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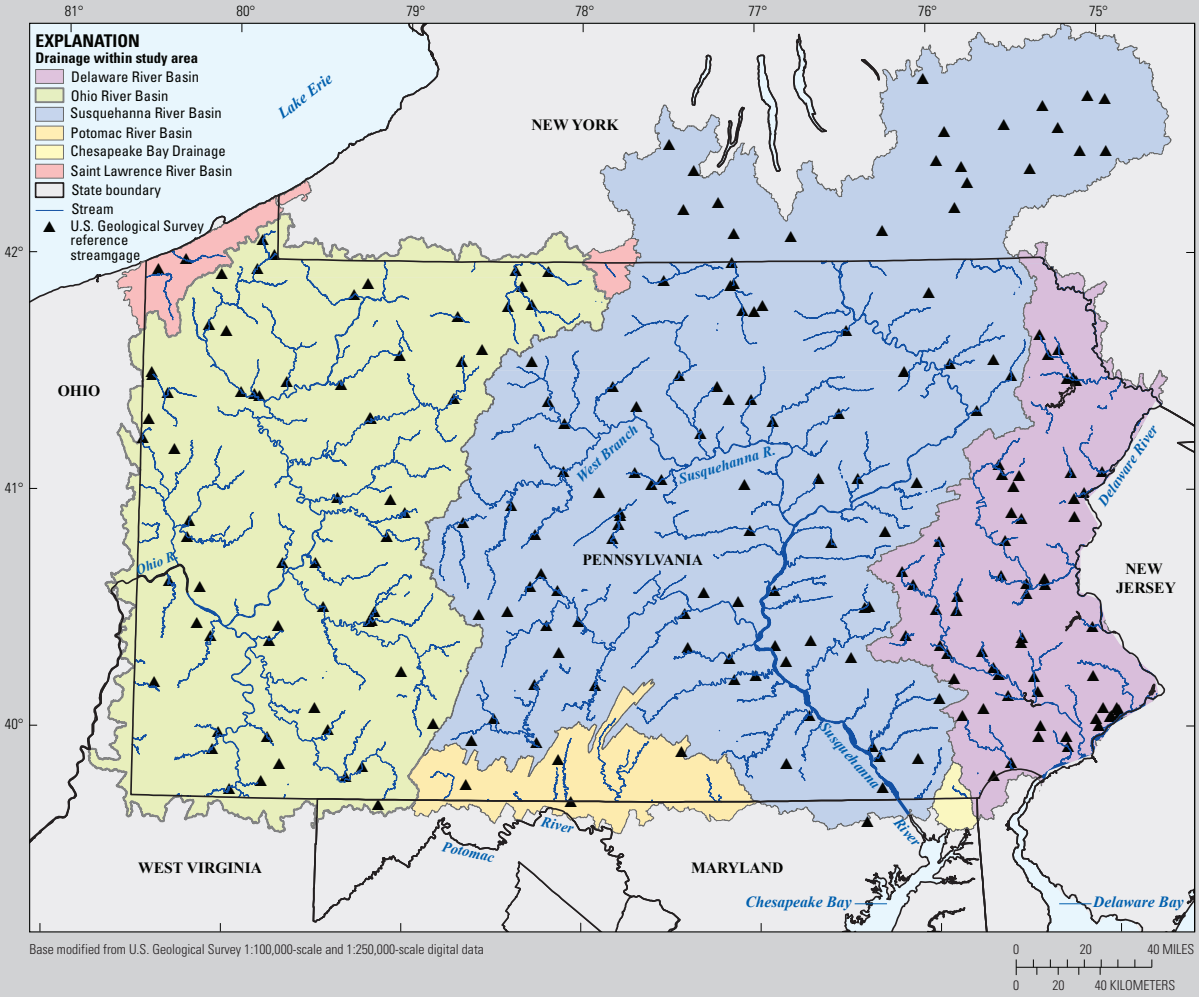
Evaluation of the Streamgage Network for Estimating Streamflow Statistics at Ungaged Sites in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York



Scientific Investigations Report 2016–5149

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U.S. Geological Survey

Cover. Map showing location of study area and U.S. Geological Survey reference streamgages in Pennsylvania and New York. Refer to figure 1.

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U.S. Geological Survey
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Conversion Factors and Datums

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
cubic foot (ft^3)	0.02832	cubic meter (m^3)

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

GSA	Gage statistical area
PaDEP	Pennsylvania Department of Environmental Protection
SRBC	Susquehanna River Basin Commission
USGS	U.S. Geological Survey
VSR	Valid statistical reach

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Abstract

The current (2015) streamgage network in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York was evaluated in order to design a network that would meet the hydrologic needs of many partners and serve a variety of purposes and interests, including estimation of streamflow statistics at ungaged sites. This study was done by the U.S. Geological Survey, in cooperation with the Pennsylvania Department of Environmental Protection and the Susquehanna River Basin Commission. The study area includes the Commonwealth of Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York. For this study, 229 streamgages were identified as reference streamgages that could be used to represent ungaged watersheds. Criteria for a reference streamgage are a minimum of 10 years of continuous record, minimally altered streamflow, and a drainage area less than 1,500 square miles. Some of the reference streamgages have been discontinued but provide historical hydrologic information valuable in the determination of streamflow characteristics of ungaged watersheds. Watersheds in the study area not adequately represented by a reference streamgage were identified by examining a range of basin characteristics, the extent of geographic coverage, and the strength of estimated streamflow correlations between gaged and ungaged sites.

Basin characteristics were determined for the reference streamgage watersheds and the 1,662 12-digit hydrologic unit code (HUC12) subwatersheds in Pennsylvania and the Susquehanna River Basin using a geographic information system (GIS) spatial analysis and nationally available GIS datasets. Basin characteristics selected for this study include drainage area, mean basin elevation, mean basin slope, percentage of urbanized area, percentage of forested area, percentage of carbonate bedrock, mean annual precipitation, and soil thickness. A GIS spatial analysis was used to identify HUC12 subwatersheds outside the range of basin characteristics of the reference streamgages. There were 320 HUC12 subwatersheds, or 19 percent of the study area, with basin characteristics outside the range represented by the reference streamgage watersheds.

A GIS spatial analysis was used to identify geographic gaps in the streamgage network. For each streamgage, a watershed area, called the gage statistical area (GSA), was delineated. The GSA shows the drainage area within a specific drainage-area ratio of the streamgage for transfer of streamflow statistics from that streamgage to ungaged sites on the valid statistical reach of the GSA for a streamgage. In Pennsylvania, a drainage-area ratio of 0.33–3 times the drainage area of the ungaged site was found to perform as well as, if not better than, more traditional ratios such as 0.5–1.5 (or 2) for transfer of selected streamflow statistics. A total of 1,102 HUC12 subwatersheds, or 66 percent of the study area, are outside the GSA for a reference streamgage.

The USGS Baseline Streamflow Estimator (BaSE) program was used to determine how well HUC12 subwatersheds outside the streamgage GSAs are represented by the reference streamgage network in Pennsylvania, based on estimated streamflow correlation. The centroid of each HUC12 subwatershed was run through the BaSE program to determine the reference streamgage with the highest estimated streamflow correlation. There were 929 HUC12 subwatersheds in Pennsylvania, or 56 percent of the State, with an estimated correlation coefficient less than 0.96.

The results from the basin characteristic, geographic, and streamflow correlation analyses were combined to identify 1,405 HUC12 subwatersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York that lack a representative reference, based on at least one identified gap. Of the 1,405 HUC12 subwatersheds, 139 exhibited all three gaps, indicating a 8-percent gap in the reference streamgage network.

Streamgages in areas with similar hydrologic characteristics and in close proximity to one another can potentially provide similar information (termed streamgages with high substitution potential). Streamgages were considered to have a high substitution potential with a nearby streamgage(s) if (1) the streamflow correlation coefficient was equal to or greater than 0.96, (2) the streamgages had 10 years of concurrent record, and (3) the streamgages are in the same watershed within the GSA of the streamgage. Seventy-four current (2015) streamgages with high substitution potential with at least one other streamgage were identified in the study area. Although these identified streamgages have a high substitution potential, they provide valuable streamflow information to a stakeholder. Selected primary uses of these streamgages were identified to determine the overall need for an individual streamgage.

Introduction

The first state-wide systematic measurement of streamflow in Pennsylvania began in the late 1800s. The establishment of a streamgage network began in the early 1930s when the Pennsylvania Department of Forest and Waters entered into a cooperative agreement with the U.S. Geological Survey (USGS) to provide for the collection and reporting of streamflow data (Durlin, 2009). The streamgages in this network were geographically located, and the primary objective was to document hydrologic resources and to forecast floods in Pennsylvania.

As needs changed for streamflow data over the years, streamgages were discontinued, new streamgages were established, and discontinued streamgages were reactivated. In addition to the scientific and engineering needs for streamgaging, regulatory and socio-economic factors have influenced the growth and decline of the USGS streamgage network in Pennsylvania. The current (2015) streamgage network is, in part, the result of requests of cooperating partners who require hydrologic data, possibly at specific locations. The resulting streamgage network may meet the needs of USGS cooperative partners but may not be ideal for establishing a reference streamgage network.

In a reference streamgage network, gaged watersheds represent composites of the upstream land cover, basin features, and hydrologic characteristics. Streamflow statistics from reference streamgages can be transferred to ungaged watersheds with similar land cover and basin features to estimate streamflow statistics. Although many of the current streamgages can be used as reference streamgages, an analysis was needed in order to design a network that would meet the hydrologic needs of many partners and serve many purposes and interests.

In 2015, the USGS operated and maintained approximately 300 real-time, continuous-record discharge streamgages across Pennsylvania that provided valuable hydrologic data for many Federal, State, and local water-resource agencies, and private industries for a variety of purposes, including regulatory, drought and flood forecasting, and long-term baseline data collection. In addition to the approximately 300 continuous-record discharge streamgages, the USGS has operated many continuous-record discharge streamgages in the past that have been discontinued because of lack of funding or changing priorities on the part of the funding cooperator. These streamgages, past and present, have drainage areas ranging in size from less than 5 square miles (mi^2) to 26,000 mi^2. Of all the streamgages, those on waterways that are minimally affected by regulation, diversion, or mining and have at least 10 years of continuous record are referred to as "reference streamgages." Although some of the reference streamgages are not currently operating, they still provide historical hydrologic information valuable in the determination of streamflow characteristics of ungaged watersheds.

The Pennsylvania Department of Environmental Protection (PaDEP), along with the Susquehanna River Basin Commission (SRBC), oversees the review and approval of many water-resource projects, including permit applications related to public water supplies and commercial and industrial activities, such as the unconventional development of shale gas. Streamgages monitoring continuous streamflow are used by the PaDEP and SRBC to evaluate water-withdrawal permits and to ensure that instream flow protection requirements are being met. The PaDEP and SRBC use reference streamgages to assist in the review of permit applications for water withdrawals in ungaged areas of the State by estimating streamflow statistics for the ungaged watershed. With the unconventional development of shale gas, there has been an increase in water-withdrawal permit applications, making the need for reliable streamflow data ever more critical. The USGS, in cooperation with the PaDEP and the SRBC, evaluated the streamgaging network for purposes of estimating streamflow statistics at ungaged sites in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.

Purpose and Scope

This report presents an evaluation of the reference streamgage network in Pennsylvania and the Susquehanna River Basin to determine whether it provides representative hydrologic information for all ungaged basins in Pennsylvania and the Susquehanna River Basin in New York and Pennsylvania for the purpose of estimating streamflow statistics. Ungaged 12-digit hydrologic unit code (HUC12) subwatersheds that are not adequately represented by a reference streamgage are identified. In addition, streamgages in the current (2015) streamgaging network with similar hydrologic characteristics and in close proximity to one another that could potentially provide similar information are also identified.

Study Area

The study area includes the Commonwealth of Pennsylvania and the part of the Susquehanna River Basin in New York (fig.1). A small part of the Susquehanna River Basin extends into Maryland but was not included in this analysis. The analysis includes HUC12 subwatersheds that straddle the Pennsylvania border, including small areas in Delaware, Maryland, New Jersey, New York, Ohio, and West Virginia, in addition to the HUC12 subwatersheds in the part of the Susquehanna River Basin in New York. Pennsylvania has three major river basins and three smaller river basins. The watersheds contain more than 98,100 linear miles of streams in the State. The Delaware River forms the boundary between Pennsylvania and New Jersey on the east, and the river flows south into the Delaware Bay. The Susquehanna River Basin is in the central part of the State, and the river flows south from New York into the Chesapeake Bay in Maryland. The Ohio River Basin drains the western part of the State, including the Allegheny and Monongahela Rivers, and the river flows into the Mississippi River and ultimately the Gulf of Mexico (not shown). The three river basins with small areas in Pennsylvania include the Potomac River Basin in the south-central part of the State; the Saint Lawrence River Basin in the northwestern part of the State, and the Chesapeake Bay Drainage in the southeastern part of the State that drains directly into the Chesapeake Bay.

Evaluation of Streamgage Network

Reference streamgages represent ungaged watersheds and can be used to estimate streamflow statistics and other hydrologic information for an ungaged watershed. Not all watersheds may be adequately represented by a reference streamgage. Watersheds that may not be adequately represented by a reference streamgage were identified by examining the range of basin characteristics, the extent of geographic coverage, and the strength of estimated streamflow correlations between gaged and ungaged sites.

The HUC12 subwatersheds represent the smallest watershed division in the hydrologic unit accounting system. A cataloging unit is defined as a geographic area representing part or all of a surface-water drainage basin, a combination of drainage basins, or a distinct hydrologic feature (Seaber and others, 1987). HUC12 subwatersheds subdivide the regions and accounting units into smaller areas. HUC12 boundaries are defined by hydrographic and topographic criteria that delineate an area upstream from a specific point on a stream. It is important to note that hydrologic units are synonymous with traditional watersheds only when all the upstream source area contributing to surface water is included (U.S. Geological Survey and U.S. Department of Agriculture, Natural Resources Conservation Service, 2013).

Reference Streamgages

For this study, 229 streamgages were identified in (or near) Pennsylvania and the Susquehanna River Basin for use as reference streamgages (table 1; fig. 1). Of those streamgages, 208 are in (or near) Pennsylvania, and 21 are in the Susquehanna River Basin outside of Pennsylvania. The criterion for a streamgage to be considered a reference streamgage is a minimum of 10 years of continuous record with minimally altered streamflow without significant alteration from flood-control reservoirs, mining, or other anthropogenic activities. Streamgages with current regulation were considered to be a reference streamgage if there was at least 10 years of minimally altered streamflow record prior to the start of regulation. Drainage basin size for a reference streamgage was limited to a maximum of 1,500 mi^2. Basins larger than 1,500 mi^2 typically contain extensive regulation, diversion, and other anthropogenic influences and are not suitable for transference of streamflow statistics to other unregulated streams.

Basin Characteristics

Basin characteristics represent the physical, ecological, and climatological aspects of watersheds and are used to assess how well a reference streamgage may represent an ungaged watershed. Basin characteristics selected for this analysis are drainage area, mean basin elevation, mean basin slope, percentage of urbanized area, percentage of forested area, percentage of carbonate bedrock, mean annual precipitation, and soil thickness (table 2). The selected basin characteristics are widely used in hydrologic and ecological studies and have been found to be important for evaluating streamflow in Pennsylvania and New York (Stuckey, 2006; Stuckey and Reed, 2000; Roland and Stuckey, 2008; Stuckey and others, 2012; Risser and others, 2008; Barnes, 1986; Randall, 2010; Lumia and others, 2006; Stedfast, 1986). Drainage area was a significant predictor variable for all recent regression studies in New York and Pennsylvania. Mean annual precipitation was significant for most of the studies. Percentage of carbonate bedrock was significant for all recent regression studies in Pennsylvania. All of the selected basin characteristics were significant in at least one of the recent regression analyses and are listed in table 2. Only basin characteristics that could easily be determined from nationally available geographic information system (GIS) datasets were considered. Land use changes over time were not considered as part of this project.

Basin characteristics were determined for the 229 USGS reference streamgages using GIS spatial analysis. Basin characteristics also were determined for 1,662 HUC12 subwatersheds in Pennsylvania and the upper Susquehanna River Basin in New York. The basin characteristics were determined for each HUC12 subwatershed, regardless of any upstream

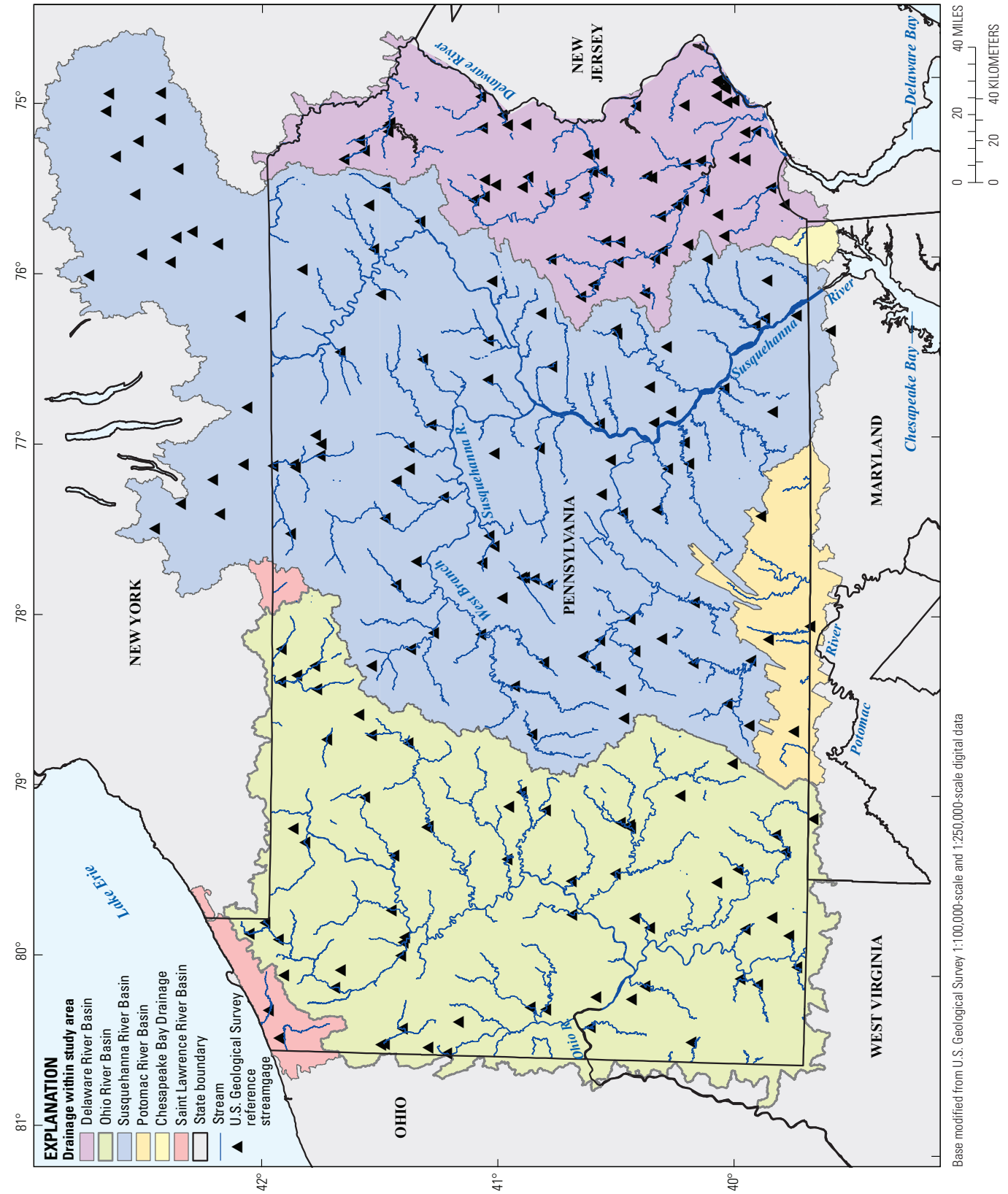

Figure 1. Location of study area and U.S. Geological Survey reference streamgages in Pennsylvania and New York.

Table 1. U.S. Geological Survey reference streamgages in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.

[USGS, U.S. Geological Survey; mi², square miles; A, active gage; AR, active gage with some degree of regulation; AS, active gage with split record from regulation; D, discontinued gage; DR, discontinued gage with some degree of regulation; DS, discontinued gage with split record from regulation]

USGS streamgage number	Streamgage name	Drainage area (mi²)	Status	Period of record used in analysis	Years of record	Regulation and diversion
01428750	West Branch Lackawaxen River near Aldenville, Pa.	40.6	A	Oct 1986–2014	27	
01429000	West Branch Lackawaxen River at Prompton, Pa.	59.7	AS	Aug 1944– Nov 1960	16	Regulated by Prompton Reservoir since Dec 1960
01429500	Dyberry Creek near Honesdale, Pa..	64.6	AS	Oct 1943–Sept 1959	15	Regulation by General Edgar Jadwin Reservoir since Oct 1959
01430500	Lackawaxen River at West Hawley, Pa.	206	D	May 1921–Sept 1937	15	Regulated at low flow by mills
01431000	Middle Creek near Hawley, Pa.	78.4	D	Aug 1944 –Sept 1960	16	
01431500	Lackawaxen River at Hawley, Pa.	290	AS	July 1908–Sept 1917 Aug 1938–Sept 1959	28	Record split; regulated by Prompton Reservoir since Dec 1960; high flow regulated by General Edgar Jadwin Reservoir since Oct 1959
01439500	Bush Kill at Shoemakers, Pa.	117	A	Oct 1908–2014	105	
01440400	Brodhead Creek near Analomink, Pa.	65.9	A	Oct 1957–2014	56	
01441000	McMichael Creek near Stroudsburg, Pa.	65.3	D	Aug 1911–Sept 1937	26	
01442500	Brodhead Creek at Minisink Hills, Pa.	259	A	Nov 1950–2014	63	
01446600	Martins Creek near East Bangor, Pa.	10.4	DR	Aug 1961–Sept 1977	16	Diversions above station for irrigation
01447500	Lehigh River at Stoddartsville, Pa.	91.7	A	Oct 1943–2014	70	
01447720	Tobyhanna Creek near Blakeslee, Pa.	118	AS	Oct 1961-1984	23	Affected by Pocono Lake since 1985; minor diversion into Wild Creek Basin
01448500	Dilldown Creek near Long Pond, Pa.	2.39	D	Oct 1948–Sept 1996	48	
01449360	Pohopoco Creek at Kresgeville, Pa.	49.9	A	Oct 1966–2014	47	
01449500	Wild Creek at Hatchery, Pa.	16.8	DS	Oct 1940–Dec 1958	17	Record split; regulated by Penn Forest Reservoir since Jan 1959
01450500	Aquashicola Creek at Palmerton, Pa.	76.7	AR	Oct 1939–2014	74	Occasional diversion from Pohopoco Creek into Aquishicola Creek by water company
01451500	Little Lehigh Creek near Allentown, Pa.	80.8	AR	Oct 1945–2014	68	Occasional regulation at low flow by fish hatchery
01451800	Jordan Creek near Schnecksville, Pa.	53	A	Feb 1966–2014	47	
01452000	Jordan Creek at Allentown, Pa.	75.8	A	Oct 1944–2014	69	
01452500	Monocacy Creek at Bethlehem, Pa.	44.5	AR	Oct 1948–2014	65	Some regulation at low flow by mill since April 1954
01453000	Lehigh River at Bethlehem, Pa.	1,279	AS	Oct 1902–Jan 1905 May 1909–Dec 1940	32	Record split; flow regulated by Wild Creek Reservoir since Jan 1941
01459500	Tohickon Creek near Pipersville, Pa.	97.4	AS	July 1935–Nov 1973	38	Regulated by Lake Nockamixon since Dec 1973
01464907	Little Neshaminy Creek at Valley Road near Neshaminy Pa.	26.8	A	Nov 1998–2014	15	
01465785	Walton Run at Philadelphia, Pa.	2.17	D	July 1964–Sept 1977	13	
01465790	Byberry Creek at Chalfont Road, Philadelphia, Pa.	5.34	D	June 1965–Sept 1977	12	
01465798	Poquessing Creek at Grant Avenue, Philadelphia, Pa.	21.4	AR	July 1965–2014	48	Flow occasionally affected by tide

Table 1. U.S. Geological Survey reference streamgages in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.—Continued

[USGS, U.S. Geological Survey; mi^2, square miles; A, active gage; AR, active gage with some degree of regulation; AS, active gage with split record from regulation; D, discontinued gage; DR, discontinued gage with some degree of regulation; DS, discontinued gage with split record from regulation]

USGS streamgage number	Streamgage name	Drainage area (mi^2)	Status	Period of record used in analysis	Years of record	Regulation and diversion
01467042	Pennypack Creek at Pine Road at Philadelphia, Pa.	37.9	A	Aug 1964–Sept 1981 Sept 2007–2014	19	
01467048	Pennypack Creek at Lower Rhawn Street Bridge, Philadelphia, Pa.	49.8	A	June 1965–2014	48	
01467050	Wooden Bridge Run at Philadelphia, Pa.	3.35	D	June 1965–Sept 1970 Oct 1974–Sept 1980	12	
01467086	Tacony Creek above Adams Avenue, Philadelphia, Pa.	16.7	A	Oct 1965–Sept 1970 June 1974–Sept 1986 Oct 2005–2014	24	
01467087	Frankford Creek at Castor Avenue, Philadelphia, Pa.	30.4	A	July 1983–2014	24	
01467500	Schuylkill River at Pottsville, Pa.	53.4	DR	Oct 1943–Sept 1969	26	Regulation by mine pumping
01468500	Schuylkill River at Landingville, Pa.	133	A	Aug 1947–Apr 1953 Oct 1963–Sept 1965 Aug 1973–2014	46	
01469500	Little Schuylkill River at Tamaqua, Pa.	42.9	AS	Oct 1919–Jan 1933	13	Flow regulated by Stillcreek Reservoir since Feb 1933
01470500	Schuylkill River at Berne, Pa.	355	AR	Aug 1947–2014	66	Some regulation at low flow by mine pumping; regulated by Stillcreek Reservoir since Feb 1933
01470720	Maiden Creek Tributary at Lenhartsville, Pa.	7.46		Oct 1965–Sept 1979	14	
01470756	Maiden Creek at Virginville, Pa.	159	D	Jan 1973–Sept 1995	23	
01470779	Tulpehocken Creek near Bernville, Pa.	66.5	A	Nov 1974–2014	39	
01471000	Tulpehocken Creek near Reading, Pa.	211	AS	Oct 1950–Mar 1979	29	Regulated by Blue Marsh Lake since April 1979
01471510	Schuylkill River at Reading, Pa.	880	AS	May 1914–Sept 1915 Oct 1919–Sept 1930	12	Record split; flow regulated by Stillcreek Reservoir since Feb 1933
01471875	Manatawny Creek near SPa.ngsville, Pa.	56.9	A	Oct 1993–2014	20	
01471980	Manatawny Creek near Pottstown, Pa.	85.5	D	Aug 1974–Sept 2004	30	
01472000	Schuylkill River at Pottstown, Pa.	1,147	AS	Oct 1927–Mar 1978	51	Regulated by Blue Marsh Lake since April 1979; some regulation by Stillcreek Reservoir since Feb 1933 and by Lake Ontelauntee
01472157	French Creek near Phoenixville, Pa.	59.1	A	Oct 1968–2014	45	
01472198	Perkiomen Creek at East Greenville, Pa.	38	A	Oct 1981–2014	32	
01472199	West Branch Perkiomen Creek at Hillegass, Pa.	23	A	Oct 1981–2014	32	
01473000	Perkiomen Creek at Graterford, Pa.	279	AS	June 1914–Nov 1956	42	Record split; regulated by Green Lane Reservoir since Dec 1956
01473120	Skippack Creek near Collegeville, Pa.	53.7	D	Apr 1966–Sept 1994	29	
01475300	Darby Creek at Waterloo Mills near Devon, Pa.	5.15	D	May 1972–Sept 1997	25	
01475510	Darby Creek near Darby, Pa.	37.4	D	Feb 1964–Sept 1990	27	

Table 1. U.S. Geological Survey reference streamgages in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.—Continued

[USGS, U.S. Geological Survey; mi², square miles; A, active gage; AR, active gage with some degree of regulation; AS, active gage with split record from regulation; D, discontinued gage; DR, discontinued gage with some degree of regulation; DS, discontinued gage with split record from regulation]

USGS streamgage number	Streamgage name	Drainage area (mi²)	Status	Period of record used in analysis	Years of record	Regulation and diversion
01475530	Cobbs Creek at US Hwy No.1 at Philadelphia, Pa.	4.78	A	Oct 1964–Sept 1981 Sept 2004–2014	25	
01475850	Crum Creek near Newtown Square, Pa.	15.8	A	Oct 1981–2014	32	
01479820	Red Clay Creek near Kennett Square, Pa.	28.3	AR	Jan 1988–2014	26	Some regulation above gage
01480300	West Branch Brandywine Creek near Honey Brook, Pa.	18.7	AR	June 1960–2014	53	Some regulation at low flow by waste water treatment plant
01480675	Marsh Creek near Glenmoore, Pa.	8.57	A	July1966–2014	47	
01481000	Brandywine Creek at Chadds Ford, Pa.	287	AS	Aug 1911–Sept 1953 Oct 1962–Oct 1973	52	Regulated by Marsh Creek Reservoir since November 1973
01496500	Oaks Creek at Index, N.Y.	102	DS	11/23/1929–09/30/1932 Mar 1937–June 1964	30	Flow regulated by Canadarago Lake since June 1964
01498500	Charlotte Creek at West Davenport, N.Y.	167	D	06/1938–10/09/1975	37	
01499000	Otego Creek near Oneonta, N.Y.	108	D	08/1940–09/30/1968	28	
01501000	Unadilla River near New Berlin, N.Y.	199	D	07/1924–09/30/1968	44	
01502000	Butternut Creek at Morris, N.Y.	59.7	D	06/19/1938–03/31/1995	57	
01502500	Unadilla River at Rockdale, N.Y.	520	D	11/22/1929–09/30/1933 01/29/1937–03/31/1995 10/01/2000–5/31/2014	74	
01505000	Chenango River at Sherburne, N.Y.	263	DR	May 1938–Oct 1995 Apr 2001–5/31/2014	1	Slight diversion for canal
01505500	Canasawacta Creek near South Plymouth, N.Y.	57.9	DR	09/1945–09/30/1975	30	Slighy diurnal fluctuation caused by mill
01507000	Chenango River at Greene, N.Y.	593	DR	Feb 1937–09/30/1970 10/01/2009–5/31/2014	35	Slight diversion for canal
01507500	Genegantslet Creek at Smithville Flats, N.Y.	82.3	D	06/1938–09/30/1970	32	
01508000	Shackham Brook near Truxton, N.Y.	3.16	D	12/01/1932–09/30/1968	36	
01510000	Otselic River at Cincinnatus, N.Y.	147	A	06/24/1938–09/30/1964 10/01/1969–2014	69	
01510500	Otselic River near Upper Lisle, N.Y.	217	D	Jan 1937–09/30/1969	33	
01512500	Chenango River near Chenango Forks, N.Y.	1,483	AS	11/11/1912–Mar 1942	30	Regulated at flood flow by Whitney Lake since April 1942; slight diversion by canal
01514000	Owego Creek near Owego, N.Y.	185	D	Jan 1930 -Sept 1978	49	
01516350	Tioga River near Mansfield, Pa.	153	A	July 1976–2014	37	
01516500	Corey Creek near Mainesburg, Pa.	12.2	A	May 1954–2014	59	
01517000	Elk Run near Mainesburg, Pa.	10.2	D	May1954–Sept 1978	25	

Table 1. U.S. Geological Survey reference streamgages in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.—Continued

[USGS, U.S. Geological Survey; mi², square miles; A, active gage; AR, active gage with some degree of regulation; AS, active gage with split record from regulation; D, discontinued gage; DR, discontinued gage with some degree of regulation; DS, discontinued gage with split record from regulation]

USGS streamgage number	Streamgage name	Drainage area (mi²)	Status	Period of record used in analysis	Years of record	Regulation and diversion
01518000	Tioga River at Tioga, Pa.	282	AS	June 1938–Sept 1977	40	Record split; flow diverted from Crooked Creek Reservoir since Jan 1977; regulated by Tioga Dam since Nov 1979; some reguation by mine pumping
01518500	Crooked Creek at Tioga, Pa.	122	D	May 1953–Sept 1974	21	
01518862	Cowanesque River at Westfield, Pa.	90.6	A	Aug 1983–2014	30	
01520000	Cowanesque River near Lawrenceville, Pa.	298	AS	June 1951–Nov 1979	28	Regulated by Cowanesque Dam since Dec 1979
01525500	Canisteo River at West Cameron, N.Y.	340	DS	Jan 1930–Sept 1931 Feb 1937–May 1949	14	Regulation at flood flow by Arkport Reservoir since Mar 1940 and by Almond Lake since June 1949
01526500	Tioga River near Erwins, N.Y.	1377	AS	July 1918–Sept 1979	60	Diversion into Tioga River since Oct 1977; regulation by Tioga Dam since Nov 1979
01527000	Cohocton River at Cohocton, N.Y.	52.2	D	10/01/1950–10/22/1981	31	
01528000	Fivemile Creek near Kanona, N.Y.	66.8	D	02/21/1937–03/31/1995	59	
01529500	Cohocton River near Campbell, N.Y.	470	AS	07/11/1918–Feb 1931	12	Large power diversion since March 1931
01530500	Newtown Creek at Elmira, N.Y.	77.5	DS	May 1938–Jul 1989	52	High flow regulated by upstream reservoir since Aug 1989; diurnal fluctuation at low flow by numerous industrial operations upstream
01532000	Towanda Creek near Monroeton, Pa.	215	A	Feb 1914–2014	100	
01532850	Middle Branch Wyalusing Creek near Birchardville, Pa.	5.67	D	Oct 1965- Sept 1979	14	
01533500	North Fork Mehoopany Creek near Lovelton, Pa.	35.2	D	Dec 1940–Sept 1958	18	
01533950	South Branch Tunkhannock Creek near Montdale, Pa.	12.6	D	Aug 1960–Sept 1978	18	
01534000	Tunkhannock Creek near Tunkhannock, Pa.	383	A	Feb 1914–2014	99	
01534500	Lackawanna River at Archbald, Pa.	108	AS	Oct 1939–Dec1959	20	Regulation by Stillwater Dam since Dec 1959
01536000	Lackawanna River at Old Forge, Pa.	332	AS	Oct 1938–Nov 1959	21	Regulation by Stillwater Dam since Dec 1959
01537500	Solomon Creek at Wilkes-Barre, Pa.	15.7	DR	Mar 1940–Sept 1990	51	Some regulation by mine pumping
01538000	Wapwallopen Creek near Wapwallopen, Pa.	43.8	A	Oct 1919 -2014	94	
01539000	Fishing Creek near Bloomsburg, Pa.	274	A	June 1938–2014	75	
01539500	Little Fishing Creek at Eyers Grove, Pa.	56.5	DR	Oct 1940–Sept 1958	18	Some regulation at low flow by mills
01540200	Trexler Run near Ringtown, Pa.	1.77	D	Sept 1963- Mar 1981	17	
01541000	West Branch Susquehanna River at Bower, Pa.	315	A	Oct 1913–2014	100	
01541308	Bradley Run near Ashville, Pa.	6.77	D	Oct 1967–Sept 1979	12	
01541500	Clearfield Creek at Dimeling, Pa.	371	AS	Aug 1913–Dec 1960	47	Regulated by Glendale Dam since Dec 1960
01542000	Moshannon Creek at Osceola Mills, Pa.	68.8	D	Oct 1940–Sept 1993	53	
01542500	West Branch Susquehanna River at Karthaus, Pa.	1,462	AS	Feb 1940 -Nov 1960	21	Regulated by Glendale Reservoir since Dec 1960 and by Curwensville Dam since Nov 1965

Table 1. U.S. Geological Survey reference streamgages in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.—Continued

[USGS, U.S. Geological Survey; mi², square miles; A, active gage; AR, active gage with some degree of regulation; AS, active gage with split record from regulation; D, discontinued gage; DR, discontinued gage with some degree of regulation; DS, discontinued gage with split record from regulation]

USGS streamgage number	Streamgage name	Drainage area (mi²)	Status	Period of record used in analysis	Years of record	Regulation and diversion
01542810	Waldy Run near Emporium, Pa.	5.24	A	Sept 1964–2014	49	
01543000	Driftwood Branch Sinnemahoning Creek at Sterling Run, Pa.	272	A	Oct 1913–2014	100	
01543500	Sinnemahoning Creek at Sinnemahoning, Pa.	685	A	Jul 1938–2014	75	
01544500	Kettle Creek at Cross Fork, Pa.	136	A	Oct 1940–2014	73	
01545600	Young Womans Creek near Renovo, Pa.	46.2	A	Dec 1964–2014	49	
01546400	Spring Creek at Houserville, Pa.	58.5	A	Nov 1984–2014	29	
01546500	Spring Creek near Axemann, Pa.	87.2	AR	Oct 1940–2014	73	Occasional regulation at low flow
01547100	Spring Creek at Milesburg, Pa.	142	AR	May 1967–2014	46	Occasional regulation at low flow
01547200	Bald Eagle Creek below Spring Creek at Milesburg, Pa.	265	A	Oct 1955–2014	58	
01547700	Marsh Creek at Blanchard, Pa.	44.1	A	Oct 1955–2014	58	
01547800	South Fork Beech Creek near Snow Shoe, Pa.	12.2	D	May 1969–March 1981	13	
01547950	Beech Creek at Monument, Pa.	152	A	Oct 1968- 2014	45	
01548005	Bald Eagle Creek near Beech Creek Station, Pa.	562	AS	July 1910–Feb 1970	59	Regulated by Foster Joseph Sayers Dam since Mar 1971
01548500	Pine Creek at Cedar Run, Pa.	604	A	July 1918–2014	95	
01549500	Blockhouse Creek near English Center, Pa.	37.7	A	Oct 1940–2014	73	
01549700	Pine Creek below L Pine Creek near Waterville, Pa.	944	AR	Oct 1957–2014	56	Regulation at flood flow by Little Pine Dam
01549780	Larrys Creek at Cogan House, Pa.	6.8	D	Apr 1960–Sept 1978	19	Regulation at low flow by several ponds
01550000	Lycoming Creek near Trout Run, Pa.	173	A	Dec 1913–2014	100	
01552000	Loyalsock Creek at Loyalsockville, Pa.	435	A	Aug 1925–Sept 1974 Oct 1975–2014	86	
01552500	Muncy Creek near Sonestown, Pa.	23.8	A	Oct 1940–2014	73	
01553130	Sand Spring Run near White Deer, Pa.	4.93	D	Jan 1968–Sept 1980	13	
01553600	East Branch Chillisquaque Creek near Washingtonville, Pa.	9.48	D	Apr 1960–Sept 1978	19	
01554500	Shamokin Creek near Shamokin, Pa.	54.2	DR	Dec 1939–Sept 1963	24	Regulation by mine pumping
01555000	Penns Creek at Penns Creek, Pa.	301	A	Oct 1929–2014	84	
01555500	East Mahantango Creek near Dalmatia, Pa.	162	AR	Oct 1929–2014	84	Intermittent regulation at low flow by unknown source
01556000	Frankstown Branch Juniata River at Williamsburg, Pa.	291	AR	Oct 1916–2014	97	Some regulation at low flow by mill
01556500	Little Juniata River at Tipton, Pa.	93.7	DD	Oct 1945–Sept 1962	17	Flow regulation by upstream reservoirs
01557500	Bald Eagle Creek at Tyrone, Pa.	44.1	AS	Nov 1952–2014	61	Discharge affected by diversions prior to Nov 1952
01558000	Little Juniata River at Spruce Creek, Pa.	220	A	June 1938–2014	75	

Table 1. U.S. Geological Survey reference streamgages in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.—Continued

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USGS streamgage number	Streamgage name	Drainage area (mi^2)	Status	Period of record used in analysis	Years of record	Regulation and diversion
01559000	Juniata River at Huntingdon, Pa.	816	AS	Jul 1972–Nov 1985	13	Regulated from Sept 1941 to June 1972 and since Dec 1985 by hydroelectric plant
01559500	Standing Stone Creek near Huntingdon, Pa.	128	D	Oct 1931–Sept 1958	27	
01559700	Buffalo Run Tributary near Manns Choice, Pa.	5.28	D	Oct 1961–Sept 1978	17	
01560000	Dunning Creek at Belden, Pa.	172	A	May 1939–2014	74	
01561000	Brush Creek at Gapsville, Pa.	36.8	D	Oct 1929–Sept 1958	29	Some reg at low flow by mills
01562000	Raystown Branch Juniata River at Saxton, Pa.	756	A	Sept 1911–2014	102	
01562500	Great Trough Creek near Marklesburg, Pa.	84.6	D	Oct 1931–Sept 1957	26	
01564500	Aughwick Creek near Three Springs, Pa.	205	A	June 1939–2014	75	
01565700	Little Lost Creek at Oakland Mills, Pa.	6.52	D	Aug 1963–Sept 1980	17	
01566000	Tuscarora Creek near Port Royal, Pa.	214	A	Oct 1910–Sept 1958 Oct 2001–2014	59	
01566500	Cocolamus Creek near Millerstown, Pa.	57.2	D	Oct 1931–Sept 1958	27	Some dirunal fluctuation caused by mills
01567500	Bixler Run near Loysville, Pa.	15	A	Feb 1954–2014	60	
01568000	Sherman Creek at Shermans Dale, Pa.	207	A	Oct 1929 –2014	84	
01569000	Stony Creek near Dauphin, Pa.	33.2	D	Sept 1937–Sept 1945 Jan 1967–Sept 1974	15	
01569800	Letort Spring Run near Carlisle, Pa.	21.6	D	June 1976–Sept 2009	33	
01570000	Conodoguinet Creek near Hogestown, Pa.	470	AS	Oct 1911–Sept 1917 Oct 1929–Sept 1958 July 1967 -June 1969	79	Diversion for water supply since June 1969
01571000	Pa.xton Creek near Penbrook, Pa.	11.2	D	Mar 1940–Sept 1950 Oct 1984–Dec 1988 Oct 1991–Sept 1995	20	
01572000	Lower Little Swatara Creek at Pine Grove, Pa.	34.3	D	Nov 1919–Sept 1932 July 1981–Sept 1984	15	
01572025	Swatara Creek near Pine Grove, Pa.	116	A	Oct 1988–Jan 1991 Oct 1991–2014	24	
01573086	Beck Creek near Cleona, Pa.	7.87	D	Aug 1963– Mar 1981	18	
01573500	Manada Creek at Manada Gap, Pa.	13.5	D	Sept 1937–Sept 1958	21	
01574000	West Conewago Creek near Manchester	510	AR	Oct 1928–2014	85	Occasional slight regulation by Conegago Lake since Oct 1959
01574500	Codorus Creek at Spring Grove, Pa.	75.5	AS	May 1929–Sept 1964 Nov 1965–Nov 1966	37	Diversion around gage by wastewater plant; regulation by Lake Marburg since Dec 1966
01576085	Little Conestoga Creek near Churchtown, Pa.	5.82	D	July 1982–Sept 1995	13	
01576754	Conestoga River at Conestoga, Pa.	470	A	Oct 1984–2014	29	

Table 1. U.S. Geological Survey reference streamgages in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.—Continued

