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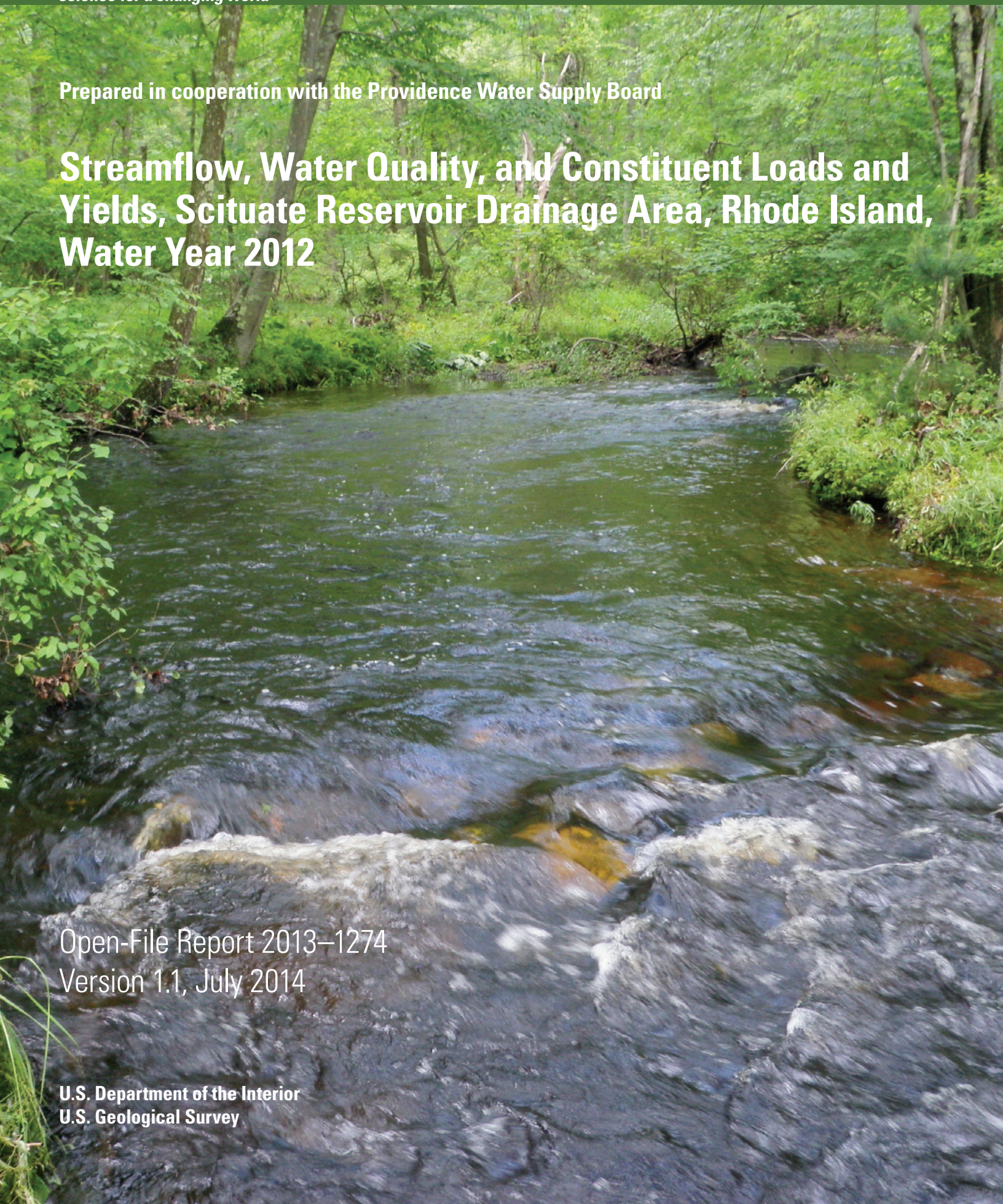

Prepared in cooperation with the Providence Water Supply Board

Streamflow, Water Quality, and Constituent Loads and Yields, Scituate Reservoir Drainage Area, Rhode Island, Water Year 2012

Open-File Report 2013–1274
Version 1.1, July 2014

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

Cover. Photograph shows Rush Brook near Elmdale road, North Scituate, Rhode Island (photograph by Joan Whitley).

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By Kirk P. Smith

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U.S. Department of the Interior
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SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

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Conversion Factors, Datum, and Abbreviations

Multiply	By	To obtain
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer [$(m^3/s)/km^2$]
	Mass	
ton, short (2,000 lb)	907.2	kilogram (kg)

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

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

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or colony forming units per 100 milliliters (CFU/100mL).

Loads of chemical constituents in water are given either in grams or kilograms (or millions of colony forming units for bacteria) per day, month, or year, and yields are given in grams or kilograms (or millions of colony forming units for bacteria) per day, month, or year per square mile.

Abbreviations

CFU	colony forming units
E. coli	*Escherichia coli*
MOVE.1	Maintenance of Variance Extension type 1
NWIS	National Water Information System
NTU	nephelometric turbidity units
PCU	platinum cobalt units
PWSB	Providence Water Supply Board
RIDEM	Rhode Island Department of Environmental Management
USGS	U.S. Geological Survey
WY	water year

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Streamflow, Water Quality, and Constituent Loads and Yields, Scituate Reservoir Drainage Area, Rhode Island, Water Year 2012

By Kirk P. Smith

Abstract

Streamflow and concentrations of sodium and chloride estimated from records of specific conductance were used to calculate loads of sodium and chloride during water year (WY) 2012 (October 1, 2011, through September 30, 2012), for tributaries to the Scituate Reservoir, Rhode Island. Streamflow and water-quality data used in the study were collected by the U.S. Geological Survey (USGS) or the Providence Water Supply Board (PWSB). Streamflow was measured or estimated by the USGS following standard methods at 23 streamgages; 14 of these streamgages were equipped with instrumentation capable of continuously monitoring water level, specific conductance, and water temperature. Water-quality samples were collected at 37 sampling stations by the PWSB and at 14 continuous-record streamgages by the USGS during WY 2012 as part of a long-term sampling program; all stations were in the Scituate Reservoir drainage area. Water-quality data collected by the PWSB were summarized by using values of central tendency and used, in combination with measured (or estimated) streamflows, to calculate loads and yields (loads per unit area) of selected water-quality constituents for WY 2012.

The largest tributary to the reservoir (the Ponaganset River, which was monitored by the USGS) contributed a mean streamflow of about 26 cubic feet per second (ft^3/s) to the reservoir during WY 2012. For the same time period, annual mean[1] streamflows measured (or estimated) for the other monitoring stations in this study ranged from about 0.40 to about 17 ft^3/s. Together, tributaries (equipped with instrumentation capable of continuously monitoring specific conductance) transported about 1,100,000 kilograms (kg) of sodium and 1,900,000 kg of chloride to the Scituate Reservoir during WY 2012; sodium and chloride yields for the tributaries ranged from 8,700 to 51,000 kilograms per square mile (kg/mi^2) and from 14,000 to 87,000 kg/mi^2, respectively.

At the stations where water-quality samples were collected by the PWSB, the median of the median chloride concentrations was 19 milligrams per liter (mg/L), median nitrite concentration was 0.002 mg/L as nitrogen (N), median nitrate concentration was less than 0.01 mg/L as N, median orthophosphate concentration was 0.06 mg/L as phosphorus, and median concentrations of total coliform and *Escherichia coli (E. coli)* bacteria were 43 and 16 colony forming units per 100 milliliters (CFU/100mL), respectively. The medians of the median daily loads (and yields) of chloride, nitrite, nitrate, orthophosphate, and total coliform and *E. coli* bacteria were 200 kilograms per day (kg/d) (71 kilograms per day per square mile ($kg/d/mi^2$)); 15 grams per day (g/d) (5.4 grams per day per square mile ($g/d/mi^2$)); 100 g/d (38 $g/d/mi^2$); 500 g/d (260 $g/d/mi^2$); 4,300 million colony forming units per day ($CFUx10^6/d$) (1,500 $CFUx10^6/d/mi^2$); and 1,000 $CFUx10^6/d$ (360 $CFUx10^6/d/mi^2$), respectively.

Introduction

The Scituate Reservoir is the primary source of drinking water for more than 60 percent of the population of Rhode Island. It covers about 94 square miles (mi^2) in parts of the towns of Cranston, Foster, Glocester, Johnston, and Scituate, Rhode Island (fig. 1). Information about the water quality of the reservoir and its tributaries is important for management of the water supply and for the protection of human health. The Providence Water Supply Board (PWSB), the agency responsible for the management and distribution of the Scituate Reservoir water supply, has been monitoring and assessing water quality in the reservoir and reservoir drainage area for more than 60 years.

Since 1993, the U.S. Geological Survey (USGS) has been cooperating with the PWSB and the Rhode Island Department of Environmental Management (RIDEM) to measure streamflow in tributaries to the Scituate Reservoir. Since 2009, streamflow has been continuously measured at 14 streamgages in the drainage area and periodically measured at 9 additional streamgages on tributaries in the drainage area. At the 9 partial-record streamgages, daily mean streamflow has been estimated by using methods developed by the USGS (Hirsch, 1982). The USGS also has been continuously measuring

[1] The arithmetic mean of the individual daily mean discharges for the year noted or for the designated period.

