science for a changing world

TECHNIQUES FOR ESTIMATING FLOOD-FREQUENCY DISCHARGES FOR STREAMS IN IOWA

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 00-4233

Prepared in cooperation with the
IOWA DEPARTMENT OF TRANSPORTATION
and the IOWA HIGHWAY RESEARCH BOARD
(Project HR-395A)

Front cover: Shaded relief map of Iowa (from U.S. Geological Survey digital elevation model (DEM) data).

TECHNIQUES FOR ESTIMATING FLOOD-FREQUENCY DISCHARGES FOR STREAMS IN IOWA

By David A. Eash

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 00–4233

Prepared in cooperation with the

IOWA DEPARTMENT OF TRANSPORTATION

and the IOWA HIGHWAY RESEARCH BOARD

(Project HR-395A)

Iowa City, Iowa
2001

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

For additional information write to:

District Chief
U.S. Geological Survey, WRD
Room 269, Federal Building
P.O. Box 1230
400 South Clinton Street
Iowa City, IA 52244

Copies of this report can be purchased from:

U.S. Geological Survey
Information Services
Box 25286
Denver, CO 80225-0286

CONTENTS

FIGURES

TABLES

CONVERSION FACTORS, ABBREVIATIONS, AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
foot per mile (ft/mi)	0.1894	meter per kilometer
mile per square mile (mi/mi^2)	0.621	kilometer per square kilometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

Sea level: In this report, “sea level” refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Water year: In U.S. Geological Survey reports dealing with surface-water supply, a water year is the 12-month period October 1 through September 30. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. Thus, the year ending September 30, 1997, is called the “1997 water year.”

Techniques for Estimating Flood-Frequency Discharges for Streams in Iowa

By David A. Eash

ABSTRACT

A statewide study was conducted to develop regression equations for estimating flood-frequency discharges for ungaged stream sites in Iowa. Thirty-eight selected basin characteristics were quantified and flood-frequency analyses were computed for 291 streamflow-gaging stations in Iowa and adjacent States. A generalized-skew-coefficient analysis was conducted to determine whether generalized skew coefficients could be improved for Iowa. Station skew coefficients were computed for 239 gaging stations in Iowa and adjacent States, and an isoline map of generalized-skew-coefficient values was developed for Iowa using variogram modeling and kriging methods. The skew map provided the lowest mean square error for the generalized-skew-coefficient analysis and was used to revise generalized skew coefficients for flood-frequency analyses for gaging stations in Iowa.

Regional regression analysis, using generalized least-squares regression and data from 241 gaging stations, was used to develop equations for three hydrologic regions defined for the State. The regression equations can be used to estimate flood discharges that have recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years for ungaged stream sites in Iowa. One-variable equations were developed for each of the three regions and multi-variable equations were developed for two of the regions. Two sets of equations are presented for two of the regions because one-variable equations are considered easy for users to apply and the predictive accuracies of multi-variable equations are greater. Standard error of prediction for the one-variable equations ranges from about 34 to 45 percent and for the multi-variable equations ranges from about 31 to 42 percent.

A region-of-influence regression method was also investigated for estimating flood-frequency discharges for ungaged stream sites in Iowa. A comparison of regional and region-of-influence regression methods, based on ease of application and root mean square errors, determined the regional regression method to be the better estimation method for Iowa.

Techniques for estimating flood-frequency discharges for streams in Iowa are presented for determining (1) regional regression estimates for ungaged sites on ungaged streams; (2) weighted estimates for gaged sites; and (3) weighted estimates for ungaged sites on gaged streams. The technique for determining regional regression estimates for ungaged sites on ungaged streams requires determining which of four possible examples applies to the location of the stream site and its basin. Illustrations for determining which example applies to an ungaged stream site and for applying both the one-variable and multi-variable regression equations are provided for the estimation techniques.

INTRODUCTION

Reliable estimates of flood-frequency discharges are essential for the economical planning and safe design of bridges, dams, levees, and other structures located along rivers and streams and for the effective management of flood plains. Techniques that are as accurate as possible, yet relatively easy to apply, are needed to estimate flood-frequency discharges at ungaged stream sites in Iowa because long-term peak-flow data are available at relatively few gaged sites.

Streamflow-gaging stations operated by the U.S. Geological Survey (USGS) are the primary source of long-term peak-flow data in Iowa. Regression analyses performed on data collected at gaging stations are used to develop equations to estimate flood-frequency discharges at ungaged sites. The equations are developed by relating flood-frequency discharges to significant basin characteristics for selected gaging stations. Flood-frequency discharges computed for gaging stations are statistics that can change as more data become available (Eash, 1997). Statistics become more reliable as longer-term data are collected and used in the computations.

In response to the need to update and improve the predictive accuracy of estimates of flood-frequency discharges for ungaged stream sites in Iowa, the USGS, in cooperation with the Iowa Department of Transportation and the Iowa Highway Research Board, initiated a statewide study in 1998. This study updates flood-frequency estimation equations for streams in Iowa with data collected through September 30, 1997.

Several improvements in analytical procedures, computer technologies, and digital-data sources recently became available and were used in this study. Kriging, a geostatistical method, was used to develop a generalized-skew-coefficient map for Iowa. Larger scale digital line graph hypsography data (1:100,000) and digital soils data (1:250,000) were used to more accurately quantify basin characteristics for gaging stations. A geographic information system (GIS) and Basinsoft (Harvey and Eash, 1996), a GIS procedure, were used to spatially analyze digital data and to quantify several additional basin characteristics. Generalized least-squares regression was used to weight regression analyses to improve the predictive accuracies of flood-frequency equations.

Purpose and Scope

The purposes of this report are to (1) present the results of a generalized-skew-coefficient analysis to determine whether generalized skew coefficients can be improved for Iowa; (2) describe the compilation of basin-characteristic and flood-frequency data sets for streamflow-gaging stations and the use of statewide, drainage-area, regional, and region-of-influence regression methods to develop estimation equations; and (3) present and describe techniques for estimating flood-frequency discharges for streams in Iowa that include equations with the greatest predictive accuracy using whichever regression method and basin characteristics that produce them and include equations that are considered easy for the user to apply. This report is the sixth in a series of reports presenting techniques for estimating flood-frequency discharges for streams in Iowa. Previous studies for Iowa were conducted by Schwob (1953, 1966), Lara (1973, 1987), and Eash (1993).

Techniques for estimating flood-frequency discharges described in this report are applicable to streams in Iowa that are not significantly affected by regulation, diversion, channelization, or urbanization. The estimation equations presented in this report are limited to streams with drainage areas ranging from 1.3 to 5,452 mi^2. Estimation equations were developed for flood discharges that have recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years.

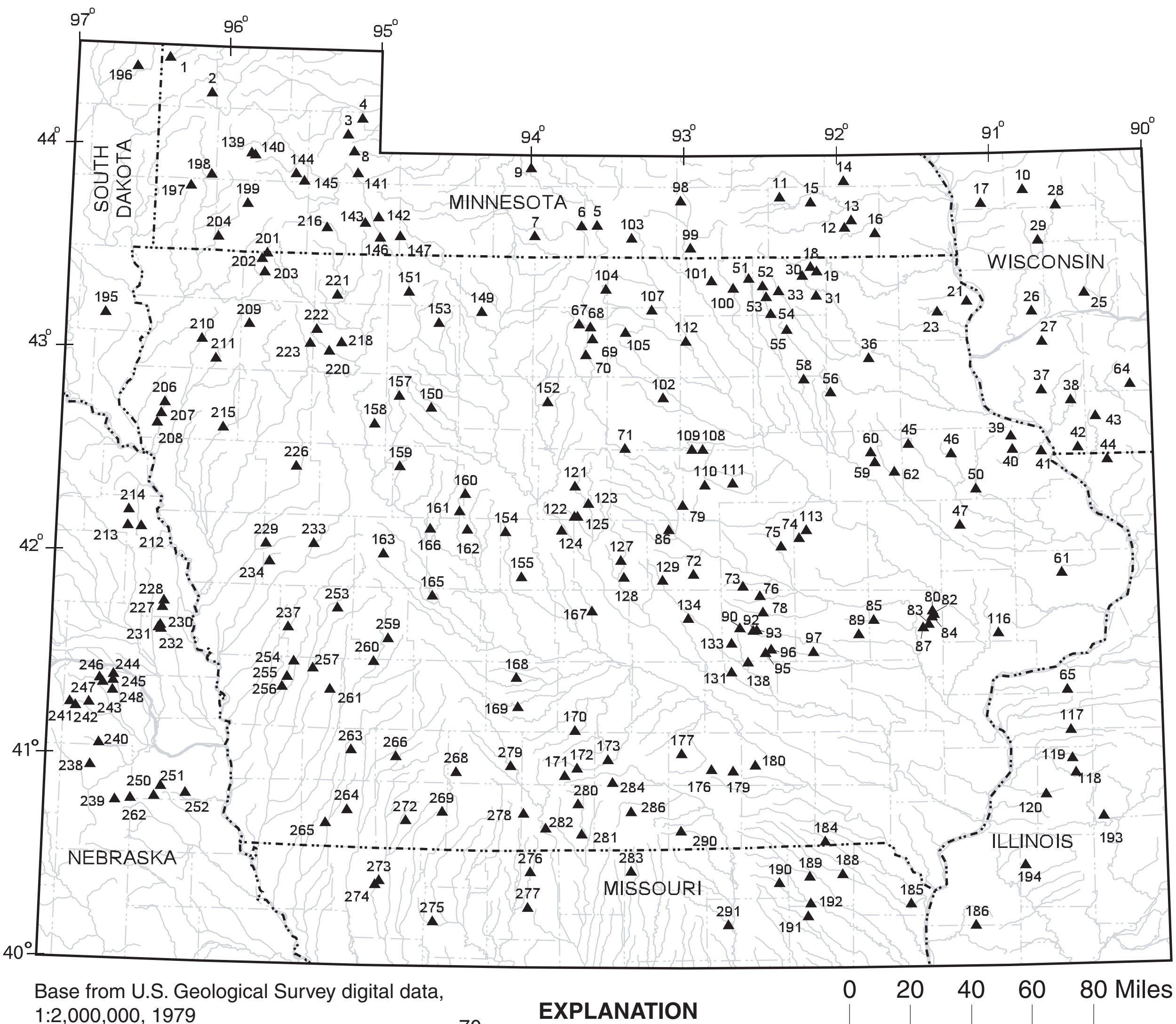
Acknowledgments

The author gratefully acknowledges the following USGS personnel: Gary Tasker, for his assistance with the generalized least-squares and region-of-influence analyses; Mike Karlinger, for his assistance with the variogram modeling and kriging analysis; Craig Harvey, for his work to create a digital elevation model (DEM) for the study area; Jan Ballew and Laura McClain, for their work to quantify basin characteristics using Basinsoft; Brian Lanning, for his work to edit digital line graph (DLG) data and perform regression analyses; and Dan Christiansen and Kelli DeBrower, for their work to edit DLG data.

The information contained herein is based on data collected by the U.S. Army Corps of Engineers, the National Weather Service, the USGS, and several State and local agencies. Appreciation is expressed to the personnel in these agencies who were involved with collection of data. The flood data used in this study often were collected during adverse conditions, and the efforts of these individuals made this study possible.

ANALYTICAL PROCEDURES

A study area surrounding Iowa, denoted by the map border shown in figure 1, was defined by a latitude and longitude to include all of Iowa and parts of adjacent States. All USGS continuous-record and high-



Base from U.S. Geological Survey digital data, 1:2,000,000, 1979
Universal Transverse Mercator projection, Zone 15

EXPLANATION

▲70 Gaging station and map number (referenced in tables 1 and 2)

Figure 1.--Location of basin centroids for streamflow-gaging stations used to develop generalized-skew-coefficient isolines for Iowa.

flow, partial-record (crest-stage) streamflow-gaging stations in Iowa and adjacent States with basins completely within the study area were evaluated for inclusion in the study. Gaging stations in Iowa with peak-flow records of 10 years or longer and gaging stations in adjacent States with records of 25 years or longer were selected for the study. Gaging stations were also selected on the basis of the following criteria: peak-flow records were not significantly affected by regulation, diversion, channelization, or urbanization; peak-flow records did not indicate a significant trend using Kendall’s Tau analysis; and gaged streams were defined for 1:100,000-scale digital line graph (DLG) hydrography data.

A total of 291 gaging stations were identified for inclusion in the study--197 gaging stations in Iowa and 94 gaging stations in adjacent States. These gaging stations are listed in table 1 (at end of report).

Quantification of Basin Characteristics

Thirty-eight selected basin characteristics were quantified for each of the 291 gaging stations for use as explanatory variables in the regression analyses. These basin characteristics are described in appendix A.

Two of the basin characteristics were manually measured from USGS topographic maps. Drainage area (DA) measurements were obtained from the USGS’s National Water Information System (NWIS) data base and are the published drainage areas for gaging stations. The majority of the DA measurements were planimetered from basin boundaries delineated on 1:24,000-scale topographic maps. The majority of the main-channel slope (MCS) measurements were obtained from previous studies (Schwob, 1966; Burmeister, 1970; Lara, 1973; Curtis, 1987; Krug and others, 1992; Alexander and Wilson, 1995; Lorenz and others, 1997; and Soenksen and others, 1999). Manual measurements of MCS were made from 1:24,000-scale topographic maps for several of the gaging stations included in this study that were not measured in previous studies.

Thirty-six of the basin characteristics were quantified using Basinsoft, a computer program developed to run with ARC/INFO (Environmental Systems Research Institute, Inc., 1998), a GIS. See Harvey and Eash (1996) for a description of Basinsoft. Twenty-eight of the 36 characteristics were quantified using the main program of Basinsoft, which requires the generation of four source-data layers, three coverages and one lattice, representing the drainage divide, hydrography (stream network), hypsography (elevation contours), and a lattice elevation model of a basin, and the attribution of the three source-data layer coverages. The four source-data layers required by Basinsoft were generated in this study from three digital data sources: (1) 1:100,000-scale digital line graph (DLG) hydrography data; (2) 1:100,000-scale DLG hypsography data; and (3) 1:100,000-scale digital elevation model (DEM) data. The DEM was created for the study area from the DLG hypsography and hydrography data prior to processing with Basinsoft.

Eight of the 36 characteristics were quantified using an optional area-weighting program of Basinsoft. The area-weighting program requires the creation of a multi-polygonal data layer representing the distribution of a characteristic. For this study, multi-polygonal data layers representing one landform characteristic, two precipitation characteristics, and five soil characteristics were created for the study area. See appendix A (at end of report) for a description of the basin characteristics quantified using Basinsoft.

Flood-Frequency Analyses at Gaged Sites

Flood discharges that have recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years were computed for each of the 291 gaging stations for use as response variables in the regression analyses. The magnitude and frequency of flood discharges or flood-frequency discharges for a streamflow-gaging station are determined from a flood-frequency analysis that relates observed annual peak flows to annual exceedance probability or recurrence interval. Annual exceedance probability is expressed as the chance that a specified flood magnitude will be exceeded in any 1 year. Recurrence interval, which is the reciprocal of the annual exceedance probability, is the statistical average number of years between exceedances of a specified flood magnitude. For example, a flood with a magnitude that is expected to be exceeded on average once during any 100-year period (recurrence interval) has a 1-percent chance (annual exceedance probability = 0.01) of being exceeded during any particular year. This flood, commonly termed the 100-year flood, is the theoretical peak discharge against which actual flood-peak discharges generally are compared. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at shorter intervals or even within the same year.

In this study, the method described in Bulletin 17B of the Interagency Advisory Committee on Water Data (1982) was used to compute flood-frequency analyses. All flood-frequency analyses were computed by fitting a Pearson Type III distribution to the logarithms (base 10) of the annual peak discharges by means of the USGS PEAKFQ program (Kirby, 1981). These flood-frequency analyses include peak-flow data collected through September 30, 1997.

At least 10 years of gaged annual peak flows are required to compute flood-frequency analyses using the "Bulletin 17B" method. The record of annual peak flows for a gaging station includes the years during which the gage was operated, which is termed the "period of systematic record." The record also may include historical floods collected for years outside the period of systematic record. Annual peak flows, which are maintained in the USGS peak-flow file data base (in NWIS), were used to perform the flood-frequency analyses described in this report. Data from the USGS peak-flow file data base can be obtained from the World Wide Web at URL (uniform resource locator) <http://waterdata.usgs.gov/nwis-w/US/>.

For flood-frequency analyses of gaging stations in Iowa, extremely small discharge values (low outliers) were censored and adjusted for, historical data were used to make adjustments for extremely large discharge values (high outliers), and a weighted skew coefficient was calculated for each gaging station using both the station skew and a generalized-skew-coefficient value obtained from a generalized-skew-coefficient analysis (described in following section). Whenever possible, historical flood data or historical information were used to extend the peak-flow record for Iowa gaging stations. Flood-frequency analyses for gaging stations in adjacent States were performed using the same computational procedures used by the respective USGS offices. Flood-frequency analyses for 95 of the 291 selected gaging stations were adjusted for historical data or information, whereas analyses for the other 196 gaging stations were based only on their period of systematic record.

Table 2 (at end of report) lists the flood-frequency discharges computed for the 291 gaging stations. Included in table 2 is a list of the generalized skew coefficients that were used to weight the station skews in the flood-frequency analyses.

Generalized-Skew-Coefficient Analysis

Bulletin 17B of the Interagency Advisory Committee on Water Data (1982) recommends the use of weighted skew coefficients for the computation of flood-frequency analyses. Weighted skew coefficients are calculated using both the station skew and a generalized skew coefficient developed from many long-term gaging stations in the region. Weighted skew coefficients provide a better estimate of the skew coefficient for a gaging station.

As part of the computation of flood-frequency analyses, a generalized-skew-coefficient analysis was conducted to determine whether generalized skew coefficients could be improved for Iowa. The generalized skew coefficient for a gaging station can be estimated using the nationwide isoline map of generalized-skew-coefficient values presented in Bulletin 17B or by using one of three regional skew-analysis procedures described in Bulletin 17B to estimate generalized skew coefficients. The nationwide skew map in Bulletin 17B was intended to be used in the absence of a detailed regional study. Bulletin 17B recommends three alternative procedures for estimating generalized skew coefficients in a regional study: (1) compute the mean station skew for a region, (2) develop a regression equation that relates station skews to basin characteristics, and (3) plot station skews at the centroids of their basins and develop an isoline map. Mean square errors (MSE's) calculated for the procedures were compared to evaluate the predictive accuracy of the procedures and to determine whether generalized skew coefficients can be improved for Iowa. The MSE was computed as the arithmetic mean of the square of the differences between the skew-coefficient estimate (calculated using either the regional skew analyses or interpolated from the nationwide skew map in Bulletin 17B) and the station skew computed from the flood-frequency analysis.

Flood-frequency analyses were performed to compute station skew coefficients for 239 gaging stations with 25 or more years of record using the USGS program PEAKFQ (Kirby, 1981) and Bulletin 17B guidelines. Figure 1 shows the location of basin centroids, and table 2 lists the station skew coefficients computed for these gaging stations. The analyses were performed using annual peak-flow data collected through September 30, 1997, for 145 gaging stations in Iowa and 94 gaging stations in adjacent States. Adjustments were made for historical data and for low-value outliers. Analyses for gaging stations in adjacent

States were performed using the same computational procedures used by the respective USGS offices.

Tasker and Stedinger (1986) discuss the use of a bias-correction factor for station skews. The bias in skew coefficients primarily results from relatively short-term records for gaging stations; however, the effect of the bias decreases with longer term records. Because of the relatively long period of record available for this generalized-skew-coefficient analysis (at least 25 years) and inclusion of historical data, the bias-correction factor was not used.

A mean square error (MSE) of 0.272 was calculated for the 145 gaging stations in Iowa from generalized skew coefficients interpolated from the nationwide skew map in Bulletin 17B using the PEAKFQ program. This MSE of 0.272 from the nationwide skew map is the base value for comparing and evaluating MSE values calculated from the three regional skew-analysis procedures recommended in Bulletin 17B.

For the first regional skew-analysis procedure, an MSE of 0.217 was computed for a mean skew-coefficient value of -0.168 that was calculated from the station skews for the 145 gaging stations in Iowa. For the second procedure, a regression analysis was performed using station-skew and basin-characteristic data collected for the 239 gaging stations. The 38 basin characteristics listed in appendix A were investigated for use in the regression analysis. A three-variable regression equation was developed with an MSE of 0.199 and a coefficient of determination (R^2) of 0.082. A split-sampling analysis was performed to test the accuracy of the regression. The data set of 239 gaging stations was split into thirds, and two of the three subsets of data were used to estimate skew-coefficient values for the third subset. The accuracy of the regression equation was verified by the fact that the MSE from each split-sampled data set was lower than the MSE for the nationwide skew map in Bulletin 17B. The regression equation was:

$$GSkew = -0.157 - (0.00682)\,(CDA)^{0.5} + (0.000637)\,(SLOPEH)^2 + (0.0546)\,(PERML)^2$$

where GSkew is the generalized-skew-coefficient estimate, and CDA, SLOPEH, and PERML are as described in appendix A.

For the third regional skew-analysis procedure, an isoline map of generalized-skew-coefficient values (fig. 2) was developed for Iowa with an MSE of 0.156. Because the MSE value (0.156) for the Iowa skew map was the lowest of the three regional skew-analysis procedures and was lower than the MSE (0.272) calculated from the nationwide skew map in Bulletin 17B, the Iowa skew map was used to revise generalized skew coefficients for flood-frequency analyses for gaging stations in the State. The remainder of the information presented in this section describes the generalized-skew-coefficient analysis performed to develop the Iowa skew map.

Station skew coefficients were plotted at the centroids of basins and a uniform grid of estimated skew coefficients was developed for the study area by kriging the point data for the 239 gaging stations. ARC/INFO (Environmental Systems Research Institute, Inc., 1998) was used to determine the locations of the centroids of the basins. The grid was contoured to create the isoline map of generalized-skew-coefficient values (fig. 2).

Kriging is a geostatistical method that determines optimal weights for measurements at sampled locations for the estimation of values at unsampled locations. Prior to kriging, variogram modeling is used to characterize the degree of spatial correlation in the station skew data. The variogram model defines the linear weighting function used to krige the grid or lattice of skew estimates. An informative discussion of variogram modeling and kriging is presented in Bossong and others (1999).

Preliminary variogram modeling was performed using VARIOWIN (Pannatier, 1996), a variogram modeling software package. Station skew data were checked for nonstationarity and anisotropy. Nonstationarity indicates a trend or drift in the spatial mean of the data that requires removal prior to variogram modeling, and anisotropy indicates a directional trend in the spatial correlation of the data that requires directional variogram modeling. Station skew data were determined to be stationary and isotropic.

Figure 3 shows the variogram model that was developed for the station skew data plotted with a lag of 25,000 meters. The variogram shows a plot of gamma or the squared differences per pair of station skews as a function of lag or distance between gaging stations. The correlation between station skews at two gaging stations is assumed to depend on the distance between the two gaging stations. This dependence can be evaluated by squaring the difference between the station skews at each pair of gaging stations and then grouping the squared differences according to the

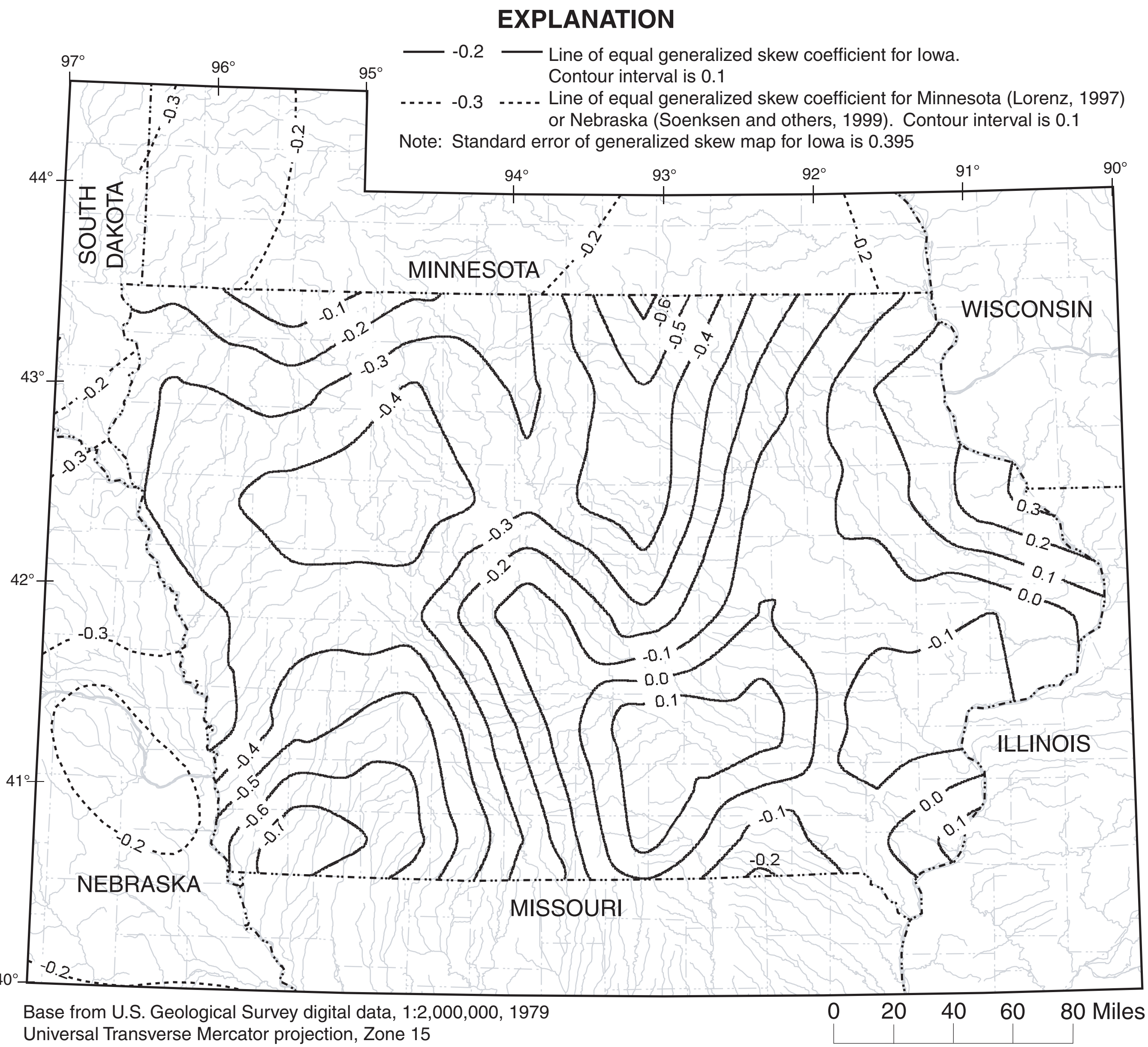


Figure 2.--Generalized-skew-coefficient isolines for Iowa.

distance between the paired locations. A model that is represented by a mathematical expression is fit to the variogram points to pass a smooth curve through the scattered points. A number of different variogram models were tested for best fit of the data and cross-validation estimation accuracy. Various lag intervals, sample sizes, and sample radii were also tested. The variogram model shown in figure 3 was developed using 230 of the 239 gaging stations. Nine outliers were removed from the data set to improve the fit of the variogram model to the data and to improve the estimation accuracy of the model. An exponential model was determined to provide the best fit and estimation accuracy for the station skew data. The exponential model parameters (Bossong and others, 1999) used to fit the variogram were nugget of 0.062, C-constant of 0.108, sill of 0.170, range of 120,000 meters, search radius of 100,000 meters, search maximum of 20 points, and search minimum of 6 points.

Final variogram modeling, cross-validation checking, and kriging were performed using GEO-EAS (Englund and Sparks, 1991). The parameters of preliminary variogram models were calibrated using a kriging cross-validation technique. In this technique, the fitted variogram is used in a series of sequential kriging analyses in which data points are individually deleted and estimates are made for the deleted point locations. After kriged values at all data point locations have been estimated, the kriged values and standard deviations of the data are used to obtain cross-validation statistics. A successful calibration is based on the criteria for these statistics. The cross validation statistics for the exponential model shown in figure 3 were MSE of 0.360, mean difference between station skews and estimated skews of 0.002, and reduced MSE of 1.049. The reduced MSE is used to determine whether the kriging variances produced by the model are within an acceptable range compared to the actual variances of the station skews.

Ordinary kriging was used to create a lattice of estimated generalized skew coefficients for the study area. All 239 station skew values were used in the kriging analysis to create the lattice, even though a reduced data set of 230 station skew values was used to develop the variogram model. Figure 1 shows the location of basin centroids for the 239 gaging stations used to develop the generalized-skew-coefficient isolines for Iowa. The lattice created from the kriging process was contoured using ARC/INFO to create the

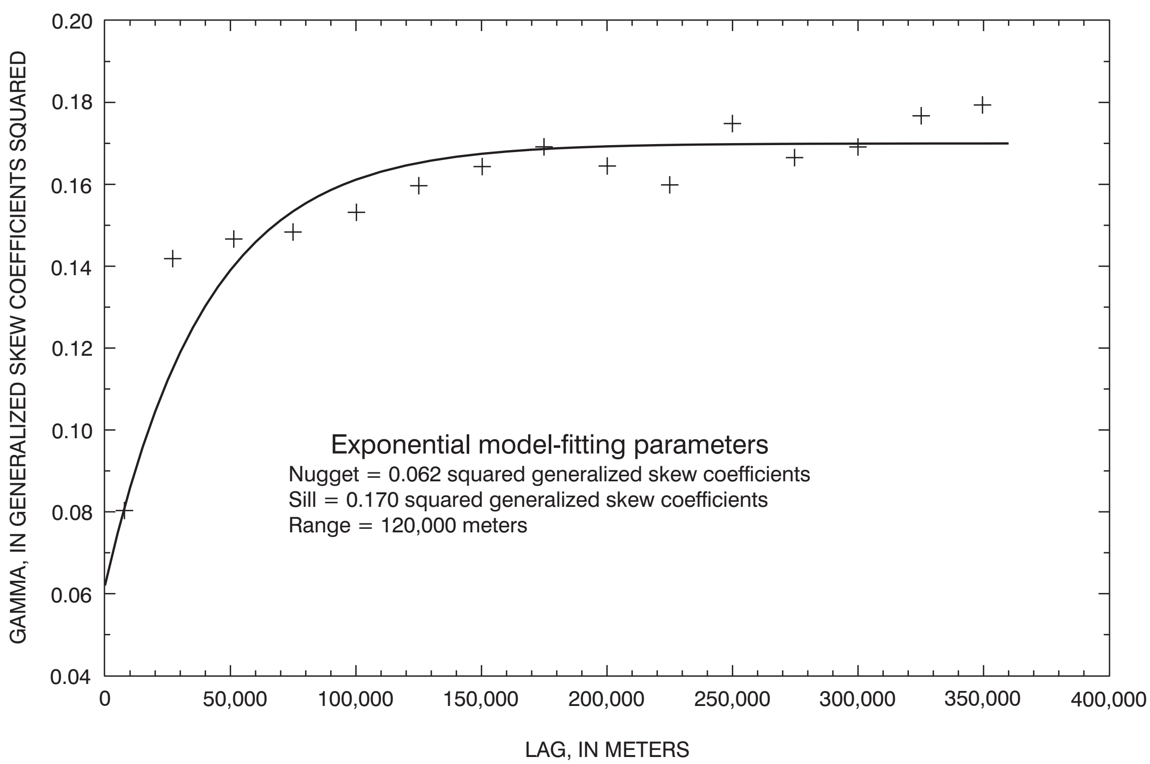


Figure 3.--Variogram used to krige estimates of generalized skew coefficients for Iowa.

isoline map. Several different grid sizes were tested during the kriging and contouring process to evaluate the detail and generality of isoline delineations. A grid spacing of 62,500 meters was determined to provide the best balance between creating an isoline map with the lowest MSE and isoline delineations considered to provide the best level of detail and generality. To improve the appearance of the final skew map (fig. 2), ARC/INFO was used to filter the lattice and to spline the isolines to smooth slightly the angularity of the delineations. An MSE computed for the final isoline map is 0.156, and the standard error of the generalized skew estimates for the map is 0.395.

Figure 4 shows the standard deviations of kriged estimates for the lattice that was contoured to create the Iowa skew map (fig. 2). Standard deviations for kriged skew estimates for Iowa range from 0.32 to 0.40. The standard deviations indicate that estimation accuracy is generally uniform throughout the State.

Figure 2 shows isolines of generalized-skew-coefficient values developed for Minnesota (Lorenz, 1997) and Nebraska (Soenksen and others, 1999) (some of which extend into South Dakota). Although some edge-matching discrepancies are evident between skew isolines delineated for each State, general patterns and values for skew isolines were in agreement. Some possible explanations for the edge-matching discrepancies include (1) differences in the contouring methods used to delineate the isolines; (2) differences in the number and location of station skews used in the skew analyses; (3) differences in periods of record used for the skew analyses; and (4) differences in computational procedures used for calculating station skews in flood-frequency analyses used in the skew analyses.

Figure 2 is applicable for determining generalized-skew-coefficient values for stream sites in Iowa by using visual approximation or GIS to interpolate a skew value for the centroid of a basin from the skew map. ARC/INFO was used to interpolate a revised generalized-skew-coefficient value for all 197 Iowa gaging stations included in this study. Flood-frequency discharges used in the regression analyses for the gaging stations in Iowa were computed using revised generalized-skew-coefficient values interpolated from the skew map (fig. 2). Table 2 lists the generalized skew coefficients used to compute flood-frequency discharges for the 291 gaging stations included in this study. In general, flood-frequency discharges for gaging stations in Iowa increased as a result of the revisions to the generalized skew coefficients. Differences between 100-year recurrence-interval discharges computed using revised and superseded generalized-skew-coefficient values are summarized below.

Statistic	Percentage difference
Maximum	33.6
Minimum	-9.98
Mean	6.70
Median	5.23

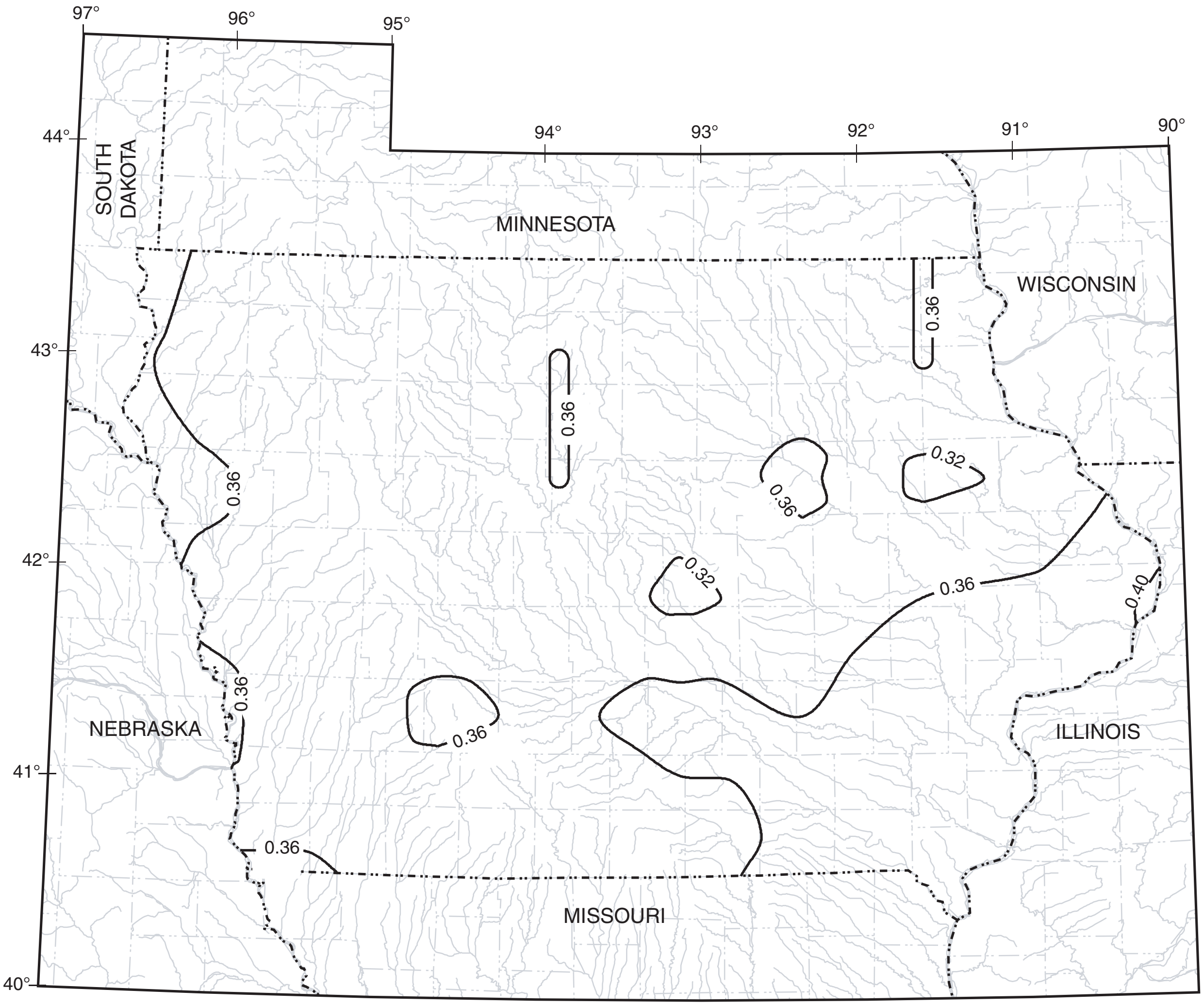
Revised 100-year flood discharge	Number of Iowa gaging stations
Increased	165
Decreased	29
No change	3
Total	197

Flood-frequency curves computed for an example gaging station using superseded and revised generalized-skew-coefficient values are shown in figure 5. For this example (fig. 5), use of the revised generalized skew coefficient increased the 100-year recurrence-interval discharge (1 percent annual exceedance probability) by about 4 percent.

Regression Methods

Four regression methods were investigated for estimating flood-frequency discharges for ungaged stream sites in Iowa. Regression analyses were used to relate basin characteristics (explanatory variables) to flood-frequency discharges (response variables) that have recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years. The 38 basin characteristics listed in appendix A were investigated for use in the regression analyses. Data collected for the 291 gaging stations were compiled into statewide, regional, drainage-area, and region-of-influence data sets for regression analyses. Root mean square errors (RMSE's) calculated for equations developed for each regression method were compared to evaluate the predictive accuracy of the equations.

