Prepared in cooperation with the Kickapoo Tribe of Oklahoma

# Groundwater Quality and Water-Well Characteristics in the Kickapoo Tribe of Oklahoma Jurisdictional Area, Central Oklahoma, 1948–2011

Open-File Report 2012–1255

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

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By Carol J. Becker

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

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

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(Available at http://pubs.usgs.gov/of/2012/1255.)

# Conversion Factors

Inch/Pound to SI

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| inch (in.) | 2.54 | centimeter (cm) |
| inch (in.) | 25.4 | millimeter (mm) |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| | Area | |
| square mile ($mi^2$) | 259.0 | hectare (ha) |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |
| | Volume | |
| gallon (gal) | 3.785 | liter (L) |
| gallon (gal) | 0.003785 | cubic meter ($m^3$) |
| | Flow rate | |
| gallon per minute (gal/min) | 0.06309 | liter per second (L/s) |

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

°F = (1.8 × °C)+32

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

°C = (°F - 32) / 1.8

Vertical coordinate information is referenced to the 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 in either milligrams per liter (mg/L) or micrograms per liter (µg/L).

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

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

# Groundwater Quality and Water-Well Characteristics in the Kickapoo Tribe of Oklahoma Jurisdictional Area, Central Oklahoma, 1948–2011

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## Abstract

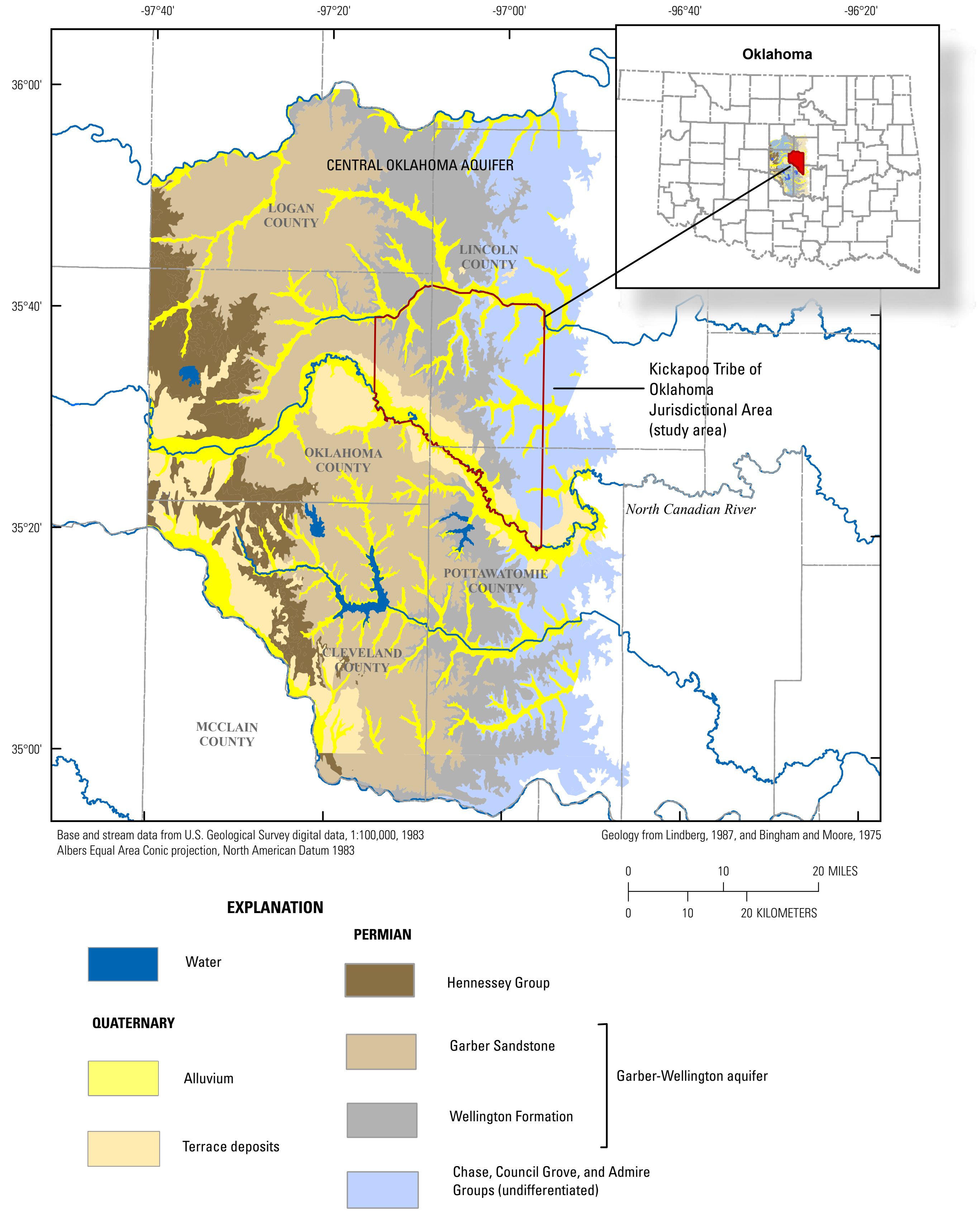
In 2012, the U.S. Geological Survey, in cooperation with the Kickapoo Tribe of Oklahoma, compiled historical groundwater-quality data collected from 1948 to 2011 and water-well completion information in parts of Lincoln, Oklahoma, and Pottawatomie Counties in central Oklahoma to support the development of a comprehensive water-management plan for the Tribe's jurisdictional area. In this study, water-quality data from 155 water wells, collected from 1948 to 2011, were retrieved from the U.S. Geological Survey National Water Information System database; these data include measurements of pH, specific conductance, and hardness and concentrations of the major ions, trace elements, and radionuclides that have Maximum Contaminant Levels or Secondary Maximum Contaminant Levels in public drinking-water supplies. Information about well characteristics includes ranges of well yield and well depth of private water wells in the study area and was compiled from the Oklahoma Water Resources Board Multi-Purpose Well Completion Report database. This report also shows depth to water from land surface by using shaded 30-foot contours that were created by using a geographic information system and spatial layers of a 2009 potentiometric surface (groundwater elevation) and land-surface elevation.

Wells in the study area produce water from the North Canadian River alluvial and terrace aquifers, the underlying Garber Sandstone and Wellington Formation that compose the Garber–Wellington aquifer, and the Chase, Council Grove, and Admire Groups. Water quality varies substantially between the alluvial and terrace aquifers and bedrock aquifers in the study area. Water from the alluvial aquifer has relatively high concentrations of dissolved solids and generally is used for livestock only, whereas water from the terrace aquifer has low concentrations of dissolved solids and is used extensively by households in the study area. Water from the bedrock aquifer also is used extensively by households but may have high concentrations of trace elements, including uranium, in some areas where groundwater pH is above 8.0.

Well yields vary and are dependent on aquifer characteristics and well-completion practices. Well yields in the unconsolidated alluvial and terrace aquifers generally are higher than yields from bedrock aquifers but are limited by the thickness and extent of these river deposits. Well yields in the alluvium and terrace aquifers commonly range from 50 to 150 gallons per minute and may exceed 300 gallons per minute, whereas well yields in the bedrock aquifers commonly range from 25 to 50 gallons per minute in the western one-third of study area (Oklahoma County) and generally less than 25 gallons per minute in the eastern two-thirds of the study area (Lincoln and Pottawatomie Counties).

## Introduction

In 2012, the U.S. Geological Survey (USGS), in cooperation with the Kickapoo Tribe of Oklahoma, compiled historical groundwater-quality data collected from 1948 to 2011 and water-well characteristics in parts of Lincoln, Oklahoma, and Pottawatomie Counties in central Oklahoma to support the development of a comprehensive water-management plan for the Tribe's jurisdictional area (fig. 1). Wells in the study area produce water from aquifers in the North Canadian River alluvium and terrace deposits and from the underlying Garber Sandstone and Wellington Formation that compose the Garber–Wellington aquifer and the Chase, Council Grove, and Admire Groups. The bedrock aquifers are part of a complex of sandstone, siltstone, and mudstone rocks, referred to as the "Central Oklahoma aquifer," that underlies about 2,890 square miles of central Oklahoma (fig. 1) and is the primary water supply for municipal, domestic, industrial, and agricultural needs (Tortorelli, 2009).



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

Geology from Lindberg, 1987, and Bingham and Moore, 1975

**Figure 1.** Surficial geology and location of the Central Oklahoma aquifer and study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma.

Water quality varies substantially between the North Canadian River alluvial and terrace aquifers and bedrock aquifers in the study area. Water from the alluvial aquifer has relatively high concentrations of dissolved solids and generally is used for livestock only, whereas water from the terrace aquifers has low concentrations of dissolved solids and is used extensively by households in the study area (Bingham and Moore, 1975). Water from the bedrock aquifers also is used extensively by households but may have high concentrations of trace elements, including radionuclides, in some areas where groundwater pH is above 8.0 (Becker, 2013). The trace elements occur naturally in the bedrock and in low concentrations in groundwater throughout the extent of the bedrock aquifers (Christenson and Havens, 1998; Schlottmann and others, 1998).

Well yields vary and are dependent on aquifer characteristics and well-completion practices. Well yields in the unconsolidated alluvial and terrace aquifers generally are higher than in bedrock aquifers but are limited by the thickness and extent of these river deposits (Bingham and Moore, 1975). Wells completed in the underlying consolidated bedrock aquifers have smaller yields in the eastern parts of the tribal jurisdictional area because the bedrock becomes shalier and is less permeable (Bingham and Moore, 1975; Becker, 2013).

## Purpose and Scope

The purpose of this report is to provide information about groundwater quality and water-well characteristics in the Kickapoo Tribe of Oklahoma Jurisdictional Area in parts of Lincoln, Oklahoma, and Pottawatomie Counties. The information is displayed on maps, listed in tables, and described in the text of the report. Locations of 155 wells that have historical water-quality information from samples collected by the USGS are shown on a map (plate 1). These samples were collected from 1948 to 2011 and may include measurements of the water properties pH, specific conductance, and calcium hardness and concentrations of naturally occurring constituents having Maximum Contaminant Levels (MCLs) or Secondary Maximum Contaminant Levels (SMCLs) in public drinking-water supplies (table 1). The water-quality information and summary statistics are provided on tables (tables 2 and 3). Ranges of well yield and depth of water wells drilled by licensed well drillers are shown on a second map (plate 2). This information is overlaid on shaded contours showing depth to water in feet below land surface.

## Aquifer Descriptions

In the study area, water wells produce water from alluvial and terrace aquifers along the North Canadian River and the underlying bedrock aquifers. These aquifers are unconfined (water-table) aquifers that are hydraulically connected but contain discontinuous beds of clay that locally slow the downward movement of groundwater (Christenson and Havens, 1998).

### Alluvial and Terrace Aquifers

In Oklahoma, aquifers in the alluvium and terrace deposits along rivers and streams consist of unconsolidated lens-shaped beds of sand, silt, clay, and gravel. Alluvium is 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 river bed was at a higher elevation. In central Oklahoma along major rivers, alluvium ranges from about 30 to 100 feet thick and averages about 50 feet thick. Terrace deposits can range from a few feet thick to about 100 feet thick and average about 50 feet thick along major streams in central Oklahoma (Bingham and Moore, 1975). In the study area, alluvium and terrace deposits are very permeable and are major sources of water where thick enough to sustain acceptable yields (Bingham and Moore, 1975).

Groundwater quality varies in the alluvial and terrace aquifers. In the study area, groundwater from the North Canadian River alluvium is typically of fair-to-poor quality having high dissolved solid concentrations (Bingham and Moore, 1975). Groundwater from the alluvium generally is used only for irrigation or livestock. In contrast, groundwater from the terrace deposits originates primarily from precipitation and has low dissolved solids content and tends to be acidic. Water from wells in the terrace deposits is used extensively for domestic use along the North Canadian River Valley in the study area (Bingham and Moore, 1975; Becker, 2013).

### Bedrock Aquifers

Bedrock aquifers in the study area are part of the Central Oklahoma aquifer and consist of the Garber–Wellington aquifer and the Chase, Council Grove, and Admire Groups (fig. 1). The Garber–Wellington aquifer is composed of the Garber Sandstone and the Wellington Formation and is the major source of water for domestic use, public supply, irrigation, industry, and other uses in central Oklahoma (Tortorelli, 2009). The Garber Sandstone consists 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 Wellington Formation is similar to that of the Garber Sandstone, but finer grained, containing a larger percentage of siltstone and mudstone. The Chase, Council Grove, and Admire Groups, also referred to as the Oscar Group by Bingham and Moore (1975), consist of red-brown to gray shale and orange-brown, fine-grained, crossbedded sandstone.

All of the bedrock units in this area gently dip in a westerly direction at about 50 feet per mile (Christenson and Havens, 1998) and become shalier (finer grained) in an easterly direction and with depth (Schlottmann and others, 1998), yielding less water in those parts of the aquifer. Previous mapping indicated that only about 16 percent of the Chase, Council Grove, and Admire Groups consist of sandstone, whereas sandstone content of the Garber–Wellington aquifer ranges from about 70 percent in the northwest corner of the jurisdictional area to about 30 percent in the southeastern part of the study area (Schlottmann and others, 1998, fig. 3).

**Table 1.** Maximum Contaminant Levels and Secondary Maximum Contaminant Levels of pH, major ions, trace elements, and radionuclides in public drinking-water supplies.

[µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; µg/L, micrograms per liter; pCi/L, picocuries per liter; —, not available; >, greater than; blue shading, water property/constituent has Secondary Maximum Contaminant Level; red shading, constituent has Maximum Contaminant Level]

| Water properties and chemical constituents (units) | Secondary Maximum Contaminant Level[1] | Maximum Contaminant Level[2] | Aesthetic effects above the Secondary Maximum Contaminant Level[1] | Potential human-health effects from long-term exposure above the Maximum Contaminant Level[2] |
|---|---|---|---|---|
| pH (standard units) | 6.5–8.5 | — | Low pH: bitter metallic taste and corrosion of pipes. High pH: slippery feel, soda taste, and mineral deposits on fixtures. | |
| Specific conductance (µS/cm at 25 degrees Celsius) | — | — | | |
| Dissolved solids (mg/L) | 500 | — | Hardness, mineral deposits and/or staining on fixtures, colored water, salty taste. | |
| Hardness (mg/L as calcium carbonate) | — | — | 0–60, soft (corrosive); 61–120, moderately hard; 121–180, hard; >180, very hard (mineral deposits on fixtures). | |
| Chloride (mg/L) | 250 | — | Salty taste. | |
| Fluoride (mg/L) | 2 | 4 | | Tooth discoloration; bone disease. |
| Nitrate nitrogen (mg/L as nitrogen) | — | 10 | | Infants younger than 6 months are at risk of blue-baby syndrome. |
| Sulfate (mg/L) | 250 | — | Aesthetic effects related to odor and taste. | |
| Aluminum (µg/L) | 50–200 | — | Aesthetic effects related to color. | |
| Arsenic (µg/L) | — | 10 | | Increased risk of cancer, skin damage; circulatory problems. |
| Barium (µg/L) | — | 2,000 | | Increase in blood pressure. |
| Beryllium (µg/L) | — | 4 | | Intestinal lesions. |
| Cadmium (µg/L) | — | 5 | | Kidney damage. |
| Chromium (µg/L) | — | 100 | | Allergic dermatitis. |
| Copper (µg/L) | 1,000 | [3]1,300 | Aesthetic effects related to odor, taste, and color. | Liver or kidney damage. |

| Water properties and chemical constituents (units) | Secondary Maximum Contaminant Level[1] | Maximum Contaminant Level[2] | Aesthetic effects above the Secondary Maximum Contaminant Level[1] | Potential human-health effects from long-term exposure above the Maximum Contaminant Level[2] |
|---|---|---|---|---|
| Iron (µg/L) | 300 | — | Aesthetic effects related to odor, taste, and color. | |
| Lead (µg/L) | — | [3]15 | | Delays in physical or mental development in children. Kidney problems and high blood pressure in adults. |
| Manganese (µg/L) | 50 | — | Black staining on fixtures; bitter metallic taste. | |
| Mercury (µg/L) | — | 2 | | Kidney damage. |
| Selenium (µg/L) | — | 50 | | Loss of hair or fingernails, numbness in fingers and toes, and circulatory problems. |
| Zinc (µg/L) | 5,000 | — | Metallic taste. | |
| Uranium, natural (µg/L) | — | 30 | | Increased risk of kidney disease and cancer. |
| Gross alpha-particle activity (pCi/L) | — | 15 | | Increased risk of cancer. |
| Gross beta-particle activity (pCi/L) | — | 4 millirems per year[4] | | Increased risk of cancer. |
| Radium-226 (pCi/L)<br>Radium-228 (pCi/L) | — | 5 (concentrations combined) | | Increased risk of cancer. |
| Radon-222 (pCi/L) | — | Not finalized[5] | | Lung cancer. |

[1] U.S. Environmental Protection Agency (2012b).

[2] U.S. Environmental Protection Agency (2012a).

[3] Copper and lead are regulated by a treatment technique that requires systems to control the corrosiveness of the water. If more than 10 percent of tap water samples exceed the Maximum Contaminant Level (MCL) of either constituent, then water systems must take corrective steps. For copper, the action level is 1,300 µg/L, and for lead it is 15 µg/L.

[4] The MCL is a concentration of beta-particle activity from radionuclides in drinking water that produces an annual radiation dose of 4 millirems per year (U.S. Environmental Protection Agency, 2000).

[5] The MCL for radon in public water-supply systems will be 4,000 pCi/L if multimedia mitigation programs are established to address radon in indoor air. A second option is an MCL of 300 pCi/L for systems that choose not to develop multimedia mitigation programs (U.S. Environmental Protection Agency, 2012a).

# Methods

Historical water-quality information for 155 water wells in the Kickapoo Tribal Jurisdictional Area was retrieved from the USGS National Water Information System (NWIS) database (U.S. Geological Survey, 2012a) (plate 1) in January 2012 and includes well depth; measurements of pH, specific conductance, dissolved solids, and hardness; and concentrations of the major ions, trace elements, and radionuclides that have MCLs or SMCLs in public drinking-water supplies (U.S. Environmental Protection Agency, 2012a, 2012b) (tables 2, at end of report, and 3). Information about other constituents that were measured in the samples but are not shown in table 2 can be found in the USGS NWIS database (U.S. Geological Survey, 2012a).

Well depths, water properties, and selected constituent concentrations (of sampled wells on table 2) were summarized statistically (table 3). The median water-property value or chemical constituent concentration was used for calculating statistics when multiple analyses were collected from one well. Twelve chloride concentrations were less than the reporting level and were not used to calculate summary statistics.

Information for ranges in well depth and well yield shown on plate 2 was retrieved from the Oklahoma Water Resources Board Multi-Purpose Well Completion Report database in November 2011 (Oklahoma Water Resources Board, 2011). This database contains well-completion information submitted to the Oklahoma Water Resources Board by licensed well drillers from 1982 to 2011. The information shown on plate 2 was not statistically summarized.

The number of wells used to compute ranges of well depths and well yields varied from 1 to 93 per Public Land Survey System section and is shown in parentheses in each section on plate 2. Well depths are described in feet below land surface, and well yields are listed in gallons per minute. Sections that did not have any reported wells do not show ranges. The information on plate 2 should be used with caution, as the accuracy of well depths, well yields, and well locations submitted by well drillers has not been field verified by the Oklahoma Water Resources Board or the USGS.

Plate 2 also shows depth to water from land surface by using shaded 30-foot contours that were created by using a geographic information system and spatial layers of the 2009 potentiometric surface (groundwater elevation) in the Central Oklahoma aquifer (Mashburn and Magers, 2011) and the land-surface elevation (U.S. Geological Survey, 2006). The potentiometric-surface map (Mashburn and Magers, 2011) was converted from a vector dataset having a contour interval of 50 feet to a raster dataset having a 10-meter grid cell resolution by using the ESRI (ESRI Inc., Redlands, California) ArcGIS 10.0 command TopoToRaster (ESRI Inc., 2012a). The land-surface-elevation spatial layer was a raster product of the National Elevation Dataset which has a 10-meter grid cell resolution (U.S. Geological Survey, 2006). Depth to water in feet was computed as the difference between the two raster datasets by using the ArcGIS 10.0 Raster Calculator Tool (ESRI Inc., 2012b).

# Groundwater Quality

The historical water-quality data (table 2) for the 155 wells (plate 1) may contain information about pH and concentrations of the major ions, trace elements, and radionuclides that have an MCL or SMCL for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a, 2012b). The number of analyses and the number of constituents analyzed for each well varied. Some wells had multiple samples analyzed for many constituents, whereas other wells may have had only pH measured.

The quality of water from private wells is not regulated, so the MCLs and SMCLs should be used only as guides for substances that may pose problems for human health or water uses (table 1). 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 uranium in public drinking-water supplies is 30 micrograms per liter, the exposure level 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, 2000). More information about the health effects of consuming groundwater constituents at concentrations exceeding MCLs can be found in U.S. Environmental Protection Agency (2012b). 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. For example, concentrations of iron or manganese that exceed the SMCL may cause staining of water fixtures and give water a metallic taste but are not considered hazardous to health.

Wells were color-coded on plate 1 to indicate if constituent concentrations in a sample exceeded an MCL and (or) an SMCL. The water-quality data are listed in table 2. Color codes on plate 1 indicate water quality as follows:

- black, all constituent concentrations were below the MCLs and SMCLs;
- blue, one or more constituent concentrations or pH exceeded the SMCL;
- red, one or more constituent concentrations exceeded the MCL;
- red/blue, one or more constituent concentrations or pH exceeded the SMCL and MCL.

Summary statistics indicate that the pH of 152 samples collected in the study area ranged from 5.2 to 8.9 with median and mean values of 7.3 (table 3). Samples from shallow wells completed in the terrace aquifer tend to have a lower pH, whereas samples from deeper wells completed in the Garber–Wellington aquifer tend to have a higher pH (Becker, 2013). The lower SMCL for pH is 6.5 because acidic groundwater can corrode metal pipes and water fixtures (table 1).

**Table 3.** Statistical summaries of well depth, water properties, and selected constituent concentrations of samples from wells in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.

[µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate]

| Property or chemical constituent | Number of values | Minimum | Percentiles | | | Maximum | Mean |
|---|---|---|---|---|---|---|---|
| | | | 25 | 50 (median) | 75 | | |
| Well depth (feet below land surface) | 139 | 7 | 60 | 110 | 150 | 412 | 114 |
| pH (standard units) | 152 | 5.2 | 6.8 | 7.3 | 7.9 | 8.9 | 7.3 |
| Specific conductance, field (µS/cm at 25 degrees Celsius) | 146 | 100 | 392 | 623 | 810 | 8,920 | 817 |
| Hardness (mg/L as $CaCO_3$) | 132 | 4.9 | 121 | 201 | 306 | 1,310 | 224 |
| Dissolved solids (mg/L) | 71 | 81 | 268 | 409 | 523 | 8,310 | 631 |
| Chloride (mg/L) | 72 | 4.7 | 13 | 25 | 48 | 1,100 | 68 |
| Sulfate (mg/L) | 115 | 2.5 | 12 | 24 | 47 | 5,410 | 107 |

The concentration of dissolved solids in a water sample is equal to the sum of all dissolved constituent concentrations and has an SMCL of 500 milligrams per liter (mg/L) in public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). Specific conductance is the measurement of the ability of water to transmit an electrical current and is directly related to the concentration of dissolved constituents in water. For example, distilled water, which has no dissolved constituents but is a polar liquid, will conduct minimal electricity, whereas sea water, which contains high concentrations of the dissolved constituents sodium and chloride, is highly conductive. The concentration of dissolved solids in a water sample generally is measured by using laboratory methods, whereas specific conductance can be quickly and inexpensively measured in the field. Specific conductance values measured in samples from 146 wells ranged from 100 to 8,920 microsiemens per centimeter and had a median of 623 and a mean of 817 microsiemens per centimeter (tables 2 and 3). Concentrations of dissolved solids in 71 samples ranged from 81 to 8,310 mg/L with a median of 409 mg/L and a mean of 631 mg/L (tables 2 and 3).

Water hardness in the study area is caused primarily by dissolved calcium and magnesium. Hardness does not have an MCL or SMCL, but information on water hardness is useful for making decisions about water use and water treatment because hard water can leave buildup of scale on pipes and fixtures and requires larger amounts of soap and detergent for washing (U.S. Geological Survey, 2012b). Water with hardness concentrations greater than 180 mg/L (as calcium carbonate) is considered to be very hard (table 1). Generally, groundwater in the study area is very hard, with concentrations in 132 samples ranging from 4.9 to 1,310 mg/L with a median of 201 mg/L and a mean of 224 mg/L (as calcium carbonate) (tables 2 and 3).

The SMCL for the major ions chloride and sulfate is 250 mg/L in public drinking-water supplies (U.S. Environmental Protection Agency, 2012a) (table 1). Chloride concentrations in 72 samples ranged from 4.7 to 1,100 mg/L with a median of 25 mg/L and a mean of 68 mg/L (tables 2 and 3). Sulfate concentrations in 115 samples ranged from 2.5 to 5,410 mg/L with a median of 24 mg/L and a mean of 107 mg/L (tables 2 and 3).

Groundwater from deep wells completed in the bedrock has the potential to contain high concentrations of the trace elements arsenic, chromium, selenium, and uranium (uranium also is a radionuclide) (Schlottmann and others, 1998; Becker, 2013). These elements occur naturally in the bedrock and in low concentrations in groundwater throughout the extent of the bedrock aquifers in central Oklahoma (Christenson and Havens, 1998; Schlottmann and others, 1998). Concentrations of these elements in groundwater are dependent in part on the presence of these elements in the bedrock and groundwater pH. Concentrations of trace elements in the bedrock tend to increase with depth and as the sediments become finer-grained (Schlottmann and others, 1998; Gromadzki, 2004). At pH values greater than 8.0, these elements are liberated from the bedrock (if present) and are mobile in groundwater. Historical water-quality data show that water samples from three wells in the study area had concentrations of arsenic exceeding the MCL and that one sample had a concentration of selenium exceeding the MCL (plate 1 and table 2). Concentrations of uranium exceeded the MCL in water samples from 13 wells in the study area and 5 of these samples had high concentrations of dissolved radon gas (plate 1 and table 2). USGS studies have shown that groundwater pH values above 8.0 in the study area are useful indicators for potentially high concentrations of uranium (and the daughter product dissolved radon gas) in addition to arsenic, chromium, and selenium in groundwater when these elements are present in the bedrock along groundwater-flow paths (Schlottmann and others, 1998; Becker, 2013).

## Water-Well Characteristics

Well depth and an estimate of well yield in gallons per minute are typically reported by licensed well drillers for completed water wells in Oklahoma. This information can be used for making decisions about designing and constructing new wells for optimum well yield.

Depths of wells having historical water-quality data in the study area show that 50 percent of the wells ranged from 60 to 150 feet deep with a median well depth of 110 feet (tables 2 and 3). Wells completed in only the alluvium and terrace deposits tend to be shallower than wells in the bedrock aquifers (Bingham and Moore, 1975). However, many wells completed in the terrace deposits also are completed in the underlying bedrock aquifer and yield water from multiple zones (Oklahoma Water Resources Board, 2011).

