Prepared in cooperation with the Citizen Potawatomi Nation

Stream-Water and Groundwater Quality in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, Pottawatomie County, Oklahoma, 2012–13

Scientific Investigations Report 2014–5178

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

Front cover:

Top, Water tower located in the Citizen Potawatomi Nation Tribal Jurisdictional Area, Shawnee, Oklahoma. Photograph by Michael Dotson, Citizen Potawatomi Nation.

Middle, Powwow dancer dancing in the powwow arena during the annual Potawatomi Gathering of Nations, August 2014. Photograph by Bo Apitz, Citizen Potawatomi Nation.

Bottom, Fountain at the Citizen Potawatomi Nation Grand Casino in Shawnee, Oklahoma. Photograph by Carol Becker, U.S. Geological Survey.

Back cover:

Top Traditional regalia bustle worn by Bob Moody of the Pokagon Band of Potawatomi Indians. Photograph by Bo Apitz, Citizen Potawatomi Nation.

Middle, A cattle ranch near Tecumseh, Oklahoma. Photograph by Jason Masoner, U.S. Geological Survey.

Bottom, Randy Schlachtun of the Citizen Potawatomi Nation poses in full regalia. Photograph by Bo Apitz, Citizen Potawatomi Nation.

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SALLY JEWELL, Secretary

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Contents

Appendixes 1–9

Figures

Tables

Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
	Volume	
gallon (gal)	3.785	liter (L)
	Radioactivity	
picocurie per liter (pCi/L)	0.037	becquerel per liter (Bq/L)
	Hydraulic gradient	
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)

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

°F = (1.8 × °C) + 32

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

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

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

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). Concentrations of radionuclides in water are given in picocuries per liter (pCi/L).

Stream-Water and Groundwater Quality in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, Pottawatomie County, Oklahoma, 2012–13

By Carol J. Becker

Abstract

The Citizen Potawatomi Nation needs to characterize their existing surface-water and groundwater resources in and near their tribal jurisdictional area to complete a water-resource management plan. Water resources in this area include surface water from the North Canadian and Little Rivers and groundwater from the terrace and alluvial aquifers and underlying bedrock aquifers. To assist in this effort, the U.S. Geological Survey (USGS), in cooperation with the Citizen Potawatomi Nation, collected water-quality samples at 4 sites on 3 streams and from 30 wells during 2012 and 2013 in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area in central Oklahoma. Stream samples were collected eight times on the North Canadian River at the upstream USGS streamflow-gaging station North Canadian River near Harrah, Okla. (07241550); at the downstream USGS streamflow-gaging station North Canadian River at Shawnee, Okla. (07241800); and on the Little River at the USGS streamflow-gaging station Little River near Tecumseh, Okla., (07230500). Stream samples also were collected three times at an ungaged site, Deer Creek near McLoud, Okla. (07241590). Water properties were measured, and water samples were analyzed for concentrations of major ions, nutrients, trace elements, counts of fecal-indicator bacteria, and 69 organic compounds.

The highest concentrations of dissolved solids and chlorides were measured in stream-water samples collected at the Little River near Tecumseh station. The Secondary Maximum Contaminant Level (SMCL) for dissolved solids in drinking water of 500 milligrams per liter (mg/L) was exceeded in 7 of 8 stream-water samples, with a median concentration of 844 mg/L at that station. The 250-mg/L SMCL for chloride was exceeded in 5 of the 8 stream-water samples collected at that station.

Median concentrations of total dissolved nitrogen were about an order of magnitude higher in stream-water samples collected at the two stations on the North Canadian River than concentrations in stream-water samples collected at the Little River near Tecumseh station and the Deer Creek site. Median concentrations of total dissolved nitrogen were 4.36 and 2.89 mg/L in stream-water samples collected at the two North Canadian River stations, 0.35 mg/L in stream-water samples collected at the Little River near Tecumseh station, and 0.76 mg/L in stream-water samples collected at the Deer Creek site.

Similar to nitrogen, median concentrations of total dissolved phosphorus were higher by about two orders of magnitude in stream-water samples collected at the two stations on the North Canadian River than concentrations in stream-water samples collected at the Little River near Tecumseh station and the Deer Creek site. Median concentrations of total dissolved phosphorus were 1.05 and 0.805 mg/L in stream-water samples collected at the two North Canadian River stations, 0.007 mg/L in stream-water samples collected at the Little River near Tecumseh station, and 0.032 mg/L from the Deer Creek site. Dissolved concentrations of total nitrogen, nitrate-nitrogen, orthophosphorus, and total phosphorus were highest in stream-water samples collected at the two North Canadian River stations at low streamflows, indicating that wastewater effluent may have been a notable source of these nutrients.

Concentrations of most trace elements increased with increasing streamflow in stream-water samples collected at the two North Canadian River stations, indicating that most trace elements are washed into the river by runoff from the land surface or resuspended from streambed sediments. In general, most trace-element concentrations were below respective Maximum Contaminant Levels (MCLs) for public drinking-water supplies, except for one stream-water sample with an arsenic concentration of 10.1 micrograms per liter (μg/L) collected from the North Canadian River and one stream-water sample with a barium concentration of 2,690 μg/L collected from the Little River. At least one stream-water sample from each of the four stream sites sampled in this study contained a lead concentration exceeding the SMCL of 15 μg/L. All of these samples were collected during high streamflows.

A greater number of organic compounds were detected in stream-water samples collected at the two stations on the North Canadian River than in stream-water samples collected at the Tecumseh station and Deer Creek site. In the 8 stream-water samples collected at the upstream Harrah station,

213 detections of organic compounds were measured, whereas in 8 samples collected at the downstream Shawnee station, 203 detections of organic compounds were measured. In contrast, 59 detections of organic compounds were measured in the 8 stream-water samples collected at the Tecumseh station, and 25 detections of organic compounds were measured in the 3 stream-water samples collected at the Deer Creek site; however, the 8 detections of 7 organic compounds in the 2 equipment-blank samples is problematic for evaluating these data, especially for the Deer Creek and Little River samples because of the comparatively low detection frequency and should be taken into consideration when evaluating these results.

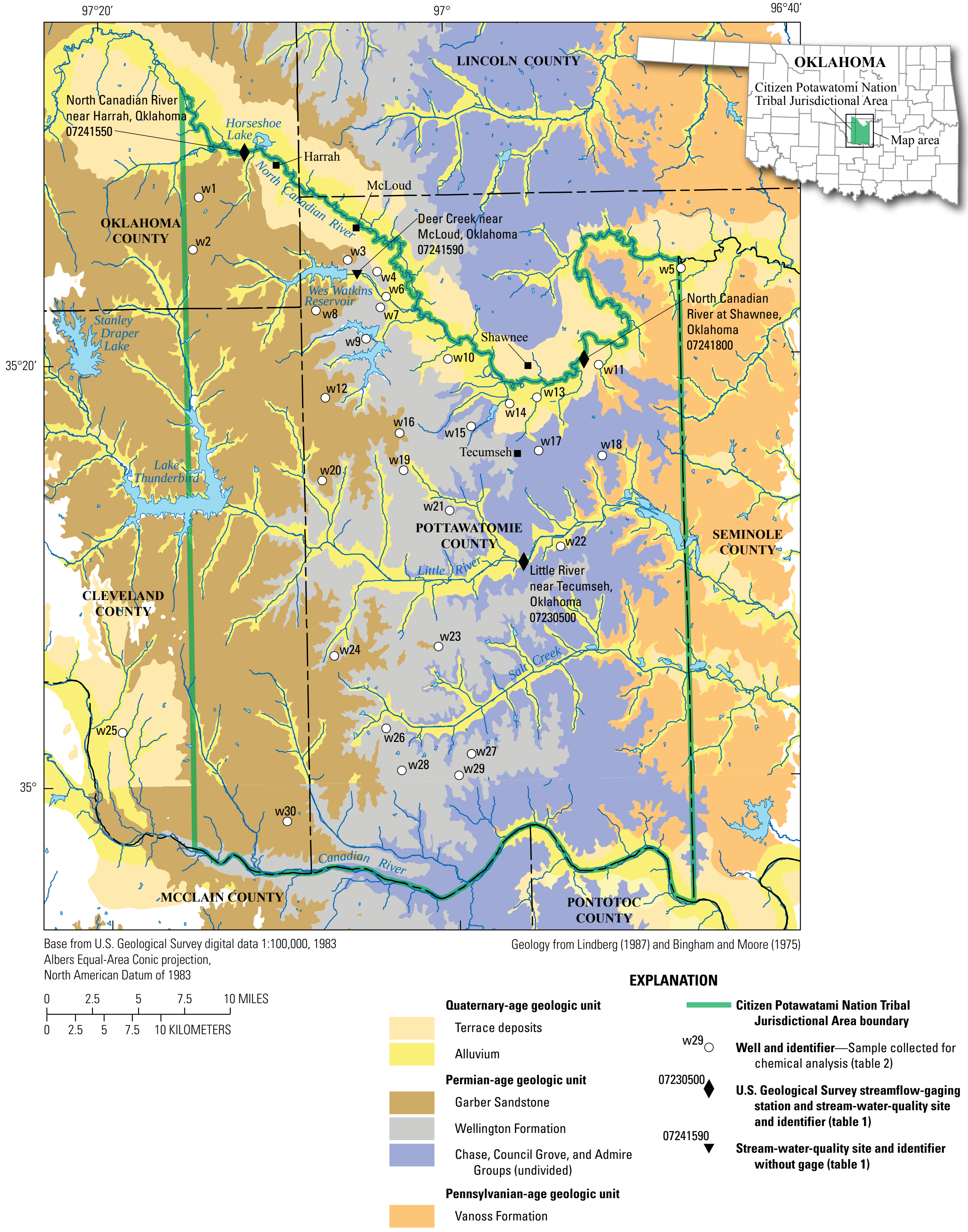
Groundwater samples also were collected once from 30 wells producing water from the Garber-Wellington aquifer; Admire, Chase, and Council Grove Groups; the Vanoss Formation; and the terrace and alluvial aquifers along the North Canadian River. Water properties were measured, and samples were analyzed for concentrations of major ions, nutrients, trace elements, and selected radionuclides in groundwater. Of 30 wells sampled for this study, 26 were completed in bedrock aquifers, and 4 were completed in terrace and alluvial aquifers. In general, groundwater in the study area is very hard, with a median concentration of 180 mg/L as calcium carbonate in water samples collected from the 30 wells. Concentrations of sulfate exceeded the 250-mg/L SMCL in two groundwater samples, and dissolved solids concentrations exceeded the 500-mg/L SMCL in nine groundwater samples. Trace-element concentrations did not exceed respective MCLs in the 30 groundwater samples collected for this study.

Concentrations of the radionuclide uranium ranged from 0.03 to 79.5 μg/L, with a median concentration of 1.9 μg/L in the 30 groundwater samples collected. Two of the groundwater samples collected for this study had uranium concentrations exceeding the MCL of 30 μg/L, with concentrations of 79.5 and 31.1 μg/L. Generally, uranium concentrations were highest in water samples collected from wells completed in the Wellington Formation and the Chase, Council Grove, and Admire Groups in the southern and eastern parts of the study area.

Introduction

The Citizen Potawatomi Nation (CPN) is a federally recognized Native American Tribe that originally lived in the Great Lakes region of the United States and was moved to central Oklahoma (fig. 1) in the late 1800s. As of 2013, the CPN had an enrollment of more than 30,000 tribal citizens, with about a third living in the State of Oklahoma (State of Oklahoma, 2013). Recent and future economic development plans of the CPN include industry and manufacturing, casinos, golf courses, retail development, agriculture, livestock, and social services, all of which require reliable and sustainable sources of water. To ensure that tribal land and its water resources will be utilized sustainably, the CPN is developing a comprehensive water-resource management plan that will guide the development of water resources for the next 50 years. To complete that plan, the CPN needs to characterize existing surface-water and groundwater resources in and surrounding their tribal jurisdictional area (TJA), which include the North Canadian and Little Rivers, Deer Creek, and groundwater from the terrace and alluvial aquifers adjacent to river channels and underlying bedrock aquifers. Additional information was needed about seasonal changes in stream-water quality, which are affected by timing or seasonal precipitation and upstream sources of chemicals, such as runoff from agricultural and urban areas and effluent from wastewater-treatment facilities. Information also is needed about groundwater quality in the TJA, which varies by location because of changing lithology of the aquifer rocks and geochemical processes that occur along groundwater flow paths.

To assist the CPN in gathering hydrologic data, the U.S. Geological Survey (USGS) collected water-quality samples at 4 stream sites and from 30 wells during 2012–13 in and near the CPN TJA to better characterize the quality of existing surface-water and groundwater resources for potential uses that include public drinking-water supply. Water used for industrial, manufacturing, and agricultural purposes has different water-quality restrictions depending upon use, which generally are less stringent than Maximum Contaminant Levels (MCL) and Secondary Maximum Contaminant Levels (SMCL) used for public drinking-water supplies. For this report, the evaluation of collected water-quality data primarily focused on suitability for human consumption, and those data were compared to MCLs and SMCLs set by the U.S. Environmental Protection Agency (EPA) for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b). The quality of water from private wells is not regulated, so MCLs and SMCLs should be used only as guides for private well owners regarding constituents that may pose problems for human health or water uses. An MCL is a constituent concentration that cannot be legally exceeded in public drinking-water supplies. Constituents that have an MCL are considered hazardous to health when they are consumed for a lifetime at concentrations exceeding the MCL; for example, the MCL for arsenic in public drinking-water supplies is 10 micrograms per liter (μg/L), and exposure to that or greater concentrations of arsenic is likely to cause a 1 in 10,000 risk of developing a fatal cancer over a lifetime of 70 years of consuming 2 liters (0.53 gallon) of water a day (U.S. Environmental Protection Agency, 2001). An SMCL is a constituent concentration that is recommended and is used as a guideline for constituents that may have negative aesthetic effects at high concentrations, such as iron that can cause staining on water fixtures at concentrations exceeding the SMCL of 300 μg/L.



Base from U.S. Geological Survey digital data 1:100,000, 1983
Albers Equal-Area Conic projection,
North American Datum of 1983

Geology from Lindberg (1987) and Bingham and Moore (1975)

Figure 1. Surficial geology and locations of 4 stream sites and 30 wells sampled in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

The study described in this report was the second part of a multipronged effort by the USGS to provide the CPN with hydrologic information needed for development of a water-resource management plan. A previous report by Andrews and others (2013) provides an overview of surface-water and groundwater data collected before 2012 for this area.

Purpose and Scope

This report describes values of water properties and concentrations of selected chemical constituents in water-quality samples collected at 4 stream sites and from 30 wells in and near the CPN TJA in central Oklahoma from January 2012 to May 2013 (fig. 1). Stream-water samples were collected eight times at two USGS streamflow-gaging stations on the North Canadian River, North Canadian River near Harrah, Okla. (07241550), and North Canadian River at Shawnee, Okla. (07241800) (referred to in the remainder of this report as the “Harrah station” and “Shawnee station,” respectively), and at one USGS streamflow-gaging station on the Little River, Little River near Tecumseh, Okla. (07230500) (referred to in the remainder of this report as the “Tecumseh station”) (table 1). Water samples also were collected three times at an ungaged site on Deer Creek, Deer Creek near McLoud, Okla. (07241590) (referred to in the remainder of this report as the “Deer Creek site”). Selected water properties—dissolved oxygen, pH, specific conductance, and water temperature—were measured during sampling. Water samples also were analyzed for concentrations of major ions, nutrients, trace elements, counts of fecal-indicator bacteria, and concentrations of 69 organic compounds. The results of those analyses are shown on graphs in relation to season and streamflow and are compared and contrasted in this report.

Groundwater samples were collected from 30 wells in the CPN TJA one time between June 2012 and May 2013 (fig. 1; table 2). Water properties were measured, and samples were analyzed for dissolved concentrations of major ions, nutrients, trace elements, and selected radionuclides. Data from those samples are shown on graphs and are compared to MCLs, SMCLs, and historical groundwater-quality data on maps in this report.

Study Area Description

The study area for this report is in and near the CPN TJA in parts of Cleveland and Pottawatomie Counties in central Oklahoma (fig. 1). The CPN TJA encompasses about 893 square miles (mi^2) and is drained by the North Canadian River which defines the northern border, the Canadian River which defines the southern border, the Little River which flows through the central part, and Salt Creek which flows in the southeastern part of the study area. All streams in the study area flow from west to east.

Recent and future economic development plans of the CPN are focused in the northern one-third of the CPN TJA. For this reason, stream sampling efforts were concentrated in this area and did not include Salt Creek and the Canadian River.

Streamflow Conditions and Land Use and Land Cover Description

The North Canadian River drains only about the northern one-quarter of the CPN TJA but has a large upstream contributing basin area that extends beyond the Texas Panhandle into northeastern New Mexico (fig. 2). The North Canadian River near the Harrah station has an upstream basin area of 10,278 mi^2, and the North Canadian River at the Shawnee station, which is about 36.5 miles downstream of the Harrah station, has an upstream contributing drainage area of 10,508 mi^2 (table 1). Streamflow characteristics of the North Canadian River can be affected by local storms in the upstream basin, especially during the spring and summer when local convective storms are common. The largest peaks in streamflow in this river typically occur in the spring when precipitation is highest. Periods of low flow are common during the summer and occasionally during the winter when precipitation is low. Streamflow in this river at the Shawnee station is regulated by four upstream reservoirs (Canton Reservoir, Lake Overholser, Wes Watkins Reservoir, and Shawnee Reservoir) and by three low-water weirs adjacent to the Oklahoma City downtown area (fig. 2). Streamflow and water quality in this river also may be affected by releases of treated effluent from multiple upstream industrial sources and wastewater-treatment facilities (Oklahoma Department of Environmental Quality, 2013) (fig. 2), but the magnitude of effects from those discharges is unknown. Additionally, water quality may be affected by surface-water runoff from agricultural and urban areas and land-application sites for treated biosolids.

Land use and land cover in the upstream basin are dominated by grassland and herbaceous vegetation, with cultivated annual crops being dominant in counties just west of the Oklahoma City area, which are commonly planted on fertile soils adjacent to the North Canadian River (fig. 2; table 1). Cultivated crops are mostly wheat, with alfalfa, sorghum, and other small-grain crops grown in smaller amounts (Fry and others, 2011). Pesticides are generally applied during the growing season from spring to autumn to control weeds, insects, and fungi on crops in this area.

The contributing basin area for the Little River at the Tecumseh station (463 mi^2) is relatively small compared to those of the two stations on the North Canadian River (fig. 2; table 1). Streamflow at the Tecumseh station is regulated upstream by Stanley Draper Lake and Lake Thunderbird, which provide water to nearby municipalities. The Little River Basin is dominated by deciduous forest, but half of the 2 percent of land used for cultivated crops in the basin is adjacent to the stream between Lake Thunderbird and the Tecumseh station (fig. 2) (Fry and others, 2011).

Table 1. Stream-site information and land use and land cover in the upstream drainage basins of four stream sites sampled in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; –, not applicable; streamflow is by calendar year; annual mean streamflow calculated for years with complete data only; streamflow represents continuous streamflow measured by real-time monitor]

USGS streamflow-gaging station and number	Upstream drainage area/contributing drainage area (square miles)	Annual mean streamflow (ft^3/s) (years of record)[a]	Mean daily streamflow Jan. 1–Dec. 31, 2012 (ft^3/s)[a]	Lowest streamflow/highest streamflow Jan. 1–Dec. 31, 2012 (ft^3/s)[a]	Information collected during study	Percentages of the three largest land use and land cover categories in the upstream drainage basin[b]
Little River near Tecumseh, Oklahoma (07230500)	463/463	143 (1966 to 2013)	12.7	0 (July 21 through August 18)/1,260 (March 19)	8 water-quality samples; 8 water-property measurements; 8 streamflow measurements	44 percent deciduous forest; 35 percent grassland or herbaceous vegetation; 8 percent lawn grasses
North Canadian River near Harrah, Oklahoma (07241550)	13,775/10,278	488 (1969 to 2011)	180	39 (November 11)/4,270 (March 20)	8 water-quality samples; 8 water-property measurements; 8 streamflow measurements; real-time measurements of water properties and streamflow	62 percent grassland or herbaceous vegetation; 24 percent cultivated crops; 6 percent shrub/scrub
Deer Creek near McLoud, Oklahoma (07241590)	40	Not gaged	–	–	3 water-quality samples; 3 water-property measurements; 2 streamflow measurements	39 percent grassland or herbaceous vegetation; 35 percent deciduous forest; 12 percent lawn grasses
North Canadian River at Shawnee, Oklahoma (07241800)	14,005/10,508	524 (2002 to 2011)	246	30 (August 5)/4,860 (April 18)	8 water-quality samples; 8 water-property measurements; 8 streamflow measurements	62 percent grassland or herbaceous vegetation; 23 percent cultivated crops; 6 percent shrub/scrub

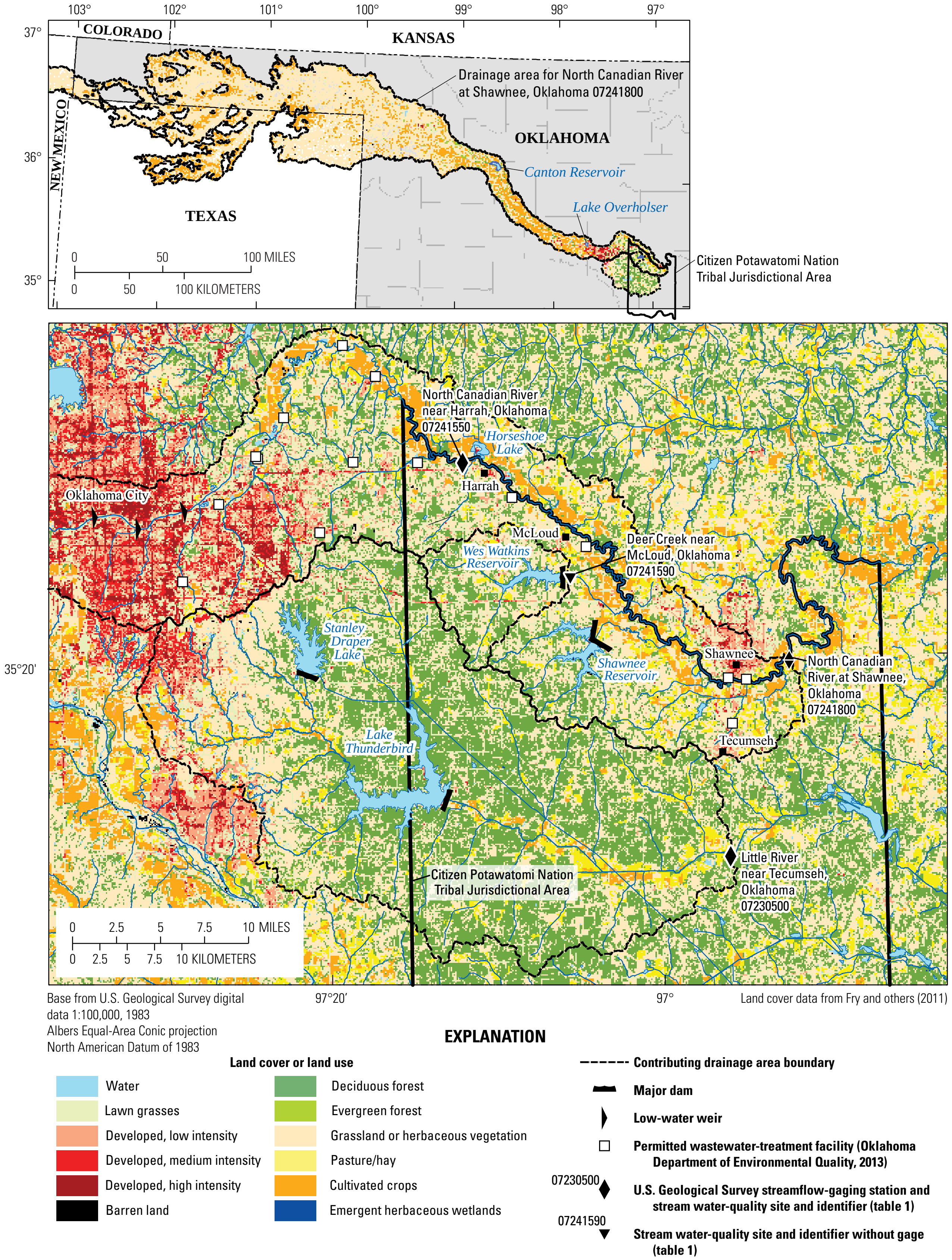
[a] U.S. Geological Survey (2013a).

[b] Fry and others (2011).

Table 2. Characteristics of 30 wells sampled in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[ID, identifier; USGS, U.S. Geological Survey; GBWG, Garber-Wellington aquifer; ALVM, alluvial aquifer; TTRC, terrace aquifer; CCGA, Chase, Council Grove, and Admire Groups; VNSS, Vanoss Formation]

Well ID	USGS station ID	Land surface altitude (feet above vertical datum)	Well depth (depth in feet below land surface)	Water use	Aquifer
w1	352755097141801	1,210	240	Domestic	GBWG
w2	352527097144201	1,244	120	Domestic	GBWG
w3	352449097054601	1,099	110	Domestic	GBWG
w4	352412097040301	1,093	170	Domestic	GBWG
w5	352407096462701	907	42	Unused	ALVM
w6	352303097033401	1,031	220	Commercial	GBWG
w7	352232097035501	1,073	60	Domestic	TTRC
w8	352226097073901	1,161	160	Domestic	GBWG
w9	352104097044701	1,101	200	Domestic	GBWG
w10	352002097000301	1,079	160	Domestic	CCGA
w11	351937096512201	993	100	Domestic	VNSS
w12	351819097071201	1,178	160	Domestic	GBWG
w13	351807096545801	991	80	Industrial	ALVM
w14	351751096563301	1,002	195	Domestic	CCGA
w15	351649096584801	1,077	90	Domestic	CCGA
w16	351634097025601	1,152	170	Domestic	GBWG
w17	351536096545501	1,072	165	Domestic	CCGA
w18	351518096511501	1,080	200	Domestic	VNSS
w19	351448097024501	1,092	160	Domestic	GBWG
w20	351422097072801	1,038	140	Domestic	GBWG
w21	351251097000801	1,013	220	Domestic	GBWG
w22	351103096534601	914	70	Stock	ALVM
w23	350624097005601	1,101	80	Domestic	GBWG
w24	350603097065901	1,117	176	Domestic	GBWG
w25	350236097191501	1,088	360	Domestic	GBWG
w26	350234097040401	1,032	80	Domestic	GBWG
w27	350117096591001	1,044	260	Domestic	GBWG
w28	350034097031201	1,103	141	Domestic	GBWG
w29	350017096595501	1,012	80	Domestic	GBWG
w30	345816097095101	1,102	200	Domestic	GBWG



Base from U.S. Geological Survey digital data 1:100,000, 1983
Albers Equal-Area Conic projection
North American Datum of 1983

Land cover data from Fry and others (2011)

Figure 2. Land use and land cover of contributing drainage areas for stream sites sampled in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

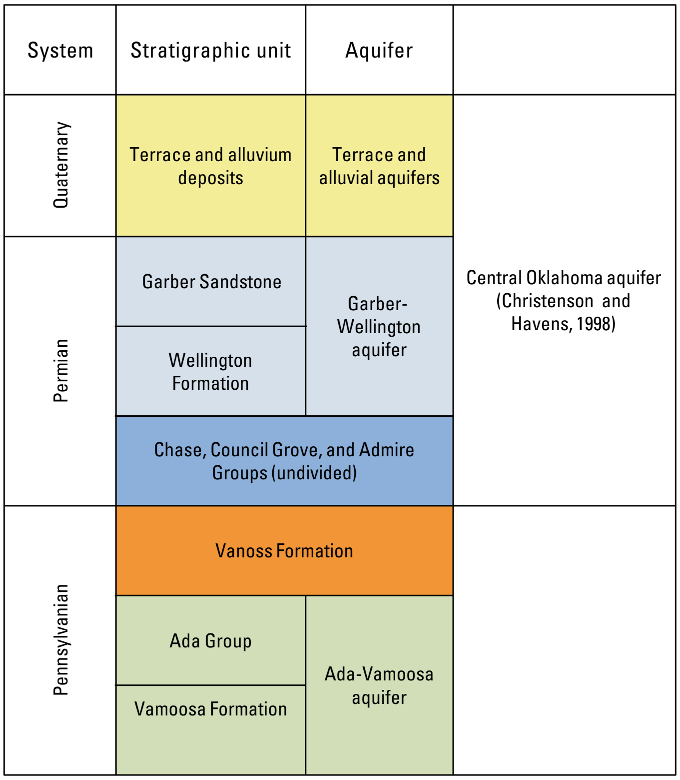
Streamflow in the North Canadian and Little Rivers in 2012 was substantially less than historical annual mean streamflows at the three gaged sites sampled for this project. Streamflow at the Harrah station ranged from 39 cubic feet per second (ft^3/s) (November 11) to 4,270 ft^3/s (March 20), with a mean daily streamflow of 180 ft^3/s during 2012 (table 1). Streamflow at the Shawnee station ranged from 30 ft^3/s (August 5) to 4,860 ft^3/s (April 18), with a mean daily streamflow of 246 ft^3/s during 2012. These mean daily streamflows were 37 percent and 47 percent of the annual mean streamflows during the years of record for the Harrah and Shawnee stations (table 1). Streamflow at the Tecumseh station ranged from zero in July and August (27 days) to 1,260 ft^3/s on March 19, 2012. Mean daily streamflow at the Tecumseh station was 12.7 ft^3/s in 2012, which was only 9 percent of the historical annual mean streamflow of 143 ft^3/s (table 1).

The Deer Creek site was about 2,760 feet (ft) downstream from the Wes Watkins Reservoir dam, with a contributing basin area of about 40 mi^2 (fig. 2). Streamflow at this site was intermittent, which restricted water-quality sampling to three occurrences. Precipitation occurred on the days that samples were collected at the Deer Creek site on March 19, 2012, and April 10, 2013, whereas the sample collected January 9, 2012, was collected at base flow, with no precipitation having fallen during the prior 2 weeks (Oklahoma Climatological Survey, 2014). Streamflow at this site is regulated by discharge from the upstream reservoir, but it is unknown if water was released prior to when samples were collected. Land cover in the Deer Creek Basin above the reservoir and sample site was dominated by grassland or herbaceous vegetation, deciduous forest, and lawn grasses in urban and other types of developed spaces (fig. 2; table 1).

Groundwater Use and Aquifer Descriptions

Private wells in the CPN TJA range in depth from less than 100 ft to generally not more than 250 ft below land surface (Oklahoma Water Resources Board, 2012). Those wells obtain water from the unconsolidated terrace and alluvial aquifers along the North Canadian and Little Rivers and from the underlying bedrock aquifers; the Garber-Wellington aquifer; the Chase, Council Grove, and Admire Groups (undivided); and the Vanoss Formation (figs. 1 and 3).

In the CPN TJA, the Quaternary-aged terrace and alluvial deposits along rivers and streams consist of unconsolidated lens-shaped beds of sand, silt, clay, and gravel (Bingham and Moore, 1975). Alluvial deposits are located in river valleys and active stream channels, whereas terrace deposits are located at higher elevations and were deposited during previous episodes of flooding when the riverbed was at a higher elevation. In central Oklahoma along major rivers, alluvial deposits range from about 30 to 100 ft thick and average about 50 ft thick (Bingham and Moore, 1975). Terrace deposits can range from a few feet thick to about 100 ft thick and average about 50 ft thick along major streams in central Oklahoma (Bingham and Moore, 1975). Terrace and alluvial deposits are very permeable and are major sources of water where the sediments are thick enough to sustain acceptable yields (Bingham and Moore, 1975). Groundwater quality, however, varies by aquifer and location; groundwater from the North Canadian River alluvium is typically of fair to poor quality, with high concentrations of dissolved solids, iron, and manganese (Bingham and Moore, 1975) and generally is used only for irrigation or livestock. In contrast, water from the terrace aquifers tends to have low dissolved solids concentrations and can be used for domestic purposes where thickness and permeability of the deposits can sustain acceptable yields (Bingham and Moore, 1975). The terrace aquifers are used extensively for domestic water use on the northern side of the North Canadian River valley in Lincoln and Pottawatomie Counties (Bingham and Moore, 1975; Becker, 2013).



System	Stratigraphic unit	Aquifer	
Quaternary	Terrace and alluvium deposits	Terrace and alluvial aquifers	Central Oklahoma aquifer (Christenson and Havens, 1998)
Permian	Garber Sandstone	Garber-Wellington aquifer	
	Wellington Formation		
	Chase, Council Grove, and Admire Groups (undivided)		
Pennsylvanian	Vanoss Formation		
	Ada Group	Ada-Vamoosa aquifer	
	Vamoosa Formation		

Figure 3. Geologic units and equivalent aquifer units in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma.

The Permian-aged bedrock aquifers in the CPN TJA are part of the Central Oklahoma aquifer (COA), a complex of rocks that is used extensively in central Oklahoma as a supply of groundwater (Christenson and Havens, 1998). The COA in the CPN TJA consists of the Garber-Wellington aquifer and the Chase, Council Grove, and Admire Groups, undivided. The Garber-Wellington aquifer is composed of the Garber Sandstone and the Wellington Formation (fig. 3). The Garber Sandstone consists mostly of lenticular beds of orange-brown fine-grained sandstone interbedded with siltstone and mudstone and small amounts of conglomerate (Breit, 1998). The lithology of the underlying Wellington Formation is similar to that of the Garber Sandstone but is finer grained, containing a higher percentage of siltstone and mudstone (Parkhurst and others, 1996). The stratigraphic contact between these two rock units is gradational, and the discernment of where one begins and the other ends is difficult (Parkhurst and others, 1996; Smith and others, 2009). Both units were deposited in a fluvial-deltaic environment at the edge of a shallow sea that periodically covered this part of Oklahoma during the Permian period (Christenson and Havens, 1998). In general, the lithologies of the Garber Sandstone and Wellington Formation are highly variable over short distances, horizontally and with depth. The bedrock units dip in a westerly direction at about 50 feet per mile (ft/mi) (Christenson and Havens, 1998) and become more shaly (fine grained) in an easterly direction and with depth (Schlottmann and others, 1998).

The Chase, Council Grove, and Admire Groups (undivided) (referred to as the “Oscar Group” by Bingham and Moore, 1975) underlie the Wellington Formation and are the easternmost groups of rocks that are part of the COA. At the land surface, these groups of rocks are similar in lithology, consisting of fine-grained sandstone, shale, and thin limestone (Christenson and Havens, 1998). Well yields are smaller in the Chase, Council Grove, and Admire Groups than in the Wellington Formation, generally less than 25 gallons per minute (gal/min) (Bingham and Moore, 1975).

Underlying the COA along the eastern part of the TJA is the Pennsylvanian-aged Vanoss Formation. The Vanoss Formation is considered to be a minor aquifer and consists of shale, fine-grained sandstone, and limestone (Bingham and Moore, 1975). Similar to the Chase, Council Grove, and Admire Groups, yields of wells completed in the Vanoss Formation are generally less than 25 gal/min (Bingham and Moore, 1975).

Previous Studies

This section describes historical studies and the types of stream-water data collected at the stream stations sampled for this study. Historical USGS studies about groundwater quality in and near the CPN TJA are also described.

Streams

Streamflow measurements have been collected at the Tecumseh station since 1943, the Harrah station since 1968, and the Shawnee station since 2001. There is a long history of water-quality sample data at the Harrah station beginning in 1900, with the majority of samples being collected after 1968 (U.S. Geological Survey, 2013d). Tortorelli (2002) provided statistical summaries of streamflow records through 1999 for the North Canadian and Little Rivers. Esralew and others (2011) described trends of land cover, streamflow, and water-quality characteristics of the North Canadian River near the Harrah station (1968–2009) and at an upstream station, North Canadian River at Britton Road at Oklahoma City, Okla. (1988–2009). That report included summary statistics of historical water-quality data, analysis of frequencies of exceedance of Criterion Continuous Concentration (CCC, a water-quality standard for protection of aquatic life) (Oklahoma Water Resources Board, 2013b), analysis of frequencies of detection of pesticides, and trends in selected nutrient, biological, and water properties with time. Esralew and others (2011) reported significant increases in flow-adjusted concentrations of dissolved nitrogen and phosphorus and significant decreases in flow-adjusted dissolved oxygen concentration at the Harrah station since 1999. These trends likely were related to decreasing streamflows at base-flow conditions and increases in population growth and discharge of treated wastewater (Esralew and others, 2011). Esralew and others (2011) stated that concentrations of chloride, lead, cadmium, and chlordane frequently exceeded the CCCs for those compounds at both the Harrah and Britton Road at Oklahoma City, Okla., stations on the North Canadian River. Esralew and others (2011) reported detections of 35 pesticides at one or both stations; diazinon, 2,4-D, and dieldrin were detected most frequently at the Harrah station in samples collected from 1968 through 2009. Six of the 35 pesticides reported by Esralew and others, (2011) were analyzed in stream samples for this project. Detection frequencies of the six pesticides from stream samples collected from 1968 through 2009 at the Harrah gage from Esralew and others (2011) are listed in table 3.

The seasonality, magnitudes, and frequencies of floods, low-flow characteristics, and long-term trends of streamflow in the North Canadian River at the Harrah and Shawnee stations and in the Little River at the Tecumseh station were summarized in Andrews and others (2013) by using data collected by the USGS from October 1984 to 2011. Historical USGS streamflow information collected at the Deer Creek site was limited at the time of this report and consisted of only five field measurements ranging from zero to 4.96 ft^3/s (U.S. Geological Survey, 2013b).

Andrews and others (2013) also summarized historical water-quality information collected by the USGS and other agencies from 1985 through 2011 at the Harrah, Shawnee, and Tecumseh stations. Those water-quality data included the water properties—dissolved oxygen concentration, specific conductance, pH, and temperature—and concentrations of dissolved solids, hardness, chloride, nitrogen, and phosphorus. Additional water-quality data summarized by Andrews and others (2013) from samples collected at the Harrah station included arsenic, chromium, and lead concentrations and counts of fecal coliform bacteria.

Table 3. Descriptions of 69 organic compounds analyzed in stream samples for this study, including suspected endocrine disruption potential, Chemical Abstract Service number, possible compound uses or sources, and detection information from previously published U.S. Geological Survey reports (Becker, 2010; Esralew and others, 2011).

[CAS, Chemical Abstract Service; Okla., Oklahoma; FI, fecal indicator; Nd, not detected; –, not analyzed; P, pesticide; PAH, polycyclic aromatic hydrocarbon; µg/L, microgram per liter; EPA, U.S. Environmental Protection Agency; I, industrial compound; DM, detergent metabolite; na, not applicable; PCP, personal care product; FR, flame retardant]

Compound name[a]	Compound type	Endocrine disruptor, known or suspected	CAS number[b]	Possible compound uses or sources[c]	Becker (2010)			Esralew and others (2011)
					North Canadian River near Hogback Road near Jones, Okla. (07241540)	North Canadian River at Shawnee, Okla. (07241700)	Little River near Tecumseh, Okla. (07230500)	North Canadian River near Harrah, Okla. (07241550)[d]
Fecal indicators and plant sterols								
3-beta-Coprostanol	FI	No	360–68–9	Carnivore fecal indicator	Detected	Nd	–	–
3-Methyl-1H-indole (Skatol)	FI	No	83–34–1	Fecal odor, present in coal tar	Detected	Detected	–	–
Caffeine	FI	No	58–08–2	Beverages, diuretic, very mobile and biodegradable	Nd	Nd	–	–
Cholesterol	FI	No	57–88–5	Fecal indicator, plant sterol	Nd	Nd	–	–
Cotinine	FI	No	486–56–6	Metabolite of nicotine	Nd	Nd	–	–
Indole	FI	No	120–72–9	Pesticide inert ingredient, odor in coffee, fecal odor	Detected	Detected	–	–
beta-Sitosterol	FI	No	83–46–5	Plant sterol	Detected	Nd	–	–
beta-Stigmastanol	FI	No	19466–47–8	Plant sterol	Nd	Nd	–	–
Pesticides								
Atrazine	P	Yes	1912–24–9	Herbicide, regulated in drinking water by the EPA (3 µg/L)	Detected	Detected	Nd	Detected in 53 of 84 samples
Bromacil	P	No	314–40–9	General use herbicide	Nd	Nd	–	Detected in 26 of 73 samples
Carbaryl	P	Yes	63–25–2	Insecticide, crop and garden uses, low persistence, common name is Sevin	Nd	Nd	Nd	–
Chlorpyrifos	P	Yes	2921–88–2	Insecticide, residential use restricted as of 2001, common name is dursban	Detected	Detected	Nd	Detected in 27 of 122 samples
Diazinon	P	Yes	333–41–5	Insecticide, residential use banned in 2004	Nd	Nd	Nd	Detected in 137 of 165 samples
Dichlorvos	P	Yes	62–73–7	Insecticide	–	–	–	–
Metalaxyl	P	No	57837–19–1	Fungicide	Nd	Nd	–	–

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Pesticides—Continued								
Metolachlor	P	No	51218–45–2	Herbicide, general use pesticide, indicator of agricultural drainage	Detected	Detected	Nd	Detected in 1 of 85 samples
N,N-Diethyl-m-toluamide (DEET)	P	No	134–62–3	Repellent used on skin and clothes for mosquitos, ticks, and other biting insects	Detected	Detected	–	–
Pentachlorophenol	P	Yes	87–86–5	Algaecide, fungicide, herbicide, and wood preservative, regulated in drinking water by the EPA (1 µg/L)	Detected	Nd	–	–
Prometon	P	No	1610–18–0	Herbicide, noncrop only, applied prior to blacktop	Detected	Nd	Nd	Detected in 10 of 85 samples
Polycyclic aromatic hydrocarbons								
1-Methylnaphthalene	PAH	No	90–12–0	Used in the manufacture of dyes, plastics, and resins	Nd	Nd	–	–
2,6-Dimethylnaphthalene	PAH	No	581–42–0	Present in diesel/kerosene (trace in gasoline)	Nd	Nd	–	–
2-Methylnaphthalene	PAH	No	91–57–6	Polycyclic aromatic hydrocarbon	Nd	Nd	–	–
9,10-Anthraquinone	PAH	No	84–65–1	Dye manufacture and textiles, seed treatment, bird repellant	Nd	Nd	–	–
Anthracene	PAH	No	120–12–7	Wood preservative	Nd	Nd	–	–
Benzo(a)pyrene	PAH	Yes	50–32–8	Probable human carcinogen, used in cancer research, combustion product, found in cigarette smoke, regulated in drinking water by the EPA	Nd	Nd	–	–

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Polycyclic aromatic hydrocarbons—Continued								
Carbazole	PAH	No	86–74–8	Insecticide, manufacture of dyes, explosives, and lubricants	Nd	Nd	–	–
Fluoranthene	PAH	No	206–44–0	Component of coal tar and asphalt, traces in gasoline and diesel fuel	Nd	Nd	–	–
Naphthalene	PAH	No	91–20–3	Fumigant, moth repellent	Nd	Nd	–	–
Phenanthrene	PAH	No	85–01–8	Manufacture of explosives	Detected	Detected	–	–
Pyrene	PAH	No	129–00–0	Forms during incomplete combustion of organic substances. Used to make dyes	Detected	Detected	–	–
Synthetic organic compounds								
1,4-Dichlorobenzene	I	Yes	106–46–7	Moth repellant, fumigant, deodorant	Nd	Nd	–	–
3,4-Dichlorophenyl isocyanate	I	No	102–36–3	Intermediate compound used in chemical synthesis and the production of plastics, cosmetics, dyes, textiles	–	–	–	–
3-tert-Butyl-4-hydroxyanisole (BHA)	I	Yes	25013–16–5	Antioxidant, general preservative	Nd	Nd	–	–
4-Cumylphenol	DM	Yes	599–64–4	Nonionic detergent metabolite	Nd	Nd	–	–
4-n-Octylphenol	DM	Yes	1806–26–4	Nonionic detergent metabolite	Nd	Nd	–	–
4-Nonylphenol (sum)	DM	No	84852–15–3	Nonionic detergent metabolite	Nd	Nd	–	–
4-Nonylphenol diethoxylate (sum) (NP2EO; total)	DM	Yes	na	Nonionic detergent metabolite	Nd	Nd	–	–

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Compound name[a]	Compound type	Endocrine disruptor, known or suspected	CAS number[b]	Possible compound uses or sources[c]	Becker (2010)			Esralew and others (2011)
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Synthetic organic compounds—Continued								
4-Nonylphenol monoethoxylate (sum) (NP1EO)	DM	Yes	104–35–8	Nonionic detergent metabolite	Nd	Nd	–	–
4-tert-Octylphenol diethoxylate (OP2EO)	DM	Yes	2315–61–9	Nonionic detergent metabolite	Detected	Nd	–	–
4-tert-Octylphenol monoethoxylate (OP1EO)	DM	Yes	2315–61–5	Nonionic detergent metabolite	Nd	Nd	–	–
4-tert-Octylphenol	DM	Yes	140–66–9	Nonionic detergent metabolite	Nd	Nd	–	–
5-Methyl-1H-benzotriazole	I	No	136–85–6	Antirust and corrosion inhibitor, antioxidant in antifreeze and deicers	Detected	Detected	–	–
Acetophenone	PCP	No	98–86–2	Fragrance in detergent and tobacco, flavor in beverages	Detected	Detected	–	–
Tonalide (AHTN)	PCP	Yes	21145–77–7	Musk fragrance, used in personal care products	Detected	Detected	–	–
2,2’,4,4’-Tetrabromodiphenylether (PBDE 47)	FR	Yes	5436–43–1	Flame retardant	–	–	–	–
Benzophenone	PCP	Yes	119–61–9	Ultraviolet blocker in perfumes, soaps, and plastics	Detected	Detected	–	–
Bis(2-ethylhexyl) phthalate	I	Yes	117–81–7	Plasticizer for polymers and resins, inert ingredient in pesticides	Nd	Nd	–	–
Bisphenol A	I	Yes	80–05–7	Plasticizer, manufacture of polycarbonate resins, antioxidant, fire repellant	Nd	Nd	–	–
Camphor	PCP	No	76–22–2	Odorant used in cooling gels and as a cough suppressant	Nd	Nd	–	–
p-Cresol	I	No	106–44–5	Wood preservative	Detected	Nd	–	–

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					Becker (2010)			Esralew and others (2011)
Compound name[a]	**Compound type**	**Endocrine disruptor, known or suspected**	**CAS number[b]**	**Possible compound uses or sources[c]**	**North Canadian River near Hogback Road near Jones, Okla. (07241540)**	**North Canadian River at Shawnee, Okla. (07241700)**	**Little River near Tecumseh, Okla. (07230500)**	**North Canadian River near Harrah, Okla. (07241550)[d]**
				Synthetic organic compounds—Continued				
Diethyl phthalate	I	Yes	84–66–2	Plasticizer for polymers and resins	Nd	Nd	–	–
d-Limonene	PCP	No	5989–27–5	Fragrance, cleaning products	Nd	Nd	–	–
Galaxolide (HHCB)	PCP	Yes	1222–05–5	Musk fragrance used in perfumes, soaps, cosmetics, and detergents	Detected	Detected	–	–
Isoborneol	PCP	No	124–76–5	Fragrance	Nd	Nd	–	–
Isophorone	I	No	78–59–1	Solvent for lacquer, plastic, oil, silicon, resin	Detected	Detected	–	–
Isopropylbenzene	I	No	98–82–8	Manufacture phenol/acetone, fuels and paint thinner	Nd	Nd	–	–
Isoquinoline	PCP	No	119–65–3	Flavors and fragrances	Nd	Nd	–	–
Menthol	PCP	No	89–78–1	Liniment, cigarettes, cough drops, mouthwash	Nd	Nd	–	–
Methyl salicylate	PCP	No	119–36–8	Liniment, food, beverage, ultraviolet-absorbing lotion	Nd	Nd	–	–
Phenol	I	No	108–95–2	Disinfectant, used in the manufacture of several products, leachate	Detected	Detected	–	–
Tetrachloroethene	I	No	127–18–4	Solvent, degreaser, veterinary anthelmintic	Nd	Nd	–	–
Tribromomethane	I	No	75–25–2	Solvent used as laboratory reagent and in the manufacture of pharmaceuticals, aircraft, and fire-resistant chemicals.	–	–	–	–
Tributyl phosphate	FR	No	126–73–8	Antifoaming agent, flame retardant	Detected	Detected	–	–

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Synthetic organic compounds—Continued								
Triclosan	PCP	Yes	3380–34–5	Disinfectant, antimicrobial (concern for acquired microbial resistance)	Detected	Nd	–	–
Triethyl citrate	PCP	No	77–93–0	Cosmetics, pharmaceutical coating, and plastic	Nd	Nd	–	–
Triphenyl phosphate	I	No	115–86–6	Plasticizer, resin, wax, roofing paper, flame retardant	Nd	Nd	–	–
Tris(2-butoxyethyl) phosphate	FR	No	78–51–3	Flame retardant, plasticizer, solvent	Detected	Detected	–	–
Tris(2-chloroethyl) phosphate	FR	Yes	115–96–8	Flame retardant	Detected	Detected	–	–
Tris(dichloroisopropyl) phosphate	FR	Yes	13674–87–8	Flame retardant	Detected	Detected	–	–

[a] Laboratory method of Zaugg and others (2006).

