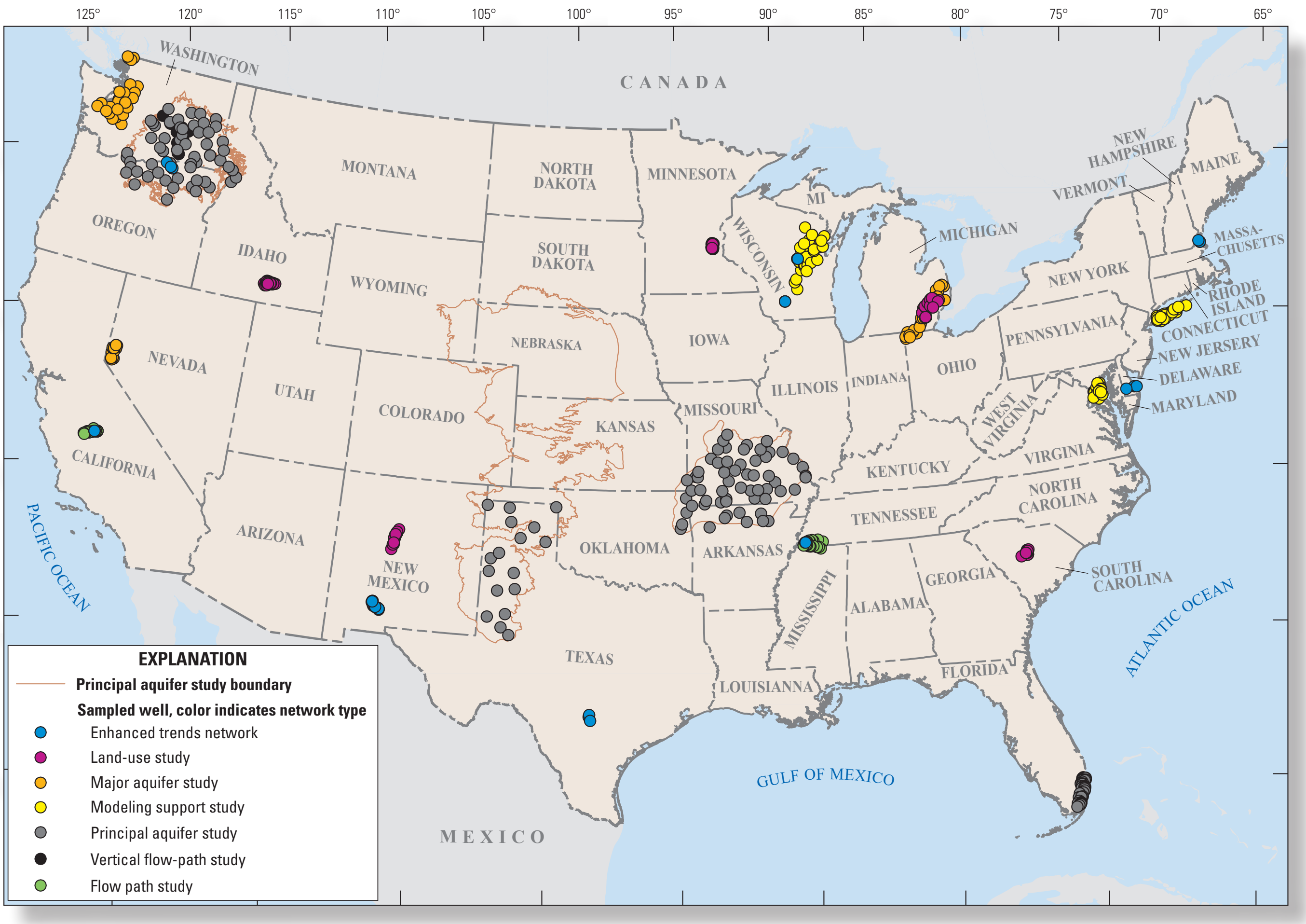
National Water-Quality Assessment Project

Groundwater-Quality and Select Quality-Control Data from the National Water-Quality Assessment Project, January through December 2016, and Previously Unpublished Data from 2013 to 2015



Data Series 1124

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

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By Terri L. Arnold, Laura M. Bexfield, MaryLynn Musgrove, Melinda L. Erickson, James A. Kingsbury, James R. Degnan, Anthony J. Tesoriero, Justin T. Kulongoski and Kenneth Belitz

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U.S. Department of the Interior
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Foreword

Sustaining the quality of the Nation's water resources and the health of our diverse ecosystems depends on the availability of sound water-resources data and information to develop effective, science-based policies. Effective management of water resources also brings more certainty and efficiency to important economic sectors. Taken together, these actions lead to immediate and long-term economic, social, and environmental benefits that make a difference to the lives of the almost 400 million people projected to live in the United States by 2050.

In 1991, Congress established the National Water-Quality Assessment (NAWQA) to address where, when, why, and how the Nation's water quality has changed, or is likely to change in the future, in response to human activities and natural factors. Since then, NAWQA has been a leading source of scientific data and knowledge used by national, regional, state, and local agencies to develop science-based policies and management strategies to improve and protect water resources used for drinking water, recreation, irrigation, energy development, and ecosystem needs (https://water.usgs.gov/nawqa/applications/). Plans for the third decade of NAWQA (2013–23) address priority water-quality issues and science needs identified by NAWQA stakeholders, such as the Advisory Committee on Water Information and the National Research Council, and are designed to meet increasing challenges related to population growth, increasing needs for clean water, and changing land-use and weather patterns.

NAWQA is assessing the quality of groundwater used for public and domestic drinking-water supply. NAWQA obtains samples from public supply wells, domestic wells, and relatively shallow monitoring wells, and analyzes those samples for a large number of chemical constituents. These data are used to assess the suitability of the resource for human consumption, as well as to evaluate changes in groundwater quality over a variety of time scales. Groundwater quality also is assessed at multiple scales: locally, regionally, and nationally. Groundwater-quality data collected by the NAWQA Project during each year are published in annual data series reports. This report, the fourth in the series, combines groundwater-quality data collected at 648 sites to provide a summary of groundwater quality in selected aquifers across the Nation during the sampling period. All NAWQA reports are available online at https://water.usgs.gov/nawqa/bib/.

We hope this publication will provide you with insights and information to meet your water-resource needs and will foster increased citizen awareness and involvement in the protection and restoration of our Nation's waters. The information in this report is intended primarily for those interested or involved in resource management and protection, conservation, regulation, and policymaking at the regional and national levels.

Dr. Donald W. Cline
Associate Director for Water
U.S. Geological Survey

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Radioactivity	
picocurie per liter (pCi/L)	0.037	becquerel per liter (Bq/L)

Datum

Vertical coordinate information is referenced to either the North American Vertical Datum of 1988 (NAVD 88) or the National Geodetic Vertical Datum of 1929 (NGVD 29) and is specified in tables where vertical datum is reported.

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.

Supplemental Information

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).

Activities for radioactive constituents in water are given in picocuries per liter (pCi/L).

Abbreviations

ASCII	American Standard Code for Information Interchange
DL	detection limit
EPA	U.S. Environmental Protection Agency
ETN	enhanced trends network
FPS	flow-path study
HHB	human-health benchmark
HHBP	human-health benchmark for pesticides
ID	identification
LUS	land-use study
MAS	major aquifer study
MRL	minimum reporting level
MSS	modeling support study
NAWQA	National Water-Quality Assessment
NWQL	National Water Quality Laboratory
PAS	principal aquifer study
QC	quality control
ssL_c	sample-specific critical level
ssMDC	sample-specific minimum detectable concentration
USGS	U.S. Geological Survey
VFPS	vertical flow-path study
VOC	volatile organic compound

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Abstract

Environmental groundwater-quality data were collected from 648 wells as part of the National Water-Quality Assessment Project of the U.S. Geological Survey National Water-Quality Program and are included in this report. Most of the wells (514) were sampled from January through December 2016, and 60 of them were sampled in 2013 and 74 in 2014. The data were collected from seven types of well networks: principal aquifer study networks, which are used to assess the quality of groundwater used for public-water supply; land-use study networks, which are used to assess land-use effects on shallow groundwater quality; major aquifer study networks, which are used to assess the quality of groundwater used for domestic supply; enhanced trends networks, which are used to evaluate the time scales during which groundwater quality changes; vertical flow-path study networks, which are used to evaluate changes in groundwater quality from shallow to deeper depths; flow-path study networks, which are used to evaluate changes in groundwater quality from shallow to deeper depths over a horizontal distance; and modeling support studies, which are used to provide data to support groundwater modeling. Groundwater samples were analyzed for many water-quality indicators and constituents, including major ions, nutrients, trace elements, volatile organic compounds, pesticides, radionuclides, and some constituents of special interest (arsenic speciation, chromium [VI], and perchlorate). These groundwater-quality data, along with data from quality-control samples, are tabulated in this report and in an associated data release. Some data from environmental samples collected in 2013–14 and quality-control samples collected in 2012–15 also are included in the associated data release. Data from samples collected in 2016 are associated with networks described in this report and have not been published previously; data from samples collected between 2012 and 2015 are associated with networks described in previous reports in this data series.

Introduction

The National Water-Quality Assessment (NAWQA) Project of the U.S. Geological Survey (USGS) National Water-Quality Project was fully implemented in 1991 and operates in about 10-year cycles. The NAWQA Project began its third cycle of studies in 2013. The NAWQA Project was designed to describe current water-quality conditions of the Nation's freshwater streams, rivers, and aquifers; to describe how water quality is changing with time; to improve understanding of the natural and human factors that affect water quality; to forecast future water-quality conditions; and to assess effects of water-quality stressors on aquatic ecosystems (Rowe and others, 2010, 2013).

The NAWQA Project groundwater assessments focus on the quality of groundwater used for public and domestic drinking-water supply; groundwater susceptibility to degradation; effects of natural and human factors on source, transport, and flux of contaminants to and within aquifers; groundwater-quality contributions to surface-water quality; and current and previous management practices relative to groundwater quality. Groundwater quality is studied at multiple scales: locally, regionally, and nationally. The primary regional scale at which groundwater data were collected during the third cycle of the NAWQA Project was the scale of the principal aquifers (Burow and Belitz, 2014). A principal aquifer is defined as a regionally extensive aquifer or aquifer system that has the potential to be used as a source of potable water. Principal aquifers were selected for assessment based on their national ranking as sources of water used for public supply (Arnold and others, 2016b).

Groundwater-quality data collected by the NAWQA Project during each year are published in data series reports. The first three reports and associated data releases in this series published available data from samples collected May 2012 through December 2013 (Arnold and others, 2016a,b), January through December 2014 (Arnold and others, 2017a,b), and January through December 2015 (Arnold and others, 2018a,b). Appendix 1, table 1.1 lists the networks that are described in this report and that are described in previous reports in this series (Arnold and others, 2016a,b, 2017a,b, 2018a,b).

Purpose and Scope

The purpose of this report is to present the analytical results of the groundwater-quality samples collected in 2016 as part of the third cycle of NAWQA Project studies and to provide brief descriptions of the groundwater-quality study networks for use in subsequent publications. Types of constituents analyzed include the following: water-quality indicators, major and minor ions, nutrients, volatile organic compounds (VOCs), pesticides, radionuclides, and select constituents of special interest (arsenic speciation, chromium [VI], and perchlorate). The water-quality data are presented in tables formatted as tab-delimited American Standard Code for Information Interchange (ASCII) text files, which may be imported into spreadsheet, database, or statistical software for manipulation and analysis. These water-quality data tables are available from a data release, Arnold and others (2020), at https://doi.org/10.5066/P9W4RR74. The data release includes data collected during 2016 and previously unpublished data from 2012 to 2015 sampling. These previously unpublished data are associated with networks described in previous reports (Arnold and others, 2016a,b, 2017a,b, 2018a,b).

Groundwater Study Design

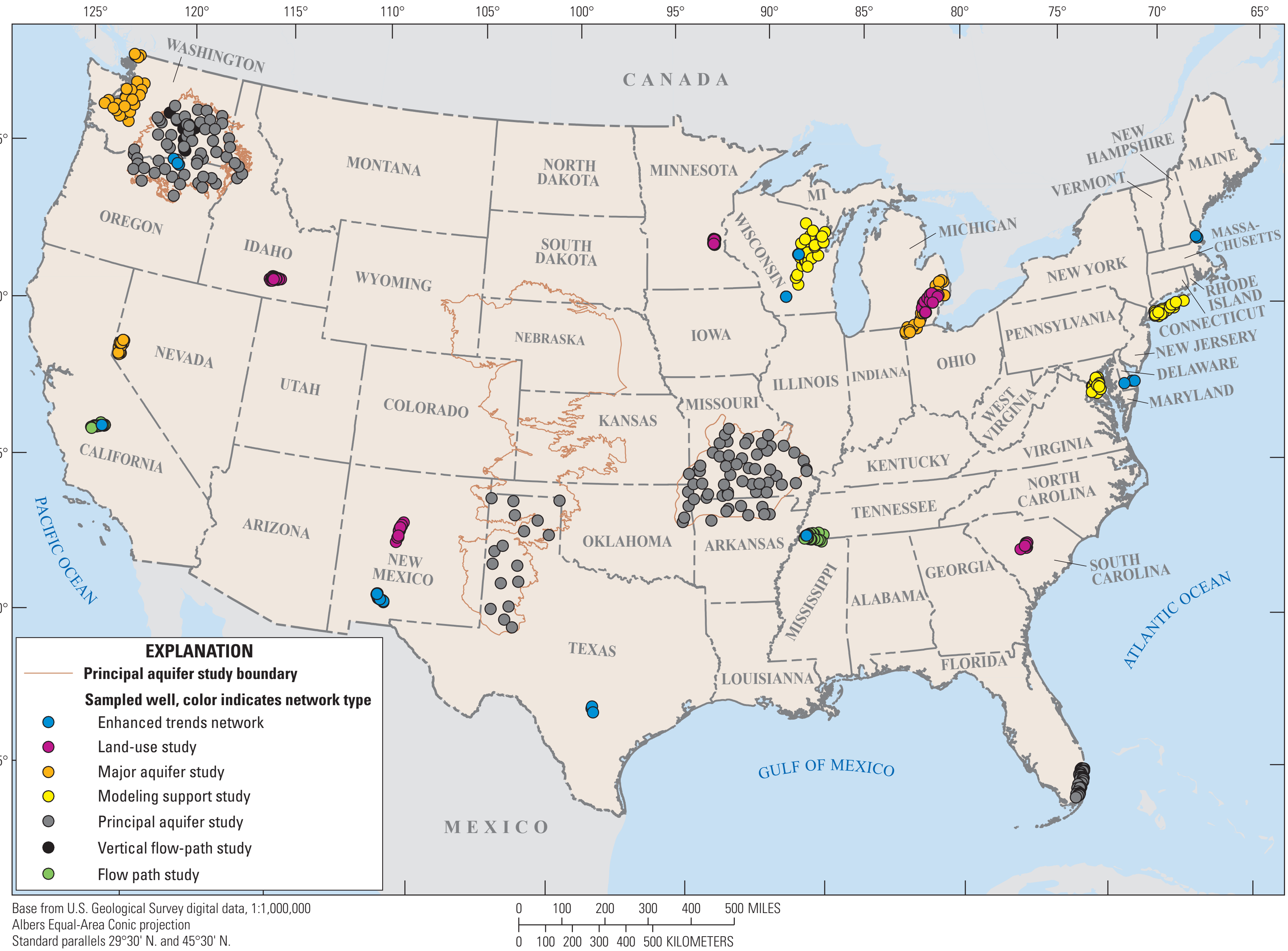
Groundwater-quality samples were collected from wells that were organized into networks (fig. 1) for study purposes. A network is a group of wells that have been selected for sampling based on specific hydrogeologic conditions, land use, or other design criteria. Many networks have wells that were sampled in multiple decadal sampling periods; however, if a network well was damaged or destroyed, had too little water, or the current owner would not permit sampling, then that well was not resampled during 2016. Maps and tables in this report and in Arnold and others (2020) have well identification (ID) numbers assigned by the NAWQA Project to identify the wells; because some wells could not be resampled, some networks do not have consecutively numbered NAWQA Project IDs. As used on maps showing network-specific information (figs. 2–26), the ID numbers are shown either as numbers only or a combination of numbers and letters that indicate a particular well within the network. The NAWQA well ID number listed in table 1 of this report and table 1 of Arnold and others (2020) are a combination of the network name and the NAWQA Project ID. Data from seven primary types of groundwater study networks are presented in this report (fig. 1): principal aquifer study (PAS), land-use study (LUS), major aquifer study (MAS), enhanced trends networks (ETN), vertical flow-path study (VFPS), flow-path study (FPS), and modeling support study (MSS).

Wells in PAS, LUS, and MAS networks were selected randomly using an equal-area grid to divide the study area of each network (Scott, 1990) into equal-area cells. The equal-area grid method allows for evaluation of constituent concentrations at a regional scale (Belitz and others, 2010). For LUS networks, random potential sampling locations in each grid cell were generated by a software program (Scott, 1990), and monitoring wells were subsequently installed as near to the randomly selected locations as possible. Study areas for LUS networks included the areal extents of the primary aquifer and a specific land use (for example, orchard) of interest. For MAS and PAS networks, one well per grid cell was randomly selected from a population of existing domestic or public-supply wells (Gilliom and others, 1995; Scott, 1990). For PAS networks, if no public-supply well was available within a grid cell (for example, because permission to sample could not be obtained), an additional well was selected within an adjacent grid cell, not to exceed four wells in two adjacent grid cells. Equal-area grids used for network design are shown only on figures relating to PAS networks because the grids are not available for LUS or MAS networks designed during the first two decades of sampling.

The ETN, VFPS, FPS, and MSS wells were selected from existing networks where possible. The ETN wells are in hydrogeologic settings where changes in hydrologic conditions, land use, or contaminant inputs are expected to be reflected quickly in groundwater (less than 10 years). The VFPS wells were "nested" wells with various depths collocated in a selected area to represent vertical gradients of groundwater flow to enhance the understanding of how contaminants move through aquifers over timespans of greater than a decade. The FPS wells were selected along a horizontal flow path. The MSS wells were selected to provide key data to support specific modeling goals.

Principal Aquifer Study Networks

The PAS networks consist of public-supply wells, and water is sampled from the part of the aquifer used for the public drinking-water supply (Burow and Belitz, 2014). Public-supply wells are generally the deepest wells sampled. Wells in PAS networks are sampled once to assess groundwater-quality conditions in the study areas. The extents of PAS network areas are based on the USGS (2003) map of principal aquifers and may be modified in some areas, as described in this report. Data from the following PAS networks are included in this report: Biscayne aquifer PAS network (biscpas1; fig. 2), Columbia Plateau Basaltic-Rock Aquifers PAS network (clptpas1; fig. 3), High Plains aquifer system PAS network (hpaqpas1; fig. 4), and Ozark Plateaus aquifer system PAS network (ozrkpas1; fig. 5).



Base from U.S. Geological Survey digital data, 1:1,000,000
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' N.
Central meridian 96°00' W.
North American Datum of 1983

Figure 1. Groundwater study networks and wells sampled as part of the U.S. Geological Survey National Water-Quality Assessment Project for which water-quality data are included in this report..

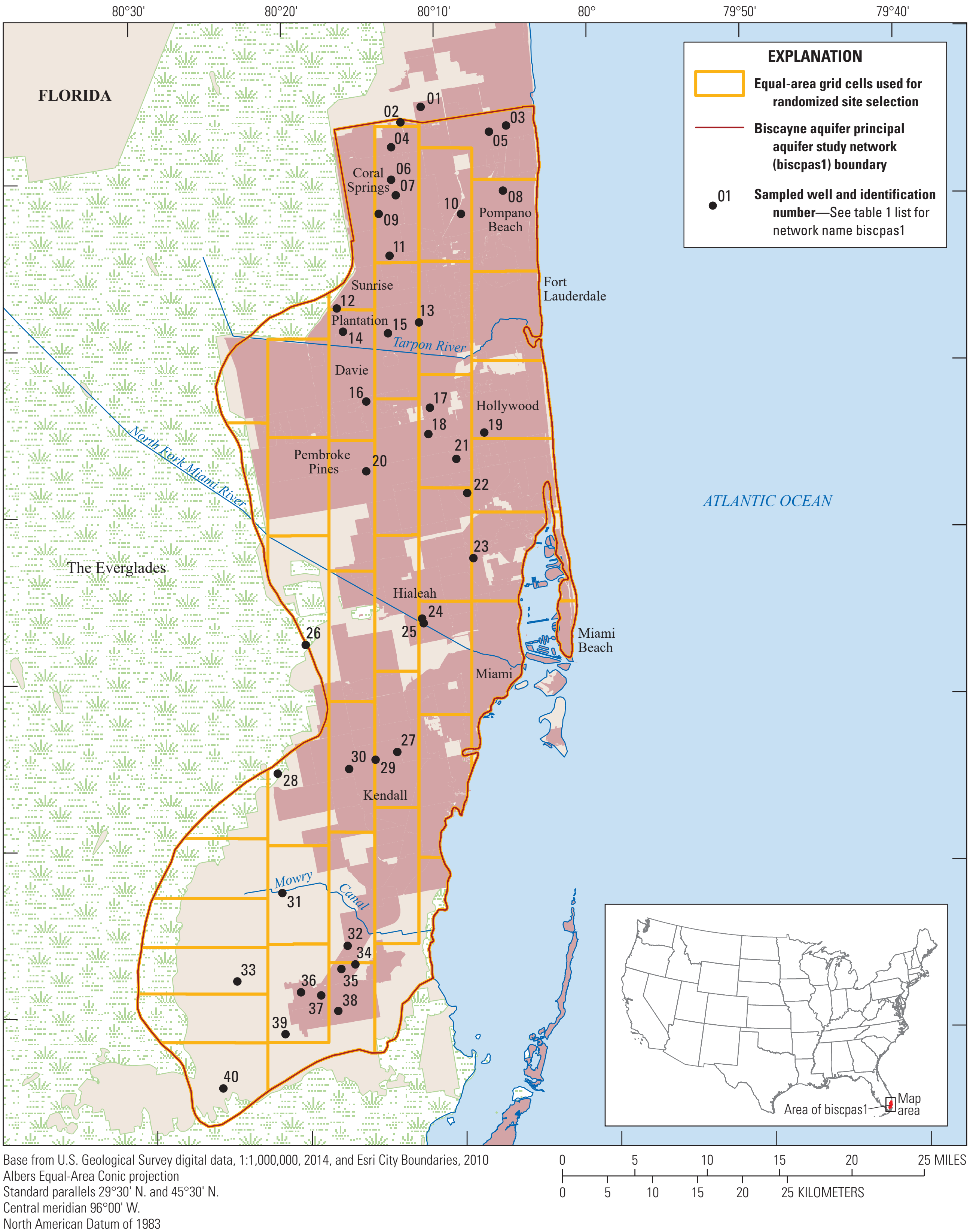
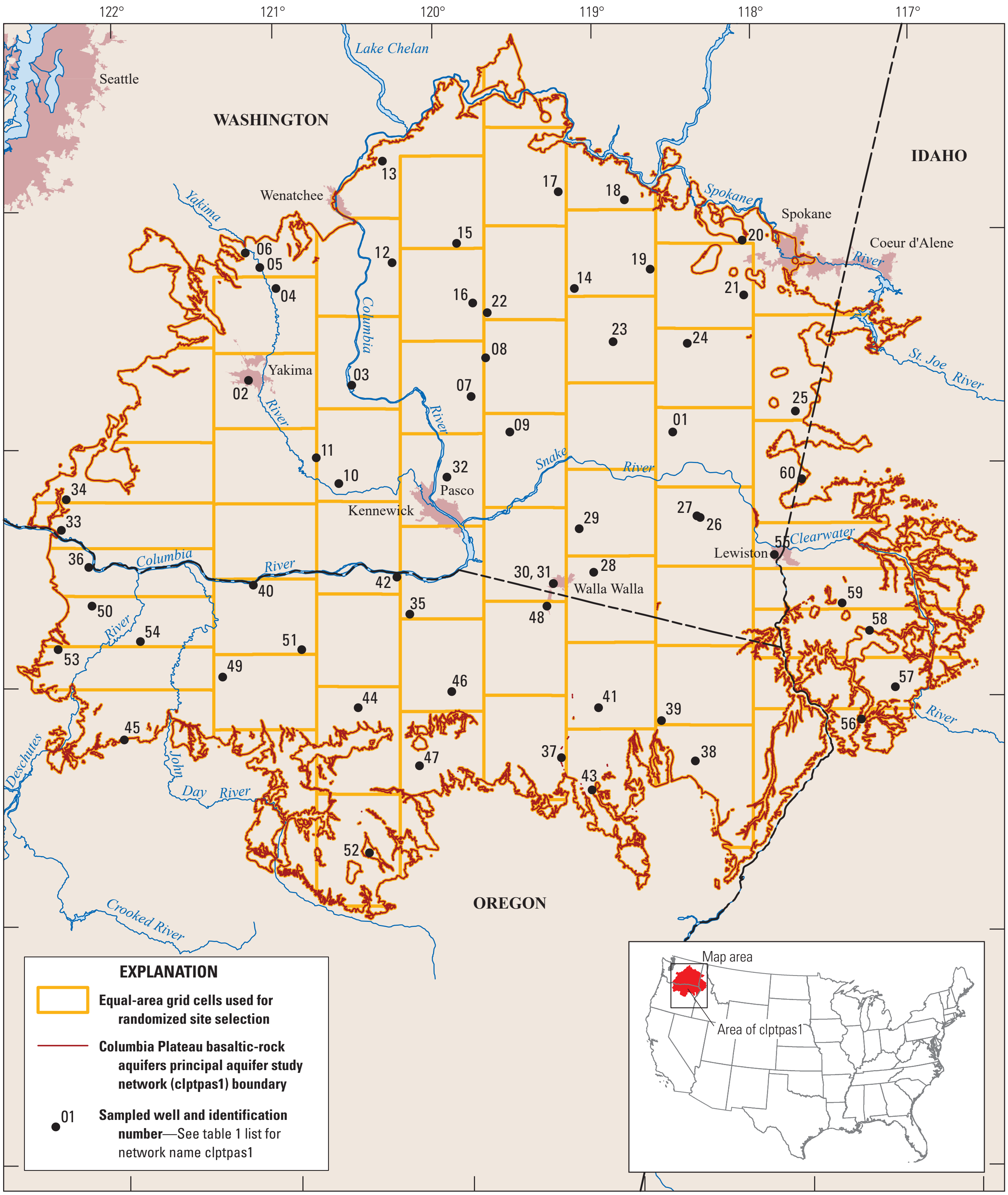


Figure 2. Study area and wells sampled as part of the Biscayne aquifer principal aquifer study network (biscpas1) for the U.S. Geological Survey National Water-Quality Assessment Project.



Base from U.S. Geological Survey digital data, 1:2,000,000, 2005, and U.S. Census Bureau Urban Areas, 2017
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' N.
Central meridian 96°00' W.
North American Datum of 1983

Figure 3. Study area and wells sampled as part of the Columbia Plateau Basaltic-Rock Aquifers principal aquifer study network (clptpas1) for the U.S. Geological Survey National Water-Quality Assessment Project.

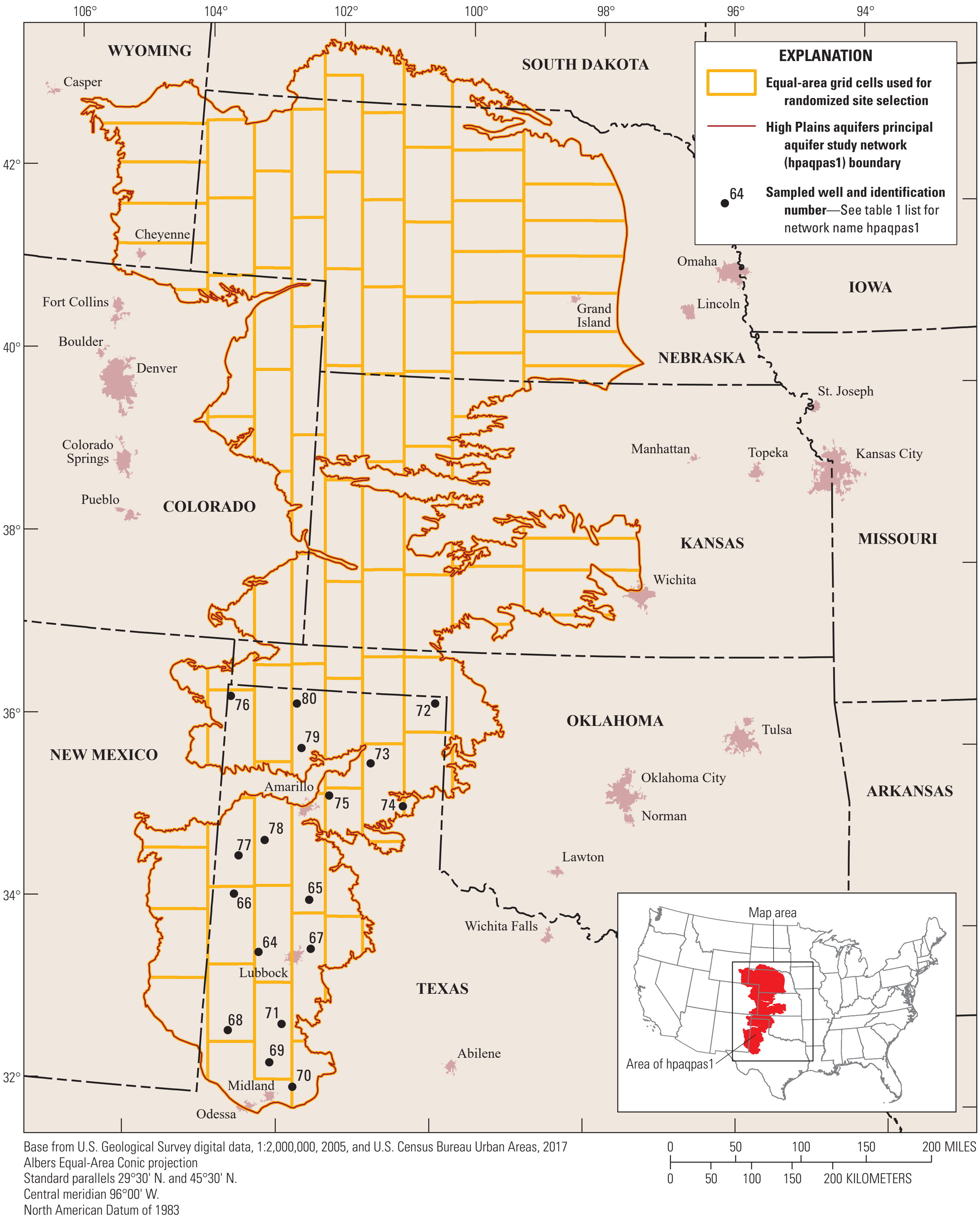
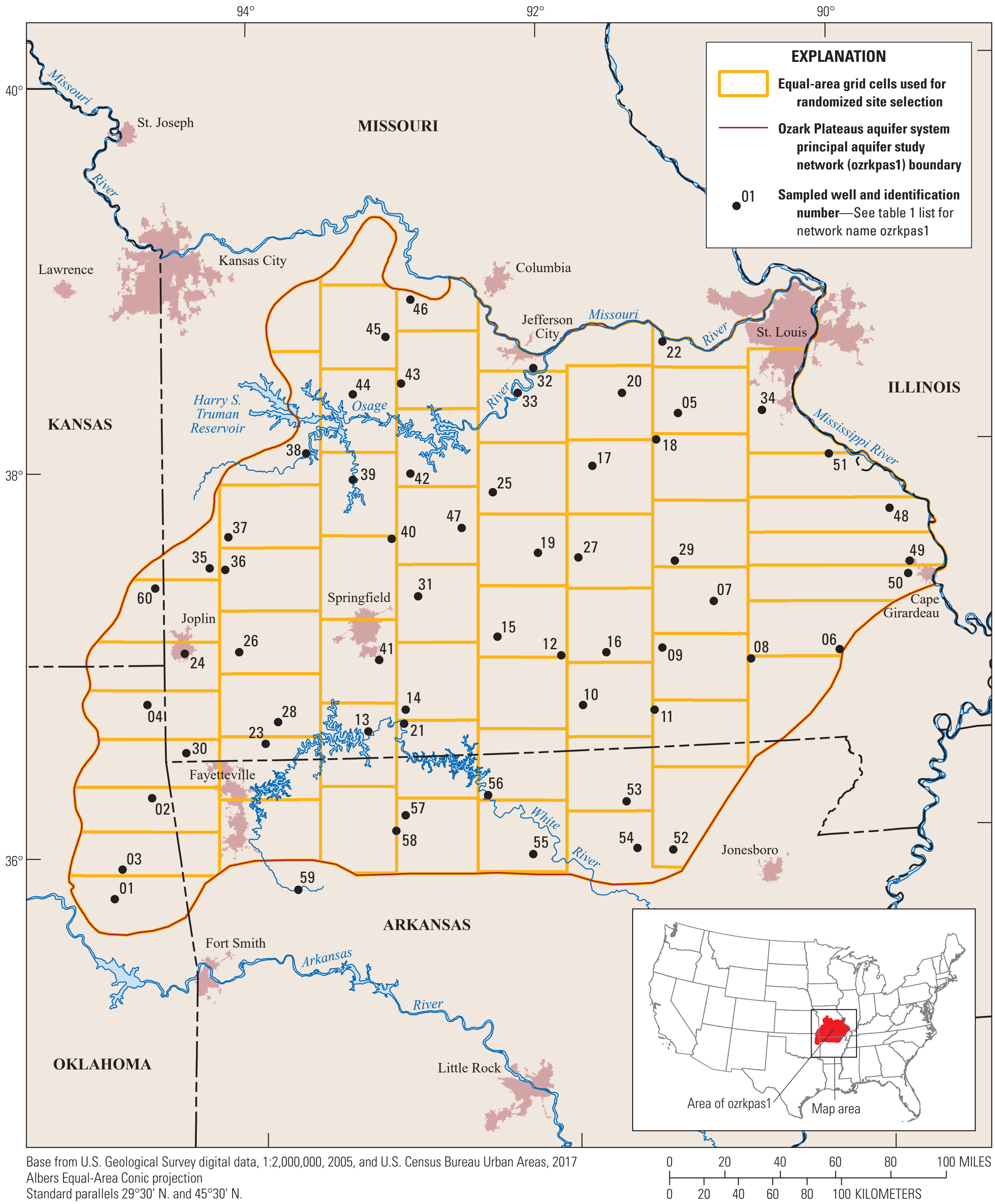


Figure 4. Study area and wells sampled as part of the High Plains aquifer system principal aquifer study network (hpaqpas1) for the U.S. Geological Survey National Water-Quality Assessment Project.



Base from U.S. Geological Survey digital data, 1:2,000,000, 2005, and U.S. Census Bureau Urban Areas, 2017
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' N.
Central meridian 96°00' W.
North American Datum of 1983

Figure 5. Study area and wells sampled as part of the Ozark Plateaus aquifer system principal aquifer study network (ozrkpas1) for the U.S. Geological Survey National Water-Quality Assessment Project.

Biscayne Aquifer Principal Aquifer Study Network (biscpas1)

The Biscayne aquifer underlies an area of about 4,000 square miles (mi^2) (Miller, 1990), which has a population of about 4 million people in southeastern Florida (U.S. Census Bureau, 2010). About 700 million gallons per day (Mgal/d) were withdrawn for public supply in 2000 (Maupin and Barber, 2005). The aquifer underlies parts of four (Broward, Miami-Dade, Palm Beach, Monroe) counties in southern Florida, which include the cities of Miami and Ft. Lauderdale. Most of the area overlying the aquifer is developed and consists of urban (63 percent) and agricultural (9 percent) land use (Homer and others, 2015).

The Biscayne aquifer is an unconfined aquifer made up of shallow, highly permeable limestone as well as some sandstone units (Miller, 1990). Because of the shallow depth of the units that make up this aquifer, the hydrologic connection to surface water is an important aspect of the hydrogeology of the Biscayne aquifer (Miller, 1990). A system of canals and levees are used to manage the freshwater resources of southern Florida. The system conserves freshwater, provides flood control, and minimizes saltwater encroachment in the aquifer along the coast (Miller, 1990). Recharge to the aquifer is from seepage of surface water from canals and from infiltration of rainfall (Miller, 1990). Groundwater generally flows from the west to the east, discharging in the Atlantic Ocean but where large withdrawals occur, flow directions have been locally modified (Miller, 1990).

The Biscayne aquifer PAS network (biscpas1; fig. 2) includes 40 public-supply wells distributed across the extent of the aquifer. Wells were selected using a 40-cell equal-area grid that extended across the extent of the aquifer system. Samples were collected between June and September 2016, and the data for these samples are presented in this report. Wells in the biscpas1 ranged from about 22 to 152 feet (ft) deep, with a median well depth of about 91 ft. (appendix 2, table 2.1).

Columbia Plateau Basaltic-Rock Aquifers Principal Aquifer Study Network (clptpas1)

The Columbia Plateau basaltic-rock aquifers underlie an area of 42,000 mi^2, which includes about 1 million people in Washington, Oregon, and Idaho (U.S. Census Bureau, 2010). The aquifer system ranks 19th in the Nation as a source of groundwater for public supply, and about 223 Mgal/d were pumped for this use in 2000 (Maupin and Barber, 2005). Land use overlying the Columbia Plateau basaltic rock aquifers is primarily natural land cover (64 percent) and agriculture (33 percent) with small amounts of urban and other developed land (4 percent) (Homer and others, 2015). The urban areas of Spokane, Washington, and the Washington Tri-Cities (Richland, Kennewick, and Pasco); Moscow and Lewiston, Idaho; and Pendleton and Hermiston, Oregon, lie within the aquifer system's overlying land along with dozens of smaller communities.

Most of the Columbia Plateau is semiarid (precipitation ranges from 7 to 15 inches per year in the central part of the Plateau), yet the region supports a $6-billion-per-year agricultural industry, which leads the Nation in production of apples, hops, and several other commodities (Vaccaro and others, 2015). Water demand for agriculture, economic development, and ecological needs in the area is high (Kahle and others, 2011). The Plateau accounts for approximately 5 percent of the Nation's irrigated lands, which are supplied by a combination of groundwater pumping and surface-water diversions.

The Columbia Plateau is an intermontane basin lying between the Cascade Range and the Rocky Mountains that is filled with Cenozoic basalt and sediment. The primary aquifers in the region are the Miocene-aged continental flood basalts of the Columbia River Basalt Group and, in places, Neogene basin-fill sediments, which generally overlie the flood basalts (Vaccaro and others, 2015). Only the basalt-rock aquifers of the clptpas1 network were sampled for this study. The Columbia Plateau basin-fill aquifers rank 67th in the Nation as a source of groundwater for public supply with less than 1 Mgal/day pumped for this use in 2000 (Maupin and Barber, 2005). The Columbia River Basalt Group consists of a series of lava flows that erupted from 17 to 6 million years ago. Individual flows range from 10 to more than 300 ft in thickness, and the total thickness of the flows was estimated to be greater than 15,000 ft in some places (Kahle and others, 2011; Vaccaro and others, 2015). The basaltic-rock aquifer consists of a series of productive basalt units, the most extensive of which is the Grande Ronde Basalt, separated by less permeable interbeds that act as confining units in most places (Whitehead, 1994; Kahle and others, 2011). Groundwater flow is from topographically high margins of the plateau toward major surface drainages, including the Columbia and Snake Rivers. The Cascade Range in Oregon and Washington is an important recharge area for the western part of the regional aquifer system, whereas the western Rocky Mountains and Blue Mountains serve as important recharge areas in the eastern and southern extents of the Columbia Plateau, respectively. Locally, groundwater levels in the Columbia Plateau have changed by up to hundreds of feet because of irrigation practices, resulting in increases (recharge from irrigation) and decreases (groundwater pumping).

The Columbia Plateau basaltic-rock aquifers PAS network (clptpas1; fig. 3) includes 60 public-supply wells, which were selected using an equal-area grid of 60 cells. All 60 of the wells that were selected using the equal-area grid were sampled between June and September 2016 and have data presented in this report. Most of these wells ranged in depth from 91 to 2,434 ft, had a median depth of 484 ft (appendix 2, table 2.1), and were open to the aquifer across long intervals ranging up to approximately 1,297 ft (appendix 2, table 2.2).

One well in this network also was sampled as part of the Columbia Plateau ETN (clptetn1) network (table 1) described later in this report and in Arnold and others (2017a,b).

High Plains Aquifer Principal Aquifer Study Network (hpaqpas1)

The High Plains aquifer underlies an area of 170,000 mi^2, which has a population of about 2 million people in parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, Texas, South Dakota, and Wyoming (U.S. Census Bureau, 2010). The High Plains aquifer previously was described in Arnold and others (2018a,b), and the description is not repeated in this report.

The High Plains aquifer system PAS network (hpaqpas1, fig. 4) consists of 80 public-supply wells that were selected based on an equal-area grid. The area of each cell was about 2,122 mi^2. Data are presented in this report for 17 wells sampled between May and July 2016 in Texas. An additional 63 wells were sampled March and September 2015 in Colorado, Kansas, Nebraska, New Mexico, Oklahoma, and Wyoming; data from the 2015 sampling are available in Arnold and others (2018a,b). Wells in the hpaqpas1 that were sampled in 2016 ranged from 180 to 812 ft deep with a median depth of about 321 ft (appendix 2, table 2.1); wells were open to the aquifer across a range of intervals, from 82 to 265 ft, with a median interval of about 161 ft (appendix 2, table 2.2).

Ozark Plateaus Aquifer System Principal Aquifer Study Network (ozrkpas1)

The Ozark Plateaus aquifer system underlies an area of about 49,000 mi^2, including much of southern Missouri, northwestern Arkansas, and relatively small parts of Kansas and Oklahoma. About 4 million people reside in areas overlying this aquifer system (U.S. Census Bureau, 2010) and about 212 Mgal/d of groundwater was withdrawn for public and domestic supply in 2010 (Hays and others, 2016). Land use in the area overlying the Ozark Plateaus aquifer system is primarily agricultural (35 percent) and natural land cover (58 percent) with a small percentage (7 percent) of urban and other developed land (Homer and others, 2015); Springfield, Missouri, is the largest city overlying this aquifer system.

The Ozark Plateaus aquifers consists of three regional aquifers that are separated by confining units (Miller and Appel, 1997, Renken, 1998). The primary lithologies of the geologic formations making up the aquifers are limestone and dolomite. The uppermost Springfield aquifer and the intermediate Ozark aquifer are the primary water-bearing units in this aquifer system. The lowermost St. Francois aquifer has limited use in Arkansas because of its depth and the availability of water in the shallower aquifers and is used primarily where it is near the surface in Missouri (Miller and Appel, 1997). The carbonate rocks that make up these aquifers are susceptible to dissolution and, as a result, karst features such as sinkholes, springs, and caves are common across this aquifer system. Recharge to these aquifers is primarily from infiltration of rainfall, but sinkholes provide areas of focused recharge (Renken, 1998).

The Ozark Plateaus aquifer system PAS network (ozrkpas1; fig. 5) includes 60 public-supply wells distributed across the extent of the aquifer system. Wells were selected using a 60-cell equal-area grid that extended across the extent of the aquifer system. Samples were collected between April and August 2016, and the data for these samples are presented in this report. Wells in the ozrkpas1 ranged from about 370 to 3,420 ft deep and had a median well depth of about 1,115 ft. (appendix 2, table 2.1).

Decadal Trends Networks—Land-Use Study Networks

The LUS networks are designed to facilitate analysis of land-use effects on shallow groundwater quality. Wells in LUS networks are sampled once per decade to assess temporal trends in water quality. Wells in LUS networks typically are shallow and screened near the water table to allow sampling of recently recharged groundwater that may exhibit chemical characteristics indicative of the overlying land use. The LUS areas are determined by the areal extents of the primary aquifer and a targeted overlying land use (Lapham and others, 1995). Data from the following LUS networks are included in this report: Lake Erie-Lake St. Clair drainages urban LUS network (lerilusrc1; fig. 6) near Detroit, Michigan; Rio Grande aquifer system agricultural LUS network (rioglusag1; fig. 7); Rio Grande aquifer system urban LUS network (rioglusrc1; fig. 8) near Albuquerque, New Mexico; Santee River Basin and Coastal Drainages urban LUS network (santusrc1; fig. 9) near Columbia, South Carolina; Upper Mississippi River Basin urban LUS network (umislusrc1; fig. 10) near Minneapolis/St. Paul, Minnesota; and Upper Snake River Basin agricultural LUS network (usnkluscr2; fig. 11).

