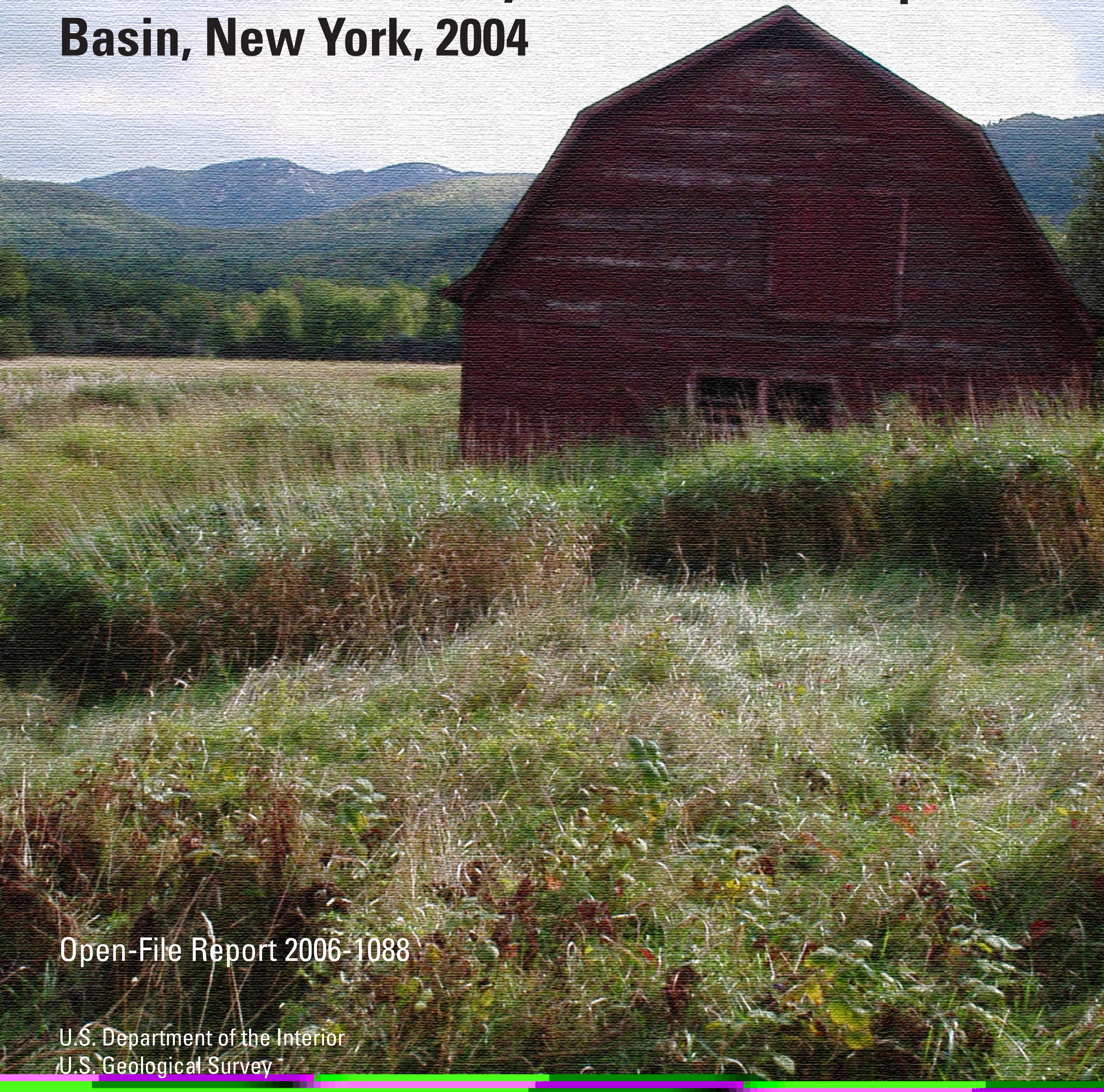
In cooperation with
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Ground-Water Quality in the Lake Champlain Basin, New York, 2004



Open-File Report 2006-1088

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

Ground-Water Quality in the Lake Champlain Basin, New York, 2004

By Elizabeth A. Nystrom

In cooperation with New York State Department of Environmental Conservation

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

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Conversion Factors, Abbreviations, and Datum

Multiply	By	To obtain
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3148	meter (m)
mile (mi)	1.609	kilometer (km)
square miles (mi^2)	2.589	square kilometers (km^2)
inch per year (in/yr)	2.54	centimeters per year (cm/yr)
gallons per minute (gal/min)	3.785	liters per minute (L/min)

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

°F = (1.8 × °C) + 32

Other abbreviations used in this report

micrometers (µm)

micrograms per liter (µg/L)

microseimens per centimeter at 25° Celsius (µS/cm)

milligrams per liter (mg/L)

picoCuries per liter (pCi/L)

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

Ground-Water Quality in the Lake Champlain Basin, New York, 2004

Elizabeth A. Nystrom

Abstract

Water samples were collected from 11 production wells and 11 private domestic wells in the Lake Champlain basin in New York during the fall of 2004 to characterize the chemical quality of ground water. Wells were selected for sampling based on location and focused on areas of greatest ground-water use. Samples were analyzed for 216 physical properties and constituents, including inorganic compounds, nutrients, metals, radionuclides, pesticides and pesticide degradates, volatile organic compounds, and bacteria.

Sixty-eight constituents were detected at concentrations above laboratory reporting levels. The cation and anion with the highest median concentration were calcium (34.8 mg/L) and bicarbonate (134 mg/L), respectively. The predominant nutrient was nitrate, which was detected in 14 (64 percent) of the 22 samples. The two metals with the highest median concentrations were iron (175 µg/L) and strontium (124 µg/L); concentrations of iron, manganese, aluminum, and zinc exceeded U.S. Environmental Protection Agency secondary drinking-water standards in one or more samples. Radon concentrations were less than 1,000 picocuries per liter (pCi/L) in most samples, but concentrations as high as 6,930 pCi/L were detected and, in eight samples, exceeded the U.S. Environmental Protection Agency proposed maximum contaminant level (300 pCi/L) for radon. The most frequently detected pesticides were degradates of the broadleaf herbicides metolachlor, alachlor, and atrazine. Volatile organic compounds were detected in only three samples; those that were detected typically were fuel oxygenates, such as methyl *tert*-butyl ether (MTBE). Coliform bacteria were detected in four samples, two of which also tested positive for *Escherichia coli*.

Introduction

The Federal Clean Water Act Amendments of 1977 require that States monitor and report biennially on the chemical quality of surface water and ground water within their boundaries (U.S. Environmental Protection Agency, 1997. Section 305(b)). In 2002, the U.S. Geological Survey (USGS), in cooperation with the New York State Department of Environmental Conservation (NYSDEC) and U.S. Environmental Protection Agency (USEPA), developed a continuing program to evaluate ground-water quality throughout selected river basins in New York State. This program parallels the NYSDEC Rotating Intensive Basin Study program, which evaluates surface-water quality in two or three of the State’s 14 river basins per year. The first basin in which ground-water quality was studied in compliance with Section 305(b) was the Mohawk River basin in 2002; the second was the Chemung River basin in 2003 (Hetcher-Aguila, 2005). The third basin to be studied was the Lake Champlain basin, the subject of this report. The Lake Champlain basin lies partly in New York, Vermont, and Quebec, Canada; but this study addressed only the part of the basin that lies in New York (fig. 1). Twenty-two samples were collected in the basin during fall of 2004.

