Prepared in cooperation with the Maine Department of Transportation

Regression Equations for Monthly and Annual Mean and Selected Percentile Streamflows for Ungaged Rivers in Maine

Scientific Investigations Report 2015–5151
Version 1.1, December 21, 2015

U.S. Department of the Interior
U.S. Geological Survey

Cover. Unnamed stream at Ferry Beach State Park, Saco, Maine. Photograph courtesy of Melissa Williams of McLean, Virginia.

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Conversion Factors

International System of Units to Inch/Pound

Multiply	By	To obtain
	Length	
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
square kilometer (km^2)	0.3861	square mile (mi^2)
	Flow rate	
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as °F = (1.8 × °C) + 32.

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Elevation, as used in this report, refers to distance above the vertical datum.

Abbreviations

ASEP	average standard error of prediction
GAGES II	Geospatial Attributes of Gages for Evaluating Streamflow version II
GIS	geographic information system
MDOT	Maine Department of Transportation
MEGIS	Maine Office of GIS
NED	National Elevation Dataset
NRCS	Natural Resources Conservation Service
NWIS	National Water Information System
PRESS	prediction error sum of squares
STATSGO	State Soil Geographic database
USGS	U.S. Geological Survey
VIF	variance inflation factor
WLS	weighted least squares
WY	water year

Regression Equations for Monthly and Annual Mean and Selected Monthly Percentile Streamflows for Ungaged Rivers in Maine

By Robert W. Dudley

Abstract

In an effort to delineate hydrologic conditions in Maine, the U.S. Geological Survey, in cooperation with the Maine Department of Transportation, used streamflow data to develop dependent variables for 130 regression equations for estimating monthly and annual mean and 1, 5, 10, 25, 50, 75, 90, 95, and 99 percentile streamflows for ungaged, unregulated rivers in Maine. Daily streamflow data from 24 rural unregulated basins with drainage areas between 14.9 and 1,419 square miles in Maine and northern New Hampshire were used in the derivation of the equations. Streamflow data collected from October 1, 1982, through September 30, 2012, were used to derive the dependent variables for this study to represent current [2015] hydrologic conditions in Maine and northern New Hampshire. Weighted least squares regression techniques were used to derive the final coefficients and measures of uncertainty for the regression equations. Eight basin characteristics serve as the explanatory variables: drainage area, distance from the coast, mean and maximum basin elevation, mean basin slope, mean basin percentage of hydrologic soil group A, fraction of sand and gravel aquifers, and percentage of open water.

The largest average errors of prediction are associated with regression equations for the lowest streamflows derived for months during which the lowest streamflows of the year occur (such as the 5 and 1 monthly percentiles for August and September). The regression equations have been derived on the basis of streamflow and basin characteristics data for unregulated, rural drainage basins without substantial streamflow or drainage modifications (for example, diversions and (or) regulation by dams or reservoirs, tile drainage, irrigation, channelization, and impervious paved surfaces), therefore using the equations for regulated or urbanized basins with substantial streamflow or drainage modifications will yield results of unknown error. Input basin characteristics derived using techniques or datasets other than those documented in this report or using values outside the ranges used to develop these regression equations also will yield results of unknown error.

Introduction

Water- and natural-resources professionals routinely need to be able to estimate various streamflow statistics to manage resources, plan projects, and permit regulated uses of surface waters. For example, quantifying streamflows at a given location on a stream may be necessary for determining adequate dilution of waste load to a stream during low-flow conditions (typical of dry conditions during summer), evaluating a hydraulic structure's conveyance during high-flow conditions (typical of wet conditions during spring snowmelt or during large rain events), and evaluating or planning hydraulic connectivity and fish passage efficacy over a range of seasonal flows ranging from low to high. Although estimation of streamflow statistics at or near locations where streamflow data are routinely collected is straightforward, only a small fraction of all the streams in Maine are gaged.

Regression equations offer a statistical method for estimating streamflows at ungaged locations. The U.S. Geological Survey (USGS) has derived a variety of statewide and regional regression equations for estimating a range of streamflow statistics for ungaged streams in Maine. Hodgkins (1999) documents statewide regression equations for estimating peak flows with probabilities of annual exceedances of 0.2, 1, 2, 4, 10, 20, and 50 percent. Dudley (2004) derived statewide equations for estimating monthly and annual mean and median streamflows as well as the 7-day low flow with a 10 percent annual exceedance probability, superseding similar equations derived by Parker (1977). A few regional studies within Maine have produced regression equations for specific months: June and August median streamflows in southern Maine (Lombard, 2010), August median streamflows in eastern coastal Maine (Lombard, 2004), and August median streamflows in eastern Aroostook County (Lombard and others, 2003). In 2012, the USGS began a cooperative investigation with the Maine Department of Transportation (MDOT) to derive statewide regression equations that can be used to estimate monthly and annual mean and 1, 5, 10, 25, 50, 75, 90, 95, and 99 percentile streamflows for ungaged rivers in Maine.

Purpose and Scope

This report documents regression equations developed for estimating monthly and annual mean and 1, 5, 10, 25, 50, 75, 90, 95, and 99 percentile streamflows for ungaged, unregulated rivers in Maine and northern New Hampshire along with the data and methods used to derive them. Statistics derived from streamflow data from 24 USGS streamgages on unregulated, rural rivers in Maine and northern New Hampshire were used as the dependent variables in the equations. Data describing various basin and climate characteristics, such as geology, land cover, land use, precipitation, and temperature, derived using geographic information systems (GIS) were used as explanatory variables in the equations. The regression equations presented in this report can be used to estimate streamflows for unregulated, rural basins in Maine and supersede those derived by Dudley (2004) because of the updated streamflow and basin characteristics data used.

Description of the Study Area

The State of Maine (fig. 1), in the northeastern United States, has a land area of 79,883 square kilometers (km^2; 30,843 square miles [mi^2]) with a population of 1.33 million people (U.S. Census Bureau, 2012). Maine is largely rural and forested with rolling topography of moderate to low relief throughout the State except for the high relief of the Appalachian Mountain Range in west-central Maine. Land elevation ranges from sea level (0 meters [m]; 0 feet [ft]) at the Atlantic coast (Gulf of Maine) to 1,606 m (5,268 ft) at the peak of Mount Katahdin (U.S. Geological Survey, 2001). The physiographic characteristics of west-central Maine extend into northernmost New Hampshire.

Basin characteristics and streamflow data from 24 streamgages on rural, unregulated basins in Maine and northern New Hampshire (fig. 1) were used to derive the regression equations for estimating selected streamflow statistics. The study basins have no substantial streamflow or drainage modifications (that is, diversions and (or) regulation by dams or reservoirs, tile drainage, irrigation, channelization, and impervious paved surfaces large enough to affect the computation of monthly statistics). The study basins range in size from 38.6 to 3,675 km^2 (14.9 to 1,419 mi^2), with mean basin elevations ranging from 73 m (240 ft) at the coast in southern Maine to 646 m (2,120 ft) in mountainous northern New Hampshire (Gesch and others, 2009; U.S. Geological Survey, 2014a).

The study basins are mostly forested, with deciduous or evergreen growth or a mix thereof (including shrub growth), covering from 67.6 to 99.2 percent (mean of 85.2 percent) of the study basin areas. Open water and wetlands compose 0.4 to 18.6 percent (mean of 8.3 percent) of the study basin areas. Land cover in the basins also includes developed land (residential housing, commercial and industrial development, and transportation; where impervious surfaces account for 20 to 100 percent of total cover) ranging from 0 to 3.7 percent (mean of 0.7 percent) and pasture and cultivated crop areas ranging from 0 to 11.6 percent (mean of 2.4 percent; Fry and others, 2011). Although the rural character of Maine has changed little since the beginning of the 20th century, the greatest changes in land use in Maine has been the replacement of agriculture and pasture lands by forest. The overall forest cover in the State is estimated to have been at its lowest around 1900 at about 70 percent. Forest cover increased to about 90 percent by 1995 (Irland, 1998).

Maine has a temperate climate with mild summers and cold winters. Climatological averages computed for the 30-year period from 1981 to 2010 indicate a mean annual air temperature for Maine of 5.8 degrees Celsius (°C; 42.5 degrees Fahrenheit [°F]). Mean annual air temperature ranged from 2.9 °C (37.3 °F) at Allagash to 8.8 °C (47.8 °F) at Sanford. For the same period, the statewide mean minimum air temperature was 0.1 °C (32.1 °F) and the mean maximum was 11.6 °C (52.9 °F). Precipitation in Maine is fairly evenly distributed throughout the year with a mean annual of 1,153 millimeters (mm; 45.4 inches [in.]) for the 30-year period from 1981 to 2010, ranging from 853 mm (33.6 in.) at Frenchville to 1,440 mm (56.7 in.) at Acadia National Park (National Climatic Data Center, 2015).

Data Used For This Study

Streamflow

Daily streamflow data collected at USGS streamgages (Rantz and others, 1982) on 24 rural, unregulated river basins in Maine and northern New Hampshire (fig. 1) were used to compute the statistics to serve as dependent variables for the regression equations developed. Candidate streamgages for this study needed to be located in Maine or in New Hampshire within 25 mi of the Maine border, in predominantly rural basins, and have more than 10 years of streamflow data substantially unaffected by diversions and (or) regulation by dams or reservoirs (table 1). The data were daily values derived and published from continuously collected data (typically in 15-minute intervals). Daily streamflow data were retrieved from the National Water Information System (NWIS; U.S. Geological Survey, 2014c) for the streamgages meeting the study criteria. Only a 6-day period of irregular low-flow regulation during September 20–25, 1985, for the Narraguagus River at Cherryfield, Maine (01022500) streamgage was censored from use in this study.

Recent studies of climate variability and its effect on hydrology in Maine and New England have documented various trends over time. Many changes have been observed in the winter and spring seasons, during which high snowmelt-related streamflows have trended to earlier dates during the course of the 20th century (Dudley and Hodgkins, 2002; Hodgkins and others, 2003; Hodgkins and Dudley,

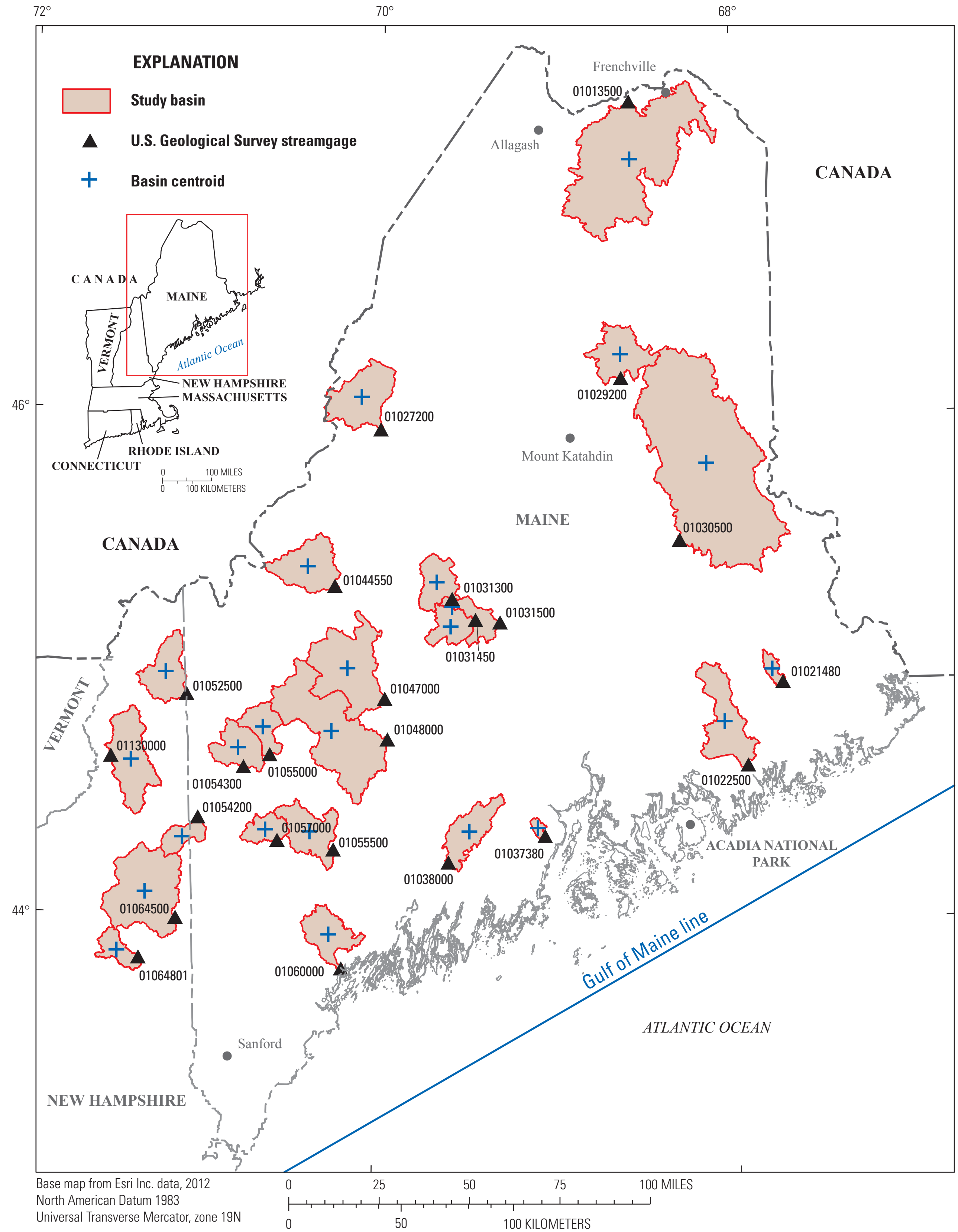

Figure 1. Locations of U.S. Geological Survey streamgages and basins in Maine and northern New Hampshire used in this study. The Gulf of Maine line is a line in the Gulf of Maine defined by end points 71W, 42.75N and 65.5W, 45N, referenced to the North American Datum of 1983 for measuring the distance from the coast for each of the basins.

Table 1. Selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[mi^2, square mile; WY, water year which begins October 1 and ends September 30 and is designated by the calendar year in which it ends]

U.S. Geological Survey streamgage		Drainage area (mi^2)	Period of record used in this study (WY)	Number of complete WY
Number	Name			
01013500	Fish River near Fort Kent, Maine	866	1983–2012	30
01021480	Old Stream near Wesley, Maine	29.8	1998–2012	14
01022500	Narraguagus River at Cherryfield, Maine	228	1983–2012	29
01027200	North Branch Penobscot River near Pittston Farm, Maine	223	2001–2012	11
01029200	Seboeis River near Shin Pond, Maine	173	1998–2012	14
01030500	Mattawamkeag River near Mattawamkeag, Maine	1,419	1983–2012	30
01031300	Piscataquis River at Blanchard, Maine	117	1997–2012	16
01031450	Kingsbury Stream at Abbot Village, Maine	95.1	1997–2012	15
01031500	Piscataquis River near Dover-Foxcroft, Maine	297	1983–2012	30
01037380	Ducktrap River near Lincolnville, Maine	14.9	1998–2012	14
01038000	Sheepscot River at North Whitefield, Maine	145	1983–2012	30
01044550	Spencer Stream near Grand Falls, Maine	194	1999–2012	13
01047000	Carrabassett River near North Anson, Maine	352	1983–2012	30
01048000	Sandy River near Mercer, Maine	516	1987–2012	25
01052500	Diamond River near Wentworth Location, New Hampshire	153	1983–2012	30
01054200	Wild River at Gilead, Maine	69.9	1983–2012	30
01054300	Ellis River at South Andover, Maine	130	2001–2012	11
01055000	Swift River near Roxbury, Maine	96.8	1983–2012	30
01055500	Nezinscot River at Turner Center, Maine	168	1983–1996, 2001–2012	25
01057000	Little Androscoggin River near South Paris, Maine	73.9	1983–2012	30
01060000	Royal River at Yarmouth, Maine	141	1983–2004	21
01064500	Saco River near Conway, New Hampshire	385	1983–2012	30
01064801	Bearcamp River at South Tamworth, New Hampshire	67.0	1993–2012	19
01130000	Upper Ammonoosuc River near Groveton, New Hampshire	231	1983–2004, 2009–2012	25

2006b). These winter and spring streamflow trends have been accompanied by earlier lake ice-out dates (Hodgkins, 2013), decreases in late-winter snowpack depth or increases in snowpack density (Hodgkins and Dudley, 2006a), and a decreased ratio of snowfall to total precipitation at sites in northern New England (Huntington and others, 2004).

