THE CULPEPER BASIN FOLIO

The Culpeper basin is a structural trough filled with sedimentary and igneous rocks of Mesozoic age that borders the eastern front of the Blue Ridge in northern Virginia. It extends from the Rapidan River near Madison Mills northeastward across the Potomac River and terminates just west of Frederick, Maryland.

This report is one of a series being prepared as part of a study of the geologic and hydrologic resources of the Culpeper basin. The scale of the maps, 1:125,000 (1 inch = approximately 2 miles), permits only a regional overview or guide to evaluating hydrologic and geologic conditions that may influence certain types of land use. The maps are not intended for enlargement, nor are they, or any graphical or tabulated data included, intended to replace site investigations. Local details at a given site may differ from the general conditions portrayed on these maps and detailed studies are invariably required for site planning. A series of larger-scale geologic maps of the basin by Lee (1979, 1980) are available for determining the rock types in which existing or proposed surface-water sites are located.

By combining the basic resource maps in a variety of ways, depending on the relevant limiting factors for any given land use, the user can derive a secondary series of maps that focus on specific problems. Potential uses of these maps and possible derivative products are discussed in the texts accompanying each map.

INTRODUCTION

Almost every practical use of water requires that at least some minimum quantity be available throughout the year. Thus, the ability of streamflow to meet the requirements for numerous applications—such as municipal or industrial water supplies, supplemental irrigation, recreation, disposal of wastes, and maintenance of conditions suitable for aquatic life—is commonly evaluated in terms of low-flow characteristics (Riggs, 1972). The magnitudes of these characteristics are determined primarily by natural conditions, but human activities may also be influential.

The low flow of most streams in and adjacent to the Culpeper geologic basin is related to drainage-basin size and rock type. Streams that drain large areas of deeply weathered crystalline rocks adjacent to the Culpeper basin generally flow continuously. In contrast, streams that drain younger, less weathered igneous and sedimentary rocks within the Culpeper basin commonly go dry during long periods of no rainfall. Ground-water discharge (also called base flow) makes up an increasingly greater proportion of total streamflow during dry weather periods. During such periods, stream water quality characteristics are increasingly influenced by drainage-basin rock type.

This report presents a summary of streamflow and water-quality data collected at 47 gaged and ungaged sites in the Culpeper basin during several periods of low streamflow between July 1979 and August 1981. Specifically, the paper (1) describes minimum 7-day flows at 14 long-term gaging stations for selected recurrence intervals, (2) estimates 7-day, 2-year and 7-day, 10-year minimum flows at 33 ungaged sites, and (3) describes the influence of basin rock type on low-flow discharge and water quality. Specific low-flow characteristics for streams are calculated from a series of discharge measurements, whereas water-quality conditions are characterized, only in a general sense, for the streams at base flow.

The basic data used in the statistical analyses presented here have been published in annual reports of the U.S. Geological Survey, WRD, Virginia and Maryland (1979–81). All of the water-quality data and most of the discharge data were collected by personnel of the Geological Survey. Supplemental stream discharge data were provided by the Virginia State Water Control Board (SWCB) and streamflow records from several long-term gaging stations operated by the SWCB were used to compute low-flow characteristics. The locations of the low-flow sites and stream-gaging stations referred to in the text and tables are shown on the accompanying map.

LOW-FLOW CHARACTERISTICS

Low-flow characteristics of streams are usually defined in terms of the lowest mean flow expected for a given duration and specified recurrence interval. A stream-discharge value designating the 7-day, 10-year (7Q10) low flow is a commonly cited criterion in Federal and State laws that regulate the discharge of wastewater to streams. The 7Q10 low flow is the discharge at the 10-year recurrence interval taken from a frequency curve of annual values of the lowest average discharge for seven consecutive days. In other words, the probability is 1/10 (or 10 percent) that in any 1 year the actual 7-day low flow will be less than the 7Q10 low flow indicated by the frequency curve (Cushing and others, 1973).

