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Selected Water-Quality Data from the Cedar River and Cedar Rapids Well Fields, Cedar Rapids, Iowa, 2006–10

Data Series 657

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

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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
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Volume	
cubic foot (ft^3)	0.02832	cubic meter (m^3)
million gallons (Mgal)	3,785	cubic meter (m^3)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

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

$$°F=(1.8\times°C)+32$$

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

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

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

Transmissivity: The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness [($ft^3/d)/ft^2$]ft. In this report, the mathematically reduced form, foot squared per day (ft^2/d), is used for convenience.

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).

Acknowledgments

The author thanks the personnel of the Cedar Rapids Water Division for their assistance in data collection and construction of monitoring wells.

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Abstract

The Cedar River alluvial aquifer is the primary source of municipal water in the Cedar Rapids, Iowa area. Municipal wells are completed in the alluvial aquifer approximately 40 to 80 feet below land surface. The City of Cedar Rapids and the U.S. Geological Survey have been conducting a cooperative study of the groundwater-flow system and water quality of the aquifer since 1992. Cooperative reports between the City of Cedar Rapids and the U.S. Geological Survey have documented hydrologic and water-quality data, geochemistry, and groundwater models. Water-quality samples were collected for studies involving well field monitoring, trends, source-water protection, groundwater geochemistry, surface-water–groundwater interaction, and pesticides in groundwater and surface water. Water-quality analyses were conducted for major ions (boron, bromide, calcium, chloride, fluoride, iron, magnesium, manganese, potassium, silica, sodium, and sulfate), nutrients (ammonia as nitrogen, nitrite as nitrogen, nitrite plus nitrate as nitrogen, and orthophosphate as phosphorus), dissolved organic carbon, and selected pesticides including two degradates of the herbicide atrazine. Physical characteristics (alkalinity, dissolved oxygen, pH, specific conductance and water temperature) were measured in the field and recorded for each water sample collected. This report presents the results of routine water-quality data-collection activities from January 2006 through December 2010. Methods of data collection, quality-assurance, and water-quality analyses are presented. Data include the results of water-quality analyses from quarterly sampling from monitoring wells, municipal wells, and the Cedar River.

Introduction

The City of Cedar Rapids, in Linn County, Iowa, obtains its municipal water supply from a shallow alluvial aquifer adjacent to the Cedar River. Fifty-three vertical wells and four horizontal collector wells are completed at about 40 to 80 feet (ft) below land surface. Vertical wells gradually are being replaced by higher-yielding horizontal collector wells, but many of the vertical wells are used regularly or are in standby operation. Adequate quantities of generally high-quality water have been obtained from the alluvial aquifer since the resource was developed in 1962. Although, increasing population and industrial development generally have increased the demand for municipal water, Cedar Rapids pumped about 35 million gallons per day (Mgal/d) from the alluvial aquiver in 2010 as compared with nearly 40 Mgal/d in 2005, a decrease of about 12 percent. However, peak demands were as much as 49 Mgal/d at certain times, typically during summer months (T. Baloch, City of Cedar Rapids Water Division, written commun., April 2011). To document the quality of water available from the Cedar River and the alluvial aquifer, the City of Cedar Rapids and the U.S. Geological Survey (USGS) have been conducting a cooperative study of the groundwater-flow system, surface-water system, and water quality in and near the well fields since 1992.

Previous Investigations

Schulmeyer (1995) analyzed the effect of the Cedar River on the quality of groundwater near the municipal well fields. Schnoebelen and Schulmeyer (1996) documented hydrogeologic data collected and compiled from October 1992 to March 1996. Schulmeyer and Schnoebelen (1998) described the hydrogeology near the municipal well fields, documented a groundwater-flow model constructed to simulate regional groundwater flow under steady-state conditions, identified sources of water to the municipal well fields, and assessed temporal and spatial variations of selected water-quality constituents and properties. Boyd (1998) characterized groundwater flow near the municipal well fields using selected environmental isotopes and tracers. Boyd (1999) evaluated the occurrence and distribution of concentrations of selected pesticides in the alluvial aquifer and Cedar River following springtime application of these pesticides to upstream cropland areas. Boyd and others (1999) further documented hydrogeologic data collected in the Cedar Rapids area from April 1996 to March 1999. Littin and Schnoebelen (2010) documented water-quality data collected in the Cedar Rapids area from calendar years 1999 to 2005.

Purpose and Scope

This report presents the results of water-quality data-collection activities from January 2006 through December 2010 for a study conducted by the USGS, in cooperation with the City of Cedar Rapids, Iowa. Data presented in this report include results of water-quality analyses and physical characteristics of water samples measured during sample collection from the Cedar River, the Cedar Rapids waterworks, and 11 wells in the Cedar Rapids municipal well fields.

Description of the Study Area

Cedar Rapids is within Linn County in east-central Iowa; municipal water for the City of Cedar Rapids is supplied from three well fields (Seminole, East, and West) along the Cedar River (fig. 1). The City of Cedar Rapids has a population of about 126,300 (U.S. Census Bureau, 2011). Several large industries are major water users resulting in a per capita water usage that is nearly three times the national average for a city of this size (R. Hesemann, Cedar Rapids Water Division, written commun., February 2004). The Cedar River Basin drains an area of about 6,510 square miles (mi^2) upstream from the stream-gaging station at Cedar Rapids (Cedar River at Cedar Rapids, USGS station number 05464500). Upstream land use is greater than 90 percent agriculture, dominated by corn and soybeans. Livestock raised in the area include cattle and hogs. Average annual precipitation for 2006 through 2010 was about 43 inches (in.) per year in the Cedar Rapids area (Iowa State University, 2011). Extreme daily mean flows recorded at the stream-gaging station during this reporting period were 138,000 cubic feet per second (ft^3/s) on June 13, 2008, and 1,270 ft^3/s on December 22, 2008 (U.S. Geological Survey, 2011). Extreme daily mean flows recorded during the period of record (1903–2010) were 138,000 ft^3/s on June 13, 2008, and 140 ft^3/s on November 18, 1989 (U.S. Geological Survey, 2011).

Hydrogeologic units in and near the well fields consist of an unconsolidated surficial layer of glacial till, loess, and the Cedar River alluvium (alluvial aquifer), underlain by carbonate bedrock of Devonian and Silurian age. The flood plain ranges from about 1,000 to 3,300 ft wide in the study area. The upland topography is characterized by rolling hills of low relief. Typically, glacial till and loess form upland areas that bound the alluvial aquifer. The alluvial aquifer ranges from 5 to 95 ft thick near the well fields and consists of a sequence of coarse sand and gravel at the base, grading upward to fine sand, silt, and clay near the surface. The thickness of the alluvium decreases as distance from the Cedar River increases; the thinnest alluvium is adjacent to the valley walls. The alluvial valley is bounded by steep bluffs that rise almost 200 ft above the river floodplain, and, in places, bedrock is exposed. The bedrock aquifer has a maximum thickness of about 700 ft near the well fields. The bedrock aquifer primarily consists of jointed and fractured limestone and dolomite, with some interbedded chert and shale (Schulmeyer and Schnoebelen, 1998). No municipal wells have been completed in the bedrock aquifer, but it is used locally by private landowners and some industrial users. The unconsolidated surficial layers, carbonate bedrock of Devonian and Silurian age, and deeper hydrogeologic units are described in detail by Hansen (1970), Wahl and Bunker (1986), and Schulmeyer and Schnoebelen (1998).

The alluvial aquifer is recharged by infiltration from the Cedar River, precipitation, and seepage from the underlying bedrock and adjacent hydrogeologic units. In areas affected by municipal pumping, groundwater flow is from the Cedar River toward the well fields; in areas outside those affected by municipal pumping, groundwater flow is toward the Cedar River. The Cedar River is in direct hydraulic connection with the alluvial aquifer (Turco and Buchmiller, 2004). Hansen (1970) calculated an approximate transmissivity of the alluvial aquifer to be about 20,000 feet squared per day (ft^2/d). Subsequent investigations by Schulmeyer (1995) indicate that the transmissivity ranges from about 1,500 to19,000 ft^2/d, depending on the physical properties of the alluvium. In May 2006, a contractor to the City of Cedar Rapids performed an aquifer test using Seminole well 10 (an abandoned well located on the edge of the river bank). This aquifer test yielded a transmissivity value of approximately 15,000 ft^2/d (R. Hesemann, Cedar Rapids Water Division, oral commun., March 2007).

Methods of Study

Samples for water-quality analysis were collected from the Cedar River, monitoring wells within the municipal well fields, municipal wells, and the Cedar Rapids waterworks plant. Data include results of water-quality analyses and physical characteristics measured at the time of sample collection. Well locations used for sampling are shown in figure 1. Statistics (minimum, maximum, mean, and median) were compiled for all water-quality samples. In addition, methods of quality assurance of samples are discussed and data on quality-control samples are presented.

Well Construction and Nomenclature

Wells sampled during the study included 2- and 4-in. outer-diameter monitoring wells. The monitoring wells were installed using hollow-stem auger drilling techniques and completed with polyvinyl-chloride (PVC) flush-joint casing. Bentonite grout was installed around the casing 6 to 8 ft below land surface, and the wells were capped with a cement pad at the surface. Well depths ranged from 22.5 to 42.5 ft. Well-construction information for all the monitoring wells is listed in table 1.

