Low-Flow Characteristics of Streams in North Carolina

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Prepared in cooperation with the North Carolina Department of Environment, Health, and Natural Resources

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By G.L. GIESE and ROBERT R. MASON, Jr.

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PLATES

[Plates are in pocket]

FIGURES

TABLES

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
	Length	
inch (in)	25 4	millimeter (mm)
foot (ft)	0 3048	meter (m)
mile (mi)	1 609	kilometer (km)
	Area	
square mile (mi^2)	2 590	square kilometer (km^2)
	Volume	
cubic foot (ft^3)	0 02832	cubic meter (m^3)
	Gradient	
foot per mile (ft/mi)	0 1894	meter per kilometer (m/km)
	Flow	
cubic foot per second (ft^3/s)	0 02832	cubic meter per second (m^3/s)
cubic foot per second per square mile ($[ft^3/s]/mi^2$)	0 01093	cubic meter per second per square kilometer ($[m^3/s]/km^2$)

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

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By G L Giese *and* Robert R Mason, Jr

Abstract

Ten low-flow hydrologic areas were defined for North Carolina by relating topography, geology, mean annual runoff, and other features to low-flow frequency characteristics for 122 continuous-record streamflow stations and 396 partial-record streamflow stations Regression equations relating low-flow characteristics to mean annual discharge or drainage area were developed for five of the hydrologic areas covering 40 percent of the State, and statistical summaries of low-flow characteristics are given for all 10 hydrologic areas

Low-flow characteristics selected for analysis were (1) the low-flow 7Q10, which is the annual minimum 7-day consecutive low flow, which on average, will be exceeded in 9 out of 10 years—or stated another way, the probability is 10 percent that the lowest 7-day consecutive flow in any year will be less than the 7Q10; (2) the low-flow W7Q10, which is similar to the low-flow 7Q10, except that it takes into account only the months from November through March, (3) the low-flow 7Q2, and (4) the low-flow 30Q2 Low-flow 7Q10's ranged from zero in some hydrologic areas in the Coastal Plain and Piedmont physiographic areas to a maximum value of 1 06 cubic feet per second per square mile for a station in the western Piedmont and mountains physiographic area

INTRODUCTION

Statistics describing the magnitude and frequency of recurrence of low streamflows are useful in evaluating reservoir release requirements, determining allowable waste-discharge loadings, and estimating biological potential of stream reaches Low flow of streams, as discussed in this report, is equivalent to base flow, or sustained fair weather flow of streams under natural conditions Base flow is composed of ground-water discharge—the spatial and temporal variations of which are largely dependent on geologic, topographic, and climatic conditions in a drainage basin In North Carolina, lowest streamflows usually occur near the end of the growing season in September, October, and November After the end of the growing season, water demand by vegetation is sharply reduced, and water which would formerly have been taken up by plants becomes available to increase base flow to streams

Low-flow characteristics can be generated for sites where sufficient continuous or partial records of streamflow are available, using techniques such as those described by Riggs (1972) Goddard (1963) reported low-flow characteristics for hundreds of specific sites in North Carolina for which continuous records of streamflow were available, and Yonts (1971) reported results of low-flow measurements at 2,250 other sites However, low-flow information commonly is needed on a timely basis at sites where suitable streamflow records are lacking

This report, prepared in cooperation with the North Carolina Department of Environment, Health, and Natural Resources (EHNR), formerly the Department of Natural Resources and Community Development, presents techniques that can be used to estimate low-flow characteristics for natural conditions at sites on North Carolina streams for which suitable streamflow records are not available The study approach was to (1) compile a data base of selected low-flow characteristics, (2) subdivide the State into hydrologic areas (pl 1) where the geologic, topographic, or climatic properties that influence low flows are relatively uniform, and (3) present the low-flow characteristics of those hydrologic areas in terms of cubic feet per second per square mile and, where possible, present regression equations useful for estimating low-flow characteristics

LOW-FLOW DATA BASE

The initial data base used for this study consisted of streamflow records for 172 continuous-record stations and flow measurements for 479 partial-record stations The 1987 climatic year (April 1, 1987, through March 31, 1988) was the last year considered for this analysis Low-flow frequency characteristics were generated for continuous-record gaging stations by examining a series of annual minimum average flows for the lowest 7 and 30 consecutive days of each climatic year and each winter period (November 1 to March 31) for stations with 8 or more years of record The values in each of the series were ranked from smallest to largest and subjected to frequency analyses using the log-Pearson type III distribution The low-flow statistics selected for compilation and analyses from the frequency distribution were (1) the low-flow 7Q10, which is the annual minimum 7-day consecutive low flow that on average will be exceeded in 9 out of 10 years—or stated another way, the probability is 10 percent that the 7-day consecutive low flow in any year will be less than the 7Q10, (2) the low-flow W7Q10, which is similar to the low-flow 7Q10, except that it takes into account only the winter months from November through March; (3) the low-flow 7Q2, and (4) the low-flow 30Q2 The low-flow 7Q10, 30Q2, and W7Q10 statistics were selected for inclusion in this study because these statistics are used by the Division of Environmental Management of EHNR to evaluate waste-discharge permit applications The low-flow 7Q2 statistic was selected because it is used in draft-storage-frequency analyses in reservoir design in the State (Arteaga and Hubbard, 1975)

The results of the log-Pearson type III analyses were screened for errors or inaccuracies in fitting Fitted log-Pearson curves were reviewed to detect and adjust for outliers Stations where values for low-flow characteristics may have been affected by streamflow regulation or diversion were eliminated from the analysis, as were all stations at stream sites with drainage areas greater than 400 square miles (mi^2) Most streams draining areas larger than this are affected by some type of regulation or diversion, or drain more than one hydrologic area

Available low-flow characteristics for partial-record sites at which five or more base-flow measurements were made were also used in the data base These base-flow measurements were plotted against concurrent base flows at nearby long-term continuous-record stations for which low-flow characteristics had been computed, as illustrated for sites on Big Shoe Heel Creek and Drowning Creek in figure 1 Lines of relation were drawn for each pair of stations Low-flow characteristics for the partial-record sites were then determined from the graphical relation and corresponding statistics for the continuous-record site

Once low-flow hydrologic areas were defined, gaging stations measuring substantial flow from more than one hydrologic area were eliminated from the data base The final data base consisted of 122 continuous-record streamflow sites and 396 partial-record streamflow measurement sites The locations of these sites are shown on plate 1 Index numbers shown on plate 1 correspond to site numbers in table 1 (at the end of the report), which provides estimated low-flow frequency characteristics

LOW-FLOW HYDROLOGIC AREAS

The strategy of dividing the State into hydrologic areas precluded the necessity to account for variations across the State in difficult-to-quantify geologic, topographic, and climatic variables, this reduces the probable errors in the regression equations This approach generally leads to simple, easy to apply equations with few variables Yet, the complexities of the situation with regard to low flows are not ignored, provided that the hydrologic areas are carefully selected with regard to geologic, topographic, and climatic variables that can reasonably be expected to influence low flows, and also provided that these variables are constant (or at least vary within narrow limits) within each hydrologic area

As the first step in defining hydrologic areas, the four low-flow characteristics for the initial 651 sites (pl 1) were plotted on State maps in terms of

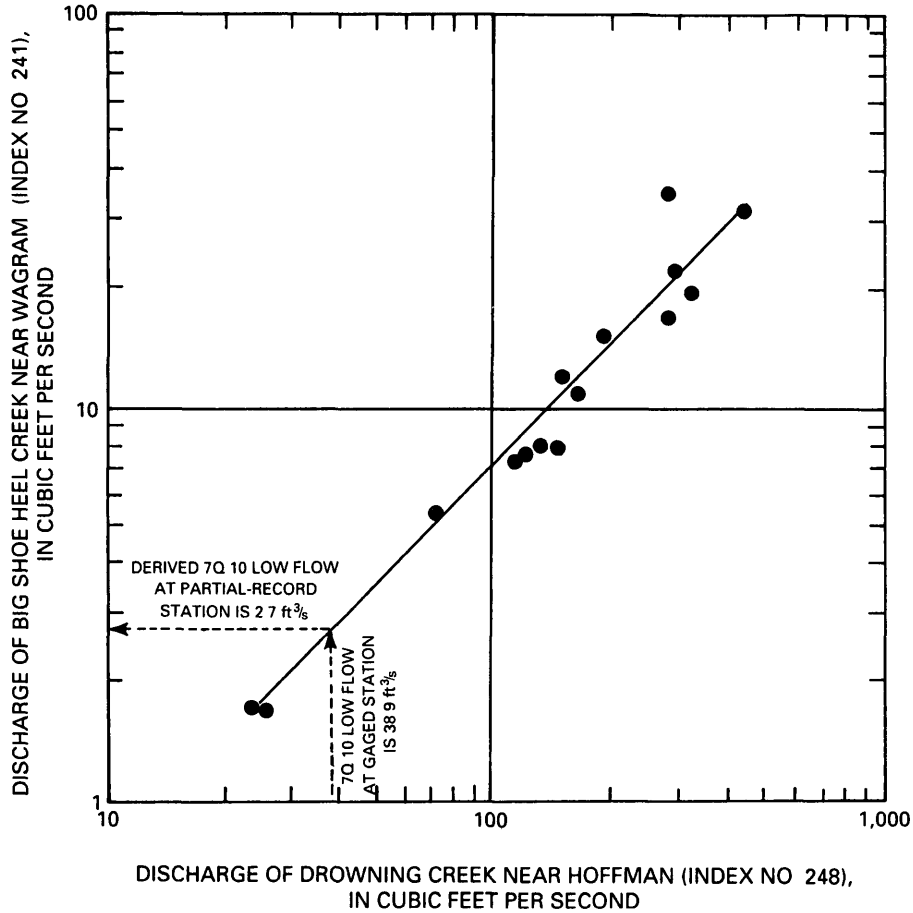

Figure 1. Relation of base-flow measurements of Big Shoe Heel Creek near Wagram, N C , to concurrent daily mean flows of Drowning Creek near Hoffman, N C

cubic feet per second per square mile ($[ft^3/s]/mi^2$), and areas of similar low-flow values were delineated Next, maps showing topography, geology, mean annual precipitation, mean annual runoff, soil type, and yield of wells by rock type were compared visually with the low-flow maps to identify situations where areas of similar low-flow characteristics coincided with areas of similar geology, topography, or climate For example, the Sand Hills area of the Coastal Plain (defined as hydrologic area HA3 as shown in pl 1) coincided with an area on the flow map where low-flow characteristics were much higher than the surrounding area This variation suggested that an area delineated by the Sand Hills would be a meaningful hydrologic area The most useful tools in making initial delineations of hydrologic areas were a State geologic map (Brown and Parker, 1985), well yields for different rock types and topographic settings for more than 6,000 wells in the Piedmont and Blue Ridge Provinces (Daniel, 1989), a map showing hydrogeologic units (Daniel and Payne, 1990), and a generalized soils map of North Carolina (Winner and Coble, 1989, modified from Tant and others, 1974).

Flow characteristics for preliminary subdivisions were subjected to statistical tests of variance and analyses of residuals from statewide regression equations to (1) test the validity of the hydrologic areas initially delineated and (2) determine which areas could be combined or further subdivided In this way, 10 final hydrologic areas (HA1-HA10) were identified in North Carolina (pl 1), forming, in most instances, southwest-northeast bands across the State. These hydrologic areas lie within three broad physiographic areas—the Coastal Plain, the eastern and central Piedmont, and the western Piedmont and mountains (pl 1) These physiographic areas correspond roughly to Fenneman's (1938) physiographic provinces named Coastal Plain, Piedmont, and Blue Ridge. However, boundaries of physiographic areas described in this report differ slightly in some areas from delineations of Fenneman's physiographic provinces Hence, the term physiographic areas is used in this report to avoid implying identity with Fenneman's physiographic provinces

Ranges of low-flow characteristics computed for the 10 respective hydrologic areas are summarized in table 2 This table lists the number of sites with drainage areas less than 400 mi^2 that were analyzed in each hydrologic area and shows the maximum, 75th-, 50th-, and 25th-percentile, and the minimum low-flow values expressed in cubic feet per second per square mile for each of the four low-flow frequency characteristics Table 2 also shows the estimated drainage area below which the indicated low-flow characteristic generally has a zero value, as determined from the drainage-area axis intercept of arithmetic bivariate plots of low-flow characteristics and drainage area The maximum and minimum values are the extremes of the low-flow characteristics computed for a hydrologic area For example, 0 694 $(ft^3/s)/mi^2$ was the maximum 7Q10 value computed for the 24 stations analyzed in hydrologic area HA3 The 75th-, 50th-, and 25th-percentile values are the low-flow characteristics that were not exceeded by the indicated percentage of stations in a hydrologic area For example, 75 percent of the 38 stations analyzed in the sandy soils hydrologic area, HA2, have 7Q10 values less than or equal to 0 022 $(ft^3/s)/mi^2$

The following discussions describe in more detail hydrologic, geologic, topographic, and climatic features of the 10 hydrologic areas as they relate to low-flow frequency characteristics The names given to most hydrologic areas correspond to commonly used geologic names such as those used by Brown and Parker (1985), however, boundaries of some units differ somewhat from those commonly used because subdivisions made in this report were based upon topographic, climatic, and hydrologic factors as well as geologic considerations

