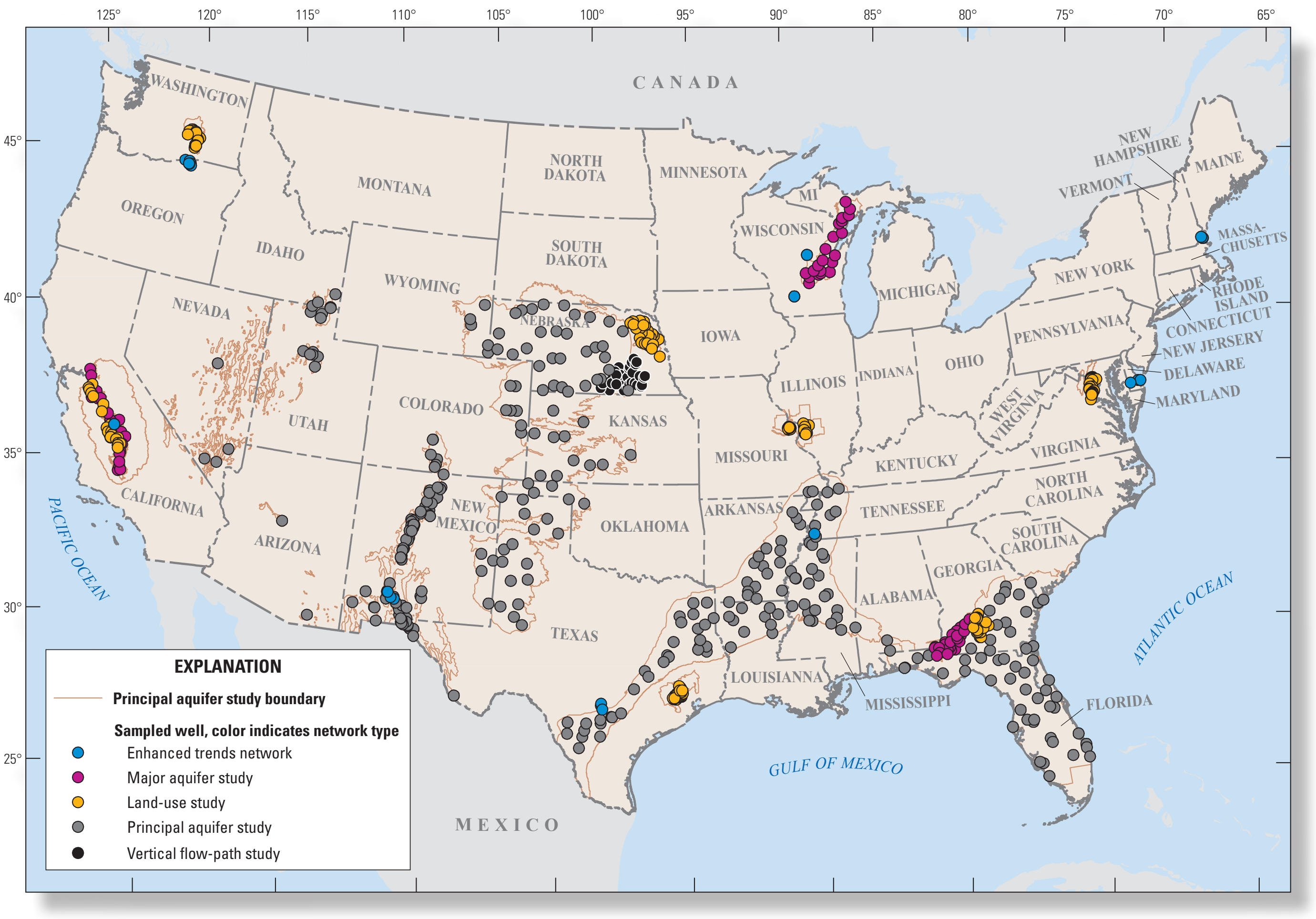
Groundwater-Quality and Select Quality-Control Data from the National Water-Quality Assessment Project, January through December 2015, and Previously Unpublished Data from 2013 to 2014



Data Series 1087

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

Cover graphic. Groundwater study networks and wells sampled as part of the U.S. Geological Survey National Water-Quality Assessment Project from July through August 2013 and January through December 2015 for which water-quality data are included in this report.

Groundwater-Quality and Select Quality-Control Data from the National Water-Quality Assessment Project, January through December 2015, and Previously Unpublished Data from 2013 to 2014

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U.S. Department of the Interior
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U.S. Department of the Interior
RYAN K. ZINKE, Secretary

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James F. Reilly II, Director

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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 third in the series, combines groundwater-quality data collected at 502 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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Figures

Tables

Conversion Factors

U.S. customary units to International System of Units (SI)

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)
	Volume	
teaspoon (tsp)	4928.82	microliter (mcL)
ounce, fluid (fl. oz)	29.5735	milliliter (ml)
	Flow rate	
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
billion gallons per day (Bgal/d)	43.81	cubic meter per second (m^3/s)
	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.

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), micrograms per liter (µg/L), or nanograms per liter (ng/L).

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

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Abbreviations

ASCII	American Standard Code for Information Interchange
EPA	U.S. Environmental Protection Agency
ETN	enhanced trends network
HHB	human-health benchmark
HHBP	human-health benchmark for pesticides
ID	identification
LRL	laboratory reporting level
LT–MDL	long-term method detection level
LUS	land-use study
MAS	major aquifer study
MDL	method detection level
NAWQA	National Water-Quality Assessment
NWQL	National Water Quality Laboratory
PAS	principal aquifer study
QC	quality control
ssLc	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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By Terri L. Arnold, Laura M. Bexfield, MaryLynn Musgrove, Paul E. Stackelberg, Bruce D. Lindsey, James A. Kingsbury, Justin T. Kulongoski, and Kenneth Belitz

Abstract

Groundwater-quality data were collected from 502 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 (500) were sampled from January through December 2015, and 2 of them were sampled in 2013. The data were collected from five 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; and vertical flow-path study networks, which are used to evaluate changes in groundwater quality from shallow to deeper depths. Groundwater samples were analyzed for a large number of 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 and quality-control samples collected in 2014 also are included in the associated data release; these data are associated with networks described in this report and have not been published previously.

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 long 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 historic 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 are collected during the third cycle of the NAWQA Project is 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, 2016a).

Groundwater-quality data collected by the NAWQA Project during each year are published in data series reports. The first two reports and associated data releases in this series published available data from samples collected May 2012 through December 2013 (Arnold and others, 2016a, b) and January through December 2014 (Arnold and others, 2017a, b).

Purpose and Scope

The purpose of this report is to present the analytical results of the groundwater-quality samples collected in 2015 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 (2018), at https://doi.org/10.5066/F7XK8DHK. The data release includes data collected during 2015 and previously unpublished data from a few environmental samples collected in 2013 and a few quality-control (QC) samples collected in 2014. These previously unpublished data are associated with networks described in this report.

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 2015. Maps and tables in this report and in Arnold and others (2018) 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. 2–19), 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 identification number listed in table 1 of this report (provided before the appendixes) and table 1 of Arnold and others (2018) are a combination of the network name and the NAWQA Project ID. Data from five 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), and vertical flowpath study (VFPS).

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). 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.

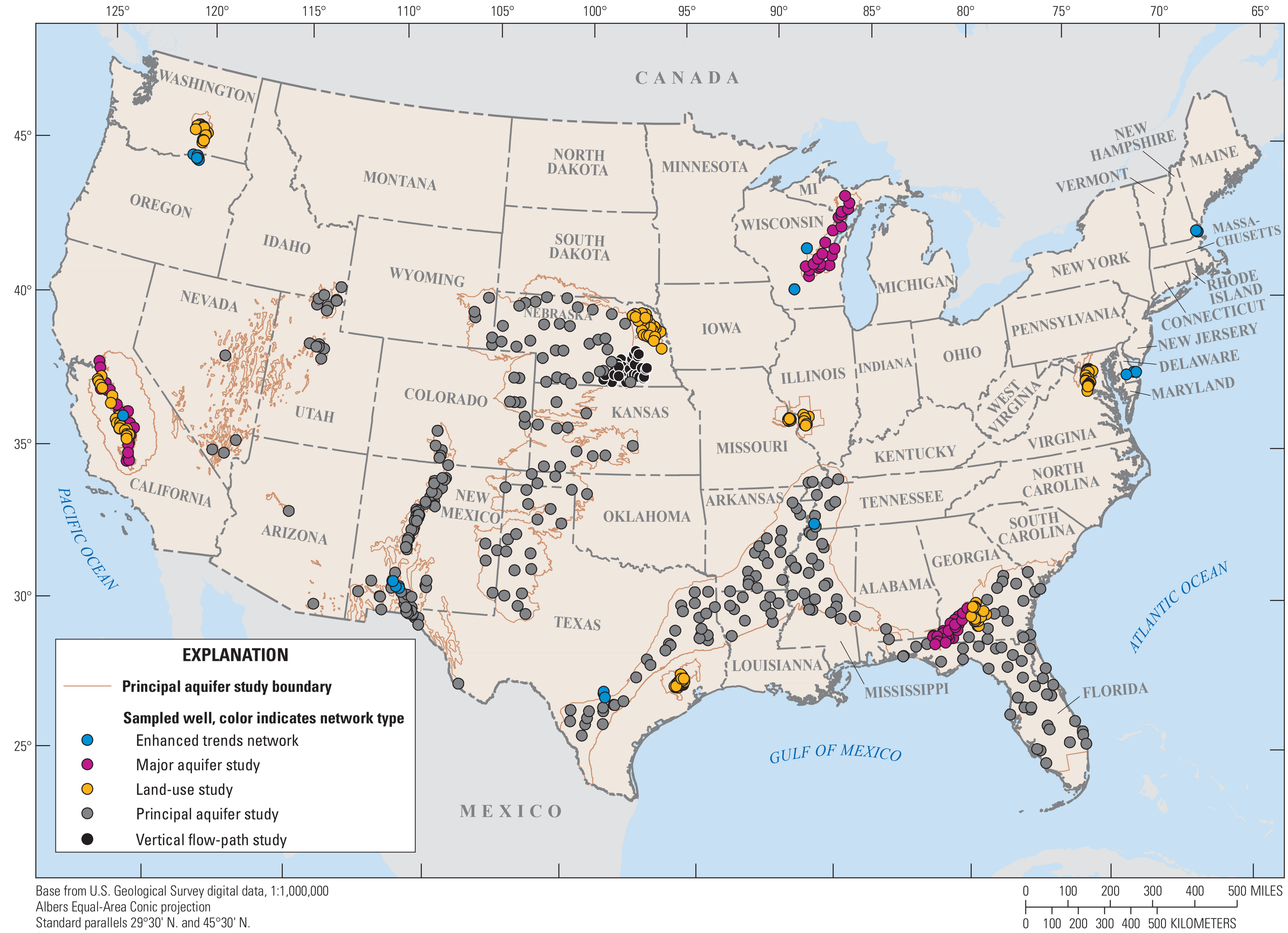
The ETN and VFPS wells were selected from existing networks where possible. The ETN wells are in hydrogeologic settings where changes in hydrologic conditions, land use, or contaminant inputs are expected to be reflected quickly in groundwater (less than 10 years). The VFPS wells were “nested” wells 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.

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: Basin and Range carbonate-rock aquifers PAS network (bnrcpas1; fig. 2), Floridan aquifer system PAS network (florpas1; fig. 3), High Plains aquifer system PAS network (hpaqpas1; fig. 4), Mississippi Embayment-Texas Coastal Uplands aquifer system PAS network (metxpas1; fig. 5), and Rio Grande aquifer system PAS network (rgaqpas1; fig. 6).

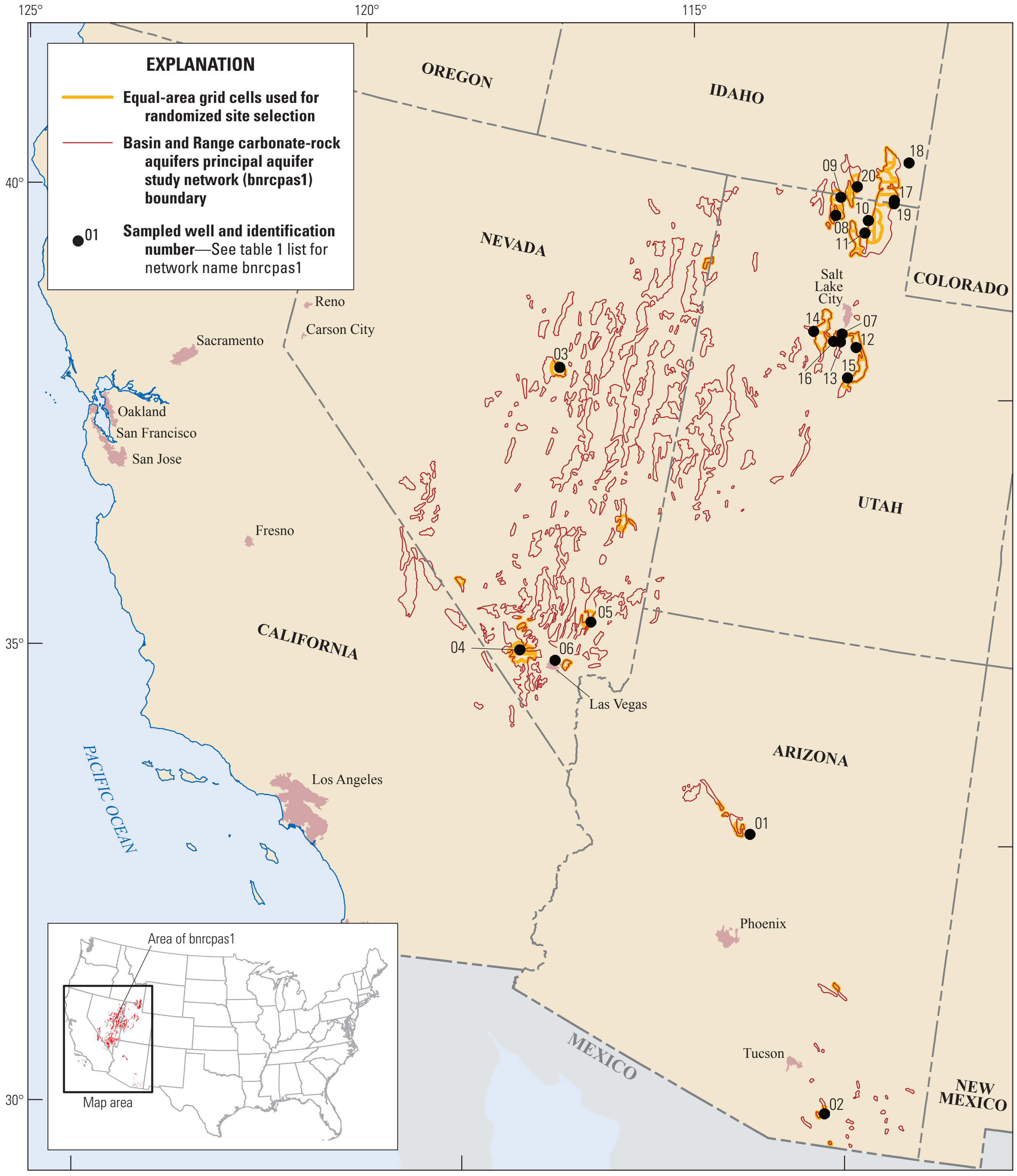
Basin and Range Carbonate-Rock Aquifers Principal Aquifer Study Network (bnrcpas1)

The Basin and Range carbonate-rock aquifers underlie an area of about 16,000 square miles (mi^2), which has a population of about 130,000 people primarily in western Utah and eastern Nevada, and small areas of Idaho, California, and Arizona (U.S. Bureau of the Census, 2010). The aquifers rank



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 from July through August 2013 and January through December 2015 for which water-quality data are included in this report.



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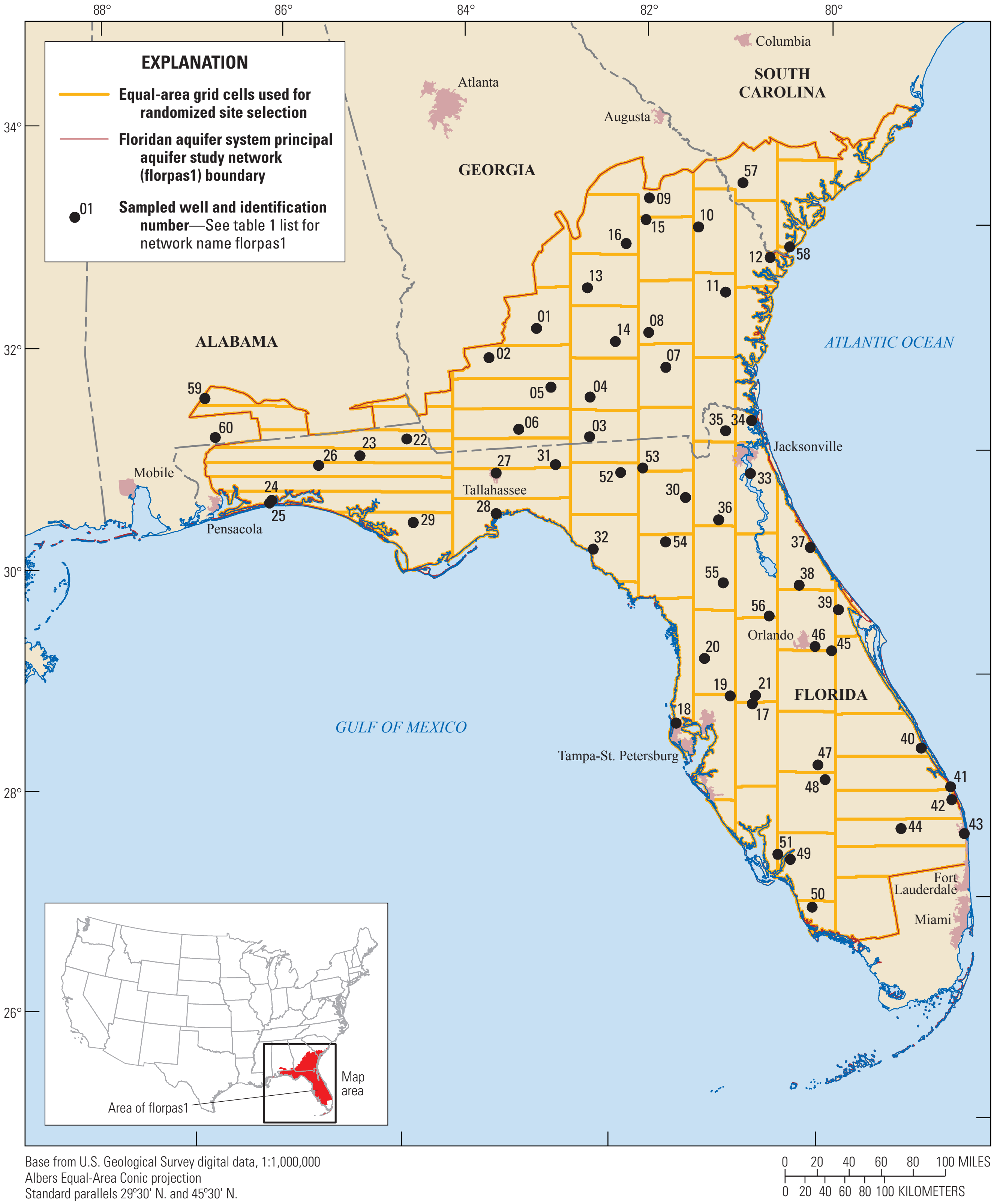
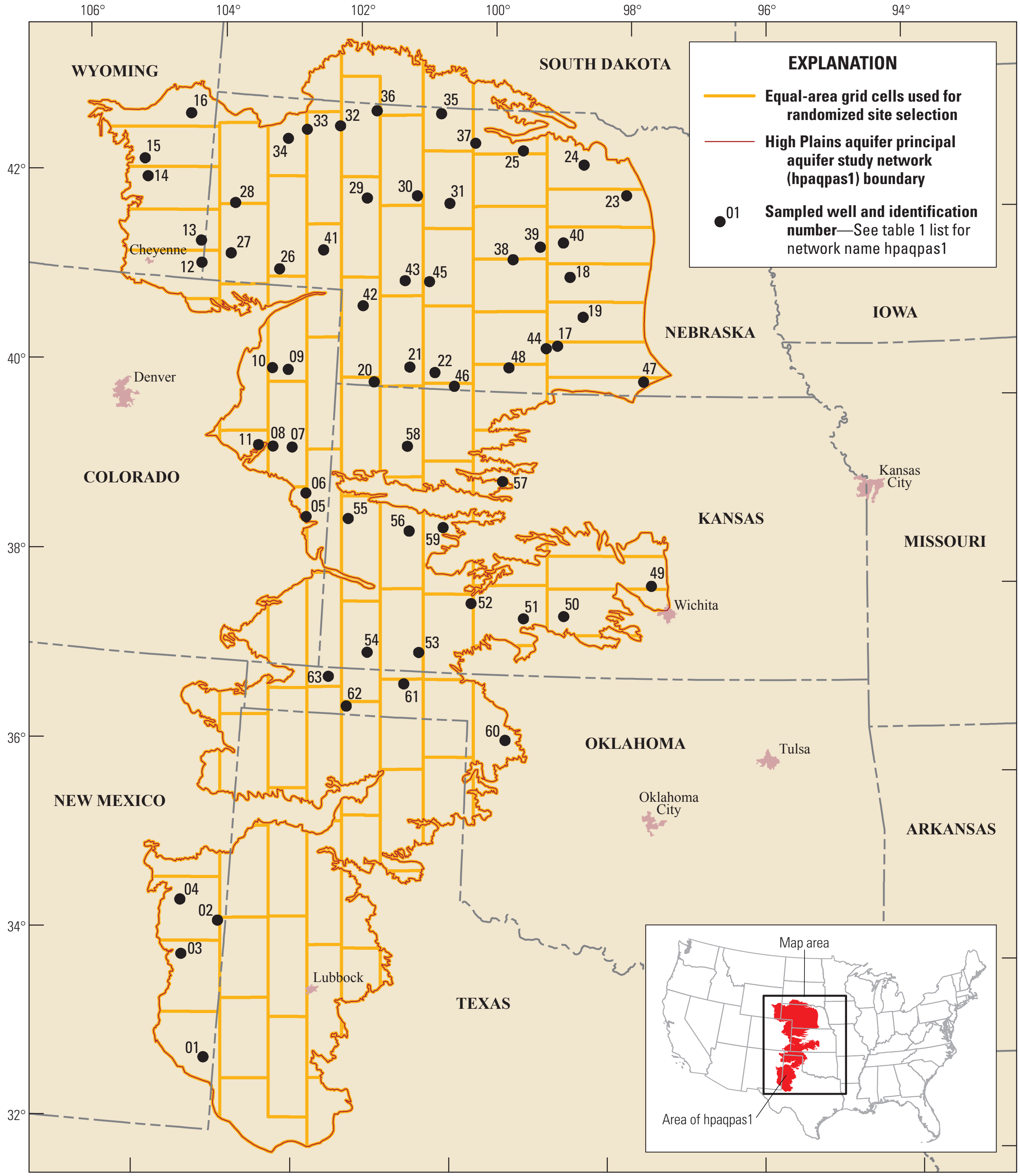
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' N.
Central meridian 96°00' W.
North American Datum of 1983

Figure 2. Study area and wells sampled as part of the Basin and Range Carbonate-Rock aquifers principal aquifer study network (bnrcpas1) for the U.S. Geological Survey National Water-Quality Assessment Project, July through August 2013 and March through September 2015.



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 3. Study area and wells sampled as part of the Floridan aquifer system principal aquifer study network (florpas1) for the U.S. Geological Survey National Water-Quality Assessment Project, March through August 2015.