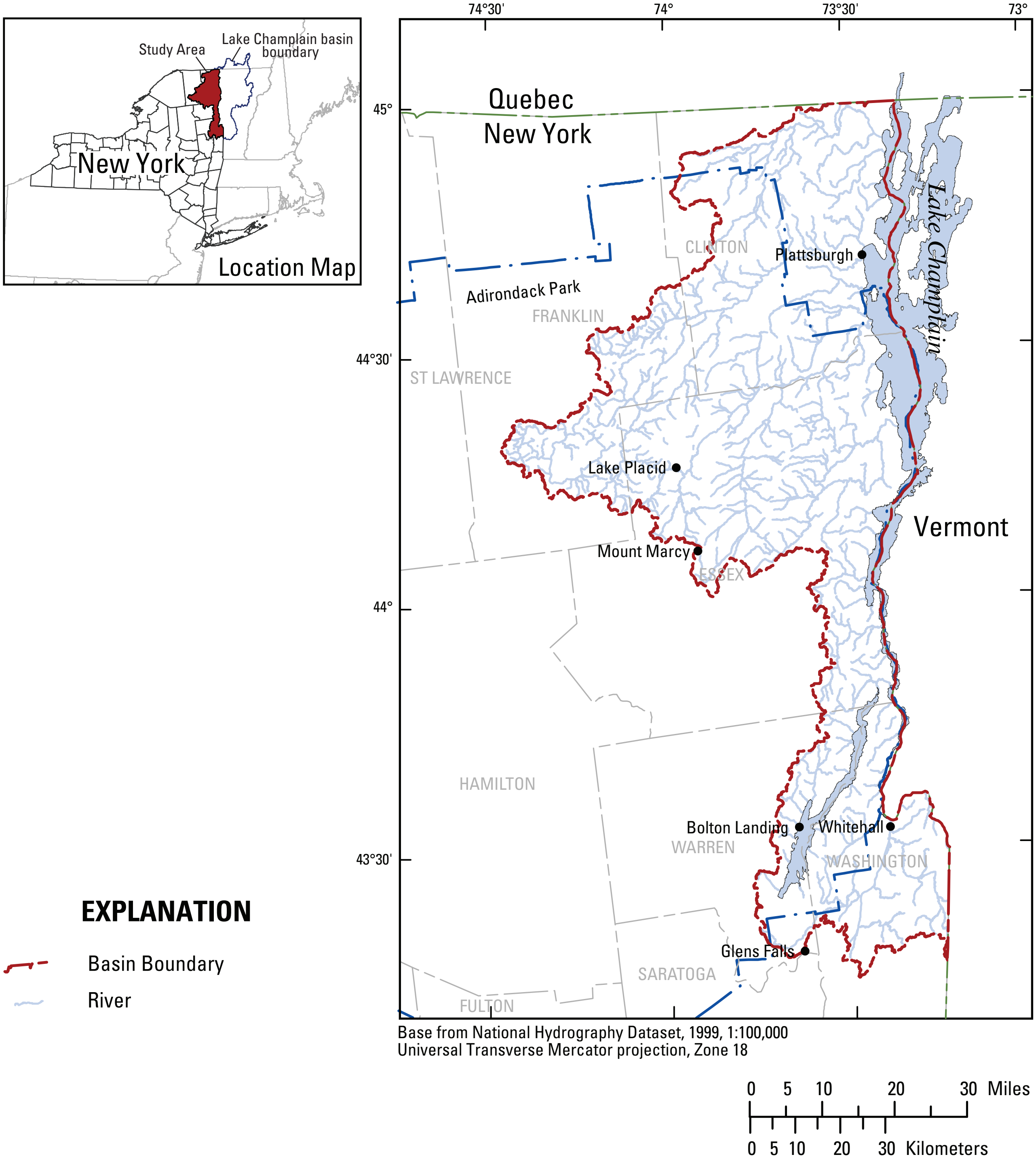
Purpose and Scope

This report (1) describes the methods of site selection, sample collection, and chemical analysis, and (2) discusses the results by category–physical properties, inorganic constituents, nutrients, metals and radionuclides, pesticides, volatile organic compounds, and bacteria. Results are presented in tables.

Hydrologic Setting

The Lake Champlain basin encompasses 8,250 mi^2, mostly along the boundary between northeastern New York and western Vermont (fig. 1) (Seaber and others, 1987). About 37 percent (3,050 mi^2) of the basin lies in New York, 56 percent (4,600 mi^2) in Vermont, and 7 percent (600 mi^2) is in Canada (New York State Department of Environmental Conservation, 1996). The main hydrologic feature of the basin is Lake Champlain, which has an area of 490 mi^2 (Butch and others, 2004).

The Lake Champlain basin in New York contains two principal physiographic regions—the Champlain Valley lowlands in the east and north, and the Adirondack Mountains



Base from National Hydrography Dataset, 1999, 1:100,000
Universal Transverse Mercator projection, Zone 18

Figure 1. Location and major features of the Lake Champlain basin in New York.

in the west; these regions can be generally identified by elevation (fig. 2). The Champlain Valley extends about 120 mi along the lake and is generally narrow throughout (at some points only 12 mi wide) whereas the lowlands extend across the entire northern end of the basin. Altitudes in the valley typically range from 100 to 500 ft (Giese and Hobba, 1970). The valley is underlain by shale, limestone, dolomite, and sandstone of late Cambrian to late Ordovician age (Ellis and others, 1977). The Adirondack Mountain part of the basin, in contrast, has a maximum elevation of 5,344 ft along the western boundary of the basin at Mount Marcy, the highest point in the State (fig.1), and is underlain by mostly crystalline metamorphic rock of Precambrian age such as granitic gneiss, metanorthosite, and olivine metagabbro (Isachsen and others, 2000).

Surficial deposits throughout the basin are the result of the Wisconsin glaciation, which covered most of New York State during the Pleistocene epoch. Till is present throughout the basin; thicker, stratified deposits of silt and clay, sand, and sand and gravel are found in the valleys (Giese and Hobba, 1970). The surficial deposits in the Adirondack Mountains typically are coarser than those in the Champlain Valley lowlands (Isachsen and others, 2000).

The two physiographic regions also differ in climate and precipitation—precipitation in the warmer Champlain Valley lowlands averages about 35 in/yr, and that in the cooler Adirondack Mountains averages about 45 in/yr (Giese and Hobba, 1970). Land use throughout the basin varies, from sparsely populated, forested areas in New York State's Adirondack Park (fig.1) to agricultural areas in the Champlain Valley lowlands and northern part of the basin, and small towns along the lake and in southern parts of the basin. The largest population centers in the basin are Plattsburgh and Glens Falls (fig. 1).

Additional information on the Lake Champlain basin, including hydrology, surface-water quality, population, and land use, is available in the publications of the NYSDEC Rotating Intensive Basin program (New York State Department of Environmental Conservation, 1996) and from the Lake Champlain Basin Program (www.lcbp.org).

Methods

The following sections describe the well-selection criteria, sampling procedures, and analytical methods. Water-sample collection and processing was conducted in accordance with standard USGS procedures (U.S. Geological Survey, variously dated).

Site Selection

Well selection was based on location, with emphasis on areas of greatest ground-water use; availability of hydrogeologic information about the well; and whether the well was finished in sand and gravel or bedrock. The 22 domestic and production wells selected for sampling represented forested, rural, residential, urban, and agricultural areas. Locations of the wells are shown in figure 2, and the predominant land use surrounding each is listed in table 1. The project did not target specific municipalities, industries, or agricultural practices.

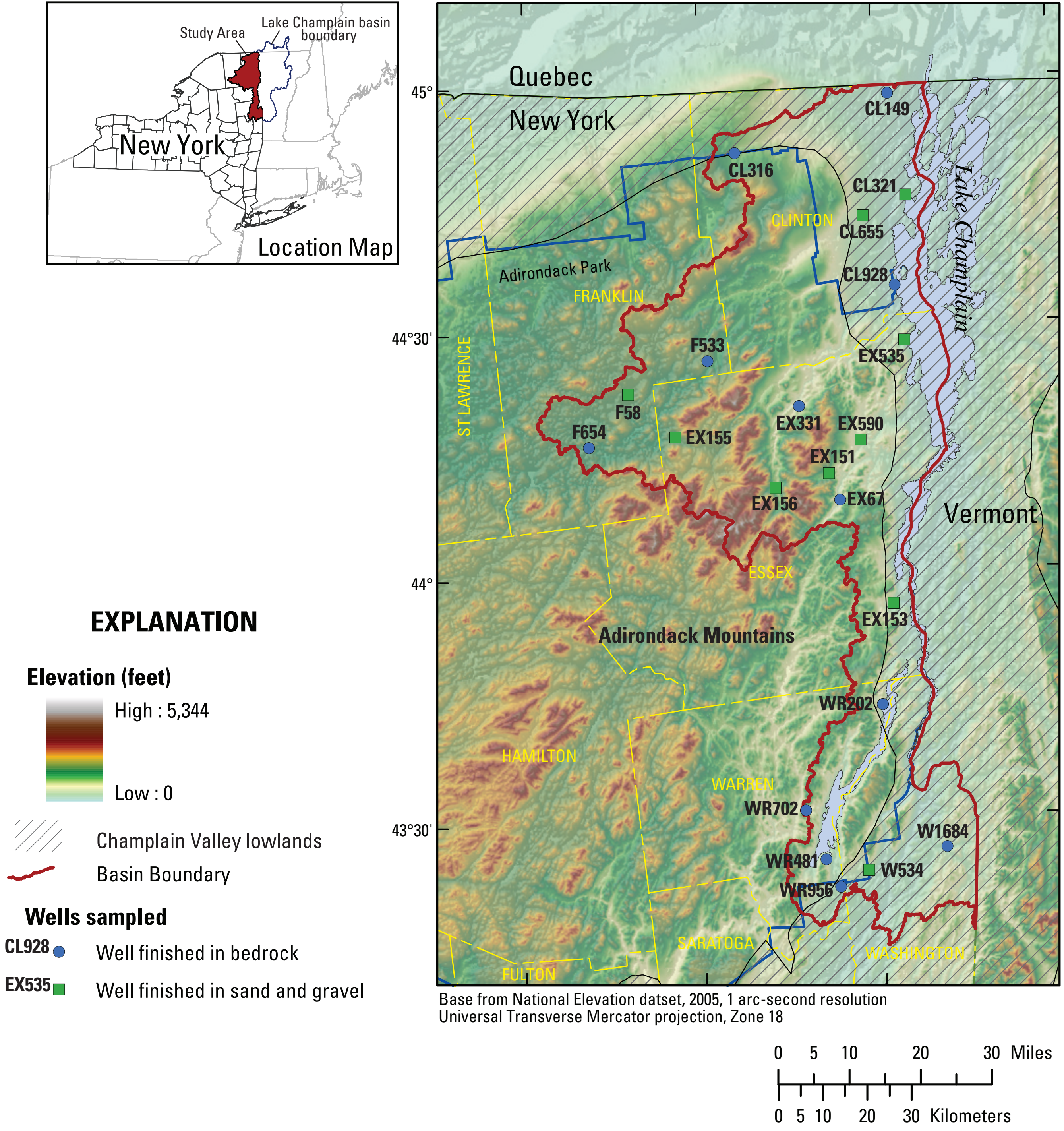
The 11 domestic wells were selected based on information from the NYSDEC Water Well program, which began in 2000 and requires that licensed well drillers file a report with NYSDEC containing basic information about each well drilled—such as well and casing depth and diameter, yield, and hydrogeologic log. Inspection of well-completion reports indicated 100 to 120 wells as potential sampling locations. The well owners were sent a letter that included a request for permission to sample the well, and a questionnaire asking the location of the well, the most convenient times for sampling, and other well-related information. Well owners who gave permission were contacted later by phone to clarify well information and arrange a sampling time.

