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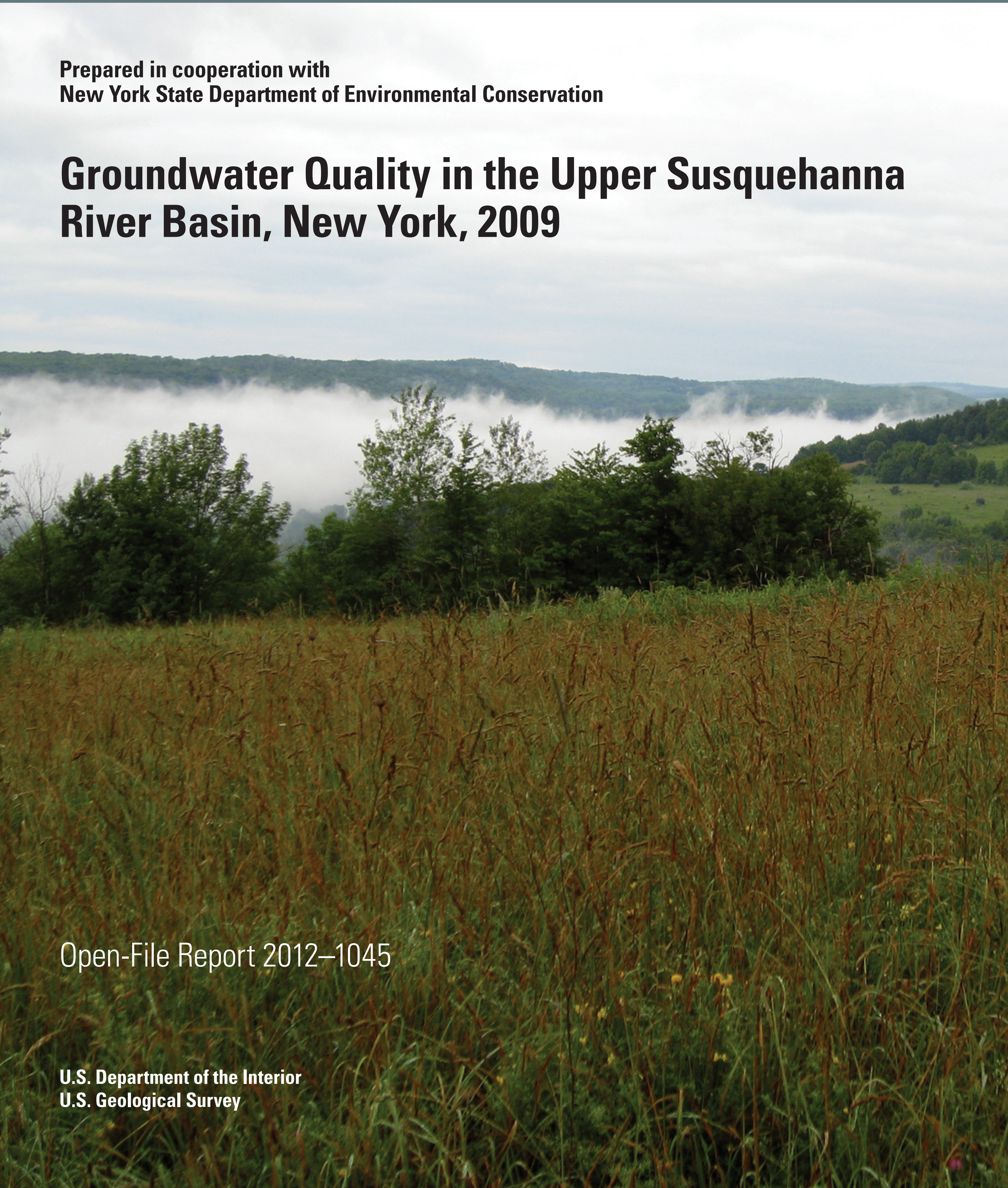
Groundwater Quality in the Upper Susquehanna River Basin, New York, 2009



Open-File Report 2012–1045

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

Cover. Morning mist along East Branch Owego Creek valley, near Hamlet of Berkshire, Tioga County.

Groundwater Quality in the Upper Susquehanna River Basin, New York, 2009

By James E. Reddy and Amy J. Risen

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U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
million gallons (Mgal)	3,785	cubic meter (m^3)
	Flow rate	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
inch per year (in/yr)	25.4	millimeter per year (mm/yr)

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

$$°F=(1.8\times°C)+32$$

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

$$°C=(°F-32)/1.8$$

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to the insert 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 micrograms per liter (µg/L).

Laboratory reporting level (LRL)—Generally equal to twice the yearly determined long-term method detection level (LT–MDL). The LRL controls false negative error. The probability of falsely reporting a nondetection for a sample that contained an analyte at a concentration equal to or greater than the LRL is predicted to be less than or equal to 1 percent. The value of the LRL will be reported with a “less than” remark code for samples in which the analyte was not detected. The National Water Quality Laboratory collects quality-control data from selected analytical methods on a continuing basis to determine LT–MDLs and to establish LRLs. These values are reevaluated annually based on the most current quality-control data, and, therefore, may change (Childress and others, 1999).

Abbreviations

AMCL	Alternative maximum contaminant level
CFCL	USGS Chlorofluorocarbon Laboratory
CFU/mL	Colony forming units per milliliter
CIAT	2-Chloro-4-isopropylamino-6-amino-s-triazine (also called deethylatrazine)
cICP-MS	Collision/reaction cell inductively coupled plasma-mass spectrometry
ESA	Ethanesulfonic acid
GC-MS	Gas chromatography-mass spectrometry
HA	Health Advisory for drinking water
HPC	Heterotrophic plate count
HPLC-MS	High-performance liquid chromatography-mass spectrometry
ICP-AES	Inductively coupled plasma-atomic emission spectrometry
ICP-MS	Inductively coupled plasma-mass spectrometry
ICP-OES	Inductively coupled plasma-optical emission spectrometry
LRL	Laboratory Reporting Level
MCL	Maximum Contaminant Level
NWQL	USGS National Water Quality Laboratory
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OIET	2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine (also called hydroxyatrazine)
SMCL	Secondary Maximum Contaminant Level
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOC	Volatile organic compound

Other abbreviations in this report:

micrometer (μm)

micrograms per liter (μg/L)

milligrams per liter (mg/L)

microsiemens per centimeter (μS/cm)

platinum-cobalt units (Pt-Co units)

picocuries per liter (pCi/L)

Groundwater Quality in the Upper Susquehanna River Basin, New York, 2009

By James E. Reddy and Amy J. Risen

Abstract

Water samples were collected from 16 production wells and 14 private residential wells in the Upper Susquehanna River Basin from August through December 2009 and were analyzed to characterize the groundwater quality in the basin. Wells at 16 of the sites were completed in sand and gravel aquifers, and 14 were finished in bedrock aquifers. In 2004–2005, six of these wells were sampled in the first Upper Susquehanna River Basin study. Water samples from the 2009 study were analyzed for 10 physical properties and 137 constituents that included nutrients, organic carbon, major inorganic ions, trace elements, radionuclides, pesticides, volatile organic compounds, and 4 types of bacterial analyses. Results of the water-quality analyses are presented in tabular form for individual wells, and summary statistics for specific constituents are presented by aquifer type. The results are compared with Federal and New York State drinking-water standards, which typically are identical. The results indicate that groundwater genrally is of acceptable quality, although concentrations of some constituents exceeded at least one drinking-water standard at 28 of the 30 wells. These constituents include: pH, sodium, aluminum, manganese, iron, arsenic, radon-222, residue on evaporation, total and fecal coliform including *Escherichia coli* and heterotrophic plate count.

Introduction

Section 305(b) of the Federal Clean Water Act Amendments of 1977 requires that states monitor and report biennially on the chemical quality of surface water and groundwater within state boundaries (U.S. Environmental Protection Agency, 1997). The U.S. Geological Survey (USGS) in 2002, in cooperation with the New York State Department of Environmental Conservation (NYSDEC), developed a program to evaluate groundwater quality throughout the major river basins in New York on a rotating basis. The program parallels the NYSDEC Rotating Intensive Basin Study program, which evaluates surface-water quality in 2 or 3 of the 14 major river basins in the State each year. The groundwater-quality program began in 2002 with a pilot study in the Mohawk River Basin and has continued throughout upstate New York since then (table 1). Sampling completed in 2008 represented the conclusion of a first round of groundwater-quality sampling throughout New York State (excluding Long Island, which is monitored through local County programs). Groundwater-quality sampling was conducted in 2009 in the Lake Champlain and Upper Susquehanna River Basins; these basins also were sampled in 2004 as part of this study. This report presents the results of the 2009 groundwater study in the Upper Susquehanna River Basin in south-central New York.

Groundwater characteristics are affected by the geology and the land use of the area. Shallow wells that tap into sand and gravel aquifers are susceptible to contamination by several kinds of compounds, including volatile organic compounds (VOCs), pesticides, deicing chemicals, and nutrients from upgradient highways, industrial, agricultural, and residential areas. The movement of these contaminants to the water table through the soils and surficial sand and gravel can be relatively rapid. Bedrock wells that tap into sandstone and shale aquifers in rural upland areas generally are less susceptible to contamination from industrial and urban sources, which are mainly in the valleys; but bedrock wells in lowland areas underlain by carbonate rock (limestone and dolostone) may be more vulnerable to contamination from surface runoff because infiltration rates and groundwater flow can be relatively rapid through solution features in the rock. Agricultural land upgradient of wells may be a potential source of contamination from fertilizers, pesticides, and fecal waste from livestock; lawns and residential septic systems also are a potential source of these contaminants. In addition to anthropogenic contaminants, the aquifers contain naturally derived constituents that may diminish water quality, such as sodium, chloride, sulfate, iron, manganese, arsenic, hydrogen sulfide, methane, and radon gases.

Table 1. Previous groundwater-quality studies and reports.

Study Area	Year	Report	Reference
Mohawk River Basin	2002	Water-Data Report NY-02-1	Butch and others, 2003
Chemung River Basin	2003	Open-File Report 2004–1329	Hetcher-Aguila, 2005
Lake Champlain Basin	2004	Open-File Report 2006–1088	Nystrom, 2006
Upper Susquehanna River Basin	2004	Open-File Report 2006–1161	Hetcher-Aguila and Eckhardt, 2006
Delaware River Basin	2005	Open-File Report 2007–1098	Nystrom, 2007b
Genesee River Basin	2005	Open-File Report 2007–1093	Eckhardt and others, 2007
St. Lawrence River Basin	2005	Open-File Report 2007–1066	Nystrom, 2007a
Mohawk River Basin	2006	Open-File Report 2008–1086	Nystrom, 2008
Western New York	2006	Open-File Report 2008–1140	Eckhardt and others, 2008
Central New York	2007	Open-File Report 2009–1257	Eckhardt and others, 2009
Upper Hudson River Basin	2007	Open-File Report 2009–1240	Nystrom, 2009
Eastern Lake Ontario Basin	2008	Open-File Report 2011–1074	Risen and Reddy, 2011a
Chemung River Basin	2008	Open-File Report 2011–1112	Risen and Reddy, 2011b
Lower Hudson River Basin	2008	Open-File Report 2010– 1197	Nystrom, 2010

Purpose and Scope

This report supplements the water-quality study completed in 2004 in the Upper Susquehanna River Basin (Hetcher-Aguila and Eckhardt, 2006) by re-sampling 6 of the wells from that study (wells BM 90, BM 375, M 595, OG 6, OG 504, and OG 846) and provides analytical results for 24 new wells (fig. 1). This report briefly describes the study area and the sampling methods, and presents results of the 2009 water-quality analyses. Summary statistics (number of samples exceeding Federal or State drinking-water standards) and the minimum, median, and maximum concentrations of selected analytes for 30 samples from wells in sand and gravel and bedrock aquifers are provided in tables 1–3; information on the sampled wells and detailed analytical results for all analytes are provided in tables 1-1 through 1-13 (appendix at end of report).

Study Area

The Upper Susquehanna River Basin lies mostly in south-central New York and partly in north-central Pennsylvania (fig. 1). A complete description of the study area is included in the first Upper Susquehanna River Basin report (Hetcher-Aguila and Eckhardt, 2006). Briefly, the study area (4,522-square miles (mi^2)) includes all or parts of 15 counties in south-central New York. The study area lies within the Appalachian Plateau physiographic province and includes the Upper Susquehanna subbasin, the Chenango River subbasin, and the Owego Creek-Wappasening Creek subbasin (fig. 1). The study area is predominantly rural, although it contains several small cities (Oneonta, Binghamton, Norwich, and Cortland, fig.1) and many villages. Most of the developed areas are within the Susquehanna, Unadilla, Chenango, and Tioughnioga River valleys (fig. 1). The main valley of the Susquehanna River trends northeast-southwest and is about 1 mile (mi) wide in most places. The Susquehanna River Basin drains most of south-central New York and one-half of Pennsylvania and eventually flows into Chesapeake Bay (fig. 1).

