TECHNIQUE FOR ESTIMATING MAGNITUDE AND FREQUENCY OF PEAK FLOWS IN MARYLAND

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 95-4154

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849

Prepared in cooperation with the

MARYLAND STATE HIGHWAY ADMINISTRATION

CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATIONS

Multiply	By	To obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
cubic foot per second per square mile [(ft^3/s)/mi^2]	0.01093	cubic meter per second per square kilometer

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

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By Jonathan J. A. Dillow

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1996

U.S. DEPARTMENT OF THE INTERIOR
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TECHNIQUE FOR ESTIMATING MAGNITUDE AND FREQUENCY OF PEAK FLOWS IN MARYLAND

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ABSTRACT

A convenient and reliable technique for estimating flood magnitudes is required for effective flood-plain management and for the efficient design of bridges, culverts, embankments, and flood-protection structures. Methods are presented for estimating peak-flow magnitudes of selected frequencies, ranging from 2 to 500 years, for all nontidal drainage basins in Maryland. The methods were developed by generalized least-squares regression techniques using data from 219 gaged basins in and near Maryland.

The State is divided into five hydrologic regions: the Appalachian Plateaus and Allegheny Ridges region, the Blue Ridge and Great Valley region, the Piedmont region, the Western Coastal Plain region, and the Eastern Coastal Plain region. These regions correspond to the physiographic provinces of the State, with the exceptions that (1) the Coastal Plain Province is divided into two hydrologic regions, and (2) there is no distinct hydrologic region corresponding to the Valley and Ridge Province as it is divided into its constituent Allegheny Ridges and Great Valley subdivisions. Sets of equations for calculating peak discharges based on physical basin characteristics are provided for each of the regions.

Based on the peak-flow equations, methods for estimating peak flows are presented for ungaged and gaged streams in Maryland. The methods and equations are supported by generalized least-squares analysis of basin and flood-frequency characteristics data from 219 drainage basins in and near Maryland.

Peak-flow estimates for each of the five regions are calculated using combinations of the following basin characteristics: drainage area, forest cover, basin relief, carbonate rock coverage, storage, and runoff-curve number. Drainage area contributes to the estimate in all five study regions. Carbonate rock coverage is used only in the Blue Ridge and Great Valley region. Storage and runoff-curve number are used solely in the Eastern Coastal Plain region. All other basin characteristics are used in two or more regions. Standard errors of estimate for the regression equations range from 19 to 31 percent in the Appalachian Plateaus and Allegheny Ridges region, 34 to 47 percent in the Blue Ridge and Great Valley region, 33 to 48 percent in the Piedmont region, 45 to 64 percent in the Western Coastal Plain region, and 36 to 42 percent in the Eastern Coastal Plain region.

INTRODUCTION

A convenient and reliable technique for estimating the magnitude and frequency of peak flows is required for effective flood-plain management and for the efficient design of bridges, culverts, and embankments. One method for estimating floods relates peak-flow characteristics to basin characteristics such as **drainage area**[1] and **forest cover**. This method was developed and applied in Maryland by Carpenter (1980) by use of flood data through September 30, 1977. In the present report, the U.S. Geological Survey (USGS), in cooperation with the Maryland State Highway Administration (MSHA), has revised and extended Carpenter's work by using the best available methods to analyze streamflow data available through September 30, 1990. The report provides equations and methods for estimating peak-flow frequencies for nontidal streams in Maryland.

Background

Techniques for estimating peak-flow frequencies for Maryland streams were previously presented in reports by Darling (1962), Tice (1968), Walker (1971), and Cushing, Kantrowitz, and Taylor (1973). The most recent technique for estimating peak-flow frequencies in Maryland was presented by Carpenter (1980). The first group of reports had relatively fewer data to work with when compared to the Carpenter study, especially with respect to drainage basins under 10 mi^2. The present report is intended to update the flood-frequency estimation technique presented by Carpenter, based on the inclusion of 13 years of additional data and using the most current available analytical methods.

Purpose and Scope

The purpose of this report is to provide equations, and methods of applying them, to estimate the magnitudes of peak flows of selected frequencies on streams in Maryland. The report provides the data used in developing the estimation equations and describes methods for using the equations to estimate peak-flow discharges that have the probability of recurring every 2, 5, 10, 25, 50, 100, and 500 years.

This report presents the peak-flow characteristics and basin characteristics for 236 streamflow-gaging stations in Maryland, Delaware, and the surrounding States of Virginia, West Virginia, and Pennsylvania. The peak-flow characteristics were computed by fitting annual peak-flow data to the log-Pearson Type III distribution. With the exceptions of the **runoff-curve number** and **carbonate rock coverage**, all basin characteristics used in this report were retrieved from the Streamflow/Basin Characteristics File in the National Water Data Storage and Retrieval System (WATSTORE). However, standard map-measurement techniques will provide acceptable estimates of basin characteristics needed to use the methods presented in the report.

This report also provides regional peak-flow-estimation equations, which are based on generalized least-squares (GLS) regressions of the peak-flow and basin characteristics data from 219 streamflow-gaging stations in Maryland. The equations provide hydrologists, engineers, and planners with methods to estimate peak-flow magnitudes for particular recurrence intervals at ungaged stream locations in Maryland. Additionally, this report presents methods and examples for determining peak-flow estimates for locations at, near, and between streamflow-gaging stations on gaged stream reaches.

The appendix presents the results of a gaging-station network analysis presenting one set of alternatives to the current streamflow-data-collection strategy.

Description of Study Area

Maryland lies between 37°53' and 39°43' north latitude and 75°04' and 79°29' west longitude (fig. 1). The State has an irregular shape that would fit on a rectangle 240 mi long (east-west) by 125 mi wide (north-south). Excluding the area covered by the Chesapeake Bay, the State has a total area of 10,577 mi^2, of which 9,891 mi^2 is land and 686 mi^2 is inland water.

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[1] Words in **bold** are defined in the Glossary.

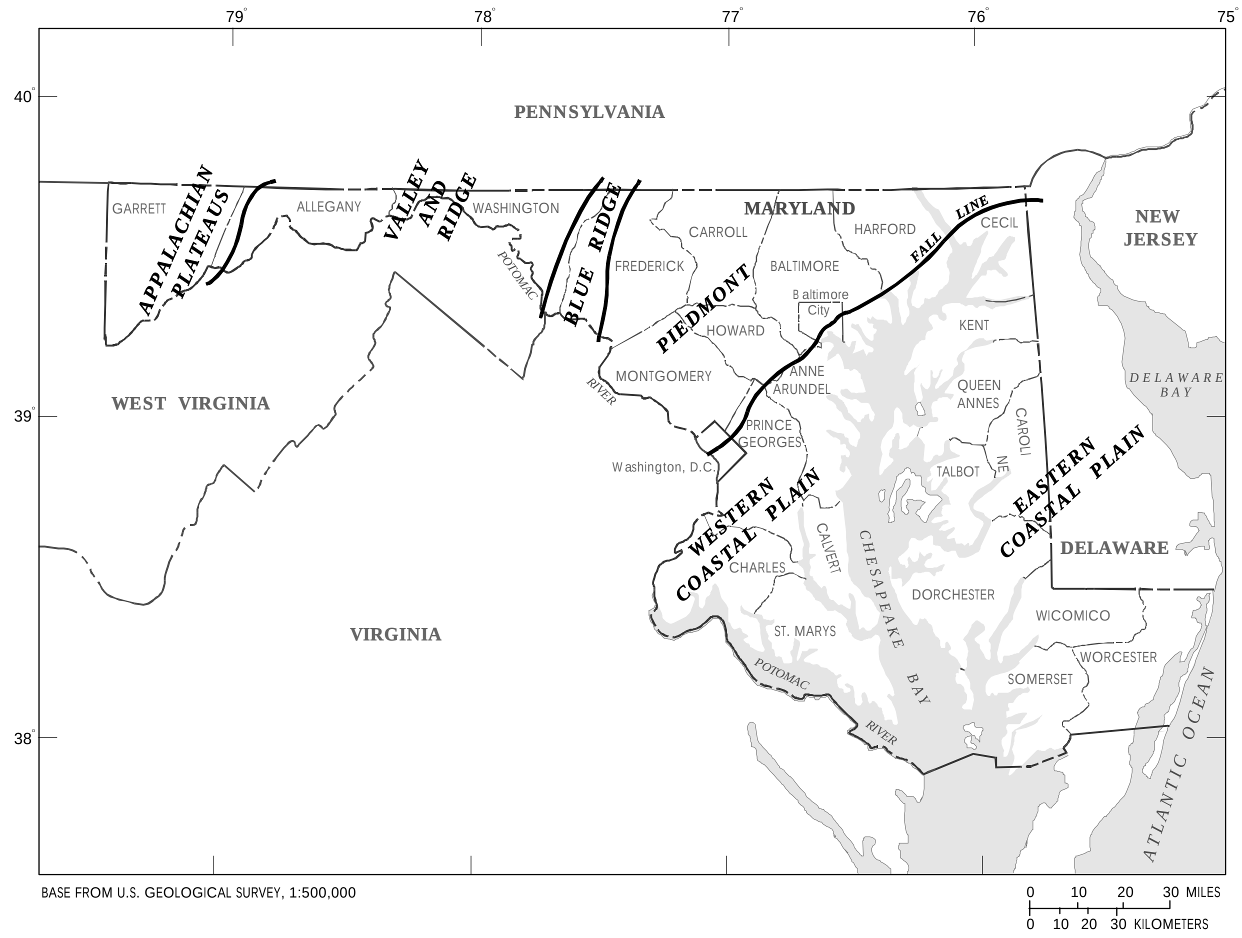


Figure 1. Study area and Physiographic Provinces in Maryland.

Physiographic Setting

According to Fenneman (1938), Maryland has five major Physiographic Provinces--the Coastal Plain, Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateaus (fig. 1). A brief description of each province follows:

Coastal Plain

The Coastal Plain Province consists of two distinct parts: (1) the Eastern Shore, and (2) the western shore lying east of the **Fall Line**. The Eastern Shore is characterized by low relief, rising from sea level to slightly less than 100 ft above sea level and is drained by small, sluggish streams. The western shore part, which rises to slightly more than 200 ft above sea level and has streams which are slightly less sluggish than those of the Eastern Shore, is a rolling upland whose topography resembles that of the Piedmont more than that of the Eastern Shore. Most streams and rivers in both parts of the Coastal Plain are affected by tides for a considerable distance above their outlets to the Chesapeake Bay. The Coastal Plain Province in Maryland includes almost 5,000 mi^2, approximately half the area of the State.

Piedmont

The Piedmont Province, covering approximately 2,500 mi^2, consists of gently rolling hills and ridges with elevations generally less than 800 ft above sea level. The province is bounded in the east by the Fall Line and in the west by Catoctin Mountain. The province is drained by many streams and rivers with fairly steep gradients in relatively deep, narrow valleys. Streams in the eastern Piedmont drain directly into the Chesapeake Bay. Streams in the western part of the province drain into the Potomac River.

Blue Ridge

The Blue Ridge Province in Maryland covers approximately 600 mi^2. The province has elevations rising to more than 1,600 ft above sea level, with rugged topography and high relief. Bounded on the east by Catoctin Mountain and on the west by South Mountain, the region is drained principally by Catoctin Creek and its tributaries. Stream gradients are fairly steep.

Valley and Ridge

The Valley and Ridge Province is separated in Maryland into the Great Valley and the Allegheny Ridges and covers almost 800 mi^2. The Great Valley is a gently rolling, broad lowland, averaging from 500 to 600 ft in elevation, and is drained by Antietam Creek in the east and by Conococheague Creek in the west. Streams have gentle gradients and meandering courses. Cavernous limestone underlies the valley. Caves, sinkholes, and springs are common and the streams tend to have a less variable flow than do streams in other areas of the State. The Allegheny Ridges are a series of northeastward-trending hills which are bounded to the west by the Allegheny Front and run eastward to the Conococheague Creek Basin. The Allegheny Ridges have relatively level and uniform ridge lines, having elevations ranging from about 400 ft in the valleys to about 1,500 ft on the ridges, and are drained by fairly steep, swift streams.

Appalachian Plateaus

The Appalachian Plateaus Province, covering approximately 800 mi^2, is a broad, dissected upland with pronounced relief and rugged topography. In Maryland, the province runs west from the Allegheny Front to the western border of the State. Elevations in the Maryland part of the province generally range from 1,500 ft to 3,000 ft, with a maximum elevation of 3,360 ft. Streams in the province generally have steep gradients.

Geologic Setting

The physiography of Maryland is diverse mainly because of the underlying geology. The geologic description which follows is derived from Vokes (1957). This information is included in the report because geologic information is used to estimate peak flows in one of the study regions of the report, and the author expects that future studies might make more extensive use of geologic information. The Coastal Plain is underlain by gently dipping unconsolidated layers containing sand and clay with some gravel. This unconsolidated material is underlain by the eastward continuation of the crystalline rocks of the Piedmont region.

In the eastern division of the Piedmont Province, the crystalline and recrystallized rocks, including altered sedimentary deposits as well as massive granitic and gabbroic rocks, exhibit intricate infolding and no trace of fossil remains. The high degree of folding and lack of fossils make age determination difficult in this area, but it is generally agreed that the Baltimore Gneiss is the oldest rock in the division. Overlying the Baltimore Gneiss is the Setters Quartzite, the Cockeysville Marble, the Wissahickon Schist, the Peters Creek Formation, the Cardiff Conglomerate, and the Peach Bottom Slate, considered the youngest unit in the division.

In the western division of the Piedmont, the rocks are less deformed than those of the eastern division, and consequently, the geology is better understood. The granitic and gabbroic rocks found in the eastern division are absent in the western division. The Wakefield Marble and an overlying sequence of volcanic rocks are generally considered to be the oldest rocks in the western division. The marble might correspond to the

Cockeysville Marble of the eastern division and the volcanics to the upper Cockeysville or the lower Wissahickon. Other units found in the western division include the Sugarloaf Mountain Quartzite; the albite-chlorite schist facies of the Wissahickon Formation overlying the volcanic sequence previously mentioned; the Marburg Schist; the Frederick Limestone and the Grove Limestone, both found in the Frederick Valley; and the Newark Group, consisting of red sandstone and shale, which strikes northeast-southwest across Carroll and Frederick Counties. The Newark rocks are also associated with numerous diabase dikes in this area.

The ridges of the Blue Ridge Province are underlain by clastic deposits consisting mainly of the Weverton Sandstone or Quartzite. The Middletown Valley part of the province is underlain predominantly by metamorphosed rhyolites and basalts, with outcrops of pre-Paleozoic gneiss evident in the southern part of the valley.

The Valley and Ridge Province consists of the Great Valley area in the east and the Allegheny Ridges in the west. The Great Valley is underlain by a thick series of Cambrian and early Ordovician limestones, with later Ordovician shales to the west. The Allegheny Ridges consist of massive sandstone and quartzite strata on the ridges alternating with eroded shale and limestone strata in the valleys.

The underlying rock of the Maryland part of the Appalachian Plateaus is gently folded and consists of units lying between and including the Dunkard Group and the Jennings Formation. The mountaintops of the region consist predominantly of the Monongahela Formation and the Conemaugh Formation, while the valleys are directly underlain by the Hampshire Formation and the Jennings Formation.

Acknowledgments

The Natural Resources Conservation Service is acknowledged for supplying all available natural soil group maps for areas outside the State of Maryland. Recognition is also due Paul E. Exter of the Maryland-Delaware-D.C. District of the U.S. Geological Survey, whose work in fulfilling the unexpected need for runoff-curve-number determination was invaluable to the timely completion of the report.

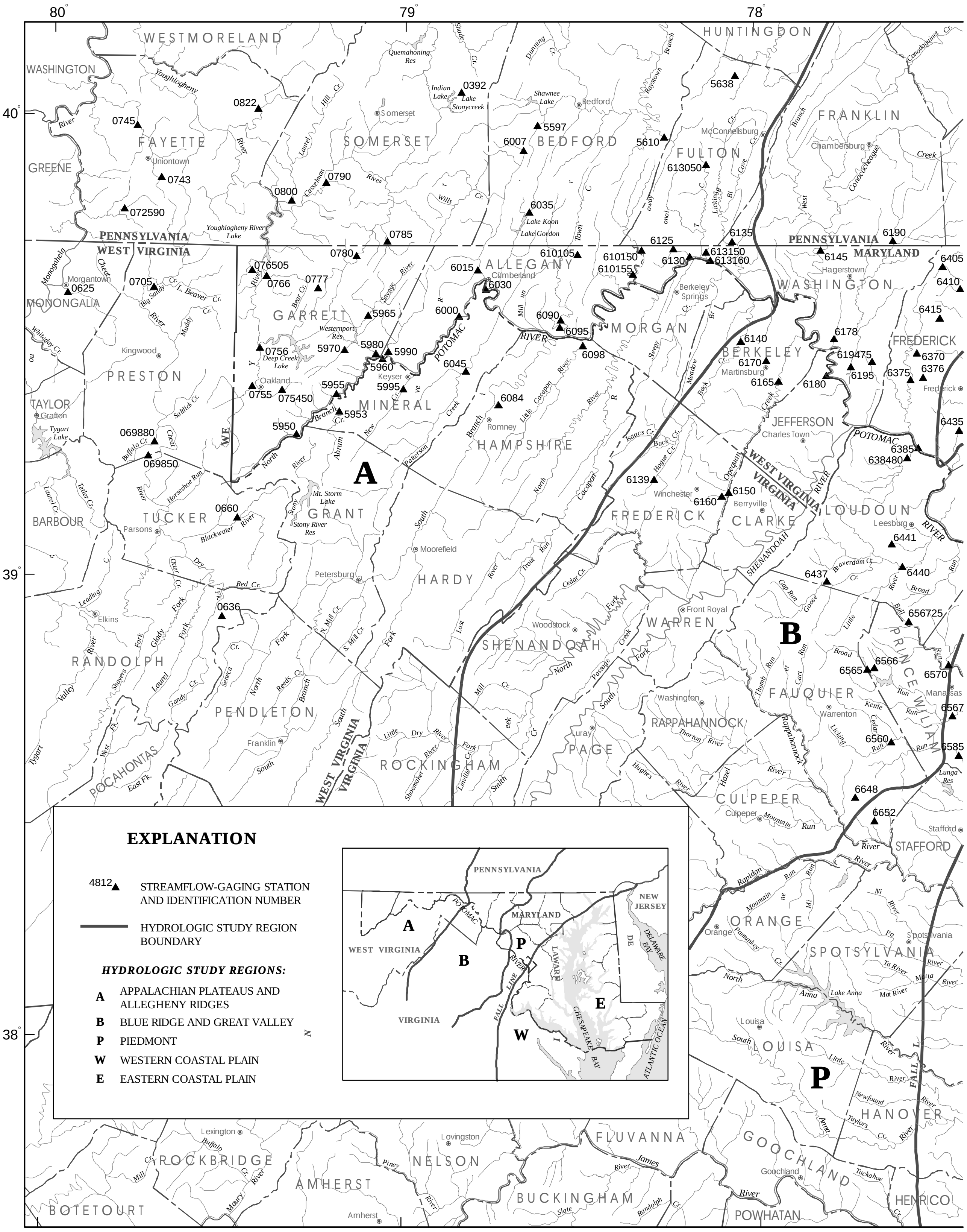
DATA COLLECTION AND ANALYSIS

The development of the technique for estimating peak-flow magnitudes for selected frequencies is based on generalized least-squares regression analysis, which weights estimates according to the variance of observed peak-flow data at a site, and also with regard to spatial correlations between streamflow-gaging stations. In preparation for generalized least-squares analysis, 219 streamflow-gaging stations were selected to provide the necessary basin and peak-flow characteristics data. On the basis of the regression analysis and known variations in basin characteristics in different physiographic provinces, five hydrologic study regions were identified. The locations of these hydrologic regions and streamflow-gaging stations are shown in figure 2. The number of stations that were chosen for inclusion in the regression analysis by hydrologic study region are listed in table 1. The following sections describe how these stations were selected, the method used to evaluate their peak-flow characteristics for various **recurrence intervals**, and the basin characteristics analyzed as potential explanatory variables.