The 11 production wells were identified through the New York State Department of Health (NYSDOH) Public Water Supply databases and the USGS Ground-Water Site Inventory (GWSI). Town officials and (or) water managers were sent letters and questionnaires similar to those sent to residential-well owners. Follow-up phone calls were used in a manner similar to that used for residential wells. Well information such as well depth and bedrock lithology was provided by water managers; in addition, hydrogeologic logs were obtained for six of the production wells sampled.

Two of the 11 domestic wells were screened in sand and gravel, and 9 were finished in bedrock. Eight of the 11 production wells were screened in sand and gravel and 3 were finished in bedrock. Characteristics of the wells are listed in table 1. The sand and gravel wells ranged from 34 to 140 ft deep; the bedrock wells ranged from 120 to 705 ft deep and typically were finished in fractured granitic gneiss, sandstone, or shale.

Sampling and Analytical Methods

Ground-water samples from the 22 wells were collected and processed by standard USGS methods (U.S. Geological Survey, variously dated). Samples were analyzed for 216 physical properties and constituents, including inorganic constituents, nutrients, metals, radionuclides, pesticides and their degradates, volatile organic compounds (VOCs), and bacteria. Physical properties such as water temperature, pH, and specific conductance were measured at the sampling site. The chemical analyses were done at four laboratories, including the USGS National Water Quality Laboratory (NWQL) in Denver, Colo., the USGS Organic Geochemistry Research Laboratory (OGRL) in Lawrence, Kans., the Darrin



Base from National Elevation datset, 2005, 1 arc-second resolution
Universal Transverse Mercator projection, Zone 18

Figure 2. Topography and locations of wells sampled in the Lake Champlain basin in New York. Well information is in table 1.

Table 1. Information on wells from which ground-water samples were collected in the Lake Champlain basin, New York, 2004.

[Dash (--) indicates unknown depth. Well locations are shown in figure 2]

Well number[1]	Date sampled	Well type	Location	Aquifer	Depth (feet below land surface)	Predominant land use within 0.5 mile of well
CL 149	9/14/2004	production	Champlain Valley	bedrock (sandstone)	140	residential, forested
CL 316	9/14/2004	domestic	Champlain Valley	bedrock (sandstone)	180	residential, agricultural
CL 321	11/1/2004	domestic	Champlain Valley	sand & gravel	80	agricultural
CL 655	9/20/2004	domestic	Champlain Valley	sand & gravel	70	residential, agricultural
CL 928	10/19/2004	domestic	Champlain Valley	bedrock (shale)	575	residential, agricultural
EX 67	11/3/2004	production	Adirondack Mts.	bedrock (crystalline)	148	forested, residential
EX 151	9/27/2004	production	Adirondack Mts.	sand & gravel	80	forested
EX 153	8/25/2004	production	Champlain Valley	sand & gravel	34	mixed
EX 155	9/21/2004	production	Adirondack Mts.	sand & gravel	--	forested
EX 156	10/18/2004	production	Adirondack Mts.	sand & gravel	80	forested, residential
EX 331	8/31/2004	domestic	Adirondack Mts.	bedrock (crystalline)	305	forested
EX 535	9/22/2004	production	Champlain Valley	sand & gravel	128	residential
EX 590	10/13/2004	production	Adirondack Mts.	sand & gravel	56	forested
F 58	9/29/2004	production	Adirondack Mts.	sand & gravel	42	forested, airport
F 533	8/30/2004	domestic	Adirondack Mts.	bedrock (shale)	185	forested
F 654	8/30/2004	domestic	Adirondack Mts.	bedrock (crystalline)	503	forested
W 534	9/28/2004	production	Champlain Valley	sand & gravel	140	forested
W 1684	8/25/2004	domestic	Champlain Valley	bedrock (shale)	705	residential
WR 202	10/12/2004	production	Champlain Valley	bedrock (crystalline)	263	residential
WR 481	12/1/2004	domestic	Adirondack Mts.	bedrock (crystalline)	617	forested, residential
WR 702	9/13/2004	domestic	Adirondack Mts.	bedrock (sandstone)	350	forested, residential
WR 956	9/13/2004	domestic	Champlain Valley	bedrock (sandstone & limestone)	120	dense residential

[1] CL, Clinton County; EX, Essex County; F, Franklin County; W, Washington County; WR, Warren County. Number is local well-identification number assigned by U.S. Geological Survey.

Fresh Water Institute in Bolton Landing, N.Y., and the Severn Trent Laboratories in Newburgh, N.Y.

Sampling Methods

The 22 wells were sampled from August through December 2004. Water samples from domestic wells were collected from a tap between the well and pressure tank, where possible, and before any water-treatment system so that they would be most representative of the water quality of the aquifer. Most production wells were sampled at a valve or a faucet used for collection of raw-water samples by water-managers.

One or two wells were sampled per day. An initial examination of the well plumbing was made, after which a 10-foot length of Teflon tubing was attached to the spigot, and the well was allowed to run to waste for at least 20 minutes to purge the well and pressure tank (if necessary) and rinse the tubing. The pumps in most of the production wells had been running for more than 1 hour before arrival at the site, typically at pumping rates on the order of 100 gal/min. Domestic wells were purged at pumping rates on the order of 5 gal/min; recent usage was taken into account in the purging. Notes about the well and the area surrounding the well (including land use) were taken at this time and a global positioning system (GPS) reading of latitude and longitude was made. While the well pump was running, water was directed from the Teflon tubing into the flow-through chamber that contained a combination meter with temperature, pH, specific conductance, and dissolved-oxygen probes at approximately 2 to 3 gal/min. The combination-meter readings were allowed to equilibrate while other sampling equipment was assembled and organized. Once the values of temperature, pH, specific conductance, dissolved oxygen concentration, and dissolved oxygen saturation had stabilized, the values were recorded.

The Teflon sampling tube was then disconnected from the combination meter and connected to a sampling chamber constructed of a PVC frame and a clear plastic bag. The flow volume was adjusted, typically to approximately 1 to 2 gal/min. The sampling chamber was placed on a plastic-box table with a built-in drain. The Teflon tubing and spigot-attachment equipment were cleaned in the laboratory before each day of sampling with a dilute Liquinox solution followed by tap-water and deionized-water rinse, and were cleaned in the same manner in the field between sampling sites. A fresh sampling-chamber bag was used at each site. Samples were collected and preserved in the sampling chamber according to standard USGS sampling methods (U.S. Geological Survey, variously dated). Sample bottles for nutrient, major-ion, and some trace-element analyses were filled with water filtered through disposable 0.45-µm pore-size cellulose ester cartridge filters that were pre-cleaned in the laboratory with deionized water the day of sample collection. Acid preservation was required for trace-metals, VOCs, and major ion analyses. Acid preservation was done only after collection of other samples to avoid the possibility of cross contamination by the acid preservative; for example, samples preserved with nitric acid were collected and preserved after the collection of samples for nutrient analysis. Water samples that were analyzed by non-USGS laboratories were collected in bottles provided by the analyzing laboratory. Samples for radon analysis were collected through a septum chamber with a glass syringe according to standard USGS procedures (U.S. Geological Survey, variously dated).

Samples for bacteriological analysis were collected in sterile containers provided by the NYSDOH-certified analyzing laboratory. These samples were collected directly from the spigot where possible; otherwise (such as if the spigot was too close to the floor to permit sampling), the sample was collected from the Teflon line after collection of the other samples was completed.

Most sampling sites had easy access to a spigot, but three production wells (CL 149, EX 151, and EX 590, fig. 2) did not have spigot-type attachments; therefore, the sample was obtained from a hydrant like device. Physical properties were measured with the combination meter in a bucket after flow adjustment to avoid air entrainment; however, air entrainment could not be avoided at EX 151, and therefore, dissolved oxygen concentration was not recorded at this site. The syringe for radon-222 sample collection at these sites was inserted directly into the flowing water in the throat of the hydrant to minimize sample exposure to the atmosphere. In addition, a domestic well (WR 702) did not have a sampling spigot between the well and pressure tank; therefore, the sample was collected from just after the pressure tank. Another domestic well (F 654) had anomalously high initial bacterial count. The initial bacterial count for the water sample from well F 654 was unusually high; therefore, the well was resampled.

All samples except those for radiological analysis were chilled to less than 4 ºC after collection. Samples for bacterial analysis were hand delivered to a NYSDOH-certified laboratory in Bolton Landing, N.Y. (fig. 1), within 6 hours of collection; the remainder of the samples were transported to the USGS office in Troy, N.Y. for overnight shipping to the designated laboratories. Samples for pesticide analysis were filtered with a 0.7-µm pore size glass-fiber filter in the laboratory at the USGS office in Troy. Filter plates and ceramic-piston pumps were pre-cleaned with a dilute Liquinox soap solution followed by tap- and deionized-water rinses, finally followed by a methanol rinse.