During deglaciation of the region, sand and gravel were deposited by meltwater streams and clay, silt, and fine sand were deposited in proglacial lakes. The glaciofluvial and glaciolacustrine deposits within the study area are described in detail by Randall (2001), Fleisher (1977a,b; 1986), MacNish and Randall (1982), and (Coates, 1966). The most productive aquifers within the study area are the glaciofluvial deposits of sand and gravel in the valleys. Bedrock aquifers typically are used for water supply in upland areas where sand and gravel aquifers are absent. The bedrock aquifers throughout most of the study area consist of fractured shale and sandstone; carbonate-bedrock aquifers of fractured and solutioned limestone and dolostone are limited to a small area in the northern part of the basin.

Methods

A total of 30 wells (table 1-1) were selected for sample collection as described by Hetcher-Aguila and Eckhardt (2006)—16 were finished in sand and gravel aquifers, and 14 were finished in bedrock aquifers. Of the 16 wells that tap into sand and gravel aquifers, 14 are production wells and 2 are private residential wells. Of the 14 bedrock wells, 2 are production wells and 12 are

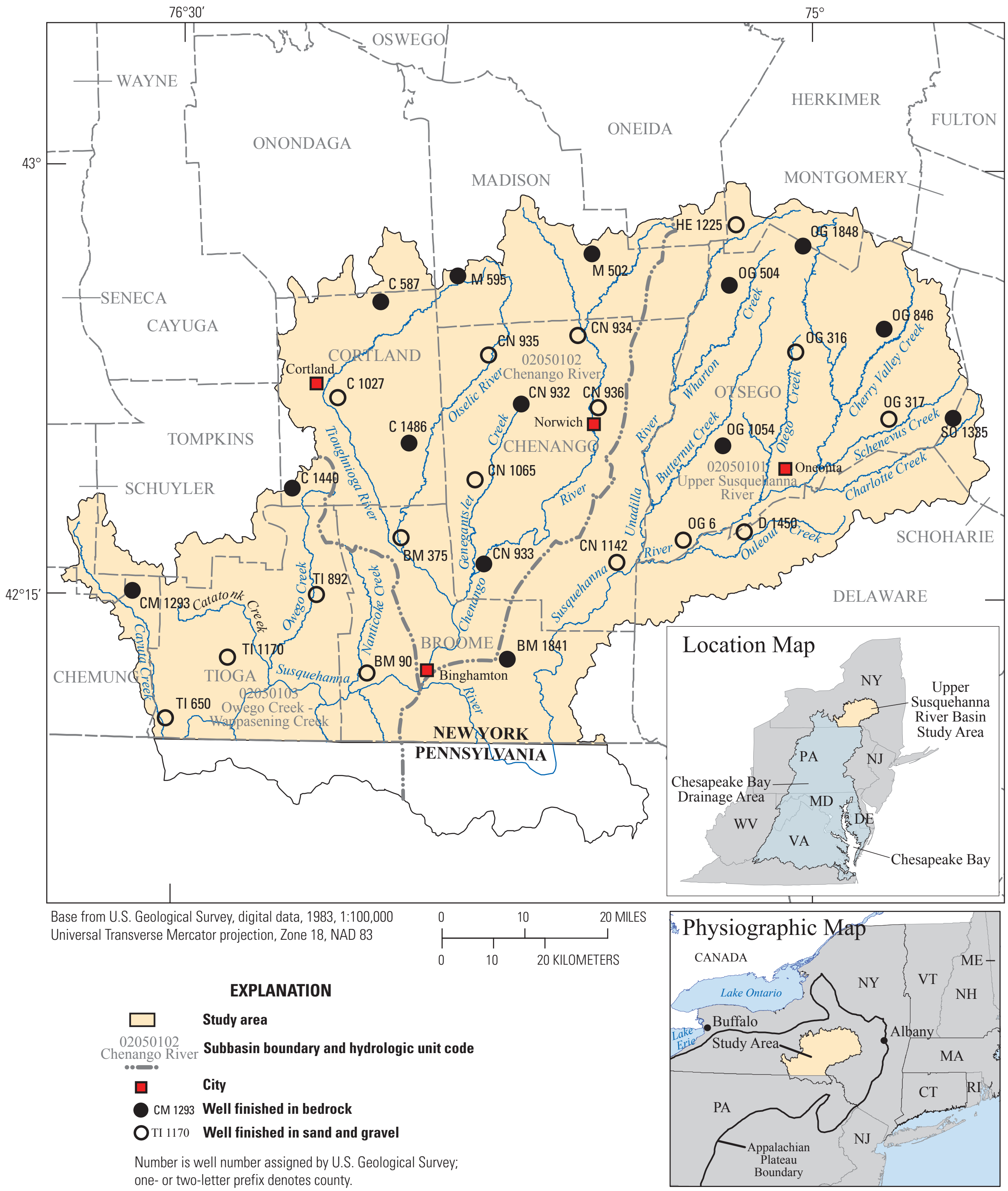

Figure 1. Pertinent geographic features of study area in the Upper Susquehanna River Basin, New York, and locations of the 30 wells sampled in 2009. (Well data are provided in table 1–1, at end of report.)

private residential wells. Samples were collected from August through December 2009. The water samples were analyzed for 10 physical properties and 137 constituents, including 4 types of bacterial analyses. Two samples (one field blank and one replicate sample) were collected for quality assurance (QA) and quality control (QC), as required for the Federal 305(b) program.

Samples were collected from every well for these analyses and were processed by methods described in U.S. Geological Survey (USGS) manuals for the collection of water-quality data (U.S. Geological Survey, variously dated). A detailed description of the sampling and analytical methods is provided by Hetcher-Aguila and Eckhardt (2006). Samples collected for pesticide analyses were processed by the methods of Shelton (1994), Sandstrom and others (2001), and Wilde and others (2004). These samples were analyzed through gas chromatography-mass spectrometry (GC-MS) and high-performance liquid chromatography-mass spectrometry (HPLC-MS), as described by Zaugg and others (1995), Furlong and others (2001), Sandstrom and others (2001), Meyer and others (1993), and Lee and Strahan (2003). The analytical method devised by Zaugg and others (1995) was developed in cooperation with the U.S. Environmental Protection Agency (USEPA) and allows detection of the Nation's most commonly used pesticides. VOCs were analyzed by GC-MS using methods described by Connor and others (1998).

Radon-222 activities were measured through liquid-scintillation counting (ASTM International, 2009). Gross alpha and gross beta radioactivities were measured through gas flow proportional counting according to USEPA method 900.0 (U.S. Environmental Protection Agency, 1980). Carbon dioxide and methane concentrations were measured through gas chromatography with flame ionization detection; dissolved nitrogen gas and argon concentration were measured through gas chromatography with thermal conductivity detection. Total organic carbon samples were analyzed by high temperature combustion and catalytic oxidation for measurement by infrared detection (American Public Health Association, 2005, Standard Method 5310 B). Mercury concentrations were measured through cold vapor-atomic fluorescence spectrometry according to methods described by Garbarino and Damrau (2001). Arsenic, chromium, and nickel analyses used collision/reaction cell inductively coupled plasma-mass spectrometry (cICP-MS) as described by Garbarino and others (2006). The remaining trace elements were analyzed by inductively coupled plasma-atomic emission spectrometry (ICP-AES) (Struzeski and others, 1996), inductively coupled plasma-optical emission spectrometry (ICP-OES), and inductively coupled plasma-mass spectrometry (ICP-MS) (Garbarino and Struzeski, 1998). In-bottle digestions for trace-element analyses described by Hoffman and others (1996) were followed. Samples for bacterial analyses were processed in accordance with New York State Department of Health (NYSDOH) guidelines.

The analyses for physical properties, most trace elements and metals, acid-neutralizing capacity, organic carbon, radiochemicals, and VOCs were done on unfiltered water samples to obtain total whole-water concentrations. Dissolved concentrations of nutrients, major inorganic constituents, three metals, and pesticides were obtained from filtered samples. Concentrations of iron and manganese were measured in filtered and unfiltered samples to provide the total and dissolved concentrations (table 1-6). Hydrochloric acid was added to samples collected for VOC, and mercury analyses, and nitric acid was added to samples collected for gross alpha and gross beta analyses and some of the samples collected for trace-element analyses to prevent sample degradation. Samples collected for dissolved inorganic-compound analyses were filtered through a 0.45-micrometer (µm) polyether sulfone capsule filter; samples for pesticide analysis were filtered through a 0.7-µm furnace-baked glass-fiber plate filter by the methods of Wilde and others (2004).

All samples except those for radiochemical analyses were chilled to 4 degrees Celsius (°C) or less and were kept chilled until delivery to the analyzing laboratory. The samples were delivered directly, or shipped by overnight delivery, to four laboratories: (1) the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado, for analysis for inorganic major ions, nutrients, total organic carbon, inorganic trace elements and radon-222, pesticides and pesticide degradates, and VOCs; (2) the USGS Chlorofluorocarbon Laboratory (CFCL) in Reston, Virginia., for select dissolved gases; (3) a NYSDOH-certified laboratory in Richmond, California, for gross alpha and gross beta radioactivities; and (4) a NYSDOH-certified laboratory in Ithaca, New York for bacterial analysis.

Groundwater Quality

Samples from 30 wells were analyzed for 147 constituents and physical properties. Many of these (74) were not detected above the laboratory reporting levels (LRLs) in any sample (table 1-2). Results for the remaining 73 constituents and properties that were detected are presented in tables 1-3 through 1-13 (at end of report). The categories are as follows: physical properties (table 1-3), inorganic constituents (table 1-4), nutrients and total organic carbon (table 1-5), trace elements and radiochemicals (table 1-6), pesticides (table 1-7), VOCs (table 1-8), and bacterial water-quality indicators (table 1-9). Some concentrations were reported as "estimated" when the detected value was less than the established LRL, or when recovery of a compound has been documented to be highly variable (Childress and others, 1999).

Analytical results for selected constituents were compared with Federal and New York State drinking-water standards, which are typically identical. The standards include Maximum Contaminant Levels (MCLs), Secondary Maximum Contaminant Levels (SMCLs), and Health Advisories (HAs) established by the USEPA (U.S. Environmental Protection Agency, 1999; 2002;

and 2009) and the NYSDOH (New York State Department of Health, 2007). MCLs are enforceable standards that specify the highest level of a contaminant that is allowed in public water drinking supplies; they are not enforceable for private homeowner wells, but are presented here as a guideline for evaluation of the water results. SMCLs are nonenforceable guidelines based on cosmetic and aesthetic criteria, such as taste and odor. HAs are estimates of acceptable drinking-water levels for contaminants that can affect human health; they are nonenforceable guidelines that provide technical guidance for water use.

The QA/QC field blank contained no constituent in concentrations greater than the LRLs, except mercury, which was detected at a trace concentration of 0.39 micrograms per liter (µg/L); however, mercury was not detected in any of the environmental samples at a concentration greater than the LRL. This indicates that little to no contamination occurred through the sampling or analytical procedures. The results of analysis of the QA/QC replicate sample indicates that variability in sample results meet the precision requirements of the study. The analytes with the largest percent differences between concentration in a groundwater sample and that in the replicate sample were acid-neutralizing capacity, residue on evaporation, and low-concentration trace elements (concentrations near the LRL for the elements).

The quality of the sampled groundwater genrally was acceptable, although in samples from 28 of the 30 wells the concentrations of at least 1 constituent exceeded recommended MCLs, SMCLs, or HAs set by the USEPA and the NYSDOH. Exceedances generally involved minerals that occur from natural interactions of water and rock (arsenic, iron, manganese, sodium), but also included bacterial contamination. A total of 17 of the wells tested exceeded the USEPA proposed MCL for radon-222, which is generated from the natural decay of uranium.

Physical Properties and Dissolved Gases

The pH of the samples (table 1-3) ranged from 6.3 to 9.2; the median was pH 7.5 for sand and gravel wells and pH 7.9 for bedrock wells. There were four bedrock wells that had pH values outside the accepted USEPA SMCL range of pH 6.5 to 8.5 (U.S. Environmental Protection Agency, 2009). The temperature of the water ranged from 8.7°C to 17.5°C; the median was 11.0°C for sand and gravel wells and 12.8°C for bedrock wells. Specific conductance of the samples ranged from 105 to 1,220 microsiemens per centimeter (µS/cm) at 25°C; the median was 390 µS/cm at 25°C for sand and gravel wells and 378 µS/cm at 25°C for bedrock wells. The color of the water samples ranged from less than 1 platinum-cobalt (Pt-Co) unit (the LRL) to 5 Pt-Co units; the median was less than 1 Pt-Co units for sand and gravel wells and 2 Pt-Co units for bedrock wells.

