work better than other plotting position formulas for the PDS because a better estimate of smaller *T*'s can be obtained – as there are multiple flood-peak discharges in a year, the *N* is greater than the number of years of the flood series. In the PDS analysis, the average number of flood peaks in a year, *r*, must be considered in the definition of *T*'s. Therefore, the *T* computed with equation 1 represents an average of *rT* events for the PDS. In this study, the *T* for PDS is approximated by

$$T = \frac{\left(\left.\frac{1}{P}\right|_{\substack{annual\\event}}\right)}{r} = \frac{1}{rP}\,(in\ years). \qquad (2)$$

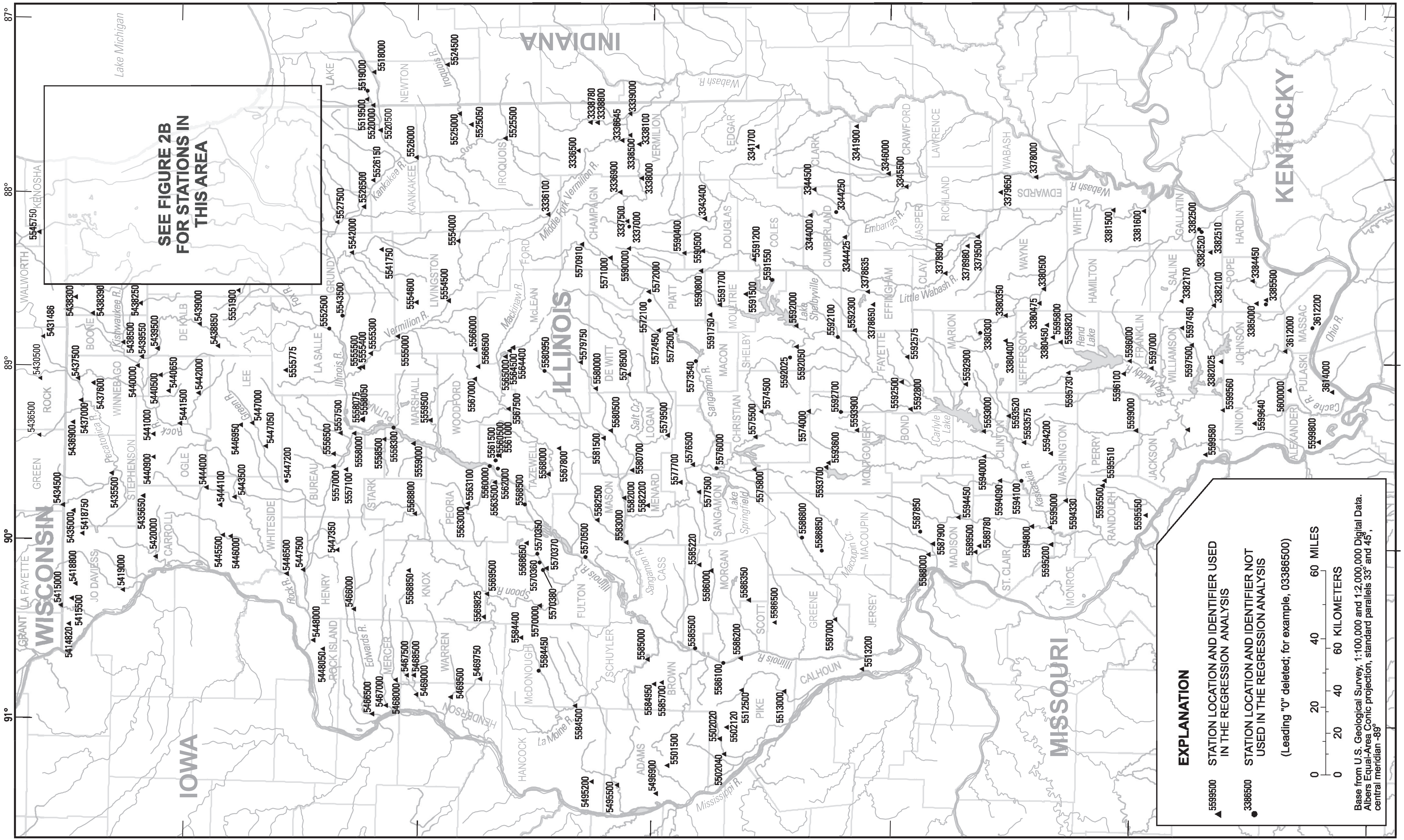


Figure 2A. Location (as of 2002) of U.S. Geological Survey streamflow-gaging stations in Illinois and adjacent States for which annual maximum series (AMS) were retrieved and flood quantiles were estimated, and stations used in the regression analysis.

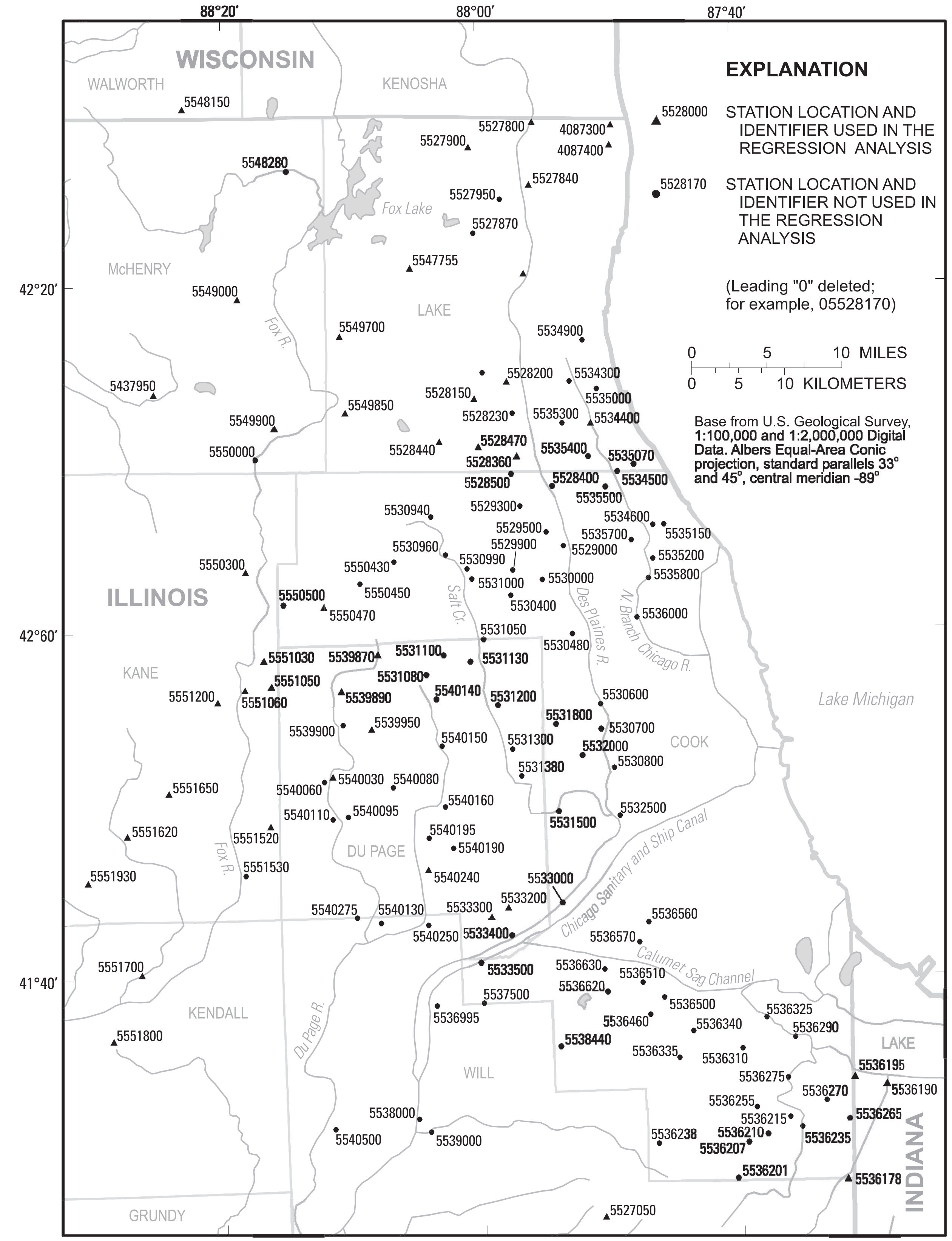
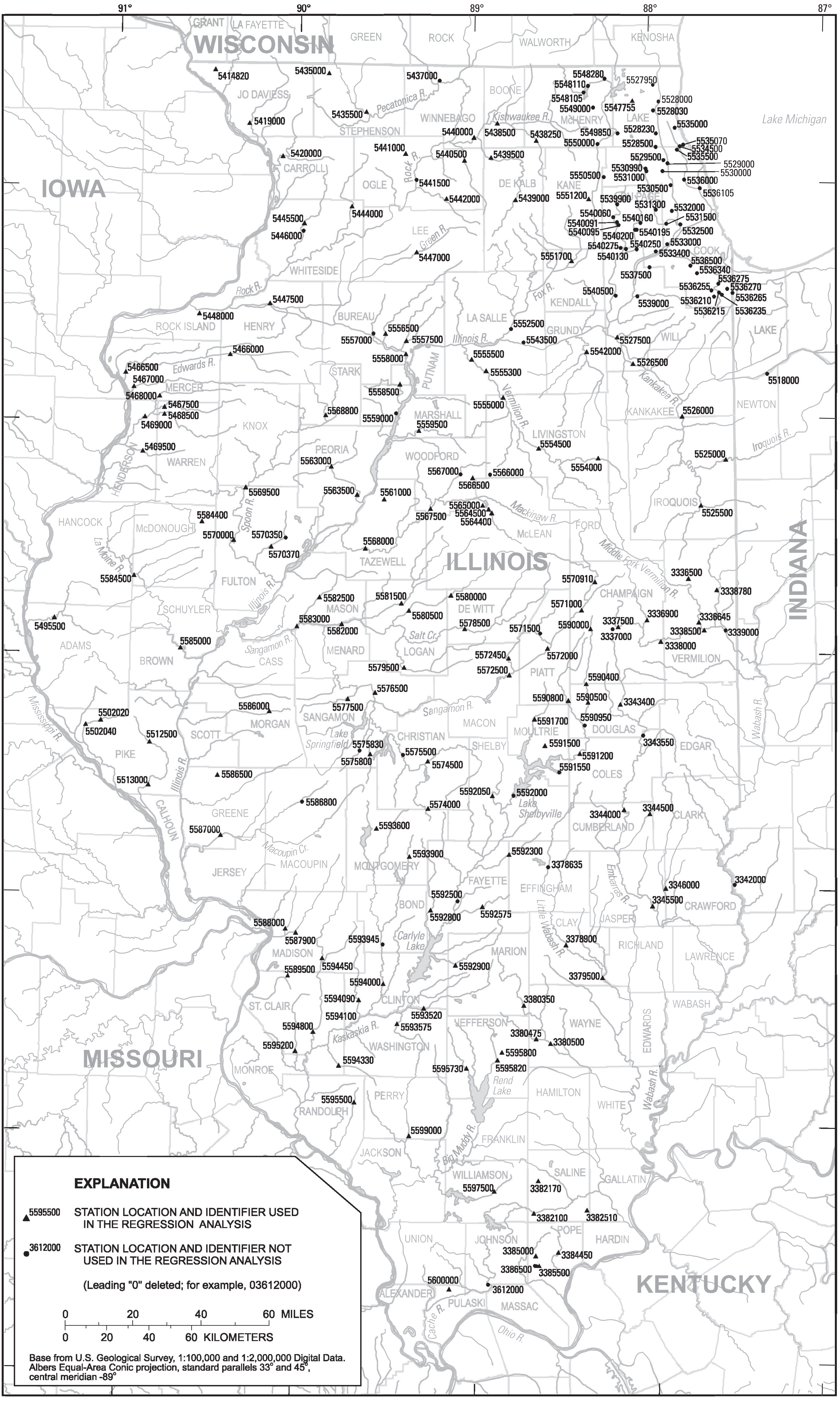


Figure 2B. Location (as of 2002) of U.S. Geological Survey streamflow-gaging stations in northern Illinois and adjacent States for which annual maximum series (AMS) were retrieved and flood quantiles were estimated, and stations used in the regression analysis. (See figure 2a for area location.)



Base from U.S. Geological Survey, 1:100,000 and 1:2,000,000 Digital Data. Albers Equal-Area Conic projection, standard parallels 33° and 45°, central meridian -89°

Figure 3. Location (as of 2002) of U.S. Geological Survey streamflow-gaging stations in Illinois and adjacent States for which partial duration series (PDS) were retrieved, and stations used in the regression analysis.

The value of *r* increases or decreases with the number of samples retained in the flood series. Depending on the data, selection of *r* could affect the structure of the flood series; hence, affect the choice of distribution. If a PDS contains 20 samples and an average of 1.6 events per year is used, the largest event of the PDS has *T* equal to 13.13 years but the smallest event has *T* equal to 0.66 year. Therefore, the difference between AMS and PDS is greater at smaller *T*'s. The *T* of PDS can be less than 1 year and is dependent on the value of *r*. If there are multiple exceedances in a year, these exceedances are not recognized in the AMS model but are recognized in the PDS model (William Kirby, U.S. Geological Survey, written commun., 2003). An analysis of a suitable value of *r* for at-site analysis is presented in appendix 2.

Estimates of Flood-Frequency Relations Based on Annual Maximum Series

At-site AMS flood frequencies were estimated based on the organized AMS with the *LP3* distribution (applying a USGS program PEAKFQ; version 4.1; Thomas and others, 1998). In order to smooth out erroneous estimates of skew coefficients because of random sample errors or from non-representative records, a weighted-skew coefficient approach (Interagency Advisory Committee on Water Data, 1982) was used. The weighted-skew for an at-site analysis was obtained by weighting between the sample skew of the systematic record and a published generalized skew coefficient for that location. The current version of generalized skew map for Illinois was published in 1976 (U.S. Water Resources Council, 1976) with values varied basically around –0.4. During this study, the generalized skew coefficients for Illinois were updated with kriging techniques (see appendix 3, Generalized Skew Coefficients for Illinois) and contours of the updated generalized skew coefficients for Illinois are shown in figure 4. Estimated AMS flood frequencies for *T*'s equal to 2, 5, 10, 25, 50, 100, and 500 years for the 419 stations are presented in table 1. The results of regional equations and weighted at-site results (to be discussed later) also are presented in table 1 (at back of report).

Estimates of Flood-Frequency Relations Based on Partial Duration Series

At-site PDS flood-frequencies were estimated based on the organized PDS data with the Generalized Pareto (*GP*) distribution. A computer program was developed for fitting the PDS data with four selected probability distributions (Gumbel, exponential, *GP*, and *LP3*), and generating the flood-frequency curves for evaluation. In the computation, corrected central moments (Rao and Hamed, 2000) were used to estimate the parameters of the probability distributions and various *r*-values were tested for these distributions. The *GP* distribution was selected and the *r* was set to 1.6 (appendix 2, At-Site Analysis of Flood-Peak Discharges). The formulas of the *GP* estimator also are given in appendix 2. Estimated PDS flood quantiles for *T*'s equal to 0.8, 1.01, 1.5, 2, 3, and 5 years for the 222 stations are presented in table 2 (at back of report).

Effect of Updated Flood-Frequency Analysis on At-Site Flood Quantiles Based on Annual Maximum Series

A review of the AMS data between WY 1986 and WY 1999, and analysis of the effects of additional streamflow records and updated generalized skew coefficients on at-site AMS flood quantiles was performed (appendix 4, Effects of Additional Flood Records and Updated Generalized Skew Coefficients). A brief summary is presented here.

Additional streamflow records between WY 1986 and WY 1999 were collected at 116 of the 268 rural streamflow-gaging stations used by Curtis (1987) (note that the 268 stations used by Curtis in regional analysis also included both active and inactive streamflow-gaging stations), and 10 streamflow-gaging stations became available after Curtis' work for the at-site and regional flood-frequency analysis. The improvement in data quality in terms of length of records was exemplified by sub-dividing the number of stations into three arbitrarily determined record-length groups: the short record-length group (< 15 years), medium record-length group (15 years ≤ records < 25 years), and long record-length group (≥ 25 years). The number of stations in the long record-length group increased from 114 stations in 1985 to 168 stations in 1999; however, the number of stations in the other two groups, with the 10 new stations included, was reduced slightly in the 1999 dataset.

In addition to increases in record lengths, major floods, some of historical scale such as the Great 1993 Flood in the Upper Mississippi River Basin, occurred in different parts of the State since analysis by Curtis (1987). For the 116 stations with additional flood records, new station flood-peak discharge magnitudes were recorded at 40 stations; flood-peak discharge(s) that were not new station records but exceeded the Q_{100} estimated by Curtis (1987) were recorded at 16 stations, and flood-peak discharge magnitude matched the 1987 Q_{100} value at 1 station. For the purpose of illustrating the spatial distribution of these newly recorded floods, the hydrologic regions for Illinois (fig. 5) are introduced but discussion on these hydrologic regions will be given later. These floods were recorded at stations mostly in regions 2, 3, and 5; but none in region 7.

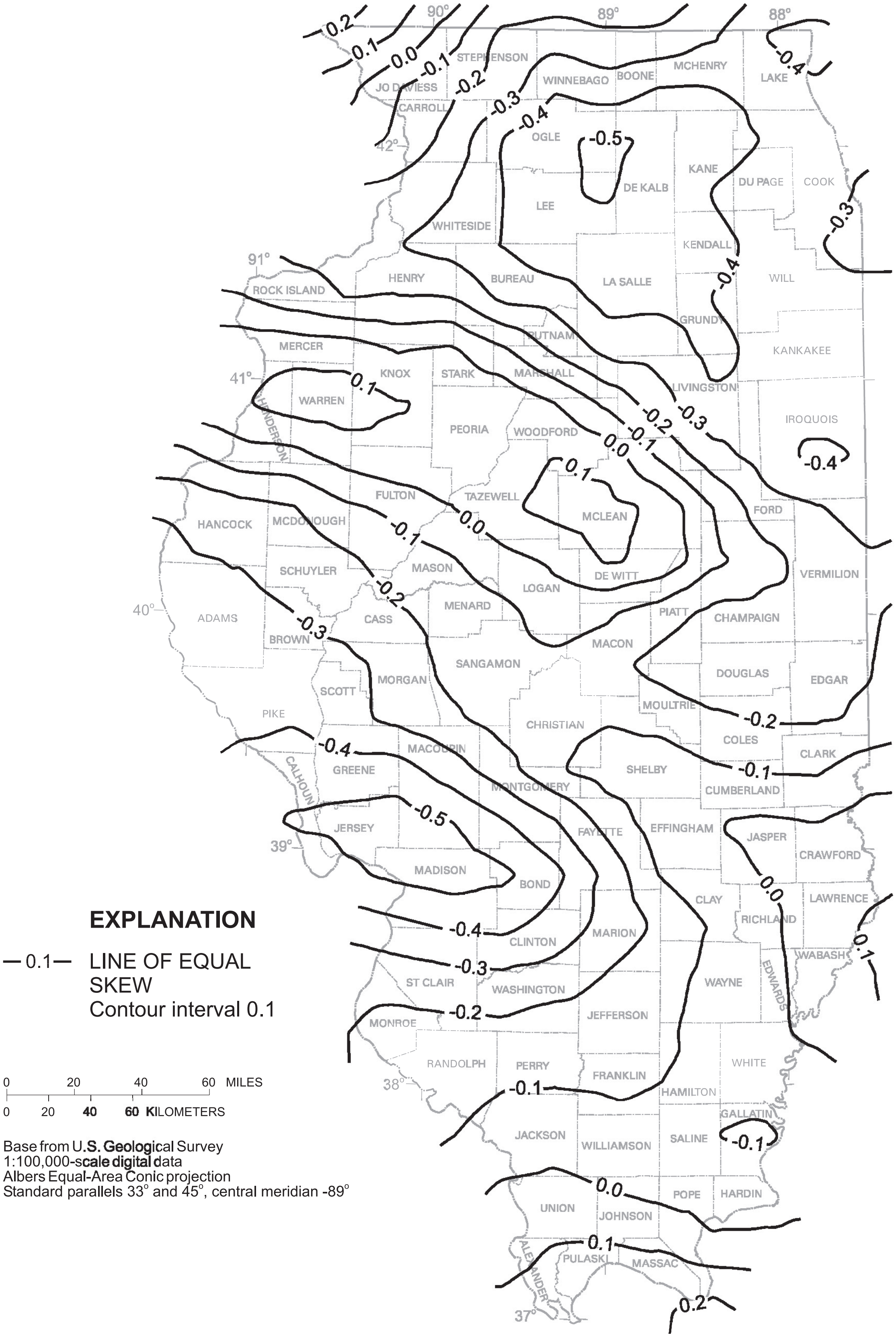


Figure 4. Updated generalized skew-coefficient map for Illinois.

The additional flood records had more apparent effects on at-site flood-frequency estimates than the updated skew coefficients. The analysis showed that the with the additional flood records, the widths of confidence intervals for both Q_2 and Q_{100} (only statistics associated with these two *T*'s were evaluated) at the 116 stations were reduced, and estimated magnitudes of Q_2 and Q_{100} were increased in regions 2, 3, 4, 5, and 6 but decreased in region 7. The updated generalized skew coefficients showed a general pattern of increasing the magnitudes and width of the confidence interval for Q_{100}, but decreasing the magnitudes and width of the confidence interval for Q_2.

The analysis also identified the lack of updated data for small watersheds in Illinois. There are only 83 stations (of the total current 288 stations) having drainage area less than or equal to 5 mi^2. No new data were available for these small watersheds after 1980. Also, 64 of the 83 small watersheds have less than 25 years of record and 18 stations have 25 years of record. The lack of data for the 1990's (a period with high flood peaks) may bias the frequency estimates for small watersheds.

Example At-Site Frequency Curves for Annual Maximum Series and Partial Duration Series

Flood-frequency curves derived for the AMS and PDS models are shown in figures 6 and 7, respectively. Streamflow records at Bluegrass Creek at Potomac, Illinois, are used in the example. The AMS results are plotted with *P* as the x-axis, the way they are obtained from the PEAKFQ output; the PDS results are plotted with *T* as the x-axis for the purpose of illustrating flood estimates at lower recurrence intervals. All at-site flood-frequency curves for both flood series are presented in the CD-ROM as documented in appendix 8.

REGIONAL FREQUENCY ANALYSIS

Hydrologic Regions for Illinois

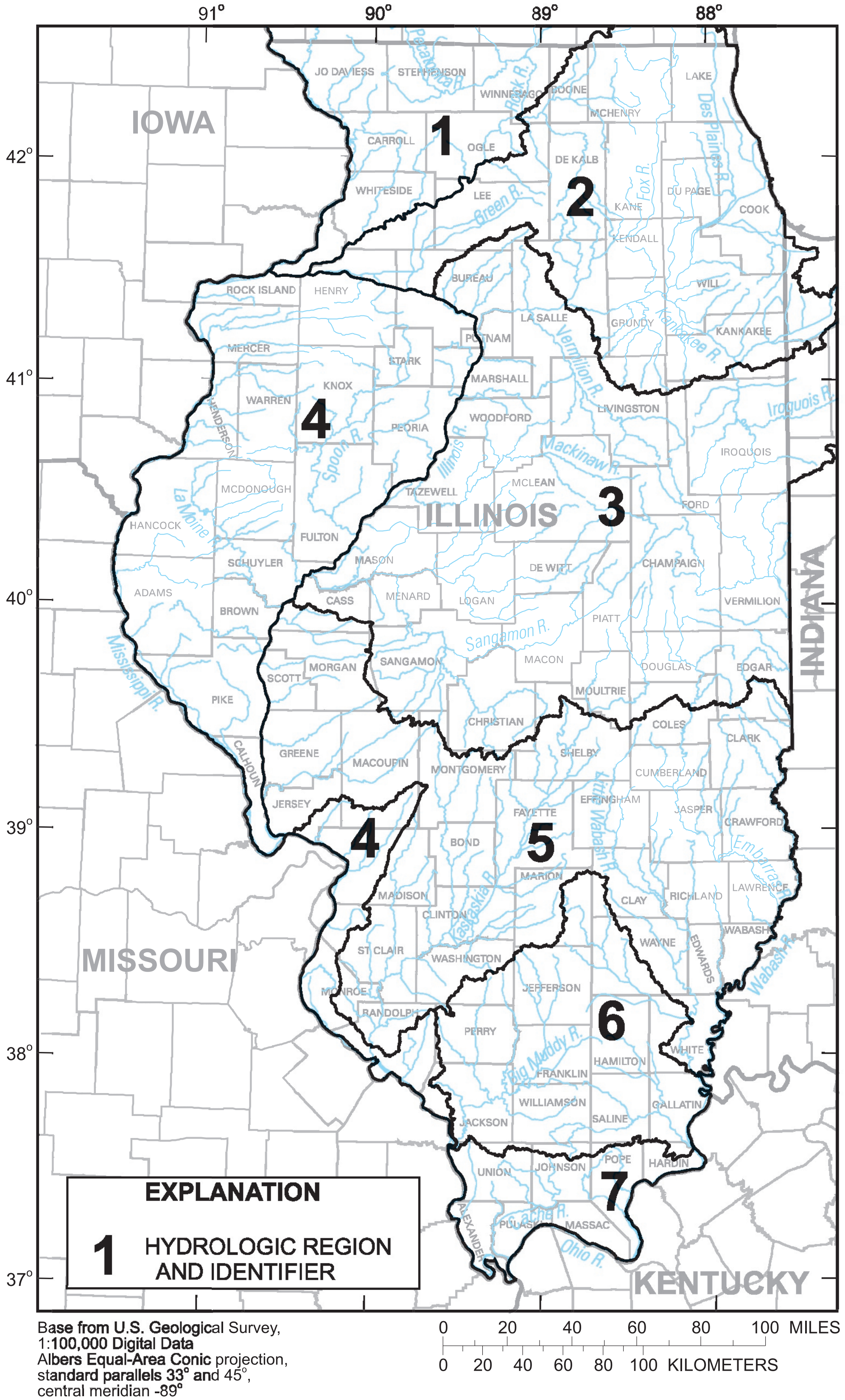
Seven hydrologic regions for Illinois (fig. 5) are delineated for the regional flood-frequency analysis. The revised region delineations are developed on the basis of physiographic features (Leighton and others, 1948) and hydrologic characteristics (Mitchell, 1954; Singh, 1981) (appendix 6, Hydrologic Regions for Illinois), and the results are different from those developed by Curtis (1987a, b; 1977) that were developed based on analysis of residuals of the regional regression analysis. By using physiographic features and hydrologic characteristics as the bases for hydrologic region delineation, it is expected that the delineations won't be altered appreciably in the future analyses and can reasonably be used in both AMS and PDS analyses. River basins of Illinois in these seven hydrologic regions are given in appendix 6.

Basin Characteristics

Thirty-eight basin characteristics describing the morphometric, soil, precipitation, and land use were defined (Eash, 2001). BASINSOFT (version 1.0, 2001) and various Arc/Info AML (Arc Macro Language) programs in conjunction with 100,000-scale DEM, STATSGO, and NLCD datasets were applied to determine the values of these basin characteristics (appendix 5, Determination of Basin Characteristics). Note that some values were averaged for the basin and presented at the basin centroid. The *TDA* is assumed to have the same value as *CDA* (contributing area) in this study. Although *CDA* is more relevant to the flow analysis than *TDA*, a recognized means for determining the *CDA* has not been yet reached, however. The values of these basin characteristics for the 288 stations are given in the CD-ROM (appendix 8).

Multiple Regression Analysis

Regional equations were developed by using the updated flood quantiles for rural watersheds (as response variables) and subgroups of the newly derived basin characteristics (as explanatory variables) with the multiple regression analysis. A preliminary analysis (appendix 7, Regression Analysis) identified the following basin characteristics that are suitable for developing the regional equations for Illinois. They are: *TDA* (total drainage areas, in square miles), *MCS* (main-channel slope, in feet per mile), *PermAvg* (average permeability, in inches per hour), *%Water*



Base from U.S. Geological Survey,
1:100,000 Digital Data
Albers Equal-Area Conic projection,
standard parallels 33° and 45°,
central meridian -89°

Figure 5. Hydrologic regions for flood-frequency analysis of rural streams in Illinois.

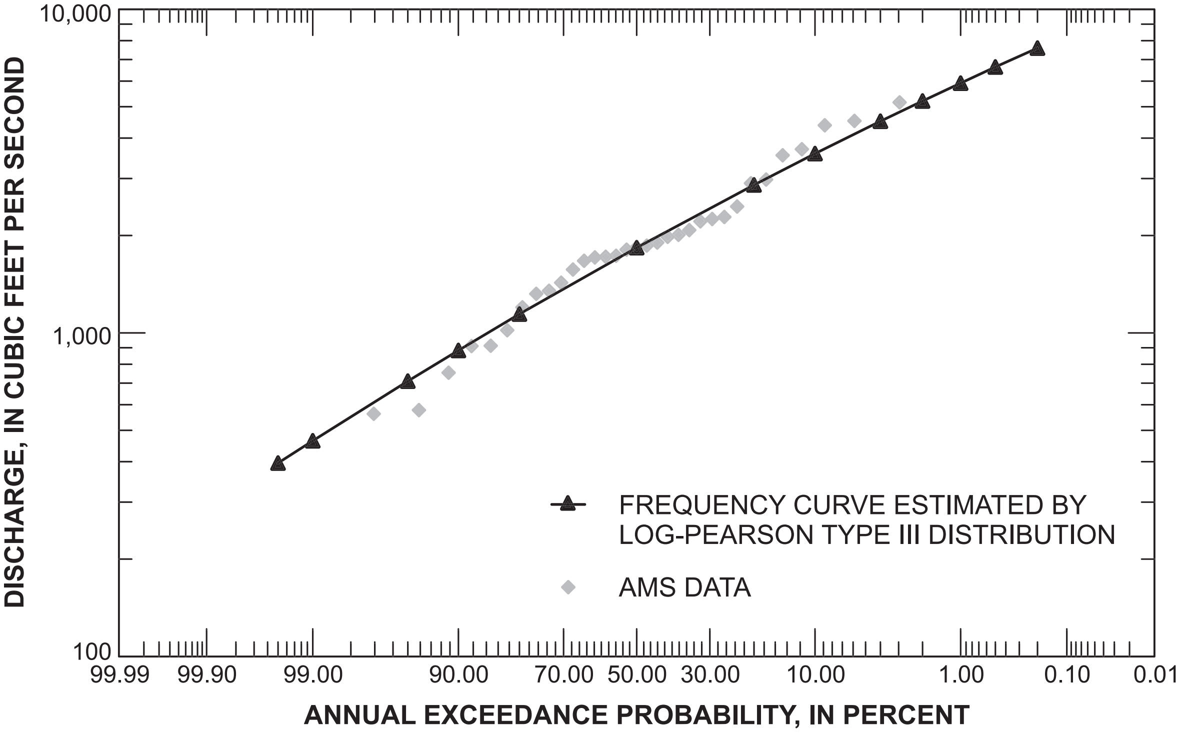


Figure 6. Flood-frequency curve based on annual maximum series (AMS) analysis for Bluegrass Creek at Potomac, Vermilion County Ill., (03336500).

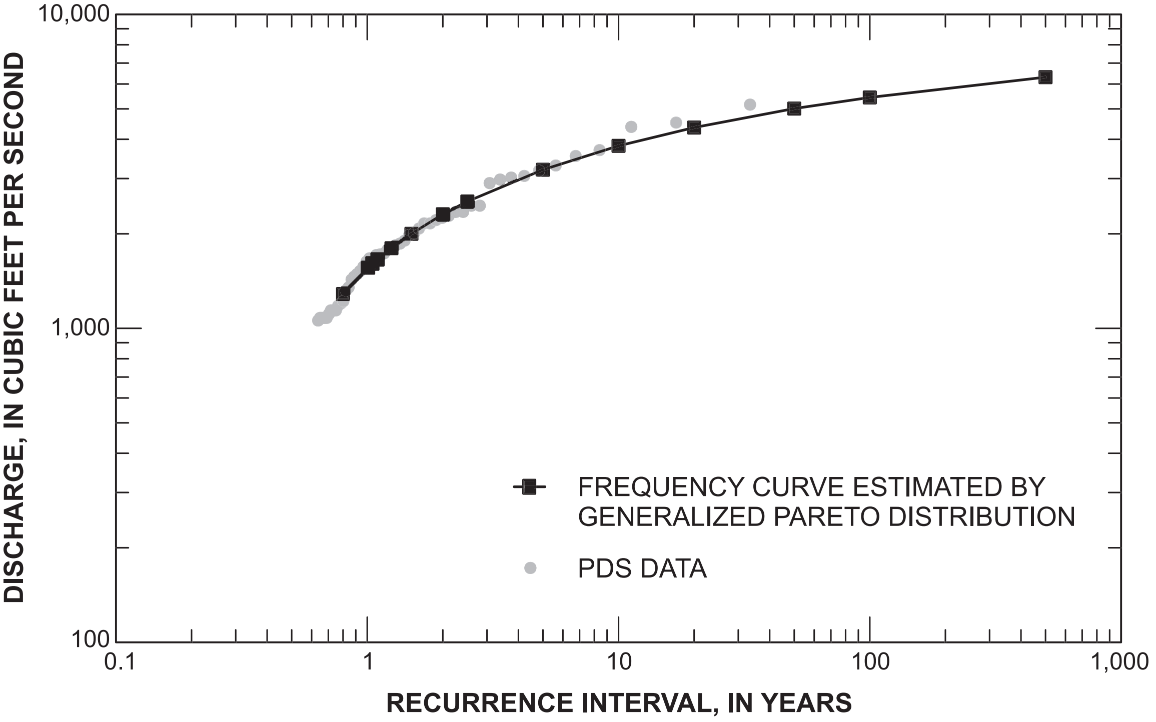


Figure 7. Flood-frequency curve based on partial duration series (PDS) analysis for Bluegrass Creek at Potomac, Vermilion County Ill., (03336500).

(area of open water and herbaceous wetland, in percent of basin area), *BL* (basin length, in miles), *BW* (basin width, in miles), *MCL* (main-channel length, in miles), and *TTF* (2-day, 24-hour rainfall depth, in inches). In addition, dummy variables were used as the surrogate for factors affecting Q_T's that could not be properly expressed as variables (for example, Helsel and Hirsch, 1992). With the use of dummy variables, all rural watersheds in the State were included in each regression analysis, not just those stations in the specified hydrologic region (appendix 7). When the analysis was concluded, the numerical values of the dummy variable were converted to regional factors for those regions using the same group of explanatory variables. At the screen stage, the OLS technique was used for identifying the optimal grouping of explanatory variables.

Using the multiple regression analysis, the regional equations were developed for each recurrence interval separately. Such procedures could result in different groupings of explanatory variables for different Q_T's in the same hydrologic region. Although conceptually correct, such a formulation could result in discontinuity in the flood-frequency curves. That is, the estimated Q_T at a lower T might have large magnitude than the estimated Q_T at the next higher T. Results like such were observed at a few small basins especially those located near the regional boundaries. In this study, the same group of explanatory variables was used for all the Q_T's in the same region. Selection of the optimal group of explanatory variables for all the Q_T's in the same region was determined by evaluating the sum of square of errors (*SSE*) for each of the potential regression equations in the screen stage. The final regression model was identified if the *SSE* for one explanatory variable group was within a specified tolerance level of the *SSE* in each of the Q_T model (appendix 7). For the AMS regional equations, a relative low tolerance level, 10 percent, could be reached. For the PDS regional equations, the tolerance level had to be relaxed to 25 percent for hydrologic region 2, 17 percent for region 3, and 10 percent for all other regions.

The screening analysis indicated that *TDA* and *MCS* were the main explanatory variables in the AMS regional equations. These results were the same as obtained by Curtis (1987, 1977b). The *TTF* was not selected in this analysis probably because the updated rainfall depths (Huff and Angel, 1992) among different regions became less distinguishable to the regression analysis. Instead, the *PermAvg*, *%Water*, or *BL* was selected as the auxiliary (third) explanatory variable. The final AMS regional equations were determined by GLS analysis. The *BL* and *BW* variables could be alternatives to *TDA* and appeared more frequently in the PDS regional equations in this study. After converting *BW* to *TDA* and *BL*, *TDA* is the main explanatory variable for the PDS regional equations. The PDS regional equations were determined by OLS analysis.

Measurement of Explanatory Variables

When the values of explanatory variables for the sites in question need to be measured, the same procedures and datasets (as described in the Basin Characteristics section) should be used whenever possible. Suggestions for using other means to determine the values of these variables are given below. However, users are first reminded of these three points.

1. Use the same definitions and units for these variables (see appendix 5).
2. Refer to published watershed boundaries or be familiar with the delineation of watersheds. Watershed boundaries determined with automated procedures need to be verified.
3. Pay attention to the map scales if multiple maps are used. Errors can result from using maps at different scales.

When measuring the variables from a map, a grid method can be used to minimize measurement errors. The method involves dividing the study area into small, uniform grids; users then can measure the variable value in each grid, and sum up the individual values. The following is a brief summary for determining each of the five explanatory variables.

- *TDA*, basin drainage areas, in square miles. *TDA* can be measured by planimetering the USGS 7.5-minute topographic, county, or other maps; obtained from DEM with other computerized programs; from published reports or other reliable means. Field reconnaissance to verify the delineated watershed always is helpful.
- *MCS*, main-channel slope, in feet per mile. *MCS* is computed from the difference in streambed elevations at points 10 percent and 85 percent of the distance along the main channel from the basin outlet to the basin divide, $MCS=(E_{85}-E_{10})/(0.75MCL)$. The *MCL* (measured with a displacement gage) and elevations can be obtained using the USGS 7.5-minute topographic, county, or other maps; from DEM with other computerized programs, field survey, published reports, or other reliable means.

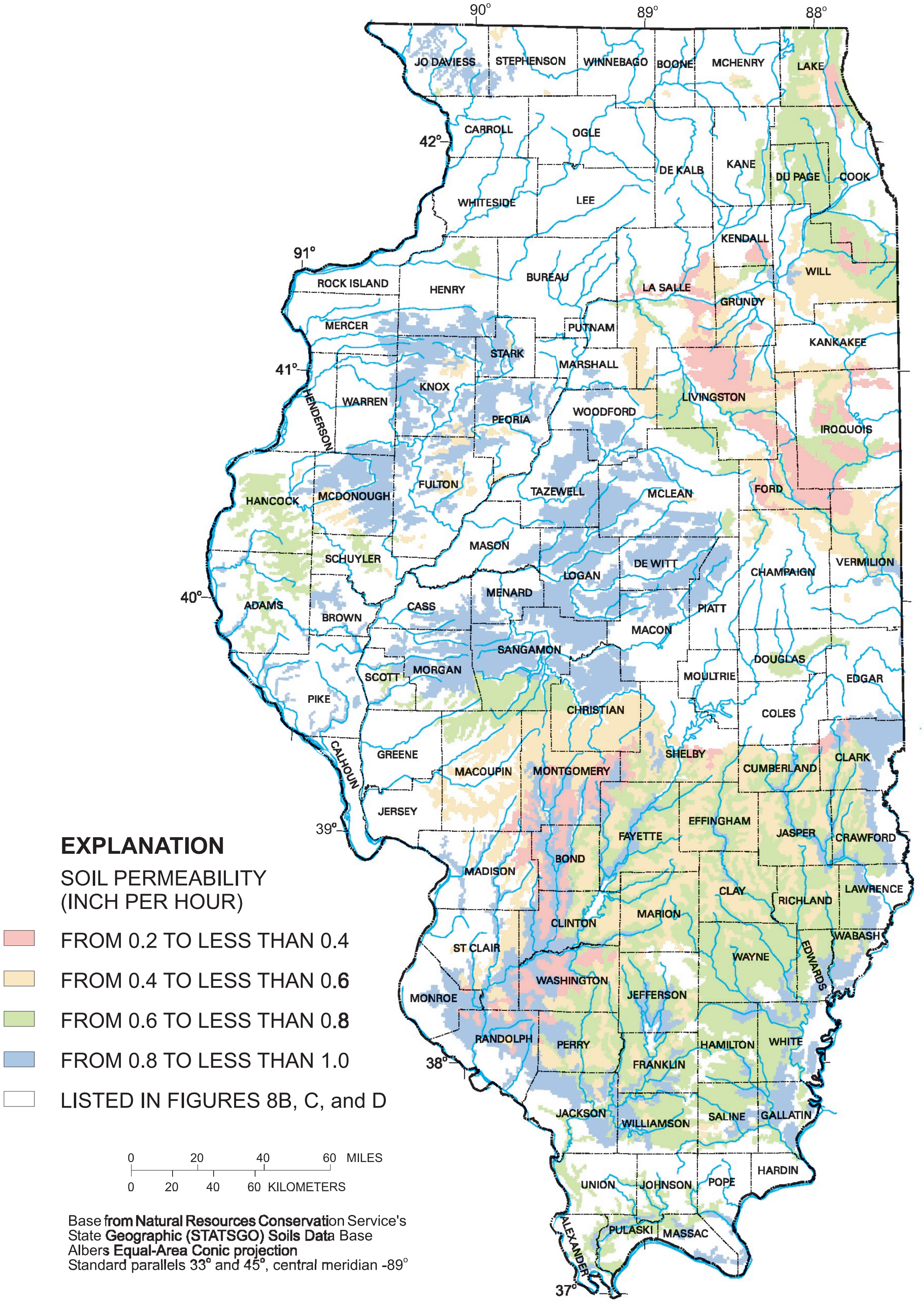
- *PermAvg*, average soil permeability, in inches per hour. This term is the area-weighted (represented at the basin centroid) arithmetic mean of *PermH(igh)* and *PermL(ow)*, which are determined from the STATSGO database. Other computer programs with GIS capabilities (the BASINSOFT program was used in this study) can be used with STATSGO to determine the *PermH* and *PermL*. The average soil permeability for the State is illustrated in figures 8A-D, in which different ranges of the *PermAvg* values are prepared. Users also can use the digital version of these figures in the attached CD-ROM to zoom in the areas under study.
- *%Water*, the percentage of area classified as open water and herbaceous wetland in a watershed. This value can be determined using computer programs with GIS capabilities on the NLCD database or other equivalent land-cover dataset (for example, the Land Cover of Illinois by the Illinois Department of Natural Resources, 1996), or measured by planimetering the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory maps, other suitable maps, by field survey, published reports, or other reliable means. The USFWS maps are available in both hard-copy and digital formats for all of Illinois and are printed at the same scale as the USGS topographic maps. There also is an interactive mapper available through the USFWS Web site (*http://mapper.tat.fws.gov/nwi/viewer.htm*, accessed December 2003), where specific study areas can be printed. Note that users need to add a constant of 5 (percent) to this explanatory variable before applying it to the regional equations. A constant 5 (percent) was added to this explanatory variable during the regression analysis to avoid zeros when transforming to logarithmic values.
- *BL*, basin length, in miles. *BL* can be measured by using a displacement gage on the USGS 7.5-minute topographic, county, or other maps; obtained from DEM with other computerized programs; or from field survey, published reports, or other reliable means. When using a map, measure along a line from the basin outlet to the intersection of the main channel (extended, if necessary) with the upper basin boundary. The line should not cross outside the drainage-basin boundaries.

TECHNIQUES FOR ESTIMATING FLOOD-PEAK DISCHARGE MAGNITUDES AND FREQUENCIES

The regional equations, for both AMS and PDS, are presented in a general form in the next two sections with tables containing the values of coefficients and exponents of the explanatory variables for each selected T. Also presented in the tables are parameters for estimating the accuracy of the regional equations. As mentioned previously, the AMS flood estimates presented here are suitable for flood protection and prevention analyses, similar to those presented in previous statewide flood-frequency analysis. The PDS flood estimates, on the other hand, could be more suitable than AMS estimates in environmental studies where damages caused by more frequent or repeated flood magnitudes in a year are of concern. However, the PDS estimates are presented only for flood-peak discharge magnitudes smaller than 5 years in this study (see appendix 1). If the Q_5 is required, the AMS result should be used unless the purpose of the study requires use of the PDS. The AMS and PDS results are presented separately and the meaning of their results should be distinguished clearly. Users also are reminded that the resulting regional equation estimates the mean (logarithmic) value of Q_T of different basins in the region with the same set of explanatory variables (William Kirby, U.S. Geological Survey, written commun., 2003). Local features that can affect flow magnitudes are not accounted for in the regional equations.

The AMS regional equations are developed for T's of 2, 5, 10, 25, 50, 100, and 500 years. The estimates of Q_{500} are included for applications in floodplain delineation and flood-insurance studies. Understandably, higher uncertainties are associated with estimates at larger T's no matter which flood series is used. The PDS regional equations are developed for T's equal to 0.8, 1.01, 1.5, 2, 3, and 5 years. An overview of the procedures for computing the flood-frequency estimates at an ungaged or gaged site is illustrated in the flowchart illustrated in figure 9, including techniques described in the following sections. After the applicability of the regional equations is determined (fig. 9), the user can proceed through the procedures as follows:

1. Identify the region where the site is located using figure 5; then identify the explanatory variables from the corresponding general regional equation. The general equation for the AMS regional equations is found in the Annual Maximum Series Regional Equations section. The general equation for the PDS regional equations is found in the Partial Duration Series Regional Equations section. Note that if the site is at a streamflow-gaging station, where at-site Q_T's have been estimated in this report, the at-site estimates may be obtained from table 1 (AMS) or table 2 (PDS). See item 4 below.



Base from Natural Resources Conservation Service's
State Geographic (STATSGO) Soils Data Base
Albers Equal-Area Conic projection
Standard parallels 33° and 45°, central meridian -89°

Figure 8A. Average soil permeability (from 0.2 to less than 1.0 inch per hour) for Illinois. Average soil permeability is obtained by taking the arithmetic average of the high and low soil-permeability values from the STATSGO database (Natural Resources Conservation Service, 1993).

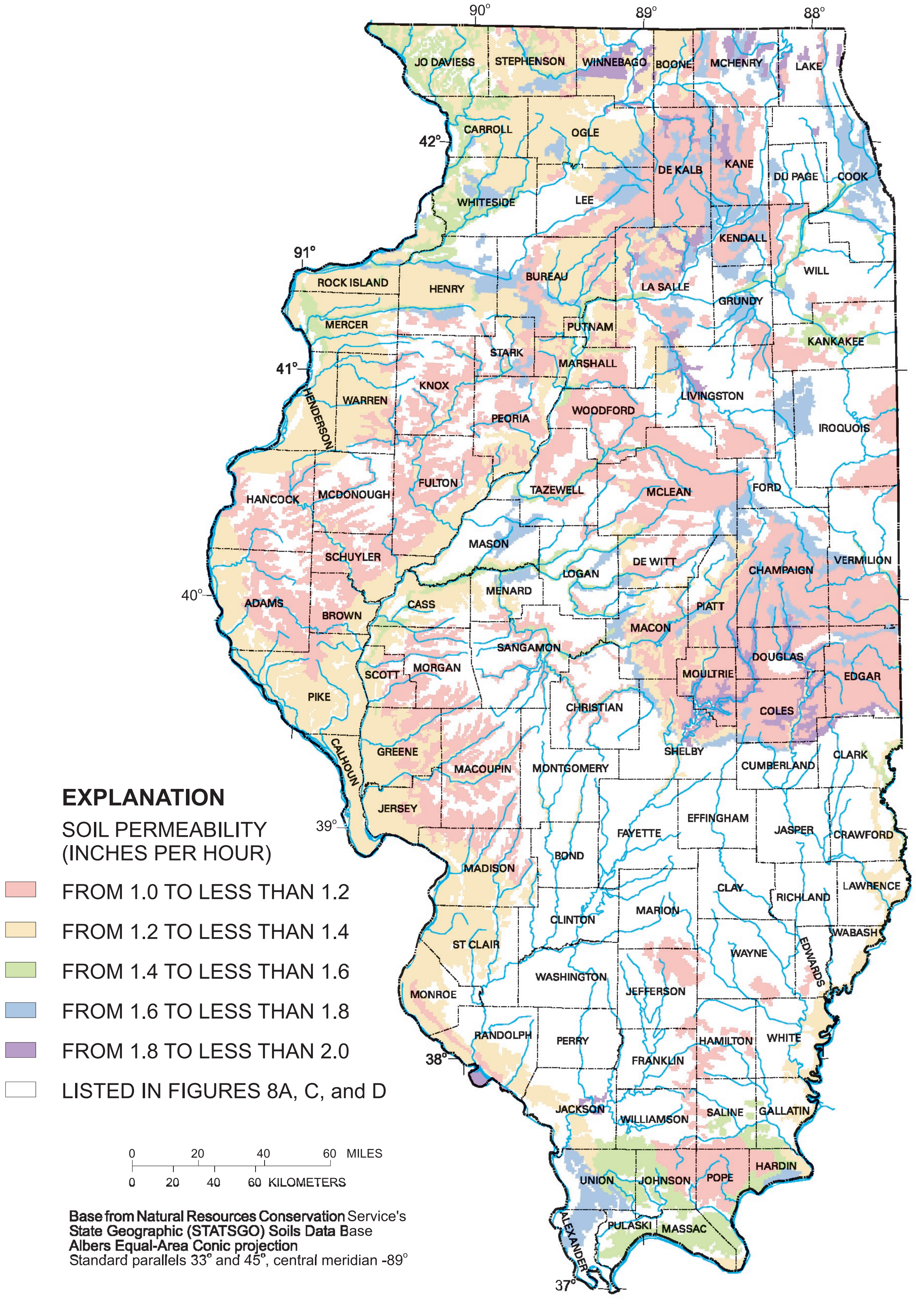
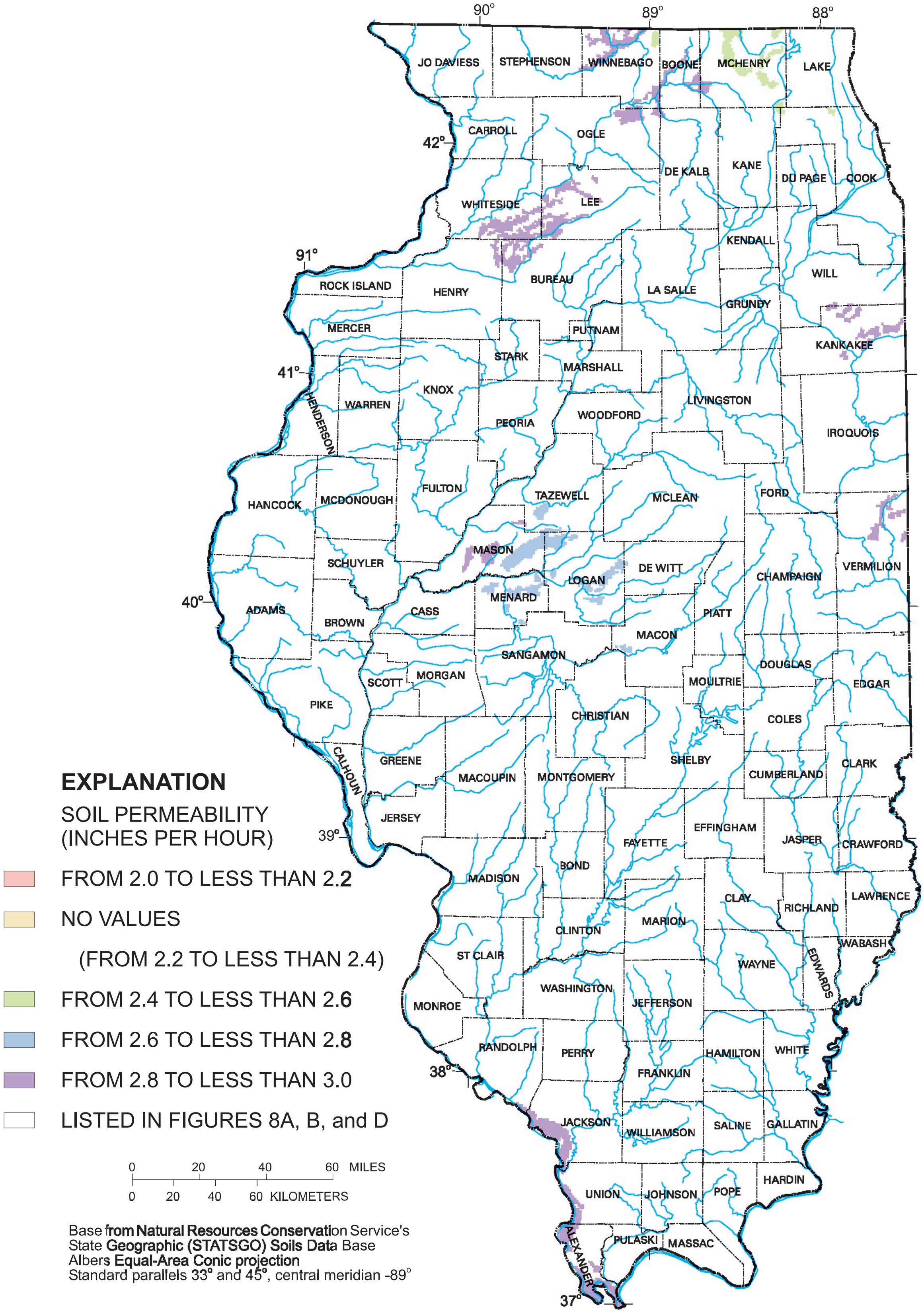
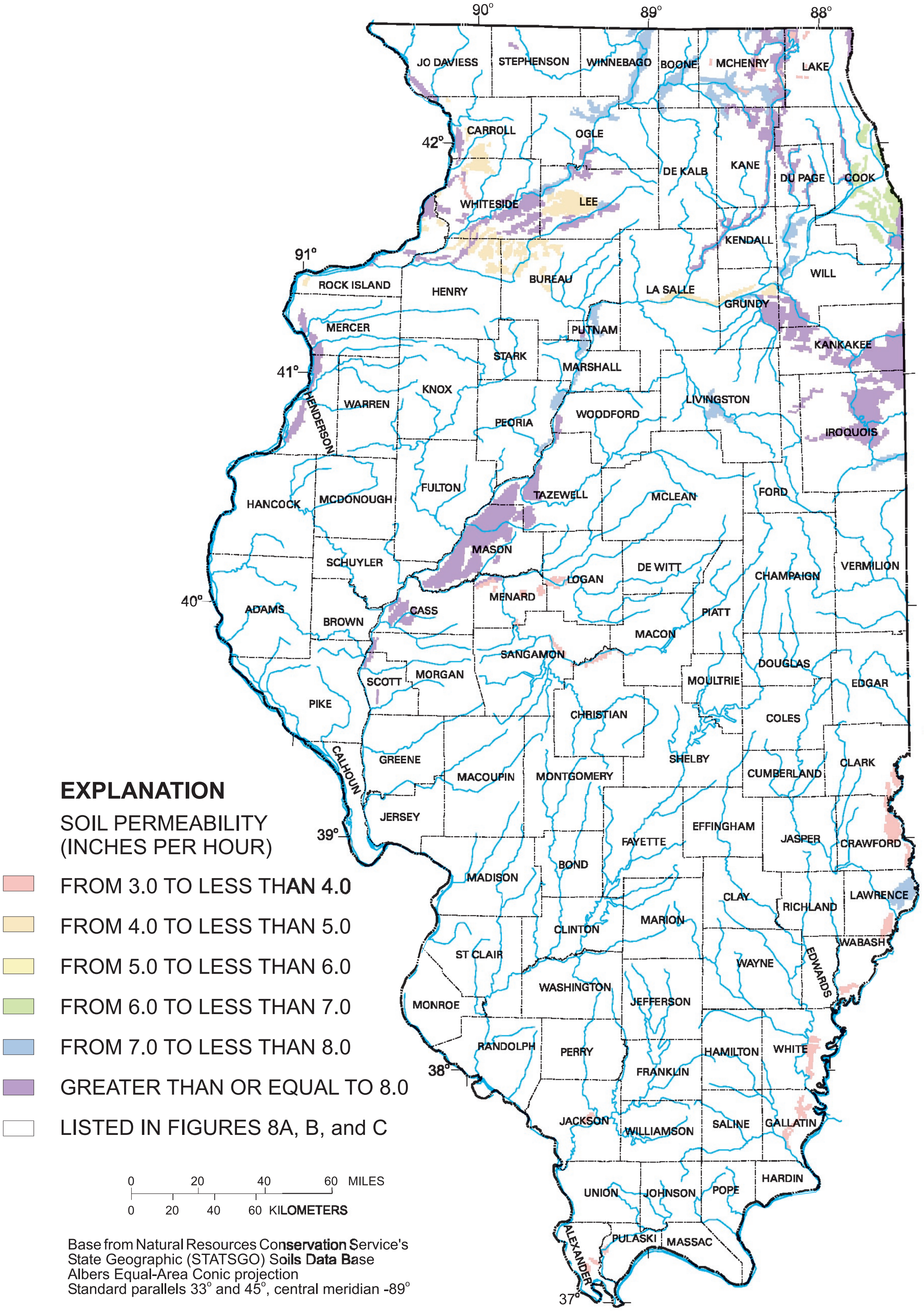


Figure 8B. Average soil permeability (from 1.0 to less than 2.0 inches per hour) for Illinois. Average soil permeability is obtained by taking the arithmetic average of the high and low soil-permeability values from the STATSGO database (Natural Resources Conservation Service, 1993).