Curves that indicate the frequency of annual minimum 7-day average flows at long-term gaging stations can be determined by a theoretical frequency analysis of the data (Riggs, 1968). Such low-flow frequency curves were developed for 14 gaging stations in the Culpeper basin; two of the curves are shown as examples in figure 1. Seven-day low flows values for recurrence intervals of 2, 5, 10, and 20 years for the gaging stations are given in table 1. The station locations are also plotted on the report map along with their respective 7-day, 2- and 10-year low-flow discharges.

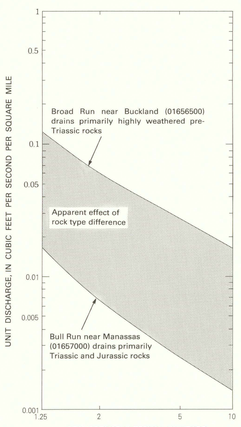

FIGURE 1.—Seven-day low-flow frequency curves for two streams draining different rock types

DERIVATION OF LOW-FLOW VALUES FOR UNGAGED SITES

Low-flow characteristics for an ungaged site on a stream can be estimated without obtaining additional field data if low-flow data already are available from a nearby point on the same stream. However, more accurate estimates can be made by obtaining several discharge measurements at the ungaged site during periods of low flow and relating them to concurrent streamflow data at a long-term gaging station either on the same stream or on a nearby stream with similar basin characteristics. Relation lines were defined using log transformed data; however, in some cases untransformed data were used when zero values were anticipated. This procedure was used to estimate low-flow characteristics at 33 selected sites on streams in and adjacent to the Culpeper basin.

For example, in figure 2, discharges determined from low-flow measurements of Limestone Branch tributary near Leesburg, Virginia (U.S. Geological Survey site number 01643600) were plotted against concurrent daily mean flows at the gaging station Bennett Creek at Park Mills, Maryland (01643500). The resulting line of relation was used to estimate low-flow characteristic values for Limestone Branch tributary from the corresponding values (determined from the low-flow frequency curve) at Bennett Creek. It is uncommon to obtain actual streamflow measurements as low as the 7-day, 10-year low-flow value for a given stream. Consequently, relations such as that shown in figure 2 must be extrapolated downward to estimate these values, which may introduce some error. However, correlations between index and miscellaneous station discharges were good in this study (coefficient of determination ranged from 0.89 to 0.99), which provides a fair degree of confidence in these estimates. Estimates of the 7-day, 2-year (7Q2) low-flow value for the miscellaneous stations should be good because at least one discharge measurement was made at each station when flows at nearby index stations were near their 7Q2 low-flow values.

The estimated low-flow characteristics presented in this report are limited to the 7-day, 2-year and 7-day, 10-year discharges. Data and estimates for these low-flow sites are presented in table 2 along with additional low-flow data from previous investigations in the area (Mohler and Hagan, 1981; Carpenter, 1983). These low-flow measurement sites are located on the accompanying map.

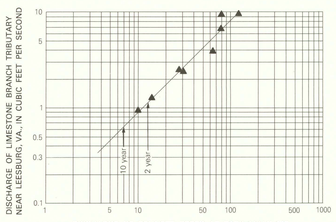

FIGURE 2.—Relation of low-flow measurements of Limestone Branch tributary near Leesburg, Virginia, to concurrent mean daily flow at Bennett Creek at Park Mills, Maryland

FACTORS AFFECTING LOW FLOWS

Various drainage basin features affect low-flow characteristics of streams (Nuckels, 1970). Natural factors include basin size, bedrock type, vegetative cover, and topographic features such as land slope and surface roughness. Climatic factors such as temperature, evapotranspiration, and precipitation also affect low-flow characteristics, but climatic variations within a limited study area such as the Culpeper basin are usually negligible. Modification of the land surface by man, such as removal of trees for agricultural, residential, and other development, may significantly affect low-flow characteristics of streams. However, this report will focus primarily on natural factors that influence low flows.