Precipitation in New England has increased across all seasons (Karl and Knight, 1998; Douglas and Fairbank, 2011; Hodgkins and Dudley, 2011). Annual low streamflows at several streamgages in northern New England have increased during the 20th century (Hodgkins and Dudley, 2005) and annual peak flows have increased during the past 50 to 100 years at several streamgages across New England (Hodgkins and Dudley, 2005; Collins, 2009; Hodgkins, 2010; Armstrong and others, 2012).

The regression equations by Dudley (2004) integrated all historical streamflow and precipitation data available at the time. However, given the evidence of hydrologic trends, future investigations of this kind might benefit from being done at regular intervals using a moving temporal window of contemporary data or considering methods for incorporating these large-scale hydrologic trends into the statistical models. Therefore, to best represent contemporary hydrologic conditions in Maine, streamflow data collected during the 30-year period from October 1, 1982, through September 30, 2012 (water years[1] 1983–2012), are used to derive the dependent variables for the study in this report (table 1).

Monthly and annual streamflow.—Mean annual streamflow was computed as the mean of all available daily mean streamflow data for the period of record during water years 1983 to 2012 for each station (appendix 1). Mean monthly streamflows were computed as the mean of all daily mean streamflow values parsed by month. The 1, 5, 10, 25, 50, 75, 90, 95, and 99 monthly and annual percentile streamflows were

[1]The water year begins October 1 and ends September 30 and is designated by the calendar year in which it ends.

computed in the manner defined by Helsel and Hirsh (2002); for example, they define the 75th percentile, as “a value which exceeds no more than 75 percent of the data and is exceeded by no more than 25 percent of the data.” The computations were done using the `quantile` function (`type=2`) in the `R` programming language. Annual percentiles were computed on the basis of all available daily mean streamflow data for the period of record during water years 1983 to 2012 for each station (appendix 1), and monthly percentiles were computed on the basis of the same daily mean streamflow values parsed by month.

Basin and Climatic Characteristics

For the study detailed in this report, 68 GIS-derived basin characteristics were tested to serve as explanatory variables for the dependent variables of monthly and annual mean and 1, 5, 10, 25, 50, 75, 90, 95, and 99 percentile streamflows. Most of the basin characteristics were retrieved from the Geospatial Attributes of Gages for Evaluating Streamflow version II (GAGES II) dataset (Falcone, 2011)—an updated version of the original Geospatial Attributes of Gages for Evaluating Streamflow dataset published in 2010 (Falcone and others, 2010). The GAGES II dataset includes several hundred watershed characteristics derived from national data sources, including environmental features and anthropogenic influences for more than 9,000 streamgages maintained by the USGS. The dataset also includes comments pertaining to hydrologic modifications published in USGS annual data reports (U.S. Geological Survey, 2014b).

The 68 basin characteristics comprise the following parameters (and variations thereof): drainage area; latitude and longitude; land surface elevation, shape, aspect, and slope; precipitation; air temperature; days of first and last freeze; snow percent of total precipitation; ratio of base flow to total streamflow; various land-cover classifications from the 2006 National Land Cover Dataset (NLCD; Fry and others, 2011); population density; hydrologic soil group types; area of sand and gravel aquifers; and distance from the coast. These candidate explanatory variables included the five explanatory variables derived by Dudley (2004) for estimating mean monthly, mean annual, and 7-day, 10-year low-flow frequency (7Q10) streamflows: drainage area, area of sand and gravel aquifers, distance from the coast, mean annual precipitation, and mean winter precipitation. Distance from the coast and area of sand and gravel aquifers are not available in the GAGES II dataset and were computed by using GIS; details describing the computation of these basin characteristics is provided in the “Final Explanatory Variables” section.

Regression Analyses

Ordinary least squares (OLS) regression techniques (Helsel and Hirsch, 2002) of all possible subsets of 68 explanatory variables for each of 130 dependent variables were used to select the explanatory variables that would appear in the final regression equations. For the exploratory OLS regression analyses, all subset regressions were evaluated on the basis of adjusted coefficient of determination (R^2) values and significance of explanatory variables. In general, explanatory variables needed to have statistically significant explanatory power (p-values less than 0.01) for several percentile regressions in order to be retained in any model set. In most cases, explanatory variables rarely exhibited statistical significance over the entire range of percentiles, from low to high streamflows, for any given monthly or annual equation set with the exception of drainage area. Explanatory variables other than drainage area often had high statistical significance at either mid-to-high streamflows or mid-to-low streamflows and decreased in significance for the other equations; such variables were nevertheless retained in model sets in the interest of coherence. In the instance of three-variable models, the two explanatory variables other than drainage area often provided complementary statistical significance but were not always both significant for any given percentile model.

For the monthly and annual 1, 5, 10, 25, 50, 75, 90, 95, and 99 percentile streamflows, emphasis was placed on developing a coherent set of equations in which each monthly or annual set of regression equations uses the same set of explanatory variables; only the coefficients vary for each percentile equation. This approach of building coherent monthly and annual regression equation sets reduced the possibility of discontinuities in the percentile estimates (for example, equations that yield a 5 percentile streamflow estimate that is greater than the 10 percentile streamflow estimate).

A variety of regression diagnostics was used to evaluate the capacity of the explanatory variables to explain the variability of the dependent variables and the overall robustness of the derived regression equations. The Cook’s D statistic (Helsel and Hirsch, 2002) was used to investigate any problems with leverage influence on the regression equations. Cook’s D indicated that basins with small drainage areas (of approximately 26 km^2 [10 mi^2] or less) and (or) mountainous character exerted high leverage; for this reason, 5 candidate streamgage study basins (2 in Maine and 3 in New Hampshire) were culled from an original set of 29 streamgages, reducing the final number of streamgage study basins to 24. Residual plots against predicted values, and partial residuals plots, were used to check for linearity, constant variance, normality, and the presence of outliers. Residuals were plotted and correlated against latitude and longitude to check for geographic bias. All correlation values were less than ±0.60 and no monthly or annual model sets indicated any systematic geographic bias. Residuals from 4 of 130 models indicated (strong, $p<0.01$) positive correlation with latitude: the May 90, 95 and 99 percentile models and the July 50th percentile model. Residuals from 2 models indicated (strong, $p<0.01$) positive correlation with longitude: the December 50 and 75 percentile models. Multicollinearity among the explanatory variables was measured using the variance inflation factor (VIF). The final explanatory variables (described in the “Final Explanatory Variables” section) had VIF values of 1.87 or lower, indicating no problems with multicollinearity.

Weighted least squares (WLS) regression techniques were used to derive the final coefficients and measures of uncertainty for the regression equations. Where OLS simply minimizes the squares of the residuals, WLS regression techniques minimize the squares of weighted residuals. The weight factors are determined such that observations with greater variance have less of an influence on the derivation of the regression model. A common application of this is to derive the weights as a function of record length base on the assumption that longer records will have lower variance (are more reliable) than for stations with less data (Helsel and Hirsch, 2002). Weights used in the study detailed in this report were computed as a function of record length, that is, the number of complete water years of record from water years 1983 to 2012 divided by the mean record length (23 years) for all the streamgages used in the analysis; the sum of the weights is therefore equal to the number of streamgages used.

Final explanatory variables.—Eight basin characteristics were identified from the initial set of the 68 to serve as explanatory variables for estimating monthly and annual mean and 1, 5, 10, 25, 50, 75, 90, 95, and 99 percentile streamflows. The eight basin characteristics are drainage area, distance from the coast, mean and maximum basin elevation, mean basin slope, mean basin percentage of hydrologic soil group A, fraction of sand and gravel aquifers, and percentage of open water (lakes and ponds; table 2). These basin characteristics were recomputed in GIS to check the GAGES II values; the newly derived values were used in the derivation of the final WLS regression equations.

Drainage Area

The drainage area, in square miles, of each study basin was computed in GIS by measuring the horizontal planar area enclosed by the topographic divide (drainage-basin boundary) inside which surface runoff drains by gravity to a common outlet point (point of interest). The drainage basin boundary was delineated using the National Elevation Dataset (NED) for Maine and northern New Hampshire derived from a 10-m (⅓ arc-second) resolution digital elevation model (DEM; Gesch and others, 2009; U.S. Geological Survey, 2014a). The 24 streamgage basin drainage areas range from 14.9 mi^2 (38.6 km^2; Ducktrap River near Lincolnville, Maine [01037380] streamgage) to 1,419 mi^2 (3,675 km^2; Mattawamkeag River near Mattawamkeag, Maine [01030500] streamgage), with a mean of 258 mi^2 (668 km^2; fig. 1; tables 1 and 2).

Distance From the Coast

Distance from the coast is an explanatory variable introduced by Dudley (2004) in regression equations for estimating January, February, March, and May mean and median streamflows. Distance from the coast is the distance, in miles, measured as the shortest distance from the drainage basin centroid to a line in the Gulf of Maine (GOM line) defined by end points 71W, 42.75N and 65.5W, 45N, referenced to the North American Datum of 1983 (NAD 83; Dudley, 2004). The shortest line of measure between a basin centroid point and the GOM line is a perpendicular intersector of the GOM line. For this study, all distance measurements were made in GIS using NAD 83, Universal Transverse Mercator zone 19 coordinate system (table 3). Distances from the GOM line to the centroid of streamgage drainage basins used in this study range from 46.6 miles (mi; 75 kilometers [km]; Narraguagus River at Cherryfield, Maine [01022500] streamgage) to 193 mi (310.6 km; Fish River near Fort Kent, Maine [01013500] streamgage), with a mean of 102 mi (164.2 km; table 2).

Mean Basin Elevation

Mean basin elevation, in thousands of meters, was computed in GIS by arithmetically averaging all 10-m NED grid point elevations, in meters, within the drainage basin boundaries and dividing the mean by 1,000. The mean basin elevation was computed in meters because it is the native vertical unit in the NED. Mean elevations of streamgage drainage basins used in this study range from 73 m (239.5 ft; Royal River at Yarmouth, Maine streamgage [01060000]) to 646 m (2,119.4 ft; Diamond River near Wentworth Location, NH streamgage [01052500]), with a mean of 339 m (1,112.2 ft; table 2).

Maximum Basin Elevation

Maximum basin elevation, in thousands of meters, was computed in GIS by identifying the maximum 10-m NED grid point elevation, in meters, within the drainage basin boundaries (typically at the basin boundary), and dividing it by 1,000. The maximum basin elevation is computed in meters because it is the native vertical unit in the NED. Maximum elevations of streamgage drainage basins used in this study range from 193 m (633.2 ft; Royal River at Yarmouth, Maine [01060000] streamgage) to 1,916 m (6,286 ft; Saco River near Conway, NH [01064500] streamgage), with a mean of 860 m (2,821.5 ft; table 2).

Mean Basin Slope

Mean basin slope, in percent, was computed in GIS by arithmetically averaging all 10-m slope grid points (steepest gradient identified between a cell and its neighboring cells derived from the 10-m NED) within the drainage basin boundaries. The slope grid was computed as the change in elevation between grid points divided by the distance between grid points and multiplied by 100 to obtain units in percent. Mean basin slopes of streamgage drainage basins used in this study

Table 2. Basin characteristics for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[Basin elevations are from the U.S. Geological Survey National Elevation Dataset and are reported in meters (m) in the original source; to convert to feet, multiply by 3.281. mi^2, square mile; mi, mile; m, meter; HGA, hydrologic soil group A; S&G, sand and gravel]

U.S. Geological Survey streamgage		Drainage area (mi^2)	Distance from the coast (mi)	Basin elevation (m)		Mean basin slope (percent rise)	Mean basin HGA (percent)	Fraction of S&G aquifer	Open water (percent)
Number	Name			Mean	Maximum				
01013500	Fish River near Fort Kent, Maine	866	193	274	609	8.8	0.7	0.008	6.2
01021480	Old Stream near Wesley, Maine	29.8	52.5	98	196	5.2	22.3	0.212	3.0
01022500	Narraguagus River at Cherryfield, Maine	228	46.6	99	452	5.6	24.8	0.150	2.1
01027200	North Branch Penobscot River near Pittston Farm, Maine	223	173	476	727	7.2	0.1	0.000	0.9
01029200	Seboeis River near Shin Pond, Maine	173	148	247	517	5.5	1.2	0.009	5.3
01030500	Mattawamkeag River near Mattawamkeag, Maine	1,419	110	172	742	4.5	2.5	0.020	2.7
01031300	Piscataquis River at Blanchard, Maine	117	119	378	799	9.1	2.5	0.012	2.1
01031450	Kingsbury Stream at Abbot Village, Maine	95.1	106	301	668	8.5	3.8	0.009	2.7
01031500	Piscataquis River near Dover-Foxcroft, Maine	297	111	302	799	8.6	4.5	0.018	2.1
01037380	Ducktrap River near Lincolnville, Maine	14.9	46.8	101	257	6.3	0.0	0.010	3.7
01038000	Sheepscot River at North Whitefield, Maine	145	55.3	109	336	6.9	0.2	0.044	3.5
01044550	Spencer Stream near Grand Falls, Maine	194	140	540	1,110	13.9	10.0	0.044	2.6
01047000	Carrabassett River near North Anson, Maine	352	111	376	1,292	13.7	9.6	0.084	0.9
01048000	Sandy River near Mercer, Maine	516	98.0	305	1,259	12.2	7.5	0.050	1.2
01052500	Diamond River near Wentworth Location, New Hampshire	153	135	646	1,107	18.7	5.4	0.057	0.3
01054200	Wild River at Gilead, Maine	69.9	93.5	625	1,472	26.6	6.7	0.006	0.0
01054300	Ellis River at South Andover, Maine	130	107	441	1,155	16.4	16.2	0.057	1.5
01055000	Swift River near Roxbury, Maine	96.8	108	566	1,148	18.9	7.8	0.012	0.1
01055500	Nezinscot River at Turner Center, Maine	168	77.2	190	667	11.9	16.4	0.088	1.4
01057000	Little Androscoggin River near South Paris, Maine	73.9	83.7	283	734	15.0	15.3	0.029	1.6
01060000	Royal River at Yarmouth, Maine	141	50.3	73	193	6.7	11.0	0.127	0.8
01064500	Saco River near Conway, New Hampshire	385	85.7	550	1,916	23.5	24.5	0.091	0.3
01064801	Bearcamp River at South Tamworth, New Hampshire	67.0	75.6	412	1,221	16.6	31.5	0.098	0.4
01130000	Upper Ammonoosuc River near Groveton, New Hampshire	231	119	579	1,269	17.6	15.2	0.048	0.5
	Minimum	14.9	46.6	73	193	4.5	0.0	0.000	0.0
	Maximum	1,419	193	646	1,916	26.6	31.5	0.212	6.2
	Mean	258	102	339	860	12.0	10.0	0.053	1.9

Table 3. Point coordinates defining the Gulf of Maine Line.

[Point coordinates are in meters, referenced to Universal Transverse Mercator zone 19 datum (fig. 1)]

	X coordinate	Y coordinate
Point A	336321.28	4734992.89
Point B	775853.75	4988911.83

range from 4.5 percent (Mattawamkeag River near Mattawamkeag, Maine [01030500] streamgage) to 26.6 percent (Wild River at Gilead, Maine [01054200] streamgage), with a mean of 12 percent (table 2).