[b] 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 ServicesSM.

[c] Modified from Tertuliani and others (2008).

[d] Detection frequencies from samples collected from 1968 through 2009.

Brigham and others (2002) summarized additional water-quality constituents measured in samples collected at the Harrah station from 1988 through 1999. Those constituents included biochemical oxygen demand and concentrations of dissolved carbon dioxide, organic carbon, and nutrient species.

Becker (2010) reported concentrations of several types of organic compounds in stream water during January and February 2009 at the Shawnee and Tecumseh stations and an ungaged site near the Harrah station. The sampling methodology used for that study entailed submerging passive samplers in the streams for a period of about 30 days. Samplers submerged at the two North Canadian River sites were analyzed for 62 pesticides, 10 pesticide metabolites, 3 polychlorinated biphenyl compounds, 35 polycyclic aromatic hydrocarbons (PAH), and 49 synthetic organic compounds, whereas samplers submerged at the Tecumseh station were analyzed for 46 pesticides and 6 pesticide metabolites. Of the 69 organic compounds analyzed in stream samples for this study, 65 were analyzed by Becker (2010) at the two North Canadian sites, and 6 organic compounds were analyzed by Becker (2010) at the Tecumseh station. Information about organic compounds detected by Becker (2010) is listed on table 3.

Groundwater

Numerous sources of information describe the hydrogeology of the COA and groundwater quality in the CPN TJA (Bingham and Moore, 1975; Christenson and Havens, 1998; Oklahoma Water Resources Board, 2013a). Andrews and others (2013) compiled and summarized historical groundwater-quality data for the CPN TJA. Water-quality data summarized in that report were obtained for 294 wells that produced water from the COA and minor aquifers. Those water-quality data were obtained from six sources that included the USGS NWIS database (U.S. Geological Survey, 2013a). Andrews and others (2013) described the water properties—dissolved oxygen, specific conductance, and pH; the distribution and concentrations of the major ions, nitrogen and phosphorus; and the trace elements arsenic, chromium, iron, lithium, manganese, uranium, and zinc in groundwater in the study area.

The bedrock and alluvial aquifers of the COA were studied comprehensively for the USGS National Water Quality Assessment Program (NAWQA) from 1987 to 1992 (Christenson and Havens, 1998). The NAWQA study examined rock cores, analyzed water-quality samples, and simulated water movement through the aquifer to describe the location, nature, and causes of selected water-quality problems (Christenson and Havens, 1998). With respect to water quality, the NAWQA study focused on arsenic, chromium, selenium, and uranium because these trace elements were found to be the most likely constituents to exceed public drinking-water MCLs in the aquifer and affect water suppliers and consumers. These trace elements occur naturally in local bedrock and tend to be soluble in oxygenated and alkaline (high pH) groundwater (Schlottman and others, 1998). A study in southern Lincoln and northern Pottawatomie Counties (just north of the CPN TJA) showed a relation between groundwater pH and groundwater quality as affected by the cation-exchange process in the bedrock aquifer (Becker, 2013). Deeper wells in local bedrock aquifers tended to produce water with higher pH values, whereas wells in the shallower terrace aquifers produced water with lower pH values and lower concentrations of all water-quality constituents (Becker, 2013). Groundwater with pH values greater than 8.0 had higher concentrations of dissolved solids, uranium, selected trace metals, radon-222 (gas), and gross alpha-particle activity (Becker, 2013). Several additional USGS reports describe the distribution and concentrations of selected trace elements in groundwater in and near the CPN TJA (Becker, 2006; Becker and others, 2010; Smith, 2005).

Methods

This section describes the field methodologies used to collect stream-water and groundwater-quality samples, procedures for quality-control, and analytical accuracy calculations. The methods used to analyze the stream-water- and groundwater-quality data also are described.

Stream-Water Data

For the study described in this report, real-time data collected at the Harrah station included instantaneous measurements of gage height, streamflow, and the water properties—dissolved oxygen concentration, pH, specific conductance, and temperature. Real-time data collected at the Tecumseh and Shawnee stations were gage height and streamflow. Methods used for real-time data collection of gage height and streamflow are described in Sauer and Turnipseed (2010) and Turnipseed and Sauer (2010). Methods used for operating continuous water-quality monitors at stations are described in Wagner and others (2006). Data continuously collected at these stations in 30-minute (min) intervals were transmitted by satellite telemetry into the USGS National Water Information System (NWIS) database (U.S. Geological Survey, 2013c).

Stream-Water-Quality Data Collection

For this report, water-quality samples were collected eight times at the Shawnee and Harrah stations on the North Canadian River and the Tecumseh station on the Little River from January 2012 to December 2012 and three times at the Deer Creek site (in January and March 2012 and April 2013). Water properties including dissolved oxygen concentration, pH, specific conductance, and temperature were measured at equal-width intervals across the stream channel with a YSI Inc. (YSI) multiprobe meter during sample collection and were averaged for final values. These water properties also were measured continuously at the Harrah station during 2012 (U.S. Geological Survey, 2013d). Stream-water samples were collected by using isokinetic, depth-integrating methods from equal-width intervals across the stream channel by using a grab sampler, weighted bottle sampler, or a US DH-81 (bottle with adapter cap and nozzle deployed by a rod), depending on stream width and streamflow at the time of sample collection. Dissolved samples were filtered through a 0.45-micrometer polysulfone capsule filter and collected in polyethylene bottles that had been prerinsed with filtered native water. Whole (unfiltered) samples analyzed for trace elements were collected in acid-rinsed polyethylene bottles that had been prerinsed with native water and then preserved by acidification with nitric acid to a pH of 2 or less. Sample bottles for anion analysis were not acid rinsed or acidified but were instead prerinsed with native water before collection. Whole samples for organic compounds were collected in 1-liter baked, amber glass bottles that were not prerinsed with native water. Samples were collected with protocols described in U.S. Geological Survey (2006) and processed with protocols described in Wilde and others (2004). Water-quality constituent concentrations were analyzed by the USGS National Water Quality Laboratory (NWQL) in Lakewood, Colorado. Water-quality samples were analyzed for dissolved concentrations of the major ions, whole (unfiltered) concentrations of the major cations, dissolved concentrations of nitrogen and phosphorus compounds, whole concentrations of total nitrogen and total phosphorus, and whole concentrations of trace elements by using analytical methods shown on table 4 (apps. 1 and 2). Water-quality samples also were analyzed for whole concentrations of 69 organic compounds by using the analytical method described by Zaugg and others (2006) (table 3). The organic compounds analyzed by using that method included 8 fecal indicators or plant sterols, 11 PAHs, 8 detergent metabolites, 14 industrial compounds, 11 pesticides, 12 personal care products (PCP), and 5 fire retardants (app. 3). Stream-water samples to be analyzed for fecal indicator bacteria, *Escherichia coli*, and total coliforms were processed at the USGS Oklahoma Water Science Center in Oklahoma City, Okla. Alkalinity, bicarbonate, and carbonate concentrations were measured in the field or within 4 hours of sample collection by using an inflection-point titration method described by Rounds (2012).

Stream-Water Quality-Control Procedures

Quality-assurance and quality-control procedures in the field used standard USGS methods designed to collect consistently high-quality data (U.S. Geological Survey, 2006). The quality-control samples collected for this study consisted of two replicates (one replicate did not include organic compounds) and two equipment blanks. A replicate sample is an extra sample set collected after the environmental sample to measure the variability of field and laboratory procedures. Replicate samples were collected with environmental samples at the Tecumseh station on June 26 and December 6, 2012. The analytical accuracy between the environmental and replicate samples was computed as the relative percent difference (RPD) of constituent concentrations by using the following equation:

$$RPD = [(C1\text{-}C2)/((C1+C2)/2)] \times 100,$$

where

$C1$ is the higher of the two concentrations, and
$C2$ is the lower of the two concentrations.

The RPD values for concentrations of the major ions measured in dissolved and whole environmental and quality-assurance stream-water samples that were analyzed at the USGS NWQL ranged from zero to 8.6 percent (app. 4).

The RPD values for concentrations of alkalinity, bicarbonate, and carbonate analyzed in dissolved environmental and quality-assurance stream-water samples in the field ranged from zero to 34.7 percent. RPD values for concentrations of total phosphorus measured in dissolved environmental and quality-assurance stream-water samples were 13.3 and 15.4 percent, respectively; however, in whole stream-water samples, the RPD values for concentrations of phosphorus were zero and 72.7 percent in quality-assurance samples. RPD values for concentrations of nitrogen compounds (ammonia nitrogen and organic nitrogen) in dissolved and whole environmental and quality-assurance stream-water samples ranged from 3.5 to 24.2 percent.

The RPD values for concentrations of 19 trace elements measured in whole environmental and quality-assurance stream-water samples ranged from zero to 48.5 percent, with iron, mercury, selenium, and zinc having the highest values (app. 4). RPD values for concentrations of iron and manganese measured in dissolved environmental and quality-assurance stream-water samples ranged from 1.3 to 49.6 percent, with dissolved iron having the highest values. Large RPD values can result from low concentrations reported with few significant figures. For example, concentrations of 2 and 3 would give an RPD of 40 percent, whereas if the concentrations were reported with more significant figures, such as 2.4 and 2.6, the RPD would be 8 percent.

The ionic balance, a measure of balance between major cations and anions dissolved in water, was calculated for each stream-sample chemical analysis as a quality-assurance check (app. 1). The ionic balance was calculated as the total dissolved cation concentration minus the total dissolved anion concentration divided by the total concentration of ions in milliequivalents per liter. The total cation concentration was the sum of concentrations of calcium, magnesium, sodium, potassium, and the trace elements iron and manganese. The total anion concentration was the sum of chloride, sulfate, fluoride, alkalinity, and nitrate-nitrogen concentrations. Of 27 stream-water analyses, 25 had ionic balances within ±6 percent, indicating that the major-ion analyses were acceptable. The stream sample collected May 31, 2012, at the Tecumseh station had an ionic balance of 6.54 percent, which was considered low enough to be acceptable in this study because there may have been organic ions that were not measured that contributed to the relatively high ionic balance number (Hem, 1985). Of the 3 stream samples collected at the Deer Creek site, 2 samples were not measured for alkalinity concentrations, the absence of which precluded ionic balance calculations.

Table 4. Method references and highest minimum laboratory reporting levels of water properties, major ions, nutrients, and trace elements measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[mg/L, milligrams per liter; –, not applicable; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; dissolved samples are filtered; whole samples are not filtered]

Water properties and chemical constituents (units)	Method references for dissolved samples	Highest minimum laboratory reporting level for dissolved samples	Method references for whole samples	Highest minimum laboratory reporting level for whole samples
		Water properties		
Dissolved oxygen, field (mg/L)	–	–	U.S. Geological Survey (2012)	0.1
pH, field (standard units)	–	–	U.S. Geological Survey (2012)	0.1
Specific conductance, field (µS/cm at 25 °C)	–	–	U.S. Geological Survey (2012)	3 significant digits
Water temperature, field (°C)	–	–	U.S. Geological Survey (2012)	0.5
		Major ions		
Calcium (mg/L)	Fishman (1993)	0.022	Garbarino and Struzeski (1998)	0.021
Magnesium (mg/L)	Fishman (1993)	0.011	Garbarino and Struzeski (1998)	0.007
Potassium (mg/L)	U.S. Environmental Protection Agency (1993)	0.03	American Public Health Association (1998)	0.015
Sodium (mg/L)	Fishman (1993)	0.06	Garbarino and Struzeski (1998)	0.06
Alkalinity (mg/L as $CaCO_3$)	Rounds (2012)	3 significant digits	–	–
Bicarbonate (mg/L)	Rounds (2012)	3 significant digits	–	–
Carbonate (mg/L)	Rounds (2012)	3 significant digits	–	–
Chloride (mg/L)	Fishman and Friedman (1989)	0.06	–	–
Fluoride (mg/L)	Fishman and Friedman (1989)	0.01	–	–
Silica (mg/L)	Fishman (1993)	0.018	–	–
Sulfate (mg/L)	Fishman and Friedman (1989)	0.09	–	–
		Nutrients		
Ammonia plus organic nitrogen (mg/L as N)	Patton and Truitt (2000)	0.07	Patton and Truitt (2000)	0.07
Ammonia nitrogen (mg/L as N)	Fishman (1993)	0.010	–	–
Nitrite plus nitrate-nitrogen (mg/L as N)	Patton and Kryskalla (2011)	0.04	–	–
Nitrite-nitrogen (mg/L as N)	Fishman (1993)	0.0010	–	–
Orthophosphorus (mg/L as P)	Fishman (1993)	0.004	–	–
Total phosphorus (mg/L)	U.S. Environmental Protection Agency (1993)	0.0030	U.S. Environmental Protection Agency (1993)	0.004

Table 4. Method references and highest minimum laboratory reporting levels of water properties, major ions, nutrients, and trace elements measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[mg/L, milligrams per liter; –, not applicable; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; dissolved samples are filtered; whole samples are not filtered]

Water properties and chemical constituents (units)	Method references for dissolved samples	Highest minimum laboratory reporting level for dissolved samples	Method references for whole samples	Highest minimum laboratory reporting level for whole samples
		Bacteria		
Escherichia coli, most probable number per 100 milliliters	–	–	Myers and others (2007)	–
Total coliforms, most probable number per 100 milliliters	–	–	Myers and others (2007)	–
		Trace elements		
Aluminum (µg/L)	–	–	Garbarino and Struzeski (1998)	50
Arsenic (µg/L)	–	–	Garbarino and others (2006)	0.28
Barium (µg/L)	–	–	Garbarino and Struzeski (1998)	0.3
Beryllium (µg/L)	–	–	Garbarino and Struzeski (1998)	0.19/0.57
Cadmium (µg/L)	–	–	Garbarino and Struzeski (1998)	0.016
Chromium (µg/L)	–	–	Garbarino and others (2006)	0.3
Cobalt (µg/L)	–	–	Garbarino and others (2006)	0.02
Copper (µg/L)	–	–	Garbarino and Struzeski (1998)	1.4
Iron (µg/L)	Fishman (1993)	4.0	Garbarino and Struzeski (1998)	4.6
Lead (µg/L)	–	–	Garbarino and Struzeski (1998)	0.04
Lithium (µg/L)	–	–	Garbarino and Struzeski (1998)	0.04
Manganese (µg/L)	Fishman (1993)	0.16	Garbarino and Struzeski (1998)	0.2
Mercury (µg/L)	–	–	Garbarino and Damrau (2001)	0.005
Molybdenum (µg/L)	–	–	Garbarino and Struzeski (1998)	0.05
Nickel (µg/L)	–	–	Garbarino and others (2006)	0.19
Selenium (µg/L)	–	–	Garbarino and others (2006)	0.05
Silver (µg/L)	–	–	Garbarino and Struzeski (1998)	0.015
Stronitum (µg/L)	–	–	Garbarino and Struzeski (1998)	0.18
Zinc (µg/L)	–	–	Garbarino and Struzeski (1998)	2

Two equipment blanks were collected to determine if field water-quality samples were contaminated by the sampling equipment, bottles, or procedural techniques. The equipment blanks were prepared with trace-metal-free blank water and analyzed for dissolved concentrations of major ions and whole concentrations of major cations, nutrients, trace elements, and organic compounds. The equipment-blank analyses indicated small concentrations (less than 1 milligram per liter [mg/L]) of calcium and chloride in both equipment-blank samples and an ammonia nitrogen concentration of 0.028 mg/L in the equipment-blank sample collected on May 31, 2012, which exceeded ammonia nitrogen concentrations measured in 7 of 8 samples collected at the Tecumseh station, in 2 samples collected at the Harrah station, and in 3 samples collected at the Shawnee station (app. 1). Water-quality analyses also indicated detectable concentrations of lead, manganese, mercury, nickel, and zinc in both equipment-blank samples, in addition to molybdenum in the June 27 equipment-blank sample (app. 2). Of these analyses, the concentrations of lead, nickel, and zinc were similar or greater than concentrations measured in the stream-water samples collected at the Tecumseh station. Mercury concentrations in the equipment-blank sample were similar or greater than concentrations measured at all four stream sites. It is suspected that during 2012, deionized water used for cleaning sampling equipment at the USGS Oklahoma Water Science Center contained small concentrations of the trace elements and ammonia nitrogen. When following USGS sampling protocol, stream-sampling equipment is rinsed with native water in the field before the environmental sample is collected, and any residual contamination from the sampling equipment would be removed before sampling occurs. Thiros and others (2011) reported that a native-water rinse of the sampling equipment was sufficient to remove residual contamination before groundwater samples were collected during a study to compare the collection of contaminated blank water and groundwater samples. Prerinsing with native water probably minimized any mixing with residual deionized water used for cleaning sampling equipment for environmental samples collected during this study.

The two equipment-blank samples analyzed for organic compounds contained eight detectable concentrations of seven organic compounds (app. 3). The equipment-blank sample collected on May 31, 2012, contained detectable concentrations of five organic compounds: (1) acetophenone, (2) benzophenone, (3) methyl salicylate (compounds found in PCPs), (4) 4-nonylphenol sum (a detergent metabolite), and (5) 1-methyl-naphthalene (a polycyclic aromatic hydrocarbon). The equipment-blank sample collected on June 27, 2012, contained detectable concentrations of three organic compounds: (1) benzophenone and (2) triethyl citrate (compounds found in PCPs) and (3) tetrachloroethylene (a solvent and degreaser). Two of these compounds, acetophenone and 1-methyl-naphthalene, were not detected in any of the environmental samples. Methyl salicylate was detected in a stream-water sample collected at the Tecumseh station, and tetrachloroethylene was detected in a stream-water sample collected at the Harrah station. The compounds, benzophenone and triethyl citrate, were detected in multiple stream-water samples collected at the Harrah and Shawnee stations, whereas 4-nonylphenol (sum) was detected in at least one stream-water sample collected at each of the three stations.

Stream-Water-Quality Data Analysis

Graphs were made of streamflow and daily range of dissolved oxygen concentration, pH, and specific conductance at the Harrah station to show diurnal variation and the relation of water properties to streamflow conditions and season. Graphs also were made of water-property values measured during sample collection at the four sites compared to streamflow or season. Water-property values, selected constituent concentrations, and bacteria counts were compared to MCL or SMCL drinking-water standards (U.S. Environmental Protection Agency, 2013a; 2013b). Piper diagrams (Piper, 1944) were made of major-ion data to examine water types and changes in major-ion proportions with streamflow. In regards to water type, cations and anions were considered to be predominant when composing 50 percent or more of the total ion-type concentration expressed in milliequivalents per liter. Ions were considered to be secondary when composing between 25 and 49 percent of total cation or anion concentration (Back, 1966).

Groundwater Data

For the study described in this report, groundwater samples were collected one time from 30 wells (w1–w30) that ranged in depth from 42 to 360 ft below land surface (fig. 1; table 2). Sampling at each of the 30 wells consisted of purging, measuring water properties, collecting water-quality samples, and preserving those samples.

Groundwater Field Methods and Laboratory Analysis

All wells had a water spigot on or near the wellhead, enabling access to untreated water near the pressure tank. Each well was purged of at least three standing well-casing volumes of water before sampling. The water properties—dissolved oxygen, pH, specific conductance, and temperature—were measured with a YSI multiprobe meter every 5–7 min starting halfway through the purging process by using procedures described by U.S. Geological Survey (2006). The highest minimum reporting levels for water properties measured in the field are listed in table 5. Samples were collected after the water properties had stabilized following the period of time needed to purge the well.

Table 5. Maximum Contaminant Levels, method references, and highest minimum laboratory reporting levels of water properties, major ions, nutrients, trace elements, and selected radionuclides measured in water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, Pottawatomie County, Oklahoma, 2012–13.

[Constituent conentrations are dissolved; mg/L, milligram per liter; –, not applicable; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; µg/L, microgram per liter; pCi/L, picocurie per liter]

Water properties and chemical constituents (units)	Maximum Contaminant Level[a]	Secondary Maximum Contaminant Level[b]	Method references	Highest minimum laboratory reporting level
Water properties				
Dissolved oxygen, field (mg/L)	–	–	U.S. Geological Survey (2012)	0.1
pH, field (standard units)	–	6.5–8.5	U.S. Geological Survey (2012)	0.1
Specific conductance, field (µS/cm at 25 °C)	–	–	U.S. Geological Survey (2012)	3 significant digits
Water temperature, field (°C)	–	–	U.S. Geological Survey (2012)	0.5
Major ions				
Bromide (mg/L)	–	–	Fishman and Friedman (1989)	0.01
Calcium (mg/L)	–	–	Fishman (1993)	0.022
Magnesium (mg/L)	–	–	Fishman (1993)	0.011
Potassium (mg/L)	–	–	Fishman and Friedman (1989)	0.03
Sodium (mg/L)	–	–	Fishman (1993)	0.06
Alkalinity, field (mg/L as $CaCO_3$)	–	–	Rounds (2012)	3 significant digits
Bicarbonate, field (mg/L)	–	–	Rounds (2012)	3 significant digits
Carbonate, field (mg/L)	–	–	Rounds (2012)	3 significant digits
Chloride (mg/L)	–	250	Fishman and Friedman (1989)	0.06
Fluoride (mg/L)	4	2	Fishman and Friedman (1989)	0.01
Silica (mg/L)	–	–	Fishman (1993)	0.018
Sulfate (mg/L)	–	250	Fishman and Friedman (1989)	0.09
Dissolved solids (mg/L)	–	500	Fishman and Friedman (1989)	20
Nutrients				
Ammonia nitrogen, (mg/L as N)	10	–	Fishman (1993)	0.01
Nitrite-nitrogen (mg/L as N)	1	–	Fishman (1993)	0.001
Nitrite plus nitrate-nitrogen (mg/L as N)	10	–	Patton and Kryskalla (2011)	0.04
Total nitrogen (mg/L)	10	–	Patton and Kryskalla (2003)	0.05
Orthophosphorus (mg/L as P)	–	–	Fishman (1993)	0.004
Total phosphorus (mg/L)	–	–	U.S. Environmental Protection Agency (1993)	0.003
Trace elements				
Aluminum (µg/L)	–	50 to 200	Garbarino and others (2006)	2.2
Antimony (µg/L)	6	–	Garbarino and others (2006)	0.027
Arsenic (µg/L)	10	–	Garbarino and others (2006)	0.04
Barium (µg/L)	2,000	–	Garbarino and others (2006)	0.7
Beryllium (µg/L)	4	–	Garbarino and others (2006)	0.006
Boron (µg/L)	–	–	Garbarino and others (2006); Garbarino (1999)	3
Cadmium (µg/L)	5	–	Garbarino and others (2006)	0.016

Table 5. Maximum Contaminant Levels, method references, and highest minimum laboratory reporting levels of water properties, major ions, nutrients, trace elements, and selected radionuclides measured in water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, Pottawatomie County, Oklahoma, 2012–13.—Continued

[Constituent conentrations are dissolved; mg/L, milligram per liter; –, not applicable; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; °C, degree Celsius; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; µg/L, microgram per liter; pCi/L, picocurie per liter]

Water properties and chemical constituents (units)	Maximum Contaminant Level[a]	Secondary Maximum Contaminant Level[b]	Method references	Highest minimum laboratory reporting level
		Trace elements—Continued		
Chromium (µg/L)	100	–	Garbarino and others (2006)	0.07, 0.14
Cobalt (µg/L)	–	–	Garbarino and others (2006)	0.023
Copper (µg/L)	1,300[c]	1,000[c]	Garbarino and others (2006)	0.8, 1.6
Iron (µg/L)	–	300	Fishman (1993)	3.2, 4
Lead (µg/L)	–[d]	15[d]	Garbarino and others (2006)	0.025
Lithium (µg/L)	–	–	Garbarino and others (2006); Garbarino (1999)	0.22
Manganese (µg/L)	–	50	Garbarino and others (2006)	0.13, 0.15
Mercury (µg/L)	2	–	Not measured in groundwater	See table 4
Molybdenum (µg/L)	–	–	Garbarino and others (2006)	0.014
Nickel (µg/L)	–	–	Garbarino and others (2006)	0.09
Selenium (µg/L)	50	–	Garbarino and others (2006)	0.03, 0.06
Silver (µg/L)	–	100	Garbarino and others (2006)	0.005, 0.01
Stronitum (µg/L)	–	–	Garbarino and others (2006); Garbarino (1999)	0.2
Thallium (µg/L)	2.0	–	Garbarino and others (2006)	0.01, 0.02
Vanadium (µg/L)	–	–	Garbarino and others (2006)	0.08
Zinc (µg/L)	–	5,000	Garbarino and others (2006)	1.4
		Radionuclides		
Uranium, natural (µg/L)	30	–	Garbarino and others (2006)	0.004
Gross alpha-particle activity (pCi/L)	15	–	National Environmental Methods Index (1980)[e]	3
Gross beta-particle activity (pCi/L)	50[f]/ 4 millirems per year	–	National Environmental Methods Index (1980)[e]	4

[a] U.S. Environmental Protection Agency, 2013a.

[b] U.S. Environmental Protection Agency, 2013b.

[c] Copper is regulated in public-water supply by a treatment technique that requires systems to control the corrosiveness of their water. If more than 10 percent of public water-supply samples exceed the action level of 1,300 µg/L, water systems must take additional steps to control the corrosiveness of their water.

[d] Lead has a nonenforceable Maximum Contaminant Level goal of zero in drinking water. Lead is regulated by a treatment technique that requires systems to control the corrosiveness of their water. If more than 10 percent of public water-supply samples exceed the action level of 15 µg/L, water systems must take additional steps to control the corrosiveness of their water.

[e] Gross alpha- and gross beta-particle activities were measured through gas-flow proportional counting at 72 hours after collection and again a second time approximately 30 days after the initial count by using a modification of EPA method number 900.0.

[f] For this report, a gross beta-particle activity of 50 pCi/L is used as an indicator for beta-particle concentrations that may exceed the Maximum Contaminant Level of 4 millirems per year; this particle activity is based on the U.S. Environmental Protection Agency National Primary Drinking Water Regulations (U.S. Environmental Protection Agency, 2000), which allow public water-supply systems that are designated by a State as "vulnerable" or "contaminated" to use 50 pCi/L as a screening level.

Equipment used to sample each well consisted of a plastic Y-connector with a polypropylene adaptor (connects Y-connector to water spigot), a garden hose, and an adaptor for plastic tubing from which samples were collected. Water was filtered for dissolved constituents, collected in bottles, and preserved in an enclosed portable sampling chamber to prevent wind-borne contamination. Water collected for analysis of major ions, trace elements, and radionuclides was filtered through 0.45-micrometer polysulfone capsule filters and collected in acid-rinsed polyethylene bottles that had been prerinsed with filtered native water. Water collected for analysis of trace elements was preserved by acidification with nitric acid to a pH of 2 or less. Sample bottles for anion analysis were neither acid rinsed nor acidified. Samples were collected with protocols described in U.S. Geological Survey (2006) and processed with protocols described in Wilde and others (2004). Samples for nutrients were shipped on ice for delivery to the laboratory within 24 hours. All constituents, except gross alpha- and gross beta-particle activities, were delivered to and analyzed by the USGS NWQL in Lakewood, Colo. Samples to be analyzed for gross alpha- and gross beta-particle activities were shipped for delivery within 24 hours to Eberline Services, Inc., in Richmond, California.

Alkalinity, bicarbonate, and carbonate concentrations of filtered water were measured in the field or within 4 hours of sample collection by using an inflection-point titration method described by Rounds (2012). Water samples were subsequently analyzed for dissolved concentrations of the major ions, nitrogen and phosphorus compounds, trace elements, and the radionuclides uranium and gross alpha- and beta-particle activities. Uranium can be considered a trace element because it generally occurs in parts per billion in groundwater; however, for this report, uranium is referred to as a “radionuclide.” Laboratory analytical methods used to analyze groundwater constituents are referenced on table 5.

The USGS NWQL reports unrounded values for gross alpha- and gross-beta particle activity in picocuries per liter and uranium in micrograms per liter with the 1-sigma combined standard uncertainty (CSU) and sample-specific critical level (ssLc) needed to analyze the results shown in appendix 5. The CSU is the statistical standard deviation of an individual radionuclide concentration and is a function of several variables that can cause variances in measurement, one of which is the counting error associated with the random nature of radioactive decay within any given brief instant of time. The counting error imposes limitation on the precision of radioactive counting techniques. The CSU is provided with the radionuclide concentration and defines upper and lower concentrations for a confidence interval of the true concentration (McCurdy and others, 2008). The ssLc is the lowest concentration measured that shows a significant statistical difference from the instrument background noise or the analytical blank sample (McCurdy and others, 2008). The ssLc is used as the detection level for determining if the radionuclide is present in a water sample. If the radionuclide concentration is greater than the ssLc, the radionuclide is considered to be present in a sample. The laboratory also reports a calculated sample-specific minimum detectable concentration (MDC) before a sample is analyzed in order to select appropriate analytical methods and parameters for the radionuclide measurement (McCurdy and others, 2008).

Groundwater Quality-Control Procedures

Decontamination of sampling equipment was performed by following USGS methods described in Wilde (2004). Quality-control samples associated with groundwater samples consisted of 3 replicates and 1 equipment blank. Replicate samples were collected with environmental samples at sites w5, w6, and w27 (app. 6). The analytical accuracy between the environmental and replicate samples was computed as the RPD of constituent concentrations.

The RPD values for concentrations of the major ions in environmental and quality-assurance groundwater samples ranged from zero to 9.7 percent (app. 7). RPD values for concentrations of nitrogen and phosphorus compounds in environmental and quality-assurance groundwater samples ranged from zero to 66.7 percent. RPD values for concentrations of 23 trace elements, including uranium, in environmental and quality-assurance groundwater samples ranged from zero to 44.4 percent.

Similar to stream-water samples, the ionic balance was calculated and examined for each groundwater-sample chemical analysis as a quality-assurance check (app. 6). All 30 stream-water analyses had ionic balances within ± 6 percent, indicating that the major-ion analyses were acceptable.

The equipment blank was prepared at the USGS Oklahoma Water Science Center laboratory with trace-metal-free blank water and was analyzed for concentrations of major ions, nutrients, and trace elements, including uranium, at the NWQL. The equipment-blank was not analyzed for gross alpha- and gross beta-particle activities. Similar to the stream-water equipment-blank analyses, the groundwater equipment-blank sample contained detectable concentrations of some major ions and trace elements. The equipment-blank analyses indicated small concentrations (less than 1 mg/L) of calcium, sodium, chloride, and silica. These concentrations were one to three orders of magnitude less than concentrations measured in the environmental samples and were considered to be negligible. The equipment-blank analyses also detected concentrations of barium, boron, copper, iron, lead, nickel, and zinc. Measured concentrations of barium and boron in the equipment-blank sample were two or more orders of magnitude less than concentrations measured in the groundwater samples and were assumed to be negligible. Concentrations of copper, iron, lead, nickel, and zinc in the equipment-blank sample were similar or exceeded concentrations measured in the groundwater samples, with copper and zinc concentrations being the highest. A copper concentration of 5.4 µg/L measured in the equipment-blank sample exceeded concentrations measured in all environmental samples, with 18 of the groundwater samples containing copper concentrations below the reporting level of 0.80 µg/L. The iron concentration of 10.2 µg/L measured in the equipment-blank sample exceeded concentrations measured in 26 of the 30 groundwater samples. The lead concentration of 0.147 µg/L measured in the equipment-blank sample exceeded concentrations measured in 24 of the 30 groundwater samples. The nickel concentration of 0.18 µg/L measured in the equipment-blank sample exceeded concentrations measured in 8 of the 30 groundwater samples. The zinc concentration of 84 µg/L measured in the equipment-blank sample exceeded concentrations measured in 29 of the 30 groundwater samples and was an order of magnitude higher than concentrations measured in 27 of the 30 groundwater samples.

As described previously, it is suspected the deionized water used for cleaning sampling equipment during 2012 at the USGS Oklahoma Water Science Center contained notable concentrations of several trace elements. When following USGS sampling protocol, groundwater-sampling equipment is rinsed with native water in the field before the environmental sample is collected, and any residual contamination from the sampling equipment probably would be removed before sampling occurs. During the purging process of a well to remove water from the casing, native water may flow through sampling equipment for 15 to 30 min, which would have minimized or negated any effects of residual metals content in deionized water used to rinse sampling equipment used for this study.

Groundwater-Quality-Data Analysis

Graphs were made to examine relations between water-property values and major-ion, trace-element, and radionuclide concentrations to pH in groundwater samples. A Piper diagram was made to show water types, trends related to geochemical processes in the sampled aquifers, and possible mixing of water types (Piper, 1944). Concentrations were compared to historical water-quality data collected by the USGS in the study area and to MCL and SMCL drinking-water standards (U.S. Environmental Protection Agency, 2013a, 2013b).

Stream-Water Quality

This section of the report describes water-property measurements in stream samples in addition to water properties measured by continuous monitors at the Harrah station. Concentrations of major ions, nutrients, and trace elements in stream samples are described in addition to fecal-indicator bacteria counts and the frequency of detection of 69 organic compounds.

Water Properties

Dissolved oxygen concentrations in stream-water samples collected at the Harrah station, measured by a real-time continuous monitor, tended to be higher during cooler months (October through February) and decreased in the warmer months with the lowest concentrations being measured during June through September (fig. 4*A*). Daily mean dissolved oxygen concentration measured at the Harrah station ranged from 1.1 mg/L on June 28, 2012, to 13.6 mg/L on December 26, 2012, with the smallest daily concentration being 0.5 mg/L and the highest concentration being 14.3 mg/L (fig. 4*A*). Dissolved oxygen concentrations measured at the Harrah station were highest during January through February and November through January with mean daily concentrations ranging from 8.5 to 13.6 mg/L (fig. 4*A*). Dissolved oxygen concentrations were lowest from June through August, with daily mean concentrations ranging from 1.1 to 9.4 mg/L, and the largest diurnal variations measured during these months ranging as much as 11 mg/L in a 24-hour period (fig. 4*A*). Concentrations of dissolved oxygen typically are lower during warmer months because oxygen solubility decreases as water temperature increases, and the aerobic bacterial decomposition of organic material is more active and likely to consume more oxygen at warmer temperatures. Diurnal variations in dissolved oxygen concentrations in stream water result from photosynthesis and aerobic respiration by algae, microbes, and aquatic plants. During the day, dissolved oxygen concentrations are highest when plants use sunlight for photosynthesis, whereas dissolved oxygen concentrations decrease at night when plant respiration of oxygen exceeds oxygen production (Livingstone, 1963).

Median and mean concentrations of dissolved oxygen measured during sample collection at the four stream sites ranged between 8.8 and 10.6 mg/L and tended to decrease with streamflow at the Harrah and Shawnee stations and increase slightly with streamflow at the Tecumseh station (fig. 5; app. 1). The lowest measured dissolved oxygen concentration was 4.8 mg/L at the Shawnee station measured on May 31, 2012, during high streamflow conditions (fig. 5*A*; app. 1).

Concentrations of dissolved oxygen measured during sample collection at the Harrah station ranged from 7.0 to 12.9 mg/L (app. 1). Dissolved oxygen concentrations (9.2 and 9.4 mg/L) measured during stream-sample collection on June 27 and August 26, 2012, were substantially higher than the largest daily maximums recorded those days (2.2 and 4.3 mg/L) (fig. 4; app. 1). This discrepancy may illustrate the occurrence of large spatial differences in dissolved oxygen concentrations in the stream during the growing season. The continuous dissolved oxygen monitor was in a sheltered location near a bridge, whereas the location of sample collection was approximately 300 ft upstream in an open channel in sunlight.

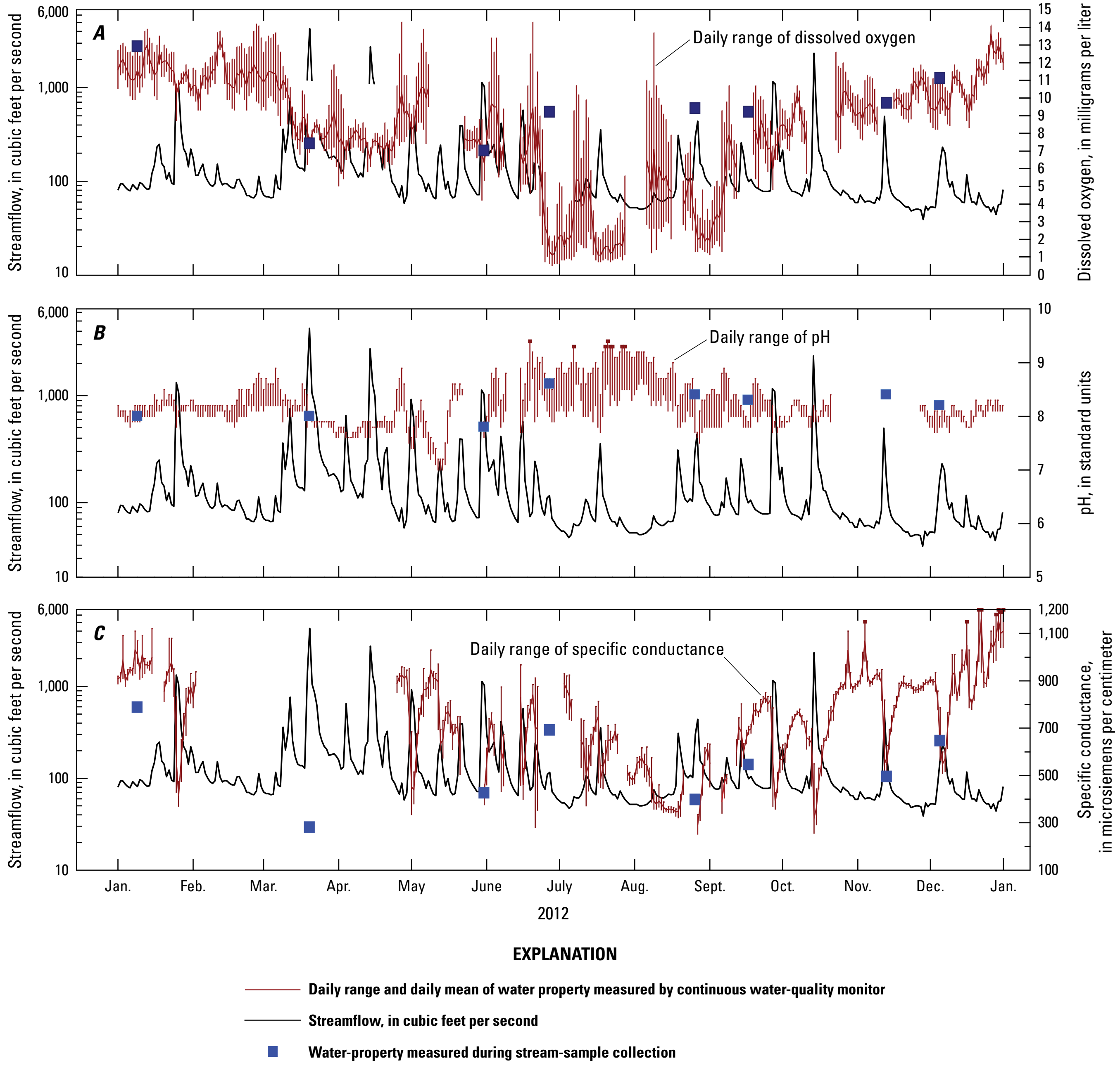


Figure 4. Streamflow and daily range of *A*, dissolved oxygen concentrations; *B*, pH; and *C*, specific conductance measured at the U.S. Geological Survey streamflow-gaging station at the North Canadian River near Harrah, Oklahoma (07241550), near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012.