Analytical Methods

Most analyses were done at the USGS NWQL in Denver, Colo.; other analyses were done at the USGS OGRL in Lawrence, Kans. and NYSDOH-certified laboratories. Nutrient analyses were done by colorimetry, as described by Fishman (1993) and by Kjeldahl digestion with photometric finish, as described by Patton and Truitt

(2000). Anion concentrations were determined by ion-exchange chromatography, and cation analyses were done through inductively coupled plasma-atomic emission spectrometry (ICP-AES), as described in Fishman (1993). Trace-element analyses were done through ICP-AES as described in Struzeski and others (1996), and through inductively coupled plasma-optical emission spectrometry and inductively coupled plasma-mass spectrometry, as described by Garbarino and Struzeski (1998). In-bottle digestions for trace-element analyses were done as described by Hoffman and others (1996). Mercury analysis was done through cold vapor–atomic fluorescence spectrometry according to methods described by Garbarino and Damrau (2001). VOC analyses were done by gas chromatography/mass spectrometry through methods described by Connor and others (1998). Radon-222 was measured through liquid-scintillation counting.

Samples for pesticide analyses were processed as described by Shelton (1994). Pesticide and pesticide-degradate analyses were done at the NWQL through gas chromatography-mass spectrometry as described by Zaugg and others (1995), Sandstrom and others (2001), and Furlong and others (2001). Acetamide parent compounds and degradation-product analyses were done by liquid chromatography-mass spectrometry at the USGS OGRL according to methods described by Lee and others (2001) and Ferrer and others (1997).

Bacteriological analyses were completed at a NYSDOH-certified laboratory within the Lake Champlain basin. The samples were collected and processed in accordance with NYSDEC and NYSDOH protocols, except that the tap from which the water sample was collected was not flame sterilized. Samples were tested for total and fecal coliform through Standard Methods 9222 B and D (American Public Health Association, 1998). Where total coliform was detected, a Lauryl Tryptose/Brilliant Green test (SM 9222 B) was used to confirm the presence of total coliform, and a MUG test (SM 9222 G) was used to check for *Escherichia coli* (*E. coli*). A heterotrophic plate count test (SM 9215 B) also was conducted.

Total organic carbon and total phenols analyses were done by a NYSDOH-certified laboratory. Total organic carbon analyses were done through method SM18 5310 C (American Public Health Association, 1998), and total phenols analyses were done by method LAC 10-210-00-1-A, which is equivalent to EPA method 420.1 (U.S. Environmental Protection Agency, 1983).

Quality Assurance

One ambient field blank sample and 1 concurrent-replicate sample were collected for quality assurance in addition to the 22 ground-water samples. Sample containers for the blank sample were filled in the field with nitrogen-purged VOC/pesticide-grade universal blank water supplied by the USGS NWQL. Sample bottles for raw-water constituents were filled directly from the blank-water bottles; water for filtered-water constituents was pumped through pre-cleaned filters. Samples were acidified in the same manner as environmental samples. The blank contained no constituent concentrations above the laboratory reporting levels. The percent-concentration differences from the concurrent-replicate sample were less than 5 percent for 19 of the 29 constituents detected in the replicate sample. The largest percent differences between concentration in the ground-water sample and the replicate sample were in acid-neutralizing capacity, alkalinity, residue on evaporation, and five low concentration metals (concentrations near or below the reporting level for the compounds).

Ground-Water Quality

The 22 ground-water samples and 2 quality-assurance samples were analyzed for 216 different properties and constituents. More than half (148) of the compounds were not detected in any sample (table 2). Concentrations of some constituents exceeded maximum contaminant levels (MCLs) or secondary drinking-water standards set by USEPA (U.S. Environmental Protection Agency, 2003) or NYSDOH (New York State Department of Health, 1998), as noted in the following sections.

Physical Properties

The physical properties of the ground-water samples are listed in table 3. Sample color ranged from less than 1 to 25 platinum-cobalt units; the color of samples from three wells equaled or exceeded the USEPA secondary standard of 15 platinum-cobalt units. The median dissolved oxygen concentration was 1.6 mg/L, or about 14 percent of saturation. Samples from all but two of the wells were within the USEPA secondary drinking-water standards pH range of 6.5 to 8.5. Specific conductance ranged from 71 to 1,090 µS/cm in the field and from 73 to 1,350 µS/cm at the laboratory. Water temperature ranged from 6.8 to 12.5 ºC.

Inorganic Constituents

Acid-neutralizing capacity of unfiltered samples ranged from 33 to 244 mg/L as calcium carbonate (table 4). Acid-neutralizing capacity of filtered samples (alkalinity) ranged from 34 to 274 mg/L as calcium carbonate. Noncarbonate hardness ranged from 1 to 100 mg/L as calcium carbonate. Hardness ranged from 29 to 380 mg/L as calcium carbonate. Alkalinity was lowest in samples from wells finished in or underlain by crystalline bedrock and highest in those finished in or underlain by carbonate bedrock, as indicated in the alkalinity table on p. 14. Alkalinity in the Adirondack

Table 2. Compounds for which ground-water samples collected from the Lake Champlain basin, New York, were analyzed but not detected and their analytical detection limits.

[WY, water year, the 12-month period from October 1 through September 30 of the following year]

NWIS code[1]	Compound	Laboratory reporting level[2] (micrograms per liter execpt as noted)		
		WY 2004	WY 2005	Oct 18-19, 2005
	Nutrients (milligrams per liter as Nitrogen)			
00613	Nitrite	0.008	0.008	0.008
	Metals			
01012	Beryllium	.06	.06	.06
71900	Mercury	.02	.01	.01
01077	Silver	.16	.16	.16
01059	Thallium	.2	.2	.2
	Pesticides			
04040	2-Chloro-4-isopropylamino-6-amino-*s*-triazine	.006	.006	.006
50470	2,4-D methyl ester	.009	.016	.016
38746	2,4-DB	.02	.02	.02
82660	2,6-Diethylaniline	.006	.006	.006
62850	2-[(2-Ethyl-6-methylphenyl)amino]-2-oxoethanesulfonic acid	.02	.02	.02
49308	3-Hydroxy carbofuran	.006	.008	.008
50295	3-Ketocarbofuran	.01	.02	.02
61029	Acetochlor ethanesulfonic acid	.02	.02	.02
61030	Acetochlor oxanilic acid	.02	.02	.02
62847	Acetochlor sulfynilacetic acid	.02	.02	.02
49260	Acetochlor	.006	.006	.006
49315	Acifluorfen	.007	.028	.028
62848	Alachlor sulfynilacetic acid	.02	.02	.02
46342	Alachlor	.004	.004	.005
49313	Aldicarb sulfone	.02	.02	.02
49314	Aldicarb sulfoxide	.008	.022	.022
49312	Aldicarb	.04	.04	.04
34253	*alpha*-HCH	.005	.005	.005
39632	Atrazine	.007	.007	.007
82686	Azinphos-methyl	.050	.050	.050
50299	Bendiocarb	.03	.02	.02
82673	Benfluralin	.010	.010	.010
50300	Benomyl	.004	.022	.022
61693	Bensulfuron	.02	.02	.02
38711	Bentazon	.01	.01	.01
04029	Bromacil	.03	.02	.02
49311	Bromoxynil	.02	.03	.03
04028	Butylate	.002	.002	.004
82680	Carbaryl	.041	.041	.041
49309	Carbofuran	.020	.020	.020
61188	Chloramben methyl ester	.02	.02	.02
50306	Chlorimuron	.010	.032	.032
49306	Chlorothalonil	.04	.04	.04
38933	Chlorpyrifos	.005	.005	.005
82687	*cis*-Permethrin	.006	.006	.006
49305	Clopyralid	.01	.02	.02

Table 2. Compounds for which ground-water samples collected from the Lake Champlain basin, New York, were analyzed but not detected and their analytical detection limits.—Continued

NWIS code[1]	Compound	Laboratory reporting level[2] (micrograms per liter execpt as noted)		
		WY 2004	WY 2005	Oct 18-19, 2005
	Pesticides—Continued			
04041	Cyanazine	0.018	0.018	0.018
04031	Cycloate	.01	.01	.01
49304	Dacthal monoacid	.01	.03	.03
82682	DCPA	.003	.003	.003
62170	Desulfinyl fipronil	.004	.004	.012
39572	Diazinon	.005	.005	.005
38442	Dicamba	.01	.04	.04
49302	Dichlorprop	.01	.03	.03
39381	Dieldrin	.005	.005	.009
61951	Dimethenamid ethanesulfonic acid	.02	.02	.02
62482	Dimethenamid oxanilic acid	.02	.02	.02
61588	Dimethenamid	.02	.02	.02
49301	Dinoseb	.01	.04	.04
04033	Diphenamid	.03	.01	.01
82677	Disulfoton	.02	.02	.02
49300	Diuron	.01	.01	.01
82668	EPTC	.002	.002	.004
82663	Ethalfluralin	.009	.009	.009
82672	Ethoprop	.005	.005	.005
49297	Fenuron	.03	.02	.02
62169	Desulfinylfipronil amide	.009	.009	.029
62166	Fipronil	.005	.005	.013
62167	Fipronil sulfide	.005	.005	.024
62168	Fipronil sulfone	.007	.007	.016
62481	Flufenacet	.02	.02	.02
61952	Flufenacet ethanesulfonic acid	.02	.02	.02
62483	Flufenacet oxanilic acid	.02	.02	.02
61694	Flumetsulam	.01	.04	.04
38811	Fluometuron	.03	.02	.02
04095	Fonofos	.003	.003	.003
50407	Imazethapyr	.02	.04	.04
39341	Lindane	.004	.004	.004
38478	Linuron	.035	.035	.035
39532	Malathion	.027	.027	.027
38482	MCPA	.02	.03	.03
38487	MCPB	.01	.01	.01
38501	Methiocarb	.008	.010	.010
49296	Methomyl	.004	.020	.020
82667	Methyl parathion	.006	.006	.015
39415	Metolachlor	.013	.013	.006
82630	Metribuzin	.006	.006	.006
61697	Metsulfuron	.03	.03	.03
82671	Molinate	.002	.002	.003
61692	*N*-(4-Chlorophenyl)-*N*′-methylurea	.02	.04	.04