The monitoring wells are named according to a convention that includes the year the well was installed (for example, 1993), the agency identifier (USGS), the local project

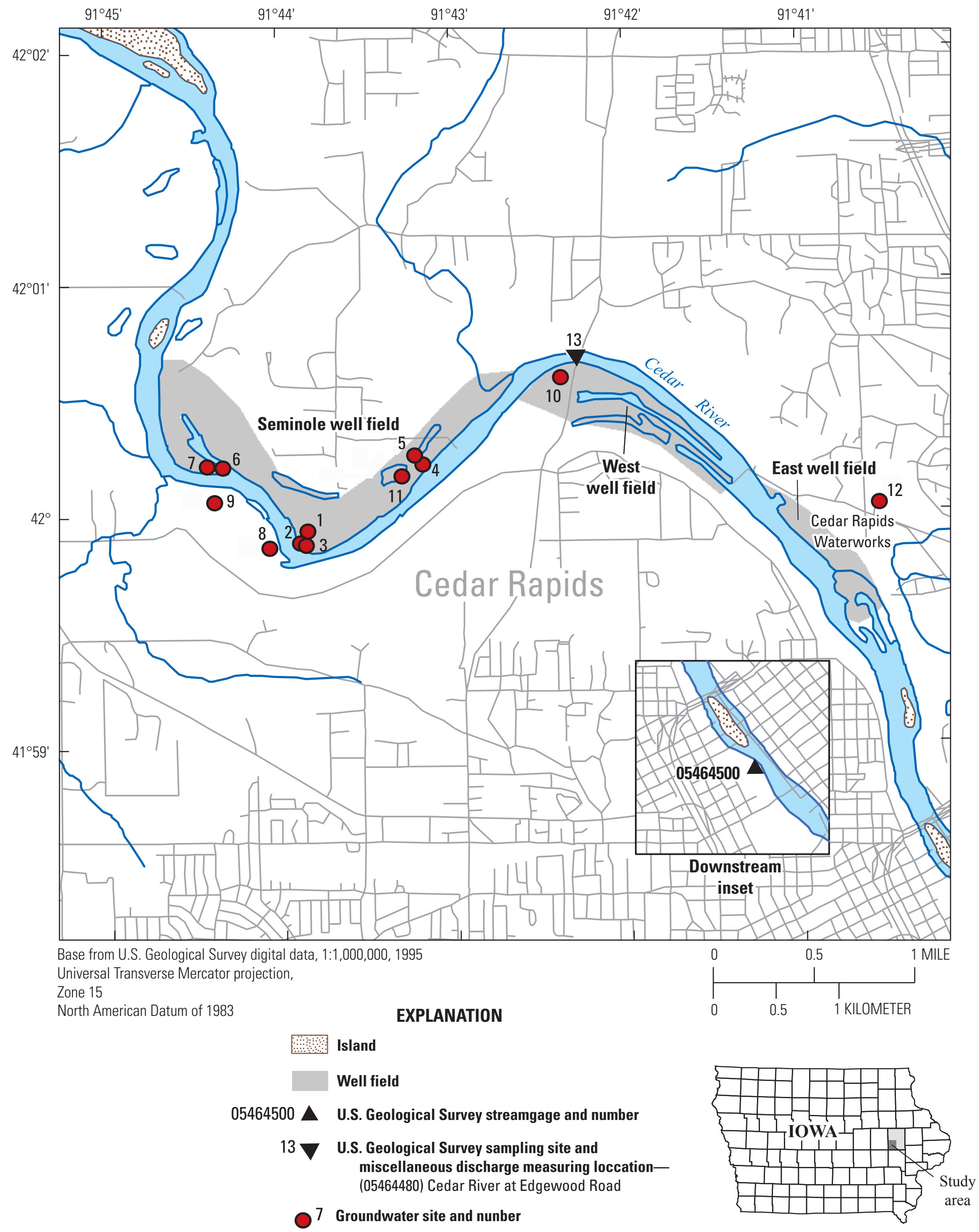

Figure 1. Groundwater and surface-water quality sampling sites, Cedar Rapids, Iowa.

Table 1. Information on groundwater and surface-water quality data-collection sites, Cedar Rapids, Iowa, calendar years 2006–10.

[ID, identifier; U, U.S. Geological Survey monitoring well; C, common ions and trace elements; N, nutrients; P, pesticides; A, alluvial; Vi, Virus; V, vertical well; H, municipal multiple-horizontal collector well; --, no data or not applicable; M, municipal multiple-well composite; S, surface water]

Map ID	Site name	Site type[1]	Type of water-quality samples collected[2]	Number of samples collected	Period of record	Total depth (feet below land surface)	Casing diameter (inches)	Screened interval top/bottom (feet below land surface)	Land-surface elevation (feet above mean sea level)[1]	Aquifer
1	1993USGS CRM-3	U	C, N, P, Vi	8	2006–2010	42.5	4	40.0/42.5	727.00	A
2	1993USGS CRM-4	U	C, N, P	2	2006–2010	42.5	4	40.0/42.5	726.45	A
3	2010USGS CRM-4A	U	C, N, P, Vi	4	2010	42.5	2	40.0/42.5	726.20	A
4	1998USGS CRM-22	U	C, N, P, Vi	23	2006–2010	22.5	4	20.0/22.5	720.07	A
5	1998USGS CRM-23	U	C, N, P	8	2006–2010	27.0	4	22.0/27.0	722.07	A
6	Seminole 17	V	C, N, P, Vi	17	2006–2010	58.0	30	34.0/54.0	717.07	A
7	Seminole 18	V	C, N, P	17	2006–2010	52.0	30	32.0/52.0	722.90	A
8	Ranney 1	H	C, N, P	19	2006–2010	59.5	--	--	722.60	A
9	Ranney 2	H	C, N, P	19	2006–2010	49.6	--	--	722.60	A
10	West Ranney 3	H	C, N, P	18	2006–2010	67.0	--	--	721.00	A
11	Seminole Ranney 4	H	C, N, P, Vi	21	2006–2010	64.0	--	--	720.00	A
12	Cedar Rapids Waterworks Plant	M	C, N, P, Vi	22	2006–2010	--	--	--	745.07	A
13	Cedar River at Edgewood Road	S	C, N, P, Vi	28	2006–2010	--	--	--	720.07	--

[1] Datum: NAD 88 at CRM4A, all others NAD 29.

identifier, (CRM, for Cedar Rapids Municipal), and a unique incremental number (beginning with number 1). For example, well 1993USGS CRM 3 is the third monitoring well installed by the USGS for CRM. For convenience in this report, the year and agency identifier typically will not be included when referring to a site name.

With the exception of Ranneys 1 and 2, municipal wells used by the City of Cedar Rapids are identified by the well field name (Seminole or West) then the well number (for example Seminole 17, West Ranney 3). Horizontal collector wells that have been added to the well fields during the last 20 years are identified as “Ranney” wells. Ranneys 1 and 2, and West Ranney 3, are labeled Seminole Ranney 1, Seminole Ranney 2, and Edgewood Ranney, respectively, in Littin and Schnoebelen, 2010.

Water-Quality Sampling and Analysis

Water-quality samples were collected from the Cedar River, 2- and 4-in. diameter monitoring wells, municipal wells, and the Cedar Rapids waterworks plant (municipal-well raw-water composite). Water-quality samples were collected from January 2006 through December 2010, and included quarterly water samples, and, beginning in May 2008, routine virus samples.

Before collecting water samples, each monitoring well was pumped to remove approximately three borehole volumes of water. Water samples were collected using a stainless-steel submersible pump and chemically inert fluoropolymer tubing. Onsite measurements of air temperature, alkalinity, air pressure, dissolved oxygen, pH, specific conductance, and water temperature were performed at the time of sample collection. Dissolved oxygen, pH, specific conductance, and water temperature were measured in a flow-through chamber for groundwater only. Water samples for analysis of nutrients and major ions were filtered through a 0.45-micrometer (µm) pore size polycarbonate capsule filter in the field. Water samples for pesticide analysis were filtered through a 0.7-µm pore size borosilicate glass-fiber filter baked at 450 degrees Celsius (ºC). All samples were collected according to USGS protocols (U.S. Geological Survey, 2006). Water samples were kept chilled and shipped by overnight air express to the USGS National Water-Quality Laboratory (NWQL) in Denver, Colorado for analysis.

Nutrients, dissolved organic carbon, and physical characteristics analyzed for in the water-quality samples, the Chemical Abstract Service Registry Number (CASRN), the National Water Information System (NWIS) parameter code, laboratory reporting limits (LRL), and reporting units are listed in table 2. This report contains CAS Registry Numbers®, which

Table 2. Nutrients, dissolved organic carbon, and physical characteristics analyzed for in water-quality samples.

[CASRN, Chemical Abstract Service Registry Number; NWIS, National Water Information System; LRLs, laboratory reporting levels; N, nitrogen; mg/L, milligrams per liter; --, not applicable; P, phosphorus; µS/cm, microsiemens per centimeter]

Water-quality constituent	CASRN[1] number	NWIS parameter code	LRLs	Reporting units
Nutrients and dissolved organic carbon				
Nitrogen, ammonia, as N	7664-41-7	00608	0.01–.04	mg/L
Nitrogen, nitrate plus nitrite, as N	--	00631	.06–.04	mg/L
Nitrogen, nitrite, as N	14797-65-0	00613	.02–.001	mg/L
Phosphorus, ortho, as P	14265-44-2	00671	.02–.006	mg/L
Dissolved organic carbon	--	00681	.40	mg/L
Physical characteristics				
Alkalinity	--	39086	--	mg/L
Dissolved oxygen	--	31501	--	mg/L
pH	--	00400	--	standard units
Specific conductance	--	00095	--	µS/cm
Temperature, water	--	00010	--	degrees Celsius

[1]This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CASRNs through CAS Client Services[SM].

is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CASRNs through CAS Client Services. The term "nitrate" as used in this report refers to the nitrite species, as this form of the nitrogen species typically is a small concentration (less than 0.1 mg/L). The major ions and selected pesticides with two pesticide degradate compounds, followed by the CASRN number, NWIS parameter code, and LRLs are listed in tables 3 and 4, respectively. The LRL is used to specify the lowest quantifiable value for constituents listed in tables 2, 3, and 4. The LRLs for many of the constituents varied during the period of record covered by this report. The LRL is defined more rigorously by statistics than the older minimum reporting level (MRL) that it replaces at the NWQL (Oblinger-Childress and others, 1999).

Quality Assurance and Quality Control

To properly interpret water-quality data and to verify that these data are reliable and accurate, quality-assurance (QA) procedures and quality-control (QC) samples are needed. In general, quality assurance includes using correct procedures and protocols, proper documentation (log books and field sheets), and approved analytical methods. The QC samples typically are used in the estimation of the magnitude of bias and variability of the environmental samples. Bias is systematic error that can "skew" results in either a positive or negative direction. The most common source of positive bias in water-quality studies is contamination of samples from airborne gases and particulates, or sampling equipment inadequately cleaned between uses and locations. Variability is the degree of random error of independent measurements of

Table 3. Major ions analyzed for in water-quality samples.