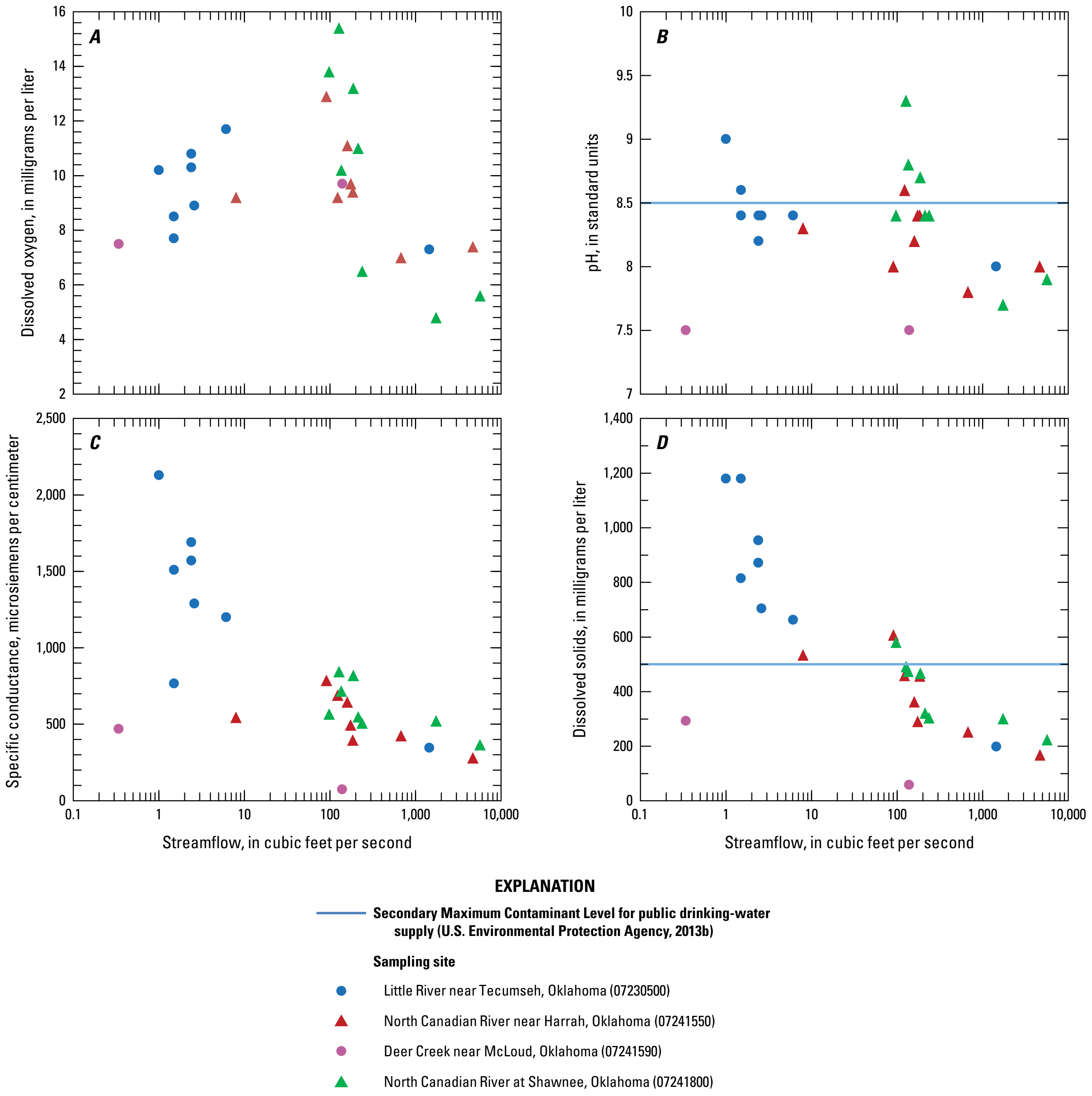


Figure 5. Water properties measured during water-sample collection, *A*, dissolved oxygen concentrations; *B*, pH; *C*, specific conductance; and *D*, dissolved solids concentrations at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

The pH values measured during sample collection at the Harrah, Shawnee, and Tecumseh stations tended to decrease with increasing streamflow (fig. 5*B*). This trend also is seen in continuous real-time measurements of pH (daily range) at the Harrah gage (fig. 4*B*) and is likely to be related to dilution of stream water by precipitation, which can be acidic (pH of 5.4) (National Atmospheric Deposition Program, 2013). At the Harrah station, continuous real-time measurements of pH fluctuated diurnally (similar to dissolved oxygen) particularly during the warmer months (fig. 4*B*). During daylight hours, respiration and photosynthesis of algae and submerged aquatic plants remove carbon dioxide from stream water causing the pH to increase, whereas, during hours of no daylight, this process stops and carbon dioxide concentrations increase, resulting in a decrease in pH (Livingstone, 1963). During the cooler months when aquatic plant growth tends to subside, the daily range of pH at the Harrah gage was generally less than 0.5 standard units in comparison to the summer months of June, July, and August, when the daily pH range periodically exceeded 1 standard unit. The uppermost daily pH values were below 9.0 throughout the year with exception of 4 weeks from June 18 through July 17 when pH values (during daylight hours) periodically exceeded 9.0. pH measured during eight sample collections at the Harrah, Shawnee, and Tecumseh stations ranged from 7.7 to 9.3 (fig. 5*B*; app. 1). The three pH measurements at the Deer Creek site, 7.4, 7.5, and 7.5 (streamflow was not measured on April 10, 2013, so only two samples are shown in fig. 5*B*), were substantially lower than pH measurements at the other three stations, which indicates that runoff from precipitation was a large proportion of streamflow when samples were collected on March 19, 2012, and April 10, 2013 (app. 1); however, a pH of 7.5 also was measured when the January 9, 2012, sample was collected. Streamflow during the January sampling was at base flow and may have represented the pH of shallow groundwater in this area.

Specific conductance measures the ability of water to transmit electricity and is linearly related to the amount of dissolved minerals in the water (U.S. Geological Survey, 2014). Similar to pH, specific conductance and the concentration of dissolved minerals in water (referred to as “dissolved solids”) at the four stream sites decreased with increases in streamflow because of dilution by precipitation runoff, which has a relatively low mineral content. This trend is evident in measurements made during sample collection at the four stream sites and in continuous real-time measurements at the Harrah station (figs. 4*C*, 5*C*, and 5*D*). The largest daily mean specific conductance (1,160 microsiemens per centimeter [µs/cm]) was measured on December 22 and 29, 2012, during base flow (64 and 56 ft^3/s, respectively), whereas the smallest daily mean specific conductance (292 µs/cm) was measured on August 27, 2012, during high flow (438 ft^3/s) at that station.

In drinking water, the SMCL for concentration of dissolved solids is 500 mg/L because high concentrations of this constituent can give water a salty taste, leave mineral deposits on fixtures, or contain constituents that cause staining or water discoloration (U.S. Environmental Protection Agency, 2013a). Water samples collected at the Tecumseh station contained the highest concentrations of dissolved solids of the collected stream-water samples, with 7 of 8 samples containing concentrations exceeding 500 mg/L (app. 1). Dissolved solids concentrations ranged from 199 to 1,180 mg/L at this station, with a median concentration of 844 mg/L (apps. 1 and 8). Dissolved solids concentrations measured in water samples collected at the Harrah and Shawnee stations on the North Canadian River were similar to each other, ranging from 168 to 607 mg/L at the Harrah station and 224 to 581 mg/L at the Shawnee station, with median concentrations of 410 and 394 mg/L, respectively (apps. 1 and 8). The three samples collected at the Deer Creek site had relatively low dissolved solids concentrations of 59, 207, and 293 mg/L (app. 1).

Major Ions

Concentrations and relative proportions of major ions and trace elements in water samples changed in relation to streamflow. Water-quality samples collected at the Harrah, Shawnee, and Tecumseh stations during low streamflows were a sodium-chloride water type, transitioning to a calcium magnesium-bicarbonate water type as streamflow increased (figs. 6*A* and 6*B*).

The SMCL for chloride in drinking water is 250 mg/L for aesthetic reasons because chloride concentrations above 250 mg/L can give water a salty taste (U.S. Environmental Protection Agency, 2013b). All chloride concentrations measured in stream-water samples collected from the North Canadian River were less than the SMCL (app. 1). Chloride concentrations in samples collected at the Tecumseh station ranged from 28.7 to 496 mg/L, with 5 of 8 samples containing chloride concentrations exceeding 250 mg/L (app. 1). These five samples were collected during periods of relatively low streamflow, whereas the two lowest chloride concentrations of 28.7 and 202 mg/L were measured during periods of higher streamflow. Chloride concentration in samples collected at the Harrah and Shawnee stations ranged from 19.9 to 158 mg/L and 27.9 to 143 mg/L, respectively, with median chloride concentrations of 94.6 and 84.1 mg/L, respectively (app. 8). The lowest concentrations of chloride were measured in the three stream-water samples collected at the Deer Creek site: 3.36, 19.8, and 29.9 mg/L (app. 1).

Similar to chloride, the SMCL for sulfate is 250 mg/L for aesthetic reasons in drinking water (U.S. Environmental Protection Agency, 2013b). The SMCL was not exceeded in stream-water samples collected for this study (app. 1). Sulfate concentrations were similar in samples from the Tecumseh, Harrah, and Shawnee stations, with median concentrations of 75.3, 63.4, and 56.8 mg/L, respectively (app. 8). Similar to chloride, stream-water samples collected at the Deer Creek site had the lowest sulfate concentrations: 3.28, 10.7, and 13.9 mg/L (app. 1).

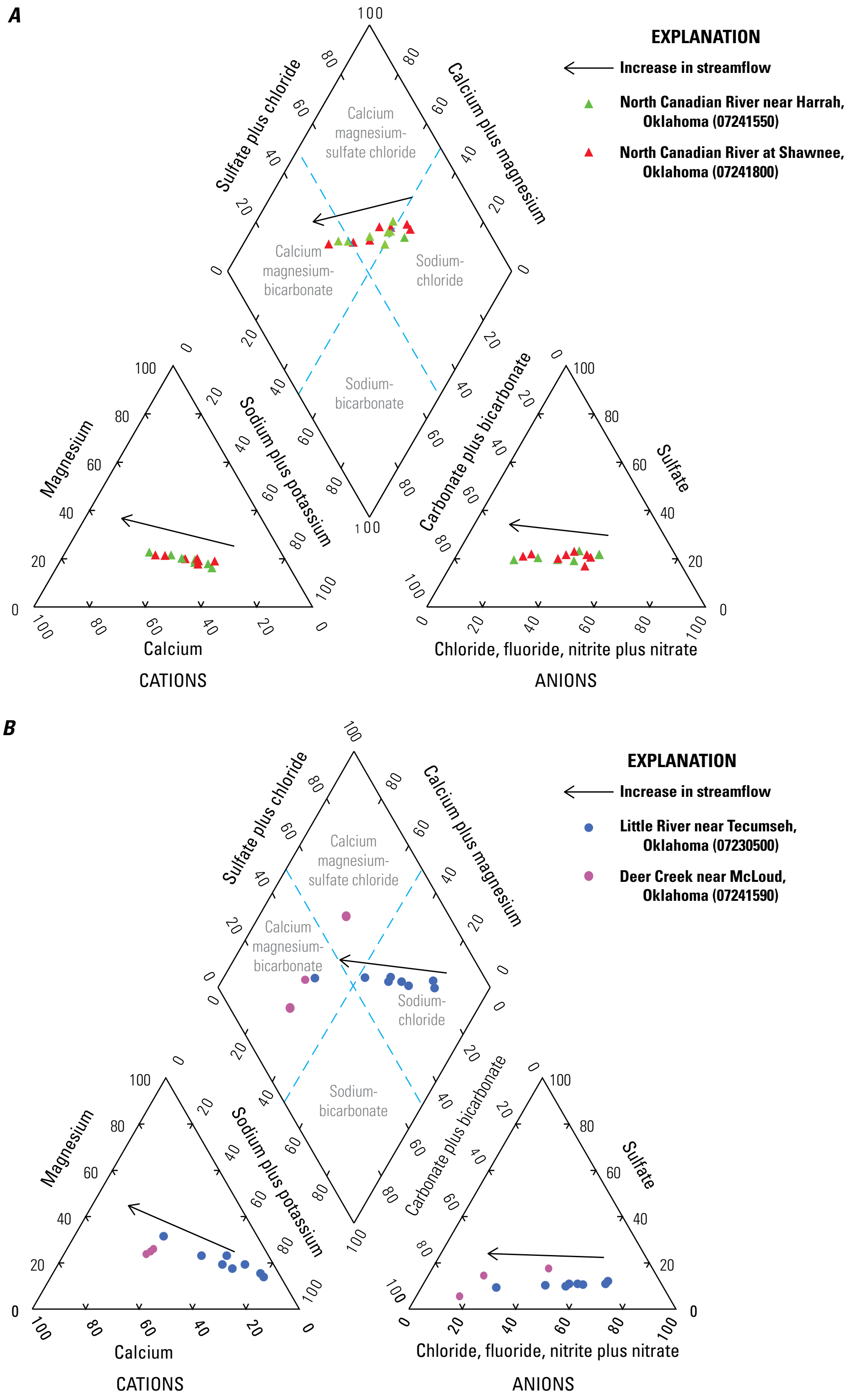


Figure 6. Water types and percentages of cations and anions in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13. *A*, North Canadian River near Harrah, Okla. (07241550), and North Canadian River at Shawnee, Okla. (07241800); and *B* , Little River near Tecumseh, Okla. (07230500), and Deer Creek near McLoud, Okla. (07241590).

Nutrients

The nutrients nitrogen and phosphorus occur naturally in surface water but also are associated with manmade sources such as fertilizers and wastewater effluent. Nationwide, total dissolved nitrogen occurs naturally in streams at a background concentration of about 0.6 mg/L (Dubrovsky and Hamilton, 2010). In agricultural settings, the median total dissolved nitrogen concentration is about 4 mg/L in streams and about 2 mg/L in urban settings nationwide (Dubrovsky and Hamilton, 2010). For this study, total dissolved nitrogen (calculated from the sum of dissolved ammonia plus organic nitrogen and nitrite plus nitrate-nitrogen concentrations) ranged from 1.25 to 9.34 mg/L in stream-water samples collected at the North Canadian River stations, with median concentrations of 4.36 mg/L at the upstream Harrah station and 2.89 mg/L at the downstream Shawnee station (apps. 1 and 8). Total dissolved nitrogen concentrations in stream-water samples collected at the Tecumseh station on the Little River ranged from 0.12 to 1.2 mg/L, with a median concentration of 0.35 mg/L, which is about an order of magnitude lower than total dissolved nitrogen concentrations in stream-water samples collected from the North Canadian River (apps. 1 and 9). Similarly, total dissolved nitrogen concentrations in three stream-water samples collected at the Deer Creek site ranged from 0.35 to 0.88 mg/L, with a median of 0.76 mg/L (apps. 1 and 8). Nitrate-nitrogen was the primary nitrogen species in all stream-water samples collected at the North Canadian River stations, whereas ammonia- and organic-nitrogen concentrations were highest in stream-water samples collected at the Tecumseh station and the Deer Creek site (app. 1). Concentrations of nitrate-nitrogen (and total dissolved nitrogen) in stream-water samples collected at the North Canadian stations were highest at relatively low streamflows and decreased with increasing streamflow (fig. 7*A*; app. 1). A decrease in nitrate-nitrogen concentration with increase in streamflow indicates that point-source discharges may be a substantial source of nitrate-nitrogen in the North Canadian River in this area. Wastewater effluent is discharged nearly continuously from upstream treatment facilities and is diluted by runoff, decreasing the concentration of nitrogen compounds in stream water. A decrease in nitrate-nitrogen concentration with increase in streamflow also was shown by previously collected sample concentrations (Esralew and others, 2011); however, that report indicated that flow-adjusted concentrations of dissolved nitrogen increased with time between 1999 and 2009 at the Harrah station. This trend was attributed to changes in the ratio of wastewater effluent to streamflows that have had decreased low flows since 1999 (Esralew and others, 2011).

Ammonia-nitrogen concentrations increased with increased streamflow in water samples collected at the North Canadian stations from less than 0.010 mg/L as nitrogen at both stations to 0.423 mg/L as nitrogen at the Shawnee station (fig. 7*B*; app. 1). Ammonia-nitrogen concentrations in stream-water samples collected from Little River and Deer Creek did not increase consistently with streamflow, except for one sample collected at the Tecumseh station, which contained a relatively large ammonia-nitrogen concentration of 0.134 mg/L as nitrogen during high streamflow (on March 19, 2012). Similarly, Brigham and others (2002) reported that ammonia-nitrogen concentrations increased with streamflow at the Harrah station, which may have been related to the runoff of animal waste from livestock and wildlife during wet periods. Brigham and others (2002) also reported that the highest concentrations of ammonia were measured during December and January and attributed those concentrations to reduced nutrient uptake by aquatic plants during the winter. The water-quality data collected for this study were insufficient to identify a seasonal trend in the concentration of ammonia nitrogen.

Similar to nitrogen, treated wastewater effluent may be a major source of phosphorus to the North Canadian River upstream from the Harrah and Shawnee stations. Concentrations of total phosphorus and orthophosphorus in stream-water samples collected during low streamflows at the North Canadian River stations were about two orders of magnitude higher than concentrations in stream-water samples collected at the Tecumseh station and the Deer Creek site (figs. 7*C* and 7*D*). Total dissolved phosphorus ranged from 0.132 to 3.22 mg/L in stream-water samples collected at both North Canadian stations, with a median concentration of 1.05 mg/L at the Harrah station and 0.805 mg/L at the Shawnee station (app. 8). These median concentrations are more than three times higher than the median total dissolved phosphorus concentration of about 0.25 mg/L reported for streams in agricultural and urban settings across the United States (Dubrovsky and Hamilton, 2010). Median total dissolved phosphorus concentrations were 0.007 mg/L and 0.032 mg/L in stream-water samples collected from the Tecumseh station and the Deer Creek site, respectively (app. 8).

Orthophosphorus was the major component of total dissolved phosphorus in all stream-water samples collected for this study (apps. 1 and 8). This form of phosphorus is readily taken up by algae and other aquatic plants in streams and lakes during warm months and can cause excessive plant growth, lowering of oxygen concentrations, and increased concentrations of algae-related organic compounds, which can cause foul tastes and odors and kill fish (Mueller and Helsel, 1996). Total dissolved phosphorus and orthophosphorus concentrations are not regulated in stream water except for selected Oklahoma streams designated as Scenic Rivers with a standard of 0.037 mg/L because of concerns about eutrophication (Oklahoma Water Resources Board, 2013b). The North Canadian and Little Rivers and Deer Creek, however, are not designated as Scenic Rivers. All measured concentrations of orthophosphorus and total dissolved phosphorus in North Canadian River samples were above that standard, whereas all concentrations measured

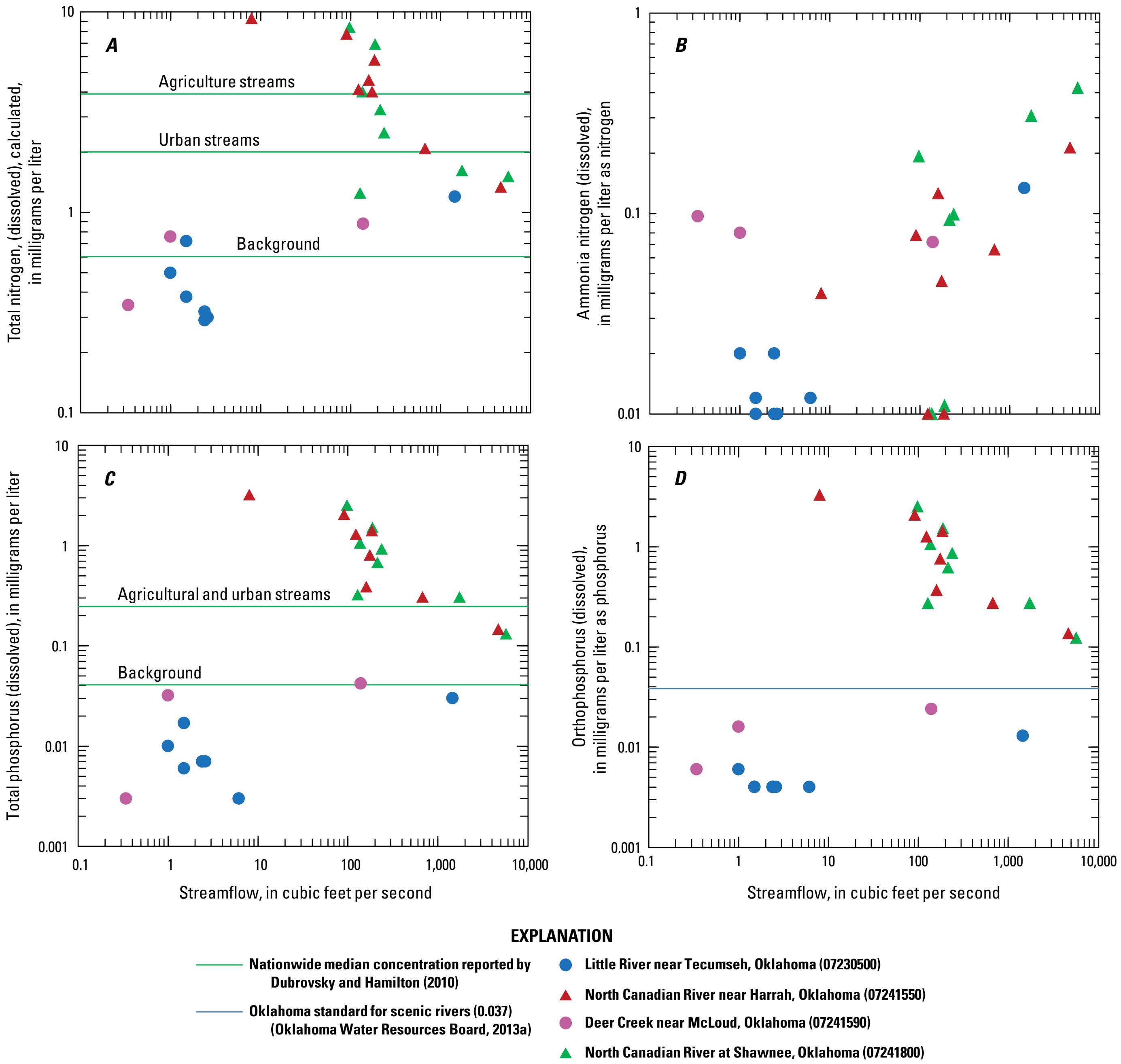


Figure 7. Nutrient concentrations in relation to streamflow, *A*, total dissolved nitrogen; *B*, dissolved ammonia nitrogen; *C*, total dissolved phosphorus; and *D*, dissolved orthophosphorus measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

in samples from the Little River and Deer Creek were less than that standard (fig. 7*D*). Similar to dissolved nitrogen concentrations, Esralew and others (2011) described increases in flow-adjusted dissolved phosphorus concentration at the Harrah station from 1999 to 2009, which was attributed to an increase in the ratio of wastewater effluent to streamflow.

Trace Elements

Concentrations of most trace elements analyzed in stream-water samples collected at the North Canadian River stations increased with increasing streamflow. This relation indicates that these trace elements are washed into the streams with surface-water runoff or resuspended with streambed sediments (fig. 8; app. 2). This relation between trace-element concentrations and streamflow was not evident in stream-water samples collected from the Little River (except for barium) and may be related to the comparatively small size and relatively undeveloped land use of the upstream basin. Trace elements that increased in concentration with streamflow at most of the stations included arsenic, aluminum, barium, cadmium, chromium, cobalt, copper, iron (dissolved and whole), lead, manganese, mercury, nickel, silver, and zinc (figs. 8 and 9; app. 2). Only the concentration of molybdenum notably decreased with increasing streamflow in stream-water samples collected at these four sites (fig. 9*B*; app. 2). Similar to nitrate-nitrogen, this relation indicates that point-source discharges, such as wastewater effluent, may be a local source of molybdenum to stream water.

In general, all whole trace-element concentrations in stream samples were below respective MCLs for public drinking-water supplies, except for one sample with an arsenic concentration of 10.1 µg/L (MCL is 10 µg/L) collected from the North Canadian River at Shawnee and one sample with a barium concentration of 2,690 µg/L (MCL is 2,000 µg/L) collected from the Little River. Both of those water samples were collected during high streamflows, 5,700 ft^3/s and 1,450 ft^3/s, respectively.

Lead has a nonenforceable MCL goal of zero in drinking water because research has determined that there is no safe level of human exposure to lead (U.S. Environmental Protection Agency, 2014). When the concentration of lead exceeds 15 µg/L in more than 10 percent of samples collected from public drinking-water systems, suppliers are required to take further steps to reduce public exposure (table 5; U.S. Environmental Protection Agency 2013a; 2013b). At least one water sample collected from each of the four stream sites had a lead concentration exceeding the 15-µg/L SMCL (fig. 8; app. 2). Those samples were collected during relatively high streamflows.

The SMCL for iron in public drinking-water supplies is 300 µg/L because concentrations greater than 300 µg/L might result in staining of plumbing fixtures and a metallic taste (U.S. Environmental Protection Agency, 2013b). Concentrations of dissolved iron were below the SMCL in all of the collected stream-water samples (app. 2). Comparison of dissolved and whole concentrations of iron indicates that a large proportion of the iron in those samples is associated with particulate material in the stream. Whole concentrations of iron were about one order of magnitude higher than dissolved iron concentrations in stream-water samples collected at the Tecumseh station and about two to three orders of magnitude higher than dissolved concentrations in the stream-water samples collected at the North Canadian River stations (fig. 8; app. 2). Whole concentrations of iron in samples collected from the North Canadian River ranged from 207 to 21,200 µg/L, with median concentrations of 1,225 and 2,140 µg/L in samples from the Harrah and Shawnee stations, respectively, whereas whole iron concentrations in samples collected from the Little River ranged from 74.1 to 41,400 µg/L, with a median concentration of 139 µg/L (app. 8).

Fecal-Indicator Bacteria

Total coliform bacteria and *Escherichia coli* (*E. coli*) bacteria were analyzed in stream-water samples collected four times at the Harrah, Shawnee, and Tecumseh stations beginning the last week of March 2012 through the third week of September 2012. Coliform bacteria are associated with animal waste and soils and are used as a general indicator of possible health risks posed by water used for drinking and recreation in which there is a possibility of contact and ingestion (U.S. Environmental Protection Agency, 2013c). *E. coli* bacteria are used as an indicator of animal waste because this species of bacteria lives in the lower intestine of warmblooded animals (U.S. Environmental Protection Agency, 2013c). Most strains of *E. coli* are harmless, but the presence of *E. coli* may indicate the potential presence of pathogenic bacteria and other microorganisms that can cause serious illnesses (U.S. Environmental Protection Agency, 2006).

In Oklahoma, raw water used for public drinking-water supply has a limit of 5,000 colonies per 100 milliliters (mL) for total coliform bacteria (30-day geometric mean), with no more than 5 percent of the samples during such a time period exceeding 20,000 colonies per 100 mL (Oklahoma Water Resources Board, 2013b). Additionally, where there is a possibility of body contact or ingestion during recreation, a primary body-contact criterion requires that *E. coli* counts should not exceed 126 colonies per 100 mL (30-day geometric mean) (Oklahoma Water Resources Board, 2013b).

Total coliform counts ranged from 6,600 to 160,000 colonies per 100 mL at the Tecumseh station; from 10,000 to 240,000 colonies per 100 mL at the Harrah station; and from 10,000 to 1,300,000 colonies per 100 mL at the Shawnee station (app. 1). *E. coli* counts ranged from 31 to 5,100 colonies per 100 mL in stream-water samples collected at the Harrah station and less than 10 to 7,500 colonies per 100 mL in stream-water samples collected at the Shawnee station. *E. coli* counts in stream-water samples collected at the Tecumseh station ranged from 10 to 8,800 colonies per 100 mL (app. 1).

Organic Compounds

Sixty-nine organic compounds were analyzed and divided into categories on the basis of common use or sources. These organic compounds included 8 fecal indicators or plant sterols, 11 PAHs, 8 detergent metabolites, 14 industrial compounds, 11 pesticides, 12 personal care products (PCPs), and 5 fire retardants. Some organic compounds have multiple uses or sources; for example, carbazole is a PAH and is categorized as a PAH but also is used as an insecticide and in the manufacture of dyes, explosives, and lubricants (table 3).

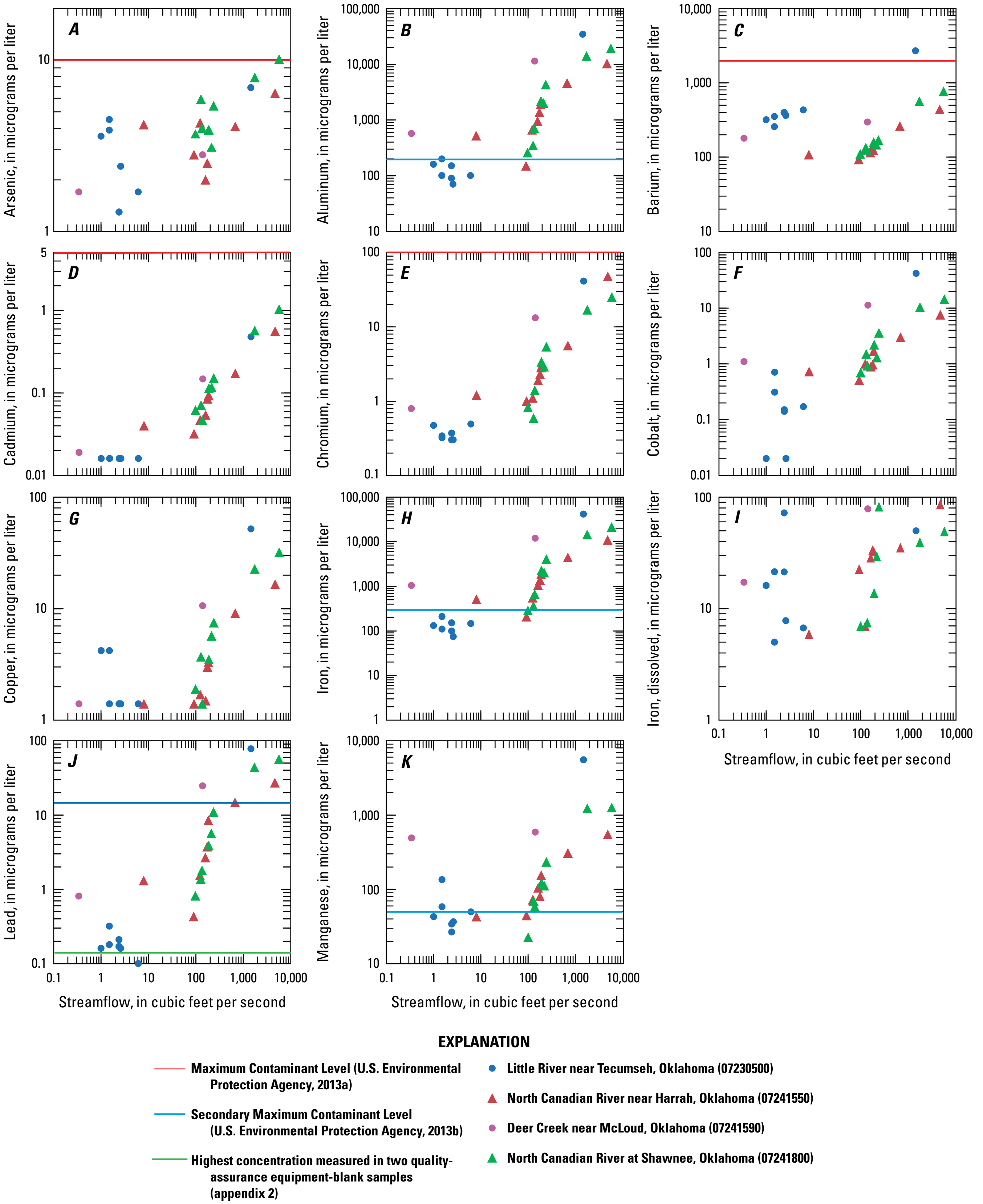


Figure 8. Trace-element concentrations in relation to streamflow, *A*, arsenic; *B*, aluminum; *C*, barium; *D*, cadmium; *E*, chromium; *F*, cobalt; *G*, copper; *H*, iron; *I*, iron (dissolved); *J*, lead, and *K*, manganese measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

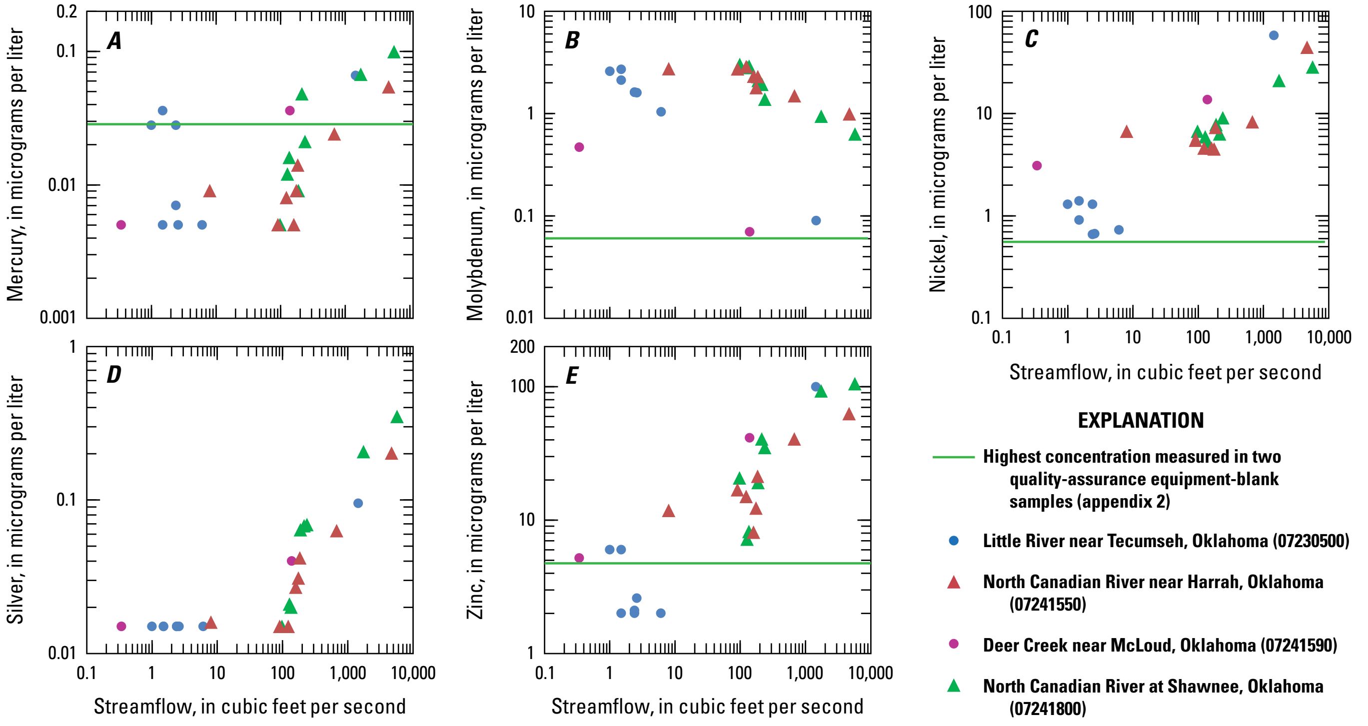


Figure 9. Trace-element concentrations in relation to streamflow, *A*, mercury; *B*, molybdenum; *C*, nickel; *D*, silver, and *E*, zinc measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

Of the 69 organic compounds analyzed for this study, 26 compounds are known or suspected endocrine disruptors that can influence or interfere with the hormonal system of growing organisms (Rhomberg and Seeley, 2005; Tulane and Xavier Universities, 2009), causing reproductive and developmental problems (table 3). In humans, the potential health effects of these compounds are uncertain, but research has shown that the consumption of low concentrations of some organic compounds or mixtures can contribute to female reproductive disorders (Crain and others, 2008). There also is speculation of other health concerns from exposure to small concentrations of these compounds, especially to growing embryos and fetuses (Tulane and Xavier Universities, 2009).

A greater number of organic compounds were detected in stream-water samples collected at the two stations on the North Canadian River than in stream-water samples collected at the Tecumseh station and Deer Creek site (figs. 10*A* and 10*B*). This difference may be related to the larger basin size and more diverse land uses of the North Canadian River and the presence of upstream metropolitan areas and wastewater-treatment facilities in that basin. In the 8 stream-water samples collected at the upstream Harrah station, 213 detections of organic compounds were measured, whereas in 8 samples collected at the downstream Shawnee station, 203 detections of organic compounds were measured. In contrast, 59 detections of organic compounds were measured in the 8 stream-water samples collected at the Tecumseh station, and 25 detections of organic compounds were measured in the 3 stream-water samples collected at the Deer Creek site; however, the 8 detections of 7 organic compounds in the 2 equipment-blank samples is problematic for evaluating these data, especially for the Deer Creek and Little River samples because of the comparatively low detection frequency and should be taken into consideration when evaluating these results.

Fecal indicators are a group of organic compounds that indicate the presence of fecal material in water. Some organic compounds occur naturally in the fecal material from livestock and humans, such as cholesterol and 3-beta-coprostanol, whereas other fecal indicators such as caffeine and cotinine (metabolite of nicotine) are excreted exclusively by humans (Glassmeyer and others, 2005). Cholesterol was the most prevalent fecal indicator in water samples and was detected in all stream-water samples collected at the Shawnee station, in 7 of 8 stream-water samples collected at the Tecumseh and Harrah stations, and in 2 of 3 samples collected at the Deer Creek site (app. 3). Caffeine also was prevalent, with detections in all samples collected from the North Canadian River at the Harrah and Shawnee stations and in 2 of 3 samples collected at the Deer Creek site. Cotinine,

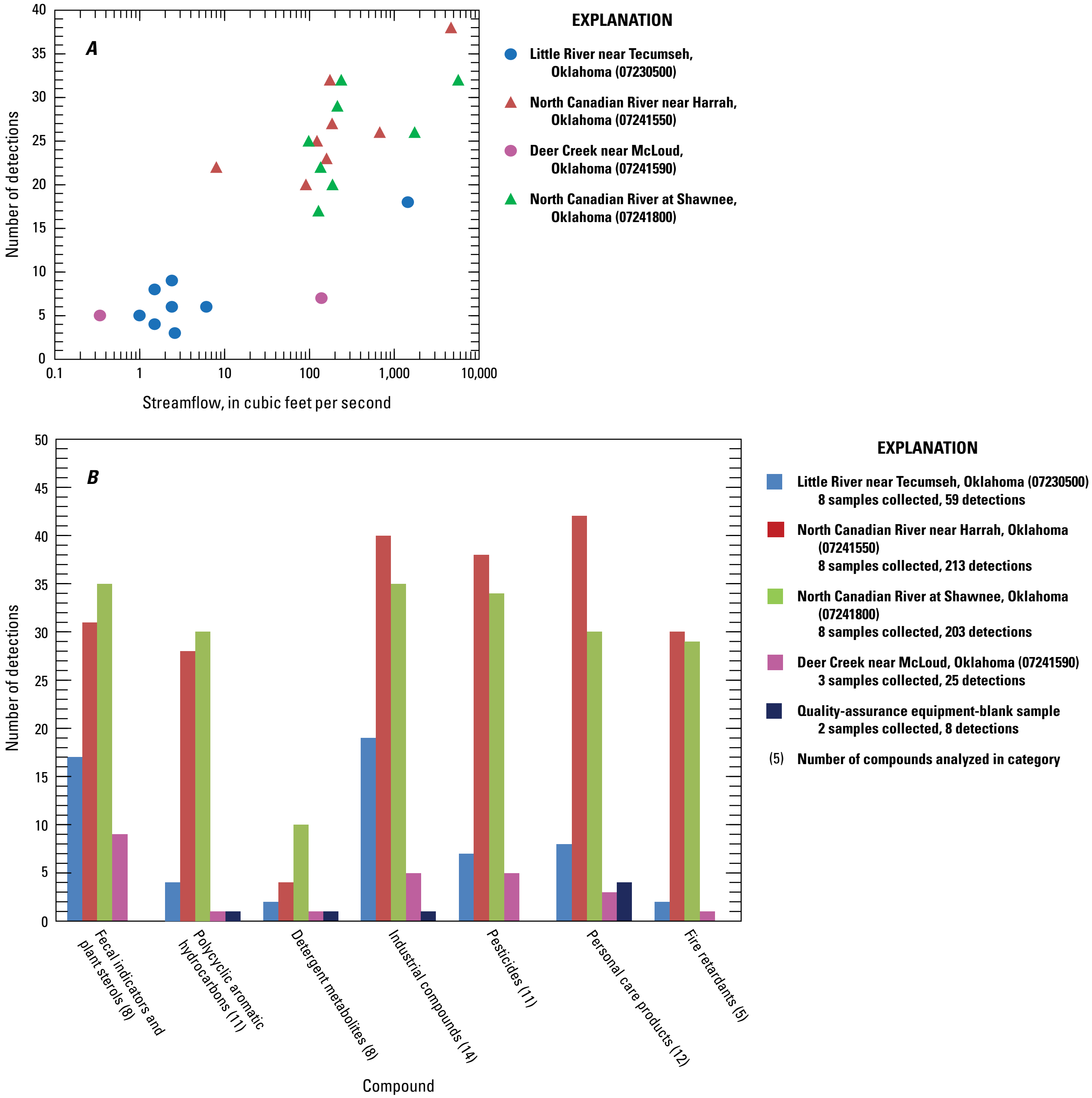


Figure 10. The detection frequency of 69 organic compounds, *A*, with streamflow, and *B*, of categories that include fecal indicators and plant sterols, polycyclic aromatic hydrocarbons, and 5 categories of synthetic organic compounds: detergent metabolites, industrial compounds, pesticides, personal-care product compounds, and fire retardants, measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

a metabolite of nicotine, was detected in 5 of 8 stream-water samples collected at the Harrah station and 3 of 8 samples collected at the Shawnee station but was not detected in stream-water samples collected at the Tecumseh station or the Deer Creek site. Caffeine and cotinine were not detected in the stream-water samples collected at the Tecumseh station, which may be related to the absence of wastewater-treatment facilities in the upstream basin. The fecal indicator 3-beta-coprostanol was detected in at least one stream-water sample collected at the Shawnee, Harrah, and Tecumseh stations. Indole, a component of fragrances and pesticides was detected in 5 of 8 stream-water samples collected at the Tecumseh station and in 2 of 3 stream-water samples collected at the Deer Creek site but was not detected in any stream-water samples collected at the Harrah and Shawnee stations. Commonly referred to as “skatole,” the fecal indicator 3-methyl-1H-indole was detected only at the Deer Creek site (in 2 of 3 stream-water samples).