Lake Erie-Lake St. Clair drainages urban land-use study network (lerilusrc1)

The Lake Erie-Lake St. Clair drainages urban LUS network (lerilusrc1; fig. 6) was established to assess how recent residential and commercial land use affects the quality of shallow groundwater in the developed area north and west of Detroit, Mich. The lerilusrc1 study area covers about 600 mi^2 and coincides with the boundary of the lerisus1 network described later in this report. Discontinuous layers of sand and gravel are present at various depths within the glacial till, and collectively, these layers of sand and gravel are considered an aquifer system that is variably confined (Fleming, 1994). The hydrogeology is complex because of heterogeneity of glacial materials, fracturing in the surficial till, and the network of tile drains. (Thomas, 2000a).

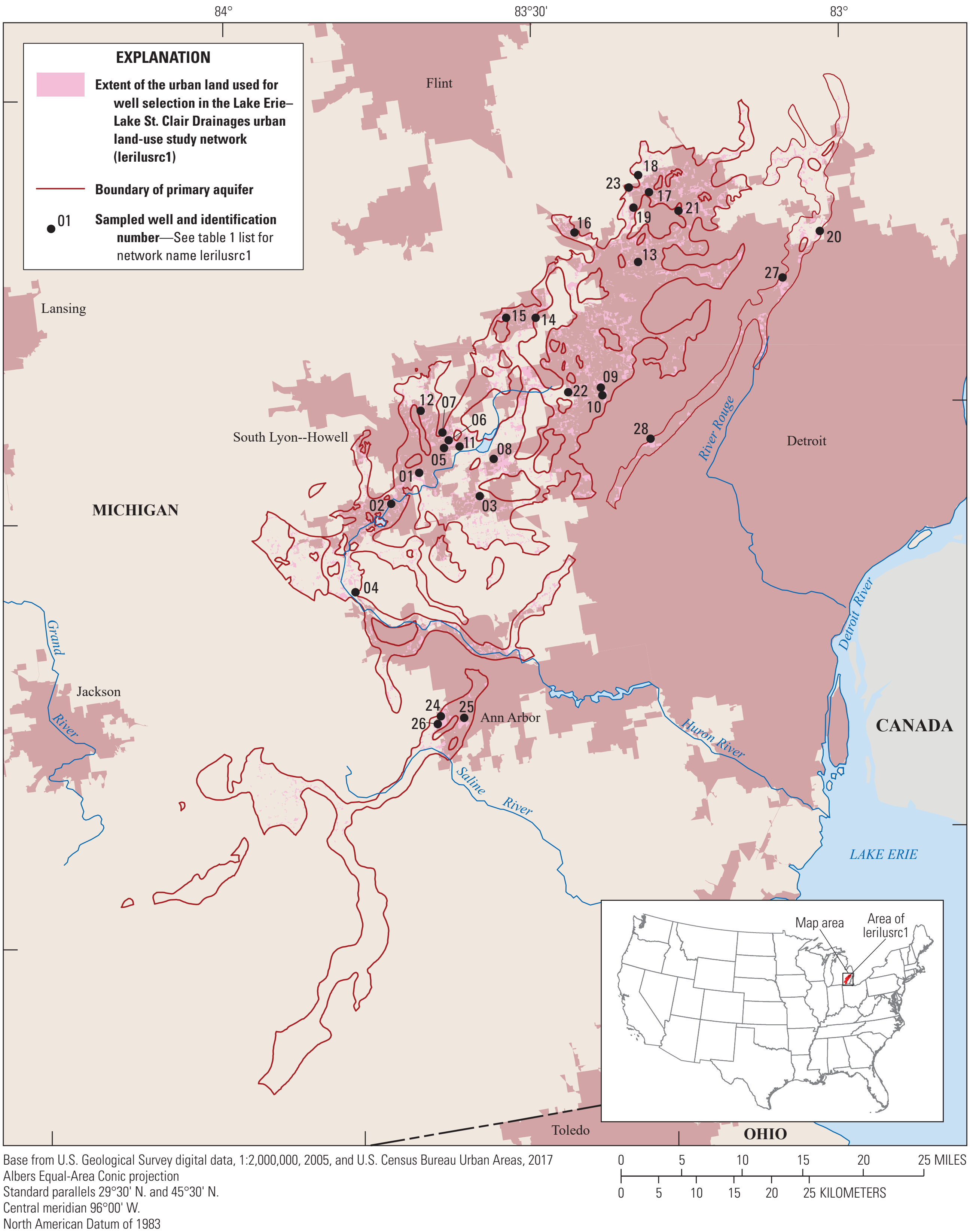


Figure 6. Study area and wells sampled as part of the Lake Erie-Lake St. Clair drainages urban land-use study network (lerilusrc1) near Detroit, Michigan for the U.S. Geological Survey National Water-Quality Assessment Project.

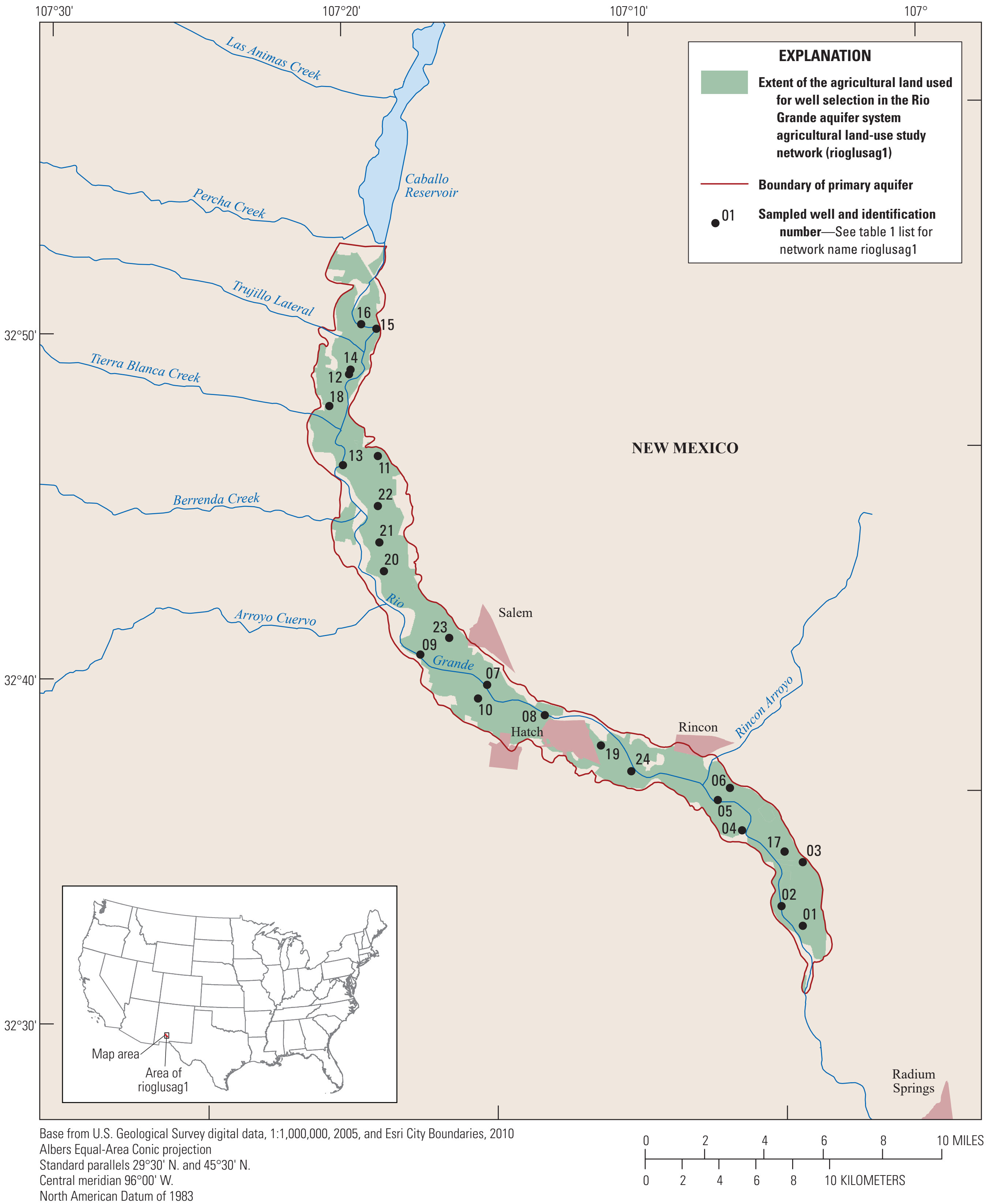
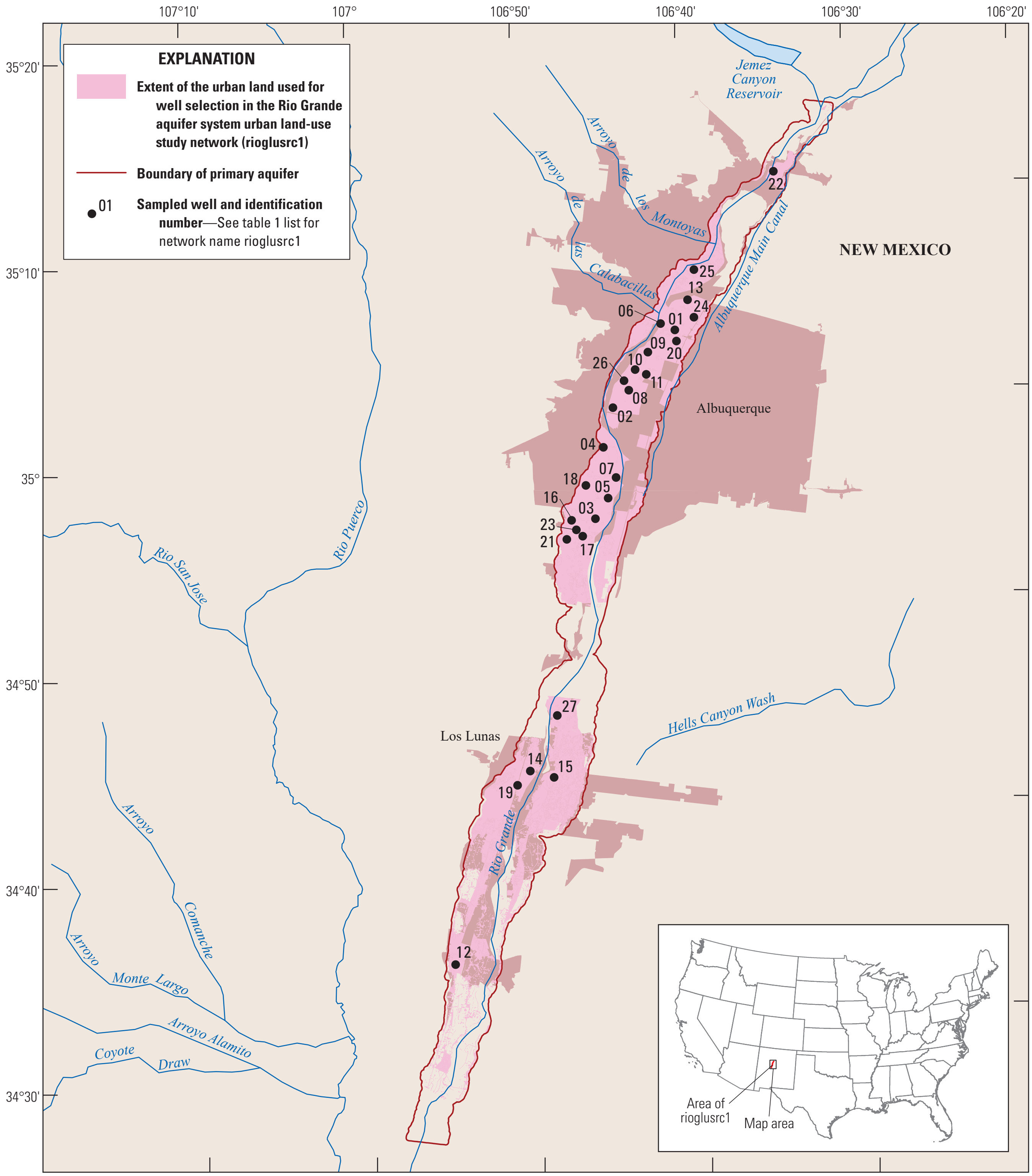


Figure 7. Study area and wells sampled as part of the Rio Grande aquifer system agricultural land-use study network (rioglusag1) for the U.S. Geological Survey National Water-Quality Assessment Project.



Base from U.S. Geological Survey digital data, 1:2,000,000, 2005, and U.S. Census Bureau Urban Areas, 2017
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' N.
Central meridian 96°00' W.
North American Datum of 1983

Figure 8. Study area and wells sampled as part of the Rio Grande aquifer system urban land-use study network (rioglusrc1) near Albuquerque, New Mexico for the U.S. Geological Survey National Water-Quality Assessment Project.

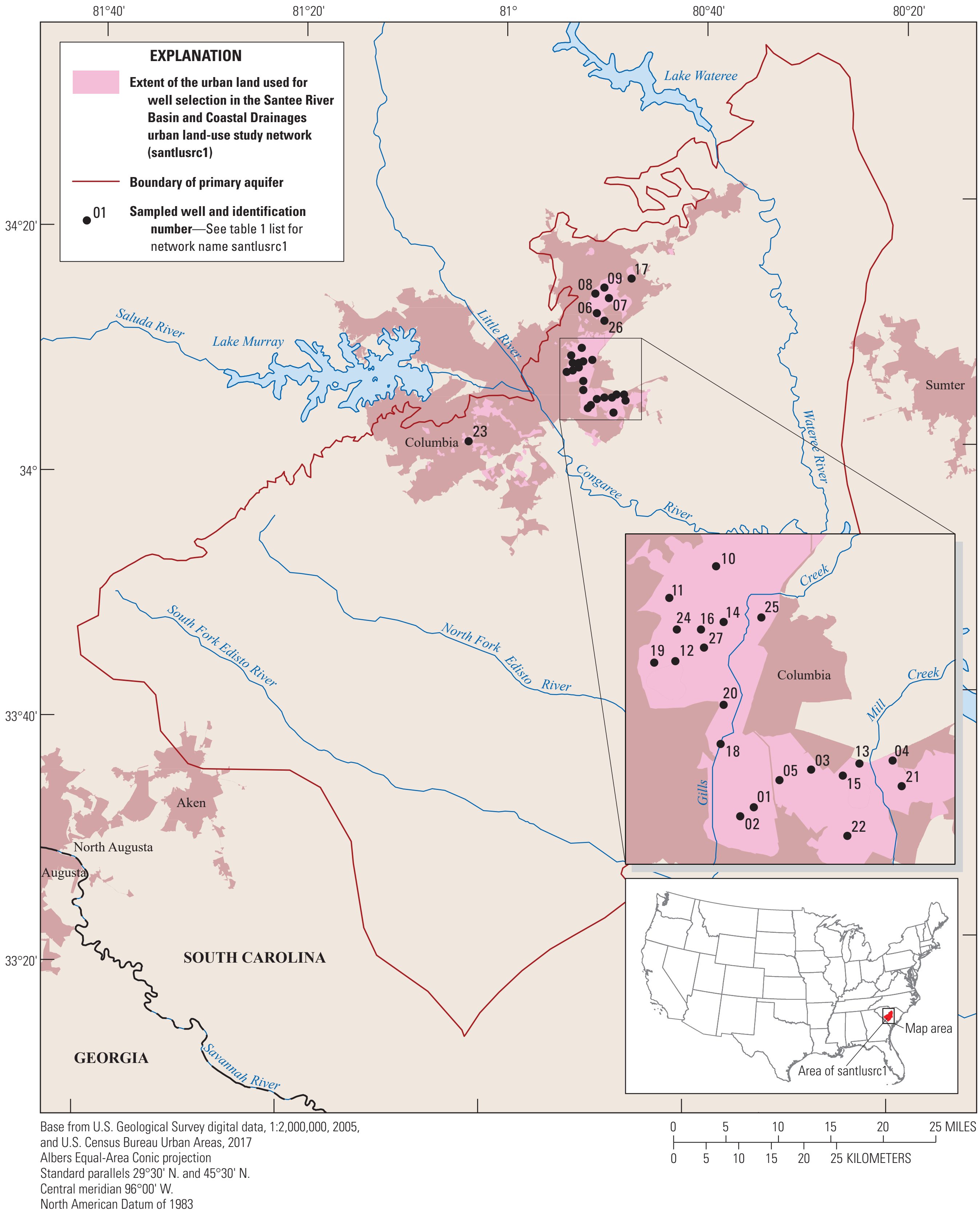


Figure 9. Study area and wells sampled as part of the Santee River Basin and Coastal Drainages urban land-use study network (santusrc1) near Columbia, South Carolina, for the U.S. Geological Survey National Water-Quality Assessment Project.

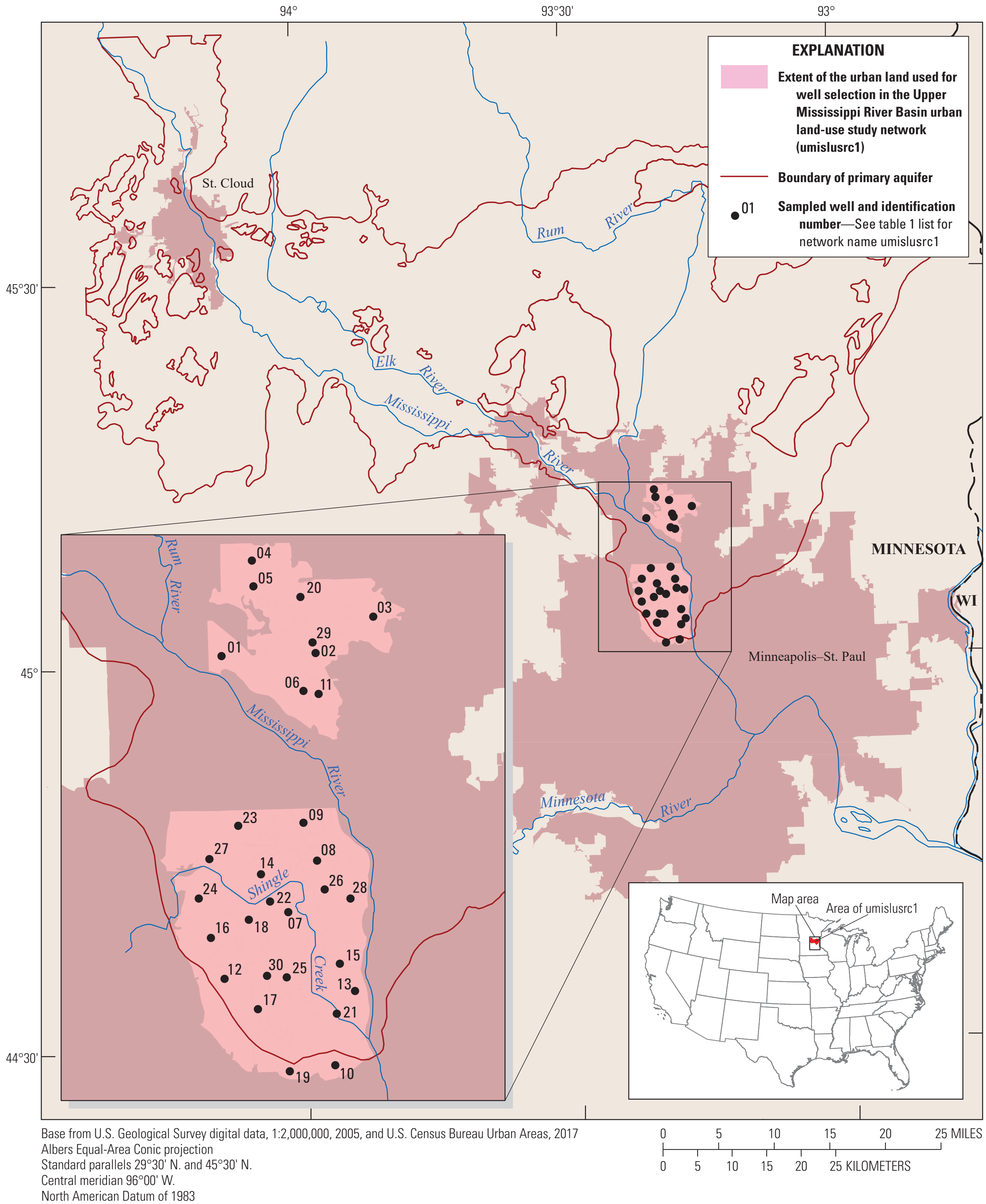


Figure 10. Study area and wells sampled as part of the Upper Mississippi River Basin urban land-use study network (umislusrc1) near Minneapolis/St. Paul, Minnesota, for the U.S. Geological Survey National Water-Quality Assessment Project.

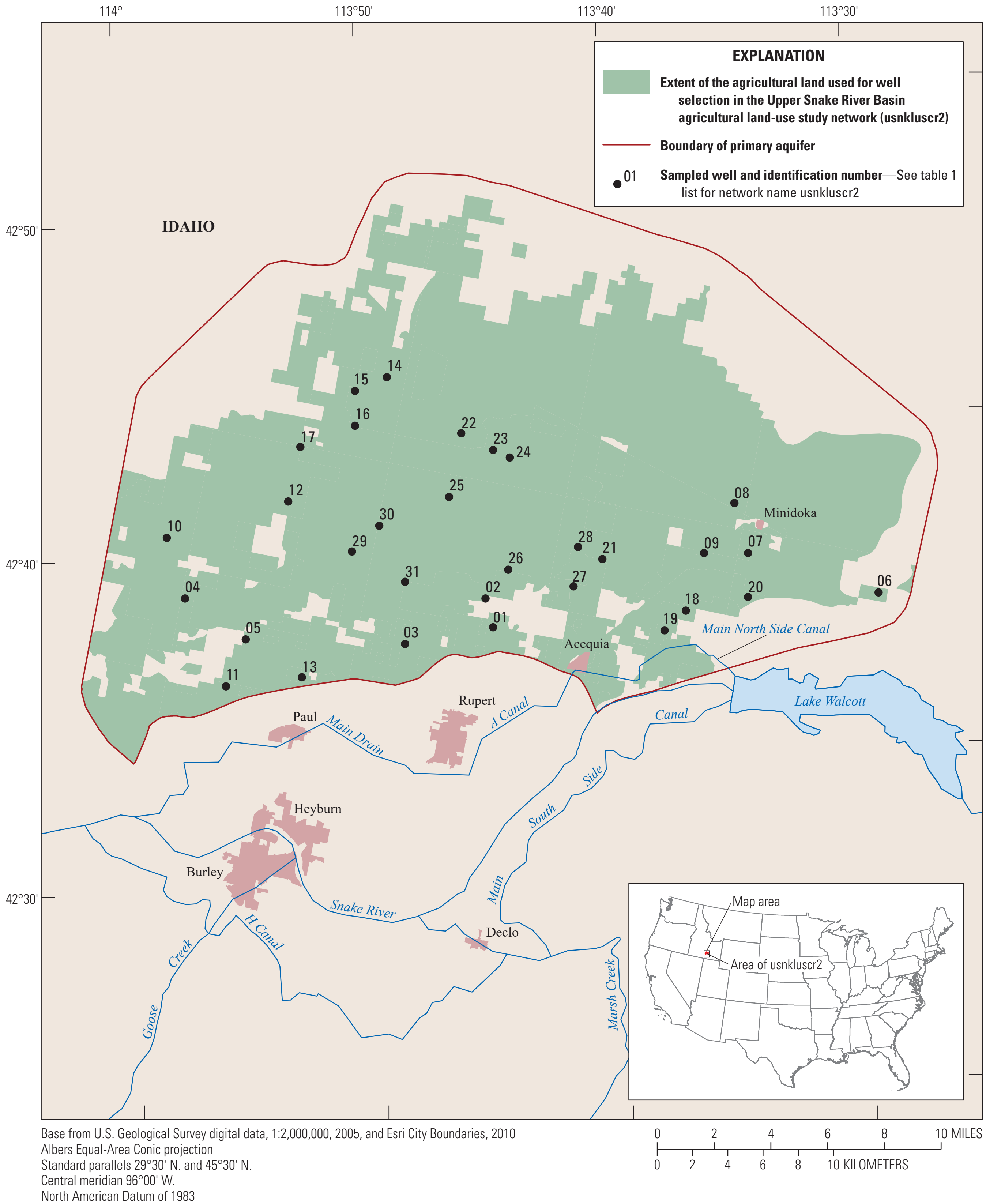


Figure 11. Study area and wells sampled as part of the Upper Snake River Basin agricultural land-use study network (usnkluscr2) for the U.S. Geological Survey National Water-Quality Assessment Project.

The LUS sampling network consists of 28 monitoring wells. The wells were typically about 16 to 46 ft deep (appendix 2, table 2.1) with about 4 to 8 ft screen intervals (appendix 2, table 2.2). The same 28 wells were also sampled as part of the glacvfps1 network (table 1) described later in this report. A total of 30 monitoring wells in the network were previously sampled in 1996 or 1997 (Thomas, 2000b) and in 2006. Subsets of wells also were sampled periodically from 2002 through 2010. Samples for the current phase of monitoring were collected from August through September 2016 and are reported here.

Rio Grande Aquifer System Agricultural Land-Use Study Network (rioglusag1)

The Rio Grande Valley agricultural LUS network (rioglusag1; fig. 7) was designed to characterize shallow groundwater quality in an agricultural area overlying the Rio Grande aquifer system in southern New Mexico. The study area of about 57 mi^2 lies within the flood plain of the Rio Grande in the narrow Rincon Valley. The aquifer system in the area consists of nonglacial sediments that can be divided into fine-grained basin-fill deposits of Tertiary age overlain by coarser valley-fill deposits of Quaternary age (Anderholm, 2002).

The rioglusag1 network consists of 24 monitoring wells completed near the water table in the Quaternary valley-fill deposits. The wells are of similar depths, ranging from about 15 to 37 ft, with a median of about 23 ft (appendix 2, table 2.1). The wells have open intervals of around 10 ft (appendix 2, table 2.2). The rioglusag1 network was previously sampled in 1994 and 2006; however, because of generally declining water levels, several wells in the original 1994 network have since gone dry. Samples for the current phase of monitoring were collected in April and May of 2016. One well in this network was also sampled as part of the Rio Grande aquifer system ETN (rgaqetn1) network (table 1) described later in this report.

Rio Grande aquifer system urban land-use study network (rioglusrc1)

The Rio Grande Basin urban LUS network (rioglusrc1, fig. 8) was designed to characterize shallow groundwater quality in an urban area overlying the Rio Grande aquifer system in central New Mexico. The study area of about 190 mi^2 in and near Albuquerque lies within the flood plain of the Rio Grande in the alluvial Middle Rio Grande Basin. The aquifer system in the basin consists of nonglacial sand and gravel that can be divided into basin-fill deposits of Tertiary age, generally thousands of feet thick, overlain by valley-fill deposits of Quaternary age, typically less than about 130 ft thick (Hawley and Haase, 1992). The aquifer system is used mainly for municipal and domestic water supply. Although the network is intended to focus on water quality underlying areas of residential and commercial land use, the study area also includes agricultural land (Anderholm, 1997).

The rioglusrc1 network consists of 27 monitoring wells completed near the water table in the Quaternary valley-fill deposits. The wells range in depth from about 13 to 57 ft, with a median of about 27 ft (appendix 2, table 2.1). Open intervals range from 5 to 15 ft and are typically about 10 ft (appendix 2, table 2.2). Several wells in the rioglusrc1 network were previously sampled in 1993, 2006, or both. There were 15 wells in this network sampled also as part of the Rio Grande aquifer system VFPS (rgaqvfps1) network (table 1) described later in this report. Samples for the current phase of monitoring were collected in July and August 2016.

Santee River Basin and Coastal Drainages Urban Land-Use Study Network (santusrc1)

The Santee River Basin and Coastal drainages urban LUS network (santlusrc1; fig. 9) consists of 27 monitoring wells installed between 8 and 54 ft deep (appendix 2, table 2.1) in semiconsolidated sand. The study area of about 3,400 mi^2 is near Columbia, South Carolina, and was designed to characterize shallow groundwater quality in a commercial and residential area. The wells are screened in the Middendorf Formation, which is part of the sandhills aquifers (Hughes and others, 2000) and the McQueen Branch Aquifer (Campbell and Landmeyer, 2014). This network previously was sampled in 1996 and 2006. Samples for the current phase of monitoring were collected in August 2016.

Upper Mississippi River Basin Urban Land-Use Study Network (umislusrc1)

The Upper Mississippi River Basin urban LUS network (umislusrc1; fig. 10) was designed to characterize the effects of urban residential and commercial development activities on shallow groundwater in a surficial sand and gravel aquifer system in the northwestern part of Minneapolis-St. Paul, Minnesota. The study area covers about 1,600 mi^2. and overlies an area of 50 to greater than 400 ft of sand, gravel, and clay, which were deposited as river terraces or overbank deposits by melt water from the Des Moines Lobe during the late Wisconsinin glacial period (Andrews and others 1997). Estimated transport times from the land surface to the water table indicate that this sand and gravel aquifer is highly susceptible to contamination from activities at the land surface (Peigat, 1989; Meyer, 1993).

The umislusrc1 consists of 30 shallow monitoring wells completed immediately below the water table at depths from about 9 to 33 ft with a median of 18 ft, (appendix 2, table 2.1). Open intervals generally were 5 ft (appendix 2, table 2.2). Wells from the umislusrc1 network were previously sampled in 1997–98 and 2006. Samples for the current phase of monitoring were collected during July, August, and September 2016, and these data are presented in this report.

Upper Snake River Basin Agricultural Land-Use Study Network (usnkluscr2)

The Upper Snake River Basin agricultural LUS network (usnkluscr2; fig. 11), with a study area of about 400 mi^2, was designed to characterize groundwater quality underlying agricultural land use in the East Snake River Plain aquifer in the Upper Snake River Basin in southern Idaho. The aquifer is composed of a series of Quaternary basalt flows that are vesicular and broken and able to transmit large volumes of water (Whitehead, 1992). The study area is characterized by a history of elevated nitrate concentrations in groundwater and is predominantly an area of groundwater-sourced irrigated agriculture (Rupert, 1997; Skinner, 2003).

The usnkluscr2 network includes 31 wells, mostly used for domestic supply. The wells range in depth from 125 to 469 ft (median of 256 ft) with a large range of open intervals from 2 to about 337 ft (median of 171 ft; appendix 2; table 2.1). Most wells are cased at the surface only with open-hole well construction. Samples for the current phase of monitoring were collected during June 2016.

Decadal Trends Networks—Major Aquifer Study Networks

The MAS networks were designed to reflect the resource used for domestic supply. The MAS networks generally consist of domestic-supply wells but also may include public-supply or other types of wells. Domestic-supply wells typically draw smaller volumes of groundwater and from shallower depths of the aquifer than do public-supply wells. The MAS areas are determined by the areal extent of the primary aquifer and physiography and are designed to assess the condition of groundwater quality in the most heavily used aquifer in the area (Lapham and others, 1995; Koterba and others, 1995). Wells in MAS networks are sampled once per decade to assess temporal trends in water quality. Data from the following MAS networks are included in this report: Lake Erie-Lake St. Clair drainages MAS network (lerisus1; fig. 12), Nevada Basin and Range MAS network (nvbrsus2; fig. 13), and Puget Sound drainages MAS network (pugtsus1; fig. 14).

Lake Erie-Lake St. Clair Drainages Major Aquifer Study Network (lerisus1)

The Lake Erie-Lake St. Clair drainages MAS network (lerisus1; fig. 12) was established to assess the water quality of an aquifer that is an important source of drinking water in the developed area north and west of Detroit, Mich. The lerisus1 study area covers about 2,500 mi^2 and coincides with the boundary of the lerilusrc1 network (described previously). Groundwater is drawn from discontinuous layers of sand and gravel that are present at various depths within the glacial till. Collectively, these layers of sand and gravel are an aquifer system that is variably confined (Fleming, 1994). The hydrogeology is complex because of heterogeneity of glacial materials, fracturing in the surficial till, and the network of agricultural tile drains. (Thomas, 2000a).

The lerisus1 consists of 24 domestic wells. The wells ranged from 35 to 205 ft deep (appendix 2, table 2.1) with 3- to 10-ft screen intervals (appendix 2, table 2.2). A total of 27 wells in the network were previously sampled in 1997 (Thomas, 2000b). Samples for the current phase of monitoring were collected from August through September 2016, and these data are reported here.

Nevada Basin and Range Major Aquifer Study Network (nvbrsus2)

The Nevada Basin and Range MAS Network (nvbrsus2; fig. 13) was designed to broadly assess the quality of groundwater in the Basin and Range basin-fill aquifers, specifically in the deep Truckee Meadows and Eagle Valley alluvial aquifers within the Truckee and Carson River Basins in western Nevada. The nvbrsus2 study area is about 380 mi^2 overlying an aquifer of nonglacial sand and gravel. Historically, agriculture was the chief land use in both valleys; however, most land has been urbanized with only about 1,200 acres for agriculture remaining in the Truckee Meadows and less than 500 acres in Eagle Valley (Homer and others, 2015).

The nvbrsus2 includes 30 wells, mostly public-supply wells (table 1). The wells range from 105 to 815 ft deep and have a median depth of 347 ft (appendix 2, table 2.1). The wells have a wide range of open intervals from 10 to 670 ft, with a median of around 193 ft (appendix 2, table 2.2). This network was previously sampled in1995 and 2003. Samples for the current phase of monitoring were collected in July through September 2016.

Puget Sound Drainages Major Aquifer Study Network (pugtsus1)

The Puget Sound Drainages MAS network (pugtsus1; fig. 14) was established to characterize the quality of shallow groundwater in the unconfined parts of the Fraser aquifer. The pugtsus1 study area covers about 2,100 mi^2 between the Canadian border, the Olympic Mountains, and the Cascade Range. Aquifers in the Puget Sound area are contained mostly within the Puget Sound Lowland, which is a structural basin filled with alluvial, glacial, and interglacial unconsolidated sediments, which can be locally more than 3,000 ft thick. (Jones, 1999). These aquifers are vulnerable to contamination where they are shallow, coarse-grained, unconfined, and overlain by urban or agricultural land use (Tesoriero and Voss, 1997). The Fraser aquifer is composed primarily of

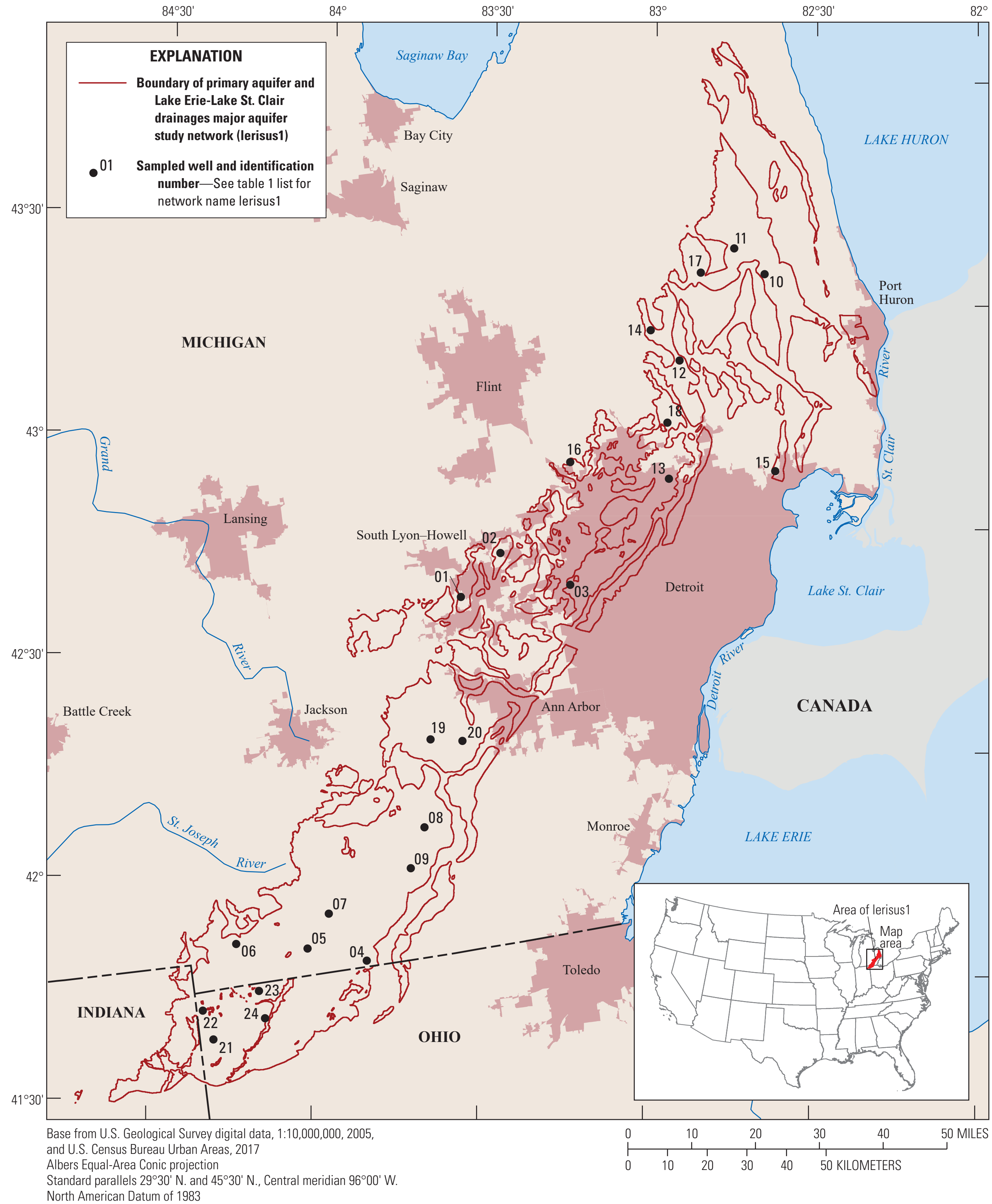


Figure 12. Study area and wells sampled as part of the Lake Erie-Lake St. Clair drainages major aquifer study network (lerisus1) for the U.S. Geological Survey National Water-Quality Assessment Project.

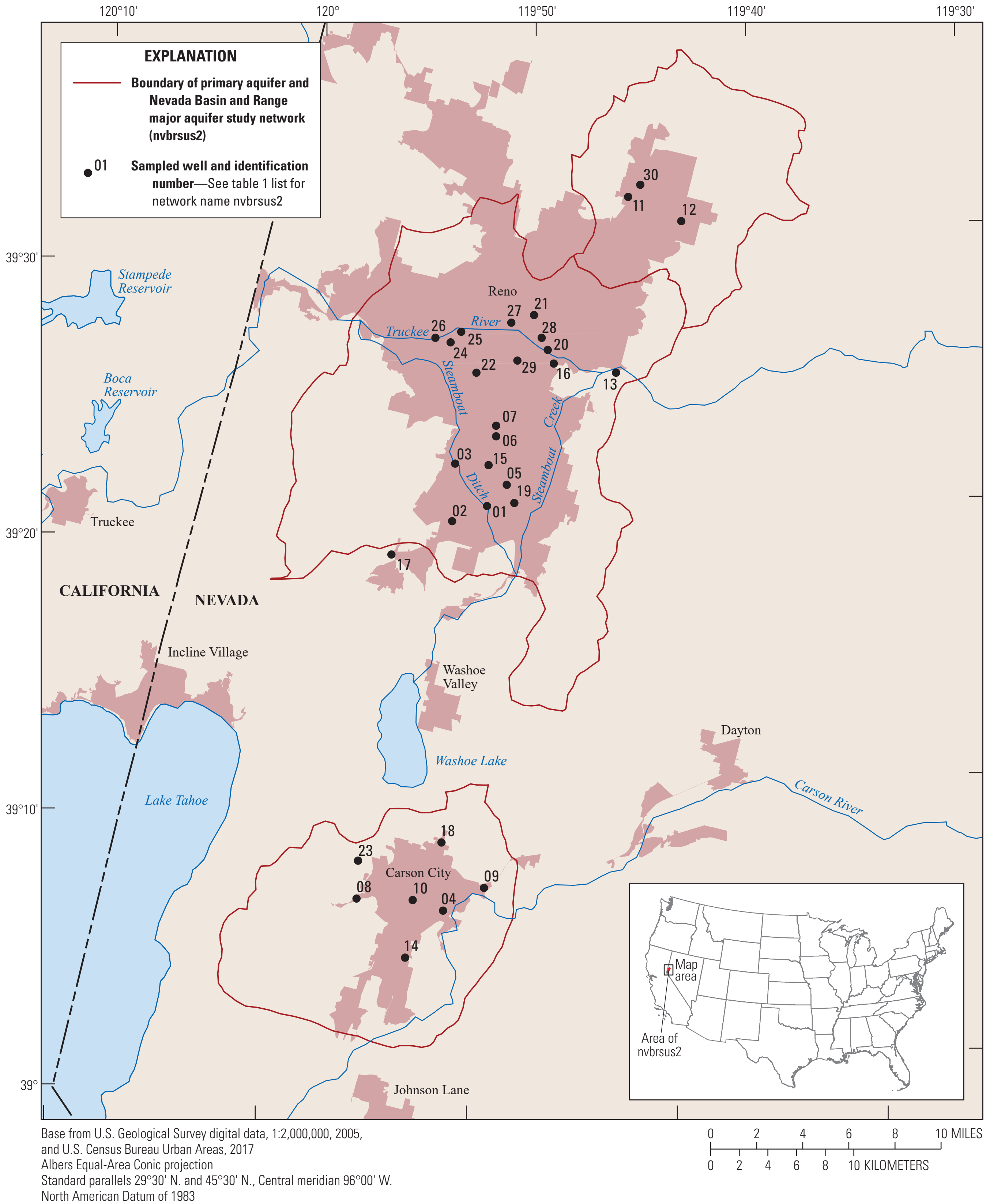


Figure 13. Study area and wells sampled as part of the Nevada Basin and Range major aquifer study network (nvbrsus2) for the U.S. Geological Survey National Water-Quality Assessment Project.

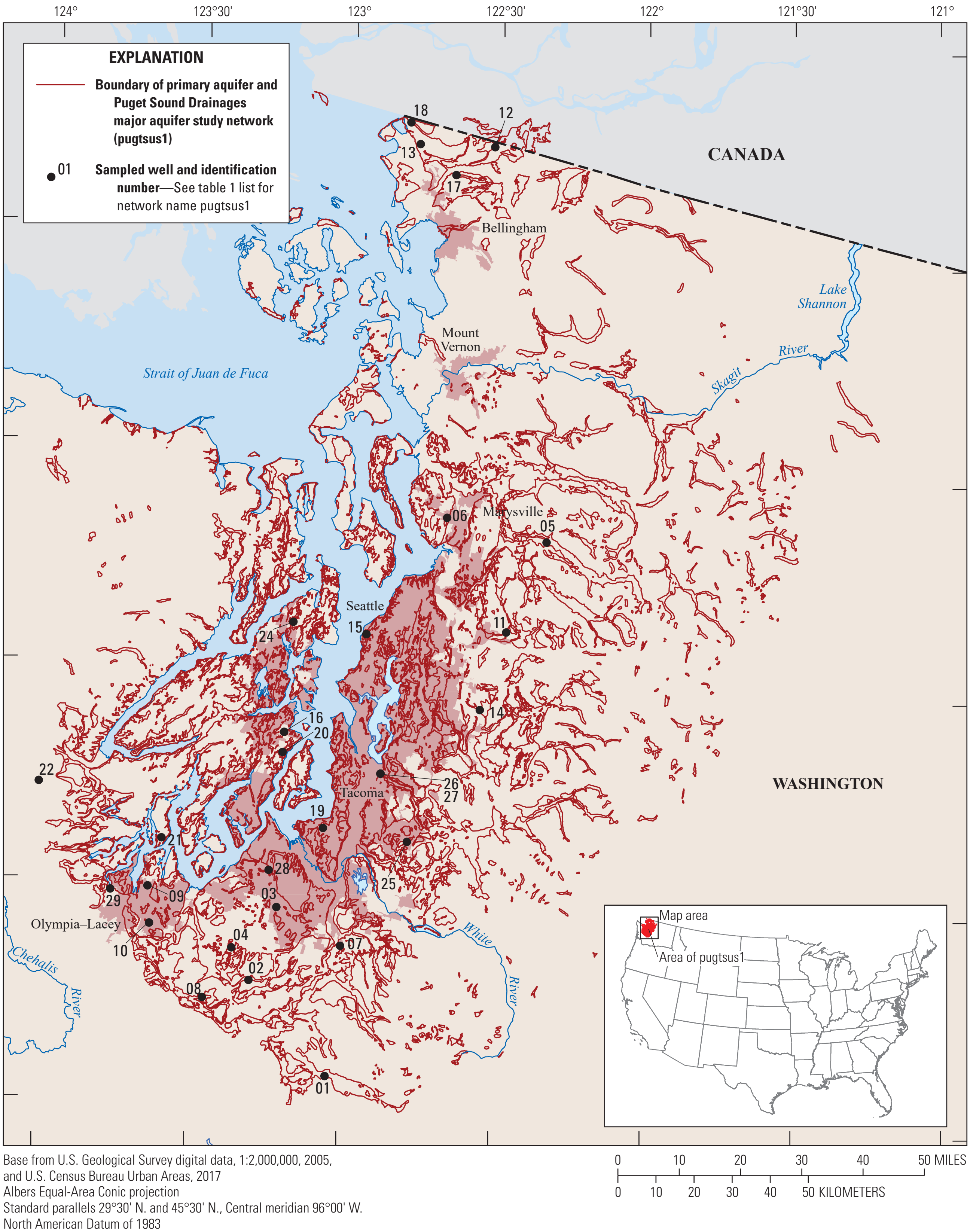


Figure 14. Study area and wells sampled as part of the Puget Sound drainages major aquifer study network (pugtsus1) for the U.S. Geological Survey National Water-Quality Assessment Project.

coarse-grained outwash deposited during glacial advances and retreats, with some finer materials interbedded (Jones, 1999). The quality of groundwater of the Puget Sound Basin area is of concern because of its importance for municipal and domestic supplies of potable water (Staubitz and others, 1997).

