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SANGAMON RIVER BASIN STREAMFLOW ASSESSMENT MODEL: HYDROLOGIC ANALYSIS

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INTRODUCTION

As the demand for water in Illinois increases, it is becoming increasingly important that streamflow conditions, and low flow conditions in particular, be well managed not only to allow for protection of the natural environment of a stream, but also to ensure that enough water is available for users during periods of low flow. Many state policies and tools for water resources planning (both existing and in the making) are dependent upon the evaluation of certain flow values at a given point of interest. Without reliable estimates of water availability a water resources planner cannot properly evaluate any type of water management scheme. The Illinois Streamflow Assessment Model was developed to provide the needed standard of information for streams in the state.

The "Streamflow Assessment Model" has two components, 1) the algorithms developed in this study which are used to estimate streamflow statistics for any location along a stream in the state, and 2) the computer program which is used to perform the algorithms and present the streamflow information to a user. The purpose of this report is to present the methodologies used to develop the algorithms which describe the variation of streamflow statistics in the Sangamon River Basin in Illinois. The Sangamon Basin is the pilot basin for this model and, as such, extra attention is given to describe some of the special aspects associated with the hydrologic analyses. The computer program, which is user-interactive and written for a personal computer, is described in a previous report Streamflow Assessment Model for the Sangamon River Basin in Illinois: User's Manual by Knapp, et al. (1985). Though the streamflow estimation algorithms presented in the present report can be applied without use of the computer program, this is not advised because in many cases a great number of flow components are involved.

General Use of the Model

The Streamflow Assessment Model produces information on 178 selected flow parameters, including flow duration (flow versus percentage-of-duration) relationships as well as both low flows and high flows for various durations and expected return intervals. The 178 flow parameters produced by the model are listed below.

Annual Flow-Duration Values (percent probability of exceedance, for example Q02 = the flow exceeded only 2% of the time)
Qmean (mean flow), Q99, Q98, Q95, Q90, Q85, Q75, Q60, Q50, Q40, Q25, Q15, Q05, Q02, Q01

Monthly Flow Duration Values (Probability of exceedance, for each month of the year)
Qmean, Q98, Q90, Q75, Q50, Q25, Q10, Q02

Low Flows (average flow rate over the given duration)
Durations: 1-day, 7-day, 15-day, 31-day, 61-day, 91-day
Return Intervals: 2 years, 10 years, 25 years, 50 years

Drought Flows (average flow rate)
Durations: 6-month, 9-mo., 12-mo., 18-mo., 30-mo., 54-mo.
Return Intervals: 10 years, 25 years, 50 years

High Flows (average flow rate)
Durations: 1-day, 7-day, 15-day, 31-day, 61-day, 91-day
Return Intervals: 2 years, 10 years, 25 years, 50 years

In order to obtain information on one or any number of the above flow parameters, the user is required to 1) identify the desired flow parameter(s), 2) enter information which will locate the point of interest in the basin, and 3) specify a reach of points for which output is also given. The flow parameters are presented for both present flow conditions and virgin conditions (the flow expected if the major withdrawals and discharges were removed from the basin). The concept of virgin flow is further described below. In addition, the user of the model may introduce a hypothetical (or potential) withdrawal/discharge and estimate its effect on the specified flow parameters. Flow conditions may be estimated for any gaged or ungaged site in the watershed having a drainage area of at least ten square miles.

Hydrologic Concepts of the Streamflow Assessment Model

The characteristics of streamflow in any moderately developed watershed will, over time, vary from earlier conditions due to the cumulative effect of man's activities in the region. The degree to which the flow regime has been changed may vary greatly from one stream to another. For example, some basins with relatively minor changes in land use practice may have only subtle (and generally inestimable) variation in its streamflow characteristics. Generally, the greatest amount of streamflow modification results from more overt water use and water resource projects including:

1) reservoirs; 2) withdrawals from the stream for either irrigation or for industrial and municipal water needs; and 3) effluent discharges, primarily from the municipal and industrial uses of water. These developments, whose effect on the streamflow may be estimable, are termed "flow modifiers." More subtle modifications to the hydrology of the basin, such as changes in land use have indeterminable effects and for this reason have not been included as flow modifiers.

By isolating the effects of the flow modifiers and removing the effects from the available streamflow records, estimates can be made describing what the streamflow would be under unmodified conditions. The computation of the unmodified flow, which is termed "virgin flow," can be represented by the equation:

$$Qv = Qp - \Sigma \Delta Qmod(i) \tag{1}$$

in which: Qv = virgin flow estimate

Qp = measured or "present" flow

AQmod(i) = the change in flow due to the presence of flow modifier "i"

The virgin flows, produced by eliminating the effects of the flow modifiers, have much greater regional homogeneity than do the present flow conditions. Thus, the accuracy of the methods used to transfer the available streamflow records to ungaged sites in the basin may be vastly improved. The linear regressions shown in Figure 1 illustrate the importance of the removal of the flow modifiers before the regression analyses. In this case almost all the error associated with the regression of present flow conditions can be explained by the effect of the flow modifiers on the virgin flow conditions.

Because land use changes are not accounted, the virgin flow should be viewed as representative of the land use that existed during the period of streamflow record.

After estimating the virgin flow (for a given streamflow parameter) for an ungaged site, the present flow can be computed by 1) locating the flow modifiers which affect that site, 2) estimating the effect of the flow modifiers on the streamflow parameter of interest, and 3) reapplying Equation 1 , this time to compute the present flow condition. These final steps are an

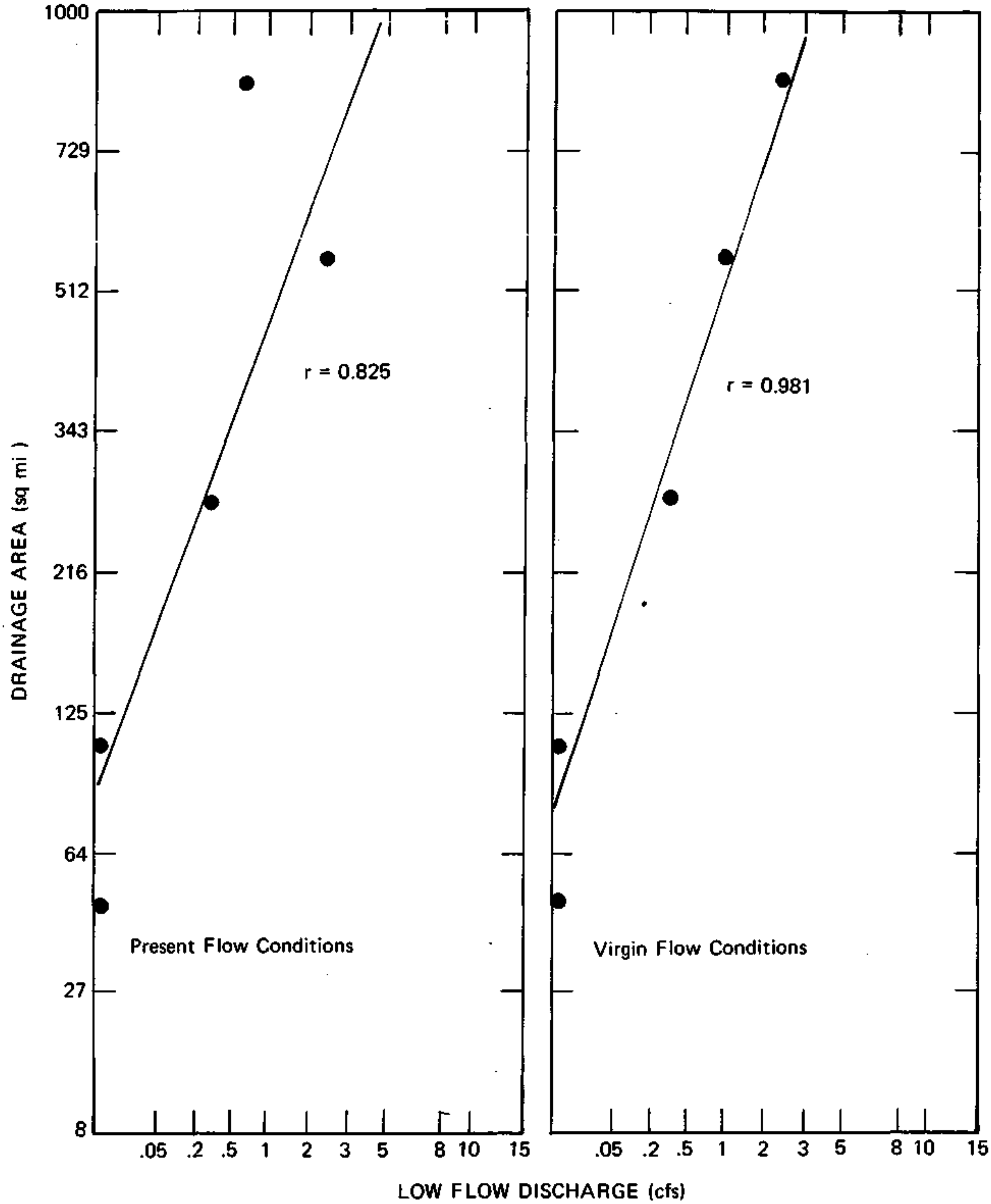

Figure 1. Effect of removing flow modifiers on the accuracy of regression: South Fork Sangamon River Basin, 60-day, 10-year low flow.

important part of the streamflow assessment model since each flow modifier must be separately evaluated and have a list of its possible effects stored within the model. However, because the effect of each of the flow modifiers is independently derived, it becomes a relatively simple process for the user of the model to introduce a new or hypothetical flow modifier and evaluate how this new modifier affects the estimated present flow conditions. In this manner a water resource planner may "trial balloon" a potential water use to determine its impact on flow in the stream system. A more detailed discussion of the use of hypothetical modifiers is presented in Knapp, et al. (1985).

DESCRIPTION OF THE SANGAMON RIVER BASIN

The Sangamon River, located in the center of Illinois (see Figure 2), is a tributary to the Illinois River having a watershed area of approximately 5420 mi^2. The Sangamon River has two major tributaries, these being the South Fork (drainage area = 883 mi^2) and Salt Creek (drainage area = 1856 mi^2). The latter drains most of the northern half of the basin.

The Sangamon River Basin is an agricultural region, being located in one of the most productive cropland areas in the United States. Virtually all the basin is cultivated and wooded areas exist only along the stream corridors. There exists little apparent vegetative variation throughout the watershed. The basin contains three metropolitan areas of prominence, these being Springfield, Decatur, and Bloomington-Normal which have populations of 100,000, 94,000, and 80,000 respectively. Some industrial activity exists in each city.

Though the Sangamon Basin is primarily agricultural, there is irrigation except in a portion of the Havana lowlands area in the western extremity of the basin. The major use of water in the Sangamon River Basin is 1) the nonconsumptive use for cooling at power plants (located at Kinkaid, Springfield, and Clinton), and 2) municipal use at the three major communities listed above. Industrial use of water does not comprise a major portion of use in the basin, though specific industries in the Decatur and Bloomington-Normal areas cumulatively employ up to 25% of their respective municipalities' total water use. These municipal water supplie rely on surface water storage for their water supply; this is necessary because

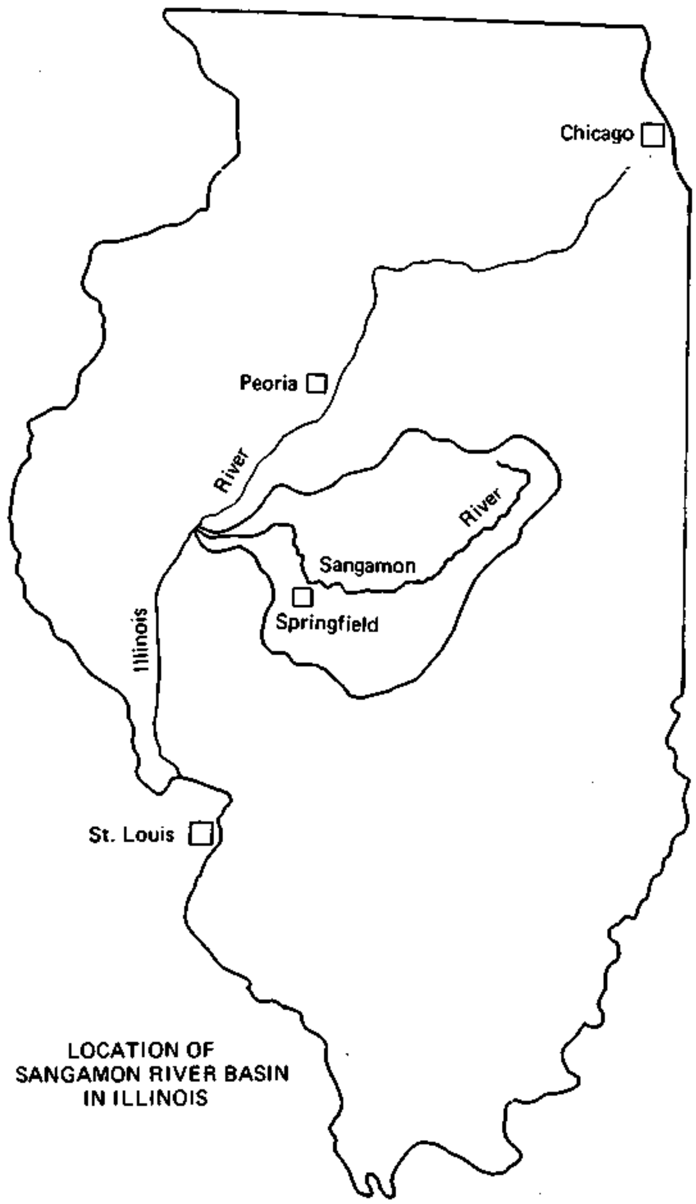

Figure 2. Location of Sangamon River Basin in Illinois.

use rate. With the exception of these major uses however, almost all of the other water uses in the basin are supplied by ground-water sources.

Precipitation

The 30-year annual average precipitation (1951-1980) for the Sangamon River Basin is approximately 37 inches. Geographically, the average annual precipitation varies only slightly from this amount, increasing from the northwestern to the southeastern portions of the basin. Though the average annual precipitation is similar across the basin, the southern portion of the basin has experienced more severe reductions in precipitation during drought years. This phenomenon is illustrated in Figure 3 which identifies the precipitation deficit (cumulative amount below normal) which occurred throughout the basin in 1953-1954, the driest consecutive years on record.

Physiography and Soils

The topography of the Sangamon River Basin is dominated by the deposition of glacial till which occurred during the Illinoian and Wisconsin glacial periods. The terrain throughout most of the watershed is flat to gently undulating topography. Generally over eighty percent of the topography is upland area having average slopes of less than 2 or 3% The local relief (within a one mile^2 area) rarely exceeds 10 or 20 feet, with exceptions along the major streams which have eroded into the depositional till. Many of these major streams acted as sluiceways for glacial outwash, including most notably the Sangamon River, Flat Branch (tributary to the South Fork), and Sugar Creek, Kickapoo Creek, and Lake Fork (tributaries to Salt Creek). Each of these streams has a noticeably wider floodplain than other streams in the basin of comparable watershed area. The total relief of the basin is approximately 485 feet, ranging from an elevation of 430 feet above mean sea level (msl) at the mouth of the Sangamon River to over 915 feet msl along the Bloomington moraine in southern McLean County.

The Sangamon watershed is divided by Leighton (1948) into two physiographic sections, these being the Bloomington Ridged Till Plain, which is of Wisconsin-age glaciation, and the Illinoisan-age Springfield Till

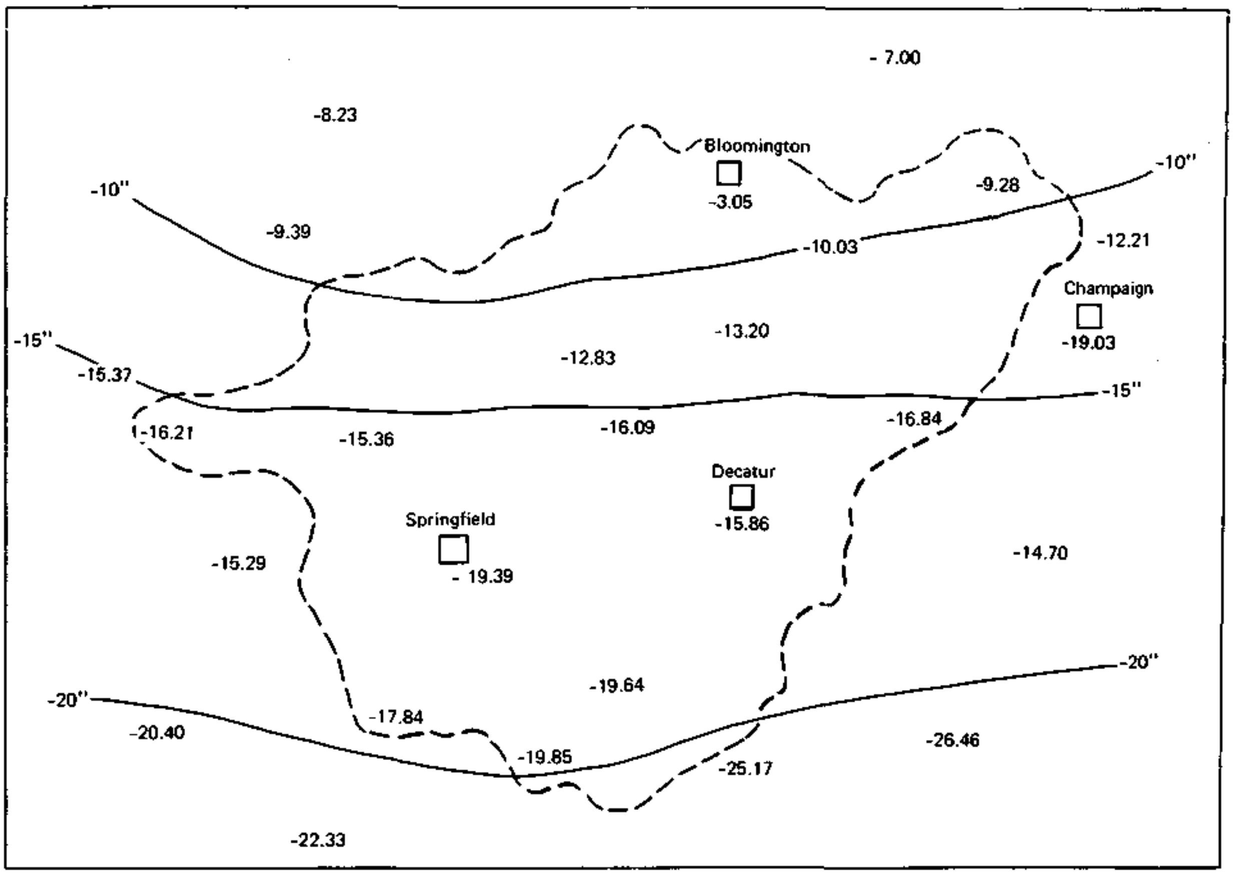

Figure 3. Departure from normal precipitation for the Sangamon River Basin, 1953-1954.

Plain. The boundary between these two sections is the Shelbyville moraine, shown in Figure 4, which marks the furthest extent of Wisconsin glaciation.

The Bloomington Ridged Plain, being of more recent glaciation, is generally less dissected by post-glacial stream erosion than is the Springfield Plain. The greatest total relief in this section results from a number of end moraines which form a series of broad ridges. The ridges, though themselves being of mild slope, provide the relief which gives streams in this region greater channel slopes than streams in other areas of the basin. Streams that flow through these ridged areas also have relatively greater entrenchment. The dominant soil types in the Bloomington Ridged Plain are the Drummer silty clay loam and Flanagan silt loam which combined cover over 60% of the area's acreage. These are generally poorly drained soils, but with moderate permeability and high water availability (Fehrenbacher, et al., 1983).

The Springfield Till Plain has a greater maturity of stream development in its upland areas than the Bloomington Ridged Plain which allows for comparatively better drainage. The total relief in this region is very small; for example the greatest elevation within the Springfield Till Plain is only 750' msl compared with the 915' msl in Bloomington Ridged Plain. This results in the streams in the Springfield Plain having very low gradients. Consequently, the uplands are low with respect to the larger streams in the section and stream entrenchment is shallow. As described later, these factors contribute to a relatively small amount of base flow and ground-water seepage to the stream. In addition, the soils in this region have higher clay content than do the soils in the Bloomington Ridged Plain, resulting in less available water and lower permeability.

For purposes of describing differences in the flow regime in this report, the physiographic sections given by Leighton are further subdivided into five regions (shown in Figure 4) and described below.

A) The Upper Sangamon region, which is essentially the flat portion of the Bloomington Ridged Plain, i.e. the area not dominated by the ridged moraines.

B) The Upper Salt Creek region, whose physiography is primarily composed of the morainic ridges, and therefore has much greater overland slope and stream entrenchment than region A.

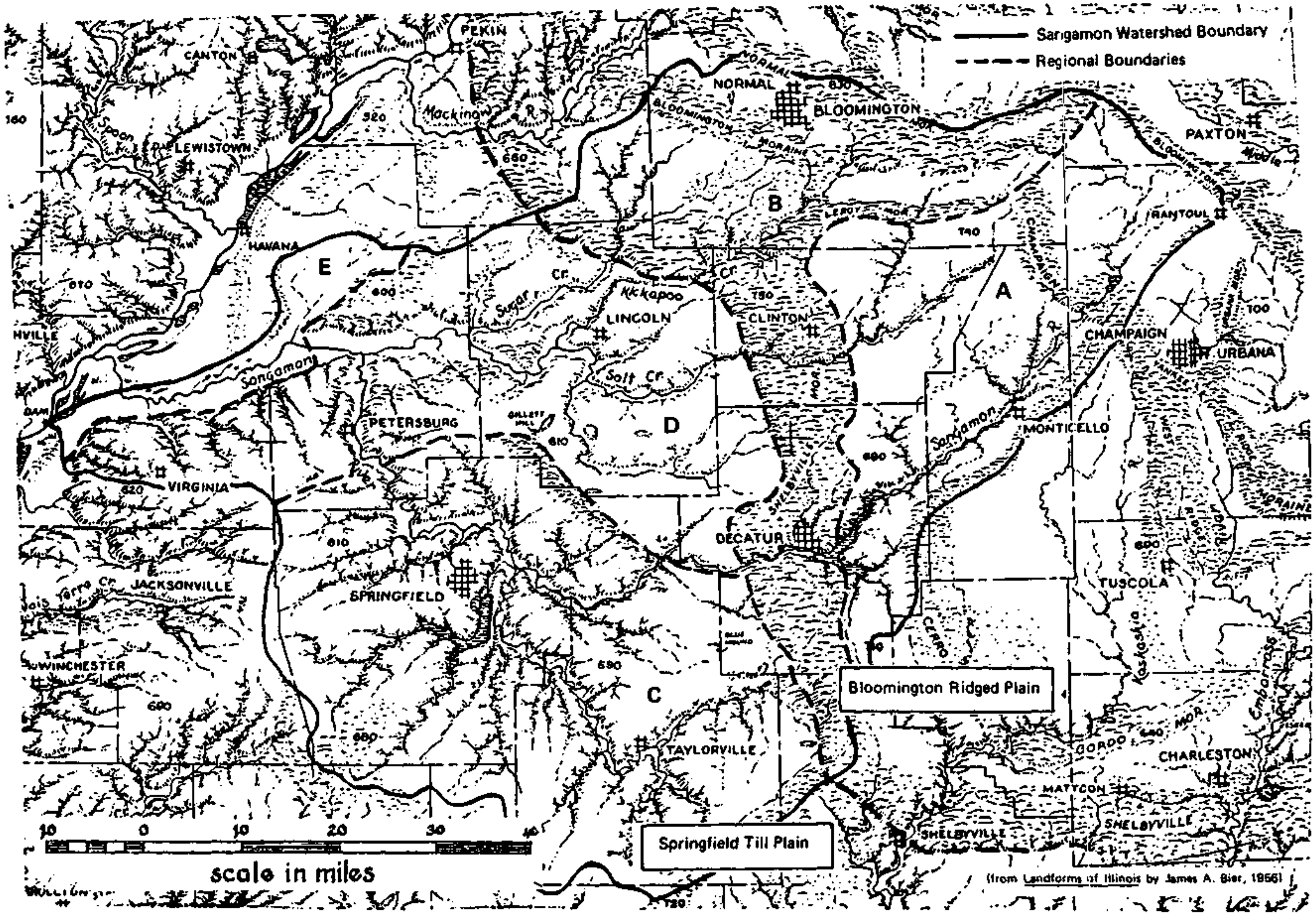

Figure 4. Landforms map of the Sangamon River Basin, showing physiographic regionalization (from Landforms of Illinois by James A. Bier, 1956).

C) The South Fork Sangamon region, which is the only major watershed within the Springfield Till Plain.

D) The Lower Sangamon Region, which is fairly similar to region C in physiography (falling within the Springfield Till Plain). It also contains the downstream portions of the Sangamon River and Salt Creek whose watersheds drain all the other previously described regions. These large streams have relatively greater entrenchment which locally provides for greater slopes.

E) The Havana Lowlands which is a broad lowlands area adjacent to the Illinois River whose surficial geology is entirely comprised of sandy, alluvial deposits resulting from glacial outwash. Because this final region is not a glacial till plain, its physiography is strongly in contrast with the other regions.

Many of the physiographic variations which influence the flow characteristics throughout the basin, such as the soil moisture availability, permeability, entrenchment, and overland slope, are often difficult to quantify. For this reason, attempts to describe the variation in streamflow from physiographic factors must rely on a few more easily determined characteristics such as the channel slope. Fortunately most of these characteristics are interrelated. For example region B, which has the steepest channel slopes, also tends to have greater entrenchment and overland slopes as well as soils with more water availability (and less clay content). In the same manner, the regions with more shallow stream slopes also have less entrenchment and higher clay content. It remains outside the purpose of this report to discuss the reasons for and limitations of the relationships between the various physical attributes of a watershed. However, given that many of these variables are difficult to quantify for individual localities, it is useful to assume that a certain relationship holds between them. In this manner a variable such as the channel slope can be used to represent the other physical characteristics for a given location.

Figure 5 presents the channel slopes estimated at gaging sites in the Sangamon Basin. From these and other measurements of channel slope an average basin relationship can be developed between the channel slope (SL)

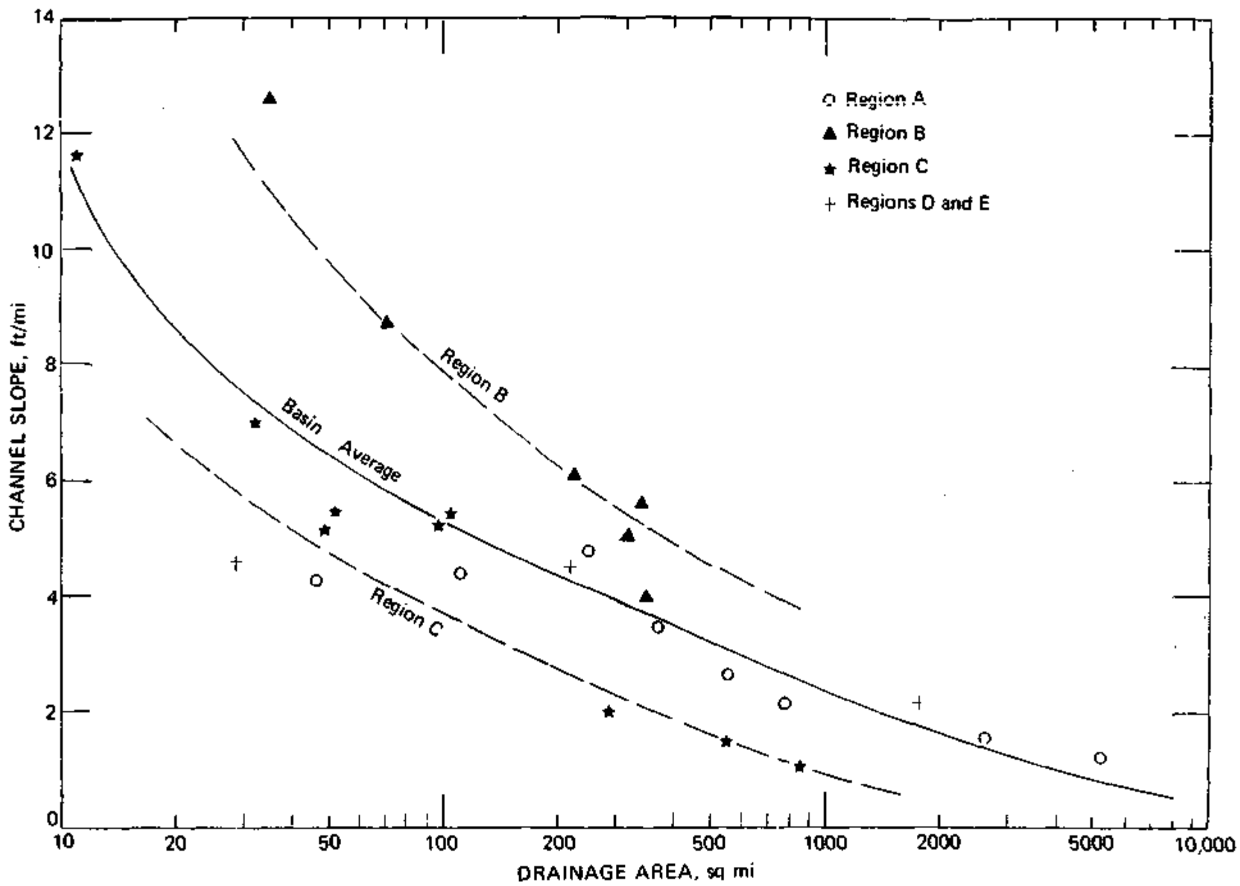

Figure 5. Relationship between slope and drainage area at gaging stations; Sangamon River Basin.

and the drainage area (DA).' The relationship shown in Figure 5 can be approximated by the following equation:

$$SL = 12.1 - (47.4 \log DA - 48.9)^{0.5} \qquad (2)$$

The channel slope is defined as the average slope in feet per mile between points 10 percent and 85 percent of the distance upstream from the point of interest to the topographic divide. Another important aspect illustrated in Figure 5 is the variation which occurs throughout the basin. As expected, region B has noticeably steeper stream slopes than the remainder of the basin, just as region C has more shallow slopes. The deviation of a basin's slope from equation 2 gives a strong indication not only of certain other physical attributes of the basin, but also of the expected streamflow characteristics.

Streamflow Characteristics

The differences in the streamflow regime exhibited across the Sangamon River Basin are illustrated in Figure 6. The three curves shown in this figure present a rough example of the flow duration curves that would be expected for a 500 mi^2 watershed in the three regions designated earlier as the A) Upper Sangamon, B) Upper Salt Creek, and C) South Fork Sangamon regions. Representative flow duration curves for the additional regions of the Lower Salt Creek and Havana Lowlands are not presented due to the limited daily streamflow records available from these regions.