The plant sterols beta-Sitosterol and beta-Stigmastanol occur naturally in plants and plant-based foods and are sometimes used as food supplements for humans and in the manufacture of drugs. These compounds are plant sterols but also may indicate the presence of fecal material. Beta-Sitosterol was more frequently detected than beta-Stigmastanol in stream-water samples collected at all four sites: in 6 of 8 stream-water samples collected at the Harrah station, in 7 of 8 stream-water samples collected at the Shawnee station, in 3 of 8 stream-water samples collected at the Tecumseh station, and in 1 of 3 stream-water samples collected at the Deer Creek site (app. 3). Beta-Stigmastanol was detected in only 1 of 8 stream-water samples collected at the Tecumseh and Harrah stations and in 3 of 8 stream-water samples collected at the Shawnee station. This plant sterol was not detected in any of the three stream-water samples collected at the Deer Creek site.

The polycyclic aromatic hydrocarbons (PAHs) compose a large group of organic compounds that are formed by the incomplete combustion of coal, oil, gas, wood, and other organic substances and commonly are detected in soil, water, or attached to particulates in air (U.S. Environmental Protection Agency, 1995). Some PAHs are used in the manufacture of explosives, dyes, and mothballs, found in cigarette smoke, and used in cancer research (U.S. Environmental Protection Agency, 1995). Of the 11 PAHs analyzed in stream-water samples for this study, only benzo(a) pyrene is considered to be an endocrine disruptor (U.S. Environmental Protection Agency, 2011).

A total of 28 detections of 7 PAHs were measured in 8 stream-water samples collected at the Harrah station, and a total of 30 detections of 8 PAHs were measured in 8 stream-water samples collected at the Shawnee station. One PAH (9,10-anthraquinone) was detected in 1 of 3 stream-water samples collected at the Deer Creek site. Four PAHs were detected in the stream-water sample collected at the Tecumseh station on March 19, 2012, during relatively high streamflow conditions. Benzo(a)pyrene was detected in four samples collected at both of the North Canadian River stations but was not detected in stream-water samples collected at the Tecumseh station and Deer Creek site (app. 3).

Synthetic organic compounds (SOC) are manmade organic compounds that are used in agriculture, pharmaceuticals, chemical manufacturing, and PCPs. These compounds may enter streams in surface-water runoff from agricultural and urban land-use areas and in treated wastewater effluent from municipal wastewater-treatment facilities. The detection and types of SOCs in groundwater and surface water have been the focus of many studies since 2000 (Galloway and others, 2004; Masoner and Mashburn, 2004; Tertuliani and others, 2008). Fifty SOCs were grouped into five categories on the basis of common uses of these compounds: (1) 8 detergent metabolites, (2) 14 industrial compounds (plasticizers, solvents, and compounds used in the manufacture of various products), (3) 11 pesticides, (4) 12 PCPs, and (5) 5 flame retardants. Of the 50 SOCs, 24 are known or suspected endocrine disruptors (table 3).

Detergent metabolites were detected most frequently in stream-water samples collected at the downstream Shawnee station on the North Canadian River. Of the 8 detergent metabolites, 4 were detected one time in the 8 stream-water samples collected at the Harrah station. Five detergent metabolites were detected in stream-water samples collected at the Shawnee station, for a total of 10 detections in the 8 stream-water samples. Two detergent metabolites were detected in 2 of the 8 stream-water samples collected at the Tecumseh station. One detergent metabolite was detected in one stream-water sample collected at the Deer Creek site. All of the detergent metabolites analyzed are known or suspected endocrine disruptors (table 3).

Of the 14 industrial compounds, 10 were detected at the Harrah station, with a total of 40 detections in 8 stream-water samples (fig. 10*B*). Three of these compounds are known or suspected endocrine disruptors: (1) 1,4-dichlorobenzene, (2) bis(2-ethylhexyl) phthalate, and (3) bisphenol A (table 3). The industrial compounds with the greatest number of detections in stream-water samples (5 of 8) collected at the Harrah station were 3,4-dichlorophenyl isocyanate, 5-Methyl-1H-benzotriazole, bisphenol A, isophorone, and triphenyl phosphate (table 3).

Of the 14 industrial compounds, 6 were detected at the Shawnee station, with a total of 35 detections in 8 stream-water samples (fig. 10*B*). Two of these compounds are known or suspected endocrine disruptors: (1) 3,4-dichlorophenyl isocyanate and (2) bisphenol A. Four industrial compounds were detected in at least 5 of 8 stream-water samples collected at the Shawnee station: (1) 3,4-dichlorophenyl isocyanate, (2) 5-Methyl-1H-benzotriazole, (3) isophorone, and (4) triphenyl phosphate (app. 3).

Eight of 14 industrial compounds were detected in the stream-water samples collected at the Tecumseh station, with a total of 19 detections (fig. 10*B*). Three of these compounds are known or suspected endocrine disruptors: (1) bis(2-ethylhexyl) phthalate, (2) bisphenol A, and (3) diethyl phthalate. The solvents isophorone and tribromomethane were the two most commonly detected industrial compounds, detected in 6 of 8 and 5 of 8 samples, respectively, collected at the Tecumseh station. Detected concentrations of these two compounds were low—less than 0.1 µg/L (app. 3); neither of these compounds are known or suspected endocrine disruptors.

Four of 14 industrial compounds were detected in stream-water samples collected at the Deer Creek site, with a total of 5 detections in 3 samples (fig. 10*B*; app. 3). One compound detected, bisphenol-A (a plasticizer), is a known or suspected endocrine disruptor. The wood preservative p-cresol was detected in 2 of the 3 stream-water samples (app. 3).

Six of 11 pesticides analyzed—atrazine, bromacil, carbaryl, metolachlor, pentachlorophenol, and prometon—were detected in at least one stream-water sample collected at both the Harrah and Shawnee stations, with bromacil, a general use herbicide, and N,N-Diethyl-m-toluamide (DEET), used to repel biting insects, being detected in all eight stream-water samples collected at both of those stations (app. 3). Dichlorvos, an insecticide, also was detected in 1 of 8 stream-water samples collected at the Harrah station during relatively high-flow conditions.

Metolachlor, DEET, and pentachlorophenol were the only pesticides detected in stream-water samples collected at the Tecumseh station, with DEET detections in the five stream-water samples collected from January through August 2012 at that station. Atrazine, metolachlor, and pentachlorophenol were detected in 1 of 3 stream-water samples collected at the Deer Creek site, and DEET was detected in 2 of 3 stream-water samples collected at that site. Of these analyzed organic compounds, only atrazine and pentachlorophenol concentrations are regulated in drinking water by the EPA and have MCLs of 3 µg/L and 1 µg/L, respectively (table 3) (U.S. Environmental Protection Agency, 2013a). Measured concentrations of these pesticides were low compared to those standards; the highest atrazine concentration was 0.51 µg/L, and the highest pentachlorophenol concentration was 0.4 µg/L in stream-water samples collected at the North Canadian River stations. Atrazine, bromacil, chlorpyrifos (common name Dursban), diazinon, metolachlor, DEET, pentachlorophenol, and prometon were historically detected in stream-water samples collected at these North Canadian River stations (Becker, 2010; Esralew and others, 2011) (table 3). Esralew and others (2011) reported that the frequency of detection of atrazine, chlorpyrifos, and diazinon in stream-water samples from the Harrah station decreased from 1988 to 2009, whereas the frequency of detection of bromacil increased from 1991 to 2009. Neither of the insecticides diazinon or chlorpyrifos was detected in the stream-water samples collected for this study nor in stream-water samples collected for Becker (2010), which may be related to the discontinuation for residential use of diazinon in 2004 and chlorpyrifos in 2001 (U.S. Environmental Protection Agency, 2002; 2012b).

The PCPs are a diverse group of organic compounds that are found in products used for human and animal health, in association with cleaning products, and for cosmetic purposes (U.S. Environmental Protection Agency, 2012a). These compounds include fragrances (such as galaxolide), antimicrobial agents (triclosan), and ultraviolet blockers (methyl salicylate). Seven of 12 PCP compounds analyzed were detected in stream-water samples collected at the Harrah station, with a total of 42 detections. Six PCP compounds were detected in stream-water samples collected at the Shawnee station, with a total of 30 detections (fig. 10*B*). Four of the compounds detected at both sites are known or suspected endocrine disruptors: (1) tonalide (AHTN) (musk fragrance), (2) benzophenone (ultraviolet blocker), (3) triclosan (antimicrobial), and (4) galaxolide (HHCB) (musk fragrance) (table 3).

Four of 12 PCP compounds were detected in the 8 stream-water samples collected at the Tecumseh station, with a total of 8 detections (fig. 10*B*). One of those detected compounds, benzophenone, is a known or suspected endocrine disruptor. Camphor (an odorant) was the only PCP compound detected in stream-water samples collected at the Deer Creek site and was detected in each of the three samples collected at this site.

Four of five analyzed flame retardants were detected in the stream-water samples collected at the North Canadian River stations, with a total of 30 detections at the Harrah station and 29 detections at the Shawnee station (fig. 10*B*). Two of the flame retardants are known or suspected endocrine disruptors: (1) tris(2-chloroethyl) phosphate and (2) tris(dichloroisopropyl) phosphate. One flame retardant, tris(2-butoxyethyl) phosphate, was detected twice in the eight stream-water samples collected at the Tecumseh station. The flame retardant tris(dichloroisopropyl) phosphate was detected in 1 of the 3 stream-water samples collected at the Deer Creek site (app. 3).

Groundwater Quality

Water from bedrock aquifers is used for many purposes in the CPN TJA, except for high volume irrigation because of inadequate well yields. Water from alluvial aquifers is used for irrigation, livestock, and industry; whereas water from terrace aquifers is limited to domestic use and other uses for which small amounts of water are sufficient (Oklahoma Water Resources Board, 2013a). Of the 30 wells sampled for this study, 26 were completed in the bedrock aquifers, and 4 were completed in the terrace or alluvial aquifers. Twenty-six of the sampled wells were used for domestic purposes, one was used for livestock, one was used for industrial purposes, one was used for commercial purposes, and one was unused (table 2).

The chemical characteristics of groundwater in the Garber-Wellington aquifer have been shown to change with residence time and with depth; older water generally is in deeper parts of the aquifer (Parkhurst and others, 1996). The chemical quality of water changes with an increase of residence time in an aquifer. Such changes include an increase in dissolved solids concentration with the constituent concentrations showing a relation to the chemical composition of the aquifer rocks and biogeochemical processes in the aquifer (Plummer and Back, 1980; Ayotte and others, 2011). In addition to an increase in dissolved solids concentration, the chemical evolution of groundwater in the Garber-Wellington aquifer is indicated by a process referred to as “cation exchange” in which calcium and magnesium cations in groundwater exchange with sodium cations present in clays. The cation-exchange process, along with the dissolution of carbonate minerals in the aquifer, causes groundwater to become sodium rich and the pH in parts of this aquifer to become alkaline (increase to pH values above 8). These chemical changes can cause mobilization of oxyanions of arsenic, chromium, selenium, and uranium, and other trace elements, if these trace elements are present in the aquifer rocks along groundwater flow paths (Schlottmann and others, 1998).

The chemical characteristics of the 30 groundwater samples collected for this study generally follow the geochemical trend of increasing pH relative to increasing concentrations of sodium (relative to calcium and magnesium) and selected trace elements; however, this geochemical trend in water samples does not appear to be related to well depth as would be expected because older water is found at deeper depths in the Garber-Wellington aquifer as described by Parkhurst and others (1996). This discrepancy may result from a common well-construction technique of using loose sand (filter pack) to fill the void space between the borehole and the well casing from the bottom of the hole to about 10–20 ft below land surface (Driscoll, 1986; Oklahoma Water Resources Board, 2013c), which allows water from multiple water-bearing zones to enter the borehole. As a result, water produced from wells completed in bedrock aquifers can be a mixture of groundwater from many zones, which complicates identifying areas or zones that may have distinctive or undesirable water-quality characteristics; for example, well w6 has a total depth of 220 ft and has openings in the casing from 170 to 180 ft and from 210 to 220 ft in the Garber-Wellington aquifer. The drillers log, however, shows that the alluvium at this location underlies the land surface to about 105 ft in depth, and even though the well casing does not have openings through this zone (Oklahoma Water Resources Board, 2012), the low dissolved oxygen concentration and the high concentrations of dissolved solids, iron, and manganese indicate that water from the alluvial aquifer may be a substantial component of the water produced from this well.

Water Properties

Field measurements of dissolved oxygen in water samples collected from the 30 wells ranged from 0.9 to 9.7 mg/L, with a median concentration of 6.6 mg/L (apps. 5 and 9). Water collected from wells w6 and w13 had the lowest dissolved oxygen concentrations (0.9 and 1.1 mg/L, respectively) and also had an associated hydrogen sulfide odor, indicating anaerobic conditions and sulfate reduction. Groundwater in bedrock aquifers in the COA generally is oxygen saturated (Parkhurst and others, 1996); however, water from alluvial aquifers commonly has low concentrations or is absent of dissolved oxygen (anaerobic conditions) because of the presence and consumption of large amounts of organic material by bacteria in the unconsolidated sediments (Appelo and Postma, 1999).

Field measurements of pH in water samples collected from wells w1–w30 ranged from 5.0 to 8.4, with a median value of 6.8 (fig. 11*A*; app. 9). The SMCL for pH ranges from 6.5 to 8.5 for effects not related to health (U.S. Environmental Protection Agency, 2013b). Water having pH values of 6.5 and below may have a bitter metallic taste and may be corrosive to plumbing fixtures, whereas water having pH values of 8.5 and above may have a soda taste, feel slippery, and leave mineral deposits on plumbing fixtures (U.S. Environmental Protection Agency, 2013b). Values of pH below the SMCL of 6.5 were measured in water samples collected from eight wells. Six of the eight wells producing water with pH values below 6.5 were in the northwestern part of the CPN TJA (w1, w2, w3, w8, w9, and w12) and were completed to yield water from the Garber Sandstone or the upper part of the Wellington Formation (figs. 1 and 11*A*). The highest pH (8.4) was measured in the water sample collected from well w25 located west of the CPN TJA (figs. 1 and 11*A*) in a part of the COA where high pH values have been associated with high concentrations of arsenic, chromium, and selenium (Smith and others, 2009). The arsenic concentration in the water sample collected from this well was 9.8 µg/L, the highest measured in groundwater in this study.

Previously collected data indicate that the highest pH values occur along the northern areas of the CPN TJA in groundwater from the deep parts of the Wellington Formation; along the eastern edge of the CPN TJA in the Chase, Council Grove, and Admire Groups; and along the western edge of the CPN TJA in deep wells completed in the Garber Sandstone (fig. 11*A*) (U.S. Geological Survey, 2013a). Previously collected pH values indicate that the northwestern quadrant of the CPN TJA tends to be underlain by groundwater with the lowest pH values. Water produced from the terrace and alluvial aquifers along the North Canadian River had a wide range of pH values (fig. 11*A*), indicating the different aquifers from which groundwater in that area is produced and comingled. Groundwater from deeper sections of the Garber-Wellington aquifer in this area generally has high pH values, whereas groundwater from shallow wells completed in the alluvial aquifers generally has neutral pH values, and groundwater from shallow wells completed in the terrace aquifers generally has low pH values (Becker, 2013).

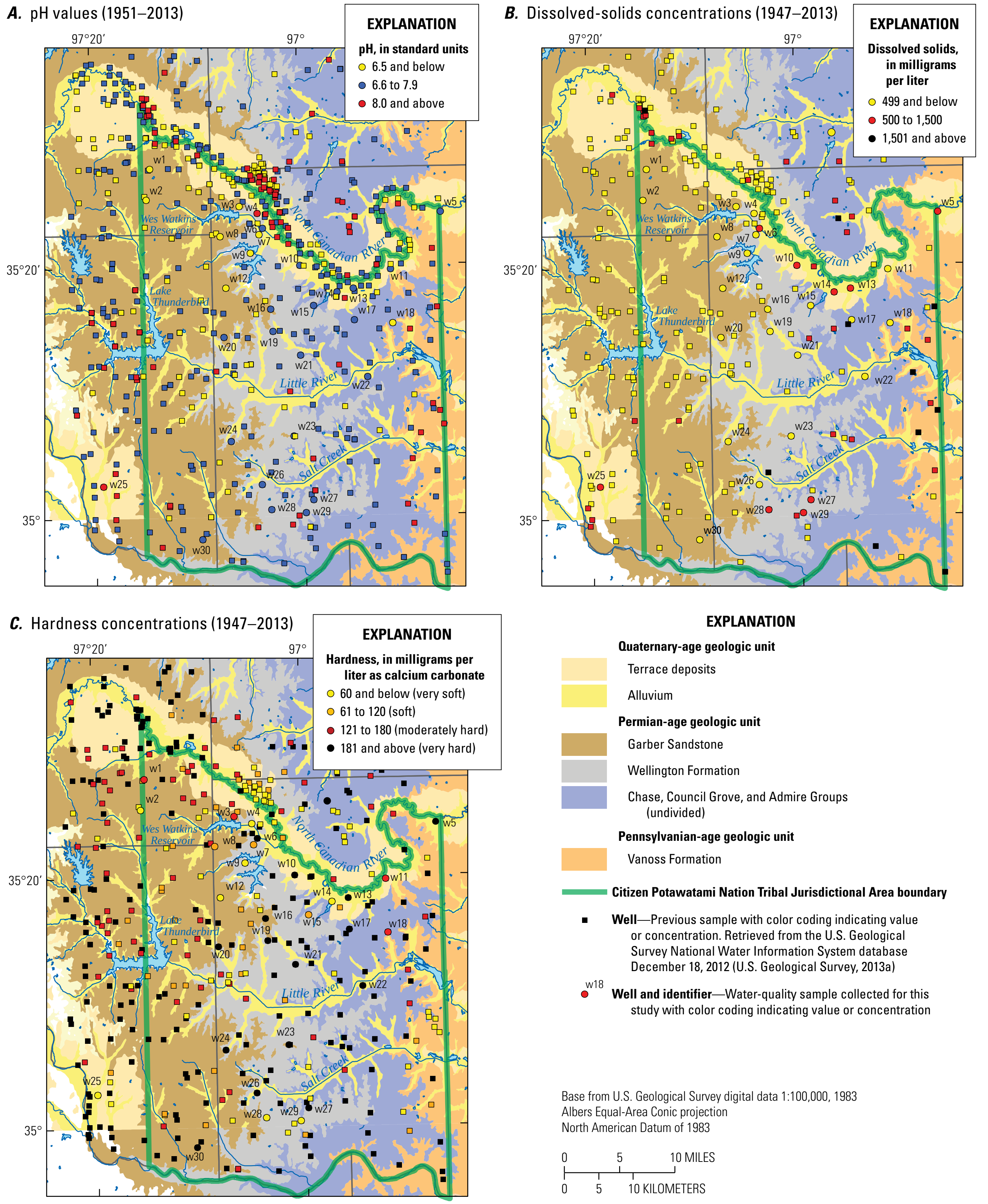


Figure 11. Groundwater-quality data collected for this study and previously collected data from wells in and surrounding the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma. *A*, pH values (1951–2013); *B*, dissolved solids concentrations (1947–2013); and *C*, hardness concentrations (1947–2013).

Field measurements of specific conductance, which is related to the concentration of dissolved solids in water, ranged from 89 to 1,920 microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C), with a median value of 596 µS/cm at 25 °C in water from the 30 wells (apps. 5 and 9). Concentrations of dissolved solids in these groundwater samples ranged from 55 to 1,280 mg/L, with a median concentration of 364 mg/L (app. 9). Water samples collected from nine wells (w5, w6, w10, w13, w14, w25, w27, w28, and w29) exceeded the drinking-water SMCL for dissolved solids of 500 mg/L (U.S. Environmental Protection Agency, 2013b) (app. 6). Five of those wells (w5, w6, w10, w13, and w14) were near to or completed in the North Canadian River alluvium (fig. 11*B*). Water from the alluvial aquifers along the North Canadian River tends to contain relatively high concentrations of dissolved solids (in addition to iron and manganese) (fig. 11*B*). Previously collected groundwater samples from the bedrock aquifer show the lowest concentrations of dissolved solids were in the western one-third of the CPN TJA and increased in an easterly direction, with the highest dissolved solids concentrations measured in samples from the Wellington Formation; the Chase, Council Grove, and Admire Groups; and the Vanoss Formation (fig. 11*B*) (U.S. Geological Survey, 2013a).

Water hardness is related to the concentrations of calcium and magnesium and minor amounts of other constituents in groundwater and is a characteristic commonly used to evaluate usability and treatment needs of water supplies. Water hardness concentration in water samples was calculated from dissolved concentrations of calcium and magnesium and is expressed as calcium carbonate ($CaCO_3$). Water hardness concentration in water samples collected from these 30 wells ranged from 19 to 465 mg/L as $CaCO_3$, with a median concentration of 180 mg/L as $CaCO_3$ (apps. 5 and 9). Hardness concentrations exceeding 180 mg/L as $CaCO_3$ are considered to be very hard (U.S. Geological Survey, 2013e). Fifteen groundwater samples contained hardness concentrations ranging from 190 to 465 mg/L as $CaCO_3$. Wells producing groundwater classified as soft (61 to 120 mg/L as $CaCO_3$) to moderately hard (121 to 180 mg/L as $CaCO_3$) are most common to the north and northeast of Lake Thunderbird and to the west of the Wes Watkins Reservoir (fig. 11*C*).

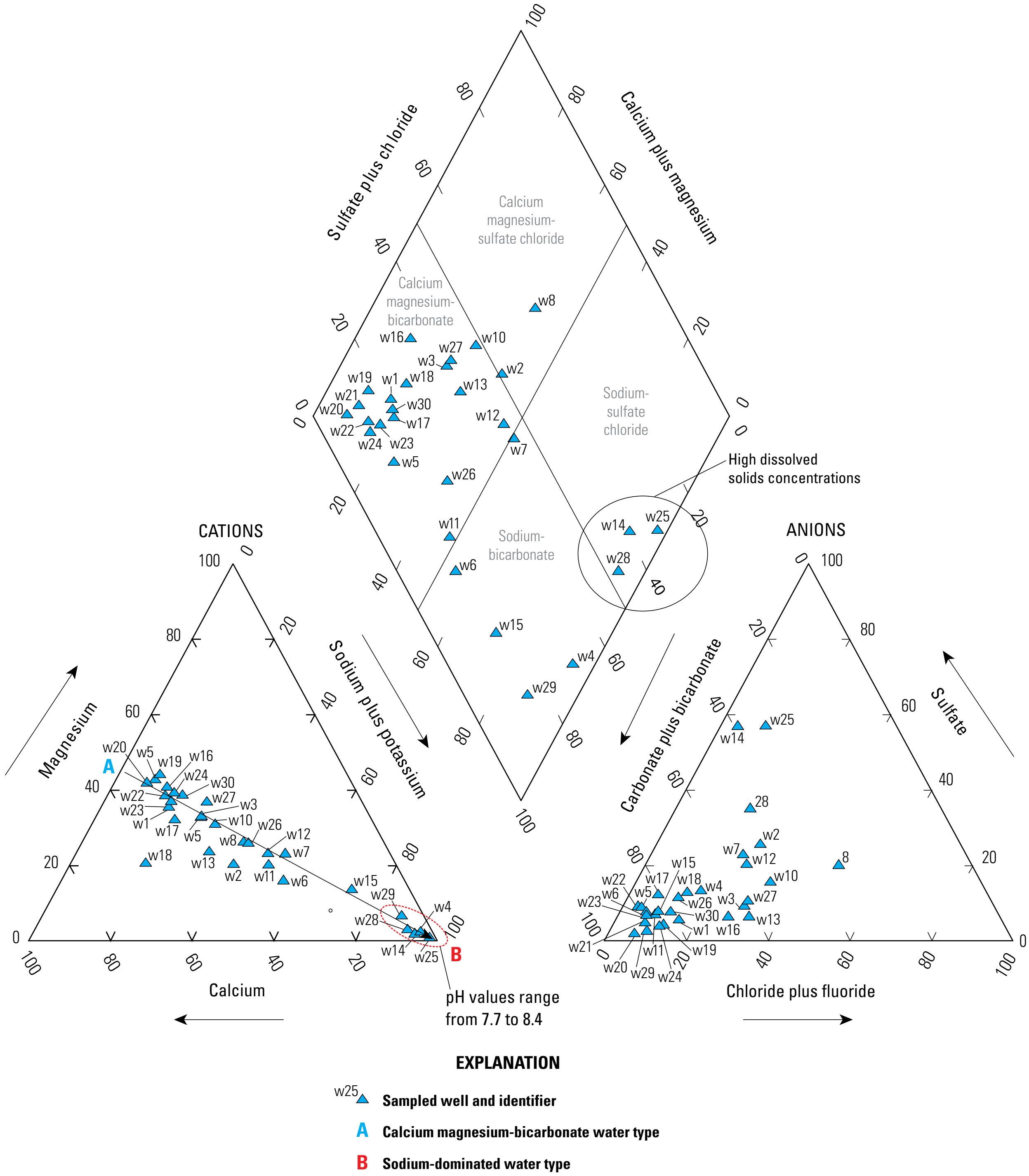
Major Ions and Water Types

Groundwater samples from 30 wells showed similar water-quality trends with respect to positive relations between pH values, dissolved solids, and water types. Similar to several previous studies in this area, calcium, magnesium, and bicarbonate were the dominant ions in groundwater samples collected in the CPN TJA part of the COA (Christenson and Havens, 1998; Andrews and others, 2013). Calcium and magnesium (responsible for water hardness) were the major cations in 22 of the 30 samples, and bicarbonate was the major anion in 23 samples (fig. 12). Those 22 samples were of a calcium magnesium-bicarbonate water type, which is characteristic of “younger” water in the COA that has not undergone cation exchange and generally has pH values below 8.0 (fig. 12) (Schlottman and others, 1998). The transition from a calcium magnesium-bicarbonate water type to a sodium-dominated water type is evident on the Piper diagram along the line from A to B (fig. 12). The water sample from well w20 is shown as the least altered sample from cation exchange and represents the end member of the calcium magnesium-bicarbonate water type group, whereas the water sample from well w25 is the most altered from cation exchange and represents the end member of the sodium-dominated water type group. The line connecting the end-member water samples from wells w20 to w25 shows the trend of water quality in local aquifers related to the process of cation exchange. Anion concentrations are not directly affected by cation exchange and are not located in distinctive groups on the anion triangle, similar to cations. The five most altered samples from cation exchange (wells w4, w14, w25, w28, and w29) also had the highest pH values, ranging from 7.7 to 8.4 and are classified as soft, with hardness concentrations below 60 mg/L as $CaCO_3$ (app. 6) (U.S. Geological Survey, 2013e).

The SMCLs of 250 mg/L apply to concentrations of both chloride and sulfate in public drinking-water supplies because of aesthetic effects related to taste (U.S. Environmental Protection Agency, 2013b). Chloride concentrations in the groundwater samples ranged from 5.13 to 120 mg/L, with a median concentration of 19.1 mg/L (apps. 5 and 9). Sulfate concentrations in these groundwater samples ranged from 4.9 to 528 mg/L, with a median concentration of 22.9 mg/L (apps. 5 and 9). Sulfate concentrations exceeded the SMCL in water samples collected from two wells: w14 (351 mg/L) and w25 (528 mg/L) (fig. 1). Water samples from 207 wells in the CPN TJA previously collected for USGS studies show that 17 samples contained sulfate concentrations exceeding the SMCL, and all of those 17 water samples were collected from wells producing water from the Chase, Council Grove, and Admire Groups in the eastern half of the CPN TJA (not shown) (U.S. Geological Survey, 2013a).

Nutrients

Nitrate-nitrogen is the most common form of nitrogen in groundwater containing dissolved oxygen and was analyzed in combination with nitrite-nitrogen for this study. Nitrite plus nitrate-nitrogen concentrations in samples collected for this study ranged from less than the reporting level of 0.038 mg/L as nitrogen in seven samples to 4.8 mg/L as nitrogen in w27, with a median concentration of 0.344 mg/L as nitrogen (apps. 5 and 9). Total nitrogen, the sum of ammonia nitrogen and nitrite plus nitrate-nitrogen, ranged in concentration from less than the reporting level of 0.05 to 5.29 mg/L, with a median concentration of 0.42 mg/L (apps. 5 and 9). Median



EXPLANATION

w25 ▲ **Sampled well and identifier**

A **Calcium magnesium-bicarbonate water type**

B **Sodium-dominated water type**

Figure 12. Water types and percentages of cations and anions in water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

concentrations of both types of nitrogen were substantially less than the nationwide median nitrate concentrations for groundwater in agricultural areas of 5.5 mg/L as nitrogen and for groundwater in urban areas of 1.4 mg/L as nitrogen (Dubrovsky and Hamilton, 2010). Of 59 historical water samples collected from the bedrock aquifers in this area, the median concentration of nitrate-nitrogen was less than 1 mg/L as nitrogen, and the MCL of 10 mg/L as nitrogen was exceeded in only two groundwater samples (Andrews and others, 2013). These low concentrations indicate that groundwater is a minor source of nitrate-nitrogen to local streams.

Ammonia nitrogen was detected in 10 of the 30 groundwater samples at concentrations ranging from 0.015 to 0.424 mg/L as nitrogen (app. 6). Ammonia nitrogen generally occurs in water with negligible or nondetectable concentrations of dissolved oxygen and may indicate a source of wastewater discharge or manure nearby. Ammonia nitrogen was not detected in the groundwater equipment-blank sample but was detected at measurable concentrations in the associated stream-water equipment-blank sample in this study.

Phosphorus tends to bind to soil particles and has relatively low solubility in water; as a result, concentrations of dissolved phosphorus in groundwater are generally very low (Hemwell, 1957). Concentrations of phosphorus in the groundwater samples collected for this study ranged from less than the reporting level of 0.003 to 0.445 mg/L, with a median concentration of 0.023 mg/L. There is not a drinking-water standard for phosphorus, but a standard of 0.037 mg/L of dissolved phosphorus was established for Oklahoma streams designated as “Scenic Rivers” because of concerns related to eutrophication in those rivers (Oklahoma Water Resources Board, 2013b). None of the streams in this study are designated as “Scenic Rivers.” Fourteen of those 30 samples contained phosphorus concentrations exceeding the 0.037 mg/L standard (app. 6). Orthophosphorus concentrations in the groundwater samples ranged from less than the reporting level of 0.004 to 0.438 mg/L as phosphorus, with a median concentration of 0.025 mg/L as phosphorus (app. 9). Orthophosphorus is the form of phosphorus that is most available for aquatic plant growth and does not have a surface-water standard in Oklahoma.

Trace Elements

Water samples collected from the 30 wells were analyzed for concentrations of 22 trace elements that occur naturally at low concentrations in rocks and in groundwater in the CPN TJA. For these 22 trace elements, 10 MCLs and 7 SMCLs have been established for public drinking-water supplies (table 5) (U.S. Environmental Protection Agency, 2013a; 2013b). None of the 10 trace-element concentrations exceeded respective MCLs (table 5; apps. 5 and 9) including arsenic, chromium, and selenium—the trace elements of most concern in the COA. Concentrations of arsenic ranged from 0.08 to 9.8 µg/L, with a median concentration of 0.58 µg/L (app. 9), which is substantially less than the MCL of 10 µg/L (table 5). The highest arsenic concentration, 9.8 µg/L, was measured in water from well w25 near the western CPN TJA boundary in an area where arsenic concentrations in groundwater from the Garber-Wellington aquifer have exceeded the MCL (fig. 1; app. 6) (Smith, 2005). Chromium concentrations ranged from less than the reporting level of 0.07 to 12.2 µg/L, with a median concentration of 0.48 µg/L, and selenium concentrations ranged from less than the reporting level of 0.03 to 9.5 µg/L, with a median concentration of 0.27 µg/L (apps. 5 and 9).

Concentrations of three trace elements—iron, manganese, and aluminum—exceeded the respective SMCLs in at least 1 of the 30 groundwater samples. SMCLs have been established for these three constituents for public drinking-water supplies because of aesthetic considerations that include the staining of household water fixtures and water discoloration (U.S. Environmental Protection Agency, 2013b). Iron and manganese concentrations exceeded the SMCLs of 300 and 50 µg/L, respectively, in three water samples collected from wells w5, w6, and w13 (fig. 1; app. 6). Two of these wells, w5 and w13, were relatively shallow, producing water from the alluvial aquifer adjoining the North Canadian River. Well w6, located on the North Canadian alluvium near the river, was completed in the Wellington Formation but also probably produced water from the alluvial aquifer. Historical groundwater samples show that high concentrations of iron and manganese commonly are associated with wells completed in the alluvial aquifer along the North Canadian River (U.S. Geological Survey, 2013a). The concentration of aluminum exceeded the SMCL of 50 µg/L in the water sample collected from well w25, with a concentration of 56.9 µg/L (app. 6). Aluminum concentrations in only four groundwater samples were equal or greater than the reporting level of 2.2 µg/L.

Concentrations of several trace elements in water samples were related to pH. Concentrations of arsenic, boron, and molybdenum were positively related to pH, indicating that concentrations of these trace elements increased as pH in water increased (figs. 13*A*–13*C*). In the form of oxyanions, these trace elements can compete for sorption sites on mineral surfaces and can be released into groundwater during the competitive sorption and cation-exchange process (Hem, 1985; Robertson, 1989; Ayotte and others, 2011). Chromium and selenium behave similarly during the cation-exchange process (Schlottman and others, 1998), but because concentrations of these trace elements are relatively low in samples with pH values above 7.5 (figs. 13*D* and 13*E*), these trace elements may be absent or only present in low concentrations in rocks along groundwater flow paths in the CPN TJA.

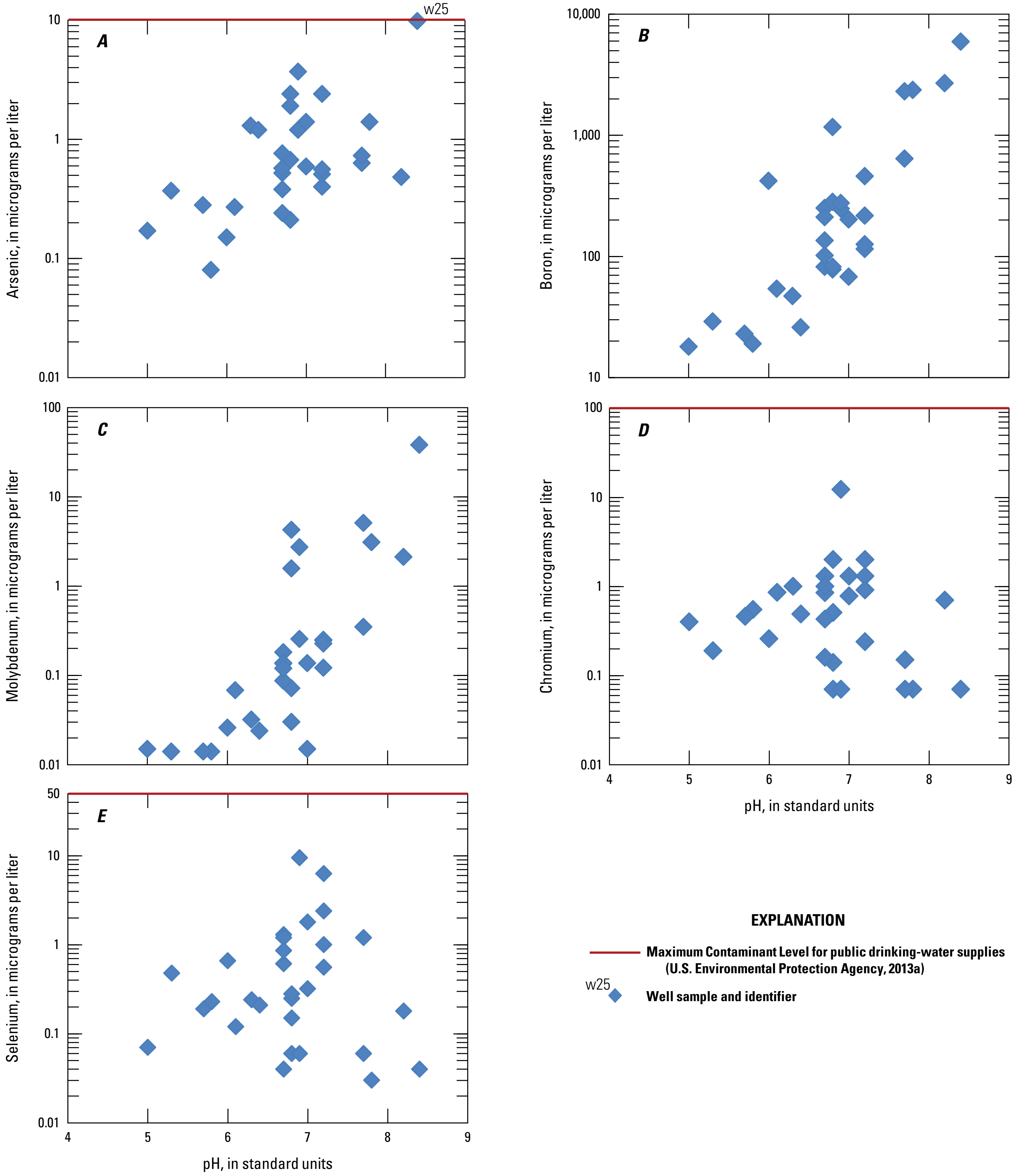


Figure 13. Concentrations of *A*, arsenic; *B*, boron; *C*, molybdenum; *D*, chromium; and *E*, selenium in relation to pH in water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

Selected Radionuclides

Concentration of the radionuclide uranium (uranium-238, the isotope measured in this study) was analyzed in water samples from 30 wells and gross alpha- and beta-particle activities were analyzed in water samples from 27 wells (app. 5). Uranium is unstable and undergoes a decay process in which radioactive particles are emitted, and daughter radionuclides are formed to stabilize the atomic configuration. The radioactive decay process of uranium and daughter radionuclides in rocks and water releases ionizing radiation composed of alpha and beta particles (Focazio and others, 2001). In drinking water, MCLs for these radionuclides have been established as follows: (1) uranium 30 μg/L, (2) gross alpha-particle activity 15 picocuries per liter (pCi/L), and (3) gross-beta particle activity 4 millirems per year, which is equivalent to a concentration of about 50 pCi/L (U.S. Environmental Protection Agency, 2013a). The greatest risk to human health from radionuclides comes from a lifetime of exposure (U.S. Environmental Protection Agency, 1999); health hazards posed by short-term exposure generally are negligible. Drinking-water MCLs for exposure to radioactivity are set at a level of about a 1 in 10,000 chance of developing a fatal cancer over a lifetime of 70 years when consuming 2 liters of water per day (U.S. Environmental Protection Agency, 2000).

Concentrations of uranium ranged from 0.03 to 79.5 μg/L in the 30 groundwater samples, with a median concentration of 1.9 μg/L (apps. 6 and 9). Water samples from wells w28 and w29 exceeded the MCL of 30 μg/L, with concentrations of 79.5 μg/L and 31.1 μg/L, respectively. Uranium concentrations generally increased with increasing pH values (fig. 14*A*) (similar to arsenic) and also increased with increasing alkalinity

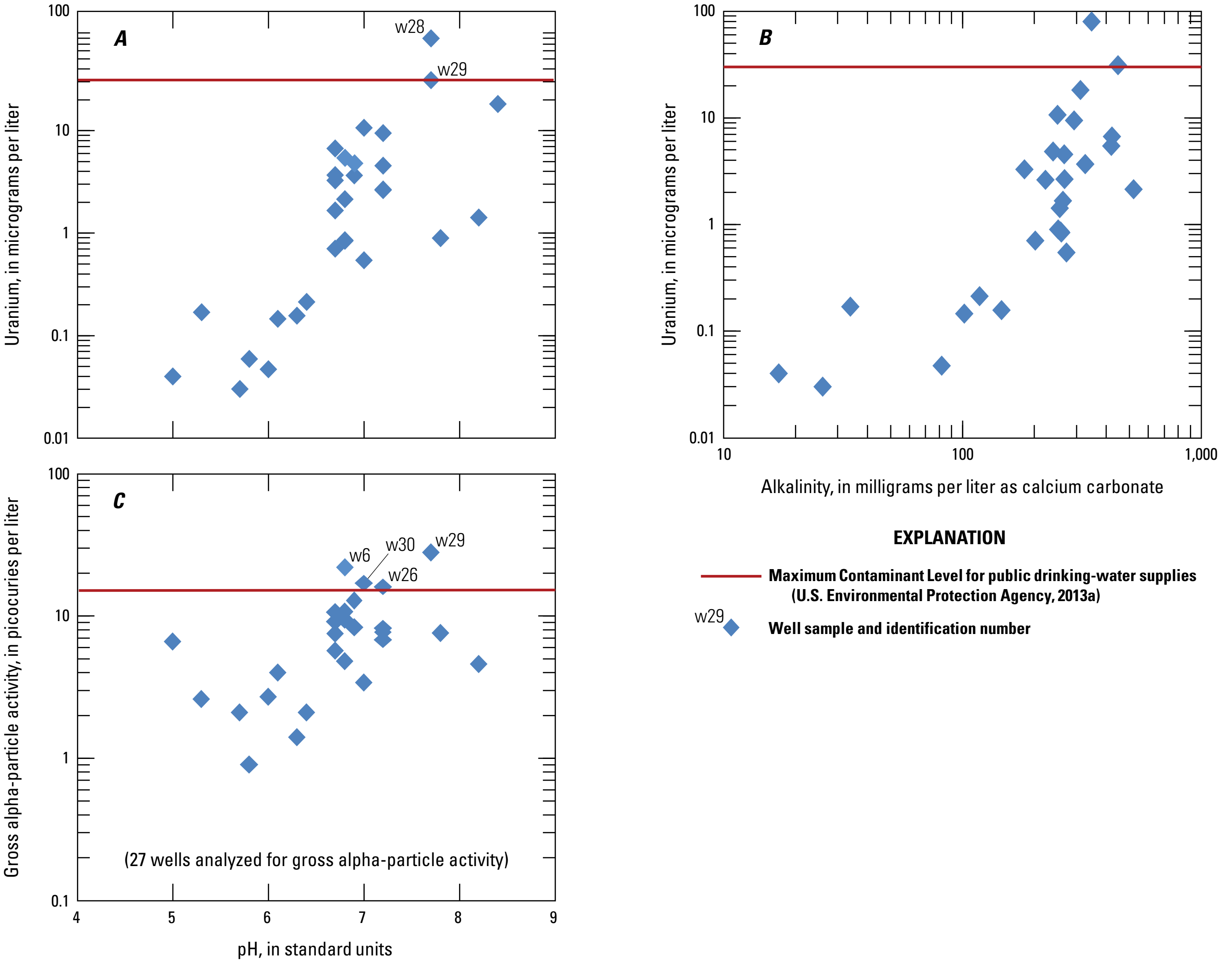


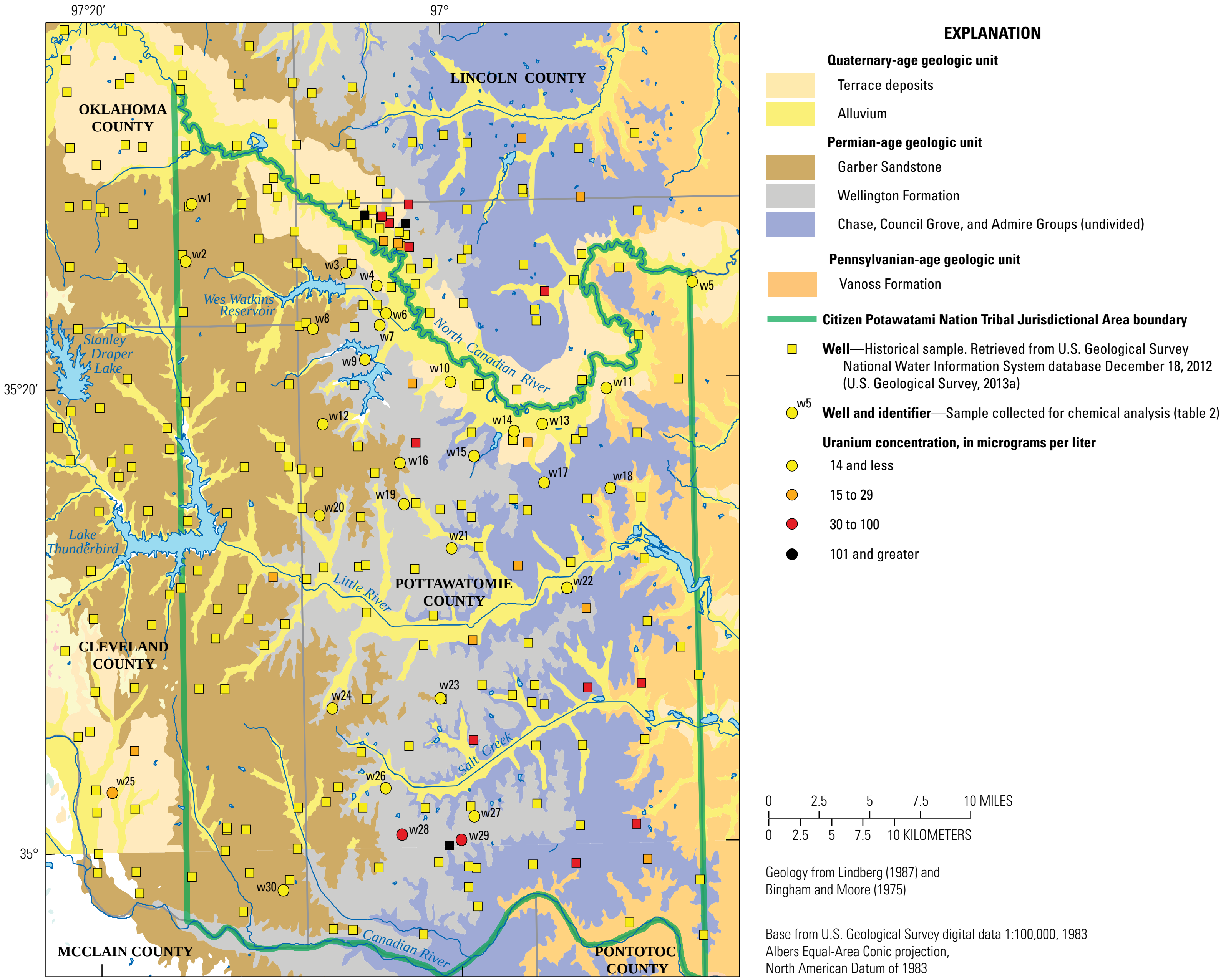
Figure 14. Concentrations of *A*, uranium in relation to pH; *B*, uranium in relation to alkalinity; and *C*, gross alpha-particle activity in relation to pH in water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

(fig. 14*B*). Water samples collected from wells w28 and w29 were relatively alkaline, both with a pH of 7.7 (fig. 14*A*; app. 6). Generally, uranium concentrations were highest in samples collected from wells completed in the Wellington Formation and the Chase, Council Grove, and Admire Groups in the southern and eastern parts of the CPN TJA (fig. 15). Historical groundwater-quality samples show similar trends in uranium concentrations and indicate an area in northwestern Pottawatomie County where exceptionally high concentrations of uranium (1,500 µg/L) were measured in groundwater from wells completed in the Wellington Formation (fig. 15) (Becker, 2013).