Dissolved-oxygen concentrations ranged from less than 0.1 milligram per liter (mg/L) (the LRL) to 8.2 mg/L; the median was 3.2 mg/L for sand and gravel wells and 0.4 mg/L for bedrock wells. Dissolved-nitrogen concentrations ranged from 18.7 mg/L to 30.6 mg/L; the median was 20.8 mg/L for sand and gravel wells and 24.6 mg/L for bedrock wells. Carbon dioxide concentrations ranged from 0.2 mg/L to 42 mg/L; the median was 17.5 mg/L for sand and gravel wells and 5.6 mg/L for bedrock wells. Methane concentrations ranged from less than 0.0005 mg/L (the LRL) to 22.4 mg/L; the median was less than 0.0005 mg/L for sand and gravel wells and 0.15 mg/L for bedrock wells. Argon concentrations ranged from 0.652 mg/L to 0.935 mg/L; the median was 0.735 mg/L for sand and gravel wells and 0.830 mg/L for bedrock wells. The odor of hydrogen sulfide gas, which may occur in the absence of oxygen, was noted by field personnel in water from eight bedrock wells.

Major Ions

The cations that were detected in the greatest concentrations were calcium and sodium (tables 1 and 1-4). Calcium concentrations ranged from 2.21 to 128 mg/L; the median was 45.7 mg/L for sand and gravel wells and 28.2 mg/L for bedrock wells. Magnesium concentrations ranged from 0.424 to 20.3 mg/L; the median was 7.37 mg/L for sand and gravel wells and 4.82 mg/L for bedrock wells. Potassium concentrations ranged from 0.23 to 3.75 mg/L; the median was 1.24 mg/L for sand and gravel wells and 0.50 mg/L for bedrock wells. Sodium concentrations ranged from 1.96 to 170 mg/L; the median was 20.3 mg/L for sand and gravel wells and 36.8 mg/L for bedrock wells. Results indicate six samples exceeded the USEPA nonregulatory drinking-water advisory taste threshold, which recommends that sodium concentrations in drinking water not exceed the range of 30 to 60 mg/L (U.S. Environmental Protection Agency, 2002; 2009).

The anion that was detected in the greatest concentration was bicarbonate, which is a measure of alkalinity and contributes to residue on evaporation (tables 1 and 1-4). Bicarbonate concentrations ranged from 45 to 329 mg/L; the median was 181 mg/L for sand and gravel wells and 206 mg/L for bedrock wells. Chloride concentrations ranged from 0.71 to 201 mg/L; the median was 34.0 mg/L for sand and gravel wells and 5.79 mg/L for bedrock wells. Fluoride concentrations ranged from an estimate of 0.04 mg/L to 0.74 mg/L; the median was an estimate of 0.06 mg/L for sand and gravel wells and 0.23 mg/L for bedrock wells. Silica concentrations ranged from 4.76 mg/L to 14.3 mg/L; the median was 7.13 mg/L for sand and gravel wells and 8.29 mg/L for bedrock wells. Sulfate concentrations ranged from an estimate of 0.17 to 36.0 mg/L; the median was 14.5 mg/L for sand and gravel wells and 7.51 mg/L for bedrock wells.

Table 2. Summary statistics for concentrations of major ions in sand and gravel aquifers and bedrock aquifers in the Upper Susquehanna River Basin, New York, 2009.

[Concentrations are in milligrams per liter. All samples represent filtered water; --, not applicable; <, less than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery; CaCO3, calcium carbonate]

	Constituent	Drinking-water standard	Number of samples exceeding standard	Sand and gravel (16 samples)			Bedrock (14 samples)		
				Minimum	Median	Maximum	Minimum	Median	Maximum
Cations	Calcium	--	--	21.8	45.7	128	2.21	28.2	81.9
	Magnesium	--	--	2.62	7.37	20.3	.424	4.82	10.3
	Potassium	--	--	.58	1.24	3.75	.23	.50	1.50
	Sodium	60[a]	6	1.96	20.3	99.7	2.96	36.8	170
Anions	Bicarbonate	--	--	46	181	329	45	206	287
	Chloride	250[b]	0	1.97	34.0	201	.71	5.79	176
	Fluoride	2.0[c], 2.2[b]	0	< .08	E .06	.21	E .04	.23	.74
	Sulfate	250[b,c]	0	3.44	14.5	36.0	E .17	7.51	33.9
Hardness as $CaCO_3$		--	--	65	145	400	7	96	230
Alkalinity as $CaCO_3$		--	--	38	148	270	37	168	235
Residue on evaporation		500[c]	3	83	207	736	60	206	506

[a] U.S. Environmental Protection Agency Drinking Water Advisory Taste Threshold.

[b] New York State Department of Health Maximum Contaminant Level.

[c] U.S. Environmental Protection Agency Secondary Maximum Contaminant Level.

Calcium and magnesium contribute to water hardness. Water hardness in the basin ranged from 7 to 400 mg/L (as $CaCO_3$); the median was 145 mg/L for sand and gravel wells and 96 mg/L for bedrock wells. Sixteen of the samples were soft to moderately hard (120 mg/L as $CaCO_3$ or less); and 14 wells yielded water that was hard to very hard (greater than 120 mg/L as $CaCO_3$) (Hem, 1985). Wells finished in bedrock were slightly more alkaline (median 168 mg/L as $CaCO_3$) than those finished in sand and gravel (median 148 mg/L as $CaCO_3$). Residue on evaporation is a measure of total dissolved solids, and ranged from 60 to 736 mg/L. The median residue on evaporation was 207 mg/L for sand and gravel wells and 206 mg/L for bedrock wells; three samples exceeded the USEPA SMCL of 500 mg/L.

Nutrients and Organic Carbon

Nitrate was the predominant nutrient in the groundwater samples (tables 2 and 1-5). Nitrate plus nitrite concentrations ranged from less than 0.04 (the LRL) to 3.72 mg/L as nitrogen (N); the median concentration was 1.18 mg/L in samples from sand and gravel wells and less than 0.04 mg/L in samples from bedrock wells. However, nitrite concentrations were typically low; the maximum concentration was 0.040 mg/L. No samples exceeded the nitrate or nitrite MCLs. Ammonia concentrations ranged from less than 0.020 (the LRL) to 0.303 mg/L as N. Orthophosphate concentrations ranged from an estimate of 0.005 to 0.311 mg/L as phosphorus (P). Total organic carbon concentrations ranged from an estimate of 0.4 mg/L to 2.5 mg/L.

Trace Elements and Radiochemicals

The trace elements detected in the greatest concentrations (>100 µg/L) were barium, boron, copper, iron, lithium, manganese, strontium, and zinc (tables 3 and 1-6). Boron, lithium, and strontium were detected at greater concentrations in bedrock wells compared to sand and gravel wells. Barium concentrations ranged from 5.7 µg/L to 944 µg/L. Boron concentrations

Table 3. Summary statistics for concentrations of nutrients and organic carbon in sand and gravel aquifers and bedrock aquifers in the Upper Susquehanna River Basin, New York, 2009.

[All samples represent filtered water except as noted; N, nitrogen; mg/L, milligrams per liter; --, not applicable; <, less than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery; P, phosphorus]

Constituent	Drinking-water standard	Number of samples exceeding limit	Sand and gravel (16 samples)			Bedrock (14 samples)		
			Minimum	Median	Maximum	Minimum	Median	Maximum
Ammonia plus organic N, mg/L as N	--	--	< 0.10	E 0.08	0.33	< 0.10	0.18	0.37
Ammonia, mg/L as N	--	--	< .020	< .020	.269	< .020	.092	.303
Nitrate plus nitrite, mg/L as N	10[a,b]	0	< .04	1.18	3.72	< .04	< .04	.89
Nitrite, mg/L as N	1[a,b]	0	< .002	< .002	< .002	< .002	< .002	.040
Orthophosphate, mg/L as P	--	--	E .005	E .008	.311	< .008	.012	.046
Total organic carbon, unfiltered, mg/L	--	--	< .6	E .4	1.7	< .6	E .6	2.5

[a] U.S. Environmental Protection Agency Drinking Water Advisory Taste Threshold.

[b] New York State Department of Health Maximum Contaminant Level.

ranged from 4.1 to 732 µg/L. Copper concentrations ranged from an estimate of 1.0 µg/L to 267 µg/L. Iron concentrations in filtered samples ranged from an estimate of 2 µg/L to 1,400 µg/L; the Federal SMCL and the New York State MCL for iron (300 µg/L) was exceeded in filtered samples from one sand and gravel well and one bedrock well. Lithium concentrations ranged from 0.7 µg/L to 347 µg/L. Manganese concentrations in filtered samples ranged from less than 0.2 µg/L (the LRL) to 937 µg/L; the Federal SMCL for manganese (50 µg/L) was exceeded in filtered samples from four sand and gravel wells and four bedrock wells. The NYSDOH MCL for manganese (300 µg/L) was exceeded in one filtered sample from a sand and gravel well. Strontium concentrations ranged from 22.8 µg/L to 1,110 µg/L. Zinc concentrations ranged from an estimate of 1.3 to 178 µg/L.

Other trace elements were detected at low to moderate concentrations (as much as 100 µg/L). Aluminum concentrations ranged from less than 6 (the LRL) to 59 µg/L; the Federal SMCL (50 µg/L) was exceeded in two bedrock well samples. Arsenic concentrations ranged from an estimate of 0.11 to 18.4 mg/L; the Federal and NYSDOH MCL (10 µg/L) was exceeded in one sand and gravel well sample. Lead concentrations ranged from an estimate of 0.06 to 6.97 µg/L. Nickel concentrations ranged from less than 0.20 (the LRL) to 1.8 µg/L. Uranium concentrations ranged from an estimate of 0.014 to 1.12 µg/L. Some trace elements were detected less frequently or at lower concentrations (no more than 1 µg/L); these include antimony, cadmium, chromium, cobalt, mercury, selenium, and silver. Beryllium and thallium were not detected in any sample (table 1-2).

Three measures of radioactivity were employed (tables 3 and 1-6). Gross alpha activity ranged from less than 0.58 to 4.9 pico curies per liter (pCi/L). Gross beta activity ranged from 0.7 to 5.0 pCi/L. Radon-222 was detected in every sample, and activity ranged from 22 to 1,140 pCi/L. The median activity was 600 pCi/L in samples from sand and gravel wells and 222 pCi/L in samples from bedrock wells. Radon currently is not regulated in drinking water; however, the USEPA proposed MCL of 300 pCi/L for radon-222 in drinking water was exceeded in 17 samples, but the USEPA proposed Alternate Maximum Contaminant Level (AMCL) of 4,000 pCi/L was not exceeded. The AMCL is the proposed allowable activity of radon in raw-water samples where the State has implemented mitigation programs to address the health risks of radon in indoor air. The proposed MCL and AMCL for radon are under review and have not been adopted (U.S. Environmental Protection Agency, 1999, 2009).

Pesticides

Five herbicides and 1 degradate were detected in samples from 12 sand and gravel wells and 1 bedrock well (table 1-7). The term degradate refers to a pesticide breakdown product resulting from biological or chemical processes. Atrazine or the triazine degradate CIAT (2-chloro-4-isopropylamino-6-amino-*s*-triazine, also called deethylatrazine) were detected in samples from 12 of the 16 sand and gravel wells. Estimated measurements were made for most of the atrazine and CIAT detections,

Table 4. Summary statistics for concentrations of trace elements and radiochemicals in sand and gravel aquifers and bedrock aquifers in the Upper Susquehanna River Basin, New York, 2009.

[All concentrations are in micrograms per liter except as noted. All samples unfiltered except as noted; <, less than ; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery; --, not applicable; pCi/L, picocuries per liter; mrem/yr, millirem per year]

Constituent	Drinking-water standard	Number of samples exceeding standard	Sand and gravel (16 samples)			Bedrock (14 samples)		
			Minimum	Median	Maximum	Minimum	Median	Maximum
Aluminum	50[c]	2	< 6	< 6	24	< 6	E 4	59
Antimony	6[a,b]	0	< .4	< .4	E .2	< .4	< .4	< .4
Arsenic	10[a,b]	1	.25	< .64	18.4	E .11	.56	5.1
Barium	2,000[a,b]	0	5.7	65.0	640	14.6	86.6	944
Boron, filtered	--	--	7.6	21	87	4.1	236	732
Cadmium	5[a,b]	0	< .04	< .04	.07	< .04	< .06	.04
Chromium	100[a,b]	0	< .40	< .42	E .33	< .40	< .4	E .31
Cobalt	--	--	< .04	E .04	.13	< .04	< .10	.11
Copper	1,000[c]	0	E .10	2.8	51.5	2.9	5.2	267
Iron, filtered	300[b,c]	2	E 2	6	1,400	E 3	20	346
Iron	300[b,c]	5	< 9	14	1,420	E 10	68	990
Lead	15[d]	0	E .06	.24	6.97	< .10	.30	1.94
Lithium	--	--	.7	2.9	13.4	1.6	31.4	347
Manganese, filtered	50[c], 300[b]	8, 1	< .2	.5	937	E .2	32.1	183
Manganese	50[c], 300[b]	10, 1	< .8	.8	1,060	E .4	33.2	184
Mercury	2[a,b]	0	< .010	< .010	< .010	< .010	< .010	E .010
Molybdenum	--	--	< .1	E .1	.7	< .1	.2	5.0
Nickel	--	--	< .20	E .34	1.8	< .20	E .14	1.3
Selenium	50[a,b]	0	< .10	E .07	.30	< .10	< .12	E .07
Silver	100[a,b]	0	< .02	< .02	E .01	< .02	< .06	< .06
Strontium	--	--	43.0	128	444	22.8	358	1,110
Uranium	30[a,b]	0	E .020	.183	1.12	E .014	.034	.574
Zinc	5,000[b,c]	0	E 1.3	5.8	178	< 2.0	3.8	67.7
Gross alpha radioactivity, pCi/L	15[a,b]	0	< .58	< 1.1	2.6	< .62	.7	4.9
Gross beta radioactivity, pCi/L	4 mrem/yr[a,b]	--	.7	1.6	5.0	< .86	1.2	5.0
Radon-222, pCi/L	300[e]	17	57	600	1,130	22	222	1,140

[a] U.S. Environmental Protection Agency Maximum Contaminant Level.