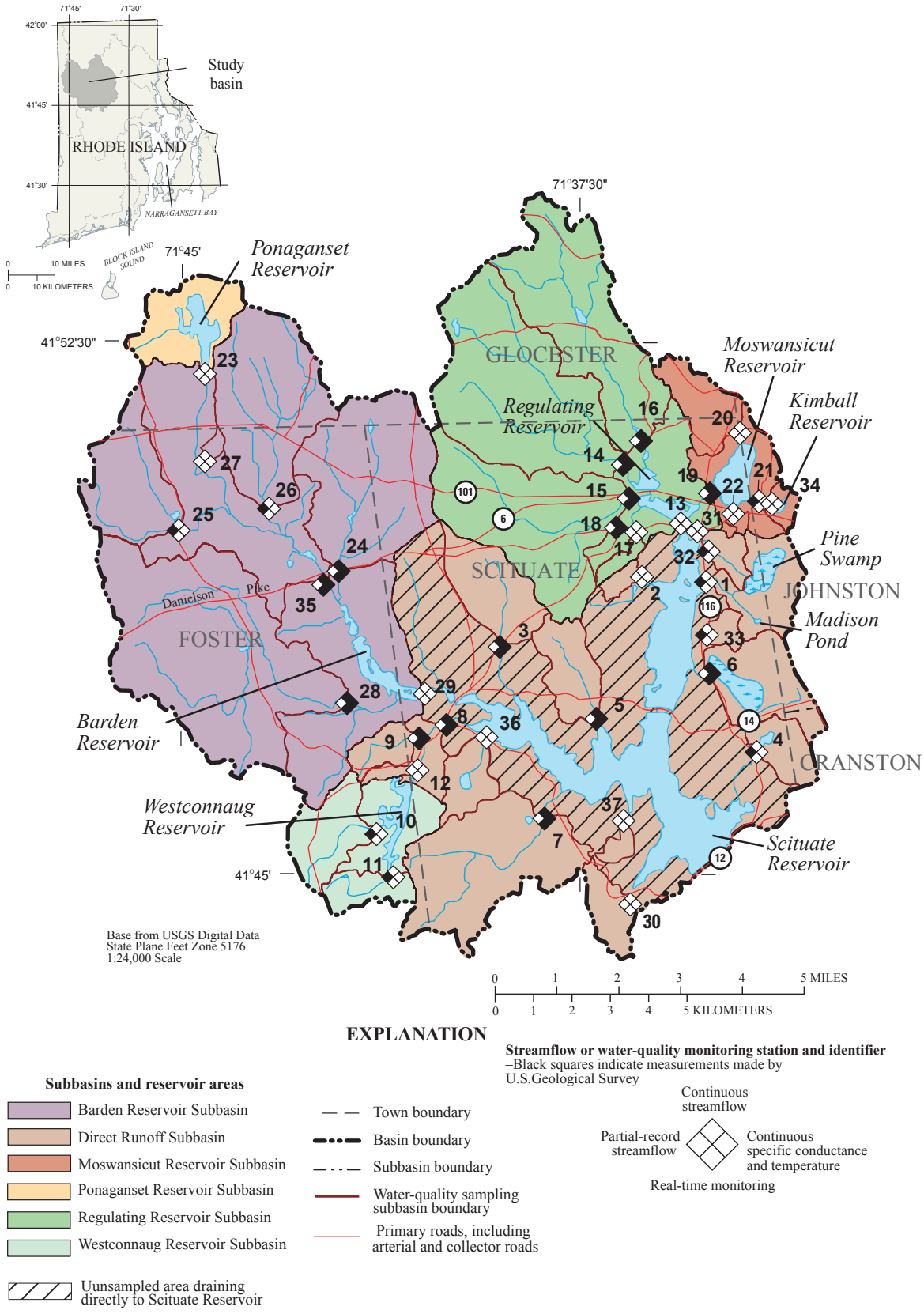

Figure 1. Locations of tributary-reservoir subbasins and streamgage- and water-quality-monitoring stations in the Scituate Reservoir drainage area, Rhode Island.

specific conductance at 14 monitoring stations since 2009. Equations that relate specific conductance to concentrations of sodium and chloride in streamwater were developed as part of a previous USGS/ PWSB cooperative study (Nimiroski and Waldron, 2002). These equations, updated here and used together with measured (or estimated) streamflows, allow for nearly continuous estimation of sodium and chloride loads to the reservoir.

Currently (2012), the PWSB regularly collects water-quality samples from 37 tributaries, either monthly or quarterly. Water-quality results are summarized by station number and constituent or parameter in annual reports published by the PWSB. In addition, the USGS has published reports that have compiled and tabulated streamflow (measured or estimated by the USGS) and water-quality data (collected by the PWSB) (Breault and others, 2000; Nimiroski and others, 2008; Breault, 2010; Breault and Campbell, 2010a,b,c,d; Breault and Smith, 2010; Smith and Breault, 2011; Smith, 2013).

This report presents data on streamflow, water quality, and loads and yields of selected constituents for water year (WY) 2012[2] in the Scituate Reservoir drainage area. These data were collected as parts of studies done by the USGS in cooperation with the PWSB and the RIDEM. A summary of measured and estimated streamflows is presented for the 14 continuous-record and 9 partial-record streamgages in the drainage area. Estimated monthly and annual loads (and yields) of sodium and chloride are presented for the 14 streamgages at which specific conductance is continuously monitored by the USGS. Summary statistics for water-quality data collected by the PWSB for 37 sampling stations during WY 2012 also are presented, and these data were used to calculate loads and yields of selected water-quality constituents (table 1).

Streamflow Data Collection and Estimation

Streamflow and water-quality data were collected by the USGS or the PWSB (table 1). Streamflow was measured or estimated by the USGS at 23 streamgages. Measured and estimated streamflows are necessary to estimate water volume and water-quality constituent loads and yields from tributary basins. Stream stage is measured every 10 minutes at most continuous-record streamgages. Streamflow is computed with a stage-discharge relation (known as a rating), which is developed on the basis of periodic manual measurements of streamflow. Daily mean streamflow at a streamgage is calculated by dividing the total volume of water that passes the streamgage each day by 86,400, the number of seconds in a day. Periodic manual streamflow measurements at partial-record streamgages are used concurrently with continuous-record measurements from streamgages in hydrologically similar drainage areas to estimate a continuous record at the partial-record streamgage. Specifically, continuous streamflow records for the nine partial-record sites in the Scituate Reservoir drainage area were estimated by using the Maintenance of Variance Extension type 1 (MOVE.1) method, as described by Ries and Friesz (2000); data needed to estimate streamflows at partial-record sites were retrieved from the USGS National Water Information System (NWIS; http://waterdata.usgs.gov/nwis/). The upper and lower 90-percent confidence limits for the estimated mean annual streamflows, as described by Tasker and Driver (1988), are presented in table 2. These data indicate that there is a 90-percent chance that the estimated mean annual streamflow is somewhere between the upper and lower 90-percent confidence limits.

Continuous-record streamgages were operated and maintained by the USGS during WY 2012 in cooperation with RIDEM (USGS streamgage 01115098) and the PWSB (fig. 1, table 1). Streamflow data for these streamgages were collected at 10 or 15-minute intervals (near-real-time streamflow data), were updated at 1-hour intervals on the World Wide Web, and are available through the NWIS Web Interface (NWIS Web; U.S. Geological Survey, 2007). Error associated with measured streamflows was generally within about 15 percent (U.S. Geological Survey, unpublished data); upper and lower 90-percent confidence limits calculated by methods described by the National Institute of Standards and Technology/SEmiconductor MAnufacturing TECHnology (2012) are shown in table 2.

Water-Quality Data Collection and Analysis

Water-quality data were collected by the USGS or the PWSB. Concentrations of sodium and chloride were estimated by the USGS from continuous or partial records of specific conductance from 14 of the 23 streamgages. Water-quality samples were collected monthly or quarterly at 37 sampling stations in the Scituate Reservoir drainage area by the PWSB during WY 2012 as part of a long-term sampling program. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate were calculated for 23 streamgages where both streamflow data and water-quality samples were collected. Yields were calculated by dividing load by drainage area.

Data Collected by the U.S. Geological Survey

Water quality was monitored in a periodic water-quality sampling program that included measurements by automatic specific-conductance probes. The USGS collected and analyzed the specific conductance data. Specific conductance was measured by the USGS at 10- or 15-minute intervals at the 14 continuous-record streamgages (fig. 1). Measurements were made by using an instream probe and standard USGS

[2] October 1, 2011, through September 30, 2012.

Table 1. Providence Water Supply Board water-quality sampling stations, water-quality samples, and available streamflow and continuous monitoring stations by tributary reservoir subbasin, in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.

[PWSB, Providence Water Supply Board; USGS, U.S. Geological Survey; mi², square miles; QW, water quality; M, monthly; Q, quarterly;Y, yes; N, no; Na, sodium; Cl, chloride; --, none; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board; not all samples were analyzed for all water-quality properties or constituents]

PWSB station number	USGS station number	Station name	Drainage area (mi²)	Water-quality samples		Daily estimated Na and Cl loads	Estimated streamflow calculated
				Frequency of QW sample collection	Number of samples collected by PWSB		
		Barden Reservoir Subbasin					
24	01115190	Dolly Cole Brook	4.90	M	12	Y	N
25	01115200	Shippee Brook	2.35	Q	4	N	Y
26	01115185	Windsor Brook	4.32	Q	4	N	Y
27	011151845	Unnamed Tributary to Ponaganset River (Unnamed Brook B, Unnamed Brook west of Windsor Brook)	0.10	Q	3	N	N
28	01115265	Barden Reservoir (Hemlock Brook)	8.72	M	12	Y	N
29	01115271	Ponaganset River (Barden Stream)	33.0	M	11	N	N
35	01115187	Ponaganset River	14.0	M	12	Y	N
		Direct Runoff Subbasin					
1	01115180	Brandy Brook	1.57	M	12	N	Y
2	01115181	Unnamed Tributary 2 to Scituate Reservoir (Unnamed Brook north of Bullhead Brook)	0.29	Q	3	N	N
3	01115280	Cork Brook	1.79	M	12	Y	N
4	01115400	Kent Brook (Betty Pond Stream)	0.85	M	11	N	Y
5	01115184	Spruce Brook	1.22	Q	3	Y	N
6	01115183	Quonapaug Brook	1.96	M	11	Y	N
7	01115297	Wilbur Hollow Brook	4.32	M	12	Y	N
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	5.18	M	12	Y	N
9	01115275	Bear Tree Brook	0.62	Q	4	Y	N
30	01115350	Unnamed Tributary 4 to Scituate Reservoir (Coventry Brook, Knight Brook)	0.78	Q	4	N	N
31	01115177	Toad Pond	0.04	Q	1	N	N
32	01115178	Unnamed Tributary 1 to Scituate Reservoir (Pine Swamp Brook)	0.45	Q	4	N	Y
33	01115182	Unnamed Tributary 3 to Scituate Reservoir (Hall's Estate Brook)	0.28	Q	4	N	Y
36	--	Outflow from King Pond	0.77	Q	4	N	N
37	--	Fire Tower Stream	0.05	Q	3	N	N
		Moswansicut Reservoir Subbasin					
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	3.25	M	11	Y	N

Table 1. Providence Water Supply Board water-quality sampling stations, water-quality samples, and available streamflow and continuous monitoring stations by tributary reservoir subbasin, in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

[PWSB, Providence Water Supply Board; USGS, U.S. Geological Survey; mi², square miles; QW, water quality; M, monthly; Q, quarterly;Y, yes; N, no; Na, sodium; Cl, chloride; --, none; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board; not all samples were analyzed for all water-quality properties or constituents]

PWSB station number	USGS station number	Station name	Drainage area (mi²)	Water-quality samples		Daily estimated Na and Cl loads	Estimated streamflow calculated
				Frequency of QW sample collection	Number of samples collected by PWSB		
20	01115160	Unnamed Tributary 1 to Moswansicut Reservoir (Blanchard Brook)	1.18	M	9	N	N
21	01115165	Unnamed Tributary 2 to Moswansicut Reservoir (Brook from Kimball Reservoir)	0.29	Q	3	N	Y
22	01115167	Moswansicut Reservoir (Moswansicut Stream South)	0.30	M	11	N	N
34	01115164	Kimball Stream	0.27	Q	4	N	N
		Ponaganset Reservoir Subbasin					
23	011151843	Ponaganset Reservoir	1.92	M	11	N	N
		Regulating Reservoir Subbasin					
13	01115176	Regulating Reservoir	22.1	M	11	N	N
14	01115110	Huntinghouse Brook	6.23	M	10	Y	N
15	01115114	Rush Brook	4.70	M	12	Y	N
16	01115098	Peeptoad Brook (Harrisdale Brook)	4.96	M	12	Y	N
17	01115119	Dexter Pond (Paine Pond)	0.22	Q	2	N	N
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	0.28	Q	3	Y	N
		Westconnaug Reservoir Subbasin					
10	01115274	Westconnaug Brook	1.48	M	12	N	Y
11	01115273	Unnamed Tributary to Westconnaug Reservoir (Unnamed Brook south of Westconnaug Reservoir)	0.72	Q	3	N	Y
12	011152745	Unnamed Tributary to Westconnaug Brook (Unnamed Brook north of Westconnaug reservoir)	0.16	Q	3	N	N

Table 2. Measured or estimated annual mean streamflow for tributary streams in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.