The radioactive decay of uranium-238 and the uranium daughter products, radium-226, and radon-222 (not analyzed in this study) emit primarily alpha particles but have short-lived, intermediate daughter products created during the decay process that emit beta particles (Zapecza and Szabo, 1988). The effects of this short-term decay are seen as a decrease in gross alpha-particle activity from 72 hours to 30 days and an increase in gross beta-particle activity from 72 hours to 30 days. The increase in gross beta-particle activity over time results from the ingrowth and decay of uranium daughter products that emit beta particles (Welch and others, 1995; Szabo and others, 2007).

Gross alpha-particle activities decreased from 72 hours to 30 days in 25 of 27 samples, showing that radioactive decay of uranium or uranium daughter products occurred. At 72 hours, gross alpha-particle activities ranged from 0.9 to 28 pCi/L with four samples (w6, w26, w29, and w30) containing gross alpha-particle activities exceeding the MCL of 15 pCi/L (fig. 14*C*; app. 5). Gross alpha-particle activity was not analyzed in the water sample collected from well w28 but probably would have exceeded the MCL, given the uranium concentration of 79.5 µg/L measured in water from that well. Uranium concentrations and gross alpha-particle activity both increased with increasing pH values (figs. 14*A* and 14*C*).

Gross beta-particle activities were slightly higher at 30 days compared to 72 hours in 16 of the 27 samples analyzed (app. 5). Gross beta-particle activity at 30 days in samples ranged from not detected to 9.7 pCi/L in the water sample from well w29, which also contained a uranium concentration (31.1 µg/L) and a gross alpha-particle activity (28 pCi/L) exceeding the respective MCLs.



Geology from Lindberg (1987) and Bingham and Moore (1975)

Base from U.S. Geological Survey digital data 1:100,000, 1983
Albers Equal-Area Conic projection,
North American Datum of 1983

Figure 15. Uranium concentrations measured in groundwater from wells sampled for this study and historical data (1977–2013) from wells in and surrounding the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma.

Summary

The U.S. Geological Survey (USGS), in cooperation with the Citizen Potawatomi Nation (CPN), collected water-quality samples at 4 sites on 3 streams and from 30 wells during 2012 and 2013 in and near the CPN tribal jurisdictional area (TJA). Stream samples were collected eight times from January 2012 to April 2013 on the North Canadian River at an upstream USGS streamflow-gaging station at North Canadian River near Harrah, Okla. (07241550); at a downstream USGS streamflow-gaging station at North Canadian River at Shawnee, Okla., (07241800); and on the Little River at the USGS streamflow-gaging station Little River near Tecumseh, Okla. (07230500). Stream samples also were collected three times at a nongaged site on Deer Creek, Deer Creek near McLoud Okla. (07241590). The water properties—dissolved oxygen, pH, specific conductance, and temperature—were measured in the field during sampling, and stream-water samples also were collected and analyzed for major ions, nutrients, trace elements, counts of fecal-indicator bacteria, and 69 organic compounds.

Streamflow at the stations on the North Canadian River and the Little River during 2012 was substantially less than historical annual mean streamflows measured at these stations. The mean daily streamflows during 2012 were 37 percent and 47 percent of the historical annual mean streamflows at the Harrah and Shawnee stations at the North Canadian River, respectively, and only 9 percent of the historical annual mean streamflow at the Tecumseh station on the Little River.

The highest concentrations of dissolved solids and chlorides were measured in stream-water samples collected at the Tecumseh station. The Secondary Maximum Contaminant Level (SMCL) for dissolved solids in drinking water of 500 milligrams per liter (mg/L) was exceeded in 7 of 8 stream-water samples, with a median concentration of 844 mg/L. The 250-mg/L SMCL for chloride was exceeded in 5 of the 8 stream-water samples collected at that station. Concentrations of dissolved solids in stream-water samples collected at the Harrah and Shawnee stations ranged from 168 to 607 mg/L and 224 to 581 mg/L, respectively, with a total of three samples collected at the two stations exceeding the SMCL of 500 mg/L. Chloride concentrations in stream-water samples collected at the Harrah and Shawnee stations ranged from 19.9 to 158 mg/L and 27.9 to 143 mg/L, respectively. Three stream-water samples collected at the Deer Creek site contained relatively low concentrations of dissolved solids and chloride, with median concentrations of 207 and 19.8 mg/L, respectively.

Median concentrations of total dissolved nitrogen were about an order of magnitude higher in stream-water samples collected at the two North Canadian River stations than concentrations in stream-water samples collected from the Little River and Deer Creek. Median concentrations in stream-water samples were 4.36 and 2.89 mg/L from the two North Canadian River stations, 0.35 mg/L from the Tecumseh station, and 0.76 mg/L from the Deer Creek site. Nitrate-nitrogen was the primary nitrogen species in all stream-water samples collected from the North Canadian River, whereas ammonia and organic nitrogen were the primary nitrogen species in stream-water samples from the Little River and Deer Creek. Concentrations of nitrate-nitrogen were highest in samples collected at the two North Canadian River stations at low streamflows. Previously measured concentrations of nitrate-nitrogen in local groundwater samples and those collected for this study contained median nitrate-nitrogen concentrations of less than 1 mg/L, indicating groundwater is a minor source of nitrate-nitrogen to local streams.

Similar to nitrogen, the median concentrations of total dissolved phosphorus were higher, by about two orders of magnitude, in stream-water samples collected at the two North Canadian River stations than concentrations in stream-water samples collected from the Tecumseh station and from the Deer Creek site. Median total dissolved phosphorus concentrations were 1.05 and 0.805 mg/L in stream-water samples collected from the two North Canadian River stations, 0.007 mg/L from the Tecumseh station, and 0.032 mg/L from the Deer Creek site. Concentrations of total dissolved phosphorus in stream samples from the North Canadian River were more than three times higher than the median concentration of about 0.25 mg/L for streams nationwide in agricultural and urban settings. Dissolved concentrations of total nitrogen, nitrate-nitrogen, orthophosphorus, and total phosphorus were highest in samples collected at the two North Canadian River stations at low streamflows, indicating that wastewater effluent was probably a notable source of these nutrients.

Concentrations of most trace elements increased with increasing streamflow in stream-water samples collected at the two North Canadian River stations, indicating that these trace elements are washed into the streams with surface-water runoff or resuspended with streambed sediments. This relation was not as evident in stream-water samples from the Little River and may be related to the comparatively small drainage basin and relative lack of developed land in the basin upstream from that station. In general, all trace-element concentrations were below respective Maximum Contaminant Levels (MCL) for public drinking-water supplies, except for one arsenic concentration of 10.1 micrograms per liter (µg/L) in a stream-water sample collected from the North Canadian River and a barium concentration of 2,690 µg/L in a stream-water sample collected from the Little River; both samples were collected during high streamflow. At least one stream-water sample from each of the four stream sites sampled in this study contained a lead concentration exceeding the SMCL of 15 µg/L. All of the samples with trace-element concentrations exceeding an MCL or SMCL were collected during high streamflows.

A greater number of organic compounds were detected in stream-water samples collected at the two North Canadian River stations than in stream-water samples collected at the Tecumseh station and the Deer Creek site. This difference may be related to the larger basin size and more diverse land uses of the North Canadian River Basin and the presence of upstream metropolitan areas and wastewater-treatment facilities in that basin. In the 8 stream-water samples collected at the upstream Harrah station, 213 detections of organic compounds were measured, whereas in 8 samples collected at the downstream Shawnee station, 203 detections of organic compounds were measured. In contrast, 59 detections of organic compounds were measured in the 8 stream-water samples collected at the Tecumseh station, and 25 detections of organic compounds were measured in the 3 stream-water samples collected at the Deer Creek site; however, the 8 detections of 7 organic compounds in the two equipment-blank samples is problematic for evaluating these data, especially for the Deer Creek and Little River samples because of the comparatively low detection frequency and should be taken into consideration when evaluating these results.

Groundwater samples were collected one time from 30 wells yielding water from the Garber-Wellington aquifer; Admire, Chase, and Council Grove Groups; Vanoss Formation; and the terrace and alluvial aquifers along the North Canadian River. The water properties—dissolved oxygen, pH, specific conductance, and temperature—were measured in the field and samples were collected and analyzed for the major ions, nutrients, trace elements, and selected radionuclides.

Of 30 wells sampled for this study, 26 were completed in bedrock aquifers, and 4 were completed in terrace or alluvial aquifers. Field measurements of pH ranged from 5.0 to 8.4, with a median value of 6.8. pH values in water samples collected from eight of those wells were below the SMCL of 6.5. In general, groundwater in the study area was very hard, with hardness concentrations ranging from 19 to 465 mg/L as calcium carbonate and a median hardness concentration of 180 mg/L as calcium carbonate measured in water samples collected from the 30 wells. Concentrations of sulfate exceeded the 250-mg/L SMCL in two groundwater samples, and dissolved solids concentration exceeded the 500-mg/L SMCL in nine groundwater samples. Previously collected samples indicated that the highest sulfate and dissolved solids concentrations occurred in groundwater from the Chase, Council Grove, and Admire Groups in the eastern half of the study area and that high concentrations of iron and manganese commonly occur in groundwater from the North Canadian River alluvium.

Nitrite plus nitrate-nitrogen concentrations in the 30 groundwater samples ranged from less than the reporting level of 0.038 (in 7 samples) to 4.8 mg/L as nitrogen, with a median concentration of 0.344 mg/L as nitrogen. Total nitrogen concentration ranged from less than the reporting level of 0.05 (in two samples) to 5.29 mg/L, with a median concentration of 0.42 mg/L. Median concentrations of both types of nitrogen analyses were substantially less than the nationwide median nitrate-nitrogen concentrations for groundwater in agricultural areas of 5.5 mg/L and in urban areas of 1.4 mg/L.

Trace-element concentrations did not exceed respective MCLs in the 30 groundwater samples collected for this study. Arsenic concentrations ranged from 0.08 to 9.8 µg/L, with a median concentration of 0.58 µg/L. Chromium concentrations ranged from less than 0.7 to 12.2 µg/L, with a median concentration of 0.48 µg/L, and selenium concentrations ranged from less than 0.03 to 9.5 µg/L, with a median concentration of 0.27 µg/L.

Concentrations of the radionuclide uranium in the 30 groundwater samples ranged from 0.03 to 79.5 µg/L, with a median concentration of 1.9 µg/L. Two water samples, from wells w28 and w29, exceeded the MCL of 30 µg/L with concentrations of 79.5 and 31.1 µg/L, respectively. Generally, uranium concentrations were highest in water samples collected from wells completed in the Wellington Formation and the Chase, Council Grove, and Admire Groups in the southern and eastern parts of the study area.

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Appendixes 1–9

Table 1–1. Water-property measurements, concentrations of major ions and nutrients, fecal-indicator bacteria counts, and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[Constituent concentrations are dissolved (filtered) unless otherwise noted; ft^3/s; cubic foot per second; NAVD 88, North American Vertical Datum of 1988; mg/L, milligram per liter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; µs/cm, microsiemens per centimeter; Env, environmental sample; Rep, replicate sample; Blank, equipment-blank quality-assurance sample; E, estimate, result is outside the lowest or highest calibration point; e, estimated; v, analyte detected in equipment-blank quality-assurance sample; <, less than; Org., organic; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; –, not determined; mL, milliliter; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Gage height (feet above NAVD 88)	Ionic balance (percent)[a]	Dissolved oxygen (mg/L)	Hardness (mg/L as $CaCO_3$)	pH (standard units)	Specific conductance (µS/cm at 25 degrees Celsius)	Water temperature (degrees Celsius)	Dissolved solids (mg/L)	Calcium (mg/L)	Calcium, (whole) (mg/L)
Little River near Tecumseh, Oklahoma (07230500)												
20120110	Env	6.1	4.54	-1.75	11.7	289	8.4	1,200	5.9	**663**	60.5v	60.8v
20120319	Env	1,450	10.06	2.86	7.3	106	8.0	345	15.3	199	22.6v	116v
20120531	Env	2.6	4.26	6.54	8.9	270	8.4	1,290	25.2	**705**	44.5v	39.8v
20120626	Env	1.5	4.17	1.05	8.5	212	8.4	1,510	30.4	**815**	30.3v	30.2v
20120626	Rep	–	–	-0.27	8.5	201	8.4	1,510	30.4	**823**	27.8v	30.1v
20120826	Env	1.5	4.19	-2.56	7.7	192	**8.6**	e766	25.7	**1,180**	23.8v	23.7v
20120918	Env	1.0	4.14	-2.32	10.2	216	**9.0**	2,130	23.2	**1,180**	27.0v	27.2v
20121114	Env	2.4	4.35	-2.20	10.3	272	8.2	1,690	8.4	**954**	52.9v	53.8v
20121206	Env	2.4	4.37	-4.79	10.8	270	8.4	1,570	10.5	**872**	53.7v	53.8v
20121206	Rep	–	–	-4.64	10.8	270	8.4	1,570	10.5	**827**	54.0v	54.0v
North Canadian River near Harrah, Oklahoma (07241550)												
20120109	Env	91	4.72	-4.46	12.9	251	8.0	786	7.7	**607**	62.9v	62.6v
20120320	Env	4,690	11.18	0.62	7.4	99.3	8.0	280	14.8	168	27.1v	60.6v
20120531	Env	677	6.68	0.90	7.0	128	7.8	425	25.8	252	33.7v	45.4v
20120627	Blank	–	–	–	–	<0.15	–	1	–	<20	0.042	0.046
20120627	Env	123	4.88	0.14	9.2	195	**8.6**	690	28.8	459	50.9v	52.1v
20120826	Env	185	5.24	-0.41	9.4	156	8.4	396	28.3	457	40.2v	46.5v
20120917	Env	e108	4.71	1.01	9.2	192	8.3	544	25.8	**534**	48.0v	49.9v
20121113	Env	175[b]	5.30	0.87	9.7	138	8.4	494	10.1	291	35.8v	38.8v
20121205	Env	162	5.10	-0.81	11.1	164	8.2	645	12.2	363	42.5v	44.7v
Deer Creek near McLoud, Oklahoma (07241590)												
20120109	Env	0.34	9.95	-1.84	7.5	169	7.5	470	5.9	293	41.5v	43.1v
20120319	Env	139	–	–	9.7	25.8	7.5	74	14.1	59	6.73v	13.3v
20130410	Env	–	–	–	9.3	116	7.4	334	8.1	207	29.3v	30.5v

Table 1–1. Water-property measurements, concentrations of major ions and nutrients, fecal-indicator bacteria counts, and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are dissolved (filtered) unless otherwise noted; ft^3/s; cubic foot per second; NAVD 88, North American Vertical Datum of 1988; mg/L, milligram per liter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; CaCO$_3$, calcium carbonate; µs/cm, microsiemens per centimeter; Env, environmental sample; Rep, replicate sample; Blank, equipment-blank quality-assurance sample; E, estimate, result is outside the lowest or highest calibration point; e, estimated; v, analyte detected in equipment-blank quality-assurance sample; <, less than; Org., organic; SiO$_2$, silicon dioxide; N, nitrogen; P, phosphorus; –, not determined; mL, milliliter; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Gage height (feet above NAVD 88)	Ionic balance (percent)[a]	Dissolved oxygen (mg/L)	Hardness (mg/L as CaCO$_3$)	pH (standard units)	Specific conductance (µS/cm at 25 degrees Celsius)	Water temperature (degrees Celsius)	Dissolved solids (mg/L)	Calcium (mg/L)	Calcium, (whole) (mg/L)
						North Canadian River at Shawnee, Oklahoma (07241800)						
20120109	Env	e98	8.38	-2.06	13.8	244	8.4	566	8.1	**581**	61.7v	62.7v
20120320	Env	5,700	16.12	1.71	5.6	120	7.9	365	15.1	224	33.0v	110v
20120531	Blank	–	–	3.84	–	<0.14	–	1	–	<20	0.038	0.054
20120531	Env	e1,740	12.58	2.18	4.8	169	7.7	522	25.2	301	45.6v	91.7v
20120626	Env	128	8.43	-0.20	15.4	190	**9.3**	843	33.2	492	44.3v	44.7v
20120826	Env	238	8.81	-6.50	6.5	112	8.4	507	25.0	304	29.3v	40.9v
20120917	Env	136	8.45	0.22	10.2	175	**8.8**	716	21.4	474	43.4v	51.3v
20121114	Env	214[b]	9.01	-1.23	11.0	150	8.4	548	11.6	321	39.4v	45.2v
20121206	Env	188[b]	9.01	-2.06	13.2	193	**8.7**	819	12.5	467	48.8v	54.1v

Date of sample (yyyymmdd)	Sample type	Magnesium, (mg/L)	Magnesium, (whole) (mg/L)	Potassium (mg/L)	Potassium, (whole) (mg/L)	Sodium (mg/L)	Sodium (whole) (mg/L)	Alkalinity (mg/L as CaCO$_3$)	Bicarbonate (mg/L)	Carbonate (mg/L)
					Little River near Tecumseh, Oklahoma (07230500)					
20120110	Env	33.4	33.8	1.84	1.83	142	140	272	326	3.1
20120319	Env	12.0	36.7	3.23	8.25	22.8	21.1	93.8	114	<1.0
20120531	Env	38.5	34.4	3.25	2.98	196	171	223	264	3.8
20120626	Env	33.1	33.1	3.19	3.28	226	224	206	244	3.1
20120626	Rep	32.0	33.0	3.14	3.30	221	223	205	241	4.4
20120826	Env	32.2	32.2	3.93	3.92	351	350	210	246	5.3
20120918	Env	36.1	36.3	2.94	3.03	346	356	201	233	5.7
20121114	Env	34.0	34.4	3.88	3.79	243	240	263	318	1.8
20121206	Env	33.1	33.5	2.99	3.10	196	214	266	317	3.7
20121206	Rep	32.9	33.5	3.03	3.23	197	217	266	317	3.7

Table 1–1. Water-property measurements, concentrations of major ions and nutrients, fecal-indicator bacteria counts, and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are dissolved (filtered) unless otherwise noted; ft^3/s; cubic foot per second; NAVD 88, North American Vertical Datum of 1988; mg/L, milligram per liter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; µs/cm, microsiemens per centimeter; Env, environmental sample; Rep, replicate sample; Blank, equipment-blank quality-assurance sample; E, estimate, result is outside the lowest or highest calibration point; e, estimated; v, analyte detected in equipment-blank quality-assurance sample; <, less than; Org., organic; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; –, not determined; mL, milliliter; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Date of sample (yyyymmdd)	Sample type	Magnesium, (mg/L)	Magnesium, (whole) (mg/L)	Potassium (mg/L)	Potassium, (whole) (mg/L)	Sodium (mg/L)	Sodium (whole) (mg/L)	Alkalinity (mg/L as $CaCO_3$)	Bicarbonate (mg/L)	Carbonate (mg/L)
North Canadian River near Harrah, Oklahoma (07241550)										
20120109	Env	22.8	22.3	11.7	11.5	114	111	198	239	1.5
20120320	Env	7.69	14.4	3.40	5.36	17.9	17.9	82.9	101	<1.0
20120531	Env	10.7	13.1	4.94	5.95	34.3	33.6	103	124	<1.0
20120627	Blank	<0.011	<0.007	<0.03	<0.015	<0.06	<0.06	–	–	–
20120627	Env	16.6	16.6	8.20	8.36	80.8	79.4	129	149	4.1
20120826	Env	13.5	14.7	10.2	10.5	85.7	84.5	97.7	118	<1.0
20120917	Env	17.5	17.7	11.8	11.9	96.0	95.5	112	135	1.0
20121113	Env	11.8	12.2	6.60	6.66	45.9	44.2	106	129	0.4
20121205	Env	14.0	14.6	7.72	8.23	56.2	58.7	114	137	0.9
Deer Creek near McLoud, Oklahoma (07241590)										
20120109	Env	16.0	16.0	1.77	1.87	34.9	35.4	200	240	1.6
20120319	Env	2.19	4.66	2.70	4.24	3.38	3.15	–	–	–
20130410	Env	10.5	10.4	2.65	2.96	23.1	21.9	–	–	–
North Canadian River at Shawnee, Oklahoma (07241800)										
20120109	Env	21.8	22.1	11.3	11.7	98.2	99.5	157	189	<1.0
20120320	Env	9.17	22.7	3.96	7.61	25.0	24.9	95.0	116	<1.0
20120531	Blank	<0.011	<0.007	<0.03	<0.015	<0.06	<0.06	–	–	–
20120531	Env	13.5	22.4	4.84	7.85	42.2	39.8	128	155	<1.0
20120626	Env	19.3	18.9	9.69	9.73	104	98.4	130	113	20.4
20120826	Env	9.44	12.1	6.78	7.77	48.0	48.0	89.4	106	1.3
20120917	Env	16.3	18.6	8.02	9.69	72.2	81.4	140	163	4.0
20121114	Env	12.7	14.0	6.18	6.76	49.1	49.1	114	138	0.4
20121206	Env	17.4	18.6	10.2	10.8	82.2	82.7	138	160	4.0

Table 1–1. Water-property measurements, concentrations of major ions and nutrients, fecal-indicator bacteria counts, and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are dissolved (filtered) unless otherwise noted; ft^3/s; cubic foot per second; NAVD 88, North American Vertical Datum of 1988; mg/L, milligram per liter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; µs/cm, microsiemens per centimeter; Env, environmental sample; Rep, replicate sample; Blank, equipment-blank quality-assurance sample; E, estimate, result is outside the lowest or highest calibration point; e, estimated; v, analyte detected in equipment-blank quality-assurance sample; <, less than; Org., organic; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; –, not determined; mL, milliliter; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Date of sample (yyyymmdd)	Sample type	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L as SiO_2)	Sulfate (mg/L)	Ammonia plus org. N (mg/L as N)	Ammonia plus org. N, (whole) (mg/L as N)	Ammonia N (mg/L as N)	Nitrite plus nitrate N (mg/L as N)	Nitrite-nitrogen (mg/L as N)
Little River near Tecumseh, Oklahoma (07230500)										
20120110	Env	202v	0.38	9.26	60.2	0.12	0.17	0.012	<0.040	<0.001
20120319	Env	28.7v	0.26	6.31	13.7	0.76	11	0.134	0.441	0.014
20120531	Env	233v	0.37	14.0	58.8	0.30	0.30	<0.010	<0.040	<0.001
20120626	Env	**294**v	0.43	13.0	69.6	0.38	0.51	<0.010	<0.040	<0.001
20120626	Rep	**291**v	0.40	12.0	69.6	0.35	0.40	<0.010	<0.040	<0.001
20120826	Env	**488**v	0.45	8.30	107	0.72	1.0	0.012	<0.040	<0.001
20120918	Env	**496**v	0.42	8.81	114	0.50	0.58	0.020	<0.040	<0.001
20121114	Env	**344**v	0.30	10.2	88.5	0.32	0.33	<0.010	<0.040	<0.001
20121206	Env	**297**v	0.33	9.43	81.0	0.29	0.25	0.020	<0.040	<0.001
20121206	Rep	**297**v	0.31	9.38	81.8	0.28	0.27	0.021	<0.040	<0.001
North Canadian River near Harrah, Oklahoma (07241550)										
20120109	Env	158v	0.86	8.29	109	0.88	1.0	0.078	6.90	0.089
20120320	Env	19.9v	0.23	5.85	26.1	0.65	2.2	0.213	0.694	0.024
20120531	Env	39.3v	0.29	3.84	39.4	0.52	1.5	0.066	1.57	0.038
20120627	Blank	0.36	<0.04	<0.018	<0.09	<0.07	<0.07	<0.010	<0.040	<0.001
20120627	Env	107v	0.60	5.09	83.0	0.68	1.5	<0.010	3.44	0.053
20120826	Env	117v	0.67	6.58	72.9	0.81	1.9	<0.010	4.97	0.065
20120917	Env	125v	0.78	8.56	83.2	0.92	1.2	0.040	8.42	0.073
20121113	Env	55.1v	0.36	6.57	43.0	0.57	1.1	0.046	3.44	0.036
20121205	Env	82.2v	0.56	6.15	53.9	0.80	1.3	0.126	3.80	0.040
Deer Creek near McLoud, Oklahoma (07241590)										
20120109	Env	29.9v	0.44	13.8	13.9	0.30	0.50	0.097	0.045	0.001
20120319	Env	3.36v	0.15	4.96	3.28	0.61	2.6	0.072	0.269	0.006
20130410	Env	19.8v	–	10.5	10.7	0.64	1.2	0.080	0.117	0.005

Table 1–1. Water-property measurements, concentrations of major ions and nutrients, fecal-indicator bacteria counts, and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are dissolved (filtered) unless otherwise noted; ft^3/s; cubic foot per second; NAVD 88, North American Vertical Datum of 1988; mg/L, milligram per liter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; µs/cm, microsiemens per centimeter; Env, environmental sample; Rep, replicate sample; Blank, equipment-blank quality-assurance sample; E, estimate, result is outside the lowest or highest calibration point; e, estimated; v, analyte detected in equipment-blank quality-assurance sample; <, less than; Org., organic; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; –, not determined; mL, milliliter; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Date of sample (yyyymmdd)	Sample type	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L as SiO_2)	Sulfate (mg/L)	Ammonia plus org. N (mg/L as N)	Ammonia plus org. N, (whole) (mg/L as N)	Ammonia N (mg/L as N)	Nitrite plus nitrate N (mg/L as N)	Nitrite-nitrogen (mg/L as N)
North Canadian River at Shawnee, Oklahoma (07241800)										
20120109	Env	143v	0.85	7.45	99.8	1.0	1.2	0.193	7.39	0.112
20120320	Env	27.9v	0.31	6.23	34.6	0.83	4.4	0.423	0.685	0.030
20120531	Blank	0.26	<0.04	<0.018	<0.09	<0.07	<0.07	0.028	<0.040	<0.001
20120531	Env	44.5v	0.38	5.31	51.2	0.72	3.1	0.307	0.901	0.088
20120626	Env	138v	0.69	0.722	78.5	0.71	3.0	<0.010	0.544	0.064
20120826	Env	58.2v	0.43	6.13	45.8	0.81	2.6	0.099	1.69	0.092
20120917	Env	106v	0.64	5.13	84.6	0.72	1.5	<0.010	3.30	0.048
20121114	Env	62.1v	0.40	6.13	49.5	0.54	1.3	0.093	2.73	0.019
20121206	Env	119v	0.75	4.57	62.3	0.90	2.3	0.011	6.03	0.044

Date of sample (yyyymmdd)	Sample type	Total nitrogen (calculated) (mg/L)[c]	Orthophosphorus (mg/L as P)	Total phosphorus (mg/L)	Total phosphorus, (whole) (mg/L)	*Escherichia coli* (most probable number per 100 mL)	Total coliforms (most probable number per 100 mL)
Little River near Tecumseh, Oklahoma (07230500)							
20120110	Env	0.12	<0.004	<0.003	0.011	–	–
20120319	Env	1.2	0.013	0.030	0.970	–	–
20120531	Env	0.30	0.004	0.007	0.017	20	6,600
20120626	Env	0.38	<0.004	0.006	0.030	10	10,000
20120626	Rep	0.35	0.004	0.007	0.014	–	–
20120826	Env	0.72	<0.004	0.017	0.073	6,700	160,000
20120918	Env	0.50	0.006	0.010	0.017	8,800	130,000
20121114	Env	0.32	<0.004	0.007	0.016	–	–
20121206	Env	0.29	0.004	0.007	0.017	–	–
20121206	Rep	0.28	<0.004	0.008	0.017	–	–

Table 1–1. Water-property measurements, concentrations of major ions and nutrients, fecal-indicator bacteria counts, and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are dissolved (filtered) unless otherwise noted; ft^3/s; cubic foot per second; NAVD 88, North American Vertical Datum of 1988; mg/L, milligram per liter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; µs/cm, microsiemens per centimeter; Env, environmental sample; Rep, replicate sample; Blank, equipment-blank quality-assurance sample; E, estimate, result is outside the lowest or highest calibration point; e, estimated; v, analyte detected in equipment-blank quality-assurance sample; <, less than; Org., organic; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; –, not determined; mL, milliliter; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Date of sample (yyyymmdd)	Sample type	Total nitrogen (calculated) (mg/L)[c]	Orthophosphorus (mg/L as P)	Total phosphorus (mg/L)	Total phosphorus, (whole) (mg/L)	*Escherichia coli* (most probable number per 100 mL)	Total coliforms (most probable number per 100 mL)
North Canadian River near Harrah, Oklahoma (07241550)							
20120109	Env	7.8	2.09	2.05	2.16	–	–
20120320	Env	1.3	0.137	0.147	1.01	–	–
20120531	Env	2.1	0.276	0.308	0.703	910	10,000
20120627	Blank	–	<0.004	<0.003	<0.004	–	–
20120627	Env	4.1	1.27	1.30	1.46	31	10,000
20120826	Env	5.8	1.43	1.41	1.70	1,700	110,000
20120917	Env	9.3	3.30	3.22	3.06	5,100	240,000
20121113	Env	4.0	0.764	0.809	0.930	–	–
20121205	Env	4.6	0.371	0.388	0.525	–	–
Deer Creek near McLoud, Oklahoma (07241590)							
20120109	Env	0.35	0.006	0.003	0.025	–	–
20120319	Env	0.88	0.024	0.042	0.655	–	–
20130410	Env	0.76	0.016	0.032	0.209	–	–
North Canadian River at Shawnee, Oklahoma (07241800)							
20120109	Env	8.4	2.53	2.53	2.70	–	–
20120320	Env	1.5	0.124	0.132	1.52	–	–
20120531	Blank	–	<0.004	<0.003	<0.004	–	–
20120531	Env	1.6	0.276	0.308	1.30	1,500	10,000
20120626	Env	1.3	0.273	0.323	0.698	<10	10,000
20120826	Env	2.5	0.867	0.929	1.34	7,500	1,300,000
20120917	Env	4.0	1.06	1.06	1.21	7,200	820,000
20121114	Env	3.3	0.620	0.681	0.954	–	–
20121206	Env	6.9	1.53	1.51	1.91	–	–

[a] The ionic balance was calculated as the total dissolved cation concentration minus the total dissolved anion concentration divided by the total concentration of ions in milliequivalents per liter. The total cation concentration was the sum of concentrations of calcium, magnesium, sodium, potassium, and the trace elements iron and manganese. The total anion concentration was the sum of chloride, sulfate, fluoride, alkalinity, and nitrate-nitrogen concentrations.

[b] Daily mean streamflow.

[c] Total dissolved nitrogen calculated from the sum of dissolved ammonia plus organic nitrogen and nitrate plus nitrite-nitrogen concentrations.

Table 2–1. Trace-element concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[Constituent concentrations are in whole water samples (unfiltered) unless otherwise noted; ft^3/s, cubic feet per second; µg/L, micrograms per liter; Env, environmental sample; Rep, replicate quality-assurance sample; Blank, equipment-blank quality-assurance sample; <, less than; –, not applicable; E, estimated (result is outside the lowest or highest calibration point); v, analyte detected in equipment-blank quality-assurance sample; **Bold** font denotes value exceeds Secondary Maximum Contaminant Level or Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Sample date (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron, (dissolved) (µg/L)	Iron (µg/L)	Lead (µg/L)
Little River near Tecumseh, Oklahoma (07230500)													
20120110	Env	6.1	**100**	1.7	430	<0.19	<0.016	0.49	0.17	<1.4	6.7	146	0.10v
20120319	Env	1,450	**34,500**	6.9	**2,690**	6.61	0.481	41.5	41.8	51.8	49.8	**41,400**	**77.9v**
20120531	Env	2.6	**70**	2.4	363	<0.19	<0.016	<0.30	<0.02	<1.4	7.8	74.1	0.16v
20120626	Env	1.5	**100**	3.9	351	<0.19	<0.016	0.32	0.31	<1.4	5.0	109	0.18v
20120626	Rep	1.5	**70**	3.9	351	<0.19	<0.016	<0.30	0.28	3.2	8.3	73.1	0.18v
20120826	Env	1.5	**200**	4.5	257	<0.57	<0.016	0.34	0.71	<4.2	21.4	209	0.32v
20120918	Env	1.0	**160**	3.6	318	<0.57	<0.016	0.47	<0.02	<4.2	16.1	131	0.16v
20121114	Env	2.4	**90**	1.3	397	<0.19	<0.016	<0.30	0.15	<1.4	72.3	99.2	0.17v
20121206	Env	2.4	**150**	1.3	396	<0.19	<0.016	0.37	0.14	<1.4	21.3	152	0.21v
20121206	Rep	2.4	**160**	1.4	394	<0.19	<0.017	0.30	0.12	<1.4	13.0	153	0.20v
North Canadian River near Harrah, Oklahoma (07241550)													
20120109	Env	91	**150**	2.8	93	<0.19	0.032	1.0	0.51	<1.4	22.6	207	0.43v
20120320	Env	4,690	**10,300**	6.4	439	0.66	0.563	47.9	7.6	16.5	86.0	**10,900**	**27.1v**
20120531	Env	677	**4,610**	4.1	261	<0.19	0.173	5.6	3.0	9.1	35.2	4,420	14.8v
20120627	Blank	–	<50	<0.28	<0.3	<0.19	<0.016	<0.30	<0.02	<1.4	<3.2	<4.6	0.11
20120627	Env	123	**670**	4.3	126	<0.19	0.047	1.1	1.0	1.7	7	554	1.54v
20120826	Env	185	**1,920**	3.9	124	<0.19	0.094	2.9	1.7	3.3	32.6	**1,860**	8.46v
20120917	Env	e108	**520**	4.2	108	0.20	0.040	1.2	0.73	<1.4	5.9	**510**	1.31v
20121113	Env	175[a]	**1,380**	2.5	135	<0.19	0.085	2.3	0.97	3.0	33.3	**1,390**	3.74v
20121205	Env	162	**950**	2.0	115	<0.19	0.054	1.9	0.89	1.5	28.7	**1,060**	2.67v
Deer Creek near McLoud, Oklahoma (07241590)													
20120109	Env	0.34	**570**	1.7	179	<0.19	0.019	0.79	1.1	<1.4	17.2	**1,040**	0.81v
20120319	Env	139	**11,400**	2.8	296	1.18	0.148	13.2	11.3	10.6	78.5	**12,000**	**24.6v**
20130410	Env	–	**2,450**	2.3	152	<0.19	0.051	2.9	2.4	25.2	208	**2,940**	3.35v

Table 2–1. Trace-element concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered) unless otherwise noted; ft³/s, cubic feet per second; µg/L, micrograms per liter; Env, environmental sample; Rep, replicate quality-assurance sample; Blank, equipment-blank quality-assurance sample; <, less than; –, not applicable; E, estimated (result is outside the lowest or highest calibration point); v, analyte detected in equipment-blank quality-assurance sample; **Bold** font denotes value exceeds Secondary Maximum Contaminant Level or Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Sample date (yyyymmdd)	Sample type	Streamflow (ft³/s)	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron, (dis-solved) (µg/L)	Iron (µg/L)	Lead (µg/L)
North Canadian River at Shawnee, Oklahoma (07241800)													
20120109	Env	e98	**260**	3.7	110	<0.19	0.062	0.82	0.7	1.9	7.0	286	0.82v
20120320	Env	5,700	**19,100**	**10.1**	765	1.59	1.04	25.2	14.4	31.9	49.3	**21,200**	**56.2v**
20120531	Blank	–	<50	<0.28	<0.3	<0.19	<0.016	<0.30	<0.02	<1.4	<3.2	<4.6	0.15
20120531	Env	e1,740	**14,000**	7.9	563	0.73	0.573	17.0	10.4	22.7	39.4	**14,400**	**43.8v**
20120626	Env	128	**350**	5.9	134	<0.19	0.071	0.59	1.5	3.7	<3.2	**359**	1.37v
20120826	Env	238	**4,320**	5.4	170	0.29	0.152	5.4	3.6	7.5	82.2	**4,060**	11.0v
20120917	Env	136	**710**	4.0	125	<0.19	0.047	1.4	0.93	<1.4	7.5	**663**	1.8v
20121114	Env	214[a]	**2,000**	3.1	147	<0.19	0.117	2.9	1.3	5.7	29.5	**2,020**	5.67v
20121206	Env	188[a]	**2,190**	3.9	159	<0.19	0.114	3.4	2.2	3.5	13.8	**2,260**	3.88v

Sample date (yyyymmdd)	Sample type	Streamflow (ft³/s)	Lithium (µg/L)	Manganese (dissolved) (µg/L)	Manganese (µg/L)	Mercury (µg/L)	Molybdenum (µg/L)	Nickel (µg/L)	Silver (µg/L)	Strontium (µg/L)	Selenium (µg/L)	Zinc (µg/L)
Little River near Tecumseh, Oklahoma (07230500)												
20120110	Env	6.1	15.5	35.1v	49.7	<0.005	1.04v	0.73v	<0.015	453	0.487	<2.0
20120319	Env	1,450	E39.6	**81.5v**	**5,540**	0.066v	0.09v	58.0v	0.095	454	0.476	100v
20120531	Env	2.6	E11.3	16.5v	36.6	<0.005	1.60v	0.67v	<0.015	429	0.222	2.6v
20120626	Env	1.5	E15.5	16.1v	**58.3**	0.036v	2.12v	0.91v	<0.015	432	0.186	<2.0
20120626	Rep	1.5	E15.3	13.2v	43.3	0.024v	2.11v	0.94v	<0.015	429	0.305	<2.0
20120826	Env	1.5	E16.7	11.9v	135	<0.005	2.71v	1.4v	<0.015	436	0.304	<6.0
20120918	Env	1.0	E15.9	4.42v	42.8	0.028v	2.59v	1.3v	<0.015	525	0.172	<6.0
20121114	Env	2.4	E15.2	20.8v	26.7	0.007v	1.62v	0.66v	<0.015	608	0.308	<2.0
20121206	Env	2.4	E10.6	20.2v	34.1	0.028v	1.61v	1.3v	<0.015	561	0.258	2.1v
20121206	Rep	2.4	E10.4	21.5v	34.5	0.028v	1.63v	1.2v	<0.015	568	0.305	3.2v

Table 2–1. Trace-element concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered) unless otherwise noted; ft^3/s, cubic feet per second; µg/L, micrograms per liter; Env, environmental sample; Rep, replicate quality-assurance sample; Blank, equipment-blank quality-assurance sample; <, less than; –, not applicable; E, estimated (result is outside the lowest or highest calibration point); v, analyte detected in equipment-blank quality-assurance sample; **Bold** font denotes value exceeds Secondary Maximum Contaminant Level or Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Sample date (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Lithium (µg/L)	Manganese (dissolved) (µg/L)	Manganese (µg/L)	Mercury (µg/L)	Molybdenum (µg/L)	Nickel (µg/L)	Silver (µg/L)	Strontium (µg/L)	Selenium (µg/L)	Zinc (µg/L)
North Canadian River near Harrah, Oklahoma (07241550)												
20120109	Env	91	26.0	28.8v	44.5	<0.005	2.73v	5.6v	<0.015	743	0.286	16.9v
20120320	Env	4,690	E19.6	11.7v	549	0.054v	0.99v	44.4v	0.202	334	0.308	62.7v
20120531	Env	677	E12.6	2.70v	309	0.024v	1.49v	8.3v	0.063	391	0.303	40.6v
20120627	Blank	–	<0.04	0.26	<0.20	0.029	0.06	0.56	<0.015	<0.18	<0.050	3.9
20120627	Env	123	E16.0	3.06v	**72.4**	0.008v	2.88v	4.6v	<0.015	647	0.352	15.0v
20120826	Env	185	E17.4	7.30v	**155**	0.014v	2.29v	7.3v	0.042	471	0.318	21.3v
20120917	Env	e108	E14.9	5.66v	43.0	0.009v	2.74v	6.7v	0.016	554	0.330	11.8v
20121113	Env	175[a]	E9.71	4.75v	**80.4**	0.009v	1.79v	4.5v	0.031	364	0.262	12.3v
20121205	Env	162	E8.98	7.81v	**105**	0.005v	2.31v	4.6v	0.027	482	0.276	8.1v
Deer Creek near McLoud, Oklahoma (07241590)												
20120109	Env	0.34	5.64	**469v**	**491**	<0.005	0.47v	3.1v	<0.015	239	0.297	5.2v
20120319	Env	139	E7.48	**79.3v**	**588**	0.036v	0.07v	13.7v	0.040	60.5	0.231	41.3v
20130410	Env	–	E3.61	**471v**	**580**	0.007v	0.37v	3.9v	0.055	164	0.335	10.3v
North Canadian River at Shawnee, Oklahoma (07241800)												
20120109	Env	e98	23.1	9.79v	22.7	<0.005	3.02v	6.7v	<0.015	662	0.298	20.7v
20120320	Env	5,700	E37.2	7.62v	**1,260**	0.099v	0.63v	28.4v	0.349	513	0.480	105v
20120531	Blank	–	<0.04	0.23	<0.20	0.010	<0.05	0.39	<0.015	<0.18	<0.050	4.8
20120531	Env	e1,740	E25.1	18.0v	**1,230**	0.067v	0.94v	21.0v	0.206	606	0.497	93.0v
20120626	Env	128	E18.6	7.55v	**69.5**	0.012v	2.81v	5.9v	0.021	589	0.339	7.2v
20120826	Env	238	E12.0	5.8v	**234**	0.021v	1.38v	9.1v	0.069	347	0.294	34.9v
20120917	Env	136	E17.1	1.87v	**58.5**	0.016v	2.90v	5.4v	0.020	583	0.241	8.2v
20121114	Env	214[a]	E12.5	3.44v	**112**	0.048v	1.93v	6.3v	0.068	422	0.318	40.6v
20121206	Env	188[a]	E12.2	7.23v	**122**	0.009v	2.10v	7.8v	0.064	544	0.314	19.1v

[a]Daily mean streamflow.

