Illinois State Water Survey Division

SURFACE WATER SECTION
AT THE
UNIVERSITY OF ILLINOIS

SWS Miscellaneous Publication 94

ILLINOIS STREAMGAGING NETWORK PROGRAM: RELATED STUDIES AND RESULTS

by

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Prepared for the
Illinois State Water Plan Task Force

Champaign, Illinois
December 1986

Illinois Department of Energy and Natural Resources

CONTENTS

I. INTRODUCTION

The United States Geological Survey (USGS) in cooperation with the Division of Water Resources (DWR), Illinois Department of Transportation, initiated an evaluation of the Illinois streamgaging program in 1981. The purpose of this study was to evaluate available streamflow data for Illinois to determine present and future needs for streamflow information and to provide guidelines for a streamgaging network that will respond satisfactorily to the informational needs of ongoing water resources programs.

The number of streamgaging stations in Illinois increased steadily from 6 gaging stations in 1903 to 46 gaging stations in 1939. The streamgaging stations were operated primarily to determine the frequency, duration, and magnitude of floods on the state's large rivers. In 1947, the "small-streams" program was initiated to determine the statewide variation of flood characteristics for smaller streams draining watersheds less than 1,000 square miles in size. This program was responsible for the increase in the number of streamgaging stations from 46 in 1939 to 157 in 1955.

Since 1955, the number of continuous streamgaging stations has varied from a minimum of 138 at present (1984) to a maximum of 171 in 1971. The average number of continuous record stations maintained during this 29-year period was 156.

Two types of auxiliary networks of partial-record stations have been maintained to provide information that augments the information obtained from the continuous streamgaging station network. One is composed of peak-flow stations; the other is composed of low-flow stations. The total gaging station network as of 1984 was thus composed of 173 stations: 138 streamgaging stations, 8 stage-only stations, 25 crest-stage stations, and 2 miscellaneous-measurement stations.

An evaluation of the nationwide streamgaging program was performed in 1969 by the U.S. Geological Survey to assist in planning for long-term streamgaging needs. The objectives of this first formal network evaluation (Carter and Benson, 1969) were to define long-term goals of the streamflow data program, analyze all available streamflow data to determine which goals had already been met, and propose alternative programs and methods to meet goals that had not been met. Results of the evaluation of the Illinois streamgaging program were presented by Sieber (1970). The study recommended a detailed network evaluation to meet various requirements and establishment of more gages on streams with less than 60 sq mi drainage area.

Prior to 1981 no integrated efforts were made to evaluate the existing gaging network and flow data requirements. Such an evaluation is essential in designing an optimal streamgaging network at different levels of funding and in identifying desirable and minimal networks to meet various needs such as hydrologic research, water management, and flow regulation. Identification of the areas needing new gaging stations, and the types of stations needed, would also form a part of this integrated effort.

Water data are used by various state, local, and federal entities. The state entities include the Division of Water Resources (DWR), Illinois State Water Survey (SWS), Illinois Environmental Protection Agency (IEPA), Illinois Department of Conservation (IDOC), and Illinois Department of Agriculture (IDOA). The local entities include the Metropolitan Sanitary District of Greater Chicago (MSDGC), a few cities and local governments, and consultants and water resource planners. Federal agencies such as the USGS, U.S. Corps of Engineers (USCOE), Soil Conservation Service (SCS), and the U.S. Environmental Protection Agency (USEPA) also have specific needs for these data. A desirable gaging network can be maintained easily if the data users contribute their fair share of the operation, maintenance, and repair costs. The regional and local interests of data users need to be defined. The requirements of the various data users must be accounted for in the development of a desirable gaging network.

In 1982 a survey was conducted by the USGS to determine the usage of streamflow data collected at 176 gaging stations. A questionnaire developed for this survey was forwarded to federal, state, and local organizations involved with water-resources planning for Illinois. A survey similar to the one by USGS was conducted independently by the Illinois State Water Survey (SWS) in 1984. The results of the two surveys are reported in Sections II and III.

In their network study initiated in 1981, USGS analyzed streamflow data at streamgaging stations and peak-flow stations through three different techniques. The Network Analysis of Regional Information (NARI) technique was used to determine the likelihood of improving statistical models for selected streamflow characteristics by collecting additional streamflow data. The Kalman Filter Analysis of Uncertainty (KFAU) approach was used to determine the accuracy of instantaneous discharge determined from a stage-discharge relation or rating curve. The Relative Worth analysis uses a point rating scheme to determine the relative worth of each gaging station. These techniques and the results of the USGS study are presented briefly in Section IV.

The State Water Survey initiated a short-term study to evaluate the existing gaging network and to analyze the available daily flow data in terms of the regional consistency of various hydrologic parameters of interest for research, design, water supply, reservoirs, flow regulation, and instream flows. These parameters include 1) means, standard deviations, and skew and serial correlation coefficients of observed and log-transformed monthly and yearly flows, 2) high and low flows for 7, 31 and 61 days for each year of the flow record, and their statistics, 3) average flows during droughts of 5-, 9-, and 13-month durations and 10- and 25-year recurrence intervals, 4) flow duration curve and percent time mean flow is exceeded, and 5) 100-year floods with the annual maximum flood data. These hydrologic parameters were used to define hydrologically homogeneous regions as well as to establish regional relations for these parameters with basin factors as independent variables. The magnitude of departure of the calculated parameter value from the regional value (taking into consideration the length of the flow record) gives a matrix of departures. This matrix is used to identify existing gaging stations that can be discontinued because the regional relations can be developed for a satisfactory estimation of parameter values. The SWS approach, examples of application to two drainage basins, and results of the analyses are presented in Section V. Crest and stage gages were not considered in these analyses because they give information only on annual flood peak and river stage, respectively.

A discussion of the two main approaches and the results of the analyses are presented in Section VI. In Section VII various network configurations are presented in a table. The choice of an optimal network will depend on fiscal constraints.

Acknowledgments

This study was conducted under the general guidance of Stanley A. Changnon, Principal Scientist and former Chief, Richard J. Schicht, Assistant Chief, and Richard G. Semonin, Chief, Illinois State Water Survey. Several USGS personnel, especially Dr. Dean Mades, provided information on various aspects of the USGS Network Study. John W. Brother, Jr. and Linda J. Riggin supervised in the preparation of illustrations. Kathleen Brown typed the rough draft and camera-ready copy, and Gail Taylor edited the report.

II. USGS QUESTIONNAIRE*

Streamflow data collected in Illinois are provided to the public in several ways. Daily mean discharge, peak flow, and miscellaneous measurements of discharge are published annually in the U.S. Geological Survey's annual water resource data reports. Daily mean discharges and peak flows are also stored on the U.S. Geological Survey's WATSTORE (National Water Data and Retrieval System), under a daily values file and a peak flow file (Hutchinson, 1975). Data stored on these files are accessible to a number of federal and state agencies. The general public may also request retrievals of the information stored in the files. Although many of the possible users of streamflow data are readily identifiable, the specific usages of the data are not.

A survey of data usage was performed during January 1982. The survey was conducted by mailing a questionnaire to federal, state, and local organizations that are involved with water resources planning in Illinois. Several of these organizations participate in funding the streamgaging program. The organizations selected for the data-use survey are a sample of public agencies that have particular streamflow data needs and are fiscally responsible, to varying degrees, for supporting the Illinois streamgaging program.

The questionnaire was composed of two parts. The first part was used to identify the principal uses and importance of streamflow data collected at each gaging station. Participants in the survey were asked to specifically describe their uses of data and to identify in which of three general purpose categories the specific uses could be categorized: current purpose (usage related to site-specific management activities); planning and design (usage related to local or regional planning activities); and determination of long-term trends. Three classifications of need (needed very much, needed marginally, and not needed) were provided for participants to describe the essentiality of the flow data at each gaging station from their perspective.

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*This section is based on a written communication from D.M. Mades and K.A. Oberg, U.S. Geological Survey, Urbana, Illinois, 1986.

The second part of the questionnaire was used to determine present and future needs for streamflow information. Participants in the survey were also asked whether those needs were being met with the present streamgaging program.

A sample of selected responses to the USGS data-use survey is given in Table 1. A listing of the organizations surveyed by USGS is given in Table 2. The importance of flow data collected at each of the streamgages in the Illinois network as perceived by the respondents in the USGS survey is given under U in Table 13, Section VII. The level of importance is classified as V for very important, M for marginal, and N for not needed.

Table 1. Sample of Selected Responses to USGS Data-Use Survey

Station no.	Station name	Agency	Categorization of purpose CP	PD	LT	Specific use	Need
03336645	Middle Fork Vermilion	DWR	-	-	X	RO	M
	R. above Oakwood, IL	IEPA	X	X	-	C	V
		USEPA	-	-	-	QW	V
03336900	Salt Fork near	SWS	-	X	-	SED, WQR	V
	St. Joseph, IL	IEPA	X	X	-	C	V
03337000	Boneyard Creek at Urbana, IL	SWS	X	-	X	RO	V
03338000	Salt Fork near	LOU	-	-	-	-	N
	Homer, IL	INHS	-	-	-	-	V
03339000	Vermilion River near	SWS	-	X	X	WQR	V
	Danville, IL	IEPA	X	X	-	BC	V
		USEPA	-	-	-	QW	V

Note: Categorization of purpose: used for current purposes (CP), planning and design (PD), or long-term trend determination (LT).
Specific use: describes the purpose for which the data are collected -- BC - biological and chemical quality, C - chemical quality, FF - flood forecasting, IR - determining impacts of reservoir, L - legal requirements, LM - lake level monitoring, OM - outflow (from lakes) monitoring, QW - water quality monitoring, RO - rainfall-runoff relations, RR - reservoir (or navigation pool) regulation, SED - sediment discharge, SHF - self-help local flood forecasting, and WQR - water quality relations.
Need: indicates the degree of importance for streamflow information; V - very important, M - marginally important, and N - not important.

Table 2. Organizations Surveyed by the USGS to Determine Streamflow Data Use

TYPE	ORGANIZATION
Federal	Corp of Engineers:
	Chicago District
	Louisville District
	Rock Island District
	St. Louis District
	Environmental Protection Agency, Region V
	Federal Emergency Management Agency, Region V
	Fish and Wildlife Service:
	Carbondale office
	Rock Island office
	Illinois Water Resources Center
	National Weather Service
	Chicago Forecast Center
	Ohio River Forecast Center
	Office of Surface Mining
	Soil Conservation Service
State	Department of Agriculture, Division of Natural Resources
	Department of Transportation, Division of Water Resources:
	Chicago office
	Springfield office
	Environmental Protection Agency
	Natural History Survey
	State Water Survey:
	Champaign office
	Peoria office
Local	Greater Egypt Regional Planning and Development Commission
	Metropolitan Sanitary District of Greater Chicago
	Northeastern Illinois Planning Commission
	Southwestern Illinois Metropolitan and Regional Planning Comm.

III. SWS QUESTIONNAIRE

Stream measurement data are used by different agencies for water management, hydraulic designs, and research. Availability and reliability of suitable streamflow data are very important for carrying out these activities satisfactorily. Several local, state, and federal agencies participate in funding of stream measurement pertaining to discharge, quality, and sediment in streams and lakes in Illinois. In recent years, the financial support from many of these agencies has gradually declined. There is a need to streamline the data collection effort to serve the various users economically through the establishment of an optimal gaging network. Various data needs were investigated and incorporated in the network analysis.

A questionnaire was developed by the Stream Measurement Work Group of the State Water Plan Task Force to define the uses of streamflow and associated data, to rank the needs for various types of data, and to examine the relative need for real-time data. A copy of the questionnaire is given in the Appendix. This questionnaire was sent to a total of 158 agencies, commissions, consulting firms, and other organizations. The number of organizations surveyed by different categories is given below.

Type of Organization	Number
Federal Agencies	9
State Agencies	15
County Planning Commissions	13
Regional Planning Commissions	16
Public Utilities	4
Sanitary Districts	7
Public Works	4
Consulting Firms	80
Private Agencies	5
Universities	5
TOTAL	158

On March 9, 1984, 158 questionnaires were mailed as part of the SWS survey of water resources data users. As of June 1984, 54 completed questionnaires had been received, a response rate of 34 percent. Some of the important findings of the survey are summarized below.

Historical and current data (54 respondents)

	Historical data			Current data		
	Users	Primary source for users, %		Users	Primary source for users, %	
	%	USGS	Other	%	USGS	Other
1. Streamflow	85	46	54	54	46	54
2. Stream stage	78	48	52	50	50	50
3. Sediment load	39	23	77	30	25	75
4. Streamwater quality	70	18	82	39	26	74

Data use categories (54 respondents)

	Percent respondents in data use category*	
Use	Historical data	Current data
1. Hydrologic design	48	26
2. Hydraulic design	54	28
3. Operating decisions	37	28
4. General background	52	32

Type of data used (54 respondents)

	Percent respondents in data type category*			
Type	Streamflow	Stream stage	Sediment	Water quality
Daily	39	37	13	19
Weekly	19	13	6	6
Monthly	28	22	7	26
Seasonal	41	28	9	31
Yearly	65	46	20	39

Historical minimum/maximum data use (54 respondents)

Minimum/maximum	Percent users
Daily flow	41
Peak annual flow	54
Lowest annual flow	37
Annual flow	35
Annual sediment yield	24

* The categories are not mutually exclusive

Some relevant and pertinent findings are as follows. About 85% of the respondents indicated use of historical streamflow data, while only 54% use current streamflow data. The USGS is the primary source of streamflow and stream stage data for about 50% of the respondents but is the primary source for fewer than 25% of the respondents for sediment and water quality data. About 50% of the respondents said that they use streamflow information in hydrologic or hydraulic design or for developing general background knowledge. About 37% use the data in the operation of water resources projects. The data type most commonly used is annual data followed by seasonal, daily, monthly, and weekly data. The percent of users of sediment data varied from 6% (weekly data) to 20% (annual data), and the percent of users of water quality data varied from 6% (weekly data) to 39% (annual data).

Several users responded to the questions about how current stream measurement data could be made more useful to them. About one-fourth of the respondents expressed an interest in acquiring current or real-time data through direct computer access. About 40% indicated that the most valuable information for their purposes would be processed data such as low-flow and water quality statistics, data on flow duration and flood stages, and storm forecasts.

IV. USGS NETWORK STUDY*

The U.S. Geological Survey (USGS) was established in 1879 for the specific purpose of gaging streams and determining the runoff in various rivers of the United States. The Water Resources Division of the USGS collects data pertaining to quantity, quality, and use of water resources on a systematic basis. This data collection effort is assisted by state and other federal and private agencies. In Illinois the main state cooperators for the USGS gaging network are the Division of Water Resources (DWR) of the Illinois Department of Transportation and the Illinois State Water Survey (SWS) of the Illinois Department of Energy and Natural Resources. The principal federal cooperators are the U.S. Army Corps of Engineers districts in Rock Island, St. Louis, and Louisville. Some local units of government as well as sanitary districts provide support to the streamgaging program.

Because of the gradual reduction in financial support for the gaging program from state and federal agencies, the DWR initiated a study in 1981 to evaluate the existing gaging network and to define an economical and adequate network to meet various needs. This study was conducted by the USGS, under a contract with the DWR.

Streamflow data from gaging stations and crest-stage stations were analyzed. The Network Analysis of Regional Information (NARI) method was used to determine the likelihood of improving statistical models for selected streamflow characteristics by continuing the collection of additional streamflow data. The Kalman filter statistical procedure was used to determine accuracy of instantaneous discharge determined from a stage-discharge (or rating) curve. The Relative Worth procedure was used to determine the relative worth of each gaging station. A brief description of these three techniques is given below.

Network Analysis of Regional Information (NARI). This technique is used to evaluate the accuracy of regional regression models developed to estimate the streamflow characteristics for any stream in a given region. The theoretical basis of the NARI procedure was presented by Moss and Karlinger (1974). Moss et al. (1982) suggested some improvements. The

* This section is based on a written communication from D.M. Mades and K.A. Oberg, U.S. Geological Survey, Urbana, Illinois, 1986.

NARI procedure involves: 1) calculation of desired streamflow characteristics, 2) regression analysis, and 3) estimation of the probability distribution of the true standard error. The streamflow characteristics selected were the 7-day 2-year and 7-day 10-year low flows, mean annual flow, and annual peak flows corresponding to 2-, 10-, 50-, and 100-year recurrence intervals. The low flows and peak flows at different recurrence intervals were estimated with the Log-Pearson Type III probability distribution. Regression models were developed for the flow characteristics on the basis of basin factors such as basin drainage area and stream slope. The state was divided into several hydrologically homogeneous regions for the development of regional regression equations. Finally, a conditional probability distribution of the true standard error, s_t, was developed for each of the regression models. This requires the computation of joint probabilities of the coefficient of variation, C , and interstation correlation coefficients, R . The computer programs to determine the probability distribution were developed in accordance with the procedures outlined by Moss et al. (1982).

Kalman Filter Analysis of Uncertainty (KFAU). The magnitude of uncertainty in streamflow measurements at gaging stations is used as a measure of the effectiveness of a streamgaging program. Uncertainty is defined as the variance of error in the instantaneous discharge estimation, and it is a function of the number of measurements made in any given year. The procedure is described in some detail by Moss and Gilroy (1980). Three sources of uncertainty in streamflow estimation are identified as: 1) error due to the use of a stage-discharge relation or rating curve; 2) error due to estimation of streamflow on the basis of streamflow at a nearby gaging station; and 3) error related to periods when no primary or other auxiliary data are available to estimate current streamflow. The total uncertainty of estimation is the sum total of the above three variances. The KFAU procedure consists of five steps: 1) estimation of long-term rating curves; 2) analyses of the time series of the residuals (a residual equals measured flow minus the flow estimated from the rating curve for the given stage); 3) evaluation of historical data on equipment performance to determine frequency of equipment malfunctions; 4) calculation of the seasonally averaged coefficient of variation and the cross correlation between flow data at adjacent stations; and 5) calculation of uncertainty functions.

Relative Worth Analysis. This analysis provides a numerical rating for the relative worth of a gaging station on the basis of four factors: site characteristics (magnitude of unmeasured mean annual flow, drainage area, standard error from KFAU, record length, and correlation between gages), 5-27 points; diversity of interest in data, 0-10 points; data uses for planning, 0-15 points; and data uses for management, 0-15 points. Responses to the USGS data-use survey were used to assign points for the last 3 factors. The relative worth of each station is indicated by its total point rating. These ratings varied from 14 for USGS No. 05593900 to 63 for 05446500 and 05583000. Seventeen gaging stations with ratings of less than 26 were designated as likely candidates for partial or complete discontinuance depending on budgetary conditions. These stations are:

USGS No.	Stream and Gaging Stations
03380475	Horse Creek near Keenes, IL
03343400	Embarras River near Camargo, IL
05414820	Sinsinawa River near Menominee, IL
05437695	Keith Creek at Eighth Street at Rockford, IL
05439000	South Branch Kishwaukee River at De Kalb, IL
05502040	Hadley Creek at Kinderhook, IL
05512500	Bay Creek at Pittsfield, IL
05560500	Farm Creek at Farmdale, IL
05561500	Fondulac Creek near East Peoria, IL
05570350	Big Creek at St. David, IL
05570360	Evelyn Branch near Bryant, IL
05570370	Big Creek near Bryant, IL
05588000	Indian Creek at Wanda, IL
05590000	Kaskaskia Ditch at Bondville, IL
05590800	Lake Fork at Atwood, IL
05593575	Little Crooked Creek near New Minden, IL
05593900	East Fork Shoal Creek near Coffeen, IL

Crest-stage stations were also evaluated through the relative worth procedure. A total of 9 crest-stage stations with relative worth ratings of less than 26 were identified.

V. SWS NETWORK STUDY

1. Introduction

The streamgaging network provides a wealth of data for hydrologic analyses and for design of water resource projects. However, prior to 1981 no integrated effort was made to evaluate the existing gaging network in Illinois. Such evaluation is essential not only in designing optimal networks at various levels of funding and data needs, but also in determining the desirable size of the network to support various hydrologic research activities, water management, and flow regulation requirements. The evaluation can also identify areas needing new gaging stations and the types of stations needed.

Water data are used by various state, local, and federal entities. The state entities include the Division of Water Resources, DWR; Illinois State Water Survey, SWS; Illinois Environmental Protection Agency, IEPA; Illinois Department of Conservation, IDOC; and Illinois Department of Agriculture, IDOA. The local entities include the Metropolitan Sanitary District of Greater Chicago, cities and local governments, engineering consultants, and water resource planners. On the federal side, there are the U.S. Geological Survey, USGS; U.S. Army Corps of Engineers, USCOE; Soil Conservation Service, SCS; and U.S. Environmental Protection Agency, USEPA. A desirable size of gaging network can be maintained easily if the data users contribute their fair share of the operation, maintenance, and repair costs. A desirable gaging network should meet the needs of various users to the extent possible.

2. Pertinent Hydrologic Information

The Illinois State Water Survey's study was designed to evaluate the existing gaging network and to analyze the available daily flow data in terms of the regional consistency of various hydrologic parameters of interest for research, design, water supply, reservoirs, flow regulation, and instream flows.