Base from Natural Resources Conservation Service's
State Geographic (STATSGO) Soils Data Base
Albers Equal-Area Conic projection
Standard parallels 33° and 45°, central meridian -89°

Figure 8C. Average soil permeability (from 2.0 to less than 3.0 inches per hour) for Illinois. Average soil permeability is obtained by taking the arithmetic average of the high and low soil-permeability values from the STATSGO database (Natural Resources Conservation Service, 1993).



Base from Natural Resources Conservation Service's
State Geographic (STATSGO) Soils Data Base
Albers Equal-Area Conic projection
Standard parallels 33° and 45°, central meridian -89°

Figure 8D. Average soil permeability (from 3.0 to greater than 8.0 inches per hour) for Illinois. Average soil permeability is obtained by taking the arithmetic average of the high and low soil-permeability values from the STATSGO database (Natural Resources Conservation Service, 1993).

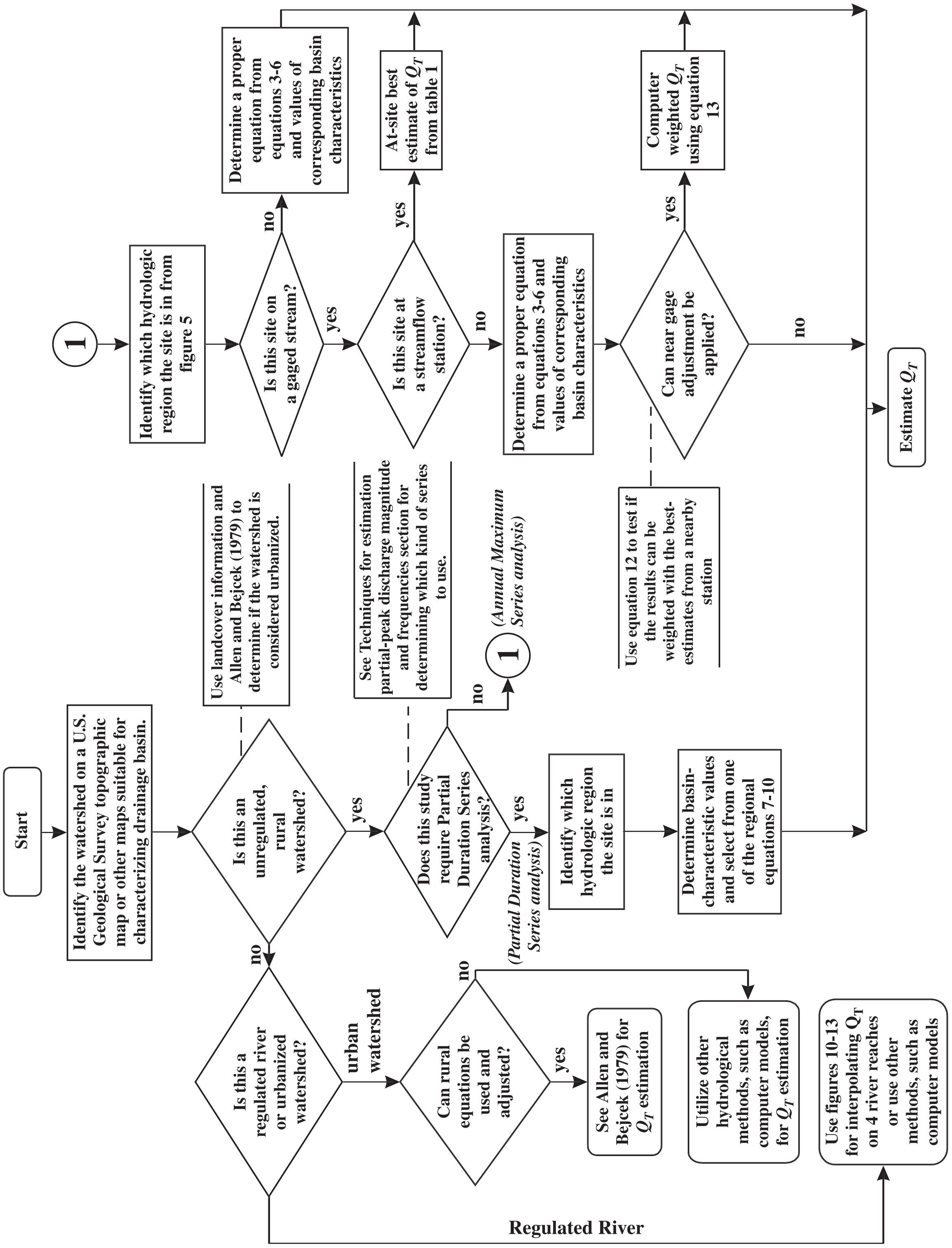


Figure 9. Procedures developed during the present study to estimate flood quantiles at a stream location.

2. Determine representative values of the explanatory variables by using tables and figures provided in the report, or measure these values from other maps (see Measurement of Explanatory Variables section above).

3. Compute Q_T's by substituting in values of the explanatory variables and selecting coefficients and exponents corresponding to the selected T's from the tables in the appropriate section below where the regional equations are described. The computed Q_T's are designated for ungaged sites.

4. For the AMS flood quantiles, if the site is on the same stream and nearby a streamflow-gaging station (use figures 2A and 2B or the digital versions in the CD-ROM) where at-site Q_T's have been estimated in this report (table 1), a weighting procedure can be applied to improve the regional equation estimates. See provided examples in the Gaged Sites and Near Gaged Sites sections for adjusting the computed Q_T's. No weighting procedure has been developed for the PDS series.

5. For Q_T's at recurrence intervals other than those given in the equations, users can develop the frequency curve on log-probability plotting paper and interpolate for the Q_T's in question.

The following sections (1) present the AMS regional equations; (2) illustrate the use of the AMS regional equations for an ungaged site with an example application; (3) illustrate the use of the AMS regional equations to improve flood quantiles at a gaged site; (4) provide a technique for improving flood quantiles near a gaged site; (5) describe the limitations and accuracy of the AMS regional equations techniques; and (6) present a technique to transfer flood quantiles in four regulated channel reaches of Illinois.

Although no example for PDS regional equation is prepared, the procedures for applying the AMS and PDS regional equations are similar, however. The PDS regional equations and their limitations and accuracy are presented after the AMS regional equation techniques. No techniques for improving the PDS regional equations estimates through regional weighting or areal adjustment, or transferring the estimates in regulated channels are provided, as these items are beyond the scope of this study.

Annual Maximum Series Regional Equations for Rural, Unregulated Streams

A general form of the regression equation for hydrologic regions 1, 3, and 5 is given in equation 3 below, and the coefficient for each term is presented in table 3.

$$Q_T = a(TDA)^b\,(MCS)^c\,(PermAvg)^d\,RF\,(N) \qquad \text{[for hydrologic regions 1, 3, and 5]} \qquad (3)$$

The parameters that can be used to measure the uncertainty and accuracy of these regression equations also are shown in table 3. These parameters were obtained from the GLSNET program (Tasker and Stedinger, 1989) output and their values were the averaged values for all the 288 rural-watershed stations. The method for using *APE* to evaluate model accuracy and uncertainty is given in appendix 7 (Regression Analysis). The *AEYR* describes the accuracy of the regression equation. It is an estimate of the number of years of streamflow record that must be collected at a streamflow-gaging station to estimate the magnitude of flood-peak discharge for a selected frequency with an accuracy equivalent to that of the regression equation (Hardison, 1971, p. C232).

A general form of the regression equation for hydrologic regions 2, 6, and 7 is given in equation 4. A constant, 5, has been added to *%Water* to avoid zero values when transformed to logarithmic values. The regression equations were developed with this constant added to the variable; therefore, the user also must add the constant (5) to the determined value of *%Water*, as shown in the equation. The corresponding coefficient for each term is presented in table 4.

$$Q_T = a(TDA)^b\,(MCS)^c\,(\%Water + 5)^d\,RF\,(N) \qquad \text{[for hydrologic regions 2, 6, and 7]} \qquad (4)$$

The regression equation for hydrologic region 4 is given as

$$Q_T = a(TDA)^b\,(MCS)^c\,(BL)^d \qquad \text{[for hydrologic region 4].} \qquad (5)$$

The corresponding coefficient for each term is given in table 5.

The explanatory variables of the AMS regional equations are similar to those used by Curtis (1987), except the third variable. The exponents of *PermAvg* in equation 3, as well as those of *%Water* in equation 4, depict the reverse relation of infiltration and storage to the magnitude of flood-peak discharges. Originally, explanatory variables

Table 3. Coefficients and exponents for equation 3 based on annual maximum series for hydrologic regions 1, 3, and 5, Illinois, for specified recurrence intervals.

[$\boldsymbol{Q_T}$, flood quantile, in cubic feet per second, *ft^3/s*; ***a***, coefficient; ***b***, exponent for drainage area ***TDA***, in square miles, *mi^2*; ***c***, exponent for main-channel slope ***MCS***, in feet per mile, *ft/mi*; ***d***, exponent for averaged permeability ***PermAvg***, in inches per hour, *in/hr*; ***RF(N)*** regional factor for region ***N***; $\boldsymbol{APE_{\%}}$, average prediction error of the regional equation, in percent, %; γ^2, model error variance, in log value; $\gamma_{\%}$, standard error of the model, in percent, %; ***AEYR***, average equivalent years of record, in years, *yr*]

Q_T (ft^3/s)	a	b	c	d	RF(1)	RF(3)	RF(5)	APE% (%)	γ^2	$\gamma_{\%}$ (%)	AEYR (yr)
Q_2	22.2	0.749	0.401	-0.224	1.467	1.620	2.128	39.5	0.0257	38.2	2.7
Q_5	34.1	.743	.437	-.223	1.563	1.811	2.360	40.0	.0263	38.7	3.2
Q_{10}	41.8	.740	.457	-.224	1.618	1.913	2.476	41.6	.0282	40.2	3.9
Q_{25}	50.8	.738	.478	-.224	1.686	2.030	2.612	44.2	.0315	42.6	4.7
Q_{50}	57.0	.737	.491	-.223	1.738	2.113	2.711	46.6	.0345	44.8	5.2
Q_{100}	62.7	.736	.503	-.222	1.790	2.192	2.809	49.0	.0378	47.1	5.6
Q_{500}	74.5	.735	.527	-.219	1.917	2.371	3.037	54.9	.0462	52.7	6.2

Table 4. Coefficients and exponents for equation 4 based on annual maximum series for hydrologic regions 2, 6, and 7, Illinois, for specified recurrence intervals.

[$\boldsymbol{Q_T}$, flood quantile, in cubic feet per second, *ft^3/s*; ***a***, coefficient; ***b***, exponent for drainage area ***TDA***, in square miles, *mi^2*; ***c***, exponent for main-channel slope ***MCS***, in feet per mile, *ft/mi*; ***d***, exponent of the (*%Water +5*) term (*%Water+5* is the percentage of open water and herbaceous wetland, where 5 is added to avoid zero values), in percent, %; ***RF(N)*** regional factor for region ***N***; $\boldsymbol{APE_{\%}}$, average prediction error of the regional equation, in percent, %; γ^2, model error variance, in log value; $\gamma_{\%}$, standard error of the model, in percent, %; ***AEYR***, average equivalent years of record, in years, *yr*]

Q_T (ft^3/s)	a	b	c	d	RF(2)	RF(6)	RF(7)	APE% (%)	γ^2	$\gamma_{\%}$ (%)	AEYR (yr)
Q_2	54.7	0.728	0.341	-0.470	1	2.963	3.515	40.4	0.0268	39.1	2.6
Q_5	94	.721	.374	-.527	1	3.119	3.281	40.7	.0271	39.3	3.1
Q_{10}	120	.718	.393	-.550	1	3.241	3.226	42.0	.0288	40.6	3.8
Q_{25}	151	.716	.413	-.573	1	3.409	3.217	44.7	.0321	43.1	4.6
Q_{50}	174	.715	.426	-.586	1	3.540	3.236	46.9	.0350	45.2	5.2
Q_{100}	195	.714	.437	-.598	1	3.672	3.269	49.2	.0381	47.3	5.6
Q_{500}	241	.714	.461	-.619	1	3.980	3.377	55.0	.0464	52.8	6.2

selected for region 4 were *TDA*, *BL*, and *BW*. Watersheds in region 4 (described by equation 5), in general, contain bedrock topography, dissected upland, and deep incised channels, where varying hydraulic factors may have considerable effects on channel flows. *BL* and *BW*, variables describing the flow time, were selected instead of the contributing area. The *BW* is a function of *TDA* and *BL* (appendix 5), thus, equation 5 has a similar form as equations 3 and 4.

Numerical values of selected basin characteristics used in the regression analysis and equivalent years of record for each recurrence interval for the 288 stations are given in table 6, and record length, historical events, and flood-peak information for these stations are presented in table 7. Tables 6 and 7 are located at the back of the report.

Application of Annual Maximum Series Regional Equations

Examples on how to use the AMS regional equations to compute flood quantiles at ungaged streams are given here. Note that the regional equations estimate the mean (logarithmic) value of Q_T of streams in the region with one set of explanatory variables. When estimated at-site flood quantiles are available or the site is near a gaging station

Table 5. Coefficients and exponents for equation 5 based on annual maximum series for hydrologic region 4, Illinois, for specified recurrence intervals.

[Q_T, flood quantile, in cubic feet per second, *ft³/s*; ***a***, coefficient; ***b***, exponent for drainage area ***TDA***, in square miles, *mi²*; ***c***, exponent for main-channel slope ***MCS***, in feet per mile, *ft/mi*; ***d***, exponent for basin length, ***BL***, in miles, *mi*; $APE_{\%}$, average prediction error of the regional equation, in percent, %; γ^2, model error variance, in log value; $\gamma_{\%}$, standard error of the model, in percent, %; ***AEYR***, average equivalent years of record, in years, *yr*]

Q_T (ft³/s)	a	b	c	d	APE% (%)	γ^2	$\gamma_{\%}$ (%)	AEYR (yr)
Q_2	49.3	0.734	0.370	-0.006	41.1	0.0277	39.8	2.5
Q_5	85.1	.772	.406	-.095	41.5	.0282	40.2	3.0
Q_{10}	111	.792	.425	-.140	43.0	.0300	41.5	3.7
Q_{25}	144	.812	.446	-.183	45.5	.0332	43.9	4.5
Q_{50}	168	.823	.460	-.207	47.7	.0361	45.9	5.0
Q_{100}	193	.833	.472	-.228	50.0	.0393	48.1	5.4
Q_{500}	250	.852	.496	-.266	55.7	.0475	53.5	6.1

on the same stream, the regional estimates could be weighted with the at-site flood quantiles to improve the estimates at that location. These three cases (ungaged, gaged, and a nearby streamflow-gaging station) are illustrated with three sites in the Blackberry Creek watershed (a tributary to the Fox River) in Kane and Kendall Counties, northern Illinois (fig. 10). The examples are illustrated with estimation of the Q_{100}.

Ungaged Sites

The first site is at the outlet of a Lake Run tributary (fig. 9), an ungaged site. The estimated magnitude of 100-year flood discharge is calculated as follows.

1. Identify the hydrologic region and explanatory variables. From figure 5, this site is located in hydrologic region 2; equation 4 and table 4 will be needed for calculating the Q_{100}. The explanatory variables are *TDA*, *MCS*, and *%Water*, and a regional factor.
2. Determine the values of drainage area *TDA*, in square miles; main-channel slope, *MCS*, in feet per mile; and the percent area classified as open water and herbaceous wetland, *%Water*, where the constant 5 is added to make the variable (*%Water+5*), using the procedures discussed in the Measurement of Explanatory Variables section. The values for Lake Run tributary are 14.0 mi², 11.4 ft/mi, and 6.34 percent for *TDA*, *MCS*, and (*%Water+5*), respectively.
3. From table 4, the coefficient and exponents corresponding to the 100-year flood quantile are 195, 0.714, 0.437, and –0.598 for the constant, *TDA*, *MCS*, and (*%Water+5*), respectively. The regional factor *RF(2)* is 1.
4. Substitute these coefficients and exponents in equation 4, and the Q100 is computed as

$$Q_{100} = 195(14.0)^{0.714}\,(11.4)^{0.437}\,(6.34)^{-0.598}\,(1), \quad \text{or}$$

$$Q_{100} = 1{,}232\ ft^3/s.$$

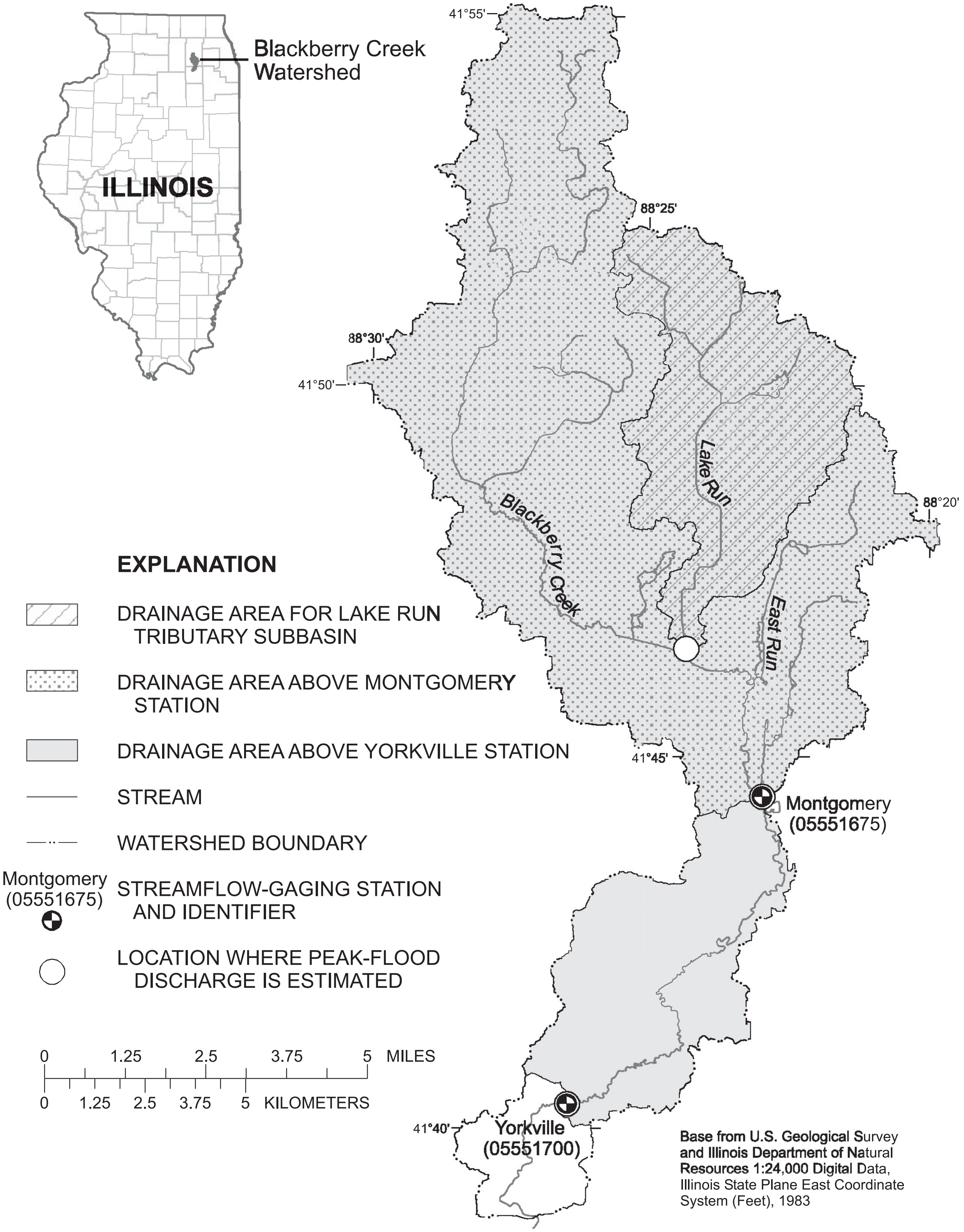
Gaged Sites

Flood quantiles at a gaged site are weighted using a procedure adopted from the equivalent years of record concept (Hardison, 1971). The procedure can be described in equation form as

$$LogQ_T\,|_{\,weighted} = \frac{(years\ of\ record)\left(logQ_T\,|_{\,at\text{-}site}\right) + (EYR)\left(logQ_T\,|_{\,regional}\right)}{(years\ of\ record + EYR)}\ , \qquad (11)$$

where EYR is the equivalent years or record at this site.

For the Blackberry Creek watershed, a USGS streamflow-gaging station is present near Yorkville (05551700)



Base from U.S. Geological Survey and Illinois Department of Natural Resources 1:24,000 Digital Data, Illinois State Plane East Coordinate System (Feet), 1983

Figure 10. Blackberry Creek watershed, Kane and Kendall Counties, Illinois, and site locations of three subbasins used in examples of application of the annual maximum series (AMS) regional equations.

near the outlet (fig. 9). Streamflow records are available since WY 1961 and there were 39 years of record up to WY 1999 that were used for this study (table 11). The estimated at-site Q_{100} is 2,847 ft^3/s, the equivalent years of record for Q_{100} at this site is 4.1 years (see table 6). The weighted Q_{100} is calculated as follows.

1. Determine the values of *TDA*, *MCS*, and (*%Water+5*), that are 69.4 mi^2, 5.9 ft/mi, and 6.04 percent, respectively.
2. Compute the regional estimate of Q_{100} by substituting these values and the coefficients in equation 4. Because the regional factor is 1, it is not shown in the calculation resulting in

$$Q_{100}\,|_{\,regional} = 195(69.4)^{0.714}\,(5.9)^{0.437}\,(6.04)^{-0.598},$$

$$= 2{,}980\,ft^3/s.$$

3. Determine the weighted Q_{100} using equation 11 as

$$LogQ_T\,|_{\,weighted} = \frac{(39)\left(\log 2{,}847\,|_{\,at\text{-}site}\right) + (4.1)\left(\log 2{,}980\,|_{\,regional}\right)}{(39+4.1)}\,.$$

   The weighted Log Q_{100} is 3.46. Note that flood quantiles are calculated in log (base 10) values. Therefore, the corresponding arithmetic value is 2,884 ft^3/s ($10^{3.46} = 2{,}884$).

The weighted result is considered the best estimate for Q_T at a gaged site.

The regional estimates for Q_T's at the 288 rural stations using regional equations 3–5 and the weighted results are listed in table 1. The weighted flood frequencies are considered the best flood estimates for these 288 rural-watershed stations.

Near Gaged Sites

Estimated flood quantiles can be adjusted at sites upstream or downstream from a gaging station on the same stream, depending on the proximity of the site to the gaging station. If the drainage area of the site in question is within ±50 percent of the drainage area of the gaging station, the estimated flood quantiles can be improved by using the ratio of the areas to compute an adjustment ratio between the regional estimate at the site and the estimate at the gaging station. Steps for estimating the flood quantiles are listed below.

1. Compute the Q_T using the appropriate regional equation.
2. Determine an adjustment ratio, *ar*, according to the drainage areas as

$$ar = \left|\frac{A_{site}}{A_{gage}} - 1\right| \times 2,\ \text{ if } 0.5 < \left|\frac{A_{site}}{A_{gage}}\right| < 1.5\ , \qquad (12)$$

$$= 1, \qquad \text{otherwise,}$$

   where A_{site} is the *TDA* of the study site and A_{gage} is the *TDA* of the gaging station. Note that the absolute value is used.

3. Calculate the adjusted flood quantile as

$$Q_T\,\Big|_{\,adjusted} = Q_T\,\Big|_{\substack{regional\\ equation}} \times ar + Q_T\,\Big|_{\substack{weighted\\ at\ gage}} \times (1-ar)\ . \qquad (13)$$

If the *TDA* of the study site is not within ±50 percent of the *TDA* at the gaging station, the adjustment ratio *ar* is 1 and the adjustment by weighted Q_T at the gaging station is zero.

For the Blackberry Creek watershed (fig. 10), the sub-watershed above Montgomery streamflow-gaging station (05551675 Blackberry Creek near Montgomery, fig. 10) is selected as an example for illustrating adjustment for sites near a gaged location. This station has been operating since WY 1998. Only 2 years of data were available by WY 1999; therefore, this station is treated as an ungaged site. The Q_{100} at this site is estimated as follows.

1. The *TDA*, *MCS*, and *(%Water+5)* at the Montgomery station are 58.6 mi^2, 7.9 ft/mi, and 6.12 percent, respectively. The estimated Q_{100} with the regional equation is 2,980 ft^3/s.
2. Because the drainage area is within 50 percent of that of the Blackberry Creek near Yorkville station and is on the main stem of the Blackberry Creek, the near gage adjustment will apply. The adjustment ratio, *ar*, is computed as

$$ar = \left| \frac{58.6\ mi^2}{69.4\ mi^2} - 1 \right| \times 2 = 0.31\ .$$

3. From the previous example, the weighted regional estimate of Q_{100} is 2,884 ft^3/s. The adjusted Q_{100} using equation 13 is

$$Q_{100} \Big|_{adjusted} = 2{,}980 \times 0.31 + 2{,}884 \times 0.69 = 2{,}913\ ft^3/s\ .$$

Accuracy and Limitation of the Annual Maximum Series Regional Equations

The average prediction error, *APE%*, in percent, ranges approximately from 41.6 to 43 percent for Q_{10} computed by various regional equations, and ranges from 49 to 50 percent for Q_{100}. The *APE%* and standard error of the model, $\gamma_{\%}$, listed in tables 3–5 are similar for all the recurrence intervals, indicating that the average standard error of sampling accounts for little additional unexplained variance of the regional equations (Wiley and others, 2000). The averaged equivalent years of record listed in tables 1–3 vary from 3.7 to 3.9 years for the 10-year flood and from 5.4 to 5.6 for the 100-year flood, for example. This information also is included in table 12 for each selected recurrence interval at the 288 stations.

The developed regional equations are applicable to rural streams of Illinois. The equations are not applicable to locations where streamflows are altered appreciably by regulation, diversion, channelization, or urbanization in the watersheds. Unusual natural morphologic, hydrologic, or geologic conditions, such as karst terrain, minimal soil cover, large off-channel storage, stream sites downstream from bluffs, and others, may cause deviations from the expected flood frequencies. In certain situations, additional adjustments to fit local hydraulics may be needed; for example, Baldwin and Potter (1986) described a case concerning the timing of tributary floods.

In developing the regional equations, a joint-parameter space, defined by the ranges of selected explanatory variables in the analysis, is defined to indicate the limitation in which the regional equations remain valid. When flood quantiles at a site in question are estimated with these regional equations, the values of explanatory variables for the watershed should be within the parameter space. Because dummy variables are used in developing the regional equations in this study, the parameter spaces are defined by explanatory variables associated with all the streamflow-gaging stations used for analysis. The ranges of selected explanatory variables for the AMS models are listed in table 8.

Record length, values of explanatory variables, and equivalent years of record are needed for applying the weighted adjustment procedures. Record length and other streamflow-record characteristics for the 288 stations are given in table 7. The values of explanatory variables and equivalent years of record for each recurrence interval for the 288 stations are given in table 12 (at back of report).

Regulated and Urban Streams

Regional equations are not applicable to regulated and urban streams. However, in the case of channel regulation, when the concern is that regulations could have created non-homogeneous peak-flow records from pre-construction datasets, at-site flood-frequencies representing a relatively constant channel condition can be used to develop a linear interpretation between these streamflow-gaging stations if the flood series are examined and non-

Table 8. Parameter space for the annual maximum series regional equations in Illinois.

[***TDA,*** total drainage area, in square miles, *mi²*; ***MCS,*** main-channel slope, in feet per mile, *ft/mi*; ***BL,*** basin length, in miles, *mi*; ***PermAvg,*** averaged permeability, in inches per hour, *in/hr*; ***(%Water+5),*** open water and herbaceous wetland plus a constant (5) in percent, %; -----, no data]

Explanatory Variables	Minimum value	Maximum value
TDA	0.03	9,554
MCS	.81	317
BL	.3	190
PermAvg	.3	8.0
(%Water+5)	5	13
-----	-----	-----

homogeneous data are removed. Regulated streams in Illinois include: Illinois River, Fox River below the Chain-of-Lakes, Kaskaskia River below Lake Shelbyville, Saline River below mouth of Cypress Ditch, and Big Muddy River below Rend Lake. Note that the Ohio, Wabash, and Mississippi Rivers are not considered in the analysis because large portions of their watersheds are outside of Illinois.

Flood frequencies for specific reaches of the Illinois River, Kaskaskia River from downstream of Cowden to upstream of Carlyle Lake, Big Muddy River below Plumfield, and Fox River below Algonquin (see figs. 2A and 2B) could be estimated by linearly interpolating between estimated flood frequencies at streamflow-gaging stations because channel conditions between the selected stations are reasonably consistent. To facilitate interpolation of flood frequencies between the gaging stations on these rivers on the basis of river miles, figures 11–14 were developed. However, these graphical interpretations only provide an approximation of the flood frequencies. The distances between these streamflow-gaging stations are large (miles and tens of miles). Other estimating methods than these graphs, such as hydraulic modeling, should be used for more detailed studies. For example, the U.S. Army Corps of Engineers has conducted a flood-frequency study on the Upper Mississippi River System (U.S. Army Corps of Engineers, 2004).

Reservoir operations, flow diversions, and/or inter-basin flow transfers modify the random nature of flood-peak discharge magnitudes; therefore, frequency analysis is not applicable. Discharge records for Saline River near Junction include inter-basin flow from the Wabash River through Cypress Ditch just upstream of the gaging station. The magnitude of the inter-basin flow depends on Wabash River stage, that, in turn, depends on Ohio River stage. The complexity of flood conditions precludes the use of regional equations on the Saline River at the confluence with the Wabash River.

Flood frequencies on urban streams in northeastern Illinois have been studied by Allen and Bejeck (1979). They have developed a set of curves (figure 6 in their report) for computing flood-peak discharge magnitudes at various levels of imperviousness or urbanization. The flood quantiles for urban streams were computed by multiplying their ratios to flood quantile for rural watersheds or less than 1-percent imperviousness. By assuming that the effects of urbanization on flood-peak discharges in northeastern Illinois are similar to urban effects in other parts of Illinois, the at-site flood quantiles and those regional equations can be used in conjunction with the correction factors developed by Allen and Bejeck (1979) to estimate flood frequencies on urban streams for other parts of Illinois. These estimates should be checked with estimates made with other methods such as rainfall-runoff models.

Partial Duration Series Regional Equations for Rural, Unregulated Streams

The PDS regional equations for rural, unregulated streams are presented in equations 6–12, and corresponding coefficients and exponents for T's equal to 0.8, 1.01, 1.5, 2, 3, and 5 years are presented in tables 9–13. Procedures for applying the PDS regional equations are similar to those for the AMS regional equations, although the PDS regional analysis yielded different explanatory variables from those AMS equations in some of the hydrologic regions.

The regression equation for hydrologic region 1 is given in equation 6 and the corresponding coefficient for each term is presented in table 9.

$$Q_T = a(TDA)^b\,(MCS)^c\,(\%Water + 5)^d \qquad \text{[for hydrologic region 1]} \qquad (6)$$

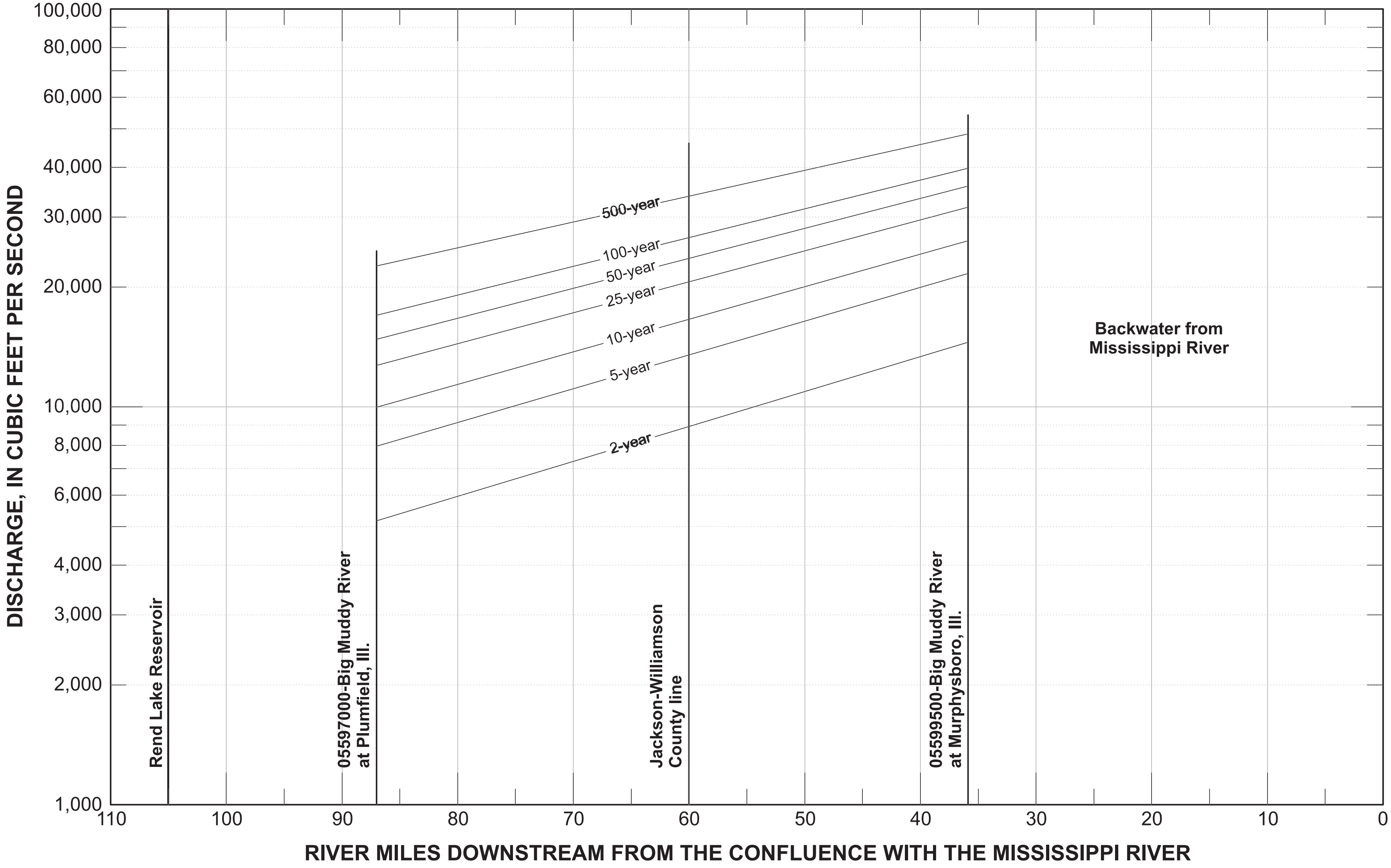


Figure 11. Estimated magnitudes of flood-peak discharges for selected recurrence intervals for the regulated reach of the Big Muddy River in southern Illinois.

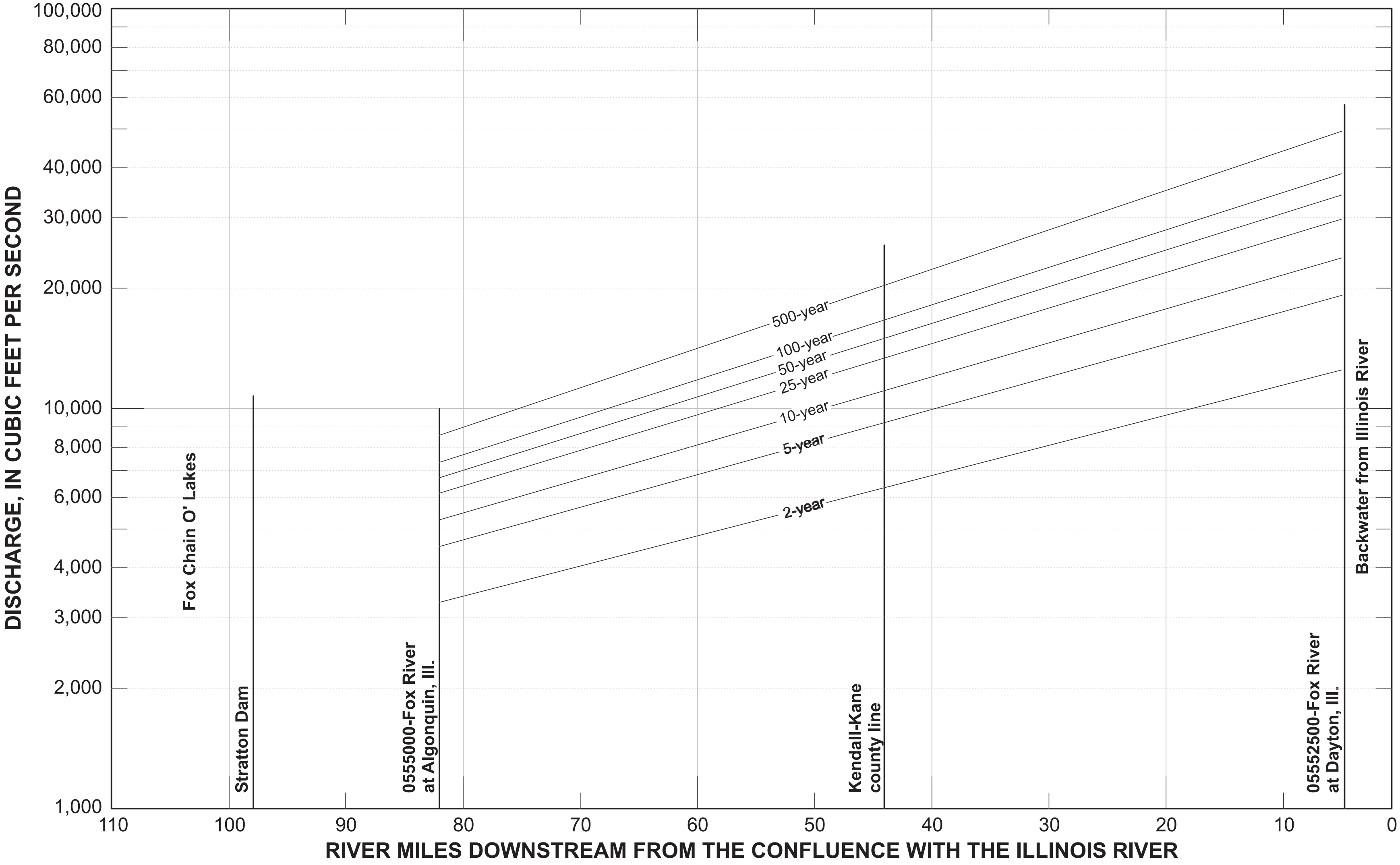


Figure 12. Estimated magnitudes of flood-peak discharges for selected recurrence intervals for the regulated reach of the Fox River in northern Illinois.

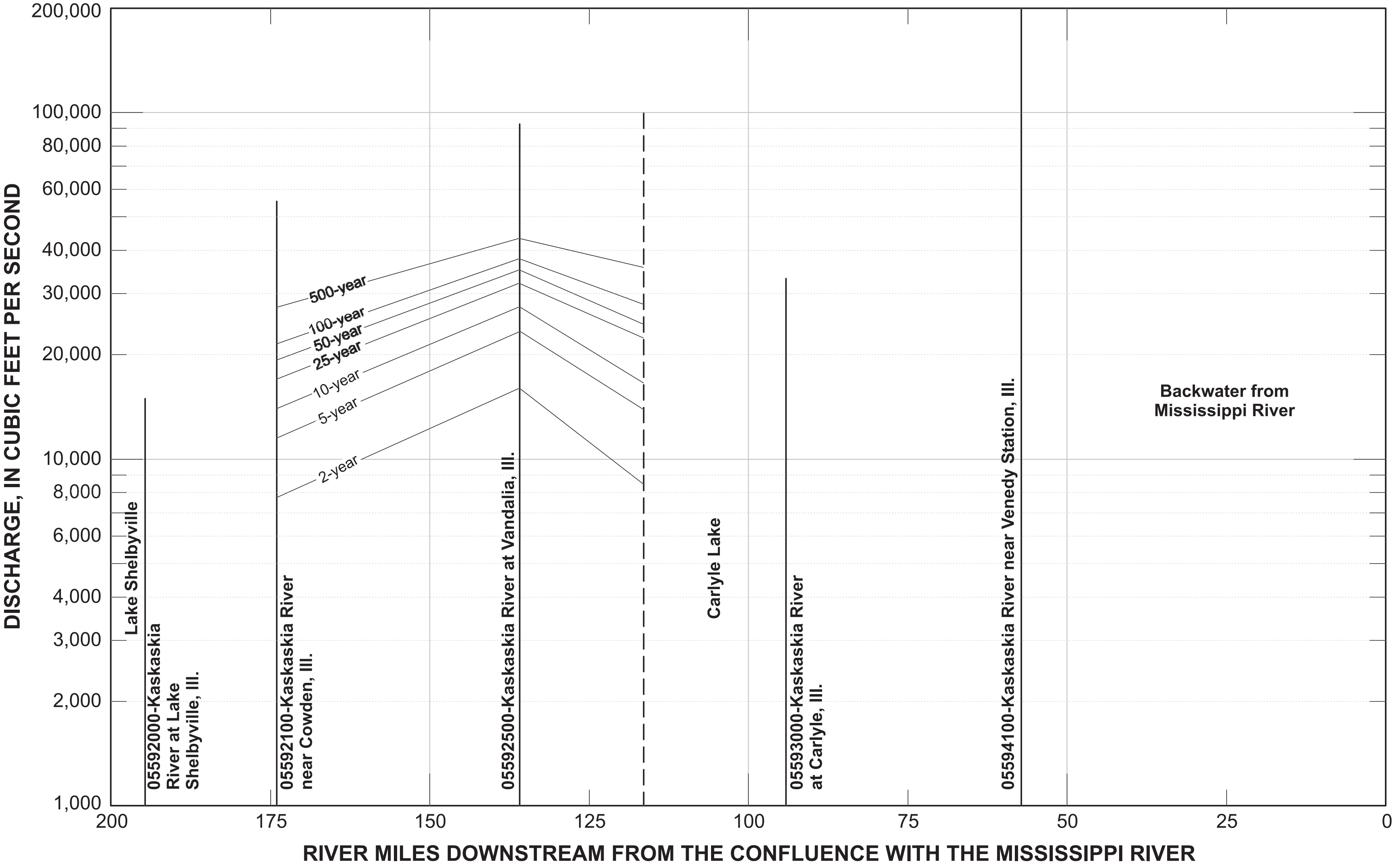


Figure 13. Estimated magnitudes of flood-peak discharges for selected recurrence intervals for the regulated reach of the Kaskaskia River in southern Illinois.

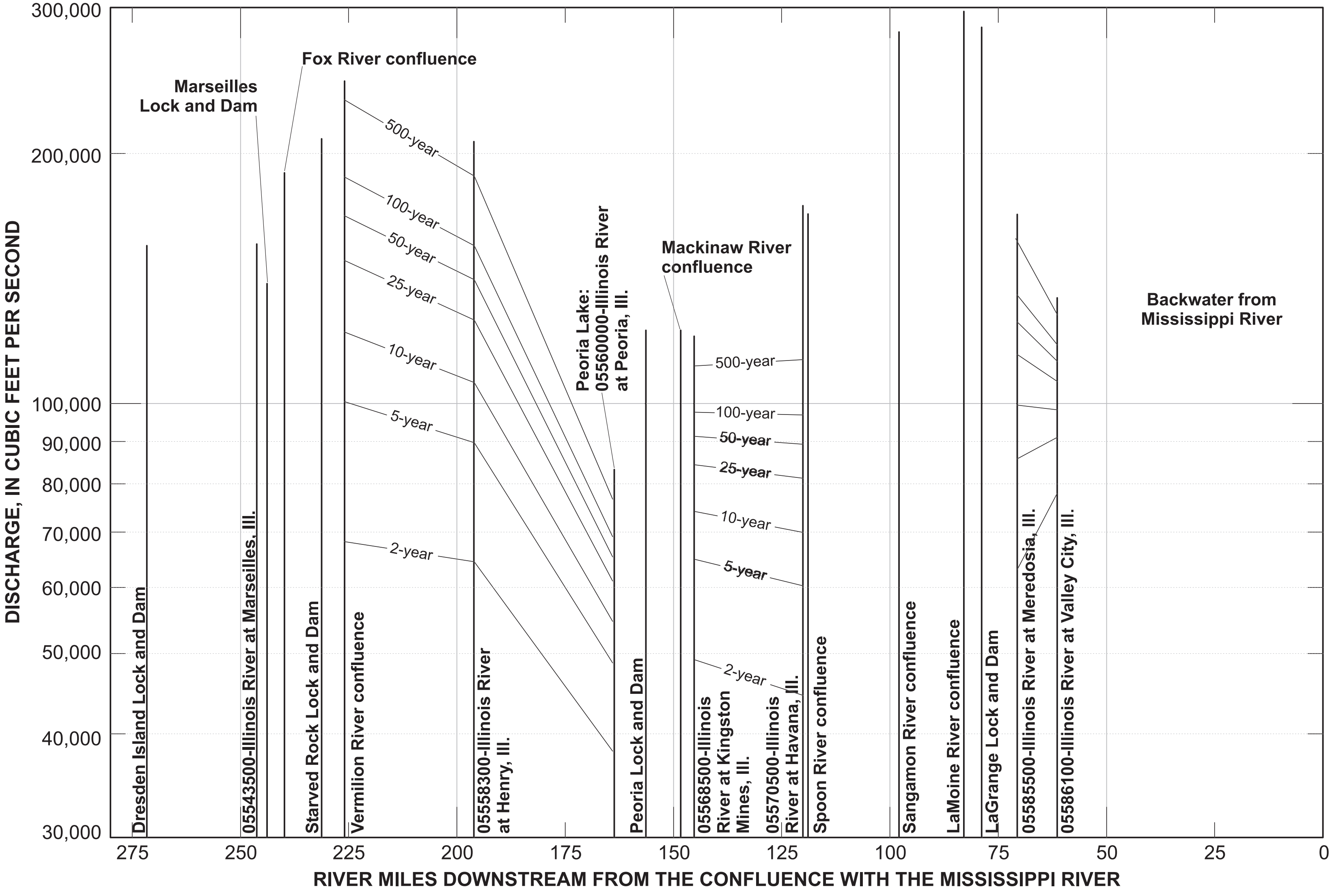


Figure 14. Estimated magnitudes of flood-peak discharges for selected recurrence intervals for the Illinois River.

Table 9. Coefficients and exponents for equation 6 based on partial duration series for hydrologic region 1, Illinois, for specified recurrence intervals.

[Q_T, flood quantile, in cubic feet per second, *ft³/s*; ***a***, coefficient; ***b***, exponent for drainage area ***TDA***, in square miles, *mi²*; ***c***, exponent for main-channel slope ***MCS***, in feet per mile, *ft/mi*; ***d***, exponent of the ***(%Water+5)*** term (*%Water* is the percentage of open water and herbaceous wetland, where the constant (5) is added to avoid zero values), in percent, %; ***SEE***, standard error of estimate of the regional equation, in percent, %; ***R²***, coefficient of determination (multiple correlation coefficient)]

Q_T (ft³/s)	a	b	c	d	SEE (%)	R^2
$Q_{0.8}$	33.3	0.771	0.438	-0.400	50.2	0.83
$Q_{1.01}$	52.6	.755	.458	-.515	44.1	.86
$Q_{1.5}$	83.9	.745	.478	-.621	41.4	.86
Q_2	107.0	.740	.488	-.673	40.9	.86
Q_3	140.8	.736	.498	-.733	41.2	.86
Q_5	185.9	.732	.508	-.793	41.7	.85

The regression equation for hydrologic region 2 is given in equation 7. Coefficients for each term are given in table 10.

$$Q_T = a(TDA)^b\,(BL)^c\,(PermAvg)^d \qquad \text{[for hydrologic region 2]} \qquad (7)$$

Table 10. Coefficients and exponents for equation 7 based on partial duration series for hydrologic region 2, Illinois, for specified recurrence intervals.

[Q_T, flood quantile, in cubic feet per second, *ft³/s*; ***a***, coefficient; ***b***, exponent for drainage area ***TDA***, in square miles, *mi²*; ***c***, exponent for basin length, ***BL***, in miles, *mi*; ***d***, exponent for averaged permeability, ***PermAvg***, in inches per hours, *in/hr*; ***SEE***, standard error of estimate of the regional equation, in percent, %; ***R²***, coefficient of determination (multiple correlation coefficient)]

Q_T (ft³/s)	a	b	c	d	SEE (%)	R^2
$Q_{0.8}$	17.9	0.775	0.223	-0.499	45.9	0.86
$Q_{1.01}$	23.7	.772	.185	-.470	41.4	.88
$Q_{1.5}$	32.8	.769	.152	-.448	39.9	.86
Q_2	39.5	.766	.138	-.438	40.2	.87
Q_3	49.1	.762	.125	-.428	40.9	.86
Q_5	61.8	.755	.114	-.417	42.5	.85

The regression equation for hydrologic region 3 is shown in equation 8. Coefficients for each term are given in table 11.

$$Q_T = a(TDA)^b\,(\%Water + 5)^c \qquad \text{[for hydrologic region 3]} \qquad (8)$$

The regression equation for hydrologic region 4 is shown in equation 9, and the coefficient for each term given in table 12.

$$Q_T = a(TDA)^b\,(MCS)^c\,(BL)^d \qquad \text{[for hydrologic region 4]} \qquad (9)$$

The regression equation for hydrologic regions 5, 6 and 7 is shown in equation 10 with the coefficient for each term given in table 13. Note that stations in region 7 are combined into region 6 because there are 11 stations in region 6 but only 4 stations in region 7. The regional factors resulting from the use of dummy variables have been combined into the corresponding coefficients and exponents.

$$Q_T = a_N(TDA)^{b_N}\,(MCS)^c\,(\%Water + 5)^d \qquad \text{[for hydrologic regions 5, 6, and 7]} \qquad (10)$$

Table 11. Coefficients and exponents for equation 8 based on partial duration series for hydrologic region 3, Illinois, for specified recurrence intervals.

[***Q_T***, flood quantile, in cubic feet per second, *ft^3/s*; ***a***, coefficient; ***b***, exponent for drainage area ***TDA***, in square miles, *mi^2*; ***c***, exponent of the (***%Water +5***) term (*%Water+5* is the percentage of open water and herbaceous wetland, where 5 is added to avoid zero values), in percent, %; ***SEE,*** standard errors of estimate of the regional equation, in percent, %; ***R^2***, coefficient of determination (multiple correlation coefficient)]

Q_T (ft^3/s)	a	b	c	SEE (%)	R^2
$Q_{0.8}$	131.0	0.672	-0.456	50.7	0.83
$Q_{1.01}$	207.1	.645	-.524	45.9	.84
$Q_{1.5}$	336.9	.624	-.593	44.3	.84
Q_2	434.5	.615	-.629	44.6	.84
Q_3	580.4	.607	-.671	45.1	.83
Q_5	777.7	.600	-.716	46.4	.82

Table 12. Coefficients and exponents for equation 9 based on partial duration series for hydrologic region 4, Illinois, for specified recurrence intervals.

[***Q_T***, flood quantile, in cubic feet per second, *ft^3/s*; ***a***, coefficient; ***b***, exponent for drainage area ***TDA***, in square miles, *mi^2*; ***c***, exponent for main-channel slope, ***MCS***, in feet per mile, *ft/mi*; ***d***, exponent for basin length, ***BL***, in miles, *mi*; ***SEE***, standard error of estimate of the regional equation, in percent, %; ***R^2***, coefficient of determination (multiple correlation coefficient)]

Q_T (ft^3/s)	a	b	c	d	SEE (%)	R^2
$Q_{0.8}$	60.3	0.907	0.386	-0.463	44.8	0.87
$Q_{1.01}$	78.7	.910	.403	-.503	39.6	.87
$Q_{1.5}$	104.9	.916	.431	-.540	37.1	.89
Q_2	121.6	.919	.447	-.553	36.6	.89
Q_3	142.3	.920	.465	-.562	37.1	.89
Q_5	164.1	.920	.484	-.561	38.1	.88

Table 13. Coefficients and exponents for equation 10 based on partial duration series for hydrologic regions 5, 6, and 7 (stations in region 7 are combined with region 6 in the analysis), Illinois, for specified recurrence intervals.

[***Q_T***, flood quantile, in cubic feet per second, *ft^3/s*; ***a_5***, coefficient for region 5; ***$a_{6,7}$***, coefficient for regions 6 and 7; b, exponent for drainage area ***TDA***, in square miles, *mi^2*; with ***b_5*** for region 5, and ***$b_{6,7}$*** for regions 6 and 7; ***c***, exponent for main-channel slope, ***MCS***, in feet per mile, *ft/mi*; ***d***, exponent of the ***(%Water +5)*** term (*%Water* is the percentage of open water and herbaceous wetland, where the constant (5) is added to avoid zero values), in percent, %; ***SEE***, standard error of estimate of the regional equation, in percent, %; ***R^2***, coefficient of determination (multiple correlation coefficient)]

Q_T (ft^3/s)	a_5	$a_{6,7}$	b_5	$b_{6,7}$	c	d	SEE (%)	R^2
$Q_{0.8}$	69.7	72.0	0.776	0.802	0.383	-0.397	44.6	0.87
$Q_{1.01}$	101.7	87.4	.759	.822	.405	-.472	39.6	.89
$Q_{1.5}$	151.4	105.0	.747	.854	.436	-.549	37.3	.89
Q_2	186.6	115.2	.742	.874	.453	-.588	37.1	.89
Q_3	236.6	128.2	.738	.898	.474	-.633	37.3	.89
Q_5	300.9	142.9	.736	.926	.494	-.682	38.4	.88

The PDS flood quantiles estimated with regional equations 6-10 are listed in row 2 of table 2; those at-site flood quantiles estimated with the *GP* distribution are listed in row 1 of the same table. For the PDS estimates, weighted procedures were not developed in this study.

Similar to the AMS regional equations, the derived equations are applicable to rural streams in Illinois. The equations are not applicable to locations where streamflows are altered appreciably by regulation, diversion, channelization, or urbanization in the watersheds. Unusual natural morphologic, hydrologic, or geologic conditions, such as karst terrain, minimal soil cover, large off-channel storage, downstream of a bluff, and others, may cause deviations from the expected flood frequencies. The ranges of selected explanatory variables for the PDS regional equations are listed in table 14.

The regression equations based on the PDS model are derived using the OLS technique. The uncertainty of prediction is expressed using the standard error of estimate, *SEE*, and the model accuracy is presented using the correlation coefficient, R^2. Values of these measures for the equations are given in tables 9–13. For example, the 1.5-year flood quantile has *SEE* varying from 37.1 to 44.3 (percent) and R^2 varying from 0.84 to 0.89 in the seven hydrologic regions. Although the R^2's and data plots (not shown) are reasonable, large residuals are observed at some stations in various regions. After the usefulness of PDS analysis is validated in the field, improvements in the PDS data and analysis should be investigated in future studies.

SUMMARY AND CONCLUSIONS

Knowledge of the frequency and magnitude of flood-peak discharges is essential for water-resources planning, risk management, and project design. To provide up-to-date flood-frequency estimates for the State of Illinois, the U.S. Geological Survey—in cooperation with the Illinois Department of Natural Resources, Offices of Water Resources, Realty and Environmental Planning–Conservation 2000 Program, and Resource Conservation; and with the Illinois Department of Transportation—began a study in 2000 to analyze flood-frequency estimates for rural Illinois streams. At-site flood frequencies have been estimated with peak-flow discharge data through September 1999 (the end of water year 1999), and regional equations have been developed with the at-site flood quantiles and geographic information system (GIS) derived basin characteristics.