Mean Basin Percent Hydrologic Soil Group A

Wolock (1997) aggregated data from the national Natural Resources Conservation Service's (NRCS) State Soil Geographic (STATSGO) database (U.S. Department of Agriculture, 1994) to compute 1-km (0.6-mi) grids of percentages of each hydrologic soil type (A, B, C, and D; U.S. Department of Agriculture, 1986). The gridded datasets of hydrologic soil types have a percentage of each soil type assigned to each grid. The percentages were computed as averages of multiple soil components and layers, weighted on the basis of soil layer thickness and component area quantified in the STATSGO database. Soils classified as hydrologic group A (HGA; fig. 2) are well drained with high infiltration rates (minimum infiltration rate of 8 to 12 millimeters per hour [mm/h] or 0.3 to 0.5 inches per hour [in/h]) and high rates of water transmission (greater than 7.6 mm/h or 0.3 in/h; Dunne and Leopold, 1978; U.S. Department of Agriculture, 1986). For use in this report, mean basin percent HGA was computed in GIS by arithmetically averaging all 1-km (0.6-mi) HGA grid points within the drainage basin boundaries. The mean basin percentages of soils classified HGA for streamgage drainage basins used in this study range from 0 percent (Ducktrap River near Lincolnville, Maine [01037380] streamgage) to 31.5 percent (Bearcamp River at South Tamworth, NH [01064801] streamgage), with a mean of 10 percent (table 2).

Fraction Sand and Gravel Aquifer

The Maine Office of GIS (MEGIS) serves a GIS dataset comprising the polygonal boundaries of significant aquifers as delineated by the Maine Geological Survey at a 1:24,000 scale throughout the State of Maine (Maine Office of GIS, 2015). Significant aquifers are sand and gravel glacial deposits having the potential to yield 38 liters per minute (L/min; 10 gallons per minute [gal/min]) or more to a properly constructed well. The aquifers are differentiated by yield in the GIS dataset, denoted by the stored value in the attribute ATYPE. A high-yield aquifer with an estimated yield greater than 189 L/min (50 gal/min) is denoted ATYPE = 1, and an aquifer with an estimated yield of 38 to 189 L/min (10 to 50 gal/min) is denoted ATYPE = 2.

The University of New Hampshire's Geographically Referenced Analysis and Information Transfer (NH GRANIT) Web site, a GIS clearinghouse for the State of New Hampshire, serves a GIS dataset comprising the polygonal boundaries of stratified drift aquifers as delineated by the USGS and the New Hampshire Department of Environmental Services, Water Resources Division (New Hampshire Geographically Referenced Analysis and Information Transfer, 2014). For the purposes of this report, the stratified drift aquifers mapped in northern New Hampshire are considered to be comparable to the significant sand and gravel aquifers mapped in Maine.

The fraction of sand and gravel aquifer was computed as the sum of polygon areas of the mapped sand and gravel aquifers for Maine (ATYPE = 1 and 2; fig. 3) and (or) the stratified drift aquifers in northern New Hampshire divided by the total basin drainage area. Fractions of sand and gravel aquifer in streamgage drainage basins used in this report range from 0 (North Branch Penobscot River nr Pittston Farm, ME [01027200] streamgage) to 0.212 (Old Stream near Wesley, Maine [01021480] streamgage), with a mean of 0.053 (table 2).

Percent Open Water

The 2006 NLCD (Multi-Resolution Land Characteristics Consortium, 2014) is a GIS 30-m (98.4-ft) gridded dataset for the conterminous United States where each grid is assigned a single value from 16 possible classes of land cover classification (Fry and others, 2011). Land cover class code 11 is designated open water and is defined as areas of open water, generally with less than 25 percent cover of vegetation or soil—such as lakes and ponds. Percent open water was computed as the sum of the area of all 30-m (98.4-ft) grids designated with land-classification code 11 divided by the total basin drainage area and multiplied by 100. Percentages of NLCD-classified open water in streamgage drainage basins used in this study (fig. 4) range from 0 percent (Wild River at Gilead, Maine [01054200] streamgage) to 6.2 percent (Fish River near Fort Kent, Maine [01013500] streamgage), with a mean of 1.9 percent (table 2).

Regression Equations

Regression equations for estimating monthly and annual mean and 1, 5, 10, 25, 50, 75, 90, 95, and 99 percentile streamflows for ungaged rivers in Maine are presented in tables 4 through 16. Drainage area is a highly significant explanatory variable (basin characteristic) for all percentile streamflows and for all monthly and annual mean streamflows; larger drainage basins contribute greater streamflows.

Mean basin elevation is a significant explanatory variable for nearly all percentile streamflows for the annual period and

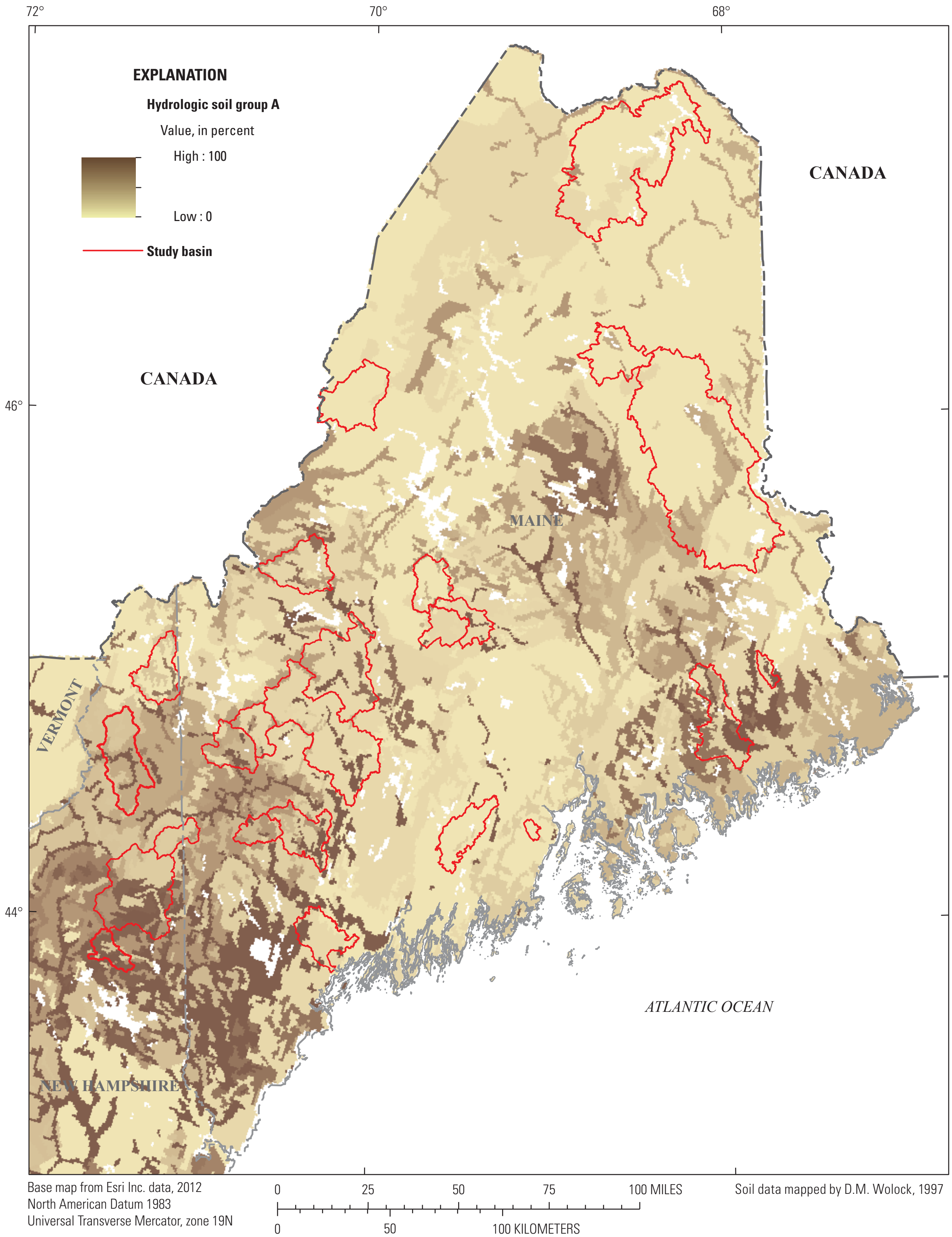

Figure 2. Distribution of hydrologic soil group A in Maine and New Hampshire.

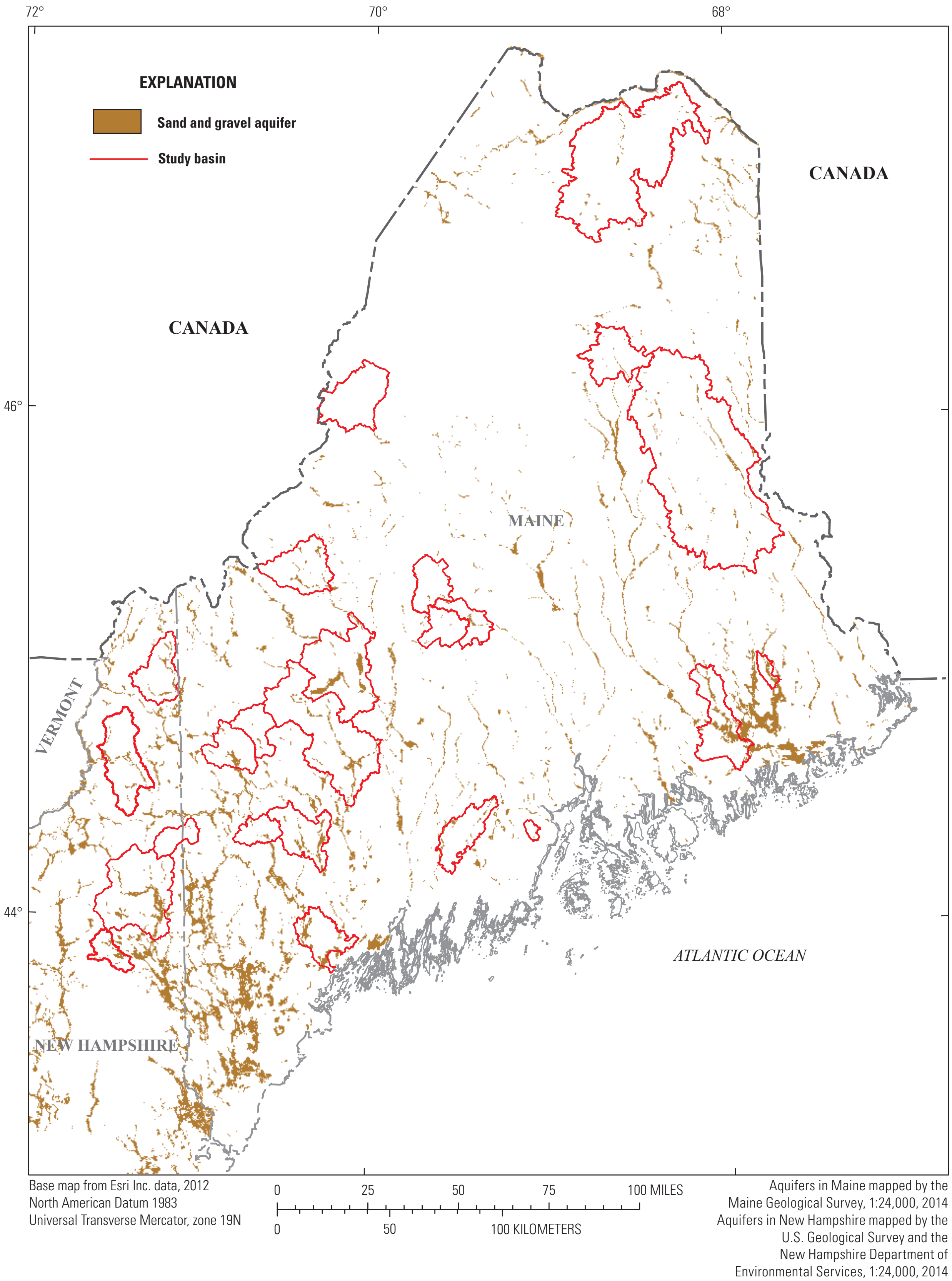

Figure 3. Distribution of sand and gravel aquifers in Maine and New Hampshire. Maine aquifers from Maine Office of GIS (2015) and New Hampshire aquifers from New Hampshire Geographically Referenced Analysis and Information Transfer (2015).

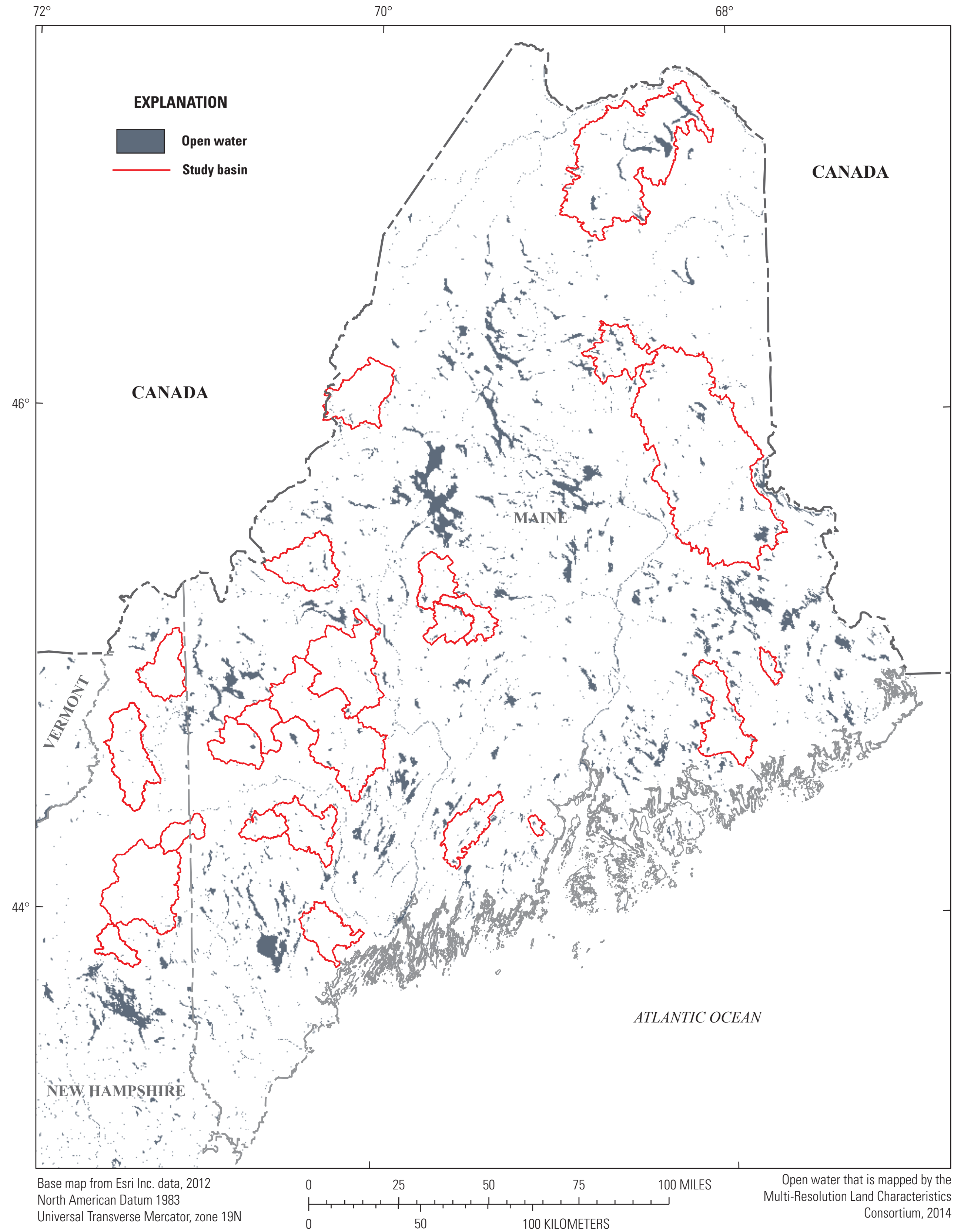

Figure 4. Distribution of land cover classified as open water (land cover code 11) in the 2006 National Land Cover Dataset (NLCD) in Maine and New Hampshire.

the months of July, August, September, and October. For these periods, the fraction of sand and gravel aquifer provides additional explanatory power for the low-streamflow percentiles (generally median and lower). Discharge from sand and gravel aquifers (groundwater discharge, also often referred to as base flow) typically composes a substantial component of the total streamflow during low-flow periods. The distance from the coast for the drainage basin provides significant explanatory power for the variability in flows during February, March, and April. Heat in the Atlantic Ocean has a warming effect on winter air temperatures near the coast; milder temperatures in basins closer to the coast generally result in less accumulated snowpack over the winter, greater occurrence of rain during winter, and earlier snowpack melt and runoff in late winter and early spring. For February, mean basin slope provides additional, significant explanatory power for median and lower streamflows with steeper slopes contributing to higher streamflows. Percent open water is a measure of storage and provides significant explanatory power for median and higher streamflows in March and for all percentiles in April.