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USGS streamgage number	Streamgage name	Drainage area (mi²)	Status	Period of record used in analysis	Years of record	Regulation and diversion
01576787	Pequea Creek at Martic Forge, Pa.	148	A	Feb 1977–Sept 1981 Feb 1993–Sept 1995 Sept 2004–2014	15	
01577500	Muddy Creek at Castle Fin, Pa.	133	D	Oct 1928–Sept 1938 Mar 1968–Sept 1971	13	
01578400	Bowery Run near Quarryville, Pa.	5.98	D	Oct 1962–Sept 1980	18	
01580000	Deer Creek at Rocks, Md.	94.4	AR	Oct 1926–2014	87	Some regulation at low flow by mills prior to 1965
01603500	Evitts Creek near Centerville, Pa.	30.2	D	Sept 1932–Sept 1982	50	
01613050	Tonoloway Creek near Needmore, Pa.	10.7	A	Oct 1965 – 2014	48	
01613500	Licking Creek near Sylvan, Pa.	158	D	June 1930–Sept 1941	12	
01614090	Conococheague Creek near Fayetteville, Pa.	5.05	D	Aug 1960–Sept 1980	20	
03007800	Allegheny River at Port Allegany, Pa.	248	A	Oct 1974–2014	39	
03008000	Newell Creek near Port Allegany, Pa.	7.79	D	Oct 1965–Sept 1978	13	
03009680	Potato Creek at Smethport, Pa.	160	D	Oct 1974–Sept 1995	21	
03010500	Allegheny River at Eldred, Pa.	550	A	Jul 1939–2014	74	
03010655	Oswayo Creek at Shinglehouse, Pa.	98.7	A	Oct 1974–2014	39	
03011800	Kinzua Creek near Guffey, Pa.	38.8	A	Oct 1965–2014	48	
03015280	Jackson Run near North Warren, Pa.	12.8	D	Oct 1962–Sept 1978	16	
03015500	Brokenstraw Creek at Youngsville, Pa.	321	A	Oct 1909–2014	104	
03017500	Tionesta Creek at Lynch, Pa.	233	A	Oct 1937–Sept 1979 Aug 2011 -2014	43	
03019000	Tionesta Creek at Nebraska, Pa.	469	D	Oct 1909–Sept 1912 Oct 1931–sept 1940	19	
03020500	Oil Creek at Rouseville, Pa.	283	A	June 1932–2014	81	
03021350	French Creek near Wattsburg, Pa.	92	A	Oct 1974–2014	39	
03021410	West Branch French Creek near Lowville, Pa..	52.3	D	Oct 1974–Sept 1993	19	
03021500	French Creek at Carters Corners, Pa.	208	D	Oct 1909–Sept 1971	62	
03021700	Little Conneauttee Creek near McKean, Pa.	3.6	D	Oct 1960–Sept 1978	18	
03022500	French Creek at Saegerstown, Pa.	629	D	May 1921–Sept 1939	19	Regulated at low flow by plants
03022540	Woodcock Creek at Blooming Valley, Pa.	31.1	D	Oct 1974–Sept 1995	21	
03024000	French Creek at Utica, Pa.	1,028	AS	Aug 1932–June 1970	38	Regulation by Union City Reservoir since July 1970 and by Woodcock Creek Lake since Jan 1974
03025000	Sugar Creek at Sugarcreek, Pa.	166	D	Aug 1932–Sept 1979	47	
03025200	Pa.tchel Run near Franklin, Pa.	5.67	D	Aug 1964–Sept 1978	14	

Table 1. U.S. Geological Survey reference streamgages in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.—Continued

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USGS streamgage number	Streamgage name	Drainage area (mi²)	Status	Period of record used in analysis	Years of record	Regulation and diversion
03026500	Sevenmile Run near Rasselas, Pa.	7.84	A	Oct 1951–2014	62	
03028000	West Branch Clarion River at Wilcox, Pa.	63	A	Oct 1953–2014	60	
03029000	Clarion River at Ridgway, Pa.	303	D	Oct 1940–May 1952	12	Regulated by East Branch Clarion River Reservoirs since June 1952; regulation at low flow by industrial plants
03029400	Toms Run at Cooksburg, Pa.	12.6	D	Oct 1959–Sept 1978	19	
03029500	Clarion River at Cooksburg, Pa.	807	AS	Oct 1938–May 1952	13	Regulated by East Branch Clarion Lake since June 1952
03031950	Big Run near Sprankle Mills, Pa.	7.38	D	Oct 1963–Sept 1980	17	
03032500	Redbank Creek at St. Charles, Pa.	528	A	Oct 1918–2014	95	
03034000	Mahoning Creek at Punxsutawney, Pa.	158	AR	Oct 1938–2014	75	Dirunal fluctuation at low flow by mine pumping
03034500	Little Mahoning Creek at McCormick, Pa.	87.4	A	Oct 1939–2014	74	
03039000	Crooked Creek at Crooked Creek Dam near Ford City	278	DS	Oct 1909–1939	30	Flow completely regulated by Crooked Creek Lake since 1940
03039200	Clear Run near Buckstown, Pa.	3.68	D	Sept 1964–Sept 1978	14	
03039925	North Fork Bens Creek at North Fork Reservoir, Pa.	3.45	D	Oct 1984–Sept 1985 Oct 1987–Sept 1998	12	
03042000	Blacklick Creek at Josephine, Pa.	192	AR	Jan 1952–2014	62	Some regulation at low flow by mine pumping
03042500	Two Lick Creek at Graceton, Pa.	171	AS	Sept 1951–Nov 1968	17	Diurnal fluctuation caused by mine pumping and by plant upstream from station; flow regulated by Two Lick Creek Reservoir since Dec 1968
03043000	Blacklick Creek at Black Lick, Pa.	390	D	Aug 1904–Sept 1913 Oct 1918–Sept 1921 Oct 1931–Sept 1951	30	Some regulation at low flow by mills
03047500	Kiskiminetas River at Avonmore, Pa.	1723	DR	June 1907–Sept 1913 Oct 1918–Sept 1921 Oct 1931–Sept 1937	13	Slight regulation at low flow from upstream power operations
03049000	Buffalo Creek near Freeport, Pa.	137	A	Nov 1940–2014	73	
03072000	Dunkard Creek at Shannopin, Pa.	229	AR	Oct 1940–2014	73	Some regulation by mine pumping
03072590	Georges Creek at Smithfield, Pa.	16.3	DR	Oct 1963–Sept 1978	15	Occasional regulation by unknown source
03072840	Tenmile Creek near Clarksville, Pa.	133	D	Oct 1968–Sept 1978	10	
03073000	South Fork Tenmile Creek at Jefferson, Pa.	180	AR	Oct 1931–Sept 1995 Oct 2010–2014	66	Slight diversion into basin during winter months; some regulation and pumping above gage
03074300	Lick Run at Hopwood, Pa.	3.8	D	Oct 1966–Sept 1978	12	
03074500	Redstone Creek at Waltersburg, Pa.	73.7	AR	Oct 1942–2014	71	Some regulation by mine pumping
03078000	Casselman River at Grantsville, Md.	62.5	AR	July 1947–2014	66	Slight diurnal fluctuation at low flow from unknown source
03079000	Casselman River at Markleton, Pa.	382	AR	Oct 1920–2014	93	Slight diversion for water supply

Table 1. U.S. Geological Survey reference streamgages in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.—Continued

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USGS streamgage number	Streamgage name	Drainage area (mi²)	Status	Period of record used in analysis	Years of record	Regulation and diversion
03080000	Laurel Hill Creek at Ursina, Pa.	121	A	Oct 1918–2014	95	
03082200	Poplar Run near Normalville, Pa.	9.27	D	Sept 1961–Sept 1978	17	
03083000	Green Lick Run at Green Lick Reservoir, Pa.	3.07	D	Aug 1941–Sept 1979	38	
03084000	Abers Creek near Murrysville, Pa.	4.39	D	Oct 1948–Sept 1993	45	
03084500	Turtle Creek at Trafford, Pa..	55.9	D	Oct 1920–Sept 1921 Oct 1931–1952	22	Some regulation at low flow by upstream power operations
03085500	Chartiers Creek at Carnegie, Pa.	257	AR	Oct 1919–Sept 1933 Oct 1940–2014	86	Some regulation at low flow by mine drainage, reservoirs, and industrial usage upstream from station
03085956	Montour Run at Scott Station near Imperial, Pa.	25.4	D	Aug 2000–Sept 2009	9	
03086100	Big Sewickley Creek near Ambridge, Pa.	15.6		Oct 1967–Sept 1979	11	
03100000	Shenango River near Turnersville, Pa.	152	D	Feb 1912–Sept 1922	11	
03101000	Sugar Run at Pymatuning Dam, Pa.	8.59	D	March 1934–Sept 1954	22	
03102500	Little Shenango River at Greenville, Pa.	104	A	Oct 1913–2014	100	
03103000	Pymatuning Creek near Orangeville, Pa.	169	DR	Oct 1913–Sept 1963	50	Some regulation at low flow by mills
03104000	Shenango River at Sharon, Pa.	608	D	Aug 1909–Sept 1921 Oct 1931–Nov 1933	15	Regulated by Pymatuning Reservoir since Dec1933; some regulation by mill operations
03104760	Harthegig Run near Greenfield, Pa.	2.26	D	Oct 1968–Mar 1981	13	
03106000	Connoquenessing Creek near Zelienople, Pa.	356	AR	Oct 1919–2014	94	Some regulation by mills
03106500	Slippery Rock Creek at Wurtemburg, Pa.	398	AS	Oct 1911–Apr 1969	58	Some regulation by Lake Arthur since May1969
03108000	Raccoon Creek at Moffatts Mill, Pa.	178	DS	Sept 1941–1956	16	Normally no regulation from Raccoon Lake; diversions from 1957 to 2002
03111150	Brush Run near Buffalo, Pa.	10.3	D	June 1960–Sept 1978 Oct 1982–Sept 1985	20	
04213040	Raccoon Creek near West Springfield, Pa.	2.53	D	Oct 1968–Sept 1994	26	
04213075	Brandy Run near Girard, Pa.	4.45	A	May 1986–2014	27	

Table 2. Basin characteristics used in the Pennsylvania streamgage network analysis.

Basin charactaristic	Unit	Source of data	Reference	Relevant regression analysis
Drainage area	Square miles	Digital Elevation Model (DEM)	U.S. Geological Survey (2013)	Stuckey, 2006; Stuckey and Reed,2000; Roland and Stuckey, 2008; Stuckey and others, 2012; Risser and others, 2008; Barnes, 1986; Randall, 2010; Lumia and others, 2006; Stedfast, 1986
Mean basin elevation	Feet	Digital Elevation Model (DEM)	U.S. Geological Survey (2013)	Stuckey, 2006; Roland and Stuckey, 2008; Barnes, 1986
Mean basin slope	Degrees	Digital Elevation Model (DEM)	U.S. Geological Survey (2013)	Stuckey, 2006
Urbanized area	Percent	National Land Cover Dataset (NLCD)	Fry and others (2011)	Stuckey, 2006; Stuckey and Reed, 2000; Roland and Stuckey, 2008; Barnes, 1986
Forested area	Percent	National Land Cover Dataset (NLCD)	Fry and others (2011)	Stuckey, 2006; Stuckey and Reed, 2000; Randall, 2010; Lumia and others, 2006
Carbonate bedrock	Percent	Pennsylvania: Pennsylvania Geological Survey state geological map; Surrounding states: carbonate, limestone, dolomite, dolostone, and marble in rock type 1 from the U.S. Geological Survey Mineral Resources State Geology Maps	Miles and Whitfield (2001); U.S. Geological Survey (2014a, 2014b, 2014c, 2014d, 2014e, 2014f)	Stuckey, 2006; Stuckey and Reed, 2000; Roland and Stuckey, 2008; Stuckey and others, 2012; Risser and others, 2008
Mean annual precipitation	Inches	Parameter-elevation Regressions on Independent Slopes Model (PRISM)	PRISM Group at Oregon State University (2012)	Stuckey, 2006; Stuckey and others, 2012; Risser and others, 2008; Barnes, 1986; Randall, 2010; Lumia and others, 2006; Stedfast, 1986
Soil thickness	Inches	State Soil Geographic (STATSGO) database	U.S. Department of Agriculture (1994)	Stuckey, 2006; Stuckey and others, 2012

contributing area. Ranges of basin characteristic values and the distribution of the values were compared for each dataset.

A matrix plot showing the relations between all the basin characteristics determined for the reference streamgage watersheds is shown in figure 2. Many of these relations are expected, such as forested area increases as mean elevation increases, or that watersheds with large drainage areas have lower percentages of urbanized area (because as the drainage area increases, the more likely it is that land uses will be mixed and not uniformly high in urbanized area). These plots may provide insight into possible deficiencies in the combinations of basin characteristics. Examples of deficiencies are the narrow range for soil thickness in drainage basins greater than 500 mi^2 and the narrow range for precipitation in watersheds with urban area greater than 40 percent. Matrix plots for the Delaware, Susquehanna and Potomac, and Ohio and Saint Lawrence River Basins are shown in Appendix 1. Although these relations are not analyzed further in this report, their use would be beneficial when siting a new reference streamgage.

Comparisons of the ranges of basin characteristics between reference streamgage watersheds and HUC12 subwatersheds were made to determine whether the reference streamgages adequately represent the range of basin characteristics found in the HUC12 subwatersheds. If the basin characteristic value determined for a HUC12 subwatershed was outside the range of basin characteristic values determined for the reference streamgages, then the HUC12 subwatershed was not considered to be represented by a reference streamgage and was identified as a potential gap. For streamgage watersheds that encompass more than one HUC12 watershed, or for streamgage watersheds that are very small and do not encompass an entire HUC12 watershed, this comparison may not be entirely equivalent.

Overall, the reference gages represent 81 percent of the range in the selected basin characteristics of the HUC12 subwatersheds. Within the Delaware River Basin, Susquehanna/Potomac River Basins, and the Ohio/Saint Lawrence River Basins, the reference streamgages represent 79 percent,

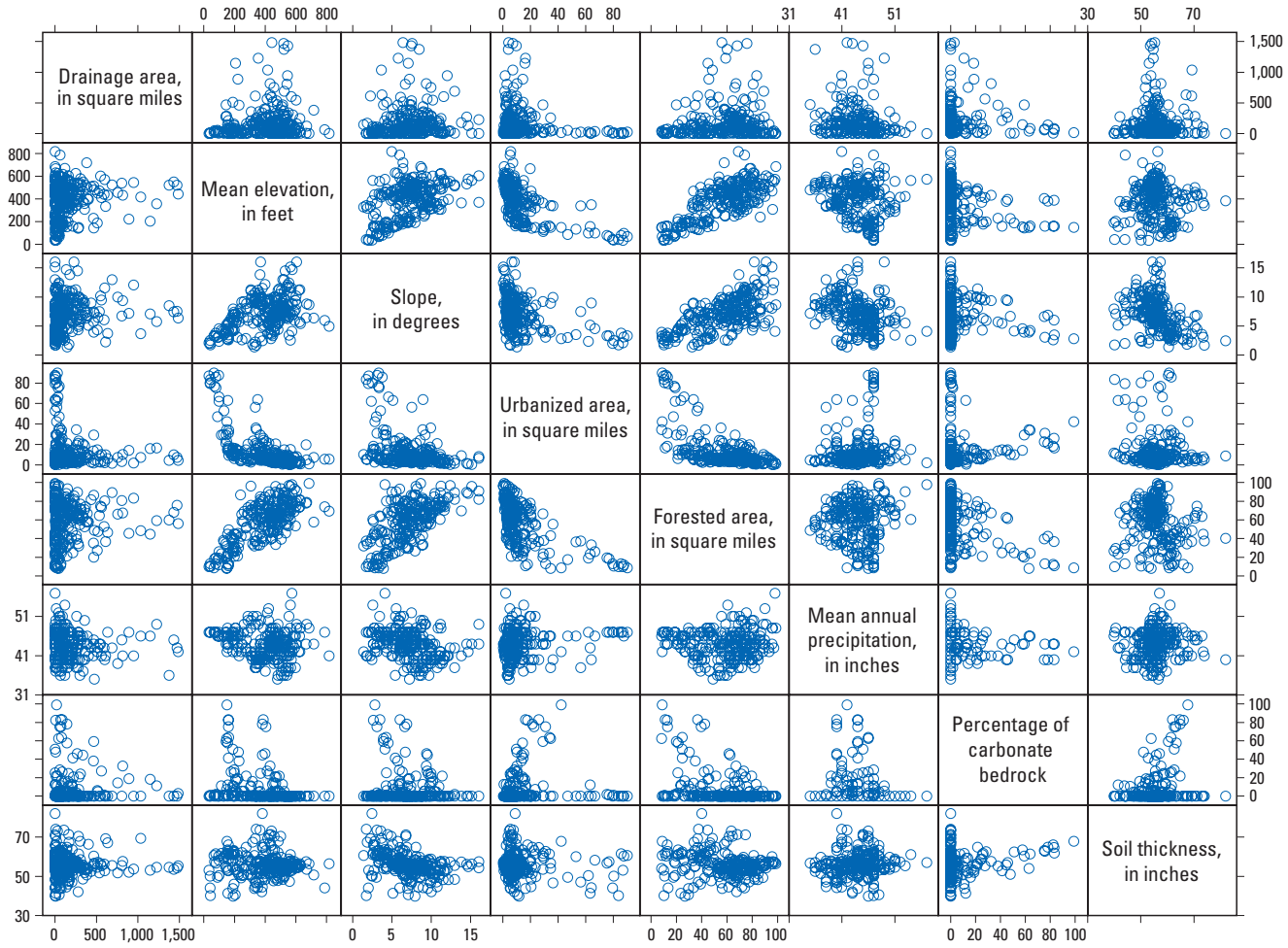

Figure 2. Comparison of basin characteristics for reference streamgages in Pennsylvania and New York.

78 percent, and 87 percent, respectively, of the range of basin characteristics found within the HUC12 subwatersheds (figs. 3–5). A total of 320 HUC12 subwatersheds, or 19 percent, in the study area had basin characteristics outside the range represented by the reference gages. Detailed analyses of each of the selected basin characteristics are in the sections that follow. A consistent theme throughout this analysis is a lack of representation of basin characteristics for watersheds in headwaters of larger rivers. The large number of headwater streams within Pennsylvania and the Susquehanna River Basin, and the unique set of basin characteristics within each of the small watersheds, can make finding a representative reference streamgage challenging.

Drainage Area

Drainage area is a fundamental physical characteristic of a watershed. It is commonly used to classify watersheds and is the basis on which many other watershed characteristics are calculated. For example, the percentage of basin covered by forest is computed in relation to the drainage area of the watershed. Overall, drainage areas for the 229 reference streamgages in the study area range from 1.80 to 1,485 mi^2 with a mean of 185 mi^2 (table 3). When grouped into the three major river basins (fig. 6), similar patterns emerge for the basins, with the largest number of reference streamgages in the range of 50 mi^2 to 150 mi^2. The Ohio River Basin has the most reference streamgages with drainage areas of 5 mi^2 or less (fig. 6). Overall in the study area, reference streamgages are on 49 headwaters streams with drainage areas less than 15 mi^2, which accounts for 21 percent of the reference streamgage watersheds. Because the areas of individual HUC12 subwatersheds do not include any contributing area upstream, a comparison of area was not done between HUC12 subwatersheds and reference streamgage watersheds.

Mean Basin Elevation

Mean basin elevation was computed as an area-weighted average from the USGS national elevation dataset (U.S. Geological Survey, 2013a). Mean basin elevations for the reference streamgage watersheds in the study area range from 34.9 to 818 feet (ft). Mean basin elevations for the HUC12 subwatersheds range from 5.49 to 779 ft (table 3). A comparison of mean basin elevations for the reference streamgage and HUC12 subwatersheds (fig. 7A) shows that 90 percent of the mean basin elevations for the HUC12 subwatersheds fall within the range for the reference streamgage watersheds. The overall distributions of mean basin elevations observed within the HUC12 subwatersheds and the reference streamgage watersheds are similar (fig. 8A). Although there are fewer reference streamgages in the range of 200–300 ft, and above 700 ft, the reference streamgage watershed mean basin elevations correspond to the distribution found in the HUC12 subwatersheds.

Within the Delaware River Basin, there are 12 HUC12 subwatersheds with mean basin elevations outside of the range for the reference streamgage watersheds within the Delaware River Basin (fig. 3). The 12 watersheds are in the Philadelphia area along the Delaware River. Within the Susquehanna and Potomac River Basins, there are 41 HUC12 subwatersheds with mean basin elevations outside the range for the reference streamgages within the Susquehanna and Potomac River Basins (fig. 4). These watersheds are generally within the lower Susquehanna River Basin and flow directly into the main stem Susquehanna River. Within the Ohio and Saint Lawrence River Basins, there are three HUC12 subwatersheds with mean basin elevations outside the range for the reference streamgage watersheds within the Ohio and Saint Lawrence River Basins (fig. 5). The three watersheds are within the Saint Lawrence River Basin and adjacent to Lake Erie in the northwestern corner of the Pennsylvania.

Mean Basin Slope

Mean basin slope was computed as area-weighted mean from the USGS National Elevation Dataset (U.S. Geological Survey, 2013a). Mean basin slope for the reference streamgage watersheds in the study area ranges from 1.4 to 16.1 degrees. Mean basin slope for the HUC12 subwatersheds ranges from 0.14 to 19 degrees (table 3). A comparison of mean basin slope between the reference streamgages and HUC12 subwatersheds (fig. 7B) shows that 96 percent of the mean basin slopes for the HUC12 subwatersheds falls within the range for the reference streamgage watersheds. The overall distribution of mean basin slope values observed within the HUC12 subwatersheds and the reference streamgage watersheds are similar (fig. 8B).

Overall, there is greater density of reference streamgage watersheds than of HUC12 subwatersheds with lower (less than 8 degrees) mean basin slope and a lesser density of reference streamgage watersheds than of HUC12 subwatersheds with higher (greater than 8 degrees) mean basin slope. There are no reference watersheds with a slope of 1 degree or less.

Within the Delaware River Basin, there are 18 HUC12 subwatersheds with mean basin slope outside of the range represented by reference streamgages within the Delaware River Basin (fig. 3). The watersheds are in the central part of the basin, characterized by moderate to high relief, and in the Philadelphia area along the Delaware River, characterized by low relief. Within the Susquehanna and Potomac River Basins, there are 27 HUC12 subwatersheds with mean basin slope outside of the range for reference streamgage watersheds within the Susquehanna and Potomac River Basins (fig. 4). These watersheds generally are in the headwaters of the West Branch Susquehanna River where the high mean basin slope is a direct result of the high basin elevation and relief found there. A few isolated watersheds in the lower Susquehanna River Basin have mean basin slope values smaller than the range for the reference streamgages. Within the Ohio and Saint Lawrence River Basins, there are 15 HUC12 subwatersheds with mean basin slope values outside the range for the

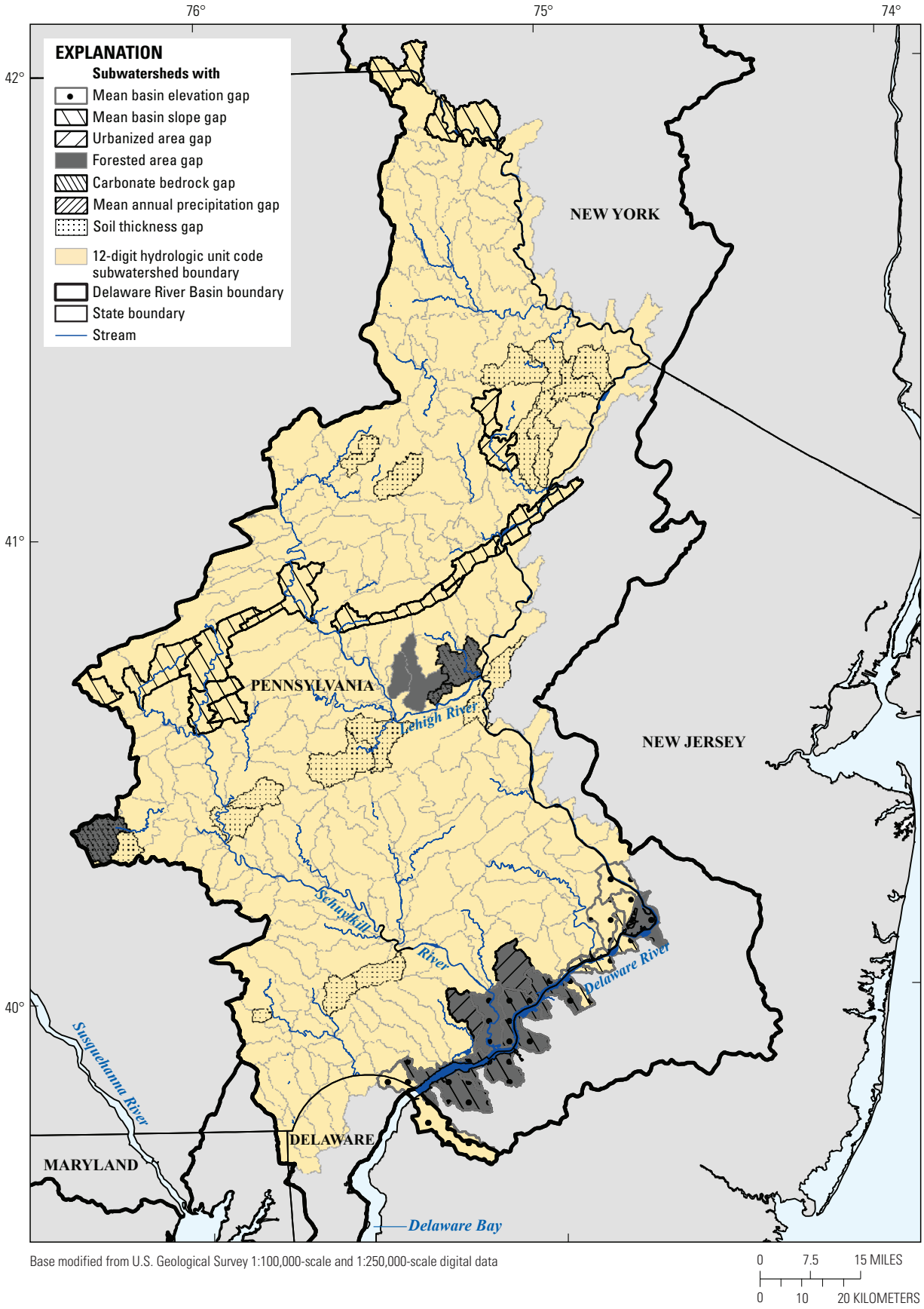

Figure 3. Basin characteristic gaps in the Delaware River Basin.

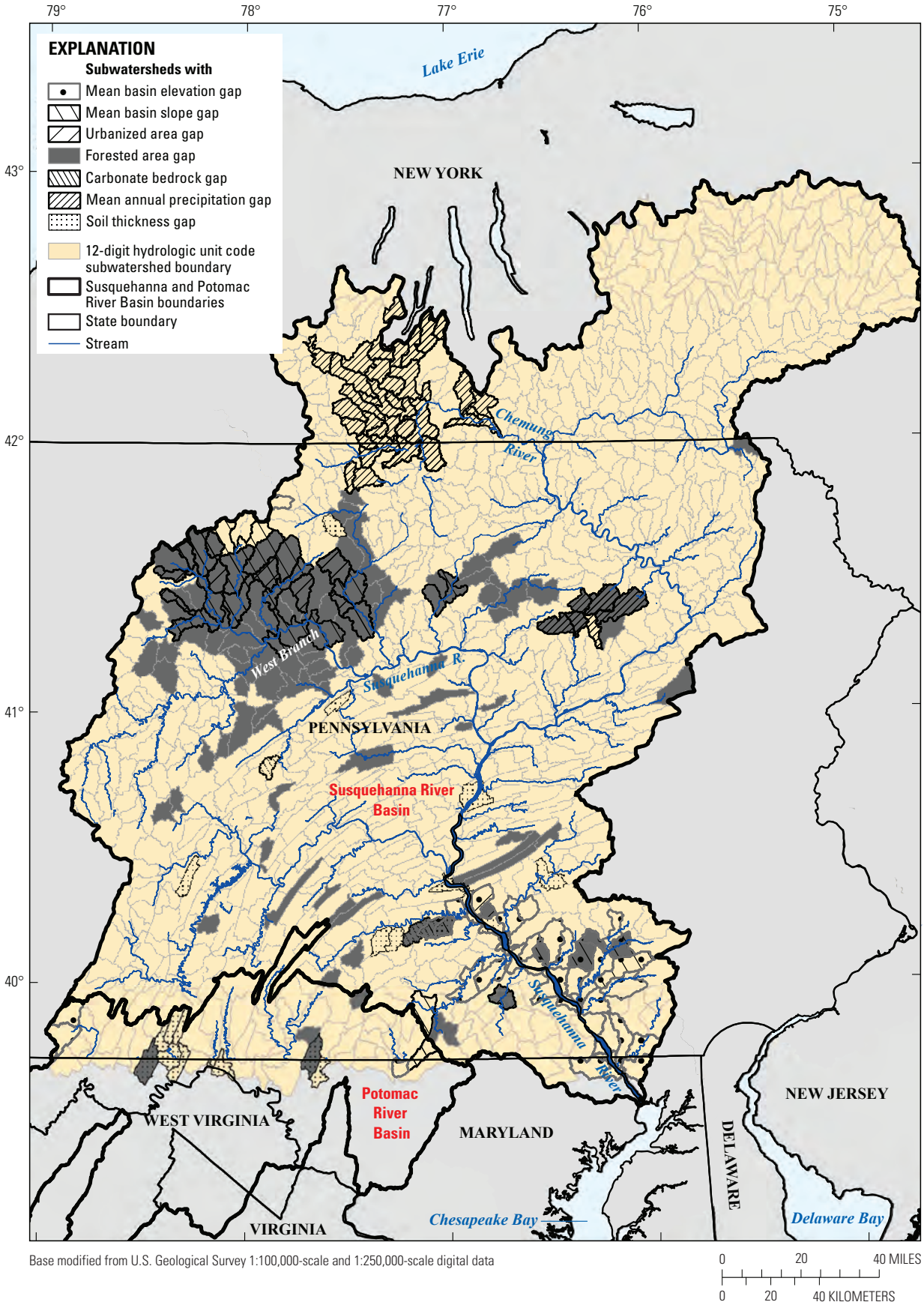

Figure 4. Basin characteristic gaps in the Susquehanna River Basin.

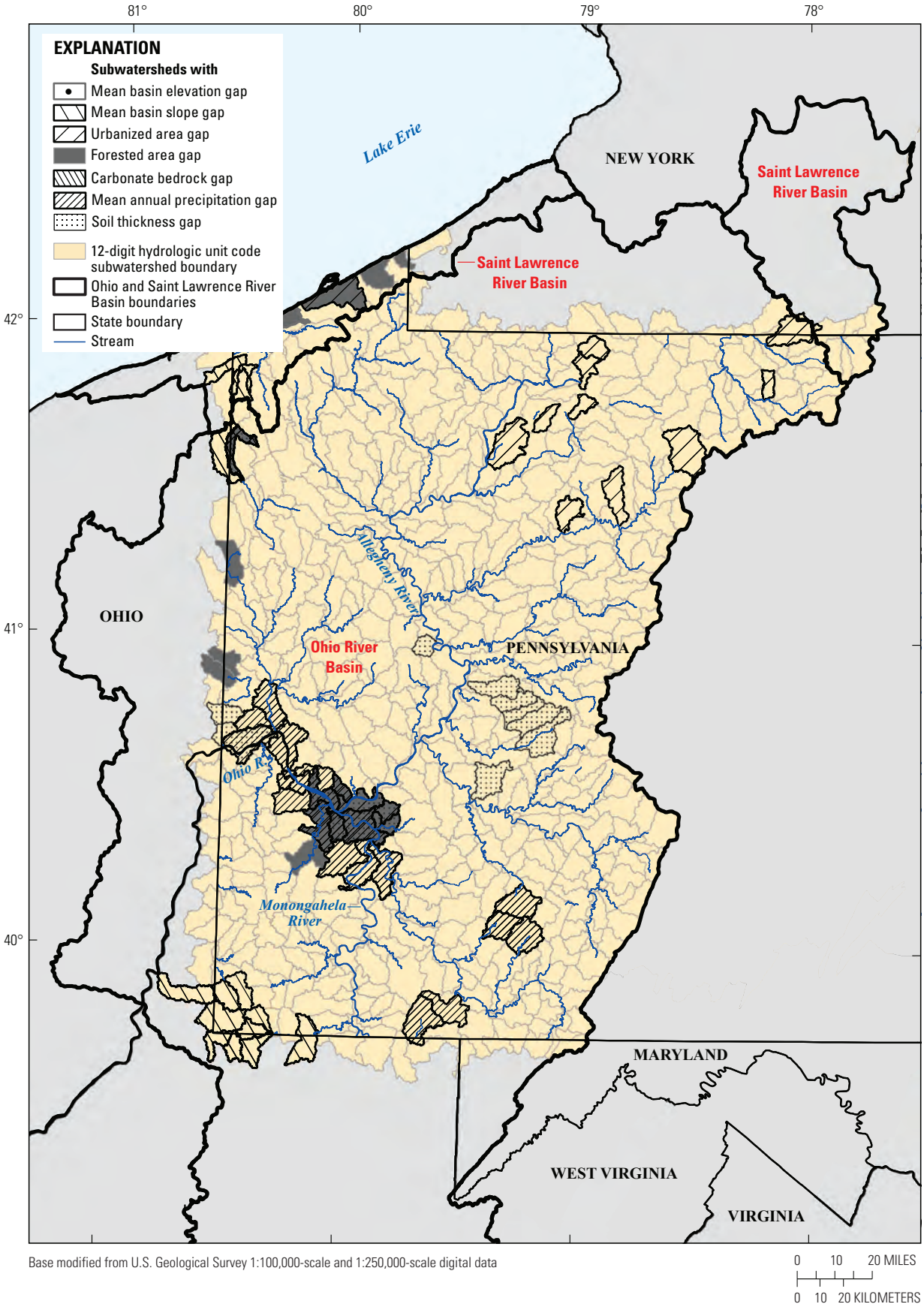

Figure 5. Basin characteristic gaps in the Ohio River Basin.

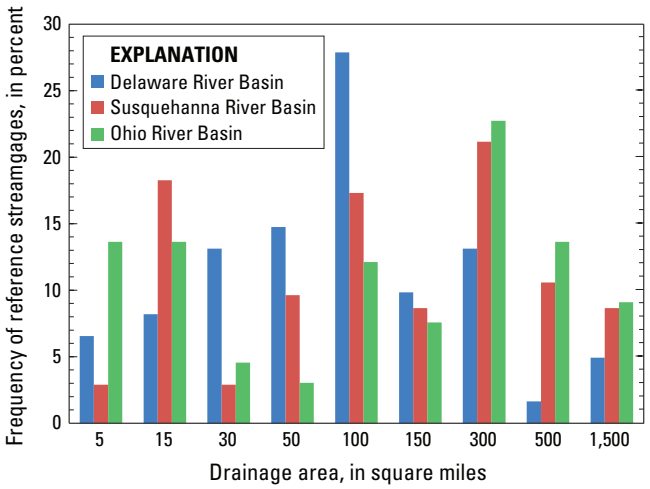

Figure 6. Drainage area of reference streamgages in the Delaware River, Susquehanna River, and Ohio River Basins.

reference streamgage watersheds within the Ohio and Saint Lawrence River Basins (fig. 5). The watersheds are present in the southwestern corner of the State and are characterized by high mean basin slope. In the Saint Lawrence River Basin, watersheds are characterized by low mean basin slope.

Percentage of Urbanized Area

The percentage of urbanized area was determined from the 2006 National Land Cover Dataset (NLCD; Fry and others, 2011). Percentage of urbanized area was determined by summing the four developed land classifications in the NLCD—developed open space, developed low intensity, developed medium intensity, and developed high intensity. Most of Pennsylvania is rural; the mean percentage of urbanized area was 13.4 for the reference streamgage watersheds and 11.4 for the HUC12 subwatersheds (table 3). The percentage of urbanized area exceeded 20 percent in 14.5 percent of the reference streamgage watersheds and 13.5 percent in the HUC12 subwatersheds. The percentage of urbanized area for the reference streamgage watersheds ranged from 0.36 to 90.1. A comparison of urbanized area between the reference streamgage and HUC12 subwatersheds (fig. 7C) shows that 98 percent of the urbanized area found within the HUC12 subwatersheds is within the range representing the reference streamgage watersheds. The distribution of percentage of urbanized area is greatest towards the lower end of the range (fig. 8C).

Within the Delaware River Basin, there are four HUC12 subwatersheds with percentage of urbanized area outside the range for the reference streamgage watersheds within the Delaware River Basin (fig. 3). The watersheds are in the northeastern part of the basin characterized by low percentages of urbanized area and in the Philadelphia area characterized by high percentages of urbanized area. Within the Susquehanna and Potomac River Basins, there are 10 HUC12 subwatersheds with percentage of urbanized area outside the range for reference streamgage watersheds within the Susquehanna and Potomac River Basins, which are mostly within the heavily forested headwaters of the West Branch Susquehanna River (fig. 4). Some HUC12 subwatersheds are outside the upper range of percentage of urbanized area in the cities of Harrisburg and York, Pa, in the south-central part of the Susquehanna River Basin. Within the Ohio and Saint Lawrence River Basins, there are 19 HUC12 subwatersheds with percentage of urbanized area outside the range for reference streamgage watersheds within the Ohio and Saint Lawrence River Basins (fig. 5). Most of these watersheds are in the headwaters of the Allegheny River and have low percentages of urbanized area. In the greater Pittsburgh area and Erie, Pa., HUC12 subwatersheds have high percentages of urbanized area.

Percentage of Forested Area

The percentage of forested area was determined from the 2006 NLCD (Fry and others, 2011). Percentage of forested area was determined by summing the three forest land classifications in the NLCD—deciduous forest, evergreen forest, and mixed forest. The percentage of forested area for the reference streamgage watersheds ranged from 8.25 to 98.8. The percentage of forested area for the HUC12 subwatersheds ranged from 1 to 98.8 percent (table 3). A comparison of percentage of forested area between the reference streamgage and HUC12 subwatersheds (fig. 7D) shows that 91 percent of the forested area found within the HUC12 subwatersheds is within the range for the reference streamgage watersheds. The distribution of percentage of forested area is skewed towards the upper end of the range (fig. 8D). The overall distribution of percentage of forested area observed within the HUC12 subwatersheds and the reference streamgage watersheds is similar, although differences can be seen throughout the plot (fig. 8D). There are no reference streamgage watersheds with percentage of forested area less than 8, and the reference streamgage density in forested areas is less than that within the HUC12 subwatersheds, in the range of 40–50 percent forested area.

Within the Delaware River Basin, there are 13 HUC12 subwatersheds with percentage of forested area outside the lower range for reference streamgage watersheds within the Delaware River Basin. These watersheds are mostly near the cities of Allentown, Pa., in the central part of the basin and Philadelphia, Pa., in the southeast. Within the Susquehanna and Potomac River Basins, there are 115 HUC12 subwatersheds with percentage of forested area outside the range for the reference streamgage watersheds within the Susquehanna and Potomac River Basins. Most of these watersheds are within the highly forested area in the headwaters of West Branch Susquehanna River in the north-central part of the

Table 3. Summary statistics for basin characteristics in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.

[HUC, hydrologic unit code; Min, minimum; Max, maximum]

Basin characteristic	Entire study area			Delaware River Basin			Susquehanna and Potomac River Basins			Ohio and Saint Lawrence River Basins		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Drainage area (square miles)												
Reference streamgage watersheds	1.80	185	1,485	2.19	131.8	1,226	1.80	210	1,485	2.28	196	1,428
12-digit HUC subwatersheds	2.87	32.7	74.1	4.81	31.02	69.55	2.87	32.0	72.7	5.82	34.8	74.1
Mean basin elevation (feet)												
Reference streamgage watersheds	34.9	393	818	34.9	259	576	145	421	669	250	471	818
12-digit HUC subwatersheds	5.49	386	779	5.49	235	573	71.3	390	685	213	449	779
Mean basin slope (degrees)												
Reference streamgage watersheds	1.40	7.16	16.1	1.76	5.26	9.30	2.66	8.35	15.1	1.40	6.99	16.1
12-digit HUC subwatersheds	0.14	7.72	19.3	1.26	5.43	10.5	2.27	8.21	19.3	0.14	7.88	19.3
Percentage of urbanized area												
Reference streamgage watersheds	0.36	13.4	90.1	2.00	25.8	90.1	0.36	8.57	63.1	0.98	9.77	63.9
12-digit HUC subwatersheds	0.05	11.4	91.5	0.05	23.9	91.5	0.07	8.31	85.0	0.45	11.4	90.2
Percentage of forested area												
Reference streamgage watersheds	8.25	58.0	98.8	8.25	44.1	97.8	8.83	63.1	97.0	32.3	62.6	98.8
12-digit HUC subwatersheds	1.00	59.1	98.8	1.08	46.9	92.6	2.99	60.2	98.8	1.00	62.9	97.0
Percentage of carbonate bedrock												
Reference streamgage watersheds	0	7.11	99.0	0	7.31	83.2	0	11.3	99.0	0	0.00	0.03
12-digit HUC subwatersheds	0	5.74	100	0	9.39	100	0	7.98	100	0	0.02	4.82
Mean annual precipitation (inches)												
Reference streamgage watersheds	35.8	44.5	57.2	42.6	47.8	57.2	35.8	42.6	49.9	38.3	44.4	49.9
12-digit HUC subwatersheds	33.0	43.2	56.2	43.6	47.5	56.2	33.0	42.0	52.2	37.1	43.5	52.1
Soil thickness (inches)												
Reference streamgage watersheds	39.9	55.9	81.9	39.9	55.3	62.5	41.4	55.1	67.8	42.2	58.0	81.9
12-digit HUC subwatersheds	29.5	55.3	81.1	39.9	55.1	65.9	36.8	54.5	68.5	5.59	56.9	81.1

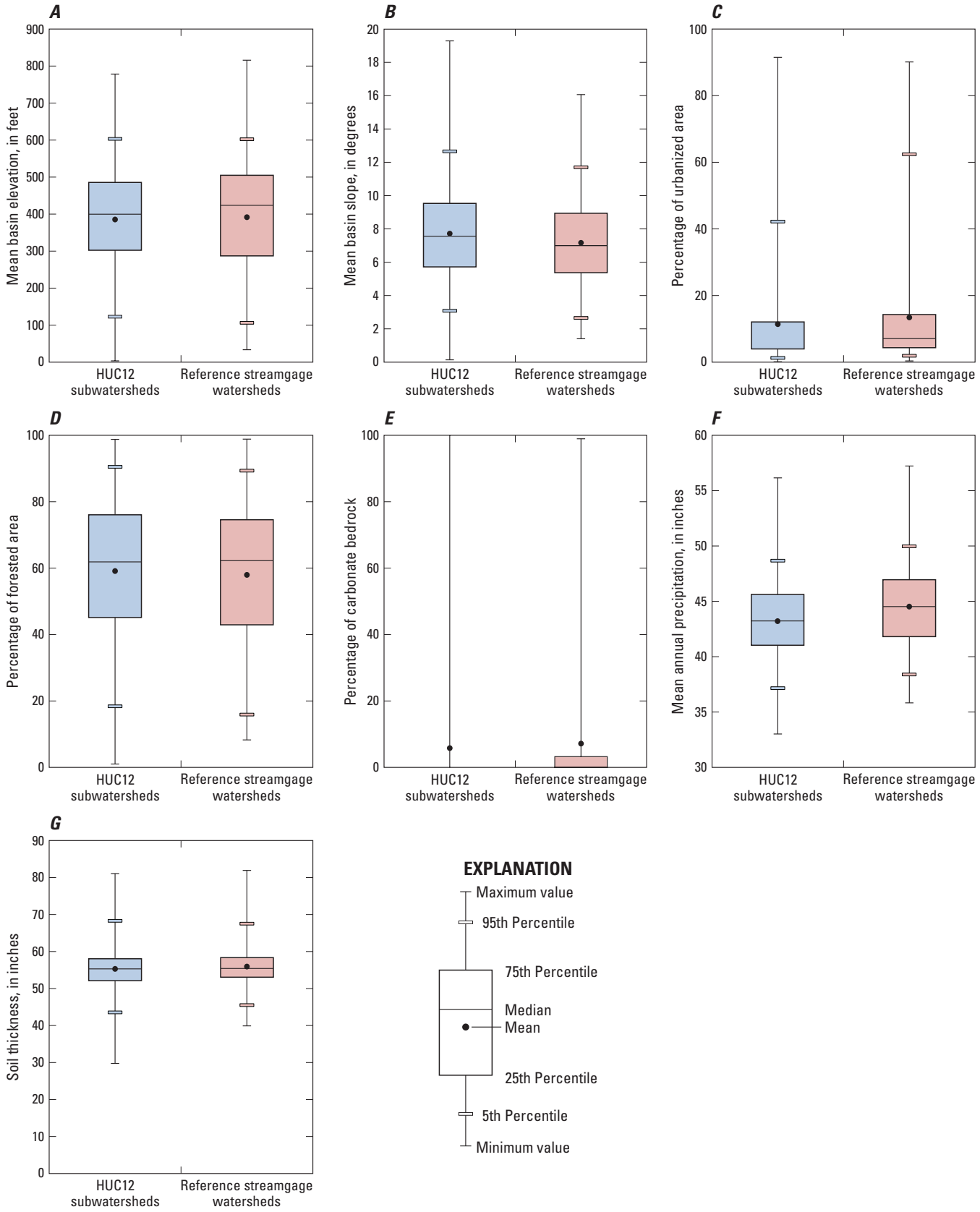

Figure 7. Box plots showing the distribution of *A*, mean basin elevation, *B*, mean basin slope, *C*, percentage of urbanized area, *D*, percentage of forested area, *E*, percentage of carbonate rock, *F*, mean annual precipitation, and *G*, soil thickness for reference streamgage and 12-digit hydrologic unit code subwatersheds in Pennsylvania and New York.