[b] New York State Department of Health Maximum Contaminant Level.

[c] U.S. Environmental Protection Agency Secondary Maximum Contaminant Level.

[d] U.S. Environmental Protection Agency Treatment Technique.

[e] U.S. Environmental Protection Agency Proposed Maximum Contaminant Level.

however atrazine concentrations above the reporting level were present in the samples from three wells; the values ranged from 0.01 to 0.09 µg/L. Alachlor was detected in one sample at an estimate of 0.002 µg/L. Metalochlor was detected in one sample at 0.058 µg/L. Prometon was detected below the LRL in samples from three wells and above the LRL in a sample from one well at a concentration of 0.01 µg/L . Simazine was detected below the LRL at one well. No pesticide concentration exceeded Federal or New York State MCLs, and no Federal MCLs currently have been established for the pesticide degradation product CIAT. These trace-level detections of pesticides are similar to those reported by Eckhardt and others (2001), Phillips and others (1999), and Eckhardt and Stackelberg (1995) from studies of pesticides in groundwater throughout New York State.

Volatile Organic Compounds

Eight VOCs were detected in samples from six sand and gravel wells and two bedrock wells (table 1-8). None of the detected compounds exceeded State or Federal drinking-water standards. Trichloromethane, bromodichloromethane, dibromochloromethane, tribromomethane, 1,1,1-trichloroethane, 1,1-dichloroethane, and *cis*-1,2-dichloroethene were detected in samples from five production wells at concentrations ranging from 0.2 to 2.5 µg/L. The first four compounds are trihalomethanes (THMs), which typically are formed as by-products when chlorine or bromine is used to disinfect water. The THMs were detected at three production wells. The State and Federal MCLs for total THMs (80 µg/L) were not exceeded. The three chlorinated solvents—1,1,1-trichloroethane, 1,1-dichloroethane, and *cis*-1,2-dichloroethene—were detected at two production wells. The NYSDOH MCL of 5 µg/L for these solvents was not exceeded. Toluene was detected in samples from three private residential wells at concentrations ranging from 0.1 to 0.2 µg/L. One of the private residential wells was finished in sand and gravel and the other two private residential wells were finished in bedrock. The concentrations of toluene at these wells are below the NYSDOH MCL of 5 µg/L.

Bacteria

All samples were analyzed for total coliform, fecal coliform, *E. coli*, and heterotrophic bacteria. Coliform bacteria were detected in nine samples, and fecal coliforms were detected in two samples (table 1-9). Coliform bacteria were detected in two samples from sand and gravel wells and in seven samples from bedrock wells. The NYSDOH and USEPA MCL violation for total coliform bacteria occurs when 5 percent of finished water samples collected in 1 month test positive for total coliform (if 40 or more samples are collected per month) or when 2 samples are positive for total coliform (if fewer than 40 samples are collected per month). *Escherichia coli* (*E. coli*) were detected in one bedrock well, exceeding the MCL. Heterotrophic plate counts (HPCs) ranged from less than 1 (absent) to 566 colony-forming units per milliliter (CFU/mL); the Federal MCL (500 CFU/mL) was exceeded in one sample.

Wells Sampled in 2004 and 2009

Six of the wells sampled as part of this study in 2009 (wells BM 90, BM 375, M 595, OG 6, OG 504, and OG 846) were sampled previously in 2004. Of the constituents and physical properties common to the 2004 and 2009 analyses, 54 were detected in both years for at least 1 of the 6 wells sampled (tables 1-10 through 1-13). The differences between 2004 and 2009 results for the same well were typically less than the results between different wells.

Summary

In 2002, the U.S. Geological Survey, in cooperation with the New York State Department of Environmental Conservation (NYSDEC), began an assessment of groundwater quality in bedrock and sand and gravel aquifers throughout New York State. As a part of this assessment, the Upper Susquehanna River Basin was studied in 2004 and again in 2009. The 2009 study is the subject of this report and includes analysis of 30 water samples collected from 16 production wells and 14 private residential wells from August through December 2009. Water samples were analyzed for 147 physical properties and constituents that included inorganic major ions, nutrients, organic carbon, trace elements, radon-222, gross alpha and gross beta radioactivities, select dissolved gases, pesticides, volatile organic compounds, and bacterial analyses. Six wells (BM 90, BM 375, M 595, OG 6, OG 504, and OG 846) were tested in both studies and a comparison was made of the results. The measurements for most of the constituents changed little between 2004 and 2009. No major changes were observed in the water quality of the six wells that were sampled in both years.

The quality of the sampled groundwater generally was acceptable in 2004 and 2009. However, 28 of the 30 wells sampled in 2009 had at least 1 constituent that exceeded a Federal or New York State drinking-water standard. Recommended Maximum Contaminant Levels (MCL), Secondary Maximum Contaminant Levels, or Health Advisories set by the U.S.Environmental Protection Agency (USEPA) and New York State Department of Health were exceeded for trace elements (arsenic, manganese, and iron) at 10 wells, bacterial analyses (total and fecal coliform or both) at 9 wells, and residue on evaporation at 3 wells. The USEPA drinking-water advisory taste threshold was exceeded for one inorganic ion (sodium) at six wells. The USEPA proposed MCL for the radioactive isotope radon-222 was exceeded at 17 wells. Eight volatile organic chemicals (trichloromethane, bromodichloromethane, dibromochloromethane, tribromomethane, 1,1,1-trichloroethane, 1,1-dichloroethane, *cis*-1,2-dichloroethene, and toluene) were detected at five production wells (for which there are public reporting requirements) and three residential wells.

References Cited

American Public Health Association, 2005, Standard methods for the examination of water and wastewater (21st ed.): Washington, D.C., American Public Health Association, American Water Works Association, and Water Environment Federation [variously paged].

ASTM International, 2009, D5072–09(2009), Standard test method for radon in drinking water: ASTM International, accessed May 5, 2009, at *http://www.astm.org*.

Butch, G.K., Murray, P.M., Hebert, G.J., and Weigel, J.F., 2003, Water Resources Data, New York, Water Year 2002: U.S. Geological Survey Water-Data Report, NY–02-1, p. 502–520.

Childress, C.J.O., Foreman, W.T., Connor, B.F., and Maloney, T.J., 1999, New reporting procedures based on long-term method detection levels and some considerations for interpretations of water-quality data provided by the U.S. Geological Survey National Water Quality Laboratory: U.S. Geological Survey Open-File Report 99–193, 19 p.

Coates, D.R., 1966, Glaciated Appalachian Plateau—Till shadows on hills: Science, v. 152, p. 1,617–1,619.

Connor, B.F., Rose, D.L., Noriega, M.C., Murtagh, L.K., and Abney, S.R., 1998, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of 86 volatile organic compounds in water by gas chromatography/mass spectrometry, including detections less than reporting limits: U.S. Geological Survey Open-File Report 97–829, 78 p.

Eckhardt, D.A., Hetcher, K.K., Phillips, P.J., and Miller, T.S., 2001, Pesticides and their metabolites in community water-supply wells of central and western New York, August 1999: U.S. Geological Survey Water-Resources Investigations Report 00–4128, 12 p.

Eckhardt, D.A., Reddy, J.E., and Shaw, S.B., 2009, Groundwater quality in central New York, 2007: U.S. Geological Survey Open-File Report 2009–1257, 40 p., at *http://pubs.usgs.gov/of/2009/1257/*.

Eckhardt, D.A., Reddy, J.E., and Tamulonis, K.L., 2007, Ground-water quality in the Genesee River Basin, New York, 2005–06: U.S. Geological Survey Open-File Report 2007–1093, 26 p., at *http://pubs.usgs.gov/of/2007/1093/*.

Eckhardt, D.A., Reddy, J.E., and Tamulonis, K.L., 2008, Ground-water quality in western New York, 2006: U.S. Geological Survey Open-File Report 2008–1140, 36 p., at *http://pubs.usgs.gov/of/2008/1140/*.

Eckhardt, D.A. and Stackelberg, P.E., 1995, Relation of ground-water quality to land use of Long Island, New York: Ground Water, v. 33, no. 6, p. 1,019–1,033.

Fleisher, P.J., 1977a, Glacial geomorphology of upper Susquehanna drainage, in Wilson, P.C., ed., New York State Geological Association Guidebook: Oneonta, State University of New York, 49th Annual Meeting, p. A1–A10.

Fleisher, P.J., 1977b, Dead ice sinks and moats, environment of stagnant ice deposition: Geology, v. 14, p. 39–42.

Fleisher, P.J., 1986, Glacial geology and late Wisconsin stratigraphy, upper Susquehanna drainage basin, New York State, *in* Cadwell, D.H., ed., The Wisconsin stage of the first geological district, eastern New York: Albany, New York State Museum Bulletin 455, p. 121–142.

Furlong, E.T., Anderson, B.D., Werner, S.L., Soliven, P.P., Coffey, L.J., and Burkhardt, M.R., 2001, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of pesticides in water by graphitized carbon-based solid-phase extraction and high-performance liquid chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01–4134, 73 p.

Garbarino, J.R., and Damrau, D.L., 2001, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of organic plus inorganic mercury in filtered and unfiltered natural water with cold vapor—Atomic fluorescence spectrometry: U.S. Geological Survey Water-Resources Investigation Report 01–4132, 16 p.

Garbarino, J.R., Kanagy, L.K., and Cree, M.E., 2006, Determination of elements in natural-water, biota, sediment and soil samples using collision/reaction cell inductively coupled plasma-mass spectrometry: U.S. Geological Survey Techniques and Methods, book 5, sec. B, chap.1, 88 p.

Garbarino, J.R., and Struzeski, T.M., 1998, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of elements in whole-water digests using inductively coupled plasma-optical emission spectrometry and inductively coupled plasma-mass spectrometry: U.S. Geological Survey Open-File Report 98–165, 101 p.

Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water (3d ed.): U.S. Geological Survey Water-Supply Paper 2254, 264 p.

Hetcher-Aguila, K.K., 2005, Ground-water quality in the Chemung River Basin, New York, 2003: U.S. Geological Survey Open-File Report 04–1329, 19 p., at *http://ny.water.usgs.gov/pubs/of/of041329/*.

Hetcher-Aguila, K.K. and Eckhardt, D.A., 2006, Ground-water quality in the Upper Susquehanna River Basin, New York, 2004–05: U.S. Geological Survey Open-File Report 06–1161, 20 p., at *http://pubs.usgs.gov/of/2006/1161/*.

Hoffman, G.L., Fishman, M.J., and Garbarino, J.R., 1996, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—In-bottle acid digestion of whole-water samples: U.S. Geological Survey Open-File Report 96–225, 28 p.

Lee, E.A., and Strahan, A.P., 2003, Determination of acetamide herbicides and their degradation products in water using online solid-phase extraction and liquid chromatography/mass spectrometry: U.S. Geological Survey Open-File Report 03–173, 17 p.

MacNish, R.D., and Randall, A.D., 1982, Stratified-drift aquifers in the Susquehanna River basin, New York: Albany, New York State Department of Environmental Conservation Bulletin 75, 68 p.

Meyer, M.T., Mills, M.S., and Thurman, E.M., 1993, Automated solid-phase extraction of herbicides from water for gas chromatographic-mass spectrometric analysis: Journal of Chromatography, v. 629, p. 55–59.

New York State Department of Health, 2007, New York State Health Department public water systems regulations: Albany, N.Y. [variously paged], accessed January 2009, at *http://www.health.state.ny.us/environmental/water/drinking/part5/tables.htm.*

Nystrom, E.A., 2006, Ground-water quality in the Lake Champlain basin, New York, 2004: U.S. Geological Survey Open-File Report 06–1088, 22 p., at *http://pubs.usgs.gov/of/2006/1088*/.