The flow duration curves for regions A and B, both located in the Bloomington Ridged Plain, are quite similar for the upper two-thirds of the flow duration relationship. For conditions of lower flow, however, watersheds in the Upper Salt Creek region (region B) tend to have noticeably greater magnitude of flow than watersheds in the Upper Sangamon Region (region A). The relative differential is amplified as the level of percentage-of-exceedance increases. For example, the magnitude of the 90% flow duration for the 500 mi^2 watershed is approximately 60% greater for region B than for region A, whereas for the 98% flow duration the region B flow is almost 3 times greater. The difference shown between the two regions is likely due in part to both the greater entrenchment of streams in ridged

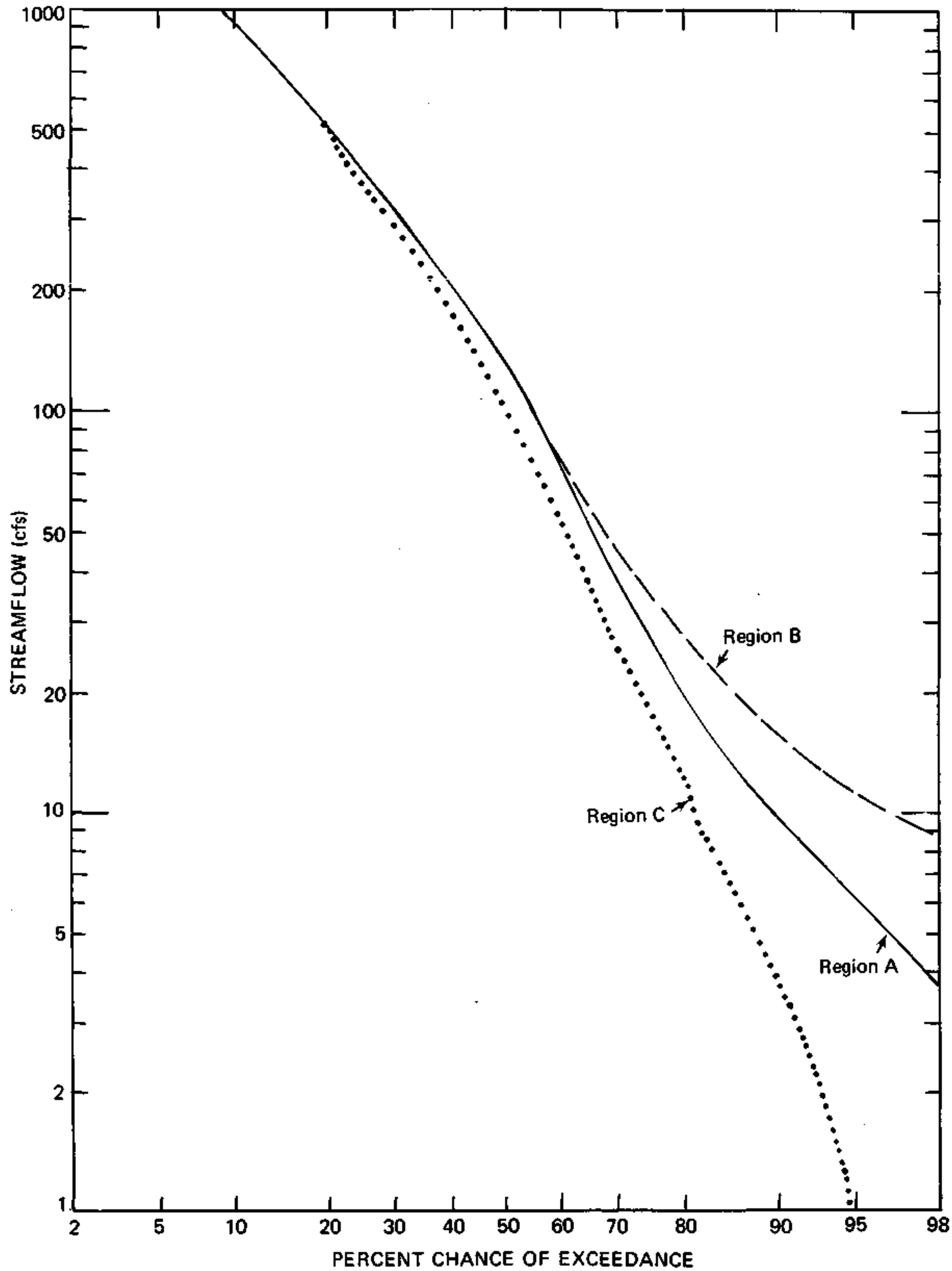

Figure 6. Typical flow duration curves of a 500 mi^2 watershed for three regions in the Sangamon River Basin.

topography of region B and the greater permeability and water availability of soils in this portion of the basin.

The South Fork Sangamon region (region C), displays a distinctly different flow regime than regions A or B. Though the high flows exhibited in the flow duration curve for region C are similar to the other two curves, most of the flow values shown for curve C in Figure 6 occur from 7 to 10% less frequently than with curves A and B. The median flow (50% exceedance) for region C, for example, is only about 88 cfs compared with the 130 cfs shown in the curves for regions A and B. The most noticeable discrepancy shown in the South Fork Sangamon region, however, is the lack of significant flow during the dryest periods.

Average annual streamflow in the basin decreases slightly from the eastern to the western portions of the basin; typical values for regions A, B, and C would be 8.8, 8.4, and 7.9 inches of runoff, respectively. The typical monthly variation in average streamflow is shown for regions A, B, and C in Figure 7. For all regions, the month with maximum average flow is April. High flow conditions are more frequent in the months of May and June (which have higher precipitation) but the average flow in these months is generally not as great as in April because of higher evapotranspirative demand. The month with minimum average flow is September, though the average flow continues to be low for October and November when both the soil moisture and shallow ground water are recovering from summer conditions.

AVAILABLE STREAMFLOW INFORMATION

Information on streamflow and modifications to streamflow in the Sangamon River Basin can be classed into five major categories, these being: 1) daily records from continuous recording streamgages; 2) miscellaneous discharge measurements at partial record streamgages; 3) data on the annual and monthly quantities of discharges into streams; 4) estimates of annual withdrawals from streams; and 5) information on major reservoirs in the basin. Descriptions of these types of information, their sources, and their use in defining flow relationships throughout the basin are presented below. The location of many of the major components in each of these five categories is shown in Figure 8.

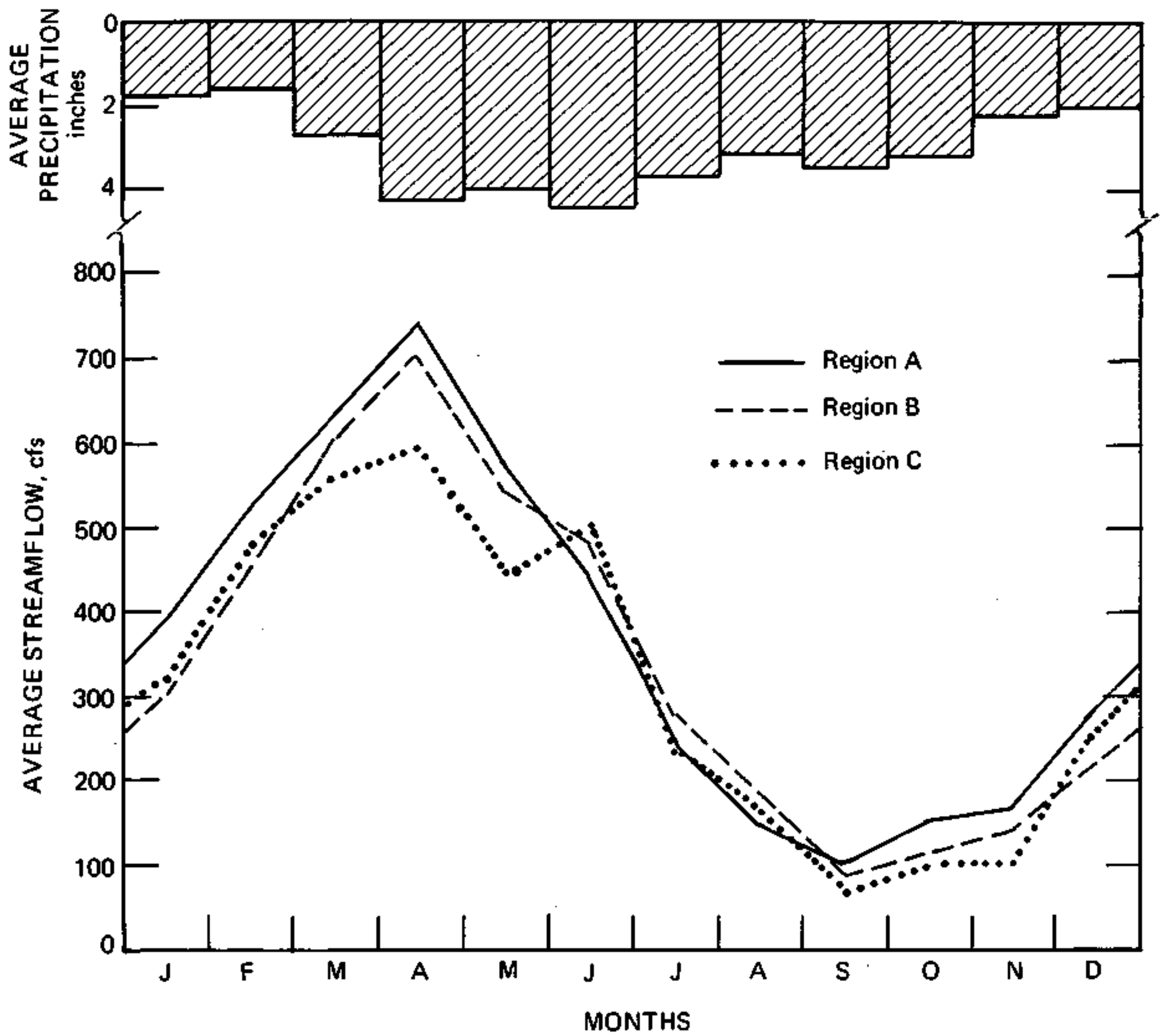

Figure 7. Average monthly values for streamflow and precipitation, for typical 500 mi^2 watersheds in the Sangamon River Basin.

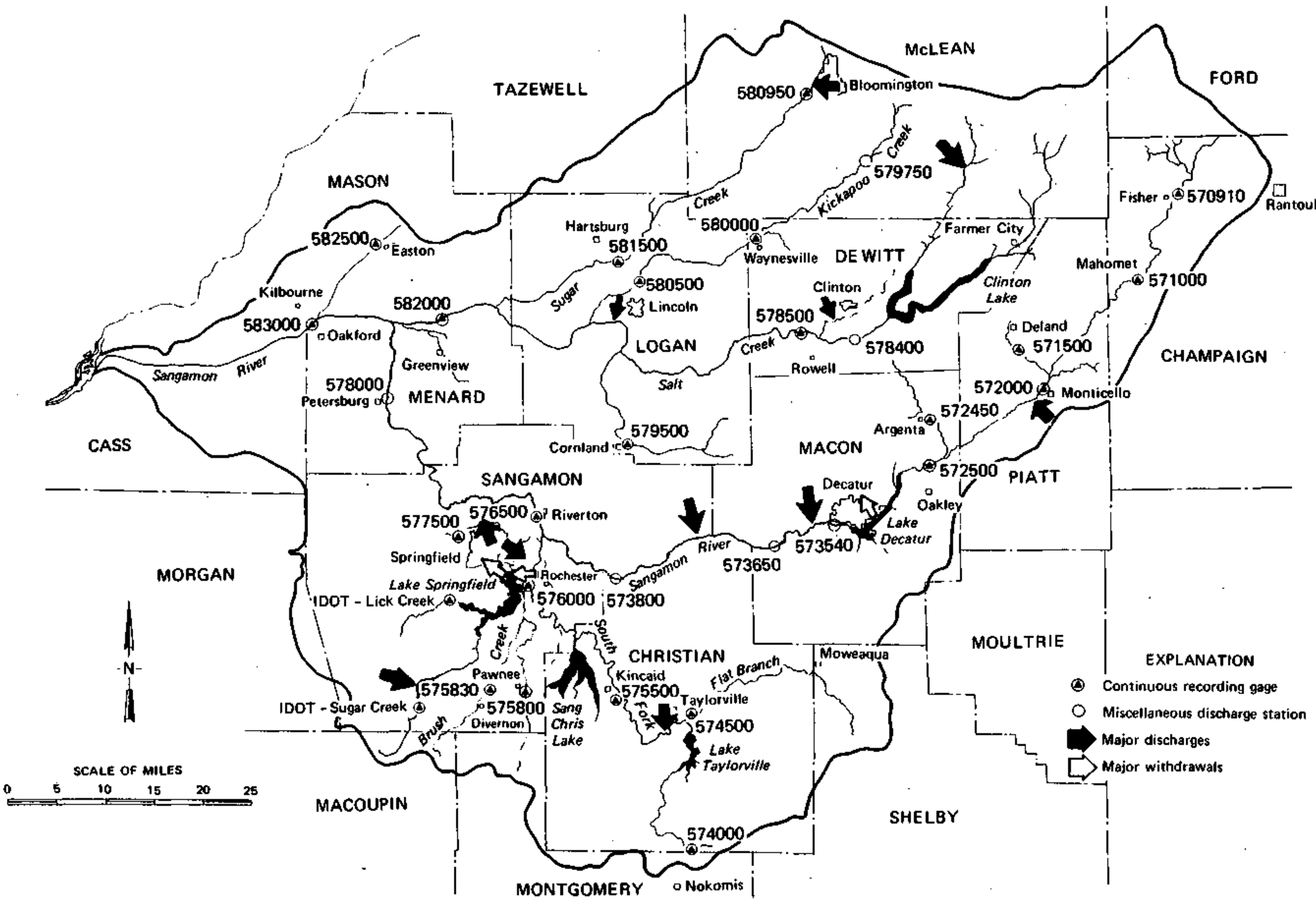

Figure 8. Location of stream gaging stations and major flow modifiers in the Sangamon River Basin.

Continuous Recording Gages

Table 1 lists the USGS streamgages in the Sangamon River Basin for which continuous daily streamflow data is available. Of the 23 stations in the basin, five have less than ten complete years of record and are of limited use when determining flow conditions with a low frequency of occurrence. Several other stations do not have records during the mid-1950s and therefore lack much information concerning severe droughts. An examination of gaging stations in basins adjacent to the Sangamon River produced two stations and streamflow conditions sufficiently similar to the Sangamon gaging stations to be useful in the analytical analyses presented in following sections. These stations are the Embarras River at Camargo and Asa Creek at Sullivan. Two additional records of daily streamflow on Sugar Creek and Lick Creek above Lake Springfield were obtained from the Illinois Department of Transportation, Division of Water Resources.

Miscellaneous Discharge Measurements

In addition to the continuous recording stations, the USGS also has sites at which discharge measurements are taken periodically for varying reasons. The greatest number of these sites are associated with the water quality monitoring program and have been in operation since 1978. Of the approximately 15 water quality stations in the Sangamon River Basin, seven are shown in Table 1 because of the relative amount of additional information they add concerning streamflow in the basin.

Effluent Discharge Measurements

Monthly totals of discharge were obtained from the Illinois Environmental Protection Agency for the time period 1980-1983 for all of the major effluent discharges in the Sangamon River Basin. A typical example of the monthly values for a municipal discharge is shown in Table 2. These monthly values were then used to describe a flow duration curve of discharge. Most of the discharges in the basin are municipal discharges from combined systems where the water treatment plant processes both sewage and storm runoff. Under these conditions the range between minimum and maximum discharges given by the duration curve of the discharge magnitude can be

Table 1. List of Stream Gaging Stations in the Sangamon River Basin

Station name	U.S. No.	Years of Record	DA (mi^2)	Slope (ft/mi)
USGS Gages Within the Basin				
Sangamon River at Fisher	05570910	5 (1978-1983)	240.	4.85
Sangamon River at Mahomet	05571000	30 (1948-1978)	362.	3.59
Goose Creek near Deland	05571500	8 (1951-1959)	47.3	4.32
Sangamon River at Monticello	05572000	69 (1914-1983)	550.	2.75
Friends Creek at Argenta	05572450	16 (1966-1982)	111.	4.48
Sangamon River near Oakley	05572500	5 (1951-1956)	774.	2.21
medium and high flows only		21 (1956-1957)		
South Fork Sangamon near Nokomis	05574000	25 (1950-1975)	11.0	11.60
Flat Branch near Taylorville	05574500	33 (1949-1982)	276.	2.00
South Fork Sangamon at Kinkaid	05575500	17 (1944-1961)	562.	1.42
Horse Creek at Pawnee	05575800	16 (1967-1983)	52.2	5.42
Brush Creek near Divernon	05575830	9 (1973-1982)	32.4	7.00
South Fork Sangamon near Rochester	05576000	34 (1949-1983)	867.	1.11
Sangamon River at Riverton	05576500	42 (1914-1956)	2618.	1.64
Spring Creek at Springfield	05577500	35 (1948-1983)	107.	5.39
Salt Creek near Rowell	05578500	41 (1942-1983)	335.	4.13
Lake Fork near Cornland	05579500	35 (1948-1983)	214.	4.53
Kickapoo Creek at Waynesville	05580000	35 (1948-1983)	227.	6.23
Kickapoo Creek near Lincoln	05580500	27 (1944-1971)	306.	5.12
Sugar Creek near Bloomington	05580950	9 (1974-1983)	34.4	12.70
Sugar Creek near Hartsburg	05581500	27(1944-1971)	333.	5.76
Salt Creek near Greenview	05582000	42 (1941-1983)	1804.	2.33
Crane Creek near Easton	05582500	26 (1949-1975)	28.7	4.55
Sangamon River near Oakford	05583000	44 (1939-1983)	5093.	1.30
USGS Gages Outside of the Basin				
Embarras River near Camargo	03343400	23 (1960-1983)	186.	2.96
Asa Creek near Sullivan	05591500	32 (1950-1982)	8.05	5.50
Illinois DOT Gages				
Sugar Creek near Auburn		30 (1948-1978)	49.1	5.17
Lick Creek near Curran		27 (1951-1978)	97.6	5.33
Selected Miscellaneous Discharge Measurement Stations				
Sangamon River at Decatur	05573540	(1978-1982)	938.	
Sangamon River near Niantic	05573650	(1977-1983)	1054.	
Sangamon River at Roby	05573800	(1967-1970) (1978-1983)	1264.	
Sangamon River at Petersburg	05578000	(1958-1983)	3063.	
Salt Creek near Clinton	05578400	(1967-1970)	305.	
Kickapoo Creek near Heyworth	05579750	(1950-1964)	71.8	

Table 2. Record of Monthly Average Discharges;
Springfield Sanitary District Discharge into Sugar Creek

	1981		1982		1983	
	mgd	cfs	mgd	cfs	mgd	cfs
January	6.3	9.8	14.0	21.7	10.6	16.4
February	9.3	14.4	18.1	28.1	11.6	18.0
March	10.2	15.8	20.4	31.6	17.3	24.6
April	14.5	22.5	14.0	21.7	22.0	34.1
May	19.4	30.1	10.3	16.0	19.8	30.7
June	12.5	19.4	9.4	14.6	13.3	18.4
July	16.1	25.0	8.6	13.3	8.3	12.8
August	16.1	25.0	7.5	11.6	6.3	9.8
September	8.7	13.5	7.3	11.3	-	-
October	6.7	10.4	8.9	13.8	-	-
November	7.4	11.4	13.2	20.5	-	-
December	6.3	9.8	21.8	33.8	-	-

considerable. Figure 9, which shows the flow duration curve corresponding to the values given in Table 2, illustrates the variation that may be expected by a combined system. One characteristic of combined sewer discharges is that the discharges can usually be well correlated to the flow of the stream into which the discharge takes place, which makes the separation of the effect of the discharge from the streamflow record much easier. Seasonal variations in actual water use were not discernible from the monthly discharges. Industrial discharges, on the other hand, usually have very constant discharges which also make their separation from the streamflow record relatively simple.

Withdrawals from Streams and Lakes

Records of annual water withdrawal in the Sangamon Basin for 1980 and 1982 were obtained from the Illinois Water Use Inventory which is operated at the State Water Survey. The inventory shows that there exist only nineteen surface water withdrawal sites in the Sangamon River Basin, only eleven of which are of a magnitude to have a significant impact on streamflow volume. Three of the largest withdrawals are used for power plant cooling purposes and are withdrawn from and immediately returned to major reservoirs. These are nonconsumptive uses of water and thus have virtually no effect on streamflow assessment in the basin.

Reservoirs

There exist five reservoirs of significant size in the Sangamon River Basin, these being Clinton Lake, Lake Springfield, Lake Sangchris, Lake Decatur, and Lake Taylorville. Though numerous smaller reservoirs exist throughout the basin, the influence of these other reservoirs on downstream flow is judged to be for practical purposes inconsequential.

Storage-outflow information was collected on the five reservoirs given above from the U.S. Corps of Engineers' Dam Safety Reports. Estimates of net lake evaporation were also compiled using climatological data from the U.S. Weather Service Springfield and Urbana stations and employing the evaporation formula given in Roberts and Stall (1967). Along with synthesized streamflow records these items were used to estimate the flow regime downstream of each

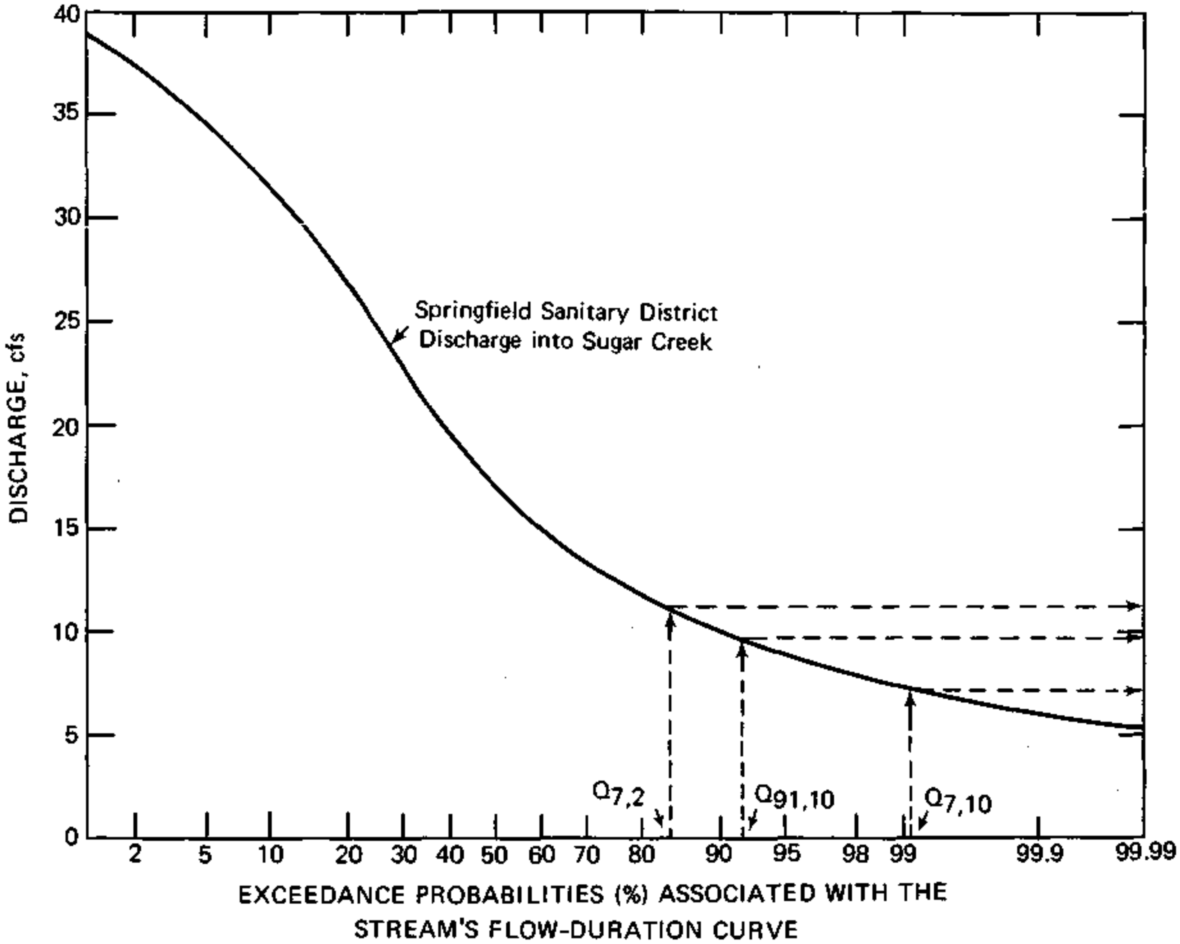

Figure 9. Flow duration curve of effluent discharge, Springfield Sanitary District.

of the major reservoirs. This process is described in the section on Ungaged Sites: Additional Considerations.

STREAMFLOW ANALYSIS FOR GAGED SITES

The objective described in this chapter is to develop estimates of the virgin and present streamflow conditions for the previously described set of streamflow parameters at the gage sites in the basin. The first steps involved in this analysis are 1) the separation of the flow record into the two elements of virgin flow and composite flow due to the modifiers, and 2) the resulting aggregation of virgin streamflow and present-condition modifiers to compute a streamflow record indicative of present flow. The estimation of each of the 178 flow parameters also involves 3) the interpretation of the record in terms of differences in the period of record at the station of interest as well as the types of analyses used to estimate the recurrence interval of extreme events. The approaches taken for all of these analytical problems are described below.

Estimation of Virgin and Present Conditions from Daily Streamflow Records

Because the number of major reservoirs and surface water withdrawals in the Sangamon Basin is fairly small, most of the gaging records are affected only by upstream effluent discharges. For this reason, the discussion concerning the separation of flow modifiers from the streamflow record presented below will primarily reference these effluent discharge modifiers. In general, this means that throughout the basin, both the streamflow records and the present-condition flows tend to be greater in magnitude than the virgin-condition flows.

In order to separate the effect of the flow modifiers from the daily streamflow records of the gages in question, a log-linear relationship was developed between the flow in the stream at that station and the magnitude of the discharge, A Qmod(i). This relationship was calibrated using monthly discharge figures for the years 1980 - 1982 which were provided by the Illinois Environmental Protection Agency. The magnitude of effluent discharges to the stream vary over the period of recorded streamflow, therefore the relationship established for 1980-1982 needed to be extended to the remainder of the flow record. This was done by examining the State Water Survey's historic records of water use and establishing a trend represented by a time-dependent multiplying factor, k. The multiplying factor changes Equation 1 to the form:

$$Qv = Qr - \Sigma \kappa \Delta Qmod(i) \qquad (3)$$

where the term Qr, represents recorded streamflow (as opposed to present flow). If the value of k = 1.0 represents the present state of the flow modifier (1982), then for most cases K takes on a value less than 1.0 for previous years. In addition, the value for K is usually linearly related to time (i.e. the number of years before present).

As a result of these operations, not only can the record of virgin daily streamflow be estimated, but also a historical series of daily flow modification from a given flow modifier can be created. For example, Figure 10 shows the series which represents the cumulative effect of the flow modifiers affecting the gaging station on the South Fork near Rochester. In this figure, the flow modifications during the period 1976 - 1977 are of particular interest because water was being withdrawn just upstream of the gaging station for transfer to Lake Springfield. Outside of this period, however, the flow modifications are due to upstream effluent discharges and show a sustained increase in average magnitude.

Because the magnitude of modifications to the streamflow vary over the span of years, the flow parameters from a gaging stations daily record will usually differ from both the virgin flow and present flow parameters. Therefore, the present flow conditions must be estimated by reconstructing the gaging record by adding the virgin flow record to a series of the daily flow modifications based on present conditions (K = 1.0 in equation 4).

Effect of Period of Record

The years which are covered in a gage's record have a profound effect on the estimation of the value of a streamflow parameter, especially on extreme events such as low flows and high flows. For example, the long-term streamflow records in central Illinois indicate that the three worst droughts in this area occurred in the 25-year period between 1930 and 1954. A gaging record which does not cover any period previous to 1955 will not have recorded any of these major droughts, and analysis from such a gaging record

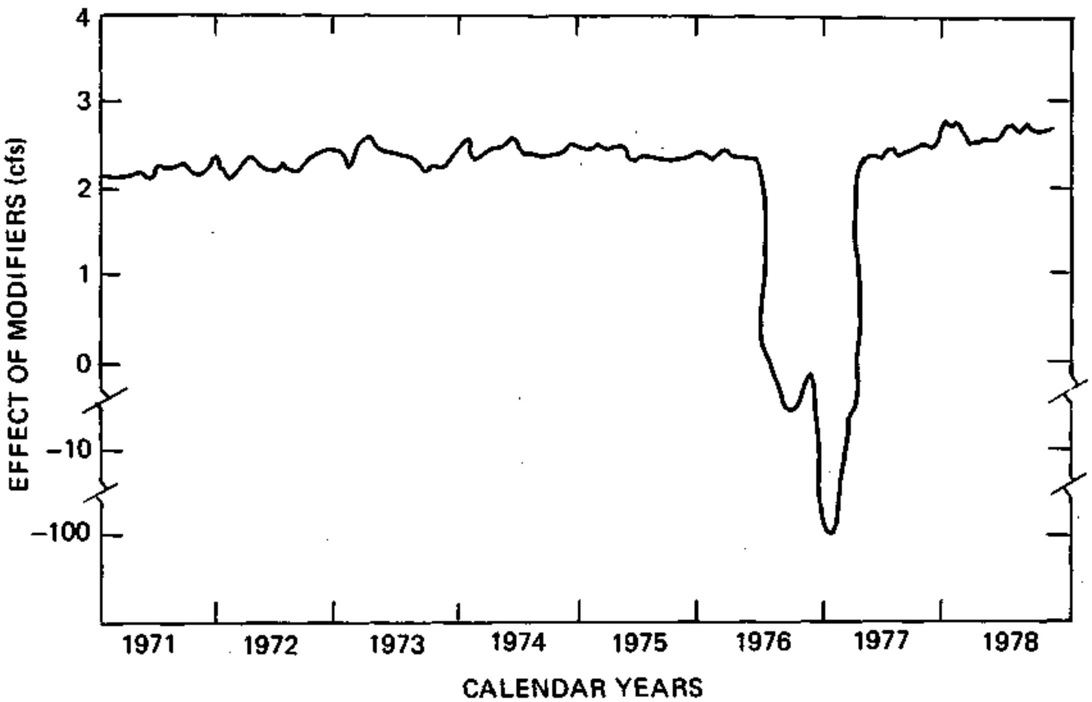

Figure 10. Cumulative effect of flow modifiers on the South Fork Sangamon River near Rochester, 1971-1978.

will produce estimates of drought recurrence which greatly differ from other streamflow records which include any one of the major droughts. A primary consideration in the development of the flow estimates in this study is that a consistent relationship be maintained between different locations. For this reason it became necessary to find a base period to which all frequency estimates could be related.

The considerations used to determine the period to which frequency estimates would be related included not only finding a period which included a representative number of extreme low flow and high flow events, but also finding a period for which many stations have records. Prior to the mid-1940s there were very few continuous recording gages in the Sangamon River Basin; in 1943 there existed only five recording gages in the basin. However, by 1953 there were 21 gages in the basin, and to date the number of gages has never decreased to less than 14. By establishing the base period as 1948-1982, most of the stations require little or no adjustment in the frequency estimates of their streamflow values. For long-term records such as for the Sangamon River at Monticello, only this latter part of the record is used in estimating the frequency relationships.