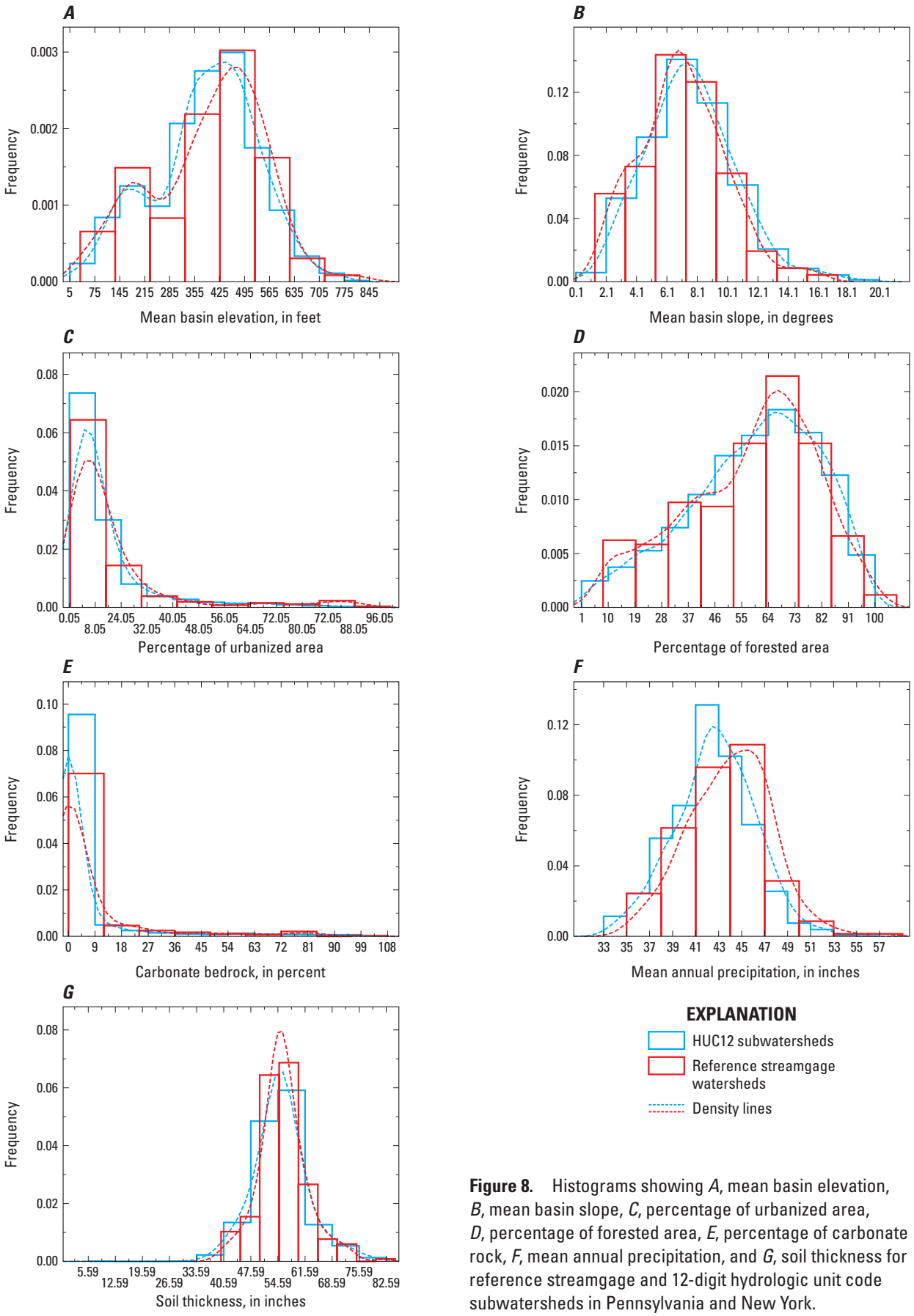

Figure 8. Histograms showing *A*, mean basin elevation, *B*, mean basin slope, *C*, percentage of urbanized area, *D*, percentage of forested area, *E*, percentage of carbonate rock, *F*, mean annual precipitation, and *G*, soil thickness for reference streamgage and 12-digit hydrologic unit code subwatersheds in Pennsylvania and New York.

State. The remaining watersheds are scattered throughout the lower Susquehanna Basin and Potomac Basin. Within the Ohio and Saint Lawrence River Basins, there are 16 HUC12 subwatersheds with percentage of forested area outside the range for the reference streamgage watersheds within the Ohio and Saint Lawrence River Basins. These HUC12 subwatersheds are generally in the greater Pittsburgh, Pa., area and the Saint Lawrence River Basin.

Percentage of Carbonate Bedrock

The percentage of each basin underlain by carbonate rock was computed using geologic maps (table 2). The percentages of carbonate rock for the reference streamgage watersheds ranged from 0 to 99. The percentages of carbonate rock for the HUC12 subwatersheds ranged from 0 to 100 (table 3). A comparison of percentage of carbonate bedrock between the reference streamgage and HUC12 subwatersheds (fig. 7E) shows that 99 percent of the carbonate bedrock values found within the HUC12 subwatersheds are within the range for the reference streamgage watersheds. A comparison of percentage of carbonate rock between the reference streamgage and HUC12 subwatersheds (fig. 8E) shows that the distribution is greater towards the low end.

Within the Delaware River Basin, there are 3 HUC12 subwatersheds with percentage of carbonate bedrock outside the range for the reference streamgage watersheds within the Delaware River Basin; all 3 HUC12 subwatersheds are near the mouth of the Lehigh River and headwaters of the Schuylkill River. Within the Susquehanna and Potomac River Basins, there are three HUC12 subwatersheds with percentage of carbonate bedrock outside the range for reference streamgage watersheds within the Susquehanna and Potomac River Basins. These HUC12 subwatersheds are in the central and south-central parts of the State. Within the Ohio and Saint Lawrence River Basins, there are no HUC12 subwatersheds with percentage of carbonate bedrock outside the range for the reference streamgage watersheds within the Ohio and Saint Lawrence River Basins.

Mean Annual Precipitation

Mean annual precipitation was estimated from the Precipitation-Elevation Regressions on Independent Slopes Model (PRISM) (PRISM Group, Oregon State University, 2012). The mean annual precipitation for the reference streamgage watersheds ranged from 35.8 to 57.2 inches per year (in/yr). The mean annual precipitation for the HUC12 subwatersheds ranged from 33.0 to 56.2 in/yr (table 3). Overall, 96 percent of the mean annual precipitation values found within the HUC12 subwatersheds are within the range for the reference streamgage watersheds. A comparison of mean annual precipitation values between the reference streamgage and HUC12 subwatersheds (fig. 7F) shows that the reference streamgage watersheds have higher mean and median values than the HUC12 subwatersheds and do not encompass the lower range of HUC12 subwatershed mean annual precipitation values, which can be seen by the shape of the density lines in figure 8F. The reference streamgage watersheds do not have any mean annual precipitation values less than 35 in/yr
(fig. 8F).

Within the Delaware River Basin, no HUC12 subwatershed has mean annual precipitation outside the range for the reference streamgage watersheds within the Delaware River Basin. Within the Susquehanna and Potomac River Basins, there are 40 HUC12 subwatersheds with mean annual precipitation outside the range for the reference streamgage watersheds within the Susquehanna and Potomac River Basins. Most of these watersheds are in the Chemung River subbasin in New York and northern Pennsylvania; a few are in the northeastern part of the basin. Within the Ohio and Saint Lawrence River Basins, there are 22 HUC12 subwatersheds with mean annual precipitation outside the range for the reference streamgage watersheds within the Ohio and Saint Lawrence River Basins. Most HUC12 subwatersheds are located along the main stem of the Ohio and Monongahela Rivers.

Soil Thickness

Soil thickness was estimated from the state soil geographic (STATSGO) digital dataset (U.S. Department of Agriculture, 1994). The soil thickness for the reference streamgage watersheds ranged from 39.9 to 81.9 in. The soil thickness for the HUC12 subwatersheds ranged from 29.5 to 81.1 inches (in; table 3). A comparison of soil thickness between the reference streamgage and HUC12 subwatersheds (fig. 7G) shows that 97 percent of the mean soil thickness within the HUC12 subwatersheds is within the range for the reference streamgage watersheds. Although the mean and median soil thicknesses for the reference streamgage and HUC12 subwatersheds are very similar, the range of soil thickness values determined for the reference streamgage watersheds do not encompass the lower range of HUC12 subwatershed soil thickness values (figs. 7G and 8G).

Within the Delaware River Basin, there are 19 HUC12 subwatersheds with soil thickness outside the range for the Delaware River Basin reference streamgage watersheds. The HUC12 subwatersheds are mostly in small groups throughout the basin. Within the Susquehanna and Potomac River Basins, there are 19 HUC12 subwatersheds with soil thickness outside the range for the reference streamgage watersheds within the Susquehanna and Potomac River Basins. These watersheds are scattered throughout the Susquehanna Basin and the Potomac Basin. Within the Ohio and Saint Lawrence River Basins, there are 17 HUC12 subwatersheds with soil thickness outside the range for the reference streamgage watersheds within the Ohio and Saint Lawrence River Basins. Most of these watersheds are in the proximity of Pittsburgh, Pa., and in the central part of the basin.

Identification of Geographic Gaps

A GIS spatial analysis was used to identify geographic gaps in the reference streamgage network. For each streamgage, a watershed area, defined as the gage statistical area (GSA), was delineated. The GSA shows the watershed area applicable for transfer of streamflow statistics from the streamgage to an ungaged site, defined as the valid statistical reach (VSR) of the GSA for a streamgage (fig. 9). The VSR is defined by the proximity to the streamgage. Flow statistics at the streamgage can be considered transferrable to any point on the VSR, assuming the basin characteristics are similar at the streamgage and ungaged site. The transfer of streamflow statistics from a streamgage to an ungaged site on the VSR is typically done using the drainage-area ratio method.

Drainage-Area Ratio Method

To define the extent of the VSR, an analysis was done to determine the appropriate extent to which statistics could be transferred using the drainage-area ratio method. The drainage-area ratio method assumes that the streamflow at an ungaged site is the same per unit area as that at a nearby, hydrologically similar streamgage. Streamflow statistics are first computed for the streamgage site, then the streamflow statistics are divided by the drainage area to determine streamflow statistic per unit area at the streamgage. This streamflow statistic per unit area value is multiplied by the drainage area at the ungaged site to obtain estimated streamflow statistics for the ungaged site. This method is most commonly applied when the streamgage is on the same stream as the ungaged site

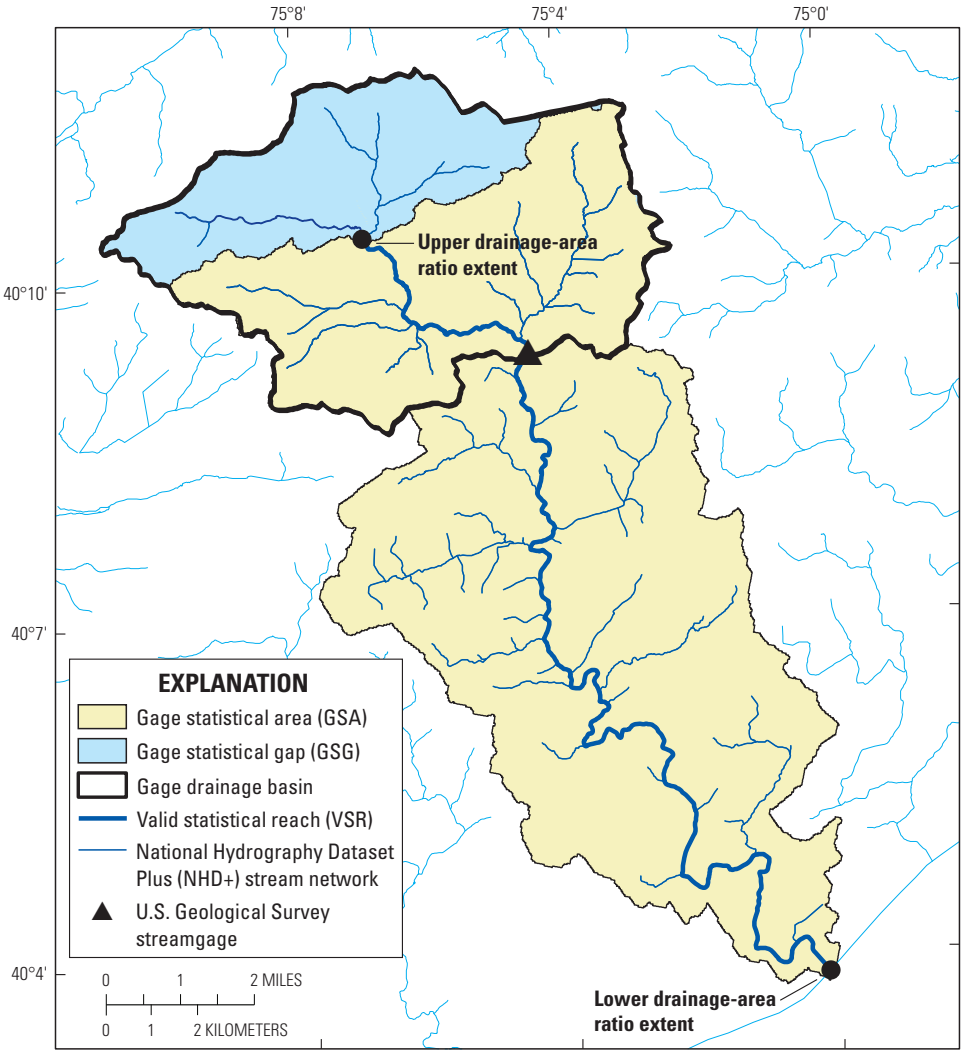

Figure 9. Gage statistical area and valid statistical reach for an example watershed.

because the accuracy of the method depends on the proximity of the two, on similarities in drainage area, and on the basin characteristics of their drainage basins (Ries and Friesz, 2000). Various studies have suggested different drainage-area ratio criteria for applying this method, but the standard ratio has been 0.5 to 1.5 or 2.0 times the drainage area of a streamgage (Choquette, 1988; Bisese, 1995; Ries and Friesz, 2000; Roland and Stuckey, 2008). A ratio in the range of 0.33–3 has been suggested for the transfer of low-flow statistics in Pennsylvania (R.E. Thompson, Jr., U.S. Geological Survey, written commun., 1999).

To determine the extent to which the drainage-area ratio method can be successfully applied upstream and downstream from a streamgage, 51 unique pairs of streamgages in Pennsylvania were evaluated (Appendix 2). Both streamgages in each pair are in the same watershed and have 10 or more years of streamflow data. Some streamgages were used multiple times in different pairs. The drainage areas of streamgages range from 4.78 mi^2 to 1,462 mi^2, with a median of 202 mi^2. Of the 102 streamgages used in the paired datasets, 39 had drainage-area ratios between 0.5 and 1.5, 46 had drainage-area ratios between 0.5 and 2.0, 69 had drainage-area ratios between 0.33 and 3.0, and 33 had drainage-area ratios less than 0.33 and greater than 3.0.

The drainage-area ratio method was used to transfer previously published streamflow statistics (termed "computed") from one gaged site to the other paired gaged site using equation 1 below. The transferred statistics were then compared to the computed statistics for the same streamgage. The period of record used to determine the computed statistics was not necessarily the same for streamgages on the same stream, and a particularly wet or dry period during a short period of record could affect the statistics. The computed statistics used in this analysis include flow duration exceedance probabilities [99-percent exceedance (P99), 95-percent exceedance (P95), 50-percent exceedance (P50), 5-percent exceedance (P5), and 1-percent exceedance (P1)], the 7-day 10-year (7Q10) low flow, and the 1-percent annual exceedance probability flood (commonly referred to as the 100-year flood or Q100); all are found in Stuckey and Roland (2011).

$$Q_{ungaged} = (DA_{ungaged}/DA_{gage})*Q_{gage} \quad (1)$$

where

$Q_{ungaged}$ is the transferred discharge at the ungaged site, in cubic feet per second;
$DA_{ungaged}$ is the drainage area at the ungaged site, in square miles;
DA_{gage} is the drainage area at the gaged site, in square miles; and
Q_{gage} is the discharge at the gaged site, in cubic feet per second.

The transferred and computed statistics were compared graphically and by using the absolute percent difference (Abs; equation 2) and the Wilcoxon signed-rank test (Helsel and Hirsch, 1992), grouped by various ratios.

$$Abs((Q_{comp} - Q_{trans})/Q_{comp})*100 \quad (2)$$

where

Q_{comp} is the computed discharge at the gaged site, in cubic feet per second; and
Q_{trans} is the transferred discharge at the gaged site, in cubic feet per second.

The mean absolute percent differences are shown in table 4, grouped by drainage-area ratios, number of years of record, and drainage area. The complete listing of absolute percent differences is in Appendix 2. The transferred peak flow frequency statistic has the largest overall percent difference, whereas the flow duration exceedances have the lowest overall differences. Peak-flow frequencies are typically a result of a major rain or storm event, which may or may not affect a larger watershed. For most transferred streamflow statistics, the drainage-area ratio 0.33–3.0 performs as well as, if not better than, the more traditional ratios (table 4). Some of the highest percent differences are found in the 0.5–1.5 drainage-area ratio range (Appendix 2). These high percent differences are likely the result of short periods of record and (or) differing drainage basin characteristics, such as carbonate bedrock, that can affect streamflow statistics. The mean absolute percent differences for all the transferred statistics in relation to the drainage-area ratio is shown in figure 10. The ratio range of 0.5–2.0 is shown by the black vertical lines, and the red vertical lines represent the ratio range of 0.33–3.0. Abnormally high absolute percent differences were not introduced by extending the ratio to 0.33–3.0 (fig. 10). Individual plots for each transferred statistic are shown in Appendix 3.

Drainage area and period of record were also evaluated. Both drainage area and period of record appear to play an important role in the success of the drainage-area ratio method. Overall, streamgages with short period of records had the highest absolute percent difference regardless of the drainage-area ratio used to transfer the statistics (table 4). Short periods of record were heavily influenced by individual wet or dry episodes during the period the streamgage was in operation, which may result in higher percent differences of transferred statistics if the other paired streamgage did not have a similar period of record. The mean absolute percent differences for all transferred streamflow statistics were plotted against the period of record at the streamgage, and a smoothed curve using local regression (LOESS) was applied (fig. 11). LOESS is a nonparametric smoothing technique that is a generalization of running means (TIBCO Software Inc., 2008). Streamgages with less than 20 years of record had the highest percent differences, and the percent differences remained relatively constant at streamgages with 40 years or more of record (fig. 11). Streamgages with drainage areas greater than 300 mi^2 had the lowest overall mean absolute percent

Table 4. Mean absolute percent difference between observed and transferred streamflow statistics using the drainage-area ratio method.

[7Q10, 7-day, 10-year low flow; P99, 99-percent duration exceedance; P95, 95-percent duration exceedance; P50, 50-percent duration exceedance; P05, 5-percent duration exceedance; P01, 1-percent duration exceedance; Q100, 1-percent annual exceedance probability flood]

Grouping	Number of streamgages	Mean absolute percent difference of streamflow statistic transferred						
		P99	P95	P50	P05	P01	7Q10	Q100
Drainage-area ratio								
0.5–1.5	39	28.2	23.9	11.8	11.2	16.1	30.2	71.5
0.5–2.0	46	28.0	23.9	13.9	11.6	16.1	29.2	65.5
0.33–3.0	69	28.2	24.7	14.0	10.3	14.6	28.0	58.0
Any	102	35.3	28.4	16.3	11.5	15.4	35.8	53.8
Number of years of record								
10–19	23	44.1	30.9	16.4	10.9	15.5	31.4	73.7
20–30	24	35.2	28.1	19.0	10.0	15.9	42.3	66.8
Greater than 30	55	31.7	27.5	15.1	12.5	15.2	34.3	30.5
Drainage area (square miles)								
Less than 50	14	50.3	24.6	23.4	9.4	13.7	39.6	54.6
50–149	29	42.0	36.4	16.2	14.8	16.7	42.5	48.0
150–300	26	30.0	26.7	13.4	11.8	14.3	33.9	82.1
Greater than 300	33	26.9	23.6	15.7	9.2	15.8	27.8	40.6

difference. As with streamgages with short periods of record, streamgages with small drainage areas can be affected by isolated weather events or unique hydrologic or geologic factors that may not translate well to other streamgages when using the drainage-area ratio method.

A Wilcoxon signed-rank test is a non-parametric test that is used to detect a significant difference between the two paired datasets (Helsel and Hirsch, 1992). A Wilcoxon signed-rank test was conducted to compare the streamflow statistics computed using streamgage data and those transferred from the streamgages within the drainage-area ratio of 0.33–3.0. None of the paired datasets were found to be significantly different at the 95-percent confidence interval.

Transferred statistics were compared graphically to regression equation estimates for the same streamgage to evaluate how the drainage-area ratio method compares to the use of regression equations. Current regression equations were used in this comparison for estimating low-flow frequencies (Stuckey, 2006), peak-flow frequencies (Roland and Stuckey, 2008), and flow-duration exceedances (Stuckey and others, 2012). The absolute percent differences were plotted against the drainage-area ratio for estimates of streamflow determined from regression equations and the drainage-area ratio method. LOESS curves were applied to the datasets to indicate the range of ratios where drainage area method generally performs better than regression equations. The smoothed curves are shown in figure 12, the red line is drawn through the absolute

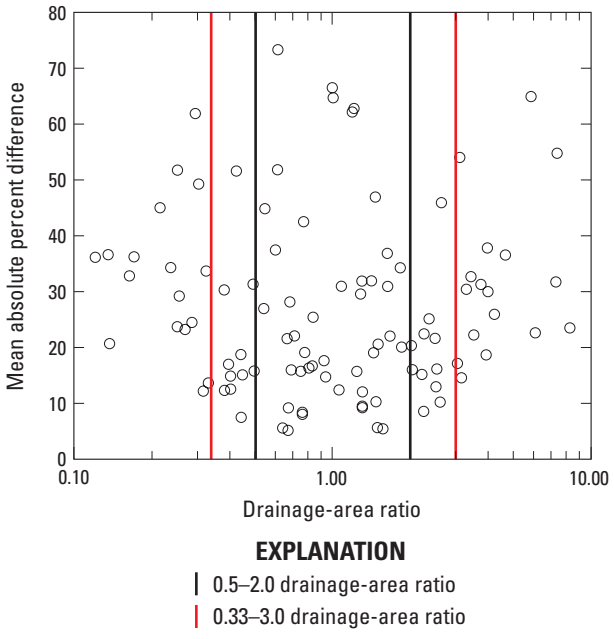

Figure 10. Absolute percent difference between observed and transferred streamflow statistics using the drainage-area ratio method in relation to drainage-area ratio at selected U.S. Geological Survey streamgages in Pennsylvania and New York.

percent differences using the drainage-area ratio method, and the blue line is drawn through the absolute percent differences using regression equations. The points where the red line crosses the blue line indicate where the drainage-area ratio method performs better than regression equations. Individual plots for each of the statistics are in Appendix 4.

Using the mean absolute percent differences for all the streamflow statistics, the drainage-area ratio method generally performs better than regression equations for drainage-area ratios between approximately 0.45 and 3.2 (fig. 12). Although the drainage-area ratio varied depending on the statistic transferred (Appendix 4), generally the low-flow statistics had a larger range of drainage-area ratios that performed better than regression equations than the higher flow statistics. The regression equations performed better than the drainage-area ratio method using all ratios for the Q100, P1, and P5, indicating that the regression equations developed for Pennsylvania may estimate high-flow statistics better than those from a nearby streamgage, regardless of the drainage-area ratio.

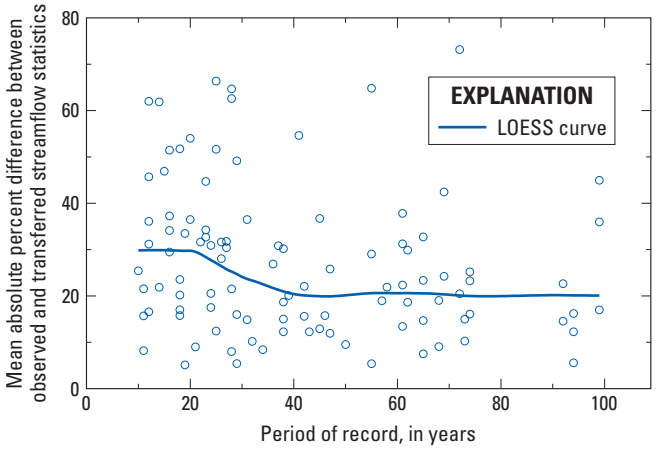

Figure 11. Relation between period of record and absolute percent differences for transferred streamflow statistics at selected U.S. Geological Survey streamgages in Pennsylvania and New York.

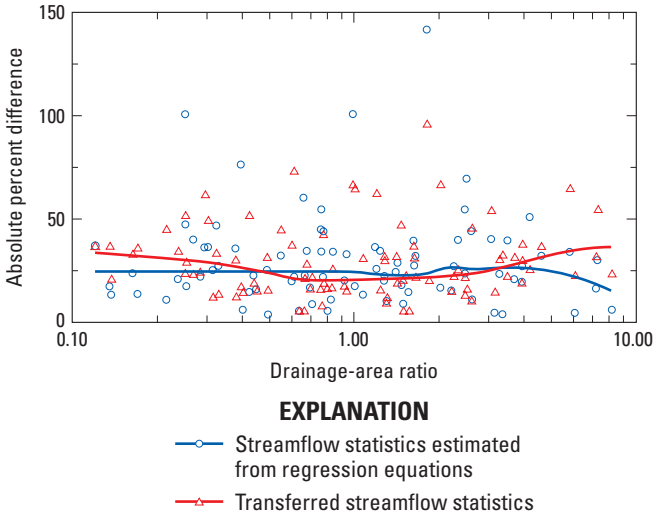

Figure 12. Example relation of drainage-area ratio to absolute percent difference for transferred streamflow statistics and streamflow statistics estimated from regression equations.

For the purposes of this study, the drainage-area ratios of 0.33–3.0 were selected to be used for the identification of potential geographic gaps in the reference streamgage network. For real-world application of the drainage-area ratio method, this analysis indicates that other factors besides drainage area need to be evaluated before use. Other factors to consider are the period of record at the streamgages (40 years or more is preferable), whether or not the period of record contains unusually wet or dry periods, similarity of basin characteristics (particularly geology), and the type of streamflow statistic to be transferred (frequency or flow duration exceedance; low flow or high flow).

Delineation of Gage Statistical Areas

The National Hydrography Dataset Plus (NHD+) and the NHD+ Flow Table Navigator Tool (Horizon Systems, Inc., 2010) were used to identify NHD reaches along the stream network with a cumulative drainage area that corresponds to the drainage-area ratio of 0.33–3.0, defined for this study as the GSA. The stream reach bounded by the most downstream and upstream points on the NHD reaches were considered to be statistically representative of the streamgage. This analysis was limited to basins with drainage areas between 15 and 500 mi^2. For drainage areas less than 15 mi^2, the GSA was considered to be the entire basin because of software limitations and use of a 1:100,000-scale stream dataset. The GSA of watersheds greater than 500 mi^2 encompassed very large and overlapping areas and was, therefore, excluded from the analysis.

The methodology to determine the GSA for a streamgage uses the watersheds created by the 0.33–3.0 drainage-area ratios in combination with the 1:100,000-scale NHD+ version 1 stream dataset, ArcMap version 9.3, and the NHD+ VAA COM Object Navigator Tool (Horizon Systems, Inc., 2014). The VAA COM Object Navigator Tool has the capability to perform upstream navigation from a starting point on a main stem stream and tributaries, as well as downstream navigation on a main stem stream and divergences. For consistency and broad application of determining the GSA, the VSR was identified as having the same stream name as the streamgage location. The VAA COM Object Navigator Tool was used to identify the same named stream along the VSR within the GSA as the reference streamgage.

To verify that the stream name in NHD+ was the same as the streamgage name, the Identify Tool in ArcMap was used. In addition, the uniquely coded reach value was retrieved for the navigation process. A query was developed to extract the VSR for the named stream at the streamgage. On the basis of the stream name in the NHD+ fields, the VSR was selected by extending upstream from the streamgage to the stream segment containing one-third of the drainage area of the streamgage and extending downstream from the stream segment containing three times the drainage area of the streamgage. For many VSR determinations, the cumulative drainage area determined using this methodology did not exactly match the calculated 0.33–3.0 drainage area because of the location of the watersheds intersecting the stream. The watersheds resulting in the cumulative area closest to the calculated 0.33–3.0 drainage area were used. The VSR resulting from the selection process was examined and checked for coding and network errors in the NHD+ stream network.

The GSA drainage network was selected using the VAA COM Object Navigator Tool. The downstream terminus of the VSR was used as the starting point to select the GSA drainage network with the VAA tool, and the network results were joined with the NHD+ catchment watersheds to create the 0.33–3.0 GSA. If a large tributary (greater than about 80 mi^2) enters at a confluence downstream from the streamgage, the entire area of the tributary was excluded from the GSA.

The process used to select the upstream streamgage drainage network is the same as described above, except the starting point is at the upstream terminus of the VSR. For consistency, the following procedure was used to determine the GSA watersheds for the geographic gap analysis. For application of the drainage-area ratio method to transfer streamflow statistics, additional analysis would need to be performed to determine the appropriateness of the reference streamgage in relation to the ungaged site.

1. Determine whether there are current continuous-record streamgages on any of the tributaries. If there are, the upstream GSA extent was stopped at the downstream GSA extent of tributary streamgage. If there are no streamgages, step 2 below was followed.

2. Using the Pennsylvania StreamStats program (Stuckey and Hoffman, 2010), basin characteristics and flow statistics from regression equations were determined for each of the large tributary watersheds and the main stem of the VSR at the streamgage. The basin characteristics, annual mean flow, and cubic feet per square mile (CFSM; equal to the mean annual discharge divided by the drainage area) were determined.

    a. If the basin characteristics or CFSM were substantially different, the upstream GSA extent was stopped at confluence of major tributaries.

    b. If the basin characteristics or CFSM were not substantially different, the upstream GSA extent was extended on both major tributaries to the one-third drainage-area ratio cutoff.

    c. The upstream GSA extent was stopped at the outflow of a large lake or reservoir. It was beyond the scope of the study to determine whether the large lakes and reservoirs were significantly controlling streamflow.

    d. If there was a confluence of major tributaries, the GSA area included the tributary with the larger drainage area.

The result of this selection process is the GSA watershed, which is defined as the total extent of the drainage area for any point located on the VSR. Because the GSA is a watershed based on drainage catchments, there are stream segments within the defined GSA that are not applicable for the transfer of streamflow statistics from a nearby streamgage because the drainage areas for small tributaries are outside the appropriate drainage-area ratio. It was beyond the scope of this study to identify the VSRs within each GSA. The area outside the GSA is defined as the gage statistical gap. This area represents the drainage areas for points on the stream where the flow statistics are not transferrable and represents a geographic gap (fig. 9).

Analysis of Geographic Gaps

The process described in the previous section was applied to all reference streamgages in the study area of less than 500 mi^2. The GSA of watersheds greater than 500 mi^2 encompassed very large and overlapping areas, so those watersheds were excluded from the analysis. All HUC12 subwatersheds with 50 percent or greater of the area within a GSA were considered to be entirely within the GSA. It is important to note, however, that only those stream segments considered to be VSRs, as defined by drainage area, within the GSAs may be applicable for the transfer of streamflow statistics. All HUC12 subwatersheds not included in a streamgage GSA or that had less than 50 percent of the area within a GSA were considered potential geographic gaps in the streamgage network. Overall, 34 percent of the study area is represented by a reference streamgage. Within the major river basins, 38 percent of the Delaware River Basin, 33 percent of the Susquehanna and Potomac River Basins, and 34 percent of the Ohio and Saint Lawrence Basins are represented by a reference streamgage. There were 1,102 HUC12 subwatersheds of the 1,662 HUC12 subwatersheds in the study area outside the GSA (figs. 13–15). Some of these HUC12 subwatersheds may contain reference streamgages, but because the GSA of the streamgage was less than one-half the area of the HUC12 subwatershed, the HUC12 subwatershed was considered to be outside the GSA.

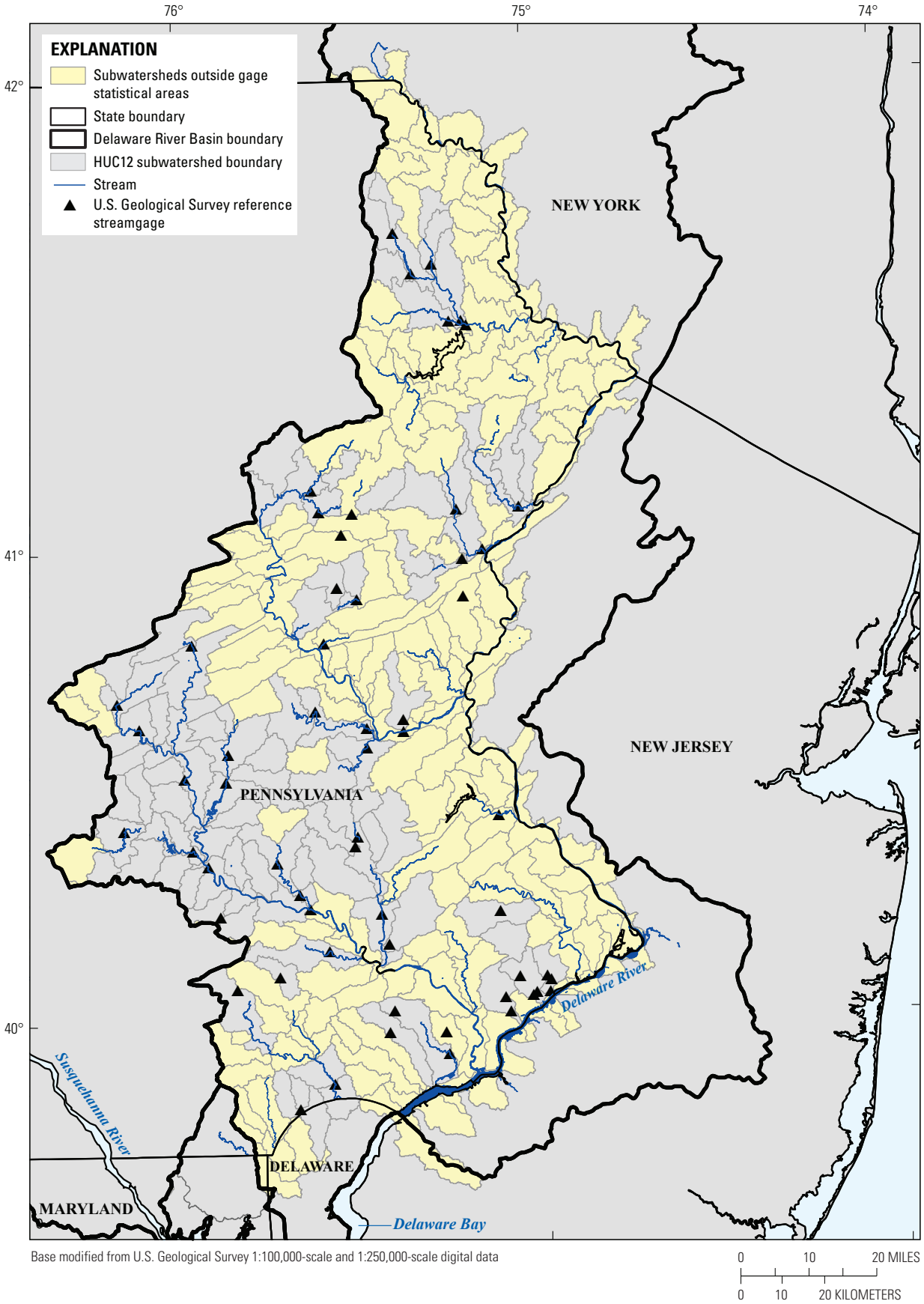

Figure 13. Location of 12-digit hydrologic unit code (HUC12) subwatersheds outside gage statistical areas in the Delaware River Basin.

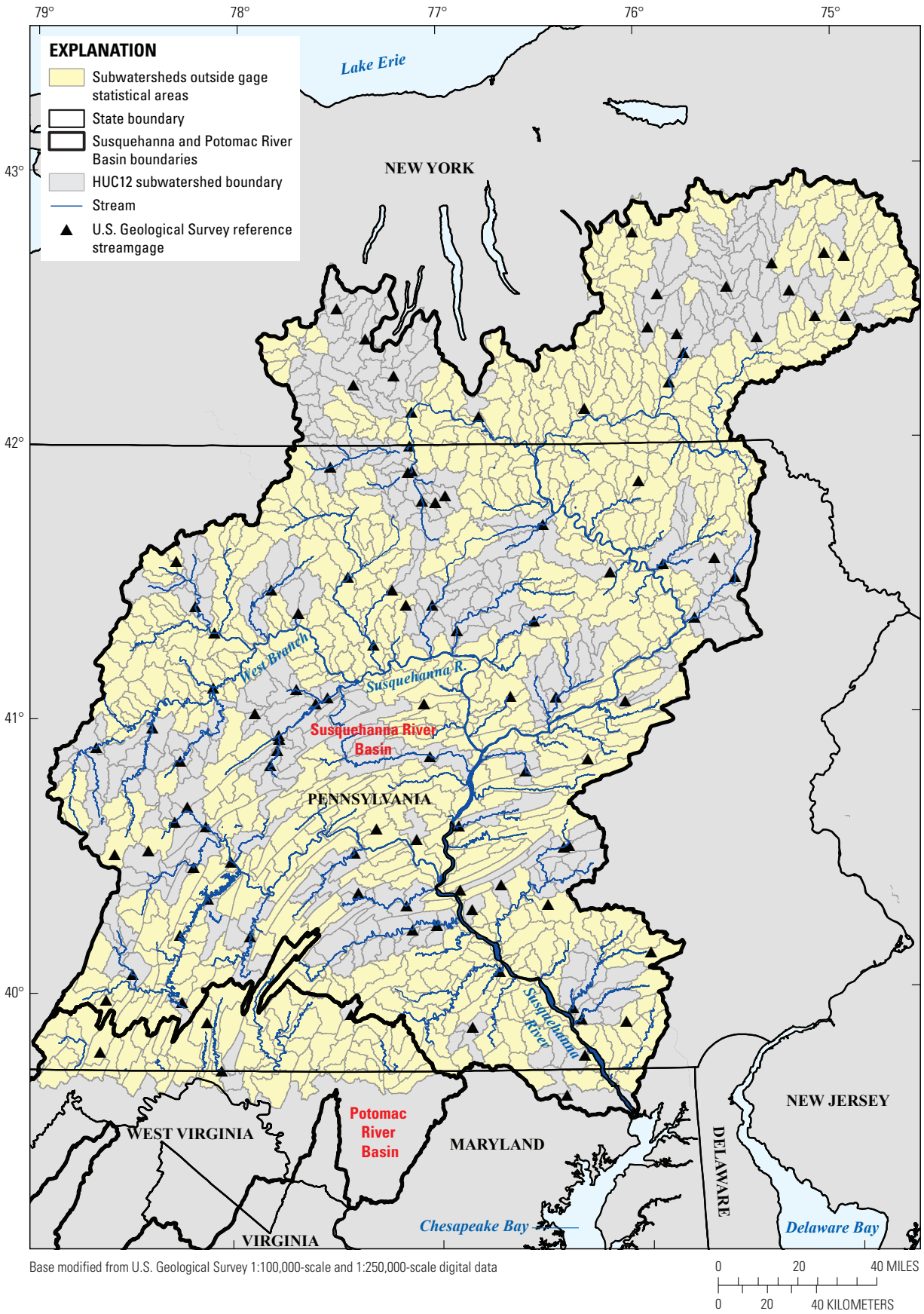

Figure 14. Location of 12-digit hydrologic unit code (HUC12) subwatersheds outside gage statistical areas in the Susquehanna and Potomac River Basins.