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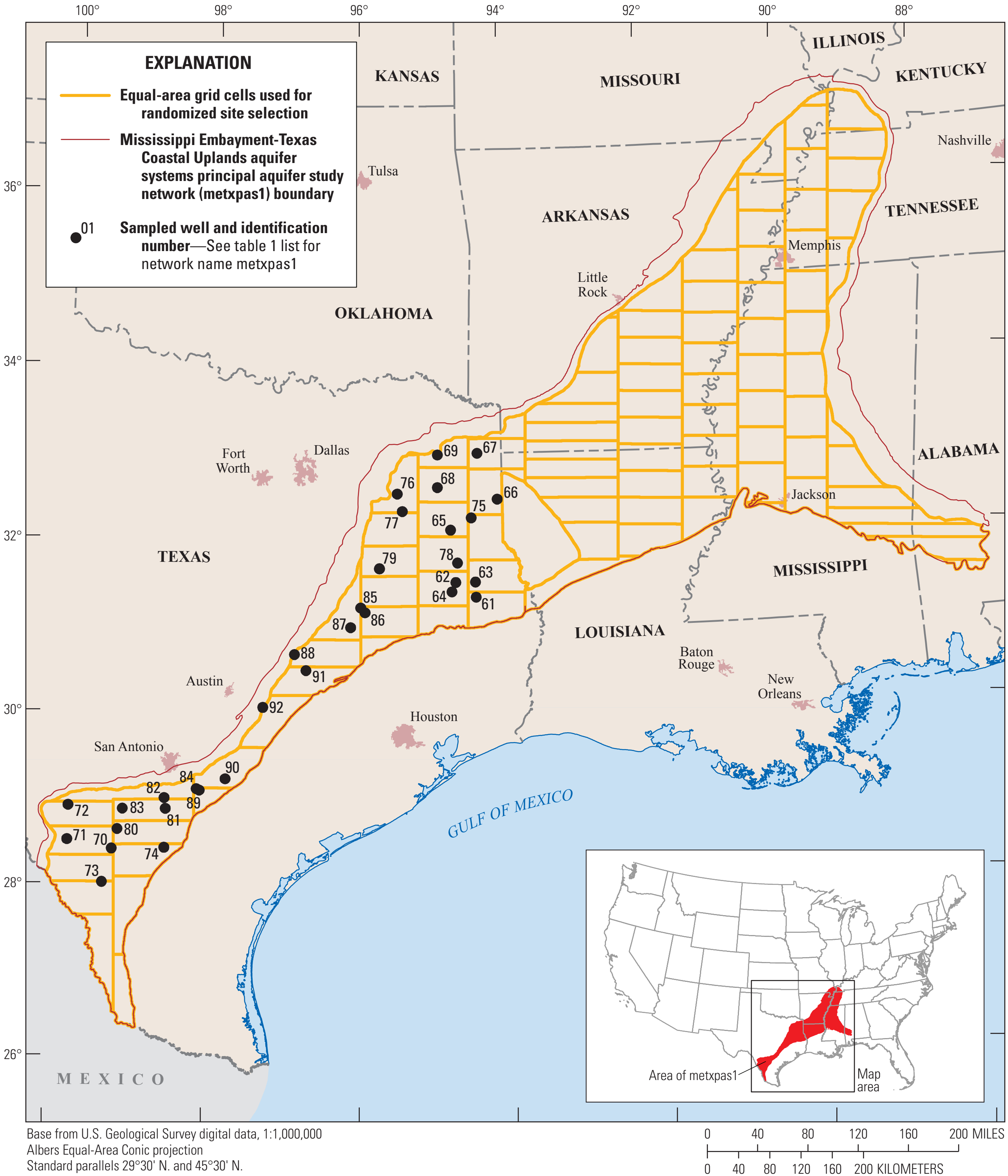
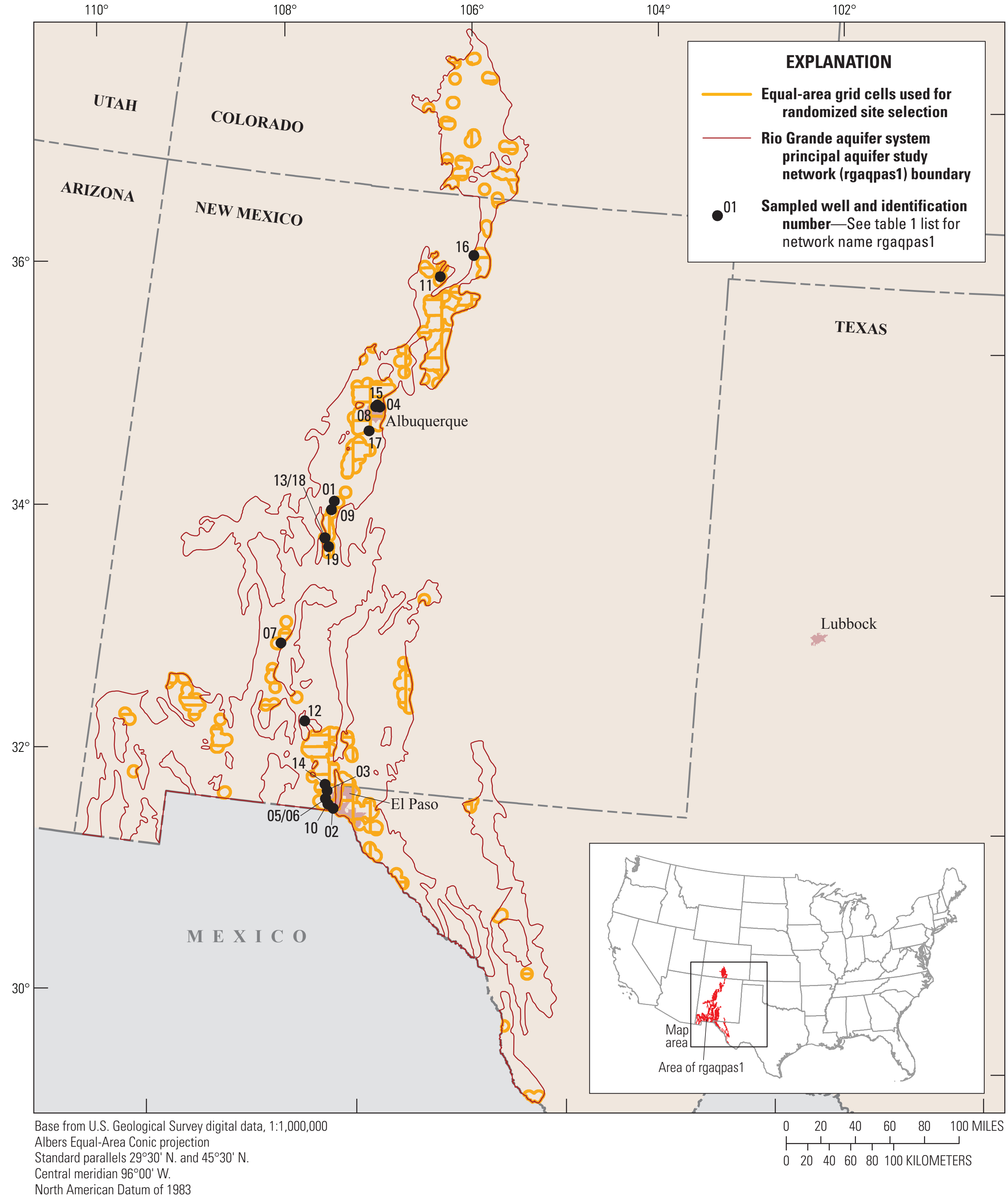
Albers Equal-Area Conic projection
Standard parallels 29°30′ N. and 45°30′ N.
Central meridian 96°00′ W.
North American Datum of 1983

Figure 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, March through September 2015.



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 5. Study area and wells sampled as part of the Mississippi Embayment-Texas Coastal Uplands aquifer system principal aquifer study network (metxpas1) for the U.S. Geological Survey National Water-Quality Assessment Project, July through September 2015.



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 6. Study area and wells sampled as part of the Rio Grande aquifer system principal aquifer study network (rgaqpas1) for the U.S. Geological Survey National Water-Quality Assessment Project, May through September 2015.

35th in the Nation as a source of groundwater for public supply; about 70 million gallons per day (Mgal/d) were pumped for this use in 2000 (Maupin and Barber, 2005; Arnold and others, 2016a). Land use overlying the Basin and Range carbonate-rock aquifers is predominantly undeveloped natural land cover (99 percent) with relatively small areas of agricultural or urban land, both of which are less than 1 percent of the area (Homer and others, 2015). Population density within the area is generally low. The rapidly growing urban areas of Salt Lake City, Utah, and Las Vegas, Nevada, are near, but not within, the boundary of the aquifers.

The Basin and Range carbonate-rock aquifers were described in detail by Harrill and Prudic (1998) and Schaefer and others (2005), and the descriptions are summarized here. The Basin and Range physiographic province is characterized by northeast-trending mountains and adjoining sediment-filled basins and a complex geologic history. Bedrock, some of which is consolidated carbonate rocks, is present in the uplifted blocks of the mountains and beneath the basin fill in the valleys. The carbonate rocks have scattered zones of enhanced permeability developed along faults, fractures, and bedding planes. The carbonate-rock aquifers are composed of thick sequences of Paleozoic and Mesozoic limestone and dolomite with smaller amounts of shale, sandstone, and quartzite. The aquifers extend across topographic basins and mountain blocks in multibasin groundwater flow systems. Numerous flow systems within the carbonate-rock aquifers have been identified, each with their own recharge and discharge areas, structural controls, and potentially variable water quality. The carbonate-rock units generally are overlain by the basin-fill aquifer materials and may be hydraulically connected to them in some flow systems. The climate is generally arid to semiarid but highly variable because of large ranges in latitude and altitude across mountain ranges. Winter months have the most precipitation, and recharge is primarily from spring and summer melting of winter mountain snowpack (although most precipitation is lost to evapotranspiration because of the generally arid climate and high summer temperatures). Interbasin flow may be an important component of recharge or discharge in the solution-altered carbonate-rock aquifers. Because the carbonate rocks are quite thick in some areas—as much as 25,000 feet (ft)—groundwater flow may be deep. These regional flow systems discharge to large springs and streams, and through underflow, interbasin flow, and well withdrawal.

The Basin and Range carbonate-rock aquifers PAS network (bnrcpas1; fig. 2) includes 20 public-supply sites, 14 of which are public-supply wells and 6 of which are springs. Sites were selected, using an equal-area grid of 20 cells. The area is sparsely populated, and public-supply wells and springs are not evenly distributed across the bnrcpas1 area. As a result, the equal-area grid was defined by placing 6.2-mile (mi) buffers around existing public-supply wells. The area of each cell was about 123 mi^2. Two public-supply wells were sampled in Arizona, 1 public-supply well and 3 springs were sampled in Idaho, 3 public-supply wells and 1 spring were sampled in Nevada, and 8 public-supply wells and 1 spring were sampled in Utah. The wells typically ranged from 282 to 1,070 ft deep (appendix 1, table 1.1) and typically were open to the aquifer across intervals from 40 to 521 ft (appendix 1, table 1.2). The wells and springs, with two exceptions, were sampled between March and September 2015; the two public-supply wells in Arizona were sampled in July and August 2013.

Floridan Aquifer System Principal Aquifer Study Network (florpas1)

The Floridan aquifer system underlies an area of 84,000 mi^2, which has a population of about 16 million people in Mississippi, Alabama, Florida, Georgia, and South Carolina (U.S. Bureau of the Census, 2010). Withdrawals from this aquifer system are among the third largest in the United States for both public and domestic supply; withdrawals in 2000 totaled 1,330 Mgal/d for public supply and 212 Mgal/d for domestic supply (Maupin and Arnold, 2010; Arnold and others, 2016a). Withdrawals are largest in Georgia and Florida, where it provides most of the public and irrigation water supply. Land use in the area overlying the Floridan aquifer system is primarily natural (72 percent) and agricultural land cover (17 percent) with a small percentage (11 percent) of urban and other developed land (Homer and others, 2015). Metropolitan areas surrounding Jacksonville, Florida, and Tampa, Fla., are included in the aquifer system area.

The Floridan aquifer system consists of Tertiary-aged carbonate rock sequences (Miller, 1986). Depending on location, the Floridan aquifer system can be under confined, semiconfined, or unconfined conditions. Recharge to the Upper Floridan aquifer primarily is in outcrop areas, and the general direction of groundwater flow is in all directions from the inland outcrop areas towards the coasts (Miller, 1986). Recharge also can be from streams or from downward movement of water from the overlying surficial aquifer and other shallow aquifers (Williams and Kuniansky, 2016). Rates of recharge from the surficial aquifer vary depending on the head potential between the surficial and Floridan aquifers and the presence of materials with relatively low permeability and low values of hydraulic conductivity (Miller, 1986). Relatively low permeability materials that act as confining units bound the Floridan aquifer system (Miller, 1986). Generally, the Floridan aquifer system functions as one aquifer; however, a discontinuous confining unit, in some locations, separates the aquifer system into two units, the Upper Floridan and Lower Floridan aquifers (Miller, 1986, Williams and Kuniansky, 2016). Both aquifers were sampled to characterize groundwater used for public supply in the Floridan aquifer system.

The Floridan aquifer system PAS network (florpas1; fig. 3) includes 60 public-supply wells. Wells were selected using an equal-area grid of 60 cells (average size, 1,375 mi^2) that extended across 83,000 mi^2 in parts of 4 States. All 60 wells were sampled between March and August 2015. Wells in the florpas1 were typically about 169 to 788 ft deep (appendix 1, table 1.1) and had a wide range of open interval lengths (appendix 1, table 1.2).

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. Bureau of the Census, 2010). The aquifer system ranks 13th in the Nation as a source of groundwater for public supply; about 390 Mgal/d were pumped for this use in 2000 (Maupin and Barber, 2005; Arnold and others, 2016a). The aquifer also is used extensively for agriculture, ranking first in the Nation as a source of groundwater for irrigation, with water pumped for irrigation an order of magnitude higher than for public supply (17,000 Mgal/d). Land use overlying the High Plains aquifer system is primarily natural (58 percent) and agricultural land (38 percent) with relatively small areas of urban and other developed land (4 percent) (Homer and others, 2015). About 20 percent of the Nation’s irrigated agricultural land overlies the High Plains aquifer system. Urban areas that lie within the aquifer system’s overlying land are Cheyenne, Wyoming, and Amarillo, Lubbock, and Midland, Texas. Most of the population of the area resides in smaller towns and cities and rural areas. Urban development is much less widespread than agriculture in the area overlying the High Plains aquifer system.

The extensive area of the High Plains aquifer system includes a large range of topography and climate and, as a result, commonly is divided into three geographic subregions: Northern, Central, and Southern High Plains. Precipitation generally decreases from east to west, and temperatures increase from north to south (Thornton and others, 1997). The aquifer system was described in detail by McMahon and others (2007) and that description is summarized here. The High Plains aquifer system is generally unconfined and is composed of Tertiary and Quaternary age near-surface deposits that form six hydraulically connected hydrogeologic units. The Ogallala Formation, which has the largest areal extent of these units, consists primarily of unconsolidated clay, silt, sand, and gravel with locally cemented carbonate zones. Older sedimentary bedrock units underlie the aquifer system. Evaporation rates are some of the highest in the Nation because of high summer air temperatures and persistent winds. Because evaporation rates exceed precipitation across much of the study area, little water recharges the aquifer. Recharge to the aquifer is primarily from infiltration of irrigation water, diffuse infiltration from precipitation, focused infiltration of runoff from storms and irrigation water through streambeds and other topographic depressions, and upward movement of water from underlying aquifers (McMahon, 2001). Discharge from the aquifer primarily is to streams and underlying aquifers, and through irrigation-well pumping, through flow across the eastern boundary of the aquifer, and through evapotranspiration. Regional groundwater flow is generally from west to east. Water level has changed substantially in the High Plains aquifer because groundwater withdrawals have greatly exceeded recharge rates across much of the aquifer; water level declines are common across parts of Kansas, Oklahoma, New Mexico, and Texas.

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 63 wells sampled between March and September 2015 in Colorado (7 wells), Kansas (11 wells), Nebraska (32 wells), New Mexico (4 wells), Oklahoma (4 wells), and Wyoming (5 wells). An additional 17 wells were sampled in Texas between May and July 2016. Wells in the hpaqpas1 that were sampled in 2015 typically ranged from 110 to 497 ft deep with a median depth of about 230 ft (appendix 1, table 1.1); wells generally were open to the aquifer across a range of intervals, from 20 to 231 ft, with a median interval of about 45 ft (appendix 1, table 1.2).

Mississippi Embayment-Texas Coastal Uplands Aquifer Systems Principal Aquifer Study Network (metxpas1)

Two regional aquifers, the Middle Claiborne aquifer and the Lower Claiborne-Upper Wilcox aquifer, were sampled to characterize groundwater used for public supply in the Mississippi Embayment-Texas Coastal Uplands aquifer systems PAS network (metxpas1; fig. 5). The Mississippi Embayment-Texas Coastal Uplands aquifer systems previously was described in Arnold and others (2017a, b) and is not repeated in this report.

The metxpas1 includes 89 public-supply wells distributed across the extent of the Middle Claiborne and Lower Claiborne-Upper Wilcox aquifers. Wells were selected using an equal-area grid that extended across 97,500 mi^2 in parts of eight States as described in Arnold and others (2017b). Samples from 60 wells were collected in the Mississippi Embayment aquifer system between April and December 2014—three of these wells were in the Mississippi River Valley alluvial aquifer (METXPAS1-22, -24, and -27; Arnold and others, 2017a, b). Samples from 32 wells were collected in the Texas Coastal Uplands between July and September 2015. Data from the 2015 sampling effort are presented in this report and the related data release (Arnold and others, 2018); data from the 2014 sampling effort were published in a previous report and data release (Arnold and others, 2017a, b). Wells in the metxpas1 sampled in 2015 were typically about 517 to 2,214 ft deep (appendix 1, table 1.1) and had a wide range of open interval lengths (appendix 1, table 1.2).

Rio Grande Aquifer System Principal Aquifer Study Network (rgaqpas1)

The Rio Grande aquifer system underlies an area of 29,000 mi^2, which has a population of about 2 million people in Colorado, New Mexico, and Texas (U.S. Bureau of the Census, 2010). The Rio Grande aquifer system previously was described in Arnold and others (2017a, b) and the description is not repeated in this report.

The Rio Grande aquifer system PAS network (rgaqpas1, fig. 6) includes 79 wells and springs. The network design is based on an equal-area grid of 60 cells. Because parts of the area are sparsely populated and public-supply wells are not evenly distributed across the aquifer area, the grid was defined by placing 3.1 mi buffers around the existing public-supply wells, as described in Arnold and others (2017b). There were 60 public-supply wells sampled in 2014 (Arnold and others, 2017a, b). An additional 19 sites (16 wells and 3 springs) in New Mexico were sampled during 2015 and have data presented in this report and in Arnold and others (2018). These 19 sites were selected to characterize geothermal waters and deep sedimentary brines that might contribute to—and affect the quality of—water withdrawn from public-supply wells in the Rio Grande aquifer system. The 16 wells sampled during 2015 ranged from 133 to 1,653 ft deep with an average depth of about 659 ft (appendix 1, table 1.1).

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 surrounding 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: Central Columbia Plateau agricultural LUS network (ccptlusor1b; fig. 7); Central Nebraska Basins agricultural LUS network (cnbrluscr1; fig. 8); Georgia-Florida Coastal Plain drainages agricultural LUS network (gaflluscr1; fig. 9); lower Illinois River Basin urban LUS network (lirblusrc1; fig. 10); Potomac River Basin and Delmarva Peninsula urban LUS network (podllusrc1; fig. 11); San Joaquin-Tulare River Basins agricultural LUS network (sanjluscr1a; fig. 12); and Trinity River Basin urban LUS network (trinlusrc1; fig. 13).

Central Columbia Plateau Agricultural Land-Use Study Network (ccptlusor1b)

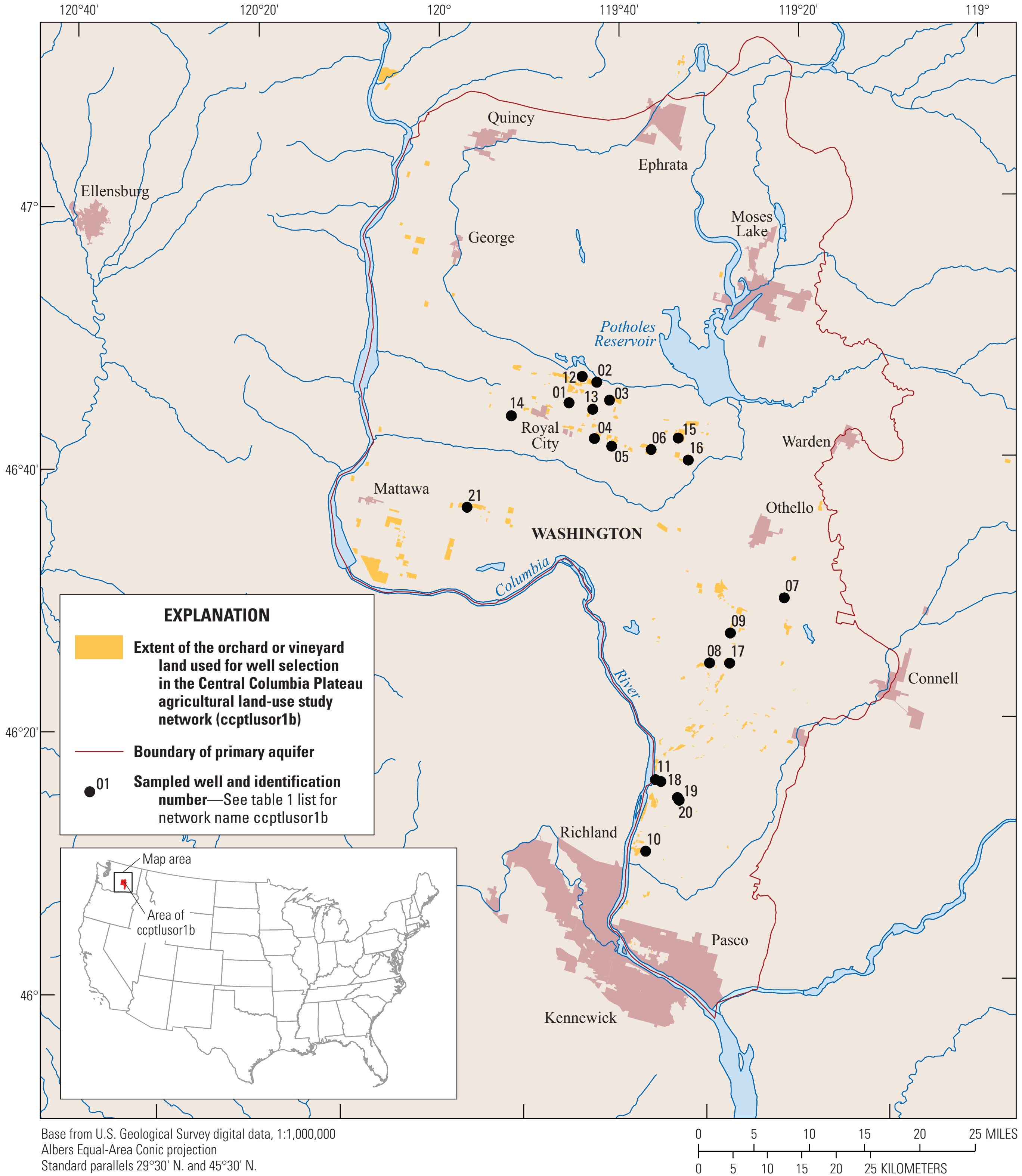
The Central Columbia Plateau agricultural LUS network (ccptlusor1b; fig. 7) was designed to characterize the effects of intensively irrigated orchards on shallow groundwater quality. The study area of 2,500 mi^2 is in south-central Washington and is contained within the Columbia Basin Irrigation Project area, a large-scale irrigation project through which a series of canals divert Columbia River water to a highly productive agricultural basin. The shallow aquifers in this area are unconsolidated basin-fill deposits; together with the underlying basaltic rocks, these aquifers make up the Columbia Plateau aquifer system (Whitehead, 1994).

The ccptlusor1b consists of 25 monitoring wells, which were installed throughout the study area in a sand and gravel aquifer. The targeted area for well installation originally was irrigated by sprinklers and rill-type irrigation. Over time, many areas have installed more efficient types of drip irrigation that often are metered by soil moisture levels. The wells originally were installed in areas dominated by various types of fruit trees (primarily apples) and grapes; however, the area has experienced rapid change in crop and irrigation types. The 21 wells with data presented in this report were sampled from August through October 2015. The sampled wells typically range from less than 19 ft to more than 73 ft deep with an average depth of 39 ft (appendix 1, table 1.1). Wells in the ccptlusor1b were sampled previously in 1994–95 and 2002.

Central Nebraska Basins Agricultural Land-Use Study Network (cnbrluscr1)

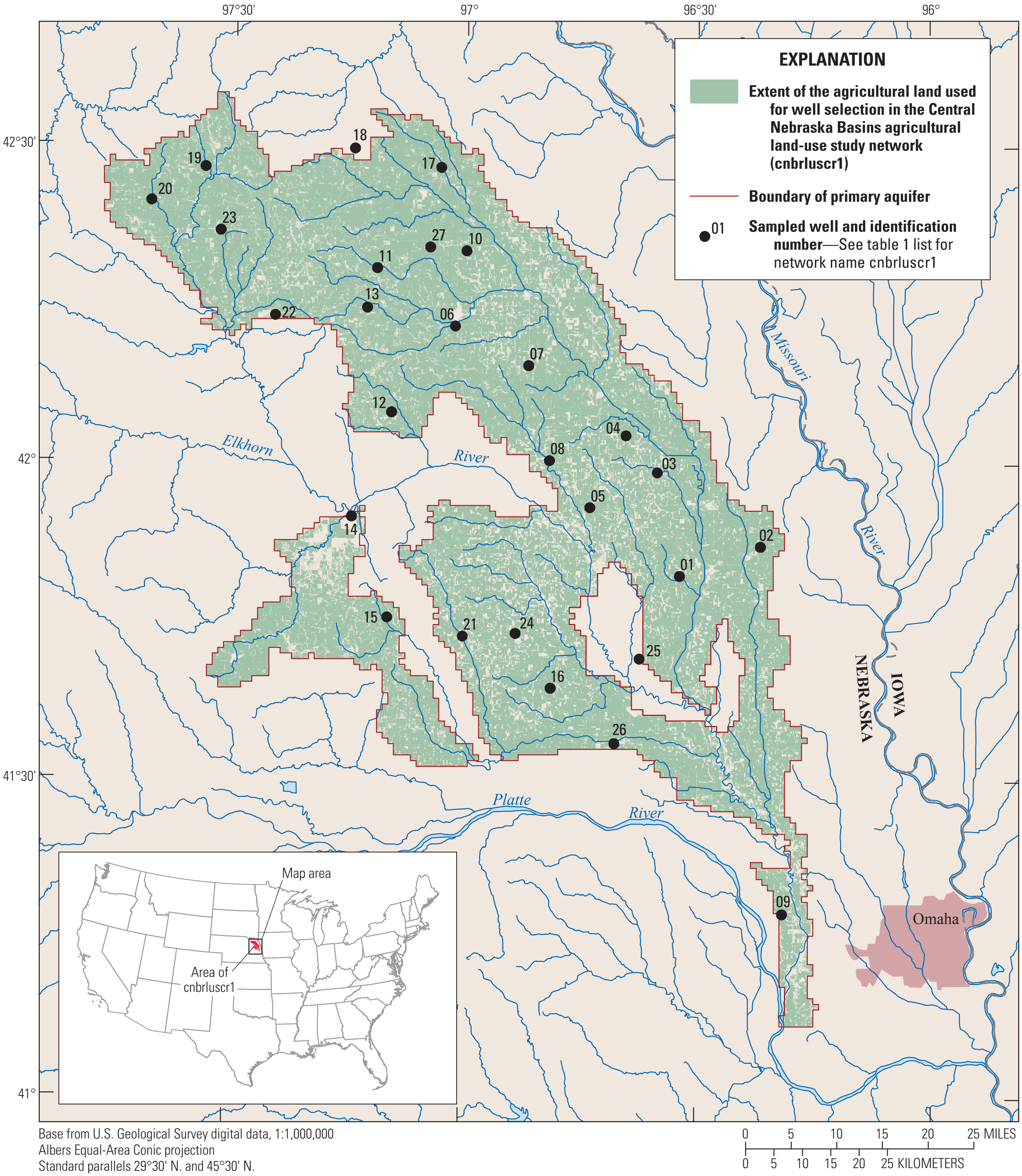
The Central Nebraska Basins agricultural LUS network (cnbrluscr1, fig. 8) wells were screened open to either the first presence of groundwater or just below the water table to provide a broad-scale evaluation of recently recharged groundwater that would most likely be affected by nearby land use. The study area is within the areal extent of the glacial till north of the Platte River in northeast Nebraska. This area of glacial till covers about 2,700 mi^2 in the lower Elkhorn River Basin (Stanton and others, 2007). The hydrogeology of the study area is a very complex mixture of deep to shallow regional and local aquifers in the glaciated area of eastern Nebraska. The regional groundwater-flow direction in the study area is from northwest to the southeast (Flowerday and others, 1998). In most of the study area, the Cretaceous-age bedrock units underlying unconsolidated aquifers generally do not yield a sufficient amount of freshwater for most uses. Land use in the study area is dominated by agriculture and most water used in the study area is for cropland irrigation. Other primary water uses include publicly supplied drinking water, self-supplied domestic drinking water, industrial, and livestock (Stanton and others, 2007).

The cnbrluscr1 includes 27 monitoring wells, which were sampled from April through June 2015. The wells with data presented in this report were typically between 20 to 65 ft deep (appendix 1, table 1.1) with 5- to 10-ft screened intervals (appendix 1, table 1.2). Wells in the cnbrluscr1 were sampled previously in 2003 (Stanton and others, 2007).