For each gaging record which needs adjustment due to period of record, an index station is identified whose record includes both the base period, 1948-1982, and the period of record of the gaging station of interest. An example of the type of adjustment made for a flow duration value to account for the period of record is shown in Figure 11. The flow value for the station of interest, (Goose Creek near Deland) is paired with the flow in the index station, (Sangamon River at Mahomet) having the same frequency of occurrence for the period of record, 1951-1959. The adjusted frequency for the Goose Creek value is then set equal to the frequency associated with the index station's flow duration curve for the base period, 1948-1978. Frequency adjustments for high and low flows follow this same process.

Defining Frequency Characteristics of Low and High Flows

Most streamflow parameters, especially those associated with the flow duration curve between 2% and 98%, can be computed directly from analysis of the daily streamflow records. However when dealing with extreme events with infrequent occurrence such as low flows and high flows with an expected

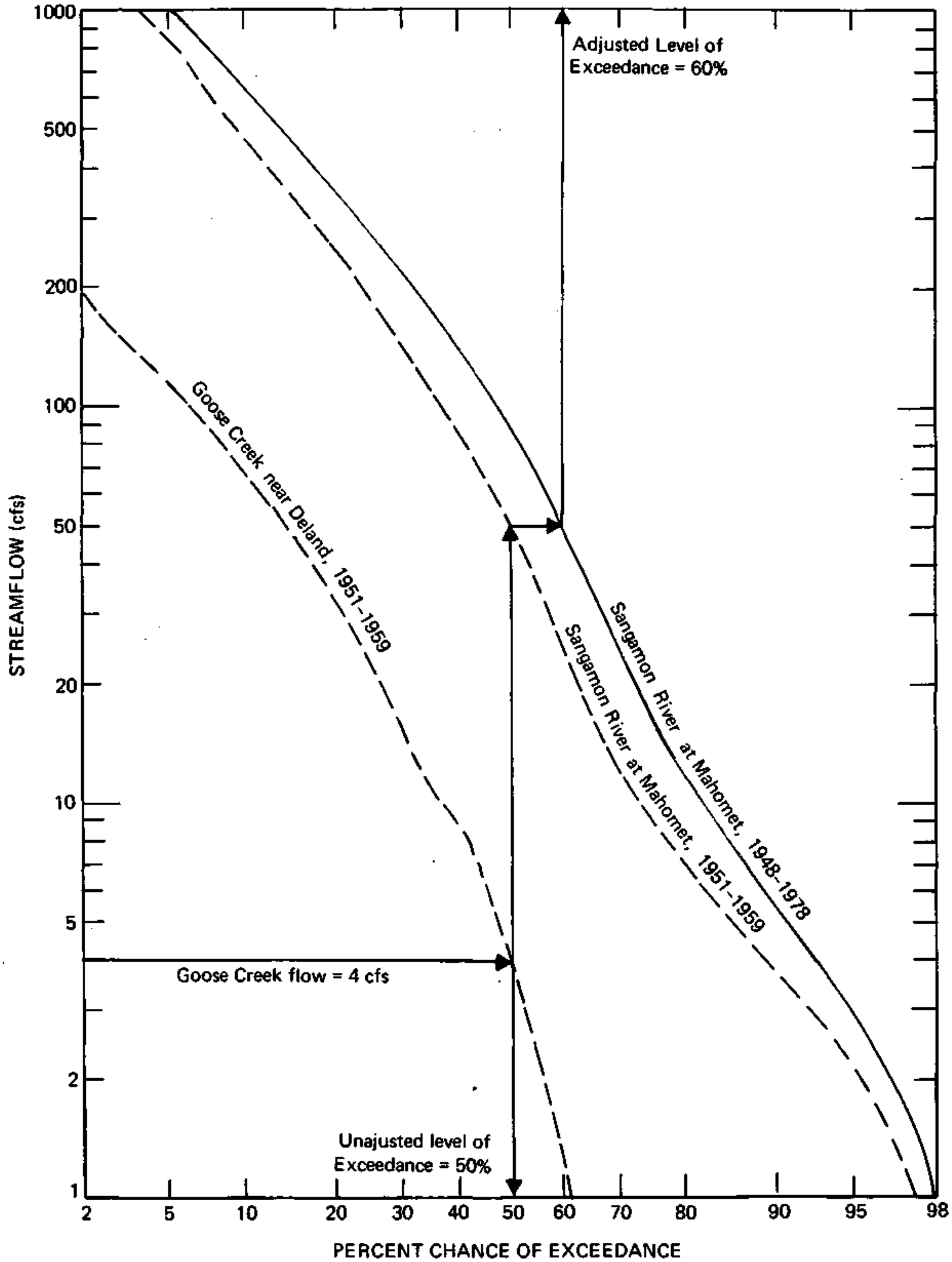

Figure 11. Adjustment in flow frequency for the effects of period of record; Goose Creek near Deland.

recurrence of over five years, estimates of the associated discharges must generally result from analysis of the annual series of the streamflow parameter involved. There exist two general types of analyses in these cases, these being 1) graphical analysis which involves plotting the frequency of exceedance vs. discharge for the annual series and then hand-drawing the indicated relationship, or 2) fitting the annual series data with a theoretical probabilistic frequency distribution. When analyzing high flows, the second method is desirable, especially considering that the process can be automated. However, when dealing with most low flow parameters and with high flows modified by a reservoir, the frequency-discharge relationship rarely follows a predescribed distribution. Various distributions have been used in other studies to describe low flow parameters, but these are generally only successful for streams that do not go dry. Though Riggs (1972) suggests the use of frequency distributions where applicable, it is also advised that the graphical method should be the basic low flow analysis technique. In this study the graphical method was found to be the only technique which provided consistently reliable estimates of extreme events.

Selected Examples of Results from the Analyses

Four of the continuous recording stations listed in Table 1 have less than 15 years of record and for this reason were not analyzed in full. Of the remaining 20 gaging stations located in the basin, 9 have significant modifications to the flow (Δ Qmod > 0.1 cfs). Five stations have noticeable adjustments in frequency due to differences in the period of record. Examples of the differences between the estimated values of the virgin flow, present flow, and the flow of record (unadjusted frequencies) are shown in Table 3. A complete list of the estimated values for the 178 streamflow parameters for each stream gaging station resulting from the analyses presented below is given in Appendix B. The following paragraphs provide a description of most of the stations where noticeable differences exist either between virgin flow and present flow conditions or due to period of record adjustments.

Sangamon River at Mahomet (Gage No. 05571000) - Upstream of this station the three communities of Gibson City, Rantoul, and Fisher discharge an average of 1.5 cfs. However during dry periods only the discharge from

Table 3. Estimates of Virgin, Present, and Period-of-Record Streamflow; Selected Stations

	Streamflow Parameters		
	$Q_{7,10}$ Low Flow	Q90	Q75
Sangamon River at Mahomet			
Virgin Flow	0.25	5.4	16.0
Present Flow	0.47	5.6	16.3
Period-of-Record	0.40	5.5	17.0
Sangamon River at Monticello			
Virgin Flow	1.6	11.0	31.0
Present Flow	2.0	11.7	32.0
Period-of-Record	2.3	11.4	30.6
Friends Creek near Argenta			
Virgin Flow	0.0	0.0	1.2
Present Flow	0.0	0.0	1.2
Period-of-Record	0.0	0.2	6.3
South Fork Sangamon near Kinkaid			
Virgin Flow	0.02	4.2	20.8
Present Flow	0.38	5.8	23.1
Period-of-Record	0.36	5.1	19.2
South Fork Sangamon near Rochester			
Virgin Flow	0.9	7.6	35.0
Present Flow	0.8	9.7	37.0
Period-of-Record	0.8	8.4	35.5
Sangamon River at Riverton			
Virgin Flow	13.4	51.0	138.
Present Flow	49.0	83.0	179.
Period-of-Record	18.4	48.0	128.
Salt Creek near Rowell			
Virgin Flow	1.7	9.6	22.8
Present Flow	2.6	3.6	21.3
Period-of-Record	2.7	10.0	23.4
Sugar Creek near Hartsburg			
Virgin Flow	2.3	8.4	19.7
Present Flow	12.5	24.6	38.2
Period-of-Record	6.8	14.2	27.0
Salt Creek near Greenview			
Virgin Flow	56.6	101.	180.
Present Flow	71.0	128.	205.
Period-of-Record	67.0	116.	198.
Sangamon River near Oakford			
Virgin Flow	147.	254.	479.
Present Flow	215.	333.	569.
Period-of-Record	191.	292.	524.

Fisher appears to affect the flow at this gage. As shown in Table 3, the estimated difference between the virgin and present conditions for the 7-day 10-year low flow ($Q_{7,10}$) is only about 0.2 cfs.

Sangamon River at Monticello (Gage No. 05572000) - Until 1964 this gage was located 0.2 miles downstream of its current site. The previous site was just downstream of the Monticello municipal discharge, and the change in location causes the station record to exhibit higher magnitude low flows than would be expected under current conditions. The only modifier affecting flows between this gage and the Mahomet gage upstream is the Mahomet municipal discharge. Cumulative discharges cause the present condition low flows to exceed the virgin low flows by approximately 0.4 cfs for a ten year recurrence. At the old location of the gage this low flow is augmented by an additional 1.6 cfs.

Friends Creek near Argenta (Gage No. 05572450) - The gaging station on Friends Creek has been in operation since 1966 and represents one of the more complete gaging records in the basin whose period of record does not cover a major drought. The magnitude of the period of record adjustments are given in Table 3. For example, the estimate of the 75% duration flow is 6.3 cfs for the period of record, but interpreted to be only 1.2 cfs after the adjustment.

South Fork Sangamon River at Kinkaid (Gage No. 05575500) - The Kinkaid gaging station is approximately 19 miles downstream of Lake Taylorville and 15 miles downstream of the Taylorville municipal and industrial discharges. Lake Taylorville causes a modest reduction in high flows. However the effect of Lake Taylorville on low flows is almost entirely masked by the Taylorville outfalls which provide an average discharge to the stream of 3.75 cfs and a minimum of 1.6 cfs during dry periods. Much of the lower magnitude discharge is lost by way of evaporation and infiltration before the South Fork reaches Kincaid as is evident from the estimates shown in Table 3.

South Fork Sangamon River near Rochester (Gage No. 05576000) - This gage is affected by several notable flow modifications, specifically: 1) discharges into the South Fork from municipal and industrial sources at Taylorville (40 miles upstream), 2) high flow and low flow reductions resulting from two major reservoirs (Lake Taylorville and Lake Sangchris), and 3) the withdrawal of water just upstream of the gaging station into Lake

Springfield during drought years. This latter modification is of special interest since it is the only withdrawal in the Sangamon Basin which has a significant effect on a gaging station. The withdrawal occurs with a frequency of approximately 8 to 10 years. The total effect of the modifications on the streamflow was shown previously in Figure 10.

Sangamon River at Riverton (Gage No. 05576500) - the daily streamflow record for this station extends from 1914 to 1956. During this time, the minimum (low flow) discharge from the Decatur Sanitary District, the major flow modifier affecting this station, increased from an average of 6 cfs up to 17 cfs. The estimated present minimum discharge at Decatur is 32 cfs. Due to this change through the years, the low flows from the station are not indicative of either virgin or present flow conditions. This gage is of special interest because it is located downstream of one of the major confluences in the basin, that being the Sangamon River and the South Fork. The major source of flow during low flow periods is apparently the Sangamon River, with the South Fork supplying little flow.

Salt Creek near Rowell (Gage No. 05578500) - Since 1977 the flow record at this station has been modified by the Clinton Reservoir 11 miles upstream, which significantly reduces both the low flows and high flows at the station. As a result of major periods for which there is little or no flow from the reservoir, the present flow conditions for many of the flow duration values up to the 85% duration flow are extremely low. However, the low flows are slightly augmented by discharges into Coon Creek from the city of Clinton.

Sugar Creek near Hartsburg (Gage No. 05581500) - The discharge from the Bloomington Sanitary District greatly impacts the low flow conditions measured at this gage. Separation of the effect of the discharge from the natural flows is difficult due to the infiltration and evaporative losses which occur between the outfall site and this gaging station. Even with these losses in flow, the present flow value for the $Q_{7,10}$ is five times greater than the virgin flow estimate.

Salt Creek near Greenview (Gage No. 05582000) - The Salt Creek watershed at this gaging station covers over a third of the total area of the Sangamon River Basin. However, most of the difference between the virgin flow and present flow conditions can be attributed to only one major flow modifier, that being the Bloomington Sanitary Discharges.

Sangamon River near Oakford (Gage No. 05583000) - The difference between the virgin and present flow conditions at this gage are of particular interest because all of the flow modifiers in the Sangamon Basin are accounted for in this difference. For the 7-day 10-year low flow, the present flow condition is 68 cfs greater than the virgin condition. This difference represents well the normal condition of low flows in the watershed, that being that the present condition flows are usually greater than the virgin condition flows. This is the result of discharges from municipal water supplies whose source of water is either ground water or surface water storage.

Use of Supplemental Discharge Measurements

Even though miscellaneous discharge measurements may cover a broad range of flow conditions, their greatest applicability appears to lie in the estimation of low flow conditions at the measurement site. However, in order that miscellaneous discharge measurements can be used in such a manner, the following conditions should hold: 1) a gaging station must exist nearby with which a regressive relationship with a high percentage of explained variance can be developed, and 2) the discharge measurements should include extreme events (greater than a 5 year recurrence) so that the derivation of flow parameters does not require extrapolation much outside of the range of the regressive relationship. Of the nine locations in the basin shown in Table 1 that have miscellaneous discharge measurements, only the site on Kickapoo Creek near Heyworth satisfies these two criteria.

The importance of the second criterion listed above for low flow measurements is illustrated by the low flow relation developed between the Heyworth location and the daily streamflow gage on Kickapoo Creek at Waynesville (see Figure 12). For discharge measurements taken near Heyworth which are above 1 or 2 cfs, the low flow relationship between the two stations is approximately linear. However, for lower discharges (such as might be experienced with recurrence greater than 5 years) the low flow relationship curves such that the expected low flow at the Heyworth site is diminished, eventually becoming zero. Most of the lowest discharge measurements near Heyworth were taken during the drought of the 1950s. If, for example, these lowest measurements were not available, the relationship

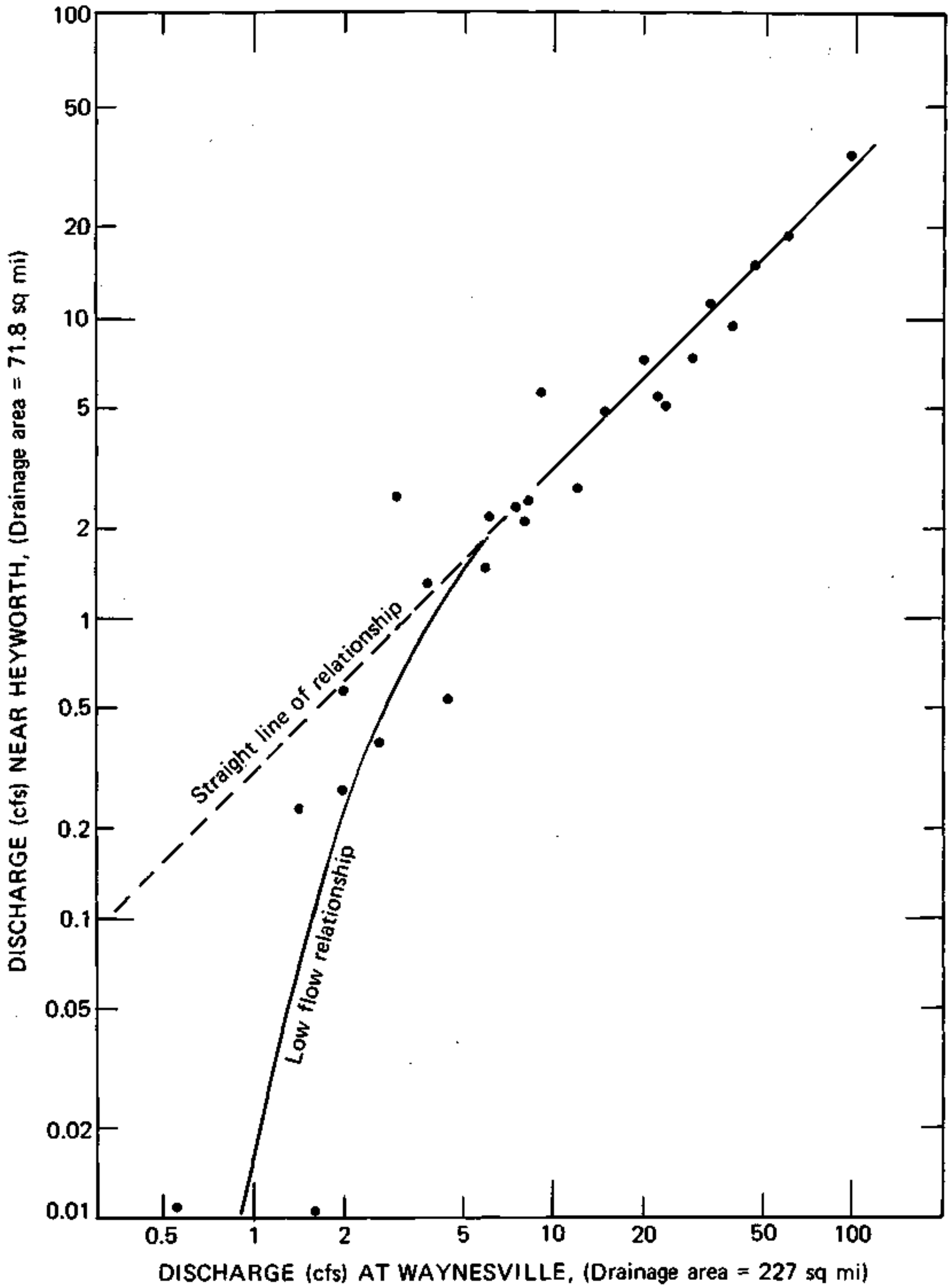

Figure 12. Low flow relationship between Kickapoo Creek at Waynesville and Kickapoo Creek near Heyworth.

based on the remaining points would indeed appear to be linear in nature, and an unwary hydrologist might be tempted to extrapolate the value of an extreme event along this line of relation. The resulting estimates would greatly misrepresent the low flow conditions at the Heyworth site. Such an extrapolation procedure may be useful when no other streamflow information is available, however the resulting estimates should never be used for estimating flows at ungaged sites or in any other way substituted for either daily streamflow records or miscellaneous measurements which cover the extreme event.

In selected cases, miscellaneous discharge measurements may provide needed information pertaining to the magnitude of an effect due to a major flow modifier. For example, three locations downstream of Lake Decatur which have miscellaneous discharges were used to estimate 1) the flow downstream of the lake during dry periods, and 2) the effect of the Decatur Sanitary District discharge on low flows in the Sangamon River. The gaging station located immediately downstream of Lake Decatur (#05573540) has a number of miscellaneous low flow measurements made between 1978 and 1982 which allow for an estimation of the distribution of low flow discharge from Lake Decatur. Each year there exists an average period of two to three months in which there is little or no flow over the gates at Lake Decatur, however even when there is no flow over the gates there is usually sufficient seepage to provide for a flow of between 3 to 4 cfs at this gaging site. Only in excessively dry periods is the flow estimated to approach zero. The gaging stations near Niantic (#05573650) and at Roby (#055738000) are located downstream of the Decatur Sanitary District discharge. The miscellaneous records from these stations helped to verify the effect of the discharge on low flows in the Sangamon River as well as to estimate the amount of natural inflow into the stream which occurs in the reach between Decatur and Springfield.

ESTIMATING FLOW AT UNGAGED SITES: REGRESSIVE ANALYSIS

The estimation of flow characteristics at an ungaged location involves two specific steps. The first step, dealt with in this section, is the estimation of the virgin flow conditions using equations developed with regressive analyses. The second step, discussed later, analyzes the factors which may cause either the virgin flow condition or the present flow condition to deviate from the value produced by these equations.

The relationship between a selected streamflow parameter and the physical attributes used to describe a stream or its watershed is rarely of a simple nature. Two common techniques which are used in an attempt to improve this relationship are 1) the transformation of the parameter values, and 2) the segmentation of the data by way of geographic regions into groups of similar response. Each of these techniques and aspects of their application are discussed in the initial portion of this section.

Data Transformations

Data transformation of the dependent and independent variables is usually performed prior to regression analyses to achieve two objectives: 1) to create an approximately linear relationship between the variables involved, and 2) to allow the variance to be more uniform over the range of the relationship. Though regression analyses need not always be conducted linearly, the linear form is preferred, especially with small samples, because it involves fewer parameters and also because equations of higher form tend to be more sensitive to eccentricities in the data.

By far the most common transformation performed on streamflow data is the logarithmic transformation, which results in a univariate regression equation of the form:

$$\log Y = b \log X_1 + c \tag{4}$$

When the logarithmic transformation is inverted by way of the exponential transformation, Equation 4 becomes a power function of the form:

$$Y = cX_1^b \tag{5}$$

Though the use of the logarithmic transformation is common, there exists no inherent physical basis for its use over other transformations. In fact, for many streamflow parameters the logarithmic transformation is inadequate because it requires the regressive relationship to pass through the origin. This is unrealistic since many low flow values can be equal to zero for sizeable drainage basins.

The transformation used for much of the analyses in this study is the power transformation, which raises the value of each parameter to a constant power. The univariate regression equation following a power transformation is:

$$Y^a = cX_1^b + d \qquad (6)$$

Note that Equation 5 is a special case of Equation 6 in which the intercept, d, equals zero and the constant of power, a, equals 1.0. The unknown constants a. b. c. and d are usually determined in an optimization procedure which minimizes the mean squared error of the regression. In this study, however, the optimization procedure was avoided by selecting two special cases of Equation 6, these being: 1) the case where the constant of power, a, equals 1.0; and 2) the case where both a and b equal 1/3. The second case, used earlier by Singh and Stall (1973), is especially useful in its property of making the residuals of regression more uniformally variant as well as allowing the relationship between low flow and drainage area to approach linearity.

Use of Regionalization

The concept of regionalization involves the separation of the data observations into groups which have a similar characteristic, generally being geographic location. The regionalization approach is used most often in cases where there exists an obvious amount of non-random variance in the dependent variable which cannot be explained through regression with available independent variables. Regressive relationships between high flows and basin characteristics such as drainage area, slope, and stream length are often quite good (in this study, for example, correlation coefficients for high flows usually exceed .995), and for these relationships, regionalization is generally of little use. Low flow conditions, however, are generally less conducive to regressive analysis for the reason that low flows are usually highly dependent on soil type, lithology, variation of evapotranspiration, and several other factors that are very difficult to quantify. In most situations, estimates of low flow at ungaged sites based just on a flow versus drainage area relationship are highly inaccurate. Riggs (1972) advises that discernible relationships with basin characteristics other than drainage area can rarely be developed and that most cases require regionalization to separate the study area into groups of more "homogeneous" response.

There exist two major problems with the regionalization approach. First, it is relatively easy to misuse the regionalization approach by failing to tie the defined regions to some definite physical factor which should explain the segmentation of data. Second, and more crucial to most applications, a major portion of the variance between estimates of a streamflow parameter at different gaged sites is absorbed by what is simply an assumption that all streams within the designated area will behave in a manner similar to the available data. The assumption of homogeneity will undoubtedly have some error associated with it, especially as the number of gaged sites within a given region becomes small. Unfortunately, this error is not estimable and apparently for this reason is rarely presented as an important aspect of the regionalization process. Therefore, attention has been given in the following discussions to describe the total amount of variance devoted to the assumption of regional homogeneity.

A regionalization of the Sangamon River Basin for purposes of estimating streamflow was previously conducted by Singh (1971). The regions designated in Singh's report are very close to those used in the current study. Regions B and D, shown earlier in Figure 3 have been combined to form one region because even though they occupy different physiographic regions their low flows are similar.

Regression Model Identification

In establishing the equations which are used to model virgin flow conditions, the 178 streamflow parameters were divided into two analysis groups. For the low flow and monthly drought flow parameters, the following five forms of regression equations were chosen as possible models for describing virgin flow:

$$Q^{1/3} = c\ A^{1/3} + d \quad (7)$$

$$Q^{1/3} = c\ A^{1/3} + d_r \quad (8)$$

$$Q^{1/3} = c_r\ A^{1/3} + d_r \quad (9)$$

$$Q^{1/3} = c_1\ A^{1/3} + c_2\ Se/So + d \quad (10)$$

For high flows and the flow duration parameters, Equations 5 and 7 were used along with the following equations:

$$Q = c\ A^b + d \quad (11)$$

$$Q = c_r\ A^r + d_r \quad (12)$$

The parameters So and Se in Equation 10 are the slope measured at the point of interest and the slope as estimated for that size drainage area by Equation 2, respectively. The subscript r used in Equations 8, 9, and 12 indicate that separate values of the coefficient were estimated for different regions. In these equations the regional separation was made using Regions A and C and a combined Region B+D. The coefficients in every equation but Equations 9 and 12 were estimated using least squares regression. The coefficients in Equations 9 and 12 were estimated by a graphical approach because the coefficient c_r is highly sensitive to variations in the data set.

Evaluation of Regression Models

The models defined by Equations 7 through 12 were compared with one another on the basis of the following criteria: 1) the mean squared error of the residuals; 2) the amount of explained variance associated with the assumption of regional homogeneity; and 3) an evaluation of the general applicability of the equation.

The mean squared error of the residuals is the squared value of the standard error of estimate of the equations. More precisely, it is equal to the sum of the squared difference between the transformations of the observed value, Q_o, and estimated value, Q_e, of the streamflow parameter in question, divided by the number of degrees of freedom, d.f., associated with the residuals:

$$MSE = \Sigma \left(Q_o^{1/3} - Q_e^{1/3}\right)^2 / d.f. \qquad (13)$$

Low Flows and Drought Flows

The mean squared errors (MSEs) of Equations 7 through 10 as applied to the estimation of low flows and drought flows are shown in Table 4. The values given are in units of $(Q^{1/3})^2$. The MSEs of Equations 8, 9, and 10 are similar, though Equation 10 is slightly superior to the other two.

Since Equations 8 and 9 include regionally developed coefficients, the assumption of regional homogeneity is responsible for at least some of the reduction of variance in the residuals. The relative amount of variance associated with the regionalization in Equation 8 and 9 is represented by the difference in the MSE of Equation 7 (shown in Table 4) and the respective MSE

Table 4. Comparison of the Mean Squared Error between Regressive Methods; Low Flows and Monthly Drought Flows

Duration	Return interval	Original variation	Mean Squared Error — Residuals from Equations (7)	(8)	(9)	(10)
1 day	2 (years)	.4227	.4646	.1172	.0730*	.1010
	10	.2919	.3053	.1892*	.2568	.2034
	25	.2556	.2005	.2023	.2707*	.2980
	50	.3425	.3743	.2774*	.4889	.4186
7 day	2 (years)	.5301	.2094	.0817	.0407*	.0843
	10	.2876	.3041	.1827	.1362*	.1834
	25	.2930	.3103	.2067*	.2692	.3136
	50	.2579	.2813	.2801	.2741*	.2948
15 day	2 (years)	.6176	.1934	.0519	.0293*	.730
	10	.3491	.2830	.1527	.0630*	.0944
	25	.2694	.2879	.1802	.1326*	.1634
	50	.3109	.3156	.1878	.2118	.1778*
31 day	2 (years)	.6983	.1373	.0438	.0406*	.0573
	10	.3166	.2279	.1420	.1296	.0686*
	25	.3479	.2695	.1880	.1200	.1096*
	50	.2354	.2252	.1795	.1838	.1379*
61 day	2 (years)	.6728	.0915	.0337	.0196*	.0415
	10	.3908	.1755	.0426*	.0801	.0499
	25	.2232	.2190	.1231	.0451*	.0681
	50	.2359	.2249	.1312	.0724*	.0736
91 day	2 (years)	.6916	.0358	.0277	.0274	.0262*
	10	.4459	.1631	.0367*	.0423	.0587
	25	.5477	.2608	.0771	.0488*	.0713
	50	.1956	.1764	.1018	.0359*	.0678
6 month	10 (years)	.6349	.1582	.0595	.0268*	.0771
	25	.5712	.2118	.0828	.0239*	.0985
	50	.6097	.2500	.0894	.0284*	.1114
9 month	10 (years)	1.1318	.2320	.0835	.0697*	.1419
	25	.7204	.1944	.0784	.0385*	.0737
	50	.6114	.1890	.0753	.0477*	.1067
12 month	10 (years)	1.5133	.0800	.0483*	.0688	.0593
	25	1.0697	.2350	.1052	.0791*	.1431
	50	1.0309	.4748	.1152	.0518*	.2387
18 month	10 (years)	1.7361	.0853	.0379	.0310*	.0774
	25	1.1588	.1563	.1142	.1973	.1088*
	50	.9124	.3699	.1645	.1770	.1224*

Table 4. (concluded)

Duration	Return interval	Original variation	Mean Squared Error — Residuals from Equations (7)	(8)	(9)	(10)
30 month	10 (years)	2.2472	.0490	.0162*	.0212	.0421
	25	1,6428	.1196	.0693*	.1033	.0880
	50	1.2493	.3225	.0968	.0730*	.1312
54 month	10 (years)	2.9615	.0421	.0210*	.0299	.0444
	25	1.9280	.0794	.0440*	.0813	.0577
	50	1.3826	.1681	.0429*	.0650	.0924
Average		.7701	.2154	.1203	.1025	.1203
Degrees of Freedom		n-1	n-2	n-4	n-5	n-3

of Equation 8 or 9. For example, for the 7-day 10-year low flow ($Q_{7,10}$), the value of (.3041 - .1827) = .1214 gives some representation of the amount of variance associated with the assumption of homogeneity of Equation 8. This value should be compared to the total sample variance of the $Q_{7,10}$ which is equal to .2876.

A more precise way of identifying the amount of variance associated with regionalization is through the use of the analysis of variance (ANOVA) table, given as Table 5. Table 5 indicates that of the total sum of squares of the sample of $Q_{7,10}$ only 6.0% can be explained by the relationship between the streamflow and the drainage area, whereas 67.7? is associated with regionalization and 26.3% is associated with the residual which is assumed to be white noise (randomness). For contrast, these results should be compared to the results of Equation 10, in which the difference in variance between the sample values and the residuals is associated with the regression of streamflow with basin characteristics. Equation 10 explains 50.4% of the variance in the sample values.

Because the multiregressive approach in Equation 10 does not rely on regionalization and yet produces streamflow estimates near in accuracy to the best regional estimates, given the first two criteria it would be considered the preferred regression model. However, at this time it is not known if Equation 10 is applicable to other regions of the state or if it truly represents a reasonable physical response of the Sangamon Basin. For these cautionary reasons it is suggested that the streamflow characteristics in more basins be studied before Equation 10 is used in the streamflow assessment model. The regressive equations following the form of Equation 9 have been adopted for use in the current model.