Pertinent hydrologic information (most useful to engineers, water resource planners, and hydrologists) for planning and design purposes consists of mean flow and its variability, flow duration curves, drought flows, low and high flows, and flood estimates. In order to test the relative homogeneity of the basin or sub-basin response, the regional relations between hydrologic parameters (such as mean flow, flow duration, drought flows, and 100-year flood) and measurable physical characteristics of the basin can be analyzed to determine the most desirable gaging network.

Mean Flow: Mean flow, $\bar{Q}$, is the mean of the average daily flows for the entire record at a gaging station. Standard deviation of mean annual flow, $\bar{Q}(s)$, is obtained from the mean annual flows for each year of record.

Flow Duration: Values of discharge or streamflow in cfs, equaled or exceeded 99, 95, 90, 80, 70, 60, 50, 40, 30, 20, 10, 5, and 1% of the time, are developed to define flow duration at a gaging station. Discharge or streamflow for any other desired percentage of time can be interpolated. The flow duration developed for a gaging station with fewer than 15-20 years of record and with major wet or dry periods occurring in that record, can be biased because of non-representativeness of data. Flow duration in percent of time that $\bar{Q}$ is equaled or exceeded is given by $t(\bar{Q})$.

Drought Flows: Values of 5-, 9-, and 13-month droughts with 10- and 25-year recurrence intervals were developed for all gaging stations. Some streams draining relatively small areas have no flow during such episodes.

100-year Flood: The values of 100-year flood or Q100 have been taken from Curtis (1977). These values correspond to the weighted or best estimated frequency curve and were obtained by weighting the station and regionalized curves.

3. Regional Analyses

The first step in regional analyses is the determination of regions of relative homogeneity with respect to the pertinent hydrologic characteristics discussed above. This determination is based on available information on physiographic, hydrologic, meteorologic, and other relevant factors from previous studies. The physiographic divisions of Illinois have been studied by Leighton et al. (1948). Hydrologic response and streamflow variability in Illinois have been studied by Singh (1971). The state of Illinois was divided into 10 regions for the 7-day 10-year low flow study (Singh and Stall, 1973) which are shown in Figure 1.

Regression analyses, in which each pertinent hydrologic variable was considered as a function of basin characteristics such as area, length, and slope, were performed for each of the 10 regions. The regression models

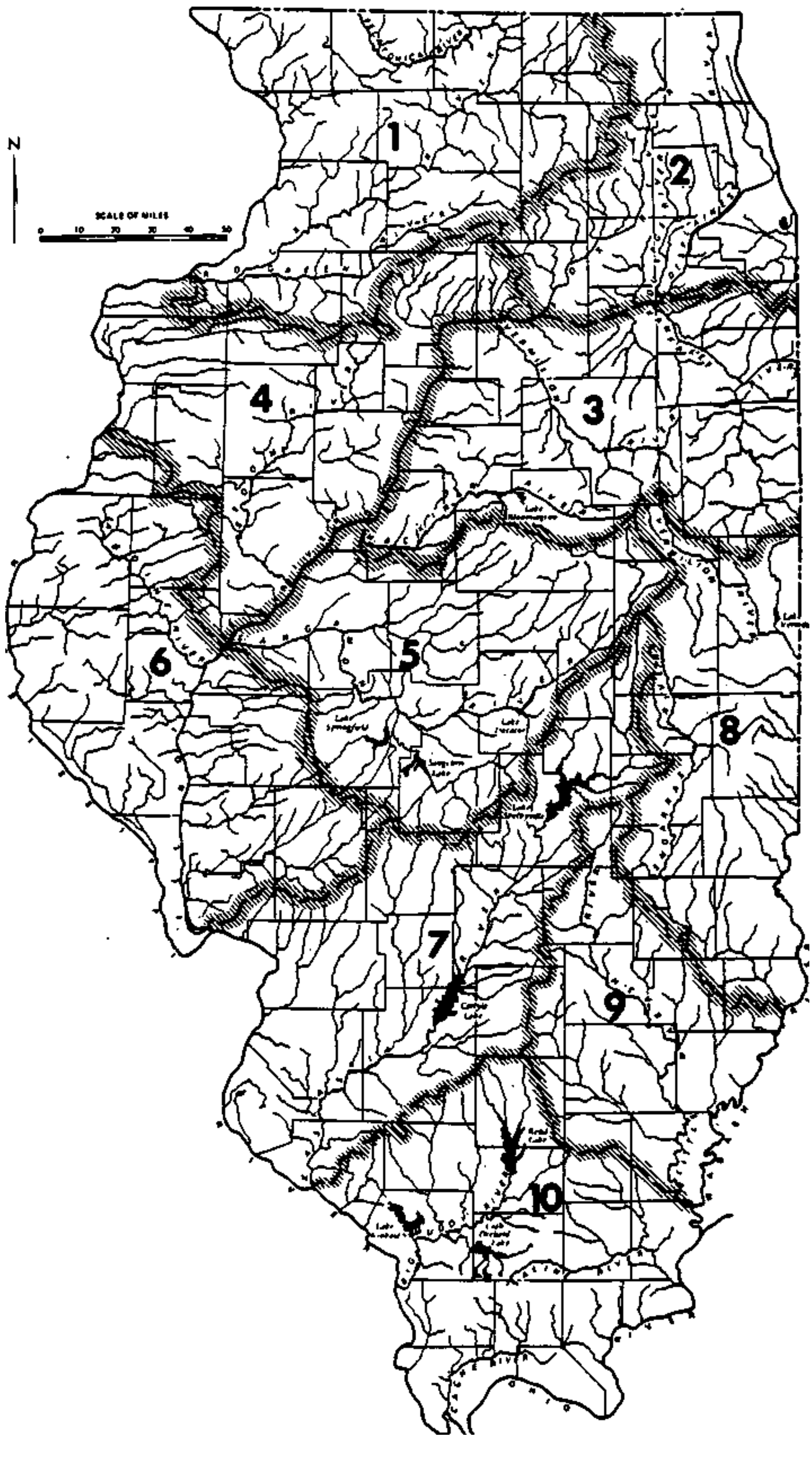

Figure 1. Location map and regions

help in identifying stations that are different in terms of hydrologic response and therefore need to be retained in the gaging network. They also identify stations which closely follow the regional regression equations for most of the variables and hence some of them can be discontinued unless needed for special purposes. The regression equations in their present form are used for investigating the homogeneity of hydrologic response. For the purpose of predicting hydrologic variables, non-linear regression equations need to be developed. Areas for which hydrologic data are lacking indicate a need for establishing new gaging stations. Brief examples of the analyses for the Sangamon River and the Rock River basins are included below.

3.1. Sangamon River Basin

The Sangamon River, draining an area of 5419 sq mi in central Illinois, has a length of 240.9 miles from the topographic divide to its mouth at Illinois River mile 98.0. The South Fork Sangamon River meets the Sangamon River 2.2 miles upstream of the gage at Riverton; their drainage areas at the confluence are 885 and 1443 sq mi, respectively. Salt Creek meets the Sangamon River 8.8 miles upstream of the gage at Oakford; their respective drainage areas at the confluence are 1868 and 3116 sq mi. Thus, the two main tributaries (South Fork Sangamon River and Salt Creek) drain 2753 sq mi, or about 51% of the total area of the Sangamon basin. A small portion of the northwestern part of the basin belongs to major areas of wind-blown sands in Illinois (Willman and Frye, 1970). A little less than one-half of the basin, or the eastern part, lies in the Bloomington Ridged Plain, and the remaining portion to the west lies in the Springfield Plain (Leighton et al., 1948). Drift thickness generally decreases from north to south. Excluding the "sand area" in the northwestern part (which has a streamgage station, Crane Creek near Easton, USGS No. 05582500), the basin has been shown to comprise three relatively homogeneous sub-basins (Singh, 1971).

a) Statistical Relations: Daily flow data are available at the 19 USGS gaging stations listed in Table 3 and shown in Figure 2. The table gives the USGS number, name of the stream and gaging station, record used in analyses, drainage area A in sq mi, stream slope S in ft/mi, and length of main channel L in miles. There were 12 gaging stations (shown by

Table 3. Stream and Gaging Stations in Sangamon River

No.	USGS No.	Stream and Gaging Station	Record Used Oct.	Sep.	N	A (sq mi)	S (ft/mi)	L (mi)
1	05571000	Sangamon River at Mahomet	1948	1978	30	362.0	3.59	56.41
2	05571500	Goose Creek near Deland	1951	1959	8	47.9		
3*	05572000	Sangamon River at Monticello	1914	1980	66	550.0	2.75	80.04
4	05572450	Friends Creek at Argenta	1966	1980	14	111.0		
5	05574000	South Fork Sangamon River near Nokomis	1951	1975	24	11.0	18.80	4.89
6	05574500	Flat Branch near Taylorville	1949	1980	31	276.0	2.01	47.49
7	05575500	South Fork Sangamon River at Kincaid	1944	1961	17	562.0	2.01	51.07
8*	05575800	Horse Creek at Pawnee	1967	1980	13	52.2	5.59	15.00
9*	05576000	South Fork Sangamon River near Rochester	1949	1978	29	867.0	1.32	84.82
10	05576500	Sangamon River at Riverton	1914	1956	42	2618.0	1.48	164.83
11*	05577500	Spring Creek at Springfield	1949	1980	31	107.0	5.39	29.37
12*	05578500	Salt Creek near Rowell	1942	1980	38	335.0	2.59	53.80
13*	05579500	Lake Fork near Cornland	1948	1980	32	214.0	4.65	37.00
14*	05580000	Kickapoo Creek at Waynesville	1948	1980	32	227.0	6.23	36.08
15	05580500	Kickapoo Creek near Lincoln	1944	1971	27	306.0	5.12	54.48
16	05581500	Sugar Creek near Hartsburg	1944	1971	27	333.0	5.76	42.77
17*	05582000	Salt Creek near Greenview	1941	1980	39	1804.0	2.22	114.68
18	05582500	Crane Creek near Easton	1949	1974	25	26.5	2.16	4.30
19*	05583000	Sangamon River near Oakford	1939	1980	41	5093.0	1.27	222.33
a*	05570910	Sangamon River at Fisher						
b	05572500	Sangamon River near Oakley						
c*	05573540	Sangamon River at Rt. 48 at Decatur						
d	05578000	Sangamon River at Petersburg						
e	05579700	Kickapoo Creek near Heyworth						
f*	05580950	Sugar Creek near Bloomington						
g	New	Flat Branch at US Highway 51 at Moweaqua						
h	New	Lick Creek at C&NW Railroad						
i	New	Salt Creek near Farmer City						

Note: * denotes stations active as of 1984, A = drainage area, S stream slope, L = length of main channel, N = number of years of record

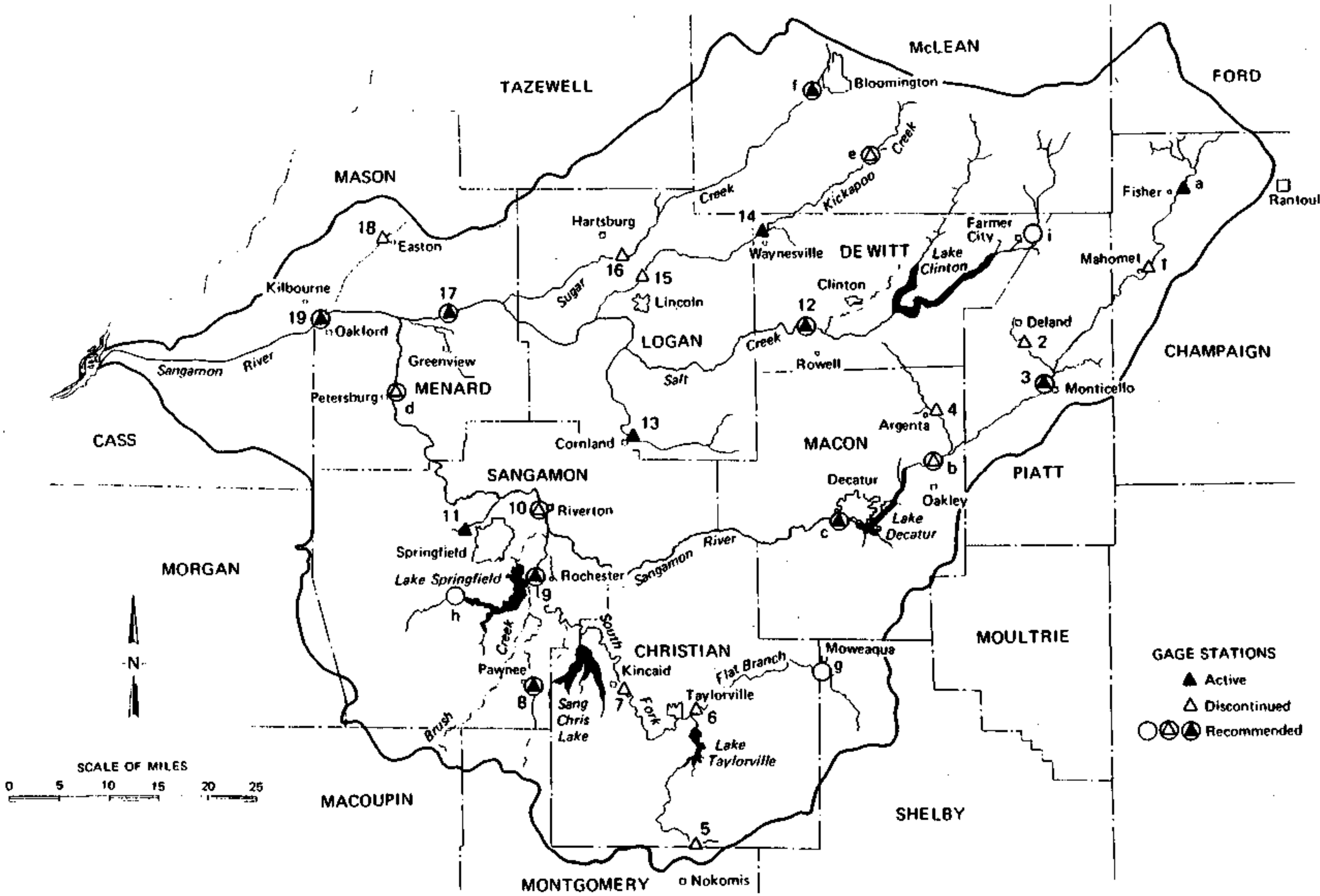

Figure 2. Sangamon River basin: active, discontinued, and recommended continuous gage stations

asterisks in Table 3) in operation in 1984: numbers 3, 8, 9, 11, 12, 13, 14, 17, and 19, and 3 new gaging stations -- a, c, and f. The new stations are located at the Sangamon River at Fisher (USGS No. 0570910, 240 sq mi, October 1978 to present), Sangamon River at Rt. 48 at Decatur (USGS No. 05573540, 938 sq mi, October 1982 to present), and Sugar Creek near Bloomington (USGS No. 05580950; 34.4 sq mi, October 1974 to present).

Flow duration values for each of the 19 stations are given in Table 4. Other pertinent hydrologic parameters such as mean flow, standard deviation of mean annual flows $\bar{Q}(s)$, drought flows with 10- and 25-year recurrence intervals, and 100-year flood estimates are given in Table 5.

Stepwise multiple regressions of hydrological parameters with basin factors of A, L, and S showed that when L and/or S were included, correlation was very slightly increased over that with A alone, and that for most of the parameters, the F statistics were lower with inclusion of L and/or S than with A alone. It was decided, therefore, to run linear regressions between the logarithms of each hydrologic parameter (with the exception of $t(\bar{Q})$ or percent time $\bar{Q}$ is equaled or exceeded) and drainage area A. The adjusted R^2 is obtained from the square of the (simple or multiple) correlation coefficient

$$\text{Adj } R^2 = 1 - (1-R^2)\ [n'/(n'-d)]$$

in which d is the number of independent variables in the regression and $n' = n-1$. The standard error in log units is given by S_e. For example, in Table 6 an S_e of 0.0293 for $\bar{Q}$ means that 67% of actual $\bar{Q}$ values are expected to lie between 1.0698 $\bar{Q}_r$, and 0.935 $\bar{Q}_r$ in which the subscript r refers to the value of $\bar{Q}$ from the regression equation.

Gaging stations 2, 4, and 8 with 8, 14, and 13 years of daily flow data, respectively, were dropped from the analyses because of short record length and nonrepresentativeness of data. Thus, the sample size N is 16 for $\bar{Q}$ and $\bar{Q}(s)$. For the flow duration, drought flows, and Q100, gaging stations 5 and 18 were dropped from the analysis, the former because of zero values for some percent durations and the latter because of its location in the "sand area." This reduced the sample size to 14, which was further reduced to 12 for Q(99) and 13 for Q(95) and Q(90) because of zero flow values at some stations. It is evident from Table 6 that R^2 increases

Table 4. Flow Duration: Sangamon River Basin

No.	N	99	95	90	80	70	60	50	40	30	20	10	5	1
		Flow (cfs) Equaled or Exceeded for Percent Time												
1	30	0.4	3.0	5.0	12	26	50	89	140	212	351	635	1040	2530
2	8	0.0	0.0	0.0	0.0	0.4	1.3	4.1	9.0	16	33	70	119	247
3	66	3.2	7.2	12	22	45	84	145	228	350	555	1050	1630	3670
4	14	0.0	0.1	0.2	2.5	12	24	37	56	84	129	230	400	909
5	24	0.0	0.0	0.0	0.0	0.1	0.3	0.7	1.2	2.0	3.8	9.4	27	131
6	31	0.0	0.4	1.9	5.6	15	29	51	82	133	226	448	894	2290
7	17	1.5	2.8	5.3	14	27	49	87	147	258	426	1000	1720	3910
8	13	0.0	0.0	0.0	0.2	1.3	2.9	5.8	11	18	33	75	159	680
9	29	0.8	3.8	9.2	26	53	97	160	258	426	702	1450	2600	5840
10	42	23	36	47	90	179	341	600	930	1460	2380	4460	7460	13400
11	31	0.0	0.0	0.0	0.7	3.6	9.0	18	28	44	72	143	264	749
12	38	3.0	7.2	10	18	31	55	90	133	200	310	564	925	2040
13	32	2.2	4.5	6.5	10	17	32	51	77	119	188	352	577	1360
14	32	0.6	2.2	4.1	8.2	16	33	54	84	126	194	350	558	1520
15	27	2.0	5.0	7.4	14	24	45	70	109	163	250	442	692	1730
16	27	8.0	12	15	23	33	52	84	123	176	266	449	724	1820
17	39	72	94	116	160	247	391	576	845	1190	1720	2890	4400	9640
18	25	1.2	2.5	3.8	5.7	7.0	8.6	10	13	17	22	33	45	94
19	41	186	240	296	424	656	1070	1560	2230	3200	4810	8490	13100	23700

N = number of years of record

Table 5. Some Pertinent Hydrologic Design Parameters: Sangamon River Basin

					Q in 10-year drought			Q in 25-year drought			
No.	N	$\bar{Q}$	$\bar{Q}(s)$	$t(\bar{Q})$	5-mo	9-mo	13-mo	5-mo	9-mo	13-mo	Q(100)
1	30	260.9	130.4	25.8	4.7	31.5	89.0	2.3	10.8	47.0	15500
2	8	25.4	14.9	23.8	.0	1.3	4.6	0.0	0.0	0.0	-
3	66	400.2	200.7	26.8	10.3	42.0	125.0	7.5	25.9	73.0	19600
4	14	96.3	41.7	26.7	.3	7.7	21.2	.1	1.7	6.2	-
5	24	7.3	5.0	12.1	.0	.2	1.2	.0	.1	.4	4920
6	31	200.1	126.4	21.9	1.9	8.4	54.0	.3	2.9	13.1	15100
7	17	374.1	223.3	22.6	5.0	12.5	38.5	2.4	7.0	10.5	21000
8	13	40.5	24.2	16.9	.0	2.3	6.3	0.0	.9	2.7	-
9	29	564.3	355.6	24.0	6.6	24.5	105.0	2.4	16.5	30.0	21600
10	42	1678.3	998.1	26.9	46.2	125.0	320.0	35.0	63.0	131.0	45800
11	31	63.4	37.6	22.2	.3	4.1	13.2	.1	1.6	6.2	8870
12	38	236.2	115.7	26.2	12.0	34.5	86.0	7.6	18.2	48.0	19300
13	32	142.9	82.3	25.8	4.9	14.5	32.5	3.3	6.7	11.3	12400
14	32	149.8	76.4	25.8	5.7	24.3	56.5	2.0	9.6	36.2	14400
15	27	187.1	87.2	26.8	9.3	34.0	67.0	3.1	12.3	50.0	15800
16	27	197.5	84.9	27.0	18.0	39.5	89.0	13.9	23.9	52.0	16500
17	39	1218.0	570.1	29.6	115.0	255.0	500.0	92.0	165.0	340.0	43700
18	25	16.3	7.8	31.5	3.1	5.3	6.6	2.7	4.6	5.8	996
19	41	3335.9	1713.9	28.8	279.0	570.0	1150.0	226.0	340.0	670.0	81700

Note: $\bar{Q}$ = long term average flow in cubic feet per second, $\bar{Q}(s)$ = standard deviation of mean annual flows, $t(\bar{Q})$ = percent time the flow equals or exceeds the long-term average flow, $\bar{Q}$; N = number of years of record, and Q(100) = best estimate for the 100-yr flood from USGS SRI 77-117 (Curtis)

Table 6. Basin Regression Parameters and Statistics
log(VAR) = a + b log A + c log L + d log S

Sangamon River Basin

VAR	a	b	c	d	Adj R^2	S_e	F	n
$\overline{Q}$	-0.2019	1.0082			0.998	0.0293	7968.0	16
$\overline{Q}(s)$	-0.4260	0.9900			0.989	0.0714	1296.2	16
Q(99)	-3.5914	1.5057			0.615	0.5140	18.6	12
Q(95)	-2.9903	1.3967			0.652	0.4356	23.5	13
Q(90)	-2.3476	1.2490			0.777	0.2885	42.8	13
Q(80)	-2.3661	1.3444			0.863	0.2470	82.8	14
Q(70)	-1.6703	1.1989			0.942	0.1375	212.5	14
Q(60)	-1.2216	1.1327			0.958	0.1097	297.7	14
Q(50)	-0.8891	1.0920			0.972	0.0863	447.9	14
Q(40)	-0.6650	1.0789			0.980	0.0715	636.4	14
Q(30)	-0.4462	1.0669			0.989	0.0510	1225.3	14
Q(20)	-0.2099	1.0533			0.992	0.0428	1694.0	14
Q(10)	0.0993	1.0400			0.993	0.0417	1737.0	14
Q(5)	0.3951	1.0124			0.987	0.0533	1007.0	14
Q(1)	1.0665	0.8997			0.986	0.0506	844.8	14
Q(5,10)	-2.8054	1.3954			0.747	0.3714	39.4	14
Q(9,10)	-1.3965	1.0817			0.765	0.2748	43.3	14
Q(13,10)	-0.7441	1.0027			0.859	0.1872	80.2	14
Q(5,25)	-3.9457	1.6972			0.686	0.5229	29.4	14
Q(9,25)	-2.0750	1.2168			0.792	0.2864	50.5	14
Q(13,25)	-1.1497	1.0306			0.675	0.3257	28.0	14
$t(\overline{Q})$*	17.6021	2.9891			0.304	1.9318	6.7	14
Q100	2.8407	0.5425			0.965	0.0476	362.3	14

*$t(\overline{Q})$ = a + b log A, or a semilogarithmic relation
n = number of gaging stations used in regressions

from a relatively low value of 0.615 for Q(99) to a value of 0.993 for Q(10).