At-site flood-frequency relations were estimated using two types of flood series: the annual maximum series (AMS) and partial duration series (PDS). However, the two flood series are different in their data structure and definitions of commonly used terms, such as the recurrence intervals, are different. Applications of flood quantiles estimated from each flood series should not be mixed. The flood-frequency analysis based on the AMS series is used for estimating flood quantiles with recurrence intervals from 2 to 500 years, for applications in cases when the chances of the estimated flood quantiles having been exceeded by the highest annual flood-peak discharge are of concern. The AMS results are used in a manner similar to that in previous studies concerning flood prevention and protection. The flood-frequency relations based on the PDS are suitable for practices concerned with not only the annual maximum events but also include the magnitudes of secondary flood-peak discharges. In this study, the PDS analysis estimated flood quantiles with recurrence intervals from 0.8 to 5 years. Potential applications of these PDS results are investigations of channel morphology, floodplain habitat protection, and other restoration issues. Regional flood-frequency prediction equations, tables, and graphs for estimating flood quantiles of rural streams of Illinois are presented for both cases.

Table 14. Parameter space for the partial duration series regional equations in Illinois.

[Total drainage area ***TDA***, in square miles, *(mi²)*; main-channel slope ***MCS***, in feet per mile, *(ft/mi)*; ***BL,*** basin length, in miles, *(mi)**;*** averaged permeability ***PermAvg***, in inches per hour, *(in/hr)*; ***(%Water+5),*** open water and herbaceous wetland plus a constant (5) in percent, *(%)*; -----, no data]

Explanatory Variables	Minimum value	Maximum value
TDA	1.08	5,149
MCS	.95	165
BL	1.22	123
PermAvg	.4	6.0
(%Water+5)	5	11
-----	-----	-----

Both AMS and PDS flood series were compiled from the peak-flow files of NWIS. A set of basin characteristics has been derived using the BASINSOFT program and Arc/Info procedures in conjunction with DEM and the digital databases STATSGO and NLCD for 288 rural streamflow-gaging stations in Illinois. These newly derived basin characteristics were used in the regression analysis for developing regional flood-frequency equations. For developing regional equations, seven hydrologic regions were determined based on physiographic and hydrologic characteristics of the State and refined using the residual analysis.

At-site AMS flood frequencies were estimated with the Log-Pearson type III distribution using the PEAKFQ program. During the study, the generalized skew coefficients were updated using kriging techniques, and seven hydrologic regions were delineated on the basis of physiographic and hydrologic characteristics of drainage basins of Illinois. The updated at-site AMS flood frequencies have changed noticeably at many stations as a result of major floods in the 1990's, extended record lengths, and the updated generalized skew coefficients from the previous statewide results completed in 1987. For the 116 stations with additional flood records, new station flood-peak discharges were recorded at 40 stations; flood-peak discharges that were not new station records but exceeded the Q_{100} estimated previously were recorded at 16 stations, and flood-peak discharge magnitude matched the 1987 Q_{100} value at 1 station. These floods were recorded at stations primarily in regions 2, 3, and 5 but none were recorded in region 7.

The AMS regional equations and a listing of their corresponding coefficients for the seven hydrologic regions are presented below. Variables in these equations are defined as follows.

Q_T is the estimated flood quantile, in cubic feet per second, for the designated recurrence interval ***T***, in years. For AMS, the *T*'s equal to 2, 5, 10, 25, 50, 100, and 500 years.

a is the coefficient of the equation, ***b***, ***c***, ***d***, ***e***, and ***f*** are exponents for variables ***TDA***, ***MCS***, ***PermAvg***, ***BL***, and ***(%Water+5)***, respectively.

TDA is the total drainage area, in square miles.

MCS is the main-channel slope, in feet per mile.

PermAvg is the averaged permeability of the watershed, in inches per hour.

BL is the basin length, in miles

(%Water +5) is the calculated percentage of open water and herbaceous wetland in the watershed plus a constant 5 percent (to avoid zero values). The unit of the ***(%Water +5)*** term is percent.

RF(N) is the regional factor for hydrologic region ***N***.

$$Q_T = a(TDA)^b\,(MCS)^c\,(PermAvg)^e\,RF\,(N) \qquad \text{[for hydrologic regions 1, 3, and 5]}$$

$$Q_T = a(TDA)^b\,(MCS)^c\,(\%Water + 5)^f\,RF\,(N) \qquad \text{[for hydrologic regions 2, 6, and 7]}$$

$$Q_T = a(TDA)^b\,(MCS)^c\,(BL)^d \qquad \text{[for hydrologic region 4]}$$

Examples on how to use these equations at ungaged, gaged, and near gaged sites have been given. The accuracy of these equations, as measured with $APE_{\%}$ (average prediction error of the regional equation), varies between 49 percent and 50 percent for Q_{100} among the seven regions. The average equivalent years of record for the same *T* varies from 5.4 to 5.6 years.

Q_T	a	b	c	d	e	f	RF(1)	RF(3)	RF(5)
					Regions 1, 3, 5				
Q_2	22.2	0.749	0.401	0	-0.224	0	1.467	1.62	2.128
Q_5	34.1	.743	.437	0	-.223	0	1.563	1.811	2.360
Q_{10}	41.8	.740	.457	0	-.224	0	1.618	1.913	2.476
Q_{25}	50.8	.738	.478	0	-.224	0	1.686	2.03	2.612
Q_{50}	57.0	.737	.491	0	-.223	0	1.738	2.113	2.711
Q_{100}	62.7	.736	.503	0	-.222	0	1.79	2.192	2.809
Q_{500}	74.5	.735	.527	0	-.219	0	1.917	2.371	3.037
					Regions 2, 6, 7		**RF(2)**	**RF(6)**	**RF(7)**
Q_2	54.7	0.728	0.341	0	0	-0.47	1	2.963	3.515
Q_5	94	.721	.374	0	0	-.527	1	3.119	3.281
Q_{10}	120	.718	.393	0	0	-.55	1	3.241	3.226
Q_{25}	151	.716	.413	0	0	-.573	1	3.409	3.217
Q_{50}	174	.715	.426	0	0	-.586	1	3.54	3.236
Q_{100}	195	.714	.437	0	0	-.598	1	3.672	3.269
Q_{500}	241	.714	.461	0	0	-.619	1	3.98	3.377
					Region 4				
Q_2	49.3	0.734	0.37	-0.006	0	0	0	0	0
Q_5	85.1	.772	.406	-.095	0	0	0	0	0
Q_{10}	111	.792	.425	-.14	0	0	0	0	0
Q_{25}	144	.812	.446	-.183	0	0	0	0	0
Q_{50}	168	.823	.46	-.207	0	0	0	0	0
Q_{100}	193	.833	.472	-.228	0	0	0	0	0
Q_{500}	250	.852	.496	-.266	0	0	0	0	0

The flood-frequency relations based on the PDS were developed using the Generalized Pareto distribution with an averaged 1.6 flood peaks per year. The same hydrologic regions and basin characteristics were used in developing the PDS regional equations. In the PDS regional equations, the *TDA* was the basic explanatory variable for all the regions. The regional equations and a listing of their corresponding coefficients for estimating flood quantiles for *T*'s equal to 0.8, 1.01, 1.5, 2, 3, and 5 years have been developed as follows.

$$Q_T = a(TDA)^b\,(MCS)^c\,(\%Water + 5)^f \qquad \text{[for hydrologic region 1].}$$

$$Q_T = a(TDA)^b\,(BL)^c\,(PermAvg)^e \qquad \text{[for hydrologic region 2].}$$

$$Q_T = a(TDA)^b\,(\%Water + 5)^f \qquad \text{[for hydrologic region 3].}$$

$$Q_T = a(TDA)^b\,(MCS)^c\,(BL)^d \qquad \text{[for hydrologic region 4].}$$

$$Q_T = a(TDA)^b\,(MCS)^c\,(\%Water + 5)^f \qquad \text{[for hydrologic regions 5, 6, and 7].}$$

The accuracy of these equations, as measured with standard error of prediction, varies from 37.1 to 44.3 (percent) for $Q_{1.5}$ among the seven regions, for example. The corresponding correlation between predicted and observed values, expressed as $\boldsymbol{R^2}$, varies from 0.84 to 0.89.

The flood-frequency results represent the most up-to-date (2004) information available. However, the analysis identified the lack of information for small watersheds since the 1980's. Although the flood-frequency analyses based on the AMS have been used for many years and have been widely used in Illinois and throughout the United States, flood-frequency analyses based on PDS will require additional study before they are as commonly utilized as the AMS. The developed regional equations are applicable to rural, natural streams in Illinois. The equations are not applicable where streamflows are altered appreciably. The regional equations should not be extrapolated beyond

Q_T	a	b	c	d	e	f
Region 1						
$Q_{0.8}$	33.3	0.771	0.438	0	0	-0.4
$Q_{1.01}$	52.6	.755	.458	0	0	-.515
$Q_{1.5}$	83.9	.745	.478	0	0	-.621
Q_2	107	.74	.488	0	0	-.673
Q_3	140.8	.736	.498	0	0	-.733
Q_5	185.9	.732	.508	0	0	-.793
Region 2						
$Q_{0.8}$	17.9	0.775	0	0.223	-0.499	0
$Q_{1.01}$	23.7	.772	0	.185	-.47	0
$Q_{1.5}$	32.8	.769	0	.152	-.448	0
Q_2	39.5	.766	0	.138	-.438	0
Q_3	49.1	.762	0	.125	-.428	0
Q_5	61.8	.755	0	.114	-.417	0
Region 3						
$Q_{0.8}$	131	0.672	0	0	0	-0.456
$Q_{1.01}$	207.1	.645	0	0	0	-.524
$Q_{1.5}$	336.9	.624	0	0	0	-.593
Q_2	434.5	.615	0	0	0	-.629
Q_3	580.4	.607	0	0	0	-.671
Q_5	777.7	.6	0	0	0	-.716
Region 4						
$Q_{0.8}$	60.3	0.907	0.386	-0.463	0	0
$Q_{1.01}$	78.7	.91	.403	-.503	0	0
$Q_{1.5}$	104.9	.916	.431	-.54	0	0
Q_2	121.6	.919	.447	-.553	0	0
Q_3	142.3	.92	.465	-.562	0	0
Q_5	164.1	.92	.484	-.561	0	0
Region 5						
$Q_{0.8}$	69.7	0.776	0.383	0	0	-0.397
$Q_{1.01}$	101.7	.759	.405	0	0	-.472
$Q_{1.5}$	151.4	.747	.436	0	0	-.549
Q_2	186.6	.742	.453	0	0	-.588
Q_3	236.6	.738	.474	0	0	-.633
Q_5	300.9	.736	.494	0	0	-.682
Regions 6 and 7						
$Q_{0.8}$	72	0.802	0.383	0	0	-0.397
$Q_{1.01}$	87.4	.822	.405	0	0	-.472
$Q_{1.5}$	105	.854	.436	0	0	-.549
Q_2	115.2	.874	.453	0	0	-.588
Q_3	128.2	.898	.474	0	0	-.633
Q_5	142.9	.926	.494	0	0	-.682

the range of selected explanatory variables in each equation. The conditions used in developing these results and equations and their limitations are explained, and the techniques should be used with caution. The equations are not designed for evaluating the effects of land-use changes within a watershed. Also, the equations estimate the mean values of flood quantiles of different basins in the hydrologic region with the same set of explanatory variables. Engineering judgment should be used in determining the applicability of these results to a given situation.

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GLOSSARY

Annual maximum flood – The highest instantaneous peak discharge in a water year.

Annual maximum series – A list of annual maximum floods.

Pearson's Correlation coefficient – A measure of the strength of the linear association between two continuous variables.

Equivalent years of record – A measure of the accuracy with which the regression model can estimate the Q_T at a site, expressed in years of at-site streamflow record. It is an estimate the years of record required at a site in order to achieve an accuracy equivalent to the standard error of estimate (or prediction) of the regional equation.

Exceedance probability – Probability that a random event will exceed a specified magnitude in a given time period, such as a water year or specified otherwise.

Frequency analysis – The estimation of how often a specified event will occur.

Flood Quantile – The flood-peak discharge magnitude corresponding to a specified exceedance probability (percent quantile). Often it also is used with the corresponding recurrence interval, T; a T-year quantile. The symbol used in this report is Q_T .

Outlier – Data points that depart significantly from the trend of the remaining data.

Partial duration series – A list of all instantaneous flood-peak discharges that exceed a specified threshold discharge.

Population – In statistics, the entire collection of objects under consideration is called a population, or universe. The entire population often is not available, so a sample often is studied.

Recurrence Interval – The average time interval between actual occurrences of a hydrologic event of a given or greater magnitude. Also known as the return period.

Water year – The 12-month period October 1 through September 30, during which streamflow data are collected, compiled, and reported. The water year is designated by the calendar year in which it ends. For example, water year 1999 or the 1999 water year covers the period from October 1, 1998, to September 30, 1999.

APPENDIXES AND TABLES

Appendix 1. Data Preparation

Procedures for preparing peak-flow data in Illinois streams for at-site flood-frequency analysis are described in this appendix. The general guidelines for these preparation procedures can be found in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982). Two types of flood series are used in the study: the annual maximum series (AMS) and partial duration series (PDS). The peak-flow data are instantaneous flood-peak discharge magnitudes retrieved from peak-flow files stored in the USGS National Water Information System (NWIS) that contain records of both continuous streamflow-gaging and crest-stage gages (CSG) stations. Data also can be obtained from the USGS Illinois Water Science Center annual water-data report, for example, Latour and others (1996), or from the Web page at URL *http://il.water.usgs.gov/usgs*. It is assumed that peak-flow data retrieved from NWIS are independent. When preparing flood-peak data for NWIS, three criteria in temporal space are specified for checking data independency (WRD Data Reports Preparation Guide: Novak, 1985, p. 93).

Preparation of Annual Maximum Series

Selection of stations

From streamflow-gaging stations that represent watersheds in Illinois or their flows drain into Illinois, 419 stations, including active and inactive, rural and urban stations, that have 10 or more years of flood-peak discharge records are selected for at-site AMS analysis. Streamflow records that have been affected by substantial urbanization or other types of watershed changes, or channelization, diversion, or regulation, are excluded from the regional regression analysis. Those alterations modify flow characteristics and separate analysis is required. Whether the watershed changes or channel modifications have induced changes in streamflow characteristics is determined by field observation and noted in the NWIS with qualification codes. “Indices of Urbanization” (Sauer and others, 1983, p. 7) also can be used to determine the degree of urbanization by users. Northeastern Illinois contains many urban streams. Regulated rivers include the Wabash River, Big Muddy River below Rend Lake, Kaskaskia River below Lake Shelbyville, Saline River below the mouth of Cypress Ditch, Fox River below the Chain-of-Lakes, Illinois River, Mississippi River, and Ohio River.

Error checking

Possible copying, decimal, or code errors in the retrieved flood-peak discharge magnitudes are checked against the published USGS data reports for stations in Illinois starting from WY 1984 to WY 1999.

Missing or discontinuous records

Missing records (no reported values for a given year) are not filled. Discontinuous records (record consists of different time periods) are treated as one entity providing no major watershed changes affect the records (Interagency Advisory Committee on Water Data , 1982).

Historical events

Bulletin 17B (Interagency Advisory Committee on Water Data, 1982) recommended the inclusion of historical events in analysis providing that the reliability of the data, causes of the events (natural causes excluding ice jams, downstream constriction, backwater, and snow melt), and changes in watershed conditions are examined and the effects on the estimated frequency curve are evaluated. Bulletin 17B also provided procedures for computing a historically adjusted *LP3* frequency curve. Historical adjustments can be bypassed (William Kirby, U.S. Geological Survey, written commun., 2003) if the following apply.

1. The systematic records are long.
2. There are no high outliers in the systematic record.
3. The magnitude and plotting position (1/(length of the historical period)) of the historical flood-peak discharge

is consistent with the systematic-record frequency curve.

Historical events are reported with peak stages, date, and, in most cases, the estimated discharges in the retrieved peak-flow data. With the criteria in mind, historical events at streamflow-gaging stations with estimated discharge are included in at-site flood-frequency analysis in this study. Historical events without discharge values have been examined to determine whether the subsequent rating curve could be used for a reasonable estimate of discharge. Judgment is required to determine if adjustment at the high end of the rating curve can be verified with measured discharge(s) and if the rating can be extended to the stage of the historical flood. If a similar event is recorded at nearby stations, for example, such information also validates the use of the historical event at the station. Estimated flood-peak discharge magnitudes that were used in the frequency analysis at the stations are shown in table 1-1.

Table 1-1. Stations with discharge estimated for their historical events in Illinois.

[**Stage**, stage above the gage datum, in feet; *ft*; **Date** of flood peak: in month/year format, *m/yr*, except for station 05592050, where only the year is presented; **Est Q**, estimated discharge, in cubic feet per second, *ft³/s*; Station numbers are referred to in figure 2A]

Station (fig. 2A)	Stage (*ft*)	Date (*m/yr*)	Est Q (*ft³/s*)	Station (fig. 2A)	Stage (*ft*)	Date (*m/yr*)	Est Q (*ft³/s*)
03337500	13.50	5/33	4,000	05467500	23.20	6/24	11,000
03338000	18.60	3/39	20,500	05468000	15.70	5/35	2,600
03338500	24.40	3/39	41,000	05468500	18.10	6/24	12,000
03378900	35.50	1/50	42,800	05469000	27.80	6/24	20,000
05439500	11.90	3/37	12,500	05469500	19.00	6/24	7,000
05441000	15.90	2/38	11,000	05502040	17.93	8/39	24,000
05441500	18.70	2/37	47,000	05512500	18.40	9/26	35,000
05444000	19.60	6/38	6,800	05513000	19.50	8/16	24,000
05445500	17.74	6/37	6,500	05580500	17.40	7/29	14,000
05448000	7.40	6/36	4,500	05592050	16.80	1957	26,400

Additional stations excluded because of urbanization

In addition to those urban stations identified by Curtis (1987), the following stations (table 1-2) are considered to be affected by urbanization during most of the period of record. This analysis is based on evaluation of USGS quadrangle topographic maps of different time periods and general knowledge of development in the Chicago metropolitan area.

Table 1-2. Additional stations compared to Curtis (1987) determined to be affected by urbanization in Illinois.

Station number (fig. 2B)	Station name	Record length	Explanation
05529000	Des Plaines River near Des Plaines, Ill.	1938-99	Most of the watershed has been urbanized for more than half the period of record.
05536190	Hart Ditch at Munster, Ind..	1943-99	Has been urbanized
05540110	Ferry Creek at Warrenville, Ill.	1961-79	Eastern Du Page County urbanized between early 1960's and mid-1970's as evidenced by revisions to topographic maps of the area
05540140	East Branch Du Page River nr Bloomingdale, Ill.	1961-79	Eastern Du Page County urbanized between early 1960's and mid-1970's as evidenced by revisions to topographic maps of the area.
05550450	Poplar Creek near Ontarioville, Ill.	1961-77	Cook County urbanized in early 1960's and mid-1970's as evidenced by revisions to topographic maps of the area

Streamflow records from urbanized watersheds

Some urban stations may have sufficient length of record before urbanization or regulation that are suitable for regression analysis. Stations that were not used by Curtis (1987) because of anomalous characteristics were reevaluated for possible use for this study. The 25 stations with records used in the regression analysis are given in table 1-3.

Table 1-3. Additional stations compared to Curtis (1987) included in the regression analysis for Illinois.

Station number (figs. 2A and B)	Station name	Record Used	Explanation
05447200	Normandy Ditch at Normandy, Ill.	1956-71	Rural drainage, only possible problem is the effects from channelization.
05528150	Indian Creek at Diamond Lake, Ill.	1960-76	Lake County, not urbanized until mid- to late-1970's well into the period of record as evidenced by revisions to topographic maps of the area.
05528170	Diamond Lake Drain at Mundelein, Ill.	1961-76	Lake County, not urbanized until mid- to late-1970's well into the period of record as evidenced by revisions to topographic maps of the area.
05528200	Hawthorn Drainage Ditch near Mundelein, Ill.	1961-76	Lake County, not urbanized until mid- to late-1970's well into the period of record as evidenced by revisions to topographic maps of the area.
05528440	Buffalo Creek near Lake Zurich, Ill.	1961-76	Lake County not urbanized until mid- to late-1970's well into the period of record as evidenced by revisions to topographic maps of the area. Trend analysis indicated significant trend but site kept in analysis because the beginning of record occurred during drought.
05528470	Buffalo Creek at Long Grove, Ill.	1961-76	Lake County not urbanized until mid- to late-1970's well into the period of record as evidenced by revisions to topographic maps of the area. Trend analysis indicated significant trend but site kept in the analysis because the beginning of record occurred during drought.
05533200	Sawmill Creek Tributary near Tiedtville, Ill.	1961-79	Only one subdivision in the drainage basin shown on topographic map that dates back to around the beginning of the period of record. Trend analysis indicated significant trend but site kept in the analysis because the beginning of record occurred during drought.
05533300	Wards Creek near Woodridge, Ill.	1962-76	Only one housing area around a lake in the upper part of basin, as shown by topographic map that dates back to the beginning of the period of record. Trend analysis indicated significant trend but site kept in the analysis because the beginning of record occurred during drought.
05534400	North Branch Chicago River at Bannockburn, Ill.	1960-76	Lake County, not urbanized until mid- to late-1970's well into the period of record as evidenced by revisions to topographic maps of the area.
05536325	Little Calumet River at Harvey, Ill.	1917-33	Assumed this area of southern Cook County not urbanized appreciably before 1933.
05539870	West Branch Du Page River at Ontarioville, Ill.	1961-79	Western Du Page County, not urbanized until mid- to late-1970's well into the period of record as evidenced by revisions to topographic maps of the area.
05539890	West Branch Du Page River near Wayne, Ill.	1961-79	Western Du Page County, not urbanized until mid- to late-1970's well into the period of record as evidenced by revisions to topographic maps of the area.
05539950	Klein Creek at Carol Stream, Ill.	1961-79	From topographic map that dates to the beginning of the period of record, only one housing subdivision present just upstream of station.

Table 1-3. Additional stations compared to Curtis (1987) included in the regression analysis for Illinois--Continued.

Station number (figs. 2A and B)	Station name	Record Used	Explanation
05540030	West Br Du Page River at West Chicago, Ill.	1961-79	Western Du Page County, not urbanized until mid- to late-1970's well into the period of record as evidenced by revisions to topographic maps of the area.
05540240	Prentiss Creek near Lisle, Ill.	1961-80	From topographic map that dates to the beginning of the period of record, only about 20 percent of drainage urbanized..
05549000	Boone Creek near Mc Henry, Ill.	1949-92	McHenry County, not urbanized until late-1980's near end of period of record, no trend in peak discharge observed.
05549850	Flint Creek near Fox River Grove, Ill.	1962-96	McHenry County, not urbanized until late-1980's near the end of the period of record, no trend in peak discharge observed.
05550470	Poplar Creek Tributary near Bartlett, Ill.	1961-79	From topographic map that dates to the beginning of the period of record, only about 25 percent of drainage urbanized.
05580700	Salt Creek Tributary at Middletown, Ill.	1961-76	Rural drainage, no perceived regulation or diversion.
05589780	Little Canteen Creek Tributary near Collinsville, Ill.	1959-72	From topographic map, one reservoir regulates only about 10 percent of drainage with other small ponds on various side channels.
05592000	Kaskaskia River at Shelbyville, Ill.	1908-99	The pre-dam period of record (1908-68) can be used. Regulated since 1969 by Lake Shelbyville.
05592500	Kaskaskia River at Vandalia, Ill.	1908-99	The pre-dam period of record (1908-68) can be used. Regulated since 1969 by Lake Shelbyville.
05593000	Kaskaskia River at Carlyle, Ill.	1908-99	The pre-dam period of record (1908-67) can be used. Regulated since 1968 by Carlyle Lake.
05597450	Crab Orchard Creek Tributary near Pittsburg, Ill.	1960-72	Rural drainage, only problem may be the effects of earthen dam upstream of gage.
05599580	Big Muddy River Tributary near Gorham, Ill.	1961-76	Rural drainage, only problem may be the effects of steep channel slope and heavily forested drainage.

Stations where basin characteristics could not be derived

When applying the BASINSOFT program to determine the specified basin characteristics, one or more basic basin characteristics at nine stations listed below (table 1-4) could not be determined because the drainage areas were too small (ranging from 0.08 to 1.10 mi^2) to contain enough hypsographic and hydrographic features for computations. Thus, these stations are not included in the regression analysis.

Therefore, 291 stations initially were used in the regression analysis. During the analysis (appendix 7), three stations were excluded because of anomalous results. The final regional equations were developed using records from 288 streamflow-gaging stations.

Table 1-4. Stations where basin characteristics could not be derived in Illinois.

Station number (fig. 2A)	Station Name	Station number (fig. 2A)	Station Name
03344250	Embarras River Tributary near Greenup, Ill.	05584450	Wigwam Hollow Creek nr Macomb, Ill.
03380300	Dums Creek Tributary near Iuka, Ill.	05586850	Bear Creek Tributary near Reeders, Ill.
03382520	Black Branch Tributary near Junction, Ill.	05587850	Cahokia Creek Tributary Number 2 nr Carpenter, Ill.
03612200	Q Ditch Tributary near Choat, Ill.	05592700	Hurricane Creek Tributary near Witt, Ill.
05572100	Wildcat Creek Tributary near Monticello, Ill.		

Stationarity in annual maximum series of selected rural watershed – trend analysis

In order to use the past flood-peak data to estimate future flood-peak magnitudes, the past flood-peak data are assumed to be random homogeneous events. Trends in streamflow data result if there are alterations in the watershed or apparent changes in climatic patterns. If a trend in an AMS is detected, it indicates that results from this AMS analysis would be derived from nonrandom samples, and uncertainty in the derived flood-frequency relation is increased. However, if randomness is the only deviation from other data assumptions, nonrandom data may define unbiased estimates of future flood activity (Interagency Advisory Committee on Water Data, 1982). McCabe and Wolock (2002) analyzed streamflow statistics for 400 sites in the conterminous United States with data measured during 1941-99. Their results indicate a noticeable increase in annual minimum and median daily streamflow around 1970, and a less noticeable mixed pattern of increase or decrease in annual maximum daily streamflow. These changes in annual streamflow statistics primarily occurred in the eastern U.S. Knapp and Markus (2003) analyzed records at 59 streamflow-gaging stations in Illinois with more than 50 years of data and found that more than half of the 48 selected stations showed significant positive trends in average flow, and roughly 25 percent showed positive trends in instantaneous flood-peak discharges.

Trends in AMS series were analyzed by using Kendall's tau (τ) analysis in the SWSTAT program (Lumb and others, 1990). A τ value (correlation coefficient) of zero indicates no trend; positive or negative τ values indicate positive or negative trends. Whether a trend is significant depends not only on the τ value but also on the sample size. Among the rural watersheds used in the AMS analysis, 62 streamflow-gaging station records are found to have significant trends within the 95-percent confidence level ($p \leq 0.05$); 12 station records have negative trends and 50 station records have positive trends. The range of absolute τ values is from 0.18 to 0.82. Among the stations with high τ values (either negative or positive), the majority have record lengths between 10 and 25 years, contain records collected from the 1950's to 1980's, and are inactive stations. The mid-1950's was one of the driest periods in the conterminous U.S. and years after 1970 generally were wetter than average (McCabe and Wolock, 2002). Drought periods at either the beginning or end of the records result in trends for these stations. Therefore, these streamflow-gaging station records are retained in the regression analysis.

Preparation of Partial Duration Series

Source of data

The PDS data also are retrieved from the peak-flow files. Secondary instantaneous flood-peak discharges and the associated stages above a selected base discharge are available if the flow above the station is not appreciably regulated. The base discharge generally is selected such that, on average, three independent flood-peak discharges, including the annual maximum peak discharge, will exceed the base discharge each water year. Criteria for deciding which streamflow-gaging stations that the secondary peaks are determined, for selecting the base discharge at the selected streamflow-gaging station, and for selecting the independent peaks greater than the base discharge are given in Novak (1985). With the availability of secondary peaks, PDS data are organized for 241 stations.

The Illinois Water Science Center maintains unit-value (or gage-value) files stored in the NWIS database. The unit-values are those recorded, transmitted, and/or computed from a streamflow-gaging station. Typical record intervals are 5, 15, or 30 minutes. These continuous hydrographs can be used to develop the PDS. However, at the time of this study, the unit-value files had been developed for 64 stations only with record starting in 1985. Samples of flood-peak discharge magnitudes are used to check the quality of the PDS data only.

Threshold value

Selecting an appropriate threshold value is a challenging task in practical use of the PDS analysis. Cunnane (1989) illustrated how selected threshold values affected the structure of flood series and, therefore, the fitted distributions. If too small a threshold is used, clusters of peak discharges of similar magnitudes are included in the PDS model. The threshold value can be the mean annual flood-peak discharge of a station, or generally it can be determined that, on average, three flood-peak discharges, including the annual maximum peak discharge a year will be reported (Novak, 1985).

Error checking

The PDS data retrieved from peak-flow files are checked for recording errors and compared with published reports by Carns (1973), USGS water-data reports, and the unit-value files. Because of time constraints, the PDS data only are checked at randomly selected sites. Some differences in magnitudes were found in comparison to the unit-value files. The differences are minor and may be explained by the time interval used in the unit-value files. Duplicated events were checked for the entire PDS dataset.

Available stations

During at-site analysis (appendix 2), some stations were discarded because their flood-peak discharge magnitudes were clustered in a narrow range. Statistical parameters estimated from such datasets could not be used to fit the selected probability distributions. In all, a total of 222 stations are fitted with the Generalized Pareto distribution (appendix 2) and at-site flood quantiles are computed. Of the 222 stations, 142 rural-watershed stations are used in regression analysis.

Possible future work

The present PDS analysis focuses on estimation at the lower recurrence intervals, those intervals from less than 1 year to 5 years. Knowledge about the more frequent floods is needed in environmental studies for the protection and restoration of channels, aquatic habitat, and floodplains, as well as fishery management. If proven applicable, the PDS analysis could enhance the applications of flood-frequency analysis. The PDS model also can be used for estimating flood magnitudes at larger recurrence intervals (as those estimated with the AMS model), which could be beneficial for flood predictions at stations with short periods of record (for example, from 5 to 10 years) but with a well-represented range of peak discharges.

The statistical significance of missing data and/or mixed data (both AMS and PDS) in the PDS dataset are not examined in detail in this study. Representative data for smaller flood-peak discharges are retained for analysis if a proper average number of peaks per year (*r*-value) is selected. On the other hand, the *r*-value will not affect samples from large flood magnitudes. Missing high flood-peak discharge magnitudes from these samples affect the ranking of all samples and the data structure.

In developing possible future PDS analysis, the unit value could be a better data source than peak-flow files. Appreciably more streamflow-gaging stations than used in this study would be required for developing future PDS regional equations.

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Appendix 2. At-Site Analysis of Flood-Peak Series

Annual Maximum Series

Flood quantiles for the AMS model are estimated with the PEAKFQ program (Thomas and others, 1998) in which the *LP3* distribution is used. In addition, the generalized skew coefficients for Illinois are analyzed and updated (appendix 3). The input and output files for the PEAKFQ program and probability plots of the fit at each streamflow-gaging station are included in the attached CD-ROM (appendix 8).

Partial Duration Series

PDS analyses are conducted with a Fortran program developed for this study. The PEAKFQ program can be used to analyze the PDS data file with minor modifications on data code in the input file. However, the analysis of PDS data is then limited to the *LP3* distribution if the PEAKFQ program is selected. Also, evaluation of parameter *r*, the average number of peaks per year, and presentation of the results at selected recurrence intervals have to be done outside of the PEAKFQ program.

A literature search indicated that three probability distributions are suitable for analyzing the PDS data: the Gumbel, exponential, and Generalized Pareto (*GP*) distributions. The *GP* distribution is the logical choice for modeling flood magnitudes that exceed a fixed threshold (Hosking and Wallis, 1987) where it can be assumed reasonably that successive flood flows follow a Poisson process with independent magnitudes (Rao and Hamed, 2000). These three distributions, and later the *LP3* distribution, are included in the program for comparative evaluations. All statistical parameters are estimated with the method of moments (Rao and Hamed, 2000). However, the program does not include, at present (2004), the detection of outliers or the adjustment for historical events. With the study emphasis on analyzing the lower flood quantiles, it was found that both *GP* and *LP3* distributions can reasonably fit the PDS data, except that probability plots showed the *GP* distribution fitted the data better, probably because the sample skew (the weighted skew approach is not used at present) may not represent the data distribution. The tests performed in selecting a suitable probability distribution for the Illinois data and the parameter *r* are described below. The *GP* distribution was selected in this study for estimating at-site flood quantiles with $r = 1.6$. A brief description of the *GP* distribution is presented first.

Generalized Pareto distribution function

The *GP* is a three-parameter Wakeby distribution. The three parameters are: α, a scale parameter (standard deviation of the *GP* distribution); ε, the lower bound of the data sample; and *k*, the shape parameter (kurtosis of the *GP* distribution). The following description of the *GP* distribution is cited from Rao and Hamed (2000).

The probability density function of the *GP* distribution can be written as

$$f(x) = \frac{1}{\alpha}\left[1 - \frac{k}{\alpha}(x - \varepsilon)\right]^{\left(\frac{1}{k} - 1\right)}, \tag{2-1}$$

where the variable x is either $\varepsilon \le x < \infty$ when $k \le 0$, or $\varepsilon \le x \le \varepsilon + \alpha/k$ when $k > 0$. This distribution function refers to the population of PDS flood events. The special case, $k = 0$, yields the exponential distribution, whereas $k = 1$ yields the uniform distribution on $[\varepsilon, \varepsilon + \alpha]$. The parameters in equation 2-1 are estimated from samples using the method of moments as

$$\hat{\alpha} = \left[m_2 \left(1 + \hat{k}\right)^2 \left(1 + 2\hat{k}\right)\right]^{\frac{1}{2}}, \tag{2-2}$$

$$\hat{\varepsilon} = m_1' - \hat{\alpha} / \left(1 + \hat{k}\right) \quad , \tag{2-3}$$

where the estimated quantities are expressed with a symbol ^, m'_r is the r^{th} moment about origin and m_r is the r^{th} central moment (the moment about the mean) calculated from samples. The moments are estimated as

$$m'_1 = \frac{1}{n}\sum_{i=1}^{n} x_i = \bar{x}\,, \qquad (2\text{-}4)$$

$$\hat{m}_2 = \frac{1}{n-1}\sum_{i=1}^{n} (x_i - \bar{x})^2, \text{ and} \qquad (2\text{-}5)$$

$$\hat{m}_3 = \frac{n}{(n-1)(n-2)}\sum_{i=1}^{n} (x_i - \bar{x})^3\,. \qquad (2\text{-}6)$$

The $\hat{k}$ is solved numerically using the relation of the coefficient of skewness C_s as

$$C_s = \frac{2(1-k)(1+2k)^{\frac{1}{2}}}{(1+3k)}\,, \qquad (2\text{-}7)$$

with the C_s approximated by

$$C_s = \frac{\hat{m}_3}{\hat{m}_2^{3/2}}\,. \qquad (2\text{-}8)$$

The flood quantile, Q_T, for a given recurrence interval T (see note below) is computed by

$$Q_T = \hat{\varepsilon} + \frac{\hat{\alpha}}{\hat{k}}\left(1 - T^{-\hat{k}}\right)\,, \qquad (2\text{-}9)$$

or when using the frequency factor method, the frequency factor is obtained as

$$K_T = \frac{(1+2k)^{\frac{1}{2}}}{k}\left[(1+k)(1-T^{-k}) - k\right]. \qquad (2\text{-}10)$$

Equation 2-9 comes from inversion of the cumulative distribution function of the *GP* distribution that is solving for the flood quantile with an exceedance probability, *P*, where *P = 1–F(x)*. For PDS, the recurrence interval, *T*, in units of years, is referred to in that there are *r* events per year, on average. Hence, the recurrence interval of a Q_T for PDS is approximated by dividing the annual *T* corresponding to equation 2-10 with the average events per year, *r*.

$$T = \frac{\left(\left.\frac{1}{P}\right|_{\substack{annual\\event}}\right)}{r} = \frac{1}{rP}\;(\textit{in years}). \qquad (2\text{-}11)$$

Thus, for a PDS recurrence interval of *T* years, the annual event probability is *P = 1/(rT)*, or one in *rT* events (William Kirby, U.S. Geological Survey, written commun., 2003). For example, if the *T* calculated in equation 2-10 is for an annual *T* of 3.2 years, then the Q_T calculated is for the 2-year event for the PDS with *r* = 1.6.

Tests Performed

Average number of flood peaks per year, *r*

The *r* is calculated from the sorted PDS peaks (in descending order) by dividing the total number of PDS peaks retained with the number of years of record. The larger the value of *r*, the more lower flood peaks are included in the analysis. When $r = 3$, where 3 has been the criterion specified in the retrieval of the PDS data from peak-flow files (see appendix 1), it is near the critical value that could render the assumptions of the PDS model invalid (Cunnane, 1989). The proper value for parameter *r* needs to be tested for the Illinois data. Note that an annual exceedance series (AES) is a special case of PDS with the number of peaks equals the number of years (thus, $r = 1$). The meaning of "annual" indicates "one", on average, not one peak for each year.

Because the Weibull formula (Chow, 1964b) is used to approximate the recurrence intervals of systematic data, the Weibull formula for TPDS can be written as

$$T_{PDS} = \frac{N+1}{nr}, \tag{2-12}$$

where *N* is the number of events and *n* is the rank of an event in ascending order. Raising or lowering the *r*-value within an allowable range increases or decreases the sample points in the flood series; therefore, this increase or decrease affects the sample variance and the frequency structure of the samples and, therefore, the fit of distributions. Cunnane (1989) discussed the values of $r = 1.65$, 1.8, 1.9 in the context of efficiency of the PDS model for estimating Q_T's. When the station data are representative, minor variations in the *r*-value would not affect appreciably the flood quantiles. However, for stations with less representative records (missing data or mixed types, appendix 1), the *r*-value could affect the flood quantiles or the success of data fitting. The *r*-value may be better determined for individual stations; however, the data processing for both input and outputs become more involved and requires re-evaluation as data are incorporated into the model. In this study, one *r* is applied to all the stations.

Various *r*-values, ranging from 1 to 2 with an increment of 0.2 have been examined during the study in various tests such as that illustrated in figure 2-1 ($r = 1.6$). The model fit in the moment ratio diagram is not sensitive to the differences in the *r*-values.

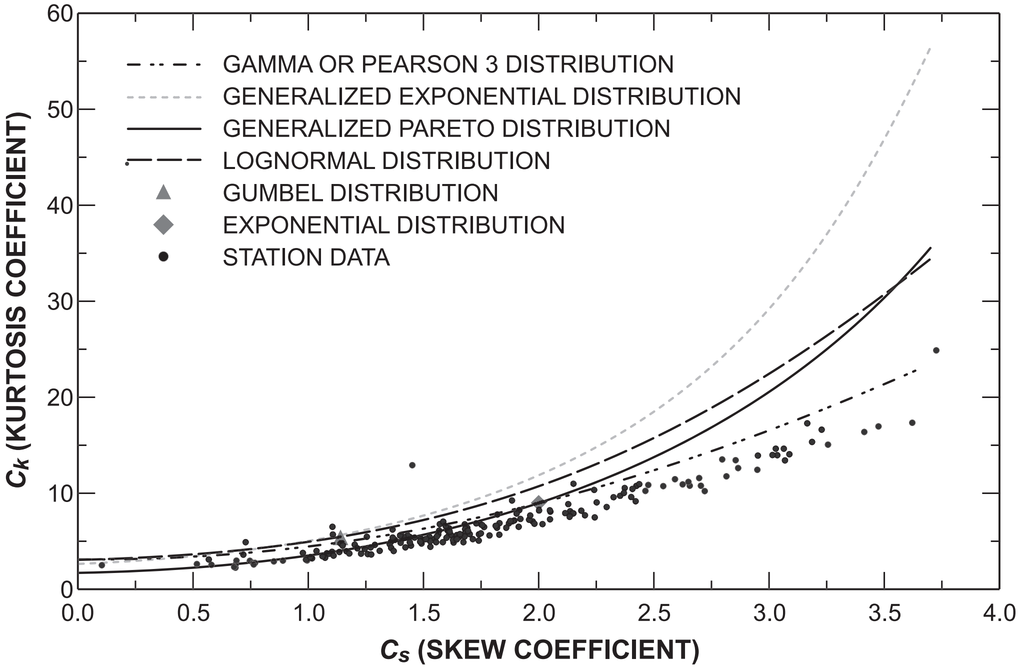

Figure 2-1. C_s-C_k moment ratio diagram for the partial duration series of flood-peak discharges in Illinois streams.

Moment ratio diagrams

For a given probability distribution, a theoretical relation between statistical parameters, such as C_s, the skew coefficient, and C_k, the kurtosis coefficient, can be developed using the conventional moments. By plotting the theoretical curves and sample values, a visual means to evaluate their agreement can be derived; figure 2-1 is developed for this purpose. In figure 2-1, coefficients C_s and C_k are computed from all PDS station (active and inactive stations, urban and rural watersheds) and the six theoretical distribution curves are obtained from Rao and Hamed (2000, p. 35), where the Gumbel and exponential distributions are represented by point values because they are two-parameter functions. The theoretical values are accurate for $C_k < 40$.

The calculated station C_ks are less than 30 (fig. 2-1); and the station values are best fit by the *Gamma (Pearson 3*) distribution followed by the *GP* distribution. The PDS data used in this figure are re-sampled for $r = 1.6$.

Chi Square and Kolmogorov-Smirnov tests

Most of the methods available for distribution selection from small sample sizes are not sensitive enough to discriminate among distributions (Rao and Hamed, 2000). In an attempt to examine the suitability between *GP* and *LP3* distributions for PDS data in Illinois, two common and well-known statistical tests for the goodness of fit are applied. These are the Chi-Square and Kolmogorov-Smirnov tests (Kite, 1977; Davis, 1973; and others). The tests are conducted using a 10-interval classification. At the 10-percent significance level, the null hypothesis that the station is a *GP* (or *LP3*) distribution is rejected if the sample results are larger than the respective critical values. For example, for approximately 100 sample points for a station, the critical Chi-Square value is 14.68 (Davis, 1973) and the $D_{critical}$ for the Kolmogorov-Simirnov test is 0.12067. A range of derived $D_{critical}$ values are available (Lyon Research Center for Images and Intelligent Information Systems, 2002). The number of stations and test results are summarized in table 2-1. Note that all the 222 stations were used in the test; but not all data could be applied to the distribution test for a given *r* because the data structure changed with *r*. However, observing that more stations passed the Kolmogorov-Smirnov test than the Chi-Square test does not indicate that either test is more appropriate for the analysis, which is consistent with the findings of Rao and Hamed (2000). A possible explanation for this result is that the confidence limits of these two tests are large (Bedient and Huber, 1992), especially when smaller samples of data are used; thus, it could not be determined from application of these tests whether the data fit a particular distribution. For the present study, the tests help identify a proper range of *r*-values for the study.

Table 2-1 Results of Chi-Square and Kolmogorov-Smirnov (*K-S*) tests on *GP* and *LP3* distributions with given *r*-values for partial duration series (PDS) data for Illinois streams (*, all PDS data points are included).

Distribution tested with data re-sampled by given *r*-value	Number of stations that pass the analysis	Number of stations that pass the Chi-Square test	Percentage of passes of the Chi-Square test	Number of stations that pass the *K-S* test	Percentage of passes of the *K-S* test
LP3_1.0	173	85	49	145	84
LP3_1.2	171	74	43	138	81
LP3_1.4	163	73	44	134	82
LP3_1.6	157	65	41	129	82
LP3_1.8	147	54	37	115	78
LP3_2.0	132	48	36	98	74
*LP3_all**	133	41	31	86	65
GP_1.0	171	109	64	137	80
GP_1.2	166	107	64	141	85
GP_1.4	165	104	63	137	83
GP_1.6	160	90	56	129	81
GP_1.8	150	78	52	113	75
GP_2.0	134	62	46	99	74
GP_all	134	51	38	84	63

Comparison to the annual maximum series estimates and probability plots

It generally is accepted that the differences in estimated flood quantiles between the AMS and PDS models diminish after T of 10 years. Chow (1964a, b) showed that the recurrence interval T_{AES} ($r = 1$) is related to T_{AMS} through the relation

$$T_{AES} = \left[\ln\left(\frac{T_{AMS}}{T_{AMS} - 1} \right) \right]^{-1}. \tag{2-13}$$

The relation is plotted in figure 2-2. Although the *GP* distribution with $r = 1.6$ is used in this study, the convergence of flood quantiles estimated by both PDS and AMS are observed in many datasets used in the study.

Probability plots, such as the one shown in figures 2-3 and 2-4, are prepared for visual examination of the goodness-of-fit between sample data and the distribution. The PDS data from actual streamflow records are illustrated in figures 2-3 and 2-4. Station 03336500, Bluegrass Creek at Potomac, Ill., contains record from 1950 to 1982 but only with CSG data from 1972 to 1982. Station 05595820, Casey Fork at Mount Vernon, Ill., has complete record from 1986 to 1999. However, because floods of lower magnitudes cluster in the dataset of station 05595820, the fit is better at 03336500 than at 05595820. All probability plots done for this study are given in the attached CD-ROM (appendix 8).

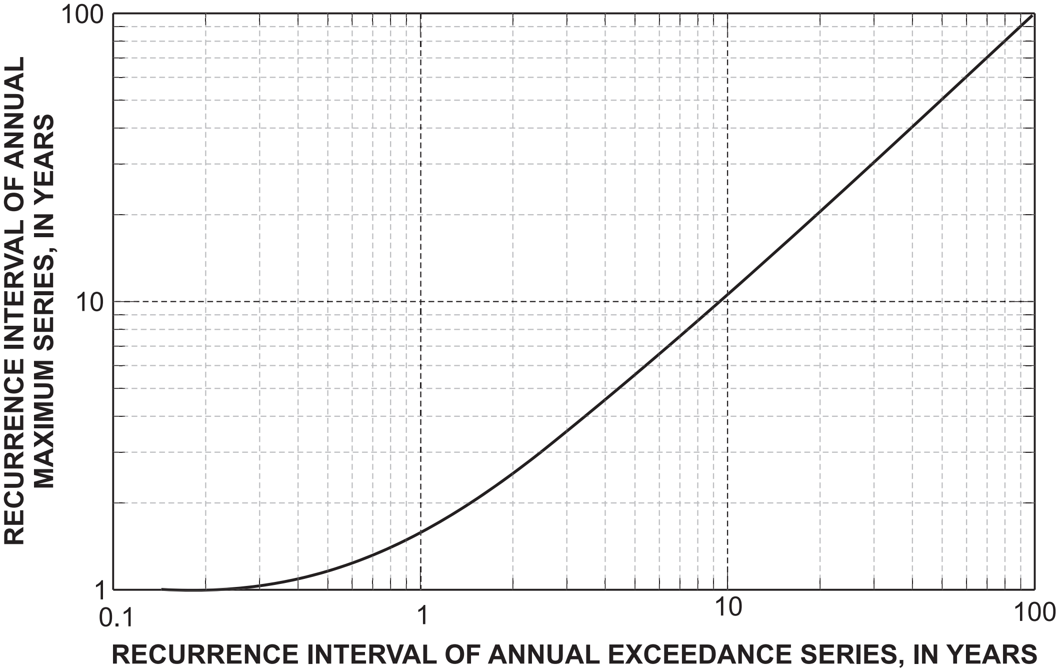

Figure 2-2. Relation between recurrence intervals of annual maximum series and annual exceedance series (Chow, 1964b).

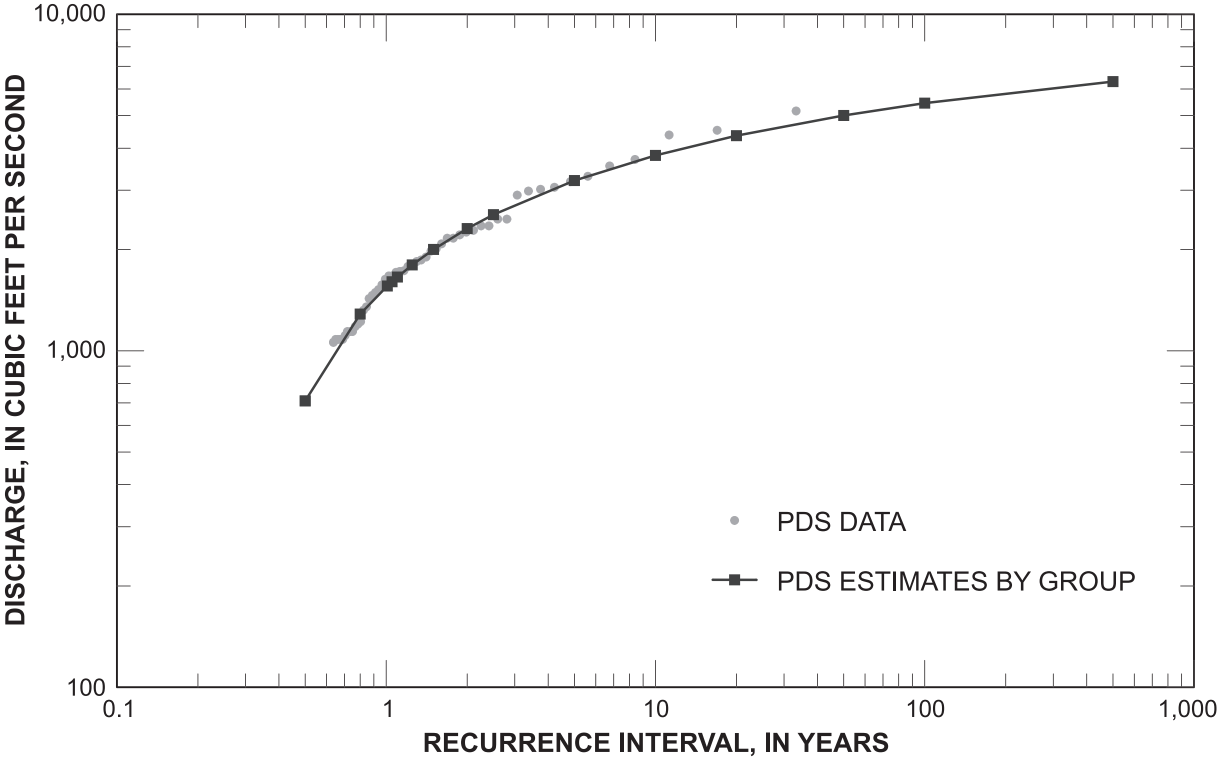

Figure 2-3. Probability plot of flood-peak discharge magnitudes estimated by Generalized Pareto (*GP*) distribution and partial duration series (PDS) data for Bluegrass Creek at Potomac, Ill., in Vermilion County (03336500).

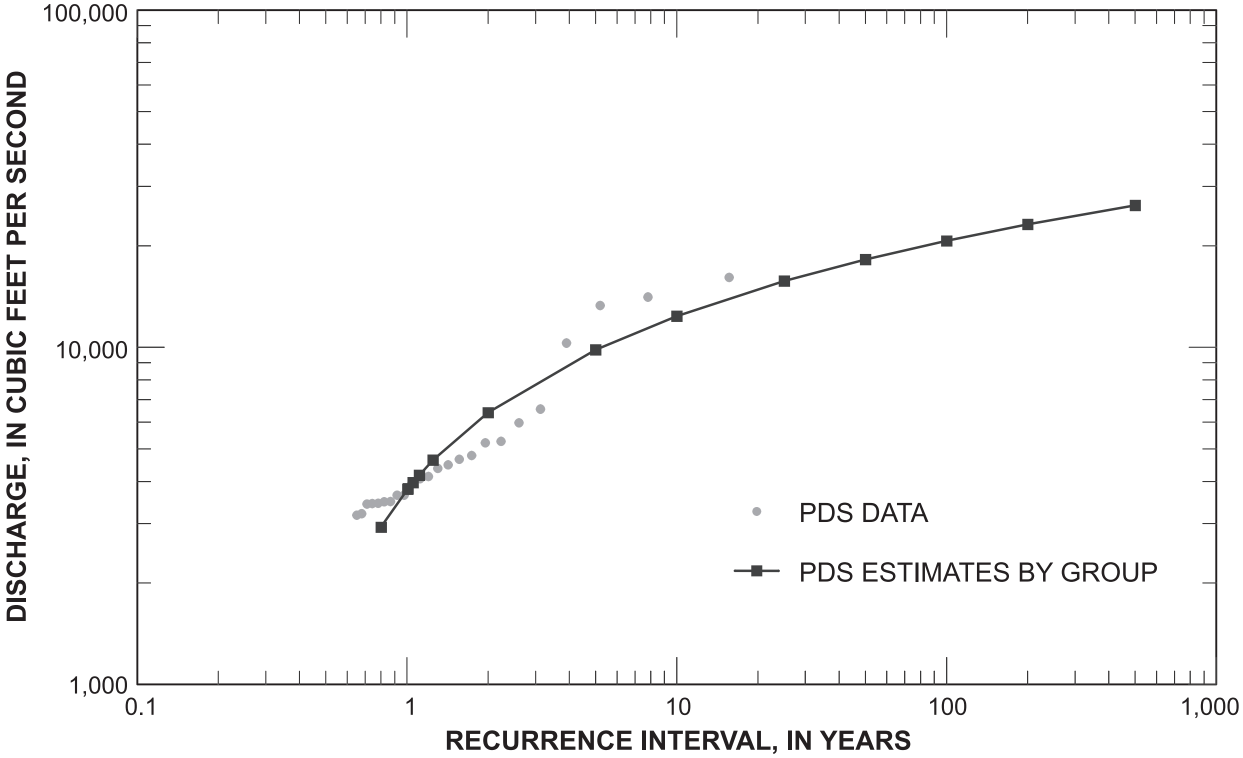

Figure 2-4. Probability plot of flood-peak discharge magnitudes estimated by Generalized Pareto (*GP*) distribution and partial duration series (PDS) data for Casey Fork at Mount Vernon, Ill., in Jefferson County (05595820).

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Appendix 3. Generalized Skew Coefficients for Illinois

The skew coefficient is used in determining the frequency factor in the *LP3* distribution. This relation is depicted as in equation 3-1 (Chow, 1964a)

$$Q_T = \mu + K\sigma \quad , \tag{3-1}$$

where Q_T is the flood quantile of recurrence interval T; μ and σ are population mean and standard deviation, respectively; and K is the frequency factor. When the population skew is estimated from station data, the sample skew (as estimated from available station data), G_S, is sensitive to extreme events and it is difficult to obtain an accurate estimate from a small set of samples. The high bias and uncertainty in the skew coefficient cause greater uncertainty in the flood quantiles especially for those of larger T's. Bulletin 17B (Interagency Advisory Committee on Water Data, 1982) recommends the use of a weighted skew, G_W, to smooth out an erratic estimate of skew coefficients from insufficient samples. The weight is calculated with a generalized skew coefficient, $\overline{G}$, as shown in equation 3-2 (Interagency Advisory Committee on Water Data, 1982)

$$G_W = \frac{MSE_{\overline{G}} \times G_S + MSE_{GS} \times \overline{G}}{MSE_{\overline{G}} + MSE_{GS}} \quad , \tag{3-2}$$

where $MSE_{\overline{G}}$ is the mean square error of generalized skew, and MSE_{GS} is the mean square error of station skew. All computations are carried in log values. The station parameters G_S and MSE_{GS} are determined from station samples after the outliers and historical data are treated. Wallis and others (1974) showed that MSE_{GS} is a function of record length and population skew. Depending on the record length and coverage of the peak-flow data, the procedure gives more weight to the generalized skew if the station record contains non-representative data. Oppositely, more weight is given to the station skew if the station records are long and/or covers sufficient wet/dry periods.

The current $\overline{G}$ and $MSE_{\overline{G}}$ were developed in the 1970s (U.S. Water Resources Council, 1976). Conducting a detailed study of the $\overline{G}$ for the study region is recommended in Bulletin 17B. This appendix describes the update of skew coefficients for Illinois.