Table 2. Compounds for which ground-water samples collected from the Lake Champlain basin, New York, were analyzed but not detected and their analytical detection limits.—Continued

NWIS code[1]	Compound	Laboratory reporting level[2] (micrograms per liter execpt as noted) WY 2004	WY 2005	Oct 18-19, 2005
	Pesticides—Continued			
82684	Napropamide	0.007	0.007	0.007
49294	Neburon	.01	.01	.01
50364	Nicosulfuron	.01	.04	.04
49293	Norflurazon	.02	.02	.02
49292	Oryzalin	.02	.01	.01
38866	Oxamyl	.01	.03	.03
34653	*p,p′*-DDE	.003	.003	.003
39542	Parathion	.010	.010	.010
82669	Pebulate	.004	.004	.004
82683	Pendimethalin	.022	.022	.022
82664	Phorate	.011	.011	.011
49291	Picloram	.02	.03	.03
04037	Prometon	.01	.01	.01
82676	Propyzamide	.004	.004	.004
04024	Propachlor	.05	.05	.05
62766	Propachlor ethanesulfonic acid	.02	.02	.02
62767	Propachlor oxanilic acid	.010	.010	.025
82679	Propanil	.011	.011	.011
82685	Propargite	.02	.02	.02
49236	Propham	.010	.030	.030
50471	Propiconazole	.02	.01	.01
38538	Propoxur	.008	.008	.008
38548	Siduron	.02	.02	.02
04035	Simazine	.005	.005	.005
50337	Sulfometuron	.009	.038	.038
82670	Tebuthiuron	.02	.02	.02
82665	Terbacil	.034	.034	.034
82675	Terbufos	.02	.02	.02
82681	Thiobencarb	.005	.005	.010
82678	Triallate	.002	.002	.006
49235	Triclopyr	.02	.03	.03
82661	Trifluralin	.009	.009	.009
	Volatile Organic Compounds			
34506	1,1,1-Trichloroethane	0.1	0.1	0.1
77652	1,1,2-Trichloro-1,2,2-trifluoroethane	.1	.1	.1
34496	1,1-Dichloroethane	.1	.1	.1
34501	1,1-Dichloroethene	.1	.1	.1
34536	1,2-Dichlorobenzene	.1	.1	.1
32103	1,2-Dichloroethane	.2	.2	.2
34541	1,2-Dichloropropane	.1	.1	.1
34566	1,3-Dichlorobenzene	.1	.1	.1
34571	1,4-Dichlorobenzene	.1	.1	.1
34030	Benzene	.1	.1	.1
32101	Bromodichloromethane	.1	.1	.1

Table 2. Compounds for which ground-water samples collected from the Lake Champlain basin, New York, were analyzed but not detected and their analytical detection limits.—Continued

NWIS code[1]	Compound	Laboratory reporting level[2] (micrograms per liter execpt as noted)		
		WY 2004	WY 2005	Oct 18-19, 2005
	Volatile Organic Compounds—Continued			
34301	Chlorobenzene	0.1	0.1	0.1
77093	*cis*-1,2-Dichloroethene	.1	.1	.1
32105	Dibromochloromethane	.2	.2	.2
34668	Dichlorodifluoromethane	.2	.2	.2
34423	Dichloromethane	.2	.2	.2
81576	Diethyl ether	.2	.2	.2
81577	Diisopropyl ether	.2	.2	.2
34371	Ethylbenzene	.1	.1	.1
50005	Methyl *tert*-pentyl ether	.2	.2	.2
85795	*m*-Xylene plus *p*-xylene	.2	.2	.2
77135	*o*-Xylene	.1	.1	.1
77128	Styrene	.1	.1	.1
34475	Tetrachloroethene	.1	.1	.1
32102	Tetrachloromethane	.2	.2	.2
34546	*trans*-1,2-Dichloroethene	.1	.1	.1
32104	Tribromomethane	.2	.2	.2
39180	Trichloroethene	.1	.1	.1
34488	Trichlorofluoromethane	.2	.2	.2
32106	Trichloromethane	.1	.1	.1
39175	Vinyl chloride	.2	.2	.2

[1] USGS National Water Information System (NWIS) parameter code.

[2] Laboratory reporting levels are reevaluated annually based on quality-assurance data, and may vary daily based on laboratory instrument operating conditions (Childress and others, 1999).

Table 3. Physical properties of ground-water samples from the Lake Champlain basin, New York, 2004.

[Pt-Co, platinum-cobalt; 00080, USGS National Water Information System (NWIS) parameter code; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; --, no data; Well locations are shown in table 1]

Sample[1]	Color, filtered, Pt-Co units (00080)	Dissolved oxygen, mg/L (00300)	pH, unfiltered, field, standard units (00400)	Specific conductance, unfiltered, field, µS/cm (00095)	Temperature, degrees Celsius (00010)
CL 149	15	1.0	7.4	1090	9.0
CL 316	5	3.5	6.6	345	8.7
CL 321	2	.0	7.2	677	9.4
CL 655	8	.0	7.1	325	9.4
CL 928	<1	--	7.4	273	10.0
EX 67	<1	.1	7.9	167	9.0
EX 151	5	--	8.2	112	7.8
EX 153	2	10.3	7.4	382	9.2
EX 155	2	4.0	6.6	112	6.8
EX 156	<1	1.2	7.0	98	8.0
EX 331	2	.1	8.2	188	10.0
EX 535	18	.0	7.3	478	9.8
EX 590	2	2.1	6.3	149	9.2
F 58	5	6.8	8.4	99	9.8
F 533	5	.1	7.6	140	8.9
F 654	25	4.6	8.6	88	9.8
W 534	2	5.3	7.2	453	9.0
W 1684	5	.5	7.7	495	11.1
WR 202	2	1.1	7.8	259	11.0
WR 481	--	2.9	6.6	237	9.3
WR 702	8	9.8	7.9	71	12.5
WR 956	8	2.4	7.7	366	11.7

[1] CL, Clinton County; EX, Essex County; F, Franklin County; W, Washington County; WR, Warren County.

Table 4. Concentrations of inorganic constituents in ground-water samples from the Lake Champlain basin, New York, 2004.

[ANC, acid-neutralizing capacity; mg/L, milligrams per liter; 90410, USGS National Water Information System (NWIS) parameter code; °C, degrees Celsius; <, less than; --, not analyzed]

Sample[1]	ANC, unfiltered, fixed end point, lab, mg/L as $CaCO_3$ (90410)	Alkalinity, filtered, fixed end point, lab, mg/L as $CaCO_3$ (29801)	Hardness, mg/L as $CaCO_3$ (00900)	Noncarbonate hardness, mg/L as $CaCO_3$ (00905)	Calcium, filtered, mg/L (00915)	Magnesium, filtered, mg/L (00925)	Potassium, filtered, mg/L (00935)
CL 149	244	253	310	59	65.8	35.8	9.25
CL 316	111	111	140	26	40.5	8.66	2.83
CL 321	209	274	380	100	111	23.9	1.45
CL 655	168	167	190	18	37.7	22.1	1.96
CL 928	226	209	240	35	54.3	26.4	1.59
EX 67	90	89	120	30	32.0	9.47	.59
EX 151	50	49	50	1	14.8	3.25	.22
EX 153	165	165	200	31	52.5	15.7	.87
EX 155	34	34	50	16	14.5	3.33	.47
EX 156	36	36	75	38	23.1	4.15	.29
EX 331	94	94	82	--	26.4	3.78	.69
EX 535	179	235	290	56	66.6	30.2	.86
EX 590	47	48	63	15	18.7	3.90	.87
F 58	47	47	46	--	13.9	2.78	.50
F 533	64	65	58	--	16.2	4.19	.32
F 654	33	34	33	--	12.2	.635	.17
W 534	146	210	250	39	67.5	19.6	.97
W 1684	121	156	180	20	52.6	10.7	2.64
WR 202	108	109	100	--	28.9	7.74	1.24
WR 481	117	124	150	23	47.2	6.93	1.80
WR 702	35	35	29	--	8.51	1.88	.69
WR 956	110	152	180	24	45.4	15.2	.77

Sample	Sodium, filtered, mg/L (00930)	Bicarbonate[2], 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°C, filtered, mg/L (70300)
CL 149	127	309	189	<.2	9.19	97.6	703
CL 316	13	135	26.5	<.2	11.8	14.2	194
CL 321	9.59	334	25.9	.1	19.7	68.4	426
CL 655	5.43	204	--	<.2	15.7	--	190
CL 928	30.6	255	6.54	.2	14.1	59.4	332
EX 67	8.43	109	19.3	<.1	20.3	10.4	159
EX 151	2.46	60	.89	<.2	17.8	7.2	83
EX 153	7.11	201	14.6	<.2	8.24	17.0	212
EX 155	2.74	41	8.29	<.2	22.1	7.3	82
EX 156	7.38	44	32.7	<.1	17.3	6.6	121
EX 331	8.87	115	2.23	<.2	19.9	1.5	114
EX 535	3.87	287	.76	<.2	18.0	30.7	289
EX 590	5.06	59	11.4	<.1	18.0	6.9	101
F 58	2.03	57	.28	.2	18.7	5.3	73
F 533	6.92	79	.47	.9	13.6	4.8	83
F 654	4.62	41	1.01	<.2	12.7	6.7	65
W 534	3.05	256	4.67	<.2	12.3	31.5	264
W 1684	27.3	190	39.8	<.2	13.5	18.5	258
WR 202	15.3	133	11.1	.4	14.8	11.6	151
WR 481	9.2	151	29.6	.2	12.2	10.3	208
WR 702	2.75	43	.67	<.2	18.2	.8	61
WR 956	8.08	185	16.0	<.2	14.9	18.1	216

[1] CL, Clinton County; EX, Essex County; F, Franklin County; W, Washington County; WR, Warren County.

