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Scientific Investigations Report 2006–5244

U.S. Department of the Interior
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Conversion Factors

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
	Area	
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second (ft^3/s)	0.6463	million gallons per day (Mgal/d)

Temperature in degrees Fahrenheit (˚F) may be converted to degrees Celsius (˚C) as follows:

˚C = (˚F - 32) / 1.8

Horizontal coordinate information is referenced to North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to North American Vertical Datum of 1988 (NAVD 88).

Selected Streamflow Statistics and Regression Equations for Predicting Statistics at Stream Locations in Monroe County, Pennsylvania

By Ronald A. Thompson and Scott A. Hoffman

Abstract

A suite of 28 streamflow statistics, ranging from extreme low to high flows, was computed for 17 continuous-record streamflow-gaging stations and predicted for 20 partial-record stations in Monroe County and contiguous counties in northeastern Pennsylvania. The predicted statistics for the partial-record stations were based on regression analyses relating intermittent flow measurements made at the partial-record stations indexed to concurrent daily mean flows at continuous-record stations during base-flow conditions. The same statistics also were predicted for 134 ungaged stream locations in Monroe County on the basis of regression analyses relating the statistics to GIS-determined basin characteristics for the continuous-record station drainage areas.

The prediction methodology for developing the regression equations used to estimate statistics was developed for estimating low-flow frequencies. This study and a companion study found that the methodology also has application potential for predicting intermediate- and high-flow statistics.

The statistics included mean monthly flows, mean annual flow, 7-day low flows for three recurrence intervals, nine flow durations, mean annual base flow, and annual mean base flows for two recurrence intervals. Low standard errors of prediction and high coefficients of determination (R^2) indicated good results in using the regression equations to predict the statistics. Regression equations for the larger flow statistics tended to have lower standard errors of prediction and higher coefficients of determination (R^2) than equations for the smaller flow statistics.

The report discusses the methodologies used in determining the statistics and the limitations of the statistics and the equations used to predict the statistics. Caution is indicated in using the predicted statistics for small drainage area situations. Study results constitute input needed by water-resource managers in Monroe County for planning purposes and evaluation of water-resources availability.

Introduction

A perception exists in the Monroe County area that increasing development constitutes a threat to surface- and ground-water availability. The U.S. Geological Survey (USGS) and the Brodhead Watershed Association (BWA) cooperated in a study to determine streamflow statistics for 14 management area pour points (MAPP) in the Paradise Creek and Pocono Creek watersheds and for 120 selected stream locations (SSL) in Monroe County. The MAPP locations were determined in prior planning studies conducted by the Paradise Township (PT), BWA, Monroe County Conservation District (MCCD), and Delaware River Basin Commission. The SSL sites were added in consultation with PT, BWA, and MCCD to expand the geographic coverage of sites in Monroe County with streamflow statistics. The statistics developed in this study quantify surface-water resources, can serve as surrogates for ground-water availability, and will assist water-resource managers within Monroe County plan for and evaluate the effects of competing water uses.

Purpose and Scope

This report presents observed and predicted streamflow statistics for streamflow-gaging stations (stations) in Monroe County and the contiguous Pennsylvania counties of Carbon, Luzerne, Northampton, Pike, and Wayne. The observed statistics in this report are those computed for the continuous-record stations. The report includes (1) a comparison of observed and predicted statistics for continuous-record stations; (2) regression equations developed for predicting the statistics; and (3) predicted statistics for the MAPP and SSL in Monroe County. The report also discusses the methods used to determine the statistics and the limitations of the statistics and equations. A glossary of selected terms used is included at the back of the report.

A suite of 28 observed and predicted streamflow statistics ranging from extreme low to high flows was developed for 37 stations and 134 ungaged locations. The 37 stations included 17 continuous-record and 20 partial-record sites located in Monroe, Carbon, Lackawanna, Northampton, Pike, and Wayne

Counties. The predicted statistics for the 134 ungaged locations were limited to streams in Monroe County. The results of regression analyses relating streamflow measurements at the partial-record stations and concurrent daily mean flows at the continuous-record stations were used to predict statistics for the partial-record stations. The results of regression analyses relating the individual observed statistics to basin characteristics at the continuous-record stations were used to predict statistics for the ungaged locations.

Study Area

Monroe, Carbon, Lackawanna, Luzerne, Northampton, Pike, and Wayne Counties are in northeastern Pennsylvania (fig. 1). The area has an average annual temperature of about 47°F and an average annual precipitation of about 44 in. (National Climatic Data Center, 2002). Average annual potential evapotranspiration is about 26 in. (Flippo, 1982a).

The Delaware River is the eastern border of Wayne, Pike, Monroe, and Northampton Counties. The Lehigh River rises in southern Wayne County, is the border between northwestern Monroe County and Lackawanna and Luzerne Counties, bisects Carbon County in a north-to-south direction, and then flows easterly through the southern third of Northampton County to its confluence with the Delaware River. Paradise and Pocono Creeks flow easterly and are tributaries to Brodhead Creek, which flows southerly towards the Delaware River (fig. 1). All streams in Monroe County are tributaries, either directly or indirectly, to the Lehigh or Delaware Rivers.

Hydrogeologic Setting

The surficial geology of Monroe County includes alluvial and glacial deposits, and siltstones, shales, sandstones, conglomerates, and small amounts of carbonate rock that have been deformed by intense folding in some parts of the area and gentle folding in other parts. The Upper, Middle, and Lower Series of the Devonian System are all exposed in the landscape. Carswell and Lloyd (1979) identified members of the Catskill Formation, Trimmers Rock Formation, and undifferentiated Hamilton and Oriskany Groups in Monroe County (fig. 2). These bedrock units generically are referred to as a sandstone and shale rock type (Risser and others, 2005) and have low primary porosity and permeability. However, post-depositional deformation and fracturing have increased secondary permeability. Deformation has also produced synclines and anticlines that provide preferential pathways for ground-water flow.

Epstein and others (1974) identified as many as four separate periods of glaciation covering the area during the Pleistocene Epoch. These glaciations left unconsolidated deposits up to approximately 100-ft thick in the stream valleys (R.A. Sloto, U.S. Geological Survey, oral commun., 2004). The deposits consist of clay, silt, sand, gravel, and boulders. Areas along the streams where porous glacial deposits are connected to the water table typically yield greater base flows per unit of drainage area during dry periods than areas along streams in the non-glaciated parts of Pennsylvania.

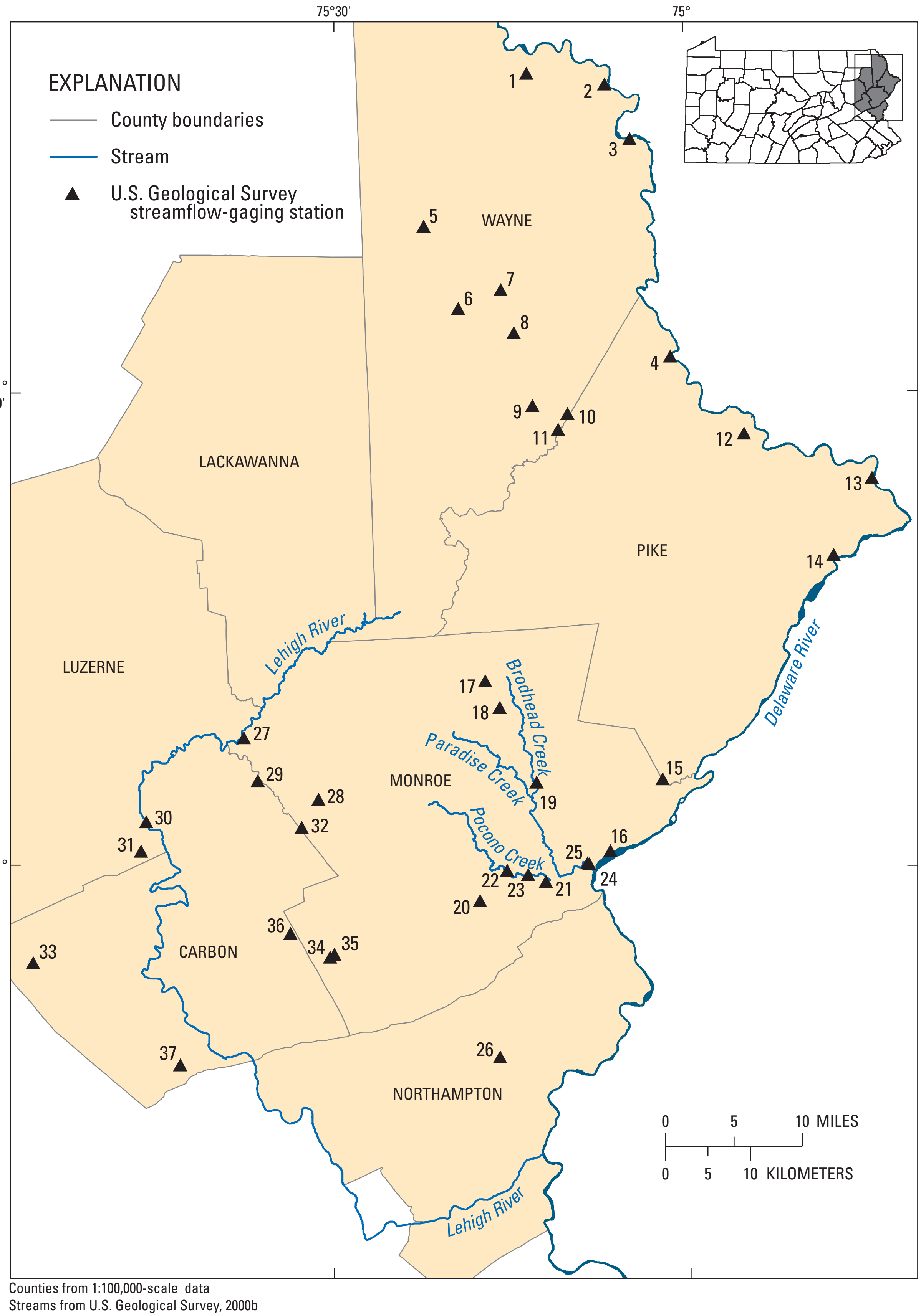

Figure 1. Pennsylvania counties, streams, and U.S. Geological Survey streamflow-gaging stations included in analyses.

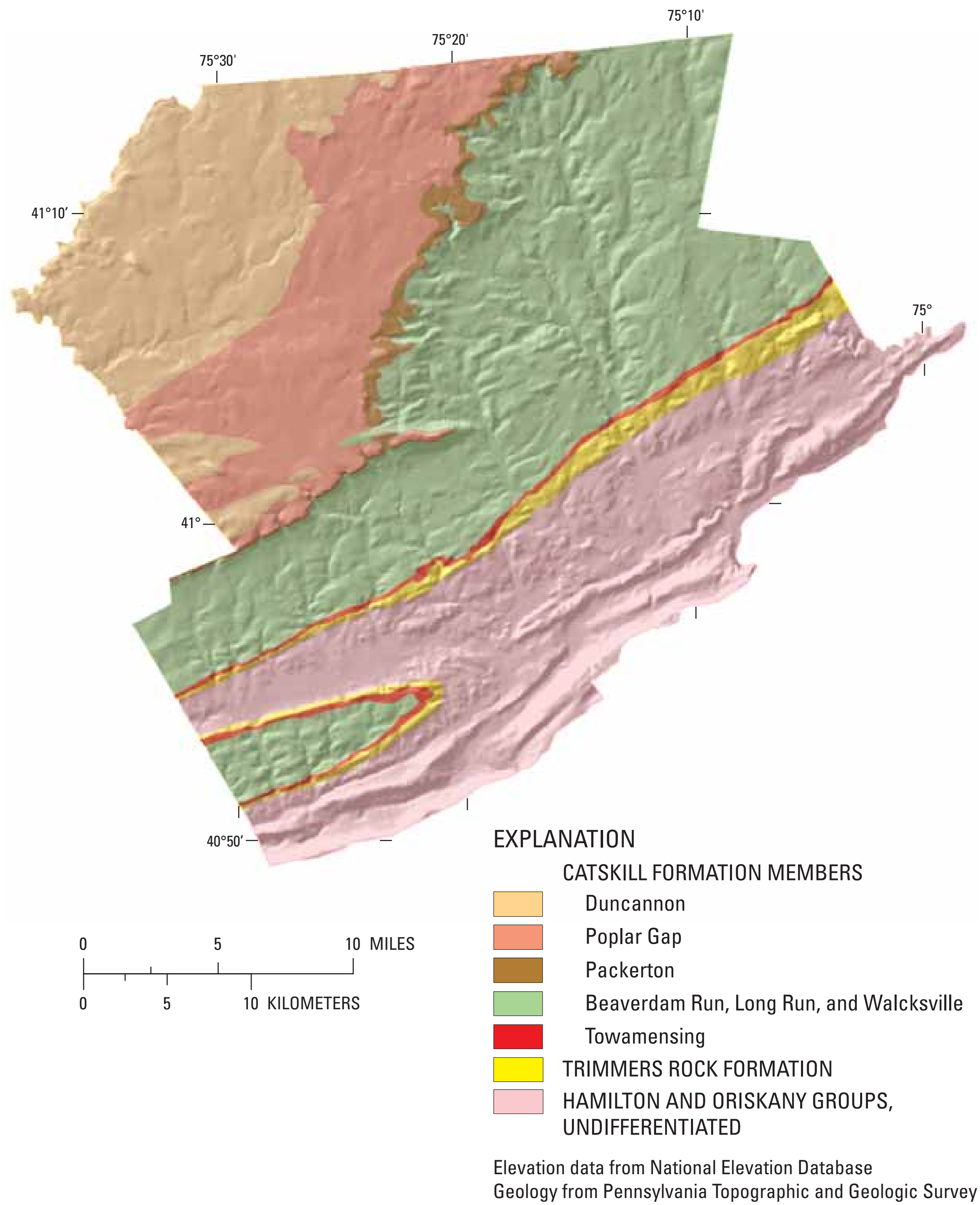

Figure 2. Bedrock geology of Monroe County, Pennsylvania.

Previous Investigations

Several approaches have been used in Pennsylvania to obtain streamflow statistics at a location without daily mean streamflow data. One approach has been to determine drainage area of the location, divide it by the drainage area of a nearby, hydrologically similar, continuous-record station with observed statistics, and multiply the area-ratio result by the observed continuous-record station statistics (U.S. Geological Survey, 2002).

Busch and Shaw (1966) used graphical correlation analysis of intermittent streamflow measurements at partial-record stations and concurrent daily mean flows at nearby continuous-record stations to predict low-flow statistics at partial-record stations. Page and Shaw (1977) updated the Busch and Shaw findings using procedures discussed by Riggs (1972).

Flippo (1982b) developed regression equations that related low-, mean-, and flood-flow statistics to basin characteristics. Schreffler (1998) used the Maintenance of Variance Extension, Type 1 (MOVE1) technique (Hirsch, 1982) to predict low-flow and harmonic-mean flow statistics at 34 partial-record stations in Chester County.