The pugtsus1 consists of 29 primarily drinking water wells (table 1). The wells were between about 22 and 309 ft deep (appendix 2, table 2.1) with screens generally between 5 and 10 ft long but as much as 60 ft long (appendix 2, table 2.2). A total of 30 wells in the network were previously sampled in 1996 (Inkpen and others, 2000). Samples for the current phase of monitoring were collected in August through December 2016, and these data are reported here.

Enhanced Trends Networks

An ETN consists of a small number of wells (typically two to four) that are sampled frequently to evaluate the time scales during which groundwater quality changes. Such changes might result from seasonal or annual variability in recharge, discharge, or contaminant loading (Rowe and others, 2013). Data from eight ETNs are included in this report (figs. 15–16): Central Valley ETN (cvaletn1), Columbia Plateau ETN (clptetn1), Edwards-Trinity aquifer system ETN (edtretn1), glacial aquifer system ETN (glacetn1), Mississippi Embayment aquifer system ETN (metxent1), Northern Atlantic Coastal Plain ETN (nacpetn1), New England crystalline-rock and glacial aquifer system ETN (negxetn1), and the Rio Grande aquifer system ETN (rgaqetn1).

Wells in an ETN are instrumented for high-frequency measurement of selected parameters and they periodically have discrete measurements of additional parameters. The parameters measured at a high frequency differ among wells and networks but generally include parameters like temperature, dissolved oxygen, pH, and specific conductance. Data collected at a high frequency for wells in the ETNs are available online; links to the data are provided in appendix 3, table 3.1.

For periodic discrete sampling, the ETNs are divided into two groups of four networks that are sampled on a 4-year alternating cycle. Four networks are sampled about once every 2 months for 4 years, whereas the other four networks are sampled annually. After the first 4-year period, the sampling frequency switches; the networks that were sampled every 2 months during the first period are sampled annually, and the other four networks are sampled every 2 months. Water-quality data from the discrete sampling during 2016 are included in this report and in Arnold and others (2020).

Central Valley Enhanced Trends Network (cvaletn1)

The Central Valley ETN (cvaletn1; fig. 15*A*, *C*) in the Central Valley aquifer system is intended to aid in the understanding of the subsurface movement of groundwater constituents (in some cases contaminants from land-use practices) between the shallow and deep parts of the aquifer system. The environmental setting of cvaletn1 previously was described in Arnold and others (2017a,b) and is not repeated in this report.

The cvaletn1 is made up of three wells that represent different depths in the regional aquifer (table 1). Two wells are relatively shallow (CVALETN1–02, 320 ft deep; and CVALETN1–03, 234 ft deep), and one well is relatively deep (CVALETN1–01, 620 ft deep). All three wells in the cvaletn1 were sampled previously in 2013 (Arnold and others, 2016a,b), 2014 (Arnold and others, 2017a,b), and 2015 (Arnold and others, 2018a,b). CVALETN1–02 also was sampled in 2013 as part of the cvalfps2 network (table 1) described later in this report. Data from the 2016 sampling are included in this report and in Arnold and others (2020).

Columbia Plateau Enhanced Trends Network (clptetn1)

The Columbia Plateau ETN (clptetn1; fig. 15*A*, *B*) in the Columbia Plateau aquifer system was designed to investigate questions about how groundwater quality differs between the shallow basin-fill (unconsolidated deposits) aquifers and the deeper, underlying basaltic-rock aquifers and how water quality varies along the flow paths. The environmental setting of clptetn1 previously was described in Arnold and others (2017a,b) and is not repeated in this report.

The clptetn1 is made up of wells that represent different positions within the regional groundwater flow system at different depths (table 1). Well CLPTETN1–01 is a shallow (80 ft), domestic well in the sand and gravel aquifer. Well CLPTETN1–04 is a deep (1,116 ft), long-screened (926–1,100 ft) supply well that is open to the basaltic-rock aquifers; this well is about 20 mi south of the Columbia River and is the most proximal of the three wells. Well CLPTETN1–05 is a shallow to moderate depth (170 ft) industrial well, cased to 144 ft also in the sand and gravel aquifer.

Wells CLPTETN1–02 and CLPTETN1–03 were sampled as part of the clptetn1 in 2014 (Arnold and others, 2017a,b); however, because of issues with sample quality and sampling access, these wells are no longer included in the clptetn1. Well CLPTETN1–01 also was sampled in 2014 (Arnold and others, 2017a,b). Wells CLPTETN1–01, CLPTETN1–04, and CLPTETN1–06 were sampled in 2015, and the data were reported in Arnold and others (2018a,b). Well CLPTETN1–06 was not resampled in 2016 because access to the well was denied; well CLPTETN1–05 was sampled instead. CLPTETN1–04 was also sampled as part of the clptpas1 network (table 1) described earlier in this report. Wells CLPTETN1–01, CLPTETN1–04, and CLPTETN1–05 were sampled in 2016 and the data are included in this report and in Arnold and others (2020).

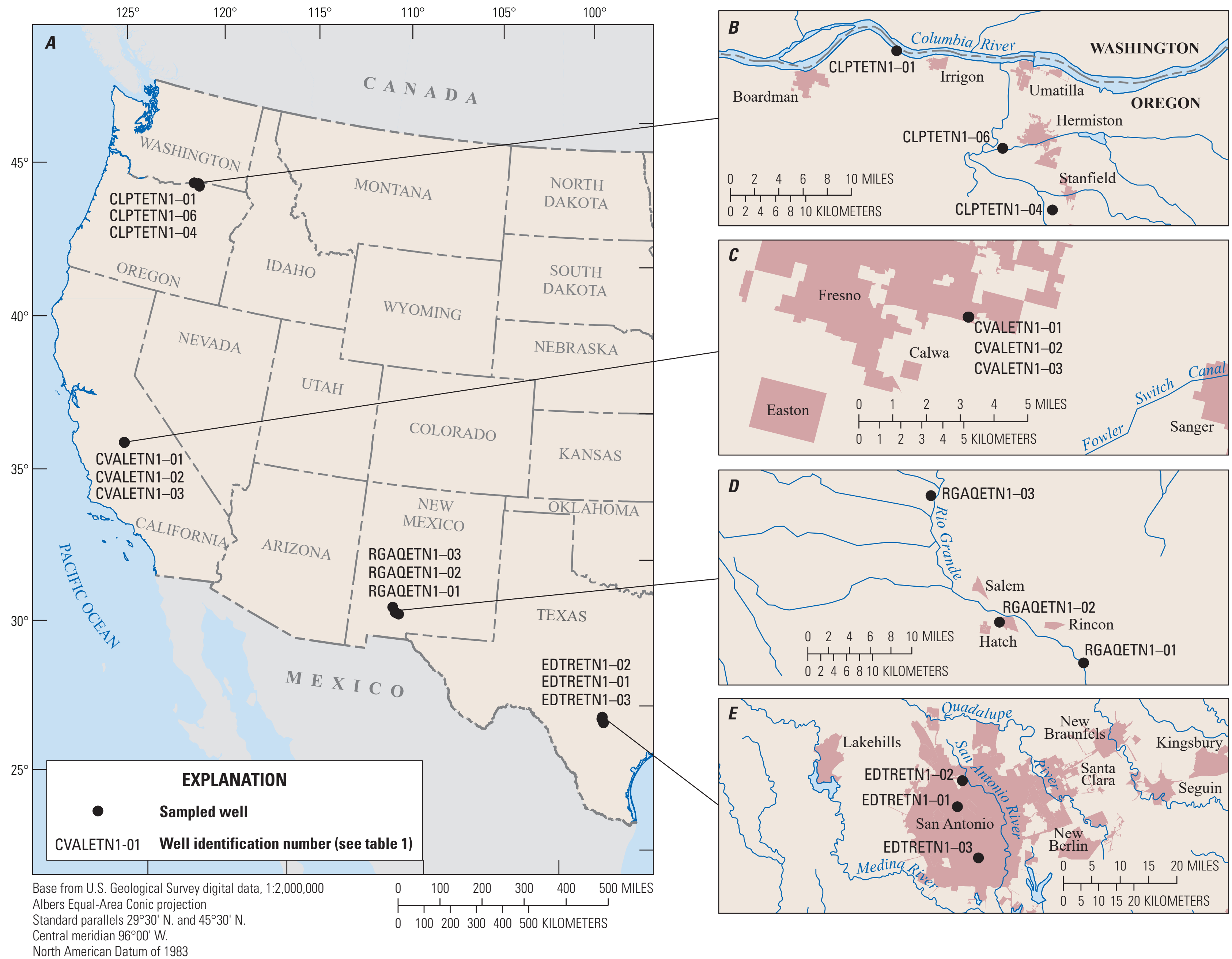


Figure 15. The, *A*, study areas and wells sampled in the western United States as part of the enhanced trends networks for the U.S. Geological Survey National Water-Quality Assessment Project; and details of well locations for, *B*, clptetn1; *C*, cvaletn1; *D*, rgaqetn1; and, *E*, edtretn1.

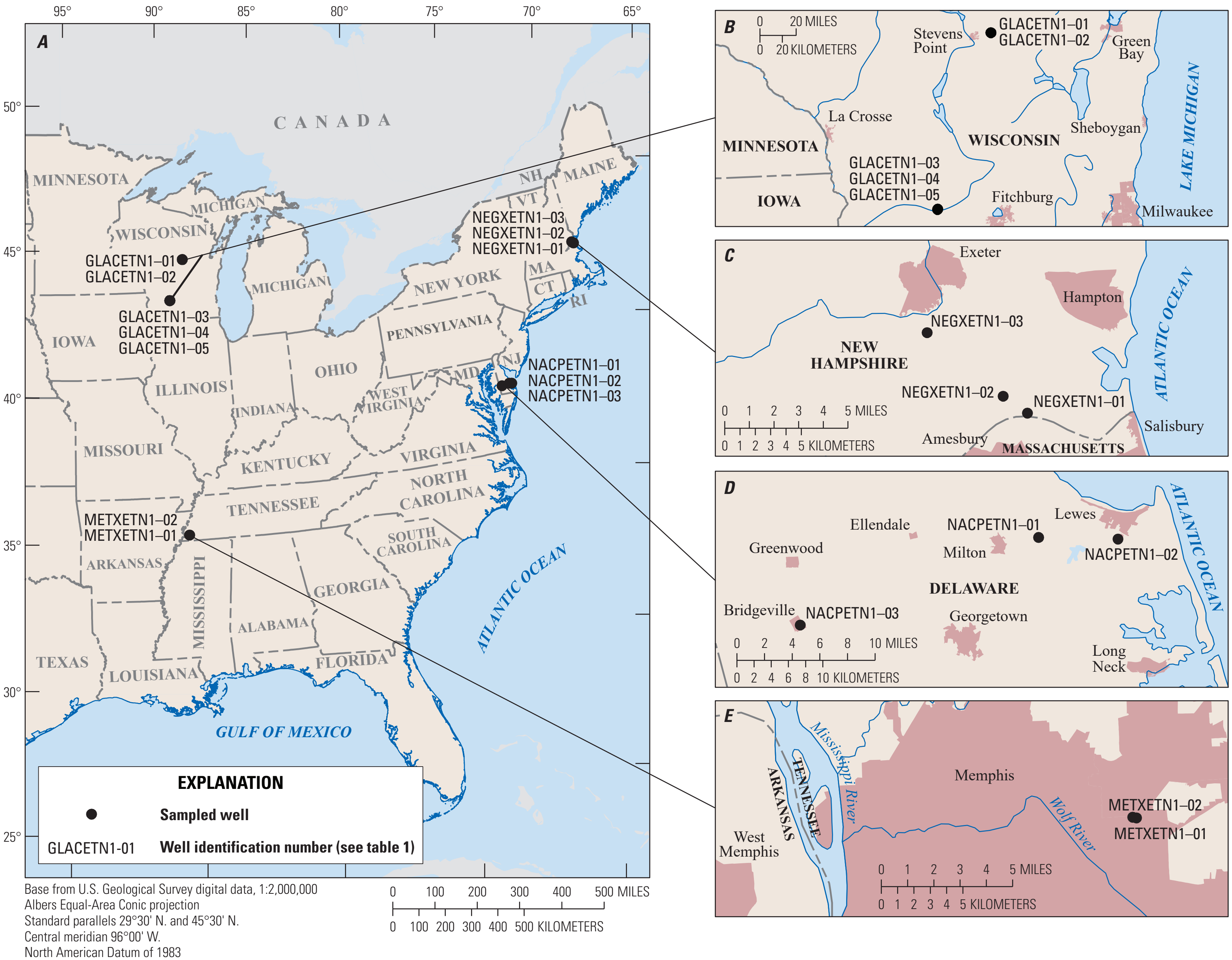


Figure 16. The, *A*, study areas and wells sampled in the eastern United States as part of the enhanced trends networks for the U.S. Geological Survey National Water-Quality Assessment Project; and details of well locations for, *B*, glacetn1; *C*, negxetn1; *D*, nacpetn1; and, *E*, metxetn1.

Edwards-Trinity Aquifer System Enhanced Trends Network (edtretn1)

The Edwards-Trinity aquifer system ETN (edtretn1; fig. 15*A*, *E*) was designed to evaluate temporal variability in groundwater quality in a dynamic karst aquifer. The environmental setting of edtretn1 previously was described in Arnold and others (2017a,b) and is not repeated in this report.

There are three wells in the edtretn1 (table 1) that are along an approximately north-to-south aquifer transect within the San Antonio metropolitan area (fig. 15*E*). One well is in the upgradient, unconfined recharge zone, and two wells are downgradient in the confined zone. The upgradient well (EDTRETN1–02) is 300 ft deep and open to the aquifer along the bottom 80 ft of its depth (table 1). The downgradient wells are 550 ft (EDTRETN1–01) and 1,550 ft (EDTRETN1–03) deep and are open to the aquifer throughout their length below the confined zone (table 1). The farthest downgradient well (EDTRETN1–03) is close to the southern boundary of the aquifer. Wells in the edtretn1 were first sampled as part of the edtretn1 in 2013 (Arnold and others, 2016a,b), and were sampled again in 2014 (Arnold and others, 2017a,b) and 2015 (Arnold and others, 2018a,b). During 2016, the wells were sampled about bimonthly from January through October 2016, and these data are included in this report and in Arnold and others (2020).

Glacial Aquifer System Enhanced Trends Network (glacetn1)

The glacial aquifer system ETN (glacetn1; fig. 16*A*, *B*) was designed to identify the temporal variability and magnitude of observed changes in groundwater quality in agricultural areas of the glacial aquifer system. The environmental setting of glacetn1 previously was described in Arnold and others (2017a,b) and is not repeated in this report.

The glacetn1 consists of five wells distributed in two locations. A location in central Wisconsin has two monitoring wells: GLACETN1–01 (83 ft deep) and GLACETN1–02 (34.5 ft deep). A location in southwestern Wisconsin has three wells: monitoring wells GLACETN1–03 (50 ft deep) and GLACETN1–04 (89 ft deep), and public-supply well GLACETN1–05 (125 ft deep). All wells in the glacetn1 were sampled in 2016, and these data are included in this report and in Arnold and others (2020). Wells GLACETN1–01 and GLACETN1–02 also were sampled in 2014 as part of the Glacial aquifer FPS (glacfps1) (table 1) described later in this report. Wells GLACETN1–01 and GLACETN1–02 have been sampled every year since 2014; and GLACETN1–03, GLACETN1–04, and GLACETN1–05 have been sampled every year since 2015 (Arnold and others, 2017a,b, 2018a,b, 2020) .

Mississippi Embayment Aquifer System Enhanced Trends Network (metxetn1)

The Mississippi Embayment aquifer system ETN (metxetn1; fig. 16*A*, *E*) was designed to study how water quality in shallow and deep parts of the regional aquifer changes in response to changing hydrologic conditions and pumping. The environmental setting of metxetn1 previously was described in Arnold and others (2017a,b) and is not repeated in this report.

The metxetn1 consists of one well in the shallow aquifer (METXETN1–02, 90 ft deep) and one well in the Memphis aquifer (METXETN1–01, 624 ft deep) (table 1). The wells were first sampled as part of the metxetn1 in 2013 (Arnold and others, 2016a,b) and again in 2014 (Arnold and others, 2017a,b) and 2015(Arnold and others, 2018a,b). In 2013, the wells also were used as part of the Mississippi Embayment aquifer system FPS (metxfps1) network (table 1) described later in this report. Sampling in 2016 was approximately bimonthly, and these data are included in this report and in Arnold and others (2020).

Northern Atlantic Coastal Plain Enhanced Trends Network (nacpetn1)

The Northern Atlantic Coastal Plain ETN (nacpetn1; fig. 16*A*, *D*) in the Northern Atlantic Coastal Plain aquifer system provides an opportunity to study the movement of contaminants from the land surface downward into aquifers and the effects of recharge and pumping on the temporal variability of water quality. The environmental setting of nacpetn1 previously was described in Arnold and others (2017a,b) and is not repeated in this report.

The nacpetn1 has three wells that are located across southern Delaware in different parts of the flow system at different depths (table 1). Well NACPETN1–03 (119 ft deep) is a public-supply well in southwestern Delaware near the center of the Delmarva Peninsula. Well NACPETN1–02 (135ft deep) also is a public-supply well, one of several supply wells for a coastal town. Well NACPETN1–01 is a shallow monitoring well (22 ft) that is surrounded locally by agricultural land use. All three wells in the nacpetn1 were sampled once in 2014 (Arnold and others, 2017a,b), once in August 2015 (Arnold and others, 2017a,b), and approximately bi-monthly during 2016. Data from the 2016 sampling are included in this report and in Arnold and others (2020).

New England Crystalline-Rock and Glacial Aquifer System Enhanced Trends Network (negxetn1)

The New England crystalline-rock and glacial aquifer system ETN (negxetn1, fig. 16*A*, *C*) provides the opportunity to study the temporal variability of contaminants in groundwater from geologic sources as well as contaminants from man-made sources with changing inputs. The environmental setting of negxetn1 previously was described in Arnold and others (2017a,b) and is not repeated in this report.

The negxetn1 consists of three wells at different depths (table 1). Two of the wells are public-supply wells, one completed in glacial sediments (NEGXETN1–01, 83 ft deep) and the other one completed in the crystalline-rock aquifer (NEGXETN1–02, 492 ft deep), and are in the southern part of the network area. The third well is a domestic-supply well in the northern part (NEGXETN1–03, about 176 ft deep). Wells in the negxetn1 were first sampled in 2014 (Arnold and others, 2017a,b) and again in 2015 (Arnold and others, 2018a,b). The wells were sampled bimonthly January through November 2016, and these data are included in this report and in Arnold and others (2020).

Rio Grande Aquifer System Enhanced Trends Network (rgaqetn1)

The Rio Grande aquifer system ETN (rgaqetn1; fig. 15*A*, *D*) provides the opportunity to study temporal variability in the water quality of shallow groundwater affected by irrigation, river water infiltration, and variable hydrologic conditions in an arid climate. The environmental setting of rgaqetn1 previously was described in Arnold and others (2017a,b) and is not repeated in this report.

The rgaqetn1 consists of three wells completed in the valley fill at different depths (table 1): two shallow wells that are screened across the water table (RGAQETN1–01, about 23 ft deep; and RGAQETN1–03, 22 ft deep) and one deeper well (RGAQETN1–02, 60 ft deep). The wells were sampled as part of the rgaqetn1 in 2014 (Arnold and others, 2017a,b) and in 2015 (Arnold and others, 2018a,b). The wells were sampled again in 2016, and these data are included in this report and in Arnold and others (2020). One well, RGAQETN1–01 also was sampled as part of rioglusag1 in 2016 (table 1).

Vertical Flow-Path Study Networks

Vertical flow-path study (VFPS) networks are designed to evaluate changes in groundwater quality over longer periods of time than the enhanced trends networks (ETNs) and decadal trends networks (LUS and MAS networks). The wells in a VFPS network are selected from public, domestic, or monitoring wells and located such that there is a representation of wells at different depths and collocated within the area to be studied. Evaluating vertical gradients of groundwater age and contaminant concentrations facilitates the understanding of changes in groundwater quality over periods greater than 10 years. VFPS networks generally are sampled once. Data from the Columbia Plateau VFPS (clptvfps1, fig. 17), Glacial aquifer system VFPS (glacvfps1, fig. 18), and Rio Grande aquifer system VFPS (rgaqvfps1, fig. 19) are included in this report.

Columbia Plateau Vertical Flow-Path Study Network (clptvfps1)

The Columbia Plateau VFPS network (clptvfps1; fig. 17) was designed to examine changes in water quality over time and to evaluate whether agriculturally derived contaminants are moving deeper into the aquifer system. The clptvfps1 is in south-central Washington and is contained within the Columbia Basin Irrigation Project area, a large-scale irrigation project through which a series of canals divert Columbia River water to a highly productive agricultural basin. The clptvps1 network consists of 19 wells from 2 decadal networks (Frans and others, 2012): 10 shallow monitoring wells from the Columbia Plateau agricultural land use study (ccptlusag2b; Arnold and others, 2017a,b) and 9 deeper domestic or public-supply wells from the Columbia Plateau major aquifer study (ccptsus1b; Arnold and others, 2017a,b). The 10 agricultural land-use study wells are typically screened in unconsolidated basin-fill deposits, whereas the 9 major aquifer study wells are typically screened in underlying basaltic rocks. Well depths range from 19 to 1,000 ft (appendix 2, table 2.1). The ccptsus1b and ccptlusag2b networks were previously sampled in 1994–95 and 2002. Samples for the clptvfps1 were collected from July to September 2014.

Glacial Aquifer System Vertical Flow-Path Study Network (glacvfps1)

The Glacial aquifer system VFPS network (glacvfps1; fig. 18) was designed to add an age framework to results from decadal networks in the glacial aquifer system to help address questions of changes in water quality over time. The glacvfps1 network is a group of 43 wells and is a combination of 28 wells from the lerilusrc1 network described earlier in this report and 15 additional wells completed at various depths ranging from about 10 to 172 ft (appendix 2, table 2.1). The wells were open to the aquifer across intervals of 4 to 10 ft, but most were open less than 5-ft intervals (appendix 2, table 2.2). Samples for the vertical flow-path study were collected August through September 2016, and these data are reported here.

Rio Grande Aquifer System Vertical Flow-Path Study Network (rgaqvfps1)

The Rio Grande aquifer system VFPS (rgaqvfps1; fig. 19) is in the alluvial Middle Rio Grande Basin, lying within the Rio Grande flood plain in and near Albuquerque. The study is focused on areas of the aquifer that are recharged by seepage from the Rio Grande. High concentrations of dissolved solids, arsenic, or both have previously been observed within the study area (Plummer and others, 2004).

The rgaqvfps1 network consists of 19 monitoring wells, 15 of which are part of the rioglusrc1 urban land-use network previously described in this report (ranging in depth from

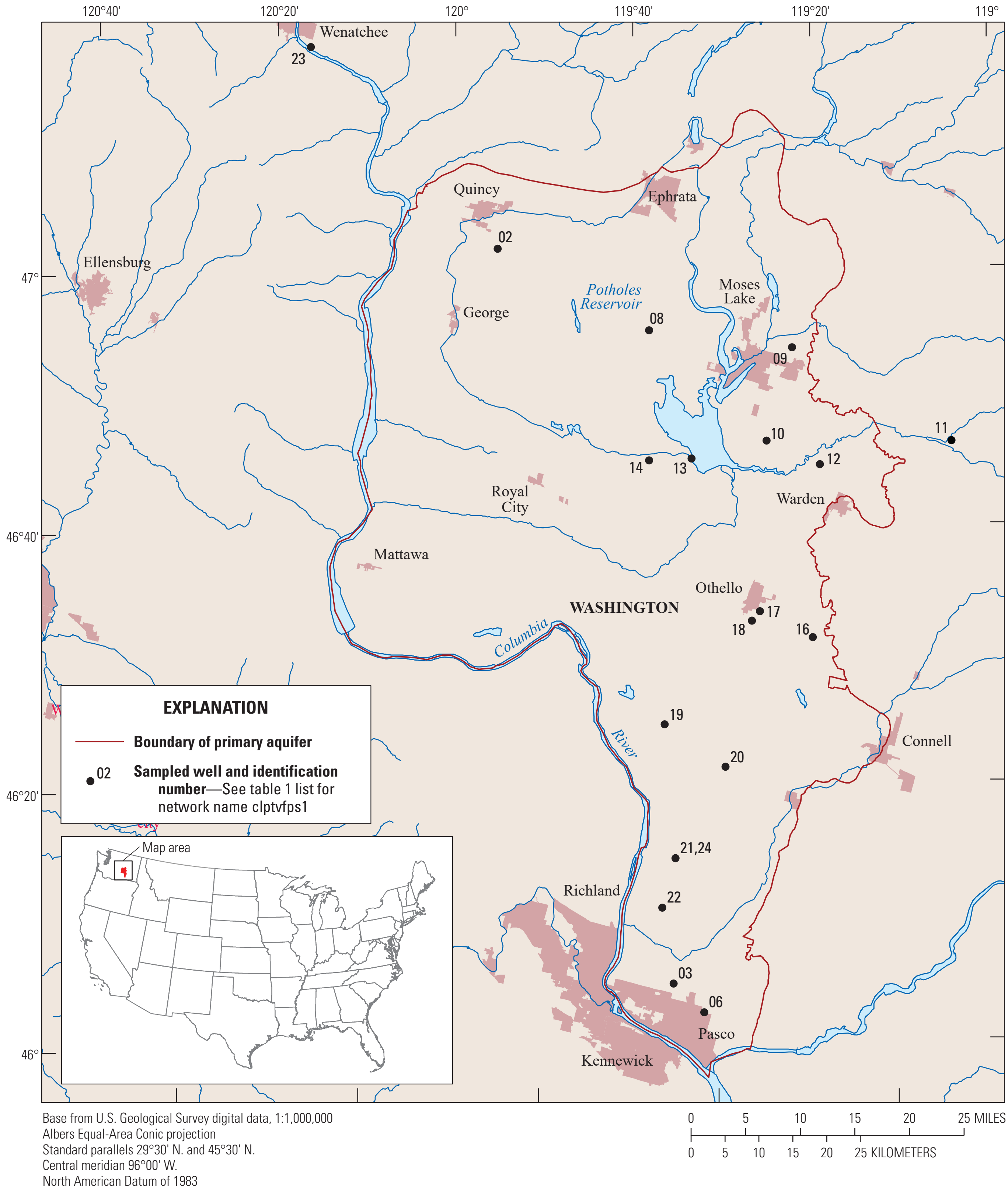


Figure 17. Study and wells sampled as part of the Columbia Plateau vertical flow-path study network (clptvfps1) for the U.S. Geological Survey National Water-Quality Assessment Project.

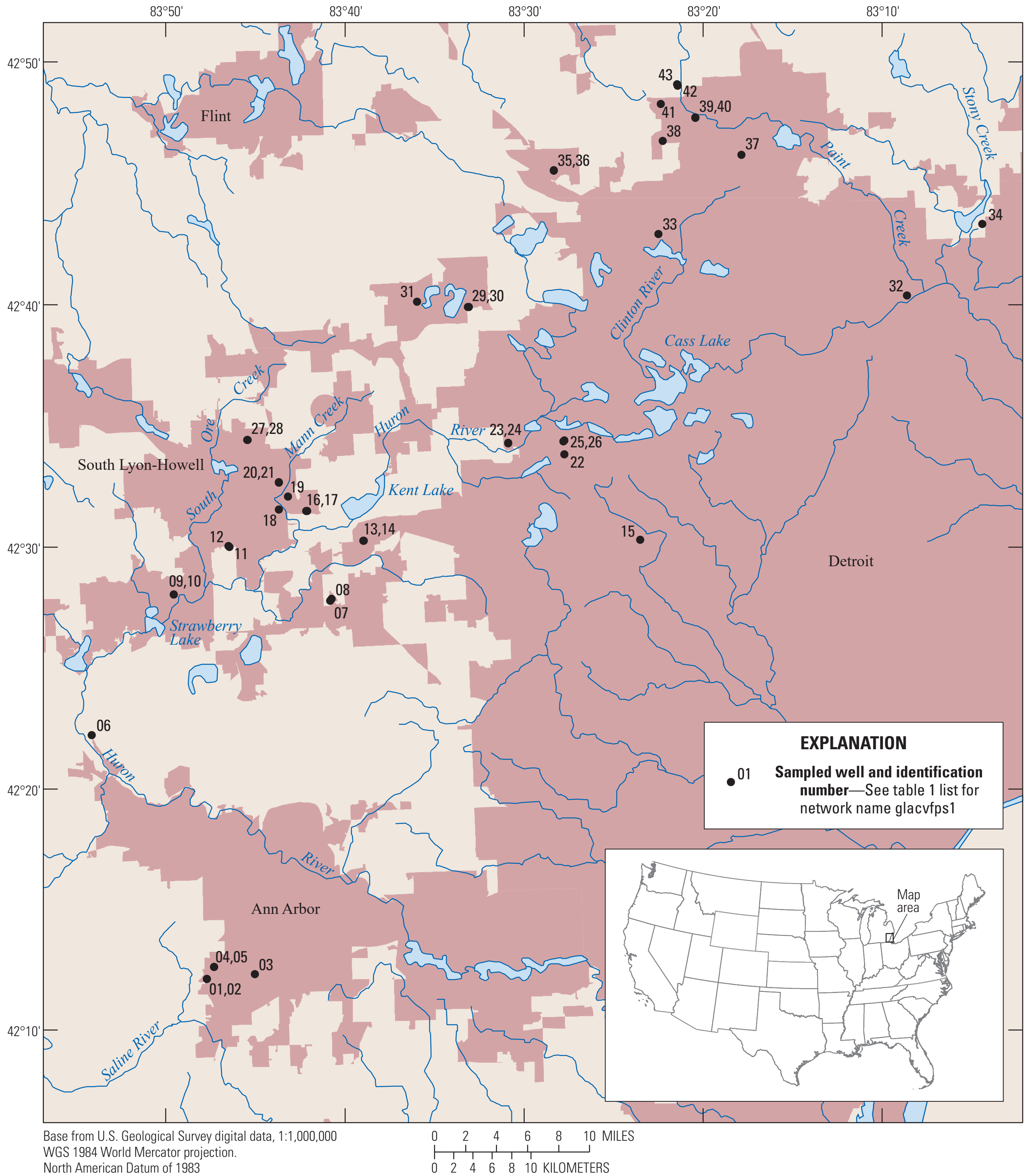


Figure 18. Study and wells sampled as part of the Glacial aquifer system vertical flow-path study network (glacvfps1) for the U.S. Geological Survey National Water-Quality Assessment Project.

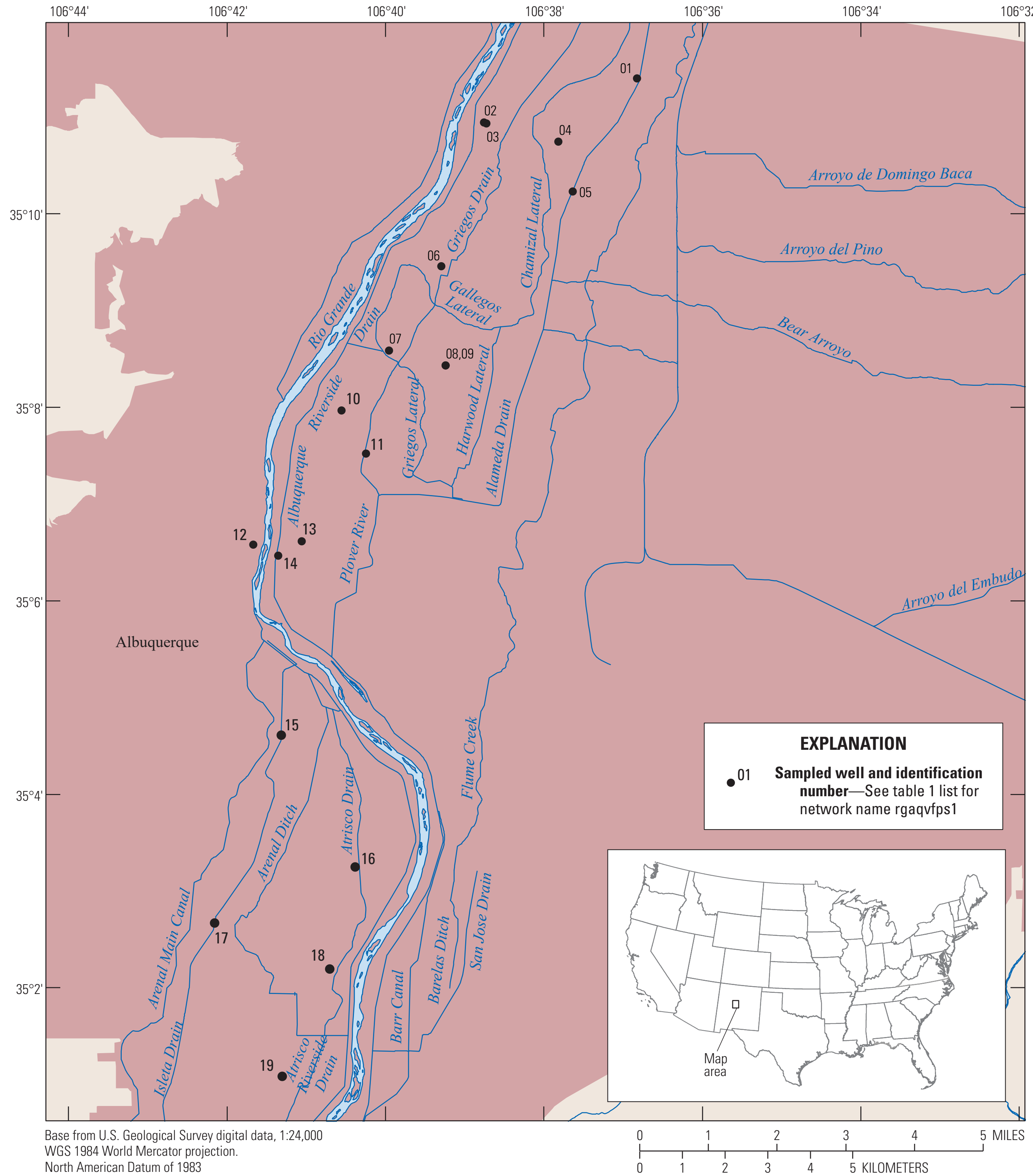


Figure 19. Study and wells sampled as part of the Rio Grande aquifer system vertical flow-path study network (rgaqvfps1) for the U.S. Geological Survey National Water-Quality Assessment Project.

about 18 to 57 ft). The additional 4 wells are deeper, ranging from 95 to 254 ft in depth (appendix 2, table 2.1). The wells are typically open to the aquifer across 10-ft intervals, although intervals range from about 5 to 82 ft (appendix 2, table 2.2). Samples were collected in July and August 2016.

Flow-Path Study Networks

Flow-path study (FPS) networks are designed to evaluate changes in groundwater quality along flow paths from recharge areas to discharges areas (streams or withdrawal from wells). For each network, monitoring wells were installed or selected at four or five locations along hypothesized groundwater flow paths, with three or four wells at each of these locations screened at various depths. These networks examine flow paths that are usually shorter (often less than about 3 miles) and shallower than VFPS networks. FPS networks are typically collocated with land-use study networks. FPS networks are designed to examine the transport and transformation of contaminants along primarily horizontal flow paths. Like the VFPS, FPS networks may be used to examine trends over decades but for a smaller spatial extent. Data from two Central Valley aquifer system FPS networks (cvalfps1 and cvalfps2; figs. 20–21); Glacial aquifer system FPS network (glacfps1; fig. 22), and Mississippi Embayment aquifer system FPS network (metxfps1; fig. 23) are included in this report.

Central Valley Aquifer System Flow-Path Study Networks (cvalfps1, cvalfps2)

The two Central Valley aquifer system FPS networks near Fresno, Calif. (cvalfps1, cvalfps2; figs. 20–21) were designed to examine the fate and transport of agricultural contaminants such as 1,2-dibromo-3-chloropropane and nitrate along groundwater flow paths. The cvalfps1 study area is west of the foothills of the Sierra Nevada and east of the San Joaquin Valley trough on the high alluvial fan of the Kings River (Burow and others, 1999). Twenty monitoring wells were installed at six well nest sites along a 2.9-mile transect to characterize changes in water quality along approximate groundwater flow paths. The monitoring well transect generally was aligned in the direction of regional groundwater movement in the study area. Well depths in the network range from 70 to 268 ft (appendix 2; table 2.1). The cvalfps1 network was previously sampled in 1994–95 (Burow and others, 1999) and 2003 (Burow and others, 2008). Samples for the current phase of monitoring for the cvalfps1 were collected from July to September 2013.

The cvalfps2 network is an extension in space from the cvalfps1 network using a mix of observation, irrigation, domestic-supply, and public-supply wells. There are 21 wells is the network, with well depths ranging from 100 to 532 ft below land surface (appendix 2; table 2.1). Samples for the current phase of monitoring for the cvalfps2 were collected from July to September 2013.

Glacial Aquifer System Flow-Path Study Network (glacfps1)

The Glacial aquifer system FPS network (glacfps1, fig. 22) was designed to examine the migration and transformation of contaminants along groundwater flow paths and groundwater-surface water interactions (Saad, 2008). The study site is in the Tomorrow River Watershed in Portage County, Wisconsin. The site includes four nests of wells installed along groundwater flow paths (as inferred from groundwater flow simulations). There are 18 total wells in these 4 nests, located upgradient from the Tomorrow River at distances of about 200 ft (well nest 4), 700 ft (well nest 3), 2,000 ft (well nest 2), and 5,000 ft (well nest 1). These well nests represent the downgradient part of the entire flow path length that discharges to the stream at this location. Eight additional samples were taken from streambed piezometers (tables 2.1 and 2.2 include the piezometers in the count of wells) that were about 1 ft below the streambed. The Tomorrow River Watershed is nested within a previously conducted agricultural land-use study area (wmiclusag2, Saad, 2008; Arnold and others, 2017a,b) and is in the same location as a previous groundwater-surface water interaction study (Tesoriero and others, 2013). Samples for the current phase of monitoring for the glacfps1 were collected in June 2014.

Mississippi Embayment Aquifer System Flow-Path Study Network (metxfps1)

The Mississippi Embayment aquifer system FPS network (metxfps1; fig. 23) was designed to examine the intrinsic vulnerability of the Memphis aquifer along two inferred flow paths (Kingsbury and others, 2017). The study site is in the northeastern part of the Mississippi Embayment in southwestern Tennessee and northwestern Mississippi and is nested with a previous urban land-use study (miselusrc1). Wells are along flow paths that begin in the outcrop area of the Memphis aquifer and end at public supply wells that are in a confined part of the aquifer. This study is designed to evaluate whether younger water is migrating into confined parts of the aquifer that are used for drinking-water supplies. The network of 22 wells consists of a mix of monitoring, domestic, commercial, and public-supply wells that range in depth from 23 to 624 ft (appendix 2; table 2.1). Samples for the current phase of monitoring for the metxfps1 were collected in August and September 2013.

Modeling Support Study Networks

Modeling support study (MSS) networks are used to support modeling efforts where more data are needed to calibrate a model. They are designed based on a specific need so that each is somewhat unique in its design. Data from two Northern Atlantic Coastal Plain MSS networks (nacpmss1 and nacpmss2; figs. 24–25); and one Glacial aquifer system MSSS network (glacmss1; fig. 26) are included in this report.

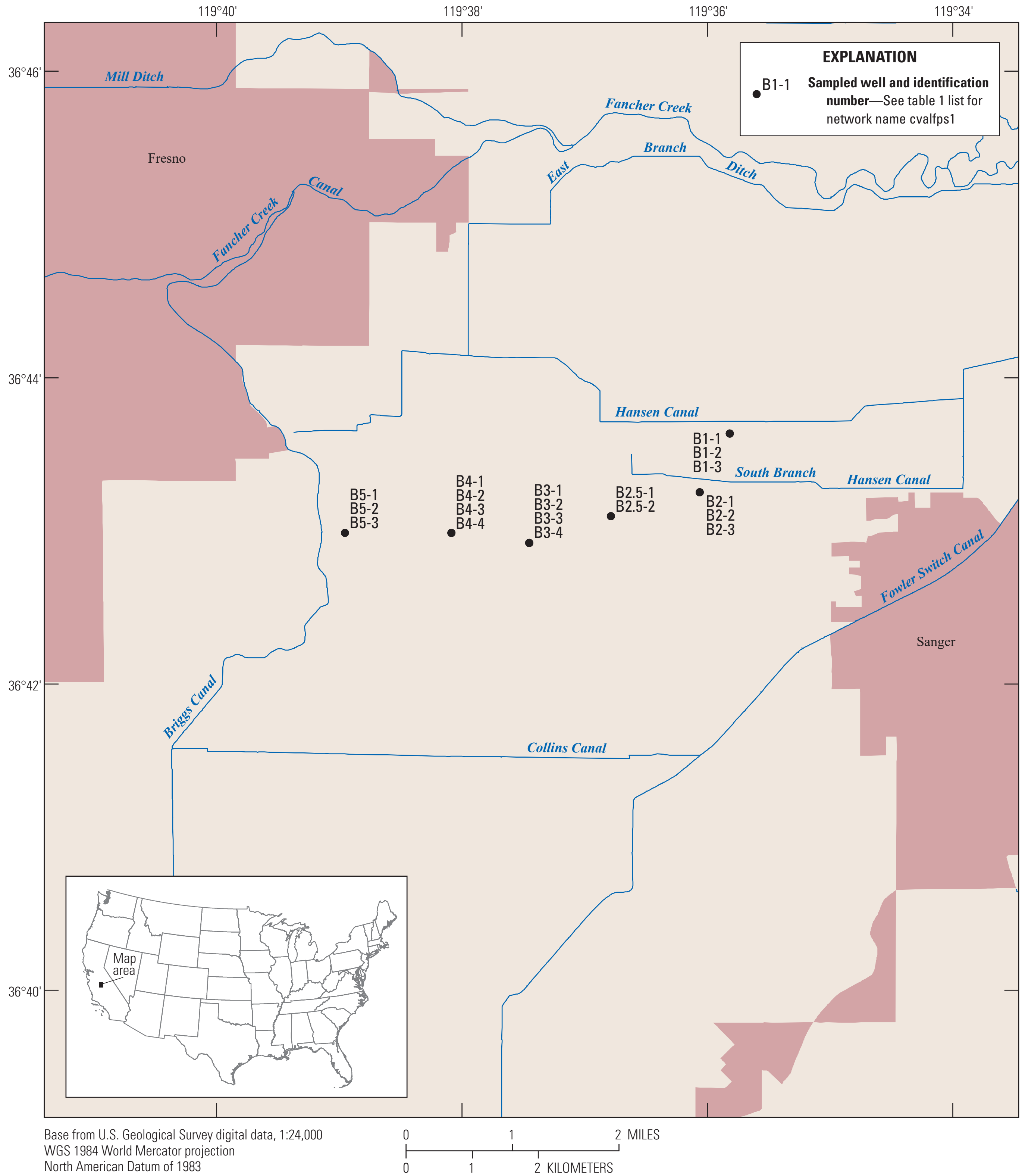
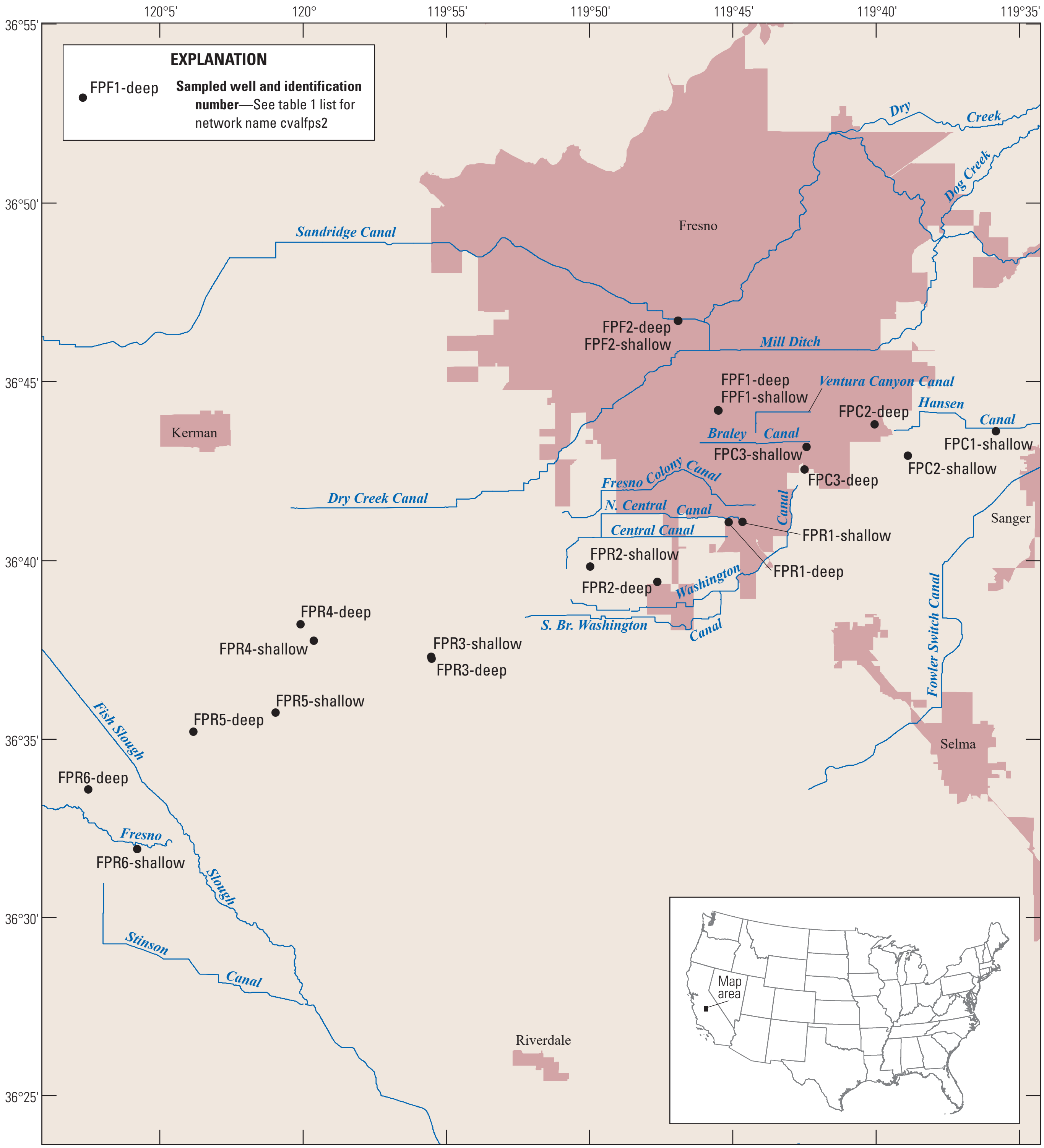


Figure 20. Study and wells sampled as part of the Central Valley aquifer system flow-path study network (cvalfps1) for the U.S. Geological Survey National Water-Quality Assessment Project.