[PWSB, Providence Water Supply Board; USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $ft^3/s/mi^2$, cubic feet per second per square mile; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board]

PWSB station number	USGS station number	Station name	Annual mean streamflow (ft^3/s)	Upper 90-percent confidence interval (ft^3/s)	Lower 90-percent confidence interval (ft^3/s)	Annual mean streamflow ($ft^3/s/mi^2$)
		Barden Reservoir Subbasin				
24	01115190	Dolly Cole Brook	9.2	10	8.1	1.9
25	01115200	Shippee Brook	5.2	18	1.5	2.2
26	01115185	Windsor Brook	7.9	32	1.9	1.8
28	01115265	Barden Reservoir (Hemlock Brook)	17	19	15	2.0
35	01115187	Ponaganset River	26	29	24	1.9
		Direct Runoff Subbasin				
1	01115180	Brandy Brook	2.4	4.3	1.3	1.5
3	01115280	Cork Brook	3.4	3.9	2.9	1.9
4	01115400	Kent Brook (Betty Pond Stream)	1.5	7.4	0.32	1.8
5	01115184	Spruce Brook	2.5	2.7	2.4	2.1
6	01115183	Quonapaug Brook	3.7	4.0	3.4	1.9
7	01115297	Wilbur Hollow Brook	7.7	8.3	7.0	1.8
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	7.7	8.1	7.4	1.5
9	01115275	Bear Tree Brook	1.4	1.4	1.3	2.2
32	01115178	Unnamed Tributary 1 to Scituate Reservoir (Pine Swamp Brook)	0.59	1.2	0.30	1.3
33	01115182	Unnamed Tributary 3 to Scituate Reservoir (Hall's Estate Brook)	0.40	1.1	0.14	1.4
		Moswansicut Reservoir Subbasin				
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	5.8	6.2	5.3	1.8
21	01115165	Unnamed Tributary 2 to Moswansicut Reservoir (Blanchard Brook)	0.64	1.4	0.29	2.2
		Regulating Reservoir Subbasin				
14	01115110	Huntinghouse Brook	12	14	10	1.9
15	01115114	Rush Brook	8.5	9.6	7.3	1.8
16	01115098	Peeptoad Brook (Harrisdale Brook)	11	13	9.3	2.2
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	0.57	0.65	0.50	2.0
		Westconnaug Reservoir Subbasin				
10	01115274	Westconnaug Brook	2.2	3.8	1.2	1.5
11	01115273	Unnamed Tributary to Westconnaug Reservoir (Unnamed Brook south of Westconnaug Reservoir)	1.2	2.1	0.73	1.7

methods for continuous streamwater-quality monitoring (Wagner and others, 2006).

Concentrations of sodium and chloride were estimated from continuous or periodic measurements of specific conductance by using equations that were developed by the USGS for this purpose (equations 1 and 2). These regression equations were developed by the MOVE.1 method (also known as the line of organic correlation; Helsel and Hirsch, 2002) on the basis of concurrent measurements of specific conductance along with sodium and chloride concentrations measured in water-quality samples collected by the USGS from tributaries in the Scituate Reservoir drainage area (U.S. Geological Survey, 2001):

$$C_{Cl} = \left(Spc^{m}\right) \times b \text{ and} \quad (1)$$

$$C_{Na} = \left(Spc^{m}\right) \times b \ , \quad (2)$$

where

C_{Cl} is the chloride concentration, in milligrams per liter;

C_{Na} is the sodium concentration, in milligrams per liter;

Spc is the specific conductance, in microsiemens per centimeter;

m is the slope from the MOVE.1 analysis (table 3); and

b is the intercept from the MOVE.1 analysis (table 3).

MOVE.1 was chosen for regression analysis to maintain variance (Hirsch and Gilroy, 1984). Some missing values of specific conductance were estimated. In these cases, values of specific conductance were estimated by proportional distribution between recorded values.

Data Collected by the Providence Water Supply Board

Water-quality samples were collected at fixed stations on 37 tributaries by the PWSB. Sampling was done monthly at 19 stations and quarterly at another 18 stations (table 1) during WY 2012. Water-quality samples were not collected during specific weather conditions; instead, a strictly periodic water-quality sampling schedule was followed so that water-quality samples would be representative of various weather conditions. However, sometimes samples could not be collected because tributaries at the sampling stations were dry or frozen. When possible, water-quality samples were collected by dipping the sample bottle into the tributary at the center of flow

Table 3. Regression equation coefficients used to estimate concentrations of chloride and sodium from values of specific conductance for each U.S. Geological Survey monitoring station in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.

[PWSB, Providence Water Supply Board; USGS, U.S. Geological Survey; RMSE, root mean square error]

PWSB station number	USGS station number	Chloride			Sodium		
		Intercept	Slope	RMSE	Intercept	Slope	RMSE
24	01115190	0.133	1.101	0.030	0.107	1.043	0.035
28	01115265	0.133	1.101	0.030	0.107	1.043	0.035
35	01115187	0.133	1.101	0.030	0.107	1.043	0.035
3	01115280	0.133	1.101	0.030	0.107	1.043	0.035
5	01115184	0.077	1.190	0.037	0.076	1.081	0.037
6	01115183	0.133	1.101	0.030	0.107	1.043	0.035
7	01115297	0.077	1.190	0.037	0.076	1.081	0.037
8	01115276	0.133	1.101	0.030	0.107	1.043	0.035
9	01115275	0.133	1.101	0.030	0.107	1.043	0.035
19	01115170	0.133	1.101	0.030	0.107	1.043	0.035
14	01115110	0.077	1.190	0.037	0.076	1.081	0.037
15	01115114	0.133	1.101	0.030	0.107	1.043	0.035
16	01115098	0.133	1.101	0.030	0.107	1.043	0.035
18	01115120	0.133	1.101	0.030	0.107	1.043	0.035

(Richard Blodgett, PWSB, written commun., 2005). Samples were transported on ice to the PWSB water-quality laboratory at the P.J. Holton Water Purification Plant in Scituate, R.I. Water-quality properties and constituent concentrations were measured by using unfiltered water samples. These water-quality properties included pH, temperature, acidity, alkalinity, color, turbidity, and concentrations of chloride, nitrite, nitrate, orthophosphate, and bacteria (*Escherichia coli* (*E. coli*) and total coliform). More information on sample-collection, analytical, and quality-control procedures can be found in the Providence Water Supply Board Quality Assurance Program Manual (Providence Water Supply Board Water Quality Laboratory, 2012).

Water-quality samples were collected by the PWSB during a wide range of flow conditions. The daily mean flow-duration curve for the Peeptoad Brook at North Scituate (USGS streamgage 01115098) for WY 2012 is shown in figure 2. The curve represents the percentage of time that each flow was exceeded at this station. The flows at this station on days when water-quality samples were collected are represented by the plotted points superimposed on the curve. Samples were collected at flow durations ranging from the 20th percentile to the 98th percentile; this range indicates that the water-quality samples collected in WY 2012 represented a wide range of flow conditions during that water year.

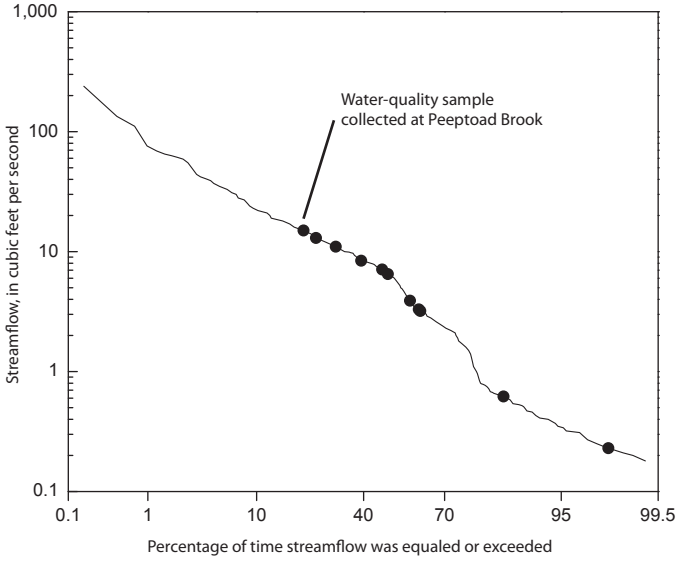

Figure 2. Flow-duration curve and streamflow values on the dates (represented by points) when water-quality samples were collected for the U.S. Geological Survey continuous streamgage on Peeptoad Brook at North Scituate (01115098) for water year 2012.

Estimating Daily, Monthly, and Annual Loads and Yields

Daily, monthly, and annual sodium and chloride loads in kilograms were estimated for all streamgages for which continuous-streamflow and specific-conductance data were available for WY 2012. Daily flow-weighted concentrations of sodium and chloride were calculated by multiplying instantaneous flows by concurrent concentrations of sodium and chloride (estimated from measurements of specific conductance) for each day and dividing by the total flow for that day. Daily sodium and chloride loads were estimated by multiplying daily flow-weighted concentrations of sodium and chloride in milligrams per liter by daily discharge (in liters per day). Daily data was added to estimate monthly or annual loads.

Daily loads of water-quality constituents (in samples collected by the PWSB) were calculated for all sampling dates during WY 2012 (table 4, at back of report) for which periodic or continuous-streamflow data were available (table 1). These loads were calculated by multiplying constituent concentrations in milligrams or colony forming units (CFU) per liter in single samples by the daily discharge (in liters per day) for the day on which each sample was collected. The flows, which in some cases were estimates, were assumed to be representative of the flow at the time of the sample collection. Loads in grams or kilograms (or millions of CFUs for bacteria) per day and yields in grams or kilograms (or millions of CFUs for bacteria) per day per square mile were calculated for bacteria, chloride, nitrite, nitrate, and orthophosphate from this water-quality data. Censored data (or concentrations reported as less than method detection limits) were replaced with concentrations equal to one-half the method detection limit.

Streamflow

Monitoring streamflow is necessary to measure the volume of water and estimate constituent loads to the Scituate Reservoir. The Ponaganset River is the largest monitored tributary to the Scituate Reservoir. Mean annual streamflow at the streamgage on the Ponaganset River (USGS streamgage 01115187) for the entire time period of its operation (mean of the annual mean streamflows for the period of record, WY 1994–2011) prior to WY 2011 was about 30 ft^3/s (http://waterdata.usgs.gov/nwis). During WY 2012, annual mean streamflow was 26 ft^3/s (fig. 3). Mean annual streamflow in Peeptoad Brook at the other long-term continuous-record streamgage in the Scituate Reservoir drainage area (streamgage 01115098) for its period of record (WY 1994–2011) prior to WY 2012 was about 11 ft^3/s (http://waterdata.usgs.gov/nwis). Annual mean streamflow in Peeptoad Brook during WY 2012 also was 11 ft^3/s (table 2).