Values of R^2 are lower and values of S_e are higher for the drought flows than the values for the flow duration parameters. Correlation of 100-year flood values with drainage area A is quite significant.

b) Sub-regional Analyses: A study of the residuals (the difference between the regression estimate and actual value of a hydrologic parameter for each of the gaging stations used in the analysis) and of the plots on log-log paper of hydrologic parameters with respect to drainage area indicated that the Sangamon basin was not homogeneous in its hydrological response and that the data points tended to cluster around three distinct, parallel straight lines. The three broad associations correspond to the Sangamon River, South Fork Sangamon River, and Salt Creek basins. These basins are designated as 1, 2, and 3, respectively, for the results of regression analyses presented in Table 7. The plots indicated that the three eye-fitted lines were practically parallel. Two dummy variables D_1 and D_2 were therefore used in the regression analyses.

Sub-region	Intercept	Exponent	Gaging stations
1	a_1	b	1,3,10,19
2	$a_1 + D_1 = a_2$	b	6,7,9,11
3	$a_1 + D_2 = a_3$	b	12,13,14,15,16,17

Values of a_1, a_2, a_3, and b together with adjusted R^2 and S_e are given in Table 7. There is significant improvement in R^2 and S_e values for hydrologic parameters of flow duration, drought flows, and $t(\bar{Q})$. Improvement in correlation is particularly great for the low flows such as Q(99) to Q(70), drought flows, and $t(\bar{Q})$.

Flow durations Q(99) to Q(70) for the Sangamon River near Riverton follow the sub-region 2 relation because of the effect of the South Fork Sangamon River, operation of Lake Decatur, and a major wastewater treatment plant below Decatur. However, the mean flow $\bar{Q}$ and flow durations Q(20) through Q(l) follow the sub-region 1 relation. Other flow durations and drought flows are intermediate between the sub -region 1 and 2 relations for the Sangamon River at Riverton. Flow duration and drought flows are intermediate between sub-regions 1 and 3 for the Sangamon River near Oakford. Some further refinement in the regressions is possible by

Table 7. Sub-Regional Regression Parameters

$\log(VAR) = a_i + b \log A \ (i=1,2,3)$

Sangamon River Basin

VAR	Regression Parameters a_1	a_2	a_3	b	Regression Statistics Adj R^2	S_e	Sample size n
$\bar{Q}$	-0.1965	-0.2047	-0.2090	1.0087	0.998	0.0310	16
$\bar{Q}(s)$	-0.4223	-0.3756	-0.4778	0.9922	0.991	0.0615	16
Q(99)	-5.1183	-5.5025	-4.4167	1.9488	0.853	0.3172	12
Q(95)	-3.6001	-4.0998	-3.1499	1.5833	0.936	0.1864	13
Q(90)	-2.8257	-3.1131	-2.4983	1.3909	0.951	0.1351	13
Q(80)	-2.2448	-2.3825	-2.0045	1.2864	0.968	0.0974	13
Q(70)	-1.7144	-1.8431	-1.5770	1.2070	0.983	0.0736	14
Q(60)	-1.1887	-1.3260	-1.1065	1.1220	0.990	0.0540	14
Q(50)	-0.7843	-0.9254	-0.7571	1.0640	0.993	0.0434	14
Q(40)	-0.5583	-0.6833	-0.5453	1.0507	0.995	0.0357	14
Q(30)	-0.3554	-0.4473	-0.3559	1.0433	0.996	0.0296	14
Q(20)	-0.0880	-0.1742	-0.1181	1.0222	0.996	0.0304	14
Q(10)	0.1903	0.1581	0.1424	1.0175	0.993	0.0409	14
Q(5)	0.4516	0.4686	0.3926	0.9991	0.992	0.0429	14
Q(1)	1.0833	1.1219	1.0392	0.8964	0.992	0.0373	14
Q(5,10)	-3.0436	-3.3670	-2.5957	1.4463	0.967	0.1339	14
Q(9,10)	-1.1771	-1.5866	-1.0298	1.0208	0.951	0.1250	14
Q(13,10)	-0.5543	0.8031	-0.5104	0.9521	0.917	0.1438	14
Q(5,25)	-3.9739	-4.5625	-3.4852	1.6924	0.944	0.2204	14
Q(9,25)	-2.0348	-2.3668	-1.8045	1.2006	0.943	0.1503	14
Q(13,25)	-0.7591	-1.2517	-0.6841	0.9268	0.858	0.2153	14
$t(\bar{Q})^*$	19.0829	16.1415	20.2173	2.5747	0.913	0.6848	14
Q(100)	2.7969	2.7873	2.8398	0.5528	0.970	0.0442	14

$t(\bar{Q}) = a_i + b \log A$, * or a semilogarithmic relation splitting the hydrologic parameters at these two stations (numbers 10 and 19) between one or the other sub-region. Another way of utilizing these stations in determining parameters at other stations is the assumption of parallel curves of relation passing through their data points.

c) Regression Results: These comprise a set of 7 figures. A brief description of each figure follows.

Figure 3: The mean flow $\bar{Q}$ is given by

$$\bar{Q} = M_i\ A^{1.0087};\ M_i = 10^{a_i} \text{ and } i = 1,2 \text{ or } 3$$

The values of M_i range from 0.618 to 0.636 (i denotes the sub-region 1, 2, or 3). Mean flows in the sub-regions are not much different. They are practically proportional to drainage area, as are the values of $\bar{Q}(s)$ with an exponent of 0.9922 for A. The M_i values for $\bar{Q}(s)$ range from 0.333 to 0.421. The minimum value is for the Salt Creek basin and the maximum value is for the South Fork Sangamon basin. Within the entire Sangamon basin, the flows have least variability in the Salt Creek basin and highest variability in the South Fork Sangamon basin.

Figure 4: Q(90), Q(80), and Q(70) are plotted versus drainage area on log-log paper. Gaging station 10 falls on curve 2 instead of curve 1, and gaging station 19 lies between curves 1 and 3. These low flows are the lowest for the South Fork Sangamon basin and the highest for the Salt Creek basin for a given size drainage area. The spread between curves 2 and 3 decreases with the decrease in percent time a flow is equaled or exceeded.

Figure 5: This figure contains plots for Q(60), Q(50), and Q(40). The spread between curves 2 and 3 decreases though the decrease rate is much less than in Figure 4. Curves 1 and 3 are very close for Q(50) and Q(40).

Figure 6: This figure contains plots for Q(30), Q(20), and Q(10). For Q(30) curves 1 and 3 are practically the same and indicate about 24% more flow than with curve 2 for the same size drainage area. For Q(10), curve 1 yields higher flow than 2 and 3 and curve 2 higher than 3.

Figure 7: In order to ensure that values of a_i and exponent b follow a smooth curve when plotted with respect to flow duration and that they are not random and without physical meaning, a_i and b are plotted in Figure 7. The smooth curves substantiate the confidence in regressions and parameters determined from such regressions.

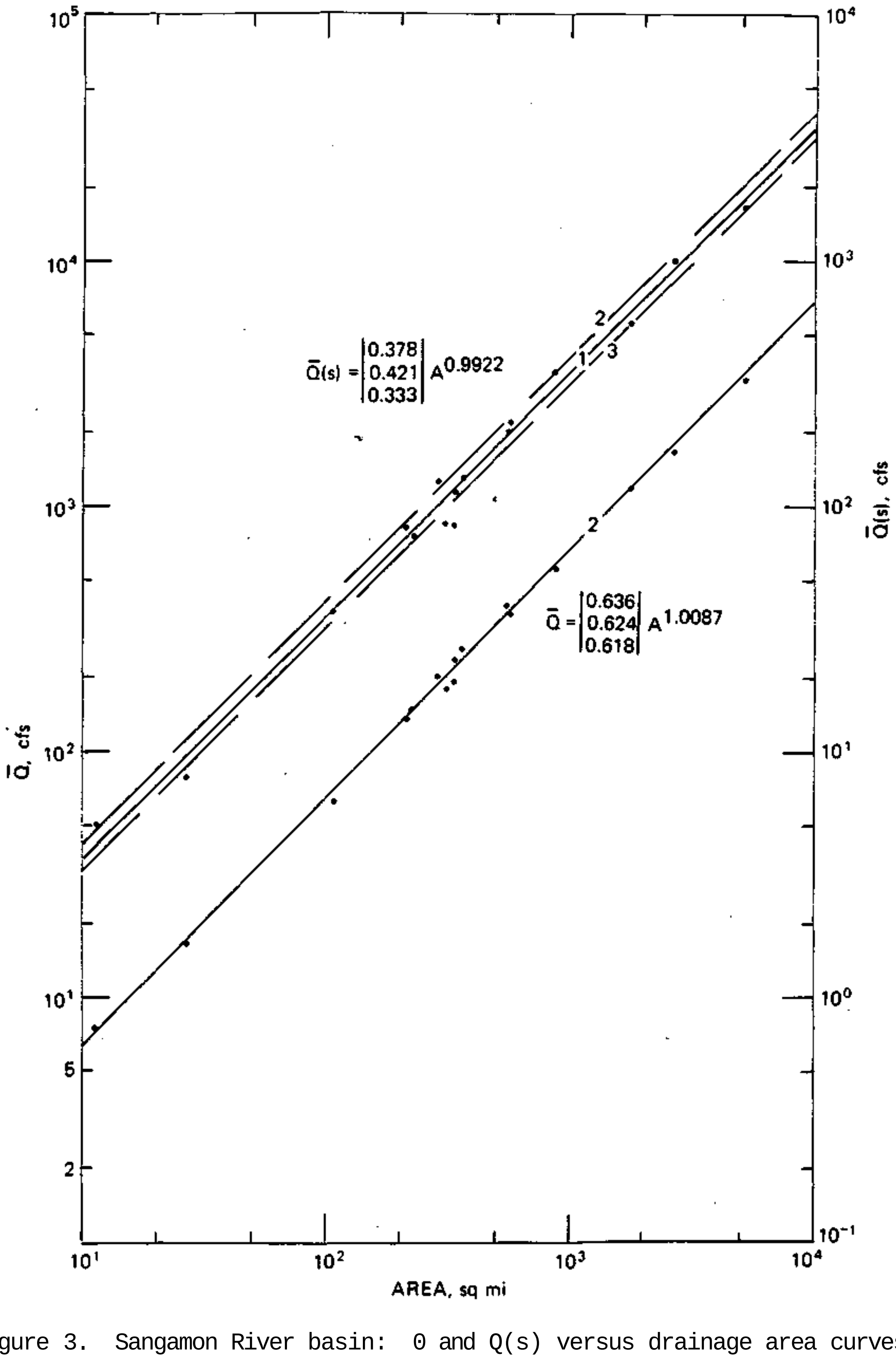

Figure 3. Sangamon River basin: 0 and Q(s) versus drainage area curves

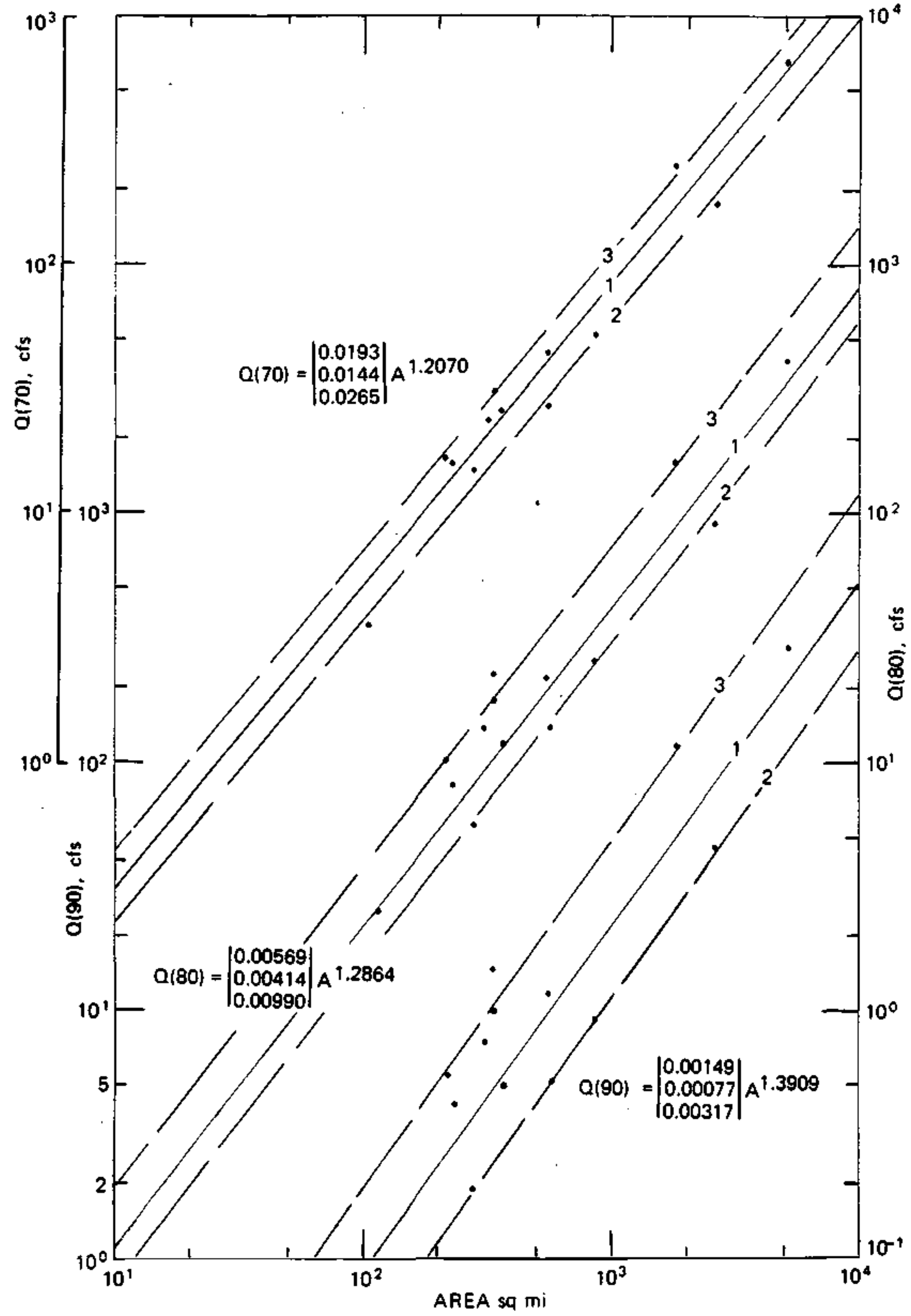

Figure A. Sangamon River basin: 0(90), Q(80), and Q(70) versus drainage area curves

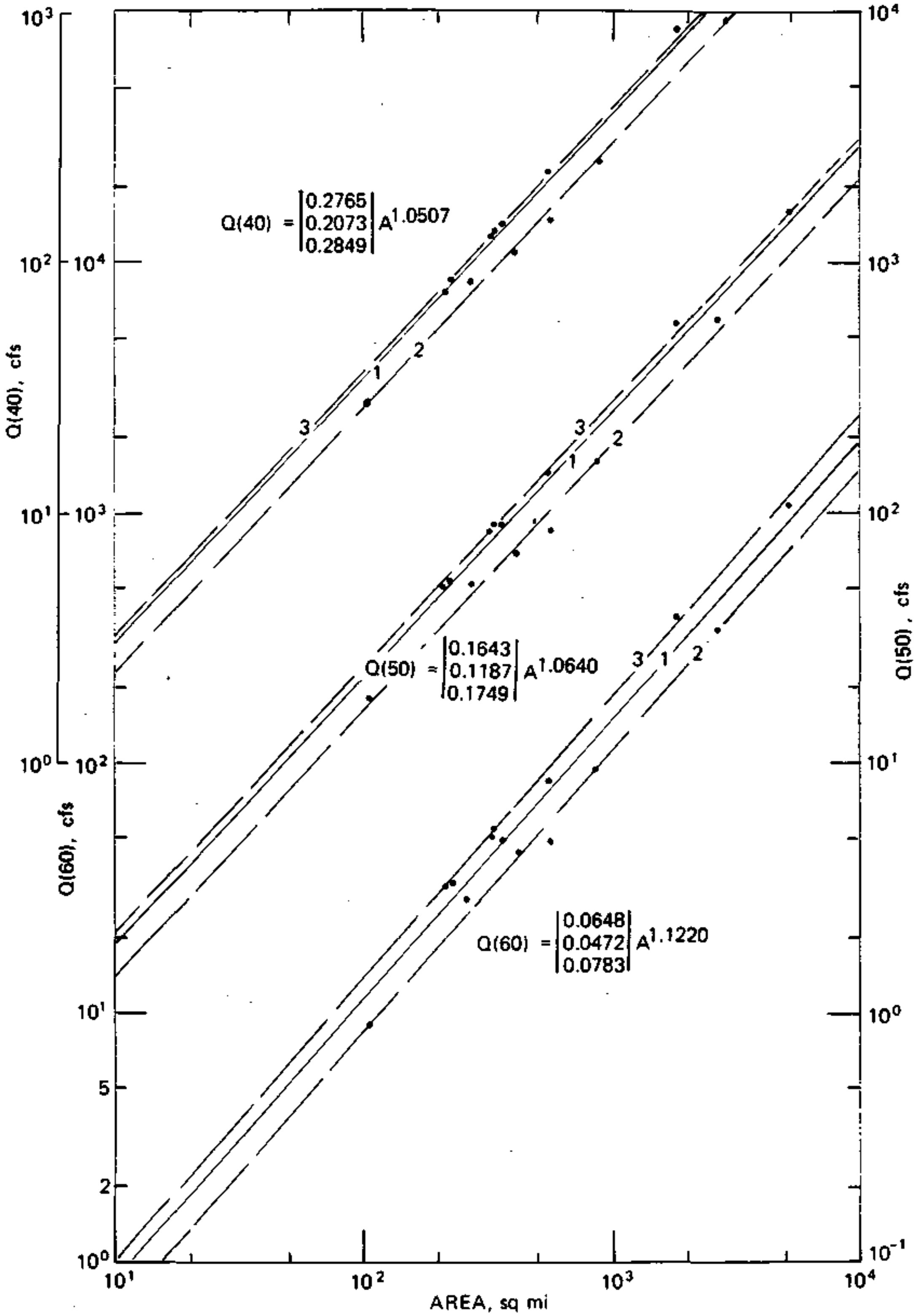

Figure 5. Sangamon River basin: Q(60), Q(50), and 0(40) versus drainage area curves