Nystrom, E.A., 2007a, Ground-water quality in the St. Lawrence River basin, New York, 2005–2006: U.S. Geological Survey Open-File Report 2007–1066, 33 p., at *http://pubs.usgs.gov/of/2007/1066/.*

Nystrom, E.A., 2007b, Ground-water quality in the Delaware River basin, New York, 2001 and 2005–2006: U.S. Geological Survey Open-File Report 2007–1098, 36 p., at *http://pubs.usgs.gov/of/2007/1098/.*

Nystrom, E.A., 2008, Ground-water quality in the Mohawk River basin, New York, 2006: U.S. Geological Survey Open-File Report 2008–1086, 33 p., at *http://pubs.usgs.gov/of/2008/1086/.*

Nystrom, E.A., 2009, Ground-water quality in the Upper Hudson River basin, New York, 2007: U.S. Geological Survey Open-File Report 2009–1240, 37 p., at *http://pubs.usgs.gov/of/2009/1240/.*

Nystrom, E.A., 2010, Groundwater quality in the Lower Hudson River basin, New York, 2008: U.S. Geological Survey Open-File Report 2010–1197, 39 p., at *http://pubs.usgs.gov/of/2010/1197/.*

Phillips, P.J., Eckhardt, D.A., Terracciano, S.A., and Rosenmann, L.R., 1999, Pesticides and their metabolites in wells of Suffolk County, New York, 1998: U.S. Geological Survey Water-Resources Investigations Report 99–4095, 12 p.

Randall, A.D., 2001, Hydrogeologic framework of stratified-drift aquifers in the glaciated Northeastern United States: U.S. Geological Survey Professional Paper 1415-B, 179 p.

Risen, A.J. and Reddy, J.E., 2011a, Groundwater quality in the Eastern Lake Ontario Basin, New York, 2008: U.S. Geological Survey Open-File Report 2011–1074, 32 p., at *http://pubs.usgs.gov/of/2011/1074/*.

Risen, A.J. and Reddy, J.E., 2011b, Groundwater quality in the Chemung River Basin, New York, 2008: U.S. Geological Survey Open-File Report 2011–1112, 25 p., at *http://pubs.usgs.gov/of/2011/1112/*.

Sandstrom, M.W., Stroppel, M.E., Foreman, W.T., and Schroeder, M.P., 2001, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of moderate-use pesticides and selected degradates in water by C-18 solid-phase extraction and gas chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01–4098, 70 p.

Shelton, L.R., 1994, Field guide for collecting and processing stream-water samples for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 94–455, 42 p.

Struzeski, T.M., DeGiacomo, W.J., and Zayhowski, E.J., 1996, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of dissolved aluminum and boron in water by inductively coupled plasma-atomic emission spectrometry: U.S. Geological Survey Open-File Report 96–149, 17 p.

U.S. Environmental Protection Agency, 1980, Prescribed Procedures for Measurement of Radioactivity in Drinking Water: EPA 600/4-80–032. (Also available at *http://www.epa.gov/ogwdw000/methods/pdfs/methods/methods_radionuclides.pdf*.)

U.S. Environmental Protection Agency, 1997, Guidelines for preparation of the comprehensive state water quality assessments 305(b) reports and electronic updates: Washington, D.C., Office of Water, EPA 841–B–97–002A and EPA 841–B–97–002B, PL 95–217, 271 p.

U.S. Environmental Protection Agency, 1999, Proposed radon in drinking water rule: Washington, D.C., U.S. Environmental Protection Agency, Office of Water, EPA 815–F–99–006, 6 p.

U.S. Environmental Protection Agency, 2002, Drinking-water advisory—Consumer acceptability advice and health effects analysis on sodium: Washington, D.C., Office of Water, EPA 822–R–02–032, 34 p.

U.S. Environmental Protection Agency, 2009, National primary drinking water standards and national secondary drinking water standards: Washington, D.C., U.S. Environmental Protection Agency, Office of Water, EPA 816–F–09–0004, 6 p. (Also available at *http://www.epa.gov/safewater/consumer/pdf/mcl.pdf.)*

U.S. Geological Survey, [variously dated], National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chapters A1–A9, available online at *http://pubs.water.usgs.gov/twri9A*.

Wilde, F.D., Radtke, D.B., Gibs, Jacob, and Iwatsubo, R.T., eds., 2004, Processing of water samples: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A5 [variously paged].

Zaugg, S.D., Sandstrom, M.W., Smith, S.G., and Fehlberg, K.M., 1995, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of pesticides in water by C-18 solid-phase extraction and capillary-column gas chromatography with selective-ion monitoring: U.S. Geological Survey Open-File Report 95–181, 49 p.

Appendix

Tables 1–1 Through 1–13

Table 1-1. Information on wells sampled in the Upper Susquehanna River Basin, New York, 2009.

[Well locations are shown in figure 1; --, information not available; well types: P, production; D, domestic]

Well number 1	U.S. Geological Survey site identifier	Date sampled	Well depth, feet below land surface	Casing depth, feet below land surface	Well type	Bedrock type
Sand and gravel wells						
BM 90	420540076030701	9/21/2009	145	--	P	--
BM 375	421954075583501	8/18/2009	25	20	P	--
C 1027	423453076074201	9/15/2009	38	38	D	--
CN 934	424119075334501	11/16/2009	60	50	P	--
CN 935	423916075462901	11/17/2009	85	75	P	--
CN 936	423244075311201	12/8/2009	198.5	170	P	--
CN 1065	422605075480301	9/30/2009	189	189	P	--
CN 1142	421733075283601	12/8/2009	205	191	P	--
D 1450	422050075095701	11/23/2009	80	70	P	--
HE 1225	425304075111801	10/5/2009	46	24	P	--
OG 6	421918075191001	10/28/2009	99	90	P	--
OG 316	423938075024001	11/18/2009	43.6	37	P	--
OG 317	423241074491101	12/15/2009	50	50	P	--
TI 650	420049076314001	10/19/2009	50	40	P	--
TI 892	421350076110301	11/4/2009	180	--	P	--
TI 1170	420710076225301	9/30/2009	108	108	D	--
Bedrock wells						
BM 1841	420712075432301	9/21/2009	60	20	D	Shale and sandstone
C 587	424430076014901	11/9/2009	102	45	P	Shale and sandstone
C 1440	422452076140301	10/27/2009	140	42	D	Shale
C 1486	422947075573901	9/15/2009	180	50	D	Shale
CM 1293	421350076362401	10/14/2009	220	29	D	Shale
CN 932	423354075414301	9/14/2009	137	--	D	Shale
CN 933	421529075470301	11/11/2009	530	48	P	Shale
M 502	424928075315301	8/24/2009	142	20	D	Shale and sandstone
M 595	424750075502401	9/28/2009	359	63	D	Shale
OG 504	424604075110301	9/8/2009	109	57	D	Shale and sandstone
OG 846	424204074501901	9/9/2009	230	34	D	Shale and sandstone
OG 1054	422946075131501	9/2/2009	313	16	D	Shale and sandstone
OG 1848	425036075014601	9/1/2009	205	196	D	Shale and sandstone
SO 1335	423231074403301	8/26/2009	97	21	D	Shale and sandstone

[1] Prefix denotes county: BM, Broome; C, Cortland; CM, Chemung; CN, Chenango; D, Delaware; HE, Herkimer; M, Madison; OG, Otsego; SO, Schoharie; TI, Tioga; number is local well-identification number assigned by U.S. Geological Survey.

Table 1-2. Compounds for which groundwater samples from the Upper Susquehanna River Basin, New York were analyzed but not detected, 2009. –Continued

USGS parameter code	Constituent	Laboratory reporting level, micrograms per liter
	Trace elements in unfiltered water	
01012	Beryllium	0.02-0.04
01059	Thallium	.12
	Pesticides in filtered water	
82660	2,6-Diethylaniline	.006
49260	Acetochlor	.01
34253	*alpha*-HCH	.004-.008
82686	Azinphos-methyl	.120
82673	Benfluralin	.014
04028	Butylate	.002-.004
82680	Carbaryl	.06-.2
82674	Carbofuran	.060
38933	Chlorpyrifos	.010
82687	*cis*-Permethrin	.014
04041	Cyanazine	.022-.040
82682	DCPA	.006-.008
62170	Desulfinyl fipronil	.012
62169	Desulfinylfipronil amide	.029
39572	Diazinon	.005
39381	Dieldrin	.009
82677	Disulfoton	.04-.05
82668	EPTC	.002
82663	Ethalfluralin	.006-.009
82672	Ethoprop	.016
62167	Fipronil sulfide	.013
62168	Fipronil sulfone	.024
62166	Fipronil	.018-.040
04095	Fonofos	.004-.010
39341	Lindane	.004-.014
82666	Linuron	.06
39532	Malathion	.016-.020
82667	Methyl parathion	.008
82630	Metribuzin	.012-.016
82671	Molinate	.002-.003
82684	Napropamide	.008-.018
34653	*p,p'*-DDE	.002-.003
39542	Parathion	.020
82669	Pebulate	.016
82683	Pendimethalin	.012
82664	Phorate	.020

Table 1-2. Compounds for which groundwater samples from the Upper Susquehanna River Basin, New York were analyzed but not detected, 2009. –Continued

04024	Propachlor	.006-.012
82679	Propanil	.010-.014
82685	Propargite	.02
82676	Propyzamide	.004
82670	Tebuthiron	.02-.03
82665	Terbacil	.024-.040
82675	Terbufos	.02
82681	Thiobencarb	.016
82678	Triallate	.006
82661	Trifluralin	.012-.018
	Volatile organic compounds, in unfiltered water	
77652	1,1,1-Trichloro-1,2,2-trifluoroethane	.1
34501	1,1-Dichloroethene	.1
34536	1,2-Dichlorobenzene	.1
32103	1,2-Dichloroethane	.2
34541	1,2-Dichloropropane	.1
34566	1,3-Dichlorobenzene	.1
34571	1,4-Dichlorobenzene	.1
34030	Benzene	.1
34301	Chlorobenzene	.1
34668	Dichlorodifluoromethane	.2
34423	Dichloromethane	.2
81576	Diethyl ether	.2
81577	Diisopropyl ether	.2
34371	Ethylbenzene	.1
78032	Methyl *tert*-butyl ether	.2
50005	Methyl *tert*-pentyl ether	.2
85795	*m* + *p* Xylene	.2
77135	o-Xylene	.1
77128	Styrene	.1
50004	*tert*-Butyl ethyl ether	.1
34475	Tetrachloroethene	.1
32102	Tetrachloromethane	.2
34546	*trans*-1,2-Dichloroethene	.1
39180	Trichloroethene	.1
34488	Trichlorofluoromethane	.2
39175	Vinyl Choride	.2

Table 1-3. Physical properties of groundwater samples from the Upper Susquehanna River Basin, New York, 2009.

[Well locations are shown in figure 1 (00080), National Water Information System (NWIS) parameter code; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter; <, less than. **Bold** values exceed one or more drinking-water standard]

Well number1	Water color, filtered, platinum cobalt units (00080)	pH, field, standard units (00400)	Specific conductance, field, µS/cm (00095)	Water temperature, degrees Celsius (00010)	Dissolved-oxygen unfiltered, field, mg/L (00300)	Dissolved nitrogen gas unfiltered mg/L (00597)	Carbon dioxide unfiltered, mg/L (00405)	Methane unfiltered, mg/L (85574)	Argon unfiltered, mg/L (82043)	Hydrogen sulfide odor field, (71875)
					Sand and gravel wells					
BM 90	5	7.3	1,220	14.9	0.3	22.8	31	0.0430	0.698	Absent
BM 375	<1	7.1	1,140	12.9	1.9	20.8	41	<.0005	.731	Absent
C 1027	2	8.2	256	15.3	3.7	19.1	2.2	<.0005	.652	Absent
CN 934	<1	7.4	802	11.7	3.8	21.4	30	<.0005	.747	Absent
CN 935	<1	8.2	152	11.5	2.7	19.9	1.9	<.0005	.707	Absent
CN 936	2	7.9	453	10.5	.60	24.5	7.4	.0770	.768	Absent
CN 1065	2	8.2	353	11.2	.50	26.1	4.7	.105	.856	Absent
CN 1142	2	8.2	366	10.1	2.8	21.8	2.5	<.0005	.757	Absent
D 1450	<1	7.1	356	9.4	5.8	20.6	26	<.0005	.743	Absent
HE 1225	<1	7.6	561	8.7	8.2	19.9	15	<.0005	.739	Absent
OG 6	<1	7.4	590	10.8	1.8	20.9	30	<.0005	.729	Absent
OG 316	<1	6.7	282	10.5	4.6	20.7	40	<.0005	.719	Absent
OG 317	2	6.5	413	10.6	4.1	19.6	42	<.0005	.729	Absent
TI 650	<1	7.4	780	11.8	5.2	18.7	20	<.0005	.690	Absent
TI 892	<1	8.0	368	10.8	4.7	20.9	4.1	<.0005	.744	Absent
TI 1170	5	8.1	273	14.6	.30	23.9	3.3	<.0005	.797	Absent
					Bedrock wells					
BM 1841	<1	7.7	288	14.2	<.30	24.6	6.5	<.0005	.840	Present
C 587	2	7.1	333	9.7	3.0	22.3	30	.0061	.756	Present
C 1440	<1	8.1	437	13.1	<.10	29.0	5.5	.920	.919	Present
C 1486	5	8.1	360	15.3	<.30	24.1	3.9	.943	.822	Present
CM 1293	5	7.9	284	12.3	3.2	21.9	4.6	<.0005	.769	Absent
CN 932	2	**6.3**	105	12.5	4.2	26.0	35	<.0005	.857	Absent
CN 933	<1	8.3	393	10.1	1.2	28.1	3.0	1.41	.911	Present
M 502	2	7.2	491	13.4	3.8	19.2	29	<.0005	.707	Absent
M 595	<1	**8.8**	953	11.5	<.30	30.6	1.0	7.44	.935	Present
OG 504	2	7.8	316	11.5	.60	25.6	5.6	.261	.838	Absent
OG 846	5	7.9	406	13.3	.30	23.6	5.8	9.58	.790	Absent
OG 1054	2	**9.1**	363	14.8	1.0	23.4	.2	<.0005	.785	Absent
OG 1848	5	7.9	440	17.5	<.20	24.7	5.9	.0456	.813	Present
SO 1335	5	**9.2**	668	12.5	<.50	26.5	.2	22.4	.883	Present

[1]Prefix denotes county: BM, Broome; C, Cortland; CM, Chemung; CN, Chenango; D, Delaware; HE, Herkimer; M, Madison; OG, Otsego; SO, Schoharie; TI, Tioga. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1-4. Concentrations of major ions in groundwater samples from the Upper Susquehanna River Basin, New York, 2009.