High Flows and Flow Duration Parameters

The mean squared error of the equations used to describe high flows and the flow duration (i.e. Equations 8, 10, 11, and 12) is shown in Table 6. The evaluation of these equations is very similar to that described above with reference to the low flow equations. Table 6 indicates that Equations 10, 11, and 12 are comparable in their estimation of the high flow values. However as evidenced by the MSEs, Equation 12 is considerably better than the others at estimating flow duration values. The form of Equations 11 and 12

Table 5. Analysis of Variance for the Estimation of the $Q_{7,10}$ Low Flow

Case 1: Regionalization Approach (Equation 9)

	d.f.	Sum of Squares	MSE
Sample Variation	9(n-1)	2.5884(100%)	.2876
Regression w/Drainage Area	1	0.1556(6.0%)	
Residual of Regression	8(n-2)	2.4328(94.0%)	.3041
Regionalization of Coefficients	3	1.7518(67.7%)	
Residual of Regionalization	5(n-5)	0.6810(26.3%)	.1362

Case 2: Multiregressive Approach (Equation 10)

	d.f.	Sum of Squares	MSE
Sample Variation	9(n-1)	2.5884(100%)	.2876
Regression w/Drainage Area	1	0.1556(6.0%)	
Regression with Slope	1	1.1490(44.4%)	
Residual of Regression	7(n-3)	1.2838(49.6%)	.1834

Table 6. Comparison of the Mean Squared Error between Regressive Methods; High Flows and Annual Flow Duration

		Mean Squared Error				
	Return	Original	Residuals from Equations			
Duration	interval	variation	(8)	(10)	(11)	(12)
1 day	2 (yrs)	177.7786	13.4255	11.8680	11.2776	10.1337*
	10	274.0954	16.4039	15.3345	12.8501*	13.1123
	25	316.5897	31.9358	30.9441	26.2090*	27.0654
	50	357.6934	52.7576	50.6289	49.9612	48.7129*
7 day	2 (yrs)	178.1071	3.0206	2.6604	2.922	2.1629*
	10	263.1737	9.9366	7.7664*	8.8658	8.7541
	25	284.7122	13.1502	9.6544*	11.6233	11.7226
	50	285.2799	17.6596	14.5776*	15.7332	15.6301
15 day	2 (yrs)	136.0262	2.0949	1.6979	2.2091	1.1620*
	10	215.3198	7.0854	4.5314*	6.7157	4.9034
	25	230.5559	8.5161	6.4923*	7.7935	7.1421
	50	231.7157	12.7194	10.8681*	11.7836	11.6088*
31 day	2 (yrs)	104.8598	1.1907	1.2156	1.1633*	1.5230
	10	175.5120	4.2596	3.7015*	4.0201	4.2112
	25	182.0654	6.1534	5.7305*	5.7309	6.2795
	50	184.6850	9.5711	9.1611	8.3132*	9.1086
61 day	2 (yrs)	90.0319	1.2384	1.2540	1.2740	1.2151*
	10	139.2810	4.5285	4.3783	4.1707*	5.3397
	25	153.0386	5.8323	5.7970	5.3627*	5.8062
	50	162.4775	10.8474	10.3829	9.7959*	10.5082
91 day	2 (yrs)	82.0669	1.3094	1.3394	1.1961	1.0048*
	10	126.1501	3.0803	2.7350	2.7076*	2.8400
	25	133.9803	3.9801	3.9370	3.6846*	3.8532
	50	135.9223	5.4534	5.4264	4.9526*	5.2501
Average		192.5474	10.2562	9.2534	9.1798	9.1270*
Flow Duration						
	1%	205.1287	3.5496	2.6229	3.5057	2.2199*
	2	178.8750	2.7966	1.4948*	2.7995	1.5590
	5	136.5296	2.0118	1.0903*	2.0040	1.2766
	10	99.6090	1.1642	1.1094	1.1516	.5978*
	15	80.4230	1.2669	1.2836	1.2916	.3976*
	25	60.4208	1.4255	1.3365	1.5952	.3491*
	40	39.8096	1.5848	1.1733	1.7664	.2141*
	50	30.3451	1.4330	1.0263	1.6082	.2718*
	60	23.3428	1.2296	.8852	1.4557	.2880*
	75	16.1278	1.0252	.4110	1.2921	.2634*
	85	10.3807	2.4228	.8398	3.0317	.2410*
	90	5.6354	1.9268	.6201	2.1876	.2390*
	95	4.0966	2.8421	.8347	2.9183	.3068*
	98	2.8314	2.5104	.9048	2.6489	.3548*
	99	3.2239	3.0389	1.2286*	3.4472	1.7335
Average		59.7798	2.0152	1.1241	2.1802	.6875*
Degrees of Freedom			n-4	n-3	n-2	n-5

is identical except that Equation 12 includes regionally-varied coefficients. Therefore the difference in the MSEs of the two equations can be attributed to the assumption of regional homogeneity. This difference is quite small for high flows, indicating that there is little regional difference in high flows within the Sangamon Basin. However, as shown in the estimation of flow duration values, the difference in the MSEs between Equation 11 and 12 becomes greater as the flow magnitude becomes lower (i.e. having a higher level of exceedance). For example, when dealing with exceedance levels greater than 90%, almost all of the reduction in variance associated with Equation 12 is due to the regionalization aspects of the regression. Though the multivariate approach of Equation 10 does not have as low MSEs as does Equation 12, on the average the multivariate technique is able to explain 70% of the variance which has been attributed to the assumption of regionalization in Equation 12. As before, however, there is some level of uncertainty associated with the overall applicability of this particular multivariate approach. Equation 12 is the equation chosen for use in the streamflow assessment model for describing high flows and flow duration values.

Application of the Virgin Flow Equations

Equations 9 and 12 were adopted for use in the Streamflow Assessment Model for the estimation of virgin flow at ungaged sites. The coefficients used in these equations are presented in Appendix A along with the standard error of estimate for each equation, which is given in units of $Q^{1/3}$. These equations should be used only for watersheds between 10 mi^2 and 2000 mi^2. The upper and lower bounds (Q_{upp} and Q_{low}) of the confidence intervals associated with the standard error of estimate, s_e, can be computed as follows:

$$Q_{upp} = (Q_v^{1/3} + z\ s_e)^3 \quad (14)$$

$$Q_{low} = (Q_v^{1/3} + z\ s_e)^3 \quad (15)$$

The value z is a function of the confidence interval of interest. For confidence intervals of 80%, 90%, and 95% the values of z are 1.282, 1.645, and 1.960, respectively.

As an example, assume that the value of the virgin flow, Q_v, for the streamflow parameter of interest is 15 cfs and the standard error of estimate is 0.3. The upper and lower bounds of the 90% confidence interval (z = 1.645) for the estimate of the virgin flow is:

$$Q_{upp} = [(15)^{1/3} + 1.645\ (0.3)]^3 = 25.9\ \text{cfs};$$

$$Q_{low} = [(15)^{1/3} + 1.645\ (0.3)]^3 = 7.7\ \text{cfs}.$$

ESTIMATING FLOW AT UNGAGED SITES: ADDITIONAL CONSIDERATIONS

The use of the virgin flow equations presented in the preceding chapter is only a preliminary step in the estimation of flow conditions at the site of interest. The best estimate of the virgin flow may at times be different than that produced by the equations depending on the availability of information at gaging sites. In addition, the present flow conditions at the site of interest can vary greatly from the estimated virgin flow due to the flow modifiers present upstream. This section of the report deals with the major aspects of applying this additional information for the computation of the present flow conditions at the point of interest.

Inclusion of Information from Nearby Gaged Sites

The virgin flows computed at gaged sites will generally not be the same values as those estimated by the virgin flow equations; the computed value is always considered superior to that produced by the equations. For ungaged sites which are located on the same stream as a gage, the estimates of virgin flow need to take advantage of the better information offered at the gage. In these cases the following methodologies are used to modify the virgin flow estimate.

There exist three different types of adjustments depending upon where the ungaged site is located with respect to the gaged sites on the stream; these being when 1) a gage exists both upstream and downstream of the site, 2) a gage exists only on the upstream side of the site, and 3) a gage exists only on the downstream side of the site. Let us represent the values estimated by the equations at the site of interest, the gage upstream, and the gage downstream by qv_i, qv_u, and qv_d, respectively. Also, let the difference between the virgin flow computed at the gage and the value estimated by the equations be represented by Δq_u for the nearest upstream gage and Δq_d for the nearest downstream gage. Then the adjustments made to compute the virgin flow, Q, ape as follows:

For gages both upstream and downstream:

$$Q = qv_i + \Delta q_d - (\Delta q_d - \Delta q_u)(qv_d - qv_i)/(qv_d - qv_u) \quad (16)$$

For gages only on the upstream side:

$$Q = qv_i + \Delta q_u \quad (17)$$

For gages only on the downstream side:

$$Q = qv_i \ (1 + \Delta q_d/qv_d) \quad (18)$$

Effect of Flow Modifiers on Downstream Sites

The estimation of present flow conditions for an ungaged site once the virgin flow has been computed involves accounting the effects of all of the flow modifiers upstream of that site. An entire list of major flow modifiers in the Sangamon River Basin is supplied in Appendix C. The estimated effect of each of these flow modifications in determining the present flow at the location of the flow modifiers is also given in Appendix C. These values represent the AQmod(i) term presented earlier in Equation 1. Further downstream, at the site of interest, the effect of the modifier is judged to be exactly the same value as what is given in Appendix C, with one major exception. When a discharge is made into a stream which is dry, i.e. has no flow, the volume of the discharged flow will usually be decreased through evaporation and infiltration into the stream bed as the flow progresses downstream. The expected loss is computed in the streamflow assessment model by the following equation:

$$\text{Loss (in cfs)} = .00814 \times L \times W \quad (19)$$

where L is the length of the stream reach in miles, and W is the width of the stream which is estimated from the flow amount, Q, and the drainage area, DA, by:

$$\log W = .345 \log Q + .155 \log DA + .608 \quad (20)$$

Equation 20 is an adaptation of the hydraulic geometry relationships given in Stall and Fok (1968). The calibration of the coefficient in Equation 19 was estimated through the examination of six gaging stations in central Illinois which exist downstream of an effluent into a dry stream.

The implementation of Equations 19 and 20 is usually completed in successive intermediate steps proceeding downstream from the location of the modifier to the site of interest. If at one of these intermediate locations the natural condition of the stream becomes wet, or has flow, the reduction of the effect of the discharge ceases.

Flow Conditions Downstream of Reservoirs

Major reservoirs will produce considerable changes in the flow characteristics of the streams on which they are located. Both peak flows and daily high flows will be diminished; the extent of this effect will depend on the storage-outflow relationship of the reservoir. The frequency of medium level flows will be increased by a reservoir and unless there exists a program for the release of minimum flows, the low flows will be drastically reduced. Even when minimum flows are released, the duration of the period of lowest flows is greatly extended.

To approximate the effect that the major reservoirs have on the present flow conditions in the basin, it was necessary to simulate inflow-outflow conditions. A reservoir routing model was developed whose inputs are the daily inflows, estimates of lake evaporation, and the storage-outflow relationship of the reservoir. Ground-water seepage was neglected. Using this model, a simulated record of daily outflows from each of the five major reservoirs in the basin was produced. As shown by the values in Table 7, each reservoir showed a reduction in the daily high flows. The amount of reduction was greatest for Clinton Lake, which has the most storage. For lakes with smaller amounts of above-spillway storage, such as Lake Springfield, the reduction in high flows much beyond a duration of one day is negligible.

For reservoirs in the South Fork Sangamon Basin (Region C) and for reservoirs in small basins the reduction of low flows is not exceptionably noticeable since there is little inflow. For Springfield, however, which withdraws a significant volume of water from the lake, the period of zero flow is considerably lengthened; for some years the routing model suggests there is no flow over the reservoir for as long as six months. For large basins which have relatively large low flows, the reduction in flow caused by the reservoir can be considerable. As shown in Table 7, there is significant reduction in the low flows for Lake Decatur and Clinton Lake.

Table 7. Estimates of Selected Streamflow Parameters of Inflow and Outflow for Major Reservoirs in the Sangamon River Basin

	Streamflow Parameters			
	$Q_{1,50}$ high flow	$Q_{7,10}$ high flow	$Q_{7,10}$ low flow	Q85
Clinton Lake				
Inflow	14500	3430	0.35	10.5
Outflow	8100	3050	0.0	1.1
Lake Decatur				
Inflow	20400	8340	7.8	30.4
Outflow	18100	8270	0.0	8.4
Sangchris Lake				
Inflow	4100	750	0.0	0.0
Outflow	1900	690	0.0	0.0
Lake Springfield				
Inflow	11500	3300	0.0	3.4
Outflow	10500	3300	0.0	0.0
Lake Taylorville				
Inflow	6600	1320	0.0	0.3
Outflow	4800	1320	0.0	0.0

UNCERTAINTIES IN FLOW ESTIMATION

The uncertainties associated with the development of the hydrologic information presented in the streamflow assessment model can be categorized into five elements, these being: 1) the natural variability of streamflow conditions to be expected within each designated region; 2) the error associated with the designation of the regions; 3) uncertainties in the model's algorithms which concern the effect of flow modifications on downstream sites (especially with regard to the losses associated with dry streams); 4) uncertainties in the separation of virgin flow and the flow modifiers; and 5) errors in the estimation of recurrence relationships. Given the present flow data, only the first of these elements is truly estimable, and is given for each region in Appendix A.

The uncertainties listed above are given in what is believed to be order of descending magnitude. Elements 4 and 5 may always be considered small in comparison to the first three. The uncertainty associated with the effect of flow modifications downstream is not usually a major concern, but in cases when a discharge is relatively large in comparison to the streamflow, this can easily be the greatest source of uncertainty in the estimate of present or altered conditions. Of particular concern in the Sangamon River Basin is the large effluent discharged into relatively dry streams at Bloomington-Normal and Taylorville.

The development of this model represents an exhaustive evaluation of the streamflow data available for the Sangamon River Basin. Therefore further data does not exist for verification of the model results. The greatest amount of uncertainty in the model output generally lies with the geographic limitation of the available data. For this reason, future improvement in the model's data as well as verification of the present output is most greatly dependent on the procurement of flow data (e.g. miscellaneous discharge measurements) at additional sites.

CONCLUSIONS

This report has presented the major analytical steps used to prepare the hydrologic data available in the Sangamon River Basin for use in the Illinois Streamflow Assessment Model. The three basic steps involved in estimating flow at any site in the basin are: 1) use of the virgin flow regressive equations, 2) adjustments in the virgin flow due to the proximity of gaging stations which have more precise information, and 3) the accounting of the effects of modifications to the flow from effluent discharges, withdrawals, and reservoirs. Streamflow information is supplied in Appendices A, B, and C which will allow a user to annually follow these steps to estimate the flow statistics at any location in the basin (with drainage area greater than 10 mi^2). However the user will undoubtedly want to use the Streamflow Assessment Model since the number of computations could be great. Readers are referred to the report Streamflow Assessment Model for the Sangamon River Basin in Illinois; User's Manual for a detailed description of how the model works.

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Appendix A. Coefficients of the Regional Virgin Flow Equations

Flow Duration Curves and High Flows: $Q = c\ DA\ + d$

Low Flows and Monthly Drought Flows: $Q = (\ c\ DA^{1/3} + d\ )^3$

	Region A			Regions B & D			Region C			standard error
ANNUAL FLOW DURATION	b	c	d	b	c	d	b	c	d	($cfs^{1/3}$)
MEAN	.985	.8097000	0.00	.979	.8139000	0.00	.985	.7333000	0.00	.0937
Q99	1.600	.0001364	-1.30	1.600	.0003740	-1.60	1.300	.0000490	-.17	1.3166
Q98	1.500	.0003460	-1.04	1.400	.0018930	-2.53	1.300	.0001420	-.33	.5957
Q95	1.500	.0005676	-1.13	1.400	.0022460	-1.37	1.300	.0005300	-.77	.5539
Q90	1.460	.0011240	-.90	1.400	.0028000	-.41	1.200	.0024340	-.66	.4889
Q85	1.450	.0017180	-1.14	1.330	.0057600	-.41	1.160	.0054600	-1.00	.4909
Q75	1.380	.0053150	-.20	1.260	.0142000	-.34	1.180	.0121900	-.74	.5132
Q60	1.270	.0289000	-.09	1.168	.0614000	-.27	1.115	.0489000	-.51	.5367
Q50	1.182	.0852000	-.11	1.129	.1244000	-.19	1.080	.1046400	-.90	.5213
Q40	1.050	.3030000	-.37	1.108	.2100000	-.34	1.060	.1942000	-1.81	.4627
Q25	1.010	.7700000	-.65	1.066	.4970000	-.52	1.020	.5528000	-4.23	.5908
Q15	.960	1.7400000	-1.33	1.017	1.0940000	-.70	1.020	1.0110000	-7.05	.6306
Q10	.940	2.7400000	-1.65	1.007	1.6050000	-.79	1.000	1.7700000	-10.50	.7732
Q05	.905	5.4900000	-3.46	.963	3.4060000	0.00	.990	3.4300000	-7.90	1.1299
Q02	.910	8.7000000	-4.50	.934	6.9200000	0.00	.958	6.9730000	-2.36	1.2486
Q01	.860	15.8000000	-11.51	.902	11.5660000	0.00	.845	19.5300000	-4.68	1.4899
MONTHLY DROUGHT FLOWS										
Q6,10	---	.4100000	-1.01	---	.5100000	-1.26	---	.2700000	-.36	.1637
Q9,10	---	.5000000	-.40	---	.5100000	-.16	---	.3700000	-.19	.2640
Q12,10	---	.6400000	-.22	---	.5700000	.17	---	.5400000	-.22	.2623
Q18,10	---	.7000000	-.12	---	.6200000	-.06	---	.6000000	-.14	.1761
Q30,10	---	.7700000	.04	---	.7600000	.04	---	.7000000	-.03	.1456
Q54,10	---	.8800000	.00	---	.8500000	-.09	---	.8400000	.02	.1729
Q6,25	---	.4000000	-1.10	---	.5000000	-1.42	---	.2300000	-.62	.1546
Q9,25	---	.4100000	-.57	---	.5000000	-.95	---	.2800000	-.22	.1962
Q12,25	---	.5600000	-.43	---	.5700000	-.78	---	.3600000	-.11	.2812
Q18,25	---	.5800000	-.38	---	.5500000	-.22	---	.4200000	-.06	.4442
Q30,25	---	.6700000	-.16	---	.6000000	-.06	---	.5300000	.04	.3214
Q54,25	---	.7300000	.03	---	.6700000	-.10	---	.6300000	-.04	.2851
Q6,50	---	.4100000	-1.33	---	.4700000	-1.46	---	.2200000	-.78	.1685
Q9,50	---	.4100000	-.88	---	.4600000	-.94	---	.2300000	-.22	.2184
Q12,50	---	.5000000	-.45	---	.5200000	-.89	---	.2600000	-.06	.2276
Q18,50	---	.5600000	-.58	---	.5500000	-.64	---	.2900000	-.04	.4207
Q30,50	---	.5800000	-.34	---	.6200000	-.57	---	.3800000	-.03	.2702
Q54,50	---	.6400000	-.08	---	.6300000	-.24	---	.4900000	-.05	.2550

	Region A			Regions B & D			Region C			standard error ($cfs^{1/3}$)
LOW FLOWS	b	c	d	b	c	d	b	c	d	
Q1,2	---	.4400000	-1.57	---	.5200000	-1.70	---	.3400000	-1.65	.2702
Q7,2	---	.4600000	-1.63	---	.5100000	-1.53	---	.3400000	-1.28	.2017
Q15,2	---	.4600000	-1.55	---	.5100000	-1.43	---	.3400000	-1.10	.1712
Q31,2	---	.4400000	-1.25	---	.5200000	-1.45	---	.3600000	-.93	.2015
Q61,2	---	.4900000	-1.35	---	.5100000	-1.18	---	.3600000	-.63	.1400
Q91,2	---	.4900000	-.96	---	.5100000	-.95	---	.4400000	-.78	.1655
Q1,10	---	.4000000	-2.28	---	.4800000	-2.05	---	.4000000	-3.80	.5068
Q7,10	---	.4200000	-2.30	---	.4700000	-1.88	---	.4000000	-3.48	.3691
Q15,10	---	.4300000	-2.25	---	.4600000	-1.75	---	.4000000	-3.12	.2510
Q31,10	---	.3600000	-1.50	---	.4600000	-1.63	---	.4000000	-2.94	.3600
Q61,10	---	.3800000	-1.45	---	.4600000	-1.48	---	.4000000	-2.44	.2830
Q91,10	---	.4000000	-1.53	---	.4400000	-1.20	---	.4000000	-2.00	.2057
Q1,25	---	.4000000	-2.74	---	.4700000	-2.18	---	.4000000	-4.14	.5203
Q7,25	---	.4000000	-2.62	---	.4700000	-2.08	---	.4000000	-3.84	.5188
Q15,25	---	.4300000	-2.63	---	.4600000	-1.92	---	.4000000	-3.50	.3641
Q31,25	---	.3600000	-1.82	---	.4500000	-1.74	---	.4000000	-3.34	.3464
Q61,25	---	.3800000	-1.75	---	.4500000	-1.60	---	.4000000	-2.87	.2124
Q91,25	---	.3800000	-1.60	---	.4400000	-1.43	---	.4000000	-2.46	.2209
Q1,50	---	.4000000	-2.94	---	.4700000	-2.30	---	.4000000	-4.30	.6992
Q7,50	---	.4000000	-2.82	---	.4700000	-2.23	---	.4000000	-4.01	.5235
Q15,50	---	.4400000	-2.90	---	.4700000	-2.15	---	.4000000	-3.68	.4602
Q31,50	---	.3700000	-2.05	---	.4600000	-1.96	---	.4000000	-3.54	.4287
Q61,50	---	.3900000	-2.00	---	.4600000	-1.82	---	.4000000	-3.09	.2691
Q91,50	---	.3800000	-1.70	---	.4600000	-1.76	---	.4000000	-2.74	.1895
HIGH FLOWS										
Q1,2	.778	36.0600000	0.00	.746	44.7300000	0.00	.687	62.7200000	0.00	3.1833
Q7,2	.884	11.6300000	0.00	1.009	4.5960000	0.00	.892	11.2600000	0.00	1.4707
Q15,2	.879	8.0200000	0.00	.963	4.0950000	0.00	.960	4.9000000	0.00	1.0780
Q31,2	.921	4.3700000	0.00	.982	2.5220000	0.00	.933	3.3300000	0.00	1.2341
Q61,2	.924	3.2000000	0.00	1.000	1.7450000	0.00	1.014	1.6700000	0.00	1.1023
Q91,2	.927	2.6100000	0.00	.990	1.6000000	0.00	1.020	1.3600000	0.00	1.0024
Q1,10	.650	162.3000000	0.00	.710	121.6100000	0.00	.727	119.1000000	0.00	3.6211
Q7,10	.722	55.9100000	0.00	.938	14.2600000	0.00	.869	27.3500000	0.00	2.9587
Q15,10	.802	22.3500000	0.00	.990	6.4490000	0.00	.962	10.1000000	0.00	2.2144
Q31,10	.848	12.1700000	0.00	1.009	4.1240000	0.00	.966	6.7300000	0.00	2.0521
Q61,10	.883	7.1400000	0.00	1.025	2.8330000	0.00	.878	7.0800000	0.00	2.3108
Q91,10	.914	4.7900000	0.00	.996	2.7310000	0.00	.985	3.5600000	0.00	1.6852
Q1,25	.614	268.8000000	0.00	.709	165.9700000	0.00	.699	188.7000000	0.00	5.2024
Q7,25	.693	84.2100000	0.00	.982	13.1500000	0.00	.837	36.6400000	0.00	3.4238
Q15,25	.766	34.1900000	0.00	1.007	7.0360000	0.00	.895	17.9500000	0.00	2.6725
Q31,25	.808	18.2200000	0.00	1.028	4.3730000	0.00	.963	7.6600000	0.00	2.5059
Q61,25	.868	9.1900000	0.00	1.001	4.1000000	0.00	.889	8.8500000	0.00	2.4096
Q91,25	.889	6.4800000	0.00	.992	3.4400000	0.00	.927	5.7100000	0.00	1.9630
Q1,50	.594	384.3000000	0.00	.683	243.6900000	0.00	.653	297.1000000	0.00	6.9794
Q7,50	.678	111.3300000	0.00	1.004	13.2900000	0.00	.775	60.9100000	0.00	3.9535
Q15,50	.741	47.0300000	0.00	1.029	6.9820000	0.00	.856	25.4800000	0.00	3.4072
Q31,50	.773	24.5600000	0.00	1.028	4.9810000	0.00	.921	10.7100000	0.00	3.0180
Q61,50	.847	11.3200000	0.00	.986	5.0130000	0.00	.933	7.2000000	0.00	3.2416
Q91,50	.863	8.1300000	0.00	.987	3.9380000	0.00	.862	9.1300000	0.00	2.2913

MONTHLY FLOW DURATION	Region A			Regions B & D			Region C			standard error
	b	c	d	b	c	d	b	c	d	
JAN MEAN	.932	1.2140000	0.00	.900	1.1980000	0.00	.970	.8454000	0.00	N/A
JAN Q98	1.800	.0000320	-.17	1.870	.0000708	0.00	1.300	.0003554	-.35	
JAN Q90	1.550	.0005538	-.75	1.465	.0018290	0.00	1.100	.0049140	-.62	
JAN Q75	1.050	.0536000	-1.55	1.120	.0316300	0.00	1.000	.0284000	-1.21	
JAN Q50	.980	.3152000	0.00	.992	.2564000	0.00	.940	.2464000	-1.51	
JAN Q25	.930	1.1280000	0.00	.910	1.1460000	0.00	1.040	.4779000	-1.33	
JAN Q10	.883	3.9160000	0.00	.919	2.5490000	0.00	1.020	1.4680000	0.00	
JAN Q02	.930	10.3800000	0.00	.879	10.0300000	0.00	.995	6.6740000	0.00	
FEB MEAN	.945	1.5000000	0.00	.960	1.1790000	0.00	1.040	.8588000	0.00	
FEB Q98	1.500	.0008310	-.85	1.580	.0007021	0.00	1.400	.0003123	-.40	
FEB Q90	1.340	.0047500	-.68	1.274	.0090400	0.00	1.080	.0111000	-.71	
FEB Q75	.985	.1201000	0.00	.940	.2087000	0.00	1.040	.0504900	-.22	
FEB Q50	1.005	.3950000	0.00	.980	.4577000	0.00	1.074	.2363000	-.82	
FEB Q25	.962	1.4590000	0.00	1.008	.9658000	0.00	1.170	.4184000	-1.48	
FEB Q10	.950	3.2780000	0.00	.974	2.3900000	0.00	1.040	2.0510000	0.00	
FEB Q02	.895	12.3400000	0.00	.956	7.5460000	0.00	.940	9.9600000	0.00	
MAR MEAN	1.015	1.1560000	0.00	.946	1.7020000	0.00	1.000	1.2260000	0.00	
MAR Q98	1.140	.0315000	-1.52	1.065	.0402200	0.00	1.400	.0008900	-.10	
MAR Q90	1.020	.1529000	-.52	.916	.2711000	0.00	1.040	.0870000	-. 60	
MAR Q75	1.070	.2151000	0.00	1.025	.2635000	0.00	1.020	.2276000	-1.45	
MAR Q50	1.020	.6920000	0.00	1.013	.6185000	0.00	1.040	.4760000	-2.37	
MAR Q25	1.002	1.5360000	0.00	1.025	1.1251000	0.00	1.056	.9496000	-5.70	
MAR Q10	.896	5.4260000	0.00	1.008	2.4530000	0.00	1.038	2.3140000	0.00	
MAR Q02	.938	8.0550000	0.00	.925	9.5890000	0.00	.937	11.1400000	0.00	
APR MEAN	.972	1.7780000	0.00	.980	1.6240000	0.00	.974	1.4750000	0.00	
APR Q98	1.030	.1075000	-2.66	.972	.0875300	0.00	1.500	.0016000	-.39	
APR Q90	1.150	.1175000	-.10	1.110	.1358000	0.00	1.030	.1171000	-1.10	
APR Q75	1.085	.2929000	-.09	1.098	.2659000	0.00	1.080	.1712000	-1.26	
APR Q50	1.050	.7236000	0.00	1.064	.5967000	0.00	1.013	.5577000	-4.20	
APR Q25	1.029	1.5240000	0.00	1.054	1.1460000	0.00	1.040	1.1030000	-8.10	
APR Q10	.987	3.4230000	0.00	1.000	2.8580000	0.00	1.027	2.5960000	0.00	
APR Q02	.944	8.8270000	0.00	.939	10.4850000	0.00	.840	17.7000000	0.00	
MAY MEAN	1.000	1.1480000	0.00	1.002	1.0790000	0.00	.973	1.1130000	0.00	
MAY Q98	1.000	.1187000	-3.16	.775	.3656000	0.00	1.300	.0058400	-2.00	
MAY Q90	1.106	.1277000	-.07	.990	.2213000	0.00	1.095	.0757000	-.32	
MAY Q75	1.060	.2610000	-.38	.973	.3940000	0.00	1.025	.1841000	-1.31	
MAY Q50	1.038	.4915000	0.00	.967	.7249000	0.00	1.036	.3300000	-2.34	
MAY Q25	1.100	.5100000	0.00	.980	1.2570000	0.00	1.005	.8562000	-6.55	
MAY Q10	1.021	2.0740000	0.00	.972	2.6020000	0.00	1.079	1.3670000	0.00	
MAY Q02	.940	8.0360000	0.00	.954	7.1140000	0.00	.911	11.3060000	0.00	
JUN MEAN	1.020	.8614000	0.00	1.003	.9656000	0.00	.937	1.5720000	0.00	
JUN Q98	1.300	.0098500	-.67	1.095	.0339500	0.00	1.300	.0104100	-2.00	
JUN Q90	1.300	.0214000	-.06	1.210	.0424300	0.00	1.200	.0240000	-1.24	
JUN Q75	1.200	.0645800	-.05	1.160	.0968800	0.00	1.110	.0718000	-.94	
JUN Q50	.992	.4361000	0.00	1.103	.2562000	0.00	1.123	.1617000	-1. 78	
JUN Q25	.980	1.1410000	0.00	1.035	.8319000	0.00	1.105	.5044000	-5.40	
JUN Q10	.965	2.9620000	0.00	.986	2.3720000	0.00	1.120	1.1360000	0.00	
JUN Q02	.958	8.0360000	0.00	.921	9.0420000	0.00	.900	11.9800000	0.00	

MONTHLY FLOW DURATION	Region A			Regions B & D			Region C			standard error
	b	c	d	b	c	d	b	c	d	
JUL MEAN	1.070	.3794000	0.00	1.120	.2665000	0.00	1.118	.2509000	0.00	N/A
JUL Q98	1.700	.0002580	-.96	1.584	.0007645	0.00	1.300	.0005000	-2.00	
JUL Q90	1.400	.0039400	-.48	1.195	.0180000	0.00	1.000	.0171200	-.69	
JUL Q75	1.350	.0120900	-.28	1.210	.0361500	0.00	1.200	.0184400	-1.14	
JUL Q50	1.155	.0923000	0.00	1.225	.0687100	0.00	1.170	.0546500	-.68	
JUL Q25	1.080	.3537000	0.00	1.141	.2406000	0.00	1.096	.2268000	-2.23	
JUL Q10	1.100	.8960000	0.00	1.137	.5157000	0.00	1.250	.2634000	0.00	
JUL Q02	.879	8.2620000	0.00	1.034	3.1830000	0.00	.967	4.9500000	0.00	
AUG MEAN	1.107	.1716000	0.00	1.000	.3874000	0.00	1.080	.2168000	0.00	
AUG Q98	1.100	.0114300	-4.80	1.777	.0001470	0.00	1.300	.0004400	-2.00	
AUG Q90	1.700	.0002820	-2.06	1.440	.0023500	0.00	1.100	.0045900	-1.43	
AUG Q75	1.800	.0002280	-.08	1.245	.0119300	0.00	1.160	.0103200	-1.28	
AUG Q50	1.450	.0043000	0.00	1.212	.0265800	0.00	1.190	.0199400	-.26	
AUG Q25	1.180	.0540000	0.00	1.270	.0410000	0.00	1.240	.0513000	-.55	
AUG Q10	.953	.9129000	0.00	1.104	.3177000	0.00	1.150	.3160000	-1.13	
AUG Q02	1.064	2.3780000	0.00	1.104	1.3120000	0.00	.952	3.9570000	0.00	
SEP MEAN	1.090	.1030000	0.00	1.110	.0871600	0.00	.914	.2456000	0.00	
SEP Q98	1.900	.0000159	-.93	2.090	.0000110	0.00	1.300	.0003100	-2.00	
SEP Q90	2.000	.0000188	-.78	1.700	.0002800	0.00	1.100	.0020000	-.82	
SEP Q75	1.800	.0001344	-.75	1.500	.0015667	0.00	1.160	.0044300	-1.35	
SEP Q50	1.640	.0007240	0.00	1.300	.0081770	0.00	1.160	.0103300	-.60	
SEP Q25	1.213	.0264000	0.00	1.215	.0205200	0.00	1.200	.0198500	-.15	
SEP Q10	1.150	.1348000	0.00	1.270	.0578000	0.00	1.100	.1414000	-.30	
SEP Q02	1.014	1.5930000	0.00	.956	2.0000000	0.00	.960	1.8300000	0.00	
OCT MEAN	1.100	.1553000	0.00	1.075	.1431000	0.00	.920	.3444000	0.00	
OCT Q98	1.700	.0000484	-1.10	2.110	.0000095	0.00	1.300	.0002700	-2.00	
OCT Q90	1.700	.0001086	-.74	1.700	.0002770	0.00	1.100	.0009230	-.42	
OCT Q75	1.600	.0004340	-.72	1.510	.0013800	0.00	1.300	.0009580	-.22	
OCT Q50	1.400	.0032260	0.00	1.300	.0080750	0.00	1.200	.0087840	-.47	
OCT Q25	1.150	.0691000	0.00	1.265	.0327000	0.00	1.020	.1114000	-.95	
OCT Q10	1.032	.4813000	0.00	1.038	.3626000	0.00	.900	.5901000	-2.08	
OCT Q02	1.010	1.8680000	0.00	1.038	1.3850000	0.00	.970	1.6800000	0.00	
NOV MEAN	1.040	.2304900	0.00	.953	.3262000	0.00	.940	.3174000	0.00	
NOV Q98	1.500	.0002650	-.67	1.900	.0000533	0.00	1.300	.0003500	-2.00	
NOV Q90	1.400	.0009000	-.64	1.570	.0007640	0.00	1.100	.0019320	-.55	
NOV Q75	1.620	.0005017	0.00	1.335	.0052700	0.00	.970	.0153000	-.85	
NOV Q50	1.110	.0360000	0.00	.975	.0917200	0.00	.950	.0837200	-.63	
NOV Q25	1.085	.1562000	0.00	1.000	.2712000	0.00	.900	.3734000	-1.73	
NOV Q10	.997	.6782000	0.00	.993	.6437000	0.00	.940	.9186000	-2.19	
NOV Q02	.960	2.4350000	0.00	1.022	1.5550000	0.00	.970	2.1790000	0.00	
DEC QMEAN	.923	.9485000	0.00	.960	.5693000	0.00	.932	.8242000	0.00	
DEC Q98	1.800	.0000410	-.59	1.925	.0000447	0.00	1.200	.0004555	-2.54	
DEC Q90	1.300	.0021840	-1.00	1.540	.0009670	0.00	1.100	.0046750	-1.14	
DEC Q75	1.500	.0015570	-.70	1.370	.0040780	0.00	1.080	.0142000	-1.14	
DEC Q50	1.015	.1284000	0.00	.984	.0886700	0.00	.870	.1981000	-.82	
DEC Q25	.932	.7366000	0.00	.850	.8545000	0.00	.987	.3930000	-1.83	
DEC Q10	.970	1.8480000	0.00	.690	6.4150000	0.00	.990	1.3580000	-.72	
DEC Q02	.983	5.6190000	0.00	.650	24.5380000	0.00	.964	6.7514000	0.00	

Appendix B. Estimated Values of Virgin and Present Flow Conditions; Sangamon River Basin.

