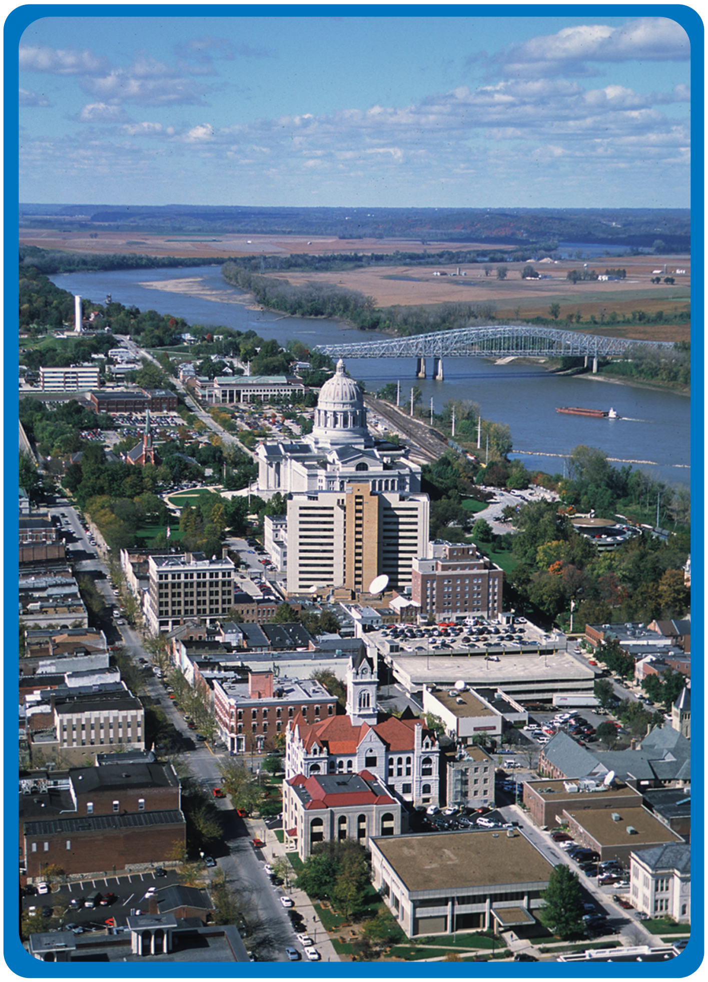
National Water-Quality Assessment Program

Estimated Withdrawals from Stream-Valley Aquifers and Refined Estimated Withdrawals from Selected Aquifers in the United States, 2000



Scientific Investigations Report 2008–5003

U.S. Department of the Interior
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Cover:

Left: The Missouri River separates agriculture from the city life as it flows past the Missouri State Capitol in Jefferson City, Missouri (photograph by Sarah Minor, U.S. Department of Agriculture, Natural Resources Conservation Service, 2002).

Upper right: Center pivot irrigation on wheat growing in Yuma County, Colorado (photograph by Gene Alexander, U.S. Department of Agriculture, Natural Resources Conservation Service, 1987).

Lower right: View to the southwest showing the Red River alluvial valley at the Louisiana Highway 8 bridge near Boyce, Louisiana (photograph by Dennis K. Demcheck, U.S. Geological Survey, December 2007).

Estimated Withdrawals from Stream-Valley Aquifers and Refined Estimated Withdrawals from Selected Aquifers in the United States, 2000

By B. Pierre Sargent, Molly A. Maupin, and Stephen R. Hinkle

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Foreword

The U.S. Geological Survey (USGS) is committed to providing the Nation with credible scientific information that helps to enhance and protect the overall quality of life and that facilitates effective management of water, biological, energy, and mineral resources (*http://www.usgs.gov/*). Information on the Nation's water resources is critical to ensuring long-term availability of water that is safe for drinking and recreation and is suitable for industry, irrigation, and fish and wildlife. Population growth and increasing demands for water make the availability of that water, now measured in terms of quantity and quality, even more essential to the long-term sustainability of our communities and ecosystems.

The USGS implemented the National Water-Quality Assessment (NAWQA) Program in 1991 to support national, regional, State, and local information needs and decisions related to water-quality management and policy (*http://water.usgs.gov/nawqa*). The NAWQA Program is designed to answer: What is the condition of our Nation's streams and ground water? How are conditions changing over time? How do natural features and human activities affect the quality of streams and ground water, and where are those effects most pronounced? By combining information on water chemistry, physical characteristics, stream habitat, and aquatic life, the NAWQA Program aims to provide science-based insights for current and emerging water issues and priorities. From 1991-2001, the NAWQA Program completed interdisciplinary assessments and established a baseline understanding of water-quality conditions in 51 of the Nation's river basins and aquifers, referred to as Study Units (*http://water.usgs.gov/nawqa/studyu.html*).

In the second decade of the Program (2001–2012), a major focus is on regional assessments of water-quality conditions and trends. These regional assessments are based on major river basins and principal aquifers, which encompass larger regions of the country than the Study Units. Regional assessments extend the findings in the Study Units by filling critical gaps in characterizing the quality of surface water and ground water, and by determining status and trends at sites that have been consistently monitored for more than a decade. In addition, the regional assessments continue to build an understanding of how natural features and human activities affect water quality. Many of the regional assessments employ modeling and other scientific tools, developed on the basis of data collected at individual sites, to help extend knowledge of water quality to unmonitored, yet comparable areas within the regions. The models thereby enhance the value of our existing data and our understanding of the hydrologic system. In addition, the models are useful in evaluating various resource-management scenarios and in predicting how our actions, such as reducing or managing nonpoint and point sources of contamination, land conversion, and altering flow and (or) pumping regimes, are likely to affect water conditions within a region.

Other activities planned during the second decade include continuing national syntheses of information on pesticides, volatile organic compounds (VOCs), nutrients, selected trace elements, and aquatic ecology; and continuing national topical studies on the fate of agricultural chemicals, effects of urbanization on stream ecosystems, bioaccumulation of mercury in stream ecosystems, effects of nutrient enrichment on stream ecosystems, and transport of contaminants to public-supply wells.

The USGS aims to disseminate credible, timely, and relevant science information to address practical and effective water-resource management and strategies that protect and restore water quality. We hope this NAWQA publication will provide you with insights and information to meet your needs, and will foster increased citizen awareness and involvement in the protection and restoration of our Nation's waters.

The USGS recognizes that a national assessment by a single program cannot address all water-resource issues of interest. External coordination at all levels is critical for cost-effective management, regulation, and conservation of our Nation's water resources. The NAWQA Program, therefore, depends on advice and information from other agencies—Federal, State, regional, interstate, Tribal, and local—as well as nongovernmental organizations, industry, academia, and other stakeholder groups. Your assistance and suggestions are greatly appreciated.

Matthew C. Larsen
Acting Associate Director for Water

Acknowledgments

The authors gratefully acknowledge the cooperation of U.S. Geological Survey National Water Use Information Program contacts for state water-use information. They are identified, and contact information for them is listed on the World Wide Web at *http://water.usgs.gov/watuse/wupersonnel.html*. Additional thanks are extended to personnel at state agencies who provided fresh ground-water withdrawal data or answered questions about aquifer extent and productivity, depth to water, or suitability of water quality for a specific water use. Wendy J. Danchuk, a cartographer at the U.S. Geological Survey, and Michael D. Kemppainen, a scientific illustrator at the U.S. Geological Survey, assisted with preparation of illustrations.

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Conversion Factors and Datum

Multiply	By	To obtain
	Length	
mile (mi)	1.609	kilometer (km)
	Area	
acre	43,560	square foot (ft^2)
acre	4,047	square meter (m^2)
acre	0.001562	square mile (mi^2)
	Volume	
gallon	3. 785	liter (L)
	Flow rate	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
gallon per day (gal/d)	3.785	liter per day
million gallons per day (Mgal/d)	1.121	thousand acre-feet per year
	0.001547	thousand cubic feet per second
	0.6944	thousand gallons per minute
	0.003785	million cubic meters per day
	1.3815	million cubic meters per year

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

Estimated Withdrawals from Stream-Valley Aquifers and Refined Estimated Withdrawals from Selected Aquifers in the United States, 2000

By B. Pierre Sargent, Molly A. Maupin, and Stephen R. Hinkle

Abstract

The U.S. Geological Survey National Water Use Information Program compiles estimates of fresh ground-water withdrawals in the United States on a 5-year interval. In the year-2000 compilation, withdrawals were reported from principal aquifers and aquifer systems including two general aquifers—*Alluvial* and *Other* aquifers. Withdrawals from a widespread aquifer group—stream-valley aquifers—were not specifically identified in the year-2000 compilation, but they are important sources of ground water. Stream-valley aquifers are alluvial aquifers located in the valley of major streams and rivers. Stream-valley aquifers are long but narrow aquifers that are in direct hydraulic connection with associated streams and limited in extent compared to most principal aquifers.

Based in large part on information published in U.S. Geological Survey reports, preliminary analysis of withdrawal data and hydrogeologic and surface-water information indicated areas in the United States where possible stream-valley aquifers were located. Further assessment focused on 24 states and the Commonwealth of Puerto Rico. Withdrawals reported from *Alluvial* aquifers and (or) *Other* aquifers in 22 states and the Commonwealth of Puerto Rico were investigated. Two additional States—Arkansas and New Jersey—were investigated because withdrawals reported from other principal aquifers in these two States may have been from stream-valley aquifers.