Low-flow discharges for streams in and adjacent to the Culpeper basin are related to drainage basin area and rock type. (Drainage areas and basin rock-type data for each site are presented in tables 1 and 2). A plot of 7Q2 low flows as a function of basin size shows the expected trend: Low-flow values are roughly proportional to drainage basin size (fig. 3). This is especially evident for streams draining pre-Triassic rocks outside the Culpeper basin. Figure 3 also illustrates the effect of drainage basin rock type on low flow. Drainage basins underlain primarily by pre-Triassic rocks have significantly higher 7Q2 values than basins underlain by Triassic and Jurassic rocks (within Culpeper basin). For Triassic and Jurassic basins of less than 50 square miles, about two-thirds have 7Q2 values of zero (table 2). In contrast, 7Q2 values greater than zero are observed in all pre-Triassic drainage basins in this size category. Moreover, unit 7Q2 values in pre-Triassic basins average 0.12 $ft^3/s/mi^2$, compared to 0.004 $ft^3/s/mi^2$ for Triassic and Jurassic basins, a thirtyfold difference. This pattern is evident in figure 1 where the difference between low-flow frequency curves for Broad Run at Buckland (01656500) and Bull Run near Manassas (01657000) is attributed to these drainage basin rock type differences.

A relation between low-flow values and drainage basin rock type is also apparent for basins underlain (greater than 75 percent) by the Triassic and Jurassic rocks of the Culpeper basin. Basins dominated by diabase (J), basalt (B), and/or thermally metamorphosed rocks (T) generally have unit 7Q2 values equal to or very near zero. Of the eight such basins included in this study, all have unit 7Q2 values of less than 0.001 $ft^3/s/mi^2$, including Marsh Run near Remington (01664750) and Cedar Run near Culpeper (01667650), both with drainage areas greater than 30 mi^2. In contrast, basins dominated by siltstone (S_1), sandstone (S_2), and/or conglomerate (S_4 and S_5) generally have higher unit 7Q2 values, averaging 0.006 $ft^3/s/mi^2$. However, unit 7Q2 values for these basins are highly variable, ranging from zero to 0.03 $ft^3/s/mi^2$, which indicates that any stream in the Culpeper basin may go dry during periods of limited precipitation, irrespective of underlying geology.

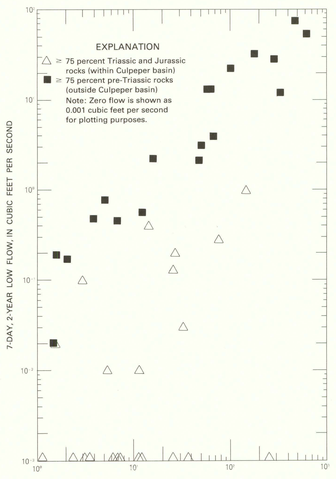

FIGURE 3.—Relation of 7-day, 2-year low flow to drainage area for Triassic and Jurassic basins and pre-Triassic basins.

The physical properties of bedrock and overburden in the study area help to explain the observed relations between rock type and low-flow characteristics (table 3). The rock types present, their ground-water transmission capacity, and the thickness and physical properties of the overburden determine to a large extent the amount of precipitation which enters the ground-water system and its rate of infiltration, and the rate of ground-water discharge as base flow. Pre-Triassic basins have relatively high unit low flows because the thick, weathered overburden captures and efficiently stores precipitation. This stored water is released slowly to augment streamflow during dry periods.

Basins underlain by diabase, basalt, and thermally metamorphosed rocks have zero to extremely low unit low flows. A lack of connections between the narrow bedrock fractures in these rocks, together with a very thin to nonexistent overburden, severely limit ground-water storage and transmission capacity. Consequently, most precipitation is lost as surface runoff, and that which recharges the ground-water system is unable to sustain an appreciable base flow (Laczniak and Zenone, 1984).