Index #	Location	Description	Flow Conditions
1	Sangamon R., mile 27.3	USGS Gage 05583000	Virgin
2	Sangamon R., mile 36.1	D/S of Salt Creek	Virgin
3	Sangamon R., mile 36.1	D/S of Salt Creek	Present
4	Sangamon R.. mile 36.2	U/S of Salt Creek	Virgin
5	Sangamon R., mile 75.0	D/S of Spring Creek	Virgin
6	Sangamon R., mile 75.0	D/S of Spring Creek	Present
7	Sangamon R., mile 84.7	USGS Gage 05576500	Virgin
8	Sangamon R., mile 84.7	USGS Gage 05576500	Present
9	Sangamon R., mile 87.0	U/S of South Fork	Virgin
10	Sangamon R., mile 127.3	D/S of Stevens Creek	Virgin
11	Sangamon R. , mile 127.3	D/S of Stevens Creek	Present
12	Sangamon R., mile 130.8	D/S of Lake Decatur	Virgin
13	Sangamon R., mile 130.8	D/S of Lake Decatur	Present
14	Sangamon R., mile 144.3	USGS Gage 05572500	Virgin
15	Sangamon R., mile 162.6	USGS Gage 05572000	Virgin
16	Sangamon R. , mile 162.6	USGS Gage 05572000	Present
17	Sangamon R., mile 186.1	USGS Gage 05571000	Virgin
18	Salt Creek, mile 4.9	USGS Gage 05582000	Virgin
19	Salt Creek, mile 11.0	D/S of Sugar Creek	Virgin
20	Salt Creek, mile 11.0	D/S of Sugar Creek	Present
21	Salt Creek, mile 11.1	U/S of Sugar Creek	Virgin
22	Salt Creek, mile 32.6	D/S of Lake Fork	Virgin
23	Salt Creek, mile 63.5	USGS Gage 05578500	Virgin
24	Salt Creek, mile 63.5	USGS Gage 05578500	Present
25	Salt Creek, mile 76.2	D/S of Clinton Lake	Virgin
26	Salt Creek, mile 76.2	D/S of Clinton Lake	Present
27	Sugar Creek, mile 48.8	USGS Gage 05580950	Virgin
28	Sugar Creek, mile 48.8	USGS Gage 05580950	Present
29	Kickapoo Cr., mile 26.2	USGS Gage 05580000	Virgin/Present
30	Lake Fork, mile 12.9	USGS Gage 05579500	Virgin/Present
31	Spring Creek, mile 8.2	USGS Gage 05577500	Virgin/Present
32	Sugar Creek, mile 8.4	D/S of Lake Springfield	Virgin
33	Sugar Creek, mile 8.4	D/S of Lake Springfield	Present
34	Sugar Creek, mile 30.3	IDOT Gage	Virgin/Present
35	South Fork, mile 7.4	USGS Gage 05576000	Virgin
36	South Fork, mile 7.4	USGS Gage 05576000	Present
37	South Fork, mile 57.3	D/S of Flat Branch	Virgin
38	South Fork, mile 57.3	D/S of Flat Branch	Present
39	South Fork, mile 59.0	D/S of Lake Taylorville	Virgin
40	South Fork, mile 59.0	D/S of Lake Taylorville	Present
41	South Fork, mile 81.5	USGS Gage 05574000	Virgin/Present
42	Clear Creek, mile 1.0	D/S of Lake Sangchris	Present
43	Flat Branch, mile 1.6	USGS Gage 05574500	Virgin/Present
44	Friends Creek, mile 6.1	USGS Gage 05572450	Virgin/Present

ANNUAL FLOW DURATION VALUES

	MEAN	Q99	Q98	Q95	Q90	Q85	Q75	Q60	Q50	Q40	Q25	Q15	Q10	Q05	Q02	Q01
1)	3264.0	143.00	163.00	198.00	254.00	305.00	479.00	1016.00	1505.00	2170.0	3810.0	6110.0	8470.0	12560.	18590.	23100.
2)	3192.0	134.00	154.00	188.00	241.00	291.00	461.00	983.00	1460.00	2110.0	3710.0	5970.0	8280.0	12300.	18190.	22600.
3)	3270.0	203.00	224.00	265.00	320.00	372.00	551.00	1095.00	1575.00	2225.0	3810.0	6070.0	8320.0	12340.	17990.	22140.
4)	2069.0	49.00	53.00	71.00	98.00	126.00	209.00	518.00	835.00	1245.0	2320.0	3850.0	5460.0	8640.	13550.	17860.
5)	1897.0	32.00	37.00	51.00	74.00	98.00	172.00	448.00	735.00	1105.0	2090.0	3530.0	5025.0	8010.	12580.	16650.
6)	1944.0	85.00	89.00	106.00	126.00	150.00	237.00	531.00	815.00	1180.0	2130.0	3550.0	4980.0	7980.	12440.	16380.
7)	1733.0	17.20	21.40	32.60	51.00	73.00	138.00	382.00	640.00	970.0	1870.0	3220.0	4610.0	7420.	11650.	15480.
8)	1750.0	54.00	57.00	69.00	83.00	104.00	179.00	437.00	689.00	1015.0	1870.0	3190.0	4520.0	7340.	11450.	15150.
9)	968.0	13.40	16.60	25.30	37.00	46.00	71.00	187.00	343.00	510.0	1040.0	1730.0	2450.0	3890.	6150.	8070.
10)	706.0	6.80	9.30	15.70	24.00	31.50	53.00	143.00	238.00	382.0	770.0	1290.0	1830.0	2900.	4550.	6120.
11)	739.0	34.80	36.50	40.30	44.70	50.70	88.00	208.00	315.00	458.0	803.0	1280.0	1760.0	2820.	4420.	5790.
12)	656.0	5.40	7.60	12.90	21.20	28.40	49.00	133.00	221.00	352.0	705.0	1180.0	1690.0	2630.	4180.	5650.
13)	635.0	.90	1.60	3.00	4.80	8.00	47.00	157.00	256.00	384.0	685.0	1120.0	1570.0	2480.	3990.	5260.
14)	566.8	3.55	5.27	9.18	19.40	29.00	52.60	131.00	218.00	325.0	606.0	1050.0	1490.0	2240.	3310.	4400.
15)	404.7	2.20	3.80	6.70	11.00	15.50	31.00	86.00	145.00	228.0	440.0	735.0	1050.0	1650.	1670.	3690.
16)	406.1	2.70	4.30	7.30	11.70	16.40	32.00	87.00	146.00	230.0	442.0	737.0	1052.0	1650.	2670.	3690.
17)	268.9	.40	.90	2.80	5.40	8.00	16.00	47.00	84.00	140.0	275.0	470.0	650.0	1070.	1900.	2800.
18)	1254.0	59.00	66.00	80.00	101.00	123.00	180.00	390.00	590.00	851.0	1470.0	2240.0	3050.0	4660.	7610.	10010.
19)	1203.0	55.00	62.00	75.00	95.00	116.00	170.00	371.00	562.00	811.0	1405.0	2140.0	2920.0	4470.	7310.	9630.
20)	1234.0	71.00	80.00	97.00	122.00	145.00	195.00	400.00	596.00	850.0	1465.0	2220.0	3000.0	4540.	7250.	9520.
21)	858.0	44.70	53.00	69.00	89.00	104.00	143.00	251.00	424.00	613.0	1055.0	1610.0	2160.0	3290.	5390.	7440.
22)	536.0	15.40	19.00	24.10	31.10	40.00	60.00	142.00	222.00	330.0	584.0	921.0	1280.0	2040.	3365.	4590.
23)	246.5	1.90	3.40	6.40	9.60	13.10	22.80	56.50	90.60	136.0	254.0	418.0	590.0	986.	1640.	2270.
24)	246.5	2.30	2.70	3.20	3.60	5.00	21.30	60.00	96.00	147.0	279.0	456.0	618.0	1001.	1530.	2130.
25)	213.4	.80	1.90	4.40	7.30	10.50	18.70	48.00	78.00	117.0	220.0	362.0	514.0	861.	1445.	1920.
26)	211.7	0.00	0.00	0.00	0.00	1.10	15.70	50.00	82.00	126.0	243.0	398.0	540.0	874.	1334.	1782.
27)	26.0	0.00	0.00	0.00	0.00	.20	.90	3.60	6.60	10.2	21.1	39.0	56.0	103.	260.	423.
28)	50.4	12.10	13.00	14.30	15.80	17.00	19.00	23.60	29.20	34.0	49.0	75.0	94.0	143.	304.	468.
29)	158.1	.60	1.20	2.20	4.30	6.20	11.50	33.00	55.00	84.0	150.0	255.0	360.0	580.	1030.	1550.
30)	156.6	2.20	3.00	4.40	6.20	8.20	11.40	33.00	55.00	85.0	150.0	248.0	360.0	580.	1000.	1450.
31)	65.3	0.00	0.00	0.00	0.00	.23	2.20	9.00	18.00	28.5	57.0	101.0	148.0	270.	500.	760.
32)	191.0	0.00	0.00	.40	1.80	3.40	9.30	28.80	49.00	79.0	163.0	297.0	439.0	846.	1620.	2180.
33)	176.0	7.70	8.20	9.10	10.00	11.00	12.70	15.00	17.00	41.0	131.0	273.0	419.0	849.	1580.	2200.
34)	29.2	0.00	0.00	0.00	0.00	0.00	.46	2.80	4.50	6.7	15.4	34.0	58.0	119.	277.	560.
35)	572.2	.10	.70	2.90	7.60	13.00	35.00	92.00	156.00	250.0	540.0	1000.0	1520.0	2770.	4550.	6000.
36)	570.5	.40	.80	5.00	9.70	15.00	37.00	95.00	159.00	253.0	544.0	1005.0	1520.0	2770.	4550.	6000.
37)	283.0	0.00	.01	.70	2.70	5.30	14.70	47.00	76.00	119.0	244.0	435.0	640.0	1195.	2190.	3110.
38)	273.0	0.00	0.00	.37	2.20	4.80	14.30	48.00	80.00	125.0	255.0	453.0	666.0	1250.	2260.	3220.
39)	76.3	0.00	0.00	0.00	0.00	.30	2.50	11.30	21.20	34.1	66.8	118.0	174.0	311.	603.	900.
40)	75.9	0.00	0.00	0.00	0.00	0.00	1.10	10.00	20.30	33.8	69.0	123.0	183.0	326.	580.	884.
41)	7.3	0.00	0.00	0.00	0.00	0.00	0.00	.26	.60	1.1	2.7	5.3	9.2	27.	76.	135.
42)	44.4	0.00	0.00	0.00	0.00	0.00	0.00	1.60	10.80	21.0	47.0	86.0	124.0	206.	323.	430.
43)	200.9	0.00	0.00	.36	1.90	3.40	9.00	30.00	51.00	82.0	170.0	308.0	455.0	890.	1710.	2350.
44)	91.2	0.00	0.00	0.00	0.00	0.00	1.20	14.00	25.00	43.0	92.0	168.0	240.0	420.	680.	820.

LOW FLOW VALUES -- DURATION (DAYS), RETURN INTERVAL (YEARS)

	1,2	7,2	15,2	31,2	61,2	91,2	1,10	7,10	15,10	31,10	61,10	91,10	1,25	7,25	15,25	31,25
1)	242.00	258.00	280.00	314.00	393.00	450.00	139.00	147.00	155.00	164.00	178.00	196.00	112.00	118.00	125.00	134.00
2)	232.00	248.00	270.00	303.00	382.00	439.00	132.00	140.00	148.00	157.00	171.00	189.00	106.00	112.00	119.00	128.00
3)	299.00	318.00	342.00	374.00	456.00	515.00	198.00	208.00	219.00	230.00	241.00	261.00	171.00	180.00	189.00	201.00
4)	88.00	95.00	105.00	119.00	139.00	178.00	38.00	40.00	42.00	46.00	54.00	59.00	30.00	32.30	35.00	37.40
5)	67.00	74.00	83.00	96.00	115.00	152.00	24.00	26.30	28.50	31.90	39.00	45.00	17.50	19.60	22.40	25.00
6)	122.00	130.00	140.00	152.00	170.00	208.00	76.00	80.00	84.00	90.00	94.00	101.00	69.00	73.00	71.00	81.00
7)	47.00	54.00	62.00	74.00	93.00	128.00	11.00	13.40	16.00	18.70	24.60	31.50	6.20	7.80	10.80	13.40
8)	79.00	87.00	95.00	105.00	125.00	158.00	46.00	49.00	52.00	54.00	60.00	64.00	41.00	45.00	48.00	50.00
9)	33.00	37.00	40.00	45.00	53.00	71.00	9.40	10.90	12.30	14.40	18.60	22.00	5.80	7.20	8.80	10.80
10)	20.70	23.20	25.80	29.20	36.00	50.00	5.40	7.30	9.00	9.60	12.60	15.80	2.20	2.40	5.00	5.90
11)	42.00	44.50	46.00	470.50	56.00	72.00	32.00	34.00	35.00	35.40	38.00	39.00	30.50	32.20	33.20	33.60
12)	17.00	20.60	23.00	25.80	33.00	46.00	4.20	5.80	7.40	8.00	10.40	13.30	1.60	2.10	3.80	4.80
13)	3.60	4.50	5.30	6.60	11.20	26.00	0.00	0.00	0.00	0.00	.80	1.40	0.00	0.00	0.00	0.00
14)	12.00	17.00	19.20	22.50	31.00	45.00	2.70	3.80	4.80	5.80	7.50	9.80	.80	1.20	2.30	3.30
15)	8.30	10.20	11.60	13.40	18.80	27.00	1.00	1.60	2.20	3.10	4.60	5.50	.10	.30	.80	1.50
16)	8.80	10.70	12.20	14.30	19.80	28.20	1.40	2.00	2.70	3.60	5.10	6.10	.20	.50	1.10	1.90
17)	3.90	4.50	5.30	7.00	9.60	16.40	.10	.25	.60	1.40	2.60	3.00	0.00	0.00	.12	.30
18)	99.10	102.00	109.00	116.00	127.00	145.00	54.50	56.60	57.20	62.50	68.70	71.70	44.40	48.00	49.30	52.30
19)	93.50	97.00	103.00	110.00	121.00	138.00	51.00	53.00	53.60	58.30	66.00	68.00	41.40	45.00	46.30	49.00
20)	106.00	111.00	118.00	125.00	140.00	158.00	65.00	67.00	69.00	75.00	82.00	84.00	54.00	59.00	61.00	65.00
21)	60.00	63.00	67.00	73.00	82.00	95.00	29.70	31.80	32.60	36.30	41.00	44.00	23.30	25.70	27.20	29.00
22)	30.80	33.10	36.00	41.00	47.00	56.00	12.40	14.30	15.20	17.30	20.80	22.70	9.00	10.50	11.40	12.40
23)	7.00	8.00	9.00	11.90	15.50	20.00	.70	1.70	2.10	2.80	4.80	6.00	.15	.50	.80	1.10
24)	3.00	3.40	3.50	5.00	10.80	15.20	1.80	2.60	2.70	2.80	3.00	3.00	1.30	1.70	2.00	2.10
25)	5.20	5.80	7.00	9.40	13.20	16.50	.10	.35	.60	1.20	3.00	4.20	0.00	0.00	0.00	.20
26)	0.00	0.00	0.00	1.20	7.20	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27)	0.00	0.00	0.00	.01	.11	.36	0.00	0.00	0.00	0.00	0.00	.01	0.00	0.00	0.00	0.00
28)	13.60	14.40	15.30	16.70	18.30	20.40	9.00	10.60	11.50	12.60	13.60	14.50	8.40	9.60	10.30	10.80
29)	2.70	3.60	4.60	5.00	7.00	9.80	.70	.80	1.00	1.30	2.10	2.80	.30	.40	.55	.75
30)	6.00	7.00	8.00	9.00	10.30	12.50	2.10	2.50	2.80	3.20	3.60	4.20	1.30	1.60	1.80	2.00
31)	0.00	0.00	.12	.70	1.30	3.90	0.00	0.00	0.00	0.00	0.00	.13	0.00	0.00	0.00	0.00
32)	1.50	2.10	2.30	3.40	6.00	12.90	0.00	0.00	0.00	0.00	.20	.60	0.00	0.00	0.00	0.00
33)	9.50	11.30	12.00	13.00	15.00	17.00	6.70	7.50	8.20	8.50	9.00	9.80	5.60	7.00	7.30	7.60
34)	0.00	0.00	0.00	.80	.50	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35)	3.60	7.00	9.40	14.00	22.00	39.00	0.00	.13	.40	.70	2.40	5.30	0.00	0.00	0.00	.20
36)	5.70	9.10	11.50	16.00	24.00	41.00	.70	.80	.80	.90	2.00	3.20	.25	.40	.40	.50
37)	1.80	2.60	4.40	6.20	10.80	20.50	0.00	0.00	0.00	.25	.75	1.50	0.00	0.00	0.00	0.00
38)	1.70	2.50	4.20	6.00	10.40	20.10	0.00	0.00	0.00	0.00	.25	.60	0.00	0.00	0.00	0.00
39)	0.00	0.00	.20	.80	2.00	4.00	0.00	0.00	0.00	0.00	0.00	.10	0.00	0.00	0.00	0.00
40)	0.00	0.00	0.00	0.00	.90	2.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41)	0.00	0.00	0.00	.03	.13	.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42)	0.00	0.00	0.00	0.00	0.00	.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43)	1.60	2.20	2.50	3.70	6.40	13.60	0.00	0.00	0.00	.01	.40	.90	0.00	0.00	0.00	0.00
44)	0.00	.05	.10	.18	.75	2.20	0.00	0.00	0.00	0.00	0.00	.05	0.00	0.00	0.00	0.00

	LOW FLOWS -- DURATION (DAYS), RETURN INTERVAL (YEARS)								HIGH FLOWS -- DURATION (DAYS), RETURN INTERVAL (YEARS)							
	61,25	91,25	1,50	7,50	15,50	31,50	61,50	91,50	1,2	7,2	15,2	31,2	61,2	91,2	1,10	7,10
1)	148.00	165.00	91.00	97.00	103.00	112.00	126.00	140.00	21800.	18500.	15100.	11200.	8400.	7250.	42200.	33300.
2)	142.00	159.00	85.00	91.00	97.00	106.00	120.00	134.00	21400.	18000.	14800.	11000.	8210.	7090.	41400.	32400.
3)	213.00	229.00	145.00	153.00	160.00	172.00	188.00	203.00	21000.	17800.	14700.	10900.	8190.	7090.	40900.	32300.
4)	43.00	47.00	27.80	29.80	32.40	34.70	40.00	44.00	18000.	14200.	10260.	7470.	5470.	4530.	31800.	25100.
5)	29.90	34.20	16.30	18.00	20.00	22.40	26.70	30.30	16900.	12900.	9510.	6920.	5025.	4160.	29600.	23000.
6)	86.00	89.00	64.00	67.00	69.00	73.00	80.00	85.00	16200.	12600.	9410.	6820.	5000.	4160.	29100.	23000.
7)	17.60	22.00	5.60	7.00	8.60	11.00	14.50	17.80	15800.	11700.	8800.	6400.	4600.	3800.	27500.	21000.
8)	53.00	55.00	40.00	44.00	45.00	46.00	48.00	51.00	15100.	11400.	8700.	6300.	4570.	3800.	27000.	21000.
9)	14.20	17.00	4.80	5.80	7.60	9.90	13.50	15.60	12800.	7900.	5060.	3480.	2700.	2150.	20000.	12100.
10)	9.50	11.70	1.30	1.80	3.30	4.80	7.30	10.00	9380.	5400.	3390.	2530.	1980.	1560.	14600.	8950.
11)	35.00	36.00	30.00	31.50	32.50	32.80	34.00	35.00	8850.	5120.	3300.	2450.	1950.	1560.	14400.	8950.
12)	7.90	9.80	.90	1.20	2.30	3.80	5.90	8.30	8750.	4930.	3070.	2290.	1800.	1410.	13600.	8340.
13)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8150.	4580.	2920.	2150.	1720.	1360.	13300.	8270.
14)	4.80	6.20	.40	.69	1.14	2.40	4.00	5.40	5500.	4100.	2600.	1930.	1450.	1300.	12100.	7400.
15)	2.70	3.60	0.00	.10	.50	1.20	2.20	3.10	4900.	3120.	2080.	1450.	1080.	910.	10000.	5380.
16)	3.20	4.10	0.00	.30	.70	1.60	2.60	3.60	4900.	3120.	2080.	1450.	1080.	910.	10000.	5380.
17)	.80	1.70	0.00	0.00	0.00	.10	.35	1.20	3900.	2220.	1450.	1010.	740.	590.	8600.	4300.
18)	58.30	60.60	39.90	42.60	45.40	48.30	53.50	56.60	12000.	8900.	5600.	3970.	3150.	2680.	25000.	16200.
19)	55.00	57.00	37.20	39.60	42.40	45.10	50.00	53.00	11600.	8520.	5370.	3820.	3020.	2570.	24200.	15500.
20)	70.00	72.00	49.00	53.00	56.00	60.00	65.00	68.00	11600.	8450.	5370.	3820.	3020.	2570.	22900.	15380.
21)	33.40	36.00	20.40	22.20	24.00	25.90	30.00	31.80	9900.	5900.	3950.	3020.	2280.	1850.	21300.	12400.
22)	15.20	17.00	7.40	8.20	9.20	10.30	12.60	14.10	5880.	3730.	2330.	1760.	1360.	1140.	14500.	7480.
23)	2.50	3.60	0.00	.10	.25	.40	1.40	2.20	3200.	1700.	1160.	820.	640.	540.	8900.	4000.
24)	2.40	2.50	1.10	1.20	1.40	1.60	2.00	2.20	2250.	1480.	1160.	820.	640.	540.	5600.	3620.
25)	1.30	2.30	0.00	0.00	0.00	0.00	.60	1.20	2720.	1560.	1030.	715.	560.	455.	7700.	3430.
26)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1770.	1340.	1030.	715.	560.	455.	4400.	3050.
27)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	733.	248.	172.	149.	115.	95.	1760.	595.
28)	12.00	12.80	8.00	9.10	9.70	10.20	11.00	11.60	781.	291.	213.	189.	154.	133.	1810.	642.
29)	1.30	1.70	.15	.20	.30	.45	.80	1.10	3300.	1210.	820.	560.	415.	370.	1300.	2600.
30)	2.20	2.50	.80	1.00	1.20	1.40	1.50	1.80	1640.	1000.	700.	500.	385.	320.	4300.	2450.
31)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1250.	560.	345.	280.	170.	132.	3600.	1100.
32)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3350.	1730.	1080.	695.	480.	385.	7400.	3300.
33)	8.10	9.00	5.20	6.30	6.50	6.80	7.50	8.50	2950.	1730.	1080.	695.	480.	385.	6400.	3300.
34)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	975.	400.	232.	135.	90.	70.	1640.	670.
35)	.90	2.30	0.00	0.00	0.00	0.00	.50	1.20	5250.	4500.	3140.	2070.	1550.	1320.	12300.	8900.
36)	.90	1.50	.05	.10	.12	.20	.40	.80	5250.	4500.	3140.	2070.	1550.	1320.	12300.	8900.
37)	.20	.45	0.00	0.00	0.00	0.00	.05	.20	4550.	2470.	1520.	960.	660.	530.	8600.	3980.
38)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4550.	2470.	1520.	960.	660.	530.	8600.	3980.
39)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1530.	710.	460.	305.	218.	172.	4100.	1320.
40)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1380.	710.	460.	305.	218.	172.	3250.	1320.
41)	0.00	0.00	0.00	0.00	0,00	0.00	0.00	0.00	290.	72.	45.	28.	19.	17.	900.	215.
42)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	490.	355.	235.	190.	115.	90.	1230.	6900.
43)	0.00	.01	0.00	0.00	0.00	0.00	0.00	0.00	3460.	1740.	1080.	695.	480.	390.	7300.	3820.
44)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1170.	700.	500.	330.	250.	210.	2950.	1420.