Coastal Plain Physiographic Area

The Coastal Plain physiographic area (pl 1), as delineated for this report, covers approximately 18,200 mi^2 in eastern North Carolina Its western limit coincides roughly with the boundary between Fenneman's (1938) Coastal Plain and Piedmont provinces, except where the Eastern Slate Belt hydrologic area (HA4 in pl 1) forms its western boundary The geology of the area consists of alternating layers of sand, silt, clay, and limestone that thicken and dip eastward With few exceptions, notably the Sand Hills hydrologic area (HA3), topographic relief in the Coastal Plain physiographic area is minimal, and the land surface dips coastward at a rate of only a few feet per mile Mean annual precipitation in the area ranges from 46 to 54 in (Eder and others, 1983)

For this report, the Coastal Plain physiographic area was divided into three hydrologic areas, mostly on the basis of soil types and topography clay soils (HA1), sandy soils (HA2), and the Sand Hills (HA3) As indicated in table 2, the clay soils hydrologic area (HA1) tends to have the lowest values of low-flow characteristics of the three hydrologic areas (median 7Q10 value is 0 $[ft^3/s]/mi^2$), sandy soil (HA2) has intermediate values (median 7Q10 value is 0 006 $[ft^3/s]/mi^2$), and the Sand Hills (HA3) has much higher values (median 7Q10 value is 0 318 $[ft^3/s]/mi^2$) Low-flow characteristics of mixed soils (pl 1) composed of variable percentages of sand and clay are not given explicitly in this report but could be expected to have low-flow characteristics ranging between those of clay soils and those of sandy soils

The clay soils and sandy soils hydrologic areas (HA1 and HA2) cover areas in the Coastal Plain physiographic area of about 8,400 and 8,000 mi^2, respectively Local topographic relief in both these areas is commonly only 1 or 2 feet per mile (ft/mi) and maximum land-surface altitude is about 150 ft above sea level Because the water table in most humid areas is a more or less subdued version of the land surface, this low topographic relief is reflected in low hydraulic gradients with less potential to move water to streams than in other areas of the State where topographic relief and hydraulic gradients are much greater The lower values for low-flow characteristics for clay soils as compared to sandy soils (table 2) result partly from the lower permeability of clay soils, a higher percentage of precipitation that falls on clay soils is rejected as recharge and runs off directly to streams. Additionally, clay soils have much lower hydraulic conductivity than do sandy soils and, thus, contribute less water to base flow of streams than do sandy soils

The Sand Hills hydrologic area (HA3) consists of rolling sand hills and covers about 1,800 mi^2 in the southwestern Coastal Plain Local topographic

Table 2. Summary of low-flow frequency characteristics of unregulated streams draining less than 400 square miles in North Carolina, by hydrologic area

[(A), lower drainage area limit of zero flow not determined, but probably less than 0 5 square mile]

Hydrologic area name and number	Number of sites	Low-flow charac-teristics	Flow, in cubic feet per second per square mile					Drainage area, in square miles, below which indicated low-flow statistic generally has a zero value
			Maximum	75th per-centile	50th per-centile	25th per-centile	Minimum	
Coastal Plain physiographic area								
Clay soils (HA1)	11	7Q10	0 019	0 002	0 000	0 000	0 000	35
		W7Q10	060	010	008	000	000	3
		7Q2	028	012	001	000	000	2
		30Q2	053	032	010	000	000	2
Sandy soils (HA2)	38	7Q10	135	022	006	001	000	2
		W7Q10	340	104	065	015	000	2
		7Q2	250	083	043	009	000	2
		30Q2	340	152	090	034	002	2
Sand Hills (HA3)	24	7Q10	694	489	318	212	112	(A)
		W7Q10	1 053	711	600	508	221	(A)
		7Q2	876	618	495	391	217	(A)
		30Q2	1 053	789	637	504	320	(A)
Eastern and central Piedmont physiographic area								
Eastern Slate Belt (HA4)	4	7Q10	0 007	0 005	0 000	0 000	0 000	18
		W7Q10	065	065	045	007	000	8
		7Q2	063	060	038	007	000	8
		30Q2	140	130	083	016	000	8
Raleigh Belt (HA5)	25	7Q10	216	123	065	016	004	2
		W7Q10	432	256	177	109	044	2
		7Q2	378	248	187	092	048	(A)
		30Q2	486	330	269	154	095	(A)
Triassic Basin (HA6)	10	7Q10	004	000	000	000	000	45
		W7Q10	015	005	000	000	000	15
		7Q2	015	004	000	000	000	22
		30Q2	025	014	005	001	000	13
Carolina Slate Belt (HA7)	58	7Q10	131	015	005	000	000	3
		W7Q10	223	079	048	013	000	1
		7Q2	211	069	038	016	000	1
		30Q2	254	104	071	028	000	1
Carolina Slate Belt (argillite zone) (HA8)	9	7Q10	009	007	001	000	000	12
		W7Q10	026	017	007	005	001	(A)
		7Q2	035	019	007	006	000	5
		30Q2	060	029	014	010	002	(A)
Charlotte Belt and Milton Belt (HA9)	38	7Q10	160	104	064	031	000	1
		W7Q10	330	232	164	090	027	1
		7Q2	304	210	149	088	026	1
		30Q2	365	271	201	125	045	1
Western Piedmont and mountains physiographic area								
Western Piedmont and mountains (HA10)	301	7Q10	1 062	0 451	0 317	0 200	0 000	(A)
		W7Q10	1 357	583	448	338	098	(A)
		7Q2	1 585	716	548	387	046	(A)
		30Q2	1 819	851	671	475	180	(A)

relief of 50–200 ft/mi is common in HA3, and maximum altitude reaches more than 700 ft above sea level The role of topographic relief in determining low-flow characteristics of streams is underscored by a comparison of the Sand Hills hydrologic area (HA3) with the Coastal Plain sandy soils hydrologic area (HA2) The major difference in the two areas with respect to factors that may influence low-flow characteristics is that topographic relief and hydraulic gradients are generally much higher in the Sand Hills hydrologic area (HA3) Otherwise, the two areas are similar with respect to characteristics that could reasonably be expected to affect low-flow characteristics The primary aquifer material is sand in each case Climate and average annual precipitation are about the same, with the Sand Hills actually receiving slightly less precipitation than the average for the entire Coastal Plain Nevertheless, low-flow characteristics given in table 2 are much higher for the Sand Hills hydrologic area (HA3) than for the Coastal Plain sandy soils hydrologic area (HA2) For example, the median (50th percentile) 7Q10 value listed in table 2 for 24 sites in hydrologic area HA3 is 0 318 $(ft^3/s)/mi^2$, the highest in the State For hydrologic area HA2, the median value for 38 sites is only 0 006 $(ft^3/s)/mi^2$

In swampy lands in hydrologic areas HA1 and HA2, which otherwise have good potential for agricultural development, stream channelization is a widespread practice Although this report gives estimates of low-flow characteristics of streams for natural conditions only, it is worthwhile to note that several studies (Heath, 1975, Winner and Simmons, 1977, Daniel, 1981, Mason and others, 1990) have shown that in swampy areas where the water table is at or near land surface, channelization results in both a deeper stream channel and lower stream stage The deeper channel causes the ground-water gradient to increase toward the stream which, in turn, results initially in greater ground-water discharge than would have occurred prior to channelization This channel deepening also allows an additional part of the shallow aquifer that would not have been dewatered prior to channelization to be dewatered between recharge Hence, in some cases, base flow in a channelized stream may be sustained for a longer period of time after recharge than in an unchannelized stream When the next recharge occurs, part or all of the dewatered shallow aquifer may be refilled and a new dewatering cycle begins Thus, the initial increase in base flow to streams due to channelization may be perpetuated, and values of low-flow characteristics for channelized streams in hydrologic areas HA1 and HA2 may be larger than those given in this report

Eastern and Central Piedmont Physiographic Area

The eastern and central Piedmont physiographic area covers about 23,000 mi^2 of rolling hills in central North Carolina The area is bounded on the east by the Coastal Plain physiographic area and on the west by the western Piedmont and mountains physiographic area Mean annual precipitation ranges from 44 to 48 in. (Eder and others, 1983) The near-surface geologic materials in much of the area are crystalline or sedimentary rocks that have weathered at the surface to form a thin covering (several feet or more) of unconsolidated material referred to as the regolith Areas of similar low-flow characteristics within this physiographic area tend to match areas of similar rock type on the State geologic map (Brown and Parker, 1985) to a greater degree than elsewhere in the State In addition, areas of similar low-flow characteristics tend to coincide with areas of similar well yields reported by Daniel (1989), which in turn relate to rock type Therefore, delineations of hydrologic areas within this physiographic area are based largely on underlying rock types

The Eastern Slate Belt hydrologic area (HA4) covers about 1,100 mi^2 and corresponds roughly to the Eastern Slate Belt of Brown and Parker (1985), which is an area underlain by nearly impermeable metavolcanic and metasedimentary rocks which crop out in many places To the east, topographic relief diminishes, metasedimentary rock outcrops are fewer, and covering soils are more typical of the Coastal Plain The felsic metavolcanic rocks and argillite found in abundance in this belt are among the lowest-ranked by Daniel (1989) in terms of their yield to wells Values for low-flow characteristics are also very low in this hydrologic area (median 7Q10 value is 0 $[ft^3/s]/mi^2$) compared with most of the other hydrologic areas of the State (table 2)

The Raleigh Belt hydrologic area (HA5) covers about 1,800 mi^2 and consists predominantly of felsic metaigneous, felsic gneiss, and schist rock types In terms of low-flow characteristics (table 2), the streams in this hydrologic area have higher low-flow values than those in HA1 and HA2 in the

Coastal Plain and most other hydrologic areas of the eastern and central Piedmont. The median 7Q10 value for HA5 is 0.065 (ft^3/s)/mi^2.

The Triassic Basin hydrologic area (HA6) (shown as two separate areas in pl. 1) covers about 1,100 mi^2 and is composed of sedimentary rocks, including shale, sandstone, and arkose. Daniel (1989) reported the Triassic sedimentary rocks to have the lowest average yield of water to wells of all rock types in the State, implying that these rocks have low permeabilities. Such low permeabilities are compatible with the low base flows of streams draining the Triassic rock terranes. The 7Q10 values for HA6 (table 2) are zero for all but the largest drainage areas.

The Carolina Slate Belt hydrologic area (HA7) (also shown as two separate areas in pl. 1) covers about 4,500 mi^2 and consists predominantly of metavolcanics and metaigneous rocks, which are among the lowest water-yielding rock units studied by Daniel (1989). Consequently, values for low-flow characteristics (table 2) are low (median 7Q10 value is 0.005 [ft^3/s]/mi^2) compared to other hydrologic areas in the State.

The Carolina Slate Belt (argillite zone) hydrologic area (HA8) covers about 1,600 mi^2 and consists primarily of argillite. Low-flow characteristics of streams in this hydrologic area are low (the median 7Q10 value is 0.001 [ft^3/s]/mi^2). Daniel (1989) showed argillite to be among the lowest-ranked rock units in terms of average yield to wells.

The Charlotte Belt and Milton Belt hydrologic area (HA9) covers about 3,600 mi^2 and consists predominantly of igneous, metaigneous, and metavolcanic rocks, which Daniel (1989) indicates yield more water to wells than rocks in the northern part of the Carolina Slate Belt hydrologic area (HA7). This is reflected in higher values for low-flow characteristics in streams for HA9 in table 2. The median 7Q10 value for HA9 is 0.064 (ft^3/s)/mi^2.

Western Piedmont and Mountains Physiographic Area

The western Piedmont and mountains physiographic area covers approximately 13,400 mi^2 in the western part of the State and consists of a single hydrologic area, the western Piedmont and mountains (HA10). Mean annual precipitation varies greatly in this area, primarily because of orographic effects associated with the relatively great topographic relief. Precipitation over the area ranges from 40 in. to more than 80 in. annually (Eder and others, 1983). The highest annual rainfall east of the Mississippi River occurs in the Highlands area just north of the North Carolina-Georgia State line.

The predominant rock types in this area are gneiss and quartzite. Subdivisions on the basis of geology were not made in this area because topographic and climatic factors appear to overshadow geologic factors. Daniel (1989) showed significant differences in well yields for different topographic settings in the Piedmont and Blue Ridge provinces. Wells located in draws and valleys had higher yields than wells located on slopes and flats, and wells located on hills and ridges had the lowest average yields. This area has the greatest variability in topographic setting of the three physiographic areas. This may partially account for the high variability in the low-flow characteristics of streams within the area (table 2). The median 7Q10 value for this hydrologic area is 0.317 (ft^3/s)/mi^2, but the maximum value is 1.062 (ft^3/s)/mi^2, and the minimum is 0 (ft^3/s)/mi^2.

Another factor that contributes to the greater variability in low-flow characteristics is the greater areal variation in precipitation here as compared to the rest of the State. Areas of high and low mean annual precipitation and runoff tend to match highs and lows in low-flow characteristics of streams, and this is particularly apparent in the western Piedmont and mountains hydrologic area (HA10). Some of the highest low-flow values in the State occur in streams in this region near the highest precipitation areas.