Percent open water continues to provide significant explanatory power for percentiles in May and June; the signs of the coefficients indicate increased amounts of open water increase low flows and decrease the highest flows. This is consistent with regression equations for estimating flood flows of various annual exceedance probabilities by Hodgkins (1999), whose equations indicate basin storage has an attenuating effect on the magnitude of flood flows. Mean basin slope provides significant explanatory power for all percentiles in May and for 25 and lower percentiles (lower flows) in June.

November, December, and January have two-variable regression equations. Maximum basin elevation adds significant explanatory power for all percentiles in November, with higher elevations corresponding with higher streamflows. The mean basin percent of HGA (well-drained soils) adds significant explanatory power for 25 and lower percentiles (lower flows) in December and 90 and lower percentiles (lower flows) in January; in all equations, higher percentages of HGA correspond with higher streamflows.

Accuracy and limitations of the equations.—The 90 percent prediction interval is a measure of uncertainty for the regression equations; it was computed by first computing the average standard error of prediction (ASEP) by taking the arithmetic mean of the standard errors of prediction for all n observations (in the case of this study, $n = 24$) for each regression equation. ASEP was then converted to a percentage for the 90 percent confidence interval, thereby representing an approximately 90 percent probability that the true value of the flow statistic at a location of interest is between the negative- and positive percent prediction intervals (tables 4–16). For example, suppose application of the annual 10 percentile flow equation (*Q10*, table 4) for a basin of interest yields 30 ft^3/s; there would be an approximate 90 percent probability that the true value of the annual 10 percentile streamflow is between -32.5 and +48.3 percent of 30 ft^3/s (20.2 to 44.5 ft^3/s).

Table 4. Regression equations for estimating annual streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where n is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; *DA*, basin drainage area, in square miles; *EAVG*, mean basin elevation, in thousand meters; *SGAQ*, fraction of drainage basin area underlain by sand and gravel aquifer]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 0.000913 DA^{1.54} 10^{1.42 EAVG} 10^{5.19 SGAQ}$	-65.3 to 188	-57.2 to 134	0.87
$Q_5 = 0.00828 DA^{1.35} 10^{1.07 EAVG} 10^{3.21 SGAQ}$	-43.6 to 77.2	-34.7 to 53.3	0.94
$Q_{10} = 0.0288 DA^{1.24} 10^{0.850 EAVG} 10^{2.26 SGAQ}$	-32.5 to 48.3	-25.0 to 33.4	0.97
$Q_{25} = 0.210 DA^{1.07} 10^{0.456 EAVG} 10^{1.15 SGAQ}$	-19.2 to 23.7	-13.2 to 15.2	0.99
$Q_{50} = 0.865 DA^{0.993} 10^{0.204 EAVG} 10^{0.715 SGAQ}$	-17.7 to 21.6	-12.4 to 14.2	0.99
$Q_{75} = 2.34 DA^{0.984} 10^{0.108 EAVG} 10^{0.341 SGAQ}$	-15.4 to 18.3	-10.9 to 12.2	0.99
$Q_{90} = 5.40 DA^{0.969} 10^{0.135 EAVG} 10^{0.046 SGAQ}$	-15.3 to 18.0	-10.1 to 11.3	0.99
$Q_{95} = 8.61 DA^{0.956} 10^{0.188 EAVG} 10^{-0.055 SGAQ}$	-16.3 to 19.5	-10.4 to 11.6	0.99
$Q_{99} = 23.4 DA^{0.879} 10^{0.349 EAVG} 10^{-0.048 SGAQ}$	-24.8 to 32.9	-16.3 to 19.5	0.97
$Q_{mean} = 2.20 DA^{0.960} 10^{0.217 EAVG} 10^{0.253 SGAQ}$	-14.4 to 16.9	-9.90 to 10.9	0.99

The prediction error sum of squares (PRESS) estimator of error is a measure of validation for the regression equations. PRESS is computed by summing the squares of the prediction residuals for the full set of n observations. A prediction residual for the ith observation is computed as the difference between the observed value of the dependent variable and the regression estimate of that variable on the basis of a regression equation derived by leaving out the ith observation (therefore using n–1 observations to develop the equation). The prediction residuals are computed for each observation, squared and summed, yielding the PRESS statistic. The ratio PRESS/n is analogous to the average variance of prediction, and the square root of PRESS/n (converted to percent in tables 4–16) is analogous to the average standard error of prediction.

The R^2 statistic is a measure of a regression model's goodness of fit to the observations; its value ranges from 0 through 1, where 1 indicates a perfect match between the regression model estimates and the observations. An adjusted R^2 (tables 4–16) is a coefficient of determination adjusted for the degrees of freedom in the model, thereby enabling direct comparison between models with differing numbers of explanatory variables.

The largest prediction intervals and PRESS percentages are associated with regression equations for the lowest streamflows derived for months during which the lowest streamflows of the year occur (such as the 1 and 5 percentiles for August and September). Large prediction intervals for a regression equation represent large uncertainty in the regression estimate. Because of the large uncertainty in regression estimates for these lowest streamflows, there is the possibility of discontinuities to arise during application of those equations. An example of a discontinuity would be a 1 percentile regression estimate larger in magnitude that the 5 percentile estimate for the same month; this does not mean either estimate is wrong, rather, the results are simply a function of the large uncertainty in the estimates of those low flows.

The regression equations presented in this report have been derived on the basis of streamflow and basin characteristics data for unregulated, rural drainage basins without substantial streamflow or drainage modifications (for example, diversions and (or) regulation by dams or reservoirs, tile drainage, irrigation, channelization, and impervious paved surfaces). Using these equations for regulated or urbanized basins with substantial streamflow or drainage modifications will yield results of unknown error. For the study detailed in this report, regulation needed to be completely absent or deemed small enough so as to have a negligible effect on the computation of monthly statistics using daily mean streamflows. For the 24 streamgage study basins, the sum of percentages of land cover classified by the NLCD as either developed open space (land-classification code 21) or low- (code 22), medium- (code 23), or high-intensity development (code 24) ranged from than 0.1 to 9.3 percent (mean of 2.3 percent). Not including developed open space, which commonly includes large-lot single-family housing units, parks, and golf courses (Fry and

Table 5. Regression equations for estimating January streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where n is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; DA, basin drainage area, in square miles; HGA, mean basin percentage of hydrologic soil group A]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 0.271DA^{0.971}10^{0.0068HGA}$	-37.4 to 59.7	-24.3 to 32.1	0.92
$Q_5 = 0.430DA^{0.946}10^{0.0048HGA}$	-30.4 to 43.7	-20.2 to 25.3	0.95
$Q_{10} = 0.555DA^{0.932}10^{0.0055HGA}$	-28.8 to 40.5	-19.3 to 23.8	0.95
$Q_{25} = 0.793DA^{0.931}10^{0.0059HGA}$	-24.4 to 32.2	-16.3 to 19.5	0.97
$Q_{50} = 1.06DA^{0.946}10^{0.0052HGA}$	-28.6 to 40.0	-19.1 to 23.7	0.96
$Q_{75} = 1.88DA^{0.925}10^{0.0048HGA}$	-31.1 to 45.2	-20.8 to 26.3	0.94
$Q_{90} = 4.01DA^{0.885}10^{0.0059HGA}$	-31.9 to 46.8	-21.6 to 27.5	0.94
$Q_{95} = 9.21DA^{0.824}10^{0.0049HGA}$	-35.0 to 54.0	-24.2 to 32.0	0.91
$Q_{99} = 27.6DA^{0.799}10^{0.0018HGA}$	-50.4 to 101	-35.1 to 54.1	0.78
$Q_{mean} = 2.40DA^{0.882}10^{0.0047HGA}$	-26.8 to 36.6	-18.0 to 21.9	0.96

Table 6. Regression equations for estimating February streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where n is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; *DA*, basin drainage area, in square miles; *SLOPE*, mean basin slope, in percent; *DIST*, distance from the coast, in miles, measured as the shortest distance from the drainage basin centroid to a line in the Gulf of Maine defined by end points 71W, 42.75N and 65.5W, 45N, referenced to North American Datum of 1983]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 1.16DA^{0.961}10^{0.0142SLOPE}DIST^{-0.384}$	-37.4 to 59.8	-25.5 to 34.3	0.91
$Q_5 = 1.80DA^{1.03}10^{0.0120SLOPE}DIST^{-0.489}$	-29.8 to 42.5	-21.5 to 27.4	0.95
$Q_{10} = 3.92DA^{1.06}10^{0.0107SLOPE}DIST^{-0.641}$	-27.4 to 37.7	-19.6 to 24.4	0.96
$Q_{25} = 7.06DA^{1.09}10^{0.0086SLOPE}DIST^{-0.718}$	-23.6 to 30.9	-17.2 to 20.8	0.97
$Q_{50} = 12.8DA^{1.09}10^{0.0058SLOPE}DIST^{-0.762}$	-20.0 to 25.1	-13.9 to 16.1	0.98
$Q_{75} = 30.8DA^{1.05}10^{0.0020SLOPE}DIST^{-0.785}$	-14.5 to 16.9	-9.90 to 11.0	0.99
$Q_{90} = 87.1DA^{1.04}10^{0.0001SLOPE}DIST^{-0.879}$	-19.7 to 24.5	-14.1 to 16.4	0.98
$Q_{95} = 244DA^{0.968}10^{-0.0002SLOPE}DIST^{-0.923}$	-25.9 to 34.9	-18.5 to 22.7	0.96
$Q_{99} = 647DA^{0.880}10^{0.0057SLOPE}DIST^{-0.902}$	-35.5 to 55.1	-26.4 to 35.8	0.90
$Q_{mean} = 35.9DA^{1.02}10^{0.0041SLOPE}DIST^{-0.814}$	-15.9 to 18.8	-11.4 to 12.9	0.99

Table 7. Regression equations for estimating March streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where n is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; *DA*, basin drainage area, in square miles; *WATER*, percent of drainage basin land cover classified as open water (National Land Cover Data land-classification code 11); *DIST*, distance from the coast, in miles, measured as the shortest distance from the drainage basin centroid to a line in the Gulf of Maine defined by end points 71W, 42.75N and 65.5W, 45N, referenced to North American Datum of 1983]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 5.83DA^{1.02}10^{-0.0034WATER}DIST^{-0.676}$	-36.5 to 57.4	-27.5 to 37.9	0.92
$Q_5 = 8.42DA^{1.03}10^{-0.0122WATER}DIST^{-0.698}$	-32.3 to 47.7	-23.8 to 31.2	0.94
$Q_{10} = 13.4DA^{1.00}10^{-0.0129WATER}DIST^{-0.720}$	-26.3 to 35.7	-19.2 to 23.8	0.96
$Q_{25} = 36.2DA^{0.990}10^{-0.0117WATER}DIST^{-0.829}$	-20.7 to 26.0	-14.5 to 17.0	0.98
$Q_{50} = 159DA^{1.01}10^{-0.0116WATER}DIST^{-1.02}$	-17.7 to 21.5	-11.7 to 13.3	0.98
$Q_{75} = 274DA^{0.992}10^{-0.0286WATER}DIST^{-0.958}$	-21.5 to 27.4	-15.5 to 18.4	0.97
$Q_{90} = 259DA^{0.930}10^{-0.0427WATER}DIST^{-0.721}$	-24.8 to 32.9	-18.6 to 22.8	0.96
$Q_{95} = 225DA^{0.913}10^{-0.0540WATER}DIST^{-0.583}$	-30.0 to 42.8	-22.1 to 28.3	0.94
$Q_{99} = 109DA^{0.807}10^{-0.0744WATER}DIST^{-0.126}$	-27.6 to 38.1	-20.3 to 25.5	0.94
$Q_{mean} = 103DA^{0.940}10^{-0.0392WATER}DIST^{-0.706}$	-18.9 to 23.3	-13.7 to 15.8	0.98

Table 8. Regression equations for estimating April streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where *n* is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; *DA*, basin drainage area, in square miles; *WATER*, percent of drainage basin land cover classified as open water (National Land Cover Data land-classification code 11); *DIST*, distance from the coast, in miles, measured as the shortest distance from the drainage basin centroid to a line in the Gulf of Maine defined by end points 71W, 42.75N and 65.5W, 45N, referenced to North American Datum of 1983]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 3.92DA^{1.12}10^{-0.0468WATER}DIST^{-0.432}$	-31.0 to 44.8	-22.1 to 28.4	0.96
$Q_5 = 3.32DA^{1.14}10^{-0.0475WATER}DIST^{-0.313}$	-30.2 to 43.3	-23.4 to 30.6	0.96
$Q_{10} = 3.22DA^{1.12}10^{-0.0415WATER}DIST^{-0.233}$	-24.0 to 31.5	-18.7 to 23.0	0.98
$Q_{25} = 2.13DA^{1.06}10^{-0.0291WATER}DIST^{0.011}$	-21.1 to 26.8	-17.1 to 20.7	0.98
$Q_{50} = 1.14DA^{1.02}10^{-0.0113WATER}DIST^{0.292}$	-19.5 to 24.2	-14.4 to 16.9	0.99
$Q_{75} = 1.59DA^{0.971}10^{-0.0207WATER}DIST^{0.404}$	-19.5 to 24.2	-13.7 to 15.9	0.99
$Q_{90} = 3.39DA^{0.924}10^{-0.0374WATER}DIST^{0.412}$	-18.2 to 22.3	-12.4 to 14.2	0.99
$Q_{95} = 6.51DA^{0.894}10^{-0.0443WATER}DIST^{0.370}$	-16.8 to 20.2	-11.2 to 12.6	0.99
$Q_{99} = 39.5DA^{0.822}10^{-0.0518WATER}DIST^{0.170}$	-26.6 to 36.2	-19.0 to 23.4	0.96
$Q_{mean} = 2.33DA^{0.964}10^{-0.0283WATER}DIST^{0.286}$	-16.7 to 20.0	-12.0 to 13.6	0.99