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[Constituent concentrations are in whole water samples (unfiltered); ft^3/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Number of detections	1,4-dichlorobenzene (µg/L)	Atrazine (µg/L)	Bromacil (µg/L)	Camphor (µg/L)	Carbaryl (µg/L)	Carbazole (µg/L)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Little River near Tecumseh, Oklahoma (07230500)											
20120110	Env	6.1	6	<0.08	<0.16	<0.16	**0.02**	<0.06	<0.020	<0.12	<0.32
20120319	Env	1,450	18	<0.08	<0.16	<0.16	**0.03**	<0.06	<0.020	<0.12	<0.32
20120531	Env	2.6	3	<0.08	<0.16	<0.16	<0.08	<0.06	<0.020	<0.12	<0.32
20120626	Env	1.5	4	<0.08	<0.16	<0.16	**0.05**	<0.06	<0.020	<0.12	<0.32
20120626	Rep	1.5	4	<0.08	<0.16	<0.16	**0.06**	<0.06	<0.020	<0.12	<0.32
20120826	Env	1.5	8	<0.08	<0.16	<0.16	<0.08	<0.06	<0.020	<0.12	<0.32
20120918	Env	1.0	5	<0.08	<0.16	<0.16	<0.08	<0.06	<0.020	<0.12	<0.32
20121114	Env	2.4	9	<0.08	<0.16	<0.16	**0.07**	<0.06	<0.020	<0.12	<0.32
20121206	Env	2.4	6	<0.08	<0.16	<0.16	**0.03**	<0.06	<0.020	<0.12	<0.32
20121206	Rep	2.4		–	–	–	–	–	–	–	–
North Canadian River near Harrah, Oklahoma (07241550)											
20120109	Env	91	20	<0.08	**0.04**	**0.33**	<0.08	<0.06	<0.020	<0.12	<0.32
20120320	Env	4,690	38	**0.01**	**0.12**	**1.14**	<0.08	**E0.09**	**0.026**	<0.12	<0.32
20120531	Env	677	26	**0.02**	**0.10**	**2.25**	<0.08	**E0.07**	<0.022	<0.12	<0.32
20120627	Blank	–	3	<0.08	<0.16	<0.16	<0.08	<0.06	<0.020	<0.12	<0.32
20120627	Env	123	25	<0.08	<0.16	**0.32**	**0.04**	<0.06	<0.020	<0.12	<0.32
20120826	Env	185	27	<0.08	<0.16	**E0.18**	**0.08**	<0.06	<0.020	<0.12	<0.32
20120917	Env	E108	22	<0.08	**0.04**	**0.18**	**0.02**	<0.06	<0.020	<0.12	<0.32
20121113	Env	175[a]	32	<0.08	<0.16	**0.26**	<0.08	**E0.05**	**0.011**	<0.12	<0.32
20121205	Env	162	23	<0.08	<0.16	**0.22**	<0.08	<0.06	<0.020	<0.12	<0.32
Deer Creek near McLoud, Oklahoma (07241590)											
20120109	Env	0.34	5	<0.08	<0.16	<0.16	**0.03**	<0.06	<0.020	<0.12	<0.32
20120319	Env	139	7	<0.08	**E0.02**	<0.16	**E0.03**	<0.06	<0.020	<0.12	<0.32
20130410	Env	–	13	<0.08	<0.16	<0.16	**0.04**	<0.06	<0.020	<0.12	<0.32

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered); ft^3/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Number of detections	1,4-dichlorobenzene (µg/L)	Atrazine (µg/L)	Bromacil (µg/L)	Camphor (µg/L)	Carbaryl (µg/L)	Carbazole (µg/L)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
North Canadian River at Shawnee, Oklahoma (07241800)											
20120109	Env	E98	25	<0.08	**0.04**	**0.23**	**0.03**	<0.06	<0.020	<0.12	<0.32
20120320	Env	5,700	32	<0.08	**0.51**	**0.84**	<0.08	**E0.07**	**0.026**	<0.12	<0.32
20120531	Blank	–	5	<0.08	<0.16	<0.16	<0.08	<0.27	<0.020	<0.12	<0.32
20120531	Env	E1,740	26	<0.08	**0.09**	**1.62**	<0.08	<0.06	**0.025**	<0.12	<0.32
20120626	Env	128	17	<0.08	<0.16	**0.32**	**0.05**	<0.06	<0.020	<0.12	<0.32
20120826	Env	238	32	<0.08	<0.16	**E0.90**	<0.08	<0.06	**0.022**	<0.12	<0.32
20120917	Env	136	22	<0.08	**E0.05**	**E0.15**	**E0.03**	<0.06	<0.020	<0.12	<0.32
20121114	Env	214[a]	29	<0.08	<0.16	**0.24**	<0.08	<0.06	**0.008**	<0.12	<0.32
20121206	Env	188[a]	20	<0.08	<0.16	**0.18**	<0.08	<0.06	<0.020	<0.12	<0.32

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Dichlorvos (µg/L)	Metalaxyl (µg/L)	Metolachlor (µg/L)	N,N-Diethyl-m-toluamide (DEET) (µg/L)	p-Cresol (µg/L)	Penta-chloro-phenol (µg/L)	Prometon (µg/L)	1-methyl-naphthalene (µg/L)	2,6-dimethyl-naphthalene (µg/L)
Little River near Tecumseh, Oklahoma (07230500)											
20120110	Env	6.1	<0.08	<0.16	<0.04	**M**	<0.08	<1.6	<0.16	<0.04	<0.04
20120319	Env	1,450	<0.08	<0.16	**0.02**	**0.05**	<0.08	**E0.2**	<0.16	<0.04	<0.04
20120531	Env	2.6	<0.08	<0.16	<0.04	**0.02**	<0.08	<1.6	<0.16	<0.04	<0.04
20120626	Env	1.5	<0.08	<0.16	<0.04	**0.03**	<0.08	<1.6	<0.16	<0.04	<0.04
20120626	Rep	1.5	<0.08	<0.16	<0.04	**0.03**	<0.08	<1.6	<0.16	<0.04	<0.04
20120826	Env	1.5	<0.08	<0.16	<0.04	**E0.06**	<0.08	<1.6	<0.16	<0.04	<0.04
20120918	Env	1.0	<0.08	<0.16	<0.04	<0.04	<0.08	<1.6	<0.16	<0.04	<0.04
20121114	Env	2.4	<0.08	<0.16	<0.04	<0.04	**0.12**	<1.6	<0.16	<0.04	<0.04
20121206	Env	2.4	<0.08	<0.16	<0.04	<0.04	<0.08	<1.6	<0.16	<0.04	<0.04
20121206	Rep	2.4	–	–	–	–	–	–	–	–	–

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered); ft^3/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Dichlorvos (µg/L)	Metalaxyl (µg/L)	Metolachlor (µg/L)	N,N-Diethyl-m-toluamide (DEET) (µg/L)	p-Cresol (µg/L)	Penta-chloro-phenol (µg/L)	Prometon (µg/L)	1-methyl-naphthalene (µg/L)	2,6-dimethyl-naphthalene (µg/L)
North Canadian River near Harrah, Oklahoma (07241550)											
20120109	Env	91	<0.08	<0.16	<0.04	**0.05**	<0.08	<1.6	<0.16	<0.04	<0.04
20120320	Env	4,690	**0.03**	<0.16	**0.02**	**0.06**	<0.08	**E0.4**	<0.16	<0.04	<0.04
20120531	Env	677	<0.08	<0.16	**0.03**	**0.14**	<0.08	**E0.2**	**0.15**	<0.04	<0.04
20120627	Blank	–	<0.08	<0.16	<0.04	<0.04	**0.01**	<1.6	<0.16	<0.04	<0.04
20120627	Env	123	<0.08	<0.16	**0.01**	**0.21**	**0.01**	**E0.1**	**0.06**	<0.04	<0.04
20120826	Env	185	<0.08	<0.16	<0.04	**E0.17**	<0.08	<1.6	**0.04**	<0.04	<0.04
20120917	Env	E108	<0.08	<0.16	**0.02**	**0.11**	<0.08	<1.6	**0.07**	<0.04	<0.04
20121113	Env	175[a]	<0.08	<0.16	**0.01**	**0.07**	**0.02**	<1.6	**0.23**	<0.04	<0.04
20121205	Env	162	<0.08	<0.16	<0.04	**0.08**	<0.08	<1.6	**0.08**	<0.04	<0.04
Deer Creek near McLoud, Oklahoma (07241590)											
20120109	Env	0.34	<0.08	<0.16	<0.04	**0.08**	**0.03**	<1.6	<0.16	<0.04	<0.04
20120319	Env	139	<0.08	<0.16	<0.04	**E0.02**	<0.08	<1.6	<0.16	<0.04	<0.04
20130410	Env	–	<0.08	<0.16	**0.02**	<0.04	**0.7**	**E0.2**	<0.16	<0.04	<0.04
North Canadian River at Shawnee, Oklahoma (07241800)											
20120109	Env	E98	<0.08	<0.16	<0.04	**0.09**	<0.08	<1.6	<0.16	<0.04	<0.04
20120320	Env	5,700	<0.08	<0.16	**0.12**	**0.06**	<0.08	**E0.4**	**0.13**	<0.04	<0.04
20120531	Blank	–	<0.08	<0.16	<0.04	<0.04	<0.08	<1.6	<0.16	**0.01**	<0.04
20120531	Env	E1,740	<0.08	<0.16	**0.03**	**0.18**	<0.08	**E0.3**	**0.11**	<0.04	<0.04
20120626	Env	128	<0.08	<0.16	<0.04	**0.25**	<0.08	<1.6	<0.16	<0.04	<0.04
20120826	Env	238	<0.08	<0.16	<0.04	**E0.21**	<0.08	**E0.1**	**0.04**	<0.04	<0.04
20120917	Env	136	<0.08	<0.16	**E0.02**	**E0.13**	<0.08	<1.6	**E0.05**	<0.04	<0.04
20121114	Env	214[a]	<0.08	<0.16	**0.01**	**0.07**	<0.08	<1.6	**0.10**	<0.04	<0.04
20121206	Env	188[a]	<0.08	<0.16	<0.04	**0.08**	<0.08	<1.6	**0.08**	<0.04	<0.04

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered); ft^3/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	2-methyl-naphthalene (µg/L)	3,4-dichloro-phenyl isocyanate (µg/L)	3-beta-co-prostanol (µg/L)	3-methyl-1h-indole (µg/L)	3-tert-butyl-4-hydroxy-anisole (µg/L)	4-cumyl-phenol (µg/L)	4-n-octyphenol (µg/L)	4-nonylphenol (sum) (µg/L)	4-nonylphenol diethoxylate (sum) (µg/L)
Little River near Tecumseh, Oklahoma (07230500)											
20120110	Env	6.1	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20120319	Env	1,450	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	**E0.2**	<1.6
20120531	Env	2.6	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20120626	Env	1.5	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20120626	Rep	1.5	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20120826	Env	1.5	<0.04	<0.32	**E0.2**	<0.04	<0.16	<0.04	<0.02	<1.6	**E0.5**
20120918	Env	1.0	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20121114	Env	2.4	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20121206	Env	2.4	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20121206	Rep	2.4	–	–	–	–	–	–	–	–	–
North Canadian River near Harrah, Oklahoma (07241550)											
20120109	Env	91	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20120320	Env	4,690	<0.04	**E1.1**	**E0.4**	<0.04	<0.16	<0.04	<0.02	**E0.2**	<1.6
20120531	Env	677	<0.04	**E1.6**	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20120627	Blank	–	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20120627	Env	123	<0.04	**E0.73**	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20120826	Env	185	<0.04	**E0.47**	**E0.3**	<0.04	<0.16	<0.04	<0.02	<1.6	**E0.5**
20120917	Env	E108	<0.04	**E0.24**	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20121113	Env	175[a]	<0.04	**E0.16**	**E0.3**	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20121205	Env	162	<0.04	**E0.16**	**E0.2**	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
Deer Creek near McLoud, Oklahoma (07241590)											
20120109	Env	0.34	<0.04	<0.32	<1.6	**0.01**	<0.16	<0.04	<0.02	<1.6	<1.6
20120319	Env	139	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	**E0.1**	<1.6
20130410	Env	–	<0.04	<0.32	<1.6	**0.03**	<0.16	<0.04	<0.02	<1.6	<1.6

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered); ft^3/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	2-methyl-naphthalene (µg/L)	3,4-dichloro-phenyl isocyanate (µg/L)	3-beta-co-prostanol (µg/L)	3-methyl-1h-indole (µg/L)	3-tert-butyl-4-hydroxy-anisole (µg/L)	4-cumyl-phenol (µg/L)	4-n-octyphenol (µg/L)	4-nonylphenol (sum) (µg/L)	4-nonylphenol diethoxylate (sum) (µg/L)
North Canadian River at Shawnee, Oklahoma (07241800)											
20120109	Env	E98	<0.04	<0.32	**E0.9**	<0.04	<0.16	<0.04	<0.02	**E0.2**	**E0.6**
20120320	Env	5,700	<0.04	**E0.80**	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20120531	Blank	–	<0.04	<0.32	<1.6	<0.04	<0.16	<0.04	<0.02	**E2.6**	<1.6
20120531	Env	E1,740	<0.04	**E2.1**	<1.6	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20120626	Env	128	<0.04	**E0.28**	**E0.9**	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20120826	Env	238	<0.04	**E0.59**	**E0.6**	<0.04	<0.16	<0.04	<0.02	**E0.6**	**E1.0**
20120917	Env	136	<0.04	**E0.31**	**E0.2**	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20121114	Env	214[a]	<0.04	**E0.16**	**E0.3**	<0.04	<0.16	<0.04	<0.02	<1.6	<1.6
20121206	Env	188[a]	<0.04	**E0.13**	**E0.5**	<0.04	<0.16	<0.04	<0.02	<1.6	**E0.7**

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	4-Nonylphenol monoethoxylate (sum) (µg/L)	4-tert-Octylphenol diethoxylate (µg/L)	4-tert-Octyl-phenol mono-ethox-ylate (µg/L)	4-tert-Octyl-phenol (µg/L)	5-Methyl-1H-benzotriazole (µg/L)	9,10-Anthra-quinone (µg/L)	Acetophenone (µg/L)	Acetyl hexamethyl tetrahydro naphthalene (µg/L)	Anthracene (µg/L)
Little River near Tecumseh, Oklahoma (07230500)											
20120110	Env	6.1	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20120319	Env	1,450	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20120531	Env	2.6	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20120626	Env	1.5	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20120626	Rep	1.5	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20120826	Env	1.5	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20120918	Env	1.0	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20121114	Env	2.4	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20121206	Env	2.4	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20121206	Rep	2.4	–	–	–	–	–	–	–	–	–

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered); ft^3/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	4-Nonylphenol monoethoxylate (sum) (µg/L)	4-tert-Octylphenol diethoxylate (µg/L)	4-tert-Octyl-phenol mono-ethoxylate (µg/L)	4-tert-Octyl-phenol (µg/L)	5-Methyl-1H-benzotriazole (µg/L)	9,10-Anthra-quinone (µg/L)	Acetophenone (µg/L)	Acetyl hexamethyl tetrahydro naphthalene (µg/L)	Anthracene (µg/L)
					North Canadian River near Harrah, Oklahoma (07241550)						
20120109	Env	91	<1.6	**M**	<0.6	<0.4	**E0.29**	**E0.03**	<0.4	**0.06**	<0.02
20120320	Env	4,690	<1.6	<0.2	<0.6	**M**	**E0.15**	**E0.10**	<0.4	**0.01**	**0.01**
20120531	Env	677	<1.6	<0.2	<0.6	<0.4	**E0.37**	**E0.10**	<0.4	<0.04	<0.02
20120627	Blank	–	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20120627	Env	123	<1.6	<0.2	<0.6	<0.4	**E0.48**	<0.04	<0.4	**E0.01**	<0.02
20120826	Env	185	<1.6	<0.2	<0.6	<0.4	**E0.64**	**E0.05**	<0.4	**E0.02**	<0.02
20120917	Env	E108	<1.6	<0.2	<0.6	<0.4	**E0.31**	**E0.03**	<0.4	**0.02**	<0.02
20121113	Env	175[a]	<1.6	<0.2	<0.6	<0.4	**E0.42**	**E0.06**	<0.4	**0.02**	**0.01**
20121205	Env	162	<1.6	<0.2	<0.6	<0.4	**E0.64**	<0.04	<0.4	**0.02**	<0.02
					Deer Creek near McLoud, Oklahoma (07241590)						
20120109	Env	0.34	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20120319	Env	139	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	<0.4	<0.04	<0.02
20130410	Env	–	<1.6	<0.2	<0.6	<0.4	<0.32	**E0.04**	<0.4	<0.04	<0.02
					North Canadian River at Shawnee, Oklahoma (07241800)						
20120109	Env	E98	**E0.27**	**E0.1**	<0.6	**M**	**E0.46**	<0.04	<0.4	**0.02**	<0.02
20120320	Env	5,700	<1.6	<0.2	<0.6	**M**	**E0.20**	**E0.08**	<0.4	<0.04	<0.02
20120531	Blank	–	<1.6	<0.2	<0.6	<0.4	<0.32	<0.04	**0.3**	<0.04	<0.02
20120531	Env	E1,740	<1.6	<0.2	<0.6	<0.4	**E0.49**	**E0.12**	<0.4	<0.04	<0.02
20120626	Env	128	<1.6	<0.2	<0.6	<0.4	**E0.49**	<0.04	<0.4	<0.04	<0.02
20120826	Env	238	<1.6	<0.2	<0.6	**M**	**E0.49**	**E0.10**	<0.4	<0.04	**0.01**
20120917	Env	136	<1.6	<0.2	<0.6	<0.4	**E0.28**	**E0.02**	<0.4	<0.04	<0.02
20121114	Env	214[a]	<1.6	<0.2	<0.6	<0.4	**E0.31**	**E0.05**	<0.4	<0.04	**0.01**
20121206	Env	188[a]	<1.6	<0.2	<0.6	<0.4	**E0.72**	<0.04	<0.4	<0.04	<0.02

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered); ft^3/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	2,2′,4,4′-Tetra-bromodiphenyl-ether (PBDE 47) (µg/L)	Benzo(a) pyrene (µg/L)	Benzophenone (µg/L)	beta-Sitosterol (µg/L)	beta-Stigmastanol (µg/L)	Bis(2-ethylhexyl) phthalate (µg/L)	Bisphenol A (µg/L)	Caffeine (µg/L)	Cholesterol (µg/L)
					Little River near Tecumseh, Oklahoma (07230500)						
20120110	Env	6.1	<0.04	<0.02	<0.08	<4.8	<3.4	<2	<0.04	<0.08	<1.6
20120319	Env	1,450	<0.04	<0.02	**0.04**	**E2.4**	**E0.7**	<2	**0.02**	<0.08	**E0.8**
20120531	Env	2.6	<0.04	<0.02	<0.08	**E0.9**	<3.4	<2	<0.04	<0.08	**E0.5**
20120626	Env	1.5	<0.04	<0.02	<0.08	<4.8	<3.4	<2	<0.04	<0.08	**E0.4**
20120626	Rep	1.5	<0.04	<0.02	<0.08	<4.8	<3.4	<2	<0.04	<0.08	**E0.5**
20120826	Env	1.5	<0.04	<0.02	<0.08	**E0.9**	<3.4	<2	<0.04	<0.08	**E0.9**
20120918	Env	1.0	<0.04	<0.02	<0.08	<4.8	<3.4	<2	**0.01**	<0.08	**E0.2**
20121114	Env	2.4	<0.04	<0.02	<0.08	<4.8	<3.4	**M**	<0.04	<0.08	**E0.5**
20121206	Env	2.4	<0.04	<0.02	<0.08	<4.8	<3.4	<2	**0.04**	<0.08	**E0.6**
20121206	Rep	2.4	–	–	–	–	–	–	–	–	–
					North Canadian River near Harrah, Oklahoma (07241550)						
20120109	Env	91	<0.04	<0.02	**0.08**	<4.8	<3.4	<2	**0.07**	**0.17**	<1.6
20120320	Env	4,690	<0.04	**0.05**	**0.03**	**E1.0**	**E0.3**	<2	**0.09**	**0.17**	**E0.7**
20120531	Env	677	<0.04	**0.04**	**0.05**	**E0.9**	<3.4	<2	**0.05**	**0.14**	**E0.8**
20120627	Blank	–	<0.04	<0.02	**0.06**	<4.8	<3.4	<2	<0.04	<0.08	<1.6
20120627	Env	123	<0.04	<0.02	**0.06**	**E0.8**	<3.4	<2	<0.04	0.09	**E0.6**
20120826	Env	185	<0.04	**0.01**	**0.09**	**E0.7**	<3.4	<2	<0.04	**0.11**	**E0.8**
20120917	Env	E108	<0.04	<0.02	**0.07**	<4.8	<3.4	<2	<0.04	**0.09**	**E0.3**
20121113	Env	175[a]	<0.04	**0.01**	**0.06**	**E1.3**	<3.4	<2	**0.07**	**0.24**	**E0.8**
20121205	Env	162	<0.04	<0.02	**0.10**	**E1.0**	<3.4	**M**	**0.06**	**0.12**	**E1.0**
					Deer Creek near McLoud, Oklahoma (07241590)						
20120109	Env	0.34	<0.04	<0.02	<0.08	<4.8	<3.4	<2	<0.04	<0.08	<1.6
20120319	Env	139	<0.04	<0.02	<0.08	<4.8	<3.4	<2	<0.04	**E0.01**	**E0.3**
20130410	Env	–	<0.04	<0.02	<0.08	**E0.9**	<3.4	<2	**0.04**	**0.05**	**E0.5**

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered); ft³/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft³/s)	2,2′,4,4′-Tetra-bromodiphenyl-ether (PBDE 47) (µg/L)	Benzo(a) pyrene (µg/L)	Benzophenone (µg/L)	beta-Sitosterol (µg/L)	beta-Stigmastanol (µg/L)	Bis(2-ethylhexyl) phthalate (µg/L)	Bisphenol A (µg/L)	Caffeine (µg/L)	Cholesterol (µg/L)
North Canadian River at Shawnee, Oklahoma (07241800)											
20120109	Env	E98	<0.04	<0.02	**0.12**	<4.8	<3.4	<2	<0.04	**0.36**	**E1.2**
20120320	Env	5,700	<0.04	**0.06**	**0.04**	**E1.7**	**E0.6**	<2	**0.06**	**0.09**	**E0.9**
20120531	Blank	–	<0.04	<0.02	**0.23**	<4.8	<3.4	<2	<0.04	<0.08	<1.6
20120531	Env	E1,740	<0.04	**0.08**	**0.04**	**E1.0**	**E0.3**	<2	**0.08**	**0.12**	**E1.1**
20120626	Env	128	<0.04	<0.02	**0.11**	**E1.5**	<3.4	<2	<0.04	**0.22**	**E2.0**
20120826	Env	238	<0.04	**0.02**	**0.06**	**E1.5**	**E0.5**	<2	**E0.08**	**0.23**	**E1.2**
20120917	Env	136	<0.04	<0.02	**E0.04**	**E0.6**	<3.4	<2	<0.04	**E0.07**	**E0.5**
20121114	Env	214[a]	<0.04	**0.01**	**0.05**	**E1.1**	<3.4	<2	**0.06**	**0.15**	**E0.9**
20121206	Env	188[a]	<0.04	<0.02	**0.08**	**E1.4**	<3.4	<2	<0.04	**0.18**	**E1.3**

Date of sample (yyyymmdd)	Sample type	Streamflow (ft³/s)	Cotinine (µg/L)	Diethyl phthalate (µg/L)	d-Limonene (µg/L)	Fluoranthene (µg/L)	Galaxolide (HHCB) (µg/L)	Indole (µg/L)	Isoborneol (µg/L)	Isophorone (µg/L)	Isopropyl-benzene (µg/L)
Little River near Tecumseh, Oklahoma (07230500)											
20120110	Env	6.1	<0.08	<0.4	<0.16	<0.02	<0.04	**M**	<0.090	**0.012**	<0.04
20120319	Env	1,450	<0.08	**0.1**	<0.16	**0.01**	<0.04	**0.01**	<0.090	**0.019**	<0.04
20120531	Env	2.6	<0.08	<0.4	<0.16	<0.02	<0.04	<0.04	<0.090	<0.050	<0.04
20120626	Env	1.5	<0.08	<0.4	<0.16	<0.02	<0.04	<0.04	<0.090	<0.050	<0.04
20120626	Rep	1.5	<0.08	<0.4	<0.16	<0.02	<0.04	<0.04	<0.090	<0.050	<0.04
20120826	Env	1.5	<0.08	<0.4	<0.16	<0.02	<0.04	**0.01**	<0.090	**0.025**	<0.04
20120918	Env	1.0	<0.08	<0.4	<0.16	<0.02	<0.04	**0.01**	<0.090	**0.016**	<0.04
20121114	Env	2.4	<0.08	<0.4	<0.16	<0.02	<0.04	**0.01**	<0.090	**0.018**	<0.04
20121206	Env	2.4	<0.08	<0.4	<0.16	<0.02	<0.04	<0.04	<0.090	**0.015**	<0.04
20121206	Rep	2.4	–	–	–	–	–	–	–	–	–

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered); ft^3/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Cotinine (µg/L)	Diethyl phthalate (µg/L)	d-Limonene (µg/L)	Fluoranthene (µg/L)	Galaxolide (HHCB) (µg/L)	Indole (µg/L)	Isoborneol (µg/L)	Isophorone (µg/L)	Isopropyl-benzene (µg/L)
North Canadian River near Harrah, Oklahoma (07241550)											
20120109	Env	91	**E0.04**	<0.4	<0.16	<0.02	**0.5**	<0.04	<0.090	<0.050	<0.04
20120320	Env	4,690	<0.08	<0.4	<0.16	**0.08**	**0.09**	<0.04	<0.090	<0.050	<0.04
20120531	Env	677	<0.08	<0.4	<0.16	**0.07**	**E0.10**	<0.04	<0.090	<0.050	<0.04
20120627	Blank	–	<0.08	<0.4	<0.16	<0.02	<0.04	<0.04	<0.090	<0.050	<0.04
20120627	Env	123	<0.08	<0.4	<0.16	**0.01**	**0.07**	<0.04	<0.090	**0.017**	<0.04
20120826	Env	185	**E0.04**	<0.4	<0.16	**0.01**	**0.14**	<0.04	<0.090	**0.017**	<0.04
20120917	Env	E108	**E0.04**	<0.4	<0.16	<0.02	**0.17**	<0.04	<0.090	**0.012**	<0.04
20121113	Env	175[b]	**E0.06**	<0.4	<0.16	**0.02**	**0.17**	<0.04	<0.090	**0.028**	<0.04
20121205	Env	162	**E0.05**	<0.4	<0.16	<0.02	**0.21**	<0.04	<0.090	**0.016**	<0.04
Deer Creek near McLoud, Oklahoma (07241590)											
20120109	Env	0.34	<0.08	<0.4	<0.16	<0.02	<0.04	**0.01**	<0.090	<0.050	<0.04
20120319	Env	139	<0.08	<0.4	<0.16	<0.02	<0.04	<0.04	<0.090	<0.050	<0.04
20130410	Env	–	<0.08	<0.4	<0.16	<0.02	<0.04	**0.02**	<0.090	**0.022**	<0.04
North Canadian River at Shawnee, Oklahoma (07241800)											
20120109	Env	E98	**E0.07**	<0.4	<0.16	<0.02	**0.27**	<0.04	<0.090	**0.026**	<0.04
20120320	Env	5,700	<0.08	<0.4	<0.16	**0.11**	**0.09**	<0.04	<0.090	**0.014**	<0.04
20120531	Blank	–	<0.08	<0.4	<0.16	<0.02	<0.04	<0.04	<0.090	<0.050	<0.04
20120531	Env	E1,740	<0.08	<0.4	<0.16	**0.14**	**0.06**	<0.04	<0.090	<0.050	<0.04
20120626	Env	128	<0.10	<0.4	<0.16	<0.02	**0.03**	<0.04	<0.090	**0.044**	<0.04
20120826	Env	238	<0.08	<0.4	<0.16	**0.05**	**0.03**	<0.04	<0.090	**0.03**	<0.04
20120917	Env	136	**E0.05**	<0.4	<0.16	<0.02	**E0.04**	<0.04	<0.090	**E0.019**	<0.04
20121114	Env	214[a]	**E0.05**	<0.4	<0.16	**0.01**	**0.09**	<0.04	<0.090	**0.019**	<0.04
20121206	Env	188[a]	<0.08	<0.4	<0.16	<0.02	**0.1**	<0.04	<0.090	**0.013**	<0.04

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered); ft^3/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Isoquinoline (µg/L)	Menthol (µg/L)	Methyl salicylate (µg/L)	Naphthalene (µg/L)	Phenanthrene (µg/L)	Phenol (µg/L)	Pyrene (µg/L)	Tetrachloro-ethene (µg/L)	Tribromo-methane (µg/L)
Little River near Tecumseh, Oklahoma (07230500)											
20120110	Env	6.1	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	**0.02**
20120319	Env	1,450	<0.04	<0.32	<0.08	**0.04**	**0.01**	<0.16	**0.01**	<0.16	<0.16
20120531	Env	2.6	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	<0.16
20120626	Env	1.5	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	**0.07**
20120626	Rep	1.5	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	**0.07**
20120826	Env	1.5	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	**0.04**
20120918	Env	1.0	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	**0.04**
20121114	Env	2.4	<0.04	<0.32	**0.03**	<0.02	<0.02	**0.04**	<0.02	<0.16	<0.16
20121206	Env	2.4	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	**0.01**
20121206	Rep	2.4	–	–	–	–	–	–	–	–	–
North Canadian River near Harrah, Oklahoma (07241550)											
20120109	Env	91	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	**0.01**
20120320	Env	4,690	<0.04	**0.05**	<0.08	<0.02	**0.04**	<0.16	**0.07**	**E0.01**	**0.01**
20120531	Env	677	<0.04	<0.32	<0.08	<0.02	**0.02**	<0.16	**0.06**	<0.16	<0.16
20120627	Blank	–	<0.04	<0.32	<0.08	**0.01**	<0.02	<0.16	<0.02	**E0.03**	<0.16
20120627	Env	123	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	**0.01**	<0.16	<0.16
20120826	Env	185	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	**0.01**	<0.16	<0.16
20120917	Env	E108	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	**0.01**	<0.16	<0.16
20121113	Env	175[a]	<0.04	<0.32	<0.08	<0.02	**0.01**	<0.16	**0.02**	<0.16	<0.16
20121205	Env	162	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	<0.16
Deer Creek near McLoud, Oklahoma (07241590)											
20120109	Env	0.34	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	<0.16
20120319	Env	139	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	<0.16
20130410	Env	–	<0.04	<0.32	<0.08	<0.02	<0.02	**0.27**	<0.02	<0.16	<0.16

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered); ft^3/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Isoquinoline (µg/L)	Menthol (µg/L)	Methyl salicylate (µg/L)	Naphthalene (µg/L)	Phenanthrene (µg/L)	Phenol (µg/L)	Pyrene (µg/L)	Tetrachloro-ethene (µg/L)	Tribromo-methane (µg/L)
North Canadian River at Shawnee, Oklahoma (07241800)											
20120109	Env	E98	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	<0.16
20120320	Env	5,700	<0.04	<0.32	<0.08	**0.02**	**0.05**	<0.16	**0.09**	<0.16	<0.16
20120531	Blank	–	<0.04	<0.32	**0.07**	<0.02	<0.02	<0.16	<0.02	<0.16	<0.16
20120531	Env	E1,740	<0.06	<0.32	<0.08	<0.02	**0.06**	**0.05**	**0.12**	<0.16	<0.16
20120626	Env	128	<0.04	<0.32	<0.08	**0.02**	<0.02	**0.07**	<0.02	<0.16	<0.16
20120826	Env	238	<0.04	<0.32	<0.08	<0.02	**0.02**	**0.05**	**0.04**	<0.16	<0.16
20120917	Env	136	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	**M**	<0.16	<0.16
20121114	Env	214[a]	<0.04	<0.32	<0.08	<0.02	**0.01**	<0.16	**0.01**	<0.16	<0.16
20121206	Env	188[a]	<0.04	<0.32	<0.08	<0.02	<0.02	<0.16	<0.02	<0.16	<0.16

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Tributyl phosphate (µg/L)	Triclosan (µg/L)	Triethyl citrate (µg/L)	Triphenyl phos-phate (µg/L)	Tris(2-butoxyethyl) phosphate (µg/L)	Tris(2-chloroethyl) phosphate (µg/L)	Tris(dichloroisopropyl) phosphate (µg/L)
Little River near Tecumseh, Oklahoma (07230500)									
20120110	Env	6.1	<0.064	<0.32	<0.04	<0.08	**E0.22**	<0.16	<0.32
20120319	Env	1,450	<0.064	<0.32	**0.04**	<0.08	<0.64	<0.16	<0.32
20120531	Env	2.6	<0.064	<0.32	<0.04	<0.08	<0.64	<0.16	<0.32
20120626	Env	1.5	<0.064	<0.32	<0.04	<0.08	<0.64	<0.16	<0.32
20120626	Rep	1.5	<0.064	<0.32	<0.04	<0.08	<0.64	<0.16	<0.32
20120826	Env	1.5	<0.064	<0.32	<0.04	<0.08	<0.64	<0.16	<0.32
20120918	Env	1.0	<0.064	<0.32	<0.04	<0.08	<0.64	<0.16	<0.32
20121114	Env	2.4	<0.064	<0.32	<0.04	<0.08	**E0.40**	<0.16	<0.32
20121206	Env	2.4	<0.064	<0.32	<0.04	**E0.01**	<0.64	<0.16	<0.32
20121206	Rep	2.4	–	–	–	–	–	–	–

Table 3–1. Organic compound concentrations and quality-control data for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered); ft^3/s, cubic feet per second; values in **bold** are detections; µg/L, micrograms per liter; Env, environmental sample; <, less than (compound not detected); Rep, replicate quality-assurance sample; –, not measured; E, estimated; Blank, equipment-blank quality-assurance sample; M, presence verified but not quantified]

Date of sample (yyyymmdd)	Sample type	Streamflow (ft^3/s)	Tributyl phosphate (µg/L)	Triclosan (µg/L)	Triethyl citrate (µg/L)	Triphenyl phosphate (µg/L)	Tris(2-butoxyethyl) phosphate (µg/L)	Tris(2-chloroethyl) phosphate (µg/L)	Tris(dichloroisopropyl) phosphate (µg/L)
North Canadian River near Harrah, Oklahoma (07241550)									
20120109	Env	91	**0.062**	**0.11**	**0.13**	**0.01**	**E0.44**	**0.18**	**0.34**
20120320	Env	4,690	**0.109**	**0.05**	**0.03**	**0.03**	**E0.53**	**0.08**	**0.14**
20120531	Env	677	**0.069**	**0.05**	<0.06	**0.02**	<0.64	**0.14**	**0.26**
20120627	Blank	–	<0.064	<0.32	**E0.01**	<0.08	<0.64	<0.16	<0.32
20120627	Env	123	**E0.186**	**0.09**	**E0.03**	**0.01**	**E0.54**	**0.17**	**0.32**
20120826	Env	185	**0.102**	**E0.11**	**E0.06**	**0.01**	**E0.67**	**0.27**	**0.50**
20120917	Env	E108	**0.048**	**0.11**	**0.09**	<0.08	<0.64	**0.26**	**0.58**
20121113	Env	175[a]	**0.061**	**0.10**	**0.06**	**E0.03**	**E0.68**	**0.17**	**0.35**
20121205	Env	162	**E0.062**	**0.12**	**0.13**	**E0.02**	**E0.72**	**0.21**	**0.43**
Deer Creek near McLoud, Oklahoma (07241590)									
20120109	Env	0.34	<0.064	<0.32	<0.04	<0.08	<0.64	<0.16	<0.32
20120319	Env	139	<0.064	<0.32	<0.04	<0.08	<0.64	<0.16	**E0.04**
20130410	Env	–	<0.064	<0.32	<0.04	<0.08	<0.64	<0.16	<0.32
North Canadian River at Shawnee, Oklahoma (07241800)									
20120109	Env	E98	**0.133**	**0.13**	**0.17**	**0.02**	**E0.48**	**0.22**	**0.41**
20120320	Env	5,700	**0.099**	**0.04**	**0.08**	**0.02**	**E0.41**	**0.09**	**0.14**
20120531	Blank	–	<0.064	<0.32	<0.04	<0.08	<0.64	<0.16	<0.32
20120531	Env	E1,740	**0.085**	<0.32	<0.05	**0.03**	<0.64	**0.11**	**0.24**
20120626	Env	128	<0.064	<0.32	<0.04	<0.08	**E0.65**	**0.26**	**0.34**
20120826	Env	238	**0.105**	**E0.09**	<0.04	**0.01**	**E0.71**	**0.19**	**0.27**
20120917	Env	136	**E0.069**	<0.32	**E0.02**	<0.08	<0.64	**E0.18**	**E0.32**
20121114	Env	214[a]	**0.043**	**0.12**	**0.04**	**E0.02**	**E0.66**	**0.16**	**0.30**
20121206	Env	188[a]	**E0.044**	**0.23**	**0.11**	**E0.01**	**E0.80**	**0.27**	**0.58**

[a] Daily mean streamflow.