General

The resultant effect of the various geologic, topographic, and climatic factors on base flow to North Carolina streams may be generalized as follows (fig. 2): (1) the lowest potential for sustaining base flow to streams is in the Coastal Plain physiographic area (excluding the Sand Hills hydrologic area (HA3), the eastern and central Piedmont physiographic area (excluding the Raleigh Belt hydrologic area (HA5), and the Charlotte Belt and Milton Belt hydrologic area [HA9]); (2) the highest potential is in the Sand Hills hydrologic area (HA3) and in the western Piedmont and mountains hydrologic area (HA10); and (3) the Raleigh Belt hydrologic area (HA5) and the Charlotte Belt and Milton Belt

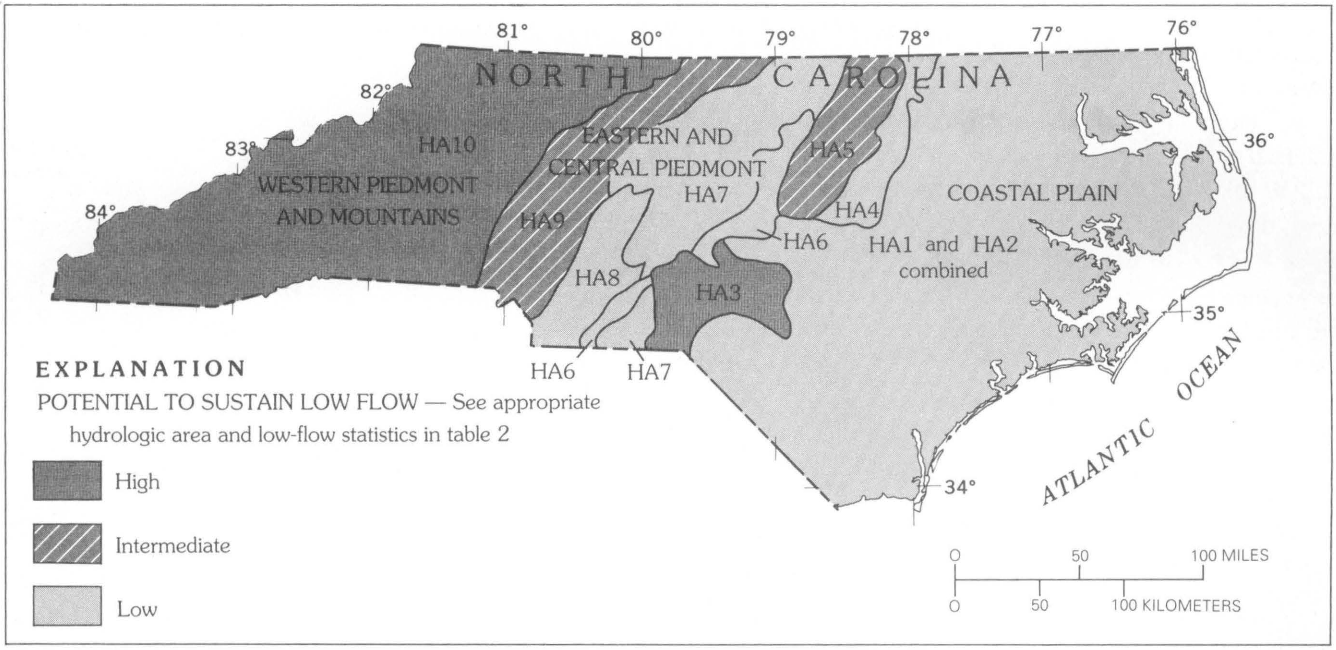

Figure 2. Areas of similar potential to sustain low flows.

hydrologic area (HA9) are intermediate in potential for sustaining base flow to streams.

REGIONAL LOW-FLOW FREQUENCY REGRESSION EQUATIONS

Multiple regression analysis was used in developing equations for estimating low-flow characteristics of streams. The assumed form of the regression equations was:

$$Y=B_0(X_1^{B_1})(X_2^{B_2})(X_3^{B_3})\ldots(X_n^{B_n}), \qquad (1)$$

where

Y is the low-flow characteristic of interest (7Q10, W7Q10, 30Q2, or 7Q2),

B_0 is the regression constant,

B_1, B_2, B_3 are regression coefficients,

and

X_1, X_2, X_3 are explanatory variables related to low-flow characteristics.

Equation 1 is similar in form to that adopted in other studies, such as those by Carpenter (1983) and Barnes (1986). To assure linearity and constancy of the error variance, equation 1 was log-transformed to:

$$\log Y=\log B_0+B_1 \log X_1+B_2 \log X_2 + B_3 \log X_3 \ldots \qquad (2)$$

Preliminary multiple regression analysis was performed on a selected data set consisting of 74 continuous-record stations having a record of 30 years or more and 7 stations with records that were extended to 30 years or more through regression techniques. A number of basin characteristics were also available for these stations, including drainage area, stream length, channel slope, percentage of basin forested, soil infiltration index, mean annual precipitation, the 2-year 24-hour rainfall intensity, mean January and July temperatures, Lane's variability index (Lane and Lei, 1950), and streamflow recession indexes. In this and subsequent regression analyses, stations for which low-flow characteristics were zero were excluded because zero values cannot be log-transformed. On a statewide basis, drainage area was the most significant of the above variables; in most regression analyses, mean annual precipitation was the second most significant variable.

Subsequent regression analyses, based on 120 continuous-record and 403 partial-record stations having drainage areas less than 400 mi^2, were used to examine fewer variables: drainage area, mean annual runoff, and average well yield by hydrologic area. Mean annual runoff, which was not tested with the preliminary 74-station data set, was used

Table 3. Low-flow frequency regression equations for selected hydrologic areas[1]

[*nQm* flow, the minimum *n*-consecutive-day discharge, in cubic feet per second, with a probability of 1/*m* of occurring in any one climatic year, W7Q10 flow takes into account only the months of November through March, R^2, coefficient of determination, *DA*, drainage area in square miles, *MAF*, mean annual flow in cubic feet per second]

Hydrologic area name and number	Number of sites	Regression equation for *nQm* flow	R^2	Standard error of estimate (percent)	Equation number
Sand Hills (HA3)	24	$7Q10=0.431DA^{0.89}$	0.86	55	3
		$W7Q10=0.789DA^{0.90}$	.94	34	4
		$7Q2=0.655DA^{0.91}$	.93	37	5
		$30Q2=0.830DA^{0.91}$	.95	31	6
Raleigh and Charlotte and Milton Belts (HA5 and HA9, combined)	60	$7Q10=0.196DA^{0.53}$	.35	92	7
		$W7Q10=0.270DA^{0.79}$	.67	65	8
		$7Q2=0.253DA^{0.78}$	.69	61	9
		$30Q2=0.316DA^{0.83}$	.78	49	10
Western Piedmont and mountains (HA10)	299	$7Q10=0.155MAF^{1.01}$	.87	50	11
		$W7Q10=0.252MAF^{0.99}$	.90	40	12
		$7Q2=0.281MAF^{1.00}$	.92	37	13
		$30Q2=0.344MAF^{1.00}$	.93	33	14

[1]See table 2 for drainage area limits below which indicated low-flow statistics are generally zero. Equations should not be used for drainage areas less than these limits or for drainage areas greater than 400 square miles. Number of sites may differ slightly from those shown in table 2 because sites with zero values for flow characteristics were not used to develop regression equations.

instead of precipitation because mean annual runoff more accurately reflects areal differences in annual evapotranspiration and infiltration than does precipitation. On an annual basis, for example, more of the precipitation that falls in the western Piedmont and mountains (HA10) eventually becomes streamflow because of the shorter growing season there as compared with other areas of the State.

In statewide regressions, drainage area, mean annual runoff, and well yield by hydrologic area were all significant at the 1-percent level. A 1-percent level of significance indicates that there is a 99-percent chance that there is a relation between the dependent and the explanatory variable. However, when regressions were performed on separate hydrologic areas or groups of similar hydrologic areas, use of the well-yield factor did not substantially improve the equations. Also, mean annual runoff resulted in distinct improvements only in the western Piedmont and mountains hydrologic area (HA10).

Residuals from statewide regressions based on drainage area alone and on drainage area and mean annual runoff together as explanatory variables were examined for areal bias. These examinations, along with student's *t*-tests and analysis of variance by ranks of low-flow characteristics, indicated that the closely ranked Raleigh Belt hydrologic area (HA5) and the Charlotte Belt and Milton Belt hydrologic area (HA9) could be combined for purposes of regression analysis. Conversely, the residuals analysis and other tests of low-flow characteristics (primarily *t*-tests) indicated that separate regressions were more accurate for the Sand Hills hydrologic area (HA3) and the western Piedmont and mountains hydrologic area (HA10) than a single regression for the two hydrologic areas. Separate regressions were particularly appropriate in the case of W7Q10 values, which were significantly lower in the western Piedmont and mountains hydrologic area (HA10) than in the Sand Hills hydrologic area (HA3). Tests indicated that a few combinations of the remaining hydrologic areas were justifiable for regression purposes, but the large percentage standard error of estimates of regression for these combinations were unacceptable. Therefore, these combinations were not used in this report. Despite some statistical homogeneity, such hydrologic areas maintain separate identities in table 2 for one or more of the following reasons (1) physical separation, (2) lack of statistical homogeneity in one or more low-flow characteristics, and (3) clearly different topographic, geologic, or climatic characteristics.

Final regression equations 3–10 for the Sand Hills hydrologic area (HA3) and the combined Raleigh Belt (HA5) and the Charlotte Belt and Milton Belt hydrologic areas (HA9) are listed in table 3, these equations incorporate drainage area (*DA*) as the only explanatory variable. Also given in table 3 are regression equations 11–14 for the western Piedmont and mountains hydrologic area (HA10); these equations incorporate mean annual flow (*MAF*) as the explanatory variable. *MAF* is a compound variable obtained by multiplying drainage area (*DA*) by mean annual runoff (*MAR*) as obtained from plate 2. Equations 3–14 listed in table 3 are useful for estimating low-flow characteristics in streams in an area that covers 20,600 mi^2, or about 40 percent of the State. Standard error of estimates for these regression equations, which are for drainage basins greater than the lower drainage area limit given in table 2 but less than 400 mi^2, ranged from 31 percent for the 30Q2 equation 6 for the Sand Hills hydrologic area (HA3) to 92 percent for the 7Q10 equation 7 for the combined hydrologic areas HA5 and HA9. Regression equations developed for the remainder of the State are not presented in the report because standard error of estimates were too high (192 percent or larger) to provide reliable equations. For hydrologic areas where no equations were developed, refer to table 2 for the percentile distributions of computed low-flow characteristics.

A point of particular interest is that all of the exponents for the four equations for the western Piedmont and mountains hydrologic area (HA10) are about 1.0. This indicates that the low-flow characteristics for unregulated streams in this hydrologic area are directly related to mean annual flow by a proportionality constant. Any such relation is probably driven by precipitation and precipitation variability, of which streamflow and streamflow variability are largely reflective.

ESTIMATING LOW-FLOW FREQUENCY CHARACTERISTICS

A hierarchy of procedures is used in estimating low-flow frequency characteristics of streams. The most reliable estimates are generated from multiyear continuous records of streamflow at the site of interest. Other reliable estimates are those made from a series of five or more base-flow measurements at a site, which are then correlated with concurrent streamflow at one or more nearby long-term continuous-record stations for which low-flow characteristics are available. Procedures for these two cases are described by Riggs (1972).

For ungaged sites on gaged or measured streams, low-flow characteristics may be estimated by using a weighted average of estimates from the gaged site and regional relations given in this report. The weight of the estimate from the gaging station is 100 percent at the gage, diminishing to 0 percent at distances upstream and downstream corresponding to one-fourth and four-times the drainage area at the gage. The weight of the estimate from regional relations would be 100 percent minus the weight of the estimates from the gaged site. Outside the one-fourth and four-times drainage area limits, regional relations could be given full weight.

In hydrologic areas HA3, HA5, HA9, and HA10, regression equations 3–14 in table 3 can be used where applicable for estimation purposes, provided the drainage area at the site is greater than the indicated lower drainage area limit in table 2 and less than 400 mi^2. Where the drainage area is less than the indicated lower limit in table 2, examination of low-flow frequency characteristics at nearby gaged sites could be the basis for estimates at the ungaged site. Preferably, however, a series of base-flow measurements could be made at the ungaged site, and correlation techniques, such as previously described, could be used for estimating low-flow characteristics. The latter approach is particularly appropriate for small drainage areas because of higher variability in per-square-mile values of low-flow statistics for small drainage areas.

The appropriate equation for the hydrologic area in which the site is located can be obtained from table 3. To use the regression equations, first determine the drainage area of the site in square miles. Then, if the site is located in the western Piedmont and mountains hydrologic area (HA10), determine the mean annual runoff for the basin, in $(ft^3/s)/mi^2$, using plate 2.

For example, assume the site of interest is in the western Piedmont and mountains hydrologic area (HA10). The drainage area is 3.5 mi^2, the mean annual runoff is 1.2 $(ft^3/s)/mi^2$, and the low-flow characteristic of interest is the 7Q10 low flow. Then:

$$MAF=(MAR)(DA) \qquad (15)$$

and substituting above values:

$$4.2\ ft^3/s=(1.2 (ft^3/s)/mi^2)(3.5\ mi^2).$$

From equation 11, table 3

$$7Q10=0.155\ MAF^{1.01};$$

by substitution,

$$7Q10=(0.155)(4.2)^{1.01}$$

or

$$7Q10=0.66 \text{ ft}^3/\text{s} \text{ (standard error 50 percent).}$$

No regional relations are provided for hydrologic areas HA1, HA2, HA4, HA6, HA7, and HA8 because of the high percentage standard error of estimates of the regression equations However, the information in table 2 may be used to estimate the probable range in unit low-flow characteristics for ungaged, unmeasured sites in these areas. For example, the low-flow 7Q10 values in HA1 range from 0 to 0.019 $(\text{ft}^3/\text{s})/\text{mi}^2$, and the median value is 0 The drainage area below which a zero value is likely for a low-flow characteristic is also given in table 2 for most hydrologic areas

Where a drainage basin is in more than one hydrologic area, the preferred procedure is to make separate estimates for the parts of the drainage basin that lie in each hydrologic area using the techniques previously described, then add the results. However, this additive approach should not be used when one or more of the downstream hydrologic areas is in an area having a zero or near-zero median value for the particular low-flow characteristic of interest For example, evidence from measurements indicates that some streams flowing out of the high-yielding Sand Hills hydrologic area (HA3) into the Coastal Plain clay soils hydrologic area (HA1) may actually lose water instead of gaining or maintaining base-flow contributions from the Sand Hills. Such losses could be due to a combination of (1) a lack of positive contribution to streamflow from the clay soils and (2) actual loss of streamflow by direct evaporation from the stream surface and by transpiration from streambank vegetation.