Stuckey and Reed (2000) developed regression equations for estimating the magnitude and frequency of floods on ungaged Pennsylvania streams with drainage areas less than 2,000 mi^2. Thompson and Cavallo (2005) used intermittent measurements of streamflow at partial-record stations and concurrent daily mean flows at continuous-record index stations to develop regression equations for predicting streamflow statistics at partial-record stations in Monroe County. This report updates Thompson and Cavallo (2005) and supersedes the statistics presented in that report for equivalent locations.

Continuous- and Partial-Record Streamflow-Gaging Stations

Information about the 17 continuous- and 20 partial-record stations used in the analyses is shown in table 1, and station locations are mapped on figure 1. Drainage areas for the stations ranged from 2.39 to 320 mi^2, and mean annual precipitation ranged from 41.0 to 49.3 in. Continuous-record stations with less than 10 years of daily mean flow data were analyzed as partial-record stations for this study and are identified in table 1.

Methods for Developing Streamflow Statistics

Twenty-eight observed streamflow statistics for the continuous-record stations were computed and predicted from daily mean flow and measurement data retrieved from a USGS database. The observed statistics included mean monthly flows, mean annual flow, 7-day low flows for the 2-, 10-, and 20-year recurrence intervals, nine flow durations, mean annual base flow, and annual mean base flows for the 10- and 25-year recurrence intervals. To determine the mean monthly and mean annual flow statistics, daily mean flow data were retrieved from the National Water Information System (NWIS) and processed using Automated Data-Processing System (ADAPS) software (U.S. Geological Survey, 1998). To determine the 7-day low-flow, recurrence-interval and flow-duration statistics, the daily mean flow data were processed using Surface-Water Statistics (SWSTAT) software (Flynn and others, 1995). To determine the annual base-flow (ground-water discharge only) recurrence-interval statistics, the daily mean flow data were first processed using the local-minimum option in the Hydrograph Separation Program (HYSEP) software (Sloto and Crouse, 1996), and the resulting daily mean base-flow data were then processed using SWSTAT.

The procedure for obtaining predicted statistics for the partial-record stations started with a plotting and correlation process developed in the USGS Pennsylvania Water Science Center (E.H. Koerkle, U.S. Geological Survey, written commun., 2004). The process plotted intermittent streamflow measurements made at the 20 partial-record stations on 4-day, daily mean flow hydrographs preceding the measurements for the 17 continuous-record stations being tested as index stations. This plotting aspect allowed acceptance or elimination of individual measurements and concurrent daily mean flows from the relation analyses on the basis of whether the continuous-record stations were in base-flow regimes. After the plotting aspect was completed, the process produced a correlation coefficient (r) for each partial- and continuous-record relation, and only those relations with r values greater than 0.70 (Stedinger and Thomas, 1985) were retained for further analyses.

Regression analyses were then conducted on the retained relation data pairs using Generalized Least Squares-Network Analysis (GLSNET) software (Tasker and Stedinger, 1989). Analyses of the flow measurements and concurrent daily mean flow data took the following form:

$$\mathrm{Log}Q_p = A + b\mathrm{Log}Q_{C1} + c\mathrm{Log}Q_{C2} + \ldots + r\mathrm{Log}Q_{C17}, \qquad (1)$$

where

Log is the base 10 logarithm,
Q_p is a flow measurement (dependent variable), in cubic feet per second (ft^3/s), made at a partial-record station,
A is the Log intercept for each partial-record station equation,
Q_{C1}, Q_{C2}, … and Q_{C17} are concurrent daily mean flows (explanatory variables), in ft^3/s, at the 17 continuous-record stations tested as indexes, and
b, c, … and r are regression coefficients specific to each partial-record station equation.

Table 1. Continuous- and partial-record stations used in analyses.

[Horizontal datum is North American Datum of 1983; mi^2, square miles; in., inches; Station type: C, continuous-record station; P, partial-record station with intermittent streamflow measurements; C-P, short continuous record used as a partial record for this report; Period of station record, time span operated as a continuous- and/or partial-record station—no ending date indicates station in operation through 2004]

U.S. Geological Survey station identification number	Station description	Location number in figure 1	Latitude (decimal degrees)	Longitude (decimal degrees)	Pennsylvania county	Drainage area (mi^2)	Mean annual precipitation (in.)	Station type	Period of station record
01427200	Equinunk Creek near Equinunk, Pa.	1	41.83759	75.23156	Wayne	56.3	44.3	P	1986-
01427300	Little Equinunk Creek at Stalker, Pa.	2	41.82620	75.12045	Wayne	24.6	42.9	P	1959-1969
01427400	Hollister Creek near Abramsville, Pa.	3	41.76814	75.08461	Wayne	9.11	42.7	P	1958-1968
01428200	Masthope Creek at Masthope, Pa.	4	41.53759	75.02739	Pike	32.2	41.0	P	1959-1969
01428750	West Branch Lackawaxen River near Aldenville, Pa.	5	41.67453	75.37601	Wayne	40.6	45.4	C	1986-
01429000	West Branch Lackawaxen River at Prompton, Pa.	6	41.58731	75.32684	Wayne	59.7	44.8	C	1944-
01429500	Dyberry Creek near Honesdale, Pa.	7	41.60731	75.26712	Wayne	64.6	43.6	C	1943-
01430000	Lackawaxen River near Honesdale, Pa.	8	41.56203	75.24795	Wayne	164	43.9	C	1948-
01431000	Middle Creek near Hawley, Pa.	9	41.48481	75.22184	Wayne	78.4	42.9	C	1945-1960
01431500	Lackawaxen River at Hawley, Pa.	10	41.47620	75.17212	Wayne	290	43.2	C	1908-
01432000	Wallenpaupack Creek at Wilsonville, Pa.	11	41.45926	75.18517	Pike	228	43.5	C	1909-1925
01432500	Shohola Creek near Shohola, Pa.	12	41.45565	74.92322	Pike	83.6	42.5	P	1957-2000
01433700	Bush Kill at Millrift, Pa.	13	41.40843	74.74266	Pike	6.84	44.4	P	1958-1968
01438300	Vandermark Creek at Milford, Pa.	14	41.32648	74.79683	Pike	5.36	43.7	P	1959-1980
01439500	Bush Kill at Shoemakers, Pa.	15	41.08815	75.03767	Monroe	117	43.4	C	1908-
01440250	Shawnee Creek at Shawnee, Pa.	16	41.01176	75.11073	Monroe	4.59	47.0	P	1970-1973
01440272	Buck Hill Creek at Buck Hill Falls, Pa.	17	41.19203	75.28657	Monroe	5.75	46.3	P	1978-1979
01440300	Mill Creek at Mountainhome, Pa.	18	41.16398	75.26629	Monroe	5.91	45.3	P	1960-1976
01440400	Brodhead Creek near Analomink, Pa.	19	41.08481	75.21463	Monroe	65.9	44.5	C	1957-
01440800	Kettle Creek at Syndersville, Pa.	20	40.95843	75.29324	Monroe	5.50	47.0	P	1944-1957
01441000	McMichael Creek near Stroudsburg, Pa.	21	40.97926	75.20101	Monroe	65.3	47.1	P	1970-1991
01441495	Pocono Creek above Wigwam Run near Stroudsburg, Pa.	22	40.99093	75.25518	Monroe	38.9	47.3	C-P	2002-
01441500	Pocono Creek near Stroudsburg, Pa.	23	40.98620	75.22601	Monroe	42.3	47.3	C-P	1970-2001
01442500	Brodhead Creek at Minisink Hills, Pa.	24	40.99871	75.14268	Monroe	259	46.3	C	1950-
01442600	Marshall Creek at Minisink Hills, Pa.	25	40.99815	75.13990	Monroe	26.9	46.4	P	1958-1991
01446800	Little Bushkill at Edelman, Pa.	26	40.79232	75.26407	Northampton	13.1	46.2	P	1948-1957
01447500	Lehigh River at Stoddartsville, Pa.	27	41.13036	75.62547	Monroe	91.7	46.0	C	1943-
01447680	Tunkhannock Creek near Long Pond, Pa.	28	41.06537	75.52019	Monroe	20.0	49.0	C	1965-
01447720	Tobyhanna Creek near Blakeslee, Pa.	29	41.08481	75.60547	Carbon	118	47.6	C	1961-
01448000	Lehigh River at Tannery, Pa.	30	41.04036	75.76130	Luzerne	320	46.4	C	1916-1959
01448100	Sandy Run near White Haven, Pa.	31	41.00870	75.76853	Luzerne	10.9	46.4	P	1970-1991
01448500	Dilldown Creek near Long Pond, Pa.	32	41.03564	75.54324	Monroe	2.39	48.9	C	1948-1996
01448800	Quakake Creek near Hazelton, Pa.	33	40.88925	75.91798	Carbon	7.28	49.3	P	1946-1954
01449355	Middle Creek at Kresgeville, Pa.	34	40.90093	75.49685	Monroe	18.4	47.7	P	1970-1991
01449360	Pohopoco Creek at Kresgeville, Pa.	35	40.89759	75.50241	Monroe	49.9	47.4	C	1966-
01449500	Wild Creek at Hatchery, Pa.	36	40.92287	75.55852	Carbon	16.8	48.9	C	1940-1979
01450400	Lizard Creek at Ashfield, Pa.	37	40.78232	75.71102	Carbon	46.5	46.6	P	1945-1955
					Maximum	320	49.3		
					Minimum	2.39	41.0		

The regression equations developed from the GLSNET software were then used to predict the statistics at the respective partial-record stations from the observed statistics at the appropriate continuous-record index stations as was done in Thompson and Cavallo (2005).

A comparison of differences between all the observed and predicted statistics for continuous-record stations (treated as partial-record stations) was conducted as in Thompson and Cavallo (2005) and similar to the low-flow statistics analyses in Wilson (2000). The comparison provided an indication of how well the Stedinger and Thomas (1985) methodology predicted intermediate- and high-flow statistics, as well as the low-flow statistics for which it was developed.

To obtain the regression equations for predicting statistics at the MAPP and SSL (ungaged locations) in Monroe County (fig. 3), further analyses were conducted using the GLSNET software. The analyses took the following form:

$$\mathrm{Log}S_{1\text{-}28} = A + b\mathrm{Log}BC_1 + c\mathrm{Log}BC_2 + \ldots + y\mathrm{Log}BC_{24}, \quad (2)$$

where

Log is the base 10 logarithm,

$S_{1\text{-}28}$ represents the 28 observed statistics (dependent variables), in ft^3/s, computed for the 17 continuous-record stations and analyzed individually,

A is the Log intercept for the respective statistic equation,

BC_1, BC_2, … and BC_{24} are 24 basin characteristics (explanatory variables) determined for each continuous-record station from digital datasets using geographic information system (GIS) software, and

b, c, … and y are regression coefficients specific to each statistic.

The 24 basin characteristics used as explanatory variables in the regression analyses included drainage area (in square miles), ground-water head (in feet), mean elevation (in feet), shape factor, basin slope (in degrees), and mid-channel slope (in feet per mile) determined from a digital elevation model (DEM) (U.S. Geological Survey, 2000a); mean annual precipitation (in inches) determined from Parameter-elevation Regressions on Independent Slopes Model (PRISM) (Daly, 1996); sinkhole density and percentages of drainage area glaciation and carbonate bedrock determined from modified geology maps; percentage of lakes determined from digitized USGS 1:24,000 scale topographic maps; percentages of urban, residential, and commercial development, forest, wetlands, and mining determined from National Land Cover Dataset enhanced version (NLCDE) (Price and others, 2003); longest drainage path (in miles) and stream density (in miles per square mile) determined from the 1:24,000 scale National Hydrography Dataset (NHD) (U.S. Geological Survey, 2000b); and soil thickness (in inches), drainage runoff curve, soil infiltration index, available water capacity (in inches per inch), and soil permeability (in inches per hour) determined from the State Soil Geographic (STATSGO) database (U.S. Department of Agriculture, 1994).

The regression equations, derived as described above, were then used to generate the streamflow statistics in appendix 1. The data in appendix 1 also include the GIS-based determinations of basin characteristics for the MAPP and SSL in Monroe County.

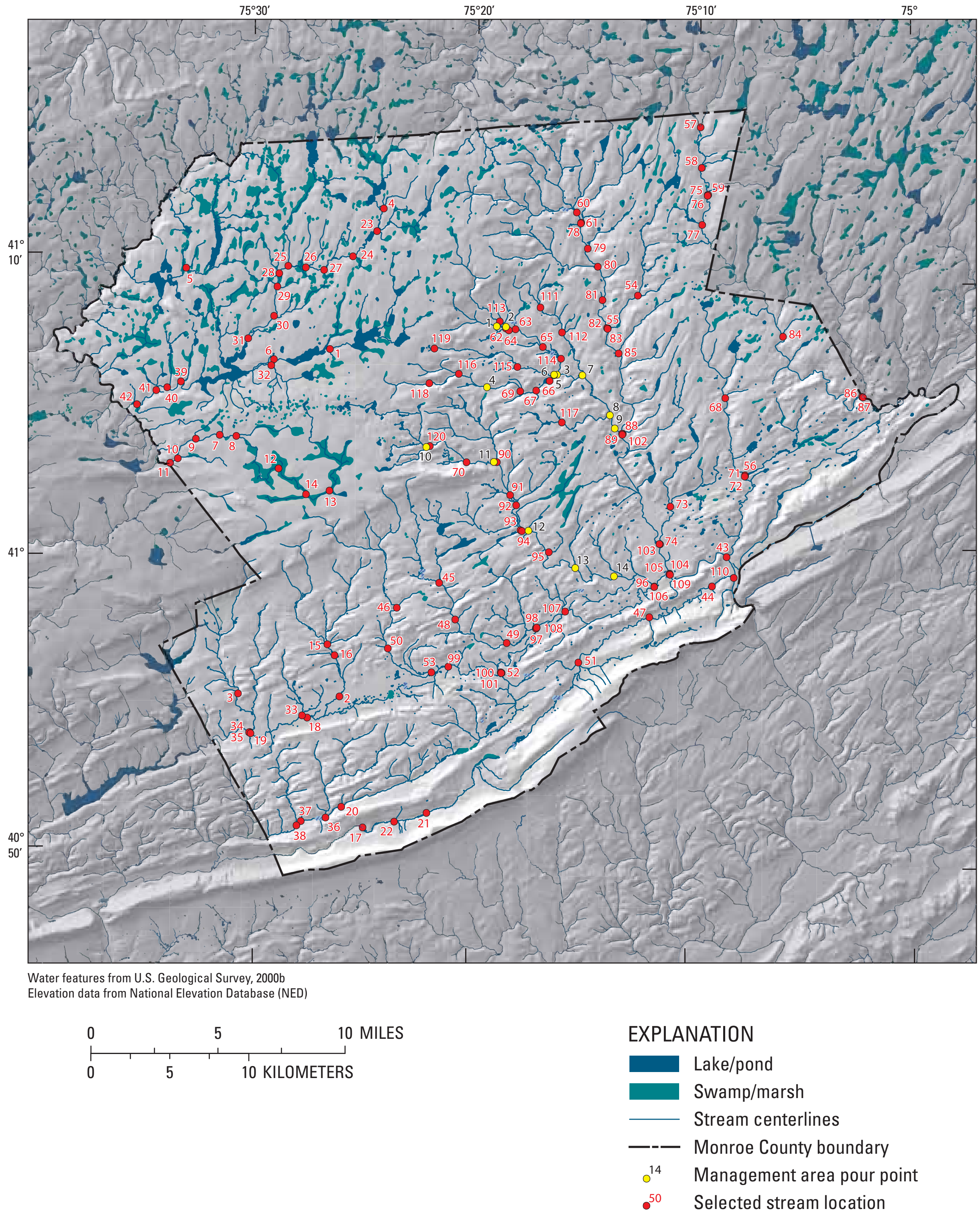

Figure 3. Ungaged stream locations in Monroe County, Pennsylvania, with predicted streamflow statistics.