Sedimentary rocks in the Culpeper basin (siltstone, sandstone, and conglomerates) may also have low unit low-flow values because of a thin, poorly weathered overburden. However, higher values are generally associated with these sedimentary rocks than with diabase, basalt, and thermally metamorphosed rocks because ground-water storage and movement is greater. Limestone conglomerate (S_4) is not grouped with the other sedimentary rocks in the Culpeper basin because of its relatively high ground-water storage capacity. High low-flows can be expected from basins underlain by this rock type, as illustrated by Limestone Branch tributary near Leesburg (01643600), which has a unit 7Q2 low-flow value of 0.18 $ft^3/s/mi^2$.

Topographic factors other than drainage area are not quantified for the low-flow basins defined in this study, but some general rules about their effect on low flow can be stated. Land slope and surface roughness, the latter taken to include plant cover, control to some extent the rate of surface runoff and therefore the time available for water to infiltrate to the ground-water table. Steep slopes promote rapid runoff and low infiltration; gentle slopes delay runoff and consequently increase potential for infiltration.

TABLE 1.—Low-flow values and basin characteristics at long-term continuous-record gaging stations in and adjacent to Culpeper basin
[Annual low flow given in cubic feet per second and, in parentheses, in cubic feet per second per square mile.]

Station number	Station name and location	Period of record climatic years ending March 31 (years)	Drainage area, in square miles	Annual 7-day low flow for indicated recurrence interval				Percentage of indicated rock type in basin[1]						
				2-year	5-year	10-year	20-year	S_3 and S_5	S_4	B	S_2	S_1	J and T	P
01637500	Catoctin Creek near Middletown, Md.	1949-78 (29)	66.9	3.9 (0.058)	1.9 (0.028)	1.0 (0.015)	0.81 (0.012)	0	0	0	0	0	0	100
01643500	Bennett Creek at Park Mills, Md.	1950-78 (20)	62.8	13 (0.21)	8.5 (0.14)	6.9 (0.11)	5.6 (0.089)	0	0	0	0	0	0	100
01644000	Goose Creek near Leesburg, Va.	1931-80 (50)	332	12 (0.036)	4.2 (0.013)	2.4 (0.007)	1.4 (0.004)	1	0	1	2	0	1	95
01645000	Seneca Creek at Dawsonville, Md.	1932-78 (47)	101	22 (0.22)	11 (0.11)	7.4 (0.073)	5.0 (0.050)	0	0	0	4	0	4	92
01646000	Difficult Run near Great Falls, Va.	1936-80 (45)	57.9	13 (0.22)	5.6 (0.097)	2.9 (0.050)	1.5 (0.026)	1	0	0	0	0	0	99
01655500	Cedar Run near Warrenton, Va.	1951-80 (29)	12.3	0.56 (0.046)	0.23 (0.019)	0.14 (0.011)	0.09 (0.007)	0	0	0	0	0	0	100
01656000	Cedar Run near Catlett, Va.	1952-80 (23)	93.4	0.96 (0.010)	0	0	0	1	0	20	18	13	5	43
01656500	Broad Run near Buckland, Va.	1951-79 (28)	50.5	3.1 (0.061)	1.4 (0.028)	0.87 (0.017)	0.58 (0.010)	1	0	5	12	0	0	82
01657000	Bull Run near Manassas, Va.	1952-62 (11)[2]	148	0.99 (0.007)	0.37 (0.003)	0.21 (0.0014)	—	6	0	7	27	33	26	1
01663500	Hazel River at Rixeyville, Va.	1944-79 (36)	287	28 (0.097)	11 (0.038)	5.9 (0.021)	3.5 (0.012)	0	0	0	0	0	0	100
01664000	Rappahannock River at Remington, Va.	1944-80 (37)	620	53 (0.085)	20 (0.032)	11 (0.018)	6.6 (0.011)	0	0	0	1	0	1	98
01665000	Mountain Run near Culpeper, Va.	1951-80 (30)	15.9	2.2 (0.138)	1.0 (0.063)	0.57 (0.036)	0.33 (0.021)	0	0	0	0	0	0	100
01666500	Robinson River near Locust Dale, Va.	1945-80 (33)	179	32 (0.18)	15 (0.084)	9.3 (0.052)	6.2 (0.035)	2	0	0	0	0	2	96
01667500	Rapidan River near Culpeper, Va.	1932-80 (49)	472	74 (0.157)	33 (0.070)	20 (0.042)	12 (0.025)	2	0	0	0	1	2	95