[CASRN, Chemical Abstract Service Registry Number; NWIS, National Water Information System; LRLs, laboratory reporting levels; µg/L, micrograms per liter; mg/L, milligrams per liter; --, not applicable]

Water-quality constituent	CASRN[1] number	NWIS parameter code	LRLs	Reporting units
Boron	7440-42-8	01020	1.8	µg/L
Bromide	24959-67-9	71870	.02	mg/L
Calcium	7440-70-2	00915	.02	mg/L
Calcium bicarbonate	3983-19-5	00453	.02	mg/L
Calcium carbonate	471-34-1	00442	.02	mg/L
Chloride	16887-00-6	00940	.12	mg/L
Fluoride	16984-48-8	00950	.12	mg/L
Iron	7439-89-6	01046	8.0–3.0	µg/L
Magnesium	7439-95-4	00925	.014	mg/L
Manganese	7439-96-5	01056	.4–.2	µg/L
Potassium	7440-09-7	00935	.02	mg/L
Silica	7631-86-9	00955	.018	mg/L
Sodium	7440-23-5	00930	.12	mg/L
Sulfate	14808-79-8	00945	.18	mg/L
Total dissolved solids	--	70300	10	mg/L

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Table 4. Selected pesticides analyzed for in water-quality samples.

[CASRN, Chemical Abstract Service Registry Number; NWIS, National Water Information System; LRLs, laboratory reporting levels; µg/L, micrograms per liter]

Water-quality constituent	CASRN[1] number	NWIS parameter code	LRLs	Reporting units
Acetochlor	34256-82-1	49260	0.05	µg/L
Alachlor	15972-60-8	46342	.05	µg/L
Ametryn	834-12-8	38401	.05	µg/L
Atrazine	1912-24-9	39632	.05	µg/L
Bromacil	314-40-9	04029	.05	µg/L
Butachlor	23184-66-9	04026	.05	µg/L
Butylate	2008-41-5	04028	.05	µg/L
Carboxin	5234-68-4	04027	.05	µg/L
Cyanazine	21725-46-2	04041	.20	µg/L
Cycloate	1134-23-2	04031	.05	µg/L
Diphenamid	957-51-7	04033	.05	µg/L
Hexazinone	51235-04-2	04025	.05	µg/L
Metolachlor	51218-45-2	39415	.05	µg/L
Metribuzin	21087-64-9	82630	.05	µg/L
Prometon	1610-18-0	04037	.05	µg/L
Prometryn	7287-19-6	04036	.05	µg/L
Propachlor	1918-16-7	04024	.05	µg/L
Propazine	139-40-2	38535	.05	µg/L
Simazine	122-34-9	04035	.05	µg/L
Simetryn	1014-70-6	04030	.05	µg/L
Terbacil	5902-51-2	04032	.05	µg/L
Trifluralin	1582-09-8	04023	.05	µg/L
Vernolate	1929-77-7	04034	.05	µg/L
CIAT[2]	6190-65-4	04040	.05	µg/L
CEAT[2]	1007-28-9	04038	.05	µg/L

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[2]Atrazine degradates: 2-Chloro-4-amino-6-isopropyl-amino-striazine (CIAT) and 2-Chloro-4-ethylamino-6-amino-s-triazine (CEAT).

the sample quantity. Variability may be the result of errors in laboratory analytical procedures or in collection of samples in the field. The QA/QC procedures are required to ensure that the data collected meet standards of reliability and accuracy.

The QA/QC procedures for the study followed USGS protocols (US Geological Survey, 2006) and other USGS guidelines (Mueller and others, 1997). Approximately 10 percent of the total samples collected for the study were analyzed for quality control including equipment blanks, field blanks, and replicates. Generally, blanks are used to estimate sample bias whereas replicates are used to estimate sample variability.

A blank is a water sample that is intended to be free of the analytes of interest. Blank samples of deionized water guaranteed by the manufacturer to be free of organic compounds and another type of deionized water guaranteed by the manufacturer to be free of inorganic compounds were passed through all sampling equipment at the beginning of the field season. Equipment blank samples are collected in a “clean” environment, such as the laboratory, to examine the cleanliness of the equipment before sampling. A field blank is a specific type of blank sample collected in the field and used to demonstrate that (1) equipment has been adequately cleaned to remove contamination introduced by samples obtained at the previous site; (2) sample collection and processing have not resulted in contamination; and (3) sample handling, transport, and laboratory analysis have not introduced contamination (Mueller and others, 1997). Field blank samples of the deionized inorganic and organic free water were collected by passing the water through all pumps, filter plates, and filters to verify the cleanliness of sampling equipment and technique. Field blank sample concentrations of inorganic and organic constituents typically were below the LRL. Otherwise stated, the blanks were “clean” and did not indicate any contamination from the equipment or sample processing methods. Results signify no cross-contamination of samples from sampling equipment between sample collection.

Replicates are two or more samples collected or processed so that the samples are considered to be essentially identical in composition. Each replicate sample is an aliquot of the native water sample that is processed and prepared in the same way as the environmental sample. For the purposes of this report, the terms “environmental sample” and “replicate sample” are used to identify the particular samples in a replicate pair.

One objective of collecting replicate samples was to estimate the precision of constituent concentrations determined by sample processing and analysis. Analytical results of organic constituents generally are more variable than those of inorganic constituents. Replicate samples were compared by using relative percent differences (RPD). RPD between replicate samples was calculated using the following:

$$RPD = |S1\text{-}S2|/(S1+S2/2) \text{ x } 100 \quad (1)$$

where $S1$ is equal to the concentration in the environmental sample, in micrograms per liter (µg/L) or milligrams per liter (mg/L) and

$S2$ is equal to the concentration in the replicate sample, in the same units as S1.

A large relative percent difference can indicate greater variability between samples. Variability for all constituents in the replicate samples generally was within 10 percent of the environmental samples. The median RPD for nutrients, organic carbon, and major ions ranged from 0 to 11.5 percent, in terms of absolute value, and the median RPD for pesticides ranged from 0.1 to 15.4 percent (table 5). It should be noted that when comparing small or low concentrations between some replicate samples, the RPD can appear relatively large, because slight differences (common at the lowest detection levels) can result in higher RPDs. This typcially is the case for individual RPDs that had the largest percentage (10 percent or greater).

Surrogates were added to all environmental and quality-control samples for pesticide analysis before sample preparation in the laboratory. A surrogate has physical and chemical properties similar to those of the analytes of interest but is not normally present in environmental samples. Surrogates provide quality control by monitoring matrix effects and gross processing errors (Wershaw and others, 1987), and help control for bias, either positive or negative. Surrogate recoveries of organic chemicals are expressed in percent and typically range from 80 to 120 percent. Surrogate recoveries that consistently are less than 70 percent may indicate that many targeted compounds may be present in greater concentrations than reported. Surrogate recovery rates median percent recoveries (ranging from 74.5 to 92.6 percent), and mean percent recoveries (ranging from 74.5 to 96.3 percent) are listed in table 6.

Water-Quality Data for Cedar River and Cedar Rapids Well Fields

The results of the water-quality samples collected from January 2006 through December 2010 are summarized in tables 7 to 19 at the back of this report. Data compiled are primarily from samples collected from the Cedar River, and monitoring wells with quarterly monitoring. Other water-quality data were obtained from surface-water–groundwater interaction studies and the characterization of water quality in shallow groundwater in the Seminole Well Field.

Water-quality data were used to assess quality of water in the alluvial aquifer and the Cedar River. The Cedar River is the major influence on water quality in the alluvial aquifer because of induced infiltration from the river as a result of the pumping of wells (Schulmeyer and Schnoebelen, 1998; Boyd, 1999; Turco and Buchmiller, 2004). Agricultural chemicals (nutrients and pesticides) are of concern because of the predominance of agricultural land use (90 percent and greater) in the Cedar River Basin. A 12-mile (mi) reach of the Cedar River upstream from Cedar Rapids, Iowa, is identified on the Total Maximum Daily Load (TMDL) list for nitrate impairment (Iowa Department of Natural Resources, 1994; U.S. Environmental Protection Agency, 2007). Water-quality data were evaluated for nutrients and pesticides, then selected major ions and physical characteristics.

Physical Characteristics, Major Ions, and Nutrients

Nutrient data were compiled for ammonia, nitrate plus nitrite, nitrite, and orthophosphate. Dissolved organic carbon data are summarized with nutrient data. Four samples were analyzed for ammonia plus organic nitrogen (filtered and unfiltered) and phosphorus (filtered and unfiltered). Nutrient summary statistics for groundwater and surface-water from all sites are shown in table 11. Nutrient summary statistics for groundwater samples from the alluvial aquifer and surface-water samples from the river are listed in table 12. Summary statistics for major ions, nutrients, and organic carbon in water samples from individual sites are listed in table 13.

Pesticides

Pesticides are used to control unwanted vegetation, insects, and other pests in agricultural and urban areas. Typically, large amounts (thousands of pounds per year) of common herbicides are applied during the growing season in the Cedar River Basin to corn and soybean crops (Schnoebelen and others, 2003). Triazine (atrazine and cyanazine) and chloroacetanilide (acetochlor and metolachlor) generally are the most extensively used herbicides in eastern Iowa. Insecticides are detected less often in water, most likely because they are used in smaller amounts than herbicides, have short persistence, and are selectively applied during periods of reduced runoff (Schnoebelen and others, 2003). Pesticide degradates are formed when a parent pesticide compound breaks down or degrades. Pesticide degradates often have been detected at higher concentrations than their parent compounds (Kolpin and others, 2000, Kolpin and others, 2004, and Schnoebelen and others, 2003). The pesticide degradates of atrazine: 2-Chloro-4-ethylamino-6-amino-*s*-triazine (CEAT) and 2-Chloro-4-amino-6-isopropyl-amino-*s*triazine (CIAT) were the only two degradates regularly analyzed. These two degradates (CEAT and CIAT) are included in all tables listing the pesticides. Pesticide sampled for during the study period and their uses are listed in table 14. Pesticides that were tested for but not detected are listed in table 15.

Pesticides detected in water samples from all sites are listed in table 16. Pesticide detections in groundwater samples from the alluvial aquifer and surface-water samples from the river are shown in table 17. Pesticide detections by individual site are listed in table 18. Seven sites (CRM-3, CRM-4A, CRM-22, Seminole 17, Seminole Ranney 4, Water Treatment Plant, and Cedar River at Edgewood Road) were sampled for enteric viruses and are listed in table 19.

Table 5. Replicate water-quality data for nutrients, major ions, and pesticides in groundwater and surface-water samples, Cedar Rapids, Iowa, calendar years 2006–10.