Well yields in the unconsolidated alluvial and terrace aquifers commonly range from 50 to 150 gallons per minute and may exceed 300 gallons per minute in some areas (Bingham and Moore, 1975). Well yields in the bedrock aquifers commonly range from 25 to 50 gallons per minute in the western one-third of study area (Oklahoma County) and generally less than 25 gallons per minute in the eastern two-thirds of the study area (Lincoln and Pottawatomie Counties) (Bingham and Moore, 1975).

## Summary

In 2012, the U.S. Geological Survey, in cooperation with the Kickapoo Tribe of Oklahoma, compiled historical groundwater-quality and water-well completion information in parts of Lincoln, Oklahoma, and Pottawatomie Counties to support the development of a comprehensive water-management plan for the Tribe's jurisdictional area. Wells in the study area produce water from the alluvial and terrace aquifers, the underlying Garber Sandstone and Wellington Formation that compose the Garber–Wellington aquifer, and the Chase, Council Grove, and Admire Groups.

Historical water-quality data for 155 water wells in the study area were retrieved from the U.S. Geological Survey National Water Information System database and include measurements of pH, specific conductance, and hardness and concentrations of the major ions, trace elements, and radionuclides that have Maximum Contaminant Levels or Secondary Maximum Contaminant Levels in public drinking-water supplies. The quality of water from private wells is not regulated, so the Maximum Contaminant Levels and Secondary Maximum Contaminant Levels should be used only as guides for substances that may pose problems for human health or water uses. The pH of 152 samples collected in the study area ranged from 5.2 to 8.9 with median and mean values of 7.3. Water from shallow wells completed in the terrace aquifer tends to have a lower pH, whereas water from deeper wells completed in the bedrock aquifer tends to have a higher pH. USGS studies have shown that groundwater pH values above 8.0 in the study area are useful indicators for potentially high concentrations of uranium (and the daughter product dissolved radon gas) in addition to arsenic, chromium, and selenium in groundwater when these elements are present in the bedrock along groundwater-flow paths.

Ranges of yield and depth of private water wells are provided per Public Land Survey System section. This information was compiled from the Oklahoma Water Resources Board Multi-Purpose Well Completion Report database. Well yields vary and are dependent on aquifer characteristics and well-completion practices. Well yields in the alluvial and terrace aquifers generally are higher than in the bedrock aquifers but are limited by the thickness and extent of these river deposits. Well yields in the alluvial and terrace aquifers commonly range from 50 to 150 gallons per minute and may exceed 300 gallons per minute, whereas well yields in the bedrock aquifers commonly range from 25 to 50 gallons per minute in the western one-third of study area (Oklahoma County) and generally less than 25 gallons per minute in the eastern two-thirds of the study area (Lincoln and Pottawatomie Counties).

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**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| | | | | Water properties | | Major ions | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Well number** | **USGS identifier** | **Well depth (feet below land surface)** | **Date of sample** | **pH (standard units)** | **Specific conductance (µS/cm at 25 degrees Celsius)** | **Dissolved solids (mg/L)** | **Hardness (mg/L as $CaCO_3$)** | **Chloride (mg/L)** | **Fluoride (mg/L)** | **Nitrate nitrogen (mg/L as N)** | **Sulfate (mg/L)** |
| 1 | 354144097093201 | 7 | 19771126 | 7.4 | 320 | — | 124 | — | — | — | 15 |
| 2 | 354048097052601 | 132 | 19771126 | 7.8 | 7,320 | — | 152 | — | — | — | 508 |
| 3 | 354048096584601 | 159 | 19780106 | 7.1 | 750 | — | 323 | — | — | — | 15 |
| 4 | 354043097020101 | 7 | 19771127 | 7.1 | 510 | — | 181 | — | — | — | 14 |
| 5 | 353959097084701 | 130 | 19771126 | 7.2 | 450 | — | 193 | — | — | — | 27 |
| 6 | 353948097112501 | 200 | 19851007 | 7.1[a] | 791 | — | 320 | 74 | — | 11.3[de] | 30 |
| 7 | 353947097113901 | 172 | 19541022 | 7.2 | 972 | 554 | 389 | 69 | 0 | 18.7 | 47 |
| 8 | 353947097111501 | 178 | 19870825 | 7.5 | 911 | 533[c] | 192 | 120 | 0.1 | 0.24 | 47 |
| 9 | 353938097031101 | 91 | 19880713 | 8.3 | 1,800 | 1,040[c] | 25.2 | 280 | 2.9 | <0.1 | 94 |
| 9 | 353938097031101 | 91 | 19900904 | 8.4 | 1,780 | — | — | — | — | — | — |
| 10 | 353931097103301 | 92 | 19880708 | 6.8 | 398 | 232[c] | 200 | 12 | 0.2 | 1.7 | 16 |
| 11 | 353925097113101 | 178 | 20050204 | — | — | 340 | 224 | 20 | 0.2 | 1.64[e] | 20 |
| 11 | 353925097113101 | 178 | 20050318 | — | — | 340 | 226 | 20 | 0.2 | 1.67[e] | 10 |
| 11 | 353925097113101 | 178 | 20050425 | — | — | 330 | 226 | 20 | 0.2 | 1.66[e] | 10 |
| 11 | 353925097113101 | 178 | 20050203 | — | — | 340 | 233 | 20 | 0.2 | 1.64[e] | 20 |
| 11 | 353925097113101 | 178 | 19851007 | 7.8[a] | 531 | — | 240 | 55 | — | 1.7[de] | <20 |
| 12 | 353909097100101 | 101 | 19880621 | 6.8 | 208 | 138[c] | 103 | 5.1 | 0.2 | 0.23 | 13 |
| 12 | 353909097100101 | 101 | 20040601 | 6.7 | 345 | 190 | 157 | <10 | 0.2 | 0.81[e] | 10 |
| 12 | 353909097100101 | 101 | 20040226 | 6.8 | 351 | 170 | 157 | <10 | 0.3 | 0.77[e] | 10 |
| 12 | 353909097100101 | 101 | 20030819 | 6.7 | 346 | 190 | 162 | <10 | 0.2 | 0.91[e] | <10 |
| 12 | 353909097100101 | 101 | 20031104 | 6.7 | 346 | 180 | 166 | <10 | 0.2 | 0.87[e] | 10 |
| 12 | 353909097100101 | 101 | 20030617 | 6.7 | 373 | 210 | 173 | <10 | 0.1 | 0.87[e] | <10 |
| 12 | 353909097100101 | 101 | 19881221 | 6.4 | 174 | — | — | — | — | — | — |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| | | | | Water properties | | Major ions | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | pH (standard units) | Specific conductance (µS/cm at 25 degrees Celsius) | Dissolved solids (mg/L) | Hardness (mg/L as $CaCO_3$) | Chloride (mg/L) | Fluoride (mg/L) | Nitrate nitrogen (mg/L as N) | Sulfate (mg/L) |
| 13 | 353835097020201 | 125 | 19771127 | 7.5 | 590 | — | 145 | — | — | — | 7 |
| 14 | 353816096585901 | 20 | 19780107 | 7.1 | 1,070 | — | 395 | — | — | — | 13 |
| 15 | 353815097045402 | 8 | 19771127 | 7.6 | 1,010 | — | 420 | — | — | — | 29 |
| 16 | 353813097080101 | 15 | 19771126 | 7.1 | 350 | — | 129 | — | — | — | 12 |
| 17 | 353812097140201 | 17 | 19771126 | 6.8 | 510 | — | 203 | — | — | — | 29 |
| 18 | 353805096553801 | 87 | 19780107 | 7.3 | 1,120 | — | 217 | — | — | — | 13 |
| 19 | 353800097040501 | 234 | 19710722 | 7.6 | 582 | 330 | 270 | 20 | — | 2.06 | 19 |
| 20 | 353746097114301 | 68 | 19771123 | 6.9 | 650 | — | 315 | — | — | — | 24 |
| 21 | 353719096594601 | — | 19830616 | 7.1[a] | — | 1,380[b] | 580 | 193 | 0.3[d] | <0.500[de] | 148 |
| 22 | 353655097114401 | — | 19850604 | 7.4[a] | — | 222[b] | 220 | <10 | 0.2[d] | <0.500[de] | <20 |
| 22 | 353655097114401 | — | 19830608 | 6.6[a] | — | 220[b] | 240 | <10 | <0.1[d] | 0.8[de] | <20 |
| 23 | 353635097081501 | 229 | 19700428 | 7.7 | 364 | 211 | 180 | 10 | — | 0.54 | 14 |
| 24 | 353634097120701 | 160 | 19860818 | 7.2[a] | — | 328[b] | 320 | 10 | 0.3[d] | 0.8[de] | <20 |
| 25 | 353631097093201 | 58 | 19771114 | 7.1 | 730 | — | 239 | — | — | — | 5 |
| 26 | 353624096565001 | 58 | 19700217 | 8.2 | 760 | 457 | 130 | 13 | — | 0.25 | 9.4 |
| 27 | 353539097050801 | 63 | 19771126 | 7.2 | 970 | — | 304 | — | — | — | 12 |
| 28 | 353539096554701 | 120 | 20040610 | 6.9 | 681 | 370 | 263 | <10 | 0.3 | 1.1[e] | <10 |
| 28 | 353539096554701 | 120 | 20031106 | 7.2 | 692 | 360 | 267 | <10 | 0.3 | 1.04[e] | <10 |
| 28 | 353539096554701 | 120 | 20040226 | 7.1 | 692 | 350 | 267 | <10 | 0.4 | 1.11[e] | <10 |
| 28 | 353539096554701 | 120 | 20030827 | 7.1 | 680 | 400 | 276 | <10 | 0.3 | 1.03[e] | <10 |
| 28 | 353539096554701 | 120 | 20030618 | 7.1 | 716 | 370 | 304 | <10 | 0.2 | 0.96[e] | <10 |
| 29 | 353539096554501 | 131 | 19880616 | 7.1 | 830 | 490[c] | 347 | 43 | 0.9 | 5.1[e] | 34 |
| 29 | 353539096554501 | 131 | 19900606 | 7.0 | 1,050 | — | — | — | — | — | — |