Streamflow data or low-flow characteristics for North Carolina streams to be used in place of, or in conjunction with, characteristics estimated by regression equations or information in table 2 are contained in table 1, in annual water-resources data reports of the U S Geological Survey, and in Yonts (1971). Measurement-based estimates of low-flow frequency characteristics at other sites on North Carolina streams are contained in Goddard (1963) and in U S. Geological Survey files in Raleigh, North Carolina

There is, however, a lack of sufficient low-flow data with which to develop low-flow frequency estimates in some areas There is little low-flow data for streams in the Coastal Plain and only slightly more data for streams in those parts of the eastern and central Piedmont physiographic area identified on figure 2 as having low potential to sustain base flow of streams The present (1992) inability to develop reliable, predictive regression equations for these parts of the State is attributable not only to the lack of sufficient data for natural base flow in these areas, but also to a lack of complete understanding of the hydrology of low flows.

The need for greater understanding of low-flow hydrology is most acute in those areas where regression equations for the low-flow characteristic values are not shown because the percentage errors of estimate are too large (HA1, HA2, HA4, HA6, HA7, and HA8) Not coincidentally, these are the areas where the magnitudes of low-flow characteristics are smallest; this leads to unacceptably large percentage errors when what might normally be judged to be small-magnitude errors in terms of cubic feet per second are expressed as a percentage of the magnitude of the low-flow characteristic itself Thus, for such areas, a more complete qualitative and quantitative understanding of the low-flow hydrology is necessary to achieve regression estimates of acceptably low percentage error.

In addition to the need for more data on and better understanding of the natural low-flow regime, there is a need for better definitions of the places and patterns of streamflow regulation and diversions, many of which may be unknown to public officials Such definitions are necessary both to ensure the integrity of the data base for natural conditions and to allow estimates of low-flow characteristics for regulated sites

SUMMARY AND CONCLUSIONS

Statistics describing the magnitude and frequency of low streamflow events for natural conditions generally are used to evaluate reservoir release requirements, determine allowable waste-discharge loadings, and to evaluate biological potential Although such statistics are easily generated for sites where streamflow data have been collected for a number of years, information is often needed at sites for which no streamflow records are available This report presents regional relations and other techniques, which can be used to estimate low-flow characteristics at sites in North Carolina for which suitable streamflow records are not available.

The low-flow characteristics selected for analysis in this study were (1) the low-flow 7Q10, which is the annual minimum 7-day consecutive low flow, which on average, will be exceeded in 9 out of 10 years, (2) the low-flow W7Q10, which is similar to the low-flow 7Q10, except that it takes into account only the months from November through March, (3) the low-flow 7Q2, and (4) the low-flow 30Q2. Ten low-flow hydrologic areas were delineated within three physiographic areas of North Carolina by relating topography, geology, mean annual runoff, and other features to the above low-flow frequency characteristics for 122 continuous-record and 396 partial-record streamflow stations. Regression equations relating low-flow characteristics to mean annual discharge or drainage area were developed for five of the hydrologic areas covering 40 percent of the State. Statistical summaries of low-flow characteristics are given for the ten hydrologic areas.

Low-flow hydrologic areas are regions within which factors affecting low-flow characteristics of streams are reasonably uniform or are within small-range variances. In the Coastal Plain physiographic area, topographic relief (or lack of it) and soil type were the main factors influencing selection of hydrologic areas. In the eastern and central Piedmont physiographic area, underlying rock type was the most important factor influencing delineations of hydrologic areas. In the western Piedmont and mountains, topographic and climatic factors were paramount.

Low-flow 7Q10's, the most widely used of the four characteristics, ranged from zero in some hydrologic areas in the Coastal Plain and eastern and central Piedmont physiographic areas to a maximum of 1.06 cubic feet per second per square mile for a station in the western Piedmont and mountains hydrologic area. Generally, the lowest potential for sustaining base flow to streams is in hydrologic areas HA1 and HA2 in the Coastal Plain physiographic area and in hydrologic areas HA4, HA6, HA7, and HA8 in the eastern and central Piedmont physiographic area. Hydrologic areas HA5 and HA9 in the eastern and central Piedmont physiographic area are considered intermediate in their ability to sustain base flow to streams. Lastly, hydrologic area HA10, which occupies the entire western Piedmont and mountains physiographic area, and hydrologic area HA3 in the Coastal Plain physiographic area are considered high in their ability to sustain base flow to streams.

Multiple regression analysis was used to develop equations for estimating low-flow characteristics of streams. A number of variables were tested for significance, including drainage area, stream length, channel slope, percentage of basin forested, soil infiltration index, mean annual precipitation, the maximum 2-year 24-hour rainfall intensity, mean January and July temperatures, mean annual runoff, Lane's variability index, and streamflow recession indexes. The basic forms of the regression equations were assumed to be multiplicative and were log-transformed to ensure consistency of the error variance. Stations for which the low-flow statistics were zero were excluded from analysis because zero values cannot be log-transformed. Drainage area was the most significant of the above variables on a statewide basis; mean annual precipitation or mean annual runoff was the second most significant variable in most regressions.

Acceptable regression equations were developed for hydrologic areas HA3, HA5, HA9, and HA10, with standard errors ranging between 31 percent for the 30Q2 for hydrologic area HA3, and 92 percent for the 7Q10 for hydrologic areas HA5 and HA9 combined. A point of particular interest is that the exponents for mean annual runoff for all four low-flow characteristics in hydrologic area HA10 were very close to 1.0, indicating that low-flow characteristics in this area are directly related to mean annual runoff by constants.

A hierarchy of procedures was used in estimating low-flow frequency characteristics of streams. Estimates derived from streamflow records at the site of interest are the most reliable. For ungaged sites on gaged streams, a weighted average of an estimated low-flow characteristic derived from gaging stations near the site and regional relations given in this report is the next most reliable. Estimates using regional relations alone are the next most reliable, provided they are used within the given drainage area limits. In areas for which no regression equations are given and for which no suitable streamflow data are available, ranges of low-flow statistics in similar areas can be used.

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TABLE 1

Table 1. Magnitude and frequency of annual low-flow characteristics at continuous-record streamflow gaging stations and partial-record measuring sites

[mi^2, square mile, period of record, given only for continuous-record stations, ft^3/s, cubic foot per second, (ft^3/s)/mi^2, cubic foot per second per square mile, 7Q2, 2-year, 7-day low flow, 30Q2, 2-year, 30-day low flow, 7Q10, 10-year, 7-day low flow, W7Q10, 10-year, 7-day low flow in winter, Type 1, continuous-record gaging station, Type 2, partial-record site]

Index No (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of record (continuous-record stations)	Average annual unit runoff ([ft^3/s]/mi^2)	7Q2 (ft^3/s)	30Q2 (ft^3/s)	7Q10 (ft^3/s)	W7Q10 (ft^3/s)	Type
1	0204385000	Pasquotank River tributary near Elizabeth City	2 00		1 1	0	<0 1	0	0	2
2	0205338000	Cole Creek near Gatesville	31 00		1 0	0	3	0	3	2
3	0206872000	Snow Creek near Prestonville	22 70		1 2	6 9	10	2 1	11	2
4	0206893100	Mill Creek at Walnut Cove	9 86		1 2	2 3	2 9	9	2 7	2
5	0206905000	Belews Creek near Pine Hall	79 30		1 0	17	22	5 3	17	2
6	0206941000	Big Beaver Island Creek near Madison	23 80		1 2	4 2	5 7	1 1	4 8	2
7	0207050000	Mayo River near Price	260 00	1931–71	1 2	112	129	64	161	1
8	0207072000	Hogan Creek near Madison	23 90		1 1	4 3	6 3	1 7	6 0	2
9	0207093000	Jacob Creek at N C 704 near Madison	36 20		1 0	6 2	8 2	2 1	7 1	2
10	0207100300	Rockhouse Creek near Wentworth	18 40		1 0	3 6	5 0	9	4 2	2
11	0207428200	Wolf Island Creek at Reidsville	3 71		1 0	6	8	3	9	2
12	0207436000	Wolf Island Creek near Pelham	68 70		9	8 9	13	2 6	13	2
13	0207509000	Hogans Creek near Providence	98 40		9	12	20	2 0	15	2
14	0207519000	Rattlesnake Creek at Blanch	23 70		1 0	2 6	3 9	7	2 2	2
15	0207520780	Country Line Creek at Secondary Road 1146 near Ashland	6 58		9	2 0	2 4	1 0	1 8	2
16	0207720000	Hyco Creek near Leasburg	45 90	1966–88	1 0	2	5	0	5 3	1
17	0207724000	Double Creek near Roseville	7 47	1966–82	1 0	3	6	< 1	1 3	1
18	0207766000	Mayo Creek near Woodsdale	52 70		1 3	7	2 0	0	2	2
19	0207921000	Island Creek near Bullock	33 10		8	3	1 0	0	2	2
20	0207970000	Smith Creek near Norlina	31 50		8	5 9	8 0	2 7	5 6	2
21	0207975000	Sixpound Creek near Oakville	12 10		9	3 3	4 2	1 8	3 2	2
22	0208074000	Quankey Creek near Halifax	31 70		9	1 8	2 9	7	2 0	2
23	0208119000	Tar River at U S 158 near Oak Hill	26 00		9	1	3	< 1	1	2
24	0208121000	Shelton Creek near Oxford	23 80		8	2	4	0	1	2
25	0208152700	Jordan Creek near Oxford	7 50		9	2	5	< 1	2	2
26	0208168000	Ruin Creek near Kittrell	28 10		9	2 2	3 7	3	2 0	2
27	0208172000	Tabbs Creek near Kittrell	70 80		1 0	3 6	6 9	6	3 1	2
28	0208173500	Lynch Creek near Franklinton	22 60		1 0	4 9	6 4	1 9	5 0	2
29	0208177000	Cedar Creek near Franklinton	11 90		1 0	2 9	4 0	9	2 9	2
30	0208177300	Brandy Creek near Franklinton	5 48		1 0	1 4	1 8	7	1 4	2
31	0208180000	Cedar Creek near Louisburg	48 20	1958–75	1 0	11	14	3 4	19	1
32	0208187400	Crooked Creek at Secondary Road 1707 near New Hope	15 40		1 0	2 5	3 6	9	2 6	2
33	0208188000	Crooked Creek at N C 39 near Bunn	30 80		1 0	4 8	7 1	1 9	5 1	2
34	0208188500	Cypress Creek near Seven Paths	24 10		1 0	1 5	3 4	2	1 7	2
35	0208260300	Compass Creek at N C 97 near Rocky Mount	10 90		1 0	< 1	1	< 1	< 1	2