Procedures

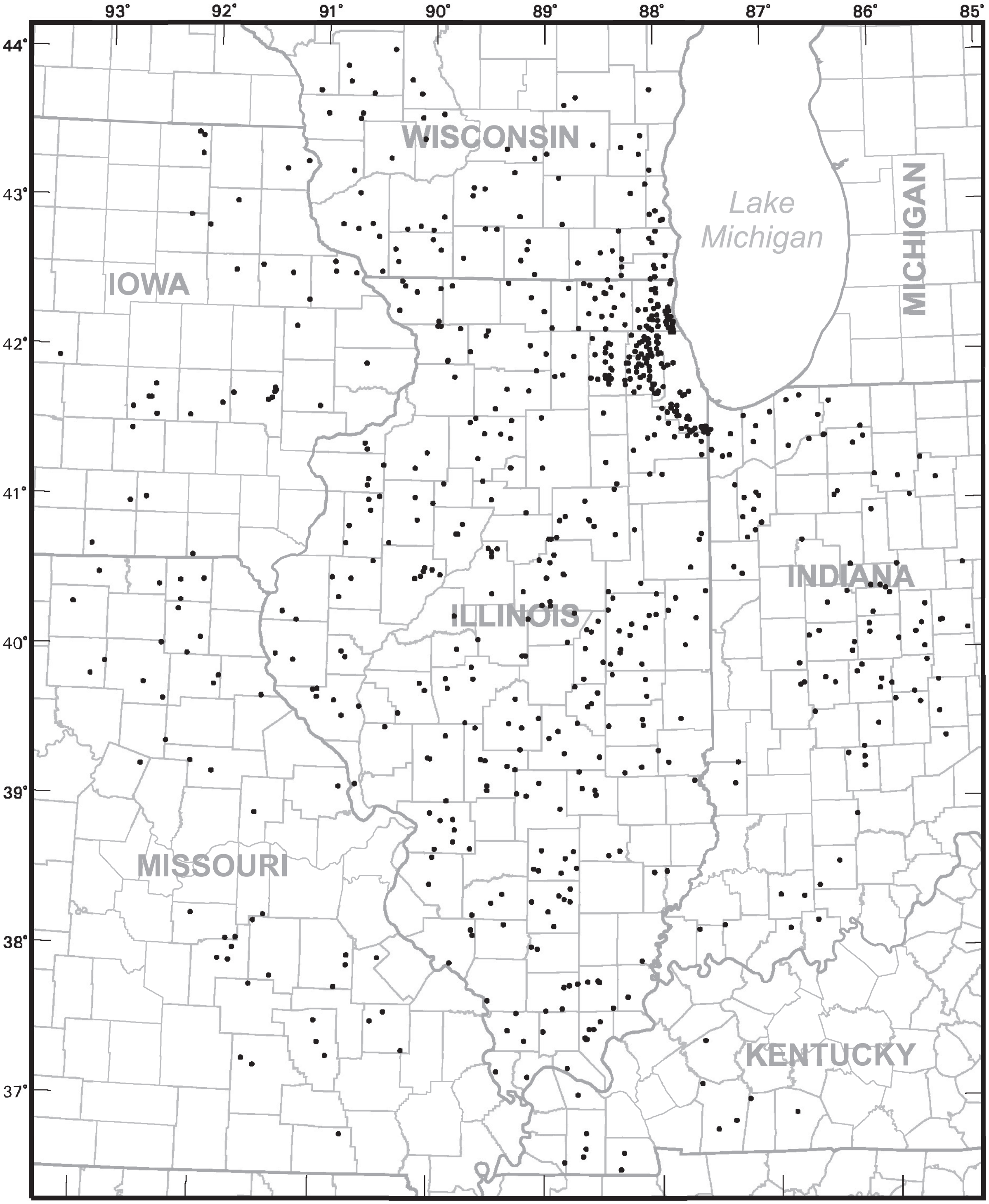
Station selection

Streamflow-gaging stations that are located in Illinois and within 100 mi outside of the State line, have 25 or more years of record, and have drainage areas between 0.5 and 2,000 mi^2 were used in determining the generalized skew coefficients. USGS offices in States adjacent to Illinois provided data for this analysis. After screening, 15 stations from adjacent States were excluded, either because their data showed significant trend or because their drainage area could not be delineated and, therefore, basin centroid could not be determined, (one basin in Wisconsin and six basins in Missouri). Locations of the 372 stations used to determine the generalized skew coefficients are shown in figure 3-1.

Methodology

Three methods listed below, suggested in Bulletin 17B, are used for developing the generalized skew coefficients.

1. Draw skew isolines on a map.
2. Develop a skew prediction equation by regression analysis with basin characteristics as explanatory variables.
3. Use the mean of station skew values in a region.



Base from U.S. Geological Survey
1:100,000 Digital Data
Albers Equal-Area Conic projection
Standard parallels 33° and 45°, central meridian -89°

Figure 3-1. Locations of basin centroids for streamflow-gaging stations in Illinois and adjacent States used in developing the generalized skew-coefficient map (fig. 4).

Oberg and Mades (1987) investigated the generalized skew coefficients for Illinois. The database for station skews in their report consisted of 730 stations with more than 10 years of record in Illinois and surrounding States as considered in the present study. Neither areal trends for drawing isolines of the skew coefficients nor reasonable regression equations could be identified, and the regional mean skew coefficient was derived in evaluating the effects on station estimates. Even with further analysis of the regional mean skew coefficient by grouping stations, they concluded that the mean skew approach only was slightly more accurate than the generalized skew coefficients (U.S. Water Resources Council, 1976) in the 30 stations tested.

The regional mean value and regression analysis are evaluated with the 372 station data directly. However, the isoline map is developed with a kriging technique described in the next section.

Kriging technique

Kriging is a geostatistical method (Isaaks and Srivastava, 1989) that statistically determines optimal weights for values at unsampled locations based on spatial autocorrelation and the assumption that points closer together are more similar than those farther apart. Kriging compares the values of pairs of sampling points and considers the distance the points are from each other. The steps used in this study for kriging the station skew values include the following.

1. Determine skew values at the centroid of the watershed
2. Analyze station data
3. Define grid for kriging
4. Conduct semivariogram analysis
5. Determine isolines

The skew values among the 372 points of station data ranged from –1.483 to 1.716. A histogram indicated that these station skew coefficients were normally distributed, and trend plots did not indicate obvious global spatial trends. ArcMap Geostatistical Analyst (Environmental Systems Research Institute, 1998) was used to krige the skew values at the basin centroids. Kriged data then were input into Arc/Info as a lattice with a resolution of 500 *m* (1 *m* = 3.28 *ft*) that was resampled to 25,000 m. Contours of skew with an interval of 0.1 were created with the LATTICE-CONTOUR command.

A uniform grid was used to estimate the skew coefficients. A spherical spatial model was fit to the station skew points based on a semivariogram where the difference in values squared and the distance that separates each pair of points is graphed. Modeling the semivariogram is a technique that defines the linear weighting functions to krige the grids and was performed prior to kriging. The best spatial model was determined to have a nugget[1] of 0.14, a range of 150,000 m, a minor range of 260,400 m, a partial sill[2] of 0.06, and 12 lags[3] at 24,000 m (Johnston and others, 2001). There was minor anisotropy[4] so a search direction of 107 degrees was used. The search neighborhood was an ellipse with a major semi-axis of 150,000 m and a minor semi-axis of 260,400 m with four angular sectors. Five points were used to determine the prediction, with a minimum of two points required within one angular sector. The semivariogram plot for residuals of skew coefficient values in Illinois and adjacent States is shown in figure 3-2.

Results and Comparisons

The generalized skew coefficients obtained by the three methods (skew isolines, skew prediction equation, and mean station skew) described previously are compared using the mean square error (*MSE*) of station skew coefficients and the generalized skew coefficients are derived from the three methods (table 3-1). The corresponding *MSE* of the generalized skew map (U.S. Water Resources Council, 1976) is shown in table 3-1.

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[1] The nugget is a measure of error at distances smaller than the sampling interval and includes measurement and independent error, and micro-scale variation too fine to detect. At distances closer than the range, the points are considered to be autocorrelated; beyond the range, there is no measurable correlation between points.

[2] The sill is equal to the variance among correlated points, in this case 0.10. The partial sill is the sill minus the nugget.

[3] A lag is the vector that spatially separates any two sample points and has both a direction and a distance.

[4] Anisotropy is a spatial trend that shows higher autocorrelation in one direction than in another.

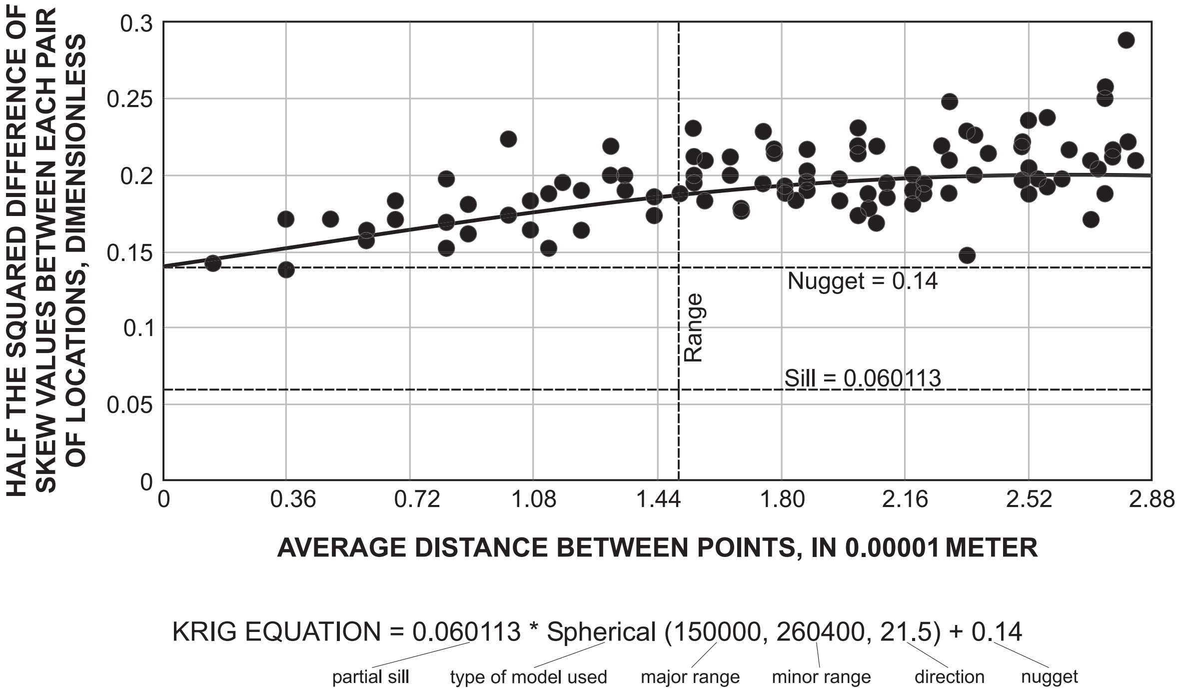

Figure 3-2. Variogram used to krig estimates of generalized skew coefficients for Illinois.

Table 3-1. Comparisons of mean square errors of regional and Illinois skew coefficients.

[The mean square errors are determined based on two groups of stations: the 372 stations with 25 or more years of records and within 100 miles of the State line (region) and the 140 stations in basins that drain into Illinois only; N/A, not available.]

Method	Mean square errors (dimensionless)	
	Region	Illinois
Generalized skew coefficient map from 1976	0.245	0.307
Mean value of station skew coefficients	.190	.245
Isoline map from kriging techniques	.121	.140
Regression equation	N/A[1]	.205

[1] The regression equation approach was not applied for the region because it would involve obtaining other ancillary data from neighboring States. This work is beyond the scope of this study.

Mean value of station skews

Mean value of station skews has the highest *MSE* in the updated data. Therefore, this approach was not used.

Regression analysis

The multiple regression of station skew with three significant explanatory variables identified by stepwise regression analysis yields

$$\overline{G}_{REG} = 3.115 + \log_{10}(BS)^{.511} + \log_{10}(LAT)^{-2.27} + \log_{10}(FOREST)^{-.622} \ , \tag{3-3}$$

where $\overline{G}_{REG}$ is the generalized skew based on regression, *BS* is the average basin slope, *LAT* is the latitude of at the basin centroid, and *FOREST* is the percentage of areas classified as forest in the drainage basin (see appendix 5). The regression yielded $R^2 = 0.08$, overall $F = 4.06$, and $p = 0.008$. These values indicate that the regression is slightly better than no regression, and the selected variables barely can explain any variance of the observed data from the mean. Low R^2 also was reported by Eash (2001).

Isoline map approach

The isoline map approach has the lowest *MSE* (0.14) and was used in the at-site frequency analysis. The *MSE* value is lower than 0.302 that was derived using the entire U.S. skew map (Interagency Advisory Committee on Water Data, 1982, p. 13). The updated generalized skew coefficients for Illinois was determined using this method. A map of isolines of generalized skew coefficient for the State is given in figure 4 in the main text.

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Appendix 4. Effects of Additional Flood Records and Updated Generalized Skew Coefficients on At-Site Flood Quantiles Based on Annual Maximum Series

Additional record length and better coverage of major flood event(s) could improve the statistical reliability of flood-frequency analysis. In this study, the generalized skew coefficients also are updated for Illinois (appendix 3). The effects of additional flood records (since WY 1986) and updated generalized skew coefficient on at-site AMS flood frequencies are examined. The evaluation first examines the new annual maximum flood records collected from WY 1986 to WY 1999 in terms of their temporal and spatial distributions, then compares the effects of additional flood records and updated generalized skew coefficients on at-site AMS flood frequencies for stations used in the regional analysis.

Record Length

Update in record length

Curtis (1987) used 268 rural streamflow-gaging stations with data up to WY 1985 in the regional regression analysis. A total of 288 streamflow-gaging stations with data up to WY 1999 were used in the regional regression analysis for this study. Among the 268 stations used by Curtis (1987), additional flood records were available at 116 stations between WY 1986 and WY 1999. Also, 10 rural-watershed stations became available for use in the regional flood-frequency analysis after 1985. The changes in record length for stations used by Curtis and the present study are examined by a comparison for the number of stations in the following three groups: records < 15 years, 15 years ≤ records < 25 years, and records ≥ 25 years. The 15 and 25 years are selected arbitrarily for this analysis, but, in general, station statistics estimated with record length between 10 and 15 years are most sensitive to extreme events, and record length of 25 years has been used as a criterion in selecting stations for updating the regional skew coefficient. The comparison shown in table 4-1 indicates that more stations appeared in the ≥ 25 years group. Also, for the remaining two groups (records < 15 years, and 15 ≤ records < 25 years), additional flood records only were collected at 10 out of the 119 stations (table 4-1).

Table 4-1. Comparisons of record length for stations used in the regional analysis of Curtis (1987) and this study in Illinois.

[<, less than; ≤, less than or equal to; ≥, greater than or equal to; yrs, years; WY, water year]

Studies	Year ends	Number of stations	< 15 yrs	15 yrs ≤ x < 25 yrs	≥ 25 yrs
Curtis (1987)	WY 1985	268	36	118	114
Present	WY 1999	288	28	91	168

For the 10 new stations, 4 have records less than 15 years and the other 6 have records between 15- and 25-years long. However, these newly added stations might fall within the short-record group because of major floods in the 1990's. Furthermore, if small watersheds are defined arbitrarily as those with drainage areas less than 5 mi^2, 83 of the 288 stations fall in this category. Among the 83 stations, 64 stations have less than 25 years of record; 18 stations have 25 years of record, 1 with 26 years, and 1 with 45 years of record (Hurricane Creek near Roodhouse, Ill., 5586500). Data-collection programs for most small watersheds ended prior to 1980. Data collection at Hurricane Creek at Roodhouse ended in 1995. The lack of data for small watersheds since 1980 could result in biases in frequency estimates for small watersheds.

Record length of streamflow-gaging stations in hydrologic regions

Information concerning the record length of streamflow-gaging stations that are used in developing regional equations is presented in table 4-2. Such information is organized with four categories and presented for individual hydrologic regions. Category A is the number of stations that received new data since Curtis (1987), and categories

Table 4-2. Spatial distributions of record length for stations used in the regional analysis of Curtis (1987) and this study in Illinois.

[<, less than; ≤, less than or equal to; ≥, greater than or equal to; **Record category: A**, number of stations with new data since water year 1986; **B**, number of stations in the < 15 years group; **C**, number stations in the 15 years ≤ records < 25 years group; **D**, number of stations in the ≥ 25 years group.]

Hydrologic Regions (fig. 5)	Record Category			
	A	B	C	D
1	12	2	6	18
2	24	7	36	29
3	31	5	21	49
4	20	3	11	34
5	21	5	10	23
6	4	4	7	9
7	4	2	0	6

B, C, and D are the same as record-length groups discussed above. The number of streamflow-gaging stations in each hydrologic region available for regression analysis is obtained by summing the stations under record categories B, C, and D. With streamflow data up to WY 1999, it can be seen that all regions have the largest number of stations in category D (the ≥ 25 years group) except for region 2. In general, the update and distribution of station records are similar in each hydrologic region.

Major flood events in the additional streamflow records

Between WY 1986 and WY 1999, large flood events occurred in various parts of Illinois. For the 116 stations with additional flood records, new maximums were established at 40 stations; 16 of the stations exceeded the Q_{100} and 1 station matched the Q_{100} estimated in 1987 (Curtis, 1987).

Distribution of major flood events in the additional streamflow records

The number of events and the years recorded are reported in table 4-3.

Table 4-3. Distributions of major flood events in Illinois from water year 1986 to water year 1999.

Hydrologic Regions (fig. 5)	Number of Events	Water Year
1	2	1993, 99
2	12	1986, 91, 93, 94, 96, 97, 99
3	9	1990, 94, 96, 97
4	2	1993, 96
5	9	1990, 94, 95, 96
6	6	1990, 94, 96
7	0	None recorded

Effects of Additional Flood Records and Updated Generalized Skew Coefficients on At-Site Flood Quantiles and Width of Confidence Intervals

Better estimate of T's for infrequent events can be obtained with additional flood records thus improving the determination of Q_T-T relations. Additional flood records also help reduce the uncertainty in estimating the statistical parameters of the distribution. On the other hand, the generalized skew coefficient is used in the weighted skew approach to smooth out potential erratic estimates of skew coefficients from the systematic data (appendix 3). In this study, two estimated flood statistics are used for evaluating the effects of additional record length and updated generalized skew coefficient on the at-site AMS flood-frequency analysis; these statistics are the flood quantiles and the width of confidence intervals. The evaluation consists of comparison of the selected parameters computed for the following three cases.

A. Parameter estimates using data up to WY 1985 and weighted with the previous generalized skew coefficients ($S_{1985\_old\_skew}$),

B. Parameter estimates using data up to WY 1999 and weighted with the previous generalized skew coefficients ($S_{1999\_old\_skew}$), and

C. Parameter estimates using data up to WY 1999 and weighted with the updated generalized skew coefficients ($S_{1999\_new\_skew}$).

The effects of additional flood records and updated generalized skew coefficients are evaluated as follows. Letting *S* be the statistical parameter that either can be the magnitude of at-site flood quantiles or the width of confidence intervals, and Δ% be the change in *S* either because of additional records or updated regional skew coefficients, then Δ%, in percent, can be computed as

$$\Delta\% = \frac{S_{1999\_old\_skew} - S_{1985\_old\_skew}}{S_{1999\_old\_skew}} \times 100 \ , \tag{4-1}$$

which is an evaluation of the effect of additional flood records, or

$$\Delta\% = \frac{S_{1999\_old\_skew} - S_{1999\_old\_skew}}{S_{1999\_old\_skew}} \times 100 \ , \tag{4-2}$$

which is an evaluation of the effect of updated generalized skew coefficients. In the evaluations, Case B is used as the base conditions for comparison. Further, only the changes associated with 2- and 100-year recurrence intervals are evaluated in the present study. Therefore, *S* either could be the magnitudes or the width of confidence intervals for Q_2 or Q_{100} at each station. After changes in *S* for all stations are computed, they are categorized according to whether they are increased (positive Δ% values), unchanged (zero Δ%), or decreased (negative Δ% values); and are organized by the hydrologic regions. Results for other recurrence intervals between 2 and 100 years could reasonably be expected to fall between the two *T*'s presented here.

Effects of additional flood records

The effects of additional flood records on percentage of changes of at-site flood frequencies and width of confidence intervals are presented in figure 4-1. In this figure, the x-axis is the seven hydrologic regions and the y-axis is the percentage of stations that fall in the increased, unchanged, and decreased categories. The percentage for each category is calculated by dividing the number of stations in "increased", "unchanged", or "decreased" category in a region by the total number of stations in that region. Note that only 126 of the 288 stations had additional flood data since WY 1986. For the purpose of presenting the comparison in a consistent basis when the updated skew is evaluated, all 288 stations are used in the presentation of figure 4-1. Therefore, besides the 126 stations with additional flood records, all other stations fall into the unchanged category.

In regions 2, 3, 4, 5, and 6, more stations have increased magnitudes of Q_2 and Q_{100} than that of decreased because of the additional flood records. Region 1 has more stations with decreased Q_2 but has more stations with increased Q_{100}. Region 7, on the other hand, has decreased values of Q_2 and Q_{100} for stations with additional flood record. The major floods in the 1990's have caused increases in estimated Q_{100} for most of the regions. The addition of large flood events may result in changes in the station statistics; in particular, skew values may increase. The estimated Q_T's at larger *T*'s (such as $T = 100$ year) will be larger for a positively skewed dataset and smaller for a negatively skewed dataset, when compared to a normally distributed dataset. The increases in flood-peak discharge magnitude at larger *T*'s potentially increase the overall slope of the frequency curves and result in decreases in lower flood quantiles for some stations.

The width of confidence interval decreases with additions in flood data and record length, as would be expected. All regions, except for region 6, have higher percentages of decreasing width of confidence interval for stations with additional flood records. The decreases in the width of confidence intervals indicate an improvement in the accuracy of the estimates in those regions. Regions 6 and 7 contain fewer stations with additional flood records than other regions since WY 1986 (table 4-2). Also, either fewer number of major storm events or no major storm event were recorded at stations in regions 6 and 7 than other regions since WY 1986. Data evaluation also indicates that increase in width of confidence interval is associated with positive changes in the skew coefficient.

Effects of updated generalized skew coefficients

The effects of updated generalized skew coefficients on the flood quantile and width of confidence intervals are presented in figure 4-2. Similar to the analysis conducted for additional flood records, records from the 288 stations are used in this evaluation. Note that equations 4-1 and 4-2 are designed to evaluate the deviations from the common basis (Case B). Therefore, a decreased value in figure 4-2 indicates an increase in the flood quantile or the width of confidence interval for Case C. With the updated generalized skew coefficients, almost all regions had a trend of decreases in magnitudes and width of confidence intervals for Q_2, but a trend of increases magnitudes and width of

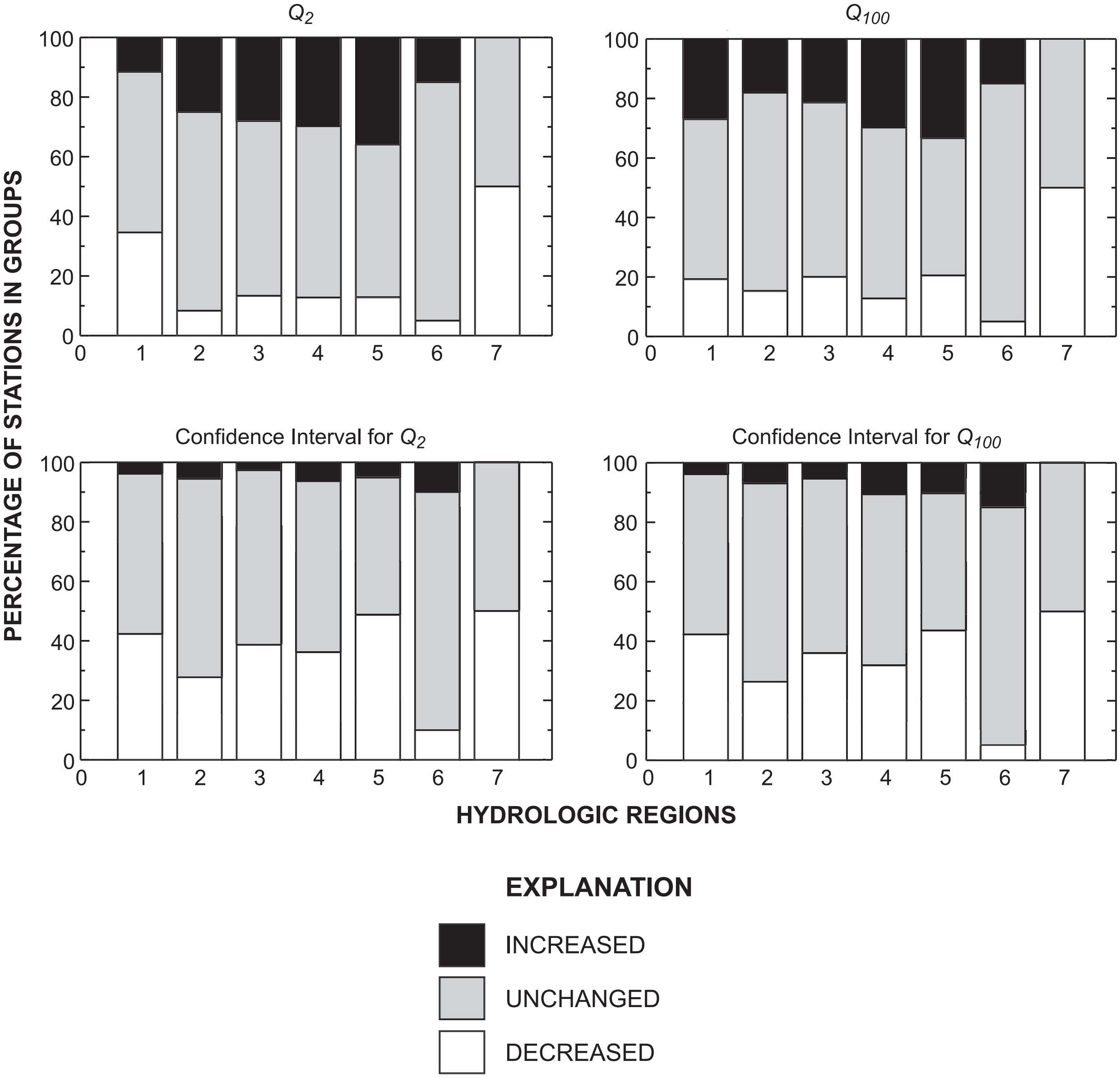

Figure 4-1. Changes in flood magnitudes and confidence intervals because of additional station records in Illinois. Percentage changes are calculated using equation 4-1; Q_2 and Q_{100} are the peak-flood discharge with 2- and 100-year recurrence interval, respectively.

confidence intervals for Q_{100}. This result could be due to the range of flood-peak discharge data added to the flood files in the 1990's. Besides observing the increased, unchanged, or decreased trend categories in the magnitudes and width of confidence intervals, the relative magnitudes in these trends are discussed in the next section.

Comparing the effects of additional flood records to updated skew coefficient

The range (minimum to maximum) of changes in the magnitudes and width of confidence intervals of Q_2 and Q_{100}, evaluated using equations 4-1 and 4-2, are listed in table 4-4 (minimum and maximum values are listed). It can be observed that the ranges in the "decrease in width of confidence interval" group are larger than the range in the "increase in width of confidence interval" group because of additional flood records. The ranges of changes resulting from additional flood records are larger than those resulting from updated skew coefficients.

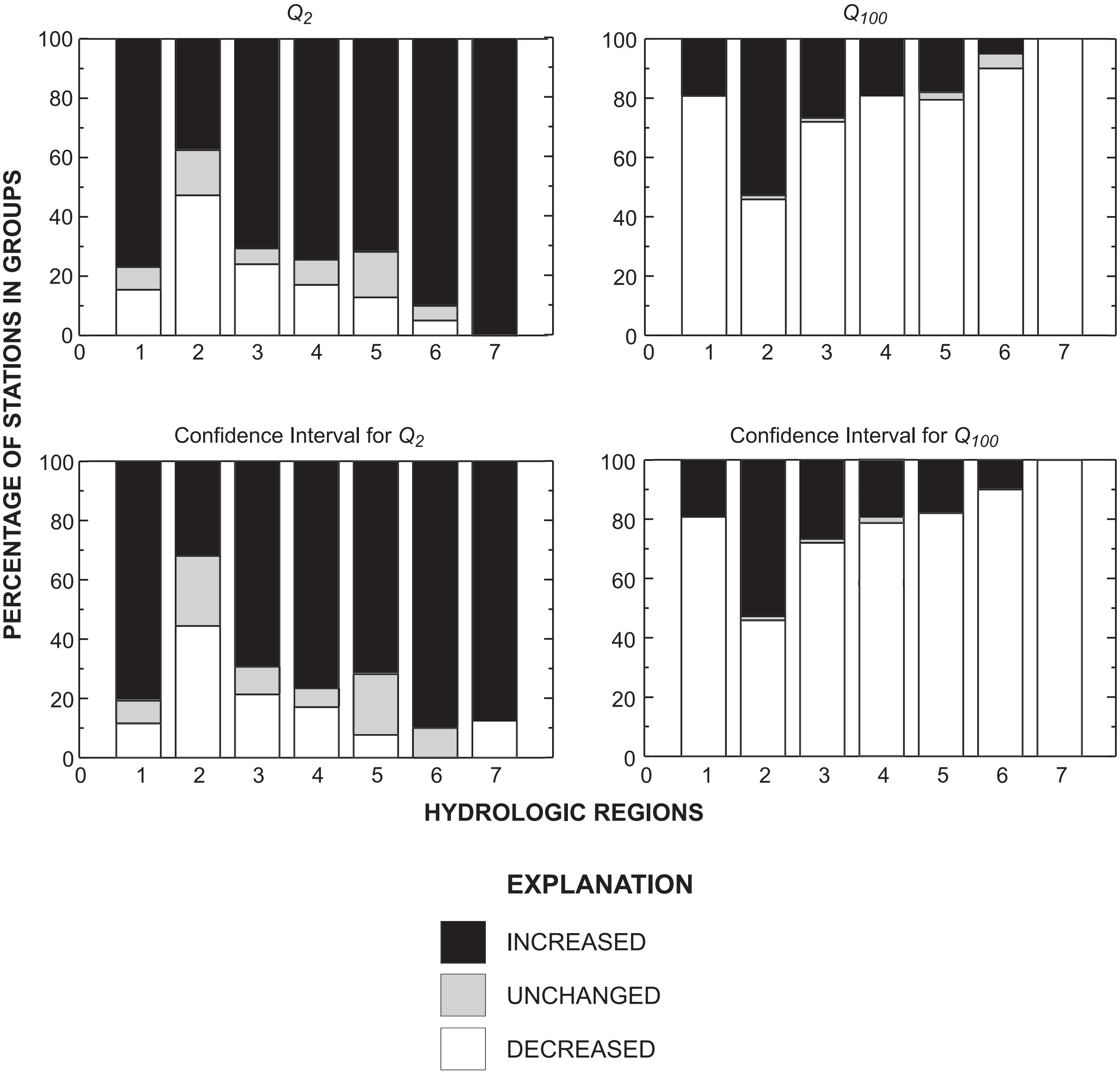

Figure 4-2. Changes in flood magnitudes and confidence intervals because of updated skew coefficients in Illinois. Percentage changes are calculated using equation 4-1; Q_2 and Q_{100} are the peak-flood discharge with 2- and 100-year recurrence interval, respectively.

References

Curtis, G.W., 1987, Technique for estimating flood-peak discharges and frequencies on rural streams in Illinois: U.S. Geological Survey Water-Resources Investigations Report 87-4207, 79 p.

Table 4-4. Changes in Q_2, Q_{100}, and the width of confidence intervals at 2 and 100 years because of additional flood records and updated generalized skew coefficients for Illinois.

[ΔQ_2, changes in 2-year flood quantile, in percent; **minimum**, minimum value of the specified quantity from the 288 stations, in percent; **maximum**, maximum value of the selected quantity from the 288 stations, in percent; ΔQ_{100}, changes in 100-year flood quantile, in percent; $\Delta ConF_2$, changes in the width of confidence interval for the 2-year flood quantile, in percent; $\Delta ConF_{100}$, changes in the width of confidence interval for the 100-year flood quantile, in percent]

	ΔQ_2 minimum	ΔQ_2 maximum	ΔQ_{100} minimum	ΔQ_{100} maximum	$\Delta ConF_2$ minimum	$\Delta ConF_2$ maximum	$\Delta ConF_{100}$ minimum	$\Delta ConF_{100}$ maximum
Additional records	-12.4	17.4	-24.3	47.7	-58.6	45.5	-99.8	67
Updated skew coefficient	-4	5.7	-31.8	14.8	-8.3	11.1	-51.4	21.6

Appendix 5. Determination of Basin Characteristics

Basin characteristics, including geometric and topographic parameters, soil variables, land uses, and rainfall intensities, have been used for interpreting flows from a watershed resulting from the rainfall-runoff processes. Determining and/or updating these basin characteristics require appreciable resources and are time consuming; therefore, only limited basin characteristics have been determined and used in previous flood-frequency studies in Illinois. Carns (1973), Curtis (1977a, b; 1987) used a maximum of nine explanatory variables from the basin characteristics in the development of regional regression equations for Illinois. Whether the regional regression equations could be improved by evaluating additional explanatory variables in basin characteristics has been a question. Computer programs, such as the BASINSOFT (Harvey and Eash, 1996), now provide an efficient and consistent way to determine basin characteristics in conjunction with the use of digital spatial data (Eash, 2001, 1993). For Illinois, spatial digital databases including a DEM, STATSGO (Natural Resources Conservation Service, 1993), NLCD (*http://landcover.usgs.gov/nationallandcover.html*), and precipitation frequency (Huff and Angel, 1992) became available after Curtis (1987). Thus, determining a set of basin characteristics for Illinois using BASINSOFT and Arc/Info procedures on these digital databases is one of the objectives of this study, and these determined basin characteristics are used in the regression analysis.

Methodology

BASINSOFT is a GIS computer program developed using the Arc/Info (Environmental System Research Institute, 1998) Arc Macro Language (AML). The BASINSOFT program used in this study is an internal USGS version (version 1.0, 2001) not publicly disseminated. For each drainage basin, four data layers, including drainage divide, stream-network, and two separate types of elevation data (contour and lattice), were used to calculate variables for input into equations used to quantify the basin-morphometric characteristics (see list below). All data layers were derived from available 1:100,000-scale digital data except in some small basins where it was necessary to manually digitize 1:24,000-scale topographic quadrangles in order to obtain enough features to allow BASINSOFT to run properly. It also was necessary to use 1:250,000-scale elevation data for various basins with drainages partially extending into Indiana where 1:100,000-scale digital data were not available. The 1:100,000-scale data sources were: 1) National Hydrography Dataset (NHD) for stream network data (*http://www.nhd.gov/*); 2) digital line graph (DLG) hypsography for elevation contour data (*http://edc.usgs.gov/doc/edchome/ndcdb/ndcdb.html*); and 3) digital elevation model (DEM) derived from the 1:100,000-scale hypsography data using the Arc/Info command, TOPOGRID.

A complete list of BASINSOFT characteristics with definitions has been compiled by Harvey and Eash (1996). Definitions for selected explanatory variables pertinent to this study are given as follows. Harvey and Eash (1996) used *CDA*, contributing drainage area, in defining most of the morphometric characteristics. The *CDA* is the more hydrologically relevant variable than *TDA* (total drainage area) for surface-water-flow studies. However, a generally accepted method for determining *CDA* has not been defined, and *TDA* is measured and used instead of *CDA* in this Illinois study. This modification is reflected in the regional equations presented in the main text.

Basin-Morphometric Characteristics

TDA—Total drainage area, in square miles, includes all area within the drainage-basin boundary.

CDA—Contributing drainage area, in square miles, defined as the total area that contributes to surface runoff at the basin outlet. By definition, *CDA* is a portion of *TDA* as computed by $CDA = TDA - NCDA$, where N*CDA* is the noncontributing area. Because a recognized way for computing *CDA* has not been determined, it is assumed that $CDA = TDA$ for all basins in Illinois in this study.

BL—Basin length, in miles, measured along a line areally centered through the drainage-basin boundary data layer from the basin outlet to the intersection of the main channel (extended) and the basin boundary.

BP—Basin perimeter, in miles, measured along the entire drainage-basin boundary.

BS—Average basin slope, in feet per mile, quantified using the "contour-band" method, which is computed as *BS*=(total length of all selected elevation contours within the *CDA*)(contour interval)/*CDA*.

BR—Basin relief, in feet, measured as the elevation difference in the digital elevation model between the highest grid cell and grid cell at the basin outlet.

BA—Basin azimuth, in compass degrees of a line defined from where the main-channel extension meets the basin divide downslope to the basin outlet. Measured clockwise from north at 0°.

BW—Effective basin width, in miles, $BW=CDA/BL$.

SF—Shape factor, dimensionless, as the ratio of basin length to effective basin width, $SF=BL/BW$.

ER—Elongation ratio, dimensionless; as the ratio of (1) the diameter of a circle of area equal to that of the basin to (2) the length of the basin, $ER=(4CDA/\pi(BL)^2)^{0.5}=1.13(1/SF)^{0.5}$.

RB—Rotundity of basin, dimensionless; $RB=(\pi(BL)^2)/(4CDA)=0.785\ SF$.

CR—Compactness ratio, dimensionless; as the ratio of the perimeter of the basin to the circumference of a circle of equal area, $CR=BP/2(\pi CDA)^{0.5}$.

RR—Relative relief, in feet per mile, $RR=BR/BP$.

MCL—Main-channel length, in miles; as measured along the main channel from the basin outlet to where the main-channel extension meets the basin divide.

TSL—Total stream length, in miles; as computed by summing the length of all stream segments within the *CDA*.

MCS—Main-channel slope, in feet per mile; an index of the slope of the main channel computed from the difference in streambed elevations at points 10 percent and 85 percent of the distance along the main channel from the basin outlet to the basin divide, $MCS=(E_{85}-E_{10})/(0.75MCL)$.

MCSR—Main-channel sinuosity ratio, dimensionless, $MCSR=MCL/BL$.

SD—Stream density, in miles per square mile, as within the *CDA*, $SD=TSL/CDA$.

CCM—Constant of channel maintenance, in square miles per mile, as within the *CDA*, $CCM=CDA/TSL=1/SD$.

MCSP—Main-channel slope proportion, $MCSP=MCL/(MCS^{0.5})$. Note that *MCSP* is not a non-dimensional term.

RN—Ruggedness number, in feet per mile, $RN=(TSL)(BR)/CDA=(SD)(BR)$.

SR—Slope ratio of main-channel slope to basin slope, dimensionless; as within the *CDA*, $SR=MCS/BS$.

FOS—Number of first-order streams within the *CDA*, dimensionless. *FOS* is computed using Strahler's method of ordering streams (Strahler, 1964, 1957).

BSO—Basin stream order, dimensionless, stream order of the main channel at the basin outlet. *BSO* is computed using Strahler's method of ordering streams (Strahler, 1964, 1957).

DF—Drainage frequency, in number of first-order streams per square mile within the *CDA*, $DF=FOS/CDA$.

RSD—Relative stream density, dimensionless, as within the *CDA*, $RSD=(FOS)(CDA)/(TSL)^2=DF/(SD)^2$.

Soil and precipitation characteristics

The following explanatory variables are quantified from STATSGO (Natural Resources Conservation Service, 1993) database and precipitation frequency estimates (Huff and Angel, 1992). Note that the variable values presented are area-weighted for the basin studied, and are computed using the area-weighting program of BASINSOFT. Description of the variables given in STATSGO is given first and in parenthesis.

PermL— (The minimum value for the range in permeability rate for the soil layer or horizon, in in/hr). Value presented is area-weighted average, minimum permeability rate of soil aggregated by soil layer and component, as a low value in the permeability range.

PermH— (The maximum value for the range in permeability rate for the soil layer or horizon, in in/hr). Value presented is area-weighted average, maximum permeability rate of soil aggregated by soil layer and component as a high value in the permeability range.

PermAvg— Average of the area-weighted *PermH* and *PermL*.

AWCL— (The minimum value for the range of available water capacity for the soil layer or horizon, in in/hr). Value presented is area-weighted average, minimum available water capacity of soil aggregated by soil layer.

AWCH— (The maximum value for the range of available water capacity for the soil layer or horizon, in in/hr). Value presented is area-weighted average, maximum available water capacity of soil aggregated by soil layer.

SlopeL— (The minimum value for the range of slope of a soil component within a map unit). Value presented is area-weighted average, minimum slope of soil, in percent, aggregated by soil component.

SlopeH— (The maximum value for the range of slope of a soil component within a map unit). Value presented is area-weighted average, maximum slope of soil, in percent, aggregated by soil component.

TTF—2-year, 24-hour precipitation depth, in inches, defined as the maximum 24-hour precipitation expected to be exceeded, on average, once every 2 years.

Land-use characteristics

Basin centroids, given as latitude-longitude coordinate pairs, were determined using the Arc/Info command CENTROIDLABELS with the INSIDE option and the ADDLATLONG[1] command with the DD (Decimal Degrees) option. Land-cover variables were determined from the Multi-Resolution Land Characteristics Consortium's National Land Cover Data (NLCD) (*http://www.epa.gov/mrlc/nlcd.html*).

LAT—Latitude of the basin centroid above the station or location of interest, in decimal degrees.

LONG—Longitude of the basin centroid above the station or location of interest, in decimal degrees.

Open water (%Water)—For a basin, the percentage of area classified as open water and herbaceous wetland (areas that are 75-100 percent grassy-type vegetation with periodic saturation).

Forest—For a basin, the percentage of area classified as forest plus the forested wetland.

Factors to be Considered in Determining Basin Characteristics

The following factors should be considered in determining basin characteristics.

- Care should be taken to convert datasets to a uniform unit system before running BASINSOFT. For example, digital elevation dataset can be specified in Standard International or English unit systems.
- The grid resolution of the 1:100,000-scale DEM was approximately 98 ft. When determining basin characteristics for small basins, 1:24,000-scale data should be digitized, including hypsography and hydrography. Typically, smaller-scale datasets (1:100,000 to 1:250,000) lack the detail necessary to run BASINSOFT for small basins.
- Until more refined procedures are developed, the basin boundaries should be determined with a reliable method. In this study, river basin boundaries delineated previously from other studies are used. These boundary delineations are digitized from the 7.5-minute quadrangle maps into GIS layers before running BASINSOFT for other parameters.
- Definition for some parameters needs to be specified by the user for the BASINSOFT analysis. The *MCL*, for example, can result in different values if a different definition for the main channel is used. Before calculations begin, the user is prompted to extend the main channel up to the basin divide and then select this new segment and the outlet point of the basin to highlight the main channel. The user can select the main channel as the set of stream segments that drain the most area, or select the main channel as identified by the named segment at the basin outlet and following this named feature to the basin divide. The latter definition is used in this study.
- In using STATSGO to determine *PermL* or *PermH*, the approximate minimum area delineated is 625 hectares (1,544 acres), which is represented on a 1:250,000 scale map by an area approximately 1 cm by 1 cm (0.33 inch by 0.33 inch). Linear delineations should not be less than 0.5 cm in width. The number of delineations per 1:250,000 quadrangle should range from 100 to 200, but a range up to 400 is allowed (*www.ftw.nrcs.usda.gov/pdf/statsgo_db.pdf*). When combining map units, the four steps listed in the manual should be followed (*www.essc.psu.edu/soil_info/index.cgi?soil_data&counus&data_cov&perm&methods*; p. 18-19).

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[1] ADDLATLONG is an AML designed by USGS personnel, which may not be included in the general public version of ArcINFO.

Two basin-morphometric parameters, *MCL* and *MCS*, determined from BASINSOFT procedures are compared to available data (Curtis, 1987) for evaluating the differences in these parameters from the two datasets; hand-delineated (Curtis, 1987) and BASIINSOFT delineated. First, the *MCS* values are compared to those reported in Curtis (1987). In general, values from the two sources are similar but some discrepancies are present especially for values greater than approximately 150 ft/mi (fig. 5-1). It is considered that measurement errors could arise from interpretations of contour values, stream-network delineation, or local effects that require engineering judgment. To examine what basin types are associated with larger measurement errors, the *MCS* data used in figure 5-1 are used to compute the percent difference, as (BASINSOFT value – Curtis value)/(Curtis value), as shown in figure 5-2. It can be seen that the *MCS* values determined by BASINSOFT are mostly within the band of +50 percent (arbitrarily defined value above this limit is considered to be an overestimate) and –50 percent (an underestimate) from those used in the 1987 study (Curtis, 1987). Underestimation of the *MCS* with BASINSOFT occurs mostly at small drainage areas (lesser than 10 mi^2), overestimation by BASINSOFT occurs mostly at drainage areas approximately between 10 and 1,000 mi^2, but larger *MCS* errors occur in watersheds with drainage areas about 10 mi^2.

Various *MCL* values determined in this study were checked with published data (Healy, 1979a, b) and the results were similar. Eash (U.S. Geological Survey, written commun., 2002) also cautioned that users might encounter mixed map scales or measurement methods. Some possible problems in determining the basin geometric parameters are listed below.

- Manual *MCS* measurements could have been derived from maps with different scales. Examples are those stored in WATSTORE dated back to mid 1970's.
- The sources of elevation and channel length data are in different scales. For example, elevation is derived from 1:24,000 data but the *MCL* is determined from 1:100,000 data.
- *MCL* measurements could be made using dividers set at 0.1-mi increments and the dividers were used to "walk" along the river to measure the *MCL.* This measurement method has been used previously and all the channel sinuosity usually is not measured with this method. Because the program measures along the stream centerline and, therefore, includes the sinuosity, the *MCL* values from BASINSOFT usually are greater than determined using graph paper.

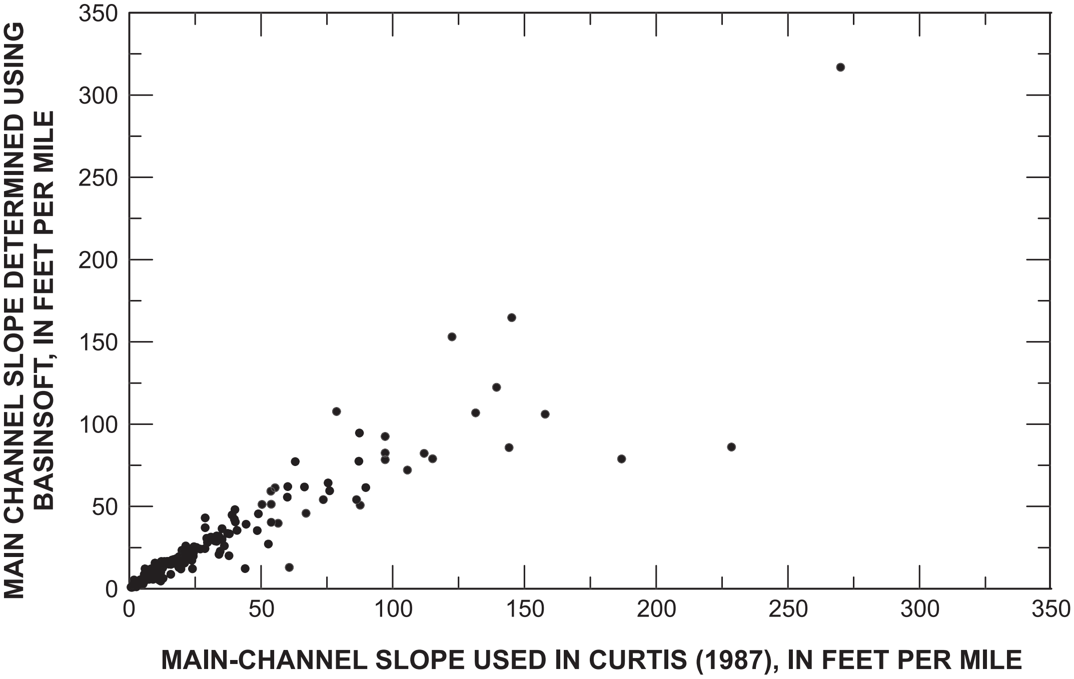

Figure 5-1. Comparisons of main-channel slope values used in Curtis (1987) and determined with the BASINSOFT program for selected watersheds in Illinois.

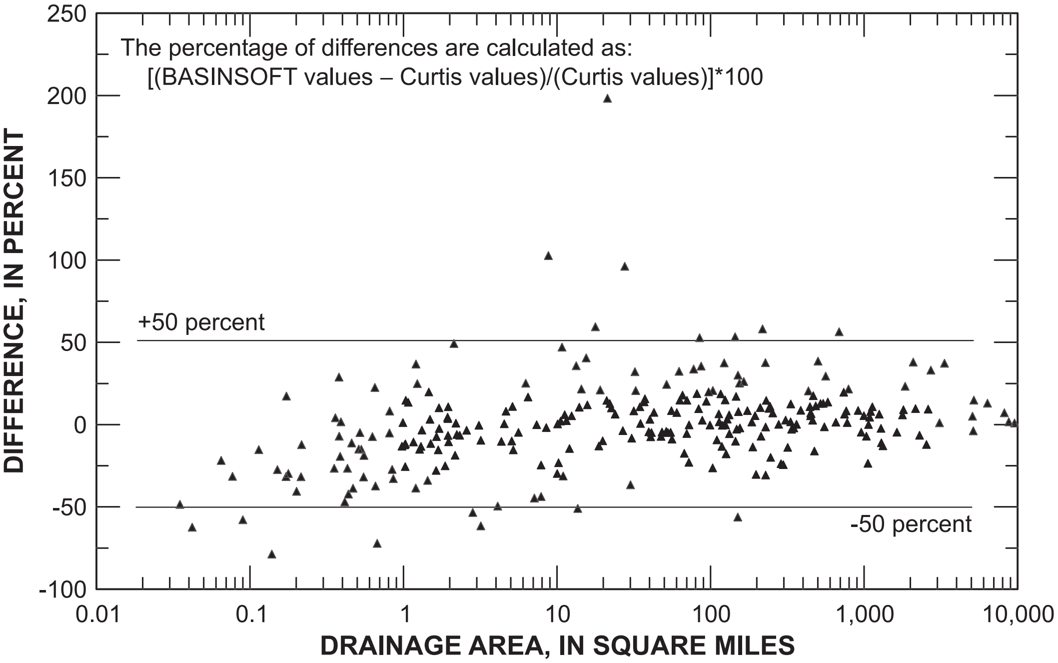

Figure 5-2. The difference, in percent, of main-channel slope between the BASINSOFT results and those used in Curtis (1987) for selected watersheds in Illinois (horizontal lines delineate the ±50 percent difference).

The last problem listed above indicates why the *MCS* determined by BASINSOFT could be lower than values determined manually. Besides the 1:100,000 digital-scale data used, 1:24,000 digital-scale data for deriving hydrography data and 1:24,000 digital-scale data for deriving elevation were used for 16 stations. Also, 1:250,000 digital-scale data for deriving elevation were used but 1:100,000 digital-scale data for deriving hydrography data were used for six stations where the drainage areas partially are located in Indiana.

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Appendix 6. Hydrologic Regions for Illinois

Regionalization is the development of techniques to extend knowledge of at-site flood-frequency relations to other stream locations within a region, where the region is defined as a collection of river basins such that the occurrence of flood-peak discharge magnitudes at any site in the region can be described with a single frequency distribution. That is, the flood-peak discharge magnitudes of each river basin in the region are considered to be sub-samples from a common population. Various methods have been designed to test and define a “statistically homogenous region” for flood-frequency analysis (for example, Chow, 1964; Kite, 1977; Nguyen, 2000; Hosking and Wallis, 1997). However, delineation of hydrologic regions remains as a state-of-the-art science and a generally accepted method for regionalization currently has not been defined (Nguyen, 2000).

Geographical closeness among stations is not necessarily an indicator of similarity of the frequency distribution (Hosking and Wallis, 1997). However, maintaining geographical closeness has advantages in practical applications. Methods for forming hydrologic regions can be developed with judgment based on basin characteristics (Acreman and Sinclair, 1986), by geographical locations (National Environmental Research Council, 1975), by analyzing skew coefficients (Interagency Advisory Committee on Water Data, 1982), or by analyzing residuals (Stedinger and Tasker, 1985; Tasker, 1989). Methods for testing homogeneity of the delineated hydrologic regions also have been developed (for example, Darlymple, 1960; Hosking and Wallis, 1993; Nguyen and others, 1997). Even if a region is moderately heterogeneous, regional analysis still will yield much more accurate flood-frequency estimates than at-site analysis (Hosking and Wallis, 1997).

Two general sets of hydrologic regions can be identified from the previous flood-frequency analyses in Illinois according to their analytical approaches (Mitchell, 1954; Carns, 1973; Curtis, 1977b; Singh, 1981; Curtis, 1987). The general hydrologic regions are based primarily on 1) physiographic characteristics, and 2) residual analysis. For Illinois, the residual analysis has been used mainly with the *LP3* distribution for AMS analysis. With the inclusion of PDS analysis and expanded basin-morphmetric characteristics, the previous development in hydrologic regions was reviewed for identifying an approach to reach delineation that is physically based and can maintain or improve the accuracy of frequency predictions for both AMS and PDS models.

Previous Development

Mitchell (1954) outlined 15 hydrologic regions in Illinois. In 11 of the 15 regions where data were available, Mitchell computed and illustrated the distinctions in parameters k (a physiographic factor), j (a climatologic factor) and c (a flood-potential factor, $c = j/k$) among these hydrologic regions. Mitchell’s hydrologic regions were developed by slightly modifying the 15 physiographic regions defined by Leighton and others (1948). Probably restricted by data availability, Mitchell predicted occasional floods (large floods, for recurrence intervals roughly larger than 50 years) using 3 hydrologic divisions (northern, central, and southern) that were formed by combining the 15 hydrologic regions.

Carns (1973) considered residual patterns from the regression analysis and watershed boundaries in defining four hydrologic regions of Illinois. Residuals were the differences in flood quantiles estimated by at-site analysis and a statewide regression analysis, where *TDA*, *MCS*, and *TTF* were used as explanatory variables in the regression equations and the *LP3* distribution was used to fit station data. These hydrologic regions are different from those outlined by Mitchell (1954). Carns’ hydrologic regions were modified by Curtis (1977a, b). Curtis used the *LP3* distribution and *TDA*, *MCS*, and (*TTF-2.5*) as explanatory variables but with updated station data and analysis techniques. The same hydrologic regions and explanatory variables were used in a later update (Curtis, 1987) but with refined regional factors.

Singh (1981) classified the State with eight hydrologic regions when he studied the parameters for unit-hydrograph analysis for Illinois. Initially, 12 regions were demarcated on the basis of physiographic regions (Leighton and others, 1948), model flow duration, and hydrologic and climatologic homogeneity. The grouping or transferring of river basins from regions was tested using regression analysis with combinations of explanatory variables in *TDA*, *MCS*, and *MCL*.

Current Approach

Analyzing residuals from a regression model can identify regional differences effectively but the results depend on the analytical techniques and explanatory variables used. Also, when additional flood data were available for a station, the residual is likely to change. In order to determine hydrologic region delineation that will not be subject to change because of changes in methodology and/or additional data, a reasonable approach is to analyze variables that are relatively invariant with time in the watershed hydrologic processes. If such an approach can be proven successful, the hydrologic regions outlined in this report could be useful in other studies, such as improving the progress in flood-frequency analysis, evaluating data needs, identifying the unit-hydrograph parameters, and others.

Two main steps were used to determine hydrologic regions in this study: 1) delineate the general outlines of the hydrologic boundary using major river basins, and 2) adjust the boundaries along basin divides of smaller watersheds. Three methods were tested for delineating the general boundaries of hydrologic regions in Illinois: 1) the updated regional skew coefficients; 2) cluster analysis (for example, Kachigan, 1986) using physiographic parameter groups such as *BS*, *MCS*, *PermH*, *PermL*, *%Water*, *DF*, *BS*, *SF*; and 3) hydrologic regions referenced to the regions delineated by Mitchell (1954) and Singh (1981). The delineation based on Mitchell and Singh showed the most consistent results. In delineating regional boundaries, a newly developed detailed surface-topography map of Illinois (Luman and others, 2003) was referenced.

Adjusting/refining the hydrologic boundaries is conducted using residual analysis and evaluated using the sum of squares of errors (*SSE*) for each region in each regression equation. Various regression models (with dummy variables) tested are described in appendix 7. Through multiple comparisons, a regional delineation that results in the lowest *SSE* is selected as the final hydrologic region for analysis. At this step, the consistency of at-site estimates and various regional equation estimates could be analyzed and the regional boundary adjusted. Uncertainty may result in adjusting boundaries at finer scales using this approach if an available subbasin has limited representation of the entire watershed. For example, the Mazon River Basin is represented by only one streamflow-gaging station at Coal City. However, the basin has a flat upland but steep slopes are present downstream especially near the Illinois River. The lower Fox River and Kankakee River below Momence have similar topographic characteristics as the Mazon River Basin.