Statewide regression equations were developed using all 291 gaging stations in the data set and using only the 197 gaging stations in Iowa. Drainage-area regression equations were developed for different ranges of drainage areas. Equations developed for the statewide and drainage-area regression methods are not listed because RMSE's are larger than those for the regional or region-of-influence regression methods.



Base from U.S. Geological Survey digital data, 1:2,000,000, 1979
Universal Transverse Mercator projection, Zone 15

0 20 40 60 80 Miles

EXPLANATION

—— 0.36 —— Line of equal standard deviation. Contour interval is 0.04

Figure 4.--Standard deviations of skew estimates for the lattice that was contoured to create the generalized-skew-coefficient isolines for Iowa (fig. 2).

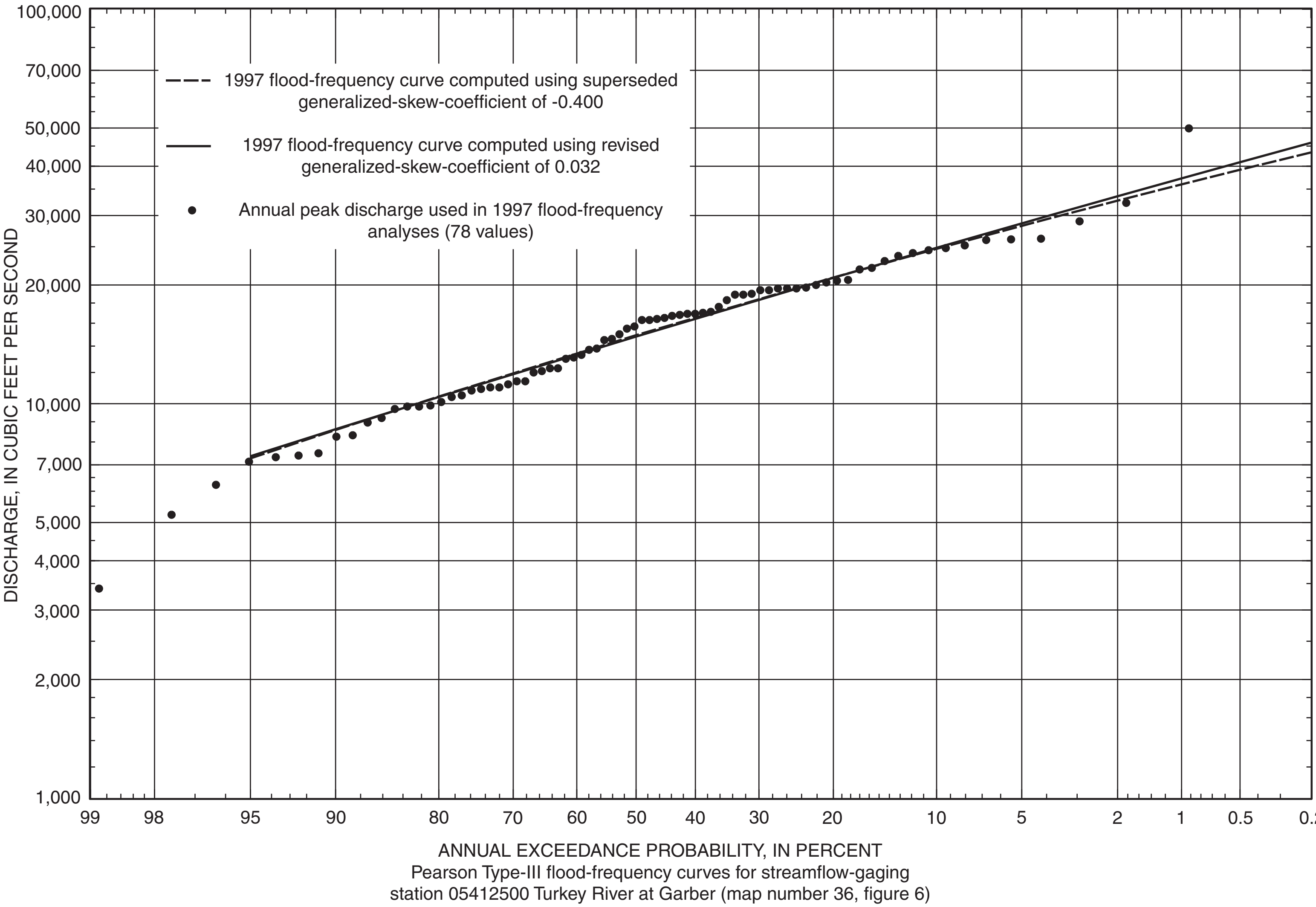


Figure 5.--Examples of flood-frequency curves computed using superseded and revised generalized-skew-coefficient values.

Regional Analysis

Ordinary least-squares (OLS) multiple-regression procedures were used to develop preliminary flood-frequency estimation equations, or models. Final equations were developed using generalized least-squares (GLS) regression procedures. OLS regression procedures were used to identify the best combinations of basin characteristics to use as explanatory variables in the development of regression models and to define hydrologic regions.

Logarithmic transformations (base 10) were performed for both the response and explanatory variables used in all of the OLS and GLS regression analyses. Data transformations were used to obtain a more constant variance of the residuals about the regression line and to linearize the relation between the response variable and the explanatory variables. The response variable is assumed to be a linear function of one or more of the explanatory variables.

Several basin characteristics were deleted from the regression data set because of multicollinearity. Multicollinearity is the condition wherein at least one explanatory variable is closely related to (that is, not independent of) one or more other explanatory variables. Regression models that include variables with multicollinearity may be unreliable because coefficients in the models may be unstable. Correlation coefficients and plots of the data were used as guides in identifying the variables with multicollinearity. The hydrologic validity of variables with multicollinearity in the context of flood runoff was the principal criterion used in determining which basin characteristics were deleted from the data set.

OLS regression analyses were performed using the Statit statistical procedures ALLREG and REGRES (Statware, Inc., 1992). Initial selections of significant explanatory variables for the OLS regression models were performed by using the ALLREG procedure. The ALLREG procedure uses an all-possible subsets regression to identify the best possible combinations of explanatory variables on the basis of the Mallows' C_p statistic (Mallows, 1973). The REGRES procedure used standard linear-regression algorithms to perform an OLS regression analysis on each best possible combination of explanatory variables. The final selection of explanatory variables was based on the following criteria (Koltun and Roberts, 1990):

(1) The selection of explanatory variables, and the signs and magnitudes of their respective regression coefficients, needs to be hydrologically valid in the context of flood runoff. This criterion takes precedence over all other criteria.

(2) All explanatory variables should be statistically significant at the 95-percent confidence level.

(3) The selection of explanatory variables, within the constraints of criteria 1 and 2, should minimize the prediction error sum of squares [the PRESS statistic, an index of the prediction error associated with the regression equation (Allen, 1971; Montgomery and Peck, 1982)], maximize the coefficient of determination (R^2, a measure of the proportion of the variation in the response variable accounted for by the regression equation), and minimize the standard error of estimate. Correlation between explanatory variables and the variance inflation factor (VIF) (Marquardt, 1970; Montgomery and Peck, 1982) was used to assess multicollinearity in the regression models. Multicollinearity problems were identified with the REGRES procedure by checking each explanatory variable for VIF greater than 10.

Residual values (differences between flood-frequency estimates (log-Pearson Type III) and regression-equation estimates) from the statewide regression analyses were plotted at gaging-station locations to identify spatial trends in the predictive accuracy of the regression equations. Differences in plotted residual values for the gaging stations were grouped to define general regions (hereafter referred to as hydrologic regions) within the study area. Gaging stations were grouped into regression subsets on the basis of hydrologic regions, and OLS multiple-regression analyses were performed for each region. Root mean square errors (RMSE's) computed for each region were compared to RMSE's for the statewide regressions to evaluate improvements in predictive accuracies.

Hydrologic regions defined by Lara (1987), landform regions defined by Prior (1991), regions defined by major basin boundaries, and several other combinations of geographic regions were evaluated in this manner. GIS analyses were used to produce shaded maps of land-surface slopes and soil-permeability rates to aid in defining hydrologic regions for purposes of this study. Six potential hydrologic regions were identified for Iowa in this process.

The six hydrologic regions were tested for significant differences by comparing the intercept for each region's regression model to that for the rest of the study area by assigning a location variable for each region. Each variable was set either at 1, if the gaging station was in a particular region, or 0, if not. A two-variable OLS regression analysis that included drainage area and the location variable was performed statewide for 100-year recurrence-interval discharges for each of the hydrologic regions. Statistical significance for each region was determined using a 95-percent confidence level. Statistical significance for the location variable indicates a difference in the intercept between gaging stations in that region and gaging stations in the rest of the study area. On the basis of the testing, four of the six hydrologic regions were not statistically independent and they were combined to form one region. Three hydrologic regions were thus defined for Iowa; each region was determined to be significantly different from the other two regions.

Several preliminary OLS regression models were developed for each of the three hydrologic regions. Gaging stations that poorly fit the linear regressions were identified as regional outliers. Outliers were inspected for data accuracy and for best regional fit if they were located near a regional border. Three gaging stations in Iowa were deleted from the regression data set on the basis of channelization. Two other gaging stations in Iowa with drainage areas less than 1 mi^2 were also deleted from the data set. Because the majority of gaging stations in the data set with drainage areas less than 1 mi^2 were identified as regional outliers, a 1-mi^2 lower limit was established for the regional regression analysis.

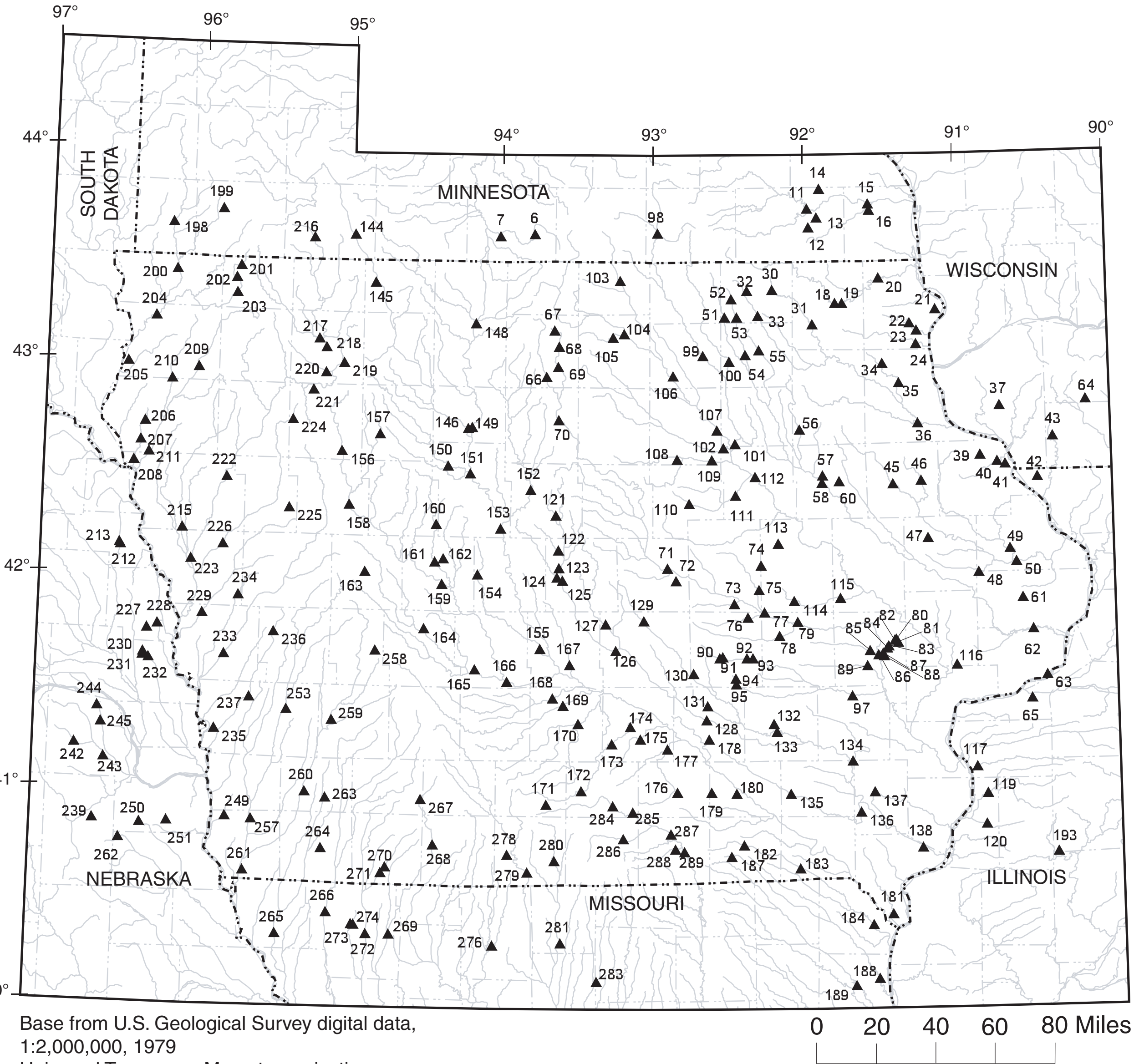
Several gaging stations located in adjacent States were identified as regional outliers. Several basin characteristics identified as the most significant explanatory variables in the preliminary OLS regressions were compiled for each hydrologic region. Ranges between minimum and maximum values for these significant basin characteristics were compiled for gaging stations in Iowa for each hydrologic region. Values measured for these basin characteristics for gaging stations in adjacent States were compared to the ranges in values determined for the gaging stations in Iowa for each region. Those gaging stations in adjacent States with basin-characteristic values outside the range of those measured for gaging stations in Iowa were deleted from the regression data set. Of the 94 gaging stations located in adjacent States, 45 of them were deleted because they had basin-characteristic values outside the range of those measured for gaging stations in Iowa. Several of these gaging stations were regional outliers.

The deletion of 50 gaging stations from the original data set of 291 left 241 gaging stations in the regression data set--or 192 gaging stations in Iowa and 49 in adjacent States. Figure 6 shows the location of the 241 gaging stations used to develop regional flood-frequency equations for Iowa. Predictive accuracies were improved for each hydrologic region as a result of deletion of several of the regional outliers.

Figure 7 shows the three hydrologic regions delineated for Iowa for which flood-frequency estimation equations were developed. These regions were defined on the basis of residuals from the regression analyses and on physiographic characteristics of the State. Where possible, regional boundaries were delineated along basin divides.

Region 1 is located in north-central Iowa (fig. 7) and contains approximately 15 percent of the total land area of the State. Figure 8 shows that Region 1 is located entirely within the Des Moines Lobe landform region, with the exception of the northeast boundary, which extends east into the Iowan Surface landform region. Region 1 comprises about 67 percent of the Des Moines Lobe and about 6 percent of the Iowan Surface landform regions. The Des Moines Lobe landform region is characteristic of a young, postglacial landscape that is unique with respect to the rest of the State (Prior, 1991). The Des Moines Lobe generally comprises low-relief terrain, accentuated by natural lakes, potholes, and marshes, where surface-water drainage typically is poorly defined and sluggish. Figure 9 shows land-surface slopes based on 1:250,000-scale digital elevation model data. The darker blue areas in figure 9 indicate areas of low slopes, and Region 1 contains the most extensive areas of low slopes in the State. The boundary defining Region 1 was delineated on the basis of regression residuals, areas of low slopes (fig. 9), and the limit of the Altamont glacial advance (fig. 8) (Prior, 1991; Tim Kemmis, Iowa Geological Survey Bureau, written commun., March 2000).

Region 2 is located in eastern, western, and central Iowa (fig. 7); it contains approximately 74 percent of the total land area of the State and it comprises, either entirely or partially, all the State’s landform regions (fig. 8). All of the Paleozoic Plateau, Northwest Iowa Plains, Loess Hills, and Missouri Alluvial Plain landform regions are within Region 2; about 94 percent of the Iowan Surface, about 90 percent of the Mississippi Alluvial Plain, about 78 percent of the Southern Iowa Drift Plain, and about 33 percent of the Des Moines Lobe landform regions are within Region 2. Region 2 was defined as the area remaining following the definition of Regions 1 and 3. Four potential hydrologic regions initially identified within Region 2 were not significantly different and were combined to form one region.



Base from U.S. Geological Survey digital data,
1:2,000,000, 1979
Universal Transverse Mercator projection,
Zone 15

EXPLANATION

▲70 Gaging station and map number (referenced in tables 1 and 2)

Figure 6.--Location of streamflow-gaging stations used to develop regional flood-frequency equations for Iowa.

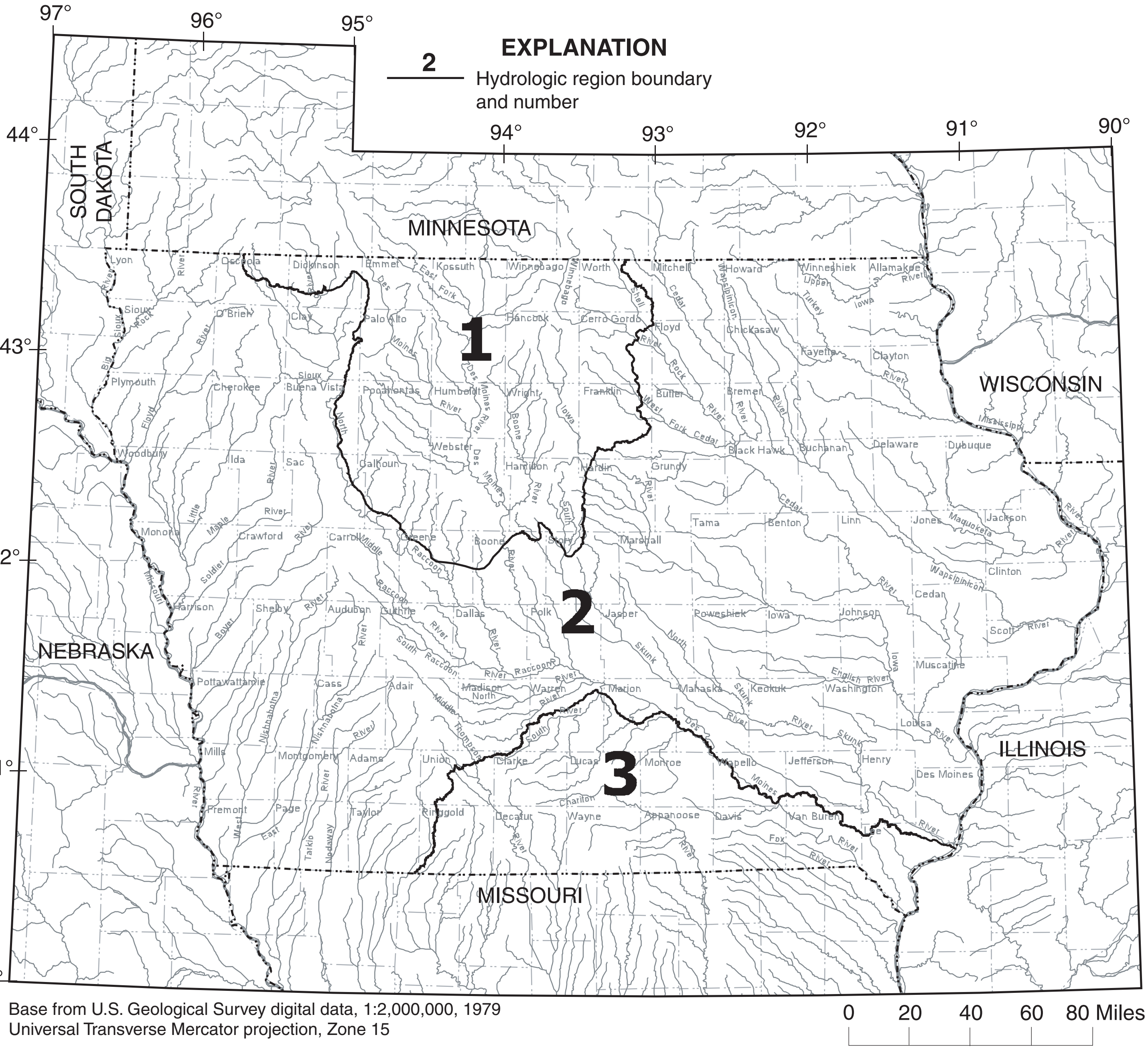


Figure 7.--Hydrologic regions in Iowa for flood-frequency estimation equations.

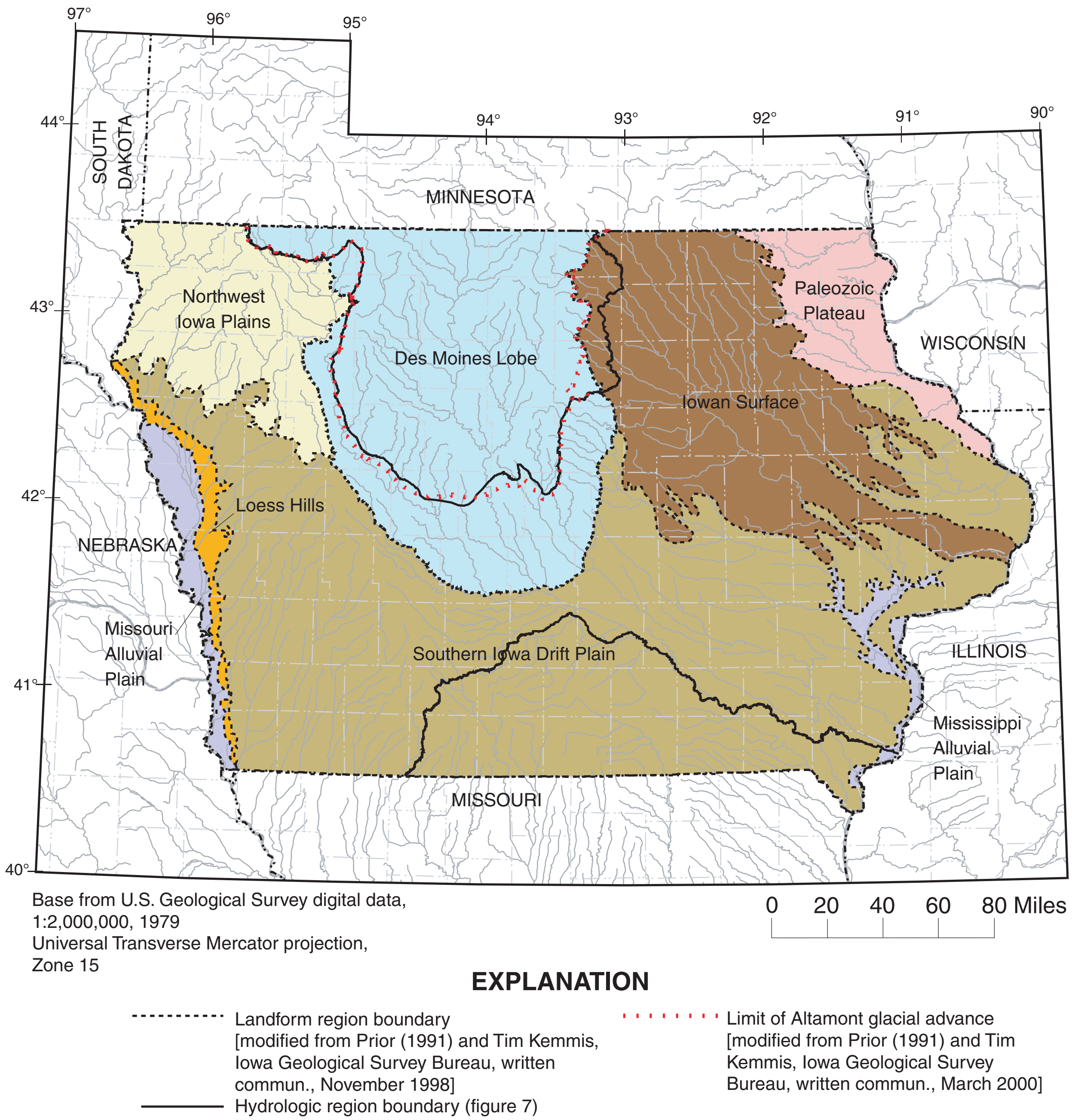


Figure 8.--Landform regions, limit of Altamont glacial advance, and hydrologic regions in Iowa.

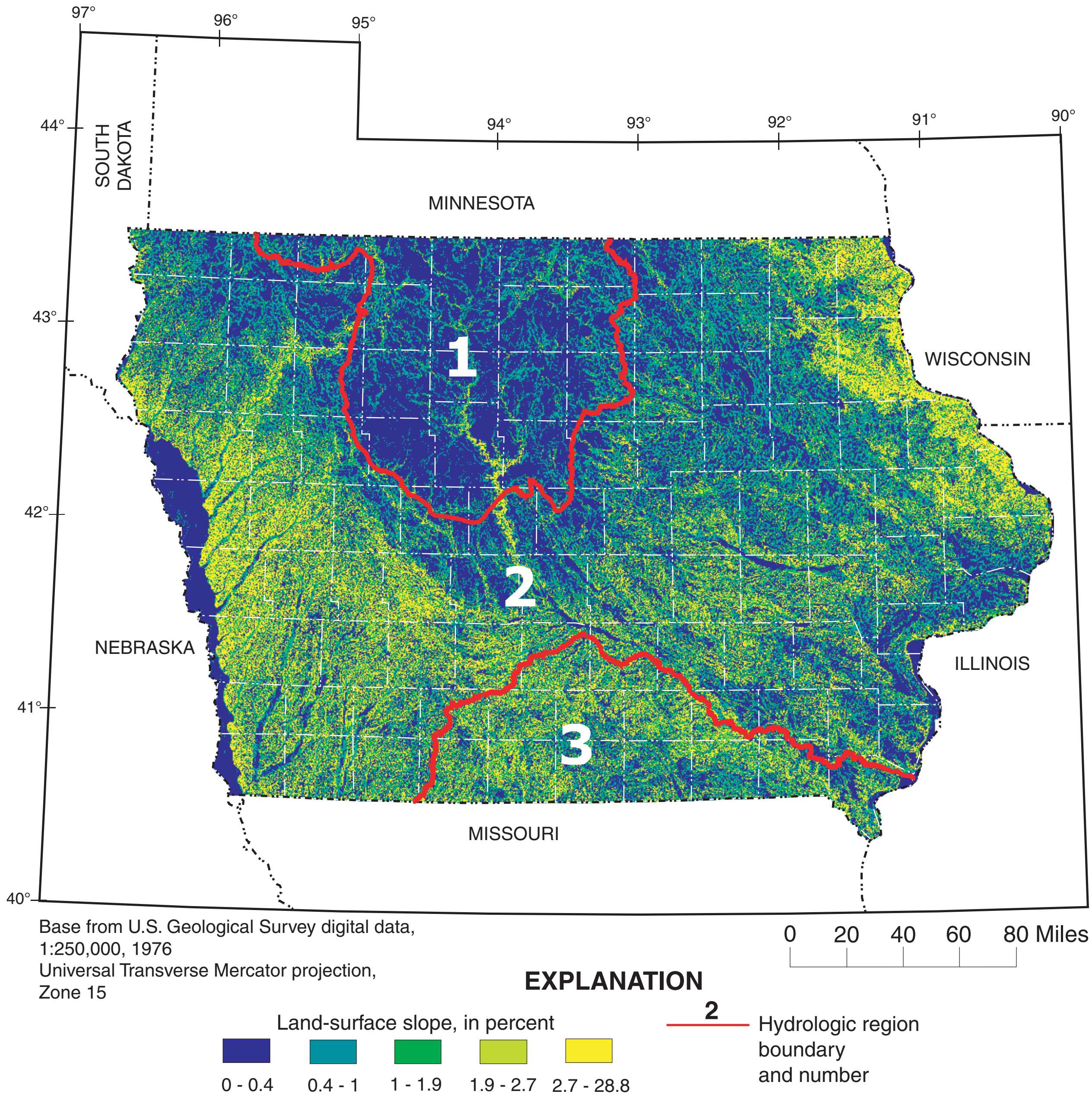


Figure 9.--Shaded land-surface slopes and hydrologic regions in Iowa.

In general, the majority of Region 2 comprises a mature, postglacial landscape that has eroded to form a steeply to gently rolling topography and a well-established drainage system. Region 2 represents a large area with a large range in land-surface slopes (fig. 9) and soil-permeability rates (fig. 10); characteristics of landform regions within Region 2 are described by Prior (1991).

Region 3 is located in south-central and southeastern Iowa (fig. 7) and contains approximately 11 percent of the total land area of the State. Figure 8 shows that Region 3 is located entirely within the Southern Iowa Drift Plain landform region, with the exception of the southeast boundary, which extends east into the Mississippi Alluvial Plain landform region. Region 3 comprises about 22 percent of the Southern Iowa Drift Plain and about 10 percent of the Mississippi Alluvial Plain landform regions. South-central Iowa can be topographically divided into flood plains and terraces, uplands, and sideslopes; well-developed flood plains and terraces occupy broad stream valleys underlain by alluvial deposits (Iowa Natural Resources Council, 1958; Cagle and Heinitz, 1978). The majority of the uplands are characterized as relatively rugged, moderately to highly dissected areas composed of hills, knobs, and ridges, but in some places the uplands are gently rolling to slightly dissected. Figure 10 shows soil-permeability rates based on 1:250,000-scale STATSGO soils data (Wolock, 1997). The darker blue area in figure 10 indicates an area of low soil-permeability rates, and Region 3 contains the most extensive area of low permeability rates in the State. The boundary defining Region 3 was delineated on the basis of regression residuals and areas of low soil-permeability rates (fig. 10).

Final regression equations were developed for each region using the generalized least-squares (GLS) program in GLSNET (Gary Tasker, U.S. Geological Survey, written commun., 1995). GLS regression, as described by Tasker and Stedinger (1989), is a method that weights gaging stations in the regression according to differences in peak-flow record reliability (record lengths) and variability (record variance) and according to cross correlations of concurrent peak flows among gaging stations. In contrast, OLS regression assumes equal variability and reliability in peak-flow records at all gaging stations and no cross correlation between peak flows collected at gaging stations; therefore, an equal weight is assigned to all gaging stations in the OLS regression. Compared to OLS regression, GLS regression provides better estimates of flood-frequency discharges and better estimates of the predictive accuracy of the regression equations (Stedinger and Tasker, 1985).

Final GLS regression models were selected on the basis of minimizing the prediction error sum of squares (PRESS) statistic and the standard error of prediction (SEP). Statistical significance for each explanatory variable was determined using a 95-percent confidence level. Tables 3-5 list the flood-frequency estimation equations that were developed for the three hydrologic regions defined for Iowa. One-variable equations that include drainage area (DA) as the explanatory variable were developed for each of the three regions. Figure 11 shows the relation between the 100-year recurrence-interval discharge and drainage area for the three one-variable regional regression equations. Figure 11D shows that for a specific size of drainage area, a relatively small discharge will be estimated for Region 1 and a relatively large discharge will be estimated for Region 3.

Multi-variable equations that provide better predictive accuracies were also developed for Regions 2 and 3 (tables 4 and 5). Three-variable equations were developed for Region 2 that include DA, main-channel slope (MCS), and the ratio of basin area within the Des Moines Lobe landform region to total area of the basin (DML); two-variable equations were developed for Region 3 that include DA and MCS. Two sets of flood-frequency estimation equations are presented for Regions 2 and 3 because the one-variable equations are considered easy for users to apply and the predictive accuracies of the multi-variable equations are greater.

The multi-variable equations developed for Regions 2 and 3 provide better predictive accuracies than the one-variable equations because slope and relief factors further define flood-frequency relations. MCS is positively related to flood runoff (tables 4 and 5). Basins with larger MCS values will produce greater flood-discharge estimates and basins with smaller MCS values will produce lesser flood-discharge estimates than estimates produced by one-variable equations for a specific drainage area. The technique for performing manual, topographic-map measurements of MCS is described in appendix B (at end of report). Figure 12 shows the Des Moines Lobe landform region and the three hydrologic regions defined for Iowa. For Region 2, DML is negatively related to flood runoff and basins with areas within the Des Moines Lobe landform region will produce lesser flood-discharge estimates than basins outside the Des Moines Lobe.

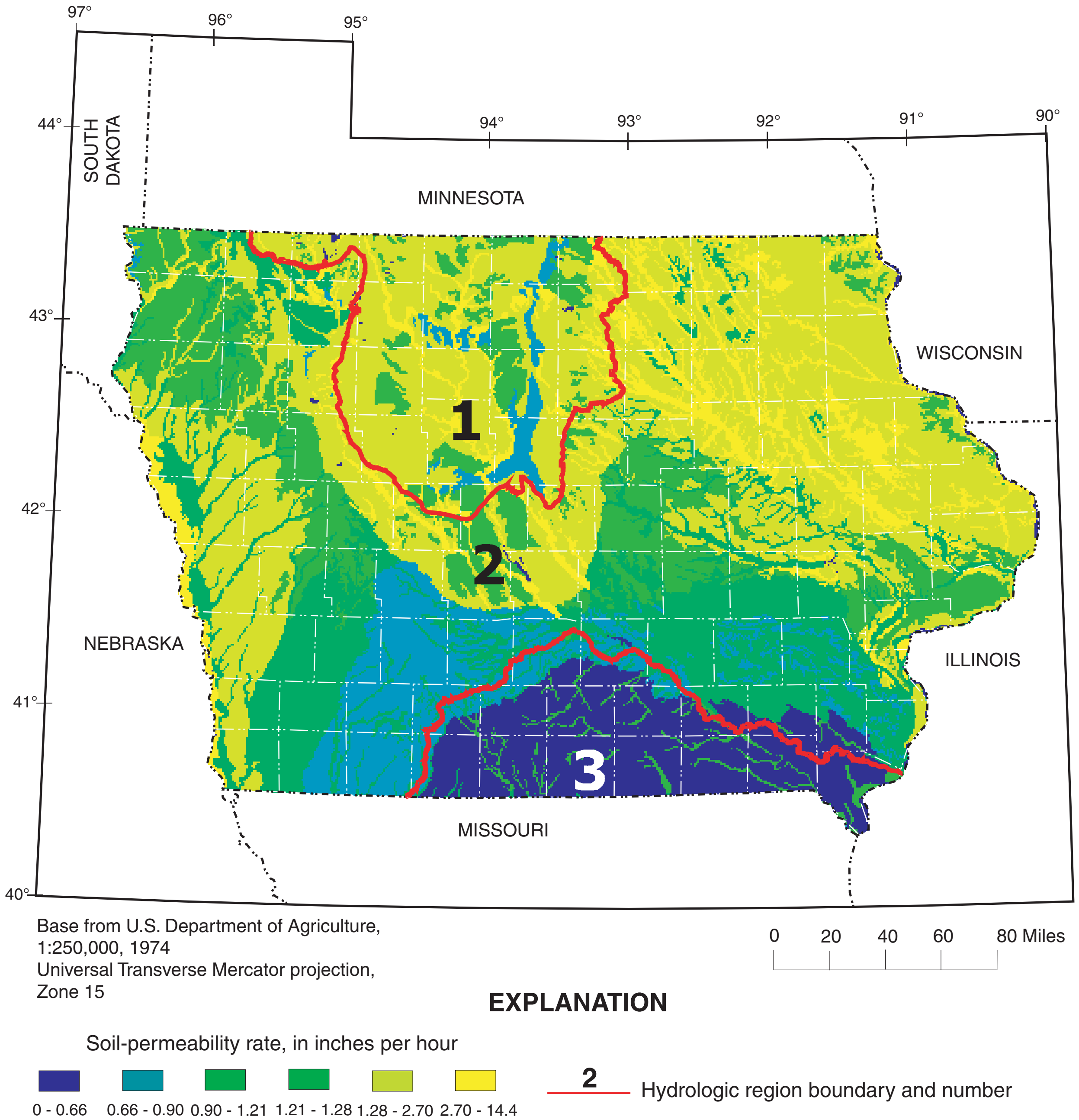


Figure 10.--Shaded soil-permeability rates and hydrologic regions in Iowa.

Table 3. Flood-frequency estimation equations for Region 1

[SEE, standard error of estimate; SEP, average standard error of prediction; EYR, equivalent years of record; Q, peak discharge, in cubic feet per second for recurrence interval, in years, indicated as subscript; DA, drainage area, in square miles]

Estimation equation	SEE (percent)	SEP (percent)	EYR (years)
(One-variable equations; number of streamflow-gaging stations = 26)			
$Q_2 = 33.8\ DA^{.656}$	35.3	41.4	4.2
$Q_5 = 60.8\ DA^{.658}$	32.0	39.4	5.8
$Q_{10} = 80.1\ DA^{.660}$	31.1	39.0	7.7
$Q_{25} = 105\ DA^{.663}$	31.3	39.2	10.1
$Q_{50} = 123\ DA^{.666}$	32.0	39.8	11.5
$Q_{100} = 141\ DA^{.669}$	33.1	40.5	12.5
$Q_{200} = 159\ DA^{.672}$	34.5	41.4	13.2
$Q_{500} = 183\ DA^{.676}$	36.5	42.7	13.7

Measurements of DML can be made for stream sites located within Region 2 by delineating the basin boundary for the stream site on figure 12 and determining the ratio of basin area within the Des Moines Lobe landform region (shaded area shown in fig. 12) to total area of the basin.

Region-of-Influence Analysis

The region-of-influence (ROI) method (Burn, 1990a, 1990b; Tasker and Slade, 1994) estimates flood-frequency discharges at ungaged stream sites by relating basin characteristics to flood-frequency discharges for a unique subset of gaged sites. This unique subset, or region of influence, defined for each ungaged site is determined by selecting gaging stations with basin characteristics that are similar to those measured for the ungaged site. The region of influence is defined as the N "nearest" gaging stations to the ungaged site, where "nearest" is measured by the similarity of basin characteristics in Euclidean space. An advantage of this method is that extrapolation errors tend to be small because predictions naturally occur near the center of the space of the basin characteristics.

To investigate the ROI method for this study, basin characteristics identified as the most significant in the statewide ordinary least-squares regression analyses were selected and compiled into a ROI data set that included the same 241 gaging stations used for the regional regression analyses (fig. 6). The ROI method uses generalized least-squares (GLS) regression to relate basin characteristics to flood-frequency discharges for gaging stations. Preliminary ROI analyses were performed to determine the best combination of two input parameters required by the ROI program: (1) a set of basin characteristics must be selected for use as explanatory variables in the GLS regression models developed for the study area and (2) the number of gaging stations (N) must be selected to compose the specific region of influence for the study area.