Streamflow-Gaging Station Statistics

Observed statistics for the continuous-record stations and predicted statistics for partial-record stations used in the analyses provide an encapsulation of the surface-water resources in Monroe County and parts of the contiguous counties. These statistics, along with the predicted statistics for ungaged stream locations discussed in a following section, also provide quantification of surface-water resources and serve as surrogates for ground-water availability.

Observed Statistics for Continuous-Record Stations

The observed statistics for the 17 continuous-record stations used in the analyses are shown in table 2. The range between the minimum and maximum statistics for each station, as exemplified by 5.8 ft^3/s (7-day low flow expected every 20 years; Q7,20) and 1,280 ft^3/s (1 percent chance of being exceeded; D1) for 01439500, Bush Kill at Shoemakers, reflected the large absolute differences in the observed statistics. The range in D1 values for all 17 stations (from 32 to 3,480 ft^3/s) reflected the two orders of magnitude range in drainage areas (from 2.39 to 320 mi^2).

Table 2. Observed streamflow statistics for continuous-record stations.

[Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow-duration statistic exceeded selected percent of time; x-year base flow, annual mean base flow for selected recurrence interval]

Statistic	Observed streamflow at continuous-record station, in cubic feet per second								
	01428750	01429000	01429500	01430000	01431000	01431500	01432000	01439500	01440400
Mean monthly flow									
Oct.	65	67	65	171	72	267	235	127	77
Nov.	97	104	113	291	127	431	271	212	127
Dec.	98	125	129	339	147	532	384	268	175
Jan.	89	112	117	311	138	519	490	258	152
Feb.	83	122	131	304	137	559	427	271	156
Mar.	139	215	234	557	237	1,010	863	432	248
Apr.	167	240	248	617	315	1,060	832	427	247
May	94	133	141	333	177	615	468	304	180
June	55	72	73	181	78	341	307	199	114
July	25	43	49	97	77	201	206	127	58
Aug.	28	35	36	100	57	168	143	102	48
Sept.	48	50	51	139	31	207	144	100	64
Mean annual flow	82	110	116	287	133	493	398	236	137
Q7,2	7.8	10	7.0	21	6.8	39	51	16	12
Q7,10	4.8	4.1	3.0	12	3.0	22	23	7.2	7.0
Q7,20	4.2	3.2	2.3	10	2.4	19	16	5.8	6.0
D99	5.5	6.4	3.8	14	3.7	24	29	8.8	7.7
D95	8.0	11	7.1	22	7.0	39	43	17	13
D90	11	15	11	31	11	53	60	27	17
D80	17	24	19	55	19	88	98	52	30
D50	45	59	58	154	63	254	242	163	86
D20	108	152	149	399	183	684	632	364	195
D10	182	252	257	640	307	1,140	937	533	304
D5	293	382	427	988	464	1,770	1,260	722	435
D1	618	769	1,040	2,220	1,140	3,850	2,340	1,280	901
Mean annual base flow	43	63	59	158	65	247	255	154	83
10-year base flow	32	46	42	119	49	180	205	111	59
25-year base flow	29	41	37	105	44	158	189	96	50
Maximum	618	769	1,040	2,220	1,140	3,850	2,340	1,280	901
Minimum	4.2	3.2	2.3	10	2.4	19	16	5.8	6.0

Table 2. Observed streamflow statistics for continuous-record stations.—Continued

[Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow-duration statistic exceeded selected percent of time; x-year base flow, annual mean base flow for selected recurrence interval]

Statistic	Observed streamflow at continuous-record station, in cubic feet per second								
	01442500	**01447500**	**01447680**	**01447720**	**01448000**	**01448500**	**01449360**	**01449500**	
Mean monthly flow									
Oct.	330	122	34	196	429	2.9	66	22	
Nov.	546	181	43	265	674	4.7	93	29	
Dec.	740	217	53	304	738	5.9	128	38	
Jan.	619	195	44	273	637	5.2	113	34	
Feb.	650	195	42	268	611	5.0	114	37	
Mar.	978	305	65	414	1,150	7.6	157	50	
Apr.	971	350	75	459	1,260	9.2	156	53	
May	699	253	57	323	867	6.6	124	50	
June	448	166	46	237	547	4.3	100	37	
July	255	106	29	149	452	2.8	65	32	
Aug.	258	92	24	126	351	2.3	53	26	
Sept.	285	98	31	187	303	2.2	63	21	
Mean annual flow	565	190	45	267	668	4.9	103	36	
Q7,2	73	23	7.1	43	101	.7	22	7.4	
Q7,10	47	13	3.8	28	65	.4	15	5.3	
Q7,20	42	11	3.1	25	58	.4	13	4.8	
D99	49	14	4.3	30	74	.1	15	5.6	
D95	72	23	7.5	45	106	.4	22	7.4	
D90	95	33	11	59	139	.8	28	9.2	
D80	145	54	16	86	198	1.5	39	13	
D50	354	131	32	182	449	3.2	76	30	
D20	801	268	63	364	998	6.8	145	58	
D10	1,240	401	92	547	1,400	9.8	202	75	
D5	1,770	561	131	773	1,890	15	276	93	
D1	3,480	1,100	245	1,650	3,490	32	512	161	
Mean annual base flow	326	121	30	164	413	3.3	72	30	
10-year base flow	227	91	20	119	315	2.3	51	23	
25-year base flow	194	80	17	104	283	1.9	43	20	
									All stations
Maximum	3,480	1,100	245	1,650	3,490	32	512	161	3,850
Minimum	42	11	3.1	25	58	.1	13	4.8	.1

Predicted Statistics for Partial-Record Stations

The regression coefficients and resulting equations for the 17 continuous-record stations tested as indexes are shown in table 3. Although all continuous-record stations appeared in at least one partial-record station relation with a correlation coefficient (r) equal to or greater than 0.70 during the tests, the best relations, lowest standard errors of prediction and highest coefficients of determination (R^2), contained only seven of the tested continuous-record stations. This result was similar to that in Thompson and Cavallo (2005), in which only four out of seven tested continuous-record stations were included in the best equations. An evaluation of the periods of record and the basin characteristics for the tested stations revealed no basis as to why 10 of the 17 tested stations were not included in the best equations. Two of the partial-record stations had two index stations in the best equations. The remaining 18 partial-record stations had only 1 index station in the best equations. The standard errors of prediction ranged from 16 to 66 percent and averaged 35 percent. The coefficients of determination (R^2) ranged from 0.69 to 0.96. These diagnostic statistics indicated that the Stedinger and Thomas (1985) methodology produced reasonably good equations for predicting low-flow statistics at the partial-record stations used in the analyses.

Although the Stedinger and Thomas (1985) methodology was developed for predicting low-flow recurrence-interval statistics, the equations in table 3 were used to predict all the statistics shown in table 2 for the partial-record stations. The predicted statistics for the partial-record stations are shown in table 4.

The range between minimum and maximum statistics for each station in table 4, as exemplified by 0.3 to 218 ft^3/s for 01440250, Shawnee Creek at Shawnee, was smaller than those in table 2 but approximately the same range in order of magnitude. The smaller range in D1 values (from 39 to 1,980 ft^3/s) for all stations reflected a smaller range of drainage areas (from 4.59 to 83.6 mi^2) for the partial-record stations than for the continuous-record stations.

Comparison of Predicted and Observed Statistics for Continuous-Record Stations

Thirteen of the 17 continuous-record stations used in the analyses discussed above also were treated as if each was a partial-record station similar to Wilson (2000) and Thompson and Cavallo (2005). The remaining four continuous-record stations have been discontinued for several years, and the measurements made during the respective periods of record were not available for this analysis. The treatment was used to determine how well the Stedinger and Thomas (1985) methodology predicted statistics compared to those observed for the continuous-record stations and to quantify how well the methodology predicted intermediate- and high-flow statistics that were based on coefficients and equations developed for base-flow conditions.

Regression coefficients and equations for continuous-record stations treated as partial-record stations and their respective indexes are shown in table 5. Eight of the 13 continuous-record stations tested as indexes were included in the best equations. An evaluation of the periods of record and the basin characteristics for the tested stations revealed no basis as to why 5 of the 13 tested stations were not included in the best equations. This result is counter to that in Wilson (2000) and Thompson and Cavallo (2005) in which stations with larger drainage areas tended to have better predictive capabilities than stations with smaller drainage areas.

The 13 equations in table 5 had standard errors of prediction equal to or smaller than 31 percent and averaged 22 percent, and the coefficients of determination (R^2) ranged from 0.84 to 0.98. These diagnostic statistics indicated the equations were good fits for predicting low-flow recurrence-interval statistics at the continuous-record stations treated as partial-record stations.

Table 3. Regression coefficients, standard errors of prediction, coefficients of determination, continuous-record index stations, and equations used to predict streamflow statistics for partial-record stations.

[Log, base 10 logarithm; --, not significant at the *p*<0.05 level or inappropriate to display; station number$_S$ indicates statistic predicted or observed as appropriate to equation; ft^3/s, cubic feet per second]

Log of statistic at partial-record station	Regression coefficients for continuous-record index stations significant at the *p*<0.05 level								Standard error of prediction		Coefficient of determination (R^2)
	Log of intercept	$\text{Log}_{01431500}$	$\text{Log}_{01439500}$	$\text{Log}_{01440400}$	$\text{Log}_{01442500}$	$\text{Log}_{01447720}$	$\text{Log}_{01448000}$	$\text{Log}_{01449360}$	Log units	Percent	
$\text{Log}_{01427200}$	-1.689	1.4271	--	-0.04422	--	--	--	--	0.15	36	0.90
$\text{Log}_{01427300}$	-1.424	1.1563	--	--	--	--	--	--	.19	46	.90
$\text{Log}_{01427400}$	-2.4541	1.305	--	--	--	--	--	--	.20	49	.91
$\text{Log}_{01428200}$	-2.5212	1.5834	--	--	--	--	--	--	.26	66	.91
$\text{Log}_{01432500}$	-.40619	--	1.0472	--	--	--	--	--	.14	33	.89
$\text{Log}_{01433700}$	-1.4382	--	1.0492	--	--	--	--	--	.26	66	.86
$\text{Log}_{01438300}$	-2.5493	--	--	--	1.2803	--	--	--	.16	38	.93
$\text{Log}_{01440250}$	-2.9365	--	--	--	1.4896	--	--	--	.11	26	.96
$\text{Log}_{01440272}$	-.69443	--	--	.8938	--	--	--	--	.12	28	.92
$\text{Log}_{01440300}$	-1.8171	--	--	--	1.0535	--	--	--	.14	33	.90
$\text{Log}_{01440800}$	-1.0323	--	.84507	--	--	--	--	--	.20	49	.69
$\text{Log}_{01441000}$	.65815	--	.58455	--	--	--	--	--	.12	28	.88
$\text{Log}_{01441495}$	-.19864	--	.86965	--	--	--	--	--	.09	21	.92
$\text{Log}_{01441500}$	.1364	--	.71495	--	--	--	--	--	.08	19	.95
$\text{Log}_{01442600}$	-.36502	--	.85075	--	--	--	--	--	.13	31	.92
$\text{Log}_{01446800}$	-.50575	--	.8145	--	--	--	--	--	.14	33	.76
$\text{Log}_{01448100}$	-1.1104	--	--	--	--	1.0206	--	--	.10	23	.89
$\text{Log}_{01448800}$	-1.5647	--	--	--	--	--	0.90921	--	.08	19	.84
$\text{Log}_{01449355}$	-.04322	--	--	.30139	--	--	--	0.49182	.07	16	.92
$\text{Log}_{01450400}$	-1.3615	--	--	--	--	--	1.2103	--	.19	46	.73
									Mean	35	--
									Maximum	66	.96
									Minimum	16	.69

Predicted partial-record station statistic$_S$ (ft^3/s)		Equations used to predict flow statistics for partial-record stations: Continuous-record index station(s) (ft^3/s)
01427200_S	=	$0.0205\ (01431500_S{}^{1.4271})(01440400_S{}^{-0.04422})$
01427300_S	=	$0.0377\ (01431500_S{}^{1.1563})$
01427400_S	=	$0.00351\ (01431500_S{}^{1.305})$
01428200_S	=	$0.00301\ (01431500_S{}^{1.5834})$
01432500_S	=	$0.392\ (01439500_S{}^{1.0472})$
01433700_S	=	$0.0365\ (01439500_S{}^{1.0492})$
01438300_S	=	$0.00282\ (01442500_S{}^{1.2803})$
01440250_S	=	$0.00116\ (01442500_S{}^{1.4896})$
01440272_S	=	$0.202\ (01440400_S{}^{0.8938})$
01440300_S	=	$0.0152\ (01442500_S{}^{1.0535})$
01440800_S	=	$0.0928\ (01439500_S{}^{0.84507})$
01441000_S	=	$4.55\ (01439500_S{}^{0.58455})$
01441495_S	=	$0.633\ (01439500_S{}^{0.86965})$
01441500_S	=	$1.37\ (01439500_S{}^{0.71495})$
01442600_S	=	$0.431\ (01439500_S{}^{0.85075})$
01446800_S	=	$0.312\ (01439500_S{}^{0.8145})$
01448100_S	=	$0.0776\ (01447720_S{}^{1.0206})$
01448800_S	=	$0.0272\ (01448000_S{}^{0.90921})$
01449355_S	=	$0.905\ (01440400_S{}^{0.30139})(01449360_S{}^{0.49182})$
01450400_S	=	$0.0435\ (01448000_S{}^{1.2103})$

Table 4. Predicted streamflow statistics for partial-record stations.

[Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow-duration statistic exceeded selected percent of time; x-year base flow, annual mean base flow for selected recurrence interval]

Statistic	Predicted streamflow statistics for partial-record stations, in cubic feet per second									
	01427200	01427300	01427400	01428200	01432500	01433700	01438300	01440250	01440272	01440300
Mean monthly flow										
Oct.	49	24	5.2	21	63	5.9	4.7	6.5	9.8	6.9
Nov.	95	42	9.6	45	107	10	9.0	14	15	12
Dec.	126	53	13	62	137	13	13	22	20	16
Jan.	123	52	12	60	132	12	11	17	18	13
Feb.	136	57	14	67	139	13	11	18	18	14
Mar.	311	112	29	172	226	21	19	33	28	22
Apr.	333	119	31	186	223	21	19	33	28	21
May	155	63	15	78	156	15	12	20	21	15
June	68	32	7.1	31	100	9.4	7.0	10	14	9.5
July	33	17	3.6	13	63	5.9	3.4	4.4	7.6	5.2
Aug.	26	14	2.8	10	50	4.7	3.5	4.5	6.4	5.3
Sept.	34	18	3.7	14	49	4.6	3.9	5.3	8.3	5.9
Mean annual flow	115	49	12	63	120	11	10	16	16	12
Q7,2	3.4	2.6	.4	.9	8.3	.8	.8	.8	2.0	1.5
Q7,10	1.5	1.3	.1	.2	2.9	.2	.4	.4	1.1	.8
Q7,20	1.3	1.1	.1	.2	2.2	.2	.3	.3	.9	.7
D99	1.7	1.5	.2	.5	3.8	.4	.4	.4	1.3	.9
D95	3.4	2.6	.4	1.0	7.6	.7	.7	.7	2.0	1.4
D90	5.2	3.7	.6	1.6	12	1.2	1.0	1.0	2.5	1.8
D80	10	6.7	1.2	3.6	25	2.3	1.7	1.9	4.2	2.9
D50	45	23	4.8	19	81	7.6	5.2	7.3	11	7.4
D20	180	71	18	93	189	18	15	24	23	17
D10	366	129	34	208	281	26	26	47	33	28
D5	675	215	61	418	387	36	41	80	46	40
D1	1,980	527	168	1,430	704	66	97	218	88	82
Mean annual base flow	44	22	4.7	19	77	7.2	4.7	6.4	10	6.8
10-year base flow	28	15	3.1	11	54	5.1	2.9	3.7	7.7	4.6
25-year base flow	24	13	2.6	9.1	47	4.4	2.4	3.0	6.7	3.9
Maximum	1,980	527	168	1,430	704	66	97	218	88	82
Minimum	1.3	1.1	.1	.2	2.2	.2	.3	.3	.9	.7

Table 4. Predicted streamflow statistics for partial-record stations.—Continued

[Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow-duration statistic exceeded selected percent of time; x-year base flow, annual mean base flow for selected recurrence interval]

Statistic	Predicted streamflow statistics for partial-record stations, in cubic feet per second										
	01440800	01441000	01441495	01441500	01442600	01446800	01448100	01448800	01449355	01450400	
Mean monthly flow											
Oct.	5.6	77	43	44	27	16	17	6.7	26	67	
Nov.	8.6	104	67	63	41	24	23	10	36	115	
Dec.	10	120	82	75	50	30	27	11	47	129	
Jan.	10	117	79	73	49	29	24	9.7	42	108	
Feb.	11	120	83	75	51	30	23	9.3	43	102	
Mar.	16	158	124	105	75	44	36	17	57	220	
Apr.	16	157	123	104	75	43	40	18	57	246	
May	12	129	91	82	56	33	28	13	46	156	
June	8.1	100	63	60	39	23	21	8.4	36	90	
July	5.6	77	43	44	27	16	13	7.1	24	71	
Aug.	4.6	68	35	37	22	13	11	5.6	20	52	
Sept.	4.5	67	35	37	22	13	16	4.9	24	44	
Mean annual flow	9.2	108	72	66	44	26	23	10	38	117	
Q7,2	1.1	25	8.0	11	5.1	3.3	3.6	1.9	9.5	13	
Q7,10	.4	13	3.5	5.5	2.2	1.5	2.1	1.2	6.1	5.6	
Q7,20	.3	11	2.8	4.6	1.7	1.2	1.8	1.0	5.4	4.4	
D99	.6	16	4.2	6.5	2.7	1.8	2.5	1.4	6.3	8.0	
D95	1.0	24	7.4	10	4.8	3.1	3.8	1.9	9.0	12	
D90	1.5	31	11	14	7.1	4.6	5.0	2.4	11	17	
D80	2.6	46	20	23	12	7.8	7.3	3.3	15	26	
D50	6.9	89	53	52	33	20	16	7.0	29	71	
D20	14	143	107	93	65	38	32	15	51	186	
D10	19	179	149	122	90	52	48	20	69	279	
D5	24	213	194	151	117	66	69	26	90	402	
D1	39	298	319	228	190	106	149	45	151	844	
Mean annual base flow	6.6	86	51	50	31	19	14	6.5	28	64	
10-year base flow	5.0	71	38	40	24	14	10	5.1	21	46	
25-year base flow	4.4	66	34	36	21	13	8.9	4.6	19	40	
											All stations
Maximum	39	298	319	228	190	106	149	45	151	844	1,980
Minimum	.3	11	2.8	4.6	1.7	1.2	1.8	1.0	5.4	4.4	.1

Table 5. Regression coefficients, standard errors of prediction, coefficients of determination, continuous-record index stations, and equations used to predict streamflow statistics for continuous-record stations (treated as partial-record stations).

[Log, base 10 logarithm; --, not significant at the $p<0.05$ level or inappropriate to display; station number$_S$ indicates statistic predicted or observed as appropriate to equation; ft^3/s; cubic feet per second]

Log of statistic at continuous-record station	Regression coefficients for continuous-record index stations significant at the $p<0.05$ level									Standard error of prediction		Adjusted coefficient of determination (R^2)
	Log of intercept	$Log_{01429000}$	$Log_{01429500}$	$Log_{01431500}$	$Log_{01439500}$	$Log_{01440400}$	$Log_{01442500}$	$Log_{01447680}$	$Log_{01447720}$	Log units	Percent	
$Log_{01428750}$	-0.12747	0.92548	--	--	--	--	--	--	--	0.10	23	0.89
$Log_{01429000}$	.43577	--	0.76357	--	--	--	--	--	--	.13	31	.85
$Log_{01429500}$	-.89291	--	--	1.0914	--	--	--	--	--	.08	19	.95
$Log_{01430000}$	-.021714	.26991	--	.70942	--	--	--	--	--	.05	12	.96
$Log_{01431500}$	.47028	1.0365	--	--	0.024449	--	--	--	--	.09	21	.92
$Log_{01439500}$	.10868	--	--	--	--	1.0743	--	--	--	.09	21	.96
$Log_{01440400}$	-.43151	--	--	--	.55502	--	0.44596	--	--	.07	16	.98
$Log_{01442500}$	.95593	--	--	--	.73041	--	--	--	--	.10	23	.94
$Log_{01447500}$	.40183	--	--	--	--	.88924	--	--	--	.10	23	.92
$Log_{01447680}$	-.7679	--	--	--	--	--	.85591	--	0.036914	.13	31	.84
$Log_{01447720}$	.16175	--	--	--	--	--	.81405	--	--	.09	21	.90
$Log_{01448500}$	-1.0684	--	--	--	--	.34512	--	.59605	--	.09	21	.95
$Log_{01449360}$	.61928	--	--	--	--	.66184	--	--	--	.11	26	.86
										Mean	22	--
										Maximum	31	.98
										Minimum	12	.84

Predicted continuous-record station statistic$_S$ (ft^3/s)	Equations used to predict flow statistics for continuous-record stations (treated as partial-record stations)	
		Continuous-record index station(s) (ft^3/s)
01428750_S	=	$0.746\ (01429000_S^{0.92548})$
01429000_S	=	$2.73\ (01429500_S^{0.76357})$
01429500_S	=	$0.128\ (01431500_S^{1.0914})$
01430000_S	=	$0.951\ (01429000_S^{0.26991})(01431500_S^{0.70942})$
01431500_S	=	$2.95\ (01429000_S^{1.0365})(01439500_S^{0.02445})$
01439500_S	=	$1.28\ (01440400_S^{1.0743})$
01440400_S	=	$0.370\ (01439500_S^{0.55502})(01442500_S^{0.44596})$
01442500_S	=	$9.04\ (01439500_S^{0.73041})$
01447500_S	=	$2.52\ (01440400_S^{0.88924})$
01447680_S	=	$0.171\ (01442500_S^{0.85591})(01447720_S^{0.03691})$
01447720_S	=	$1.45\ (01442500_S^{0.81405})$
01448500_S	=	$0.0854\ (01440400_S^{0.34512})(01447680_S^{0.59605})$
01449360_S	=	$4.16\ (01440400_S^{0.66184})$

Statistics predicted using the equations in table 5 and the percentage differences between predicted and observed statistics are shown in table 6. The differences ranged from 0 to 122 percent and averaged 15 percent; the median was 10 percent. The higher differences tended to be for the extreme low-flow statistics, as exemplified by 63 percent for the 7-day low flow expected every 20 years (Q7,20) for 01428750, West Branch Lackawaxen River near Aldenville, and 122 percent for the flow exceeded 99 percent of the time (D99) for 01448500, Dilldown Creek near Long Pond. The low average and median differences were similar to those in Thompson and Cavallo (2005), which found that there may be a consistent relation between low- and high-flow statistics at a station and that the Stedinger and Thomas (1985) methodology has application potential for predicting intermediate- and high-flow statistics as well as predicting low-flow statistics for which it was developed.

Regression Equations and Predicted Statistics for Ungaged Stream Locations in Monroe County

Regression coefficients and equations for individually relating the 28 observed statistics (dependent variables) to the 24 basin characteristics (explanatory variables) tested in the analyses are shown in table 7. The only two basin characteristics significant at the $p<0.05$ level were drainage area and mean-annual precipitation.

The standard errors of prediction ranged from 5 to 43 percent and averaged 16 percent; coefficients of determination (R^2) ranged from 0.918 to 0.998 (table 7). These diagnostic statistics indicated the equations were good fits for predicting the 28 statistics at ungaged locations in Monroe County where the drainage area ranged from about 2.0 to 350 mi^2 and mean annual precipitation ranged from about 40 to 50 in. Similar to the percentage differences in table 6, the higher standard errors of prediction, in percent, in table 7 were for the extreme low-flow statistics, specifically the 7-day low flow expected every 2, 10, and 20 years (Q7,2; Q7,10; and Q7,20) and the flow exceeded 99 percent of the time (D99).

Drainage area, mean annual precipitation, 4 other GIS-determined basin characteristics needed by the BWA, and the 28 predicted statistics, derived from the equations in table 7, for the 134 Monroe County ungaged locations shown in figure 3 are included in appendix 1. Drainage area ranged from 0.41 to 309 mi^2, and mean annual precipitation ranged from 43 to 49 in.

Limitations of the Statistics and Equations

This study is limited to streams in Monroe County and stations in contiguous counties. All the observed and predicted statistics are estimates affected by error. The determinations of basin characteristics used in the regression analyses are limited by the accuracies of the information contained in the analyzed datasets and the GIS-based automated procedures used to process the datasets.

The observed statistics for the continuous-record stations are based on samples (restricted to the respective periods of record) of daily mean flow data populations and may not reflect the true long-term values for those statistics. The predicted statistics for the partial-record stations are based on regression analyses of small subsets of the continuous-record station data and a limited number of intermittent measurements made at the partial-record stations and therefore are likely to have more inherent error than the observed statistics. The results of the regression analysis explain as much variance in the data as possible at the $p<0.05$ level of significance but should not be thought of as providing cause and effect relations.

The methodology used to generate the regression equations (Stedinger and Thomas, 1985) for predicting the statistics at ungaged locations was developed for estimating low-flow frequencies and may not be applicable to higher streamflow statistics. The findings reported herein, however, indicate the method may have transfer value for predicting a complete range of low- to high-flow statistics at ungaged locations in areas where streamflow-gaging data are available from hydrologically similar continuous- and partial-record stations. The GLS-NET software (Tasker and Stedinger, 1989), which was used to develop the regression equations for predicting the statistics at ungaged locations, did provide unbiased estimates of the statistics but also resulted in standard errors of prediction that may not be acceptable for some planning purposes or management decisions. The basin characteristic data used in the regression analyses were GIS-determined and are subject to the errors inherent to the individual datasets and the automated GIS procedures used in the determination process.

All the ungaged locations for which statistics were predicted are shown on perennial streams on USGS topographic maps; however, some of the predicted extreme low-flow statistics for small drainage areas approached or equaled zero. Caution is therefore indicated in using the statistics for planning applications that involve small drainage areas.

Table 6. Predicted streamflow statistics and percent differences from observed statistics for continuous-record stations (treated as partial-record stations).

[ft^3/s, cubic feet per second; %, percent difference from observed; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow-duration statistics exceeded selected percent of time; x-year base flow, annual mean base flow for selected recurrence interval]

Statistic	Predicted streamflow and percent differences for continuous-record stations (treated as partial-record stations)													
	01428750		01429000		01429500		01430000		01431500		01439500		01440400	
	ft^3/s	%	ft^3/s	%	ft^3/s	%	ft^3/s	%	ft^3/s	%	ft^3/s	%	ft^3/s	%
Mean monthly flow														
Oct.	37	56	66	1	57	13	156	9	205	26	137	7	72	6
Nov.	55	55	101	3	96	16	246	17	319	30	234	10	120	5
Dec.	65	40	112	11	121	7	301	12	384	32	330	21	157	11
Jan.	59	41	104	8	118	1	287	8	343	41	284	9	142	7
Feb.	64	26	113	8	128	3	309	2	374	40	292	7	149	5
Mar.	107	26	176	20	243	4	548	2	666	41	480	10	232	7
Apr.	119	34	184	27	256	3	585	5	747	35	478	11	229	7
May	69	31	119	11	142	0	339	2	408	40	340	11	164	9
June	39	34	72	0	74	2	189	4	218	44	208	5	106	7
July	24	3	53	21	42	16	113	15	129	43	101	23	64	11
Aug.	20	33	42	18	34	5	94	6	105	46	82	22	57	18
Sept.	28	53	55	9	43	17	120	15	152	31	112	11	59	8
Mean annual flow	58	35	103	7	111	4	275	4	337	38	254	7	130	6
Q7,2	6.3	22	12	19	7.0	0	24	13	30	26	19	15	12	3
Q7,10	2.8	54	6.3	42	3.7	22	12	4	12	58	10	36	6.2	13
Q7,20	2.2	63	5.2	47	3.2	32	11	5	9.4	67	8.8	41	5.2	14
D99	4.2	28	7.6	17	4.1	8	15	7	19	22	12	27	7.0	9
D95	6.9	15	12	10	7.0	2	24	11	33	16	20	17	12	8
D90	9.1	18	17	13	10	12	33	6	45	16	27	0	18	3
D80	14	18	26	7	17	11	54	2	72	20	50	5	31	2
D50	32	32	61	3	54	7	145	6	179	35	154	6	86	0
D20	78	32	124	20	159	6	379	5	467	38	371	2	193	1
D10	124	38	189	29	278	8	624	3	781	37	597	11	289	5
D5	183	46	278	31	449	5	954	4	1,190	39	877	19	401	8
D1	349	56	549	33	1,050	1	2,000	10	2,430	45	1,920	40	746	19
Mean annual base flow	34	22	61	3	52	12	145	9	191	25	148	4	80	4
10-year base flow	26	22	47	3	37	13	106	11	139	26	103	8	57	4
25-year base flow	23	22	43	5	32	14	94	11	124	24	86	11	49	2
Mean		34		15		9		7		35		14		7
Median		33		11		7		6		36		11		7
Maximum		63		47		32		17		67		41		19
Minimum		3		0		0		2		16		0		0