River basins re-assigned to adjacent regions are those in the Green River Lowland, Mazon and Vermilion (in northern Illinois) River Basins, and bluff watersheds in the American Bottoms Lowlands in the southwestern part of the State. The Clark unit hydrograph storage coefficients study (Graf and others, 1982) was evaluated to justify the regional delineation of the Skillet Fork of the Little Wabash River in southeastern Illinois. There also are three stations that are considered anomalous and deleted from the regional analysis after examining their flow records (appendix 7).

Description of Current Hydrologic Regions for Illinois

The final delineation of the hydrologic regions is presented in figure 5 in the main text. An Adobe Acrobat image file (pdf extension) is given in the attached CD-ROM. The text below describes the river basins in each hydrologic region with a brief reference to the hydrologic characterization of Mitchell (1954) and physiographic divisions of Leighton and others (1948). However, only general information concerning the features of the regions was given in these reports. More specific information on physiographic and other features in various river basins has been collected since these studies but a comprehensive documentation compiling the newly identified physiographic characteristics is not yet available. A brief description of the hydrologic regions defined during this study are listed below.

Region 1: River basins in region 1 include the Apple River Basin, Rock River Basin, and Kishwaukee River Basin of the Rock River. The Wisconsin Driftless area and Rock River Hill Country dominate the region. The Wisconsin Driftless area is characterized by flat upland areas but channels are steep sloped with narrow valleys. The Rock River Hill Country is characterized by deep and permeable soils.

Region 2: River basins in region 2 include the Des Plaines River, Fox River, Green River, and Kankakee River excluding the Iroquois River. The Chicago Lake Plain, Wheaton Morainal Region, Green River Lowland, a portion of the Kankakee Plain, and a portion of the Bloomington Ridged Plain above the Illinois River cover this region. The Chicago Lake Plain has swampy and poorly drained soils; the Wheaton Morainal Region has flat slopes, long, narrow basins, and large storage in lakes and swamp areas; the Green River Basin has low and poorly drained plains; the Fox River Basin contains many lakes; and the Kankakee Plain is characterized as a level to gently undulatory plain. Hydrographs of streams in these regions generally have low, flat crests with long recession limbs.

Region 3: River basins in the region include the Bureau Creek Basin, Mazon River Basin, Vermilion River Basin, Iroquois River Basin, Upper Embarras River Basin, Upper Sangamon River Basin, Mackinaw River Basin, and Macoupin River Basin. The region primarily is composed of the lower portion of the Kankakee and Bloomington Ridged Plains, and the upper portion of the Springfield Plain. Leighton and others (1948) described it as "It was in this district more than in any other that the grass-covered stretches of rolling prairie and extensive swamps, …" Region 3 is characterized by thick glacial deposits.

Region 4: The region includes the Edward River Basin, Pope Creek Basin, Spoon River Basin, La Moine River Basin, Bear Creek Basin, Bay Creek Basin, and the Cahokia River Basin. The region consists of the entire Galesburg Plain Region, Lincoln Hills Region, and Upper Salem Plateau Section. The Galesburg Plain contains steeply sloping channels and sharply incised valleys. Lincoln Hills and Salem Plateau are unglaciated with some loess deposits or underlain by limestones.

Region 5: River basins in the region include the Kaskaskia River Basin below Lake Shelbyville, Lower Embarras River Basin, and Upper Little Wabash River Basin. The region consists of Springfield Plain Region and Little Wabash River Basin of the Mt. Vernon Hill Region. The Springfield Plain Region is characterized by flat topography but well-developed drainage systems. The uplands are relatively low with respect to the main stream and contain shallow valleys. Streams have low-gradients and occupy broad alluviated and terraced valleys. The Mt. Vernon Hill Region contains low-gradient streams, long and narrow basins, and wide floodplains for potential storage.

Region 6: This region includes the Big Muddy River Basin, Skillet Fork of the Little Wabash River Basin, Saline River Basin, Wabash River Basin, Blue River Basin, and Bonpas Creek Basin. The region consists of the Mt. Vernon Hill Region and the northern portion of the Shawnee Hill Region. The Shawnee Hill Region lies between the southern limits of glacial drift and the northern limits of Coastal Plain sediment. The regional structure is complicated by faulting and folding over a large part of the basin (Leighton and others, 1948). The northern Shawnee Hill Region is composed of largely Pennsylvanian rocks, where in most places, the ridge is maturely dissected by youthful valleys, but remnants of flat upland are preserved locally on narrow ridge crests throughout the length of the escarpment (Leighton and others, 1948). The physiographic features seem appreciably different from those of region 2, but analysis of streamflow records showed some similarities to those features in region 2. It is likely that the low-gradient and broad alluviated valleys for possible storage, as well as swamp areas, characterize the locations of the gaging stations located in the Shawnee Hill Region.

Region 7: The region includes the Cache River Basin. The region consists of the Coastal Plain Province and Shawnee Hill Region. The Coastal Plain Province consists of alluvial plain of the Cache and Mississippi Valleys and the Cretaceous hills between the Cache Valley and the Ohio River. The alluvial plains are characterized by terraces and recent floodplain features, and the Cretaceous hills have eroded into a low upland of gently sloping knolls and ridges (Leighton and others, 1948). Similar to region 6, the regional structure is complicated and the flow characteristics observed at streamflow-gaging stations reflect largely the local features. For example, swamp areas are known to be present along Cache River above Forman, but the basin above Wetaug is long and narrow (Mitchell, 1954).

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Appendix 7. Regression Analysis

The regression analysis is used to identify the relations between the at-site estimate Q_T (response variable) and subset of basin characteristics (explanatory variables) for a specified T among stations in the hydrologic regions. The determined relations then can be used for estimating Q_T at ungaged streams or improving estimates of Q_T at gaged streams. Various factors can affect the accuracy of the analysis, including the errors and uncertainties in the estimated at-site Q_T's and the basin characteristics, the grouping of selected explanatory variables to explain the variations in Q_T's, and the techniques of regression analysis utilized.

Multiple linear regression (MLR) analysis is used when two or more explanatory variables are considered; the response and explanatory variables are transformed into log-10 units in the analysis to derive the final equations in non-linear (power-law) forms. In exploring which group of explanatory variables can best predict the Q_T's, the ordinary least squares (OLS) regression technique is used. However, OLS assigns equal weights to all at-site Q_T's regardless of differences in record length at various stations and cannot account for inter-site correlations. Stedinger and Tasker (1985) developed a weighted least squares (WLS) technique that can account for different record length of stations. Stedinger and Tasker (1986) further developed the regression techniques, obtaining a generalized least squares (GLS) technique. The GLS technique accounts for differences in record lengths, differences in flood-peak discharge variances, and cross-correlations of concurrent flood-peak discharges among stations used in the regression analysis, and, therefore, improves the accuracy of regression equations. This appendix explains the procedures used in identifying suitable grouping of explanatory variables and the evaluation of the accuracy of selected regression equations.

Analytical procedures used in this study can be described as follows.

1. Identify potential groupings of explanatory variables.
2. Apply MLR with OLS regression technique to identify the most suitable variable grouping for each region and for each Q_T.
3. Evaluate the delineation of hydrologic regions and re-adjust regional boundaries by reassigning subbasins to adjacent regions (see appendix 6).
4. Apply the estimated generalized least squares (EGLS) technique in the GLSNET program (Tasker and Stedinger, 1989) to AMS data. Evaluate and remove stations that are clearly outliers, and derive the final GLS regression equations for the AMS model. For PDS, the GLSNET program is not applicable because the *GP* distribution and $r = 1.6$ are used. Therefore, the regression equations for the PDS model are derived with the OLS technique.

Grouping of Explanatory Variables

Step-wise regression techniques (forward, backward, and step-wise) were used to detect suitable variables to be included in the analysis. However, these techniques might not lead to a unique combination of explanatory variables (Helsel and Hirsch, 1992). For example, highly correlated variables (collinearity) may be selected. For analyses such as making inferences about coefficients, undesirable consequences can result when selected explanatory variables have high multi-collinearity. However, if the purpose of the regression analysis is for prediction, such concerns could are reduced (Helsel and Hirsch, 1992).

Multi-collinearity among variables was analyzed first with a correlation matrix analysis. From the definitions of basin-morphometric characteristics (appendix 5), one could expect that various variables would be highly correlated (to *TDA*, for example; see appendix 5) according to how they were measured or derived. Clearly, *TDA* is the predominant explanatory variable in estimating flood hydrology from a river basin. The multi-collinearity analysis indicated that most basin geometric variables are highly correlated to *TDA* except the variables of *MCS*, *TTF*, *PermH*, *PermL*, and *%Water*. Also alternatively, *BL* and *BW* could be used in place of *TDA* in grouping the variables. Variables with high correlations to *TDA* were removed from the subsequent step-wise regression analysis presented in the following sections. Note that the average permeability rate, *PermAvg* (computed as the arithmetic average of *PermH* and *PermH*), is used in place of *PermL* or *PermH*.

Potential Regression Equations

Results from step-wise regression analysis

Two regression equations resulting from step-wise analysis are given below.

$$Q_T = f_{step\text{-}wise(1)}\ (TDA,\ MCS,\ Water\%,\ PermAvg) \text{ and} \tag{7-1}$$

$$Q_T = f_{step\text{-}wise(2)}\ (BL,\ BW,\ MCS,\ Water\%,\ PermAvg), \tag{7-2}$$

where $f_{step\text{-}wise}$ stands for the function derived from the step-wise regression analysis and the function is expressed with the explanatory variables in the parenthesis. Similar f terms are used in the following. The explanatory variables have been defined in appendix 6.

Curtis (1987, 1977) and Carns (1973)

The general form of the Curtis (1987, 1977) and Carns (1973) equations can be described as

$$Q_T = f_{Curtis\text{-}Carns}\ [TDA,\ MCS,\ (TTF\text{-}constant),\ RF], \tag{7-3}$$

where the constant is 0 in Carns' and 2.5 in Curtis' equations, respectively; and *RF* stands for regional factors resulting from the use of dummy variables.

Singh (1981)

The regional equations for flood-peak discharge of the normalized unit hydrograph, Q_P, can be described as

$$Q_P = f_{Singh}\ (TDA,\ MCS,\ MCL)\ . \tag{7-4}$$

The final regional equations for each region contain all or subsets of the variables.

Clearly, *TDA* and *MCS* are two primary explanatory variables relating to flood-peak discharge magnitudes in Illinois. Variable *BL* is an analogy of the travel time of flow in the main stem, variable *BW* is an analogy of the travel time of lateral inflows, and variables *PermAvg* and *Water%* are analogies of storage characteristics of the drainage basin. The updated *TTF* is not included probably because the rainfall depth has little variation across the State, as shown in figure 7-1.

Use of Dummy Variables

Dummy variables are used as the surrogate for factors affecting Q_T's that could not be properly expressed as variables (for example, Helsel and Hirsch, 1992). At the end of analysis, the values of the dummy variable are converted to a scale factor that varied among different hydrologic regions where the same group of explanatory variables is used. Use of the dummy variables is appropriate in this analysis because the physiographic contrast among hydrologic regions of Illinois is not substantial but different hydrologic characteristics in flood-producing mechanisms are expected. Subsequently, the intercepts and/or slopes in the regional-regression equations will vary when the same group of variables is used.

Dummy variables were applied to the regression constant (intercept) for all regions in the AMS analysis, but to the regression constant and/or an explanatory variable (slope of the variable, primarily on *TDA*) for regions in the PDS analysis. A partial residual test (Helsel and Hirsch, 1992) was used to test the necessity for applying a dummy variable to *TDA*.

Besides as an additional explanatory variable, use of the dummy variables provided an opportunity for reviewing the reasonableness of delineated hydrologic regions. If the values of a dummy variable for two different regions were similar, the result could indicate that additional evaluation of the two hydrologic regions was needed. Use of the dummy-variable technique also was helpful to a systematic evaluation of regression equations in this study

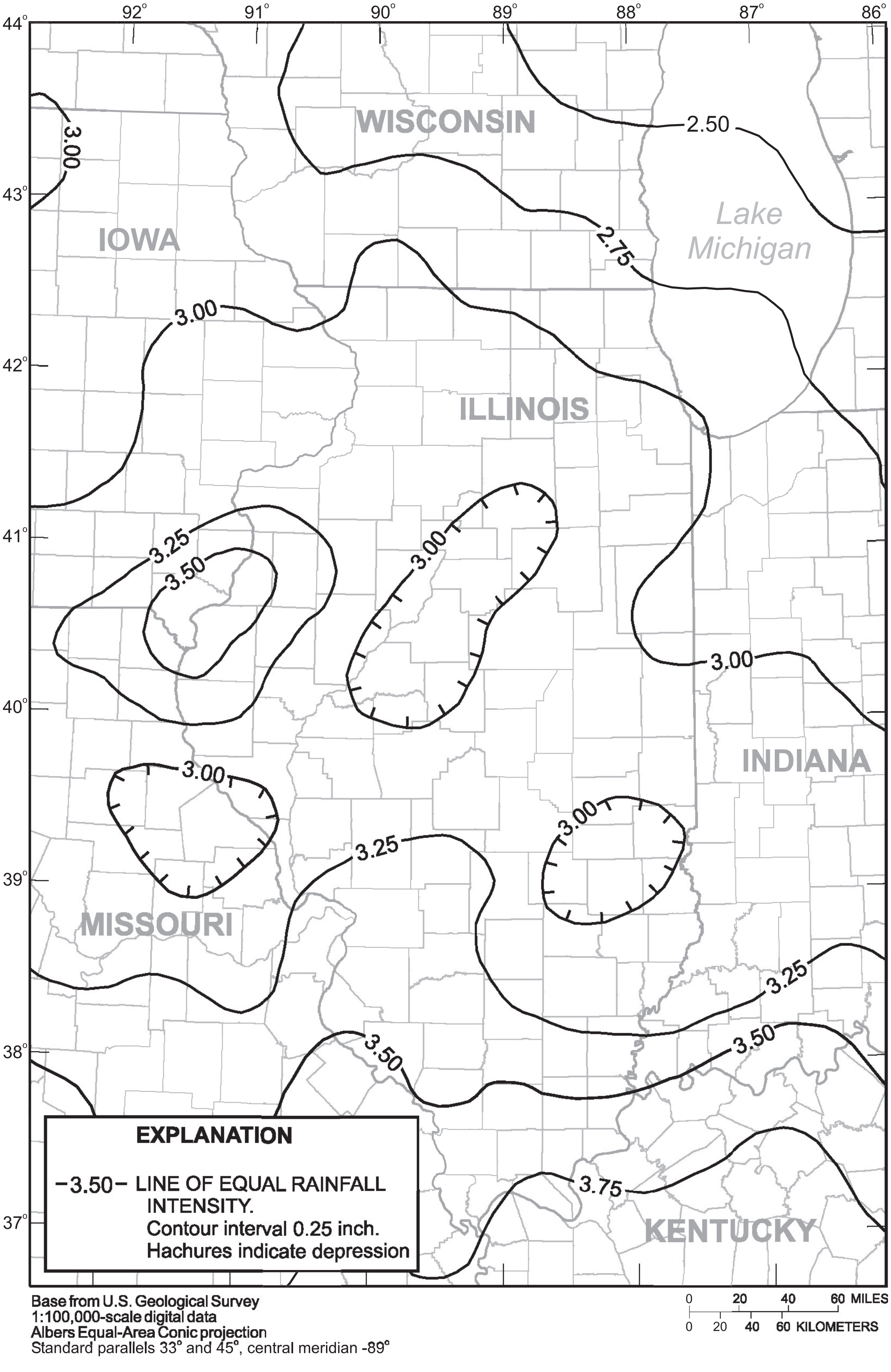

Figure 7-1. Two-year, 24-hour rainfall intensity for Illinois and adjacent States (modified from Huff and Angel, 1991).

because the sum of squares of errors for each equation was calculated with the entire station data (either AMS or PDS), not merely station data in each region. Also, the same upper and lower limits of the parameter space for explanatory variables could be used for various hydrologic regions when their regional equations used the same group of explanatory variables.

Evaluation of Regression Equations

Regression equations with explanatory variables, such as those described in equations 7-1 to 7-4 or subgroups of the explanatory variables in equations 7-1 and 7-2 and with dummy variables, were evaluated with their corresponding sum of square of error (*SSE*) The *SSE* is defined as

$$SSE = \sum_{i=1}^{N} residual_i^2 = \sum_{i=1}^{N} (Q_{predicted} - Q_{observed})^2 , \tag{7-5}$$

where *N* is the total number of stations in a hydrologic region. The regression equation with the least *SSE* was first selected to represent the region. The procedures then were repeated for each selected *T*'s. However, different groups of explanatory variables might result for different *T*'s in the same hydrologic region, and for the same *T*'s in different regions. Such outcomes could be expected because physical processes involved in producing flood-peak discharges of different magnitudes would be different even if in the same watershed, not to mention in other watersheds in other hydrologic regions. However, using regression equations with different groups of explanatory variables for different *T*'s in a watershed might result in a discontinuity in the estimated flood-frequency curve. That is, higher Q_T's could be predicted at lower *T*'s. This situation was observed at a few small watersheds especially for those near the boundary of hydrological regions. To prevent such erroneous estimates, one group of explanatory variables was used in the regression equations for all Q_T's in a hydrologic region in this study, but different regression equations might be used in different hydrologic regions. The procedures used for determining a regression equation for each hydrologic region are described in the following steps.

1. Conduct regression analysis with each selected group of explanatory variables.
2. Calculate *SSE* for each regression equation for each region.
3. Evaluate *SSE*'s for all regression equations and all *T*'s in a region, identify the equation with the lowest *SSE* for all the *T*'s.
4. If different regression equations result from step 3, identify the equation where *SSE*'s are within 10 percent of the lowest *SSE* for all the *T*'s.

By setting a tolerance of 10 percent within the best-fit regression equation (step 4), one regression equation could be identified for all Q_T's of a region for AMS analysis. On the other hand, in order to use only one regional regression equation in the PDS analysis, the 10-percent tolerance had to be relaxed to 25 percent for region 2 and 17 percent for region 3.

For peak flows in Illinois, the parameters *TDA* (for some regions the parameters are *BL* and *BW*) and *MCS* form the basic group of explanatory variables for all the regions. However, an additional explanatory variable, such as *PermAvg* or *%Water*, could improve regression relations in separate regions for different Q_T's. The final regression equations for each hydrologic region for the AMS and PDS model are presented in the main text.

Adjusting Regional Boundaries

Refining hydrologic regions was conducted based on the AMS results. The general forms of AMS equations used in the study were as follows.

For regions 1, 3, and 5:

$$Q_T = f(TDA,\ MCS,\ PermAvg,\ \beta_{iT} Z), \tag{7-6}$$

where β_{iT} is the constant for dummy variable Z for region *i* and recurrence interval *T*.
For regions 2, 6, and 7:

$$Q_T = f(TDA, MCS, \%water{+}5, \beta_{iT} Z). \qquad (7\text{-}7)$$

For region 4 (note that the final equation was modified with *BW=TDA/BL*):

$$Q_T = f(BL, BW, MCS, \beta_{iT} Z). \qquad (7\text{-}8)$$

After the regression analysis, if a β_{iT} variable was significant, then it meant that there was a difference between stations in region *i* and stations that are not in region *i* for that *T*. If the β_{iT}'s of two or three regions were approximately the same, these regions possibly could be combined into a single region. When testing if two regions could be combined, the test should be done for each *T* years (Gary Tasker, U.S. Geological Survey, written commun. 2002). The current region 4 resulted from combining two regions initially designated as two separate regions.

During the *SSE* analysis, if station(s) in a subbasin of a region indicated that their Q_T's were better predicted by variables from the adjacent regions, the station records and basin-morphometric characteristics were examined. If the results indicated that the subbasin could be incorporated into an adjacent region and the subbasin was located near the region boundaries, the subbasin was assigned to the adjacent region. The analysis resulted in reassigning the Green River Lowland from region 1 to region 2, readjusting the basin boundaries between region 1 and region 2 along the Upper Fox River (switch to region 2), and reassigning the Upper Kankakee River subbasin from region 1 to region 2. Strip-mine areas in central and southern Illinois were kept in their assigned regions. Zuehls and others (1981) found that flood-peak discharge magnitudes in the strip-mine areas could be predicted with similar basin characteristics used in this study.

Identify Station Outliers

Regression equations 7-6 to 7-8 were tested against the proposed hydrologic regions of Illinois using the GLSNET program in the final stage of the analysis. From the GLSNET output, station records showing large residuals and large Cook's D (Helsel and Hirsch, 1992) were examined. In general, large residuals resulted at stations either with non-representative data (either record length or coverage of events) or at locations with unique physiographic features. Some of these features include the driftless area in northwestern Illinois or low-gradient areas near the confluence of the Illinois and Sangamon Rivers or the Cache River Basin in southern Illinois. Initially, 291 rural station records were selected and used for the regional regression analysis. After examining for possible errors in the observed flood-peak discharge magnitudes and in basin characteristics at stations, and reviewing the probability plots from the PEAKFQ (Gary Tasker, U.S. Geological Survey, written commun. 2002), the following three stations were considered to be outliers and, therefore, excluded from the rest of the stations used in the regression analysis.

1. Normandy Ditch at Normandy, Ill., (5447200): The lower half of the main channel has been channelized.
2. Diamond Lake Drain at Mundelein, Ill., (5528170): This streamflow-gaging station is located downstream of Diamond Lake.
3. Little Calumet River at Harvey, Ill., (5536325): This station has an extremely flat *MCS*.

Uncertainty and Accuracy of the Annual Maximum Series Regression Equations

Various parameters for evaluating accuracy and uncertainty of the regression equations have been reported in tables 3, 4, and 5. All these parameters are obtained from the GLSNET program (Tasker and Stedinger, 1989). Among them, the average prediction error and equivalent years of record (Hardison, 1971) quantify the accuracy of regression equations. A method for estimating the model uncertainty has been developed and widely utilized in various recent flood-frequency analysis reports (for example, Hodge and Tasker, 1995; Wiley and others, 2000). The following is a brief summary of how to use the GLSNET output information to calculate uncertainty. Definitions of the variables are given below.

AEYR: average equivalent years of record

MSE: mean square error (this and all the following terms are in log-10 units, unless specified otherwise)

SEE: standard error of estimate

APE: average prediction error for a site, ***i***, or for a region, ***r***

γ^2: model error variance

γ: standard error of the model

SE_i: standard error of prediction, sample error at site ***i***

ASE: average standard error of prediction, average of sample error for the region

The *AEYR* describes the accuracy of the regression equation. It is an estimate of the number of years of streamflow records that must be collected at a streamflow-gaging station to estimate the flood magnitude for a selected frequency with accuracy equivalent to that of the regression equation (Hardison, 1971, p. C232). The *AEYR* is used as a weighting factor (along with the years of record at the station in question) in improving the flood-quantile estimate at gaged sites (equation 11).

The method for using *APE* to evaluate model accuracy and uncertainty are briefly presented here. Full descriptions of the method are presented in Tasker (1987) and Tasker and Steinger (1989) and reports mentioned earlier.

The linear form of a regression model can rewritten as (in log-10 units)

$$Y = X\beta + e, \tag{7-9}$$

where Y is a (n × 1) matrix of at-site estimates of the T-year flood, where n is the number of sites in the region under study, X is a (n × m) matrix of basin characteristics (m-1 explanatory variables) augmented by a column of ones, β is a (m × 1) matrix of regression coefficients, and e is a (n × 1) matrix of random errors. In the GLS model, the assumptions of equal variance of the T-year events and zero cross-correlation for concurrent flows are relaxed, and the GLS estimator for β is (Stedinger and Tasker, 1985)

$$\beta = (X^T \Lambda^{-1} X)^{-1} X^T \Lambda^{-1} Y\,, \tag{7-10}$$

where it is assumed that the errors have zero mean $E[e] = 0$, and covariance $E[e\, e^T] = \Lambda$. Stedinger and Tasker (1985) proposed an estimator for this error covariance matrix Λ as

$$\Lambda = \gamma^2 I + \Sigma\,, \tag{7-11}$$

where γ^2 is an estimate of the model-error variance because of an imperfect model (a measure of the precision of the true regression model), I is an (n × n) identity matrix, and Σ is a (n × n) matrix of sampling covariance. The diagonal elements of Λ, therefore, are the sum of γ^2 and a sampling error because of estimating the true model parameters from observed flows for site i, and $i = 1, 2, \ldots n$. On the other hand, the off-diagonal elements are the estimated cross-correlations between flood peaks at sites i and j. The model-error variance is defined by

$$\gamma^2 = E[Y - X\beta)^2]\,, \tag{7-12}$$

where the β estimator by GLS is given by equation 7-10. Once the γ^2 is calculated, the standard error of the model, γ, can be transformed from log 10 unit to percent by

$$\gamma_{\%} = 100\left[e^{(5.30119\gamma^2)} - 1\right]^{0.5}. \tag{7-13}$$

The γ^2 and $\gamma_{\%}$ values for each model and each T were given in tables 1, 2, and 3.

For a GLS regression model, the *SE* at a site *i* is computed as

$$SE_i = \sqrt{x_o \, \{X^T \, \Lambda^{-1} \, X\}^{-1} \, x_o^T} \;, \tag{7-14}$$

where the x_o is a row matrix containing basin characteristics determined at the study site ***i***. By treating each gaged site in the region as if it were an ungaged site, the *ASE* for the region can be calculated as

$$ASE = \sqrt{\sum_{i=1}^{n} \frac{x_o \, \{X^T \, \Lambda^{-1} \, X\}^{-1} \, x_o^T}{n}} \;, \tag{7-15}$$

for all sites i where i is counted from 1 to the nth sites in the region. For each regression model, the matrix $\{X^T \, \Lambda^{-1} \, X\}^{-1}$ is given in the attached CD-ROM.

In applying the GLS regression model to estimate flood frequencies at an ungaged site, the uncertainty or error in prediction is estimated by computing the standard error of estimate, *SEE*. The *SEE* for a site *i* or for a region is estimated, respectively, as

$$SEE_i = \sqrt{\gamma^2 + SE_i^2} \;,$$

$$\text{or} \qquad SEE = \sqrt{\gamma^2 + ASE^2} \;. \tag{7-16}$$

The average prediction error of the model for a region, *APE*, in percent, can be computed as

$$APE_{\%} = 100 \left[e^{(5.30119 SEE)} - 1 \right]^{0.5} . \tag{7-17}$$

These *APE* values are reported in tables 3, 4 and 5. The prediction error at a site can be computed as

$$PE_{\%} = 100 \left[e^{(5.30119 SEE_i)} - 1 \right]^{0.5} . \tag{7-18}$$

Computing model error at a ungaged site

In the following example, it is assumed that the Blackberry Creek at Yorkville station, as described in the main text, was an ungaged site. Therefore, the χ_o matrix, containing the explanatory variables for region 2, can be written as

Coefficient	log(*TDA*)	log(*MCS*)	Log(*%Water+5*)	RF(1)	RF(3)	RF(4)	RF(5)	RF(6)	RF(7)
1	log(69.4)	log(5.9)	log(6.04)	0	0	0	0	0	0

Note that RF for region 2 is 1. The $\{X^T \, \Lambda^{-1} \, X\}^{-1}$ matrix for the 100-year recurrence interval, for example, is

COEFF.	*TDA*	*MCS*	*% WATER*	REGION 1	REGION 3	REGION 4	REGION 5	REGION 6	REGION 7
3.38E-02	-2.54E-03	-6.71E-03	-2.83E-02	-1.08E-03	-2.98E-03	-1.64E-03	-2.76E-03	-1.63E-04	-5.50E-04
-2.54E-03	7.09E-04	1.35E-03	2.22E-04	-2.62E-04	-2.78E-05	-1.43E-04	2.12E-05	-6.07E-05	-1.91E-04
-6.71E-03	1.35E-03	3.63E-03	2.03E-03	-4.43E-04	1.64E-04	-4.62E-04	1.35E-04	-2.04E-04	-8.93E-04
-2.83E-02	2.22E-04	2.03E-03	3.30E-02	1.20E-03	2.34E-03	1.35E-03	1.82E-03	-9.92E-04	2.97E-04
-1.08E-03	-2.62E-04	-4.43E-04	1.20E-03	3.46E-03	1.06E-03	1.17E-03	1.04E-03	9.68E-04	1.08E-03
-2.98E-03	-2.78E-05	1.64E-04	2.34E-03	1.06E-03	2.32E-03	1.36E-03	1.46E-03	1.15E-03	1.16E-03
-1.64E-03	-1.43E-04	-4.62E-04	1.35E-03	1.17E-03	1.36E-03	2.84E-03	1.47E-03	1.34E-03	1.53E-03
-2.76E-03	2.12E-05	1.35E-04	1.82E-03	1.04E-03	1.46E-03	1.47E-03	3.15E-03	1.62E-03	1.49E-03
-1.63E-04	-6.07E-05	-2.04E-04	-9.92E-04	9.68E-04	1.15E-03	1.34E-03	1.62E-03	4.76E-03	2.07E-03
-5.50E-04	-1.91E-04	-8.93E-04	2.97E-04	1.08E-03	1.16E-03	1.53E-03	1.49E-03	2.07E-03	8.68E-03

After removing the zero terms, the matrix reduces to

$$\begin{vmatrix} 1 & \log(69.4) & \log(5.9) & \log(6.04) \end{vmatrix} \times \begin{vmatrix} 3.38E\text{-}02 & -2.54E\text{-}03 & -6.71E\text{-}03 & -2.83E\text{-}02 \\ -2.54E\text{-}03 & 7.09E\text{-}04 & 1.35E\text{-}03 & 2.22E\text{-}04 \\ -6.71E\text{-}03 & 1.35E\text{-}03 & 3.63E\text{-}03 & 2.03E\text{-}03 \\ -2.83E\text{-}02 & 2.22E\text{-}04 & 2.03E\text{-}03 & 3.30E\text{-}02 \end{vmatrix} \times \begin{vmatrix} 1 \\ \log(69.4) \\ \log(5.9) \\ \log(6.04) \end{vmatrix}$$

and the result is 0.0396 in log value. The prediction error, in percent, is calculated in the following steps.

(1) Obtain $\boldsymbol{\gamma}^2$ from table 2; compute SE_P using equation 7-14 as

$$SE_P = 0.0381 + 0.0396 = 0.0777.$$

(2) Convert to percent using equation 7-18 as

$$PE_{\%} = 100\left[e^{0.0777} - 1\right]^{0.5} = 35.3 \text{ percent} .$$

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Appendix 8. Digital Data and Plots

The CD-ROM (in pocket), contains input data, output results, and plots produced for the flood-frequency analysis for the State of Illinois. The eight sub-directories in the CD-ROM are described in three major groups: the input and output files for the annual maximum series (AMS), the input and output files for the partial duration series (PDS), and basin characteristics derived from the BASINSOFT program. The input data for the AMS and PDS are obtained from the peak-flow files and are presented in space-delimited American Standard Code for Information Interchange (ASCII) text files. The covariance matrix $\{X^T \Lambda^{-1} X\}^{-1}$ for each regression model for each recurrence interval obtained from the EGLS analysis using GLSNET program also is presented in the ASCII file. The ASCII text files can be opened with a text editor for a quick view or imported into a spreadsheet or database for data analysis. The basin characteristics are presented in the Microsoft Excel file and can be opened with Excel or similar programs. The outputs are plots from the AMS and PDS analysis and are presented with postscript files. These files can be opened with Adobe Acrobat reader. For explanations of variable fields and station option records, users can refer to Novak (1985) for the AMS and PDS input files, and appendix 5 for basin characteristics. The locations of the AMS and PDS stations are given in figures 2A, 2B, and 3 in the main text.

Descriptions of Files Stored on CD

Files stored on the CD-ROM are organized in directories (folders). The eight directories and associated file names, and contents are:

Directory name	File name	Content
AMS_PEAKFQ_INPUT	AMS_424_1999.inp	AMS input data for PEAKFQ program
AMS_PEAKFQ_OUTPUT	AMS_424_1999.out	AMS output from PEAKFQ program
AMS_PLOT_OUTPUT	AMS_plots.pdf	Postscript plots of AMS curves
AMS_GLS_OUTPUT	Cov_matrix.xls	$\{X^T \Lambda^{-1} X\}^{-1}$ matrices
PDS_INPUT	PDS_1999.inp	PDS input data
PDS_OUTPUT	PDS_142_1999.xls	PDS output data
PDS_PLOT_OUTPUT	Various pdf files	Postscript files for plots of PDS curves
BASIN_CHARACTERISTICS	Basin_char_288_xls	Basin characteristics of the watersheds
(same)	AMS_fig2a.pdf	Digital image of figure 2A
(same)	AMS_fig2b.pdf	Digital image of figure 2B
(same)	PDS_fig3.pdf	Digital image of figure 3
(same)	Hydrologic_regions.pdf	Digital image of figure 5
(same)	PermAvg_fig8a.pdf	Digital image of figure 8A
(same)	PermAvg_fig8b.pdf	Digital image of figure 8B
(same)	PermAvg_fig8c.pdf	Digital image of figure 8C
(same)	PermAvg_fig8d.pdf	Digital image of figure 8D

Specific content descriptions of the directories are given below.

AMS_PEAKFQ_INPUT is a directory containing the data file AMS_424_1999.inp for the 419 streamflow-gaging stations with more than 10 years of annual maximum series data with WY 1999 as the ending year for data retrieval. The last five stations at the end of the file contain records modified to remove the period affected by reservoir operations. Overall, these 419 stations either are in rural or in urbanized areas, or subject to flow alterations. Among these 419 stations, 288 stations are selected for regression analysis (appendix 1). The file can be run with the frequency-analysis program PEAKFQ.

AMS_PEAKFQ_OUTPUT is a directory containing output of the PEAKFQ analysis of the input data (AMS_424_1999.inp). The file name is AMS_424_1999.out.

AMS_PLOT_OUTPUT is a directory containing a postscript file (Adobe Acrobat readable) AMS_plots.pdf for all the AMS stations included in AMS_424_1999.out. The plots are obtained from the PEAKFQ program.

AMS_GLS_OUTPUT is a directory containing an Excel file Cov_matrix.xls, which contains the $\{X^T \Lambda^{-1} X\}^{-1}$ matrix for each regression model at each recurrence interval.

PDS_INPUT is a directory containing the data file PDS_1999.inp that includes all the partial duration series records retrieved from peak-flow files with WY 1999 as the ending year. The format is the same as the AMS data file.

PDS_OUTPUT is a directory containing the output file PDS_142_1999.xls for the 142 streamflow-gaging stations that are fit with the Generalized Pareto distribution. The reported estimates are for recurrence intervals of 0.8, 1.01, 1.5, 2. 3, and 5 years and based on the average number of years equal to 1.6.

PDS_PLOT_OUTPUT is a directory containing the Adobe Acrobat readable postcript files for the *GP*-fitted flood-frequency curves (for example, figure 6) for the 142 streamflow-gaging stations.

BASIN_CHARACTERISTICS directory contains an Excel file Basin_char_288.exl for the 288 streamflow-gaging stations used in the regression analysis, and eight Adobe Acrobat readable files that are digital images of figures 2A, 2B, 3, 7, 8A, B, C, and D that users can use the zoom features to identify their sites or parameter values. These eight files are: AMS_fig2a.pdf, location of active and inactive U.S. Geological Survey streamflow-gaging stations in Illinois and adjacent States where annual maximum series were retrieved and flood quantiles were estimated, and stations used in the regression analysis.

AMS_fig2b.pdf, location of active and inactive U.S. Geological Survey streamflow-gaging stations in northern Illinois and adjacent States where annual maximum series were retrieved and flood quantiles were estimated, and stations used in the regression analysis.

PDS_fig3.pdf, Location of active and non-active U.S. Geological Survey streamflow-gaging stations in Illinois and adjacent States where partial duration series were retrieved, and stations used in the regression analysis.

Hydrologic_Regions.pdf, Hydrologic regions for flood-frequency analysis of rural streams in Illinois.

PermAvg_fig8a.pdf, Average soil permeability (from 0.2 to less than 1.0 inch per hour) for Illinois. Average soil permeability is obtained by taking the arithmetic average of the high and low soil permeability values from the STATSGO database (Natural Resources Conservation Service, 1993).

PermAvg_fig8b.pdf, Average soil permeability (from 1.0 to less than 2.0 inches per hour) for Illinois.

PermAvg_fig8c.pdf, Average soil permeability (from 2.0 to less than 3.0 inches per hour) for Illinois.

PermAvg_fig8d.pdf, Average soil permeability (from 3.0 to greater than 8.0 inches per hour) for Illinois.

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Table 1. Flood-peak discharges for recurrence intervals, *T*, of 2, 5, 10, 25, 50, 100, and 500 years estimated from the annual maximum series at streamflow-gaging stations in Illinois and adjacent States.

[***T***, recurrence interval in years, Q_T, instantaneous peak-flood discharge, in cubic feet per second, for a given ***T*** of 2-, 5-, 10-, 25-, 50-, 100-, and 500-year flood. Three estimates are listed for each station: the values in the top row are Q_T from at-site frequency curves; values in the middle row are Q_T from regional regression equations; values in the bottom row are Q_T obtained by weighting the at-site and regional regression frequency curves; NA, not assigned; dashes (---) given in any Q_T row indicates that the corresponding frequency curves are not computed. Station noted by an asterisk (*) have anomalous characteristics and are omitted from the regional analysis]

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
03336100	Big Four Ditch Tributary near Paxton, Ill.	3	115	183	228	284	324	363	450
			132	251	342	467	565	667	913
			117	192	245	315	368	420	542
03336500	Bluegrass Creek at Potomac, Ill.	3	1,840	2,870	3,580	4,490	5,180	5,870	7,500
			1,310	2,350	3,130	4,160	4,970	5,780	7,750
			1,780	2,810	3,520	4,440	5,150	5,870	7,570
03336645	Middle Fork Vermilion River above Oakwood, Ill.	3	6,500	9,470	11,400	13,800	15,500	17,200	21,000
			5,560	9,510	12,300	16,000	18,800	21,700	28,300
			6,380	9,470	11,500	14,200	16,100	18,100	22,600
03336900	Salt Fork near St. Joseph, Ill.	3	2,530	3,810	4,740	5,990	6,970	8,000	10,600
			2,580	4,560	6,010	7,940	9,420	10,900	14,600
			2,530	3,880	4,870	6,220	7,280	8,390	11,200
03337000	Boneyard Creek at Urbana, Ill.	NA	533	705	815	951	1,050	1,150	1,370
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
03337500	Saline Branch at Urbana, Ill.	3	1,300	2,110	2,680	3,410	3,970	4,530	5,850
			1,070	1,840	2,380	3,090	3,630	4,170	5,440
			1,280	2,100	2,650	3,380	3,930	4,480	5,790
01	Salt Fork near Homer, Ill.	3	3,780	6,120	7,880	10,330	12,300	14,400	19,800
			4,140	7,120	9,250	12,000	14,200	16,300	21,400
			3,800	6,200	8,000	10,500	12,500	14,600	20,100
03338100	Salt Fork Trib near Catlin, Ill.	3	189	375	515	703	847	991	1,330
			188	354	481	655	792	934	1,280
			189	371	509	693	836	980	1,320
03338500	Vermilion River near Catlin, Ill.	3	8,570	15,000	20,300	27,900	34,500	41,700	61,400
			9,600	16,400	21,200	27,600	32,400	37,300	48,900
			8,700	15,200	20,400	27,900	34,000	40,600	58,100
03338780	North Fork Vermilion River near Bismarck, Ill.	3	8,010	13,300	17,200	22,500	26,600	30,900	41,500
			3,900	6,780	8,870	11,600	13,700	15,800	20,900
			6,900	11,300	14,300	18,200	21,200	24,300	32,000
03338800	N F Vermilion River Tributary near Danville, Ill.	3	292	539	737	1,030	1,270	1,530	2,220
			199	387	535	740	904	1,080	1,500
			274	505	685	941	1,150	1,380	1,960
03339000	Vermilion River near Danville, Ill.	3	14,200	22,200	27,600	34,600	39,900	45,200	57,600
			12,200	20,800	27,000	35,100	41,300	47,500	62,400
			14,200	22,100	27,600	34,700	40,000	45,300	58,000

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_{2}	Q_{5}	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
03341700	Big Creek Tributary near Dudley, Ill.	3	183	293	375	488	579	675	922
			157	309	429	597	731	873	1,230
			177	297	389	520	627	740	1,030
03341900	Raccoon Creek Trib near Annapolis, Ill.	5	18	32	42	57	69	82	114
			14	27	37	51	63	74	104
			17	31	41	56	68	80	112
03343400	Embarras River near Camargo, Ill.	3	3,200	4,850	5,870	7,060	7,880	8,630	10,200
			2,620	4,520	5,890	7,680	9,040	10,400	13,700
			3,150	4,820	5,880	7,140	8,030	8,870	10,700
03344000	Embarras River near Diona, Ill.	3	9,200	13,800	17,000	20,900	23,800	26,600	33,300
			6,940	11,600	14,900	19,100	22,300	25,400	32,900
			8,990	13,600	16,700	20,600	23,500	26,400	33,200
03344250	Embarras River Tributary near Greenup, Ill.	NA	23	38	49	65	78	92	127
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
03344425	Muddy Creek Tributary at Woodbury, Ill.	5	23	49	73	111	146	188	313
			58	118	166	234	289	348	498
			28	60	90	139	183	232	371
03344500	Range Creek near Casey, Ill.	5	896	1,620	2,220	3,110	3,870	4,720	7,050
			603	1,100	1,460	1,950	2,330	2,720	3,670
			868	1,560	2,120	2,920	3,600	4,330	6,320
03345500	Embarras River at Ste. Marie, Ill.	5	14,600	23,900	30,500	39,000	45,500	52,000	67,500
			13,800	22,900	29,100	37,100	43,100	49,100	63,500
			14,600	23,900	30,500	39,000	45,500	52,000	67,500
03346000	North Fork Embarras River near Oblong, Ill.	5	8,180	14,200	18,600	24,400	28,700	33,100	43,500
			6,490	11,200	14,500	18,800	22,100	25,500	33,600
			8,090	14,000	18,300	23,900	28,100	32,400	42,600
03378000	Bonpas Creek at Browns, Ill.	5	3,110	4,360	5,190	6,240	7,020	7,810	9,670
			3,950	6,640	8,520	10,900	12,800	14,600	19,000
			3,140	4,450	5,350	6,510	7,380	8,260	10,300
03378635	Little Wabash River near Effingham, Ill.	5	6,190	9,400	11,700	14,900	17,300	19,900	26,400
			6,140	10,800	14,100	18,500	21,900	25,400	33,900
			6,180	9,510	12,000	15,300	17,900	20,600	27,500
03378650	Second Creek Tributary at Keptown, Ill.	5	227	385	509	687	836	998	1,430
			168	313	422	570	685	804	1,100
			216	369	487	654	790	935	1,310
03378900	Little Wabash River at Louisville, Ill.	5	11,500	18,800	24,300	31,900	38,200	44,800	62,100
			11,200	18,900	24,400	31,500	36,900	42,300	55,300
			11,500	18,800	24,300	31,900	38,000	44,400	60,800
03378980	Little Wabash River Trib at Clay City, Ill.	5	127	241	332	460	564	674	956
			118	235	328	457	562	672	950
			125	240	330	459	563	673	953

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_{2}	Q_{5}	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
03379500	Little Wabash River below Clay City, Ill.	5	13,600	23,900	31,800	42,800	51,700	61,100	85,200
			14,000	23,400	30,000	38,500	44,900	51,400	66,800
			13,700	23,900	31,700	42,600	51,300	60,400	83,700
03379650	Madden Creek near West Salem, Ill.	5	411	664	860	1,140	1,380	1,630	2,320
			292	559	764	1,050	1,270	1,510	2,090
			389	642	838	1,120	1,350	1,590	2,250
03380300	Dums Creek Tributary near Iuka, Ill.	NA	42	66	83	104	121	138	179
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
03380350	Skillet Fork near Iuka, Ill.	6	4,940	9,000	12,100	16,500	20,000	23,600	32,900
			5,430	8,930	11,500	14,900	17,500	20,200	26,800
			4,990	8,990	12,000	16,200	19,500	22,900	31,500
03380400	Horse Creek Tributary near Cartter, Ill.	6	221	366	474	621	738	862	1,170
			264	486	661	905	1,100	1,310	1,840
			229	390	517	696	842	995	1,380
03380450	White Feather Creek near Marlow, Ill.	6	134	205	254	317	364	412	524
			153	289	397	550	674	807	1,150
			136	215	273	351	412	475	627
03380475	Horse Creek near Keenes, Ill.	6	4,030	6,790	8,830	11,600	13,800	16,000	21,600
			3,540	5,940	7,690	10,100	11,900	13,800	18,500
			4,000	6,720	8,710	11,400	13,500	15,700	21,100
03380500	Skillet Fork at Wayne City, Ill.	6	8,700	16,000	22,100	31,200	38,900	47,600	71,500
			7,930	12,700	16,100	20,600	24,100	27,600	36,100
			8,670	15,900	21,900	30,600	38,000	46,300	68,800
03381500	Little Wabash River at Carmi, Ill.	5	15,600	23,500	29,100	36,500	42,200	48,100	62,700
			22,600	36,700	46,300	58,500	67,600	76,800	98,100
			15,800	24,000	29,900	37,600	43,700	49,900	65,000
03381600	Little Wabash River Tributary nr New Haven, Ill.	5	88	157	212	293	362	437	643
			62	125	175	245	302	362	515
			83	149	202	278	342	411	595
03382025	Little Saline Creek Tributary near Goreville, Ill.	6	271	354	408	475	525	574	688
			185	351	483	672	827	992	1,410
			258	354	421	511	581	653	827
03382100	South Fork Saline River nr Carrier Mills, Ill.	6	2,790	3,790	4,440	5,260	5,860	6,460	7,850
			3,470	5,580	7,110	9,150	10,700	12,300	16,300
			2,820	3,870	4,590	5,500	6,190	6,870	8,490
03382170	Brushy Creek near Harco, Ill.	6	1,130	1,550	1,840	2,220	2,500	2,800	3,530
			1,030	1,780	2,340	3,120	3,740	4,390	6,000
			1,110	1,580	1,930	2,400	2,770	3,150	4,090
03382500	Saline River near Junction, Ill.	NA	10,800	17,300	22,200	29,000	34,500	40,400	55,600
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
03382510	Eagle Creek near Equality, Ill.	6	520	599	642	690	722	751	812
			1,030	1,860	2,500	3,390	4,110	4,870	6,780
			575	727	845	1,000	1,120	1,240	1,500
03382520	Black Branch Tributary near Junction, Ill.	NA	154	304	434	634	809	1,010	1,570
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
03384450	Lusk Creek near Eddyville, Ill.	7	5,180	7,690	9,460	11,800	13,700	15,600	20,400
			3,630	5,680	7,150	9,120	10,600	12,200	16,100
			5,090	7,540	9,260	11,600	13,400	15,200	19,800
03385000	Hayes Creek at Glendale, Ill.	7	2,170	3,610	4,690	6,160	7,320	8,540	11,600
			2,310	3,670	4,670	6,010	7,060	8,150	10,800
			2,170	3,610	4,690	6,150	7,310	8,520	11,600
03385500	Lake Glendale Inlet near Dixon Springs, Ill.	7	569	932	1,200	1,550	1,820	2,110	2,810
			495	849	1,120	1,500	1,810	2,130	2,950
			563	924	1,190	1,540	1,820	2,110	2,830
03386500	Sugar Creek near Dixon Springs, Ill.	NA	1,440	1,890	2,200	2,600	2,910	3,220	4,000
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
03612000	Cache River at Forman, Ill.	7	3,640	5,870	7,480	9,650	11,300	13,100	17,400
			6,090	8,710	10,500	12,800	14,500	16,200	20,300
			3,670	5,910	7,540	9,720	11,400	13,200	17,500
03612200	Q Ditch Tributary near Choat, Ill.	NA	134	224	296	401	489	587	854
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
03614000	Hess Bayou Tributary near Mound City, Ill.	7	449	594	692	819	915	1,010	1,250
			367	589	751	967	1,140	1,310	1,740
			439	594	702	845	957	1,070	1,350
04087300	Lake Michigan Tributary at Winthrop Harbor, Ill.	2	82	148	199	270	327	388	544
			111	194	253	330	387	444	575
			86	154	207	281	339	400	551
04087400	Kellogg Ravine at Zion, Ill.	2	239	412	542	721	864	1,010	1,390
			228	389	503	647	754	860	1,100
			237	409	535	705	837	973	1,300
05414820	Sinsinawa River near Menominee, Ill.	1	2,720	5,840	8,810	13,800	18,500	24,100	41,800
			1,610	2,870	3,820	5,100	6,110	7,160	9,760
			2,610	5,460	8,000	12,000	15,700	19,900	32,600
05415000	Galena River at Buncombe, Wis.	1	4,190	7,030	9,320	12,700	15,600	18,800	27,700
			3,030	5,250	6,880	9,060	10,800	12,500	16,800
			4,130	6,910	9,130	12,400	15,100	18,100	26,400
05415500	East Fork Galena River at Council Hills, Ill.	1	1,930	4,140	6,280	9,930	13,500	17,800	31,700
			1,180	2,150	2,900	3,920	4,730	5,590	7,720
			1,850	3,850	5,680	8,620	11,300	14,500	24,300

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_{2}	Q_{5}	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05418750	South Fork Apple River near Nora, Ill.	1	202	360	480	644	774	910	1,250
			214	399	541	737	893	1,060	1,470
			204	366	490	663	800	944	1,300
05418800	Mill Creek Tributary near Scales Mound, Ill.	1	247	431	577	788	964	1,160	1,670
			184	357	496	692	851	1,020	1,450
			236	417	559	763	932	1,120	1,600
05419000	Apple River near Hanover, Ill.	1	5,140	7,610	9,360	11,700	13,500	15,500	20,200
			4,550	7,770	10,100	13,200	15,700	18,100	24,200
			5,120	7,620	9,410	11,800	13,700	15,700	20,600
05420000	Plum River bl Carroll Creek nr Savanna, Ill.	1	3,510	5,930	7,730	10,200	12,200	14,200	19,400
			4,070	6,920	8,990	11,700	13,800	16,000	21,300
			3,550	6,000	7,840	10,400	12,300	14,400	19,600
05430500	Rock River at Afton, Wis.	2	6,390	8,840	10,400	12,200	13,400	14,600	17,300
			6,630	9,400	11,100	13,100	14,400	15,700	18,300
			6,390	8,840	10,400	12,200	13,400	14,600	17,300
05431486	Turtle Creek at Carvers Rock Road nr Clinton, Wis.	1	1,840	3,580	5,050	7,260	9,170	11,300	17,200
			2,070	3,400	4,340	5,550	6,470	7,400	9,650
			1,850	3,570	5,010	7,150	8,960	11,000	16,400
05434500	Pecatonica River at Martintown, Wis.	1	5,070	8,330	10,800	14,100	16,700	19,500	26,600
			7,550	12,100	15,300	19,400	22,400	25,500	32,900
			5,140	8,450	10,900	14,300	17,100	19,900	27,000
05435000	Cedar Creek near Winslow, Ill.	1	100	292	497	859	1,210	1,630	2,930
			160	299	405	552	669	792	1,100
			105	292	480	790	1,070	1,400	2,340
05435500	Pecatonica River at Freeport, Ill.	1	5,470	8,920	11,600	15,300	18,400	21,800	30,600
			7,700	12,200	15,200	19,100	22,000	24,900	31,800
			5,520	8,990	11,700	15,500	18,600	21,900	30,700
05435650	Lost Creek Tributary near Shannon, Ill.	1	285	401	477	571	639	706	861
			199	367	496	674	815	962	1,330
			268	394	480	594	682	771	984
05436500	Sugar River near Brodhead, Wis.	1	3,280	5,930	8,040	11,100	13,600	16,300	23,400
			4,600	7,580	9,670	12,400	14,500	16,600	21,800
			3,310	5,970	8,090	11,100	13,600	16,300	23,300
05436900	Otter Creek Tributary near Durand, Ill.	1	51	97	136	192	240	293	436
			116	226	313	436	536	642	913
			58	113	161	234	296	363	542
05437000	Pecatonica River at Shirland, Ill.	1	8,280	12,300	14,900	18,300	20,800	23,300	29,100
			9,360	14,400	17,800	22,100	25,200	28,400	35,700
			8,340	12,400	15,100	18,600	21,200	23,800	29,800
05437500	Rock River at Rockton, Ill.	1	14,700	20,800	24,600	29,200	32,500	35,700	42,900
			17,900	27,500	34,000	42,200	48,300	54,400	68,800
			14,800	20,900	24,900	29,700	33,100	36,500	44,000

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05437600	Rock River Tributary near Rockton, Ill.	1	142	259	344	455	539	623	818
			235	439	596	813	987	1,170	1,630
			155	286	389	529	638	750	1,020
05437950	Kishwaukee River near Huntley, Ill.	2	128	158	175	194	206	216	238
			320	519	654	820	941	1,060	1,320
			142	187	218	258	285	311	364
05438250	Coon Creek at Riley, Ill.	2	1,250	2,120	2,690	3,400	3,890	4,370	5,370
			1,330	2,170	2,740	3,450	3,970	4,470	5,600
			1,250	2,110	2,690	3,400	3,900	4,380	5,420
05438300	Lawrence Creek Tributary near Harvard, Ill.	2	77	130	168	219	258	299	398
			96	174	232	309	367	426	564
			79	135	177	234	278	323	434
05438390	Piscasaw Creek below Mokeler Creek nr Capron, Ill.	2	1,800	2,530	3,010	3,630	4,090	4,550	5,630
			1,320	2,150	2,700	3,400	3,900	4,390	5,490
			1,710	2,450	2,940	3,570	4,030	4,500	5,580
05438500	Kishwaukee River at Belvidere, Ill.	2	3,890	6,760	8,850	11,600	13,700	15,900	21,000
			4,080	6,400	7,940	9,820	11,200	12,500	15,400
			3,890	6,740	8,800	11,500	13,600	15,700	20,600
05438850	M Br of So Br Kishwaukee R nr Malta, Ill.	2	136	246	320	411	476	537	665
			111	193	251	326	381	436	562
			134	239	310	397	460	519	649
05439000	South Branch Kishwaukee River at Dekalb, Ill.	2	908	1,440	1,810	2,300	2,680	3,070	4,020
			927	1,470	1,820	2,250	2,560	2,860	3,510
			909	1,440	1,810	2,290	2,660	3,040	3,930
05439500	South Branch Kishwaukee River nr Fairdale, Ill.	2	4,170	7,030	9,060	11,700	13,700	15,700	20,400
			2,610	4,030	4,950	6,050	6,830	7,580	9,200
			4,110	6,960	8,850	11,320	13,200	15,100	19,400
05439550	South Branch Kishwaukee River Trib nr Irene, Ill.	2	81	191	287	433	556	690	1,040
			151	271	358	472	559	646	849
			88	201	299	441	558	681	992
05440000	Kishwaukee River near Perryville, Ill.	2	7,490	12,500	15,800	20,100	23,200	26,200	32,900
			6,610	10,300	12,700	15,700	17,800	19,800	24,300
			7,450	12,400	15,700	19,800	22,700	25,600	32,000
05440500	Killbuck Creek near Monroe Center, Ill.	2	2,400	4,320	5,590	7,110	8,160	9,130	11,100
			1,610	2,610	3,290	4,130	4,730	5,330	6,650
			2,360	4,200	5,400	6,820	7,810	8,730	10,600
05440650	Stillman Creek Tributary near Holcomb, Ill.	2	82	144	188	248	293	339	447
			79	139	181	236	277	317	410
			81	143	187	245	290	334	439
05440900	Leaf River Tributary near Forreston, Ill.	1	56	104	143	199	246	298	436
			55	107	149	207	254	305	433
			56	104	144	201	249	300	436