[mg/L, milligrams per liter; N, nitrogen; P, phosphorus; µg/L, microgram per liter]

Water-quality constituent	Number of replicate samples	Relative percent difference 2006–10)			
		Minimum	Maximum	Mean	Median
Nutrients					
Ammonia (mg/L as N)	10	0	169	22.6	0.6
Nitrite + nitrate (mg/L as N)	10	0	8.1	1.5	.8
Nitrite (mg/L as N)	10	0	40	9	1.9
Orthophosphate (mg/L as P)	10	0	129.2	25.3	9.2
Organic carbon (mg/L)	8	0	43.9	14.6	11.5
Major ions					
Boron (mg/L)	8	0	8	2.8	2.4
Bromide (mg/L)	11	0	40	7.9	0
Calcium (mg/L)	10	0	2.7	1.5	1.7
Chloride (mg/L)	10	0	18.1	2.7	0.5
Fluoride (mg/L)	10	0	8	3.7	4.1
Iron (mg/L)	10	0	16.6	4.2	0
Magnesium (mg/L)	10	.4	4	1.9	1.8
Manganese (mg/L)	10	.5	9	2.5	1.75
Potassium (mg/L)	10	.4	5.8	2.3	2.05
Silica (mg/L)	10	0	5.7	1.1	.5
Sodium (mg/L)	10	0	8.1	2.7	2
Sulfate (mg/L)	10	0	17.9	2	.3
Residue on evaporation (mg/L)	10	.3	16.8	2.7	1.3
Pesticides					
Acetochlor (µg/L)	14	0	11.8	1.5	0
Alachlor (µg/L)	14	0	0	0	0
Ametryn (µg/L)	14	0	0	0	0
Atrazine (µg/L)	14	0	140	18.8	2
Bromacil (µg/L)	14	0	0	0	0
Cyanazine (µg/L)	14	0	0	0	0
Cycloate (µg/L)	14	0	0	0	0
Diphenamid (µg/L)	14	0	0	0	0
Metolachlor (µg/L)	14	0	40	4.5	0
Metribuzin (µg/L)	14	0	0	0	0
Prometon (µg/L)	14	0	0	0	0
Propazine (µg/L)	14	0	0	0	0
Simazine (µg/L)	14	0	0	0	0
Terbacil (µg/L)	14	0	0	0	0
Trifluralin (µg/L)	14	0	0	0	0
CIAT (µg/L)[1]	14	0	135	23.6	15.4
CEAT (µg/L)[1]	14	0	0	0	0

[1] Atrazine degradates: 2-Chloro-4-amino-6-isopropyl-amino-s-triazine (CIAT) and 2-Chloro-4-ethylamino-6-amino-s-triazine (CEAT).

Table 6. Surrogate pesticide data for groundwater and surface-water samples with minimum, maximum, median, and mean percent recovery, Cedar Rapids, Iowa, calendar years 2006–10.

Site name	Minimum	Maximum	Median	Mean
Alpha-HCH-d6 surrogate (percent recovery)				
CRM-3	60.5	102	80.9	83.3
CRM-4	71.3	78.5	74.9	74.9
CRM-4A	79.2	91.7	84.3	84.9
CRM-22	63.1	101	80.1	81.6
CRM-23	65.1	122	83.5	83.5
Ranney 1	71.0	102	84.8	85.6
Ranney 2	66.1	104	80.8	82.5
West Ranney 3	63.7	108	82.7	81.7
Seminole Ranney 4	64.2	95.1	80.6	81.3
Seminole 17	67.6	99.3	83.5	83.6
Seminole 18	64.7	103	80.7	80.8
Cedar Rapids Waterworks	65.9	96.1	80.3	80.0
Cedar River at Edgewood Road	67.2	110	81.6	84.8
Diazinon-d10 surrogate (percent recovery)				
CRM-3	54.5	130	87.7	88.3
CRM-4	67.4	81.6	74.5	74.5
CRM-4A	64	106	90.2	87.6
CRM-22	56.8	101	87.1	85.9
CRM-23	57.8	147	90.3	96.3
Ranney 1	59.7	127	85.7	87.5
Ranney 2	57.9	126	86.9	83.7
West Ranney 3	48.5	112	82.2	80.3
Seminole Ranney 4	55.4	119	81.9	83.5
Seminole 17	62.8	111	85.9	86.7
Seminole 18	54.2	126	87.3	87.0
Cedar Rapids Waterworks	41.8	106	87.5	82.1
Cedar River at Edgewood Road	64.9	113	92.6	89.7

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Tables 7–19

Table 7. Summary statistics for physical characteristics of groundwater and surface-water samples, for all sites combined, Cedar Rapids, Iowa, calendar years 2006–10.

[Numbers in parentheses indicate parameter codes; mm Hg, millimeters mercury; mg/L milligrams per liter; w, water; u, unfiltered; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; $CaCO_3$, calcium carbonate]

	Air pressure (00025) (mm Hg)	Dissolved oxygen[1] (00300) (mg/L)	pH, field[2] (00400) (standard units)	pH, wu, lab (00403) (standard units)	Specific conductance, field[3] (00095) (µS/cm)	Specific conductance, lab (90095) (µS/cm)	Water temperature (00010) (°C)	Air temperature (00020) (°C)	Alkalinity (39086) (mg/L as $CaCO_3$)
Number of samples:	95	152	162	162	170	161	162	66	164
Maximum:	752	16.3	8.8	9	638	652	26.1	32.5	425
Minimum:	727	.1	6.6	6.2	358	354	.1	-5	95
Mean:	743	3.4	7.4	7.7	537	548	13.1	17.1	199

[1] Instrument accuracy for 0 to 20 milligrams per liter was plus or minus 2 percent of reading or plus or minus 0.2 milligrams per liter, whichever was greater.

[2] Instrument accuracy was plus or minus 0.2 units.

[3] Instrument accuracy was plus or minus 0.5 percent of reading plus 0.001 microsiemens per centimeter at 25 degrees Celsius.

Table 8. Summary statistics for physical characteristics of groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.

[Numbers in parentheses indicate parameter codes; mm Hg, millimeters mercury; mg/L milligrams per liter; w, water; u, unfiltered; µS/cm, microsiemens per centimeter at 25 degress Celsius; °C, degrees Celsius; $CaCO_3$, calcium carbonate; na, not applicable]

	Air pressure (00025) (mm Hg)	Dissolved oxygen (00300) (mg/L)	pH (00400) (standard units)	pH, wu, lab (00403) (standard units)
1993USGS CRM-3				
Number of samples:	6	6	7	6
Maximum:	751	2.9	7.5	7.7
Minimum:	740	.1	6.9	7.6
Mean:	744	.8	7.3	7.7
1993USGS CRM-4				
Number of samples:	1	2	2	2
Maximum:	751	8.6	7.3	7.6
Minimum:	751	6.2	7.2	7.6
Mean:	751	7.4	7.2	7.6
2010USGS CRM-4A				
Number of samples:	2	4	4	4
Maximum:	745	6.4	7.6	8
Minimum:	735	.1	7.1	7.5
Mean:	740	1.8	7.3	7.7
1993USGS CRM-22				
Number of samples:	8	12	15	17
Maximum:	751	9	7.9	8.2
Minimum:	732	.1	7	6.2
Mean:	744	1.9	7.5	7.7
1998USGS CRM-23				
Number of samples:	3	3	3	4
Maximum:	747	.7	7.3	7.5
Minimum:	744	.5	6.7	7.3
Mean:	745	.6	6.9	7.4

Table 8. Summary statistics for physical characteristics of groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[Numbers in parentheses indicate parameter codes; mm Hg, millimeters mercury; mg/L milligrams per liter; w, water; u, unfiltered; µS/cm, microsiemens per centimeter at 25 degress Celsius; °C, degrees Celsius; $CaCO_3$, calcium carbonate; na, not applicable]

	Air pressure (00025) (mm Hg)	Dissolved oxygen (00300) (mg/L)	pH (00400) (standard units)	pH, wu, lab (00403) (standard units)
Ranney 1				
Number of samples:	9	16	17	17
Maximum:	748	7.1	7.5	7.7
Minimum:	734	.5	6.6	7.5
Average:	742	3.8	7.2	7.6
Ranney 2				
Number of samples:	8	16	16	18
Maximum:	752	8.7	7.6	7.8
Minimum:	734	.2	6.9	7.5
Average:	743	3.8	7.4	7.7
West Ranney 3				
Number of samples:	9	16	17	16
Maximum:	748	7.7	7.6	7.9
Minimum:	735	.3	6.8	7.4
Average:	741	2.6	7.3	7.6
Seminole Ranney 4				
Number of samples:	8	15	15	15
Maximum:	747	9.7	7.5	8
Minimum:	735	.3	6.6	7.4
Average:	742	3.1	8.6	7.6
Seminole 17				
Number of samples:	11	13	14	14
Maximum:	750	7	7.4	7.7
Minimum:	735	.3	6.6	7
Average:	744	1.8	7.2	7.6
Seminole 18				
Number of samples:	8	14	15	15
Maximum:	748	6.7	7.4	8
Minimum:	735	.2	6.7	7.5
Average:	744	1.7	7.2	7.6
Cedar Rapids Waterworks				
Number of samples:	10	17	19	17
Maximum:	746	4	7.3	8.1
Minimum:	727	.1	6.8	7.1
Average:	740	1.2	7.2	7.6
Cedar River at Edgewood Road				
Number of samples:	12	18	18	17
Maximum:	751	16.3	8.8	9
Minimum:	737	5.3	7.3	7.4
Average:	744	11	8.2	8.2

Table 9. Summary statistics for major ions in groundwater and surface-water samples, for all sites combined, Cedar Rapids, Iowa, calendar years 2006–10.

[Concentrations are in milligrams per liter unless otherwise indicated; <, actual value is known to be less than value shown]

Major ion	Number of samples	Maximum concentration	Minimum concentration	Mean
Calcium	160	85.9	25.1	70.4
Magnesium	160	33	14.9	21.2
Potassium	160	4.18	1.43	2.33
Sodium	160	17.8	5.01	10.5
Bromide	165	.07	.01	.03
Chloride	160	33.3	15.1	23.4
Fluoride	160	.35	.13	.23
Silica	160	15.6	.18	10.6
Sulfate	160	43.3	17.1	29.3
Boron[1]	159	43	9.2	24.5
Iron[1]	160	558	<10	46
Manganese[1]	159	2,060	<3	190

[1] Concentrations in micrograms per liter.

Table 10. Summary statistics for major ions in groundwater and surface-water samples, Cedar Rapids, Iowa, calendar years 2006–10.