|  |  |  |  | Water properties |  |  | Major ions |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | pH (standard units) | Specific conductance (μS/cm at 25 degrees Celsius) | Dissolved solids (mg/L) | Hardness (mg/L as $CaCO_3$) | Chloride (mg/L) | Fluoride (mg/L) | Nitrate nitrogen (mg/L as N) | Sulfate (mg/L) |
| 29 | 353539096554501 | 131 | 19881220 | 7.2 | 720 | — | — | — | — | — | — |
| 30 | 353539096554401 | 33 | 19780104 | 6.7 | 620 | — | 307 | — | — | — | 13 |
| 31 | 353537097124101 | 31 | 19670209 | 8.1 | 698 | 422 | 330 | 40 | — | 0.25 | 43 |
| 32 | 353536096585001 | 141 | 19780104 | 6.6 | 610 | — | 199 | — | — | — | 14 |
| 33 | 353522097020201 | 119 | 19771126 | 6.5 | 2,500 | — | 655 | — | — | — | 8 |
| 34 | 353440097105501 | 185 | 19771115 | 6.6 | 750 | — | 280 | — | — | — | 10 |
| 35 | 353435097145101 | 171 | 19771119 | 6.9 | 510 | — | 153 | — | — | — | 20 |
| 36 | 353407097113301 | 140 | 19541022 | 7.5 | 612 | 326 | 310 | 10 | 0 | 0.11 | 4.9 |
| 37 | 353351096574601 | 162 | 19880615 | 7.2 | 1,270 | 776[c] | 264 | 37 | 0.3 | 0.88 | 35 |
| 38 | 353335097145501 | 31 | 19720619 | 8.1 | 660 | 464 | 350 | 17 | — | 0.09 | 31 |
| 39 | 353332097142901 | 45 | 19720619 | 8.2 | 675 | 424 | 350 | 14 | — | 0.07 | 54 |
| 40 | 353328097144101 | 60 | 19890616 | 7.2 | 769 | 477[c] | 342 | 17 | 0.8 | <0.1 | 37 |
| 40 | 353328097144101 | 60 | 19820609 | 7.1 | 736 | — | — | — | — | — | — |
| 40 | 353328097144101 | 60 | 19900606 | 7.3 | 779 | — | — | — | — | — | — |
| 41 | 353304097113201 | 45 | 19771115 | 6.9 | 390 | — | 71.8 | — | — | — | 16 |
| 42 | 353304097083201 | 49 | 19771114 | 7.0 | 690 | — | 294 | — | — | — | 7 |
| 43 | 353304097022001 | 128 | 19771126 | 7.7 | 940 | — | 226 | — | — | — | <5 |
| 44 | 353302097145201 | 95 | 19720613 | 7.8 | 733 | 430 | 280 | 16 | — | 0.02 | 35 |
| 44 | 353302097145201 | 95 | 19820609 | 7.0 | 720 | — | — | — | — | — | — |
| 45 | 353301097144801 | 44 | 19720616 | 8.2 | 620 | 438 | 360 | 21 | — | 0.18 | 74 |
| 46 | 353257096585501 | 170 | 19780104 | 7.9 | 990 | — | 67.1 | — | — | — | 22 |
| 47 | 353254096560501 | 93 | 19780104 | 7.6 | 790 | — | 109 | — | — | — | 24 |
| 48 | 353251097144801 | 31 | 19771119 | 6.7 | 960 | — | 306 | — | — | — | 53 |
| 49 | 353250097134801 | 44 | 19720616 | 8.1 | 609 | 367 | 320 | 8 | — | 0.07 | 22 |
| 50 | 353250097051201 | 66.9 | 19771126 | 7.0 | 930 | — | 122 | — | — | — | 19 |
| 51 | 353249097145101 | 80 | 19850610 | 7.2[a] | — | 588[b] | 400 | 47 | 0.7[d] | 0.5[de] | 82 |
| 52 | 353238097142001 | 50 | 19720614 | 8.0 | 3,950 | 2,320 | — | 1,100 | — | 0.14 | 72 |
| 53 | 353237097142801 | 50 | 19720615 | 7.9 | 760 | 524 | — | 17 | — | 0.04 | 63 |
| 54 | 353236097141901 | 52 | 19720613 | 8.0 | 757 | 454 | 380 | 5.6 | — | 0.11 | 46 |
| 54 | 353236097141901 | 52 | 19720825 | 8.2 | 809 | 509 | 402 | 8 | — | 0.02 | 45 |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Water properties | | Major ions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | pH (standard units) | Specific conductance (µS/cm at 25 degrees Celsius) | Dissolved solids (mg/L) | Hardness (mg/L as $CaCO_3$) | Chloride (mg/L) | Fluoride (mg/L) | Nitrate nitrogen (mg/L as N) | Sulfate (mg/L) |
| 55 | 353236097072801 | 140 | 19880524 | 6.5 | 349 | 199[c] | 130 | 50 | 0.3 | 0.53 | 25 |
| 56 | 353214097141601 | 50 | 19720615 | 8.0 | 810 | 522 | | 7.7 | — | 0.23 | 52 |
| 57 | 353212097142301 | 130 | 20081202 | 7.2 | 717 | 424 | 197 | 41.1 | 0.46 | <0.016 | 42.9 |
| 58 | 353208097142901 | 120 | 19720827 | 8.2 | 1,330 | 780 | 282 | 220 | — | 0.09 | 76 |
| 59 | 353207096583301 | 54 | 19890725 | 8.6 | 6,010 | 4,540[c] | 217 | 220 | 3 | <0.1 | 2,600 |
| 60 | 353119097094101 | 133 | 19890615 | 7.4 | 490 | 290[c] | 229 | 7 | 0.2 | 1.1 | 5 |
| 61 | 353052097110701 | 412 | 19741218 | 7.8 | 836 | 473 | 258 | 80 | — | — | 50 |
| 62 | 353050097134401 | 87 | 19651012 | 8.2 | 2,450 | 1,380 | 550 | 655 | — | 0.04 | 29 |
| 63 | 353040097000901 | 135 | 19870915 | 6.5 | 438 | 271[c] | 144 | 29 | 0.3 | 1.3 | 29 |
| 63 | 353040097000901 | 135 | 19870915 | — | — | — | — | — | — | — | — |
| 64 | 353032097110701 | 400 | 20050304 | — | — | 980 | 292 | 150 | 0.2 | <0.10[e] | 100 |
| 64 | 353032097110701 | 400 | 20040616 | — | — | 630 | 303 | 150 | 0.2 | 0.05[e] | 90 |
| 64 | 353032097110701 | 400 | 20050103 | — | — | 690 | 311 | 150 | 0.2 | 0.06[e] | 100 |
| 64 | 353032097110701 | 400 | 20050314 | — | — | 1,140 | 386 | 170 | 0.1 | <0.10[e] | 130 |
| 65 | 353030096554901 | 200 | 19780104 | 7.8 | 1,270 | — | 163 | — | — | — | 15 |
| 66 | 353027097143501 | 73 | 19771119 | 7.0 | 1,470 | — | 465 | — | — | — | 50 |
| 67 | 353027097114101 | 141 | 19771119 | 7.5 | 720 | — | 232 | — | — | — | 30 |
| 68 | 353027097052001 | 149 | 19771126 | 7.8 | 860 | — | 97.1 | — | — | — | 6 |
| 69 | 353023097082301 | 71 | 19771119 | 7.1 | 540 | — | 175 | — | — | — | 8 |
| 70 | 353023097015401 | 15 | 19771126 | 7.1 | 1,160 | — | 422 | — | — | — | 36 |
| 71 | 353021096595601 | — | 19830616 | 7.2[a] | — | 409[b] | 200 | 33 | 0.4[d] | 0.4[de] | <20 |
| 72 | 353020097115001 | 46 | 19690408 | 7.7 | 916 | 592 | 410 | 20 | — | 0.02 | 72 |
| 73 | 353019096585001 | 16 | 19780104 | 6.5 | 750 | — | 290 | — | — | — | 6 |

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Water properties |  | Major ions |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  | pH (standard units) | Specific conductance (µS/cm at 25 degrees Celsius) | Dissolved solids (mg/L) | Hardness (mg/L as $CaCO_3$) | Chloride (mg/L) | Fluoride (mg/L) | Nitrate nitrogen (mg/L as N) | Sulfate (mg/L) |
| 74 | 353007097114301 | 80 | 19640706 | 8.0 | 793 | 488 | 320 | 34 | — | — | 63 |
| 75 | 352957097134401 | 30 | 19651012 | 8.4 | 1,170 | 626 | 160 | 240 | — | 0.02 | 80 |
| 76 | 352936097083901 | 155 | 19830608 | 7.1[a] | — | 266[b] | 270 | 16 | 0.2d | <0.5[de] | <20 |
| 77 | 352854097072301 | 103 | 19890619 | 6.6 | 459 | 277[c] | 170 | 35 | 0.2 | 0.84 | 14 |
| 78 | 352851097093801 | 400 | 19880418 | 7.9 | 466 | 264[c] | 127 | 20 | 0.2 | 0.48[e] | 15 |
| 78 | 352851097093801 | 400 | 19900530 | 8.4 | 530 | — | — | — | — | — | — |
| 79 | 352844097034401 | 120 | 20110926 | 5.9 | 132 | 90[c] | 38.3 | 7.32 | 0.14 | — | 9.53 |
| 80 | 352839097053401 | 160 | 20110323 | 7.4 | 443 | — | — | — | — | — | — |
| 81 | 352820097005001 | 86 | 19710316 | 8.0 | 1,410 | 840 | 110 | 100 | — | 0.02 | 38 |
| 82 | 352816096554701 | 96 | 19880714 | 8.9 | 854 | 523[c] | 11.5 | 31 | 0.3 | 0.56 | 15 |
| 83 | 352813097033401 | 60 | 20110314 | 5.6 | 639 | — | — | — | — | — | — |
| 84 | 352813097032401 | 61 | 20110823 | 5.7 | 277 | 157[c] | 65.5 | 49.1 | <0.04 | — | 25.1 |
| 85 | 352812097052101 | 143 | 20110822 | 7.4 | 346 | 194[c] | 143 | 6.89 | 0.16 | — | 2.71 |
| 86 | 352810097092901 | 49 | 19890621 | 7.3 | 469 | 274[c] | 188 | 22 | 0.1 | 3.2 | 11 |
| 87 | 352807096554501 | 42 | 19771127 | 7.0 | 100 | — | 345 | — | — | — | 61 |
| 88 | 352805097041301 | 95 | 20110803 | 6.0 | 230 | — | — | — | — | — | — |
| 89 | 352800097032201 | 120 | 20110314 | 6.5 | 252 | — | — | — | — | — | — |
| 90 | 352756097035501 | 125 | 20110323 | 5.2 | 125 | — | — | — | — | — | — |
| 91 | 352753097040301 | 110 | 20110314 | 5.3 | 213 | — | — | — | — | — | — |
| 92 | 352751097050801 | 103 | 19771126 | 7.5 | 900 | — | 146 | — | — | — | <5 |
| 92 | 352751097050801 | 103 | 20110314 | 7.2 | 366 | — | — | — | — | — | — |
| 93 | 352751097045401 | 255 | 20110815 | 8.2 | 1,020 | — | — | — | — | — | — |
| 94 | 352751097041401 | 132 | 20110314 | 6.2 | 152 | — | — | — | — | — | — |
| 95 | 352751097034501 | 100 | 20110323 | 5.2 | 247 | — | — | — | — | — | — |
| 96 | 352748097032601 | — | 20110314 | 7.5 | 316 | — | — | — | — | — | — |
| 97 | 352747097051401 | 180 | 20110913 | 6.6 | 285 | 161[c] | 87 | 8.73 | 0.16 | — | 6.11 |
| 98 | 352745097041501 | — | 20110314 | 6.2 | 224 | — | — | — | — | — | — |
| 99 | 352743097044101 | 110 | 20110318 | 6.0 | 218 | — | — | — | — | — | — |
| 100 | 352743097021102 | 43 | 19771126 | 8.0 | 1,800 | — | 26.6 | — | — | — | 15 |
| 101 | 352734097020001 | 222 | 20110314 | 6.6 | 275 | — | — | — | — | — | — |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| | | | | Water properties | | | Major ions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | pH (standard units) | Specific conductance (µS/cm at 25 degrees Celsius) | Dissolved solids (mg/L) | Hardness (mg/L as $CaCO_3$) | Chloride (mg/L) | Fluoride (mg/L) | Nitrate nitrogen (mg/L as N) | Sulfate (mg/L) |
| 102 | 352733097042101 | 110 | 20110318 | 7.5 | 327 | — | — | — | — | — | — |
| 103 | 352732097041501 | 102 | 20111012 | 5.9 | 184 | 110[c] | 64.8 | 9.63 | 0.27 | — | 11.1 |
| 104 | 352728097035001 | 110 | 20110318 | 5.6 | 143 | — | | — | — | — | — |
| 105 | 352727096585501 | 91 | 19780104 | 7.5 | 560 | — | 170 | — | | — | 29 |
| 106 | 352726097041401 | — | 20111005 | 6.0 | 223 | — | — | — | — | — | — |
| 107 | 352726097035001 | — | 20110318 | 5.7 | 153 | — | — | — | — | — | — |
| 108 | 352726097031601 | 125 | 20111012 | 6.5 | 373 | 198[c] | 119 | 23.8 | 0.28 | — | 23.8 |
| 109 | 352717097043801 | 140 | 20111004 | 8.3 | 522 | 315[c] | 49.7 | 26 | 0.7 | — | 21.8 |
| 110 | 352714097034101 | 135 | 20110822 | 8.5 | 690 | 401[c] | 12.2 | 30.9 | 1 | — | 40.5 |
| 111 | 352712097032101 | 125 | 20110314 | 6.2 | 306 | — | — | — | — | — | — |
| 112 | 352710097034601 | 220 | 20081203 | 8.2 | 443 | 251 | 79.6 | 4.67 | 0.24 | 0.172[e] | 10.8 |
| 113 | 352704097031401 | 150 | 20110314 | 6.2 | 261 | — | — | — | — | — | — |
| 114 | 352701097031901 | — | 20110317 | 6.0 | 424 | — | — | — | — | — | — |
| 115 | 352700097032201 | — | 20110317 | 7.4 | 500 | — | — | — | — | — | — |
| 116 | 352657097054401 | 80 | 20110318 | 7.5 | 506 | — | — | — | — | — | — |
| 117 | 352657097042401 | 80 | 20110803 | 6.8 | 563 | — | — | — | — | — | — |
| 118 | 352656097031601 | 320 | 20110928 | 8.4 | 687 | 409[c] | 19.9 | 27.1 | 0.85 | — | 36.7 |
| 119 | 352655097043201 | 82 | 20110830 | 8.7 | 870 | 501[c] | 8.37 | 76.5 | 1.23 | — | 51.5 |
| 120 | 352654097022301 | 160 | 20110830 | 8.0 | 443 | 251[c] | 93.5 | 16.1 | 0.36 | — | 24.1 |
| 121 | 352652097050501 | 86 | 20110804 | 6.9 | 810 | — | — | — | — | — | — |
| 122 | 352651097023201 | 120 | 20110323 | 5.6 | 181 | — | — | — | — | — | — |
| 123 | 352642097034801 | 108 | 20110912 | 8.2 | 632 | 367[c] | 23.2 | 29.7 | 0.82 | — | 33.1 |
| 123 | 352642097034801 | 108 | 20110912 | 8.2 | 632 | — | — | — | — | — | — |
| 123 | 352642097034801 | 108 | 19820616 | 8.2 | 571 | — | — | — | — | — | — |
| 124 | 352635097025201 | 150 | 20110323 | 5.7 | 251 | — | — | — | — | — | — |