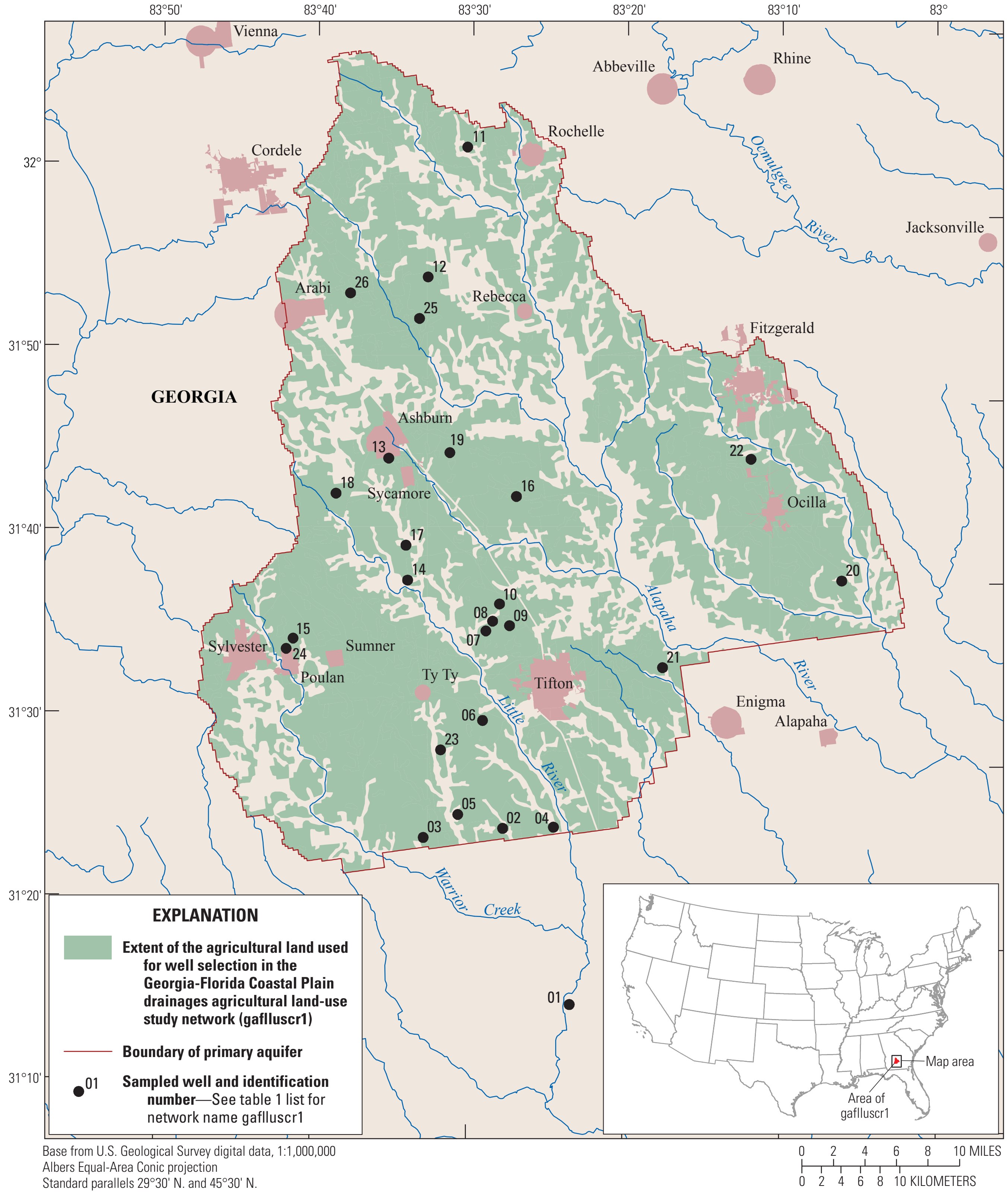
Base from U.S. Geological Survey digital data, 1:1,000,000
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' N.
Central meridian 96°00' W.
North American Datum of 1983

Figure 7. Study area and wells sampled as part of the Central Columbia Plateau agricultural land-use study network (ccptlusor1b) for the U.S. Geological Survey National Water-Quality Assessment Project, August through October 2015.



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 8. Study area and wells sampled as part of the Central Nebraska Basins agricultural land-use study network (cnbrluscr1) for the U.S. Geological Survey National Water-Quality Assessment Project, April through June 2015.



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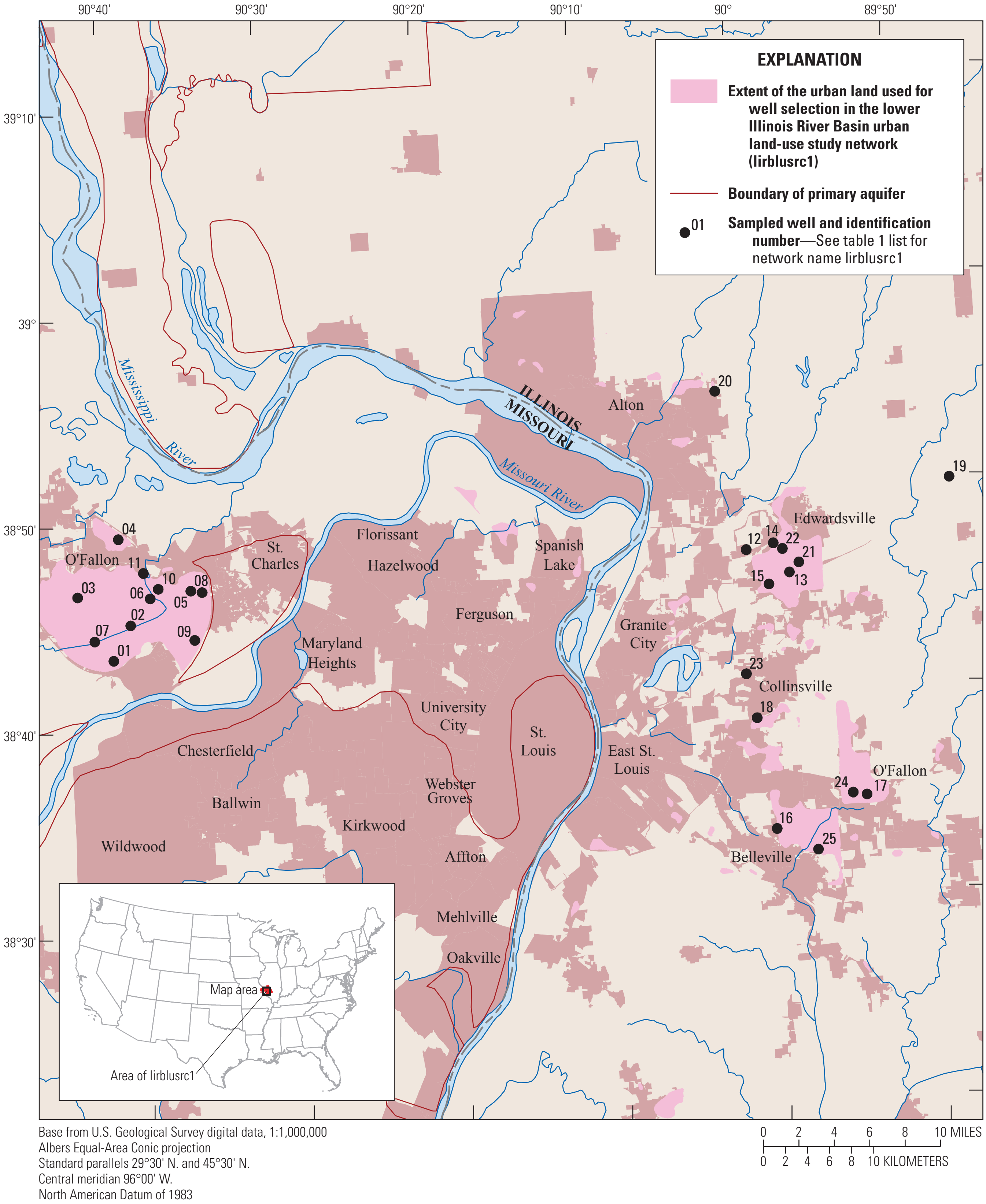
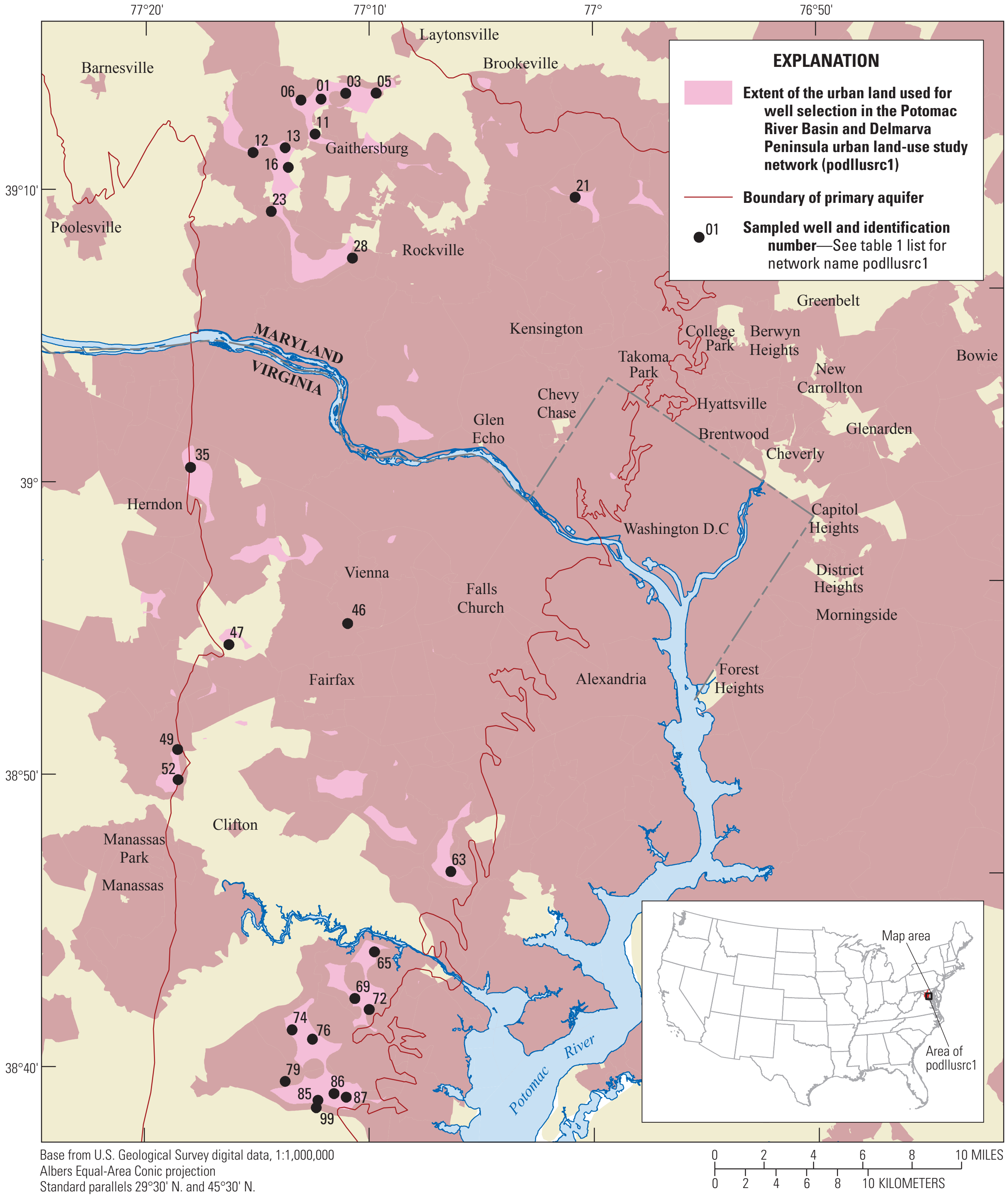
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' N.
Central meridian 96°00' W.
North American Datum of 1983

Figure 9. Study area and wells sampled as part of the Georgia-Florida Coastal Plain drainages agricultural land-use study network (gaflluscr1) for the U.S. Geological Survey National Water-Quality Assessment Project, May 2015.



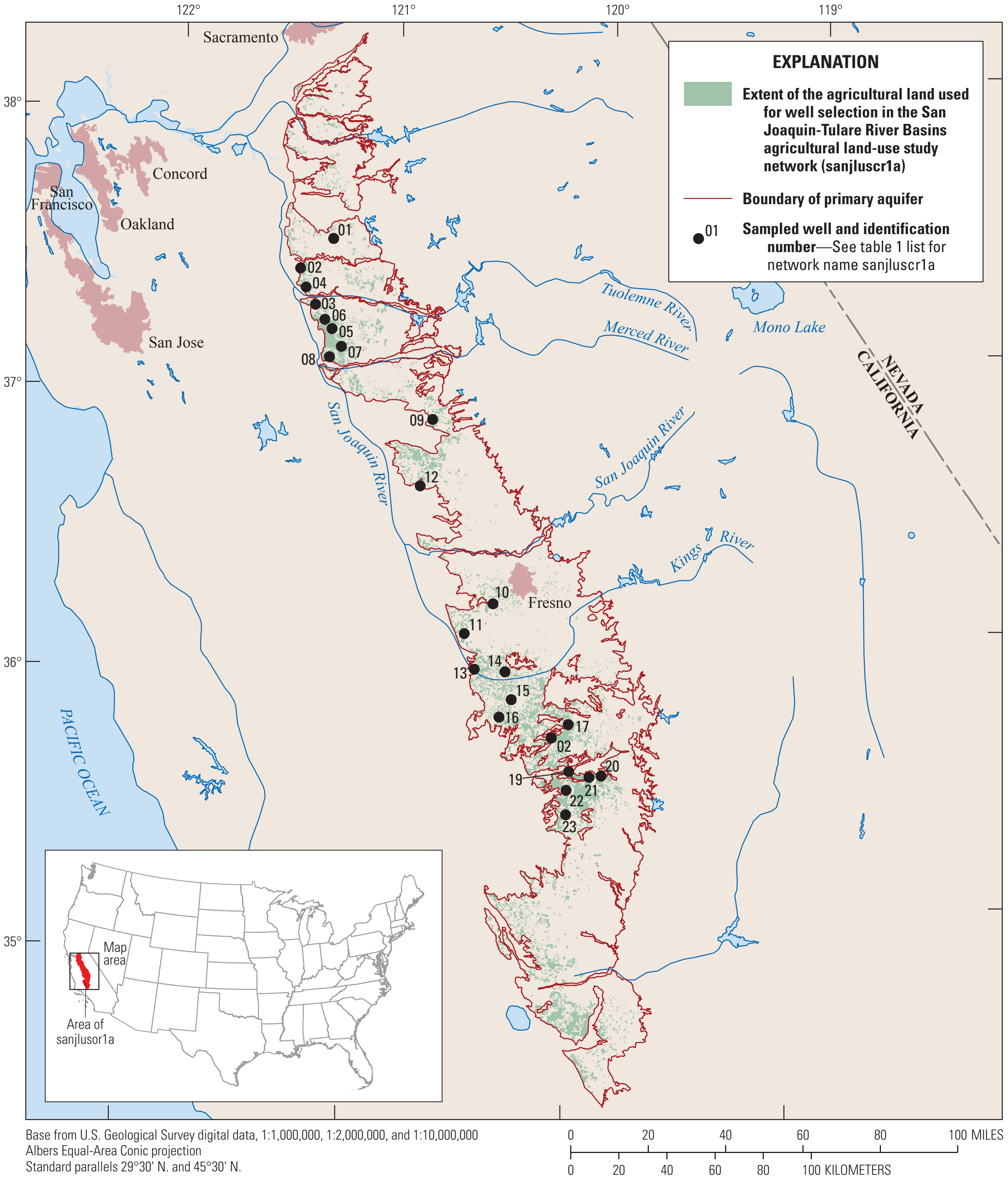
Base from U.S. Geological Survey digital data, 1:1,000,000
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' N.
Central meridian 96°00' W.
North American Datum of 1983

Figure 10. Study area and wells sampled as part of the lower Illinois River Basin urban land-use study network (lirblusrc1) near St. Louis, Missouri, for the U.S. Geological Survey National Water-Quality Assessment Project, July through August 2015.



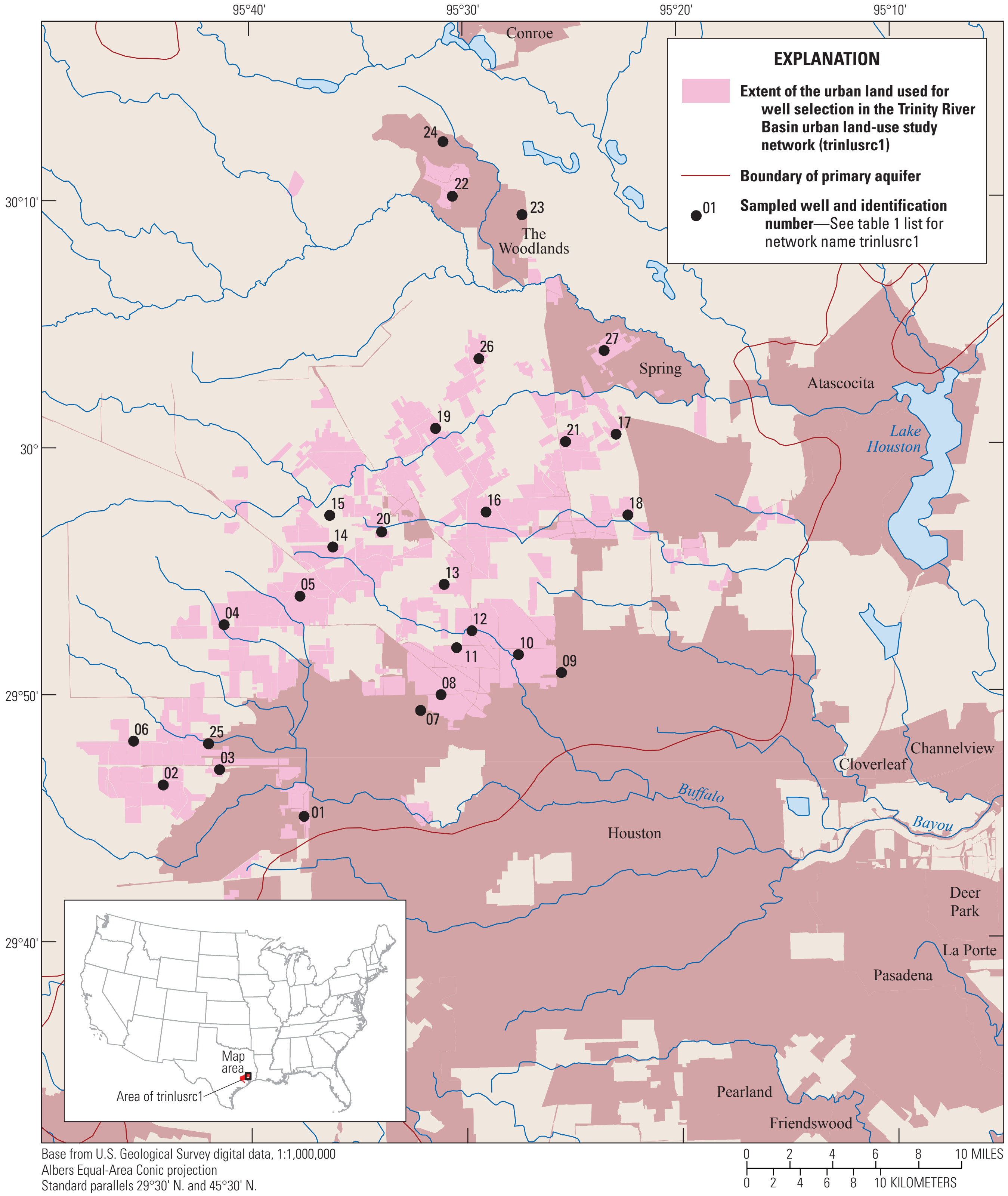
Base from U.S. Geological Survey digital data, 1:1,000,000
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' N.
Central meridian 96°00' W.
North American Datum of 1983

Figure 11. Study area and wells sampled as part of the Potomac River Basin and Delmarva Peninsula urban land-use study network (podllusrc1) near Washington, D.C., for the U.S. Geological Survey National Water-Quality Assessment Project, June through August 2015.



Base from U.S. Geological Survey digital data, 1:1,000,000, 1:2,000,000, and 1:10,000,000
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 12. Study area and wells sampled as part of the San Joaquin-Tulare River Basins agricultural land-use study network (sanjluscr1a) for the U.S. Geological Survey National Water-Quality Assessment Project, July through August 2015.



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 13. Study area and wells sampled as part of the Trinity River Basin urban land-use study network (trinlusrc1) near Houston, Texas, for the U.S. Geological Survey National Water-Quality Assessment Project, January through April 2015.

Georgia-Florida Coastal Plain Drainages Agricultural Land-Use Study Network (gaflluscr1)

The Georgia-Florida Coastal Plain drainages agricultural LUS network (gaflluscr1, fig. 9) was designed to characterize the effects of agriculture on shallow groundwater quality in the surficial aquifer in south-central Georgia. The study area of 1,300 mi^2 is an area of shallow groundwater in the surficial aquifer beneath cropland. The surficial aquifer is an unconfined sand and clay aquifer, about 10 to 60 ft thick (Metz and others, 2007). A clay confining unit separates the surficial aquifer from the Upper Floridan aquifer in parts of the study area. The Floridan aquifer system and its relation to the surficial aquifer are described in the section about the florpas1.

The gaflluscr1 includes 26 monitoring wells sampled in May 2015 (fig. 9). The wells with data included in this report were typically 20 to 65 ft deep (appendix 1, table 1.1). Wells in the network were previously sampled in 1994 and 2002 (Berndt and others, 2014).

Lower Illinois River Basin Urban Land-Use Study Network (lirblusrc1)

The lower Illinois River Basin urban LUS network (lirblusrc1, fig. 10) wells near St. Louis, Missouri, were screened open to shallow glacial and alluvial deposits to provide a broad-scale evaluation of recently recharged groundwater that would most likely be affected by nearby urban land use. The lirblusrc1 area includes recently urbanized areas near St. Louis, Mo. This area covers about 5,700 mi^2 near the Mississippi River.

The lirblusrc1 includes 26 monitoring wells. The wells with data included in this report were typically about 18 to 52 ft deep (appendix 1, table 1.1) with 5-ft screened intervals (appendix 1, table 1.2). Samples were collected from 25 wells, 11 in Missouri and 14 in Illinois, in July and August 2015. Wells in this network were sampled previously in 2005.

Potomac River Basin and Delmarva Peninsula Urban Land-Use Study Network (podllusrc1)

The Potomac River Basin and Delmarva Peninsula urban LUS network (podllusrc1, fig. 11) near Washington, D.C., was designed to characterize the effects of urban land use on shallow groundwater quality in the Piedmont and Blue Ridge crystalline-rock aquifers. The study area is about 1,800 mi^2 and is defined as an area of shallow groundwater in urban and suburban areas within the Potomac River Basin near Washington, D.C., and Baltimore, Maryland. The Piedmont and Blue Ridge crystalline-rock aquifers consist of a variety of rock types such as gneiss, schist, phyllite, granite, and basalt (Chapman and others, 2013). Rocks are overlain by unconsolidated material called regolith, which is more permeable than the underlying bedrock and is important for storage and transmission of water. Most recharge to these aquifers is from local precipitation. Flow in the crystalline-rock aquifers is limited to fractures; thus, individual well yields are low in these aquifers relative to well yields in other bedrock types in the area (Trapp and Horn, 1997).

The podllusrc1 includes 28 monitoring wells (fig. 11). The wells with data included in this report typically were 45 to 112 ft deep (appendix 1, table 1.1) with open intervals mostly between 13 and 85 ft (appendix 1, table 1.2). Samples for the current phase of monitoring were collected in June to August 2015. Wells from the podllusrc1 were sampled previously in 2003.

San Joaquin-Tulare River Basins Agricultural Land-Use Study Network (sanjluscr1a)

The San Joaquin-Tulare River Basins agricultural LUS network (sanjluscr1a, fig. 12) was designed to characterize shallow groundwater quality underlying agricultural land use in the eastern San Joaquin Valley of California. The eastern San Joaquin Valley is an area of intensive farming that also has a large urban population. The sanjluscr1a area is in the eastern alluvial fans physiographic region and has extensive and widespread deposits of coarse-grained sediment (Burow and others, 1998; Thiros and others, 2010). The sanjluscr1a area of about 520 mi^2 is limited to areas where the predominant crops grown are corn, alfalfa, and vegetables; this crop grouping is one of the major types of agriculture in the area.

The sanjluscr1a includes 23 wells sampled between July and August 2015. The wells with data presented in this report typically ranged from 108 to 361 ft deep but generally were less than 200 ft deep (appendix 1, table 1.1). The wells are open to the aquifer across intervals of 20 to 174 ft (appendix 1, table 1.2). Wells in the sanjluscr1a were previously sampled in 1994–95 and in 2002.

Trinity River Basin Urban Land-Use Study Network (trinlusrc1)

The Trinity River Basin urban LUS network (trinlusrc1, fig. 13) near Houston, Tex., was designed to characterize the quality of groundwater in the Chicot aquifer within the Coastal Lowlands aquifer system underlying urban land use within northwest Houston, Tex. The Coastal Lowlands aquifer system is unconsolidated to partially consolidated sand, silt, and clay of Oligocene to Holocene age (Ryder, 1996; Renken, 1998). The trinlusrc1 area (about 4,000 mi^2) is in the southern part of the Trinity River Basin within northwest Houston, Tex.

The trinlusrc1 includes 27 wells sampled January through April 2015. Because the wells were sampled early in 2015, some of the blank samples were collected in November 2014 to check the cleanliness of the sampling equipment. The wells with data included in this report typically were about 28 to 80 ft deep (appendix 1, table 1.1) and had open intervals of around 10 ft (appendix 1, table 1.2). Wells in the trinlusrc1 were previously sampled in 2003.

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 groundwater from shallower depths of the aquifer than do public-supply wells. Additionally, domestic-supply wells tend to draw smaller volumes of water from 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: Apalachicola-Chattahoochee-Flint River Basins MAS network (acfbsus1; fig. 14), San Joaquin-Tulare River Basins MAS network (sanjsus1; fig. 15), and western Lake Michigan drainages MAS network (wmicsus1; fig. 16).

Apalachicola-Chattahoochee-Flint River Basins Major Aquifer Study Network (acfbsus1)

The Apalachicola-Chattahoochee-Flint River Basins MAS network (acfbsus1, fig. 14) was designed to characterize the quality of water used for water supply in the Floridan aquifer. The Floridan aquifer (previously described for florpas1) is a limestone and dolomite aquifer that is used heavily as a source of water supply in several southeastern States (Miller, 1990). The acfbsus1 area of 3,900 mi^2 is defined as those areas where the Upper Floridan aquifer lies within the Apalachicola-Chattahoochee-Flint River Basins (Wangsness, 1997; Frick and others, 1998).

The acfbsus1 includes 27 wells. The wells with data included in this report typically were 78 to 249 ft deep (appendix 1, table 1.1) with open intervals of around 12 to 164 ft (appendix 1, table 1.2). Samples for the current phase of monitoring were collected in August 2015. Wells in the acfbsus1 were sampled previously in 1995 and 2002 (Berndt and others, 2014).

San Joaquin-Tulare River Basins Major Aquifer Study Network (sanjsus1)

The San Joaquin-Tulare River Basins MAS network (sanjsus1, fig. 15) was designed to characterize the quality of shallow groundwater in the eastern San Joaquin Valley within the Central Valley aquifer system in the San Joaquin-Tulare Basins study unit in California. The eastern San Joaquin Valley is an area of intensive farming that also has a large urban population. The study area is in the eastern alluvial fans physiographic region and has extensive and widespread deposits of coarse-grained sediment (Burow and others, 1998; Thiros and others, 2010). The sanjsus1 area is about 520 mi^2.

The sanjsus1 includes 26 wells sampled between July and August 2015. The wells with data presented in this report typically ranged from 106 to 464 ft deep (appendix 1, table 1.1) and had a mean well depth of 232 ft. The wells typically were open to the aquifer across intervals of 16 to 105 ft (appendix 1, table 1.2). Wells in the sanjsus1 were sampled previously in 1995 and in 2002.