[Concentrations are in milligrams per liter unless otherwise indicated; <, actual value is known to be less than value shown]

Major ion	Number of samples	Maximum concentration	Minimum concentration	Mean
Groundwater				
Calcium	143	85.9	43.5	71.3
Magnesium	143	33	14.9	21.3
Potassium	143	3.26	1.43	2.33
Sodium	143	17.8	6.8	10.6
Bromide	149	.06	.01	.03
Chloride	143	33.3	15.1	23.5
Fluoride	143	.35	.13	.23
Silica	143	15.6	6.21	10.9
Sulfate	143	43.3	17.7	29.4
Boron[1]	143	43	9.2	24.7
Iron[1]	143	558	<10	51
Manganese[1]	142	2,060	<3	208
Surface water				
Calcium	17	82.9	25.1	63.3
Magnesium	17	25	15.2	20.6
Potassium	17	4.18	1.49	2.3
Sodium	17	14.2	5	9.7
Bromide	16	.07	.02	.04
Chloride	17	28.4	15.8	22.2
Fluoride	17	.29	.18	.22
Silica	17	14	.18	8.16
Sulfate	17	36.3	17.1	27.8
Boron[1]	16	37	14	23
Iron[1]	17	20	<10	8
Manganese[1]	17	14.5	<3	4.7

[1] Concentrations in micrograms per liter.

Table 11. Summary statistics for nutrients in groundwater and surface-water samples, for all sites combined, Cedar Rapids, Iowa, calendar years 2006–10.

[mg/L, milligrams per liter; NH_3+orgN, ammonia plus organic nitrogen; w, water; f, filtered; u, unfiltered; <, less than; NO_2+NO_3, nitrite plus nitrate; E, estimated]

Nutrient	Number of samples	Maximum concentration (mg/L)	Minimum concentration (mg/L)	Average (mg/L)
NH_3+orgN, wf	1	0.33	0.33	0.33
NH_3+orgN, wu	1	1.5	1.5	1.5
Ammonia	169	4	<.02	.14
NO_2+NO_3	169	10.5	E.02	5
Nitrite	169	4	<.02	.04
Orthophosphate	169	4	E.003	.089
Phosphorus, wf	1	.007	.007	.007
Phosphorus, wu	1	.136	.136	.136
Organic carbon	157	6	1.3	2

Table 12. Summary statistics for nutrients in groundwater and surface-water samples, Cedar Rapids, Iowa, calendar years 2006–10.

[mg/L, milligrams per liter; NH_3+orgN, ammonia plus organic nitrogen; w, water; f, filtered; --, no data; u, unfiltered; <, less than; NO_2+NO_3, nitrite plus nitrate; E, estimated]

Nutrient	Number of samples	Maximum concentration (mg/L)	Minimum concentration (mg/L)	Average (mg/L)
Groundwater				
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--
Ammonia	146	1.75	<0.01	0.12
NO_2+NO_3	146	10.5	E.02	4.9
Nitrite	146	.091	<.001	.011
Orthophosphate	146	.25	<.01	.06
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	136	3.3	1.3	1.8
Surface water				
NH_3+orgN, wf	1	0.33	0.33	0.33
NH_3+orgN, wu	1	1.5	1.5	1.5
Ammonia	18	.336	<.01	E.047
NO_2+NO_3	18	10.1	.97	6.24
Nitrite	18	.045	.008	.019
Orthophosphate	18	.201	E.003	E.067
Phosphorus, wf	1	.007	.007	.007
Phosphorus, wu	1	.136	.136	.136
Organic carbon	16	6	2	3.1

Table 13. Summary statistics for major ions and nutrients in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.

[Concentrations are in milligrams per liter unless otherwise indicated; <, actual value is known to be less than value shown; E, estimated; NH_3+orgN, ammonia plus organic nitrogen; w, water; f, filtered; u, unfiltered; --, no data; NO_2+NO_3, nitrite plus nitrate]

Constituent	Number of samples	Maximum concentration	Minimum concentration	Average
		1993USGS CRM-3		
Calcium	6	75.4	55.7	66.5
Magnesium	6	29.1	20.4	23.6
Potassium	6	2.84	1.63	2.09
Sodium	6	14.4	8.6	11.4
Bromide	7	.03	<.02	E.02
Chloride	6	33.3	17.4	24.9
Fluoride	6	.35	.26	.29
Silica	6	8.42	6.21	7.43
Sulfate	6	39	21.6	32
Boron[1]	6	35	9.9	19
Iron[1]	6	43	<8	E11
Manganese[1]	6	1,220	484	855
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--
Ammonia	7	<.02	<.02	<.02
NO_2+NO_3	7	7.4	E.02	E5
Nitrite	7	.052	<.002	E.035
Orthophosphate	7	E.023	.011	E.014
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	6	2.3	1.3	1.7
		1993USGS CRM-4		
Calcium	2	75.2	74.3	74.8
Magnesium	2	25.5	24.6	25.1
Potassium	2	3.26	2.13	2.7
Sodium	2	11.9	8.2	10
Bromide	2	.03	.03	.03
Chloride	2	31.3	21	26.2
Fluoride	2	.29	.14	.22
Silica	2	10.8	6.7	8.8
Sulfate	2	34.7	28.6	31.7
Boron[1]	2	21	14	18
Iron[1]	2	<8	<8	<8
Manganese[1]	2	377	<.05	189
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--
Ammonia	2	E.013	<.02	E.012

Table 13. Summary statistics for major ions and nutrients in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[Concentrations are in milligrams per liter unless otherwise indicated; <, actual value is known to be less than value shown; E, estimated; NH_3+orgN, ammonia plus organic nitrogen; w, water; f, filtered; u, unfiltered; --, no data; NO_2+NO_3, nitrite plus nitrate]

Constituent	Number of samples	Maximum concentration	Minimum concentration	Average
1993USGS CRM-4—Continued				
NO_2+NO_3	2	7.23	6.86	7.05
Nitrite	2	.067	<.02	E.039
Orthophosphate	2	.087	.058	.073
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	1	1.4	1.4	1.4
2009USGS CRM-4A				
Calcium	4	70.5	53.5	61.6
Magnesium	4	25.9	14.9	19.4
Potassium	4	2.76	2	2.48
Sodium	4	9.1	6.9	8.1
Bromide	4	.04	<.03	.03
Chloride	4	22.8	15.1	18.5
Fluoride	4	.3	.18	.23
Silica	4	14.5	10.6	12.6
Sulfate	4	31.3	17.7	23.2
Boron[1]	4	36	14	26
Iron[1]	4	54	3	16
Manganese[1]	4	192	.3	65
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--
Ammonia	4	<.02	<.02	<.02
NO_2+NO_3	4	7.7	2.9	5.7
Nitrite	4	.018	.003	.011
Orthophosphate	4	.113	.089	.102
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	4	3.3	1.5	2.1
1998USGS CRM-22				
Calcium	16	79	43.5	67
Magnesium	16	33	17	21.8
Potassium	16	2.96	1.43	2.13
Sodium	16	17.8	6.8	10.6
Bromide	16	.05	.02	.03
Chloride	16	31.4	17.9	23.5
Fluoride	16	.3	.13	.24
Silica	16	13.5	7.9	10.1
Sulfate	16	40.7	20.2	28.2

Table 13. Summary statistics for major ions and nutrients in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[Concentrations are in milligrams per liter unless otherwise indicated; <, actual value is known to be less than value shown; E, estimated; NH_3+orgN, ammonia plus organic nitrogen; w, water; f, filtered; u, unfiltered; --, no data; NO_2+NO_3, nitrite plus nitrate]

Constituent	Number of samples	Maximum concentration	Minimum concentration	Average
1998USGS CRM-22—Continued				
Boron[1]	16	34	9.2	23
Iron[1]	16	363	<3	50.3
Manganese[1]	16	2,060	<.2	249
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--
Ammonia	16	1.75	<.01	E.163
NO_2+NO_3	16	10.2	<.06	6.39
Nitrite	16	.091	E.001	E.012
Orthophosphate	16	.25	.118	.185
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	16	2.7	1.6	2.1
1998USGS CRM-23				
Calcium	4	85.9	75.5	79.1
Magnesium	4	24.3	20.1	21.8
Potassium	4	2.72	1.84	2.34
Sodium	4	12.3	9.1	11.3
Bromide	4	.05	.03	.04
Chloride	4	32.4	23.6	26.7
Fluoride	4	.24	.19	.23
Silica	4	13.3	8.53	11.36
Sulfate	4	36.3	26.3	33.4
Boron[1]	4	20	9.6	16.2
Iron[1]	4	33	<6	23
Manganese[1]	4	35.3	.8	21.3
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--
Ammonia	4	<.04	<.01	E.011
NO_2+NO_3	4	9.7	.7	4.6
Nitrite	4	.061	<.002	E.023
Orthophosphate	4	.138	.09	.115
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	4	2.5	2	2.3

Table 13. Summary statistics for major ions and nutrients in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[Concentrations are in milligrams per liter unless otherwise indicated; <, actual value is known to be less than value shown; E, estimated; NH_3+orgN, ammonia plus organic nitrogen; w, water; f, filtered; u, unfiltered; --, no data; NO_2+NO_3, nitrite plus nitrate]

Constituent	Number of samples	Maximum concentration	Minimum concentration	Average
		Ranney 1		
Calcium	17	81.4	60.1	73.8
Magnesium	17	26.1	16.6	21.5
Potassium	17	3.14	1.78	2.26
Sodium	17	14.1	8.2	10.7
Bromide	18	.05	.03	.03
Chloride	17	30.6	16.9	23.4
Fluoride	17	.3	.17	.22
Silica	17	15.4	7.9	11.1
Sulfate	17	39.4	21.6	29.9
Boron[1]	17	33	17	24
Iron[1]	17	<8	<3	<5.4
Manganese[1]	16	42	9.1	20.1
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--
Ammonia	17	.062	<.02	E.022
NO_2+NO_3	17	7.63	1.19	4.77
Nitrite	17	.013	E.001	E.004
Orthophosphate	17	.074	E.02	E.041
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	16	2.3	1.3	1.7
		Ranney 2		
Calcium	14	83.3	50.5	72.5
Magnesium	14	25.9	15.2	21.4
Potassium	14	3.05	1.78	2.32
Sodium	14	14.6	7.9	10.8
Bromide	14	.05	.03	.04
Chloride	14	30.3	17.7	24.4
Fluoride	14	.28	.19	.24
Silica	14	13.5	7.5	10.1
Sulfate	14	38	24.3	31.7
Boron[1]	14	32	19	24
Iron[1]	14	36	<4	E9
Manganese[1]	14	35.3	1.4	12.9
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--