Withdrawals from stream-valley aquifers were identified in 20 States and were 1,560 Mgal/d (million gallons per day), a rate comparable to withdrawals from the 10th most productive principal aquifer in the United States. Of the 1,560 Mgal/d of withdrawals attributed to stream-valley aquifers, 1,240 Mgal/d were disaggregated from *Alluvial* aquifers, 150 Mgal/d from glacial sand and gravel aquifers, 116 Mgal/d from *Other* aquifers, 28.1 Mgal/d from Pennsylvanian aquifers, and 24.9 Mgal/d from the Mississippi River Valley alluvial aquifer. Five States, including Colorado (552 Mgal/d), Kansas (384 Mgal/d), Oklahoma (126 Mgal/d), Kentucky (102 Mgal/d), and Ohio (100 Mgal/d), accounted for 81 percent of estimated stream-valley aquifer withdrawals identified in this report. Of the total withdrawals from stream-valley aquifers, about 63 percent (984 Mgal/d) were used for irrigation, 26 percent (400 Mgal/d) for public-supply, and 11 percent (177 Mgal/d) for self-supplied industrial uses. The largest estimated water withdrawals were from stream-valley aquifers associated with the South Platte (404 Mgal/d), Arkansas (395 Mgal/d), and Ohio (221 Mgal/d) Rivers.

Introduction

The U.S. Geological Survey (USGS) National Water Use Information Program (NWUIP) compiles estimates of fresh ground-water withdrawals in the United States on a 5-year interval. Water-use reports that present the compilations are accessible on the World Wide Web (online) at *http://water.usgs.gov/watuse/50years.html*, and the compilation data grouped by county and watershed are accessible at *http://water.usgs.gov/watuse/*. In this report, the compilation of interest is for the year 2000 and is referred to as the 2000 compilation. As part of the 2000 compilation, the USGS estimated ground-water withdrawals for 66 principal aquifers and aquifer systems and an *Other*[1] aquifer group. The *Other* aquifer group includes withdrawals from aquifers that were not included in one of the principal aquifers. The resulting publication, "Estimated Withdrawals from Principal Aquifers in the United States, 2000" (Maupin and Barber, 2005), which is accessible online at *http://pubs.usgs.gov/circ/2005/1279*, includes estimated freshwater withdrawals for the water-use categories of irrigation, public supply, and self-supplied industrial. The three categories of use represented 92 percent of total ground-water use in the United States in 2000 (Maupin and Barber, 2005).

Most of the principal aquifers and aquifer systems are equivalent to major aquifers and aquifer systems described

[1] The specific term *Other* aquifers, denoted with *italics*, is used to refer to withdrawals from various miscellaneous aquifers and water-bearing units reported as "Other" aquifers by Maupin and Barber (2005).

by Miller (2000) in the “Ground Water Atlas of the United States” (hereafter called the atlas) and are depicted on the map of the “Principal Aquifers of the 48 conterminous United States, Hawaii, Puerto Rico, and the U.S. Virgin Islands” (hereafter called the principal aquifer map) (U.S. Geological Survey, 2003). Although *Alluvial*[2] and *Other* aquifers (Maupin and Barber, 2005) are not shown on the principal aquifer map, large withdrawals were assigned to these two general aquifers. Stream-valley aquifers were not specifically identified by Maupin and Barber (2005); however, the NWUIP recognized the importance of stream-valley aquifer withdrawals. The aquifer group, *Alluvial* aquifers, was expected to include withdrawals from stream-valley aquifers and other alluvial materials.

Withdrawals from the *Alluvial* (1,800 Mgal/d [million gallons per day]) and *Other* (1,160 Mgal/d) aquifers were the 10th and 11th largest, respectively, within the ranking of total withdrawals from the 67 aquifers and aquifer systems in the United States in 2000 (Maupin and Barber, 2005). Further investigation of withdrawals from *Alluvial* and *Other* aquifers was needed to (1) improve the knowledge of regional water availability and use, and (2) refine (disaggregate and redistribute) withdrawals assigned to *Alluvial* and *Other* aquifers to determine whether another potentially important aquifer group—stream-valley aquifers—provides substantial amounts of freshwater for irrigation, public-supply, and self-supplied industrial uses.

Background

Identification and compilation of withdrawals from stream-valley aquifers will provide information useful to water managers and the USGS water-resources monitoring and assessment programs. In particular, refined water-withdrawal data will assist the USGS National Water-Quality Assessment (NAWQA) Program in addressing its long-term goals: the description of the status and trends in the quality of a large, representative part of the Nation’s surface and ground-water resources, and the identification of the major natural and human factors that affect the quality of these resources. In 2001, the NAWQA Program began ground-water investigations that focused on regional assessments based on a framework of principal aquifers that provide the majority of water used in the United States (Lapham and others, 2005). The studies included 19 of the principal aquifers (Lapham and others, 2005) shown on the principal aquifer map (U.S. Geological Survey, 2003). The criteria for selecting the 19 study sites included the analysis of withdrawals from aquifers described by the NWUIP, which provided a means to prioritize and rank principal aquifers and aquifer systems on the basis of total annual withdrawals. Withdrawal estimates from stream-valley aquifers will improve the knowledge of the nature and locations of the specific aquifers represented by *Alluvial* and *Other* aquifers in Maupin and Barber (2005), and will further assist the NAWQA Program in its overall evaluation of ground-water-quality assessments of aquifers that provide the largest withdrawals nationwide. In 2004, the NAWQA Program began a study of withdrawals from *Alluvial* and *Other* aquifers described in Maupin and Barber (2005) to determine whether any withdrawal amount could be reassigned to stream-valley aquifers or various other relatively less important (local or regional) aquifers.

Purpose and Scope

This report describes estimated fresh ground-water withdrawals for irrigation, public-supply, and self-supplied industrial uses from stream-valley aquifers in the United States for the year 2000, which were refined from estimated withdrawals from *Alluvial* aquifers, selected principal aquifers, and *Other* aquifers described by Maupin and Barber (2005). The report includes a summary of estimated stream-valley aquifer withdrawals at the state level and a brief national overview of the results of this investigation. Discussions, maps, and tables, grouped by states and water-resources regions, provide an understanding of the distribution of withdrawals from specific stream-valley aquifers. The section presented by states includes (for each state) a brief description of efforts to refine the data and tabulated withdrawals for the three water-use categories; supporting information on each state’s sources of data for the 2000 compilation is included in appendix 1. The relative importance of withdrawals from *Alluvial* and *Other* aquifers in comparison to withdrawals from other principal aquifers within a state is discussed. The section presented by water-resources regions includes tabulated withdrawals within the USGS two-digit hydrologic unit codes (HUC’s) (Seaber and others, 1987).

The data presented represent the amount of water withdrawn from aquifers at the point of the well. There are no double-accounted withdrawals for a stream-valley aquifer. In this report, the amount of water withdrawn from a stream-valley aquifer and reported by a state is not included in a reported value for another state with a stream-valley aquifer of the same name. An interbasin transfer of water from stream-valley aquifers can not be determined from the data collected. The estimated withdrawals are rounded to three significant figures. All values are rounded independently; therefore, the sums of individual rounded numbers may not equal the totals. Appendix 2 lists selected water-withdrawal data from Maupin and Barber (2005) that are used in the current report.

Description of Study Area

Twenty-four states and the Commonwealth of Puerto Rico (Puerto Rico) are included in the study area (fig. 1).

[2] In this report, the general term “alluvial aquifers” refers to unconsolidated sand and gravel aquifers that typically consist of sediments deposited by rivers and streams. The term *Alluvial* aquifers denoted with italics, refers to withdrawals from alluvial-type deposits that were not represented in any other aquifer or aquifer system, as reported by Maupin and Barber (2005).

Figure 1. Location of the study area in the contiguous United States and the Commonwealth of Puerto Rico.

These states and Puerto Rico were identified as areas where stream-valley aquifer withdrawals could be present based in large part on the atlas (Miller, 2000). Many of these states and Puerto Rico reported withdrawals for *Alluvial* and/or *Other* aquifers in 2000 (Maupin and Barber, 2005). Withdrawals from *Alluvial* aquifers were reported for 16 States—Colorado, Kansas, Kentucky, Louisiana, Missouri, Montana, North Dakota, Nebraska, Ohio, Oklahoma, South Dakota, Tennessee, Texas, Utah, West Virginia, and Wyoming. Six additional States—Arizona, Illinois, Indiana, New Mexico, New York, and Pennsylvania and Puerto Rico—reported 2000 withdrawals from *Other* aquifers (Maupin and Barber, 2005). Two States—Arkansas and New Jersey—were investigated because information presented in the atlas (Miller, 2000) indicated the possible presence of stream-valley aquifers.

The study area generally excluded areas that lie completely within the maximum extent of Quaternary continental glaciation, areas west of the Rocky Mountain/Colorado Plateau region, and areas coincident with the North Atlantic Coastal Plain aquifer systems, Basin and Range basin-fill aquifers, and Northern Rocky Mountains Intermontane Basins aquifer system (U.S. Geological Survey, 2003). Within the study area, the areal extent of the High Plains aquifer and glaciated areas also were excluded from the investigation (fig. 1). In these excluded areas, stream-valley aquifers and their withdrawals typically cannot be differentiated from other principal aquifers consisting of the same types of lithologic materials.

Aquifer Terminology

A principal aquifer, as used in this report and in the principal aquifer map of the National Atlas of the United States (U.S. Geological Survey, 2003), is defined as a regionally extensive aquifer or aquifer system that has the potential to be used as a source of potable water. *Alluvial* aquifers and glacial sand and gravel aquifers are considered principal aquifers (U.S. Geological Survey, 2003; Maupin and Barber, 2005). *Alluvial* aquifers consist of sediments deposited by rivers and streams that are present in or near existing major streams (Maupin and Barber, 2005), but the aquifers also include terrace deposits and unconsolidated sediments deposited by ancient streams. Some eolian deposits or wind-blown sediments in Colorado were included in *Alluvial* aquifers (Maupin and Barber, 2005). For the purpose of this report, stream-valley aquifers are alluvial sand and gravel aquifers that are in direct hydraulic connection with an existing stream or river. Stream-valley aquifers are similar to alluvial-valley aquifers described by Rosenshein (1988, p. 174) and alluvial valleys described by Heath (1984, p. 59). Rosenshein (1988) defined alluvial-valley aquifers to be long but narrow aquifers that "are in hydraulic connection with associated streams," and that "are of limited areal extent in comparison to most aquifer systems, [but] they are among the most intensively used." Heath (1984, p. 58) defined alluvial valleys as "thick sand and gravel deposits beneath floodplains and terraces of streams." Heath (1984, p. 59) used three criteria to distinguish alluvial valleys. These criteria are as follows:

1. The valleys contain sand and gravel deposits thick enough to supply water to wells at moderate to large rates. [Commonly, the water-transmitting capacity of the sand and gravel is at least 10 times larger than that of the adjacent (enclosing) rocks.]