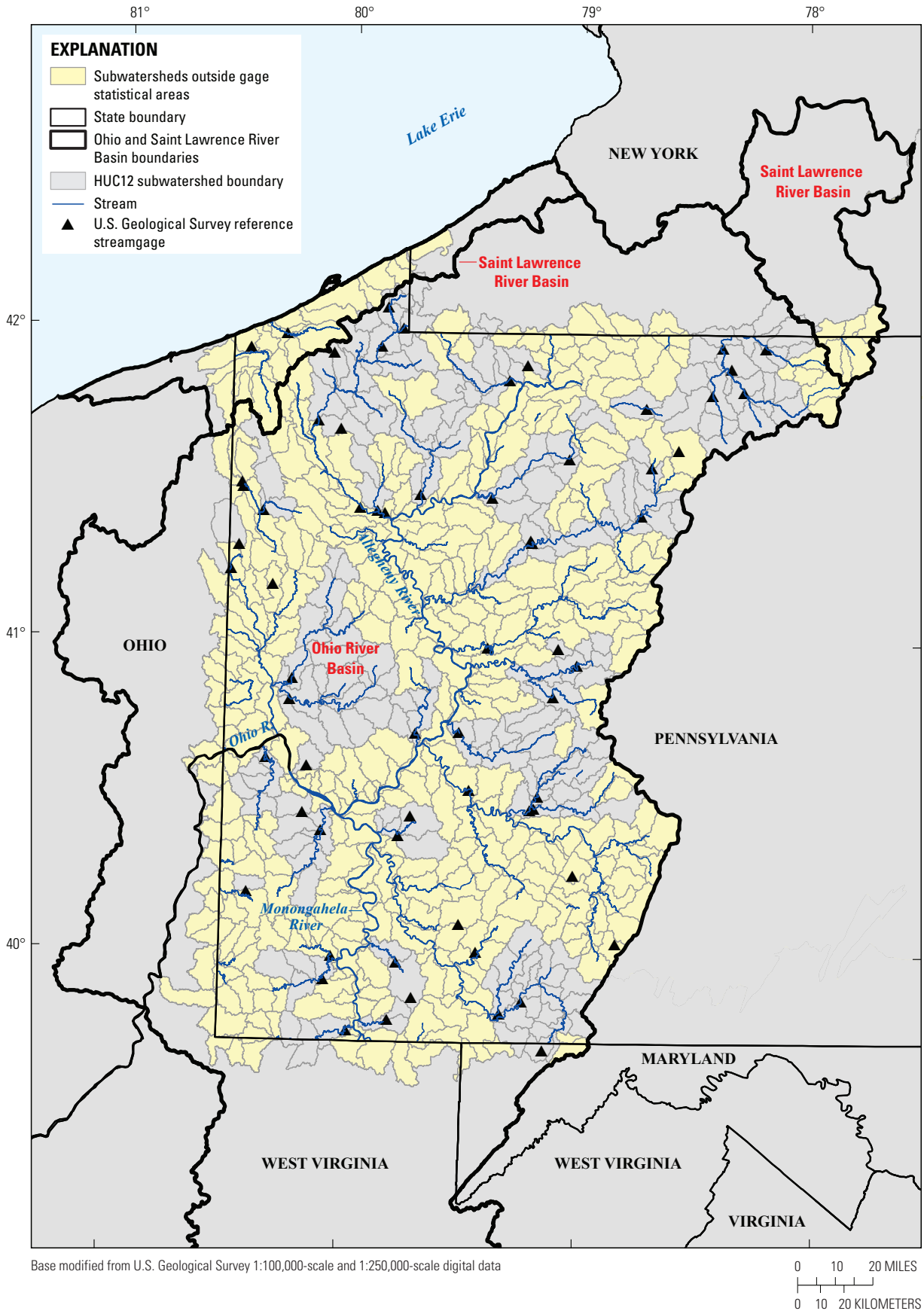

Figure 15. Location of 12-digit hydrologic unit code (HUC12) subwatersheds outside gage statistical areas in the Ohio and Saint Lawrence River Basins.

Estimated Streamflow Correlation of Ungaged Watersheds with Reference Streamgages

The USGS Baseline Streamflow Estimator (BaSE) version 1.1 (Stuckey and others, 2012) was used to determine how well HUC12 subwatersheds in Pennsylvania are represented by the reference streamgage network, based on estimated streamflow correlation. This analysis was done only for Pennsylvania because a similar program was not available for New York at the time of analysis. The BaSE program uses a predetermined set of 168 reference streamgages in Pennsylvania, New York, Ohio, Maryland, and West Virginia, which are listed in Stuckey and others (2012, Appendix 1).

The BaSE program selects a reference streamgage for an ungaged site in Pennsylvania on the basis of geostatistical estimates of streamflow correlation. The BaSE program uses map correlation, an application of ordinary kriging, summarized here from Archfield and Vogel (2010). A spatial model, termed a "variogram," is fit to the correlation values between each streamgage and the other streamgages in the study area, resulting in one spatial model per streamgage. This spatial model is used to estimate the correlation between the streamgage and an ungaged site. When there is more than one potential reference streamgage, the spatial model can be used to discern which reference streamgage results in the highest estimated correlation with the ungaged site.

The centroid of each HUC12 subwatershed was determined using a GIS spatial analysis. The centroid location of each HUC12 subwatershed was entered as an ungaged site into the BaSE program to determine the reference streamgage with the highest estimated correlation with the HUC12 watershed. The BaSE program provided the name of the reference streamgage and the correlation coefficient for the five best estimated correlations.

Overall, the estimated correlation coefficients for the HUC12 subwatersheds in Pennsylvania were relatively high, ranging from 0.8896 to 0.9974. The HUC12 subwatersheds were divided into three groups—those with the lowest estimated streamflow correlation (correlation coefficient less than or equal to 0.92), those with estimated streamflow correlation coefficients greater than 0.92 and less than 0.96, and those with the highest estimated streamflow correlation (correlation coefficient equal to or greater than 0.96). There were 249 HUC12 subwatersheds in the lowest estimated correlation group, 680 watersheds in the middle estimated correlation group, and 518 watersheds in the highest estimated correlation group. The locations of the HUC12 subwatersheds with an estimated correlation less than 0.96 are shown in figures 16–18. In all the major basins, groupings of HUC12 subwatersheds with estimated streamflow correlation less than 0.96 are adjacent to major rivers. This is likely because streamgages with drainage area greater than 1,400 mi^2 were not used to create the correlation maps in BaSE. Because these streamgages with large drainage areas were excluded from the map correlation process, there were no correlations for the vicinity of the streamgage, resulting in lowered estimated correlation. HUC12 subwatersheds with estimated streamflow correlations less than 0.96 are scattered throughout the basins in headwater watersheds.

Reference Streamgage Network Gaps

The results from the basin characteristic, geographic, and estimated streamflow correlation analyses presented above were combined to identify HUC12 subwatersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York that lack a representative reference streamgage. Overall, 1,405, or about 84 percent, of the 1,662 HUC12 subwatersheds had at least one basin characteristic, geographic, or correlation gap. A total of 668, or 40 percent, of the 1,662 HUC12 subwatersheds had two gaps, and 139, or about 8 percent, of HUC12 subwatersheds had gaps identified by all three analyses (table 5 and Appendix 5). Of the 668 HUC12 subwatersheds exhibiting 2 gaps, 11 are in New York where the analyses were limited to 2; the streamflow correlation analysis was excluded. Those HUC12 subwatersheds in Pennsylvania exhibiting all 3 gaps or 2 gaps for those HUC12 subwatersheds in New York are shown in table 6 and summarized by 8-digit HUC (HUC8) in table 7. The Beaver HUC8 watershed (05030104) has the highest percentage of gaps at 67 percent (table 7). The locations of HUC12 subwatersheds with resulting gaps are shown in figures 19–21.

The Pennsylvania locations of HUC12 subwatersheds with three gaps and HUC12 subwatersheds in the Susquehanna Basin in New York with two gaps are shown in figure 22. Ideally, these watersheds have the highest priority when siting a new streamgage. Although not used in the analysis, current (2015) streamgages with less than 10 years of record are shown on figure 22. Given sufficient period of record, these streamgages could potentially become reference streamgages. One such streamgage is contained within a HUC12 subwatershed with three gaps in the Ohio River Basin. The Potomac River Basin, which historically has had few reference streamgages, had the highest percentage of HUC12 subwatersheds (15 percent) with three gaps (table 5). HUC12 subwatersheds with three gaps are also found in the southwestern corner of Pennsylvania (fig. 22), another area of Pennsylvania that historically has been lacking in reference streamgages. Overall, the Ohio River Basin had the lowest percentage of watersheds (8 percent) with three gaps (table 5).

Streamgages with High Substitution Potential in the Current Network

Streamgages in areas with similar hydrologic characteristics and in close proximity to one another can potentially provide similar information, termed here "streamgages with high substitution potential." Current (2015) streamgages with high substitution potential, regardless of their use as a reference streamgage, were identified using the following method. Streamgages were considered for substitution if (1) the streamflow correlation coefficient was equal to or greater

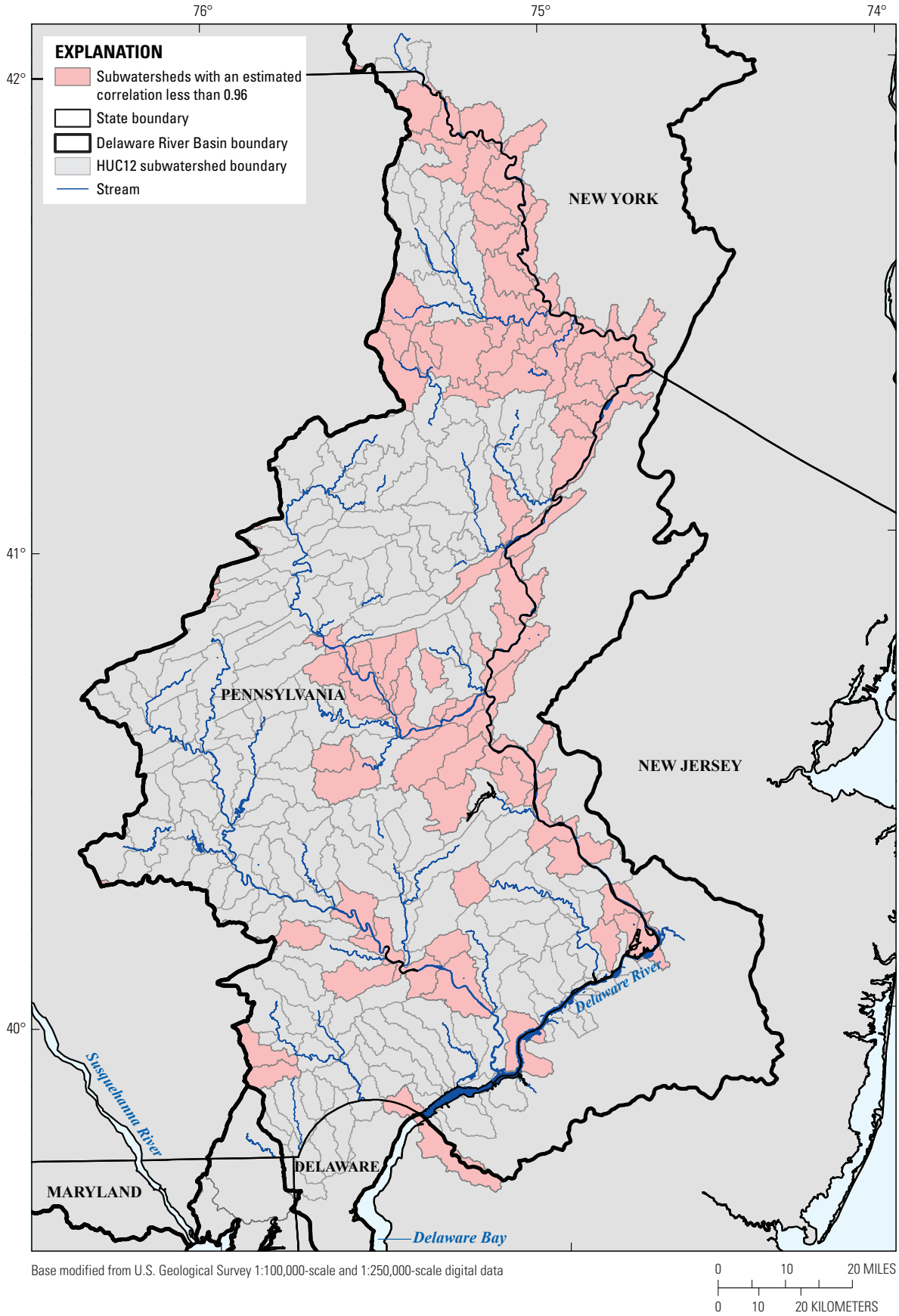

Figure 16. Location of a 12-digit hydrologic unit code (HUC12) subwatershed with an estimated streamflow correlation less than 0.96 in the Delaware River Basin.

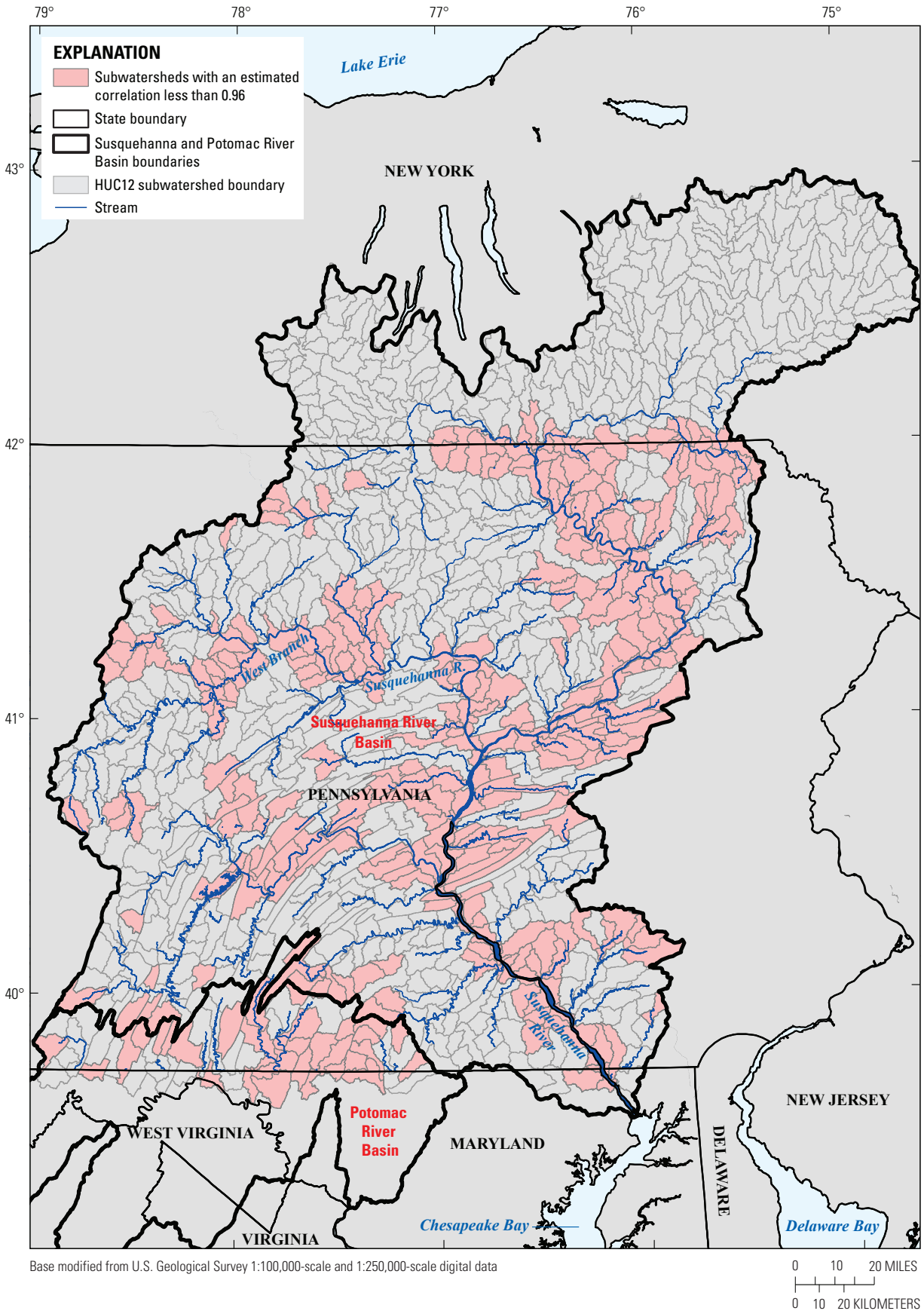

Figure 17. Location of a 12-digit hydrologic unit code (HUC12) subwatershed with an estimated streamflow correlation less than 0.96 in the Susquehanna River Basin.

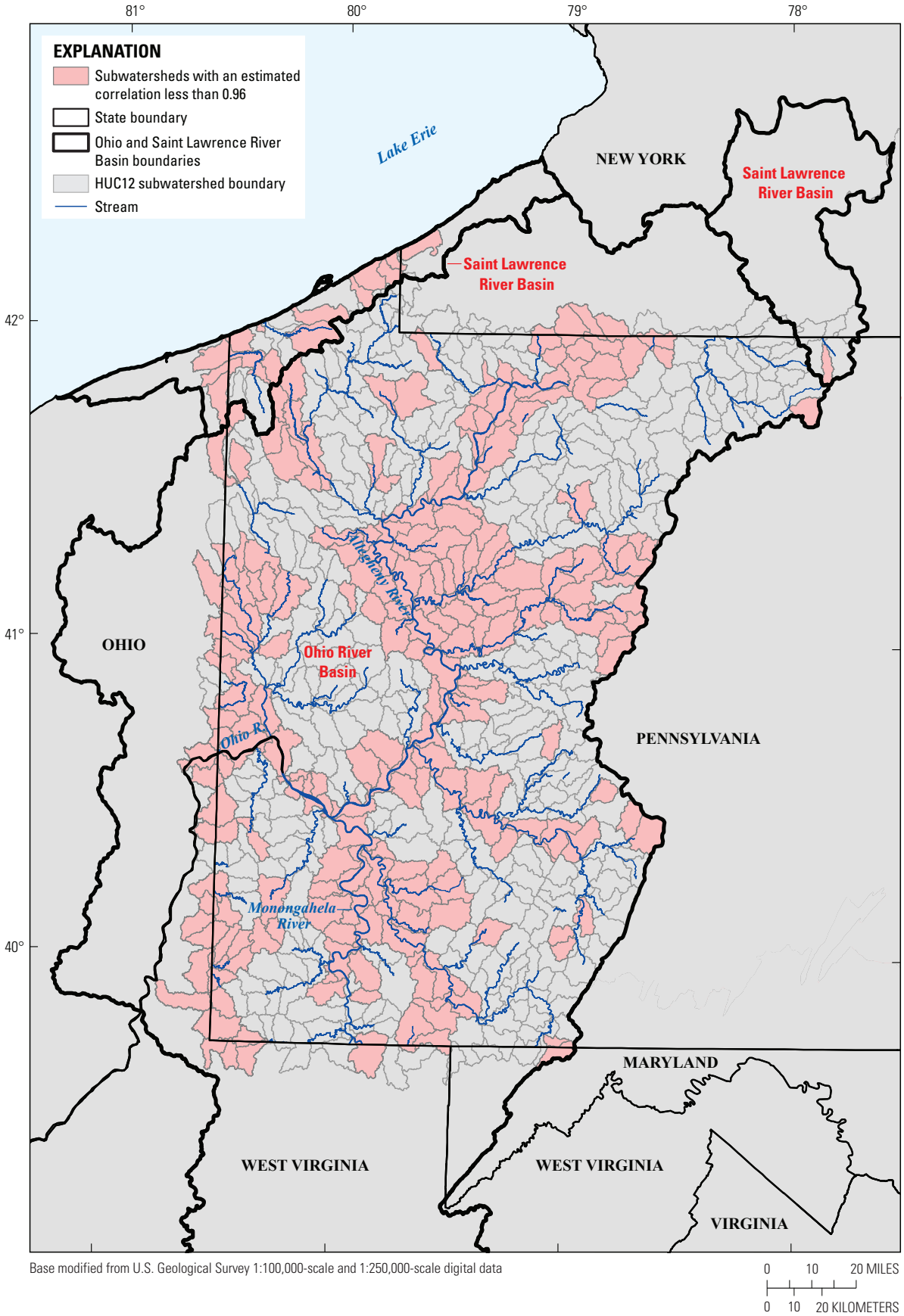

Figure 18. Location of a 12-digit hydrologic unit code (HUC12) subwatershed with an estimated streamflow correlation less than 0.96 in the Ohio River Basin.

Table 5. Summary of basin characteristic, geographic, and correlation gaps, by basin, in Pennsylvania and New York.

[HUC12, 12-digit hydrologic unit code; --, no data]

Basin	Total number of HUC12 subwater-sheds	Basin characteristic gap	Geographic gap	Estimated correlation gap	HUC12 subwater-sheds with 1 gap	HUC12 subwater-sheds with 2 gaps	HUC12 subwater-sheds with 3 gaps
Delaware River Basin	229	48	141	142	75	95	22
Susquehanna River Basin	645	157	430	433	209	305	67
Susquehanna River Basin—New York	215	28	131	--	137	11	--
Potomac River Basin	65	19	62	43	16	39	10
Ohio River Basin	483	60	313	299	153	204	37
Saint Lawrence River Basin	25	8	25	12	8	14	3
Study area total	1,662	320	1,102	929	598	668	139

than 0.96, (2) the streamgages have 10 years of concurrent record, and (3) the streamgages are located in the same watershed within the GSA of the streamgage. A correlation matrix was generated using concurrent daily streamflow data from current continuous record streamgages with greater than 10 years of record. Correlations were based on log-transformed daily streamflow values. Streamgages with a Pearson product-moment correlation coefficient (Pearson, 1896) equal to or greater than 0.96 were considered. On that group of streamgages, a spatial analysis was conducted to identify the streamgages with high streamflow correlation (equal to or greater than 0.96) located in the same watershed and having a drainage-area ratio within the range of 0.33–3.0. Seventy-four streamgages with high substitution potential with at least one other streamgage were identified (table 8). The maximum number of streamgages found to have high substitution potential with a single streamgage is three. These streamgages are listed with more detail in Appendix 6, including the distance between streamgages, drainage-area ratio, and streamflow correlation with the high substitution streamgages.

Although there are many uses of streamgage data, six primary uses that are important to a range of stakeholders and cooperators are shown in table 8. The selected primary uses identified in table 8 are (1) Regulatory/Compliance, as determined from information obtained from PaDEP, SRBC, and Delaware River Basin Commission (2) flood forecast, as determined from information obtained from the National Weather Service; (3) drought monitor, as determined from information obtained from PaDEP; (4) State water-quality network, as determined from information obtained from PaDEP; (5) Reservoir/Lock and Dam operation, as determined from proximity to U.S. Army Corps of Engineers projects; and (6) National Streamflow Information Program (NSIP), as determined from information from the USGS. Many of the streamgages with high substitution potential have specific regulatory and (or) compliance uses for which streamflow data are required to satisfy regulatory, permitting, or pass-by flow requirements. Information on regulatory or compliance uses for streamgages in the Ohio River Basin (streamgage numbers beginning with "03" in table 8) was not readily available and was not included in this analysis. Many of the streamgages on larger streams with high substitution potential are needed for reservoir operations and, in the Ohio Basin, for lock and dam operation. The NSIP program identifies streamgages meeting five Federal goals (interstate and international waters, forecasts, major river outflows, sentinel watersheds, and water quality) (U.S. Geological Survey, 2014g).

Of the 74 streamgages with high substitution potential, 46 have 3 or more selected primary uses, 16 have 2 selected primary uses, 8 have 1 selected primary uses, and 4 have no selected primary use. Of the 8 streamgages with one selected primary use, 6 are used in flood forecasting by the National Weather Service and 2 are used in the State water quality network. Of the four that do not have any selected primary uses, the data provided by these streamgages are likely important to the individual cooperators funding the streamgage.

The streamgages listed in table 8 are highly related to another streamgage and could possibly be used in place of the other. Many of the streamgages listed in table 8 have more than one other streamgage with high substitution potential (example, Swatara Creek at Inwood has a high substitution potential with three other streamgages on the Swatara Creek). Most of the streamgages have specific uses important to a stakeholder and may have been written into specific policy or requirements associated with permits, reservoir operation manuals, forecast models, or other management plans. In these situations, it may be difficult to substitute a streamgage without a lengthy process to alter the policy or requirements currently in place. In other situations, such substitutions may be more feasible, and funding for a streamgage with high substitution potential may be re-allocated to initiate a needed streamgage to fill an identified gap in the network.

Table 6. 12-digit hydrologic unit code (HUC12) subwatersheds with basin characteristic, geographic, and correlation gaps in Pennsylvania and New York.

[HUC12; 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X indicates gap; ---, streamflow correlation gap analysis not available]

HUC12 indentification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020401010403	Factory Creek-Delaware River	DEL	3	X	X	X
020401010406	Pea Brook-Delaware River	DEL	3	X	X	X
020401040401	Upper Shahola Creek	DEL	3	X	X	X
020401040402	Middle Shahola Creek	DEL	3	X	X	X
020401040701	Sawkill Creek	DEL	3	X	X	X
020401040702	Raymondskill Creek	DEL	3	X	X	X
020401041004	Cherry Creek	DEL	3	X	X	X
020401041005	Vancampens Brook-Delaware River	DEL	3	X	X	X
020401050303	Lower Bushkill Creek	DEL	3	X	X	X
020401050605	Lopatcong Creek-Delaware River	DEL	3	X	X	X
020401050911	Buck Creek-Delaware River	DEL	3	X	X	X
020401060310	Mauch Chunk Creek-Lehigh River	DEL	3	X	X	X
020401060502	Aquashicola Creek-Lehigh River	DEL	3	X	X	X
020401060808	Catasauqua Creek	DEL	3	X	X	X
020401060812	Nancy Run	DEL	3	X	X	X
020402010403	Martins Creek	DEL	3	X	X	X
020402010404	Van Sciver Lake-Delaware River	DEL	3	X	X	X
020402010405	Mill Creek-Silver Lake	DEL	3	X	X	X
020402020405	Petty Island-Delaware River	DEL	3	X	X	X
020402020608	Oldmans Creek-Delaware River	DEL	3	X	X	X
020402031004	Little Valley Creek-Valley Creek	DEL	3	X	X	X
020402050201	Sucker Run	DEL	3	X	X	X
020501010302	Elk Creek	SUSQ NY	2	X	X	---
020501040301	South Branch Tuscarora Creek	SUSQ NY	2	X	X	---
020501040302	Upper Tuscarora Creek	SUSQ NY	2	X	X	---
020501040303	North Branch Tuscarora Creek	SUSQ NY	2	X	X	---
020501040304	Middle Tuscarora Creek	SUSQ NY	2	X	X	---
020501040305	Elk Creek	SUSQ NY	2	X	X	---
020501040306	Lower Tuscarora Creek	SUSQ NY	2	X	X	---
020501040908	Mutton Lane Creek-Tioga River	SUSQ	3	X	X	X
020501040909	Glendening Creek	SUSQ NY	2	X	X	---
020501040910	Lower Tioga River	SUSQ	3	X	X	X
020501050403	Sing Sing Creek	SUSQ NY	2	X	X	---
020501050405	Hendy Creek-Chemung River	SUSQ NY	2	X	X	---
020501050508	Coldbrook Creek-Chemung River	SUSQ NY	2	X	X	---
020501060901	Upper Mehoopany Creek	SUSQ	3	X	X	X
020501061302	Upper Bowman Creek	SUSQ	3	X	X	X
020501070401	Little Nescopeck Creek-Nescopeck Creek	SUSQ	3	X	X	X

Table 6. 12-digit hydrologic unit code (HUC12) subwatersheds with basin characteristic, geographic, and correlation gaps in Pennsylvania and New York.—Continued

[HUC12; 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X indicates gap; ---, streamflow correlation gap analysis not available]

HUC12 indentification number	HUC12 name	Basin	Number of gaps	Basin charac-teristic gap	Geo-graphic gap	Streamflow correlation gap
020501070701	East Branch Fishing Creek	SUSQ	3	X	X	X
020502010702	Trout Run	SUSQ	3	X	X	X
020502010710	Sterling Run	SUSQ	3	X	X	X
020502010711	Birch Island Run	SUSQ	3	X	X	X
020502010712	Lower Three Runs-West Branch Susquehanna River	SUSQ	3	X	X	X
020502010713	Burns Run-West Branch Susquehanna River	SUSQ	3	X	X	X
020502020202	Clear Creek	SUSQ	3	X	X	X
020502020303	Laurel Run	SUSQ	3	X	X	X
020502020304	Medix Run	SUSQ	3	X	X	X
020502020308	Dents Run	SUSQ	3	X	X	X
020502020403	Upper First Fork Sinnemahoning Creek	SUSQ	3	X	X	X
020502020404	Freeman Run	SUSQ	3	X	X	X
020502020502	Sinnemahoning Creek-West Branch Susquehanna River	SUSQ	3	X	X	X
020502030201	Cooks Run	SUSQ	3	X	X	X
020502030203	Drury Run	SUSQ	3	X	X	X
020502030205	Hall Run-West Branch Susquehanna River	SUSQ	3	X	X	X
020502030402	Rattlesnake Run-West Branch Susquehanna River	SUSQ	3	X	X	X
020502030403	Clendenin Branch Baker Run	SUSQ	3	X	X	X
020502030404	Baker Run	SUSQ	3	X	X	X
020502030405	North Fork Tangascootack Creek	SUSQ	3	X	X	X
020502030406	Tangascootack Creek	SUSQ	3	X	X	X
020502030407	Lick Run	SUSQ	3	X	X	X
020502030409	Queens Run	SUSQ	3	X	X	X
020502030410	McElhattan Creek	SUSQ	3	X	X	X
020502050201	Ninemile Run	SUSQ	3	X	X	X
020502050505	Otter Run	SUSQ	3	X	X	X
020502050604	Mill Run-Pine Creek	SUSQ	3	X	X	X
020502050605	Trout Run	SUSQ	3	X	X	X
020502050606	Upper Pine Bottom Run-Pine Creek	SUSQ	3	X	X	X
020502061204	Limestone Run-Northumberland County	SUSQ	3	X	X	X
020502061206	Limestone Run-Union County	SUSQ	3	X	X	X
020503010902	Rattling Creek	SUSQ	3	X	X	X
020503011002	Fidlers Run-Susquehanna River	SUSQ	3	X	X	X
020503040102	Mill Creek	SUSQ	3	X	X	X
020503040302	Blacklog Creek	SUSQ	3	X	X	X
020503050201	Rowe Run	SUSQ	3	X	X	X
020503050904	Spring Creek	SUSQ	3	X	X	X
020503050906	Swatara Creek-Susquehanna River	SUSQ	3	X	X	X

Table 6. 12-digit hydrologic unit code (HUC12) subwatersheds with basin characteristic, geographic, and correlation gaps in Pennsylvania and New York.—Continued

[HUC12; 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X indicates gap; ---, streamflow correlation gap analysis not available]

HUC12 indentification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020503051002	Clark Creek	SUSQ	3	X	X	X
020503051006	Cove Creek-Susquehanna River	SUSQ	3	X	X	X
020503051008	Spring Creek	SUSQ	3	X	X	X
020503051011	Laurel Run-Susquehanna River	SUSQ	3	X	X	X
020503060102	Plum Creek-South Branch Conewago Creek	SUSQ	3	X	X	X
020503060203	Swift Run-Conewago Creek	SUSQ	3	X	X	X
020503060402	Lower Little Conewago Creek	SUSQ	3	X	X	X
020503060502	Davidsburg Run-Conewago Creek	SUSQ	3	X	X	X
020503060705	Willis Run-Codorus Creek	SUSQ	3	X	X	X
020503060802	Little Chickies Creek	SUSQ	3	X	X	X
020503060803	Donegal Creek	SUSQ	3	X	X	X
020503060804	Lower Chickies Creek	SUSQ	3	X	X	X
020503060904	Cocalico Creek-Conestoga River	SUSQ	3	X	X	X
020503061104	Middle Conestoga River	SUSQ	3	X	X	X
020503061502	Tweed Creek-Octoraro Creek	SUSQ	3	X	X	X
020503061503	Basin Run-Octoraro Creek	SUSQ	3	X	X	X
020503061701	Conoy Creek	SUSQ	3	X	X	X
020503061702	Hartman Run-Susquehanna River	SUSQ	3	X	X	X
020503061704	Cabin Creek-Susquehanna River	SUSQ	3	X	X	X
020503061706	Green Branch-Susquehanna River	SUSQ	3	X	X	X
020503061709	Fishing Creek-Susquehanna River	SUSQ	3	X	X	X
020503061710	Broad Creek	SUSQ	3	X	X	X
020503061711	Conowingo Creek	SUSQ	3	X	X	X
020503061712	Conowingo Dam-Susquehanna River	SUSQ	3	X	X	X
020600020102	North East Creek	POT	3	X	X	X
020700020501	Brush Creek	POT	3	X	X	X
020700020502	Laurel Run	POT	3	X	X	X
020700030401	East Branch Sideling Hill Creek	POT	3	X	X	X
020700030402	West Branch Sideling Hill Creek	POT	3	X	X	X
020700040504	Ditch Run-Potomac River	POT	3	X	X	X
020700040804	Muddy Run	POT	3	X	X	X
020700041005	West Branch Marsh Run-Marsh Run	POT	3	X	X	X
020700041006	Middle Antietam Creek	POT	3	X	X	X
020700090501	Alloway Creek	POT	3	X	X	X
041100030103	Upper Ashtabula River	STLAW	3	X	X	X
041201010404	Twelvemile Creek-Frontal Lake Erie	STLAW	3	X	X	X
041201010702	Turkey Creek-Frontal Lake Erie	STLAW	3	X	X	X

Table 6. 12-digit hydrologic unit code (HUC12) subwatersheds with basin characteristic, geographic, and correlation gaps in Pennsylvania and New York.—Continued

[HUC12; 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X indicates gap; ---, streamflow correlation gap analysis not available]

HUC12 indentification number	HUC12 name	Basin	Number of gaps	Basin charac-teristic gap	Geo-graphic gap	Streamflow correlation gap
050100011205	Cornplanter Run-Allegheny River	OHIO	3	X	X	X
050100011208	Hodge Run-Allegheny River	OHIO	3	X	X	X
050100030104	East Hickory Creek	OHIO	3	X	X	X
050100061101	Sugar Creek	OHIO	3	X	X	X
050100061103	South Fork Pine Creek	OHIO	3	X	X	X
050100080101	Headwaters Loyalhanna Creek	OHIO	3	X	X	X
050100080201	Blacklegs Creek	OHIO	3	X	X	X
050100090308	Allegheny River-Ohio River	OHIO	3	X	X	X
050200040602	Upper Big Sandy Creek	OHIO	3	X	X	X
050200050102	West Virginia Fork	OHIO	3	X	X	X
050200050103	Pennsylvania Fork-Dunkard Creek	OHIO	3	X	X	X
050200050806	Piney Fork-Peters Creek	OHIO	3	X	X	X
050200050807	Fallen Timber Run-Monongahela River	OHIO	3	X	X	X
050200050808	Streets Run-Monongahela River	OHIO	3	X	X	X
050200060801	Headwaters Indian Creek	OHIO	3	X	X	X
050200060901	Meadow Run	OHIO	3	X	X	X
050200061203	Pollack Run-Youghiogheny River	OHIO	3	X	X	X
050301010301	Sawmill Run	OHIO	3	X	X	X
050301010302	Lowries Run	OHIO	3	X	X	X
050301010303	Kilbuck Run-Ohio River	OHIO	3	X	X	X
050301010305	Little Sewickley Creek	OHIO	3	X	X	X
050301010307	McCabe Run-Ohio River	OHIO	3	X	X	X
050301010309	Crows Run-Ohio River	OHIO	3	X	X	X
050301010310	Sixmile Run-Ohio River	OHIO	3	X	X	X
050301010602	Honey Creek	OHIO	3	X	X	X
050301010608	Brush Run-North Fork Little Beaver Creek	OHIO	3	X	X	X
050301010610	Bieler Run-Little Beaver Creek	OHIO	3	X	X	X
050301020104	Frontal Pymatuning Reservoir	OHIO	3	X	X	X
050301020105	Pymatuning Reservoir	OHIO	3	X	X	X
050301020603	McCullough Run-Shenango River	OHIO	3	X	X	X
050301040102	Brady Run	OHIO	3	X	X	X
050301040103	Beaver River-Ohio River	OHIO	3	X	X	X
050301060502	South Fork Dunkard Fork	OHIO	3	X	X	X
050301060802	Grave Creek	OHIO	3	X	X	X
050301061001	Upper West Virginia Fork Fish Creek	OHIO	3	X	X	X
050301061003	Middle West Virginia Fork Fish Creek	OHIO	3	X	X	X
050301061101	Pennsylvania Fork Fish Creek	OHIO	3	X	X	X

Table 7. Summary of watersheds exhibiting basin characteristic, geographic, and correlation gaps by 8-digit hydrologic unit code (HUC8) in Pennsylvania and New York.

[HUC12, 12-digit hydrologic unit code]

HUC8	Watershed name	Number of HUC12 watersheds with all three gaps[1]	Percent of HUC12 watersheds with all three gaps[1]
02040101	Upper Delaware	2	14
02040104	Middle Delaware-Mongaup-Brodhead	6	21
02040105	Middle Delaware-Musconetcong	3	18
02040106	Lehigh	4	10
02040201	Crosswicks-Neshaminy	3	27
02040202	Lower Delaware	2	12
02040203	Schuylkill	1	2
02040205	Brandywine-Christina	1	5
02050101	Upper Susquehanna	1	1
02050104	Tioga	9	15
02050105	Chemung	3	7
02050106	Upper Susquehanna-Tunkhannock	2	4
02050107	Upper Susquehanna-Lackawanna	2	4
02050201	Upper West Branch Susquehanna	5	11
02050202	Sinnemahoning	7	23
02050203	Middle West Branch Susquehanna	11	44
02050205	Pine	5	16
02050206	Lower West Branch Susquehanna	2	4
02050301	Lower Susquehanna-Penns	2	5
02050304	Lower Juniata	2	5
02050305	Lower Susquehanna-Swatara	7	12
02050306	Lower Susquehanna	20	29
02060002	Chester-Sassafras	1	20
02070002	North Branch Potomac	2	25
02070003	Cacapon-Town	2	22
02070004	Conococheague-Opequon	4	13
02070009	Monocacy	1	9
04110003	Ashtabula-Chagrin	1	50
04120101	Chautauqua-Conneaut	2	12
05010001	Upper Allegheny	2	4
05010003	Middle Allegheny-Tionesta	1	2
05010006	Middle Allegheny-Redbank	2	5
05010008	Kiskiminetas	2	15
05010009	Lower Allegheny	1	7
05020004	Cheat	1	20
05020005	Lower Monongahela	5	12
05020006	Youghiogheny	3	8
05030101	Upper Ohio	10	27
05030102	Shenango	3	12
05030104	Beaver	2	67
05030106	Upper Ohio-Wheeling	5	28

[1] Includes those HUC12 watersheds entirely in New York with 2 gaps.

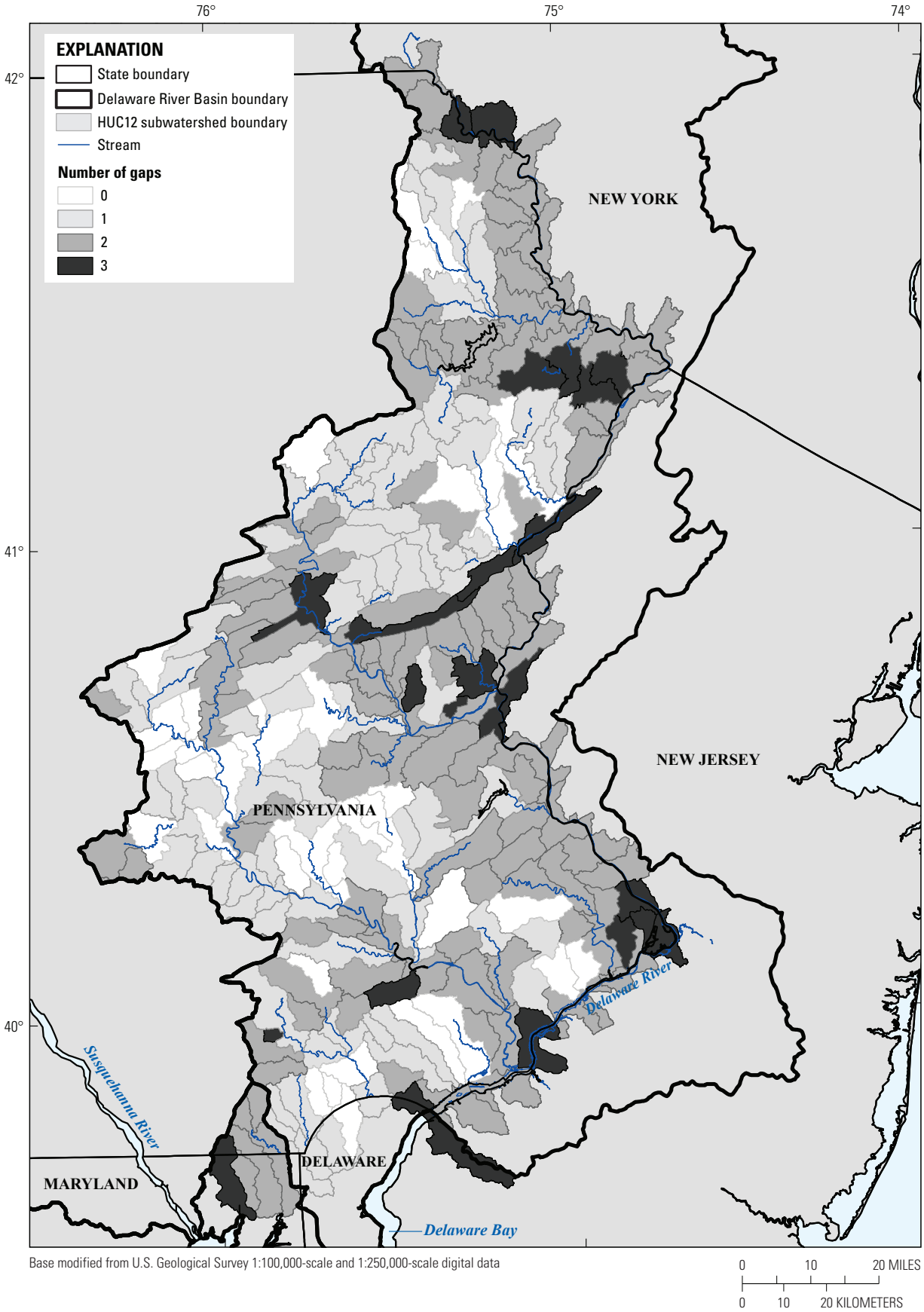

Figure 19. Location of 12-digit hydrologic unit code (HUC12) subwatersheds with basin characteristic, geographic, and correlation gaps in the Delaware River Basin.