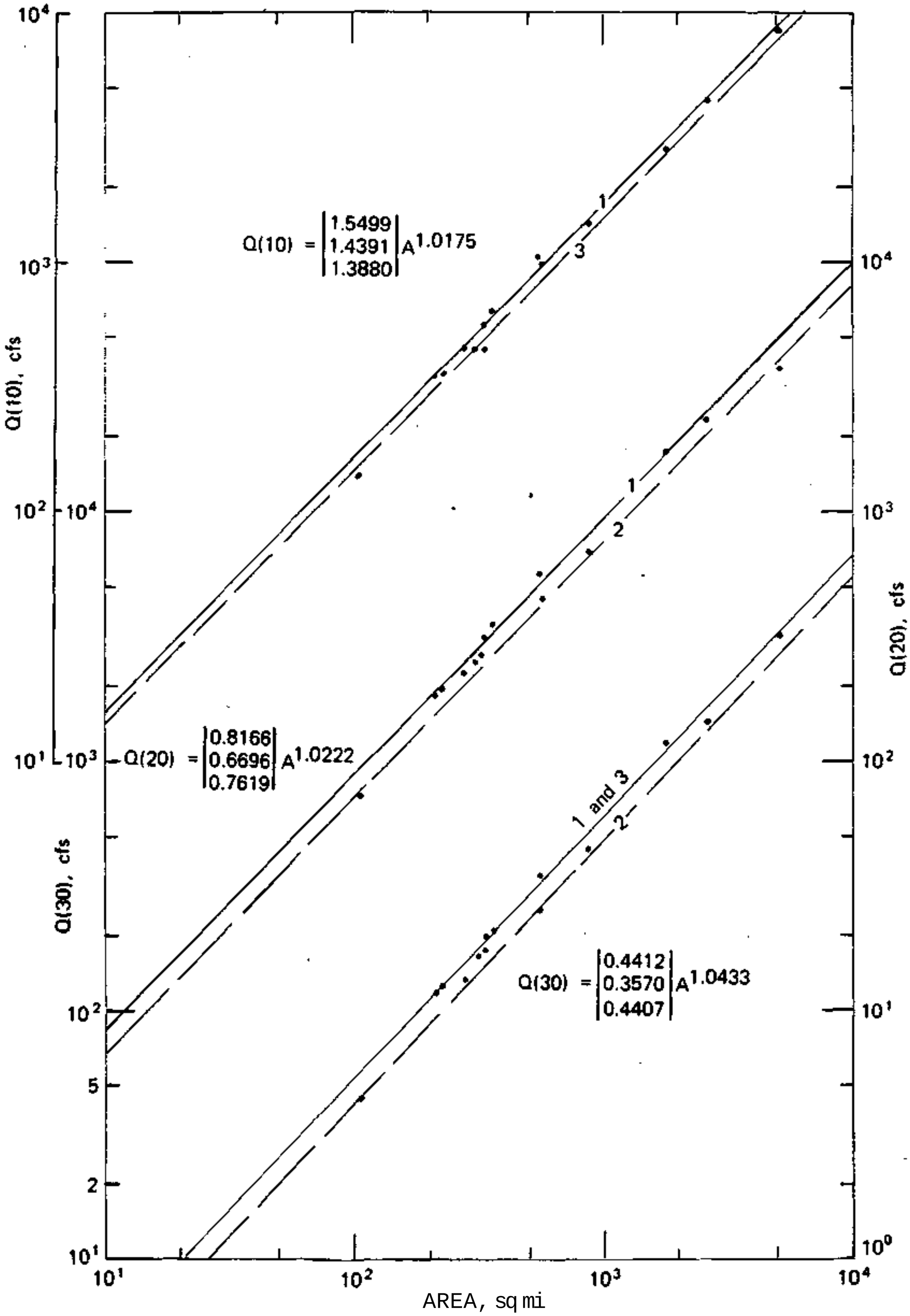

Figure 6. Sangamon River basin: Q(30), Q(20), and Q(10) versus drainage area curves

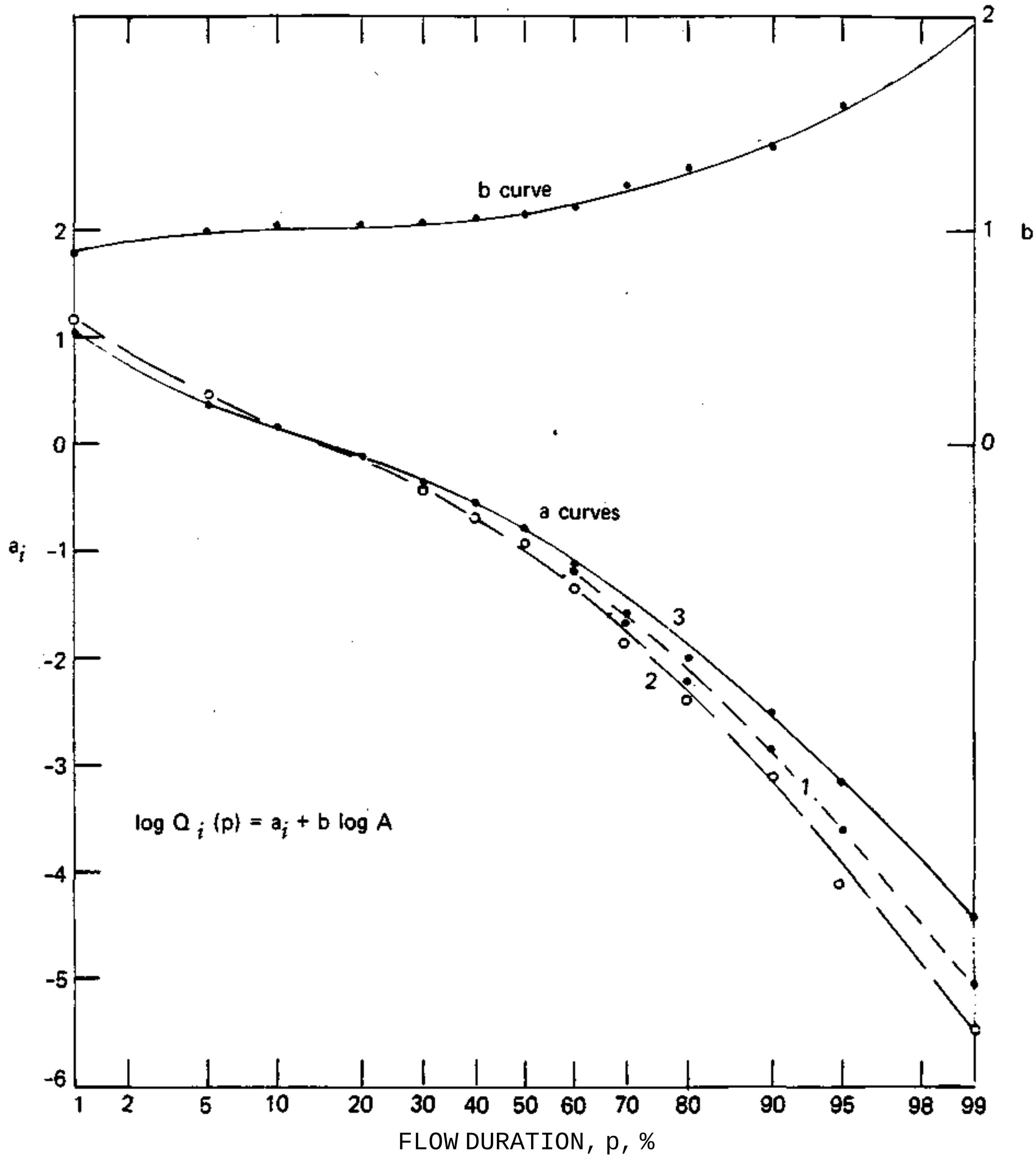

Figure 7. Sangamon River basin: a and b versus flow duration curves

Figure 8: Drought flows of 5-, 9-, and 13-month duration, occurring once in 10 years on the average, are plotted on log-log paper in this figure with respect to drainage area A. Here again, gaging station 10 plots close to curve 2 but gaging station 19 plots close to curve 1 for the 5-month duration and close to curve 3 for the 9- and 13-month durations. The spread decreases with an increase in duration in months, though the spread between 1 and 3 decreases at a much faster rate than that between 2 and 3.

Figure 9: This figure contains the drought flows for the 25-year recurrence interval. Comments similar to those for Figure 8 apply here also. Sub-region 2 or the South Fork Sangamon River basin is prone to very low flows during droughts.

d) Cautionary Remarks: The low stream flows (in the range of Q(99) to Q(90) or even Q(80) and drought flows) are affected by water withdrawals from the streams for municipal and industrial water supply, discharge of effluents from wastewater treatment plants, and existence and operation of man-made lakes and reservoirs. The magnitude of these effects varies with the size of withdrawals and returns as well as flow regulation. These effects are of less consequence when the streamflow is much greater than the variations caused by withdrawals, returns, and regulation. The major extraneous factors which can have significant effect on low flows for a considerable distance downstream are Lake Decatur, Lake Springfield, Clinton Lake, and wastewater treatment plants for Decatur, Bloomington, and Springfield. The effect of such extraneous factors can be estimated. The same can be evaluated better if some new gaging stations are installed with this specific purpose in mind. The low flows were not adjusted in this study for the effects of extraneous factors mentioned above.

The gaging stations active at present are distributed as follows with respect to drainage area:

Drainage area, sq mi	10-100	100-1000	>1000
Number of gaging stations	2	7	2

More gaging stations are needed for drainage areas xess than 100 sq mi for verification of the suitability of the developed sub-regional relations for such areas.

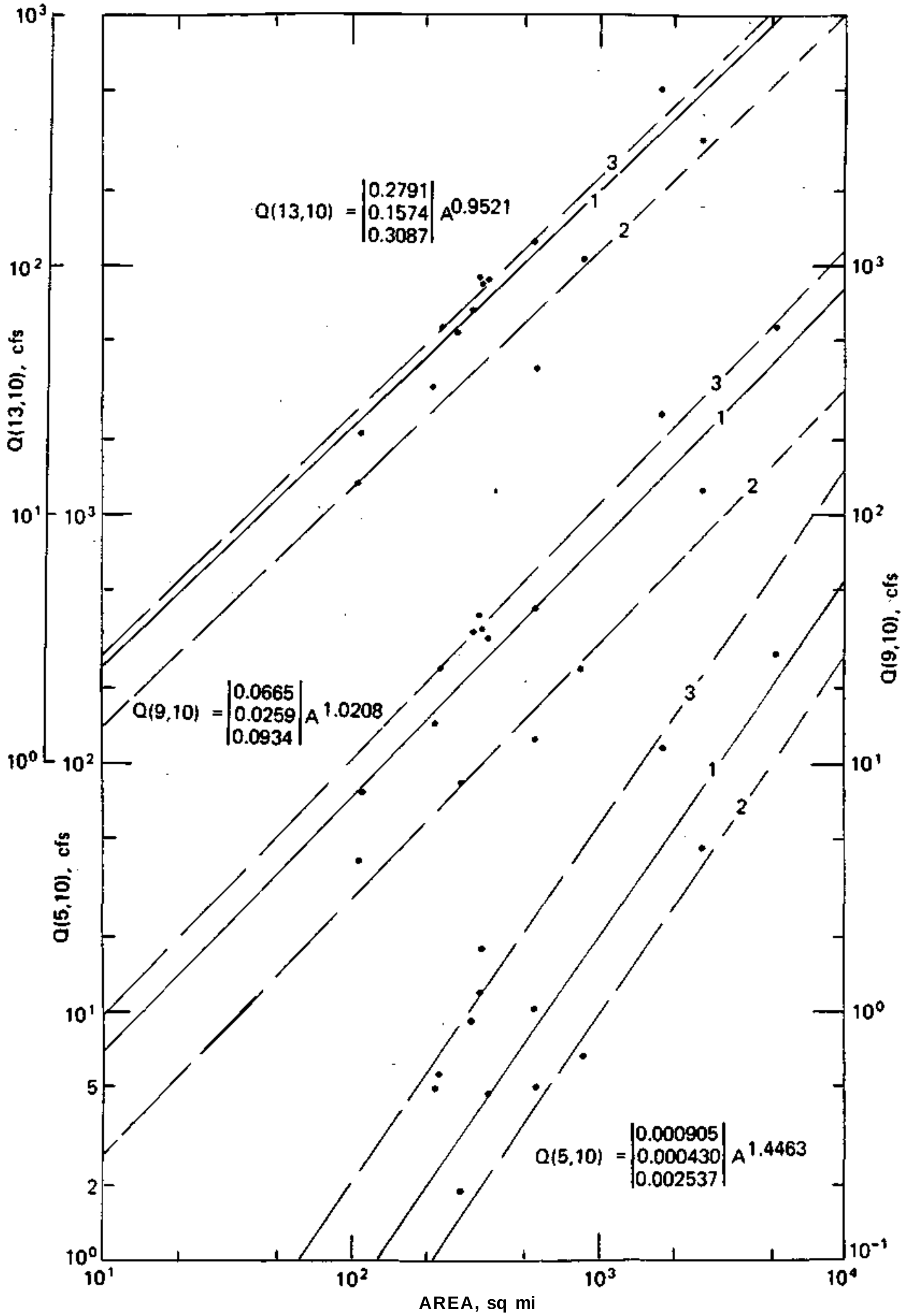

Figure 8. Sangamon River basin: Q{(5,9, or 13),10} versus drainage area curves

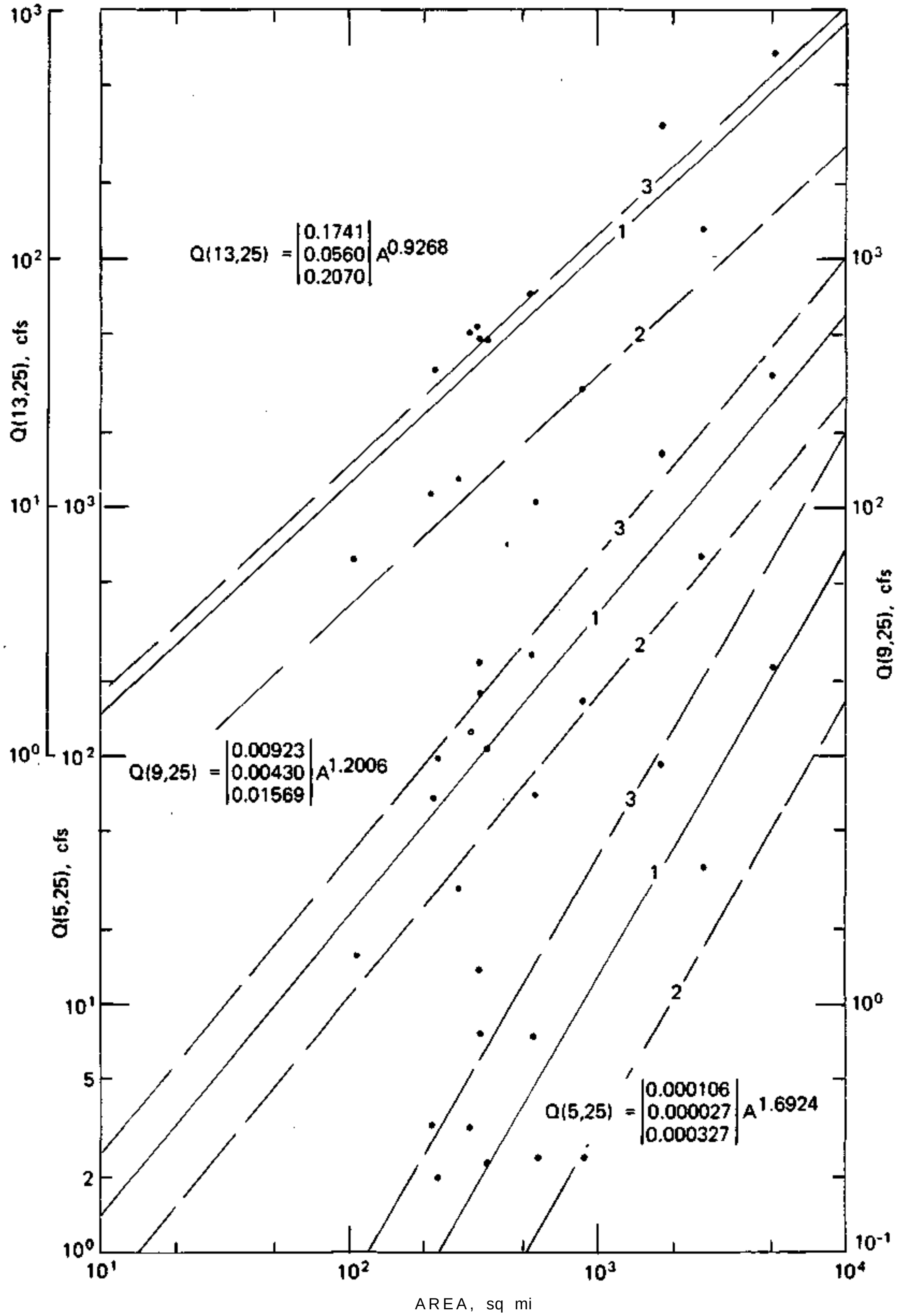

Figure 9. Sangamon River basin: {Q (5,9, or 13), 25} versus drainage area curves

e) Recommendations

(i) Eight gaping stations should be retained out of the existing 11 stations:

Four stations to serve as long-term and benchmark stations: Sangamon River at Monticello, South Fork Sangamon River near Rochester, Salt Creek near Greenview, and Sangamon River near Oakford.

Three stations to help in regional analyses: Horse Creek at Pawnee, Salt Creek near Rowell, and Sugar Creek near Bloomington. The station at Pawnee will also be helpful in water supply planning. The Bloomington station will be useful for assessing flow losses during dry weather as well as for water quality modeling of effluent from Bloomington as it travels downstream. The station near Rowell will also provide data on change in flow regime caused by the operation of Clinton Lake.

One station for lake operation: Sangamon River below Decatur at IL HWY 48 (old USGS 05573540, drainage area 938 sq mi) for monitoring outflows from Lake Decatur and developing better lake operation and sediment reduction strategies - - needed for 10 years in conjunction with the gaging station at the Sangamon River near Oakley.

Three stations that can be discontinued are the Sangamon River at Fisher (USGS 05570910), Spring Creek at Springfield (USGS 05577500), and Lake Fork near Cornland (USGS 05579500).

(ii) Four gaging stations should be reactivated:

These 4 stations are the Sangamon River near Oakley for monitoring the inflows to Lake Decatur in order to develop better lake operation and sediment entrapment reduction strategies; Sangamon River at Riverton for analyzing problems related to confluence of two major streams draining diverse hydrologic basins, as well as for planning water supply alternatives for the city of Springfield; Kickapoo Creek near Heyworth (old USGS No. 05579700, drainage area 71.8 sq mi) for regional information and monitoring low flow discharges; and Sangamon River at Petersburg (old USGS 05578000, drainage area 3063 sq mi) for analysis of confluence problems related to Salt Creek and the Sangamon River in conjunction with gages near Greenview and Oakford -- needed for about 10 years.

(iii) Three new gaging stations should be established:

Lick Creek at C&NW RR, tributary to Lake Springfield, drainage area <100 sq mi, for lake operation, sedimentation, and regional information.

Flat Branch near Moweaqua, drainage area 110 sq mi, for regional information.

Salt Creek at IC RR, 3 mi upstream of Farmer City, drainage area <100 sq mi, for regional information.

3.2. Rock River Basin and N.W. Mississippi Direct

The Rock River drains a total area of 9656 sq mi, of which 4208 sq mi is located in northwestern Illinois and 5448 sq mi in southern Wisconsin. The southern portion of the Rock River basin is dominated by broad alluvial plain except near the Mississippi River, where the terrain is rugged and the streambanks have steep slopes (UMRBC, 1979). The main tributaries to the Rock River in Illinois are the Pecatonica, Kishwaukee, and Green Rivers. The length of the river from the Illinois-Wisconsin state line is 162.8 miles. The Pecatonica, Kishwaukee, and Green Rivers enter the Rock River at 157.2, 130.0, and 13.0 miles from the mouth, contributing 2641, 1257, and 1131 sq miles, respectively, to the drainage area of the Rock River basin.

a) Statistical Relations: Daily flow data are available at 23 gaging stations listed in Table 8 (shown in Figure 10). The table gives the USGS number, name of the stream and gaging station, record used in analyses, drainage area A in sq mi, stream slope S in ft/mi, and length of main channel L in miles. There were 15 gaging stations (shown by asterisks in Table 8) in operation in 1984: numbers 1, 4, 7, 9, 11, 12, 13, 18, 19, 20, 21, and 23; 2 new gaging stations, a and b; and 1 station, d, which does not conform to the general hydrologic response of the region.