HIGH FLOW VALUES -- DURATION (DAYS), RETURN INTERVAL (YEARS)

	15,10	31,10	61,10	91,10	1,25	7,25	15,25	31,25	61,25	91,25	1,50	7,50	15,50	31,50	61,50	91,50
1)	25100.	19000.	15000.	12400.	59000.	43200.	31200.	22500.	18300.	14700.	77000.	54800.	37500.	26700.	20800.	16300.
2)	24500.	18500.	14400.	12100.	57900.	42000.	30400.	21900.	17800.	19300.	75800.	53300.	36500.	26000.	20300.	15900.
3)	24400.	18400.	14330.	12100.	56600.	41700.	30300.	21800.	17700.	14300.	73300.	53000.	36300.	25900.	20200.	15900.
4)	18600.	13440.	10270.	8410.	41800.	32100.	23300.	16800.	12470.	9810.	55700.	43900.	30000.	19700.	14100.	10460.
5)	17100.	12300.	9360.	7740.	38900.	29200.	21400.	15370.	11410.	8980.	52300.	40300.	27700.	18070.	12980.	9560.
6)	17000.	12200.	9260.	7740.	37900.	28900.	21300.	15270.	11310.	8980.	49800.	39900.	27500.	18000.	12880.	9580.
7)	15700.	11200.	8500.	7100.	36000.	26500.	19600.	14000.	10400.	8200.	49000.	37000.	25500.	16500.	11900.	8700.
8)	15600.	11100.	8400.	7100.	35000.	26200.	19500.	13900.	10300.	8200.	46500.	36600.	25300.	16400.	11800.	8700.
9)	7900.	5500.	4900.	3700.	24200.	13900.	9100.	6640.	5140.	4150.	29000.	16100.	10300.	7400.	5900.	4360.
10)	5830.	4390.	3270.	2700.	18500.	10700.	6960.	5080.	3840.	3060.	21800.	12300.	8020.	5330.	4100.	3260.
11)	5690.	4320.	3140.	2660.	17900.	10380.	6850.	4990.	3770.	3060.	19600.	11900.	7870.	5)250.	4010.	3250.
12)	5360.	4020.	2980.	2450.	17300.	10100.	6420.	4670.	3510.	2890.	20400.	11500.	7420.	4920.	3750.	2980.
13)	5150.	3890.	2850.	2360.	16600.	9580.	6240.	4530.	3420.	2820.	18100.	11000.	7200.	4780.	3600.	2910.
14)	4650.	3400.	2550.	2100.	15500.	8900.	5600.	3800.	2900.	2380.	18200.	10200.	6500.	4100.	3100.	2500.
15)	3520.	2600.	1900.	1530.	13000.	6650.	4350.	2950.	2200.	1800.	16000.	8200.	5200.	3250.	2400.	1900.
16)	3520.	2600.	1900.	1530.	13000.	6650.	4350.	2950.	2200.	1800.	16000.	8200.	3250.	3250.	2400.	1900.
17)	2600.	1820.	1320.	1040.	12200.	5600.	3350.	2280.	1550.	1220.	15800.	7000.	4200.	2550.	1670.	1320.
18)	10800.	8000.	6200.	4800.	34000.	20800.	13400.	9800.	7300.	5900.	41000.	24800.	15700.	11200.	8200.	6500.
19)	10340.	7650.	5920.	4590.	32900.	19900.	12800.	9350.	7170.	5640.	39800.	23700.	15000.	10680.	7830.	6210.
20)	10290.	7600.	5920.	4590.	31100.	19700.	12700.	9250.	7170.	5640.	37300.	23500.	14900.	10580.	7830.	6210.
21)	8600.	6430.	4600.	3670.	29000.	16700.	10800.	7500.	5750.	4550.	34500.	19500.	12900.	8600.	6400.	5030.
22)	4800.	3700.	2980.	2290.	19600.	8790.	5680.	4420.	3550.	2820.	25300.	9720.	6220.	4880.	3870.	3070.
23)	2600.	1900.	1330.	1060.	13500.	4500.	3100.	2200.	1750.	1350.	19500.	5250.	3400.	2450.	1950.	1450.
24)	2420.	1900.	1330.	1060.	8850.	3930.	2860.	2150.	1750.	1350.	13100.	4550.	3100.	2350.	1950.	1450.
25)	2300.	1610.	1190.	900.	11000.	4320.	2820.	1850.	1480.	1020.	14500.	5100.	3200.	2150.	1620.	1270.
26)	2120.	1610.	1190.	900.	6350.	3750.	2580.	1800.	1480.	1020.	8100.	4400.	2900.	2050.	1620.	1270.
27)	344.	254.	192.	165.	2390.	701.	407.	305.	255.	205.	3200.	940.	545.	347.	296.	231.
28)	388.	297.	233.	205.	2450.	749.	452.	349.	298.	247.	3260.	990.	592.	381.	340.	273.
29)	1400.	1060.	840.	680.	11000.	3380.	2050.	1500.	1220.	900.	14500.	4200.	2650.	1980.	1470.	1080.
30)	1420.	1040.	820.	690.	5650.	2950.	1630.	1200.	970.	830.	6600.	3250.	1750.	1300.	1070.	920.
31)	700.	540.	385.	325.	4700.	1560.	920.	612.	438.	390.	5970.	1980.	1050.	620.	445.	410.
32)	2140.	1420.	1100.	900.	9900.	3950.	2510.	1700.	1400.	1110.	11500.	4400.	2670.	1850.	1540.	1220.
33)	2140.	1420.	1100.	900.	8700.	3950.	2510.	1700.	1400.	1110.	10500.	4400.	2670.	I850.	1540.	1220.
34)	407.	235.	175.	140.	2170.	755.	475.	305.	198.	154.	2700.	950.	560.	350.	214.	160.
35)	6300.	4370.	2650.	2650.	16200.	10400.	7000.	4720.	3320.	2820.	19300.	11300.	7590.	4900.	3700.	2900.
36)	6300.	4370.	2650.	2650.	16200.	10400.	7000.	4720.	3320.	2820.	19300.	11300.	7590.	4900.	3700.	2900.
37)	2700.	1840.	1450.	1210.	11700.	4800.	3020.	2080.	1720.	1480.	14200.	5600.	3250.	2200.	1850.	1600.
38)	2700.	1840.	1450.	1210.	11700.	4800.	3020.	2080.	1720.	1480.	14200.	5600.	3250.	2200.	1850.	1600.
39)	890.	580.	430.	360.	5620.	1670.	1050.	705.	515.	430.	6600.	1950.	1160.	810.	575.	490.
40)	890.	580.	430.	360.	4200.	1670.	1050.	705.	515.	430.	4800.	1950.	1160.	810.	575.	490.
41)	114.	64.	46.	38.	1430.	342.	170.	96.	66.	49.	2050.	445.	223.	124.	80.	57.
42)	480.	360.	260.	220.	1550.	870.	590.	430.	300.	265.	1900.	1020.	660.	480.	340.	280.
43)	2100.	1480.	1120.	890.	10500.	4600.	2680.	1850.	1390.	1140.	13000.	5500.	3200.	2180.	2170.	1320.
44)	890.	660.	465.	360.	4450.	1900.	1140.	800.	560.	440.	6200.	2420.	1400.	890.	640.	490.

MONTHLY DROUGHT FLOWS -- DURATION (MONTHS), RETURN INTERVAL (YEARS)

	6,10	9,10	12,10	18,10	30,10	54,10	6,25	9,25	12,25	18,25	30,25	54,25	6,50	9,50	12,50	18,50	30,50	54,50
1)	276.00	513.00	980.0	1300.0	2200.0	2950.0	205.00	330.00	525.0	662.0	1150.0	1680.0	162.00	235.00	337.00	385.0	610.0	920.0
2)	265.00	499.00	960.0	1270.0	2150.0	2890.0	196.00	319.00	508.0	645.0	1130.0	1650.0	154.00	227.00	325.00	369.0	587.0	894.0
3)	344.00	597.00	960.0	1310.0	2190.0	2800.0	274.00	412.00	1593.0	1727.0	1190.0	1700.0	232.00	300.00	440.00	485.0	685.0	988.0
4)	83.00	173.00	455.0	667.0	1180.0	1620.0	67.00	106.00	221.0	280.0	551.0	997.0	52.00	80.00	145.00	177.0	404.0	720.0
5)	60.00	141.00	407.0	607.0	1067.0	1470.0	47.00	82.00	183.0	240.0	497.0	922.0	36.00	61.00	117.00	141.0	351.0	657.0
6)	121.00	223.00	391.0	623.0	1080.0	1350.0	109.00	163.00	244.0	303.0	533.0	950.0	98.00	123.00	219.00	225.0	427.0	730.0
7)	38.00	110.00	360.0	550.0	960.0	1480.0	27.50	59.00	146.0	202.0	445.0	850.0	20.00	44.00	91.00	107.0	300.0	600.0
8)	77.00	169.00	320.0	540.0	920.0	1330.0	67.00	117.00	183.0	217.0	455.0	850.0	60.00	97.00	149.00	165.0	350.0	645.0
9)	24.00	72.00	235.0	370.0	630.0	920.0	19.00	36.00	97.0	130.0	295.0	580.0	15.60	28.00	66.00	73.0	230.0	450.0
10)	18.80	60.00	187.0	277.0	442.0	660.0	14.70	32.00	87.0	118.0	234.0	419.0	12.10	23.40	61.00	68.0	176.0	320.0
11)	52.00	114.00	212.0	304,0	474.0	673.0	46.00	80.00	140.0	151.0	273.0	450.0	41.00	60.00	114.00	125.0	235.0	362.0
12)	17.50	57.00	175.0	253.0	395.0	595.0	14.00	30.00	82.0	113.0	219.0	379.0	11.30	22.10	52.00	67.0	163.0	286.0
13)	14.80	72.00	168.0	247.0	383.0	562.0	10.70	40.00	95.0	105.0	216.0	366.0	6.10	22.00	74.00	83.0	181.0	296.0
14)	15.70	52.00	141.0	210.0	340.0	430.0	12.40	27.60	76.0	103.0	195.0	320.0	10.30	19.70	47.00	63.0	147.0	220.0
15)	13.00	45.00	115.0	150.0	250.0	330.0	10.00	24.00	68.0	82.0	150.0	220.0	8.70	16.00	40.00	58.0	96.0	140.0
16)	13.80	46.00	116.0	151.0	250.0	330.0	10.60	25.00	69.0	83.0	151.0	220.0	9.20	16.90	41.00	59.0	97.0	141.0
17)	6.80	32.00	64.0	120.0	150.0	230.0	3.30	10.00	30.0	44.0	78.0	110.0	2.10	3.60	19.00	24.0	45.0	94.0
18)	123.00	220.00	360.0	420.0	800.0	1150.0	98.00	135.00	235.0	270.0	380.0	540.0	78.00	100.00	160.00	220.0	340.0	380.0
19)	117.00	211.00	345.0	402.0	767.0	1100.0	94.00	128.00	224.0	258.0	364.0	518.0	73.00	95.00	152.00	210.0	324.0	362.0
20)	134.00	227.00	362.0	428.0	797.0	1135.0	110.00	140.00	238.0	277.0	387.0	543.0	89.00	106.00	165.00	242.0	346.0	382.0
21)	76.00	141.00	242.0	290.0	548.0	750.0	61.00	87.00	150.0	175.0	260.0	375.0	46.00	63.00	103.00	140.0	222.0	290.0
22)	39.00	72.00	143.0	181.0	334.0	452.0	29.40	49.00	80.0	94.0	155.0	234.0	23.40	35.00	58.00	70.0	121.0	162.0
23)	12.00	34.00	71.0	89.0	150.0	200.0	7.70	21.00	36.0	50.0	81.0	125.0	6.10	13.00	26.00	32.0	52.0	76.0
24)	7.00	28.00	65.0	89.0	152.0	202.0	4.20	13.00	28.0	45.0	77.0	119.0	3.90	5.00	17.00	23.0	48.0	66.0
25)	9.80	28.00	61.0	76.0	126.0	182.0	5.50	17.50	35.0	43.0	78.0	108.0	3.40	11.30	23.00	28.0	51.0	66.0
26)	3.50	20.00	53.0	74.0	126.0	182.0	.80	8.00	25.0	36.0	72.0	100.0	0.00	2.00	13.00	18.0	45.0	54.0
27)	.06	3.40	8.3	7.5	15.8	19.1	0.00	.30	1.2	3.8	6.8	9.0	0.00	.17	.50	1.5	3.0	5.9
28)	18.00	21.00	27.5	29.0	40.0	47.0	16.00	17.10	19.5	24.0	29.5	35.0	15.00	16.00	18.20	21.0	25.0	31.0
29)	8.20	26.00	46.0	52.0	100.0	120.0	4.30	15.00	30.0	31.0	54.0	74.0	2.20	6.80	14.00	29.0	46.0	54.0
30)	5.60	12.00	36.0	44.0	96.0	130.0	3.90	6.30	9.6	11.0	31.0	49.0	3.60	5.40	7.60	6.6	23.0	36.0
31)	1.10	4.30	12.0	21.0	37.0	64.0	.11	1.70	3.7	8.0	18.0	28.0	.03	.40	1.50	3.6	4.0	13.0
32)	2.50	8.40	45.0	62.0	102.0	145.0	.70	2.90	21.0	32.0	51.0	74.0	.20	1.70	9.00	14.0	26.0	38.0
33)	11.80	13.50	23.0	34.0	90.0	140.0	11.00	12.80	15.0	17.0	43.0	59.0	10.30	12.20	14.00	14.0	18.0	31.0
34)	.15	1.00	3.5	7.7	14.0	32.0	.02	.34	1.2	2.0	2.5	9.6	0.00	.16	.43	1.0	1.8	6.0
35)	11.00	30.00	115.0	160.0	290.0	520.0	5.20	18.00	40.0	66.0	130.0	200.0	3.40	13.00	19.00	32.0	60.0	120.0
36)	6.50	20.70	60.0	140.0	225.0	360.0	4.20	17.00	29.0	60.0	105.0	180.0	3.40	13.00	19.00	32.0	60.0	120.0
37)	4.30	17.00	66.0	88.0	156.0	224.0	1.20	5.30	31.0	52.0	64.0	102.0	.40	1.80	9.00	17.0	29.0	43.0
38)	2.90	17.00	66.0	88.0	156.0	224.0	.70	3.70	30.0	52.0	64.0	102.0	.20	1.30	7.70	16.0	28.0	43.0
39)	1.20	5.00	13.6	24.0	43.0	63.0	.12	1.50	5.8	10.0	21.0	34.0	.02	.30	1.60	2.8	7.0	11.0
40)	0.00	3.00	10.4	21.0	42.0	63.0	0.00	0.00	2.0	7.0	15.0	33.0	0.00	0.00	0.00	0.0	4.0	12.5
41)	.06	.22	1.0	1.7	3.7	4.3	.02	.09	.4	.6	.9	1.4	0.00	.04	.20	.3	.6	1.1
42)	0.00	0.00	2.6	9.6	24.0	37.0	0.00	0.00	0.0	2.0	9.0	18.0	0.00	0.00	0.00	0.0	.5	2.5
43)	5.00	14.00	55.0	67.0	105.0	160.0	.70	4.30	20.0	32.0	56.0	74.0	.10	2.20	4.50	9.8	25.0	40.0
44)	.37	6.20	18.0	28.0	53.0	89.0	.29	2.10	11.0	13.0	28.0	41.0	.26	1.10	7.00	8.5	16.0	36.0

FLOW DURATION VALUES FOR THE MONTH OF JANUARY

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	2856.0	169.00	201.00	338.00	1200.00	3260.0	6630.0	18500.
2)	2800.0	145.00	186.00	327.00	1170.00	3210.0	6500.0	18200.
3)	2785.0	208.00	251.00	378.00	1150.00	3250.0	6270.0	17500.
4)	1964.0	81.00	102.00	147.00	697.00	1930.0	4950.0	15880.
5)	1841.0	55.00	72.00	123.00	636.00	1800.0	4640.0	15020.
6)	1806.0	106.00	121.00	158.00	585.00	1790.0	4410.0	14570.
7)	1722.0	23.80	48.40	101.00	578.00	1675.0	1340.0	14200.
8)	1660.0	60.00	77.00	112.00	496.00	1625.0	4060.0	13700.
9)	921.0	14.60	32.80	71.00	331.00	835.0	2340.0	1600.
10)	685.0	8.50	21.40	53.00	254.00	622.0	1940.0	5670.
11)	628.0	36.00	43.00	54.00	197.00	594.0	1690.0	5340.
12)	618.0	7.10	18.50	48.00	228.00	564.0	1780.0	5060.
13)	518.0	2.00	3.80	6.00	129.00	490.0	1480.0	4660.
14)	563.3	4.64	14.60	49.90	222.00	540.0	1540.0	4150.
15)	414.5	2.70	9.20	32.50	143.00	375.0	960.0	4250.
16)	416.0	3.20	9.80	33.00	144.00	376.0	960.0	4250.
17)	322.0	.28	4.00	30.00	116.00	304.0	820.0	2650.
18)	1019.0	65.00	108.00	140.00	435.00	1050.0	2500.0	7300.
19)	982.0	59.00	101.00	134.00	417.00	1010.0	2410.0	7030.
20)	1002.0	71.00	117.00	150.00	449.00	1060.0	2410.0	6790.
21)	728.0	43.00	62.00	92.00	298.00	748.0	1790.0	5240.
22)	474.0	17.40	29.90	54.00	187.00	486.0	1179.0	3400.
23)	247.0	3.80	9.60	26.50	93.00	262.0	608.0	1700.
24)	246.0	2.90	9.50	24.80	105.00	296.0	579.0	1420.
25)	214.0	2.10	7.50	22.20	82.00	230.0	542.0	1555.
26)	211.0	0.00	6.10	19.00	92.00	262.0	511.0	1276.
27)	13.2	0.00	0.00	.50	1.70	8.1	26.0	122.
28)	34.2	13.40	15.50	18.50	21.20	30.1	58.0	162.
29)	151.0	1.10	4.10	12.70	56.00	145.0	325.0	1180.
30)	139.3	2.20	4.50	9.30	47.00	130.0	342.0	1130.
31)	54.9	0.00	0.00	.80	19.00	48.0	135.0	510.
32)	200.0	.20	2.00	7.30	47.00	170.0	434.0	1730.
33)	195.0	8.20	10.00	15.00	18.00	161.0	419.0	1820.
34)	31.8	0.00	0.00	.20	3.90	15.8	62.0	325.
35)	570.0	2.00	7.80	23.00	135.00	520.0	1370.0	5450.
36)	570.0	3.10	5.60	23.70	138.00	506.0	1350.0	5200.
37)	266.0	.20	3.10	10.30	70.00	230.0	628.0	2200.
38)	266.0	.20	3.10	11.30	71.00	234.0	648.0	2180.
39)	64.0	0.00	0.00	1.40	17.80	57.0	147.0	529.
40)	64.0	0.00	0.00	2.40	18.50	61.0	167.0	514.
41)	9.5	0.00	0.00	0.00	.92	4.2	14.5	102.
42)	37.7	0.00	0.00	0.00	14.10	43.0	111.0	254.
43)	210.6	.20	2.10	7.70	48.00	178.0	450.0	1870.
44)	92.7	0.00	.07	1.10	30.00	82.0	250.0	780.

FLOW DURATION VALUES FOR THE MONTH OF FEBRUARY

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	4364.0	190.00	277.00	528.00	2100.0	6030.0	11400.0	22000.
2)	4266.0	173.00	264.00	515.00	2060.0	5920.0	11200.0	21500.
3)	4250.0	226.00	332.00	541.00	2085.0	5970.0	11200.0	21400.
4)	2930.0	103.00	127.00	282.00	1240.0	3640.0	7460.0	17930.
5)	2720.0	73.00	100.00	251.00	1145.0	3370.0	6980.0	16640.
6)	2679.0	110.00	148.00	254.00	1125.0	3300.0	6910.0	16490.
7)	2520.0	46.70	76.00	221.00	1051.0	3120.0	6520.0	15400.
8)	2453.0	70.00	104.00	200.00	1000.0	3005.0	6400.0	15200.
9)	1259.0	35.40	52.20	112.00	483.0	1428.0	3020.0	7900.
10)	930.0	25.80	36.50	87.00	367.0	1040.0	2620.0	6280.
11)	884.0	42.00	51.00	69.00	359.0	964.0	2480.0	6160.
12)	846.0	21.80	32.20	79.00	331.0	948.0	2390.0	5730.
13)	757.0	3.40	6.60	18.00	279.0	823.0	2200.0	5540.
14)	831.0	16.30	35.20	91.00	323.0	964.0	2060.0	4910.
15)	572.7	11.30	20.40	53.00	217.0	625.0	1300.0	3300.
16)	574.0	12.00	21.40	54.00	218.0	627.0	1300.0	3300.
17)	406.0	4.70	11.90	49.00	158.0	430.0	910.0	2700.
18)	1576.0	76.00	127.00	240.00	710.0	1850.0	3550.0	9800.
19)	1512.0	70.00	120.00	231.00	681.0	1770.0	3400.0	9400.
20)	1537.0	86.00	140.00	254.00	725.0	1810.0	3460.0	9440.
21)	1100.0	55.00	78.00	168.00	496.0	1280.0	1460.0	6690.
22)	693.0	26.40	43.00	106.00	322.0	806.0	1530.0	4010.
23)	321.0	8.20	18.00	52.00	158.0	359.0	671.0	1770.
24)	310.0	10.00	21.20	57.00	181.0	375.0	689.0	1765.
25)	278.0	6.20	14.50	44.00	135.0	318.0	597.0	1613.
26)	275.0	6.80	16.30	47.00	156.0	332.0	613.0	1609.
27)	28.5	0.00	0.00	1.40	4.2	13.0	59.0	350.
28)	54.0	14.10	16.50	19.40	24.7	38.5	97.0	395.
29)	209.0	3.20	7.40	35.00	82.0	210.0	470.0	1500.
30)	214.1	4.10	6.20	31.00	89.0	240.0	488.0	1300.
31)	85.9	0.00	.08	4.60	28.0	97.0	205.0	620.
32)	280.0	.70	4.40	19.10	101.0	295.0	782.0	1770.
33)	263.0	8.40	10.50	16.00	49.0	276.0	793.0	1860.
34)	47.9	0.00	0.00	1.60	10.3	37.0	113.0	450.
35)	934.0	3.90	14.80	56.00	325.0	1150.0	2850.0	5600.
36)	930.0	3.80	8.50	54.60	333.0	1140.0	2860.0	5420.
37)	385.0	.80	6.30	30.20	147.0	411.0	1054.0	2500.
38)	386.0	.80	6.10	29.80	148.0	419.0	1073.0	2540.
39)	105.0	0.00	.22	6.20	35.0	114.0	254.0	789.
40)	106.0	0.00	0.00	5.80	36.4	122.0	273.0	825.
41)	10.4	0.00	0.00	.39	2.2	5.8	18.5	115.
42)	64.5	0.00	0.00	12.50	26.0	95.0	170.0	380.
43)	295.0	.70	4.40	20.00	103.0	308.0	810.0	1950.
44)	128.1	.12	.42	6.60	41.5	141.0	290.0	840.

FLOW DURATION VALUES FOR THE MONTH OF MARCH

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	5119.0	276.00	855.00	1710.0	3390.0	6170.0	11900.0	20600.
2)	4995.0	268.00	842.00	1670.0	3310.0	6010.0	11600.0	20100.
3)	4923.0	287.00	1025.00	1750.0	3425.0	6060.0	11505.0	19610.
4)	3556.0	143.00	499.00	985.0	2120.0	4510.0	8740.0	17640.
5)	3289.0	124.00	467.00	901.0	1940.0	4150.0	8065.0	16400.
6)	3188.0	128.00	308.00	854.0	1870.0	4120.0	7930.0	16150.
7)	3034.0	107.00	436.00	821.0	1770.0	3813.0	7425.0	15200.
8)	2904.0	94.00	257.00	750.0	1670.0	3740.0	7240.0	14900.
9)	1626.0	87.00	209.00	433.0	1045.0	2030.0	3670.0	7260.
10)	1210.0	72.00	153.00	324.0	787.0	1590.0	2870.0	5670.
11)	1121.0	55.00	75.00	310.0	728.0	1540.0	2690.0	5370.
12)	1090.0	62.00	138.00	292.0	711.0	1480.0	2630.0	5160.
13)	968.0	5.50	16.00	235.0	606.0	1380.0	2490.0	4800.
14)	1022.0	48.20	148.00	280.0	652.0	1390.0	2260.0	4410.
15)	729.2	40.00	94.00	187.0	440.0	880.0	1560.0	3100.
16)	731.0	41.00	95.00	188.0	442.0	882.0	1560.0	3100.
17)	409.0	24.00	61.00	110.0	265.0	520.0	910.0	1850.
18)	2046.0	96.00	260.00	590.0	1230.0	2450.0	4700.0	9900.
19)	1966.0	90.00	250.00	549.0	1175.0	2340.0	4500.0	9510.
20)	1995.0	105.00	274.00	579.0	1220.0	2420.0	4540.0	9270.
21)	1426.0	84.00	187.00	388.0	852.0	1680.0	3320.0	7080.
22)	894.0	59.00	124.00	244.0	535.0	1068.0	2190.0	4620.
23)	436.0	38.00	65.00	116.0	246.0	478.0	1040.0	2340.
24)	438.0	34.80	69.00	124.0	267.0	519.0	1040.0	2150.
25)	378.0	31.00	57.00	99.0	215.0	405.0	891.0	2068.
26)	378.0	26.30	59.00	105.0	234.0	444.0	891.0	1876.
27)	54.0	.90	2.20	5.7	14.0	38.0	125.0	481.
28)	82.0	18.90	21.70	27.7	40.0	74.0	166.0	527.
29)	287.0	17.00	37.00	72.0	150.0	307.0	591.0	1700.
30)	255.0	6.20	35.00	62.0	150.0	308.0	620.0	1360.
31)	113.2	.05	10.20	23.0	53.0	113.0	236.0	720.
32)	330.0	1.80	30.10	74.0	162.0	332.0	779.0	2030.
33)	297.0	8.60	11.00	17.0	116.0	303.0	782.0	1970.
34)	51.1	0.00	2.20	5.8	16.3	45.0	111.0	490.
35)	1024.0	6.50	96.00	220.0	525.0	1160.0	2500.0	6100.
36)	1015.0	3.30	14.00	219.0	525.0	1170.0	2490.0	6150.
37)	461.0	2.20	52.60	105.0	234.0	476.0	1080.0	2770.
38)	462.0	2.10	53.00	106.0	237.0	481.0	1105.0	2770.
39)	133.0	.12	13.00	29.4	61.0	138.0	289.0	810.
40)	133.0	0.00	13.20	30.3	64.5	143.0	313.0	808.
41)	12.1	0.00	.48	1.3	3.1	7.0	26.3	130.
42)	75.4	0.00	0.00	19.5	40.7	96.0	193.0	390.
43)	347.0	2.10	30.00	76.0	170.0	345.0	820.0	2050.
44)	155.3	1.84	14.00	29.0	86.0	184.0	390.0	720.

FLOW DURATION VALUES FOR THE MONTH OF APRIL

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	6264.0	443.00	1180.0	2240.0	4210.0	8130.0	13400.0	25500.
2)	6100.0	436.00	1140.0	2170.0	4090.0	7920.0	13100.0	24900.
3)	6128.0	435.00	1145.0	2259.0	4170.0	7990.0	13140.0	24140.
4)	4097.0	228.00	767.0	1360.0	2710.0	5200.0	9250.0	17780.
5)	3751.0	211.00	674.0	1580.0	2440.0	4725.0	8520.0	16230.
6)	3743.0	204.00	658.0	1630.0	2460.0	4725.0	8440.0	15930.
7)	3421.0	194.00	587.0	1040.0	2180.0	4275.0	7830.0	14750.
8)	3372.0	170.00	551.0	1070.0	2170.0	4230.0	7700.0	14400.
9)	1980.0	137.00	372.0	632.0	1312.0	2420.0	4170.0	9400.
10)	1480.0	114.00	271.0	465.0	990.0	1880.0	3300.0	6530.
11)	1471.0	124.00	330.0	538.0	1020.0	1840.0	3170.0	6160.
12)	1350.0	102.00	239.0	406.0	894.0	1682.0	2980.0	5950.
13)	1298.0	72.00	255.0	434.0	876.0	1582.0	2790.0	5520.
14)	1208.0	99.60	246.0	416.0	823.0	1510.0	2510.0	5090.
15)	828.3	66.00	170.0	282.0	560.0	1040.0	1800.0	4100.
16)	830.0	67.00	171.0	283.0	562.0	1040.0	1800.0	4100.
17)	530.0	48.00	96.0	164.0	328.0	600.0	1040.0	2750.
18)	2520.0	106.00	560.0	1000.0	1740.0	3100.0	5150.0	12000.
19)	2418.0	101.00	532.0	954.0	1660.0	2960.0	4940.0	11540.
20)	2454.0	117.00	553.0	993.0	1720.0	3030.0	5060.0	11080.
21)	1690.0	96.00	366.0	659.0	1160.0	2100.0	3580.0	8700.
22)	982.0	72.00	209.0	385.0	687.0	1293.0	2230.0	5900.
23)	529.0	43.00	96.0	164.0	298.0	590.0	1080.0	2830.
24)	536.0	41.00	97.0	180.0	328.0	624.0	1156.0	2300.
25)	459.0	35.00	84.0	140.0	263.0	508.0	954.0	2572.
26)	464.0	31.00	83.0	154.0	291.0	540.0	1030.0	2043.
27)	45.0	1.10	3.7	7.1	17.0	34.0	95.0	397.
28)	74.0	19.10	23.2	30.1	45.0	69.0	135.0	442.
29)	347.0	17.00	63.0	109.0	210.0	370.0	640.0	1850.
30)	290.0	16.00	41.0	94.0	177.0	335.0	580.0	1330.
31)	144.8	.12	12.6	29.0	65.0	153.0	325.0	890.
32)	337.0	7.10	38.0	73.0	155.0	349.0	775.0	1860.
33)	309.0	8.60	11.0	29.0	115.0	326.0	790.0	1950.
34)	49.3	0.00	2.9	6.6	15.2	38.0	93.0	470.
35)	1043.0	40.00	122.0	255.0	520.0	1240.0	2600.0	5200.
36)	1032.0	4.60	53.0	250.0	522.0	1240.0	2590.0	5140.
37)	497.0	20.40	54.7	114.0	241.0	558.0	1150.0	2600.
38)	498.0	20.20	53.0	114.0	243.0	563.0	1160.0	2620.
39)	167.0	.24	16.2	36.0	80.0	175.0	366.0	983.
40)	168.0	0.00	14.0	35.5	82.0	180.0	374.0	1007.
41)	10.4	0.00	.4	.9	2.1	5.5	17.5	120.
42)	102.0	0.00	0.0	9.1	58.0	127.0	245.0	566.
43)	355.0	7.20	41.0	75.0	165.0	368.0	820.0	2000.
44)	183.2	7.40	28.0	54.0	112.0	205.0	400.0	900.

FLOW DURATION VALUES FOR THE MONTH OF MAY

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	5680.0	732.0	1340.00	1980.00	3340.00	6250.0	12100.0	26000.
2)	5546.0	727.0	1320.00	1950.00	3280.00	6140.0	11900.0	25500.
3)	5689.0	885.0	1364.00	2081.00	3437.00	6310.0	11970.0	25370.
4)	3052.0	181.0	649.00	972.00	1680.00	3150.0	6850.0	15740.
5)	2772.0	169.0	597.00	893.00	1540.00	2890.0	6330.0	145500.
6)	2880.0	323.0	658.00	1003.00	1660.00	2970.0	6260.0	14200.
7)	2505.0	157.0	548.00	818.00	1410.00	2630.0	5840.0	13400.
8)	2568.0	294.0	589.00	904.00	1500.00	2670.0	5820.0	13000.
9)	1424.0	139.0	315.00	478.00	799.00	1467.0	3050.0	7100.
10)	1060.0	106.0	234.00	360.00	584.00	1090.0	2460.0	5650.
11)	1152.0	240.0	342.00	486.00	712.00	1160.0	2530.0	5480.
12)	954.0	96.0	209.00	324.00	561.00	1005.0	2210.0	5130.
13)	1003.0	190.0	275.00	406.00	644.00	1025.0	2230.0	4900.
14)	883.1	81.8	210.00	325.00	516.00	916.0	1840.0	4370.
15)	640.3	61.0	139.00	213.00	350.00	630.0	1320.0	3000.
16)	642.0	62.0	140.00	214.00	352.00	632.0	1320.0	3000.
17)	400.0	42.0	82.00	127.00	210.00	375.0	830.0	2100.
18)	1974.0	100.0	370.00	580.00	1020.00	1950.0	3800.0	9100.
19)	1890.0	96.0	355.00	556.00	980.00	1870.0	3650.0	8720.
20)	1925.0	100.0	338.00	577.00	1017.00	1960.0	3790.0	8940.
21)	1318.0	84.0	260.00	405.00	712.00	1370.0	2680.0	6500.
22)	874.0	47.0	167.00	258.00	451.00	870.0	1730.0	4340.
23)	424.0	34.0	80.00	125.00	220.00	414.0	858.0	1970.
24)	431.0	20.2	77.00	123.00	231.00	474.0	960.0	2155.
25)	368.0	28.2	66.00	110.00	191.00	357.0	739.0	1699.
26)	373.0	12.9	61.00	105.00	198.00	415.0	839.0	1882.
27)	41.0	.3	3.50	5.70	13.00	25.0	85.0	386.
28)	69.0	18.0	23.00	28.70	39.00	56.0	124.0	431.
29)	228.0	23.5	43.00	74.00	130.00	240.0	455.0	1200.
30)	231.0	7.7	47.00	73.00	126.00	235.0	475.0	1450.
31)	100.1	0.0	13.00	25.00	45.00	96.0	210.0	600.
32)	255.0	4.1	37.00	57.00	102.00	220.0	560.0	1930.
33)	217.0	8.4	10.50	18.00	66.00	187.0	514.0	1830.
34)	43.5	0.0	3.00	5.40	10.80	26.0	83.0	440.
35)	782.0	11.5	126.00	190.00	360.00	750.0	2000.0	5200.
36)	780.0	9.4	85.00	188.00	355.00	747.0	1960.0	5060.
37)	372.0	4.4	62.00	89.00	166.00	346.0	839.0	2560.
38)	371.0	4.4	58.00	86.00	167.00	348.0	848.0	2520.
39)	121.0	0.0	16.80	29.60	56.00	118.0	251.0	7650.
40)	120.0	0.0	12.70	26.70	57.00	120.0	260.0	721.
41)	7.0	0.0	.14	.73	.16	2.9	7.8	79.
42)	70.6	0.0	0.00	0.00	34.30	82.0	177.0	382.
43)	268.0	4.6	38.00	59.00	108.00	230.0	600.0	2000.
44)	134.3	10.0	23.30	39.00	70.00	132.0	275.0	720.