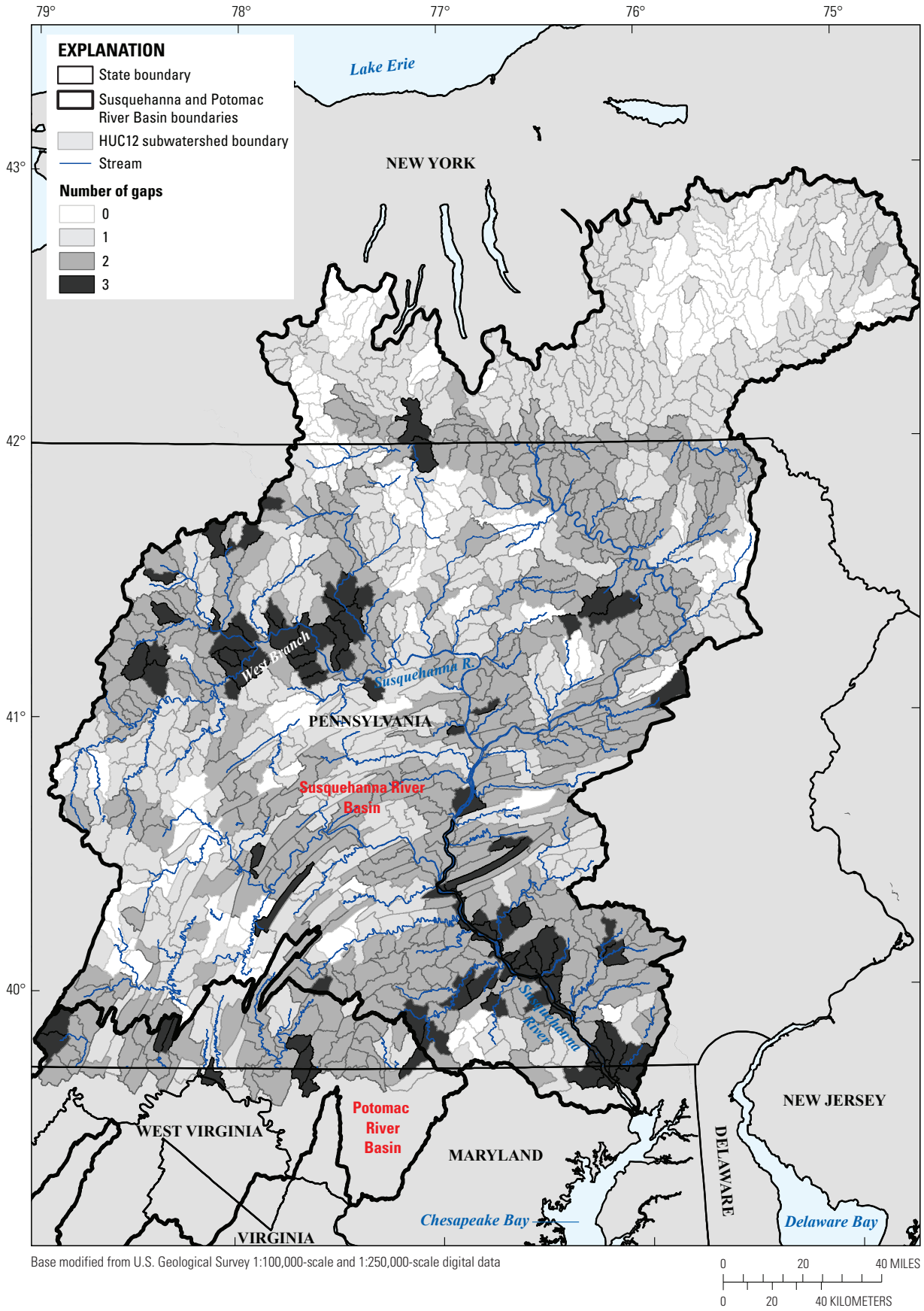

Figure 20. Location of 12-digit hydrologic unit code (HUC12) subwatersheds with basin characteristic, geographic, and correlation gaps in the Susquehanna River Basin.

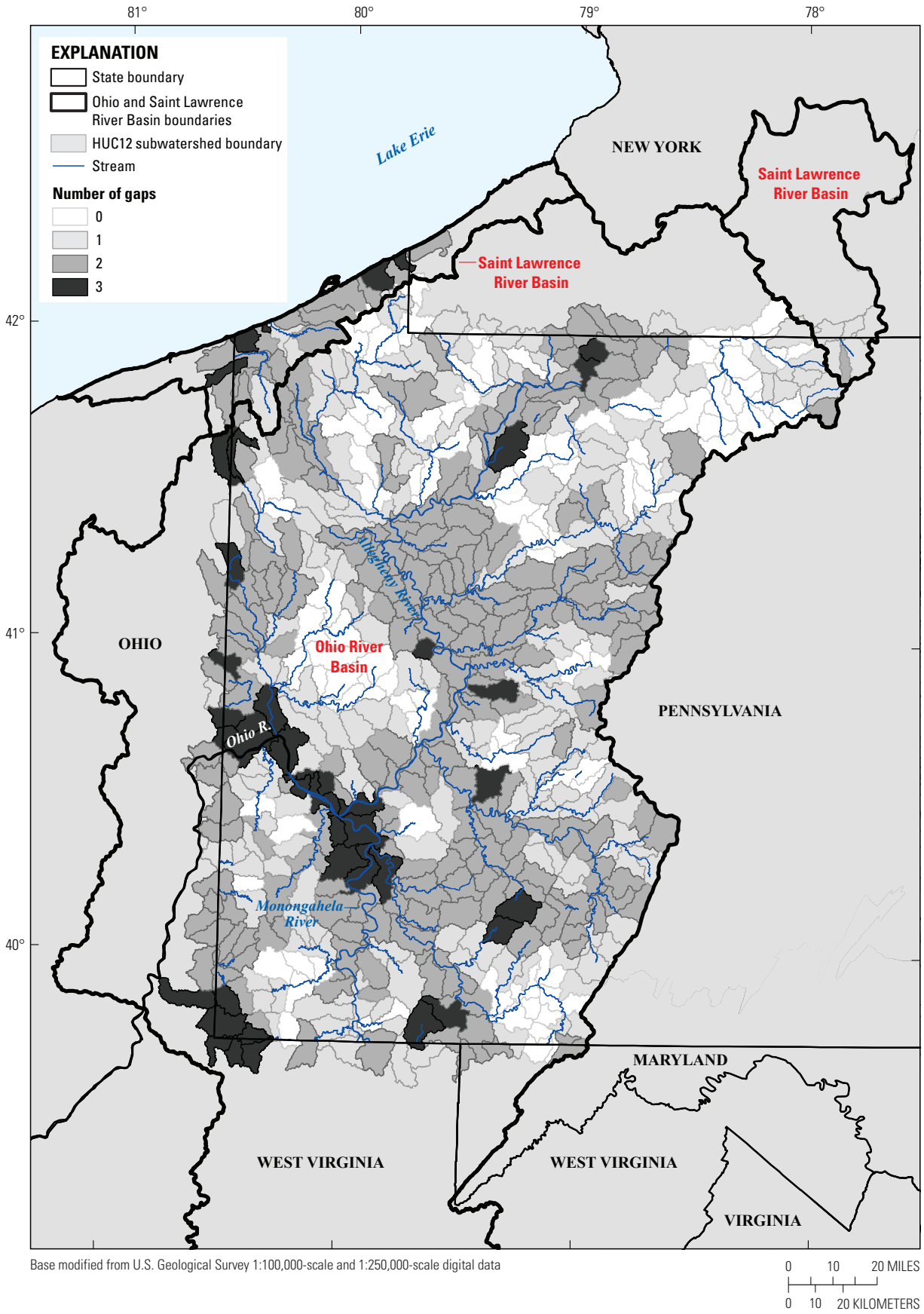

Figure 21. Location of 12-digit hydrologic unit code (HUC12) subwatersheds with basin characteristic, geographic, and correlation gaps in the Ohio River Basin.

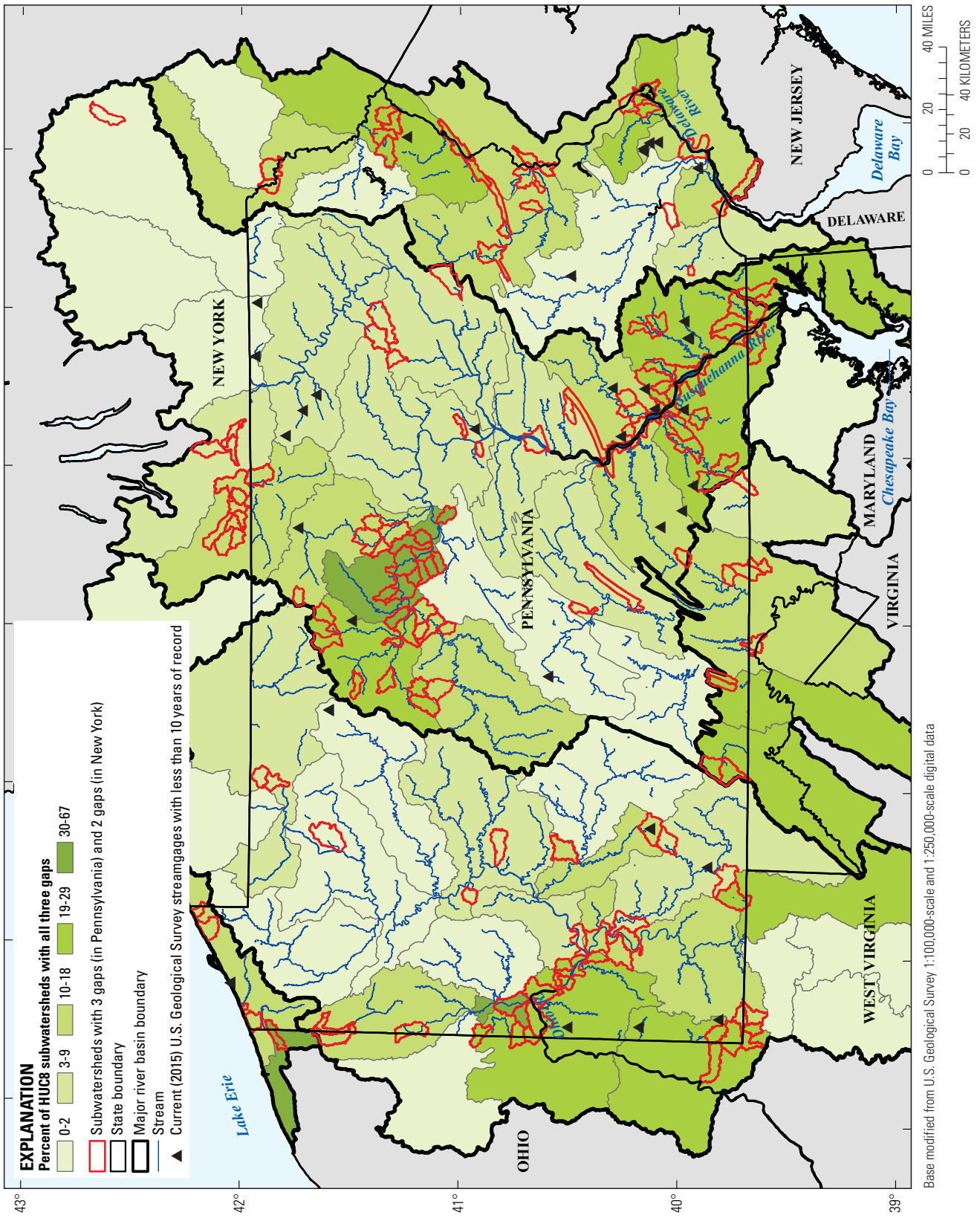

Figure 22. Location of streamgages with less than 10 years of record in Pennsylvania and percent of 8-digit hydrologic unit code (HUC8) subwatersheds containing basin characteristic, geographic, and correlation gaps.

Table 8. U.S. Geological Survey streamgages with high substitution potential in Pennsylvania.

[Y, yes; Streamgages with high substitution potential are those with similar hydrologic characteristics and in close proximity to another streamgage]

Station number	Stream name	Location	Drainage area	Regulated	Streamgages with high substitution potential[1]	Number of identified uses[2]	Regulatory/ compliance	Flood forecast	Drought monitor	State water quality network	Reservoir/lock and dam operation	National Streamflow Information Program
01429000	W. Br. Lackawaxen River	at Prompton	59.7	Y	01430000	2		Y			Y	
01430000	Lackawaxen River	near Honesdale	164	Y	01429000 1431500	2		Y			Y	
01431500	Lackawaxen River	at Hawley	290	Y	01430000	4	Y	Y			Y	Y
01449000	Lehigh River	at Lehighton	591	Y	01451000 01453000	3	Y	Y			Y	
01451000	Lehigh River	at Walnutport	889	Y	01449000 01453000	4		Y		Y	Y	Y
01453000	Lehigh River	at Bethlehem	1,279	Y	0144900 01451000	4	Y	Y			Y	Y
01451500	Little Lehigh Creek	near Allentown	80.8		01451650	2		Y	Y			
01451650	Little Lehigh Creek	at 10th St. at Allentown	98.2		01451500	2		Y				Y
01451800	Jordan Creek	near Schnecksville	53		01452000	0						
01452000	Jordan Creek	at Allentown	75.8		01451800	3		Y		Y		Y
01467042	Pennypack Creek	at Pine Rd., Philadelphia	37.9		01467048	1		Y				
01467048	Pennypack Creek	at Lower Rhawn Street Bridge, Philadelphia	49.8		01467042	2		Y	Y			
01470960	Tulpehocken Creek	at dam near Reading	175	Y	01471000	2		Y			Y	
01471000	Tulpehocken Creek	near Reading	211	Y	01470960	4		Y		Y	Y	Y
01468500	Schuylkill River	at Landingville	133		01470500	3		Y	Y		Y	
01470500	Schuylkill River	at Berne	355		01468500	4		Y		Y	Y	Y
01471510	Schuylkill River	at Reading	880	Y	01472000	3		Y			Y	Y
01472000	Schuylkill River	at Pottstown	1,147	Y	01471510 01474500	5	Y	Y		Y	Y	Y
01473500	Schuylkill River	at Norristown	1,760	Y	01472000 01474500	2		Y				Y
01474500	Schuylkill River	at Philadelphia	1,893	Y	01472000 01473500	3	Y	Y				Y
01473900	Wissahickon Creek	at Fort Washington	40.8		01474000	1				Y		
01474000	Wissahickon Creek	at Philadelphia	64		01473900	1				Y		
01480500	W. Br. Brandywine Creek	at Coatesville	45.8		01480617	1		Y				
01480617	W. Br. Brandywine Creek	at Modena	55		01480500	1		Y				
01480700	E. Br. Brandywine Creek	near Downingtown	60.6	Y	01480870	1		Y				
01480870	E. Br. Brandywine Creek	below Downingtown	89.9	Y	01480700	2		Y				Y
01518000	Tioga River	at Tioga	282	Y	01518700	3		Y			Y	Y
01518700	Tioga River	at Tioga Junction	446	Y	01518000	5	Y	Y		Y	Y	Y
01531500	Susquehanna River	at Towanda	7,797		01533400	2		Y		Y		
01533400	Susquehanna River	at Meshoppen	8,720		01531500 01536500	2	Y	Y				

Table 8. U.S. Geological Survey streamgages with high substitution potential in Pennsylvania.—Continued

[Y, yes; Streamgages with high substitution potential are those with similar hydrologic characteristics and in close proximity to another streamgage]

Station number	Stream name	Location	Drainage area	Regulated	Streamgages with high substitution potential[1]	Number of identified uses[2]	Regulatory/ compliance	Flood forecast	Drought monitor	State water quality network	Reservoir/lock and dam operation	National Streamflow Information Program
01536500	Susquehanna River	at Wilkes-Barre	9,960		01533400	5	Y	Y		Y	Y	Y
01540500	Susquehanna River	at Danville	11,220		01554000	4	Y	Y			Y	Y
01554000	Susquehanna River	at Sunbury	18,300		01540500	3		Y			Y	Y
01570500	Susquehannah River	at Harrisburg	24,100		01576000	4	Y	Y		Y		Y
01576000	Susquehanna River	at Marietta	25,990		01570500	2	Y	Y				Y
01541200	W. Br. Susquehanna River	near Curwensville	367	Y	01541303	1		Y			Y	
01541303	W. Br. Susquehanna River	at Hyde	474	Y	01541200	3	Y	Y			Y	
01542500	W. Br. Susquehanna River	at Karthaus	1,462	Y	01545500	3	Y	Y				Y
01545500	W. Br. Susquehanna River	at Renovo	2,975	Y	01542500	4	Y	Y			Y	Y
01551500	W. Br. Susquehanna River	at Williamsport	5,682	Y	01553500	5	Y	Y		Y	Y	Y
01553500	W. Br. Susquehanna River	at Lewisburg	6,847	Y	01551500	4	Y	Y			Y	Y
01543000	Driftwood Br. Sinn. Creek	at Sterling Run	272		01543500	4	Y	Y	Y	Y		
01543500	Sinnemahoning Creek	at Sinnemahoning	685		01543000	4		Y		Y	Y	Y
01546400	Spring Creek	at Houserville	58.5		01546500 01547100	2	Y	Y				
01546500	Spring Creek	near Axemann	87.2		01546400 01547100	2		Y		Y		
01547100	Spring Creek	at Milesburg	142		01546400 01546500	1		Y				
01548500	Pine Creek	at Cedar Run	604		01549700	4	Y	Y		Y		Y
01549700	Pine Creek	near Waterville	944		01548500	3	Y	Y		Y		
01556000	Frank. Br. Juniata River	at Williamsburg	291		01559000	3		Y		Y		Y
01559000	Juniata River	at Huntingdon	816		01556000	3		Y			Y	Y
01572025	Swatara Creek	near Pine Grove	116		01572190 01573000	0						
01572190	Swatara Creek	at Inwood	167		01572025 01573000 01573560	0						
01573000	Swatara Creek	at Harper Tavern	337		01572025 01572190 01573560	3	Y	Y	Y			
01573560	Swatara Creek	near Hershey	483		01572190 01573000	3	Y	Y				Y
01576500	Conestoga River	at Lancaster	324		01576754	4	Y	Y	Y			Y
01576754	Conestoga River	at Conestoga	470		01576500	0						
03007800	Allegheny River	at Port Allegany	248		03010500	2		Y		Y		
03010500	Allegheny River	at Eldred	550		03007800	5		Y	Y	Y	Y	Y
03016000	Allegheny River	at West Hickory	3,660	Y	03025500	4		Y		Y	Y	Y

Table 8. U.S. Geological Survey streamgages with high substitution potential in Pennsylvania.—Continued

[Y, yes; Streamgages with high substitution potential are those with similar hydrologic characteristics and in close proximity to another streamgage]

Station number	Stream name	Location	Drainage area	Regulated	Streamgages with high substitution potential[1]	Number of identified uses[2]	Regulatory/ compliance	Flood forecast	Drought monitor	State water quality network	Reservoir/lock and dam operation	National Streamflow Information Program
03025500	Allegheny River	at Franklin	5,982	Y	03016000 03031500	4		Y		Y	Y	Y
03031500	Allegheny River	at Parker	7,671	Y	03025500 03036500	3		Y			Y	Y
03036500	Allegheny River (L&D #7)	at Kittanning	8,973	Y	03031500 03049500	4		Y		Y	Y	Y
03049500	Allegheny River (L&D #4)	at Natrona	11,410	Y	03036500	4		Y		Y	Y	Y
03023100	French Creek	at Meadville	788	Y	03024000	4		Y		Y	Y	Y
03024000	French Creek	at Utica	1,028	Y	03023100	3		Y		Y	Y	
03041029	Conemaugh River	at Minersville	678	Y	03041500	2		Y				Y
03041500	Conemaugh River	at Seward	715	Y	03041029	3		Y			Y	Y
03072655	Monongahela River (L&D)	near Masontown (Grays Landing)	4,440	Y	03075070	3		Y			Y	Y
03075070	Monongahela River	at Elizabeth	5,340	Y	03072655	4		Y		Y	Y	Y
03081000	Youghiogheny River	below Confluence	1,029	Y	03082500	2		Y				Y
03082500	Youghiogheny River	at Connellsville	1,326	Y	03081000 03083500	3		Y			Y	Y
03083500	Youghiogheny River	at Sutersville	1,715	Y	03082500	3		Y		Y		Y
03105500	Beaver River	at Wampum	2,235	Y	03107500	3		Y		Y	Y	
03107500	Beaver River	at Beaver Falls	3,106	Y	03105500	4		Y		Y	Y	Y

[1] Streamgages with a correlation coefficent equal to or greater than 0.96, a minimum of 10 years concurrent data, and in the same watershed within 0.33 to 3 times the drainage area of selected streamgage.

[2] Identified uses as determined by the National Weather Service, U.S. Army Corps of Engineers, Pennsylvania Department of Environmental Protection, Susquehanna River Basin Commission, Delaware River Basin Commission, and the U.S. Geological Survey. There are many other stakeholders and uses of the streamgage data.

Summary

The current (2015) streamgage network in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York fulfills Federal purposes and interests and the needs of cooperating partners who require hydrologic data to manage water resources. Therefore, the streamgage network meets the needs of U.S. Geological Survey (USGS) cooperative partners but may not be ideal for establishing a reference streamgage network. In a reference streamgage network, gaged watersheds represent a composite of the upstream land cover, basin features, and hydrologic characteristics. Streamflow statistics from a reference streamgage can be transferred to ungaged watersheds with similar land cover and basin features to estimate streamflow. Although many of the current streamgages can be used as reference streamgages, an analysis was needed in order to design a network that would meet the hydrologic needs of many partners and serve various purposes and interests. The USGS, in cooperation with the Pennsylvania Department of Environmental Protection (PaDEP) and the Susquehanna River Basin Commission (SRBC), evaluated the streamgaging network for the purpose of estimating streamflow statistics at ungaged sites in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York.

The study area includes the Commonwealth of Pennsylvania and the entire Susquehanna River Basin in Pennsylvania and New York. Watersheds in the study area that are not adequately represented by a reference or current streamgage were identified by examining the range of basin characteristics, the extent of geographic coverage, and the strength of estimated streamflow correlations between gaged and ungaged sites. For this study, 229 streamgages were identified as reference streamgages. Criteria for a streamgage to be considered a reference streamgage are a minimum of 10 years of continuous record and minimally altered streamflow. Drainage basin size for a reference streamgage was limited to a maximum size of 1,500 square miles.

Basin characteristics were determined for the 229 watersheds with USGS reference streamgages using GIS spatial analysis. Basin characteristics also were determined for the 1,662 12-digit hydrologic unit code (HUC12) watersheds in Pennsylvania and the entire Susquehanna River Basin. Basin characteristics selected for this study were drainage area, mean basin elevation, mean basin slope, percentage of urbanized area, percentage of forested area, percentage of carbonate bedrock, mean annual precipitation, and soil thickness. Overall, the reference streamgages represent 80 percent of the variation in the selected basin characteristics found in the HUC12 subwatersheds. A total of 320 HUC12 subwatersheds in the study area have basin characteristics outside the range represented by the reference streamgages. The large number of headwater streams found within Pennsylvania and the Susquehanna River Basin in New York, and the unique set of basin characteristics found within these small watersheds, can make finding a representative reference streamgage challenging.

A GIS spatial analysis was used to identify geographic gaps in the streamgage network. For each streamgage, a watershed area called the gage statistical area (GSA) was delineated. The GSA shows the drainage area suitable for transfer of streamflow statistics from that streamgage to an ungaged site on the valid statistical reach (VSR) of the GSA for a streamgage. A drainage-area ratio of 0.33–0.3 times the drainage area at the streamgage was used to define the GSA. In the study area, 1,102 HUC12 subwatersheds, or 66 percent, are outside the GSA.

The USGS Baseline Streamflow Estimator program (BaSE) was used to determine how well HUC12 subwatersheds are represented by the reference streamgage network in Pennsylvania. The centroid location of each HUC12 subwatershed was entered as an ungaged site into the BaSE program to determine the reference streamgage with the highest estimated correlation to the HUC12 watershed. Correlation coefficients ranged from 0.8896 to 0.9974. There were 929 HUC12 subwatersheds with an estimated streamflow correlation less than or equal to 0.96.

The results from the basin characteristics, geographic, and streamflow correlation analyses were combined to identify 1,405 HUC12 subwatersheds, or about 84 percent, in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York that had one or more gaps (lack of streamgage coverage on the basis of basin characteristic, geographic location, or estimated correlation analysis). There were 667 HUC12 subwatersheds, or 40 percent, that had two gaps, and 139 HUC12 subwatersheds, or 8 percent, that exhibited all three gaps. The Potomac River Basin had the highest percentage of HUC12 subwatersheds with three gaps at 15 percent, whereas the Ohio River Basin had the lowest percentage of watersheds with three gaps, at 8 percent.

Streamgages with similar hydrologic characteristics in close proximity to one another can potentially provide similar information and have a high substitution potential. Streamgages were considered to have high substitution potential if (1) the streamflow correlation coefficient was equal to or greater than 0.96, (2) the streamgages had 10 years of concurrent record, and (3) the streamgages are in the same watershed within one-third to three times the drainage area at the streamgage. Seventy-four streamgages with high substitution potential were identified. Six selected primary uses for these streamgages were identified to help evaluate the overall need of an individual streamgage.

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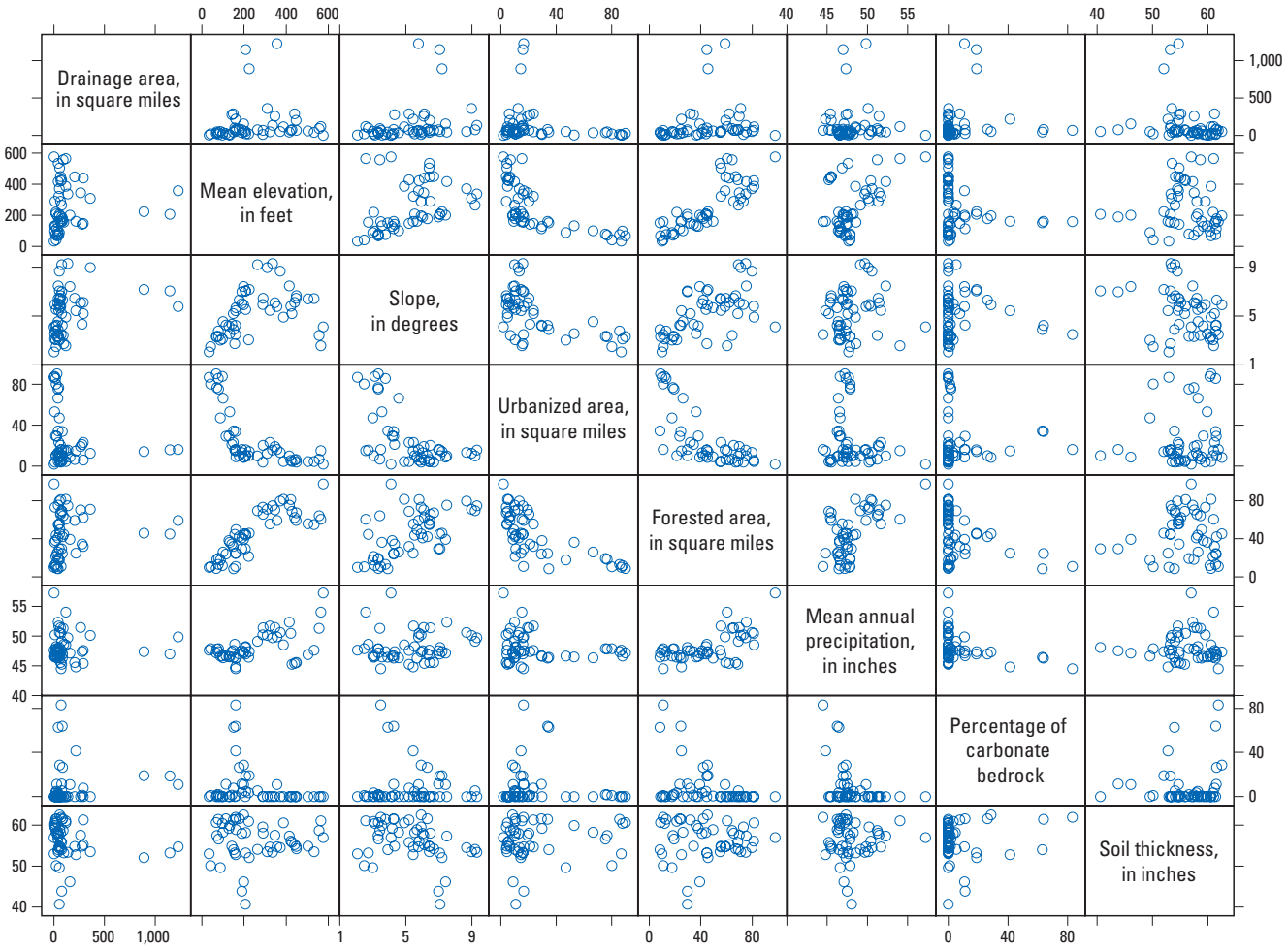
Appendixes 1–6

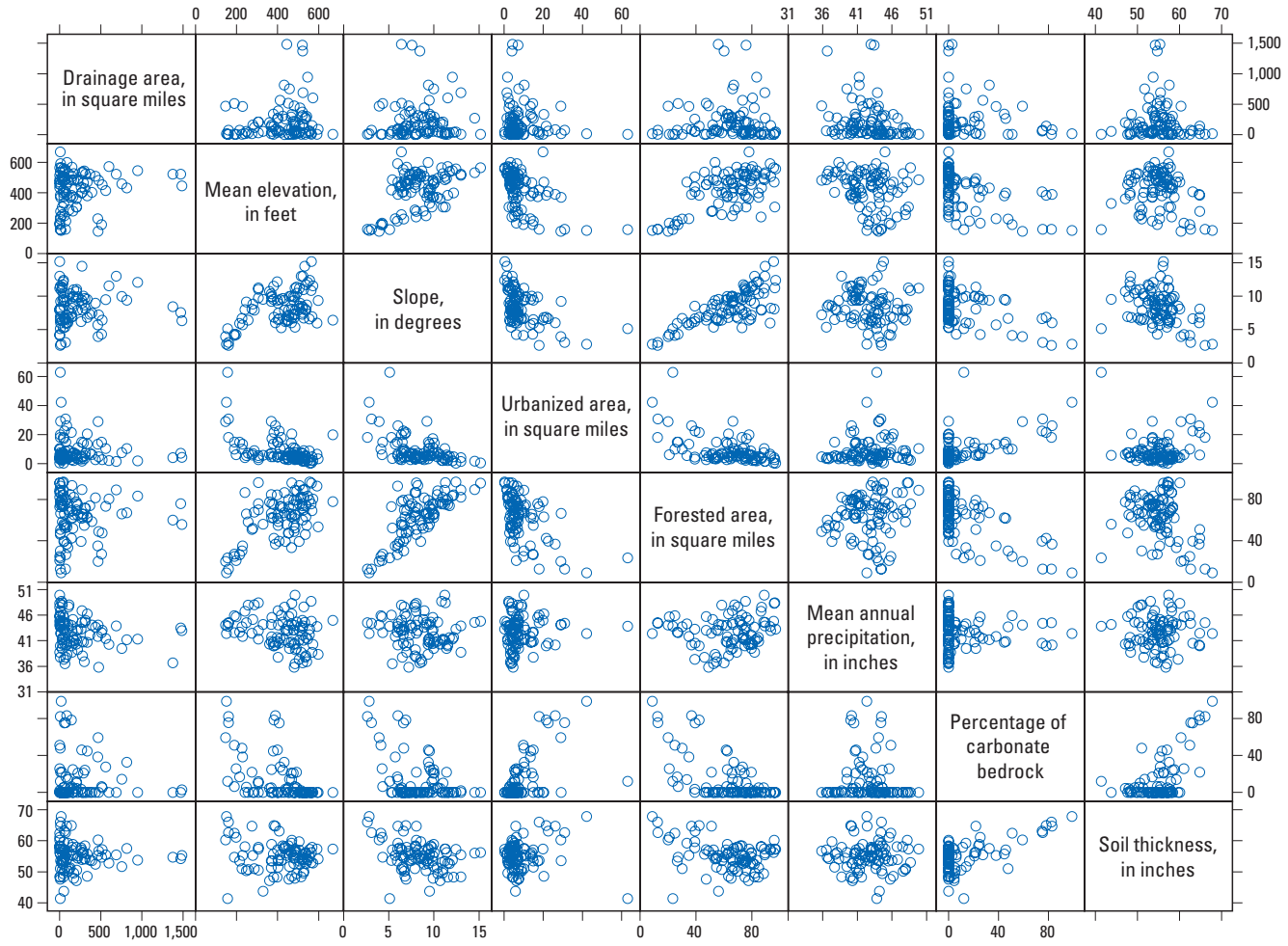
Appendix 1. Matrix of basin characteristics at U.S. Geological Survey reference streamgages in *A*, Delaware River Basin, *B*, Susquehanna and Potomac River Basins, and *C*, Ohio and Saint Lawrence River Basins in Pennsylvania and New York.

***A*. Delaware River Basin**



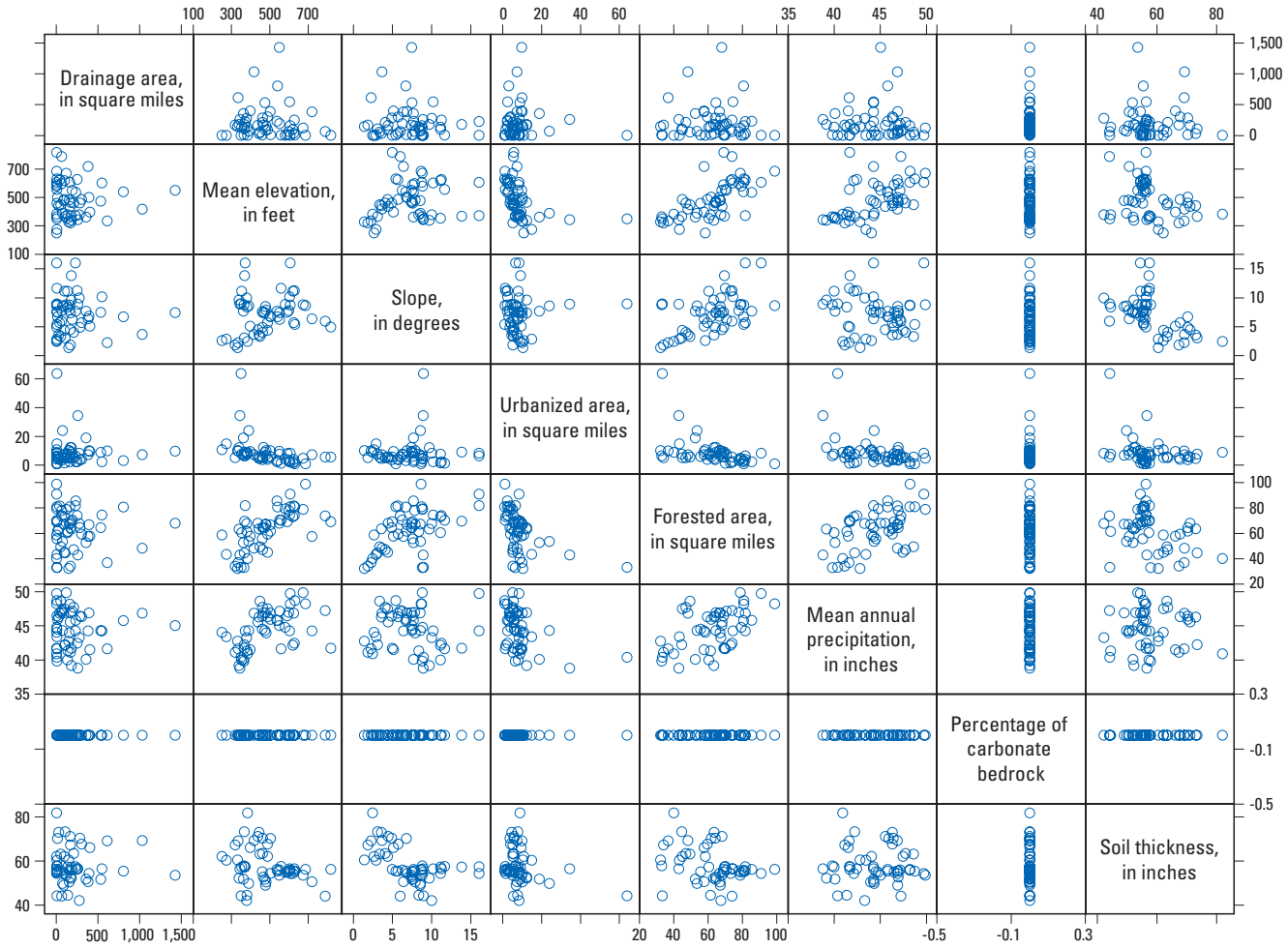
Appendix 1. Matrix of basin characteristics at U.S. Geological Survey reference streamgages in *A*, Delaware River Basin, *B*, Susquehanna and Potomac River Basins, and *C*, Ohio and Saint Lawrence River Basins in Pennsylvania and New York. —Continued

***B.* Susquehanna and Potomac River Basins**



Appendix 1. Matrix of basin characteristics at U.S. Geological Survey reference streamgages in *A*, Delaware River Basin, *B*, Susquehanna and Potomac River Basins, and *C*, Ohio and Saint Lawrence River Basins in Pennsylvania and New York. —Continued

***C.* Ohio and Saint Lawrence River Basins**



Appendix 2. Absolute percent difference between observed and transferred streamflow statistics using the drainage-area ratio method at U.S. Geological Survey streamgages in Pennsylvania and southern New York.

[USGS, U.S. Geological Survey; Streamgage may be listed more than once if there was more than one nearby streamgage in same watershed; 7Q10, 7-day, 10-year low flow; P99, 99-percent duration exceedance; P95, 95-percent duration exceedance; P50, 50-percent duration exceedance; P5, 5-percent duration exceedance; P1, 1-percent duration exceedance; 1-percent AEP, 1-percent annual exceedance probability floods; --, statistic was not available for analysis]

USGS streamgage number	Station name	Drainage area (square miles)	Years of record used in analysis	Drainage area ratio	P99 Transferred percent difference	P95 Transferred percent difference	P50 Transferred percent difference	P5 Transferred percent difference	P1 Transferred percent difference	7Q10 Transferred percent difference	1-percent AEP Transferred percent difference
01428750	West Branch Lackawaxen River near Aldenville, Pa.	40.6	26	0.68	27.30	9.89	10.08	9.40	20.83	37.13	81.70
01429000	West Branch Lackawaxen River at Prompton, Pa..	59.7	15	1.47	37.56	10.98	11.21	10.38	26.31	59.05	172.85
01430500	Lackawaxen River at West Hawley, Pa.	206	14	0.71	35.63	27.15	5.76	9.92	15.10	46.35	13.11
01431500	Lackawaxen River at Hawley, Pa.	290	27	1.41	55.36	37.27	6.12	9.03	13.12	86.39	15.08
01440400	Brodhead Creek near Analomink, Pa.	65.9	55	1.01	119.10	96.79	6.85	19.26	19.20	120.93	71.53
01441000	McMichael Creek near Stroudsburg, Pa.	65.3	25	0.99	54.36	49.18	7.36	23.86	23.76	54.74	251.23
01441000	McMichael Creek near Stroudsburg, Pa.	65.3	25	0.25	23.60	21.35	11.78	26.79	20.06	24.67	233.21
01442500	Brodhead Creek at Minisink Hills, Pa.	259	62	3.97	30.89	27.14	10.54	21.13	16.71	32.76	69.99
01440400	Brodhead Creek near Analomink, Pa.	65.9	55	0.25	67.39	54.78	4.12	2.36	2.99	66.42	5.13
01442500	Brodhead Creek at Minisink Hills, Pa.	259	62	3.93	40.26	35.39	3.95	2.31	3.08	39.91	5.41
01447500	Lehigh River at Stoddartsville, Pa.	91.7	69	0.78	78.74	65.90	14.18	9.16	20.81	71.44	36.75
01447720	Tobyhanna Creek near Blakeslee, Pa.	118	22	1.29	44.05	39.72	12.42	8.39	17.22	41.67	58.09
01453000	Lehigh River at Bethlehem, Pa.	1,279	31	0.94	32.36	20.01	8.62	2.93	3.74	29.37	6.81
01454700	Lehigh River at Glendon, Pa.	1,359	38	1.06	24.45	16.67	7.93	2.85	3.88	22.70	7.31
01451800	Jordan Creek near Schnecksville, Pa.	53	46	0.70	26.08	25.22	11.53	16.31	12.53	4.65	13.96
01452000	Jordan Creek at Allentown, Pa.	75.8	68	1.43	35.29	33.73	13.03	19.49	14.32	4.88	12.25
01447500	Lehigh River at Stoddartsville, Pa.	91.7	69	0.28	49.71	31.25	1.64	2.11	2.00	45.00	37.75
01448000	Lehigh River at Tannery, Pa.	322	42	3.51	33.21	23.81	1.67	2.15	1.96	31.03	60.63
01465770	Poquessing Creek at Trevose Rd, Philadelphia, Pa.	5.08	16	0.24	137.38	10.63	23.01	18.22	11.98	33.75	3.78
01465798	Poquessing Creek at Grant Ave. at Philadelphia, Pa.	21.4	47	4.21	57.87	11.90	29.89	15.41	10.70	50.95	3.93
01467042	Pennypack Creek at Pine Road, at Philadelphia, Pa.	37.9	18	0.76	13.72	1.08	11.09	11.80	8.34	0.98	63.08
01467048	Pennypack Creek at Lower Rhawn St Bdg, Philadelphia, Pa.	49.8	47	1.31	12.06	1.06	12.48	10.56	7.70	0.99	38.68
01467086	Tacony Creek above Adams Avenue, Philadelphia, Pa.	16.7	23	0.55	58.80	52.39	41.98	11.90	36.25	73.78	37.77
01467087	Frankford Creek at Castor Ave, Philadelphia, Pa.	30.4	23	1.82	--	--	72.34	10.64	26.60	--	27.41
01467500	Schuylkill River at Pottsville, Pa.	53.4	25	0.40	5.54	5.93	21.31	11.59	11.53	3.88	27.22
01468500	Schuylkill River at Landingville, Pa.	133	45	2.49	5.25	5.60	17.57	10.39	10.34	3.73	37.40
01469500	Little Schuylkill River at Tamaqua, Pa.	42.9	12	0.12	80.28	58.22	3.26	3.87	12.47	80.83	13.68
01470500	Schuylkill River at Berne, Pa.	355	65	8.28	44.53	36.80	3.16	4.03	14.25	44.70	15.85

Appendix 2. Absolute percent difference between observed and transferred streamflow statistics using the drainage-area ratio method at U.S. Geological Survey streamgages in Pennsylvania and southern New York.—Continued

[USGS, U.S. Geological Survey; Streamgage may be listed more than once if there was more than one nearby streamgage in same watershed; 7Q10, 7-day, 10-year low flow; P99, 99-percent duration exceedance; P95, 95-percent duration exceedance; P50, 50-percent duration exceedance; P5, 5-percent duration exceedance; P1, 1-percent duration exceedance; 1-percent AEP, 1-percent annual exceedance probability floods; --, statistic was not available for analysis]