2. The sand and gravel deposits are in hydraulic contact with a perennial stream which serves as a source of recharge and whose flow normally far exceeds the demand from any typical well field.

3. The sand and gravel deposit occurs in a clearly defined band ('channel') that normally does not extend beyond the floodplain and adjacent terraces. (In other words, the width of the deposit is small or very small compared with its length.)

Figure 2 shows two hydrogeologic settings that illustrate the nature of stream-valley aquifers. On the left side of the figure, the sand and gravel aquifer is clearly defined within the alluvial floodplain and in hydraulic contact with the river. Recharge to wells screened in the alluvial floodplain is provided directly by precipitation or by infiltration from the river. This setting meets some of the criteria for stream-valley aquifer designation. On the right side of figure 2, the sand and gravel deposits in a buried river valley may have water-transmitting capacity greater than adjacent rocks, but recharge is reduced to the volume that passes through the overlying clay and silt. There is no direct hydraulic connection to an existing river. The setting on the right side of the figure does not meet the criteria for stream-valley aquifer designation but the sediments deposited by ancient streams may transmit sufficient water to wells to be classified as an alluvial aquifer.

In the atlas, stream-valley aquifers are defined as alluvial aquifers "located beneath channels, floodplains, and terraces in the valleys of major streams" (Miller, 2000, p. A6). Miller (2000) further states that, "stream-valley aquifers are not shown [on the principal aquifer map] because they are too small to map accurately at the scale of the figure." However, the most important stream-valley aquifers are mapped in the further descriptive atlas chapters and provide a guide for this investigation.

Glacial sand and gravel aquifers are unconsolidated deposits of sand, gravel, and silt and clay located north of the limit of Quaternary continental glaciation and east of the Rocky Mountains. Large areas of North America were subjected to episodes of continental glacial advances and retreats over millions of years. After each retreat, the glaciers left thick sequences of sediments (collectively called glacial

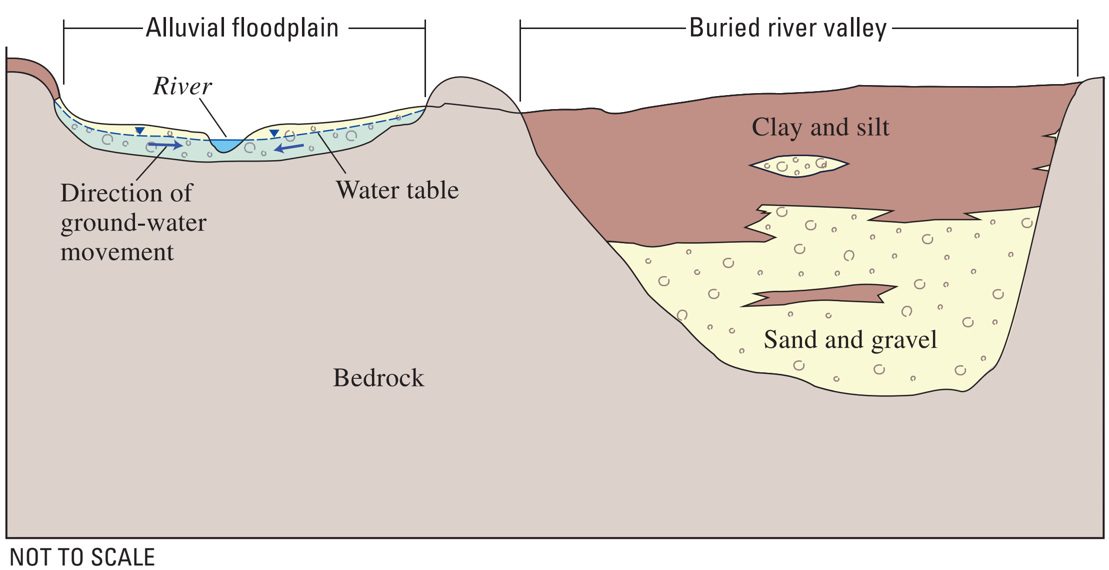


Figure 2. Diagrammatic section of hydrogeologic setting of two alluvial aquifers. The alluvial aquifer on the left meets the definition of a stream-valley aquifer, but the alluvial aquifer on the right does not.

drift) in basins and valleys. Materials deposited by the glacial ice may vary in size from clay to boulders and be unsorted and unstratified. Vast amounts of fluvial material (glacial outwash) were carried away from the glaciers by streams and rivers originating from the melting glaciers. Over time, more recent (Holocene) alluvial deposits were deposited and reworked. Glacial sand and gravel aquifers often are not distinguishable from overlying stream-valley aquifers that are present beneath and along rivers and streams.

Approach and Estimation Methods

In this report, ground-water withdrawals reported from *Alluvial* and *Other* aquifers in Maupin and Barber (2005) that meet the definition of stream-valley aquifers are identified. Residual *Alluvial* aquifer withdrawals from deposits that do not fit the definition of a stream-valley aquifer also are identified. Elevated terrace deposits in Oklahoma and eolian sand and isolated terrace deposits in Colorado are examples of deposits that do not meet the definition of a stream-valley aquifer although they are considered *Alluvial* aquifers in this report.

There are instances where withdrawals were reclassified based upon this analysis. For example, some year-2000 withdrawals from counties south of the extent of Quaternary continental glaciation previously assigned to glacial sand and gravel aquifers (Maupin and Barber, 2005) were reclassified as stream-valley aquifer withdrawals. If withdrawals from *Alluvial* or *Other* aquifers could not be disaggregated and assigned to a specific aquifer or aquifer system, the withdrawals remained assigned to *Alluvial* or *Other aquifers*. Thus estimated withdrawals from stream-valley aquifers associated with specific rivers, creeks, or areas represent a minimum estimate. Nevertheless, this estimate provides a quantitative assessment on their importance and, as such, this estimate may be useful for researchers evaluating ground-water resources at regional and national scales.

All data and supporting information were gathered from USGS offices or state agencies. Supporting information includes, for example, owner name, county, aquifer extent, eight-digit HUC, well location, well depth, and well diameter. Water-use and ground-water data used to assign withdrawals to aquifers were obtained from USGS water-use specialists in states in the study area. Sources and details of the data provided by the specialists are listed in appendix 1. Additional data for selected states were obtained from the USGS National Water Information System Ground-Water Site-Inventory System (GWSI) data base (U.S. Geological Survey, 1998). Potential sources of water-use information and guidelines for estimating water use for the 2000 compilation are described by Kenny (2004).

Maps in the atlas show the areal extent of stream-valley aquifers from which withdrawals could be estimated. USGS HUC maps (Seaber and others, 1987) and state watershed maps were used to assign stream-valley aquifer withdrawals to river basins and water-resources regions. In general, if the information was available, the smallest-size tributary name was used to designate a stream-valley aquifer.

The estimation of stream-valley aquifer withdrawals required the collecting, assessing, and joining of water-use, ground-water, and surface-water data. Water-use data typically included withdrawal rate, water source (ground water or surface water), category (irrigation, public supply, or self-supplied industrial), and Standard Industrial Classification (SIC) code (Office of Management and Budget, 1987). Ground-water data typically included well identifier, well location, aquifer unit of the screened interval, well use, well owner, well depth, well status, and well permit number. Surface-water data typically included river name, HUC's, and state watershed name. Because this was a multistate study, all data characterization had to be equivalent across state lines. In states where water-use data were assigned a SIC code, the SIC code was used to separate industrial from commercial water use, and to make comparable the self-supplied industrial water use throughout the study area.

A combination of site-specific and aggregate (non-site specific) data were available. Site-specific data include locations of individual wells or facilities where water is withdrawn. Aggregate data do not include specific locations of wells or facilities. Data are grouped by area, such as a county or watershed. In some states, water-use data (withdrawal rate, source, and use) were aggregated at the county level, but ground-water data (wells and associated data) were site specific.

Two analytical methods were used to estimate stream-valley aquifer withdrawals. The site-specific method was used to link water-use, ground-water, and surface-water data sets to specific locations. Using this method, withdrawals from each well can be grouped by location or other attributes, and totaled to estimate stream-valley aquifer withdrawals. The locations of some wells were compared with maps of watersheds and aquifers to determine stream-valley aquifer withdrawals.

An aggregate method was applied when site specific data were not available. The aggregate method typically was used to estimate withdrawals by making an assumption about the data and using knowledge of an area. In some states, a combination of both methods (aggregate and site specific) was used to estimate withdrawals. For example, withdrawal rates at individual irrigation wells in a county were not known, but ground-water withdrawals for irrigation were estimated based on county crop acreage and irrigation application rates (aggregate data) (Kenny, 2004). If the atlas indicates that only one stream-valley aquifer is present and no other alluvial deposits are present in the county, and well data indicate all irrigation wells are shallow and screened in alluvial material, the decision was made to assign all irrigation withdrawals in the county to the stream-valley aquifer.

Summary of Refined Estimated Withdrawals from Selected Aquifers in the United States, 2000

The analysis and disaggregation of ground-water withdrawals from *Alluvial* aquifers, selected principal aquifers, and *Other* aquifers as published in Maupin and Barber (2005) resulted in the identification of withdrawals of 1,560 Mgal/d from stream-valley aquifers in 20 states (table 1). This withdrawal rate is comparable to withdrawals from the 10th most productive principal aquifer in the United States (Maupin and Barber, 2005). Of the withdrawals attributed to stream-valley aquifers, 1,240 Mgal/d were disaggregated from *Alluvial* aquifers, 150 Mgal/d from glacial sand and gravel aquifers, 116 Mgal/d from *Other* aquifers, 28.1 Mgal/d from Pennsylvanian aquifers, and 24.9 Mgal/d from the Mississippi River Valley alluvial aquifer.