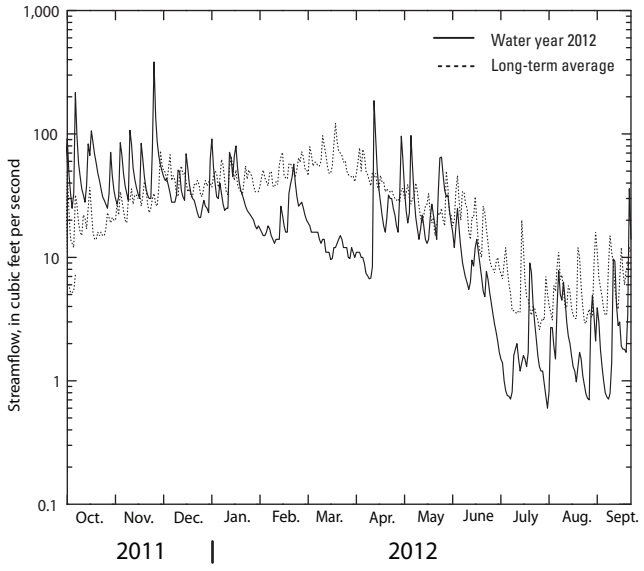

Figure 3. Measured daily mean streamflow for October 1, 2011, through September 30, 2012, and mean daily streamflow for October 1, 1994, through September 30, 2011, for the U.S. Geological Survey continuous-record streamgage on the Ponaganset River at South Foster (01115187) in the Scituate Reservoir drainage area, Rhode Island.

Water Quality and Constituent Loads and Yields

Water-quality conditions in the Scituate Reservoir drainage area are described by summary statistics for water-quality properties, constituent concentrations, and estimated constituent loads and yields. Loads and yields characterize the rates at which masses of constituents are transferred to the reservoir by tributaries. In the case of loads, tributaries with high flows tend to have high loads because the greater volume of water can carry more of the constituent to the reservoir per unit time. Yields represent the constituent load per unit drainage area and are calculated by dividing the load estimated for a streamgage by the drainage area to the monitoring station. Yields are useful for comparison among streamgages that have different drainage areas because the effects of basin size and therefore total streamflow volume are attenuated. Yields also are useful for examining potential differences among basin properties that may contribute to reservoir quality.

Summary statistics include means and medians. For some purposes, median values are more appropriate because they are less likely to be affected by high or low concentrations (or outliers). Medians are especially important to use for summarizing a relatively limited number of values. In contrast, continuously monitored streamflow and sodium and chloride loads (estimated from measurements of specific conductance), which include a large number of values, are better summarized in terms of means because a large dataset is more resistant to the effects of outliers. Mean values also are particularly appropriate for characterizing loads because outlier values, which typically represent large flows, are important to include in estimates of constituent masses delivered to receiving waters.

Sodium and Chloride Loads and Yields Estimated from Specific-Conductance Monitoring Data

Sodium and chloride are constituents of special concern in the Scituate Reservoir drainage area; they are major constituents of road salt used for deicing, and several major roadways cross the drainage basin. State Routes 12 and 14 cut across the main body of the reservoir, and State Route 116 parallels the eastern limb (fig. 1). Nimiroski and Waldron (2002) previously indicated that tributaries in basins with state-maintained roads had substantially higher concentrations of sodium and chloride than tributaries in basins with low road density, presumably because of deicing activities. In addition, sodium is a constituent of potential concern for human health; some persons on restricted diets might need to limit their intake of sodium.

Estimated monthly mean[3] sodium concentrations in tributaries of the Scituate Reservoir drainage area ranged from 0.0 to 37.6 mg/L, and estimated monthly mean chloride concentrations ranged from 0.0 to 64.8 mg/L (table 5). The highest monthly mean concentrations of sodium and chloride were measured in Bear Tree Brook (PWSB station 9) in August 2012 (37.6 and 64.8 mg/L, respectively; table 5). The highest annual mean[4] concentrations of sodium and chloride also were measured in Bear Tree Brook, 26.6 and 45.9 mg/L, respectively (table 6). These high concentrations are the result of residual sodium and chloride leaching from a formerly uncovered salt storage pile to groundwater (Nimiroski and Waldron, 2002) and relatively small surface-water flows.

During WY 2012, the Scituate Reservoir received about 1,100,000 kg (about 1,200 tons) of sodium and 1,900,000 kg (about 2,100 tons) of chloride from tributaries that were equipped with instrumentation capable of continuously monitoring specific conductance. The highest sodium and chloride loads in the watershed during WY 2012 (210,000 kg and 330,000 kg, respectively) were measured at the Ponaganset River station (PWSB station 35; table 6). Monthly estimated sodium and chloride loads were highest in the months of October, November, and December (table 7). The maximum monthly loads of sodium and chloride at each station accounted for 13–20 percent of the annual load for each constituent at the respective stations. The highest annual sodium and chloride yields were 51,000 and 87,000 kg/mi^2,

[3] Monthly mean concentrations were calculated by dividing the total monthly load by the total discharge for the month.

[4] Annual mean concentrations were calculated by dividing the total annual load by the total discharge for the year.

Table 5. Monthly mean concentrations of chloride and sodium estimated from continuous measurements of specific conductance in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.

[PWSB, Providence Water Supply Board; USGS, U.S. Geological Survey; Cl, chloride; mg/L, milligrams per liter; Na, sodium; monthly mean concentrations were calculated by dividing the monthly load by the total discharge for the month; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	October		November		December		January		February		March	
			Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)
Barden Reservoir Subbasin														
24	01115190	Dolly Cole Brook	18.2	11.3	17.7	11.0	15.6	9.78	16.7	10.4	18.3	11.4	19.6	12.1
28	01115265	Barden Reservoir (Hemlock Brook)	13.8	8.70	14.1	8.85	11.3	7.2	14.1	8.85	17.8	11.0	17.2	10.7
35	01115187	Ponaganset River	14.3	8.99	14.1	8.87	12.0	7.59	14.1	8.86	15.5	9.69	16.4	10.3
Direct Runoff Subbasin														
3	01115280	Cork Brook	22.1	13.6	23.4	14.3	18.8	11.6	22.5	13.8	25.1	15.3	28.3	17.2
5	01115184	Spruce Brook	15.2	9.22	13.8	8.42	12.1	7.45	13.8	8.42	14.6	8.88	15.7	9.48
6	01115183	Quonapaug Brook	29.8	18.0	28.0	17.0	22.7	13.9	27.6	16.7	29.6	17.9	33.4	20.1
7	01115297	Wilbur Hollow Brook	9.18	5.83	9.72	6.13	7.31	4.73	8.40	5.37	9.18	5.83	8.80	5.60
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	17.2	10.7	17.3	10.7	15.9	9.93	17.3	10.8	19.2	11.9	19.1	11.8
9	01115275	Bear Tree Brook	41.8	24.8	43.0	25.5	38.8	23.1	44.2	26.2	49.6	29.2	48.2	28.4
Moswansicut Reservoir Subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	33.9	20.4	31.7	19.1	31.8	19.2	33.6	20.2	33.7	20.3	34.3	20.6
Regulating Reservoir Subbasin														
14	01115110	Huntinghouse Brook	8.66	5.52	8.57	5.47	7.40	4.78	8.10	5.19	9.90	6.24	9.78	6.17
15	01115114	Regulating Reservoir (Rush Brook)	23.9	14.6	24.9	15.2	19.1	11.8	23.8	14.6	31.7	19.1	33.7	20.3
16	01115098	Peeptoad Brook (Harrisdale Brook)	32.2	19.4	28.3	17.2	22.4	13.8	26.2	15.9	27.8	16.9	30.7	18.5
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	37.1	22.2	37.8	22.6	29.4	17.7	35.7	21.3	40.3	24.0	45.1	26.7
Scituate Reservoir Basin														
		Average	22.7	13.8	22.3	13.6	18.9	11.6	21.9	13.3	24.4	14.8	25.7	15.6

Table 5. Monthly mean concentrations of chloride and sodium estimated from continuous measurements of specific conductance in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

[PWSB, Providence Water Supply Board; USGS, U.S. Geological Survey; Cl, chloride; mg/L, milligrams per liter; Na, sodium; monthly mean concentrations were calculated by dividing the monthly load by the total discharge for the month; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	April		May		June		July		August		September	
			Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)
Barden Reservoir Subbasin														
24	01115190	Dolly Cole Brook	18.3	11.4	17.5	10.9	18.7	11.6	22.2	13.6	25.7	15.6	27.1	16.5
28	01115265	Barden Reservoir (Hemlock Brook)	14.8	9.28	13.9	8.77	16.9	10.5	24.7	15.1	29.5	17.8	28.9	17.5
35	01115187	Ponaganset River	14.9	9.37	14.8	9.28	14.7	9.20	17.7	11.0	19.4	12.0	17.6	11.0
Direct Runoff Subbasin														
3	01115280	Cork Brook	23.2	14.2	23.2	14.2	25.2	15.4	24.0	14.7	36.1	21.6	35.8	21.4
5	01115184	Spruce Brook	13.8	8.40	12.7	7.83	14.6	8.9	17.5	10.5	21.3	12.5	20.2	11.9
6	01115183	Quonapaug Brook	28.9	17.5	30.2	18.3	32.2	19.4	41.2	24.5	42.2	25.0	39.9	23.7
7	01115297	Wilbur Hollow Brook	8.68	5.53	7.67	4.95	8.22	5.27	11.5	7.17	13.5	8.27	12.6	7.74
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	19.5	12.1	16.3	10.2	19.0	11.8	27.0	16.4	30.4	18.4	28.4	17.2
9	01115275	Bear Tree Brook	46.4	27.4	42.3	25.1	47.2	27.9	55.5	32.4	64.8	37.6	54.4	31.8
Moswansicut Reservoir Subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	35.0	21.0	35.9	21.5	36.4	21.8	39.5	23.5	39.6	23.6	37.4	22.4
Regulating Reservoir Subbasin														
14	01115110	Huntinghouse Brook	5.9	3.86	6.54	4.27	9.54	6.02	13.0	8.00	14.1	8.59	14.2	8.64
15	01115114	Regulating Reservoir (Rush Brook)	23.4	14.3	22.8	14.0	27.6	16.7	34.0	20.4	44.9	26.5	40.0	23.8
16	01115098	Peeptoad Brook (Harrisdale Brook)	28.1	17.0	26.7	16.2	29.5	17.8	33.0	19.8	33.1	19.9	32.5	19.6
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	24.4	14.8	26.4	16.0	35.2	21.1	23.9	14.6	0.00	0.00	31.3	18.9
Scituate Reservoir Basin														
		Average	21.8	13.3	21.2	13.0	23.9	14.5	27.5	16.5	29.6	17.7	30.0	18.0

Table 6. Annual mean chloride and sodium concentrations, loads, and yields by sampling station in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.