Flow duration values for each of the 23 stations are given in Table 9. Other pertinent hydrologic parameters such as mean flow, flow duration, drought flows at various recurrence intervals, and the 100-year flood estimates are given in Table 10.

Table 8. Stream and Continuous Gaging Stations in Rock River, and N.W. Mississippi Direct Basins

No.	USGS No.	Stream and Gaging Station	Record Oct.	Record Sep.	N	A (sq mi)	S (ft/mi)	L (mi)
1*	05414820	Sinsinawa River near Menominee	1967	1978	11	39.6	-	-
2	05415000	Galena River at Buncombe, Wisconsin	1939	1979	40	125.0	11.32	28.20
3	05415500	E.F. Galena River at Council Hill	1939	1968	29	17.6	37.30	7.45
4*	05419000	Apple River near Hanover	1934	1978	44	247.0	10.93	36.91
5	05420000	Plum R. below Carroll Ck. near Savanna	1940	1977	37	230.0	6.55	31.38
6	05435000	Cedar Creek near Winslow	1951	1971	20	1.3	40.90	2.01
7*	05435500	Pecatonica River at Freeport	1914	1978	64	1326.0	2.01	99.14
8	05437000	Pecatonica River at Shirland	1939	1958	19	2550.0	2.01	118.50
9*	05437500	Rock River at Rockton	1939	1978	39	6363.0	.84	178.14
10	05438250	Coon Creek at Riley	1961	1978	17	85.1	5.72	16.45
11*	05438500	Kishwaukee River at Belvidere	1939	1978	39	538.0	4.59	41.30
12*	05439500	S.B. Kishwaukee River near Fairdale	1939	1978	39	387.0	2.27	40.29
13*	05440000	Kishwaukee River near Perryville	1939	1978	39	1099.0	4.07	52.97
14	05440500	Killbuck Creek near Monroe Center	1939	1971	32	117.0	6.34	26.80
15	05441000	Leaf River at Leaf River	1939	1958	19	103.0	10.45	18.27
16	05441500	Rock River at Oregon	1939	1949	10	8205.0	.95	225.62
17	05442000	Kyte River near Flagg Center	1939	1951	12	116.0	5.17	17.00
18*	05443500	Rock River at Como	1934	1971	37	8755.0	1.00	266.76
19*	05444000	Elkhorn Creek near Penrose	1939	1980	41	146.0	4.28	38.97
20*	05445500	Rock Creek near Morrison	1942	1958	16	158.0	3.91	38.68
21*	05446500	Rock River near Joslin	1939	1980	41	9551.0	1.11	309.23
22	05447000	Green River at Amboy	1939	1958	19	201.0	3.85	23.63
23*	05447500	Green River near Geneseo	1936	1978	42	1003.0	2.53	80.41
a*	05437695	Keith Creek at 8th St. at Rockford						
b*	05439000	S. Br. Kiswaukee River near DeKalb						
c	New	Green River upstream of I&M Canal feeder						
d*	05448000	Mill Creek at Milan						

Note: * denotes stations active as of 1984; A - drainage area, S = stream slope, L - length of main stream, N = number of years of record

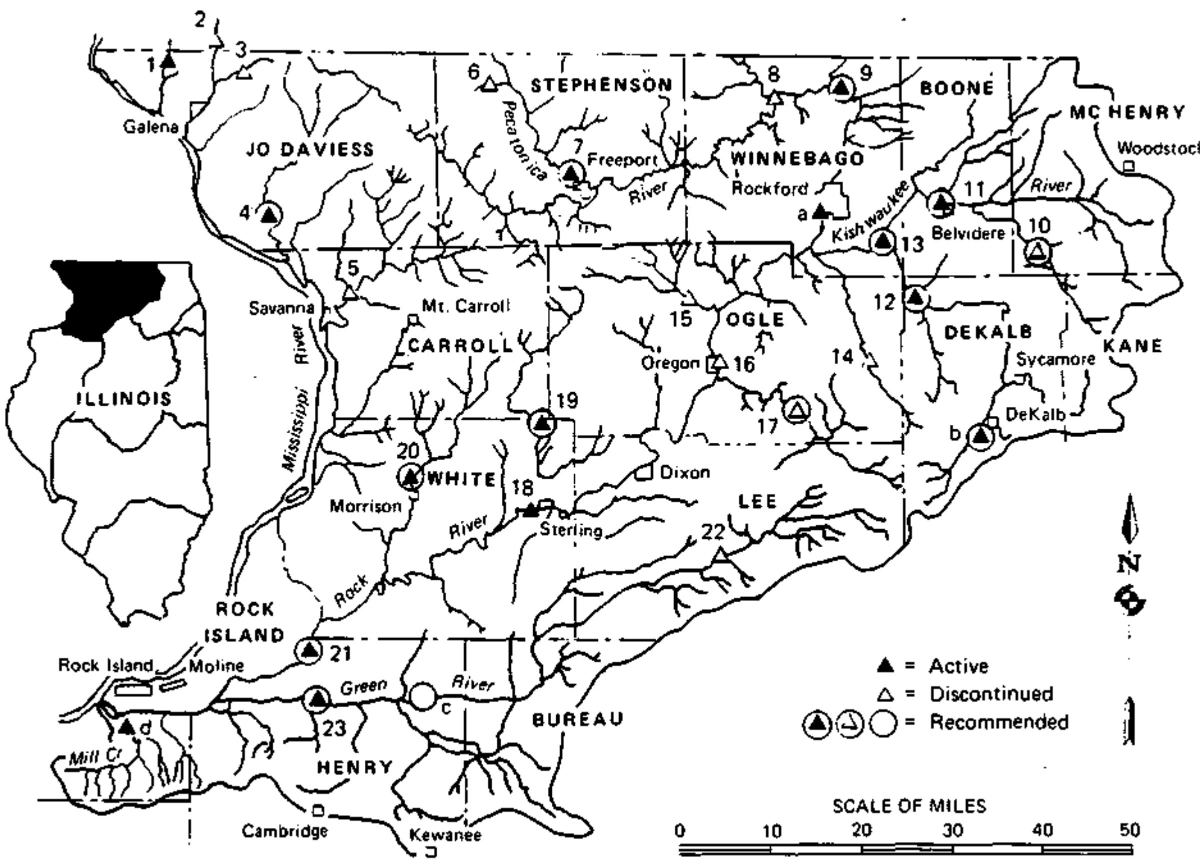

Figure 10. Rock River basin: active, discontinued, and recommended continuous gage stations

Table 9. Flow Duration: Rock River Basin

		Flow Corresponding to Percent Duration of												
No.	N	99	95	90	80	70	60	50	40	30	20	10	5	1
1	11	6.7	7.8	8.7	9.8	11	13	14	17	22	29	42	65	250
2	40	13	18	21	26	32	38	44	52	64	82	123	196	691
3	29	1.2	2.6	3.2	4.0	4.7	5.5	6.6	8.0	10	13	21	33	106
4	44	13	25	30	37	45	58	70	92	121	170	300	534	1780
5	37	11	16	19	26	35	45	62	87	116	168	300	517	1420
6	20	0	0	0	0	0	0	0.1	0.1	0.2	0.4	0.9	1.6	7.0
7	64	190	260	298	360	422	492	575	690	842	1100	1690	2650	5280
8	19	430	520	580	665	760	890	1000	1200	1450	1830	2920	4520	8600
9	39	800	1000	1160	1450	1790	2130	2580	3190	3990	5300	7640	10500	16800
10	17	3.0	4.8	6.4	9.6	14	21	29	39	56	82	140	220	525
11	39	36	50	60	81	108	140	179	225	303	438	711	1120	2430
12	39	9.1	13	16	24	38	63	100	147	214	330	612	983	2150
13	39	72	95	111	148	200	261	350	453	632	920	1500	2300	5000
14	32	3.3	4.7	5.8	8.4	11	16	23	34	46	70	120	195	654
15	19	10	13	14	18	21	25	30	37	48	63	90	127	500
16	10	1100	1370	1530	1800	2070	2440	2920	3540	4380	5620	8170	11000	20700
17	12	3.2	5.0	6.0	8.0	11	15	22	34	50	76	142	252	692
18	37	1020	1280	1500	1850	2270	2730	3350	4200	5210	6820	9500	12900	22200
19	41	15	20	23	30	36	42	50	62	78	100	156	255	944
20	16	16	18	20	24	28	33	38	46	61	83	134	250	942
21	41	1290	1570	1820	2270	2800	3430	4200	5100	6330	8310	12100	16300	26000
22	19	5.0	8.0	10	14	18	24	36	55	78	118	202	338	910
23	42	46	65	86	120	163	232	326	443	600	830	1330	1980	4180

N = number of years of record

Table 10. Some Pertinent Hydrologic Design Parameters: Rock River Basin

					Q in 10-year drought			Q in 25-yr drought			
No.	N	$\bar{Q}$	$\bar{Q}_s$	$t(\bar{Q})$	5-mo.	9-mo.	13-mo.	5-mo.	9-mo.	13-mo.	Q100
1	11	28.2	14.1	20.2	9.1	10.5	12.5	8.2	9.1	10.8	-
2	40	76.7	30.8	22.4	21.0	27.5	33.9	19.2	23.9	27.5	16500
3	29	12.3	5.1	21.8	3.5	5.0	6.0	2.7	3.4	4.3	10500
4	44	166.0	86.9	20.8	31.0	46.3	64.0	27.8	36.9	44.2	15900
5	37	146.9	81.7	23.6	19.4	36.0	55.5	16.5	28.1	38.9	13500
6	20	0.4	0.3	18.2	0.0	0.1	0.0	0.0	0.0	0.0	906
7	64	886.6	328.3	28.0	298.0	351.0	388.0	259.0	304.0	346.0	21700
8	19	1513.3	506.6	27.6	570.0	740.0	808.0	550.0	706.0	730.0	24600
9	39	3714.5	1534.5	32.9	1090.0	1423.0	1865.0	1005.0	1175.0	1550.0	36800
10	17	61.4	30.6	27.5	5.7	10.1	15.9	4.6	7.1	10.5	4500
11	39	328.9	168.7	27.9	57.0	88.2	117.0	50.5	75.9	101.0	15400
12	39	244.5	126.6	26.9	15.9	37.7	78.5	14.0	31.1	60.0	10800
13	39	672.6	332.2	28.3	105.0	175.0	263.0	96.1	156.0	215.0	25200
14	32	59.7	29.2	23.6	5.7	12.9	21.2	4.4	9.5	17.3	10400
15	19	55.8	24.1	25.0	14.6	21.1	26.5	13.9	17.8	21.2	13600
16	10	4205.1	927.4	31.5	1460.0	1930.0	2600.0	1400.0	1700.0	2260.0	59400
17	12	64.8	24.3	23.2	5.6	13.9	24.6	2.8	7.3	8.7	3860
18	37	4749.2	1558.9	34.0	1400.0	1850.0	2400.0	1290.0	1560.0	2090.0	63100
19	41	95.2	48.5	21.2	21.9	32.0	40.5	20.6	27.6	34.0	9520
20	16	85.7	29.3	19.1	23.5	31.4	41.9	22.7	30.1	40.1	5790
21	41	5873.2	2405.0	33.5	1650.0	2260.0	2850.0	1500.0	1930.0	2470.0	63100
22	19	93.0	48.9	25.4	9.5	17.2	29.4	9.1	16.6	24.4	8100
23	42	586.3	295.0	30.8	73.9	130.0	200.0	60.0	108.0	146.0	15300

Note: $\bar{Q}$ = long-term average flow in cubic feet per second, $\bar{Q}(s)$ = standard deviation of mean annual flows, $t(\bar{Q})$ = percent time the flow equals or exceeds the long-term average flow, $\bar{Q}$, Q100 = best estimate for the 100-yr flood from USGS WRI 77-117 (Curtis), and N = number of years of record

Stepwise multiple regression analyses of the hydrologic parameters as a function of basin area A, stream length L, and stream slope S indicate that inclusion of L and S in the regression equation does not significantly improve the correlation obtained by using A alone. On the basis of the preliminary analysis, log-linear regression models were derived for each of the hydrologic parameters (except for $t(\bar{Q})$, or percent time $\bar{Q}$ is equaled or exceeded, for which a semilog-linear model was used) with A as the only explanatory variable. The regression coefficients and other statistics such as adjusted R^2, standard error of estimate S_e, and the F statistic are given in Table 11 for each of the hydrologic parameters considered.

Gaging stations 1, 6, and 16 with 11, 20, and 10 years of daily flow data respectively, were dropped from the regression analyses because of the short period of record for 1 and 16 and the very small drainage area for 6. Stations 10 and 20 were also dropped from the analyses because the data at these stations did not conform to the general hydrologic response. This reduced the sample to 18. In modelling flow duration, the value of the adjusted R^2 increases from a value of 0.928 for Q(99) to 0.997 for Q(20). The adjusted R^2 values for the drought flow equations are also highly significant.

b) Sub-regional Analyses: The residuals of the regression equations for each of the hydrologic parameters were examined to determine the homogeneity of the sample. The residuals tended to cluster around 3 straight lines. These groups generally conform to the southern part of the basin, the main stem of the Rock River, and the northern part of the basin, and are designated as 1, 2, and 3 for the results of the analyses presented in Table 12. The straight lines were parallel for sub-regions 1 and 3. Three dummy variables, D_1, D_2, and D_3, were therefore used in the regression analyses.

Subregion	Intercept	Exponent	Gaging stations
1	a_1	b_1	12,14,17,22
2	$a_1 + d_1 = a_2$	$b_2 = b_1 + D_3$	7,8,9,18,21
3	$a_1 + d_2 = a_3$	$b_3 = b_1$	2,3,4,5,11,13,15,19,23

Values of a_1, a_2, a_3, b_1, and b_2 and adjusted R^2 and S_e are given in Table 12. The correlations are highly significant. The results of the sub-regional regression analyses are also presented in graphical form in Figures 11 through 17.

Table 11. Basin Regression Parameters and Statistics

$$\log(VAR) = a + b \log A + c \log L + d \log S$$

Rock River Basin

VAR	a	b	c	d	Adj R^2	S_e	F	n
$\bar{Q}$	-0.2110	0.9950			0.996	0.0466	4432.4	18
$\bar{Q}(s)$	-0.4660	0.9590			0.987	0.0828	1301.7	18
Q(99)	-1.6735	1.1865			0.928	0.2494	219.5	16
Q(95)	-1.3550	1.2548			0.923	0.2447	205.2	16
Q(90)	-1.2664	1.1201			0.929	0.2326	225.0	16
Q(80)	-1.1165	1.1072			0.942	0.2068	278.0	16
Q(70)	-1.0042	1.1041			0.957	0.1775	375.3	16
Q(60)	-0.8783	1.0966			0.971	0.1431	569.9	16
Q(50)	-0.7357	1.0845			0.984	0.1044	1047.6	16
Q(40)	-0.5781	1.0691			0.993	0.0699	2273.2	16
Q(30)	-0.4302	1.0578			0.996	0.0537	3769.5	16
Q(20)	-0.2627	1.0477			0.997	0.0449	5282.8	16
Q(10)	0.0107	1.0229			0.994	0.0611	2721.6	16
Q(5)	0.2900	0.9909			0.989	0.0777	1578.4	16
Q(1)	1.0947	0.8388			0.989	0.0672	1512.0	16
Q(5,10)	-1.2257	1.1003			0.921	0.2432	198.6	16
Q(9,10)	-0.8922	1.0512			0.961	0.1598	419.8	16
Q(13,10)	-0.6846	1.0281			0.986	0.0941	1157.2	16
Q(5,25)	-1.3732	1.1310			0.908	0.2713	168.6	16
Q(9,25)	-1.0674	1.0838			0.957	0.1738	377.5	16
Q(13,25)	-0.8878	1.0650			0.981	0.1127	866.1	16
$t(\bar{Q})$*	12.9440	5.0395			0.799	1.8932	68.7	16
Q100	3.3157	0.3355			0.682	0.1707	37.5	17

* $t(\bar{Q}) = a + b \log A$, or a semilogarithmic relation

n = number of gaging stations used in regressions

Table 12. Sub-Regional Regression Parameters

$\log(VAR) = a_i + b_i \log A;\ (i = 1,2,3)$

Rock River Basin

VAR	Regression Parameters a_1	a_2	a_3	$b_1 = b_3$	b_2	Regression Statistics Adj R^2	S_e	Sample size n
$\overline{Q}$	-0.2143	0.0060	-0.1382	0.9751	0.9374	0.998	0.0342	18
$\overline{Q}(s)$	-0.6858	-0.5389	-0.6011	1.0380	0.9683	0.992	0.0639	18
Q(99)	-1.3726	-0.4659	-0.9342	0.9056	0.8908	0.991	0.0941	16
Q(95)	-0.9933	-0.2307	-0.5346	0.8158	0.8539	0.997	0.0538	16
Q(90)	-0.9179	-0.2232	-0.4687	0.8220	0.8685	0.998	0.0404	16
Q(80)	-0.8263	-0.2367	-0.4187	0.8488	0.8955	0.998	0.0367	16
Q(70)	-0.7843	-0.2831	-0.4224	0.8931	0.9300	0.998	0.0393	16
Q(60)	-0.7326	-0.2854	-0.4360	0.9409	0.9514	0.997	0.0442	16
Q(50)	-0.6483	-0.3371	-0.4345	0.9812	0.9863	0.997	0.0482	16
Q(40)	-0.5174	-0.3110	-0.3819	1.0019	1.0029	0.998	0.0411	16
Q(30)	-0.4265	-0.2676	-0.3320	1.0296	1.0159	0.997	0.0439	16
Q(20)	-0.3060	-0.1901	-0.2636	1.0573	1.0261	0.997	0.0466	16
Q(10)	-0.0704	0.1671	-0.0733	1.0645	0.9752	0.995	0.0559	16
Q(5)	0.1825	0.6349	0.1616	1.0509	0.8900	0.995	0.0563	16
Q(1)	0.9339	1.2733	0.9462	0.9100	0.7821	0.992	0.0583	16
Q(5,10)	-0.8457	-0.0802	-0.3876	0.7831	0.8234	0.998	0.0439	16
Q(9,10)	-0.6079	-0.1830	-0.3204	0.8307	0.8821	0.998	0.0408	16
Q(13,10)	-0.4959	-0.4384	-0.3413	0.8947	0.9754	0.997	0.0466	16
Q(5,25)	-1.0600	-0.1615	-0.5458	0.8250	0.8354	0.989	0.0965	16
Q(9,25)	-0.8720	-0.1208	-0.5470	0.8912	0.8482	0.995	0.0640	16
Q(13,25)	-0.7001	-0.4129	-0.5149	0.9210	0.9515	0.995	0.0582	16
$t(\overline{Q})$*	13.0860	2.2460	12.3782	5.1793	7.9243	0.784	2.0513	16
Q100	3.6087	3.6311	3.7868	0.1549	0.2740	0.9048	0.6823	17

* $t(\overline{Q}) = a_i + b_i \log A;\ (i = 1,2,3)$, or a semilogarithmic relation

n = number of gaging stations used in regressions

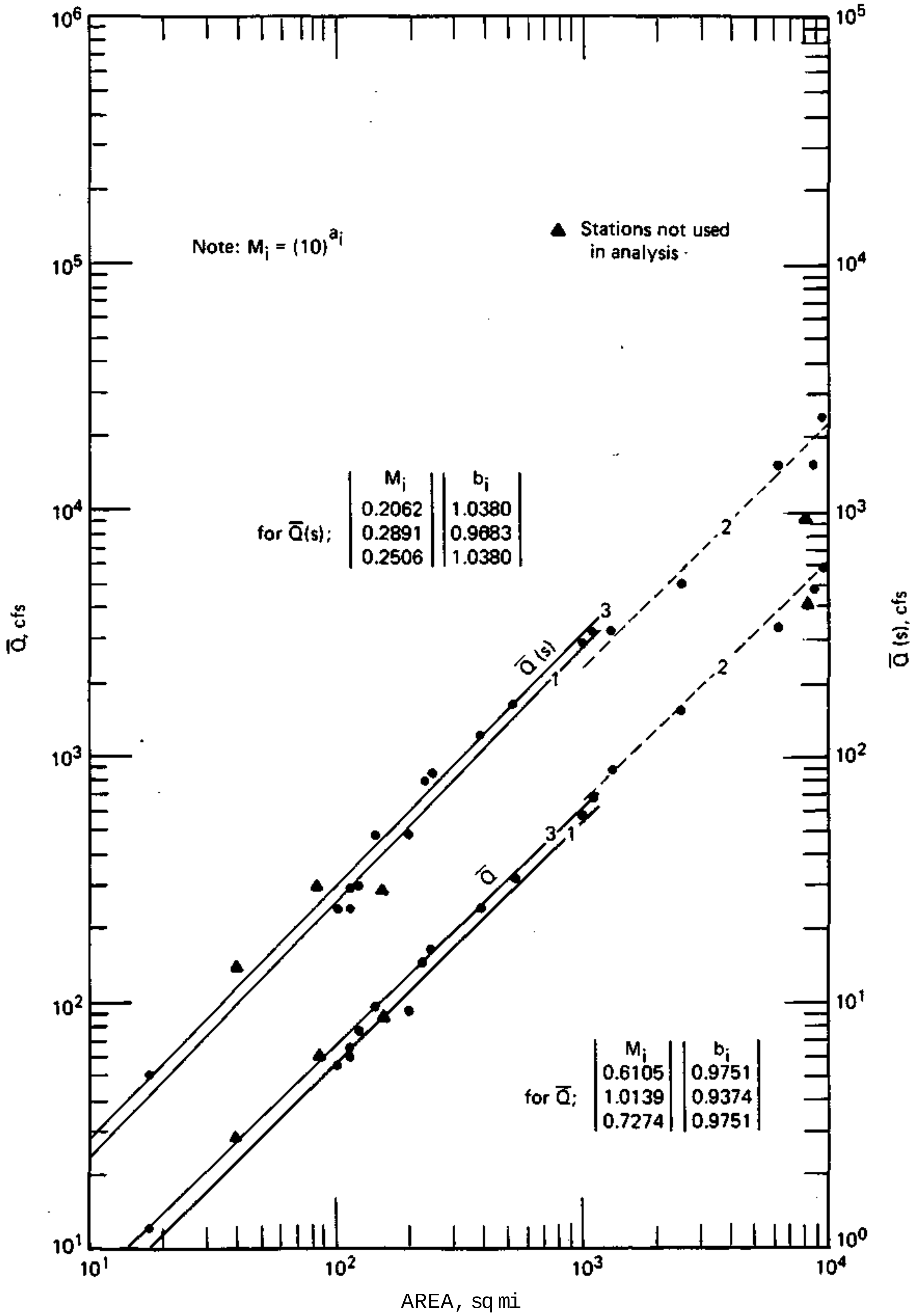

Figure 11. Rock River basin: $\bar{Q}$ and $\bar{Q}(s)$ versus drainage area curves