Root mean square errors (RMSE's) were evaluated for the preliminary ROI analyses to determine the best combination for the two required input parameters. For this study, three basin characteristics were identified as the most significant for use as explanatory variables, and the best number of gaging stations (N) to use for composing the region of influence was determined to be 63. The three basin characteristics selected for the final ROI analyses were drainage area (DA), main-channel slope (MCS), and drainage frequency (DF) (see appendix A for a description of basin characteristics).

Table 4. Flood-frequency estimation equations for Region 2

[SEE, standard error of estimate; SEP, average standard error of prediction; EYR, equivalent years of record; Q, peak discharge, in cubic feet per second for recurrence interval, in years, indicated as subscript; DA, drainage area, in square miles; MCS, main-channel slope, in feet per mile; DML, Des Moines Lobe, ratio of basin area within Des Moines Lobe landform region to total area of basin]

Estimation equation	SEE (percent)	SEP (percent)	EYR (years)
(One-variable equations; number of streamflow-gaging stations = 188)			
$Q_2 = 182\ DA^{.540}$	43.0	44.6	3.6
$Q_5 = 464\ DA^{.490}$	31.2	38.1	7.9
$Q_{10} = 728\ DA^{.465}$	26.9	35.4	13.5
$Q_{25} = 1{,}120\ DA^{.441}$	25.2	34.4	20.5
$Q_{50} = 1{,}440\ DA^{.427}$	25.6	34.8	24.0
$Q_{100} = 1{,}800\ DA^{.415}$	26.8	35.6	25.9
$Q_{200} = 2{,}200\ DA^{.403}$	28.6	36.7	26.5
$Q_{500} = 2{,}790\ DA^{.389}$	31.4	38.4	26.0
(Three-variable equations; number of streamflow-gaging stations = 188)			
$Q_2 = 52.2\ DA^{.677}\ MCS^{.316}\ (DML+1)^{-.753}$	37.3	41.7	4.6
$Q_5 = 144\ DA^{.616}\ MCS^{.305}\ (DML+1)^{-.653}$	25.4	34.5	11.3
$Q_{10} = 225\ DA^{.590}\ MCS^{.306}\ (DML+1)^{-.601}$	21.6	32.0	19.9
$Q_{25} = 337\ DA^{.567}\ MCS^{.309}\ (DML+1)^{-.567}$	20.4	31.3	29.5
$Q_{50} = 430\ DA^{.554}\ MCS^{.311}\ (DML+1)^{-.555}$	21.2	31.9	33.2
$Q_{100} = 531\ DA^{.542}\ MCS^{.313}\ (DML+1)^{-.549}$	22.6	32.9	34.3
$Q_{200} = 641\ DA^{.532}\ MCS^{.316}\ (DML+1)^{-.545}$	24.6	34.4	33.7
$Q_{500} = 800\ DA^{.519}\ MCS^{.320}\ (DML+1)^{-.542}$	27.8	36.5	31.7

Table 5. Flood-frequency estimation equations for Region 3

[SEE, standard error of estimate; SEP, average standard error of prediction; EYR, equivalent years of record; Q, peak discharge, in cubic feet per second for recurrence interval, in years, indicated as subscript; DA, drainage area, in square miles; MCS, main-channel slope, in feet per mile]

Estimation equation	SEE (percent)	SEP (percent)	EYR (years)
(One-variable equations; number of streamflow-gaging stations = 27)			
$Q_2 = 286\ DA^{.536}$	36.6	41.9	3.6
$Q_5 = 737\ DA^{.466}$	30.1	38.2	6.9
$Q_{10} = 1{,}180\ DA^{.431}$	27.1	36.4	11.0
$Q_{25} = 1{,}900\ DA^{.397}$	25.1	35.2	17.5
$Q_{50} = 2{,}550\ DA^{.376}$	24.3	34.8	22.2
$Q_{100} = 3{,}300\ DA^{.357}$	24.3	35.0	26.2
$Q_{200} = 4{,}160\ DA^{.340}$	24.7	35.4	29.0
$Q_{500} = 5{,}490\ DA^{.321}$	26.1	36.5	31.0
(Two-variable equations; number of streamflow-gaging stations = 27)			
$Q_2 = 7.75\ DA^{.888}\ MCS^{.977}$	29.4	38.0	5.2
$Q_5 = 22.6\ DA^{.805}\ MCS^{.939}$	22.2	33.3	11.5
$Q_{10} = 40.0\ DA^{.761}\ MCS^{.910}$	19.6	31.6	18.9
$Q_{25} = 72.3\ DA^{.715}\ MCS^{.875}$	18.0	30.8	29.2
$Q_{50} = 108\ DA^{.683}\ MCS^{.845}$	17.8	30.9	35.2
$Q_{100} = 158\ DA^{.652}\ MCS^{.809}$	18.6	31.6	38.5
$Q_{200} = 232\ DA^{.621}\ MCS^{.769}$	19.9	32.8	39.2
$Q_{500} = 382\ DA^{.580}\ MCS^{.709}$	22.4	34.8	37.4

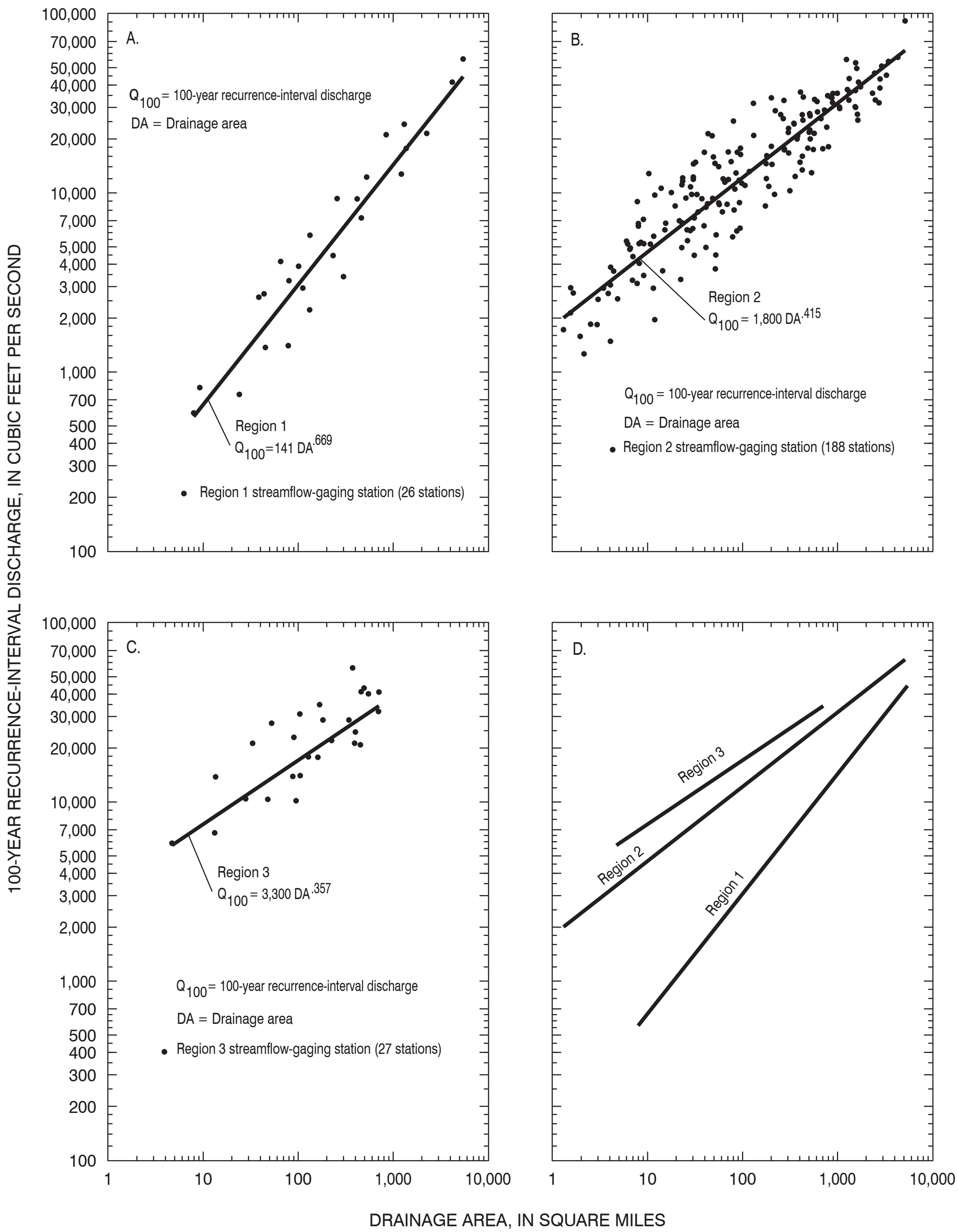


Figure 11.--Relation between 100-year recurrence-interval discharge and drainage area for (A) Region 1, (B) Region 2, (C) Region 3, and (D) all three one-variable regional regression equations.

Base from U.S. Geological Survey digital data, 1:2,000,000, 1979
Universal Transverse Mercator projection, Zone 15

EXPLANATION

- Des Moines Lobe landform region
- Des Moines Lobe landform region boundary within Iowa (Tim Kemmis, Iowa Geological Survey Bureau, written commun., November 1998)
- Des Moines Lobe landform region boundary within Minnesota [western boundary modified from MLRA-103 Stratigraphic/Geomorphic Field Investigation map (1995) provided by Deb Quade, Iowa Geological Survey Bureau, written commun., November 1998; eastern boundary modified from Soller and Packard (1998)]
- 2 — Hydrologic region boundary and number (figure 7)

Figure 12.--Des Moines Lobe landform region and hydrologic regions in Iowa.

Comparison of Regression Method Results

To estimate flood-frequency discharges for an ungaged stream site in Iowa, the regional regression equations require the measurement of one to three variables, dependent upon which equation is applied. The statewide region-of-influence (ROI) regression method requires the measurement of three variables for ungaged sites.

The root mean square error (RMSE), computed for each hydrologic region and recurrence interval, provides a means for comparing the predictive accuracy of the regional and region-of-influence regression methods (table 6). RMSE was computed as the square root of the arithmetic mean of the square of the differences between the flood-frequency estimate (log-Pearson Type III) and the flood-frequency estimate computed using either the regional regression equation or the region-of-influence regression method.

RMSE’s for the regional regression method are lower than those for the ROI regression method for the one-variable equations for Region 1, for the majority of the multi-variable equations for Region 2, and for the multi-variable equations for Region 3. RMSE’s are lower for the ROI method than for the multi-variable equations for Region 2 for the 2-, 5-, and 10-year recurrence intervals. RMSE’s are also lower for the ROI method than for the one-variable equations for Region 2 and for the one-variable equations for Region 3 for the 2-, 5-, and 10-year recurrence intervals. As discussed previously at the beginning of the “Regression Methods” section, equations developed for the statewide and drainage-area regression methods are not listed for this study because RMSE’s were larger than those for the regional or ROI regression methods.

A comparison of the regional and ROI regression methods, based on ease of application and RMSE’s, determined the regional regression method to be the better estimation method for Iowa. For this study, the ROI regression method is not included as an alternative flood-frequency estimation method for the following reasons: (1) the one-variable regression equations for Region 1 and the multi-variable regression equations for Regions 2 and 3 provide better overall predictive accuracies; (2) the ROI regression method requires the measurement of three basin characteristics for ungaged sites, whereas the regional regression equations require fewer measurements of basin characteristics for Regions 1 and 3, and the three basin-characteristic measurements required for the multi-variable equations for Region 2 are considered easier (in general, measurements of DML are considered easier than measurements of DF); and (3) application of the regional regression equations do not require computer processing (application of the ROI regression method requires computer processing to run the ROI program).

ACCURACY AND LIMITATIONS OF REGIONAL REGRESSION ESTIMATES

The regional regression equations developed in this study apply only to stream sites in Iowa where flood discharge is not significantly affected by regulation, diversion, channelization, or urbanization. The applicability and accuracy of the regional equations depend on whether the basin characteristics measured for a stream site are within the range or explanatory space of the characteristic values used to develop the regression equations. The acceptable range for drainage areas used to develop the one-variable regional equations (tables 3-5) are tabulated as maximum and minimum values in table 7.

The acceptable explanatory space for each pair of basin characteristics used to develop the multi-variable equations for Regions 2 and 3 (tables 4 and 5) are shown as shaded areas in figures 13 and 14. Each shaded area indicates an approximate explanatory space defined by the relation between two basin characteristics (explanatory variables). The multi-variable regression equations are applicable for stream sites with characteristics that are within these approximate explanatory spaces. Map number 199 was not included in the explanatory space for the bottom graph in figure 13 because this site is an outlier that plots substantially far away from the majority of the other sites. The applicability of the regional equations is unknown when the characteristic values associated with a stream site are outside the acceptable ranges or explanatory spaces. The predictive errors of the equations increase with distance from the mean or median values of the explanatory variables, and errors are unknown and may be large beyond the approximate explanatory spaces.

The standard error of estimate (SEE) and average standard error of prediction (SEP) listed in tables 3-5 are estimates of the expected accuracy of the regression equations. They provide measures of the difference between the flood-frequency estimate (log-

Table 6. Root mean square error of flood-frequency discharge computed by the regional and region-of-influence regression methods, presented by hydrologic region and recurrence interval

[NA, not applicable]

Hydrologic region	Recurrence interval (years)	Root mean square error (percent)		
		Regional regression methods		Region-of-influence regression method
		One-variable regional regression	Multi-variable regional regression	
1	2	37.2	NA	47.3
1	5	34.4	NA	44.3
1	10	34.1	NA	44.5
1	25	34.8	NA	46.1
1	50	35.8	NA	48.2
1	100	37.2	NA	46.8
1	200	38.8	NA	48.7
1	500	41.1	NA	55.6
1 (mean)		36.7	NA	47.7
2	2	50.0	44.2	43.3
2	5	40.2	34.3	33.4
2	10	37.3	31.3	30.8
2	25	36.0	30.1	30.8
2	50	36.9	31.3	32.8
2	100	39.0	33.9	35.0
2	200	42.1	37.5	38.2
2	500	47.3	43.3	43.9
2 (mean)		41.1	35.7	36.0
3	2	38.8	31.8	38.1
3	5	33.8	26.5	31.7
3	10	32.3	25.7	30.8
3	25	32.6	27.6	39.2
3	50	34.2	30.7	44.4
3	100	37.0	34.8	48.3
3	200	40.7	39.5	50.7
3	500	46.6	46.4	54.8
3 (mean)		37.0	32.9	42.2

Table 7. Statistical summary of basin characteristics used to develop regional regression equations

[DA, drainage area; MCS, main-channel slope; DML, Des Moines Lobe, ratio of basin area within Des Moines Lobe landform region to total area of basin; mi^2, square miles; ft/mi, feet per mile; NA, not applicable, basin characteristic not used to develop regional regression equations]

Statistic	**DA (mi^2)**	**MCS (ft/mi)**	**DML (ratio)**
REGION 1			
Maximum	5,452	NA	NA
Minimum	7.94	NA	NA
Mean	758	NA	NA
Median	183	NA	NA
Number of sites	26	NA	NA
REGION 2			
Maximum	5,146	100	1.00
Minimum	1.30	1.81	0.00
Mean	459	12.9	0.13
Median	84.2	7.54	0.00
Number of sites	188	188	188
REGION 3			
Maximum	708	26.9	NA
Minimum	4.69	3.42	NA
Mean	237	8.25	NA
Median	161	6.00	NA
Number of sites	27	27	NA

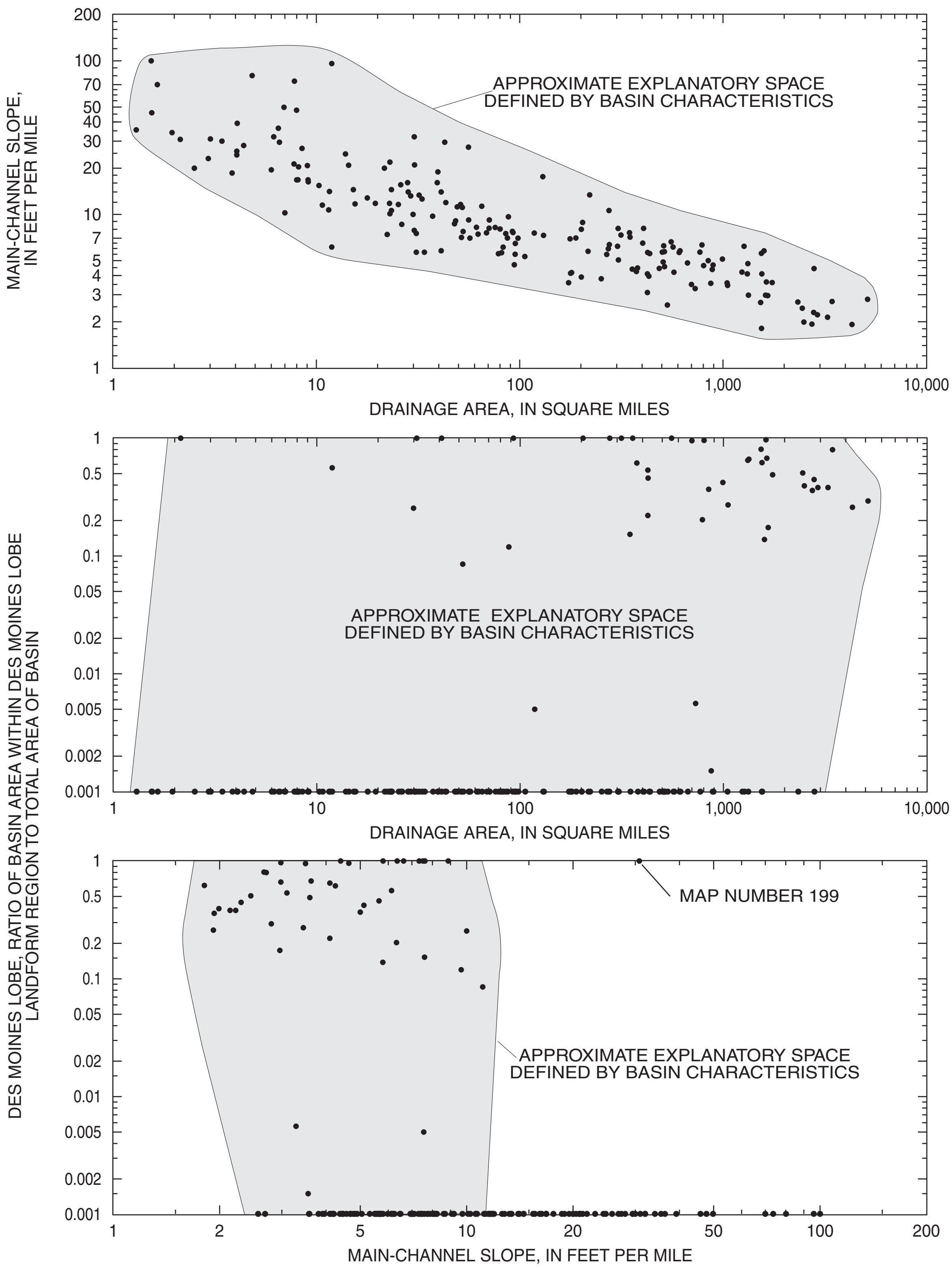


Figure 13.--Relation between basin characteristics for Region 2.

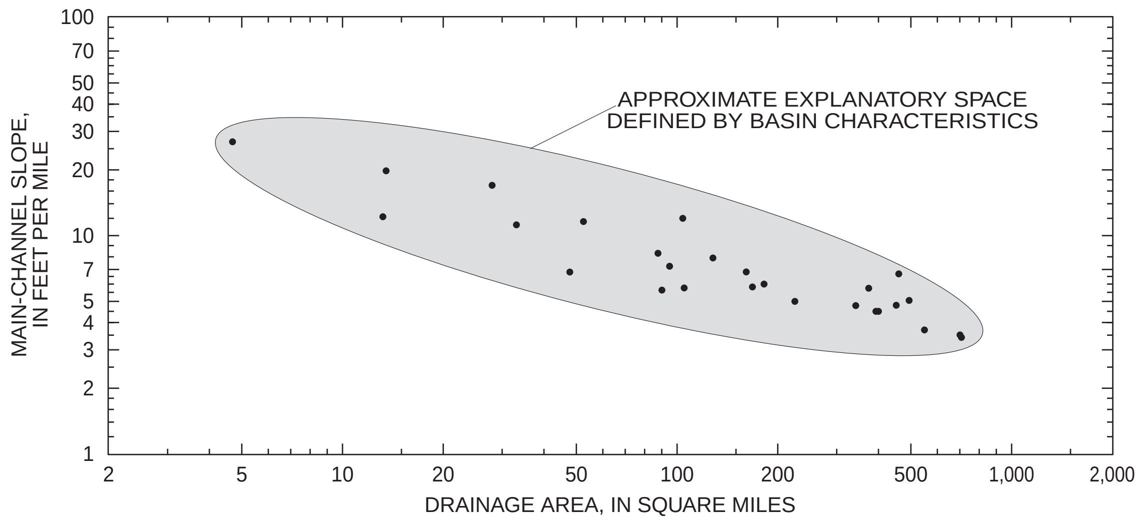


Figure 14.--Relation between basin characteristics for Region 3.

Pearson Type III) and the regression estimate for a flood recurrence interval. The SEE is a measure of the fit of the observed data to the regression model and of the error inherent in the regression model (model error) that cannot be changed by collecting more data (Gary Tasker, U.S. Geological Survey, written commun., 1995). SEE is comparable to the “standard error” or “standard error of estimate” reported for regression equations in previous studies for Iowa. SEE for the one-variable equations ranges from about 24 to 43 percent and for the multi-variable equations from about 18 to 37 percent (tables 3-5).

The SEP is a measure of the accuracy with which the regression model can predict flood-frequency discharge at an ungaged site. The SEP accounts for both model error and sampling error (error that results from estimating model parameters from limited data) in estimating the accuracy of the equations. Compared to the SEE, the SEP provides a better overall measure of the predictive ability of a model. SEP for the one-variable equations ranges from about 34 to 45 percent and for the multi-variable equations from about 31 to 42 percent (tables 3-5). The SEE and SEP listed in tables 3-5 were converted to percentages from their logarithms (base 10) using methods described by Hardison (1971).

Another measure of the predictive ability of the regional equations is equivalent years of record (EYR) (tables 3-5). The EYR represents an estimate of the number of years of actual peak-flow record required at a stream site to achieve a flood-frequency estimate (log-Pearson Type III) with an accuracy equivalent to a regional regression estimate (Hardison, 1971).

TECHNIQUES FOR ESTIMATING FLOOD-FREQUENCY DISCHARGES FOR STREAMS IN IOWA

The following techniques for estimating flood-frequency discharges are applicable for stream sites in Iowa that are not significantly affected by regulation, diversion, channelization, or urbanization. To determine which technique is applicable for a specific stream site, the user must first determine whether the stream site is located at a site that has been gaged or is located on a stream that has been gaged. Locations of gaging stations are shown in figure 6, and the names of gaging stations and gaged streams are listed in table 1.

If the stream site is located on an ungaged stream, then refer to the following section "Regional Regression Estimates for Ungaged Sites on Ungaged Streams." If the stream site is located at a gaged site, then refer to the section "Weighted Estimates for Gaged Sites." If the stream site is located on a gaged stream, then refer to the section "Weighted Estimates for Ungaged Sites on Gaged Streams."

All estimation techniques for ungaged sites require the measurement of drainage area (DA). DA can be determined for many stream sites directly, or interpolated indirectly from the report "*Drainage Areas of Iowa Streams*" (Larimer, 1957). Drainage areas can also be determined by planimetering or digitizing basin boundaries from topographic maps.

Regional Regression Estimates for Ungaged Sites on Ungaged Streams

To estimate flood-frequency discharges for a stream site using the regional regression equations listed in tables 3-5 requires determining which of four possible examples applies to the location of the stream site and its basin. For the following examples, gaged sites are used for convenience to illustrate the techniques for estimating flood-frequency discharges for ungaged sites. Figure 15 shows the locations of four stream sites and their basins; the location of each basin represents one of the four possible examples. To determine which example is applicable for an ungaged site, delineate the areal location of the basin for the stream site on figure 7 or 12. Use figure 15 and the following four examples to determine which example applies to the stream site for which flood-frequency estimates are to be made.

Examples are presented for both the one-variable (Example A) and multi-variable (Example B) regional regression equations. The one-variable equations for all three hydrologic regions require the measurement of drainage area (DA). The multi-variable equations for Region 2 require the additional measurements of main-channel slope (MCS) and the ratio of basin area within the Des Moines Lobe landform region to total area of the basin (DML) and for Region 3, the additional measurement of MCS. The technique for performing manual, topographic-map measurements of MCS is described in appendix B. Measurements of DML can be made for stream sites located within Region 2 by delineating the basin boundary for the stream site on figure 12 and determining the ratio of basin area within the Des Moines Lobe landform region (shaded area shown in fig. 12) to total area of the basin.

Example 1: Estimates for Single-Region Basins Not Overlying the Des Moines Lobe

Figure 15 shows the location of the stream site and basin for map number 83 (Rapid Creek tributary near Iowa City, gaging station number 05453950). Example 1 is applicable for this basin because the basin does not overlie a hydrologic region boundary (basin located entirely within Region 2) or the Des Moines Lobe landform region. For examples 1A and 1B, determine the 100-year flood-discharge estimate for this stream site.

Example 1A: One-Variable Equation

(1) Use figure 7 to determine which hydrologic region the basin is located within and select the appropriate one-variable regional equation from tables 3-5.

(2) Determine the drainage area (DA) for the stream site and calculate the flood-frequency estimate using the regional equation.

For the stream site with map number 83 (fig. 15), the basin is located within Region 2. The 100-year flood-estimation equation listed for Region 2 in table 4 is:

$$Q_{100} = 1{,}800\ DA^{.415}$$

DA for the basin was determined to be 3.43 mi^2. The flood-discharge estimate is calculated as:

$$Q_{100} = 1{,}800\ (3.43)^{.415}$$

$$Q_{100} = 3{,}000\ ft^3/s$$

Example 1B: Multi-Variable Equation

(1) Use figure 7 to determine which hydrologic region the basin is located within and select the appropriate multi-variable regional regression equation from tables 3-5. If the basin is located within Region 1, only the one-variable equations are applicable.

(2) Determine the drainage area (DA), the main-channel slope (MCS), and the ratio of basin area within the Des Moines Lobe landform region to total area of the basin (DML) for the stream site. The technique for performing manual, topographic-map measurements of MCS is described in appendix B. Measurements of DML can be made for stream sites located within Region 2 by delineating the basin boundary for the

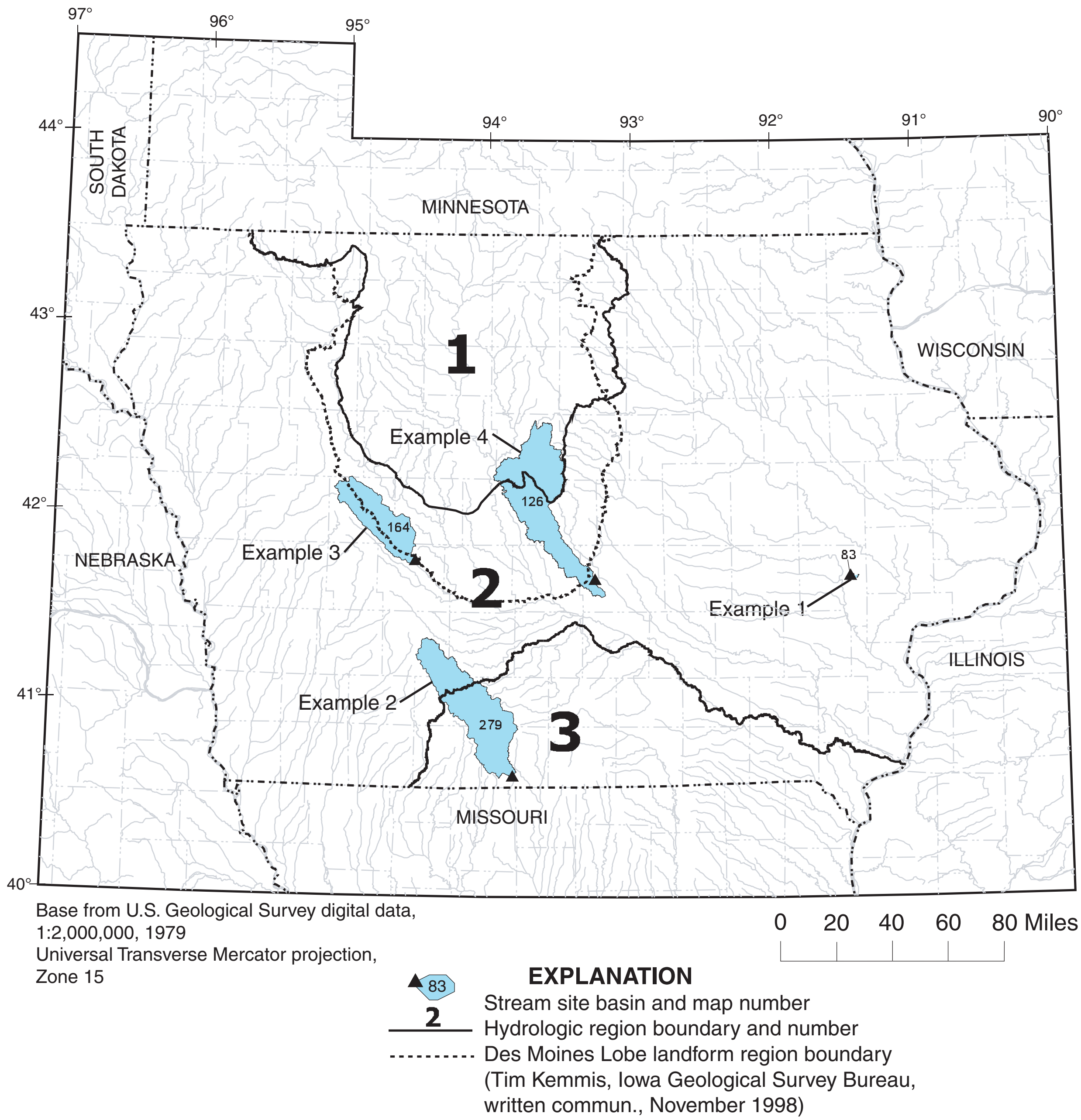


Figure 15.--Location of stream sites and basins used to exemplify techniques for estimating flood-frequency discharges.

stream site on figure 12 and determining the ratio of basin area within the Des Moines Lobe landform region (shaded area shown in fig. 12) to total area of the basin.

For the stream site with map number 83 (fig. 15), the basin is located within Region 2. The 100-year flood-estimation equation listed for Region 2 in table 4 is:

$$Q_{100} = 531\ DA^{.542}\ MCS^{.313}\ (DML+1)^{-.549}$$

DA for the basin was determined to be 3.43 mi^2 and MCS for the basin was determined to be 30.0 ft/mi. Because the basin is located completely outside the Des Moines Lobe landform region, the value for DML was determined to be 0.00. The flood-discharge estimate is calculated as:

$$Q_{100} = 531\ (3.43)^{.542}\ (30.0)^{.313}\ (0.00+1)^{-.549}$$

$$Q_{100} = 3{,}000\ ft^3/s$$

Example 2: Estimates for Mixed-Region Basins Not Overlying the Des Moines Lobe

Estimates for stream sites with basins overlying more than one hydrologic region can be improved by calculating a mixed-region flood-frequency estimate. The procedure for calculating a mixed-region estimate from two regional estimates is:

$$Q_{t(mr)} = (DA_{Region\ x} / DA_{Total})\ (Q_{t(Region\ x)}) + (DA_{Region\ y} / DA_{Total})\ (Q_{t(Region\ y)}), \quad (1)$$

where $Q_{t(mr)}$ = the mixed-region discharge estimate for recurrence interval t;

$DA_{Region\ x}$, $DA_{Region\ y}$ = the area of the basin within Region x or y, respectively;

DA_{Total} = the total area of the basin; and

$Q_{t(Region\ x)}$, $Q_{t(Region\ y)}$ = the regression estimate for recurrence interval t, computed using Region x or y regional equations, respectively.

Figure 15 shows the location of the stream site and basin for map number 279 (Thompson River at Davis City, gaging station number 06898000). Example 2 is applicable for this basin because the basin overlies a hydrologic region boundary (boundary between Regions 2 and 3) and does not overlie the Des Moines Lobe landform region. For examples 2A and 2B, determine the mixed-region, 50-year flood-discharge estimate for this stream site using equation 1.

Example 2A: One-Variable Equation

(1) Use figure 7 to determine which hydrologic regions the basin is located within and select the appropriate one-variable equation for each region from tables 3-5.

(2) Determine the drainage area (DA) for the entire basin and drainage area of the basin in each hydrologic region. Calculate the flood-frequency estimate using each regional equation and calculate a mixed-region estimate from the regional estimates using equation 1.

For the stream site with map number 279 (fig. 15), the basin is located within Regions 2 and 3. The 50-year flood-estimation equations listed for Regions 2 and 3 in tables 4 and 5 are:

$$Q_{50} = 1{,}440\ DA^{.427}\ \text{(Region 2)}$$

$$Q_{50} = 2{,}550\ DA^{.376}\ \text{(Region 3)}$$

DA for the basin was determined to be 701 mi^2. By overlaying the basin boundary on figure 7, it was determined that approximately 215 mi^2 of the drainage area is located within Region 2 and 486 mi^2 is located within Region 3. The flood-discharge estimate for each hydrologic region is calculated as:

$$Q_{50} = 1{,}440\ (701)^{.427}\ \text{(Region 2)}$$

$$Q_{50} = 23{,}600\ ft^3/s\ \text{(Region 2)}$$

$$Q_{50} = 2{,}550\ (701)^{.376}\ \text{(Region 3)}$$

$$Q_{50} = 30{,}000\ ft^3/s\ \text{(Region 3)}$$

The mixed-region estimate calculated from the two regional estimates using equation 1 is:

$$Q_{50(mr)} = (215 / 701)\ (23{,}600) + (486 / 701)\ (30{,}000)$$

$$Q_{50(mr)} = 28{,}000\ ft^3/s$$

Example 2B: Multi-Variable Equation

(1) Use figure 7 to determine which hydrologic regions the basin is located within and select the appropriate multi-variable regression equation for each region from tables 3-5. If a portion of the basin is located within Region 1, then only the one-variable equations are applicable for the portion in Region 1.

(2) Determine the drainage area (DA), the main-channel slope (MCS), and the ratio of basin area within the Des Moines Lobe landform region to total area of the basin (DML) for the entire basin. Determine the

drainage area of the basin within each hydrologic region. The technique for performing manual, topographic-map measurements of MCS is described in appendix B. Measurements of DML can be made for stream sites located within Region 2 by delineating the basin boundary for the stream site on figure 12 and determining the ratio of basin area within the Des Moines Lobe landform region (shaded area shown in fig. 12) to total area of the basin. Calculate the flood-frequency estimate using each regional equation and calculate a mixed-region estimate from the regional estimates using equation 1.

For the stream site with map number 279 (fig. 15), the basin is located within Regions 2 and 3. The 50-year flood-estimation equations listed for Regions 2 and 3 in tables 4 and 5 are:

$$Q_{50} = 430\ DA^{.554}\ MCS^{.311}\ (DML+1)^{-.555}\ \text{(Region 2)}$$

$$Q_{50} = 108\ DA^{.683}\ MCS^{.845}\ \text{(Region 3)}$$

DA for the basin was determined to be 701 mi^2. By overlaying the basin boundary on figure 7, it was determined that approximately 215 mi^2 of the drainage area is located within Region 2 and 486 mi^2 is located within Region 3. MCS for the entire basin was determined to be 3.51 ft/mi. Because the basin is located completely outside the Des Moines Lobe landform region, the value for DML is 0.00. The flood-discharge estimate for each hydrologic region is calculated as:

$$Q_{50} = 430\ (701)^{.554}\ (3.51)^{.311}\ (0.00+1)^{-.555}\ \text{(Region 2)}$$

$$Q_{50} = 24{,}000\ ft^3/s\ \text{(Region 2)}$$

$$Q_{50} = 108\ (701)^{.683}\ (3.51)^{.845}\ \text{(Region 3)}$$

$$Q_{50} = 27{,}400\ ft^3/s\ \text{(Region 3)}$$

The mixed-region estimate calculated from the two regional estimates using equation 1 is:

$$Q_{50(mr)} = (215 / 701)\ (24{,}000) + (486 / 701)\ (27{,}400)$$

$$Q_{50(mr)} = 26{,}400\ ft^3/s$$

Example 3: Estimates for Region 2 Basins Overlying the Des Moines Lobe

Figure 15 shows the location of the stream site and basin for map number 164 (Middle Raccoon River near Bayard, gaging station number 05483450). Example 3 is applicable only for basins located entirely within Region 2 that also overlie the Des Moines Lobe landform region. Example 1 is applicable for basins located entirely within Region 1 that also overlie the Des Moines Lobe landform region. For examples 3A and 3B, determine the 500-year flood-discharge estimate for this stream site.

Example 3A: One-Variable Equation

(1) Use figure 7 to verify that the basin is located entirely within Region 2. The application of the one-variable equation for example 3A is the same as the one-variable equation for example 1A. Select the appropriate one-variable equation from table 4.

(2) Determine the drainage area (DA) for the stream site and calculate the flood-frequency estimate using the regional equation.

For the stream site with map number 164 (fig. 15), the basin is located entirely within Region 2. The 500-year flood-estimation equation listed for Region 2 in table 4 is:

$$Q_{500} = 2{,}790\ DA^{.389}$$

DA for the basin was determined to be 375 mi^2. The flood-discharge estimate is calculated as:

$$Q_{500} = 2{,}790\ (375)^{.389}$$

$$Q_{500} = 28{,}000\ ft^3/s$$

Example 3B: Multi-Variable Equation

(1) Use figure 7 to verify that the basin is located entirely within Region 2 and use figure 12 to verify that the basin overlies the Des Moines Lobe landform region. Select the appropriate multi-variable equation from table 4.