[PWSB, Providence Water Supply Board; USGS, U.S. Geological Survey; mg/L, milligrams per liter; kg, kilograms; kg/mi^2, kilograms per square mile; Cl, chloride; Na, sodium; annual mean concentrations were calculated by dividing the annual load by the total discharge for the year; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	Concentration		Load		Yield	
			Cl (mg/L)	Na (mg/L)	Cl (kg)	Na (kg)	Cl (kg/mi^2)	Na (kg/mi^2)
		Barden Reservoir Subbasin						
24	01115190	Dolly Cole Brook	17.6	11.0	140,000	89,000	29,000	18,000
28	01115265	Barden Reservoir (Hemlock Brook)	14.4	9.02	220,000	140,000	25,000	16,000
35	01115187	Ponaganset River	14.2	8.95	330,000	210,000	24,000	15,000
		Direct Runoff Subbasin						
3	01115280	Cork Brook	22.8	14.0	69,000	42,000	38,000	24,000
5	01115184	Spruce Brook	14.2	8.64	32,000	19,000	26,000	16,000
6	01115183	Quonapaug Brook	28.8	17.5	95,000	57,000	48,000	29,000
7	01115297	Wilbur Hollow Brook	8.72	5.55	59,000	38,000	14,000	8,700
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	18.5	11.5	130,000	79,000	25,000	15,000
9	01115275	Bear Tree Brook	45.0	26.6	54,000	32,000	87,000	51,000
		Moswansicut Reservoir Subbasin						
19	01115170	Moswansicut Reservoir, (Moswansicut Stream North, Moswansicut Pond)	33.8	20.3	170,000	100,000	53,000	32,000
		Regulating Reservoir Subbasin						
14	01115110	Huntinghouse Brook	8.14	5.20	87,000	55,000	14,000	8,900
15	01115114	Rush Brook	24.6	15.0	190,000	110,000	39,000	24,000
16	01115098	Peeptoad Brook (Harrisdale Brook)	27.5	16.7	270,000	160,000	53,000	32,000
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	34.3	20.5	18,000	10,000	63,000	37,000
		Scituate Reservoir Basin						
			Average		Total		Average	
			22.3	13.6	1,900,000	1,100,000	38,000	23,000

Table 7. Monthly estimated chloride and sodium loads by sampling station in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.

[PWSB, Providence Water Supply Board; USGS, U.S. Geological Survey; Cl, chloride; Na, sodium; kg, kilogram; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB Station number	USGS station number	Station name	October		November		December		January		February		March	
			Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)
Barden Reservoir Subbasin														
24	01115190	Dolly Cole Brook	27,000	17,000	25,000	15,000	24,000	15,000	16,000	10,000	7,700	4,800	9,700	6,000
28	01115265	Barden Reservoir (Hemlock Brook)	36,000	23,000	29,000	19,000	35,000	22,000	25,000	16,000	13,000	7,900	17,000	11,000
35	01115187	Ponaganset River	55,000	34,000	48,000	30,000	52,000	33,000	41,000	26,000	21,000	13,000	26,000	16,000
Direct Runoff Subbasin														
3	01115280	Cork Brook	9,800	6,000	9,200	5,600	12,000	7,400	6,900	4,200	2,800	1,700	4,400	2,700
5	01115184	Spruce Brook	4,300	2,600	4,100	2,500	4,500	2,800	3,600	2,200	2,700	1,700	2,900	1,800
6	01115183	Quonapaug Brook	16,000	9,700	13,000	8,000	13,000	8,200	11,000	6,700	7,100	4,300	8,100	4,800
7	01115297	Wilbur Hollow Brook	8,500	5,400	9,300	5,900	8,600	5,600	6,900	4,400	4,400	2,800	4,500	2,900
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	16,000	9,800	14,000	8,500	15,000	9,400	13,000	8,200	11,000	6,900	11,000	6,700
9	01115275	Bear Tree Brook	6,400	3,800	6,700	4,000	7,400	4,400	6,400	3,800	5,100	3,000	4,900	2,900
Moswansicut Reservoir Subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	25,000	15,000	24,000	14,000	31,000	19,000	20,000	12,000	10,000	6,100	11,000	6,700
Regulating Reservoir Subbasin														
14	01115110	Huntinghouse Brook	16,000	9,900	14,000	8,700	16,000	10,000	9,500	6,100	5,400	3,400	7,700	4,900
15	01115114	Regulating Reservoir (Rush Brook)	31,000	19,000	27,000	16,000	25,000	15,000	21,000	13,000	12,000	7,300	19,000	11,000
16	01115098	Peeptoad Brook (Harrisdale Brook)	52,000	32,000	49,000	29,000	47,000	29,000	28,000	17,000	15,000	9,400	13,000	7,800
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	2,700	1,600	2,900	1,700	2,800	1,700	2,400	1,500	1,600	950	2,000	1,200
Scituate Reservoir Basin														
		Total	310,000	190,000	280,000	170,000	290,000	180,000	210,000	130,000	120,000	73,000	140,000	86,000

Table 7. Monthly estimated chloride and sodium loads by sampling station, in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

[PWSB, Providence Water Supply Board; USGS, U.S. Geological Survey; Cl, chloride; Na, sodium; kg, kilogram; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB Station number	USGS station number	Station name	April		May		June		July		August		September	
			Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)
Barden Reservoir Subbasin														
24	01115190	Dolly Cole Brook	9,900	6,200	13,000	7,900	8,000	5,000	2,200	1,300	800	490	810	500
28	01115265	Barden Reservoir (Hemlock Brook)	18,000	11,000	22,000	14,000	13,000	8,200	3,200	1,900	3,300	2,000	3,900	2,300
35	01115187	Ponaganset River	25,000	16,000	32,000	20,000	21,000	13,000	3,700	2,300	3,400	2,100	5,200	3,200
Direct Runoff Subbasin														
3	01115280	Cork Brook	5,900	3,600	9,200	5,600	4,600	2,800	1,400	860	770	460	1,900	1,200
5	01115184	Spruce Brook	2,200	1,300	2,900	1,800	1,900	1,100	1,100	670	730	430	960	570
6	01115183	Quonapaug Brook	6,500	3,900	8,500	5,100	5,000	3,000	2,000	1,200	1,600	950	2,500	1,500
7	01115297	Wilbur Hollow Brook	4,500	2,800	5,200	3,300	3,400	2,200	950	590	540	330	2,500	1,600
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	9,200	5,700	12,000	7,500	9,500	5,900	6,300	3,800	5,300	3,200	5,300	3,200
9	01115275	Bear Tree Brook	3,800	2,200	4,100	2,400	3,400	2,000	2,100	1,300	1,700	980	2,000	1,200
Moswansicut Reservoir Subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	13,000	7,700	23,000	14,000	8,300	5,000	2,300	1,400	2,400	1,400	3,000	1,800
Regulating Reservoir Subbasin														
14	01115110	Huntinghouse Brook	5,200	3,400	7,300	4,800	4,300	2,700	930	570	340	210	810	490
15	01115114	Regulating Reservoir (Rush Brook)	16,000	9,800	19,000	12,000	9,900	6,000	2,700	1,600	800	470	3,000	1,800
16	01115098	Peeptoad Brook (Harrisdale Brook)	22,000	13,000	23,000	14,000	9,300	5,600	3,300	2,000	1,400	810	1,400	830
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	810	490	1,500	920	640	380	110	69	0	0	100	60
Scituate Reservoir Basin														
		Total	140,000	87,000	180,000	110,000	100,000	63,000	32,000	20,000	23,000	14,000	33,000	20,000

respectively, and were measured at Bear Tree Brook (PWSB station 9; table 6).

Uncertainties associated with measuring streamflow and specific conductance and with sodium and chloride sample collection, preservation, and analysis produce uncertainties in load and yield estimates. The load and yield estimates presented in the text and tables are the most likely values for sodium and chloride coming from tributaries or their drainage basins. It may be best to discuss loads and yields in terms of a range within which the true values lie; however, the most probable values of loads and yields are presented for ease of discussion and presentation. The range within which the true values lie depends on the uncertainties in individual measurements of streamflow and concentration, which are difficult to quantify with available information. The uncertainties associated with estimating streamflow are commonly assumed to affect load and yield calculations more than the errors associated with measuring specific conductance and (or) chemical analysis. The most probable values of loads and yields presented in the tables and text are sufficient for planning-level analysis of water quality in tributaries and their drainage basins.

Physical and Chemical Properties and Daily Loads and Yields Estimated from Data Collected by the Providence Water Supply Board

Physical and Chemical Properties

Physical and chemical properties including pH, turbidity, alkalinity, specific conductance, and color were routinely measured to characterize water quality from each basin (table 8). Specifically, pH is a measure of the acidity of the water, color can be an indirect measure of the amount of organic carbon dissolved in the water column, turbidity is an indirect measure of suspended particles, and alkalinity is a measure of the acid-neutralizing capacity of water.

The median pH in tributaries in the Scituate Reservoir drainage area ranged from 5.7 to 6.9; the median of the medians for all stations was 6.3. Median values of color ranged from 15 to 120 platinum cobalt units (PCU); the median for all stations was 48 PCU. Median values of turbidity ranged from 0.28 to 2.1 nephelometric turbidity units (NTU); the median for all stations was 0.72 NTU. Median alkalinity values in tributaries were low, ranging from 2.5 to 12 mg/L as $CaCO_3$; the median for all stations was 6.0 mg/L as $CaCO_3$ (table 8).

Constituent Concentrations and Daily Loads and Yields

Fecal indicator bacteria, chloride, and nutrients such as phosphorus and nitrogen are commonly detected in natural water; at elevated concentrations, these constituents can render water unfit for the intended use. Fecal indicator bacteria, which are found in the intestines of warm-blooded animals, may indicate impairment from sewage contamination or from livestock or wildlife that defecate in or near the stream margin. Chloride originates in tributary streamwater from precipitation, weathering, or human activities such as waste disposal, use of septic systems, and road deicing. Sources of nutrients in tributary streamwater include atmospheric deposition, leaching of naturally occurring organic material, discharge of groundwater that is enriched with nutrients from septic-system leachate, and runoff contaminated with fertilizer or animal waste. The ultimate intended use of water in the tributaries is drinking water, which must meet specific water-quality standards. For this reason, the PWSB and the USGS closely monitor concentrations of these constituents in tributaries. Median concentrations, loads, and yields of water-quality constituents are given in tables 8 and 9.

Bacteria

Median concentrations of total coliform and *E. coli* bacteria were above the detection limit (3 CFU/100 mL) at nearly all sites (table 8). Total coliform bacteria concentrations were in most cases equal to or greater than *E. coli* concentrations (as expected because total coliform is more inclusive); the median concentrations for all sites in the drainage basin were equal to 43 CFU/100 mL for total coliform bacteria and 16 CFU/100 mL for *E. coli* bacteria. Median concentrations of total coliform bacteria were highest at Unnamed Tributary 2 to Scituate Reservoir (PWSB station 2; table 8), Cork Brook (PWSB station 3; table 8), and at Toad Pond (PWSB station 31; table 8) at more than 2,400 CFU/100 mL. Median concentrations of *E. coli* bacteria were highest at Toad Pond (PWSB station 31; table 8) at more than 2,400 CFU/100 mL.