Table 9. Regression equations for estimating May streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where *n* is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; *DA*, basin drainage area, in square miles; *WATER*, percent of drainage basin land cover classified as open water (National Land Cover Data land-classification code 11); *SLOPE*, mean basin slope, in percent]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 0.0913DA^{1.20}10^{0.0373WATER}10^{0.0233SLOPE}$	-33.7 to 50.9	-21.9 to 28.0	0.96
$Q_5 = 0.158DA^{1.17}10^{0.0430WATER}10^{0.0224SLOPE}$	-28.4 to 39.7	-20.1 to 25.2	0.97
$Q_{10} = 0.216DA^{1.15}10^{0.0462WATER}10^{0.0219SLOPE}$	-26.4 to 35.9	-18.6 to 22.8	0.98
$Q_{25} = 0.362DA^{1.13}10^{0.0507WATER}10^{0.0208SLOPE}$	-22.4 to 28.8	-15.6 to 18.5	0.98
$Q_{50} = 0.615DA^{1.13}10^{0.0457WATER}10^{0.0190SLOPE}$	-19.6 to 24.4	-12.7 to 14.5	0.99
$Q_{75} = 1.10DA^{1.12}10^{0.0397WATER}10^{0.0175SLOPE}$	-21.4 to 27.3	-13.8 to 16.0	0.98
$Q_{90} = 2.14DA^{1.10}10^{0.0253WATER}10^{0.0161SLOPE}$	-25.6 to 34.4	-16.8 to 20.2	0.98
$Q_{95} = 3.67DA^{1.06}10^{0.0181WATER}10^{0.0160SLOPE}$	-26.4 to 35.8	-17.4 to 21.0	0.97
$Q_{99} = 9.39DA^{1.02}10^{-0.0039WATER}10^{0.0139SLOPE}$	-23.4 to 30.6	-16.0 to 19.1	0.98
$Q_{mean} = 1.07DA^{1.10}10^{0.0323WATER}10^{0.0174SLOPE}$	-20.4 to 25.6	-13.3 to 15.4	0.99

Table 10. Regression equations for estimating June streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where *n* is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; *DA*, basin drainage area, in square miles; *WATER*, percent of drainage basin land cover classified as open water (National Land Cover Data land-classification code 11); *SLOPE*, mean basin slope, in percent]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 0.0689DA^{1.15}10^{0.0328WATER}10^{0.0173SLOPE}$	-46.5 to 86.8	-34.0 to 51.6	0.91
$Q_5 = 0.0922DA^{1.13}10^{0.0405WATER}10^{0.0197SLOPE}$	-38.9 to 63.7	-28.1 to 39.1	0.94
$Q_{10} = 0.109DA^{1.14}10^{0.0394WATER}10^{0.0195SLOPE}$	-35.2 to 54.4	-25.0 to 33.4	0.95
$Q_{25} = 0.188DA^{1.13}10^{0.0312WATER}10^{0.0178SLOPE}$	-28.1 to 39.2	-19.5 to 24.2	0.97
$Q_{50} = 0.384DA^{1.10}10^{0.0258WATER}10^{0.0147SLOPE}$	-23.3 to 30.3	-15.9 to 18.9	0.98
$Q_{75} = 1.12DA^{1.04}10^{0.0165WATER}10^{0.0108SLOPE}$	-24.1 to 31.7	-17.5 to 20.5	0.98
$Q_{90} = 3.64DA^{0.970}10^{-0.0026WATER}10^{0.0074SLOPE}$	-27.9 to 38.8	-20.0 to 25.0	0.96
$Q_{95} = 8.95DA^{0.920}10^{-0.0253WATER}10^{0.0029SLOPE}$	-28.3 to 39.4	-20.4 to 25.6	0.96
$Q_{99} = 35.8DA^{0.882}10^{-0.0780WATER}10^{-0.0017SLOPE}$	-35.8 to 55.9	-25.4 to 34.0	0.92
$Q_{mean} = 1.41DA^{1.00}10^{0.0006WATER}10^{0.0104SLOPE}$	-18.6 to 22.9	-13.6 to 15.7	0.98

Table 11. Regression equations for estimating July streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where *n* is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; *DA*, basin drainage area, in square miles; *EAVG*, mean basin elevation, in thousands of meters; *SGAQ*, fraction of drainage basin area underlain by sand and gravel aquifer]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 0.0061DA^{1.38}10^{0.891EAVG}10^{3.04SGAQ}$	-55.5 to 125	-42.9 to 75.1	0.90
$Q_5 = 0.0148DA^{1.31}10^{0.788EAVG}10^{2.48SGAQ}$	-49.9 to 99.6	-36.6 to 57.8	0.91
$Q_{10} = 0.0207DA^{1.30}10^{0.745EAVG}10^{2.07SGAQ}$	-44.3 to 79.5	-31.5 to 45.9	0.94
$Q_{25} = 0.0382DA^{1.27}10^{0.656EAVG}10^{1.51SGAQ}$	-37.0 to 58.8	-25.3 to 33.9	0.96
$Q_{50} = 0.105DA^{1.20}10^{0.586EAVG}10^{0.781SGAQ}$	-29.9 to 42.7	-20.1 to 25.2	0.97
$Q_{75} = 0.363DA^{1.11}10^{0.499EAVG}10^{0.001SGAQ}$	-26.3 to 35.7	-18.5 to 22.7	0.98
$Q_{90} = 1.08DA^{1.05}10^{0.474EAVG}10^{-0.070SGAQ}$	-24.3 to 32.1	-17.8 to 21.7	0.98
$Q_{95} = 2.11DA^{1.01}10^{0.463EAVG}10^{-0.044SGAQ}$	-27.2 to 37.3	-19.2 to 23.7	0.97
$Q_{99} = 6.35DA^{0.926}10^{0.593EAVG}10^{0.048SGAQ}$	-42.8 to 74.7	-31.0 to 44.9	0.89
$Q_{mean} = 0.432DA^{1.08}10^{0.508EAVG}10^{0.165SGAQ}$	-19.8 to 24.7	-14.4 to 16.8	0.99

Table 12. Regression equations for estimating August streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where n is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; DA, basin drainage area, in square miles; $EAVG$, mean basin elevation, in thousands of meters; $SGAQ$, fraction of drainage basin area underlain by sand and gravel aquifer]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 0.000136DA^{1.77}10^{1.66EAVG}10^{6.56SGAQ}$	-78.8 to 373	-71.4 to 250	0.80
$Q_5 = 0.000774DA^{1.60}10^{1.36EAVG}10^{4.87SGAQ}$	-67.0 to 203	-58.0 to 138	0.86
$Q_{10} = 0.00136DA^{1.56}10^{1.28EAVG}10^{4.46SGAQ}$	-62.9 to 170	-53.7 to 116	0.88
$Q_{25} = 0.0108DA^{1.36}10^{0.926EAVG}10^{2.80SGAQ}$	-42.4 to 73.6	-31.3 to 45.5	0.95
$Q_{50} = 0.0339DA^{1.27}10^{0.831EAVG}10^{1.87SGAQ}$	-32.0 to 47.1	-23.0 to 29.9	0.97
$Q_{75} = 0.157DA^{1.17}10^{0.720EAVG}10^{0.655SGAQ}$	-28.5 to 39.9	-19.3 to 23.8	0.97
$Q_{90} = 0.497DA^{1.12}10^{0.717EAVG}10^{0.053SGAQ}$	-29.4 to 41.6	-20.4 to 25.6	0.97
$Q_{95} = 0.903DA^{1.09}10^{0.779EAVG}10^{0.233SGAQ}$	-28.5 to 39.8	-19.5 to 24.2	0.97
$Q_{99} = 4.00DA^{0.945}10^{0.914EAVG}10^{0.780SGAQ}$	-42.1 to 72.7	-29.8 to 42.5	0.91
$Q_{mean} = 0.206DA^{1.11}10^{0.811EAVG}10^{0.905SGAQ}$	-28.0 to 38.8	-19.1 to 23.7	0.97

Table 13. Regression equations for estimating September streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where n is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; DA, basin drainage area, in square miles; $EAVG$, mean basin elevation, in thousands of meters; $SGAQ$, fraction of drainage basin area underlain by sand and gravel aquifer]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 0.00013DA^{1.72}10^{1.65EAVG}10^{6.96SGAQ}$	-78.3 to 360	-70.5 to 238	0.80
$Q_5 = 0.000199DA^{1.73}10^{1.71EAVG}10^{6.28SGAQ}$	-78.7 to 369	-72.6 to 265	0.80
$Q_{10} = 0.00217DA^{1.45}10^{1.29EAVG}10^{4.54SGAQ}$	-57.9 to 138	-49.2 to 97.0	0.90
$Q_{25} = 0.00865DA^{1.33}10^{1.18EAVG}10^{3.17SGAQ}$	-44.6 to 80.6	-35.4 to 54.9	0.94
$Q_{50} = 0.0380DA^{1.21}10^{0.990EAVG}10^{2.09SGAQ}$	-29.3 to 41.5	-22.2 to 28.5	0.97
$Q_{75} = 0.203DA^{1.08}10^{0.759EAVG}10^{0.901SGAQ}$	-22.6 to 29.1	-15.2 to 17.9	0.98
$Q_{90} = 0.575DA^{1.04}10^{0.711EAVG}10^{0.329SGAQ}$	-30.9 to 44.7	-21.1 to 26.7	0.96
$Q_{95} = 1.29DA^{1.01}10^{0.596EAVG}10^{-0.067SGAQ}$	-34.2 to 52.1	-23.3 to 30.3	0.95
$Q_{99} = 6.84DA^{0.892}10^{0.522EAVG}10^{0.207SGAQ}$	-45.5 to 83.6	-31.2 to 45.4	0.87
$Q_{mean} = 0.279DA^{1.04}10^{0.729EAVG}10^{0.795SGAQ}$	-27.3 to 37.6	-18.5 to 22.7	0.97

Table 14. Regression equations for estimating October streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where *n* is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; *DA*, basin drainage area, in square miles; *EAVG*, mean basin elevation, in thousands of meters; *SGAQ*, fraction of drainage basin area underlain by sand and gravel aquifer]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 0.00303DA^{1.33}10^{1.52EAVG}10^{4.93SGAQ}$	-62.8 to 169	-56.0 to 127	0.86
$Q_5 = 0.00476DA^{1.36}10^{1.38EAVG}10^{3.93SGAQ}$	-59.0 to 144	-52.2 to 109	0.88
$Q_{10} = 0.0142DA^{1.27}10^{1.18EAVG}10^{2.78SGAQ}$	-44.1 to 79.0	-37.4 to 59.8	0.94
$Q_{25} = 0.0759DA^{1.13}10^{0.869EAVG}10^{1.75SGAQ}$	-23.7 to 31.1	-17.0 to 20.5	0.98
$Q_{50} = 0.366DA^{1.02}10^{0.658EAVG}10^{0.566SGAQ}$	-27.2 to 37.3	-19.2 to 23.8	0.97
$Q_{75} = 1.53DA^{0.951}10^{0.455EAVG}10^{-0.002SGAQ}$	-31.1 to 45.2	-22.7 to 29.4	0.95
$Q_{90} = 4.60DA^{0.896}10^{0.447EAVG}10^{-0.159SGAQ}$	-35.9 to 56.0	-24.8 to 33.0	0.92
$Q_{95} = 9.43DA^{0.841}10^{0.499EAVG}10^{-0.082SGAQ}$	-35.1 to 54.0	-23.1 to 30.1	0.92
$Q_{99} = 30.8DA^{0.784}10^{0.578EAVG}10^{-0.218SGAQ}$	-42.9 to 75.2	-29.2 to 41.2	0.86
$Q_{mean} = 1.91DA^{0.895}10^{0.526EAVG}10^{0.083SGAQ}$	-28.9 to 40.6	-19.6 to 24.4	0.96

Table 15. Regression equations for estimating November streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where *n* is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; *DA*, basin drainage area, in square miles; *EMAX*, maximum basin elevation, in thousands of meters]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 0.0514DA^{1.13}10^{0.376EMAX}$	-65.0 to 185	-55.1 to 123	0.80
$Q_5 = 0.100DA^{1.10}10^{0.342EMAX}$	-54.2 to 118	-43.2 to 76.1	0.87
$Q_{10} = 0.290DA^{1.02}10^{0.246EMAX}$	-34.7 to 53.2	-24.8 to 33.0	0.95
$Q_{25} = 0.977DA^{0.937}10^{0.146EMAX}$	-27.0 to 37.0	-17.3 to 20.9	0.96
$Q_{50} = 1.87DA^{0.955}10^{0.081EMAX}$	-21.0 to 26.6	-14.4 to 16.9	0.98
$Q_{75} = 3.65DA^{0.949}10^{0.050EMAX}$	-19.0 to 23.4	-12.6 to 14.5	0.98
$Q_{90} = 7.74DA^{0.901}10^{0.064EMAX}$	-22.5 to 29.0	-14.4 to 16.8	0.97
$Q_{95} = 12.3DA^{0.867}10^{0.094EMAX}$	-30.4 to 43.6	-19.7 to 24.6	0.94
$Q_{99} = 33.1DA^{0.758}10^{0.182EMAX}$	-41.9 to 72.0	-28.4 to 39.6	0.86
$Q_{mean} = 3.49DA^{0.902}10^{0.099EMAX}$	-20.2 to 25.4	-12.9 to 14.8	0.98

Table 16. Regression equations for estimating December streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

[$(PRESS/n)^{1/2}$, prediction error sum of squares, in percent, where *n* is the number of streamgages used in the regression equation derivation; R^2, coefficient of determination; Q_x, the streamflow estimate in cubic feet per second for x percentile, in percent; Q_{mean}, the mean streamflow estimate in cubic feet per second; *DA*, basin drainage area, in square miles; *HGA*, mean basin percentage of hydrologic soil group A]

Regression equation	90-percent prediction interval (percent)	$(PRESS/n)^{1/2}$ (percent)	Adjusted R^2
$Q_1 = 0.0516DA^{1.28}10^{0.0132HGA}$	-58.6 to 142	-48.7 to 95.0	0.85
$Q_5 = 0.222DA^{1.11}10^{0.0083HGA}$	-27.6 to 38.2	-19.9 to 24.9	0.97
$Q_{10} = 0.573DA^{0.986}10^{0.0047HGA}$	-22.7 to 29.4	-15.8 to 18.7	0.98
$Q_{25} = 1.12DA^{0.935}10^{0.0036HGA}$	-23.2 to 30.2	-15.8 to 18.7	0.97
$Q_{50} = 1.92DA^{0.936}10^{0.0021HGA}$	-28.9 to 40.6	-19.5 to 24.2	0.96
$Q_{75} = 2.90DA^{0.955}10^{0.0032HGA}$	-31.6 to 46.1	-21.9 to 28.1	0.95
$Q_{90} = 5.46DA^{0.943}10^{0.0038HGA}$	-31.6 to 46.2	-21.6 to 27.5	0.94
$Q_{95} = 10.8DA^{0.888}10^{0.0037HGA}$	-30.4 to 43.8	-20.8 to 26.3	0.94
$Q_{99} = 27.6DA^{0.855}10^{0.0059HGA}$	-43.0 to 75.5	-29.3 to 41.3	0.86
$Q_{mean} = 3.16DA^{0.921}10^{0.0035HGA}$	-24.9 to 33.1	-16.6 to 20.0	0.97