[2] Bicarbonate values calculated from alkalinity.

Mountain part of the basin was lower than in the Champlain Valley lowlands. Water hardness and acid-neutralizing capacity showed similar lithographic and geographic patterns.

Alkalinity as $CaCO_3$ in mg/L

	Crystalline	Silicate Sedimentary	Carbonate
Minimum	34	35	152
Median	48	156	188
Maximum	124	253	274

The two cations with the highest median concentrations were calcium (34.8 mg/L) and sodium (7.2 mg/L) (table 4); these cations also had the highest measured concentrations, 111 mg/L and 127 mg/L, respectively. The anion with the highest median concentration was bicarbonate (134 mg/L); median chloride and sulfate concentrations (11.1 mg/L and 10.4 mg/L, respectively) were much lower. No ion concentrations exceeded established MCLs.

Concentrations of calcium and magnesium were higher in samples from wells finished in, or underlain by, carbonate bedrock (median concentrations 56.4 mg/L and 20.8 mg/L, respectively) than crystalline bedrock (median concentrations 18.7 mg/L and 3.9 mg/L); sulfate concentrations were higher in samples from wells finished in or underlain by sedimentary bedrock (median concentration 18.1 mg/L) than crystalline bedrock (7.2 mg/L). The Champlain Valley lowlands tended to have higher concentrations of calcium, magnesium, potassium, sodium, and sulfate than the upland (Adirondack Mountain) part of the basin, as shown below.

Median ion concentrations by region in mg/L

	Adirondack Mountains	Champlain Valley
Calcium	16.2	52.6
Magnesium	3.78	19.6
Potassium	.50	1.45
Sodium	5.06	9.59
Sulfate	6.7	18.5

Concentrations of silica ranged from 8.24 mg/L to 22.1 mg/L with a median of 15.3 mg/L, and median concentrations were slightly higher in the Adirondack Mountain portion of the basin (18 mg/L) than in the Champlain Valley (14.1 mg/L). Residue on evaporation at 180 °C ranged from 61 mg/L to 703 mg/L and was higher in the Champlain Valley lowlands (median concentration 258 mg/L) than in the Adirondack Mountains (median concentration 53 mg/L).

Nutrients

Ammonia plus organic nitrogen (N) was detected in 36 percent (eight) of the samples; the maximum concentration was 0.2 mg/L as N (table 5). Ammonia plus organic nitrogen was detected in 70 percent of samples (7 of 10) from agricultural areas and 8 percent of samples (1 of 12) from non-agricultural areas. The predominant nutrient was nitrate; nitrate was detected in 64 percent of the samples (14). Concentrations of nitrate ranged from < 0.06 to 2.3 mg/L as N; all were well below the MCL of 10 mg/L and generally within the range considered to be naturally occurring (Madison and Brunett, 1985; Mueller and Helsel, 1996). Nitrate was detected in 40 percent of samples (4 of 10) from agricultural areas and in 83 percent of samples (10 of 12) from nonagricultural areas; the highest concentrations of nitrate were in samples from bedrock wells. Nitrite was not detected above the minimum reporting limit of 0.008 mg/L in any sample. Total organic carbon was detected in 50 percent of samples (11) and concentrations ranged from less than 1 mg/L to 2.18 mg/L.

Metals and Radionuclides

The metals with the highest concentrations were iron and strontium; their median concentrations were 175 µg/L and 124 µg/L, respectively (table 6). The two metals with the highest single concentrations were zinc (10,800 µg/L) and strontium (3,230 µg/L). Concentrations of most metals were higher in samples from wells finished in bedrock than in samples from wells finished in sand and gravel. Concentrations of chromium and zinc were highest in wells finished in crystalline bedrock. Concentrations of lithium and strontium were highest in wells finished in shale.

Concentrations of several metals exceeded secondary drinking-water standards. Concentrations of iron in unfiltered water equaled or exceeded the secondary standard of 300 µg/L in 9 of 22 samples and were as high as 1,820 µg/L; those concentrations in filtered water exceeded the secondary standard in 5 of 22 samples. Concentrations of manganese in filtered and unfiltered water exceeded the secondary standard of 50 µg/L in three samples, and exceeded 170 µg/L in one sample. Concentrations of aluminum exceeded the secondary standard (50 to 200 µg/L) in two samples, and zinc exceeded the secondary standard (5,000 µg/L) in one sample.

The concentration of zinc in one sample was unusually high—10,800 µg/L. This value was 2.5 to 3 orders of magnitude greater than the concentrations of zinc in the other samples and much higher than any expected natural zinc concentrations (Hem, 1985). The sample was collected through the house plumbing, and the concentrations were measured in unfiltered samples, thus including any particulates in the sample. Therefore, the high zinc concentration probably reflects the plumbing associated with the well, and not ambient ground-water conditions.

Concentrations of radon-222 ranged from 40 to 6,930 pCi/L. Nineteen (86 percent) of the samples had radon concentrations less than 1,000 pCi/L, and twelve had concentrations less than 250 pCi/L. USEPA does not currently regulate radon in drinking water, but has proposed an MCL of 300 pCi/L and an Alternative MCL (AMCL) of 4,000 pCi/L

Table 5. Concentrations of nutrients in ground-water samples from the Lake Champlain basin, New York, 2004.

[mg/L, milligrams per liter; N, Nitrogen; 00623, USGS National Water Information System (NWIS) parameter code; P, Phosphorus; <, less than; E, estimated value]

Sample[1]	Ammonia + organic-N, filtered, mg/L as N (00623)	Ammonia, filtered, mg/L as N (00608)	Nitrite + nitrate, filtered, mg/L as N (00631)	Orthophosphate, filtered, mg/L as P (00671)	Organic carbon, unfiltered, mg/L (00680)
CL 149	0.12	0.07	<0.06	<0.02	2.01
CL 316	^{E}.07	<.04	2.30	^{E}.01	2.18
CL 321	^{E}.06	^{E}.04	<.06	<.02	1.35
CL 655	<.10	<.04	<.06	<.02	1.22
CL 928	^{E}.06	^{E}.03	<.06	<.02	<1.00
EX 67	<.10	<.04	2.20	<.02	<1.00
EX 151	<.10	<.04	.08	.03	1.09
EX 153	<.10	<.04	.43	<.02	<1.00
EX 155	<.10	<.04	.06	<.02	1.35
EX 156	<.10	<.04	.27	<.02	<1.00
EX 331	.20	.19	<.06	.05	<1.00
EX 535	<.10	<.04	<.06	<.02	^{E}1.42
EX 590	<.10	<.04	1.14	<.02	<1.00
F 58	<.10	<.04	.06	.03	<1.00
F 533	<.10	<.04	.14	.03	<1.00
F 654	<.10	<.04	.66	.06	<1.00
W 534	<.10	<.04	.55	<.02	1.21
W 1684	.18	.15	<.06	<.02	1.17
WR 202	<.10	<.04	<.06	<.02	<1.00
WR 481	^{E}.07	<.04	1.42	<.02	1.85
WR 702	<.10	<.04	.13	.14	<1.00
WR 956	^{E}.07	<.04	.12	<.02	1.14

[1] CL, Clinton County; EX, Essex County; F, Franklin County; W, Washington County; WR, Warren County.

Table 6. Concentrations of metals and radon-222 in ground-water samples from the Lake Champlain basin, New York, 2004.