Criteria for Station Selection

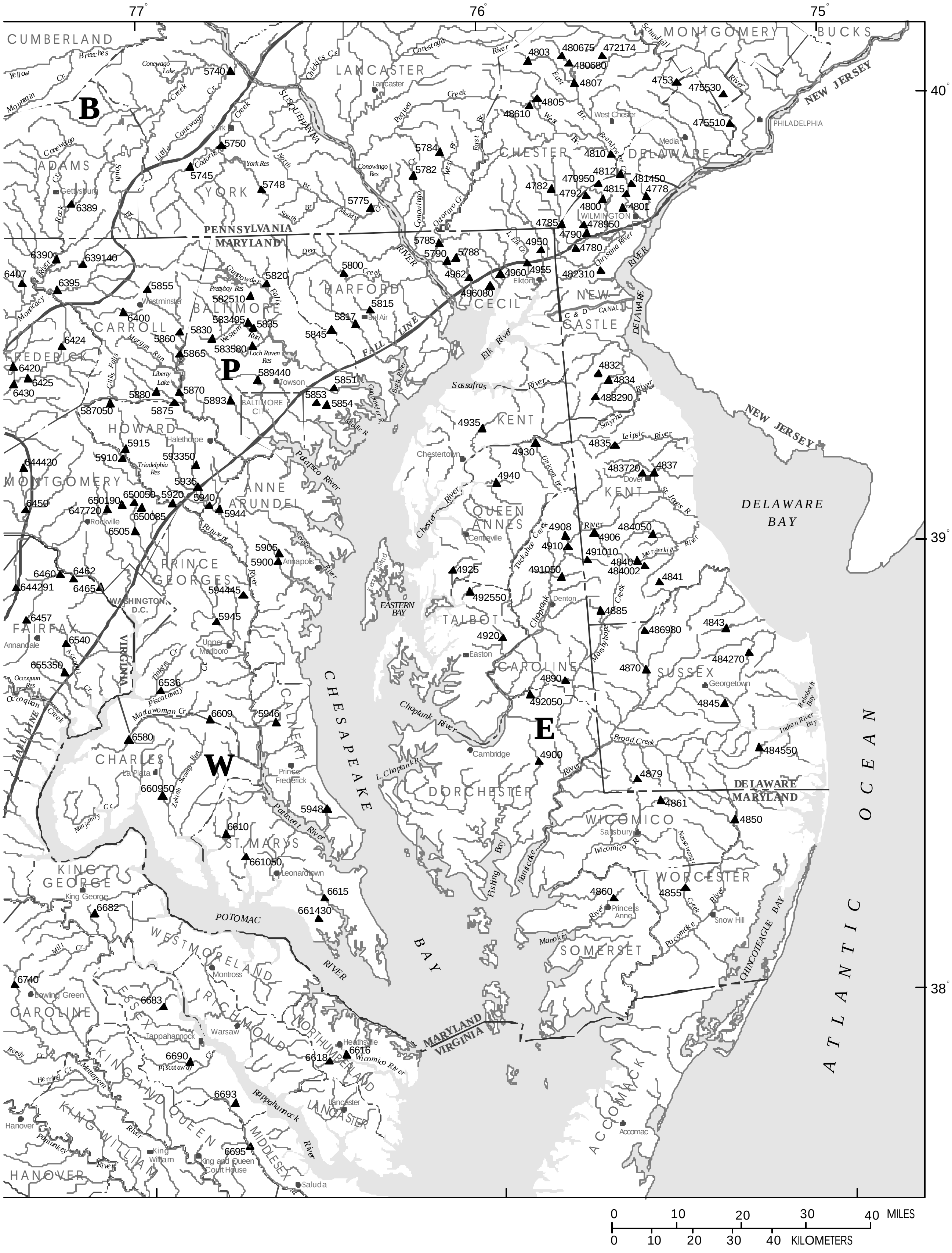
Certain criteria were required for a gaged basin to be chosen for regression analysis. The first criterion was that the basin had to be within the boundaries of the State of Maryland, or that the centroid of the basin be located within 25 mi of the State border. A summary of the number of stations and the average record length, listed by size of drainage area, is shown in table 2. Estimates of peak flows from sites with longer records have lower variances and receive greater weight in generalized least-squares analysis development of flow-prediction equations. As in the Carpenter study, the methods developed in this study are based on a broad range in sizes of drainage-basins, with 100 basins smaller than 10 mi^2.

The second criterion for a gaged basin to be included in the analysis was that flow



BASE FROM U.S. GEOLOGICAL SURVEY, 1:500,000, 1979

Figure 2. Location of streamflow-gaging stations and hydrologic study regions in Maryland and surrounding States.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HOWARD
MONTGOMERY
ANNE ARUNDEL
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CHARLES
CALVERT
ST. MARYS
KING GEORGE
WESTMORELAND
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ESSEX
RICHMOND
NORTHUMBERLAND
LANCASTER
KING AND QUEEN
KING WILLIAM
MIDDLESEX
HANOVER
NEW CASTLE
KENT
QUEEN ANNES
TALBOT
CAROLINE
DORCHESTER
SUSSEX
WICOMICO
WORCESTER
SOMERSET
ACCOMACK
NEW JERSEY
DELAWARE BAY
CHESAPEAKE BAY
ATLANTIC OCEAN
DELAWARE
MARYLAND
MARYLAND
VIRGINIA
FALL LINE
FALL LINE
POTOMAC RIVER
SUSQUEHANNA RIVER
DELAWARE RIVER
C & D CANAL
EASTERN BAY
CHINCOTEAGUE BAY
Lancaster
West Chester
PHILADELPHIA
Media
WILMINGTON
York
Gettysburg
Westminster
Elkton
Bel Air
Towson
BALTIMORE CITY
Halethorpe
Chestertown
Dover
Centreville
Annapolis
Rockville
Denton
Easton
Upper Marlboro
Annandale
Georgetown
Cambridge
La Plata
Prince Frederick
Salisbury
Leonardtown
Princess Anne
Snow Hill
King George
Montross
Bowling Green
Warsaw
Tappahannock
Heathsville
Lancaster
Hanover
King William
King and Queen Court House
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Accomac
Conewago Lake
York Res
Conowingo Res
Prettyboy Res
Loch Raven Res
Liberty Lake
Triadelphia Res
Occoquan Res
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0 10 20 30 40 KILOMETERS

Table 1. *Number of streamflow-gaging stations by hydrologic study region in Maryland and surrounding States*

Hydrologic study region	Number of gaging stations
Appalachian Plateaus and Allegheny Ridges	46
Blue Ridge and Great Valley	34
Piedmont	81
Western Coastal Plain	21
Eastern Coastal Plain	37

Table 2. *Summary of drainage area, number of streamflow-gaging stations, and average years of record used in regression analyses for Maryland*

Drainage area (square miles)	Number of gaging stations	Average years of observed record
0 - 1	21	11
1 - 2	13	10
2 - 5	30	17
5 - 10	38	25
10 - 20	26	24
20 - 50	31	36
50 - 100	30	42
100 - 200	16	33
200 - 500	13	58
500 -1,000	1	62

from the basin could not be significantly affected by either regulation or alteration of the basin hydrologic characteristics. Alterations in the drainage efficiency of a basin over time make the results of a peak-flow analysis for the basin less meaningful since peak-flow characteristics are determined on the assumption of constant basin conditions. As in Sauer and others (1983), significant alteration to the basin was assumed, if more than 15 percent of the basin land use was characterized as commercial, industrial, and (or) residential. Monotonic trends in the peak-flow records, which can indicate changing development conditions, were identified by Kendall's tau analysis (Helsel and Hirsch, 1992).

The third criterion for a drainage basin of a stream to be chosen for inclusion in the analysis was that the basin had to lie predominantly within one of the five physiographic provinces. This criterion was needed to avoid heterogeneity of basin characteristics caused by differences in physiography.

The application of these three criteria to the station-selection process produced a data set consisting of 219 gaging stations located in Maryland, Delaware, Pennsylvania, Virginia, and West Virginia, which provided the necessary data for the generalized least-squares analysis. In addition to these 219 stations, data from gaging stations located on the main stem of the Potomac River and stations whose basins were located in more than one physiographic province are in-cluded in this report. Data associated with the additional streamflow gages are presented in the appendix, and the stations can be located in figure 2. Of the 219 gaging stations used in the generalized least-squares analysis, 107 were located in Maryland, 34 in Delaware, 35 in Pennsylvania, 29 in Virginia, and 14 in West Virginia (fig. 2).

Station Flood-Frequency Analysis

The peak-flow characteristics of each gaged basin chosen for use in the generalized least-squares analysis can be derived from the systematic record. This derivation is carried out by defining a peak-flow-frequency curve for each gaged basin to be used in the GLS analysis, as specified in "Guidelines for Determining Flood Flow Frequency" Bulletin 17B (Interagency Advisory Committee on Water Data, 1982). The systematic records needed to perform peak-flow characteristic analysis for each gaged basin can be obtained from the Peak Flow File of the Water Data Storage and Retrieval System (WATSTORE) maintained at the USGS National Headquarters in Reston, Va., and are also available in the annual U.S. Geological Survey Water Resources Data reports issued for Maryland and Delaware and the surrounding States.

Peak-flow characteristics were determined for recurrence intervals of 2, 5, 10, 25, 50, 100, and 500 years for 236 gaged basins, including those stations in Maryland not used in the generalized least-squares analysis. These magnitudes were determined by fitting the log-Pearson Type III probability distribution to the observed annual peaks recorded at each station. The fitting procedure was carried out using the interactive USGS computer program ANNIE (Lumb, Kittle, and Flynn, 1990). The statistical parameters defining the distribution--(1) mean, (2) standard deviation, and (3) skew coefficient--were then used to determine the peak-flow characteristics for each gaged basin. In cases where historical flood information or outliers were encountered, adjustments were carried out in accordance with Bulletin 17B guidelines.

Deriving peak-flow characteristics by use of the methods described in Bulletin 17B is an example of an analysis where information about a statistical population, annual peak flows of a drainage basin, is inferred from the analysis of a sample, the systematic peak-flow record. Deriving the peak-flow characteristics from the systematic peak-flow record provides estimates of the characteristics for the whole population, not exact values. A major source of uncertainty in the case of peak-flow prediction is caused by the assumption that a station’s systematic peak-flow record accurately represents the entire population of annual peak discharges at that site. This assumption introduces a time-sampling error into the analysis being performed. As previously mentioned, one advantage to using GLS regression analysis in this study is that it attempts to minimize the effect of time-sampling error by weighting the peak-flow records according to the length of systematic record available from each gaging station.

Explanatory Variable Identification

Based on the results of previous investigations, the following basin, stream, and precipitation characteristics were considered as potential explanatory variables for peak-flow estimation: (1) drainage area, (2) main channel slope, (3)**storage**, (4) **forest cover**, (5) 2-year, 24-hour precipitation, (6) mean annual precipitation, (7) average basin elevation, (8) gaging-station elevation, (9) **basin relief**, (10) carbonate rock coverage, (11) **hypsometric-curve** area, (12) maximum hypsometric-curve slope, (13) soil type A, (14) soil type D, and (15) runoff-curve number.

Generalized least-squares regression analysis of the selected data indicated that drainage area, storage, forest cover, basin relief, carbonate rock coverage, and runoff-curve number were the variables most appropriate for use in the estimation equations for the various hydrologic study regions in Maryland (table 3). With the exceptions of the runoff-curve number and carbonate rock coverage, the selected variables for each gaged basin used in the analysis were obtained from the Basin Characteristics File of the Water Data Storage and Retrieval System (WATSTORE). The procedures that can be used to determine runoff-curve number and carbonate rock coverage, as well as the other explanatory variables, are stated below. Guidelines for the proper use of these variables are given in the Accuracy and Limitations section of the report. The user is referred to the Glossary section of the report for definitions of the explanatory variables.

The runoff-curve number (RCN) was determined by use of a geographic information system (GIS). Assuming that Antecedent Soil Moisture Condition (AMC) II is prevalent, the RCN, as defined by the Natural Resources Conservation Service (NRCS), is dependent upon the combination of land use and type of hydrologic soil existing in a basin (McCuen, 1982). Each combination of land use and soil type has an associated RCN. The RCN evaluation system used in this study is defined in table 4 (McCuen, 1982).

The RCN value for a basin was determined by relating each land-use/soil-type combination to the associated basin area, weighting each of the subvalues in proportion to the associated area, and dividing the sum by the total basin area. Alexander and others (1976) provided the land-use coverage used in the study, and the soil-type coverage was derived from U.S. Natural Resources Conservation Service (Department of Agriculture) natural soil group maps interpreted for types of hydrologic soil (Maryland Department of State Planning, 1973). These maps can be obtained by contacting any NRCS office.

Table 3. *Summary of statistics for variables associated with gaged basins in Maryland in regression analyses for hydrologic study regions in Maryland*

[mi^2, square mile; ft, feet; --, data not collected]

Hydrologic study regions	Drainage area (mi^2)	Carbonate rock coverage (percent)	Storage (percent)	Basin relief (ft)	Forest cover (percent)	Runoff-curve number
Appalachian Plateaus and Allegheny Ridges	0.22 to 247	--	--	88 to 1,431	28 to 96	--
Blue Ridge and Great Valley	.10 to 494	0 to 100	--	18 to 745	--	--
Piedmont	.26 to 165	--	--	--	0 to 96	--
Western Coastal Plain	.30 to 54.8	--	--	--	19 to 83	--
Eastern Coastal Plain	3.80 to 113	--	0.000 to 15.800	4 to 57	8 to 85	72.85 to 87.29

Table 4. *Runoff-curve numbers defined by land use and hydrologic soil type*

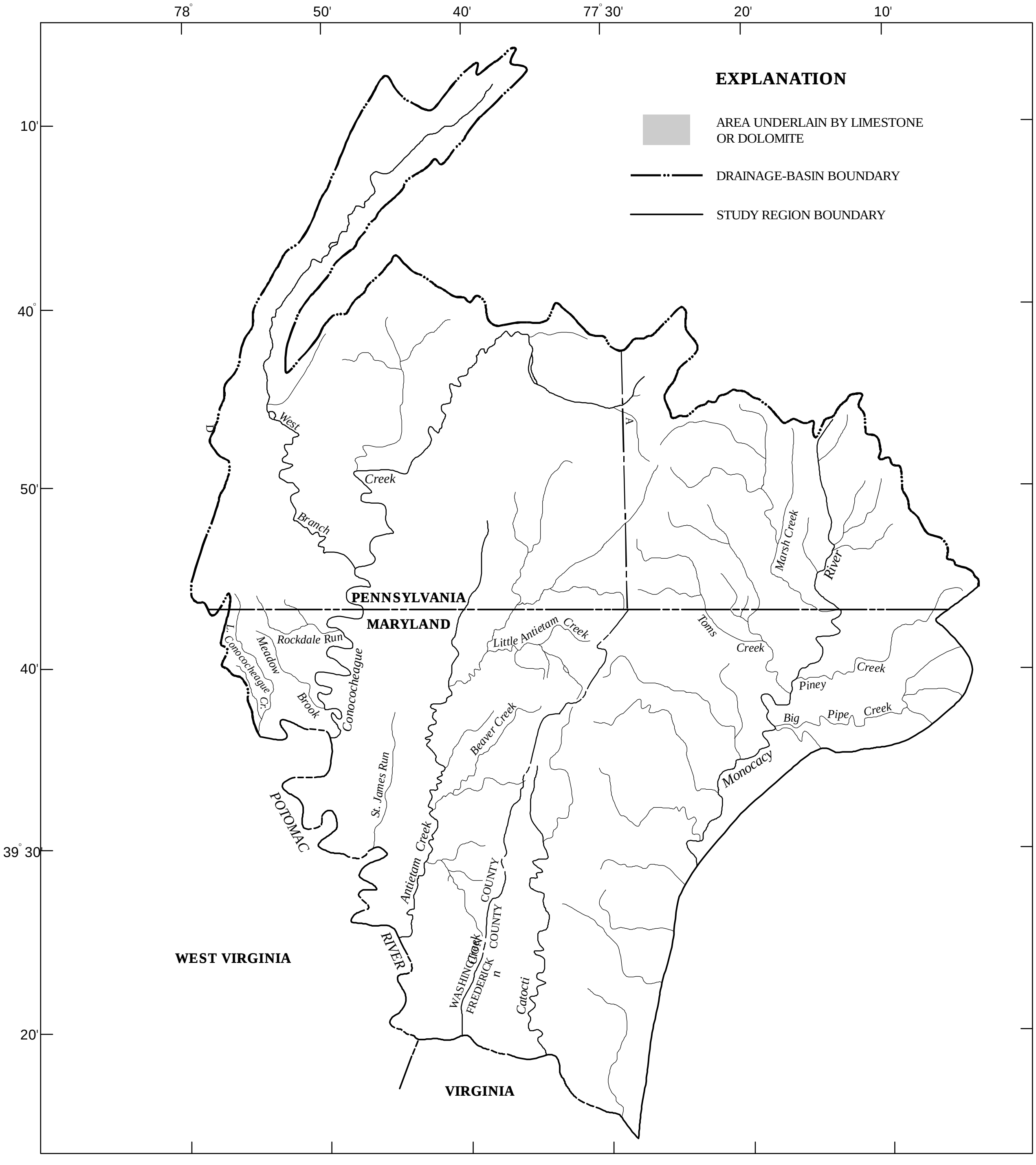
[Hydrologic soil types: A, soil exhibiting low runoff potential; B, soil exhibiting moderately low runoff potential; C, soil exhibiting moderately high runoff potential; and D, soil exhibiting high runoff potential; DU/AC, dwelling units per acre; >, greater than]

	Hydrologic soil type			
Land-use category	A	B	C	D
Residential (0.2 to 2 DU/AC)	54	70	80	85
Residential (>2 to 8 DU/AC)	61	75	83	87
Residential (>8 DU/AC)	77	85	90	92
Commercial/ industrial	89	92	94	95
Institutional	81	88	91	93
Forest	36	60	73	79
Brush	35	56	70	77
Water	100	100	100	100
Wetlands	100	100	100	100
Beach/barren/ extractive	77	86	91	94
Cropland	72	81	88	91
Grass	49	69	79	84

Note that if reliable predictions of future land use are available, the predicted RCN value, along with other appropriate explanatory variables, may be used to estimate future peak-flow conditions.

The percentage of carbonate rock coverage was determined for the gaged basins in the Blue Ridge and Great Valley hydrologic region using the appropriate geologic maps for the areas of interest (Berg, 1980; Butts and Edmundson, 1963; Cardwell, 1968; Edwards, 1978; Hubbard, 1990; Jonas and Stose, 1938). The percentage of the basins underlain by limestone or dolomite was determined as follows: (1) delineate the drainage basin of interest and use a planimeter to determine its area, and (2) use a planimeter to determine the area of the basin exhibiting carbonate rock and express it as a percentage of the total area (fig. 3).

Drainage area should be planimetered from the best available topographic maps. Forest cover should be determined from best available topographic maps as follows: Planimeter the area of the drainage basin covered by forests (shaded green on U.S. Geological Survey maps). Divide the resulting value by the drainage area and multiply by 100 to obtain a percentage value.