Index No (pl 1)	USGS downstream order number	Station name	Drainage area (mi²)	Period of record (continuous-record stations)	Average annual unit runoff ([ft³/s]/mi²)	7Q2 (ft³/s)	30Q2 (ft³/s)	7Q10 (ft³/s)	W7Q10 (ft³/s)	Type
36	0208262100	Beech Branch near Rocky Mount	10 10		1 0	< 1	1	0	< 1	2
37	0208263000	Harts Mill Run near Tarboro	8 60		1 0	6	9	3	5	2
38	0208271000	Sandy Creek near Alert	54 10		9	7 0	10	2 0	6 8	2
39	0208276000	Red Bud Creek near Castalia	18 90		1 2	5	1 2	0	5	2
40	0208283500	Fishing Creek near Warrenton	46 50		8	8 2	12	9	8 0	2
41	0208285200	Possumquarter Creek at Warrenton	1 40		8	3	4	2	3	2
42	0208291000	Shocco Creek near Elberon	18 90		1 2	2 9	4 3	1 1	2 7	2
43	0208293000	Reedy Creek near Odell	33 60		9	2 1	3 5	3	2 3	2
44	0208294000	Bear Swamp near Brinkleyville	42 80		9	2 7	6 0	0	2 8	2
45	0208315400	Marsh Swamp at Enfield	94 70		1 0	2	3	2	2	2
46	0208316800	Burnt Coat Swamp near Enfield	36 90		1 0	3	4	1	2	2
47	0208361000	Town Creek near Mercer	92 00		1 0	9	2 2	2	9	2
48	0208362000	Cokey Swamp near Mercer	52 00		1 0	0	1	0	0	2
49	0208369000	Otter Creek near Falkland	47 00		1 1	1 0	1 6	3	8	2
50	0208455700	Van Swamp near Hoke	23 00		1 1	< 1	2	0	< 1	2
51	0208481200	East Fork Eno River near Cedar Grove	11 50		9	1 1	1 7	2	1 0	2
52	0208489000	Eno River near Carr	26 70		9	2 0	3 3	3	2 2	2
53	0208500600	Cates Creek near Hillsborough	4 18		9	< 1	1	< 1	1	2
54	0208513000	South Fork Little River near Quail Roost	38 20		1 0	1 5	2 7	1	1 0	2
55	0208521000	North Fork Little River near Orange Factory	29 70		1 0	4	8	1	3	2
56	0208522000	Little River near Orange Factory	80 40	1963–87	9	2 6	4 4	2	2 3	1
57	0208526200	Little River near Weaver	105 00		9	3 4	5 8	2	3 7	2
58	0208539000	North Flat River at Timberlake	33 00		9	1 6	2 6	3	8	2
59	0208543000	Deep Creek near Moriah	32 50		1 0	0	4	0	0	2
60	0208550000	Flat River at Bahama	149 00	1927–88	1 0	5 2	8 9	1 0	2 9	1
61	0208600000	Dial Creek near Bahama	4 76	1927–71	9	2	3	0	1	1
62	0208627500	Dry Creek near Bahama	1 24		1 0	0	0	0	0	2
63	0208701000	Little Lick Creek near Redwood	19 40		1 0	0	1	0	0	2
64	0208706000	Beaverdam Creek near Creedmoor	44 20		1 0	4	1 1	0	2	2
65	0208718700	Richard Creek at N C 98 at Wake Forest	7 66		1 1	1 5	2 2	5	1 6	2
66	0208719400	Austin Creek at Wake Forest	3 98		1 1	1 0	1 5	3	9	2
67	0208722000	Harris Creek near Wake Crossroads	9 85		1 1	2 4	3 2	1 2	2 5	2
68	0208725100	Crabtree Creek near Cary	52 20		1 1	8	1 2	2	8	2
69	0208727000	Hare Snipe Creek near Millbrook	7 19		1 0	8	1 2	3	9	2
70	0208729000	Mine Creek near Millbrook	8 87		1 1	2 5	3 2	1 1	2 7	2
71	0208732000	Big Branch near Millbrook	3 70		1 1	1 4	1 8	8	1 6	2
72	0208741000	Poplar Creek near Knightdale	8 83		1 1	2 6	3 4	1 2	2 8	2
73	0208761000	Swift Creek near McCullers	55 20		1 1	4 0	6 8	6	5 1	2
74	0208800000	Middle Creek near Clayton	83 50	1941–88	1 1	4 0	8 1	3	4 2	1

Table 1. Magnitude and frequency of annual low-flow characteristics at continuous-record streamflow gaging stations and partial-record measuring sites—Continued

Index No. (pl 1)	USGS downstream order number	Station name	Drainage area (mi²)	Period of record (continuous-record stations)	Average annual unit runoff ([ft³/s]/mi²)	7Q2 (ft³/s)	30Q2 (ft³/s)	7Q10 (ft³/s)	W7Q10 (ft³/s)	Type
75	0208809000	Black Creek near Four Oaks	81 90		1 1	< 1	7	0	2	2
76	0208827500	Mill Creek near Cox Mill	185 00		9	10	20	2 2	16	2
77	0208831000	Buck Swamp near Dudley	15 50		1 2	1 0	2 3	< 1	1 2	2
78	0208843400	Buffalo Creek at Poole Road near Wendell	15 80		1 1	9	1 5	2	9	2
79	0208848000	Little Buffalo Creek near Kenly	9 34		1 1	0	0	0	0	2
80	0208924000	Bear Creek near LaGrange	49 20		1 1	9 0	11	4	8 2	2
81	0208958000	Deep Run at Deep Run	6 10		1 1	9	1 5	2	5	2
82	0208969000	Stonyton Creek at Graingers	36 00		1 1	3	8	< 1	2	2
83	0208994600	Moccasin Creek near Zebulon	29 80		1 1	1 5	3 0	2	1 9	2
84	0209062500	Turner Swamp near Eureka	2 10	1970–87	1 2	4	5	3	3	1
85	0209154400	Wheat Swamp near Hugo	20 50		1 2	4	2 1	4	1.4	2
86	0209196000	Creeping Swamp near Calico	9 80	1972–77	1 4	0	0	0	0	1
87	0209197000	Creeping Swamp near Vanceboro	27 00	1972–85	1 4	0	0	0	0	1
88	0209202000	Palmetto Swamp near Vanceboro	24 20	1972–76	1 1	0	< 1	0	0	1
89	0209204000	Poplar Branch near Vanceboro	3 60		1 1	6	6	0	6	2
90	0209212000	Bachelor Creek near New Bern	34 00		1 1	4	1 1	0	3	2
91	0209272010	White Oak River at Belgrade	53 00		1 4	1 5	2 8	4	5	2
92	0209273000	Starky Creek near Belgrade	17 60		1 4	2	4	< 1	2	2
93	0209313000	Southwest Creek near Haw	35 00		1 5	1 9	3 8	6	1 9	2
94	0209317000	Northeast Creek near Kellum	27 90		1 4	2 6	5 4	1 3	2 9	2
95	0209326000	Haw River at U.S 220 near Summerfield	20 60		1 0	3 0	4 4	9	4 0	2
96	0209400000	Horsepen Creek at Battle Ground	16 40	1927–59	9	2 5	3 3	1 4	3 0	1
97	0209498000	South Buffalo Creek at Willow Road at Greensboro	29 90		1 1	1 8	2 5	5	2 0	2
98	0209500000	South Buffalo Creek near Greensboro	34 00	1930–58	1 1	4 0	5 3	1 8	2 8	1
99	0209518100	North Buffalo Creek at Westover Terrace at Greensboro	9 55		9	6	1 0	3	9	2
100	0209540600	Muddy Creek at Greensboro	3 85		9	3	4	2	4	2
101	0209597800	Stony Creek near Stony Creek	23 90		8	6	1 2	0	7	2
102	0209600000	Stony Creek near Burlington	45 20	1954–59	8	2	6	0	0	1
103	0209612000	Buttermilk Creek near Burlington	14 30		1 1	< 1	2	0	1	2
104	0209623000	Jordan Creek near Union Ridge	24 10		1 1	< 1	3	0	0	2
105	0209660400	Little Alamance Creek near Greensboro	9 45		1 0	3	6	1	5	2
106	0209661000	Little Alamance Creek near Whitsett	39 10		9	3 3	5 4	6	3 7	2
107	0209666000	Rock Creek near Whitsett	14 60		8	7	1 3	1	1 0	2
108	0209670000	Big Alamance Creek near Elon College	116 00	1959–80	1 0	5 4	9 6	1 5	8 4	1
109	0209670700	Back Creek near Gibsonville	3 19		1 0	3	4	0	2	2
110	0209672000	Big Alamance Creek at Alamance	144 00		9	7 0	12	2 2	11	2

Index No. (pl 1)	USGS downstream order number	Station name	Drainage area (mi²)	Period of record (continuous-record stations)	Average annual unit runoff ([ft³/s]/mi²)	7Q2 (ft³/s)	30Q2 (ft³/s)	7Q10 (ft³/s)	W7Q10 (ft³/s)	Type
111	0209678000	South Prong Stinking Quarter Creek near Bellemont	33 60		9	2 1	3 3	3	2 0	2
112	0209682000	Haw Creek at Swepsonville	27 80		9	1 2	2 2	2	2 0	2
113	0209683300	Motes Creek at Saxapahaw	5 50		9	5	8	3	6	2
114	0209685000	Cane Creek near Teer	33 40	1961–73	9	1 0	1 8	2	1 5	1
115	0209686000	Cane Creek near Carrboro	36 60		9	1 1	2 0	2	1 8	2
116	0209689900	South Fork Cane Creek near Saxapahaw	18 50		1 0	0	0	0	0	2
117	0209693000	Terrell Creek near Pittsboro	20 90		9	1	2	0	1	2
118	0209736000	Bolin Creek at Chapel Hill	10 70		1 0	7	9	5	6	2
119	0209744000	Northeast Creek at OKellys Church	35 00		1 0	1	1	0	< 1	2
120	0209791000	White Oak Creek near Wilsonville	24 00		1 0	< 1	2	0	0	2
121	0209834300	West Fork Deep River near Friendship	11 50		1 0	2 8	3 3	1 7	3 0	2
122	0209850000	West Fork Deep River near High Point	32 50	1925–58	1 0	4 2	5 8	2 1	5 5	1
123	0209900000	East Fork Deep River near High Point	14 80	1930–88	1 1	3 1	3 8	1 9	3 3	1
124	0209924000	Bull Run at Oakdale	7 75		1 0	2	6	0	2	2
125	0209948000	Richard Creek near Archdale	12 50		1 0	1 7	2 2	9	2 0	2
126	0210018000	Polecat Creek near Climax	29 10		9	7	1 6	< 1	9	2
127	0210064000	Richard Creek near Asheboro	36 80		1 0	1 5	3 0	1	1 9	2
128	0210071000	Brush Creek near Coleridge	67 40		1 0	1 8	3 3	4	2 1	2
129	0210073000	Fork Creek near Coleridge	38 50		1 0	1 3	2 6	1	1 6	2
130	0210104500	Buffalo Creek at McConnell	21 40		1 0	< 1	1	0	< 1	2
131	0210166000	Rocky River near Liberty	4 52		9	2	4	< 1	3	2
132	0210180000	Tick Creek near Mount Vernon Springs	15 50	1960–81	1 0	9	3	0	1	1
133	0210217900	White Oak Creek near Friendship	13 20		1 1	0	0	0	0	2
134	0210218000	White Oak Creek near Holly Springs	22 50		1 0	0	2	0	2	2
135	0210271900	Joes Fork near Pinehurst	3 52		1 2	1 7	2 1	1 3	2 0	2
136	0210277800	Nicks Creek near Eastwood	20 60		1 3	4 8	6 6	2 4	6 4	2
137	0210290800	Flat Creek near Inverness	7 63	1970–88	1 9	5 4	6 5	3 8	5 9	1
138	0210300000	Little River at Manchester	347 00	1940–50	1 2	75	114	39	77	1
139	0210308100	Tank Creek at Manchester	8 11		1 3	2 2	2 9	1 3	2 7	2
140	0210377000	Cross Creek at Langdon Street at Fayetteville	14 50		1 3	8 6	9 8	6 4	9 6	2
141	0210396000	Blounts Creek at Fayetteville	4 20		1 3	3 1	3 6	2 2	3 2	2
142	0210422000	Rockfish Creek at Raeford	92 70		1 2	58	68	46	66	2
143	0210425500	Beaver Creek near Arabia	11 90		1 2	4 8	5 6	3 6	5 2	2
144	0210432000	Little Rockfish Creek near Cumberland	44 90		1 3	25	30	18	28	2
145	0210438000	Beaver Creek at Cumberland	32 60		1 2	19	22	15	20	2
146	0210450000	Rockfish Creek near Hope Mills	292 00	1930–54	1 3	144	127	98	163	1
147	0210552000	Harrisons Creek at White Oak	50 10		1 1	2 2	4 1	2	3 9	2
148	0210563000	Turnbull Creek near Elizabethtown	60 10		1 1	3 2	6 0	4	4 5	2

Table 1. Magnitude and frequency of annual low-flow characteristics at continuous-record streamflow gaging stations and partial-record measuring sites—Continued

Index No. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi²)	Period of record (continuous-record stations)	Average annual unit runoff ([ft³/s]/mi²)	7Q2 (ft³/s)	30Q2 (ft³/s)	7Q10 (ft³/s)	W7Q10 (ft³/s)	Type
149	0210596000	Great Coharie Creek near Parkersburg	201.00		1.2	20	33	6.2	23	2
150	0210600000	Little Coharie Creek near Roseboro	92.80	1951–87	1.2	6.5	13	1.0	12	1
151	0210636000	Six Runs Creek near Clinton	108.00		1.0	2.1	5.6	.2	3.5	2
152	0210676000	Mingo Swamp near Dunn	50.40		1.0	.2	3.3	0	1.6	2
153	0210696000	Beaverdam Creek near Stedman	16.30		1.2	.1	.5	0	.4	2
154	0210760000	Northeast Cape Fear River near Seven Springs	48.70	1960–75	1.3	9.8	12	5.0	9.4	1
155	0210799000	Muddy Creek near Chinquapin	34.50		1.4	.5	1.2	.1	.9	2
156	0210858000	Holly Shelter Creek near Maple Hill	33.60		1.5	1.7	4.5	.4	1.9	2
157	0210862000	Prince George Creek near Castle Hayne	4.20		1.5	<.1	.1	<.1	.2	2
158	0210879500	Mott Creek near Myrtle Grove	1.35		1.5	<.1	.1	<.1	.1	2
159	0210918400	Soules Swamp above east side sewage plant at Chadbourn	.53		1.0	<.1	<.1	<.1	<.1	2
160	0211100000	Yadkin River at Patterson	28.80	1941–88	1.7	16	19	9.1	12	1
161	0211118000	Elk Creek at Elkville	48.10	1967–88	2.2	28	34	18	24	1
162	0211126000	Stony Fork near Ferguson	33.70		1.7	24	28	15	19	2
163	0211132000	North Prong Lewis Fork at Champion	34.80		1.6	22	26	14	19	2
164	0211137000	South Prong Lewis Fork at Champion	36.40		1.9	25	29	16	21	2
165	0211140300	Moravian Creek near Moravian Falls	18.30		1.3	11	13	6.6	9.9	2
166	0211141000	Moravian Creek near Wilkesboro	24.70		1.4	16	18	9.1	14	2
167	0211144000	Middle Fork Reddies River near Wilbar	15.70		1.7	11	13	6.7	8.9	2
168	0211150000	Reddies River at North Wilkesboro	89.20	1941–88	1.6	60	69	38	50	1
169	0211204000	Mulberry Creek near North Wilkesboro	45.80		1.4	30	34	18	25	2
170	0211212000	Roaring River near Roaring River	128.00	1965–88	1.5	78	88	51	77	1
171	0211217000	Bugaboo Creek at Ronda	17.80		1.4	.0	13	6.8	9.0	2
172	0211231000	Mitchell River near Mountain Park	30.10		2.0	22	26	14	20	2
173	0211236000	Mitchell River near State Road	78.80	1965–88	1.6	54	62	34	53	1
174	0211250000	Fisher River near Dobson	116.00	1922–32	1.4	52	68	25	46	1
175	0211300000	Fisher River near Copeland	128.00	1933–88	1.4	62	75	31	63	1
176	0211362000	Ararat River at Mount Airy	65.70		1.3	34	38	16	35	2
177	0211389000	Toms Creek at Pilot Mountain	29.20		1.2	9.6	12	4.7	9.6	2
178	0211440100	Danbury Creek at Dalton	8.14		1.2	2.4	2.9	1.0	2.8	2
179	0211445000	Little Yadkin River at Dalton	42.80	1962–88	1.1	8.5	11	2.8	12	1
180	0211550000	Forbush Creek near Yadkinville	22.10	1941–71	1.0	5.8	7.3	2.2	6.8	1
181	0211553000	Logan Creek near Enon	26.40		1.0	6.0	8.2	2.1	6.7	2
182	0211559000	South Deep Creek at Shacktown	63.10		1.3	20	24	10	20	2
183	0211561000	North Deep Creek near Yadkinville	35.80		1.2	10	14	3.9	10	2
184	0211567100	Ellison Creek near Lewisville	3.93		.9	1.0	1.3	.4	1.0	2