(2) Determine the drainage area (DA), the main-channel slope (MCS), and the ratio of basin area within the Des Moines Lobe landform region to total area of the basin (DML) for the entire basin. The technique for performing manual, topographic-map measurements of MCS is described in appendix B. Measurements of DML can be made for stream sites located within Region 2 by delineating the basin boundary for the stream site on figure 12 and determining the ratio of basin area within the Des Moines Lobe landform region (shaded area shown in fig. 12) to total area of the basin.

For the stream site with map number 164 (fig. 15), the basin is located entirely within Region 2 and overlies the Des Moines Lobe landform region. The 500-year flood-estimation equation listed for Region 2 in table 4 is:

$$Q_{500} = 800\ DA^{.519}\ MCS^{.320}\ (DML+1)^{-.542}$$

DA for the basin was determined to be 375 mi^2. MCS for the basin was determined to be 4.25 ft/mi. By overlaying the basin boundary on figure 12, it was determined that approximately 232 mi^2 of the drainage area is located within the Des Moines Lobe landform region. DML was calculated to be 0.62 (232 mi^2/375 mi^2). The flood-discharge estimate is calculated as:

$$Q_{500} = 800\ (375)^{.519}\ (4.25)^{.320}\ (0.62 + 1)^{-.542}$$

$$Q_{500} = 21{,}200\ ft^3/s$$

Example 4: Estimates for Mixed-Region Basins Overlying the Des Moines Lobe

Figure 15 shows the location of the stream site and basin for map number 126 (South Skunk River at Colfax, gaging station number 05471050). Example 4 is applicable for this basin because the basin overlies a hydrologic region boundary (boundary between Regions 1 and 2) and overlies the Des Moines Lobe landform region. For examples 4A and 4B, determine the mixed-region, 100-year flood-discharge estimate for this stream site using equation 1.

Example 4A: One-Variable Equation

(1) Use figure 7 to determine which hydrologic regions the basin is located within and select the appropriate one-variable equation for each region from tables 3-5.

(2) Determine the drainage area (DA) for the entire basin and drainage area of the basin in each hydrologic region. Calculate the flood-frequency estimate using each regional equation and calculate a mixed-region estimate from the regional estimates using equation 1. The application of the one-variable equation for example 4A is the same as the one-variable equation for example 2A.

For the stream site with map number 126 (fig. 15), the basin is located within Regions 1 and 2. The 100-year flood-estimation equations listed for Regions 1 and 2 in tables 3 and 4 are:

$$Q_{100} = 141\ DA^{.669}\ \text{(Region 1)}$$

$$Q_{100} = 1{,}800\ DA^{.415}\ \text{(Region 2)}$$

DA for the basin was determined to be 803 mi^2. By overlaying the basin boundary on figure 7, it was determined that approximately 371 mi^2 of the drainage area is located within Region 1 and 432 mi^2 is located within Region 2. The flood-discharge estimate for each hydrologic region is calculated as:

$$Q_{100} = 141\ (803)^{.669}\ \text{(Region 1)}$$

$$Q_{100} = 12{,}400\ ft^3/s\ \text{(Region 1)}$$

$$Q_{100} = 1{,}800\ (803)^{.415}\ \text{(Region 2)}$$

$$Q_{100} = 28{,}900\ ft^3/s\ \text{(Region 2)}$$

The mixed-region estimate calculated from the two regional estimates using equation 1 is:

$$Q_{100(mr)} = (371 / 803)\ (12{,}400) + (432 / 803)\ (28{,}900)$$

$$Q_{100(mr)} = 21{,}300\ ft^3/s$$

Example 4B: Multi-Variable Equation

(1) Use figure 7 to determine which hydrologic regions the basin is located within and select the appropriate multi-variable regression equation for each region from tables 3-5. If a portion of the basin is located within Region 1, then only the one-variable equations are applicable for the portion in Region 1.

(2) Determine the drainage area (DA), the main-channel slope (MCS), and the ratio of basin area within the Des Moines Lobe landform region to total area of the basin (DML) for the entire basin. Determine the drainage area of the basin within each hydrologic region. The technique for performing manual, topographic-map measurements of MCS is described in appendix B. Measurements of DML can be made for stream sites located within Region 2 by delineating the basin boundary for the stream site on figure 12 and determining the ratio of basin area within the Des Moines Lobe landform region (shaded area shown in fig. 12) to total area of the basin. Calculate the flood-frequency estimate using each regional equation and calculate a mixed-region estimate from the regional estimates using equation 1.

For the stream site with map number 126 (fig. 15), the basin is located within Regions 1 and 2. The 100-year flood-estimation equations listed for Regions 1 and 2 in tables 3 and 4 are:

$$Q_{100} = 141\ DA^{.669}\ \text{(Region 1; only one-variable equation is applicable)}$$

$$Q_{100} = 531\ DA^{.542}\ MCS^{.313}\ (DML+1)^{-.549}\ \text{(Region 2)}$$

DA for the basin was determined to be 803 mi^2. By overlaying the basin boundary on figure 7, it was determined that approximately 371 mi^2 of the drainage area is located within Region 1 and 432 mi^2 is located within Region 2. MCS for the entire basin was determined to be 4.64 ft/mi. By overlaying the basin boundary on figure 12, it was determined that approximately 771 mi^2 of the drainage area is located within the Des Moines Lobe landform region. DML was calculated to be 0.96 (771 mi^2/803 mi^2). The flood-discharge estimate for each hydrologic region is calculated as:

$Q_{100} = 141\ (803)^{.669}$ (Region 1; only one-variable equation is applicable)

$Q_{100} = 12{,}400\ ft^3/s$ (Region 1)

$Q_{100} = 531\ (803)^{.542}\ (4.64)^{.313}\ (0.96+1)^{-.549}$ (Region 2)

$Q_{100} = 22{,}300\ ft^3/s$ (Region 2)

The mixed-region estimate calculated from the two regional estimates using equation 1 is:

$Q_{100(mr)} = (371 / 803)\ (12{,}400) + (432 / 803)\ (22{,}300)$

$Q_{100(mr)} = 17{,}700\ ft^3/s$

Weighted Estimates for Gaged Sites

Estimates at gaged sites can be improved by weighting the flood-frequency estimates (log-Pearson Type III) with regional regression estimates. At a gaged site, the best estimate of flood-frequency discharge can be calculated using the following weighting procedure:

$$Q_{t(wg)} = [(Q_{t(pg)})\ (ERL) + (Q_{t(rg)})\ (EYR)] / (ERL + EYR), \quad (2)$$

where $Q_{t(wg)}$ = the weighted discharge estimate for a gaged site for recurrence interval t;

$Q_{t(pg)}$ = the flood-discharge estimate (log-Pearson Type III) for a gaged site for recurrence interval t (listed in table 2 on the first line of the flood-frequency discharges);

ERL = the effective record length for a gaged site, in years (listed in table 1);

$Q_{t(rg)}$ = the regional-regression discharge estimate for a gaged site for recurrence interval t (listed in the flood-frequency discharges in table 2 on the second line for one-variable equations or on the third line for multi-variable equations for Regions 2 and 3); and

EYR = the equivalent years of record for the regional regression equation used to determine $Q_{t(rg)}$ (tables 3-5).

Figure 15 shows the location of the stream site and basin for map number 126 (South Skunk River at Colfax, gaging station number 05471050). For examples A and B, determine the weighted, 100-year flood-discharge estimate for this gaged site using equation 2.

Example A: One-Variable Equation

(1) Use the flood-frequency discharges listed in table 2 to obtain $Q_{t(pg)}$ and $Q_{t(rg)}$ for the gaged site; the flood-frequency estimate (log-Pearson Type III) ($Q_{t(pg)}$) is listed on the first line, and the one-variable regional regression estimate ($Q_{t(rg)}$) is listed on the second line.

(2) Use table 1 to obtain the hydrologic region and the effective record length (ERL) for the gaged site and use tables 3-5 to obtain the equivalent years of record (EYR) for the regional regression equation used to determine $Q_{t(rg)}$. Calculate a weighted flood-frequency estimate for the gaged site using equation 2.

For the gaged site with map number 126 (fig. 15), table 2 lists a flood-frequency estimate (log-Pearson Type III) ($Q_{100(pg)}$) of 18,100 ft^3/s and a one-variable regional regression estimate ($Q_{100(rg)}$) of 28,900 ft^3/s. Table 1 indicates that the gaged site is located in Region 2 and has an ERL of 12 years. Table 4 lists an EYR of 25.9 years for the one-variable, 100-year recurrence-interval regression equation for Region 2. The weighted, one-variable, 100-year flood-discharge estimate for the gaged site is calculated using equation 2 as:

$Q_{100(wg)} = [(18{,}100)\ (12) + (28{,}900)\ (25.9)] / (12 + 25.9)$

$Q_{t(wg)} = 25{,}500\ ft^3/s$

Example B: Multi-Variable Equation

(1) Use the flood-frequency discharges listed in table 2 to obtain $Q_{t(pg)}$ and $Q_{t(rg)}$ for the gaged site; the flood-frequency estimate (log-Pearson Type III) ($Q_{t(pg)}$) is listed on the first line, and the multi-variable regional regression estimate ($Q_{t(rg)}$) is listed on the third line for Regions 2 and 3. If the gaged site is located within Region 1, then only the one-variable equations are applicable.

(2) Use table 1 to obtain the hydrologic region and the effective record length (ERL) for the gaged site and use tables 3-5 to obtain the equivalent years of record (EYR) for the regional regression equation used to determine $Q_{t(rg)}$. Calculate a weighted flood-frequency estimate for the gaged site using equation 2.

For the gaged site with map number 126 (fig. 15), table 2 lists a flood-frequency estimate (log-Pearson Type III) ($Q_{100(pg)}$) of 18,100 ft^3/s and a multi-variable regional regression estimate ($Q_{100(rg)}$) of 22,300 ft^3/s. Table 1 indicates that the gaged site is located in Region 2 and has an ERL of 12 years. Table 4 lists an EYR of 34.3 years for the multi-variable, 100-year recurrence-interval regression equation for Region 2. The weighted, multi-variable, 100-year flood-discharge estimate for the gaged site is calculated using equation 2 as:

$$Q_{100(wg)} = [(18,100)\ (12) + (22,300)\ (34.3)]\ /\ (12 + 34.3)$$

$$Q_{100(wg)} = 21,200\ ft^3/s$$

Weighted Estimates for Ungaged Sites on Gaged Streams

Flood-frequency estimates at ungaged sites located on gaged streams can be determined by weighting flood-frequency estimates from a nearby gaged site. Two techniques for weighting flood-frequency estimates from a gaged site are applicable. Both techniques require the measurement of drainage area (DA) for the ungaged site and a weighted flood-frequency estimate ($Q_{t(wg)}$) from a nearby gaged site (see eq. 2 in previous section "Weighted Estimates for Gaged Sites"). The first weighting technique, presented in the following section "Regression-Weighted Estimates for Ungaged Sites on Gaged Streams," requires a regional regression estimate for the ungaged site. The second weighting technique, presented in the following section "Area-Weighted Estimates for Ungaged Sites on Gaged Streams," does not require a regional regression estimate for the ungaged site. Flood-discharge estimates calculated from the regression-weighted technique are considered to provide better predictive accuracies for ungaged sites than estimates calculated from the area-weighted technique. To determine if either of these estimation techniques is applicable for an ungaged site, calculate the following drainage area ratio:

$$DAR = |DA_g - DA_u|\ /\ DA_g, \qquad (3)$$

where DAR is the drainage area ratio, defined as the absolute value of the difference between the drainage area of the gaged site (DA_g) and the drainage area of the ungaged site (DA_u) divided by the drainage area of the gaged site (DA_g).

Figure 15 shows the location of the stream site and basin for map number 126 (South Skunk River at Colfax, gaging station number 05471050). For the following examples this stream site is assumed to be an "ungaged site."

(1) Determine if the ungaged site is located on a gaged stream. Locations of gaging stations are shown in figure 6, and the names of gaging stations and gaged streams are listed in table 1.

(2) Determine the drainage area ratio (DAR) for the gaged and ungaged sites using equation 3. If the DAR is calculated to be greater than 0.5, this estimation technique is not applicable for the ungaged site and the technique described in the section "Regional Regression Estimates for Ungaged Sites on Ungaged Streams" is applicable. If the DAR is less than or equal to 0.5, either the regression-weighted or area-weighted techniques are applicable for the ungaged site.

An inspection of figure 6 and table 1 indicates that the "ungaged site" (map number 126) is located on a gaged stream with gaging stations located both upstream and downstream from the "ungaged site." The South Skunk River below Squaw Creek near Ames gaging station (station number 05471000, map number 125), with a drainage area of 556 mi^2, is located upstream from the "ungaged site;" the South Skunk River near Oskaloosa gaging station (station number 05471500, map number 128), with a drainage area of 1,635 mi^2, is located downstream from the "ungaged site." The drainage area for the "ungaged site" (map number 126) was determined to be 803 mi^2. Drainage area ratios (DAR's) for gaged sites and the "ungaged site" were calculated using equation 3 as:

$DAR = |556 - 803|\ /\ 556 = 0.444$ (upstream gaged site, map number 125)

$DAR = |1,635 - 803|\ /\ 1,635 = 0.509$ (downstream gaged site, map number 128)

On the basis of the DAR calculations, the downstream gaged site (map number 128) is not applicable for weighting the "ungaged site" because the DAR is greater than 0.5; the upstream gaged site (map number 125) can be used to weight the "ungaged site" because the DAR is less than or equal to 0.5.

Regression-Weighted Estimates for Ungaged Sites on Gaged Streams

This weighting technique requires a regional regression estimate for the ungaged site. The calculation for the regression-weighted technique is:

$$Q_{t(rw)} = Q_{t(ru)} \, [AF - (2\,DAR)\,(AF - 1)], \qquad (4)$$

where $Q_{t(rw)}$ = the regression-weighted discharge estimate for an ungaged site on a gaged stream for recurrence interval t;

$Q_{t(ru)}$ = the regional regression discharge estimate for an ungaged site for recurrence interval t, determined using the technique described in the section "Regional Regression Estimates for Ungaged Sites on Ungaged Streams;" and

AF = the adjustment factor for the gaged site and is calculated as

$$AF = Q_{t(wg)} \,/\, Q_{t(rg)}, \qquad (5)$$

where $Q_{t(wg)}$ and $Q_{t(rg)}$ are as defined for equation 2.

Figure 15 shows the location of the stream site and basin for map number 126 (South Skunk River at Colfax, gaging station number 05471050). For the following examples this stream site is assumed to be an "ungaged site." Determine the regression-weighted, 100-year flood-discharge estimate for the "ungaged site" using equation 4. Examples are presented for both the one-variable (Example A) and multi-variable (Example B) regional regression equations.

Example A: One-Variable Equation

(1) Determine if the ungaged site is located on a gaged stream. Use figure 7 to determine which hydrologic region the ungaged site is located within.

(2) Determine the drainage area ratio (DAR) for the gaged and ungaged sites using equation 3. If the DAR is greater than 0.5, this estimation technique is not applicable (use technique described in the section "Regional Regression Estimates for Ungaged Sites on Ungaged Streams").

(3) Determine which of the four possible examples described in the section "Regional Regression Estimates for Ungaged Sites on Ungaged Streams" applies to the location of the ungaged site and its basin. Use the estimation technique described for the applicable example to calculate the one-variable regional regression estimate for the ungaged site ($Q_{t(ru)}$).

(4) Use equation 2 and the one-variable estimation technique described in the section "Weighted Estimates for Gaged Sites" to calculate the weighted estimate for the gaged site ($Q_{t(wg)}$). Use table 2 to obtain the one-variable regional regression estimate for the gaged site ($Q_{t(rg)}$). Use equation 5 to calculate the adjustment factor (AF) and equation 4 to calculate a regression-weighted flood-discharge estimate for the ungaged site ($Q_{t(rw)}$).

The discussion at the beginning of this section determined that (1) the "ungaged site" (map number 126) is on a gaged stream and (2) a nearby gaged site (map number 125) could be used to weight flood-discharge estimates at the "ungaged site" (DAR of 0.444, eq. 3). To calculate the regional regression estimate ($Q_{100(ru)}$) for the "ungaged site" (map number 126), example 4 is applicable because the basin overlies a hydrologic region boundary (boundary between Regions 1 and 2) and overlies the Des Moines Lobe landform region (fig. 15). The one-variable regional regression estimate for the "ungaged site" ($Q_{100(ru)}$) was calculated to be 21,300 ft^3/s (Example 4A).

For the gaged site (map number 125), table 2 lists a one-variable regional regression estimate ($Q_{100(rg)}$) of 24,700 ft^3/s. Using equation 2 and the one-variable estimation technique described in the section "Weighted Estimates for Gaged Sites," the weighted flood-discharge estimate for the gaged site ($Q_{100(wg)}$) (map number 125) is calculated as:

$$Q_{100(wg)} = [(17{,}500)\,(43) + (24{,}700)\,(25.9)] \,/\, (43 + 25.9)$$

$$Q_{100(wg)} = 20{,}200 \; ft^3/s$$

Using equation 5, the adjustment factor (AF) is calculated to be 0.818 (20,200 ft^3/s / 24,700 ft^3/s). A regression-weighted flood-discharge estimate is calculated for the "ungaged site" using equation 4 as:

$$Q_{100(rw)} = 21{,}300\,[0.818 - (2)\,(0.444)\,(0.818 - 1)]$$

$$Q_{100(rw)} = 20{,}900 \; ft^3/s$$

Example B: Multi-Variable Equation

(1) Determine if the ungaged site is located on a gaged stream. Use figure 7 to determine which hydrologic region the ungaged site is located within.

(2) Determine the drainage area ratio (DAR) for the gaged and ungaged sites using equation 3. If the DAR is greater than 0.5, this estimation technique is not applicable (use technique described in the section "Regional Regression Estimates for Ungaged Sites on Ungaged Streams").

(3) Determine which of the four possible examples described in the section "Regional Regression Estimates for Ungaged Sites on Ungaged Streams" applies to the location of the ungaged site and its basin. Use the estimation technique described for the applicable example to calculate the multi-variable regional regression estimate for the ungaged site ($Q_{t(ru)}$).

(4) Use equation 2 and the multi-variable estimation technique described in the section "Weighted Estimates for Gaged Sites" to calculate the weighted estimate for the gaged site ($Q_{t(wg)}$). Use table 2 to obtain the multi-variable regional regression estimate for the gaged site ($Q_{t(rg)}$). Use equation 5 to calculate the adjustment factor (AF) and equation 4 to calculate a regression-weighted flood-discharge estimate for the ungaged site ($Q_{t(rw)}$).

The discussion at the beginning of this section determined that (1) the "ungaged site" (map number 126) is on a gaged stream and (2) a nearby gaged site (map number 125) could be used to weight flood-discharge estimates at the "ungaged site" (DAR of 0.444, eq. 3). To calculate the regional regression estimate ($Q_{100(ru)}$) for the "ungaged site" (map number 126), example 4 is applicable because the basin overlies a hydrologic region boundary (boundary between Regions 1 and 2) and overlies the Des Moines Lobe landform region (fig. 15). The multi-variable regional regression estimate for the "ungaged site" ($Q_{100(ru)}$) was calculated to be 17,700 ft^3/s (Example 4B).

For the gaged site (map number 125), table 2 lists a multi-variable regional regression estimate ($Q_{100(rg)}$) of 20,200 ft^3/s. Using equation 2 and the multi-variable estimation technique described in the section "Weighted Estimates for Gaged Sites," the weighted flood-discharge estimate for the gaged site ($Q_{100(wg)}$) (map number 125) is calculated as:

$$Q_{100(wg)} = [(17{,}500)\ (43) + (20{,}200)\ (34.3)]\ /\ (43 + 34.3)$$

$$Q_{100(wg)} = 18{,}700\ ft^3/s$$

Using equation 5, the adjustment factor (AF) is calculated to be 0.926 (18,700 ft^3/s / 20,200 ft^3/s). A regression-weighted flood-discharge estimate is calculated for the "ungaged site" using equation 4 as:

$$Q_{100(rw)} = 17{,}700\ [0.926 - (2)\ (0.444)\ (0.926 - 1)]$$

$$Q_{100(rw)} = 17{,}600\ ft^3/s$$

Area-Weighted Estimates for Ungaged Sites on Gaged Streams

This weighting technique does not require a regional regression estimate for the ungaged site. The calculation for the area-weighted technique is:

$$Q_{t(aw)} = Q_{t(wg)}\ (DA_u\ /\ DA_g)^x, \qquad (6)$$

where $Q_{t(aw)}$ = the area-weighted discharge estimate for an ungaged site on a gaged stream for recurrence interval t;
$Q_{t(wg)}$ = as defined for equation 2;
DA_u, DA_g = as defined for equation 3; and
x = the mean exponent for a hydrologic region; for Region 1, the mean exponent is 0.665; Region 2, 0.446; and Region 3, 0.403.

The mean exponent (x) is selected for the region the ungaged site is located within. The mean exponent is the average of the drainage-area (DA) exponents listed for the one-variable regional equations (tables 3-5).

Figure 15 shows the location of the stream site and basin for map number 126 (South Skunk River at Colfax, gaging station number 05471050). For the following examples this stream site is assumed to be an "ungaged site." Determine the area-weighted, 100-year flood-discharge estimate for the "ungaged site" using equation 6. Examples are presented for both the one-variable (Example A) and multi-variable (Example B) weighted flood estimates for the gaged site ($Q_{t(wg)}$).

Example A: One-Variable Equation

(1) Determine if the ungaged site is located on a gaged stream. Use figure 7 to determine which hydrologic region the ungaged site is located within.

(2) Determine the drainage area ratio (DAR) for the gaged and ungaged sites using equation 3. If the DAR is greater than 0.5, this estimation technique is not applicable (use technique described in the section

"Regional Regression Estimates for Ungaged Sites on Ungaged Streams").

(3) Select the mean exponent (x) value listed for equation 6 for the hydrologic region the ungaged site is located within. Use equation 6 to calculate an area-weighted flood-discharge estimate for the ungaged site ($Q_{t(aw)}$).

The discussion at the beginning of this section determined that (1) the "ungaged site" (map number 126) is on a gaged stream and (2) a nearby gaged site (map number 125) could be used to weight flood-discharge estimates at the "ungaged site" (DAR of 0.444, eq. 3). The drainage area for the "ungaged site" (map number 126) was determined to be 803 mi^2 and the drainage area for the gaged site (map number 125) was determined to be 556 mi^2.

Using equation 2 and the one-variable estimation technique described in the section "Weighted Estimates for Gaged Sites," the weighted flood-discharge estimate for the gaged site ($Q_{100(wg)}$) (map number 125) is calculated as:

$$Q_{100(wg)} = [(17{,}500)\ (43) + (24{,}700)\ (25.9)]\ /\ (43 + 25.9)$$

$$Q_{100(wg)} = 20{,}200\ ft^3/s$$

The "ungaged site" is located in Region 2. The mean exponent (x) listed for Region 2 is 0.446 (eq. 6). An area-weighted flood-discharge estimate is calculated for the "ungaged site" using equation 6 as:

$$Q_{100(aw)} = (20{,}200)\ (803\ /\ 556)^{0.446}$$

$$Q_{100(aw)} = 23{,}800\ ft^3/s$$

Example B: Multi-Variable Equation

(1) Determine if the ungaged site is located on a gaged stream. Use figure 7 to determine which hydrologic region the ungaged site is located within.

(2) Determine the drainage area ratio (DAR) for the gaged and ungaged sites using equation 3. If the DAR is greater than 0.5, this estimation technique is not applicable (use technique described in the section "Regional Regression Estimates for Ungaged Sites on Ungaged Streams").

(3) Select the mean exponent (x) value listed for equation 6 for the hydrologic region the ungaged site is located within. Use equation 6 to calculate an area-weighted flood-discharge estimate for the ungaged site ($Q_{t(aw)}$).

The discussion at the beginning of this section determined that (1) the "ungaged site" (map number 126) is on a gaged stream and (2) a nearby gaged site (map number 125) could be used to weight flood-discharge estimates at the "ungaged site" (DAR of 0.444, eq. 3). The drainage area for the "ungaged site" (map number 126) was determined to be 803 mi^2 and the drainage area for the gaged site (map number 125) was determined to be 556 mi^2.

Using equation 2 and the multi-variable estimation technique described in the section "Weighted Estimates for Gaged Sites," the weighted flood-discharge estimate for the gaged site ($Q_{100(wg)}$) (map number 125) is calculated as:

$$Q_{100(wg)} = [(17{,}500)\ (43) + (20{,}200)\ (34.3)]\ /\ (43 + 34.3)$$

$$Q_{100(wg)} = 18{,}700\ ft^3/s$$

The "ungaged site" is located in Region 2. The mean exponent (x) listed for Region 2 is 0.446 (eq. 6). An area-weighted flood-discharge estimate is calculated for the "ungaged site" using equation 6 as:

$$Q_{100(aw)} = (18{,}700)\ (803\ /\ 556)^{0.446}$$

$$Q_{100(aw)} = 22{,}000\ ft^3/s$$

MAXIMUM FLOODS IN IOWA

For certain high-risk flood-plain developments or for evaluation of the reasonableness of unusually large flood-discharge estimates, data on maximum known floods may be considered in addition to flood-frequency estimates. Maximum floods in Iowa and their estimated recurrence intervals are listed in table 1 for streamflow-gaging stations included in this study. Figure 16 shows the relation between maximum flood discharge and drainage area for 366 stream sites in Iowa. A total of 207 of the sites are gaging stations (includes 197 gaging stations in Iowa listed in table 1) and 159 sites are ungaged sites. Flood-peak discharges were determined at the ungaged sites using indirect measurement methods (Benson and Dalrymple, 1967). Regression lines for the 500-year recurrence-interval discharge (one-variable equations) and enveloping curves for the maximum known floods are shown for each hydrologic region in figure 16. The enveloping curves indicate maximum flood-discharge potential for a range of drainage areas for each region.

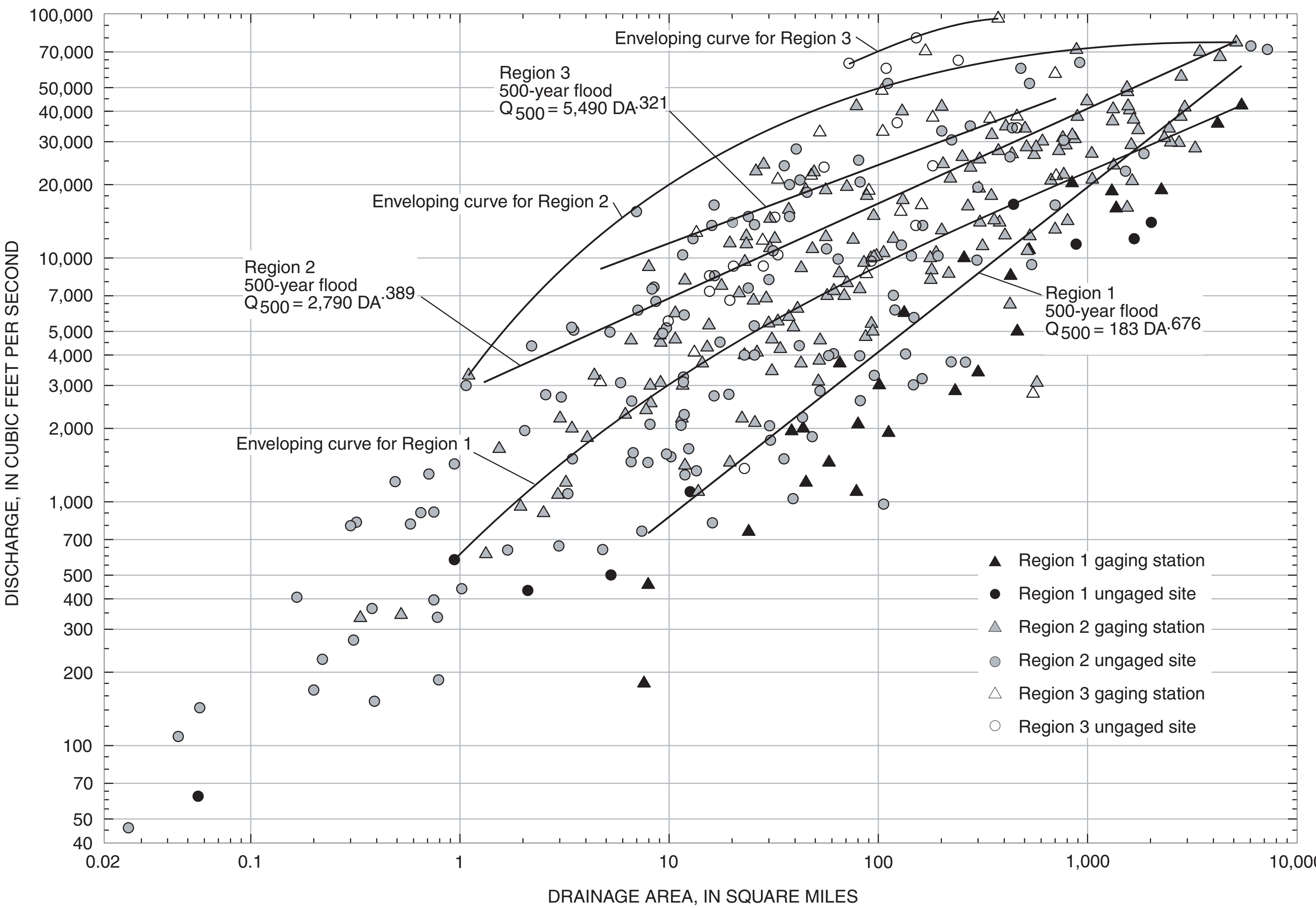


Figure 16.--Relation between maximum flood discharge and drainage area for streams in Iowa.

Figure 16 shows that approximately 78 of the 366, or about 21 percent, of the data points for gaging stations and ungaged sites lie between the enveloping curves and the regional regression lines for the 500-year flood. The majority of these maximum floods occurred as the result of rare storm phenomena.

From the principles of probability (Chow, 1964; Linsley and Franzini, 1964; Lara, 1973), the probability of floods exceeding the 500-year recurrence interval is calculated as:

$$P_n = 1 - (1 - 1/t)^n,$$

where P_n = the probability of a peak discharge to be exceeded within n years;

t = the recurrence interval of the peak discharge, in years; and

n = a time period, in years.

For the 197 gaging stations in Iowa listed in table 1, the mean effective record length (ERL) is 39 years and the median ERL is 36 years. For gaging stations with 40 years of peak-flow record, the above probability calculation indicates that independent flood events would exceed the 500-year recurrence interval at about 8 percent of the gaged sites. Flood events would not be considered independent if the same flood occurred at more than one site in a basin or in two or more nearby basins. For example, maximum floods for map numbers 124 and 125 in table 1 (1993 flood at station numbers 05470500 and 05471000) are not independent. Table 1 lists recurrence intervals greater than the 500-year flood for 18 of the 197, or about 9 percent, of the gaging stations in Iowa. Of these 18 flood events, about 14 of them are considered independent flood events; the 500-year recurrence interval was exceeded by independent flood events at about 7 percent of the 197 gaging stations in Iowa listed in table 1.

Rainfall amounts that produced several of these maximum floods were recorded in the range of 12 to 16 inches (Schwob, 1969; Lara, 1973; Waite, 1988; U.S. Geological Survey flood-profile reports, 1963-97, a list of which can be obtained from the World Wide Web at URL <http://ia.water.usgs.gov/projects/profiles>). Ranges in rainfall amounts reported for Iowa for the 100-year recurrence interval (Huff and Angel, 1992) and for the probable maximum precipitation (PMP) (Waite, 1988) are listed below for selected durations. PMP's are the greatest all season depths of precipitation that are meteorologically probable for a selected duration.

Probability	Rainfall in Iowa, in inches, for indicated durations		
	6 hours	24 hours	72 hours
100-year recurrence interval	5-6	6-8	8-9
Probable maximum precipitation (PMP) for 10 mi^2	25-27	31-33	36-38

As shown in figure 16 for Region 2, the ends of the enveloping curve nearly coincide with the ends of the regression line for the 500-year flood. Maximum differences between the regression line and the enveloping curve occur in the drainage area range from approximately 10 to 200 mi^2. These differences may indicate that the maximum flood-discharge potential for basins in Region 2 may be greatest within this drainage-area range.

SUMMARY

Reliable estimates of flood-frequency discharges are essential for the economical planning and safe design of bridges, dams, levees, and other structures located along rivers and streams and for the effective management of flood plains. In response to the need to update and improve the predictive accuracy of estimates of flood-frequency discharges for ungaged stream sites in Iowa, the USGS, in cooperation with the Iowa Department of Transportation and the Iowa Highway Research Board, initiated a statewide study in 1998.

This report (1) presents the results of a skew analysis to determine whether generalized skew coefficients can be improved for Iowa; (2) describes the compilation of basin-characteristic and flood-frequency data sets for streamflow-gaging stations and the use of statewide, drainage-area, regional, and region-of-influence regression methods to develop estimation equations; and (3) presents and describes techniques for estimating flood-frequency discharges for streams in Iowa that include equations with the greatest predictive accuracy and include equations that are easy for the user to apply.

Techniques for estimating flood-frequency discharges described in this report are applicable to streams in Iowa that are not significantly affected by regulation, diversion, channelization, or urbanization. The estimation equations presented in this report are limited to streams with drainage areas ranging from 1.3 to 5,452 mi^2. Estimation equations were developed for flood discharges that have recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years.

As part of the computation of flood-frequency analyses, a generalized-skew-coefficient analysis was conducted to determine whether generalized skew coefficients could be improved for Iowa. Three regional skew-analysis procedures recommended by Bulletin 17B for estimating generalized skew coefficients were investigated for Iowa using 239 gaging stations. The mean square error (MSE) was used to evaluate the results for each of the procedures and to compare their results to the MSE calculated for generalized skew coefficients interpolated for 145 gaging stations in Iowa from the nationwide skew map in Bulletin 17B. An isoline map of generalized-skew-coefficient values was developed for Iowa using variogram modeling and kriging methods with an MSE of 0.156. Because the MSE value for the Iowa skew map was the lowest of the three regional skew-analysis procedures and was lower than the MSE of 0.272 calculated for Iowa from the nationwide skew map in Bulletin 17B, the Iowa skew map was used to revise generalized skew coefficients for flood-frequency analyses for gaging stations in the State.

Flood-frequency discharges were computed for 291 gaging stations using revised generalized skew coefficients and peak-flow data collected through September 30, 1997. Thirty-eight selected basin characteristics were quantified for each of the gaging stations; two of the basin characteristics were manually measured from topographic maps and 36 of the characteristics were quantified from digital data sources using Basinsoft, a GIS procedure.

Four regression methods were investigated for estimating flood-frequency discharges for ungaged stream sites in Iowa. Regression analyses were used to relate basin characteristics to flood-frequency discharges. Data collected for the 291 gaging stations were compiled into statewide, regional, drainage-area, and region-of-influence data sets for regression analyses. Root mean square errors (RMSE's) calculated for equations developed for each regression method were compared to evaluate the predictive accuracy of the equations. Equations developed for the statewide and drainage-area regression methods are not listed because their RMSE's were larger than those developed for the regional and region-of-influence regression methods.

Three hydrologic regions were defined for the State, and regression equations developed for each region are presented for estimating flood-frequency discharges for ungaged stream sites in Iowa. Preliminary multiple regression analyses, using ordinary least-squares regression, were conducted to test for significant differences among the hydrologic regions and to identify the most significant basin characteristics for inclusion in the generalized least-squares regression. The final regression analyses included 241 gaging stations after 50 gaging stations were deleted from the regression data set. Forty-five gaging stations in adjacent States were deleted because they had significant basin-characteristic values outside the range of those measured for gaging stations in the State, and five gaging stations in Iowa were deleted on the basis of channelization or drainage areas less than 1 mi^2.

Generalized least-square (GLS) regression was used to develop a set of one-variable equations for each region and to develop a set of multi-variable equations for Regions 2 and 3. The multi-variable equations developed for Regions 2 and 3 provide better predictive accuracies than the one-variable equations because slope and relief factors further define flood-frequency relations. Two sets of equations are presented for Regions 2 and 3 because the one-variable equations are considered easy for users to apply and the predictive accuracies of the multi-variable equations are greater. Standard error of prediction for the one-variable equations ranges from about 34 to 45 percent and for the multi-variable equations from about 31 to 42 percent.

The region-of-influence (ROI) regression method was also investigated for estimating flood-frequency discharges for ungaged stream sites in Iowa. The same 241 gaging stations included in the regional regression analysis were used in the ROI regression analysis. The ROI analysis used GLS regression to relate basin characteristics to flood-frequency discharges for a unique subset of gaging stations. RMSE's were evaluated for the ROI analyses to determine the most significant basin characteristics and the best number of gaging stations to use for composing the ROI.

A comparison of the regional and ROI regression methods, based on ease of application and RMSE's, determined the regional regression method to be the better estimation method for Iowa. For this study, the ROI regression method is not included as an alternative flood-frequency estimation method because regional regression equations provided better overall predictive accuracies, required fewer overall measurements of basin characteristics for ungaged sites, and did not require computer processing for application of equations.

Techniques for estimating flood-frequency discharges for streams in Iowa are presented for determining (1) regional regression estimates for ungaged sites on ungaged streams; (2) weighted estimates for gaged sites; and (3) weighted estimates for ungaged sites on gaged streams. The technique for determining regional regression estimates for ungaged sites on ungaged streams requires determining which of four possible examples applies to the location of the stream site and its basin. Illustrations for determining which example applies to an ungaged stream site and for applying both the one-variable and multi-variable regression equations are provided for the estimation techniques.

Information on maximum floods in Iowa also is presented to supplement information on flood-frequency estimates. Enveloping curves for the maximum known floods in Iowa indicate maximum flood-discharge potential for a range of drainage areas for each hydrologic region.

REFERENCES CITED

Alexander, T.W., and Wilson, G.L., 1995, Technique for estimating the 2- to 500-year flood discharges on unregulated streams in rural Missouri: U.S. Geological Survey Water-Resources Investigations Report 95-4231, 33 p.

Allen, D.M., 1971, Mean square error of prediction as a criterion for selecting prediction variables: Technometrics, v. 13, p. 469-475.

Benson, M.A., and Dalrymple, Tate, 1967, General field and office procedures for indirect discharge measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A1, 30 p.

Bossong, C.R., Karlinger, M.R., Troutman, B.M., and Vecchia, A.V., 1999, Overview and technical and practical aspects for use of geostatistics in hazardous-, toxic-, and radioactive-waste-site investigations: U.S. Geological Survey Water-Resources Investigations Report 98-4145, 70 p.