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Water properties | | Major ions | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | pH (standard units) | Specific conductance (µS/cm at 25 degrees Celsius) | Dissolved solids (mg/L) | Hardness (mg/L as $CaCO_3$) | Chloride (mg/L) | Fluoride (mg/L) | Nitrate nitrogen (mg/L as N) | Sulfate (mg/L) |
| 125 | 352632097024401 | 155 | 20110831 | 5.5 | 156 | 89[c] | 46.1 | 15.8 | 0.04 | — | 18.5 |
| 126 | 352625097022401 | 172 | 20110926 | 5.6 | 146 | 81[c] | 46.6 | 11.7 | 0.04 | — | 17.6 |
| 127 | 352622097020701 | — | 20110314 | 5.4 | 239 | — | — | — | — | — | — |
| 128 | 352620097024201 | 150 | 20110323 | 7.6 | 513 | — | — | — | — | — | — |
| 129 | 352617097031801 | 180 | 20110314 | 7.7 | 504 | — | — | — | — | — | — |
| 130 | 352612097020701 | 114 | 20110927 | 7.8 | 792 | — | — | — | — | — | — |
| 131 | 352609097033801 | 180 | 20110830 | 8.0 | 559 | 330[c] | 45.7 | 12.6 | 0.49 | — | 19.1 |
| 132 | 352603097024901 | — | 20110823 | 8.4 | 673 | 400[c] | 14.1 | 16.1 | 0.57 | — | 24.3 |
| 133 | 352603097022901 | 125 | 20110323 | 5.7 | 336 | — | — | — | — | — | — |
| 134 | 352557097024101 | 180 | 20111005 | 8.5 | 809 | 485[c] | 15.5 | 41.4 | 0.72 | — | 44.4 |
| 135 | 352553097021101 | 167 | 20110906 | 8.4 | 783 | 464 | 22 | 28.8 | 0.89 | — | 66.2 |
| 136 | 352543097021601 | 160 | 20110323 | 8.1 | 809 | — | — | — | — | — | — |
| 137 | 352543096585601 | 140 | 19880615 | 7.4 | 537 | 318[c] | 227 | 35 | 0.1 | 4.6 | 12 |
| 138 | 352536097021101 | — | 20110927 | 7.8 | 709 | — | — | — | — | — | — |
| 139 | 352533097015901 | 240 | 20110323 | 7.7 | 626 | — | — | — | — | — | — |
| 140 | 352529097021801 | 103 | 20110815 | 8.6 | 733 | — | — | — | — | — | — |
| 141 | 352520096591501 | 98 | 19771127 | 7.7 | 543 | — | 51.1 | — | | — | 7 |
| 142 | 352510097011201 | 142 | 20110831 | 7.3 | 693 | 389[c] | 131 | 40.6 | 0.47 | — | 33.7 |
| 143 | 352508096561401 | — | 19830615 | 8.6[a] | — | 746[b] | 49 | 66 | 1.6[d] | 1.6[de] | 123 |
| 144 | 352501096554901 | 66 | 19771127 | 8.4 | 1,220 | — | 4.91 | — | — | — | 72 |
| 145 | 352458097020801 | — | 20110815 | 6.9 | 744 | — | — | — | — | — | — |
| 146 | 352457097020601 | 17 | 19771126 | 7.1 | 1,120 | — | 442 | — | — | — | 76 |
| 147 | 352422097012101 | 90 | 20110815 | 7.8 | 402 | — | — | — | — | — | — |
| 148 | 352417097015301 | 110 | 20110823 | 8.3 | 415 | 248[c] | 24.8 | 17.9 | 0.25 | — | 13.3 |
| 149 | 352415097013901 | — | 20110927 | 7.9 | 407 | — | — | — | — | — | — |
| 150 | 352343096555801 | — | 19480101 | — | 8,920 | 8,310 | 1,310 | 100 | — | 0 | 5,410 |
| 151 | 352325096591301 | 20 | 19780104 | 6.9 | 180 | — | — | — | — | — | — |
| 152 | 352302097010601 | 33 | 19771126 | 8.3 | 550 | — | 82.9 | — | — | — | 10 |
| 152 | 352302097010601 | 33 | 19820617 | 6.2 | 204 | — | — | — | — | — | — |
| 153 | 351955096582501 | 54 | 19890621 | 7.1 | 1,340 | 937[c] | 669 | 26 | 0.9 | 0.87 | 290 |
| 154 | 351951096583401 | 8 | 19780103 | 7.2 | 1,110 | — | 521 | — | — | — | 150 |
| 155 | 351938096562001 | 121 | 19770103 | 7.4 | 390 | — | 129 | — | — | — | 56 |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Trace elements | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Aluminum (µg/L) | Arsenic (µg/L) | Barium (µg/L) | Beryllium (µg/L) | Cadmium (µg/L) | Chromium (µg/L) | Copper (µg/L) | Iron (µg/L) | Lead (µg/L) | Manganese (µg/L) | Mercury (µg/L) | Selenium (µg/L) | Zinc (µg/L) | Uranium (µg/L) |
| 1 | 354144097093201 | 7 | 19771126 | 15 | <0.5 | 124 | <1 | — | <4 | M | <10 | — | M | — | M | 120 | 0.2 |
| 2 | 354048097052601 | 132 | 19771126 | 18 | <0.5 | 10 | <1 | — | <4 | M | <10 | — | <2 | — | M | 10 | 71.1 |
| 3 | 354048096584601 | 159 | 19780106 | 10 | <0.5 | 137 | <1 | — | <4 | <2 | <10 | — | M | — | <0.199 | 70 | 8.8 |
| 4 | 354043097020101 | 7 | 19771127 | <10 | <0.5 | 90 | <1 | — | <4 | <2 | <10 | — | <2 | — | M | 230 | 1.9 |
| 5 | 353959097084701 | 130 | 19771126 | <10 | <0.5 | 108 | <1 | — | <4 | M | <10 | — | <2 | — | M | 80 | <0.2 |
| 6 | 353948097112501 | 200 | 19851007 | — | — | — | — | — | <10[d] | — | — | — | — | — | <5[d] | — | — |
| 7 | 353947097113901 | 172 | 19541022 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 8 | 353947097111501 | 178 | 19870825 | <10 | 1 | 150 | <0.5 | <1 | 20 | <10 | 5 | <10 | <1 | — | 12 | 8 | 19.9 |
| 9 | 353938097031101 | 91 | 19880713 | 10 | 1 | 30 | <0.5 | <1 | <5 | <10 | 16 | <10 | 2 | 0.2 | <1 | 9 | 68.6 |
| 9 | 353938097031101 | 91 | 19900904 | — | — | — | — | — | — | — | — | — | — | — | — | — | 98.2 |
| 10 | 353931097103301 | 92 | 19880708 | <10 | <1 | 130 | <0.5 | <1 | <5 | 10 | <3 | <10 | <1 | <0.1 | <1 | <3 | 0.5 |
| 11 | 353925097113101 | 178 | 20050204 | — | <10 | 260 | — | <5 | 10 | <5 | <20 | — | <5 | — | <10 | M | — |
| 11 | 353925097113101 | 178 | 20050318 | — | 15 | 270 | — | <5 | 10 | <5 | <20 | — | <5 | — | 20 | M | — |
| 11 | 353925097113101 | 178 | 20050425 | — | 18 | 270 | — | <5 | 10 | <5 | <20 | — | <5 | — | 10 | <5 | — |
| 11 | 353925097113101 | 178 | 20050203 | — | <10 | 270 | — | <5 | 10 | <5 | <20 | — | <5 | — | 10 | <5 | — |
| 11 | 353925097113101 | 178 | 19851007 | — | — | — | — | — | <10[d] | — | — | — | — | — | <5[d] | — | — |
| 12 | 353909097100101 | 101 | 19880621 | 10 | 1 | 51 | <0.5 | <1 | <5 | <10 | <3 | <10 | <1 | <0.1 | 1 | 7 | <0.2 |
| 12 | 353909097100101 | 101 | 20040601 | — | <2 | 110 | — | <2 | <10 | <10 | 50 | — | <10 | — | <10 | <10 | — |
| 12 | 353909097100101 | 101 | 20040226 | — | <2 | 110 | — | <2 | <10 | <10 | <10 | — | <10 | — | <10 | <10 | — |
| 12 | 353909097100101 | 101 | 20030819 | — | <2 | 110 | — | <2 | <10 | <10 | <10 | — | <10 | — | <10 | <10 | — |
| 12 | 353909097100101 | 101 | 20031104 | — | <2 | 100 | — | <2 | <10 | <10 | <10 | — | <10 | — | <10 | <10 | — |
| 12 | 353909097100101 | 101 | 20030617 | — | <2 | 120 | — | <2 | <10 | <10 | <10 | — | <10 | — | <10 | <10 | — |
| 12 | 353909097100101 | 101 | 19881221 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 13 | 353835097020201 | 125 | 19771127 | <10 | 0.7 | 138 | <1 | — | <4 | <2 | <10 | — | <2 | — | M | 20 | 16.8 |

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Trace elements: Aluminum (µg/L) | Arsenic (µg/L) | Barium (µg/L) | Beryllium (µg/L) | Cadmium (µg/L) | Chromium (µg/L) | Copper (µg/L) | Iron (µg/L) | Lead (µg/L) | Manganese (µg/L) | Mercury (µg/L) | Selenium (µg/L) | Zinc (µg/L) | Uranium (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | 353816096585901 | 20 | 19780107 | 12 | <0.5 | 497 | <1 | — | M | M | <10 | — | M | — | <0.199 | 70 | 30.4 |
| 15 | 353815097045402 | 8 | 19771127 | 10 | <0.5 | 286 | <1 | — | <4 | M | <10 | — | <2 | — | M | 40 | 10.8 |
| 16 | 353813097080101 | 15 | 19771126 | <10 | <0.5 | 100 | <1 | — | <4 | M | <10 | — | <2 | — | <0.199 | 130 | <0.2 |
| 17 | 353812097140201 | 17 | 19771126 | <10 | <0.5 | 158 | <1 | — | <4 | M | <10 | — | <2 | — | <0.199 | 40 | 0.6 |
| 18 | 353805096553801 | 87 | 19780107 | <10 | <0.5 | 95 | <1 | — | M | M | <10 | — | M | — | <0.199 | 60 | 15.8 |
| 19 | 353800097040501 | 234 | 19710722 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 20 | 353746097114301 | 68 | 19771123 | <10 | <0.5 | 274 | <1 | — | <4 | M | <10 | — | M | — | M | 770 | 14.1 |
| 21 | 353719096594601 | — | 19830616 | — | <10[d] | <200[d] | — | <2[d] | <10[d] | 30[d] | 540[d] | <20[d] | 620[d] | — | 6[d] | 80[d] | — |
| 22 | 353655097114401 | — | 19850604 | — | — | — | — | — | — | — | <100[d] | — | — | — | — | — | — |
| 22 | 353655097114401 | — | 19830608 | — | <10[d] | 200[d] | — | <2[d] | <10[d] | 20[d] | <100[d] | <20[d] | <20[d] | — | <5[d] | 90[d] | — |
| 23 | 353635097081501 | 229 | 19700428 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 24 | 353634097120701 | 160 | 19860818 | — | <10[d] | 300[d] |  | <5[d] | <10[d] | <10[d] | 880[d] | <45[d] | <10[d] | — | 65[d] | <5[d] | — |
| 25 | 353631097093201 | 58 | 19771114 | <10 | <0.5 | 149 | <1 | — | <4 | 20 | <10 | — | <2 | — | <0.199[d] | 10 | 1.8 |
| 26 | 353624096565001 | 58 | 19700217 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 27 | 353539097050801 | 63 | 19771126 | <10 | <0.5 | 133 | <1 | — | <4 | M | <10 | — | M | — | M | 30 | <0.019 |
| 28 | 353539096554701 | 120 | 20040610 | — | <2 | 730 | — | <2 | <10 | <10 | <10 | — | <10 | — | <10 | 10 | — |
| 28 | 353539096554701 | 120 | 20031106 | — | <2 | 660 | — | <2 | <10 | <10 | <10 | — | <10 | — | <10 | <10 | — |
| 28 | 353539096554701 | 120 | 20040226 | — | <2 | 730 | — | <2 | <10 | <10 | <10 | — | <10 | — | <10 | <10 | — |
| 28 | 353539096554701 | 120 | 20030827 | — | <2 | 800 | — | <2 | <10 | <10 | <10 | — | <10 | — | <10 | 50 | — |
| 28 | 353539096554701 | 120 | 20030618 | — | <2 | 830 | — | <2 | <10 | <10 | <10 | — | <10 | — | <10 | <10 | — |
| 29 | 353539096554501 | 131 | 19880616 | <10 | <1 | 130 | <0.5 | <1 | <5 | <10 | 79 | <10 | 2 | <0.1 | 2 | 28 | 5 |
| 29 | 353539096554501 | 131 | 19900606 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 29 | 353539096554501 | 131 | 19881220 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 30 | 353539096554401 | 33 | 19780104 | <10 | <0.5 | 705 | <1 | — | <4 | 40 | <10 | — | M | — | M | 70 | 2.4 |
| 31 | 353537097124101 | 31 | 19670209 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 32 | 353536096585001 | 141 | 19780104 | <10 | <0.5 | 368 | <1 | — | <4 | <2 | <10 | — | <2 | — | M | 80 | 13.7 |
| 33 | 353522097020201 | 119 | 19771126 | <10 | <0.5 | 733 | <1 | — | <4 | <2 | <10 | — | 60 | — | M | 50 | <0.019 |
| 34 | 353440097105501 | 185 | 19771115 | <10 | <0.5 | 196 | <1 | — | <4 | <2 | <10 | — | <2 | — | <0.199 | M | 1.3 |
| 35 | 353435097145101 | 171 | 19771119 | <10 | <0.5 | 128 | <1 | — | <4 | M | <10 | — | <2 | — | M | 10 | 1.1 |
| 36 | 353407097113301 | 140 | 19541022 | — | — | — | — | — | — | — | 0 | — | — | — | — | — | — |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Trace elements | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Aluminum (µg/L) | Arsenic (µg/L) | Barium (µg/L) | Beryllium (µg/L) | Cadmium (µg/L) | Chromium (µg/L) | Copper (µg/L) | Iron (µg/L) | Lead (µg/L) | Manganese (µg/L) | Mercury (µg/L) | Selenium (µg/L) | Zinc (µg/L) | Uranium (µg/L) |
| 37 | 353351096574601 | 162 | 19880615 | 20 | 1 | 210 | <0.5 | <1 | <5 | <10 | <3 | <10 | 10 | <0.1 | 1 | 130 | 217 |
| 38 | 353335097145501 | 31 | 19720619 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 39 | 353332097142901 | 45 | 19720619 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 40 | 353328097144101 | 60 | 19890616 | <10 | 2 | 190 | <0.5 | <1 | <5 | <10 | 2,000 | <10 | 680 | <0.1 | <1 | 10 | 1.4 |
| 40 | 353328097144101 | 60 | 19820609 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 40 | 353328097144101 | 60 | 19900606 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 41 | 353304097113201 | 45 | 19771115 | <10 | <0.5 | 207 | <1 | — | <4 | M | <10 | — | M | — | <0.199 | 80 | <0.2 |
| 42 | 353304097083201 | 49 | 19771114 | <10 | <0.5 | 244 | <1 | — | M | <2 | <10 | — | <2 | — | <0.199 | 10 | 1.1 |
| 43 | 353304097022001 | 128 | 19771126 | <10 | <0.5 | 148 | <1 | — | <4 | <2 | <10 | — | <2 | — | <0.199 | 260 | 1.2 |
| 44 | 353302097145201 | 95 | 19720613 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 44 | 353302097145201 | 95 | 19820609 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 45 | 353301097144801 | 44 | 19720616 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 46 | 353257096585501 | 170 | 19780104 | 14 | 9.8 | 208 | <1 | — | <4 | M | <10 | — | <2 | — | M | 10 | 57 |
| 47 | 353254096560501 | 93 | 19780104 | <10 | 0.9 | 149 | <1 | — | <4 | <2 | <10 | — | <2 | — | M | 100 | 10.1 |
| 48 | 353251097144801 | 31 | 19771119 | <10 | 0.6 | 56 | <1 | — | <4 | <2 | <10 | — | <2 | — | <0.199 | <4 | 0.4 |
| 49 | 353250097134801 | 44 | 19720616 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 50 | 353250097051201 | 66.9 | 19771126 | <10 | <0.5 | 146 | <1 | — | <4 | 30 | <10 | — | 10 | — | <0.199 | 120 | <0.019 |
| 51 | 353249097145101 | 80 | 19850610 | | <10[d] | <200[d] | — | <2[d] | <10[d] | M[d] | 350[d] | <20[d] | 400[d] | — | <5[d] | 90[d] | — |
| 52 | 353238097142001 | 50 | 19720614 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 53 | 353237097142801 | 50 | 19720615 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 54 | 353236097141901 | 52 | 19720613 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 54 | 353236097141901 | 52 | 19720825 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 55 | 353236097072801 | 140 | 19880524 | <10 | <1 | 210 | <0.5 | <1 | <5 | <10 | <3 | <10 | <1 | <0.1 | <1 | <3 | <0.2 |