Base from U.S. Geological Survey digital data, 1:24,000
WGS 1984 World Mercator projection
North American Datum of 1983

0 2 4 6 8 10 MILES
0 2 4 6 8 10 KILOMETERS

Figure 21. Study and wells sampled as part of the Central Valley aquifer system flow-path study network (cvalfps2) for the U.S. Geological Survey National Water-Quality Assessment Project.

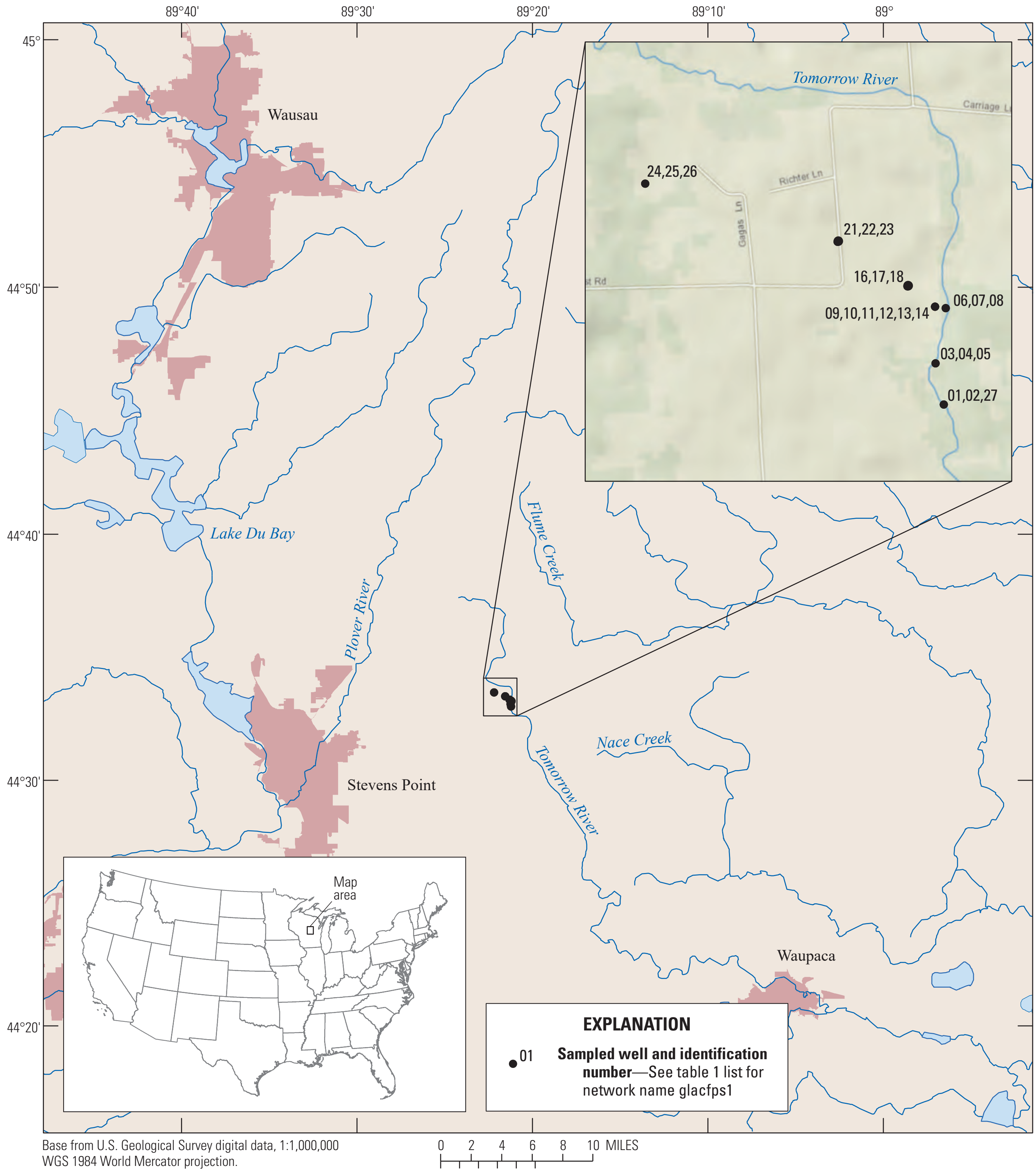


Figure 22. Study and wells sampled as part of the Glacial aquifer system flow-path study network (glacfps1) for the U.S. Geological Survey National Water-Quality Assessment Project.

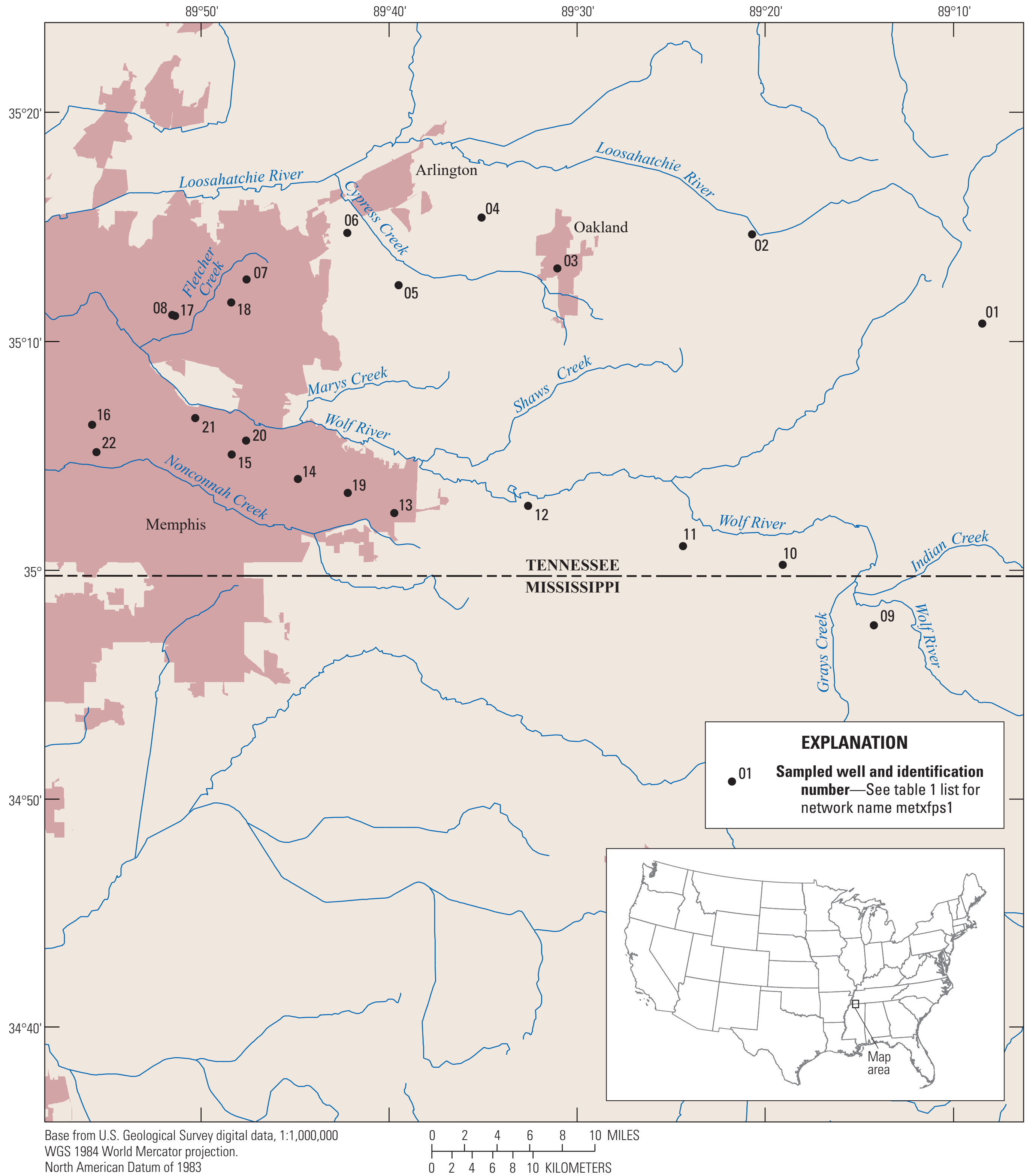


Figure 23. Study and wells sampled as part of the Mississippi Embayment aquifer system flow-path study network (metxfps1) for the U.S. Geological Survey National Water-Quality Assessment Project.

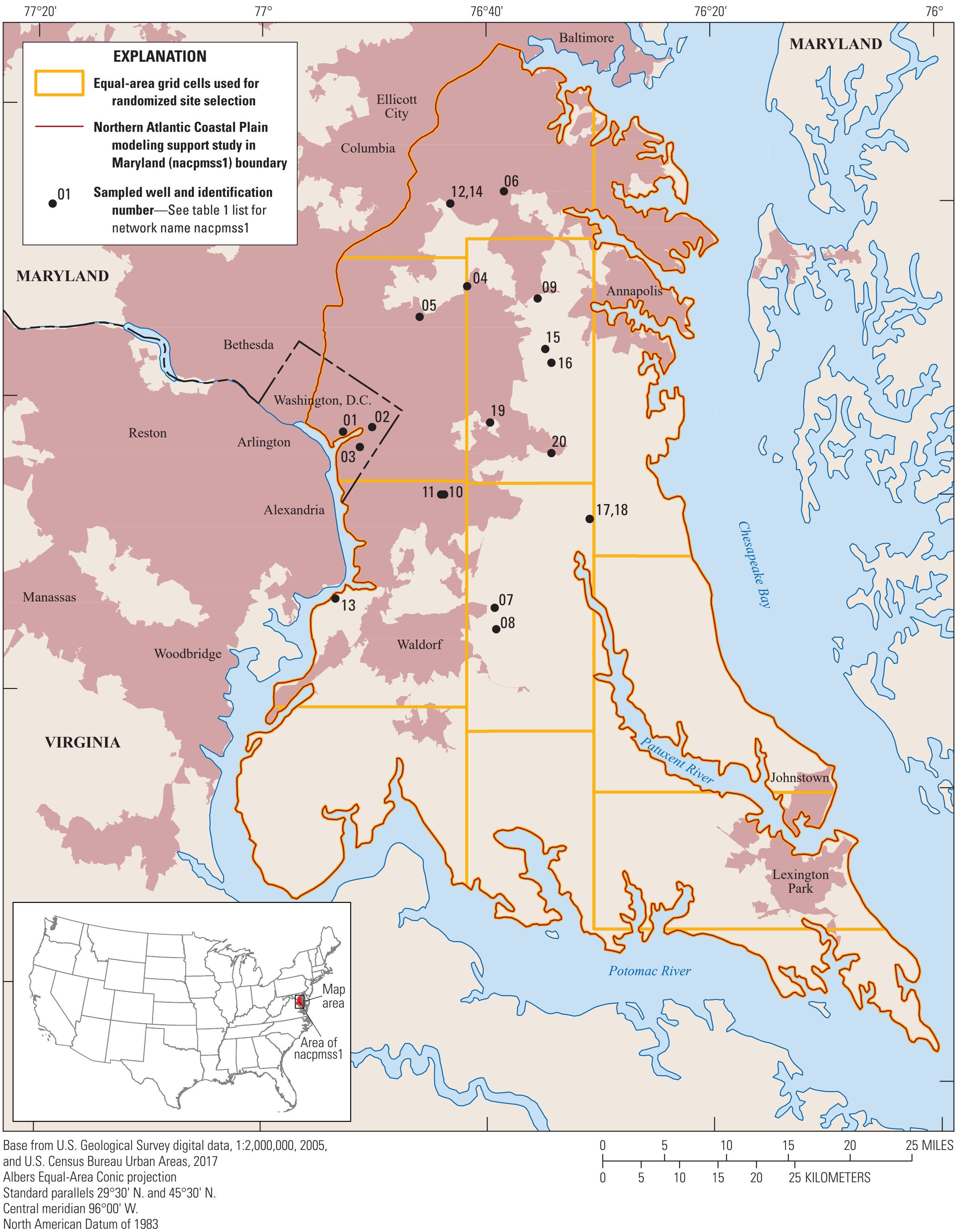


Figure 24. Study and wells sampled as part of the Northern Atlantic Coastal Plain modeling support study network (nacpmss1) for the U.S. Geological Survey National Water-Quality Assessment Project.

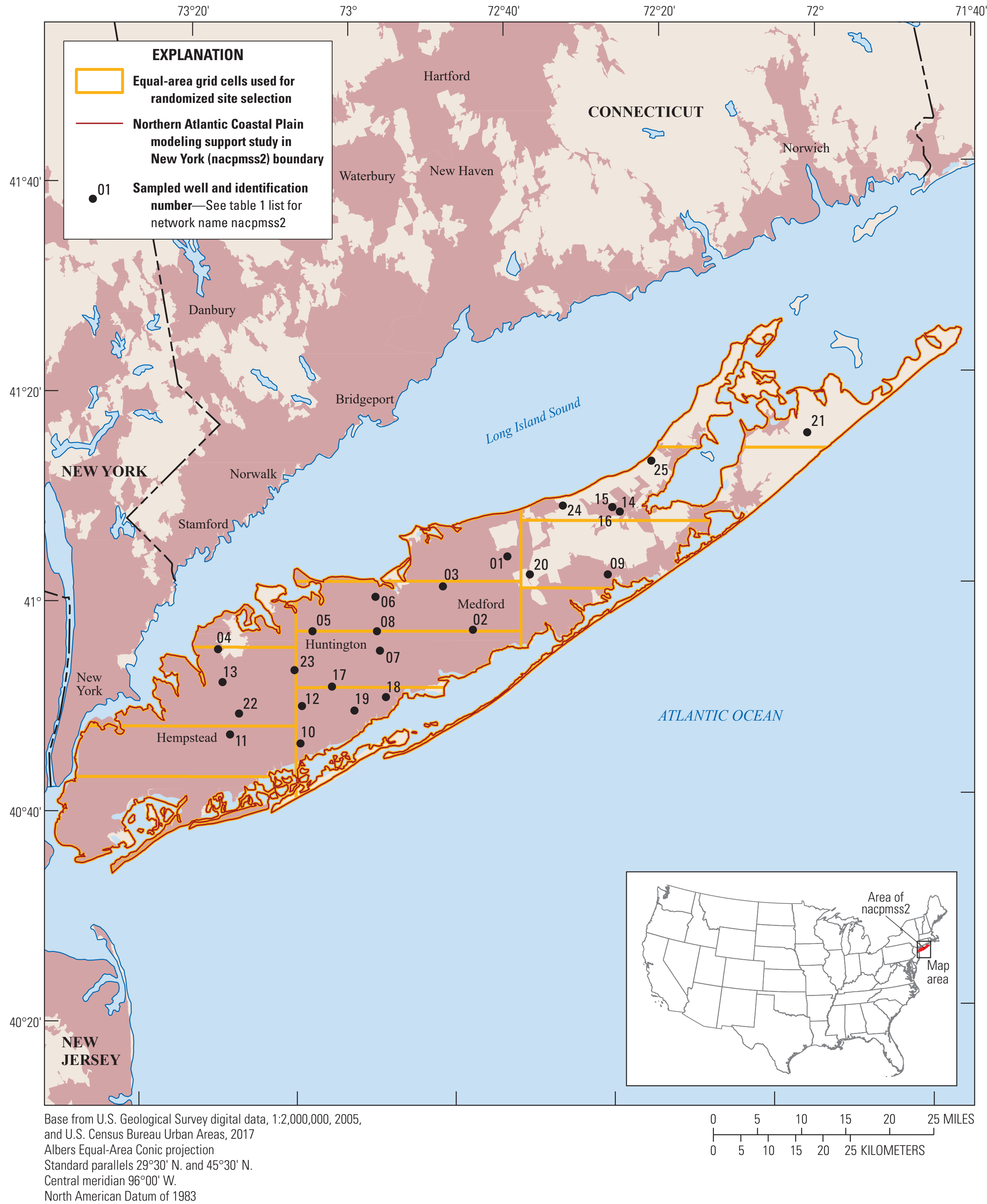


Figure 25. Study and wells sampled as part of the Northern Atlantic Coastal Plain modeling support study network (nacpmss2) for the U.S. Geological Survey National Water-Quality Assessment Project.

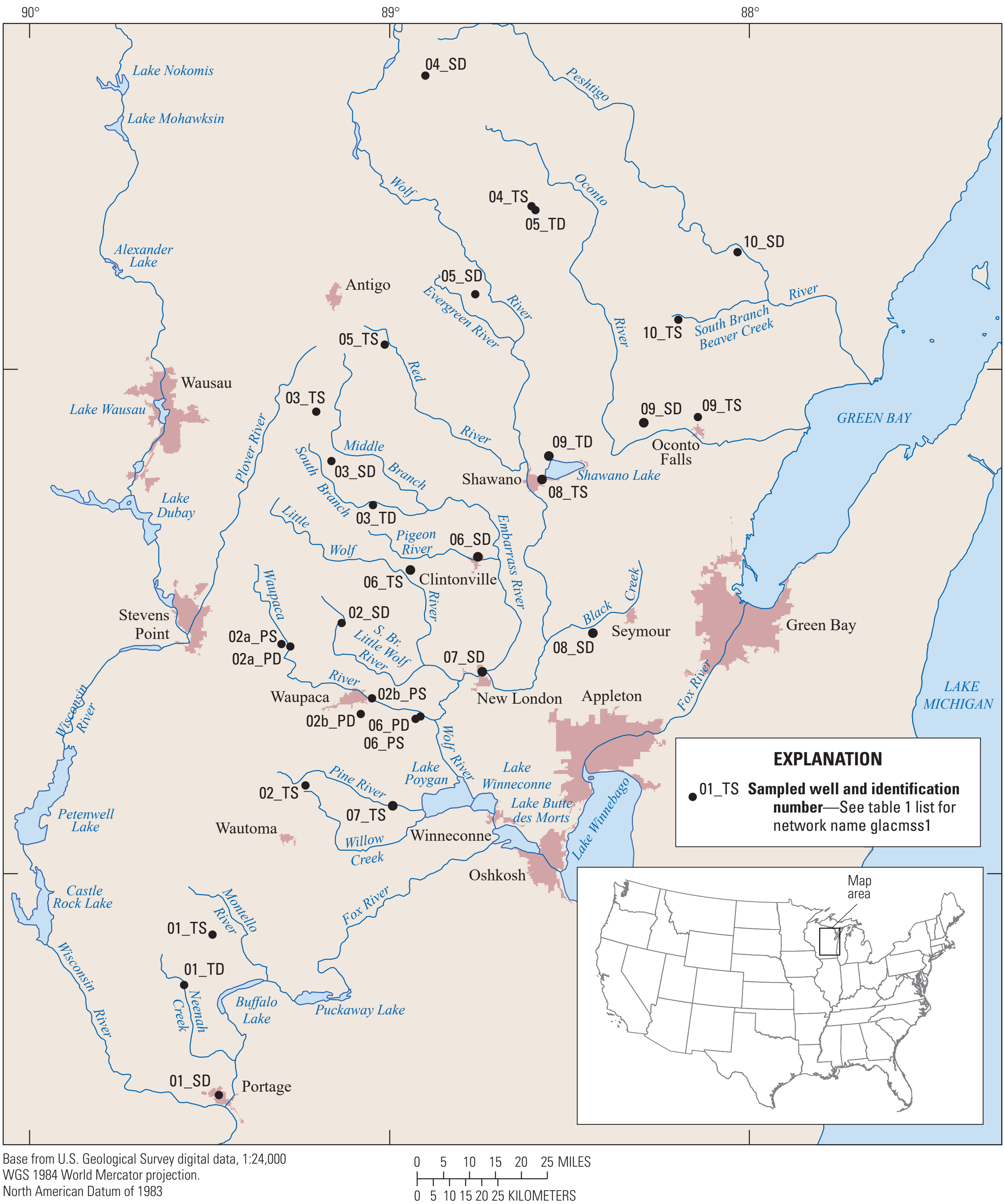


Figure 26. Study and wells sampled as part of the Glacial aquifer system modeling support study network (glacmss1) for the U.S. Geological Survey National Water-Quality Assessment Project.

Glacial Aquifer System Modeling Support Study Network (glacmss1)

The Glacial aquifer system MSS network (glacmss1, fig. 24), in eastern Wisconsin, was designed to provide additional groundwater quality and age information for the parts of the glacial aquifer in the Fox-Wolf-Peshtigo groundwater model area that were not already covered by other NAWQA groundwater networks. More specifically, this network provides information about the deeper parts of the sand and gravel aquifer, and about both the shallow and deep parts of the till in the Fox-Wolf-Peshtigo model area. The network also provides some vertical flow path information for the sand and gravel aquifer.

The eastern part of the network area is underlain by east-sloping sedimentary rocks of Cambrian, Ordovician, and Silurian age (Batten and Bradbury, 1996). Rocks of Precambrian age, primarily granite, underlie the western part of the network area. Quaternary age unconsolidated deposits overlie the entire area, and these deposits are generally thickest along major river valleys (Batten and Bradbury, 1996; Soller and others, 2012). Groundwater is an important source of drinking water in the study area, especially for domestic wells. Both naturally occurring and anthropogenic contaminants adversely affect drinking-water quality in the area. In the Central Sands, nitrate is a common contaminant, while arsenic is common in parts of Paleozoic aquifers in eastern Wisconsin (Luczaj and Masarik, 2015).

The network includes a total of 30 wells: 10 deep sand and gravel wells, 6 shallow sand and gravel wells that are paired with deep sand and gravel wells, 10 shallow till wells, and 4 deep till wells. Well depths range from 45 to 245 ft below ground surface. Samples for the model support study were collected August through September 2014, and these data are reported here.

Northern Atlantic Coastal Plain Modeling Support Study Networks (nacpmss1, nacpmss2)

There are two MSS networks in the Northern Atlantic Coastal Plain aquifer (nacpmss1, fig. 25; nacpmss2, fig. 26). One is in Maryland (nacpmss1), and the other one is in New York (nacpmss2). The nacpmss1 underlies and is to the east of the cities of Baltimore, Maryland, and Washington, D.C. This study is within the broader Northern Atlantic Coastal Plain principal aquifer setting described in Arnold and others, (Arnold and others, 2017b). It consists of unconsolidated to partly consolidated Early Cretaceous to Holocene age sediments that thicken and deepen toward the Atlantic Coast. Twenty wells ranging in depth from 60 to 645 ft were sampled from regional layered aquifers in the Piney Point, Nanjemoy, Aquia, Magothy, Potomac, Patapsco (upper and lower), and Patuxent Formations (Shedlock and others, 2007).

The Northern Atlantic Coastal Plain aquifer modeling support study area in New York, nacpmss2, underlies the half of Long Island (split the long way) along the Atlantic Coast to the east and north of New York City. This study is within the broader Northern Atlantic Coastal Plain principal aquifer setting described in Arnold and others (2017b). Twenty-five wells ranging in depth from 200 to 900 ft were sampled in the Magothy Formation regional layered aquifer.

Sample Collection and Analysis

Water-quality data from samples collected at 648 wells (fig. 1; table 1) are available in Arnold and others (2020). Groundwater samples were collected and processed using methods designed to yield samples that were representative of environmental conditions, minimally affected by contamination, and consistent nationwide (Koterba and others, 1995; Lapham and others, 1995; USGS, variously dated). All samples were collected at the wellhead (the point at which the groundwater exits the well near land surface) or as close to the wellhead as possible. This location was selected so that samples were collected before any treatment or blending potentially could alter constituent concentrations. Samples were collected and processed using prescribed protocols described in Koterba and others (1995), Lapham and others (1995), and the USGS National Field Manual (USGS, variously dated). Samples were analyzed at the USGS National Water-Quality Laboratory (NWQL) in Denver, Colorado, for water-quality indicators, nutrients and dissolved organic carbon, major and minor ions, trace elements, VOCs, pesticides, radon radiochemistry, and one item of special interest, arsenic speciation. Four radionuclide constituent concentrations (lead–210, polonium–210, radium–224, radium–226, and radium–228) were analyzed by ALS Environmental in Fort Collins, Colo. Perchlorate concentrations were analyzed by Weck Laboratories, Inc. in Industry, Calif. Hexavalent chromium (chromium [VI]) concentrations were analyzed by the USGS Trace Metal Laboratory in Boulder, Colo. Strontium concentrations were analyzed by the Metal and Metalloid Isotope Research Laboratory in Menlo Park, Calif.

The constituents for which samples were collected are listed in table 2 of Arnold and others (2020) and are organized by constituent class; constituent primary uses and sources; analytical schedules and sampling period; analytical method references; USGS parameter codes; comparison thresholds; reporting levels for the 2016 sampling period; number of analyses, detections, and detections above the reporting level; and the table in which the data for the constituent class are shown. The reporting levels shown are for the samples collected in 2016. Reporting levels for earlier data are shown in Arnold and others (2016b, 2017a, 2018a). Analytical schedules are groups of constituents for which laboratory analysis is requested. The USGS parameter code identifies the constituents, and the method reference indicates the laboratory method used to analyze the samples. The reported concentration of a constituent can be evaluated using the comparison threshold value. Of the comparison thresholds listed in table 2 of Arnold and others (2020), only the secondary maximum contaminant level is not health based.

In addition to discrete water-quality samples that are collected periodically, the ETN wells also are instrumented to measure basic water-quality parameters at a high frequency during specific periods throughout each day. Each well is instrumented with a water-quality sonde that contains temperature, specific conductance, pH, and dissolved oxygen probes. Some wells also are instrumented to measure nitrate. The sonde sits in a flow-through chamber that receives groundwater flow from near the wellhead. Measurements of the basic water-quality parameters are made when the well is pumping and groundwater is flowing through the system, which may range from 1 to 24 hours per day. Water-quality data are recorded by the sonde at different intervals, from 2 minutes to 12 hours, depending on the network. The water-quality data are transmitted to a data collection platform where the data are stored and transmitted to the USGS National Water Information System (USGS, 2018) database by the Geostationary Operational Environmental Satellite network. The high-frequency data are reviewed, corrected, and approved according to recommendations for publishing continuous water-quality records (Wagner and others, 2006).

Data Reporting

Laboratories use specified values, referred to as reporting levels, in reporting results determined during analysis of water samples. Different reporting levels are used depending on the constituent and the laboratory method used to analyze the sample. Concentrations not measured above a certain threshold concentration for that constituent are reported as less than the reporting level; these are censored data.

Reporting levels are defined differently by the NWQL for inorganic and organic constituents. Inorganic constituents (major ions, nutrients, and trace elements) for samples analyzed in 2016 are each reported using a reporting level (RL) that is equivalent to the detection limit (DL). The DL is the smallest concentration that can be measured and reported with 99-percent confidence that the concentration is greater than zero, which means less than or equal to a 1-percent chance of a false positive (Williams and others, 2015). The DLs used in 2016 for both inorganic and organic constituents generally were determined using the DQCALC method described in Williams and others (2015); this is indicated as DLDQC in table 2 of Arnold and others (2020). However, for a few constituents that have commonly been detected in laboratory blank samples, the DLs were determined using an approach that calculates a DL directly from blank data (Williams and others, 2015); this is indicated as DLBLNK in table 2 of Arnold and others (2020). Organic constituents (VOCs and pesticides) are each reported using an RL that typically is about twice, but may be more than twice, the DL (Williams and others, 2015); this is indicated by RLDQC in table 2 of Arnold and others (2020) when calculated from a DL determined using the DQCALC method. This approach to setting the RL is estimated to limit the chance of incorrectly reporting the constituent as absent to less than or equal to 1 percent (Williams and others, 2015). In other words, there is at least a 99-percent confidence that the constituent really is absent from the sample when it is reported relative to the RL. The RLs are used for reporting analytical results for VOCs and pesticides to allow for the robust analysis and interpretation of detection frequencies. The NWQL uses information-rich analytical methods such as gas chromatography or high-performance liquid chromatography for these constituents and often provides results that indicate the presence of these constituents at concentrations less than their RLs, and even at concentrations less than their DLs.

A few constituents are reported using minimum reporting levels (MRLs). The MRLs are calculated according to the EPA definition of an MRL, described previously as the minimum concentration of a substance that can be measured and reported with 99-percent confidence that the value is above zero (Childress and others, 1999). An MRL is a reporting level that is chosen by the laboratory.

Radionuclides are reported using units of radioactive activity (picocuries per liter) rather than concentration. Reporting levels for these constituents are based on the sample-specific critical level (ssLc) or sample-specific minimum detectable concentrations (ssMDCs) (McCurdy and others, 2008). The ssLc and ssMDC are calculated for each sample from parameter values used during the actual analysis of the sample. The ssLc and ssMDC are analogous to the DL and RL, respectively. The ssLc is defined as the smallest measured activity that indicates detection of the radionuclide, with no more than a 5-percent chance of a false positive detection (EPA, 2004). The specified probability associated with a critical level can vary, but it is typically 5 percent for radionuclides. Like the DL, the ssLc is a reporting level that is based on a specified probability of false positive errors; that is, incorrectly reporting that the radionuclide is present. The ssMDC, like the RL, is a reporting level that is based on a specified probability of false negative errors; that is, failing to report that the radionuclide is present. The ssMDC is defined as the activity at which there is 5-percent chance of a false negative error and typically is about two times greater than the ssLc (McCurdy and others, 2008).

The laboratory method used to analyze samples for VOCs in schedules 4436 and 4437 was approved and published in 2016 (Rose and others, 2016). Results for laboratory methods that are unapproved generally are not made available to the public by the USGS because the quality of the results could be affected by problems subsequently discovered during the process of method approval; however, the method approval process revealed no substantial problems and resulted in no changes in the analytical process (Duane Wydoski, USGS, written commun., 2015). This indicates that the data reported before approval for these methods were of sufficient quality for public release.

Concentrations below DLs, and concentrations between DLs and RLs, are reported without any qualifiers in this report. Concentrations below DLs or between DLs and RLs can be identified by comparing the reported concentrations with the DLs and RLs listed by compound in table 2 of Arnold and others (2020). It is important to note that there is greater uncertainty associated with values less than DLs (regarding risk of false positive errors or inaccurate detections) and with values less than RLs (regarding risk of false negative values or inaccurate nondetections) than with values that are greater than DLs, RLs, or both.

The data presented in this report and associated data release (Arnold and others, 2020) are current as of the date of retrieval (December 18, 2018) from the National Water Information System (USGS, 2018). For example, RLs may be adjusted when additional QC data for the method are examined. The well information and water-quality data presented in this report and the associated data release were reviewed by USGS personnel and subsequently verified by coauthors who are responsible for tracking the data.

Quality-Assurance and Quality-Control Methods

The quality-assurance plan for NAWQA Project groundwater samples was derived from previous NAWQA Project cycles of study (Koterba and others, 1995) and the USGS National Field Manual (USGS, variously dated). About 14 percent of samples collected during any period are for data quality assurance and quality control (QC). Types of QC samples include equipment blanks, source solution blanks, field blanks, replicates, field spikes, and laboratory spikes. Data and results from statistical analysis of blank QC samples are presented in appendix 4 (tables 4.1 and 4.2).

Blanks are used to test for bias from an unintentional introduction of contamination to environmental samples. Equipment blanks are used to test whether equipment is clean and free of contamination. Source solution blanks are used to test whether the water used for the blank sample is free of contamination. Field blanks are used to test for contamination that may be introduced during sample collection, processing, handling, and analysis. Field blanks also are used to test for contamination from the environment around where the sample was collected. Replicates are samples that are collected at the same time and using the same method as the environmental sample. Replicates measure the variability of determining a concentration in samples that should be essentially identical. Spiked samples are used to measure the performance of analytical methods on an environmental water sample. A sample can be spiked in the field or the laboratory.

The number and type of QC samples planned for each network study depend on the number of wells sampled, the number of sampling teams that are involved in the sampling, and the constituents for which samples will be analyzed, as described in the following criteria:

- Equipment blanks are collected for nutrients, trace elements, and VOCs at the quantity of one blank for each team sampling the network.
- Source solution blanks are collected for nutrients, trace elements, and VOCs at the quantity of one blank for each team sampling the network. The VOCs have additional source solution blanks that are collected with each field blank.
- Field blanks are collected for major ions, nutrients, dissolved organic carbon, trace elements, and pesticides at the quantity of 1 blank for every 15 wells sampled or 1 blank for each team sampling the network (whichever results in a greater number of blanks). Field blanks are collected for VOCs at the quantity of 1 blank for every 10 wells sampled or 1 blank for each team sampling the network (whichever results in a greater number of blanks).
- Replicate samples are collected for major ions, nutrients, dissolved organic carbon, trace elements, VOCs, and radionuclides at the quantity of 1 replicate for every 30 wells sampled. Replicate samples are collected for pesticides at the quantity of 1 replicate for every 15 wells.
- Field spikes are collected for pesticides at the quantity of 1 spike sample for every 30 wells sampled.
- Laboratory spikes are collected for VOCs at the quantity of 1 spike sample for every 30 wells sampled.

Statistical analysis of QC sample data can be used to evaluate the variability or bias of the data, sampling and sample handling procedures, and laboratory and (or) field methods and to ensure the environmental assessment samples represent true groundwater chemistry. The QC sample data provided in Arnold and others (2020) include water quality for all blank QC samples collected between January and December 2016 in association with the environmental sample data and a few results from earlier sampling periods that were not previously published. Data from the 2012–13 sampling period are presented in Arnold and others (2016a,b), data from the 2014 sampling period are presented in Arnold and others (2017a,b), and data from the 2015 sampling period are presented in Arnold and others (2018a,b).

Groundwater-Quality Data

Groundwater-quality data from 648 wells are included in this report (table 1). Samples were analyzed for 376 constituents (table 2 of Arnold and others, 2020); however, not all wells were sampled for all constituents. Results of analyses are presented in tables 3–13 of Arnold and others (2020), which are organized by constituent class: water-quality indicators (table 3); nutrients and dissolved organic carbon (table 4); major and minor ions (table 5); trace elements (table 6); VOCs (tables 7); pesticides (table 8); radiochemistry (table 9); and special-interest constituents, including arsenic speciation (table 10), chromium (VI) (table 11), perchlorate (table 12), and strontium (table 13). The constituents for which samples were analyzed and the table in which the data are presented are listed in table 2 of Arnold and others (2020). Comparative benchmarks (thresholds) listed in that table provide context for evaluating the constituent concentration data in terms of human health and other characteristics relevant for drinking-water use. Several types of thresholds are listed. The EPA maximum contaminant levels are legally enforceable drinking-water standards that specify the maximum permissible level of a constituent that can be delivered to a user of a public water system. The EPA human-health benchmarks for pesticides (HHBPs) are nonenforceable screening levels for evaluating if a pesticide concentration in drinking-water sources may indicate a potential human-health risk (EPA, 2012). The HHBPs include benchmarks for cancer and noncancer health effects (EPA, 2013). The USGS Health-Based Screening Levels are nonenforceable benchmarks for constituents that do not have HHBPs or maximum contaminant levels (MCLs) that can be used to evaluate if constituent concentrations may indicate a potential human-health concern (Toccalino, 2007; Toccalino and others, 2014). Like EPA HHBPs, USGS health-based screening levels are categorized in terms of cancer and noncancer health effects.

The groundwater-quality data from January to December 2016 are presented in the format of tab-delimited ASCII text files and are available for download from Arnold and others (2020) along with complete metadata files that describe the contents of each text file. The data may be imported into a spreadsheet, database, or statistical software for manipulation and analysis. The data available from Arnold and others (2020) are referenced as tables 1–13 and appendix tables 4.10–4.19 in this report.

Water-Quality Indicators

Water-quality indicators include water temperature, dissolved oxygen, specific conductance, pH, alkalinity, carbonate and bicarbonate (calculated from alkalinity), and turbidity (table 3 of Arnold and others, 2020). Water-quality indicators are measured in the field when the other water samples are collected (USGS, variously dated), and pH and specific conductance sometimes are also measured in the laboratory.

Water-quality indicators provide basic information about the general quality and geochemical conditions of the water. Dissolved oxygen is the concentration of oxygen dissolved in the water and is an indicator of reduction-oxidation (redox) conditions in the aquifer. Measurements of pH indicate the acidity or basicity of water. Dissolved oxygen and pH are important controls on the chemical reactions that can happen in water. Specific conductance is a measure of how well the water conducts electricity and indicates the relative amount of dissolved solids in the water. Alkalinity, carbonate, and bicarbonate indicate the hardness of water and are related to pH. Turbidity is a measure of the suspended solids in the water.

Inorganic Constituents

Inorganic constituents are most often naturally present in groundwater. Groundwater samples were analyzed for the following inorganic constituent classes: major and minor ions, nutrients and dissolved organic carbon, and trace elements (including metals; tables 4–6 of Arnold and others, 2020).

Nutrients include nitrogen and phosphorus compounds and dissolved organic carbon. Data for ammonia, nitrate plus nitrite, nitrite, total nitrogen, and phosphorus measured as orthophosphate are presented in table 4 of Arnold and others (2020). Nutrients are present naturally, but nutrient concentrations also are affected by human activities such as farming and wastewater disposal (Hem, 1992). Nitrogen was measured as total nitrogen and as the individual nitrogen species of nitrite, nitrate, and ammonia. Nutrient concentrations can affect the quality of groundwater for use as drinking water.

Major and minor ions are cations and anions that can be dissolved in water from geologic materials. Concentrations of major and minor ions can be used to classify water into different types (Hem, 1992; Hiscock, 2005). Waters with similar ion concentrations often have similar history, recharge areas, climate, mineralogy, and residence time (Güler and others, 2002). Some major ions can affect the quality of water for drinking and other uses. Groundwater samples were analyzed for 10 major and minor ions and total dissolved solids (table 5 of Arnold and others, 2020).

Trace elements consist of metals that are usually present in the environment in very small quantities (Hem, 1992). Trace elements often are dissolved in water from geologic materials, but concentrations of these elements also can be affected by human activities such as mining. Many trace elements can affect the quality of groundwater for use as drinking water. Groundwater samples were analyzed for 22 trace elements (table 6 of Arnold and others, 2020).

Organic Compounds

Organic compounds are man-made chemicals and include VOCs and pesticides. VOCs are chemicals that tend to evaporate into the air and are in a variety of substances including disinfectants, solvents, paint, fumigants, asphalt, and fuel additives (Zagorsky and others, 2006). Pesticides are chemical compounds used to control plant or insect pests and include fungicides, herbicides, and insecticides (Gilliom and others, 2006). Many VOCs and pesticides, if present, can affect the quality of groundwater used for drinking water. Groundwater samples from 2016 were analyzed for 85 VOCs and 225 pesticides (tables 7 and 8 of Arnold and others, 2020).

Radiochemistry

Radiochemical constituents include radionuclides and measurements of radioactivity. Radionuclides are chemical constituents that are produced naturally by the decay of radioactive parent elements such as uranium and thorium. Sources of radionuclides in groundwater are geologic material such as rocks and soils (Hem, 1992). Radionuclides and measurements of radioactivity included in this report are α radioactivity, β radioactivity, radon (a dissolved gas), several isotopes of radium (radium-224, radium-226, and radium-228), polonium-210, and lead-210 (table 9 of Arnold and others, 2020). Uranium, which also is a radionuclide, is included with trace elements (table 6 of Arnold and others, 2020) because uranium is measured in units of mass concentration rather than as units of radioactivity. In total, groundwater samples were analyzed for eight radionuclides and measures of radioactivity.

Constituents of Special Interest

Several constituents of special interest were included for selected networks. Constituents of special interest were arsenic species (arsenate, arsenite, monomethylarsonate, and dimethylarsinate), which are derived from arsenic, hexavalent chromium (chromium [VI]), perchlorate, and strontium isotopes ($^{87}Sr/^{86}Sr$) (tables 10–13 of Arnold and others, 2020). Arsenic and chromium are predominantly natural in origin but may have localized anthropogenic sources. Anthropogenic arsenic uses include metal and ore processing, glass production, fossil fuel combustion, wood preservatives, pesticides, semiconductor production, and pharmaceuticals (Garelick and others, 2008). Hexavalent chromium is chromium in the +6 oxidation state (six electrons lost from the atom) and is used in textile dyes, wood preservation, anticorrosive agents, and other surface coatings (Nriagu and Niebor, 1988). Geochemical conditions such as redox and pH affect the speciation of chromium and arsenic in groundwater (Hem, 1992). Most arsenic and chromium in groundwater is from geologic sources in rocks and soils. Perchlorate is an inorganic constituent used in rocket fuels, fireworks, safety flares, and other products; it is present in some fertilizers and may be present naturally at low concentrations in groundwater (Srinivasan and Sorial, 2009; Jackson and others, 2015). Strontium isotope variations in groundwater provide insight into the sources of dissolved constituents to groundwater and have been used to trace flow paths and mineral-solution reactions in soils and aquifer rocks (Banner, 2004).

Summary

As part of the third decadal cycle of the U.S. Geological Survey National Water-Quality Assessment Project, groundwater-quality data are being collected from well networks to assess water-quality conditions in the Nation’s principal aquifers and investigate changes in groundwater-quality conditions in selected land use and hydrogeologic settings. Groundwater-quality data are published in annual data series reports, of which this report is the third in the series.