Burmeister, I.L., 1970, The streamflow data program in Iowa: U.S. Geological Survey Open-File Report, 82 p.

Burn, D.H., 1990a, An appraisal of the "region of influence" approach to flood frequency analysis: Hydrological Sciences Journal, v. 35, no. 24, p. 149-154.

———1990b, Evaluation of regional flood frequency analysis with region of influence approach: Water Resources Research, v. 26, no. 10, p. 2257-2265.

Cagle, J.W., and Heinitz, A.J., 1978, Water resources of south-central Iowa: Iowa Geological Survey Water Atlas No. 5, 97 p.

Chow, V.T., 1964, Frequency analysis, *in* Chow, V.T., Handbook of applied hydrology: New York, McGraw-Hill Book Co., p. 8-1 to 8-42.

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.

Eash, D.A., 1993, Estimating design-flood discharges for streams in Iowa using drainage-basin and channel-geometry characteristics: U.S. Geological Survey Water-Resources Investigations Report 93-4062, 96 p.

———1997, Effects of the 1993 flood on the determination of flood magnitude and frequency in Iowa: U.S. Geological Survey Circular 1120-K, 23 p.

Englund, E.J., and Sparks, A.R., 1991, GEO-EAS (Geostatistical Environmental Assessment Software) users guide: Las Vegas, Nev., Environmental Monitoring Systems Laboratory Report EPA/600/8-91/008. [Available from National Technical Information Service, Springfield, VA 22161 at NTIS Report PB90-151 252.]

Environmental Systems Research Institute, Inc. (ESRI), 1998, ARC/INFO user's guide, version 7.2.1: Redlands, Calif., Environmental Systems Research Institute.

Hardison, C.H., 1971, Prediction error of regression estimates of streamflow characteristics at gaged sites: U.S. Geological Survey Professional Paper 750-C, p. C228-C236.

Harvey, C.A., and Eash, D.A., 1996, Description, instructions, and verification for Basinsoft, a computer program to quantify drainage-basin characteristics: U.S. Geological Survey Water-Resources Investigations Report 95-4287, 25 p.

Huff, F.A., and Angel, J.R., 1992, Rainfall frequency atlas of the Midwest: Champaign, Illinois State Water Survey, Bulletin 71, 141 p.

Interagency Advisory Committee on Water Data, 1982, Guidelines for determining flood flow frequency: Hydrology Subcommittee Bulletin 17B, 28 p. and appendixes.

Iowa Natural Resources Council, 1958, An inventory of water resources and water problems, southern Iowa river basins: Des Moines, Iowa Natural Resources Council Bulletin 6, 70 p.

Kirby, W.H., 1981, Annual flood frequency analysis using U.S. Water Resources Council guidelines (program J407): U.S. Geological Survey Open-File Report 79-1336-I, WATSTORE User's Guide, v. 4, chap. I, sec. C, 56 p.

Koltun, G.F., and Roberts, J.W., 1990, Techniques for estimating flood-peak discharges of rural, unregulated streams in Ohio: U.S. Geological Survey Water-Resources Investigations Report 89-4126, 68 p.

Krug, W.R., Conger, D.H., and Gebert, W.A., 1992, Flood-frequency characteristics of Wisconsin streams: U.S. Geological Survey Water-Resources Investigations Report 91-4128, 185 p.

Lara, O.G., 1973, Floods in Iowa--Technical manual for estimating their magnitude and frequency: Iowa Natural Resources Council Bulletin 11, 56 p.

———1987, Method for estimating the magnitude and frequency of floods at ungaged sites on unregulated rural streams in Iowa: U.S. Geological Survey Water-Resources Investigations Report 87-4132, 34 p.

Larimer, O.J., 1957, Drainage areas of Iowa streams: Iowa Highway Research Board Bulletin 7 (reprinted 1974), 439 p.

Linsley, R.K., and Franzini, J.B., 1964, Water-resources engineering: New York, McGraw-Hill Book Co., p. 110-133.

Lorenz, D.L., 1997, Generalized skew coefficients for flood-frequency analysis in Minnesota: U.S. Geological Survey Water-Resources Investigations Report 97-4089, 15 p.

Lorenz, D.L., Carlson, G.H., and Sanocki, C.A., 1997, Techniques for estimating peak flow on small streams in Minnesota: U.S. Geological Survey Water-Resources Investigations Report 97-4249, 42 p.

Mallows, C.L., 1973, Some comments on Cp: Technometrics, v. 15, p. 661-675.

Marquardt, D.W., 1970, Generalized inverses, ridge regression, biased linear estimation, and nonlinear estimation: Technometrics, v. 12, p. 591-612.

Montgomery, D.C., and Peck, E.A., 1982, Introduction to linear regression analysis: New York, Wiley and Sons, 504 p.

Pannatier, Yvan, 1996, VARIOWIN, Software for spatial data analysis in 2D: New York, Springer-Verlag, 104 p.

Prior, J.C., 1991, Landforms of Iowa: Iowa City, Iowa Department of Natural Resources, University of Iowa Press, 153 p.

Schwob, H.H., 1953, Iowa floods--Magnitude and frequency: Iowa Highway Research Board Bulletin 1, 171 p.

———1966, Magnitude and frequency of Iowa floods: Iowa Highway Research Board Bulletin 28, parts I and II, 423 p.

———1969, Floods in Iowa, *in* Gougal, M.D., ed., Flood plain management, Iowa's experience: Ames, Iowa State University Press, p. 27-35.

Soenksen, P.J., Miller, L.D., Sharpe, J.B., and Watton, J.R., 1999, Peak-flow frequency relations and evaluation of the peak-flow gaging network in Nebraska: U.S. Geological Survey Water-Resources Investigations Report 99-4032, 102 p.

Soller, D.R., and Packard, P.H., 1998, Digital representation of a map showing the thickness and character of Quaternary sediments in the glaciated United States east of the Rocky Mountains: U.S. Geological Survey Digital Data Series DDS-0038, 1 disc.

Statware, Inc., 1992, Statit statistics reference manual, release 3.0: Corvallis, Oreg., Statware, Inc., chap. 6, 48 p.

Stedinger, J.R., and Tasker, G.D., 1985, Regional hydrologic analysis 1--Ordinary, weighted, and generalized least square compared: Water Resources Research, v. 21, no. 9, p. 1421-1432.

Strahler, A.N., 1952, Hypsometric (area-altitude) analysis of erosional topography: Bulletin of the Geological Society of America, v. 63, p. 1117-1141.

Tasker, G.D., and Slade, R.M., 1994, An interactive regional regression approach to estimating flood quantiles, *in* Fontane, D.G., and Tuvel, N.H., eds., Proceedings of the Twenty-First Annual Conference, Water policy and management, solving the problems, May 23-26, 1994: Denver, Colo., Denver Society of American Society of Civil Engineers, p. 782-785.

Tasker, G.D., and Stedinger, J.R., 1986, Regional skew with weighted regression: Journal of Water Resources Planning and Management, v. 112, no. 2, p. 225-37.

———1989, An operational GLS model for hydrologic regression: Journal of Hydrology, v. 111, p. 361-375.

Waite, Paul, 1988, Iowa precipitation frequencies: Des Moines, Iowa Department of Agriculture and Land Stewardship, State Climatology Office, Climatology of Iowa Series no. 2, revised, 42 p.

Wendland, W.M., Kunkel, K.E., Conner, Glen, Decker, W.L., Hillaker, Harry, Naber-Knox, Pam, Nurnberger, F.V., Rogers, Jeffrey, Scheeringa, Kenneth, and Zandlo, James, 1992, Mean 1961-1990 temperature and precipitation over the upper Midwest: Midwestern Climate Center Research Report 92-01, 27 p.

Wolock, D.M., 1997, STATSGO soil characteristics for the conterminous United States: U.S. Geological Survey Open-File Report 97-656, digital data release.

APPENDIX A

Selected Basin Characteristics

Thirty-eight selected basin characteristics were measured for each streamflow-gaging station used in the regression analyses. A description of these characteristics follows.

Characteristics Manually Measured from Topographic Maps

Two characteristics were manually measured from 1:24,000-scale USGS topographic maps:

DA - Drainage area, in square miles--published drainage area for streamflow-gaging station.

MCS - Main-channel slope (1:24,000 scale), in feet per mile--an index of the slope of the main channel computed from the difference in streambed elevations (E) at points 10 percent and 85 percent of the distance along the main channel from the basin outlet to the basin divide, MCS = $(E_{85} - E_{10}) / (0.75$ MCL).

Morphometric Characteristics Quantified from Digital Data Sources Using Basinsoft

Twenty-eight morphometric characteristics were quantified using Basinsoft, a geographic-information-system (GIS) procedure (Harvey and Eash, 1996). These characteristics were quantified from one or more of three digital data sources: (1) 1:100,000-scale digital line graph (DLG) hydrography (stream network) data; (2) 1:100,000-scale DLG hypsography (elevation contour) data; and (3) 1:100,000-scale digital elevation model (DEM) data.

Basin-Area Measurements

TDA - Total drainage area, in square miles--includes noncontributing areas.

CDA - Contributing drainage area, in square miles--total area that contributes to surface-water runoff at the basin outlet, CDA = TDA - NCDA.

NCDA - Noncontributing drainage area, in square miles--total area that does not contribute to surface-water runoff at the basin outlet.

Basin-Length Measurements

BL - Basin length, in miles--measured along a line areally centered through the basin polygon from the basin outlet to where the main-channel extension meets the basin divide.

BP - Basin perimeter, in miles--measured along entire basin divide.

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

Basin-Relief Measurements

BS - Average basin slope, in feet per mile--measured by the “contour-band” method, within the contributing drainage area (CDA).

BS = (total length of all selected elevation contours) (contour interval) /CDA.

BR - Basin relief, in feet--measured as the difference between the elevation of the highest grid cell and the elevation of the lowest grid cell at the basin outlet within the TDA.

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

Area-Altitude Measurement

HI - Hypsometric integral, in percent--computed from the hypsometric curve (relation of horizontal cross-sectional area of basin to relative elevation upslope of basin outlet) as the ratio of area under the hypsometric curve to the area of the entire hypsometric square (Strahler, 1952).

Basin-Aspect Measurement

BA - Basin azimuth, in degrees--compass direction 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^{o}.

Basin-Shape Measurements

SF - Shape factor, dimensionless--ratio of basin length to effective basin width, SF = BL / BW.

ER - Elongation ratio, dimensionless--ratio of (1) the diameter of a circle of area equal to that of

the basin to (2) the length of the basin, ER = $[4\ CDA / \pi\ (BL)^2]^{0.5}$ = 1.13 $(1 / SF)^{0.5}$.
RB - Rotundity of basin, dimensionless, RB = $[\pi\ (BL)^2] / [4\ CDA]$ = 0.785 SF.
CR - Compactness ratio, dimensionless--is the ratio of the perimeter of the basin to the circumference of a circle of equal area, CR = BP / 2 $(\pi\ CDA)^{0.5}$.

Channel- (Stream-) Length Measurements

MCL - Main-channel length, in miles--measured along the main channel from the basin outlet to where the main-channel extension meets the basin divide.
MCSR - Main-channel sinuosity ratio, dimensionless, MCSR = MCL / BL.
TSL - Total stream length, in miles--computed by summing the length of all stream segments within the CDA.
SD - Stream density, in miles per square mile--within the CDA, SD = TSL / CDA.
CCM - Constant of channel maintenance, in square miles per mile--within the CDA, CCM = CDA / TSL = 1 / SD.

Channel-Relief Measurements

MCS100 - Main-channel slope (1:100,000 scale), in feet per mile--see above description for MCS.
MCSP - Main-channel slope proportion, dimensionless, MCSP = MCL / $(MCS100)^{0.5}$.
RN - Ruggedness number, in feet per mile, RN = (TSL) (BR) / CDA = (SD) (BR).
SR - Slope ratio of main-channel slope to basin slope, dimensionless--within the CDA, SR = MCS100 / BS.

Stream-Order Measurements

FOS - Number of first-order streams within the CDA, dimensionless. FOS is computed using Strahler's method of ordering streams.
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.
DF - Drainage frequency, in number of first-order streams per square mile--within the CDA, DF = FOS / CDA.
RSD - Relative stream density, dimensionless--within the CDA, RSD = (FOS) (CDA) / $(TSL)^2$ = DF / $(SD)^2$.

Landform Characteristic Quantified from Digital Data Source Using Basinsoft

One landform characteristic was quantified using an optional area-weighting program of Basinsoft. The Des Moines Lobe landform region boundary (figs. 8 and 12) was created from 1:24,000-scale digital data provided by Tim Kemmis (Iowa Geological Survey Bureau, written commun., November 1998).
DML - Des Moines Lobe, ratio of basin area within the Des Moines Lobe landform region to total area of the basin.

Precipitation Characteristics Quantified from Digital Data Sources Using Basinsoft

Two precipitation characteristics were quantified using an optional area-weighting program of Basinsoft. A digital data layer representing mean annual precipitation was created from a 1:250,000-scale grid of mean annual precipitation data (*Central United States Average Monthly or Annual Precipitation, 1961-90*, 1998, Chris Daly, Oregon State University, and George Taylor, Oregon Climate Service) downloaded from the PRISM (Parameter-Elevation Regressions on Independent Slopes Model) World Wide Web site <URL:http://www.ocs.orst.edu/prism/prism_new.html>. The grid was contoured using a 1-inch contour interval. The accuracy of those contours was verified using two digital data layers contoured at 2-inch intervals; one data layer was obtained from the PRISM web site and the other data layer was digitized from a mean annual precipitation map (Wendland and others, 1992).

A digital data layer representing 2-year, 24-hour precipitation intensity was created by digitizing a rainfall frequency map (Huff and Angel, 1992) contoured at a 0.25-inch interval. This data layer was further processed to create contours at a 0.125-inch interval.
AP - Mean annual precipitation (1961-90), in

inches--computed as a weighted average within the TDA.

TTF - 2-year, 24-hour precipitation intensity, in inches--defined as the maximum 24-hour precipitation expected to be exceeded on the average once every 2 years, computed as a weighted average within the TDA.

Soil Characteristics Quantified from Digital Data Sources Using Basinsoft

Five soil characteristics were quantified using an optional area-weighting program of Basinsoft. A digital data layer representing State Soil Geographic Data Base (STATSGO) soil characteristics was created from a 1-kilometer-resolution grid (Wolock, 1997) downloaded from a USGS World Wide Web site <URL:http://water.usgs.gov/GIS/metadata/usgswrd/muid.html>.

AWCA - Average available water capacity of soil, in inches/hr--aggregated by soil layer and component, and computed first as an average of low and high values for ranges in available water capacity and second as a weighted average within the TDA.

PERMA - Average permeability rate of soil, in inches/hr--aggregated by soil layer and component, and computed first as an average of low and high values for ranges in permeability and second as a weighted average within the TDA.

PERML - Average minimum permeability rate of soil, in inches/hr--aggregated by soil layer and component as a low value for range in permeability, and computed as a weighted average within the TDA.

SLOPEA - Average slope of soil, in percent--aggregated by soil component, and computed first as an average of low and high values for ranges in land-surface slope and second as a weighted average within the TDA.

SLOPEH - Average maximum slope of soil, in percent--aggregated by soil component as a high value for range in land-surface slope, and computed as a weighted average within the TDA.

APPENDIX B

Technique for Manual, Topographic-Map Measurement of Main-Channel Slope

Measurements of main-channel slope (MCS) are required as input parameters for the multi-variable regression equations for Regions 2 and 3 (tables 4 and 5). Because these equations were developed using measurements of MCS made from 1:24,000-scale USGS topographic maps, the appropriate scale to use for measurements of MCS for input to the multi-variable equations listed in tables 4 and 5 is 1:24,000.

Figure 17 illustrates the measurement of MCS for the Rapid Creek tributary near Iowa City streamflow-gaging station (station number 05453950, map number 83, fig. 15). The measurement of MCS involves five steps:

(1) Using 1:24,000-scale topographic maps, identify the location of the stream site for which the flood-frequency estimate is to be made. Determine the main channel of the stream network for the basin from the stream site upstream to the basin divide. At each stream fork, follow the fork that contributes the greater drainage area. The main channel needs to be extended from the end of the blue line shown on the topographic map to the basin divide. Figure 17 shows the main channel and the main-channel extension for the example basin.

(2) Measure the total length of the main channel, in miles, from stream site to basin divide. For many of the gaging stations in Iowa listed in table 1, main-channel length (MCL) was measured from 1:24,000-scale topographic maps with dividers graduated at 0.1-mi increments (Burmeister, 1970). For several of the gaging stations included in this study, graph paper overlain on 1:24,000-scale topographic maps on a light table was used to measure MCL by aligning the ruling on the graph paper along the main channel. Figure 17 shows that the MCL for the example basin is 4.0 mi.

(3) Locate two points on the main channel, one that is 10 percent of the total length of the main channel (0.10 MCL) upstream from the stream site, and the other that is 85 percent of the total length (0.85 MCL), or 15 percent of the total length downstream from where the main channel meets the basin divide. Figure 17 shows the location of the 0.10-MCL and 0.85-MCL points on the main channel.

(4) For both the 0.10- and 0.85-MCL points, locate the nearest elevation contours on the topographic map that cross the main channel upstream and downstream from each point. Using the elevations determined for these contour lines, interpolate an elevation for both the 0.10- and 0.85-MCL points. Figure 17 shows that the 700- and 690-ft contours are the nearest contours crossing the main channel upstream and downstream from the 0.10-MCL point, and an elevation (E_{10}) of 696 ft was interpolated for the 0.10-MCL point. Likewise, 790- and 780-ft contours are the nearest contour lines upstream and downstream from the 0.85-MCL point, and an elevation (E_{85}) of 786 ft was interpolated for the 0.85-MCL point.

(5) Calculate main-channel slope (MCS) as follows:

$$MCS = (E_{85} - E_{10}) / (0.75\ MCL)$$

For the example basin, the calculation is:

$$MCS = (786 - 696) / (0.75 \times 4.0)$$

$$MCS = 90/3.0 = 30.0 \text{ ft/mi.}$$

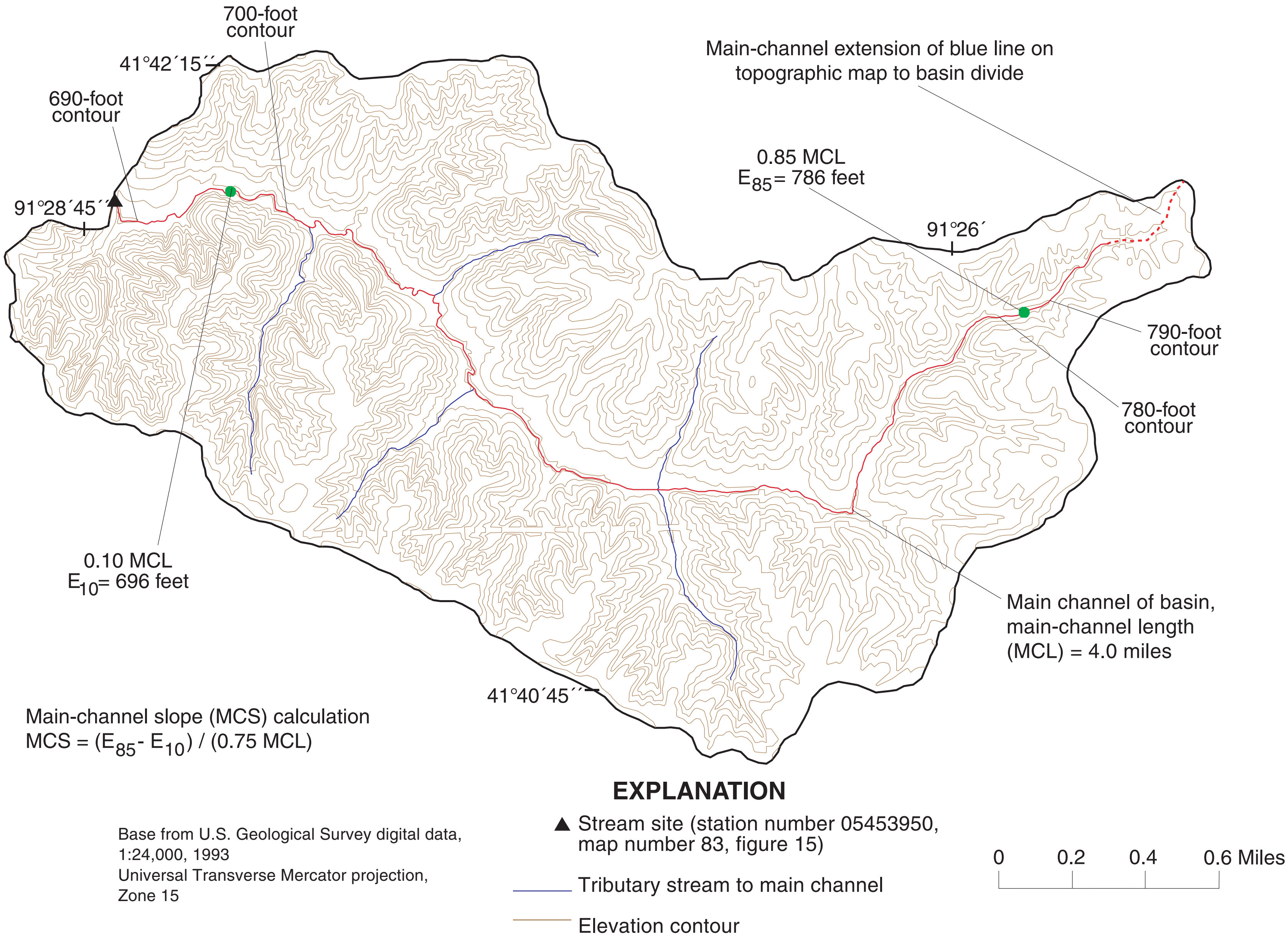


Figure 17.--Topographic-map measurements for calculating main-channel slope (MCS).

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations

[DA, drainage area; MCS, main-channel slope; DML, Des Moines Lobe, ratio of basin area within Des Moines Lobe landform region to total area of basin; ERL, effective record length, indicates systematic record length used in flood-frequency analysis (log-Pearson Type III) when no value is listed for HST; yrs, years; HST, historically adjusted record length used in flood-frequency analysis (log-Pearson Type III); mi^2, square miles; ft/mi, feet per mile; ft^3/s, cubic feet per second; Recur. interv., approximate recurrence interval interpolated from flood-frequency analysis (log-Pearson Type III), rounded to nearest 5 years for 20- to 50-year recurrence intervals, to nearest 10 years for 50- to 100-year recurrence intervals, to nearest 20 years for 100- to 200-year recurrence intervals, and to nearest 25 years for 200- to 500-year recurrence intervals; NA, not applicable, either the gaging station was not used to develop the regional regression equations or a historically adjusted flood-frequency analysis (log-Pearson Type III) was not computed for the gaging station; P, high-flow, partial-record (crest-stage) gage; C, continuous-record gage; B, both continuous-record and high-flow, partial-record gage; >, greater than]

								Peak-flow record			Maximum flood		
Map no. (figs. 1 and 6)	**Station number**	**Station name**	**Hydrologic region (fig. 7)**	**DA (mi^2)**	**MCS (ft/mi)**	**DML (ratio)**	**Type of gage**	**ERL (yrs)**	**HST (yrs)**	**Period of peak-flow record (water years)**	**Water year**	**Dis-charge (ft^3/s)**	**Recur. interv. (yrs)**
1	05311200	North Branch Yellow Medicine River near Ivanhoe, MN	NA	14.8	8.5	1.00	P	26	NA	1960-85	1969	940	40
2	05315000	Redwood River near Marshall, MN	NA	259	9.4	1.00	C	57	59	1940-97	1993	6,380	80
3	05316900	Dry Creek near Jeffers, MN	NA	3.13	47.2	1.00	P	25	NA	1961-85	1984	530	14
4	05316920	Cottonwood River tributary near Sanborn, MN	NA	0.42	44.2	1.00	P	27	NA	1966-90, 1993-94	1993	134	19
5	05317850	Foster Creek near Alden, MN	NA	2.26	26.3	1.00	P	26	NA	1959-84	1981	223	11
6	05318000	East Branch Blue Earth River near Bricelyn, MN	1	132	5.8	1.00	P	35	NA	1951-70, 1973-87	1951	1,320	17
7	05318100	East Branch Blue Earth River tributary near Blue Earth, MN	1	9.20	9.1	1.00	P	26	NA	1960-85	1981	610	35
8	05318300	Watonwan River near Delft, MN	NA	13.0	14.6	1.00	P	38	NA	1960-97	1993	1,000	18
9	05320400	Maple River tributary near Mapleton, MN	NA	6.22	10.0	1.00	P	27	NA	1959-85	1981	2,000	120
10	05382500	Little La Crosse River near Leon, WI	NA	77.1	20.0	0.00	C	47	NA	1934-78, 1980-81	1935	4,620	225
11	05384000	Root River near Lanesboro, MN	2	615	5.8	0.00	B	65	NA	1910-14, 1916-17, 1940-97	1962	22,100	30
12	05384100	Duschee Creek near Lanesboro, MN	2	3.85	18.6	0.00	P	26	NA	1959-84	1969	1,680	30
13	05384200	Gribben Creek near Whalen, MN	2	7.80	73.7	0.00	P	27	NA	1959-85	1974	5,200	30
14	05384400	Pine Creek near Arendahl, MN	2	28.1	16.1	0.00	P	27	NA	1959-85	1978	4,150	25
15	05385000	Root River near Houston, MN	2	1,270	6.2	0.00	B	76	88	1910-17, 1930-97	1952	37,000	90
16	05385500	South Fork Root River near Houston, MN	2	275	10.6	0.00	B	45	NA	1950, 1953-83, 1985-97	1974, 1978[a]	11,000	25
17	05386300	Mormon Creek near La Crosse, WI	NA	25.2	60.6	0.00	P	33	NA	1961-93	1978	6,600	35

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	Peak-flow record: ERL (yrs)	Peak-flow record: HST (yrs)	Peak-flow record: Period of peak-flow record (water years)	Maximum flood: Water year	Maximum flood: Discharge (ft^3/s)	Maximum flood: Recur. interv. (yrs)
18	05387500	Upper Iowa River at Decorah, IA	2	511	6.25	0.00	B	45	77	1941, 1952-90	1941	28,500	425
19	05388000	Upper Iowa River near Decorah, IA	2	568	6.13	0.00	C	35	77	1914, 1919-27, 1933-52	1941	28,500	>500
20	05388250	Upper Iowa River near Dorchester, IA	2	770	5.68	0.00	C	28	84	1941, 1976-95, 1997	1941	30,400	300
21	05388400	Wexford Creek near Harpers Ferry, IA	2	11.9	96.0	0.00	P	37	48	1953-89	1978	8,100	70
22	05388500	Paint Creek at Waterville, IA	2	42.8	29.5	0.00	C	21	23	1951, 1953-73	1951	9,100	120
23	05388600	Paint Creek near Waterville, IA	2	56.0	27.4	0.00	P	37	45	1951, 1953-86	1974	19,000	250
24	05389000	Yellow River at Ion, IA	2	221	13.4	0.00	C	17	NA	1935-51	1941	21,200	30
25	05406800	Rocky Branch near Richland Center, WI	NA	1.68	100	0.00	P	34	NA	1960-93	1972	870	60
26	05407100	Richland Creek near Plugtown, WI	NA	19.2	51.8	0.00	P	36	NA	1958-93	1982	4,400	70
27	05407200	Crooked Creek near Boscobel, WI	NA	12.9	51.1	0.00	P	39	NA	1959-97	1964	2,460	90
28	05408000	Kickapoo River at La Farge, WI	NA	266	9.13	0.00	C	59	NA	1939-97	1978	14,300	225
29	05410490	Kickapoo River at Steuben, WI	NA	687	4.30	0.00	C	64	NA	1934-97	1978	16,500	140
30	05411530	North Branch Turkey River near Cresco, IA	2	19.5	11.8	0.00	P	28	NA	1966-93	1993	4,500	35
31	05411600	Turkey River at Spillville, IA	2	177	6.93	0.00	C	34	45	1947, 1956-73, 1978-91	1947	10,000	25
32	05411650	Crane Creek tributary near Saratoga, IA	2	4.06	25.8	0.00	P	23	NA	1953-75	1962	1,830	15
33	05411700	Crane Creek near Lourdes, IA	2	75.8	8.22	0.00	P	38	NA	1953-90	1962	11,900	45
34	05412060	Silver Creek near Luana, IA	2	4.39	28.1	0.00	C	12	18	1988-97	1991	3,300	80
35	05412100	Roberts Creek above Saint Olaf, IA	2	70.7	8.13	0.00	C	12	18	1987-97	1991	19,600	140
36	05412500	Turkey River at Garber, IA	2	1,545	5.58	0.00	C	83	108	1902, 1914-16, 1919-27, 1930, 1933-97	1991	49,900	>500
37	05413400	Pigeon Creek near Lancaster, WI	2	6.93	49.8	0.00	P	38	NA	1960-97	1967	2,800	70
38	05414200	Bear Branch near Platteville, WI	NA	2.72	60.2	0.00	P	36	NA	1958-93	1974	1,330	60
39	05414450	North Fork Little Maquoketa River near Rickardsville, IA	2	21.6	20.0	0.00	P	43	NA	1951-97	1972	7,180	100

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	Peak-flow record: ERL (yrs)	Peak-flow record: HST (yrs)	Peak-flow record: Period of peak-flow record (water years)	Maximum flood: Water year	Maximum flood: Discharge (ft^3/s)	Maximum flood: Recur. interv. (yrs)
40	05414500	Little Maquoketa River near Durango, IA	2	130	17.6	0.00	B	64	121	1925, 1935-83, 1986-92, 1994	1972	40,000	225
41	05414600	Little Maquoketa River tributary at Dubuque, IA	2	1.54	100	0.00	P	45	NA	1951-65, 1967-92, 1994-97	1957	1,650	50
42	05414820	Sinsinawa River near Menominee, IL	2	39.6	18.9	0.00	C	30	NA	1968-97	1969	11,600	30
43	05414900	Pats Creek near Elk Grove, WI	2	8.50	26.9	0.00	P	37	NA	1960-97	1969	7,040	200
44	05415500	East Fork Galena River at Council Hill, IL	NA	20.1	37.3	0.00	P	30	NA	1940-69	1947	16,600	120
45	05417000	Maquoketa River near Manchester, IA	2	305	8.10	0.00	C	53	59	1925, 1928-30, 1933-73, 1976-83	1925	25,400	160
46	05417530	Plum Creek at Earlville, IA	2	41.1	14.0	0.00	P	25	NA	1966-91	1974	6,200	40
47	05417590	Kitty Creek near Langworthy, IA	2	14.4	20.9	0.00	P	26	NA	1966-92	1969	3,700	100
48	05417700	Bear Creek near Monmouth, IA	2	61.3	8.24	0.00	C	19	NA	1944, 1958-76	1965	7,340	80
49	05418450	North Fork Maquoketa River at Fulton, IA	2	516	4.57	0.00	C	15	NA	1974, 1977-91	1981	10,700	7
50	05418500	Maquoketa River near Maquoketa, IA	2	1,553	4.10	0.00	C	86	95	1903, 1914-97	1944	48,000	60
51	05420560	Wapsipinicon River near Elma, IA	2	95.2	6.47	0.00	C	34	NA	1959-92	1974	10,100	25
52	05420620	Little Wapsipinicon River near Acme, IA	2	7.76	21.3	0.00	P	40	NA	1953-91, 1993	1962	2,380	45
53	05420640	Little Wapsipinicon River at Elma, IA	2	37.3	9.73	0.00	P	41	49	1953-91, 1993	1993	11,700	225
54	05420650	Little Wapsipinicon River near New Hampton, IA	2	95.0	5.50	0.00	P	31	49	1966-93	1993	29,500	425
55	05420690	East Fork Wapsipinicon River near New Hampton, IA	2	30.3	32.0	0.00	P	31	49	1966-91, 1993	1969	11,000	80
56	05420850	Little Wapsipinicon River near Oran, IA	2	94.1	4.70	0.00	P	31	NA	1966-97	1990	5,040	40
57	05420960	Harter Creek near Independence, IA	2	6.17	32.0	0.00	P	12	NA	1952-63	1962	2,280	19
58	05421000	Wapsipinicon River at Independence, IA	2	1,048	3.58	0.00	C	67	98	1934-97	1968	26,800	60

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	Peak-flow record: ERL (yrs)	Peak-flow record: HST (yrs)	Peak-flow record: Period of peak-flow record (water years)	Maximum flood: Water year	Maximum flood: Discharge (ft^3/s)	Maximum flood: Recur. interv. (yrs)
59	05421100	Pine Creek tributary near Winthrop, IA	NA	0.33	87.2	0.00	P	46	NA	1952-97	1968	334	25
60	05421200	Pine Creek near Winthrop, IA	2	28.3	14.0	0.00	P	50	72	1950-91, 1993	1968	24,200	>500
61	05421890	Silver Creek at Welton, IA	2	9.03	20.8	0.00	P	31	NA	1966-97	1974	4,820	30
62	05422000	Wapsipinicon River near De Witt, IA	2	2,330	2.69	0.00	C	63	NA	1935-97	1990	31,100	50
63	05422470	Crow Creek at Bettendorf, IA	2	17.8	12.8	0.00	C	19	NA	1978-93, 1995-97	1990	7,700	50
64	05432300	Rock Branch near Mineral Point, WI	2	4.83	80.1	0.00	P	39	NA	1959-97	1993	3,100	160
65	05448000	Mill Creek at Milan, IL	2	62.4	7.44	0.00	C	55	NA	1940-86, 1990-97	1973	9,300	30
66	05448500	West Branch Iowa River near Klemme, IA	1	112	1.17	1.00	C	10	NA	1949-58	1954	1,920	25
67	05448700	East Branch Iowa River near Hayfield, IA	1	7.94	8.00	1.00	P	37	NA	1952-86, 1990-91	1954	457	35
68	05448800	East Branch Iowa River near Garner, IA	1	45.1	3.26	1.00	P	40	NA	1952-91	1961	1,120	35
69	05449000	East Branch Iowa River near Klemme, IA	1	133	1.44	1.00	C	50	79	1944, 1949-76, 1978-95	1954	5,960	120
70	05449500	Iowa River near Rowan, IA	1	429	1.31	1.00	C	56	NA	1941-76, 1978-97	1954	8,460	70
71	05451500	Iowa River near Marshalltown, IA	2	1,532	2.67	0.81	C	84	116	1903, 1915-27, 1929-30, 1933-97	1918	42,000	>500
72	05451700	Timber Creek near Marshalltown, IA	2	118	7.56	0.00	C	48	NA	1947, 1950-97	1977	12,000	70
73	05451900	Richland Creek near Haven, IA	2	56.1	9.20	0.00	C	48	NA	1918, 1950-97	1991	12,200	350
74	05451955	Stein Creek near Clutier, IA	2	23.4	10.6	0.00	P	31	50	1972-87, 1989-97	1982	11,400	80
75	05452000	Salt Creek near Elberon, IA	2	201	8.00	0.00	C	59	79	1944, 1946-97	1993	36,600	120
76	05452200	Walnut Creek near Hartwick, IA	2	70.9	9.20	0.00	C	48	NA	1947, 1950-97	1991	7,900	20
77	05452500	Iowa River near Belle Plaine, IA	2	2,455	2.45	0.51	C	20	NA	1918, 1940-59	1947	34,000	25
78	05453000	Big Bear Creek at Ladora, IA	2	189	7.02	0.00	C	52	NA	1946-97	1960	10,500	80
79	05453100	Iowa River at Marengo, IA	2	2,794	2.30	0.45	C	41	NA	1957-97	1993	38,000	90
80	05453600	Rapid Creek below Morse, IA	2	8.12	16.8	0.00	P	40	NA	1951-92	1987	3,000	25

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

								Peak-flow record			Maximum flood		
Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	ERL (yrs)	HST (yrs)	Period of peak-flow record (water years)	Water year	Discharge (ft^3/s)	Recur. interv. (yrs)
81	05453700	Rapid Creek tributary No. 4 near Oasis, IA	2	1.95	34.1	0.00	P	24	NA	1951-74	1953	956	25
82	05453750	Rapid Creek southwest of Morse, IA	2	15.2	14.5	0.00	P	40	NA	1951-87, 1989-92	1972	4,300	30
83	05453950	Rapid Creek tributary near Iowa City, IA	2	3.43	30.0	0.00	P	39	NA	1951-86, 1988, 1990-92	1972	2,000	30
84	05454000	Rapid Creek near Iowa City, IA	2	25.3	11.6	0.00	C	60	NA	1938-97	1993	6,700	30
85	05454300	Clear Creek near Coralville, IA	2	98.1	7.00	0.00	C	45	NA	1953-97	1990	10,200	70
86	05454500	Iowa River at Iowa City, IA	2	3,271	2.14	0.38	C	64	108	1851, 1881, 1903-58[b]	1851	70,000	>500
87	05455000	Ralston Creek at Iowa City, IA	2	3.01	31.0	0.00	C	58	NA	1925-82[b]	1971	2,200	60
88	05455010	South Branch Ralston Creek at Iowa City, IA	2	2.94	23.1	0.00	C	17	NA	1962, 1964-80[b]	1972	1,070	13
89	05455100	Old Mans Creek near Iowa City, IA	2	201	3.91	0.00	B	46	NA	1951-87, 1989-97	1982	13,500	40
90	05455140	North English River near Montezuma, IA	2	31.0	5.67	0.00	P	25	NA	1973-97	1978	4,640	20
91	05455150	North English River near Malcom, IA	2	34.0	5.67	0.00	P	23	NA	1953-61, 1963, 1965-77	1953	4,240	11
92	05455200	North English River near Guernsey, IA	2	68.7	7.59	0.00	P	30	NA	1953-86	1953	7,000	35
93	05455210	North English River at Guernsey, IA	2	81.5	5.63	0.00	P	33	NA	1960, 1966-97	1982	7,460	50
94	05455280	South English River tributary near Barnes City, IA	2	2.51	20.0	0.00	P	23	NA	1953-76	1970	900	10
95	05455300	South English River near Barnes City, IA	2	11.5	10.7	0.00	P	35	NA	1953-87	1982	2,200	40
96	05455350	South English River tributary No. 2 near Montezuma, IA	NA	0.52	34.6	0.00	P	28	NA	1953-80[b]	1961	344	50
97	05455500	English River at Kalona, IA	2	573	4.20	0.00	C	58	NA	1930, 1940-97	1993	36,100	140
98	05457000	Cedar River near Austin, MN	2	425	3.1	0.54	B	61	88	1910-14, 1945-97	1978	12,400	60
99	05457700	Cedar River at Charles City, IA	2	1,054	3.45	0.27	C	44	51	1946-95	1961	29,200	90
100	05458000	Little Cedar River near Ionia, IA	2	306	5.05	0.00	C	44	NA	1954-97	1993	14,000	50