BASE FROM U.S. GEOLOGICAL SURVEY, 1:250,000
GEOLOGY BY EDWARDS, 1978, AND BERG, 1980.

Figure 3. Distribution of underlying limestone / dolomite in the Blue Ridge and Great Valley hydrologic region in Maryland and surrounding States.

Basin relief can be calculated using the best available topographic maps with equally spaced grid lines superposed over the drainage basin. Compute the arithmetic average of the elevations of 50 to 100 points within the basin at the intersections of the grid lines. Subtract the gage or outlet-point elevation from this value to obtain basin relief.

Storage should be determined from the best available topographic maps as follows: Planimeter the area of the drainage basin covered by lakes, ponds, and swamps. Divide the resulting value by the drainage area and multiply by 100 to obtain a percentage value.

Using the procedures described above to determine values of explanatory variables for basins in Maryland, the user can apply the following estimation equations in order to predict peak-flow magnitudes for various recurrence intervals.

METHODS FOR ESTIMATING MAGNITUDE AND FREQUENCY OF FLOODS

Methods developed using current analytical procedures are presented here for the estimation of flood magnitudes of selected frequencies in ungaged and gaged drainage basins. The methods presented are based, in part, on the following equations:

Appalachian Plateaus and Allegheny Ridges region

$$Q_2 = 106A^{0.851}(F+10)^{-0.223}\,BR^{0.056} \tag{1}$$

$$Q_5 = 109A^{0.858}(F+10)^{-0.143}\,BR^{0.064} \tag{2}$$

$$Q_{10} = 113A^{0.859}(F+10)^{-0.106}BR^{0.072} \tag{3}$$

$$Q_{25} = 118A^{0.858}(F+10)^{-0.072}\,BR^{0.087} \tag{4}$$

$$Q_{50} = 121A^{0.858}(F+10)^{-0.051}\,BR^{0.099} \tag{5}$$

$$Q_{100} = 124A^{0.858}(F+10)^{-0.033}\,BR^{0.111} \tag{6}$$

$$Q_{500} = 127A^{0.859}(F+10)^{0.004}\,BR^{0.140} \tag{7}$$

Blue Ridge and Great Valley region

$$Q_2 = 4{,}260A^{0.774}(LI+10)^{-0.549}\,BR^{-0.405} \tag{8}$$

$$Q_5 = 6{,}670A^{0.752}(LI+10)^{-0.564}\,BR^{-0.354} \tag{9}$$

$$Q_{10} = 8{,}740A^{0.741}(LI+10)^{-0.579}\,BR^{-0.326} \tag{10}$$

$$Q_{25} = 12{,}000A^{0.730}(LI+10)^{-0.602}\,BR^{-0.295} \tag{11}$$

$$Q_{50} = 15{,}100A^{0.723}(LI+10)^{-0.620}\,BR^{-0.276} \tag{12}$$

$$Q_{100} = 18{,}900A^{0.719}(LI+10)^{-0.639}\,BR^{-0.261} \tag{13}$$

$$Q_{500} = 31{,}800A^{0.712}(LI+10)^{-0.686}\,BR^{-0.241} \tag{14}$$

Piedmont region

$$Q_2 = 451A^{0.635}(F+10)^{-0.266} \tag{15}$$

$$Q_5 = 839A^{0.606}(F+10)^{-0.248} \tag{16}$$

$$Q_{10} = 1{,}210A^{0.589}(F+10)^{-0.242} \tag{17}$$

$$Q_{25} = 1{,}820A^{0.574}(F+10)^{-0.239} \tag{18}$$

$$Q_{50} = 2{,}390A^{0.565}(F+10)^{-0.240} \tag{19}$$

$$Q_{100} = 3{,}060A^{0.557}(F+10)^{-0.241} \tag{20}$$

$$Q_{500} = 5{,}190A^{0.543}(F+10)^{-0.245} \tag{21}$$

Western Coastal Plain region

$$Q_2 = 1{,}410A^{0.761}(F+10)^{-0.782} \tag{22}$$

$$Q_5 = 1{,}780A^{0.769}(F+10)^{-0.687} \tag{23}$$

$$Q_{10} = 1{,}910A^{0.771}(F+10)^{-0.613} \tag{24}$$

$$Q_{25} = 2{,}000A^{0.772}(F+10)^{-0.519} \tag{25}$$

$$Q_{50} = 2{,}060A^{0.771}(F+10)^{-0.452} \tag{26}$$

$$Q_{100} = 2{,}140A^{0.770}(F+10)^{-0.391} \tag{27}$$

$$Q_{500} = 2{,}380A^{0.765}(F+10)^{-0.263} \tag{28}$$

Eastern Coastal Plain region

$$Q_2 = 0.25A^{0.591}(RCN-33)^{1.70}\,BR^{0.310}(F+10)^{-0.464}(ST+10)^{-0.148} \tag{29}$$

$$Q_5 = 1.05A^{0.595}(RCN-33)^{1.74}BR^{0.404}(F+10)^{-0.586}(ST+10)^{-0.498} \tag{30}$$

$$Q_{10} = 3.24A^{0.597}(RCN-33)^{1.71}BR^{0.436}(F+10)^{-0.667}(ST+10)^{-0.694} \tag{31}$$

$$Q_{25} = 13.1A^{0.597}(RCN-33)^{1.66}BR^{0.457}(F+10)^{-0.770}(ST+10)^{-0.892} \tag{32}$$

$$Q_{50} = 35.0A^{0.594}(RCN-33)^{1.62}\,BR^{0.465}(F+10)^{-0.847}(ST+10)^{-1.01} \tag{33}$$

$$Q_{100} = 87.6A^{0.589}(RCN-33)^{1.58}\,BR^{0.470}(F+10)^{-0.923}(ST+10)^{-1.11} \tag{34}$$

$$Q_{500} = 627A^{0.573}(RCN-33)^{1.49}\,BR^{0.478}(F+10)^{-1.10}(ST+10)^{-1.29} \tag{35}$$

where

Q_2, Q_5,...,Q_{500} are the peak discharges for floods with recurrence intervals of 2 years, 5 years,..., 500 years;
A is the drainage area, in square miles;
ST is the storage (lakes, ponds, and swamps), in percent;
LI is the limestone geology (limestone, dolomite), in percent;
RCN is the runoff-curve number;
F is the forest cover, in percent; and
BR is the basin relief, in feet.

Flow values calculated using these equations are in units of cubic feet per second. Conversion to other measurement systems may be performed by applying the appropriate transformation factor to the equation result.

Magnitude Estimation Method for Ungaged Streams

Peak-discharge magnitude estimates may be made for ungaged streams within the hydrologic-study regions shown in figure 2 using the preceding equations. The estimates obtained using the equations will be accurate within the limits given in the Accuracy and Limitations section if the input variables are measured or known with reasonable accuracy.

Demonstration of the Estimation Method for Ungaged Streams

The following example is presented to demonstrate the proper use of the estimation equations. An estimate of peak discharge for a site on any ungaged stream in Maryland can be obtained by following the procedure used in the example.

Problem 1: Estimate the 50-year discharge on Grave Run at Resh Mill Road above Albantown, Md., 39°39'15" north latitude and 76°48'07" west longitude.

1. Determine in which region the drainage basin is located (fig. 2) to determine which equation (1-35) should be used;

   Region: Piedmont region.

   Use equation 19. Drainage area and forest cover are required for use in this equation.

2. Determine drainage area. Outline the drainage basin above Resh Mill Road on the best available topographic map(s) and use a planimeter to determine the area of the basin;

   $$A = 5.80 \text{ mi}^2.$$

3. Determine forest cover. On the topographic map(s), use a planimeter to determine the forested area within the drainage basin; express this number as a percentage of the drainage area.

   Forest cover area: 1.95 mi^2.

   $$F = (1.95/A) \times 100 = (1.95/5.80) \times 100 = 34 \text{ percent.}$$

4. Determine peak discharge. Using equation 19,

   $$Q_{50} = 2{,}390A^{0.565}(F+10)^{-0.240}.$$

   By substitution,

   $$Q_{50} = 2{,}390(5.80)^{0.565}(34+10)^{-0.240};$$
   $$Q_{50} = 2{,}600 \text{ ft}^3\text{/s}.$$

The boundaries between the Blue Ridge and Great Valley and Piedmont regions, and also between the Piedmont and the Western Coastal Plain regions, are not drainage divides, so it is possible that a drainage basin may lie in more than one region. When a basin lies in more than one region, the discharge for the basin is computed twice, as if the basin were entirely within each region. A weighted average discharge is then calculated--the weighting factors being the percentages of the total basin area falling in each region. All other study region boundaries are drainage divides.

Sensitivity Analysis of Explanatory Variables

A certain amount of error is inherent in the determination of explanatory variable values, and occasionally the user of the estimation equation might be more interested in obtaining an approximate estimate immediately rather than taking the time to develop the best possible flow estimate. So that the user may quantify the effect of measurement error, a method of determining the sensitivity of an estimation equation to variation in the values of its explanatory variables is presented.

After determining the region in which the site is located, and which estimation equation is appropriate, the sensitivity of the equation to variations in the values of its variables can be determined as follows:

1. Make an estimate of the actual value of the variable of interest.
2. Multiply the estimate by the appropriate factor; if interested in the effect of increasing the variable's value by 10 percent, multiply by 1.1.
3. If necessary, add or subtract the prescribed constant from each value.
4. Raise the value to the exponent for that variable.
5. Divide the adjusted quantity by the quantity resulting from the original estimate.
6. Subtract one from the resulting ratio and multiply by 100.

The result of this procedure is the percentage of change in the peak-flow estimate because of a specified variation in the chosen variable's value. This procedure can be repeated for variations of any magnitude in the same variable and for other variables of interest in the same equation.

Caution should be used when estimating the value of a variable that will have a constant added or subtracted to it before being raised to the appropriate exponent. In these cases, the magnitude of the estimated value will affect the percentage of change calculated for the equation result. When dealing with a variable that does not have a constant added or subtracted before exponentiation, the estimated value of the variable does not matter, as long as it does not equal zero.

For example, consider the drainage basin identified in Problem 1. Using equation 19, the 50-year recurrence-interval flow for that basin was estimated to be 2,600 ft^3/s. This estimate was calculated using measured values of 5.80 mi^2 for drainage area and 34 percent for forest cover. Use the following procedures to determine the effect of measurement error on the resulting estimate. (For example, the effect of a 10-percent overestimate of the area of the drainage basin.)

1. The original estimate of the drainage basin area is

   $$A = 5.80 \text{ mi}^2 .$$

2. Increasing this value by 10 percent,

   $$A = 1.1 x 5.80 = 6.38 \text{ mi}^2.$$

3. No constant is added to this variable in equation 19.

4. $6.38^{0.574} = 2.90$

5. $(6.38^{0.574})/(5.80^{0.574}) = 2.90/2.74 = 1.056$.

6. (1.056-1)x100 = 5.6 percent.

A 10-percent increase in the estimate of the drainage area results in an increase of 5.6 percent in the flow estimate. The effect of a 10-percent increase in the estimate of forest cover can be determined as follows.

1. Originally, F = 34.

2. F = 1.1 x 34 = 37.4.

3. Add the constant indicated in equation 19, 37.4+10 = 47.4.

4. $47.4^{-0.240} = 0.39611$.

5. $(47.4^{-0.240})/(44^{-0.240}) = (0.39611/0.40325) = 0.982$.

6. (0.982-1) x 100 = -1.8 percent.

A 10-percent increase in the estimate of forest cover results in a decrease of 1.8 percent in the flow estimate.

In this example, overestimating the drainage area by 10 percent could have a significant impact on the peak-flow estimate, whereas overestimating the forest cover value by 10 percent has a minor impact on the estimate. The procedure can be used to estimate the effect of any percentage of error in the measurement for any variable in any of the equations (1-35).

Accuracy and Limitations

One measure of the accuracy of the results of the estimation equations is called the standard error of estimate. The standard error of estimate is a measure of how well the estimated peak flows agree with actual peak flows. The standard error of estimate is derived from the model error, which measures the inability of the estimation equations to provide peak estimates that match observed peak records. Another measure of equation accuracy, the standard error of prediction, is derived from two quantities--the model error; and the sampling error, which is an estimate of the inability of the observed peak records to describe the actual peak-flow characteristics of a stream.

The standard errors of estimate, and the standard errors of prediction, for equations 1 through 35 are presented in table 5. The relation of observed and estimated flow values for the 100-year recurrence interval in the Appalachian Plateau and Allegheny Ridges region are shown in figure 4. About 68 percent of the predicted values should fall within one standard error of the corresponding observed values if the data distribution is approximately normal. Likewise, about 95 percent of the data points should fall within two standard errors.

Another measure of the accuracy of the estimation equations is the equivalent years of record. The equivalent years of record is an estimate of the number of years of record needed at a given site to produce flood-magnitude estimates with an accuracy equal to that of the estimation equations. The equivalent years of record is derived from a relation between the standard error of estimate and the measure of variability of the observed flood-magnitude data used to develop the equations. The values of the equivalent years of record for the estimation equations are shown in table 6. Since the predictive capability available from 1 or 2 years of record is poor, the accuracy of a given estimation equation may be somewhat higher than indicated in cases where the equivalent years of record value is low, equal to 1or 2 years. The concept of equivalent years of record as a measure of equation accuracy, however, is valid for longer periods of record.

Table 5. *Standard errors of estimate and standard errors of prediction for estimation equations, by hydrologic study region in Maryland*

[Values are given in percent; standard errors of prediction are in parentheses]

Recurrence interval (years)	**Appalachian Plateaus and Allegheny Ridges**	**Blue Ridge and Great Valley**	**Piedmont**	**Western Coastal Plain**	**Eastern Coastal Plain**
2	23 (24)	47 (50)	38 (39)	50 (55)	42 (46)
5	20 (22)	41 (45)	34 (36)	46 (51)	40 (46)
10	19 (21)	37 (42)	33 (35)	45 (51)	39 (45)
25	21 (23)	35 (41)	34 (37)	46 (54)	37 (45)
50	22 (25)	34 (40)	36 (40)	49 (58)	37 (45)
100	25 (28)	34 (41)	39 (43)	52 (63)	36 (46)
500	31 (35)	37 (45)	48 (52)	64 (77)	36 (48)

.In order to provide a perspective of the magnitudes of peak flows that have occurred historically in and around Maryland, figures 5a to 5e have been included to show the maximum known peak flows normalized by drainage area. The data consist of a compilation of the most extreme floods recorded at the 219 gaging stations used to develop the estimation equations. The data are given in units of cubic feet per second per square mile. The data are available from the U.S. Geological Survey's Water Resources Data series.

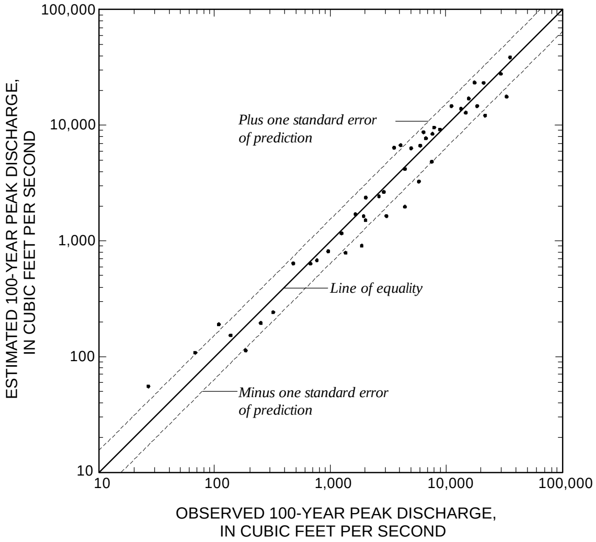


Figure 4. Relation of observed to estimated 100-year peak discharges for the Appalachian Plateaus and Allegheny Ridges hydrologic region in Maryland and surrounding States.

Table 6. *Equivalent years of record for estimation equations, by hydrologic study region in Maryland*

	Equivalent years of record by hydrologic study region				
Recurrence interval (years)	**Appalachian Plateaus and Allegheny Ridges**	**Blue Ridge and Great Valley**	**Piedmont**	**Western Coastal Plain**	**Eastern Coastal Plain**
2	5	2	3	2	2
5	10	4	7	4	5
10	14	7	10	7	7
25	18	12	15	10	12
50	20	15	17	12	16
100	20	18	19	13	19
500	19	23	20	14	28

In addition to knowing the accuracy that can be expected from the estimation equations, understanding some of the limitations that apply to their use is also important. The range of Maryland basin characteristics used to develop the estimation equations for each study region are listed in table 3. The standard errors of estimate presented as measures of accuracy are only valid for sites within Maryland whose characteristics lie within the appropriate ranges. Predictions made for a site having one or more characteristics that have values outside the prescribed limits may result in flow estimates that contain considerably greater errors than those listed in table 5. The estimation equations should not be used for sites having one or more characteristics that are outside the range(s) used to develop the equations. The equations are not applicable at sites that are affected by (1) peak-flow regulation by dams; (2) tidal marshes; or (3) excavation, mining, or landfill activities. Also, the equations are only valid for use with non-urban drainage basins. This is true even in the Eastern Coastal Plain region, where the significance of RCN is related more to soil type than land use. Peak-flow estimates for other than non-urban drainage basins may be obtained by using the methods explained in the report by Sauer and others (1983).

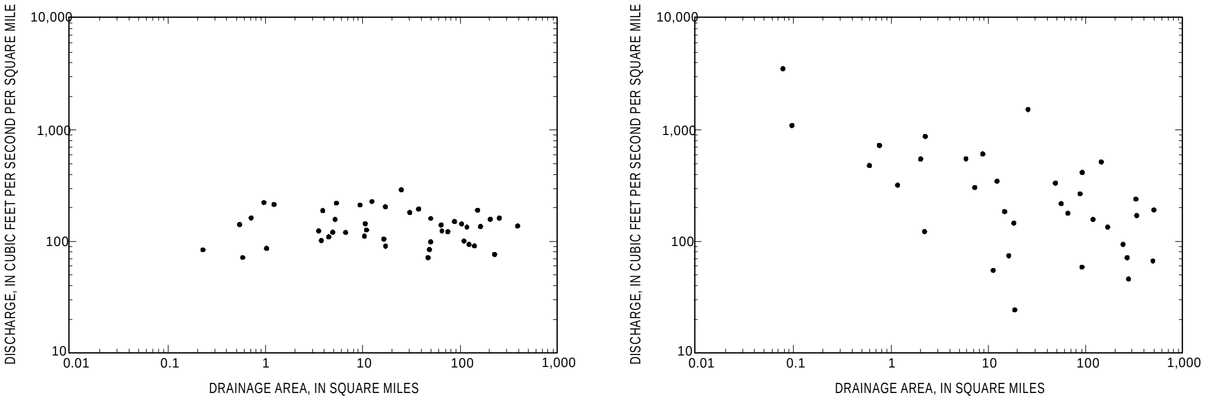
Magnitude Estimation Method for Gaged Streams

The estimation equations can also be used to estimate peak flows at sites on gaged streams. Methods for making such estimates are presented in this section for instances when the selected site is at a gaged location, near a gaged location, and between two gaged locations.