Ground-water withdrawals from stream-valley aquifers for each state are listed in table 2, which indicates that Colorado (552 Mgal/d), Kansas (384 Mgal/d), Oklahoma (126 Mgal/d), Kentucky (102 Mgal/d), and Ohio (100 Mgal/d) accounted for most (81 percent) of the total withdrawals from stream-valley aquifers. Of this total, 984 Mgal/d (63 percent) was for irrigation, 400 Mgal/d (26 percent) for public supply, and 177 Mgal/d (11 percent) for self-supplied industrial uses. The largest estimated water withdrawals were from stream-valley aquifers associated with the South Platte (404 Mgal/d), Arkansas (395 Mgal/d), and Ohio (221 Mgal/d) Rivers.

Estimated Withdrawals from Stream-Valley Aquifers

States and the Commonwealth of Puerto Rico

Withdrawals for irrigation, public supply, and self-supplied industrial uses from *Alluvial* and *Other* aquifers in each state in the study area were analyzed and, where applicable, assigned to stream-valley aquifers (table 3). Twenty states were determined to have withdrawals from stream-valley aquifers. In some states, such as Louisiana, a portion of withdrawals from *Alluvial* aquifers were determined to be attributable to other principal aquifers, and the withdrawals were reassigned (table 1). Where possible, withdrawals from *Other* aquifers were disaggregated to withdrawals from specific aquifers or aquifer systems. The results of the disaggregation of *Other* aquifers are tabulated in table 4, by state, aquifer or water-bearing unit, and water-use category.

Arizona

In 2000, total ground-water withdrawals for all categories of use in Arizona were about 3,420 Mgal/d (Hutson and others, 2004). About 95 percent of the withdrawals (3,240 Mgal/d) were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to three principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). No withdrawals were assigned to *Alluvial* aquifers in Arizona in 2000. Withdrawals from *Other* aquifers (88.2 Mgal/d) accounted for about 3 percent of the withdrawals from principal and *Other* aquifers in Arizona and were used for public supply (58.3 Mgal/d) and irrigation (29.9 Mgal/d) (appendix 2). No withdrawals from *Other* aquifers could be attributed to stream-valley aquifers in Arizona. All *Other* aquifer withdrawals were attributed to withdrawals in the Central Highlands Province (fig. 3).

Arkansas

In 2000, total ground-water withdrawals for all categories of use in Arkansas were 6,920 Mgal/d (Hutson and others, 2004). About 97 percent (6,710 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to four principal aquifers, including the Mississippi River Valley alluvial aquifer (Maupin and Barber, 2005) (fig. 4, appendix 2). Estimated withdrawals from the Mississippi River Valley alluvial aquifer were 6,370 Mgal/d, including 6,320 Mgal/d for irrigation, 40.5 Mgal/d for public-supply, and 5.74 Mgal/d for self-supplied industrial uses (appendix 2). No withdrawals were assigned to *Alluvial* or *Other* aquifers in Arkansas in 2000 (Maupin and Barber, 2005).

Withdrawals of 24.9 Mgal/d in Arkansas were reassigned from the Mississippi River Valley alluvial aquifer to stream-valley aquifers associated with the Red (17.5 Mgal/d), Arkansas (7.22 Mgal/d), and Ouachita-Saline Rivers (0.21 Mgal/d) (fig. 4, table 3). About 77 percent (19.1 Mgal/d) of the withdrawals were for irrigation. The reassignment reduced withdrawals from the Mississippi River Valley alluvial aquifer for the three water-use categories by less than 1 percent to 6,350 Mgal/d (table 1).

Colorado

In 2000, total ground-water withdrawals for all categories of use in Colorado were about 2,320 Mgal/d (Hutson and others, 2004). About 96 percent (2,230 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to five principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* (496 Mgal/d) and *Other* (114 Mgal/d) aquifers accounted for 27 percent of the withdrawals from principal aquifers and *Other* aquifers (appendix 2). Withdrawals were mostly for irrigation from *Alluvial* aquifers (482 Mgal/d), and to a lesser degree from *Other* aquifers (89.4 Mgal/d) (appendix 2).

A total of 552 Mgal/d, 478 Mgal/d from *Alluvial* aquifers and about 73.9 Mgal/d from *Other* aquifers (table 1), were

Table 1. Summary of original (Maupin and Barber, 2005) and revised estimated withdrawals from principal and *Other* aquifers, and estimated withdrawals attributed to stream-valley aquifers.

[Values have been rounded]

State	Principal aquifer or aquifer group	Withdrawals, in million gallons per day			
		Original total withdrawals (Maupin and Barber, 2005)	Revised total withdrawals	Difference	Withdrawals attributed to stream-valley aquifers
Arkansas	Mississippi River Valley alluvial aquifer	6,370	6,350	-24.9	24.9
Colorado	*Other* aquifers	114	40.5	-73.9	
	Alluvial aquifers	496	17.8	-478	
	Sum of previous two differences			**-552**	**552**
Illinois	Glacial sand and gravel aquifers	413	403	-9.58	
	Mississippi River Valley alluvial aquifer	.00	2.44	+2.44	
	Sum of previous two differences			**-7.14**	**7.14**
Indiana	Glacial sand and gravel aquifers	455	416	-38.5	38.5
Kansas	*Alluvial* aquifers	435	51.0	-384	384
Kentucky	*Alluvial* aquifers	123	21.6	-102	102
Louisiana	*Alluvial* aquifers	6.78	.00	-6.78	
	Coastal Lowlands aquifer system	1,040	1,040	+2.35	
	Mississippi River Valley alluvial aquifer	283	284	+1.51	
	Sum of previous three differences			**-2.93**	**2.93**
Missouri	*Alluvial* aquifers	176	122	-54.4	54.4
Montana	*Alluvial* aquifers	33.6	26.3	-7.24	7.24
Nebraska	*Alluvial* aquifers	150	147	-2.61	2.61
New York	Glacial sand and gravel aquifers	263	259	-4.07	4.07
Ohio	Glacial sand and gravel aquifers	421	321	-100	100
	Alluvial aquifers	53.0	53.0	.0	
Oklahoma	*Alluvial* aquifers	128	1.62	-126	126
Pennsylvania	*Other* aquifers	109	67.2	-42.1	
	Pennsylvanian aquifers	43.6	15.5	-28.1	
	Sum of previous two differences			**-70.2**	**70.2**
South Dakota	*Alluvial* aquifers	40.2	26.6	-13.6	13.6
Tennessee	*Alluvial* aquifers	2.43	0.13	-2.30	2.30
Texas	*Alluvial* aquifers	12.6	.00	-12.6	12.6
Utah	Basin and Range basin-fill aquifers	679	678	-0.77	
	Alluvial aquifers[1]	31.6	7.5	-24.1	
	Sum of previous two differences			**-24.8**	**24.8**
West Virginia	*Alluvial* aquifers	21.5	.16	-21.3	21.3
Wyoming	*Alluvial* aquifers	67.1	57.5	-9.59	9.59
Total estimated withdrawals attributed to stream-valley aquifers					**1,560**

[1] Withdrawals of 0.77 Mgal/d from Basin and Range basin-fill aquifers were reassigned to *Alluvial* aquifers in Utah.

Table 2. Total estimated withdrawals from stream-valley aquifers associated with major rivers, by state, 2000.

[Values have been rounded]

State	Total estimated withdrawals, in million gallons per day
Arkansas	24.9
Colorado	552
Illinois	7.14
Indiana	38.5
Kansas	384
Kentucky	102
Louisiana	2.93
Missouri	54.4
Montana	7.24
Nebraska	2.61
New York	4.07
Ohio	100
Oklahoma	126
Pennsylvania	70.2
South Dakota	13.6
Tennessee	2.30
Texas	12.6
Utah	24.8
West Virginia	21.3
Wyoming	9.59
Total	**1,560**

attributed to stream-valley aquifers associated with the South Platte (404 Mgal/d) and Arkansas (134 Mgal/d) Rivers, and miscellaneous rivers in mountainous areas (14.6 Mgal/d) (fig. 5, table 3). The withdrawals were used mostly for irrigation (526 Mgal/d). The revised total *Alluvial* aquifers withdrawals (17.8 Mgal/d, table 1) were attributed to eolian sands and isolated terrace deposits, and were used mostly for irrigation (15.2 Mgal/d, table 3).

The reassignment reduced withdrawals from *Other* aquifers by about 65 percent to 40.5 Mgal/d (table 1). The withdrawals were attributed to seven bedrock aquifers and were used mostly for irrigation (30.1 Mgal/d, table 4).

Illinois

In 2000, total ground-water withdrawals for all categories of use in Illinois were about 813 Mgal/d (Hutson and others, 2004). About 78 percent (634 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to five principal aquifers, including glacial sand and gravel aquifers and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from glacial sand and gravel aquifers (413 Mgal/d) accounted for 65 percent of total withdrawals from principal and *Other* aquifers, and included 181 Mgal/d for public-supply, 140 Mgal/d for irrigation, and 91.9 Mgal/d for self-supplied industrial uses (appendix 2). No withdrawals were assigned to the Mississippi River Valley alluvial aquifer (fig. 6) or *Alluvial* aquifers in Illinois in 2000 (Maupin and Barber, 2005). Total withdrawals from *Other* aquifers were 10.9 Mgal/d (appendix 2). No withdrawals from *Other* aquifers could be attributed to stream-valley aquifers.