Index No (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of record (continuous-record stations)	Average annual unit runoff ([ft^3/s]/mi^2)	7Q2 (ft^3/s)	30Q2 (ft^3/s)	7Q10 (ft^3/s)	W7Q10 (ft^3/s)	Type
185	0211572000	Mill Creek near Ogburn Station	6 58		1 0	1 8	2 2	9	2 2	2
186	0211583000	Smith Creek near Kernersville	2 00		1 0	5	6	3	5	2
187	0211583300	Kerners Mill Creek at Guthrie	8 86		1 0	2 3	3 0	1 2	2 8	2
188	0211677000	Dutchmans Creek near Maine	57 60		1 0	6 4	9 5	1 4	6 6	2
189	0211679000	Cedar Creek near Smith Grove	19 40		1 0	1 0	1 6	2	1 2	2
190	0211703000	Humpy Creek near Fork	1 05	1970–83	1 1	2	3	1	3	1
191	0211707000	South Yadkin River at Hiddenite	35 70		1 2	12	15	5 8	11	2
192	0211722000	South Yadkin River near Statesville	76 20		1 0	28	33	14	26	2
193	0211728500	Snow Creek near Scotts	25 90		1 2	11	12	5 8	10	2
194	0211750000	Rocky Creek at Turnersburg	101 00	1941–71	1 1	38	45	21	38	1
195	0211760600	South Yadkin River near Turnersburg	233 00		1 1	83	99	46	83	2
196	0211771000	Fifth Creek near Statesville	28 20		1 1	10	12	5 0	9 1	2
197	0211800000	South Yadkin River near Mocksville	306 00	1940–88	1 1	110	129	58	111	1
198	0211850000	Hunting Creek near Harmony	155 00	1952–88	1 3	71	83	39	64	1
199	0211858000	Hunting Creek at Calahan	185 00		1 4	78	96	34	84	2
200	0211891000	Bear Creek at Mocksville	21 20		1 0	2 5	3 8	6	2 7	2
201	0211943100	Third Creek at U S 64–70 near Statesville	25 50		1 0	11	13	6 7	11	2
202	0211943500	Third Creek near Barium Springs	29 30		1 0	13	15	8 6	13	2
203	0212074000	Back Creek near Mill Bridge	38 00		1 0	8 1	10	3 8	8 0	2
204	0212091000	Grants Creek at Salisbury	36 90		1 0	6 6	9 4	3 4	7 3	2
205	0212118000	North Potts Creek at Linwood	9 62		9	2 2	2 6	1 2	2 6	2
206	0212133200	Swearing Creek near Lexington	26 40		9	4 5	5 7	2 1	4 5	2
207	0212137000	Crane Creek near Granite Quarry	18 20		1 0	9	1 6	2	9	2
208	0212138300	Town Creek near Spencer	16 30		1 0	1 5	2 1	6	1 5	2
209	0212143000	Abbotts Creek near Wallburg	33 20		1 0	5 2	6 6	2 6	5 5	2
210	0212145000	Brush Fork near Thomasville	21 00		1 0	3 5	4 6	1 6	3 4	2
211	0212146800	Rich Fork near Wallburg	9 91		9	2	8	0	4	2
212	0212148335	North Hamby Creek at Secondary Road 2085 near Thomasville	3 90		9	3	4	2	4	2
213	0212253000	Lick Creek at Healing Springs	28 00		9	< 1	1	0	< 1	2
214	0212300000	Uwharrie River near Trinity	10 90	1936–41	1 0	6	9	4	1 0	1
215	0212311300	Uwharrie River near Glenola	32 10		9	3 0	4 0	1 4	3 8	2
216	0212330000	Caraway Creek near Flint Hill	24 20		9	1 7	2 7	4	1 6	2
217	0212408000	Clarke Creek near Harrisburg	21 90		1 1	2 0	2 7	1 2	2 2	2
218	0212409100	Clarke Creek at Pleasant Grove	28 20		1 0	1 9	2 7	1 2	2 1	2
219	0212430295	Reedy Creek at Secondary Road 2804 near Wilgrove	12 70		1 0	2 3	3 3	1 4	2 2	2
220	0212430645	McKee Creek at Secondary Road 2808 near Wilgrove	4 08		1 0	3	6	1	3	2
221	0212432000	Reedy Creek at Rocky River	30 90		1 1	2 8	3 9	1 0	2 8	2
222	0212433400	Rocky River near Rocky River	277 00		1 1	23	34	14	24	2

Table 1. Magnitude and frequency of annual low-flow characteristics at continuous-record streamflow gaging stations and partial-record measuring sites—Continued

Index No. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi²)	Period of record (continuous-record stations)	Average annual unit runoff ([ft³/s]/mi²)	7Q2 (ft³/s)	30Q2 (ft³/s)	7Q10 (ft³/s)	W7Q10 (ft³/s)	Type
223	0212440800	Hamby Branch near Georgeville	6 94		1 0	2	3	0	2	2
224	0212446000	Dutch Buffalo Creek near Rimer	33 80		1 0	1 6	2 6	6	1 6	2
225	0212469200	Goose Creek at Fairview	24 00		1 0	8	1 6	3	9	2
226	0212474500	North Fork Crooked Creek near Fairview	16 00		1 0	3	3	0	1	2
227	0212476600	Crooked Creek at Fairview	36 90		9	2	5	0	3	2
228	0212477300	Rock Hole Creek near Stanfield	4 27		1 0	< 1	< 1	0	< 1	2
229	0212483500	Long Creek near Plyler	27 50		1 0	1 0	1 6	2	7	2
230	0212494400	Little Bear Creek at Saint Martin	12 40		1 0	2	4	1	2	2
231	0212500000	Big Bear Creek near Richfield	55 60	1955–88	1 0	4	6	1	3	1
232	0212502000	Big Bear Creek near Albemarle	70 50		1 0	4	6	1	5	2
233	0212502300	Big Bear Creek at Secondary Road 1968 near Saint Martin	73 90		1 0	1 4	1 8	7	1 2	2
234	0212650000	Little Brown Creek near Polkton	13 70	1936–40	1 0	0	1	0	0	1
235	0212700000	Brown Creek near Polkton	110 00	1939–71	8	0	2	0	0	1
236	0212802500	Denson Creek at Troy	26 40		1 0	2 0	3 8	3	2 0	2
237	0212838000	Buffalo Creek near Covington	10 90		1 1	0	0	0	0	2
238	0212924000	Falling Creek near Rockingham	6 67		1 2	3 1	3 8	2 0	3 8	2
239	0212957000	Marks Creek near Osborne	29 90		1 1	11	15	6 3	15	2
240	0213215000	Gum Swamp Creek near Laurinburg	40 10		1 2	31	36	23	34	2
241	0213228500	Big Shoe Heel Creek near Wagram	20 00		1 1	5 0	6 8	2 7	6 8	2
242	0213232600	Maxton Branch at Maxton	2 16		1 1	2	4	< 1	4	2
243	0213238600	Mitchell Swamp at Rowland	4 13		1 2	2	3	1	3	2
244	0213283800	Drowning Creek at Candor	2 09		1 2	1 8	2 2	1 2	2 2	2
245	0213291000	Drowning Creek at Jackson Springs	31 90		1 7	12	17	3 6	14	2
246	0213298000	Naked Creek near Hoffman	38 00		1 4	19	23	10	22	2
247	0213300000	Deep Creek near Roseland	19 80		1 4	11	13	6 9	14	2
248	0213350000	Drowning Creek near Hoffman	183 00	1941–87	1 4	71	93	39	96	1
249	0213350400	Aberdeen Creek near Pinehurst	4 04		1 4	2 0	2 7	1 0	2 8	2
250	0213358100	Drowning Creek at U S 15 near Hoffman	247 00		1 4	102	132	58	132	2
251	0213359500	Quewhiffle Creek at Pine Hill	17 80		1 4	16	18	12	17	2
252	0213360400	Mountain Creek near Montrose	9 90		1 3	5 1	8 0	2 1	7 0	2
253	0213372000	Back Swamp near Lumberton	28 50		1 2	2	1 1	0	1	2
254	0213408000	Raft Swamp near Lumberton	105 00		1 2	8 4	14	7	11	2
255	0213432700	Little Marsh Swamp near Lumber Bridge	19 10		1 3	7	1 7	1	1 4	2
256	0213433800	Little Marsh Swamp near Parkton	36 30		1 2	1 3	3 2	1	2 6	2
257	0213650000	Catawba River at Old Fort	14 10		1 8	6 4	8 6	2 7	4 8	2
258	0213753000	Crooked Creek near Old Fort	35 60		1 8	30	36	16	25	2

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259	0213772700	Catawba River near Pleasant Gardens	126 00	1982–88	2 0	79	93	48	78	1
260	0213800000	Catawba River near Marion	172 00	1943–81	2 0	125	146	66	90	1
261	0213807000	Armstrong Creek at Sevier	28 60		2 1	18	21	10	14	2
262	0213834000	Mill Timber Creek at Crossnore	3 99		2 5	2 4	3 0	1 6	2 2	2
263	0213850000	Linville River near Nebo	66 70	1924–88	2 2	31	40	17	27	1
264	0213872000	North Muddy Creek near Nebo	45 70		1 5	25	32	12	20	2
265	0213881000	Muddy Creek at Bridgewater	98 70		1 5	55	66	31	43	2
266	0213912000	Silver Creek near Glen Alpine	26 10		1 5	16	18	11	13	2
267	0213939000	Warrior Fork near Morganton	80 80		1 5	40	48	21	32	2
268	0213960500	Hunting Creek near Chambers	4 96		1 5	2 7	3 4	1 5	2 6	2
269	0213965000	East Prong near Morganton	9 01	1968–74	1 6	5 6	6 4	4 9	6 2	1
270	0213995400	Dyson Creek near Globe	90		1 5	4	5	2	3	2
271	0214000000	Johns River at Collettsville	69 00		2 0	15	29	3 9	16	2
272	0214051000	Wilson Creek at Adako	68 02		1 8	37	45	20	30	2
273	0214111000	Lower Creek at Lenoir	13 90		1 5	5 6	6 8	2 6	5 0	2
274	0214115000	Lower Creek at Mulberry Street at Lenoir	28 10	1968–78	1 5	13	16	9 1	16	1
275	0214118500	Spainhour Creek at N C 18A near Lenoir	8 70		1 4	3 3	4 3	2 5	3 3	2
276	0214124500	Lower Creek near Morganton	89 50		1 4	35	40	24	32	2
277	0214136400	Dye Branch at Valdese	20		1 5	1	1	< 1	1	2
278	0214156000	Drowning Creek near Hildebran	14 10		1 4	10	12	6 6	9.2	2
279	0214165200	Connelly Creek near Hudson	2 10		1 4	1 0	1 1	5	.8	2
280	0214167000	Gunpowder Creek at Hudson	15 00		1 2	5 4	6 2	3 4	4 6	2
281	0214185100	Falling Creek at Secondary Road 1402 near Hickory	4 15		1 2	1 6	1 8	7	1 3	2
282	0214189000	Duck Creek near Taylorsville	18 40		1 2	8 8	10	4 8	8 2	2
283	0214200000	Lower Little River near All Healing Springs	28 20	1954–88	1 4	12	14	5 6	10	1
284	0214203200	Muddy Fork Creek near Taylorsville	6 94		1 1	2 6	3 1	1 1	2 1	2
285	0214206000	Lower Little River near Taylorsville	58 00		1 2	23	28	11	20	2
286	0214238000	Glade Creek at Millersville	12 70		1 2	6 6	7 7	3 8	6 1	2
287	0214241000	Elk Shoals Creek near Paynes Store	13 60		1 0	6 4	7 2	4 3	5 8	2
288	0214244500	Lyle Creek near Conover	11 40		1 4	8 6	9 9	4 7	7 5	2
289	0214244600	Bakers Creek near Conover	6 68		1 1	3 1	11	1 7	2 8	2
290	0214260000	Mountain Creek near Terrell	42 40	1959–62	1 4	18	20	13	15	1
291	0214266000	McDowell Creek near Charlotte	26 30		1 0	3 3	4 5	1 6	3 9	2
292	0214269000	Leepers Creek near Lowesville	52 60		1 2	17	21	9 8	20	2
293	0214271000	Killian Creek near Lowesville	47 00		1 1	7 7	11	3 1	7 7	2
294	0214300000	Henry Fork near Henry River	83 20	1927–88	1 6	39	49	22	32	1
295	0214304000	Jacob Fork at Ramsey	25 70	1963–88	2 0	14	16	9 5	14	1
296	0214318000	Maiden Creek at Maiden	16 50		1 2	6 6	7 8	4 0	6 5	2