Table 13. Summary statistics for major ions and nutrients in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[Concentrations are in milligrams per liter unless otherwise indicated; <, actual value is known to be less than value shown; E, estimated; NH_3+orgN, ammonia plus organic nitrogen; w, water; f, filtered; u, unfiltered; --, no data; NO_2+NO_3, nitrite plus nitrate]

Constituent	Number of samples	Maximum concentration	Minimum concentration	Average
Ranney 2—Continued				
Ammonia	17	0.049	<.01	E.012
NO_2+NO_3	17	10.5	1.11	5.9
Nitrite	17	.74	<.001	E.007
Orthophosphate	17	.234	.042	.074
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	16	2.1	1.3	1.7
West Ranney 3				
Calcium	16	79	64.1	71
Magnesium	16	25.6	17.6	20.8
Potassium	16	2.98	1.93	2.42
Sodium	16	16.6	8	10.8
Bromide	17	.05	.02	.03
Chloride	16	31.7	17.8	23.9
Fluoride	16	.28	.19	.23
Silica	16	15.6	11	12.5
Sulfate	16	38.2	22.3	29.1
Boron[1]	16	34	18	24
Iron[1]	16	159	<3	E23.5
Manganese[1]	16	1,150	125	398
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--
Ammonia	16	1.07	.07	.37
NO_2+NO_3	16	7	.6	4.3
Nitrite	16	.023	<.008	E.008
Orthophosphate	16	.079	.03	.055
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	15	2.3	1.3	1.8
Seminole Ranney 4				
Calcium	15	79.3	59.8	70.9
Magnesium	15	26.9	17.2	20.5
Potassium	15	2.87	1.56	2.33
Sodium	15	13.9	7	9.9
Bromide	16	.05	E.01	E.03
Chloride	15	29.9	16.6	22.7
Fluoride	15	.3	.14	.23

Table 13. Summary statistics for major ions and nutrients in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[Concentrations are in milligrams per liter unless otherwise indicated; <, actual value is known to be less than value shown; E, estimated; NH_3+orgN, ammonia plus organic nitrogen; w, water; f, filtered; u, unfiltered; --, no data; NO_2+NO_3, nitrite plus nitrate]

Constituent	Number of samples	Maximum concentration	Minimum concentration	Average
Seminole Ranney 4—Continued				
Silica	15	14.1	8.4	11.3
Sulfate	15	43.3	19.5	29.4
Boron[1]	15	35	19	26
Iron[1]	15	7	<3	E3.4
Manganese[1]	15	248	9.7	68.9
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--
Ammonia	16	.23	<.02	E.07
NO_2+NO_3	16	8.6	.8	5.3
Nitrite	16	.026	E.002	E.01
Orthophosphate	16	.076	.04	.058
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	15	2.1	1.6	1.8
Seminole 17				
Calcium	14	78.9	66.6	72
Magnesium	14	23.6	18.1	20.7
Potassium	14	2.97	1.79	2.38
Sodium	14	13.3	8.3	10.5
Bromide	15	.04	.03	.04
Chloride	14	28.4	17.9	23.3
Fluoride	14	.27	.2	.23
Silica	14	12.8	8.4	10.3
Sulfate	14	37.3	23.4	28.9
Boron[1]	14	31	19	23
Iron[1]	14	139	E5	E88.5
Manganese[1]	14	402	135	274
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--
Ammonia	15	.141	.026	.082
NO_2+NO_3	15	7.3	1.8	4.1
Nitrite	15	.016	E.004	E.008
Orthophosphate	15	.038	E.01	E.028
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	14	2.2	1.5	1.9

Table 13. Summary statistics for major ions and nutrients in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[Concentrations are in milligrams per liter unless otherwise indicated; <, actual value is known to be less than value shown; E, estimated; NH_3+orgN, ammonia plus organic nitrogen; w, water; f, filtered; u, unfiltered; --, no data; NO_2+NO_3, nitrite plus nitrate]

Constituent	Number of samples	Maximum concentration	Minimum concentration	Average
Seminole 18				
Calcium	15	79	68.3	72.9
Magnesium	15	27.8	18	20.8
Potassium	15	3.02	1.78	2.43
Sodium	15	14.6	7.8	10.2
Bromide	16	.05	<.02	E.03
Chloride	15	30.1	17	22.4
Fluoride	15	.27	.18	.23
Silica	15	13.5	6.2	10.4
Sulfate	15	41.2	20.1	28.1
Boron[1]	15	31	17	24
Iron[1]	15	117	66	88
Manganese[1]	15	431	79.6	161
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--
Ammonia	15	.487	E.017	E.058
NO_2+NO_3	15	7.68	2	4.35
Nitrite	15	.008	.003	E.005
Orthophosphate	15	.034	<.01	E.022
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	14	2.3	1.5	1.8
Cedar Rapids Waterworks				
Calcium	17	78.1	66.3	71.9
Magnesium	17	27.1	18.7	22.2
Potassium	17	3.09	2.03	2.46
Sodium	17	14.1	8.8	11.2
Bromide	17	.06	.03	.04
Chloride	17	30.7	19.2	24.6
Fluoride	17	.28	.19	.24
Silica	17	15	10.4	12.5
Sulfate	17	37.8	24.2	29.8
Boron[1]	17	43	21	33
Iron[1]	17	558	8	179
Manganese[1]	17	816	54	353
NH_3+orgN, wf	--	--	--	--
NH_3+orgN, wu	--	--	--	--

Table 13. Summary statistics for major ions and nutrients in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[Concentrations are in milligrams per liter unless otherwise indicated; <, actual value is known to be less than value shown; E, estimated; NH_3+orgN, ammonia plus organic nitrogen; w, water; f, filtered; u, unfiltered; --, no data; NO_2+NO_3, nitrite plus nitrate]

Constituent	Number of samples	Maximum concentration	Minimum concentration	Average
Cedar Rapids Waterworks—Continued				
Ammonia	17	.97	.027	.343
NO_2+NO_3	17	6	.6	3.8
Nitrite	17	.07	.005	.019
Orthophosphate	17	.083	.028	.047
Phosphorus, wf	--	--	--	--
Phosphorus, wu	--	--	--	--
Organic carbon	16	2.3	1.5	1.9
Cedar River Edgewood Road				
Calcium	17	82.9	25.1	63.3
Magnesium	17	25	15.2	20.6
Potassium	17	4.18	1.49	2.3
Sodium	17	14.2	5	9.7
Bromide	16	.07	E.02	E.04
Chloride	17	28.4	15.8	22.2
Fluoride	17	.29	.18	.23
Silica	17	14	.18	8.2
Sulfate	17	36.3	17.1	27.8
Boron[1]	16	37	14	23
Iron[1]	17	20	E2	E8
Manganese[1]	17	14.5	1.5	4.7
NH_3+orgN, wf	1	.33	.33	.33
NH_3+orgN, wu	1	1.5	1.5	1.5
Ammonia	18	.336	<.01	E.047
NO_2+NO_3	18	10.1	.97	6.2
Nitrite	18	.045	.008	.019
Orthophosphate	18	.201	E.003	E.067
Phosphorus, wf	1	.007	.007	.007
Phosphorus, wu	1	.136	.136	.136
Organic carbon	16	6	2	3.1

[1] Concentrations in micrograms per liter.

Table 14. Description of pesticides in water-quality samples, Cedar Rapids, Iowa, calendar years 2006–10.

[NWIS, National Water Information System; CASRN, Chemical Abstract Service Registry Number]

NWIS code	NWIS name	Other common names[1]	CASRN[2]	Use[3]	Chemical class[3]
46342	Alachlor	Alanox, Lasso, Metachlor	[3]15972-60-8	Herbicide	Chloroacetanilide
49260	Acetochlor	Harness, Nevirex	[3]34256-82-1	Herbicide	Chloroacetanilide
38401	Ametryn	Topazol, Trinatox D	834-12-8	Herbicide	Triazine
39632	Atrazine	Fenatrol, Herbatoxol, Weedex	93616-39-8	Herbicide	Triazine
04029	Bromacil	Du Pont herbicide 976, Nalkil, Rout G-8	[3]314-40-9	Herbicide	Uracil
04026	Butachlor	Machete, Weedout	23184-66-9	Herbicide	Chloroacetanilide
04028	Butylate	Tomahawk	2008-41-5	Herbicide	Thiocarbamate
04027	Carboxin	Enhance, Germate Plus	5234-68-4	Fungicide	Carboxamide
04041	Cyanazine	Bladex, Cynex, Fortrol	21725-46-2	Herbicide	Triazine
04031	Cycloate	Ro-Neet, Ronit	[3]1134-23-2	Herbicide	Thiocarbamate
04033	Diphenamid	Fenam, Rideon	957-51-7	Herbicide	Amide
04025	Hexazinone	Velpar, Pronone	[3]51235-04-2	Herbicide	Triazinone
39415	Metolachlor	Dual Magnum, Pennant, Primextra	[3]51218-45-2	Herbicide	Chloroacetanilide
82630	Metribuzin	Lexone, Zenkor	21087-64-9	Herbicide	Triazinone
04037	Prometon	Ontrack, Primatol	[3]1610-18-0	Herbicide	Triazine
04036	Prometryn	Primatol, Selectin, Mercazin	[3]7287-19-6	Herbicide	Triazine
04024	Propachlor	Croptex, Orange, Ramrod, Sentinel	[3]1918-16-7	Herbicide	Chloroacetanilide
38535	Propazine	Maxx 90, Propazine	139-40-2	Herbicide	Triazine
04035	Simazine	Azotop, Herbex, Radocon, Weedex	[3]122-34-9	Herbicide	Triazine
04030	Simetryn	Gy-Bon, Simetryn	1014-70-6	Herbicide	Triazine
82665 and 04032	Terbacil	Sinbar, Terbacil	5902-51-2	Herbicide	Uracil
82661 and 04023	Trifluralin	Heritage, Trifloran, Trigard, Tristar	[3]1582-09-8	Herbicide	2,6-Dinitroaniline
04034	Vernolate	PPTC, Surpass, Vernolate	1929-77-7	Herbicide	Thiocarbamate
04040	CIAT[4]	Deethylatrazine (DEA)	6190-54-4	Breakdown product of atrazine	Triazine
04038	CEAT[5]	Deisopropylatrazine (DIA)	1007-28-9	Breakdown product of atrazine	Triazine

[1] From *http://www.chemindustry.com* (unless otherwise noted).