Estimation Method for a Site at a Gaged Location

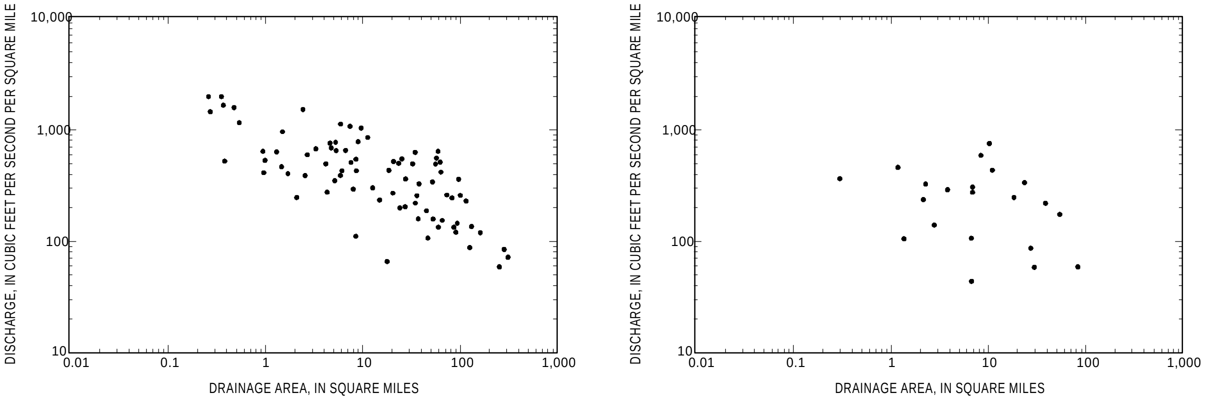
When a peak-flow estimate is desired at a gaged location, it should be derived from a weighted average of the flow obtained by use of the appropriate estimation equation and the flow obtained from analysis of the observed data. The weighting factor used should be the equivalent years of record associated with the estimation equation (table 6) and the years of record at the gaging station.

MD FLOOD - Fig. 5



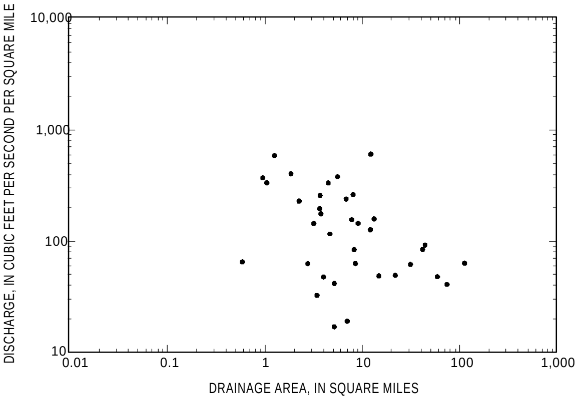
(a) APPALACHIAN PLATEAUS and ALLEGHENY RIDGES

(b) BLUE RIDGE and GREAT VALLEY



(c) PIEDMONT

(d) WESTERN COASTAL PLAIN



(e) EASTERN COASTAL PLAIN

Figure 5. Relation of maximum known unit discharge to drainage area for hydrologic regions: (a) Appalachian Plateaus and Allegheny Ridges, (b) Blue Ridge and Great Valley, (c) Piedmont, (d) Western Coastal Plain, and (e) Eastern Coastal Plain in Maryland and surrounding States.

The discharges derived from the observed data can be obtained from table 7 (at the end of report) for all stations used in the study, along with the number of years of record for each station. After retrieving the derived discharge and number of years of record for a selected site, as well as computing the flow from the estimation equation and finding the equivalent years of record for the equation in table 6, the following equation should be used to weight the results and obtain the peak-flow estimate at the site:

$$Q_w = \frac{Q_g N_g + Q_r N_r}{N_g + N_r} \qquad (36)$$

where

Q_w is the log of the weighted peak-flow estimate at the gaged location;
Q_g is the log of the discharge at the gaged location for the selected recurrence interval, derived from the observed data (table 7);
Q_r is the log of the discharge computed using the estimation equation for the selected recurrence interval;
N_g is the number of years of record associated with the gaged location (table 7); and
N_r is the number of equivalent years of record for the selected estimation equation (table 6).

The following example demonstrates the application of the procedure just described:

Problem 2: Estimate the 100-year flood at streamflow-gaging station 01583580, Baisman Run at Broadmoor, located at Ivy Hill Road, 1.8 mi west of Cockeysville, Md.

1. Obtain the discharge for a 100-year recurrence interval for Baisman Run at the gaged location from table 7;

$$Q_g = \log(1{,}120 \text{ ft}^3/\text{s}) = 3.0492.$$

2. Obtain drainage area and forest cover from table 7;

$$A = 1.47 \text{ mi}^2;$$
$$F = 68 \text{ percent.}$$

3. Compute the discharge for the 100-year recurrence interval at the gaged location using equation 20 (Piedmont region),

$$Q_{100} = 3{,}060A^{0.557}(F+10)^{-0.241}.$$

By substitution,

$$Q_{100} = 3{,}060(1.47)^{0.557}(68+10)^{-0.241};$$
$$Q_{100} = 1{,}330 \text{ ft}^3/\text{s}.$$
$$Q_r = \log(Q_{100}) = \log(1{,}340 \text{ ft}^3/\text{s}) = 3.1229.$$

4. Obtain the number of observed years of record at the gaged location from table 7;

$$N_g = 12 \text{ years.}$$

5. Obtain the number of equivalent years of record for equation 20 from table 6;

$$N_r = 19 \text{ years.}$$

6. From equation 36, the weighted discharge at the gaged location is:

$$Q_w = \frac{Q_g N_g + Q_r N_r}{N_g + N_r} .$$

By substitution,

$$Q_w = \frac{(3.0492x12) + (3.1229x19)}{12 + 19}$$

$$Q_w = 3.0944.$$

The weighted peak-flow estimate is $10^{3.0944}$, which is 1,240 ft^3/s.

Estimation Method for a Site Near a Gaged Location

When a peak-flow estimate is required at an ungaged site whose drainage area does not differ by more than 50 percent from that of a gaged location on the same stream, the following procedure is recommended for determining the estimate.

1. Use the procedure described in the previous section to obtain the weighted peak-flow estimate, Q_w .

2. Determine the weighted average between the weighted peak-flow estimate, Q_w, and the discharge, Q_r, calculated using the estimation equation as follows:

$$R = \frac{10^{Q_w}}{10^{Q_r}} \qquad (37)$$

where

R is the ratio of the weighted peak-flow estimate to the discharge calculated using the estimation equation; and

Qw and Qr are as defined in the previous section.

The ratio R is then scaled, based on the difference in drainage area between the ungaged site and the gaged location, to apply to the selected ungaged site, by use of the following equation:

$$R_w = R - \frac{2|A_g - A_u|}{A_g}(R - 1) \qquad (38)$$

where

R_w is the ratio R scaled to account for the difference in drainage areas between the selected site and the gaged location on the same stream;
R is as defined in equation 37;
A_g is the drainage area at the nearby gaged location; and
A_u is the drainage area at the selected site.

3. Calculate the discharge at the ungaged site using the appropriate estimation equation by the procedure described in Problem 1. Using this computed discharge and the weighted ratio R_w , the final weighted peak-flow estimate can be obtained from the following equation:

$$Q_f = R_w \times Q_u \qquad (39)$$

where

Q_f is the final weighted peak-flow estimate at the selected ungaged site on the gaged stream;
R_w is as defined in equation 38; and
Q_u is the discharge at the selected ungaged site, calculated from the appropriate estimation equation.

If a peak-flow prediction is needed at an ungaged site on a gaged stream, but the drainage area of the selected site differs by more than 50 percent from that of the gaged location, the appropriate estimation equation should be used to obtain the estimate by the procedure used in Problem 1.

Estimation Method for a Site Between Gaged Locations

In the case where a peak-flow estimate is required for a site that is located between two gaged locations on a stream, the estimate can be obtained using the procedure presented for calculating estimates for a site at a gaged location with the following procedural alteration.

Since the site is ungaged, a direct determination of Q_g for the selected recurrence interval from the observed data is not possible. However, there are gaged locations upstream and downstream from the selected site. To obtain the interpolated value for Q_g for use in equation 36, use the following procedure:

1. On log paper, plot the peak-flow discharge for the selected recurrence interval against the drainage area (table 7) for the two adjacent gaged locations.
2. Draw a line between these two points and find the point on the line which corresponds to the drainage area associated with the selected site.
3. Determine the discharge associated with this point.

This discharge value may be used in equation 36 in place of Q_g .

The value for N_g is also not obtainable in this case. A value may be calculated, however, by finding an arithmetically weighted average of the periods of record for the upstream and downstream stations, using the difference in the two drainage areas as the weighting factor. Once these values of Q_g and N_g have been calculated, the peak-flow estimate for the selected ungaged site may be obtained using equation 36.

If a peak-flow estimate between gaged locations is desired on the Potomac River, it can be obtained directly from figure 6, which displays curves for various recurrence-interval flows based on observed data at nine mainstem gaging stations. In order to obtain such estimates for sites on the Susquehanna River, the user should refer to Flippo (1977).

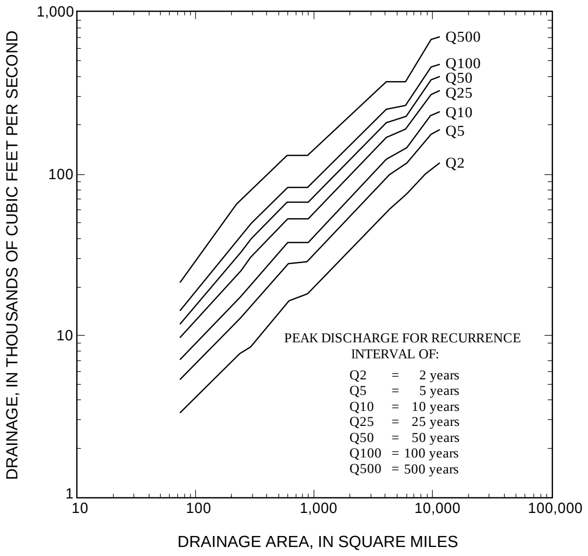


Figure 6. Flood magnitudes and frequencies for the Potomac River.

SUMMARY AND CONCLUSIONS

This report presents a convenient and reliable technique for estimating peak-flow discharges for nontidal streams in Maryland. The State was divided into five study regions--the Appalachian Plateaus and Allegheny Ridges, the Blue Ridge and Great Valley, the Piedmont, the Western Coastal Plain, and the Eastern Coastal Plain--based on its hydrologic characteristics. Analyses of basin characteristics and peak-flow data from 219 streamflow-gaging stations revealed that drainage area, storage, carbonate rock coverage, runoff-curve number, forest cover, and basin relief are the explanatory variables that provide the best estimation equations for peak flow across the State.

The accuracy of the estimation equations is described by the standard error of estimate. For the equations presented in this report, the standard error of estimate ranges from 19 to 64 percent. Methods are presented that explain the use of the estimation equations with regard to sites on ungaged and gaged streams, and are valid for use in the estimation of peak-flow discharges throughout the State of Maryland, with the exception of the mainstem of the Potomac River, for which an alternate estimation method is given. Adherence to the guidelines set forth in the Accuracy and Limitations section will ensure satisfactory results from the equations within the appropriate standard errors of estimate.

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Basin relief: The difference between the gage or outlet point elevation and the average basin elevation, where all elevations are referenced to sea level.

Carbonate rock coverage: The part of a drainage basin which is directly underlain by geologic units consisting of limestone and(or) dolomite.

Drainage area: The planar area of a drainage basin.

Fall Line. The line marking the point on each stream where the flow descends from the Piedmont Plateau to the Coastal Plain in Maryland.

Forest cover: The part of a drainage basin where the land use is defined as forest.

Hypsometric curve. The relation of horizontal cross-sectional drainage-basin area to elevation, or relative area a/A to relative height h/H.

Kendall's tau. A measure of the strength of the monotonic relation between annual peak-flow values and their temporal position in the station record.

Planimeter. An instrument for measuring the area of a plane figure by tracing its boundary line.

Recurrence interval. The average interval of years during which a given peak discharge can be expected to be exceeded once.

Runoff-curve number. An index ranging in value from 1 to 100 which indicates the potential for runoff on a given land surface, given the associated land use and hydrologic soil type.

Storage: The part of a drainage basin which exists as a lake, pond, or swamp.

Table 7. *Basin characteristics and observed flood-frequency characteristics for selected drainage basins in Maryland and surrounding States*

[mi^2, square miles; ft, feet; %, percent; ft^3/s, cubic feet per second; -----, data not determined; Footnotes are at end of table]

		Basin characteristics					
Station no.	**Years of record**	**Drainage area (mi^2)**	**Basin relief (ft)**	**Runoff-curve number**	**Storage (%)**	**Carbonate rock coverage (%)**	**Forest cover (%)**
01472174	16	5.98	160	-----	0.000	-----	14
01475300	18	5.15	117	-----	.000	-----	26
01475510	27	37.4	210	-----	.000	-----	18
01475530	17	4.78	205	-----	.000	-----	6
01477800 +	45	7.46	253	-----	.000	-----	12
01478000	48	20.5	173	-----	.070	-----	19
01478200	31	12.7	261	-----	.000	-----	11
01478500	24	66.7	301	-----	.073	-----	19
01478950 *	7	6.04	219	-----	.050	-----	25
01479000	50	89.1	333	-----	.090	-----	23
01479200 *	10	4.19	141	-----	.000	-----	9
01479950 *	10	.38	167	-----	.000	-----	27
01480000	48	47.0	259	-----	.822	-----	18
01480100	18	6.70	105	-----	.164	-----	14
01480300	31	18.7	149	-----	.000	-----	18
01480500	30	45.8	355	-----	.350	-----	25
01480610	27	2.57	185	-----	.000	-----	23
01480675	24	8.57	160	-----	6.100	-----	27
01480680	12	17.8	260	-----	3.030	-----	30
01480700	25	60.6	258	-----	.990	-----	19
01481000	71	287	320	-----	.160	-----	45
01481200 *	10	.97	201	-----	.310	-----	43
01481450	10	.37	44	-----	.000	-----	11
01481500	44	314	401	-----	.170	-----	18
01482310 *	10	1.07	45	82.91	.960	-----	9
01483200 *	39	3.85	45	71.68	1.900	-----	43
01483290 *	10	1.30	21	76.49	.000	-----	17
01483400 *	10	.60	18	71.25	5.200	-----	26
01483500 *	33	9.35	43	79.47	.102	-----	21
01483700	33	31.9	43	79.47	2.420	-----	46
01483720 *	10	2.3	27	71.52	.000	-----	20
01484000 #	28	13.6	35	73.39	.647	-----	35
01484002 *#	10	.97	25	57.52	.000	-----	28
01484050 *	9	3.29	31	72.54	.000	-----	16
01484100 *	33	2.83	17	70.11	.360	-----	45
01484270 *	15	6.10	33	63.12	2.200	-----	57
01484300	22	7.08	35	49.60	3.953	-----	54
01484500 *	48	5.24	21	76.78	.040	-----	51
01484550 *	15	8.78	25	83.09	.150	-----	46
01485000	41	60.5	30	87.29	15.800	-----	30
01485500	41	44.9	34	77.28	6.200	-----	85
01486000	40	4.80	17	81.00	.000	-----	57
01486100 *	10	4.1	20	77.12	2.900	-----	77
01486980 *	10	5.28	12	80.29	.210	-----	68
01487000	47	75.4	36	77.32	1.700	-----	40

Flood-frequency characteristics							
Peak discharge, in cubic feet per second, for indicated recurrence interval in years							Station no.
2	5	10	25	50	100	500	
640	1,310	1,930	2,920	3,820	4,890	8,080	01472174
658	1,030	1,310	1,690	2,000	2,330	3,180	01475300
2,870	4,210	5,160	6,400	7,360	8,340	10,800	01475510
770	1,470	2,160	3,390	4,610	6,180	11,700	01475530
860	3,150	4,360	6,400	8,390	10,900	19,100	01477800 +
1,770	2,590	3,200	4,020	4,680	5,370	7,170	01478000
1,040	1,750	2,350	3,270	4,090	5,030	7,770	01478200
3,000	4,600	5,860	7,700	9,250	11,000	15,800	01478500
844	1,650	2,340	3,420	4,370	5,460	8,580	01478950 *
3,660	5,250	6,430	8,060	9,390	10,800	14,600	01479000
550	970	1,340	1,920	2,450	3,070	4,960	01479200 *
43	81	121	196	276	383	796	01479950 *
2,180	3,080	3,740	4,650	5,380	6,170	8,230	01480000
931	1,720	2,510	3,740	5,410	7,310	14,200	01480100
1,290	2,690	4,200	7,080	10,200	14,400	30,700	01480300
1,810	3,340	4,770	7,150	9,430	12,200	21,300	01480500
350	654	924	1,360	1,750	2,220	3,640	01480610
241	432	600	869	1,120	1,410	2,310	01480675
648	848	988	1,180	1,320	1,480	1,870	01480680
3,140	5,260	7,090	9,980	12,600	15,700	25,000	01480700
6,660	10,200	12,900	17,000	20,400	24,200	35,000	01481000
100	208	321	526	741	1,030	2,090	01481200 *
240	366	471	629	770	930	1,410	01481450
7,320	11,500	15,100	20,700	25,800	31,900	50,200	01481500
141	266	374	544	695	869	1,380	01482310 *
134	275	408	631	842	1,100	1,910	01483200 *
143	258	371	568	767	1,020	1,920	01483290 *
24	35	46	66	85	108	181	01483400 *
223	461	697	1,100	1,520	2,040	3,820	01483500 *
474	824	1,100	1,500	1,830	2,180	3,140	01483700
158	296	425	643	852	1,110	1,950	01483720 *
289	565	803	1,170	1,500	1,870	2,940	01484000 #
18	29	40	60	79	105	198	01484002 *#
64	134	209	356	516	733	1,610	01484050 *
53	87	120	175	231	300	542	01484100 *
27	36	43	53	61	69	91	01484270 *
35	55	73	100	126	156	250	01484300
62	107	150	225	301	397	737	01484500 *
273	413	547	781	1,020	1,320	2,410	01484550 *
659	947	1,190	1,580	1,930	2,330	3,580	01485000
512	827	1,070	1,410	1,690	2,000	2,800	01485500
131	232	317	445	556	682	1,040	01486000
90	144	192	272	374	439	743	01486100 *
41	59	74	97	117	141	212	01486980 *
567	1,010	1,420	2,090	2,730	3,510	6,010	01487000

Table 7. *Basin characteristics and observed flood-frequency characteristics for selected drainage basins in Maryland and surrounding States--Continued*