[Well locations are shown in figure 1. mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; (29805), USGS National Water Information System (NWIS) parameter code; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery; <, less than. **Bold** values exceed one or more drinking-water standard]

Well number [1]	Hardness, filtered, mg/L as $CaCO_3$ (00900)	Calcium, filtered, mg/L (00915)	Magnesium, filtered, mg/L (00925)	Potassium, filtered, mg/L (00935)	Sodium, filtered, mg/L (00930)	Acid-neutral-izing capacity,[2] unfiltered, mg/L as $CaCO_3$ (90410)	Alkalinity,[2] filtered, mg/L as $CaCO_3$ (29801)
Sand and gravel wells							
BM 90	400	128	20.3	2.14	**70.4**	269	270
BM 375	310	102	14.6	1.37	**99.7**	265	266
C 1027	110	35.1	4.57	.82	6.69	106	106
CN 934	290	97.0	11.2	3.75	48.6	265	265
CN 935	68	23.0	2.62	.63	1.96	60	60
CN 936	190	56.3	13.1	.81	13.2	166	167
CN 1065	140	41.5	7.65	.60	22.8	183	184
CN 1142	130	44.8	5.38	1.19	14.3	108	108
D 1450	120	38.8	6.14	1.00	16.4	60	60
HE 1225	230	79.4	7.85	2.12	17.8	209	209
OG 6	250	86.5	7.09	1.80	23.4	202	202
OG 316	65	21.8	2.67	2.09	27.2	63	63
OG 317	82	24.0	5.34	1.30	37.3	38	38
TI 650	290	91.1	16.0	1.33	40.8	213	216
TI 892	150	46.6	8.00	.98	15.6	129	129
TI 1170	120	37.5	5.31	.58	10.4	113	113
Bedrock wells							
BM 1841	120	33.7	8.46	1.50	12.6	139	138
C 587	140	49.8	3.64	.48	13.5	157	158
C 1440	140	39.5	10.3	.51	41.4	210	211
C 1486	110	31.2	7.67	.71	32.3	180	181
CM 1293	82	25.2	4.64	.53	24.3	128	128
CN 932	44	14.5	2.00	.3	2.96	36	37
CN 933	73	21.1	5.00	.73	50.3	178	179
M 502	230	81.9	5.30	.38	12.8	236	235
M 595	58	18.8	2.80	.50	**170**	200	199
OG 504	120	38.3	7.00	.46	17.2	158	156
OG 846	40	12.2	2.23	.55	**70.7**	117	129
OG 1054	7	2.21	.424	.23	**77.1**	149	154
OG 1848	130	35.2	9.04	1.35	46.4	192	197
SO 1335	16	4.29	1.18	.38	**127**	192	191

[1]Prefix denotes county: BM, Broome; C, Cortland; CM, Chemung; CN, Chenango; D, Delaware; HE, Herkimer; M, Madison; OG, Otsego; SO, Schoharie; TI, Tioga. Number is local well-identification number assigned by U.S. Geological Survey.

[2]Fixed-endpoint titration at pH 4.5.

[3]Calculated from alkalinity.

Table 1-4. Concentrations of major ions in groundwater samples from the Upper Susquehanna River Basin, New York, 2009.—Continued

[Well locations are shown in figure 1. mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; (29805), USGS National Water Information System (NWIS) parameter code; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery; <, less than. **Bold** values exceed one or more drinking-water standard]

Well number[1]	Bicarbonate,[3] filtered, mg/L (29805)	Chloride, filtered, mg/L (00940)	Fluoride, filtered, mg/L (00950)	Silica, filtered, mg/L (00955)	Sulfate, filtered, mg/L (00945)	Residue on evaporation, at 180° Celsius, filtered, mg/L (70300)
Sand and gravel wells						
BM 90	329	201	E.07	10.7	36.0	**736**
BM 375	325	180	E.05	7.16	22.9	**621**
C 1027	129	11.5	E.05	6.02	6.34	143
CN 934	323	79.7	<.08	7.10	17.2	456
CN 935	73	1.97	<.08	5.40	8.55	83
CN 936	204	26.2	.08	11.1	27.7	253
CN 1065	224	2.40	.13	10.8	3.44	197
CN 1142	132	33.8	<.08	6.78	19.1	200
D 1450	73	56.6	E.06	8.78	11.5	202
HE 1225	255	32.3	E.06	4.76	21.5	306
OG 6	246	42.5	E.06	8.01	18.8	334
OG 316	77	34.3	.10	5.56	10.4	144
OG 317	46	88.1	<.08	5.61	11.4	212
TI 650	264	99.3	.09	8.51	16.8	419
TI 892	157	26.3	<.08	6.05	9.79	195
TI 1170	138	9.80	.21	10.8	12.2	146
Bedrock wells						
BM 1841	168	.71	.20	14.3	12.4	173
C 587	193	4.51	.08	6.25	8.59	178
C 1440	257	9.35	.22	10.8	10.1	244
C 1486	221	8.18	.13	10.3	1.38	199
CM 1293	156	1.30	.23	8.87	16.9	153
CN 932	45	5.03	E.04	7.37	7.41	60
CN 933	218	5.28	.32	11.1	6.70	201
M 502	287	6.30	E.08	5.78	12.1	269
M 595	243	176	.74	7.71	2.48	**506**
OG 504	190	4.90	.11	12.3	3.56	178
OG 846	157	48.5	.34	7.06	3.14	231
OG 1054	188	17.0	.43	7.57	7.60	212
OG 1848	240	1.54	.25	9.10	33.9	263
SO 1335	233	88.0	.34	7.71	E.17	368

[1]Prefix denotes county: BM, Broome; C, Cortland; CM, Chemung; CN, Chenango; D, Delaware; HE, Herkimer; M, Madison; OG, Otsego; SO, Schoharie; TI, Tioga. Number is local well-identification number assigned by U.S. Geological Survey.

[2]Fixed-endpoint titration at pH 4.5.

[3]Calculated from alkalinity.

Table 1-5. Concentrations of nutrients and total organic carbon in groundwater samples from the Upper Susquehanna River Basin, New York, 2009.

[Well locations are shown in figure 1. mg/L, milligrams per liter; N, nitrogen; (00623), National Water Information System (NWIS) parameter code; P, phosphorus; <, less than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery]

Well number[1]	Ammonia plus organic nitrogen, filtered, mg/L as N (00623)	Ammonia, filtered, mg/L as N (00608)	Nitrate plus nitrite, filtered, mg/L as N (00631)	Nitrite, filtered, mg/L as N (00613)	Orthophosphate, filtered, mg/L as P (00671)	Total organic carbon, unfiltered, mg/L (00680)
Sand and gravel wells						
BM 90	0.33	0.269	<.04	<.002	0.311	1.7
BM 375	E.08	<.020	1.79	<.002	E.008	1
C 1027	.26	<.020	.30	<.002	E.008	.9
CN 934	E.09	<.020	3.67	<.002	E.005	E.4
CN 935	E.07	<.020	1.15	<.002	E.006	<.6
CN 936	E.10	.066	<.04	<.002	.010	E.4
CN 1065	E.09	.091	<.04	<.002	.175	E.4
CN 1142	<.10	<.020	.76	<.002	.009	E.3
D 1450	<.10	<.020	1.88	<.002	E.007	<.6
HE 1225	E.07	<.020	2.75	<.002	E.006	1.1
OG 6	E.06	<.020	3.72	<.002	E.005	<.6
OG 316	E.09	<.020	1.34	<.002	.010	.8
OG 317	.10	<.020	1.20	<.002	.011	E.5
TI 650	<.10	<.020	1.84	<.002	E.005	E.4
TI 892	E.06	<.020	1.03	<.002	E.005	E.5
TI 1170	E.07	.057	<.04	<.002	.021	E.4
Bedrock wells						
BM 1841	.24	.079	<.04	<.002	E.008	.7
C 587	E.06	.036	.89	E.002	E.005	E.5
C 1440	.20	.155	<.04	E.001	.022	<.6
C 1486	.25	.258	<.04	<.002	.013	E.3
CM 1293	E.07	<.020	.05	<.002	.011	E.4
CN 932	E.06	<.020	.27	<.002	.011	.8
CN 933	.29	.233	<.04	<.002	.015	<.6
M 502	E.07	<.020	.80	<.002	<.008	.7
M 595	.31	.303	<.04	<.002	.031	<.6
OG 504	<.10	.063	<.04	<.002	.012	E.6
OG 846	.17	.105	.14	.040	.022	2.2
OG 1054	E.10	.043	E.03	.027	.023	E.6
OG 1848	.37	.303	<.04	<.002	<.008	1.7
SO 1335	.26	.188	<.04	<.002	.046	2.5

[1]Prefix denotes county: BM, Broome; C, Cortland; CM, Chemung; CN, Chenango; D, Delaware; HE, Herkimer; M, Madison; OG, Otsego; SO, Schoharie; TI, Tioga. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1–6. Concentrations of trace elements and radiochemicals in groundwater samples from the Upper Susquehanna River Basin, New York, 2009.

[Well locations are shown in figure 1. pCi/L, picocuries per liter; µg/L, micrograms per liter; (01105), USGS National Water Information System (NWIS) parameter code; <, less than;
E, estimated value—constituent was detected in the sample but with low or inconsistent recovery. **Bold** values exceed one or more drinking-water standard]

Well number[1]	Aluminum, unfiltered, µg/L (01105)	Antimony, unfiltered, µg/L (01097)	Arsenic, unfiltered, µg/L (01002)	Barium, unfiltered, µg/L (01007)	Boron, filtered, µg/L (01020)	Cadmium, unfiltered, µg/L (01027)	Chromium, unfiltered, µg/L (01034)	Cobalt, unfiltered, µg/L (01037)	Copper, unfiltered, µg/L (01042)
Sand and gravel wells									
BM 90	<6	<.4	9.7	640	37	<.06	<.40	E.09	E3.2
BM 375	<6	<.4	1.6	72.5	38	<.06	E.30	E.09	<4.0
C 1027	<6	<.4	.61	15.6	9.1	<.06	<.40	<.10	<4.0
CN 934	<6	<.4	.45	57.6	28	<.04	E.33	.08	34.9
CN 935	E3	<.4	.26	14.7	7.6	<.04	<.42	<.04	2.7
CN 936	<6	<.4	.98	111	23	<.04	<.42	.04	2.8
CN 1065	<6	<.4	**18.4**	482	87	<.06	<.40	<.10	E2.0
CN 1142	<6	E.2	1.2	149	22	<.04	<.42	E.02	51.5
D 1450	<6	<.4	.36	117	11	<.04	<.42	E.04	13.0
HE 1225	<6	<.4	1.2	49.1	20	<.04	E.23	.04	E1.3
OG 6	<6	<.4	.66	112	39	<.04	<.42	.13	3.5
OG 316	<6	<.4	.29	5.7	13	<.04	<.42	E.03	4.7
OG 317	<6	<.4	.25	8.1	14	.07	<.42	E.04	E.93
TI 650	6	<.4	.56	148	22	<.04	E.22	.06	4.3
TI 892	24	<.4	.44	34.1	9.7	<.04	E.32	<.04	E1.0
TI 1170	<6	<.4	.93	29.1	16	<.06	<.40	<.10	<4.0
Bedrock wells									
BM 1841	<6	<.4	1.2	116	104	<.06	<.40	<.10	4.7
C 587	30	<.4	.61	92.9	73	<.04	E.31	.11	2.9
C 1440	<6	<.4	.57	169	237	.04	<.42	<.04	22.3
C 1486	<6	<.4	.43	944	236	<.06	<.40	<.10	<4.0
CM 1293	**59**	<.4	.56	150	126	<.04	<.42	.06	5.8
CN 932	<6	<.4	.32	23.5	4.1	<.06	<.40	<.10	267
CN 933	E5	<.4	E.18	356	308	<.04	<.42	<.04	25.4
M 502	<6	<.4	.93	53.8	69	<.06	<.40	<.10	E3.8
M 595	E4	<.4	.29	722	732	<.06	<.40	<.10	<4.0
OG 504	<6	<.4	.79	66.5	156	<.06	<.40	<.10	<4.0
OG 846	8	<.4	.58	44.2	401	<.06	<.40	<.10	6.2
OG 1054	**57**	<.4	5.1	14.6	287	<.06	E.31	<.10	E2.4
OG 1848	<6	<.4	.39	62.7	551	<.06	<.40	<.10	17.4
SO 1335	11	<.4	E.11	80.4	537	<.06	<.40	<.10	11.5