Table 6. Predicted streamflow statistics and percent differences from observed statistics for continuous-record stations (treated as partial-record stations).—Continued

[ft^3/s, cubic feet per second; %, percent difference from observed; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow-duration statistics exceeded selected percent of time; x-year base flow, annual mean base flow for selected recurrence interval]

Statistic	Predicted streamflow and percent differences for continuous-record stations (treated as partial-record stations)												
	01442500		01447500		01447680		01447720		01448500		01449360		
	ft^3/s	%	ft^3/s	%	ft^3/s	%	ft^3/s	%	ft^3/s	%	ft^3/s	%	
Mean monthly flow													
Oct.	311	6	120	2	30	14	162.9	18	3.1	8	74	11	
Nov.	452	19	187	3	46	7	245.4	8	4.3	9	103	10	
Dec.	536	32	249	14	60	13	314.4	3	5.4	9	127	1	
Jan.	522	17	220	12	51	16	271.8	0	4.6	12	116	2	
Feb.	541	18	225	14	54	24	282.9	5	4.5	10	118	3	
Mar.	760	25	340	11	77	17	394.5	5	6.9	10	160	2	
Apr.	754	25	338	3	77	3	392.2	16	7.5	20	160	2	
May	588	17	255	1	57	1	300.1	7	5.7	14	129	4	
June	432	4	170	2	39	17	208.9	13	4.3	0	96	4	
July	311	20	93	13	24	21	132.1	12	2.6	8	61	6	
Aug.	265	3	79	15	24	1	133.3	6	2.2	6	54	2	
Sept.	261	9	102	4	26	17	144.6	26	2.8	23	65	4	
Mean annual flow	488	15	201	5	48	5	252.3	6	4.5	8	108	5	
Q7,2	68	6	23	0	7.7	8	48	10	.6	8	22	2	
Q7,10	38	21	14	9	5.2	31	33	17	.4	8	15	1	
Q7,20	33	25	12	12	4.7	41	30	20	.3	25	14	5	
D99	44	10	15	10	5.4	23	34	14	.4	122	16	7	
D95	72	1	25	7	7.6	2	47	5	.7	53	23	3	
D90	100	5	31	5	10	12	59	0	.9	17	27	3	
D80	162	11	52	4	14	12	83	3	1.4	4	40	1	
D50	373	5	132	1	31	2	172.5	5	3.1	2	79	4	
D20	671	18	274	2	65	3	335.3	8	6.2	9	136	6	
D10	886	33	407	2	96	4	478.6	13	9.1	7	183	10	
D5	1,110	46	560	0	131	0	639.4	19	13	17	232	17	
D1	1,680	70	1,070	3	241	2	1,110	39	24	30	376	31	
Mean annual base flow	358	9	128	6	29	3	161.3	2	3.0	10	78	7	
10-year base flow	282	22	95	4	21	6	120.1	1	2.1	10	62	19	
25-year base flow	253	27	82	2	18	8	105.7	2	1.8	6	55	25	
													All stations
Mean		18		6		11		10		17		7	15
Median		17		4		8		8		10		4	10
Maximum		70		15		41		39		122		31	122
Minimum		1		0		0		0		0		1	0

Table 7. Regression coefficients, basin characteristics, standard errors of prediction, coefficients of determination, continuous-record stations, and equations used to predict streamflow statistics for ungaged locations in Monroe County, Pennsylvania.

[Log, base 10 logarithm; DA, drainage area in square miles; P, mean annual precipitation in inches; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow-duration statistics exceeded selected percent of time; x-year base flow, annual mean base flow for selected recurrence interval; --, not appropriate to display; ft^3/s, cubic feet per second]

Log of statistic	Regression coefficients for basin characteristics significant at the $p<0.05$ level			Standard error of prediction		Coefficient of determination (R^2)
	Log of Intercept	LogDA	LogP	Log units	Percent	
Mean monthly flow						
$Log_{Oct.}$	-6.157	1.0509	3.7057	0.05	12	0.991
$Log_{Nov.}$	-3.4596	1.0292	2.2106	.06	14	.986
$Log_{Dec.}$	-3.214	1.0245	2.1234	.04	9	.992
$Log_{Jan.}$	-1.169	1.0145	.88303	.03	7	.995
$Log_{Feb.}$	-.56354	1.0128	.52	.03	7	.994
$Log_{Mar.}$	1.149	1.0252	-.3944	.02	5	.998
$Log_{Apr.}$	1.1061	1.0012	-.32468	.03	7	.997
Log_{May}	-2.3436	1.0046	1.6485	.03	7	.995
Log_{June}	-7.735	1.0361	4.7442	.06	14	.986
Log_{July}	-9.7249	1.0441	5.8152	.10	23	.964
$Log_{Aug.}$	-10.918	1.0642	6.466	.07	16	.982
$Log_{Sept.}$	-10.951	1.0879	6.4902	.09	21	.973
$Log_{Mean\ annual\ flow}$	-2.5737	1.0244	1.7036	.02	5	.997
$Log_{Q7,2}$	-20.528	1.1196	11.84	.13	31	.947
$Log_{Q7,10}$	-27.594	1.1956	15.842	.17	41	.925
$Log_{Q7,20}$	-29.452	1.217	16.891	.18	43	.918
Log_{D99}	-25.501	1.4404	14.336	.17	41	.947
Log_{D95}	-20.488	1.2192	11.705	.08	19	.980
Log_{D90}	-17.606	1.1331	10.156	.06	14	.985
Log_{D80}	-13.478	1.077	7.8586	.06	14	.986
Log_{D50}	-7.3329	1.0408	4.434	.06	14	.987
Log_{D20}	-2.5205	1.0249	1.7686	.03	7	.995
Log_{D10}	-.78052	1.0254	.82437	.02	5	.998
Log_{D5}	.6618	1.0102	.0635	.03	7	.996
Log_{D1}	3.2865	.97406	-1.2955	.06	14	.987
$Log_{Mean\ annual\ base\ flow}$	-6.7941	1.0166	4.1297	.06	14	.989
$Log_{10\text{-}year\ base\ flow}$	-6.2627	1.0243	3.7153	.06	14	.988
$Log_{25\text{-}year\ base\ flow}$	-5.9185	1.0284	3.4684	.06	14	.987
				Mean	16	--
				Maximum	43	.998
				Minimum	5	.918

Table 7. Regression coefficients, basin characteristics, standard errors of prediction, coefficients of determination, continuous-record stations, and equations used to predict streamflow statistics for ungaged locations in Monroe County, Pennsylvania.—Continued

[Log, base 10 logarithm; DA, drainage area in square miles; P, mean annual precipitation in inches; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow-duration statistics exceeded selected percent of time; x-year base flow, annual mean base flow for selected recurrence interval; --, not appropriate to display; ft^3/s, cubic feet per second]

Predicted statistic (ft^3/s)	Equations used to predict flow statistics at Monroe County stream locations	
Mean monthly flow		
Oct.	=	6.97E-07 ($DA^{1.0509}$)($P^{3.7057}$)
Nov.	=	3.47E-04 ($DA^{1.0292}$)($P^{2.2106}$)
Dec.	=	6.11E-04 ($DA^{1.0245}$)($P^{2.1234}$)
Jan.	=	6.78E-02 ($DA^{1.0145}$)($P^{0.88303}$)
Feb.	=	2.73E-01 ($DA^{1.0128}$)($P^{0.52}$)
Mar.	=	1.41E+01 ($DA^{1.0252}$)($P^{-0.3944}$)
Apr.	=	1.28E+01 ($DA^{1.0012}$)($P^{-0.32468}$)
May	=	4.53E-03 ($DA^{1.0046}$)($P^{1.6485}$)
June	=	1.84E-08 ($DA^{1.0361}$)($P^{4.7442}$)
July	=	1.88E-10 ($DA^{1.0441}$)($P^{5.8152}$)
Aug.	=	1.21E-11 ($DA^{1.0642}$)($P^{6.466}$)
Sept.	=	1.12E-11 ($DA^{1.0879}$)($P^{6.4902}$)
Mean annual flow	=	2.67E-03 ($DA^{1.0244}$)($P^{1.7036}$)
Q7,2	=	2.96E-21 ($DA^{1.1196}$)($P^{11.84}$)
Q7,10	=	2.55E-28 ($DA^{1.1956}$)($P^{15.842}$)
Q7,20	=	3.53E-30 ($DA^{1.217}$)($P^{16.891}$)
D99	=	3.16E-26 $DA^{1.4404}$)($P^{14.336}$)
D95	=	3.25E-21 ($DA^{1.2192}$)($P^{11.705}$)
D90	=	2.48E-18 ($DA^{1.1331}$)($P^{10.156}$)
D80	=	3.33E-14 ($DA^{1.077}$)($P^{7.8586}$)
D50	=	4.65E-08 ($DA^{1.0408}$)($P^{4.434}$)
D20	=	3.02E-03 ($DA^{1.0249}$)($P^{1.7686}$)
D10	=	1.66E-01 ($DA^{1.0254}$)($P^{0.82437}$)
D5	=	4.59E+00 ($DA^{1.0102}$)($P^{0.0635}$)
D1	=	1.93E+03 ($DA^{0.97406}$)($P^{-1.2955}$)
Mean annual base flow	=	1.61E-07 ($DA^{1.0166}$)($P^{4.1297}$)
10-year base flow	=	5.46E-07 ($DA^{1.0243}$)($P^{3.7153}$)
25-year base flow	=	1.21E-06 ($DA^{1.0284}$)($P^{3.4684}$)

Summary and Conclusions

Streamflow statistics are needed for many locations in Monroe County, Pa., to quantify surface-water resources, serve as surrogates for ground-water availability, and aid in the evaluation of and planning for competing water uses. To fulfill these purposes, the U.S. Geological Survey and the Brodhead Watershed Association cooperated in a study to determine the needed streamflow statistics.

Monroe County is in northeastern Pennsylvania, and surficial geology includes alluvial and glacial deposits, and siltstones, shales, sandstones, conglomerates, and small amounts of carbonate rock that generically are referred to as a sandstone and shale rock type. Streams where the ground-water table is connected to porous glacial deposits typically discharge higher base flows per unit of drainage area during dry periods than streams in the nonglaciated parts of Pennsylvania.

Several differing approaches have been used to predict streamflow statistics at ungaged stream locations in Pennsylvania without daily mean flow data. For this study, 28 observed streamflow statistics for 17 continuous-record streamflow-gaging stations were computed from daily mean flow data retrieved from a U.S. Geological Survey database. The statistics were predicted for 20 partial-record stations by developing regression equations based on correlations of intermittent measurements made at the partial-record stations and concurrent daily mean flows at continuous-record index stations. Regression equations relating the flow statistics to drainage area and mean annual precipitation basin characteristics for the continuous-record stations also were developed to predict statistics at 134 ungaged locations.

The observed and predicted statistics included mean monthly flows, mean annual flow, 7-day low flows for three recurrence intervals, nine flow durations, mean annual base flow, and annual mean base flows for two recurrence intervals. The statistics for each station ranged in magnitude from the 7-day low flows expected every 20 years (Q7,20) or low flows exceeded 99 percent of the time (D99) to the high flows exceeded only 1 percent of the time (D1). Low standard errors of prediction and high coefficients of determination (R^2) indicated reasonably good agreement in using the regression equations relating intermittent measurements at partial-record stations to concurrent daily mean flows at continuous-record stations for predicting low-flow statistics at the partial-record stations in Monroe County and the contiguous counties. Low standard errors of prediction and high coefficients of determination (R^2) indicated good agreement in using the regression equations relating observed flow statistics to drainage area and annual precipitation basin characteristics for continuous-record stations to predict statistics at ungaged stream locations in Monroe County.

Although the prediction methodology used in the study was developed for estimating low-flow frequencies, a comparison of predicted and observed statistics for the continuous-record stations also indicated the methodology has application potential for predicting intermediate- and high-flow statistics. This finding was similar to that of a previous study conducted in the same area.

This study is limited to streams in Monroe County and stations in contiguous counties. All the observed and predicted statistics are estimates affected by error. The determinations of basin characteristics used in the regression analyses are limited by the accuracies of the information contained in the analyzed datasets and the GIS-based automated procedures used to process the datasets. Caution is indicated in using the predicted statistics for small drainage-area applications. Although the observed and predicted statistics contain inherent error, they constitute results needed by the Brodhead Watershed Association, Paradise Township, and other agencies in Monroe County for planning purposes and evaluation of water-resources availability.

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Glossary of Selected Terms

Annual mean base flow The average base flow for a year.

Continuous-record streamflow-gaging stations USGS streamflow gages where frequent measurements of streamflow are made, that continuously record stage or elevation of the water surface, and which are used to compute daily mean streamflow.

Continuous-record index stations Continuous-record gages found to be statistically correlated to and used for transferring computed statistics to partial-record stations.

Flow duration The streamflow exceeded a specified percent of time, for example the 99 percent flow duration is that flow exceeded 99 percent of the time.

Management area pour points Subbasin stream locations identified as indicator points reflecting conditions in upstream drainage areas.

Mean annual base flow The average of all streamflows for period of record coming just from ground-water discharge (does not include overland runoff during precipitation events).

Mean annual flow The average of all annual streamflows for the period of record; also known as mean flow.

Mean monthly flow The average of each monthly streamflow for the period of record at a gage, for example the average flow for all Octobers.

Partial-record stations Sites where intermittent measurements of streamflow are made, but stage is not recorded.

Recurrence interval The reciprocal of a specific probability that a streamflow event will occur in any year, for example the 1-percent probability is also known as the 100-year recurrence interval.

7-day low flow The average of the lowest streamflows for a continuous 7-day period during a year.