Station no.	Years of record	Basin characteristics					
		Drainage area (mi^2)	Basin relief (ft)	Runoff-curve number	Storage (%)	Carbonate rock coverage (%)	Forest cover (%)
01487900 *	9	3.47	4	79.18	0.000	-----	44
01488500	45	43.9	28	83.91	.300	-----	29
01489000	41	7.10	29	79.75	.474	-----	33
01490000	30	15.0	18	76.21	.100	-----	50
01490600 *#	10	8.4	22	82.65	1.200	-----	48
01490800	10	3.9	25	80.61	.714	-----	29
01491000	43	113	56	80.14	1.909	-----	35
01491010 *#	10	1.90	16	84.02	.140	-----	28
01491050	10	3.8	17	75.85	.074	-----	25
01492000	32	5.85	53	72.88	.000	-----	26
01492050	11	8.4	39	75.12	.000	-----	23
01492500	30	8.09	44	84.96	.000	-----	32
01492550	11	4.6	41	72.85	.335	-----	14
01493000	42	22.3	57	79.31	1.540	-----	43
01493500	40	12.7	45	80.51	.200	-----	8
01494000	13	12.5	51	77.59	.008	-----	24
01495000 #	59	52.6	329	-----	.053	-----	14
01495500	10	26.8	292	-----	.065	-----	23
01496000	36	24.3	265	-----	.094	-----	22
01496080	10	1.7	174	-----	.025	-----	96
01496200	24	9.03	160	-----	.019	-----	17
01559700	17	5.28	450	-----	.000	-----	69
01561000	29	36.8	428	-----	.000	-----	70
01563800	19	3.46	---	-----	.000	-----	52
01574000	62	510	306	-----	.210	-----	33
01574500	60	74.3	224	-----	.220	-----	21
01574800	15	5.17	210	-----	.000	-----	22
01575000	62	117	347	-----	.210	-----	12
01577500	14	133	475	-----	.000	-----	32
01578200	27	8.71	190	-----	.000	-----	23
01578400	19	5.98	182	-----	.000	-----	22
01578500 @	21	193	423	-----	.000	-----	32
01578800 *	10	1.3	78	-----	.184	-----	12
01579000 *	22	5.31	128	-----	.077	-----	22
01580000	64	94.4	407	-----	.028	-----	50
01581500	24	8.52	138	-----	.124	-----	22
01581700	24	34.8	293	-----	.079	-----	29
01582000 #	47	52.9	353	-----	.063	-----	27
01582510	14	1.5	222	-----	.000	-----	30
01583000	34	2.09	166	-----	.027	-----	36
01583495	14	.26	122	-----	.000	-----	0
01583500	46	59.8	281	-----	.057	-----	44
01583580 *	12	1.47	226	-----	.000	-----	68
01584500	58	36.1	281	-----	.100	-----	40
01585100 @	31	7.61	---	-----	.680	-----	37

Flood-frequency characteristics							
Peak discharge, in cubic feet per second, for indicated recurrence interval in years							Station no.
2	5	10	25	50	100	500	
77	108	142	204	272	370	746	01487900 *
881	1,700	2,380	3,410	4,300	5,290	8,030	01488500
241	563	885	1,440	1,990	2,660	4,830	01489000
225	361	471	633	771	925	1,360	01490000
208	356	491	715	931	1,190	2,070	01490600 *#
187	341	484	723	952	1,230	2,140	01490800
1,640	2,920	3,990	5,640	7,090	8,750	13,500	01491000
70	149	230	376	525	717	1,400	01491010 *#
74	179	311	606	972	1,530	4,180	01491050
266	532	807	1,310	1,840	2,530	5,070	01492000
96	197	307	519	752	1,070	2,340	01492050
216	469	732	1,210	1,710	2,350	4,630	01492500
126	278	459	838	1,290	1,940	4,820	01492550
294	507	676	921	1,130	1,350	1,950	01493000
363	793	1,270	2,180	3,190	4,570	9,960	01493500
463	827	1,170	1,740	2,300	3,000	5,300	01494000
2,790	4,720	6,370	8,940	11,200	13,900	21,900	01495000 #
1,690	2,520	3,240	4,380	5,410	6,640	10,400	01495500
1,500	2,360	3,050	4,100	5,020	6,060	9,050	01496000
277	494	679	965	1,220	1,510	2,360	01496080
1,100	2,190	3,220	4,960	6,640	8,690	15,400	01496200
293	547	773	1,130	1,470	1,860	3,040	01559700
900	1,760	2,610	4,110	5,620	7,540	14,200	01561000
166	266	344	457	552	656	942	01563800
15,200	23,000	30,000	41,300	51,900	64,700	105,000	01574000
1,980	3,370	4,620	6,670	8,610	11,000	18,500	01574500
215	580	1,070	2,230	3,740	6,130	18,300	01574800
2,200	3,850	5,410	8,060	10,600	13,900	24,700	01575000
5,280	8,830	12,100	17,400	22,600	28,800	49,200	01577500
496	921	1,340	2,100	2,870	3,870	7,420	01578200
612	1,270	2,000	3,440	5,040	7,270	16,200	01578400
4,920	11,100	17,900	31,400	46,200	66,700	148,000	01578500 @
364	556	725	1,030	1,340	1,750	3,210	01578800 *
720	1,350	1,980	3,130	4,350	6,000	12,200	01579000 *
3,660	5,690	7,310	9,670	11,700	13,900	20,200	01580000
1,030	1,810	2,530	3,750	4,940	6,410	11,300	01581500
2,580	5,160	7,360	10,700	13,600	16,900	25,900	01581700
2,360	3,720	4,820	6,460	7,890	9,490	14,100	01582000 #
267	698	1,190	2,140	3,160	4,530	9,640	01582510
154	251	330	448	551	667	998	01583000
107	243	384	639	899	1,230	2,390	01583495
2,180	4,460	6,850	11,300	16,100	22,300	45,900	01583500
152	282	407	629	848	1,120	2,050	01583580 *
2,830	5,020	6,890	9,790	12,400	15,400	24,100	01584500
1,330	2,510	3,560	5,230	6,750	8,540	13,900	01585100 @

Table 7. *Basin characteristics and observed flood-frequency characteristics for selected drainage basins in Maryland and surrounding States--Continued*

		Basin characteristics					
Station no.	Years of record	Drainage area (mi^2)	Basin relief (ft)	Runoff-curve number	Storage (%)	Carbonate rock coverage (%)	Forest cover (%)
01585300 @	30	4.46	---	-----	0.140	-----	24
01585400 @	29	1.97	---	-----	.078	-----	34
01585500	42	3.29	153	-----	.000	-----	23
01586000	45	56.6	322	-----	.072	-----	38
01586500	26	91.0	358	-----	.045	-----	35
01587000	24	165	395	-----	.025	-----	32
01587050	11	.54	84	-----	.000	-----	1
01587500	32	64.4	353	-----	.002	-----	22
01588000	43	11.4	215	-----	.004	-----	17
01589300	33	32.5	194	-----	.047	-----	33
01589440	31	25.2	251	-----	.140	-----	44
01590000#	42	8.5	105	70.45	1.450	-----	70
01590500	35	6.92	105	67.79	3.094	-----	70
01591000	46	34.8	224	-----	.000	-----	26
01591500	12	27.7	189	-----	.001	-----	18
01592000	32	127	275	-----	.003	-----	29
01593350	10	.95	160	-----	.000	-----	16
01593500	58	38	150	-----	.058	-----	33
01594000 #	42	98.4	299	-----	.060	-----	22
01594400 @	19	11.6	142	-----	1.090	-----	42
01594445	10	1.19	54	74.09	.180	-----	19
01594500	25	30.2	101	73.08	.480	-----	47
01594600	19	3.85	66	68.33	.000	-----	46
01594800	11	6.73	103	62.38	.010	-----	83
01595000 @	34	73.0	174	-----	.186	-----	78
01595300	27	47.3	830	-----	.000	-----	75
01595500 @	41	225	1,248	-----	.282	-----	73
01596000 @	26	287	1,718	-----	.221	-----	77
01596500	42	49.1	905	-----	.624	-----	81
01597000	33	16.7	981	-----	.118	-----	79
01598000	24	115	1,431	-----	.318	-----	83
01599000	60	72.4	1,211	-----	.013	-----	92
01599500	22	45.7	960	-----	.000	-----	75
01600000 @	16	596	1,622	-----	.169	-----	74
01600700	21	10.2	546	-----	.000	-----	70
01601500	61	247	1,239	-----	.028	-----	70
01603000 @	54	875	1,575	-----	.123	-----	73
01603500	50	30.2	542	-----	.000	-----	59
01604500	52	219	655	-----	.000	-----	74
01608400 *	8	4.37	550	-----	.000	-----	95
01609000	23	148	760	-----	.055	-----	79
01609500	25	5.08	244	-----	.028	-----	90
01609800	11	108	680	-----	.000	-----	70
01610105	16	.70	347	-----	.000	-----	92
01610150	18	10.4	434	-----	.126	-----	62

Flood-frequency characteristics							
Peak discharge, in cubic feet per second, for indicated recurrence interval in years							Station no.
2	5	10	25	50	100	500	
1,240	2,070	2,750	3,790	4,700	5,750	8,790	01585300 @
322	643	982	1,620	2,310	3,230	6,770	01585400 @
223	531	881	1,570	2,340	3,400	7,580	01585500
2,270	4,160	6,110	9,730	13,500	18,600	37,800	01586000
2,510	4,150	5,570	7,830	9,880	12,300	19,800	01586500
3,610	6,310	8,800	12,900	16,900	21,700	37,400	01587000
123	252	387	638	903	1,250	2,560	01587050
2,670	5,440	8,420	14,100	20,300	28,700	61,200	01587500
666	1,510	2,450	4,250	6,220	8,900	19,200	01588000
1,510	3,100	4,830	8,170	11,800	16,800	36,400	01589300
902	2,110	3,600	6,870	10,900	16,900	45,000	01589440
135	271	427	750	1,130	1,670	4,180	01590000#
201	396	587	921	1,250	1,670	3,100	01590500
1,510	3,530	5,870	10,600	16,000	23,700	55,200	01591000
833	1,720	2,700	4,640	6,800	9,820	22,100	01591500
2,530	3,930	5,100	6,910	8,530	10,400	16,000	01592000
165	345	527	852	1,180	1,600	3,080	01593350
1,340	2,480	3,620	5,670	7,780	10,500	20,300	01593500
3,080	5,410	7,730	11,900	16,100	21,600	41,400	01594000 #
446	677	878	1,200	1,490	1,840	2,910	01594400 @
153	276	393	590	782	1,020	1,810	01594445
881	1,300	1,590	1,970	2,270	2,580	3,340	01594500
139	323	539	985	1,500	2,240	5,360	01594600
117	170	212	276	331	393	574	01594800
3,320	5,360	7,020	9,520	11,700	14,100	21,100	01595000 @
1,300	1,830	2,210	2,730	3,150	3,600	4,750	01595300
7,470	12,100	16,400	23,500	30,200	38,500	65,400	01595500 @
8,100	13,700	18,400	25,700	32,100	39,500	61,200	01596000 @
1,460	2,300	2,990	4,040	4,960	6,000	9,050	01596500
484	843	1,170	1,720	2,250	2,890	4,990	01597000
3,450	5,880	8,030	11,500	14,600	18,400	30,100	01598000
1,860	2,980	3,900	5,290	6,500	7,890	11,900	01599000
1,040	1,850	2,500	3,430	4,200	5,030	7,220	01599500
15,800	26,700	36,000	50,400	63,400	78,400	123,000	01600000 @
438	817	1,170	1,770	2,350	3,060	5,390	01600700
5,930	9,660	13,000	18,300	23,300	29,400	48,500	01601500
17,600	27,300	35,500	48,000	59,200	72,200	111,000	01603000 @
920	1,580	2,120	2,940	3,640	4,430	6,670	01603500
4,050	7,090	9,400	12,600	15,100	17,700	24,300	01604500
275	455	580	750	870	1,000	1,290	01608400 *
3,800	6,160	8,030	10,800	13,100	15,700	23,000	01609000
266	398	504	662	798	951	1,390	01609500
3,800	5,970	7,700	10,300	12,400	14,900	21,700	01609800
54	74	88	106	120	135	171	01610105
378	668	907	1,270	1,580	1,920	2,900	01610150

Table 7. *Basin characteristics and observed flood-frequency characteristics for selected drainage basins in Maryland and surrounding States--Continued*

Station no.	Years of record	Basin characteristics					
		Drainage area (mi^2)	Basin relief (ft)	Runoff-curve number	Storage (%)	Carbonate rock coverage (%)	Forest cover (%)
01610155	10	102	680	-----	0.047	-----	73
01612500	17	16.9	393	-----	.236	-----	74
01613000 @	61	4,073	1,416	-----	.060	-----	77
01613050	28	10.7	541	-----	.000	-----	76
01613150	22	4.8	319	-----	.317	-----	28
01613160	12	1.2	267	-----	.630	-----	40
01613500	11	158	586	-----	.200	-----	56
01613900	30	15.0	531	-----	1.500	11.0	70
01614000	41	243	474	-----	.000	5.0	70
01614500 #	64	494	658	-----	.227	42.0	37
01615000	47	57.4	257	-----	.000	42.0	38
01616000	23	16.5	274	-----	.000	73.0	42
01616500	44	272	275	-----	.000	61.0	30
01617000	25	11.3	294	-----	.000	75.0	30
01617800	26	18.9	154	-----	.115	100.0	12
01618000 @	64	5,936	1,239	-----	.051	-----	68
01619000	19	93.5	459	-----	.184	47.0	46
01619475	11	.10	18	-----	.000	69.0	26
01619500	63	281	470	-----	.123	64.0	30
01637000	30	8.83	470	-----	.006	0.0	48
01637500	43	66.9	725	-----	.024	.0	37
01637600	11	2.3	246	-----	.130	.0	26
01638480	19	89.6	351	-----	.000	.0	30
01638500 @	97	9,651	1,159	-----	.044	-----	59
01638900	20	12.4	135	-----	.000	.0	12
01639000	50	173	256	-----	.000	3.2	24
01639095	10	.62	73	-----	.920	.0	7
01639500 @	43	102	285	-----	.020	-----	17
01640000	28	8.10	184	-----	.012	-----	12
01640500	53	5.93	495	-----	.000	.0	71
01640700	11	1.2	58	-----	.260	.0	8
01641000	41	18.4	745	-----	.336	8.5	77
01641500	37	7.29	715	-----	.000	.0	100
01642000 @	35	665	489	-----	.054	-----	36
01642400	10	2.7	136	-----	.200	-----	4
01642500	40	82.3	306	-----	.012	-----	20
01643000 @	62	817	389	-----	.049	-----	33
01643500	41	62.8	281	-----	.010	-----	26
01643700	23	123	370	-----	.000	.0	40
01644000 #	64	332	411	-----	.000	.0	35
01644100 *	11	2.05	180	-----	.000	.0	17
01644291	10	.08	33	-----	.000	.0	90
01644420	10	.27	172	-----	.000	-----	23
01645000	60	101	254	-----	.011	-----	20
01645700	20	4.29	100	-----	.000	-----	73

Flood-frequency characteristics							
Peak discharge, in cubic feet per second, for indicated recurrence interval in years							Station no.
2	5	10	25	50	100	500	
4,450	7,620	10,300	14,300	17,800	21,900	33,500	01610155
520	898	1,220	1,700	2,130	2,630	4,060	01612500
56,400	92,200	122,000	168,000	209,000	256,000	393,000	01613000 @
365	618	821	1,120	1,380	1,660	2,440	01613050
237	377	489	653	792	948	1,380	01613150
105	149	183	230	270	313	431	01613160
4,560	8,460	12,200	18,800	25,200	33,400	61,400	01613500
823	1,530	2,090	2,870	3,510	4,190	5,940	01613900
5,280	8,640	11,600	16,200	20,400	25,400	40,800	01614000
7,440	11,000	13,900	18,300	22,100	26,400	38,800	01614500 #
2,150	3,990	5,570	8,020	10,200	12,700	20,100	01615000
463	758	987	1,310	1,580	1,870	2,650	01616000
4,030	7,350	10,300	15,000	19,200	24,200	39,400	01616500
175	291	386	530	657	801	1,220	01617000
94	186	277	438	599	804	1,510	01617800
72,900	113,000	145,000	191,000	229,000	272,000	390,000	01618000 @
1,460	2,590	3,600	5,240	6,770	8,590	14,300	01619000
21	44	68	111	156	215	428	01619475
2,560	4,490	6,150	8,760	11,100	13,900	22,100	01619500
547	1,250	2,000	3,390	4,860	6,790	13,800	01637000
2,280	4,030	5,650	8,330	10,900	14,000	24,200	01637500
234	412	571	828	1,070	1,350	2,250	01637600
4,040	8,320	12,400	19,500	26,300	34,800	62,400	01638480
103,000	164,000	212,000	282,000	340,000	404,000	580,000	01638500 @
1,290	2,360	3,350	5,000	6,570	8,490	14,700	01638900
8,250	11,300	13,600	16,600	19,100	21,600	28,300	01639000
126	218	296	417	525	648	1,010	01639095
3,310	5,790	8,200	12,400	16,700	22,200	41,400	01639500 @
420	861	1,300	2,090	2,880	3,890	7,390	01640000
377	875	1,420	2,440	3,520	4,970	10,300	01640500
163	266	352	484	601	735	1,130	01640700
841	1,410	1,850	2,480	3,000	3,560	5,040	01641000
134	307	505	904	1,350	1,980	4,560	01641500
16,900	22,500	26,400	31,600	35,700	39,900	50,400	01642000 @
437	889	1,330	2,090	2,840	3,780	6,920	01642400
2,460	4,130	5,610	8,020	10,300	13,000	21,400	01642500
18,200	27,500	34,800	45,200	53,900	63,400	89,600	01643000 @
2,360	4,560	6,900	11,400	16,200	22,700	48,200	01643500
3,690	7,310	10,700	16,600	22,200	29,100	51,600	01643700
6,820	13,300	19,500	30,100	40,300	53,000	95,000	01644000 #
302	542	821	1,370	1,950	2,740	5,870	01644100 *
103	166	220	305	382	473	751	01644291
96	188	276	427	573	755	1,350	01644420
2,770	5,580	8,650	14,600	21,200	30,300	66,800	01645000
489	745	933	1,190	1,400	1,620	2,180	01645700

Table 7. *Basin characteristics and observed flood-frequency characteristics for selected drainage basins in Maryland and surrounding States--Continued*

		Basin characteristics					
Station no.	**Years of record**	**Drainage area (mi^2)**	**Basin relief (ft)**	**Runoff-curve number**	**Storage (%)**	**Carbonate rock coverage (%)**	**Forest cover (%)**
01646000	56	57.9	209	-----	0.000	-----	60
01646200	12	4.69	190	-----	.122	-----	50
01646500 @	60	11,560	1,202	-----	.048	-----	55
01647720	11	9.73	137	-----	.169	-----	23
01650050 *	10	2.45	95	-----	.260	-----	33
01650085 *	10	.35	84	-----	.000	-----	8
01650190	10	.47	122	-----	.000	-----	8
01650500	60	21.1	150	-----	.040	-----	31
01653600	25	39.5	187	77.41	2.460	-----	42
01654000	43	23.5	129	-----	.000	-----	65
01655350	10	15.0	176	-----	.000	-----	60
01656000	40	93.4	231	-----	.000	.0	36
01656500	36	50.5	325	-----	.000	.0	38
01656600 *	10	.79	92	-----	.530	.0	61
01656700	13	343	240	-----	.000	.0	45
01656725	17	25.8	202	-----	2.000	.0	40
01657000	31	148	241	-----	.000	.0	47
01658000	37	54.8	143	77.70	3.210	-----	69
01658500	39	7.64	101	-----	.000	-----	97
01660900	14	2.3	56	74.53	.000	-----	82
01660930 *	11	11.2	115	71.40	2.320	-----	6
01661000	25	10.4	118	78.35	.000	-----	66
01661050	21	18.5	104	70.24	.005	-----	60
01661430	11	.30	61	81.29	.480	-----	25
01661500	44	24.0	91	77.31	.312	-----	82
01661600	18	6.98	38	-----	1.600	-----	66
01661800	24	6.82	56	-----	.000	-----	85
01664800 *	10	2.28	62	-----	1.600	.0	75
01665200	10	1.00	60	-----	.000	-----	98
01668200 *	9	2.82	100	65.00	.000	-----	69
01668300	25	2.18	78	68.12	.000	-----	68
01669000	39	28.0	118	-----	.000	-----	69
01669300	10	1.37	35	75.31	.000	-----	79
01669500	38	84.9	86	-----	.000	-----	71
01674000	49	257	195	-----	.000	-----	81
03039200	18	3.68	351	-----	.000	-----	97
03062500 #	23	63.2	950	-----	.000	-----	65
03063600 *	8	6.57	719	-----	.000	-----	50
03066000	69	86.2	191	-----	.000	-----	50
03069850	11	.95	310	-----	.000	-----	99
03069880 *	10	12.2	650	-----	.000	-----	60
03070500	77	200	760	-----	.000	-----	10
03072590	15	16.3	381	-----	.000	-----	45
03074300	20	3.80	450	-----	.000	-----	98
03074500	48	73.7	367	-----	.000	-----	45