Table 4–1. Analytical relative percent difference for concentrations of major ions, nutrients, and trace elements in two quality-control samples for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[Concentrations of major ions and nutrients are dissolved unless noted otherwise; Concentrations of trace elements are in whole-water samples unless noted otherwise; mg/L, millgrams per liter; RPD, relative percent difference; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; –, not detected; N, nitrogen; P, phosphorus; <, less than; µg/L, micrograms per liter; RPD was not calculated if one constituent had an estimated concentration or a concentration less than the minimum reporting level]

Sample date	Sample type	Dissolved solids (mg/L)	Calcium (mg/L)	Calcium (whole) (mg/L)	Magnesium (mg/L)	Magnesium (whole) (mg/L)	Potassium (mg/L)	Potassium (whole) (mg/L)	Sodium (mg/L)
					Little River near Tecumseh, Oklahoma (07230500)				
20120626	Environmental	815	30.3	30.2	33.1	33.1	3.19	3.28	226
20120626	Replicate	823	27.8	30.1	32.0	33.0	3.14	3.30	221
RPD		1.0 percent	8.6 percent	0.3 percent	3.4 percent	0.3 percent	1.6 percent	0.6 percent	2.2 percent
20121206	Environmental	872	53.7	53.8	33.1	33.5	2.99	3.10	196
20121206	Replicate	827	54.0	54.0	32.9	33.5	3.03	3.23	197
RPD		5.3 percent	0.6 percent	0.4 percent	0.6 percent	0 percent	1.3 percent	4.1 percent	0.5 percent

Sample date	Sample type	Sodium whole (mg/L)	Alkalinity (mg/L as $CaCO_3$)	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L as SiO_2)	Sulfate (mg/L)
					Little River near Tecumseh, Oklahoma (07230500)				
20120626	Environmental	224	206	244	3.10	294	0.43	13.0	69.6
20120626	Replicate	223	205	241	4.40	291	0.40	12.0	69.6
RPD		0.4 percent	0.5 percent	1.2 percent	34.7 percent	1.0 percent	7.2 percent	8.0 percent	0 percent
20121206	Environmental	214	266	317	3.7	297	0.33	9.43	81.0
20121206	Replicate	217	266	317	3.7	297	0.31	9.38	81.8
RPD		1.4 percent	0 percent	0 percent	0 percent	0 percent	6.3 percent	0.5 percent	1 percent

Sample date	Sample type	Ammonia plus organic nitrogen (mg/L as N)	Ammonia plus organic nitrogen (whole) (mg/L as N)	Ammonia nitrogen (mg/L as N)	Nitrite plus nitrate-nitrogen (mg/L as N)	Nitrite-nitrogen (mg/L as N)	Orthophosphate phosphorus (mg/L as P)	Total phosphorus (mg/L)	Total phosphorus (whole) (mg/L)
					Little River near Tecumseh, Oklahoma (07230500)				
20120626	Environmental	0.38	0.51	<0.010	<0.040	<0.001	<0.004	0.006	0.030
20120626	Replicate	0.35	0.40	<0.010	<0.040	<0.001	0.004	0.007	0.014
RPD		8.2 percent	24.2 percent	–	–	–	–	15.4 percent	72.7 percent
20121206	Environmental	0.29	0.25	0.020	<0.040	<0.001	0.004	0.007	0.017
20121206	Replicate	0.28	0.27	0.021	<0.040	<0.001	<0.004	0.008	0.017
RPD		3.5 percent	7.7 percent	4.9 percent	–	–	–	13.3 percent	0 percent

Table 4–1. Analytical relative percent difference for concentrations of major ions, nutrients, and trace elements in two quality-control samples for water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Concentrations of major ions and nutrients are dissolved unless noted otherwise; Concentrations of trace elements are in whole-water samples unless noted otherwise; mg/L, millgrams per liter; RPD, relative percent difference; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; –, not detected; N, nitrogen; P, phosphorus; <, less than; µg/L, micrograms per liter; RPD was not calculated if one constituent had an estimated concentration or a concentration less than the minimum reporting level]

Sample date	Sample type	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron (dissolved) (µg/L)	Iron (µg/L)
Little River near Tecumseh, Oklahoma (07230500)											
20120626	Environmental	100	3.9	351	<0.19	<0.016	0.32	0.31	<1.4	5.0	109
20120626	Replicate	70	3.9	351	<0.19	<0.016	<0.30	0.28	3.2	8.3	73.1
RPD		35.3	0	0	–	–	–	10.2	–	49.6	39.4
20121206	Environmental	150	1.3	396	<0.19	<0.016	0.37	0.14	<1.4	21.3	152
20121206	Replicate	160	1.4	394	<0.19	0.017	<0.30	0.12	<1.4	13.0	153
RPD		6.5 percent	7.4 percent	0.5 percent	–	–	–	15.4 percent	–	48.4 percent	0.7 percent

Sample date	Sample type	Lead (µg/L)	Lithium (µg/L)	Manganese (dissolved) (µg/L	Manganese (µg/L)	Mercury (µg/L)	Molybdenum (µg/L)	Nickel (µg/L)	Silver (µg/L)	Selenium (µg/L)	Strontium (µg/L)	Zinc (µg/L)
Little River near Tecumseh, Oklahoma (07230500)												
20120626	Environmental	0.18	15.5	16.1	58.3	0.036	2.12	0.91	<0.015	0.186	432	<2.0
20120626	Replicate	0.18	15.3	13.2	43.3	0.024	2.11	0.94	<0.015	0.305	429	<2.0
RPD		0 percent	1.3 percent	19.8 percent	29.5 percent	40 percent	0.5 percent	3.2 percent	–	48.5 percent	0.7 percent	–
20121206	Environmental	0.21	10.6	20.2	34.1	0.028	1.61	1.3	<0.015	0.258	561	2.1
20121206	Replicate	0.20	10.4	21.5	34.5	0.028	1.63	1.2	<0.015	0.305	568	3.2
RPD		4.9 percent	1.9 percent	6.2 percent	1.2 percent	0 percent	1.2 percent	8.0 percent	–	16.7 percent	1.2 percent	41.5 percent

Table 5–1. Selected radionuclide concentrations and quality-control data for samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[ID, identifier; USGS, U.S. Geological Survey; Env, environmental sample; ND, analyte not detected (concentration is less than the sample-specific critical level); –, not applicable; pCi/L, picocurie per liter; ±, plus or minus; µg/L, micrograms per liter; Rep, replicate quality-control sample; Result, radiological concentrations plus or minus the 1-sigma combined standard uncertainty; GA (72h), sample analyzed for gross alpha-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using 230Thorium; GA (30d), sample used for the 72-hour gross alpha-particle analysis is counted a second time approximately 30 days after the initial count as referenced to a detector calibrated by using 230Thorium; GB (72h), sample analyzed for gross beta-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using 137Cesium; GB (30d), sample used for the 72-hour gross beta-particle analysis is counted a second time approximately 30 days after the initial count as referenced to a detector calibrated by using 137Cesium; –, not applicable; a, laboratory background blank was greater than the sample-specific critical level; b, sample-specific minimum detectable concentration was above the contractual (also called the *a priori*) minimum detectable concentration; c, counted five days after collection; d, diluted sample because the high range of the method was exceeded; **Bold** font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a)]

Well and sample ID	USGS station ID	Sample date (yyyymmdd)	Sample type	Radionuclide constituent	Result	Sample-specific critical level	Remark	Units
w1	352755097141801	20130312	Env	GA (30d)	ND	0.4	–	pCi/L
w1	352755097141801	20130312	Env	GA (72h)	1.4 ± 0.37	0.32	–	pCi/L
w1	352755097141801	20130312	Env	GB (30d)	1.7 ± 0.44	0.64	–	pCi/L
w1	352755097141801	20130312	Env	GB (72h)	ND	0.47	–	pCi/L
w1	352755097141801	20130312	Env	Uranium	0.156	0.004	–	µg/L
w2	352527097144201	20130312	Env	GA (30d)	1.5 ± 0.72	0.85	–	pCi/L
w2	352527097144201	20130312	Env	GA (72h)	6.6 ± 1.3	0.88	–	pCi/L
w2	352527097144201	20130312	Env	GB (30d)	1.9 ± 0.48	0.7	–	pCi/L
w2	352527097144201	20130312	Env	GB (72h)	1.4 ± 0.51	0.8	–	pCi/L
w2	352527097144201	20130312	Env	Uranium	0.04	0.004	–	µg/L
w3	352449097054601	20120919	Env	GA (30d)	ND	0.69	–	pCi/L
w3	352449097054601	20120919	Env	GA (72h)	4 ± 0.99	0.72	–	pCi/L
w3	352449097054601	20120919	Env	GB (30d)	1.7 ± 0.5	0.76	–	pCi/L
w3	352449097054601	20120919	Env	GB (72h)	2.2 ± 0.5	0.68	–	pCi/L
w3	352449097054601	20120919	Env	Uranium	0.145	0.004	–	µg/L
w4	352412097040301	20120731	Env	GA (30d)	5.9 ± 1.3	1.1	–	pCi/L
w4	352412097040301	20120731	Env	GA (72h)	4.6 ± 1.1	0.85	–	pCi/L
w4	352412097040301	20120731	Env	GB (30d)	1.5 ± 0.56	0.85	–	pCi/L
w4	352412097040301	20120731	Env	GB (72h)	1.2 ± 0.6	0.97	–	pCi/L
w4	352412097040301	20120731	Env	Uranium	1.42	0.004	–	µg/L
w5	352407096462701	20120718	Env	GA (30d)	ND	1.5	b	pCi/L
w5	352407096462701	20120718	Rep	GA (30d)	1.4 ± 1.1	1.4	b	pCi/L
w5	352407096462701	20120718	Env	GA (72h)	4.8 ± 1.6	1.7	b	pCi/L
w5	352407096462701	20120718	Rep	GA (72h)	6.9 ± 1.5	0.94	–	pCi/L
w5	352407096462701	20120718	Env	GB (30d)	2.6 ± 0.52	0.75	–	pCi/L
w5	352407096462701	20120718	Rep	GB (30d)	1.9 ± 0.42	0.61	–	pCi/L
w5	352407096462701	20120718	Env	GB (72h)	4.4 ± 0.65	0.89	–	pCi/L
w5	352407096462701	20120718	Rep	GB (72h)	2 ± 0.49	0.71	–	pCi/L
w5	352407096462701	20120718	Env	Uranium	2.13	0.004	–	µg/L
w5	352407096462701	20120718	Rep	Uranium	2.14	0.004	–	µg/L
w6	352303097033401	20120910	Env	GA (30d)	11 ± 2.2	2.1	b	pCi/L
w6	352303097033401	20120910	Rep	GA (30d)	**18 ± 3**	1.9	b	pCi/L
w6	352303097033401	20120910	Env	GA (72h)	**22 ± 3.3**	1.5	b	pCi/L

Table 5–1. Selected radionuclide concentrations and quality-control data for samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[ID, identifier; USGS, U.S. Geological Survey; Env, environmental sample; ND, analyte not detected (concentration is less than the sample-specific critical level); –, not applicable; pCi/L, picocurie per liter; ±, plus or minus; µg/L, micrograms per liter; Rep, replicate quality-control sample; Result, radiological concentrations plus or minus the 1-sigma combined standard uncertainty; GA (72h), sample analyzed for gross alpha-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using 230Thorium; GA (30d), sample used for the 72-hour gross alpha-particle analysis is counted a second time approximately 30 days after the initial count as referenced to a detector calibrated by using 230Thorium; GB (72h), sample analyzed for gross beta-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using 137Cesium; GB (30d), sample used for the 72-hour gross beta-particle analysis is counted a second time approximately 30 days after the initial count as referenced to a detector calibrated by using 137Cesium; –, not applicable; a, laboratory background blank was greater than the sample-specific critical level; b, sample-specific minimum detectable concentration was above the contractual (also called the *a priori*) minimum detectable concentration; c, counted five days after collection; d, diluted sample because the high range of the method was exceeded; **Bold** font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a)]

Well and sample ID	USGS station ID	Sample date (yyyymmdd)	Sample type	Radionuclide constituent	Result	Sample-specific critical level	Remark	Units
w6	352303097033401	20120910	Rep	GA (72h)	**20 ± 3**	0.94	–	pCi/L
w6	352303097033401	20120910	Env	GB (30d)	3.3 ± 0.68	0.92	–	pCi/L
w6	352303097033401	20120910	Rep	GB (30d)	4 ± 0.64	0.76	–	pCi/L
w6	352303097033401	20120910	Env	GB (72h)	3.8 ± 0.43	0.5	–	pCi/L
w6	352303097033401	20120910	Rep	GB (72h)	3.5 ± 0.45	0.57	–	pCi/L
w6	352303097033401	20120910	Env	Uranium	5.43	0.004	d	µg/L
w6	352303097033401	20120910	Rep	Uranium	5.83	0.004	–	µg/L
w7	352232097035501	20120731	Env	GA (30d)	1.4 ± 0.67	0.63	–	pCi/L
w7	352232097035501	20120731	Env	GA (72h)	2.7 ± 0.85	0.59	–	pCi/L
w7	352232097035501	20120731	Env	GB (30d)	1.5 ± 0.56	0.83	–	pCi/L
w7	352232097035501	20120731	Env	GB (72h)	ND	0.86	–	pCi/L
w7	352232097035501	20120731	Env	Uranium	0.047	0.004	–	µg/L
w8	352226097073901	20120718	Env	GA (30d)	1.3 ± 0.49	0.43	–	pCi/L
w8	352226097073901	20120718	Env	GA (72h)	2.6 ± 0.7	0.51	–	pCi/L
w8	352226097073901	20120718	Env	GB (30d)	1.2 ± 0.42	0.63	–	pCi/L
w8	352226097073901	20120718	Env	GB (72h)	3.7 ± 0.63	0.84	–	pCi/L
w8	352226097073901	20120718	Env	Uranium	0.169	0.004	–	µg/L
w9	352104097044701	20120724	Env	GA (30d)	ND	0.44	–	pCi/L
w9	352104097044701	20120724	Env	GA (72h)	0.9 ± 0.61	0.62	a	pCi/L
w9	352104097044701	20120724	Env	GB (30d)	ND	0.79	–	pCi/L
w9	352104097044701	20120724	Env	GB (72h)	ND	0.9	–	pCi/L
w9	352104097044701	20120724	Env	Uranium	0.059	0.004	–	µg/L
w10	352002097000301	20120829	Env	GA (30d)	4.2 ± 1.3	1.5	b	pCi/L
w10	352002097000301	20120829	Env	GA (72h)	9.1 ± 1.7	0.88	–	pCi/L
w10	352002097000301	20120829	Env	GB (30d)	2.1 ± 0.34	0.46	–	pCi/L
w10	352002097000301	20120829	Env	GB (72h)	1.6 ± 0.45	0.67	–	pCi/L
w10	352002097000301	20120829	Env	Uranium	1.66	0.004	–	µg/L
w11	351937096512201	20120919	Env	GA (30d)	5.9 ± 1.1	0.81	–	pCi/L
w11	351937096512201	20120919	Env	GA (72h)	8.2 ± 1.8	1.2	–	pCi/L
w11	351937096512201	20120919	Env	GB (30d)	2.5 ± 0.52	0.76	–	pCi/L
w11	351937096512201	20120919	Env	GB (72h)	1.8 ± 0.71	1.1	–	pCi/L
w11	351937096512201	20120919	Env	Uranium	4.53	0.004	–	µg/L

Table 5–1. Selected radionuclide concentrations and quality-control data for samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[ID, identifier; USGS, U.S. Geological Survey; Env, environmental sample; ND, analyte not detected (concentration is less than the sample-specific critical level); –, not applicable; pCi/L, picocurie per liter; ±, plus or minus; µg/L, micrograms per liter; Rep, replicate quality-control sample; Result, radiological concentrations plus or minus the 1-sigma combined standard uncertainty; GA (72h), sample analyzed for gross alpha-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using 230Thorium; GA (30d), sample used for the 72-hour gross alpha-particle analysis is counted a second time approximately 30 days after the initial count as referenced to a detector calibrated by using 230Thorium; GB (72h), sample analyzed for gross beta-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using 137Cesium; GB (30d), sample used for the 72-hour gross beta-particle analysis is counted a second time approximately 30 days after the initial count as referenced to a detector calibrated by using 137Cesium; –, not applicable; a, laboratory background blank was greater than the sample-specific critical level; b, sample-specific minimum detectable concentration was above the contractual (also called the *a priori*) minimum detectable concentration; c, counted five days after collection; d, diluted sample because the high range of the method was exceeded; **Bold** font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a)]

Well and sample ID	USGS station ID	Sample date (yyyymmdd)	Sample type	Radionuclide constituent	Result	Sample-specific critical level	Remark	Units
w12	351819097071201	20120724	Env	GA (30d)	0.6 ± 0.41	0.42	–	pCi/L
w12	351819097071201	20120724	Env	GA (72h)	2.1 ± 0.73	0.63	a	pCi/L
w12	351819097071201	20120724	Env	GB (30d)	ND	0.69	–	pCi/L
w12	351819097071201	20120724	Env	GB (72h)	ND	0.92	–	pCi/L
w12	351819097071201	20120724	Env	Uranium	0.03	0.004	–	µg/L
w13	351807096545801	20120619	Env	GA (30d)	ND	1.5	b	pCi/L
w13	351807096545801	20120619	Env	GA (72h)	8.3 ± 1.8	1.5	b	pCi/L
w13	351807096545801	20120619	Env	GB (30d)	2.4 ± 0.51	0.76	–	pCi/L
w13	351807096545801	20120619	Env	GB (72h)	2.3 ± 0.49	0.69	–	pCi/L
w13	351807096545801	20120619	Env	Uranium	3.66	0.004	–	µg/L
w14	351751096563301	20120924	Env	GA (30d)	1.9 ± 1.3	1.8	b	pCi/L
w14	351751096563301	20120924	Env	GA (72h)	7.6 ± 1.9	1.7	a, b	pCi/L
w14	351751096563301	20120924	Env	GB (30d)	2.4 ± 0.52	0.76	–	pCi/L
w14	351751096563301	20120924	Env	GB (72h)	2.8 ± 0.57	0.8	–	pCi/L
w14	351751096563301	20120924	Env	Uranium	0.895	0.004	–	µg/L
w15	351649096584801	20120910	Env	GA (30d)	11.7 ± 1.9	0.83	–	pCi/L
w15	351649096584801	20120910	Env	GA (72h)	12.8 ± 1.8	0.75	–	pCi/L
w15	351649096584801	20120910	Env	GB (30d)	2.6 ± 0.57	0.76	–	pCi/L
w15	351649096584801	20120910	Env	GB (72h)	1.4 ± 0.41	0.6	–	pCi/L
w15	351649096584801	20120910	Env	Uranium	4.8	0.004	–	µg/L
w16	351634097025601	20120627	Env	GA (30d)	ND	0.99	–	pCi/L
w16	351634097025601	20120627	Env	GA (72h)	9.4 ± 1.9	1.4	b	pCi/L
w16	351634097025601	20120627	Env	GB (30d)	1 ± 0.42	0.66	–	pCi/L
w16	351634097025601	20120627	Env	GB (72h)	2.8 ± 0.42	0.57	–	pCi/L
w16	351634097025601	20120627	Env	Uranium	0.837	0.004	–	µg/L
w17	351536096545501	20120619	Env	GA (30d)	3.4 ± 0.92	0.76	–	pCi/L
w17	351536096545501	20120619	Env	GA (72h)	6.8 ± 1.2	0.75	–	pCi/L
w17	351536096545501	20120619	Env	GB (30d)	1 ± 0.55	0.9	–	pCi/L
w17	351536096545501	20120619	Env	GB (72h)	1.9 ± 0.61	0.91	–	pCi/L
w17	351536096545501	20120619	Env	Uranium	2.62	0.004	–	µg/L
w18	351518096511501	20120724	Env	GA (30d)	ND	0.63	–	pCi/L
w18	351518096511501	20120724	Env	GA (72h)	2.1 ± 0.55	0.43	a	pCi/L
w18	351518096511501	20120724	Env	GB (30d)	1.1 ± 0.48	0.74	–	pCi/L

Table 5–1. Selected radionuclide concentrations and quality-control data for samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[ID, identifier; USGS, U.S. Geological Survey; Env, environmental sample; ND, analyte not detected (concentration is less than the sample-specific critical level); –, not applicable; pCi/L, picocurie per liter; ±, plus or minus; µg/L, micrograms per liter; Rep, replicate quality-control sample; Result, radiological concentrations plus or minus the 1-sigma combined standard uncertainty; GA (72h), sample analyzed for gross alpha-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using 230Thorium; GA (30d), sample used for the 72-hour gross alpha-particle analysis is counted a second time approximately 30 days after the initial count as referenced to a detector calibrated by using 230Thorium; GB (72h), sample analyzed for gross beta-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using 137Cesium; GB (30d), sample used for the 72-hour gross beta-particle analysis is counted a second time approximately 30 days after the initial count as referenced to a detector calibrated by using 137Cesium; –, not applicable; a, laboratory background blank was greater than the sample-specific critical level; b, sample-specific minimum detectable concentration was above the contractual (also called the *a priori*) minimum detectable concentration; c, counted five days after collection; d, diluted sample because the high range of the method was exceeded; **Bold** font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a)]

Well and sample ID	USGS station ID	Sample date (yyyymmdd)	Sample type	Radionuclide constituent	Result	Sample-specific critical level	Remark	Units
w18	351518096511501	20120724	Env	GB (72h)	ND	0.5	–	pCi/L
w18	351518096511501	20120724	Env	Uranium	0.212	0.004	–	µg/L
w19	351448097024501	20120919	Env	GA (30d)	ND	1.1	–	pCi/L
w19	351448097024501	20120919	Env	GA (72h)	10.6 ± 1.7	0.87	–	pCi/L
w19	351448097024501	20120919	Env	GB (30d)	4.4 ± 0.84	1.2	–	pCi/L
w19	351448097024501	20120919	Env	GB (72h)	3 ± 0.67	1	–	pCi/L
w19	351448097024501	20120919	Env	Uranium	3.68	0.004	–	µg/L
w20	351422097072801	20120627	Env	GA (30d)	3.2 ± 0.96	1	–	pCi/L
w20	351422097072801	20120627	Env	GA (72h)	10.7 ± 1.7	0.96	–	pCi/L
w20	351422097072801	20120627	Env	GB (30d)	2.7 ± 0.72	1.1	–	pCi/L
w20	351422097072801	20120627	Env	GB (72h)	5.5 ± 0.9	1.2	–	pCi/L
w20	351422097072801	20120627	Env	Uranium	0.853	0.004	–	µg/L
w21	351251097000801	20120619	Env	GA (30d)	ND	0.74	–	pCi/L
w21	351251097000801	20120619	Env	GA (72h)	3.4 ± 0.96	0.99	–	pCi/L
w21	351251097000801	20120619	Env	GB (30d)	1.2 ± 0.55	0.86	–	pCi/L
w21	351251097000801	20120619	Env	GB (72h)	ND	1.1	–	pCi/L
w21	351251097000801	20120619	Env	Uranium	0.542	0.004	–	µg/L
w22	351103096534601	20120829	Env	GA (30d)	2.6 ± 1.2	1.3	b	pCi/L
w22	351103096534601	20120829	Env	GA (72h)	7.5 ± 1.5	1	–	pCi/L
w22	351103096534601	20120829	Env	GB (30d)	2.9 ± 0.41	0.54	–	pCi/L
w22	351103096534601	20120829	Env	GB (72h)	0.7 ± 0.35	0.54	–	pCi/L
w22	351103096534601	20120829	Env	Uranium	6.68	0.004	–	µg/L
w23	350624097005601	20130501	Env	Uranium	0.704	0.004	–	µg/L
w24	350603097065901	20130313	Env	GA (30d)	1.5 ± 0.72	0.85	–	pCi/L
w24	350603097065901	20130313	Env	GA (72h)	5.7 ± 1.1	0.93	c	pCi/L
w24	350603097065901	20130313	Env	GB (30d)	3.4 ± 0.52	0.7	–	pCi/L
w24	350603097065901	20130313	Env	GB (72h)	1.8 ± 0.51	0.8	c	pCi/L
w24	350603097065901	20130313	Env	Uranium	3.27	0.004	–	µg/L
w25	350236097191501	20130501	Env	Uranium	18.2	0.004	–	µg/L
w26	350234097040401	20130326	Env	GA (30d)	11 ± 1.9	0.95	–	pCi/L
w26	350234097040401	20130326	Env	GA (72h)	**16 ± 2.4**	1.2	–	pCi/L
w26	350234097040401	20130326	Env	GB (30d)	4.7 ± 0.75	0.94	–	pCi/L
w26	350234097040401	20130326	Env	GB (72h)	2 ± 0.61	0.92	–	pCi/L

Table 5–1. Selected radionuclide concentrations and quality-control data for samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[ID, identifier; USGS, U.S. Geological Survey; Env, environmental sample; ND, analyte not detected (concentration is less than the sample-specific critical level); –, not applicable; pCi/L, picocurie per liter; ±, plus or minus; µg/L, micrograms per liter; Rep, replicate quality-control sample; Result, radiological concentrations plus or minus the 1-sigma combined standard uncertainty; GA (72h), sample analyzed for gross alpha-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using 230Thorium; GA (30d), sample used for the 72-hour gross alpha-particle analysis is counted a second time approximately 30 days after the initial count as referenced to a detector calibrated by using 230Thorium; GB (72h), sample analyzed for gross beta-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using 137Cesium; GB (30d), sample used for the 72-hour gross beta-particle analysis is counted a second time approximately 30 days after the initial count as referenced to a detector calibrated by using 137Cesium; –, not applicable; a, laboratory background blank was greater than the sample-specific critical level; b, sample-specific minimum detectable concentration was above the contractual (also called the *a priori*) minimum detectable concentration; c, counted five days after collection; d, diluted sample because the high range of the method was exceeded; **Bold** font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a)]

Well and sample ID	USGS station ID	Sample date (yyyymmdd)	Sample type	Radionuclide constituent	Result	Sample-specific critical level	Remark	Units
w26	350234097040401	20130326	Env	Uranium	9.43	0.004	–	µg/L
w27	350117096591001	20130326	Env	GA (30d)	2.8 ± 1.2	1.4	b	pCi/L
w27	350117096591001	20130326	Rep	GA (30d)	2.9 ± 1.5	1.9	b	pCi/L
w27	350117096591001	20130326	Env	GA (72h)	7.7 ± 1.8	1.4	b	pCi/L
w27	350117096591001	20130326	Rep	GA (72h)	7.5 ± 1.8	1.7	b	pCi/L
w27	350117096591001	20130326	Env	GB (30d)	1.9 ± 0.66	1	–	pCi/L
w27	350117096591001	20130326	Rep	GB (30d)	1.8 ± 0.61	0.93	–	pCi/L
w27	350117096591001	20130326	Env	GB (72h)	3.1 ± 0.62	0.88	–	pCi/L
w27	350117096591001	20130326	Rep	GB (72h)	1.9 ± 0.56	0.89	–	pCi/L
w27	350117096591001	20130326	Env	Uranium	2.66	0.004	–	µg/L
w27	350117096591001	20130326	Rep	Uranium	2.66	0.004	–	µg/L
w28	350034097031201	20130501	Env	Uranium	**79.5**	0.004	–	µg/L
w29	350017096595501	20130326	Env	GA (30d)	**23 ± 3.2**	1.5	b	pCi/L
w29	350017096595501	20130326	Env	GA (72h)	**28 ± 3.7**	1	–	pCi/L
w29	350017096595501	20130326	Env	GB (30d)	9.7 ± 0.96	0.92	–	pCi/L
w29	350017096595501	20130326	Env	GB (72h)	3.2 ± 0.72	1	–	pCi/L
w29	350017096595501	20130326	Env	Uranium	**31.1**	0.004	–	µg/L
w30	345816097095101	20130313	Env	GA (30d)	10.3 ± 1.9	1.3	–	pCi/L
w30	345816097095101	20130313	Env	GA (72h)	**17 ± 2.5**	1.1	–	pCi/L
w30	345816097095101	20130313	Env	GB (30d)	7 ± 0.84	1	–	pCi/L
w30	345816097095101	20130313	Env	GB (72h)	3.2 ± 0.67	0.95	–	pCi/L
w30	345816097095101	20130313	Env	Uranium	10.6	0.004	–	µg/L
–	–	20120615	Blank	Uranium	ND	0.004	–	µg/L

Table 6–1. Water-property measurements and concentrations of major ions, nutrients, and trace-elements and quality-control data for water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[Constituent concentrations are dissolved (filtered); USGS, U.S. Geological Survey; ID, identifier; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; Env, environmental sample; Rep, replicate quality-assurance sample; –, not available; Blank, equipment-blank quality-assurance sample; <, less than; SiO_2, silica dioxide; e, may not represent true concentration in sample. Something other than carbonate and bicarbonate was neutralized in this sample; P, phosphorus; N, nitrogen; µg/L, micrograms per liter; v, analyte detected in equipment-blank quality-assurance sample; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

USGS station ID	Date of sample (yyyymmdd)	Well and sample ID	Sample type	Ionic balance (percent)[a]	Dissolved oxygen (mg/L)	pH (standard units)	Specific conductance (µS/cm at 25 degrees Celsius)	Water temperature (degrees Celsius)	Dissolved solids (mg/L)	Hardness (calculated) (mg/L as $CaCO_3$)
352755097141801	20130312	w1	Env	4.16	5.6	**6.3**	376	16.6	212	167
352527097144201	20130312	w2	Env	4.30	9.7	**5.0**	89	16.7	55	21.8
352449097054601	20120919	w3	Env	2.70	7.3	**6.1**	338	18.9	205	130
352412097040301	20120731	w4	Env	-1.40	2.3	8.2	703	16.4	445	18.6
352407096462701	20120718	w5	Env	2.02	7.7	6.8	1,020	17.1	**624**	465
352407096462701	20120718	w5	Rep	–	–	–	–	–	**643**	466
352303097033401	20120910	w6	Env	-0.67	0.9	6.8	854	17.0	**532**	217
352303097033401	20120910	w6	Rep	–	–	–	–	–	**527**	218
352232097035501	20120731	w7	Env	1.60	8.6	**6.0**	308	19.0	192	75.4
352226097073901	20120718	w8	Env	2.98	5.0	**5.3**	227	17.8	145	66.0
352104097044701	20120724	w9	Env	1.32	5.5	**5.8**	114	18.6	73	34.7
352002097000301	20120829	w10	Env	1.32	6.6	6.7	955	18.2	**580**	366
351937096512201	20120919	w11	Env	1.55	6.8	7.2	587	17.7	365	170
351819097071201	20120724	w12	Env	1.54	8.0	5.7	101	18.3	62	25.8
351807096545801	20120619	w13	Env	-1.27	1.1	6.9	1,010	17.6	**606**	369
351751096563301	20120924	w14	Env	0.22	4.0	7.8	1,250	17.7	**877**	55.5
351649096584801	20120910	w15	Env	2.30	7.8	6.9	517	18.3	300	79.2
351634097025601	20120627	w16	Env	1.32	6.6	6.8	744	17.4	421	354
351536096545501	20120619	w17	Env	3.20	7.0	7.2	511	18.8	318	232
351518096511501	20120724	w18	Env	1.56	7.6	6.4	323	18.6	187	140
351448097024501	20120919	w19	Env	1.36	7.2	6.7	706	17.5	394	364
351422097072801	20120627	w20	Env	1.39	5.7	6.8	502	16.2	282	266
351251097000801	20120619	w21	Env	1.98	6.5	7.0	560	18.7	321	289
351103096534601	20120829	w22	Env	1.93	4.4	6.7	834	18.4	493	433
350624097005601	20130501	w23	Env	4.56	8.8	6.7	431	18.1	249	201
350603097065901	20130313	w24	Env	-3.35	2.6	6.7	399	17.5	227	190
350236097191501	20130501	w25	Env	-1.23	1.4	8.4	1,920	18.2	**1,280**	21.0
350234097040401	20130326	w26	Env	-0.77	7.8	7.2	704	16.9	433	224

Table 6–1. Water-property measurements and concentrations of major ions, nutrients, and trace-elements and quality-control data for water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are dissolved (filtered); USGS, U.S. Geological Survey; ID, identifier; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; Env, environmental sample; Rep, replicate quality-assurance sample; –, not available; Blank, equipment-blank quality-assurance sample; <, less than; SiO_2, silica dioxide; e, may not represent true concentration in sample. Something other than carbonate and bicarbonate was neutralized in this sample; P, phosphorus; N, nitrogen; µg/L, micrograms per liter; v, analyte detected in equipment-blank quality-assurance sample; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

USGS station ID	Date of sample (yyyymmdd)	Well and sample ID	Sample type	Ionic balance (percent)[a]	Dissolved oxygen (mg/L)	pH (standard units)	Specific conductance (µS/cm at 25 degrees Celsius)	Water temperature (degrees Celsius)	Dissolved solids (mg/L)	Hardness (calculated) (mg/L as $CaCO_3$)
350117096591001	20130326	w27	Env	1.32	9.7	7.2	846	18.0	**502**	328
350117096591001	20130326	w27	Rep	–	–	–	–	–	**501**	328
350034097031201	20130501	w28	Env	-0.69	2.4	7.7	1,420	17.7	**900**	47.8
350017096595501	20130326	w29	Env	-4.09	2.8	7.7	934	17.8	**578**	59.2
345816097095101	20130313	w30	Env	2.09	6.1	7.0	605	17.2	363	270
–	20120615	–	Blank	–	–	–	–	–	<20	–

Well and sample ID	Sample type	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Alkalinity (mg/L as $CaCO_3$)	Bicarbonate (mg/L)	Carbonate (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)
w1	Env	38.4v	17.1	1.33	14.5v	146	177	0.1	0.150	19.0v	–
w2	Env	5.75v	1.76	0.83	6.17v	17.0	20	<1.0	0.056	5.13v	–
w3	Env	29.0v	14.0	1.73	19.8v	102	124	<1.0	0.608	34.1v	0.06
w4	Env	4.17v	1.96	0.99	154v	256	304	3.9	0.126	42.5v	0.95
w5	Env	104v	49.7	1.61	72.5v	522	648	0.4	<0.010	18.9v	0.62
w5	Rep	104v	49.5	1.56	73.6v	–	–	–	<0.010	18.8v	0.66
w6	Env	56.5v	18.2	1.62	118v	420	512	0.4	0.100	21.5v	0.48
w6	Rep	56.7v	18.4	1.65	121v	–	–	–	0.103	21.6v	0.48
w7	Env	16.0v	8.59	1.12	35.8v	82.0	100	<1.0	0.071	17.3v	0.31
w8	Env	15.0v	6.88	0.86	19.3v	34.0	41e	<1.0	0.188	23.9v	0.09
w9	Env	7.35v	3.95	0.80	8.77v	–	–	–	0.060	5.47v	0.05
w10	Env	82.1v	39.0	1.31	71.8v	264	322	0.1	0.651	106v	0.15
w11	Env	41.3v	16.0	1.45	72.8v	267	324	0.3	0.301	19.1v	0.15
w12	Env	5.80v	2.70	0.77	10.0v	26.0	32	<1.0	0.099	7.38v	0.08
w13	Env	96.3v	31.1	1.10	80.6v	327	398	0.3	<0.010	120v	0.56
w14	Env	15.0v	4.30	1.72	262v	252	303	1.9	0.097	17.1v	1.05
w15	Env	16.2v	9.38	1.25	94.2v	240	291	0.8	0.074	15.8v	0.29
w16	Env	75.1v	40.2	1.87	24.3v	260	317	0.2	0.553	73.8v	0.16
w17	Env	54.8v	22.0	1.36	24.9v	223	272	0.4	0.053	12.1v	0.29

Table 6–1. Water-property measurements and concentrations of major ions, nutrients, and trace-elements and quality-control data for water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are dissolved (filtered); USGS, U.S. Geological Survey; ID, identifier; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; Env, environmental sample; Rep, replicate quality-assurance sample; –, not available; Blank, equipment-blank quality-assurance sample; <, less than; SiO_2, silica dioxide; e, may not represent true concentration in sample. Something other than carbonate and bicarbonate was neutralized in this sample; P, phosphorus; N, nitrogen; µg/L, micrograms per liter; v, analyte detected in equipment-blank quality-assurance sample; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Well and sample ID	Sample type	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Alkalinity (mg/L as $CaCO_3$)	Bicarbonate (mg/L)	Carbonate (mg/L)	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)
w18	Env	42.1v	8.50	0.64	14.1v	118	144e	<1.0	0.047	13.5v	0.32
w19	Env	74.4v	43.1	2.45	17.3v	327	399	0.1	0.371	31.4v	0.16
w20	Env	58.0v	29.2	1.44	9.87v	258	314	0.3	0.124	10.1v	0.22
w21	Env	61.1v	33.0	1.08	13.7v	273	332	0.4	0.153	14.5v	0.20
w22	Env	95.7v	46.9	0.70	32.4v	423	516	0.2	0.111	12.1v	0.18
w23	Env	45.1v	21.5	0.69	17.8v	202	246	0.1	0.098	10.8v	0.14
w24	Env	40.5v	21.4	1.43	15.7v	182	222	0.1	0.116	12.1v	–
w25	Env	5.36v	1.81	0.91	409v	312	372	4.3	0.190	75.0v	2.65
w26	Env	50.3v	23.6	1.53	69.8v	294	358	0.3	0.304	32.6v	–
w27	Env	66.5v	39.0	1.48	52.0v	268	326	0.3	0.460	82.5v	–
w27	Rep	66.7v	38.9	1.43	49.7v	–	–	–	0.507	82.8v	–
w28	Env	13.7v	3.12	1.35	316v	348	–	1.1	0.189	95.7v	1.66
w29	Env	10.9v	7.67	1.60	196v	449	423	1.3	0.061	43.1v	–
w30	Env	56.3v	30.5	2.25	26.3v	250	305	0.2	0.168	20.8v	–
–	Blank	0.071	<0.011	<0.03	0.10	–	–	–	<0.010	0.94	<0.04

Well and sample ID	Sample type	Silica (mg/L as SiO_2)	Sulfate (mg/L)	Ammonia nitrogen (mg/L as N)	Nitrite plus nitrate-nitrogen (mg/L as N)	Nitrate-nitrogen (calculated) (mg/L as N)	Nitrite-nitrogen (mg/L as N)	Total nitrogen (mg/L)	Orthophosphorus (mg/L as P)	Phosphorus (mg/L)
w1	Env	14.1v	9.46	<0.010	0.326	0.326	<0.001	0.35	0.080	0.079
w2	Env	17.7v	8.12	<0.010	0.303	0.303	<0.001	0.32	0.013	0.010
w3	Env	15.8v	14.4	<0.010	0.204	0.204	<0.001	0.21	0.049	0.047
w4	Env	8.58v	46.2	0.046	<0.040	<0.040	<0.001	<0.05	0.010	0.009
w5	Env	24.2v	51.7	0.227	<0.040	<0.038	0.002	0.33	0.181	0.212
w5	Rep	24.4v	51.3	0.230	<0.040	<0.039	0.001	0.32	0.154	0.226
w6	Env	22.4v	35.1	0.328	<0.040	<0.039	0.001	0.37	0.196	0.214
w6	Rep	22.5v	35.2	0.344	<0.040	<0.039	0.001	0.38	0.198	0.211
w7	Env	11.8v	32.7	<0.010	2.35	2.35	<0.001	2.41	0.021	0.019

Table 6–1. Water-property measurements and concentrations of major ions, nutrients, and trace-elements and quality-control data for water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are dissolved (filtered); USGS, U.S. Geological Survey; ID, identifier; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; Env, environmental sample; Rep, replicate quality-assurance sample; –, not available; Blank, equipment-blank quality-assurance sample; <, less than; SiO_2, silica dioxide; e, may not represent true concentration in sample. Something other than carbonate and bicarbonate was neutralized in this sample; P, phosphorus; N, nitrogen; µg/L, micrograms per liter; v, analyte detected in equipment-blank quality-assurance sample; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Well and sample ID	Sample type	Silica (mg/L as SiO_2)	Sulfate (mg/L)	Ammonia nitrogen (mg/L as N)	Nitrite plus nitrate-nitrogen (mg/L as N)	Nitrate-nitrogen (calculated) (mg/L as N)	Nitrite-nitrogen (mg/L as N)	Total nitrogen (mg/L)	Orthophosphorus (mg/L as P)	Phosphorus (mg/L)
w8	Env	14.6v	19.6	<0.010	4.09	4.09	0.001	4.21	0.052	0.053
w9	Env	9.51v	14.3	<0.010	0.188	0.188	<0.001	0.19	0.005	0.004
w10	Env	15.5v	75.6	<0.010	4.73	4.73	<0.001	5.29	0.050	0.047
w11	Env	18.0v	23.8	<0.010	0.657	0.657	<0.001	0.66	0.025	0.023
w12	Env	12.3v	9.12	<0.010	0.295	0.295	<0.001	0.30	0.122	0.124
w13	Env	27.8v	31.8	0.134	<0.040	<0.040	<0.001	0.41	0.096	0.153
w14	Env	10.7v	**351**	0.424	0.046	0.046	<0.001	0.43	<0.004	0.005
w15	Env	12.9v	18.6	<0.010	0.585	0.585	<0.001	0.57	0.025	0.022
w16	Env	14.7v	23.3	<0.010	0.362	0.362	<0.001	0.41	0.042	0.039
w17	Env	19.5v	32.0	0.015	0.440	0.440	<0.001	0.76	0.011	<0.003
w18	Env	23.7v	19.6	<0.010	0.654	0.654	<0.001	0.69	0.438	0.445
w19	Env	17.4v	15.7	<0.010	0.960	0.960	<0.001	0.97	0.016	0.012
w20	Env	11.9v	4.99	<0.010	0.847	0.847	<0.001	0.87	0.025	0.022
w21	Env	15.1v	13.8	0.016	0.760	0.760	<0.001	0.87	0.064	0.061
w22	Env	18.2v	41.5	<0.010	<0.040	<0.040	<0.001	<0.05	0.026	0.022
w23	Env	19.3v	13.1	<0.010	0.267	0.267	<0.001	0.28	0.126	0.119
w24	Env	17.4v	4.93	<0.010	0.464	0.464	<0.001	0.50	0.047	0.042
w25	Env	8.56v	**528**	0.235	<0.040	<0.040	<0.001	0.25	0.021	0.019
w26	Env	16.0v	41.8	<0.010	0.438	0.438	<0.001	0.45	0.020	0.016
w27	Env	15.3v	44.8	<0.010	4.80	4.80	<0.001	5.20	0.039	0.037
w27	Rep	15.3v	44.8	<0.010	4.95	4.95	<0.001	5.16	0.038	0.037
w28	Env	9.96v	249	0.198	0.047	0.047	<0.001	0.24	0.010	0.005
w29	Env	11.1v	18.9	0.108	<0.040	<0.040	<0.001	0.10	0.008	0.005
w30	Env	17.1v	22.4	<0.010	2.61	2.61	0.001	2.74	0.008	0.004
–	Blank	0.153	<0.09	<0.010	<0.040	–	<0.001	<0.05	<0.004	<0.003

Table 6–1. Water-property measurements and concentrations of major ions, nutrients, and trace-elements and quality-control data for water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are dissolved (filtered); USGS, U.S. Geological Survey; ID, identifier; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; Env, environmental sample; Rep, replicate quality-assurance sample; –, not available; Blank, equipment-blank quality-assurance sample; <, less than; SiO_2, silica dioxide; e, may not represent true concentration in sample. Something other than carbonate and bicarbonate was neutralized in this sample; P, phosphorus; N, nitrogen; µg/L, micrograms per liter; v, analyte detected in equipment-blank quality-assurance sample; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Well and sample ID	Sample type	Aluminum (µg/L)	Antimony (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron (µg/L)
w1	Env	<2.2	<0.027	1.3	321v	0.010	47v	<0.016	1.0	<0.023	<0.80	<4.0
w2	Env	<2.2	<0.027	0.17	213v	0.101	18v	<0.016	0.40	<0.023	1.4v	<4.0
w3	Env	<2.2	<0.027	0.27	114v	0.028	54v	<0.016	0.86	<0.021	3.1v	<3.2
w4	Env	<2.2	<0.027	0.48	48.4v	0.074	2,680v	<0.016	<0.07	<0.021	<0.80	<3.2
w5	Env	<2.2	<0.027	2.4	176v	0.015	281v	0.018	<0.07	0.110	<0.80	**2,310v**
w5	Rep	<2.2	<0.027	2.4	179v	0.015	279v	<0.016	<0.07	0.106	<0.80	**2,310v**
w6	Env	<4.4	<0.054	0.67	800v	0.038	1,170v	<0.032	<0.14	<0.042	<1.6	**3,000v**
w6	Rep	<2.2	<0.027	0.65	834v	0.046	1,010v	<0.016	<0.07	0.024	<0.80	**3,000v**
w7	Env	<2.2	<0.027	0.15	69.6v	0.064	420v	<0.016	0.26	0.547	2.7v	<3.2
w8	Env	<2.2	<0.027	0.37	77.3v	0.088	29v	<0.016	0.19	0.038	4.0v	<3.2
w9	Env	<2.2	<0.027	0.08	47.3v	0.196	19v	<0.016	0.55	<0.021	<0.80	<3.2
w10	Env	<2.2	<0.027	0.52	216v	0.013	82v	<0.016	0.85	0.064	1.9v	5.9v
w11	Env	<2.2	<0.027	0.40	102v	0.007	217v	<0.016	0.24	<0.021	<0.80	<3.2
w12	Env	<2.2	<0.027	0.28	220v	0.066	23v	<0.016	0.46	0.054	1.2v	<3.2
w13	Env	<2.2	<0.027	3.7	289v	0.010	247v	<0.016	<0.07	0.247	<0.80	**768v**
w14	Env	<2.2	<0.027	1.4	11.9v	0.071	2,370v	<0.016	<0.07	<0.021	<0.80	8.2v
w15	Env	<2.2	<0.027	1.2	88.8v	0.009	275v	<0.016	12.2	<0.021	<0.80	<3.2
w16	Env	<2.2	<0.027	1.9	272v	0.007	82v	<0.016	0.51	0.026	1.4v	3.2v
w17	Env	<2.2	<0.027	2.4	125v	<0.006	115v	<0.016	1.3	<0.021	<0.80	<3.2
w18	Env	<2.2	<0.027	1.2	45.9v	0.012	26v	<0.016	0.49	0.030	<0.80	<3.2
w19	Env	<2.2	<0.027	0.57	616v	0.019	135v	<0.016	0.43	0.044	<0.80	<3.2
w20	Env	<2.2	<0.027	0.21	424v	<0.006	78v	<0.016	2.0	<0.021	<0.80	3.4v
w21	Env	<2.2	<0.027	1.4	238v	<0.006	68v	<0.016	1.3	0.023	0.93v	<3.2
w22	Env	<2.2	<0.027	0.24	507v	0.011	251v	<0.016	0.16	0.026	<0.80	4.7v
w23	Env	<2.2	<0.027	0.76	299v	0.020	102v	<0.016	1.3	<0.023	5.3v	<4.0
w24	Env	<2.2	<0.027	0.38	545v	0.020	211v	<0.016	1.0	0.023	<0.80	7.1v
w25	Env	**56.9**	<0.027	9.8	15.2v	0.322	5,900v	0.148	<0.07	0.038	<0.80	31.4v
w26	Env	<2.2	<0.027	0.51	83.8v	0.026	459v	<0.016	2.0	<0.023	4.2v	<4.0

Table 6–1. Water-property measurements and concentrations of major ions, nutrients, and trace-elements and quality-control data for water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are dissolved (filtered); USGS, U.S. Geological Survey; ID, identifier; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; Env, environmental sample; Rep, replicate quality-assurance sample; –, not available; Blank, equipment-blank quality-assurance sample; <, less than; SiO_2, silica dioxide; e, may not represent true concentration in sample. Something other than carbonate and bicarbonate was neutralized in this sample; P, phosphorus; N, nitrogen; µg/L, micrograms per liter; v, analyte detected in equipment-blank quality-assurance sample; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Well and sample ID	Sample type	Aluminum (µg/L)	Antimony (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron (µg/L)
w27	Env	2.4	0.031	0.56	208v	0.008	126v	<0.016	0.91	0.073	1.1v	7.1v
w27	Rep	2.2	0.027	0.60	210v	0.007	127v	<0.016	0.91	0.072	1.0v	<4.0
w28	Env	4.5	<0.027	0.63	16v	0.105	2,300v	0.025	0.15	<0.023	<0.80	6.9v
w29	Env	<2.2	<0.027	0.73	129v	0.032	641v	<0.016	<0.07	<0.023	<0.80	<4.0
w30	Env	<2.2	<0.027	0.59	372v	0.011	202v	<0.016	0.78	0.058	1.3v	<4.0
–	Blank	<2.2	<0.027	<0.03	0.49	<0.006	4	<0.016	<0.07	<0.021	5.4	10.2

Well and sample ID	Sample type	Lead (µg/L)	Lithium (µg/L)	Manganese (µg/L)	Molybdenum (µg/L)	Nickel (µg/L)	Selenium (µg/L)	Silver (µg/L)	Strontium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
w1	Env	0.068v	17.0	0.17	0.032	0.33v	0.24	<0.005	110	<0.010	7.8	13.2v
w2	Env	0.102v	4.55	0.75	0.015	1.4v	0.07	<0.005	31.2	<0.010	0.23	93.1v
w3	Env	0.215v	11.1	<0.13	0.068	2.4v	0.12	<0.005	99.2	<0.010	1.1	2.7v
w4	Env	0.060v	6.20	4.51	2.12	<0.09	0.18	<0.005	79.6	<0.010	0.62	<1.4
w5	Env	<0.025	25.4	**519**	4.27	0.46v	0.15	0.008	1,050	<0.010	0.26	3.7v
w5	Rep	<0.025	25.2	**516**	4.26	0.44v	0.16	0.006	1,050	<0.010	0.25	3.5v
w6	Env	0.084v	9.74	**310**	1.58	0.29v	<0.06	<0.010	370	<0.020	2.9	6.2v
w6	Rep	0.132v	11.1	**314**	1.65	0.25v	0.03	<0.005	388	<0.010	2.9	7.2v
w7	Env	0.270v	2.47	0.13	0.026	2.2v	0.66	<0.005	118	<0.010	0.91	2.9v
w8	Env	0.935v	8.01	0.44	<0.014	2.6v	0.48	<0.005	78.4	<0.010	0.91	11.1v
w9	Env	0.045v	1.82	0.27	<0.014	2.6v	0.23	<0.005	50.7	<0.010	0.38	<1.4
w10	Env	0.118v	16.9	<0.13	0.182	1.1v	1.3	<0.005	268	<0.010	6.1	2.7v
w11	Env	0.054v	17.5	0.77	0.246	0.18v	1.0	<0.005	267	<0.010	5.5	<1.4
w12	Env	0.110v	5.45	<0.13	<0.014	1.0v	0.19	<0.005	29.9	<0.010	1.0	<1.4
w13	Env	<0.025	17.5	**489**	2.73	1.3v	0.06	<0.005	761	<0.010	0.30	2.0v
w14	Env	0.075v	10.7	7.74	3.10	<0.09	<0.03	<0.005	306	<0.010	0.20	<1.4
w15	Env	0.038v	11.9	<0.13	0.256	<0.09	9.5	<0.005	97.1	<0.010	19.2	8.2v
w16	Env	0.043v	16.3	<0.13	0.072	0.26v	0.25	<0.005	364	<0.010	11.9	<1.4
w17	Env	<0.025	11.7	<0.13	0.249	0.14v	0.56	<0.005	3,500	<0.010	13.5	<1.4

Table 6–1. Water-property measurements and concentrations of major ions, nutrients, and trace-elements and quality-control data for water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are dissolved (filtered); USGS, U.S. Geological Survey; ID, identifier; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter; Hardness concentration calculated from dissolved concentrations of calcium and magnesium expressed as calcium carbonate; $CaCO_3$, calcium carbonate; Env, environmental sample; Rep, replicate quality-assurance sample; –, not available; Blank, equipment-blank quality-assurance sample; <, less than; SiO_2, silica dioxide; e, may not represent true concentration in sample. Something other than carbonate and bicarbonate was neutralized in this sample; P, phosphorus; N, nitrogen; µg/L, micrograms per liter; v, analyte detected in equipment-blank quality-assurance sample; **Bold** font denotes value exceeds Maximum Contaminant Level or Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2013a, 2013b)]

Well and sample ID	Sample type	Lead (µg/L)	Lithium (µg/L)	Manganese (µg/L)	Molybdenum (µg/L)	Nickel (µg/L)	Selenium (µg/L)	Silver (µg/L)	Strontium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
w18	Env	0.078v	2.10	<0.13	0.024	0.26v	0.21	<0.005	71.6	<0.010	2.1	<1.4
w19	Env	0.096v	13.7	0.29	0.087	0.30v	1.2	<0.005	341	<0.010	11.0	<1.4
w20	Env	<0.025	11.6	<0.13	0.030	0.20v	0.28	<0.005	175	<0.010	3.1	<1.4
w21	Env	0.064v	4.74	<0.13	0.015	0.22v	0.32	<0.005	138	<0.010	9.6	4.2v
w22	Env	0.026v	6.62	0.56	0.136	0.33v	0.04	<0.005	423	<0.010	1.5	<1.4
w23	Env	0.054v	7.79	<0.15	0.137	0.17v	0.61	<0.005	91.3	<0.010	7.4	2.6v
w24	Env	0.140v	16.3	0.25	0.120	0.54v	0.86	<0.005	313	<0.010	7.8	7.8v
w25	Env	0.432v	15.1	10.7	38.0	<0.09	0.04	<0.005	106	<0.010	2.4	1.6v
w26	Env	0.263v	19.8	<0.15	0.227	0.26v	6.3	<0.005	1,340	<0.010	33.1	9.3v
w27	Env	0.053v	12.6	0.52	0.122	0.46v	2.4	<0.005	885	<0.010	4.5	1.6v
w27	Rep	0.054v	12.7	0.47	0.118	0.44v	2.5	<0.005	894	<0.010	4.5	1.6v
w28	Env	0.117v	18.1	30.1	5.10	0.14v	1.2	<0.005	737	<0.010	2.6	4.8v
w29	Env	0.087v	18.0	28.0	0.348	<0.09	0.06	<0.005	225	<0.010	2.5	<1.4
w30	Env	0.835v	12.6	<0.15	0.137	0.47v	1.8	0.007	3,000	<0.010	11.2	5.2v
–	Blank	0.147	<0.22	<0.13	<0.014	0.18	<0.03	<0.005	<0.20	<0.010	<0.08	84

[a] The ionic balance was calculated as the total dissolved cation concentration minus the total dissolved anion concentration divided by the total concentration of ions in milliequivalents per liter. The total cation concentration was the sum of concentrations of calcium, magnesium, sodium, potassium, and the trace elements iron and manganese. The total anion concentration was the sum of chloride, sulfate, fluoride, alkalinity, and nitrate-nitrogen concentrations.