Appendix 1

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Monthly and annual mean flows, in cubic feet per second												
	October	November	December	January	February	March	April	May	June	July	August	September	Annual mean
1	19	29	36	32	32	50	56	40	27	18	15	16	31
2	23	34	42	38	37	59	65	47	32	21	18	19	36
3	14	21	26	23	23	35	39	29	20	13	11	12	22
4	13	20	25	22	22	35	39	28	18	12	10	10	21
5	11	18	22	21	21	33	37	25	16	10	8	8.6	19
6	26	38	47	43	42	67	73	53	36	23	19	21	41
7	30	42	52	45	44	67	74	57	44	30	25	28	44
8	29	40	49	43	42	63	70	54	41	28	24	26	42
9	32	44	55	47	46	71	78	60	46	31	27	29	47
10	35	49	60	52	51	77	85	66	51	34	30	33	51
11	36	50	62	53	52	80	88	68	52	36	31	34	53
12	20	28	35	30	30	45	50	39	29	20	17	18	30
13	13	18	22	19	19	28	32	25	18	12	10	11	19
14	16	23	29	25	24	37	41	32	24	16	14	15	24
15	17	25	31	28	27	43	47	35	24	16	13	14	27
16	20	29	36	32	32	50	55	40	28	18	15	16	31
17	18	27	34	31	30	48	53	38	25	16	13	15	29
18	31	46	56	51	50	79	87	63	43	28	24	26	49
19	25	36	45	40	39	61	68	50	35	23	19	21	39
20	10	15	19	17	17	27	31	22	14	9.1	7.5	8.0	17
21	12	19	23	21	21	33	37	26	17	11	9.1	10	20
22	15	23	28	26	25	40	45	32	21	14	11	12	24
23	21	32	39	36	36	56	62	44	30	19	16	17	34
24	25	36	45	41	41	64	71	51	34	22	18	20	39
25	37	54	67	60	60	95	104	74	50	33	27	30	58
26	32	46	57	52	52	82	90	64	43	28	23	26	50
27	28	41	51	46	46	73	80	57	38	25	21	23	44
28	39	57	71	64	64	101	111	79	54	35	29	32	62
29	42	62	77	69	69	110	119	86	58	38	32	35	67
30	46	68	84	76	75	120	130	93	63	41	35	39	73
31	50	73	90	81	80	128	139	100	68	44	37	42	78
32	33	48	59	53	52	82	90	66	46	30	25	28	51

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Monthly and annual mean flows, in cubic feet per second												
	October	November	December	January	February	March	April	May	June	July	August	September	Annual mean
33	36	52	65	58	58	91	100	72	50	33	27	30	56
34	69	98	121	107	106	168	182	133	94	62	53	59	104
35	41	60	74	66	66	104	114	82	57	37	31	35	64
36	24	35	44	40	40	63	70	50	33	21	18	19	38
37	25	37	46	42	42	67	74	52	34	22	18	20	40
38	31	46	57	52	52	83	91	64	42	27	23	25	50
39	110	156	192	171	169	270	288	209	149	98	84	95	166
40	113	160	198	176	173	278	297	215	153	101	87	98	171
41	115	163	201	179	176	283	302	219	156	103	88	100	174
42	118	168	207	184	181	291	310	225	160	106	91	103	179
43	33	50	61	57	56	91	99	69	45	29	24	26	54
44	26	38	47	43	42	67	74	53	35	23	19	21	41
45	12	18	22	20	20	31	35	25	16	11	8.7	9.3	19
46	15	22	28	25	24	38	42	31	21	14	12	13	24
47	21	31	39	35	35	55	61	44	29	19	16	17	34
48	16	24	30	27	27	42	47	33	22	14	12	13	26
49	20	30	37	34	33	52	58	42	28	18	15	16	32
50	18	27	33	30	30	46	51	38	26	17	14	15	29
51	12	19	23	21	21	33	37	26	17	11	9.1	10	20
52	12	18	22	20	20	31	35	25	16	10	8.6	9.2	19
53	23	34	42	38	37	59	65	47	33	21	18	19	36
54	8.0	14	17	17	17	29	33	20	10	6.1	4.7	5.0	15
55	10	16	20	20	21	35	39	24	12	7.3	5.7	6.1	18
56	10	15	19	18	18	28	32	22	14	8.8	7.2	7.7	17
57	11	19	23	23	24	41	45	27	14	8.3	6.5	7.0	21
58	15	25	31	31	32	55	60	36	19	11	8.7	9.5	28
59	16	27	33	34	34	59	65	39	20	12	9.4	10	30
60	10	15	19	18	18	29	32	22	13	8.3	6.7	7.2	17
61	7.5	13	16	16	16	28	31	19	10	5.7	4.5	4.8	14
62	11	17	21	19	19	31	34	24	15	10	7.7	8.3	18
63	13	20	25	23	23	38	42	29	18	11	9.2	10	22
64	12	18	23	21	21	34	38	26	16	10	8.4	9.0	20

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Monthly and annual mean flows, in cubic feet per second												
	October	November	December	January	February	March	April	May	June	July	August	September	Annual mean
65	15	23	28	26	26	42	47	32	20	13	10	11	25
66	11	17	22	20	20	32	36	25	16	10	8.0	8.6	19
67	11	16	20	19	19	30	33	23	15	9.3	7.6	8.1	18
68	10	16	20	19	19	30	33	23	14	8.5	6.8	7.3	17
69	9.5	14	18	17	17	26	29	21	13	8.4	6.8	7.3	16
70	15	21	26	23	23	35	39	29	21	14	11	12	22
71	16	24	30	28	28	45	50	34	21	14	11	12	26
72	27	40	50	46	46	74	82	57	36	23	19	21	44
73	10	15	19	17	17	27	30	22	14	9.1	7.4	7.9	16
74	12	19	23	21	21	33	37	26	17	11	9.1	10	20
75	36	60	75	75	77	133	144	86	45	27	21	23	67
76	54	88	110	110	112	195	209	126	66	40	32	35	99
77	57	93	116	116	118	206	220	133	70	42	34	38	104
78	32	51	63	61	61	102	111	72	42	26	21	23	56
79	36	58	72	69	70	117	127	82	47	29	23	26	63
80	45	72	89	86	86	145	156	101	59	36	29	33	79
81	48	76	95	91	92	155	167	107	62	38	31	35	84
82	51	80	100	96	97	164	176	113	65	40	33	37	89
83	62	98	121	117	118	201	215	137	79	48	40	44	108
84	79	128	159	157	161	279	296	180	97	58	47	53	142
85	67	105	130	126	127	215	230	147	85	52	43	48	116
86	89	143	177	175	178	309	327	201	110	66	54	61	159
87	121	194	241	237	242	421	443	272	150	90	74	84	216
88	79	123	152	146	147	248	265	171	101	62	52	58	135
89	54	81	101	93	93	152	165	113	72	46	38	42	88
90	24	35	44	39	39	61	68	49	34	22	18	20	38
91	29	42	53	47	47	74	81	59	40	26	22	24	45
92	33	48	60	54	53	84	92	67	46	30	25	28	52
93	42	61	75	67	67	106	115	83	57	37	32	35	65
94	46	67	82	74	73	116	126	91	63	41	35	39	71
95	50	73	90	80	80	126	137	99	69	45	38	43	78
96	66	94	116	104	102	163	176	128	90	59	50	56	101

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Monthly and annual mean flows, in cubic feet per second												
	October	November	December	January	February	March	April	May	June	July	August	September	Annual mean
97	28	42	52	47	47	74	81	58	39	25	21	23	45
98	48	69	86	77	76	120	131	95	66	43	36	40	74
99	28	41	51	45	45	71	78	57	39	25	21	23	44
100	45	65	80	72	71	112	122	89	61	40	34	37	69
101	32	46	57	51	50	80	87	63	44	29	24	26	49
102	138	208	257	241	242	407	430	284	177	111	93	106	227
103	161	241	297	276	277	463	487	327	208	132	112	128	262
104	181	268	331	306	306	511	536	363	234	149	127	145	291
105	161	228	280	248	245	395	418	303	218	144	124	142	242
106	90	129	159	142	140	225	241	174	122	80	68	77	137
107	84	121	149	133	132	211	227	164	115	75	64	72	129
108	79	113	140	125	124	198	213	154	107	70	60	67	121
109	354	506	621	560	556	922	955	668	462	301	261	303	542
110	430	611	749	673	667	1110	1140	802	561	366	319	372	653
111	2.7	4.4	5.5	5.4	5.5	8.9	10	6.6	3.6	2.2	1.7	1.8	4.9
112	4.4	7.1	8.9	8.7	8.8	14	16	11	5.9	3.6	2.8	3.0	7.9
113	5.6	8.6	11	10	10	15	18	12	7.8	5.0	4.0	4.2	9.3
114	16	25	31	29	29	46	51	35	22	14	11	12	27
115	3.9	6.3	7.9	7.6	7.6	12	14	9.3	5.4	3.3	2.6	2.8	7.0
116	6.6	10	12	11	11	17	20	14	9.4	6.1	4.9	5.2	11
117	2.3	3.7	4.7	4.4	4.4	7.0	8.1	5.5	3.2	2.0	1.6	1.6	4.1
118	3.0	4.5	5.6	5.1	5.1	7.8	9.0	6.6	4.3	2.8	2.2	2.3	4.9
119	.4	.7	.9	.8	.8	1.2	1.5	1.1	.6	.4	.3	.3	.8
120	12	17	21	18	18	28	31	23	17	11	9.2	10	18
Management area pour points in fig. 3													
1	3.5	5.5	6.9	6.5	6.4	10	12	8.1	4.9	3.1	2.5	2.6	6.0
2	6.9	11	13	12	12	20	22	15	10	6.1	4.9	5.2	12
3	16	25	31	29	29	47	52	35	22	14	11	12	27
4	7.9	12	15	14	14	21	24	17	11	7.1	5.8	6.2	13

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Monthly and annual mean flows, in cubic feet per second												
	October	November	December	January	February	March	April	May	June	July	August	September	Annual mean
5	11	17	22	20	20	32	36	25	16	10	8.0	8.6	19
6	5.0	8.0	10	10	10	16	18	12	6.9	4.3	3.4	3.6	8.8
7	6.9	11	14	14	14	23	26	17	9.2	5.6	4.4	4.7	12
8	5.6	8.6	11	10	10	16	18	13	7.8	5.0	4.0	4.2	9.4
9	54	81	101	93	93	152	164	112	72	46	38	42	88
10	2.8	4.2	5.2	4.7	4.7	7.0	8.2	6.1	4.1	2.7	2.2	2.2	4.5
11	17	24	30	27	27	41	46	34	24	16	13	14	26
12	49	70	87	78	77	122	133	96	67	44	37	41	75
13	52	76	93	84	83	131	143	103	72	47	40	44	81
14	57	83	102	91	90	143	155	113	79	52	44	49	88

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Q7 flows, in cubic feet per sec			Flow durations, in cubic feet per second								
	Q7,2	Q7,10	Q7,20	D99	D95	D90	D80	D50	D20	D10	D5	D1
1	4.2	2.2	1.8	1.6	3.6	5.5	9.0	21	45	65	149	186
2	5.2	2.8	2.4	2.1	4.5	6.8	11	25	53	76	174	215
3	3.4	1.9	1.6	1.2	2.8	4.3	7.0	16	32	46	104	129
4	2.6	1.3	1.1	.9	2.2	3.5	5.9	14	31	45	104	132
5	1.9	.9	.7	.6	1.6	2.6	4.7	12	28	41	97	127
6	5.6	3.0	2.5	2.3	4.9	7.4	12	28	59	86	197	243
7	8.9	5.6	4.9	4.1	7.8	11	16	33	65	90	200	235
8	8.4	5.3	4.6	3.8	7.3	10	15	32	61	86	190	224
9	9.5	6.0	5.2	4.5	8.3	12	17	35	68	95	212	248
10	11	6.7	5.9	5.1	9.3	13	19	39	75	105	232	271
11	11	6.9	6.1	5.3	9.7	13	20	40	77	108	239	279
12	5.8	3.5	3.1	2.4	4.9	7.1	11	22	43	61	135	161
13	3.5	2.1	1.8	1.2	2.8	4.3	6.6	14	27	38	85	103
14	4.6	2.8	2.4	1.8	3.8	5.7	8.7	18	36	50	111	134
15	3.8	2.1	1.7	1.4	3.2	4.9	8.0	18	39	55	127	158
16	4.4	2.4	2.0	1.7	3.8	5.8	9.3	21	45	65	148	183
17	3.7	1.9	1.6	1.4	3.1	4.9	8.2	19	42	62	142	179
18	7.0	3.9	3.3	3.1	6.2	9.2	15	34	71	102	233	285
19	5.9	3.3	2.8	2.5	5.1	7.6	12	27	56	80	182	223
20	2.0	1.0	.8	.6	1.6	2.6	4.5	11	24	35	81	104
21	2.5	1.2	1.0	.8	2.0	3.3	5.5	13	29	42	98	125
22	3.1	1.6	1.3	1.1	2.6	4.1	6.8	16	35	51	119	151
23	4.4	2.3	1.9	1.7	3.8	5.9	9.7	23	50	72	166	208
24	5.1	2.7	2.3	2.1	4.5	6.8	11	26	57	83	190	237
25	7.9	4.3	3.6	3.7	7.2	11	17	39	84	122	279	342
26	6.7	3.6	3.0	2.9	6.0	8.9	14	34	72	105	241	297
27	5.9	3.1	2.6	2.5	5.2	7.8	13	30	64	93	214	265
28	8.4	4.6	3.9	4.0	7.7	11	18	42	90	130	296	363
29	9.2	5.1	4.3	4.4	8.5	12	20	45	97	141	320	392
30	10	5.6	4.7	5.0	9.4	14	21	49	106	154	349	426
31	11	6.1	5.2	5.5	10	15	23	53	113	165	374	455
32	7.7	4.3	3.7	3.5	6.9	10	16	36	75	107	243	296

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Q7 flows, in cubic feet per sec			Flow durations, in cubic feet per second								
	Q7,2	Q7,10	Q7,20	D99	D95	D90	D80	D50	D20	D10	D5	D1
33	8.1	4.5	3.8	3.8	7.3	11	17	39	82	118	268	327
34	16	9.7	8.3	9.3	16	22	33	73	152	219	491	585
35	9.3	5.2	4.4	4.5	8.5	12	19	44	93	135	305	371
36	4.9	2.6	2.1	2.0	4.3	6.5	11	26	56	81	186	233
37	5.1	2.7	2.2	2.1	4.5	6.8	11	27	59	85	196	245
38	6.2	3.3	2.7	2.7	5.6	8.4	14	33	72	105	242	302
39	26	16	14	17	26	35	53	116	242	349	781	919
40	27	16	14	18	27	36	54	119	249	360	804	945
41	28	17	15	18	28	37	55	122	253	366	818	961
42	29	17	15	19	29	38	57	125	260	376	841	986
43	6.4	3.3	2.7	2.8	5.8	8.7	14	35	78	114	264	331
44	5.4	2.9	2.4	2.2	4.7	7.2	12	27	59	86	198	246
45	2.3	1.2	1.0	.8	1.9	3.1	5.2	13	28	40	93	119
46	3.5	1.9	1.6	1.3	2.9	4.5	7.3	17	35	49	113	141
47	4.4	2.3	1.9	1.7	3.8	5.8	9.5	23	49	71	164	205
48	3.2	1.7	1.4	1.2	2.7	4.3	7.1	17	37	54	125	158
49	4.1	2.2	1.8	1.6	3.6	5.5	9.1	21	46	67	155	195
50	4.2	2.3	1.9	1.6	3.5	5.4	8.8	20	42	60	138	171
51	2.5	1.2	1.0	.8	2.0	3.3	5.5	13	29	42	98	125
52	2.3	1.2	1.0	.8	1.9	3.0	5.2	13	28	40	93	119
53	5.3	2.9	2.4	2.2	4.6	6.9	11	25	53	76	174	214
54	.8	.3	.2	.2	.7	1.2	2.5	8	22	34	85	121
55	1.0	.4	.3	.3	.9	1.5	3.1	10	26	40	99	140
56	1.8	.9	.7	.6	1.5	2.4	4.3	11	24	36	83	109
57	1.1	.4	.3	.3	1.0	1.7	3.5	11	30	47	116	165
58	1.5	.6	.4	.5	1.3	2.4	4.7	15	40	63	155	218
59	1.7	.6	.5	.5	1.5	2.6	5.1	16	43	68	167	234
60	1.6	.7	.6	.5	1.3	2.2	3.9	10	24	36	85	113
61	.8	.3	.2	.2	.6	1.2	2.4	7.7	21	32	80	114
62	1.9	.9	.8	.6	1.6	2.6	4.6	12	26	39	90	118
63	2.3	1.1	.9	.7	1.9	3.1	5.4	14	32	47	111	144
64	2.1	1.0	.8	.7	1.7	2.8	5.0	13	29	42	100	130