[1]Rock types mapped by Leavy and others (1983) and Lee (1979, 1980).
S_1, siltstone; S_2, sandstone; S_3, conglomerate (schist & quartz); S_4, conglomerate (limestone); S_5, conglomerate (greenstone); B, basalt; T, thermally metamorphosed rocks; J, diabase; P, pre-Triassic rocks (schist, phyllite, limestone, greenstone, and quartzite).

[2]Period of record for low-flow analysis ends in 1962 because of sewage inputs beginning in 1963.

TABLE 2.—Low-flow values and basin characteristics at low-flow measuring stations on streams in and adjacent to Culpeper basin
[Annual low flow given in cubic feet per second and, in parentheses, in cubic feet per second per square mile.]

Station number	Station name and location	Period of record (water years)	Drainage area, in square miles	Estimated annual 7-day low flow for indicated recurrence interval		Lowest measured streamflow, in cubic feet per second	Percentage of indicated rock type in basin[1]						
				2-year	10-year		S_3 and S_5	S_4	B	S_2	S_1	J and T	P
01638600[3]	Tuscarora Creek at Tuscarora, Md.	1975-79	20.3	4.2 (0.21)	2.4 (0.12)	—	0	17	0	19	15	0	49
01643125[3]	Ballenger Creek near Lime Kiln, Md.	1977-80	20.2	4.9 (0.24)	2.9 (0.14)	—	0	8	0	7	20	2	63
01643585	Potomac R. trib. 1 near Lucketts, Va.	1979-81	2.95	0.10 (0.034)	0.04 (0.014)	.08	0	1	0	[6]61	31	7	0
01643600	Limestone Br. trib. near Leesburg, Va.	1979-81	6.82	1.2 (0.18)	0.6 (0.09)	1.0	0	51	0	0	5	0	44
01643613	Broad Run trib. near Poolesville, Md.	1979-81	0.78	0.008 (0.010)	0	0.007	0	0	0	[6]100	0	0	0
01643615[3]	Broad Run at Elmer, Md.	1975-80	14.2	0.4 (0.028)	0.1 (0.007)	—	0	0	0	66	28	6	0
01643988	Little River near Oatlands, Va.	1968-69 1979-81	47.7	2.1 (0.044)	0.50 (0.010)	2.3	0	0	6	2	0	0	92
01643990	Howsers Branch near Oatlands, Va.	1979-81	5.98	0	0	0	37	0	28	32	0	3	0
01644255	S. F. Broad Run near Arcola, Va.	1979-81	5.31	0.01 (0.002)	0	.03	39	0	0	0	26	35	0
01644277	Beaverdam Run near Ashburn, Va.	1979-81	11.2	0	0	0	0	0	0	0	59	41	0
01644280	Broad Run near Leesburg, Va.	1979-81	76.1	0.28 (0.004)	0.02 (0.0003)	0.35	7	0	0	6	55	32	0
01644283	Potomac R. trib. 2 near Sterling, Va.	1979-81	3.47	0	0	0	0	0	0	0	100	0	0
01644291[3]	Stave Run near Reston, Va.	1971-78[5]	0.08	0	0	—	0	0	0	0	0	100	0
01644295[3]	Smilax Branch at Reston, Va.	1967-78[5]	0.32	0	0	—	27	0	0	0	0	21	52
01644300[3]	Sugarland Run at Herndon, Va.	1965-74 1978-81	3.36	0	0	0	0	0	0	0	0	100	0
01645050	Dry Seneca Creek near Seneca, Md.	1979-81	19.2	0.9 (0.047)	0.2 (0.010)	0.28	0	0	0	71	0	0	29
01645750[3]	South Fork Little Difficult Run near Fairfax, Va.	1966-74, 77	1.59	0.19 (0.12)	0.03 (0.02)	—	7	0	0	0	0	3	90
01645784[3]	Snakeden Branch at Reston, Va.	1974-78	0.79	0.22 (0.28)	0.06 (0.08)	—	0	0	0	0	0	0	100