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05441000	Leaf River at Leaf River, Ill.	1	2,770	5,580	7,730	10,600	12,800	15,100	20,200
			2,620	4,570	6,000	7,930	9,430	11,000	14,800
			2,760	5,500	7,600	10,300	12,400	14,500	19,500
05441500	Rock River at Oregon, Ill.	1	21,700	33,300	41,800	53,400	62,600	72,200	96,800
			22,400	34,600	42,800	53,100	60,800	68,600	86,800
			21,800	33,500	42,000	53,000	62,200	71,300	94,000
05442000	Kyte River near Flagg Center, Ill.	2	1,270	1,740	2,030	2,370	2,610	2,840	3,330
			1,330	2,110	2,630	3,260	3,710	4,150	5,110
			1,280	1,800	2,130	2,540	2,840	3,100	3,740
05443500	Rock River at Como, Ill.	1	24,800	36,200	43,200	51,500	57,300	62,800	74,500
			23,500	36,300	44,800	55,600	63,700	71,800	91,000
			24,800	36,100	43,200	51,600	57,500	63,100	75,200
05444000	Elkhorn Creek near Penrose, Ill.	1	2,980	4,670	5,710	6,900	7,700	8,430	9,910
			2,200	3,660	4,690	6,040	7,070	8,120	10,600
			2,950	4,620	5,650	6,860	7,690	8,460	10,100
05444100	Spring Creek Tributary near Coleta, Ill.	1	272	480	634	841	1,000	1,160	1,560
			216	411	564	777	948	1,130	1,590
			260	464	615	822	985	1,150	1,570
05445500	Rock Creek near Morrison, Ill.	1	2,260	3,320	4,050	5,000	5,720	6,460	8,250
			2,410	4,040	5,210	6,740	7,910	9,120	12,000
			2,270	3,370	4,140	5,160	5,950	6,750	8,690
05446000	Rock Creek at Morrison, Ill.	1	2,120	2,960	3,520	4,250	4,800	5,360	6,710
			2,380	3,980	5,120	6,610	7,750	8,920	11,700
			2,130	3,000	3,600	4,380	4,980	5,590	7,060
05446500	Rock River near Joslin, Ill.	1	23,500	34,200	41,100	49,400	55,400	61,100	73,900
			26,200	40,400	50,100	62,300	71,400	80,600	102,000
			23,600	34,400	41,400	50,000	56,100	62,100	75,500
05446950	Green River Tributary near Amboy, Ill.	2	91	202	300	452	585	733	1,140
			74	132	175	231	273	316	414
			88	188	270	388	485	589	860
05447000	Green River at Amboy, Ill.	2	2,730	4,460	5,520	6,740	7,550	8,280	9,720
			1,650	2,560	3,150	3,870	4,370	4,860	5,910
			2,670	4,330	5,340	6,490	7,260	7,960	9,380
05447050	Green River Tributary No 2 near Ohio, Ill.	2	148	233	292	368	425	483	618
			231	395	510	657	766	874	1,120
			158	254	325	420	491	563	730
05447200	Normandy Ditch at Normandy, Ill.	NA	47	72	88	108	122	136	165
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05447350	Mud Creek Tributary near Atkinson, Ill.	4	192	327	434	590	721	864	1,250
			191	356	483	659	798	944	1,300
			192	332	445	607	741	886	1,270

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05447500	Green River near Geneseo, Ill.	2	6,260	8,690	10,100	11,600	12,600	13,400	15,200
			5,240	8,030	9,840	12,000	13,600	15,100	18,300
			6,230	8,660	10,100	11,600	12,600	13,600	15,400
05448000	Mill Creek at Milan, Ill.	4	2,640	4,580	5,960	7,750	9,090	10,400	13,500
			2,350	4,100	5,400	7,140	8,490	9,870	13,200
			2,630	4,560	5,930	7,700	9,040	10,400	13,500
05448050	Sand Creek near Milan, Ill.	4	36	79	120	186	247	317	526
			66	126	174	241	295	351	491
			38	85	128	196	256	325	518
05466000	Edwards River near Orion, Ill.	4	3,420	4,610	5,350	6,230	6,860	7,470	8,820
			3,550	5,970	7,710	10,000	11,700	13,500	17,800
			3,430	4,660	5,460	6,430	7,130	7,820	9,360
05466500	Edwards River near New Boston, Ill.	4	4,170	6,450	7,990	9,950	11,400	12,800	16,200
			6,340	10,000	12,600	15,800	18,300	20,700	26,500
			4,210	6,540	8,130	10,200	11,700	13,200	16,700
05467000	Pope Creek near Keithsburg, Ill.	4	2,440	4,010	5,190	6,820	8,130	9,520	13,100
			3,520	5,580	7,010	8,840	10,200	11,600	14,800
			2,470	4,060	5,260	6,920	8,240	9,640	13,200
05467500	Henderson Creek near Little York, Ill.	4	2,320	4,230	5,940	8,720	11,300	14,400	23,800
			3,610	5,970	7,650	9,850	11,500	13,200	17,300
			2,370	4,310	6,050	8,800	11,300	14,200	23,000
05468000	North Henderson Creek near Seaton, Ill.	4	1,130	1,570	1,870	2,240	2,530	2,820	3,510
			2,020	3,300	4,210	5,390	6,280	7,190	9,340
			1,230	1,780	2,190	2,750	3,180	3,610	4,650
05468500	Cedar Creek at Little York, Ill.	4	2,140	4,480	6,650	10,200	13,500	17,500	29,700
			3,100	5,130	6,570	8,460	9,890	11,300	14,800
			2,170	4,500	6,650	10,100	13,300	17,000	28,000
05469000	Henderson Creek near Oquawka, Ill.	4	4,800	8,450	11,600	16,600	21,100	26,400	42,300
			7,410	12,500	16,100	21,000	24,700	28,400	37,500
			4,880	8,600	11,800	16,800	21,300	26,500	41,900
05469500	South Henderson Creek at Biggsville, Ill.	4	1,690	3,230	4,600	6,790	8,800	11,400	18,200
			2,550	4,220	5,420	6,990	8,190	9,400	12,300
			1,720	3,270	4,650	6,800	8,700	11,000	17,500
05469750	Ellison Creek Tributary near Roseville, Ill.	4	50	92	125	172	210	250	354
			92	173	235	321	389	460	637
			54	100	138	192	237	284	405
05495200	Little Creek near Breckenridge, Ill.	4	393	743	1,010	1,380	1,670	1,980	2,720
			204	381	517	706	854	1,010	1,390
			364	679	909	1,220	1,460	1,710	2,320
05495500	Bear Creek near Marcelline, Ill.	4	9,550	16,100	20,800	26,800	31,300	35,800	46,300
			5,730	9,810	12,800	16,700	19,800	22,800	30,200
			9,340	15,700	20,100	25,800	30,100	34,400	44,500

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05496900	Homan Creek Tributary near Quincy, Ill.	4	248	465	627	846	1,020	1,190	1,600
			155	305	426	598	737	884	1,260
			231	431	579	779	935	1,100	1,490
05501500	Burton Creek Tributary near Burton, Ill.	4	163	345	497	721	908	1,110	1,630
			112	211	289	398	485	576	804
			152	312	438	613	755	906	1,290
05502020	Hadley Creek near Barry, Ill.	4	4,240	6,300	7,590	9,130	10,200	11,200	13,400
			2,170	3,900	5,220	7,020	8,440	9,910	13,500
			4,070	6,070	7,330	8,860	9,960	11,000	13,400
05502040	Hadley Creek at Kinderhook, Ill.	4	6,650	11,100	14,200	18,000	20,900	23,700	30,000
			3,060	5,400	7,140	9,500	11,400	13,300	17,900
			6,390	10,600	13,400	17,000	19,600	22,200	28,200
05502120	Kiser Creek Trib near Barry, Ill.	4	373	638	836	1,110	1,330	1,550	2,130
			319	630	884	1,250	1,540	1,860	2,660
			366	637	845	1,140	1,370	1,620	2,260
05512500	Bay Creek at Pittsfield, Ill.	4	4,470	8,460	11,600	15,800	19,300	22,800	31,600
			1,740	3,040	3,990	5,280	6,270	7,300	9,780
			4,300	8,060	10,900	14,700	17,700	20,800	28,400
05513000	Bay Creek at Nebo, Ill.	4	7,120	12,200	15,700	20,300	23,600	26,900	34,300
			3,860	6,490	8,390	10,900	12,800	14,800	19,500
			6,930	11,800	15,100	19,300	22,400	25,400	32,400
05513200	Salt Spring Creek near Gilead, Ill.	4	282	511	687	934	1,130	1,340	1,870
			368	731	1,030	1,450	1,800	2,180	3,140
			292	539	739	1,030	1,260	1,510	2,150
05518000	Kankakee River at Shelby, Ind.	2	4,390	5,320	5,830	6,380	6,740	7,060	7,720
			5,070	7,390	8,830	10,500	11,700	12,700	15,000
			4,400	5,350	5,890	6,480	6,870	7,220	7,940
05519000	Singleton Ditch at Schneider, Ind.	NA	1,230	1,770	2,120	2,550	2,850	3,140	3,800
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05519500	West Creek near Schneider, Ind.	2	954	1,370	1,630	1,950	2,170	2,380	2,830
			572	886	1,090	1,330	1,500	1,660	2,010
			921	1,320	1,570	1,860	2,070	2,260	2,690
05520000	Singleton Ditch at Illinoi, Ill.	2	1,710	2,070	2,250	2,450	2,570	2,680	2,880
			1,800	2,790	3,450	4,240	4,800	5,340	6,530
			1,720	2,100	2,320	2,560	2,720	2,870	3,160
05520500	Kankakee River at Momence, Ill.	2	6,740	8,890	10,100	11,500	12,400	13,300	15,000
			5,900	8,550	10,200	12,100	13,400	14,600	17,200
			6,730	8,880	10,100	11,500	12,500	13,300	15,100
05524500	Iroquois River near Foresman, Ind.	2	2,870	3,910	4,520	5,220	5,690	6,130	7,050
			2,660	4,060	4,960	6,030	6,790	7,510	9,070
			2,870	3,910	4,530	5,250	5,740	6,200	7,170

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05525000	Iroquois River at Iroquois, Ill.	2	3,910	5,530	6,550	7,750	8,610	9,420	11,200
			3,410	5,160	6,270	7,600	8,530	9,410	11,300
			3,900	5,520	6,540	7,760	8,610	9,440	11,200
05525050	Eastburn Hollow near Sheldon, Ill.	3	270	518	724	1,030	1,290	1,580	2,360
			360	651	868	1,160	1,380	1,610	2,170
			281	539	751	1,060	1,310	1,590	2,300
05525500	Sugar Creek at Milford, Ill.	3	6,610	11,500	15,000	19,700	23,300	26,900	35,600
			6,300	11,000	14,500	19,100	22,600	26,200	34,800
			6,600	11,400	15,000	19,600	23,200	26,900	35,600
05526000	Iroquois River near Chebanse, Ill.	3	13,200	18,900	22,600	27,000	30,100	33,100	39,800
			8,380	13,600	17,300	21,900	25,300	28,700	36,700
			13,000	18,700	22,300	26,700	29,800	32,800	39,600
05526150	Kankakee River Tributary near Bourbonnais, Ill.	2	32	82	131	213	289	379	648
			26	46	61	80	94	109	142
			31	77	118	182	239	302	480
05526500	Terry Creek near Custer Park, Ill.	2	148	268	364	503	619	746	1,080
			342	568	723	918	1,060	1,200	1,510
			158	286	392	543	668	801	1,140
05527050	Prairie Creek near Frankfort, Ill.	2	82	132	172	230	279	334	485
			69	121	158	205	241	276	357
			80	130	169	225	271	320	450
05527500	Kankakee River near Wilmington, Ill.	2	24,710	37,200	45,400	55,500	62,900	70,100	86,300
			12,600	18,500	22,200	26,500	29,600	32,400	38,500
			24,400	36,700	44,600	54,300	61,400	6,820	83,600
05527800	Des Plaines River at Russell, Ill.	2	700	1,270	1,670	2,180	2,550	2,910	3,700
			995	1,520	1,870	2,270	2,560	2,830	3,420
			710	1,280	1,680	2,180	2,550	2,910	3,700
05527840	Des Plaines River at Wadsworth, Ill.	2	832	1,620	2,180	2,910	3,430	3,950	5,060
			1,090	1,660	2,030	2,460	2,770	3,060	3,690
			854	1,620	2,160	2,840	3,320	3,780	4,800
05527870	Mill Creek at Wedges Corner, Ill.	NA	84	139	179	232	274	316	419
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05527900	North Mill Creek at Hickory Corners, Ill.	2	210	306	369	447	504	559	686
			303	472	583	718	814	906	1,110
			217	320	391	480	545	608	751
05527950	Mill Creek at Old Mill Creek, Ill.	NA	535	856	1,060	1,290	1,450	1,590	1,890
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05528000	Des Plaines River near Gurnee, Ill.	2	1,310	2,000	2,420	2,900	3,230	3,530	4,150
			1,270	1,900	2,290	2,760	3,090	3,390	4,050
			1,310	2,000	2,420	2,910	3,240	3,550	4,180

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05528150	Indian Creek at Diamond Lake, Ill.	2	282	522	700	939	1,120	1,310	1,760
			261	423	534	674	775	874	1,100
			280	510	677	894	1,060	1,220	1,610
05528170	Diamond Lake Drain at Mundelein, Ill.	NA	54	76	90	107	119	131	157
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05528200	Hawthorn Drainage Ditch near Mundelein, Ill.	2	211	318	392	486	557	629	800
			125	204	257	323	371	418	522
			201	302	369	454	518	582	732
05528230	Indian Creek at Prairie View, Ill.	NA	547	885	1,120	1,430	1,660	1,890	2,450
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05528360	Aptakisic Creek at Aptakisic, Ill.	2	111	192	253	334	398	463	623
			90	146	184	230	263	295	366
			108	186	241	313	367	422	553
05528400	Des Plaines River at Wheeling, Ill.	NA	1,750	2,640	3,200	3,850	4,290	4,710	5,570
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05528440	Buffalo Creek near Lake Zurich, Ill.	2	81	131	165	210	244	278	359
			85	149	196	256	300	345	447
			82	133	171	219	256	294	382
05528470	Buffalo Creek at Long Grove, Ill.	2	228	367	460	575	657	737	915
			229	377	478	606	698	789	993
			228	368	462	580	666	749	934
05528500	Buffalo Creek near Wheeling, Ill.	NA	384	581	699	834	925	1,010	1,170
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05529000	Des Plaines River near Des Plaines, Ill.	NA	2,280	3,250	3,830	4,490	4,940	5,350	6,210
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05529300	Mc Donald Creek near Wheeling, Ill.	NA	178	315	415	547	647	748	987
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05529500	Mc Donald Creek near Mount Prospect, Ill.	NA	200	361	478	631	747	863	1,130
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05529900	Weller Creek at Mount Prospect, Ill.	NA	485	779	986	1,250	1,460	1,670	2,160
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05530000	Weller Creek at Des Plaines, Ill.	NA	749	1,080	1,290	1,520	1,690	1,840	2,160
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05530400	Higgins Creek near Mount Prospect, Ill.	NA	138	246	327	438	525	615	838
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05530480	Willow Creek at Orchard Place, Ill.	NA	564	1,050	1,420	1,940	2,350	2,790	3,880
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05530600	Des Plaines River at River Grove, Ill.	NA	2,560	3,380	3,850	4,360	4,700	5,010	5,640
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05530700	Silver Creek at Melrose Park, Ill.	NA	444	557	622	698	749	798	901
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05530800	Des Plaines River at Forest Park, Ill.	NA	2,760	3,680	4,200	4,780	5,170	5,510	6,200
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05530940	Salt Creek at Palatine, Ill.	NA	204	290	348	422	478	535	670
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05530960	Salt Creek near Palatine, Ill.	NA	303	467	580	724	831	939	1,190
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05530990	Salt Creek at Rolling Meadows, Ill.	NA	783	1,060	1,230	1,440	1,590	1,730	2,060
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05531000	Salt Creek near Arlington Heights, Ill.	NA	453	701	864	1,070	1,210	1,360	1,680
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05531050	Salt Creek near Wood Dale, Ill.	NA	667	1,000	1,230	1,520	1,750	1,970	2,510
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05531080	Spring Brook at Bloomingdale, Ill.	NA	175	247	296	359	406	455	571
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05531100	Meacham Creek at Medinah, Ill.	NA	60	90	111	140	163	187	247
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05531130	Spring Brook at Walnut Ave at Itasca, Ill.	NA	241	339	404	485	544	604	742
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05531200	Salt Creek at Addison, Ill.	NA	814	1,090	1,270	1,490	1,650	1,810	2,190
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05531300	Salt Creek at Elmhurst, Ill.	NA	1,060	1,400	1,600	1,850	2,020	2,180	2,550
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05531380	Salt Creek at Oak Brook, Ill.	NA	999	1,290	1,460	1,650	1,780	1,900	2,160
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05531500	Salt Creek at Western Springs, Ill.	NA	1,260	1,710	1,990	2,340	2,580	2,820	3,360
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05531800	Addison Creek at Northlake, Ill.	NA	311	376	411	448	473	494	537
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05532000	Addison Creek at Bellwood, Ill.	NA	464	629	732	855	941	1,020	1,210
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05532500	Des Plaines River at Riverside, Ill.	NA	4,020	5,400	6,220	7,150	7,790	8,380	9,620
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05533000	Flag Creek near Willow Springs, Ill.	NA	836	1,340	1,700	2,180	2,550	2,930	3,860
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05533200	Sawmill Creek Tributary near Tiedtville, Ill.	2	232	279	305	334	352	369	403
			150	261	341	443	520	596	771
			220	276	310	352	382	410	471
05533300	Wards Creek near Woodridge, Ill.	2	80	113	134	159	177	194	230
			122	202	258	327	378	428	539
			84	123	149	183	207	231	283
05533400	Sawmill Creek near Lemont, Ill.	NA	656	1,120	1,460	1,920	2,280	2,660	3,580
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05533500	Des Plaines River at Lemont, Ill.	NA	3,110	4,190	4,810	5,510	5,980	6,410	7,290
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05534300	North Branch Chicago River at Lake Forest, Ill.	NA	192	262	303	351	383	413	475
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05534400	North Branch Chicago River at Bannockburn, Ill.	2	246	320	362	408	438	465	520
			263	415	515	636	723	806	987
			248	329	379	437	478	515	592
05534500	North Branch Chicago River at Deerfield, Ill.	NA	338	506	615	749	845	939	1,150
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_{2}	Q_{5}	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05534600	North Branch Chicago River at Northfield, Ill.	NA	345	433	483	538	574	607	674
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05534900	Skokie River at Lake Bluff, Ill.	NA	204	314	385	472	534	594	726
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05535000	Skokie River at Lake Forest, Ill.	NA	234	338	401	476	527	575	676
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05535070	Skokie River near Highland Park, Ill.	NA	458	628	735	862	953	1,040	1,230
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05535150	Skokie River at Northfield, Ill.	NA	378	449	488	533	563	591	648
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05535200	North Branch Chicago River at Glenview, Ill.	NA	696	872	977	1,100	1,190	1,270	1,450
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05535300	WF of Nb Chicago River at Bannockburn, Ill.	NA	210	285	332	386	424	459	537
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05535400	WF of Nb Chicago River at Deerfield, Ill.	NA	365	453	504	560	598	632	705
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05535500	WF of Nb Chicago River at Northbrook Il	NA	493	691	809	945	1,040	1,120	1,300
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05535700	WF of Nb Chicago River at Glenview, Ill.	NA	633	845	971	1,120	1,220	1,310	1,510
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05535800	N Branch Chicago River at Morton Grove, Ill.	NA	1,030	1,340	1,530	1,750	1,910	2,060	2,390
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536000	North Branch Chicago River at Niles, Ill.	NA	1,210	1,580	1,820	2,100	2,300	2,500	2,940
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536178	Plum Creek near Dyer, Ind.	2	1,160	1,710	2,060	2,460	2,740	3,000	3,570
			589	949	1,190	1,490	1,700	1,910	2,370
			1,070	1,570	1,860	2,210	2,460	2,700	3,210
05536190	Hart Ditch at Munster, Ind.	2	1,520	2,150	2,540	3,000	3,330	3,640	4,310
			908	1,440	1,800	2,230	2,550	2,850	3,530
			1,500	2,120	2,500	2,950	3,270	3,580	4,250

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05536195	Little Calumet River at Munster, Ind.	2	757	943	1,060	1,190	1,280	1,370	1,570
			1,040	1,640	2,030	2,520	2,860	3,200	3,940
			767	969	1,100	1,250	1,370	1,470	1,710
05536201	Thorn Creek at Park Forest, Ill.	NA	322	601	831	1,170	1,460	1,780	2,660
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536207	Thorn Creek Tributary at Chicago Heights, Ill.	NA	262	428	555	733	879	1,040	1,450
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536210	Thorn Creek near Chicago Heights, Ill.	NA	996	1,430	1,720	2,090	2,360	2,630	3,260
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536215	Thorn Creek at Glenwood, Ill.	NA	1,120	1,630	1,980	2,430	2,770	3,130	3,990
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536235	Deer Creek near Chicago Heights, Ill.	NA	553	731	845	983	1,080	1,180	1,410
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536238	Butterfield Creek near Lincoln Estates, Ill.	NA	141	265	362	498	607	722	1,010
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536255	Butterfield Creek at Flossmoor, Ill.	NA	709	1,170	1,520	2,000	2,390	2,800	3,860
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536265	Lansing Ditch near Lansing, Ill.	NA	180	264	319	385	433	479	583
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536270	North Creek near Lansing, Ill.	NA	354	512	614	738	827	913	1,110
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536275	Thorn Creek at Thornton, Ill.	NA	2,040	2,990	3,610	4,410	5,000	5,590	6,970
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536290	Little Calumet River at South Holland, Ill.	NA	2,520	3,350	3,840	4,420	4,820	5,200	6,010
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536310	Calumet Union Drainage Ca near Markham, Ill.	NA	300	389	440	498	538	574	650
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536325	Little Calumet River at Harvey, Ill.	NA	1,970	2,970	3,620	4,420	5,000	5,570	6,840
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05536335	Midlothian Creek near Tinley Park, Ill.	NA	223	295	342	401	445	489	594
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536340	Midlothian Creek at Oak Forest, Ill.	NA	244	339	403	486	550	614	771
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536460	Tinley Creek near Oak Forest, Ill.	NA	421	634	778	961	1,100	1,230	1,550
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536500	Tinley Creek near Palos Park, Ill.	NA	597	953	1,220	1,590	1,890	2,210	3,030
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536510	Navajo Creek at Palos Heights, Ill.	NA	236	313	363	424	468	511	611
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536560	Melvina Ditch near Oak Lawn, Ill.	NA	140	234	301	390	458	527	691
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536570	Stony Creek (West) at Worth, Ill.	NA	421	713	922	1,200	1,400	1,610	2,110
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536620	Mill Creek near Palos Park, Ill.	NA	131	251	355	515	657	818	1,280
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536630	Mill Creek at Palos Park, Ill.	NA	213	447	664	1,010	1,340	1,720	2,860
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05536995	Chicago Sanitary and Ship Ca at Romeoville, Ill.	NA	15,800	18,200	19,500	20,900	21,800	22,600	24,100
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05537500	Long Run near Lemont, Ill.	NA	602	1,090	1,510	2,140	2,700	3,340	5,160
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05538000	Des Plaines River at Joliet, Ill.	NA	15,400	18,100	19,600	21,300	22,400	23,400	25,500
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05538440	Spring Creek near Orland Park, Ill.	NA	41	60	73	89	100	111	137
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05539000	Hickory Creek at Joliet, Ill.	NA	2,910	5,040	6,820	9,520	11,900	14,600	22,300
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05539870	West Branch Du Page River at Ontarioville, Ill.	2	311	498	620	768	873	973	1,190
			228	367	461	576	659	739	917
			302	482	597	736	835	929	1,140
05539890	West Branch Du Page River near Wayne, Ill.	2	488	775	977	1,240	1,440	1,650	2,140
			422	675	845	1,050	1,200	1,350	1,670
			483	765	962	1,220	1,410	1,600	2,050
05539900	W Branch Du Page River nr West Chicago, Ill.	NA	509	707	823	954	1,040	1,120	1,280
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05539950	Klein Creek at Carol Stream, Ill.	2	184	281	352	448	523	602	800
			244	400	507	640	737	831	1,040
			189	293	370	474	555	639	845
05540030	West Br Du Page River at West Chicago, Ill.	2	724	1,010	1,190	1,390	1,530	1,660	1,950
			748	1,180	1,460	1,810	2,060	2,300	2,830
			726	1,030	1,220	1,440	1,600	1,760	2,090
05540060	Kress Creek at West Chicago, Ill.	NA	278	419	526	676	799	932	1,290
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05540080	Spring Brook at Wheaton, Ill.	NA	149	207	245	296	334	372	466
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05540095	West Br Du Page River near Warrenville, Ill.	NA	1,260	1,840	2,230	2,730	3,100	3,470	4,360
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05540110	Ferry Creek at Warrenville, Ill.	NA	87	128	156	192	219	246	310
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05540130	West Branch Du Page River near Naperville, Ill.	NA	2,150	2,870	3,310	3,820	4,180	4,520	5,260
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05540140	East Br Du Page River nr Bloomingdale, Ill.	NA	59	102	133	173	204	234	304
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05540150	East Br Du Page River at Glen Ellyn, Ill.	NA	243	398	506	643	744	845	1,080
			----	----	----	----	----	----	----
			----	----	----	----	----	----	----
05540160	E Br Du Page River near Downers Grove, Ill.	NA	597	862	1,030	1,250	1,400	1,550	1,900
			----	----	----	----	----	----	----
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05540190	St. Joseph Creek at Belmont, Ill.	NA	343	517	630	768	867	963	1,180
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Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_{2}	Q_{5}	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05540195	St. Joseph Creek at U.S. Route 34 at Lisle, Ill.	NA	617	861	1,020	1,210	1,350	1,490	1,800
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05540240	Prentiss Creek near Lisle, Ill.	2	193	304	385	497	585	678	913
			283	484	626	807	941	1,070	1,380
			201	322	413	540	639	742	998
05540250	East Branch Du Page River at Bolingbrook, Ill.	NA	1,050	1,520	1,840	2,270	2,590	2,920	3,720
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05540275	Spring Brook at 87th Street near Naperville, Ill.	NA	195	366	514	746	954	1,190	1,900
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05540500	Du Page River at Shorewood, Ill.	NA	3,750	5,930	7,540	9,730	11,500	13,300	17,900
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05541750	Mazon River Tributary near Gardner, Ill.	2	106	145	167	191	206	221	249
			150	248	314	396	455	513	640
			109	153	180	212	234	254	297
05542000	Mazon River near Coal City, Ill.	2	9,080	14,000	17,000	20,500	22,900	25,100	29,600
			3,250	5,050	6,240	7,690	8,720	9,720	11,900
			8,830	13,500	16,300	19,600	21,800	23,800	28,100
05543500	Illinois River at Marseilles, Ill.	NA	45,000	63,500	75,200	89,300	99,400	109,000	131,000
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05545750	Fox River near New Munster, Wis.	2	2,690	3,860	4,660	5,680	6,460	7,240	9,100
			2,670	3,870	4,620	5,490	6,090	6,660	7,860
			2,690	3,860	4,650	5,670	6,430	7,190	9,010
05547755	Squaw Creek at Round Lake, Ill.	2	188	254	294	340	372	402	466
			248	386	477	585	662	736	896
			195	271	322	383	427	468	558
05548150	North Br Nippersink Crk nr Genoa City, Wis.	2	181	270	332	410	470	530	672
			290	468	587	734	840	942	1,170
			185	279	346	432	497	562	716
05548280	Nippersink Creek near Spring Grove, Ill.	NA	1,270	2,030	2,540	3,170	3,630	4,080	5,080
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05549000	Boone Creek near Mc Henry, Ill.	2	126	199	247	308	353	396	494
			357	581	734	924	1,060	1,200	1,500
			131	209	264	334	385	436	549
05549700	Mutton Creek at Island Lake, Ill.	2	80	161	230	332	419	514	771
			246	397	500	627	719	808	1,010
			89	179	255	368	460	559	813

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05549850	Flint Creek near Fox River Grove, Ill.	2	275	380	449	535	599	663	812
			507	794	987	1,220	1,390	1,560	1,920
			285	401	481	584	660	736	911
05549900	Fox River Tributary near Cary, Ill.	2	11	25	37	56	72	90	139
			18	32	44	58	69	81	107
			12	26	38	56	71	88	131
05550000	Fox River at Algonquin, Ill.	NA	3,270	4,520	5,280	6,190	6,820	7,420	8,730
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05550300	Tyler Creek at Elgin, Ill.	2	342	457	531	622	688	753	902
			773	1,270	1,610	2,040	2,350	2,650	3,340
			370	514	618	754	855	955	1,180
05550430	East Branch Poplar Creek near Palatine, Ill.	NA	87	125	151	184	210	235	297
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05550450	Poplar Creek near Ontarioville, Ill.	NA	211	290	340	398	440	480	567
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05550470	Poplar Creek Trib near Bartlett, Ill.	2	162	240	295	365	419	474	606
			155	257	327	414	477	539	678
			161	242	299	373	429	486	620
05550500	Poplar Creek at Elgin, Ill.	NA	431	643	781	951	1,070	1,190	1,460
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05551030	Brewster Creek at Valley View, Ill.	2	236	411	535	695	815	933	1,210
			308	498	627	787	903	1,020	1,270
			242	419	546	709	830	949	1,220
05551050	Norton Creek near Wayne, Ill.	2	97	201	295	443	576	730	1,180
			192	311	392	492	565	635	791
			103	210	305	450	574	713	1,090
05551060	Norton Creek near St. Charles, Ill.	2	123	216	290	397	486	584	845
			292	478	604	762	876	988	1,240
			133	235	319	439	537	641	908
05551200	Ferson Creek near St. Charles, Ill.	2	929	1,530	1,910	2,370	2,680	2,970	3,560
			1,120	1,850	2,370	3,010	3,490	3,960	5,030
			938	1,550	1,940	2,420	2,750	3,070	3,730
05551520	Indian Creek near North Aurora, Ill.	2	133	217	275	350	406	463	595
			92	148	186	232	264	296	365
			129	208	262	329	379	429	543
05551530	Indian Creek at Aurora, Ill.	NA	525	659	733	814	866	913	1,010
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Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_{2}	Q_{5}	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05551620	Blackberry Creek near Kaneville, Ill.	2	430	529	585	647	689	727	806
			552	917	1,170	1,490	1,720	1,940	2,460
			442	569	653	756	829	898	1,050
05551650	Lake Run Trib near Batavia, Ill.	2	52	116	175	268	352	447	717
			158	278	365	478	563	648	845
			60	133	201	304	393	490	749
05551700	Blackberry Creek near Yorkville, Ill.	2	686	1,200	1,570	2,070	2,460	2,850	3,800
			976	1,560	1,950	2,440	2,780	3,120	3,870
			697	1,210	1,590	2,100	2,480	2,870	3,800
05551800	Fox River Tributary No 2 near Fox, Ill.	2	68	165	254	392	512	645	1,010
			64	116	155	206	245	284	376
			67	156	233	344	435	533	786
05551900	East Branch Big Rock Creek near Big Rock, Ill.	2	643	950	1,150	1,400	1,580	1,760	2,160
			713	1,180	1,490	1,890	2,180	2,470	3,110
			652	980	1,200	1,490	1,700	1,900	2,360
05551930	Welch Creek near Big Rock, Ill.	2	320	460	547	651	724	794	946
			543	899	1,140	1,450	1,680	1,900	2,390
			341	504	616	759	862	962	1,180
05552500	Fox River at Dayton, Ill.	NA	12,600	19,200	23,800	29,700	34,100	38,600	49,100
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05554000	North Fork Vermilion River near Charlotte, Ill.	3	2,420	3,740	4,560	5,510	6,160	6,760	8,000
			3,130	5,490	7,210	9,490	11,200	13,000	17,300
			2,450	3,820	4,700	5,760	6,510	7,220	8,740
05554500	Vermilion River at Pontiac, Ill.	3	5,730	8,650	10,500	12,700	14,200	15,700	18,800
			4,510	7,480	9,560	12,200	14,200	16,200	20,800
			5,670	8,580	10,400	12,700	14,200	15,700	19,000
05554600	Mud Creek Tributary near Odell, Ill.	3	49	90	120	158	186	213	273
			30	57	78	106	129	152	207
			45	82	108	142	167	192	250
05555000	Vermilion River at Streator, Ill.	3	7,760	12,400	15,500	19,500	22,400	25,300	32,100
			7,450	12,300	15,700	20,100	23,300	26,600	34,200
			7,720	12,300	15,500	19,600	22,600	25,700	32,700
05555300	Vermilion River near Leonore, Ill.	3	12,400	20,000	25,100	31,300	35,700	40,000	49,600
			8,630	14,300	18,300	23,400	27,200	31,100	40,000
			12,300	19,700	24,700	30,800	35,200	39,500	49,000
05555400	Vermilion River Tributary at Lowell, Ill.	3	26	68	111	187	261	351	638
			98	195	274	383	472	565	798
			33	84	137	227	310	406	686
05555500	Vermilion River at Lowell, Ill.	3	10,700	17,900	23,100	29,900	35,000	40,300	52,700
			8,970	14,900	19,100	24,400	28,500	32,500	41,900
			10,600	17,700	22,800	29,300	34,300	39,400	51,400

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_{2}	Q_{5}	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05555775	Vermilion Creek Tributary at Meriden, Ill.	3	43	69	86	108	124	140	176
			75	147	203	280	341	405	564
			48	83	110	147	177	206	277
05556500	Big Bureau Creek at Princeton, Ill.	3	4,470	7,320	9,110	11,200	12,500	13,800	16,300
			3,750	6,650	8,800	11,700	13,900	16,100	21,600
			4,420	7,270	9,080	11,200	12,700	14,100	16,900
05557000	West Bureau Creek at Wyanet, Ill.	3	2,660	4,810	6,470	8,820	10,700	12,700	17,900
			2,480	4,530	6,070	8,170	9,810	11,500	15,700
			2,650	4,780	6,440	8,750	10,600	12,600	17,600
05557100	West Bureau Creek Tributary near Wyanet, Ill.	4	81	159	222	316	395	480	708
			123	229	310	424	514	608	844
			85	167	235	334	417	506	739
05557500	East Bureau Creek near Bureau, Ill.	3	2,340	4,120	5,410	7,110	8,420	9,730	12,800
			2,980	5,450	7,310	9,840	11,800	13,900	18,900
			2,370	4,190	5,530	7,320	8,700	10,100	13,400
05558000	Big Bureau Creek at Bureau, Ill.	3	8,070	11,800	14,100	17,000	19,000	21,000	25,300
			7,530	13,300	17,600	23,300	27,700	32,300	43,200
			7,950	12,100	15,000	18,800	21,600	24,500	31,100
05558050	Coffee Creek Tributary near Florid, Ill.	3	19	39	56	83	106	131	203
			19	38	55	78	97	117	168
			19	39	56	81	103	126	190
05558075	Coffee Creek Tributary near Hennepin, Ill.	3	61	117	163	234	296	365	557
			54	112	160	229	286	346	503
			60	116	163	233	294	360	542
05558300	Illinois River at Henry, Ill.	NA	64,800	89,800	106,000	125,000	138,000	152,000	182,000
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05558500	Crow Creek (West) near Henry, Ill.	4	1,500	2,680	3,630	5,050	6,250	7,590	11,300
			2,260	4,010	5,330	7,100	8,490	9,920	13,400
			1,550	2,770	3,780	5,270	6,520	7,880	11,600
05559000	Gimlet Creek at Sparland, Ill.	4	810	1,300	1,640	2,090	2,430	2,780	3,600
			745	1,410	1,940	2,670	3,260	3,880	5,440
			800	1,310	1,680	2,170	2,550	2,940	3,890
05559500	Crow Creek near Washburn, Ill.	3	2,170	3,350	4,190	5,290	6,140	7,020	9,150
			2,570	4,560	6,040	8,000	9,520	11,100	14,800
			2,200	3,440	4,350	5,580	6,530	7,510	9,900
05560000	Illinois River at Peoria, Ill.	NA	38,000	48,700	54,700	61,400	65,800	69,800	78,000
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05560500	Farm Creek at Farmdale, Ill.	NA	578	818	998	1,250	1,460	1,680	2,290
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Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_{2}	Q_{5}	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05561000	Ackerman Creek at Farmdale, Ill.	3	630	1,370	2,060	3,170	4,180	5,360	8,840
			976	1,890	2,610	3,620	4,430	5,290	7,420
			666	1,440	2,150	3,260	4,240	5,340	8,460
05561500	Fondulac Creek near East Peoria, Ill.	NA	249	362	443	550	634	722	942
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05562000	Farm Creek at East Peoria, Ill.	NA	3,410	6,970	10,200	15,400	20,100	25,700	42,400
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05563000	Kickapoo Creek near Kickapoo, Ill.	4	7,110	13,800	19,400	28,100	35,700	44,200	68,300
			3,920	6,920	9,170	12,200	14,600	17,000	23,000
			6,910	13,200	18,500	26,200	32,900	40,300	60,700
05563100	Kickapoo Creek Tributary near Kickapoo, Ill.	4	27	65	102	166	228	303	544
			30	59	83	115	142	170	239
			28	64	98	152	202	260	429
05563500	Kickapoo Creek at Peoria, Ill.	4	7,700	13,200	17,700	24,300	30,000	36,200	53,500
			6,020	10,200	13,300	17,400	20,600	23,800	31,600
			7,630	13,100	17,500	23,800	29,100	35,000	51,000
05564400	Money Creek near Towanda, Ill.	3	867	1,380	1,760	2,290	2,720	3,180	4,370
			1,200	2,130	2,810	3,710	4,400	5,110	6,800
			897	1,450	1,890	2,490	2,980	3,490	4,800
05564500	Money Creek above Lake Bloomington, Ill.	3	935	1,520	1,980	2,660	3,240	3,880	5,650
			1,250	2,220	2,930	3,860	4,580	5,320	7,070
			965	1,590	2,100	2,840	3,460	4,140	5,960
05565000	Hickory Creek above Lake Bloomington, Ill.	3	493	991	1,410	2,040	2,570	3,150	4,730
			471	860	1,150	1,550	1,850	2,160	2,920
			490	968	1,360	1,910	2,370	2,860	4,130
05566000	East Branch Panther Creek near Gridley, Ill.	3	152	285	402	589	760	961	1,570
			450	841	1,140	1,550	1,860	2,190	2,990
			176	338	488	727	939	1,180	1,860
05566500	East Branch Panther Creek at El Paso, Ill.	3	573	1,100	1,580	2,370	3,120	4,010	6,790
			845	1,490	1,970	2,600	3,080	3,560	4,720
			592	1,130	1,620	2,410	3,110	3,940	6,390
05567000	Panther Creek near El Paso, Ill.	3	2,310	4,660	6,590	9,390	11,700	14,200	20,600
			2,060	3,640	4,790	6,320	7,490	8,680	11,500
			2,290	4,580	6,430	9,040	11,200	13,400	19,200
05567500	Mackinaw River near Congerville, Ill.	3	8,940	16,200	22,000	30,400	37,400	45,100	65,600
			7,390	12,500	16,200	21,000	24,600	28,200	36,900
			8,860	15,900	21,500	29,400	36,000	43,100	61,800
05567800	Indian Creek Tributary near Hopedale, Ill.	3	185	328	442	609	749	903	1,320
			142	278	384	532	650	773	1,080
			173	312	422	579	708	846	1,210

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05568000	Mackinaw River near Green Valley, Ill.	3	8,330	15,100	21,000	30,500	39,000	49,000	79,200
			9,480	16,000	20,700	26,800	31,400	36,100	47,100
			8,370	15,100	21,100	30,300	38,500	48,100	76,500
05568500	Illinois River at Kingston Mines, Ill.	NA	49,000	64,900	74,200	84,700	91,800	98,300	112,000
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05568650	Duck Creek near Canton, Ill.	4	66	103	130	167	198	230	313
			93	172	232	314	378	444	605
			70	112	146	194	233	274	379
05568800	Indian Creek near Wyoming, Ill.	4	1,660	2,660	3,440	4,540	5,460	6,450	9,110
			2,130	3,590	4,650	6,040	7,110	8,190	10,800
			1,680	2,710	3,520	4,670	5,610	6,630	9,320
05568850	Forman Creek Tributary near Victoria, Ill.	4	101	192	270	388	491	608	937
			79	151	208	287	350	415	577
			97	183	254	357	444	539	796
05569500	Spoon River at London Mills, Ill.	4	9,750	15,000	19,200	25,200	30,300	36,000	51,500
			10,900	17,700	22,400	28,600	33,200	37,800	48,800
			9,780	15,100	19,300	25,400	30,500	36,100	51,400
05569825	Cedar Creek Tributary at St. Augustine, Ill.	4	382	613	799	1,070	1,310	1,570	2,300
			451	834	1,130	1,530	1,850	2,190	3,010
			389	637	841	1,140	1,400	1,680	2,450
05570000	Spoon River at Seville, Ill.	4	12,600	19,600	24,600	31,200	36,300	41,600	54,500
			13,900	22,200	28,000	35,400	41,000	46,500	59,700
			12,700	19,700	24,700	31,300	36,500	41,800	54,700
05570350	Big Creek at St. David, Ill.	NA	859	1,210	1,460	1,790	2,050	2,320	2,990
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05570360	Evelyn Branch near Bryant, Ill.	NA	75	150	216	315	403	501	775
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05570370	Big Creek near Bryant, Ill.	4	761	1,030	1,200	1,400	1,540	1,680	1,980
			1,710	2,890	3,760	4,900	5,780	6,670	8,830
			823	1,160	1,410	1,720	1,960	2,180	2,700
05570380	Slug Run near Bryant,Ill.	NA	138	306	455	687	891	1,120	1,760
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05570500	Illinois River at Havana, Ill.	NA	44,700	60,300	69,700	80,600	88,100	95,200	110,000
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05570910	Sangamon River at Fisher, Ill.	3	3,930	6,490	8,350	10,800	12,800	14,800	19,600
			4,040	7,080	9,300	12,300	14,500	16,800	22,400
			3,940	6,580	8,510	11,100	13,100	15,200	20,300

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05571000	Sangamon River at Mahomet, Ill.	3	4,080	7,040	9,330	12,500	15,200	18,000	25,200
			4,880	8,440	11,000	14,400	17,000	19,600	25,800
			4,140	7,170	9,510	12,800	15,400	18,200	25,300
05572000	Sangamon River at Monticello, Ill.	3	5,400	8,950	11,500	15,000	17,800	20,600	27,600
			5,940	10,100	13,100	17,100	20,000	23,000	30,200
			5,420	8,980	11,600	15,100	17,900	20,700	27,800
05572100	Wildcat Creek Tributary near Monticello, Ill.	NA	28	46	58	75	88	101	134
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05572450	Friends Creek at Argenta, Ill.	3	1,630	2,760	3,670	4,990	6,110	7,340	10,700
			2,420	4,280	5,640	7,460	8,850	10,300	13,700
			1,730	3,000	4,030	5,530	6,760	8,090	11,600
05572500	Sangamon River near Oakley, Ill.	3	5,610	9,190	12,000	16,100	19,500	23,200	33,300
			7,110	12,000	15,500	20,000	23,500	26,900	35,000
			5,720	9,450	12,400	16,600	20,000	23,800	33,600
05573540	Sangamon River at Rt 48 at Decatur, Ill.	NA	8,610	12,800	15,500	18,900	21,500	24,000	29,700
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05574000	South Fork Sangamon River near Nokomis, Ill.	3	956	1,830	2,640	3,980	5,260	6,820	11,800
			691	1,280	1,730	2,340	2,820	3,310	4,510
			925	1,750	2,480	3,640	4,700	5,940	9,680
05574500	Flat Branch near Taylorville, Ill.	3	3,920	6,590	8,510	11,000	13,000	14,900	19,600
			3,250	5,520	7,120	9,200	10,800	12,300	16,100
			3,870	6,490	8,360	10,800	12,700	14,600	19,100
05575500	South Fork Sangamon River at Kincaid, Ill.	3	4,290	7,860	10,700	15,000	18,500	22,500	33,000
			6,330	10,800	14,000	18,100	21,300	24,400	31,900
			4,360	7,960	10,900	15,100	18,700	22,600	32,800
05575800	Horse Creek at Pawnee, Ill.	3	1,870	2,970	3,720	4,660	5,350	6,030	7,600
			1,540	2,740	3,620	4,790	5,690	6,600	8,790
			1,820	2,930	3,700	4,690	5,440	6,190	7,940
05576000	South Fork Sangamon River nr Rochester, Ill.	NA	5,620	9,810	12,900	17,000	20,200	23,500	31,300
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05576500	Sangamon River at Riverton, Ill.	3	15,800	25,200	31,400	39,100	44,600	49,900	61,600
			15,900	26,300	33,700	43,100	50,200	57,300	73,900
			15,700	25,200	31,400	39,200	44,900	50,300	62,500
05577500	Spring Creek at Springfield, Ill.	3	1,730	3,760	5,620	8,570	11,200	14,300	23,100
			2,030	3,540	4,650	6,110	7,220	8,350	11,100
			1,740	3,740	5,530	8,290	10,700	13,500	21,200
05577700	Sangamon River Tributary at Andrew, Ill.	3	214	386	518	702	849	1,000	1,400
			226	447	622	869	1,070	1,280	1,800
			215	395	537	737	899	1,070	1,500

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05578500	Salt Creek near Rowell, Ill.	3	3,380	6,350	8,920	12,900	16,500	20,600	32,500
			4,230	7,250	9,430	12,300	14,400	16,600	21,800
			3,410	6,390	8,950	12,900	16,300	20,200	31,300
05579500	Lake Fork near Cornland, Ill.	3	2,140	4,070	5,840	8,720	11,400	14,600	24,700
			3,460	6,050	7,940	10,400	12,300	14,300	18,900
			2,190	4,170	5,970	8,870	11,500	14,600	24,000
05579750	Kickapoo Creek Tributary at Heyworth, Ill.	3	385	674	917	1,290	1,620	1,990	3,070
			283	541	740	1,010	1,230	1,460	2,020
			365	645	873	1,210	1,500	1,810	2,680
05580000	Kickapoo Creek at Waynesville, Ill.	3	4,350	8,000	11,200	16,200	20,700	26,000	41,700
			4,280	7,570	10,000	13,200	15,700	18,300	24,400
			4,350	7,970	11,100	15,900	20,200	25,000	39,100
05580500	Kickapoo Creek near Lincoln, Ill.	3	3,980	7,020	9,600	13,600	17,100	21,200	33,000
			5,030	8,840	11,600	15,300	18,200	21,100	28,000
			4,030	7,130	9,750	13,800	17,200	21,200	32,300
05580700	Salt Creek Tributary at Middletown, Ill.	3	95	307	551	1,000	1,460	2,020	3,820
			116	228	316	439	538	643	904
			98	288	479	789	1,070	1,390	2,310
05580950	Sugar Creek near Bloomington, Ill.	NA	2,580	3,910	4,850	6,090	7,050	8,040	10,500
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05581500	Sugar Creek near Hartsburg, Ill.	3	5,510	11,300	16,900	26,500	35,800	47,300	84,600
			5,610	9,880	13,000	17,200	20,400	23,700	31,600
			5,510	11,200	16,500	25,300	33,600	43,500	74,500
05582000	Salt Creek near Greenview, Ill.	3	12,500	20,800	27,000	35,600	42,500	49,700	68,200
			13,500	22,700	29,300	37,900	44,400	50,900	66,400
			12,600	20,900	27,100	35,700	42,500	49,700	67,800
05582200	Cabiness Creek Tributary near Petersburg, Ill.	3	124	312	501	824	1,130	1,500	2,640
			98	188	257	351	426	503	693
			120	286	437	674	882	1,120	1,790
05582500	Crane Creek near Easton, Ill.	3	217	400	538	728	877	1,030	1,410
			642	1,140	1,500	1,980	2,350	2,720	3,620
			237	442	605	834	1,020	1,200	1,660
05583000	Sangamon River near Oakford, Ill.	3	22,500	38,300	49,500	64,100	75,100	86,200	112,000
			23,500	38,400	48,800	62,100	72,100	82,100	105,000
			22,500	38,200	49,400	64,000	75,000	86,000	112,000
05584400	Drowning Fork at Bushnell, Ill.	4	576	1,170	1,670	2,420	3,070	3,780	5,720
			1,030	1,780	2,330	3,060	3,630	4,200	5,570
			601	1,210	1,730	2,500	3,140	3,840	5,700
05584450	Wigwam Hollow Creek near Macomb, Ill.	NA	208	343	439	566	664	763	1,000
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Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_{2}	Q_{5}	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05584500	La Moine River at Colmar, Ill.	4	8,490	15,700	21,300	28,900	35,000	41,300	57,000
			9,190	15,600	20,300	26,500	31,200	36,000	47,600
			8,510	15,700	21,200	28,700	34,600	40,800	56,000
05584950	West Creek at Mount Sterling, Ill.	4	231	369	468	600	702	807	1,060
			262	478	642	867	1,040	1,230	1,680
			236	391	508	670	798	931	1,260
05585000	La Moine River at Ripley, Ill.	4	9,530	15,400	19,600	25,100	29,400	33,700	44,200
			11,200	18,100	23,000	29,300	34,000	38,800	50,000
			9,570	15,500	19,700	25,300	29,600	34,000	44,600
05585220	Indian Creek Tributary near Sinclair, Ill.	5	387	722	978	1,330	1,610	1,890	2,600
			369	691	934	1,270	1,530	1,800	2,470
			384	717	970	1,320	1,590	1,870	2,570
05585500	Illinois River at Meredosia, Ill.	NA	62,200	85,700	100,000	117,000	129,000	140,000	164,000
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05585700	Dry Fork Tributary near Mount Sterling, Ill.	4	32	51	64	80	92	104	132
			46	87	119	163	197	234	323
			34	55	71	93	110	127	168
05586000	N Fk Mauvaise Terre Cr nr Jacksonville, Ill.	5	957	2,270	3,480	5,350	6,990	8,830	13,800
			1,220	2,170	2,860	3,770	4,480	5,200	6,940
			970	2,260	3,410	5,160	6,650	8,300	12,700
05586100	Illinois River at Valley City, Ill.	NA	78,500	91,200	98,500	107,000	112,000	118,000	129,000
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05586200	Illinois River Tributary at Florence, Ill.	4	320	561	728	937	1,090	1,230	1,560
			179	356	499	703	870	1,050	1,500
			297	524	681	883	1,040	1,190	1,550
05586350	Little Sandy Creek Tributary nr Murrayville, Ill.	5	402	791	1,100	1,520	1,860	2,220	3,090
			338	657	906	1,250	1,530	1,820	2,560
			385	750	1,030	1,420	1,720	2,050	2,850
05586500	Hurricane Creek near Roodhouse, Ill.	5	209	427	610	880	1,110	1,350	2,010
			263	498	677	921	1,120	1,320	1,820
			213	433	617	885	1,110	1,350	1,980
05586800	Otter Creek near Palmyra, Ill.	NA	2,480	5,580	8,360	12,700	16,500	20,800	32,800
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05586850	Bear Creek Tributary near Reeders, Ill.	NA	13	22	28	37	45	52	72
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05587000	Macoupin Creek near Kane, Ill.	5	9,920	17,500	23,000	30,100	35,400	40,700	52,800
			10,900	18,400	23,600	30,300	35,500	40,600	53,000
			10,000	17,600	23,000	30,100	35,400	40,700	53,000

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05587850	Cahokia Creek Tributary No 2 nr Carpenter, Ill.	NA	158	299	404	542	647	751	994
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05587900	Cahokia Creek at Edwardsville, Ill.	4	5,030	6,800	7,730	8,690	9,270	9,760	10,700
			4,660	7,700	9,870	12,700	14,900	17,100	22,300
			4,990	6,860	7,910	9,080	9,850	10,500	11,900
05588000	Indian Creek at Wanda, Ill.	4	1,870	3,280	4,340	5,810	6,980	8,210	11,300
			1,570	2,620	3,370	4,360	5,110	5,880	7,730
			1,860	3,240	4,280	5,700	6,830	8,000	10,900
05589500	Canteen Creek at Caseyville, Ill.	4	1,830	3,260	4,350	5,870	7,080	8,350	11,600
			1,210	2,100	2,750	3,620	4,300	4,990	6,680
			1,790	3,170	4,210	5,620	6,740	7,910	10,800
05589780	Little Canteen Creek Trib near Collinsville, Ill.	5	172	379	557	827	1,060	1,310	1,980
			298	582	804	1,110	1,360	1,630	2,290
			194	421	620	913	1,160	1,420	2,100
05590000	Kaskaskia Ditch at Bondville, Ill.	3	370	665	908	1,270	1,590	1,940	2,920
			683	1,280	1,740	2,370	2,870	3,390	4,660
			386	701	968	1,370	1,710	2,090	3,130
05590400	Kaskaskia River near Pesotum, Ill.	3	1,810	2,450	2,860	3,360	3,730	4,080	4,900
			1,570	2,700	3,500	4,540	5,330	6,120	8,000
			1,770	2,490	2,980	3,620	4,090	4,570	5,660
05590500	Kaskaskia River at Ficklin, Ill.	3	1,930	3,220	4,150	5,390	6,350	7,330	9,710
			1,610	2,730	3,530	4,560	5,330	6,110	7,940
			1,870	3,100	3,980	5,130	6,000	6,900	9,040
05590800	Lake Fork at Atwood, Ill.	3	2,230	3,010	3,470	3,980	4,330	4,650	5,320
			1,580	2,630	3,370	4,310	5,020	5,720	7,350
			2,170	2,970	3,450	4,020	4,420	4,810	5,630
05591200	Kaskaskia River at Cooks Mills, Ill.	3	5,350	7,600	8,970	10,600	11,700	12,700	14,900
			3,800	6,320	8,080	10,300	12,000	13,700	17,600
			5,210	7,470	8,870	10,500	11,700	12,900	15,300
05591500	Asa Creek at Sullivan, Ill.	3	333	655	915	1,290	1,590	1,920	2,750
			253	447	587	770	909	1,050	1,380
			326	631	869	1,200	1,470	1,750	2,450
05591550	Whitley Creek near Allenville, Ill.	NA	1,100	1,840	2,420	3,230	3,900	4,630	6,560
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05591700	West Okaw River near Lovington, Ill.	3	3,190	5,040	6,390	8,210	9,650	11,100	14,900
			2,060	3,590	4,710	6,180	7,300	8,440	11,200
			3,020	4,790	6,050	7,730	9,050	10,400	13,800
05591750	Stringtown Branch Tributary near Lake City, Ill.	3	51	86	111	143	167	191	248
			65	125	170	233	282	333	458
			53	92	121	161	191	223	297