Table 1–6. Concentrations of trace elements and radiochemicals in groundwater samples from the Upper Susquehanna River Basin, New York, 2009.—Continued

[Well locations are shown in figure 1. µg/L, micrograms per liter; (01105), USGS National Water Information System (NWIS) parameter code; <, less than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery. **Bold** values exceed one or more drinking-water standard]

Well number[1]	Gross alpha radioactivity, pCi/L (01519)	Gross beta radioactivity, pCi/L (85817)	Iron, filtered, µg/L (01046)	Iron, unfiltered, µg/L (01045)	Lead, unfiltered, µg/L (01051)	Lithium, unfiltered, µg/L (01132)	Manganese, filtered, µg/L (01056)	Manganese, unfiltered, µg/L (01055)	Mercury, unfiltered, µg/L (71900)
Sand and gravel wells									
BM 90	2.6	2.2	**1,400**	**1,420**	0.14	13.4	**937**	**1,060**	<.010
BM 375	<1.7	1.7	E2	<14	E.06	1.9	.6	.8	<.010
C 1027	1.2	1.9	4	15	.15	.7	.2	.4	<.010
CN 934	<1.1	2.7	13	30	1.71	5.9	E.2	<.8	<.010
CN 935	<.72	<1.4	<6	<9	.22	1.9	<.2	<.8	<.010
CN 936	1.0	.7	28	36	.18	7.9	**262**	**271**	<.010
CN 1065	2.2	2.1	120	131	.16	9.6	**114**	**118**	<.010
CN 1142	<.58	1.6	8	12	.17	4.6	1.7	2.0	<.010
D 1450	<.86	.9	124	123	6.97	1.5	3.9	3.8	<.010
HE 1225	<1.1	2.3	E4	62	.85	1.3	<.2	<.8	<.010
OG 6	<.83	5.0	<6	<9	.27	3.7	<.2	<.8	<.010
OG 316	1.1	2.7	<6	<9	.64	2.1	.3	E.4	<.010
OG 317	<.88	<.91	11	12	.12	1.3	.4	E.7	<.010
TI 650	<.73	1.1	<6	12	2.49	4.8	.8	1.4	<.010
TI 892	<.95	1.6	<6	E6	.80	3.9	<.2	<.8	<.010
TI 1170	.7	<.89	118	**320**	.53	1.6	**192**	**196**	<.010
Bedrock wells									
BM 1841	<.95	1.6	37	76	.30	24.0	**183**	**184**	<.010
C 587	<.87	<.95	23	**394**	.86	29.9	32.3	**61.5**	<.010
C 1440	<.79	5.0	15	17	.09	32.9	**55.8**	**61.4**	<.010
C 1486	4.9	<1.3	51	82	E.09	34.0	31.9	31.7	<.010
CM 1293	<.87	<.86	E5	70	.47	18.7	1.6	4.6	<.010
CN 932	<.62	1.1	5	E10	1.94	1.6	.3	E.4	E.010
CN 933	3.0	<.94	17	34	.36	63.4	48.9	**52.4**	<.010
M 502	1.2	1.2	E3	E11	.67	19.7	E.2	E.4	<.010
M 595	3.0	1.8	69	67	.10	347	35.9	33.7	<.010
OG 504	<1.1	<1.3	**346**	**375**	<.10	19.8	**123**	**120**	<.010
OG 846	<.83	1.3	32	54	.26	80.2	25.4	32.6	<.010
OG 1054	1.8	<.91	17	80	.31	29.1	.4	2.6	<.010
OG 1848	.7	1.2	117	**990**	.27	46.1	**55.1**	**53.7**	<.010
SO 1335	1.8	<1.1	10	57	.95	194	13.8	13.6	<.010

Table 1–6. Concentrations of trace elements and radiochemicals in groundwater samples from the Upper Susquehanna River Basin, New York, 2009.—Continued

[Well locations are shown in figure 1. µg/L, micrograms per liter; (01105), USGS National Water Information System (NWIS) parameter code; <, less than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery. **Bold** values exceed one or more drinking-water standard]

Well number[1]	Molybdenum, unfiltered, µg/L (01062)	Nickel, unfiltered, µg/L (01067)	Selenium, unfiltered, µg/L (01147)	Silver, unfiltered, µg/L (01077)	Strontium, unfiltered, µg/L (01082)	Radon-222, unfiltered, pCi/L (82303)	Uranium, unfiltered, µg/L (28011)	Zinc, unfiltered, µg/L (01092)
Sand and gravel wells								
BM 90	0.4	0.78	<.12	<.06	394	276	1.120	7.5
BM 375	E.1	.59	.30	<.06	157	**780**	.755	3.9
C 1027	<.1	<.20	<.12	<.06	54.0	**520**	.094	9.6
CN 934	<.1	.67	.13	E.01	159	**520**	.173	21.0
CN 935	<.1	E.34	E.06	<.02	43.0	**600**	.033	4.0
CN 936	.3	E.25	<.10	<.02	444	135	.619	E1.8
CN 1065	.6	E.12	<.12	<.06	271	57	.044	2.8
CN 1142	.2	E.35	0.23	<.02	89.7	**890**	.721	7.4
D 1450	<.1	.62	E.08	<.02	86.4	**1,130**	E.020	48.1
HE 1225	.4	.36	.19	<.02	407	300	.329	2.8
OG 6	<.1	E.30	.30	<.02	129	**810**	.196	4.2
OG 316	.1	E.20	E.06	<.02	58.5	**880**	.114	E1.3
OG 317	<.1	1.8	E.10	<.02	74.7	**700**	<.028	24.3
TI 650	E.1	.62	.19	<.02	128	**590**	.193	3.6
TI 892	<.1	<.36	<.10	<.02	78.8	**620**	.099	18.5
TI 1170	.7	E.15	<.12	<.06	146	**370**	.574	178
Bedrock wells								
BM 1841	.4	1.3	<.12	<.06	901	**550**	.027	24.1
C 587	E.1	.38	E.07	<.02	268	**560**	.171	10.0
C 1440	.2	<.36	<.10	<.02	1,030	70	.057	E1.9
C 1486	<.1	<.20	<.12	<.06	713	80	<.020	67.7
CM 1293	.2	E.28	E.07	<.02	393	251	.115	6.5
CN 932	<.1	.28	<.12	<.06	22.8	**1,010**	.034	10.1
CN 933	.2	<.36	<.10	<.02	748	118	.035	2.1
M 502	<.1	.31	<.12	<.06	143	300	.214	3.3
M 595	.5	<.20	<.12	<.06	1,110	169	.030	<2.0
OG 504	.4	<.20	<.12	<.06	324	192	.072	6.4
OG 846	.1	E.14	<.12	<.06	284	175	E.014	2.4
OG 1054	5.0	E.13	<.12	<.06	38.7	**1,140**	.574	4.3
OG 1848	3.0	.31	<.12	<.06	848	22	E.018	E1.8
SO 1335	.1	<.20	<.12	<.06	258	**320**	<.020	E1.4

[1]Prefix denotes county: BM, Broome; C, Cortland; CM, Chemung; CN, Chenango; D, Delaware; HE, Herkimer; M, Madison; OG, Otsego; SO, Schoharie; TI, Tioga. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1-7. Concentrations of pesticides detected in groundwater samples from the Upper Susquehanna River Basin, New York, 2009.

[Well locations are shown in figure 1. CIAT, 2-Chloro-4-isopropylamino-6-amino-s-triazine; µg/L, micrograms per liter; (04040), USGS National Water Information System (NWIS) parameter code; <, less than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery; --, no data; M, measured but not quantified]

Well number[1]	CIAT, filtered, µg/L (04040)	Alachlor, filtered, µg/L (46342)	Atrazine, filtered, µg/L (39632)	Metalochlor, filtered, µg/L (39415)	Prometon, filtered, µg/L (04037)	Simazine, filtered, µg/L (04035)
Sand and gravel wells						
BM 90	<.014	<.008	<.007	<.014	<.01	<.010
BM 375	E.006	E.002	E.003	<.014	E.01	E.004
C 1027	E.022	<.008	.021	<.014	E.01	<.010
CN 934	E.058	<.008	.09	0.058	.01	<.006
CN 935	E.003	<.008	<.007	<.014	<.01	<.006
CN 936	<.014	<.008	<.007	<.014	<.01	<.006
CN 1065	<.014	<.008	<.007	<.014	<.01	<.010
CN 1142	E.002	<.008	<.007	<.014	<.01	<.006
D 1450	E.002	<.008	<.007	<.014	<.01	<.006
HE 1225	E.011	<.008	.01	<.014	<.01	<.006
OG 6	E.005	<.008	E.002	<.014	<.01	<.006
OG 316	E.005	<.008	E.003	<.014	<.01	<.006
OG 317	E.003	<.008	E.002	<.014	<.01	<.006
TI 650	E.003	<.008	E.002	<.014	<.01	<.006
TI 892	E.015	<.008	E.003	<.014	<.01	<.006
TI 1170	<.014	<.008	<.007	<.014	<.01	<.010
Bedrock wells						
BM 1841	<.014	<.008	<.007	<.014	<.01	<.010
C 587	<.014	<.008	<.007	<.014	<.01	<.006
C 1440	<.014	<.008	<.007	<.014	<.01	<.006
C 1486	<.014	<.008	<.007	<.014	<.01	<.010
CM 1293	<.014	<.008	<.007	<.014	<.01	<.006
CN 932	<.014	<.008	<.007	<.014	<.01	<.010
CN 933	--	--	--	--	--	--
M 502	<.014	<.008	<.007	<.014	<.01	<.010
M 595	<.014	<.008	<.007	<.014	<.01	<.010
OG 504	<.014	<.008	<.007	<.014	<.01	<.010
OG 846	<.014	<.008	<.007	<.014	<.01	<.010
OG 1054	<.014	<.008	<.007	<.014	<.01	<.010
OG 1848	<.014	<.008	<.007	<.014	<.01	<.010
SO 1335	<.014	<.008	<.007	<.014	M	<.010

[1]Prefix denotes county: BM, Broome; C, Cortland; CM, Chemung; CN, Chenango; D, Delaware; HE, Herkimer; M, Madison; OG, Otsego; SO, Schoharie; TI, Tioga. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1-8. Concentrations of volatile organic compounds in groundwater samples from the Upper Susquehanna River Basin, New York, 2009.

[Well locations are shown in figure 1. µg/L, micrograms per liter; (32106), USGS National Water Information System parameter code; <, less than]

Well number[1]	Trichloro-methane, unfiltered, µg/L (32106)	Bromo-dichloro-methane, unfiltered, µg/L (32101)	Dibromo-chloro-methane, unfiltered, µg/L (32105)	Tribromo-methane, unfiltered, µg/L (32104)	1,1,1-Trichloro-ethane, unfiltered, µg/L (34506)	1,1-Dichloro-ethane, unfiltered, µg/L (34496)	*cis*-1,2-Dichloro-ethene, unfiltered, µg/L (77093)	Toluene, unfiltered, µg/L (34010)
Sand and gravel wells								
BM 90	<.1	<.1	<.2	<.2	<.1	1.3	2.5	<.1
BM 375	.5	<.1	<.2	<.2	<.1	<.1	<.1	<.1
C 1027	<.1	<.1	<.2	<.2	<.1	<.1	<.1	.1
CN 934	.9	.9	1.1	.5	<.1	<.1	<.1	<.1
CN 935	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
CN 936	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
CN 1065	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
CN 1142	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
D 1450	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
HE 1225	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
OG 6	<.1	<.1	<.2	<.2	.6	<.1	<.1	<.1
OG 316	.2	<.1	<.2	<.2	<.1	<.1	<.1	<.1
OG 317	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
TI 650	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
TI 892	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
TI 1170	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
Bedrock wells								
BM 1841	<.1	<.1	<.2	<.2	<.1	<.1	<.1	.2
C 587	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
C 1440	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
C 1486	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
CM 1293	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
CN 932	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
CN 933	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
M 502	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
M 595	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
OG 504	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
OG 846	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
OG 1054	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1
OG 1848	<.1	<.1	<.2	<.2	<.1	<.1	<.1	.2
SO 1335	<.1	<.1	<.2	<.2	<.1	<.1	<.1	<.1

[1]Prefix denotes county: BM, Broome; C, Cortland; CM, Chemung; CN, Chenango; D, Delaware; HE, Herkimer; M, Madison; OG, Otsego; SO, Schoharie; TI, Tioga. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1-9. Concentrations of bacteria in unfiltered groundwater samples from the Upper Susquehanna River Basin, New York, 2009.