01645900[3]	Colvin Run at Reston, Va.	1962-70, 1972-74, 77	5.09	0.78 (0.15)	0.13 (0.026)	—	0	0	0	0	0	0	100
01645950[3]	Piney Run at Reston, Va.	1965-66, 77	2.06	0.17 (0.083)	0.004 (0.002)	—	0	0	0	0	0	0	100
01653900[3]	Accotink Creek at Fairfax, Va.	1960-64, 1966-74, 77	6.80	0.45 (0.066)	0.06 (0.009)	—	0	0	0	0	0	0	100
01656100	Cedar Run near Aden, Va.	1974-83[4]	155	3.0 (0.019)	0.7 (0.004)	0.25	2	0	12	17	24	14	31
01656645	Rocky Br. trib. near Gainesville, Va.	1979-81	2.32	0	0	0	0	0	0	0	0	100	0
01656650	Broad Run near Bristow, Va.	1968-71	89.6	[3]3.6 (0.04)	[3]<1.0 (<0.011)	1.3	1	0	7	22	4	16	50
		1975-83[5]		[4]4.4 (0.05)	[4]1.3 (0.015)	0.90							
01656655	Kettle Run near Nokesville, Va.	1979-81	11.9	0	0	0	0	0	0	14	27	45	10	4
01656659	Kettle Run at Brentsville, Va.	1968-69 1979-81	25.0	0	0	0	0	0	0	7	16	47	28	2
01656670	Broad Run at Brentsville, Va.	1943, 51-54	137	[3]3.3 (0.024)	[3]1.2 (0.009)	1.0	0	0	6	20	22	19	33
		1979-81		[4]5.0 (0.036)	[4]1.5 (0.011)	8.0							
01656705	Black Branch at Haymarket, Va.	1969-71 1979-81	3.05	0.02 (0.007)	0	0.07	0	0	55	17	0	0	28
01656715	Chestnut Lick near Catharpin, Va.	1979-81	11.1	0.01 (0.001	0	<0.01	5	0	35	48	0	0	12
01656725	Bull Run near Catharpin, Va.	1951-54 1971-81[6]	25.8	0.13 (0.005)	0	0	10	0	27	42	0	13	8
01656743	Lick Branch at Catharpin, Va.	1979-81	3.06	0	0	0	31	0	0	69	0	0	0
01656750	Little Bull Run near Bull Run, Va.	1968-71 1979-81	27.2	0.2 (0.007)	0	0.06	3	0	11	45	16	15	10
01656768	Flat Branch near Manassas, Va.	1950-54 1979-81	1.10	0	0	0	0	0	0	0	62	38	0
01656800[3]	Cub Run near Chantilly, Va.	1962 1964-69, 77	7.13	0	0	—	0	0	0	0	81	19	0
01656930	Elklick Run near Chantilly, Va.	1979-81	10.9	0	0	0	0	0	0	0	27	73	0
01657245	Russia Branch at Manassas, Va.	1979-81	1.47	0.02 (0.014)	0.004 (0.003)	0.025	0	0	0	100	0	0	0
01657300[3]	Popes Head Creek at Fairfax Station, Va.	1964-65, 77	3.88	0.48 (0.12)	0.07 (0.02)	—	0	0	0	0	0	0	100
01657400[3]	Popes Head Creek at Clifton, Va.	1964, 65, 77	17.2	1.2 (0.070)	0.11 (0.006)	—	0	0	0	0	0	0	100
01664100	Tinpot Run at Remington, Va.	1979-81	9.70	0	0	0	0	0	35	14	21	3	27
01664690	Browns Run near Elk Run, Va.	1979-81	2.55	0	0	0	0	0	0	0	53	47	0
01664750	Marsh Run near Remington, Va.	1979-81	37.3	0	0	0	0	0	8	23	26	42	1
01665100	Jonas Run near Brandy Station, Va.	1979-81	11.4	<0.01 (<0.001)	0	0.03	38	0	0	31	11	12	8
01665150	Mountain Run near Kellys Ford, Va.	1979-81	118	4.1 (0.035)	0.8 (0.007)	9.6	14	0	0	6	18	15	47
01667650	Cedar Run near Culpeper, Va.	1951-54 1979-81	33.2	0.03 (0.0009)	0	0	17	0	0	3	0	62	18
01667700	Summerduck Run near Culpeper, Va.	1979-81	11.0	<0.01 (<0.001)	0	0.02	18	0	0	0	0	82	0
01667750	Potato Run near Stevensburg, Va.	1979-81	6.67	0	0	0	0	0	0	0	18	82	0