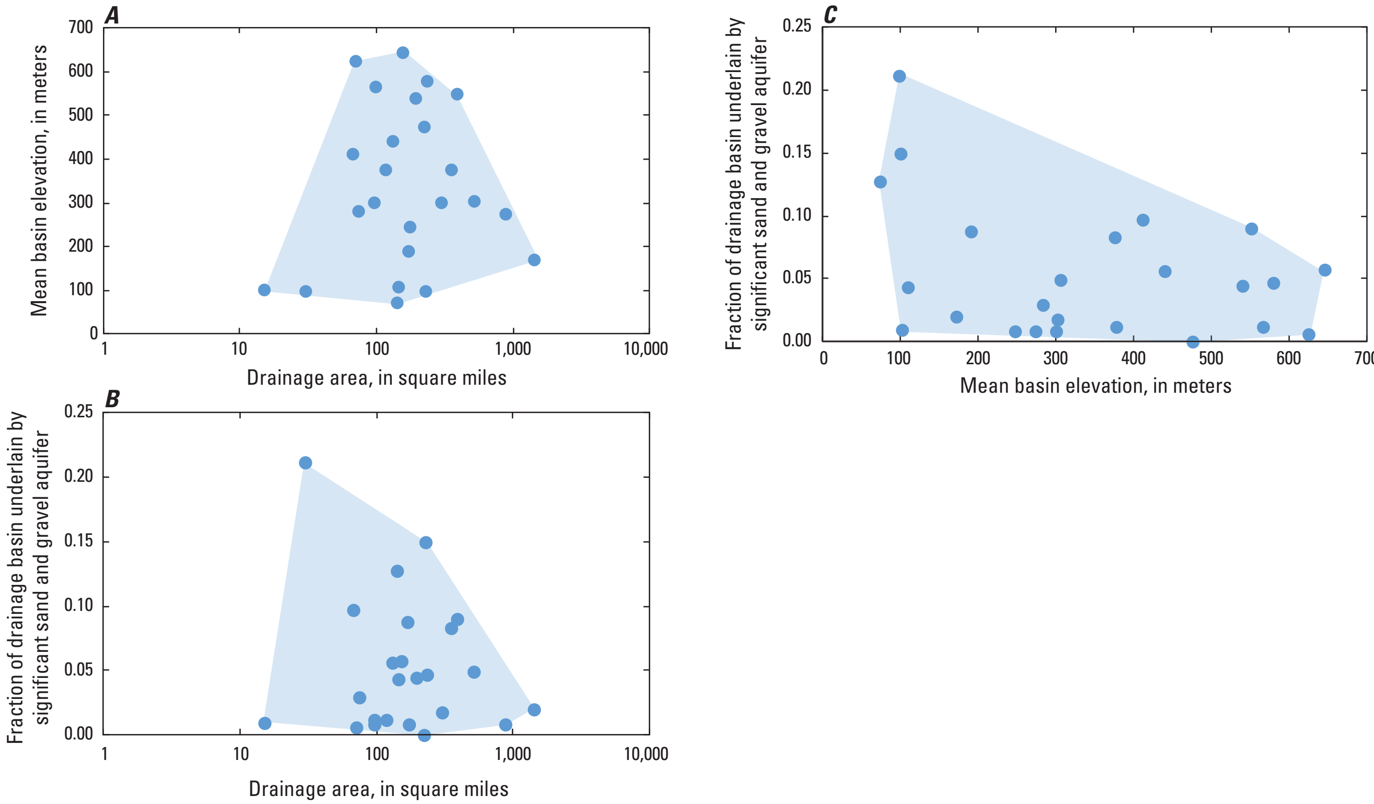

Figure 5. Two-dimensional ranges of explanatory variables used in regression equations for estimating annual and July, August, September, and October mean and selected percentile streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

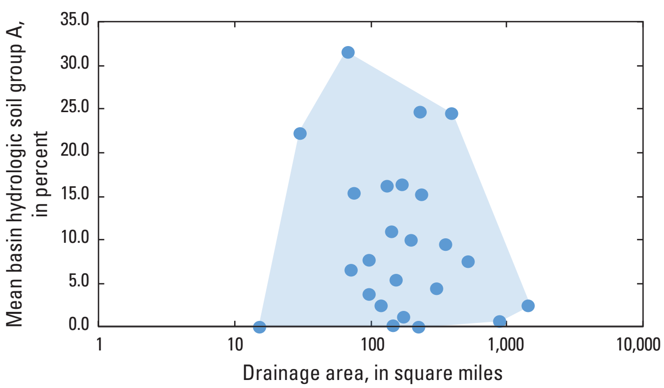

Figure 6. Two-dimensional range of explanatory variables used in regression equations for estimating January and December mean and selected percentile streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

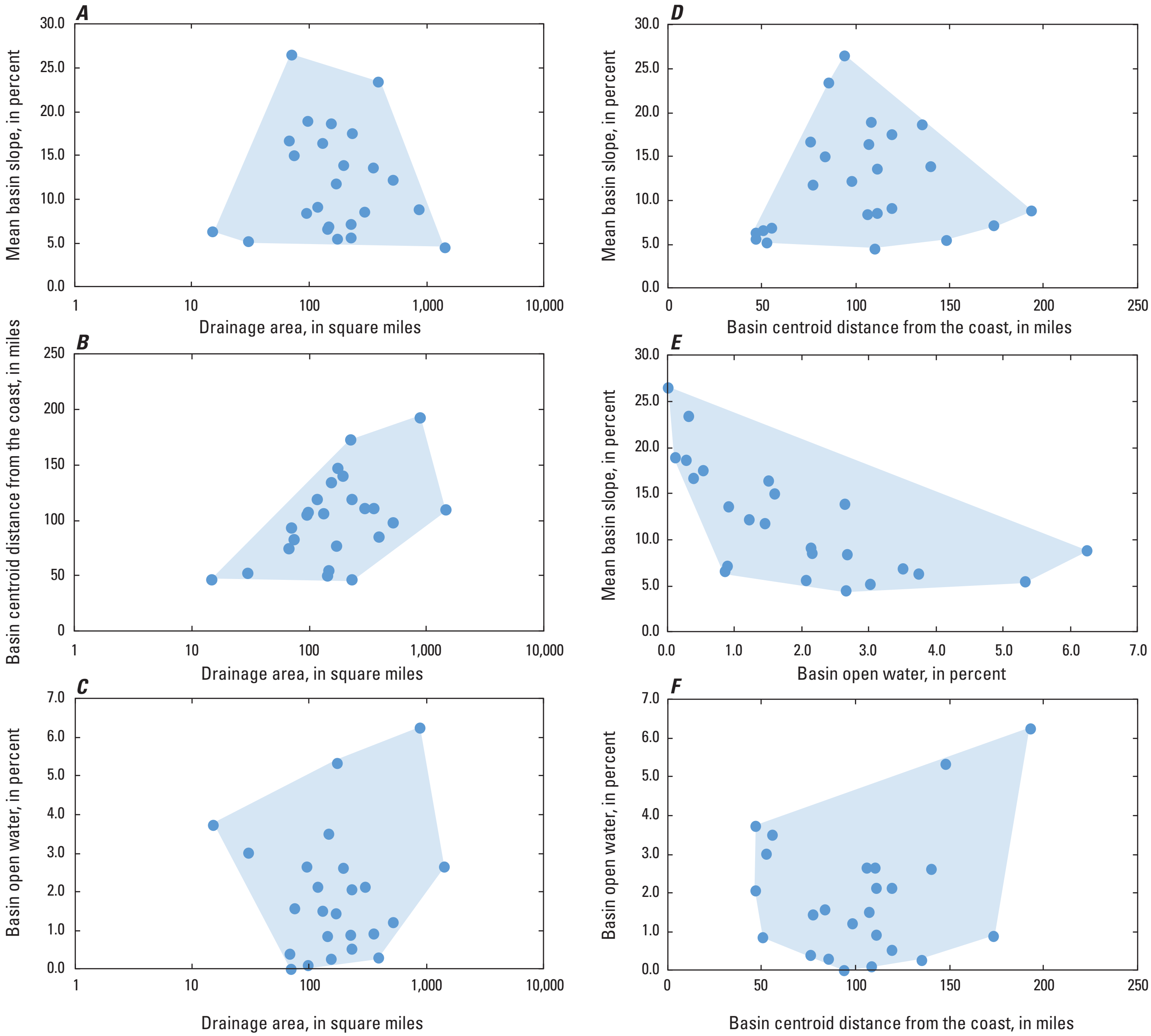

Figure 7. Two-dimensional ranges of explanatory variables used in regression equations for estimating February, March, April, May, and June mean and selected percentile streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

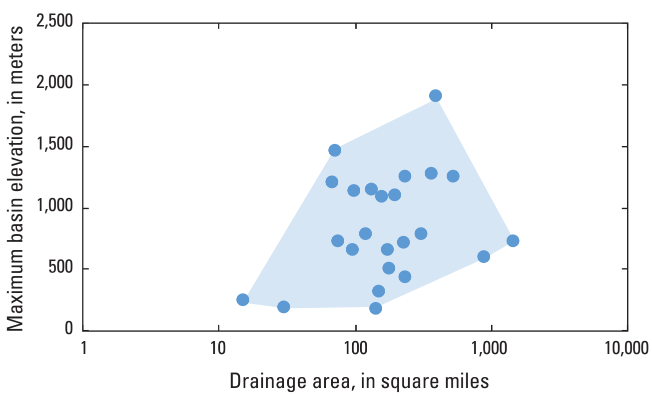

Figure 8. Two-dimensional range of explanatory variables used in regression equations for estimating November mean and selected percentile streamflows for ungaged, unregulated streams in rural drainage basins in Maine and northern New Hampshire.

others, 2011), maximum developed land cover is 3.7 percent (mean of 0.7 percent for all 24 basins). Drainage alterations are assumed to accompany development and are considered negligible for all study basins in this report.

When using the regression equations, the basin characteristics needed for the equations (explanatory variables) should be derived using the same or comparable methods with the same sets of data as those documented in this report. Basin characteristics derived using other techniques or datasets or using values outside the ranges (and combined ranges of multiple explanatory variables in a single equation (fig. 5–8) used to develop these regression equations (table 2) will yield results of unknown error.

Summary

Regression equations offer a statistical method for estimating streamflows at ungaged locations, which is useful for water management, project planning, and other activities related to monitoring and regulating surface waters. The U.S. Geological Survey and the Maine Department of Transportation used streamflow data to develop dependent variables for 130 regression equations for estimating monthly and annual mean and 1, 5, 10, 25, 50, 75, 90, 95, and 99 percentile streamflows for ungaged, unregulated rivers in Maine and northern New Hampshire along with the data and methods used to derive them in an effort to delineate hydrologic conditions. The regression equations presented in this report supersede previously published regression equations because of the updated streamflow and basin characteristics data used in this report.

Daily streamflow data from 24 streamgages in Maine and northern New Hampshire were used to derive the regression equations. Streamflow in these 24 rural, unregulated basins was deemed to be substantially unaffected by diversions and (or) regulation by dams or reservoirs. The land cover in the study basins was mostly forested; open water and wetlands composed a mean of 8.3 percent of the study basin areas, and developed land of any kind composed less than 10 percent of any study basin area. Given recent studies documenting climatic trends and their effects on hydrology in Maine and New England, streamflow data collected during the 30-year period from October 1, 1982, through September 30, 2012, were used to derive the dependent variables for this report, thereby representing contemporary hydrologic conditions in Maine and northern New Hampshire.

Sixty-eight explanatory variables comprising characteristics such as geology, land cover, land use, precipitation, and temperature were derived using a geographic information system and tested for use as potential explanatory variables for the dependent streamflow variables. Ordinary least squares regression of all possible subsets of 68 explanatory variables for each of 130 dependent streamflow variables were used to select the explanatory variables that would appear in the final regression equations. Emphasis was placed on developing a coherent set of equations in an effort to reduce the possibility of discontinuities in the percentile estimates. Weighted least squares (WLS) regression techniques were used to derive the final coefficients and measures of uncertainty for the regression equations. WLS weights were computed as a function of the number of complete water years of record from water years 1983 to 2012 divided by the mean record length for all of the stations used in the analysis.

Eight basin characteristics serve as the final explanatory variables for estimating monthly and annual mean and 1, 5, 10, 25, 50, 75, 90, 95, and 99 percentile streamflows: drainage area, distance from the coast, mean and maximum basin elevation, mean basin slope, mean basin percentage of hydrologic soil group A (HGA), fraction of sand and gravel aquifers, and percent open water. Drainage area is a highly significant explanatory variable for all percentile streamflows and for all monthly and annual mean streamflows; larger drainage basins contribute greater streamflows. Mean basin elevation and fraction of sand and gravel aquifer are both significant explanatory variables for the annual period and low flow months. Distance from the coast provides explanatory power for the variability in February, March, and April flows. Percent open water, which is a measure of storage, provides explanatory power during spring months, with greater amounts of open water corresponding with lower flows in March and April and higher flows in May and June, in general. Mean basin slope provides explanatory power for streamflows in February, May, and June, with steeper slopes contributing to higher streamflows, in general. Maximum basin elevation provides explanatory power for November, with higher elevations corresponding with higher streamflows. Mean basin percent of HGA (well-drained soils) provides explanatory power for streamflows in December and January, with higher percentages of HGA corresponding with higher streamflows.

The largest uncertainties are associated with regression equations for the lowest streamflows derived for months during which the lowest streamflows of the year occur (such as the 1 and 5 percentiles for August and September). The regression equations have been derived from streamflow and basin characteristics data for unregulated, rural drainage basins without substantial drainage alterations (for example, diversions and (or) regulation by dams or reservoirs, tile drainage, irrigation, channelization, and impervious paved surfaces); therefore, using them for regulated or urbanized basins with substantial drainage alterations will yield results of unknown error. Basin characteristics derived using techniques or datasets other than those documented in this report or using values outside the ranges (and combined ranges of multiple explanatory variables in a single equation) used to develop these regression equations will yield streamflow estimates of unknown error.

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Appendix 1. Monthly and Annual Mean and Selected Percentile Streamflows for Selected U.S. Geological Survey Streamgages in Maine and Northern New Hampshire

Tables 1–1—1–10. Computed monthly and annual streamflow statistics for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire

Table 1–1. Computed monthly and annual mean streamflows for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[ft^3/s, cubic foot per second]

U.S. Geological Survey streamgage		Monthly mean streamflow (ft^3/s)												Annual mean streamflow (ft^3/s)
Number	Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
01013500	Fish River near Fort Kent, Maine	798	623	715	4,140	4,450	1,650	1,030	843	567	932	1,530	1,420	1,560
01021480	Old Stream near Wesley, Maine	58.6	46.1	108	151	76.7	44.6	17.5	15.5	14.3	44.2	82.1	99.2	62.5
01022500	Narraguagus River at Cherryfield, Maine	483	453	838	1,150	656	396	204	155	157	319	597	656	505
01027200	North Branch Penobscot River near Pittston Farm, Maine	258	124	365	1,720	764	437	303	293	164	540	546	422	492
01029200	Seboeis River near Shin Pond, Maine	208	125	248	1,080	599	228	129	117	126	261	403	373	326
01030500	Mattawamkeag River near Mattawamkeag, Maine	1,650	1,310	2,950	9,080	4,670	1,940	1,200	882	671	1,670	3,300	3,070	2,700
01031300	Piscataquis River at Blanchard, Maine	134	89	259	850	375	220	109	76	93.3	248	347	282	257
01031450	Kingsbury Stream at Abbot Village, Maine	120	91.1	300	712	270	211	85.4	60.7	80.3	243	317	257	227
01031500	Piscataquis River near Dover-Foxcroft, Maine	384	294	740	2,160	897	536	278	184	193	525	827	656	639
01037380	Ducktrap River near Lincolnville, Maine	34.7	32	67.9	85.2	40.7	28.8	11.7	4.01	4.99	32.1	48.3	49.3	36.1
01038000	Sheepscot River at North Whitefield, Maine	274	239	504	721	351	211	84.4	54.4	52.4	146	306	369	276
01044550	Spencer Stream near Grand Falls, Maine	200	147	314	1,260	807	409	205	174	177	377	459	350	404
01047000	Carrabassett River near North Anson, Maine	471	371	970	2,470	1,270	783	418	317	274	661	982	776	813
01048000	Sandy River near Mercer, Maine	686	528	1,390	3,280	1,610	1,090	526	385	297	865	1,300	1,080	1,080
01052500	Diamond River near Wentworth Location, New Hampshire	200	148	352	1,200	690	346	197	175	149	321	391	261	369
01054200	Wild River at Gilead, Maine	134	92.5	245	561	336	172	87.2	97.4	77.5	188	259	180	203
01054300	Ellis River at South Andover, Maine	194	103	259	841	468	329	159	147	97	320	359	414	308
01055000	Swift River near Roxbury, Maine	139	94.6	238	685	394	224	119	95.7	82.6	205	266	193	228
01055500	Nezinscot River at Turner Center, Maine	246	224	508	957	457	303	136	114	71	218	397	368	331
01057000	Little Androscoggin River near South Paris, Maine	97.5	84.1	224	424	195	136	59.5	52.1	35.9	101	169	154	144
01060000	Royal River at Yarmouth, Maine	203	224	570	650	330	203	96.8	91.3	83.1	150	290	295	266
01064500	Saco River near Conway, New Hampshire	702	502	1,080	2,770	1,870	946	529	540	429	913	1,210	1,050	1,050
01064801	Bearcamp River at South Tamworth, New Hampshire	129	100	238	440	207	136	75.9	68	63	167	192	199	168
01130000	Upper Ammonoosuc River near Groveton, NH	303	239	560	1,460	924	456	260	226	207	403	491	419	493