Withdrawals of 7.14 Mgal/d for irrigation and public-supply uses in Illinois were reassigned from glacial sand and gravel aquifers to stream-valley aquifers (table 3). The withdrawals were 5.52, 1.19, and 0.43 Mgal/d from stream-valley aquifers associated with the Ohio River, the Mississippi River below St. Louis, and the Wabash River, respectively (fig. 6, table 3).

Withdrawals of 2.44 Mgal/d were reassigned from glacial sand and gravel aquifers to the Mississippi River Valley alluvial aquifer (fig. 6, table 1). The withdrawals included 1.63 Mgal/d for irrigation and 0.81 Mgal/d for public-supply uses (table 3). The reassignments of withdrawals reduced total withdrawals from glacial sand and gravel aquifers in Illinois by 9.58 Mgal/d, about 2 percent (table 1).

Indiana

In 2000, total ground-water withdrawals for all categories of use in Indiana were 656 Mgal/d (Hutson and others, 2004). About 76 percent (500 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to four principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). No withdrawals were assigned to *Alluvial* aquifers in Indiana in 2000. Withdrawals from glacial sand and gravel aquifers (455 Mgal/d) accounted for 91 percent of total withdrawals from principal and *Other* aquifers, and included 309 Mgal/d for public-supply, 94.9 Mgal/d for self-supplied industrial, and 50.6 Mgal/d for irrigation uses. Total withdrawals from *Other* aquifers were 0.10 Mgal/d. No withdrawals from *Other* aquifers were attributed to stream-valley aquifers.

Withdrawals of 38.5 Mgal/d were reassigned from glacial sand and gravel aquifers to stream-valley aquifers in Indiana (table 1). The withdrawals were 37.0, 1.19, and 0.37 Mgal/d from stream-valley aquifers associated with the Ohio River, the Lower East Fork White River, and the Wabash River, respectively (fig. 7, table 3). The withdrawals included 33.0 Mgal/d for public-supply, 4.98 Mgal/d for self-supplied industrial, and 0.51 Mgal/d for irrigation uses. The reassignment of withdrawals reduced withdrawals from glacial sand and gravel aquifers in Indiana by about 8 percent, to 416 Mgal/d (table 1).

Table 3. Estimated withdrawals for irrigation, public-supply, and self-supplied industrial uses from stream-valley aquifers associated with major rivers and principal aquifers in 20 States, 2000.

[Values have been rounded]

Aquifer or water-bearing unit	Withdrawals, in million gallons per day (Mgal/d), by water-use category			
	Irrigation	Public supply	Self-supplied industrial	Total
Arkansas				
Stream-valley aquifer associated with major river				
Arkansas River	3.60	3.60	0.02	7.22
Ouachita-Saline River	.05	.14	.02	.21
Red River	15.4	1.81	.24	17.4
Subtotal	**19.1**	**5.55**	**.28**	**24.9**
Mississippi River Valley alluvial aquifer[1]	**6,300**	**35.0**	**5.46**	**6,350**
Total	**6,320**	**40.6**	**5.74**	**6,370**
Colorado				
Stream-valley aquifer associated with major river				
Arkansas River	129	3.48	1.25	134
South Platte River	387	5.87	10.8	404
Miscellaneous rivers in mountainous areas	9.85	3.86	.94	14.6
Subtotal	**526**	**13.2**	**13.0**	**552**
Eolian sands and isolated terrace deposits	**15.2**	**1.86**	**.74**	**17.8**
Total[2]	**541**	**15.1**	**13.7**	**570**
Illinois[3]				
Stream-valley aquifer associated with major river (disaggregated from glacial sand and gravel aquifers)				
Mississippi River below St. Louis	.41	.78	.00	1.19
Ohio River	2.47	3.05	.00	5.52
Wabash River	.00	.43	.00	.43
Subtotal	**2.88**	**4.26**	**.00**	**7.14**
Withdrawal disaggregated from glacial sand and gravel aquifers to the Mississippi River Valley alluvial aquifer	**1.63**	**.81**	**.00**	**2.44**
Total	**4.51**	**5.07**	**.00**	**9.58**
Indiana				
Stream-valley aquifer associated with major river (disaggregated from glacial sand and gravel aquifers)				
Lower East Fork White River	.00	1.09	.10	1.19
Ohio River	.14	32.0	4.88	37.0
Wabash River	.37	.00	.00	.37
Total	**.51**	**33.0**	**4.98**	**38.5**
Kansas				
Stream-valley aquifer associated with major river				
Arkansas River	184	26.3	17.8	228
Big Blue River	.31	2.91	.00	3.22
Cimarron River	5.08	.51	.00	5.59
Kansas River	3.01	1.53	3.04	7.58
Marais des Cygnes River	.00	.05	.00	.05
Neosho River	.21	.33	.01	.55
Republican River	64.3	9.40	.10	73.8
Saline River	2.74	.55	.00	3.29
Smoky Hill River	21.2	8.56	.02	29.8
Solomon River	18.9	3.31	.00	22.2
Verdigris River	.00	.13	.00	.13
Walnut River	8.90	.57	.05	9.52
Subtotal	**309**	**54.1**	**21.0**	**384**
Withdrawal disaggregated from areas north of the line of Quaternary continental glaciation	**18.2**	**27.2**	**6.09**	**51.0**
Total	**327**	**81.3**	**27.1**	**435**

Table 3. Estimated withdrawals for irrigation, public-supply, and self-supplied industrial uses from stream-valley aquifers associated with major rivers and principal aquifers in 20 States, 2000—Continued.

[Values have been rounded]

Aquifer or water-bearing unit	Withdrawals, in million gallons per day (Mgal/d), by water-use category			
	Irrigation	Public supply	Self-supplied industrial	Total
Kentucky				
Stream-valley aquifer associated with major river (disaggregated from *Alluvial* aquifers)				
Ohio River	0.00	40.8	60.9	102
***Alluvial* aquifers, withdrawals may be from areas north of the line of Quaternary continental glaciation**	**.00**	**6.35**	**15.2**	**21.6**
Total	**.00**	**47.2**	**76.1**	**123**
Louisiana				
Stream-valley aquifer associated with major river				
Red River	2.77	.16	.00	2.93
***Alluvial* aquifers withdrawals reassigned to a principal aquifer**				
Coastal lowlands aquifer system	2.35	.00	.00	2.35
Mississippi River Valley alluvial aquifer	1.51	.00	.00	1.51
Subtotal	**3.85**	**.00**	**.00**	**3.85**
Total	**6.62**	**.16**	**.00**	**6.78**
Missouri				
Stream-valley aquifer associated with major river				
Mississippi River below St. Louis	.00	3.24	.29	3.53
Missouri River	1.23	46.6	2.27	50.1
South Grand River	.21	.19	.00	.40
Osage River	.33	.07	.00	.40
Subtotal	**1.77**	**50.1**	**2.56**	**54.4**
Withdrawal disaggregated from areas north of the line of Quaternary continental glaciation	**57.2**	**55.8**	**8.52**	**122**
Total	**59.0**	**106**	**11.1**	**176**
Montana				
Stream-valley aquifer associated with major river				
Little Missouri River	.32	.08	.00	.40
Yellowstone River	5.20	1.54	.10	6.84
Subtotal	**5.52**	**1.62**	**.10**	**7.24**
***Alluvial* aquifers, withdrawal not disaggregated**	**16.2**	**9.48**	**.67**	**26.3**
Total	**21.7**	**11.1**	**.77**	**33.6**
Nebraska				
Stream-valley aquifer associated with major river				
Big Blue River	.00	.00	1.67	1.67
Missouri River	.07	.80	.07	.94
Subtotal	**.07**	**.80**	**1.74**	**2.61**
***Alluvial* aquifers, withdrawal not disaggregated**	**92.1**	**49.2**	**5.94**	**147**
Total	**92.2**	**50.0**	**7.68**	**150**
New York				
Stream-valley aquifer associated with the following river				
Allegheny River	.00	4.07	.00	4.07
Withdrawal from Cattarougus County not disaggregated	**.00**	**3.37**	**2.68**	**6.05**
Total	**.00**	**7.44**	**2.68**	**10.1**

Table 3. Estimated withdrawals for irrigation, public-supply, and self-supplied industrial uses from stream-valley aquifers associated with major rivers and principal aquifers in 20 States, 2000—Continued.

[Values have been rounded]

Aquifer or water-bearing unit	Withdrawals, in million gallons per day (Mgal/d), by water-use category			
	Irrigation	Public supply	Self-supplied industrial	Total
Ohio				
Stream-valley aquifer associated with major river (disaggregated from glacial sand and gravel aquifers)				
Hocking River	0.00	4.32	0.00	4.32
Miscellaneous rivers and creeks	.00	.24	.00	.24
Muskingum River	.00	15.7	1.98	17.7
Ohio River	.00	23.4	6.73	30.1
Sandy Creek	.00	1.32	.28	1.60
Scioto River	.00	6.60	.01	6.61
Tuscarawas River	.12	17.4	14.2	31.6
Walhonding River	.00	8.18	.00	8.18
Total	**.12**	**77.1**	**23.2**	**100**
Oklahoma				
Stream-valley aquifer associated with major river				
Arkansas River	11.7	11.3	3.03	26.0
Canadian River	8.27	4.59	.01	12.9
Cimarron River	12.7	12.4	.06	25.1
North Canadian River	12.4	11.4	.44	24.3
Red River	23.7	7.81	.02	31.5
Washita River	5.43	.95	.00	6.38
Subtotal	**74.2**	**48.4**	**3.55**	**126**
***Alluvial* aquifers, withdrawal disaggregated to isolated terrace deposit**				
Enid isolated terrace deposits	.29	.58	.00	.87
Gerty Sands	.06	.14	.00	.20
Isolated terrace deposits south of the Canadian River	.00	.16	.00	.16
Isolated terrace deposits south of the Washita River	.00	.03	.00	.03
Odee Formation	.36	.00	.00	.36
Subtotal	**.70**	**.92**	**.00**	**1.62**
Total	**74.9**	**49.3**	**3.55**	**128**
Pennsylvania				
Stream-valley aquifer associated with major river				
Allegheny River	.00	13.0	26.3	39.4
Beaver River	.00	1.13	.30	1.43
Delaware River	.00	.10	.00	.10
Miscellaneous Rivers	.00	.01	.00	.01
Monongahela River	.00	.91	2.44	3.35
Ohio River	.00	10.4	15.5	25.9
Total	**.00**	**25.6**	**44.6**	**70.2**
South Dakota				
Stream-valley aquifer associated with major river or creek				
Bear Butte Creek	.08	.00	.00	.08
Belle Fourche River	.01	.00	.00	.01
Cheyenne River	.05	13.2	.14	13.4
White River	.05	.05	.00	.10
Subtotal	**.19**	**13.3**	**.14**	**13.6**
Withdrawal in areas north of the line of Quaternary continental glaciation (Missouri River)	**24.5**	**1.88**	**.07**	**26.5**
***Alluvial* aquifers, withdrawal not disaggregated**	**.10**	**.00**	**.00**	**.10**
Total	**24.9**	**15.1**	**.21**	**40.2**

Table 3. Estimated withdrawals for irrigation, public-supply, and self-supplied industrial uses from stream-valley aquifers associated with major rivers and principal aquifers in 20 States, 2000—Continued.