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Q7 flows, in cubic feet per sec			Flow durations, in cubic feet per second								
	Q7,2	Q7,10	Q7,20	D99	D95	D90	D80	D50	D20	D10	D5	D1
65	2.5	1.2	1.0	0.9	2.1	3.4	6.0	16	36	53	124	162
66	2.0	.9	.8	.6	1.6	2.7	4.7	12	27	40	94	123
67	1.9	.9	.7	.6	1.6	2.6	4.5	11	26	38	88	115
68	1.6	.7	.6	.5	1.3	2.2	4.0	11	25	37	88	117
69	1.7	.8	.7	.5	1.4	2.3	4.1	10	23	33	78	101
70	3.5	1.9	1.6	1.2	2.9	4.4	7.1	16	33	46	106	131
71	2.7	1.3	1.1	1.0	2.3	3.7	6.5	17	38	56	132	171
72	5.0	2.5	2.1	2.0	4.4	6.8	11	28	63	94	217	275
73	2.0	1.0	.8	.6	1.6	2.6	4.5	11	24	35	80	103
74	2.5	1.2	1.0	.8	2.0	3.3	5.5	13	29	42	98	125
75	3.8	1.5	1.2	1.6	3.6	5.9	11	36	97	153	373	512
76	5.9	2.4	1.9	2.7	5.8	9.2	17	53	143	225	544	735
77	6.3	2.5	2.0	2.9	6.2	9.8	18	56	151	238	573	774
78	4.6	2.1	1.7	1.9	4.2	6.7	12	33	81	123	292	384
79	5.1	2.2	1.8	2.2	4.7	7.4	13	37	92	141	333	439
80	6.5	2.9	2.4	3.0	6.2	9.5	17	46	114	174	412	537
81	6.8	3.1	2.5	3.2	6.5	10	18	49	122	186	439	573
82	7.2	3.2	2.6	3.4	6.9	11	19	52	128	197	464	605
83	8.6	3.9	3.1	4.3	8.4	13	23	63	156	240	566	736
84	9.1	3.8	3.0	4.8	9.3	14	26	78	206	324	776	1030
85	9.4	4.3	3.5	4.8	9.3	14	25	68	168	258	607	786
86	11	4.6	3.7	5.8	11	17	30	88	230	360	859	1130
87	15	6.5	5.2	8.9	16	23	41	120	313	491	1160	1520
88	12	5.5	4.5	6.4	12	17	30	80	196	299	700	895
89	9.8	5.0	4.2	5.0	9.4	14	23	56	128	190	439	548
90	5.3	2.9	2.4	2.2	4.6	7.0	11	26	55	79	181	224
91	6.4	3.5	3.0	2.8	5.7	8.5	14	31	66	95	218	268
92	7.4	4.1	3.4	3.3	6.6	9.7	15	35	75	108	247	302
93	9.3	5.2	4.4	4.5	8.6	12	19	44	94	136	310	377
94	10	5.9	5.1	5.3	9.7	14	22	49	104	150	338	410
95	12	6.5	5.6	5.9	10.8	15	24	54	113	163	369	446
96	15	9.0	7.7	8.6	14.8	21	31	70	146	211	475	568

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Q7 flows, in cubic feet per sec			Flow durations, in cubic feet per second								
	Q7,2	Q7,10	Q7,20	D99	D95	D90	D80	D50	D20	D10	D5	D1
97	6	3.2	2.7	2.6	5.3	8.0	13	30	66	95	218	270
98	11	6.1	5.2	5.5	10.1	14	22	51	108	156	352	427
99	6.3	3.5	2.9	2.7	5.6	8.3	13	30	64	92	209	256
100	10	5.7	4.8	5.0	9.3	13	21	47	100	145	329	400
101	7.1	3.9	3.3	3.2	6.3	9.3	15	34	72	103	234	287
102	23	12	9.9	15	24	34	55	140	329	497	1150	1420
103	29	15	13	20	31	42	67	165	380	570	1300	1590
104	34	18	15	24	36	48	76	185	422	632	1440	1740
105	39	24	21	29	41	53	78	170	353	511	1140	1320
106	21	12	11	13	21	28	42	95	200	289	651	773
107	20	11	9.8	12	19	26	40	89	188	272	613	730
108	18	11	9.1	11	18	24	37	84	176	255	574	685
109	78	47	41	70	88	110	161	364	788	1160	2590	3010
110	97	60	52	93	112	137	198	442	950	1400	3110	3580
111	.3	.1	.1	.1	.2	.5	.9	2.8	7.1	11	26	38
112	.6	.2	.2	.1	.4	.8	1.6	4.6	11	17	42	59
113	1.0	.5	.4	.3	.8	1.3	2.4	6.0	14	20	46	61
114	2.7	1.3	1.0	.9	2.3	3.7	6.5	17	39	58	135	176
115	.6	.2	.2	.1	.4	.8	1.5	4.2	10	15	36	50
116	1.3	.7	.5	.4	1.0	1.7	3.0	7.2	16	22	52	68
117	.4	.1	.1	.1	.3	.5	.9	2.5	5.9	8.7	21	29
118	.6	.3	.2	.1	.4	.8	1.4	3.3	7.1	10	24	31
119	.1	.0	.0	.0	.0	.1	.2	.5	1.1	1.6	3.9	5.5
120	2.8	1.6	1.3	1.0	2.3	3.6	5.7	13	26	37	84	104
Management area pour points in fig. 3												
1	.6	.3	.2	.1	.4	.8	1.5	3.8	8.7	13	30	41
2	1.2	.5	.4	.3	.9	1.6	2.9	7.4	17	25	59	78
3	2.7	1.3	1.0	.9	2.3	3.7	6.6	17	39	58	136	178
4	1.5	.7	.6	.4	1.2	2.0	3.5	8.6	19	27	64	83

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Q7 flows, in cubic feet per sec			Flow durations, in cubic feet per second								
	Q7,2	Q7,10	Q7,20	D99	D95	D90	D80	D50	D20	D10	D5	D1
5	2.0	1.0	0.8	0.6	1.6	2.7	4.8	12	27	40	95	124
6	.7	.3	.2	.2	.6	1.0	1.9	5.3	13	19	46	63
7	.9	.4	.3	.2	.7	1.3	2.5	7.2	18	28	67	92
8	1.0	.5	.4	.3	.8	1.3	2.4	6.0	14	20	47	62
9	9.8	5.0	4.2	5.0	9.4	14	23	56	128	190	438	547
10	.6	.3	.2	.1	.4	.8	1.3	3.1	6.5	9.3	22	28
11	3.9	2.2	1.8	1.5	3.3	5.1	8.1	18	38	54	123	153
12	11	6.3	5.4	5.7	10	15	23	52	110	158	358	433
13	12	6.8	5.8	6.2	11	16	25	56	118	170	384	464
14	13	7.7	6.6	7.2	13	18	27	61	128	185	418	502

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Base flows, in cubic feet per second		
	Annual mean	10-year recurrence interval	25-year recurrence interval
1	21	15	13
2	25	18	15
3	16	11	9.4
4	14	10	8.7
5	12	8.7	7.6
6	28	19	17
7	33	23	19
8	31	22	18
9	35	24	21
10	38	26	23
11	39	27	23
12	22	15	13
13	14	9.6	8.2
14	18	13	11
15	18	13	11
16	21	15	13
17	20	14	12
18	33	23	20
19	27	19	16
20	11	7.8	6.7
21	14	9.5	8.2
22	16	12	10
23	23	16	14
24	26	19	16
25	39	27	24
26	33	24	20
27	30	21	18
28	41	29	25
29	45	32	27
30	49	34	30
31	52	37	32
32	35	25	21

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Base flows, in cubic feet per second		
	Annual mean	10-year recurrence interval	25-year recurrence interval
33	38	27	23
34	71	50	44
35	43	31	26
36	26	18	16
37	27	19	16
38	33	23	20
39	112	79	69
40	115	82	71
41	117	83	72
42	120	85	74
43	35	25	21
44	27	19	17
45	13	9.0	7.8
46	17	12	10
47	23	16	14
48	17	12	10
49	21	15	13
50	20	14	12
51	14	9.5	8.2
52	13	8.9	7.7
53	25	18	15
54	8.5	6.1	5.4
55	10	7.3	6.4
56	11	7.7	6.7
57	12	8.4	7.4
58	15	11	9.8
59	16	12	11
60	11	7.5	6.5
61	8.0	5.8	5.1
62	12	8.3	7.2
63	14	10	8.7
64	13	9.1	7.9

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Base flows, in cubic feet per second		
	Annual mean	10-year recurrence interval	25-year recurrence interval
65	16	11	9.7
66	12	8.7	7.5
67	12	8.2	7.1
68	11	7.7	6.6
69	10	7.3	6.3
70	16	11	9.5
71	17	12	10
72	28	20	17
73	11	7.8	6.7
74	14	9.5	8.2
75	36	27	24
76	53	39	35
77	56	41	37
78	33	24	21
79	37	27	24
80	46	33	29
81	49	35	31
82	51	37	33
83	62	45	40
84	77	57	50
85	67	49	43
86	87	64	57
87	118	87	77
88	79	57	50
89	55	40	35
90	26	18	16
91	31	22	19
92	35	25	21
93	44	31	27
94	48	34	29
95	53	37	32
96	68	48	42

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Base flows, in cubic feet per second		
	Annual mean	10-year recurrence interval	25-year recurrence interval
97	30	21	18
98	50	35	31
99	30	21	18
100	47	33	29
101	34	24	20
102	136	99	87
103	159	115	101
104	178	129	113
105	162	116	101
106	92	65	57
107	87	61	53
108	81	58	50
109	343	248	218
110	414	300	263
111	3.0	2.1	1.8
112	4.8	3.4	3.0
113	6.2	4.3	3.7
114	17	12	11
115	4.4	3.1	2.7
116	7.4	5.1	4.4
117	2.7	1.9	1.6
118	3.4	2.4	2.0
119	.5	.4	.3
120	13	8.9	7.6
Management area pour points in fig. 3			
1	4.0	2.8	2.4
2	7.6	5.4	4.6
3	17	12	11
4	8.8	6.1	5.3

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Base flows, in cubic feet per second		
	Annual mean	10-year recurrence interval	25-year recurrence interval
5	12	8.7	7.5
6	5.6	3.9	3.4
7	7.5	5.4	4.7
8	6.2	4.4	3.8
9	55	40	35
10	3.2	2.2	1.9
11	18	13	11
12	51	36	31
13	55	39	33
14	60	42	37

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Location description	Latitude (decimal degrees)	Longitude (decimal degrees)	Basin characteristics					
				Drainage area (mi^2)	Mean annual precipitation (in.)	Basin slope (percent)	Mean elevation (ft)	Lakes (%)	Forest (%)
1	Upper Tunkhannock Creek upstream from Millers Drive	41.11540	75.44074	15.2	47.2	1.4	1890	5.0	53
2	Pohopoco Creek at Gilbert, Pa.	40.91706	75.43225	17.7	47.4	5.5	1149	.3	68
3	Dotters Creek along State Highway 534	40.91847	75.50857	10.7	48.0	4.9	1269	.2	77
4	Tobyhanna Creek below confluence with Singer Run	41.19575	75.40052	10.7	47.0	2.3	2045	15	73
5	Trout Creek near Arrowhead Lake	41.16135	75.54947	10.0	46.1	1.9	1796	7.0	67
6	Upper Tunkhannock Creek at Pocono Lake	41.10940	75.48290	20.0	47.2	1.5	1874	5.7	53
7	Tunkhannock Creek near Pocono International Raceway	41.06605	75.52348	20.4	49.0	1.4	1877	5.8	67
8	Tunkhannock Creek at Pocono International Raceway	41.06551	75.51100	19.4	49.0	1.4	1879	6.2	67
9	Tunkhannock Creek below Pocono International Raceway	41.06373	75.54142	21.5	49.0	1.5	1874	5.5	67
10	Tunkhannock Creek along State Highway 903	41.05249	75.55493	23.6	49.0	1.6	1871	5.1	67
11	Tunkhannock Creek at Henning Road	41.04991	75.56074	24.3	49.0	1.7	1870	5.0	68
12	Tunkhannock Creek near Long Pond, Pa.	41.04707	75.47899	13.8	49.0	1.3	1883	4.8	69
13	Tunkhannock Creek downstream from Grass Lake	41.03451	75.44054	8.76	49.0	1.2	1892	3.9	73
14	Tunkhannock Creek below confluence with Mud Pond Run	41.03239	75.45823	11.4	49.0	1.4	1888	3.0	71
15	Pohopoco Creek below confluence with Sugar Hollow Creek	40.94681	75.44155	13.0	47.6	5.6	1237	.2	69
16	Pohopoco Creek at Effort, Pa.	40.94056	75.43609	15.1	47.5	5.6	1202	.1	71
17	Aquashicola Creek near Smith Gap, Pa.	40.84235	75.41438	14.5	47.0	8.8	988	1.0	88
18	Pohopoco Creek near Gilbert, Pa.	40.90490	75.45647	23.7	47.3	5.2	1058	.3	61
19	Middle Creek above confluence with Pohopoco Creek	40.89647	75.49954	18.6	47.8	5.2	1160	1.0	61
20	Buckwha Creek near Kunkletown, Pa.	40.85406	75.43054	8.32	47.0	9.1	833	1.3	74
21	Aquashicola Creek above Chicola Lake	40.85081	75.36647	10.1	47.0	8.0	1022	1.2	85
22	Aquashicola Creek along Upper Smith Gap Road	40.84569	75.39076	12.2	47.0	8.5	1005	1.1	86
23	Tobyhanna Creek upstream from Millpond Number 1	41.18280	75.40557	17.0	47.0	2.2	2034	12	69
24	Tobyhanna Creek below confluence with Pollys Run	41.16835	75.42366	19.4	47.0	2.2	2022	11	68
25	Tobyhanna Creek below confluence with Frame Cabin Run	41.16276	75.47252	28.3	47.0	2.2	1980	7.8	71
26	Tobyhanna Creek below confluence with Cross Keys Run	41.16193	75.45920	24.5	47.0	2.2	1995	8.5	70
27	Tobyhanna Creek near Beagle Hole Swamp	41.16054	75.44542	21.8	47.0	2.2	2009	9.6	68
28	Tobyhanna Creek near Bill Warner Spring	41.15849	75.47924	30.1	47.0	2.2	1970	7.3	71
29	Tobyhanna Creek at Still Swamp	41.15095	75.48060	32.5	47.0	2.2	1954	6.8	72
30	Tobyhanna Creek below confluence with Kistler Run	41.13417	75.48303	35.4	47.0	2.2	1941	6.2	72
31	Tobyhanna Creek above Pocono Lake	41.12126	75.50247	37.9	47.0	2.2	1928	5.9	73
32	Upper Tunkhannock Creek below confluence with Beaver Creek	41.10593	75.48494	24.7	47.5	1.7	1870	5.1	56