USGS streamgage number	Station name	Drainage area (square miles)	Years of record used in analysis	Drainage area ratio	P99 Transferred percent difference	P95 Transferred percent difference	P50 Transferred percent difference	P5 Transferred percent difference	P1 Transferred percent difference	7Q10 Transferred percent difference	1-percent AEP Transferred percent difference
01471875	Manatawny Creek near Spangsville, Pa.	56.9	19	0.67	4.29	7.29	12.97	2.55	2.53	0.39	5.71
01471980	Manatawny Creek near Pottstown, Pa.	85.5	29	1.50	4.12	7.87	14.91	2.62	2.60	0.39	5.41
01470960	Tulpehocken Creek at Blue Marsh Damsite nr Reading, Pa.	175	12	0.83	17.38	5.13	2.88	4.65	0.03	5.77	80.19
01471000	Tulpehocken Creek near Reading, Pa.	211	28	1.21	14.81	4.88	2.80	4.44	0.03	6.13	404.89
01471510	Schuylkill River at Reading, Pa.	880	11	0.77	2.51	0.74	6.98	8.83	11.08	5.36	21.87
01472000	Schuylkill River at Pottstown, Pa.	1,147	50	1.30	2.45	0.74	7.51	9.69	12.47	5.66	27.98
01472198	Perkiomen Creek at East Greenville, Pa.	38	31	0.14	40.35	44.58	34.62	25.85	28.19	38.44	43.31
01473000	Perkiomen Creek at Graterford, Pa.	279	41	7.34	67.65	80.43	52.96	20.54	21.99	62.44	76.40
01470779	Tulpehocken Creek near Bernville, Pa.	66.5	38	0.38	50.18	39.42	18.19	17.74	21.75	40.99	22.85
01470960	Tulpehocken Creek at Blue Marsh Damsite near Reading, Pa.	175	12	2.63	100.71	65.08	22.23	15.07	17.86	69.47	29.62
01470500	Schuylkill River at Berne, Pa.	355	65	0.40	6.84	4.51	0.47	8.18	13.60	19.60	49.64
01471510	Schuylkill River at Reading, Pa.	880	11	2.48	6.40	4.31	0.47	8.90	15.74	16.39	98.58
01475300	Darby Creek at Waterloo Mills near Devon, Pa.	5.15	24	0.14	18.03	17.05	5.03	0.36	11.34	31.96	59.93
01475510	Darby Creek near Darby, Pa.	37.4	26	7.26	15.28	14.56	4.79	0.36	12.78	24.22	149.58
01475300	Darby Creek at Waterloo Mills near Devon, Pa.	5.15	24	1.08	15.44	3.03	19.65	5.00	1.95	16.72	154.36
01475530	Cobbs Creek at US Hwy 1 at Philadelphia, Pa.	4.78	24	0.93	13.37	3.13	24.46	4.76	1.91	14.32	60.69
01501000	Unadilla River near New Berlin, N.Y.	199	43	0.38	22.22	25.96	8.73	3.33	1.18	--	--
01502500	Unadilla River at Rockdale, N.Y.	520	73	2.61	18.18	20.61	8.03	3.22	1.19	--	--
01505000	Chenango River at Sherburne, N.Y.	263	65	0.44	10.94	14.16	9.41	0.60	2.39	--	--
01507000	Chenango River at Greene, N.Y.	593	34	2.25	12.29	16.50	10.39	0.61	2.34	--	--
01510000	Otselic River at Cincinnatus, N.Y.	147	68	0.68	6.10	14.35	13.91	6.56	4.42	--	--
01510500	Otselic River near Upper Lisle, N.Y.	217	32	1.48	6.50	16.75	16.16	7.02	4.62	--	--
01518862	Cowanesque River at Westfield, Pa.	90.6	29	0.30	88.12	32.67	24.96	5.12	0.74	105.22	87.14
01520000	Cowanesque River near Lawrenceville, Pa.	298	27	3.29	46.84	24.62	33.27	4.87	0.75	51.27	51.27
01516350	Tioga River near Mansfield, Pa.	153	36	0.54	26.43	13.00	3.34	42.10	36.64	39.68	--
01518000	Tioga River at Tioga, Pa.	282	39	1.84	20.91	11.51	3.24	29.63	26.82	28.41	--
01534500	Lackawanna River at Archbald, Pa.	108	19	0.33	44.42	44.03	34.94	27.10	25.86	43.42	14.53
01536000	Lackawanna River at Old Forge, Pa.	332	20	3.07	79.92	78.65	53.70	37.17	34.88	76.74	17.00

Appendix 2. Absolute percent difference between observed and transferred streamflow statistics using the drainage-area ratio method at U.S. Geological Survey streamgages in Pennsylvania and southern New York.—Continued

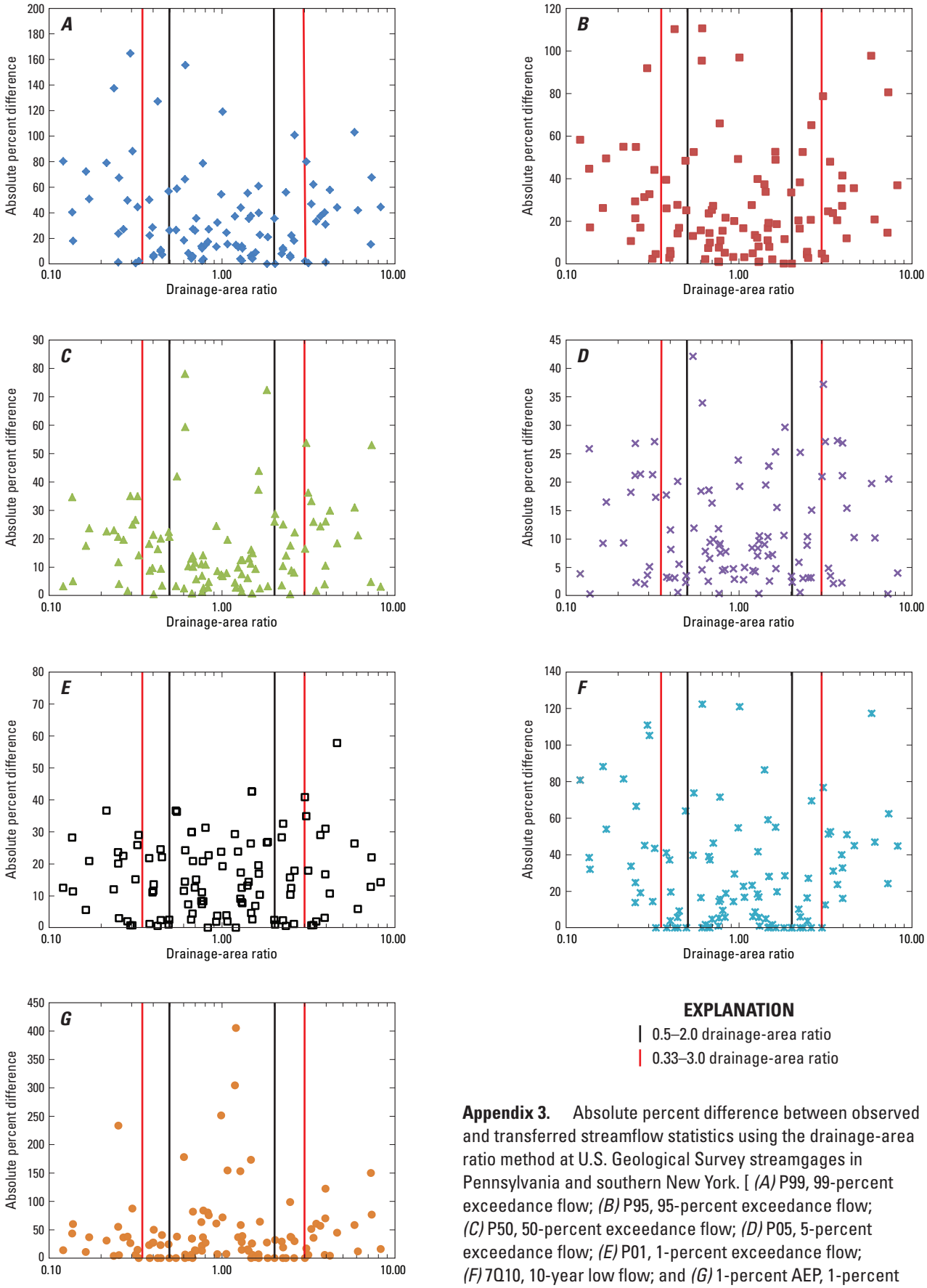
[USGS, U.S. Geological Survey; Streamgage may be listed more than once if there was more than one nearby streamgage in same watershed; 7Q10, 7-day, 10-year low flow; P99, 99-percent duration exceedance; P95, 95-percent duration exceedance; P50, 50-percent duration exceedance; P5, 5-percent duration exceedance; P1, 1-percent duration exceedance; 1-percent AEP, 1-percent annual exceedance probability floods; --, statistic was not available for analysis]

USGS streamgage number	Station name	Drainage area (square miles)	Years of record used in analysis	Drainage area ratio	P99 Transferred percent difference	P95 Transferred percent difference	P50 Transferred percent difference	P5 Transferred percent difference	P1 Transferred percent difference	7Q10 Transferred percent difference	1-percent AEP Transferred percent difference
01541000	West Branch Susquehanna River at Bower, Pa.	315	99	0.22	79.05	54.86	22.59	9.30	36.60	81.48	30.83
01542500	West Branch Susquehanna River at Karthaus, Pa.	1,462	20	4.64	44.15	35.43	18.43	10.26	57.72	44.90	44.57
01543000	Driftwood Branch Sinnemahoning Creek at Sterling Run, Pa.	272	99	0.40	28.47	2.77	9.67	3.09	11.04	37.09	26.57
01543500	Sinnemahoning Creek at Sinnemahoning, Pa.	685	74	2.52	22.16	2.70	8.82	3.19	12.41	27.05	36.18
01546400	Spring Creek at Houserville, Pa.	58.5	28	0.67	4.82	23.58	0.71	18.59	29.87	38.97	34.17
01546500	Spring Creek near Axemann, Pa.	87.2	72	1.49	4.60	19.08	0.72	22.84	42.60	28.04	25.47
01546500	Spring Creek near Axemann, Pa.	87.2	72	0.61	155.46	110.54	59.33	33.90	24.23	122.34	6.16
01547100	Spring Creek at Milesburg, Pa.	142	45	1.63	60.85	52.50	37.24	25.32	19.50	55.02	6.56
01547200	Bald Eagle Creek below Spring Creek at Milesburg, Pa.	265	57	0.78	3.76	10.85	2.65	7.57	8.29	15.64	83.81
01547500	Bald Eagle Creek at Blanchard, Pa.	339	16	1.28	3.91	12.17	2.73	7.04	9.04	18.54	152.68
01547500	Bald Eagle Creek at Blanchard, Pa.	339	16	0.60	18.51	15.64	2.54	18.39	11.51	16.44	177.84
01548005	Bald Eagle Creek near Beech Creek Station, Pa.	562	58	1.66	22.72	18.54	2.48	15.54	10.33	19.67	64.01
01548500	Pine Creek at Cedar Run, Pa.	604	94	0.81	15.16	15.49	10.88	4.46	31.28	9.49	26.77
01549000	Pine Creek near Waterville, Pa.	750	11	1.24	13.17	13.41	9.81	4.27	23.83	8.66	36.56
01548500	Pine Creek at Cedar Run, Pa.	604	94	0.64	8.29	2.10	10.32	7.83	7.31	1.65	1.42
01549700	Pine Creek below Little Pine Creek near Waterville, Pa.	944	55	1.56	9.04	2.06	9.35	7.26	6.81	1.67	1.40
01556500	Little Juniata River at Tipton, Pa.	93.7	16	0.43	127.15	110.12	16.35	3.17	0.56	--	--
01558000	Little Juniata River at Spruce Creek, Pa.	220	74	2.35	55.98	52.41	14.05	3.07	0.57	--	--
01558000	Little Juniata River at Spruce Creek, Pa.	220	74	0.27	27.12	16.93	19.60	21.42	22.46	19.12	36.13
01559000	Juniata River at Huntingdon, Pa.	816	12	3.71	37.21	20.38	24.38	27.26	28.96	23.64	56.56
01572000	Lower Little Swatara Creek at Pine Grove, Pa.	34.3	14	0.30	164.64	91.82	35.03	3.64	0.78	110.84	26.33
01572025	Swatara Creek near Pine Grove, Pa.	116	23	3.38	62.21	47.87	25.94	3.51	0.79	52.57	35.74
03007800	Allegheny River at Port Allegany, Pa.	248	38	0.45	7.31	16.86	3.51	5.56	22.03	9.23	40.53
03010500	Allegheny River at Eldred, Pa.	550	73	2.22	7.89	20.28	3.63	5.89	28.25	10.17	28.84
03017500	Tionesta Creek at Lynch, Pa.	233	42	0.50	26.22	25.07	20.64	3.56	2.50	--	--
03019000	Tionesta Creek at Nebraska, Pa.	469	18	2.01	35.53	33.46	26.00	3.44	2.44	--	--
03021350	French Creek near Wattsburg, Pa.	92	38	0.44	9.90	27.62	20.04	20.13	24.53	5.64	22.80
03021500	French Creek at Carters Corners, Pa.	208	61	2.26	10.99	38.16	25.07	25.21	32.51	5.98	18.56

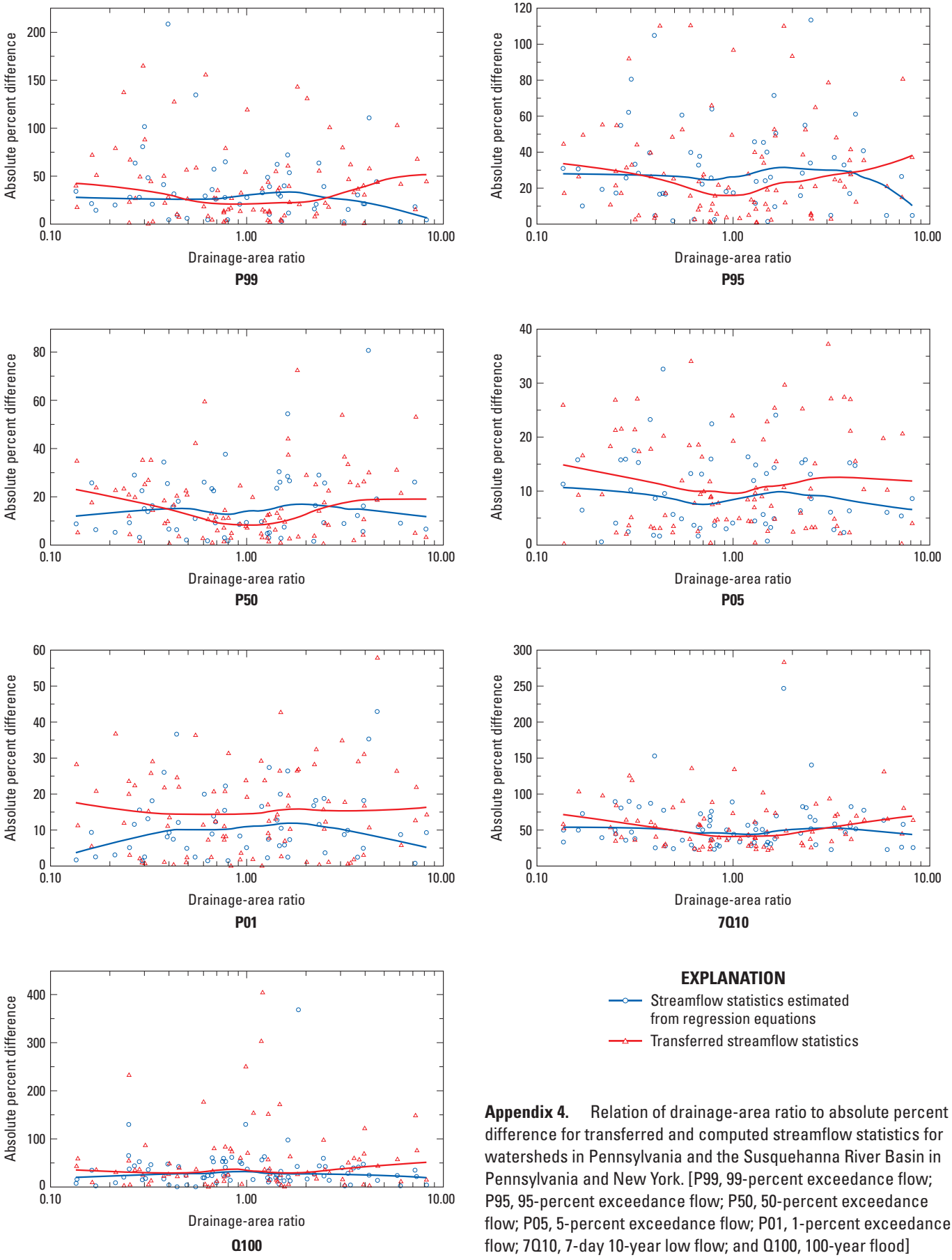
Appendix 2. Absolute percent difference between observed and transferred streamflow statistics using the drainage-area ratio method at U.S. Geological Survey streamgages in Pennsylvania and southern New York.—Continued

[USGS, U.S. Geological Survey; Streamgage may be listed more than once if there was more than one nearby streamgage in same watershed; 7Q10, 7-day, 10-year low flow; P99, 99-percent duration exceedance; P95, 95-percent duration exceedance; P50, 50-percent duration exceedance; P5, 5-percent duration exceedance; P1, 1-percent duration exceedance; 1-percent AEP, 1-percent annual exceedance probability floods; --, statistic was not available for analysis]

USGS streamgage number	Station name	Drainage area (square miles)	Years of record used in analysis	Drainage area ratio	P99 Transferred percent difference	P95 Transferred percent difference	P50 Transferred percent difference	P5 Transferred percent difference	P1 Transferred percent difference	7Q10 Transferred percent difference	1-percent AEP Transferred percent difference
03021410	West Branch French Creek near Lowville, Pa.	52.3	18	0.25	1.22	29.28	20.69	21.17	23.64	13.79	54.96
03021500	French Creek at Carters Corners, Pa.	208	61	3.98	1.23	41.41	26.08	26.86	30.97	16.00	122.02
03021500	French Creek at Carters Corners, Pa.	208	61	0.33	2.21	4.47	14.16	17.33	29.00	--	--
03022500	French Creek at Saegerstown, Pa.	629	18	3.02	2.16	4.68	16.50	20.96	40.84	--	--
03022500	French Creek at Saegerstown, Pa.	629	18	0.61	66.28	95.33	78.04	4.58	14.42	--	--
03024000	French Creek at Utica, Pa.	1,028	37	1.63	39.86	48.80	43.83	4.80	16.85	--	--
03042000	Blacklick Creek at Josephine, Pa.	192	61	0.49	56.71	48.32	22.34	2.35	1.01	63.91	24.12
03043000	Blacklick Creek at Black Lick, Pa.	390	29	2.03	--	--	28.77	2.41	1.00	--	31.78
03078000	Casselman River at Grantsville, Md.	62.5	65	0.16	72.22	26.12	17.47	9.23	5.55	88.15	10.54
03079000	Casselman River at Markleton, Pa.	382	92	6.11	41.94	20.71	21.17	10.17	5.88	46.85	11.78
03079000	Casselman River at Markleton, Pa.	382	92	3.16	0.55	2.39	36.22	27.09	17.83	12.50	5.46
03080000	Laurel Hill Creek at Ursina, Pa.	121	94	0.32	0.56	2.33	26.59	21.32	15.13	14.28	5.77
03100000	Shenango River near Turnersville, Pa.	152	10	0.84	27.09	21.58	4.76	7.78	22.66	18.82	75.24
03102000	Shenango River nr Jamestown, Pa.	181	12	1.19	37.16	27.51	4.54	8.44	29.29	23.19	303.96
03104000	Shenango River at Sharon, Pa.	608	28	0.77	12.20	7.49	1.30	0.43	7.37	14.41	12.64
03104500	Shenago River at New Castle, Pa.	792	21	1.30	13.90	8.10	1.32	0.42	7.96	16.84	14.47
03102500	Little Shenango River at Greenville, Pa.	104	99	0.17	50.75	49.41	23.65	16.49	20.84	53.97	36.67
03104000	Shenango River at Sharon, Pa.	608	28	5.85	103.04	97.68	30.97	19.75	26.32	117.26	57.91



Appendix 3. Absolute percent difference between observed and transferred streamflow statistics using the drainage-area ratio method at U.S. Geological Survey streamgages in Pennsylvania and southern New York. [*(A)* P99, 99-percent exceedance flow; *(B)* P95, 95-percent exceedance flow; *(C)* P50, 50-percent exceedance flow; *(D)* P05, 5-percent exceedance flow; *(E)* P01, 1-percent exceedance flow; *(F)* 7Q10, 10-year low flow; and *(G)* 1-percent AEP, 1-percent annual exceedance probability flood flow]



Appendix 4. Relation of drainage-area ratio to absolute percent difference for transferred and computed streamflow statistics for watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York. [P99, 99-percent exceedance flow; P95, 95-percent exceedance flow; P50, 50-percent exceedance flow; P05, 5-percent exceedance flow; P01, 1-percent exceedance flow; 7Q10, 7-day 10-year low flow; and Q100, 100-year flood]

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020401010401	Upper Equinunk Creek	DEL	1		X	
020401030101	Johnson Creek	DEL	1			X
020401030202	West Branch Dyberry Creek	DEL	1		X	
020401030203	Big Brook-Dyberry Creek	DEL	1			X
020401030302	Lower Middle Creek	DEL	1			X
020401030501	Bridge Creek	DEL	1		X	
020401030503	Headwaters Wallenpaupack Creek	DEL	1		X	
020401030601	Carley Brook-Lackawaxen River	DEL	1			X
020401040602	Upper Bush Kill	DEL	1		X	
020401040604	Saw Creek	DEL	1	X		
020401040605	Little Bush Kill	DEL	1	X		
020401040801	Upper McMichael Creek	DEL	1		X	
020401040802	Appenzell Creek	DEL	1			X
020401040804	Lower Pocono Creek	DEL	1		X	
020401040805	Lower McMichael Creek	DEL	1			X
020401040901	Upper Broadhead Creek	DEL	1		X	
020401050702	Middle Tohickon Creek	DEL	1		X	
020401060102	Pocono Lake Dam-Tobyhanna Creek	DEL	1		X	
020401060103	Tunkhannock Creek	DEL	1		X	
020401060104	Tobyhanna Creek-Lehigh River	DEL	1			X
020401060201	Headwaters Lehigh River	DEL	1		X	
020401060202	Brady's Lake-Trout Creek	DEL	1	X		
020401060204	Wright Creek-Lehigh River	DEL	1			X
020401060302	Sandy Run	DEL	1		X	
020401060303	Mud Run	DEL	1		X	
020401060305	Hazle Creek	DEL	1		X	
020401060401	Middle Creek	DEL	1			X
020401060402	Headwaters Pohopoco Creek	DEL	1		X	
020401060403	Wild Creek	DEL	1			X
020401060404	Beltzville Lake-Pohopoco Creek	DEL	1			X
020401060602	Lower Jordan Creek	DEL	1			X
020401060801	Lizard Creek	DEL	1		X	
020401060810	Monocacy Creek	DEL	1	X		
020402020303	Upper Pennypack Creek	DEL	1			X
020402020402	Tacony Creek-Frankford Creek	DEL	1	X		
020402020602	Ridley Creek	DEL	1		X	
020402020603	East Branch Chester Creek	DEL	1		X	
020402020605	Chester Creek	DEL	1		X	
020402030101	Headwaters Little Schuylkill River	DEL	1			X
020402030203	East Branch Schuylkill River	DEL	1		X	
020402030204	Headwaters Schuylkill River	DEL	1	X		

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020402030301	Ontelaunee Creek	DEL	1		X	
020402030302	Pine Creek	DEL	1	X		
020402030303	Eagle Point-Mill Creek	DEL	1			X
020402030304	Sacony Creek	DEL	1			X
020402030307	Lower Maiden Creek	DEL	1			X
020402030404	Little Northkill Creek	DEL	1			X
020402030405	Northkill Creek	DEL	1			X
020402030406	Spring Creek	DEL	1			X
020402030407	Middle Tulpehocken Creek	DEL	1			X
020402030408	Cacoosing Creek	DEL	1			X
020402030501	Upper Manatawny Creek	DEL	1		X	
020402030602	Irish Creek	DEL	1			X
020402030605	Wyomissing Creek	DEL	1			X
020402030606	Green Hills Lake-Allegheny Creek	DEL	1			X
020402030607	Antietam Creek	DEL	1			X
020402030608	Hay Creek	DEL	1			X
020402030609	Angelica Creek-Schuylkill River	DEL	1			X
020402030611	Sixpenny Creek-Schuylkill River	DEL	1			X
020402030702	Lower French Creek	DEL	1			X
020402030803	Macoby Creek	DEL	1			X
020402030804	Unami Creek	DEL	1			X
020402030805	Swamp Creek	DEL	1			X
020402030809	Lower Perkiomen Creek	DEL	1			X
020402030901	Upper Wissahickon Creek	DEL	1		X	
020402050105	Lower East Branch Brandywine Creek	DEL	1		X	
020402050202	Upper West Branch Brandywine Creek	DEL	1			X
020402050205	Lower West Branch Brandywine Creek	DEL	1		X	
020402050301	Middle Branch White Clay Creek	DEL	1		X	
020402050302	West Branch White Clay Creek	DEL	1		X	
020402050303	East Branch White Clay Creek	DEL	1		X	
020402050306	Upper White Clay Creek	DEL	1		X	
020402050308	Lower White Clay Creek	DEL	1		X	
020402050402	Middle Brandywine Creek	DEL	1			X
020402050502	Upper Christina River	DEL	1		X	
020501010101	Ocquionis Creek	SUSQ NY	1		X	
020501010102	Herkimer Creek-Canadarago Lake	SUSQ NY	1		X	
020501010201	Pleasant Brook	SUSQ NY	1		X	
020501010202	Upper Cherry Valley Creek	SUSQ NY	1		X	
020501010203	Middle Cherry Valley Creek	SUSQ NY	1		X	
020501010204	Lower Cherry Valley Creek	SUSQ NY	1		X	
020501010301	Upper Schenevus Creek	SUSQ NY	1		X	

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020501010303	Middle Schenevus Creek	SUSQ NY	1		X	
020501010304	Lower Schenevus Creek	SUSQ NY	1		X	
020501010401	Center Brook	SUSQ NY	1		X	
020501010402	Middle Brook	SUSQ NY	1		X	
020501010403	Upper Charlotte Creek	SUSQ NY	1		X	
020501010501	West Branch Otego Creek	SUSQ NY	1		X	
020501010502	Upper Otego Creek	SUSQ NY	1		X	
020501010601	Cripple Creek	SUSQ NY	1		X	
020501010602	Shadow Brook	SUSQ NY	1		X	
020501010603	Hayden Creek-Ostego Lake	SUSQ NY	1		X	
020501010604	Red Creek-Susquehanna River	SUSQ NY	1		X	
020501010605	Goodyear Lake-Susquehanna River	SUSQ NY	1		X	
020501010606	Oneonta Creek-Susquehanna River	SUSQ NY	1		X	
020501010701	Upper Wharton Creek	SUSQ NY	1		X	
020501010702	Middle Wharton Creek	SUSQ NY	1		X	
020501010703	Lower Wharton Creek	SUSQ NY	1		X	
020501010801	Upper Butternut Creek	SUSQ NY	1		X	
020501010901	North Winfield Creek	SUSQ NY	1		X	
020501010902	West Branch Unadilla River	SUSQ NY	1		X	
020501010903	Headwaters Unadilla River	SUSQ NY	1		X	
020501011001	Upper Ouleout Creek	SUSQ NY	1		X	
020501011002	Treadwell Creek	SUSQ NY	1		X	
020501011003	Middle Ouleout Creek	SUSQ NY	1		X	
020501011004	Handsome Brook	SUSQ NY	1		X	
020501011005	Lower Ouleout Creek	SUSQ NY	1		X	
020501011101	Otsdawa Creek	SUSQ NY	1		X	
020501011102	Brier Creek-Susquehanna River	SUSQ NY	1		X	
020501011103	Sand Hill Creek-Susquehanna River	SUSQ NY	1		X	
020501011104	Carrs Creek	SUSQ NY	1		X	
020501011105	Martin Brook-Susquehanna River	SUSQ NY	1		X	
020501011201	Bennettsville Creek	SUSQ NY	1		X	
020501011202	Kelsey Brook	SUSQ NY	1		X	
020501011203	Yaleville Brook-Susquehanna River	SUSQ NY	1		X	
020501011204	Wylie Brook	SUSQ NY	1		X	
020501011205	Cornell Creek-Susquehanna River	SUSQ NY	1		X	
020501011206	Belden Brook-Susquehanna River	SUSQ NY	1		X	
020501011207	Ouaquaga Creek-Susquehanna River	SUSQ NY	1		X	
020501011208	Occanum Creek-Susquehanna River	SUSQ NY	1		X	
020501011209	Cascade Creek-Susquehanna River	SUSQ	1		X	
020501011307	Trowbridge Creek	SUSQ	1		X	
020501011309	Silver Creek	SUSQ	1		X	

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020501011313	Park Creek-Susquehanna River	SUSQ NY	1		X	
020501020101	Fabius Brook-West Branch Tioughnioga Creek	SUSQ NY	1		X	
020501020102	Upper East Branch Tioughnioga Creek	SUSQ NY	1		X	
020501020103	Labrador Creek	SUSQ NY	1		X	
020501020104	Middle East Branch Tioughnioga Creek	SUSQ NY	1		X	
020501020105	Cheningo Creek	SUSQ NY	1		X	
020501020106	Lower East Branch Tioughnioga Creek	SUSQ NY	1		X	
020501020201	Cold Brook	SUSQ NY	1		X	
020501020202	Upper Little York Lake-West Br. Tioughnioga River	SUSQ NY	1		X	
020501020203	Factory Creek	SUSQ NY	1		X	
020501020204	Otter Creek	SUSQ NY	1		X	
020501020205	Dry Creek-West Branch Tioughnioga River	SUSQ NY	1		X	
020501020301	Headwaters Otselic River	SUSQ NY	1		X	
020501020401	Trout Brook	SUSQ NY	1		X	
020501020402	Gridley Creek	SUSQ NY	1		X	
020501020403	Upper Tioughnioga River	SUSQ NY	1		X	
020501020404	Jennings Creek	SUSQ NY	1		X	
020501020405	Culver Creek-Dudley Creek	SUSQ NY	1		X	
020501020406	Middle Tioughnioga River	SUSQ NY	1		X	
020501020407	Halfway Brook	SUSQ NY	1		X	
020501020408	Lower Tioughnioga River	SUSQ NY	1		X	
020501020504	Callahan Brook-Chenango River	SUSQ NY	1		X	
020501020505	Payne Brook	SUSQ NY	1		X	
020501020506	Eaton Brook-Chenango River	SUSQ NY	1		X	
020501020701	Headwaters Genegantslet Creek	SUSQ NY	1		X	
020501020807	Page Brook	SUSQ NY	1		X	
020501020808	Osborne Creek	SUSQ NY	1		X	
020501020809	Castle Creek	SUSQ NY	1		X	
020501020810	Thomas Creek-Chenango River	SUSQ NY	1		X	
020501030101	Upper Nanticoke Creek	SUSQ NY	1		X	
020501030102	East Branch Nanticoke Creek	SUSQ NY	1		X	
020501030103	Crocker Creek	SUSQ NY	1		X	
020501030104	Middle Nanticoke Creek	SUSQ NY	1		X	
020501030105	Lower Nanticoke Creek	SUSQ NY	1		X	
020501030201	Little Choconut Creek-Susquehanna River	SUSQ NY	1		X	
020501030202	Upper Chocohut Creek	SUSQ	1		X	
020501030204	Lower Chocohut Creek	SUSQ NY	1		X	
020501030205	Patterson Creek-Susquehanna River	SUSQ NY	1		X	
020501030206	Tracy Creek-Susquehanna River	SUSQ NY	1		X	
020501030301	Upper Catatonk Creek	SUSQ NY	1		X	
020501030302	South Branch Catatonk Creek	SUSQ NY	1		X	

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020501030303	Willseyville Creek	SUSQ NY	1		X	
020501030304	Middle Catatonk Creek	SUSQ NY	1		X	
020501030305	Lower Catatonk Creek	SUSQ NY	1		X	
020501030401	Headwaters East Branch Owego Creek	SUSQ NY	1		X	
020501030402	Upper East Branch Owego Creek	SUSQ NY	1		X	
020501030403	Wilson Creek	SUSQ NY	1		X	
020501030404	Middle East Branch Owego Creek	SUSQ NY	1		X	
020501030405	Upper West Branch Owego Creek	SUSQ NY	1		X	
020501030406	Middle West Branch Owego Creek	SUSQ NY	1		X	
020501030407	Doolittle Creek	SUSQ NY	1		X	
020501030408	Lower West Branch Owego Creek	SUSQ NY	1		X	
020501030409	Lower East Branch Owego Creek-Owego Creek	SUSQ NY	1		X	
020501030502	Little Nanticoke Creek	SUSQ NY	1		X	
020501030503	Pumpelly Creek-Susquehanna River	SUSQ NY	1		X	
020501030504	Chambers Creek-Pipe Creek	SUSQ NY	1		X	
020501030505	Hunts Creek-Susquehanna River	SUSQ NY	1		X	
020501030601	Pony Hollow Creek	SUSQ NY	1		X	
020501030602	Headwaters Cayuta Creek	SUSQ NY	1		X	
020501030603	Upper Cayuta Creek	SUSQ NY	1		X	
020501030604	Middle Cayuta Creek	SUSQ NY	1		X	
020501030705	Ellis Creek	SUSQ NY	1		X	
020501040101	McHenry Valley Creek	SUSQ NY	1		X	
020501040102	Karr Valley Creek	SUSQ NY	1		X	
020501040103	Upper Canacadea Creek	SUSQ NY	1		X	
020501040104	Lower Canacadea Creek	SUSQ NY	1		X	
020501040401	Lime Kiln Creek	SUSQ NY	1		X	
020501040402	Headwaters Canisteo River	SUSQ NY	1		X	
020501040403	Seeley Creek	SUSQ NY	1		X	
020501040404	Big Creek	SUSQ NY	1		X	
020501040406	Upper Canisteo River	SUSQ NY	1	X		
020501040408	Middle Canisteo River	SUSQ NY	1	X		
020501040409	Tracy Creek	SUSQ NY	1	X		
020501040410	Goodhue Creek	SUSQ NY	1	X		
020501040411	Lower Canisteo River	SUSQ NY	1	X		
020501040602	Norris Brook	SUSQ	1			X
020501040603	Losey Creek	SUSQ	1		X	
020501040703	Painter Run-Mill Creek	SUSQ	1			X
020501040801	Headwaters Cowanesque River	SUSQ	1		X	
020501040804	Jemison Creek	SUSQ	1	X		
020501040806	Holden Creek	SUSQ	1	X		
020501040808	MIddle Cowanesque River	SUSQ	1	X		

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020501040901	Headwaters Tioga River	SUSQ	1		X	
020501040902	Johnson Creek	SUSQ	1			X
020501040907	Middle Tioga River	SUSQ	1			X
020501050202	Middle Fivemile Creek	SUSQ NY	1	X		
020501050204	Campbell Creek	SUSQ NY	1	X		
020501050205	Stocking Creek	SUSQ NY	1	X		
020501050206	Knight Creek-Cohocton River	SUSQ NY	1	X		
020501050207	Smith Run-Cohocton River	SUSQ NY	1	X		
020501050301	Tobehanna Creek	SUSQ NY	1	X		
020501050302	Lamoka Lake-Mud Creek	SUSQ NY	1	X		
020501050303	Mud Creek	SUSQ NY	1	X		
020501050304	Michigan Creek	SUSQ NY	1	X		
020501050307	Curtis Creek-Cohocton River	SUSQ NY	1	X		
020501050308	Hodgmans Creek-Cohocton River	SUSQ NY	1	X		
020501050401	Post Creek	SUSQ NY	1		X	
020501050402	Cutler Creek-Chemung River	SUSQ NY	1		X	
020501050404	Whisky Creek-Chemung River	SUSQ NY	1		X	
020501050502	Upper Newtown Creek	SUSQ NY	1		X	
020501050503	Lower Newtown Creek	SUSQ NY	1	X		
020501050604	Baldwin Creek	SUSQ NY	1		X	
020501050606	Wyncoop Creek	SUSQ NY	1		X	
020501060101	North Branch Sugar Creek	SUSQ	1		X	
020501060102	South Branch Sugar Creek	SUSQ	1		X	
020501060104	Mill Creek-Sugar Creek	SUSQ	1		X	
020501060106	Browns Creek	SUSQ	1		X	
020501060201	Little Schrader Creek	SUSQ	1	X		
020501060303	South Branch Towanda Creek	SUSQ	1			X
020501060601	Lake Stream	SUSQ	1		X	
020501060602	Deer Lick Creek-East Branch Wyalusing Creek	SUSQ	1		X	
020501060701	Middle Branch Wyalusing Creek	SUSQ	1		X	
020501060703	North Branch Wyalusing Creek	SUSQ	1		X	
020501060902	North Branch Mehoopany Creek	SUSQ	1			X
020501061001	Upper East Branch Tunkhannock Creek	SUSQ	1		X	
020501061102	Lower South Branch Tunkhannock Creek	SUSQ	1			X
020501061205	Hop Bottom Creek	SUSQ	1			X
020501061206	Martins Creek	SUSQ	1			X
020501061208	Lower Tunkhannock Creek	SUSQ	1			X
020501070101	West Branch Lackawanna River	SUSQ	1		X	
020501070102	East Branch Lackawanna River	SUSQ	1		X	
020501070106	Grassy Island Creek-Lackawanna River	SUSQ	1			X
020501070107	Roaring Brook	SUSQ	1			X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020501070108	Spring Brook	SUSQ	1			X
020501070109	City of Scranton-Lackawanna River	SUSQ	1			X
020501070110	Lackawanna River-Susquehanna River	SUSQ	1			X
020501070204	Sugar Notch Run-Solomon Creek	SUSQ	1			X
020501070206	Nanticoke Creek	SUSQ	1		X	
020501070304	Little Wapwallopen Creek	SUSQ	1		X	
020501070306	Wapwallopen Creek	SUSQ	1			X
020501070504	Huntington Creek-Fishing Creek	SUSQ	1			X
020501070601	Kline Hollow Run-Little Fishing Creek	SUSQ	1			X
020501070602	Little Fishing Creek-Fishing Creek	SUSQ	1			X
020501070705	Mud Run-Green Creek	SUSQ	1			X
020501070706	Hemlock Creek	SUSQ	1			X
020501070707	Fishing Creek-Susquehanna River	SUSQ	1			X
020502010101	Upper Chest Creek	SUSQ	1			X
020502010102	Middle Chest Creek	SUSQ	1			X
020502010301	Headwaters Clearfield Creek	SUSQ	1		X	
020502010305	South Witmer Run-North Witmer Run	SUSQ	1			X
020502010306	Muddy Run	SUSQ	1			X
020502010307	Middle Clearfield Creek	SUSQ	1			X
020502010308	Lower Clearfield Creek	SUSQ	1			X
020502010309	Little Clearfield Creek	SUSQ	1			X
020502010310	Morgan Run-Lower Clearfield Creek	SUSQ	1			X
020502010403	Beaver Run-West Branch Susquehanna River	SUSQ	1		X	
020502010404	Bear Run	SUSQ	1			X
020502010405	Bell Run	SUSQ	1			X
020502010406	Deer Run-West Branch Susquehanna River	SUSQ	1			X
020502010501	Beaver Run	SUSQ	1			X
020502010502	Upper Moshannon Creek	SUSQ	1		X	
020502010503	Laurel Run	SUSQ	1			X
020502010504	Cold Stream	SUSQ	1	X		
020502010506	Middle Moshannon Creek	SUSQ	1			X
020502010508	Lower Moshannon Creek	SUSQ	1			X
020502010601	Headwaters Mosquito Creek	SUSQ	1		X	
020502010703	Moravian Run	SUSQ	1		X	
020502010707	Millstone Run-West Branch Susquehanna River	SUSQ	1		X	
020502020101	Cowley Run	SUSQ	1	X		
020502020102	Sinnemahoning Portage Creek-Driftwood Branch Sinnemahoning Creek	SUSQ	1	X		
020502020204	West Creek	SUSQ	1			X
020502020205	Hunts Run	SUSQ	1	X		
020502020207	Driftwood Branch Sinnemahoning Creek-Sinnemahoning Creek	SUSQ	1	X		
020502020401	Big Moores Run	SUSQ	1		X	

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020502030102	Upper Kettle Creek	SUSQ	1		X	
020502030103	Cross Fork	SUSQ	1	X		
020502030104	Hammersley Fork	SUSQ	1	X		
020502030105	Middle Kettle Creek	SUSQ	1	X		
020502030106	Lower Kettle Creek	SUSQ	1	X		
020502030301	Left Branch Young Womans Creek	SUSQ	1	X		
020502030302	Young Womans Creek-West Branch Susquehanna River	SUSQ	1	X		
020502040104	Logan Branch	SUSQ	1			X
020502040105	Buffalo Run	SUSQ	1			X
020502040106	Spring Creek-Bald Eagle Creek	SUSQ	1			X
020502040202	North Fork Beach Creek	SUSQ	1			X
020502040203	Sandy Run-Beech Creek	SUSQ	1	X		
020502040205	Beech Creek-Bald Eagle Creek	SUSQ	1	X		
020502040302	Little Fishing Creek	SUSQ	1			X
020502040303	Cedar Run	SUSQ	1	X		
020502040304	Long Run	SUSQ	1			X
020502040305	Cherry Run-Fishing Creek	SUSQ	1			X
020502040402	Dicks Run-Bald Eagle Creek	SUSQ	1		X	
020502040403	Wallace Run	SUSQ	1	X		
020502040404	Nittany Creek	SUSQ	1			X
020502040407	Bald Eagle Creek-West Branch Susquehanna River	SUSQ	1			X
020502050102	Wetmore Run-West Branch Pine Creek	SUSQ	1		X	
020502050203	Genesee Forks	SUSQ	1		X	
020502050205	Phoenix Run	SUSQ	1		X	
020502050301	Charleston Creek	SUSQ	1		X	
020502050303	Marsh Creek-Pine Creek	SUSQ	1		X	
020502050401	Headwaters Babb Creek	SUSQ	1		X	
020502050402	Wilson Creek	SUSQ	1		X	
020502050403	East Branch Stony Fork	SUSQ	1		X	
020502050404	Stony Fork	SUSQ	1		X	
020502050405	Long Run-Babb Creek	SUSQ	1		X	
020502050501	Zimmerman Creek	SUSQ	1		X	
020502050502	Texas Creek	SUSQ	1		X	
020502060101	Second Fork Larrys Creek	SUSQ	1		X	
020502060103	Larrys Creek-West Branch Susquehanna River	SUSQ	1		X	
020502060201	Roaring Branch	SUSQ	1		X	
020502060202	Mill Creek-Lycoming Creek	SUSQ	1		X	
020502060203	Rock Run	SUSQ	1	X		
020502060204	Pleasant Stream	SUSQ	1	X		
020502060205	Grays Run	SUSQ	1	X		
020502060208	Lycoming Creek-West Branch Susquehanna River	SUSQ	1			X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020502060401	Lick Creek	SUSQ	1		X	
020502060501	Porter Creek-Hoagland Branch	SUSQ	1			X
020502060502	Elk Creek	SUSQ	1			X
020502060504	Plunketts Creek	SUSQ	1	X		
020502060505	Bear Creek	SUSQ	1	X		
020502060507	Mill Creek-East Side of Loyalsock Creek	SUSQ	1			X
020502060508	Mill Creek-West Side of Loyalsock Creek	SUSQ	1			X
020502060509	Little Bear Creek-Loyalsock Creek	SUSQ	1			X
020502060601	Antes Creek	SUSQ	1		X	
020502060602	Quenshukeny Run	SUSQ	1		X	
020502060605	Wolf Run	SUSQ	1		X	
020502060802	Rock Run-Muncy Creek	SUSQ	1			X
020502060902	White Deer Hole Creek-West Branch Susquehanna River	SUSQ	1		X	
020502061001	North Branch Buffalo Creek	SUSQ	1		X	
020502061002	Rapid Run	SUSQ	1		X	
020502061003	Spruce Run	SUSQ	1		X	
020503010102	Carbon Run-Shamokin Creek	SUSQ	1			X
020503010104	Shamokin Creek-Susquehanna River	SUSQ	1			X
020503010201	Elk Creek	SUSQ	1			X
020503010202	Voneida Run-Pine Creek	SUSQ	1			X
020503010403	Upper Penns Creek	SUSQ	1	X		
020503010404	Laurel Run	SUSQ	1			X
020503010405	Middle Penns Creek	SUSQ	1			X
020503010406	Lower Penns Creek-Susquehanna River	SUSQ	1			X
020503010501	Upper Mahanoy Creek	SUSQ	1		X	
020503010702	Rausch Creek-Pine Creek	SUSQ	1		X	
020503010802	Lower Mahantango Creek	SUSQ	1			X
020503020102	South Poplar Run-Frankstown Branch Juniata River	SUSQ	1		X	
020503020103	Plum Creek	SUSQ	1		X	
020503020104	Halter Creek	SUSQ	1		X	
020503020201	Blair Gap Run	SUSQ	1			X
020503020202	Mill Run-Beaverdam Branch	SUSQ	1			X
020503020301	Canoe Creek	SUSQ	1			X
020503020303	Piney Creek	SUSQ	1	X		
020503020304	Clover Creek	SUSQ	1		X	
020503020403	Warriors Mark Run	SUSQ	1		X	
020503020503	Tipton Run	SUSQ	1	X		
020503020703	East Branch Standing Stone Creek	SUSQ	1			X
020503020704	Lower Standing Stone Creek	SUSQ	1			X
020503020801	Juniata River-City of Huntingdon	SUSQ	1		X	
020503020802	Snyders Run-Juniata River	SUSQ	1		X	