FLOW DURATION VALUES FOR THE MONTH OF JUNE

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	4718.0	595.0	961.0	1520.00	2730.00	6100.0	11100.0	20000.
2)	4597.0	586.0	927.0	1470.00	2660.00	5970.0	10900.0	19500.
3)	5037.0	670.0	1075.0	1680.00	2861.00	6180.0	11010.0	19930.
4)	2946.0	193.0	452.0	736.00	1400.00	3330.0	7420.0	17220.
5)	2693.0	173.0	382.0	633.00	1237.00	3040.0	6890.0	16080.
6)	2824.0	255.0	530.0	827.00	1400.00	3200.0	6970.0	16230.
7)	2452.0	154.0	316.0	536.00	1082.00	2760.0	6380.0	15000.
8)	2552.0	219.0	444.0	706.00	1215.00	2880.0	6415.0	15100.
9)	1250.0	77.0	164.0	295.00	526.00	1350.0	2920.0	7260.
10)	922.0	58.0	127.0	225.00	398.00	1820.0	2630.0	5500.
11)	1042.0	130.0	279.0	412.00	574.00	1160.0	2630.0	5510.
12)	831.0	50.0	110.0	198.00	361.00	935.0	2400.0	4910.
13)	908.0	82.0	221.0	343.00	502.00	1025.0	2340.0	4860.
14)	801.0	62.8	123.0	198.00	354.00	873.0	2060.0	4030.
15)	487.9	37.0	79.0	128.00	240.00	570.0	1310.0	3400.
16)	489.0	38.0	80.0	129.00	241.00	572.0	1310.0	3400.
17)	331.0	16.0	39.0	70.00	130.00	340.0	700.0	2300.
18)	1783.0	103.0	370.0	580.00	1000.00	1950.0	2850.0	9100.
19)	1706.0	98.0	351.0	552.00	954.00	1870.0	3690.0	8680.
20)	1715.0	100.0	351.0	568.00	992.00	1920.0	3720.0	8960.
21)	1217.0	83.0	232.0	374.00	656.00	1330.0	2700.0	6480.
22)	745.0	51.0	129.0	205.00	378.00	817.0	1730.0	3820.
23)	318.0	19.5	47.0	78.00	157.00	358.0	813.0	1640.
24)	302.0	4.2	29.5	75.00	171.00	387.0	803.0	1880.
25)	276.0	16.7	40.0	67.00	136.00	308.0	694.0	1413.
26)	258.0	0.0	20.5	62.00	148.00	335.0	682.0	1169.
27)	28.5	0.0	1.1	2.80	9.10	20.0	40.0	299.
28)	53.0	17.2	19.1	22.00	33.10	49.0	76.0	343.
29)	222.0	11.0	32.0	53.00	96.00	195.0	440.0	1500.
30)	229.0	15.5	31.0	49.00	94.00	230.0	500.0	1350.
31)	93.9	1.2	5.5	12.50	27.00	61.0	167.0	910.
32)	320.0	4.2	18.0	35.00	89.00	248.0	670.0	2640.
33)	298.0	8.2	10.0	15.00	50.00	226.0	706.0	2700.
34)	41.6	0.0	1.4	3.40	7.00	23.0	75.0	505.
35)	835.0	32.0	79.0	130.00	315.00	860.0	2200.0	5250.
36)	836.0	21.1	63.0	133.00	312.00	859.0	2200.0	5350.
37)	431.0	9.1	29.2	56.00	129.00	341.0	962.0	3880.
38)	428.0	9.1	22.5	51.00	125.00	345.0	983.0	3820.
39)	111.0	0.0	7.1	15.90	34.00	81.0	202.0	1030.
40)	108.0	0.0	.4	11.40	30.50	85.0	223.0	972.
41)	13.7	0.0	0.0	.15	.62	2.3	10.8	132.
42)	60.8	0.0	0.0	0.00	17.30	64.0	160.0	437.
43)	336.0	4.5	18.5	36.00	91.00	266.0	700.0	2800.
44)	117.4	1.8	12.1	23.60	50.00	130.0	290.0	800.

FLOW DURATION VALUES FOR THE MONTH OF JULY

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	2986.0	251.00	440.00	912.00	1730.00	3250.0	7190.0	15400.
2)	2885.0	232.00	428.00	884.00	1670.00	3150.0	6980.0	14900.
3)	3057.0	300.00	579.00	1188.00	1892.00	3445.0	7160.0	14500.
4)	1802.0	104.00	149.00	394.00	855.00	1920.0	4820.0	10490.
5)	1603.0	71.00	122.00	334.00	725.00	1705.0	4370.0	9390.
6)	1747.0	126.00	269.00	543.00	926.00	1950.0	4420.0	9100.
7)	1416.0	41.10	98.00	278.00	604.00	1500.0	3950.0	8340.
8)	1531.0	79.00	225.00	463.00	774.00	1705.0	3950.0	8000.
9)	777.0	38.30	62.00	134.00	323.00	762.0	1930.0	5380.
10)	577.0	27.20	46.00	103.00	211.00	562.0	1490.0	3950.
11)	707.0	55.00	174.00	284.00	400.00	708.0	1540.0	3810.
12)	521.0	22.00	40.00	89.00	194.00	507.0	1340.0	3620.
13)	608.0	13.00	130.00	231.00	339.00	608.0	1340.0	3420.
14)	508.4	21.30	47.90	105.00	218.00	521.0	1400.0	3140.
15)	275.8	11.20	16.50	62.00	140.00	340.0	840.0	2200.
16)	277.0	11.90	17.40	63.00	141.00	341.0	842.0	2200.
17)	179.0	3.80	11.00	30.50	73.00	170.0	370.0	1300.
18)	1181.0	88.00	140.00	315.00	670.00	1250.0	2600.0	7400.
19)	1127.0	81.00	133.00	299.00	635.00	1190.0	2470.0	7090.
20)	1155.0	94.00	137.00	304.00	656.00	1240.0	2600.0	6980.
21)	784.0	60.00	89.00	198.00	421.00	812.0	1700.0	5100.
22)	470.0	28.30	48.00	108.00	230.00	465.0	987.0	32200.
23)	187.3	6.20	18.70	39.00	83.00	177.0	380.0	1500.
24)	188.0	3.10	4.50	25.40	83.00	207.0	475.0	13550.
25)	162.0	4.30	15.50	34.00	71.00	153.0	335.0	1250.
26)	161.0	0.00	0.00	18.40	69.00	181.0	428.0	1106.
27)	17.5	0.00	.04	1.20	5.10	10.5	37.0	246.
28)	45.0	16.10	18.40	20.20	25.60	35.0	72.0	279.
29)	113.0	2.60	12.30	24.00	53.00	117.0	235.0	720.
30)	129.7	6.30	9.70	26.00	53.00	123.0	265.0	850.
31)	35.8	0.00	.70	3.50	12.00	33.0	80.0	316.
32)	135.0	0.00	4.00	13.40	40.70	111.0	304.0	1230.
33)	118.0	8.00	10.00	15.00	17.00	71.0	270.0	1100.
34)	20.1	0.00	0.00	.60	3.20	7.5	26.0	190.
35)	480.0	.20	13.60	59.00	150.00	370.0	1230.0	3300.
36)	481.0	1.20	7.10	60.00	153.00	368.0	1220.0	3260.
37)	188.0	.08	5.90	21.40	66.00	161.0	451.0	1580.
38)	186.0	.08	4.90	17.10	64.00	160.0	455.0	1520.
39)	54.0	0.00	1.00	4.70	17.00	47.0	104.0	425.
40)	52.0	0.00	0.00	.40	14.60	46.0	108.0	364.
41)	4.6	0.00	0.00	0.00	.28	.9	3.4	51.
42)	28.7	0.00	0.00	0.00	3.30	26.8	81.0	223.
43)	141.7	0.00	4.20	13.50	43.00	115.0	316.0	1260.
44)	69.7	0.00	.54	6.60	22.00	63.0	160.0	560.

FLOW DURATION VALUES FOR THE MONTH OF AUGUST

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	1706.0	199.00	287.00	483.00	832.00	1530.0	3380.0	11400.
2)	1659.0	178.00	271.00	470.00	811.00	1470.0	3290.0	11000.
3)	1814.0	237.00	337.00	600.00	987.00	1670.0	3450.0	11030.
4)	1073.0	77.00	109.00	152.00	302.00	924.0	2230.0	9720.
5)	975.0	54.00	80.00	125.00	257.00	809.0	2020.0	8870.
6)	1108.0	100.00	134.00	248.00	420.00	974.0	2140.0	8890.
7)	881.0	34.40	53.00	100.00	215.00	702.0	1828.0	8070.
8)	976.0	63.00	87.00	199.00	347.00	825.0	1895.0	8040.
9)	445.0	29.20	37.30	51.00	89.00	221.0	797.0	5180.
10)	289.0	17.50	24.00	37.00	68.00	170.0	594.0	3870.
11)	389.0	36.00	48.00	125.00	197.00	324.0	701.0	3870.
12)	257.0	14.90	20.20	31.60	56.00	149.0	535.0	3470.
13)	314.0	0.00	10.00	93.00	145.00	261.0	595.0	3410.
14)	287.2	11.20	21.30	37.90	69.60	156.0	584.0	2880.
15)	171.4	7.00	10.80	19.50	41.00	98.0	370.0	2100.
16)	173.0	7.50	11.50	20.50	42.00	99.0	372.0	2100.
17)	94.8	1.50	4.20	8.80	20.00	46.0	130.0	860.
18)	699.0	68.00	115.00	135.00	235.00	560.0	1250.0	5170.
19)	669.0	62.00	108.00	128.00	223.00	530.0	1190.0	4920.
20)	691.0	75.00	120.00	135.00	236.00	565.0	1230.0	4930.
21)	480.0	47.00	66.00	84.00	147.00	346.0	838.0	3800.
22)	284.0	20.80	33.00	45.00	79.00	188.0	516.0	2880.
23)	130.3	4.30	8.20	15.20	27.60	63.0	231.0	1570.
24)	130.0	3.00	3.40	4.10	20.10	76.0	244.0	1545.
25)	112.0	2.50	6.00	12.40	22.90	54.0	214.0	1299.
26)	110.0	0.00	0.00	0.00	14.00	65.0	225.0	1275.
27)	11.8	0.00	0.00	.90	2.90	5.6	14.0	69.
28)	33.8	14.40	16.70	18.90	23.40	27.6	40.0	108.
29)	93.8	1.30	4.40	8.70	17.80	42.0	135.0	540.
30)	77.0	4.20	7.70	10.50	19.00	45.0	126.0	650.
31)	29.5	0.00	0.00	.60	4.60	11.3	48.0	320.
32)	90.0	0.00	.70	5.30	16.70	61.0	233.0	888.
33)	92.0	7.80	9.50	14.00	16.00	29.0	187.0	890.
34)	11.2	0.00	0.00	.80	1.10	4.0	16.0	98.
35)	321.0	0.00	6.30	25.00	62.00	224.0	750.0	2420.
36)	322.0	.90	4.10	26.40	65.00	224.0	757.0	2390.
37)	140.0	0.00	1.50	8.80	25.80	94.0	337.0	1314.
38)	138.0	0.00	1.50	7.10	24.30	93.0	337.0	1254.
39)	43.0	0.00	0.00	.93	5.80	21.6	70.0	436.
40)	42.0	0.00	0.00	0.00	4.30	20.2	70.0	376.
41)	3.5	0.00	0.00	0.00	.08	.6	2.8	40.
42)	23.2	0.00	0.00	0.00	0.00	11.8	56.0	237.
43)	103.4	0.00	.70	5.50	17.00	63.0	245.0	920.
44)	42.3	0.00	0.00	.19	2.10	18.7	80.0	550.

FLOW DURATION VALUES FOR THE MONTH OF SEPTEMBER

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	868.0	139.00	202.00	302.00	453.00	774.00	1740.0	5760.
2)	858.0	122.00	182.00	284.00	438.00	750.00	1660.0	5620.
3)	984.0	189.00	246.00	372.00	592.00	934.00	1799.0	5300.
4)	497.0	45.00	91.00	116.00	157.00	322.00	1150.0	4170.
5)	437.0	29.00	58.00	85.00	127.00	286.00	986.0	3830.
6)	527.0	83.00	107.00	161.00	268.00	447.00	1095.0	3470.
7)	381.0	15.20	28.40	54.80	99.00	253.00	835.0	3500.
8)	447.0	52.00	57.00	107.00	209.00	372.00	894.0	3090.
9)	212.0	11.40	20.40	35.60	55.00	134.00	443.0	2210.
10)	128.0	6.20	13.20	24.70	39.00	94.00	336.0	1640.
11)	187.0	34.00	42.00	63.00	138.00	203.00	407.0	1390.
12)	115.0	4.60	12.30	19.10	31.00	82.00	316.0	1460.
13)	131.0	0.00	5.00	18.10	102.00	151.00	343.0	1160.
14)	134.1	2.70	7.50	18.00	40.10	96.10	327.0	1190.
15)	121.7	1.70	4.90	10.80	22.60	58.00	200.0	950.
16)	123.0	2.10	5.40	11.50	23.60	59.00	201.0	953.
17)	55.5	.16	1.65	4.80	11.00	27.00	100.0	660.
18)	354.0	48.00	96.00	120.00	140.00	258.00	790.0	2600.
19)	342.0	43.00	89.00	113.00	132.00	245.00	750.0	2490.
20)	378.0	58.00	104.00	125.00	145.00	268.00	780.0	2530.
21)	240.0	31.20	50.00	68.00	84.00	163.00	494.0	1690.
22)	124.0	10.50	22.10	33.50	41.00	82.00	272.0	902.
23)	43.9	.80	4.10	8.60	14.50	33.40	93.0	366.
24)	43.5	2.00	2.90	3.60	7.50	34.00	98.0	373.
25)	37.2	0.00	2.40	6.30	11.90	28.80	81.0	327.
26)	35.5	0.00	0.00	0.00	3.60	28.00	84.0	332.
27)	5.2	0.00	0.00	.20	1.50	4.20	11.5	27.
28)	24.2	13.70	15.70	17.30	21.80	26.20	36.0	59.
29)	44.0	.50	1.60	3.40	8.80	21.00	67.0	490.
30)	33.9	1.40	4.60	7.30	11.00	23.00	67.0	275.
31)	20.8	0.00	0.00	0.00	1.50	7.30	26.0	280.
32)	38.8	0.00	0.00	1.60	5.70	17.00	62.0	412.
33)	44.0	7.60	9.00	13.00	15.00	23.00	43.0	340.
34)	8.3	0.00	0.00	0.00	.20	3.10	7.2	76.
35)	123.0	0.00	2.40	10.00	255.00	67.00	240.0	1250.
36)	124.0	.60	1.80	11.20	26.50	70.00	246.0	1160.
37)	62.0	0.00	.02	3.10	10.60	33.00	129.0	617.
38)	62.0	0.00	.02	3.10	10.20	34.00	134.0	622.
39)	24.6	0.00	0.00	.01	2.30	10.80	35.0	316.
40)	24.6	0.00	0.00	0.00	1.90	11.90	40.0	321.
41)	2.0	0.00	0.00	0.00	0.00	.20	1.4	19.
42)	13.1	0.00	0.00	0.00	0.00	8.20	27.8	182.
43)	40.8	0.00	0.00	1.60	5.90	12.40	69.0	420.
44)	14.7	0.00	0.00	.04	.48	6.20	31.0	160.

FLOW DURATION VALUES FOR THE MONTH OF OCTOBER

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	1231.0	120.00	187.00	258.00	397.00	1170.00	2870.0	9260.
2)	1195.0	112.00	167.00	240.00	382.00	1130.00	2810.0	9040.
3)	1308.0	178.00	233.00	309.00	512.00	1260.00	2890.0	9020.
4)	735.0	39.00	85.00	105.00	167.00	617.00	1750.0	5430.
5)	664.0	25.00	53.00	74.00	137.00	529.00	1620.0	4930.
6)	735.0	79.00	106.00	133.00	250.00	627.00	1660.0	4800.
7)	596.0	12.20	23.80	45.10	110.00	447.00	1495.0	4460.
8)	646.0	49.00	57.00	80.00	192.00	504.00	1490.0	4280.
9)	353.0	11.10	185.00	33.80	56.00	225.00	1040.0	3290.
10)	223.0	4.60	13.70	22.80	41.00	174.00	772.0	2460.
11)	257.0	33.00	37.00	44.00	112.00	246.00	781.0	2320.
12)	206.0	3.50	12.70	18.70	32.00	161.00	718.0	2250.
13)	197.0	0.00	1.60	4.20	66.00	191.00	680.0	2060.
14)	227.6	2.10	6.60	16.90	40.20	161.00	654.0	1940.
15)	177.1	1.10	3.90	9.80	22.00	104.00	450.0	1420.
16)	178.0	1.40	4.40	10.40	23.00	105.00	452.0	1420.
17)	90.1	0.00	2.00	4.10	11.90	48.00	260.0	850.
18)	453.0	49.00	95.00	114.00	138.00	430.00	870.0	4050.
19)	431.0	44.00	88.00	107.00	131.00	407.00	832.0	3180.
20)	474.0	58.00	101.00	117.00	148.00	439.00	872.0	3290.
21)	302.0	31.70	49.00	65.00	84.00	267.00	586.0	2680.
22)	181.0	11.20	21.70	32.10	43.00	146.00	350.0	1500.
23)	70.6	1.00	37.00	84.00	160.00	51.00	156.0	514.
24)	73.0	2.20	2.60	3.50	15.50	61.00	168.0	588.
25)	60.4	.01	2.30	6.10	13.10	43.00	133.0	442.
26)	61.2	0.00	0.00	0.00	11.30	51.00	143.0	514.
27)	5.8	0.00	0.00	0.00	.60	5.70	20.2	91.
28)	24.8	12.90	14.10	15.30	18.60	27.70	48.2	130.
29)	50.4	.30	1.40	3.30	8.20	34.00	110.0	390.
30)	54.3	1.90	4.60	7.10	9.80	34.00	92.0	590.
31)	21.8	0.00	0.00	0.00	1.20	10.50	48.0	158.
32)	62.0	0.00	.10	1.50	5.80	38.00	97.0	453.
33)	66.0	7.60	9.00	13.00	15.00	23.00	84.0	450.
34)	12.8	0.00	0.00	0.00	1.10	4.80	13.5	102.
35)	171.0	0.00	1.10	5.00	28.50	113.00	285.0	1200.
36)	172.0	.40	1.60	6.60	29.10	112.00	284.0	1160.
37)	86.0	0.00	.11	2.30	12.30	62.00	156.0	608.
38)	86.0	0.00	.11	2.30	12.20	62.00	158.0	609.
39)	24.5	0.00	0.00	0.00	2.10	13.50	52.0	204.
40)	24.3	0.00	0.00	0.00	2.00	13.10	34.0	205.
41)	2.8	0.00	0.00	0.00	0.00	.30	1.2	8.
42)	15.6	0.00	0.00	0.00	0.00	11.50	41.0	154.
43)	64.8	0.00	.01	1.50	5.90	40.00	104.0	440.
44)	30.0	0.00	0.00	.07	.90	19.00	74.0	290.

FLOW DURATION VALUES FOR THE MONTH OF NOVEMBER

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	1461.0	142.00	185.00	261.00	475.00	1590.0	4040.0	10300.
2)	1436.0	118.00	168.00	248.00	467.00	1560.0	3970.0	10100.
3)	1493.0	182.00	231.00	322.00	514.00	1553.0	3960.0	9990.
4)	679.0	49.00	84.00	105.00	222.00	823.0	1660.0	5100.
5)	624.0	32.00	55.00	79.00	204.00	754.0	1510.0	4620.
6)	645.0	85.00	107.00	138.00	230.00	717.0	1460.0	4550.
7)	572.0	17.20	28.30	54.40	186.00	688.0	1360.0	4160.
8)	565.0	52.00	60.00	88.00	181.00	609.0	1260.0	4040.
9)	325.0	15.60	23.20	38.50	86.00	358.0	816.0	12360.
10)	201.0	7.90	15.10	28.60	64.00	236.0	620.0	1710.
11)	200.0	34.00	38.00	48.00	60.00	184.0	585.0	1580.
12)	177.0	6.60	13.10	23.20	58.00	214.0	577.0	1520.
13)	123.0	0.00	2.00	4.60	13.00	118.0	696.0	1340.
14)	215.6	4.85	8.40	20.40	64.80	239.0	552.0	1550.
15)	194.6	3.10	5.40	13.00	40.00	152.0	360.0	1030.
16)	196.0	3.60	5.90	13.70	41.00	153.0	362.0	1030.
17)	96.1	1.15	4.10	8.60	23.00	83.0	250.0	700.
18)	413.0	60.00	99.00	117.00	137.00	490.0	1100.0	3300.
19)	397.0	55.00	92.00	111.00	132.00	469.0	1060.0	3170.
20)	433.0	67.00	103.00	126.00	155.00	499.0	1100.0	3130.
21)	287.0	40.00	55.00	71.00	96.00	340.0	747.0	2250.
22)	169.0	16.00	26.20	38.00	64.00	190.0	444.0	1305.
23)	90.1	3.20	7.60	13.80	34.00	89.0	219.0	660.
24)	91.0	2.60	3.40	11.40	39.00	97.0	232.0	583.
25)	77.4	1.80	5.40	10.60	28.50	75.0	188.0	558.
26)	76.2	0.00	0.00	6.90	31.10	81.0	199.0	479.
27)	8.3	0.00	0.00	0.00	1.50	4.3	17.8	79.
28)	27.3	13.40	14.80	16.80	19.60	26.3	44.8	118.
29)	52.1	1.00	3.00	6.80	20.40	88.0	280.0	790.
30)	38.0	2.20	4.30	7.30	15.70	47.0	105.0	260.
31)	20.2	0.00	0.00	.09	4.40	24.0	55.0	147.
32)	64.0	0.00	1.20	2.80	19.10	57.0	186.0	402.
33)	57.0	7.80	9.50	14.00	16.00	30.0	118.0	430.
34)	9.5	0.00	0.00	0.00	1.90	6.2	20.0	81.
35)	172.0	0.00	2.40	9.40	50.00	160.0	490.0	1400.
36)	173.0	.50	2.00	11.70	51.00	159.0	494.0	1380.
37)	87.0	0.00	1.60	5.20	32.30	79.0	269.0	521.
38)	87.0	0.00	1.60	5.00	31.40	78.0	270.0	515.
39)	23.0	0.00	0.00	.22	6.20	27.3	63.0	169.
40)	22.8	0.00	0.00	0.00	5.30	26.6	64.0	163.
41)	2.3	0.00	0.00	0.00	.20	1.3	4.4	25.
42)	13.5	0.00	0.00	0.00	0.00	16.3	42.0	95.
43)	67.5	0.00	1.20	2.90	20.50	61.0	196.0	460.
44)	25.8	0.00	0.00	.14	7.00	28.0	70.0	160.

FLOW DURATION VALUES FOR THE MONTH OF DECEMBER

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	2031.0	145.00	191.00	281.00	721.00	2260,0	4910.0	14300.
2)	1984.0	120.00	175.00	267.00	713.00	2220.0	4840.0	14100.
3)	2075.0	185.00	232.00	342.00	702.00	2198.0	4640.0	14200.
4)	1562.0	57.00	91.00	133.00	351.00	1180.0	3880.0	12070.
5)	1461.0	38.00	63.00	105.00	332.00	1125.0	3780.0	11820.
6)	1503.0	91.00	109.00	158.00	282.00	1065.0	3550.0	11830.
7)	1364.0	21.10	36.70	80.00	313.00	1070.0	3690.0	11580.
8)	1288.0	57.00	63.00	109.00	244.00	971.0	3410.0	11540.
9)	717.0	15.30	28.10	50.00	173.00	583.0	1970.0	5930.
10)	517.0	8.60	18.70	34.50	131.00	393.0	1440.0	4650.
11)	450.0	35.00	40.00	51.00	72.00	312.0	1180.0	4620.
12)	472.0	6.80	16.40	28.00	119.00	349.0	1340.0	4150.
13)	362.0	1.00	2.40	5.20	16.00	283.0	1030.0	4060.
14)	460.8	4.28	9.70	34.20	127.00	404.0	1270.0	3400.
15)	311.0	3.10	7.00	18.00	78.00	260.0	820.0	2820.
16)	312.0	3.60	7.50	19.00	79.00	261.0	823.0	2820.
17)	228.0	.40	3.90	9.90	47.00	180.0	590.0	1800.
18)	761.0	61.00	100.00	110.00	142.00	500.0	1130.0	3200.
19)	730.0	56.00	94.00	111.00	136.00	483.0	1100.0	3120.
20)	779.0	68.00	105.00	133.00	175.00	521.0	1130.0	3210.
21)	534.0	39.00	56.00	73.00	104.00	370.0	869.0	2580.
22)	341.0	13.80	27.40	41.00	88.00	255.0	618.0	1975.
23)	166.6	3.60	8.70	16.00	54.00	139.0	381.0	1230.
24)	164.0	2.40	3.40	20.10	73.00	155.0	380.0	1280.
25)	144.0	2.40	6.60	13.20	44.00	119.0	339.0	1085.
26)	139.0	0.00	0.00	15.90	60.70	133.0	336.0	1139.
27)	10.6	0.00	0.00	.90	1.80	6.3	17.0	101.
28)	31.6	13.30	15.70	19.10	21.30	28.3	43.6	141.
29)	108.0	1.00	3.00	6.80	2.00	86.0	275.0	790.
30)	96.5	1.60	4.20	8.00	19.00	81.0	235.0	810.
31)	43.1	0.00	0.00	.30	9.50	30.0	77.0	320.
32)	180.0	0.00	1.80	5.00	29.40	118.0	467.0	1720.
33)	170.0	8.00	10.00	15.00	17.00	101.0	451.0	1650.
34)	24.6	0.00	0.00	.08	3.30	7.0	46.0	290.
35)	442.0	1.00	6.50	19.50	70.00	305.0	1150.0	4450.
36)	442.0	.40	2.80	20.30	71.00	303.0	1150.0	4510.
37)	230.0	0.00	2.10	7.50	48.00	163.0	589.0	2280.
38)	230.0	0.00	2.10	7.10	50.00	167.0	592.0	2282.
39)	48.0	0.00	0.00	.43	10.90	40.0	86.0	377.
40)	49.0	0.00	0.00	0.00	12.70	44.0	89.0	379.
41)	9.1	0.00	0.00	0.00	.72	2.4	10.3	90.
42)	29.9	0.00	0.00	0.00	0.00	31.2	58.0	270.
43)	189.0	0.00	1.80	5.20	30.00	123.0	495.0	1800.
44)	67.7	0.00	0.00	.18	13.50	61.0	170.0	610.

Appendix C. List of Major Discharges in the Sangamon River Basin and Their Effects on Streamflow.