Table 1. Magnitude and frequency of annual low-flow characteristics at continuous-record streamflow gaging stations and partial-record measuring sites—Continued

Index No. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi²)	Period of record (continuous-record stations)	Average annual unit runoff ([ft³/s]/mi²)	7Q2 (ft³/s)	30Q2 (ft³/s)	7Q10 (ft³/s)	W7Q10 (ft³/s)	Type
297	0214323600	Clark Creek near Lincolnton	84 10		1 2	36	48	15	36	2
298	0214344000	Indian Creek near Flay	27 00		1 3	11	13	6 0	11	2
299	0214347100	Lick Fork above County Line near Cherryville	5 10		1 3	2 0	2 5	9	1 9	2
300	0214348100	Indian Creek near Crouse	50 00		1 3	17	22	7 5	16	2
301	0214350000	Indian Creek near Laboratory	69 20	1953–88	1 3	22	28	8 9	23	1
302	0214356000	Beaverdam Creek near Crouse	20 80		1 2	6 0	7 8	2 6	5 4	2
303	0214376000	Hoyle Creek near Alexis	16 80		1 2	5 6	7 0	3 2	6 2	2
304	0214386600	Mauney Creek near Spencer Mountain	5 14		1 2	1 0	1 3	6	1 0	2
305	0214400000	Long Creek near Bessemer City	31 80	1954–88	1 2	5 9	7 9	1 4	6 4	1
306	0214401000	Long Creek at N C 275 near Gastonia	34 20		1 2	8 8	12	4 7	8 0	2
307	0214556200	Abernathy Creek at Mountain View	6 90		1 2	2 2	2 7	1 3	2 2	2
308	0214650000	Little Sugar Creek near Charlotte	40 80	1926–77	1 2	5 8	8 7	3 4	5 5	1
309	0214833200	Broad River near Bat Cave	34 40		1 5	39	29	23	44	2
310	0214850000	Broad River near Chimney Rock	96 00	1928–58	1 8	38	64	6 6	33	1
311	0214882000	Cove Creek near Whitehouse	32 50		1 5	26	28	16	20	2
312	0214900000	Cove Creek near Lake Lure	79 00	1952–88	1 7	55	63	33	44	1
313	0214924000	Mountain Creek near Rutherfordton	43 20		1 4	31	35	19	24	2
314	0214939000	Green River near Merrittsville	25 90		2 4	28	33	16	21	2
315	0214950000	Green River at Saluda	50 20		1 5	54	63	35	47	2
316	0214986000	Walnut Creek near Rock Springs	12 00		1 5	8 9	10	5 6	7 0	2
317	0215000000	Green River near Mill Spring	177 00	1941–54	2 2	133	174	55	93	1
318	0215002000	White Oak Creek tributary at Columbus	2 27		1 5	1 4	1 6	7	1 0	2
319	0215004000	White Oak Creek near Collinsville	36 10		1 5	33	37	20	25	2
320	0215020600	Bracketts Creek near Forest City	3 47		1 5	2 4	2 8	1 7	2 4	2
321	0215026000	Floyds Creek near Cliffside	27 00		1 5	14	18	5 8	9 0	2
322	0215046000	Cane Creek near Westminster	23 70		1 6	13	15	8 8	12	2
323	0215049500	Second Broad River near Logan	86 20		1 6	52	60	28	38	2
324	0215062000	Catheys Creek near Ruth	28 50		1 5	21	24	14	18	2
325	0215074000	Second Broad River near Bostic	164 00		1 5	95	110	51	69	2
326	0215174200	Sandy Run Creek at Secondary Road 1003 near Boiling Springs	51 60		1 4	28	32	16	24	2
327	0215210000	First Broad River near Casar	60 50	1960–88	1 6	33	39	22	32	1
328	0215244500	Knob Creek near Lawndale	33 30		1 4	22	27	13	22	2
329	0215250000	First Broad River near Lawndale	200 00	1941–71	1 4	98	115	53	84	1
330	0215256400	Brushy Creek at Dover Mill near Shelby	26 50		1 4	15	17	8 4	14	2
331	0215258000	Brushy Creek at U S 74 near Shelby	27 50		1 4	14	18	7 4	14	2

Index No. (pl 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of record (continuous-record stations)	Average annual unit runoff ([ft^3/s]/mi^2)	7Q2 (ft^3/s)	30Q2 (ft^3/s)	7Q10 (ft^3/s)	W7Q10 (ft^3/s)	Type
332	0215258700	Hickory Creek at Shelby	14 20		1 4	6 4	8 6	3 1	6 2	2
333	0215261000	Sugar Branch near Boiling Springs	1 42	1970–87	1 7	5	5	1	5	1
334	0215328000	Buffalo Creek near Waco	43 30		1 4	14	18	5 6	13	2
335	0215331100	Gilliam Creek tributary near Cherryville	4 45		1 3	1 8	2 2	9	1 7	2
336	0215332000	Muddy Fork near Oak Grove	32 40		1 3	11	14	5 0	11	2
337	0215336500	Long Branch at mouth near Grover	6 37		1 2	3 8	4 3	2 4	3 7	2
338	0215389800	North Pacolet River at N C 108 at Lynn	21 70		2 1	25	28	14	19	2
339	0216087000	Beaver Creek at mouth near Othello	16 50		2 1	10	12	7 1	8 8	2
340	0217690800	Chattooga River at Cashiers	7 69		3 5	6 1	7 5	3 5	4 4	2
341	0217691200	Chattooga River near Highlands	22 90		3 5	16	20	8 9	10	2
342	0218412200	Toxaway River at Lake Toxaway	7 79		3 9	4 9	6 6	2 3	5 0	2
343	0218426000	Whitewater River near Cashiers	12 90		3 5	17	22	9 2	18	2
344	0316011000	Middle Fork South Fork New River near Blowing Rock	8 90		3 2	6 2	8 1	3 3	5 1	2
345	0316031000	Howard Creek at Sands	10 30		2 0	7 0	8 2	4 3	5 6	2
346	0316076700	Beaver Creek at Beaver Creek	3 94		2 1	3 2	3 7	2 2	2 7	2
347	0316100000	South Fork New River near Jefferson	205 00	1926–88	2 1	164	190	106	132	1
348	0316150000	South Fork New River near Crumpler	327 00	1910–16	2 2	302	352	216	316	1
349	0316188000	North Fork New River at Creston	61 70		2 1	42	49	28	36	2
350	0316211000	Buffalo Creek at Warrensville	21 80		2 1	11	13	8 6	9 8	2
351	0316222000	Horse Creek at Bina	56 40		1 6	16	18	13	15	2
352	0316246000	Helton Creek near Helton	43 70		1 5	12	15	6 0	8 7	2
353	0316250000	North Fork New River at Crumpler	277 00	1910–58	1 7	128	155	80	109	1
354	0316284000	Elk Creek near Stratford	12 50		1 8	7 8	8 7	5 8	6 9	2
355	0316294000	Brush Creek near Blevins Crossroads	31 50		1 8	31	36	20	31	2
356	0316296000	Crab Creek near Blevins Crossroads	11 20		1 8	8 4	9 7	6 2	8 4	2
357	0343888100	West Fork French Broad River at Rosman	29 40		3 4	36	43	25	28	2
358	0343900000	French Broad River at Rosman	67 90	1909–88	3 5	80	93	55	63	1
359	0343916600	Middle Fork French Broad River near Rosman	5 63		3 4	7 5	8 6	5 2	6 8	2
360	0343933000	East Fork French Broad River near Rosman	25 90		2 9	36	40	24	32	2
361	0343950000	French Broad River at Calvert	103 00	1926–55	3 3	115	134	72	86	1
362	0344000000	Catheys Creek near Brevard	11 40	1946–55	3 2	13	15	7 8	8 5	1
363	0344011100	Nicholson Creek at Brevard	3 02		3 0	3 8	4 3	2 8	3 2	2
364	0344027200	King Creek at U S 64 at Brevard	3 60		3 0	3 8	4 4	2 5	3 2	2
365	0344043200	Looking Glass Creek at Looking Glass Falls	8 79		2 8	7 2	10	5 2	6 3	2
366	0344050000	Davidson River near Davidson River	31 00		3 2	49	56	33	33	2
367	0344100000	Davidson River near Brevard	40 40	1922–88	3 2	38	46	24	30	1
368	0344108000	Turkey Creek near Pisgah Forest	5 55		2 5	6 4	7 3	4 6	5 3	2
369	0344142000	Little River at Cedar Mountain	16 10		3 4	16	20	10	12	2
370	0344144000	Little River above High Falls near Cedar Mountain	26 80	1964–88	4 1	27	33	15	23	1

Table 1. Magnitude and frequency of annual low-flow characteristics at continuous-record streamflow gaging stations and partial-record measuring sites—Continued

Index No. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi²)	Period of record (continuous-record stations)	Average annual unit runoff ([ft³/s]/mi²)	7Q2 (ft³/s)	30Q2 (ft³/s)	7Q10 (ft³/s)	W7Q10 (ft³/s)	Type
371	0344150000	Little River near Penrose	41 40	1944–55	3 5	37	47	7 1	24	1
372	0344200000	Crab Creek near Penrose	10 90	1944–55	2 6	10	12	6 4	7 7	1
373	0344250000	Little River at Calhoun	60 10		3 5	21	69	10	36	2
374	0344300000	French Broad River at Blantyre	296 00	1922–88	3 4	319	379	206	253	1
375	0344326600	Big Willow Creek near Blantyre	9 11		2 5	8 9	10	5 8	6 9	2
376	0344376500	Shaw Creek at Horseshoe	5 36		2 0	3 0	3 6	2 1	2 4	2
377	0344400000	Boylston Creek near Horseshoe	14 80	1944–55	2 2	12	14	7 3	8 3	1
378	0344450000	South Fork Mills River at the Pink Beds	9 99	1927–73	3 2	7 0	9 1	3 8	6 4	1
379	0344550000	North Fork Mills River at Pink Beds	23 10		2 3	17	20	9 6	12	2
380	0344555000	North Fork Mills River near Mills River	24 00		2 4	18	21	10	13	2
381	0344600000	Mills River near Mills River	66 70	1926–88	2 5	52	62	31	39	1
382	0344636300	Mud Creek at Balfour	52 20		2 0	30	36	16	22	2
383	0344650000	Clear Creek near Hendersonville	42 20	1947–55	1 7	24	28	12	18	1
384	0344700000	Mud Creek at U S 25 at Naples	110 00	1940–55	1 8	69	79	40	53	1
385	0344723000	Cane Creek above Fairview	16 80		1 4	12	13	7 5	9 6	2
386	0344750000	Cane Creek at Fletcher	63 10	1944–58	1 2	22	26	12	18	1
387	0344758000	Hoopers Creek near Fletcher	15 50		1 4	4 8	6 1	2 6	3 9	2
388	0344776600	Avery Creek at mouth near Fletcher	8 60		1 4	5 8	7 0	3 4	4 5	2
389	0344813600	North Hominy Creek at N C 19 near Canton	7 82		1 2	3 2	3 9	1 8	2 6	2
390	0344821000	Hominy Creek above South Hominy Creek at Candler	30 20		1 1	11	13	6 7	9 1	2
391	0344850000	Hominy Creek at Candler	79 80	1944–77	1 2	35	41	21	28	1
392	0344891000	Swannanoa River at Grovestone at Swannanoa	21 20		1 0	10	13	5 6	8 2	2
393	0344900000	North Fork Swannanoa River near Black Mountain	23 80	1927–58	2 0	3 3	4 4	1 3	2 3	1
394	0345000000	Beetree Creek near Swannanoa	5 46	1927–81	1 9	1 4	1 8	7	1 2	1
395	0345026600	Bull Creek at mouth near Azalea	10 60		1 2	2 0	2 6	1 0	1 6	2
396	0345092100	Haw Creek at mouth at Biltmore	4 73		1 0	1 1	1 4	6	9	2
397	0345100000	Swannanoa River at Biltmore	130 00	1922–88	1 2	34	42	12	27	1
398	0345126600	Smith Mill Creek at Asheville	6 85		1 0	3 0	3 3	1 8	2 4	2
399	0345169000	Newfound Creek near Alexander	34 20		9	10	12	6 6	8 8	2
400	0345189000	Reems Creek at Alexander	36 30		9	8 0	7 2	4 3	7 3	2
401	0345196200	Flat Creek near Alexander	24 50		9	3 7	4 4	1 9	3 2	2
402	0345197100	Sandymush Creek near Sandymush	24 80		9	6 9	8 8	3 6	5 8	2
403	0345199600	North Turkey Creek near Leicester	9 53		8	2 6	3 1	1 7	2 4	2
404	0345199700	Turkey Creek near Leicester	10 90		9	3 6	4 2	2 3	3 2	2
405	0345199800	Turkey Creek at Secondary Road 1629 near Leicester	27 40		1 0	8 5	9 9	6 0	7 6	2
406	0345200000	Sandymush Creek near Alexander	79 50	1944–55	7	15	17	5 2	13	1