Median concentrations of fecal indicator bacteria were lowest at sampling stations Westconnaug Brook (PWSB station 8) and Ponaganset Reservoir (PWSB station 23). Median concentrations of *E. coli* bacteria also were low at Ponaganset River (PWSB station 35), Westconnaug Brook (PWSB station 8), Fire Tower Stream (PWSB station 37), Ponaganset Reservoir (PWSB station 23), and Regulating Reservoir (PWSB station 13). Median daily loads and yields of total coliform and *E. coli* bacteria varied by about three orders of magnitude; the highest median daily yield of total coliform bacteria was at Shippee Brook (PWSB station 25; table 9), and the highest median daily yield of *E. coli* bacteria was at Unnamed Tributary 1 to Scituate Reservoir (PWSB station 32; table 9). Although relatively high for sampling stations in the Scituate Reservoir Subbasin, median daily bacteria yields at Unnamed Tributary 1 are low to moderate compared to yields of indicator bacteria in sewage-contaminated streamwater or streamwater affected by stormwater runoff in an urban environment (Breault and others, 2002). The median daily loads of total coliform bacteria for all subbasins in the Scituate Reservoir drainage area ranged from 40 to 65,000 CFUx10^6/d, and

Table 8. Median values for water-quality data collected at Providence Water Supply Board stations by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.

[Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; PCU, platinum cobalt units; NTU, nephelometric turbidity units; CFU/100mL, colony forming units per 100 milliliters; *E.coli., Escherichia coli;* mg/L, milligrams per liter ; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, less than; >, greater than; --, no data; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	Properties			Constituents						
			pH	Color	Turbidity	Total coliform bacteria	*E. coli*	Alkalinity	Chloride	Nitrite	Nitrate	Orthophosphate
			(Units)	(PCU)	(NTU)	(CFU/100mL)	(CFU/100mL)	(mg/L as $CaCO_3$)	(mg/L)	(mg/L as N)	(mg/L as N)	(mg/L as P)
Barden Reservoir Subbasin												
24	01115190	Dolly Cole Brook	6.3	68	0.72	49	7.0	6.3	24	0.002	0.01	0.06
25	01115200	Shippee Brook	6.1	60	0.75	130	22	4.2	11	0.002	0.01	0.08
26	01115185	Windsor Brook	6.3	32	0.72	23	23	4.2	20	0.001	0.02	0.09
27	011151845	Unnamed Tributary to Ponaganset River (Unnamed Brook B, Unnamed Brook west of Windsor Brook)	6.0	25	0.31	93	23	3.9	14	0.001	0.01	0.11
28	01115265	Barden Reservoir (Hemlock Brook)	6.1	93	0.60	43	18	5.3	18	0.003	<0.01	0.05
29	01115271	Ponaganset River (Barden Stream)	6.2	50	0.67	23	9.0	5.0	17	0.002	<0.01	0.06
35	01115187	Ponaganset River	6.1	50	0.73	16	<3.0	4.6	19	0.002	0.01	0.05
Direct Runoff Subbasin												
1	01115180	Brandy Brook	6.6	78	1.8	79	19	10	12	0.003	0.01	0.05
2	01115181	Unnamed Tributary #2 to Scituate Reservoir (Unnamed Brook north of Bullhead Brook)	6.3	27	0.45	>2400	23	3.3	13	0.001	<0.01	0.09
3	01115280	Cork Brook	6.6	40	0.48	>2400	23	7.1	28	0.002	0.02	0.06
4	01115400	Kent Brook (Betty Pond Stream)	6.4	34	0.60	15	4.0	7.0	5.8	0.002	<0.01	0.05
5	01115184	Spruce Brook	6.4	38	0.59	43	5.0	3.6	30	0.003	0.06	0.11
6	01115183	Quonapaug Brook	6.5	95	1.5	93	93	8.8	35	0.003	0.01	0.04
7	01115297	Wilbur Hollow Brook	6.3	80	0.70	89	9.0	5.7	12	0.002	0.008	0.06
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	6.3	23	0.44	<3.0	<3.0	4.2	12	0.001	<0.01	0.08
9	01115275	Bear Tree Brook	6.7	35	0.47	33	3.3	10	44	0.002	0.045	0.11
30	01115350	Unnamed Tributary #4 to Scituate Reservoir (Coventry Brook, Knight Brook)	6.2	28	0.71	130	12	4.8	19	0.002	0.02	0.09
31	1115177	Toad Pond	5.9	100	2.1	>2400	>2400	6.8	2.4	0.006	0.11	0.15
32	01115178	Unnamed Tributary #1 to Scituate Reservoir (Pine Swamp Brook)	6.5	65	1.4	1200	550	4.2	13	0.003	<0.01	0.06
33	01115182	Unnamed Tributary #3 to Scituate Reservoir (Hall's Estate Brook)	6.2	34	0.69	16	16	6.7	13	0.001	0.01	0.13
36	--	Outflow from King Pond	6.6	24	0.47	7.5	3.5	5.4	5.1	0.001	<0.01	0.06
37	--	Fire Tower Stream	5.8	30	0.34	23	<3.0	2.5	6.2	0.001	0.03	0.05

Table 8. Median values for water-quality data collected at Providence Water Supply Board stations by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

[Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; PCU, platinum cobalt units; NTU, nephelometric turbidity units; CFU/100mL, colony forming units per 100 milliliters; *E.coli., Escherichia coli;* mg/L, milligrams per liter ; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, less than; >, greater than; --, no data; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	Properties			Constituents						
			pH	Color	Turbidity	Total coliform bacteria	E. coli	Alkalinity	Chloride	Nitrite	Nitrate	Orthophosphate
			(Units)	(PCU)	(NTU)	(CFU/100mL)	(CFU/100mL)	(mg/L as $CaCO_3$)	(mg/L)	(mg/L as N)	(mg/L as N)	(mg/L as P)
Moswansicut Reservoir Subbasin												
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	6.6	25	1.1	23	4.0	6.8	34	0.002	<0.01	0.04
20	01115160	Unnamed Tributary #1 to Moswansicut Reservoir (Blanchard Brook)	6.2	95	0.73	23	9.0	6.1	50	0.003	<0.01	0.04
21	01115165	Unnamed Tributary #2 to Moswansicut Reservoir (Brook from Kimball Reservoir)	6.7	55	1.5	43	23	9.2	30	0.002	0.02	0.04
22	01115167	Moswansicut Reservoir (Moswansicut Stream South)	6.5	38	1.3	75	23	12	31	0.002	0.05	0.04
34	01115164	Kimball Stream	6.3	48	0.91	23	5.8	11	34	0.003	<0.01	0.12
Ponaganset Reservoir Subbasin												
23	011151843	Ponaganset Reservoir	6.1	15	0.51	4.0	<3.0	3.2	12	0.001	<0.01	0.03
Regulating Reservoir Subbasin												
13	01115176	Regulating Reservoir	6.9	42	0.83	23	1.5	9.1	27	0.002	0.005	0.05
14	01115110	Huntinghouse Brook	6.4	53	0.80	23	23	6.7	9.8	0.001	0.008	0.09
15	01115114	Rush Brook	6.8	58	1.0	460	330	9.8	29	0.002	0.01	0.06
16	01115098	Peeptoad Brook (Harrisdale Brook)	6.6	38	0.91	59	22	10	29	0.002	0.01	0.06
17	01115119	Dexter Pond (Paine Pond)	6.1	48	0.64	120	22	6.0	30	0.002	<0.01	0.11
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	6.4	85	1.3	240	43	8.8	41	0.002	0.02	0.32
Westconnaug Reservoir Subbasin												
10	01115274	Westconnaug Brook	5.8	34	0.28	33	12	4.3	18	0.001	<0.01	0.07
11	01115273	Unnamed Tributary to Westconnaug Reservoir (Unnamed Brook south of Westconnaug Reservoir)	5.7	120	1.1	75	43	4.4	49	0.003	<0.01	0.08
12	011152745	Unnamed Tributary to Westconnaug Brook (Unnamed Brook north of Westconnaug reservoir)	6.0	85	0.81	43	4.0	4.2	7.2	0.002	0.02	0.12
Scituate Reservoir Basin												
		Minimum	5.7	15	0.28	<3.0	<3.0	2.5	2.4	0.001	<0.01	0.03
		Median	6.3	48	0.72	43	16	6.0	19	0.002	<0.01	0.06
		Maximum	6.9	120	2.1	>2400	>2400	12	50	0.006	0.11	0.32

Table 9. Median daily loads and yields of bacteria, chloride, nitrite, nitrate, and orthophosphate, by tributary reservoir subbasin, in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.

[Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; CFUx106/d; millions of colony forming units per day; *E. coli, Escherichia coli*; N, nitrogen; P, phosphorus; kg/d, kilograms per day; kg/d/mi^2, kilograms per day per square mile; g/d, grams per day; g/d/mi^2, grams per day per square mile; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station no.	USGS station no.	Station name	Total coliform bacteria		*E. Coli*		Chloride		Nitrite (as N)		Nitrate (as N)		Orthophosphate (as P)	
			(CFUx10^6/d)	(CFUx10^6/mi^2)	(CFUx10^6/d)	(CFUx10^6/mi^2)	(kg/d)	(kg/d/mi^2)	(g/d)	(g/d/mi^2)	(g/d)	(g/d/mi^2)	(g/d)	(g/d/mi^2)
Barden Reservoir Subbasin														
24	01115190	Dolly Cole Brook	5,100	1,000	760	150	400	81	17	3.4	150	30	440	89
25	01115200	Shippee Brook	65,000	28,000	4,500	1,900	210	87	35	15	210	90	2,400	1,000
26	01115185	Windsor Brook	11,000	2,600	5,000	1,100	310	72	26	6.1	290	67	4,500	1,000
28	01115265	Barden Reservoir	12,000	1,400	1,900	220	310	36	27	3.1	94	11	860	99
35	01115187	Ponaganset River	8,900	640	1,000	73	900	64	58	4.1	420	30	1,500	110
Direct Runoff Subbasin														
1	01115180	Brandy Brook	7,800	4,900	430	270	64	41	14	8.9	60	38	230	140
3	01115280	Cork Brook	3,000	1,600	2,000	1,100	100	56	9.7	5.4	90	50	470	260
4	01115400	Kent Brook	500	590	54	64	23	27	5.8	6.8	36	42	88	100
5	01115184	Spruce Brook	3,600	3,000	330	270	200	160	8.3	6.8	380	310	580	480
6	01115183	Quonapaug Brook	9,200	4,700	4,100	2,100	200	100	24	12	100	51	280	140
7	01115297	Wilbur Hollow Brook	8,300	1,900	1,600	360	180	41	22	4.9	180	40	870	200
8	01115276	Westconnaug Brook	440	85	390	74	330	63	24	4.6	140	26	1,600	310
9	01115275	Bear Tree Brook	960	1,500	50	80	83	130	3.6	5.7	130	210	250	410
32	01115178	Unnamed Tributary #1 to Scituate Reservoir (Pine Swamp Brook)	40	89	13,000	28,000	16	37	2.5	5.6	6.4	14	250	550
33	01115182	Unnamed Tributary #3 to Scituate Reservoir (Hall's Estate Brook)	230	800	230	800	22	79	1.5	5.2	15	52	160	570
Moswansicut Reservoir Subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	4,400	1,400	260	80	230	71	15	4.6	95	29	510	160
21	01115165	Unnamed Tributary #2 to Moswansicut Reservoir (Brook from Kimball Reservoir)	530	1,800	130	450	57	200	3.9	13	39	130	74	260