[Well locations are shown in figure 1. mL, milliliter; (61213), National Water Information System (NWIS) parameter code; CFU, colony-forming unit; <, less than; >, greater than. **Bold** values exceed one or more drinking-water standard]

Well number[1]	Total coliform colonies per 100 mL (61213)	Fecal coliform colonies per 100 mL (61215)	Escherichia coli, colonies per 100 mL (31691)	Heterotrophic plate count, CFUs per mL (31692)
Sand and gravel wells				
BM 90	<1	<1	<1	7
BM 375	**32**	<1	<1	9
C 1027	<1	<1	<1	7
CN 934	<1	<1	<1	1
CN 935	<1	<1	<1	<1
CN 936	<1	<1	<1	1
CN 1065	<1	<1	<1	24
CN 1142	<1	<1	<1	<1
D 1450	<1	<1	<1	2
HE 1225	<1	<1	<1	1
OG 6	<1	<1	<1	1
OG 316	<1	<1	<1	3
OG 317	**>200**	<1	<1	5
TI 650	<1	<1	<1	1
TI 892	<1	<1	<1	7
TI 1170	<1	<1	<1	29
Bedrock wells				
BM 1841	<1	<1	<1	6
C 587	<1	<1	<1	2
C 1440	<1	<1	<1	46
C 1486	<1	<1	<1	3
CM 1293	<1	<1	<1	27
CN 932	**4**	<1	<1	2
CN 933	<1	<1	<1	1
M 502	**4**	**1**	<1	1
M 595	**27**	<1	<1	6
OG 504	<1	<1	<1	3
OG 846	**9**	<1	<1	**566**
OG 1054	**8**	**1**	**2**	24
OG 1848	**10**	<1	<1	12
SO 1335	**88**	<1	<1	16

[1]Prefix denotes county: BM, Broome; C, Cortland; CM, Chemung; CN, Chenango; D, Delaware; HE, Herkimer; M, Madison; OG, Otsego; SO, Schoharie; TI, Tioga. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1-10. Physical properties of and concentrations of major ions, nutrients and total organic carbon, and bacteria in groundwater samples collected in the Upper Susquehanna River Basin, New York, 2004 and 2009.

[Well locations are shown in figure 1. NWIS, National Water Information System; wf, filtered water; <, less than; wu, unfiltered water; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; CaCO3, calcium carbonate; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery; N, nitrogen; P, phosphorus; --, no data; CFU, colony-forming unit; mL, milliliter. **Bold** values exceed one or more drinking-water standard]

U.S. Geological Survey NWIS parameter code	Constituent	BM 90[1]		BM 375[1]		M 595[1]		OG 6[1]		OG 504[1]		OG 846[1]	
		2004	2009	2004	2009	2004	2009	2004	2009	2004	2009	2004	2009
00080	Color, wf, platinum-cobalt units	**25**	5	2	<1	2	<1	<1	<1	10	2	<1	5
00300	Dissolved oxygen, wu, mg/L	7.2	.3	6.9	1.9	6.5	<.3	2.3	1.8	.3	.6	3.5	.3
00400	pH, wu	7.6	7.3	7.1	7.1	**8.6**	**8.8**	8.0	7.4	**8.6**	7.8	**8.8**	7.9
00095	Specific conductance, wu, µS/cm	969	1,220	1,010	1,140	1,330	953	566	590	307	316	455	406
00010	Temperature, wu, degrees Celsius	11.8	14.9	8.4	12.9	8.4	11.5	10.5	10.8	9.6	11.5	9.5	13.3
00915	Calcium, wf, mg/L	126	128	104	102	32.1	18.8	87.3	86.5	41.0	38.3	13.0	12.2
00925	Magnesium, wf, mg/L	19.9	20.3	14.7	14.6	4.83	2.80	7.48	7.09	6.98	7.00	2.38	2.23
00935	Potassium, wf, mg/L	2.00	2.14	1.29	1.37	.65	.5	2.00	1.80	.49	.46	.50	.55
00930	Sodium, wf, mg/L	53.7	**70.4**	**85.6**	**99.7**	23.4	**170**	21.5	23.4	15.1	17.2	**76.8**	**70.7**
90410	Acid neutralizing capacity, wu, fixed endpoint, lab, mg/L as CaCO3	258	269	254	265	188	200	159	202	127	158	147	117
29801	Alkalinity, wf, fixed end point, laboratory, mg/L as CaCO3	258	270	254	266	197	199	203	202	154	156	146	129
29805	Bicarbonate, wf, fixed endpoint, laboratory, mg/L	315	329	310	325	240	243	248	246	188	190	174	157
00940	Chloride, wf, mg/L	140	201	144	180	**297**	176	39.5	42.5	2.92	4.90	50.6	48.5
00950	Fluoride, wf, mg/L	E.1	E.06	E.1	E.05	.8	.74	E.1	E.06	.1	.11	.4	.34
00955	Silica, wf, mg/L	11.2	10.7	7.34	7.16	8.40	7.71	9.28	8.01	13.6	12.3	8.07	7.06
00945	Sulfate, wf, mg/L	33.9	36.0	17.2	22.9	3.2	2.48	17.5	18.8	3.6	3.56	2.4	3.14
70300	Residue on evaporation @180C, wf, mg/L	**546**	**736**	**518**	**621**	**705**	**506**	325	334	175	178	251	231
00623	Ammonia + organic-N, wf, mg/L as N	.26	.33	E.5	E.08	.36	.31	<.10	E.06	<.10	<.10	.22	.17
00608	Ammonia, wf, mg/L as N	.25	.269	<.04	<.020	.34	.303	E.02	<.020	.06	.063	.16	.105
00631	Nitrate plus nitrite, wf, mg/L as N	<.06	<.04	3.36	1.79	<.06	<.04	3.89	3.72	<.06	<.04	E.05	.14
00613	Nitrite, wf, mg/L as N	<.008	<.002	<.008	<.002	<.008	<.002	<.008	<.002	<.008	<.002	E.005	.040
00671	Orthophosphate, wf, mg/L as P	--	.311	<.02	E.008	.02	.031	<.02	E.005	<.02	.012	.02	.022
00680	Total organic carbon, wu, mg/L	1.46	1.7	1.5	1	<1.00	<.6	<1.00	<.6	<1.00	E.6	<1.00	2.2
31692	Heterotrophic plate count, wu, CFU per ml	<1	7	2	9	<1	6	<1	1	<1	3	248	**566**
61213	Total coliform, wu, CFU per 100 mL	<1	<1	**18**	**32**	<1	**27**	<1	<1	<1	<1	**39**	**9**

[1] Well number. Prefix denotes county: BM, Broome; M, Madison; OG, Otsego. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1-11. Concentrations of trace elements and radiochemicals in groundwater samples collected in the Upper Susquehanna River Basin, New York, 2004 and 2009.

[Well locations are shown in figure 1. NWIS, National Water Information System; wu, unfiltered water; µg/L, micrograms per liter; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery; <, less than; wf, filtered water; M, constituent was detected in the sample but was not quantified; pCi/L, picocuries per liter. **Bold** values exceed one or more drinking-water standard]

U.S. Geological Survey NWIS parameter code	Constituent	BM 901		BM 3751		M 5951		OG 61		OG 5041		OG 8461	
		2004	2009	2004	2009	2004	2009	2004	2009	2004	2009	2004	2009
01105	Aluminum, wu, µg/L	E1	<6	<2	<6	13	E4	2	<6	E2	<6	11	8
01002	Arsenic, wu, µg/L	7	9.7	<2	1.6	<2	.29	<2	.66	<2	.79	<2	.58
01007	Barium, wu, µg/L	508	640	61	72.5	1,420	722	109	112	55	66.5	48	44.2
01020	Boron, wf, µg/L	47	37	31	38	624	732	43	39	118	156	489	401
01034	Chromium, wu, µg/L	<.8	<.40	<.8	E.30	E.5	<.40	1.5	<.42	<.8	<.40	<.8	<.40
01037	Cobalt, wu, µg/L	.507	E.09	.354	E.09	.11	<.10	.481	.13	.145	<.10	.066	<.10
01042	Copper, wu, µg/L	7.5	E 3.2	2.0	<4.0	2.6	<4.0	1.6	3.5	E.3	<4.0	1.8	6.2
01046	Iron, wf, µg/L	**1,230**	**1,400**	<6	E2	<6	69	<6	<6	**303**	**346**	6	32
01045	Iron, wu, µg/L	**1,150**	**1,420**	<6	<14	240	67	M	<9	**350**	**375**	50	54
01051	Lead, wu, µg/L	E.04	.14	.07	E.06	.31	.1	.08	.27	E.05	<.10	.14	.26
01132	Lithium, wu, µg/L	10.8	13.4	1.0	1.9	425	347	3.2	3.7	14.2	19.8	132	80.2
01056	Manganese, wf, µg/L	**969**	**937**	.6	.6	**62.1**	35.9	<.6	<.2	**138**	**123**	41.1	25.4
01055	Manganese, wu, µg/L	**975**	**1,060**	E.5	.8	**59.5**	33.7	<.6	<.8	**134**	**120**	37.6	32.6
71900	Mercury, wu, µg/L	<.01	<.010	<.01	<.010	<.01	<.010	E.01	<.010	<.01	<.010	<.01	<.010
01062	Molybdenum, wu, µg/L	.4	.4	<.2	E.1	.50	0.5	<.2	<.1	.5	.4	.2	.1
01067	Nickel, wu, µg/L	2.45	.78	1.05	.59	.53	<.20	1.26	E.30	.61	<.20	.55	E.14
01147	Selenium, wu, µg/L	.6	<.12	.6	.30	3.00	<.12	.5	.30	E.4	<.12	.8	<.12
01082	Strontium, wu, µg/L	340	394	127	157	2,400	1,110	117	129	281	1,110	322	284
82303	Radon-222, wu, pCi/L	290	276	**840**	**780**	90	169	**1,180**	**810**	280	169	110	175
28011	Uranium, wu, µg/L	.869	1.120	.505	.755	.033	.03	.182	.196	.088	.03	.018	E.014
01092	Zinc, wu, µg/L	19	7.5	5	3.9	E2	<2.0	E1	4.2	7.0	<2.0	E1	2.4

[1]Well number. Prefix denotes county: BM, Broome; M, Madison; OG, Otsego. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1-12. Concentrations of pesticides in groundwater samples collected in the Upper Susquehanna River Basin, New York, 2004 and 2009.

[Well locations are shown in figure 1. NWIS, National Water Information System; wf, filtered water; µg/L, micrograms per liter; <, less than; E, estimated value—constituent was detected in the sample but with low or inconsistent recovery. **Bold** values indicate detections]

U.S. Geological Survey NWIS parameter code	Constituent	BM 90[1]		BM 375[1]		M 595[1]		OG 6[1]		OG 504[1]		OG 846[1]	
		2004	2009	2004	2009	2004	2009	2004	2009	2004	2009	2004	2009
04040	2-Chloro-4-isopropylamino-6-amino-s-triazine (CIAT), wf, µg/L	< .006	< .014	< .006	**E .006**	< .006	< .014	**E .003**	**E .005**	< .006	< .014	< .006	< .014
46342	Alachlor, wf, µg/L	< .004	< .008	< .005	**E .002**	< .005	< .008	< .004	< .008	< .004	< .008	< .004	< .008
39632	Atrazine, wf, µg/L	< .007	< .007	< .007	**E .003**	< .007	< .007	< .007	**E .002**	< .007	< .007	< .007	< .007

[1]Well number. Prefix denotes county: BM, Broome; M, Madison; OG, Otsego. Number is local well-identification number assigned by U.S. Geological Survey.

Table 1-13. Concentrations of volatile organic compounds in groundwater samples collected in the Upper Susquehanna River Basin, New York, 2004 and 2009.

[Well locations are shown in figure 1. NWIS, National Water Information System; wu, unfiltered water; µg/L, micrograms per liter; <, less than. **Bold** values indicate detections]

U.S. Geological Survey NWIS parameter code	Constituent	BM 90[1]		BM 375[1]		M 595[1]		OG 6[1]		OG 504[1]		OG 846[1]	
		2004	2009	2004	2009	2004	2009	2004	2009	2004	2009	2004	2009
32106	Trichloromethane, wu, µg/L	<.1	<.1	<.1	**.5**	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
34506	1,1,1-Trichloroethane, wu, µg/L	**.1**	<.1	<.1	<.1	<.1	<.1	**.7**	**.6**	<.1	<.1	<.1	<.1
34496	1,1-Dichloroethane, wu, µg/L	**1.2**	**1.3**	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
77093	cis-1,2-Dichloroethene, wu, µg/L	**2.5**	**2.5**	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
34010	Toluene, wu, µg/L	<.1	<.1	<.1	<.1	**.1**	<.1	<.1	<.1	<.1	<.1	<.1	<.1

[1]Well number. Prefix denotes county: BM, Broome; M, Madison; OG, Otsego. Number is local well-identification number assigned by U.S. Geological Survey.

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