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020503030104	Shobers Run	SUSQ	1		X	
020503030201	Scrubgrass Creek	SUSQ	1			X
020503030301	Upper Dunning Creek	SUSQ	1		X	
020503030401	Little Brush Creek	SUSQ	1		X	
020503030504	Tub Mill Run-Raystown Branch Juniata River	SUSQ	1		X	
020503030505	Sandy Run-Raystown Branch Juniata River	SUSQ	1		X	
020503030602	Upper Yellow Creek	SUSQ	1		X	
020503030603	Lower Yellow Creek	SUSQ	1		X	
020503030701	Little Trough Creek	SUSQ	1		X	
020503030802	Sixmile Run-Raystown Branch Juniata River	SUSQ	1		X	
020503030803	Shy Beaver Creek-Raystown Lake	SUSQ	1		X	
020503040202	Wooden Bridge Creek	SUSQ	1		X	
020503040203	Lower Sideling Hill Creek	SUSQ	1		X	
020503040301	Shade Creek	SUSQ	1		X	
020503040601	Treaster Run	SUSQ	1		X	
020503040602	Laurel Creek	SUSQ	1		X	
020503040603	Honey Creek-Kishacoquillas Creek	SUSQ	1		X	
020503040702	Lower Kishacoquillas Creek	SUSQ	1		X	
020503040802	Little Lost Creek-Lost Creek	SUSQ	1		X	
020503040902	Trough Spring Branch-Tuscarora Creek	SUSQ	1		X	
020503040904	Willow Run	SUSQ	1			X
020503040905	Lick Run-Tuscarora Creek	SUSQ	1			X
020503040907	Tuscarora Creek-Juniata River	SUSQ	1			X
020503041001	Upper Cocolamus Creek	SUSQ	1		X	
020503041002	Lower Cocolamus Creek	SUSQ	1			X
020503041201	Doe Run-Juniata River	SUSQ	1		X	
020503050101	Shultz Creek-Sherman Creek	SUSQ	1		X	
020503050104	Upper Sherman Creek	SUSQ	1			X
020503050106	Middle Sherman Creek	SUSQ	1			X
020503050107	Lower Sherman Creek	SUSQ	1			X
020503050303	Laughlin Run-Paxton Run	SUSQ	1			X
020503050308	Big Spring Creek-Conodoguinet Creek	SUSQ	1			X
020503050403	Wertz Run-Conodoguinet Creek	SUSQ	1			X
020503050406	Simmons Creek-Conodoguinet Creek	SUSQ	1			X
020503050601	Upper Little Swartara Creek	SUSQ	1			X
020503050603	Lower Little Swatara Creek	SUSQ	1			X
020503050605	Middle Swatara Creek	SUSQ	1			X
020503050606	Lower Swatara Creek	SUSQ	1			X
020503050701	Crosskill Creek	SUSQ	1			X
020503050702	Upper Little Swatara Creek	SUSQ	1			X
020503050703	Lower Little Swatara Creek	SUSQ	1			X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020503050903	Manada Creek	SUSQ	1			X
020503060601	Upper South Branch Codorus Creek	SUSQ	1		X	
020503060602	Lake Redman-Lake Williams-East Branch Codorus Creek	SUSQ	1		X	
020503060603	Lower South Branch Codorus Creek	SUSQ	1		X	
020503060701	Lake Marburo-West Branch Codorus Creek	SUSQ	1		X	
020503061302	South Branch Muddy Creek	SUSQ	1			X
020503061303	Bald Eagle Creek-Muddy Creek	SUSQ	1			X
020503061304	Fishing Creek-Muddy Creek	SUSQ	1			X
020503061401	Pine Creek	SUSQ	1		X	
020503061501	West Branch Octoraro Creek	SUSQ	1		X	
020503061602	Upper Deer Creek	SUSQ	1			X
020600030301	South Branch Gunpowder Falls-Gunpowder Falls	POT	1		X	
020700020601	Upper Evitts Creek	POT	1		X	
020700030102	Flintstone Creek	POT	1		X	
020700040102	Barnetts Run-Tonoloway Creek	POT	1		X	
020700040301	Patterson Run-Licking Creek	POT	1		X	
020700040303	Little Cove Creek	POT	1			X
020700040304	Owl Creek-Licking Creek	POT	1		X	
020700040305	Lanes Run-Licking Creek	POT	1			X
020700040501	Minnow Run-Little Tonoloway Creek(MD)	POT	1		X	
020700040602	Upper West Branch Conococheague Creek	POT	1		X	
020700040702	Dennis Creek-Back Creek	POT	1		X	
020700040703	Campbell Run-Back Creek	POT	1		X	
020700040802	Headwaters Conococheague Creek	POT	1	X		
020700090102	Lower Rock Creek	POT	1		X	
020700090203	Lower Marsh Creek	POT	1		X	
020700090502	Piney Creek	POT	1		X	
041201010502	Little Elk Creek	STLAW	1		X	
041201010503	Lower Elk Creek	STLAW	1		X	
041201010601	Headwaters Conneaut Creek	STLAW	1		X	
041300020102	West Branch Genesee River	STLAW	1		X	
041300020103	Headwaters Genesee River	STLAW	1		X	
041300020301	Marsh Creek	STLAW	1		X	
041300020302	Cryder Creek	STLAW	1		X	
041300020303	Marsh Creek-Genesee River	STLAW	1		X	
050100010104	Cole Creek	OHIO	1			X
050100010201	South Branch Oswayo	OHIO	1		X	
050100010202	Clara Creek-Oswayo Creek	OHIO	1		X	
050100010204	Honeoye Creek	OHIO	1	X		
050100010206	Bell Run	OHIO	1			X
050100010301	Headwaters Allegheny River	OHIO	1		X	

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
050100010304	Fishing Creek	OHIO	1			X
050100010305	Sartwell Creek	OHIO	1	X		
050100010601	East Branch Tunungwant Creek	OHIO	1		X	
050100010605	Outlet Tunungwant Creek	OHIO	1		X	
050100010903	South Branch	OHIO	1		X	
050100011001	East Branch Little Brokenstraw Creek	OHIO	1			X
050100011101	Coffee Creek	OHIO	1		X	
050100011102	Brownell Branch-Brokenstraw Creek	OHIO	1		X	
050100011104	Spring Creek	OHIO	1			X
050100011107	Matthews Run	OHIO	1			X
050100011108	Irvine Run-Brokenstraw Creek	OHIO	1			X
050100020501	Upper Stillwater Creek	OHIO	1		X	
050100020504	Kiantone Creek	OHIO	1		X	
050100020508	Rhine Run-Conewago Creek	OHIO	1		X	
050100030105	West Hickory Creek	OHIO	1		X	
050100030201	East Branch Tionesta Creek	OHIO	1		X	
050100030202	South Branch Tionesta Creek-Tionesta Creek	OHIO	1		X	
050100030305	West Branch Tionesta Creek-Tionesta Creek	OHIO	1		X	
050100030404	Salmon Creek	OHIO	1			X
050100030502	Caldwell Creek	OHIO	1			X
050100030604	Dewolfe Run-Oil Creek	OHIO	1			X
050100030801	Sandy Creek-Sandy Lake Dam	OHIO	1		X	
050100030802	Little Sandy Creek	OHIO	1		X	
050100030904	Twomile Run	OHIO	1		X	
050100040104	Darrow Brook-West Branch French Creek	OHIO	1			X
050100040105	Alder Brook-W. Branch French Creek	OHIO	1			X
050100040201	Slaughter Run-S. Branch French Creek	OHIO	1			X
050100040202	Pine Run-S. Branch French Creek	OHIO	1			X
050100040801	West Branch Sugar Creek-Sugar Creek	OHIO	1		X	
050100040803	Prather Creek-Sugar Creek	OHIO	1		X	
050100040804	Little Sugar Creek-Sugar Creek	OHIO	1		X	
050100040901	Kelly Run-French Creek	OHIO	1			X
050100040902	Little Conneauttee Creek-French Creek	OHIO	1			X
050100040903	Conneauttee Creek-French Creek	OHIO	1			X
050100040904	Gravel Run-French Creek	OHIO	1			X
050100040907	Little Sugar Creek-French Creek	OHIO	1		X	
050100040908	North Deer Creek-French Creek	OHIO	1		X	
050100040909	Mill Creek-French Creek	OHIO	1		X	
050100050102	East Branch Clarion River-Clarion River	OHIO	1		X	
050100050202	Rocky Run-West Branch Clarion River	OHIO	1		X	
050100050301	Laurel Run Dam-Elk Creek	OHIO	1			X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

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HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
050100050302	Elk Creek-Clarion River	OHIO	1			X
050100050501	East Branch Spring Creek	OHIO	1		X	
050100050603	Bear Creek	OHIO	1	X		
050100050604	Irwin Run-Clarion River	OHIO	1			X
050100050605	Maxwell Run-Clarion River	OHIO	1			X
050100050606	West Branch Millstone Creek	OHIO	1		X	
050100050704	Blyson Run-Clarion River	OHIO	1			X
050100060302	Wolf Run	OHIO	1		X	
050100060401	Big Run	OHIO	1			X
050100060402	Little Sandy Creek-Redbank Creek	OHIO	1		X	
050100060602	Little Mahoning Creek-Mahoning Creek	OHIO	1			X
050100060703	Big Run	OHIO	1			X
050100060704	Canoe Creek	OHIO	1			X
050100060707	Mahoning Creek Lake-Mahoning Creek	OHIO	1			X
050100060901	South Branch Plum Creek	OHIO	1	X		
050100060902	Keystone Lake-North Branch Plum Creek	OHIO	1	X		
050100061002	McKee Run-Crooked Creek	OHIO	1	X		
050100061004	Cherry Run	OHIO	1			X
050100061005	Crooked Creek-Allegheny River	OHIO	1			X
050100070201	Dark Shade Creek	OHIO	1		X	
050100070301	Indian Lake-Lake Stonycreek-Rhoads Creek	OHIO	1		X	
050100070302	Headwaters Stonycreek River	OHIO	1		X	
050100070305	Upper Stonycreek River	OHIO	1		X	
050100070308	South Fork Bens Creek	OHIO	1		X	
050100070309	North Fork Bens Creek	OHIO	1		X	
050100070401	Beaverdam Run-South Fork Little Conemaugh	OHIO	1		X	
050100070402	South Fork Little Conemaugh-Little Conemaugh River	OHIO	1		X	
050100070503	Little Conemaugh River-Conemaugh River	OHIO	1		X	
050100070602	North Branch Blacklick Creek-Backlick Creek	OHIO	1		X	
050100070801	South Branch Two Lick Creek	OHIO	1			X
050100070802	North Branch Two Lick Creek	OHIO	1			X
050100070803	Cherry Run	OHIO	1			X
050100070804	Two Lick Creek-Blacklick Creek	OHIO	1			X
050100070901	South Branch Blacklick Creek	OHIO	1			X
050100070902	Mardis Creek-Blacklick Creek	OHIO	1			X
050100070903	Brush Creek	OHIO	1			X
050100070904	Backlick Creek-Conemaugh River	OHIO	1			X
050100071003	Hendricks Creek	OHIO	1		X	
050100071004	Tubmill Creek	OHIO	1		X	
050100080203	Beaver Run Reservoir-Beaver Run	OHIO	1		X	
050100090101	Patterson Creek	OHIO	1			X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

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HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
050100090102	Headwaters Buffalo Creek	OHIO	1		X	
050100090104	Little Buffalo Creek	OHIO	1			X
050100090202	Little Pine Creek-Pine Creek	OHIO	1		X	
050100090305	Plum Creek	OHIO	1		X	
050100090306	Squaw Run	OHIO	1		X	
050200030309	West Run-Monongahela River	OHIO	1		X	
050200040604	Middle Big Sandy Creek	OHIO	1		X	
050200040605	Lower Big Sandy Creek	OHIO	1		X	
050200050105	Hoovers Run-Dunkard Creek	OHIO	1		X	
050200050109	Meadow Run-Dunkard Creek	OHIO	1			X
050200050201	Mountain Creek	OHIO	1			X
050200050202	York Run	OHIO	1		X	
050200050301	Hargus Creek	OHIO	1		X	
050200050302	Grays Fork-South Fork Tenmile Creek	OHIO	1		X	
050200050303	Parsley Creek-South Fork Tenmile Creek	OHIO	1		X	
050200050403	Little Tenmile Creek	OHIO	1		X	
050200050404	Daniels Run	OHIO	1		X	
050200050405	Plum Run-Tenmile Creek	OHIO	1		X	
050200050501	Whiteley Creek	OHIO	1		X	
050200050503	Little Whitely Creek-Monongahela River	OHIO	1		X	
050200050601	Cove Run-Redstone Creek	OHIO	1			X
050200050602	Bolden Run-Redstone Creek	OHIO	1			X
050200050702	Brush Creek	OHIO	1			X
050200060406	Miller Run-Casselman River	OHIO	1			X
050200060501	Lake Somerset-East Branch Coxes Creek	OHIO	1			X
050200060602	Fall Creek-Laurel Hill Creek	OHIO	1			X
050200060701	Flaugherty Creek	OHIO	1			X
050200060703	Buffalo Creek	OHIO	1			X
050200060705	Middle Creek	OHIO	1			X
050200060708	Whites Creek	OHIO	1			X
050200060802	Champion Creek-Indian Creek	OHIO	1		X	
050200060803	Mill Run Reservoir-Indian Creek	OHIO	1		X	
050200060905	Mounts Creek	OHIO	1		X	
050301010101	Chartiers Run	OHIO	1		X	
050301010103	Little Chartiers Creek-Canonsburg Lake	OHIO	1			X
050301010105	Millers Run	OHIO	1			X
050301010201	Burgetts Fork	OHIO	1		X	
050301010202	Little Racoon Creek	OHIO	1		X	
050301010205	Traverse Creek	OHIO	1			X
050301010206	Ambridge Reservoir-Service Creek	OHIO	1			X
050301010207	Raredon Run-Racoon Creek	OHIO	1			X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
050301010304	Montour Run	OHIO	1	X		
050301010308	Big Sewickley Creek	OHIO	1			X
050301010606	Leslie Run-Bull Creek	OHIO	1		X	
050301010901	North Fork Cross Creek	OHIO	1		X	
050301010902	South Fork Cross Creek-Cross Creek	OHIO	1		X	
050301020102	Linesville Creek-Frontal Pymatuning Reservoir	OHIO	1			X
050301020201	Upper Little Shenango River	OHIO	1		X	
050301020304	Booth Run-Pymatuning Creek	OHIO	1			X
050301020401	Sugar Run-Shenango River	OHIO	1		X	
050301020403	Mathay Run-Shenango River	OHIO	1		X	
050301020501	Yellow Creek	OHIO	1		X	
050301020502	Cool Spring Creek	OHIO	1		X	
050301020507	Hottenbaugh Run-Neshannock Creek	OHIO	1		X	
050301040101	McKee Run-Beaver Creek	OHIO	1		X	
050301050201	East Branch Wolf Creek	OHIO	1			X
050301050202	Pine Swamp-Wolf Creek	OHIO	1			X
050301050303	McMurray Run-Slippery Rock Creek	OHIO	1		X	
050301050304	South Branch Slippery Rock Creek	OHIO	1		X	
050301050404	Thorn Creek	OHIO	1			X
050301050405	Glade Creek	OHIO	1			X
050301050406	Breakneck Creek	OHIO	1			X
050301050408	Brush Creek	OHIO	1			X
050301050409	Connoquenessing Creek-Beaver River	OHIO	1			X
050301060102	Headwaters Buffalo Creek	OHIO	1		X	
020401010305	Sherman Creek-Lower West Branch Delaware River	DEL	2	X	X	
020401010307	Balls Creek-Lower West Branch Delaware River	DEL	2		X	X
020401010402	Lower Equinunk Creek	DEL	2		X	X
020401010405	Little Equinunk Creek	DEL	2		X	X
020401010501	Hankins Creek-Delaware River	DEL	2		X	X
020401010506	Beaverdam Creek-Delaware River	DEL	2		X	X
020401010601	North Branch Calkins Creek	DEL	2		X	X
020401010602	South Branch Calkins Creek	DEL	2		X	X
020401010604	Peggy Run-Delaware River	DEL	2		X	X
020401010605	Masthope Creek	DEL	2		X	X
020401010606	Westcolang Creek-Delaware River	DEL	2		X	X
020401030301	Upper Middle Creek	DEL	2		X	X
020401030401	Jones Creek	DEL	2		X	X
020401030402	Butternut Creek-West Branch Wallenpaupack Creek	DEL	2		X	X
020401030502	East Branch Wallenpaupack	DEL	2		X	X
020401030504	Ariel Creek	DEL	2		X	X
020401030505	Lake Wallenpaupack-Wallenpaupack Creek	DEL	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020401030602	Blooming Grove Creek	DEL	2		X	X
020401030603	Lackawaxen River-Delaware River	DEL	2		X	X
020401040403	Lower Shohola Creek	DEL	2		X	X
020401040504	Twin Lakes Creek-Delaware River	DEL	2		X	X
020401040505	Shingle Kill-Delaware River	DEL	2		X	X
020401040703	Dingmans Creek	DEL	2		X	X
020401040704	Shimers Brook-Delaware River	DEL	2		X	X
020401040705	Hornbecks Creek-Delaware River	DEL	2		X	X
020401040803	Upper Pocono Creek	DEL	2		X	X
020401040904	Marshalls Creek	DEL	2		X	X
020401050301	Little Bushkill Creek	DEL	2		X	X
020401050302	Upper Bushkill Creek	DEL	2		X	X
020401050601	Allegheny Creek-Delaware River	DEL	2		X	X
020401050602	Martins Creek-Delaware River	DEL	2		X	X
020401050603	Buckhorn Creek-Delaware River	DEL	2		X	X
020401050604	Cooks Creek-Delaware River	DEL	2		X	X
020401050701	Upper Tohickon Creek	DEL	2		X	X
020401050703	Lower Tohickon Creek	DEL	2		X	X
020401050903	Tinicum Creek-Delaware River	DEL	2		X	X
020401050904	Harihokake Creek-Delaware River	DEL	2		X	X
020401050908	Paunnacussing Creek-Delaware River	DEL	2		X	X
020401050909	Pidcock Creek-Delaware River	DEL	2		X	X
020401050910	Jacobs Creek-Delaware River	DEL	2		X	X
020401060101	Stillwater Lake-Upper Tunkhannock Creek	DEL	2	X		X
020401060301	Black Creek-East Side of Lehigh River	DEL	2		X	X
020401060304	Stony Creek-Lehigh River	DEL	2		X	X
020401060306	Quakake Creek	DEL	2		X	X
020401060307	Beaver Creek-Black Creek	DEL	2		X	X
020401060308	Nesquehoning Creek	DEL	2		X	X
020401060309	Mahoning Creek	DEL	2		X	X
020401060501	Buckwha Creek	DEL	2		X	X
020401060701	Spring Creek	DEL	2		X	X
020401060702	Liebert Creek-Little Lehigh Creek	DEL	2	X		X
020401060703	Little Lehigh Creek-Lehigh River	DEL	2	X		X
020401060802	Trout Creek	DEL	2		X	X
020401060803	Bertsch Creek	DEL	2		X	X
020401060804	Fireline Creek-Lehigh River	DEL	2		X	X
020401060805	Indian Creek	DEL	2		X	X
020401060806	Hokendauqua Creek	DEL	2		X	X
020401060807	Coplay Creek	DEL	2		X	X
020401060809	East Branch Monocacy Creek	DEL	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020401060811	Saucon Creek	DEL	2		X	X
020401060813	Lehigh River-Delaware River	DEL	2		X	X
020402010201	North Branch Neshaminy Creek	DEL	2		X	X
020402010202	West Branch Neshaminy Creek	DEL	2		X	X
020402010204	Cooks Run-Neshaminy Creek	DEL	2		X	X
020402010301	Mill Creek-Neshaminy Creek	DEL	2		X	X
020402010302	Ironworks Creek-Mill Creek	DEL	2		X	X
020402010303	Core Creek-Neshaminy Creek	DEL	2		X	X
020402010407	Burlington Island-Delaware River	DEL	2	X	X	
020402020305	Swede Run-Delaware River	DEL	2	X	X	
020402020403	Pompeston Creek-Delaware River	DEL	2	X	X	
020402020504	Cobbs Creek	DEL	2	X	X	
020402020507	Woodbury Creek-Delaware River	DEL	2	X	X	
020402020604	West Branch Chester Creek	DEL	2		X	X
020402020607	Repaupo Creek-Delaware River	DEL	2	X	X	
020402030102	Upper Little Schuylkill River	DEL	2	X		X
020402030103	Lower Little Schuylkill River	DEL	2	X		X
020402030202	West Branch Schuylkill River	DEL	2	X	X	
020402030306	Willow Creek	DEL	2	X		X
020402030401	Mill Creek	DEL	2	X		X
020402030402	Headwaters Tulpehocken Creek	DEL	2	X	X	
020402030604	Laurel Run-Schuylkill River	DEL	2	X		X
020402030701	Upper French Creek	DEL	2		X	X
020402030807	East Branch Perkiomen Creek	DEL	2		X	X
020402030902	Lower Wissahickon Creek	DEL	2		X	X
020402031001	Pigeon Creek	DEL	2		X	X
020402031002	Sprogles Run-Schuylkill River	DEL	2		X	X
020402031003	Pickering Creek	DEL	2		X	X
020402031005	Stony Creek	DEL	2		X	X
020402031006	Mingo Creek-Schuylkill River	DEL	2		X	X
020402031007	Plymouth Creek-Schuylkill River	DEL	2		X	X
020402031008	City of Philadelphia-Schuylkill River	DEL	2	X	X	
020402050102	Beaver Creek	DEL	2		X	X
020402050103	Upper East Branch Brandywine Creek	DEL	2		X	X
020402050104	Valley Creek	DEL	2	X	X	
020402050203	Doe Run	DEL	2		X	X
020402050204	Buck Run	DEL	2		X	X
020501010302	Elk Creek	SUSQ NY	2	X	X	
020501011301	Shadigee Creek	SUSQ	2		X	X
020501011302	Upper Starrucca Creek	SUSQ	2		X	X
020501011303	Middle Starrucca Creek	SUSQ	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

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HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020501011304	Lower Starrucca Creek	SUSQ	2	X	X	
020501011305	Canawacta Creek-Susquehanna River	SUSQ	2		X	X
020501011306	Salt Lick Creek	SUSQ	2		X	X
020501011308	Mitchell Creek-Susquehanna River	SUSQ	2		X	X
020501011310	Snake Creek	SUSQ	2		X	X
020501011311	Little Snake Creek	SUSQ	2		X	X
020501011312	Carlin Creek	SUSQ	2		X	X
020501030203	Middle Chocohut Creek	SUSQ	2		X	X
020501030501	Apalachin Creek	SUSQ	2		X	X
020501030605	Lower Cayuta Creek	SUSQ	2		X	X
020501030701	Upper Wappasening Creek	SUSQ	2		X	X
020501030702	Middle Wappasening Creek	SUSQ	2		X	X
020501030703	Lower Wappasening Creek	SUSQ	2		X	X
020501030704	Sackett Creek-Susquehanna River	SUSQ	2		X	X
020501030706	Parks Creek-Susquehanna River	SUSQ	2		X	X
020501030707	Satterlee Creek-Susquehanna River	SUSQ	2		X	X
020501040301	South Branch Tuscarora Creek	SUSQ NY	2	X	X	
020501040302	Upper Tuscarora Creek	SUSQ NY	2	X	X	
020501040303	North Branch Tuscarora Creek	SUSQ NY	2	X	X	
020501040304	Middle Tuscarora Creek	SUSQ NY	2	X	X	
020501040305	Elk Creek	SUSQ NY	2	X	X	
020501040306	Lower Tuscarora Creek	SUSQ NY	2	X	X	
020501040604	Upper Crooked Creek	SUSQ	2	X	X	
020501040809	Lower Cowanesque River	SUSQ	2	X		X
020501040909	Glendening Creek	SUSQ NY	2	X	X	
020501050403	Sing Sing Creek	SUSQ NY	2	X	X	
020501050405	Hendy Creek-Chemung River	SUSQ NY	2	X	X	
020501050504	Hammond Creek	SUSQ	2		X	X
020501050505	Mudlick Creek	SUSQ	2		X	X
020501050506	South Creek	SUSQ	2		X	X
020501050507	Seeley Creek	SUSQ	2		X	X
020501050508	Coldbrook Creek-Chemung River	SUSQ NY	2	X	X	
020501050601	Upper Bentley Creek	SUSQ	2		X	X
020501050602	Middle Bentley Creek	SUSQ	2		X	X
020501050603	Lower Bentley Creek	SUSQ	2		X	X
020501050605	Shoemaker Mountain-Chemung River	SUSQ	2		X	X
020501050607	Dry Brook-Chemung River	SUSQ	2		X	X
020501050608	Wolcott Creek-Chemung River	SUSQ	2		X	X
020501060103	Leonard Creek	SUSQ	2		X	X
020501060105	Tomjack Creek	SUSQ	2		X	X
020501060107	Bailey Run-Sugar Creek	SUSQ	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020501060301	Headwaters Towanda Creek	SUSQ	2		X	X
020501060401	Bullard Creek	SUSQ	2		X	X
020501060402	Johnson Creek	SUSQ	2		X	X
020501060403	Parks Creek-Wysox Creek	SUSQ	2		X	X
020501060501	Spaulding Creek-Susquehanna River	SUSQ	2		X	X
020501060502	Laning Creek-Upper Susquehanna River	SUSQ	2		X	X
020501060503	Rummerfield Creek-Susquehanna River	SUSQ	2		X	X
020501060702	Gaylord Creek	SUSQ	2		X	X
020501060704	Rockwell Creek-Wyalusing Creek	SUSQ	2		X	X
020501060705	Cold Creek-Wyalusing Creek	SUSQ	2		X	X
020501060801	Riley Creek	SUSQ	2		X	X
020501060802	West Branch Meshoppen Creek	SUSQ	2		X	X
020501060803	Thomas Creek-Meshoppen Creek	SUSQ	2		X	X
020501060804	Little Meshoppen Creek-Meshoppen Creek	SUSQ	2		X	X
020501060903	Lower Mehoopany Creek	SUSQ	2		X	X
020501061002	Lower East Branch Tunkhannock Creek	SUSQ	2		X	X
020501061201	Upper Tunhannock Creek	SUSQ	2		X	X
020501061202	Butler Creek	SUSQ	2		X	X
020501061203	Nine Partners Creek	SUSQ	2		X	X
020501061204	Middle Tunkhannock Creek	SUSQ	2		X	X
020501061301	Leonard Creek	SUSQ	2		X	X
020501061303	Lower Bowman Creek	SUSQ	2		X	X
020501061401	Sugar Run	SUSQ	2		X	X
020501061402	Sugar Run Creek	SUSQ	2		X	X
020501061403	Tuscarora Creek	SUSQ	2		X	X
020501061404	Little Tuscurora Creek-Lower Susquehanna River	SUSQ	2		X	X
020501061405	Little Mehoopany Creek-Lower Susquehanna River	SUSQ	2		X	X
020501061406	Mill Run-Lower Susquehanna River	SUSQ	2		X	X
020501061407	Buttermilk Creek	SUSQ	2		X	X
020501061408	Gardner Creek	SUSQ	2		X	X
020501061409	Obendoffers Creek-Susquehanna River	SUSQ	2		X	X
020501070201	Abrahams Creek	SUSQ	2		X	X
020501070202	City of Wilkes-Barre-Mill Creek	SUSQ	2		X	X
020501070203	Toby Creek	SUSQ	2		X	X
020501070205	City of Wilkes-Barre-Susquehanna River	SUSQ	2		X	X
020501070207	Newport Creek	SUSQ	2		X	X
020501070208	Warrior Creek-Susquehanna River	SUSQ	2		X	X
020501070301	Harveys Lake-Harveys Creek	SUSQ	2		X	X
020501070302	Hunlock Creek	SUSQ	2		X	X
020501070303	Little Shickshinny Creek-Shickshinny Creek	SUSQ	2		X	X
020501070307	City of Berwick-Susquehanna River	SUSQ	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

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HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020501070402	Black Creek	SUSQ	2		X	X
020501070403	Nescopeck Creek-Susquehanna River	SUSQ	2		X	X
020501070501	Headwaters Huntington Creek	SUSQ	2	X		X
020501070502	Kitchen Creek	SUSQ	2	X		X
020501070702	West Branch Fishing Creek	SUSQ	2	X	X	
020501070703	West Creek	SUSQ	2		X	X
020501070801	Little Catawissa Creek	SUSQ	2		X	X
020501070802	Tomicken Creek	SUSQ	2		X	X
020501070803	Messers Run-Catawissa Creek	SUSQ	2		X	X
020501070804	Beaver Run-Catawissa Creek	SUSQ	2		X	X
020501070805	Catawissa Creek-Susquehanna River	SUSQ	2		X	X
020501070901	Mugser Run-South Branch Roaring Creek	SUSQ	2		X	X
020501070902	Roaring Creek-Susquehanna River	SUSQ	2		X	X
020501071001	Briar Creek	SUSQ	2		X	X
020501071002	Tenmile Creek-Susquehanna River	SUSQ	2		X	X
020501071003	Logan Run	SUSQ	2		X	X
020501071004	Sechler Run	SUSQ	2		X	X
020501071005	Mahoning Creek	SUSQ	2		X	X
020501071006	City of Sunbury-Susquehanna River	SUSQ	2		X	X
020502010201	Upper Anderson Creek	SUSQ	2		X	X
020502010202	Lower Anderson Creek	SUSQ	2		X	X
020502010302	Slate Lick Run	SUSQ	2		X	X
020502010303	Glendale Dam-Beaverdam Run	SUSQ	2		X	X
020502010304	Upper Clearfield Creek	SUSQ	2		X	X
020502010401	Headwaters West Branch Susquehanna River	SUSQ	2		X	X
020502010407	Montgomery Creek	SUSQ	2		X	X
020502010408	Curwensville Dam-West Branch Susquehanna River	SUSQ	2		X	X
020502010505	Sixmile Run	SUSQ	2	X		X
020502010507	Black Moshannon Creek	SUSQ	2	X	X	
020502010602	Gifford Run-Mosquito Creek	SUSQ	2		X	X
020502010701	Lick Run	SUSQ	2		X	X
020502010704	Deer Creek	SUSQ	2		X	X
020502010705	Sandy Creek	SUSQ	2		X	X
020502010706	Alder Run	SUSQ	2		X	X
020502010708	Upper Three Runs	SUSQ	2		X	X
020502010709	Saltlick Run-West Branch Susquehanna River	SUSQ	2		X	X
020502020201	Elk Fork-Driftwood Branch Sinnemahoning Creek	SUSQ	2	X	X	
020502020203	North Creek	SUSQ	2	X	X	
020502020206	Sterling Run	SUSQ	2	X		X
020502020301	Upper Bennett Branch Sinnemahoning Creek	SUSQ	2		X	X
020502020302	Kersey Run	SUSQ	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

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HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020502020305	Middle Bennett Branch Sinnemahoning Creek	SUSQ	2		X	X
020502020306	Spring Run	SUSQ	2	X	X	
020502020307	Trout Run	SUSQ	2		X	X
020502020309	East Branch Hicks Run	SUSQ	2	X	X	
020502020310	Hicks Run	SUSQ	2	X	X	
020502020311	Mix Run	SUSQ	2	X	X	
020502020312	Lower Bennett Branch Sinnemahoning Creek	SUSQ	2	X	X	
020502020402	South Woods Branch	SUSQ	2		X	X
020502020405	East Fork Sinnemahoning Creek	SUSQ	2	X	X	
020502020406	Middle First Fork Sinnemahoning Creek	SUSQ	2	X	X	
020502020407	Lower First Fork Sinnemahoning Creek	SUSQ	2	X	X	
020502020501	Wykoff Run	SUSQ	2	X	X	
020502030202	Fish Dam Run-West Branch Susquehanna River	SUSQ	2	X	X	
020502030204	Paddy Run	SUSQ	2	X	X	
020502030401	Hyner Run	SUSQ	2	X	X	
020502030408	Ferney Run-West Branch Susquehanna River	SUSQ	2		X	X
020502030411	Chatham Run	SUSQ	2		X	X
020502030412	Reeds Run-West Branch Susquehanna River	SUSQ	2		X	X
020502040103	Big Hollow	SUSQ	2	X		X
020502040201	South Fork Beach Creek	SUSQ	2	X		X
020502040204	Big Run	SUSQ	2	X		X
020502040401	Laurel Run-Bald Eagle Creek	SUSQ	2		X	X
020502050101	Lyman Run	SUSQ	2		X	X
020502050202	Headwaters Pine Creek	SUSQ	2		X	X
020502050204	West Branch Pine Creek-Pine Creek	SUSQ	2		X	X
020502050206	Elk Run	SUSQ	2	X	X	
020502050207	Long Run	SUSQ	2		X	X
020502050208	Lick Run-Pine Creek	SUSQ	2	X	X	
020502050302	Asaph Run	SUSQ	2	X	X	
020502050506	Little Pine Creek-Pine Creek	SUSQ	2	X	X	
020502050601	Trout Run-Pine Creek	SUSQ	2	X	X	
020502050602	Cedar Run	SUSQ	2	X	X	
020502050603	Slate Run	SUSQ	2	X	X	
020502050607	Pine Creek-West Branch Susquehanna River	SUSQ	2		X	X
020502060102	First Fork Larrys Creek	SUSQ	2		X	X
020502060206	Trout Run-Lycoming Creek	SUSQ	2	X		X
020502060301	Lopez Creek	SUSQ	2	X	X	
020502060302	Glass Creek-Loyalsock Creek	SUSQ	2		X	X
020502060303	Birch Creek	SUSQ	2		X	X
020502060304	Little Loyalsock Creek-Loyalsock Creek	SUSQ	2	X	X	
020502060402	Black Creek-Little Loyalsock Creek	SUSQ	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020502060503	Ogdonia Creek-Loyalsock Creek	SUSQ	2	X		X
020502060603	Mosquito Creek	SUSQ	2	X	X	
020502060604	Millers Run	SUSQ	2		X	X
020502060701	Beaver Run	SUSQ	2		X	X
020502060702	Big Run	SUSQ	2		X	X
020502060803	Gregs Run-Muncy Creek	SUSQ	2		X	X
020502060901	Spring Creek	SUSQ	2		X	X
020502061004	Little Buffalo Creek	SUSQ	2		X	X
020502061005	Buffalo Creek-West Branch Susquehanna River	SUSQ	2		X	X
020502061101	Mud Creek	SUSQ	2		X	X
020502061102	Upper Branches Chillisquaque Creek	SUSQ	2		X	X
020502061103	Chillisquaque Creek-West Branch Susquehanna River	SUSQ	2		X	X
020502061201	White Deer Creek-Lower West Branch Susquehanna River	SUSQ	2	X	X	
020502061202	Delaware Run-Lower West Branch Susquehanna River	SUSQ	2		X	X
020502061203	Warrior Run	SUSQ	2		X	X
020502061205	Muddy Run-Lower West Branch Susquehanna River	SUSQ	2		X	X
020502061207	West Branch Susquehanna River-Susquehanna River	SUSQ	2		X	X
020503010101	Shamokin Creek-City of Shamokin	SUSQ	2		X	X
020503010103	Little Shamokin Creek	SUSQ	2		X	X
020503010301	Faylor Lake Dam-South Branch Middle Creek	SUSQ	2		X	X
020503010302	North Branch Middle Creek-Walker Lake Dam	SUSQ	2		X	X
020503010303	North Branch Middle Creek	SUSQ	2		X	X
020503010304	Beaver Creek-Middle Creek	SUSQ	2		X	X
020503010305	Middle Creek-Penns Creek	SUSQ	2		X	X
020503010401	Colyer Lake-Sinking Creek	SUSQ	2		X	X
020503010402	Headwaters Penns Creek	SUSQ	2		X	X
020503010502	Schwaben Creek	SUSQ	2		X	X
020503010503	Lower Mahanoy Creek-Susquehanna River	SUSQ	2		X	X
020503010601	North Branch Mahantango Creek	SUSQ	2		X	X
020503010602	Upper West Branch Mahantango Creek	SUSQ	2		X	X
020503010603	Lower West Branch Mahantango Creek	SUSQ	2		X	X
020503010701	Hans Yost Creek-Deep Creek	SUSQ	2		X	X
020503010901	Upper Wiconisco Creek	SUSQ	2		X	X
020503010903	Little Wiconisco Creek	SUSQ	2		X	X
020503010904	Lower Wiconisco Creek	SUSQ	2		X	X
020503011001	Hallowing Run-Susquehanna River	SUSQ	2		X	X
020503011003	Bargers Run-Susquehanna River	SUSQ	2		X	X
020503011004	Armstrong Creek	SUSQ	2		X	X
020503011005	Powell Creek	SUSQ	2		X	X
020503011006	Haldeman Island-Susquehanna River	SUSQ	2		X	X
020503020101	Beaverdam Creek	SUSQ	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020503020401	Beaver Branch	SUSQ	2		X	X
020503020402	Halfmoon Creek	SUSQ	2		X	X
020503020404	Spruce Creek-Little Juniata River	SUSQ	2		X	X
020503020501	Bells Gap Run	SUSQ	2	X		X
020503020502	Upper Little Juniata River	SUSQ	2		X	X
020503020601	Upper Shaver Creek	SUSQ	2		X	X
020503020602	Lower Shaver Creek	SUSQ	2		X	X
020503020701	Laurel Run	SUSQ	2	X		X
020503020702	Upper Standing Stone Creek	SUSQ	2		X	X
020503020803	Crooked Creek-Juniata River	SUSQ	2		X	X
020503030101	Shawnee Branch-Shawnee Lake	SUSQ	2		X	X
020503030102	Headwaters Raystown Branch Juniata River	SUSQ	2		X	X
020503030103	Buffalo Run	SUSQ	2		X	X
020503030105	Cumberland Valley Run-Raystown Branch Juniata River	SUSQ	2		X	X
020503030402	Shaffer Creek	SUSQ	2		X	X
020503030501	Cove Creek	SUSQ	2		X	X
020503030502	Snake Spring Valley Run	SUSQ	2		X	X
020503030503	Clear Creek	SUSQ	2		X	X
020503030601	Beaver Creek	SUSQ	2		X	X
020503030801	Shoup Run	SUSQ	2	X	X	
020503030804	Raystown Lake-Raystown Branch Juniata River-Juniata River	SUSQ	2		X	X
020503040101	Saddler Creek	SUSQ	2		X	X
020503040103	Hares Valley Creek-Juniata River	SUSQ	2		X	X
020503040201	Upper Sideling Hill Creek	SUSQ	2		X	X
020503040501	West Licking Creek-Juniata River	SUSQ	2		X	X
020503040502	Musser Run-Juniata River	SUSQ	2		X	X
020503040503	Strodes Run-Juniata River	SUSQ	2		X	X
020503040701	Upper Kishacoquillas Creek	SUSQ	2		X	X
020503040801	Meadow Creek-Jacks Creek	SUSQ	2		X	X
020503040803	Horning Creek-Juniata River	SUSQ	2		X	X
020503040901	Narrows Branch Tuscarora Creek	SUSQ	2		X	X
020503040903	Horse Valley Run	SUSQ	2	X		X
020503040906	East Licking Creek	SUSQ	2		X	X
020503041101	Upper Buffalo Creek	SUSQ	2		X	X
020503041102	Lower Buffalo Creek	SUSQ	2		X	X
020503041202	Raccoon Creek	SUSQ	2		X	X
020503041203	Little Buffalo Creek	SUSQ	2		X	X
020503041204	Juniata River-Susquehanna River	SUSQ	2		X	X
020503050102	Bull Run	SUSQ	2	X	X	
020503050105	Laurel Run	SUSQ	2	X		X
020503050202	Lehman Run-Muddy Run	SUSQ	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020503050203	Trout Run-Conodoguinet Creek	SUSQ	2		X	X
020503050301	Thompson Creek-Burd Run	SUSQ	2		X	X
020503050302	Middle Spring Creek	SUSQ	2		X	X
020503050304	Bulls Head Branch	SUSQ	2	X		X
020503050305	Green Spring Creek	SUSQ	2		X	X
020503050401	Mount Rock Spring Creek	SUSQ	2	X		X
020503050402	Alexanders Spring Creek	SUSQ	2	X		X
020503050404	Letort Spring Run	SUSQ	2	X		X
020503050405	Hogestown Run	SUSQ	2	X		X
020503050407	Trindle Spring Run	SUSQ	2	X		X
020503050408	Conodoguinet Creek-Susquehanna River	SUSQ	2	X		X
020503050501	Headwaters Yellow Breeches Creek	SUSQ	2		X	X
020503050502	Upper Yellow Breeches Creek	SUSQ	2		X	X
020503050503	Mountain Creek	SUSQ	2		X	X
020503050504	Middle Yellow Breeches Creek	SUSQ	2		X	X
020503050505	Lower Yellow Breeches Creek	SUSQ	2		X	X
020503050602	Good Spring Creek-Upper Swatara Creek	SUSQ	2		X	X
020503050604	Mill Creek	SUSQ	2	X		X
020503050801	Killinger Creek	SUSQ	2		X	X
020503050802	Snitz Creek-Quittapahilla Creek	SUSQ	2		X	X
020503050901	Reeds Run-Swatara Creek	SUSQ	2	X		X
020503050902	Bow Creek-Swatara Creek	SUSQ	2		X	X
020503050905	Beaver Creek	SUSQ	2		X	X
020503051001	Little Juniata Creek	SUSQ	2		X	X
020503051003	Stony Creek	SUSQ	2	X		X
020503051004	Fishing Creek-Dauphin County	SUSQ	2		X	X
020503051005	Fishing Creek-Perry County	SUSQ	2		X	X
020503051007	Paxton Creek	SUSQ	2	X		X
020503051009	Fishing Creek-York County	SUSQ	2		X	X
020503051010	Conewago Creek	SUSQ	2		X	X
020503060101	Headwaters South Branch Conewago Creek	SUSQ	2		X	X
020503060201	Opossum Creek	SUSQ	2		X	X
020503060202	Headwaters Conewago Creek	SUSQ	2		X	X
020503060204	Boro of East Berlin-Conewago Creek	SUSQ	2		X	X
020503060301	Latimore Creek	SUSQ	2		X	X
020503060302	North Branch Bermudian Creek	SUSQ	2		X	X
020503060303	Mud Run-Bermudian Creek	SUSQ	2		X	X
020503060401	Upper Little Conewago Creek	SUSQ	2		X	X
020503060501	Beaver Creek	SUSQ	2		X	X
020503060503	Conewago Lake-Beaver Creek	SUSQ	2		X	X
020503060504	Conewago Creek-Susquehanna River	SUSQ	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020503060706	Mill Creek	SUSQ	2		X	X
020503060707	Codorus Creek-Susquehanna River	SUSQ	2		X	X
020503060801	Upper Chickies Creek	SUSQ	2		X	X
020503060901	Little Cocalico Creek-Cocalico Creek	SUSQ	2		X	X
020503060902	Middle Creek	SUSQ	2		X	X
020503060903	Hammer Creek	SUSQ	2		X	X
020503061001	Millers Run-Little Conestoga Creek	SUSQ	2	X		X
020503061002	West Branch Little Conestoga Creek-Little Conestoga Creek	SUSQ	2	X		X
020503061101	Little Muddy Creek	SUSQ	2		X	X
020503061102	Muddy Creek	SUSQ	2		X	X
020503061103	Upper Conestoga River	SUSQ	2		X	X
020503061105	Lititz Run	SUSQ	2	X		X
020503061106	Muddy Run-Mill Creek	SUSQ	2	X		X
020503061107	Lower Conestoga River	SUSQ	2	X		X
020503061201	Headwaters Pequea Creek	SUSQ	2		X	X
020503061202	Eshleman Run-Pequea Creek	SUSQ	2	X		X
020503061204	Climbers Run-Pequea Creek	SUSQ	2	X		X
020503061301	North Branch Muddy Creek	SUSQ	2		X	X
020503061402	Valley Creek-East Branch Octoraro Creek	SUSQ	2		X	X
020503061403	Muddy Run-East Branch Octoraro Creek	SUSQ	2		X	X
020503061601	Headwaters Deer Creek	SUSQ	2		X	X
020503061703	Kreutz Creek	SUSQ	2		X	X
020503061705	Fishing Creek	SUSQ	2		X	X
020503061707	Otter Creek	SUSQ	2		X	X
020503061708	Muddy Run-Susquehanna River	SUSQ	2		X	X
020600020101	Little North East Creek	POT	2	X	X	
020600020201	East Branch Big Elk Creek	POT	2		X	X
020600020202	Little Elk Creek	POT	2	X	X	
020600020203	Big Elk Creek	POT	2	X	X	
020600030401	Little Falls	POT	2		X	X
020700020503	Little Wills Creek	POT	2		X	X
020700020504	Gladdens Run	POT	2		X	X
020700020505	Jennings Run	POT	2		X	X
020700020506	Shaffers Run-Wills Creek	POT	2		X	X
020700020602	Rocky Gap Run-Evitts Creek	POT	2		X	X
020700030101	Wilson Run-Elk Lick Creek	POT	2		X	X
020700030104	Sweet Root Creek-Town Creek	POT	2		X	X
020700030301	Upper Fifteenmile Creek	POT	2	X	X	
020700030304	Crooked Run-Sideling Hill Creek	POT	2	X	X	
020700030305	Bear Creek-Sideling Hill Creek	POT	2	X	X	
020700030403	Piney Creek	POT	2	X	X	