Index #	Location	Description
1	Sangamon R., mile 162.5	Monticello Sanitary Outfall / Viobin Mfg.
2	Sangamon R., mile 185.2	Mahomet Sanitary Outfall
3	Salt Creek, mile 28.2	Lincoln Sanitary Outfall
4	Salt Creek, mile 96.7	Farmer City Sanitary Outfall
5	Sugar Creek, mile 49.0	Bloomington-Normal Sanitary Outfall
6	Sugar Creek, mile 49.4	Ralston Purina Industrial Outfall
7	Sugar Creek tributary	Beich Company Industrial Outfall
8	Lake Fork, mile 44.6	Maroa Sanitary Outfall
9	Coon Creek, mile 4.6	Clinton Sanitary Outfall
10	Coon Creek, mile 5.8	Revere Copper & Brass Indust. Outfall
11	N Fk Salt Cr., mile 19.4	Leroy Sanitary Outfall
12	Spring Creek, mile 2.2	Springfield Sanitary District Outfall #1
13	Sugar Creek, mile 8.4	Springfield Sanitary District Outfall #2
14	Sugar Creek, mile 29.4	Auburn Sanitary Outfall
15	South Fk., mile 38.4	Kinkaid Sanitary Outfall
16	South Fork, mile 55.1	Taylorville Sanitary Outfall
17	South Fork, mile 57.1	Georgia Pacific Industrial Outfall
18	Black Branch, mile 3.0	Rochester Sanitary Outfall
19	Horse Creek, mile 19.8	Pawnee Sanitary Outfall
20	Long Point Slough trib.	Borden Chemical Industrial Outfall
21	Stevens Creek, mile 0.1	Decatur Sanitary District Outfall
22	Finley Creek, mile 4.1	Mt. Zion Sanitary Outfall

ANNUAL FLOW DURATION VALUES

	MEAN	Q99	Q98	Q95	Q90	Q85	Q75	Q60	Q50	Q40	Q25	Q15	Q10	Q05	Q02	Q01
1)	2.54	1.56	1.60	1.70	1.82	1.90	2.06	2.29	2.46	2.69	3.25	3.81	4.14	4.58	4.98	5.17
2)	.48	.29	.30	.33	.36	.38	.41	.44	.47	.51	.59	.68	.76	.87	.97	1.02
3)	3.70	3.76	3.90	4.10	4.25	4.53	5.04	5.58	6.15	7.05	7.60	7.95	8.12	8.85	9.25	.53
4)	.55	.10	.12	.16	.20	.25	.33	.43	.50	.58	.75	.90	.99	1.15	1.35	1.45
5)	23.70	11.40	12.30	13.60	15.10	16.10	17.40	19.30	21.90	23.10	27.30	35.30	37.30	39.30	43.30	44.30
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51
8)	.60	.10	.12	.16	.20	.25	.33	.45	.54	.64	.85	1.06	1.18	1.36	1.52	1.60
9)	1.78	.56	.60	.70	.88	1.01	1.22	1.48	1.69	1.92	2.34	2.60	2.76	3.00	3.20	3.33
10)	1.05	.13	.14	.18	.25	.36	.57	.88	1.04	1.21	1.48	1.64	1.76	1.96	2.18	2.31
11)	1.05	.22	.26	.32	.39	.46	.61	.80	.93	1.09	1.47	1.82	2.00	2.20	2.40	2.55
12)	29.20	15.30	16.30	18.00	19.70	21.20	23.90	27.60	31.00	35.20	41'. 00	45.00	48.00	52.00	57.00	60.00
13)	20.70	7.40	8.20	9.10	10.10	11.00	12.70	15.00	17.10	19.60	24.70	29.00	31.30	34.20	37.10	38.80
14)	.98	.39	.42	.48	.55	.60	.70	.82	.90	.98	1.11	1.20	1.25	1.33	1.40	1.45
15)	.55	.35	.36	.39	.42	.43	.46	.50	.54	.57	.65	.71	.75	.82	.90	.96
16)	2.56	1.06	1.12	1.23	1.35	1.49	1.74	2.08	2.39	2.70	3.30	3.82	4.12	4.40	4.62	4.76
17)	1.19	.66	.69	.74	.81	.86	.96	1.10	1.18	1.26	1.38	1.48	1.54	1.61	1.68	1.71
18)	.52	.32	.34	.36	.39	.40	.43	.47	.51	.54	.62	.68	.72	.79	.87	.93
19)	.49	.22	.23	.26	.28	.31	.36	.44	.48	.56	.67	.80	.88	.99	1.07	1.11
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	41.10	32.50	33.20	34.50	36.00	37.00	38.70	41.10	42.50	44.40	47.00	50.00	52.00	55.00	60.00	65.00
22)	.73	.38	.40	.44	.48	.50	.56	.64	.71	.78	.90	1.02	1.09	1.19	1.26	1.30

LOW FLOW VALUES -- DURATION (DAYS), RETURN INTERVAL (YEARS)

	1,2	7,2	15,2	31,2	61,2	91,2	1,10	7,10	15,10	31,10	61,10	91,10	1,25	7,25	15,25	31,25
1)	1.76	1.80	1.84	1.88	1.95	2.06	1.54	1.55	1.57	1.60	1.65	1.70	1.49	1.51	1.54	1.55
2)	.35	.35	.36	.37	.39	.29	.28	.29	.29	.30	.32	.41	.26	.27	.28	.29
3)	5.89	3.50	3.54	3.58	3.62	3.67	4.00	4.06	4.13	4.21	4.33	4.53	3.65	3.68	3.72	3.75
4)	.18	.19	.21	.23	.27	.33	.09	.10	.11	.12	.14	.16	.08	.08	.09	.10
5)	14.35	14.80	15.30	15.80	16.49	17.40	10.26	11.02	11.67	12.21	12.95	13.60	8.40	9.06	9.88	10.83
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51
8)	.18	.19	.21	.23	.27	.33	.09	.10	.11	.12	.14	.16	.08	.08	.09	.10
9)	.79	.84	.91	.97	1.07	1.22	.54	.55	.57	.60	.65	.70	.48	.50	.53	.55
10)	.22	.24	.27	.33	.42	.57	.12	.13	.13	.14	.16	.18	.11	.12	.12	.13
11)	.36	.38	.40	.44	.51	.61	.21	.22	.23	.26	.29	.32	.18	.19	.20	.21
12)	18.85	19.36	20.00	20.75	22.01	23.90	14.82	15.14	15.60	16.20	17.15	18.00	13.05	13.92	14.66	15.06
13)	9.60	9.90	10.28	10.73	11.51	12.70	7.04	7.28	7.64	8.12	8.65	9.10	6.00	6.48	6.92	7.22
14)	.52	.54	.56	.59	.63	.70	.37	.38	.40	.42	.45	.48	.31	.34	.37	.38
15)	.40	.41	.42	.43	.44	.46	.34	.35	.35	.36	.38	.39	.33	.34	.34	.35
16)	1.29	1.33	1.38	1.45	1.57	1.74	1.03	1.05	1.08	1.11	1.17	1.23	.97	.99	1.02	1.04
17)	.78	.80	.82	.85	.89	.96	.65	.66	.67	.69	.72	.74	.63	.64	.64	.65
18)	.38	.38	.39	.40	.41	.43	.31	.32	.33	.34	.35	.36	.30	.31	.31	.32
19)	.27	.28	.29	.30	.33	.36	.21	.22	.22	.23	.25	.26	.20	.21	.21	.22
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	35.25	35.70	36.20	36.70	37.51	38.70	32.08	32.36	32.71	33.13	33.85	34.50	30.70	31.36	31.94	32.29
22)	.46	.47	.48	.49	.52	.56	.37	.38	.39	.40	.42	.44	.36	.37	.37	.38

	LOW FLOW VALUES -- DURATION (DAYS), RETURN INTERVAL (YEARS)								HIGH FLOW VALUES -- DURATION (DAYS), RETURN INTERVAL (YEARS)							
	61,25	91,25	1,50	7,50	15,50	31,50	61,50	91,50	1,2	7,2	15,2	31,2	61,2	91,2	1,10	7,10
1)	1.57	1.60	1.45	1.47	1.51	1.53	1.55	1.58	5.17	5.04	4.74	4.45	4.23	4.04	5.17	5.17
2)	.29	.33	.24	.25	.27	.28	.29	.30	.29	1.02	1.02	1.02	1.01	.98	1.02	.98
3)	3.83	3.90	3.56	3.60	3.64	3.68	3.72	3.76	3.72	9.25	9.25	9.25	9.17	8.93	9.25	8.97
4)	.11	.12	.06	.07	.08	.09	.10	.11	1.45	1.38	1.23	1.10	1.02	.96	1.45	1.45
5)	11.67	12.30	7.30	7.96	8.84	9.50	10.64	11.76	44.30	43.60	40.90	38.70	37.70	36.70	44.30	44.30
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51
8)	.11	.12	.06	.07	.08	.09	.10	.11	1.60	1.54	1.42	1.31	1.22	1.14	1.60	1.60
9)	.57	.60	.44	.46	.50	.52	.54	.58	3.33	3.24	3.08	2.93	2.81	2.71	3.33	3.33
10)	.13	.14	.10	.11	.11	.12	.13	.13	2.31	2.22	2.05	1.90	1.80	1,72	2.31	2.31
11)	.23	.26	.16	.17	.19	.20	.21	.24	2.55	2.45	2.28	2.14	2.04	1.95	2.55	2.55
12)	15.60	16.30	11.60	12.47	13.63	14.50	14.98	15.70	60.00	57.90	54.00	50.80	48.80	47.10	60.00	60.00
13)	7.64	8.20	5.20	5.68	6.32	6.80	7.16	7.72	38.80	37.61	35.36	33.33	31.88	30.61	38.80	38.80
14)	.40	.42	.26	.29	.33	.36	.38	.40	1.45	1.42	1.36	1.31	1.27	1.24	1.45	1.45
15)	.35	.36	.32	.33	.33	,34	.35	.35	.96	.92	.85	.80	.76	.74	.96	.96
16)	1.08	1.12	.92	.95	.98	1.01	1.04	1.08	4.76	4.66	4.49	4.32	4.18	4.03	4.76	4.76
17)	.67	.69	.62	.63	.63	.64	.65	.67	1.71	1.69	1.64	1.59	1.55	1.52	1.71	1.71
18)	.33	.34	.29	.30	.30	.31	.32	.33	.93	.89	.82	.77	.73	.71	.93	.93
19)	.22	.23	.19	.20	.20	.21	.22	.22	1.11	1.08	1.02	.96	.90	86	1.11	1.11
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	32.71	33.20	29.60	30.26	31.14	31.80	32.22	32.78	65.00	61.50	57.00	54.10	52.60	51 40	65.00	65.00
22)	.39	.40	.35	.36	.36	.37	.38	.39	1.30	1.27	1.22	1.16	1.11	1,07	1.30	1.30

HIGH FLOW VALUES -- DURATION (DAYS), RETURN INTERVAL (YEARS)

	15,10	31,10	61,10	91,10	1,25	7,25	15,25	31,25	61,25	91,25	1,50	7,50	15,50	31,50	61,50	91,50
1)	5.15	4.98	4.70	4.58	5.17	5.17	5.17	5.09	4.90	4.70	5.17	5.17	5.17	5.13	5.02	4.78
2)	.91	.84	.78	.74	1.02	1.02	1.02	.97	.90	.87	1.02	1.02	1.02	1.00	.95	.90
3)	8.41	8.07	7.98	7.85	9.25	9.25	9.21	8.85	8.34	8.12	9.25	9.25	9.25	9.09	8.70	8.34
4)	1.44	1.35	1.21	1.15	1.45	1.45	1.45	1.41	1.31	1.21	1.45	1.45	1.45	1.43	1.37	1.25
5)	44.20	43.30	40.50	39.30	44.30	44.30	44.30	43.90	42.50	40.50	44.30	44.30	44.30	44.10	43.50	41.30
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51
8)	1.59	1.52	1.41	1.36	1.60	1.60	1.60	1.57	1.49	1.41	1.60	1.60	1.60	1.58	1.54	1.44
9)	3.32	3.20	3.06	3.00	3.33	3.33	3.33	3.28	3.16	3.06	3.33	3.33	3.33	3.30	3.23	3.10
10)	2.30	2.18	2.03	1.96	2.31	2.31	2.31	2.26	2.14	2.03	2.31	2.31	2.31	2.28	2.21	2.07
11)	2.53	2.40	2.26	2.20	2.55	2.55	2.55	2.49	2.36	2.26	2.55	2.55	2.55	2.52	2.43	2.30
12)	59.70	57.00	53.50	52.00	60.00	60.00	60.00	58.80	56.00	53.50	60.00	60.00	60.00	59.40	57.60	54.50
13)	38.63	37.10	35.07	34.20	38.80	38.80	38.80	38.12	36.52	35.07	38.80	38.80	38.80	38.46	37.44	35.65
14)	1.45	1.40	1.35	1.33	1.45	1.45	1.45	1.43	1.39	1.35	1.45	1.45	1.45	1.44	1.41	1.37
15)	.95	.90	.84	.82	.96	.96	.96	.94	.88	.84	.96	.96	.96	.95	.91	.86
16)	4.75	4.62	4.47	4.40	4.76	4.76	4.76	4.70	4.58	4.47	4.76	4.76	4.76	4.73	4.65	4.51
17)	1.71	1.68	1.63	1.61	1.71	1.71	1.71	1.70	1.67	1.63	1.71	1.71	1.71	1.70	1.69	1.65
18)	.92	.87	.81	.79	.93	.93	.93	.91	.85	.81	.93	.93	.93	.92	.88	.83
19)	1.11	1.07	1.01	.99	1.11	1.11	1.11	1.09	1.05	1.01	1.11	1.11	1.11	1.10	1.08	1.03
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	64.50	60.00	56.50	55.00	65.00	65.00	65.00	63.00	59.00	56.50	65.00	65.00	65.00	64.00	61.00	57.50
22)	1.30	1.26	1.21	1.19	1.30	1.30	1.30	1.28	1.25	1.21	1.30	1.30	1.30	1.29	1.27	1.23

MONTHLY DROUGHT FLOWS -- DURATION (MONTHS), RETURN INTERVAL (YEARS)

	6,10	9,10	12,10	18,10	30,10	54,10	6,25	9,25	12,25	18,25	30,25	54,25	6,50	9,50	12,50	18,50	30,50	54,50
1)	1.90	2.13	2.38	2.51	2.75	3.14	1.80	1.98	2.18	2.27	2.43	2.58	1.72	1.88	2.04	2.13	2.27	2.43
2)	.92	.34	.38	.41	.42	.44	.38	.42	.46	.48	.52	.57	.35	.40	.43	.44	.46	.49
3)	8.49	3.94	4.22	4.50	4.68	4.99	4.25	4.68	5.31	5.69	6.24	6.87	4.06	4.39	4.79	4.99	5.47	5.87
4)	.25	.36	.47	.52	.60	.72	.19	.29	.38	.42	.49	.54	.17	.24	.32	.36	.42	.49
5)	16.10	17.97	20.60	22.14	23.52	26.46	14.80	16.75	18.35	19.11	21.38	22.50	13.90	15.90	17.27	17.97	19.11	21.38
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51
8)	.25	.37	.50	.56	.66	.81	.19	.29	.39	.44	.52	.59	.17	.24	.32	.37	.44	.52
9)	1.01	1.30	1.59	1.74	1.96	2.26	.84	1.12	1.35	1.45	1.65	1.81	.74	.98	1.20	1.30	1.45	1.65
10)	.36	.66	.96	1.07	1.24	1.43	.24	.47	.73	.85	1.01	1.13	.19	.34	.55	.66	.85	1.01
11)	.46	.67	.87	.96	1.13	1.39	.38	.54	.71	.78	.90	1.01	.33	,45	.59	.67	.78	.90
12)	21.20	25.01	29.30	31.84	35.78	39.84	19.36	22.55	25.75	27.23	30.32	33.10	18.34	20.90	23.63	25.01	27.23	30.32
13)	11.00	13.39	16.05	17.60	20.11	23.68	9.90	11.85	13.85	14.77	16.68	18.35	9.30	10.82	12.53	13.39	14.77	16.68
14)	.60	.74	.86	.92	.99	1 .08	.54	.65	.76	.81	.88	.94	.49	.59	.69	.74	.81	.88
15)	.43	.47	.52	.55	.58	.63	.41	.45	.48	.50	.53	.56	.40	.43	.46	.47	.50	.53
16)	1.49	1.84	2.24	2.45	2.76	3.18	1.33	1.62	1.91	2.05	2.33	2.55	1.25	1.46	1.71	1.84	2.05	2.33
17)	.86	1.00	1.14	1.20	1.27	1.36	.80	.91	1.03	1.09	1.16	1.22	.75	.85	.95	1.00	1.09	1.16
18)	.40	.44	.49	.52	.55	.60	.38	.42	.45	.47	.50	.52	.37	.40	.43	.44	.47	.50
19)	.31	.38	.46	.50	.57	.65	.28	.34	.40	.43	.47	.52	.26	.30	.36	.38	.43	.47
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	37.00	39.42	41.80	42.88	44.66	46.48	35.70	37.85	39.90	40.86	42.22	43.45	34.80	36.80	38.53	39.42	40.86	42.22
22)	.50	.58	.67	.72	.79	.88	.47	.53	.60	.63	.70	.75	.45	.50	.55	.58	.63	.70

FLOW DURATION VALUES FOR THE MONTH OF JANUARY

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	3.25	1.65	1.82	2.06	2.46	3.25	4.14	5.04
2)	.30	.35	.39	.43	.51	.68	.97	.46
3)	3.75	4.00	4.31	4.94	6.15	7.60	8.85	5.47
4)	.75	.14	.20	.33	.50	.75	.99	1.38
5)	27.30	12.95	15.10	17.40	21.90	27.30	37.30	43.60
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	.85	.14	.20	.33	.54	.85	1.18	1.54
9)	2.34	.65	.88	1.22	1.69	2.34	2.76	3.24
10)	1.48	.16	.25	.57	1.04	1.48	1.76	2.22
11)	1.47	.29	.39	.61	.93	1.47	2.00	2.45
12)	41.00	17.15	19.70	23.90	31.00	41.00	48.00	57.90
13)	24.70	8.65	10.10	12.70	17.10	24.70	31.30	37.61
14)	1.11	.45	.55	.70	.90	1.11	1.25	1.42
15)	.65	.38	.42	.46	.54	.65	.75	.92
16)	3.30	1.17	1.35	1.74	2.39	3.30	4.12	4.66
17)	1.38	.72	.81	.96	1.18	1.38	1.54	1.69
18)	.62	.35	.39	.43	.51	.62	.72	.89
19)	.67	.25	.28	.36	.48	.67	.88	1.08
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	47.00	33.85	36.00	38.70	42.50	47.00	52.00	61.50
22)	.90	.42	.48	.56	.71	.90	1.09	1.27

FLOW DURATION VALUES FOR THE MONTH OF FEBRUARY

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	3.53	1.77	1.93	2.18	2.69	3.70	4.36	5.11
2)	.59	.32	.36	.41	.47	.59	.76	.98
3)	7.05	3.83	4.10	4.53	5.58	7.05	7.95	8.97
4)	.83	.18	.27	.38	.58	.87	1.07	1.42
5)	31.30	14.50	16.36	18.35	23.10	33.70	38.30	44.00
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	.96	.18	.27	.39	.64	1.02	1.27	1.58
9)	2.47	.81	1.05	1.35	1.92	2.55	2.88	3.29
10)	1.56	.22	.40	.73	1.21	1.61	1.86	2.27
11)	1.65	.36	.49	.71	1.09	1.75	2.10	2.51
12)	43.00	19.02	21.74	25.75	35.20	44.20	50.00	59.10
13)	26.85	9.70	11.34	13.85	19.60	28.14	32.75	38.29
14)	1.16	.52	.62	.76	.98	1.18	1.29	1.44
15)	.68	.41	.44	.48	.57	.70	.79	.94
16)	3.56	1.30	1.54	1.91	2.70	3.72	4.26	4.72
17)	1.43	.78	.88	1.03	1.26	1.46	1.58	1.70
18)	.65	.38	.41	.45	.54	.67	.76	.91
19)	.74	.27	.32	.40	.56	.77	.94	1.10
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	48.50	35.40	37.34	39.90	44.40	49.40	53.50	63.50
22)	.96	.46	.51	.60	.78	1.00	1.14	1.29

FLOW DUARTION VALUES FOR THE MONTH OF MARCH

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	3.81	1.90	2.29	2.58	3.25	3.94	4.58	5.17
2)	.64	.35	.39	.43	.51	.66	.82	1.01
3)	7.33	4.02	4.31	4.79	6.15	7.49	8.04	9.13
4)	.90	.25	.43	.54	.75	.94	1.15	1.45
5)	35.30	16.10	19.30	22.50	27.30	36.10	39.30	44.30
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	1.06	.25	.45	.59	.85	1.11	1.36	1.60
9)	2.60	1.01	1.48	1.81	2.34	2.66	3.00	3.33
10)	1.64	.36	.88	1.13	1.48	1.69	1.96	2.31
11)	1.82	.46	.80	1.01	1.47	1.89	2.20	2.55
12)	45.00	21.20	27.60	33.10	41.00	46.20	52.00	60.00
13)	29.00	11.00	15.00	18.35	24.70	29.92	34.20	38.80
14)	1.20	.60	.82	.94	1.11	1.22	1.33	1.45
15)	.71	.43	.50	.56	.65	.73	.82	.96
16)	3.82	1.49	2.08	2.55	3.30	3.94	4.40	4.76
17)	1.48	.86	1.10	1.22	1.38	1.50	1.61	1.71
18)	.68	.40	.47	.52	.62	.70	.79	.93
19)	.80	.31	.44	.52	.67	.83	.99	1.11
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	50.00	37.00	41.10	43.45	47.00	50.80	55.00	65.00
22)	1.02	.50	.64	.75	.90	1.05	1.19	1.30

FLOW DUARTION VALUES FOR THE MONTH OF APRIL

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	3.91	1.98	2.43	2.69	3.42	4.07	4.58	5.17
2)	.68	.38	.44	.49	.59	.71	.87	1.02
3)	7.60	4.25	5.04	5.87	7.05	7.74	8.12	9.25
4)	.93	.29	.49	.58	.80	.97	1.15	1.45
5)	35.90	16.75	21.38	23.10	29.70	36.90	39.30	44.30
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	1.10	.29	.52	.64	.91	1.16	1.36	1.60
9)	2.65	1.12	1.65	1.92	2.42	2.73	3.00	3.33
10)	1.68	.47	1.01	1.21	1.53	1.74	1.96	2.31
11)	1.87	.54	.90	1.09	1.58	1.96	2.20	2.55
12)	45.90	22.55	30.32	35.20	42.20	47.40	52.00	60.00
13)	29.69	11.85	16.68	19.60	25.99	30.84	34.20	38.80
14)	1.22	.65	.88	.98	1.14	1.24	1.33	1.45
15)	.72	.45	.53	.57	.67	.74	.82	.96
16)	3.91	1.62	2.33	2.70	3.46	4.06	4.40	4.76
17)	1.50	.91	1.16	1.26	1.41	1.53	1.61	1.71
18)	.69	.42	.50	.52	.64	.71	.79	.93
19)	.82	.34	.47	.56	.71	.86	.99	1.11
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	50.60	37.85	42.22	44.40	47.90	51.60	55.00	65.00
22)	1.04	.53	.70	.78	.94	1.08	1.19	1.30

FLOW DURATION VALUES FOR THE MONTH OF MAY

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	3.64	1.93	2.38	2.58	2.97	3.59	4.36	5.07
2)	.70	.40	.46	.51	.62	.74	.87	1.02
3)	7.71	4.39	5.47	6.15	7.22	7.88	8.12	9.25
4)	.85	.27	.47	.54	.67	.84	1.07	1.40
5)	32.90	16.36	20.60	22.50	25.20	32.10	38.30	43.80
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	1.00	.27	.50	.59	.75	.98	1.27	1.56
9)	2.52	1.05	1.59	1.81	2.13	2.50	2.88	3.27
10)	1.59	.40	.96	1.13	1.35	1.58	1.86	2.24
11)	1.71	.49	.87	1.01	1.28	1.68	2.10	2.47
12)	43.80	21.74	29.30	33.10	38.10	43.40	50.00	58.50
13)	27.71	11.34	16.05	18.35	22.15	27.28	32.75	37.95
14)	1.17	.62	.86	.94	1.05	1.16	1.29	1.43
15)	.69	.44	.52	.56	.61	.69	.79	.93
16)	3.66	1.54	2.24	2.55	3.00	3.61	4.26	4.69
17)	1.45	.88	1.14	1.22	1.32	1.44	1.58	1.70
18)	.66	.41	.49	.54	.58	.66	.76	.90
19)	.76	.32	.46	.52	.62	.75	.94	1.09
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	49.10	37.34	41.80	43.45	45.70	48.80	53.50	62.50
22)	.98	.51	.67	.75	.84	.97	1.14	1.28

FLOW DURATION VALES FOR THE MONTH OF JUNE

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	3.42	1.90	2.22	2.41	2.69	3.47	4.36	5.17
2)	.65	.39	.46	.49	.55	.64	.82	1.00
3)	7.44	4.31	5.31	5.87	6.60	7.38	8.04	9.05
4)	.80	.25	.40	.48	.58	.81	1.07	1.45
5)	29.70	16.10	18.73	21.12	23.10	30.50	38.30	44.30
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	.91	.25	.41	.51	.64	.93	1.27	1.60
9)	2.42	1.01	1.40	1.63	1.92	2.44	2.88	3.33
10)	1.53	.36	.79	.99	1.21	1.54	1.86	2.31
11)	1.58	.46	.74	.89	1.09	1.61	2.10	2.55
12)	42.20	21.20	26.49	29.98	35.20	42.60	50.00	60.00
13)	25.99	11.00	14.31	16.47	19.60	26.42	32.75	38.80
14)	1.14	.60	.78	.88	.98	1.15	1.29	1.45
15)	.67	.43	.49	.53	.57	.67	.79	.96
16)	3.46	1.49	1.98	2.30	2.70	3.51	4.26	4.76
17)	1.41	.86	1.06	1.16	1.26	1.42	1.58	1.71
18)	.64	.40	.46	.50	.54	.64	.76	.93
19)	.71	.31	.42	.47	.56	.72	.94	1.11
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	47.90	37.00	40.38	42.08	44.40	48.20	53.50	65.00
22)	.94	.50	.62	.69	.78	.95	1.14	1.30

FLOW DURATION VALUES FOR THE MONTH OF JULY

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	2.97	1.70	1.96	2.15	2.46	2.86	3.81	4.78
2)	.62	.38	.43	.46	.51	.63	.82	1.02
3)	7.22	4.25	4.89	5.42	6.15	7.27	8.04	9.25
4)	.67	.16	.28	.37	.50	.63	.90	1.25
5)	25.20	13.60	16.62	18.16	21.90	24.36	35.30	41.30
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	.75	.16	.28	.38	.54	.70	1.06	1.44
9)	2.13	.70	1.09	1.32	1.69	2.05	2.60	3.10
10)	1.35	.18	.44	.69	1.04	1.29	1.64	2.07
11)	1.28	.32	.52	.69	.93	1.20	1.82	2.30
12)	38.10	18.00	22.28	25.38	31.00	36.94	45.00	54.50
13)	22.15	9.10	11.68	13.62	17.10	21.13	29.00	35.65
14)	1.05	.48	.64	.75	.90	1.02	1.20	1.37
15)	.61	.39	.44	.48	.54	.59	.71	.86
16)	3.00	1.23	1.59	1.88	2.39	2.88	3.82	4.51
17)	1.32	.74	.90	1.02	1.18	1.30	1.48	1.65
18)	.58	.36	.41	.45	.51	.56	.68	.83
19)	.62	.26	.33	.39	.48	.59	.80	1.03
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	45.70	34.50	37.68	39.66	42.50	45.18	50.00	57.50
22)	.84	.44	.52	.59	.71	.82	1.02	1.23

FLOW DURATION VALUES FOR THE MONTH OF AUGUST

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	2.64	1.60	1.82	1.95	2.13	2.41	3.14	4.58
2)	.55	.33	.39	.42	.47	.53	.68	.92
3)	6.60	3.90	4.36	4.73	5.58	6.42	7.60	8.49
4)	.56	.12	.20	.27	.36	.48	.72	1.15
5)	22.86	12.30	15.10	16.49	17.97	21.12	26.46	39.30
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	.62	.12	.20	.27	.37	.51	.81	1.36
9)	1.87	.60	.88	1.07	1.30	1.63	2.26	3.00
10)	1.18	.14	.25	.42	.66	.99	1.43	1.96
11)	1.06	.26	.39	.51	.67	.89	1.39	2.20
12)	34.36	16.30	19.70	22.01	25.01	29.98	39.84	52.00
13)	19.10	8.20	10.10	11.51	13.39	16.47	23.68	34.20
14)	.96	.42	.55	.63	.74	.88	1.08	1.33
15)	.56	.36	.42	.44	.47	.53	.63	.82
16)	2.64	1.12	1.35	1.57	1.84	2.30	3.18	4.40
17)	1.24	.69	.81	.89	1.00	1.16	1.36	1.61
18)	.53	.34	.39	.41	.44	.50	.60	.79
19)	.54	.23	.28	.33	.38	.47	.65	.99
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	44.02	33.20	36.00	37.51	39.42	42.08	46.48	55.00
22)	.77	.40	.48	.52	.58	.69	.88	1.19

FLOW DURATION VALUES FOR THE MONTH OF SEPTEMBER

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	2.38	1.56	1.70	1.84	1.96	2.13	2.62	4.14
2)	.50	.30	.36	.39	.42	.46	.57	.87
3)	5.31	3.76	4.10	4.33	4.68	5.42	6.87	8.12
4)	.47	.10	.16	.21	.28	.37	.56	.99
5)	20.60	11.40	13.60	15.30	16.62	18.16	22.74	37.30
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	.50	.10	.16	.21	.28	.38	.61	1.18
9)	1.59	.56	.70	.91	1.09	1.32	1.85	2.76
10)	.96	.13	.18	.27	.44	.69	1.16	1.76
11)	.87	.22	.32	.40	.52	.69	1.04	2.00
12)	29.30	15.30	18.00	20.00	22.28	25.38	33.94	48.00
13)	16.05	7.40	9.10	10.28	11.68	13.62	18.85	31.30
14)	.86	.39	.48	.56	.64	.75	.96	1.25
15)	.52	.35	.39	.42	.44	.48	.56	.75
16)	2.24	1.06	1.23	1.38	1.59	1.88	2.61	4.12
17)	1.14	.66	.74	.82	.90	1.02	1.24	1.54
18)	.49	.32	.36	.39	.41	.45	.53	.72
19)	.46	.22	.26	.29	.33	.39	.54	.88
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	41.80	32.50	34.50	36.20	37.68	39.66	43.83	52.00
22)	.67	.38	.44	.48	.52	.59	.76	1.09

FLOW DURATION VALUES FOR THE MONTH OF OCTOBER

	MEAN	Q98	Q90	Q75	Q50	Q23	010	Q02
1)	2.46	1.93	1.65	1.82	1.96	2.32	2.97	4.27
2)	.46	.29	.33	.36	.39	.42	.50	.76
3)	5.58	3.70	3.90	4.13	4.36	4.73	5.98	7.95
4)	.50	.09	.14	.20	.28	.44	.67	1.04
5)	21.90	9.50	12.95	15.10	16.62	19.82	25.20	37.90
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	.54	.09	.14	.20	.28	.47	.75	1.23
9)	1.69	.52	.65	.88	1.09	1.52	2.13	2.83
10)	1.04	.12	.16	.25	.44	.91	1.35	1.82
11)	.93	.20	.29	.39	.52	.83	1.28	2.06
12)	31.00	14.50	17.15	19.70	22.28	28.28	38.10	49.20
13)	17.10	6.80	8.65	10.10	11.68	15.42	22.15	32.17
14)	.90	.36	.45	.55	.64	.84	1.05	1.27
15)	.54	.34	.38	.42	.44	.51	.61	.77
16)	2.39	1.01	1.17	1.35	1.59	2.14	3.00	4.20
17)	1.18	.64	.72	.81	.90	1.12	1.32	1.56
18)	.51	.31	.35	.39	.41	.48	.58	.74
19)	.48	.21	.25	.28	.33	.45	.62	.91
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	42.50	31.80	33.85	36.00	37.68	41.38	45.70	52.90
22)	.71	.37	.42	.48	.52	.65	.84	1.12

FLOW DURATION VALUES FOR THE MONTH OF NOVEMBER

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	2.46	1.56	1.70	1.88	2.13	2.51	3.25	4.49
2)	.47	.28	.32	.36	.39	.45	.55	.79
3)	5.58	3.62	3.83	4.10	4.36	5.15	6.60	8.00
4)	.50	.10	.16	.24	.36	.52	.75	1.12
5)	21.90	11.40	13.60	15.90	17.97	22.14	27.30	38.90
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	.54	.10	.16	.24	.37	.56	.85	1.32
9)	1.69	.56	.70	.98	1.30	1.74	2.34	2.95
10)	1.04	.13	.18	.34	.66	1.07	1.48	1.92
11)	.93	.22	.32	.45	.67	.96	1.47	2.16
12)	31.00	15.30	18.00	20.90	25.01	31.84	41.00	51.20
13)	17.10	7.40	9.10	10.82	13.39	17.60	24.70	33.62
14)	.90	.39	.48	.59	.74	.92	1.11	1.31
15)	.54	.35	.39	.43	.47	.55	.65	.81
16)	2.39	1.06	1.23	1.46	1.84	2.45	3.30	4.34
17)	1.18	.66	.74	.85	1.00	1.20	1.38	1.60
18)	.51	.32	.36	.40	.44	.52	.62	.78
19)	.48	.22	.26	.30	.38	.50	.67	.97
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	42.50	32.50	34.50	36.80	39.42	42.88	47.00	54.40
22)	.71	.38	.44	.50	.58	.72	.90	1.17

FLOW DURATION VALUES FOR THE MONTH OF DECEMBER

	MEAN	Q98	Q90	Q75	Q50	Q25	Q10	Q02
1)	2.80	1.59	1.76	1.93	2.24	2.69	3.81	4.98
2)	.47	.29	.33	.38	.42	.48	.59	.85
3)	6.33	3.70	3.90	4.22	4.68	5.69	7.05	8.09
4)	.61	.12	.18	.27	.41	.58	.90	1.35
5)	23.94	12.12	14.35	16.36	18.92	23.10	35.30	43.30
6)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
7)	.51	.51	.51	.51	.51	.51	.51	.51
8)	.68	.12	.18	.27	.43	.64	1.06	1.52
9)	2.00	.59	.79	1.05	1.43	1.92	2.60	3.20
10)	1.26	.14	.22	.40	.82	1.21	1.64	2.18
11)	1.17	.25	.36	.49	.76	1.09	1.82	2.40
12)	36.36	16.10	18.85	21.74	26.86	35.20	45.00	57.00
13)	20.62	8.04	9.60	11.34	14.54	19.60	29.00	37.10
14)	1.01	.41	.52	.62	.80	.98	1.20	1.40
15)	.59	.36	.40	.44	.49	.57	.71	.90
16)	2.82	1.11	1.29	1.54	2.01	2.70	3.82	4.62
17)	1.28	.68	.78	.88	1.07	1.26	1.48	1.68
18)	.56	.34	.38	.41	.46	.54	.68	.87
19)	.58	.23	.27	.32	.42	.56	.80	1.07
20)	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
21)	44.92	33.06	35.25	37.34	40.62	44.40	50.00	60.00
22)	.80	.40	.46	.51	.62	.78	1.02	1.26