Table 1–2. Computed monthly and annual 1 percentile streamflows for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[ft^3/s, cubic foot per second]

U.S. Geological Survey streamgage		Monthly streamflow (ft^3/s)												Annual streamflow (ft^3/s)
Number	Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
01013500	Fish River near Fort Kent, Maine	275	195	220	382	852	466	289	116	62	58	253	405	118
01021480	Old Stream near Wesley, Maine	6.7	8.3	12	30	13	9.7	3.2	1.9	1.6	2.5	4.3	6.1	2.3
01022500	Narraguagus River at Cherryfield, Maine	83	83	130	279	170	86	47	27	22	34	50.5	58	34
01027200	North Branch Penobscot River near Pittston Farm, Maine	48	32	24	91	89	67	38	12	6.7	23	57	80	19
01029200	Seboeis River near Shin Pond, Maine	51	50	39	107	103	58	31	6.8	6.3	9.5	28	65	10
01030500	Mattawamkeag River near Mattawamkeag, Maine	245	186	265	1,260	731	226	91	45	35	64	188	460	69
01031300	Piscataquis River at Blanchard, Maine	29	22	19	70	42	25	11	4.3	3.4	7.1	17	31	6.3
01031450	Kingsbury Stream at Abbot Village, Maine	21	22	21	71	29	17	4.7	1.4	2	8	18	23	2.8
01031500	Piscataquis River near Dover-Foxcroft, Maine	62	41	68	267	123	71	30	12	9.05	23	37	61	16
01037380	Ducktrap River near Lincolnville, Maine	4.1	3.9	6.5	8.8	4.4	2.1	0.15	0.001	0.001	0.02	0.11	0.25	0.01
01038000	Sheepscot River at North Whitefield, Maine	38	34	56	116	70	28.5	16	9.8	7.85	11	16.5	21	12
01044550	Spencer Stream near Grand Falls, Maine	55	50	45	110	153	85	34	19	11	29	50	71	26
01047000	Carrabassett River near North Anson, Maine	57	54	99	382	250	117	65	38	33.5	51	72.5	108	49
01048000	Sandy River near Mercer, Maine	119	112	119	495	295	140	72	44	35	61	98	129	55
01052500	Diamond River near Wentworth Location, New Hampshire	53	48	46	102	99	50.5	23	16	12	31	58.5	56	25
01054200	Wild River at Gilead, Maine	24	26	20	80	69	24	12	8.2	7.2	12	25	30	10
01054300	Ellis River at South Andover, Maine	33	33	35	75	83	43	27	11	9.2	15	32	38	12
01055000	Swift River near Roxbury, Maine	20	24	26	100	58	26.5	12	6	4.1	15	24.5	36	9
01055500	Nezinscot River at Turner Center, Maine	39	37	51	127	85	45	21	15	11	27	42	61	17
01057000	Little Androscoggin River near South Paris, Maine	21	19	22	60.5	29	9.4	4	1.5	0.76	4.7	19.5	28	3.1
01060000	Royal River at Yarmouth, Maine	42	42	58	109	63	40	24	21	20	24	38	47	23
01064500	Saco River near Conway, New Hampshire	178	175	203	542	494	212	137	98	84	132	226	216	115
01064801	Bearcamp River at South Tamworth, New Hampshire	27	29	29	61.5	29	16	7.7	3.1	3.1	10	24	39	6
01130000	Upper Ammonoosuc River near Groveton, New Hampshire	100	68	64	210	188	100	63	42	33	63	114	125	51

Table 1–3. Computed monthly and annual 5 percentile streamflows for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[ft³/s, cubic foot per second]

U.S. Geological Survey streamgage		Monthly streamflow (ft³/s)												Annual streamflow (ft³/s)
Number	Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
01013500	Fish River near Fort Kent, Maine	330	250	240	614	1,450	630	386	191	109	118	358	490	238
01021480	Old Stream near Wesley, Maine	10	13	16	41	22	11	5.7	2.3	2	2.8	5.55	11	3.9
01022500	Narraguagus River at Cherryfield, Maine	105	120	180	360	228	108	58	33	33	48	95	150	55
01027200	North Branch Penobscot River near Pittston Farm, Maine	54	34	31	119	159	95	59	25	13.5	28	95	99	36
01029200	Seboeis River near Shin Pond, Maine	69	55	48	140	143	75	42	11	9.5	15	44.5	86	22
01030500	Mattawamkeag River near Mattawamkeag, Maine	365	280	361	2,780	1,050	342	149	81	62	142	326	590	177
01031300	Piscataquis River at Blanchard, Maine	36	26	31	161	77	35.5	16	6.6	5.45	9.6	24	41	12
01031450	Kingsbury Stream at Abbot Village, Maine	29	26	30	108	50	28	10	2.5	3.35	12	23	36	10
01031500	Piscataquis River near Dover-Foxcroft, Maine	77	75	97	459	197	87.5	41	15	14	30	74.5	130	36
01037380	Ducktrap River near Lincolnville, Maine	6.2	4.7	8.4	14	6.4	3.2	0.39	0.01	0.001	0.04	0.47	2.9	0.17
01038000	Sheepscot River at North Whitefield, Maine	60	48	75	190	93	37.5	21	13	11	15	22	52	18
01044550	Spencer Stream near Grand Falls, Maine	61	58	71	228	231	118	55	28	22	36	64	95	45
01047000	Carrabassett River near North Anson, Maine	107	101	145	592	343	154	75	50	45	73	136	172	79
01048000	Sandy River near Mercer, Maine	143	143	220	811	418	170	102	60	45	83	162	187	96
01052500	Diamond River near Wentworth Location, New Hampshire	65	55	59	203	159	78	37	27	22.5	48	105	70	45
01054200	Wild River at Gilead, Maine	32	30	30	114	88	32	17	10	9.65	19	39	40	19
01054300	Ellis River at South Andover, Maine	39	39	46	156	134	58	32	13	10	17	45	49	31
01055000	Swift River near Roxbury, Maine	33	30	31	144	94	36.5	18	8.6	8	20	42.5	44	19
01055500	Nezinscot River at Turner Center, Maine	50	57	65	219	124	57	26	18	13	31	59	76	27
01057000	Little Androscoggin River near South Paris, Maine	27	23	32	101	52	18	5.4	3.4	2	9.3	28	35	7.1
01060000	Royal River at Yarmouth, Maine	51	48	72	159	87	45	35	24	22	29	48	61	34
01064500	Saco River near Conway, New Hampshire	205	210	255	755	616	297	169	115	104	160	276	260	181
01064801	Bearcamp River at South Tamworth, New Hampshire	34	31	34	94.5	44.5	21	10	5.8	5.6	13	32	48	13
01130000	Upper Ammonoosuc River near Groveton, New Hampshire	114	95	93	369	280	122	76	54	46	90	142	140	83

Table 1–4. Computed monthly and annual 10 percentile streamflows for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[ft³/s, cubic foot per second]

U.S. Geological Survey streamgage		Monthly streamflow (ft³/s)												Annual streamflow (ft³/s)
Number	Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
01013500	Fish River near Fort Kent, Maine	360	270	266	809	1,780	748	440	238	146	198	450	568	305
01021480	Old Stream near Wesley, Maine	14	17	22	47.5	28	12.5	6.3	3.4	2.8	3.1	12.5	20	5.9
01022500	Narraguagus River at Cherryfield, Maine	141	167	200	457	263	128	64	41	38	63	144	179	77
01027200	North Branch Penobscot River near Pittston Farm, Maine	62	41	49	272	213	111	78	35	20	35	119	126	51
01029200	Seboeis River near Shin Pond, Maine	80	60	60	253	187	91	49	17	11	25	72.9	109	41
01030500	Mattawamkeag River near Mattawamkeag, Maine	454	355	417	3,410	1,310	452	211	120	90	205	597	710	275
01031300	Piscataquis River at Blanchard, Maine	42	31	35	196	98	41	19	7.6	7.7	16	63	57	22
01031450	Kingsbury Stream at Abbot Village, Maine	36	30	36	143	64	35	12	3.2	5.9	18	41.5	46	17
01031500	Piscataquis River near Dover-Foxcroft, Maine	95.5	88	128	628	249	105	49	22	19.5	44	126	156	58
01037380	Ducktrap River near Lincolnville, Maine	8.2	6.2	11	18.5	9.5	3.9	0.66	0.02	0.03	0.22	2.5	11	0.59
01038000	Sheepscot River at North Whitefield, Maine	72.5	59	93	259	110	48	23	15	13	16	39.5	75	24
01044550	Spencer Stream near Grand Falls, Maine	79	64	87	260	277	139	67	33	28	45	107	104	61
01047000	Carrabassett River near North Anson, Maine	138	139	170	782	395	195	92	59	59	93.5	203	210	109
01048000	Sandy River near Mercer, Maine	185	212	272	1,070	527	218	122	71	59	109	259	261	131
01052500	Diamond River near Wentworth Location, New Hampshire	75	59	69	260	202	96	45	33	30	67	132	82	59
01054200	Wild River at Gilead, Maine	43	34	35	139	104	39.5	20	13	13	24	50	51	26
01054300	Ellis River at South Andover, Maine	45	48	55	219	161	70.5	37	16	13.5	28	76.5	63	41
01055000	Swift River near Roxbury, Maine	38	34	41.5	180	115	45	21	12	10	29	63	53	29
01055500	Nezinscot River at Turner Center, Maine	65	64	99	298	151	66.5	30	21	18	38	72.5	89	39
01057000	Little Androscoggin River near South Paris, Maine	32	30	40.5	132	63	24	7.2	4.5	4	12	38	40	13
01060000	Royal River at Yarmouth, Maine	56	64	107	205	99	53	37	28	27	34	61	71	40
01064500	Saco River near Conway, New Hampshire	241	240	280	907	731	344	193	143	136	192	338	294	219
01064801	Bearcamp River at South Tamworth, New Hampshire	42	36	41	122	59.5	25	12	7.5	8.15	18	45	56	18
01130000	Upper Ammonoosuc River near Groveton, New Hampshire	127	104	105	457	338	150	88	66	59	105	179	160	104

Table 1–5. Computed monthly and annual 25 percentile streamflows for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[ft³/s, cubic foot per second]

U.S. Geological Survey streamgage		Monthly streamflow (ft³/s)												Annual streamflow (ft³/s)
Number	Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
01013500	Fish River near Fort Kent, Maine	451	366	345	1,510	2,600	970	626	339	233	311	787	717	470
01021480	Old Stream near Wesley, Maine	31	24	33	74	42	16	7.9	5	3.5	8.5	32	38	13
01022500	Narraguagus River at Cherryfield, Maine	222	229	304	634	355	172	88	60	55	101	265	250	148
01027200	North Branch Penobscot River near Pittston Farm, Maine	89	52	76	563	330	183	111	64	37.5	124	217	173	103
01029200	Seboeis River near Shin Pond, Maine	105	70	87	488	284	130	67	29	21	60	137	179	82
01030500	Mattawamkeag River near Mattawamkeag, Maine	704	567	765	4,950	2,130	773	382	232	170	403	1,200	1,080	570
01031300	Piscataquis River at Blanchard, Maine	59.5	41.5	57	336	145	67	26	11	12	37	113	96.5	48
01031450	Kingsbury Stream at Abbot Village, Maine	50	38	63	239	99	54	20	11	11	30	89	76	38
01031500	Piscataquis River near Dover-Foxcroft, Maine	153	129	195	926	372	166	71	40	34	87	266	212	127
01037380	Ducktrap River near Lincolnville, Maine	12	8.8	22	31.5	17	6.4	1.4	0.29	0.18	1.7	17	19	4.7
01038000	Sheepscot River at North Whitefield, Maine	108	101	157	363	184	71	29	21	18	26	77	131	51
01044550	Spencer Stream near Grand Falls, Maine	118	98.5	106	507	398	199	92	49	48	88	213	187	108
01047000	Carrabassett River near North Anson, Maine	205	190	270	1,110	586	275	136	87	85	160	319	270	199
01048000	Sandy River near Mercer, Maine	320	289	425	1,490	758	331	157	104	99	156	419	353	245
01052500	Diamond River near Wentworth Location, New Hampshire	96	74	91	461	292	145	67	46	50	97	178	115	93
01054200	Wild River at Gilead, Maine	53	43	59	209	151	60	26	20	21	37	84	70	45
01054300	Ellis River at South Andover, Maine	88.5	61	76	379	230	113	48	32	38	48	127	136	71
01055000	Swift River near Roxbury, Maine	53	46	58	274	168	70.5	31	19	23	43	95.5	77	49
01055500	Nezinscot River at Turner Center, Maine	99	103	150	423	213	101	42	29	26	56	129	132	74
01057000	Little Androscoggin River near South Paris, Maine	44	42	63	189	96	40	13	7.8	7.3	20	64	56	33
01060000	Royal River at Yarmouth, Maine	76	81	163	285	140	71	44	35	35	44	92	99	59
01064500	Saco River near Conway, New Hampshire	305	300	358	1,280	1,020	442	249	197	191	268	541	425	315
01064801	Bearcamp River at South Tamworth, New Hampshire	54	45	82	172	92.5	38	18	15	13	30	82	74	39
01130000	Upper Ammonoosuc River near Groveton, New Hampshire	155	138	170	712	459	223	116	91	91	145	262	210	156

Table 1–6. Computed monthly and annual 50 percentile streamflows for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[ft^3/s, cubic foot per second]

U.S. Geological Survey streamgage		Monthly streamflow (ft^3/s)												Annual streamflow (ft^3/s)
Number	Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
01013500	Fish River near Fort Kent, Maine	672	490	556	3,850	3,800	1,370	865	476	369	575	1,120	1,130	880
01021480	Old Stream near Wesley, Maine	44	31	74.5	119	62	24	11	7.5	6.45	20	63	68.5	36
01022500	Narraguagus River at Cherryfield, Maine	333	307	628	905	519	268	130	94	86	175	455	433	308
01027200	North Branch Penobscot River near Pittston Farm, Maine	143	79	160	1,190	506	286	184	147	69	283	416	269	235
01029200	Seboeis River near Shin Pond, Maine	154	92	157	945	463	188	100	51	37.5	130	296	282	169
01030500	Mattawamkeag River near Mattawamkeag, Maine	1,160	856	1,880	8,510	3,810	1,380	635	436	310	889	2,770	1,980	1,320
01031300	Piscataquis River at Blanchard, Maine	81	56	127	658	239	118	55	33.5	29	99.5	207	182	112
01031450	Kingsbury Stream at Abbot Village, Maine	73	53	137	531	178	90	34	19	28	78	174	157	89
01031500	Piscataquis River near Dover-Foxcroft, Maine	210	190	365	1,570	631	291	125	73.5	70	205	530	381	275
01037380	Ducktrap River near Lincolnville, Maine	19	14.0	50	55	28	13	3.4	0.94	0.865	8.85	32	34	17
01038000	Sheepscot River at North Whitefield, Maine	180	161	388	550	296	122	46	28	27	52	196	283	143
01044550	Spencer Stream near Grand Falls, Maine	166	127	191	926	617	312	141	77	81.5	188	368	260	214
01047000	Carrabassett River near North Anson, Maine	270	270	536	1,760	906	414	207	149	152	268	618	452	369
01048000	Sandy River near Mercer, Maine	445	391	928	2,350	1,170	564	251	159	170	348	866	658	516
01052500	Diamond River near Wentworth Location, New Hampshire	125	95	170	859	484	224	113	79	87	177	274	175	176
01054200	Wild River at Gilead, Maine	70	57	115	353	236	91	41	32	35	66	144	104	88
01054300	Ellis River at South Andover, Maine	126	81	158	568	358	211	78	56	52	139	261	230	154
01055000	Swift River near Roxbury, Maine	73	58	113	466	268	117	54	34	39	85	169	114	100
01055500	Nezinscot River at Turner Center, Maine	150	151	330	672	338	162	65	49	44	91	278	221	164
01057000	Little Androscoggin River near South Paris, Maine	59.5	58	137	286	147	70.5	27	17	16	44	117	90.5	70
01060000	Royal River at Yarmouth, Maine	110	121	350	418	220	107	57	47	44	57.5	177	149	118
01064500	Saco River near Conway, New Hampshire	436	375	700	2,000	1,490	640	343	278	269	426	875	663	569
01064801	Bearcamp River at South Tamworth, New Hampshire	76	61	159	292	151	59	31	22	23	62	128	120	82
01130000	Upper Ammonoosuc River near Groveton, New Hampshire	217	180	310	1,120	740	324	165	137	138	246	386	300	275