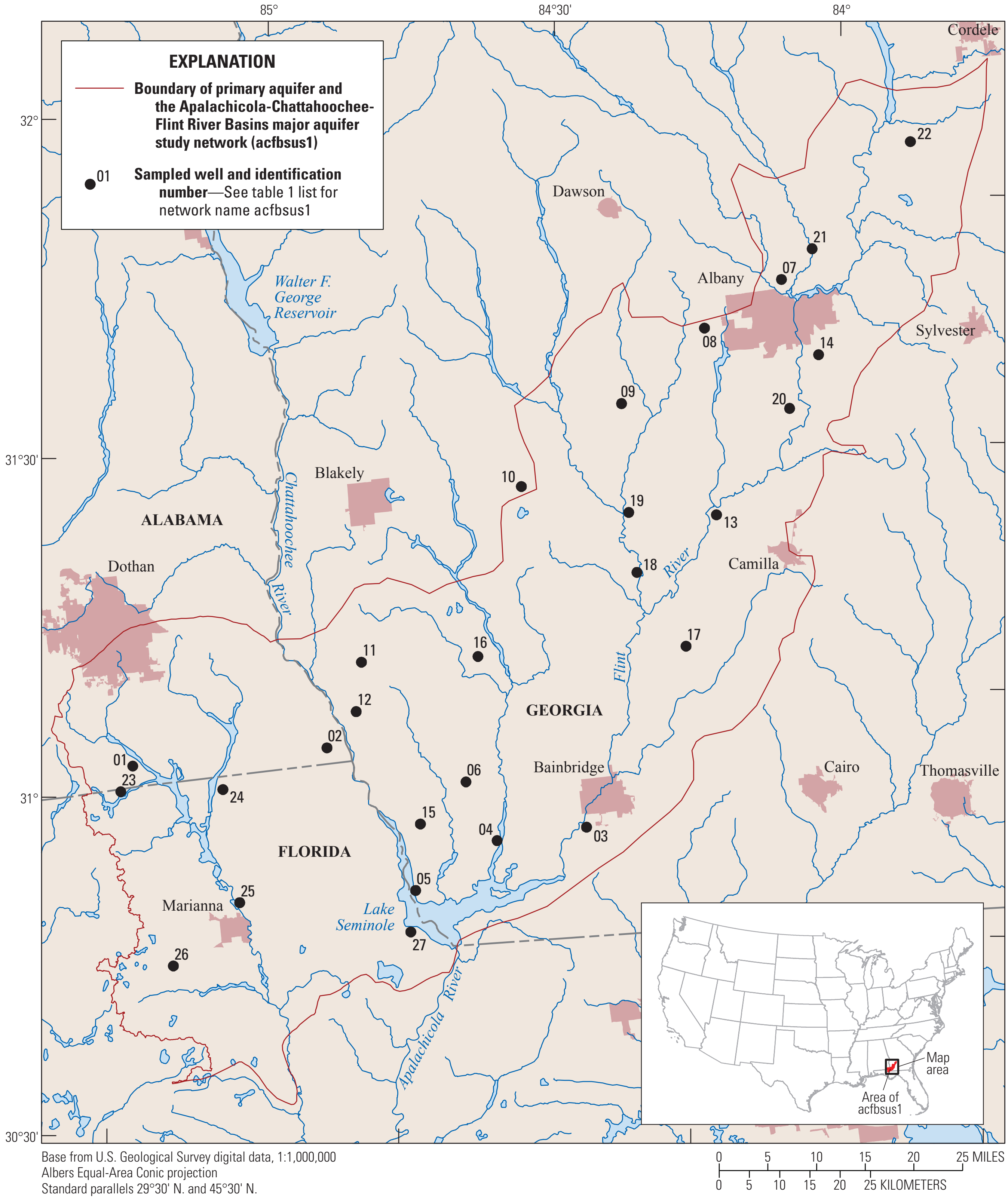
Western Lake Michigan Drainages Major Aquifer Study Network (wmicsus1)

The western Lake Michigan drainages MAS network (wmicsus1, fig. 16) was designed to characterize the quality of groundwater in the parts of the Cambrian-Ordovician aquifer that are most heavily used for water supply in that area. The western Lake Michigan drainages include those parts of eastern Wisconsin and the Upper Peninsula of Michigan that drain to Green Bay and Lake Michigan (Peters and others, 1998). The wmicsus1 covers an area of about 8,100 mi^2. The Cambrian-Ordovician aquifer in the vicinity of the wmicsus1 is principally Cambrian- and Ordovician-age sandstone and dolomite. Land use and land cover overlying wmicsus1 (Saad, 1996) is mainly forest and forested wetland in the north and agricultural land in the south. Urban land use in the wmicsus1 area is mainly along the shores of Lake Winnebago and in the lower Fox River Valley from Appleton to Green Bay, Wisconsin. Most of the larger urban areas in the wmicsus1 area obtain most of their water from surface-water sources, such as Lake Winnebago, but some supplement this source with groundwater primarily from the Cambrian-Ordovician aquifer (Saad, 1996).

The wmicsus1 includes 21 wells, mostly drinking-water supply wells, which were sampled July through September 2015. The wells with data included in this report typically were 95 to 675 ft deep (appendix 1, table 1.1) with about 20- to 307-ft open intervals (appendix 1, table 1.2). Wells in the wmicsus1 were previously sampled in 1995 and in 2002.

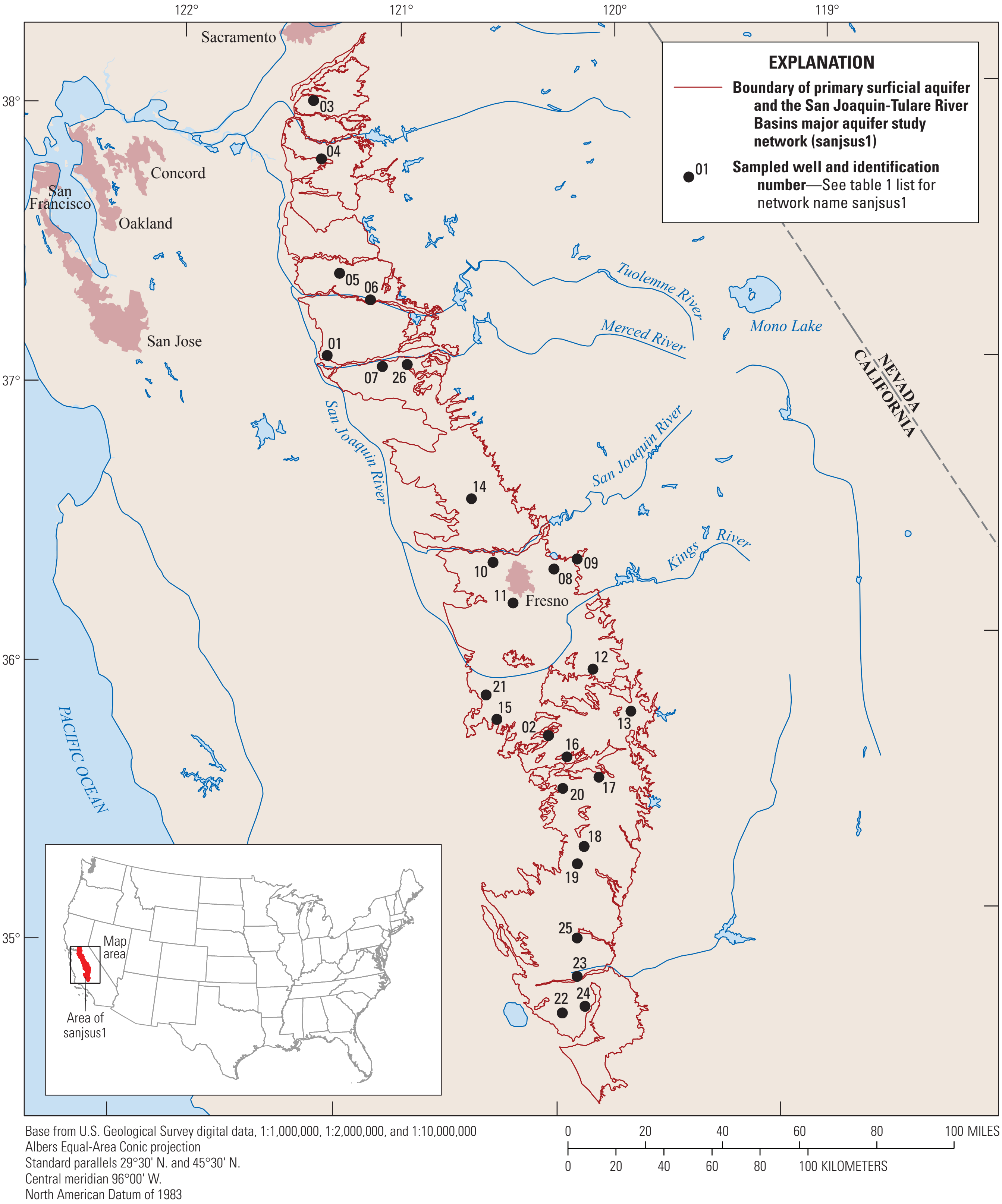
Enhanced Trends Networks

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. 17–18): 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).



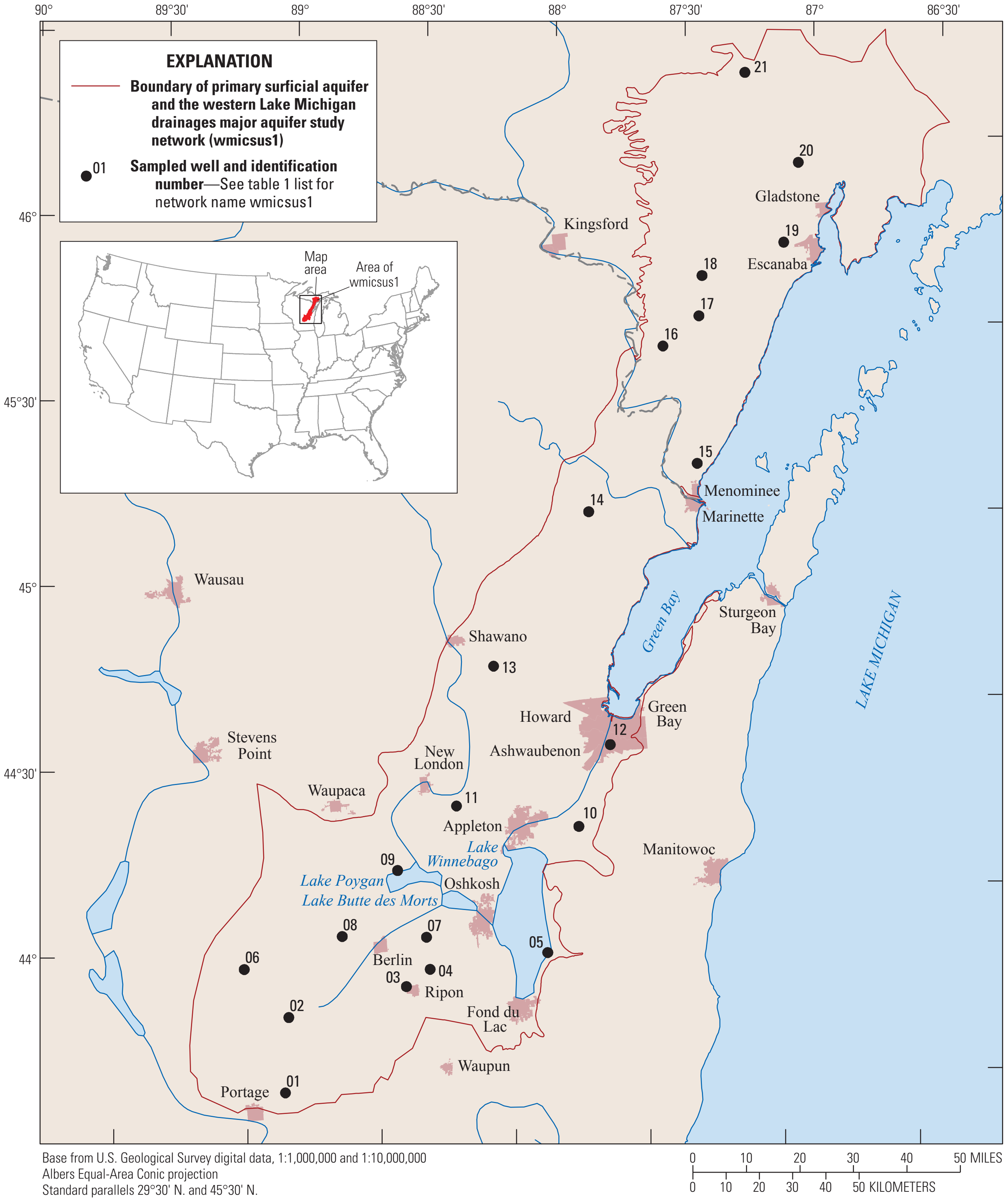
Base from U.S. Geological Survey digital data, 1:1,000,000
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' W.
Central meridian 96°00' W.
North American Datum of 1983

Figure 14. Study area and wells sampled as part of the Apalachicola-Chattahoochee-Flint River Basins major aquifer study network (acfbsus1) for the U.S. Geological Survey National Water-Quality Assessment Project, August 2015.



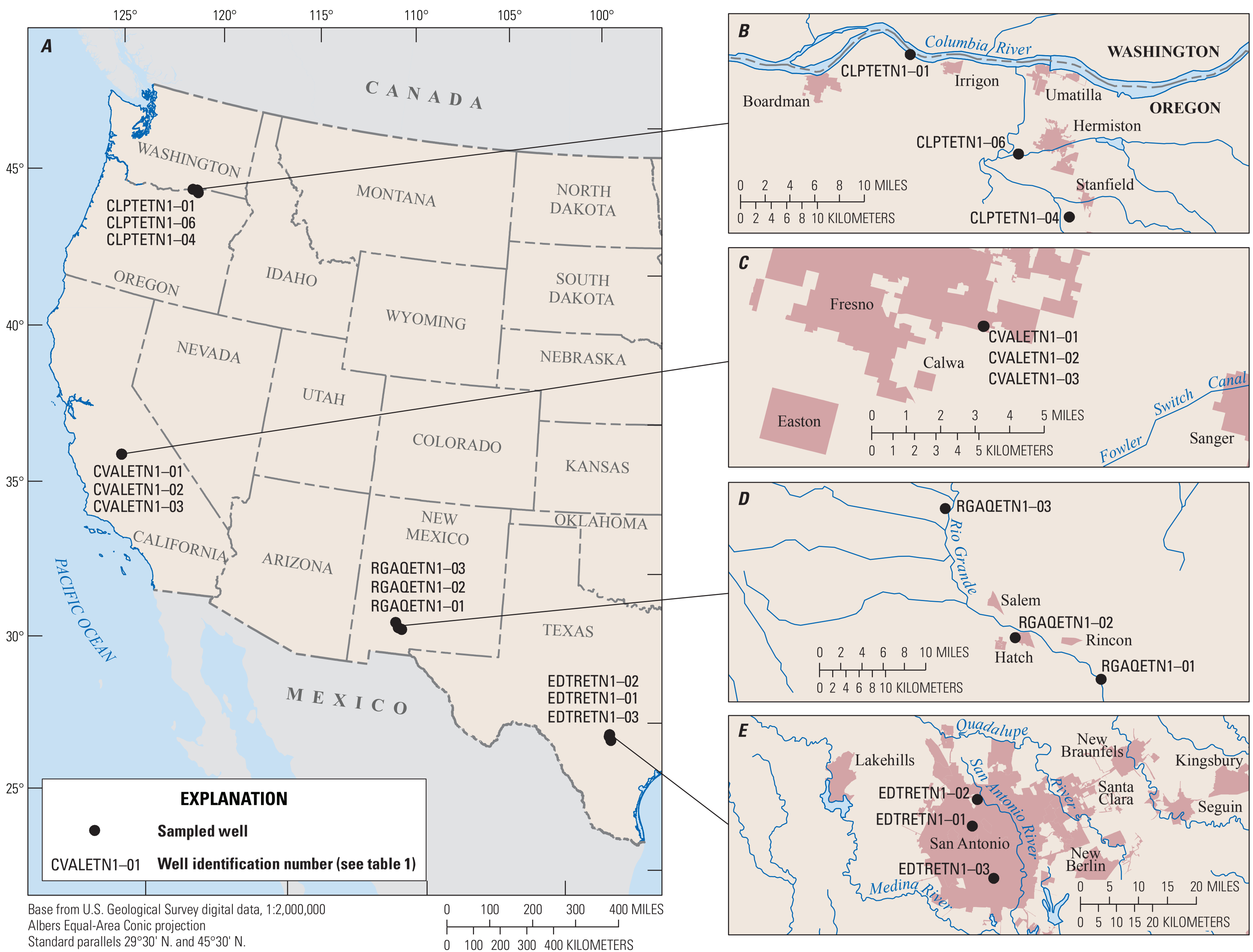
Base from U.S. Geological Survey digital data, 1:1,000,000, 1:2,000,000, and 1:10,000,000
Albers Equal-Area Conic projection
Standard parallels 29°30′ N. and 45°30′ N.
Central meridian 96°00′ W.
North American Datum of 1983

Figure 15. Study area and wells sampled as part of the San Joaquin-Tulare River Basins major aquifer study network (sanjsus1) for the U.S. Geological Survey National Water-Quality Assessment Project, July through August 2015.



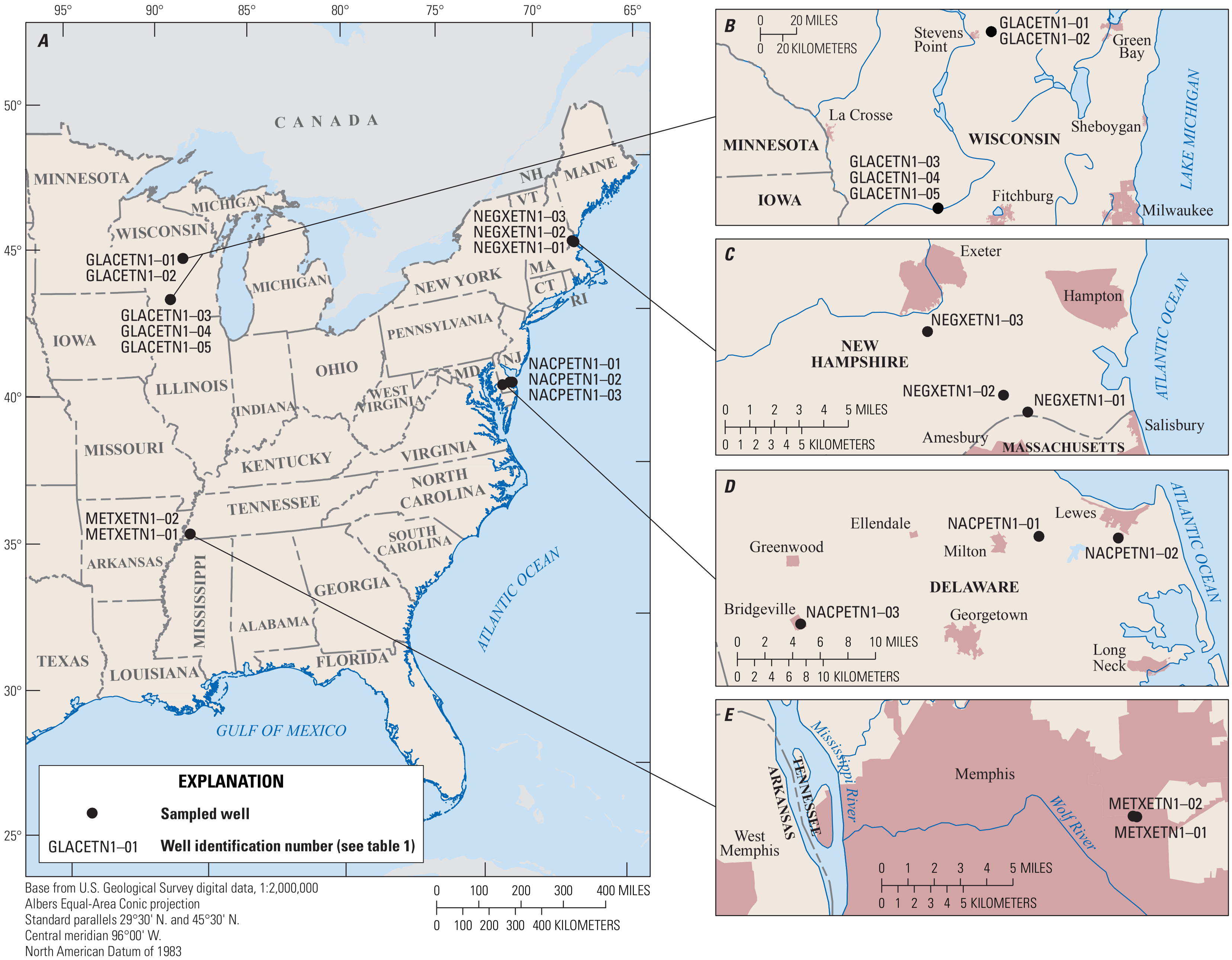
Base from U.S. Geological Survey digital data, 1:1,000,000 and 1:10,000,000
Albers Equal-Area Conic projection
Standard parallels 29°30' N. and 45°30' N.
Central meridian 96°00' W.
North American Datum of 1983

Figure 16. Study area and wells sampled as part of the western Lake Michigan drainages major aquifer study network (wmicsus1) for the U.S. Geological Survey National Water-Quality Assessment Project, July through September 2015.



Base from U.S. Geological Survey digital data, 1:2,000,000
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 17. Study areas and wells sampled, *A*, in the western United States as part of the enhanced trends networks for the U.S. Geological Survey National Water-Quality Assessment Project, January through December 2015. Detail of well locations for *B*, clptetn1; *C*, cvaletn1; *D*, rgaqetn1; and *E*, edtretn1.



Base from U.S. Geological Survey digital data, 1:2,000,000
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 18. Study areas and wells sampled, *A*, in the eastern United States as part of the enhanced trends networks for the U.S. Geological Survey National Water-Quality Assessment Project, January through December 2015. Detail of well locations for *B*, glacetn1; *C*, negxetn1; *D*, nacpetn1; and *E*, metxetn1.

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 2, table 2.1.

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 approximately 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 2015 are included in this report and in Arnold and others (2018).

Central Valley Enhanced Trends Network (cvaletn1)

The Central Valley ETN (cvaletn1; fig. 17*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) and 2014 (Arnold and others, 2017a, b). During 2015, the CVALETN1–01 and CVALETN1–03 wells were sampled approximately once every 2 months between January and November; CVALETN1–02 was sampled once in October. Data from the 2015 sampling are included in this report and in Arnold and others (2018).

Columbia Plateau Enhanced Trends Network (clptetn1)

The Columbia Plateau ETN (clptetn1; fig. 17*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 CLPTETN1–06 is a shallow (40 ft) domestic well, 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 once in October 2015, and the data are included in this report and in Arnold and others (2018).

Edwards-Trinity Aquifer System Enhanced Trends Network (edtretn1)

The Edwards-Trinity aquifer system ETN (edtretn1; fig. 17*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. 17*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 sampled again in 2014 (Arnold and others, 2017a, b). During 2015, the wells were sampled approximately bimonthly from January through December 2015, and these data are included in this report and in Arnold and others (2018).

Glacial Aquifer System Enhanced Trends Network (glacetn1)

The glacial aquifer system ETN (glacetn1; fig. 18*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 the wells in the glacetn1 were sampled once in September 2015, and these data are included in this report and in Arnold and others (2018). Wells GLACETN1–01 and GLACETN1–02 also were sampled in 2014 (Arnold and others, 2017a, b).

Mississippi Embayment Aquifer System Enhanced Trends Network (metxetn1)

The Mississippi Embayment aquifer system ETN (metxetn1; fig. 18*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). Sampling in 2015 was approximately bimonthly between February and December 2015, and these data are included in this report and in Arnold and others (2018).

Northern Atlantic Coastal Plain Enhanced Trends Network (nacpetn1)

The Northern Atlantic Coastal Plain ETN (nacpetn1; fig. 18*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 (139 ft 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) and once in August 2015. Data from the 2015 sampling are included in this report and in Arnold and others (2018).

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

The New England crystalline-rock and glacial aquifer system ETN (negxetn1, fig. 18*A*, *C*) provides the opportunity to study the temporal variability of contaminants in groundwater from geologic sources as well as contaminants from manmade 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, 176 ft deep). Wells in the negxetn1 were first sampled in 2014 (Arnold and others, 2017a, b). The wells were sampled bimonthly January through November 2015, and these data are included in this report and in Arnold and others (2018).

Rio Grande Aquifer System Enhanced Trends Network (rgaqetn1)

The Rio Grande aquifer system ETN (rgaqetn1; fig. 17*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, 23 ft deep; and RGAQETN1–03, 22 ft deep) and one deeper well (RGAQETN1–02, 60 ft deep). The wells were first sampled as part of the rgaqetn1 in 2014 (Arnold and others, 2017a, b). The wells were sampled again in May 2015, and these data are included in this report and in Arnold and others (2018).

Vertical Flow-Path Study Networks

The VFPS networks are designed to evaluate changes in groundwater quality over longer periods of time than the enhanced trends networks (ETN) and decadal trends networks (LUS and MAS networks). The wells in a VFPS network are selected from public, domestic, or monitoring wells and are collocated so that there is a representation of wells at different depths 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 of time greater than 10 years. VFPS networks generally are sampled once. Data from the High Plains aquifer VFPS network (hpaqvfps1; fig. 19) are included in this report.

High Plains Aquifer Vertical Flow-Path Study Network (hpaqvfps1)

The High Plains aquifer VFPS network (hpaqvfps1; fig. 19) was designed to help address questions of changes in water quality over time. The hpaqvfps1 is in the Eastern Nebraska hydrogeologic unit of the High Plains aquifer, where the Ogallala formation is thin or absent (Stanton and Fahlquist, 2006; Stanton and Qi, 2007). The High Plains aquifer is described earlier in this report for the hpaqpas1. The hpaqvfps1 consists of 34 wells selected from 2 existing decadal trends networks: the agricultural LUS network, hpgwlusag3; and the MAS network, hpgwsus4. The hpgwlusag3 network was designed to assess the quality of shallow groundwater beneath an area of extensive irrigated agriculture in the northern High Plains aquifer; the primary crops grown were corn and soybeans (Stanton and Fahlquist, 2006). The hpgwlusag3 network was last sampled in 2004. The hpgwsus4 network was designed to assess the quality of groundwater at the depth used for domestic supply in the Eastern Nebraska hydrogeologic unit. The hpgwsus4 was last sampled in 2003. The hpaqvfps1 wells typically range in depth from 95 to 217 ft (appendix 1, table 1.1). The wells generally were open to the aquifer across intervals of 10 to 47 ft (appendix 1, table 1.2), but most were open to less than 20-ft intervals.