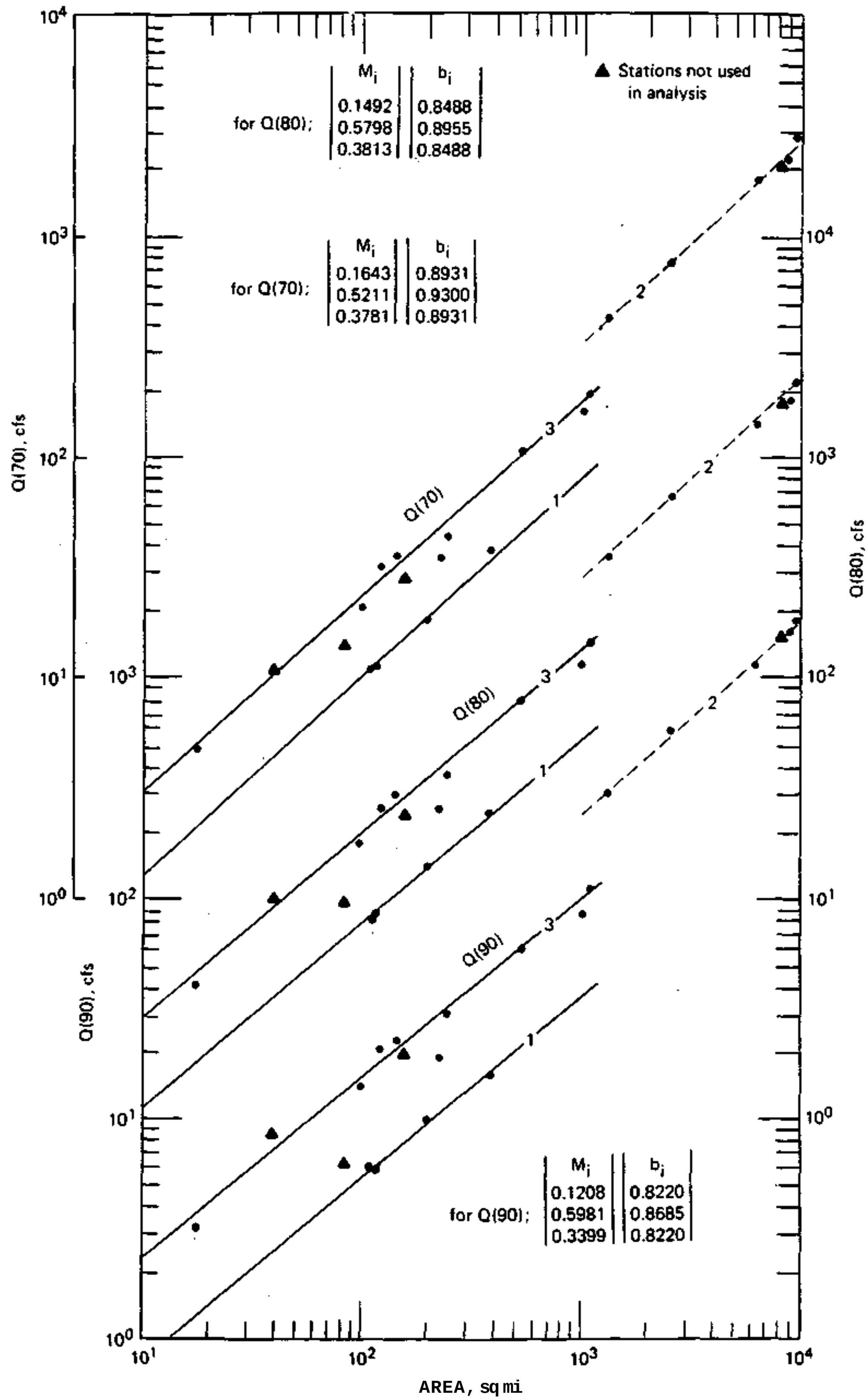

Figure 12. Rock River basin: Q(90), Q(80), and Q(70) versus drainage area curves

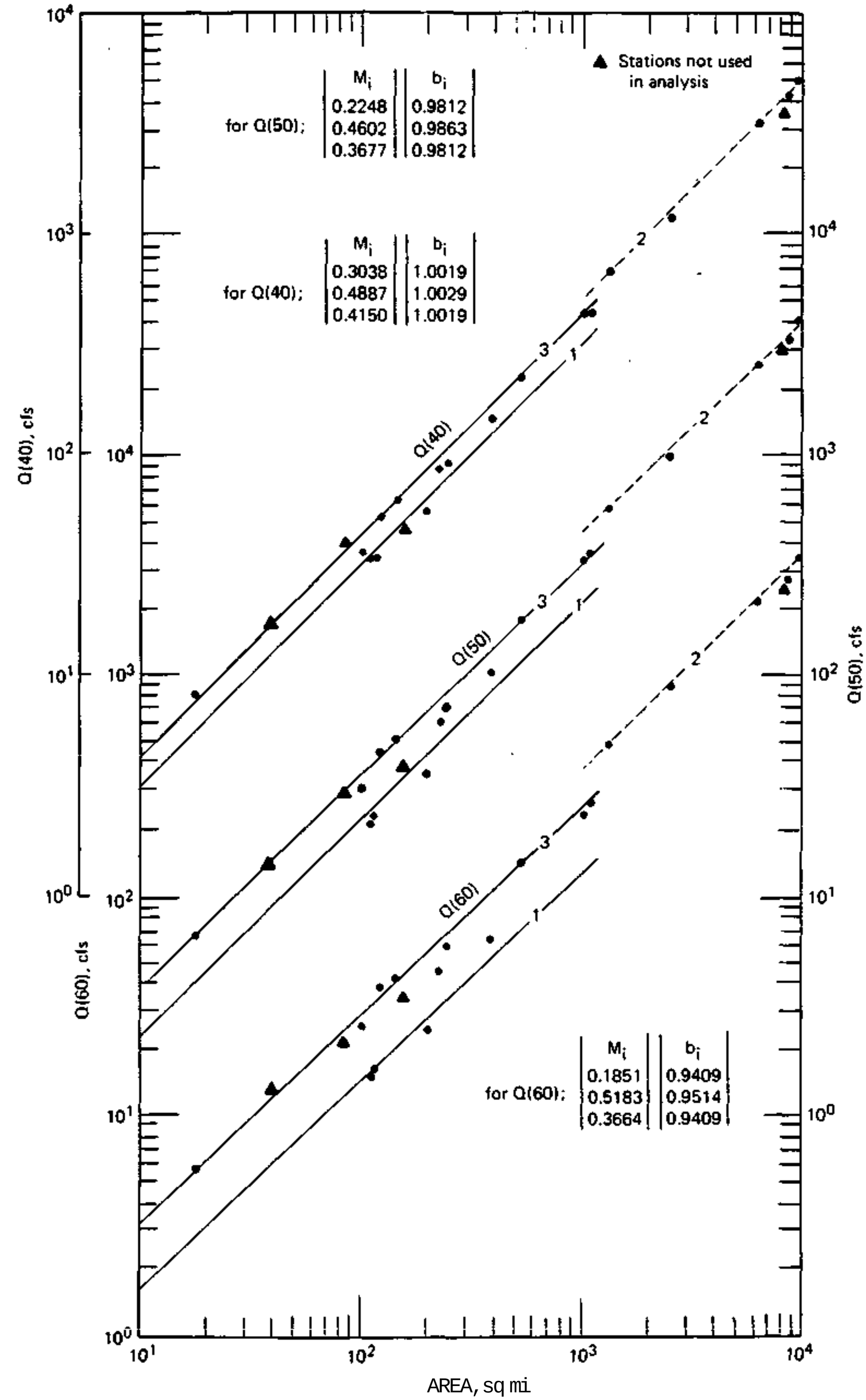

Figure 13. Rock River basin: Q(60), Q(50), and Q(40) versus drainage area curves

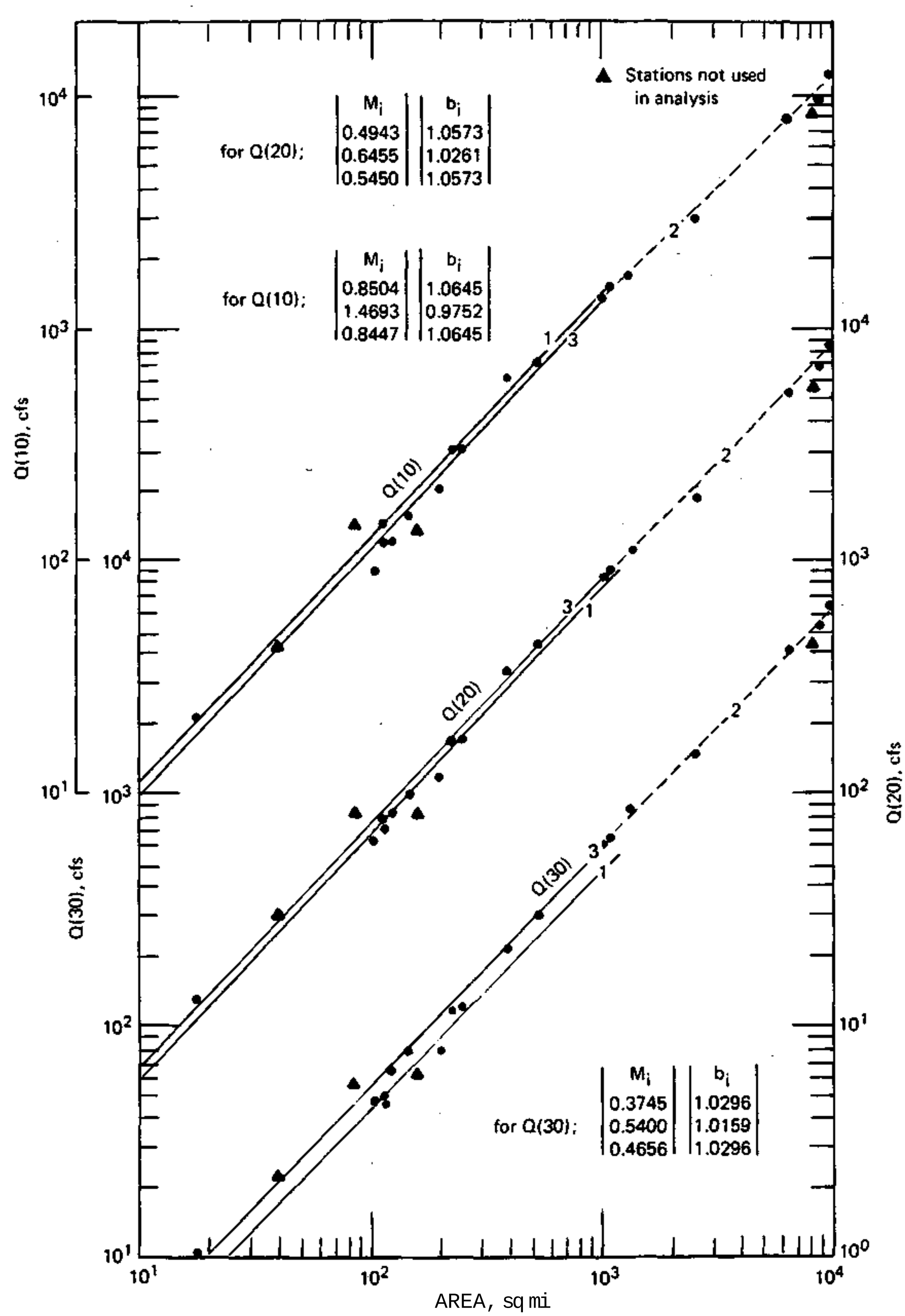

Figure 14. Rock River basin: 0(30), Q(20), and Q(10) versus drainage area curves

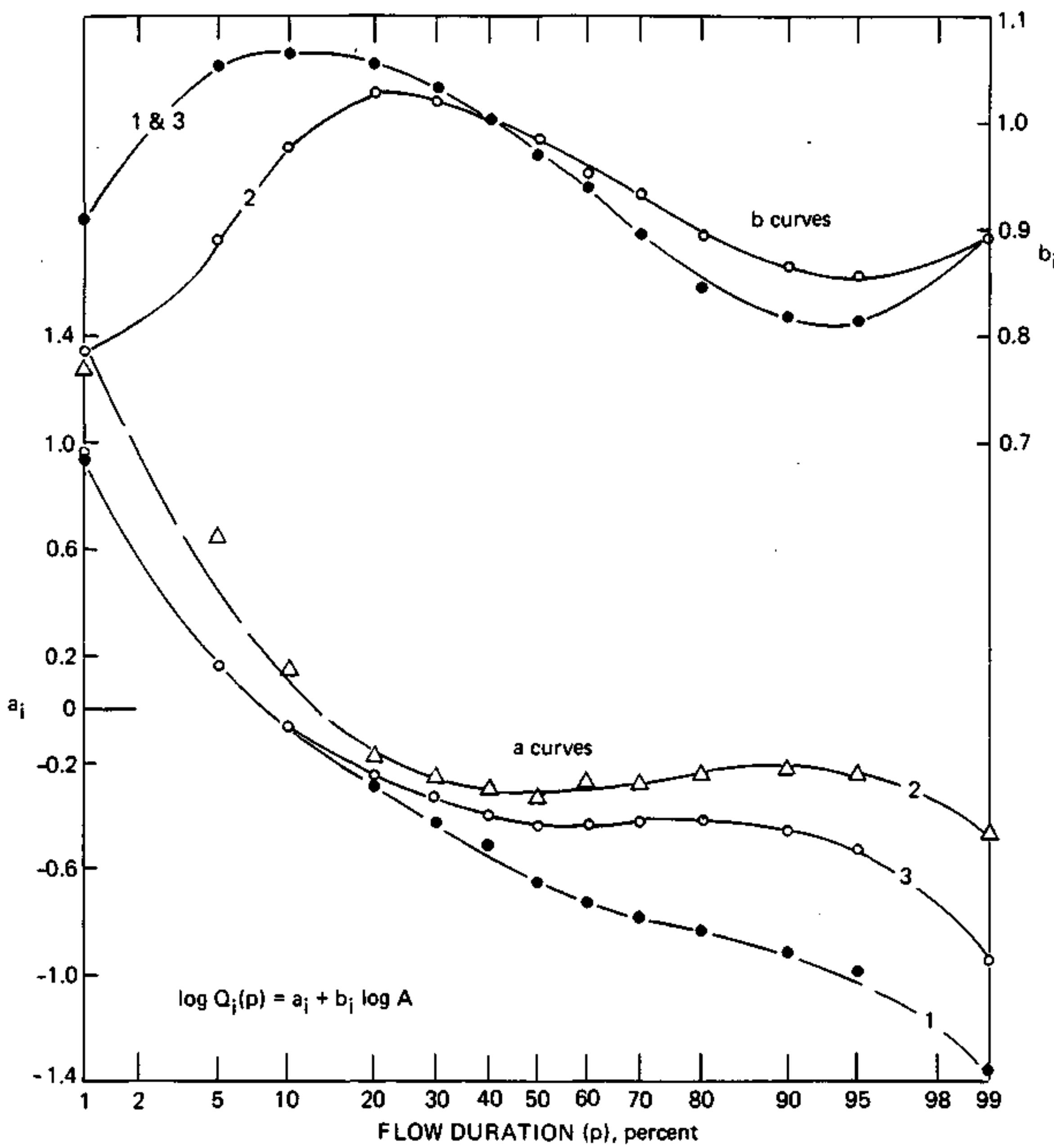

Figure 15. Rock River basin: a and b versus flow duration curves

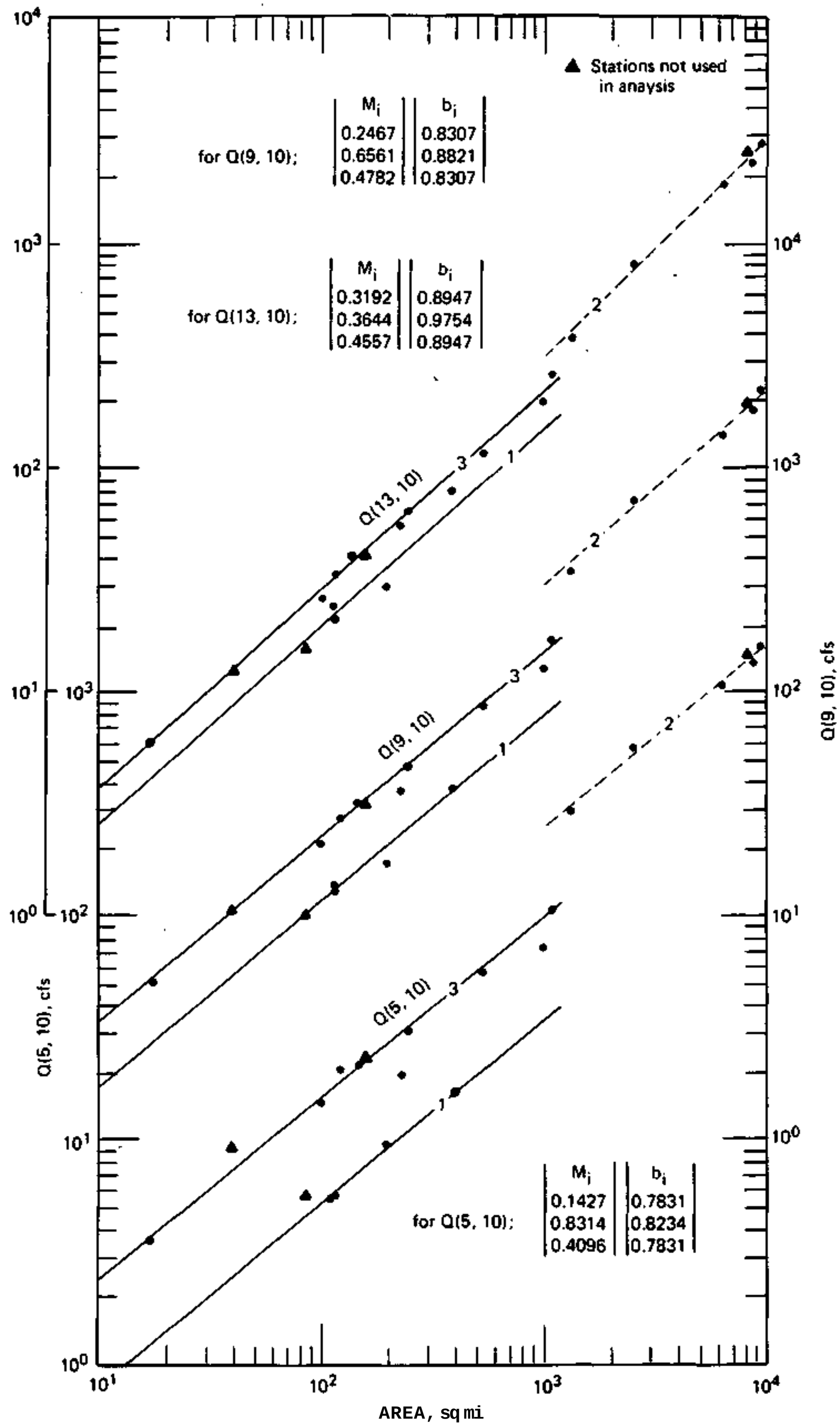

Figure 16. Rock River basin: Q{(5,9, or 13), 10} versus drainage area curves

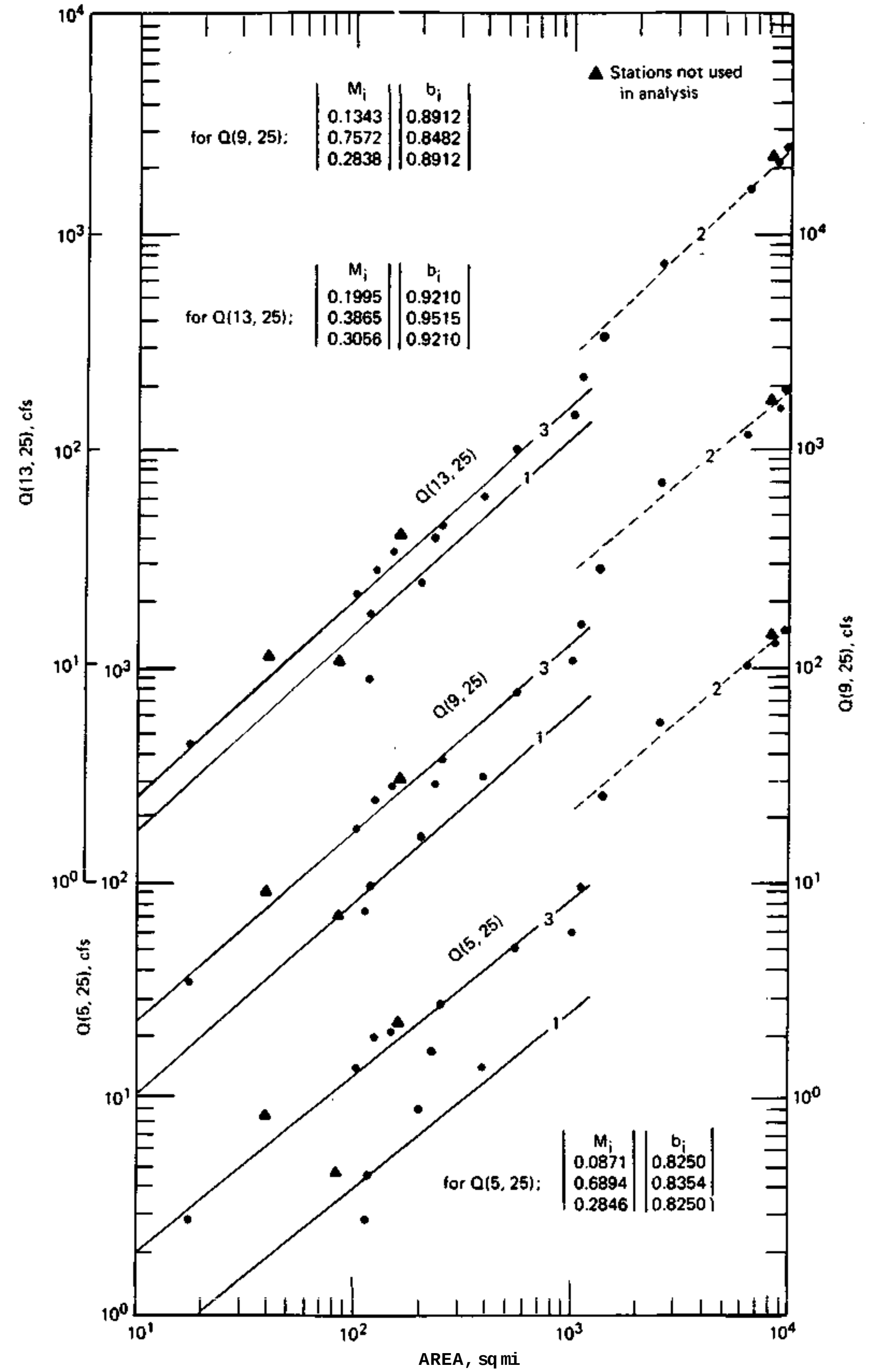

Figure 17. Rock River basin: Q{(5,9, or 13), 25} versus drainage area curves

c) Recommendations

(i) Eleven gaping stations should be retained out of the existing 15 stations:

Stations that can be discontinued are Sinsinawa River near Menominee, Keith Creek at 8th Street at Rockford, Rock River at Como, and Mill Creek at Milan. Some of these may be special purpose stations, and decisions about their continuance can be made after discussion with the U.S. Corps of Engineers, Rock Island district.

(ii) Two gaging stations should be reactivated:

These two stations are Coon Creek at Riley (presently in operation as a crest-gage station) and Kyte River near Flagg Center. These stations are needed for regional studies,

(iii) One new gaging station should be established:

Green River upstream of I & M Canal Feeder (drainage area of about 400 sq mi). The flow information for the Green River is available at Amboy (201 sq mi) and at Geneseo (1003 sq mi). For better definition of the variability in hydrologic response, flow information at an intermediate station with drainage of about 400 sq mi is needed.

4. Summary

To facilitate the regionalization of hydrologic parameters for Illinois, the state was divided into 10 regions on the basis of physiography, glacial drift thickness, and soil type. Some regions, however, are not hydrologically homogeneous because of variations in surficial soil characteristics, depth and location of water table aquifers, stream entrenchment, thickness of glacial drift, etc. Therefore, all 10 regions were investigated at length to identify any hydrologically homogeneous sub-regions within each region. In the Rock River region, for example, 3 subdivisions were identified: the main stem, northern area, and southern area. The northern area of the basin has deeper stream entrenchment and more sustained low flow than the southern area. Thus 3 subdivisions were needed to model the hydrologic response of the Rock River basin in Illinois.

The results of the general analyses, presented in Section VII, show to some extent that if the flow data at a given station are highly correlated with those at a nearby gaging station and also if more than 25 years of data are available, then one of the stations can be discontinued without significant loss of information. Some new stations need to be included to fill in some of the gaps in the present streamgaging network in order to improve the distribution of area sizes measured and to increase the geographical coverage of gaging stations.

VI. NETWORK EVALUATION: APPROACHES USED

Data use surveys by the USGS and the SWS were designed to determine the present and future needs of streamflow data for operation, planning and design, and estimation of long-term trends. The surveys were helpful in identifying stations considered to be very important (V) marginally important (M) or not important (N) by the various co-sponsors of streamgaging stations and the data users (see Table 13). The USGS survey indicates 11 active stations as marginally important and 9 as not important.

The USGS has applied the Network Analysis of Regional Information (NARI) to evaluate the representativeness of streamflow characteristics estimated through regional regression analyses. The state was divided into 15 regions for this purpose. Thirteen of these regions had drainage area as the only independent variable, and the remaining 2 regions had drainage area and slope as the independent variables. Conditional probability distributions of the true standard error were developed on the basis of the number of gaging stations in a region and the length of record. The procedure employed in the development of the conditional probabilities is based on many assumptions and uses a suitable streamflow generator. The results of the NARI analyses indicate that the accuracy of regional regression models for peak flow and 1-day mean flood volume characteristics would not be significantly improved by increasing the density of gaging stations and increasing the number of years of record. The regional analyses for 7-day 2-year and 7-day 10-year low flows, however, are considerably affected by increases in effluent discharges from various municipal and industrial wastewater treatment plants.

The Kalman Filter Analysis of Uncertainty (KFAU) was used to determine the percentage deviations in measured discharges from a long-term rating curve as well as the percent standard error, S_p. Out of a total of 138 streamgaging stations operated in 1983, the USGS has determined that values of S_p are less than 5.1% for 21 stations, 5.1 to 15% for 53 stations, 15-30% for 48 stations, and greater than 30% for 16 gaging stations. These values are more representative of low to medium discharges for which stage discharge relations are affected by transient variations in stream bed geometry, debris jams, or channel resistance. The accuracy of high discharges was evaluated qualitatively. The possibility of reduction in error by developing seasonal rating curves was not investigated.

The USGS computed the relative worth of the gaging stations operated in 1983 on the basis of 8 factors which are listed below.

Factor	Point range
1. Quantity of water (not measured elsewhere)	1 - 3
2. Areal coverage	1 - 6
3. Data accuracy	1 - 8
4. Length of record	2 - 6
5. Correlation efficiency	0 - 4
6. Diversity of interest in data	0 - 10
7. Data uses for planning	0 - 15
8. Data uses for management	0 - 15

The numerical evaluation system designed by USGS assigns points that can vary from a minimum of 5 to a maximum of 67 for any station. The higher the number of points, the more valuable the station in the network. Criteria 1 and 2 assign more points for larger drainage area streams. Criterion 5 gives more points for higher interstation correlation. A case can be made for the opposite for criterion 5 since two stations that are highly correlated give similar information. The relative spread of points for each criterion is subject to personal judgement. However, this can be a good technique for comparing the utility of streamgages in a network.

The State Water Survey approach was designed to systematically evaluate the information content at each gaging station and to develop regional regression equations as the basis for identifying candidate stations for discontinuance. The procedure employed by the State Water Survey was as follows:

1. The state was divided into 10 regions; each region included one or more drainage basins.
2. Hydrologic parameters needed in planning, design, and operation of water resource projects were identified.
3. Each region was investigated extensively for hydrologic homogeneity. Subdivision of a region into 2 or more sub-regions was done on the basis of results of regression analyses of hydrologic parameters with respect to basin characteristics (for example, Sangamon River basin). Thus hydrologic homogeneity of each region

or sub-region was achieved to the extent possible with the available flow data.

In the case of the Rock River region, which covers drainage areas in both Wisconsin and Illinois, the subdivisions of the Illinois portion correspond to the northern area, the southern area, and the main stem. The main stem of the Rock River in Illinois behaves quite differently from other tributaries draining into it.

4. The regional analyses indicate the existence of some stations which have atypical behavior compared with other stations. These stations should be retained until their behavior can be better explained in terms of relevant physical and other factors.
5. Within a hydrologically homogeneous region or sub-region, there may be a number of stations that exhibit similar behavior for some of the desired hydrologic parameters. Under these circumstances some of these stations can be discontinued since data from other stations can be used to develop satisfactory information at such stations. The decision to discontinue any station will, however, depend on the responses of co-sponsors and users regarding the usefulness of that station. If a station is being used for any project operations, it cannot be considered as a candidate for discontinuance.