Groundwater-quality data from 648 wells were collected from 7 types of well networks: principal aquifer study networks, land-use study networks, major aquifer study networks, enhanced trends networks, vertical flow-path study networks, flow-path study (FPS), and modeling support study (MSS). Within principal aquifer, land-use, and major aquifer study networks, study areas were divided into equal-area grid cells and wells were selected for sampling using a stratified random sampling design. The number of wells in principal aquifer networks ranged from about 40 to 60 wells per network for the studies included in this report. About 30 wells typically made up each land-use or major aquifer study network. Enhanced trends networks that were sampled in 2016 consisted of two to five wells that were selected at locations within aquifers where temporal changes in groundwater quality might be expected. Three vertical flow-path study network, four flow-path studies, and three modeling support studies are described in this report.

Groundwater samples were analyzed for water-quality indicators and constituents, including nutrients, major and minor ions, trace elements, volatile organic compounds, pesticides, radiochemistry, and select special-interest constituents such as arsenic speciation, hexavalent chromium, and perchlorate. These groundwater-quality data are tabulated in this report and associated data release. Quality-control samples were collected along with environmental samples, and data from blank quality-control samples also are included in this report. The data release includes data collected during 2015 and previously unpublished data from selected environmental samples collected in 2013 and selected quality-control samples collected in 2014. These previously unpublished data are associated with networks described in this report.

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Table 1. Information about wells that have environmental data included in this report.

[NAWQA, National Water-Quality Assessment; ID, identification; no., number; LS, land surface; ft bls, foot below land surface; lat., latitude, in degrees and minutes; long., longitude in degrees and minutes; PAS, principal aquifer study; FL, Florida; na, not available; NGVD 29, National Geodetic Vertical Datum of 1929; NAVD 88, North American Vertical Datum of 1988; ETN, enhanced trends network; TX, Texas; NM, New Mexico; LUS, land-use study; SC, South Carolina; FPS, flow-path study; MS, Mississippi; VFPS; vertical flow-path study; TN, Tennessee; OK, Oklahoma; AR, Arkansas; CA, California; MO, Missouri; KS, Kansas; MD, Maryland; MSS, modeling support study; DE, Delaware; DC, District of Columbia; MAS, major aquifer study; NV, Nevada; NY, New York; OH, Ohio; MI, Michigan; ID, Idaho; NH, New Hampshire; WI, Wisconsin; OR, Oregon; MN, Minnesota; WA, Washington]

Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–01	NV	Washoe	7/5/2016	4,690	NGVD 29	Public supply	530	260	520
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–02	NV	Washoe	7/5/2016	5,193	NGVD 29	Public supply	760	400	750
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–03	NV	Washoe	7/6/2016	4,700	NGVD 29	Domestic	242	109	243
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–04	NV	Carson City	7/7/2016	4,620.00	NGVD 29	Observation	105	85	105
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–05	NV	Washoe	7/18/2016	4,490	NGVD 29	Public supply	429	130	408
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–06	NV	Washoe	7/19/2016	4,480	NGVD 29	Public supply	286	110	272
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–07	NV	Washoe	7/20/2016	4,458	NGVD 29	Public supply	323	114	308
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–08	NV	Carson City	7/21/2016	4,889.10	NGVD 29	Observation	190	175	185
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–09	NV	Carson City	7/25/2016	4,666.70	NGVD 29	Public supply	460	175	450
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–10	NV	Carson City	7/26/2016	4,652	NGVD 29	Public supply	700	250	680
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–11	NV	Washoe	7/27/2016	4,485	NGVD 29	Public supply	815	238	812
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–12	NV	Washoe	7/28/2016	4,504	NGVD 29	Public supply	797	459	797
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–13	NV	Washoe	8/1/2016	4,391.60	NAVD 88	Observation	161	151	161
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–14	NV	Carson City	8/2/2016	4,718	NGVD 29	Domestic	174	131	174
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–15	NV	Washoe	8/16/2016	4,530	NGVD 29	Public supply	334	133	321

Table 1. Information about wells that have environmental data included in this report.—Continued

[NAWQA, National Water-Quality Assessment; ID, identification; no., number; LS, land surface; ft bls, foot below land surface; lat., latitude, in degrees and minutes; long., longitude in degrees and minutes; PAS, principal aquifer study; FL, Florida; na, not available; NGVD 29, National Geodetic Vertical Datum of 1929; NAVD 88, North American Vertical Datum of 1988; ETN, enhanced trends network; TX, Texas; NM, New Mexico; LUS, land-use study; SC, South Carolina; FPS, flow-path study; MS, Mississippi; VFPS; vertical flow-path study; TN, Tennessee; OK, Oklahoma; AR, Arkansas; CA, California; MO, Missouri; KS, Kansas; MD, Maryland; MSS, modeling support study; DE, Delaware; DC, District of Columbia; MAS, major aquifer study; NV, Nevada; NY, New York; OH, Ohio; MI, Michigan; ID, Idaho; NH, New Hampshire; WI, Wisconsin; OR, Oregon; MN, Minnesota; WA, Washington]

Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–16	NV	Washoe	8/16/2016	4,400	NGVD 29	Public supply	191	105	191
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–17	NV	Washoe	8/17/2016	5,800	NGVD 29	Public supply	236	173	236
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–18	NV	Carson City	8/18/2016	4,803.90	NGVD 29	Observation	238	225	235
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–19	NV	Washoe	8/22/2016	4,500	NAVD 88	Observation	780	100	770
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–20	NV	Washoe	8/23/2016	4,410	NGVD 29	Public supply	274	110	260
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–21	NV	Washoe	8/23/2016	4,438	NGVD 29	Public supply	375	143	360
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–22	NV	Washoe	9/7/2016	4,488	NAVD 88	Other	153	103	153
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–23	NV	Carson City	9/8/2016	5,181.50	NGVD 29	Observation	163	148	158
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–24	NV	Washoe	9/12/2016	4,550	NGVD 29	Public supply	485	215	475
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–25	NV	Washoe	9/13/2016	4,510	NGVD 29	Public supply	456	180	420
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–26	NV	Washoe	9/13/2016	4,563	NGVD 29	Public supply	360	170	350
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–27	NV	Washoe	9/14/2016	4,475	NGVD 29	Public supply	583	203	441
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–28	NV	Washoe	9/14/2016	4,420	NGVD 29	Public supply	665	453	645
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–29	NV	Washoe	9/15/2016	4,410	NGVD 29	Public supply	685	330	665
Basin and Range aquifers	MAS	nvbrsus2	NVBRSUS2–30	NV	Washoe	9/21/2016	4,495	NGVD 29	Public supply	300	58	288

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Biscayne aquifer	PAS	biscpas1	BISCPAS1–01	FL	Palm Beach	8/22/2016	15	NAVD 88	Public supply	115	105	115
Biscayne aquifer	PAS	biscpas1	BISCPAS1–02	FL	Palm Beach	8/22/2016	na	na	Public supply	77	na	77[a]
Biscayne aquifer	PAS	biscpas1	BISCPAS1–03	FL	Broward	8/23/2016	na	na	Public supply	96	60	96
Biscayne aquifer	PAS	biscpas1	BISCPAS1–04	FL	Broward	8/30/2016	na	na	Public supply	na	na	na
Biscayne aquifer	PAS	biscpas1	BISCPAS1–05	FL	Broward	6/20/2016	na	na	Public supply	101	75	101
Biscayne aquifer	PAS	biscpas1	BISCPAS1–06	FL	Broward	6/20/2016	na	na	Public supply	140	77	140
Biscayne aquifer	PAS	biscpas1	BISCPAS1–07	FL	Broward	8/30/2016	na	na	Public supply	152	85	145
Biscayne aquifer	PAS	biscpas1	BISCPAS1–08	FL	Broward	6/21/2016	14	NGVD 29	Public supply	140	na	140[a]
Biscayne aquifer	PAS	biscpas1	BISCPAS1–09	FL	Broward	6/21/2016	na	na	Public supply	105	65	105
Biscayne aquifer	PAS	biscpas1	BISCPAS1–10	FL	Broward	9/1/2016	na	na	Public supply	na	na	na
Biscayne aquifer	PAS	biscpas1	BISCPAS1–11	FL	Broward	6/22/2016	14.7	NGVD 29	Public supply	115	108	115
Biscayne aquifer	PAS	biscpas1	BISCPAS1–12	FL	Broward	6/23/2016	na	na	Public supply	na	na	na
Biscayne aquifer	PAS	biscpas1	BISCPAS1–13	FL	Broward	6/22/2016	8	NGVD 29	Public supply	90	84	90
Biscayne aquifer	PAS	biscpas1	BISCPAS1–14	FL	Broward	8/23/2016	8	NGVD 29	Observation	22	12	22
Biscayne aquifer	PAS	biscpas1	BISCPAS1–15	FL	Broward	6/22/2016	na	na	Public supply	140	75	140
Biscayne aquifer	PAS	biscpas1	BISCPAS1–16	FL	Broward	8/29/2016	na	na	Public supply	70	na	70[a]
Biscayne aquifer	PAS	biscpas1	BISCPAS1–17	FL	Broward	6/23/2016	na	na	Public supply	125	117	125
Biscayne aquifer	PAS	biscpas1	BISCPAS1–18	FL	Broward	8/29/2016	na	na	Public supply	112	105	112
Biscayne aquifer	PAS	biscpas1	BISCPAS1–19	FL	Broward	6/23/2016	na	na	Public supply	60	na	60[a]
Biscayne aquifer	PAS	biscpas1	BISCPAS1–20	FL	Broward	8/24/2016	na	na	Public supply	na	na	na
Biscayne aquifer	PAS	biscpas1	BISCPAS1–21	FL	Broward	8/24/2016	na	na	Public supply	110	100	110
Biscayne aquifer	PAS	biscpas1	BISCPAS1–22	FL	Miami-Dade	6/16/2016	na	na	Public supply	60	na	60[a]
Biscayne aquifer	PAS	biscpas1	BISCPAS1–23	FL	Miami-Dade	6/16/2016	na	na	Public supply	60	46	60
Biscayne aquifer	PAS	biscpas1	BISCPAS1–24	FL	Miami-Dade	6/15/2016	7	NGVD 29	Public supply	95	66	95
Biscayne aquifer	PAS	biscpas1	BISCPAS1–25	FL	Miami-Dade	6/15/2016	12	NGVD 29	Public supply	91	85	91
Biscayne aquifer	PAS	biscpas1	BISCPAS1–26	FL	Miami-Dade	6/13/2016	na	na	Observation	40	na	40[a]
Biscayne aquifer	PAS	biscpas1	BISCPAS1–27	FL	Miami-Dade	6/14/2016	9.5	NGVD 29	Public supply	100	45	100

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Biscayne aquifer	PAS	biscpas1	BISCPAS1–28	FL	Miami-Dade	8/31/2016	na	na	Public supply	na	na	na
Biscayne aquifer	PAS	biscpas1	BISCPAS1–29	FL	Miami-Dade	6/14/2016	8.2	NGVD 29	Public supply	132	61	132
Biscayne aquifer	PAS	biscpas1	BISCPAS1–30	FL	Miami-Dade	6/13/2016	na	na	Public supply	90	45	90
Biscayne aquifer	PAS	biscpas1	BISCPAS1–31	FL	Miami-Dade	8/31/2016	na	na	Public supply	na	na	na
Biscayne aquifer	PAS	biscpas1	BISCPAS1–32	FL	Miami-Dade	6/8/2016	na	na	Public supply	35	27	30
Biscayne aquifer	PAS	biscpas1	BISCPAS1–33	FL	Miami-Dade	6/9/2016	na	na	Public supply	na	na	na
Biscayne aquifer	PAS	biscpas1	BISCPAS1–34	FL	Miami-Dade	6/8/2016	na	na	Public supply	na	na	na
Biscayne aquifer	PAS	biscpas1	BISCPAS1–35	FL	Miami-Dade	6/8/2016	na	na	Public supply	40	37	40
Biscayne aquifer	PAS	biscpas1	BISCPAS1–36	FL	Miami-Dade	6/7/2016	na	na	Public supply	61	31	61
Biscayne aquifer	PAS	biscpas1	BISCPAS1–37	FL	Miami-Dade	8/25/2016	na	na	Observation	62	40	62
Biscayne aquifer	PAS	biscpas1	BISCPAS1–38	FL	Miami-Dade	6/7/2016	5.3	NGVD 29	Observation	22	17	22
Biscayne aquifer	PAS	biscpas1	BISCPAS1–39	FL	Miami-Dade	6/6/2016	7	NGVD 29	Public supply	60	20	60
Biscayne aquifer	PAS	biscpas1	BISCPAS1–40	FL	Miami-Dade	6/6/2016	na	na	Public supply	na	na	na
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B1–1	CA	Fresno	7/25/2013	353	NGVD 29	Observation	81	71	76
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B1–2	CA	Fresno	7/25/2013	353	NGVD 29	Observation	168	158	163
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B1–3	CA	Fresno	8/12/2013	353	NGVD 29	Observation	268	258	263
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B2.5–1	CA	Fresno	9/25/2013	343	NGVD 29	Observation	140	130	135
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B2.5–2	CA	Fresno	9/25/2013	343	NGVD 29	Observation	177	167	172
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B2–1	CA	Fresno	9/10/2013	350	NGVD 29	Observation	81	71	76
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B2–2	CA	Fresno	9/9/2013	351	NGVD 29	Observation	89	79	84
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B2–3	CA	Fresno	9/9/2013	351	NGVD 29	Observation	135	125	130

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B3–1	CA	Fresno	8/13/2013	342	NGVD 29	Observation	70	60	65
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B3–2	CA	Fresno	8/14/2013	342	NGVD 29	Observation	113	103	108
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B3–3	CA	Fresno	8/13/2013	342	NGVD 29	Observation	172	162	167
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B3–4	CA	Fresno	8/14/2013	342	NGVD 29	Observation	197	187	192
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B3–5	CA	Fresno	8/13/2013	342	NGVD 29	Observation	265	255	260
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B4–1	CA	Fresno	8/19/2013	337	NGVD 29	Observation	77	67	72
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B4–2	CA	Fresno	8/20/2013	337	NGVD 29	Observation	115	105	110
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B4–3	CA	Fresno	8/20/2013	337	NGVD 29	Observation	184	174	179
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B4–4	CA	Fresno	8/19/2013	337	NGVD 29	Observation	261	251	256
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B5–1	CA	Fresno	7/23/2013	329	NGVD 29	Observation	80	70	75
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B5–2	CA	Fresno	7/23/2013	329	NGVD 29	Observation	158	148	153
Central Valley aquifer system	FPS	cvalfps1	CVALFPS1–B5–3	CA	Fresno	7/24/2013	329	NGVD 29	Observation	268	258	263
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPC1–shallow	CA	Fresno	7/24/2013	356	NGVD 29	Domestic	125	125	125
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPC2–deep	CA	Fresno	8/28/2013	328	NAVD 88	Public supply	400	150	390
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPC2–shallow	CA	Fresno	7/22/2013	331	NGVD 29	Domestic	132	na	132[a]

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPC3–shallow	CA	Fresno	9/17/2013	312	NAVD 88	Domestic	145	85	145
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPF1–deep	CA	Fresno	8/27/2013	300	NAVD 88	Public supply	530	180	520
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPF1–shallow	CA	Fresno	9/11/2013	300	NAVD 88	Observation	160	140	150
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPF2–deep	CA	Fresno	8/27/2013	313	NAVD 88	Public supply	455	170	455
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPF2–shallow	CA	Fresno	9/11/2013	313	NAVD 88	Observation	190	170	180
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR1–deep	CA	Fresno	8/28/2013	298	NAVD 88	Public supply	440	230	430
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR1–shallow	CA	Fresno	9/24/2013	295	NAVD 88	Domestic	100	80	100
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR2–deep	CA	Fresno	9/19/2013	275	NAVD 88	Public supply	370.3	370.3	370.3
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR2–shallow	CA	Fresno	8/22/2013	261	NAVD 88	Domestic	180	140	180
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR3–deep	CA	Fresno	9/18/2013	232	NAVD 88	Other	504	210	504
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR3–shallow	CA	Fresno	8/29/2013	231	NAVD 88	Public supply	245	185	245
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR4–deep	CA	Fresno	8/26/2013	214	NAVD 88	Other	500	335	490
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR4–shallow	CA	Fresno	9/18/2013	213	NAVD 88	Domestic	212	152	212
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR5–deep	CA	Fresno	8/26/2013	193	NAVD 88	Other	532	250	528
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR5–shallow	CA	Fresno	9/12/2013	205	NAVD 88	Domestic	300	300	300

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR6–deep	CA	Fresno	8/21/2013	170	NGVD 29	Other	520	280	520
Central Valley aquifer system	FPS	cvalfps2	CVALFPS2–FPR6–shallow	CA	Fresno	9/16/2013	188	NAVD 88	Domestic	300	240	300
Central Valley aquifer system	ETN	cvaletn1	CVALETN1–01	CA	Fresno	3/3, 3/17, 5/17, 11/17, 12/7/2016	308	NAVD 88	Public supply	620	410	610
Central Valley aquifer system	ETN/ FPS	cvaletn1/ cvalfps2	CVALETN1–02/ CVALFPS2—FPC3–deep	CA	Fresno	9/17/2013 (fps2); 3/3, 7/17/2016	308	NAVD 88	Public supply	320	160	310
Central Valley aquifer system	ETN	cvaletn1	CVALETN1–03	CA	Fresno	3/17, 5/17, 8/24, 12/7/2016	308	NAVD 88	Observation	234	214	224
Columbia Plateau basin-fill and basaltic-rock aquifers	ETN	clptetn1	CLPTETN1–01	OR	Morrow	1/20, 3/18, 4/21, 6/22, 7/28, 9/8, 11/17/2016	292	NGVD 29	Domestic	80	79	80
Columbia Plateau basin-fill and basaltic-rock aquifers	ETN	clptetn1	CLPTETN1–05	OR	Umatilla	3/17, 4/21, 6/23, 9/9, 10/25, 11/18/2016	616	NAVD 88	Other	170	144	170
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–01	WA	Whitman	8/4/2016	1,557.90	NAVD 88	Public supply	273	86	273
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–02	WA	Yakima	6/27/2016	1,110	NGVD 29	Public supply	1,171	878	1,163

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–03	WA	Grant	6/28/2016	533	NAVD 88	Public supply	91	86	91
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–04	WA	Kittitas	6/29/2016	1,570	NAVD 88	Public supply	na	na	na
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–05	WA	Kittitas	6/30/2016	1,625	NAVD 88	Public supply	720	453	720
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–06	WA	Kittitas	6/30/2016	2,240	NGVD 29	Public supply	500	190	500
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–07	WA	Adams	7/11/2016	931	NAVD 88	Public supply	280	na	280[a]
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–08	WA	Grant	7/11/2016	1,129	NAVD 88	Public supply	335	26	335
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–09	WA	Franklin	7/12/2016	860	NGVD 29	Public supply	1,325	750	1,325
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–10	WA	Benton	7/13/2016	na	na	Public supply	na	na	na

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
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Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–11	WA	Yakima	7/14/2016	745	NGVD 29	Public supply	385	305	375
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–12	WA	Grant	7/18/2016	1,317	NAVD 88	Public supply	406	195	406
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–13	WA	Douglas	7/19/2016	2,760	NAVD 88	Public supply	605	na	605[a]
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–14	WA	Lincoln	7/20/2016	1,692	NGVD 29	Public supply	595	250	595
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–15	WA	Grant	7/21/2016	1,122	NAVD 88	Public supply	466	na	466[a]
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–16	WA	Grant	7/21/2016	1,175	NAVD 88	Public supply	743	669	740
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–17	WA	Lincoln	7/25/2016	1,922	NGVD 29	Public supply	149	60	208
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–18	WA	Lincoln	7/25/2016	2,480	NGVD 29	Public supply	455	na	455[a]

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
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Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–19	WA	Lincoln	7/26/2016	2,141	NGVD 29	Public supply	300	180	300
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–20	WA	Spokane	7/26/2016	2,444	NAVD 88	Public supply	260	187	260
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–21	WA	Spokane	7/27/2016	2,364	NAVD 88	Public supply	710	530	710
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–22	WA	Grant	7/28/2016	1,210	NAVD 88	Public supply	1,240	686	1,240
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–23	WA	Adams	8/1/2016	1,979	NGVD 29	Public supply	789	34	34
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–24	WA	Whitman	8/1/2016	1,984	NAVD 88	Public supply	285	215	285
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–25	WA	Whitman	8/2/2016	2,578	NAVD 88	Public supply	315	211	315
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–26	WA	Garfield	8/3/2016	1,891	NAVD 88	Public supply	347	60	347

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–27	WA	Garfield	8/3/2016	1,892	NAVD 88	Public supply	997	373	997
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–28	WA	Walla Walla	8/8/2016	1,624	NAVD 88	Public supply	512	42	512
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–29	WA	Walla Walla	8/8/2016	1,062	NAVD 88	Public supply	484	145	484
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–30	WA	Walla Walla	8/9/2016	802	NAVD 88	Public supply	708	554	708
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–31	WA	Walla Walla	8/9/2016	802	NAVD 88	Public supply	787	585	787
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–32	WA	Franklin	8/10/2016	723	NAVD 88	Public supply	363	352	363
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–33	WA	Klickitat	8/16/2016	2,168	NAVD 88	Public supply	240	38	240
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–34	WA	Klickitat	8/17/2016	1,381	NAVD 88	Public supply	600	50	600

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											Top	Bottom
Columbia Plateau basin-fill and basaltic-rock aquifers	PAS/ ETN	clptpas1/ clptetn1	CLPTPAS1–35/ CLPTETN1–04	OR	Umatilla	1/21, 3/18, 4/20, 6/23, 7/27, 9/9, 11/18/2016	693	NAVD 88	Public supply	1,116	926	1,100
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–36	OR	Wasco	7/11/2016	168	NAVD 88	Public supply	242	165	242
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–37	OR	Union	7/12/2016	2,798	NAVD 88	Public supply	2,434	1,132.80	2,429.50
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–38	OR	Wallowa	7/13/2016	3,832	NAVD 88	Public supply	1315	440	1,315
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–39	OR	Wallowa	7/14/2016	2,947	NAVD 88	Public supply	870	840	870[b]
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–40	OR	Gilliam	7/25/2016	463	NAVD 88	Public supply	470	195	470
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–41	OR	Union	7/26/2016	2,730	NGVD 29	Public supply	600	482	596
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–42	OR	Umatilla	8/1/2016	485	NGVD 29	Public supply	785	535	785

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
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Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–43	OR	Union	8/2/2016	2,792	NGVD 29	Public supply	1,200	495.5	1,200
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–44	OR	Morrow	8/3/2016	2,700	NGVD 29	Public supply	422	34	422
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–45	OR	Wasco	8/4/2016	3,070	NAVD 88	Public supply	150	61	150
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–46	OR	Umatilla	8/8/2016	1,649	NAVD 88	Public supply	309	31	309
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–47	OR	Umatilla	8/9/2016	3,403	NGVD 29	Public supply	580	501	580
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–48	OR	Umatilla	8/10/2016	1,005	NAVD 88	Public supply	502	212	502
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–49	OR	Gilliam	8/11/2016	2,300	NGVD 29	Public supply	174	55	174
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–50	OR	Wasco	8/22/2016	13,40	NGVD 29	Public supply	624	385	624

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											Top	Bottom
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–51	OR	Morrow	8/23/2016	1,100	NGVD 29	Public supply	675	25	675
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–52	OR	Grant	8/24/2016	3,710	NGVD 29	Public supply	272	198	272
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–53	OR	Wasco	8/25/2016	1,765	NAVD 88	Public supply	340	133	340
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–54	OR	Sherman	9/1/2016	2,292	NAVD 88	Public supply	450	284	450
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–55	WA	Asotin	8/4/2016	1,180	NGVD 29	Public supply	1,340	653	1,340
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–56	ID	Idaho	8/1/2016	1,440	NGVD 29	Public supply	195	28	195
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–57	ID	Idaho	8/2/2016	3,255	NAVD 88	Public supply	101	na	101[a]
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–58	ID	Idaho	8/3/2016	3,752	NAVD 88	Public supply	na	na	na

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											Top	Bottom
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–59	ID	Lewis	8/3/2016	3,917	NAVD 88	Public supply	382	na	382[a]
Columbia Plateau basaltic-rock aquifers	PAS	clptpas1	CLPTPAS1–60	ID	Latah	8/4/2016	2,617	NGVD 29	Public supply	1,458	1,047	1,458
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–02	WA	Grant	7/30/2014	1,246	NAVD 88	Observation	21.5	18.5	21.5
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–03	WA	Franklin	8/18/2014	457	NAVD 88	Public supply	155	na	155[a]
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–06	WA	Franklin	8/26/2014	423	NAVD 88	Observation	88	83	88
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–08	WA	Grant	9/19/2014	1,236	NAVD 88	Observation	112	107	112
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–09	WA	Grant	7/24/2014	1,202	NAVD 88	Public supply	170	19	170

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–10	WA	Grant	7/24/2014	1,117	NAVD 88	Observation	38.5	33.5	38.5
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–11	WA	Adams	7/23/2014	1,256.40	NAVD 88	Public supply	430	47	430
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–12	WA	Grant	7/23/2014	1,144	NAVD 88	Observation	31	25	30
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–13	WA	Grant	7/28/2014	1,063	NAVD 88	Public supply	180	73	180
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–14	WA	Grant	7/30/2014	1,132	NAVD 88	Observation	29	24	29
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–16	WA	Adams	8/12/2014	1,205.10	NAVD 88	Observation	34	29	34

Table 1. Information about wells that have environmental data included in this report.—Continued

[NAWQA, National Water-Quality Assessment; ID, identification; no., number; LS, land surface; ft bls, foot below land surface; lat., latitude, in degrees and minutes; long., longitude in degrees and minutes; PAS, principal aquifer study; FL, Florida; na, not available; NGVD 29, National Geodetic Vertical Datum of 1929; NAVD 88, North American Vertical Datum of 1988; ETN, enhanced trends network; TX, Texas; NM, New Mexico; LUS, land-use study; SC, South Carolina; FPS, flow-path study; MS, Mississippi; VFPS; vertical flow-path study; TN, Tennessee; OK, Oklahoma; AR, Arkansas; CA, California; MO, Missouri; KS, Kansas; MD, Maryland; MSS, modeling support study; DE, Delaware; DC, District of Columbia; MAS, major aquifer study; NV, Nevada; NY, New York; OH, Ohio; MI, Michigan; ID, Idaho; NH, New Hampshire; WI, Wisconsin; OR, Oregon; MN, Minnesota; WA, Washington]

Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–17	WA	Adams	9/11/2014	1,044	NAVD 88	Public supply	450	190	450
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–18	WA	Adams	8/12/2014	1,078.80	NAVD 88	Observation	38	33	38
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–19	WA	Franklin	8/11/2014	976.1	NAVD 88	Observation	19	14	19
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–20	WA	Franklin	8/26/2014	728.6	NAVD 88	Public supply	747	22	703
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–21	WA	Franklin	8/27/2014	927	NAVD 88	Public supply	1,000	575	1,000
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–22	WA	Franklin	8/19/2014	713.3	NAVD 88	Observation	42.4	37	42

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–23	WA	Douglas	7/7/2014	640.5	NAVD 88	Public supply	36	26	36
Columbia Plateau basin-fill and basaltic-rock aquifers	VFPS	clptvfps1	CLPTVFPS1–24	WA	Franklin	8/25/2014	926.9	NAVD 88	Public supply	105	47	105
Edwards-Trinity aquifer system	ETN	edtretn1	EDTRETN1–01	TX	Bexar	11/12, 12/17/2013; 2/10, 4/1, 7/17, 8/28, 9/2, 11/24/2014; 1/27, 3/24, 5/20, 6/4, 8/18, 10/22, 12/9/2015; 3/10, 5/9, 6/2, 8/23, 10/19/2016	946	NAVD 88	Public supply	550	317	550

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Edwards-Trinity aquifer system	ETN	edtretn1	EDTRETN1–02	TX	Bexar	11/13, 12/16/2013; 2/11, 3/31, 6/2, 7/16, 9/3, 11/25/2014; 1/26, 3/25, 5/15, 6/3, 8/19, 10/21, 12/7/2015; 3/9, 4/21, 6/1, 8/22, 10/18/2016	975	NGVD 29	Observation	300	220	300
Edwards-Trinity aquifer system	ETN	edtretn1	EDTRETN1–03	TX	Bexar	11/14, 12/17/2013; 2/10, 4/1, 6/3, 7/16, 9/2, 11/24/2014; 1/27, 3/26, 5/27, 6/4, 8/18, 10/22, 12/8/2015; 3/10, 5/13, 6/2, 8/23, 10/19/2016	585	NAVD 88	Public supply	1,500	1,320	1,550
Glacial aquifer and New England crystalline-rock aquifers	ETN	negxetn1	NEGXETN1–01	NH	Rockingham	1/13, 3/11, 5/24, 7/20, 9/30, 11/16/2016	60	NGVD 29	Public supply	83	73	83
Glacial aquifer and New England crystalline-rock aquifers	ETN	negxetn1	NEGXETN1–02	NH	Rockingham	1/13, 3/11, 5/23, 7/13, 9/30, 11/16/2016	80	NGVD 29	Public supply	492	88	492

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer and New England crystalline-rock aquifers	ETN	negxetn1	NEGXETN1–03	NH	Rockingham	1/13, 3/9, 5/25, 7/12, 9/29, 11/17/2016	110	NGVD 29	Domestic	176.3	na	176.3[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–01_SD	WI	Columbia	8/21/2014	824	NGVD 29	Public supply	125	75	120
Glacial aquifer system	MSS	glacmss1	GLACMSS1–01_TD	WI	Marquette	9/15/2014	865	NGVD 29	Other	199	180	200
Glacial aquifer system	MSS	glacmss1	GLACMSS1–01_TS	WI	Marquette	8/20/2014	na	na	Observation	na	na	na
Glacial aquifer system	MSS	glacmss1	GLACMSS1–02_SD	WI	Waupaca	8/12/2014	na	na	Public supply	141	na	141[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–02_TS	WI	Waushara	8/20/2014	na	na	Observation	na	na	na
Glacial aquifer system	MSS	glacmss1	GLACMSS1–02a_PD	WI	Portage	8/11/2014	na	na	Public supply	140	na	140[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–02a_PS	WI	Portage	8/12/2014	1,090	NAVD 88	Domestic	63	na	63[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–02b_PD	WI	Waupaca	8/11/2014	844.5	NGVD 29	Public supply	84	59	84
Glacial aquifer system	MSS	glacmss1	GLACMSS1–02b_PS	WI	Waupaca	9/16/2014	833	NAVD 88	Other	45	na	45[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–03_SD	WI	Shawano	8/13/2014	1,160	NGVD 29	Public supply	52	42.5	52.6
Glacial aquifer system	MSS	glacmss1	GLACMSS1–03_TD	WI	Shawano	9/24/2014	1,026	NAVD 88	Public supply	88	na	88[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–03_TS	WI	Shawano	9/22/2014	1,287	NAVD 88	Other	61	na	61[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–04_SD	WI	Forest	8/13/2014	1,637	NGVD 29	Public supply	90	70	90

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	MSS	glacmss1	GLACMSS1–04_TS	WI	Oconto	9/22/2014	1,348	NAVD 88	Domestic	76	na	76[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–05_SD	WI	Langlade	8/18/2014	1,290	NGVD 29	Public supply	95.3	68.7	95.3
Glacial aquifer system	MSS	glacmss1	GLACMSS1–05_TD	WI	Oconto	9/22/2014	1,362	NAVD 88	Domestic	170	na	170[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–05_TS	WI	Langlade	9/22/2014	1,317	NAVD 88	Public supply	54	na	54[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–06_PD	WI	Waupaca	8/11/2014	780	NGVD 29	Public supply	90	70	90
Glacial aquifer system	MSS	glacmss1	GLACMSS1–06_PS	WI	Waupaca	9/17/2014	792	NAVD 88	Other	120	116	120
Glacial aquifer system	MSS	glacmss1	GLACMSS1–06_SD	WI	Waupaca	9/23/2014	852	NGVD 29	Public supply	172	147	172
Glacial aquifer system	MSS	glacmss1	GLACMSS1–06_TS	WI	Waupaca	9/24/2014	907	NAVD 88	Domestic	80	na	80[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–07_SD	WI	Waupaca	8/19/2014	760	NGVD 29	Public supply	118	75	115
Glacial aquifer system	MSS	glacmss1	GLACMSS1–07_TS	WI	Waushara	9/24/2014	788	NAVD 88	Other	68	na	68[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–08_SD	WI	Outagamie	9/16/2014	800	NGVD 29	Public supply	141	106	141
Glacial aquifer system	MSS	glacmss1	GLACMSS1–08_TS	WI	Shawano	9/16/2014	812	NAVD 88	Other	62	54	62
Glacial aquifer system	MSS	glacmss1	GLACMSS1–09_SD	WI	Oconto	8/19/2014	810	NGVD 29	Public supply	245	215	245
Glacial aquifer system	MSS	glacmss1	GLACMSS1–09_TD	WI	Shawano	9/23/2014	838	NGVD 29	Public supply	151	120	152
Glacial aquifer system	MSS	glacmss1	GLACMSS1–09_TS	WI	Oconto	9/23/2014	741	NAVD 88	Domestic	53	na	53[a]

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	MSS	glacmss1	GLACMSS1–10_SD	WI	Marinette	8/18/2014	697	NAVD 88	Public supply	51.5	na	51.5[a]
Glacial aquifer system	MSS	glacmss1	GLACMSS1–10_TS	WI	Oconto	8/18/2014	na	na	Observation	na	na	na
Glacial aquifer system	MAS	lerisus1	LERISUS1–01	MI	Livingston	8/4/2016	951	NGVD 29	Domestic	103	99	103
Glacial aquifer system	MAS	lerisus1	LERISUS1–02	MI	Livingston	8/4/2016	987	NGVD 29	Domestic	79	72	76
Glacial aquifer system	MAS	lerisus1	LERISUS1–03	MI	Oakland	8/8/2016	943	NGVD 29	Domestic	72	60	70
Glacial aquifer system	MAS	lerisus1	LERISUS1–04	MI	Lenawee	8/22/2016	808	NGVD 29	Domestic	158	155	158
Glacial aquifer system	MAS	lerisus1	LERISUS1–05	MI	Hillsdale	8/22/2016	900	NAVD 88	Domestic	58	54	58
Glacial aquifer system	MAS	lerisus1	LERISUS1–06	MI	Hillsdale	8/23/2016	1,048	NGVD 29	Domestic	90	86	90
Glacial aquifer system	MAS	lerisus1	LERISUS1–07	MI	Hillsdale	8/23/2016	922	NGVD 29	Domestic	91	88	91
Glacial aquifer system	MAS	lerisus1	LERISUS1–08	MI	Lenawee	8/24/2016	865	NGVD 29	Domestic	87	82	86
Glacial aquifer system	MAS	lerisus1	LERISUS1–09	MI	Lenawee	8/24/2016	863	NGVD 29	Domestic	80	72	80
Glacial aquifer system	MAS	lerisus1	LERISUS1–10	MI	St. Clair	9/6/2016	788	NGVD 29	Domestic	127	123	127
Glacial aquifer system	MAS	lerisus1	LERISUS1–11	MI	Sanilac	9/6/2016	814	NGVD 29	Domestic	54	50	54
Glacial aquifer system	MAS	lerisus1	LERISUS1–12	MI	Lapeer	9/6/2016	833	NAVD 88	Domestic	100	96	100
Glacial aquifer system	MAS	lerisus1	LERISUS1–13	MI	Oakland	9/7/2016	815	NGVD 29	Domestic	73	69	73

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	MAS	lerisus1	LERISUS1–14	MI	Lapeer	9/8/2016	862	NGVD 29	Domestic	100	92	100
Glacial aquifer system	MAS	lerisus1	LERISUS1–15	MI	Macomb	9/8/2016	630	NGVD 29	Domestic	35	31	35
Glacial aquifer system	MAS	lerisus1	LERISUS1–16	MI	Oakland	9/12/2016	1,117	NGVD 29	Domestic	120	116	120
Glacial aquifer system	MAS	lerisus1	LERISUS1–17	MI	Sanilac	9/12/2016	812	NGVD 29	Domestic	205	201	205
Glacial aquifer system	MAS	lerisus1	LERISUS1–18	MI	Oakland	9/12/2016	1,020	NGVD 29	Domestic	170	162	170
Glacial aquifer system	MAS	lerisus1	LERISUS1–19	MI	Washtenaw	9/13/2016	995	NGVD 29	Domestic	92	88	92
Glacial aquifer system	MAS	lerisus1	LERISUS1–20	MI	Washtenaw	9/13/2016	921	NGVD 29	Domestic	100	92	96
Glacial aquifer system	MAS	lerisus1	LERISUS1–21	OH	Williams	8/23/2016	927	NGVD 29	Domestic	70	62	67
Glacial aquifer system	MAS	lerisus1	LERISUS1–22	OH	Williams	8/23/2016	980	NGVD 29	Domestic	82	78	82
Glacial aquifer system	MAS	lerisus1	LERISUS1–23	OH	Williams	8/24/2016	912	NGVD 29	Domestic	70	67	70
Glacial aquifer system	MAS	lerisus1	LERISUS1–24	OH	Williams	8/24/2016	863	NGVD 29	Domestic	121	118	121
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–01	WA	Pierce	8/22/2016	1,450	NGVD 29	Domestic	78	78	78[a]
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–02	WA	Pierce	8/22/2016	480	NGVD 29	Domestic	78	78	78[a]
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–03	WA	Pierce	8/23/2016	360	NGVD 29	Domestic	40	40	40[a]
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–04	WA	Pierce	8/23/2016	360	NGVD 29	Domestic	100	100	100[a]

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–05	WA	Snohomish	8/25/2016	1,040	NGVD 29	Domestic	186	182	186
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–06	WA	Snohomish	8/25/2016	220	NGVD 29	Domestic	71	70	71[a]
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–07	WA	Pierce	9/6/2016	720	NGVD 29	Domestic	40	40	40[a]
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–08	WA	Thurston	9/6/2016	430	NGVD 29	Domestic	58	58	58[a]
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–09	WA	Thurston	9/13/2016	14	NGVD 29	Domestic	72	67	72
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–10	WA	Thurston	9/13/2016	210	NGVD 29	Domestic	68	62	64
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–11	WA	Snohomish	9/15/2016	230	NGVD 29	Domestic	70	65	70
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–12	WA	Whatcom	9/21/2016	144	NGVD 29	Domestic	29	24	29
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–13	WA	Whatcom	9/21/2016	65	NGVD 29	Domestic	22.5	17.5	22.5
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–14	WA	King	11/1/2016	320	NGVD 29	Domestic	75	70	75
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–15	WA	Snohomish	11/8/2016	240	NGVD 29	Domestic	42	32	42
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–16	WA	Kitsap	11/14/2016	67	NAVD 88	Domestic	85	82	85
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–17	WA	Whatcom	11/16/2016	60	NGVD 29	Domestic	40	35	40
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–18	WA	Whatcom	11/16/2016	130	NGVD 29	Domestic	98	98	98[a]
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–19	WA	King	11/17/2016	346	NAVD 88	Public supply	230	190	230

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–20	WA	Kitsap	11/21/2016	304	NAVD 88	Domestic	300	na	300[a]
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–21	WA	Mason	11/21/2016	262	NAVD 88	Domestic	309	na	309[a]
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–22	WA	Mason	11/22/2016	480	NAVD 88	Domestic	60	55.5	60
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–23	WA	Mason	11/22/2016	227	NAVD 88	Domestic	180	120	180
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–24	WA	Kitsap	11/28/2016	219	NAVD 88	Other	277	272	277
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–25	WA	King	11/29/2016	532	NGVD 29	Public supply	85	75	85
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–26	WA	King	12/5/2016	47	NGVD 29	Public supply	92	82	92
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–27	WA	King	12/5/2016	40	NGVD 29	Public supply	82	44	82
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–28	WA	Pierce	12/7/2016	261	NAVD 88	Public supply	112	55	107
Glacial aquifer system	MAS	pugtsus1	PUGTSUS1–29	WA	Thurston	12/7/2016	29	NAVD 88	Public supply	170.6	130	159.6
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–01	MN	Anoka	7/11/2016	857.9	NAVD 88	Observation	14	9	14
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–02	MN	Anoka	7/12/2016	856.9	NGVD 29	Observation	18	13	18
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–03	MN	Anoka	7/12/2016	894.7	NAVD 88	Observation	15	10	15
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–04	MN	Anoka	7/13/2016	879.1	NAVD 88	Observation	20.8	15.8	20.8
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–05	MN	Anoka	7/13/2016	877.4	NGVD 29	Observation	20	15	20

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–06	MN	Anoka	7/14/2016	854.1	NAVD 88	Observation	12.2	7.2	12.2
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–07	MN	Hennepin	7/14/2016	849.1	NGVD 29	Observation	9	4	9
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–08	MN	Hennepin	8/1/2016	867.9	NGVD 29	Observation	13.5	8.5	13.5
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–09	MN	Hennepin	8/2/2016	858.4	NGVD 29	Observation	24	19	24
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–10	MN	Hennepin	8/2/2016	910.8	NGVD 29	Observation	28.5	24	28.5
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–11	MN	Anoka	8/3/2016	862	NGVD 29	Observation	19	14	19
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–12	MN	Hennepin	8/4/2016	872.8	NGVD 29	Observation	18	13	18
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–13	MN	Hennepin	8/15/2016	841.8	NAVD 88	Observation	16	11	16
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–14	MN	Hennepin	8/15/2016	866.6	NGVD 29	Observation	22.5	17.5	22.5
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–15	MN	Hennepin	8/16/2016	845.8	NAVD 88	Observation	15	10	15
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–16	MN	Hennepin	8/17/2016	880.6	NAVD 88	Observation	26	16	26
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–17	MN	Hennepin	8/18/2016	872.3	NAVD 88	Observation	25.4	20.4	25.1
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–18	MN	Hennepin	8/22/2016	864.9	NAVD 88	Observation	18	13	18
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–19	MN	Hennepin	8/22/2016	857.7	NGVD 29	Observation	19	14	19
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–20	MN	Anoka	8/23/2016	895.7	NGVD 29	Observation	24.5	19.5	24.5

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–21	MN	Hennepin	8/23/2016	844.1	NGVD 29	Observation	17	12	17
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–22	MN	Hennepin	8/23/2016	863.3	NGVD 29	Observation	23	18	23
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–23	MN	Hennepin	8/24/2016	868.1	NGVD 29	Observation	24.3	19.3	24.3
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–24	MN	Hennepin	8/25/2016	876.2	NGVD 29	Observation	18	13	18
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–25	MN	Hennepin	8/25/2016	851	NGVD 29	Observation	10	5	10
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–26	MN	Hennepin	8/25/2016	849.6	NGVD 29	Observation	15	10	15
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–27	MN	Hennepin	8/29/2016	875.2	NGVD 29	Observation	29	24	29
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–28	MN	Hennepin	8/29/2016	850.4	NGVD 29	Observation	33.5	28.5	33.5
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–29	MN	Anoka	8/30/2016	867.9	NGVD 29	Observation	13	8	13
Glacial aquifer system	LUS	umislusrc1	UMISLUSRC1–30	MN	Hennepin	9/8/2016	857.9	NGVD 29	Observation	9	4	9
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–01/ GLACVFPS1–11	MI	Livingston	8/1/2016	895	NGVD 29	Observation	25	20.1	24.6
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–02/ GLACVFPS1–09	MI	Livingston	8/1/2016	880	NGVD 29	Observation	26.5	21.2	25.7
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–03/ GLACVFPS1–07	MI	Livingston	8/2/2016	905	NGVD 29	Observation	15.4	10.5	15
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–04/ GLACVFPS1–06	MI	Washtenaw	8/2/2016	870	NAVD 88	Observation	28.5	23.2	28.2

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–05/ GLACVFPS1–18	MI	Livingston	8/3/2016	925	NGVD 29	Observation	21	16.2	20.7
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–06/ GLACVFPS1–19	MI	Livingston	8/3/2016	935	NGVD 29	Observation	16.3	11.5	16
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–07/ GLACVFPS1–20	MI	Livingston	8/3/2016	995	NGVD 29	Observation	30.4	25.5	30
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–08/ GLACVFPS1–13	MI	Oakland	8/9/2016	915	NGVD 29	Observation	10.5	5.7	10.2
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–09/ GLACVFPS1–25	MI	Oakland	8/10/2016	935	NGVD 29	Observation	20.1	15.2	19.7
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–10/ GLACVFPS1–22	MI	Oakland	8/11/2016	940	NAVD 88	Observation	49	40.1	48.2
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–11/ GLACVFPS1–16	MI	Livingston	8/15/2016	935	NGVD 29	Observation	40.9	36.1	40.6
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–12/ GLACVFPS1–27	MI	Livingston	8/15/2016	1,010	NGVD 29	Observation	68.5	63.6	68.1
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–13/ GLACVFPS1–33	MI	Oakland	8/16/2016	990	NGVD 29	Observation	39.8	35	39.5
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–14/ GLACVFPS1–29	MI	Oakland	8/16/2016	1,035	NGVD 29	Observation	32.1	27.3	31.8
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–15/ GLACVFPS1–31	MI	Oakland	8/16/2016	1,025	NGVD 29	Observation	22.1	17.3	21.8
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–16/ GLACVFPS1–35	MI	Oakland	8/17/2016	1,045	NGVD 29	Observation	41.7	36.9	41.4
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–17/ GLACVFPS1–39	MI	Oakland	8/17/2016	1,040	NGVD 29	Observation	18.1	13.3	17.8