Sample Collection and Analysis

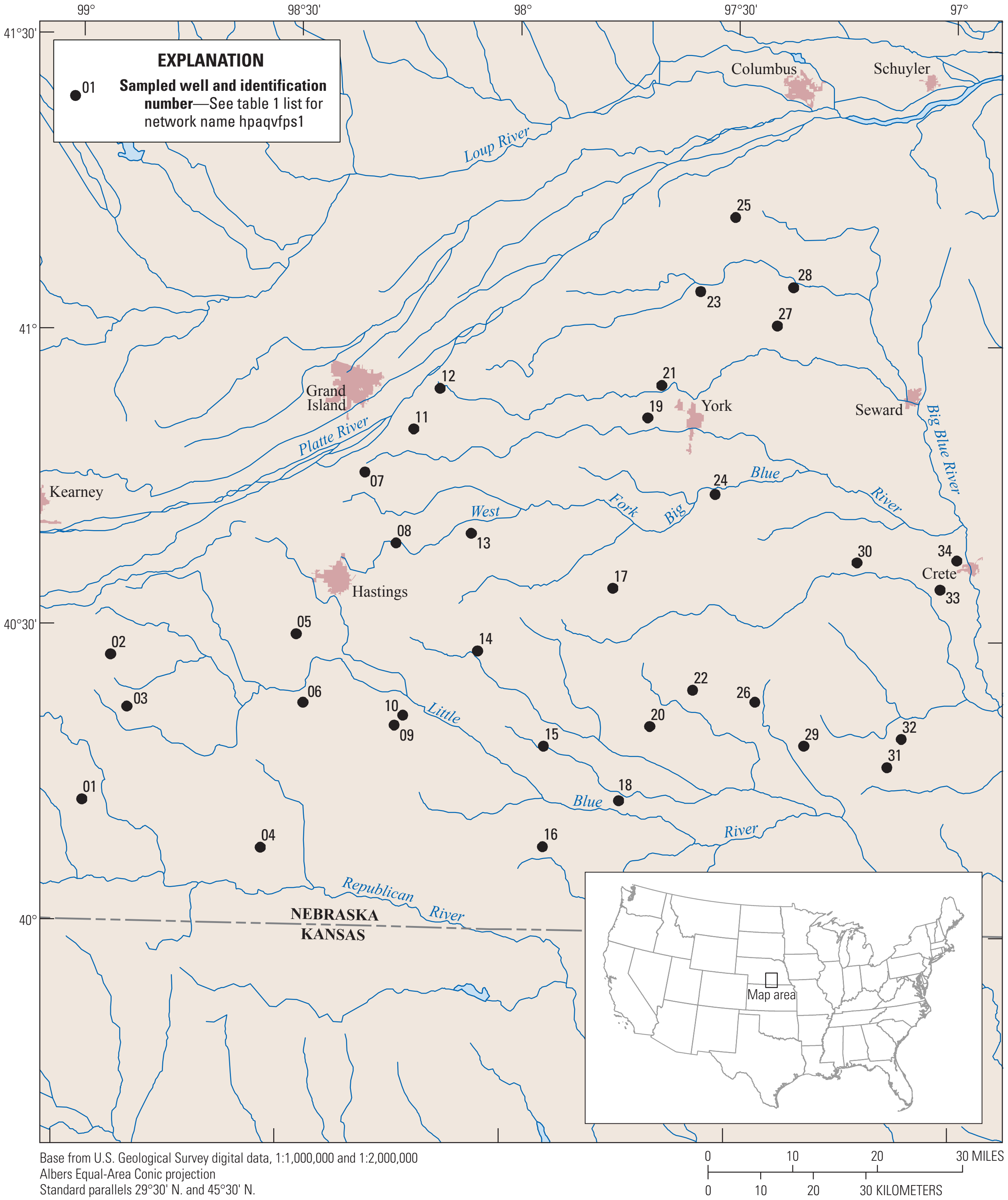
Water-quality data from samples collected at 502 wells (fig. 1; table 1) are available in Arnold and others (2018); 500 wells were sampled January through December 2015, and 2 wells were sampled July through August 2013. Groundwater samples were collected and processed using methods designed to yield 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, and radium–226) were analyzed by TestAmerica in Richlands, Washington, in 2014 and by ALS Environmental in Fort Collins, Colo., in 2015. Perchlorate concentrations were analyzed by Weck Laboratories, Inc. in Industry, California. Hexavalent chromium (chromium [VI]) concentrations were analyzed by the USGS Trace Metal Laboratory in Boulder, Colo.

The constituents for which samples were collected are listed in table 2 of Arnold and others (2018) 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; number of analyses, detections, and detections above the reporting level; and the table in which the data for the constituent class are shown. 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 (2018), 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, 2017) 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

Several conventions are used for the constituent concentrations that are reported as not detected in water-quality samples (censored data or concentrations that are reported by the laboratory as less than a specified value). Inorganic constituents (major ions, nutrients, and trace elements) are reported using long-term method detection levels (LT–MDL) as the reporting levels. The LT–MDL is the smallest concentration



Base from U.S. Geological Survey digital data, 1:1,000,000 and 1:2,000,000
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 19. Study and wells sampled as part of the High Plains aquifer vertical flow-path study network (hpaqvfps1) for the U.S. Geological Survey National Water-Quality Assessment Project, April through August 2015.

that can be measured and reported with 99-percent confidence that the concentration is greater than zero (Childress and others, 1999). The LT–MDL is similar to a method detection level (MDL; U.S. Environmental Protection Agency [EPA], 2015) with the added characteristic that it is determined from statistical analysis of laboratory QC data during an extended period (Bonn, 2008). Organic constituents (VOCs and pesticides) are reported using laboratory reporting levels (LRLs). An LRL for a constituent is typically about two times greater than the LT–MDL and is defined as the concentration at which the chance of a false negative error is 1 percent (Childress and others, 1999). In other words, there is 99-percent confidence at the LRL that a constituent has been correctly reported as absent.

The LRL is more protective than the LT–MDL against the chance of false negative errors; that is, the chance of incorrectly reporting that a constituent is absent in a water sample when it actually is present. The LT–MDL is defined in terms of false positive errors. For concentrations near the LT–MDL, the chance of incorrectly reporting that a constituent is present in a water sample when it actually is absent is 1 percent; however, the chance of a false negative error (incorrectly reporting that the constituent is absent when it actually is present) at the LT–MDL is 50 percent. In contrast, the LRL has a 1-percent chance of a false negative error. In other words, if a value is reported as less than an LRL, there is only a very small chance that it is present at a concentration greater than the LRL, whereas if a value is reported as less than an LT–MDL, there is a 50-percent chance that it is present at a concentration near but above the LT–MDL. The LRLs 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 LRLs.

A few constituents (for example, nitrate plus nitrite) are reported using MDLs or minimum reporting levels. The MDLs are calculated according to the EPA definition of an MDL, 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 (Patton and Kryskalla, 2011; EPA, 2015). A minimum reporting level is a reporting level that is chosen by the laboratory, but it is not necessarily associated with any specific method of determination or statistical certainty (Bonn, 2008).

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 (ssL$_c$) or sample-specific minimum detectable concentrations (ssMDCs) (McCurdy and others, 2008). The ssL$_c$ and ssMDC are calculated for each sample from parameter values used during the actual analysis of the sample. The ssL$_c$ and ssMDC are analogous to the LT–MDL and LRL, respectively. The ssL$_c$ 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 LT–MDL, the ssL$_c$ is a reporting level that is based on a specified probability of false positive errors; that is, incorrectly reporting that the radionuclide is present when it is actually absent. The ssMDC, like the LRL, 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 ssL$_c$ (McCurdy and others, 2008).

The analytical methods for pesticides and VOCs in schedules 2437, 4436, and 4437 (table 2 of Arnold and others, 2018) are new methods that were still in the process of USGS approval when samples were analyzed. 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. For schedules 2437, 4436, and 4437, the method approval process revealed no substantial problems and resulted in no changes in the analytical process (Duane Wydoski, USGS, written commun., 2015), thus indicating that the data reported before approval for these methods were of sufficient quality for public release. However, LRLs for individual compounds may be adjusted when additional QC data for the method are obtained and examined. The data from schedules 2437, 4436, and 4437 are reported relative to interim reporting levels, which are similar to LRLs. The analytical methods for pesticide schedule 2437 (Sandstrom and others, 2016), and VOC schedules 4436 and 4437 (Rose and others, 2016), were approved and published in 2016.

During the period that samples were being analyzed by the NWQL for the data presented in this report, the laboratory implemented a new procedure for determining and revising reporting and detection levels for various constituents as an alternative to the LT–MDL procedure (Williams and others, 2015). The new procedure involves using ASTM International's Standard Practice D6091–07 (ASTM International, 2014) and supporting DQCALC software to verify or revise detection limits and reporting limits each year. Like the LT–MDL, a detection limit set using DQCALC (referred to as DLDQC) is the smallest concentration that can be measured and reported with 99-percent confidence that the concentration is greater than zero (less than or equal to a 1-percent chance if a false positive). A reporting level set by DQCALC (referred to as RLDQC) is greater than or equal to two times the DLDQC and has a less than or equal to 1 percent chance of falsely reporting the results as a nondetection for a sample that actually contains the analyte.

Concentrations below LT–MDLs, and concentrations between LT–MDLs and LRLs, are reported without any qualifiers in this report. Concentrations below LT–MDLs or between LT–MDLs and LRLs can be identified by comparing the reported concentrations with the LT–MDLs and LRLs listed by compound in table 2 of Arnold and others (2018).

It is important to note that there is greater uncertainty associated with values less than LT–MDLs (regarding risk of false positive errors or inaccurate detections) and with values less than LRLs (regarding risk of false negative values or inaccurate nondetections) than with values that are greater than LT–MDLs, LRLs, or both.

The data presented in this report and associated data release (Arnold and others, 2018) are current as of the date of retrieval (May 31, 2017) from the National Water Information System (USGS, 2017). However, results for individual constituents (also called parameters) may be updated at a later date to correct a previously undetected error or to reflect improved information about the performance of a laboratory method. For example, LRLs 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 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 3 (tables 3.1 and 3.2).

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 (2018) include water quality for all blank QC samples collected between January and December 2015 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), and data from the 2014 sampling period are presented in Arnold and others (2017a, b).

Groundwater-Quality Data

Groundwater-quality data from 502 wells are included in this report. Groundwater samples were collected at 500 wells between January and December 2015 and at 2 wells between July and August 2013 (table 1). Samples were analyzed for about 380 constituents (table 2 of Arnold and others, 2018); however, not all wells were sampled for all constituents. Results of analyses are presented in tables 3–12 of Arnold and others (2018), 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), and perchlorate (table 12). 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 (2018). 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 MCLs or HHBPs 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 2015 are presented in the format of tab-delimited ASCII text files and are available for download from Arnold and others (2018) along with complete metadata files that describe the contents of each text file. In addition to the complete metadata, each data file includes header lines that describe the source of the file. Header lines in the data files are indicated by the pound symbol (#), and the last line of the header is numbered. The first line after the header contains the column names for the tab-delimited data columns. The data may be imported into spreadsheet, database, or statistical software for manipulation and analysis. The data available from Arnold and others (2018) are referenced as tables 1–12 and appendix tables 3.3–3.10 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, 2018). 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, 2018).

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 (2018). 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, 2018).

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 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, 2018).

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 (Zogorski 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 2015 were analyzed for 85 VOCs and 227 pesticides (tables 7 and 8 of Arnold and others, 2018).

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, 2018). Uranium, which also is a radionuclide, is included with trace elements (table 6 of Arnold and others, 2018) 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]), and perchlorate (tables 10–12 of Arnold and others, 2018). 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).

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 502 wells were collected from 5 types of well networks: principal aquifer study networks, land-use study networks, major aquifer study networks, enhanced trends networks, and vertical flow-path study networks. Within principal aquifer, land-use, and major aquifer study networks, study areas were divided into equal-area grids and wells were selected for sampling using a stratified random sampling design. The number of wells in principal aquifer networks ranged from about 20 to 63 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 2015 consisted of two to five wells that were selected at locations within aquifers where temporal changes in groundwater quality might be expected. One vertical flow-path study network was sampled in 2015.

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 a few environmental samples collected in 2013 and a few quality-control samples collected in 2014. These previously unpublished data are associated with networks described in this report.

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References Cited

Arnold, T.L., Bexfield, L.M., Musgrove, MaryLynn, Lindsey, B.D., Stackelberg, P.E., Barlow, J.R., DeSimone, L.A., Kulongoski, J.T., Kingsbury, J.A., Ayotte, J.D., Fleming, B.J., and Belitz, Kenneth, 2017a, Datasets from groundwater quality data from the National Water Quality Assessment Project, January through December 2014 and select quality-control data from May 2012 through December 2014: U.S. Geological Survey data release, accessed March 28, 2018, at https://doi.org/10.5066/F7W0942N.

Arnold, T.L., Bexfield, L.M., Musgrove, MaryLynn, Lindsey, B.D., Stackelberg, P.E., Barlow, J.R., DeSimone, L.A., Kulongoski, J.T., Kingsbury, J.A., Ayotte, J.D., Fleming, B.J., and Belitz, Kenneth, 2017b, Groundwater-quality data from the National Water-Quality Assessment Project, January through December 2014 and select quality-control data from May 2012 through December 2014: U.S. Geological Survey Data Series 1063, 83 p., accessed March 28, 2018, at https://doi.org/10.3133/ds1063.

Arnold, T.L., Bexfield, L.M., Musgrove, MaryLynn, Stackelberg, P.E., Lindsey, B.D., Kingsbury, J.A., Kulongoski, J.T., Belitz, Kenneth, and Sharpe, J.B., 2018, Datasets from groundwater-quality and select quality-control data from the National Water-Quality Assessment Project, January through December 2015 and previously unpublished data from 2013–2014: U.S. Geological Survey data release, accessed June 21, 2018, at https://doi.org/10.5066/F7XK8DHK.

Arnold, T.L., DeSimone, L.A., Bexfield, L.M., Lindsey, B.D., Barlow, J.R., Kulongoski, J.T., Musgrove, MaryLynn, Kingsbury, J.A., and Belitz, Kenneth, 2016a, Groundwater quality data from the National Water-Quality Assessment Project, May 2012 through December 2013: U.S. Geological Survey Data Series 997, 56 p., accessed March 28, 2018, at https://doi.org/10.3133/ds997.

Arnold, T.L., DeSimone, L.A., Bexfield, L.M., Lindsey, B.D., Barlow, J.R., Kulongoski, J.T., Musgrove, MaryLynn, Kingsbury, J.A., and Belitz, Kenneth, 2016b, Groundwater quality data from the National Water Quality Assessment Project, May 2012 through December 2013 and select quality-control data from May 2012 through December 2013: U.S. Geological Survey data release, accessed March 28, 2018, at https://doi.org/10.5066/F7HQ3X18.

ASTM International, 2014, Standard practice for 99 %/95 % interlaboratory detection estimate (IDE) for analytical methods with negligible calibration error: West Conshohocken, Pa., ASTM International, ASTM D6091–07, 13 p. [Also available at http://www.astm.org/Standards/D6091.htm.]

Belitz, Kenneth; Jurgens, Bryant; Landon, M.K.; Fram, M.S.; and Johnson, Tyler, 2010, Estimation of aquifer scale proportion using equal area grids—Assessment of regional scale groundwater quality: Water Resources Research, v. 46, no. 11, 14 p, accessed March 15, 2017, at https://doi.org/10.1029/2010WR009321.

Berndt, M.P., Katz, B.G., Kingsbury, J.A., and Crandall, C.A., 2014, The quality of our Nation's waters—Water quality in the Upper Floridan aquifer and overlying surficial aquifers, southeastern United States, 1993–2010: U.S. Geological Survey Circular 1355, 72 p., accessed January 4, 2016, at https://doi.org/10.3133/cir1355.

Bonn, B.A., 2008, Using the U.S. Geological Survey National Water-Quality Laboratory LT–MDL to evaluate and analyze date: U.S. Geological Survey Open-File Report 2008–1227, 73 p., accessed January 4, 2016, at https://pubs.usgs.gov/of/2008/1227/.

Burow, K.R., and Belitz, Kenneth, 2014, Groundwater studies—Principal aquifer surveys: U.S. Geological Survey Fact Sheet 2014–3024, 2 p., accessed January 4, 2016, at https://doi.org/10.3133/fs2014302.

Burow, K.R., Shelton, J.L., and Dubrovsky, N.M., 1998, Occurrence of nitrate and pesticides in ground water beneath three agricultural land-use settings in the eastern San Joaquin Valley, California, 1993–1995: U.S. Geological Survey Water-Resources Investigations Reports 97–4284, 51 p. [Also available at https://pubs.er.usgs.gov/publication/wri974284.]

Chapman, M.J., Cravotta, C.A., III, Szabo, Zoltan, and Lindsey, B.D., 2013, Naturally occurring contaminants in the Piedmont and Blue Ridge crystalline-rock aquifers and Piedmont Early Mesozoic basin siliciclastic-rock aquifers, eastern United States, 1994–2008: U.S. Geological Survey Scientific Investigations Report 2013–5072, 74 p. [Also available at https://pubs.usgs.gov/sir/2013/5072/.]

Childress, C.J.O., Forman, W.T., Connor, B.F., and Maloney, T.J., 1999, New reporting procedures based on long-term method detection levels and some considerations for interpretations of water-quality data provided by the U.S. Geological Survey National Water Quality Laboratory: U.S. Geological Survey Open-File Report 99–193, 19 p., accessed January 4, 2016, at https://water.usgs.gov/owq/OFR_99-193/index.html.

Flowerday, C.A., Kuzelka, R.D., and Pederson, D.T., 1998, The groundwater atlas of Nebraska (2d ed.): University of Nebraska–Lincoln, Conservation and Survey Division, Resource Atlas no. 4A, 44 p.

Frick, E.A., Hippe, D.J., Buell, G.R., Couch, C.A., Hopkins, E.H., Wangsness, D.J., and Garrett, J.W., 1998, Water quality in the Apalachicola-Chattahoochee-Flint River Basin, Georgia, Alabama, and Florida 1992–95: U.S. Geological Survey Circular 1164, 38 p., accessed January 4, 2016, at https://pubs.usgs.gov/circ/circ1164/.

Garelick, Hemda; Jones, Huw; Agnieszka, Dybowska; and Valsami-Jones, Eva, 2008, Arsenic pollution sources, *in* Garelick, Hemda, and Jones, Huw, eds., Reviews of environmental contamination and toxicology—Arsenic pollution and remediation—An international perspective: Springer-Verlag New York, Reviews of Environmental Contamination and Toxicology, v. 197, p. 17–60.

Gilliom, R.J., Alley, W.M., and Gurtz, M.E., 1995, Design of the National Water-Quality Assessment Program—Occurrence and distribution of water-quality conditions: U.S. Geological Survey Circular 1112, 33 p. accessed March 1, 2016, at https://pubs.er.usgs.gov/publication/cir1112.

Gilliom, R.J., Barbash, J.E., Crawford, C.G., Hamilton, P.A., Martin, J.D., Nakagaki, Naomi, Nowell, L.H., Scott, J.C., Stackelberg, P.E., Thelin, G.P., and Wolock, D.M., 2006, The quality of our Nation's waters—Pesticides in the Nation's streams and ground water, 1992–2001: U.S. Geological Survey Circular 1291, 172 p., accessed August 9, 2017, at https://pubs.usgs.gov/circ/2005/1291/.

Güler, Cüneyt, Thyne, G.D., McCray, J.E., and Turner, A.K., 2002, Evaluation of graphical and multivariate statistical methods for classification of water chemistry data: Hydrogeology Journal, v. 10, no. 4, p. 455–474.

Harrill, J.R., and Prudic, D.E., 1998, Aquifer systems in the Great Basin Region of Nevada, Utah, and adjacent states—Summary report: U.S. Geological Survey Professional Paper 1409–A, 66 p.

Hem, J.D., 1992, Study and interpretation of the chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 2254, 264 p.

Hiscock, K.M., 2005, Hydrogeology—Principles and practice: United Kingdom, Blackwell Publishing, 389 p.

Homer, C.G.; Dewitz, J.A.; Yang, Limin; Jin, Suming; Danielson, Patrick; Xian, George; Coulston, John; Herold, N.D.; Wickham, J.D.; and Megown, Kevin, 2015, Completion of the 2011 National Land Cover Database for the conterminous United States—Representing a decade of land cover change information: Photogrammetric Engineering and Remote Sensing, v. 81, no. 5, p. 345–354.

Jackson, W.A., Bohlke, J.K., Andraski, B.J., Fahlquist, Lynne, Bexfield, L.M., Eckardt, F.D., Gates, J.B., Davila, A.F., McKay, C.P., Rao, Balaji, Sevanthi, Ritesh, Rajagopalan, Srinath, Estrada, Nubia, Sturchio, Neil, Hatzinger, P.B., Anderson, T.A., Orris, G., Betahcourt, Julio, Stonestrom, David, Latorre, Claudio, Li, Yanhe, and Harvey, G.J., 2015, Global patterns and environmental controls of perchlorate and nitrate co-occurrence in arid and semi-arid environments: Geochimica et Cosmochimica Acta, v. 164, p. 502–522.

Koterba, M.T., Wilde, F.D., and Lapham, W.W., 1995, Groundwater data-collection protocols and procedures for the National Water-Quality Assessment Program—Collection and documentation of water-quality samples and related data: U.S. Geological Survey Open-File Report 95–399, 113 p., accessed January 4, 2016, at https://pubs.usgs.gov/of/1995/ofr-95-399/.

Lapham, W.W., Wilde, F.D., and Koterba, M.T., 1995, Ground-water data-collection protocols and procedures for the National Water-Quality Assessment Program—Selection, installation, and documentation of wells, and collection of related data: U.S. Geological Survey Open-File Report 95–398, 71 p., accessed January 4, 2016, at https://pubs.usgs.gov/of/1995/ofr-95-398/.

Maupin, M.A., and Arnold, T.L., 2010, Estimates for self-supplied domestic withdrawals and population served for selected principal aquifers, calendar year 2005: U.S. Geological Survey Open-File Report 2010–1223, 10 p., accessed January 4, 2016, at https://pubs.usgs.gov/of/2010/1223/.

Maupin, M.A., and Barber, N.L., 2005, Estimated withdrawals from principal aquifers in the United States, 2000: U.S. Geological Survey Circular 1279, 46 p., accessed January 4, 2016, at https://pubs.usgs.gov/circ/2005/1279/.

McCurdy, D.E., Garbarino, J.R., and Mullin, A.H., 2008, Interpreting and reporting radiological water-quality data: U.S. Geological Survey Techniques and Methods, book 5, chap. B6, 33 p., accessed January 4, 2016, at https://pubs.usgs.gov/tm/05b06/.

McMahon, P.B., 2001, Vertical gradients in water chemistry in the Central High Plains aquifer, southwestern Kansas and Oklahoma panhandle, 1999: U.S. Geological Survey Water Resources Investigations Report 01–4028, 47 p.

McMahon, P.B., Dennehy, K.F., Bruce, B.W., Gurdak, J.J., and Qi, S.L., 2007, Water-quality assessment of the High Plains Aquifer, 1999–2004: U.S. Geological Survey Professional Paper 1749, 136 p.

Metz, P.A., Delzer, G.C., Berndt, M.P., Crandall, C.A., and Toccalino, P.L., 2007, Anthropogenic organic compounds in ground water and finished water of community water systems in the northern Tampa Bay area, Florida, 2002–04: U.S. Geological Survey Scientific Investigations Report 2006–5267, 48 p., accessed January 4, 2016, at http://pubs.usgs.gov/sir/2006/5267/.

Miller, J.A., 1986, Hydrogeologic framework of the Floridan aquifer system in Florida and in parts of Georgia, Alabama, and South Carolina: U.S. Geological Survey Professional Paper 1403–B, 91 p., 33 pls.

Miller, J.A., 1990, Ground water atlas of the United States—Alabama, Florida, Georgia, South Carolina: U.S. Geological Survey Hydrologic Atlas 730–G, accessed January 4, 2016, at http://pubs.usgs.gov/ha/ha730/ch_g/index.html.

Nriagu, J.O., and Niebor, Evert, eds., 1988, Chromium in the natural and human environments: New York, John Wiley & Sons, 571 p.

Patton, C.J., and Kryskalla, J.R., 2011, Colorimetric determination of nitrate plus nitrite in water by enzymatic reduction, automated discrete analyzer methods: U.S. Geological Survey Techniques and Methods, book 5, chap. B8, 34 p., accessed January 4, 2016, at https://pubs.usgs.gov/tm/05b08/.

Peters, C.A., Robertson, D.M., Saad, D.A., Sullivan, D.J., Scudder, B.C., Fitzpatrick, F.A., Richards, K.D., Stewart, J.S., Fitzgerald, S.A., and Lenz, B.N., 1998, Water quality in the western Lake Michigan drainages, Wisconsin and Michigan, 1992–95: U.S. Geological Survey Circular 1156, accessed October 18, 2017, at https://pubs.usgs.gov/circ/circ1156/.

Renken, R.A., 1998, Ground water atlas of the United States—Arkansas, Louisiana, Mississippi: U.S. Geological Survey Hydrologic Atlas 730–F, accessed January 4, 2016, at https://pubs.usgs.gov/ha/ha730/ch_f/index.html.

Rose, D.L., Sandstrom, M.W., and Murtagh, L.K., 2016, Determination of heat purgeable and ambient purgeable volatile organic compounds in water by gas chromatography/mass spectrometry: U.S. Geological Survey Techniques and Methods, book 5, chap. B12, 62 p. [Also available at https://doi.org/10.3133/tm5B12.]

Rowe, G.L., Jr., Belitz, Kenneth, Demas, C.R., Essaid, H.I., Gilliom, R.J., Hamilton, P.A., Hoos, A.B., Lee, C.J., Munn, M.D., and Wolock, D.W., 2013, Design of cycle 3 of the National Water-Quality Assessment Program, 2013–23—Part 2—Science plan for improved water-quality information and management: U.S. Geological Survey Open File Report 2013–1160, 110 p., accessed January 4, 2016, at https://pubs.usgs.gov/of/2013/1160/.

Rowe, G.L., Jr., Belitz, Kenneth, Essaid, H.I., Gilliom, R.J., Hamilton, P.A., Hoos, A.B., Lynch, D.D., Munn, M.D., and Wolock, D.W., 2010, Design of cycle 3 of the National Water-Quality Assessment Program, 2013–2023—Part 1—Framework of water-quality issues and potential approaches: U.S. Geological Survey Open-File Report 2009–1296, 54 p., accessed January 4, 2016, at https://pubs.usgs.gov/of/2009/1296/.

Ryder, P.D., 1996, Ground water atlas of the United States—Oklahoma, Texas: U.S. Geological Survey Hydrologic Atlas 730–E, accessed January 4, 2016, at https://pubs.usgs.gov/ha/ha730/ch_e/index.html.

Saad, D.A., 1996, Ground-water quality in the western part of the Cambrian-Ordovician aquifer in the Western Lake Michigan Drainages, Wisconsin and Michigan: U.S. Geological Survey Water-Resources Investigations Report 96–4231, 40 p.

Sandstrom, M.W., Kanagy, L.K., Anderson, C.E., and Kanagy, C.J., 2016, Determination of pesticides and pesticide degradates in filtered water by direct aqueous injection liquid chromatography tandem mass spectrometry: U.S. Geological Survey Techniques and Methods, book 5, chap. B11, 54 p. [Also available at https://doi.org/10.3133/tm5B11.]

Schaefer, D.H., Thiros, S.A., and Rosen, M.R., 2005, Groundwater quality in the carbonate rock aquifer of the Great Basin, Nevada and Utah, 2003: U.S. Geological Survey Scientific Investigations Report 2005–5232, 32 p.

Scott, J.C., 1990, Computerized stratified random site-selection approaches for design of a ground-water-quality sampling network: U.S. Geological Survey Water-Resources Investigations Report 90–4101, 109 p., accessed January 4, 2016, at https://pubs.er.usgs.gov/publication/wri904101.