Flood-frequency characteristics							
Peak discharge, in cubic feet per second, for indicated recurrence interval in years							Station no.
2	5	10	25	50	100	500	
1,550	2,960	4,490	7,440	10,700	15,200	33,200	01646000
1,110	2,190	3,230	5,000	6,720	8,860	15,900	01646200
113,000	184,000	243,000	331,000	408,000	496,000	750,000	01646500 @
878	2,070	3,540	6,690	10,500	16,100	41,600	01647720
575	1,210	1,900	3,260	4,790	6,950	12,700	01650050 *
79	200	351	681	1,080	1,680	4,400	01650085 *
177	375	586	983	1,400	1,970	4,070	01650190
1,230	2,230	3,250	5,110	7,030	9,550	18,800	01650500
935	1,880	2,930	4,980	7,270	10,400	23,400	01653600
2,010	3,840	5,580	8,550	11,400	15,000	27,000	01654000
871	1,430	1,960	2,830	3,680	4,730	8,220	01655350
3,520	6,440	9,180	13,800	18,300	23,800	42,000	01656000
1,740	3,550	5,440	8,930	12,600	17,400	35,300	01656500
190	337	426	546	651	773	1,080	01656600 *
11,800	22,300	32,000	47,800	62,600	80,400	136,000	01656700
2,140	4,720	7,740	14,000	21,400	32,000	78,400	01656725
6,820	12,500	18,000	27,700	37,400	49,700	92,400	01657000
1,260	2,890	4,600	7,770	11,100	15,400	30,800	01658000
477	966	1,490	2,470	3,510	4,920	10,300	01658500
123	253	391	655	940	1,320	2,810	01660900
430	937	1,540	2,810	4,330	6,570	16,800	01660930 *
341	732	1,200	2,180	3,350	5,080	12,800	01661000
689	1,740	3,010	5,650	8,700	13,100	31,500	01661050
25	45	64	95	126	163	285	01661430
834	1,790	2,820	4,790	6,900	9,760	20,700	01661500
711	925	1,100	1,370	1,610	1,880	2,670	01661600
166	293	400	565	712	880	1,370	01661800
241	541	840	1,390	1,970	2,730	5,470	01664800 *
79	195	328	596	897	1,320	3,000	01665200
91	243	418	769	1,160	1,710	3,860	01668200 *
74	153	235	389	554	774	1,610	01668300
291	575	863	1,380	1,920	2,620	5,130	01669000
31	64	98	162	230	321	665	01669300
608	1,310	2,040	3,400	4,820	6,700	13,600	01669500
3,100	5,760	7,970	11,300	14,200	17,400	26,300	01674000
134	206	261	338	401	470	651	03039200
1,690	2,830	3,760	5,150	6,350	7,710	11,500	03062500 #
339	520	663	870	1,040	1,240	1,780	03063600 *
2,460	3,690	4,690	6,190	7,490	8,970	13,200	03066000
78	114	141	180	212	246	340	03069850
1,270	1,940	2,440	3,170	3,760	4,420	6,170	03069880 *
7,190	10,100	12,400	15,600	18,300	21,300	29,400	03070500
662	978	1,210	1,520	1,770	2,030	2,700	03072590
151	259	350	490	613	754	1,170	03074300
2,200	3,160	3,860	4,820	5,590	6,410	8,550	03074500

Table 7. *Basin characteristics and observed flood-frequency characteristics for selected drainage basins in Maryland and surrounding States--Continued*

		Basin characteristics					
Station no.	**Years of record**	**Drainage area (mi^2)**	**Basin relief (ft)**	**Runoff-curve number**	**Storage (%)**	**Carbonate rock coverage (%)**	**Forest cover (%)**
03075450	12	.57	88	-----	0.000	-----	79
03075500	49	134	256	-----	.245	-----	64
03075600	22	.53	180	-----	.000	-----	63
03076505	12	.22	290	-----	.000	-----	45
03076600	26	48.9	905	-----	.120	-----	44
03077700	12	1.0	165	-----	.000	-----	96
03078000	43	62.5	521	-----	.000	-----	80
03078500	51	24.5	310	-----	.160	-----	65
03079000	76	382	765	-----	.240	-----	64
03080000	77	121	935	-----	.400	-----	86
03082200	17	9.27	522	-----	.000	-----	60

* Flood-frequency data are weighted estimates based on observed and synthetic flood-frequency curves.
\+ Flood-frequency data based on flood-frequency curves derived from truncated observed record to eliminate time trend.
\# Flood-frequency data adjusted for historical flood information.
@ Site not used in development of estimation equations.

Flood-frequency characteristics							
Peak discharge, in cubic feet per second, for indicated recurrence interval in years							Station no.
2	5	10	25	50	100	500	
24	35	43	52	59	66	83	03075450
4,200	6,330	7,900	10,000	11,800	13,600	18,300	03075500
30	54	76	111	143	182	303	03075600
12	16	18	21	24	26	31	03076505
1,570	2,170	2,590	3,160	3,600	4,060	5,210	03076600
43	59	70	84	95	106	134	03077700
2,010	2,920	3,650	4,730	5,680	6,740	9,800	03078000
1,020	1,810	2,500	3,610	4,630	5,820	9,460	03078500
10,900	15,900	19,800	25,600	30,500	36,000	51,400	03079000
4,150	5,940	7,160	8,750	9,960	11,200	14,200	03080000
651	935	1,150	1,470	1,730	2,010	2,790	03082200

APPENDIX

ANALYSIS OF THE STREAMFLOW-GAGING-STATION NETWORK

One measure of the accuracy of the estimation equations presented in this report is the standard error of prediction. The standard error of prediction associated with each estimation equation was presented in table 5. The smaller the standard error of prediction, the more accurate the results from an equation are expected to be. Therefore, it is a point of interest to determine how the standard error of prediction for equations in the various study regions may be reduced. One way of making this determination is by network analysis.

The standard error of prediction is directly dependent upon two types of error--model error and sampling error. Model error refers to the error that is present because of the inability of the current best set of explanatory variables in an equation to fully account for all factors affecting peak-flow discharge at a site. Sampling error refers to the inability of the observed flow data to define with complete accuracy the peak-flow discharge at a site. The model error can be affected by using a different set of explanatory variables in an equation. The sampling error can be affected by the accuracy of the data collected, errors associated with autocorrelation and correlation with other gages, the basin characteristic values of potential basins, and the number and (or) location of gaging-station sites in the data set used to develop the estimation equation.

Since the analysis methods used in this study have already minimized the model error by choosing the set of explanatory variables on the basis of their statistical significance and utilizing them to develop the current estimation equations, it is not possible to predict further reductions in the model error using the methods and data available. However, by specifying potential new gaging-station sites (fig. 7) and allowing the generalized least-squares analysis package to estimate the reduction in sampling error associated with each site, it is possible to predict the change that may occur in the sampling error because of changes in the number and location of gaging stations in operation. Locations of the potential new gaging-station sites are in table 8. Locations of gaging stations used in the report are in table 9 (at the end of the appendix).

According to Carpenter and others (1987), an analysis of the streamflow-gaging-station network of Maryland indicated that of all the active stations, three could be considered for discontinuation--01485500, 01493500, and 01590500. The analysis took a number of data-use classes into account, including regional hydrology, hydrologic systems, project operation, hydrologic forecasts, water-quality monitoring, and research, as well as other miscellaneous uses. The results of the network analysis conducted as part of this study indicate agreement with Carpenter's conclusions.

Using a planning horizon of 10 years, the network analysis indicated that, in general, there would be a slight increase in the average sampling error in the regions in which these stations are located if they were discontinued. In the Western Coastal Plain region, the discontinuation of station 01590500 is predicted to have the effect of increasing the average sampling error of the network by 0.08 percent with respect to 2-year recurrence-interval estimates, and by 0.65 percent with respect to 100-year recurrence-interval estimates. In the Eastern Coastal Plain region, the discontinuation of stations 01485500 and 01493500 is predicted to have the effect of increasing the average sampling error of the network by 0.20 percent with respect to 2-year recurrence-interval estimates, and by 0.30 percent with respect to 100-year recurrence-interval estimates. Increases of the average sampling error of these magnitudes have no appreciable effect on the standard errors of prediction for these two regions, so these three stations were categorized as eligible for discontinuation in the network analysis.

In order to determine if the standard error of prediction for each study region could be appreciably reduced, potential gaging-station sites were selected in each region. Constraining the analysis such that all gaging stations currently active in the network must remain active, with the exception of the three gages discussed above, and again using a 10-year planning horizon, the following predictions were made.

In the Appalachian Plateaus and Allegheny Ridges region, the average sampling error could be reduced by 35 percent and 30 percent for 2-year and 100-year estimates, respectively, by collecting data at potential gaging-station sites A2 and A5 over the length of the planning period. Since the sampling errors for the two equations referenced are already relatively small in comparison with their model errors, however, the effect on the standard errors of prediction would be a 2.4-percent reduction in magnitude for the 2-year recurrence interval, and a 3.7-percent reduction in magnitude for the 100-year recurrence interval. With this in mind, it is doubtful that any of the potential gaging-station sites selected for this analysis be activated.

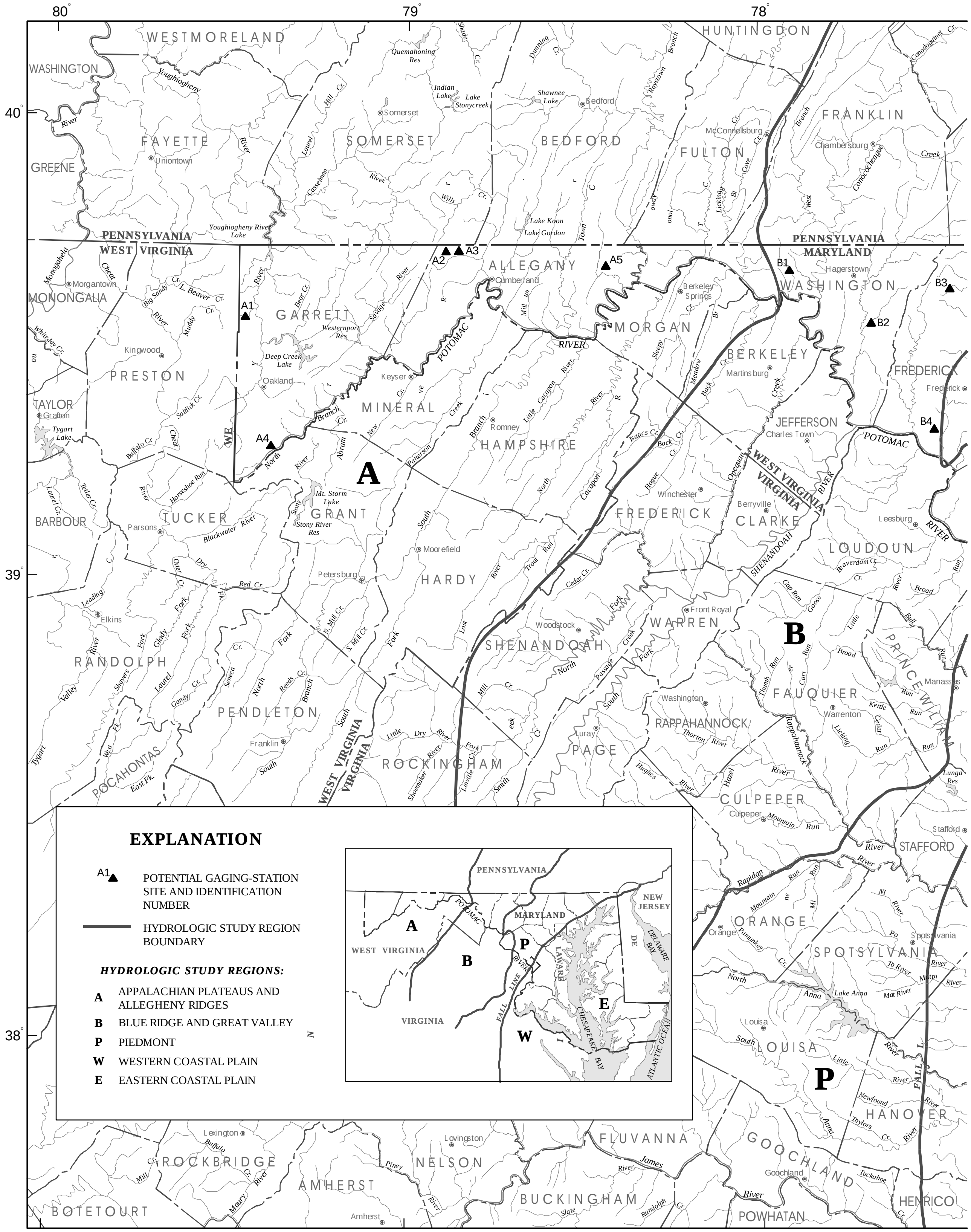
In the Blue Ridge and Great Valley region, the average sampling error could be reduced by 58 percent for 2-year estimates and by 53 percent for 100-year estimates by activating potential gaging-station sites B1, B2, B3, and B5. This would result in a reduction of the magnitude of the standard errors by prediction 4.5 percent and 9.1 percent for the 2-year and 100-year recurrence-interval equations, respectively.

In the Piedmont region, reductions in the average sampling error of 20 percent and 16 percent for the 2-year and 100-year recurrence-interval estimates, respectively, could be achieved by activating potential gaging-station site P4. Because of the relative magnitudes of the sampling errors and the model errors in this region, however, the effect of the additional station would be reductions of 1.9 percent and 1.8 percent in the magnitudes of the standard error for the 2-year and 100-year recurrence-interval equations.

In the Western Coastal Plain region, reductions in the average sampling error of 55 percent and 47 percent for the 2-year and 100-year recurrence- interval estimates, respectively, could be achieved by activating potential gaging-station sites W4 and W5, while discontinuing station 01590500. The result would be a reduction in the magnitude of the standard errors of prediction by 4.7 and 7.5 percent for the 2-year and 100-year recurrence-interval equations, respectively.

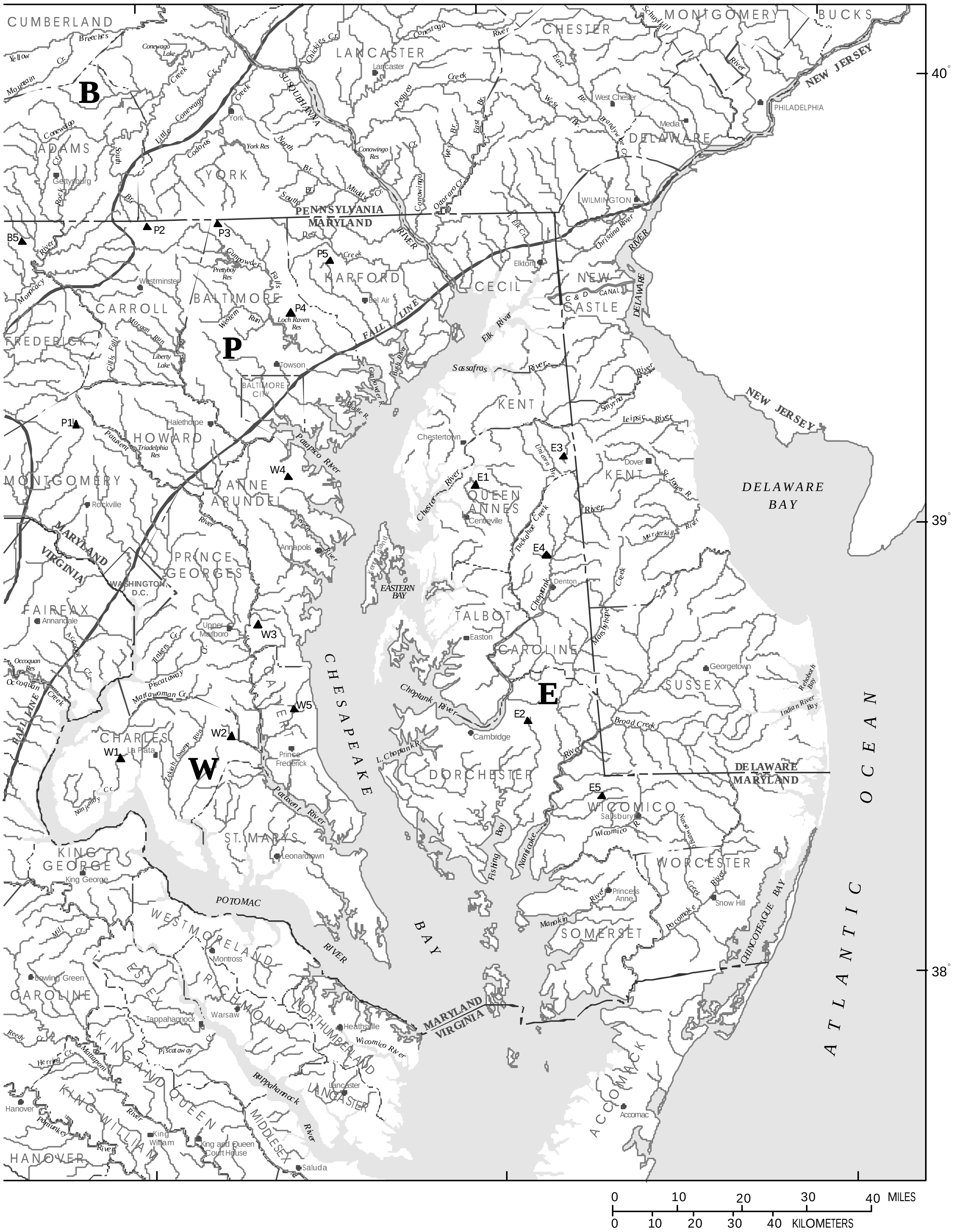
In the Eastern Coastal Plain region, reductions in the average sampling error of 51 percent and 54 percent for the 2-year and 100-year recurrence-interval estimates, respectively, could be achieved by activating potential gaging-station sites E2, E3, and E4, while discontinuing stations 01485500 and 01493500. The result of these alterations in the gaging-station network for this region would be to reduce the magnitude of the standard errors of prediction by 5.7 percent for the 2-year recurrence-interval equation, and by 11.0 percent for the 100-year recurrence-interval equation.

These predictions are based on a set of potential gaging-station sites possessing a range of basin characteristics selected within each hydrologic study region by the author, an assumption of comparable gage-record accuracy, and estimated errors of autocorrelation and intercorrelation. The analysis assumed that the cost of operation was the same for all stations. The results of this analysis indicate, however, that the fewer the number of gaging stations available for analysis in a region, the more likely it is that average sampling errors, and thus standard errors of prediction, for that region may be reduced by the addition of new gaging stations to the network. The analysis also indicates that adding gaged basins to the network that have combinations of basin-characteristics values that are uncommon or unique in the existing network acts to decrease the sampling error.



BASE FROM U.S. GEOLOGICAL SURVEY, 1:500,000, 1979

Figure 7. Location of potential gaging-station sites in Maryland.