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_{2}	Q_{5}	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05592000	Kaskaskia River at Shelbyville, Ill.	3	9,330	16,200	21,100	27,500	32,200	36,900	47,900
			6,560	10,800	13,700	17,400	20,200	23,000	29,400
			9,120	15,700	20,300	26,100	30,500	34,800	44,900
05592000	Kaskaskia River at Shelbyville, Ill.	NA	3,820	5,120	5,880	6,770	7,370	7,930	9,110
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05592025	Mud Creek Tributary near Tower Hill, Ill.	NA	112	223	320	471	604	757	1,190
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05592050	Robinson Creek near Shelbyville, Ill.	5	3,670	6,580	9,040	12,800	16,200	20,000	31,000
			3,150	5,590	7,350	9,710	11,500	13,400	17,900
			3,600	6,420	8,720	12,100	15,000	18,200	27,000
05592100	Kaskaskia River near Cowden, Ill.	NA	7,710	11,500	14,000	17,200	19,600	21,900	27,400
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05592300	Wolf Creek near Beecher City, Ill.	5	2,930	4,990	6,540	8,650	10,300	12,100	16,500
			2,070	3,680	4,850	6,400	7,590	8,820	11,800
			2,810	4,790	6,220	8,160	9,690	11,300	15,200
05592500	Kaskaskia River at Vandalia, Ill.	3	12,700	21,800	29,200	40,300	49,800	60,500	90,400
			12,400	20,700	26,500	34,000	39,600	45,200	58,400
			12,700	21,800	29,100	39,800	49,000	59,100	87,000
05592500	Kaskaskia River at Vandalia, Ill.	NA	15,700	23,300	28,100	33,900	38,100	42,000	50,600
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05592575	Hickory Creek nr Brownstown, Ill.	5	3,820	5,230	6,120	7,200	7,980	8,730	10,400
			2,340	4,240	5,640	7,530	9,000	10,500	14,200
			3,410	4,940	5,960	7,310	8,340	9,380	11,900
05592700	Hurricane Creek Tributary near Witt, Ill.	NA	71	98	115	135	149	163	193
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05592800	Hurricane Creek near Mulberry Grove, Ill.	5	8,120	12,200	14,800	17,900	20,100	22,200	26,700
			4,770	8,410	11,000	14,500	17,200	20,000	26,700
			7,720	11,700	14,200	17,300	19,600	21,800	26,800
05592900	East Fork Kaskaskia River near Sandoval, Ill.	5	4,050	7,370	9,970	13,600	16,600	19,800	27,900
			3,340	5,830	7,610	9,950	11,700	13,600	18,000
			3,950	7,100	9,480	12,700	15,300	18,000	24,900
05593000	Kaskaskia River at Carlyle, Ill.	5	13,700	24,600	33,200	45,300	55,200	65,700	93,000
			22,500	37,100	47,100	60,000	69,700	79,400	103,000
			14,000	25,200	34,000	46,400	56,300	66,900	93,800
05593000	Kaskaskia River at Carlyle, Ill.	NA	8,560	11,500	13,300	15,300	16,700	18,000	20,700
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Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05593520	Crooked Creek near Hoffman, Ill.	5	6,120	11,100	14,900	20,200	24,400	28,900	40,200
			5,160	8,800	11,400	14,700	17,300	19,800	26,000
			6,010	10,800	14,300	19,100	22,900	26,800	36,700
05593575	Little Crooked Creek near New Minden, Ill.	5	4,430	7,570	9,860	12,900	15,200	17,600	23,400
			2,810	4,930	6,450	8,460	10,000	11,600	15,400
			4,260	7,250	9,360	12,100	14,300	16,400	21,700
05593600	Blue Grass Creek near Raymond, Ill.	5	954	1,360	1,620	1,930	2,150	2,360	2,830
			834	1,460	1,910	2,500	2,950	3,410	4,500
			943	1,370	1,650	2,000	2,260	2,510	3,080
05593700	Blue Grass Creek Tributary near Raymond, Ill.	5	147	213	257	313	355	396	492
			110	210	287	393	476	563	777
			137	212	266	339	396	454	594
05593900	East Fork Shoal Creek near Coffeen, Ill.	5	2,250	3,420	4,220	5,240	6,010	6,780	8,590
			2,110	3,710	4,870	6,400	7,570	8,770	11,600
			2,240	3,440	4,280	5,380	6,210	7,050	9,040
05594000	Shoal Creek near Breese, Ill.	5	9,240	15,700	20,300	26,300	30,800	35,200	45,600
			11,100	18,700	24,100	31,100	36,400	41,800	54,600
			9,310	15,900	20,500	26,600	31,200	35,700	46,400
05594090	Sugar Creek at Albers, Ill.	5	3,730	6,540	8,530	11,100	13,000	14,900	19,200
			3,170	5,480	7,140	9,300	11,000	12,700	16,700
			3,600	6,250	8,090	10,500	12,200	14,000	18,200
05594100	Kaskaskia River near Venedy Station, Ill.	NA	22,600	37,000	46,900	59,400	68,600	77,700	98,500
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05594200	Williams Creek near Cordes, Ill.	5	338	598	801	1,090	1,330	1,580	2,240
			299	561	759	1,030	1,240	1,460	2,000
			331	590	791	1,070	1,300	1,540	2,160
05594330	Mud Creek near Marissa, Ill.	5	1,870	3,230	4,310	5,850	7,130	8,510	12,200
			2,280	3,980	5,200	6,810	8,050	9,310	12,300
			1,940	3,390	4,530	6,130	7,420	8,780	12,200
05594450	Silver Creek near Troy, Ill.	5	3,870	6,770	8,650	10,900	12,400	13,700	16,500
			4,040	7,050	9,220	12,100	14,300	16,500	22,000
			3,880	6,790	8,710	11,000	12,700	14,200	17,500
05594800	Silver Creek near Freeburg, Ill.	5	5,220	9,110	11,700	14,700	16,900	18,900	23,000
			7,170	12,200	15,700	20,200	23,700	27,200	35,600
			5,360	9,350	12,100	15,400	17,800	20,100	25,000
05595000	Kaskaskia River at New Athens, Ill.	5	22,700	41,100	55,200	74,700	90,200	106,000	147,000
			33,300	54,100	68,200	86,200	99,700	113,000	145,000
			23,100	41,700	55,900	75,500	91,000	107,000	147,000
05595200	Richland Creek near Hecker, Ill.	5	5,580	9,400	12,200	16,000	19,000	22,000	29,600
			3,750	6,630	8,720	11,500	13,700	15,900	21,300
			5,380	9,060	11,700	15,200	18,000	20,800	27,900

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_{2}	Q_{5}	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05595500	Marys River near Sparta, Ill.	4	1,450	2,890	4,150	6,130	7,890	9,910	15,700
			1,110	2,010	2,690	3,620	4,340	5,090	6,940
			1,410	2,750	3,880	5,560	6,990	8,590	13,000
05595510	Lick Branch near Eden, Ill.	4	160	322	468	700	911	1,160	1,890
			206	377	508	688	829	976	1,340
			167	332	476	696	885	1,100	1,680
05595550	Marys River Tributary at Chester, Ill.	4	265	383	463	566	643	720	904
			180	352	490	686	844	1,010	1,440
			246	376	470	598	701	807	1,070
05595730	Rayse Creek near Waltonville, Ill.	6	6,170	13,100	19,200	28,400	36,300	45,000	68,900
			3,620	6,110	7,950	10,400	12,400	14,400	19,400
			5,840	12,000	16,900	23,900	29,700	36,000	52,600
05595800	Sevenmile Creek near Mt. Vernon, Ill.	6	1,020	1,560	1,940	2,430	2,810	3,190	4,130
			1,740	3,070	4,080	5,490	6,610	7,780	10,700
			1,080	1,700	2,160	2,800	3,300	3,820	5,080
05595820	Casey Fork at Mount Vernon, Ill.	6	5,250	9,890	13,600	19,000	23,400	28,100	40,500
			2,910	4,860	6,300	8,240	9,760	11,300	15,200
			4,850	8,840	11,800	15,800	19,000	22,400	31,100
05596000	Big Muddy River near Benton, Ill.	6	7,450	14,200	19,800	28,400	35,900	44,300	67,900
			6,140	9,460	11,800	14,900	17,200	19,600	25,300
			7,370	13,800	19,000	26,600	33,100	40,300	59,900
05596100	Andy Creek Tributary at Valier, Ill.	6	248	454	615	842	1,030	1,220	1,730
			275	513	702	968	1,190	1,420	2,000
			252	464	631	870	1,060	1,270	1,800
05597000	Big Muddy River at Plumfield, Ill.	6	7,570	12,800	16,400	21,100	24,600	28,100	36,100
			10,200	16,000	20,100	25,500	29,700	33,900	44,000
			7,640	12,900	16,600	21,400	24,900	28,500	36,700
05597000	Big Muddy River at Plumfield, Ill.	NA	5,160	7,960	9,990	12,700	14,900	17,100	22,800
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05597450	Crab Orchard Creek Tributary near Pittsburg, Ill.	6	210	257	289	329	359	389	460
			162	297	403	552	674	802	1,130
			201	265	312	377	429	483	615
05597500	Crab Orchard Creek near Marion, Ill.	6	1,650	2,910	3,900	5,310	6,480	7,740	11,100
			1,710	2,910	3,810	5,020	5,980	6,970	9,420
			1,650	2,910	3,890	5,290	6,440	7,660	10,900
05599000	Beaucoup Creek near Matthews, Ill.	6	4,710	8,970	12,500	17,800	22,400	27,500	41,400
			4,960	7,880	9,940	12,700	14,700	16,800	21,900
			4,720	8,900	12,300	17,300	21,600	26,200	38,700
05599500	Big Muddy River at Murphysboro, Ill.	6	12,500	20,400	25,800	32,700	37,800	42,800	54,300
			15,700	23,800	29,400	36,600	42,100	47,600	60,700
			12,600	20,500	26,000	33,000	38,100	43,300	55,100

Station number (figs. 2A and 2B)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval						
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
05599500	Big Muddy River at Murphysboro, Ill.	NA	14,400	21,500	26,300	32,500	37,100	41,600	52,400
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05599560	Clay Lick Creek near Makanda, Ill.	6	731	1,300	1,780	2,500	3,140	3,860	5,910
			479	897	1,230	1,700	2,090	2,500	3,560
			685	1,220	1,650	2,280	2,820	3,420	5,090
05599580	Big Muddy River Tributary near Gorham, Ill.	4	38	65	86	117	143	171	247
			115	231	328	467	581	704	1,020
			47	85	121	175	221	273	408
05599640	Green Creek Tributary near Jonesboro, Ill.	7	259	416	529	680	797	917	1,210
			207	350	458	606	724	848	1,160
			254	409	520	669	784	904	1,200
05599800	Orchard Creek near Fayville, Ill.	7	60	99	130	176	214	256	371
			63	107	140	186	222	260	355
			60	100	132	178	216	257	366
05600000	Big Creek near Wetaug, Ill.	7	2,090	2,770	3,270	3,930	4,460	5,020	6,470
			2,680	4,160	5,220	6,620	7,710	8,820	11,500
			2,100	2,810	3,330	4,030	4,600	5,190	6,730

Table 2. Flood-peak discharges for recurrence intervals, *T*, of 0.8, 1.01, 1.5, 2, 3, and 5 years estimated from the partial duration series at streamflow-gaging stations in Illinois and adjacent States.

[***T***, recurrence interval in years, Q_T, instantaneous peak-flood discharge, in cubic feet per second, for a given ***T*** of 0.8-, 1.01-, 1.5-, 2-, 3-, and 5-year flood. Two estimates are listed for each station: the values in the top row are Q_T from at-site frequency curves; values in the bottom row are Q_T from regional regression equations]

Station number (fig. 3)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval					
			$Q_{0.8}$	$Q_{1.01}$	$Q_{1.5}$	Q_2	Q_3	Q_5
3336500	Bluegrass Creek at Potomac, Ill.	3	1,290	1,560	2,000	2,300	2,720	3,200
			683	879	1,190	1,400	1,700	2,060
3336645	Middle Fork Vermilion River above Oakwood, Ill.	3	4,900	5,610	6,780	7,600	8,720	10,100
			3,600	4,300	5,470	6,310	7,470	8,900
3336900	Salt Fork near St. Joseph, Ill.	3	1,810	2,100	2,590	2,950	3,450	4,090
			1,660	2,050	2,680	3,130	3,740	4,510
3337500	Saline Branch at Urbana, Ill.	3	864	1,010	1,260	1,440	1,700	2,030
			1,040	1,310	1,730	2,030	2,440	2,950
3338000	Salt Fork near Homer, Ill.	3	2,330	2,770	3,500	4,030	4,760	5,660
			3,080	3,710	4,750	5,500	6,530	7,800
3338500	Vermilion River near Catlin, Ill.	3	6,850	7,810	9,520	10,800	12,800	15,400
			6,080	7,100	8,880	10,200	12,000	14,000
3338780	North Fork Vermilion River near Bismarck, Ill.	3	4,910	6,170	8,240	9,720	11,700	14,200
			2,630	3,200	4,140	4,800	5,720	6,850
3343400	Embarras River near Camargo, Ill.	3	2,450	2,800	3,360	3,760	4,300	4,960
			2,080	2,550	3,320	3,860	4,610	5,540
3344000	Embarras River near Diona, Ill.	3	6,200	7,500	9,530	10,900	12,600	14,600
			5,970	6,990	8,760	10,000	11,800	14,000
3344500	Range Creek near Casey, Ill.	5	550	730	1,020	1,240	1,530	1,900
			386	506	695	829	1,010	1,240
3345500	Embarras River at Ste. Marie, Ill.	5	10,700	12,800	16,300	18,800	22,000	25,800
			12,800	14,600	17,800	20,000	23,000	26,900
3346000	North Fork Embarras River near Oblong, Ill.	5	5,750	6,900	8,830	10,200	12,100	14,500
			5,270	6,340	8,080	9,310	11,000	13,100
3378900	Little Wabash River at Louisvile, Ill.	5	8,270	9,880	12,300	13,900	15,900	18,100
			8,850	10,360	12,900	14,600	17,100	20,100
3379500	Little Wabash River below Clay City, Ill.	5	8,710	10,900	14,700	17,300	21,000	25,500
			11,000	12,700	15,600	17,600	20,400	23,800
3380350	Skillet Fork near Iuka, Ill.	6	3,610	4,290	5,480	6,360	7,640	9,300
			4,300	5,230	6,790	7,920	9,540	11,600
3380475	Horse Creek near Keenes, Ill.	6	3,150	3,570	4,330	4,910	5,780	6,950
			2,670	3,230	4,160	4,810	5,740	6,910
3380500	Skillet Fork at Wayne City, Ill.	6	5,410	6,820	9,330	11,200	14,100	17,900
			6,490	7,920	10,360	12,200	14,800	18,200

Station number (fig. 3)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval					
			$Q_{0.8}$	$Q_{1.01}$	$Q_{1.5}$	Q_{2}	Q_{3}	Q_{5}
3382100	South Fork Saline River nr Carrie Mills, Ill.	6	2,370	2,660	3,100	3,400	3,780	4,210
			2,840	3,290	4,070	4,620	5,400	6,350
3382170	Brushy Creek near Harco, Ill.	6	960	1,040	1,180	1,290	1,440	1,630
			726	841	1,020	1,140	1,300	1,490
3382510	Eagle Creek near Equality, Ill.	6	490	510	550	570	590	610
			698	834	1,040	1,180	1,370	1,590
3384450	Lusk Creek near Eddyville, Ill.	7	4,400	4,880	5,710	6,330	7,220	8,360
			2,290	2,810	3,670	4,280	5,140	6,220
3385000	Hayes Creek at Glendale, Ill.	7	1,450	1,720	2,190	2,540	3,060	3,720
			1,390	1,700	2,180	2,530	3,000	3,580
3385500	Lake Glendale Inlet near Dixon Springs, Ill.	7	242	341	501	611	758	930
			263	312	384	431	490	558
5414820	Sinsinawa River near Menominee, Ill.	1	1,480	2,170	3,350	4,230	5,480	7,090
			1,110	1,450	1,990	2,360	2,860	3,470
5419000	Apple River near Hanover, Ill.	1	4,050	4,710	5,750	6,470	7,400	8,470
			3,080	3,840	5,050	5,880	7,000	8,340
5420000	Plum River bl Carroll Creek nr Savanna, Ill.	1	2,430	3,000	3,950	4,620	5,530	6,640
			2,710	3,360	4,390	5,110	6,070	7,210
5435000	Cedar Creek near Winslow, Ill.	1	17	53	116	162	227	309
			102	144	207	250	310	385
5435500	Pecatonica River at Freeport, Ill.	1	3,550	4,370	5,730	6,700	8,040	9,680
			5,090	5,950	7,420	8,440	9,810	11,400
5438250	Coon Creek at Riley, Ill.	2	794	936	1,185	1,370	1,650	2,020
			625	760	974	1,130	1,340	1,610
5438500	Kishwaukee River at Belvidere, Ill.	2	3,140	3,660	4,530	5,130	5,960	6,950
			2,720	3,240	4,080	4,670	5,480	6,470
5439000	South Branch Kishwaukee River at Dekalb, Ill.	2	699	778	919	1,030	1,190	1,420
			795	950	1,200	1,380	1,630	1,940
5439500	South Branch Kishwaukee River nr Fairdale, Ill.	2	3,170	3,600	4,360	4,960	5,860	7,110
			3,260	3,770	4,620	5,230	6,070	7,110
5440000	Kishwaukee River near Perryville, Ill.	2	6,170	7,090	8,610	9,680	11,200	13,000
			5,720	6,680	8,250	9,350	10,900	12,700
5440500	Killbuck Creek near Monroe Center, Ill.	2	1,560	1,950	2,580	3,000	3,550	4,180
			1,190	1,400	1,740	1,990	2,340	2,770
5441000	Leaf River at Leaf River, Ill.	1	1,710	2,280	3,190	3,800	4,580	5,460
			1,890	2,420	3,250	3,820	4,600	5,530
5442000	Kyte River near Flagg Center, Ill.	2	1,010	1,110	1,280	1,400	1,570	1,780
			909	1,110	1,420	1,640	1,950	2,330

Station number (fig. 3)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval					
			$Q_{0.8}$	$Q_{1.01}$	$Q_{1.5}$	Q_2	Q_3	Q_5
5444000	Elkhorn Creek near Penrose, Ill.	1	2,380	2,720	3,260	3,620	4,100	4,650
			1,470	1,820	2,390	2,780	3,300	3,920
5445500	Rock Creek near Morrison, Ill.	1	1,450	1,680	2,080	2,360	2,750	3,240
			1,720	2,150	2,820	3,280	3,900	4,640
5447000	Green River at Amboy, Ill.	2	1,740	2,070	2,610	2,990	3,520	4,160
			1,360	1,630	2,050	2,360	2,780	3,300
5447500	Green River near Geneseo, Ill.	2	5,390	5,930	6,790	7,370	8,110	8,960
			6,040	6,830	8,210	9,200	10,600	12,300
5448000	Mill Creek at Milan, Ill.	4	2,280	2,700	3,400	3,900	4,610	5,480
			1,870	2,330	3,080	3,610	4,340	5,240
5466000	Edwards River near Orion, Ill.	4	2,890	3,120	3,500	3,780	4,170	4,680
			2,570	3,100	3,960	4,570	5,410	6,450
5466500	Edwards River near New Boston, Ill.	4	3,840	4,160	4,740	5,190	5,850	6,750
			3,580	4,140	5,080	5,750	6,710	7,930
5467000	Pope Creek near Keithsburg, Ill.		2,180	2,540	3,150	3,580	4,180	4,930
		4	1,970	2,320	2,880	3,280	3,850	4,570
5467500	Henderson Creek near Little York, Ill.		831	1,280	2,090	2,730	3,710	5,070
		4	2,370	2,850	3,620	4,170	4,940	5,910
5468000	North Henderson Creek near Seaton, Ill.		900	1,030	1,190	1,290	1,390	1,490
		4	1,260	1,530	1,950	2,250	2,670	3,200
5468500	Cedar Creek at Little York, Ill.		1,120	1,590	2,420	3,050	3,980	5,240
		4	2,090	2,510	3,190	3,670	4,330	5,170
5469000	Henderson Creek near Oquawka, Ill.		3,470	4,180	5,470	6,470	7,970	10,000
		4	5,320	6,350	8,020	9,220	10,900	13,000
5469500	South Henderson Creek at Biggsvile, Ill.		1,020	1,350	1,910	2,350	2,980	3,830
		4	1,640	1,980	2,550	2,950	3,510	4,220
5495500	Bear Creek near Marcelline, Ill.		8,230	9,430	11,500	12,900	15,000	17,600
		4	4,720	5,680	7,220	8,300	9,790	11,600
5502020	Hadley Creek near Barry, Ill.		2,710	3,300	4,230	4,840	5,630	6,510
		4	1,850	2,350	3,190	3,780	4,610	5,630
5502040	Hadley Creek at Kinderhook, Ill.	4	6,270	7,180	8,560	9,440	10,500	11,700
			2,380	2,980	3,960	4,660	5,650	6,880
5512500	Bay Creek at Pittsfield, Ill.	4	3,380	4,240	5,610	6,540	7,750	9,130
			1,380	1,730	2,290	2,690	3,250	3,930
5513000	Bay Creek at Nebo, Ill.	4	5,920	6,810	8,300	9,360	10,800	12,600
			2,660	3,210	4,120	4,770	5,680	6,810
5525000	Kankakee River at Shelby, Ind.	2	2,290	2,800	3,620	4,170	4,900	5,740
			3,390	3,960	4,900	5,560	6,470	7,590

Station number (fig. 3)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval					
			$Q_{0.8}$	$Q_{1.01}$	$Q_{1.5}$	Q_2	Q_3	Q_5
5525500	Sugar Creek at Milford, Ill.	3	5,100	6,070	7,680	8,830	10,400	12,300
			3,770	4,510	5,760	6,660	7,890	9,420
5526000	Iroquois River near Chebanse, Ill.	3	9,370	10,900	13,400	15,100	17,400	20,000
			10,300	11,800	14,500	16,400	19,200	22,600
5526500	Terry Creek near Custer Park, Ill.	2	58	97	167	222	305	421
			79	101	136	161	196	241
5527500	Kankakee River near Wilmington, Ill.	2	16,900	19,800	24,600	28,100	32,800	38,700
			18,400	20,700	24,700	27,500	31,400	36,000
5542000	Mazon River near Coal City, Ill.	2	7,130	8,120	9,750	10,880	12,400	14,200
			3,560	4,140	5,100	5,780	6,720	7,880
5547755	Squaw Creek at Round Lake, Ill.	2	149	167	194	213	237	265
			277	336	430	498	594	716
5551200	Ferson Creek near St. Charles, Ill.	2	747	855	1,033	1,159	1,330	1,540
			470	575	741	860	1,030	1,230
5551700	Blackberry Creek near Yorkvile, Ill.	2	418	522	712	861	1,090	1,400
			743	881	1,104	1,266	1,490	1,770
5554000	North Fork Vermilion River near Charlotte, Ill.	3	1,270	1,800	2,530	2,960	3,450	3,920
			2,110	2,580	3,360	3,910	4,670	5,610
5554500	Vermilion River at Pontiac, Ill.	3	5,540	6,010	6,780	7,310	8,010	8,850
			4,430	5,260	6,670	7,670	9,070	10,800
5555000	Vermilion River at Streator, Ill.	3	6,160	7,460	9,430	10,700	12,200	13,900
			6,700	7,800	9,750	11,100	13,100	15,500
5555300	Vermilion River near Leonore, Ill.	3	9,860	11,400	14,000	15,700	17,900	20,500
			7,370	8,550	10,700	12,200	14,300	16,900
5555500	Vermilion River at Lowell, Ill.	3	9,000	10,400	12,700	14,300	16,600	19,300
			7,470	8,660	10,800	12,300	14,400	17,100
5556500	Big Bureau Creek at Princeton, Ill.	3	3,190	3,690	4,540	5,150	6,010	7,080
			2,160	2,640	3,440	4,000	4,770	5,730
5557500	East Bureau Creek near Bureau, Ill.	3	1,590	1,950	2,560	3,000	3,610	4,360
			1,370	1,710	2,250	2,630	3,160	3,810
5558000	Big Bureau Creek at Bureau, Ill.	3	6,170	7,030	8,450	9,450	10,830	12,510
			3,920	4,680	5,950	6,860	8,120	9,670
5558500	Crow Creek (West) near Henry, Ill.	4	1,080	1,370	1,870	2,230	2,740	3,390
			1,930	2,430	3,240	3,810	4,600	5,560
5559500	Crow Creek near Washburn, Ill.	3	1,480	1,760	2,220	2,540	2,980	3,500
			1,490	1,860	2,440	2,850	3,410	4,110
5561000	Ackerman Creek at Farmdale, Ill.	3	400	519	734	901	1,152	1,500
			303	399	547	651	792	966

Station number (fig. 3)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval					
			$Q_{0.8}$	$Q_{1.01}$	$Q_{1.5}$	Q_{2}	Q_{3}	Q_{5}
5563000	Kickapoo Creek near Kickapoo, Ill.	4	2,670	4,340	7,070	8,980	11,600	14,600
			3,210	3,990	5,270	6,170	7,430	9,000
5563500	Kickapoo Creek at Peoria, Ill.	4	4,100	5,240	7,270	8,820	11,100	14,300
			4,490	5,410	6,920	7,990	9,480	11,300
5564400	Money Creek near Towanda, Ill.	3	798	893	1,050	1,170	1,330	1,540
			839	1,070	1,430	1,690	2,040	2,470
5564500	Money Creek above Lake Bloomington, Ill.	3	750	864	1,070	1,220	1,440	1,730
			883	1,120	1,500	1,770	2,140	2,590
5565000	Hickory Creek above Lake Bloomington, Ill.	3	471	558	698	796	928	1,090
			296	394	545	651	797	977
5566500	East Branch Panther Creek at El Paso, Ill.	3	373	490	700	860	1,110	1,450
			620	798	1,080	1,270	1,540	1,880
5567500	Mackinaw River near Congervile, Ill.	3	7,060	8,280	10,400	12,100	14,500	17,700
			5,250	6,170	7,750	8,900	10,500	12,400
5568000	Mackinaw River near Green Valley, Ill.	3	5,950	7,310	9,700	11,500	14,200	17,700
			6,570	7,650	9,540	10,900	12,800	15,100
5568800	Indian Creek near Wyoming, Ill.	4	1,270	1,460	1,790	2,030	2,390	2,860
			1,500	1,830	2,380	2,760	3,300	3,960
5569500	Spoon River at London Mills, Ill.	4	7,480	8,590	10,500	12,000	14,100	16,900
			7,130	8,240	10,100	11,400	13,200	15,500
5570000	Spoon River at Seville, Ill.	4	10,300	11,700	14,100	15,800	18,100	21,000
			8,640	9,870	11,900	13,400	15,500	18,100
5570370	Big Creek near Bryant, Ill.	4	676	751	860	926	1,000	1,080
			1,200	1,480	1,940	2,270	2,720	3,290
5570910	Sangamon River at Fisher, Ill.	3	2,690	3,150	3,930	4,520	5,360	6,460
			2,460	2,990	3,860	4,480	5,330	6,380
5571000	Sangamon River at Mahomet, Ill.	3	3,130	3,750	4,780	5,530	6,560	7,840
			3,240	3,890	4,990	5,760	6,840	8,160
5572000	Sangamon River at Monticello, Ill.	3	4,060	4,730	5,870	6,700	7,860	9,330
			4,260	5,070	6,420	7,390	8,740	10,400
5572450	Friends Creek at Argenta, Ill.	3	1,060	1,350	1,820	2,170	2,660	3,270
			1,510	1,880	2,470	2,890	3,470	4,180
5572500	Sangamon River near Oakley, Ill.	3	3,690	4,580	6,060	7,100	8,540	10,300
			5,380	6,330	7,970	9,150	10,800	12,800
5574000	South Fork Sangamon River near Nokomis, Ill.	3	620	860	1,280	1,600	2,080	2,730
			313	415	574	685	837	1,030
5574500	Flat Branch near Taylorville, Ill.	3	2,690	3,310	4,330	5,070	6,070	7,300
			2,720	3,290	4,240	4,920	5,850	7,000

Station number (fig. 3)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval					
			$Q_{0.8}$	$Q_{1.01}$	$Q_{1.5}$	Q_{2}	Q_{3}	Q_{5}
5575800	Horse Creek at Pawnee, Ill.	3	1,650	1,910	2,290	2,510	2,760	3,000
			900	1,140	1,530	1,800	2,170	2,630
5576500	Sangamon River at Riverton, Ill.	3	9,490	11,300	14,600	17,000	20,400	24,900
			11,500	13,000	15,800	17,800	20,700	24,200
5577500	Spring Creek at Springfield, Ill.	3	1,000	1,460	2,230	2,800	3,600	4,600
			1,400	1,750	2,300	2,690	3,230	3,890
5578500	Salt Creek near Rowell, Ill.	3	2,320	3,000	4,210	5,130	6,470	8,250
			2,570	3,020	3,770	4,300	5,030	5,900
5579500	Lake Fork near Cornland, Ill.	3	1,160	1,610	2,440	3,090	4,090	5,500
			2,300	2,810	3,650	4,250	5,070	6,080
5580000	Kickapoo Creek at Waynesville, Ill.	3	3,060	3,830	5,180	6,200	7,670	9,610
			2,350	2,860	3,690	4,280	5,100	6,100
5580500	Kickapoo Creek near Lincoln, Ill.	3	2,070	2,880	4,300	5,370	6,940	9,000
			2,880	3,470	4,460	5,150	6,120	7,310
5581500	Sugar Creek near Hartsburg, Ill.	3	1,850	3,190	5,540	7,310	9,920	13,400
			3,050	3,680	4,710	5,450	6,480	7,740
5582000	Salt Creek near Greenview, Ill.	3	10,490	12,000	14,550	16,400	19,010	22,290
			9,120	10,430	12,830	14,570	17,000	20,000
5582500	Crane Creek near Easton, Ill.	3	167	213	281	324	377	431
			584	760	1,030	1,210	1,470	1,790
5583000	Sangamon River near Oakford, Ill.	3	13,900	16,700	21,500	25,200	30,600	37,800
			18,200	20,200	24,200	27,200	31,500	36,700
5584400	Drowning Fork at Bushnell, Ill.	4	401	496	664	792	982	1,240
			890	1,110	1,470	1,710	2,040	2,440
5584500	La Moine River at Colmar, Ill.	4	7,330	8,530	10,600	12,100	14,300	17,100
			7,120	8,470	10,700	12,200	14,400	17,100
5585000	La Moine River at Ripley, Ill.	4	7,510	8,840	11,000	12,600	14,700	17,200
			7,750	8,940	10,900	12,200	14,200	16,500
5586000	N Fk Mauvaise Terre Cr nr Jacksonvile, Ill.	5	287	547	1,000	1,340	1,840	2,480
			1,000	1,270	1,690	1,990	2,390	2,890
5586500	Hurricane Creek near Roodhouse, Ill.	5	110	151	224	281	365	480
			208	283	404	491	612	765
5587000	Macoupin Creek near Kane, Ill.	5	8,700	9,920	12,000	13,600	15,800	18,800
			9,340	10,900	13,400	15,200	17,700	20,700
5587900	Cahokia Creek at Edwardsville, Ill.	4	4,650	4,950	5,430	5,750	6,150	6,600
			3,010	3,590	4,550	5,230	6,200	7,410
5588000	Indian Creek at Wanda, Ill.	4	1,330	1,570	2,010	2,340	2,830	3,480
			1,020	1,250	1,630	1,900	2,280	2,750

Station number (fig. 3)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval					
			$Q_{0.8}$	$Q_{1.01}$	$Q_{1.5}$	Q_{2}	Q_{3}	Q_{5}
5589500	Canteen Creek at Caseyville, Ill.	4	1,200	1,490	2,020	2,430	3,030	3,840
			921	1,160	1,550	1,820	2,200	2,670
5590000	Kaskaskia Ditch at Bondville, Ill.	3	287	354	468	550	664	805
			334	440	604	719	876	1,070
5590400	Kaskaskia River near Pesotum, Ill.	3	1,440	1,620	1,900	2,100	2,340	2,630
			1,440	1,790	2,350	2,740	3,290	3,950
5590500	Kaskaskia River at Ficklin, Ill.	3	1,240	1,550	2,040	2,370	2,830	3,360
			1,590	1,960	2,570	3,000	3,580	4,310
5590800	Lake Fork at Atwood, Ill.	3	1,800	1,980	2,270	2,480	2,740	3,060
			1,830	2,260	2,950	3,440	4,120	4,960
5591200	Kaskaskia River at Cooks Mills, Ill.	3	3,930	4,560	5,530	6,150	6,940	7,790
			3,860	4,610	5,860	6,760	8,000	9,530
5591500	Asa Creek at Sullivan, Ill.	3	195	260	371	451	563	703
			252	337	469	562	689	846
5591700	West Okaw River near Lovington, Ill.	3	2,050	2,420	3,070	3,560	4,270	5,200
			1,500	1,860	2,450	2,870	3,440	4,150
5592050	Robinson Creek near Shelbyville, Ill.	5	2,630	3,130	3,970	4,590	5,480	6,600
			2,660	3,320	4,370	5,120	6,160	7,460
5592300	Wolf Creek near Beecher City, Ill.	5	2,230	2,790	3,660	4,230	4,950	5,750
			1,500	1,890	2,500	2,940	3,540	4,290
5592575	Hickory Creek nr Brownstown, Ill.	5	2,430	2,920	3,660	4,130	4,710	5,310
			1,670	2,120	2,860	3,380	4,110	5,020
5592800	Hurricane Creek near Mulberry Grove, Ill.	5	6,000	7,370	9,410	10,700	12,300	13,900
			3,600	4,420	5,780	6,730	8,070	9,720
5592900	East Fork Kaskaskia River near Sandoval, Ill.	5	2,740	3,370	4,460	5,270	6,430	7,950
			2,470	3,030	3,920	4,540	5,400	6,460
5593520	Crooked Creek near Hoffman, Ill.	5	4,150	5,060	6,650	7,830	9,560	11,830
			3,750	4,440	5,560	6,340	7,400	8,700
5593575	Little Crooked Creek near New Minden, Ill.	5	2,520	3,260	4,480	5,330	6,480	7,860
			2,010	2,480	3,220	3,750	4,460	5,350
5593600	Blue Grass Creek near Raymond, Ill.	5	820	900	1,040	1,140	1,280	1,450
			590	750	990	1,160	1,380	1,660
5593900	East Fork Shoal Creek near Coffeen, Ill.	5	1,900	2,130	2,520	2,810	3,200	3,690
			1,540	1,920	2,520	2,940	3,530	4,240
5594000	Shoal Creek near Breese, Ill.	5	7,090	8,070	9,820	11,200	13,200	16,000
			8,300	9,630	11,800	13,400	15,600	18,200
5594090	Sugar Creek at Albers, Ill.	5	2,640	3,060	3,790	4,330	5,110	6,110
			2,530	3,080	3,960	4,580	5,430	6,480

Station number (fig. 3)	Station Name	Hydrologic Region	Flood Quantiles of Selected Recurrence Interval					
			$Q_{0.8}$	$Q_{1.01}$	$Q_{1.5}$	Q_2	Q_3	Q_5
5594330	Mud Creek near Marissa, Ill.	5	1,750	2,030	2,480	2,810	3,270	3,830
			1,710	2,100	2,710	3,140	3,740	4,460
5594450	Silver Creek near Troy, Ill.	5	2,970	3,410	4,150	4,680	5,420	6,320
			3,330	4,070	5,280	6,130	7,300	8,750
5594800	Silver Creek near Freeburg, Ill.	5	4,320	4,850	5,750	6,410	7,340	8,510
			5,990	7,040	8,760	9,970	11,600	13,700
5595200	Richland Creek near Hecker, Ill.	5	4,060	4,690	5,810	6,660	7,910	9,590
			3,010	3,660	4,730	5,490	6,530	7,820
5595500	Marys River near Sparta, Ill.	4	1,020	1,380	1,990	2,430	3,050	3,840
			1,010	1,300	1,770	2,100	2,560	3,110
5595730	Rayse Creek near Waltonville, Ill.	6	3,770	5,330	7,830	9,550	11,800	14,500
			2,750	3,330	4,300	4,990	5,960	7,190
5595800	Sevenmile Creek near Mt. Vernon, Ill.	6	753	893	1,120	1,280	1,490	1,740
			1,240	1,490	1,890	2,170	2,550	3,010
5595820	Casey Fork at Mount Vernon, Ill.	6	2,930	3,820	5,320	6,400	7,930	9,830
			2,210	2,630	3,330	3,820	4,500	5,350
5597500	Crab Orchard Creek near Marion, Ill.	6	1,120	1,390	1,880	2,250	2,790	3,510
			1,240	1,460	1,810	2,050	2,390	2,790
5599000	Beaucoup Creek near Matthews, Ill.	6	3,100	4,020	5,560	6,670	8,200	10,100
			4,010	4,750	5,990	6,900	8,180	9,790
5600000	Big Creek near Wetaug, Ill.	7	1,810	1,930	2,140	2,310	2,550	2,890
			1,650	2,000	2,560	2,950	3,490	4,160

Table 6. Selected basin characteristics and equivalent years of record for the 288 streamflow-gaging stations in Illinois and adjacent States.

[***TDA***, basin drainage area in square miles, *mi*^{2}; ***MCS***, main-channel slope in feet per mile, *ft/mi*; ***BL***, basin length in miles, *mi*; ***BW***, basin width in miles, *mi*; ***PermAvg***, averaged permeability in inches per hour, *in/hr*; ***(%Water +5)*** percentage of open water and herbaceous wetland plus a constant 5, in percent; equivalent years of record for various Q_T (flood quantiles of specific recurrence intervals), in years]

Station number (figs. 2A and 2B)	TDA (*mi*^{2})	MCS (*ft/mi*)	BL (*mi*)	BW (*mi*)	PermAvg (*in/hr*)	(%water + 5) (*percent*)	Hydrologic Region (fig. 7)	Equivalent years of record (years)						
								Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
3336100	1.03	15.66	1.91	0.54	0.452	5.00	3	3.8	4.6	5.6	6.7	7.4	8.0	8.9
3336500	35.0	6.97	8.03	4.36	.514	5.02	3	3.3	4.0	4.9	5.9	6.5	7.0	7.8
3336645	432	2.75	52.77	8.18	.679	5.35	3	2.8	3.4	4.1	5.0	5.5	6.0	6.6
3336900	133	5.19	20.25	6.55	1.242	5.15	3	3.0	3.6	4.4	5.3	5.9	6.3	7.0
3337500	67.5	2.14	13.44	5.02	1.368	5.28	3	2.6	3.2	3.9	4.7	5.2	5.6	6.2
3338000	337	2.93	30.83	10.94	1.232	5.23	3	2.7	3.3	4.0	4.9	5.4	5.8	6.4
3338100	2.22	14.87	3.12	.71	1.140	5.00	3	3.5	4.3	5.2	6.3	7.0	7.5	8.3
3338500	957	2.98	55.05	17.38	.980	5.46	3	2.7	3.3	4.0	4.9	5.4	5.8	6.4
3338780	262	3.84	26.29	9.97	1.126	5.08	3	2.9	3.4	4.2	5.1	5.6	6.1	6.7
3338800	1.32	32.12	1.65	.80	.610	5.00	3	4.1	4.9	6.0	7.2	8.0	8.6	9.5
3339000	1,289	3.15	58.18	22.15	1.000	5.53	3	2.7	3.3	4.0	4.9	5.4	5.8	6.4
3341700	1.03	39.18	1.61	.64	1.083	5.00	3	4.0	4.8	5.9	7.1	7.9	8.5	9.4
3341900	.04	27.21	.32	.11	1.279	5.00	5	3.6	4.3	5.3	6.4	7.1	7.6	8.4
3343400	186	3.01	22.85	8.12	1.363	5.11	3	2.8	3.3	4.0	4.9	5.4	5.8	6.4
3344000	916	1.66	60.55	15.13	1.267	5.34	3	2.5	3.0	3.7	4.5	4.9	5.3	5.9
3344425	0.11	82.43	0.51	0.22	0.760	5.00	5	4.4	5.3	6.5	7.9	8.7	9.4	10.3
3344500	7.13	8.71	4.18	1.71	.398	5.02	5	3.4	4.1	5.0	6.1	6.7	7.2	8.0
3345500	1,510	1.67	92.71	16.29	1.061	5.37	5	2.4	2.9	3.6	4.3	4.8	5.1	5.7
3346000	318	3.73	38.63	8.23	.716	5.14	5	2.8	3.4	4.2	5.0	5.6	6.0	6.6
3378000	228	1.98	28.50	8.01	.699	5.27	5	2.6	3.2	3.9	4.7	5.2	5.6	6.2
3378635	240	5.87	27.72	8.66	0.800	6.43	5	3.0	3.6	4.4	5.3	5.8	6.3	7.0
3378650	1.20	12.04	2.08	.58	.549	5.03	5	3.5	4.2	5.2	6.3	6.9	7.4	8.2
3378900	746	2.83	52.89	14.10	.662	5.64	5	2.7	3.3	4.0	4.8	5.3	5.7	6.3
3378980	.35	54.11	1.17	.30	.647	5.98	5	4.3	5.1	6.2	7.5	8.3	9.0	9.9
3379500	1,131	2.23	64.26	17.60	.638	5.81	5	2.6	3.2	3.8	4.7	5.2	5.5	6.1
3379650	1.63	26.03	1.46	1.12	0.517	5.11	5	3.9	4.7	5.7	7.0	7.7	8.3	9.1
3380350	209	3.61	20.43	10.23	.598	5.67	6	2.1	2.5	3.1	3.8	4.2	4.5	5.0
3380400	1.14	30.92	1.35	.84	.619	5.21	6	2.9	3.5	4.3	5.2	5.8	6.2	6.9
3380450	.44	50.74	1.04	.42	1.001	5.40	6	3.1	3.7	4.5	5.5	6.1	6.6	7.3
3380475	97.1	4.88	17.49	5.55	.912	5.34	6	2.2	2.7	3.3	4.0	4.5	4.8	5.3
3380500	463	1.95	35.08	13.20	0.698	5.54	6	1.9	2.4	2.9	3.5	3.9	4.2	4.6
3381500	3,102	1.17	109.43	28.35	.696	5.71	5	2.4	2.8	3.5	4.2	4.7	5.0	5.5
3381600	.17	61.51	.40	.44	1.279	6.21	5	4.1	4.9	6.0	7.3	8.0	8.6	9.5
3382025	.51	64.30	1.00	.51	1.405	5.48	6	3.1	3.8	4.6	5.6	6.2	6.7	7.4
3382100	147	4.99	22.32	6.57	.936	10.71	6	1.8	2.1	2.6	3.2	3.5	3.8	4.2

Station number (figs. 2A and 2B)	TDA (*mi^2*)	MCS (*ft/mi*)	BL (*mi*)	BW (*mi*)	PermAvg (*in/hr*)	(%water + 5) (*percent*)	Hydrologic Region (fig. 7)	Equivalent years of record (years)						
								Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
3382170	13.3	16.52	7.42	1.79	0.860	8.26	6	2.3	2.8	3.4	4.1	4.6	4.9	5.5
3382510	8.51	25.05	4.51	1.89	1.331	5.51	6	2.7	3.3	4.0	4.9	5.4	5.8	6.5
3384450	42.8	17.45	8.92	4.80	1.001	5.16	7	1.8	2.1	2.6	3.1	3.5	3.7	4.1
3385000	19.1	25.97	8.07	2.37	1.001	5.18	7	1.8	2.2	2.7	3.3	3.6	3.9	4.3
3385500	1.08	164.76	1.22	.88	1.001	6.07	7	2.2	2.6	3.2	3.9	4.3	4.6	5.1
3612000	244	2.99	27.12	8.99	1.242	7.06	7	1.3	1.5	1.9	2.3	2.5	2.7	3.0
3614000	1.71	23.32	2.99	.57	1.404	5.69	7	1.9	2.2	2.7	3.3	3.7	3.9	4.4
4087300	1.51	30.41	2.32	.65	1.561	5.00	2	2.4	3.0	3.6	4.4	4.9	5.3	5.9
4087400	5.08	19.52	3.90	1.30	2.864	5.12	2	2.3	2.8	3.4	4.1	4.6	5.0	5.5
5414820	40.3	19.53	9.86	4.09	1.304	5.08	1	2.9	3.4	4.2	5.0	5.6	6.0	6.6
5415000	125	11.31	20.19	6.19	1.302	5.11	1	2.6	3.2	3.8	4.7	5.1	5.5	6.1
5415500	19.8	33.65	7.05	2.82	1.306	5.04	1	3.1	3.7	4.5	5.4	5.9	6.4	7.1
5418750	1.94	36.50	2.43	.80	1.280	5.00	1	3.2	3.8	4.7	5.6	6.2	6.7	7.4
5418800	.86	106.05	1.24	.69	1.123	5.00	1	3.6	4.4	5.3	6.4	7.1	7.6	8.4
5419000	246	8.76	24.39	10.09	1.295	5.34	1	2.5	3.0	3.7	4.5	4.9	5.3	5.9
5420000	230	7.51	21.85	10.53	1.285	5.47	1	2.5	3.0	3.6	4.4	4.9	5.2	5.8
5430500	3,343	1.02	86.69	38.57	3.677	10.69	2	1.2	1.4	1.7	2.1	2.4	2.5	2.8
5431486	196	2.89	15.19	12.90	2.804	7.22	1	2.1	2.5	3.0	3.7	4.1	4.4	4.8
5434500	1,034	2.11	46.25	22.36	1.288	5.23	1	2.1	2.5	3.1	3.7	4.1	4.4	4.8
5435000	1.30	35.51	1.92	.68	1.162	5.00	1	3.2	3.8	4.7	5.7	6.3	6.7	7.4
5435500	1,327	1.40	64.69	20.51	1.307	5.27	1	2.0	2.4	2.9	3.5	3.8	4.1	4.6
5435650	1.94	30.69	2.04	.95	1.307	5.00	1	3.1	3.7	4.6	5.5	6.1	6.5	7.2
5436500	521	3.59	36.02	14.46	3.051	5.26	1	2.1	2.5	3.1	3.7	4.1	4.4	4.9
5436900	.52	92.48	1.05	.50	1.267	5.00	1	3.6	4.3	5.2	6.3	7.0	7.5	8.3
5437000	2,548	.81	78.96	32.27	1.816	5.35	1	1.8	2.1	2.6	3.1	3.4	3.7	4.1
5437500	6,360	0.95	104.04	61.13	2.889	8.25	1	1.7	2.1	2.5	3.0	3.4	3.6	4.0
5437600	2.20	40.64	2.44	.90	1.555	5.00	1	3.2	3.8	4.6	5.6	6.2	6.7	7.4
5437950	14.4	8.98	6.44	2.24	3.602	7.12	2	1.9	2.3	2.8	3.4	3.8	4.1	4.6
5438250	84.9	8.74	13.95	6.08	2.585	5.22	2	2.0	2.4	3.0	3.6	4.0	4.3	4.8
5438300	.81	94.58	1.91	.43	1.069	5.90	2	2.6	3.1	3.8	4.7	5.2	5.6	6.2
5438390	88.4	8.49	12.96	6.82	2.626	5.53	2	1.9	2.4	2.9	3.5	3.9	4.3	4.7
5438500	542	5.18	22.15	24.46	2.976	5.85	2	1.8	2.1	2.6	3.2	3.5	3.8	4.2
5438850	1.68	24.34	2.01	.84	1.161	5.00	2	2.4	2.9	3.5	4.3	4.8	5.2	5.8
5439000	77.7	3.55	14.33	5.42	1.408	5.13	2	1.8	2.2	2.7	3.3	3.7	4.0	4.4
5439500	387	2.47	30.25	12.79	1.408	5.25	2	1.7	2.1	2.5	3.1	3.4	3.7	4.1
5439550	1.70	59.25	1.96	0.87	4.894	5.04	2	2.6	3.1	3.8	4.7	5.2	5.6	6.2
5440000	1,103	4.40	31.21	35.35	2.355	5.60	2	1.7	2.1	2.6	3.1	3.5	3.7	4.1
5440500	116	7.52	19.77	5.89	1.366	5.09	2	2.0	2.4	2.9	3.6	4.0	4.3	4.7
5440650	.98	28.81	2.17	.45	1.373	5.04	2	2.4	3.0	3.6	4.4	4.9	5.3	5.9
5440900	.20	85.77	.87	.23	1.305	5.00	1	3.6	4.3	5.2	6.3	7.0	7.5	8.3

Station number (figs. 2A and 2B)	TDA (*mi²*)	MCS (*ft/mi*)	BL (*mi*)	BW (*mi*)	PermAvg (*in/hr*)	(%water + 5) (*percent*)	Hydrologic Region (fig. 7)	Equivalent years of record (years)						
								Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
5441000	103	12.62	17.42	5.94	1.602	5.09	1	2.6	3.2	3.9	4.7	5.2	5.5	6.1
5441500	8,201	1.02	133.13	61.60	2.768	7.68	1	1.7	2.1	2.5	3.1	3.4	3.6	4.0
5442000	118	4.49	10.08	11.75	1.771	5.41	2	1.8	2.2	2.7	3.3	3.7	4.0	4.4
5443500	8,754	1.02	167.54	52.25	2.775	7.61	1	1.7	2.1	2.5	3.1	3.4	3.6	4.0
5444000	145	3.85	16.94	8.57	1.308	5.03	1	2.3	2.8	3.4	4.1	4.5	4.9	5.4
5444100	1.49	62.11	1.33	1.12	1.307	5.05	1	3.4	4.1	4.9	6.0	6.6	7.1	7.8
5445500	158	4.90	22.29	7.08	1.764	5.11	1	2.3	2.8	3.4	4.1	4.6	4.9	5.4
5446000	165	4.39	24.94	6.60	1.755	5.11	1	2.3	2.8	3.4	4.1	4.5	4.8	5.3
5446500	9,554	1.12	189.80	50.34	2.756	7.46	1	1.8	2.1	2.6	3.1	3.4	3.7	4.1
5446950	.66	54.09	.98	.67	2.856	5.00	2	2.6	3.2	3.9	4.7	5.2	5.7	6.3
5447000	198	2.69	18.20	10.88	2.293	5.28	2	1.7	2.1	2.6	3.1	3.5	3.8	4.2
5447050	5.12	23.24	3.65	1.40	5.904	5.71	2	2.2	2.7	3.3	4.1	4.5	4.9	5.4
5447350	1.16	29.08	1.75	.67	1.309	5.00	4	3.1	3.7	4.5	5.5	6.2	6.7	7.5
5447500	999	2.67	82.34	12.13	2.789	5.47	2	1.7	2.0	2.5	3.0	3.3	3.6	4.0
5448000	62.4	9.86	13.17	4.74	1.320	5.24	4	2.5	3.1	3.8	4.6	5.1	5.6	6.2
5448050	0.22	45.84	0.72	0.30	1.308	5.00	4	3.3	4.0	4.9	6.0	6.7	7.2	8.1
5466000	155	4.97	22.36	6.94	1.265	5.06	4	2.3	2.7	3.4	4.1	4.6	4.9	5.5
5466500	445	2.99	56.08	7.93	1.385	5.33	4	1.8	2.2	2.7	3.3	3.6	3.9	4.4
5467000	174	3.90	40.45	4.30	1.313	5.25	4	1.8	2.1	2.6	3.2	3.6	3.9	4.3
5467500	151	5.49	27.22	5.54	1.116	5.24	4	2.1	2.5	3.1	3.8	4.3	4.6	5.2
5468000	65.7	5.92	22.22	2.96	1.193	5.13	4	2.0	2.4	2.9	3.6	4.0	4.3	4.8
5468500	132	4.76	24.60	5.37	1.221	5.24	4	2.1	2.5	3.1	3.8	4.3	4.6	5.2
5469000	435	4.73	33.35	13.03	1.204	5.23	4	2.3	2.8	3.4	4.2	4.6	5.0	5.6
5469500	81.4	7.28	23.04	3.54	1.306	5.19	4	2.1	2.5	3.1	3.8	4.2	4.6	5.1
5469750	.38	37.11	1.14	.33	1.305	5.00	4	3.0	3.6	4.5	5.5	6.1	6.6	7.4
5495200	1.44	22.80	1.72	0.84	0.867	5.10	4	3.1	3.7	4.6	5.6	6.3	6.8	7.6
5495500	349	3.63	22.62	15.43	.873	5.27	4	2.5	3.0	3.6	4.5	5.0	5.4	6.0
5496900	.55	72.13	.99	.56	1.302	5.13	4	3.6	4.4	5.4	6.6	7.3	7.9	8.9
5501500	.38	61.84	1.24	.31	1.005	5.00	4	3.1	3.8	4.6	5.6	6.3	6.8	7.6
5502020	40.8	18.29	9.82	4.15	1.149	5.26	4	2.8	3.4	4.2	5.1	5.7	6.1	6.9
5502040	72.5	14.98	14.87	4.88	1.179	5.42	4	2.6	3.1	3.9	4.7	5.3	5.7	6.3
5502120	1.21	107.69	1.54	.78	1.092	5.17	4	3.7	4.4	5.4	6.6	7.4	8.0	8.9
5512500	39.5	10.77	11.24	3.52	1.192	5.24	4	2.5	3.0	3.7	4.6	5.1	5.5	6.2
5513000	148	6.83	24.76	5.98	1.234	5.17	4	2.2	2.7	3.3	4.1	4.5	4.9	5.5
5513200	1.23	153.11	1.72	.72	1.300	5.06	4	3.6	4.4	5.4	6.6	7.3	7.9	8.8
5518000	1,777	0.95	68.11	26.10	6.632	6.79	2	1.4	3.2	3.9	4.7	5.3	5.7	6.3
5519500	55.0	2.19	18.36	3.00	.760	5.93	2	1.7	2.0	2.5	3.0	3.4	3.6	4.0
5520000	218	4.11	26.57	8.20	3.066	6.89	2	1.7	2.0	2.5	3.1	3.4	3.7	4.1
5520500	2,301	.84	85.62	26.87	6.436	6.72	2	1.4	1.7	2.0	2.5	2.8	3.0	3.3
5524500	449	2.14	27.06	16.59	5.014	5.74	2	1.6	2.0	2.4	3.0	3.3	3.6	4.0

Station number (figs. 2A and 2B)	TDA (*mi*²)	MCS (*ft/mi*)	BL (*mi*)	BW (*mi*)	PermAvg (*in/hr*)	(%water + 5) (*percent*)	Hydrologic Region (fig. 7)	Equivalent years of record (years)						
								Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
5525000	687	1.74	43.97	15.63	3.758	5.61	2	1.6	1.9	2.4	2.9	3.2	3.5	3.9
5525050	10.2	6.41	4.43	2.31	2.294	5.01	3	3.0	3.6	4.3	5.2	5.8	6.2	6.9
5525500	447	5.12	25.73	17.39	1.331	5.09	3	2.9	3.5	4.2	5.1	5.7	6.1	6.8
5526000	2,089	.95	48.27	43.28	3.194	5.45	3	2.1	2.5	3.1	3.8	4.2	4.5	4.9
5526150	.18	39.77	.66	.27	.708	5.00	2	2.6	3.1	3.8	4.6	5.2	5.6	6.2
5526500	12.1	10.20	6.98	1.73	5.855	5.14	2	2.1	2.6	3.1	3.8	4.2	4.6	5.1
5527050	.81	28.16	1.79	.45	.311	5.00	2	2.4	3.0	3.6	4.4	4.9	5.3	5.9
5527500	5,149	1.22	123.47	41.71	4.570	6.08	2	1.4	1.7	2.1	2.6	2.9	3.1	3.5
5527800	123	2.42	16.24	7.55	.718	6.80	2	1.6	2.0	2.4	2.9	3.3	3.5	3.9
5527840	145	2.18	20.35	7.11	.726	6.74	2	1.6	1.9	2.4	2.9	3.2	3.5	3.9
5527900	21.3	5.37	6.66	3.20	0.766	10.15	2	1.6	1.9	2.3	2.8	3.1	3.4	3.8
5528000	228	1.75	27.58	8.26	.773	8.31	2	1.4	1.8	2.1	2.6	2.9	3.1	3.5
5528150	10.6	18.40	4.13	2.56	.587	11.45	2	1.7	2.0	2.5	3.0	3.4	3.6	4.0
5528200	4.12	12.14	3.63	1.14	.840	9.39	2	1.8	2.2	2.7	3.2	3.6	3.9	4.3
5528360	2.83	5.30	2.72	1.04	.957	5.85	2	1.9	2.3	2.8	3.5	3.8	4.1	4.6
5528440	1.02	33.35	1.91	0.53	0.595	5.10	2	2.5	3.0	3.7	4.5	5.0	5.4	5.9
5528470	7.89	15.10	5.01	1.57	.624	8.29	2	1.9	2.3	2.8	3.4	3.8	4.1	4.6
5533200	2.32	31.83	2.32	1.00	.619	5.31	2	2.4	2.9	3.6	4.3	4.8	5.2	5.8
5533300	3.19	15.38	2.47	1.29	.633	7.93	2	2.0	2.4	2.9	3.6	3.9	4.3	4.7
5534400	15.8	4.48	11.54	1.37	.337	7.53	2	1.7	2.1	2.6	3.1	3.5	3.7	4.1
5536178	34.7	6.65	12.31	2.82	0.636	6.10	2	1.9	2.3	2.8	3.4	3.8	4.1	4.6
5536190	69.9	6.62	19.96	3.50	4.037	7.16	2	1.8	2.2	2.6	3.2	3.6	3.9	4.3
5536195	91.9	6.29	22.88	4.02	5.569	7.90	2	1.7	2.1	2.5	3.1	3.4	3.7	4.1
5539870	10.1	7.03	4.07	2.48	.712	7.10	2	1.8	2.2	2.8	3.4	3.7	4.0	4.5
5539890	23.9	7.45	7.62	3.14	2.016	7.57	2	1.8	2.2	2.7	3.3	3.6	3.9	4.4
5539950	8.80	12.17	3.96	2.22	2.686	7.39	2	1.9	2.4	2.9	3.5	3.9	4.2	4.7
5540030	60.2	5.36	13.52	4.45	2.696	7.38	2	1.7	2.1	2.6	3.1	3.5	3.8	4.2
5540240	6.48	23.35	3.82	1.69	.904	5.38	2	2.3	2.8	3.4	4.1	4.6	5.0	5.5
5541750	4.65	7.09	4.81	.97	1.133	5.21	2	2.0	2.5	3.0	3.7	4.1	4.4	4.9
5542000	452	4.62	25.05	18.03	1.382	6.58	2	1.7	2.1	2.5	3.1	3.4	3.7	4.1
5545750	805	1.39	44.00	18.30	3.771	10.27	2	1.3	1.5	1.9	2.3	2.6	2.8	3.1
5547755	17.2	4.11	7.67	2.25	.848	9.13	2	1.6	1.9	2.4	2.9	3.2	3.4	3.8
5548150	13.7	6.29	4.79	2.85	3.817	6.26	2	1.9	2.3	2.8	3.4	3.8	4.1	4.6
5549000	15.5	9.84	2.38	6.50	4.443	6.76	2	1.9	2.4	2.9	3.5	3.9	4.2	4.7
5549700	10.8	12.18	4.44	2.42	1.153	9.86	2	1.7	2.1	2.6	3.1	3.5	3.7	4.2
5549850	36.9	9.11	7.44	4.96	0.794	11.63	2	1.5	1.9	2.3	2.8	3.1	3.3	3.7
5549900	.08	78.96	.31	.25	8.015	5.00	2	2.8	3.4	4.1	5.0	5.6	6.0	6.7
5550300	37.8	11.69	9.61	3.93	4.400	5.88	2	2.0	2.4	3.0	3.7	4.1	4.4	4.9
5550470	4.54	11.07	3.43	1.32	.623	6.45	2	2.0	2.5	3.0	3.7	4.1	4.4	4.9
5551030	14.0	12.07	5.58	2.50	3.612	9.13	2	1.8	2.2	2.6	3.2	3.6	3.8	4.3