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Location description	Latitude (decimal degrees)	Longitude (decimal degrees)	Basin characteristics					
				Drainage area (mi^2)	Mean annual precipitation (in.)	Basin slope (percent)	Mean elevation (ft)	Lakes (%)	Forest (%)
33	Pohopoco Creek near Greenhill Road	40.90615	75.46034	27.2	47.3	5.2	1031	0.3	61
34	Pohopoco Creek below confluence with Middle Creek	40.89631	75.50014	49.6	47.4	5.1	1059	.2	65
35	Pohopoco Creek above confluence with Middle Creek	40.89583	75.49897	31.0	47.3	5.1	1000	.3	59
36	Buckwha Creek below confluence with Princess Run	40.84792	75.44228	19.0	46.9	7.9	885	.6	68
37	Buckwha Creek upstream from confluence with Chapple Run	40.84582	75.46088	20.0	46.8	7.8	875	.6	68
38	Buckwha Creek below confluence with Chapple Creek	40.84337	75.46417	24.7	46.7	7.8	868	.5	67
39	Tobyhanna Creek below confluence with Deep Run	41.09640	75.55295	78.6	47.3	2.1	1868	5.8	67
40	Tobyhanna Creek below confluence with Davey Run	41.09301	75.56332	80.9	47.3	2.1	1864	5.6	67
41	Tobyhanna Creek downstream from confluence with Red Run	41.09139	75.57159	82.2	47.3	2.1	1861	5.6	67
42	Tobyhanna Creek near State Highway 115	41.08323	75.58606	84.5	47.3	2.1	1856	5.4	67
43	Marshalls Creek above confluence with Brodhead Creek	40.99731	75.14121	26.9	46.4	5.3	817	1.3	79
44	Cherry Creek at Delaware Water Gap, Pa.	40.98055	75.15216	20.2	47.0	9.3	798	.4	83
45	Appenzell Creek near Appenzell, Pa.	40.98221	75.35767	9.57	47.0	4.9	1180	2.9	75
46	McMichael Creek along Hillside Road	40.96789	75.38939	11.6	47.7	5.6	1422	.7	84
47	Cherry Creek below confluence with Mountain Run	40.96288	75.19928	16.7	47.0	9.2	842	.5	83
48	Appenzell Creek at Neola, Pa.	40.96130	75.34543	12.8	47.0	5.6	1140	2.2	79
49	Appenzell Creek at Sandhill, Pa.	40.94797	75.30663	15.9	47.0	5.8	1075	1.9	79
50	McMichael Creek at Effort Neola Road	40.94462	75.39601	14.1	47.6	5.9	1346	.6	84
51	Cherry Creek at Kemmertown Road	40.93697	75.25266	10.1	47.0	9.9	898	.6	85
52	Lake Creek above confluence with McMichael Creek	40.93085	75.31030	9.52	47.0	5.8	759	.8	57
53	McMichael Creek at McIlhaney Road	40.93108	75.36316	17.7	47.5	5.9	1245	1.8	82
54	Stony Run below confluence with Mud Run	41.14651	75.20853	8.76	43.4	4.3	1249	2.9	88
55	Stony Run above confluence with Brodhead Creek	41.12786	75.23113	10.3	43.6	4.5	1206	2.4	89
56	Pond Creek above confluence with Marshalls Creek	41.04371	75.12730	8.59	46.5	5.4	709	1.6	78
57	Brights Creek below confluence with Mud Pond Run	41.24264	75.16137	12.0	43.3	5.8	1595	2.6	93
58	Brights Creek below confluence with Henderson Swamp Run	41.21947	75.16046	15.9	43.3	5.5	1523	1.9	94
59	Brights Creek above confluence with Bush Kill	41.20395	75.15599	17.2	43.2	5.4	1499	1.8	94
60	Buck Hill Creek above confluence with Brodhead Creek	41.19391	75.25472	8.78	45.8	5.9	1791	1.0	90
61	Goose Pond Run above confluence with Brodhead Creek	41.18807	75.25138	8.24	43.5	4.6	1412	1.8	87
62	Paradise Creek below confluence with Devils Hole Creek	41.12752	75.30800	9.30	46.4	5.2	1750	1.0	85
63	Paradise Creek near Paradise Valley Church	41.12708	75.30075	11.4	46.1	5.0	1660	.0	86
64	Paradise Creek downstream of route 940	41.12648	75.30578	10.2	46.3	5.2	1707	.0	86

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Location description	Latitude (decimal degrees)	Longitude (decimal degrees)	Basin characteristics					
				Drainage area (mi^2)	Mean annual precipi-tation (in.)	Basin slope (percent)	Mean elevation (ft)	Lakes (%)	Forest (%)
65	Paradise Creek near Paradise Valley, Pa.	41.11704	75.28007	12.7	46.0	5.0	1599	0.0	86
66	Swiftwater Creek below Swiftwater Lake	41.09765	75.27492	9.71	46.3	6.2	1479	.3	79
67	Swiftwater Creek upstream of Swiftwater Lake	41.09212	75.28503	9.08	46.5	6.1	1511	.0	79
68	Marshalls Creek near Pocono Heights, Pa.	41.08805	75.14241	9.05	45.7	3.8	1052	1.9	78
69	Swiftwater Creek along State Highway 314 (Lower Swiftwater Road)	41.09168	75.29708	8.02	46.6	5.8	1563	.0	77
70	Pocono Creek near Camelback Mountain	41.05110	75.33730	10.8	48.0	6.0	1753	2.3	71
71	Marshalls Creek above confluence with Pond Creek	41.04399	75.12753	13.5	46.1	4.6	969	1.3	80
72	Marshalls Creek below confluence with Pond Creek	41.04337	75.12768	22.1	46.3	4.9	868	1.5	79
73	Sambo Creek near East Stroudsburg, Pa.	41.02610	75.18363	8.28	47.0	5.1	733	1.7	86
74	Sambo Creek above confluence with Brodhead Creek	41.00457	75.19133	10.1	47.0	4.9	696	1.5	80
75	Bush Kill above confluence with Brights Creek	41.20404	75.15551	38.0	43.0	3.4	1402	6.0	75
76	Bush Kill below confluence with Brights Creek	41.20359	75.15601	55.2	43.1	4.1	1432	4.7	81
77	Bush Kill below confluence with Sixteenmile Run	41.18694	75.16007	58.2	43.1	4.1	1420	4.5	81
78	Brodhead Creek below confluence with Goose Pond Run	41.18762	75.25176	29.8	44.7	5.6	1622	1.7	89
79	Brodhead Creek below confluence with Spruce Cabin Run	41.17327	75.24639	33.9	44.5	5.5	1572	1.5	89
80	Brodhead Creek below confluence with Mill Creek	41.16291	75.23884	41.8	44.6	5.6	1556	1.2	88
81	Brodhead Creek between Mill Creek and Stony Run	41.14390	75.23522	44.6	44.5	5.7	1527	1.1	88
82	Brodhead Creek above confluence above Stony Run	41.12797	75.23172	47.1	44.4	5.6	1498	1.2	88
83	Brodhead Creek below confluence with Stony Run	41.12751	75.23126	57.4	44.3	5.4	1445	1.4	89
84	Bush Kill upstream of Resica Falls, Pa.	41.12318	75.09894	78.4	43.2	4.0	1348	4.2	83
85	Brodhead Creek below confluence with Poplar Run	41.11344	75.22292	61.4	44.3	5.4	1419	1.3	89
86	Busk Kill above confluence with Saw Creek	41.08878	75.03923	86.8	43.4	4.4	1305	3.8	83
87	Bush Kill below confluence with Saw Creek	41.08858	75.03853	117.3	43.4	4.4	1270	3.4	84
88	Brodhead Creek above confluence with Paradise Creek	41.06759	75.21961	70.7	44.6	5.5	1362	1.3	89
89	Paradise Creek above confluence with Brodhead Creek	41.06761	75.22020	44.4	45.9	5.7	1329	.4	85
90	Pocono Creek below confluence with Scot Run	41.05120	75.31444	18.5	47.3	6.5	1565	1.6	79
91	Pocono Creek at Lower Tannersville, Pa.	41.03241	75.30438	22.2	47.3	6.4	1488	1.4	78
92	Pocono Creek below confluence with Bulgers Run	41.02663	75.29986	25.1	47.3	6.2	1432	1.2	78
93	Rocky Run above confluence with Pocono Creek	41.01232	75.29652	31.4	47.2	5.8	1347	1.1	79
94	Pocono Creek below confluence with Rocky Run	41.01193	75.29546	34.3	47.3	5.6	1312	1.8	78
95	Pocono Creek at Interstate 80 Interchange 46	40.99992	75.27514	37.4	47.3	5.6	1279	1.7	78
96	Pocono Creek above confluence with McMichael Creek	40.98045	75.19568	48.0	47.3	5.5	1145	1.4	74

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Location description	Latitude (decimal degrees)	Longitude (decimal degrees)	Basin characteristics: Drainage area (mi^2)	Mean annual precipi-tation (in.)	Basin slope (percent)	Mean elevation (ft)	Lakes (%)	Forest (%)
97	Appenzell Creek above confluence with McMichael Creek	40.95646	75.28477	22.2	47.0	5.9	997	1.4	78
98	McMichael Creek above confluence with Appenzell Creek	40.95628	75.28454	35.7	47.2	5.8	992	1.2	71
99	McMichael Creek along State Highway 3022	40.93430	75.35043	21.3	47.4	5.9	1176	1.6	80
100	McMichael Creek below confluence with Lake Creek	40.93123	75.31111	33.4	47.2	5.8	1020	1.2	72
101	McMichael Creek above confluence with Lake Creek	40.93077	75.31066	23.9	47.4	5.8	1124	1.4	79
102	Brodhead Creek below confluence with Paradise Creek	41.06706	75.21999	115.2	45.1	5.6	1349	.9	87
103	Brodhead Creek above confluence with Sambo Creek	41.00468	75.19180	130.9	45.4	5.5	1284	1.0	86
104	Brodhead Creek above confluence with Pocono Creek	40.98774	75.18408	144.2	45.5	5.4	1225	1.0	84
105	Pocono Creek above confluence with Brodhead Creek	40.98747	75.18433	113.9	47.2	5.7	1031	1.2	74
106	McMichael Creek above confluence with Pocono Creek	40.98018	75.19570	65.6	47.1	6.0	949	1.2	74
107	McMichael Creek near Snydersville, Pa.	40.96603	75.26263	61.8	47.1	5.9	973	1.2	74
108	McMichael Creek below confluence with Appenzell Creek	40.95681	75.28405	57.9	47.2	5.8	994	1.3	74
109	Brodhead Creek below confluence with Pocono Creek	40.98719	75.18375	258.1	46.3	5.6	1139	1.1	80
110	Brodhead Creek above confluence with Delaware River	40.98547	75.13578	308.9	46.4	5.8	1081	1.1	80
111	Cranberry Creek downstream from Cresco, Pa.	41.13956	75.28202	2.75	44.9	6.1	1320	1.0	87
112	Cranberry Creek near Paradise Valley, Pa.	41.12532	75.26562	4.36	44.9	6.1	1234	1.0	88
113	Devils Hole Creek near Paradise Crossing, Pa.	41.13151	75.31265	4.80	46.7	5.0	1882	1.0	87
114	Paradise Creek below Lake Crawford	41.11031	75.26638	13.9	45.9	4.9	1549	.2	85
115	Forest Hills Run downstream of East Swiftwater, Pa.	41.10554	75.29920	3.76	45.6	5.5	1401	.8	72
116	Swiftwater Creek below confluence with Indian Run	41.10149	75.34343	5.40	47.4	5.6	1728	.0	74
117	Butz Run near Meisertown, Pa.	41.07397	75.26562	2.20	46.1	4.2	1176	2.7	86
118	Swiftwater Creek at Pocono Manor, Pa.	41.09611	75.36566	2.47	47.7	4.4	1800	1.0	72
119	Forest Hills Run at Mt. Pocono, Pa.	41.11592	75.36191	.41	47.3	3.6	1794	.0	45
120	Pocono Creek below confluence with Wolf Swamp Run and Dry Sawmill Run	41.06021	75.36503	8.59	48.3	4.7	1824	2.9	68
Management area pour points in fig. 3									
1	Paradise Creek at Devils Hole Road	41.12861	75.31528	3.16	46.5	5.4	1691	.0	78
2	Devils Hole Creek above confluence with Paradise Creek	41.12833	75.30833	6.07	46.4	5.2	1785	.0	89
3	Paradise Creek upstream from Swiftwater Creek confluence	41.10111	75.26972	14.0	45.9	5.0	1533	.2	86
4	Swiftwater Creek at Swiftwater, Pa.	41.09389	75.32250	6.59	47.0	5.7	1653	.0	77

Appendix 1. Predicted statistics and basin characteristics for ungaged locations.—Continued

[Horizontal datum is North American Datum of 1983; vertical datum is North American Vertical Datum of 1988; mi^2, square miles; in., inches; ft, feet; %, percent of drainage area; Q7,x, 7-day low-flow statistic for selected recurrence interval; Dx, flow duration statistic exceeded selected percent of time]

Selected stream locations in figure 3	Location description	Latitude (decimal degrees)	Longitude (decimal degrees)	Basin characteristics					
				Drainage area (mi^2)	Mean annual precipitation (in.)	Basin slope (percent)	Mean elevation (ft)	Lakes (%)	Forest (%)
5	Swiftwater Creek above confluence with Forest Hills Run	41.10083	75.27194	9.75	46.3	6.2	1475	0.4	80
6	Forest Hills Run above confluence with Swiftwater Creek	41.10111	75.27194	4.77	45.6	5.7	1315	.6	78
7	Cranberry Creek above confluence with Paradise Creek	41.10083	75.25056	6.88	44.8	5.7	1133	.0	89
8	Butz Run above confluence with Paradise Creek	41.07806	75.22972	4.86	46.6	4.8	1085	1.9	85
9	Paradise Creek above confluence with Brodhead Creek	41.07056	75.22611	44.4	45.9	5.7	1329	.4	85
10	Wolf Swamp Run above confluence with Pocono Creek	41.05958	75.36808	2.25	48.1	5.6	1814	1.8	95
11	Pocono Creek above Scot Run at Interstate 80	41.05120	75.31710	12.6	47.9	6.5	1721	2.0	74
12	Pocono Creek at Rimrock Drive	41.01200	75.29086	36.3	47.3	5.6	1290	1.7	78
13	Pocono Creek above Wigwam Run near Stroudsburg	40.99083	75.25556	38.9	47.3	5.5	1257	1.6	78
14	Pocono Creek near Stroudsburg	40.98611	75.22639	42.3	47.3	5.5	1216	1.5	77
Maximum				309	49.0				
Minimum				.41	43.0				