B
P
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E4
E5
CUMBERLAND
ADAMS
YORK
LANCASTER
CHESTER
MONTGOMERY
BUCKS
DELAWARE
NEW JERSEY
PHILADELPHIA
West Chester
Media
WILMINGTON
PENNSYLVANIA
MARYLAND
CARROLL
BALTIMORE
HARFORD
CECIL
NEW CASTLE
FREDERICK
HOWARD
BALTIMORE CITY
Towson
Bel Air
Elkton
Westminster
Gettysburg
York
Lancaster
KENT
Chestertown
Dover
MONTGOMERY
Rockville
ANNE ARUNDEL
Annapolis
QUEEN ANNES
Centreville
PRINCE GEORGES
WASHINGTON D.C.
Upper Marlboro
MARYLAND
VIRGINIA
FAIRFAX
Annandale
TALBOT
Easton
CAROLINE
Denton
SUSSEX
Georgetown
DELAWARE BAY
CHESAPEAKE BAY
EASTERN BAY
CALVERT
Prince Frederick
CHARLES
La Plata
DORCHESTER
Cambridge
WICOMICO
Salisbury
DELAWARE
MARYLAND
WORCESTER
Snow Hill
SOMERSET
Princess Anne
ST. MARYS
Leonardtown
KING GEORGE
King George
WESTMORELAND
Montross
RICHMOND
Warsaw
NORTHUMBERLAND
Heathsville
LANCASTER
Lancaster
ESSEX
Tappahannock
CAROLINE
Bowling Green
KING AND QUEEN
King and Queen Court House
KING WILLIAM
King William
HANOVER
Hanover
MIDDLESEX
Saluda
ACCOMACK
Accomac
ATLANTIC OCEAN
CHINCOTEAGUE BAY
FALL LINE
SUSQUEHANNA RIVER
POTOMAC RIVER
Patuxent River
Patapsco River
Choptank River
Nanticoke River
Pocomoke River
Rappahannock River
C & D CANAL
Loch Raven Res
Prettyboy Res
Liberty Lake
Triadelphia Res
Conowingo Res
Occoquan Res
40°
39°
38°
0 10 20 30 40 MILES
0 10 20 30 40 KILOMETERS

Table 8. *Basin characteristics for potential gaging-station sites in Maryland*

[°, degree; ’ minute; " second; mi^2, square miles; ft, feet; A, drainage area; LI, carbonate rock coverage; ST, storage; BR, basin relief; F, forest cover; RCN, runoff-curve number; --, data not collected]

			Basin characteristics					
Site identification	**Latitude (° ’ ")**	**Longitude (° ’ ")**	**A (mi^2)**	**LI (percent)**	**ST (percent)**	**BR (ft)**	**F (percent)**	**RCN**
A1	39 33 53	79 28 04	3.17	--	--	187	44	--
A2	39 42 28	78 53 41	2.11	--	--	688	80	--
A3	39 42 17	78 51 52	.23	--	--	241	19	--
A4	39 16 26	79 23 26	2.30	--	--	334	80	--
A5	39 40 05	78 26 00	4.05	--	--	384	90	--
B1	39 39 03	77 53 53	10.16	30	--	434	--	--
B2	39 32 47	77 40 39	8.81	60	--	362	--	--
B3	39 37 15	77 26 24	.38	0	--	567	--	--
B4	39 18 47	77 28 38	8.34	32	--	146	--	--
B5	39 40 10	77 20 15	.69	31	--	101	--	--
P1	39 12 59	77 10 25	2.04	--	--	--	23	--
P2	39 40 16	76 57 49	.98	--	--	--	44	--
P3	39 40 33	76 46 43	.69	--	--	--	28	--
P4	39 27 42	76 32 39	.54	--	--	--	64	--
P5	39 34 35	76 26 23	6.97	--	--	--	32	--
W1	38 29 02	77 06 41	1.20	--	--	--	63	--
W2	38 31 43	76 48 13	1.59	--	--	--	53	--
W3	38 45 43	76 43 23	1.63	--	--	--	31	--
W4	39 05 40	76 37 17	.56	--	--	--	69	--
W5	38 35 02	76 36 20	9.38	--	--	--	74	--
E1	39 04 43	76 02 06	2.55	--	0.000	24	33	85.00
E2	38 34 09	75 56 43	1.24	--	.000	12	67	83.00
E3	39 08 30	75 46 00	1.49	--	.003	12	14	87.00
E4	38 55 30	75 49 20	.73	--	.001	28	41	69.00
E5	38 23 18	75 41 42	1.51	--	.000	9	41	54.00

Table 9. *Maximum discharges at selected streamflow-gaging stations*

[mi^2, square miles; ft^3/s, cubic feet per second; [(ft^3/s)/mi^2], cubic feet per second per square mile; °, degree; ’ minute; " second]

Station no.	**Station name**	**Latitude (° ’ ")**	**Longitude (° ’ ")**	**Drainage area (mi^2)**	**Period**	**Date**	**Maximum discharge (ft^3/s)**	**Maximum discharge [(ft^3/s)/mi^2]**
01472174	Pickering Creek near Chester Springs, Pa.	40 05 22	75 37 50	5.98	1967-82	6/22/72	2,410	403
01475300	Darby Creek at Waterloo Mills near Devon, Pa.	40 01 21	75 25 20	5.15	1973-90	9/06/79	1,800	350
01475510	Darby Creek near Darby, Pa.	39 55 44	75 16 22	37.4	1964-90	8/23/74	5,920	158
01475530	Cobbs Creek at U.S. Highway No. 1 at Philadelphia, Pa.	39 59 29	75 16 49	4.78	1965-81	8/23/74	3,480	728
01477800	Shellpot Creek at Wilmington, Del.	39 45 39	75 31 10	7.46	1946-90	7/05/89	8,040	1,080
01478000	Christina River at Coochs Bridge, Del.	39 38 14	75 43 43	20.5	1943-90	5/01/47	4,330	211
01478200	Middle Branch White Clay Creek near Landenberg, Pa.	39 46 54	75 48 03	12.7	1960-90	6/22/72	3,860	304
01478500	White Clay Creek above Newark, Del.	39 42 50	75 45 35	66.7	1953-58, 1963-80	6/22/72	10,200	153
01478950	Pike Creek near Newark, Del.	39 42 11	75 41 41	6.04	1969-75	7/28/69	2,550	422
01479000	White Clay Creek near Newark, Del.	39 42 01	75 41 00	89.1	1932-36, 1943-57, 1960-68, 1970-90	6/22/72	9,080	103
01479200	Mill Creek at Hockessin, Del.	39 46 31	75 41 26	4.19	1966-75	7/28/69	2,100	501
01479950	Red Clay Creek tributary near Yorklyn, Del.	39 47 50	75 39 33	.38	1966-75	7/28/69	200	526
01480000	Red Clay Creek at Wooddale, Del.	39 45 52	75 38 08	47.0	1943-90	7/21/75	5,010	107
01480100	Little Mill Creek at Elsmere, Del.	39 44 05	75 35 14	6.70	1964-80, 1989	7/05/89	4,400	657
01480300	West Branch Brandywine Creek near Honey Brook, Pa.	40 04 22	75 51 40	18.7	1960-90	6/22/72	8,140	435
01480500	West Branch Brandywine Creek at Coatesville, Pa.	39 59 08	75 49 40	45.8	1942, 1944-51, 1970-90	8/09/42	8,600	188
01480610	Sucker Run near Coatesville, Pa.	39 58 20	75 51 06	2.57	1964-90	6/29/73	1,010	393
01480675	Marsh Creek near Glenmore, Pa.	40 05 52	75 44 31	8.57	1967-90	6/22/72	946	110

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	Station name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (mi^2)	Period	Date	Maximum discharge (ft^3/s)	Maximum discharge [(ft^3/s)/mi^2]
01480680	Marsh Creek near Lyndell, Pa.	40 03 58	75 43 38	17.8	1960-71	2/13/71	1,150	65
01480700	East Branch Brandywine Creek near Downington, Pa.	40 02 05	75 42 32	60.6	1966-90	6/22/72	8,070	133
01481000	Brandwine Creek at Chadds Ford, Pa.	39 52 11	75 35 37	287	1912-53, 1955, 1963-90	6/22/72	23,800	83
01481200	Brandywine Creek tributary near Centerville, Del.	39 50 08	75 35 57	.97	1966-75	9/13/71	405	418
01481450	Willow River at Rockland, Del.	39 47 32	75 33 16	.37	1966-75	9/13/71	620	1,680
01481500	Brandywine Creek at Wilmington, Del.	39 46 09	75 34 25	314	1947-90	6/23/72	29,000	92
01482310	Doll Run at Red Lion, Del.	39 35 53	75 39 43	1.07	1966-75	7/15/73	360	336
01483200	Blackbird Creek at Blackbird, Del.	39 21 58	75 40 10	3.85	1952-90	6/22/72	712	185
01483290	Paw Paw Branch tributary near Clayton, Del.	39 18 41	75 40 08	1.30	1966-75	6/22/72	760	585
01483400	Sawmill Branch tributary near Blackbird, Del.	39 20 57	75 38 31	.6	1966-75	7/28/69	39	65
01483500	Leipsic River near Cheswold, Del.	39 13 58	75 37 57	9.35	1943-75	9/12/60	1,340	143
01483700	St. Jones River at Dover, Del.	39 09 49	75 31 10	31.9	1958-90	9/13/60	1,900	60
01483720	Puncheon Branch at Dover, Del.	39 08 25	75 32 20	2.3	1966-75	7/13/75	520	226
01484000	Murderkill River near Felton, Del.	38 58 33	75 34 03	13.6	1932-33, 1960-85	8/04/67	2,090	154
01484002	Murderkill River tributary near Felton, Del.	38 58 19	75 33 31	.97	1966-75	8/04/67	360	371
01484050	Pratt Branch near Felton, Del.	39 00 37	75 31 46	3.29	1967-75	8/04/67	459	140
01484100	Beaverdam Branch at Houston, Del.	38 54 20	75 30 49	2.83	1958-90	9/12/60	176	62
01484270	Beaverdam Creek near Milton, Del.	38 45 41	75 16 03	6.10	1966-80	2/26/79	63	10

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	Station name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (mi^2)	Period	Date	Maximum discharge (ft^3/s)	Maximum discharge [(ft^3/s)/mi^2]
01484300	Sowbridge Branch near Milton, Del.	38 48 51	75 19 39	7.08	1957-78	8/05/67	134	19
01484500	Stockley Branch at Stockley, Del.	38 38 19	75 20 31	5.24	1943-90	2/26/79	217	41
01484550	Pepper Creek at Dagsboro, Del.	38 32 50	75 14 39	8.78	1961-75	10/24/71	545	62
01485000	Pocomoke River near Willards, Md.	38 23 20	75 19 30	60.5	1950-90	8/20/89	2,820	47
01485500	Nassawango Creek near Snow Hill, Md.	38 13 44	75 28 19	44.9	1950-90	6/30/72	1,320	29
01486000	Manokin Branch near Princess Anne, Md.	38 12 50	75 40 18	4.80	1951-90	8/20/69	547	114
01486100	Andrews Branch near Delmar, Md.	38 26 15	75 31 46	4.1	1967-76	8/22/73	191	47
01486980	Toms Dam Branch near Greenwood, Del.	38 48 04	75 33 28	5.28	1966-75	8/04/67	88	17
01487000	Nanticoke River near Bridgeville, Del.	38 43 42	75 33 44	75.4	1943-69, 1971-90	2/26/79	3,020	40
01487900	Meadow Branch near Delmar, Del.	38 29 05	75 35 16	3.47	1967-75	8/22/73	112	32
01488500	Marshyhope Creek near Adamsville, Del.	38 50 59	75 40 24	43.9	1943-68, 1972-90	7/13/75	3,700	84
01489000	Faulkner Branch near Federalsburg, Md.	38 42 44	75 47 34	7.10	1950-90	7/13/75	1,680	237
01490000	Chicamacomico River near Salem, Md.	38 30 43	75 52 51	15.0	1951-80	2/26/79	715	48
01490600	Meredith Branch near Sandtown, Del.	39 02 23	75 41 52	8.4	1966-75	8/04/67	2,140	255
01490800	Oldtown Branch at Goldsboro, Md.	39 01 23	75 47 16	3.9	1967-76	8/04/67	690	177
01491000	Choptank River near Greensboro, Md.	38 59 50	75 47 09	113	1948-90	8/04/67	6,970	62
01491010	Sangston Prong near Whiteleysburg, Del.	38 58 25	75 43 32	1.9	1966-75	8/04/67	765	403
01491050	Spring Branch near Greensboro, Md.	38 56 34	75 47 25	3.8	1967-76	8/04/67	965	254
01492000	Beaverdam Branch at Matthews, Md.	38 48 41	75 58 15	5.85	1950-81	9/12/60	2,200	376
01492050	Gravel Run at Beulah, Md.	38 40 54	75 53 53	8.4	1966-76	7/13/75	690	82

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	Station name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (mi^2)	Period	Date	Maximum discharge (ft^3/s)	Maximum discharge [(ft^3/s)/mi^2]
01492500	Sallie Harris Creek near Carmicheal, Md.	38 57 55	76 06 30	8.09	1952-81	9/12/60	1,240	153
01492550	Mill Creek near Skipton, Md.	38 55 00	76 03 42	4.6	1966-76	8/04/67	1,520	330
01493000	Unicorn Branch near Millington, Md.	39 14 59	75 51 40	22.3	1949-90	9/12/60	1,060	48
01493500	Morgan Creek near Kennedyville, Md.	39 16 48	76 00 54	12.7	1951-90	6/22/72	7,500	591
01494000	Southeast Creek at Church Hill, Del.	39 07 57	75 58 51	12.5	1952-59, 1961-65	11/02/56	1,560	125
01495000	Big Elk Creek at Elk Mills, Md.	39 39 26	75 49 20	52.6	1884, 1937-90	6/1884	18,000	342
01495500	Little Elk Creek at Childs, Md.	39 38 30	75 52 00	26.8	1949-58	8/12/55	5,400	201
01496000	Northeast Creek at Leslie, Md.	39 37 38	75 56 40	24.3	1949-84	6/22/72	4,800	198
01496080	Northeast River tributary near Charlestown, Md.	39 35 53	75 58 37	1.7	1967-76	7/20/75	700	412
01496200	Principio Creek near Principio Furnace, Md.	39 37 34	76 02 27	9.03	1967-90	8/04/69	7,060	782
01559700	Buffalo Run tributary near Manns Choice, Pa.	39 58 40	78 37 08	5.28	1962-78	7/20/77	1,120	212
01561000	Brush Creek at Gapsville, Pa.	39 57 20	78 15 15	36.8	1930-58	3/17/36	6,870	187
01563800	Elders Branch near Hustontown, Pa.	40 05 20	78 02 55	3.46	1960-78	6/22/72	540	156
01574000	West Conewago Creek near Manchester, Pa.	40 04 52	76 43 07	510	1929-90	9/26/75	96,200	189
01574500	Codorus Creek at Spring Grove, Pa.	39 52 43	76 51 13	74.3	1930-64, 1966-90	6/22/72	19,400	257
01574800	East Branch Codorus Creek tributary near Winterstown, Pa.	39 48 57	76 37 59	5.17	1961-75	5/22/75	3,,930	760
01575000	South Branch Codorus Creek near York, Pa.	39 55 14	76 44 57	117	1928-29, 1931-90	6/22/72	26,700	228

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	**Station name**	**Latitude (° ' ")**	**Longitude (° ' ")**	**Drainage area (mi^2)**	**Period**	**Date**	**Maximum discharge (ft^3/s)**	**Maximum discharge [(ft^3/s)/mi^2]**
01577500	Muddy Creek at Castle Fin, Pa.	39 46 21	76 18 58	133	1929-38, 1968-70, 1972	6/22/72	18,000	135
01578200	Conowingo Creek near Buck, Pa.	39 50 35	76 11 45	8.71	1963-89	6/29/73	3,780	434
01578400	Bowery Run near Quarryville, Pa.	39 53 41	76 06 50	5.98	1963-81	1/26/78	6,740	1,130
1578500	Octoraro Creek near Rising Sun, Md.	39 41 24	76 07 43	193	1884, 1918, 1932-50	6/1884	60,000	311
01578800	Basin Run at West Nottingham, Md.	39 39 23	76 04 30	1.3	1967-76	8/09/67	825	635
01579000	Basin Run at Liberty Grove, Md.	39 39 30	76 06 10	5.31	1949-58, 1965-76	8/09/67	3,500	659
01580000	Deer Creek at Rocks, Md.	39 37 49	76 24 13	94.4	1927-90	8/23/33	13,600	144
01581500	Bynum Run at Bel Air, Md.	39 32 30	76 19 50	8.52	1945-50, 1955-72	6/22/72	4,650	546
01581700	Winter Run near Benson, Md.	39 31 12	76 22 24	34.8	1967-90	6/22/72	7,600	218
01582000	Little Falls at Blue Mount, Md.	39 36 16	76 37 16	52.9	1933, 1945-90	6/22/72	8,280	157
01582510	Piney Creek near Hereford, Md.	39 34 38	76 40 39	1.5	1966-79	9/06/79	1,450	967
01583000	Slade Run near Glyndon, Md.	39 29 40	76 47 45	2.09	1948-81	6/22/72	515	246
01583495	Western Run tributary at Western Run, Md.	39 31 01	76 41 04	.26	1966-79	6/22/72	515	1,980
01583500	Western Run at Western Run, Md.	39 30 38	76 40 37	59.8	1945-90	6/22/72	38,000	635
01583580	Baisman Run at Broadmoor, Md.	39 28 45	76 40 42	1.47	1965-76	6/22/72	692	461
01584500	Little Gunpowder Falls at Laurel Brook, Md.	39 30 18	76 25 56	36.1	1927-73, 1975-85	7/01/84	11,800	327
01585100	WhiteMarsh Run at White Marsh, Md.	39 22 15	76 26 46	7.61	1960-90	8/01/71	8,000	1,050
01585300	West Branch Herring Run at Idlewylde, Md.	39 22 25	76 35 05	4.46	1958-87	9/11/71	1,740	390
01585400	Brien Run at Stemmers Run, Md.	39 20 01	76 28 23	1.97	1959-87	8/01/71	3,500	1,780

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	Station name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (mi^2)	Period	Date	Maximum discharge (ft^3/s)	Maximum discharge [(ft^3/s)/mi^2]
01585500	Cranberry Branch near Westminster, Md.	39 35 35	76 58 05	3.29	1949-90	9/26/75	2,220	675
01586000	North Branch Patapsco River at Cedarhurst, Md.	39 30 00	76 53 00	56.6	1946-90	6/22/72	27,800	491
01586500	North Branch Patapsco River near Reisterstown, Md.	39 26 31	76 53 14	91.0	1928-53	8/24/33	11,000	121
01587000	North Branch Patpsco River near Marriottsville, Md.	39 21 56	76 53 06	165	1930-53	8/24/33	19,500	118
01587050	Hay Meadow Branch tributary at Poplar Springs, Md.	39 20 55	77 06 02	.54	1966-76	9/11/71	630	1,170
01587500	South Branch Patapsco River at Henryton, Md.	39 21 05	76 54 50	64.4	1949-80	6/22/72	26,900	418
01588000	Piney Run near Sykesville, Md.	39 22 55	76 58 00	11.4	1932-74	6/22/72	9,700	851
01589300	Gwynns Falls at Villa Nova, Md.	39 20 45	76 44 01	32.5	1956-88	6/22/72	16,200	498
01589440	Jones Fall at Sorrento, Md.	39 23 30	76 39 42	25.2	1958-88	6/22/72	13,800	548
01590000	North River near Annapolis, Md.	38 59 09	76 37 21	8.5	1932-35, 1937-74	8/02/44	5,000	588
01590500	Bacon Ridge Branch at Chesterfield, Md.	39 00 07	76 36 53	6.92	1944-52, 1965-90	8/02/44	2,100	303
01591000	Patuxent River near Unity, Md.	39 14 18	77 03 23	34.8	1945-90	9/11/71	21,800	626
01591500	Cattail Creek at Roxbury Mills, Md.	39 15 17	77 02 43	27.7	1945-56	7/21/56	10,100	365
01592000	Patuxent River near Burtonsville, Md.	39 07 47	76 55 04	127	1911-22, 1924-43	8/24/33	11,000	87
01593350	Little Patuxent River tributary at Guilford Downs, Md.	39 13 39	76 50 41	.95	1966-67, 1969-76	6/22/72	620	653
01593500	Little Patuxent River at Guilford Md.	39 10 04	76 51 07	38.0	1933-90	6/22/72	12,400	326
01594000	Little Patuxent River at Savage, Md.	39 08 00	76 48 58	98.4	1940-64, 1972, 1975-90	6/22/72	35,400	360
01594400	Dorsey Run near Jessup, Md.	39 07 15	76 47 00	11.6	1949-62, 1964-68	8/13/55	1,400	121