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

								Peak-flow record			Maximum flood		
Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	ERL (yrs)	HST (yrs)	Period of peak-flow record (water years)	Water year	Dis-charge (ft^3/s)	Recur. interv. (yrs)
101	05458500	Cedar River at Janesville, IA	2	1,661	2.96	0.17	C	77	NA	1905-06, 1915-21, 1923-27, 1933-42, 1945-97	1961	37,000	60
102	05458900	West Fork Cedar River at Finchford, IA	2	846	5.00	0.37	C	54	69	1929, 1946-97	1951	31,900	70
103	05459000	Shell Rock River near Northwood, IA	1	300	2.24	0.98	C	41	NA	1946-86	1965	3,400	100
104	05459500	Winnebago River at Mason City, IA	1	526	2.56	0.82	C	65	NA	1933-97	1933	10,800	50
105	05460100	Willow Creek near Mason City, IA	1	78.6	5.19	0.82	P	30	NA	1966-97	1984	1,150	20
106	05460500	Shell Rock River at Marble Rock, IA	2	1,318	4.10	0.65	C	21	NA	1933-53, 1961-62	1933	36,400	180
107	05462000	Shell Rock River at Shell Rock, IA	2	1,746	3.60	0.49	C	49	142	1856, 1954-97	1856	45,000	225
108	05462750	Beaver Creek tributary near Aplington, IA	2	11.6	14.1	0.00	P	26	NA	1966-91	1983	3,000	12
109	05463000	Beaver Creek at New Hartford, IA	2	347	7.60	0.15	C	52	NA	1946-97	1947	18,000	30
110	05463090	Black Hawk Creek at Grundy Center, IA	2	56.9	7.01	0.00	P	26	NA	1966-91	1969	7,000	50
111	05463500	Black Hawk Creek at Hudson, IA	2	303	6.20	0.00	C	44	NA	1952-95	1969	19,300	70
112	05464000	Cedar River at Waterloo, IA	2	5,146	2.80	0.29	C	71	116	1929, 1933, 1941-97	1961	76,700	40
113	05464310	Pratt Creek near Garrison, IA	2	23.4	14.5	0.00	P	34	50	1966-94	1993	12,300	120
114	05464560	Prairie Creek at Blairstown, IA	2	87.0	7.02	0.00	P	21	NA	1966-84, 1986-87	1982	4,750	25
115	05464640	Prairie Creek at Fairfax, IA	2	178	4.14	0.00	C	16	NA	1967-82	1979	8,140	20
116	05464880	Otter Creek at Wilton, IA	2	10.7	11.5	0.00	P	31	50	1966-93	1990	5,940	180
117	05467000	Pope Creek near Keithsburg, IL	2	174	3.59	0.00	C	58	NA	1935-86, 1991-96	1973	8,900	140
118	05468500	Cedar Creek at Little York, IL	NA	132	4.49	0.00	B	54	NA	1941-78, 1980-97	1993	18,100	160
119	05469000	Henderson Creek near Oquawka, IL	2	432	3.96	0.00	C	62	NA	1935-96	1982	34,600	300
120	05469500	South Henderson Creek at Biggsville, IL	2	82.9	6.12	0.00	C	42	NA	1940-76, 1978-82	1982	10,500	100
121	05469860	Mud Lake drainage ditch 71 at Jewell, IA	1	65.4	10.4	1.00	P	32	NA	1966-97	1993	3,700	60
122	05469990	Keigley Branch near Story City, IA	2	31.0	7.52	1.00	P	32	NA	1966-97	1996	3,440	50

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

								Peak-flow record			Maximum flood		
Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	ERL (yrs)	HST (yrs)	Period of peak-flow record (water years)	Water year	Discharge (ft^3/s)	Recur. interv. (yrs)
123	05470000	South Skunk River near Ames, IA	2	315	7.34	1.00	C	74	79	1921-27, 1930, 1933-97	1996	14,000	>500
124	05470500	Squaw Creek at Ames, IA	2	204	8.87	1.00	C	51	80	1918, 1920-27, 1965-97	1993	24,300	>500
125	05471000	South Skunk River below Squaw Creek near Ames, IA	2	556	6.63	1.00	C	43	79	1944, 1953-79, 1990, 1992-97	1993	26,500	>500
126	05471050	South Skunk River at Colfax, IA	2	803	4.64	0.96	C	12	NA	1986-97	1993	14,200	30
127	05471200	Indian Creek near Mingo, IA	2	276	6.36	1.00	C	34	53	1958-75, 1986-97	1991	23,500	375
128	05471500	South Skunk River near Oskaloosa, IA	2	1,635	3.63	0.68	C	54	67	1944, 1946-97	1944	37,000	>500
129	05472090	North Skunk River near Baxter, IA	2	52.2	11.1	0.09	P	29	NA	1966-94	1966	3,800	25
130	05472290	Sugar Creek near Searsboro, IA	2	52.7	7.74	0.00	P	23	NA	1966-88	1974	4,600	40
131	05472390	Middle Creek near Lacey, IA	2	23.0	10.1	0.00	P	31	NA	1966-97	1976	9,650	300
132	05472445	Rock Creek at Sigourney, IA	2	26.3	8.61	0.00	P	22	NA	1966-88	1970	4,100	45
133	05472500	North Skunk River near Sigourney, IA	2	730	3.29	0.01	C	52	NA	1944, 1946-97	1960	27,500	80
134	05473000	Skunk River at Coppock, IA	2	2,916	2.22	0.38	C	45	69	1903, 1914-50	1944	41,500	40
135	05473300	Cedar Creek near Batavia, IA	2	252	3.81	0.00	P	23	NA	1965-87	1965	26,000	80
136	05473400	Cedar Creek near Oakland Mills, IA	2	530	2.57	0.00	C	19	NA	1979-97	1996	12,300	60
137	05473500	Big Creek near Mount Pleasant, IA	2	106	5.32	0.00	C	26	32	1956-79	1973	10,500	80
138	05474000	Skunk River at Augusta, IA	2	4,303	1.92	0.26	C	86	146	1903, 1915-97	1973	66,800	375
139	05474750	Beaver Creek tributary #2 near Slayton, MN	NA	5.10	25.9	1.00	P	25	NA	1961-85	1979	228	20
140	05474760	Beaver Creek tributary above Slayton, MN	NA	2.20	35.4	1.00	P	25	NA	1961-85	1979	160	20
141	05475400	Warren Lake tributary near Windom, MN	NA	1.39	24.0	1.00	P	28	NA	1960-87	1980	666	160
142	05475800	Des Moines River tributary near Jackson, MN	NA	1.52	20.3	1.00	P	26	NA	1960-85	1969	134	60
143	05475900	Des Moines River tributary #2 near Lakefield, MN	NA	5.18	13.5	1.00	P	26	NA	1960-85	1969	271	140

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

								Peak-flow record			Maximum flood		
Map no. (figs. 1 and 6)	**Station number**	**Station name**	**Hydrologic region (fig. 7)**	**DA (mi^2)**	**MCS (ft/mi)**	**DML (ratio)**	**Type of gage**	**ERL (yrs)**	**HST (yrs)**	**Period of peak-flow record (water years)**	**Water year**	**Dis-charge (ft^3/s)**	**Recur. interv. (yrs)**
144	05476000	Des Moines River at Jackson, MN	1	1,220	2.60	1.00	B	74	89	1909-13, 1931-97	1969	15,700	200
145	05476500	Des Moines River at Estherville, IA	1	1,372	3.08	1.00	C	45	56	1952-94	1969	16,000	70
146	05476750	Des Moines River at Humboldt, IA	1	2,256	2.85	1.00	C	58	NA	1940-97	1993	19,000	60
147	05476900	Fourmile Creek near Dunnell, MN	NA	14.0	14.0	1.00	P	38	NA	1960-97	1962	2,200	90
148	05478000	East Fork Des Moines River near Burt, IA	1	462	2.50	1.00	C	23	NA	1952-74	1965	5,000	30
149	05479000	East Fork Des Moines River at Dakota City, IA	1	1,308	1.67	1.00	C	60	79	1938, 1940-97	1938	22,000	70
150	05480000	Lizard Creek near Clare, IA	1	257	4.45	1.00	C	42	NA	1940-81	1947	10,000	140
151	05480500	Des Moines River at Fort Dodge, IA	1	4,190	2.87	1.00	C	67	NA	1905-06, 1914-27, 1947-97	1965	35,600	50
152	05481000	Boone River near Webster City, IA	1	844	2.38	1.00	C	61	101	1918, 1932, 1941-97	1918	21,500	120
153	05481300	Des Moines River near Stratford, IA	1	5,452	2.80	1.00	C	92	95	1903, 1905-29, 1931, 1933-97[c]	1954	57,400	120
154	05481680	Beaver Creek at Beaver, IA	1	38.5	8.32	1.00	P	25	NA	1966-90	1979	1,950	30
155	05481950	Beaver Creek near Grimes, IA	2	358	4.40	1.00	C	38	NA	1960-97	1993	14,300	180
156	05482135	North Raccoon River near Newell, IA	1	233	3.37	0.99	C	12	NA	1983-93, 1995	1984	2,850	9
157	05482170	Big Cedar Creek near Varina, IA	1	80.0	5.55	1.00	C	32	NA	1960-91	1962	2,080	17
158	05482300	North Raccoon River near Sac City, IA	2	700	3.50	0.95	C	39	NA	1954, 1959-97	1979	13,100	25
159	05482500	North Raccoon River near Jefferson, IA	2	1,619	2.98	0.97	C	58	NA	1940-97	1947	29,100	140
160	05482600	Hardin Creek at Farnhamville, IA	1	43.7	2.43	1.00	P	39	NA	1952-90	1954	2,000	30
161	05482900	Hardin Creek near Farlin, IA	1	101	3.26	1.00	P	46	NA	1951-93, 1995-97	1993	3,010	40
162	05483000	East Fork Hardin Creek near Churdan, IA	1	24.0	8.40	1.00	C	40	NA	1952-91	1990	754	100
163	05483349	Middle Raccoon River tributary at Carroll, IA	2	6.58	29.5	0.00	P	37	50	1966-97	1996	4,600	80

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	Peak-flow record: ERL (yrs)	HST (yrs)	Period of peak-flow record (water years)	Maximum flood: Water year	Discharge (ft^3/s)	Recur. interv. (yrs)
164	05483450	Middle Raccoon River near Bayard, IA	2	375	4.25	0.62	C	24	50	1973, 1979-97	1993	27,500	350
165	05484000	South Raccoon River at Redfield, IA	2	994	5.12	0.42	C	58	NA	1940-97	1993	44,000	400
166	05484500	Raccoon River at Van Meter, IA	2	3,441	2.71	0.80	C	83	NA	1915-97	1993	70,100	425
167	05485640	Fourmile Creek at Des Moines, IA	2	92.7	7.62	1.00	C	25	NA	1972-79, 1981-97	1977	5,380	15
168	05486000	North River near Norwalk, IA	2	349	7.11	0.00	C	58	NA	1940-97	1947	32,000	250
169	05486490	Middle River near Indianola, IA	2	503	5.68	0.00	C	58	NA	1940-97	1947	34,000	>500
170	05487470	South River near Ackworth, IA	3	460	6.68	0.00	C	58	NA	1930, 1940-97	1990	38,100	70
171	05487600	South White Breast Creek near Osceola, IA	3	28.0	17.0	0.00	P	29	NA	1953-81	1981	11,800	180
172	05487800	White Breast Creek at Lucas, IA	3	128	7.90	0.00	P	38	NA	1953-88, 1990-91	1981	15,500	60
173	05487980	White Breast Creek near Dallas, IA	3	342	4.78	0.00	C	40	53	1962-94, 1996-97	1982	37,300	300
174	05488000	White Breast Creek near Knoxville, IA	2	380	4.48	0.00	C	17	NA	1946-62	1947	14,000	17
175	05488200	English Creek near Knoxville, IA	3	90.1	5.63	0.00	C	18	50	1982, 1986-97	1982	28,000	160
176	05488620	Coal Creek near Albia, IA	3	13.5	19.8	0.00	P	30	42	1966-91	1982	12,700	80
177	05489000	Cedar Creek near Bussey, IA	3	374	5.74	0.00	C	56	146	1946, 1948-97	1982	96,000	475
178	05489150	Little Muchakinock Creek at Oskaloosa, IA	2	9.12	16.3	0.00	P	23	NA	1966-88	1970	4,500	70
179	05489350	South Avery Creek near Blakesburg, IA	3	33.1	11.2	0.00	P	32	NA	1965-97	1982	21,000	100
180	05489490	Bear Creek at Ottumwa, IA	2	22.9	11.8	0.00	P	32	NA	1965-97	1982	4,030	30
181	05491000	Sugar Creek near Keokuk, IA	3	105	5.76	0.00	C	30	94	1905, 1923-28, 1930-31, 1959-73	1905	33,000	>500
182	05494300	Fox River at Bloomfield, IA	3	87.7	8.30	0.00	B	21	NA	1953-73	1960	8,600	19
183	05494500	Fox River at Cantril, IA	3	161	6.82	0.00	C	11	NA	1920, 1941-51	1946	16,500	70
184	05495000	Fox River At Wayland, MO	3	400	4.50	0.00	C	76	NA	1922-97	1973	26,400	160

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	Peak-flow record: ERL (yrs)	Peak-flow record: HST (yrs)	Peak-flow record: Period of peak-flow record (water years)	Maximum flood: Water year	Maximum flood: Discharge (ft^3/s)	Maximum flood: Recur. interv. (yrs)
185	05495100	Big Branch tributary near Wayland, MO	NA	0.70	80.8	0.00	P	35	93	1956-84	1973	941	120
186	05495500	Bear Creek near Marcelline, IL	NA	349	3.70	0.00	C	54	NA	1944-97	1996	35,500	100
187	05495600	South Wyaconda River near West Grove, IA	3	4.69	26.9	0.00	P	23	NA	1953-75	1970	3,100	25
188	05496000	Wyaconda River above Canton, MO	3	393	4.50	0.00	C	71	NA	1922-72, 1976, 1978-92, 1994-97	1933	17,700	40
189	05497000	North Fabius River at Monticello, MO	3	452	4.80	0.00	C	83	124	1922-97	1973	20,700	100
190	05497500	Middle Fabius River near Baring, MO	NA	185	6.80	0.00	C	49	NA	1931-61, 1963-80	1973	12,100	25
191	05497700	Bridge Creek Branch near Baring, MO	NA	2.38	31.5	0.00	P	25	NA	1955-79	1970	1,090	35
192	05498000	Middle Fabius River near Monticello, MO	NA	393	4.10	0.00	C	52	NA	1946-97	1973	17,700	80
193	05569825	Cedar Creek tributary at St. Augustine, IL	2	4.06	24.4	0.00	P	25	NA	1956-80	1967	1,460	90
194	05584500	La Moine River at Colmar, IL	NA	655	3.70	0.00	C	53	NA	1945-97	1985	38,900	90
195	06478820	Saddlerock Creek tributary near Beresford, SD	NA	2.22	41.3	1.00	P	25	NA	1956-80	1978	120	20
196	06479950	Deer Creek near Brookings, SD	NA	4.04	47.4	0.00	P	25	NA	1956-80	1969	750	17
197	06482950	Mound Creek near Hardwick, MN	NA	2.47	24.1	0.00	P	27	NA	1959-85	1979	459	50
198	06483000	Rock River at Luverne, MN	2	425	4.10	0.22	B	36	86	1912-14, 1969, 1972-97	1993	35,400	180
199	06483210	Kanaranzi Creek tributary #2 near Wilmont, MN	2	2.14	30.8	1.00	P	26	28	1966-90, 1993	1969	1,230	90
200	06483270	Rock River at Rock Rapids, IA	2	788	6.33	0.20	C	23	99	1960-74	1969	29,000	60
201	06483410	Otter Creek north of Sibley, IA	2	11.9	6.13	0.56	P	36	NA	1952-88	1962	1,410	50
202	06483430	Otter Creek at Sibley, IA	2	29.9	10.0	0.25	P	35	NA	1952-88	1953	5,400	80
203	06483460	Otter Creek near Ashton, IA	2	88.0	9.65	0.12	P	39	63	1952-72, 1974-88	1979	18,000	120
204	06483500	Rock River near Rock Valley, IA	2	1,592	5.79	0.14	C	55	100	1948-97	1969	40,400	50
205	06484000	Dry Creek at Hawarden, IA	2	48.4	9.08	0.00	C	25	43	1949-69	1953	10,900	160

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	Peak-flow record			Maximum flood		
								ERL (yrs)	HST (yrs)	Period of peak-flow record (water years)	Water year	Dis-charge (ft^3/s)	Recur. interv. (yrs)
206	06599800	Perry Creek near Merrill, IA	2	8.17	20.4	0.00	P	40	NA	1953-84, 1986-97	1953	2,540	35
207	06599950	Perry Creek near Hinton, IA	2	33.1	12.6	0.00	P	35	45	1953-55, 1957-86, 1989-90, 1995-97	1981	5,500	20
208	06600000	Perry Creek at 38th Street, Sioux City, IA	2	65.1	11.3	0.00	C	47	NA	1939-69, 1982-97	1944	9,600	45
209	06600100	Floyd River at Alton, IA	2	268	5.49	0.00	C	48	122	1953, 1956-97	1953	45,500	500
210	06600300	West Branch Floyd River near Struble, IA	2	180	4.18	0.00	B	41	NA	1956-94, 1996-97	1994	8,920	17
211	06600500	Floyd River at James, IA	2	886	4.38	0.00	C	67	122	1935-97	1953	71,500	>500
212	06600800	South Omaha Creek tributary No. 2 near Walthill, NE	2	1.65	70.0	0.00	P	29	NA	1950-78	1954	2,150	50
213	06600900	South Omaha Creek at Walthill, NE	2	51.2	11.6	0.00	P	31	38	1951-78	1957	14,200	90
214	06601000	Omaha Creek at Homer, NE	NA	168	10.3	0.00	C	55	77	1940, 1946-97	1940	51,000	>500
215	06602020	West Fork ditch at Hornick, IA	2	403	6.50	0.00	C	54	NA	1939-69, 1975-97	1962	12,400	45
216	06603530	Little Sioux River near Spafford, MN	2	41.1	5.8	1.00	P	36	NA	1962-97	1969	4,500	80
217	06605000	Ocheyedan River near Spencer, IA	2	426	5.65	0.46	C	28	106	1953, 1969, 1978-97	1953	26,000	>500
218	06605340	Prairie Creek near Spencer, IA	2	22.3	7.4	0.00	P	28	NA	1966-93	1971	2,200	30
219	06605600	Little Sioux River at Gillett Grove, IA	2	1,334	2.98	0.66	C	23	105	1953, 1959-73	1953	24,000	35
220	06605750	Willow Creek near Cornell, IA	2	78.6	5.55	0.00	P	32	NA	1966-97	1979	4,200	35
221	06605850	Little Sioux River at Linn Grove, IA	2	1,548	1.81	0.62	C	35	106	1953, 1961-62, 1965, 1973-97	1953	22,500	40
222	06606600	Little Sioux River at Correctionville, IA	2	2,500	1.99	0.39	C	72	NA	1919-25, 1929-32, 1937-97	1965	29,800	70
223	06606700	Little Sioux River near Kennebec, IA	2	2,738	1.93	0.36	C	30	NA	1940-69	1965	29,700	70
224	06606790	Maple Creek near Alta, IA	2	15.5	11.7	0.00	P	27	36	1966-89	1969	5,300	70
225	06607000	Odebolt Creek near Arthur, IA	2	39.3	16.1	0.00	C	18	NA	1951, 1958-75	1962	5,200	45
226	06607200	Maple River at Mapleton, IA	2	669	4.83	0.00	C	56	NA	1942-97	1978	20,800	35

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	Peak-flow record: ERL (yrs)	Peak-flow record: HST (yrs)	Peak-flow record: Period of peak-flow record (water years)	Maximum flood: Water year	Maximum flood: Discharge (ft^3/s)	Maximum flood: Recur. interv. (yrs)
227	06607800	South Branch Tekamah Creek tributary near Tekamah, NE	2	4.08	39.2	0.00	P	29	NA	1950-78	1950	5,000	275
228	06608000	Tekamah Creek at Tekamah, NE	2	23.0	21.9	0.00	P	31	NA	1950-80	1963	6,180	15
229	06608500	Soldier River at Pisgah, IA	2	407	8.11	0.00	C	58	NA	1940-97	1996	34,700	80
230	06608700	New York Creek tributary near Spiker, NE	2	1.55	45.9	0.00	P	28	NA	1951-78	1957	1,580	25
231	06608800	New York Creek north of Spiker, NE	2	6.50	36.4	0.00	P	25	NA	1951-75	1960	3,620	30
232	06608900	New York Creek east of Spiker, NE	2	13.9	24.8	0.00	P	29	NA	1950-78	1960	9,250	70
233	06609500	Boyer River at Logan, IA	2	871	3.56	0.00	C	68	NA	1918-25, 1938-97	1990	30,800	50
234	06609560	Willow Creek near Soldier, IA	2	29.1	13.2	0.00	P	31	NA	1966-77, 1979-97	1993	6,840	40
235	06610500	Indian Creek at Council Bluffs, IA	2	7.99	47.7	0.00	C	27	55	1942, 1955-76	1942	9,200	250
236	06610520	Mosquito Creek near Earling, IA	2	32.0	13.4	0.00	C	19	37	1965-79	1972	12,000	45
237	06610600	Mosquito Creek at Neola, IA	2	131	7.30	0.00	P	44	NA	1952-95	1958	17,300	50
238	06803510	Little Salt Creek near Lincoln, NE	NA	43.6	13.2	0.00	C	29	NA	1969-97	1993	8,480	25
239	06803520	Stevens Creek near Lincoln, NE	2	47.8	8.69	0.00	C	29	NA	1969-97	1989	12,900	30
240	06803530	Rock Creek near Ceresco, NE	NA	119	7.71	0.00	C	28	NA	1970-97	1987	23,300	250
241	06803600	North Fork Wahoo Creek near Prague, NE	NA	15.4	27.0	0.00	P	34	135	1951-78	1963	15,900	45
242	06803900	North Fork Wahoo Creek at Weston, NE	2	43.3	12.0	0.00	P	41	77	1951-78	1963	81,400	>500
243	06804000	Wahoo Creek at Ithaca, NE	2	271	5.98	0.00	C	53	154	1950-97	1963	77,400	>500
244	06804100	Silver Creek near Cedar Bluffs, NE	2	7.00	10.2	0.00	P	35	84	1950-78	1959	4,040	80
245	06804200	Silver Creek near Colon, NE	2	30.3	7.87	0.00	P	35	84	1950-78	1959	12,000	100
246	06804300	Silver Creek tributary near Colon, NE	NA	10.3	8.33	0.00	P	34	84	1951-78	1959	5,000	450
247	06804400	Silver Creek tributary at Colon, NE	NA	17.6	7.66	0.00	P	34	84	1951-78	1959	4,640	140
248	06804500	Silver Creek at Ithaca, NE	NA	80.0	6.74	0.00	P	35	84	1950-78	1959	21,600	70
249	06806000	Waubonsie Creek near Bartlett, IA	2	30.4	21.0	0.00	C	28	39	1946-69	1950	14,500	100
250	06806440	Stove Creek at Elmwood, NE	2	10.3	15.4	0.00	P	29	NA	1950-78	1950	9,500	45

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	Peak-flow record: ERL (yrs)	Peak-flow record: HST (yrs)	Peak-flow record: Period of peak-flow record (water years)	Maximum flood: Water year	Maximum flood: Discharge (ft^3/s)	Maximum flood: Recur. interv. (yrs)
251	06806460	Weeping Water Creek at Weeping Water, NE	2	80.1	8.03	0.00	P	35	96	1947, 1950-78	1950	30,300	180
252	06806500	Weeping Water Creek at Union, NE	NA	241	6.48	0.00	C	48	NA	1950-97	1993	65,100	120
253	06807410	West Nishnabotna River at Hancock, IA	2	609	5.65	0.00	C	41	50	1960-97	1993	30,100	60
254	06807720	Middle Silver Creek near Avoca, IA	NA	3.21	22.6	0.00	P	32	NA	1953-84, 1986	1976	1,200	35
255	06807760	Middle Silver Creek near Oakland, IA	NA	25.7	10.2	0.00	P	45	NA	1953-97	1991	2,500	120
256	06807780	Middle Silver Creek at Treynor, IA	NA	42.7	9.10	0.00	P	37	NA	1953-55, 1957-90	1973	3,700	80
257	06808500	West Nishnabotna River at Randolph, IA	2	1,326	4.78	0.00	C	53	94	1949-97	1987	40,800	60
258	06809000	Davids Creek near Hamlin, IA	2	26.0	15.6	0.00	C	29	80	1952-73	1958	22,700	>500
259	06809210	East Nishnabotna River near Atlantic, IA	2	436	5.56	0.00	C	40	50	1958, 1961-97	1958	34,200	100
260	06809500	East Nishnabotna River at Red Oak, IA	2	894	4.68	0.00	C	71	NA	1917-25, 1936-97	1972	38,000	140
261	06810000	Nishnabotna River above Hamburg, IA	2	2,806	4.44	0.00	C	71	NA	1922-23, 1929-97	1947	55,500	>500
262	06810100	Hooper Creek tributary near Palmyra, NE	2	8.00	16.8	0.00	P	29	NA	1950-78	1963	4,210	30
263	06811840	Tarkio River at Stanton, IA	2	49.3	11.2	0.00	C	39	44	1952, 1954-56, 1958-91	1967	22,500	500
264	06811875	Snake Creek near Yorktown, IA	2	9.10	16.8	0.00	P	29	45	1966-91	1987	3,080	45
265	06813000	Tarkio River at Fairfax, MO	2	508	4.90	0.00	C	69	NA	1922-90	1942	16,300	12
266	06817500	Nodaway River near Burlington Junction, MO	2	1,240	4.21	0.00	C	62	NA	1922-83	1974	46,000	40
267	06818598	Platte River near Stringtown, IA	2	51.7	7.08	0.00	P	23	NA	1966-88	1974	3,120	30
268	06818750	Platte River near Diagonal, IA	2	217	5.75	0.00	C	25	NA	1967-91	1989	8,630	25
269	06818900	Platte River at Ravenwood, MO	2	486	4.45	0.00	C	33	NA	1922-23, 1929-32, 1959-81, 1983-86	1979	16,500	60

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

								Peak-flow record			Maximum flood		
Map no. (figs. 1 and 6)	**Station number**	**Station name**	**Hydrologic region (fig. 7)**	**DA (mi^2)**	**MCS (ft/mi)**	**DML (ratio)**	**Type of gage**	**ERL (yrs)**	**HST (yrs)**	**Period of peak-flow record (water years)**	**Water year**	**Dis-charge (ft^3/s)**	**Recur. interv. (yrs)**
270	06819185	East Fork One Hundred and Two River at Bedford, IA	2	85.4	7.50	0.00	C	16	23	1984-97	1986	9,570	14
271	06819190	East Fork One Hundred and Two River near Bedford, IA	2	92.1	7.75	0.00	C	24	NA	1960-83	1974	9,980	35
272	06819500	One Hundred and Two River at Maryville, MO	2	515	5.72	0.00	C	59	NA	1926, 1933-91	1974	28,000	120
273	06820000	White Cloud Creek near Maryville, MO	2	6.00	19.5	0.00	B	36	70	1949-79	1974	7,200	275
274	06820300	Big Slough near Wilcox, MO	2	1.30	35.5	0.00	P	26	NA	1950-54, 1956, 1958-62, 1964-78	1967	1,450	45
275	06896180	Demoss Branch near Stanberry, MO	NA	0.38	106	0.00	P	25	NA	1955-79	1958	399	19
276	06897000	East Fork Big Creek near Bethany, MO	3	95.0	7.24	0.00	C	43	70	1934-72, 1974	1974	13,000	325
277	06897200	Simpson Branch near Bethany, MO	NA	4.72	27.6	0.00	P	25	NA	1955-79	1956	4,500	30
278	06897950	Elk Creek near Decatur City, IA	3	52.5	11.6	0.00	B	36	113	1967-97	1993	32,800	275
279	06898000	Thompson River at Davis City, IA	3	701	3.51	0.00	C	75	113	1885, 1918-26, 1941-97	1992	57,000	>500
280	06898400	Weldon River near Leon, IA	3	104	12.0	0.00	C	41	74	1959-92	1992	76,200	>500
281	06899000	Weldon River at Mill Grove, MO	3	494	5.05	0.00	C	43	NA	1909, 1930-72	1959	46,000	140
282	06899500	Thompson River at Trenton, MO	NA	1,670	3.67	0.00	C	72	NA	1909, 1922-23, 1928-97	1947	95,000	160
283	06900000	Medicine Creek near Galt, MO	3	225	5.00	0.00	C	66	NA	1909, 1922-28, 1930-75, 1978-90	1947	24,200	180
284	06903400	Chariton River near Chariton, IA	3	182	6.00	0.00	C	32	NA	1947, 1960, 1966-97	1992	37,700	225
285	06903500	Honey Creek near Russell, IA	3	13.2	12.2	0.00	C	11	NA	1952-62	1959	4,100	35
286	06903700	South Fork Chariton River near Promise City, IA	3	168	5.82	0.00	C	35	51	1965, 1968-97	1992	70,600	>500
287	06903900	Chariton River near Rathbun, IA	3	549	3.70	0.00	C	18	41	1957-69[b]	1960	21,800	20
288	06903990	Cooper Creek at Centerville, IA	3	47.8	6.81	0.00	P	24	NA	1966-89	1982	7,000	30
289	06904000	Chariton River near Centerville, IA	3	708	3.42	0.00	C	22	NA	1938-59	1946	21,700	19

Table 1. Selected basin-characteristic, peak-flow-record, and maximum-flood information for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	Hydrologic region (fig. 7)	DA (mi^2)	MCS (ft/mi)	DML (ratio)	Type of gage	Peak-flow record: ERL (yrs)	Peak-flow record: HST (yrs)	Peak-flow record: Period of peak-flow record (water years)	Maximum flood: Water year	Maximum flood: Discharge (ft^3/s)	Maximum flood: Recur. interv. (yrs)
290	06904500	Chariton River at Novinger, MO	NA	1,370	2.63	0.00	C	46	NA	1917, 1922-52, 1955-69[b]	1947	22,900	30
291	06904700	Strop Branch near Novinger, MO	NA	0.96	94.7	0.00	P	25	NA	1955-79	1956	1,730	11

[a]Maximum flood discharge of 11,000 ft^3/s occurred in both 1974 and 1978.

[b]Streamflow regulated during part of gaged record. Only unregulated peak discharges at these gaging stations were used in flood-frequency analyses.

[c]Includes 1903, 1905-29, 1931, and 1933-67 peak-flow record from Des Moines River near Boone (station number 05481500); records are considered equivalent.

Table 2. Flood-frequency data for streamflow-gaging stations

[DA, drainage area; mi^2, square miles; NA, not applicable, either the gaging station was not used to develop the generalized skew coefficient map or the gaging station was not used to develop the regional regression equations. Discharge: First line represents flood-frequency (log-Pearson Type III) estimates; second line, if shown, represents one-variable, regional regression estimates for gaging stations used to develop one-variable regional regression equations; third line, if shown, represents multi-variable, regional regression estimates for gaging stations used to develop multi-variable regional regression equations]

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Generalized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
1	05311200	North Branch Yellow Medicine River near Ivanhoe, MN	14.8	-0.437	-0.307	NA	89	266	451	765	1,060	1,400	1,790	2,380
2	05315000	Redwood River near Marshall, MN	259	-0.284	-0.239	NA	739	1,760	2,700	4,180	5,480	6,940	8,580	11,000
3	05316900	Dry Creek near Jeffers, MN	3.13	-0.151	-0.173	NA	133	298	448	683	892	1,130	1,400	1,800
4	05316920	Cottonwood River tributary near Sanborn, MN	0.42	-0.292	-0.166	NA	28	65	100	153	201	255	315	406
5	05317850	Foster Creek near Alden, MN	2.26	-1.190	-0.201	NA	90	166	219	288	338	388	436	499
6	05318000	East Branch Blue Earth River near Bricelyn, MN	132	-0.587	-0.182	1	373 832	761 1,510	1,070 2,010	1,510 2,680	1,860 3,190	2,220 3,710	2,600 4,240	3,130 4,960
7	05318100	East Branch Blue Earth River tributary near Blue Earth, MN	9.20	-0.215	-0.165	1	152 145	287 262	396 347	552 457	681 540	819 624	966 708	1,180 819
8	05318300	Watonwan River near Delft, MN	13.0	0.145	-0.165	NA	114	364	668	1,280	1,940	2,830	4,000	6,080
9	05320400	Maple River tributary near Mapleton, MN	6.22	0.450	-0.142	NA	140	348	567	963	1,360	1,870	2,500	3,580
10	05382500	Little La Crosse River near Leon, WI	77.1	-0.173	-0.397	NA	999	1,700	2,210	2,890	3,420	3,960	4,520	5,290
11	05384000	Root River near Lanesboro, MN	615	-0.365	-0.239	2	7,650 5,830 7,050	12,800 10,800 12,900	16,400 14,400 17,000	21,200 19,000 22,100	24,700 22,400 26,000	28,300 25,800 29,900	31,900 29,300 33,900	36,700 34,000 39,400
12	05384100	Duschee Creek near Lanesboro, MN	3.85	-0.201	-0.243	2	214 376 328	569 898 805	925 1,360 1,220	1,530 2,020 1,790	2,090 2,560 2,250	2,750 3,150 2,760	3,510 3,780 3,300	4,700 4,710 4,100
13	05384200	Gribben Creek near Whalen, MN	7.80	0.262	-0.235	2	610 551 817	1,610 1,270 1,890	2,680 1,890 2,820	4,600 2,760 4,090	6,530 3,460 5,110	8,940 4,220 6,220	11,900 5,030 7,430	16,900 6,200 9,200
14	05384400	Pine Creek near Arendahl, MN	28.1	-0.910	-0.224	2	823 1,100 1,200	1,890 2,380 2,620	2,780 3,430 3,770	4,060 4,860 5,280	5,080 5,990 6,470	6,160 7,180 7,740	7,270 8,430 9,080	8,780 10,200 11,000

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi²)	Station skew	Generalized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
15	05385000	Root River near Houston, MN	1,270	-0.427	-0.183	2	9,860	16,800	21,700	28,100	32,900	37,800	42,600	49,000
							8,630	15,400	20,100	26,100	30,500	34,800	39,200	45,100
							11,800	20,500	26,600	34,100	39,700	45,300	51,000	58,600
16	05385500	South Fork Root River near Houston, MN	275	-0.019	-0.184	2	2,410	5,000	7,270	10,800	13,900	17,400	21,300	27,300
							3,780	7,260	9,900	13,300	15,900	18,500	21,200	24,800
							4,950	9,420	12,700	16,900	20,100	23,400	26,800	31,400
17	05386300	Mormon Creek near La Crosse, WI	25.2	-0.466	-0.400	NA	728	2,120	3,510	5,770	7,800	10,100	12,600	16,300
18	05387500	Upper Iowa River at Decorah, IA	511	-0.413	-0.212	2	5,800	9,900	12,800	16,600	19,500	22,500	25,400	29,300
							5,280	9,840	13,200	17,500	20,700	23,900	27,200	31,600
							6,370	11,700	15,600	20,400	24,000	27,700	31,500	36,600
19	05388000	Upper Iowa River near Decorah, IA	568	-0.270	-0.193	2	8,030	11,700	14,200	17,200	19,400	21,500	23,600	26,400
							5,590	10,400	13,900	18,300	21,600	25,000	28,300	32,900
							6,800	12,500	16,500	21,500	25,300	29,200	33,100	38,500
20	05388250	Upper Iowa River near Dorchester, IA	770	NA	-0.150	2	6,050	9,370	12,000	16,000	19,400	23,300	27,600	34,200
							6,590	12,000	16,000	20,900	24,600	28,300	32,000	37,100
							8,160	14,700	19,300	25,000	29,300	33,600	38,000	44,000
21	05388400	Wexford Creek near Harpers Ferry, IA	11.9	0.005	0.119	2	692	1,790	2,940	5,030	7,110	9,720	12,900	18,300
							692	1,560	2,300	3,330	4,150	5,020	5,960	7,310
							1,180	2,660	3,920	5,640	7,010	8,490	10,100	12,500
22	05388500	Paint Creek at Waterville, IA	42.8	NA	0.082	2	2,180	3,520	4,570	6,070	7,320	8,690	10,200	12,400
							1,380	2,920	4,170	5,850	7,170	8,540	9,990	12,000
							1,940	4,090	5,810	8,080	9,870	11,700	13,800	16,600
23	05388600	Paint Creek near Waterville, IA	56.0	0.583	0.090	2	2,040	3,880	5,570	8,330	10,900	14,000	17,700	23,700
							1,600	3,330	4,730	6,590	8,040	9,550	11,100	13,400
							2,270	4,720	6,660	9,200	11,200	13,300	15,500	18,700
24	05389000	Yellow River at Ion, IA	221	NA	0.084	2	7,790	12,400	15,900	20,700	24,600	28,700	33,100	39,400
							3,360	6,530	8,940	12,100	14,400	16,900	19,400	22,800
							4,590	8,840	12,000	16,100	19,200	22,300	25,700	30,300
25	05406800	Rocky Branch near Richland Center, WI	1.68	0.493	-0.396	NA	107	238	365	583	793	1,050	1,360	1,870
26	05407100	Richland Creek near Plugtown, WI	19.2	0.200	-0.399	NA	687	1,410	2,050	3,060	3,970	5,010	6,190	8,010
27	05407200	Crooked Creek near Boscobel, WI	12.9	-0.064	-0.399	NA	364	760	1,100	1,620	2,060	2,550	3,100	3,900