[Values have been rounded]

Aquifer or water-bearing unit	Withdrawals, in million gallons per day (Mgal/d), by water-use category			
	Irrigation	Public supply	Self-supplied industrial	Total
Tennessee				
Stream-valley aquifer associated with major river				
Tennessee River	0.00	2.30	0.00	2.30
***Alluvial* aquifers, withdrawal not disaggregated**	**.03**	**.10**	**.00**	**.13**
Total	**.03**	**2.40**	**.00**	**2.43**
Texas				
Stream-valley aquifer associated with major river				
Brazos River	12.6	.01	.00	12.6
Utah				
Stream-valley aquifer associated with major river				
Bear River	.89	.00	.00	.89
Duchesne River	.89	.00	.00	.89
Fremont River	3.12	.00	.00	3.12
Provo River	.89	.53	.00	1.42
San Pitch River	.00	.22	.47	.69
Sevier River	14.0	3.30	.00	17.3
Weber River	.09	.43	.00	.52
Subtotal	**19.9**	**4.48**	**.47**	**24.8**
***Alluvial* aquifers, withdrawal not disaggregated but identified**				
Box Elder County	.00	1.02	.00	1.02
Multiple counties	2.12	.35	.00	2.47
Spring flows from glacial deposits other glacial sand and gravel aquifers (Uintah County)	.89	3.12	.00	4.01
Subtotal	**3.01**	**4.49**	**.00**	**7.50**
Total[4]	**22.9**	**8.97**	**.47**	**32.3**
West Virginia				
Stream-valley aquifer associated with major river				
Kanawha River	.00	.00	.09	.09
Monongahela River	.00	.00	.03	.03
Ohio River	.00	20.8	.39	21.2
Potomac River	.00	.00	.01	.01
Subtotal	**.00**	**20.8**	**.52**	**21.3**
***Alluvial* aquifers, withdrawal not disaggregated**	**.00**	**.00**	**.16**	**.16**
Total	**.00**	**20.8**	**.68**	**21.5**
Wyoming				
Stream-valley aquifers associated with major river or creek				
Belle Fourche River	1.15	.00	.00	1.15
Niobrara River	5.77	.00	.00	5.77
Sand Creek	2.66	.00	.01	2.67
Subtotal	**9.58**	**.00**	**.01**	**9.59**
***Alluvial* aquifers, withdrawal not disaggregated**	**40.8**	**15.7**	**1.01**	**57.5**
Total	**50.4**	**15.7**	**1.02**	**67.1**

[1] Total withdrawals from Mississippi River Valley alluvial aquifer do not equal total in appendix 1 because about 25 Mgal/d were identified to be from stream-valley aquifers associated with the listed rivers.

[2] Total withdrawals are greater than total *Alluvial* aquifers withdrawals in appendix 2 because withdrawals from *Other* aquifers are assigned to stream-valley aquifers associated with rivers or eolian sand and isolated terrace deposits.

[3] Illinois State Water Survey's Public-Industrial-Commercial Database was a source of water-use data.

[4] Total public-supply withdrawals in this table are greater than total public-supply withdrawals from *Alluvial* aquifers (appendix 2) because 0.77 Mgal/d from Basin and Range basin-fill aquifers were assigned to *Alluvial* aquifers. Total withdrawals also are greater.

Table 4. Distribution of estimated withdrawals for irrigation, public-supply, and self-supplied industrial uses from aquifers and water-bearing units disaggregated from withdrawals from *Other* aquifers in 10 States, 2000.

[Values have been rounded. Names and descriptions of aquifers and geologic units listed in this table are those used by various U.S. Geological Survey offices or supplied by other agencies for water-use accounting purposes and do not necessarily correspond to officially recognized names or denote any official acceptances of these names and descriptions. However, the names and descriptions are included here to provide more detailed information of aquifers and aquifer units disaggregated from *Other*]

State	Aquifer or water-bearing unit	Withdrawals, in million gallons per day, by water-use category			
		Irrigation	Public supply	Self-supplied industrial	Total
Colorado[1]	Colorado group	8.38	0.27	0.08	8.70
	Dakota-Cheyenne aquifer	11.4	1.93	.20	13.5
	Fractured crystalline-rock aquifers	4.08	4.92	.47	9.50
	Laramie-Fox Hills aquifer (outside Denver ground-water basin)	2.43	.11	.08	2.60
	Leadville Limestone group	1.30	.78	.20	2.30
	North, Middle, and South Park Basins	.57	.33	.08	1.00
	Raton Basin	1.92	.55	.39	2.90
	Total	**30.1**	**8.90**	**1.50**	**40.5**
Kansas	Admine Group	.00	.11	.00	.11
	Bedrock	.00	.35	.00	.35
	Belleville Formation	.00	.00	.02	.02
	Belleville/Meade/Grand Formation	3.29	.00	.00	3.29
	Carlile Shale	.00	.02	.01	.03
	Chase Group	.04	.12	.00	.16
	Cheyenne-Jurassic-Triassic	.78	.00	.00	.78
	Colorado Group	.44	.00	.00	.44
	Council Grove Group	.00	.03	.00	.03
	Cretaceous System	.00	.06	.00	.06
	Douglas Group	.00	.01	.00	.01
	Glacial Deposits (State defined)	12.3	.49	.00	12.8
	Kansas Stage	.21	.29	.00	.50
	Meade Formation	.00	.54	.00	.54
	Morrision Formation	.24	.00	.00	.24
	Neppewalla Group	.05	.03	.00	.08
	Permian System	.14	.00	.00	.14
	Stranger Formation	.00	.18	.00	.18
	Sumner Group	.11	.00	.00	.11
	Unknown	65.7	2.87	.38	69.0
	Wellington Formation	.13	.00	.07	.20
	Total	**83.5**	**5.10**	**.48**	**89.0**
Nebraska	Pliocene-Pleistocene aquifers	4.12	10.3	1.08	15.5
North Dakota	Variously named aquifers, some in counties coincident with glaciated regions	2.34	4.28	.44	7.06
Ohio	Cambrain-Ordovician and unknown aquifers	.06	4.35	1.40	5.81
Oklahoma	Atoka Formation	.00	.26	.00	.26
	Bison Shale	.00	.13	.00	.13
	Boggy Formation	.04	.35	.00	.39
	Cambrian System	.00	.05	.00	.05
	Cedar Hills Sandstone	.23	.98	.00	1.21
	Chickasha Formation	.01	.18	.00	.19

Table 4. Distribution of estimated withdrawals for irrigation, public-supply, and self-supplied industrial uses from aquifers and water-bearing units disaggregated from withdrawals from *Other* aquifers in 10 States, 2000—Continued.

[Values have been rounded. Names and descriptions of aquifers and geologic units listed in this table are those used by various U.S. Geological Survey offices or supplied by other agencies for water-use accounting purposes and do not necessarily correspond to officially recognized names or denote any official acceptances of these names and descriptions. However, the names and descriptions are included here to provide more detailed information of aquifers and aquifer units disaggregated from *Other*]

State	Aquifer or water-bearing unit	Withdrawals, in million gallons per day, by water-use category			
		Irrigation	Public supply	Self-supplied industrial	Total
Oklahoma—Continued	Cloud Chief Group	0.39	0.00	0.00	0.39
	Cretaceous System	8.02	.00	.00	8.02
	Dees Formation	.00	.01	.00	.01
	Dockum Group	.09	.00	.00	.09
	Doxey Shale	.35	.00	.03	.38
	Duncan Sandstone	.00	.23	.00	.23
	El Reno Group	.00	.22	.00	.22
	El Reno Group	.03	.00	.00	.03
	Elk City Sandstone	1.03	.91	.00	1.94
	Flowerpot Shale	.09	.00	.00	.09
	Hennessey Group	.61	.10	.10	.81
	Hoxbar Formation	.00	.00	.04	.04
	Marlow Formation	.77	.53	.00	1.30
	Mcalester Formation	.00	.04	.00	.04
	Post Oak Conglomerate	.00	.32	.00	.32
	Purcell Sandstone	.00	.32	.00	.32
	Purgatoire Formation	.34	.00	.00	.34
	Senore Formation	.00	.08	.00	.08
	Union Valley Formation	.00	.07	.00	.07
	Vanoss Group	.00	.18	.00	.18
	Wellingon Formation	.00	.06	.00	.06
	Wewoka Formation	.57	.02	.00	.59
	Whitehorse Group	.68	.34	.00	1.02
	Wichita Formation	.00	.22	.00	.22
	Woodbine Formation	.00	.23	.00	.23
	Total	**13.3**	**5.83**	**.17**	**19.3**
Tennessee	Knox Dolomite	.04	.00	.01	.05
Texas	Blossom Sand	.00	.86	.00	.86
	Bone Spring Limestone	204	.04	.00	204
	Captain Reef Complex	3.30	.01	.00	3.31
	Dockum Group	22.9	4.12	.14	27.2
	Ellenburger Group and San Saba aquifer	.45	3.75	.00	4.20
	Hickory Sandstone	11.7	4.10	.00	15.8
	Igneous Rocks	.78	4.85	.00	5.63
	Leona and Anacacho Formations	22.1	.92	.00	23.0
	Marathon Limestone	.00	.11	.00	.11
	Marble Falls Limestone	.20	.95	.02	1.17
	Other Undifferentiated	11.4	4.16	2.62	18.2
	Rustler Formation	1.26	.00	.00	1.26
	Upper Jurassic Series	4.86	.22	.00	5.08
	Total	**283**	**24.1**	**2.80**	**310**
Utah	Unspecified bedrock units or basin-fill alluvial aquifers	.00	31.7	.01	31.7
West Virginia	Appalachian Plateau aquifers and unnamed aquifers	.00	1.58	.14	1.72

[1] Total withdrawals from *Other* aquifers in Colorado do not equal *Other* aquifers in appendix 1 because some withdrawals were assigned to stream-valley aquifers (see tables 1 and 3).