6. The extensive regional analyses and the regression graphs provide some information on the distribution of drainage areas at the existing gaging stations. A uniform distribution of the drainage areas in terms of their logarithms may be the most desirable. The regression graphs indicate where new gaging stations may be needed to achieve a satisfactory areal distribution.
7. There may be a need for a limited number of new stations for specific purposes such as sediment input-output analyses, optimal reservoir operation, and research on the effects downstream of the confluence of two major streams.
8. Three levels of network have been identified. Level 1 is the desirable network which comprises gaging stations required for obtaining desirable hydrologic information. Level 2 has fewer stations than Level 1. The decrease reflects those stations that

are identified as less important and may be discontinued under moderate budgetary constraints. Level 3 is the minimal network and includes stations that are critical to the information needs of the state and should be retained even under severe fiscal constraints. The Level 2 and Level 3 networks will not be able to supply all the hydrologic information needed by various state, federal, and private agencies and citizens of Illinois.

VII. RECOMMENDED STREAMGAGING NETWORK FOR ILLINOIS

The desirable streamgaging network for Illinois has been investigated under three scenarios of financial support: Level 1 when sufficient financial support is available to maintain a network to fully meet various needs; Level 2 when there is a moderate budgetary constraint and maintenance of the Level 1 network is not possible with the available financial support; and Level 3 when there is severe budgetary constraint which leads to a minimal network. Level 2 and Level 3 networks, although designed to meet various data needs, will not be able to provide satisfactory regional information. The configuration of these networks is based on extensive regional analyses done by the State Water Survey, and on responses to USGS and SWS questionnaires.

The existing streamgaging network (as of 1984) includes 138 continuous record gaging stations (D), 25 crest-stage stations (C), and 8 stage-only stations (S). A list of D, C, and S stations with recommendations for inclusion in the network at Levels 1, 2, and 3 is given in Table 13. The need for new crest-stage and stage-only stations was not investigated. The SWS study focuses primarily on the evaluation of continuous record gaging stations. The recommended network of gaging stations at the three levels consist of currently active gaging stations, conversion of currently active crest-stage stations to gaging stations, and some new gaging stations. The recommended network is summarized below.

	Continuous gaging stations					
Level	Currently active	Conversion of C to D	New	Total	Crest-stage total	Stage-only total
1	118	6	14	138	11	8
2	114	6	11	131	6	6
3	107	0	3	110	1	6

At Level 1 there is no change in the total number of continuous gaging stations. However the recommendations call for the discontinuance of 20 currently active gaging stations, to be replaced by 20 converted and new gaging stations. This action would require a one-time expenditure of $60,000 to $80,000 of state funds for installation of new gaging stations and conversion of some crest-stage stations to continuous stations. Operational costs of the Level 1 network would not be significantly different from the existing network.

Table 13. Streamgaging Network for Illinois

Table includes continuous (D), stage (S), and crest (C) gages co-sponsored by DWR, RI, SWS, FED, LOU, and STL. Need was determined through a network analysis covering regions 1 through 10 in Illinois (Figure 1). Level 1 is the desirable network; Level 2 is acceptable under moderate budgetary constraints, and Level 3 is the minimal network. Some special purpose stations may have to be added to the list if needed.

	USGS No.	Stream and Gaging Station	Type	Area mi^2	Years	Co-Sp.	U	Purposes	1	2	3
	REGION 1										
1	05414820	Sinsinawa River near Menominee	D	39.6	68-	DWR	M				
2	05419000	Apple River near Hanover	D	247	35-	RI	V	LT,RS,FF	X	X	X
3	05435500	Pecatonica River at Freeport	D	1,326	15-	SWS	V	LT,RS,FF,WQ,SD	X	X	X
4	05437500	Rock River at Rockton	D	6,363	40-	FED	V	LT,RS,WQ	X	X	X
5	05437695	Keith Creek at 8th St. at Rockford	D	13.4	80-	RI	N				
6	05438250	Coon Creek at Riley (convert to D)	C	85.1	62-	SWS	V	FF,WQ (D+C)	X	X	
7	05438500	Kishwaukee River at Belvidere	D	538	40-	DWR	V	LT,FF,RS	X	X	X
8	05439000	S Br Kishwaukee River at DeKalb	D	77.7	80-	RI	N	RS	X		
9	05439500	S Br Kishwaukee River near Fairdale	D	387	40-	DWR	V	LT,RS,FF,WQ	X	X	X
10	05440000	Kishwaukee River near Perryville	D	1,099	40-	DWR	V	LT,RS,FF,WQ	X	X	X
11	05442000	Kyte R. near Flagg Center (reactivate as D)	D	116				RS,FF	X	X	
12	05443500	Rock River at Como	D	8,753	15-	RI	V				
13	05444000	Elkhorn Creek near Penrose	D	146	40-	DWR	V	LT,RS,FF,WQ	X	X	X
14	05446000	Rock Creek at Morrison	D	164	40-	RI	V	RS	X	X	
15	05446500	Rock River near Joslin	D	9,549	40-	RI	V	LT,RS,FF,WQ	X	X	X
16	NEW	Green River upstream of I&M Canal Feeder	D					RS,FF	X	X	
17	05447500	Green River near Geneseo	D	1,003	37-	RI	V	LT,RS,FF,WQ	X	X	X
18	05448000	Mill Creek at Milan	D	62.4	42-	RI	V				
	REGION 2 (urban area; asterisks designate stations needed by DWR for their operational needs and responsibilities)										
1	05527800	Des Plaines River at Russell	D	123	62-	DWR	V	RS,WQ,WL	X	X	X
2	05528000	Des Plaines River near Gurnee	D	232	46-	DWR	V	RS,FF,WL,UA	X	X	X
3	05528500*	Buffalo Creek near Wheeling	D	19.6	53-	DWR	V	FF,RO,UA	X	X	X
4	05529000	Des Plaines River near Des Plaines	D	360	41-	DWR	V	LT,WQ,FF,UA	X	X	X
5	05529500	McDonald Creek near Mt. Prospect	D	7.9	53-	DWR	V	RS,FF	X	X	X
6	05530000	Weller Creek at Des Plaines	D	13.2	51-	DWR	V	FF,RO,VA	X	X	X
7	05530990*	Salt Creek at Rolling Meadows	D	30.5	74-	DWR	V	FF,RO,UA	X	X	X
8	05531500	Salt Creek at Western Springs	D	114	46-	DWR	V	LT,WQ,RO,FF,UA	X	X	X
9	05532000	Addison Creek at Bellwood	D	17.9	51-	DWR	V	RO,FF,UA,WQ	X	X	X
10	05532500	Des Plaines River at Riverside	D	630	44-	SWS	V	LT,WQ,FF,UA,SD	X	X	X
11	05533000*	Flag Creek near Willow Springs	D	16.5	52-	DWR	V	RO,FF,UA	X	X	X
12	05534500	N. Br. Chicago River at Deerfield	D	19.7	53-	DWR	V	RO,FF,UA,WQ	X	X	X
13	05535000	Skokie River at Lake Forest	D	13.0	52-	DWR	V	RO,FF,UA	X	X	X
14	05535070*	Skokie River near Highland Park	D	21.1	67-	DWR	V	RO,RR,UA	X	X	X
15	05535500*	WF of N. Br. Chicago River at Northbrook	D	11.5	53-	DWR	V	RO,FF,UA	X	X	X
16	05536000	N. Br. Chicago River at Niles	D	100	51-	DWR	V	RO,FF,WQ,UA,RS	X	X	X
17	05536215	Thorn Creek at Glenwood	D	24.7	50-	DWR	V	FF,RO,WQ,UA	X	X	X
18	05536235*	Deer Creek near Chicago Heights	D	23.1	49-	DWR	V	FF,RO,UA	X	X	X
19	05536255*	Butterfield Creek at Flossmoor	D	23.5	49-	DWR	V	FF,RO	X	X	X
20	05536265*	Lansing Ditch near Lansing	D	8.8	49-	DWR	V	FF,RO,UA	X	X	X

	USGS No.	Stream and Gaging Station	Type	Area mi^2	Years	Co-Sp.	U	Purposes	1	2	3
21	05536275	Thorn Creek at Thornton	D	104	49-	DWR	V	FF,RO,UA,WQ	X	X	X
22	05536290	Little Calumet River at South Holland	D	208	48-	DWR	V	FF,RO,UA	X	X	X
23	05536340*	Midlothian Creek at Oak Forest	D	12.6	51-	DWR	V	FF,RO	X	X	X
24	05536500*	Tinley Creek near Palos Park	D	11.2	52-	DWR	V	FF,RO,UA •	X	X	X
25	05537000	Chicago Sanitary & Ship Canal at Lockport	D			DWR	V	FF,WQ,RO,OP	X	X	X
26	05537500	Long Run near Lemont	D	20.9	52-	DWR	M				
27	05539000	Hickory Creek at Joliet	D	107	45-	DWR	V	FF,WQ,UA	X	X	X
28	05539900*	West Branch DuPage River near West Chicago	D	28.5	62-	DWR	V	FF,WQ,RO,UA	X	X	X
29	05540095	West Branch DuPage River near Warrenville	D	90.4	69-	DWR	V	WQ,FF,UA	X	X	X
30	05540500	DuPage River at Shorewood	D	324	41-	DWR	V	LT,WQ,FF,RO,UA	X	X	X
31	05547000*	Channel Lake near Antioch	S		40-	DWR	V	FF,RO	X	X	X
32	05547500*	Fox Lake near Lake Villa	S		40-	DWR	V	FF,RO	X	X	X
33	05548000*	Nippersink Lake at Fox Lake	S		40-	DWR	V	FF,RO	X	X	X
34	05548200	Nippersink Creek near Spring Grove	D	192	67-	DWR	V	FF,RS,WQ,OP	X	X	X
35	05548500*	Fox River at Johnsburg	S	1,205	40-	DWR	V	FF,RO,OP	X	X	X
36	05549000	Boone Creek near McHenry	C	15.5	49-	SWS	N	(D+C)			
37	05549500*	Fox River near McHenry	S	1,250	42-	DWR	V	RO,OP	X	X	X
38	05550000	Fox River at Algonquin	D	1,403	16-	SWS	V	LT,SD,WQ,FF,RS	X	X	X
39	05550500*	Poplar Creek at Elgin	D	35.2	52-	DWR	V	RO,WQ	X	X	X
40	05551200	Ferson Creek near St. Charles	D	51.7	61-	SWS	V	SD,RS	X	X	X
41	05551700*	Blackberry Creek near Yorkville	D	70.2	61-	DWR	V	WQ,RS	X	X	X
42	05552500	Fox River at Dayton	D	2,642	15-	DWR	V	LT,FF,WQ,RS	X	X	X