[2] This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CASRNs through CAS Client Services[SM].

[3] From *http://www.pesticideinfo.org/Index.html*.

[4] 2-Chloro-4-isopropylamino-6-amino-s-triazine (CIAT).

[5] 2-Chloro-6-ethylamino-4-amino-s-triazine (CEAT).

Table 15. Pesticides that were not detected in water-quality samples, Cedar Rapids, Iowa, calendar years 2006–10.

[NWIS, National Water Inventory System; LRL, laboratory reporting level; µg/L, micrograms per liter]

NWIS parameter code	Pesticides (not detected)	LRL (µg/L)
38401	Ametryn	0.05
04029	Bromacil	.05
04026	Butachlor	.05
04028	Butylate	.05
04041	Cyanazine	.05
04031	Cycloate	.05
04033	Diphenamid	.05
04025	Hexazinone	.05
04037	Prometon	.05
04036	Prometryn	.05
04024	Propachlor	.05
04032	Terbacil	.05
04023	Trifluralin	.05
04030	Simetryn	.05
04034	Vernolate	.05

Table 16. Selected pesticides detected and frequency of detections in groundwater and surface-water samples, for all sites combined, Cedar Rapids, Iowa, calendar years 2006–10.

[LRL, laboratory reporting level; µg/L, micrograms per liter; E, estimate]

Pesticide	Number of detections/ samples	LRL[1] (µg/L)	Number of detectable concentrations at or above LRL	Number of detectable concentrations below LRL[2]	Percentage of samples with detectable concentrations[2]	Detectable concentrations (µg/L)	
						Maximum	Median
Atrazine	172/173	0.05	161	11	99.4	2.17	0.11
CIAT[3]	172/173	.05	172	0	99.4	.39	.09
Metolachlor	172/173	.05	113	59	99.4	.84	.05
Acetochlor	67/173	.05	29	38	38.7	.88	.04
[3]CEAT	39/173	.05	14	25	22.5	.15	.04
Propazine	19/173	.05	0	19	10.9	E.04	.01
Alachlor	4/173	.05	0	4	2.3	E.04	.02
Simazine	3/173	.05	0	3	1.7	E.02	.02
Metribuzin	2/173	.05	0	2	1.2	E.03	.02
Carboxin	1/173	.05	0	1	.6	E.01	.01

[1] Highest laboratory reporting level for period of record.

[2] Includes both quantifiable and unquantifiable (estimated) concentrations. Quantifiable detections exist for concentrations that exceeded lower laboratory reporting levels during period of record.

[3] Atrazine degradates: 2-Chloro-4-amino-6-isopropyl-amino-striazine (CIAT) and 2-Chloro-4-ethylamino-6-amino-s-triazine (CEAT).

Table 17. Selected pesticides detected and frequency of detections in groundwater and surface-water samples, Cedar Rapids, Iowa, calendar years 2006–10.

[LRL, laboratory reporting level; µg/L, micrograms per liter; E, estimate; ND, not detected]

Pesticide	Number of detections/ samples	LRL[1] (µg/L)	Number of detectable concentrations at or greater than LRL	Number of detectable concentrations less than LRL[2]	Percentage of samples with detectable concentrations[2]	Detectable concentrations (µg/L)	
						Maximum	Median
Groundwater							
Atrazine	155/156	0.05	146	9	99.4	1.1	0.12
[3]CIAT	155/156	.05	155	0	99.4	.24	.09
Metolachlor	155/156	.05	99	56	99.4	.45	.06
Acetochlor	57/156	.05	20	37	36.5	.21	E.03
[3]CEAT	36/156	.05	12	24	23.1	.09	E.04
Propazine	16/156	.05	0	16	10.2	E.02	E.01
Alachlor	3/156	.05	0	3	1.9	E.02	E.02
Simazine	2/156	.05	0	2	1.3	E.03	E.02
Metribuzin	2/156	.05	0	2	1.3	E.03	E.02
Carboxin	1/156	.05	0	1	.6	E.02	E.02
Surface water							
Atrazine	17/17	0.05	16	1	100	2.17	0.1
[3]CIAT	17/17	.05	17	0	100	.39	.09
Metolachlor	17/17	.05	13	4	100	.84	.06
Acetochlor	9/17	.05	8	1	52.9	.88	.08
[3]CEAT	4/16	.05	3	1	25	.15	.06
Propazine	3/17	.05	0	3	17.6	E.04	E.02
Alachlor	1/17	.05	0	1	5.9	E.02	E.02
Simazine	1/17	.05	0	1	5.9	E.04	E.04
Metribuzin	0/17	.05	0	0	0	ND	ND
Carboxin	0/17	.05	0	0	0	ND	ND

[1] Highest laboratory reporting level for period of record.

[2] Includes both quantifiable and unquantifiable (estimated) concentrations. Quantifiable detections exist for concentrations that exceeded lower laboratory reporting levels during period of record.

[3] Atrazine degradates: 2-Chloro-4-amino-6-isopropyl-amino-striazine (CIAT) and 2-Chloro-4-ethylamino-6-amino-s-triazine (CEAT).

Table 18. Selected pesticides detected and frequency of detections in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.

[LRL, laboratory reporting level; µg/L,micrograms per liter; E, estimate; ND, no detection]

Pesticide	Number of detections/ samples	LRL[1] (µg/L)	Number of detectable concentrations at or greater than LRL	Number of detectable concentrations less than LRL[2]	Percentage of samples with detectable concentrations[2]	Detectable concentrations (µg/L)	
						Maximum	Median
1993USGS CRM-3							
Atrazine	8/8	0.05	8	0	100	0.86	0.16
CIAT[3]	8/8	.05	8	0	100	.18	.09
Metolachlor	8/8	.05	4	4	100	.28	E.05
CEAT[3]	3/8	.05	2	1	37.5	.09	.08
Acetochlor	2/8	.05	1	1	25	.05	E.035
Propazine	2/8	.05	0	2	25	E.02	E.015
Simazine	1/8	.05	0	1	12.5	E.01	E.01
Alachlor	0/8	.05	0	0	0	ND	ND
Metribuzin	0/8	.05	0	0	0	ND	ND
Carboxin	0/8	.05	0	0	0	ND	ND
1993USGS CRM-4							
Atrazine	2/2	0.05	0	2	100	E.04	E.04
CIAT[3]	2/2	.05	2	0	100	.08	.15
Metolachlor	2/2	.05	0	2	100	E.02	E.02
Carboxin	1/2	.05	0	1	50	E.02	E.02
Acetochlor	1/2	.05	0	1	50	E.01	E.01
CEAT[3]	0/2	.05	0	0	0	ND	ND
Propazine	0/2	.05	0	0	0	ND	ND
Alachlor	0/2	.05	0	0	0	ND	ND
Simazine	0/2	.05	0	0	0	ND	ND
Metribuzin	0/2	.05	0	0	0	ND	ND
2009USGS CRM-4A							
Atrazine	4/4	0.05	3	1	100	0.52	0.14
CIAT[3]	4/4	.05	4	0	100	.21	.13
Metolachlor	4/4	.05	3	1	100	.19	.07
CEAT[3]	2/4	.05	2	0	50	.06	.06
Acetochlor	1/4	.05	0	1	25	E.02	E.02
Propazine	1/4	.05	0	1	25	E.01	E.01
Alachlor	0/4	.05	0	0	0	ND	ND
Simazine	0/4	.05	0	0	0	ND	ND
Metribuzin	0/4	.05	0	0	0	ND	ND
Carboxin	0/4	.05	0	0	0	ND	ND
1998USGS CRM-22							
Atrazine	17/18	0.05	16	1	94.4	1.11	0.085
CIAT[3]	17/18	.05	17	0	94.4	.24	.085
Metolachlor	17/18	.05	12	5	94.4	.45	.12
CEAT[3]	4/18	.05	1	3	22.2	.08	E.02

Table 18. Selected pesticides detected and frequency of detections in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[LRL, laboratory reporting level; µg/L,micrograms per liter; E, estimate; ND, no detection]

Pesticide	Number of detections/ samples	LRL[1] (µg/L)	Number of detectable concentrations at or greater than LRL	Number of detectable con-centrations less than LRL[2]	Percentage of samples with detectable concentrations[2]	Detectable concentrations (µg/L)	
						Maximum	Median
1998USGS CRM-22—Continued							
Acetochlor	3/18	.05	2	1	16.7	.15	.1
Propazine	1/18	.05	0	1	5.6	E.02	E.02
Alachlor	1/18	.05	0	1	5.6	E.01	E.01
Simazine	1/18	.05	0	1	5.6	E.02	E.02
Metribuzin	0/18	.05	0	0	0	ND	ND
Carboxin	0/18	.05	0	0	0	ND	ND
1998USGS CRM-23							
Atrazine	4/4	0.05	4	0	100	0.09	0.08
CIAT[3]	4/4	.05	4	0	100	.11	E.06
Metolachlor	4/4	.05	1	3	100	.05	E.035
CEAT[3]	0/4	.05	0	0	0	ND	ND
Acetochlor	0/4	.05	0	0	0	ND	ND
Propazine	0/4	.05	0	0	0	ND	ND
Alachlor	0/4	.05	0	0	0	ND	ND
Simazine	0/4	.05	0	0	0	ND	ND
Metribuzin	0/4	.05	0	0	0	ND	ND
Carboxin	0/4	.05	0	0	0	ND	ND
1990Seminole 17							
Atrazine	16/16	0.05	16	0	100	0.44	0.13
CIAT[3]	16/16	.05	16	0	100	.16	.08
Metolachlor	16/16	.05	14	2	100	.12	.07
Acetochlor	7/16	.05	2	5	43.8	.1	E.03
CEAT[3]	3/16	.05	1	2	18.8	.05	E.04
Propazine	2/16	.05	0	2	12.5	E.01	E.01
Alachlor	0/16	.05	0	0	0	ND	ND
Simazine	0/16	.05	0	0	0	ND	ND
Metribuzin	0/16	.05	0	0	0	ND	ND
Carboxin	0/16	.05	0	0	0	ND	ND
Seminole 18							
Atrazine	12/12	0.05	12	0	100	0.51	0.18
CIAT[3]	12/12	.05	12	0	100	.17	.12
Metolachlor	12/12	.05	9	3	100	.12	.06
Acetochlor	6/12	.05	2	4	50	.1	E.035
Propazine	3/12	.05	0	3	25	E.01	E.007
CEAT[3]	2/12	.05	0	2	16.7	E.04	E.04
Alachlor	0/12	.05	0	0	0	ND	ND
Simazine	0/12	.05	0	0	0	ND	ND