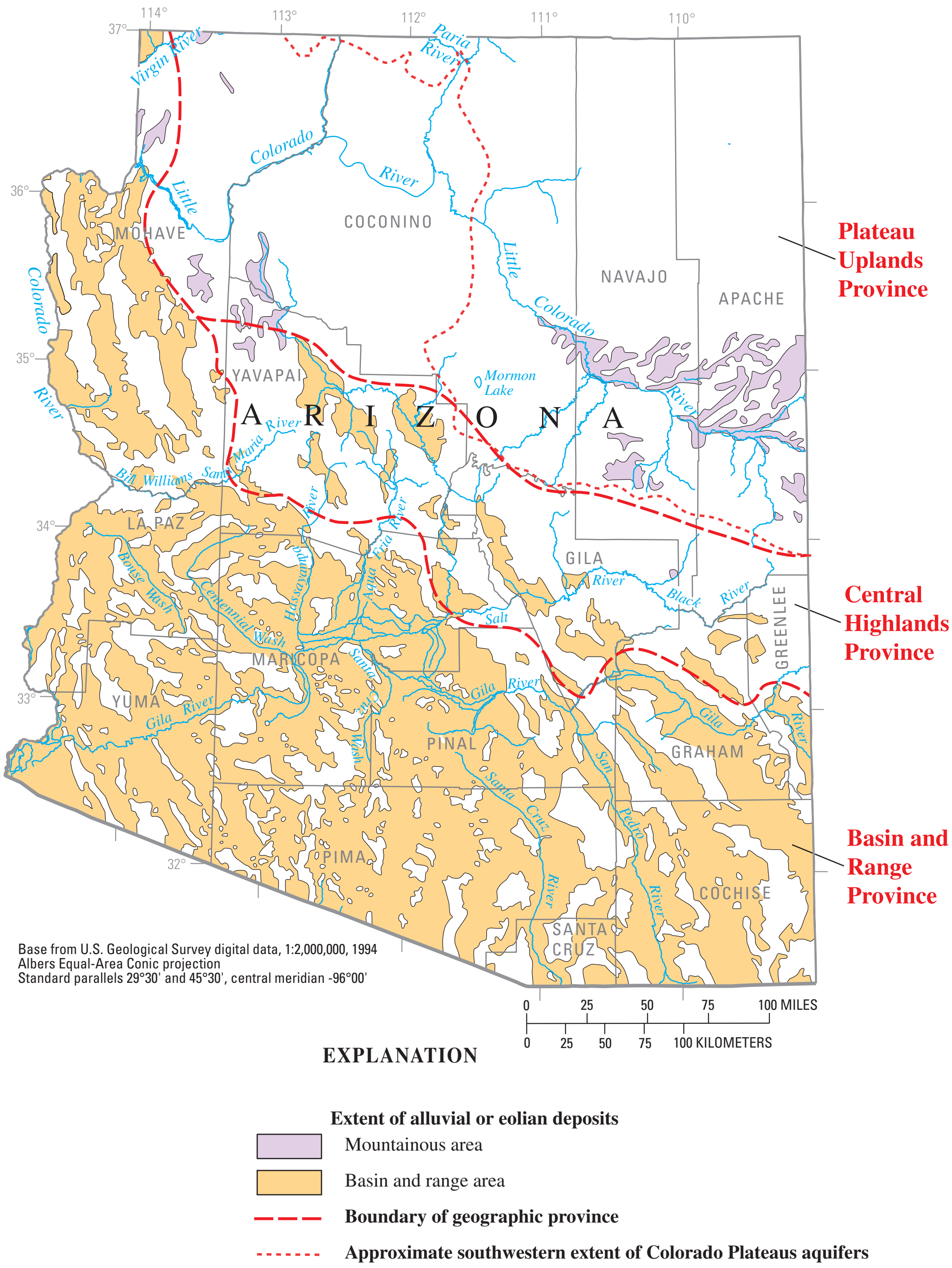


Figure 3. Extent of alluvial deposits in Arizona where stream-valley aquifer withdrawals were investigated (source: Miller, 2000, fig. 18, p. C7).

Kansas

In 2000, total ground-water withdrawals for all categories of use in Kansas were 3,790 Mgal/d (Hutson and others, 2004). More than 96 percent (3,650 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to five principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* (435 Mgal/d) and *Other* (89.0 Mgal/d) aquifers accounted for 14 percent of the withdrawals from principal aquifers and *Other* aquifers (appendix 2). Withdrawals were used mostly for irrigation from *Alluvial* (327 Mgal/d) and *Other* (83.5 Mgal/d) aquifers.

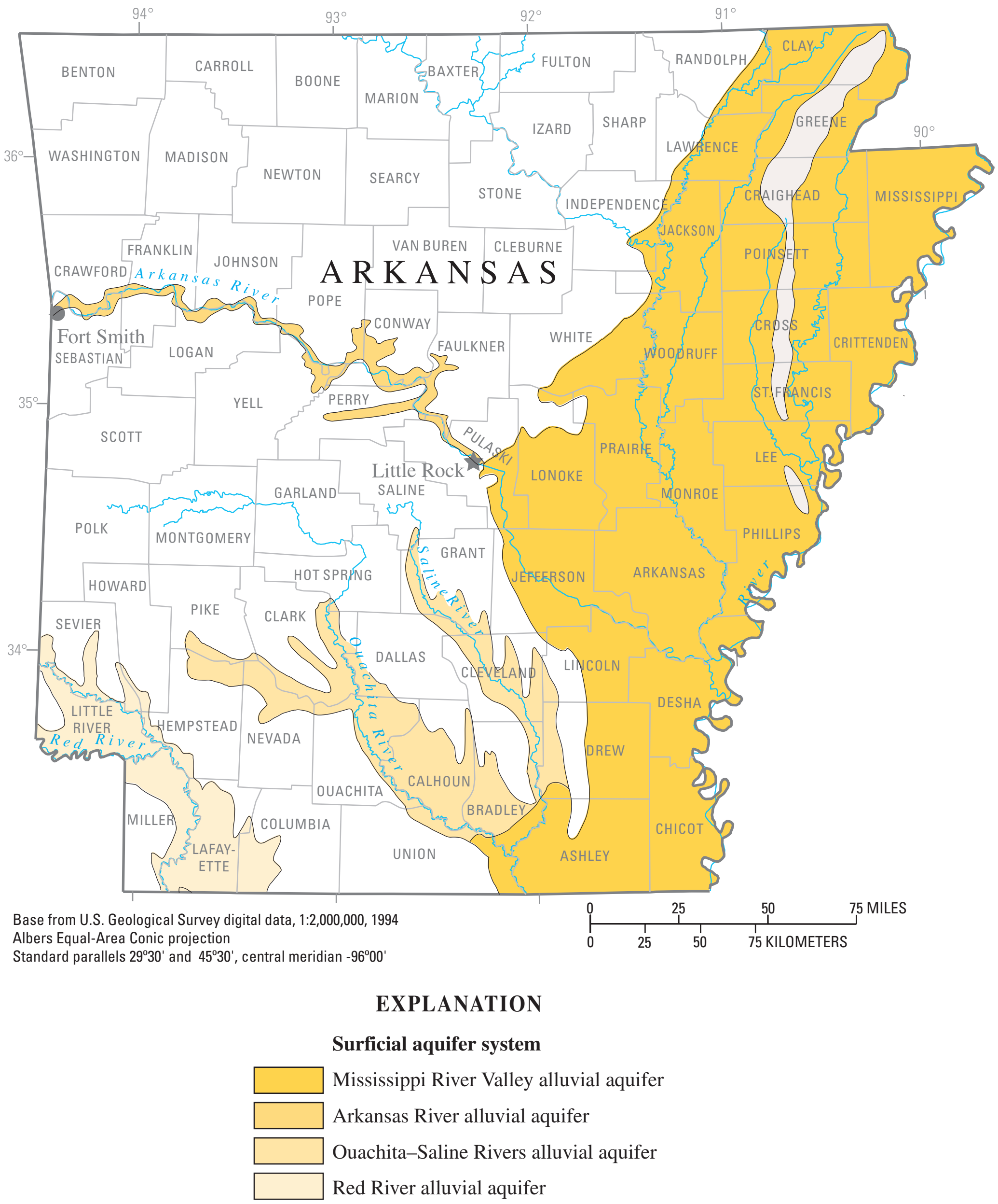


Figure 4. Extent of the Mississippi River Valley alluvial aquifer and other surficial alluvial aquifers along major rivers in Arkansas where withdrawals were associated with stream-valley aquifers (source: Miller, 2000, fig. 23, p. F8). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits along the Red, Arkansas, and Ouachita-Saline Rivers. These withdrawals had been attributed to the Mississippi River Valley alluvial aquifer.