REGION 3

1	05520500	Kankakee River at Momence	D	2,294	16-	SWS	V	LT,RS,FF,WQ,SD	X	X	X
2	05525000	Iroquois River at Iroquois	D	686	45-	RI	V	LT,RS,FF,WQ	X	X	X
3	05525500	Sugar Creek at Milford	D	446	49-	RI	V	WQ,RS	X	X	
4	05526000	Iroquois River near Chebanse	D	2,091	24-	DWR	V	LT,RS,FF,WQ	X	X	X
5	05527500	Kankakee River near Wilmington	D	5,150	34-	SWS	V	LT,WQ,SD,RS	X	X	X
6	05543500	Mazon River near Coal City	D	455	40-	RI	V	LT,FF,WQ,RS	X	X	X
7	05543500	Illinois River at Marseilles	D	8,259	20-	FED	V	LT,WQ,OP	X	X	X
8	05554000	N F Vermilion R. near Charlotte(convert to D)	C	186	43-	RI	V	FF,OP (D+C)	X	X	
9	05554500	Vermilion River at Pontiac	D	579	43-	DWR	V	LT,RS,FF	X	X	X
10	05555300	Vermilion River near Leonore	D	1,251	32-	SWS	V	FF,SD,RS,WQ	X	X	X
11	05558300	Illinois River at Henry	D	13,543	82-	RI	V				
12	05560500	Farm Creek at Farmdale	D	27.4	49-	RI	V	FF,RR			
13	05561500	Fondulac Creek near East Peoria	D	5.5	49-	RI	V	FF,RR			
14	05567000	Panther Creek near El Paso	C	93.9	50-	RI	M	RS (D+C)			
15	05567500	Mackinaw River near Congerville	D	767	45-	SWS	V	LT,RS,FF,WQ,SD	X	X	X
16	05568000	Mackinaw River near Green Valley	C	1,089	22-	RI	V	FF,RR (D+C)			
17	05568500	Illinois River at Kingston Mines	D	15,819	40-	DWR	V	LT,RS,WQ	X	X	X

REGION 4

1	05466000	Edwards River near Orion	D	155	41-	SWS	V	SD,RS,FF	X	X	X
2	05466500	Edwards River near New Boston	D	445	35-	DWR	V	LT,FF,WQ,RS	X	X	X
3	05467000	Pope Creek near Keithsburg	D	174	35-	RI	V	FF,RS	X		
4	05468500	Cedar Creek at Little York	C	130	41-	DWR	V	RO (D+C)			
5	05469000	Henderson Creek near Oquawka	D	432	35-	RI	V	LT,FF,RS,WQ,RO	X	X	X
6	05556500	Big Bureau Creek at Princeton	D	196	37-	RI	V	FF,RO,WQ,RS	X	X	X
7	05557000	West Bureau Creek at Wyanet	C	86.7	37-	RI	V	FF,RO,WQ (D+C)	X		

	USGS No.	Stream and Gaging Station	Type	Area mi^2	Years	Co-Sp.	U	Purposes	1	2	3
8	05557500	East Bureau Creek near Bureau	C	99.0	37-	RI	V	FF,RO,WQ (D+C)	X		
9	05563000	Kickapoo Creek near Kickapoo (convert to D)	C	119	45-	RI	V	FF,RO (D+C)	X	X	
10	05563500	Kickapoo Creek at Peoria	C	297	43-	RI	V	FF,RO (D+C)	X		
11	05568775	Spoon R. near Wyoming (reactivate as D)	D	197				RS,FF	X	X	X
12	05568800	Indian Creek near Wyoming	D	62.7	60-	SWS	V				
13	05569500	Spoon River at London Mills	D	1,062	43-	RI	V	LT,RS,FF,WQ	X	X	X
14	05570000	Spoon River at Seville	D	1,636	15-	DWR	V	LT,RS,FF,WQ	X	X	X
15	05570350	Big Creek at St. David	D	28.0	MSDGC		V		X	X	X
16	05570360	Evelyn Branch near Bryant	D	5.8	MSDGC		V		X	X	X
17	05570370	Big Creek near Bryant	D	41.2	MSDGC		V		X	X	X
18	05570380	Slug Run near Bryant	D	7.1	MSDGC		V		X	X	X

REGION 5

	USGS No.	Stream and Gaging Station	Type	Area mi^2	Years	Co-Sp.	U	Purposes	1	2	3
1	05570910	Sangamon River at Fisher	D	240	79-	DWR	V	WQ			
2	05572000	Sangamon River at Monticello	D	550	15-	SWS	V	LT,RS,FF,WQ,SD	X	X	X
3	05572500	Sangamon R. near Oakley (reactivate as D)	D	774				RS,LS	X	X	
4	05573540	Sangamon River at Route 48 at Decatur	D	938	Decatur				X	X	X
5	NEW	Flat Branch at US Hwy 51 at Moweaqua	D	109				RS	X		
6	05575500	S F Sangamon River at Kincaid	C	562	45-	RI	V	(D+C)			
7	05575800	Horse Creek at Pawnee	D	52.2	Springfield				X	X	X
8	05576000	S F Sangamon near Rochester	D	867	50-	RI	V	LT,FF,RS,RR	X	X	X
9	05576500	Sangamon River at Riverton (convert to D)	C	2,618	15-	RI	V	FF,WQ,CS (D+C)	X	X	
10	NEW	Lick Creek Trib to Lake Springfield	D					RS,LS	X	X	
11	05577500	Spring Creek at Springfield	D	107	49-	DWR	V	WQ			
12	05578000	Sangamon R. at Petersburg (reactivate as D)	D	3,063			V	RS,CS	X		
13	NEW	Salt Creek near Farmer City	D					RS	X		
14	05578500	Salt Creek near Rowell	D	335	43-	DWR	V	LT,RS,WQ,FF	X	X	X
15	05579500	Lake Fork near Cornland	D	214	49-	DWR	V	WQ			
16	05579700	Kickapoo Cr. near Heyworth (reactivate as D)	D	71.8				RS,FF	X	X	
17	05580000	Kickapoo Creek at Waynesville	D	227	49-	RI	V	RO,WQ,RS	X	X	
18	05580500	Kickapoo Creek near Lincoln	C	306	45-	DWR	V	WQ (D+C)			
19	05580950	Sugar Creek near Bloomington	D	34.4	Bloomington				X	X	X
20	05581500	Sugar Creek near Hartsburg	C	333	45-	DWR	V	(D+C)	X	X	
21	05582000	Salt Creek near Greenview	D	1,804	42-	SWS	V	LT,WQ,SD,FF,RS	X	X	X
22	05583000	Sangamon River near Oakford	D	5,093	40-	RI	V	LT,FF,WQ,RS,CS	X	X	X

REGION 6

	USGS No.	Stream and Gaging Station	Type	Area mi^2	Years	Co-Sp.	U	Purposes	1	2	3
1	05495500	Bear Creek near Marcelline	D	349	45-	RI	V	LT,RS,FF,WQ,RO	X	X	X
2	05502020	Hadley Creek near Barry	C	40.9	55-	DWR	V	(D+C)			
3	05502040	Hadley Creek at Kinderhook	D	72.7	40-	RI	V		X		
4	05512500	Bay Creek at Pittsfield	D	39.4	40-	FED	M	LT,RS,RO,FF	X	X	X
5	05513000	Bay Creek at Nebo	D	161	40-	RI	V		X		
6	05584400	Drowning Fork at Bushnell	C	26.3	61-	SWS	N	FF (D+C)	X	X	
7	NEW	La Moine River at US 136	D					RS,FF	X	X	X
8	05584500	La Moine River at Colmar	D	655	45-	RI	V	LT,FF,SD,WQ,RS	X	X	X
9	05584500	La Moine River at Ripley	D	1,293	22-	SWS	V	LT,FF,SD,WQ,RS	X	X	X
10	05585500	Illinois River at Meredosia	D	26,028	39-	STL	V	LT,FF,WQ,OP	X	X	X
11	05586000	N F Mauvaise Terre Creek near Jacksonville	C	29.1	50-	DWR	N	(D+C)			
12	05586500	Hurricane Creek near Roodhouse	C	2.3	51-	STL	V	(D+C)			

	USGS No.	Stream and Gaging Station	Type	Area mi²	Years	Co-Sp.	U	Purposes	1	2	3
13	NEW	Macoupin Creek at Macoupin-Jersey Line	D				V	RS,FF	X	X	X
14	05587000	Macoupin Creek near Kane	D	868	41-	DWR	V	LT,RS,FF,WQ	X	X	X

REGION 7 (asterisks designate stations needed by STL for operation of Shelbyville and Carlyle Lakes and operation of navigation channel)

	USGS No.	Stream and Gaging Station	Type	Area mi²	Years	Co-Sp.	U	Purposes	1	2	3
1	05587900	Cahokia Creek at Edwardsville	D	212	70-	DWR	V	CS,WQ,RO	X	X	
2	05588000	Indian Creek at Wanda	D	36.7	41-	SWS	N				
3	05589500	Canteen Creek at Caseyville	C	22.6	40-	SWS	M				
4	05590000	Kaskaskia Ditch at Bondville	D	12.4	49-	SWS	N	RS	X		
5	05590800	Lake Fork at Atwood	D	149	73-	DWR	M				
6	05591200*	Kaskaskia River at Cooks Mills	D	473	71-	STL	V	RS,OP,RO	X	X	X
7	05591550*	Whitley Creek near Allenville	D	34.6	80-	STL	V	OP,RO	X	X	X
8	05591700*	West Okaw River near Lovington	D	112	80-	STL	V	OP,RO	X	X	X
9	05592000*	Kaskaskia River at Shelbyville	D	1,054	41-	STL	V	LT,FF,OP,RS	X	X	X
10	05592050*	Robinson Creek near Shelbyville	D	93.1	80-	STL	V	OP,RO	X	X	X
11	05592100*	Kaskaskia River near Cowden	D	1,330	71-	STL	V	OP,RS,WQ	X	X	X
12	05592500	Kaskaskia River at Vandalia	D	1,940	15-	STL	V	LT,FF,RO,OP,RS	X	X	X
13	05592600*	Hickory Creek near Bluff City	S	77.6	80-	STL	V	OP,RO,WQ	X	X	X
14	05592800*	Hurricane Creek near Mulberry Grove	D	152	71-	STL	V	OP,RO,WQ	X	X	X
15	05592900*	E F Kaskaskia River near Sandoval	D	113	80-	STL	V	OP,RO,WQ	X	X	X
16	05593000	Kaskaskia River at Carlyle	D	2,719	39-	STL	V	LT,FF,OP,RS			
17	05593520	Crooked Creek near Hoffman	D	254	75-	DWR	V				
18	05593575	L. Crooked Creek near New Minden	D	84.3	68-	DWR	M	RS,FF	X	X	
19	05593600	Blue Grass Creek near Raymond	C	17.3	61-	SWS	N	FF (D+C)	X		
20	NEW	Shoal Creek at Montgomery/Bond County Line	D	300				RS,FF	X	X	
21	05593900	E F Shoal Creek near Coffeen	D	55.5	64-	SWS	M	RS	X	X	
22	05594000	Shoal Creek near Breese	D	735	46-	DWR	V	LT,FF,RS,WQ	X	X	X
23	05594100	Kaskaskia River near Venedy Station	D	4,393	70-	DWR	V	FF,RS,OP	X	X	
24	05594450	Silver Creek near Troy	D	154	67-	DWR	V	RS,WQ,FF	X	X	X
25	05594800	Silver Creek near Freeburg	D	464	71-	STL	V	RS,FF,RO	X	X	X
26	05595200	Richland Creek near Hecker	D	129	70-	STL	V		X	X	X

REGION 8

	USGS No.	Stream and Gaging Station	Type	Area mi²	Years	Co-Sp.	U	Purposes	1	2	3
1	03336150	Big Four Ditch above Paxton(reactivate as D)	D	151				RS,FF,WQ	X	X	
2	03336645	M.F. Vermilion River above Oakwood	D	432	79-	DWR	V	RS,FF,WQ,SD	X	X	
3	03336900	Salt Fork near St. Joseph	D	134	59-	SWS	V	RS,WQ,SD	X	X	X
4	03337000	Boneyard Creek at Urbana	D	4.5	49-	SWS	V	UH	X	X	X
5	03339000	Vermilion River near Danville	D	1,290	29-	SWS	V	LT,FF,RS,WQ	X	X	X
6	03343400	Embarras River near Camargo	D	186	61-	SWS	M	RS,FF	X	X	X
7	03344000	Embarras River near Diona	C	919	71-	LOU	V	WQ,FF (D+C)	X		
8	03344500	Range Creek near Casey	C	7.6	51-	SWS	M	(D+C)			
9	03345500	Embarras River at Ste. Marie	D	1,516	15-	SWS	V	LT,RS,FF,SD	X	X	X
10	03346000	N.F. Embarras River near Oblong	D	318	41-	DWR	V	LT,RS,FF	X	X	X

REGION 9 (asterisks designate stations needed by LOU)

	USGS No.	Stream and Gaging Station	Type	Area mi²	Years	Co-Sp.	U	Purposes	1	2	3
1	03378000	Bonpas Creek at Browns	D	228	41-	DWR	V	LT,RS,FF,WQ	X	X	X
2	03378635	L. Wabash River near Effingham	D	240	67-	DWR	V	RS,FF,WQ	X	X	X
3	03378900*	L. Wabash R. at Louisville (convert to D)	C	745	66-	LOU	V	(D+C),RS,FF	X	X	
4	03379500	L. Wabash River below Clay City	D	1,131	15-	SWS	V	LT,RS,FF	X	X	X

	USGS No.	Stream and Gaging Station	Type	Area mi²	Years	Co-Sp.	U	Purposes	1	2	3
5	03380475	Horse Creek near Keenes	D	97.2	60-	SWS	M				
6	03380500	Skillet Fork at Wayne City	D	464	29-	LOU	V	LT,RS,FF,WQ	X	X	X
7	03381500	L. Wabash River at Carmi	D	3,102	40-	DWR	V	LT,RS,FF	X	X	X

REGION 10 (asterisks designate stations needed by LOU and STL)

	USGS No.	Stream and Gaging Station	Type	Area mi²	Years	Co-Sp.	U	Purposes	1	2	3
1	03382100	S.F. Saline River near Carrier Mills	D	147	66-	LOU	V	RS,FF,WQ	X	X	X
2	NEW	N.F. Saline R. below Saline/Gallatin line	D	200				RS,FF	X	X	
3	03384450	Lusk Creek near Eddyville	D	42.9	68-	DWR	V	RS,FF,SD,WQ	X	X	X
4	03385000*	Hayes Creek at Glendale	C	19.1	50-	LOU	N	(D+C)	X	X	X
5	03612000	Cache River at Forman	D	244	25-	LOU	V	LT,RS,FF,WQ	X	X	X
6	05595700*	Big Muddy River near Mt. Vernon	S	71.9	80-	LOU	V		X		
7	05595730*	Rayse Creek near Waltonville	D	88.0	80-	STL	V		X		
8	05595830*	Casey Fork at Route 37 near Mt. Vernon	S	87.7	80-	STL	V		X		
9	05597000	Big Muddy River at Plumfield	D	794	15-	STL	V	LT,RS,FF,WQ,OP	X	X	X
10	05597280	Little Muddy R. near Elkville (convert to D)	D	213				RS,FF	X	X	
11	05597500	Crab Orchard Creek near Marion	D	31.7	52-	DWR	V	RS,FF,WQ	X	X	
12	05599500	Big Muddy River at Murphysboro	D	2,169	17-	STL	V	LT,RS,FF	X	X	X
13	05600000	Big Creek near Wetaug	C	32.2	41-	DWR	V	RS,FF	X	X	

C = crest gage
D = continuous gage
D+C = D converted to C
S = stage gage
U = importance of the gaging station as perceived by respondents to the USGS survey
V = very important
M = marginally important
N = not important

Co-sponsors: DWR = Division of Water Resources; RI = Rock Island District; STL = St. Louis District; LOU = Louisville District; SWS = State Water Survey; FED = Federal
MSDGC = Metropolitan Sanitary District of Greater Chicago

Purposes: LT = Long-term and benchmark; FF = flood frequency and flood forecast; RS = regional study; SD = sediment load; RO = rainfall-runoff relations; RR = reservoir regulation; OP = operation; WQ = water quality; UA = urbanizing area; UH = urban hydrology; WL = wetland study; CS = chemical sampling; LS = lake studies; and ROP = reservoir operation Shelbyville-Carlyle lakes.

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USE OF STRKAM MEASUREMENTS

QUESTIONNAIRE

Section 1 — Historical Data

1. Does your firm/agency use historical records of the following data?

Stream flow	____Yes	____No
Stream stage	____Yes	____No
Sediment load	____Yes	____No
Streamwater quality	____Yes	____No

(If no to all the above, please skip to question 12)

2. What are the sources of your data?

Streamflow	________	________
Stream stage	________	________
Sediment load	________	________
Streamwater quality	________	________
Others (please specify)	________	________

3. How is the above information used?

Hydrologic design	________
Hydraulic design	________
Operating decisions	________
General background	________
Others (please specify)	________

4. What type of data do you use? (Please check appropriate columns)

	Streamflow	Stream stage	Sediment	Water quality
Daily	____	____	____	____
Weekly	____	____	____	____
Monthly	____	____	____	____
Seasonal	____	____	____	____
Yearly	____	____	____	____

5. What specific data sets do you use and for what purpose?

a. ________ for ________

b. ________ for ________

c. ________ for ________

d. ________ for ________

e. ________ for ________

6. What specific products do you use and for what purpose?

a. flow duration, for

b. floods of specified frequency, for

c. peak stages, for

d. annual lake sedimentation, for

e. water quality statistics, for

f. monthly flow statistics, for

g. annual flow statistics, for

h. sediment load statistics, for

i. drought statistics, for

j. 7-day 10-year low flow, for

k. others (please specify)

7. How often should products such as those above be updated?

8. Do you prefer to use available products or develop them from the raw data yourself?

9. Does Information on historical maximum and minimum values help you in making decisions?

Maximum/Minimum	for which decision
a. Daily flow	______
b. Peak annual flow	______
c. Lowest annual flow	______
d. Annual flow	______
e. Annual sediment yield	______
f. Water quality parameters (please specify)	
i. ______	______
ii. ______	______
iii. ______	______
iv. ______	______
g. Other	

10. Do you compile point/basin data for regional analysis?

______ Yes ______ No

If yes, what data do you compile? Please specify.

a. ______

b. ______

c. ______

d. ______

11. What is the availability of products and/or data you wish to use?

Product	Data	Source	Percent time available <25	25-75	>75
______	______	______	______	______	______
______	______	______	______	______	______
______	______	______	______	______	______
______	______	______	______	______	______

12. If you do not use relevant historical data for making decisions or for design, check the statements below with which you agree.

a. Data not easily available ______ Yes ______ No

b. Too costly to convert data to usable products ______ Yes ______ No

c. Spatial distribution of data inadequate ______ Yes ______ No

d. Other reasons (please specify) ______

______

13. What data would you like to use that are not readily available now?

a. ______

b. ______

c. ______

d. ______

14. What produces (e.g., flow duration, sediment load, water quality statistics, etc.) would you like to use that are not readily available now?

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

15. Is there some way in which stream measurements, discussed above, could be made more useful to you?

Section 11 — Current Information and Forecasts

16. Does your firm/agency use current information on the following?

Streamflow	____ Yes	____ No
Stream stage	____ Yes	____ No
Sediment load	____ Yes	____ No
Streamwater quality	____ Yes	____ No

(If no to all the above, please skip to question 22)

17. What are the sources of your current information?

Streamflow	________	________
Stream stage	________	________
Sediment load	________	________
Streamwater quality	________	________

18. How is the above information used?

Hydrologic design	________
Hydraulic design	________
Operating decisions	________
General background	________
Others (please specify)	________

19. What current information do you use and what are the specific purposes for which you use it?

	Type of information		Purpose
a.	________	for	________
b.	________	for	________
c.	________	for	________
d.	________	for	________

20. What is the availability of information you wish to use?

Usable information	Agency	Percent time available		
		<25	25-75	>75
________	________	____	____	____
________	________	____	____	____
________	________	____	____	____
________	________	____	____	____

21. How timely must current information be for your use?

22. If you do not use current information in your work or decisions, check the statements with which you agree.

a. Information not easily available ______ Yes ______ No

b. Information not timely ______ Yes ______ No

c. Information too costly to process ______ Yes ______ No

d. Spatial distribution inadequate ______ Yes ______ No

e. Other reasons (please specify)

23. What Information and in what format **would** be most valuable to you?

	Information	Format
a.	______	______
b.	______	______
c.	______	______
d.	______	______

24. What short term forecasts would be most valuable to you? Please specify.

a. ______

b. ______

c. ______

d. ______

25. What accuracy of forecasts would be satisfactory to you? A measure of accuracy may be considered as the variation of the forecast from the event when it occurs, expressed as a fraction of the observed event.

Measure				
$\pm$ 0.2	______ Poor	______ Fair	______ Good	______ Very good
$\pm$ 0.4	______ Poor	______ Fair	______ Good	______ Very good
$\pm$ 0.6	______ Poor	______ Fair	______ Good	______ Very good

26. Is there some way in which current Information, discussed above, could be made more useful to you?