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Trace elements | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Aluminum (µg/L) | Arsenic (µg/L) | Barium (µg/L) | Beryllium (µg/L) | Cadmium (µg/L) | Chromium (µg/L) | Copper (µg/L) | Iron (µg/L) | Lead (µg/L) | Manganese (µg/L) | Mercury (µg/L) | Selenium (µg/L) | Zinc (µg/L) | Uranium (µg/L) |
| 56 | 353214097141601 | 50 | 19720615 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 57 | 353212097142301 | 130 | 20081202 | — | — | — | — | — | — | — | 130 | — | 158 | — | — | — | — |
| 58 | 353208097142901 | 120 | 19720827 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 59 | 353207096583301 | 54 | 19890725 | <10 | 1 | <5 | <2.5 | <5 | <25 | <50 | 27 | <50 | 19 | <0.1 | <1 | 22 | 8.9 |
| 60 | 353119097094101 | 133 | 19890615 | 10 | <1 | 230 | <0.5 | 1 | <5 | <10 | <3 | <10 | <1 | <0.1 | <1 | 3 | <0.2 |
| 61 | 353052097110701 | 412 | 19741218 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 62 | 353050097134401 | 87 | 19651012 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 63 | 353040097000901 | 135 | 19870915 | <10 | <1 | 44 | <0.5 | <1 | <5 | 10 | 6 | <10 | <1 | — | <1 | <3 | 0.9 |
| 63 | 353040097000901 | 135 | 19870915 | — | — | — | — | — | 1.6 | — | — | — | — | — | — | — | — |
| 64 | 353032097110701 | 400 | 20050304 | — | 19 | 40 | — | <5 | <5 | <5 | 1,780 | — | 520 | — | 20 | <5 | — |
| 64 | 353032097110701 | 400 | 20040616 | — | <10 | 50 | — | <5 | <5 | M | 1,930 | — | 150 | — | <10 | M | — |
| 64 | 353032097110701 | 400 | 20050103 | — | <10 | 40 | — | <5 | M | <5 | 60 | — | 40 | — | <10 | <5 | — |
| 64 | 353032097110701 | 400 | 20050314 | — | 16 | 50 | — | <5 | <5 | <5 | 1,020 | — | 140 | — | 10 | <5 | — |
| 65 | 353030096554901 | 200 | 19780104 | 11 | 1.3 | 25 | <1 | — | <4 | M | <10 | — | <2 | — | <0.199 | M | 17.7 |
| 66 | 353027097143501 | 73 | 19771119 | <10 | <0.5 | 130 | <1 | — | <4 | M | <10 | — | <2 | — | M | 10 | 4.6 |
| 67 | 353027097114101 | 141 | 19771119 | 10 | <0.5 | 75 | <1 | — | <4 | <2 | <10 | — | <2 | — | <0.199 | 30 | 5.1 |
| 68 | 353027097052001 | 149 | 19771126 | <10 | <0.5 | 119 | <1 | — | <4 | M | <10 | — | <2 | — | <0.199 | 40 | <0.019 |
| 69 | 353023097082301 | 71 | 19771119 | <10 | <0.5 | 128 | <1 | — | <4 | <2 | <10 | — | <2 | — | <0.199 | 250 | 0.4 |
| 70 | 353023097015401 | 15 | 19771126 | <10 | <0.5 | 66 | <1 | — | <4 | M | <10 | — | <2 | — | M | 20 | 2 |
| 71 | 353021096595601 | — | 19830616 | — | <10[d] | <200[d] | — | <2[d] | <10[d] | 150[d] | 110[d] | <20[d] | <20[d] | — | 6[d] | 20[d] | — |
| 72 | 353020097115001 | 46 | 19690408 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 73 | 353019096585001 | 16 | 19780104 | 19 | <0.5 | 137 | <1 | — | <4 | 30 | <10 | — | M | — | <0.199 | 110 | 14.9 |
| 74 | 353007097114301 | 80 | 19640706 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 75 | 352957097134401 | 30 | 19651012 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 76 | 352936097083901 | 155 | 19830608 | — | <10[d] | 300[d] | — | <2[d] | <10[d] | M[d] | <100[d] | <20[d] | <20[d] | — | <5[d] | M | — |
| 77 | 352854097072301 | 103 | 19890619 | 10 | <1 | 270 | <0.5 | <1 | <5 | <10 | <3 | <10 | <1 | <0.1 | <1 | <3 | 0.7 |
| 78 | 352851097093801 | 400 | 19880418 | <10 | <1 | 260 | <0.5 | <1 | <5 | <10 | 3 | <10 | <1 | <0.1 | 3 | <3 | 10.2 |
| 78 | 352851097093801 | 400 | 19900530 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 79 | 352844097034401 | 120 | 20110926 | — | 0.15 | 60.1 | 0.041 | <0.016 | 0.52 | 0.74 | <3.2 | 0.389 | <0.13 | — | 1.1 | 48.5 | 0.022 |
| 80 | 352839097053401 | 160 | 20110323 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 81 | 352820097005001 | 86 | 19710316 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 82 | 352816096554701 | 96 | 19880714 | <10 | 1 | 120 | <0.5 | <1 | <5 | <10 | 5 | <10 | <1 | <0.1 | <1 | 7 | 8.7 |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Trace elements | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Aluminum (µg/L) | Arsenic (µg/L) | Barium (µg/L) | Beryllium (µg/L) | Cadmium (µg/L) | Chromium (µg/L) | Copper (µg/L) | Iron (µg/L) | Lead (µg/L) | Manganese (µg/L) | Mercury (µg/L) | Selenium (µg/L) | Zinc (µg/L) | Uranium (µg/L) |
| 83 | 352813097033401 | 60 | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 84 | 352813097032401 | 61 | 20110823 | — | 0.16 | 83.4 | 0.249 | <0.016 | 0.61 | 0.87 | 6.3 | 0.058 | 5.32 | — | 0.15 | 71.8 | 0.026 |
| 85 | 352812097052101 | 143 | 20110822 | — | 0.62 | 159 | <0.006 | <0.016 | 2.7 | <0.5 | <3.2 | 0.03 | <0.13 | — | 0.23 | <1.4 | 0.23 |
| 86 | 352810097092901 | 49 | 19890621 | <10 | <1 | 290 | <0.5 | <1 | <5 | 20 | 3 | <10 | <1 | <0.1 | <1 | 4 | 0.7 |
| 87 | 352807096554501 | 42 | 19771127 | <10 | 1.2 | 103 | <1 | — | <4 | <2 | <10 | — | <2 | — | M | 20 | 6.1 |
| 88 | 352805097041301 | 95 | 20110803 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 89 | 352800097032201 | 120 | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 90 | 352756097035501 | 125 | 20110323 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 91 | 352753097040301 | 110 | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 92 | 352751097050801 | 103 | 19771126 | <10 | <0.5 | 81 | <1 | — | <4 | M | <10 | — | <2 | — | M | 50 | <0.019 |
| 92 | 352751097050801 | 103 | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 93 | 352751097045401 | 255 | 20110815 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 94 | 352751097041401 | 132 | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 95 | 352751097034501 | 100 | 20110323 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 96 | 352748097032601 | — | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 97 | 352747097051401 | 180 | 20110913 | — | 0.63 | 88.4 | 0.006 | <0.016 | 0.9 | <0.5 | <3.2 | 0.026 | 0.68 | — | 0.36 | <1.4 | 0.145 |
| 98 | 352745097041501 | — | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 99 | 352743097044101 | 110 | 20110318 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 100 | 352743097021102 | 43 | 19771126 | <10 | 2.3 | 57 | <1 | — | 30 | <2 | <10 | — | <2 | — | M | 10 | 35.8 |
| 101 | 352734097020001 | 222 | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 102 | 352733097042101 | 110 | 20110318 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 103 | 352732097041501 | 102 | 20111012 | — | 0.22 | 75.3 | 0.037 | <0.016 | 1.2 | <0.8 | 3.4 | 0.03 | 0.36 | — | 0.3 | <1.4 | 0.207 |
| 104 | 352728097035001 | 110 | 20110318 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 105 | 352727096585501 | 91 | 19780104 | <10 | <0.5 | 76 | <1 | — | <4 | M | <10 | — | M | — | M | 190 | 10.1 |
| 106 | 352726097041401 | — | 20111005 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Trace elements | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Aluminum (µg/L) | Arsenic (µg/L) | Barium (µg/L) | Beryllium (µg/L) | Cadmium (µg/L) | Chromium (µg/L) | Copper (µg/L) | Iron (µg/L) | Lead (µg/L) | Manganese (µg/L) | Mercury (µg/L) | Selenium (µg/L) | Zinc (µg/L) | Uranium (µg/L) |
| 107 | 352726097035001 | — | 20110318 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 108 | 352726097031601 | 125 | 20111012 | — | 0.23 | 95 | 0.019 | <0.016 | 1 | <0.8 | <3.2 | 0.058 | <0.13 | — | 1.2 | <1.4 | 0.468 |
| 109 | 352717097043801 | 140 | 20111004 | — | 6.6 | 108 | 0.009 | <0.016 | 3.2 | <0.8 | <3.2 | <0.025 | <0.13 | — | 0.76 | 3.4 | 383 |
| 110 | 352714097034101 | 135 | 20110822 | — | 6.8 | 56.9 | 0.024 | <0.016 | <0.06 | <0.5 | <3.2 | 0.05 | 1.46 | — | <0.03 | <1.4 | 77.9 |
| 111 | 352712097032101 | 125 | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 112 | 352710097034601 | 220 | 20081203 | — | 3.6 | 239 | <0.02 | <0.02 | 0.24 | 2.3 | <4 | <0.06 | 0.68 | — | 5.1 | <2 | 1,500 |
| 113 | 352704097031401 | 150 | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 114 | 352701097031901 | — | 20110317 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 115 | 352700097032201 | — | 20110317 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 116 | 352657097054401 | 80 | 20110318 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 117 | 352657097042401 | 80 | 20110803 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 118 | 352656097031601 | 320 | 20110928 | — | 4.8 | 51.3 | 0.021 | <0.016 | 4.5 | <0.5 | <3.2 | <0.015 | <0.13 | — | 147 | <1.4 | 55.1 |
| 119 | 352655097043201 | 82 | 20110830 | — | 0.15 | 44.6 | 0.035 | <0.016 | <0.06 | <0.5 | <3.2 | 0.161 | 3.1 | — | <0.03 | <1.4 | 1.46 |
| 120 | 352654097022301 | 160 | 20110830 | — | 24.7 | 97.2 | 0.009 | <0.016 | 1.3 | 1.6 | 3.4 | 0.075 | <0.13 | — | 36.8 | 3.6 | 306 |
| 121 | 352652097050501 | 86 | 20110804 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 122 | 352651097023201 | 120 | 20110323 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 123 | 352642097034801 | 108 | 20110912 | — | 0.54 | 68.1 | 0.037 | <0.016 | <0.06 | <0.5 | <3.2 | <0.015 | 4.27 | — | <0.03 | <1.4 | 1.09 |
| 123 | 352642097034801 | 108 | 20110912 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 123 | 352642097034801 | 108 | 19820616 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 124 | 352635097025201 | 150 | 20110323 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 125 | 352632097024401 | 155 | 20110831 | — | 0.07 | 61.5 | 0.179 | <0.016 | 0.26 | 21.6 | 3.2 | 0.136 | 0.44 | — | 0.2 | 2.3 | 0.116 |
| 126 | 352625097022401 | 172 | 20110926 | — | 0.1 | 63.7 | 0.076 | <0.016 | 0.12 | 0.62 | 6.6 | 0.064 | 0.59 | — | 0.22 | 1.7 | 0.084 |
| 127 | 352622097020701 | — | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 128 | 352620097024201 | 150 | 20110323 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 129 | 352617097031801 | 180 | 20110314 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 130 | 352612097020701 | 114 | 20110927 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 131 | 352609097033801 | 180 | 20110830 | — | 0.33 | 115 | 0.009 | <0.016 | 24.4 | 0.8 | 4.5 | <0.015 | <0.13 | — | 24 | 1.5 | 26.3 |
| 132 | 352603097024901 | — | 20110823 | — | 0.57 | 39.7 | 0.008 | <0.016 | 31.4 | <0.5 | <3.2 | 0.181 | <0.13 | — | 12.8 | <1.4 | 19.7 |
| 133 | 352603097022901 | 125 | 20110323 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 134 | 352557097024101 | 180 | 20111005 | — | 0.72 | 43.5 | 0.015 | <0.016 | 15.6 | <0.8 | <3.2 | <0.025 | <0.13 | — | 29.3 | <1.4 | 28.2 |
| 135 | 352553097021101 | 167 | 20110906 | — | 3.1 | 39 | 0.02 | <0.02 | 4.7 | <0.5 | <3 | 0.01 | <0.03 | — | 23.1 | <1.4 | 48.3 |
| 136 | 352543097021601 | 160 | 20110323 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Trace elements | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Aluminum (µg/L) | Arsenic (µg/L) | Barium (µg/L) | Beryllium (µg/L) | Cadmium (µg/L) | Chromium (µg/L) | Copper (µg/L) | Iron (µg/L) | Lead (µg/L) | Manganese (µg/L) | Mercury (µg/L) | Selenium (µg/L) | Zinc (µg/L) | Uranium (µg/L) |
| 137 | 352543096585601 | 140 | 19880615 | <10 | <1 | 55 | <0.5 | <1 | <5 | <10 | 30 | <10 | 7 | <0.1 | <1 | 44 | 0.3 |
| 138 | 352536097021101 | — | 20110927 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 139 | 352533097015901 | 240 | 20110323 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 140 | 352529097021801 | 103 | 20110815 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 141 | 352520096591501 | 98 | 19771127 | <10 | 0.5 | 32 | <1 | — | M | <2 | <10 | — | <2 | — | M | 30 | 2.6 |
| 142 | 352510097011201 | 142 | 20110831 | — | 0.73 | 130 | <0.006 | <0.016 | 11.2 | <0.5 | <3.2 | 0.025 | <0.13 | — | 4.4 | <1.4 | 4.61 |
| 143 | 352508096561401 | — | 19830615 | — | <10[d] | <200[d] | — | <2[d] | <10[d] | M[d] | <100[d] | <20[d] | <20[d] | — | <5[d] | 10[d] | — |
| 144 | 352501096554901 | 66 | 19771127 | <10 | 0.8 | 27 | <1 | — | <4 | <2 | <10 | — | <2 | — | M | <4 | 7.9 |
| 145 | 352458097020801 | — | 20110815 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 146 | 352457097020601 | 17 | 19771126 | <10 | <0.5 | 136 | <1 | — | <4 | M | <10 | — | M | — | <0.199 | 200 | 11.7 |
| 147 | 352422097012101 | 90 | 20110815 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 148 | 352417097015301 | 110 | 20110823 | — | 0.9 | 110 | <0.006 | <0.016 | 8.6 | 0.51 | <3.2 | 0.028 | <0.13 | — | 2.8 | 1.6 | 1.62 |
| 149 | 352415097013901 | — | 20110927 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 150 | 352343096555801 | — | 19480101 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 151 | 352325096591301 | 20 | 19780104 | <10 | <0.5 | 53 | <1 | — | <4 | 10 | <10 | — | <2 | — | <0.199 | 50 | <0.2 |
| 152 | 352302097010601 | 33 | 19771126 | 10 | <0.5 | 112 | <1 | — | <4 | M | <10 | — | M | — | <0.199 | 150 | <0.019 |
| 152 | 352302097010601 | 33 | 19820617 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 153 | 351955096582501 | 54 | 19890621 | <10 | <1 | 57 | <0.5 | <1 | <5 | <10.0 | 2,800 | <10 | 1,200 | <0.1 | <1 | 38 | <0.2 |
| 154 | 351951096583401 | 8 | 19780103 | <10 | <0.5 | 56 | <1 | — | M | <2 | <10 | — | M | — | <0.199 | 20 | 2.7 |
| 155 | 351938096562001 | 121 | 19770103 | <10 | <0.5 | 114 | <1 | — | <4 | 20 | <10 | — | M | — | <0.199 | 680 | <0.2 |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Radionuclides | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gross alpha-particle activity (pCi/L) (72 h)[f] | Gross alpha-particle activity (pCi/L) (30 d)[g] | Gross beta-particle activity 72 (pCi/L) (72 h)[h] | Gross beta-particle activity (pCi/L) (30 d)[i] | Radium-226 (pCi/L) | Radium-228 (pCi/L) | Radon-222 (pCi/L) |
| 1 | 354144097093201 | 7 | 19771126 | — | — | — | — | — | — | — |
| 2 | 354048097052601 | 132 | 19771126 | — | — | — | — | — | — | — |
| 3 | 354048096584601 | 159 | 19780106 | — | — | — | — | — | — | — |
| 4 | 354043097020101 | 7 | 19771127 | — | — | — | — | — | — | — |
| 5 | 353959097084701 | 130 | 19771126 | — | — | — | — | — | — | — |
| 6 | 353948097112501 | 200 | 19851007 | — | — | — | — | — | — | — |
| 7 | 353947097113901 | 172 | 19541022 | — | — | — | — | — | — | — |
| 8 | 353947097111501 | 178 | 19870825 | — | — | — | — | 0.29 | 2 | E300 |
| 9 | 353938097031101 | 91 | 19880713 | — | — | 73 | — | — | — | 170 |
| 9 | 353938097031101 | 91 | 19900904 | — | — | 60.4 | — | — | — | 270 |
| 10 | 353931097103301 | 92 | 19880708 | — | — | 1 | — | — | — | 120 |
| 11 | 353925097113101 | 178 | 20050204 | — | — | — | — | — | — | — |
| 11 | 353925097113101 | 178 | 20050318 | — | — | — | — | — | — | — |
| 11 | 353925097113101 | 178 | 20050425 | — | — | — | — | — | — | — |
| 11 | 353925097113101 | 178 | 20050203 | — | — | — | — | — | — | — |
| 11 | 353925097113101 | 178 | 19851007 | — | — | — | — | — | — | — |
| 12 | 353909097100101 | 101 | 19880621 | — | — | 1 | — | — | — | 90 |
| 12 | 353909097100101 | 101 | 20040601 | — | — | — | — | — | — | — |
| 12 | 353909097100101 | 101 | 20040226 | — | — | — | — | — | — | — |
| 12 | 353909097100101 | 101 | 20030819 | — | — | — | — | — | — | — |
| 12 | 353909097100101 | 101 | 20031104 | — | — | — | — | — | — | — |
| 12 | 353909097100101 | 101 | 20030617 | — | — | — | — | — | — | — |
| 12 | 353909097100101 | 101 | 19881221 | — | — | — | — | — | — | — |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Radionuclides | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gross alpha-particle activity (pCi/L) (72 h)[f] | Gross alpha-particle activity (pCi/L) (30 d)[g] | Gross beta-particle activity 72 (pCi/L) (72 h)[h] | Gross beta-particle activity (pCi/L) (30 d)[i] | Radium-226 (pCi/L) | Radium-228 (pCi/L) | Radon-222 (pCi/L) |
| 13 | 353835097020201 | 125 | 19771127 | — | — | — | — | — | — | — |
| 14 | 353816096585901 | 20 | 19780107 | — | — | — | — | — | — | — |
| 15 | 353815097045402 | 8 | 19771127 | — | — | — | — | — | — | — |
| 16 | 353813097080101 | 15 | 19771126 | — | — | — | — | — | — | — |
| 17 | 353812097140201 | 17 | 19771126 | — | — | — | — | — | — | — |
| 18 | 353805096553801 | 87 | 19780107 | — | — | — | — | — | — | — |
| 19 | 353800097040501 | 234 | 19710722 | — | — | — | — | — | — | — |
| 20 | 353746097114301 | 68 | 19771123 | — | — | — | — | — | — | — |
| 21 | 353719096594601 | — | 19830616 | — | — | — | — | — | — | — |
| 22 | 353655097114401 | — | 19850604 | — | — | — | — | — | — | — |
| 22 | 353655097114401 | — | 19830608 | — | — | — | — | — | — | — |
| 23 | 353635097081501 | 229 | 19700428 | — | — | — | — | — | — | — |
| 24 | 353634097120701 | 160 | 19860818 | — | — | — | — | — | — | — |
| 25 | 353631097093201 | 58 | 19771114 | — | — | — | — | — | — | — |
| 26 | 353624096565001 | 58 | 19700217 | — | — | — | — | — | — | — |
| 27 | 353539097050801 | 63 | 19771126 | — | — | — | — | — | — | — |
| 28 | 353539096554701 | 120 | 20040610 | — | — | — | — | — | — | — |
| 28 | 353539096554701 | 120 | 20031106 | — | — | — | — | — | — | — |
| 28 | 353539096554701 | 120 | 20040226 | — | — | — | — | — | — | — |
| 28 | 353539096554701 | 120 | 20030827 | — | — | — | — | — | — | — |
| 28 | 353539096554701 | 120 | 20030618 | — | — | — | — | — | — | — |
| 29 | 353539096554501 | 131 | 19880616 | — | — | 13 | — | — | — | 90 |
| 29 | 353539096554501 | 131 | 19900606 | — | — | — | — | — | — | — |
| 29 | 353539096554501 | 131 | 19881220 | — | — | — | — | — | — | — |