[All values are in micrograms per liter except Rn-222 (radon-222) in picocuries per liter (pCi/L). Rec., recoverable; 00105, USGS National Water Information System (NWIS) parameter code. E, estimated value; <, less than]

Sample[1]	Aluminum, unfiltered, Rec. (01105)	Antimony, unfiltered (01097)	Arsenic, unfiltered (01002)	Barium, unfiltered, Rec. (01007)	Boron, filtered, (01020)	Cadmium, unfiltered (01027)	Chromium, unfiltered, Rec. (01034)	Cobalt, unfiltered, Rec. (01037)	Copper, unfiltered, Rec. (01042)	Iron, filtered (01046)	Iron, unfiltered, Rec. (01045)
CL 149	^{E}2	<0.2	<2	66	115	^{E}0.02	<0.8	0.397	1.4	543	540
CL 316	^{E}2	<.2	<2	154	25	<.04	<.8	.497	11.2	^{E}5	130
CL 321	<2	<.2	<2	219	9.2	<.04	<.8	.496	2.9	1,890	1,820
CL 655	37	<.2	<2	27	22	<.04	1.0	.242	2.3	305	390
CL 928	^{E}1	<.2	<2	50	71	<.04	<.8	.248	1.2	1,500	1,460
EX 67	2	<.2	<2	3	12	<.04	3.6	.183	1.7	<6	70
EX 151	52	<.2	^{E}1	1	^{E}4.3	<.04	1.1	.090	3.0	<6	50
EX 153	<2	<.2	<8	11	^{E}5.4	<.04	<3.2	.227	31.0	<6	<9.0
EX 155	<2	<.2	<2	2	8.5	<.04	^{E}.4	.047	2.5	7	40
EX 156	2	<.2	<2	3	^{E}6.5	<.04	<.8	.096	.8	^{E}4	10
EX 331	5	<.2	<2	19	79	<.04	<.8	.110	1.0	37	270
EX 535	2	<.2	<2	12	^{E}4.4	<.04	<.8	.312	1.5	662	620
EX 590	<2	<.2	<2	3	11	<.04	<.8	.122	1.3	7	10
F 58	5	<.2	<2	2	10	<.04	^{E}.8	.051	.9	<6	10
F 533	^{E}1	<.2	<2	M	21	<.04	<.8	.080	.8	8	220
F 654	8	<.2	<2	M	15	<.04	1.1	.111	2.9	130	940
W 534	<2	<.2	<2	15	^{E}6.6	<.04	<.8	.249	1.6	<6	<9.0
W 1684	180	^{E}.1	3	136	52	<.04	<.8	.350	1.7	^{E}6	1,000
WR 202	^{E}1	<.2	<2	16	52	<.04	<.8	.142	.7	<6	20
WR 481	^{E}2	<.2	<2	9	^{E}6.4	.05	1.6	.345	82.2	11	20
WR 702	41	<.2	<2	12	^{E}4.0	<.04	1.3	.077	2.9	37	300
WR 956	12	<.2	<2	6	19	<.04	^{E}.6	.247	5.0	<6	310

Sample	Lead, unfiltered, Rec. (01051)	Lithium, unfiltered, Rec. (01132)	Manga-nese, filtered (01056)	Manga-nese, unfiltered, Rec. (01055)	Molyb-denum, unfiltered, Rec. (01062)	Nickel, unfiltered, Rec. (01067)	Selenium, unfiltered (01147)	Strontium, unfiltered, Rec. (01082)	Zinc, unfiltered, Rec. (01092)	Rn-222, unfiltered, pCi/L (82303)	Uranium, natural, unfiltered (28011)
CL 149	<0.06	12.5	172	176	4.1	2.09	^{E}0.3	1,090	<2	230	0.309
CL 316	1.49	1.1	7.8	7.6	.9	1.10	^{E}.3	184	6	6,930	4.91
CL 321	.07	4.4	59.0	57.9	1.1	.77	<.4	953	^{E}1	130	.253
CL 655	3.80	1.0	19.9	19.2	.9	1.35	^{E}.3	167	^{E}1	240	.501
CL 928	.09	8.2	24.0	22.9	2.5	.99	^{E}.3	508	^{E}1	40	.217
EX 67	.59	.9	<.6	^{E}.6	^{E}.1	2.34	<.4	79.2	2	120	.090
EX 151	1.53	<.6	^{E}.8	1.8	.2	.23	<.4	51.3	4	260	.092
EX 153	1.67	1.1	<.8	<1.2	.7	2.88	.5	205	6	300	.351
EX 155	.62	<.6	<.8	<1.2	<.2	.23	<.4	49.0	10	100	.018
EX 156	2.00	<.6	^{E}.5	2.3	<.2	.47	.5	59.5	5	80	.023
EX 331	.11	.7	13.2	14.5	1.3	.84	^{E}.3	124	<2	180	.130
EX 535	.16	.9	16.9	16.1	1.7	.76	<.4	125	<2	160	.531
EX 590	.28	^{E}.5	^{E}.6	<.6	<.2	.41	^{E}.3	65.7	31	280	.018
F 58	.07	^{E}.5	<.8	^{E}.9	.5	^{E}.13	<.4	40.3	<2	190	.164
F 533	.43	3.1	1.5	3.2	5.3	.49	.4	32.2	<2	740	.512
F 654	.38	<.6	7.8	12.2	^{E}.2	.78	.4	57.6	65	190	.066
W 534	.09	1.2	9.5	15.3	.3	.63	<.4	280	^{E}1	400	.512
W 1684	2.40	38.1	124	136	1.8	1.59	^{E}.2	3,230	^{E}1	890	.119
WR 202	.08	7.1	1.7	1.3	1.8	.50	.5	174	<2	220	1.11
WR 481	6.43	1.4	8.0	7	.5	.94	.5	115	10,800	1,150	1.45
WR 702	.28	^{E}.5	12.9	16.3	1.1	.21	<.4	41.1	^{E}1	2,290	.044
WR 956	1.58	1.2	14.0	18.6	1.4	.73	<.4	240	<2	890	.329

[1] CL, Clinton County; EX, Essex County; F, Franklin County; W, Washington County; WR, Warren County.

(U.S. Environmental Protection Agency, 1999). The AMCL would be in effect in states that have established Multimedia Mitigation (MMM) programs to address radon in indoor air. Eight samples had concentrations that exceeded the proposed MCL for radon; the concentration in one of these samples also exceeded the proposed AMCL of 4,000 pCi/L. The highest concentrations of radon-222 were in samples from wells finished in sandstone bedrock.

Pesticides

Thirteen pesticides and their degradates were detected in the ground water samples (table 7). Most were degradates (also referred to as metabolites or transformation products) of herbicides such as metolachlor, alachlor, and atrazine, that are used to control broadleaf weeds. Two other herbicides (2,4-D and imazaquin) were detected, and two insecticides (carbaryl and imidacloprid) were detected. The only fungicide detected was metalaxyl. All of the pesticide detections were at concentrations of 0.2 µg/L or less, except 2-hydroxy-4-isopropylamino-6-ethylamino-*s*-triazine (OIET), detected in one sample slightly above 1 µg/L. Pesticides were detected in samples from seven wells, two of which were finished in sand and gravel and five of which were finished in bedrock; two of the seven wells were production wells. At least one pesticide was detected in each of the five wells sampled in Clinton County; all of those wells are in areas with at least some agriculture within 1 mi of the well and are in the Champlain Valley. Caffeine, which was included in the pesticide analysis, was detected in samples from two sites in concentrations of hundredths of a microgram per liter.

Volatile Organic Compounds and Phenolic Compounds

VOCs were detected in three of the samples (table 8). Toluene was detected in one sample at a concentration of 0.1 µg/L; the MCL for toluene is 1,000 µg/L. Toluene is a solvent and is used in the manufacture of chemicals; it is also used as a fuel oxygenate. Methyl *tert*-butyl ether (MTBE) was detected in two samples at a concentration of 0.7 µg/L, and ethyl *tert*-butyl ether (ETBE) was detected in one of those samples at a concentration of 0.5 µg/L. MTBE and ETBE are fuel oxygenates that are added to gasoline to increase octane rating. MTBE and ETBE do not have established MCLs, but the USEPA has suggested a limit of 20 to 40 µg/L for MTBE on the basis of taste and odor.

Total phenolic compounds were detected in four samples. Concentrations ranged from 0.006 to 0.027 mg/L, but the quality-assurance blank sample had a concentration of 0.010 mg/L; therefore, the results for those four samples should be interpreted with caution.

Bacteria

All 22 samples were tested for total coliform, 20 of which also were tested for fecal coliform (table 9). If either was detected, the sample was tested for *E. coli*. A heterotrophic plate count test was also performed. Four of the 22 samples tested positive for total coliform; the maximum concentration was 11 colonies per 100 mL of sample. Two of the four samples that tested positive for total coliform also tested positive for *E. coli*. Any positive result is considered to be above the MCL for total coliform and *E. coli*. All four samples that tested positive for total coliform were from domestic wells, three of which were in mainly residential or agricultural areas. The owners of the wells were notified of the results upon receipt from the laboratory. Fecal coliform was not detected (< 1 colony-forming unit per 100 mL of sample) in any of the 20 samples tested. Bacterial colonies formed in 14 of the 22 heterotrophic plate count tests, and the counts ranged 1 to 103 colonies per 1 mL of sample. The samples with the highest number of colonies per 1 mL were those from domestic wells (maximum 103 colonies per 1 mL). The maximum concentration in production well samples was 8 colonies per mL. No samples exceeded the MCL of 500 colonies per 1 mL.

Table 7. Concentrations of selected pesticides in filtered ground-water samples from the Lake Champlain basin, New York, 2004.