Station number (figs. 2A and 2B)	TDA (mi^2)	MCS (*ft/mi*)	BL (*mi*)	BW (*mi*)	PermAvg (*in/hr*)	(%water + 5) (*percent*)	Hydrologic Region (fig. 7)	Equivalent years of record (years)						
								Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
5551050	7.37	9.36	2.97	2.48	4.487	7.75	2	1.9	2.3	2.8	3.4	3.7	4.0	4.5
5551060	11.5	10.87	2.88	4.00	3.099	7.04	2	1.9	2.4	2.9	3.5	3.9	4.2	4.7
5551200	51.7	16.57	9.32	5.55	1.775	5.65	2	2.1	2.5	3.1	3.8	4.2	4.5	5.0
5551520	3.19	4.61	2.19	1.46	.702	6.09	2	1.8	2.2	2.7	3.4	3.7	4.0	4.5
5551620	21.5	12.75	8.90	2.42	1.279	5.38	2	2.1	2.6	3.1	3.8	4.2	4.6	5.1
5551650	2.13	43.06	1.82	1.17	1.150	5.20	2	2.5	3.0	3.7	4.5	5.0	5.4	6.0
5551700	70.2	6.43	19.65	3.57	1.585	6.06	2	1.9	2.3	2.8	3.4	3.8	4.1	4.5
5551800	.46	77.47	1.00	.46	1.086	5.08	2	2.7	3.3	4.0	4.9	5.4	5.8	6.5
5551900	32.6	10.61	7.40	4.40	1.246	5.17	2	2.1	2.5	3.1	3.8	4.2	4.5	5.0
5551930	22.0	11.32	11.78	1.87	1.389	5.29	2	2.1	2.5	3.1	3.8	4.2	4.6	5.1
5554000	188	4.66	15.57	12.08	1.409	5.08	3	2.9	3.5	4.2	5.1	5.7	6.1	6.8
5554500	580	1.26	30.07	19.31	1.154	5.24	3	2.5	2.9	3.6	4.4	4.8	5.2	5.7
5554600	.14	13.00	.53	.26	.310	10.76	3	3.7	4.5	5.4	6.6	7.3	7.8	8.6
5555000	1,086	1.33	51.38	21.13	1.095	5.33	3	2.5	3.0	3.6	4.4	4.8	5.2	5.8
5555300	1,256	1.46	60.93	20.62	1.094	5.35	3	2.5	3.0	3.6	4.4	4.9	5.3	5.8
5555400	0.39	51.23	1.03	0.38	0.569	5.00	3	4.4	5.2	6.4	7.7	8.6	9.2	10.2
5555500	1,282	1.54	66.23	19.36	1.087	5.36	3	2.5	3.0	3.7	4.5	4.9	5.3	5.9
5555775	.51	25.57	.96	.54	1.304	5.00	3	3.8	4.5	5.5	6.7	7.4	8.0	8.8
5556500	195	6.40	34.89	5.59	1.249	5.09	3	3.0	3.6	4.4	5.4	5.9	6.4	7.1
5557000	86.8	12.25	13.04	6.66	1.691	5.01	3	3.2	3.9	4.7	5.7	6.3	6.8	7.5
5557100	0.39	78.44	1.69	0.23	1.290	5.00	4	2.8	3.4	4.2	5.1	5.7	6.2	6.9
5557500	99.1	12.69	17.11	5.79	1.227	5.11	3	3.3	4.0	4.8	5.8	6.5	7.0	7.7
5558000	485	6.99	41.40	11.71	1.370	5.25	3	3.0	3.6	4.3	5.3	5.8	6.3	6.9
5558050	.04	86.06	.28	.15	1.368	5.00	3	4.4	5.3	6.4	7.8	8.6	9.2	10.2
5558075	.22	122.41	.75	.29	5.261	5.48	3	4.0	4.7	5.8	7.0	7.7	8.3	9.1
5558500	55.6	11.11	10.84	5.13	1.236	5.18	4	2.7	3.3	4.0	4.9	5.5	5.9	6.6
5559000	5.61	51.36	3.63	1.55	1.219	5.04	4	3.2	3.9	4.8	5.9	6.5	7.0	7.9
5559500	114	6.17	16.64	6.84	1.049	5.15	3	3.1	3.7	4.5	5.5	6.1	6.5	7.2
5561000	11.2	42.26	5.62	1.99	1.054	5.59	3	3.9	4.7	5.7	6.9	7.7	8.2	9.1
5563000	119	10.89	15.80	7.55	1.007	5.19	4	2.7	3.2	3.9	4.8	5.4	5.8	6.5
5563100	0.07	59.50	0.37	0.17	1.005	5.00	4	3.5	4.2	5.2	6.3	7.0	7.6	8.5
5563500	298	5.68	26.78	11.12	.996	5.79	4	2.4	2.9	3.5	4.3	4.8	5.2	5.8
5564400	47.6	4.88	17.99	2.65	1.109	5.05	3	3.0	3.6	4.4	5.4	5.9	6.4	7.1
5564500	51.4	4.71	19.51	2.63	1.107	5.05	3	3.0	3.6	4.4	5.3	5.9	6.4	7.0
5565000	10.0	8.36	5.38	1.87	1.038	5.01	3	3.3	4.0	4.8	5.8	6.5	7.0	7.7
5566000	6.26	13.94	2.63	2.38	0.652	5.03	3	3.6	4.4	5.3	6.5	7.1	7.7	8.5
5566500	30.7	4.17	7.97	3.85	.920	5.13	3	3.0	3.6	4.4	5.3	5.9	6.4	7.0
5567000	94.0	4.82	10.09	9.31	.945	5.09	3	3.0	3.6	4.4	5.4	6.0	6.4	7.1
5567500	765	2.46	56.07	13.65	1.066	5.43	3	2.7	3.2	3.9	4.8	5.3	5.7	6.3
5567800	.99	31.38	2.43	.41	.996	5.00	3	4.0	4.7	5.8	7.0	7.8	8.3	9.2

Station number (figs. 2A and 2B)	TDA (*mi^2*)	MCS (*ft/mi*)	BL (*mi*)	BW (*mi*)	PermAvg (*in/hr*)	(%water + 5) (*percent*)	Hydrologic Region (fig. 7)	Equivalent years of record (years)						
								Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
5568000	1,072	2.45	77.71	13.79	1.067	5.45	3	2.7	3.2	3.9	4.7	5.2	5.6	6.2
5568650	.68	12.26	1.10	.62	1.002	5.46	4	2.9	3.5	4.3	5.3	5.9	6.3	7.1
5568800	63.2	7.40	17.25	3.66	1.000	5.03	4	2.2	2.7	3.3	4.1	4.5	4.9	5.5
5568850	.42	20.12	.69	.60	.645	12.44	4	3.3	4.0	5.0	6.1	6.7	7.3	8.1
5569500	1,069	2.27	56.21	19.03	1.064	5.65	4	2.0	2.4	3.0	3.7	4.1	4.4	4.9
5569825	4.34	21.91	3.02	1.44	0.996	5.00	4	3.0	3.7	4.5	5.5	6.1	6.6	7.4
5570000	1,635	1.89	73.09	22.37	1.056	5.78	4	1.9	2.3	2.9	3.5	3.9	4.2	4.7
5570370	41.1	9.48	14.71	2.79	.852	10.00	4	2.3	2.7	3.4	4.1	4.6	4.9	5.5
5570910	240	4.91	29.35	8.18	1.126	5.20	3	3.0	3.5	4.3	5.2	5.8	6.2	6.9
5571000	364	3.60	34.03	10.68	1.108	5.23	3	2.8	3.4	4.1	5.0	5.6	6.0	6.6
5572000	551	2.71	38.76	14.21	1.118	5.27	3	2.7	3.3	4.0	4.8	5.3	5.7	6.4
5572450	113	5.36	9.88	11.45	1.043	5.01	3	3.0	3.6	4.4	5.4	6.0	6.4	7.1
5572500	776	2.24	42.80	18.12	1.115	5.25	3	2.6	3.2	3.9	4.7	5.2	5.6	6.2
5574000	11.0	12.94	4.19	2.62	.548	5.04	3	3.6	4.3	5.3	6.4	7.1	7.6	8.4
5574500	277	2.02	22.34	12.42	.972	5.16	3	2.7	3.2	3.9	4.7	5.2	5.6	6.2
5575500	562	2.60	20.93	26.84	0.831	5.60	3	2.8	3.3	4.0	4.9	5.4	5.8	6.4
5575800	52.7	5.32	13.03	4.05	.599	5.05	3	3.2	3.8	4.6	5.6	6.2	6.7	7.4
5576500	2,617	1.62	73.34	35.69	1.005	5.97	3	2.5	3.0	3.7	4.4	4.9	5.3	5.8
5577500	103	3.97	21.81	4.74	.996	5.13	3	2.9	3.5	4.3	5.2	5.8	6.2	6.9
5577700	1.46	48.07	1.76	.83	.997	5.00	3	4.1	5.0	6.0	7.3	8.1	8.7	9.6
5578500	333	2.92	36.49	9.12	1.077	7.63	3	2.8	3.3	4.1	4.9	5.4	5.9	6.5
5579500	213	4.32	30.84	6.92	1.195	5.05	3	2.9	3.5	4.3	5.2	5.7	6.1	6.8
5579750	3.10	21.68	3.30	.94	1.080	5.00	3	3.7	4.5	5.5	6.6	7.3	7.9	8.7
5580000	228	6.14	27.60	8.28	1.092	5.31	3	3.0	3.6	4.4	5.4	6.0	6.4	7.1
5580500	308	5.27	41.85	7.37	1.098	5.31	3	3.0	3.6	4.3	5.3	5.8	6.3	6.9
5580700	0.90	37.57	1.47	0.61	2.514	5.50	3	3.7	4.5	5.4	6.6	7.3	7.8	8.7
5581500	332	5.86	37.45	8.86	1.049	5.22	3	3.0	3.6	4.4	5.3	5.9	6.3	7.0
5582000	1,804	2.42	71.36	25.27	1.237	5.72	3	2.6	3.1	3.8	4.6	5.1	5.5	6.1
5582200	.84	17.30	1.57	.54	1.046	5.00	3	3.6	4.4	5.3	6.5	7.2	7.7	8.5
5582500	27.6	4.24	5.40	5.12	2.282	5.01	3	2.8	3.3	4.1	4.9	5.5	5.9	6.5
5583000	5,091	1.34	87.46	58.21	1.164	5.83	3	2.4	2.9	3.5	4.2	4.7	5.0	5.6
5584400	26.9	5.55	7.87	3.42	.995	5.00	4	2.5	3.0	3.7	4.5	5.0	5.4	6.1
5584500	655	3.75	32.77	19.98	.986	5.34	4	2.4	2.9	3.5	4.3	4.8	5.2	5.8
5584950	1.97	24.20	2.60	.76	.995	5.07	4	2.8	3.4	4.2	5.2	5.7	6.2	6.9
5585000	1,295	1.65	52.23	24.80	.960	5.27	4	2.1	2.5	3.0	3.7	4.2	4.5	5.0
5585220	3.48	16.36	3.03	1.15	0.997	5.01	5	3.5	4.2	5.1	6.2	6.9	7.4	8.2
5585700	.15	35.29	.68	.22	.998	5.93	4	3.1	3.7	4.5	5.6	6.2	6.7	7.5
5586000	30.1	5.73	7.31	4.13	.996	5.07	5	3.0	3.6	4.4	5.3	5.9	6.4	7.0
5586200	.55	106.86	1.08	.51	1.309	5.06	4	3.7	4.4	5.4	6.6	7.4	8.0	8.9
5586350	1.87	40.37	2.21	.84	.922	5.11	5	3.9	4.7	5.8	7.0	7.7	8.3	9.2

Station number (figs. 2A and 2B)	TDA (*mi*^{2})	MCS (*ft/mi*)	BL (*mi*)	BW (*mi*)	PermAvg (*in/hr*)	(%water + 5) (*percent*)	Hydrologic Region (fig. 7)	Equivalent years of record (years)						
								Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
5586500	2.17	19.78	3.70	0.59	1.297	5.11	5	3.5	4.2	5.1	6.2	6.9	7.4	8.2
5587000	865	2.40	49.16	17.60	.898	5.63	5	2.6	3.1	3.8	4.6	5.1	5.5	6.1
5587900	211	5.65	32.31	6.53	.907	5.88	4	2.1	2.5	3.1	3.8	4.2	4.6	5.1
5588000	37.4	9.16	16.87	2.22	1.089	5.54	4	2.1	2.5	3.1	3.8	4.2	4.6	5.1
5589500	22.6	12.21	9.96	2.27	1.307	5.61	4	2.4	2.9	3.6	4.4	4.9	5.3	6.0
5589780	1.64	45.47	2.14	0.77	1.305	5.55	5	3.9	4.7	5.7	6.9	7.6	8.2	9.0
5590000	12.4	17.90	5.65	2.21	1.580	5.29	3	3.5	4.2	5.1	6.2	6.8	7.4	8.1
5590400	110	2.23	23.06	4.77	1.344	5.28	3	2.7	3.2	3.9	4.7	5.2	5.6	6.2
5590500	126	1.83	28.15	4.48	1.353	5.25	3	2.6	3.1	3.8	4.6	5.1	5.4	6.0
5590800	150	1.17	23.73	6.34	1.197	5.01	3	2.4	2.9	3.6	4.3	4.8	5.1	5.7
5591200	474	1.28	46.85	10.12	1.282	5.25	3	2.4	2.9	3.6	4.3	4.8	5.2	5.7
5591500	7.88	2.95	2.12	3.72	1.140	5.00	3	2.8	3.4	4.1	5.0	5.5	5.9	6.5
5591700	112	3.83	15.34	7.32	1.151	5.03	3	2.9	3.5	4.2	5.1	5.7	6.1	6.8
5591750	.53	15.57	2.15	.25	1.140	5.00	3	3.6	4.3	5.2	6.3	7.0	7.5	8.3
5592000	1,058	1.09	64.89	16.30	1.254	5.24	3	2.4	2.9	3.5	4.2	4.7	5.0	5.6
5592050	97.7	6.72	15.05	6.49	0.990	5.04	5	3.0	3.6	4.4	5.4	5.9	6.4	7.1
5592300	48.3	6.30	15.52	3.11	.545	5.07	5	3.2	3.8	4.6	5.6	6.2	6.7	7.4
5592500	1,853	1.69	103.09	17.98	1.021	6.33	3	2.5	3.0	3.7	4.5	5.0	5.3	5.9
5592575	44.2	10.43	10.48	4.21	.573	5.26	5	3.4	4.0	4.9	6.0	6.6	7.1	7.8
5592800	152	6.29	26.31	5.77	.602	5.24	5	3.1	3.7	4.5	5.5	6.1	6.5	7.2
5592900	113	4.43	24.61	4.58	0.582	5.37	5	3.0	3.6	4.4	5.3	5.9	6.3	7.0
5593000	2,723	1.69	132.67	20.52	.883	6.02	5	2.4	2.9	3.6	4.3	4.8	5.2	5.7
5593520	254	2.92	31.43	8.09	.611	6.18	5	2.8	3.4	4.1	5.0	5.5	5.9	6.5
5593575	83.6	4.85	14.52	5.75	.543	5.48	5	3.0	3.7	4.5	5.4	6.0	6.4	7.1
5593600	18.7	3.73	6.27	2.99	.518	5.01	5	3.0	3.6	4.4	5.3	5.9	6.3	7.0
5593700	0.47	20.92	1.23	0.38	0.425	5.00	5	3.9	4.7	5.7	6.9	7.6	8.2	9.0
5593900	56.1	5.05	12.88	4.36	.558	5.16	5	3.1	3.7	4.5	5.5	6.0	6.5	7.2
5594000	737	2.78	54.45	13.54	.650	6.37	5	2.7	3.3	4.0	4.8	5.3	5.7	6.3
5594090	124	3.81	22.57	5.51	.786	5.33	5	2.9	3.4	4.2	5.1	5.6	6.1	6.7
5594200	1.95	16.04	2.22	.88	.355	5.02	5	3.8	4.5	5.5	6.7	7.4	7.9	8.8
5594330	72.3	4.41	14.10	5.13	0.724	5.71	5	3.0	3.6	4.3	5.3	5.8	6.3	6.9
5594450	154	5.01	27.95	5.52	.897	5.28	5	2.9	3.5	4.3	5.2	5.7	6.2	6.8
5594800	466	2.75	50.27	9.27	.952	5.86	5	2.7	3.2	3.9	4.7	5.2	5.6	6.2
5595000	5,189	1.28	163.59	31.72	.802	6.83	5	2.3	2.8	3.4	4.2	4.6	4.9	5.5
5595200	129	6.65	21.06	6.11	1.121	6.28	5	3.0	3.6	4.4	5.3	5.8	6.3	7.0
5595500	17.8	15.58	6.31	2.82	0.798	7.91	4	2.8	3.4	4.2	5.2	5.7	6.2	6.9
5595510	1.27	29.94	2.23	.57	.887	6.09	4	2.9	3.4	4.2	5.2	5.8	6.2	7.0
5595550	.65	77.28	1.18	.55	1.210	5.32	4	3.5	4.3	5.3	6.4	7.2	7.7	8.6
5595730	91.4	6.06	15.70	5.82	.609	5.42	6	2.3	2.8	3.4	4.1	4.5	4.9	5.4
5595800	21.1	16.65	7.08	2.97	.850	5.51	6	2.6	3.1	3.8	4.6	5.1	5.5	6.1

Station number (figs. 2A and 2B)	TDA (*mi²*)	MCS (*ft/mi*)	BL (*mi*)	BW (*mi*)	PermAvg (*in/hr*)	(%water + 5) (*percent*)	Hydrologic Region (fig. 7)	Equivalent years of record (years)						
								Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}
5595820	76.8	6.10	15.63	4.91	0.864	6.63	6	2.2	2.6	3.2	3.9	4.3	4.7	5.2
5596000	502	2.50	36.66	13.69	.693	12.94	6	1.5	1.8	2.2	2.7	3.0	3.2	3.5
5596100	1.03	44.80	1.71	.61	.496	5.37	6	3.0	3.6	4.4	5.4	6.0	6.4	7.1
5597000	792	1.86	45.53	17.40	.710	7.22	6	1.8	2.2	2.6	3.2	3.6	3.8	4.3
5597450	.63	55.66	1.59	.40	.664	8.97	6	2.6	3.2	3.9	4.7	5.2	5.6	6.2
5597500	31.6	8.76	8.79	3.60	0.702	6.72	6	2.3	2.8	3.4	4.1	4.5	4.9	5.4
5599000	288	2.02	30.33	9.49	.635	7.36	6	1.8	2.2	2.7	3.3	3.6	3.9	4.4
5599500	2,161	1.10	57.89	37.33	.749	9.22	6	1.5	1.9	2.3	2.8	3.1	3.3	3.6
5599560	1.96	61.34	2.33	.84	1.400	5.57	6	3.0	3.6	4.5	5.4	6.0	6.4	7.1
5599580	.17	316.86	.85	.20	2.020	5.00	4	3.6	4.4	5.4	6.5	7.3	7.9	8.8
5599640	0.43	82.30	1.13	0.38	1.676	5.72	7	2.2	2.6	3.2	3.8	4.3	4.6	5.1
5599800	.09	78.87	.37	.25	1.676	6.15	7	2.1	2.6	3.1	3.8	4.2	4.5	5.0
5600000	32.2	14.93	12.09	2.66	1.461	5.64	7	1.7	2.0	2.5	3.0	3.3	3.6	4.0

Table 7. Selected flood-peak information for the 288 streamflow-gaging stations in Illinois and adjacent States.

[**No.**, number; The magnitude of flood peak is expressed in cubic feet per second, ft^3/s; historically adjusted record length used in the flood-frequency analysis is obtained from Log Pearson III analysis (PEAKFQ output); the water year of maximum peak presented in parenthesis indicates that the peak represents a historical event; approximate recurrence interval of maximum peak is interpolated from flood-frequency curves (PEAKFQ output), rounded to the nearest 5 years for 20- to 50-years, to the nearest 10 years for 50- to 100-years, to the nearest 20 years for 100- to 200-years, to the nearest 25 years for 200- to 500-years; >, greater than]

Station number (figs. 2A and 2B)	Station name	Period of record (Water Years)	Systematic record length (No. of years)	Weighted skew	Sample skew	Historically adjusted record length (No. of years)	Maximum peakflow (ft^3/s)	Water year of maximum peak	Approximate recurrence interval of maximum peak (years)
3336100	Big Four Ditch Tributary near Paxton, Ill.	1956-80	25	-0.413	-0.671	25	249	1959	15
3336500	Bluegrass Creek at Potomac, Ill.	1950-82	33	-.223	-.206	33	5,160	1968	50
3336645	Middle Fork Vermilion River above Oakwood, Ill.	1979-99	21	-.261	-.263	21	15,500	1994	50
3336900	Salt Fork near St. Joseph, Ill.	1959-91	33	.057	.349	33	6,860	1968	50
3337500	Saline Branch at Urbana, Ill.	1937-75	39	-.276	-.502	43	4,080	1964	60
3338000	Salt Fork near Homer, Ill.	1945-82	37	0.017	-0.687	44	20,500	(1939)	>500
3338100	Salt Fork Trib near Catlin, Ill.	1959-80	22	-.492	-1.299	22	640	1980	20
3338500	Vermilion River near Catlin, Ill.	1940-58	19	.072	.182	56	41,000	(1939)	100
3338780	North Fork Vermilion River near Bismarck, Ill.	1989-99	11	-.165	.353	11	20,100	1990/94	15
3338800	N F Vermilion River Tributary near Danville, Ill.	1956-76	21	-.087	.297	21	1,600	1974	60
3339000	Vermilion River near Danville, Ill.	1915-99	77	-0.225	-0.559	77	48,700	1939	200
3341700	Big Creek Tributary near Dudley, Ill.	1961-75	15	.017	.673	15	511	1961	30
3341900	Raccoon Creek Trib near Annapolis, Ill.	1956-80	25	-.178	-.483	25	48	1974	15
3343400	Embarras River near Camargo, Ill.	1961-99	39	-.556	-1.116	39	8,040	1994	60
3344000	Embarras River near Diona, Ill.	1939-92	27	-.242	-.178	27	20,400	1985	25
3344425	Muddy Creek Tributary at Woodbury, Ill.	1959-76	18	0.060	0.190	18	112	1974	30
3344500	Range Creek near Casey, Ill.	1951-91	41	.041	-.685	41	3,500	1961	35
3345500	Embarras River at Ste. Marie, Ill.	1908-99	88	-.271	-1.485	88	44,800	1950	50
3346000	North Fork Embarras River near Oblong, Ill.	1941-99	59	-.350	-1.533	59	27,100	1950	45
3378000	Bonpas Creek at Browns, Ill.	1941-99	59	-.052	-1.180	59	7,500	1961	80
3378635	Little Wabash River near Effingham, Ill.	1967-99	33	0.045	0.139	33	17,800	1996	60
3378650	Second Creek Tributary at Keptown, Ill.	1956-72	17	.071	.338	17	930	1970	60
3378900	Little Wabash River at Louisville, Ill.	1966-92	27	.026	-.277	43	42,800	(1950)	90
3378980	Little Wabash River Trib at Clay City, Ill.	1959-80	22	-.241	-.606	22	409	1971	20
3379500	Little Wabash River below Clay City, Ill.	1915-99	85	-.135	-.422	85	47,000	1950	40
3379650	Madden Creek near West Salem, Ill.	1956-76	21	0.167	0.562	21	1,550	1961	90
3380350	Skillet Fork near Iuka, Ill.	1966-83	18	-.223	-.267	18	19,000	1968	40
3380400	Horse Creek Tributary near Cartter, Ill.	1961-72	12	-.089	.228	12	570	1961/68	15
3380450	White Feather Creek near Marlow, Ill.	1956-80	25	-.198	-.272	25	323	1975	25
3380475	Horse Creek near Keenes, Ill.	1960-90	31	-.177	-.211	31	17,100	1961	150
3380500	Skillet Fork at Wayne City, Ill.	1909-99	82	0.018	-0.147	82	59,400	1990	250
3381500	Little Wabash River at Carmi, Ill.	1940-99	60	-.025	-.290	60	46,900	1961	100
3381600	Little Wabash River Tributary nr New Haven, Ill.	1960-76	17	.035	.314	17	484	1974	180
3382025	Little Saline Creek Tributary near Goreville, Ill.	1959-80	22	.046	-2.063	22	563	1969	90
3382100	South Fork Saline River nr Carrier Mills, Ill.	1966-99	34	-.031	-.465	34	5,160	1982	25
3382170	Brushy Creek near Harco, Ill.	1969-82	14	0.144	0.819	14	2,590	1977	60
3382510	Eagle Creek near Equality, Ill.	1967-82	16	-.218	-.644	16	668	1973	20
3384450	Lusk Creek near Eddyville, Ill.	1968-99	32	.050	.134	32	16,100	1985	120

Station number (figs. 2A and 2B)	Station name	Period of record (Water Years)	Systematic record length (No. of years)	Weighted skew	Sample skew	Historically adjusted record length (No. of years)	Maximum peakflow (*ft*³/s)	Water year of maximum peak	Approximate recurrence interval of maximum peak (years)
3385000	Hayes Creek at Glendale, Ill.	1950-99	50	-0.120	-0.206	50	9,450	1985	180
3385500	Lake Glendale Inlet near Dixon Springs, Ill.	1955-80	26	-.160	-.433	26	1,500	1958	30
3612000	Cache River at Forman, Ill.	1923-99	77	-.133	-.227	77	9,630	1935	25
3614000	Hess Bayou Tributary near Mound City, Ill.	1959-72	14	.212	-.406	14	754	1966	15
4087300	Lake Michigan Tributary at Winthrop Harbor, Ill.	1956-72	17	-.160	.608	17	355	1969	70
4087400	Kellogg Ravine at Zion, Ill.	1962-76	15	-0.171	0.651	15	937	1969	70
5414820	Sinsinawa River near Menominee, Ill.	1968-99	32	.130	.025	32	17,000	1999	40
5415000	Galena River at Buncombe, Wis.	1937-92	53	.200	.284	84	29,700	1969	>500
5415500	East Fork Galena River at Council Hills, Ill.	1940-69	30	.220	.342	30	16,600	1947	85
5418750	South Fork Apple River near Nora, Ill.	1961-80	20	-.229	-1.060	20	520	1974	15
5418800	Mill Creek Tributary near Scales Mound, Ill.	1956-75	20	0.008	-0.177	20	862	1965	45
5419000	Apple River near Hanover, Ill.	1935-99	65	.071	.086	65	12,000	1946	70
5420000	Plum River bl Carroll Creek nr Savanna, Ill.	1941-77	37	-.132	-.070	37	11,600	1946	45
5430500	Rock River at Afton, Wis.	1914-99	86	-.312	-.671	86	13,000	1929	50
5431486	Turtle Creek at Carvers Rock Road nr Clinton, Wis.	1938-99	60	-.051	-.046	63	16,500	1973	350
5434500	Pecatonica River at Martintown, Wis.	1916-99	60	-0.071	-0.140	84	15,100	1969	35
5435000	Cedar Creek near Winslow, Ill.	1952-76	25	-.230	-.470	25	698	1974	20
5435500	Pecatonica River at Freeport, Ill.	1914-99	86	.090	.097	86	18,400	1929	50
5435650	Lost Creek Tributary near Shannon, Ill.	1961-76	16	-.165	-1.399	16	660	1974	50
5436500	Sugar River near Brodhead, Wis.	1914-99	86	-.091	-.105	86	14,800	1915	90
5436900	Otter Creek Tributary near Durand, Ill.	1961-80	20	-0.072	0.258	20	187	1969	25
5437000	Pecatonica River at Shirland, Ill.	1940-71	32	-.182	-.345	43	16,600	1959	20
5437500	Rock River at Rockton, Ill.	1904-99	70	-.264	-.328	70	32,500	1916	50
5437600	Rock River Tributary near Rockton, Ill.	1961-76	16	-.432	-.859	16	308	1974	15
5437950	Kishwaukee River near Huntley, Ill.	1965-78	14	-.450	-.612	14	192	1972	25
5438250	Coon Creek at Riley, Ill.	1962-91	30	-0.578	-1.027	30	5,090	1978	350
5438300	Lawrence Creek Tributary near Harvard, Ill.	1961-80	20	-.209	-.163	20	180	1972	15
5438390	Piscasaw Creek below Mokeler Creek nr Capron, Ill.	1970-79	10	-.063	-1.265	10	4,000	1973	40
5438500	Kishwaukee River at Belvidere, Ill.	1940-99	60	-.319	-.301	60	11,900	1994	35
5438850	M Br of So Br Kishwaukee R nr Malta, Ill.	1956-80	25	-.638	-.930	25	393	1959	45
5439000	South Branch Kishwaukee River at Dekalb, Ill.	1926-99	28	-0.149	0.375	28	3,500	1983	225
5439500	South Branch Kishwaukee River nr Fairdale, Ill.	1940-99	60	-.336	-.243	63	25,400	1996	>500
5439550	South Branch Kishwaukee River Trib nr Irene, Ill.	1959-76	18	-.378	-.279	18	452	1971	30
5440000	Kishwaukee River near Perryville, Ill.	1940-99	60	-.450	-.480	62	24,200	1996	70
5440500	Killbuck Creek near Monroe Center, Ill.	1940-80	41	-.712	-1.043	41	6,100	1951/55	15
5440650	Stillman Creek Tributary near Holcomb, Ill.	1959-79	18	-0.348	-0.049	18	297	1971	50
5440900	Leaf River Tributary near Forreston, Ill.	1956-79	23	-.083	.455	23	212	1958	35
5441000	Leaf River at Leaf River, Ill.	1940-82	43	-.508	-.719	45	11,000	(1938)	25
5441500	Rock River at Oregon, Ill.	1940-49	10	.051	.338	35	47,000	(1937)	15
5442000	Kyte River near Flagg Center, Ill.	1940-51	12	-.310	.321	15	2,630	1951	60
5443500	Rock River at Como, Ill.	1915-99	80	-0.434	-0.827	80	59,700	1973	90
5444000	Elkhorn Creek near Penrose, Ill.	1940-99	60	-.648	-.995	62	6,800	(1938)	25
5444100	Spring Creek Tributary near Coleta, Ill.	1959-72	14	-.306	-.383	14	832	1965	25

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5445500	Rock Creek near Morrison, Ill.	1940-71	32	-0.039	-0.014	35	6,500	(1937)	100
5446000	Rock Creek at Morrison, Ill.	1940-99	54	.048	.290	54	5,770	1946	150
5446500	Rock River near Joslin, Ill.	1940-99	60	-.321	-.465	60	46,500	1993	20
5446950	Green River Tributary near Amboy, Ill.	1961-76	16	-.207	.495	16	493	1967	30
5447000	Green River at Amboy, Ill.	1940-82	42	-.722	-1.075	42	7,600	1981	50
5447050	Green River Tributary No 2 near Ohio, Ill.	1959-72	14	-0.239	-0.801	14	431	1969	50
5447350	Mud Creek Tributary near Atkinson, Ill.	1961-76	16	.082	-.431	16	890	1967	150
5447500	Green River near Geneseo, Ill.	1936-99	64	-.627	-1.050	64	12,100	1974	40
5448000	Mill Creek at Milan, Ill.	1940-99	57	-.404	-.579	100	9,300	1973	50
5448050	Sand Creek near Milan, Ill.	1956-80	25	-.055	.181	25	168	1980	20
5466000	Edwards River near Orion, Ill.	1941-99	59	-0.208	-1.524	76	8,910	1951	>500
5466500	Edwards River near New Boston, Ill.	1935-99	65	-.272	-.383	65	18,000	1973	>500
5467000	Pope Creek near Keithsburg, Ill.	1935-99	60	-.030	-.061	60	8,900	1973	70
5467500	Henderson Creek near Little York, Ill.	1941-82	41	.389	.761	59	23,400	1982	500
5468000	North Henderson Creek near Seaton, Ill.	1941-51	11	.017	-.791	17	2,600	(1935)	50
5468500	Cedar Creek at Little York, Ill.	1941-99	56	0.126	0.123	76	18,100	1993	100
5469000	Henderson Creek near Oquawka, Ill.	1935-99	64	.372	.563	76	34,600	1982	250
5469500	South Henderson Creek at Biggsville, Ill.	1940-82	42	.220	-.159	59	10,500	1982	100
5469750	Ellison Creek Tributary near Roseville, Ill.	1956-80	25	-.175	-1.549	25	182	1958	30
5495200	Little Creek near Breckenridge, Ill.	1956-80	24	-.333	-.377	24	1,110	1958	15
5495500	Bear Creek near Marcelline, Ill.	1944-99	56	-0.353	-0.399	56	35,500	1996	100
5496900	Homan Creek Tributary near Quincy, Ill.	1956-76	21	-.390	-.585	21	616	1960	10
5501500	Burton Creek Tributary near Burton, Ill.	1961-76	15	-.298	-.238	15	796	1962	30
5502020	Hadley Creek near Barry, Ill.	1956-99	43	-.441	-1.080	43	9,000	1973/79	25
5502040	Hadley Creek at Kinderhook, Ill.	1940-86	46	-.419	-.864	48	24,000	(1939)	100
5502120	Kiser Creek Trib near Barry, Ill.	1956-80	25	-0.149	-0.572	25	1,330	1966	50
5512500	Bay Creek at Pittsfield, Ill.	1940-99	60	-.306	-.523	73	35,000	(1926)	>500
5513000	Bay Creek at Nebo, Ill.	1940-86	47	-.439	-.802	70	24,000	(1916)	50
5513200	Salt Spring Creek near Gilead, Ill.	1956-80	24	-.199	.335	24	1,280	1960	90
5518000	Kankakee River at Shelby, Ind.	1923-99	77	-.418	-.745	77	7,650	1982	350
5519500	West Creek near Schneider, Ind.	1949-72	23	-0.370	-1.263	23	1,840	1955	20
5520000	Singleton Ditch at Illlinoi, Ill.	1945-77	33	-.577	-1.842	63	3,610	1976	>500
5520500	Kankakee River at Momence, Ill.	1915-99	85	-.459	-.583	85	16,000	1979	>500
5524500	Iroquois River near Foresman, Ind.	1949-99	51	-.436	-.526	51	5,930	1958	50
5525000	Iroquois River at Iroquois, Ill.	1945-99	55	-.336	-.337	55	10,400	1958	250
5525050	Eastburn Hollow near Sheldon, Ill.	1956-72	17	-0.084	0.494	22	1,950	1957	250
5525500	Sugar Creek at Milford, Ill.	1949-99	51	-.315	-.264	51	22,900	1951	50
5526000	Iroquois River near Chebanse, Ill.	1924-99	76	-.319	-.572	87	34,000	(1913)	100
5526150	Kankakee River Tributary near Bourbonnais, Ill.	1956-80	25	-.173	.092	25	233	1957	30
5526500	Terry Creek near Custer Park, Ill.	1950-75	26	-.051	.641	63	1,710	1970	>500
5527050	Prairie Creek near Frankfort, Ill.	1956-72	17	0.254	0.121	60	786	1957	>500
5527500	Kankakee River near Wilmington, Ill.	1915-99	85	-.313	-.277	117	75,900	1957	180
5527800	Des Plaines River at Russell, Ill.	1960-99	39	-.542	-.746	39	2,120	1979	20

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5527840	Des Plaines River at Wadsworth, Ill.	1962-76	15	-0.612	-1.155	15	2,170	1976	10
5527900	North Mill Creek at Hickory Corners, Ill.	1962-76	15	-.245	-.962	17	510	(1960)	50
5528000	Des Plaines River near Gurnee, Ill.	1946-99	53	-.603	-1.139	53	3,530	1986	100
5528150	Indian Creek at Diamond Lake, Ill.	1990-76	17	-.387	-.440	17	1,150	1960	60
5528200	Hawthorn Drainage Ditch near Mundelein, Ill.	1961-76	16	-.144	.409	16	543	1970	40
5528360	Aptakisic Creek at Aptakisic, Ill.	1961-76	16	-0.257	0.014	16	390	1972	50
5528440	Buffalo Creek near Lake Zurich, Ill.	1961-76	16	-.247	.060	16	203	1972	20
5528470	Buffalo Creek at Long Grove, Ill.	1961-76	16	-.441	-.626	16	539	1972	20
5533200	Sawmill Creek Tributary near Tiedtville, Ill.	1961-79	18	-.389	-2.668	18	315	1976	15
5533300	Wards Creek near Woodridge, Ill.	1962-76	15	-.339	-1.025	15	151	1966	20
5534400	North Branch Chicago River at Bannockburn, Ill.	1960-76	17	-0.501	-0.785	17	355	1967	10
5536178	Plum Creek near Dyer, Ind.	1966-77	12	-.455	-1.094	24	2,480	(1955)	25
5536190	Hart Ditch at Munster, Ind.	1943-99	57	-.353	-.401	57	3,010	1991	25
5536195	Little Calumet River at Munster, Ind.	1959-99	39	-.099	.059	39	1,510	1959	250
5539870	West Branch Du Page River at Ontarioville, Ill.	1961-79	19	-.495	-.735	19	630	1972	10
5539890	West Branch Du Page River near Wayne, Ill.	1961-79	19	-0.192	-0.101	25	1,620	(1955)	100
5539950	Klein Creek at Carol Stream, Ill.	1961-79	19	.030	1.390	32	888	1972	>500
5540030	West Br Du Page River at West Chicago, Ill.	1961-79	19	-.392	-.202	26	1,670	1972	100
5540240	Prentiss Creek near Lisle, Ill.	1961-80	20	.004	.710	20	532	1961	40
5541750	Mazon River Tributary near Gardner, Ill.	1959-80	22	-.587	-1.702	22	173	1979	15
5542000	Mazon River near Coal City, Ill.	1940-99	59	-0.595	-1.172	59	22,400	1983	50
5545750	Fox River near New Munster, Wis.	1940-99	60	-.049	.031	60	7,520	1960	150
5547755	Squaw Creek at Round Lake, Ill.	1990-99	10	-.351	-.335	10	312	1993	15
5548150	North Br Nippersink Crk nr Genoa City, Wis.	1962-99	38	-.140	-.031	38	517	1999	100
5549000	Boone Creek near Mc Henry, Ill.	1949-92	43	-.371	-.399	43	345	1986	50
5549700	Mutton Creek at Island Lake, Ill.	1962-76	15	-0.170	0.097	17	378	(1960)	40
5549850	Flint Creek near Fox River Grove, Ill.	1962-96	22	-.061	.616	22	690	1996	150
5549900	Fox River Tributary near Cary, Ill.	1956-79	23	-.227	.031	23	59	1972	30
5550300	Tyler Creek at Elgin, Ill.	1962-99	19	-.071	-.994	19	953	1999	>500
5550470	Poplar Creek Trib near Bartlett, Ill.	1961-79	19	-.075	.544	28	565	1967	400
5551030	Brewster Creek at Valley View, Ill.	1962-79	17	-0.418	-0.306	17	687	1967	25
5551050	Norton Creek near Wayne, Ill.	1962-79	18	-.002	.586	23	890	(1957)	160
5551060	Norton Creek near St. Charles, Ill.	1962-79	18	.002	1.054	23	954	1967	>500
5551200	Ferson Creek near St. Charles, Ill.	1961-99	39	-.636	-.887	39	2,580	1997	40
5551520	Indian Creek near North Aurora, Ill.	1961-79	19	-.298	-.084	19	402	1978	50
5551620	Blackberry Creek near Kaneville, Ill.	1961-79	17	-0.348	-0.713	17	640	1974	25
5551650	Lake Run Trib near Batavia, Ill.	1961-76	16	-.149	.626	16	346	1970	50
5551700	Blackberry Creek near Yorkville, Ill.	1961-99	39	-.301	.035	85	5,510	1996	>500
5551800	Fox River Tributary River No 2 near Fox, Ill.	1961-80	19	-.339	-.120	19	320	1978	15
5551900	East Branch Big Rock Creek near Big Rock, Ill.	1965-79	15	-.278	.174	15	1,580	1974	50
5551930	Welch Creek near Big Rock, Ill.	1965-80	16	-0.363	-0.197	16	694	1974	40
5554000	North Fork Vermilion River near Charlotte, Ill.	1943-99	57	-.581	-.773	57	4,900	1987/90	15
5554500	Vermilion River at Pontiac, Ill.	1943-99	56	-.469	-.595	56	13,100	1983	30

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5554600	Mud Creek Tributary near Odell, Ill.	1959-76	18	-0.550	-0.719	18	163	1965	30
5555000	Vermilion River at Streator, Ill.	1915-30	15	-.319	-.380	15	17,100	1920	15
5555300	Vermilion River near Leonore, Ill.	1931-99	69	-.448	-.573	69	33,500	1958	35
5555400	Vermilion River Tributary at Lowell, Ill.	1956-76	21	-.066	.531	21	176	1958	20
5555500	Vermilion River at Lowell, Ill.	1931-71	41	-.285	-.257	41	33,500	1958	50
5555775	Vermilion Creek Tributary at Meriden, Ill.	1959-72	14	-0.390	-0.651	14	98	1960	15
5556500	Big Bureau Creek at Princeton, Ill.	1937-99	63	-.701	-1.046	63	12,500	1974	50
5557000	West Bureau Creek at Wyanet, Ill.	1937-91	54	-.169	-.016	61	20,100	1974	>500
5557100	West Bureau Creek Tributary near Wyanet, Ill.	1956-79	22	-.159	.036	22	261	1973	15
5557500	East Bureau Creek near Bureau, Ill.	1937-99	63	-.350	-.313	63	9,260	1997	90
5558000	Big Bureau Creek at Bureau, Ill.	1941-51	11	-0.340	-0.168	11	18,000	1951	35
5558050	Coffee Creek Tributary near Florid, Ill.	1956-76	21	-.100	.368	21	122	1958	100
5558075	Coffee Creek Tributary near Hennepin, Ill.	1956-80	24	-.005	.643	24	372	1958	100
5558500	Crow Creek (West) near Henry, Ill.	1950-82	33	.059	.257	33	6,930	1970	70
5559000	Gimlet Creek at Sparland, Ill.	1946-82	35	-.233	-.522	59	1,940	1974	20
5559500	Crow Creek near Washburn, Ill.	1945-82	37	-0.089	-0.076	37	5,750	1954	40
5561000	Ackerman Creek at Farmdale, Ill.	1954-80	27	-.032	-.222	27	5,100	1980	100
5563000	Kickapoo Creek near Kickapoo, Ill.	1945-99	53	.005	-.082	53	27,500	1967	30
5563100	Kickapoo Creek Tributary near Kickapoo, Ill.	1956-80	21	.050	.017	21	246	1959	60
5563500	Kickapoo Creek at Peoria, Ill.	1943-99	57	.132	.212	73	48,500	1974	320
5564400	Money Creek near Towanda, Ill.	1958-82	25	0.058	-0.030	25	2,600	1980	40
5564500	Money Creek above Lake Bloomington, Ill.	1934-58	25	.258	-.952	25	3,900	1947	100
5565000	Hickory Creek above Lake Bloomington, Ill.	1939-58	20	-.159	-.989	20	1,690	1951	15
5566000	East Branch Panther Creek near Gridley, Ill.	1950-72	23	.263	1.321	23	1,470	1951	400
5566500	East Branch Panther Creek at El Paso, Ill.	1950-82	33	.317	.989	33	5,300	1951	200
5567000	Panther Creek near El Paso, Ill.	1950-98	49	-0.263	-0.511	49	10,900	1951	35
5567500	Mackinaw River near Congerville, Ill.	1945-99	55	-.043	-.112	55	44,800	1983	100
5567800	Indian Creek Tributary near Hopedale, Ill.	1960-71	12	.007	-.918	12	446	1968	10
5568000	Mackinaw River near Green Valley, Ill.	1922-99	77	.311	.425	77	51,000	1983	100
5568650	Duck Creek near Canton, Ill.	1956-72	17	.094	.270	17	146	1968	15
5568800	Indian Creek near Wyoming, Ill.	1960-99	40	0.154	0.294	40	6,540	1974	100
5568850	Forman Creek Tributary near Victoria, Ill.	1961-76	16	.033	-.677	16	391	1975	25
5569500	Spoon River at London Mills, Ill.	1943-99	57	.352	.580	76	41,000	1974	180
5569825	Cedar Creek Tributary at St. Augustine, Ill.	1956-80	25	.318	-.191	25	1,460	1967	80
5570000	Spoon River at Seville, Ill.	1916-99	83	-.085	-.189	83	37,300	1924	60
5570370	Big Creek near Bryant, Ill.	1972-92	21	-0.269	-2.349	21	1,220	1974	10
5570910	Sangamon River at Fisher, Ill.	1979-99	21	-.190	-.422	21	13,000	1994	50
5571000	Sangamon River at Mahomet, Ill.	1948-78	31	-.073	-.073	31	14,600	1956	40
5572000	Sangamon River at Monticello, Ill.	1908-99	90	-.157	-.431	90	19,000	1927	70
5572450	Friends Creek at Argenta, Ill.	1967-82	16	.119	.678	16	5,660	1968	35
5572500	Sangamon River near Oakley, Ill.	1951-77	27	0.155	0.398	27	16,000	1974	25
5574000	South Fork Sangamon River near Nokomis, Ill.	1951-82	32	.393	.874	75	8,600	1957	200
5574500	Flat Branch near Taylorville, Ill.	1950-82	33	-.275	-.874	33	13,000	1957	50

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5575500	South Fork Sangamon River at Kincaid, Ill.	1908-92	70	-0.037	-0.019	70	21,500	1957	90
5575800	Horse Creek at Pawnee, Ill.	1968-85	18	-.334	-.823	18	3,300	1983	15
5576500	Sangamon River at Riverton, Ill.	1908-99	86	-.442	-1.152	117	68,700	1943	>500
5577500	Spring Creek at Springfield, Ill.	1948-99	52	-.076	-.003	52	10,700	1996	50
5577700	Sangamon River Tributary at Andrew, Ill.	1956-80	24	-.206	-.310	24	660	1979	20
5578500	Salt Creek near Rowell, Ill.	1908-99	62	0.143	0.180	62	24,500	1968	180
5579500	Lake Fork near Cornland, Ill.	1948-99	52	.322	-.655	57	29,000	(1943)	>500
5579750	Kickapoo Creek Tributary at Heyworth, Ill.	1956-73	18	.250	.609	31	2,400	1956	200
5580000	Kickapoo Creek at Waynesville, Ill.	1948-99	52	.245	.341	52	24,600	1981	80
5580500	Kickapoo Creek near Lincoln, Ill.	1945-92	47	.260	.427	93	23,300	1983	140
5580700	Salt Creek Tributary at Middletown, Ill.	1961-76	15	-0.242	-0.589	15	556	1974	10
5581500	Sugar Creek near Hartsburg, Ill.	1945-92	48	.312	.436	48	41,200	1983	70
5582000	Salt Creek near Greenview, Ill.	1942-99	58	-.069	-.158	58	41,200	1943	50
5582200	Cabiness Creek Tributary near Petersburg, Ill.	1956-76	21	-.097	.010	21	1,500	1965	100
5582500	Crane Creek near Easton, Ill.	1950-81	32	-.302	-.616	32	534	1979	10
5583000	Sangamon River near Oakford, Ill.	1910-99	82	-0.351	-0.544	82	123,000	1943	>500
5584400	Drowning Fork at Bushnell, Ill.	1961-92	31	-.149	-.287	31	3,500	1980	80
5584500	La Moine River at Colmar, Ill.	1945-99	55	-.284	-.358	55	38,900	1985	80
5584950	West Creek at Mount Sterling, Ill.	1961-72	12	-.147	.316	12	653	1961	30
5585000	La Moine River at Ripley, Ill.	1921-99	79	-.193	-.452	79	28,000	1985	35
5585220	Indian Creek Tributary near Sinclair, Ill.	1956-80	25	-0.321	-0.453	25	1,010	1958	10
5585700	Dry Fork Tributary near Mount Sterling, Ill.	1956-76	21	-.284	-.218	21	74	1961	20
5586000	N Fk Mauvaise Terre Cr nr Jacksonville, Ill.	1950-99	49	-.288	-.340	49	7,160	1994	50
5586200	Illinois River Tributary at Florence, Ill.	1956-80	25	-.528	-.905	25	730	1961	10
5586350	Little Sandy Creek Tributary nr Murrayville, Ill.	1961-72	12	-.353	-.606	12	1,130	1966	10
5586500	Hurricane Creek near Roodhouse, Ill.	1951-95	44	-0.225	-0.119	44	1,700	1957	200
5587000	Macoupin Creek near Kane, Ill.	1921-99	72	-.423	-.631	72	40,100	1994	100
5587900	Cahokia Creek at Edwardsville, Ill.	1969-99	31	-.823	-1.589	31	8,200	1979	15
5588000	Indian Creek at Wanda, Ill.	1941-99	59	-.184	.043	59	9,340	1946	160
5589500	Canteen Creek at Caseyville, Ill.	1939-84	46	-.199	-.026	46	10,200	1957	250
5589780	Little Canteen Creek Trib near Collinsville, Ill.	1959-72	14	-0.278	-0.028	14	613	1960	15
5590000	Kaskaskia Ditch at Bondville, Ill.	1924-90	46	.093	.286	46	1,490	1968	30
5590400	Kaskaskia River near Pesotum, Ill.	1965-79	15	-.120	-.632	15	3,310	1974	25
5590500	Kaskaskia River at Ficklin, Ill.	1954-64	11	-.221	-.170	11	4,400	1959	10
5590800	Lake Fork at Atwood, Ill.	1973-99	27	-.448	-.746	27	4,030	1979	30
5591200	Kaskaskia River at Cooks Mills, Ill.	1971-99	29	-0.439	-0.666	29	9,950	1994	20
5591500	Asa Creek at Sullivan, Ill.	1951-82	32	-.258	-1.571	32	1,460	1974	40
5591700	West Okaw River near Lovington, Ill.	1980-99	20	-.041	-.328	20	10,300	1996	70
5591750	Stringtown Branch Tributary near Lake City, Ill.	1961-80	20	-.336	-.576	20	150	1978	30
5592000	Kaskaskia River at Shelbyville, Ill.	1908-68	33	-.402	-1.152	33	25,900	1957	20
5592050	Robinson Creek near Shelbyville, Ill.	1980-99	20	0.203	0.150	43	26,400	(1957)	250
5592300	Wolf Creek near Beecher City, Ill.	1959-82	24	-.160	-.377	24	7,480	1970	20
5592500	Kaskaskia River at Vandalia, Ill.	1908-68	58	.190	-1.132	58	62,700	1957	100

Station number (figs. 2A and 2B)	Station name	Period of record (Water Years)	Systematic record length (No. of years)	Weighted skew	Sample skew	Historically adjusted record length (No. of years)	Maximum peakflow (ft^3/s)	Water year of maximum peak	Approximate recurrence interval of maximum peak (years)
5592575	Hickory Creek nr Brownstown, Ill.	1989-99	11	-0.188	-0.264	11	6,250	1994	10
5592800	Hurricane Creek near Mulberry Grove, Ill.	1971-99	29	-.429	-1.206	29	17,900	1983	25
5592900	East Fork Kaskaskia River near Sandoval, Ill.	1980-99	19	-.171	.023	19	17,000	1990	60
5593000	Kaskaskia River at Carlyle, Ill.	1908-67	44	-.137	-.973	44	54,400	1943	50
5593520	Crooked Creek near Hoffman, Ill.	1975-98	24	-.205	-.138	24	26,900	1990	80
5593575	Little Crooked Creek near New Minden, Ill.	1968-99	32	-0.270	-0.837	32	11,900	1995	20
5593600	Blue Grass Creek near Raymond, Ill.	1961-91	31	-.308	-.773	31	2,140	1973	50
5593700	Blue Grass Creek Tributary near Raymond, Ill.	1959-71	13	-.151	.161	13	356	1966	50
5593900	East Fork Shoal Creek near Coffeen, Ill.	1964-99	36	-.186	-.644	36	5,910	1967	50
5594000	Shoal Creek near Breese, Ill.	1910-99	59	-.365	-.662	59	52,000	1943	>500
5594090	Sugar Creek at Albers, Ill.	1973-82	10	-0.439	-0.414	10	10,500	1973	20
5594200	Williams Creek near Cordes, Ill.	1956-72	17	-.084	.169	17	966	1968	20
5594330	Mud Creek near Marissa, Ill.	1971-82	12	-.007	.500	12	5,520	1979	20
5594450	Silver Creek near Troy, Ill.	1967-99	33	-.725	-1.028	33	10,600	1979	25
5594800	Silver Creek near Freeburg, Ill.	1971-99	29	-.656	-1.001	29	15,300	1995	30
5595000	Kaskaskia River at New Athens, Ill.	1908-71	50	-0.235	-0.183	50	83,000	1943	40
5595200	Richland Creek near Hecker, Ill.	1970-99	30	-.189	-.113	30	23,400	1996	150
5595500	Marys River near Sparta, Ill.	1949-71	23	.029	.344	23	7,760	1968	50
5595510	Lick Branch near Eden, Ill.	1959-72	14	.099	.693	14	777	1969	30
5595550	Marys River Tributary at Chester, Ill.	1959-73	15	-.080	.022	15	572	1959	25
5595730	Rayse Creek near Waltonville, Ill.	1980-99	20	-0.197	-0.228	20	21,200	1994	10
5595800	Sevenmile Creek near Mt. Vernon, Ill.	1961-82	22	-.111	-.031	22	2,530	1961	30
5595820	Casey Fork at Mount Vernon, Ill.	1986-99	14	-.165	-.153	14	16,100	1990	15
5596000	Big Muddy River near Benton, Ill.	1946-70	25	.019	.272	25	38,600	1961	60
5596100	Andy Creek Tributary at Valier, Ill.	1956-72	17	-.181	-.332	17	835	1970	25
5597000	Big Muddy River at Plumfield, Ill.	1909-70	60	0.383	-0.961	60	42,900	1961	>500
5597450	Crab Orchard Creek Tributary near Pittsburg, Ill.	1960-72	13	.347	1.039	64	438	1961	250
5597500	Crab Orchard Creek near Marion, Ill.	1952-99	48	-.057	-.025	48	9,270	1996	200
5599000	Beaucoup Creek near Matthews, Ill.	1946-82	36	-.043	.070	36	18,800	1961	30
5599500	Big Muddy River at Murphysboro, Ill.	1916-70	43	-.357	-.956	43	33,300	1961	25
5599560	Clay Lick Creek near Makanda, Ill.	1960-76	17	0.175	0.614	17	3,000	1969	50
5599580	Big Muddy River Tributary near Gorham, Ill.	1961-76	16	.055	.230	16	114	1965	20
5599640	Green Creek Tributary near Jonesboro, Ill.	1956-80	25	-.147	-.521	25	605	1965	15
5599800	Orchard Creek near Fayville, Ill.	1961-72	12	.166	.291	12	148	1961	15
5600000	Big Creek near Wetaug, Ill.	1942-99	58	.476	.875	58	7,200	1943	>500

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