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Radionuclides | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gross alpha-particle activity (pCi/L) (72 h)[f] | Gross alpha-particle activity (pCi/L) (30 d)[g] | Gross beta-particle activity 72 (pCi/L) (72 h)[h] | Gross beta-particle activity (pCi/L) (30 d)[i] | Radium-226 (pCi/L) | Radium-228 (pCi/L) | Radon-222 (pCi/L) |
| 30 | 353539096554401 | 33 | 19780104 | — | — | — | — | — | — | — |
| 31 | 353537097124101 | 31 | 19670209 | — | — | — | — | — | — | — |
| 32 | 353536096585001 | 141 | 19780104 | — | — | — | — | — | — | — |
| 33 | 353522097020201 | 119 | 19771126 | — | — | — | — | — | — | — |
| 34 | 353440097105501 | 185 | 19771115 | — | — | — | — | — | — | — |
| 35 | 353435097145101 | 171 | 19771119 | — | — | — | — | — | — | — |
| 36 | 353407097113301 | 140 | 19541022 | — | — | — | — | — | — | — |
| 37 | 353351096574601 | 162 | 19880615 | — | — | 2 | — | — | — | 4,900 |
| 38 | 353335097145501 | 31 | 19720619 | — | — | — | — | — | — | — |
| 39 | 353332097142901 | 45 | 19720619 | — | — | — | — | — | — | — |
| 40 | 353328097144101 | 60 | 19890616 | — | — | 7 | — | — | — | 120 |
| 40 | 353328097144101 | 60 | 19820609 | — | — | — | — | — | — | — |
| 40 | 353328097144101 | 60 | 19900606 | — | — | — | — | — | — | — |
| 41 | 353304097113201 | 45 | 19771115 | — | — | — | — | — | — | — |
| 42 | 353304097083201 | 49 | 19771114 | — | — | — | — | — | — | — |
| 43 | 353304097022001 | 128 | 19771126 | — | — | — | — | — | — | — |
| 44 | 353302097145201 | 95 | 19720613 | — | — | — | — | — | — | — |
| 44 | 353302097145201 | 95 | 19820609 | — | — | — | — | — | — | — |
| 45 | 353301097144801 | 44 | 19720616 | — | — | — | — | — | — | — |
| 46 | 353257096585501 | 170 | 19780104 | — | — | — | — | — | — | — |
| 47 | 353254096560501 | 93 | 19780104 | — | — | — | — | — | — | — |
| 48 | 353251097144801 | 31 | 19771119 | — | — | — | — | — | — | — |
| 49 | 353250097134801 | 44 | 19720616 | — | — | — | — | — | — | — |
| 50 | 353250097051201 | 66.9 | 19771126 | — | — | — | — | — | — | — |
| 51 | 353249097145101 | 80 | 19850610 | — | — | — | — | — | — | — |
| 52 | 353238097142001 | 50 | 19720614 | — | — | — | — | — | — | — |
| 53 | 353237097142801 | 50 | 19720615 | — | — | — | — | — | — | — |
| 54 | 353236097141901 | 52 | 19720613 | — | — | — | — | — | — | — |
| 54 | 353236097141901 | 52 | 19720825 | — | — | — | — | — | — | — |
| 55 | 353236097072801 | 140 | 19880524 | — | — | 2 | — | — | — | 180 |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Radionuclides | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gross alpha-particle activity (pCi/L) (72 h)[f] | Gross alpha-particle activity (pCi/L) (30 d)[g] | Gross beta-particle activity 72 (pCi/L) (72 h)[h] | Gross beta-particle activity (pCi/L) (30 d)[i] | Radium-226 (pCi/L) | Radium-228 (pCi/L) | Radon-222 (pCi/L) |
| 56 | 353214097141601 | 50 | 19720615 | — | — | — | — | — | — | — |
| 57 | 353212097142301 | 130 | 20081202 | — | — | — | — | — | — | — |
| 58 | 353208097142901 | 120 | 19720827 | — | — | — | — | — | — | — |
| 59 | 353207096583301 | 54 | 19890725 | — | — | 200 | — | — | — | 420 |
| 60 | 353119097094101 | 133 | 19890615 | — | — | 4 | — | — | — | 200 |
| 61 | 353052097110701 | 412 | 19741218 | — | — | — | — | — | — | — |
| 62 | 353050097134401 | 87 | 19651012 | — | — | — | — | — | — | — |
| 63 | 353040097000901 | 135 | 19870915 | — | — | — | — | 0.13 | 1 | E600 |
| 63 | 353040097000901 | 135 | 19870915 | — | — | — | — | — | — | — |
| 64 | 353032097110701 | 400 | 20050304 | — | — | — | — | — | — | — |
| 64 | 353032097110701 | 400 | 20040616 | — | — | — | — | — | — | — |
| 64 | 353032097110701 | 400 | 20050103 | — | — | — | — | — | — | — |
| 64 | 353032097110701 | 400 | 20050314 | — | — | — | — | — | — | — |
| 65 | 353030096554901 | 200 | 19780104 | — | — | — | — | — | — | — |
| 66 | 353027097143501 | 73 | 19771119 | — | — | — | — | — | — | — |
| 67 | 353027097114101 | 141 | 19771119 | — | — | — | — | — | — | — |
| 68 | 353027097052001 | 149 | 19771126 | — | — | — | — | — | — | — |
| 69 | 353023097082301 | 71 | 19771119 | — | — | — | — | — | — | — |
| 70 | 353023097015401 | 15 | 19771126 | — | — | — | — | — | — | — |
| 71 | 353021096595601 | — | 19830616 | — | — | — | — | — | — | — |
| 72 | 353020097115001 | 46 | 19690408 | — | — | — | — | — | — | — |
| 73 | 353019096585001 | 16 | 19780104 | — | — | — | — | — | — | — |
| 74 | 353007097114301 | 80 | 19640706 | — | — | — | — | — | — | — |
| 75 | 352957097134401 | 30 | 19651012 | — | — | — | — | — | — | — |