[All values are in micrograms per liter. 39732, USGS National Water Information System (NWIS) parameter code; CEAT, 2-chloro-6-ethylamino-4-amino-*s*-triazine; OIET, 2-hydroxy-4-isopropylamino-6-ethylamino-*s*-triazine; SA, secondary amide; ESA, ethanesulfonic acid; OA, oxanilic acid; E, estimated value; <, less than]

Sample[1]	2,4-D (39732)	CEAT (04038)	OIET (50355)	Alachlor SA (62849)	Alachlor ESA (50009)	Alachlor OA (61031)	Caffeine (50305)
CL 149	<0.02	<0.01	<0.008	0.03	0.17	<0.02	<0.010
CL 316	<.02	<.01	<.008	<.02	<.02	<.02	<.010
CL 321	<.04	<.08	<.032	<.02	<.02	.02	<.018
CL 655	.08	<.01	<.008	<.02	<.02	<.02	^{E}.041
CL 928	<.04	<.08	<.032	<.02	<.02	<.02	<.018
EX 67	<.04	^{E}.04	1.02	<.02	<.02	<.02	<.018
EX 151	<.02	<.01	<.008	<.02	<.02	<.02	<.010
EX 153	<.02	<.01	<.008	<.02	<.02	<.02	<.010
EX 155	<.02	<.01	<.008	<.02	<.02	<.02	<.010
EX 156	<.04	<.08	<.032	<.02	<.02	<.02	<.018
EX 331	<.02	<.01	<.008	<.02	<.02	<.02	<.010
EX 535	<.02	<.01	<.008	<.02	<.02	<.02	<.010
EX 590	<.04	<.08	<.032	<.02	<.02	<.02	<.018
F 58	<.02	<.01	<.008	<.02	<.02	<.02	<.010
F 533	<.02	<.01	<.008	<.02	<.02	<.02	<.010
F 654	<.02	<.01	<.008	<.02	<.02	<.02	<.010
W 534	<.02	<.01	<.008	<.02	<.02	<.02	<.010
W 1684	<.02	<.01	<.008	<.02	<.02	<.02	<.010
WR 202	<.04	<.08	<.032	<.02	<.02	<.02	<.018
WR 481	<.04	<.08	<.032	<.02	<.02	<.02	^{E}.008
WR 702	<.02	<.01	<.008	<.02	<.02	<.02	<.010
WR 956	<.02	<.01	<.008	<.02	<.02	<.02	<.010

Sample	Carbaryl (49310)	Chloro-diamino-*s*-triazine (04039)	Imazaquin (50356)	Imidacloprid (61695)	Metalaxyl (50359)	Metolachlor ESA (61043)	Metolachlor OA (61044)
CL 149	<0.03	<0.04	<0.02	<0.007	<0.02	0.08	0.09
CL 316	<.03	<.04	<.02	<.007	<.02	.03	<.02
CL 321	<.02	<.04	<.04	<.020	<.01	<.02	<.02
CL 655	.03	<.04	^{E}.02	.166	^{E}.01	<.02	<.02
CL 928	<.02	<.04	<.04	<.020	<.01	.03	<.02
EX 67	<.02	^{E}.14	<.04	<.020	<.01	<.02	<.02
EX 151	<.03	<.04	<.02	<.007	<.02	<.02	<.02
EX 153	<.03	<.04	<.02	<.007	<.02	<.02	<.02
EX 155	<.03	<.04	<.02	<.007	<.02	<.02	<.02
EX 156	<.02	<.04	<.04	<.020	<.01	<.02	<.02
EX 331	<.03	<.04	<.02	<.007	<.02	<.02	<.02
EX 535	<.03	<.04	<.02	<.007	<.02	<.02	<.02
EX 590	<.02	<.04	<.04	<.020	<.01	<.02	<.02
F 58	<.03	<.04	<.02	<.007	<.02	<.02	<.02
F 533	<.03	<.04	<.02	<.007	<.02	<.02	<.02
F 654	<.03	<.04	<.02	<.007	<.02	<.02	<.02
W 534	<.03	<.04	<.02	<.007	<.02	<.02	<.02
W 1684	<.03	<.04	<.02	<.007	<.02	<.02	<.02
WR 202	<.02	<.04	<.04	<.020	<.01	<.02	<.02
WR 481	<.02	<.04	<.04	.022	<.01	<.02	<.02
WR 702	<.03	<.04	<.02	<.007	<.02	<.02	<.02
WR 956	<.03	<.04	<.02	<.007	<.02	<.02	<.02

[1] CL, Clinton County; EX, Essex County; F, Franklin County; W, Washington County; WR, Warren County.

Table 8. Concentrations of selected volatile organic compounds (VOCs) and phenolic compounds in ground-water samples from the Lake Champlain basin, New York, 2004.

[µg/L, micrograms per liter; 50004, USGS National Water Information System (NWIS) parameter code; <, less than]

Sample[1]	Ethyl *tert*-butyl ether, µg/L (50004)	Methyl *tert*-butyl ether, µg/L (78032)	Toluene, µg/L (34010)	Phenolic compounds[2], µg/L (32730)
CL 149	<0.1	0.7	<0.1	0.006
CL 316	<.1	<.2	<.1	<.005
CL 321	<.1	<.2	<.1	<.005
CL 655	<.1	<.2	<.1	<.005
CL 928	<.1	<.2	<.1	<.005
EX 67	<.1	<.2	<.1	<.005
EX 151	<.1	<.2	<.1	<.005
EX 153	<.1	<.2	<.1	<.010
EX 155	<.1	<.2	<.1	<.005
EX 156	<.1	<.2	<.1	<.005
EX 331	<.1	<.2	<.1	<.005
EX 535	<.1	<.2	<.1	.008
EX 590	<.1	<.2	<.1	<.005
F 58	<.1	<.2	<.1	<.005
F 533	<.1	<.2	<.1	<.005
F 654	<.1	<.2	<.1	<.005
W 534	<.1	<.2	<.1	<.005
W 1684	<.1	<.2	<.1	<.010
WR 202	<.1	<.2	<.1	<.005
WR 481	.5	.7	<.1	.027
WR 702	<.1	<.2	<.1	.006
WR 956	<.1	<.2	.1	<.005

[1] CL, Clinton County; EX, Essex County; F, Franklin County; W, Washington County; WR, Warren County.

[2] Phenolic compounds were detected in the quality-assurance blank sample at a concentration of 10 micrograms per liter.

Table 9. Concentrations of bacteria in ground-water samples from the Lake Champlain basin, New York, 2004.

[31684, USGS National Water Information System (NWIS) parameter code; <, less than; mL, milliliters; --, not analyzed]

Sample[1]	*Escherichia coli (E. coli)* (positive or negative)[2] (31684)	Heterotrophic bacteria (colonies per mL) (78943)	Total coliform (colonies per 100 mL) (31501)	Fecal Coliform (colonies per 100 mL) (31616)
CL 149	--	3	< 1	< 1
CL 316	--	4	< 1	< 1
CL 321	negative	2	11	< 1
CL 655	negative	73	5	< 1
CL 928	--	58	< 1	< 1
EX 67	--	< 1	< 1	< 1
EX 151	--	< 1	< 1	< 1
EX 153	--	< 1	< 1	--
EX 155	--	1	< 1	< 1
EX 156	--	1	< 1	< 1
EX 331	--	< 1	< 1	< 1
EX 535	--	1	< 1	< 1
EX 590	--	< 1	< 1	< 1
F 58	--	< 1	< 1	< 1
F 533	--	14	< 1	< 1
F 654	--	< 1	< 1	< 1
W 534	positive	7	4	< 1
W 1684	positive	103	2	--
WR 202	--	< 1	< 1	< 1
WR 481	--	8	< 1	< 1
WR 702	--	4	< 1	< 1
WR 956	--	55	< 1	< 1

[1] CL, Clinton County; EX, Essex County; F, Franklin County; W, Washington County; WR, Warren County.

[2] Positive indicates *E. coli* detected; negative indicates *E. coli* not detected.

Summary

Water samples were collected from 11 production wells and 11 domestic wells during the fall of 2004 for analysis to characterize the chemical quality of ground water in the Lake Champlain basin in New York State. Samples were analyzed for 216 physical properties and constituents, including inorganic compounds, nutrients, metals, radionuclides, pesticides and pesticide degradates, volatile organic compounds, and bacteria. Sixty-nine percent (148) of the constituents were not detected in any sample; the other 31 percent (68 constituents) were detected at concentrations above laboratory reporting levels.

The color of samples from three wells equaled or exceeded the USEPA secondary standard of 15 platinum-cobalt units. The pH of samples from two wells exceeded the range of the USEPA secondary drinking-water standards (6.5 to 8.5). Alkalinity and water hardness in the Adirondack Mountain part of the basin was lower than in the Champlain Valley lowlands. The cation with the highest concentrations was calcium; the anion with the highest concentrations was bicarbonate. No cation or anion concentrations exceeded MCLs. The predominant nutrient was nitrate, but no samples exceeded the 10 mg/L MCL. The metals with the highest concentrations were iron and strontium. Concentrations of several metals exceeded secondary drinking-water standards, including iron (300 µg/L or greater in samples from 9 of the 22 wells), manganese (50 µg/L or greater at 3 wells), aluminum (50 to 200 µg/L and greater at 2 wells), and zinc (5,000 µg/L or greater at 1 well). Concentrations of radon-222 ranged from 40 to 6,930 pCi/L; samples from eight wells had concentrations that exceeded the proposed MCL for radon (300 pCi/L). Thirteen pesticides and their degradates were detected in the samples; most were degradates of broadleaf herbicides such as metolachlor, alachlor, and atrazine. Three VOCs were detected—toluene, methyl *tert*-butyl ether (MTBE), and ethyl *tert*-butyl ether (ETBE); all of which are used as gasoline additives. None of the pesticides or VOCs detected exceeded established MCLs. Samples from four wells tested positive for total coliform; two of these also tested positive for *E. coli*. Any positive sample is considered to be above the MCL for total coliform and *E. coli*. The samples with the highest bacterial concentrations in a heterotrophic plate count test were from domestic wells; but no sample exceeded the MCL of 500 colonies per mL.

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