[1]Rock types mapped by Leavy and others (1983) and Lee (1979, 1980).
S_1, siltstone; S_2, sandstone; S_3, conglomerate (schist & quartz); S_4, conglomerate (limestone); S_5, conglomerate (greenstone); B, basalt; T, thermally metamorphosed rocks; J, diabase; P, pre-Triassic rocks (schist, phyllite, limestone, greenstone, and quartzite).

[2]Data obtained from Carpenter (1983).
[3]Includes 8 percent sandstone (S_2) overlain by terrace gravels (Lee, 1979).
[4]Sandstone (S_2) overlain by terrace gravels (Lee, 1979).
[5]Data obtained from Mohler and Hagan (1981).
[6]Continuous record station.
[7]Prior to construction of Lake Manassas.
[8]After construction of Lake Manassas.

EXPLANATION

- Culpeper basin boundary
- ▲ Continuous-record streamflow gaging station
- Low-flow measurement site
- 01655500 Station number
- .56:.14 Numbers represent 7-day, 2-year, low flow in cubic feet per second (left), and 7-day, 10-year, low flow in cubic feet per second (right)

BEDROCK UNITS

Dominant rock units in basin, discussed in text

S_1 Siltstone S_2 Sandstone J Diabase (sills, dikes, and stocks)

Minor rock units (indicated by letter only)

T Thermally Metamorphosed Rocks B Basalt flows

S_3 S_4 S_5 Conglomerates of different clast types P Pre-Triassic rocks

TABLE 3.—Rock types and associated overburden and hydrologic characteristics of drainage basins in and adjacent to Culpeper basin

	TRIASSIC AND JURASSIC[1]		PRE-TRIASSIC
	(S_1, S_2, S_3, S_5)	(B, J, T)	(P)
Rock type[2]	Siltstone, sandstone, shale, and conglomerate of schist, quartz and greenstone clasts.	Fine- to coarse - crystalline rock including diabase, basalt, and thermally metamorphosed rock.	Piedmont surrounding Culpeper basin comprised of crystalline rocks.
Overburden structure	Very thin; typically 0–15 feet but as much as 50 feet locally.	Very thin; generally 0–15 feet but as much as 50 feet locally.	Thick overburden (as great as 200 feet).
Ground-water transmission capability	Low to moderately high	Very low to low	Very low to moderate
Ground-water storage capability	Low to moderate	Very low	Moderate to high
Unit 7-day, 2-year low-flow characteristics, in cubic feet per second per square mile	Low unit flow to no flow; generally 0.001 to 0.03. Variation between basins is relatively high.	Very low unit flow or no flow; values generally range from 0.00 to 0.001.	High unit flow in basins over 1 mi^2; generally 0.05 to 0.25.

[1]Excluding limestone conglomerate.
[2]See table 1 for rock type classifications.

SCALE 1:125 000
5 4 3 2 1 0 5 MILES
5 4 3 2 1 0 5 10 KILOMETERS

LOW-FLOW CHARACTERISTICS AND CHEMICAL QUALITY OF STREAMS IN THE CULPEPER GEOLOGIC BASIN, VIRGINIA AND MARYLAND

By
D. D. Lynch, E. H. Nuckels and Chester Zenone

1987

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