Table 7–1. Analytical relative percent difference for concentrations of major ions, nutrients, trace elements, and uranium in three quality-control samples for water samples from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[Concentrations are of dissolved constituents, (filtered); ID, identifier; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; Env, environmental sample; <, less than; Rep, replicate quality-control sample; RPD, relative percent difference; –, not calculated; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; RPD was not calculated if one constituent had an estimated concentration or a concentration less than the minimum reporting level]

Well and sample ID	Date of sample (yyyymmdd)	Sample type	Dissolved solids (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Bromide (mg/L)	Chloride (mg/L)
w5	20120718	Env	624	104	49.7	1.61	72.5	<0.010	18.9
w5	20120718	Rep	643	104	49.5	1.56	73.6	<0.010	18.8
	RPD		3 percent	0 percent	0.4 percent	3.2 percent	1.5 percent	–	0.5 percent
w6	20120910	Env	532	56.5	18.2	1.62	118	0.100	21.5
w6	20120910	Rep	527	56.7	18.4	1.65	121	0.103	21.6
	RPD		0.9 percent	0.4 percent	1.1 percent	1.8 percent	2.5 percent	3 percent	0.5 percent
w27	20130326	Env	502	66.5	39.0	1.48	52.0	0.460	82.5
w27	20130326	Rep	501	66.7	38.9	1.43	49.7	0.507	82.8
	RPD		0.2 percent	0.3 percent	0.3 percent	3.4 percent	4.5 percent	9.7 percent	0.4 percent

Well and sample ID	Date of sample (yyyymmdd)	Sample type	Fluoride (mg/L)	Silica (mg/L as SiO_2)	Ammonia nitrogen (mg/L as N)	Nitrite plus nitrate-nitrogen (mg/L as N)	Nitrite-nitrogen (mg/L as N)	Total nitrogen (mg/L)	Orthophosphorus (mg/L as P)
w5	20120718	Env	0.62	24.2	0.227	<0.040	0.002	0.33	0.181
w5	20120718	Rep	0.66	24.4	0.23	<0.040	0.001	0.32	0.154
	RPD		6.3 percent	0.2 percent	1.3 percent	–	66.7 percent	3.1 percent	16.1 percent
w6	20120910	Env	0.48	22.4	0.328	<0.040	0.001	0.37	0.196
w6	20120910	Rep	0.48	22.5	0.344	<0.040	0.001	0.38	0.198
	RPD		0 percent	0.5 percent	4.8 percent	–	0 percent	2.7 percent	1 percent
w27	20130326	Env	–	15.3	<0.010	4.80	<0.001	5.20	0.039
w27	20130326	Rep	–	15.3	<0.010	4.95	<0.001	5.16	0.038
	RPD		–	0 percent	–	3.1 percent	–	0.8 percent	2.6 percent

Table 7–1. Analytical relative percent difference for concentrations of major ions, nutrients, trace elements, and uranium in three quality-control samples for water samples from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Concentrations are of dissolved constituents, (filtered); ID, identifier; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; Env, environmental sample; <, less than; Rep, replicate quality-control sample; RPD, relative percent difference; –, not calculated; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; RPD was not calculated if one constituent had an estimated concentration or a concentration less than the minimum reporting level]

Well and sample ID	Date of sample (yyyymmdd)	Sample type	Phosphorus (mg/L)	Aluminum (µg/L)	Antimony (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Boron (µg/L)	Cadmium (µg/L)
w5	20120718	Env	0.212	<2.2	<0.027	2.4	176	0.015	281	0.018
w5	20120718	Rep	0.226	<2.2	<0.027	2.4	179	0.015	279	<0.016
RPD			6.4 percent	–	–	0 percent	1.7 percent	0 percent	0.7 percent	–
w6	20120910	Env	0.214	<4.4	<0.054	0.67	800	0.038	1,170	<0.032
w6	20120910	Rep	0.211	<2.2	<0.027	0.65	834	0.046	1,010	<0.016
RPD			1.4 percent	–	–	3.0 percent	4.2 percent	19.1 percent	14.7 percent	–
w27	20130326	Env	0.037	2.4	0.031	0.56	208	0.008	126	<0.016
w27	20130326	Rep	0.037	2.2	0.027	0.60	210	0.007	127	<0.016
RPD			0 percent	8.7 percent	13.8 percent	6.9 percent	1 percent	13.3 percent	0.8 percent	–

Well and sample ID	Date of sample (yyyymmdd)	Sample type	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Lithium (µg/L)	Manganese (µg/L)	Molybdenum (µg/L)
w5	20120718	Env	<0.07	0.110	<0.80	2,310	<0.025	25.4	519	4.27
w5	20120718	Rep	<0.07	0.106	<0.80	2,310	<0.025	25.2	516	4.26
RPD			–	3.7 percent	–	0 percent	–	0.8 percent	0.6 percent	0.2 percent
w6	20120910	Env	<0.14	<0.042	<1.6	3,000	0.084	9.74	310	1.58
w6	20120910	Rep	<0.07	0.024	<0.80	3,000	0.132	11.1	314	1.65
RPD			–	–	–	0 percent	44.4 percent	13.1 percent	1.3 percent	4.3 percent
w27	20130326	Env	0.91	0.073	1.1	7.1	0.053	12.6	0.52	0.122
w27	20130326	Rep	0.91	0.072	1.0	<4.0	0.054	12.7	0.47	0.118
RPD			0 percent	1.4 percent	9.5 percent	–	1.9 percent	0.8 percent	10.1 percent	3.3 percent

Table 7–1. Analytical relative percent difference for concentrations of major ions, nutrients, trace elements, and uranium in three quality-control samples for water samples from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Concentrations are of dissolved constituents, (filtered); ID, identifier; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; Env, environmental sample; <, less than; Rep, replicate quality-control sample; RPD, relative percent difference; –, not calculated; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; RPD was not calculated if one constituent had an estimated concentration or a concentration less than the minimum reporting level]

Well and sample ID	Date of sample (yyyymmdd)	Sample type	Nickel (µg/L)	Selenium (µg/L)	Silver (µg/L)	Strontium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)	Uranium (µg/L)
w5	20120718	Env	0.46	0.15	0.008	1,050	<0.010	0.26	3.7	2.13
w5	20120718	Rep	0.44	0.16	0.006	1,050	<0.010	0.25	3.5	2.14
RPD			4.4 percent	6.5 percent	28.6 percent	0 percent	–	3.9 percent	5.6 percent	0.5 percent
w6	20120910	Env	0.29	<0.06	<0.010	370	<0.020	2.9	6.2	5.43
w6	20120910	Rep	0.25	0.03	<0.005	388	<0.010	2.9	7.2	5.83
RPD			14.8 percent	–	–	4.8 percent	–	0 percent	14.9 percent	7.1 percent
w27	20130326	Env	0.46	2.4	<0.005	885	<0.010	4.5	1.6	2.66
w27	20130326	Rep	0.44	2.5	<0.005	894	<0.010	4.5	1.6	2.66
RPD			4.4 percent	4.1 percent	–	1.0 percent	–	0 percent	0 percent	0 percent

Table 8–1. Summary statistics of water-quality properties and constituent concentrations measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[Constituent concentrations are in whole water samples (unfiltered) unless otherwise noted; MCL, Maximum Contaminant Level; SMCL, Secondary Maximum Contaminant Level; mg/L, milligrams per liter; –, not determined; µS/cm, microsiemens per centimeter; $CaCO_3$, calcium carbonate; <, less than; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; E, estimate (result is outside the lowest or highest calibration point); Total nitrogen was calculated as the sum of dissolved nitrogen compounds]

Constituent	Minimum value	25th percentile	50th percentile	75th percentile	Maximum value	Mean value[a]	Samples exceeding MCL/ SMCL	Number of samples
Little River near Tecumseh, Oklahoma (07230500)								
Dissolved oxygen (mg/L)	7.3	8.3	9.6	10.4	11.7	9.4	–	8
pH (standard units)	8.0	8.4	8.4	8.5	9.0	–	–	8
Specific conductance (uS/cm at 25 degrees Celsius)	345	1,092	1,400	1,600	2,130	1,313	–	8
Water temperature (degrees Celsius)	5.9	9.5	19.3	25.5	30.4	18.1	–	8
Dissolved solids (mg/L)	199	695	844	1,011	1,180	821	7	8
Major ions								
Calcium, (dissolved) (mg/L)	22.6	26.2	37.4	53.1	60.5	39.4	–	8
Calcium (mg/L)	23.7	29.5	46.8	55.6	116	50.7	–	8
Magnesium, (dissolved) (mg/L)	12.0	32.9	33.3	34.5	38.5	31.6	–	8
Magnesium (mg/L)	32.2	33.4	34.1	34.9	36.7	34.3	–	8
Potassium, (dissolved) (mg/L)	1.84	2.98	3.21	3.41	3.93	3.16	–	8
Potassium (mg/L)	1.83	3.01	3.19	3.82	8.25	3.77	–	8
Sodium, (dissolved) (mg/L)	22.8	183	211	269	351	215	–	8
Sodium (mg/L)	21.1	163	219	268	356	215	–	8
Alkalinity (mg/L as $CaCO_3$)	94	205	217	264	272	217	–	8
Bicarbonate (mg/L)	114	241	255	317	326	258	–	8
Carbonate (mg/L)	<1.0	2.5	3.4	4.6	5.7	–	–	8
Chloride (mg/L)	28.7	225	296	380	496	298	5	8
Fluoride (mg/L)	0.26	0.32	0.38	0.42	0.45	0.37	0	8
Silica (mg/L as SiO_2)	6.31	8.68	9.35	10.9	14.0	9.91	–	8
Sulfate (mg/L)	13.7	59.9	75.3	93.1	114	74.1	0	8
Nutrients								
Ammonia plus organic nitrogen, (dissolved) (mg/L as N)	0.12	0.30	0.35	0.56	0.76	0.42	–	8
Ammonia plus organic nitrogen (mg/L as N)	0.17	0.29	0.42	0.69	11	1.8	–	8
Ammonia nitrogen, (dissolved) (mg/L as N)	<0.01	<0.01	0.01	0.02	0.13	–	–	8
Nitrite plus nitrate-nitrogen, (dissolved) (mg/L as N)	<0.04	<0.04	<0.04	<0.04	0.44	–	0	8

Table 8–1. Summary statistics of water-quality properties and constituent concentrations measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered) unless otherwise noted; MCL, Maximum Contaminant Level; SMCL, Secondary Maximum Contaminant Level; mg/L, milligrams per liter; –, not determined; µS/cm, microsiemens per centimeter; $CaCO_3$, calcium carbonate; <, less than; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; E, estimate (result is outside the lowest or highest calibration point); Total nitrogen was calculated as the sum of dissolved nitrogen compounds]

Constituent	Minimum value	25th percentile	50th percentile	75th percentile	Maximum value	Mean value[a]	Samples exceeding MCL/ SMCL	Number of samples
Nutrients—Continued								
Nitrite-nitrogen, (dissolved) (mg/L as N)	<0.001	<0.001	<0.001	<0.001	0.014	–	0	8
Total nitrogen (calculated) (mg/L)	0.12	0.3	0.35	0.61	1.2	0.48	–	–
Orthophosphorus, (dissolved) (mg/L as P)	<0.004	<0.004	–	0.005	0.013	–	–	8
Total phosphorus, (dissolved) (mg/L)	<0.003	0.007	0.007	0.014	0.030	–	–	8
Total phosphorus (mg/L)	0.011	0.017	0.017	0.265	0.970	0.144	–	8
Trace elements								
Aluminum (µg/L)	70	98	125	170	34,500	4,421	2	8
Arsenic (µg/L)	1.3	1.6	3.0	4.1	6.9	3.2	0	8
Barium (µg/L)	257	343	380	405	2,690	650	1	8
Beryllium (µg/L)	<0.19	<0.19	<0.19	<.57	6.6	–	1	8
Cadmium (µg/L)	<0.016	<0.016	<0.016	<0.016	0.481	–	0	8
Chromium (µg/L)	<0.30	–	0.36	0.48	41.5	–	0	8
Cobalt (µg/L)	<0.02	–	0.16	0.51	41.8	–	–	8
Copper (µg/L)	<1.4	<1.4	<1.4	<4.2	51.8	–	0	8
Iron, (dissolved) (µg/L)	5.0	7.3	18.7	35.6	72.3	25.1	0	8
Iron (µg/L)	74	107	139	166	41,400	5,290	1	8
Lead (µg/L)	0.10	0.16	0.18	0.24	77.9	9.9	1	8
Lithium (µg/L)	E10.6	E13.3	E15.5	E16.3	E39.6	E17.5	–	8
Manganese, (dissolved) (µg/L)	4.42	15.1	18.4	24.4	81.5	25.8	1	8
Manganese (µg/L)	26.7	40.0	46.3	77.5	5,540	740	3	8
Mercury (µg/L)	<0.005	<0.005	0.018	0.032	0.066	–	0	8
Molybdenum (µg/L)	0.09	1.46	1.62	2.24	2.71	1.67	–	8
Nickel (µg/L)	0.66	0.72	1.1	1.3	58.0	8.1	0	8
Selenium (µg/L)	0.172	0.213	0.281	0.35	0.487	0.302	0	8
Silver (µg/L)	<0.015	<0.015	<0.015	<0.015	0.095	–	0	8
Strontium (µg/L)	429	435	454	534	608	487	–	8
Zinc (µg/L)	<2.0	<2.0	<6.0	2.3	100	–	0	8

Table 8–1. Summary statistics of water-quality properties and constituent concentrations measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered) unless otherwise noted; MCL, Maximum Contaminant Level; SMCL, Secondary Maximum Contaminant Level; mg/L, milligrams per liter; –, not determined; µS/cm, microsiemens per centimeter; $CaCO_3$, calcium carbonate; <, less than; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; E, estimate (result is outside the lowest or highest calibration point); Total nitrogen was calculated as the sum of dissolved nitrogen compounds]

Constituent	Minimum value	25th percentile	50th percentile	75th percentile	Maximum value	Mean value[a]	Samples exceeding MCL/ SMCL	Number of samples
North Canadian River near Harrah, Oklahoma (07241550)								
Water properties								
Dissolved oxygen (mg/L)	7.0	8.75	9.3	10.1	12.9	9.5	–	8
pH (standard units)	7.8	8.0	8.3	8.4	8.6	–	1	8
Specific conductance (uS/cm at 25 degrees Celsius)	280	418	519	656	786	533	–	8
Water temperature (degrees Celsius)	7.7	11.7	20.3	26.4	28.8	19.2	–	8
Dissolved solids (mg/L)	168	281	410	478	607	391	2	8
Major ions								
Calcium, (dissolved) (mg/L)	27.1	35.3	41.4	48.7	62.9	42.6	–	8
Calcium (mg/L)	38.8	45.2	48.2	54.2	62.6	50.1	–	8
Magnesium, (dissolved) (mg/L)	7.69	11.5	13.8	16.8	22.8	14.3	–	8
Magnesium (mg/L)	12.2	14.1	14.7	16.9	22.3	15.7	–	8
Potassium, (dissolved) (mg/L)	3.40	6.2	8.0	10.6	11.8	8.1	–	8
Potassium (mg/L)	5.36	6.48	8.30	10.8	11.9	8.56	–	8
Sodium, (dissolved) (mg/L)	17.9	43.0	68.5	88.3	114	66.4	–	8
Sodium (mg/L)	17.9	41.6	69.1	87.3	111	65.6	–	8
Alkalinity (mg/L as $CaCO_3$)	82.9	102	109	118	198	118	–	8
Bicarbonate (mg/L)	101	123	132	140	239	142	–	8
Carbonate (mg/L)	<1.0	<1.0	0.7	1.3	4.1	–	–	8
Chloride (mg/L)	19.9	51.2	94.6	119	158	87.9	0	8
Fluoride (mg/L)	0.23	0.34	0.58	0.70	0.86	0.54	0	8
Silica (mg/L as SiO_2)	3.84	5.66	6.36	7.01	8.56	6.37	–	8
Sulfate (mg/L)	26.1	42.1	63.4	83.1	109	63.8	0	8
Nutrients								
Ammonia plus organic nitrogen, (dissolved) (mg/L as N)	0.52	0.63	0.74	0.83	0.92	0.73	–	8
Ammonia plus organic nitrogen (mg/L as N)	1.0	1.2	1.4	1.6	2.2	1.5	–	8
Ammonia nitrogen, (dissolved) (mg/L as N)	<0.01	–	0.056	0.102	0.213	–	–	8

Table 8–1. Summary statistics of water-quality properties and constituent concentrations measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered) unless otherwise noted; MCL, Maximum Contaminant Level; SMCL, Secondary Maximum Contaminant Level; mg/L, milligrams per liter; –, not determined; µS/cm, microsiemens per centimeter; $CaCO_3$, calcium carbonate; <, less than; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; E, estimate (result is outside the lowest or highest calibration point); Total nitrogen was calculated as the sum of dissolved nitrogen compounds]

Constituent	Minimum value	25th percentile	50th percentile	75th percentile	Maximum value	Mean value[a]	Samples exceeding MCL/ SMCL	Number of samples
Nutrients—Continued								
Nitrite plus nitrate-nitrogen, (dissolved) (mg/L as N)	0.694	2.97	3.62	5.45	8.42	4.15	0	8
Nitrite-nitrogen, (dissolved) (mg/L as N)	0.024	0.038	0.047	0.067	0.089	0.052	0	8
Total nitrogen (calculated) (mg/L)	1.34	3.05	4.36	6.78	9.34	4.88	–	–
Orthophosphorus, (dissolved) (mg/L as P)	0.137	0.347	1.02	1.60	3.30	1.20	–	8
Total phosphorus, (dissolved) (mg/L)	0.147	0.368	1.05	1.57	3.22	1.20	–	8
Total phosphorus (mg/L)	0.525	0.873	1.24	1.82	3.06	1.44	–	8
Trace elements								
Aluminum (µg/L)	150	633	1,165	2,593	10,300	2,563	8	8
Arsenic (µg/L)	2.0	2.7	4.0	4.2	6.4	3.8	0	8
Barium (µg/L)	93	113	125	167	439	175	0	8
Beryllium (µg/L)	<0.19	<0.19	<0.19	–	0.66	–	0	8
Cadmium (µg/L)	0.032	0.045	0.070	0.114	0.563	0.136	0	8
Chromium (µg/L)	1	1.2	2.1	3.6	47.9	8.0	0	8
Cobalt (µg/L)	0.51	0.85	0.99	2.0	7.6	2.1	–	8
Copper (µg/L)	<1.4	–	2.35	6.2	16.5	–	0	8
Iron, (dissolved) (µg/L)	5.9	14.8	30.6	34.3	86.0	31.4	0	8
Iron (µg/L)	207	543	1,225	2,500	10,900	2,612	7	8
Lead (µg/L)	0.43	1.48	3.2	10.0	27.1	7.51	1	8
Lithium (µg/L)	E8.98	E11.2	E15.5	E18.5	E26.0	E15.6	0	8
Manganese (dissolved) (µg/L)	2.7	4.3	6.5	8.8	28.8	9.0	0	8
Manganese (µg/L)	43.0	65.4	92.7	194	549	170	0	8
Mercury (µg/L)	<0.005	0.007	0.009	0.019	0.054	–	0	8
Molybdenum (µg/L)	0.99	1.72	2.30	2.73	2.88	2.15	0	8
Nickel (µg/L)	4.5	4.6	6.2	7.6	44.4	10.8	–	8
Selenium (µg/L)	0.262	0.284	0.306	0.321	0.352	0.304	0	8
Silver (µg/L)	<0.015	–	0.053	0.029	0.202	–	0	8
Strontium (µg/L)	334	384	476	577	743	498	–	8
Zinc (µg/L)	8.1	12.2	16.0	26.1	62.7	23.6	0	8

Table 8–1. Summary statistics of water-quality properties and constituent concentrations measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered) unless otherwise noted; MCL, Maximum Contaminant Level; SMCL, Secondary Maximum Contaminant Level; mg/L, milligrams per liter; –, not determined; µS/cm, microsiemens per centimeter; $CaCO_3$, calcium carbonate; <, less than; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; E, estimate (result is outside the lowest or highest calibration point); Total nitrogen was calculated as the sum of dissolved nitrogen compounds]

Constituent	Minimum value	25th percentile	50th percentile	75th percentile	Maximum value	Mean value[a]	Samples exceeding MCL/ SMCL	Number of samples
			Deer Creek near McLoud, Oklahoma (07241590)					
			Water properties					
Dissolved oxygen (mg/L)	7.5	–	9.3	–	9.7	8.8	–	3
pH (standard units)	7.4	–	7.4	–	7.5	–	0	3
Specific conductance (uS/cm at 25 degrees Celsius)	74	–	334	–	470	293	–	3
Water temperature (degrees Celsius)	5.9	–	8.1	–	14.1	9.4	–	3
Dissolved solids (mg/L)	59	–	207	–	293	186	0	3
			Major ions					
Calcium, (dissolved) (mg/L)	6.73	–	29.3	–	41.5	25.8	–	3
Calcium (mg/L)	13.3	–	30.5	–	43.1	29.0	–	3
Magnesium, (dissolved) (mg/L)	2.19	–	10.5	–	16.0	9.6	–	3
Magnesium (mg/L)	4.66	–	10.4	–	16.0	10.4	–	3
Potassium, (dissolved) (mg/L)	1.77	–	2.65	–	2.70	2.37	–	3
Potassium (mg/L)	1.87	–	2.96	–	4.24	3.02	–	3
Sodium, (dissolved) (mg/L)	3.38	–	23.1	–	34.9	20.2	–	3
Sodium (mg/L)	3.15	–	21.9	–	35.4	20.2	–	3
Alkalinity (mg/L as $CaCO_3$)	25	–	–	–	200	113	–	2
Bicarbonate (mg/L)	30	–	–	–	240	135	–	2
Chloride (mg/L)	3.36	–	19.8	–	29.9	17.7	0	3
Fluoride (mg/L)	0.15	–	–	–	0.44	0.30	0	2
Silica (mg/L as SiO_2)	4.96	–	10.5	–	13.8	9.75	–	3
Sulfate (mg/L)	3.28	–	10.7	–	13.9	9.29	0	3
			Nutrients					
Ammonia plus organic nitrogen, (dissolved) (mg/L as N)	0.30	–	0.61	–	0.64	0.52	–	3
Ammonia plus organic nitrogen (mg/L as N)	0.50	–	1.2	–	2.6	1.4	–	3
Ammonia nitrogen, (dissolved) (mg/L as N)	0.072	–	0.080	–	0.097	0.083	–	3
Nitrite plus nitrate-nitrogen, (dissolved) (mg/L as N)	0.045	–	0.117	–	0.269	0.144	0	3

Table 8–1. Summary statistics of water-quality properties and constituent concentrations measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered) unless otherwise noted; MCL, Maximum Contaminant Level; SMCL, Secondary Maximum Contaminant Level; mg/L, milligrams per liter; –, not determined; µS/cm, microsiemens per centimeter; $CaCO_3$, calcium carbonate; <, less than; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; E, estimate (result is outside the lowest or highest calibration point); Total nitrogen was calculated as the sum of dissolved nitrogen compounds]

Constituent	Minimum value	25th percentile	50th percentile	75th percentile	Maximum value	Mean value[a]	Samples exceeding MCL/ SMCL	Number of samples
				Nutrients—Continued				
Nitrite-nitrogen, (dissolved) (mg/L as N)	0.001	–	0.005	–	0.006	0.004	0	3
Total nitrogen (calculated) (mg/L)	0.35	–	0.76	–	0.88	0.66	0	–
Orthophosphorus, (dissolved) (mg/L as P)	0.006	–	0.016	–	0.024	0.015	–	3
Total phosphorus, (dissolved) (mg/L)	0.003	–	0.032	–	0.042	0.026	–	3
Total phosphorus (mg/L)	0.025	–	0.209	–	0.655	0.296	–	3
				Trace elements				
Aluminum (µg/L)	570	–	2,450	–	11,400	4,807	3	3
Arsenic (µg/L)	1.7	–	2.3	–	2.8	2.3	0	3
Barium (µg/L)	152	–	179	–	296	209	0	3
Beryllium (µg/L)	<0.19	–	<0.19	–	1.18	–	0	3
Cadmium (µg/L)	0.019	–	0.051	–	0.148	0.073	0	3
Chromium (µg/L)	0.79	–	2.9	–	13.2	5.6	0	3
Cobalt (µg/L)	1.1	–	2.4	–	11.3	4.9	0	3
Copper (µg/L)	<1.4	–	10.6	–	25.2	–	0	3
Iron, (dissolved) (µg/L)	17.2	–	78.5	–	208	101	0	3
Iron (µg/L)	1,040	–	2,940	–	12,000	5,327	3	3
Lead (µg/L)	0.81	–	3.35	–	24.6	9.59	1	3
Lithium (µg/L)	E3.61	–	E5.64	–	E7.48	E5.58	0	3
Manganese, (dissolved) (µg/L)	79.3	–	469	–	471	340	3	3
Manganese (µg/L)	491	–	580	–	588	553	3	3
Mercury (µg/L)	<0.005	–	0.007	–	0.036	–	0	3
Molybdenum (µg/L)	0.07	–	0.37	–	0.47	0.30	–	3
Nickel (µg/L)	3.1	–	3.9	–	13.7	6.9	–	3
Selenium (µg/L)	0.231	–	0.297	–	0.335	0.288	0	3
Silver (µg/L)	<0.015	–	0.040	–	0.055	0.048	0	3
Strontium (µg/L)	60.5	–	164	–	239	155	–	3
Zinc (µg/L)	5.2	–	10.3	–	41.3	18.9	0	3

Table 8–1. Summary statistics of water-quality properties and constituent concentrations measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered) unless otherwise noted; MCL, Maximum Contaminant Level; SMCL, Secondary Maximum Contaminant Level; mg/L, milligrams per liter; –, not determined; µS/cm, microsiemens per centimeter; $CaCO_3$, calcium carbonate; <, less than; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; E, estimate (result is outside the lowest or highest calibration point); Total nitrogen was calculated as the sum of dissolved nitrogen compounds]

Constituent	Minimum value	25th percentile	50th percentile	75th percentile	Maximum value	Mean value[a]	Samples exceeding MCL/ SMCL	Number of samples
North Canadian River at Shawnee, Oklahoma (07241800)								
Water properties								
Dissolved oxygen (mg/L)	4.8	6.3	10.6	13.4	15.4	10.1	–	8
pH (standard units)	7.7	8.3	8.4	8.7	9.3	–	3	8
Specific conductance (uS/cm at 25 degrees Celsius)	365	518	557	742	843	611	–	8
Water temperature (degrees Celsius)	8.1	12.3	18.3	25.0	33.2	19.0	–	8
Dissolved solids (mg/L)	224	303	394	479	581	396	1	8
Major ions								
Calcium, (dissolved) (mg/L)	29.3	37.8	43.9	46.4	61.7	43.2	–	8
Calcium (mg/L)	40.9	45.1	52.7	70.0	110	62.6	–	8
Magnesium, (dissolved) (mg/L)	9.17	11.89	14.9	17.9	21.8	15.0	–	8
Magnesium (mg/L)	12.1	17.5	18.8	22.2	22.7	18.7	–	8
Potassium, (dissolved) (mg/L)	3.96	5.85	7.40	9.82	11.3	7.62	–	8
Potassium (mg/L)	6.76	7.73	8.77	10.0	11.7	8.99	–	8
Sodium, (dissolved) (mg/L)	25.0	46.6	60.7	86.2	104	65.1	–	8
Sodium (mg/L)	24.9	46.0	65.3	86.6	99.5	65.5	–	8
Alkalinity (mg/L as $CaCO_3$)	89.4	109	129	139	157	124	–	8
Bicarbonate (mg/L)	106	115	147	161	189	143	–	8
Carbonate (mg/L)	<1.0	<1.0	0.9	4.0	20.4	–	–	8
Chloride (mg/L)	27.9	54.8	84.1	124	143	87.3	0	8
Fluoride (mg/L)	0.31	0.40	0.54	0.71	0.85	0.56	0	8
Silica (mg/L as SiO_2)	0.72	4.99	5.72	6.16	7.45	5.21	–	8
Sulfate (mg/L)	34.6	48.6	56.8	80.0	99.8	63.3	0	8
Nutrients								
Ammonia plus organic nitrogen, (dissolved) (mg/L as N)	0.54	0.72	0.77	0.85	1.0	0.78	–	8
Ammonia plus organic nitrogen (mg/L as N)	1.2	1.5	2.5	3.0	4.4	2.4	–	8
Ammonia nitrogen, (dissolved) (mg/L as N)	<0.010	–	0.096	0.250	0.423	–	–	8
Nitrite plus nitrate-nitrogen, (dissolved) (mg/L as N)	0.544	0.847	2.21	3.98	7.39	2.91	0	8

Table 8–1. Summary statistics of water-quality properties and constituent concentrations measured in water samples collected at four stream sites in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Constituent concentrations are in whole water samples (unfiltered) unless otherwise noted; MCL, Maximum Contaminant Level; SMCL, Secondary Maximum Contaminant Level; mg/L, milligrams per liter; –, not determined; µS/cm, microsiemens per centimeter; $CaCO_3$, calcium carbonate; <, less than; SiO_2, silicon dioxide; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; E, estimate (result is outside the lowest or highest calibration point); Total nitrogen was calculated as the sum of dissolved nitrogen compounds]

Constituent	Minimum value	25th percentile	50th percentile	75th percentile	Maximum value	Mean value[a]	Samples exceeding MCL/ SMCL	Number of samples
Nutrients—Continued								
Nitrite-nitrogen, (dissolved) (mg/L as N)	0.019	0.041	0.056	0.089	0.112	0.062	0	8
Total nitrogen (calculated) (mg/L)	1.25	1.57	2.89	5.48	8.39	3.69	0	–
Orthophosphorus, (dissolved) (mg/L as P)	0.124	0.275	0.744	1.18	2.53	0.91	–	8
Total phosphorus, (dissolved) (mg/L)	0.132	0.319	0.805	1.17	2.53	0.934	–	8
Total phosphorus (mg/L)	0.698	1.15	1.32	1.62	2.70	1.45	–	8
Trace elements								
Aluminum (µg/L)	260	620	2,095	6,740	19,100	5,366	8	8
Arsenic (µg/L)	3.1	3.9	4.7	6.4	10.1	5.5	1	8
Barium (µg/L)	110	132	153	268	765	272	0	8
Beryllium (µg/L)	<0.19	<0.19	<0.19	1.16	1.59	–	0	8
Cadmium (µg/L)	0.047	0.069	0.116	0.257	1.04	0.272	0	8
Chromium (µg/L)	0.59	1.26	3.15	8.30	25.2	7.09	0	8
Cobalt (µg/L)	0.7	1.21	1.85	5.30	14.4	4.38	–	8
Copper (µg/L)	<1.4	2.7	4.7	15.1	31.9	–	0	8
Iron, (dissolved) (µg/L)	<3.2	7.25	21.7	44.4	82.2	–	0	8
Iron (µg/L)	286	587	2,140	6,645	21,200	5,656	7	8
Lead (µg/L)	0.82	1.69	4.78	19.2	56.2	15.6	2	8
Lithium (µg/L)	E12	E12.4	E17.9	E24.1	E37.2	E19.7	–	8
Manganese, (dissolved) (µg/L)	1.87	5.21	7.39	8.16	18.0	7.66	0	8
Manganese (µg/L)	22.7	66.8	117	483	1,260	389	7	8
Mercury (µg/L)	<0.005	0.011	0.019	0.058	0.099	–	0	8
Molybdenum (µg/L)	0.63	1.27	2.02	2.83	3.02	1.96	–	8
Nickel (µg/L)	5.4	6.2	7.3	12.1	28.4	11.3	–	8
Selenium (µg/L)	0.241	0.297	0.316	0.374	0.497	0.348	0	8
Silver (µg/L)	<0.015	0.020	0.066	0.138	0.349	–	0	8
Strontium (µg/L)	347	490	564	593	662	533	–	8
Zinc (µg/L)	7.2	16.4	27.8	53.7	105	41.1	0	8

[a] Mean values not calculated for constituents having censored (<) data.

Table 9–1. Summary statistics of water-quality properties and constituent concentrations measured in water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.

[Concentrations are dissolved (filtered); MCL, Maximum Contaminant Level; SMCL, Secondary Maximum Contaminant Level; mg/L, milligrams per liter; –, not determined; µs/cm, microsiemens per centimeter; CaCO$_3$, calcium carbonate; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; <, less than; pCi/L, picocuries per liter]

Constituent	Minimum value	25th percentile	50th percentile	75th percentile	Maximum value	Mean value[a]	Number of samples exceeding MCL/SMCL	Number of samples
Water properties								
Dissolved oxygen (mg/L)	0.9	4.1	6.6	7.7	9.7	5.8	–	30
pH (standard units)	5.0	6.5	6.8	7.2	8.4	6.8	8	30
Specific conductgance (µS/cm at 25 degrees Celsius)	89	382	596	852	1,920	663	–	30
Dissolved solids (mg/L)	55	216	364	525	1,280	407	9	30
Hardness (calculated) (mg/L as CaCO$_3$)	19	61	180	284	465	189	–	30
Major ions								
Calcium (mg/L)	4.17	15.0	41.7	60.3	104	42.8	–	30
Magnesium (mg/L)	1.76	7.08	17.7	31.0	49.7	19.9	–	30
Potassium (mg/L)	0.64	0.93	1.34	1.58	2.45	1.31	–	30
Sodium (mg/L)	6.17	16.1	29.4	78.7	409	76.0	–	30
Alkalinity (mg/L)	17	182	258	312	522	246	–	30
Bicarbonate (mg/L)	20	222	314	372	648	300	–	29
Carbonate (mg/L)	<1.0	0.1	0.3	0.4	4.3	–	–	29
Chloride (mg/L)	5.13	12.5	19.1	40.4	120	33.8	0	30
Fluoride (mg/L)	0.05	0.15	0.22	0.56	2.65	0.47	0	23
Silica (mg/L as SiO$_2$)	8.6	12.0	15.4	17.9	27.8	15.7	–	30
Sulfate (mg/L)	4.9	14.3	22.9	41.7	528	60.5	2	30
Nutrients								
Ammonia nitrogen (mg/L as N)	<0.010	<0.010	<0.010	0.046	0.424	–	–	30
Nitrite-nitrogen (mg/L as N)	<0.001	<0.001	<0.001	<0.001	0.002	–	0	30
Nitrite plus nitrate-nitrogen (mg/L as N)	<0.038	0.046	0.344	0.760	4.8	–	0	30
Total nitrogen (mg/L)	<0.05	0.28	0.42	0.87	5.29	–	0	30
Orthophosphorus (mg/L as P)	<0.004	0.013	0.025	0.064	0.438	–	–	30
Phosphorus (mg/L)	<0.003	0.01	0.023	0.061	0.445	–	–	30
Trace elements								
Aluminum (µg/L)	<2.2	<2.2	<2.2	<2.2	56.9	–	1	30
Antimony (µg/L)	<0.027	<0.027	<0.027	<0.027	0.031	–	0	30
Arsenic (µg/L)	0.08	0.37	0.58	1.3	9.8	1.2	0	30

Table 9–1. Summary statistics of water-quality properties and constituent concentrations measured in water samples collected from 30 wells in and near the Citizen Potawatomi Nation Tribal Jurisdictional Area, central Oklahoma, 2012–13.—Continued

[Concentrations are dissolved (filtered); MCL, Maximum Contaminant Level; SMCL, Secondary Maximum Contaminant Level; mg/L, milligrams per liter; –, not determined; µs/cm, microsiemens per centimeter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; µg/L, micrograms per liter; <, less than; pCi/L, picocuries per liter]

Constituent	Minimum value	25th percentile	50th percentile	75th percentile	Maximum value	Mean value[a]	Number of samples exceeding MCL/SMCL	Number of samples
				Trace elements—Continued				
Barium (µg/L)	11.9	77.3	192	299	800	223	0	30
Beryllium (µg/L)	<0.006	0.010	0.020	0.066	0.322	–	0	30
Boron (µg/L)	18	68	169	420	5,900	621	0	30
Cadmium (µg/L)	<0.016	<0.016	<0.016	<0.016	0.148	–	0	30
Chromium (µg/L)	<0.07	0.15	0.48	1.0	12.2	–	0	30
Cobalt (µg/L)	<0.021	<0.021	0.023	0.044	0.547	–	0	30
Copper (µg/L)	<0.8	<0.8	<0.8	1.4	5.3	–	0	30
Iron (µg/L)	<3.2	<3.2	<4.0	6.9	3,000	–	3	30
Lead (µg/L)	<0.025	0.045	0.077	0.118	0.935	–	0	30
Lithium (µg/L)	1.82	6.62	11.8	16.9	25.4	11.8	0	30
Manganese (µg/L)	<0.13	<0.13	0.26	4.51	519	–	3	30
Molybdenum (µg/L)	<0.014	0.030	0.137	0.348	38.0	–	0	30
Nickel (µg/L)	<0.09	0.17	0.30	1.0	2.6	–	0	30
Selenium (µg/L)	<0.03	0.12	0.27	1.0	9.5	–	0	30
Silver (µg/L)	<0.005	<0.005	<0.005	<0.005	0.008	–	0	30
Strontium (µg/L)	29.9	97.1	246	423	3,500	514	0	30
Thorium (µg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	–	0	30
Vanadium (µg/L)	0.20	0.91	2.8	7.8	33.1	5.7	0	30
Zinc (µg/L)	<1.4	<1.4	2.3	5.2	93.1	–	0	30
				Radionuclides				
Gross alpha-particle activity at 72 hours (pCi/L)	0.9	3.7	7.5	10	28	8.2	4	27
Gross alpha-particle activity at 30 days (pCi/L)	0.0	0.0	1.5	5.1	23	3.8	0	27
Gross beta-particle activity at 72 hours (pCi/L	0.0	1.0	1.9	3.1	5.5	2.0	0	27
Gross beta-particle activity at 30 days (pCi/L)	0.0	1.4	2.1	2.8	9.7	2.5	0	27
Uranium (µg/L)	0.03	0.29	1.9	4.7	79.5	6.5	2	30

[a] Mean values not calculated for constituents having censored (<) data.

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