Table 9. Median daily loads and yields of bacteria, chloride, nitrite, nitrate, and orthophosphate, by tributary reservoir subbasin, in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

[Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; CFUx106/d; millions of colony forming units per day; *E. coli, Escherichia coli*; N, nitrogen; P, phosphorus; kg/d, kilograms per day; kg/d/mi^2, kilograms per day per square mile; g/d, grams per day; g/d/mi^2, grams per day per square mile; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station no.	USGS station no.	Station name	Total coliform bacteria		*E. Coli*		Chloride		Nitrite (as N)		Nitrate (as N)		Orthophos-phate (as P)	
			(CFUx10^6/d)	(CFUx10^6/mi^2)	(CFUx10^6/d)	(CFUx10^6/mi^2)	(kg/d)	(kg/d/mi^2)	(g/d)	(g/d/mi^2)	(g/d)	(g/d/mi^2)	(g/d)	(g/d/mi^2)
		Regulating Reservoir Subbasin												
14	01115110	Huntinghouse Brook	4,300	690	3,600	580	210	34	32	5.1	190	30	2,100	340
15	01115115	Regulating Reservoir (Rush Brook)	8,800	1,900	4,400	940	310	66	25	5.3	120	24	710	150
16	01115098	Peeptoad Brook (Harrisdale Brook)	7,400	1,500	5,300	1,100	410	82	23	4.6	160	32	1,100	230
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	350	1,300	63	230	34	120	1.5	5.4	7.6	27	220	790
		Westconnaug Reservoir Subbasin												
10	01115274	Westconnaug Brook	1,400	940	180	120	80	54	4.1	2.8	18	12	200	140
11	01115273	Unnamed Tributary to Westconnaug Reservoir (Unnamed Brook south of Westconnaug Reservoir)	3,200	4,400	3,200	4,400	340	470	15	21	50	69	500	690
		Scituate Reservoir Basin												
		Minimum	40	85	50	64	16	27	1.5	2.8	6.4	11	74	89
		Median	4,300	1,500	1,000	360	200	71	15	5.4	100	38	500	260
		Maximum	65,000	28,000	13,000	28,000	900	470	58	21	420	310	4,500	1,000

yields ranged from 85 to greater than 28,000 CFUx10^6/d/mi^2; *E coli* loads ranged from 50 to 13,000 CFUx10^6/d, and yields ranged from 64 to 28,000 CFUx10^6/d/mi^2 (table 9). These median daily loads were substantially lower than the values in the previous water year, when the median daily loads of total coliform bacteria ranged from 570 to 290,000 CFUx10^6/d, and loads of *E coli* bacteria ranged from 70 to 160,000 CFUx10^6/d (Smith, 2013).

Chloride

The highest median chloride concentration (50 mg/L) was measured in the Moswansicut Reservoir Subbasin at Unnamed Tributary 1 to Moswansicut Reservoir (PWSB station 20; table 8). Median daily chloride loads and yields estimated from samples collected by the PWSB varied among monitoring stations in the drainage area (table 9); the median daily chloride yield for the overall drainage area was about 71 kg/d/mi^2. Ponaganset River (PWSB station 35) had the largest median daily chloride load (900 kg/d), which coincidentally also was the average daily load during the water year estimated on the basis of continuous records of flow and concentrations of chloride estimated from records of specific conductance. The largest median daily chloride yield (470 kg/d/mi^2) was determined for Unnamed Tributary to Westconnaug Reservoir (PWSB station 11). The annual mean yields of chloride and sodium for the drainage areas above the 14 USGS continuous-record streamgages, which represent nearly 66 percent of the Scituate watershed, were 82 kg/d/mi^2 and 50 kg/d/mi^2, respectively.

Nutrients

Median concentrations of nitrite and nitrate (table 8) were 0.002 and less than 0.01 mg/L as nitrogen (N), respectively. The highest median concentrations of nitrite (0.006 mg/L) and nitrate (0.11 mg/L) were measured in a single sample collected at Toad Pond (PWSB station 31) in October 2011. The median concentration of orthophosphate for the entire study area (table 8) was 0.06 mg/L as P. The maximum median concentration of orthophosphate (0.32 mg/L as P) was measured in Unnamed Tributary to Regulating Reservoir (PWSB station 18). Median daily nutrient loads from the Ponaganset River (PWSB station 35) into the Scituate Reservoir—nitrite (58 g/d), nitrate (420 g/d), and orthophosphate (1,500 g/d)—were among the largest for all the sampled stations. However, median daily orthophosphate loads for WY 2012 were large at several stations including Shippee Brook (PWSB station 25; 2,400 g/d), Windsor Brook (PWSB station 26; 4,500 g/d), Westconnaug Brook (PWSB station 8; 1,600 g/d), and Hunting House Brook (PWSB station 14; 2,100 g/d). The largest median daily yield for nitrite (21 g/d/mi^2) was determined for Unnamed Tributary to Westconnaug Reservoir (PWSB station 11). The largest median daily yield for nitrate (310 g/d/mi^2) was determined for Spruce Brook (PWSB station 5), and the largest median daily yields for orthophosphate (1,000 g/d/mi^2) were determined for Shippee Brook and Windsor Brook (table 9). The median daily yields for orthophosphate for Unnamed Tributary to Regulating Reservoir (PWSB station number 18; 790 g/d/ mi^2) and Unnamed Tributary to Regulating Reservoir (PWSB station 18; 690 g/d/mi^2) also were high compared to yields at the other stations in the monitoring network.

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Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.

[Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $CFU \times 10^6/d$; millions of colony forming units per day; *E. coli, Escherichia coli*; kg/d, kilograms per day; g/d, grams per day; N, nitrogen; P, phosphorus; <, less than; >, greater than; --, data not available; shaded areas indicate values that were calculated with concentration data censored at half the detection level; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as P)
Barden Reservoir Subbasin										
24	01115190	Dolly Cole Brook	10/07/11	9.9	18,000	10,000	490	48	120	1,700
			11/04/11	17	62,000	9,600	920	42	210	2,900
			12/02/11	18	10,000	660	810	88	220	880
			01/06/12	7.1	690	690	520	17	170	3,000
			02/03/12	8.4	820	820	1,000	410	3,300	100
			03/20/12	5.2	2,900	510	300	13	64	250
			04/06/12	3.2	120	120	210	16	230	470
			05/04/12	8.7	1,900	1,900	510	43	2,100	1,700
			06/01/12	2.6	4,800	2,700	170	13	32	320
			07/18/12	1.1	110,000	130	53	8.1	27	400
			08/03/12	0.42	9,200	1,000	21	3.1	10	41
			09/07/12	0.48	5,400	590	32	2.3	12	59
25	01115200	Shippee Brook	10/21/11	21	130,000	22,000	1,100	100	520	4,700
			01/27/12	14	500	500	400	67	340	4,700
			04/20/12	0.48	270	17	11	2.3	81	70
			07/20/12	0.49	130,000	8,400	7.4	2.4	12	60
26	01115185	Windsor Brook	10/21/11	33	18,000	18,000	2,800	240	800	8,800
			01/27/12	21	4,600	4,600	590	51	510	9,200
			04/20/12	0.69	390	390	35	1.7	34	100
			07/20/12	0.72	930,000	5,300	33	1.8	70	110

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

[Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $CFU \times 10^6/d$; millions of colony forming units per day; *E. coli, Escherichia coli*; kg/d, kilograms per day; g/d, grams per day; N, nitrogen; P, phosphorus; <, less than; >, greater than; --, data not available; shaded areas indicate values that were calculated with concentration data censored at half the detection level; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as P)
Barden Reservoir Subbasin—Continued										
28	01115265	Barden Reservoir (Hemlock Brook)	10/11/11	7.9	14,000	1,700	330	77	97	7,500
			11/08/11	15	16,000	16,000	590	110	180	5,900
			12/13/11	27	9,900	9,900	1,000	--	330	5,900
			01/10/12	9.5	5,300	2,100	440	46	230	1,900
			02/14/12	7.4	720	270	230	91	91	910
			03/13/12	11	2,400	400	360	160	130	810
			04/10/12	5.5	32,000	5,800	290	27	67	400
			05/08/12	8.6	9,000	9,000	610	21	110	110
			06/12/12	6.3	6,000	1,400	35	15	77	1,700
			07/10/12	1.0	16,000	490	60	12	12	120
			08/17/12	3.3	210,000	16,000	250	24	81	400
			09/11/12	1.4	25,000	1,400	110	10	34	17
35	01115187	Ponaganset River	10/07/11	26	150,000	950	1,200	130	320	6,400
			11/04/11	42	24,000	24,000	2,400	100	1,000	5,100
			12/02/11	45	9,900	1,700	1,100	220	550	4,400
			01/06/12	21	2,100	770	930	51	510	1,500
			02/03/12	26	950	950	860	64	640	1,300
			03/20/12	14	510	510	690	34	170	680
			04/06/12	12	440	440	380	29	880	1,500
			05/04/12	30	1,100	1,100	1,600	150	11,000	37,000
			06/01/12	14	7,900	7,900	940	68	170	1,700
			07/18/12	0.81	100,000	5,900	36	5.9	10	180
			08/03/12	1.6	35,000	780	75	12	39	390
			09/07/12	3.3	210,000	11,000	120	16	81	480

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

[Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $CFU \times 10^6/d$; millions of colony forming units per day; *E. coli, Escherichia coli*; kg/d, kilograms per day; g/d, grams per day; N, nitrogen; P, phosphorus; <, less than; >, greater than; --, data not available; shaded areas indicate values that were calculated with concentration data censored at half the detection level; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as P)
				Direct Runoff Subbasin						
1	01115180	Brandy Brook	10/04/11	4.8	54,000	54,000	120	24	59	590
			11/01/11	4.9	11,000	11,000	140	24	60	3,200
			12/06/11	3.2	120	120	190	23	160	39
			01/03/12	2.8	1,600	270	160	14	34	410
			02/07/12	2.6	97	97	67	6.5	190	520
			03/19/12	1.9	420	190	61	14	23	23
			04/03/12	1.7	98,000	1,100	55	8.1	41	20
			05/01/12	2.8	4,500	4,500	61	21	70	280
			06/05/12	2.6	2,800	580	80	19	130	260
			07/03/12	0.66	21,000	81	17	4.8	65	48
			08/07/12	0.23	17,000	220	6.4	1.7	5.6	95
			09/04/12	0.71	730,000	35,000	23	5.2	17	190
3	01115280	Cork Brook	10/06/11	2.3	62,000	62,000	180	17	56	1,100
			11/03/11	4.6	2,600	1,000	330	23	56	1,000
			12/01/11	5.7	3,200	3,200	67	28	140	70
			01/05/12	3.0	34,000	34,000	38	7.3	150	660
			02/02/12	2.2	220	220	130	5.4	160	430
			03/01/12	5.1	500	500	380	25	250	620
			04/05/12	1.0	37	37	69	2.4	12	120
			05/15/12	5.4	3,000	3,000	150	26	260	530
			06/07/12	5.1	2,900	2,900	330	12	120	500
			07/05/12	0.36	1,500	44	24	1.8	53	35
			08/02/12	0.23	11,000	340	19	0.56	11	39
			09/12/12	0.81	57,000	4,000	62	2.0	59	160