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

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HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020700040101	Little Tonoloway Creek(PA)	POT	2		X	X
020700040302	Big Cove Creek	POT	2		X	X
020700040601	Headwaters West Branch Conococheague Creek	POT	2		X	X
020700040603	Middle West Branch Conococheague Creek	POT	2		X	X
020700040604	Licking Creek	POT	2		X	X
020700040605	Lower West Branch Conococheague Creek	POT	2		X	X
020700040701	Rocky Spring Branch	POT	2		X	X
020700040801	Rocky Mountain Creek	POT	2		X	X
020700040803	Mountain Creek-Conococheague Creek	POT	2		X	X
020700040805	Falling Spring Branch-Conococheague Creek	POT	2		X	X
020700040806	Rockdale Run-Conococheague Creek	POT	2		X	X
020700040807	Meadow Brook-Conococheague Creek	POT	2		X	X
020700041001	Red Run	POT	2		X	X
020700041002	East Branch Antietam Creek	POT	2		X	X
020700041003	West Branch Antietam Creek	POT	2		X	X
020700041102	Little Conococheague Creek	POT	2		X	X
020700090101	Upper Rock Creek	POT	2		X	X
020700090201	Little Marsh Creek	POT	2		X	X
020700090202	Upper Marsh Creek	POT	2		X	X
020700090301	Upper Toms Creek	POT	2		X	X
020700090302	Middle Creek	POT	2		X	X
020700090303	Lower Toms Creek	POT	2		X	X
020700090503	Cattail Branch-Monocacy River	POT	2	X	X	
041100030101	East Branch Ashtabula River	STLAW	2		X	X
041201010401	Freelings Creek-Frontal Lake Erie	STLAW	2		X	X
041201010403	Sixteenmile Creek	STLAW	2		X	X
041201010405	Sixmile Creek	STLAW	2		X	X
041201010406	Mill Creek-Frontal Lake Erie	STLAW	2	X	X	
041201010407	Walnut Creek	STLAW	2		X	X
041201010408	Elk Creek-Frontal Lake Erie	STLAW	2	X	X	
041201010501	Upper Elk Creek	STLAW	2		X	X
041201010602	East Branch of West Branch Conneaut Creek	STLAW	2	X	X	
041201010603	West Branch Conneaut Creek	STLAW	2	X	X	
041201010604	Temple Creek-East Branch Conneaut Creek	STLAW	2		X	X
041201010605	Marsh Run-Conneaut Creek	STLAW	2		X	X
041201010701	Crooked Creek	STLAW	2	X	X	
041300020101	Middle Branch Genesee River	STLAW	2		X	X
050100010302	Mill Creek	OHIO	2		X	X
050100010602	West Branch Tunungwant Creek	OHIO	2		X	X
050100010603	Kendall Creek-Tunungwant Creek	OHIO	2		X	X
050100010604	Bolivar Run-Tunungwant Creek	OHIO	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
050100010904	Chappel Fork	OHIO	2		X	X
050100010905	Kinzua Creek Outlet	OHIO	2		X	X
050100011103	Hare Creek	OHIO	2		X	X
050100011201	Quaker Run-Allegheny River	OHIO	2		X	X
050100011202	Wolf Run-Allegheny River	OHIO	2		X	X
050100011203	Willow Creek-Allegheny River	OHIO	2		X	X
050100011204	Sawmill Run-Allegheny River	OHIO	2		X	X
050100011206	Sugar Run-Allegheny River	OHIO	2		X	X
050100011207	Browns Run	OHIO	2		X	X
050100011209	Morse Run-Allegheny River	OHIO	2		X	X
050100020505	Storehouse Run-Conewago Creek	OHIO	2		X	X
050100020506	Akeley Run	OHIO	2		X	X
050100030101	Stewards Island-Allegheny River	OHIO	2		X	X
050100030102	Tidioute Creek	OHIO	2		X	X
050100030103	Perry Magee Run-Allegheny River	OHIO	2		X	X
050100030106	Tubbs Run-Allegheny River	OHIO	2		X	X
050100030301	Farnsworth Branch	OHIO	2	X	X	
050100030302	Elkhorn Run-West Branch Tionesta Creek	OHIO	2		X	X
050100030303	Fourmile Run	OHIO	2	X		X
050100030601	Mosey Creek-Oil Creek	OHIO	2		X	X
050100030602	East Branch Oil Creek	OHIO	2		X	X
050100030701	Little East Sandy Creek-East Sandy Creek	OHIO	2		X	X
050100030702	Pine Run	OHIO	2		X	X
050100030703	East Sandy Creek-Alleghey River	OHIO	2		X	X
050100030803	South Sandy Creek	OHIO	2		X	X
050100030804	Sandy Creek-Allegheny River	OHIO	2		X	X
050100030901	Hemlock Creek	OHIO	2		X	X
050100030902	Stewart Run-Allegheny River	OHIO	2		X	X
050100030903	Pithole Creek	OHIO	2		X	X
050100030905	Horse Creek-Allegheny River	OHIO	2		X	X
050100030906	Scrubgrass Creek	OHIO	2		X	X
050100030907	Lower Twomile Run-Allegheny River	OHIO	2		X	X
050100030908	Little Scrubgrass Creek	OHIO	2		X	X
050100030909	Clarion River-Allegheny River	OHIO	2		X	X
050100040601	West Branch Cussewago Creek-Cussewago Creek	OHIO	2		X	X
050100040602	Carr Run-Cussewago Creek	OHIO	2		X	X
050100040603	Spring Run-Cussewago Creek	OHIO	2		X	X
050100040701	Conneaut Lake-Conneaut Outlet	OHIO	2		X	X
050100040702	Williams Run-Conneaut Outlet	OHIO	2		X	X
050100040703	Rock Creek-Conneaut Outlet	OHIO	2		X	X
050100040802	East Branch Sugar Creek-Sugar Creek	OHIO	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

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HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
050100040805	East Branch Sugar Creek-Sugar Creek	OHIO	2		X	X
050100040906	Van Home Creek-French Creek	OHIO	2		X	X
050100050101	East Branch Clarion River-East Branch Lake Dam	OHIO	2	X	X	
050100050401	Brandy Camp Creek	OHIO	2		X	X
050100050402	Upper Little Toby Creek	OHIO	2		X	X
050100050403	Middle Little Toby Creek	OHIO	2		X	X
050100050404	Rattlesnake Creek	OHIO	2		X	X
050100050405	Lower Little Toby Creek	OHIO	2		X	X
050100050502	Spring Creek-Clarion River	OHIO	2		X	X
050100050607	East Branch Millstone Creek-Millstone Creek	OHIO	2	X	X	
050100050702	Mill Creek	OHIO	2		X	X
050100050703	Toby Creek	OHIO	2		X	X
050100050801	Little Piney Creek	OHIO	2		X	X
050100050802	Piney Creek-Clarion River	OHIO	2		X	X
050100050901	Licking Creek	OHIO	2		X	X
050100050902	Paint Creek	OHIO	2		X	X
050100050903	Deer Creek-Clarion River	OHIO	2		X	X
050100051001	Canoe Creek	OHIO	2		X	X
050100051002	Beaver Creek	OHIO	2		X	X
050100051003	Cherry Run	OHIO	2		X	X
050100051004	Licking Creek	OHIO	2		X	X
050100051005	Turkey Run-Clarion River	OHIO	2		X	X
050100060101	North Branch Bear Creek	OHIO	2		X	X
050100060102	South Branch Bear Creek	OHIO	2		X	X
050100060201	South Branch-North Fork Redbank Creek	OHIO	2		X	X
050100060202	Pekin Run-North Fork Redbank Creek	OHIO	2		X	X
050100060301	Laborde Branch	OHIO	2		X	X
050100060303	Gravel Lick Run-Sandy Lick Creek	OHIO	2		X	X
050100060304	Mill Creek	OHIO	2		X	X
050100060305	Fivemile Run	OHIO	2		X	X
050100060306	Sandy Lick Creek-Redbank Creek	OHIO	2		X	X
050100060501	Upper Redbank Creek	OHIO	2		X	X
050100060502	Middle Redbank Creek	OHIO	2		X	X
050100060503	Leatherwood Creek	OHIO	2		X	X
050100060504	Lower Redbank Creek	OHIO	2		X	X
050100060601	North Branch Little Mahoning Creek-Little Mahoning Creek	OHIO	2		X	X
050100060701	Stump Creek	OHIO	2		X	X
050100060702	East Branch Mahoning Creek	OHIO	2		X	X
050100060708	Pine Run	OHIO	2		X	X
050100060709	Mahoning Creek-Allegheny River	OHIO	2		X	X
050100060801	Upper Cowanshannock Creek	OHIO	2	X	X	

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
050100060802	Lower Cowanshannock Creek	OHIO	2		X	X
050100061001	Headwaters Crooked Creek	OHIO	2		X	X
050100061102	Catfish Run-Allegheny River	OHIO	2		X	X
050100061104	North Fork Pine Creek	OHIO	2		X	X
050100061105	Limestone Run-Allegheny River	OHIO	2		X	X
050100061106	Glade Run	OHIO	2		X	X
050100061107	Garretts Run-Allegheny River	OHIO	2		X	X
050100070101	North Branch Quemahoning Creek	OHIO	2		X	X
050100070102	Beaverdam Creek-Quemahoning Creek	OHIO	2		X	X
050100070103	Roaring Run-Quemahoning Creek	OHIO	2		X	X
050100070202	Clear Shade Creek	OHIO	2		X	X
050100070203	Shade Creek-Stony Creek	OHIO	2		X	X
050100070303	Wells Creek	OHIO	2		X	X
050100070304	Beaverdam Creek	OHIO	2		X	X
050100070306	Middle Stonycreek River	OHIO	2		X	X
050100070307	Paint Creek	OHIO	2		X	X
050100070310	Lower Stonycreek River-Conemaugh River	OHIO	2		X	X
050100070501	North Branch Little Conemaugh	OHIO	2		X	X
050100070502	Bens Creek-Little Conemaugh River	OHIO	2		X	X
050100070601	Elk Creek	OHIO	2		X	X
050100071001	Hinckston Run-Conemaugh River	OHIO	2		X	X
050100071002	Baldwin Creek-Conemaugh River	OHIO	2		X	X
050100071005	Richards Run-Conemaugh River	OHIO	2		X	X
050100071006	McGee Run	OHIO	2		X	X
050100071007	Aultmans Run	OHIO	2		X	X
050100071008	Conemaugh River-Kiskiminetas River	OHIO	2		X	X
050100080102	Mill Creek	OHIO	2		X	X
050100080103	Fourmile Run	OHIO	2		X	X
050100080104	Upper Loyalhanna Creek	OHIO	2		X	X
050100080105	Ninemile Run	OHIO	2		X	X
050100080106	Middle Loyalhanna Creek	OHIO	2		X	X
050100080107	Crabtree Creek	OHIO	2		X	X
050100080108	Lower Loyalhanna Creek	OHIO	2		X	X
050100080202	Roaring Run-Kiskiminetas River	OHIO	2		X	X
050100080204	Pine Run	OHIO	2		X	X
050100080205	Kiskiminetas River-Allegheny River	OHIO	2		X	X
050100090201	Pine Creek-North Park Lake	OHIO	2		X	X
050100090301	Bull Creek	OHIO	2		X	X
050100090302	Pucketa Creek	OHIO	2		X	X
050100090303	Deer Creek	OHIO	2		X	X
050100090304	Chartiers Run-Allegheny River	OHIO	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
050100090307	Girtys Run	OHIO	2	X	X	
050200040601	Fike Run-Little Sandy Creek	OHIO	2		X	X
050200040707	Cheat Lake-Cheat River	OHIO	2		X	X
050200050101	Blockhouse Run-Toms Run	OHIO	2	X	X	
050200050108	Jakes Run-Dunkard Creek	OHIO	2	X		X
050200050401	Bane Creek	OHIO	2		X	X
050200050402	Short Creek-Tenmile Creek	OHIO	2		X	X
050200050502	Browns Run	OHIO	2		X	X
050200050504	Muddy Creek	OHIO	2		X	X
050200050505	Pumpkin Run	OHIO	2		X	X
050200050506	Dunlap Creek	OHIO	2		X	X
050200050507	Fishpot Run-Monongahela River	OHIO	2		X	X
050200050703	Thompson Run	OHIO	2	X		X
050200050704	Sawmill Run-Turtle Creek	OHIO	2	X		X
050200050801	Pike Run	OHIO	2		X	X
050200050802	Little Redstone Creek-Monongahela River	OHIO	2		X	X
050200050803	Maple Creek-Monongahela River	OHIO	2		X	X
050200050804	Pigeon Creek	OHIO	2		X	X
050200050805	Mingo Creek-Monongahela River	OHIO	2		X	X
050200060303	Buffalo Run	OHIO	2		X	X
050200060304	Mill Run	OHIO	2		X	X
050200060305	Youghiogheny River Lake	OHIO	2		X	X
050200060403	Red Run-Piney Creek	OHIO	2		X	X
050200060404	Little Piney Creek-Piney Creek	OHIO	2		X	X
050200060601	Laurel Hill Creek-Laurel Hill Lake Dam	OHIO	2	X		X
050200060902	Drake Run-Youghioheny River	OHIO	2		X	X
050200060903	Dunbar Creek	OHIO	2		X	X
050200060904	Opossum Run-Youghiogheny River	OHIO	2		X	X
050200060906	Dickerson Run-Youghiogheny River	OHIO	2		X	X
050200061001	Headwaters Jacobs Creek	OHIO	2		X	X
050200061002	Jacobs Creek-Youghiogheny River	OHIO	2		X	X
050200061101	Jacks Run	OHIO	2		X	X
050200061102	Upper Sewickley Creek	OHIO	2		X	X
050200061103	Little Sewickley Creek	OHIO	2		X	X
050200061104	Lower Sewickley Creek	OHIO	2		X	X
050200061201	Cedar Creek-Youghiogheny River	OHIO	2		X	X
050200061202	Long Run	OHIO	2		X	X
050301010102	Upper Chartiers Creek	OHIO	2		X	X
050301010104	Middle Chartiers Creek	OHIO	2	X		X
050301010107	Lower Chartiers Creek	OHIO	2	X		X
050301010203	Headwaters Racoon Creek-Cherry Valley Reservoir	OHIO	2		X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
050301010306	Flaugherty Run	OHIO	2	X	X	
050301010603	Headwaters North Fork Little Beaver Creek	OHIO	2	X	X	
050301010607	Dilworth Run-North Fork Little Beaver Creek	OHIO	2		X	X
050301011101	Mill CreeK	OHIO	2		X	X
050301011103	Carpenter Run-Ohio River	OHIO	2		X	X
050301011104	Tomlinson Run	OHIO	2		X	X
050301011105	Kings Creek	OHIO	2		X	X
050301011108	Harmon Creek	OHIO	2		X	X
050301020101	Paden Creek	OHIO	2		X	X
050301020103	Bennett Run-Frontal Pymatuning Reservoir	OHIO	2		X	X
050301020402	Big Run	OHIO	2		X	X
050301020404	Shenango River Lake-Shenango River	OHIO	2		X	X
050301020405	Shenango River Lake Dam-Shenango River	OHIO	2		X	X
050301020503	Otter Creek	OHIO	2		X	X
050301020504	Pine Run-Neshannock Creek	OHIO	2		X	X
050301020505	West Branch Little Neshannock Creek	OHIO	2		X	X
050301020506	Little Neshannock Creek	OHIO	2		X	X
050301020602	Little Yankee Run	OHIO	2		X	X
050301020604	Hogback Run-Shenango River	OHIO	2		X	X
050301020605	Big Run	OHIO	2		X	X
050301020606	Deer Creek-Shenango River	OHIO	2		X	X
050301030808	Hickory Run	OHIO	2		X	X
050301030809	Coffee Run-Mahoning River	OHIO	2		X	X
050301050301	Seaton Creek-Slippery Rock Creek	OHIO	2		X	X
050301050302	North Branch Slippery Rock Creek	OHIO	2		X	X
050301060103	Dutch Fork	OHIO	2		X	X
050301060104	Castleman Run	OHIO	2		X	X
050301060105	Sugarcamp Run-Buffalo Creek	OHIO	2		X	X
050301060401	Templeton Fork	OHIO	2		X	X
050301060402	Robinson Fork	OHIO	2		X	X
050301060403	Enlow Fork	OHIO	2		X	X
050301060501	North Fork Dunkard Fork	OHIO	2	X	X	
050301060503	Outlet Dunkard Fork	OHIO	2		X	X
050301060601	Upper Wheeling Creek	OHIO	2		X	X
050301060602	Middle Wheeling Creek	OHIO	2		X	X
050301060603	Little Wheeling Creek	OHIO	2		X	X
020401010403	Factory Creek-Delaware River	DEL	3	X	X	X
020401010406	Pea Brook-Delaware River	DEL	3	X	X	X
020401040401	Upper Shahola Creek	DEL	3	X	X	X
020401040402	Middle Shahola Creek	DEL	3	X	X	X
020401040701	Sawkill Creek	DEL	3	X	X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020401040702	Raymondskill Creek	DEL	3	X	X	X
020401041004	Cherry Creek	DEL	3	X	X	X
020401041005	Vancampens Brook-Delaware River	DEL	3	X	X	X
020401050303	Lower Bushkill Creek	DEL	3	X	X	X
020401050605	Lopatcong Creek-Delaware River	DEL	3	X	X	X
020401050911	Buck Creek-Delaware River	DEL	3	X	X	X
020401060310	Mauch Chunk Creek-Lehigh River	DEL	3	X	X	X
020401060502	Aquashicola Creek-Lehigh River	DEL	3	X	X	X
020401060808	Catasauqua Creek	DEL	3	X	X	X
020401060812	Nancy Run	DEL	3	X	X	X
020402010403	Martins Creek	DEL	3	X	X	X
020402010404	Van Sciver Lake-Delaware River	DEL	3	X	X	X
020402010405	Mill Creek-Silver Lake	DEL	3	X	X	X
020402020405	Petty Island-Delaware River	DEL	3	X	X	X
020402020608	Oldmans Creek-Delaware River	DEL	3	X	X	X
020402031004	Little Valley Creek-Valley Creek	DEL	3	X	X	X
020402050201	Sucker Run	DEL	3	X	X	X
020501040908	Mutton Lane Creek-Tioga River	SUSQ	3	X	X	X
020501040910	Lower Tioga River	SUSQ	3	X	X	X
020501060901	Upper Mehoopany Creek	SUSQ	3	X	X	X
020501061302	Upper Bowman Creek	SUSQ	3	X	X	X
020501070401	Little Nescopeck Creek-Nescopeck Creek	SUSQ	3	X	X	X
020501070701	East Branch Fishing Creek	SUSQ	3	X	X	X
020502010702	Trout Run	SUSQ	3	X	X	X
020502010710	Sterling Run	SUSQ	3	X	X	X
020502010711	Birch Island Run	SUSQ	3	X	X	X
020502010712	Lower Three Runs-West Branch Susquehanna River	SUSQ	3	X	X	X
020502010713	Burns Run-West Branch Susquehanna River	SUSQ	3	X	X	X
020502020202	Clear Creek	SUSQ	3	X	X	X
020502020303	Laurel Run	SUSQ	3	X	X	X
020502020304	Medix Run	SUSQ	3	X	X	X
020502020308	Dents Run	SUSQ	3	X	X	X
020502020403	Upper First Fork Sinnemahoning Creek	SUSQ	3	X	X	X
020502020404	Freeman Run	SUSQ	3	X	X	X
020502020502	Sinnemahoning Creek-West Branch Susquehanna River	SUSQ	3	X	X	X
020502030201	Cooks Run	SUSQ	3	X	X	X
020502030203	Drury Run	SUSQ	3	X	X	X
020502030205	Hall Run-West Branch Susquehanna River	SUSQ	3	X	X	X
020502030402	Rattlesnake Run-West Branch Susquehanna River	SUSQ	3	X	X	X
020502030403	Clendenin Branch Baker Run	SUSQ	3	X	X	X
020502030404	Baker Run	SUSQ	3	X	X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020502030405	North Fork Tangascootack Creek	SUSQ	3	X	X	X
020502030406	Tangascootack Creek	SUSQ	3	X	X	X
020502030407	Lick Run	SUSQ	3	X	X	X
020502030409	Queens Run	SUSQ	3	X	X	X
020502030410	McElhattan Creek	SUSQ	3	X	X	X
020502050201	Ninemile Run	SUSQ	3	X	X	X
020502050505	Otter Run	SUSQ	3	X	X	X
020502050604	Mill Run-Pine Creek	SUSQ	3	X	X	X
020502050605	Trout Run	SUSQ	3	X	X	X
020502050606	Upper Pine Bottom Run-Pine Creek	SUSQ	3	X	X	X
020502061204	Limestone Run-Northumberland County	SUSQ	3	X	X	X
020502061206	Limestone Run-Union County	SUSQ	3	X	X	X
020503010902	Rattling Creek	SUSQ	3	X	X	X
020503011002	Fidlers Run-Susquehanna River	SUSQ	3	X	X	X
020503040102	Mill Creek	SUSQ	3	X	X	X
020503040302	Blacklog Creek	SUSQ	3	X	X	X
020503050201	Rowe Run	SUSQ	3	X	X	X
020503050904	Spring Creek	SUSQ	3	X	X	X
020503050906	Swatara Creek-Susquehanna River	SUSQ	3	X	X	X
020503051002	Clark Creek	SUSQ	3	X	X	X
020503051006	Cove Creek-Susquehanna River	SUSQ	3	X	X	X
020503051008	Spring Creek	SUSQ	3	X	X	X
020503051011	Laurel Run-Susquehanna River	SUSQ	3	X	X	X
020503060102	Plum Creek-South Branch Conewago Creek	SUSQ	3	X	X	X
020503060203	Swift Run-Conewago Creek	SUSQ	3	X	X	X
020503060402	Lower Little Conewago Creek	SUSQ	3	X	X	X
020503060502	Davidsburg Run-Conewago Creek	SUSQ	3	X	X	X
020503060705	Willis Run-Codorus Creek	SUSQ	3	X	X	X
020503060802	Little Chickies Creek	SUSQ	3	X	X	X
020503060803	Donegal Creek	SUSQ	3	X	X	X
020503060804	Lower Chickies Creek	SUSQ	3	X	X	X
020503060904	Cocalico Creek-Conestoga River	SUSQ	3	X	X	X
020503061104	Middle Conestoga River	SUSQ	3	X	X	X
020503061502	Tweed Creek-Octoraro Creek	SUSQ	3	X	X	X
020503061503	Basin Run-Octoraro Creek	SUSQ	3	X	X	X
020503061701	Conoy Creek	SUSQ	3	X	X	X
020503061702	Hartman Run-Susquehanna River	SUSQ	3	X	X	X
020503061704	Cabin Creek-Susquehanna River	SUSQ	3	X	X	X
020503061706	Green Branch-Susquehanna River	SUSQ	3	X	X	X
020503061709	Fishing Creek-Susquehanna River	SUSQ	3	X	X	X
020503061710	Broad Creek	SUSQ	3	X	X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
020503061711	Conowingo Creek	SUSQ	3	X	X	X
020503061712	Conowingo Dam-Susquehanna River	SUSQ	3	X	X	X
020600020102	North East Creek	POT	3	X	X	X
020700020501	Brush Creek	POT	3	X	X	X
020700020502	Laurel Run	POT	3	X	X	X
020700030401	East Branch Sideling Hill Creek	POT	3	X	X	X
020700030402	West Branch Sideling Hill Creek	POT	3	X	X	X
020700040504	Ditch Run-Potomac River	POT	3	X	X	X
020700040804	Muddy Run	POT	3	X	X	X
020700041005	West Branch Marsh Run-Marsh Run	POT	3	X	X	X
020700041006	Middle Antietam Creek	POT	3	X	X	X
020700090501	Alloway Creek	POT	3	X	X	X
041100030103	Upper Ashtabula River	STLAW	3	X	X	X
041201010404	Twelvemile Creek-Frontal Lake Erie	STLAW	3	X	X	X
041201010702	Turkey Creek-Frontal Lake Erie	STLAW	3	X	X	X
050100011205	Cornplanter Run-Allegheny River	OHIO	3	X	X	X
050100011208	Hodge Run-Allegheny River	OHIO	3	X	X	X
050100030104	East Hickory Creek	OHIO	3	X	X	X
050100061101	Sugar Creek	OHIO	3	X	X	X
050100061103	South Fork Pine Creek	OHIO	3	X	X	X
050100080101	Headwaters Loyalhanna Creek	OHIO	3	X	X	X
050100080201	Blacklegs Creek	OHIO	3	X	X	X
050100090308	Allegheny River-Ohio River	OHIO	3	X	X	X
050200040602	Upper Big Sandy Creek	OHIO	3	X	X	X
050200050102	West Virginia Fork	OHIO	3	X	X	X
050200050103	Pennsylvania Fork-Dunkard Creek	OHIO	3	X	X	X
050200050806	Piney Fork-Peters Creek	OHIO	3	X	X	X
050200050807	Fallen Timber Run-Monongahela River	OHIO	3	X	X	X
050200050808	Streets Run-Monongahela River	OHIO	3	X	X	X
050200060801	Headwaters Indian Creek	OHIO	3	X	X	X
050200060901	Meadow Run	OHIO	3	X	X	X
050200061203	Pollack Run-Youghiogheny River	OHIO	3	X	X	X
050301010301	Sawmill Run	OHIO	3	X	X	X
050301010302	Lowries Run	OHIO	3	X	X	X
050301010303	Kilbuck Run-Ohio River	OHIO	3	X	X	X
050301010305	Little Sewickley Creek	OHIO	3	X	X	X
050301010307	McCabe Run-Ohio River	OHIO	3	X	X	X
050301010309	Crows Run-Ohio River	OHIO	3	X	X	X
050301010310	Sixmile Run-Ohio River	OHIO	3	X	X	X
050301010602	Honey Creek	OHIO	3	X	X	X
050301010608	Brush Run-North Fork Little Beaver Creek	OHIO	3	X	X	X

Appendix 5. Complete listing of HUC12 watersheds in Pennsylvania and the Susquehanna River Basin in Pennsylvania and New York with basin characteristic, geographic, or streamflow correlation gaps.—Continued

[HUC12, 12-digit hydrologic unit code; DEL, Delaware River Basin; STLAW, Saint Lawrence River Basin; OHIO, Ohio River Basin; POT, Potomac River Basin; SUSQ, Susquehanna River Basin; SUSQ NY, Susquehanna River Basin watersheds entirely in New York; X, indicates gap]

HUC12 identification number	HUC12 name	Basin	Number of gaps	Basin characteristic gap	Geographic gap	Streamflow correlation gap
050301010610	Bieler Run-Little Beaver Creek	OHIO	3	X	X	X
050301020104	Frontal Pymatuning Reservoir	OHIO	3	X	X	X
050301020105	Pymatuning Reservoir	OHIO	3	X	X	X
050301020603	McCullough Run-Shenango River	OHIO	3	X	X	X
050301040102	Brady Run	OHIO	3	X	X	X
050301040103	Beaver River-Ohio River	OHIO	3	X	X	X
050301060502	South Fork Dunkard Fork	OHIO	3	X	X	X
050301060802	Grave Creek	OHIO	3	X	X	X
050301061001	Upper West Virginia Fork Fish Creek	OHIO	3	X	X	X
050301061003	Middle West Virginia Fork Fish Creek	OHIO	3	X	X	X
050301061101	Pennsylvania Fork Fish Creek	OHIO	3	X	X	X

Appendix 6. U.S. Geological Survey streamgages in Pennsylvania with high-substitution potential.

[USGS, U.S. Geological Survey; Y, yes]

					Streamgage 1 with high substitution potential						Streamgage 2 with high substitution potential						Streamgage 3 with high substitution potential					
USGS stream-gage number	Drain-age area (square miles)	Period of record	Regu-lated	Regulated period (month/ year)	USGS stream-gage number	Drain-age area (square miles)	Drain-age-area ratio	Distance between stream-gages (miles)	Stream-flow cor-relation (Spear-man's rho)	Con-cur-rent years of re-cord	USGS stream-gage number	Drain-age area (square miles)	Drainage-area ratio	Distance between stream-gages (miles)	Stream-flow cor-relation (Spear-man's rho)	Con-cur-rent years of re-cord	USGS stream-gage number	Drain-age area (square miles)	Drain-age-area ratio	Dis-tance be-tween stream-gages (miles)	Stream-flow cor-relation (Spear-man's rho)	Con-cur-rent years of re-cord
01429000	59.7	8/1944-11/1960	Y	10/1960-2014	1430000	164	2.747	4.475	0.979	66												
01430000	164	10/1948-1960	Y	10/1960-9/1969; 10/1985-2014	01429000	59.7	0.364	4.475	0.979	38	01431500	290	1.768293	7.147	0.99	38						
01431500	290	7/1908-9/1917; 8/1938-9/1959	Y	10/1960-2014	01430000	164	0.566	7.147	0.990	38												
01449000	591		Y	10/1982-2014	01451000	889	1.504	7.334	0.983	32	01453000	1,279	2.164129	22.685	0.964	32						
01451000	889	10/1946-9/1961	Y	10/1961-2014	01449000	591	0.665	7.334	0.983	32	01453000	1,279	1.438695	15.351	0.982	53						
01453000	1,279	10/1902-1/1905; 5/1909-12/1940	Y	10/1961-2014	0144900	591	0.462	22.685	0.964	32	01451000	889	0.695074	15.351	0.982	53						
01451500	80.8	10/1945-2014			01451650	98.2	1.215	1.057	0.974	28												
01451650	98.2	10/1986-2014			01451500	80.8	0.823	1.057	0.974	28												
01451800	53	2/1966-2014			01452000	75.8	1.430	8.080	0.982	48												
01452000	75.8	10/1944-2014			01451800	53	0.699	8.080	0.982	48												
01467042	37.9	8/1964-9/1981; 9/2007-2014			01467048	49.8	1.314	3.356	0.972	24												
01467048	49.8	6/1965-2014			1467042	37.9	0.761	3.356	0.972	24												
01470960	175	5/1965-3/1979	Y	4/1979-2014	01471000	211	1.206	2.424	0.982	35												
01471000	211	10/1950-3/1979	Y	4/1979-2014	01470960	175	0.829	2.424	0.982	35												
01468500	133	8/1947-4/1953; 10/1963-9/1965; 8/1973-2014			01470500	355	2.669	9.944	0.973	49												

Appendix 6. U.S. Geological Survey streamgages in Pennsylvania with high-substitution potential.—Continued

[USGS, U.S. Geological Survey; Y, yes]

					Streamgage 1 with high substitution potential						Streamgage 2 with high substitution potential						Streamgage 3 with high substitution potential					
USGS stream-gage number	Drain-age area (square miles)	Period of record	Regu-lated	Regulated period (month/year)	USGS stream-gage number	Drain-age area (square miles)	Drain-age-area ratio	Distance between stream-gages (miles)	Stream-flow cor-relation (Spear-man's rho)	Con-cur-rent years of re-cord	USGS stream-gage number	Drain-age area (square miles)	Drainage-area ratio	Distance between stream-gages (miles)	Stream-flow cor-relation (Spear-man's rho)	Con-cur-rent years of re-cord	USGS stream-gage number	Drain-age area (square miles)	Drain-age-area ratio	Dis-tance be-tween stream-gages (miles)	Stream-flow cor-relation (Spear-man's rho)	Con-cur-rent years of re-cord
01470500	355	8/1947-2014			01468500	133	0.375	9.944	0.973	49												
01471510	880	5/1914-9/1915; 10/1919-9/1930	Y	10/1/1979-2014	01472000	1,147	1.303409	16.408	0.987	35												
01472000	1,147	10/1927-3/1978	Y	10/1/1979-2014	01471510	880	0.767	16.408	0.987	35	01474500	1,893	1.650392	31.075	0.968	35						
01473500	1,760		Y	8/2001-2014	01472000	1,147	0.651705	18.521	0.980	13	01474500	1,893	1.075568	12.989	0.994	13						
01474500	1,893	10/1931-1978	Y	10/1/1979-2014	01472000	1,147	0.605917	31.075	0.968	35	01473500	1,760	0.929741	12.989	0.994	13						
01473900	40.8	9/1961-3/1969; 6/2000-2014			01474000	64	1.568627	7.520	0.963	11												
01474000	64	6/1897-9/1903; 1/1905-7/1906; 10/1965-2014			01473900	40.8	0.6375	7.520	0.963	11												
01480500	45.8	10/1943-12/1951; 1/1970-2014			01480617	55	1.201	2.175	0.979	44												
01480617	55	1/1970-2014			01480500	45.8	0.833	2.175	0.979	44												
01480700	60.6	10/1965-10/1973	Y	11/1973-2014	01480870	89.9	1.483	4.972	0.979	41												
01480870	89.9		Y	11/1973-2014	01480700	60.6	0.674	4.972	0.979	41												
01518000	282	6/1938-9/1977	Y	11/1979-2014	01518700	446	1.582	11.063	0.993	35												
01518700	446		Y	11/1979-2014	01518000	282	0.632	11.063	0.993	35												
01531500	7,797	10/1913-2014			01533400	8,720	1.118	22.996	0.993	38												
01533400	8,720	10/1976-2014			01531500	7,797	0.894	22.996	0.993	38	01536500	9,960	1.142202	26.165	0.992	38						
01536500	9,960	4/1889-2014			01533400	8,720	0.876	26.165	0.992	38												

Appendix 6. U.S. Geological Survey streamgages in Pennsylvania with high-substitution potential.—Continued

[USGS, U.S. Geological Survey; Y, yes]

					Streamgage 1 with high substitution potential						Streamgage 2 with high substitution potential						Streamgage 3 with high substitution potential					
USGS streamgage number	Drainage area (square miles)	Period of record	Regulated	Regulated period (month/year)	USGS streamgage number	Drainage area (square miles)	Drainage-area ratio	Distance between streamgages (miles)	Streamflow correlation (Spearman's rho)	Concurrent years of record	USGS streamgage number	Drainage area (square miles)	Drainage-area ratio	Distance between streamgages (miles)	Streamflow correlation (Spearman's rho)	Concurrent years of record	USGS streamgage number	Drainage area (square miles)	Drainage-area ratio	Distance between streamgages (miles)	Streamflow correlation (Spearman's rho)	Concurrent years of record
01540500	11,220	3/1889-2014			01554000	18,300	1.631	12.119	0.980	77												
01554000	18,300	10/1937-2014			01540500	11,220	0.613	12.119	0.980	77												
01570500	24,100	10/1890-2014			01576000	25,990	1.078	23.369		83												
01576000	25,990	10/1931-2014			01570500	24,100	0.927	23.369		83												
01541200	367	10/1955-10/1965	Y	11/1965-2014	01541303	474	1.292	4.413		36												
01541303	474		Y	10/1978-2014	01541200	367	0.774262	4.413	0.991	36												
01542500	1,462	2/1940-11/1960	Y	10/2004-2014	01545500	2,975	2.035	23.493	0.981	10												
01545500	2,975	10/2007-9/2003	Y	10/2003-2014	01542500	1,462	0.491	23.493	0.981	11												
01551500	5,682	3/1895-9/1961	Y	10/1961-2014	01553500	6,847	1.205	19.577	0.994	49												
01553500	6,847	10/1939-9/1965	Y	10/1965-2014	01551500	5,682	0.830	19.577	0.994	49												
01543000	272	10/1913-2014			01543500	685	2.518	8.266	0.983	76												
01543500	685	4/1938-2014			01543000	272	0.397	8.266	0.983	76												
01546400	58.5	11/1984-2014			01546500	87.2	1.491	4.226	0.970	30	01547100	142	2.427350	7.085	0.966	30						
01546500	87.2	10/1940-2015			01546400	58.5	0.671	4.226	0.970	30	01547100	142	1.628440	2.921	0.976	47						
01547100	142	5/1967-2014			01546400	58.5	0.412	7.085	0.966	30	01546500	87.2	0.614085	2.921	0.976	47						
01548500	604	7/1918-2014			01549700	944	1.563	18.272	0.988	57												
01549700	944	10/1957-2014			01548500	604	0.640	18.272	0.988	57												
01556000	291	10/1916-2014			01559000	816	2.804	9.633	0.973	13												
01559000	816	10/1972-11/1985			01556000	291	0.357	9.633	0.973	13												

Appendix 6. U.S. Geological Survey streamgages in Pennsylvania with high-substitution potential.—Continued

[USGS, U.S. Geological Survey; Y,yes]

					Streamgage 1 with high substitution potential						Streamgage 2 with high substitution potential						Streamgage 3 with high substitution potential					
USGS stream-gage number	Drain-age area (square miles)	Period of record	Regu-lated	Regulated period (month/year)	USGS stream-gage number	Drain-age area (square miles)	Drain-age-area ratio	Distance between stream-gages (miles)	Stream-flow cor-relation (Spear-man's rho)	Con-cur-rent years of re-cord	USGS stream-gage number	Drain-age area (square miles)	Drainage-area ratio	Distance between stream-gages (miles)	Stream-flow cor-relation (Spear-man's rho)	Con-cur-rent years of re-cord	USGS stream-gage number	Drain-age area (square miles)	Drain-age-area ratio	Dis-tance be-tween stream-gages (miles)	Stream-flow cor-relation (Spear-man's rho)	Con-cur-rent years of re-cord
01572025	116	10/1988-1/1991; 10/1992-2014			01572190	167	1.440	7.707	0.993	25	01573000	337	2.905172	12.865	0.98	26						
01572190	167	10/1988-1/1991; 10/1991-2014			01572025	116	0.695	7.707	0.993	25	01573000	337	2.017964	5.842	0.985	27	01573560	483	2.892216	14.419	0.975	26
01573000	337	1/1919-2014			01572025	116	0.344	12.865	0.980	25	01572190	167	0.495549	5.842	0.985	27	01573560	483	1.433234	8.639	0.987	39
01573560	483	10/1975-2014			01572190	167	0.346	14.419	0.975	25	01573000	337	0.697723	8.639	0.987	39						
01576500	324	10/1928-3/1932; 4/1933-2014			01576754	470	1.451	8.639	0.986	30												
01576754	470	10/1984-2014			01576500	324	0.689	8.639	0.986	30												
03007800	248	10/1974-2014			03010500	550	2.218	11.063	0.982	40												
03010500	550	7/1939-2014			03007800	248	0.451	11.063	0.982	40												
03016000	3,660	10/1941-9/1965	Y	10/1965-2014	03025500	5,982	1.634426	24.798	0.974	49												
03025500	5,982	10/1914-9/1940	Y	10/1940-2014	03016000	3,660	0.612	24.798	0.974	49	03031500	7,671	1.282347	21.193	0.989	74						
03031500	7,671	10/1932-9/1940	Y	10/1940-2014	03025500	5,982	0.780	21.193	0.989	74	03036500	8,973	1.169730	20.883	0.992	74						
03036500	8,973	8/1904-9/1923	Y	10/1923-2014	03031500	7,671	0.855	20.883	0.992	74	03049500	11,410	1.271593	17.216	0.99	76						
03049500	11,410		Y	10/1938-2014	03036500	8,973	0.786	17.216	0.990	76												
03023100	788		Y	10/1988-2014	03024000	1,028	1.305	17.091	0.988	26												
03024000	1,028	8/1932-7/1970	Y	7/1970-2014	03023100	788	0.767	17.091	0.988	26												
03041029	678		Y	12/2001-2014	03041500	715	1.055	7.520	0.995	13												
03041500	715		Y	5/1938-2014	03041029	678	0.948	7.520	0.995	13												

Appendix 6. U.S. Geological Survey streamgages in Pennsylvania with high-substitution potential.—Continued

[USGS, U.S. Geological Survey; Y, yes]

					Streamgage 1 with high substitution potential						Streamgage 2 with high substitution potential						Streamgage 3 with high substitution potential					
USGS streamgage number	Drainage area (square miles)	Period of record	Regulated	Regulated period (month/year)	USGS streamgage number	Drainage area (square miles)	Drainage-area ratio	Distance between streamgages (miles)	Streamflow correlation (Spearman's rho)	Concurrent years of record	USGS streamgage number	Drainage area (square miles)	Drainage-area ratio	Distance between streamgages (miles)	Streamflow correlation (Spearman's rho)	Concurrent years of record	USGS streamgage number	Drainage area (square miles)	Drainage-area ratio	Distance between streamgages (miles)	Streamflow correlation (Spearman's rho)	Concurrent years of record
03072655	4,440		Y	10/1938-2014	03075070	5,340	1.203	30.205	0.983	76												
03075070	5,340		Y	10/1933-2014	03072655	4,440	0.831	30.205	0.983	76												
03081000	1,029		Y	6/1940-2014	03082500	1,326	1.289	17.589	0.981	74												
03082500	1,326	7/1908-9/1924	Y	10/1924-2014	03081000	1,029	0.776	17.589	0.981	74	03083500	1,715	1.293363	19.018	0.986	90						
03083500	1,715	10/1920-9/1924	Y	10/1924-2015	03082500	1,326	0.773	19.018	0.986	91												
03105500	2,235		Y	10/1915-2014	03107500	3,106	1.390	8.701	0.981	79												
03107500	3,106		Y	10/1935-2014	03105500	2,235	0.720	8.701	0.981	79												

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