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	Station name	Latitude (° ’ ")	Longitude (° ’ ")	Drainage area (mi^2)	Period	Date	Maximum discharge (ft^3/s)	Maximum discharge [(ft^3/s)/mi^2]
01594445	Mill Branch near Mitchellville, Md.	38 55 44	76 43 03	1.19	1967-76	8/02/69	545	495
01594500	Western Branch near Largo, Md.	38 52 24	76 47 54	30.2	1950-74	8/27/71	1,760	58
01594600	Cocktown Creek near Huntingtown, Md.	38 38 27	76 38 07	3.85	1958-76	6/14/60	1,120	291
01594800	St. Leonard Creek near St. Leonard, Md.	38 26 57	76 29 43	6.73	1958-68	7/30/60	288	43
01595000	North Branch Potomac River at Steyer, Md.	39 18 07	79 18 26	73.0	1957-90	11/05/85	11,500	158
01595300	Abram Creek at Oakmont, W. Va.	39 22 00	79 10 45	47.3	1955, 1957-82	6/18/55	3,830	81
01595500	North Branch Potomac River at Kitzmiller, Md.	39 23 38	79 10 55	225	1950-90	11/05/85	50,400	224
01596000	North Branch Potomac River at Bloomington, Md.	39 28 48	79 04 08	287	1924-27, 1930-50, 1955	10/15/54	37,400	130
01596500	Savage River near Barton, Md.	39 34 05	79 06 10	49.1	1949-90	10/15/54	7,510	153
01597000	Crabtree Creek near Swanton, Md.	39 30 00	79 09 35	16.7	1949-81	7/12/49	3,260	195
01598000	Savage River at Bloomington, Md.	39 29 00	79 04 24	115	1925-27, 1930-50	3/17/36	14,800	129
01599000	Georges Creek at Franklin, Md.	39 29 38	79 02 42	72.4	1931-90	3/17/36	8,500	117
01599500	New Creek near Keyser, W. Va.	39 24 35	79 00 05	45.7	1931, 1948-63, 1965-69	8/18/55	3,110	68
01600000	North Branch Potomac River at Pinto, Md.	39 33 59	78 50 25	596	1924, 1936-50	3/29/24	55,000	92
01600700	Little Wills Creek at Bard, Pa.	39 55 35	78 39 40	10.2	1961-81	9/29/67	1,100	108
01601500	Wills Creek near Cumberland, Md,	39 40 07	78 47 18	247	1930-90	3/17/36	38,100	154
01603000	North Branch Potomac River near Cumberland, Md.	39 37 16	78 46 24	875	1889, 1924, 1930-81	6/1/1889	89,000	102
01603500	Evitts Creek near Centerville, Pa.	39 47 23	78 38 48	30.2	1933-82	3/17/36	5,240	174

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	Station name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (mi^2)	Period	Date	Maximum discharge (ft^3/s)	Maximum discharge [(ft^3/s)/mi^2]
01604500	Patterson Creek near Headsville, W. Va.	39 26 35	78 49 20	219	1939-90	8/19/55	16,000	73
01608400	Buffalo Creek near Romney, W. Va.	39 22 18	78 43 51	4.37	1970-77	10/08/76	463	106
01609000	Town Creek near Oldtown, Md.	39 33 12	78 33 19	148	1928-36, 1968-81	3/17/36	27,000	182
01609500	Sawpit Run near Oldtown, Md.	39 32 48	78 33 20	5.08	1948-58, 1963-76	10/15/54	770	152
01609800	Little Cacapon River near Levels, W. Va.	39 29 55	78 29 20	108	1967-77	6/22/72	10,500	97
01610105	Pratt Hollow tributary at Pratt, Md.	39 41 35	78 30 18	.70	1971-86	6/22/72	110	157
01610150	Bear Creek at Forest Park, Md.	39 42 07	78 19 02	10.4	1965-69, 1971-83	6/22/72	1,450	139
01610155	Sideling Hill Creek near Bellegrove, Md.	39 38 58	78 20 40	102	1968-77	6/22/72	14,200	139
01612500	Little Tonoloway Creek near Hancock, Md.	39 42 45	78 13 55	16.9	1948-64	10/15/54	1,470	87
01613000	Potomac River at Hancock, Md.	39 41 49	78 10 39	4,073	1889, 1924, 1929, 1933-90	3/18/36	340,000	83
01613050	Tonoloway Creek near Needmore, Pa.	39 53 54	78 07 57	10.7	1963-90	6/22/72	1,300	121
01613150	Ditch Run near Hancock, Md.	39 41 30	78 07 57	4.8	1965-86	8/04/78	650	135
01613160	Potomac River tributary near Hancock, Md.	39 41 27	78 07 38	1.2	1965-76	10/29/73	250	208
01613500	Licking Creek near Sylvan, Pa.	39 43 20	78 03 52	158	1931-41	3/18/36	20,700	131
01613900	Hogue Creek near Hayfield, Va.	39 12 52	78 17 18	15.0	1961-90	6/22/72	2,760	184
01614000	Back Creek near Jones, W. Va.	39 30 43	78 02 15	243	1929-31, 1936, 1939-75	10/15/42	22,400	92
01614500	Conococheague Creek at Fairview, Md.	39 42 57	77 49 28	494	1889, 1924, 1929-90	6/23/72	32,400	66
01615000	Opequon Creek near Berryville, Va.	39 10 40	78 04 20	57.4	1944-90	5/18/88	12,600	220

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	Station name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (mi^2)	Period	Date	Maximum discharge (ft^3/s)	Maximum discharge [$(ft^3/s)/mi^2$]
01616000	Abrams Creek near Winchester, Va.	39 10 40	78 05 10	16.5	1950-60, 1979-90	5/18/88	1,220	74
01616500	Opequon Creek near Martinsburg, W. Va.	39 25 25	77 56 20	272	1906, 1948-90	6/22/72	19,000	70
01617000	Tuscarora Creek above Martinsburg, W. Va.	39 28 10	77 58 18	11.3	1949-63, 1968-77	6/27/75	610	54
01617800	Marsh Run at Grimes, Md.	39 30 53	77 46 38	18.9	1964-68, 1970-90	2/12/85	459	24
01618000	Potomac River at Shepherdstown, W. Va.	39 26 04	77 48 07	5,936	1889, 1924, 1929-90	6/1/1889	290,000	49
01619000	Antietam Creek near Waynesboro, Pa.	39 42 59	77 36 28	93.5	1949-51, 1966-81	6/22/72	5,430	58
01619475	Dog Creek tributary near Locust Grove, Md.	39 27 57	77 39 31	.10	1966-76	8/07/67	110	1,100
01619500	Antietam Creek near Sharpsburg, Md.	39 27 01	77 43 52	281	1928-90	7/20/56	12,600	45
01637000	Little Catoctin Creek at Harmony, Md.	39 28 54	77 32 17	8.83	1948-77	8/20/52	5,400	612
01637500	Catoctin Creek near Middletown, Md.	39 25 35	77 33 25	66.9	1948-90	10/09/76	12,000	179
01637600	Hollow Road Creek near Middletown, Md.	39 26 07	77 31 15	2.3	1965-74, 1977	10/09/76	2,000	870
01638480	Catoctin Creek at Taylorsville, Va.	39 15 18	77 34 36	89.6	1972-90	6/22/72	23,800	266
01638500	Potomac River at Point of Rocks, Md.	39 16 25	77 32 25	9,651	1889, 1895-1990	3/19/36	480,000	50
01638900	White Run near Gettysburg, Pa.	39 47 45	77 11 50	12.4	1961-80	6/22/72	4,360	352
01639000	Monocacy River at Bridgeport, Md.	39 40 43	77 14 06	173	1933, 1942-90	8/24/33	23,000	133
01639095	Piney Creek tributary at Taneytown, Md.	39 39 53	77 09 59	.62	1967-76	9/26/75	300	484
01639500	Big Pipe Creek at Bruceville, Md.	39 36 45	77 14 10	102	1948-90	9/26/75	28,000	275
01640000	Little Pipe Creek at Avondale, Md.	39 33 40	77 02 38	8.10	1948-56, 1959-62, 1964, 1967-80	6/22/72	2,400	296
01640500	Owens Creek at Lantz, MD.	39 40 36	77 27 50	5.93	1932-84	12/01/34	3,270	551

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	Station name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (mi^2)	Period	Date	Maximum discharge (ft^3/s)	Maximum discharge [(ft^3/s)/mi^2]
01640700	Owens Creek tributary near Rocky Ridge, Md.	39 37 16	77 20 26	1.2	1967-77	10/09/76	1,370	1,140
01641000	Hunting Creek at Jimtown, Md.	39 35 40	77 23 50	18.4	1950-90	10/09/76	2,670	145
01641500	Fishing Creek near Lewistown, Md.	39 31 35	77 28 00	7.29	1948-84	10/09/76	2,200	302
01642000	Monocacy River near Frederick, Md.	39 27 09	77 22 16	665	1889, 1897-1930	6/1889	46,000	69
01642400	Dollyhyde Creek at Libertytown, Md.	39 28 55	77 13 38	2.7	1967-76	6/21/72	1,620	600
01642500	Linganore Creek near Frederick, Md.	39 24 55	77 20 00	82.3	1933-72	6/22/72	20,100	244
01643000	Monocacy River at Jug Bridge near Frederick, Md.	39 24 13	77 21 58	817	1889, 1930-90	6/23/72	81,600	100
01643500	Bennett Creek at Park Mills, Md.	39 17 40	77 24 30	62.8	1949-58, 1960-90	6/21/72	32,200	513
01643700	Goose Creek near Middleburg, Va.	38 59 11	77 47 49	123	1966-67, 1970-90	6/22/72	19,200	156
01644000	Goose Creek near Leesburg, Va.	39 01 10	77 34 40	332	1889, 1910-12, 1930-61, 1963-90	6/22/72	78,100	235
01644100	South Fork Sycolin Crek near Leesburg, Va.	39 04 15	77 36 35	2.05	1966-76	6/21/72	1,130	551
01644291	Stave Run near Reston, Va.	38 56 56	77 22 16	.08	1972-81	8/13/78	281	3,510
01644420	Bucklodge Branch tributary near Barnesville, Md.	39 12 42	77 21 02	.27	1967-76	6/21/72	396	1,470
01645000	Seneca Creek at Dawsonville, Md.	39 07 41	77 20 13	101	1931-90	6/22/72	26,100	258
01645700	Difficult Run near Fairfax, Va.	38 52 29	77 20 18	4.29	1950-68, 1970	8/24/67	1,180	275
01646000	Difficult Run near Great Falls, Va.	38 58 33	77 14 46	57.9	1935-90	6/22/72	32,200	556
01646200	Scott Run near McLean, Va.	38 57 32	77 12 21	4.69	1961-72	9/14/66	3,560	759
01646500	Potomac River near Washington, D.C.	38 56 58	77 07 40	11,560	1931-90	3/19/36	484,000	42

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	Station name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (mi^2)	Period	Date	Maximum discharge (ft^3/s)	Maximum discharge [($ft^3/s)/mi^2$]
01647720	North Branch Rock Creek near Norbeck, Md.	39 06 59	77 06 09	9.73	1967-77	6/22/72	10,100	1,040
01650050	Northwest Branch Anacostia River at Norwood, Md.	39 07 36	77 01 15	2.45	1967-76	6/21/72	3,750	1,530
01650085	Nursery Run at Cloverly, Md.	39 07 05	77 00 24	.35	1967-76	6/21/72	695	1,990
01650190	Batchellors Run at Oakdale, Md.	39 07 21	77 03 37	.47	1967-76	7/15/75	750	1,600
01650500	Northwest Branch Anacostia River near Colesville, Md.	39 03 55	77 01 48	21.1	1924-83	6/22/72	11,000	521
01653600	Piscataway Creek at Piscataway, Md.	38 42 20	76 58 00	39.5	1966-90	9/06/79	8,500	215
01654000	Accotink Creek near Annandale, Va.	38 48 46	77 13 43	23.5	1947-89	6/22/72	12,000	511
01655350	Pohick Creek near Springfield, Va.	38 45 26	77 13 37	15.0	1961-70	8/25/67	3,510	234
01656000	Cedar Run near Catlett, Va.	38 38 12	77 37 31	93.4	1951-90	6/22/72	38,600	413
01656500	Broad Run at Buckland, Va.	38 46 50	77 40 22	50.5	1951-86	6/21/72	16,800	333
01656600	Broad Run tributary at Buckland, Va.	38 46 50	77 40 15	.79	1966-75	6/21/72	575	728
01656700	Occoquan River near Manassas, Va.	38 42 19	77 26 46	343	1969-81	6/22/72	57,400	167
01656725	Bull Run near Catharpin, Va.	38 53 21	77 34 14	25.8	1970-86	6/22/72	39,400	1,530
01657000	Bull Run near Manassas, Va.	38 47 50	77 27 28	148	1951-81	6/22/72	76,100	514
01658000	Mattawoman Creek near Pomonkey, Md.	38 35 45	77 03 25	54.8	1950-86	8/13/55	9,300	170
01658500	South Fork Quantico Creek near Independent Hill, Va.	38 35 14	77 25 44	7.64	1952-90	6/21/72	3,940	516
01660900	Wolf Den Branch near Cedarville, Md.	38 38 29	76 49 02	2.3	1967-80	9/25/75	750	326
01660930	Clark Run near Bel Alton, Md.	38 28 21	76 57 22	11.2	1966-76	6/22/72	4,800	462
01661000	Chaptico Creek at Chaptico, Md.	38 22 45	76 46 56	10.4	1948-72	9/10/50	7,800	729

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	Station name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (mi^2)	Period	Date	Maximum discharge (ft^3/s)	Maximum discharge [(ft^3/s)/mi^2]
01661050	St. Clement Creek near Clements, Md.	38 20 00	76 43 31	18.5	1969-88, 1990	6/22/72	4,350	235
01661430	Glebe Branch at Valley Lee, Md.	38 11 40	76 31 13	.30	1968-78	8/20/69	110	367
01661500	St. Marys River at Great Mills, Md.	38 14 36	76 30 13	24.0	1947-90	8/20/69	7,950	331
01661600	Great Wicomico River near Horses Head, Va.	37 53 15	76 27 00	6.98	1970-73 1977-90	6/03/79	1,950	279
01661800	Bush Mill Stream near Heathsville, Va.	37 52 36	76 29 42	6.82	1964-87	8/20/69	450	66
01664800	Harpers Run near Morrisville, Va.	38 31 00	77 43 05	2.28	1966-75	6/21/72	1,900	833
01665200	Rock Run tributary near Goldvein, Va.	38 27 45	77 40 10	1.00	1966-75	6/21/72	536	536
01668200	Gingoteague Run near Port Royal, Va.	38 12 40	77 09 10	2.82	1966-74	6/22/72	388	138
01668300	Farmers Hall Creek near Champlain, Va.	38 00 05	76 58 40	2.18	1966-90	8/20/69	510	234
01669000	Piscataway Creek near Tappahannock, Va.	37 52 37	76 54 03	28.0	1952-90	8/20/69	2,380	85
01669300	Yorkers Swamp near Center Cross, Va.	37 47 10	76 45 55	1.37	1966-75	6/22/72	142	104
01669500	Dragon Swamp near Church View, Va.	37 41 05	76 43 37	84.9	1944-81	9/06/79	4,910	58
01674000	Mattaponi River near Bowling Green, Va.	38 03 42	77 23 10	257	1928, 1943-90	8/0/1928	15,000	58
03039200	Clear Run near Buckstown, Pa.	40 02 49	78 50 00	3.68	1961-78	7/20/77	366	99
03062500	Deckers Creek at Morgantown, W. Va.	39 37 45	79 57 10	63.2	1947-69	8/05/56	5,680	90
03063600	Horsecamp Run at Harmon, W. Va.	38 54 51	79 30 32	6.57	1970-77	12/26/73	760	116
03066000	Blackwater River at Davis, W. Va.	39 07 35	79 28 10	86.2	1922-90	11/05/85	12,500	145
03069850	Long Run near Parson, W. Va.	39 15 32	79 43 18	.95	1967-77	8/10/69	205	216
03069880	Buffalo Creek near Rowlesburg, W. Va.	39 17 19	79 42 16	12.2	1968-77	9/13/71	2,690	220
03070500	Big Sandy Creek at Rockville, W. Va.	39 37 15	79 42 20	200	1888, 1910-13, 1915-17, 1922-90	7/10/1888	30,000	150

Table 9. *Maximum discharges at selected streamflow-gaging stations--Continued*

Station no.	Station name	Latitude (° ' ")	Longitude (° ' ")	Drainage area (mi^2)	Period	Date	Maximum discharge (ft^3/s)	Maximum discharge [$(ft^3/s)/mi^2$]
03072590	Georges Creek at Smithfield, Pa.	39 47 44	79 47 47	16.3	1964-78	6/23/72	1,640	101
03074300	Lick Run at Hopwood, Pa.	39 52 04	79 41 40	3.80	1959-78	6/23/72	690	182
03074500	Redstone Creek at Waltersburg, Pa.	39 58 48	79 45 52	73.7	1943-90	6/23/72	8,660	118
03075450	Little Youghiogheny River tributary near Deer Park, Md.	39 24 37	79 21 00	.57	1965-76	6/29/72	40	70
03075500	Youghiogheny River near Oakland, Md.	39 25 19	79 25 32	134	1942-90	10/16/54	11,800	88
03075600	Toliver Run tributary near Hoyes Run, Md.	39 29 39	79 25 14	.53	1965-86	4/05/84	195	368
03076505	Youghiogheny River tributary near Friendsville, Md.	39 39 48	79 25 42	.22	1965-76	5/18/74	18	82
03076600	Bear Creek at Friendsville, Md.	39 39 22	79 23 41	48.9	1965-90	9/14/71	4,650	95
03077700	North Branch Casselman River tributary at Foxtown, Md.	39 37 58	79 14 36	1.0	1965-76	9/14/71	84	84
03078000	Casselman River at Grantsville, Md.	39 42 08	79 08 12	62.5	1948-90	10/15/54	8,400	134
03078500	Big Piney Run near Salisbury, Pa.	39 43 34	79 02 55	24.5	1933-70, 1974-86	10/15/54	6,850	280
03079000	Casselman River at Markleton, Pa.	39 51 35	79 13 40	382	1915-90	10/15/54	50,000	131
03080000	Laurel Hill Creek at Ursina, Pa.	39 49 22	79 19 14	121	1914-90	10/15/54	10,900	90
03082200	Poplar Run near Normalville, Pa.	40 00 59	79 25 33	9.27	1962-78	9/14/71	1,890	204