Table 1–7. Computed monthly and annual 75 percentile streamflows for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[ft^3/s, cubic foot per second]

U.S. Geological Survey streamgage		Monthly streamflow (ft^3/s)												Annual streamflow (ft^3/s)
Number	Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
01013500	Fish River near Fort Kent, Maine	1,000	679	800	6,040	5,910	2,010	1,290	962	611	1,240	2,020	1,830	1,840
01021480	Old Stream near Wesley, Maine	65	51	143	188	92	48.5	18	15	13	51	98.5	118	78
01022500	Narraguagus River at Cherryfield, Maine	524	488	1,100	1,380	754	426	214	158	158	347	724	811	630
01027200	North Branch Penobscot River near Pittston Farm, Maine	277	145	410	2,490	890	526	416	316	153	691	728	476	546
01029200	Seboeis River near Shin Pond, Maine	229	159	263	1,540	740	297	156	129	120	318	555	428	385
01030500	Mattawamkeag River near Mattawamkeag, Maine	1,790	1,440	4,030	12,300	6,120	2,210	1,280	995	701	1,890	4,290	3,780	3,370
01031300	Piscataquis River at Blanchard, Maine	132	94.5	290	1,160	467	241	127	74	77.5	250	433	289	271
01031450	Kingsbury Stream at Abbot Village, Maine	123	94	340	920	336	214	76	49	56.5	231	365	247	228
01031500	Piscataquis River near Dover-Foxcroft, Maine	326	305	820	2,690	1,100	559	282	176	163	498	1,010	682	688
01037380	Ducktrap River near Lincolnville, Maine	35	28.0	83	98.5	48	29	11	4.4	5.1	31	58	61	42
01038000	Sheepscot River at North Whitefield, Maine	305	268	693	861	438	227	76	52	47	143	431	495	358
01044550	Spencer Stream near Grand Falls, Maine	232	178	332	1,690	954	471	228	171	160	444	576	369	453
01047000	Carrabassett River near North Anson, Maine	410	410	1,050	3,060	1,540	773	383	277	263	609	1,140	774	876
01048000	Sandy River near Mercer, Maine	667	595	1,610	4,100	1,950	1,110	489	312	287	839	1,560	1,190	1,210
01052500	Diamond River near Wentworth Location, New Hampshire	178	143	350	1,520	824	386	205	169	156	317	473	278	386
01054200	Wild River at Gilead, Maine	108	87	235	674	367	151	76	72	63	152	240	164	195
01054300	Ellis River at South Andover, Maine	209	115	306	1,090	596	391	143	136	98.5	366	455	408	366
01055000	Swift River near Roxbury, Maine	109	93	230	828	466	217	115	76	78	182	282	180	230
01055500	Nezinscot River at Turner Center, Maine	250	220	667	1,060	541	304	125	96	77	221	505	428	387
01057000	Little Androscoggin River near South Paris, Maine	92	86	261	504	223	129	61	45	35	101	202	165	162
01060000	Royal River at Yarmouth, Maine	178	229	768	721	358	168	90	68	61	126	320	274	274
01064500	Saco River near Conway, New Hampshire	684	534	1,180	3,470	2,220	961	534	487	409	911	1,400	1,130	1,170
01064801	Bearcamp River at South Tamworth, New Hampshire	123	103	294	549	249	114	69	48	55.5	140	218	208	180
01130000	Upper Ammonoosuc River near Groveton, New Hampshire	310	240	643	1,770	1,090	504	269	241	231	423	628	480	565

Table 1–8. Computed monthly and annual 90 percentile streamflows for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[ft^3/s, cubic foot per second]

U.S. Geological Survey streamgage		Monthly streamflow (ft^3/s)												Annual streamflow (ft^3/s)
Number	Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
01013500	Fish River near Fort Kent, Maine	1,380	1,210	1,330	7,820	7,870	3,070	1,880	2,080	1,290	1,900	3,120	2,670	3,770
01021480	Old Stream near Wesley, Maine	110	79	229	287	134	92	37	33	32	99	169	198	150
01022500	Narraguagus River at Cherryfield, Maine	974	880	1,810	2,000	1,140	768	407	310	268	659	1,220	1,370	1,160
01027200	North Branch Penobscot River near Pittston Farm, Maine	538	267	793	3,830	1,650	922	654	662	401	1,190	1,210	938	1,140
01029200	Seboeis River near Shin Pond, Maine	355	227	587	2,100	1,140	394	239	294	342	581	852	717	784
01030500	Mattawamkeag River near Mattawamkeag, Maine	3,000	2,580	6,950	15,900	9,210	3,710	2,600	2,140	1,370	4,170	6,650	6,740	7,100
01031300	Piscataquis River at Blanchard, Maine	249	170	585	1,770	845	496	251	177	200	609	802	549	661
01031450	Kingsbury Stream at Abbot Village, Maine	224	170	690	1,540	590	535	183	121	130	605	705	492	580
01031500	Piscataquis River near Dover-Foxcroft, Maine	612	510	1,750	4,370	1,830	1,170	651	435	405	1,210	1,750	1,280	1,560
01037380	Ducktrap River near Lincolnville, Maine	67	65.0	139	159	79	66	29	11	10.5	80	104	103	87
01038000	Sheepscot River at North Whitefield, Maine	532	475	1,120	1,360	601	475	176	122	96.5	325	678	800	676
01044550	Spencer Stream near Grand Falls, Maine	339	239	682	2,740	1,500	737	371	380	372	929	903	621	925
01047000	Carrabassett River near North Anson, Maine	700	632	2,130	5,160	2,500	1,610	881	646	476	1,600	2,110	1,510	1,910
01048000	Sandy River near Mercer, Maine	1,150	871	2,930	6,970	3,050	2,300	1,050	783	573	2,020	2,730	2,170	2,500
01052500	Diamond River near Wentworth Location, New Hampshire	353	234	754	2,520	1,340	758	425	395	292	686	783	486	858
01054200	Wild River at Gilead, Maine	185	150	568	1,230	640	307	159	189	135	359	485	283	434
01054300	Ellis River at South Andover, Maine	378	170	569	1,860	898	646	321	370	206	825	752	821	737
01055000	Swift River near Roxbury, Maine	200	148	538	1,440	779	457	247	182	152	438	528	319	532
01055500	Nezinscot River at Turner Center, Maine	465	380	1,130	1,940	866	621	266	222	133	522	871	821	791
01057000	Little Androscoggin River near South Paris, Maine	163	136	528	869	353	276	132	119	73.5	221	346	294	327
01060000	Royal River at Yarmouth, Maine	400	513	1,360	1,270	607	339	161	108	106	274	613	652	608
01064500	Saco River near Conway, New Hampshire	1,230	878	2,070	5,580	3,360	1,620	1,000	926	765	1,830	2,220	1,980	2,230
01064801	Bearcamp River at South Tamworth, New Hampshire	250	171	511	970	377	252	170	111	136	373	396	399	384
01130000	Upper Ammonoosuc River near Groveton, New Hampshire	540	420	1,200	2,850	1,660	829	537	468	397	770	933	739	1,090

Table 1–9. Computed monthly and annual 95 percentile streamflows for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[ft^3/s, cubic foot per second]

U.S. Geological Survey streamgage		Monthly streamflow (ft^3/s)												Annual streamflow (ft^3/s)
Number	Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
01013500	Fish River near Fort Kent, Maine	1,670	1,680	1,800	9,420	9,160	3,630	2,280	2,770	1,940	2,710	3,860	3,200	5,610
01021480	Old Stream near Wesley, Maine	163	149	308	376	190	154	59	53	54	180	241	274	215
01022500	Narraguagus River at Cherryfield, Maine	1,530	1,380	2,210	2,860	1,480	1,180	628	497	436	947	1,660	1,810	1,630
01027200	North Branch Penobscot River near Pittston Farm, Maine	872	390	1,030	5,300	2,360	1,330	896	1,110	679	1,750	1,530	1,370	1,830
01029200	Seboeis River near Shin Pond, Maine	491	314	750	2,390	1,530	492	341	451	571	1,030	1,070	949	1,220
01030500	Mattawamkeag River near Mattawamkeag, Maine	4,620	3,750	9,540	17,900	11,500	5,360	4,010	3,620	2,540	5,500	9,450	9,020	10,300
01031300	Piscataquis River at Blanchard, Maine	461	260	910	2,230	1,110	738	399	280	349	918	1,060	832	994
01031450	Kingsbury Stream at Abbot Village, Maine	368	254	1,130	2,010	761	817	339	259	293	967	1,120	830	910
01031500	Piscataquis River near Dover-Foxcroft, Maine	1,220	794	2,750	5,730	2,400	1,720	1,070	670	735	1,970	2,630	2,010	2,450
01037380	Ducktrap River near Lincolnville, Maine	129	125.0	214	240	111	116	47	17	20	119	145	153	128
01038000	Sheepscot River at North Whitefield, Maine	852	768	1,330	1,770	821	733	320	211	193	577	966	977	974
01044550	Spencer Stream near Grand Falls, Maine	496	304	1,030	3,560	2,190	992	559	626	607	1,310	1,130	937	1,410
01047000	Carrabassett River near North Anson, Maine	1,250	917	3,460	6,660	3,140	2,640	1,500	1,010	773	2,520	3,160	2,450	3,010
01048000	Sandy River near Mercer, Maine	1,830	1,170	4,430	9,100	4,100	3,690	1,970	1,450	878	3,330	4,030	3,140	3,910
01052500	Diamond River near Wentworth Location, New Hampshire	559	397	1,160	3,460	1,940	1,070	693	675	473	979	1,070	745	1,330
01054200	Wild River at Gilead, Maine	357	250	895	1,690	964	481	303	333	249	691	895	524	751
01054300	Ellis River at South Andover, Maine	564	224	807	2,350	1,190	950	571	586	325	1,310	975	1,510	1,110
01055000	Swift River near Roxbury, Maine	382	244	772	2,070	1,090	751	388	359	223	798	881	545	844
01055500	Nezinscot River at Turner Center, Maine	705	648	1,440	2,600	1,150	951	487	406	198	814	1,170	1,130	1,150
01057000	Little Androscoggin River near South Paris, Maine	264	225	724	1,200	488	460	198	193	120	385	491	477	526
01060000	Royal River at Yarmouth, Maine	690	760	1,720	1,840	885	669	259	189	171	483	924	1,130	1,000
01064500	Saco River near Conway, New Hampshire	1,850	1,200	3,360	7,330	4,260	2,370	1,470	1,780	1,190	3,250	3,170	2,870	3,430
01064801	Bearcamp River at South Tamworth, New Hampshire	438	360	727	1,230	532	406	273	247	224	679	533	583	603
01130000	Upper Ammonoosuc River near Groveton, New Hampshire	800	600	1,710	3,890	2,370	1,130	764	674	557	1,290	1,150	1,100	1,640

Table 1–10. Computed monthly and annual 99 percentile streamflows for selected U.S. Geological Survey streamgages in Maine and northern New Hampshire.

[ft^3/s, cubic foot per second]

U.S. Geological Survey streamgage		Monthly streamflow (ft^3/s)												Annual streamflow (ft^3/s)
Number	Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
01013500	Fish River near Fort Kent, Maine	2,510	2,300	3,810	11,900	12,000	4,760	2,650	4,060	3,170	5,230	4,780	5,360	8,950
01021480	Old Stream near Wesley, Maine	270	273	511	584	336	322	109	135	135	341	437	673	407
01022500	Narraguagus River at Cherryfield, Maine	2,370	2,340	3,660	4,440	2,670	2,440	1,150	1,010	1,490	2,620	2,900	3,650	2,920
01027200	North Branch Penobscot River near Pittston Farm, Maine	1,770	552	4,440	7,050	4,210	2,090	1,430	2,450	1,210	4,920	1,940	2,100	4,180
01029200	Seboeis River near Shin Pond, Maine	1,210	476	1,340	3,150	2,750	807	530	779	1,120	1,850	1,680	1,810	2,140
01030500	Mattawamkeag River near Mattawamkeag, Maine	12,100	7,500	13,900	22,500	18,100	14,400	9,530	6,530	6,490	12,500	15,000	16,500	16,500
01031300	Piscataquis River at Blanchard, Maine	954	620	2,330	3,470	1,620	1,550	854	714	1,280	2,310	1,990	2,440	2,100
01031450	Kingsbury Stream at Abbot Village, Maine	828	720	2,900	3,060	1,340	1,660	801	879	1,120	2,740	2,330	2,460	2,060
01031500	Piscataquis River near Dover-Foxcroft, Maine	3,800	2,310	5,150	9,790	3,970	4,200	1,980	1,670	1,900	5,590	5,020	6,010	5,300
01037380	Ducktrap River near Lincolnville, Maine	251	323.0	369	643	180	271	112	42	79	363	329	235	306
01038000	Sheepscot River at North Whitefield, Maine	1,640	1,290	2,090	3,240	1,490	1,310	606	355	440	1,610	1,610	1,540	1,720
01044550	Spencer Stream near Grand Falls, Maine	808	560	2,360	5,120	3,420	2,080	1,260	1,520	1,580	2,610	2,060	1,880	2,890
01047000	Carrabassett River near North Anson, Maine	5,410	2,170	6,270	10,800	5,610	6,850	3,490	2,690	2,550	6,400	5,890	5,640	6,400
01048000	Sandy River near Mercer, Maine	5,400	2,750	8,140	13,600	7,530	9,340	4,780	3,040	2,520	8,480	7,910	8,480	8,570
01052500	Diamond River near Wentworth Location, New Hampshire	1,500	1,020	3,340	5,570	3,750	2,000	1,510	1,460	999	2,700	1,810	1,810	3,050
01054200	Wild River at Gilead, Maine	1,590	710	1,980	3,440	1,880	1,480	922	1,130	876	2,580	2,480	1,770	1,870
01054300	Ellis River at South Andover, Maine	1,260	475	1,550	2,850	1,630	2,050	1,400	1,430	765	2,440	1,770	3,250	2,300
01055000	Swift River near Roxbury, Maine	1,410	738	1,990	3,250	2,000	1,980	927	982	911	2,290	1,850	1,390	2,080
01055500	Nezinscot River at Turner Center, Maine	1,740	1,600	2,910	5,110	2,480	2,260	1,260	1,090	539	1,780	1,850	2,210	2,430
01057000	Little Androscoggin River near South Paris, Maine	757	676	1,410	2,070	990	1,140	555	606	312	842	923	1,160	1,130
01060000	Royal River at Yarmouth, Maine	1,450	1,550	2,900	4,440	1,790	2,320	593	914	872	1,420	1,950	2,380	2,220
01064500	Saco River near Conway, New Hampshire	4,360	2,340	7,120	11,600	7,440	5,100	3,200	4,510	2,900	8,130	6,860	8,340	7,370
01064801	Bearcamp River at South Tamworth, New Hampshire	824	780	1,490	2,270	1,080	1,890	696	983	722	1,830	1,020	1,360	1,360
01130000	Upper Ammonoosuc River near Groveton, New Hampshire	1,750	1,200	4,000	5,920	3,870	2,430	1,620	1,470	1,100	3,110	1,910	2,240	3,320

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