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–18/ GLACVFPS1–42	MI	Oakland	8/18/2016	1,045	NGVD 29	Observation	16.7	11.9	16.4
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–19/ GLACVFPS1–38	MI	Oakland	9/7/2016	1,055	NAVD 88	Observation	39.9	34.4	39.4
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–20/ GLACVFPS1–34	MI	Macomb	9/7/2016	840	NAVD 88	Observation	30	25	30
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–21/ GLACVFPS1–37	MI	Oakland	9/7/2016	995	NGVD 29	Observation	16.6	11.8	16.3
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–22/ GLACVFPS1–23	MI	Oakland	9/13/2016	920	NGVD 29	Observation	31.8	27	31.5
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–23/ GLACVFPS1–41	MI	Oakland	9/14/2016	1,045	NGVD 29	Observation	33.9	29	33.5
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–24/ GLACVFPS1–01	MI	Washtenaw	9/14/2016	845	NGVD 29	Observation	27.3	22.5	27
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–25/ GLACVFPS1–03	MI	Washtenaw	9/15/2016	835	NGVD 29	Observation	22	17.1	21.7
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–26/ GLACVFPS1–04	MI	Washtenaw	9/15/2016	855	NGVD 29	Observation	31.2	26.4	30.9
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–27/ GLACVFPS1–32	MI	Oakland	9/22/2016	768	NAVD 88	Observation	23	15	22.5
Glacial aquifer system	LUS/ VFPS	lerilusrc1/ glacvfps1	LERILUSRC1–28/ GLACVFPS1–15	MI	Oakland	9/27/2016	875	NGVD 29	Observation	13.9	9.1	13.6
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–02	MI	Washtenaw	9/14/2016	845	NGVD 29	Domestic	138	134	138
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–05	MI	Washtenaw	9/15/2016	855	NGVD 29	Domestic	145	140	145
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–08	MI	Livingston	8/2/2016	910	NGVD 29	Domestic	49	44	49

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–10	MI	Livingston	8/1/2016	880	NGVD 29	Domestic	60	56	60
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–12	MI	Livingston	8/2/2016	895	NGVD 29	Domestic	116	112	116
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–14	MI	Oakland	8/9/2016	915	NGVD 29	Domestic	38	32	38
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–17	MI	Livingston	8/15/2016	935	NGVD 29	Domestic	106	102	106
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–21	MI	Livingston	8/3/2016	995	NGVD 29	Domestic	92	88	92
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–24	MI	Oakland	9/13/2016	920	NGVD 29	Domestic	127	123	127
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–26	MI	Oakland	8/10/2016	933	NAVD 88	Domestic	60	56	60
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–28	MI	Livingston	8/15/2016	1,000	NGVD 29	Domestic	105	101	105
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–30	MI	Oakland	8/16/2016	1,035	NGVD 29	Domestic	90	80	90
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–36	MI	Oakland	8/17/2016	1,035	NGVD 29	Domestic	172	168	172
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–40	MI	Oakland	8/17/2016	1,040	NGVD 29	Domestic	127	123	127
Glacial aquifer system	VFPS	glacvfps1	GLACVFPS1–43	MI	Oakland	8/18/2016	1,045	NGVD 29	Domestic	84	80	84
Glacial aquifer system	ETN/ FPS	glacetn1/ glacfps1	GLACETN1–01/ GLACFPS1–17	WI	Portage	6/9/2014; 2/17, 5/6, 6/29, 8/2, 9/5/2016	1,135.70	NAVD 88	Observation	83	80	83
Glacial aquifer system	ETN/ FPS	glacetn1/ glacfps1	GLACETN1–02/ GLACFPS1–18	WI	Portage	6/9/2014; 2/17, 5/6, 6/29, 8/2, 9/5/2016	1,135.70	NAVD 88	Observation	34.5	24.5	34.5

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	ETN	glacetn1	GLACETN1–03	WI	Sauk	8/3/2016	723.4	NAVD 88	Observation	50.1	45.1	50.1
Glacial aquifer system	ETN	glacetn1	GLACETN1–04	WI	Sauk	8/26/2016	723.4	NAVD 88	Observation	89	84	89
Glacial aquifer system	ETN	glacetn1	GLACETN1–05	WI	Sauk	8/3/2016	730	NAVD 88	Public supply	125	na	125[a]
Glacial aquifer system	FPS	glacfps1	GLACFPS1–01	WI	Portage	6/11/2014	1,100	NAVD 88	Observation	1.3	1.2	1.3
Glacial aquifer system	FPS	glacfps1	GLACFPS1–02	WI	Portage	6/11/2014	1,100	NAVD 88	Observation	1.3	1.2	1.3
Glacial aquifer system	FPS	glacfps1	GLACFPS1–03	WI	Portage	6/12/2014	1,111	NAVD 88	Observation	1.3	na	1.3[a]
Glacial aquifer system	FPS	glacfps1	GLACFPS1–04	WI	Portage	6/12/2014	1,100	NAVD 88	Observation	1.3	1.2	1.3
Glacial aquifer system	FPS	glacfps1	GLACFPS1–05	WI	Portage	6/12/2014	1,100	NAVD 88	Observation	1.3	1.2	1.3
Glacial aquifer system	FPS	glacfps1	GLACFPS1–06	WI	Portage	6/10/2014	1,100	NAVD 88	Observation	1.3	1.2	1.3
Glacial aquifer system	FPS	glacfps1	GLACFPS1–07	WI	Portage	6/10/2014	1,100	NAVD 88	Observation	1.3	1.2	1.3
Glacial aquifer system	FPS	glacfps1	GLACFPS1–08	WI	Portage	6/11/2014	1,100	NAVD 88	Observation	1.3	1.2	1.3
Glacial aquifer system	FPS	glacfps1	GLACFPS1–09	WI	Portage	6/10/2014	1,109	NGVD 29	Observation	11.5	6.5	11.5
Glacial aquifer system	FPS	glacfps1	GLACFPS1–10	WI	Portage	6/10/2014	1,109	NGVD 29	Observation	23.5	20.5	23.5
Glacial aquifer system	FPS	glacfps1	GLACFPS1–11	WI	Portage	6/11/2014	1,109	NGVD 29	Observation	31.5	28.5	31.5
Glacial aquifer system	FPS	glacfps1	GLACFPS1–12	WI	Portage	6/11/2014	1,109	NGVD 29	Observation	44	41	44

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Glacial aquifer system	FPS	glacfps1	GLACFPS1–13	WI	Portage	6/11/2014	1,109	NGVD 29	Observation	61	58	61
Glacial aquifer system	FPS	glacfps1	GLACFPS1–14	WI	Portage	6/11/2014	1,109	NGVD 29	Observation	76	73	76
Glacial aquifer system	FPS	glacfps1	GLACFPS1–15	WI	Portage	6/10/2014	1,135	NGVD 29	Observation	28	23	28
Glacial aquifer system	FPS	glacfps1	GLACFPS1–16	WI	Portage	6/10/2014	1,135	NGVD 29	Observation	53	50	53
Glacial aquifer system	FPS	glacfps1	GLACFPS1–19	WI	Portage	6/12/2014	1,148	NGVD 29	Observation	38	35	38
Glacial aquifer system	FPS	glacfps1	GLACFPS1–20	WI	Portage	6/12/2014	1,148	NGVD 29	Observation	46	43	46
Glacial aquifer system	FPS	glacfps1	GLACFPS1–21	WI	Portage	6/17/2014	1,148	NGVD 29	Observation	80	55	58
Glacial aquifer system	FPS	glacfps1	GLACFPS1–22	WI	Portage	6/18/2014	1,148	NGVD 29	Observation	83	80	83
Glacial aquifer system	FPS	glacfps1	GLACFPS1–23	WI	Portage	6/17/2014	1,148	NGVD 29	Observation	99	96	99
Glacial aquifer system	FPS	glacfps1	GLACFPS1–24	WI	Portage	6/16/2014	1,150	NGVD 29	Observation	33	23	33
Glacial aquifer system	FPS	glacfps1	GLACFPS1–25	WI	Portage	6/17/2014	1,150	NGVD 29	Observation	63	58	63
Glacial aquifer system	FPS	glacfps1	GLACFPS1–26	WI	Portage	6/16/2014	1,150	NGVD 29	Observation	93	90	93
Glacial aquifer system	FPS	glacfps1	GLACFPS1–27	WI	Portage	6/11/2014	1,100	NAVD 88	Observation	1.25	1.2	1.25
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–64	TX	Hockley	5/23/2016	3,508	NAVD 88	Public supply	242	na	242[a]
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–65	TX	Hale	5/24/2016	3,402	NGVD 29	Public supply	330	240	330

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–66	TX	Bailey	5/25/2016	3,808	NGVD 29	Public supply	201	40	201
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–67	TX	Lubbock	5/26/2016	3,186	NGVD 29	Public supply	321	na	321[a]
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–68	TX	Gaines	5/31/2016	3,341	NAVD 88	Public supply	253	na	253[a]
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–69	TX	Martin	5/31/2016	2,909	NGVD 29	Public supply	214	127	209
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–70	TX	Martin	6/1/2016	2,683	NAVD 88	Public supply	180	na	180[a]
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–71	TX	Dawson	6/2/2016	3,020	NAVD 88	Public supply	190	na	190[a]
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–72	TX	Lipscomb	6/13/2016	2,624	NGVD 29	Public supply	478	270	460
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–73	TX	Roberts	6/14/2016	3,089	NGVD 29	Public supply	711	510	695
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–74	TX	Wheeler	6/15/2016	2,748	NAVD 88	Public supply	262	na	262[a]
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–75	TX	Carson	6/16/2016	3,529	NGVD 29	Public supply	812	547	812
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–76	TX	Dallam	6/20/2016	4,620	NAVD 88	Public supply	363	na	363[a]
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–77	TX	Parmer	6/21/2016	4,017	NAVD 88	Public supply	320	na	320[a]
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–78	TX	Deaf Smith	6/21/2016	3,823	NGVD 29	Public supply	348	180	340
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–79	TX	Moore	6/23/2016	3,666	NAVD 88	Public supply	620	na	620[a]
High Plains aquifer	PAS	hpaqpas1	HPAQPAS1–80	TX	Sherman	7/13/2016	3,695	NAVD 88	Public supply	395	na	395[a]

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–01	TN	Hardeman	9/9/2013	500	NGVD 29	Observation	62.7	52.2	62.2
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–02	TN	Fayette	9/11/2013	351	NAVD 88	Public supply	120	na	120[a]
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–03	TN	Fayette	9/10/2013	385	NGVD 29	Public supply	198	162	198
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–04	TN	Fayette	9/10/2013	350	NGVD 29	Domestic	210	200	210
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–05	TN	Shelby	9/11/2013	332	NGVD 29	Other	180	160	180
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–06	TN	Shelby	8/21/2013	298	NGVD 29	Observation	300	280	300

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–07	TN	Shelby	8/29/2013	316	NGVD 29	Public supply	582	490	578
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–09	MS	Benton	8/15/2013	411	NAVD 88	Observation	23	13	23
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–10	TN	Fayette	8/14/2013	421	NGVD 29	Domestic	95	85	95
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–11	TN	Fayette	8/22/2013	432	NGVD 29	Domestic	200	180	200
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–12	TN	Fayette	8/20/2013	311	NGVD 29	Public supply	174	130	174
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–13	TN	Shelby	8/14/2013	383	NGVD 29	Public supply	263	223	263

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–14	TN	Shelby	8/20/2013	352	NGVD 29	Public supply	269	190	265
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–15	TN	Shelby	8/21/2013	360	NGVD 29	Public supply	304	240	300
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–16	TN	Shelby	8/27/2013	280	NGVD 29	Public supply	598	490	590
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–18	TN	Shelby	8/19/2013	290	NGVD 29	Observation	87	77	87
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–19	TN	Shelby	9/12/2013	360	NGVD 29	Other	155	135	155
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–20	TN	Shelby	8/13/2013	300	NGVD 29	Observation	107.7	97.7	107.7

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–21	TN	Shelby	8/12/2013	268	NGVD 29	Observation	76.1	66.1	76.1
Miss. Embayment-TX Coastal Uplands aquifer system	FPS	metxfps1	METXFPS1–22	TN	Shelby	8/27/2013	259	NGVD 29	Observation	91	81	91
Miss. Embayment-TX Coastal Uplands aquifer system	ETN/ FPS	metxetn1/ metxfps1	METXETN1–01/ METXFPS1–08	TN	Shelby	8/28/2013; 4/26, 6/22, 8/22, 10/31, 12/13/2016	320	NGVD 29	Public supply	624	520	624
Miss. Embayment-TX Coastal Uplands aquifer system	ETN/ FPS	metxetn1/ metxfps1	METXETN1–02/ METXFPS1–17	TN	Shelby	8/28, 11/19, 12/16/2013; 2/3/2014, 2/29, 4/26, 6/22, 8/23, 10/31, 12/13/2016	310	NGVD 29	Observation	90	80	90
Northern Atlantic Coastal Plain aquifer system	ETN	nacpetn1	NACPETN1–01	DE	Sussex	3/2, 3/23, 4/26, 6/28, 8/10, 10/4/2016	16	NGVD 29	Observation	22	19	22
Northern Atlantic Coastal Plain aquifer system	ETN	nacpetn1	NACPETN1–02	DE	Sussex	3/2, 4/26, 8/9, 8/29, 10/5/2016	13.8	NGVD 29	Public supply	135	85	135
Northern Atlantic Coastal Plain aquifer system	ETN	nacpetn1	NACPETN1–03	DE	Sussex	3/3, 4/27, 5/6, 6/29, 8/11, 10/4/2016	41.6	NGVD 29	Public supply	119	100	119

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–01	DC	District of Columbia	12/19/2016	60.6	NAVD 88	Observation	290	140	290
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–02	DC	District of Columbia	12/6/2016	58.8	NAVD 88	Observation	265	255	265
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–03	DC	District of Columbia	12/20/2016	142.6	NAVD 88	Observation	60	49.5	59.5
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–04	MD	Prince George’s	8/22/2016	180	NAVD 88	Other	345	290	340
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–05	MD	Prince George's	8/23/2016	185	NGVD 29	Other	430	385	425
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–06	MD	Anne Arundel	8/24/2016	126	NGVD 29	Public supply	295	275	295
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–07	MD	Prince George's	10/26/2016	212	NAVD 88	unknown	607	533	607
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–08	MD	Charles	10/27/2016	204.6	NGVD 29	Other	397	377	397
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–09	MD	Anne Arundel	11/15/2016	70	NGVD 29	Other	280	259	277
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–10	MD	Prince George's	11/16/2016	240.9	NGVD 29	Other	342	317	342

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–11	MD	Prince George's	11/17/2016	240	NGVD 29	Other	645	530	640
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–12	MD	Anne Arundel	11/21/2016	162.8	NAVD 88	Observation	240	215	235
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–13	MD	Prince George's	11/21/2016	28	NAVD 88	unknown	415	385	391
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–14	MD	Anne Arundel	11/22/2016	163.4	NAVD 88	Observation	125	100	120
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–15	MD	Anne Arundel	11/22/2016	51	NAVD 88	Other	200	186	193
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–16	MD	Anne Arundel	11/30/2016	35	NAVD 88	Other	360	349	356
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–17	MD	Calvert	12/12/2016	137.9	NGVD 29	Domestic	320	310	320
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–18	MD	Calvert	12/13/2016	138.8	NGVD 29	Observation	170	160	170
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–19	MD	Prince George's	12/20/2016	95.8	NGVD 29	Observation	155	150	155
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss1	NACPMSS1–20	MD	Anne Arundel	12/28/2016	51.3	NGVD 29	Observation	177	142	172

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–01	NY	Suffolk	8/16/2016	75	NGVD 29	Public supply	388	307	367
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–02	NY	Suffolk	8/17/2016	71	NGVD 29	Public supply	543	425.6	529
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–03	NY	Suffolk	8/17/2016	108	NAVD 88	Domestic	734	670	730.8
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–04	NY	Nassau	8/22/2016	145	NGVD 29	Public supply	283	221	280
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–05	NY	Suffolk	8/23/2016	185	NGVD 29	Public supply	488	423	483
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–06	NY	Suffolk	8/23/2016	157	NAVD 88	Domestic	468	410	465
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–07	NY	Suffolk	8/24/2016	110	NGVD 29	Public supply	900	585	645
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–08	NY	Suffolk	8/24/2016	120	NGVD 29	Public supply	312	260	310
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–09	NY	Suffolk	8/25/2016	39	NAVD 88	Domestic	620	561	616
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–10	NY	Nassau	8/30/2016	26	NGVD 29	Public supply	626	566	626

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–11	NY	Nassau	8/31/2016	61	NGVD 29	Public supply	449	394	444
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–12	NY	Nassau	8/31/2016	101	NGVD 29	Public supply	227	175	222
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–13	NY	Nassau	9/1, 9/20/2016	253	NGVD 29	Public supply	535	470	530
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–14	NY	Suffolk	9/7/2016	24	NAVD 88	Domestic	397	340	392
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–15	NY	Suffolk	9/7/2016	26	NGVD 29	Observation	721	668	718
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–16	NY	Suffolk	9/8/2016	12	NAVD 88	Domestic	250	190	250
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–17	NY	Suffolk	9/12/2016	79	NGVD 29	Public supply	200	170	200
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–18	NY	Suffolk	9/13/2016	26	NGVD 29	Public supply	714	650	710
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–19	NY	Suffolk	9/14/2016	21	NAVD 88	Public supply	708	645	705
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–20	NY	Suffolk	9/15/2016	105	NGVD 29	Public supply	269	214	265

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–21	NY	Suffolk	9/21/2016	61	NAVD 88	Domestic	293	235	290
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–22	NY	Nassau	9/28/2016	98	NGVD 29	Public supply	340	275	335
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–23	NY	Nassau	10/5/2016	235	NAVD 88	Public supply	701	636	696
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–24	NY	Suffolk	10/11/2016	113	NAVD 88	Public supply	466	na	466[a]
Northern Atlantic Coastal Plain aquifer system	MSS	nacpmss2	NACPMSS2–25	NY	Suffolk	10/18/2016	54	NAVD 88	Public supply	303	270	300
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–01	OK	Cherokee	5/23/2016	965	NAVD 88	Public supply	420	na	420
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–02	OK	Delaware	5/24/2016	891	NAVD 88	Public supply	370	na	370[a]
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–03	OK	Cherokee	6/13/2016	707	NAVD 88	Public supply	na	na	na
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–04	OK	Ottawa	6/14/2016	810	NGVD 29	Public supply	1,150	850	1,150
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–05	MO	Franklin	6/2/2016	905	NGVD 29	Public supply	775	314	775
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–06	MO	Stoddard	4/27/2016	379	NAVD 88	Public supply	508	54	497
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–07	MO	Reynolds	4/28/2016	859	NAVD 88	Public supply	670	530	670
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–08	MO	Carter	5/3/2016	720	NGVD 29	Public supply	1,000	128	136

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–09	MO	Shannon	5/4/2016	986	NGVD 29	Public supply	1,110	452	1,110
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–10	MO	Howell	5/17/2016	1,055	NGVD 29	Public supply	1,535	950	1,535
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–11	MO	Oregon	5/18/2016	755	NAVD 88	Public supply	1,200	525	1,315
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–12	MO	Howell	5/19/2016	1,414	NAVD 88	Public supply	1,495	505	1,495
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–13	MO	Taney	5/23/2016	1,060	NGVD 29	Public supply	1,570	450	1,475
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–14	MO	Taney	5/24/2016	1,010	NGVD 29	Public supply	1,000	400	1,000
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–15	MO	Wright	5/25/2016	15,30	NGVD 29	Public supply	1,475	600	1,475
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–16	MO	Howell	5/26/2016	1,165	NGVD 29	Public supply	1,368	414	1,368
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–17	MO	Phelps	5/31/2016	1,192	NAVD 88	Public supply	1,050	425	1,050
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–18	MO	Crawford	6/1/2016	1,027	NAVD 88	Public supply	1,050	506	1,050
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–19	MO	Texas	6/6/2016	1,472	NGVD 29	Public supply	1,100	500	1,100
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–20	MO	Gasconade	6/7/2016	987	NGVD 29	Public supply	875	404	875
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–21	MO	Taney	6/7/2016	981	NAVD 88	Public supply	1,025	484	1,025
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–22	MO	Franklin	6/8/2016	598	NGVD 29	Public supply	900	525	900
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–23	MO	Barry	6/8/2016	1,497	NGVD 29	Public supply	1,675	652	1,675

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–24	MO	Jasper	6/9/2016	1,054	NAVD 88	Public supply	1,875	na	1,875[a]
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–25	MO	Pulaski	6/9/2016	1,110	NGVD 29	Public supply	1,202	335	1,202
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–26	MO	Jasper	6/14/2016	1,149	NAVD 88	Public supply	1,500	453	1,500
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–27	MO	Texas	6/14/2016	1,267	NGVD 29	Public supply	931	310	931
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–28	MO	Barry	6/15/2016	1,480	NGVD 29	Public supply	1,425	485	1,425
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–29	MO	Dent	6/15, 7/7/2016	1,380	NGVD 29	Public supply	850	310	850
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–30	MO	McDonald	6/16/2016	1,040	NGVD 29	Public supply	1,225	225	1,300
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–31	MO	Webster	6/27/2016	1,490	NGVD 29	Public supply	1,420	425	1,420
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–32	MO	Cole	6/29/2016	815	NAVD 88	Public supply	1,100	400	1,100
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–33	MO	Cole	6/30/2016	795	NGVD 29	Public supply	730	400	730
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–34	MO	Jefferson	7/6, 8/17/2016	800	NGVD 29	Public supply	1,200	480	1,200
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–35	MO	Barton	7/11/2016	995	NAVD 88	Public supply	1,200	603	1,200
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–36	MO	Barton	7/12/2016	1,020	NGVD 29	Public supply	940	550	940
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–37	MO	Vernon	7/13/2016	985	NAVD 88	Public supply	1,115	560	1,115
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–38	MO	St. Clair	7/14/2016	822	NGVD 29	Public supply	852	252	852

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–39	MO	Hickory	7/18/2016	277	NGVD 29	Public supply	1,002	455	1,002
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–40	MO	Dallas	7/19/2016	1,195	NAVD 88	Public supply	1,225	477	1,225
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–41	MO	Christian	7/20/2016	1,340	NGVD 29	Public supply	1,375	450	1,375
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–42	MO	Camden	7/21/2016	1,040	NGVD 29	Public supply	597	425	597
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–43	MO	Morgan	7/25/2016	1,070	NGVD 29	Public supply	525	161	525
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–44	MO	Benton	7/26/2016	952	NAVD 88	Public supply	1,155	450	1,155
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–45	MO	Pettis	7/27/2016	865	NGVD 29	Public supply	1,105	350	1,105
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–46	MO	Cooper	7/28/2016	855	NGVD 29	Public supply	630	300	630
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–47	MO	Laclede	8/16/2016	1,357	NAVD 88	Public supply	1,250	630	1,250
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–48	MO	Perry	8/22, 8/24/2016	652	NAVD 88	Public supply	500	350	500
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–49	MO	Cape Girardeau	8/23/2016	450	NGVD 29	Public supply	2,217	356	2,217
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–50	MO	Cape Girardeau	8/24/2016	na	na	Public supply	1,318	386	1,318
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–51	MO	Ste. Genevieve	8/25/2016	770	NGVD 29	Public supply	1,700	500	1,500
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–52	AR	Lawrence	4/25/2016	318	NGVD 29	Public supply	526	40	527
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–53	AR	Sharp	4/26/2016	653	NAVD 88	Public supply	1,525	500	1,525

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–54	AR	Sharp	5/2/2016	1,667	NGVD 29	Public supply	na	na	na
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–55	AR	Stone	5/5/2016	980	NGVD 29	Public supply	3,420	na	3,420[a]
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–56	AR	Baxter	5/31/2016	720	NAVD 88	Public supply	1,625	300	1,625
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–57	AR	Boone	6/1/2016	1,146	NAVD 88	Public supply	1,649	na	1,649[a]
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–58	AR	Newton	6/1/2016	1,344.50	NGVD 29	Public supply	2,576	607.5	2,576
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–59	AR	Madison	6/6/2016	1,446	NGVD 29	Public supply	na	na	na
Ozark Plateaus aquifer system	PAS	ozrkpas1	OZRKPAS1–60	KS	Crawford	6/13/2016	887	NGVD 29	Public supply	1,052	na	1,052[a]
Rio Grande aquifer system	ETN	rgaqetn1	RGAQETN1–02	NM	Dona Ana	5/10/2016	4,058	NAVD 88	Other	60	40	60
Rio Grande aquifer system	ETN	rgaqetn1	RGAQETN1–03	NM	Sierra	5/9/2016	4,134	NAVD 88	Observation	22	11.5	21.5
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–01	NM	Dona Ana	4/4/2016	4,000.70	NAVD 88	Observation	15.1	5.1	14.4
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–02	NM	Dona Ana	4/4/2016	4,005.10	NAVD 88	Observation	14.9	4.9	14.3
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–03	NM	Dona Ana	4/5/2016	4,015.40	NAVD 88	Observation	23	13.1	22.4
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–04	NM	Dona Ana	4/5/2016	4,023.40	NAVD 88	Observation	16.9	6.9	16.2
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–05	NM	Dona Ana	4/5/2016	4,028.40	NAVD 88	Observation	18.3	8.3	17.6
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–06	NM	Dona Ana	4/5/2016	4,028.40	NAVD 88	Observation	18.2	8.2	17.5

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–07	NM	Dona Ana	4/6/2016	4,071	NAVD 88	Observation	28.1	13.5	23.5
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–08	NM	Dona Ana	4/6/2016	4,057.40	NAVD 88	Observation	16.1	6.1	15.4
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–09	NM	Dona Ana	4/6/2016	4,081.50	NAVD 88	Observation	24.2	14.2	23.6
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–10	NM	Dona Ana	4/6/2016	4,069.10	NAVD 88	Observation	19.9	9.9	19.3
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–11	NM	Sierra	4/7/2016	4,118.60	NAVD 88	Observation	26.4	9	19
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–12	NM	Sierra	4/7/2016	4,132.60	NAVD 88	Observation	17.5	7.5	16.9
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–13	NM	Sierra	4/7/2016	4,119.90	NAVD 88	Observation	32.6	15	25
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–14	NM	Sierra	4/12/2016	4,135.30	NAVD 88	Observation	20.3	10.3	19.7
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–15	NM	Sierra	4/12/2016	4,138.70	NAVD 88	Observation	20.9	10.9	20.2
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–16	NM	Sierra	4/13/2016	4,138.20	NAVD 88	Observation	21.8	11.9	21.2
Rio Grande aquifer system	LUS/ ETN	rioglusag1/ rgaqetn1	RIOGLUSAG1–17/ RGAQETN1–01	NM	Dona Ana	5/10/2016	4,015.30	NAVD 88	Observation	22.6	7.5	17.5
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–18	NM	Sierra	5/16/2016	4,133	NAVD 88	Observation	33.5	23.3	32.9
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–19	NM	Dona Ana	5/16/2016	4,055	NAVD 88	Observation	32.2	22.2	31.8
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–20	NM	Dona Ana	5/17/2016	4,100	NAVD 88	Observation	33.7	23.7	33.3

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–21	NM	Dona Ana	5/17/2016	4,104	NAVD 88	Observation	37.2	27.2	36.8
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–22	NM	Dona Ana	5/18/2016	4,110	NAVD 88	Observation	34.5	24.5	34.1
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–23	NM	Dona Ana	5/18/2016	4,078	NAVD 88	Observation	37	27	36.6
Rio Grande aquifer system	LUS	rioglusag1	RIOGLUSAG1–24	NM	Dona Ana	4/12/2016	4,047.40	NAVD 88	Observation	22.9	12.9	22.2
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–01/ RGAQVFPS1–04	NM	Bernalillo	7/11/2016	4,991	NGVD 29	Observation	44	26	41
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–02/ RGAQVFPS1–13	NM	Bernalillo	7/12/2016	4,965	NGVD 29	Observation	26.5	16	26
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–03/ RGAQVFPS1–19	NM	Bernalillo	7/12/2016	4,927	NGVD 29	Observation	20.2	7.5	17.5
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–04/ RGAQVFPS1–15	NM	Bernalillo	7/13/2016	4,945	NGVD 29	Observation	28	18	28
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–05/ RGAQVFPS1–18	NM	Bernalillo	7/13/2016	4,935	NGVD 29	Observation	18.3	7.8	17.8
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–06/ RGAQVFPS1–02	NM	Bernalillo	7/13/2016	4,990	NGVD 29	Observation	23.4	13	23
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–07/ RGAQVFPS1–16	NM	Bernalillo	7/13/2016	4,940	NGVD 29	Observation	19.7	9.5	19.5
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–08/ RGAQVFPS1–11	NM	Bernalillo	7/14/2016	4,967	NGVD 29	Observation	38.5	21	36
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–09/ RGAQVFPS1–06	NM	Bernalillo	7/14/2016	4,980	NGVD 29	Observation	34.8	17.5	32.5
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–10/ RGAQVFPS1–07	NM	Bernalillo	7/14/2016	4,969.80	NGVD 29	Observation	39.7	30	35

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–11/ RGAQVFPS1–08	NM	Bernalillo	7/14/2016	4,972.30	NGVD 29	Observation	49.8	40	45
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–12	NM	Valencia	7/18/2016	4,800	NGVD 29	Observation	29.5	16.5	26.5
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–13	NM	Bernalillo	7/18/2016	5,002	NGVD 29	Observation	22.9	11	21
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–14	NM	Valencia	7/18/2016	4,852	NGVD 29	Observation	20.4	5	15
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–15	NM	Valencia	7/19/2016	4,848	NGVD 29	Observation	21.2	7	17
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–16	NM	Bernalillo	7/19/2016	4,925	NGVD 29	Observation	18.9	8.3	18.3
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–17	NM	Bernalillo	7/19/2016	4,919	NGVD 29	Observation	22.1	9.5	19.5
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–18/ RGAQVFPS1–17	NM	Bernalillo	7/19/2016	4,935	NGVD 29	Observation	28.3	18	28
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–19	NM	Valencia	7/20/2016	4,845	NGVD 29	Observation	22.3	8.5	18.5
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–20/ RGAQVFPS1–05	NM	Bernalillo	7/20/2016	4,989	NGVD 29	Observation	57	41	56
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–21	NM	Bernalillo	7/20/2016	4,920	NGVD 29	Observation	19.9	7.5	17.5
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–22	NM	Sandoval	7/20/2016	5,053	NGVD 29	Observation	28.1	18.1	27.7
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–23	NM	Bernalillo	7/21/2016	4,925	NGVD 29	Observation	12.5	7	12
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–24/ RGAQVFPS1–01	NM	Bernalillo	7/21/2016	4,995	NGVD 29	Observation	31.5	21.4	31.4

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–25	NM	Sandoval	8/1/2016	5,015	NGVD 29	Observation	29	18	28
Rio Grande aquifer system	LUS/ VFPS	rioglusrc1/ rgaqvfps1	RIOGLUSRC1–26/ RGAQVFPS1–10	NM	Bernalillo	8/4/2016	4,965	NGVD 29	Observation	27.8	17.5	27.5
Rio Grande aquifer system	LUS	rioglusrc1	RIOGLUSRC1–27	NM	Bernalillo	8/8/2016	4,865	NGVD 29	Observation	24.3	11.5	21.5
Rio Grande aquifer system	VFPS	rgaqvfps1	RGAQVFPS1–03	NM	Bernalillo	7/22/2016	4,988.60	NGVD 29	Observation	95	8	90
Rio Grande aquifer system	VFPS	rgaqvfps1	RGAQVFPS1–09	NM	Bernalillo	7/26/2016	4,972.30	NGVD 29	Observation	149.8	140	145
Rio Grande aquifer system	VFPS	rgaqvfps1	RGAQVFPS1–12	NM	Bernalillo	7/25/2016	5,110	NAVD 88	Observation	254	244	249
Rio Grande aquifer system	VFPS	rgaqvfps1	RGAQVFPS1–14	NM	Bernalillo	7/21/2016	4,961.70	NGVD 29	Observation	100	95	100
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–01	ID	Minidoka	6/13/2016	4,151.40	NAVD 88	Domestic	150	113	150
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–02	ID	Minidoka	6/13/2016	4,191.50	NAVD 88	Domestic	190	19	190
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–03	ID	Minidoka	6/14/2016	4,151.60	NAVD 88	Domestic	130	127	129
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–04	ID	Minidoka	6/14/2016	4,216.10	NAVD 88	Domestic	265	167	265
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–05	ID	Minidoka	6/14/2016	4,157.20	NAVD 88	Domestic	215	161	215

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–06	ID	Blaine	6/15/2016	4,338.30	NAVD 88	Domestic	282	147	282
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–07	ID	Minidoka	6/15/2016	4,279.80	NAVD 88	Domestic	225	8	225
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–08	ID	Minidoka	6/15/2016	4,305	NAVD 88	Domestic	275	19	275
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–09	ID	Minidoka	6/15/2016	4,244.20	NAVD 88	Domestic	255	38	255
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–10	ID	Minidoka	6/16/2016	4,344.60	NAVD 88	Domestic	469	na	469[a]
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–11	ID	Minidoka	6/16/2016	4,181.20	NAVD 88	Domestic	180	119	180
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–12	ID	Minidoka	6/20/2016	4,299.60	NAVD 88	Domestic	331	na	331[a]
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–13	ID	Minidoka	6/20/2016	4,153	NAVD 88	Domestic	125	109	114
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–14	ID	Minidoka	6/21/2016	4,302.40	NGVD 29	Domestic	350	16	350
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–15	ID	Lincoln	6/21/2016	4,289.50	NAVD 88	Domestic	313	na	313[a]

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–16	ID	Lincoln	6/21/2016	4,292.10	NGVD 29	Other	355	18.5	355
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–17	ID	Minidoka	6/21/2016	4,304.10	NAVD 88	Domestic	na	na	na
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–18	ID	Minidoka	6/22/2016	4,193	NAVD 88	Domestic	180	20	180
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–19	ID	Minidoka	6/22/2016	4,170.10	NAVD 88	Domestic	165	24	165
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–20	ID	Minidoka	6/22/2016	4,253	NAVD 88	Domestic	280	18	280
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–21	ID	Minidoka	6/22/2016	4,209.10	NAVD 88	Domestic	197	19	197
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–22	ID	Minidoka	6/23/2016	4,303	NAVD 88	Domestic	365	19	275
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–23	ID	Minidoka	6/27/2016	4,260.80	NAVD 88	Domestic	283	na	283[a]
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–24	ID	Minidoka	6/27/2016	4,278.70	NAVD 88	Domestic	300	30	300
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–25	ID	Minidoka	6/27/2016	4,249.80	NAVD 88	Domestic	284	6	284

Table 1. Information about wells that have environmental data included in this report.—Continued

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–26	ID	Minidoka	6/28/2016	4,210.10	NAVD 88	Domestic	250	198	250
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–27	ID	Minidoka	6/28/2016	4,201.20	NAVD 88	Domestic	200	na	200[a]
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–28	ID	Minidoka	6/28/2016	4,210.20	NAVD 88	Domestic	214	89	147
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–29	ID	Minidoka	6/29/2016	4,223.60	NAVD 88	Domestic	260	55	260
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–30	ID	Minidoka	6/29/2016	4,239.30	NAVD 88	Domestic	257	15	257
Snake River Plain aquifer system	LUS	usnkluscr2	USNKLUSCR2–31	ID	Minidoka	6/29/2016	4,211	NAVD 88	Domestic	200	165	200
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–01	SC	Richland	8/1/2016	244	NAVD 88	Observation	49	34	49
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–02	SC	Richland	8/2/2016	219	NGVD 29	Observation	19.5	14.4	19.4
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–03	SC	Richland	8/3/2016	261	NGVD 29	Observation	47	42	47
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–04	SC	Richland	8/3/2016	260	NGVD 29	Observation	21.5	16.5	21.5

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–05	SC	Richland	8/4/2016	250	NGVD 29	Observation	13.5	8.5	13.5
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–06	SC	Richland	8/8/2016	290	NGVD 29	Observation	24.2	19.2	24.2
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–07	SC	Richland	8/9/2016	400	NGVD 29	Observation	54	49	54
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–08	SC	Richland	8/15/2016	320	NGVD 29	Observation	24.3	19.3	24.3
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–09	SC	Richland	8/15/2016	380	NGVD 29	Observation	15.9	10.9	15.9
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–10	SC	Richland	8/16/2016	215	NGVD 29	Observation	11.1	6.1	11.1
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–11	SC	Richland	8/16/2016	240	NGVD 29	Observation	33.3	28	33
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–12	SC	Richland	8/16/2016	293	NGVD 29	Observation	50.4	45.4	50.4
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–13	SC	Richland	8/17/2016	230	NGVD 29	Observation	11.2	6.1	11.2
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–14	SC	Richland	8/17/2016	210	NGVD 29	Observation	15.4	10.4	15.4

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Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–15	SC	Richland	8/17/2016	301	NGVD 29	Observation	53.3	48.3	53.3
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–16	SC	Richland	8/17/2016	240	NGVD 29	Observation	22	17	22
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–17	SC	Richland	8/18/2016	383	NAVD 88	Observation	29.5	9	24
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–18	SC	Richland	8/22/2016	142	NGVD 29	Observation	13.9	8.8	13.8
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–19	SC	Richland	8/23/2016	280	NGVD 29	Observation	23.3	18.3	23.3
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–20	SC	Richland	8/23/2016	170	NGVD 29	Observation	8.6	3.6	8.6
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–21	SC	Richland	8/24/2016	289	NGVD 29	Observation	53.4	48.4	53.4
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–22	SC	Richland	8/24/2016	212	NGVD 29	Observation	16.3	11.3	16.3
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–23	SC	Lexington	8/25/2016	290	NGVD 29	Observation	9	4	9
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–24	SC	Richland	8/29/2016	200	NGVD 29	Observation	8.8	3.8	8.8

Table 1. Information about wells that have environmental data included in this report.—Continued

[NAWQA, National Water-Quality Assessment; ID, identification; no., number; LS, land surface; ft bls, foot below land surface; lat., latitude, in degrees and minutes; long., longitude in degrees and minutes; PAS, principal aquifer study; FL, Florida; na, not available; NGVD 29, National Geodetic Vertical Datum of 1929; NAVD 88, North American Vertical Datum of 1988; ETN, enhanced trends network; TX, Texas; NM, New Mexico; LUS, land-use study; SC, South Carolina; FPS, flow-path study; MS, Mississippi; VFPS; vertical flow-path study; TN, Tennessee; OK, Oklahoma; AR, Arkansas; CA, California; MO, Missouri; KS, Kansas; MD, Maryland; MSS, modeling support study; DE, Delaware; DC, District of Columbia; MAS, major aquifer study; NV, Nevada; NY, New York; OH, Ohio; MI, Michigan; ID, Idaho; NH, New Hampshire; WI, Wisconsin; OR, Oregon; MN, Minnesota; WA, Washington]

Principal and regional and (or) other aquifer information	Network type	Network name	NAWQA well ID no.	State	County	Sample date	Altitude LS	Altitude datum	Water use	Well depth (ft bls)	Depth to perforation (ft bls)	
											Top	Bottom
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–25	SC	Richland	8/30/2016	200	NGVD 29	Observation	11.7	6.7	11.7
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–26	SC	Richland	8/31/2016	277	NAVD 88	Observation	21.5	11	21
Southeastern Coastal Plain aquifer system	LUS	santlusrc1	SANTLUSRC1–27	SC	Richland	9/1/2016	215	NGVD 29	Observation	50	45	50

[a]There was no information available about the bottom of perforation but was assumed to be the bottom of well (Well_depth).

[b]The depth to the bottom was less than the depth to the top of the open interval and was assumed to be the well depth.

Appendix 1. Information Contained in Previous Reports in This Series

A list of reports in this series and the networks discussed are listed in table 1.1.

Table 1.1. Index to which report contains each network description.