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
28	05408000	Kickapoo River at La Farge, WI	266	0.342	-0.396	NA	2,570	4,360	5,800	7,920	9,720	11,700	13,900	17,200
29	05410490	Kickapoo River at Steuben, WI	687	0.414	-0.399	NA	2,770	4,940	6,790	9,610	12,100	14,900	18,200	23,100
30	05411530	North Branch Turkey River near Cresco, IA	19.5	0.054	-0.217	2	311	1,060	1,980	3,820	5,810	8,450	11,900	17,900
							904	1,990	2,890	4,140	5,120	6,170	7,280	8,860
							852	1,910	2,760	3,900	4,800	5,760	6,780	8,240
31	05411600	Turkey River at Spillville, IA	177	-0.552	-0.162	2	2,810	5,400	7,400	10,100	12,300	14,600	16,900	20,000
							2,980	5,860	8,070	10,900	13,100	15,400	17,700	20,900
							3,210	6,310	8,610	11,600	13,800	16,100	18,500	21,800
32	05411650	Crane Creek tributary near Saratoga, IA	4.06	NA	-0.258	2	625	1,170	1,590	2,160	2,610	3,060	3,540	4,180
							387	922	1,400	2,070	2,620	3,220	3,870	4,810
							377	920	1,390	2,040	2,570	3,140	3,770	4,680
33	05411700	Crane Creek near Lourdes, IA	75.8	-0.596	-0.250	2	2,020	4,520	6,640	9,720	12,200	14,900	17,800	21,700
							1,880	3,870	5,440	7,530	9,150	10,800	12,600	15,000
							1,910	3,940	5,500	7,530	9,100	10,700	12,400	14,900
34	05412060	Silver Creek near Luana, IA	4.39	NA	0.115	2	256	621	1,020	1,780	2,590	3,660	5,060	7,590
							404	958	1,450	2,140	2,710	3,320	3,990	4,960
							408	990	1,500	2,190	2,750	3,370	4,030	5,010
35	05412100	Roberts Creek above Saint Olaf, IA	70.7	NA	0.123	2	1,110	2,740	4,550	8,060	11,800	16,900	23,700	35,900
							1,810	3,740	5,270	7,300	8,880	10,500	12,200	14,600
							1,810	3,760	5,260	7,210	8,720	10,300	12,000	14,300
36	05412500	Turkey River at Garber, IA	1,545	-0.152	0.032	2	14,800	20,900	24,800	29,900	33,600	37,300	41,000	45,900
							9,600	16,900	22,100	28,500	33,100	37,800	42,400	48,600
							13,000	22,400	28,900	36,900	42,800	48,700	54,700	62,700
37	05413400	Pigeon Creek near Lancaster, WI	6.93	0.492	-0.400	2	400	828	1,230	1,890	2,510	3,250	4,140	5,560
							517	1,200	1,790	2,620	3,290	4,020	4,800	5,920
							667	1,560	2,330	3,390	4,240	5,160	6,160	7,630
38	05414200	Bear Branch near Platteville, WI	2.72	-0.290	-0.400	NA	389	655	844	1,090	1,270	1,460	1,650	1,900
39	05414450	North Fork Little Maquoketa River near Rickardsville, IA	21.6	0.674	0.246	2	1,160	2,080	2,900	4,240	5,490	6,990	8,770	11,700
							955	2,090	3,040	4,330	5,350	6,430	7,580	9,220
							1,080	2,380	3,450	4,870	5,990	7,180	8,460	10,300
40	05414500	Little Maquoketa River near Durango, IA	130	0.714	0.253	2	6,420	10,800	14,500	20,300	25,500	31,600	38,800	50,100
							2,520	5,030	6,990	9,550	11,500	13,500	15,600	18,500
							3,500	6,930	9,550	12,900	15,500	18,200	21,100	25,100

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
41	05414600	Little Maquoketa River tributary at Dubuque, IA	1.54	-0.074	0.298	2	228	503	767	1,210	1,630	2,140	2,740	3,720
							229	573	890	1,350	1,730	2,150	2,610	3,300
							300	765	1,190	1,790	2,290	2,840	3,450	4,370
42	05414820	Sinsinawa River near Menominee, IL	39.6	-0.056	-0.400	2	2,650	5,340	7,590	10,900	13,800	16,900	20,200	25,100
							1,330	2,810	4,020	5,650	6,930	8,270	9,680	11,700
							1,600	3,400	4,840	6,740	8,230	9,800	11,500	13,800
43	05414900	Pats Creek near Elk Grove, WI	8.50	1.686	-0.400	2	453	1,010	1,600	2,690	3,820	5,300	7,200	10,600
							577	1,320	1,970	2,870	3,590	4,370	5,210	6,410
							630	1,470	2,180	3,140	3,920	4,750	5,660	6,970
44	05415500	East Fork Galena River at Council Hill, IL	20.1	0.342	-0.400	NA	1,980	4,180	6,190	9,450	12,400	16,000	20,100	26,500
45	05417000	Maquoketa River near Manchester, IA	305	0.007	0.060	2	4,660	8,260	11,200	15,400	19,000	22,900	27,200	33,600
							3,990	7,640	10,400	13,900	16,600	19,300	22,100	25,900
							4,870	9,250	12,400	16,500	19,600	22,700	26,000	30,400
46	05417530	Plum Creek at Earlville, IA	41.1	0.461	0.136	2	1,330	2,480	3,490	5,110	6,580	8,310	10,300	13,500
							1,350	2,860	4,090	5,750	7,040	8,400	9,830	11,800
							1,490	3,180	4,520	6,270	7,650	9,100	10,600	12,800
47	05417590	Kitty Creek near Langworthy, IA	14.4	0.389	0.036	2	739	1,290	1,740	2,420	3,010	3,670	4,420	5,550
							767	1,710	2,510	3,620	4,500	5,440	6,440	7,870
							831	1,880	2,750	3,920	4,850	5,840	6,910	8,450
48	05417700	Bear Creek near Monmouth, IA	61.3	NA	0.007	2	1,650	2,950	3,960	5,390	6,570	7,830	9,190	11,100
							1,680	3,480	4,930	6,860	8,350	9,920	11,600	13,800
							1,650	3,460	4,860	6,680	8,090	9,570	11,100	13,300
49	05418450	North Fork Maquoketa River at Fulton, IA	516	NA	0.198	2	6,170	9,560	12,000	15,100	17,500	20,000	22,600	26,000
							5,310	9,890	13,300	17,500	20,700	24,000	27,300	31,700
							5,810	10,700	14,200	18,600	21,900	25,300	28,700	33,300
50	05418500	Maquoketa River near Maquoketa, IA	1,553	-0.185	0.136	2	14,600	23,600	30,200	39,000	46,000	53,200	60,800	71,300
							9,630	17,000	22,100	28,500	33,200	37,900	42,500	48,700
							11,800	20,500	26,400	33,600	39,000	44,400	49,800	57,000
51	05420560	Wapsipinicon River near Elma, IA	95.2	-0.416	-0.354	2	2,110	4,790	7,100	10,500	13,300	16,400	19,600	24,200
							2,130	4,320	6,050	8,320	10,100	11,900	13,800	16,400
							2,060	4,210	5,850	7,960	9,580	11,300	13,000	15,500

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
52	05420620	Little Wapsipinicon River near Acme, IA	7.76	0.482	-0.303	2	453	899	1,290	1,920	2,480	3,120	3,870	5,020
							549	1,270	1,890	2,760	3,460	4,210	5,020	6,190
							550	1,290	1,920	2,780	3,460	4,200	5,000	6,170
53	05420640	Little Wapsipinicon River at Elma, IA	37.3	0.038	-0.278	2	1,200	2,560	3,770	5,670	7,360	9,280	11,500	14,800
							1,280	2,730	3,910	5,510	6,760	8,070	9,450	11,400
							1,240	2,680	3,820	5,310	6,470	7,700	9,000	10,800
54	05420650	Little Wapsipinicon River near New Hampton, IA	95.0	1.061	-0.244	2	2,110	4,330	6,450	10,000	13,500	17,800	22,900	31,500
							2,130	4,320	6,040	8,320	10,100	11,900	13,800	16,400
							1,960	4,010	5,560	7,560	9,100	10,700	12,400	14,700
55	05420690	East Fork Wapsipinicon River near New Hampton, IA	30.3	-0.322	-0.183	2	1,730	3,460	4,990	7,360	9,480	11,900	14,700	18,900
							1,150	2,470	3,550	5,020	6,180	7,400	8,690	10,500
							1,570	3,390	4,860	6,820	8,360	9,990	11,700	14,200
56	05420850	Little Wapsipinicon River near Oran, IA	94.1	0.231	-0.043	2	1,490	2,500	3,280	4,400	5,340	6,350	7,460	9,080
							2,120	4,300	6,010	8,280	10,000	11,800	13,700	16,400
							1,850	3,800	5,270	7,160	8,620	10,100	11,700	13,900
57	05420960	Harter Creek near Independence, IA	6.17	NA	0.002	2	352	941	1,570	2,690	3,800	5,190	6,900	9,720
							485	1,130	1,700	2,490	3,130	3,830	4,580	5,660
							536	1,270	1,900	2,770	3,460	4,220	5,040	6,240
58	05421000	Wapsipinicon River at Independence, IA	1,048	-0.324	-0.098	2	6,170	11,400	15,400	21,000	25,500	30,100	35,000	41,800
							7,780	14,000	18,400	24,000	28,100	32,200	36,300	41,800
							8,690	15,400	20,100	25,800	30,100	34,400	38,700	44,500
59	05421100	Pine Creek tributary near Winthrop, IA	0.33	-0.292	0.013	NA	74	154	223	328	418	519	631	797
60	05421200	Pine Creek near Winthrop, IA	28.3	1.398	0.012	2	1,010	2,160	3,350	5,540	7,830	10,800	14,700	21,600
							1,110	2,390	3,440	4,880	6,010	7,200	8,460	10,200
							1,160	2,530	3,620	5,080	6,220	7,430	8,720	10,600
61	05421890	Silver Creek at Welton, IA	9.03	-0.114	-0.016	2	1,080	2,160	3,090	4,500	5,730	7,110	8,660	11,000
							596	1,360	2,020	2,950	3,690	4,480	5,340	6,560
							605	1,410	2,090	3,000	3,740	4,530	5,380	6,620
62	05422000	Wapsipinicon River near De Witt, IA	2,330	-0.298	0.023	2	10,100	16,400	20,800	26,800	31,300	36,000	40,800	47,400
							12,000	20,700	26,700	34,100	39,500	44,900	50,100	57,100
							13,700	23,200	29,500	37,200	42,900	48,500	54,100	61,600

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
63	05422470	Crow Creek at Bettendorf, IA	17.8	NA	-0.047	2	920	2,130	3,350	5,450	7,510	10,000	13,100	18,200
							860	1,900	2,770	3,970	4,930	5,940	7,010	8,550
							822	1,850	2,680	3,800	4,680	5,620	6,630	8,060
64	05432300	Rock Branch near Mineral Point, WI	4.83	0.910	-0.400	2	289	597	897	1,420	1,930	2,560	3,350	4,680
							425	1,000	1,510	2,240	2,820	3,460	4,150	5,150
							607	1,450	2,180	3,200	4,020	4,920	5,910	7,360
65	05448000	Mill Creek at Milan, IL	62.4	-0.558	-0.400	2	3,000	5,330	6,950	9,010	10,500	12,000	13,400	15,200
							1,700	3,510	4,970	6,910	8,420	9,990	11,600	13,900
							1,620	3,390	4,760	6,540	7,920	9,360	10,900	13,000
66	05448500	West Branch Iowa River near	112	NA	-0.327	1	503	983	1,380	1,950	2,430	2,940	3,500	4,310
		Klemme, IA					747	1,360	1,810	2,400	2,860	3,320	3,790	4,430
67	05448700	East Branch Iowa River near Hayfield,	7.94	-0.126	-0.356	1	117	218	297	408	497	591	690	829
		IA					131	238	315	415	490	565	641	741
68	05448800	East Branch Iowa River near Garner,	45.1	-0.340	-0.379	1	361	614	792	1,020	1,200	1,370	1,550	1,780
		IA					411	746	991	1,310	1,560	1,810	2,060	2,400
69	05449000	East Branch Iowa River near Klemme,	133	0.073	-0.374	1	900	1,790	2,560	3,710	4,700	5,800	7,030	8,850
		IA					836	1,520	2,020	2,690	3,200	3,730	4,260	4,980
70	05449500	Iowa River near Rowan, IA	429	-0.278	-0.351	1	2,050	3,700	4,940	6,610	7,910	9,260	10,600	12,500
							1,770	3,230	4,310	5,750	6,870	8,020	9,190	10,800
71	05451500	Iowa River near Marshalltown, IA	1,532	-0.398	-0.435	2	8,250	13,900	17,900	22,900	26,600	30,300	33,900	38,600
							9,550	16,800	22,000	28,300	33,000	37,700	42,300	48,500
							6,570	12,100	16,100	20,900	24,400	27,800	31,300	35,800
72	05451700	Timber Creek near Marshalltown, IA	118	-0.135	-0.220	2	2,480	4,660	6,400	8,900	11,000	13,200	15,500	18,900
							2,390	4,800	6,680	9,150	11,100	13,000	15,000	17,900
							2,500	5,030	6,940	9,400	11,300	13,300	15,300	18,100
73	05451900	Richland Creek near Haven, IA	56.1	0.383	-0.079	2	1,650	2,950	4,040	5,700	7,150	8,790	10,600	13,500
							1,600	3,340	4,730	6,590	8,040	9,560	11,100	13,400
							1,610	3,390	4,770	6,570	7,980	9,440	11,000	13,200
74	05451955	Stein Creek near Clutier, IA	23.4	0.012	-0.018	2	1,510	3,220	4,770	7,250	9,510	12,100	15,200	19,800
							997	2,170	3,150	4,480	5,540	6,650	7,830	9,510
							932	2,060	2,980	4,180	5,140	6,140	7,220	8,750

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
75	05452000	Salt Creek near Elberon, IA	201	0.609	-0.016	2	4,310	8,610	12,700	19,500	26,000	33,900	43,600	59,500
							3,190	6,230	8,560	11,600	13,900	16,200	18,600	22,000
							3,660	7,120	9,700	13,000	15,500	18,100	20,700	24,400
76	05452200	Walnut Creek near Hartwick, IA	70.9	-0.482	-0.021	2	2,590	4,670	6,240	8,400	10,100	11,900	13,700	16,300
							1,820	3,740	5,270	7,310	8,890	10,500	12,200	14,600
							1,890	3,910	5,480	7,510	9,080	10,700	12,400	14,900
77	05452500	Iowa River near Belle Plaine, IA	2,455	NA	-0.426	2	10,600	18,900	25,100	33,400	39,900	46,600	53,400	62,700
							12,300	21,200	27,400	34,900	40,400	45,800	51,200	58,200
							10,100	17,800	23,100	29,500	34,100	38,600	43,200	49,100
78	05453000	Big Bear Creek at Ladora, IA	189	-0.629	0.016	2	4,260	6,160	7,370	8,830	9,870	10,900	11,900	13,100
							3,080	6,050	8,310	11,300	13,500	15,800	18,200	21,500
							3,370	6,590	8,990	12,000	14,400	16,800	19,300	22,700
79	05453100	Iowa River at Marengo, IA	2,794	-0.418	-0.357	2	12,800	19,900	24,500	30,300	34,500	38,500	42,400	47,500
							13,200	22,600	29,100	36,900	42,700	48,300	53,900	61,200
							11,100	19,400	25,000	31,800	36,700	41,600	46,400	52,600
80	05453600	Rapid Creek below Morse, IA	8.12	-0.116	-0.096	2	626	1,380	2,060	3,140	4,100	5,210	6,470	8,380
							563	1,290	1,930	2,810	3,520	4,290	5,110	6,300
							526	1,240	1,840	2,650	3,300	4,000	4,760	5,850
81	05453700	Rapid Creek tributary No. 4 near Oasis, IA	1.95	NA	-0.106	2	173	399	607	940	1,240	1,580	1,970	2,560
							260	644	993	1,500	1,920	2,370	2,880	3,610
							251	637	983	1,470	1,870	2,300	2,790	3,500
82	05453750	Rapid Creek southwest of Morse, IA	15.2	-0.262	-0.099	2	1,080	2,100	2,930	4,130	5,130	6,220	7,390	9,070
							790	1,760	2,580	3,710	4,610	5,560	6,580	8,040
							768	1,740	2,540	3,610	4,460	5,360	6,340	7,730
83	05453950	Rapid Creek tributary near Iowa City, IA	3.43	-0.493	-0.108	2	386	852	1,260	1,860	2,380	2,940	3,550	4,430
							353	849	1,290	1,920	2,440	3,000	3,610	4,500
							353	868	1,320	1,940	2,450	3,000	3,610	4,500
84	05454000	Rapid Creek near Iowa City, IA	25.3	-0.544	-0.102	2	1,430	3,010	4,310	6,190	7,730	9,360	11,100	13,500
							1,040	2,260	3,270	4,640	5,730	6,870	8,080	9,800
							1,010	2,230	3,200	4,500	5,520	6,590	7,740	9,380
85	05454300	Clear Creek near Coralville, IA	98.1	0.018	-0.065	2	1,870	3,600	5,060	7,270	9,180	11,300	13,700	17,300
							2,160	4,390	6,130	8,440	10,200	12,000	14,000	16,600
							2,160	4,400	6,100	8,290	9,980	11,700	13,600	16,100

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
86	05454500	Iowa River at Iowa City, IA	3,271	-0.143	-0.360	2	11,100	19,000	24,800	32,700	38,900	45,400	52,100	61,300
							14,400	24,400	31,300	39,600	45,600	51,600	57,400	65,100
							12,500	21,500	27,600	34,900	40,200	45,400	50,500	57,200
87	05455000	Ralston Creek at Iowa City, IA	3.01	-0.289	-0.111	2	402	813	1,160	1,660	2,080	2,540	3,040	3,760
							329	796	1,220	1,820	2,310	2,840	3,430	4,280
							326	809	1,230	1,820	2,300	2,830	3,410	4,250
88	05455010	South Branch Ralston Creek at Iowa City, IA	2.94	NA	-0.114	2	408	730	973	1,310	1,570	1,840	2,120	2,510
							325	787	1,200	1,800	2,280	2,810	3,390	4,240
							293	729	1,110	1,640	2,080	2,550	3,060	3,820
89	05455100	Old Mans Creek near Iowa City, IA	201	0.111	-0.048	2	2,660	5,300	7,610	11,200	14,500	18,200	22,400	29,000
							3,190	6,230	8,560	11,600	13,900	16,200	18,600	22,000
							2,920	5,730	7,790	10,400	12,400	14,400	16,500	19,400
90	05455140	North English River near Montezuma, IA	31.0	-0.088	0.014	2	1,400	2,550	3,480	4,850	5,990	7,250	8,620	10,600
							1,160	2,490	3,590	5,080	6,250	7,470	8,770	10,600
							925	2,030	2,900	4,040	4,940	5,880	6,880	8,290
91	05455150	North English River near Malcom, IA	34.0	NA	0.017	2	1,770	3,070	4,070	5,480	6,620	7,830	9,110	10,900
							1,220	2,610	3,750	5,290	6,500	7,770	9,110	11,000
							985	2,150	3,060	4,260	5,200	6,190	7,230	8,700
92	05455200	North English River near Guernsey, IA	68.7	-0.327	0.037	2	2,540	4,020	5,060	6,460	7,530	8,640	9,780	11,300
							1,790	3,680	5,200	7,210	8,770	10,400	12,100	14,500
							1,740	3,620	5,070	6,950	8,400	9,920	11,500	13,800
93	05455210	North English River at Guernsey, IA	81.5	-0.414	0.043	2	4,130	5,310	6,020	6,870	7,460	8,030	8,580	9,280
							1,960	4,010	5,630	7,770	9,440	11,200	13,000	15,500
							1,780	3,670	5,110	6,980	8,420	9,910	11,500	13,700
94	05455280	South English River tributary near Barnes City, IA	2.51	NA	0.093	2	366	672	914	1,260	1,540	1,850	2,180	2,640
							299	728	1,120	1,680	2,140	2,640	3,180	3,990
							251	633	969	1,440	1,820	2,240	2,690	3,360
95	05455300	South English River near Barnes City, IA	11.5	0.096	0.095	2	513	950	1,320	1,880	2,380	2,940	3,570	4,530
							679	1,540	2,270	3,280	4,090	4,950	5,880	7,210
							578	1,340	1,960	2,810	3,480	4,190	4,960	6,070
96	05455350	South English River tributary No. 2 near Montezuma, IA	0.52	0.694	0.093	NA	39	90	145	247	353	490	667	979

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Generalized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
97	05455500	English River at Kalona, IA	573	0.111	0.042	2	6,090	11,100	15,300	21,600	27,100	33,200	40,100	50,500
							5,620	10,400	13,900	18,400	21,700	25,100	28,500	33,100
							6,080	11,200	14,800	19,300	22,600	26,100	29,500	34,300
98	05457000	Cedar River near Austin, MN	425	-0.933	-0.269	2	4,020	6,780	8,560	10,700	12,100	13,400	14,700	16,200
							4,780	8,990	12,100	16,100	19,100	22,100	25,200	29,400
							3,260	6,400	8,720	11,600	13,700	15,900	18,100	21,100
99	05457700	Cedar River at Charles City, IA	1,054	-0.797	-0.571	2	9,250	15,400	19,200	23,700	26,800	29,600	32,200	35,200
							7,810	14,000	18,500	24,000	28,100	32,200	36,400	41,900
							7,190	13,100	17,200	22,300	26,100	29,900	33,600	38,700
100	05458000	Little Cedar River near Ionia, IA	306	-0.376	-0.386	2	2,780	5,690	8,020	11,300	13,900	16,700	19,600	23,500
							4,000	7,650	10,400	13,900	16,600	19,300	22,100	25,900
							4,210	8,020	10,800	14,300	16,900	19,600	22,400	26,200
101	05458500	Cedar River at Janesville, IA	1,661	-0.498	-0.461	2	10,100	18,000	23,700	30,900	36,200	41,500	46,700	53,400
							9,980	17,500	22,800	29,400	34,200	38,900	43,700	50,000
							9,900	17,400	22,600	28,800	33,500	38,000	42,600	48,800
102	05458900	West Fork Cedar River at Finchford, IA	846	-0.549	-0.490	2	5,310	11,500	16,500	23,400	28,800	34,300	39,900	47,300
							6,930	12,600	16,700	21,800	25,600	29,400	33,300	38,500
							6,600	12,200	16,200	21,200	24,900	28,600	32,300	37,400
103	05459000	Shell Rock River near Northwood, IA	300	-0.598	-0.567	1	1,210	1,880	2,290	2,770	3,100	3,410	3,690	4,040
							1,430	2,600	3,460	4,620	5,510	6,420	7,360	8,630
104	05459500	Winnebago River at Mason City, IA	526	-0.221	-0.445	1	3,200	5,410	6,990	9,070	10,700	12,300	13,900	16,100
							2,060	3,760	5,020	6,700	8,010	9,350	10,700	12,600
105	05460100	Willow Creek near Mason City, IA	78.6	-0.661	-0.446	1	620	872	1,020	1,190	1,300	1,400	1,500	1,610
							592	1,080	1,430	1,900	2,260	2,620	2,990	3,490
106	05460500	Shell Rock River at Marble Rock, IA	1,318	NA	-0.508	2	9,500	15,300	19,300	24,700	28,800	32,900	37,100	42,900
							8,810	15,600	20,500	26,500	31,000	35,400	39,800	45,700
							7,270	13,400	17,700	23,100	27,000	30,800	34,700	39,900
107	05462000	Shell Rock River at Shell Rock, IA	1,746	-0.472	-0.532	2	8,390	15,800	21,300	28,400	33,800	39,100	44,400	51,400
							10,300	18,000	23,400	30,000	34,900	39,700	44,600	51,000
							9,110	16,300	21,400	27,500	32,000	36,500	40,900	46,800
108	05462750	Beaver Creek tributary near Aplington, IA	11.6	-0.657	-0.350	2	955	1,990	2,810	3,930	4,820	5,730	6,660	7,910
							683	1,540	2,270	3,290	4,100	4,970	5,900	7,240
							634	1,460	2,150	3,070	3,810	4,590	5,440	6,660

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Generalized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
109	05463000	Beaver Creek at New Hartford, IA	347	-0.893	-0.389	2	3,740	8,380	12,000	17,000	20,700	24,500	28,200	32,900
							4,280	8,140	11,000	14,700	17,500	20,300	23,200	27,200
							4,680	8,950	12,100	16,100	19,000	22,100	25,200	29,500
110	05463090	Black Hawk Creek at Grundy Center, IA	56.9	-0.480	-0.314	2	1,150	2,570	3,780	5,560	7,030	8,610	10,300	12,600
							1,610	3,360	4,760	6,630	8,090	9,610	11,200	13,400
							1,490	3,140	4,430	6,090	7,390	8,740	10,200	12,200
111	05463500	Black Hawk Creek at Hudson, IA	303	-0.384	-0.220	2	2,840	6,300	9,290	13,800	17,600	21,800	26,300	32,700
							3,980	7,620	10,400	13,900	16,500	19,200	22,000	25,800
							4,460	8,490	11,400	15,100	17,900	20,800	23,800	27,900
112	05464000	Cedar River at Waterloo, IA	5,146	-0.603	-0.449	2	22,700	40,700	53,200	68,900	80,200	91,200	102,000	115,000
							18,400	30,500	38,600	48,400	55,400	62,200	68,900	77,700
							19,500	32,300	40,800	51,000	58,300	65,500	72,500	81,800
113	05464310	Pratt Creek near Garrison, IA	23.4	0.406	-0.021	2	1,020	2,360	3,720	6,150	8,570	11,600	15,400	21,900
							997	2,170	3,150	4,480	5,540	6,650	7,830	9,510
							1,030	2,270	3,280	4,610	5,660	6,780	7,970	9,670
114	05464560	Prairie Creek at Blairstown, IA	87.0	NA	-0.015	2	2,140	3,130	3,810	4,720	5,410	6,130	6,870	7,880
							2,030	4,130	5,800	8,000	9,700	11,500	13,300	15,900
							1,990	4,090	5,690	7,750	9,350	11,000	12,700	15,200
115	05464640	Prairie Creek at Fairfax, IA	178	NA	-0.020	2	3,060	5,090	6,600	8,660	10,300	12,000	13,800	16,300
							2,990	5,870	8,090	11,000	13,200	15,400	17,800	21,000
							2,740	5,410	7,380	9,880	11,800	13,800	15,800	18,600
116	05464880	Otter Creek at Wilton, IA	10.7	-0.337	-0.117	2	948	1,850	2,550	3,550	4,340	5,180	6,050	7,270
							654	1,480	2,190	3,180	3,970	4,810	5,710	7,010
							563	1,310	1,920	2,750	3,420	4,120	4,890	5,980
117	05467000	Pope Creek near Keithsburg, IL	174	-0.110	-0.400	2	2,420	3,880	4,930	6,310	7,370	8,450	9,560	11,100
							2,950	5,810	8,000	10,900	13,000	15,300	17,600	20,800
							2,580	5,110	6,970	9,330	11,100	13,000	14,900	17,500
118	05468500	Cedar Creek at Little York, IL	132	0.200	-0.400	NA	2,290	4,570	6,580	9,720	12,500	15,800	19,400	25,100
119	05469000	Henderson Creek near Oquawka, IL	432	0.589	-0.400	2	4,760	8,370	11,500	16,200	20,500	25,400	31,100	40,000
							4,820	9,060	12,200	16,200	19,200	22,300	25,400	29,600
							4,920	9,210	12,300	16,100	19,000	21,900	24,900	29,000
120	05469500	South Henderson Creek at Biggsville, IL	82.9	0.862	-0.400	2	1,770	3,200	4,460	6,470	8,320	10,500	13,100	17,200
							1,980	4,040	5,670	7,830	9,500	11,200	13,000	15,600
							1,850	3,800	5,300	7,230	8,720	10,300	11,900	14,200

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
121	05469860	Mud Lake drainage ditch 71 at Jewell,	65.4	-0.642	-0.324	1	814	1,580	2,160	2,940	3,540	4,140	4,750	5,560
		IA					525	953	1,270	1,680	2,000	2,320	2,640	3,080
122	05469990	Keigley Branch near Story City, IA	31.0	0.344	-0.247	2	544	1,160	1,730	2,650	3,500	4,480	5,640	7,440
							1,160	2,490	3,590	5,080	6,250	7,470	8,770	10,600
							601	1,410	2,080	2,980	3,670	4,390	5,160	6,230
123	05470000	South Skunk River near Ames, IA	315	-0.390	-0.301	2	3,100	4,990	6,280	7,910	9,100	10,300	11,500	13,000
							4,060	7,760	10,500	14,100	16,800	19,500	22,300	26,200
							2,870	5,820	8,120	11,000	13,200	15,300	17,600	20,600
124	05470500	Squaw Creek at Ames, IA	204	0.502	-0.187	2	2,700	4,790	6,550	9,270	11,700	14,400	17,600	22,400
							3,210	6,280	8,610	11,700	14,000	16,300	18,800	22,100
							2,270	4,720	6,660	9,120	11,000	12,800	14,800	17,500
125	05471000	South Skunk River below Squaw	556	0.106	-0.252	2	5,620	8,480	10,500	13,200	15,300	17,500	19,700	22,800
		Creek near Ames, IA					5,530	10,300	13,700	18,100	21,400	24,700	28,100	32,700
							4,080	8,010	11,000	14,700	17,500	20,200	23,000	26,800
126	05471050	South Skunk River at Colfax, IA	803	NA	-0.207	2	5,440	8,590	10,800	13,700	15,900	18,100	20,300	23,400
							6,740	12,300	16,300	21,300	25,100	28,900	32,600	37,700
							4,750	9,140	12,400	16,400	19,400	22,300	25,300	29,300
127	05471200	Indian Creek near Mingo, IA	276	0.085	-0.232	2	3,850	6,710	8,940	12,100	14,700	17,600	20,600	25,000
							3,780	7,280	9,910	13,300	15,900	18,500	21,200	24,900
							2,500	5,140	7,190	9,770	11,700	13,600	15,600	18,400
128	05471500	South Skunk River near Oskaloosa, IA	1,635	-0.047	-0.203	2	8,370	12,600	15,600	19,500	22,500	25,500	28,600	32,700
							9,900	17,400	22,700	29,200	33,900	38,700	43,400	49,700
							7,990	14,500	19,200	24,900	29,000	33,100	37,100	42,600
129	05472090	North Skunk River near Baxter, IA	52.2	-0.490	-0.282	2	2,060	2,810	3,260	3,790	4,160	4,500	4,830	5,230
							1,540	3,220	4,570	6,390	7,800	9,280	10,800	13,000
							1,530	3,250	4,610	6,380	7,760	9,210	10,700	12,900
130	05472290	Sugar Creek near Searsboro, IA	52.7	NA	-0.018	2	1,390	2,300	3,010	4,040	4,900	5,830	6,850	8,350
							1,550	3,230	4,590	6,410	7,830	9,310	10,900	13,000
							1,460	3,090	4,360	6,010	7,300	8,650	10,100	12,100
131	05472390	Middle Creek near Lacey, IA	23.0	0.887	0.120	2	1,080	1,970	2,780	4,100	5,330	6,810	8,580	11,500
							988	2,160	3,130	4,450	5,500	6,600	7,780	9,450
							907	2,010	2,900	4,080	5,010	6,000	7,050	8,540

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
132	05472445	Rock Creek at Sigourney, IA	26.3	NA	0.113	2	839	1,620	2,300	3,360	4,310	5,410	6,670	8,620
							1,060	2,300	3,330	4,720	5,820	6,980	8,210	9,950
							945	2,080	2,990	4,190	5,140	6,130	7,190	8,700
133	05472500	North Skunk River near Sigourney, IA	730	-0.474	0.044	2	5,890	10,900	14,700	20,100	24,400	29,000	33,800	40,500
							6,400	11,700	15,600	20,400	24,100	27,700	31,400	36,300
							6,590	12,000	15,700	20,400	23,900	27,400	31,000	35,800
134	05473000	Skunk River at Coppock, IA	2,916	-0.238	-0.089	2	12,700	21,500	28,000	36,800	43,800	51,000	58,500	68,900
							13,500	23,100	29,600	37,700	43,500	49,200	54,800	62,300
							11,700	20,300	26,100	33,100	38,200	43,100	48,100	54,600
135	05473300	Cedar Creek near Batavia, IA	252	NA	0.021	2	5,140	8,970	12,300	17,400	22,000	27,400	33,600	43,300
							3,600	6,960	9,500	12,800	15,300	17,800	20,400	24,000
							3,370	6,530	8,830	11,700	13,900	16,200	18,500	21,700
136	05473400	Cedar Creek near Oakland Mills, IA	530	NA	-0.048	2	6,360	8,300	9,500	10,900	12,000	13,000	13,900	15,200
							5,400	10,000	13,500	17,800	21,000	24,300	27,600	32,100
							4,950	9,190	12,200	15,900	18,700	21,500	24,300	28,200
137	05473500	Big Creek near Mount Pleasant, IA	106	NA	-0.068	2	1,940	3,740	5,210	7,330	9,100	11,000	13,100	16,000
							2,260	4,550	6,360	8,730	10,600	12,400	14,400	17,100
							2,090	4,240	5,870	7,960	9,570	11,200	13,000	15,400
138	05474000	Skunk River at Augusta, IA	4,303	-0.589	0.103	2	20,900	31,300	37,900	46,000	51,700	57,200	62,400	69,200
							16,700	28,000	35,500	44,700	51,400	57,800	64,200	72,500
							15,600	26,200	33,200	41,600	47,700	53,600	59,500	67,100
139	05474750	Beaver Creek tributary #2 near Slayton, MN	5.10	0.230	-0.228	NA	79	134	177	237	286	339	396	477
140	05474760	Beaver Creek tributary above Slayton, MN	2.20	-0.445	-0.227	NA	53	94	125	166	197	230	263	307
141	05475400	Warren Lake tributary near Windom, MN	1.39	0.654	-0.165	NA	43	103	166	280	396	543	729	1,050
142	05475800	Des Moines River tributary near Jackson, MN	1.52	-0.467	-0.159	NA	24	50	70	101	126	153	181	222
143	05475900	Des Moines River tributary #2 near Lakefield, MN	5.18	-0.460	-0.160	NA	74	120	153	194	226	258	289	332
144	05476000	Des Moines River at Jackson, MN	1,220	-0.191	-0.158	1	1,780	3,750	5,450	8,030	10,300	12,700	15,500	19,500
							3,580	6,540	8,750	11,700	14,000	16,400	18,900	22,300

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
145	05476500	Des Moines River at Estherville, IA	1,372	0.006	-0.049	1	2,250	4,760	7,030	10,600	13,900	17,700	22,100	28,800
							3,870	7,070	9,450	12,700	15,200	17,800	20,400	24,100
146	05476750	Des Moines River at Humboldt, IA	2,256	-0.754	-0.075	1	4,410	8,380	11,300	15,300	18,400	21,500	24,600	28,800
							5,360	9,810	13,100	17,600	21,100	24,800	28,500	33,800
147	05476900	Fourmile Creek near Dunnell, MN	14.0	0.068	-0.154	NA	209	503	794	1,290	1,760	2,330	3,010	4,090
148	05478000	East Fork Des Moines River near Burt, IA	462	NA	-0.213	1	1,150	2,270	3,220	4,650	5,880	7,250	8,770	11,000
							1,890	3,450	4,610	6,150	7,340	8,570	9,830	11,600
149	05479000	East Fork Des Moines River at Dakota City, IA	1,308	-0.197	-0.301	1	4,000	7,980	11,200	16,000	19,900	24,200	28,700	35,200
							3,750	6,850	9,160	12,300	14,700	17,200	19,800	23,400
150	05480000	Lizard Creek near Clare, IA	257	-0.684	-0.440	1	1,600	3,350	4,700	6,510	7,900	9,290	10,700	12,500
							1,290	2,350	3,130	4,170	4,970	5,790	6,630	7,770
151	05480500	Des Moines River at Fort Dodge, IA	4,190	-0.199	-0.242	1	10,500	17,800	23,100	30,200	35,800	41,500	47,400	55,500
							8,040	14,700	19,700	26,500	31,900	37,500	43,300	51,300
152	05481000	Boone River near Webster City, IA	844	-0.294	-0.304	1	5,180	8,970	11,700	15,400	18,200	21,100	24,100	28,100
							2,810	5,130	6,860	9,170	11,000	12,800	14,700	17,400
153	05481300	Des Moines River near Stratford, IA	5,452	-0.227	-0.334	1	14,500	24,400	31,600	41,100	48,400	55,900	63,500	73,900
							9,560	17,500	23,500	31,600	38,000	44,700	51,600	61,300
154	05481680	Beaver Creek at Beaver, IA	38.5	-0.634	-0.233	1	590	1,070	1,420	1,890	2,250	2,620	2,980	3,480
							371	672	893	1,180	1,400	1,630	1,850	2,160
155	05481950	Beaver Creek near Grimes, IA	358	0.110	-0.089	2	2,620	4,590	6,150	8,400	10,300	12,400	14,600	17,900
							4,360	8,270	11,200	14,900	17,700	20,600	23,500	27,500
							2,660	5,390	7,480	10,100	12,000	14,000	16,000	18,700
156	05482135	North Raccoon River near Newell, IA	233	NA	-0.391	1	1,530	2,380	2,920	3,580	4,040	4,470	4,890	5,410
							1,210	2,200	2,930	3,900	4,650	5,420	6,210	7,280
157	05482170	Big Cedar Creek near Varina, IA	80.0	-0.751	-0.415	1	661	1,290	1,750	2,350	2,790	3,240	3,670	4,230
							599	1,090	1,450	1,920	2,280	2,650	3,030	3,530
158	05482300	North Raccoon River near Sac City, IA	700	-1.012	-0.423	2	3,900	7,490	10,000	13,200	15,500	17,600	19,700	22,300
							6,260	11,500	15,300	20,100	23,600	27,200	30,800	35,700
							3,970	7,720	10,500	14,000	16,500	19,000	21,500	24,900
159	05482500	North Raccoon River near Jefferson, IA	1,619	-0.696	-0.475	2	7,050	12,600	16,300	21,000	24,300	27,500	30,500	34,300
							9,840	17,300	22,500	29,000	33,800	38,500	43,200	49,500
							6,610	12,300	16,300	21,300	24,800	28,300	31,800	36,400