Index No. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi²)	Period of record (continuous-record stations)	Average annual unit runoff ([ft³/s]/mi²)	7Q2 (ft³/s)	30Q2 (ft³/s)	7Q10 (ft³/s)	W7Q10 (ft³/s)	Type
407	0345262000	Ivy River above Forks of Ivy near Democrat	60 60		7	14	17	8 0	13	2
408	0345280500	Little Ivy Creek at Beech Glen	38 70		7	6 8	8 2	4 3	6 3	2
409	0345282100	Little Ivy Creek above Forks of Ivy near Mars Hill	46 50		1 0	7 7	9 3	4 6	7 1	2
410	0345383200	Gabriel Creek at Mars Hill	3 83		1 0	8	1 0	5	7	2
411	0345292000	Bull Creek near Mars Hill	23 00		1 0	3 7	4 7	2 2	3 0	2
412	0345300000	Ivy Creek near Marshall	158 00	1935–73	1 0	29	36	17	27	1
413	0345377000	Big Pine Creek at Barnard	16 60		1 0	3 0	3 7	1 8	2 5	2
414	0345400000	Big Laurel Creek near Stackhouse	126 00	1935–71	1 5	40	48	26	31	1
415	0345461000	Spring Creek above Hot Springs	71 80		1 4	15	20	8 5	11	2
416	0345550000	West Fork Pigeon River above Lake Logan near Hazelwood	27 60	1955–88	3 7	20	26	15	19	1
417	0345600000	West Fork Pigeon River below Lake Logan near Waynesville	55 30	1955–80	3 0	38	47	27	32	1
418	0345650000	East Fork Pigeon River near Canton	51 50	1955–88	2 8	30	36	20	26	1
419	0345700000	Pigeon River at Canton	133 00	1909–84	2 4	74	88	52	62	1
420	0345706200	Beaverdam Creek near Canton	11 20		2 5	2 6	3 3	1 6	2 0	2
421	0345733200	Richland Creek at Hazelwood	10 90		2 5	8 4	10	6 5	8 0	2
422	0345736000	Richland Creek below Hyatt Creek at Hazelwood	13 20		2 6	7 8	9 3	5 6	6 3	2
423	0345750000	Allen Creek near Hazelwood	14 40	1951–72	2 4	7 7	9 9	3 6	5 4	1
424	0345850000	Pigeon River near Crabtree	243 00	1922–29	1 9	113	151	66	107	1
425	0345862000	Crabtree Creek at Crabtree	25 80		1 3	6 2	7 6	4 1	5 1	2
426	0345869000	Campbell Creek at Maggie	13 80		1 6	3 5	4 4	2 2	2 8	2
427	0345872100	Jonathan Creek above Dellwood	26 50		2 4	22	25	15	18	2
428	0345882100	Jonathan Creek below Dellwood	48 00		2 0	32	37	24	28	2
429	0345900000	Jonathan Creek near Cove Creek	65 30	1931–72	2 0	38	44	27	32	1
430	0345950000	Pigeon River near Hepco	350 00	1929–88	1 9	178	214	125	152	1
431	0345977000	Fines Creek at Hepco	27 20		1 3	7 3	9 0	4 8	5 8	2
432	0345993000	Palmer Creek near Cataloochee	8 48		2 5	6 1	7 2	4 1	4 7	2
433	0345999000	Caldwell Fork at Cataloochee	15 80		2 0	12	13	8 7	9 6	2
434	0346000000	Cataloochee Creek near Cataloochee	49 20	1935–88	2 3	30	35	22	24	1
435	0346062000	Big Creek near Mount Sterling	13 40		2 2	6 1	7 3	4 1	4 9	2
436	0346062500	Big Creek at U S 284 at Mount Sterling	33 00		2 2	13	16	8 6	10	2
437	0346191000	North Toe River at Newland	9 21		2 2	5 2	6 7	3 0	4 4	2
438	0346200000	North Toe River at Altapass	104 00	1940–57	1 8	52	63	34	43	1
439	0346307000	Big Crabtree Creek near Newdale	16 60		2 8	11	14	7 4	10	2
440	0346330000	South Toe River near Celo	43 30	1959–88	3 4	31	40	20	29	1
441	0346340200	South Toe River at Celo	53 93		3 4	42	54	28	38	2
442	0346350000	South Toe River at Newdale	59 90	1935–52	2 9	40	51	26	24	1
443	0346367000	Cane Creek at Loafers Glory	27 10		1 5	7 5	9 7	4 4	6 0	2
444	0346379000	Cane River at Pensacola	38 50		2 4	17	22	10	13	2
445	0346380100	Cane River at Burnsville	54 40		2 0	29	38	18	25	2

Table 1. Magnitude and frequency of annual low-flow characteristics at continuous-record streamflow gaging stations and partial-record measuring sites—Continued

Index No. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi²)	Period of record (continuous-record stations)	Average annual unit runoff ([ft³/s]/mi²)	7Q2 (ft³/s)	30Q2 (ft³/s)	7Q10 (ft³/s)	W7Q10 (ft³/s)	Type
446	0346392000	Price Creek at U S 19 near Ball Creek	22 40		2 0	8 1	10	5 2	6 6	2
447	0346392200	Bald Creek near Bald Creek	17 20		1 7	8 0	9 4	5 4	7 0	2
448	0346400000	Cane River near Sioux	157 00	1935–71	1 6	63	78	40	52	1
449	0347872000	Watauga River at Foscoe	10 90		2 0	5 8	7 4	3 1	4 6	2
450	0347888400	Watauga River at Valle Crucis	48 60		1 9	19	24	11	15	2
451	0347900000	Watauga River near Sugar Grove	92 10	1941–88	1 9	34	44	20	29	1
452	0348041000	Elk River at Banner Elk	7 44		2 2	4 2	5 4	2 4	3 5	2
453	0348050000	Elk River near Banner Elk	17 80	1936–40	2 4	8 2	11	5 6	6 9	1
454	0348100000	Elk River near Elk Park	42 10	1936–55	1 9	17	20	9 1	13	1
455	0349993600	Little Tennessee River near Norton	63 80		3 0	61	73	45	54	2
456	0349994000	Tessentee Creek near Otto	14 80		2 5	9 2	11	5 9	7 8	2
457	0349998400	Coweeta Creek near Franklin	16 90		2 5	17	21	8 2	13	2
458	0350000000	Little Tennessee River near Prentiss	140 00	1945–88	2 8	116	135	83	98	1
459	0350007100	Wayah Creek near Franklin	13 80		3 5	9 1	12	5 9	7 1	2
460	0350024000	Cartoogechaye Creek near Franklin	57 10	1963–88	2 6	45	51	30	39	1
461	0350032400	Mill Creek at U S 64 at Highlands	1 15		3 5	7	9	3	4	2
462	0350050000	Cullasaja River at Highlands	14 90	1933–71	4 0	11	16	2 4	5 4	1
463	0350078000	Ellijay Creek near Cullasaja	20 40		2 5	12	15	9 2	11	2
464	0350100000	Cullasaja River at Cullasaja	86 50	1909–71	2 6	60	71	37	45	1
465	0350233000	Cowee Creek near Wests Mill	25 10		2 5	14	17	9 4	11	2
466	0350263000	Burningtown Creek at Stiles	26 60		2 5	17	20	12	14	2
467	0350276600	Tellico Creek near Stiles	12 20		3 0	5 7	7 3	3 8	4 6	2
468	0350356100	Nantahala River at U S 64 at Rainbow Springs	24 20		3 5	27	33	20	23	2
469	0350400000	Nantahala River near Rainbow Springs	51 90	1942–88	3 9	58	69	41	48	1
470	0350526600	Queens Creek near Nantahala	2 79		3 0	1 6	1 8	1 3	1 4	2
471	0350550000	Nantahala River at Nantahala	144 00	1944–81	3 5	55	191	34	73	1
472	0350650000	Nantahala River at Almond	174 00	1914–43	2 9	143	164	101	119	1
473	0350716600	Sols Creek near Argura	3 86		3 6	3 2	3 8	2 4	2 5	2
474	0350749500	Pine Creek near Glenville	6 92		3 0	6 6	7 8	4 4	5 1	2
475	0350800000	Tuckasegee River at Tuckasegee	143 00	1936–76	2 8	111	163	57	81	1
476	0350824000	Caney Fork at East Laport	51 20		2 4	32	37	25	26	2
477	0350862100	Cullowhee Creek above sewage effluent outfall at Cullowhee	20 60		2 2	9 8	12	6 7	7 0	2
478	0350874000	Savannah Creek near Webster	41 20		2 2	28	31	24	24	2
479	0350900000	Scott Creek above Sylva	51 00	1943–75	2 3	38	45	28	30	1
480	0350950000	Scott Creek at Sylva	55 50	1929–41	2 2	36	40	24	26	1
481	0351050000	Tuckasegee River at Dillsboro	347 00	1935–81	2 2	285	353	198	236	1

Index No. (pl. 1)	USGS downstream order number	Station name	Drainage area (mi^2)	Period of record (continuous-record stations)	Average annual unit runoff ([ft^3/s]/mi^2)	7Q2 (ft^3/s)	30Q2 (ft^3/s)	7Q10 (ft^3/s)	W7Q10 (ft^3/s)	Type
482	0351056600	Dicks Creek at U S 19A near Dillsboro	8 70		2 1	3 1	4 1	2 0	2 3	2
483	0351061000	Connley Creek at Whittier	13 50		2 1	7 1	8 8	4 6	5 2	2
484	0351064000	Beech Flats Prong at U S 441 near Smokemont	81		2 6	7	8	5	6	2
485	0351068000	Oconaluftee River near Smokemont	20 70		2 5	18	21	13	15	2
486	0351074000	Bradley Fork at Smokemont	19 90		2 8	13	16	9 4	11	2
487	0351081500	Mingus Creek at Ravensford	4 70		2 9	3 4	4 3	2 0	2 5	2
488	0351087000	Raven Fork at Swayney	47 70		2 8	36	45	25	29	2
489	0351100000	Oconaluftee River at Cherokee	131 00	1922–49	2 9	103	117	72	83	1
490	0351136000	Soco Creek near Cherokee	44 70		2 3	27	32	19	22	2
491	0351200000	Oconaluftee River at Birdtown	184 00	1948–88	2 8	141	173	103	118	1
492	0351218000	Cooper Creek at mouth near Bryson City	7 10		2 5	5 5	7 0	3 7	4 3	2
493	0351274000	Deep Creek near Bryson City	40 20		2 4	32	40	22	26	2
494	0351346500	Lands Creek near Bryson City	2 52		2 9	8	1 1	4	5	2
495	0351350000	Noland Creek near Bryson City	13 80	1937–71	3 2	10	13	6 4	7 6	1
496	0351378000	Panther Creek at Japan	11 10		3 5	5 2	6 0	3 6	4 2	2
497	0351400000	Hazel Creek at Proctor	44 40	1944–52	2 9	32	37	23	30	1
498	0351512000	Twenty Mile Creek near Fontana Dam	15 10		2 5	9 8	13	6 3	8 0	2
499	0351536000	Sweetwater Creek near Robbinsville	13 60		3 0	7 0	8 0	5 2	6 1	2
500	0351561000	Long Creek at Robbinsville	11 80		3 5	7 6	9 2	4 2	5 6	2
501	0351600000	Snowbird Creek near Robbinsville	42 00	1944–52	3 8	39	45	32	38	1
502	0351614100	West Buffalo creek at mouth near Santeetlah	13 80		3 0	8 4	10	3 9	5 9	2
503	0351622000	Santeetlah Creek near Rattler Ford	19 60		2 5	9 3	12	4 0	6 3	2
504	0351700000	Cheoah River at Johnson	177 00	1914–26	2 9	131	154	68	111	1
505	0351704000	Yellow Creek near Tapoco	12 70		2 8	7 1	7 9	5 1	6 2	2
506	0354600000	Shooting Creek near Hayesville	37 60	1943–55	2 4	21	24	13	17	1
507	0354754000	Tusquitee Creek below Greasy Creek near Hayesville	42 50		2 5	28	32	18	22	2
508	0354800000	Hiwassee River below Hayesville	252 00	1936–45	2 0	117	132	52	56	1
509	0354841300	Peachtree Creek near Murphy	18 20		2 2	7 8	12	3 2	4 9	2
510	0354912400	Valley River at Buffalo	20 80		2 5	8 2	11	4 8	6 3	2
511	0354924900	Junaluska Creek near Andrews	8 11		2 9	4 2	5 0	3 0	3 6	2
512	0354937400	Tatham Creek at Andrews	8 24		2 4	3 4	4 3	2 1	2 7	2
513	0354958300	Valley River near Andrews	49 40		2 5	20	24	11	15	2
514	0354964100	Taylor Creek at Coalville	5 78		2 5	3 1	3 6	1 9	2 5	2
515	0354982000	Hyatt Creek at U S 19 at Marble	7 23		2 5	3 8	4 5	2 3	3 0	2
516	0355000000	Valley River at Tomotla	104 00	1906–88	2 5	52	61	30	40	1
517	0355400000	Nottely River near Ranger	272 00	1902–45	1 8	150	175	41	46	1
518	0355554400	Shuler Creek near Violet	13 90		2 5	9 4	10	6 9	8 0	2

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