Reference	Year network was sampled	Network name abbreviation	Network name used in report
Arnold and others (2016a,b)	2013	acfbluscr3	Apalachicola-Chattahoochee-Flint River Basin agricultural land-use study network
	2013	albesus7	Albemarle-Pamlico Drainage Basin major aquifer study network
	2013	bnrfpas1	Basin and Range Basin-Fill Aquifers principal aquifer study network
	2013	clowpas1	Coastal Lowlands Aquifer System principal aquifer study network
	2013	cvaletn1	Central Valley Aquifer System enhanced trends network
	2012	dlmvluscr1	Delmarva Peninsula agricultural land-use study network
	2013	dlmvsus1	Delmarva Peninsula major aquifer study network
	2013	edtretn1	Edwards-Trinity Aquifer System enhanced trends network
	2012	gafllusrc1a	Georgia-Florida urban land-use study network near Tampa, Florida
	2012	gafllusrc1b	Georgia-Florida urban land-use study network near Tampa, Florida
	2013	gaflsus4	Georgia-Florida major aquifer study network
	2013	glacpas1	Glacial Aquifer System principal aquifer study network
	2013	metxetn1	Mississippi Embayment Aquifer System enhanced trends network
	2012	nacppas1	Northern Atlantic Coastal Plain Aquifer System principal aquifer study networks
	2013	nacppas2	Northern Atlantic Coastal Plain Aquifer System principal aquifer study networks
	2013	nvbrlusrc1	Nevada Basin and Range urban land-use study network near Reno and Carson City, Nevada
	2013	sanjlusor1a	San Joaquin Valley agricultural land-use study network
	2013	secppas1	Southeastern Coastal Plain Aquifer System principal aquifer study network
	2013	spltluscr1	South Platte River agricultural land-use study network
	2013	vpdcpas1	Valley and Ridge, and Piedmont and Blue Ridge Carbonate-Rock Aquifers principal aquifer study network
	2013	wmicsus2	Western Lake Michigan Drainages major aquifer study network

Table 1.1. Index to which report contains each network description.—Continued

Reference	Year network was sampled	Network name abbreviation	Network name used in report
Arnold and others (2017a,b)	2014	albelusag1	Albemarle-Pamlico Drainage Basin agricultural land-use study network
	2014	ccptlusag2b	Columbia Plateau agricultural land-use study network
	2014	ccptsus1b	Columbia Plateau major aquifer study network
	2014	clptetn1	Columbia Plateau enhanced trends network
	2014	cmorpas1	Cambrian-Ordovician Aquifer System principal aquifer study network
	2014	cvaletn1	Central Valley Aquifer System enhanced trends network
	2014	edtretn1	Edwards-Trinity Aquifer System enhanced trends network
	2014	glacetn1	Glacial Aquifer System enhanced trends network
	2014	glacpas1	Glacial Aquifer System principal aquifer study network
	2014	metxetn1	Mississippi Embayment Aquifer System enhanced trends network
	2014	metxpas1	Mississippi Embayment-Texas Coastal Uplands Aquifer Systems principal aquifer study network
	2014	nacpetn1	Northern Atlantic Coastal Plain enhanced trends network
	2014	negxetn1	New England Crystalline-Rock and Glacial Aquifer System enhanced trends network
	2014	piedpas1	Piedmont and Blue Ridge Crystalline-Rock Aquifers principal aquifer study network
	2014	potolusag1	Potomac River Basin agricultural land-use study network
	2014	potosus1	Potomac River Basin crystalline-rock major aquifer study network
	2014	rgaqetn1	Rio Grande Aquifer System enhanced trends network
	2014	rgaqpas1	Rio Grande Aquifer System principal aquifer study network
	2014	sanjlusor2a	San Joaquin Valley agricultural land-use study network
	2014	trinsus3	Trinity River Basin major aquifer study network
	2014	whitluscr1	White River Basin agricultural land-use study network
	2014	wmiclusag2	Western Lake Michigan Drainages agricultural land-use study network

Table 1.1. Index to which report contains each network description.—Continued

Reference	Year network was sampled	Network name abbreviation	Network name used in report
Arnold and others (2018a,b)	2015	acfbsus1	Apalachicola-Chattahoochee-Flint River Basins major aquifer study network
	2015	bnrcpas1	Basin and Range Carbonate-Rock Aquifers principal aquifer study network
	2015	ccptlusor1b	Central Columbia Plateau Orchard agricultural land-use study network
	2015	clptetn1	Columbia Plateau enhanced trends network
	2015	cnbrluscr1	Central Nebraska Basins agricultural land-use study network
	2015	cvaletn1	Central Valley Aquifer System enhanced trends network
	2015	edtretn1	Edwards-Trinity Aquifer System enhanced trends network
	2015	florpas1	Floridan Principal Aquifer System principal aquifer study network
	2015	gaflluscr1	Georgia-Florida Coastal Plain Drainages agricultural land-use study network
	2015	glacetn1	Glacial Aquifer System enhanced trends network
	2015	hpaqpas1	High Plains aquifer principal aquifer study network
	2015	hpaqvfps1	High Plains Aquifer vertical flow-path study network
	2015	lirblusrc1	Lower Illinois River Basin urban land-use study network near St. Louis, Missouri
	2015	metxetn1	Mississippi Embayment Aquifer System enhanced trends network
	2015	metxpas1	Mississippi Embayment-Texas Coastal Uplands Aquifer Systems principal aquifer study network
	2015	nacpetn1	Northern Atlantic Coastal Plain enhanced trends network
	2015	negxetn1	New England Crystalline-Rock and Glacial Aquifer System enhanced trends network
	2015	podllusrc1	Potomac River Basin and Delmarva Peninsula urban land-use study network near Washington, D.C.
	2015	rgaqetn1	Rio Grande Aquifer System enhanced trends network
	2015	rgaqpas1	Rio Grande Aquifer System principal aquifer study network
	2015	sanjluscr1a	San Joaquin-Tulare River Basins agricultural land-use study network
	2015	sanjsus1	San Joaquin-Tulare River Basins major aquifer study network
	2015	trinlusrc1	Trinity River Basin urban land-use study network near Houston, Texas
	2015	wmicsus1	Western Lake Michigan Drainages major aquifer study network

Table 1.1. Index to which report contains each network description.—Continued

Reference	Year network was sampled	Network name abbreviation	Network name used in report
Arnold and others (2020a,b)	2016	biscpas1	Biscayne aquifer principal aquifer study network
	2016	clptpas1	Columbia Plateau Basaltic-Rock Aquifers principal aquifer study network
	2016	hpaqpas1	High Plains aquifer system principal aquifer study network
	2016	ozrkpas1	Ozark Plateaus aquifer system principal aquifer study network
	2016	lerilusrc1	Lake Erie-Lake St. Clair drainages urban land-use study network near Detroit, Michigan
	2016	rioglusag1	Rio Grande aquifer system agricultural land-use study network
	2016	rioglusrc1	Rio Grande aquifer system urban land-use study network near Albuquerque, New Mexico
	2016	santlusrc1	Santee River Basin and Coastal Drainages urban land-use study network near Columbia, South Carolina
	2016	umislusrc1	Upper Mississippi River Basin urban land-use study network near Minneapolis/St. Paul, Minnesota
	2016	usnkluscr2	Upper Snake River Basin agricultural land-use study network
	2016	lerisus1	Lake Erie-Lake St. Clair drainages major aquifer study network
	2016	nvbrsus2	Nevada Basin and Range major aquifer study network
	2016	pugtsus1	Puget Sound drainages major aquifer study network
	2016	clptetn1	Columbia Plateau enhanced trends network
	2016	cvaletn1	Central Valley enhanced trends network
	2016	edtretn1	Edwards-Trinity aquifer system enhanced trends network
	2016	glacetn1	Glacial aquifer system enhanced trends network
	2016	metxetn1	Mississippi Embayment aquifer system enhanced trends network
	2016	nacpetn1	Northern Atlantic Coastal Plain enhanced trends network
	2016	negxetn1	New England crystalline-rock and glacial aquifer system enhanced trends network
	2016	rgaqetn1	Rio Grande aquifer system enhanced trends network
	2016	cvalfps1	Central Valley aquifer system flow-path study network 1
	2016	cvalfps2	Central Valley aquifer system flow-path study network 2
	2016	glacfps1	Glacial aquifer system flow-path study network
	2016	metxfps1	Mississippi Embayment aquifer system flow-path study network
	2016	clptvfps1	Columbia Plateau vertical flow-path study network
	2016	glacvfps1	Glacial aquifer system vertical flow-path study network
	2016	rgaqvfps1	Rio Grande aquifer system vertical flow-path study network
	2016	glacmss1	Glacial Aquifer System Modeling Support Study
	2016	nacpmss1	Northern Atlantic Coastal Plain modeling support study network 1
	2016	nacpmss2	Northern Atlantic Coastal Plain modeling support study network 2

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Appendix 2. Well Depth and Open Interval by Study Network

Well depths and open intervals by study network are provided in tables 2.1 and 2.2, respectively.

Table 2.1. Well depth by study network.

[ETN, enhanced trends network; nc, not calculated; LUS, land-use study; MAS, major aquifer study; PAS, principal aquifer study; VFPS, vertical flow-path study]

Network type	Network name	Number of wells in network with data presented in this report	Number of wells with well depth data	Well depth, in feet below land surface						
				Minimum	10th percentile	25th percentile	Median	75th percentile	95th percentile	Maximum
ETN	clptetn1	3	3	80	nc	nc	170	nc	nc	1,116
ETN	cvaletn1	3	3	234	nc	nc	320	nc	nc	620
ETN	edtretn1	3	3	300	nc	nc	550	nc	nc	1,500
ETN	glacetn1	5	5	34.5	nc	nc	83	nc	nc	125
ETN	metxetn1	2	2	90	nc	nc	357	nc	nc	624
ETN	nacpetn1	3	3	22	nc	nc	119	nc	nc	135
ETN	negxetn1	3	3	83	nc	nc	176.3	nc	nc	492
ETN	rgaqetn1	3	3	22	nc	nc	22.6	nc	nc	60
FPS	cvalfps1	20	20	70	79.7	87	149	187.25	268	268
FPS	cvalfps2	21	21	100	132	180	300	455	530	532
FPS	glacfps1	26[a]	27	1.25	1.3	1.3	33	62	90	99
FPS	metxfps1	22	22	23	77.19	92	177	267.5	597.2	624
LUS	lerilusrc1	28	28	10.5	16.03	19.6	26.9	32.55	46.445	68.5
LUS	rioglusag1	24	24	14.9	16.34	18.275	22.75	32.3	36.625	37.2
LUS	rioglusrc1	27	27	12.5	19.38	20.8	26.5	30.5	48.06	57
LUS	santlusrc1	27	27	8.6	10.26	13.7	21.5	40.15	53.37	54
LUS	umislusrc1	30	30	9	11.98	15	18	23.75	28.775	33.5
LUS	usnkluscr2	31	30	125	163.5	197.75	256	283.75	360.5	469
MAS	lerisus1	24	24	35	61.6	72.75	90.5	107.25	168.2	205
MAS	nvbrsus2	30	30	105	162.8	236.5	347	569.75	789.35	815
MAS	pugtsus1	29	29	22.5	40	60	78	112	290.8	309
MSS	glacmss1	30	27	45	52.6	62.5	90	140.5	190.9	245
MSS	nacpmss1	20	20	60	152	194.25	292.5	369.25	608.9	645
MSS	nacpmss2	25	25	200	257.6	303	466	626	731.4	900
PAS	biscpas1	40	31	22	40	60	91	113.5	140	152
PAS	clptpas1	60	57	91	222	309	484	743	1,328	2,434
PAS	hpaqpas1	17	17	180	196.6	242	321	395	731.2	812
PAS	ozrkpas1	60	57	370	568.6	900	1,115	1,425	1,943.4	3,420
VFPS	clptvfps1	19	19	19	27.5	35	88	175	772.3	1,000
VFPS	glacvfps1	43	43	10.5	16.62	22.55	33.9	76.25	136.9	172
VFPS	rgaqvfps1	19	19	18.3	20.1	27.15	34.8	53.4	160.22	254

[a]18 wells and 8 piezometers.

Table 2.2. Length of open interval by study network.

[ETN, enhanced trends network; nc, not calculated; LUS, land-use study; MAS, major aquifer study; PAS, principal aquifer study; na, not available; VFPS, vertical flow-path study]

Network type	Network name	Number of wells in network with data presented in this report	Number of wells with open interval data	Length of open interval, in feet						
				Minimum	10th percentile	25th percentile	Median	75th percentile	95th percentile	Maximum
ETN	clptetn1	3	3	1	nc	nc	26	nc	nc	174
ETN	cvaletn1	3	3	10	nc	nc	150	nc	nc	200
ETN	edtretn1	3	3	80	nc	nc	230	nc	nc	233
ETN	glacetn1	5	4	3	nc	nc	5	nc	nc	10
ETN	metxetn1	2	2	10	nc	nc	57	nc	nc	104
ETN	nacpetn1	3	3	3	nc	nc	19	nc	nc	50
ETN	negxetn1	3	2	10	nc	nc	207	nc	nc	404
ETN	rgaqetn1	3	3	10	nc	nc	10	nc	nc	20
FPS	cvalfps1	20	20	5	5	5	5	5	5	5
FPS	cvalfps2	21	20	0	0	17.5	60	240	296.3	340
FPS	glacfps1	26	26	0.05	0.1	0.1	3	3	8.75	10
FPS	metxfps1	22	21	10	10	10	20	44	100	104
LUS	lerilusrc1	28	28	4.5	4.5	4.5	4.5	4.5	6.625	8.1
LUS	rioglusag1	24	24	9.3	9.3	9.3	9.4	9.6	10	10
LUS	rioglusrc1	27	27	5	7.76	10	10	10	15	15
LUS	santlusrc1	27	27	5	5	5	5	5	13.5	15
LUS	umislusrc1	30	30	4.5	5	5	5	5	5	10
LUS	usnkluscr2	31	25	2	35.8	58	171	256	322.8	336.5
MAS	lerisus1	24	24	3	3	4	4	4	8	10
MAS	nvbrsus2	30	30	10	10	68.75	193	271.25	509.2	670
MAS	pugtsus1	29	27	0	0	0.5	5	10	48.4	60
MSS	glacmss1	30	14	4	8.63	20	25	31.5	41.75	45
MSS	nacpmss1	20	20	5	6.9	10	20	32.5	112	150
MSS	nacpmss2	25	24	30	47.9	50.75	59.5	60	60.68	103.4
PAS	biscpas1	40	25	3	5.4	7	22	40	64.6	71
PAS	clptpas1	60	51	0	70	109	207	342	695.75	1,296.70
PAS	hpaqpas1	17	7	82	86.8	125	161	187.5	242.5	265
PAS	ozrkpas1	60	51	8	330	479	621	936	1,200	1,968.50
VFPS	clptvfps1	19	18	3	5	5	5	140	463.4	681
VFPS	glacvfps1	43	43	4	4	4.25	4.5	4.5	7.35	10
VFPS	rgaqvfps1	19	19	5	5	7.5	10	12.5	21.7	82

Appendix 3. High-Frequency Data from Enhanced Trends Networks

High-frequency data collected at enhanced trends network sites are available from the National Water Information System (U.S. Geological Survey, 2018) online database (table 3.1). The links in table 3.1 below provide access to the high-frequency data on the web. To access the data for the period covered by this report, the user should open the National Water Information System web page at https://doi.org/10.5066/F7P55KJN. The user should then change the begin and end dates to retrieve the data for the period January 1, 2015, to December 31, 2015.

Some of the enhanced trends network sites may have different equipment installed and may collect different parameters than others. Additionally, some sites have missing records for various properties because of equipment failures at various times during the data-collection period. Locations of the enhanced trends networks are shown in figures 15–16 of this report.

Table 3.1. Web links to data collected at a high frequency from enhanced trends networks.

[See figures 15–16 of this report for locations of enhanced trends networks. NAWQA, National Water-Quality Assessment]

Network name	NAWQA Project well identification number	Link to data collected at a high frequency (U.S. Geological Survey, 2018)
clptetn1	CLPTETN1–01	https://waterdata.usgs.gov/nwis/uv?site_no=455415119314601
clptetn1	CLPTETN1–04	https://waterdata.usgs.gov/nwis/uv?site_no=454554119121801
clptetn1	CLPTETN1–05	https://waterdata.usgs.gov/nwis/uv?site_no=454827119173401
cvaletn1	CVALETN1–01	https://waterdata.usgs.gov/nwis/uv?site_no=364200119420001
cvaletn1	CVALETN1–02	https://waterdata.usgs.gov/nwis/uv?site_no=364200119420002
cvaletn1	CVALETN1–03	https://waterdata.usgs.gov/nwis/uv?site_no=364200119420003
edtretn1	EDTRETN1–01	https://waterdata.usgs.gov/nwis/uv?site_no=293116098334101
edtretn1	EDTRETN1–02	https://waterdata.usgs.gov/nwis/uv?site_no=293516098325501
edtretn1	EDTRETN1–03	https://waterdata.usgs.gov/nwis/uv?site_no=292331098294501
glacetn1	GLACETN1–01	https://waterdata.usgs.gov/nwis/uv?site_no=443320089212303
glacetn1	GLACETN1–02	https://waterdata.usgs.gov/nwis/uv?site_no=443320089212304
glacetn1	GLACETN1–03	https://waterdata.usgs.gov/nwis/uv?site_no=431053090042702
glacetn1	GLACETN1–04	https://waterdata.usgs.gov/nwis/uv?site_no=431053090042701
glacetn1	GLACETN1–05	https://waterdata.usgs.gov/nwis/uv?site_no=431037090043401
metxetn1	METXETN1–01	https://waterdata.usgs.gov/nwis/uv?site_no=351113089513401
metxetn1	METXETN1–02	https://waterdata.usgs.gov/nwis/uv?site_no=351111089512501
nacpetn1	NACPETN1–01	https://waterdata.usgs.gov/nwis/uv?site_no=384637075153201
nacpetn1	NACPETN1–02	https://waterdata.usgs.gov/nwis/uv?site_no=384526075091601
nacpetn1	NACPETN1–03	https://waterdata.usgs.gov/nwis/uv?site_no=384428075355701
negxetn1	NEGXETN1–01	https://waterdata.usgs.gov/nwis/uv?site_no=425311070535801
negxetn1	NEGXETN1–02	https://waterdata.usgs.gov/nwis/uv?site_no=425400070545401
negxetn1	NEGXETN1–03	https://waterdata.usgs.gov/nwis/uv?site_no=425651070573701
rgaqetn1	RGAQETN1–01	https://waterdata.usgs.gov/nwis/uv?site_no=323733107011002
rgaqetn1	RGAQETN1–02	https://waterdata.usgs.gov/nwis/uv?site_no=324007107095501
rgaqetn1	RGAQETN1–03	https://waterdata.usgs.gov/nwis/uv?site_no=324955107180902

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U.S. Geological Survey, 2018, USGS water data for the Nation: U.S. Geological Survey National Water Information System database, accessed December 18, 2018, at https://doi.org/10.5066/F7P55KJN.

Appendix 4. Quality-Control Samples and Data Analysis

Samples

Quality-control (QC) samples are routinely collected along with the environmental groundwater samples. The third cycle of the National Water-Quality Assessment (NAWQA) groundwater studies began in 2013, but a small pilot study was completed in 2012. The entire third cycle sampling period currently is May 2012–December 2016; this period is hereafter referred to as "the cycle 3 sampling period." Data from the environmental and QC blank and replicate samples from the 2012–13 sampling period were presented in Arnold and others (2016a,b) and from the 2014 sampling period were presented in Arnold and others (2017a,b). Data from the environmental and QC blank samples from the 2015 sampling period were presented in Arnold and others (2018a,b). The Arnold and others (2017a,b) publications also presented data for selected spike samples collected in 2012–14. This current report presents a summary of QC samples from the entire cycle 3 sampling period (May 2012–December 2016) as well as the January–December 2016 sampling period covered by this report. A summary of results from blank samples collected during the sampling period January–December 2016 is provided in table 4.1, and a summary for the cycle 3 sampling period is provided in table 4.2. A summary of replicate samples, an analysis of the variability in detections and concentrations of selected analytes from replicate samples, and a summary of spike samples for the entire sampling period May 2012–December 2016 are provided in tables 4.3 through 4.9. Data from the environmental and QC samples from the January–December 2016 sampling period are presented in tables 4.10–4.19 of Arnold and others (2020).

Table 4.1. Summary of results for field blanks collected by the National Water-Quality Assessment Project from January to December 2016.

[DOC, dissolved organic carbon; VOC, volatile organic compound; HHB, human-health benchmark; --, not applicable; SMCL, secondary maximum contaminant level]

Type of summary	Major and minor elements	Trace elements	Nutrients and DOC	VOCs	Pesticide compounds
Total number of blank samples	48	80	43 to 82	87	29
Number of field blanks	43	46	41 to 47	38	26
Number of constituents analyzed	10	22	6	85	225
Number of constituents detected in field blanks	9	20	4	19	1
Number of constituents detected in field blanks that have an HHB	1	17	1	7	0
Number of constituents detected in field blanks that have an SMCL	4	5	0	0	0
Largest ratio of the maximum concentration in a field blank to the corresponding HHB, in percent	2	4.5	0.16	0.36	--
Largest ratio of the maximum concentration in a field blank to the corresponding SMCL, in percent	26	38	--	--	--

Table 4.2. Summary of results for field blanks collected by the National Water-Quality Assessment Project from May 2012 to December 2016.ww

[DOC, dissolved organic carbon; VOC, volatile organic compound; HHB, human-health benchmark; SMCL, secondary maximum contaminant level; --, not applicable]

Type of summary	Major and minor elements	Trace elements	Nutrients and DOC	VOCs	Pesticide compounds	Special-interest analytes
Total number of blank samples	227	458	209 to 457	564	184	6 to 54
Number of field blanks	208	219	200 to 220	200	165	6 to 20
Number of constituents analyzed	10	22	6	129	272	7
Number of constituents detected in field blanks	10	21	6	27	27	3
Number of constituents detected in field blanks that have an HHB	1	18	2	12	18	2
Number of constituents detected in field blanks that have an SMCL	4	5	0	0	0	0
Largest ratio of the maximum concentration in a field blank to the corresponding HHB, in percent	2	4.8	0.67	2.4	0.25	750
Largest ratio of the maximum concentration in a field blank to the corresponding SMCL, in percent	26	199	--	--	--	--

Blank Sample Approach

Blank samples are QC samples that are used to determine if water samples become contaminated during sample collection, field processing, transport, or laboratory analysis. Blank samples are collected using blank water that has been prepared to be free of detectable concentrations of the constituents of interest. An equipment blank generally is collected in a controlled environment (such as a laboratory) before field sampling begins and is intended to evaluate the suitability of the equipment and equipment cleaning protocols for the established data-quality requirements. A field blank is subjected to all the same aspects of sample collection, field processing, preservation, transportation, and laboratory handling as an environmental sample and is intended to evaluate the potential for these procedures to be sources of contamination. A source solution blank is a sample of the water used to collect the equipment and field blanks and is intended to verify that the blank water itself has no detectable concentrations of the constituents of interest. Because field blanks are collected under conditions most comparable to conditions affecting environmental samples, these blanks are most directly representative of potential sources of contamination to environmental samples and were the focus of this initial evaluation of blank-sample results.

Results of the initial evaluation of data from field blanks for major and trace elements, nutrients, volatile organic compounds (VOCs), and pesticide compounds collected during the 2016 sampling period of January–December 2016 and the cycle 3 sampling period are presented in this report. Data from 2016 are published in this report, data from 2012 to 2013 were published in Arnold and others (2016a,b), and data from 2014 were published in Arnold and others (2017a,b). About 70 to 75 percent of the field blanks collected for each of these constituents during the cycle 3 sampling period have been associated with groundwater sites that are sampled using a dedicated pump (primarily public-supply and domestic wells), and the rest have been associated with groundwater sites that are sampled using a portable sampling pump (monitoring wells). The objective of this initial evaluation of field blanks was to determine if environmental concentrations of these constituents as reported by the relevant laboratories are suitable for comparison to their corresponding human-health benchmarks (HHBs) or to U.S. Environmental Protection Agency (EPA) secondary maximum contaminant levels (SMCLs) if HHBs have not been established. The HHBs are a set of health-based comparison thresholds that include EPA maximum contaminant levels (MCLs), health-based screening levels (HBSLs), and human-health benchmarks for pesticides (HHBPs). Further evaluation of results for blank samples, such as through methods used by Olsen and others (2010), Bender and others (2011), Fram and others (2012), or Davis and others (2014), would be needed to determine if inadvertent contamination of samples with certain constituents would affect the interpretation of environmental concentrations of those constituents for objectives other than those presented in this report.

Table 4.3. Summary of results for replicate samples collected by the National Water-Quality Assessment Project from May 2012 to December 2016.

[VOC, volatile organic compound; mg/L, milligram per liter; µg/L, microgram per liter; ng/L, nanogram per liter; pCi/L, picocurie per liter]

Type of summary	Major and minor elements and physical parameters	Trace elements	Nutrients and dissolved organic carbon	VOCs	Pesticide compounds	Radio-logical analytes	Special-interest analytes
Total number of replicate samples	58 to 119	128	103 to 120	110	142	46 to 86	4 to 10
Number of samples included in analysis of replicate results (2013–16 samples for VOCs and pesticide compounds)	58 to 119	128	103 to 120	105	138	46 to 86	10
Total number of analytes included in analysis of replicate results	14	22	6	85	225	8	1
Number of analytes that include censored values and have at least 10 replicate pairs without consistent non-detections	5	19	6	4	11	7	0
Range in mean detection rate for replicate pairs having at least 1 detection, in percent	90.6–100	80.0–100	84.6–99.5	93.8–100	78.1–97.8	81.8–94.3	--
Number of analytes with mean detection rate less than 75 percent	0	0	0	0	0	0	--
Range in percentage of replicate pairs with inconsistent detections	0–18.8	0–40.0	0.9–30.8	0–12.5	4.3–43.8	11.4–36.5	--
Number of analytes with percentage of replicate pairs with inconsistent detections greater than 50 percent	0	0	0	0	0	0	--
Number of analytes that have at least 10 replicate pairs with consistent analyte detections	14	18	6	4	9	8	0
Range in standard deviation for lower concentration range of two-range model	0.0014–7.3 mg/L	0.0022–1.3 µg/L	0.0004–0.039 mg/L	0.0013–0.013 µg/L	1.1–19 ng/L	0.13–12 pCi/L	--
Range in relative standard deviation for higher concentration range of two-range model, in percent	0.24–5.7	1.2–9.3	0.98–10.8	5.8	3.6–13	2.9–14	--

Blank Sample Counts

The total number of blank samples and the number of field blanks collected for groundwater sites differs by constituent group during the 2016 sampling period and the cycle 3 sampling period (tables 4.1 and 4.2, respectively). Data for all blank samples from the 2016 sampling period are presented in tables 4.10–4.17 of Arnold and others (2020). All blank samples collected during the cycle 3 sampling period were analyzed using the corresponding laboratory methods listed in table 2 of Arnold and others (2020, 2016a, 2017a, 2018a). Of the 564 VOC blank samples collected during the cycle 3 sampling period (table 4.2), 26 were collected in 2012 or early 2013 and analyzed for an older analytical schedule using purge and trap gas chromatography/mass spectrometry (Gilliom and others, 2006; Zogorski and others, 2006); and 538 were collected in 2013–16 and analyzed using the most recent analytical schedule and laboratory methods (purge and trap gas chromatography/mass spectrometry and heated purge and trap gas chromatography/mass spectrometry). Of the 184 pesticide blank samples collected during the cycle 3 sampling period (table 4.2), 8 were collected in 2012 and analyzed for an older analytical schedule using gas chromatography/mass spectrometry; and 176 were collected in 2013–16 and analyzed using the most recent analytical schedule and laboratory method (direct aqueous injection liquid chromatography tandem mass spectrometry). One blank sample collected in 2014 was analyzed using both an older and the most recent analytical schedule. Not included in table 4.1 are sample counts for special analytes collected only in selected well networks during the cycle 3 sampling period: arsenic species, perchlorate, and hexavalent chromium. In January–December 2016, no field blanks were collected for arsenic species, and only two each were collected for perchlorate and hexavalent chromium.

Constituent Concentrations in Blank Samples

Of the 10 major or minor elements included in laboratory analysis (not including analysis for dissolved-solids concentration), 9 were detected in at least 1 field blank collected in 2016 (table 4.1); all 10 elements were detected in at least 1 field blank collected during the cycle 3 sampling period (table 4.2). Only one of the major or minor elements detected during the cycle 3 sampling period (fluoride) had an HHB (table 2 of Arnold and others, 2020); four (chloride, fluoride, sulfate, and iron) had SMCLs. The maximum concentration for fluoride in any field blank from the cycle 3 sampling period was 2.0 percent of its corresponding HHB. For chloride and sulfate, the maximum concentration in any field blank from the cycle 3 sampling period was less than 1 percent of the corresponding SMCL. For fluoride, the maximum concentration was 3.9 percent of the corresponding SMCL. For iron, the maximum concentration in any field blank from the cycle 3 sampling period was 26 percent of its corresponding SMCL of 300 micrograms per liter (µg/L), reported for an August 2016 sample. Results for blind blanks submitted to the NWQL to evaluate laboratory data quality indicate a slight high bias for iron during 2016, but no evidence of a laboratory contamination issue (Tedmund Struzeski, U.S. Geological Survey [USGS] Inorganic Blind Sample Project, written commun., 2017, 2018). Out of 207 NAWQA cycle 3 field blanks for iron, the two results that exceed 10 percent of the SMCL (42.0 and 78.6 µg/L for samples collected in September 2014 and August 2016, respectively) likely reflect isolated events.

Of the 22 trace elements included in laboratory analysis, 20 were detected in at least 1 field blank collected in 2016 (table 4.1), and 21 were detected in at least 1 field blank from the cycle 3 sampling period (table 4.2). Of the 21 trace elements detected in field blanks from the cycle 3 sampling period, 18 (antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, lead, manganese, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, and zinc) had HHBs (table 2 of Arnold and others, 2020); and 5 (aluminum, copper, manganese, silver, and zinc) had SMCLs. For 7 of the 18 detected trace elements with HHBs, the maximum concentration measured in a field blank from the cycle 3 sampling period was less than 1 percent of the corresponding HHB; for the remaining 11 trace elements (antimony, arsenic, beryllium, cadmium, copper, lead, manganese, molybdenum, nickel, thallium, and zinc), the maximum concentration was less than 5 percent of the HHB. For silver and zinc, the maximum concentration measured in a field blank from the cycle 3 sampling period was less than 1 percent of the corresponding SMCL; for copper, the maximum concentration was less than 9 percent of the corresponding SMCL. However, for aluminum, the maximum concentration was nearly 200 percent of the corresponding SMCL of 50 µg/L. Results for blind blanks submitted to NWQL to evaluate laboratory data quality indicate false positive detections of aluminum in blank samples submitted to the laboratory during July and August 2014, August–December 2015, and June 2016 (USGS Inorganic Blind Sample Project, https://bqs.usgs.gov/ibsp/). Investigation of this issue by the NWQL indicated the occurrence of sporadic contamination at concentrations of as much as 63 µg/L from at least July 2014 through December 2015, although the source of contamination and, therefore, the exact magnitude of contamination and the period(s) affected were not established (Tedmund Struzeski, USGS Inorganic Blind Sample Project, written commun., 2015). For NAWQA field blanks collected through the end of December 2016, reported detections of aluminum above the laboratory reporting limit occurred in blank samples collected primarily between May 29 and July 16, 2014, between March 25 and September 8, 2015, and between April 7 and August 10, 2016.

Also, regarding trace elements, the USGS Office of Water Quality has documented random low-level contamination of water samples with cobalt and manganese from certain capsule filters used by the NAWQA Project and across the USGS from about October 1, 2008, to about September 30, 2014 (USGS Office of Water Quality, written commun., July 1, 2016). Blank samples for cobalt and manganese that were collected for NAWQA during this period were evaluated to determine the possible effects of this contamination on environmental samples, and evaluation results were described in appendix 3 of Arnold and others (2017b).

Of the five nutrients or groups of nutrients that the laboratory analyzes directly (as opposed to the nutrients with calculated results), three were detected in at least one field blank collected in 2016, as was dissolved organic carbon (DOC) (table 4.1). All five nutrients and DOC were detected in at least one field blank from the cycle 3 sampling period (table 4.2). Two of the nutrients detected in field blanks from the cycle 3 sampling period (nitrite and nitrate) have HHBs (table 2 of Arnold and others, 2020); none have SMCLs. For each of the two nutrients with HHBs, the maximum concentration measured in a field blank from the cycle 3 sampling period was less than 1 percent of the corresponding threshold. DOC does not have an HHB but was detected in 15 of 41 field blanks collected during 2016, and in 62 of 200 field blanks collected during cycle 3. Concentrations during cycle 3 ranged from 0.23 to 633 milligrams per liter (mg/L) and included multiple values above 1 mg/L. However, concentrations of this magnitude probably reflect inadequate rinsing of sampling equipment with blank water between use of methanol during the cleaning process and subsequent collection of the blank sample. Therefore, these results likely are not representative of the actual potential for contamination of environmental samples, which are collected only after flushing of sampling equipment with copious quantities of native groundwater.

Blank samples collected in 2012 were analyzed for 85 VOCs, and blank samples collected in 2013 through 2016 were analyzed for a different (but partially overlapping) list of 85 VOCs; the change in laboratory methods and constituent lists resulted in a total of 129 different VOCs being included in the overall dataset of blank results. In total, 19 VOCs were detected in at least 1 field blank collected in 2016 (table 4.1), and 27 VOCs were detected in at least 1 field blank from the cycle 3 sampling period (table 4.2). Twelve compounds detected in field blanks from the cycle 3 sampling period (1,1-dichloroethene, 1,2-dibromo-3-chloropropane, 1,4-dichlorobenzene, benzene, carbon disulfide, dichloromethane, ethylbenzene, m-xylene plus p-xylene, o-xylene, styrene, toluene, and trichloromethane) have HHBs (table 2 of Arnold and others, 2020) and none have SMCLs. For 9 of the 12 VOCs with HHBs, the maximum concentration measured in a blank was less than 1 percent of the corresponding HHB threshold; for the remaining 3 VOCs (1,1-dichloroethene, 1,2-dibromo-3-chloropropane, and dichloromethane), the maximum concentration was less than 3 percent of the corresponding HHB threshold.

Blank samples collected in 2012 were analyzed for 137 pesticide compounds, and blank samples collected in 2013 through 2016 were analyzed for 225 to 227 pesticide compounds; the change in laboratory methods and constituents resulted in 272 pesticide compounds being included in the overall dataset of blank results. One pesticide compound was detected in 1 field blank collected in 2016 (table 4.1), and 27 pesticide compounds were detected in at least 1 field blank from the cycle 3 sampling period (table 4.2). Eighteen compounds detected in field blanks from the cycle 3 sampling period (aldicarb sulfone, atrazine, bromacil, desulfinylfipronil, diflubenzuron, 2-hydroxy-4-isopropylamino-6-ethylamino-s-triazine, imazethapyr, methyoxyfenozide, metolachlor, metribuzin, nicosulfuron, pendimethalin, cis-permethrin, *trans*-permethrin, piperonyl butoxide, prometryn, propiconazole, and tebuthiuron) have HHBs (table 2 of Arnold and others, 2020) and none have SMCLs. For all the pesticide compounds with HHBs, the maximum concentration measured in a field blank was about 0.25 percent or less of the corresponding HHB threshold.

A few of the special analytes collected in only selected well networks were detected in one or more field blanks from the cycle 3 sampling period. The one field blank collected in 2016 for arsenic speciation had no detections. Six field blanks were collected for arsenic speciation during the cycle 3 sampling period. In these six field blanks, there were no detections of three arsenic species (arsenite, dimethylarsinate, and monomethylarsonate), but arsenate was detected in one field blank at a concentration of 1.51 μg/L, which is about 15 percent of the HHB of 10 μg/L for total arsenic. Because it is possible that contamination could limit the suitability of arsenate results for comparison with the arsenic HHB, total arsenic results by NWQL laboratory schedule 2710, which are available for all samples that have arsenate results, should be used for comparison with the HHB. Perchlorate was not detected in any of the 4 field blanks collected during 2016, or in any of the 18 total field blanks collected during the cycle 3 sampling period. Hexavalent chromium was detected in one of the seven field blanks collected in 2015 at a concentration of 0.2 μg/L, which is 5.0 percent of the upper cancer HBSL of 4 μg/L. Hexavalent chromium was detected in 2 of the 20 field blanks from the cycle 3 sampling period at a maximum concentration of 0.3 μg/L, which is 7.5 percent of the upper cancer HBSL of 0.04 μg/L. Corresponding total chromium values typically are reported by the same USGS Trace Metal Laboratory in Boulder, Colo., that analyzes for hexavalent chromium. For the four hexavalent chromium field blanks collected in 2016, the corresponding total chromium values were below detection. Of the 19 samples from the cycle 3 sampling period that had total chromium results reported by this laboratory, 2 field blanks had a detection of total chromium at concentrations as much as 0.6 μg/L, which is 0.6 percent of the HHB of 100 μg/L. Therefore, it seems that there is minimal potential for contamination of total chromium from the USGS Trace Metal Laboratory to affect comparison of these values to HHBs.

The maximum concentrations of nutrients, VOCs, and pesticide compounds in field blanks from the cycle 3 sampling period are all substantially less than the thresholds used by the NAWQA Project to distinguish between low and moderate concentrations (50 percent of the HHB or SMCL for inorganic constituents and 10 percent of the HHB for organic constituents); therefore, results of the field blank samples for these constituent groups indicate minimal potential for effects of contamination on the number of groundwater samples that would be classified as having moderate or high concentrations relative to current HHBs or SMCLs. For major, minor, and trace elements, the maximum concentrations in field blanks from the cycle 3 sampling period also are substantially less than the relevant thresholds except for iron and aluminum. Data from third-party blind blanks and from NAWQA Project field blanks do not indicate systematic contamination issues for iron that would substantially affect classification of results relative to the SMCL of 300 µg/L. Because data from blind blanks and field blanks indicate that laboratory contamination might have affected aluminum results considerably for some environmental samples from late May 2014 through at least August 2016, aluminum results from this period cannot positively be classified as moderate or high relative to the SMCL of 50 µg/L.

Replicate Sample Approach

Replicate samples are QC samples that are used to estimate variability of analytical results caused by random measurement error (Mueller and others, 2015). Replicate samples are two or more water samples that are collected, processed, and analyzed in a manner that allows them to be considered essentially identical in composition and analysis (Mueller and others, 2015). Replicate groundwater samples for NAWQA consist of two samples collected one after the other in the field (sequential field replicates).

Replicate samples typically are used to evaluate variability in analyte concentration by estimating standard deviation (SD) as a function of concentration (Mueller and others, 2015). The presence of censored values affects the calculation of these estimates and generally necessitates estimation of the variability in analyte detection, as well. One measure of the variability in analyte detection is the mean detection rate for all replicate pairs having at least one detection (Martin, 2002; Mueller and others, 2015). Another measure is the percentage of replicate sets with inconsistent detections, which is calculated as the number of replicate sets with inconsistent detections divided by the total number of replicate sets minus the number of sets with consistent non-detections (Martin, 2002; Mueller and others, 2015). A one-sided upper confidence limit for the percentage of inconsistent replicate sets can be calculated as described by Mueller and others (2015, p. 32). Multiple approaches are available to estimate the variability of analyte concentrations as a function of concentration. Three of these approaches and the requirements to apply them were described by Mueller and others (2015, p. 32).

Data and results of the initial evaluation of data from replicate samples for a variety of analytes collected during the entire cycle 3 sampling period of May 2012 through December 2016 are presented in this report. The objective of this initial evaluation of replicate samples was to broadly characterize variability in analyte detection and concentration to explore implications for comparisons of environmental concentrations of analytes as reported by the relevant laboratories with their corresponding HHBs or SMCLs. For example, large variability in analyte detection and (or) concentration near an HHB could reduce confidence in the reported concentration representing a true exceedance of an HHB in the environment. As part of this evaluation, for analytes that include censored values and have at least 10 replicate pairs not composed of consistent nondetections, the mean detection rate (for all replicate pairs having at least 1 detection) and the percentage of replicate sets with inconsistent detections were calculated. A piecewise-linear model used by Mueller and Titus (2005) and described by Mueller and others (2015) was used to estimate variability in concentrations for analytes having at least 10 replicate pairs with consistent detections. This two-range model divides concentrations into: (1) a low range for which the SD of replicates generally is uniform and the average SD is used to estimate variability; and (2) a high range for which the relative standard deviation (RSD; the ratio, in percent, of SD to mean concentration) generally is uniform and the average RSD is used to estimate variability. Graphs of SD and RSD against mean concentration are used to select an appropriate boundary concentration between the low and high ranges (Mueller and others, 2015). In some cases, either SD or RSD is fairly uniform throughout the range of available concentrations and, therefore, no boundary is needed.

Replicate Sample Counts

The total number of replicate samples collected for groundwater sites during cycle 3 varies by analyte group (table 4.3). Data for all replicate samples from the 2015 and 2016 sampling periods are presented in tables 4.10–4.19 of Arnold and others (2020). All cycle 3 replicate samples were analyzed using the corresponding laboratory methods listed in table 2 of Arnold and others (2020). Of the 110 cycle 3 VOC replicate samples, 5 were collected in 2012 and analyzed for an older analytical schedule using purge and trap gas chromatography/mass spectrometry (Gilliom and others, 2006; Zogorski and others, 2006). The remaining 105 were collected in 2013–16 and analyzed using the most recent analytical schedule and laboratory methods (purge and trap gas chromatography/mass spectrometry and heated purge and trap gas chromatography/mass spectrometry). Of the 142 cycle 3 pesticide replicate samples, 4 were collected in 2012 and analyzed for an older analytical schedule using gas chromatography/mass spectrometry. The remaining 138 were collected in 2013–16 and analyzed using the most recent analytical schedule and laboratory method (direct aqueous injection liquid chromatography tandem mass spectrometry).

Replicate Sample Results

Analysis of variability in analyte detection, analyte concentration, or both was attempted for only the subset of analytes that met certain requirements. Analysis of replicate results was not attempted for analyte/method combinations for which fewer than 10 replicate pairs had been analyzed. Therefore, VOCs and pesticide compounds determined with older laboratory methods used for analysis of replicates collected in 2012 were not evaluated for variability. In addition, analysis of variability in analyte detection was performed only for analytes that included censored values and had at least 10 replicate pairs without consistent non-detections (table 4.4). Analysis of analyte concentrations was performed only for analytes that had at least 10 replicate pairs with consistent detections (table 4.5).

Among all constituents for which variability in detection was estimated, the mean detection rate ranged from 78.1 to 100 percent and the percentage of pairs with inconsistent detections ranged from 0.0 to 43.8 percent (table 4.4). In his assessment of pesticides, Martin (2002) used a mean detection rate of 75 percent or less or a percentage of inconsistent replicate sets of 50 percent or more to indicate high variability of detection. Using those same criteria, none of the constituents analyzed for this study would be considered to have high variability of detection. Martin (2002) also used a mean detection rate of 90 percent or more or a percentage of inconsistent replicate sets of 25 percent or less to indicate low variability of detection. Under these criteria, the following constituents do not have low variability of detection but rather would be considered to have moderate variability: the nutrient nitrite; the pesticide compounds hexazinone, metolachlor, and OIAT; and the radiological analytes alpha radioactivity (30-day count), radium-226, and radium-228. The initial analysis of variability of detection presented here did not include calculation of an upper confidence bound on percentages of inconsistent replicate sets to quantify uncertainty and did not account for changes in variability across concentration ranges. In general, variability of detection is higher at low concentrations and decreases with increasing concentrations (Martin, 2002). More detailed analysis of this type might be needed for the interpretation of environmental concentrations for objectives other than those presented in this report.

For all constituents for which variability in concentration was estimated, the mean SD, RSD, or both, were determined for specified concentration ranges by means of the two-range model and are presented in table 4.5. For major and minor elements and physical parameters, the mean SD at lower or all concentrations was 0.22 mg/L or less, except for alkalinity and residue on evaporation (dissolved solids), and the mean RSD at higher concentrations was less than 3 percent, except for bromide and iron. For trace elements, the mean SD at lower or all concentrations was 0.3 microgram per liter or less, except for aluminum and zinc, and the mean RSD at higher concentrations was less than 5 percent, except for cobalt and lead. For nutrients and dissolved organic carbon, the mean SD at lower concentrations was less than 0.04 mg/L, and the mean RSD at higher concentrations was 3 percent or less, except for dissolved organic carbon. For VOCs, only 4 compounds had at least 10 replicate pairs with consistent detections. Mean SDs were calculated for lower concentration ranges for three compounds and were all 0.013 microgram per liter or less; only one compound had sufficient data to calculate a mean RSD (5.8 percent) for the upper concentration range. For pesticide compounds, 9 compounds had at least 10 replicate pairs with consistent detections. Six compounds had sufficient data to calculate a mean SD for lower concentrations; the mean SD for each of these compounds was less than 10 nanograms per liter, except for metolachlor sulfonic acid. Data for pesticide compounds generally were insufficient to reasonably estimate the mean RSD at higher concentrations. For radiological analytes, the mean SD at lower concentrations was 0.76 picocurie per liter or less, except for radon, and the mean RSD at higher concentrations was less than 10 percent, except for α radioactivity (72-hour count).

None of the special-interest analytes collected in only selected well networks had more than 10 replicate pairs without consistent nondetections for a rigorous evaluation of variability. However, the six available replicate pairs for the four arsenic species indicated no inconsistent detections. Only arsenate and arsenite were detected; within the four to five pairs with consistent detections of these analytes, concentrations were similar. Out of 10 sample pairs, perchlorate was not detected in either sample of 3 pairs, was detected in 1 sample of a single pair (at a concentration nearly equivalent to the laboratory reporting level) and was detected in both samples of 6 pairs (at similar concentrations). Out of 9 samples pairs, hexavalent chromium was not detected in either sample of 3 pairs and had inconsistent detections in 3 of the 6 other pairs; concentrations within the 3 pairs with consistent detections were similar. Out of 8 sample pairs for total chromium from the Boulder, Colo., laboratory, chromium was not detected in either sample of 2 pairs, was detected in 1 sample of 2 pairs, and was detected in both samples of 4 pairs (2 of which had similar concentrations between samples). Four replicate samples were analyzed for strontium isotope ratios, for which a non-detection is not a possible result; the isotope ratios within all four sample pairs were identical.

Overall, the available results indicate generally low variability in analyte detection and concentration, meaning that random measurement error has minimal potential to affect the number of groundwater samples that would be classified as having moderate or high concentrations relative to current HHBs or SMCLs. However, further analysis beyond the scope of this initial evaluation of replicate results, such as the calculation of confidence intervals, would be needed to quantify the likely effects of variability for use of the environmental data for specific purposes.

Table 4.4. Estimated variability in detection of selected analytes based on field replicate samples collected by the U.S. Geological Survey National Water-Quality Assessment Project, May 2013 through December 2016.