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Radionuclides | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gross alpha-particle activity (pCi/L) (72 h)[f] | Gross alpha-particle activity (pCi/L) (30 d)[g] | Gross beta-particle activity 72 (pCi/L) (72 h)[h] | Gross beta-particle activity (pCi/L) (30 d)[i] | Radium-226 (pCi/L) | Radium-228 (pCi/L) | Radon-222 (pCi/L) |
| 76 | 352936097083901 | 155 | 19830608 | — | — | — | — | — | — | — |
| 77 | 352854097072301 | 103 | 19890619 | — | — | 4 | — | — | — | 220 |
| 78 | 352851097093801 | 400 | 19880418 | — | — | 12 | — | — | — | 108 |
| 78 | 352851097093801 | 400 | 19900530 | — | — | — | — | — | — | — |
| 79 | 352844097034401 | 120 | 20110926 | 1.5 | ND | 0.8 | 0.9 | 0.076 | 0.25 | 170 |
| 80 | 352839097053401 | 160 | 20110323 | — | — | — | — | — | — | — |
| 81 | 352820097005001 | 86 | 19710316 | — | — | — | — | — | — | — |
| 82 | 352816096554701 | 96 | 19880714 | — | — | 11 | — | — | — | 110 |
| 83 | 352813097033401 | 60 | 20110314 | — | — | — | — | — | — | — |
| 84 | 352813097032401 | 61 | 20110823 | ND | ND | ND | 1.4 | 0.042 | ND | 251 |
| 85 | 352812097052101 | 143 | 20110822 | 4 | 0.9 | 1.6 | 1.7 | 0.21 | 0.49 | 117 |
| 86 | 352810097092901 | 49 | 19890621 | — | — | 6 | — | — | — | 190 |
| 87 | 352807096554501 | 42 | 19771127 | — | — | — | — | — | — | — |
| 88 | 352805097041301 | 95 | 20110803 | — | — | — | — | — | — | — |
| 89 | 352800097032201 | 120 | 20110314 | — | — | — | — | — | — | — |
| 90 | 352756097035501 | 125 | 20110323 | — | — | — | — | — | — | — |
| 91 | 352753097040301 | 110 | 20110314 | — | — | — | — | — | — | — |
| 92 | 352751097050801 | 103 | 19771126 | — | — | — | — | — | — | — |
| 92 | 352751097050801 | 103 | 20110314 | — | — | — | — | — | — | — |
| 93 | 352751097045401 | 255 | 20110815 | — | — | — | — | — | — | — |
| 94 | 352751097041401 | 132 | 20110314 | — | — | — | — | — | — | — |
| 95 | 352751097034501 | 100 | 20110323 | — | — | — | — | — | — | — |
| 96 | 352748097032601 | — | 20110314 | — | — | — | — | — | — | — |
| 97 | 352747097051401 | 180 | 20110913 | 1 | 0.8 | 1.2 | 1.7 | 0.15 | 0.4 | 167 |
| 98 | 352745097041501 | — | 20110314 | — | — | — | — | — | — | — |
| 99 | 352743097044101 | 110 | 20110318 | — | — | — | — | — | — | — |
| 100 | 352743097021102 | 43 | 19771126 | — | — | — | — | — | — | — |
| 101 | 352734097020001 | 222 | 20110314 | — | — | — | — | — | — | — |
| 102 | 352733097042101 | 110 | 20110318 | — | — | — | — | — | — | — |
| 103 | 352732097041501 | 102 | 20111012 | 0.8 | ND | ND | 0.8 | 0.07 | ND | 278 |
| 104 | 352728097035001 | 110 | 20110318 | — | — | — | — | — | — | — |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Radionuclides | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gross alpha-particle activity (pCi/L) (72 h)[f] | Gross alpha-particle activity (pCi/L) (30 d)[g] | Gross beta-particle activity 72 (pCi/L) (72 h)[h] | Gross beta-particle activity (pCi/L) (30 d)[i] | Radium-226 (pCi/L) | Radium-228 (pCi/L) | Radon-222 (pCi/L) |
| 105 | 352727096585501 | 91 | 19780104 | — | — | — | — | — | — | — |
| 106 | 352726097041401 | — | 20111005 | — | — | — | — | — | — | — |
| 107 | 352726097035001 | — | 20110318 | — | — | — | — | — | — | — |
| 108 | 352726097031601 | 125 | 20111012 | 5.2 | 1 | 1.7 | 1.7 | 0.095 | 0.42 | 149 |
| 109 | 352717097043801 | 140 | 20111004 | 370 | 350 | 6.9 | 102 | 0.77 | 0.68 | 1,680 |
| 110 | 352714097034101 | 135 | 20110822 | 114 | 116 | 1.6 | 22 | 0.43 | 0.29 | 3,600 |
| 111 | 352712097032101 | 125 | 20110314 | — | — | — | — | — | — | — |
| 112 | 352710097034601 | 220 | 20081203 | — | — | — | — | — | — | — |
| 113 | 352704097031401 | 150 | 20110314 | — | — | — | — | — | — | — |
| 114 | 352701097031901 | — | 20110317 | — | — | — | — | — | — | — |
| 115 | 352700097032201 | — | 20110317 | — | — | — | — | — | — | — |
| 116 | 352657097054401 | 80 | 20110318 | — | — | — | — | — | — | — |
| 117 | 352657097042401 | 80 | 20110803 | — | — | — | — | — | — | — |
| 118 | 352656097031601 | 320 | 20110928 | 77 | 80 | 1.9 | 16.4 | ND | 0.48 | 640 |
| 119 | 352655097043201 | 82 | 20110830 | 5.3 | 4 | 0.8 | 1.5 | 0.18 | 0.33 | 350 |
| 120 | 352654097022301 | 160 | 20110830 | 270 | 260 | 8.6 | 89 | 0.69 | 0.47 | 1,040 |
| 121 | 352652097050501 | 86 | 20110804 | — | — | — | — | — | — | — |
| 122 | 352651097023201 | 120 | 20110323 | — | — | — | — | — | — | — |
| 123 | 352642097034801 | 108 | 20110912 | 5 | 11.1 | 2.8 | 3.5 | 1.2 | 0.53 | 1,220 |
| 123 | 352642097034801 | 108 | 20110912 | — | — | — | — | — | — | — |
| 123 | 352642097034801 | 108 | 19820616 | — | — | — | — | — | — | — |
| 124 | 352635097025201 | 150 | 20110323 | — | — | — | — | — | — | — |
| 125 | 352632097024401 | 155 | 20110831 | 2 | ND | 1.3 | 1 | 0.133 | ND | 95 |

| Well number | USGS identifier | Well depth (feet below land surface) | Date of sample | Radionuclides |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  | Gross alpha-particle activity (pCi/L) (72 h)[f] | Gross alpha-particle activity (pCi/L) (30 d)[g] | Gross beta-particle activity 72 (pCi/L) (72 h)[h] | Gross beta-particle activity (pCi/L) (30 d)[i] | Radium-226 (pCi/L) | Radium-228 (pCi/L) | Radon-222 (pCi/L) |
| 126 | 352625097022401 | 172 | 20110926 | 0.9 | ND | 1.2 | 0.9 | 0.04 | 0.22 | 270 |
| 127 | 352622097020701 | — | 20110314 | — | — | — | — | — | — | — |
| 128 | 352620097024201 | 150 | 20110323 | — | — | — | — | — | — | — |
| 129 | 352617097031801 | 180 | 20110314 | — | — | — | — | — | — | — |
| 130 | 352612097020701 | 114 | 20110927 | — | — | — | — | — | — | — |
| 131 | 352609097033801 | 180 | 20110830 | 47 | 43 | 2.4 | 8.8 | 0.23 | 0.2 | 380 |
| 132 | 352603097024901 | — | 20110823 | 23 | 24 | ND | 6 | 0.031 | ND | 169 |
| 133 | 352603097022901 | 125 | 20110323 | — | — | — | — | — | — | — |
| 134 | 352557097024101 | 180 | 20111005 | 37 | 39 | 1.3 | 7.4 | 0.03 | 0.3 | 244 |
| 135 | 352553097021101 | 167 | 20110906 | 92 | 74 | ND | 12 | 0.09 | ND | 237 |
| 136 | 352543097021601 | 160 | 20110323 | — | — | — | — | — | — | — |
| 137 | 352543096585601 | 140 | 19880615 | — | — | 2 | — | — | — | <80 |
| 138 | 352536097021101 | — | 20110927 | — | — | — | — | — | — | — |
| 139 | 352533097015901 | 240 | 20110323 | — | — | — | — | — | — | — |
| 140 | 352529097021801 | 103 | 20110815 | — | — | — | — | — | — | — |
| 141 | 352520096591501 | 98 | 19771127 | — | — | — | — | — | — | — |
| 142 | 352510097011201 | 142 | 20110831 | 12 | 9 | 1.4 | 2.4 | 0.094 | ND | 143 |
| 143 | 352508096561401 | — | 19830615 | — | — | — | — | — | — | — |
| 144 | 352501096554901 | 66 | 19771127 | — | — | — | — | — | — | — |
| 145 | 352458097020801 | — | 20110815 | — | — | — | — | — | — | — |
| 146 | 352457097020601 | 17 | 19771126 | — | — | — | — | — | — | — |
| 147 | 352422097012101 | 90 | 20110815 | — | — | — | — | — | — | — |
| 148 | 352417097015301 | 110 | 20110823 | 5.4 | 5.7 | 2.3 | 1.8 | 0.4 | 0.35 | 410 |
| 149 | 352415097013901 | — | 20110927 | — | — | — | — | — | — | — |

**Table 2.** Water-quality information for wells shown on plate 1 in the study area in parts of Lincoln, Oklahoma, and Pottawatomie Counties, Oklahoma, 1948–2011.—Continued

[Water-quality data were retrieved from the U.S. Geological Survey National Water Information System database (U.S. Geological Survey, 2012a) in January 2012. All concentrations are of constituents in filtered water unless otherwise noted. Blue font denotes value exceeds Secondary Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012b); red font denotes value exceeds Maximum Contaminant Level for public drinking-water supplies (U.S. Environmental Protection Agency, 2012a). USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; pCi/L, picocuries per liter; 30 d, 30 days; 72 h, 72 hours; —, not available or not measured; <, less than; M, presence detected at concentration less than reporting level; ND, not detected; E, estimated. Estimated concentrations are smaller than a minimum concentration that can be reliably reported by a given analytical method but generally larger than the long-term method detection level (Childress and others, 1999). Concentrations reported as estimated indicate that the constituent is present in the water sample, but there is some type of quantitative analytical uncertainty, such as from matrix effects, associated with the reported concentration. For this report, a gross beta-particle activity of 50 picocuries per liter 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 picocuries per liter as a screening level]

| | | | | Radionuclides | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Well number** | **USGS identifier** | **Well depth (feet below land surface)** | **Date of sample** | **Gross alpha-particle activity (pCi/L) (72 h)[f]** | **Gross alpha-particle activity (pCi/L) (30 d)[g]** | **Gross beta-particle activity 72 (pCi/L) (72 h)[h]** | **Gross beta-particle activity (pCi/L) (30 d)[i]** | **Radium-226 (pCi/L)** | **Radium-228 (pCi/L)** | **Radon-222 (pCi/L)** |
| 150 | 352343096555801 | — | 19480101 | — | — | — | — | — | — | — |
| 151 | 352325096591301 | 20 | 19780104 | — | — | — | — | — | — | — |
| 152 | 352302097010601 | 33 | 19771126 | — | — | — | — | — | — | — |
| 152 | 352302097010601 | 33 | 19820617 | — | — | — | — | — | — | — |
| 153 | 351955096582501 | 54 | 19890621 | — | — | 3[h] | — | — | — | 160 |
| 154 | 351951096583401 | 8 | 19780103 | — | — | — | — | — | — | — |
| 155 | 351938096562001 | 121 | 19770103 | — | — | — | — | — | — | — |

[a] pH of unfiltered water measured in laboratory.

[b] Dissolved solids from sample dried at 105 degrees Celsius.

[c] Dissolved solids calculated from the sum of constituents.

[d] Concentration of constituent in unfiltered water.

[e] Nitrate plus nitrite nitrogen.

[f] Analyzed for gross alpha-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using $^{230}$Thorium.

[g] Analyzed for gross alpha-particle activity at approximately 30 days after sample collection as referenced to a detector calibrated by using $^{230}$Thorium.

[h] Analyzed for gross beta-particle activity at approximately 72 hours after sample collection as referenced to a detector calibrated by using $^{137}$Cesium.

[i] Analyzed for gross beta-particle activity at approximately 30 days after sample collection as referenced to a detector calibrated by using $^{137}$Cesium.

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