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

[Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $CFU \times 10^6/d$; millions of colony forming units per day; *E. coli, Escherichia coli*; kg/d, kilograms per day; g/d, grams per day; N, nitrogen; P, phosphorus; <, less than; >, greater than; --, data not available; shaded areas indicate values that were calculated with concentration data censored at half the detection level; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as P)
Direct Runoff Subbasin—Continued										
4	01115400	Kent Brook	10/04/11	3.6	2,000	130	40	35	44	700
			11/01/11	4.5	2,500	2,500	31	33	55	8,300
			12/06/11	1.5	54	54	26	7.1	36	18
			01/03/12	1.2	44	44	52	8.8	88	180
			02/07/12	0.90	33	33	20	2.2	130	88
			03/19/12	0.62	23	23	9.2	4.5	7.6	45
			04/03/12	0.51	110	110	7.0	2.5	13	6.3
			05/01/12	0.90	500	500	10	2.2	11	530
			06/05/12	2.7	990	260	38	46	130	330
			07/03/12	0.18	6,800	45	11	0.45	2.3	2.3
			08/07/12	0.01	540	32	<0.01	<0.01	0.16	1.9
5	01115184	Spruce Brook	10/18/11	2.6	1,500	570	200	19	380	700
			01/17/12	3.4	3,600	330	250	8.3	1,000	580
			07/17/12	0.25	21,000	31	14	1.8	18	260
6	01115183	Quonapaug Brook	10/04/11	8.7	>510,000	45,000	600	43	110	2,300
			11/01/11	8.9	16,000	5,000	910	65	110	7,200
			12/06/11	4.9	11,000	11,000	180	24	120	60
			01/03/12	4.1	4,300	1,500	200	30	600	1,500
			02/07/12	3.8	7,000	4,000	320	19	560	280
			03/19/12	2.4	1,400	1,400	58	12	29	530
			04/03/12	2.0	7,300	7,300	190	4.9	98	24
			05/01/12	4.2	2,400	2,400	280	41	100	410
			06/05/12	3.8	43,000	22,000	390	65	93	280
			07/03/12	0.56	45,000	4,100	52	8.2	68	6.8
			08/07/12	0.13	38,000	2,500	15	1.9	1.6	45

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

[Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $CFU \times 10^6/d$; millions of colony forming units per day; *E. coli, Escherichia coli*; kg/d, kilograms per day; g/d, grams per day; N, nitrogen; P, phosphorus; <, less than; >, greater than; --, data not available; shaded areas indicate values that were calculated with concentration data censored at half the detection level; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as P)
Direct Runoff Subbasin—Continued										
7	01115297	Wilbur Hollow Brook	10/06/11	8.8	99,000	99,000	200	65	110	15,000
			11/03/11	14	51,000	32,000	99	68	170	6,500
			12/01/11	15	10,000	3,300	520	110	180	2,200
			01/05/12	7.2	700	260	260	18	180	1,600
			02/02/12	8.9	870	870	640	22	2,400	440
			03/01/12	11	1,100	1,100	660	81	270	1,300
			04/05/12	4.4	750	750	100	11	54	220
			05/15/12	7.2	4,100	1,600	160	35	530	1,100
			06/07/12	8.6	50,000	1,500	640	21	840	630
			07/05/12	1.3	6,600	320	31	13	16	95
			08/02/12	0.84	64,000	2,100	69	2.1	41	140
			09/12/12	0.98	120,000	2,400	19	7.2	12	290
8	01115276	Westconnaug Brook	10/14/11	12	440	440	390	29	150	5,000
			11/15/11	10	2,200	2,200	350	24	2,200	1,500
			12/09/11	23	5,100	840	610	56	280	7,300
			01/13/12	11	400	400	300	27	270	2,200
			02/10/12	8.7	320	320	210	21	110	3,400
			03/09/12	9.6	350	350	460	47	470	120
			04/30/12	7.8	290	290	240	19	95	380
			05/17/12	12	440	440	550	29	290	880
			06/08/12	10	370	370	450	24	120	1,700
			07/13/12	2.2	16,000	3,800	50	5.4	27	430
			08/10/12	2.9	310,000	350	66	7.1	35	920
			09/14/12	2.0	68,000	240	44	4.9	24	1,900

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

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PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as P)
Direct Runoff Subbasin—Continued										
9	01115275	Bear Tree Brook	10/18/11	1.4	1,500	1,500	150	3.4	210	450
			01/17/12	1.9	420	70	86	9.3	140	980
			04/17/12	0.75	420	28	79	3.7	9.2	18
			07/17/12	0.24	16,000	29	42	1.2	120	53
32	01115178	Unnamed Tributary 1 to Scituate Reservoir (Pine Swamp Brook)	10/20/11	2.5	>150,000	68,000	61	31	31	430
			01/19/12	0.70	26	26	24	1.7	8.6	69
			04/19/12	0.18	40	18	6.7	0.45	2.2	8.9
			07/19/12	0.33	500,000	25,000	8.9	3.3	4.1	520
33	01115182	Unnamed Tributary 3 to Scituate Reservoir (Hall's Estate Brook)	10/26/11	0.41	230	230	20	1.0	10	170
			01/25/12	1.0	220	220	34	2.4	120	690
			04/25/12	0.79	130	29	24	1.9	19	150
			07/30/12	0.10	11,000	250	2.8	0.25	1.3	18
Moswansicut Reservoir Subbasin										
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	10/13/11	6.3	14,000	230	360	15	77	770
			11/10/11	7.8	4,400	4,400	350	38	95	1,500
			12/08/11	37	190,000	10,000	3,300	360	3,600	24,000
			01/31/12	7.2	700	260	610	35	180	700
			02/16/12	4.0	150	150	210	29	200	49
			03/08/12	5.2	510	510	230	13	130	510
			04/12/12	1.9	70	70	160	9.3	23	190
			05/10/12	20	11,000	11,000	1,600	98	240	980
			06/18/12	1.6	59	59	130	3.9	78	78
			07/12/12	0.51	75,000	62	45	1.2	6.2	120
			08/16/12	1.3	150,000	6,400	120	3.2	16	95

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

[Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $CFU \times 10^6/d$; millions of colony forming units per day; *E. coli, Escherichia coli*; kg/d, kilograms per day; g/d, grams per day; N, nitrogen; P, phosphorus; <, less than; >, greater than; --, data not available; shaded areas indicate values that were calculated with concentration data censored at half the detection level; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as P)
Moswansicut Reservoir Subbasin—Continued										
21	01115165	Unnamed Tributary 2 to Moswansicut Reservoir (Brook from Kimball Reservoir)	10/17/11	0.79	440	440	58	3.9	39	310
			01/23/12	0.76	800	28	57	7.4	110	74
			04/16/12	0.23	530	130	16	1.1	2.8	2.8
Regulating Reservoir Subbasin										
14	01115110	Huntinghouse Brook	10/03/11	11	>650,000	12,000	75	54	270	1,900
			11/07/11	11	25,000	12,000	220	27	270	3,500
			12/05/11	15	8,400	8,400	290	37	180	8,800
			01/30/12	17	2,900	2,900	2,800	42	210	2,100
			02/15/12	6.5	640	640	130	16	160	2,400
			03/16/12	7.8	290	290	200	38	190	2,100
			04/02/12	6.8	1,500	1,500	430	17	83	1,000
			05/07/12	7.7	4,300	4,300	180	19	190	940
			06/04/12	17	190,000	190,000	1,100	210	210	2,100
			08/06/12	0.14	21,000	310	14	0.68	1.7	58
15	01115114	Rush Brook	10/03/11	9.0	100,000	100,000	320	88	110	2,400
			11/07/11	7.4	430,000	430,000	300	36	180	3,100
			12/05/11	7.7	87,000	87,000	570	380	190	940
			01/30/12	10	5,600	2,200	680	49	120	1,200
			02/15/12	4.7	2,600	2,600	210	11	110	1,100
			03/16/12	4.9	180	180	450	24	120	480
			04/02/12	6.3	6,600	1,400	800	15	77	460
			05/07/12	5.2	2,900	2,900	210	25	130	130
			06/04/12	16	940,000	940,000	2,000	160	390	1,600
			07/02/12	1.0	11,000	11,000	91	7.3	24	150
			08/06/12	0.12	32,000	5,900	2.6	0.88	1.5	32
			09/17/12	0.02	1,100	98	2.1	<0.01	0.24	4.4

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

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PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as P)
Regulating Reservoir Subbasin—Continued										
16	01115098	Peeptoad Brook (Harrisdale Brook)	10/03/11	8.4	19,000	19,000	600	41	100	4,100
			11/07/11	13	7,300	7,300	950	640	320	2,900
			12/05/11	15	28,000	3,300	1,000	73	370	2,200
			01/31/12	13	7,300	7,300	840	64	160	1,900
			02/15/12	6.5	240	240	130	16	160	2,400
			03/16/12	3.2	120	120	240	16	160	470
			04/02/12	3.3	120	120	310	8.1	40	650
			05/07/12	7.1	7,500	7,500	500	35	170	170
			06/04/12	11	300,000	300,000	1,100	27	540	1,600
			07/02/12	3.9	260,000	19,000	270	19	95	290
			08/06/12	0.62	18,000	76	42	3.0	7.6	45
			09/17/12	0.23	6,200	110	16	0.56	2.8	73
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	10/17/11	0.31	3,500	1,100	34	1.5	7.6	68
			01/23/12	0.77	75	28	67	1.9	150	600
			04/16/12	0.06	350	63	6.0	0.44	2.9	220

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2011, through September 30, 2012.—Continued

[Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $CFU \times 10^6/d$; millions of colony forming units per day; *E. coli, Escherichia coli*; kg/d, kilograms per day; g/d, grams per day; N, nitrogen; P, phosphorus; <, less than; >, greater than; --, data not available; shaded areas indicate values that were calculated with concentration data censored at half the detection level; alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board]

PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as P)
Regulating Reservoir Subbasin—Continued										
10	01115274	Westconnaug Brook	10/11/11	2.0	12,000	190	110	4.8	24	720
			11/08/11	2.8	3,000	3,000	130	6.9	69	830
			12/13/11	4.3	160	160	240	--	620	730
			01/10/12	1.9	180	68	76	4.5	23	320
			02/14/12	1.7	62	62	140	4.1	21	660
			03/13/12	1.7	980	980	140	13	42	85
			04/10/12	0.74	4,400	1,700	32	1.8	9	73
			05/08/12	1.3	710	46	84	3.1	15	31
			06/12/12	0.58	130	21	23	7.0	7	890
			07/10/12	0.05	1,800	24	1.4	0.24	1	10
			08/17/12	0.38	39,000	1,800	14	1.8	9.2	28
			09/11/12	0.21	33,000	1,500	7.4	0.51	5.1	5.1
11	01115273	Unnamed Tributary to Westconnaug Reservoir (Unnamed Brook south of Westconnaug Reservoir)	10/25/11	1.7	3,100	160	200	12	120	330
			01/24/12	3.0	3,200	3,200	340	15	37	730
			04/24/12	4.1	240,000	24,000	490	30	50	500

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