[Variability was evaluated only for constituents having censored values and at least 10 replicate pairs without consistent nondetections. *n*, number of pairs with at least one detection; CAAT, chlorodiamino-*s*-triazine; CEAT, 2-chloro-6-ethylamino-4-amino-*s*-triazine; OIAT, 2-hydroxy-4-isopropylamino-6-amino-*s*-triazine; OIET, 2-hydroxy-4-isopropylamino-6-ethylamino-*s*-triazine; SA, sulfonic acid]

Constituent	*n*	Mean detection rate (percent)	Pairs with inconsistent detections (percent)
Major and minor elements			
Bromide	95	97.4	5.3
Fluoride	113	100	0
Dissolved solids	118	99.6	0.8
Iron	80	90.6	18.8
Sulfate	115	100	0
Trace elements			
Aluminum	52	90.4	19.2
Antimony	50	95	10
Arsenic	102	98.5	2.9
Beryllium	30	100	0
Boron	111	99.5	0.9
Cadmium	28	94.6	10.7
Chromium	54	97.2	5.6
Cobalt	82	94.5	11
Copper	54	89.8	20.4
Lead	81	92.6	14.8
Lithium	118	100	0
Manganese	92	97.8	4.3
Molybdenum	107	100	0
Nickel	94	98.9	2.1
Selenium	85	96.5	7.1
Thallium	16	96.9	6.3
Uranium	102	99	2
Vanadium	99	96	8.1
Zinc	66	94.7	10.6
Nutrients and dissolved organic carbon			
Ammonia	50	93	14
Nitrite plus nitrate	77	98.7	2.6
Nitrite	26	84.6	30.8
Total nitrogen	108	99.5	0.9
Orthophosphate	106	99.5	0.9
Dissolved organic carbon	80	95.6	8.8

Table 4.4. Estimated variability in detection of selected analytes based on field replicate samples collected by the U.S. Geological Survey National Water-Quality Assessment Project, May 2013 through December 2016.—Continued

[Variability was evaluated only for constituents having censored values and at least 10 replicate pairs without consistent nondetections. *n*, number of pairs with at least one detection; CAAT, chlorodiamino-*s*-triazine; CEAT, 2-chloro-6-ethylamino-4-amino-*s*-triazine; OIAT, 2-hydroxy-4-isopropylamino-6-amino-*s*-triazine; OIET, 2-hydroxy-4-isopropylamino-6-ethylamino-*s*-triazine; SA, sulfonic acid]

Constituent	*n*	Mean detection rate (percent)	Pairs with inconsistent detections (percent)
Volatile organic compounds			
1,2-Dichloropropane	11	100	0
Carbon disulfide	16	93.8	12.5
Methyl *tert*-butyl ether	17	100	0
Trichloromethane	28	100	0
Pesticide compounds			
Atrazine	39	91	17.9
CAAT	41	96.3	7.3
CEAT	23	97.8	4.3
Deethylatrazine (CIAT)	41	89	22
Hexazinone	16	81.3	37.5
Metolachlor	16	78.1	43.8
Metolachlor SA	43	95.3	9.3
OIAT	15	80	40
OIET	12	95.8	8.3
Prometon	13	92.3	15.4
Simazine	18	91.7	16.7
Radiological analytes			
α radioactivity, 30-day count	57	85.1	29.8
α radioactivity, 72-hour count	68	89	22.1
β radioactivity, 30-day count	76	93.4	13.2
β radioactivity, 72-hour count	79	94.3	11.4
Radium-224	59	89.8	20.3
Radium-226	74	81.8	36.5
Radium-228	54	84.3	31.5

Spike Sample Approach

Spike samples are QC samples that are used to estimate any positive or negative bias that might result from method performance, effects of the sample matrix, and (or) analyte degradation during sample shipment and storage (Mueller and others, 2015). Spike samples are collected by fortifying (spiking) a water sample with known concentrations of analytes. For VOCs, NAWQA collects laboratory matrix spikes, meaning that the spike solution is added to an environmental sample at the laboratory. For pesticide compounds and arsenic species, NAWQA collects field matrix spikes, meaning that the spike solution is added to an environmental sample in the field. Both types of spikes estimate recovery bias in an environmental water sample that could be caused by a problem with performance of the laboratory method, by the chemical, physical, or biological characteristics of the water, or by both (Mueller and others, 2015). Field spikes also reflect any degradation that might have occurred in an analyte during the time between sample collection and laboratory analysis. Evaluations of recoveries for laboratory spikes for VOCs and field spikes for arsenic species are included in this report, but an evaluation of recoveries for field spikes for pesticides is not included here because Shoda and others (2018) presented this type of evaluation for pesticide spike samples collected for the NAWQA Project in 2013–15.

Table 4.5. Estimated variability in concentrations of selected analytes based on field replicate samples collected by the U.S. Geological Survey National Water-Quality Assessment Project, May 2013 through December 2016.

[Variability was evaluated only for constituents having at least 10 replicate pairs with consistent detections. *n*, number of values in that category; IPT, inflection point titration method; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; µS/cm, microsiemen per centimeter at 25 degrees Celsius; µg/L, microgram per liter; InsD, insufficient data; ng/L, nanogram per liter; SD, standard deviation; RSD, relative standard deviation; CAAT, chlorodiamino-*s*-triazine; CEAT, 2-chloro-6-ethylamino-4-amino-*s*-triazine; OIET, 2-hydroxy-4-isopropylamino-6-ethylamino-*s*-triazine; SA, sulfonic acid; pCi/L, picocurie per liter]

Constituent	Concentration range (unit)	*n*	Variability		
			Statistic	Value	Unit
Major and minor elements and physical parameters					
Alkalinity by IPT	All available values (mg/L as $CaCO_3$)	58	Mean SD	6.4	mg/L as $CaCO_3$
pH	All available values (pH units)	118	Mean SD	0.031	pH units
Specific conductance	All available values (µS/cm)	118	Mean RSD	0.24	percent
Calcium	<10	23	Mean SD	0.059	mg/L
	>10	96	Mean RSD	1.3	percent
Magnesium	All available concentrations	119	Mean RSD	1	percent
Potassium	<1.5	45	Mean SD	0.016	mg/L
	>1.5	74	Mean RSD	1.9	percent
Sodium	All available concentrations	119	Mean RSD	1.5	percent
Bromide	<0.1	53	Mean SD	0.0026	mg/L
	>0.1	37	Mean RSD	5.7	percent
Chloride	<40	91	Mean SD	0.05	mg/L
	>40	28	Mean RSD	1.2	percent
Fluoride	<0.2	62	Mean SD	0.0014	mg/L
	>0.2	51	Mean RSD	2.5	percent
Silica	All available concentrations	119	Mean SD	0.22	mg/L
Sulfate	<40	72	Mean SD	0.029	mg/L
	>40	43	Mean RSD	0.93	percent
Residue on evaporation	<900	107	Mean SD	7.3	mg/L
	>900	10	Mean RSD	0.82	percent
Iron	<100	36	Mean SD	5.3	µg/L
	>100	29	Mean RSD	5.4	percent
Trace elements					
Aluminum	All available concentrations	42	Mean SD	1	µg/L
Antimony	<0.1	33	Mean SD	0.0026	µg/L
	>0.1	12	Mean RSD	4.3	percent
Arsenic	<1.0	48	Mean SD	0.0083	µg/L
	>1.0	51	Mean RSD	1.6	percent
Barium	<50	73	Mean SD	0.22	µg/L
	>50	47	Mean RSD	1.6	percent
Beryllium	All available concentrations	30	Mean SD	0.0028	µg/L
Boron	<30	44	Mean SD	0.3	µg/L
	>30	66	Mean RSD	1.9	percent
Cadmium	All available concentrations	25	Mean SD	0.0036	µg/L
Chromium	<2	39	Mean SD	0.028	µg/L
	>2	12	Mean RSD	2.6	percent

Table 4.5. Estimated variability in concentrations of selected analytes based on field replicate samples collected by the U.S. Geological Survey National Water-Quality Assessment Project, May 2013 through December 2016.—Continued

[Variability was evaluated only for constituents having at least 10 replicate pairs with consistent detections. *n*, number of values in that category; IPT, inflection point titration method; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; µS/cm, microsiemen per centimeter at 25 degrees Celsius; µg/L, microgram per liter; InsD, insufficient data; ng/L, nanogram per liter; SD, standard deviation; RSD, relative standard deviation; CAAT, chlorodiamino-*s*-triazine; CEAT, 2-chloro-6-ethylamino-4-amino-*s*-triazine; OIET, 2-hydroxy-4-isopropylamino-6-ethylamino-*s*-triazine; SA, sulfonic acid; pCi/L, picocurie per liter]

Constituent	Concentration range (unit)	*n*	Variability		
			Statistic	Value	Unit
	Trace elements—Continued				
Cobalt	<0.2	53	Mean SD	0.0061	µg/L
	>0.2	20	Mean RSD	7.9	percent
Copper	<8	37	Mean SD	0.17	µg/L
	>8	6	Mean RSD	InsD	percent
Lead	<0.4	52	Mean SD	0.021	µg/L
	>0.4	17	Mean RSD	9.3	percent
Lithium	All available concentrations	118	Mean RSD	1.8	percent
Manganese	<10	44	Mean SD	0.11	µg/L
	>10	44	Mean RSD	4.2	percent
Molybdenum	<1	53	Mean SD	0.0076	µg/L
	>1	54	Mean RSD	1.6	percent
Nickel	<2	76	Mean SD	0.041	µg/L
	>2	16	Mean RSD	2	percent
Selenium	<0.5	57	Mean SD	0.0069	µg/L
	>0.5	22	Mean RSD	2.9	percent
Strontium	All available concentrations	123	Mean RSD	1.2	percent
Thallium	All available concentrations	15	Mean SD	0.0022	µg/L
Uranium	<1	56	Mean SD	0.0061	µg/L
	>1	44	Mean RSD	2	percent
Vanadium	<2	49	Mean SD	0.018	µg/L
	>2	42	Mean RSD	1.3	percent
Zinc	All available concentrations	59	Mean SD	1.3	µg/L
	Nutrients				
Ammonia	<0.2	23	Mean SD	0.0019	mg/L
	>0.2	20	Mean RSD	3	percent
Nitrite plus nitrate	<3	40	Mean SD	0.0092	mg/L
	>3	35	Mean RSD	0.98	percent
Nitrite	All available concentrations	18	Mean SD	0.0004	mg/L
Total nitrogen	<3	73	Mean SD	0.039	mg/L
	>3	34	Mean RSD	1.5	percent
Orthophosphate	<0.07	84	Mean SD	0.001	mg/L
	>0.07	21	Mean RSD	2.3	percent
Dissolved organic carbon	>1	41	Mean SD	0.03	mg/L
	<1	32	Mean RSD	10.8	percent
	Volatile organic compounds				
1,2-Dichloropropane	All available concentrations	11	Mean RSD	5.8	percent
Carbon disulfide	<0.3	11	Mean SD	0.013	µg/L
	>0.3	3	Mean RSD	InsD	percent

Table 4.5. Estimated variability in concentrations of selected analytes based on field replicate samples collected by the U.S. Geological Survey National Water-Quality Assessment Project, May 2013 through December 2016.—Continued

[Variability was evaluated only for constituents having at least 10 replicate pairs with consistent detections. *n*, number of values in that category; IPT, inflection point titration method; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; µS/cm, microsiemen per centimeter at 25 degrees Celsius; µg/L, microgram per liter; InsD, insufficient data; ng/L, nanogram per liter; SD, standard deviation; RSD, relative standard deviation; CAAT, chlorodiamino-*s*-triazine; CEAT, 2-chloro-6-ethylamino-4-amino-*s*-triazine; OIET, 2-hydroxy-4-isopropylamino-6-ethylamino-*s*-triazine; SA, sulfonic acid; pCi/L, picocurie per liter]

Constituent	Concentration range (unit)	*n*	Variability		
			Statistic	Value	Unit
	Volatile organic compounds—Continued				
Methyl *tert*-butyl ether	<0.3	14	Mean SD	0.0014	µg/L
	>0.3	3	Mean RSD	InsD	percent
Trichloromethane	<0.2	20	Mean SD	0.0013	µg/L
	>0.2	9	Mean RSD	InsD	percent
	Pesticide compounds				
Atrazine	<90	29	Mean SD	1.1	ng/L
	>90	3	Mean RSD	InsD	percent
Deethylatrazine (CIAT)	<200	27	Mean SD	4.8	ng/L
	>200	5	Mean RSD	InsD	percent
CEAT	<500	21	Mean SD	7.7	ng/L
	>500	1	Mean RSD	InsD	percent
CAAT	<65	12	Mean SD	4	ng/L
	>65	26	Mean RSD	13	percent
Hexazinone	<15	8	Mean SD	InsD	ng/L
	>15	2	Mean RSD	InsD	percent
Metolachlor SA	<500	14	Mean SD	19	ng/L
	>500	5	Mean RSD	3.6	percent
OIET	<50	9	Mean SD	InsD	ng/L
	>50	2	Mean RSD	InsD	percent
Prometon	<10	6	Mean SD	InsD	ng/L
	>10	5	Mean RSD	InsD	percent
Simazine	<50	14	Mean SD	2.1	ng/L
	>50	1	Mean RSD	InsD	percent
	Radiological analytes				
α radioactivity, 30-day count	<5	25	Mean SD	0.5	pCi/L
	>5	15	Mean RSD	9.7	percent
α radioactivity, 72-hour count	<10	41	Mean SD	0.55	pCi/L
	>10	12	Mean RSD	14	percent
β radioactivity, 30-day count	<8	44	Mean SD	0.59	pCi/L
	>8	22	Mean RSD	8.3	percent
β radioactivity, 72-hour count	<10	57	Mean SD	0.76	pCi/L
	≥10	13	Mean RSD	8.6	percent
Radium-224	All available concentrations	48	Mean SD	0.15	pCi/L
Radium-226	All available concentrations	48	Mean SD	0.13	pCi/L
Radium-228	All available concentrations	38	Mean SD	0.16	pCi/L
Radon	<500	32	Mean SD	12	pCi/L
	>500	14	Mean RSD	2.9	percent

The percent recovery of an analyte in an individual spike sample is calculated by subtracting the concentration of the paired unspiked sample (collected closely in time) from the concentration of the spiked sample, then dividing by the expected concentration and multiplying by 100. The expected concentration is equal to the concentration of the spike solution times the amount of spike solution added to the sample, divided by the volume of the spiked sample. When the NWQL reported that an analyte was not detected in the paired unspiked sample, a concentration of zero was assumed for the purposes of the calculating the percent recovery. Spike solutions were obtained from the NWQL, which provides the concentration of each analyte included in an individual spike lot. Analytes included in spike solutions were assumed not to have degraded before use of the spike solution, although it is possible that future evaluation of spike sample results might indicate that the assumption is violated for certain spike lots, compounds, or both. For VOCs, the NWQL was assumed to have added 20 microliters of spike solution to a 43-milliliter sample. For arsenic species, field crews were assumed to have added 100 microliters of spike solution to an 11.5-milliliter sample. Samples were excluded from analysis of recoveries when there was evidence that they had been collected after chlorination, which can affect the analysis of many compounds. Individual results were excluded from analysis of recoveries when the concentration present for the compound in the unspiked sample exceeded the expected spike concentration because this can result in increased uncertainty in recovery (Shoda and others, 2018).

Results of an initial evaluation of recovery data from laboratory spikes for VOCs analyzed under laboratory schedules 4436 (S4436) and 4437 (S4437) and from field spikes for arsenic species analyzed under laboratory code 3142 (LC3142) during the entire cycle 3 sampling period are presented in this report (laboratory schedules and codes are listed in table 2 of Arnold and others (2020, 2017b, 2018b). Data for laboratory spikes collected for VOCs and field spikes collected for arsenic species in January 2015–December 2016 also are published in this report. Data and results of earlier evaluations of recovery data from laboratory spikes collected for VOCs in 2012 under older laboratory schedules 2020 and 4024 and from laboratory spikes collected for VOCs collected in May 2013 through December 2014 for S4436 and S4437 are presented in Arnold and others (2017a,b); data and results of an earlier evaluation of recovery data for field spikes collected for arsenic speciation in 2014 also are presented there. Although an evaluation of recovery results for field spikes collected for pesticides is not included in this report, data for pesticide spike samples collected in May 2013–December 2016 are published here.

The objective of performing an initial evaluation of spike samples was to determine if substantial positive or negative recovery bias exists for any analytes. Substantial positive or negative bias could have implications for comparisons of environmental concentrations of these analytes as reported by the NWQL with their corresponding HHBs. For example, a large negative recovery bias could result in the laboratory reporting a concentration that is substantially less than the concentration actually present in the environment, leading to an incorrect conclusion that the concentration in the environment does not exceed an HHB when it actually does. For the purposes of this initial evaluation of spike samples, a median recovery between 70 and 130 percent is considered acceptable. Further evaluation of results for spike samples would be needed to determine if recovery bias for certain analytes would affect the interpretation of environmental concentrations of those analytes for objectives other than those presented in this report.

Spike Sample Counts

Between May 2013 and December 2016, a total of 96 laboratory spikes for VOCs by S4436, 97 laboratory spikes for VOCs by S4437, and 9 field spikes for arsenic species were collected for the NAWQA Project (tables 4.6–4.9). Data for VOC and arsenic species spike samples from January 2015 through December 2016 are presented in tables 4.13–4.15 of Arnold and others (2020). Data for the 60 field spikes collected for pesticides by S2437 during cycle 3 are presented in table 4.14 of Arnold and others (2020).

Spike Sample Results

For VOC laboratory spikes collected during cycle 3 for analysis by S4436 or S4437, the median recovery for individual compounds ranged from 69.4 to 110.4 percent (tables 4.6–4.8; figs. 4.1 and 4.2; table 4.13 of Arnold and others, 2020). Only butane, which is included on S4436 and has no HHB, had a median recovery less than 70 percent. No VOCs had median recoveries greater than 130 percent. Therefore, laboratory spike recovery results do not indicate any issues with comparing reported VOC concentrations to their corresponding HHBs.

For the nine arsenic speciation field spikes collected during cycle 3 for analysis by LC3142, recoveries ranged from 77.3 to 124.7 percent for arsenate, 60.6 to 111.2 percent for arsenite, 63.6 to 100.0 percent for dimethylarsinate, and 70.6 to 103.3 percent for monomethylarsonate (table 4.15 of Arnold and others, 2020; fig. 4.3). Median recoveries for all four species were between 85.3 and 90.6 percent (table 4.6). These results indicate bias from method performance, effects of the sample matrix, or analyte degradation, or all of the above generally is small but is more likely to be slightly negative than positive. No HHBs exist that are specific to individual arsenic species, although there is an HHB for total arsenic.

Table 4.6. Summary of results for spike samples collected by the National Water-Quality Assessment Project from May 2013 to December 2016.

[VOC, volatile organic compound; HHB, human-health benchmark; --, not applicable]

Type of summary	VOC by schedule 4436	VOC by schedule 4437	Arsenic species
Total number of field spikes	0	0	9
Total number of laboratory blanks	96	97	0
Number of constituents analyzed	49	38	4
Range of median spike recoveries, in percent	69.4–107.5	88.3–110.4	85.3–90.6
Number of compounds with median spike recovery less than 70 percent	1	0	0
Number of compounds with median spike recovery less than 70 percent with a corresponding HHB	0	--	--
Number of compounds with median spike recovery greater than 130 percent	0	0	0
Number of compounds with median spike recovery greater than 130 percent with a corresponding HHB	--	--	--

Table 4.7. Statistical summary of laboratory spike recovery results for volatile organic compounds included in laboratory schedule 4436.

[*n*, number of values for that constituent; min, minimum; 10th, 25th, 75th, and 90th, 10th, 25th, 75th, and 90th percentiles; med, median, max, maximum]

Parameter code	Constituent	Statistic							
		n	Min	10th	25th	Med	75th	90th	Max
P62174	2,2-Dichloro-1,1,1-trifluoroethane, water, unfiltered, recoverable, micrograms per liter	96	84.3	94.1	98.7	101.7	107.4	110.9	118.6
P45028	Chlorodifluoromethane, water, unfiltered, recoverable, micrograms per liter	96	67.4	79.0	87.1	94.0	105.6	117.2	133.0
P77119	Dichlorofluoromethane, water, unfiltered, recoverable, micrograms per liter	96	90.2	95.1	100.6	103.1	108.5	114.9	124.2
P81590	Hexane, water, unfiltered, recoverable, micrograms per liter	96	42.3	55.4	64.5	75.1	83.2	92.1	103.8
P81604	*n*-Pentane, water, unfiltered, recoverable, micrograms per liter	96	55.2	65.2	76.3	88.8	98.6	106.9	124.7
P77562	1,1,1,2-Tetrachloroethane, water, unfiltered, recoverable, micrograms per liter	96	78.8	88.4	90.8	95.3	100.7	106.9	120.3
P34506	1,1,1-Trichloroethane, water, unfiltered, recoverable, micrograms per liter	96	81.9	91.8	96.2	100.6	105.5	107.7	122.2
P34511	1,1,2-Trichloroethane, water, unfiltered, recoverable, micrograms per liter	96	86.3	91.8	96.9	100.7	104.7	109.8	118.9
P34496	1,1-Dichloroethane, water, unfiltered, recoverable, micrograms per liter	96	82.7	93.3	98.0	101.3	106.1	110.2	124.2
P34501	1,1-Dichloroethene, water, unfiltered, recoverable, micrograms per liter	96	81.0	86.3	91.8	99.4	103.3	108.5	117.7
P34551	1,2,4-Trichlorobenzene, water, unfiltered, recoverable, micrograms per liter	96	75.4	84.8	88.1	92.2	98.2	104.7	116.5
P77222	1,2,4-Trimethylbenzene, water, unfiltered, recoverable, micrograms per liter	96	73.5	80.5	84.5	95.8	107.0	117.3	133.0
P34536	1,2-Dichlorobenzene, water, unfiltered, recoverable, micrograms per liter	96	83.7	99.8	103.5	107.5	111.5	115.9	124.5
P32103	1,2-Dichloroethane, water, unfiltered, recoverable, micrograms per liter	96	87.4	95.5	97.9	100.5	103.2	107.2	115.9
P34571	1,4-Dichlorobenzene, water, unfiltered, recoverable, micrograms per liter	96	84.1	93.9	97.6	101.6	107.1	112.6	126.1
P34030	Benzene, water, unfiltered, recoverable, micrograms per liter	96	83.5	90.8	97.9	101.3	106.1	110.2	123.9
P77297	Bromochloromethane, water, unfiltered, recoverable, micrograms per liter	96	86.2	95.2	99.9	103.7	109.5	114.4	121.6
P32101	Bromodichloromethane, water, unfiltered, recoverable, micrograms per liter	96	79.7	85.6	89.1	94.3	104.3	110.9	127.0
P34413	Bromomethane, water, unfiltered, recoverable, micrograms per liter	96	42.6	82.8	95.3	107.0	125.8	149.6	195.6
P77041	Carbon disulfide, water, unfiltered, micrograms per liter	93	42.4	73.2	78.9	88.7	97.8	110.0	175.5
P34301	Chlorobenzene, water, unfiltered, recoverable, micrograms per liter	96	80.9	85.6	89.0	93.4	100.4	105.2	116.3
P34418	Chloromethane, water, unfiltered, recoverable, micrograms per liter	96	56.0	74.8	89.1	102.6	113.9	129.8	154.8
P77093	*cis*-1,2-Dichloroethene, water, unfiltered, recoverable, micrograms per liter	96	84.4	92.0	94.8	99.0	102.6	110.1	121.1

Table 4.7. Statistical summary of laboratory spike recovery results for volatile organic compounds included in laboratory schedule 4436.—Continued

[*n*, number of values for that constituent; min, minimum; 10th, 25th, 75th, and 90th, 10th, 25th, 75th, and 90th percentiles; med, median, max, maximum]

Parameter code	Constituent	Statistic							
		n	Min	10th	25th	Med	75th	90th	Max
P34704	*cis*-1,3-Dichloropropene, water, unfiltered, recoverable, micrograms per liter	96	78.3	84.9	88.3	92.1	98.4	104.4	115.3
P32105	Dibromochloromethane, water, unfiltered, recoverable, micrograms per liter	96	80.8	83.4	87.1	92.3	102.1	107.2	127.8
P34423	Dichloromethane, water, unfiltered, recoverable, micrograms per liter	96	74.3	93.9	98.6	101.6	105.1	110.9	117.0
P34371	Ethylbenzene, water, unfiltered, recoverable, micrograms per liter	96	73.6	78.7	83.3	88.6	98.0	104.9	125.0
P85795	*m*-Xylene plus *p*-xylene, water, unfiltered, recoverable, micrograms per liter	96	69.2	76.3	79.7	89.9	106.0	118.2	134.1
P34696	Naphthalene, water, unfiltered, recoverable, micrograms per liter	96	67.2	72.9	77.0	83.0	94.4	104.1	110.9
P77224	*n*-Propylbenzene, water, unfiltered, recoverable, micrograms per liter	96	70.9	75.1	78.3	84.0	102.7	111.9	130.0
P77135	*o*-Xylene, water, unfiltered, recoverable, micrograms per liter	96	79.0	80.6	84.5	90.5	100.4	107.0	126.2
P77350	*sec*-Butylbenzene, water, unfiltered, recoverable, micrograms per liter	96	72.6	77.7	80.5	88.9	100.0	108.2	126.9
P77128	Styrene, water, unfiltered, recoverable, micrograms per liter	96	0.0	77.0	80.7	88.3	103.4	112.9	130.2
P78032	Methyl *tert*-butyl ether, water, unfiltered, recoverable, micrograms per liter	96	73.4	92.0	94.9	98.8	103.4	109.4	125.5
P34475	Tetrachloroethene, water, unfiltered, recoverable, micrograms per liter	95	86.7	91.4	96.2	103.9	111.6	120.9	138.7
P32102	Tetrachloromethane, water, unfiltered, recoverable, micrograms per liter	96	83.9	88.9	91.7	96.5	101.9	108.9	122.3
P34010	Toluene, water, unfiltered, recoverable, micrograms per liter	96	86.7	93.7	97.6	101.6	108.3	112.1	123.9
P34546	*trans*-1,2-Dichloroethene, water, unfiltered, recoverable, micrograms per liter	96	80.7	89.6	94.9	100.5	106.0	109.6	123.0
P34699	*trans*-1,3-Dichloropropene, water, unfiltered, recoverable, micrograms per liter	96	70.7	78.5	83.3	87.2	94.5	100.0	123.6
P32104	Tribromomethane, water, unfiltered, recoverable, micrograms per liter	96	80.0	84.4	88.4	92.2	99.4	107.2	133.9
P39180	Trichloroethene, water, unfiltered, recoverable, micrograms per liter	95	77.9	84.2	87.3	94.0	99.6	102.6	111.3
P32106	Trichloromethane, water, unfiltered, recoverable, micrograms per liter	93	89.9	96.0	100.5	104.6	107.9	112.8	121.5
P39175	Vinyl chloride, water, unfiltered, recoverable, micrograms per liter	96	73.0	81.6	89.1	96.4	103.8	110.0	140.5
P68726	1,3-Butadiene, water, unfiltered, recoverable, micrograms per liter	96	4.4	71.3	78.8	89.8	102.6	112.7	131.7
P49538	1,1-Difluoroethane, water, unfiltered, recoverable, micrograms per liter	96	72.0	81.3	85.1	90.7	96.3	101.2	108.9
P77323	1,2,3,4-Tetrahydronaphthalene, water, unfiltered, recoverable, micrograms per liter	96	58.0	65.3	75.3	84.3	107.0	115.5	127.7

Table 4.7. Statistical summary of laboratory spike recovery results for volatile organic compounds included in laboratory schedule 4436.—Continued

[*n*, number of values for that constituent; min, minimum; 10th, 25th, 75th, and 90th, 10th, 25th, 75th, and 90th percentiles; med, median, max, maximum]

Parameter code	Constituent	Statistic							
		n	Min	10th	25th	Med	75th	90th	Max
P50985	1,2-Dichloro-1,1,2,2-tetrafluoroethane, water, unfiltered, recoverable, micrograms per liter	96	47.1	62.0	68.0	76.0	84.0	91.3	101.7
P85668	1-Chloro-1,1-difluoroethane, water, unfiltered, recoverable, micrograms per liter	96	59.4	78.8	87.8	94.8	101.5	104.6	131.6
P81563	Butane, water, unfiltered, recoverable, micro-grams per liter	96	52.1	58.8	64.5	69.4	77.9	85.5	109.0

Table 4.8. Statistical summary of laboratory spike recovery results for volatile organic compounds included in laboratory schedule 4437.

[*n*, number of values for that constituent; min, minimum; 10th, 25th, 75th, and 90th, 10th, 25th, 75th, and 90th percentiles; med, median, max, maximum]

Parameter code	Constituent	Statistic							
		n	Min	10th	25th	Med	75th	90th	Max
P80336	1,1-Dichloro-2-propanone, water, unfiltered, recoverable, micrograms per liter	97	61.5	95.5	100.3	105.4	111.4	117.6	138.7
P81582	1,4-Dioxane, water, unfiltered, recoverable, micrograms per liter	97	69.6	90.1	93.6	97.5	102.0	106.3	114.5
P77076	2-Nitropropane, water, unfiltered, recoverable, micrograms per liter	97	64.1	92.8	95.3	98.6	103.7	107.5	117.4
P76997	Acetonitrile, water, unfiltered, recoverable, micrograms per liter	97	75.5	99.4	103.5	110.0	118.7	126.6	142.4
P34210	Acrolein, water, unfiltered, recoverable, micrograms per liter	77	0.0	81.6	87.4	94.6	103.8	108.4	118.2
P81578	Dimethoxymethane, water, unfiltered, recoverable, micrograms per liter	97	71.5	97.5	100.7	106.2	111.8	116.2	125.8
P81585	Ethyl acetate, water, unfiltered, recoverable, micrograms per liter	97	60.7	88.4	94.3	101.5	107.0	110.9	125.8
P34386	Hexachlorocyclopentadiene, water, unfiltered, recoverable, micrograms per liter	97	46.7	71.1	79.2	89.3	108.4	121.2	149.8
P34408	Isophorone, water, unfiltered, recoverable, micrograms per liter	97	57.2	83.7	91.7	105.7	119.5	129.3	137.8
P77032	Methyl acetate, water, unfiltered, recoverable, micrograms per liter	97	71.6	93.9	98.3	103.4	110.5	118.1	132.0
P34447	Nitrobenzene, water, unfiltered, recoverable, micrograms per liter	97	54.9	82.5	89.3	97.2	106.5	118.0	133.6
P78200	*N*-Nitrosodiethylamine, water, unfiltered, recoverable, micrograms per liter	97	65.2	83.8	92.3	107.4	120.0	127.3	143.8
P77035	*tert*-Butyl alcohol, water, unfiltered, recoverable, micrograms per liter	97	64.9	94.6	97.8	100.8	106.3	111.8	119.6
P77443	1,2,3-Trichloropropane, water, unfiltered, recoverable, micrograms per liter	97	64.1	92.4	97.2	100.0	104.6	108.4	117.2
P82625	1,2-Dibromo-3-chloropropane, water, unfiltered, recoverable, micrograms per liter	97	61.3	89.6	93.8	98.2	103.7	109.9	122.4
P77651	1,2-Dibromoethane, water, unfiltered, recoverable, micrograms per liter	97	64.0	93.6	97.1	99.7	104.3	108.0	120.4
P34541	1,2-Dichloropropane, water, unfiltered, recoverable, micrograms per liter	97	68.9	92.1	96.4	100.2	105.3	108.8	120.4
P78032	Methyl *tert*-butyl ether, water, unfiltered, recoverable, micrograms per liter	97	67.4	93.8	99.0	102.7	107.3	112.1	118.6
P68728	2-Ethoxyethyl acetate, water, unfiltered, recoverable, micrograms per liter	97	72.7	93.7	100.6	110.4	120.3	126.7	135.1
P68729	2-Propen-1-ol, water, unfiltered, recoverable, micrograms per liter	97	68.4	93.8	99.7	107.0	114.3	118.4	125.1
P68730	α-Terpineo, water, unfiltered, recoverable, micrograms per liter	97	51.9	78.0	87.0	98.4	113.2	126.2	145.1
P68732	Butanal, water, unfiltered, recoverable, micrograms per liter	97	69.3	87.3	90.2	95.5	102.9	107.4	120.4
P77548	Chloropicrin, water, unfiltered, recoverable, micrograms per liter	97	67.1	92.9	99.8	105.1	114.7	123.1	133.8

Table 4.8. Statistical summary of laboratory spike recovery results for volatile organic compounds included in laboratory schedule 4437.—Continued

[*n*, number of values for that constituent; min, minimum; 10th, 25th, 75th, and 90th, 10th, 25th, 75th, and 90th percentiles; med, median, max, maximum]

Parameter code	Constituent	Statistic							
		n	Min	10th	25th	Med	75th	90th	Max
P68733	*trans*-Crotonaldehyde, water, unfiltered, recoverable, micrograms per liter	97	73.5	87.7	92.9	96.9	101.7	106.2	115.8
P81583	1,3-Dioxolane, water, unfiltered, recoverable, micrograms per liter	97	75.1	93.3	98.2	103.3	108.9	113.5	122.2
P77034	1-Butanol, water, unfiltered, recoverable, micrograms per liter	97	62.0	91.8	95.3	101.0	105.3	110.7	120.5
P68066	1-Methoxy-4-(2-propenyl)benzene, water, unfiltered, recoverable, micrograms per liter	97	58.4	75.7	81.6	89.7	100.7	111.9	130.0
P77310	1-Octanol, water, unfiltered, recoverable, micrograms per liter	97	56.5	79.9	84.5	89.9	94.9	100.4	115.7
P77419	2,6-Dimethyl-4-heptanone, water, unfiltered, recoverable, micrograms per liter	97	53.8	81.5	85.3	90.2	97.2	103.3	116.9
P77311	2-Ethyl-1-hexanol, water, unfiltered, recoverable, micrograms per liter	97	51.6	79.1	84.0	89.7	96.0	102.3	112.8
P77201	2-Methylpropyl acetate, water, unfiltered, recoverable, micrograms per liter	97	60.2	79.9	84.3	88.3	93.6	97.2	109.1
P77113	4-Methyl-2-pentanol, water, unfiltered, recoverable, micrograms per liter	97	60.1	89.1	93.3	97.3	102.0	104.7	109.5
P77179	5-Methyl-2-hexanone, water, unfiltered, recoverable, micrograms per liter	97	60.7	89.1	93.1	98.8	104.5	108.0	115.0
P77097	Cyclohexanone, water, unfiltered, recoverable, micrograms per liter	97	64.8	88.8	92.9	98.5	104.8	111.7	168.3
P45013	Isopropyl acetate, water, unfiltered, recoverable, micrograms per liter	97	67.6	94.2	99.9	103.3	108.1	113.5	125.4
P77015	Isopropyl alcohol, water, unfiltered, recoverable, micrograms per liter	97	64.9	89.0	93.5	97.6	103.1	110.9	332.4
P77061	*n*-Pentanal, water, unfiltered, recoverable, micrograms per liter	97	63.9	85.3	88.9	93.1	97.3	102.2	115.5
P45022	Propyl acetate, water, unfiltered, recoverable, micrograms per liter	97	69.3	85.6	89.0	93.9	100.1	105.8	118.2

Table 4.9. Statistical summary of field spike recovery results for arsenic species analyzed under laboratory code 3142.

[*n*, number of values for that constituent; min, minimum; 10th, 25th, 75th, and 90th, 10th, 25th, 75th, and 90th percentiles; med, median, max, maximum]

Parameter code	Constituent	Statistic							
		n	Min	10th	25th	Med	75th	90th	Max
P62453	Arsenate ($H_2AsO_4^-$), water, filtered, micrograms per liter as arsenic	7	77.3	82.8	86.6	88.0	97.8	113.2	124.7
P62452	Arsenite (H_3AsO_3), water, filtered, micrograms per liter as arsenic	9	60.6	79.1	84.9	90.6	97.4	111.0	111.2
P62455	Dimethylarsinate ($[CH_3]2HAsO_2$), water, filtered, recoverable, micrograms per liter as arsenic	9	63.6	68.4	87.3	89.9	93.8	99.3	100.0
P62454	Monomethylarsonate ($[CH_3]HAsO_3^-$), water, filtered, recoverable, micrograms per liter as arsenic	9	70.6	79.3	83.1	85.3	96.9	100.2	103.3

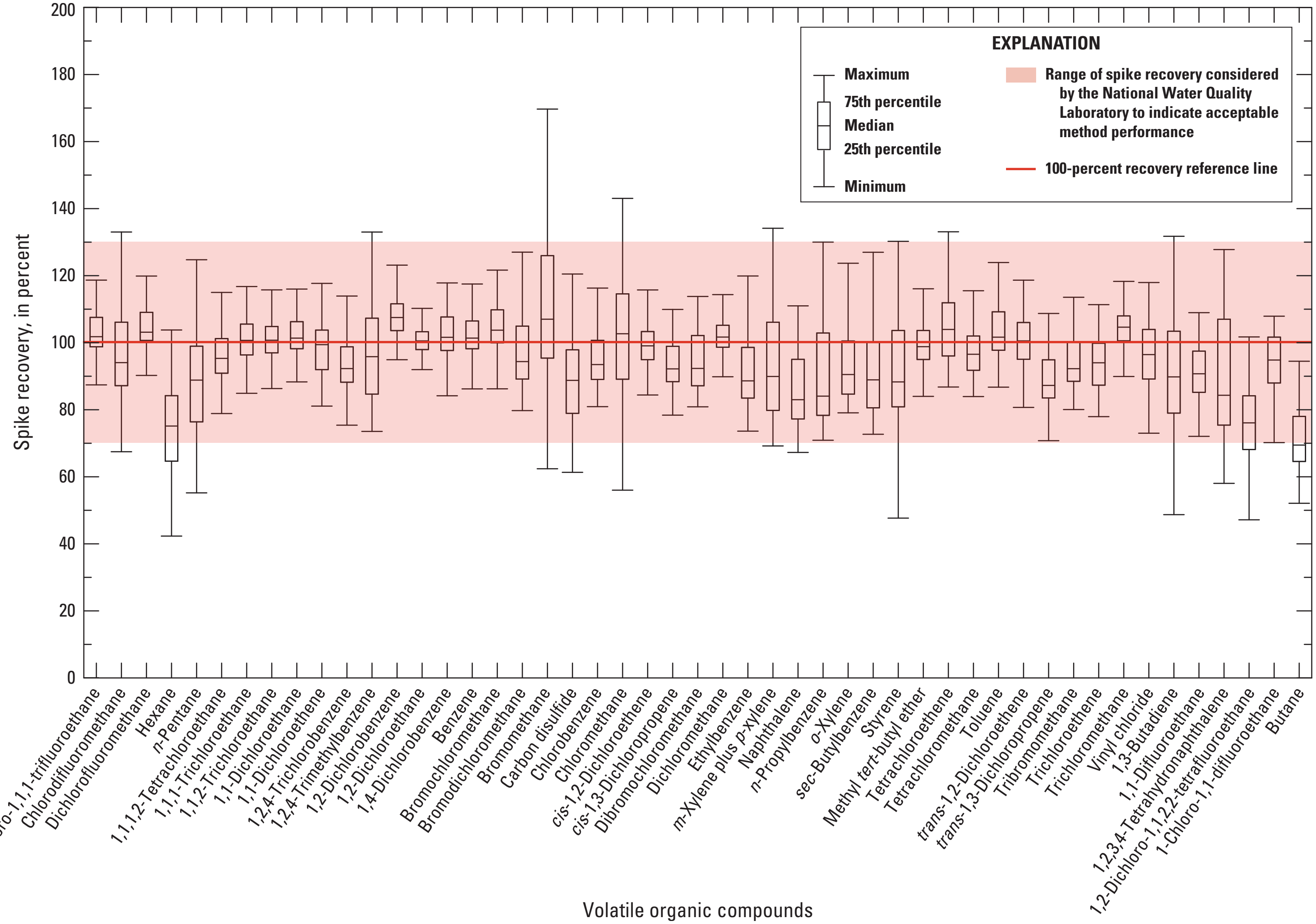

Figure 4.1. Laboratory spike recovery results for volatile organic compounds included in laboratory schedule 4436.

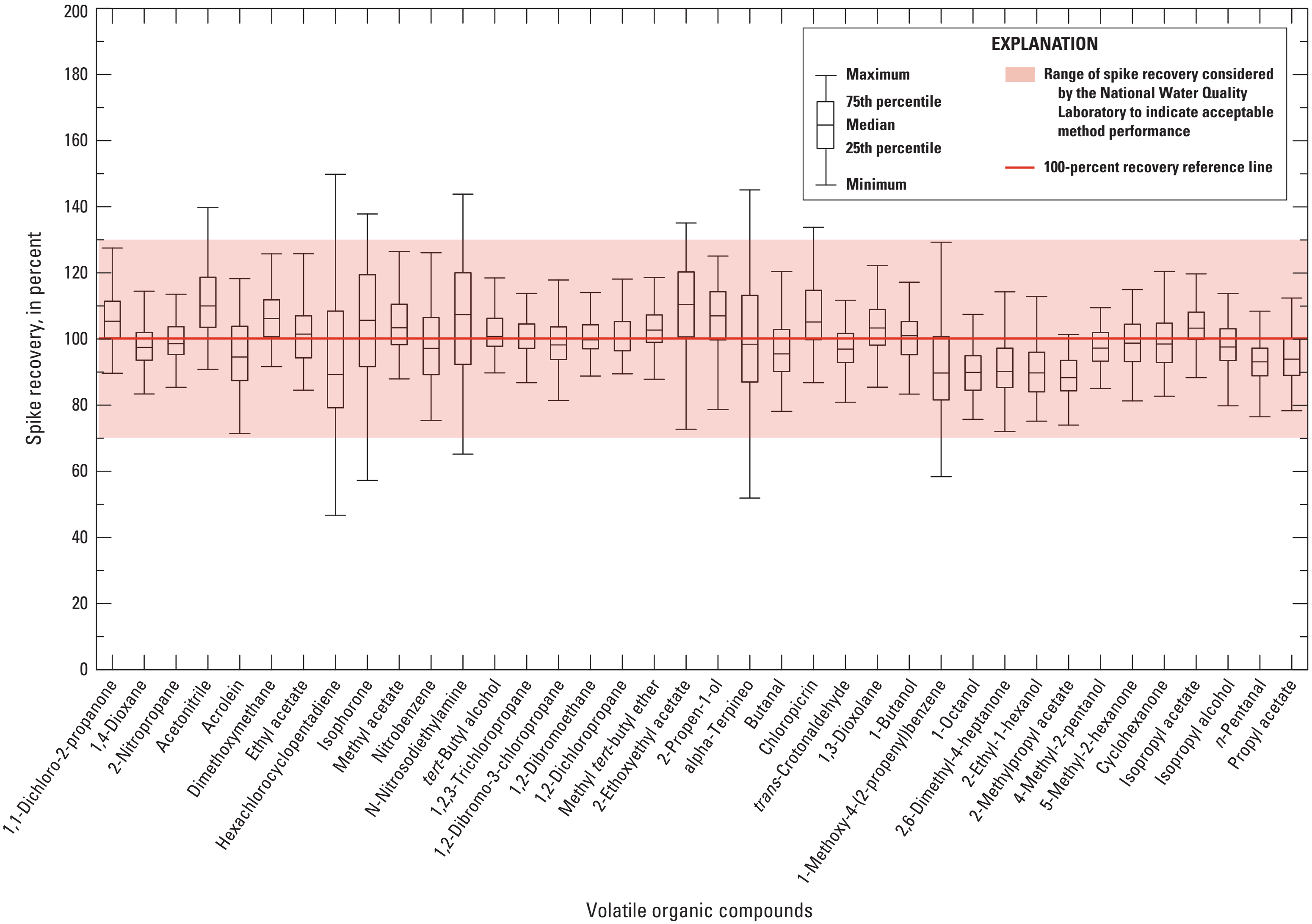

Figure 4.2. Laboratory spike recovery results for volatile organic compounds included in laboratory schedule 4437.

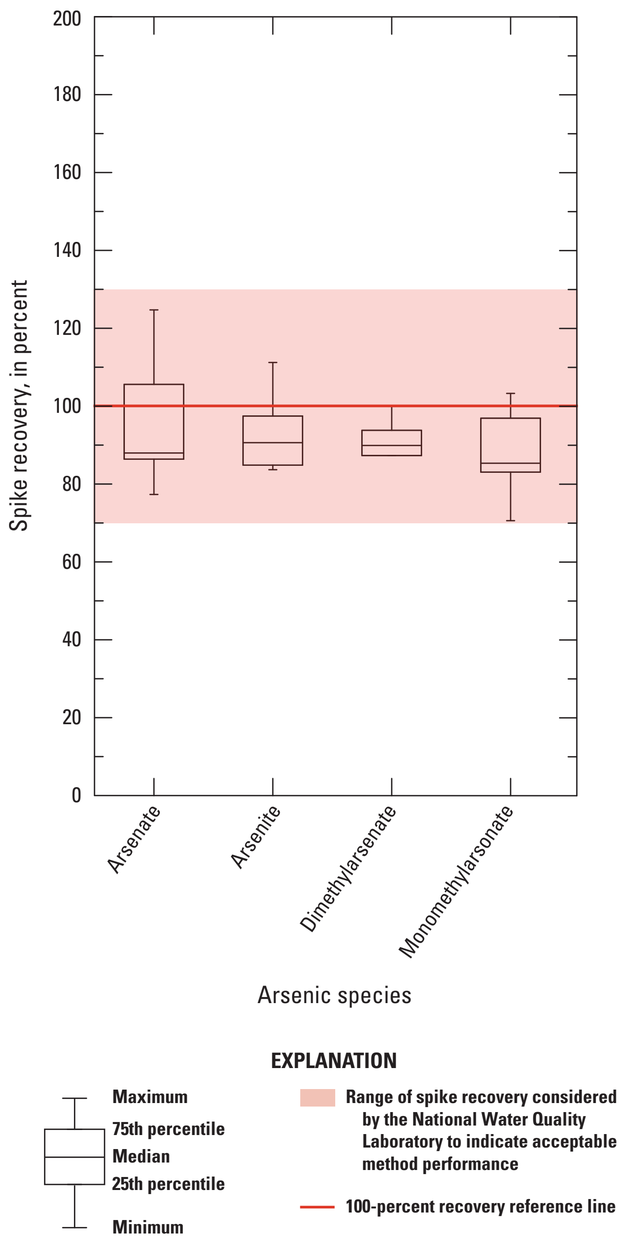

Figure 4.3. Field spike recovery results for arsenic speciation by laboratory code 3142.

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