Srinivasan, Rangesh, and Sorial, G.A., 2009, Treatment of perchlorate in drinking water—A critical review: Separation and Purification Technology, v. 69, no. 1, p. 7–21.

Stanton, J.S., and Fahlquist, Lynne, 2006, Ground-water quality beneath irrigated cropland of the northern and southern High Plains aquifer, Nebraska and Texas, 2003–04: U.S. Geological Survey Scientific Investigations Report 2006–5196, 95 p.

Stanton, J.S., and Qi, S.L., 2007, Ground-water quality of the northern High Plains aquifer, 1997, 2002–04: U.S. Geological Survey Scientific Investigations Report 2006–5138, 60 p.

Stanton, J.S., Steele, G.V., and Vogel, J.R., 2007, Occurrence of agricultural chemicals in shallow ground water and the unsaturated zone, northeast Nebraska glacial till, 2002–04: U.S. Geological Survey Scientific Investigations Report 2007–5228, 51 p.

Thiros, S.A., Bexfield, L.M., Anning, D.W., and Huntington, J.M., eds., 2010, Conceptual understanding and groundwater quality of selected basin-fill aquifers in the Southwestern United States: U.S. Geological Survey Professional Paper 1781, 288 p.

Thornton, P.E., Running, S.W., and White, M.A., 1997, Generating surfaces of daily meteorological variables over large regions of complex terrain: Journal of Hydrology, v. 190, nos. 3–4, p. 214–251.

Toccalino, P.L., 2007, Development and application of health-based screening levels for use in water-quality assessments: U.S. Geological Survey Scientific Investigations Report 2007–5106, 12 p., accessed January 4, 2016, at https://pubs.usgs.gov/sir/2007/5106/.

Toccalino, P.L., Norman, J.E., and Schoephoester, K.M., 2014, Health-based screening levels for evaluating water-quality data: U.S. Geological Survey data release, accessed January 4, 2016, https://doi.org/10.5066/F71C1TWP.

Trapp, Henry, Jr., and Horn, M.A., 1997, Ground water atlas of the United States—Delaware, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, and West Virginia: U.S. Geological Survey Hydrologic Atlas 730–L, accessed January 4, 2016, at https://pubs.usgs.gov/ha/ha730/ch_l/index.html.

U.S. Bureau of the Census, 2010, Census of population and housing, 2010: U.S. Bureau of the Census, digital data, accessed March 1, 2018 at https://www.census.gov/prod/www/decennial.html.

U.S. Environmental Protection Agency [EPA], 2004, Multi-agency radiological laboratory analytical protocols manual (MARLAP)—Part II—Chapters 18–20, appendix G (volume III): U.S. Environmental Protection Agency, EPA 402–B–04–001C, accessed May 19, 2015, at http://nepis.epa.gov/Exe/ZyPDF.cgi/P10094KI.PDF?Dockey=P10094KI.PDF.

U.S. Environmental Protection Agency [EPA], 2012, Human health benchmarks for pesticides: U.S. Environmental Protection Agency, EPA 822–F–12–001, accessed May 19, 2015, at http://nepis.epa.gov/Exe/ZyPDF.cgi/P100E60P.PDF?Dockey=P100E60P.PDF.

U.S. Environmental Protection Agency [EPA], 2013, Human health benchmarks for pesticides—Updated 2013 technical document: U.S. Environmental Protection Agency, EPA 820–R–13–010, accessed May 19, 2015, at http://nepis.epa.gov/Exe/ZyPDF.cgi/P100GRDJ.PDF?Dockey=P100GRDJ.PDF.

U.S. Environmental Protection Agency [EPA], 2015, Definition and procedure for the determination of the method detection limit—revision 1.11: U.S. Code of Federal Regulations, Title 40, v. 24, pt. 136, app. B, accessed May 14, 2015, at http://www.gpo.gov/fdsys/pkg/CFR-2012-title40-vol24/pdf/CFR-2012-title40-vol24-part136-appB.pdf.

U.S. Geological Survey [USGS], 2003, Principal aquifers of the 48 conterminous United States, Hawaii, Puerto Rico, and the U.S. Virgin Islands: U.S. Geological Survey, digital data, accessed January 4, 2016, at http://water.usgs.gov/GIS/metadata/usgswrd/XML/aquifers_us.xml.

U.S. Geological Survey [USGS], 2017, National Water Information System—Web interface: U.S. Geological Survey, accessed May 31, 2017, at https://doi.org/10.5066/F7P55KJN.

U.S. Geological Survey [USGS], variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A9, accessed January 4, 2016, at https://pubs.water.usgs.gov/twri9A.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods, book 1, chap. D3, 51 p., accessed January 4, 2016, at https://pubs.usgs.gov/tm/2006/tm1D3/.

Wangsness, D.J., 1997, The National Water-quality Assessment Program—Example of study unit design for the Apalachicola–Chattahoochee–Flint River Basin in Georgia, Alabama, and Florida, 1991–97: U.S. Geological Survey Open-File Report 97–48, 29 p., accessed September 14, 2017, at https://pubs.usgs.gov/of/1997/ofr97-048/.

Whitehead, R.L., 1994, Ground water atlas of the United States—Idaho, Oregon, Washington: U.S. Geological Survey Hydrologic Atlas 730–H, accessed January 4, 2016, at https://pubs.usgs.gov/ha/ha730/ch_h/index.html.

Williams, Teresa, Foreman, W.T., Decess, Jessica, Reed-Parker, Carmen, and Stevenson, D.L., 2015, Changes to National Water Quality Laboratory (NWQL) procedures used to establish and verify laboratory detection and reporting limits: U.S. Geological Survey, National Water Quality Laboratory Technical Memorandum 15.02, 21 p., accessed January 4, 2016, at https://nwql.usgs.gov/Public/tech_memos/nwql.2015-02.pdf.

Williams, L.J., and Kuniansky, E.L., 2016, Revised hydrogeologic framework of the Floridan aquifer system in Florida and parts of Georgia, Alabama, and South Carolina (ver 1.1, March 2016): U.S. Geological Survey Professional Paper 1807, 140 p., 23 pls., accessed February 28, 2018, at https://doi.org/10.3133/pp1807.

Zagorsky, J.S., Carter, J.M., Ivahnenko, Tamara, Lapham, W.W., Moran, M.J., Rowe, B.L., Squillace, P.J., and Toccalino, P.L., 2006, The quality of our Nation's waters—Volatile organic compounds in the Nation's ground water and drinking-water supply wells: U.S. Geological Survey Circular 1292, 101 p., accessed January 4, 2016, at http://pubs.usgs.gov/circ/circ1292/.

Table 1

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

[MAS, major aquifer study; na, information is not available and cannot be assumed; PAS, principal aquifer study; *, information is unavailable about the bottom of perforation, but it is assumed to be bottom of well (well_depth); LUS, land-use study network; ETN, enhanced trends network; **, the recorded well depth was less than the recorded depth to the bottom of the perforated interval but is assumed to be the depth to the bottom of the perforated interval; VFPS, vertical flow-path study]

Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
acfbsus1	ACFBSUS1–01	01	MAS	Alabama	Floridan aquifer system	95	65	95
acfbsus1	ACFBSUS1–02	02	MAS	Alabama	Floridan aquifer system	118	72	118
acfbsus1	ACFBSUS1–03	03	MAS	Georgia	Floridan aquifer system	80	72	80
acfbsus1	ACFBSUS1–04	04	MAS	Georgia	Floridan aquifer system	72	60	72
acfbsus1	ACFBSUS1–05	05	MAS	Georgia	Floridan aquifer system	220	130	220
acfbsus1	ACFBSUS1–06	06	MAS	Georgia	Floridan aquifer system	85	82	85
acfbsus1	ACFBSUS1–07	07	MAS	Georgia	Floridan aquifer system	181	41	181
acfbsus1	ACFBSUS1–08	08	MAS	Georgia	Floridan aquifer system	64	35	64
acfbsus1	ACFBSUS1–09	09	MAS	Georgia	Floridan aquifer system	138	55	138
acfbsus1	ACFBSUS1–10	10	MAS	Georgia	Floridan aquifer system	125	61	125
acfbsus1	ACFBSUS1–11	11	MAS	Georgia	Floridan aquifer system	245	70	200
acfbsus1	ACFBSUS1–12	12	MAS	Georgia	Floridan aquifer system	123	58	122.5
acfbsus1	ACFBSUS1–13	13	MAS	Georgia	Floridan aquifer system	225	62	225
acfbsus1	ACFBSUS1–14	14	MAS	Georgia	Floridan aquifer system	218	54	218
acfbsus1	ACFBSUS1–15	15	MAS	Georgia	Floridan aquifer system	98.5	62	98.5
acfbsus1	ACFBSUS1–16	16	MAS	Georgia	Floridan aquifer system	75	63	75
acfbsus1	ACFBSUS1–17	17	MAS	Georgia	Floridan aquifer system	370	120	370
acfbsus1	ACFBSUS1–18	18	MAS	Georgia	Floridan aquifer system	169	157.7	169
acfbsus1	ACFBSUS1–19	19	MAS	Georgia	Floridan aquifer system	100	75	100
acfbsus1	ACFBSUS1–20	20	MAS	Georgia	Floridan aquifer system	na	na	na
acfbsus1	ACFBSUS1–21	21	MAS	Georgia	Floridan aquifer system	105	42	105
acfbsus1	ACFBSUS1–22	22	MAS	Georgia	Floridan aquifer system	250	100	250
acfbsus1	ACFBSUS1–23	23	MAS	Florida	Floridan aquifer system	234	110	234
acfbsus1	ACFBSUS1–24	24	MAS	Florida	Floridan aquifer system	200	150	200
acfbsus1	ACFBSUS1–25	25	MAS	Florida	Floridan aquifer system	160	80	160
acfbsus1	ACFBSUS1–26	26	MAS	Florida	Floridan aquifer system	115	98	115
acfbsus1	ACFBSUS1–27	27	MAS	Florida	Floridan aquifer system	180	128	180

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

[MAS, major aquifer study; na, information is not available and cannot be assumed; PAS, principal aquifer study; *, information is unavailable about the bottom of perforation, but it is assumed to be bottom of well (well_depth); LUS, land-use study network; ETN, enhanced trends network; **, the recorded well depth was less than the recorded depth to the bottom of the perforated interval but is assumed to be the depth to the bottom of the perforated interval; VFPS, vertical flow-path study]

Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
bnrcpas1	BNRCPAS1–01	01	PAS	Arizona	Basin and Range carbonate-rock aquifers	520	na	520*
bnrcpas1	BNRCPAS1–02	02	PAS	Arizona	Basin and Range carbonate-rock aquifers	na	na	na
bnrcpas1	BNRCPAS1–03	03	PAS	Nevada	Basin and Range carbonate-rock aquifers	na	na	na
bnrcpas1	BNRCPAS1–04	04	PAS	Nevada	Basin and Range carbonate-rock aquifers	350	50	350
bnrcpas1	BNRCPAS1–05	05	PAS	Nevada	Basin and Range carbonate-rock aquifers	565	205	565
bnrcpas1	BNRCPAS1–06	06	PAS	Nevada	Basin and Range carbonate-rock aquifers	291	na	291*
bnrcpas1	BNRCPAS1–07	07	PAS	Utah	Basin and Range carbonate-rock aquifers	980	696	736
bnrcpas1	BNRCPAS1–08	08	PAS	Utah	Basin and Range carbonate-rock aquifers	520	480	520
bnrcpas1	BNRCPAS1–09	09	PAS	Utah	Basin and Range carbonate-rock aquifers	280	200	280
bnrcpas1	BNRCPAS1–10	10	PAS	Utah	Basin and Range carbonate-rock aquifers	721	178	710
bnrcpas1	BNRCPAS1–11	11	PAS	Utah	Basin and Range carbonate-rock aquifers	269	149	269
bnrcpas1	BNRCPAS1–12	12	PAS	Utah	Basin and Range carbonate-rock aquifers	na	na	na
bnrcpas1	BNRCPAS1–13	13	PAS	Utah	Basin and Range carbonate-rock aquifers	525	100	505
bnrcpas1	BNRCPAS1–14	14	PAS	Utah	Basin and Range carbonate-rock aquifers	620	420	620
bnrcpas1	BNRCPAS1–15	15	PAS	Utah	Basin and Range carbonate-rock aquifers	na	na	na
bnrcpas1	BNRCPAS1–16	16	PAS	Utah	Basin and Range carbonate-rock aquifers	1,205	695	1,205
bnrcpas1	BNRCPAS1–17	17	PAS	Idaho	Basin and Range carbonate-rock aquifers	na	na	na
bnrcpas1	BNRCPAS1–18	18	PAS	Idaho	Basin and Range carbonate-rock aquifers	na	na	na
bnrcpas1	BNRCPAS1–19	19	PAS	Idaho	Basin and Range carbonate-rock aquifers	382	302	382
bnrcpas1	BNRCPAS1–20	20	PAS	Idaho	Basin and Range carbonate-rock aquifers	na	na	na
ccptlusor1b	CCPTLUSOR1B–01	01	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	42	37	42
ccptlusor1b	CCPTLUSOR1B–02	02	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	30	24.5	29.5
ccptlusor1b	CCPTLUSOR1B–03	03	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	28	17.5	27.5
ccptlusor1b	CCPTLUSOR1B–04	04	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	28	23	28
ccptlusor1b	CCPTLUSOR1B–05	05	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	56	50.4	55.6
ccptlusor1b	CCPTLUSOR1B–06	06	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	49	43.5	48.5
ccptlusor1b	CCPTLUSOR1B–07	07	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	25	19.5	24.5
ccptlusor1b	CCPTLUSOR1B–08	08	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	28	23	28

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

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Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
ccptlusor1b	CCPTLUSOR1B–09	09	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	23	18	23
ccptlusor1b	CCPTLUSOR1B–10	10	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	70	64	69
ccptlusor1b	CCPTLUSOR1B–11	11	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	73	68	73
ccptlusor1b	CCPTLUSOR1B–12	12	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	15	10	15
ccptlusor1b	CCPTLUSOR1B–13	13	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	19	14	19
ccptlusor1b	CCPTLUSOR1B–14	14	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	24	19	24
ccptlusor1b	CCPTLUSOR1B–15	15	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	19	14	19
ccptlusor1b	CCPTLUSOR1B–16	16	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	33	28	33
ccptlusor1b	CCPTLUSOR1B–17	17	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	34	28.5	33.5
ccptlusor1b	CCPTLUSOR1B–18	18	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	73	67.3	72.8
ccptlusor1b	CCPTLUSOR1B–19	19	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	29	24	29
ccptlusor1b	CCPTLUSOR1B–20	20	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	25	20	25
ccptlusor1b	CCPTLUSOR1B–21	21	LUS	Washington	Columbia Plateau basin-fill and basaltic-rock aquifers	90	80	90
clptetn1	CLPTETN1–01	01	ETN	Oregon	Columbia Plateau basin-fill and basaltic-rock aquifers	80	79	80
clptetn1	CLPTETN1–04	04	ETN	Oregon	Columbia Plateau basin-fill and basaltic-rock aquifers	1,116	926	1,100
clptetn1	CLPTETN1–06	06	ETN	Oregon	Columbia Plateau basin-fill and basaltic-rock aquifers	40	na	40*
cnbrluscr1	CNBRLUSCR1–01	01	LUS	Nebraska	Glacial aquifer system	25	15	25
cnbrluscr1	CNBRLUSCR1–02	02	LUS	Nebraska	Glacial aquifer system	17	7	17
cnbrluscr1	CNBRLUSCR1–03	03	LUS	Nebraska	Glacial aquifer system	32	22	32
cnbrluscr1	CNBRLUSCR1–04	04	LUS	Nebraska	Glacial aquifer system	30	20	25
cnbrluscr1	CNBRLUSCR1–05	05	LUS	Nebraska	Glacial aquifer system	45	35	45
cnbrluscr1	CNBRLUSCR1–06	06	LUS	Nebraska	Glacial aquifer system	35	29.8	34.8
cnbrluscr1	CNBRLUSCR1–07	07	LUS	Nebraska	Glacial aquifer system	39	34	39
cnbrluscr1	CNBRLUSCR1–08	08	LUS	Nebraska	Glacial aquifer system	22	17	22
cnbrluscr1	CNBRLUSCR1–09	09	LUS	Nebraska	Glacial aquifer system	15	10	15
cnbrluscr1	CNBRLUSCR1–10	10	LUS	Nebraska	Glacial aquifer system	65	60	65
cnbrluscr1	CNBRLUSCR1–11	11	LUS	Nebraska	Glacial aquifer system	35	25	35
cnbrluscr1	CNBRLUSCR1–12	12	LUS	Nebraska	Glacial aquifer system	20	15	20

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

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Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
cnbrluscr1	CNBRLUSCR1–13	13	LUS	Nebraska	Glacial aquifer system	53**	48	53
cnbrluscr1	CNBRLUSCR1–14	14	LUS	Nebraska	Glacial aquifer system	29	24	29
cnbrluscr1	CNBRLUSCR1–15	15	LUS	Nebraska	Glacial aquifer system	65	55	65
cnbrluscr1	CNBRLUSCR1–16	16	LUS	Nebraska	Glacial aquifer system	32	27	32
cnbrluscr1	CNBRLUSCR1–17	17	LUS	Nebraska	Glacial aquifer system	20	15	20
cnbrluscr1	CNBRLUSCR1–18	18	LUS	Nebraska	Glacial aquifer system	24	13.5	23.5
cnbrluscr1	CNBRLUSCR1–19	19	LUS	Nebraska	Glacial aquifer system	45	40	45
cnbrluscr1	CNBRLUSCR1–20	20	LUS	Nebraska	Glacial aquifer system	60	50	60
cnbrluscr1	CNBRLUSCR1–21	21	LUS	Nebraska	Glacial aquifer system	25	15	25
cnbrluscr1	CNBRLUSCR1–22	22	LUS	Nebraska	Glacial aquifer system	25	20	25
cnbrluscr1	CNBRLUSCR1–23	23	LUS	Nebraska	Glacial aquifer system	39	29	39
cnbrluscr1	CNBRLUSCR1–24	24	LUS	Nebraska	Glacial aquifer system	30	19.5	29.5
cnbrluscr1	CNBRLUSCR1–25	25	LUS	Nebraska	Glacial aquifer system	57	52	57
cnbrluscr1	CNBRLUSCR1–26	26	LUS	Nebraska	Glacial aquifer system	25	19.5	24.5
cnbrluscr1	CNBRLUSCR1–27	27	LUS	Nebraska	Glacial aquifer system	73	68	73
cvaletn1	CVALETN1–01	01	ETN	California	Central Valley aquifer system	620	410	610
cvaletn1	CVALETN1–02	02	ETN	California	Central Valley aquifer system	320	160	310
cvaletn1	CVALETN1–03	03	ETN	California	Central Valley aquifer system	234	214	224
edtretn1	EDTRETN1–01	01	ETN	Texas	Edwards-Trinity aquifer system	550	317	550
edtretn1	EDTRETN1–02	02	ETN	Texas	Edwards-Trinity aquifer system	300	220	300
edtretn1	EDTRETN1–03	03	ETN	Texas	Edwards-Trinity aquifer system	1,550	1,320	1,550
florpas1	FLORPAS1–01	01	PAS	Georgia	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–02	02	PAS	Georgia	Floridan aquifer system	168	111	168
florpas1	FLORPAS1–03	03	PAS	Georgia	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–04	04	PAS	Georgia	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–05	05	PAS	Georgia	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–06	06	PAS	Georgia	Floridan aquifer system	400	157	400
florpas1	FLORPAS1–07	07	PAS	Georgia	Floridan aquifer system	775	470	775

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

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Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
florpas1	FLORPAS1–08	08	PAS	Georgia	Floridan aquifer system	840	501	840
florpas1	FLORPAS1–09	09	PAS	Georgia	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–10	10	PAS	Georgia	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–11	11	PAS	Georgia	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–12	12	PAS	Georgia	Floridan aquifer system	525	250	525
florpas1	FLORPAS1–13	13	PAS	Georgia	Floridan aquifer system	576	262	576
florpas1	FLORPAS1–14	14	PAS	Georgia	Floridan aquifer system	590	na	590*
florpas1	FLORPAS1–15	15	PAS	Georgia	Floridan aquifer system	289	210	289
florpas1	FLORPAS1–16	16	PAS	Georgia	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–17	17	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–18	18	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–19	19	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–20	20	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–21	21	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–22	22	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–23	23	PAS	Florida	Floridan aquifer system	170	114	170*
florpas1	FLORPAS1–24	24	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–25	25	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–26	26	PAS	Florida	Floridan aquifer system	621	304	621*
florpas1	FLORPAS1–27	27	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–28	28	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–29	29	PAS	Florida	Floridan aquifer system	578	248	578*
florpas1	FLORPAS1–30	30	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–31	31	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–32	32	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–33	33	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–34	34	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–35	35	PAS	Florida	Floridan aquifer system	na	na	na

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

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Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
florpas1	FLORPAS1–36	36	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–37	37	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–38	38	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–39	39	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–40	40	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–41	41	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–42	42	PAS	Florida	Floridan aquifer system	140	na	140*
florpas1	FLORPAS1–43	43	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–44	44	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–45	45	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–46	46	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–47	47	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–48	48	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–49	49	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–50	50	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–51	51	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–52	52	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–53	53	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–54	54	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–55	55	PAS	Florida	Floridan aquifer system	265	85	265*
florpas1	FLORPAS1–56	56	PAS	Florida	Floridan aquifer system	na	na	na
florpas1	FLORPAS1–57	57	PAS	South Carolina	Floridan aquifer system	195	135	180
florpas1	FLORPAS1–58	58	PAS	South Carolina	Floridan aquifer system	200	123	200
florpas1	FLORPAS1–59	59	PAS	Alabama	Floridan aquifer system	204	na	204*
florpas1	FLORPAS1–60	60	PAS	Alabama	Floridan aquifer system	700	630	660

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

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Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
gaflluscr1	GAFLLUSCR1–01	01	LUS	Georgia	Surficial aquifer system	24	13.5	23.5
gaflluscr1	GAFLLUSCR1–02	02	LUS	Georgia	Surficial aquifer system	31	21	31
gaflluscr1	GAFLLUSCR1–03	03	LUS	Georgia	Surficial aquifer system	17	7	17
gaflluscr1	GAFLLUSCR1–04	04	LUS	Georgia	Surficial aquifer system	22	12	22
gaflluscr1	GAFLLUSCR1–05	05	LUS	Georgia	Surficial aquifer system	57	46	56
gaflluscr1	GAFLLUSCR1–06	06	LUS	Georgia	Surficial aquifer system	32	21.3	31.3
gaflluscr1	GAFLLUSCR1–07	07	LUS	Georgia	Surficial aquifer system	32	21.3	31.3
gaflluscr1	GAFLLUSCR1–08	08	LUS	Georgia	Surficial aquifer system	27	16.3	26.3
gaflluscr1	GAFLLUSCR1–09	09	LUS	Georgia	Surficial aquifer system	19	9	19
gaflluscr1	GAFLLUSCR1–10	10	LUS	Georgia	Surficial aquifer system	32	21.5	31.5
gaflluscr1	GAFLLUSCR1–11	11	LUS	Georgia	Surficial aquifer system	45	30	40
gaflluscr1	GAFLLUSCR1–12	12	LUS	Georgia	Surficial aquifer system	30	20	30
gaflluscr1	GAFLLUSCR1–13	13	LUS	Georgia	Surficial aquifer system	40	20	40
gaflluscr1	GAFLLUSCR1–14	14	LUS	Georgia	Surficial aquifer system	20	10	20
gaflluscr1	GAFLLUSCR1–15	15	LUS	Georgia	Surficial aquifer system	25	15	25
gaflluscr1	GAFLLUSCR1–16	16	LUS	Georgia	Surficial aquifer system	45	30	40
gaflluscr1	GAFLLUSCR1–17	17	LUS	Georgia	Surficial aquifer system	65	35	65
gaflluscr1	GAFLLUSCR1–18	18	LUS	Georgia	Surficial aquifer system	20	10	20
gaflluscr1	GAFLLUSCR1–19	19	LUS	Georgia	Surficial aquifer system	29	19	29
gaflluscr1	GAFLLUSCR1–20	20	LUS	Georgia	Surficial aquifer system	41	25	35
gaflluscr1	GAFLLUSCR1–21	21	LUS	Georgia	Surficial aquifer system	70	40	70
gaflluscr1	GAFLLUSCR1–22	22	LUS	Georgia	Surficial aquifer system	37	27	37
gaflluscr1	GAFLLUSCR1–23	23	LUS	Georgia	Surficial aquifer system	49	38.5	48.5
gaflluscr1	GAFLLUSCR1–24	24	LUS	Georgia	Surficial aquifer system	64	53.5	63.5
gaflluscr1	GAFLLUSCR1–25	25	LUS	Georgia	Surficial aquifer system	51	26	46
gaflluscr1	GAFLLUSCR1–26	26	LUS	Georgia	Surficial aquifer system	37	21	36
glacetn1	GLACETN1–01	01	ETN	Wisconsin	Glacial aquifer system	83	80	83
glacetn1	GLACETN1–02	02	ETN	Wisconsin	Glacial aquifer system	35	24.5	34.5

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

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Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
glacetn1	GLACETN1–03	03	ETN	Wisconsin	Glacial aquifer system	50	45.1	50.1
glacetn1	GLACETN1–04	04	ETN	Wisconsin	Glacial aquifer system	89	84	89
glacetn1	GLACETN1–05	05	ETN	Wisconsin	Glacial aquifer system	125	na	125*
hpaqpas1	HPAQPAS1–01	01	PAS	New Mexico	High Plains aquifer	220	195	220*
hpaqpas1	HPAQPAS1–02	02	PAS	New Mexico	High Plains aquifer	200	85	195
hpaqpas1	HPAQPAS1–03	03	PAS	New Mexico	High Plains aquifer	133	67	132.5
hpaqpas1	HPAQPAS1–04	04	PAS	New Mexico	High Plains aquifer	110	na	110*
hpaqpas1	HPAQPAS1–05	05	PAS	Colorado	High Plains aquifer	145	105	145
hpaqpas1	HPAQPAS1–06	06	PAS	Colorado	High Plains aquifer	307	245	305
hpaqpas1	HPAQPAS1–07	07	PAS	Colorado	High Plains aquifer	245	195	245
hpaqpas1	HPAQPAS1–08	08	PAS	Colorado	High Plains aquifer	150	132	150
hpaqpas1	HPAQPAS1–09	09	PAS	Colorado	High Plains aquifer	355	291	355
hpaqpas1	HPAQPAS1–10	10	PAS	Colorado	High Plains aquifer	297	271.5	291.5
hpaqpas1	HPAQPAS1–11	11	PAS	Colorado	High Plains aquifer	141	111	141
hpaqpas1	HPAQPAS1–12	12	PAS	Wyoming	High Plains aquifer	116	22	116
hpaqpas1	HPAQPAS1–13	13	PAS	Wyoming	High Plains aquifer	361	240	320
hpaqpas1	HPAQPAS1–14	14	PAS	Wyoming	High Plains aquifer	500	190	500
hpaqpas1	HPAQPAS1–15	15	PAS	Wyoming	High Plains aquifer	665	290	665
hpaqpas1	HPAQPAS1–16	16	PAS	Wyoming	High Plains aquifer	446	61	360
hpaqpas1	HPAQPAS1–17	17	PAS	Nebraska	High Plains aquifer	190	148	188
hpaqpas1	HPAQPAS1–18	18	PAS	Nebraska	High Plains aquifer	440	320	440
hpaqpas1	HPAQPAS1–19	19	PAS	Nebraska	High Plains aquifer	211	171	211
hpaqpas1	HPAQPAS1–20	20	PAS	Nebraska	High Plains aquifer	54	32	43
hpaqpas1	HPAQPAS1–21	21	PAS	Nebraska	High Plains aquifer	211	197	209
hpaqpas1	HPAQPAS1–22	22	PAS	Nebraska	High Plains aquifer	68	52	68
hpaqpas1	HPAQPAS1–23	23	PAS	Nebraska	High Plains aquifer	252	158	252
hpaqpas1	HPAQPAS1–24	24	PAS	Nebraska	High Plains aquifer	314	212	312
hpaqpas1	HPAQPAS1–25	25	PAS	Nebraska	High Plains aquifer	298	198	298