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Generalized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
160	05482600	Hardin Creek at Farnhamville, IA	43.7	-0.274	-0.385	1	504	981	1,360	1,880	2,300	2,730	3,190	3,820
							403	731	971	1,290	1,530	1,770	2,020	2,350
161	05482900	Hardin Creek near Farlin, IA	101	-0.128	-0.365	1	655	1,300	1,820	2,590	3,220	3,890	4,620	5,660
							698	1,270	1,690	2,240	2,670	3,100	3,540	4,140
162	05483000	East Fork Hardin Creek near Churdan, IA	24.0	-0.308	-0.317	1	229	365	458	576	663	750	836	950
							272	493	653	864	1,020	1,190	1,350	1,570
163	05483349	Middle Raccoon River tributary at Carroll, IA	6.58	0.142	-0.372	2	449	1,080	1,690	2,740	3,730	4,920	6,340	8,610
							503	1,170	1,750	2,560	3,220	3,930	4,700	5,800
							545	1,290	1,930	2,800	3,500	4,260	5,080	6,280
164	05483450	Middle Raccoon River near Bayard, IA	375	NA	-0.359	2	3,590	6,690	9,250	13,100	16,400	20,000	24,000	30,000
							4,470	8,460	11,400	15,200	18,100	21,000	24,000	28,000
							3,190	6,310	8,650	11,600	13,800	16,000	18,200	21,200
165	05484000	South Raccoon River at Redfield, IA	994	-0.500	-0.342	2	10,500	17,300	21,900	27,700	31,900	36,000	40,000	45,200
							7,560	13,600	18,000	23,400	27,400	31,500	35,500	41,000
							7,200	13,200	17,600	22,900	26,900	30,800	34,800	40,100
166	05484500	Raccoon River at Van Meter, IA	3,441	-0.081	-0.394	2	14,400	23,800	30,600	39,700	46,900	54,200	61,800	72,200
							14,800	25,000	32,000	40,500	46,600	52,700	58,600	66,400
							11,400	20,100	26,100	33,300	38,400	43,500	48,400	54,900
167	05485640	Fourmile Creek at Des Moines, IA	92.7	-0.111	-0.094	2	2,180	3,660	4,780	6,310	7,540	8,830	10,200	12,100
							2,100	4,270	5,970	8,230	9,970	11,800	13,600	16,300
							1,270	2,770	3,990	5,570	6,760	7,990	9,270	11,100
168	05486000	North River near Norwalk, IA	349	0.170	-0.233	2	3,420	6,940	10,000	14,900	19,300	24,300	30,000	38,700
							4,300	8,160	11,100	14,800	17,600	20,400	23,300	27,200
							5,120	9,660	12,900	17,100	20,300	23,500	26,800	31,300
169	05486490	Middle River near Indianola, IA	503	-0.423	-0.265	2	7,340	11,300	13,900	17,200	19,500	21,800	24,000	26,900
							5,230	9,760	13,100	17,300	20,500	23,700	27,000	31,400
							6,110	11,300	15,000	19,600	23,100	26,700	30,300	35,200
170	05487470	South River near Ackworth, IA	460	-0.627	-0.103	3	10,800	18,400	23,800	30,800	36,000	41,200	46,400	53,300
							7,670	12,800	16,600	21,600	25,500	29,500	33,600	39,200
							11,500	18,800	23,900	30,500	35,300	40,100	44,900	51,400
171	05487600	South White Breast Creek near Osceola, IA	28.0	-0.401	-0.181	3	2,200	4,020	5,410	7,320	8,830	10,400	12,000	14,300
							1,710	3,480	4,970	7,130	8,920	10,800	12,900	16,000
							2,380	4,740	6,640	9,330	11,500	13,800	16,200	19,600

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
172	05487800	White Breast Creek at Lucas, IA	128	-0.159	-0.130	3	3,490	6,440	8,780	12,100	14,900	17,900	21,000	25,600
							3,860	7,060	9,570	13,000	15,800	18,700	21,700	26,000
							4,350	7,850	10,500	14,100	17,000	20,000	23,100	27,600
173	05487980	White Breast Creek near Dallas, IA	342	1.088	-0.018	3	7,280	11,400	14,700	19,600	23,900	28,700	34,100	42,400
							6,540	11,200	14,600	19,200	22,800	26,500	30,300	35,700
							6,370	10,800	14,100	18,400	21,800	25,200	28,900	34,100
174	05488000	White Breast Creek near Knoxville, IA	380	NA	0.003	2	6,180	9,720	12,200	15,600	18,200	20,800	23,600	27,300
							4,500	8,510	11,500	15,300	18,200	21,100	24,100	28,200
							4,690	8,840	11,800	15,600	18,400	21,300	24,200	28,200
175	05488200	English Creek near Knoxville, IA	90.1	NA	0.158	3	2,570	5,130	7,710	12,300	17,000	23,000	30,600	44,000
							3,200	5,990	8,220	11,300	13,800	16,500	19,300	23,200
							2,290	4,310	5,920	8,180	10,000	12,100	14,300	17,700
176	05488620	Coal Creek near Albia, IA	13.5	0.015	0.084	3	1,050	2,660	4,330	7,290	10,200	13,800	18,200	25,500
							1,160	2,480	3,630	5,340	6,780	8,360	10,100	12,700
							1,450	3,040	4,380	6,330	7,940	9,690	11,600	14,300
177	05489000	Cedar Creek near Bussey, IA	374	0.663	0.148	3	8,180	15,200	21,700	32,700	43,200	56,000	71,800	98,000
							6,860	11,600	15,200	19,900	23,600	27,400	31,300	36,700
							8,240	13,800	17,800	23,000	27,000	31,000	35,200	40,900
178	05489150	Little Muchakinock Creek at Oskaloosa, IA	9.12	NA	0.140	2	379	906	1,480	2,560	3,700	5,200	7,170	10,700
							599	1,370	2,030	2,960	3,700	4,500	5,360	6,590
							564	1,320	1,950	2,800	3,490	4,220	5,010	6,160
179	05489350	South Avery Creek near Blakesburg, IA	33.1	0.256	0.044	3	4,220	7,430	10,100	14,000	17,400	21,300	25,600	32,000
							1,870	3,760	5,340	7,620	9,490	11,500	13,700	16,900
							1,840	3,670	5,160	7,300	9,060	11,000	13,000	16,100
180	05489490	Bear Creek at Ottumwa, IA	22.9	0.141	0.018	2	1,990	2,750	3,270	3,930	4,440	4,950	5,480	6,190
							986	2,150	3,120	4,440	5,490	6,590	7,760	9,430
							950	2,100	3,040	4,270	5,250	6,280	7,380	8,950
181	05491000	Sugar Creek near Keokuk, IA	105	NA	-0.028	3	2,980	5,090	6,800	9,360	11,600	14,000	16,800	21,000
							3,470	6,440	8,780	12,000	14,600	17,400	20,300	24,400
							2,680	4,980	6,790	9,310	11,400	13,600	16,000	19,600
182	05494300	Fox River at Bloomfield, IA	87.7	NA	-0.077	3	2,640	4,950	6,790	9,420	11,600	13,900	16,400	19,900
							3,150	5,920	8,130	11,200	13,700	16,300	19,100	23,000
							3,260	6,070	8,250	11,300	13,700	16,200	19,000	22,900

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
183	05494500	Fox River at Cantril, IA	161	NA	-0.148	3	6,250	9,040	11,000	13,600	15,700	17,800	19,900	23,000
							4,370	7,850	10,600	14,300	17,200	20,300	23,500	28,000
							4,620	8,230	11,000	14,700	17,600	20,600	23,800	28,400
184	05495000	Fox River At Wayland, MO	400	-0.464	-0.400	3	6,630	11,300	14,500	18,600	21,600	24,600	27,500	31,200
							7,110	12,000	15,600	20,500	24,200	28,000	32,000	37,500
							6,900	11,600	15,000	19,500	23,000	26,600	30,400	35,800
185	05495100	Big Branch tributary near Wayland, MO	0.70	0.247	-0.400	NA	119	238	347	521	680	867	1,090	1,430
186	05495500	Bear Creek near Marcelline, IL	349	-0.372	-0.400	NA	9,480	16,000	20,700	26,600	31,000	35,400	39,800	45,600
187	05495600	South Wyaconda River near West Grove, IA	4.69	NA	-0.121	3	456	1,210	1,980	3,270	4,470	5,890	7,540	10,100
							655	1,510	2,300	3,510	4,560	5,730	7,040	9,020
							763	1,730	2,590	3,880	5,000	6,230	7,600	9,650
188	05496000	Wyaconda River above Canton, MO	393	-0.117	-0.400	3	5,710	9,390	12,100	15,600	18,400	21,300	24,200	28,300
							7,050	11,900	15,500	20,300	24,000	27,900	31,800	37,300
							6,790	11,400	14,800	19,300	22,700	26,300	30,100	35,400
189	05497000	North Fabius River at Monticello, MO	452	-0.480	-0.400	3	8,150	11,900	14,200	17,000	19,000	20,800	22,600	24,900
							7,590	12,700	16,500	21,500	25,300	29,300	33,400	39,000
							8,190	13,600	17,500	22,500	26,400	30,400	34,500	40,200
190	05497500	Middle Fabius River near Baring, MO	185	-0.627	-0.397	NA	4,580	7,530	9,550	12,100	14,000	15,800	17,600	20,000
191	05497700	Bridge Creek Branch near Baring, MO	2.38	-0.156	-0.397	NA	364	596	765	991	1,170	1,350	1,540	1,800
192	05498000	Middle Fabius River near Monticello, MO	393	-0.303	-0.400	NA	5,990	9,360	11,600	14,500	16,500	18,600	20,600	23,200
193	05569825	Cedar Creek tributary at St. Augustine, IL	4.06	0.677	-0.400	2	386	616	794	1,050	1,260	1,480	1,730	2,100
							387	922	1,400	2,070	2,620	3,220	3,870	4,810
							370	904	1,370	2,010	2,520	3,090	3,700	4,600
194	05584500	La Moine River at Colmar, IL	655	-0.420	-0.400	NA	8,790	16,200	21,600	28,800	34,200	39,800	45,300	52,700
195	06478820	Saddlerock Creek tributary near Beresford, SD	2.22	-0.070	-0.287	NA	16	46	79	138	196	269	356	499
196	06479950	Deer Creek near Brookings, SD	4.04	-0.549	-0.400	NA	56	250	505	1,010	1,520	2,160	2,930	4,150
197	06482950	Mound Creek near Hardwick, MN	2.47	0.119	-0.255	NA	39	109	184	321	458	629	839	1,190

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
198	06483000	Rock River at Luverne, MN	425	0.340	-0.241	2	2,180	5,250	8,440	14,200	20,000	27,300	36,500	52,100
							4,780	8,990	12,100	16,100	19,100	22,100	25,200	29,400
							4,230	8,090	10,900	14,400	17,000	19,700	22,400	26,100
199	06483210	Kanaranzi Creek tributary #2 near Wilmont, MN	2.14	-0.788	-0.221	2	129	327	507	781	1,010	1,260	1,530	1,910
							274	674	1,040	1,560	1,990	2,470	2,990	3,750
							153	416	664	1,010	1,300	1,600	1,940	2,440
200	06483270	Rock River at Rock Rapids, IA	788	NA	-0.124	2	3,800	8,650	13,200	20,500	27,200	34,900	43,800	57,600
							6,670	12,200	16,100	21,100	24,900	28,600	32,300	37,400
							7,460	13,600	18,100	23,600	27,700	31,800	36,000	41,700
201	06483410	Otter Creek north of Sibley, IA	11.9	0.030	-0.061	2	137	361	596	1,020	1,440	1,960	2,600	3,670
							692	1,560	2,300	3,330	4,150	5,020	5,960	7,310
							355	861	1,290	1,870	2,330	2,810	3,330	4,060
202	06483430	Otter Creek at Sibley, IA	29.9	0.588	-0.081	2	263	784	1,420	2,740	4,240	6,320	9,160	14,500
							1,140	2,450	3,530	5,000	6,150	7,360	8,650	10,500
							911	2,030	2,950	4,150	5,090	6,080	7,140	8,630
203	06483460	Otter Creek near Ashton, IA	88.0	0.503	-0.105	2	823	2,310	4,060	7,590	11,500	16,900	24,100	37,400
							2,040	4,160	5,830	8,040	9,750	11,500	13,400	15,900
							2,040	4,210	5,900	8,080	9,760	11,500	13,300	15,900
204	06483500	Rock River near Rock Valley, IA	1,592	-0.447	-0.113	2	6,500	14,500	21,400	31,600	40,200	49,500	59,600	73,800
							9,750	17,200	22,400	28,800	33,600	38,300	43,000	49,200
							12,200	21,200	27,500	35,300	41,000	46,700	52,400	60,100
205	06484000	Dry Creek at Hawarden, IA	48.4	NA	-0.271	2	728	1,910	3,110	5,130	7,050	9,320	12,000	16,200
							1,480	3,100	4,420	6,180	7,550	8,990	10,500	12,600
							1,450	3,080	4,350	6,020	7,320	8,680	10,100	12,100
206	06599800	Perry Creek near Merrill, IA	8.17	-0.100	-0.300	2	245	710	1,210	2,100	2,980	4,040	5,320	7,380
							565	1,300	1,930	2,820	3,530	4,300	5,120	6,310
							562	1,320	1,960	2,820	3,520	4,260	5,070	6,250
207	06599950	Perry Creek near Hinton, IA	33.1	-0.488	-0.298	2	942	2,410	3,770	5,900	7,750	9,800	12,000	15,300
							1,200	2,580	3,700	5,220	6,420	7,680	9,010	10,900
							1,250	2,690	3,850	5,370	6,570	7,830	9,170	11,100
208	06600000	Perry Creek at 38th Street, Sioux City, IA	65.1	-0.734	-0.295	2	2,370	4,550	6,160	8,280	9,880	11,500	13,000	15,100
							1,730	3,590	5,070	7,040	8,570	10,200	11,800	14,200
							1,900	3,950	5,550	7,620	9,230	10,900	12,700	15,200

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
209	06600100	Floyd River at Alton, IA	268	-0.185	-0.227	2	1,870	5,080	8,390	14,100	19,500	26,000	33,600	45,700
							3,720	7,170	9,780	13,100	15,700	18,300	20,900	24,600
							3,950	7,580	10,200	13,600	16,100	18,800	21,400	25,100
210	06600300	West Branch Floyd River near Struble, IA	180	-0.651	-0.286	2	2,080	4,790	7,100	10,500	13,200	16,100	19,200	23,400
							3,000	5,900	8,130	11,000	13,200	15,500	17,800	21,100
							2,770	5,460	7,450	9,970	11,900	13,900	15,900	18,700
211	06600500	Floyd River at James, IA	886	-0.036	-0.305	2	4,080	8,750	12,900	19,500	25,300	32,000	39,500	50,900
							7,110	12,900	17,000	22,300	26,100	30,000	33,900	39,200
							8,260	14,800	19,300	25,000	29,200	33,400	37,700	43,500
212	06600800	South Omaha Creek tributary No. 2 near Walthill, NE	1.65	-0.414	-0.166	2	298	694	1,060	1,640	2,170	2,760	3,440	4,460
							238	593	919	1,390	1,790	2,220	2,690	3,390
							281	716	1,110	1,670	2,130	2,640	3,200	4,040
213	06600900	South Omaha Creek at Walthill, NE	51.2	-0.230	-0.388	2	1,920	4,310	6,350	9,380	11,900	14,600	17,500	21,600
							1,520	3,190	4,530	6,330	7,740	9,200	10,700	12,900
							1,630	3,440	4,850	6,710	8,150	9,660	11,300	13,500
214	06601000	Omaha Creek at Homer, NE	168	0.288	-0.539	NA	3,500	6,880	9,530	13,200	16,200	19,200	22,400	26,800
215	06602020	West Fork ditch at Hornick, IA	403	-0.398	-0.346	2	3,230	5,930	7,940	10,600	12,700	14,800	17,000	19,900
							4,640	8,760	11,800	15,700	18,700	21,600	24,700	28,800
							5,490	10,300	13,700	18,100	21,300	24,700	28,100	32,800
216	06603530	Little Sioux River near Spafford, MN	41.1	0.240	-0.171	2	259	745	1,300	2,370	3,490	4,960	6,860	10,200
							1,350	2,860	4,090	5,750	7,040	8,400	9,830	11,800
							670	1,550	2,270	3,230	3,960	4,720	5,520	6,640
217	06605000	Ocheyedan River near Spencer, IA	426	NA	-0.090	2	2,840	5,320	7,380	10,500	13,100	16,000	19,300	24,100
							4,780	9,000	12,100	16,100	19,100	22,100	25,200	29,400
							4,110	7,960	10,800	14,400	17,100	19,800	22,500	26,300
218	06605340	Prairie Creek near Spencer, IA	22.3	-0.457	-0.277	2	386	902	1,360	2,050	2,640	3,290	3,990	4,990
							972	2,120	3,080	4,390	5,430	6,520	7,680	9,330
							805	1,800	2,590	3,640	4,470	5,350	6,280	7,610
219	06605600	Little Sioux River at Gillett Grove, IA	1,334	NA	-0.122	2	4,280	9,220	13,800	21,300	28,300	36,500	46,100	61,300
							8,870	15,700	20,600	26,700	31,100	35,600	40,000	45,900
							6,580	12,100	16,100	21,000	24,500	28,000	31,500	36,100
220	06605750	Willow Creek near Cornell, IA	78.6	-0.363	-0.281	2	854	1,800	2,580	3,720	4,670	5,680	6,760	8,290
							1,920	3,930	5,530	7,650	9,290	11,000	12,800	15,200
							1,730	3,570	4,980	6,810	8,210	9,680	11,200	13,300

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years) 2	5	10	25	50	100	200	500
221	06605850	Little Sioux River at Linn Grove, IA	1,548	-0.142	-0.151	2	4,790	9,540	13,500	19,400	24,500	30,000	36,100	45,000
							9,610	16,900	22,100	28,500	33,200	37,800	42,500	48,700
							6,340	11,600	15,300	19,800	23,100	26,300	29,500	33,700
222	06606600	Little Sioux River at Correctionville,	2,500	0.014	-0.210	2	6,720	12,100	16,300	22,400	27,500	33,000	39,000	47,600
		IA					12,400	21,400	27,600	35,200	40,700	46,100	51,500	58,600
							10,100	17,700	22,900	29,200	33,700	38,200	42,600	48,400
223	06606700	Little Sioux River near Kennebec, IA	2,738	-0.189	-0.237	2	7,630	13,200	17,300	22,900	27,300	31,800	36,600	43,100
							13,100	22,400	28,800	36,600	42,300	47,900	53,500	60,800
							10,900	18,900	24,300	30,900	35,600	40,200	44,900	50,900
224	06606790	Maple Creek near Alta, IA	15.5	NA	-0.348	2	121	561	1,210	2,660	4,370	6,770	10,000	16,000
							798	1,780	2,600	3,740	4,650	5,610	6,630	8,100
							727	1,650	2,410	3,420	4,220	5,070	5,980	7,290
225	06607000	Odebolt Creek near Arthur, IA	39.3	NA	-0.436	2	994	2,010	2,880	4,180	5,310	6,550	7,930	9,970
							1,320	2,800	4,010	5,640	6,910	8,250	9,650	11,600
							1,510	3,230	4,590	6,390	7,790	9,280	10,900	13,100
226	06607200	Maple River at Mapleton, IA	669	-0.419	-0.440	2	6,860	11,800	15,200	19,600	22,800	26,000	29,100	33,200
							6,110	11,200	15,000	19,700	23,200	26,700	30,300	35,100
							7,050	12,800	16,900	22,000	25,700	29,600	33,500	38,800
227	06607800	South Branch Tekamah Creek	4.08	-0.029	-0.204	2	602	1,220	1,730	2,490	3,140	3,850	4,620	5,740
		tributary near Tekamah, NE					388	924	1,400	2,080	2,630	3,220	3,870	4,820
							432	1,050	1,590	2,330	2,930	3,590	4,310	5,370
228	06608000	Tekamah Creek at Tekamah, NE	23.0	-0.629	-0.473	2	1,740	3,730	5,330	7,550	9,290	11,100	12,900	15,400
							988	2,160	3,130	4,450	5,500	6,600	7,780	9,450
							1,160	2,550	3,680	5,190	6,380	7,640	9,000	10,900
229	06608500	Soldier River at Pisgah, IA	407	-0.284	-0.353	2	8,620	15,200	20,000	26,500	31,400	36,500	41,700	48,700
							4,670	8,800	11,900	15,800	18,700	21,700	24,800	28,900
							5,930	11,000	14,800	19,400	23,000	26,600	30,300	35,400
230	06608700	New York Creek tributary near Spiker,	1.55	-0.299	-0.205	2	242	629	1,010	1,660	2,250	2,950	3,760	5,020
		NE					230	575	893	1,350	1,740	2,160	2,620	3,310
							236	606	941	1,410	1,800	2,230	2,710	3,420
231	06608800	New York Creek north of Spiker, NE	6.50	-0.152	-0.180	2	1,250	2,090	2,700	3,530	4,180	4,840	5,540	6,490
							499	1,160	1,740	2,550	3,210	3,910	4,670	5,780
							578	1,370	2,040	2,960	3,710	4,520	5,390	6,680

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Generalized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
232	06608900	New York Creek east of Spiker, NE	13.9	0.213	-0.202	2	776	2,080	3,410	5,730	7,950	10,600	13,800	18,800
							753	1,680	2,470	3,560	4,430	5,360	6,350	7,770
							856	1,940	2,840	4,050	5,010	6,040	7,150	8,760
233	06609500	Boyer River at Logan, IA	871	-0.764	-0.387	2	12,200	18,800	22,900	27,700	30,900	33,900	36,700	40,100
							7,040	12,800	16,900	22,100	25,900	29,800	33,700	38,900
							7,640	13,700	17,900	23,200	27,100	31,000	35,000	40,300
234	06609560	Willow Creek near Soldier, IA	29.1	-0.061	-0.341	2	910	2,250	3,540	5,650	7,570	9,800	12,400	16,300
							1,120	2,420	3,490	4,940	6,080	7,280	8,550	10,400
							1,160	2,520	3,620	5,070	6,200	7,410	8,690	10,500
235	06610500	Indian Creek at Council Bluffs, IA	7.99	NA	-0.273	2	542	1,420	2,290	3,760	5,130	6,740	8,620	11,500
							558	1,280	1,910	2,790	3,500	4,260	5,080	6,260
							724	1,680	2,500	3,620	4,520	5,500	6,560	8,100
236	06610520	Mosquito Creek near Earling, IA	32.0	NA	-0.359	2	2,920	5,530	7,540	10,300	12,500	14,800	17,200	20,500
							1,180	2,530	3,640	5,150	6,330	7,570	8,890	10,700
							1,240	2,680	3,840	5,370	6,560	7,830	9,170	11,100
237	06610600	Mosquito Creek at Neola, IA	131	0.237	-0.365	2	4,250	7,610	10,300	14,200	17,400	20,900	24,800	30,300
							2,530	5,050	7,010	9,580	11,600	13,600	15,700	18,600
							2,660	5,320	7,330	9,900	11,900	13,900	16,000	19,000
238	06803510	Little Salt Creek near Lincoln, NE	43.6	0.370	-0.313	NA	1,640	3,700	5,540	8,360	10,800	13,500	16,500	20,900
239	06803520	Stevens Creek near Lincoln, NE	47.8	-0.789	-0.329	2	1,790	4,750	7,590	12,200	16,200	20,800	26,000	33,500
							1,470	3,080	4,390	6,140	7,510	8,940	10,400	12,600
							1,420	3,020	4,270	5,900	7,170	8,500	9,910	11,900
240	06803530	Rock Creek near Ceresco, NE	119	0.385	-0.273	NA	2,850	5,840	8,360	12,100	15,200	18,600	22,300	27,700
241	06803600	North Fork Wahoo Creek near Prague, NE	15.4	-0.524	-0.440	NA	1,420	4,350	7,380	12,400	17,000	22,200	27,900	36,500
242	06803900	North Fork Wahoo Creek at Weston, NE	43.3	-0.104	-0.438	2	1,560	4,440	7,320	12,100	16,400	21,400	27,000	35,400
							1,390	2,940	4,190	5,880	7,200	8,590	10,000	12,100
							1,470	3,130	4,440	6,160	7,500	8,910	10,400	12,500
243	06804000	Wahoo Creek at Ithaca, NE	271	0.024	-0.345	2	4,230	9,270	13,700	20,500	26,300	32,800	40,000	50,600
							3,760	7,240	9,860	13,200	15,800	18,400	21,100	24,800
							4,110	7,870	10,600	14,100	16,800	19,500	22,300	26,100

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
244	06804100	Silver Creek near Cedar Bluffs, NE	7.00	-0.489	-0.113	2	475	1,100	1,690	2,620	3,450	4,410	5,500	7,150
							520	1,200	1,800	2,630	3,310	4,030	4,810	5,950
							407	971	1,450	2,090	2,610	3,160	3,760	4,630
245	06804200	Silver Creek near Colon, NE	30.3	0.014	-0.127	2	600	1,840	3,250	5,940	8,710	12,300	16,700	24,300
							1,150	2,470	3,550	5,020	6,180	7,400	8,690	10,500
							1,010	2,210	3,160	4,420	5,400	6,440	7,540	9,100
246	06804300	Silver Creek tributary near Colon, NE	10.3	0.115	-0.077	NA	77	270	517	1,030	1,600	2,390	3,430	5,310
247	06804400	Silver Creek tributary at Colon, NE	17.6	-0.055	-0.080	NA	102	386	766	1,580	2,500	3,780	5,500	8,640
248	06804500	Silver Creek at Ithaca, NE	80.0	-0.425	-0.111	NA	643	2,590	5,220	10,800	17,100	25,800	37,200	57,600
249	06806000	Waubonsie Creek near Bartlett, IA	30.4	NA	-0.515	2	2,730	5,240	7,210	9,960	12,200	14,500	17,000	20,400
							1,150	2,470	3,560	5,030	6,190	7,410	8,710	10,500
							1,380	2,990	4,280	6,000	7,340	8,770	10,300	12,500
250	06806440	Stove Creek at Elmwood, NE	10.3	-0.632	-0.323	2	1,310	3,230	4,990	7,750	10,100	12,800	15,800	20,000
							640	1,450	2,150	3,120	3,900	4,730	5,630	6,910
							602	1,400	2,060	2,950	3,660	4,430	5,250	6,440
251	06806460	Weeping Water Creek at Weeping Water, NE	80.1	-0.575	-0.286	2	2,360	6,010	9,450	14,900	19,700	25,200	31,200	40,100
							1,940	3,970	5,580	7,710	9,370	11,100	12,900	15,400
							1,970	4,050	5,640	7,710	9,310	11,000	12,700	15,200
252	06806500	Weeping Water Creek at Union, NE	241	-0.213	-0.367	NA	5,210	14,000	22,500	36,400	48,800	63,000	78,900	103,000
253	06807410	West Nishnabotna River at Hancock, IA	609	-0.683	-0.377	2	9,070	15,400	19,700	25,000	28,800	32,400	35,800	40,200
							5,800	10,700	14,300	18,900	22,300	25,700	29,200	33,800
							6,950	12,700	16,800	21,800	25,700	29,500	33,500	38,900
254	06807720	Middle Silver Creek near Avoca, IA	3.21	-0.728	-0.397	NA	389	673	866	1,110	1,280	1,450	1,610	1,810
255	06807760	Middle Silver Creek near Oakland, IA	25.7	0.300	-0.393	NA	863	1,250	1,520	1,880	2,140	2,420	2,700	3,080
256	06807780	Middle Silver Creek at Treynor, IA	42.7	0.314	-0.387	NA	1,330	1,950	2,380	2,940	3,370	3,810	4,260	4,870
257	06808500	West Nishnabotna River at Randolph, IA	1,326	-1.103	-0.435	2	14,500	23,700	29,400	35,700	39,800	43,500	46,800	50,600
							8,840	15,700	20,600	26,600	31,000	35,500	39,900	45,800
							11,200	19,500	25,200	32,200	37,500	42,700	48,000	55,200
258	06809000	Davids Creek near Hamlin, IA	26.0	NA	-0.403	2	782	1,600	2,360	3,620	4,800	6,220	7,930	10,700
							1,060	2,290	3,310	4,700	5,790	6,950	8,170	9,910
							1,130	2,480	3,560	5,000	6,140	7,340	8,630	10,500

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
259	06809210	East Nishnabotna River near Atlantic, IA	436	-0.566	-0.434	2	8,950	15,600	20,200	26,000	30,200	34,300	38,300	43,400
							4,850	9,100	12,300	16,300	19,300	22,400	25,500	29,700
							5,510	10,300	13,700	18,000	21,200	24,500	27,900	32,500
260	06809500	East Nishnabotna River at Red Oak, IA	894	-0.714	-0.465	2	9,970	17,200	22,000	27,900	32,000	35,900	39,600	44,200
							7,140	12,900	17,100	22,400	26,200	30,100	34,000	39,300
							8,490	15,200	19,800	25,600	29,900	34,300	38,700	44,700
261	06810000	Nishnabotna River above Hamburg, IA	2,806	-0.781	-0.471	2	16,600	25,000	30,100	35,900	39,700	43,200	46,400	50,200
							13,200	22,700	29,100	37,000	42,800	48,400	54,000	61,300
							18,100	30,200	38,300	48,200	55,500	62,700	69,900	79,500
262	06810100	Hooper Creek tributary near Palmyra, NE	8.00	-0.666	-0.323	2	710	1,710	2,610	4,000	5,200	6,520	7,970	10,100
							558	1,290	1,910	2,790	3,500	4,260	5,080	6,260
							521	1,230	1,820	2,620	3,270	3,960	4,720	5,800
263	06811840	Tarkio River at Stanton, IA	49.3	-1.003	-0.611	2	2,970	6,300	8,710	11,700	13,900	15,900	17,800	20,000
							1,490	3,130	4,450	6,230	7,610	9,060	10,600	12,700
							1,570	3,320	4,690	6,490	7,890	9,360	10,900	13,100
264	06811875	Snake Creek near Yorktown, IA	9.10	-0.691	-0.742	2	1,170	1,890	2,330	2,830	3,160	3,460	3,730	4,050
							599	1,370	2,030	2,960	3,700	4,500	5,350	6,580
							569	1,330	1,960	2,820	3,510	4,250	5,050	6,210
265	06813000	Tarkio River at Fairfax, MO	508	-1.243	-0.284	2	6,840	11,800	15,400	20,200	23,900	27,700	31,500	36,800
							5,260	9,810	13,200	17,400	20,600	23,800	27,100	31,500
							5,870	10,900	14,400	18,900	22,200	25,600	29,100	33,800
266	06817500	Nodaway River near Burlington Junction, MO	1,240	-0.946	-0.304	2	13,300	23,300	30,600	40,400	47,900	55,600	63,400	74,000
							8,520	15,200	19,900	25,800	30,200	34,500	38,800	44,600
							10,200	18,000	23,300	29,800	34,700	39,600	44,500	51,200
267	06818598	Platte River near Stringtown, IA	51.7	NA	-0.506	2	1,450	2,100	2,520	3,040	3,410	3,770	4,120	4,580
							1,530	3,200	4,550	6,360	7,770	9,240	10,800	13,000
							1,400	2,970	4,200	5,790	7,030	8,320	9,690	11,600
268	06818750	Platte River near Diagonal, IA	217	-0.866	-0.524	2	5,010	6,700	7,620	8,620	9,250	9,810	10,300	10,900
							3,320	6,470	8,870	12,000	14,300	16,700	19,200	22,600
							3,470	6,750	9,170	12,200	14,600	17,000	19,500	22,900
269	06818900	Platte River at Ravenwood, MO	486	-0.757	-0.321	2	6,970	10,300	12,400	14,700	16,300	17,800	19,100	20,700
							5,140	9,600	12,900	17,100	20,200	23,400	26,600	31,000
							5,530	10,300	13,600	17,900	21,000	24,200	27,500	32,000

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
270	06819185	East Fork One Hundred and Two River at Bedford, IA	85.4	NA	-0.636	2	4,520	7,260	8,890	10,700	11,900	12,900	13,800	14,900
							2,010	4,100	5,750	7,940	9,630	11,400	13,200	15,700
							2,010	4,120	5,740	7,830	9,440	11,100	12,900	15,300
271	06819190	East Fork One Hundred and Two River near Bedford, IA	92.1	NA	-0.641	2	4,270	6,460	7,850	9,510	10,700	11,800	12,800	14,200
							2,090	4,250	5,950	8,200	9,940	11,700	13,600	16,200
							2,140	4,360	6,060	8,260	9,950	11,700	13,600	16,100
272	06819500	One Hundred and Two River at Maryville, MO	515	-0.559	-0.314	2	7,990	12,900	16,200	20,500	23,700	26,900	30,100	34,300
							5,300	9,880	13,200	17,500	20,700	24,000	27,200	31,700
							6,230	11,500	15,200	19,900	23,500	27,100	30,700	35,800
273	06820000	White Cloud Creek near Maryville, MO	6.00	0.185	-0.312	2	620	1,450	2,190	3,320	4,300	5,380	6,570	8,290
							478	1,120	1,670	2,460	3,100	3,780	4,520	5,600
							450	1,070	1,610	2,340	2,920	3,560	4,240	5,250
274	06820300	Big Slough near Wilcox, MO	1.30	-0.475	-0.311	2	453	765	988	1,280	1,500	1,720	1,950	2,250
							209	528	823	1,250	1,610	2,010	2,440	3,090
							193	502	784	1,180	1,510	1,870	2,270	2,870
275	06896180	Demoss Branch near Stanberry, MO	0.38	-0.534	-0.323	NA	137	246	327	436	521	607	695	815
276	06897000	East Fork Big Creek near Bethany, MO	95.0	0.236	-0.348	3	2,650	4,250	5,480	7,210	8,630	10,200	11,800	14,200
							3,290	6,140	8,410	11,600	14,100	16,800	19,600	23,600
							3,060	5,690	7,750	10,600	12,900	15,300	18,000	21,800
277	06897200	Simpson Branch near Bethany, MO	4.72	-0.126	-0.349	NA	1,050	2,080	2,930	4,160	5,180	6,280	7,470	9,170
278	06897950	Elk Creek near Decatur City, IA	52.5	-0.695	-0.349	3	5,230	10,500	14,500	19,700	23,700	27,500	31,300	36,200
							2,390	4,660	6,510	9,150	11,300	13,600	16,000	19,600
							2,870	5,500	7,570	10,500	12,800	15,200	17,800	21,600
279	06898000	Thompson River at Davis City, IA	701	0.276	-0.348	3	7,900	12,900	16,800	22,400	27,000	32,000	37,400	45,300
							9,610	15,600	19,900	25,600	30,000	34,300	38,700	44,900
							8,910	14,400	18,400	23,500	27,400	31,400	35,600	41,600
280	06898400	Weldon River near Leon, IA	104	0.658	-0.160	3	5,750	10,100	13,900	19,700	24,900	31,000	38,000	48,900
							3,450	6,410	8,750	12,000	14,600	17,300	20,200	24,300
							5,440	9,840	13,100	17,600	21,000	24,500	28,000	32,900
281	06899000	Weldon River at Mill Grove, MO	494	-0.505	-0.364	3	10,900	18,900	24,600	32,000	37,600	43,200	48,900	56,400
							7,970	13,200	17,100	22,300	26,200	30,200	34,400	40,100
							9,310	15,300	19,600	25,100	29,300	33,500	37,900	43,900
282	06899500	Thompson River at Trenton, MO	1,670	-0.559	-0.356	NA	23,900	40,000	51,200	65,800	76,600	87,400	98,200	112,000

Table 2. Flood-frequency data for streamflow-gaging stations--Continued

Map no. (figs. 1 and 6)	Station number	Station name	DA (mi^2)	Station skew	Gener-alized skew	Hydrologic region (fig. 7)	Discharge (cubic feet per second) for indicated recurrence interval (years)							
							2	5	10	25	50	100	200	500
283	06900000	Medicine Creek near Galt, MO	225	-0.519	-0.369	3	5,970	10,000	12,900	16,600	19,300	22,000	24,800	28,300
							5,230	9,180	12,200	16,300	19,500	22,800	26,300	31,200
							4,590	8,050	10,700	14,200	17,000	19,900	23,100	27,600
284	06903400	Chariton River near Chariton, IA	182	0.763	-0.018	3	3,780	7,480	10,900	16,700	22,100	28,700	36,600	49,500
							4,660	8,320	11,100	15,000	18,000	21,200	24,500	29,100
							4,540	8,050	10,700	14,300	17,100	20,100	23,300	27,800
285	06903500	Honey Creek near Russell, IA	13.2	NA	0.149	3	570	1,320	2,090	3,490	4,910	6,720	9,020	13,000
							1,140	2,450	3,590	5,290	6,720	8,290	10,000	12,600
							884	1,900	2,770	4,080	5,200	6,450	7,870	10,000
286	06903700	South Fork Chariton River near Promise City, IA	168	0.781	0.026	3	5,870	10,600	14,700	21,400	27,600	34,900	43,600	57,500
							4,470	8,010	10,800	14,500	17,500	20,600	23,800	28,400
							4,100	7,340	9,800	13,100	15,800	18,600	21,600	26,000
287	06903900	Chariton River near Rathbun, IA	549	NA	0.067	3	4,880	10,400	15,400	23,700	31,200	40,100	50,500	66,900
							8,430	13,900	17,900	23,200	27,300	31,400	35,600	41,500
							7,550	12,400	16,000	20,600	24,200	27,900	31,800	37,400
288	06903990	Cooper Creek at Centerville, IA	47.8	NA	0.043	3	1,520	3,100	4,470	6,540	8,340	10,300	12,600	15,900
							2,280	4,460	6,260	8,810	10,900	13,100	15,500	19,000
							1,570	3,090	4,340	6,140	7,650	9,310	11,200	14,000
289	06904000	Chariton River near Centerville, IA	708	NA	0.104	3	5,430	11,200	16,400	24,700	32,300	41,100	51,200	67,100
							9,660	15,700	20,000	25,700	30,000	34,400	38,900	45,000
							8,760	14,200	18,100	23,100	26,900	30,900	35,100	41,000
290	06904500	Chariton River at Novinger, MO	1,370	-0.375	-0.389	NA	9,700	14,900	18,300	22,400	25,400	28,300	31,100	34,700
291	06904700	Strop Branch near Novinger, MO	0.96	-0.599	-0.389	NA	514	1,150	1,670	2,410	3,000	3,610	4,230	5,070