Table 18. Selected pesticides detected and frequency of detections in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[LRL, laboratory reporting level; µg/L,micrograms per liter; E, estimate; ND, no detection]

Pesticide	Number of detections/ samples	LRL[1] (µg/L)	Number of detectable concentrations at or greater than LRL	Number of detectable concentrations less than LRL[2]	Percentage of samples with detectable concentrations[2]	Detectable concentrations (µg/L)	
						Maximum	Median
Seminole 18—Continued							
Metribuzin	0/12	.05	0	0	0	ND	ND
Carboxin	0/12	.05	0	0	0	ND	ND
Ranney 1							
Atrazine	19/19	0.05	18	1	100	0.68	0.08
CIAT[3]	19/19	.05	19	0	100	.17	.09
Metolachlor	19/19	.05	11	8	100	.14	.05
Acetochlor	7/19	.05	2	5	36.8	.09	E.03
CEAT[3]	4/19	.05	2	2	21	.05	E.045
Propazine	2/19	.05	0	2	10.5	E.01	E.01
Alachlor	0/19	.05	0	0	0	ND	ND
Simazine	0/19	.05	0	0	0	ND	ND
Metribuzin	0/19	.05	0	0	0	ND	ND
Carboxin	0/19	.05	0	0	0	ND	ND
Ranney 2							
Atrazine	19/19	0.05	17	2	100	0.48	0.12
CIAT[3]	19/19	.05	17	0	100	.18	.09
Metolachlor	19/19	.05	13	6	100	.16	.07
Acetochlor	8/19	.05	2	6	42.1	.13	E.03
CEAT[3]	4/19	.05	1	3	21	E.05	E.04
Propazine	1/19	.05	0	1	5.3	E.01	E.01
Alachlor	0/19	.05	0	0	0	ND	E.02
Simazine	0/19	.05	0	0	0	ND	ND
Metribuzin	0/19	.05	0	0	0	ND	ND
Carboxin	0/19	.05	0	0	0	ND	ND
West Ranney 3							
Atrazine	18/18	0.05	17	1	100	0.69	0.125
CIAT[3]	18/18	.05	18	0	100	.18	.1
Metolachlor	18/18	.05	11	7	100	.3	.055
Acetochlor	7/18	.05	4	3	38.9	.21	E.05
CEAT[3]	4/18	.05	1	3	22.2	E.05	E.035
Propazine	2/18	.05	0	2	11.1	E.02	E.015
Alachlor	1/18	.05	0	1	5.6	E.03	E.03
Metribuzin	1/18	.05	0	1	5.6	E.03	E.03
Simazine	0/18	.05	0	0	0	ND	ND
Carboxin	0/18	.05	0	0	0	ND	ND

Table 18. Selected pesticides detected and frequency of detections in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[LRL, laboratory reporting level; µg/L,micrograms per liter; E, estimate; ND, no detection]

Pesticide	Number of detections/ samples	LRL[1] (µg/L)	Number of detectable concentrations at or greater than LRL	Number of detectable concentrations less than LRL[2]	Percentage of samples with detectable concentrations[2]	Detectable concentrations (µg/L)	
						Maximum	Median
Seminole Ranney 4							
Atrazine	17/17	0.05	16	1	100	0.56	0.14
CIAT[3]	17/17	.05	17	0	100	.21	.09
Metolachlor	17/17	.05	17	1	100	.21	.06
Acetochlor	8/17	.05	3	5	47	.14	E.035
CEAT[3]	5/17	.05	2	3	29.4	.06	E.04
Propazine	0/17	.05	0	0	0	ND	ND
Alachlor	0/17	.05	0	0	0	ND	ND
Simazine	0/17	.05	0	0	0	ND	ND
Metribuzin	0/17	.05	0	0	0	ND	ND
Carboxin	0/17	.05	0	0	0	ND	ND
Cedar Rapids Waterworks							
Atrazine	19/19	0.05	19	0	100	0.37	0.11
CIAT[3]	19/19	.05	19	0	100	.13	.08
Metolachlor	19/19	.05	11	8	100	.16	.06
Acetochlor	8/19	.05	3	5	42.1	.10	E.035
CEAT[3]	5/19	.05	0	5	26.3	E.03	E.03
Propazine	2/19	.05	0	2	10.5	E.01	E.01
Alachlor	1/19	.05	0	1	5.3	E.01	E.01
Metribuzin	1/19	.05	0	1	5.3	E.01	E.01
Simazine	0/19	.05	0	0	0	ND	ND
Carboxin	0/19	.05	0	0	0	ND	ND
Cedar River at Edgewood Road							
Atrazine	17/17	0.5	16	1	100	2.17	0.1
CIAT[3]	17/17	.05	17	0	100	.39	.09
Metolachlor	17/17	.05	14	3	100	.84	.06
Acetochlor	9/17	.05	8	1	52.9	.88	.08
CEAT[3]	4/17	.05	3	1	23.5	.15	E.055
Propazine	3/17	.05	0	3	17.6	E.01	E.01
Alachlor	1/17	.05	0	1	5.9	E.04	E.04
Simazine	1/17	.05	0	1	5.9	E.02	E.02
Metribuzin	0/17	.05	0	0	0	ND	ND
Carboxin	0/17	.05	0	0	0	ND	ND

[1] Highest laboratory reporting limit for period of record.

[2] Includes both quantifiable and unquantifiable (estimated) concentrations. Quantifiable detections are concentrations that exceeded lower laboratory reporting limits during period of record.

[3] Atrazine degradates: 2-Chloro-4-amino-6-isopropyl-amino-striazine (CIAT) and 2-Chloro-4-ethylamino-6-amino-s-triazine (CEAT).

Table 19. Virus in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.

[LIMS ID, Laboratory Information Management System Identification number; gc/Tv, genomic copies per total volume sampled; ND, not detected; NA, not available; DNQ, detected, not quantified; E, estimated; NA, not available]

Date (year, month, day)	Time (24-hour)	LIMS ID	Adenovirus (gc/Tv)	Enterovirus (gc/Tv)	Norovirus GI[1] (gc/Tv)	Norovirus GII[1] (gc/Tv)
1998USGS CRM-3						
20080519	1250	1122-01	ND	ND	ND	ND
20080804	1600	1226-01	ND	NA	ND	ND
20081009	1110	1305-01	ND	ND	ND	ND
20090608	1035	1493-01	ND	ND	ND	ND
20090915	0955	1642-01	ND	ND	ND	ND
2010USGS CRM-4A						
20100720	1020	1758-01	ND	ND	ND	ND
20100909	0905	1794-01	ND	ND	ND	ND
1998USGS CRM-22						
20080514	1345	1119-01	ND	ND	ND	ND
20080731	1035	1222-01	ND	NA	ND	DNQ
20081014	1145	1306-01	ND	ND	ND	ND
20090402	1115	1390-01	ND	ND	ND	ND
20090609	1150	1495-01	ND	ND	ND	ND
Seminole 17						
20080513	1230	1116-01	ND	ND	ND	ND
20080729	0940	1219-01	DNQ	NA	ND	DNQ
20081006	0945	1296-01	ND	ND	ND	ND
20090402	1115	1390-01	ND	ND	ND	ND
20090602	1055	1483-02	ND	ND	ND	ND
20090910	1030	1637-01	DNQ	ND	ND	ND
20100721	1120	1762-01	ND	ND	ND	ND
Seminole Ranney 4						
20080515	1145	1121-01	ND	ND	ND	ND
20080730	0956	1221-01	ND	ND	ND	ND
20081007	1135	1299-01	ND	ND	ND	ND
20090604	1005	1490-01	ND	ND	ND	ND
20090908	1040	1635-01	61	ND	ND	ND
20090908	1045	1635-02	ND	ND	ND	ND
20100719	1015	1757-01	ND	ND	ND	ND
20100719	1020	1757-02	ND	ND	ND	ND
20100830	1520	1783-02	ND	ND	ND	ND
Cedar Rapids Waterworks (raw water)						
20090407	1045	1396-01	ND	ND	ND	ND
20090930	1140	1648-01	ND	ND	ND	ND
20090602	1025	1483-01	36E	ND	ND	ND
20100316	0900	1697-01	ND	ND	ND	ND
20100615	0830	1735-01	ND	ND	ND	ND
20100831	1510	1786-01	ND	ND	ND	ND

Table 19. Virus in groundwater and surface-water samples, by site, Cedar Rapids, Iowa, calendar years 2006–10.—Continued

[LIMS ID, Laboratory Information Management System Identification number; gc/Tv, genomic copies per total volume sampled; ND, not detected; NA, not available; DNQ, detected, not quantified; E, estimated; NA, not available]

Date (year, month, day)	Time (24-hour)	LIMS ID	Adenovirus (gc/Tv)	Enterovirus (gc/Tv)	Norovirus GI[1] (gc/Tv)	Norovirus GII[1] (gc/Tv)
Cedar Rapids Waterworks (finished water)						
20100315	1210	1696-01	ND	ND	ND	ND
20100615	1520	1735-02	ND	ND	ND	ND
20100830	1625	1783-01	ND	ND	ND	ND
Cedar River at Edgewood Rd						
20080520	1615	1126-01	DNQ	ND	ND	3,400E
20080805	0945	1228-01	DNQ	ND	ND	ND
20090402	1020	1390-02	130	ND	ND	ND
20090603	1014	1487-01	21E	ND	ND	DNQ
20090909	0920	1636-01	ND	ND	ND	ND
20100323	1536	1705-01	ND	ND	ND	ND
20100614	1800	1733-01	ND	ND	ND	ND
20100908	1535	1792-01	ND	ND	ND	ND

[1] Norovirus cannot be accurately quantified since it cannot grow in cultured cells like other enteric viruses. Norovirus positive controls are obtained from positive stool samples from the local health department. Estimated quantities are given because the true limit of quantification cannot be known until an accurate method is developed. Therefore, low levels of norovirus may be present in these samples (Erin Stelzer, U.S. Geological Survey, Ohio Water Microbiology Laboratory, written commun., 2011).

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