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

[MAS, major aquifer study; na, information is not available and cannot be assumed; PAS, principal aquifer study; *, information is unavailable about the bottom of perforation, but it is assumed to be bottom of well (well_depth); LUS, land-use study network; ETN, enhanced trends network; **, the recorded well depth was less than the recorded depth to the bottom of the perforated interval but is assumed to be the depth to the bottom of the perforated interval; VFPS, vertical flow-path study]

Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
hpaqpas1	HPAQPAS1–26	26	PAS	Nebraska	High Plains aquifer	155	130	150
hpaqpas1	HPAQPAS1–27	27	PAS	Nebraska	High Plains aquifer	378	335	375
hpaqpas1	HPAQPAS1–28	28	PAS	Nebraska	High Plains aquifer	81	53	78
hpaqpas1	HPAQPAS1–29	29	PAS	Nebraska	High Plains aquifer	730	640	700
hpaqpas1	HPAQPAS1–30	30	PAS	Nebraska	High Plains aquifer	180	140	180
hpaqpas1	HPAQPAS1–31	31	PAS	Nebraska	High Plains aquifer	98	75	95
hpaqpas1	HPAQPAS1–32	32	PAS	Nebraska	High Plains aquifer	330	270	315
hpaqpas1	HPAQPAS1–33	33	PAS	Nebraska	High Plains aquifer	364	314	364
hpaqpas1	HPAQPAS1–34	34	PAS	Nebraska	High Plains aquifer	230	140	230
hpaqpas1	HPAQPAS1–35	35	PAS	Nebraska	High Plains aquifer	140	109	135
hpaqpas1	HPAQPAS1–36	36	PAS	Nebraska	High Plains aquifer	268	173	268
hpaqpas1	HPAQPAS1–37	37	PAS	Nebraska	High Plains aquifer	340	280	340
hpaqpas1	HPAQPAS1–38	38	PAS	Nebraska	High Plains aquifer	465	380	460
hpaqpas1	HPAQPAS1–39	39	PAS	Nebraska	High Plains aquifer	325	130	325
hpaqpas1	HPAQPAS1–40	40	PAS	Nebraska	High Plains aquifer	180	60	120
hpaqpas1	HPAQPAS1–41	41	PAS	Nebraska	High Plains aquifer	90	45	90
hpaqpas1	HPAQPAS1–42	42	PAS	Nebraska	High Plains aquifer	447	348	443
hpaqpas1	HPAQPAS1–43	43	PAS	Nebraska	High Plains aquifer	190	140	180
hpaqpas1	HPAQPAS1–44	44	PAS	Nebraska	High Plains aquifer	360	317	357
hpaqpas1	HPAQPAS1–45	45	PAS	Nebraska	High Plains aquifer	360	255	335
hpaqpas1	HPAQPAS1–46	46	PAS	Nebraska	High Plains aquifer	112	88	98
hpaqpas1	HPAQPAS1–47	47	PAS	Nebraska	High Plains aquifer	300	260	300
hpaqpas1	HPAQPAS1–48	48	PAS	Nebraska	High Plains aquifer	117	96	116
hpaqpas1	HPAQPAS1–49	49	PAS	Kansas	High Plains aquifer	247	80	241
hpaqpas1	HPAQPAS1–50	50	PAS	Kansas	High Plains aquifer	127	94	127
hpaqpas1	HPAQPAS1–51	51	PAS	Kansas	High Plains aquifer	110**	85	110
hpaqpas1	HPAQPAS1–52	52	PAS	Kansas	High Plains aquifer	146	125	146
hpaqpas1	HPAQPAS1–53	53	PAS	Kansas	High Plains aquifer	436	243	436

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

[MAS, major aquifer study; na, information is not available and cannot be assumed; PAS, principal aquifer study; *, information is unavailable about the bottom of perforation, but it is assumed to be bottom of well (well_depth); LUS, land-use study network; ETN, enhanced trends network; **, the recorded well depth was less than the recorded depth to the bottom of the perforated interval but is assumed to be the depth to the bottom of the perforated interval; VFPS, vertical flow-path study]

Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
hpaqpas1	HPAQPAS1–54	54	PAS	Kansas	High Plains aquifer	545	322	545
hpaqpas1	HPAQPAS1–55	55	PAS	Kansas	High Plains aquifer	212	192	212
hpaqpas1	HPAQPAS1–56	56	PAS	Kansas	High Plains aquifer	194	na	194*
hpaqpas1	HPAQPAS1–57	57	PAS	Kansas	High Plains aquifer	122	99	118
hpaqpas1	HPAQPAS1–58	58	PAS	Kansas	High Plains aquifer	270	230	270
hpaqpas1	HPAQPAS1–59	59	PAS	Kansas	High Plains aquifer	146	na	146*
hpaqpas1	HPAQPAS1–60	60	PAS	Oklahoma	High Plains aquifer	276	206	236
hpaqpas1	HPAQPAS1–61	61	PAS	Oklahoma	High Plains aquifer	324	215	315
hpaqpas1	HPAQPAS1–62	62	PAS	Oklahoma	High Plains aquifer	188	168	188
hpaqpas1	HPAQPAS1–63	63	PAS	Oklahoma	High Plains aquifer	300	na	300*
hpaqvfps1	HPAQVFPS1–1	01	VFPS	Nebraska	High Plains aquifer	230	210	230
hpaqvfps1	HPAQVFPS1–10	10	VFPS	Nebraska	High Plains aquifer	200	100	200
hpaqvfps1	HPAQVFPS1–11	11	VFPS	Nebraska	High Plains aquifer	92	77	87
hpaqvfps1	HPAQVFPS1–12	12	VFPS	Nebraska	High Plains aquifer	183	173	183
hpaqvfps1	HPAQVFPS1–13	13	VFPS	Nebraska	High Plains aquifer	118	102.7	112.7
hpaqvfps1	HPAQVFPS1–14	14	VFPS	Nebraska	High Plains aquifer	200	180	200
hpaqvfps1	HPAQVFPS1–15	15	VFPS	Nebraska	High Plains aquifer	112	97	107
hpaqvfps1	HPAQVFPS1–16	16	VFPS	Nebraska	High Plains aquifer	190	130	190
hpaqvfps1	HPAQVFPS1–17	17	VFPS	Nebraska	High Plains aquifer	124	108	118
hpaqvfps1	HPAQVFPS1–18	18	VFPS	Nebraska	High Plains aquifer	59	43	53
hpaqvfps1	HPAQVFPS1–19	19	VFPS	Nebraska	High Plains aquifer	98	82.7	92.7
hpaqvfps1	HPAQVFPS1–2	02	VFPS	Nebraska	High Plains aquifer	129	113.9	123.9
hpaqvfps1	HPAQVFPS1–20	20	VFPS	Nebraska	High Plains aquifer	109	93.3	103.3
hpaqvfps1	HPAQVFPS1–21	21	VFPS	Nebraska	High Plains aquifer	156	130	150
hpaqvfps1	HPAQVFPS1–22	22	VFPS	Nebraska	High Plains aquifer	180	160	180
hpaqvfps1	HPAQVFPS1–23	23	VFPS	Nebraska	High Plains aquifer	94	78.1	88.1
hpaqvfps1	HPAQVFPS1–24	24	VFPS	Nebraska	High Plains aquifer	54	38.1	48.1
hpaqvfps1	HPAQVFPS1–25	25	VFPS	Nebraska	High Plains aquifer	134	118	128

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

[MAS, major aquifer study; na, information is not available and cannot be assumed; PAS, principal aquifer study; *, information is unavailable about the bottom of perforation, but it is assumed to be bottom of well (well_depth); LUS, land-use study network; ETN, enhanced trends network; **, the recorded well depth was less than the recorded depth to the bottom of the perforated interval but is assumed to be the depth to the bottom of the perforated interval; VFPS, vertical flow-path study]

Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
hpaqvfps1	HPAQVFPS1–26	26	VFPS	Nebraska	High Plains aquifer	158	138	158
hpaqvfps1	HPAQVFPS1–27	27	VFPS	Nebraska	High Plains aquifer	136	132	136
hpaqvfps1	HPAQVFPS1–28	28	VFPS	Nebraska	High Plains aquifer	99	83.1	93.1
hpaqvfps1	HPAQVFPS1–29	29	VFPS	Nebraska	High Plains aquifer	128	112.9	122.9
hpaqvfps1	HPAQVFPS1–03	03	VFPS	Nebraska	High Plains aquifer	158	143	153
hpaqvfps1	HPAQVFPS1–30	30	VFPS	Nebraska	High Plains aquifer	114	98.1	108.1
hpaqvfps1	HPAQVFPS1–31	31	VFPS	Nebraska	High Plains aquifer	129	113	123
hpaqvfps1	HPAQVFPS1–32	32	VFPS	Nebraska	High Plains aquifer	160	140	160
hpaqvfps1	HPAQVFPS1–33	33	VFPS	Nebraska	High Plains aquifer	114	98.5	108.5
hpaqvfps1	HPAQVFPS1–34	34	VFPS	Nebraska	High Plains aquifer	202	192	202
hpaqvfps1	HPAQVFPS1–04	04	VFPS	Nebraska	High Plains aquifer	118	102.8	112.8
hpaqvfps1	HPAQVFPS1–05	05	VFPS	Nebraska	High Plains aquifer	119	103	113
hpaqvfps1	HPAQVFPS1–06	06	VFPS	Nebraska	High Plains aquifer	185	165	185
hpaqvfps1	HPAQVFPS1–07	07	VFPS	Nebraska	High Plains aquifer	210	180	210
hpaqvfps1	HPAQVFPS1–08	08	VFPS	Nebraska	High Plains aquifer	170	150	170
hpaqvfps1	HPAQVFPS1–09	09	VFPS	Nebraska	High Plains aquifer	232	192	232
lirblusrc1	LIRBLUSRC1–01	01	LUS	Missouri	Glacial aquifer system	29	23.8	28.8
lirblusrc1	LIRBLUSRC1–02	02	LUS	Missouri	Glacial aquifer system	23	17.4	22.4
lirblusrc1	LIRBLUSRC1–03	03	LUS	Missouri	Glacial aquifer system	8	5	8
lirblusrc1	LIRBLUSRC1–04	04	LUS	Missouri	Glacial aquifer system	34	28.7	33.7
lirblusrc1	LIRBLUSRC1–05	05	LUS	Missouri	Glacial aquifer system	15	9.7	14.7
lirblusrc1	LIRBLUSRC1–06	06	LUS	Missouri	Glacial aquifer system	43	37.4	42.4
lirblusrc1	LIRBLUSRC1–07	07	LUS	Missouri	Glacial aquifer system	24	18.2	23.2
lirblusrc1	LIRBLUSRC1–08	08	LUS	Missouri	Glacial aquifer system	21	15.9	20.9
lirblusrc1	LIRBLUSRC1–09	09	LUS	Missouri	Glacial aquifer system	29	23.9	28.9
lirblusrc1	LIRBLUSRC1–10	10	LUS	Missouri	Glacial aquifer system	20	14.5	19.5
lirblusrc1	LIRBLUSRC1–11	11	LUS	Missouri	Glacial aquifer system	28	22.1	24.1
lirblusrc1	LIRBLUSRC1–12	12	LUS	Illinois	Glacial aquifer system	44	38	43

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

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Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
lirblusrc1	LIRBLUSRC1–13	13	LUS	Illinois	Glacial aquifer system	19	13.8	18.8
lirblusrc1	LIRBLUSRC1–14	14	LUS	Illinois	Glacial aquifer system	44	38	43
lirblusrc1	LIRBLUSRC1–15	15	LUS	Illinois	Glacial aquifer system	54	48.1	53.1
lirblusrc1	LIRBLUSRC1–16	16	LUS	Illinois	Glacial aquifer system	37	31	36
lirblusrc1	LIRBLUSRC1–17	17	LUS	Illinois	Glacial aquifer system	31	25.4	30.4
lirblusrc1	LIRBLUSRC1–18	18	LUS	Illinois	Glacial aquifer system	60	53.5	58.5
lirblusrc1	LIRBLUSRC1–19	19	LUS	Illinois	Glacial aquifer system	20.5**	14.5	20.5
lirblusrc1	LIRBLUSRC1–20	20	LUS	Illinois	Glacial aquifer system	17	11.5	16.5
lirblusrc1	LIRBLUSRC1–21	21	LUS	Illinois	Glacial aquifer system	24	18.6	23.6
lirblusrc1	LIRBLUSRC1–22	22	LUS	Illinois	Glacial aquifer system	47	41.1	46.1
lirblusrc1	LIRBLUSRC1–23	23	LUS	Illinois	Glacial aquifer system	24	18.6	23.6
lirblusrc1	LIRBLUSRC1–24	24	LUS	Illinois	Glacial aquifer system	43	37.9	42.9
lirblusrc1	LIRBLUSRC1–25	25	LUS	Illinois	Glacial aquifer system	38	32.9	37.9
metxetn1	METXETN1–01	01	ETN	Tennessee	Mississippi Embayment-Texas Coastal Uplands aquifer system	624	520	624
metxetn1	METXETN1–02	02	ETN	Tennessee	Mississippi Embayment-Texas Coastal Uplands aquifer system	90	80	90
metxpas1	METXPAS1–61	61	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,080	na	1,080*
metxpas1	METXPAS1–62	62	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	696	na	696*
metxpas1	METXPAS1–63	63	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	630	na	630*
metxpas1	METXPAS1–64	64	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,072	na	1,072*
metxpas1	METXPAS1–65	65	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	697	na	697*
metxpas1	METXPAS1–66	66	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	156	na	156*
metxpas1	METXPAS1–67	67	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	740	na	740*
metxpas1	METXPAS1–68	68	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	510	na	510*
metxpas1	METXPAS1–69	69	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	423	na	423*
metxpas1	METXPAS1–70	70	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	2,376	na	2,376*
metxpas1	METXPAS1–71	71	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	530	na	530*
metxpas1	METXPAS1–72	72	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	695	na	695*
metxpas1	METXPAS1–73	73	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	750	na	750*

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

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Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
metxpas1	METXPAS1–74	74	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	4,261	na	4,261*
metxpas1	METXPAS1–75	75	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	560	na	560*
metxpas1	METXPAS1–76	76	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	880	na	880*
metxpas1	METXPAS1–77	77	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	825	na	825*
metxpas1	METXPAS1–78	78	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	565	na	565*
metxpas1	METXPAS1–79	79	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	653	na	653*
metxpas1	METXPAS1–80	80	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	2,082	na	2,082*
metxpas1	METXPAS1–81	81	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,960	na	1,960*
metxpas1	METXPAS1–82	82	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,064	na	1,064*
metxpas1	METXPAS1–83	83	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,572	na	1,572*
metxpas1	METXPAS1–84	84	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,220	na	1,220*
metxpas1	METXPAS1–85	85	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,033	na	1,033*
metxpas1	METXPAS1–86	86	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,054	na	1,054*
metxpas1	METXPAS1–87	87	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,250	na	1,250*
metxpas1	METXPAS1–88	88	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	800	na	800*
metxpas1	METXPAS1–89	89	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,306	na	1,306*
metxpas1	METXPAS1–90	90	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,580	na	1,580*
metxpas1	METXPAS1–91	91	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	1,314	na	1,314*
metxpas1	METXPAS1–92	92	PAS	Texas	Mississippi Embayment-Texas Coastal Uplands aquifer system	515	na	515*
nacpetn1	NACPETN1–01	01	ETN	Delaware	Northern Atlantic Coastal Plain aquifer system	22	19	22
nacpetn1	NACPETN1–02	02	ETN	Delaware	Northern Atlantic Coastal Plain aquifer system	139	85	135
nacpetn1	NACPETN1–03	03	ETN	Delaware	Northern Atlantic Coastal Plain aquifer system	119	100	119
negxetn1	NEGXETN1–01	01	ETN	New Hampshire	Glacial aquifer and New England crystalline-rock aquifers	83	73	83
negxetn1	NEGXETN1–02	02	ETN	New Hampshire	Glacial aquifer and New England crystalline-rock aquifers	492	88	492
negxetn1	NEGXETN1–03	03	ETN	New Hampshire	Glacial aquifer and New England crystalline-rock aquifers	176.3	na	176.3*

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

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Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
podllusrc1	PODLUSRC1–01	01	LUS	Maryland	Piedmont and Blue Ridge crystalline-rock aquifers	50**	19	50
podllusrc1	PODLUSRC1–03	03	LUS	Maryland	Piedmont and Blue Ridge crystalline-rock aquifers	45	38	45
podllusrc1	PODLUSRC1–05	05	LUS	Maryland	Piedmont and Blue Ridge crystalline-rock aquifers	68.8	53.5	68.8
podllusrc1	PODLUSRC1–06	06	LUS	Maryland	Piedmont and Blue Ridge crystalline-rock aquifers	45	18.5	45
podllusrc1	PODLUSRC1–11	11	LUS	Maryland	Piedmont and Blue Ridge crystalline-rock aquifers	59.8	33	59
podllusrc1	PODLUSRC1–12	12	LUS	Maryland	Piedmont and Blue Ridge crystalline-rock aquifers	65.4	30	65
podllusrc1	PODLUSRC1–13	13	LUS	Maryland	Piedmont and Blue Ridge crystalline-rock aquifers	75**	20	75
podllusrc1	PODLUSRC1–16	16	LUS	Maryland	Piedmont and Blue Ridge crystalline-rock aquifers	64.8	23	64.8
podllusrc1	PODLUSRC1–21	21	LUS	Maryland	Piedmont and Blue Ridge crystalline-rock aquifers	45.1	18	45.1
podllusrc1	PODLUSRC1–23	23	LUS	Maryland	Piedmont and Blue Ridge crystalline-rock aquifers	77	30	77
podllusrc1	PODLUSRC1–28	28	LUS	Maryland	Piedmont and Blue Ridge crystalline-rock aquifers	43.2	15	43.2
podllusrc1	PODLUSRC1–35	35	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	120.4	17.5	120
podllusrc1	PODLUSRC1–46	46	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	47**	33	47
podllusrc1	PODLUSRC1–47	47	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	61.6	20	61.6
podllusrc1	PODLUSRC1–49	49	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	82**	18.5	82
podllusrc1	PODLUSRC1–52	52	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	62**	14	62
podllusrc1	PODLUSRC1–63	63	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	78.9	52.5	78.9
podllusrc1	PODLUSRC1–65	65	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	62**	11	62
podllusrc1	PODLUSRC1–69	69	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	58.9	38	58.9
podllusrc1	PODLUSRC1–72	72	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	77**	12.5	77
podllusrc1	PODLUSRC1–74	74	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	44**	33	44
podllusrc1	PODLUSRC1–76	76	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	67.1	53	67.1
podllusrc1	PODLUSRC1–79	79	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	55	36.5	55
podllusrc1	PODLUSRC1–85	85	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	120	27	120
podllusrc1	PODLUSRC1–86	86	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	56**	23	56

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

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Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
podllusrc1	PODLUSRC1–87	87	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	72**	23	72
podllusrc1	PODLUSRC1–89	89	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	50	40	50
podllusrc1	PODLUSRC1–99	99	LUS	Virginia	Piedmont and Blue Ridge crystalline-rock aquifers	96	na	96*
rgaqetn1	RGAQETN1–01	01	ETN	New Mexico	Rio Grande aquifer system	22.6	7.5	17.5
rgaqetn1	RGAQETN1–02	02	ETN	New Mexico	Rio Grande aquifer system	60	40	60
rgaqetn1	RGAQETN1–03	03	ETN	New Mexico	Rio Grande aquifer system	22	11.5	21.5
rgaqpas1	RGAQPAS1U–01	01	PAS	New Mexico	Rio Grande aquifer system	223	210	220
rgaqpas1	RGAQPAS1U–02	02	PAS	New Mexico	Rio Grande aquifer system	165.5	134.7	154.7
rgaqpas1	RGAQPAS1U–03	03	PAS	New Mexico	Rio Grande aquifer system	1,321.5	1,290	1,310
rgaqpas1	RGAQPAS1U–04	04	PAS	New Mexico	Rio Grande aquifer system	1,723	991	1,711
rgaqpas1	RGAQPAS1U–05	05	PAS	New Mexico	Rio Grande aquifer system	427	396.1	416.1
rgaqpas1	RGAQPAS1U–06	06	PAS	New Mexico	Rio Grande aquifer system	198	167.2	187.2
rgaqpas1	RGAQPAS1U–07	07	PAS	New Mexico	Rio Grande aquifer system	42	na	42*
rgaqpas1	RGAQPAS1U–08	08	PAS	New Mexico	Rio Grande aquifer system	1,194	479	1,184
rgaqpas1	RGAQPAS1U–09	09	PAS	New Mexico	Rio Grande aquifer system	520	na	520*
rgaqpas1	RGAQPAS1U–10	10	PAS	New Mexico	Rio Grande aquifer system	306	276	296
rgaqpas1	RGAQPAS1U–11	11	PAS	New Mexico	Rio Grande aquifer system	100	na	100*
rgaqpas1	RGAQPAS1U–12	12	PAS	New Mexico	Rio Grande aquifer system	800	na	800*
rgaqpas1	RGAQPAS1U–13	13	PAS	New Mexico	Rio Grande aquifer system	177	na	177*
rgaqpas1	RGAQPAS1U–14	14	PAS	New Mexico	Rio Grande aquifer system	200	na	200*
rgaqpas1	RGAQPAS1U–15	15	PAS	New Mexico	Rio Grande aquifer system	1,525	1,515	1,520
rgaqpas1	RGAQPAS1U–16	16	PAS	New Mexico	Rio Grande aquifer system	na	na	na
rgaqpas1	RGAQPAS1U–17	17	PAS	New Mexico	Rio Grande aquifer system	1,630	1,580	1,620
rgaqpas1	RGAQPAS1U–18	18	PAS	New Mexico	Rio Grande aquifer system	na	na	na
rgaqpas1	RGAQPAS1U–19	19	PAS	New Mexico	Rio Grande aquifer system	na	na	na
sanjluscr1a	SANJLUSCR1A–01	01	LUS	California	Central Valley aquifer system	160	140	160
sanjluscr1a	SANJLUSCR1A–02	02	LUS	California	Central Valley aquifer system	127	107	127
sanjluscr1a	SANJLUSCR1A–03	03	LUS	California	Central Valley aquifer system	125	105	125

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

[MAS, major aquifer study; na, information is not available and cannot be assumed; PAS, principal aquifer study; *, information is unavailable about the bottom of perforation, but it is assumed to be bottom of well (well_depth); LUS, land-use study network; ETN, enhanced trends network; **, the recorded well depth was less than the recorded depth to the bottom of the perforated interval but is assumed to be the depth to the bottom of the perforated interval; VFPS, vertical flow-path study]

Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
sanjluscr1a	SANJLUSCR1A–04	04	LUS	California	Central Valley aquifer system	108	na	108*
sanjluscr1a	SANJLUSCR1A–05	05	LUS	California	Central Valley aquifer system	125	105	125
sanjluscr1a	SANJLUSCR1A–06	06	LUS	California	Central Valley aquifer system	130	110	130
sanjluscr1a	SANJLUSCR1A–07	07	LUS	California	Central Valley aquifer system	115	95	115
sanjluscr1a	SANJLUSCR1A–09	09	LUS	California	Central Valley aquifer system	110	na	110*
sanjluscr1a	SANJLUSCR1A–10	10	LUS	California	Central Valley aquifer system	165	na	165*
sanjluscr1a	SANJLUSCR1A–11	11	LUS	California	Central Valley aquifer system	417	na	417*
sanjluscr1a	SANJLUSCR1A–12	12	LUS	California	Central Valley aquifer system	212	na	212*
sanjluscr1a	SANJLUSCR1A–13	13	LUS	California	Central Valley aquifer system	200	140	200
sanjluscr1a	SANJLUSCR1A–14	14	LUS	California	Central Valley aquifer system	160	120	160
sanjluscr1a	SANJLUSCR1A–15	15	LUS	California	Central Valley aquifer system	200	180	200
sanjluscr1a	SANJLUSCR1A–16	16	LUS	California	Central Valley aquifer system	55	35	55
sanjluscr1a	SANJLUSCR1A–17	17	LUS	California	Central Valley aquifer system	200	150	190
sanjluscr1a	SANJLUSCR1A–19	19	LUS	California	Central Valley aquifer system	147	na	147*
sanjluscr1a	SANJLUSCR1A–20	20	LUS	California	Central Valley aquifer system	118	na	118*
sanjluscr1a	SANJLUSCR1A–21	21	LUS	California	Central Valley aquifer system	366	192	366
sanjluscr1a	SANJLUSCR1A–22	22	LUS	California	Central Valley aquifer system	280	220	280
sanjluscr1a	SANJLUSCR1A–23	23	LUS	California	Central Valley aquifer system	313	na	313*
sanjluscr1a/ sanjsus1	SANJLUSCR1A–18/ SANJSUS1–02	18 (luscr1a) or 02 (sus1)	LUS/ MAS	California	Central Valley aquifer system	182	158	182
sanjluscr1a/ sanjsus1	SANJLUSCR1A–08/ SANJSUS1–01	08 (luscr1a) or 01 (sus1)	LUS/ MAS	California	Central Valley aquifer system	108	na	108*
sanjsus1	SANJSUS1–03	03	MAS	California	Central Valley aquifer system	160	na	160*
sanjsus1	SANJSUS1–04	04	MAS	California	Central Valley aquifer system	215	195	215
sanjsus1	SANJSUS1–05	05	MAS	California	Central Valley aquifer system	110	92	110
sanjsus1	SANJSUS1–06	06	MAS	California	Central Valley aquifer system	182	162	182
sanjsus1	SANJSUS1–07	07	MAS	California	Central Valley aquifer system	121	116	121
sanjsus1	SANJSUS1–08	08	MAS	California	Central Valley aquifer system	120	80	120

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

[MAS, major aquifer study; na, information is not available and cannot be assumed; PAS, principal aquifer study; *, information is unavailable about the bottom of perforation, but it is assumed to be bottom of well (well_depth); LUS, land-use study network; ETN, enhanced trends network; **, the recorded well depth was less than the recorded depth to the bottom of the perforated interval but is assumed to be the depth to the bottom of the perforated interval; VFPS, vertical flow-path study]

Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
sanjsus1	SANJSUS1–09	09	MAS	California	Central Valley aquifer system	72	25	72
sanjsus1	SANJSUS1–10	10	MAS	California	Central Valley aquifer system	145	105	145
sanjsus1	SANJSUS1–11	11	MAS	California	Central Valley aquifer system	124	64	124
sanjsus1	SANJSUS1–12	12	MAS	California	Central Valley aquifer system	120	40	120
sanjsus1	SANJSUS1–13	13	MAS	California	Central Valley aquifer system	104	38	63
sanjsus1	SANJSUS1–14	14	MAS	California	Central Valley aquifer system	340	na	340*
sanjsus1	SANJSUS1–15	15	MAS	California	Central Valley aquifer system	73	na	73*
sanjsus1	SANJSUS1–16	16	MAS	California	Central Valley aquifer system	236	200	236
sanjsus1	SANJSUS1–17	17	MAS	California	Central Valley aquifer system	300	na	300*
sanjsus1	SANJSUS1–18	18	MAS	California	Central Valley aquifer system	400	na	400*
sanjsus1	SANJSUS1–19	19	MAS	California	Central Valley aquifer system	336	na	336*
sanjsus1	SANJSUS1–20	20	MAS	California	Central Valley aquifer system	310	210	310
sanjsus1	SANJSUS1–21	21	MAS	California	Central Valley aquifer system	232	160	232
sanjsus1	SANJSUS1–22	22	MAS	California	Central Valley aquifer system	300	200	300
sanjsus1	SANJSUS1–23	23	MAS	California	Central Valley aquifer system	350	200	350
sanjsus1	SANJSUS1–24	24	MAS	California	Central Valley aquifer system	200	160	200
sanjsus1	SANJSUS1–25	25	MAS	California	Central Valley aquifer system	702	602	702
sanjsus1	SANJSUS1–26	26	MAS	California	Central Valley aquifer system	485**	475	485
trinlusrc1	TRINLUSRC1–01	01	LUS	Texas	Coastal lowlands aquifer system	33.5	20.5	30.5
trinlusrc1	TRINLUSRC1–02	02	LUS	Texas	Coastal lowlands aquifer system	41	28	38
trinlusrc1	TRINLUSRC1–03	03	LUS	Texas	Coastal lowlands aquifer system	53.5	40.5	50.5
trinlusrc1	TRINLUSRC1–04	04	LUS	Texas	Coastal lowlands aquifer system	43.5	30.5	40.5
trinlusrc1	TRINLUSRC1–05	05	LUS	Texas	Coastal lowlands aquifer system	33.5	20.5	30.5
trinlusrc1	TRINLUSRC1–06	06	LUS	Texas	Coastal lowlands aquifer system	53	40	50
trinlusrc1	TRINLUSRC1–07	07	LUS	Texas	Coastal lowlands aquifer system	26.5	13.5	23.5
trinlusrc1	TRINLUSRC1–08	08	LUS	Texas	Coastal lowlands aquifer system	33.5	20.5	30.5
trinlusrc1	TRINLUSRC1–09	09	LUS	Texas	Coastal lowlands aquifer system	23.5	10.5	20.5
trinlusrc1	TRINLUSRC1–10	10	LUS	Texas	Coastal lowlands aquifer system	32.5	19.5	29.5

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

[MAS, major aquifer study; na, information is not available and cannot be assumed; PAS, principal aquifer study; *, information is unavailable about the bottom of perforation, but it is assumed to be bottom of well (well_depth); LUS, land-use study network; ETN, enhanced trends network; **, the recorded well depth was less than the recorded depth to the bottom of the perforated interval but is assumed to be the depth to the bottom of the perforated interval; VFPS, vertical flow-path study]

Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
trinlusrc1	TRINLUSRC1–11	11	LUS	Texas	Coastal lowlands aquifer system	33.5	20.5	30.5
trinlusrc1	TRINLUSRC1–12	12	LUS	Texas	Coastal lowlands aquifer system	27.5	14.5	24.5
trinlusrc1	TRINLUSRC1–13	13	LUS	Texas	Coastal lowlands aquifer system	33	23	33
trinlusrc1	TRINLUSRC1–14	14	LUS	Texas	Coastal lowlands aquifer system	28.5	15.5	25.5
trinlusrc1	TRINLUSRC1–15	15	LUS	Texas	Coastal lowlands aquifer system	46.5	33.5	43.5
trinlusrc1	TRINLUSRC1–16	16	LUS	Texas	Coastal lowlands aquifer system	28.5	15.5	25.5
trinlusrc1	TRINLUSRC1–17	17	LUS	Texas	Coastal lowlands aquifer system	33.5	20.5	30.5
trinlusrc1	TRINLUSRC1–18	18	LUS	Texas	Coastal lowlands aquifer system	33.5	20.5	30.5
trinlusrc1	TRINLUSRC1–19	19	LUS	Texas	Coastal lowlands aquifer system	66.2	51.2	61.2
trinlusrc1	TRINLUSRC1–20	20	LUS	Texas	Coastal lowlands aquifer system	41	28	38
trinlusrc1	TRINLUSRC1–21	21	LUS	Texas	Coastal lowlands aquifer system	30	20	30
trinlusrc1	TRINLUSRC1–22	22	LUS	Texas	Coastal lowlands aquifer system	73	60	73
trinlusrc1	TRINLUSRC1–23	23	LUS	Texas	Coastal lowlands aquifer system	48	38	48
trinlusrc1	TRINLUSRC1–24	24	LUS	Texas	Coastal lowlands aquifer system	53.5	38.5	48.5
trinlusrc1	TRINLUSRC1–25	25	LUS	Texas	Coastal lowlands aquifer system	118.5	105.5	115.5
trinlusrc1	TRINLUSRC1–26	26	LUS	Texas	Coastal lowlands aquifer system	83.5	68.5	78.5
trinlusrc1	TRINLUSRC1–27	27	LUS	Texas	Coastal lowlands aquifer system	38.5	25.5	35.5
wmicsus1	WMICSUS1–01	01	MAS	Wisconsin	Cambrian-Ordovician aquifer system	123	65	123
wmicsus1	WMICSUS1–02	02	MAS	Wisconsin	Cambrian-Ordovician aquifer system	210	179	210
wmicsus1	WMICSUS1–03	03	MAS	Wisconsin	Cambrian-Ordovician aquifer system	320	135	320
wmicsus1	WMICSUS1–04	04	MAS	Wisconsin	Cambrian-Ordovician aquifer system	111	66	111
wmicsus1	WMICSUS1–05	05	MAS	Wisconsin	Cambrian-Ordovician aquifer system	466	324	466
wmicsus1	WMICSUS1–06	06	MAS	Wisconsin	Cambrian-Ordovician aquifer system	179	125	179
wmicsus1	WMICSUS1–07	07	MAS	Wisconsin	Cambrian-Ordovician aquifer system	102	42	102
wmicsus1	WMICSUS1–08	08	MAS	Wisconsin	Cambrian-Ordovician aquifer system	95	63	95
wmicsus1	WMICSUS1–09	09	MAS	Wisconsin	Cambrian-Ordovician aquifer system	95	80	95
wmicsus1	WMICSUS1–10	10	MAS	Wisconsin	Cambrian-Ordovician aquifer system	675	457	675
wmicsus1	WMICSUS1–11	11	MAS	Wisconsin	Cambrian-Ordovician aquifer system	140	119	140

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

[MAS, major aquifer study; na, information is not available and cannot be assumed; PAS, principal aquifer study; *, information is unavailable about the bottom of perforation, but it is assumed to be bottom of well (well_depth); LUS, land-use study network; ETN, enhanced trends network; **, the recorded well depth was less than the recorded depth to the bottom of the perforated interval but is assumed to be the depth to the bottom of the perforated interval; VFPS, vertical flow-path study]

Network name	Well identification number	Identification number shown on figures 2–19	Network type	State	Aquifer	Well depth, in feet below land surface	Depth to perforation top, in feet below land surface	Depth to perforation bottom, in feet below land surface
wmicsus1	WMICSUS1–12	12	MAS	Wisconsin	Cambrian-Ordovician aquifer system	870	235	870
wmicsus1	WMICSUS1–13	13	MAS	Wisconsin	Cambrian-Ordovician aquifer system	125	97	125
wmicsus1	WMICSUS1–14	14	MAS	Wisconsin	Cambrian-Ordovician aquifer system	346	120	346
wmicsus1	WMICSUS1–15	15	MAS	Michigan	Cambrian-Ordovician aquifer system	432	332	432
wmicsus1	WMICSUS1–16	16	MAS	Michigan	Cambrian-Ordovician aquifer system	46	na	46*
wmicsus1	WMICSUS1–17	17	MAS	Michigan	Cambrian-Ordovician aquifer system	483	212	483
wmicsus1	WMICSUS1–18	18	MAS	Michigan	Cambrian-Ordovician aquifer system	137	na	137*
wmicsus1	WMICSUS1–19	19	MAS	Michigan	Cambrian-Ordovician aquifer system	290	252	290
wmicsus1	WMICSUS1–20	20	MAS	Michigan	Cambrian-Ordovician aquifer system	305	203	305
wmicsus1	WMICSUS1–21	21	MAS	Michigan	Cambrian-Ordovician aquifer system	31	28	31

Appendixes 1–3

Appendix 1. Well Depth and Open Interval by Study Network

Table 1.1. 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	Numbr of wells with well depth data	Well depth, in feet below land surface							
				Minimum	10th percentile	25th percentile	Median	75th percentile	95th percentile	Maximum	Mean
ETN	clptetn1	3	3	40	nc	nc	80	nc	nc	1,116	nc
ETN	cvaletn1	3	3	234	nc	nc	320	nc	nc	620	nc
ETN	edtretn1	3	3	300	nc	nc	550	nc	nc	1,550	nc
ETN	glacetn1	5	5	34.5	nc	nc	83	nc	nc	125	nc
ETN	metxetn1	2	2	90	nc	nc	357	nc	nc	624	nc
ETN	nacpetn1	3	3	22	nc	nc	119	nc	nc	139	nc
ETN	negxetn1	3	3	83	nc	nc	176.3	nc	nc	492	nc
ETN	rgaqetn1	3	3	22	nc	nc	22.6	nc	nc	60	nc
LUS	ccptlusor1b	21	21	15	19	24.5	29	48.5	73.1	90	39
LUS	cnbrluscr1	27	27	15	20	24.8	32	45	65	73	36
LUS	gaflluscr1	26	26	17	20	25.4	31.8	45	64.8	70	37
LUS	lirblusrc1	25	25	8	17.9	21.4	29.3	42.9	52.2	60	31
LUS	podllusrc1	28	28	43.2	45	50	62	75.5	111.6	120.4	66
LUS	sanjluscr1a	23	23	55	108.4	121.5	160	200	360.7	417	179
LUS	trinlusrc1	27	27	23.5	28.1	32.8	33.5	50.5	80.4	118.5	44
MAS	acfbsus1	27	26	64	77.5	98.9	131.5	213.5	248.8	370	156
MAS	sanjsus1	26	26	72	106	120.3	191	307.5	463.8	702	232
MAS	wmicsus1	21	21	31	95	111	179	346	675	870	266
PAS	bnrcpas1	20	13	269	282.2	350	520	620	1,070	1,205	556
PAS	florpas1	60	17	140	169.2	200	400	590	788	840	426
PAS	hpaqpas1	63	63	54	110.4	145.5	230	335	496.5	730	259
PAS	metxpas1	32	32	156	516.5	647.3	852.5	1264	2,214.3	4,261	1,089
PAS	rgaqpas1	19	16	42	132.8	192.8	366.4	1,225.9	1,653.3	1,723	660
VFPS	hpaqvfps1	34	34	53.6	95.0	113.7	131.5	182.3	217	232	144

Table 1.2. 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	Mean
ETN	clptetn1	3	2	1	nc	nc	87.5	nc	nc	174	nc
ETN	cvaletn1	3	3	10	nc	nc	150	nc	nc	200	nc
ETN	edtretn1	3	3	80	nc	nc	230	nc	nc	233	nc
ETN	glacetn1	5	4	3	nc	nc	5	nc	nc	10	nc
ETN	metxetn1	2	2	10	nc	nc	57	nc	nc	104	nc
ETN	nacpetn1	3	3	3	nc	nc	19	nc	nc	50	nc
ETN	negxetn1	3	2	10	nc	nc	207	nc	nc	404	nc
ETN	rgaqetn1	3	3	10	nc	nc	10	nc	nc	20	nc
LUS	ccptlusor1b	21	21	5	5	5	5	5	10	10	6
LUS	cnbrluscr1	27	27	5	5	5	5	10	10	10	7
LUS	gaflluscr1	26	26	10	10	10	10	10	27.5	30	13
LUS	lirblusrc1	25	25	2	5	5	5	5	5	6	5
LUS	podllusrc1	28	27	7	12.8	19.7	31	48.5	84.5	102.5	37
LUS	sanjluscr1a	23	14	20	20	20	20	40	99.9	174	40
LUS	trinlusrc1	27	27	10	10	10	10	10	10	13	10
MAS	acfbsus1	27	26	3	11.7	26	57.5	115.5	163.8	250	73
MAS	sanjsus1	26	19	5	16.4	22	40	76	105	150	52
MAS	wmicsus1	21	19	3	19.8	31.5	58	163.5	307.4	635	119
PAS	bnrcpas1	20	11	40	40	80	200	382.5	521	532	243
PAS	florpas1	60	14	30	48.3	62	211.5	311.8	333.2	339	189
PAS	hpaqpas1	63	59	10	19.8	25	45	94	230.6	375	74
PAS	metxpas1	32	0	na	na	na	na	na	na	na	na
PAS	rgaqpas1	19	10	5	9.5	20	20	35	713.3	720	158
VFPS	hpaqvfps1	34	34	4	10	10	10	20	47	100	18

Appendix 2. 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, 2017) online database (table 2.1). The links in table 2.1 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 parameters because of equipment failures at various times during the data-collection period.

Table 2.1. Web links to data collected at a high-frequency from enhanced trends networks.

[See figures 17–18 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
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	CLPTETN1–06	https://waterdata.usgs.gov/nwis/uv?site_no=454919119184701
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

Reference Cited

U.S. Geological Survey, 2017, National Water Information System—Web interface: U.S. Geological Survey, accessed May 31, 2017, at https://doi.org/10.5066/F7P55KJN.

Appendix 3. Quality-Control Data and Analysis

Samples

Quality-control (QC) samples are routinely collected along with the environmental groundwater samples. The third cycle of the NAWQA groundwater studies began in 2013 but there was a small pilot study in 2012. The entire third cycle sampling period currently is May 2012–December 2015; 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). 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 blank samples from the entire Cycle 3 sampling period (May 2012–December 2015) as well as the January–December 2015 sampling period covered by this report. A summary of results from blank samples collected during the sampling period January–December 2015 is shown in table 3.1, and a summary for the Cycle 3 sampling period is shown in table 3.2. Data from the blank QC samples from the January–December 2015 sampling period are presented in tables 3.3–3.10 of Arnold and others (2018).

Blank Sample Approach

Blank samples are QC samples that are used to determine if water samples might 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 2015 sampling period of January–December 2015 and the Cycle 3 sampling period are presented in this report. Data from 2015 are published in this report, data from 2012–13 are published in Arnold and others (2016a, b), and data from 2014 are published in Arnold and others (2017a, b). About 75 to 80 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 National Water-Quality Laboratory (NWQL, Denver, Colorado) 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.

Blank Sample Counts

The total number of blank samples and the number of field blanks collected for groundwater sites differs by constituent group during both the 2015 sampling period and the Cycle 3 sampling period (tables 3.1 and 3.2, respectively). Data for all blank samples from the 2015 sampling period are presented in tables 3.3–3.10 of Arnold and others (2018). 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 (2016b, 2017a, 2018). Of the 457 VOC blank samples collected during the Cycle 3 sampling period, 28 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); 429 were collected in 2013–15 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 143 pesticide blank samples collected during the Cycle 3 sampling period, 8 were collected

Table 3.1. Summary of results for field blanks collected by the National Water-Quality Assessment Project from January 2015 to December 2015.

[VOCs, volatile organic compounds; HHB, human-health benchmark; SMCL, secondary maximum contaminant level]

Type of summary	Major and minor elements (not including dissolved solids)	Trace elements	Nutrients	VOCs	Pesticide compounds
Total number of blank samples	47	99	100	107	37
Number of field blanks	42	43	44	37	32
Number of constituents analyzed	10	22	5	85	227
Number of constituents detected in field blanks	8	20	3	15	5
Number of constituents detected in field blanks that have an HHB	0	17	2	7	3
Number of constituents detected in field blanks that have an SMCL	3	4	0	0	0
Largest ratio of the maximum concentration in a field blank to the corresponding HHB, in percent	Not applicable	4.8	0.63	2.4	0.001
Largest ratio of the maximum concentration in a field blank to the corresponding SMCL, in percent	1.7	51	Not applicable	Not applicable	Not applicable

Table 3.2. Summary of results for field blanks collected by the National Water-Quality Assessment Project from May 2012 to December 2015.

[VOCs, volatile organic compounds; HHB, human-health benchmark; SMCL, secondary maximum contaminant level]

Type of summary	Major and minor elements (not including dissolved solids)	Trace elements	Nutrients	VOCs	Pesticide compounds
Total number of blank samples	302	352	350	457	143
Number of field blanks	155	154	156	152	132
Number of constituents analyzed	10	22	5	129	272
Number of constituents detected in field blanks	9	21	4	25	21
Number of constituents detected in field blanks that have an HHB	1	18	2	12	15
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	0.4	4.8	0.67	2.4	0.25
Largest ratio of the maximum concentration in a field blank to the corresponding SMCL, in percent	14	199	Not applicable	Not applicable	Not applicable

in 2012 and analyzed for an older analytical schedule using gas chromatography/mass spectrometry; 135 were collected in 2013–15 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 3.1 are sample counts for special analytes collected only in selected well networks during the Cycle 3 sampling period: arsenic species, perchlorate, and hexavalent chromium; only 1 to 9 field blanks were collected for each of these analytes in January–December 2015.

Constituent Concentrations in Blank Samples

Of the 10 major or minor elements included in laboratory analysis (not including analysis for dissolved-solids concentration), 8 were detected in at least 1 field blank collected in 2015 (table 3.1); 9 elements were detected in at least 1 field blank (table 3.2) collected during the Cycle 3 sampling period. 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, 2018); four (chloride, fluoride, sulfate, and iron) had SMCLs. The maximum concentration for fluoride in any field blank from the Cycle 3 sampling period was 0.4 percent of its corresponding HHB. For chloride, fluoride, 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 iron, the maximum concentration was 14 percent of its corresponding SMCL.

Of the 22 trace elements included in laboratory analysis, 20 were detected in at least 1 field blank collected in 2015 (table 3.1), and 21 were detected in at least 1 field blank from the Cycle 3 sampling period (table 3.2). 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, 2018); 5 (aluminum, copper, manganese, silver, and zinc) had SMCLs. For 11 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 7 trace elements (antimony, arsenic, beryllium, copper, lead, nickel, and thallium), 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 and manganese, the maximum concentration was less than 4 percent of the corresponding SMCL. However, for aluminum the maximum concentration was nearly 200 percent of the corresponding SMCL. 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 and during August–December 2015 (USGS Inorganic Blind Sample Project, https://bqs.usgs.gov/ibsp/). Investigation of this issue by the NWQL indicated sporadic contamination at concentrations of as much as 63 µg/L from about 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 Project field blanks collected through the end of December 2015, reported detections of aluminum above the laboratory reporting limit were in blank samples collected primarily between May 29 and July 16, 2014, and between March 25 and September 8, 2015.

Also regarding trace elements, the maximum concentration of manganese (1.83 µg/L) reported in a field blank from the Cycle 3 sampling period was less than 1 percent of the corresponding HHB of 300 µg/L. However, the USGS Office of Water Quality has documented random low-level contamination of water samples with 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). Cobalt, which has no corresponding HHB, similarly was documented to be randomly introduced to water samples by the capsule filters. Blank samples for cobalt and manganese that were collected for the NAWQA Project 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 2015 (table 3.1), and four were detected in at least one field blank from the Cycle 3 sampling period (table 3.2). 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, 2018); 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.

Blank samples collected in 2012 were analyzed for 85 VOCs, and blank samples collected in 2013 through 2015 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, 15 VOCs were detected in at least 1 field blank collected in 2015 (table 3.1), and 25 VOCs were detected in at least 1 field blank from the Cycle 3 sampling period (table 3.2). Of the 12 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), all have HHBs (table 2 of Arnold and others, 2018) 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 2015 were analyzed for 227 pesticide compounds; the change in laboratory methods and constituents resulted in 272 pesticide compounds being included in the overall dataset of blank results. Five pesticide compounds were detected in at least one field blank collected in 2015 (table 3.1), and 21 pesticide compounds were detected in at least one field blank from the Cycle 3 sampling period (table 3.2). Of the 15 compounds detected in field blanks from the Cycle 3 sampling period (atrazine, metolachlor, nicosulfuron, piperonyl butoxide, aldicarb sulfone, bromacil, cis-permethrin, desulfinylfipronil, diflubenzuron, imazethapyr, metribuzin, oxamyl, propiconazole, tebuthiuron, and trans-permethrin), all have HHBs (table 2 of Arnold and others, 2018) 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 2015 for arsenic speciation had no detections. Five field blanks were collected for arsenic speciation during the Cycle 3 sampling period. In these five 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. Therefore, it is possible that contamination could limit the suitability of arsenate results for comparison with the arsenic HHB. Perchlorate was not detected in any of the nine field blanks collected during 2015, or in any of the 14 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 14 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. Corresponding total chromium values typically are reported by the same USGS Trace Metal Laboratory in Boulder, Colo., that analyzes for hexavalent chromium. For the seven hexavalent chromium field blanks collected in 2015, six had corresponding total chromium results, and no detections of total chromium were reported. Of the 13 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 hexavalent chromium or total chromium from the USGS Trace Metal Laboratory to affect comparison of these values to HHBs.

The maximum concentrations of major and minor ions, 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 trace elements, the maximum concentrations in field blanks from the Cycle 3 sampling period also are substantially less than the relevant thresholds with the exception of aluminum. Because data from laboratory blind blanks and from NAWQA Project field blanks indicate that laboratory contamination might have affected aluminum results considerably for some environmental samples from late May 2014 through at least December 2015, aluminum results from this period cannot be classified positively as moderate or high relative to the SMCL of 50 µg/L.

References Cited

Arnold, T.L., Bexfield, L.M., Musgrove, MaryLynn, Lindsey, B.D., Stackelberg, P.E., Barlow, J.R., DeSimone, L.A., Kulongoski, J.T., Kingsbury, J.A., Ayotte, J.D., Fleming, B.J., and Belitz, Kenneth, 2017a, Datasets from groundwater quality data from the National Water Quality Assessment Project, January through December 2014 and select quality-control data from May 2012 through December 2014: U.S. Geological Survey data release, accessed March 28, 2018, at https://doi.org/10.5066/F7W0942N.

Arnold, T.L., Bexfield, L.M., Musgrove, MaryLynn, Lindsey, B.D., Stackelberg, P.E., Barlow, J.R., DeSimone, L.A., Kulongoski, J.T., Kingsbury, J.A., Ayotte, J.D., Fleming, B.J., and Belitz, Kenneth, 2017b, Groundwater-quality data from the National Water-Quality Assessment Project, January through December 2014 and select quality-control data from May 2012 through December 2014: U.S. Geological Survey Data Series 1063, 83 p., accessed March 28, 2018, at https://doi.org/10.3133/ds1063.

Arnold, T.L., Bexfield, L.M., Musgrove, MaryLynn, Stackelberg, P.E., Lindsey, B.D., Kingsbury, J.A., Kulongoski, J.T., Belitz, Kenneth, and Sharpe, J.B., 2018, Datasets from groundwater-quality and select quality-control data from the National Water-Quality Assessment Project, January through December 2015 and previously unpublished data from 2013–2014: U.S. Geological Survey data release, accessed June 21, 2018, at https://doi.org/10.5066/F7XK8DHK.

Arnold, T.L., DeSimone, L.A., Bexfield, L.M., Lindsey, B.D., Barlow, J.R., Kulongoski, J.T., Musgrove, MaryLynn, Kingsbury, J.A., and Belitz, Kenneth, 2016a, Groundwater quality data from the National Water-Quality Assessment Project, May 2012 through December 2013: U.S. Geological Survey Data Series 997, 56 p., accessed March 28, 2018, at https://doi.org/10.3133/ds997.

Arnold, T.L., DeSimone, L.A., Bexfield, L.M., Lindsey, B.D., Barlow, J.R., Kulongoski, J.T., Musgrove, MaryLynn, Kingsbury, J.A., and Belitz, Kenneth, 2016b, Groundwater quality data from the National Water Quality Assessment Project, May 2012 through December 2013 and select quality-control data from May 2012 through December 2013: U.S. Geological Survey data release, accessed March 28, 2018, at https://doi.org/10.5066/F7HQ3X18.

Bender, D.A., Zagorsky, J.S., Mueller, D.K., Rose, D.L., Martin, J.D., and Brenner, C.K., 2011, Quality of volatile organic compound data from groundwater and surface water for the National Water-Quality Assessment Program, October 1996–December 2008: U.S. Geological Survey Scientific Investigations Report 2011–5204, 128 p., accessed January 4, 2016, at https://pubs.usgs.gov/sir/2011/5204/.

Davis, T.A., Olsen, L.D., Fram, M.S., and Belitz, Kenneth, 2014, Updated study reporting levels (SRLs) for trace-element data collected for the California Groundwater Ambient Monitoring and Assessment (GAMA) Priority Basin Project, October 2009–March 2013: U.S. Geological Survey Scientific Investigations Report 2014–5105, 52 p., accessed January 4, 2016, at https://doi.org/10.3133/sir20145105.

Fram, M.S., Olsen, L.D., and Belitz, Kenneth, 2012, Evaluation of volatile organic compound (VOC) blank data and application of study reporting levels to groundwater data collected for the California GAMA Priority Basin Project, May 2004 through September 2010: U.S. Geological Survey Scientific Investigations Report 2012–5139, 94 p., accessed January 4, 2016, at https://pubs.usgs.gov/sir/2012/5139/.

Gilliom, R.J., Barbash, J.E., Crawford, C.G., Hamilton, P.A., Martin, J.D., Nakagaki, Naomi, Nowell, L.H., Scott, J.C., Stackelberg, P.E., Thelin, G.P., and Wolock, D.M., 2006, The quality of our Nation's waters—Pesticides in the Nation's streams and ground water, 1992–2001: U.S. Geological Survey Circular 1291, accessed January 4, 2016, at https://pubs.usgs.gov/circ/2005/1291/.

Olsen, L.D., Fram, M.S., and Belitz, Kenneth, 2010, Review of trace-element field-blank data collected for the California Groundwater Ambient Monitoring and Assessment (GAMA) Program, May 2004–January 2008: U.S. Geological Survey Scientific Investigations Report 2009–5220, 47 p., accessed January 4, 2016, at https://pubs.usgs.gov/sir/2009/5220/.

Zogorski, J.S., Carter, J.M., Ivahnenko, Tamara, Lapham, W.W., Moran, M.J., Rowe, B.L., Squillace, P.J., and Toccalino, P.L., 2006, The quality of our Nation's waters—Volatile organic compounds in the Nation's groundwater and drinking-water supply wells: U.S. Geological Survey Circular 1292, 101 p., accessed January 4, 2016, at http://pubs.usgs.gov/circ/circ1292/.

For more information about this publication, contact
Director, USGS Central Midwest Water Science Center
405 N. Goodwin
Urbana, IL 61801
(217) 328–8747

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