Withdrawals of 384 Mgal/d from *Alluvial* aquifers in Kansas were attributed to stream-valley aquifers associated with 12 major rivers (table 3). Withdrawals from a stream-valley aquifer associated with the Arkansas River (228 Mgal/d, fig. 8) accounted for more than half of the total stream-valley aquifer withdrawals. About 80 percent of withdrawals from stream-valley aquifers in Kansas were used for irrigation (309 Mgal/d). The revised total *Alluvial* aquifers withdrawals (51.0 Mgal/d, table 1) were attributed to withdrawals disaggregated from areas north of the line of Quaternary continental glaciation, and were used mostly for public supply (27.2 Mgal/d, table 3).

Withdrawals from *Other* aquifers could not be attributed to stream-valley aquifers. The withdrawals were attributed to (1) various bedrock units, (2) deposits that are locally recognized as glacial deposits, but are located south of the

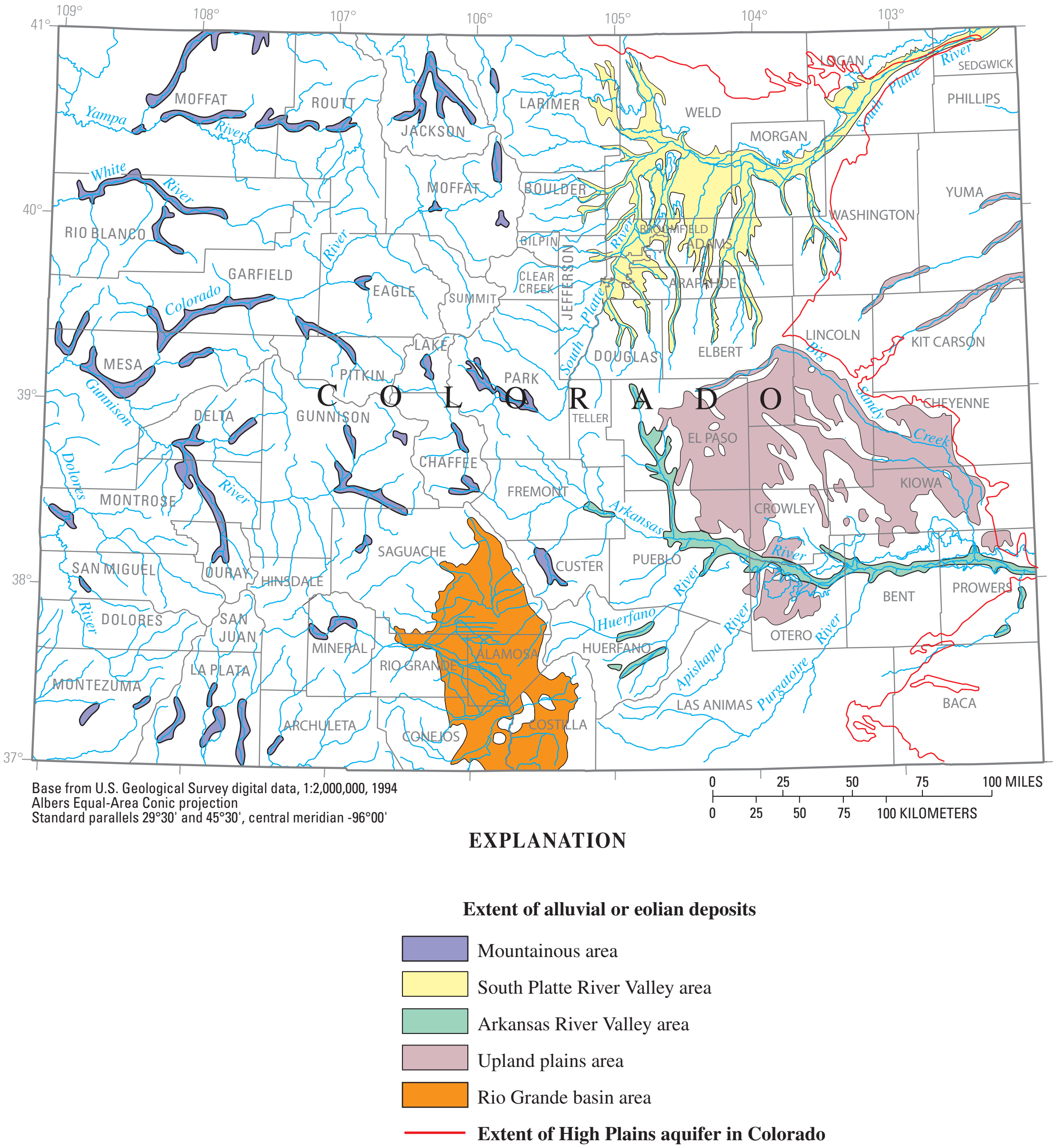


Figure 5. Extent of alluvial deposits in Colorado where withdrawals from *Alluvial* and *Other* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 18, p. C7). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits. (See fig. 1 for full extent of the High Plains aquifer.)

extent of Quaternary continental glaciation (fig. 8), and (3) unknown (table 4). No withdrawals from *Other* aquifers were attributed to stream-valley aquifers.

Kentucky

In 2000, total ground-water withdrawals for all categories of use in Kentucky were about 189 Mgal/d (Hutson and others, 2004). About 88 percent (167 Mgal/d) were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to five principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* aquifers totaled 123 Mgal/d, mostly for self-supplied industrial (76.1 Mgal/d) and public-supply (47.1 Mgal/d) uses. Withdrawals from *Other* aquifers were 1.24 Mgal/d and used for irrigation (appendix 2).

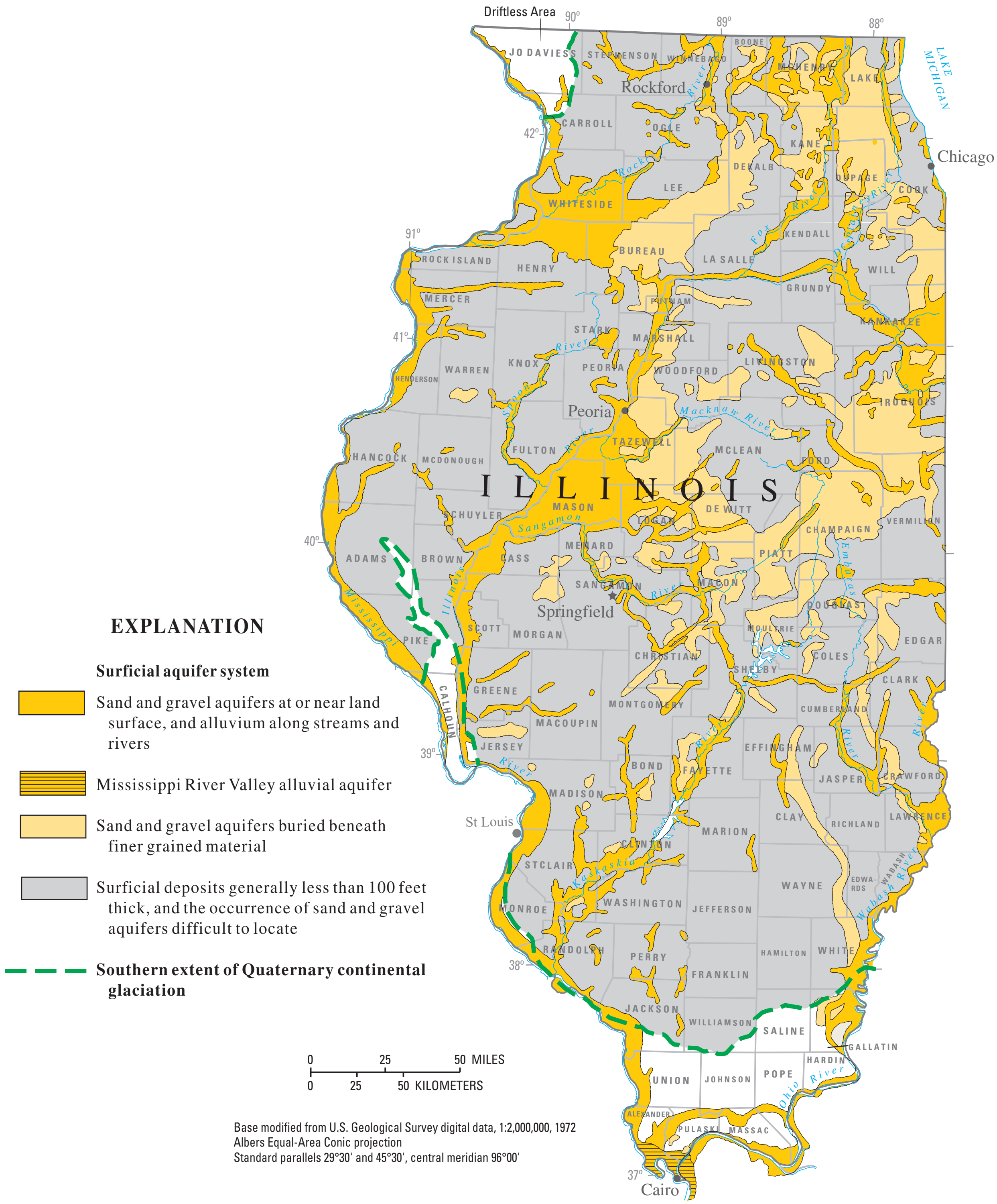


Figure 6. Extent of alluvial deposits and the Mississippi River Valley alluvial aquifer in Illinois that were evaluated for possible withdrawals from stream-valley aquifers (source: Miller, 2000, fig. 4, p. K3). Some of the withdrawals from glacial sand and gravel aquifers were attributed to stream-valley aquifers in a subset of the sediments in the non-glaciated area.

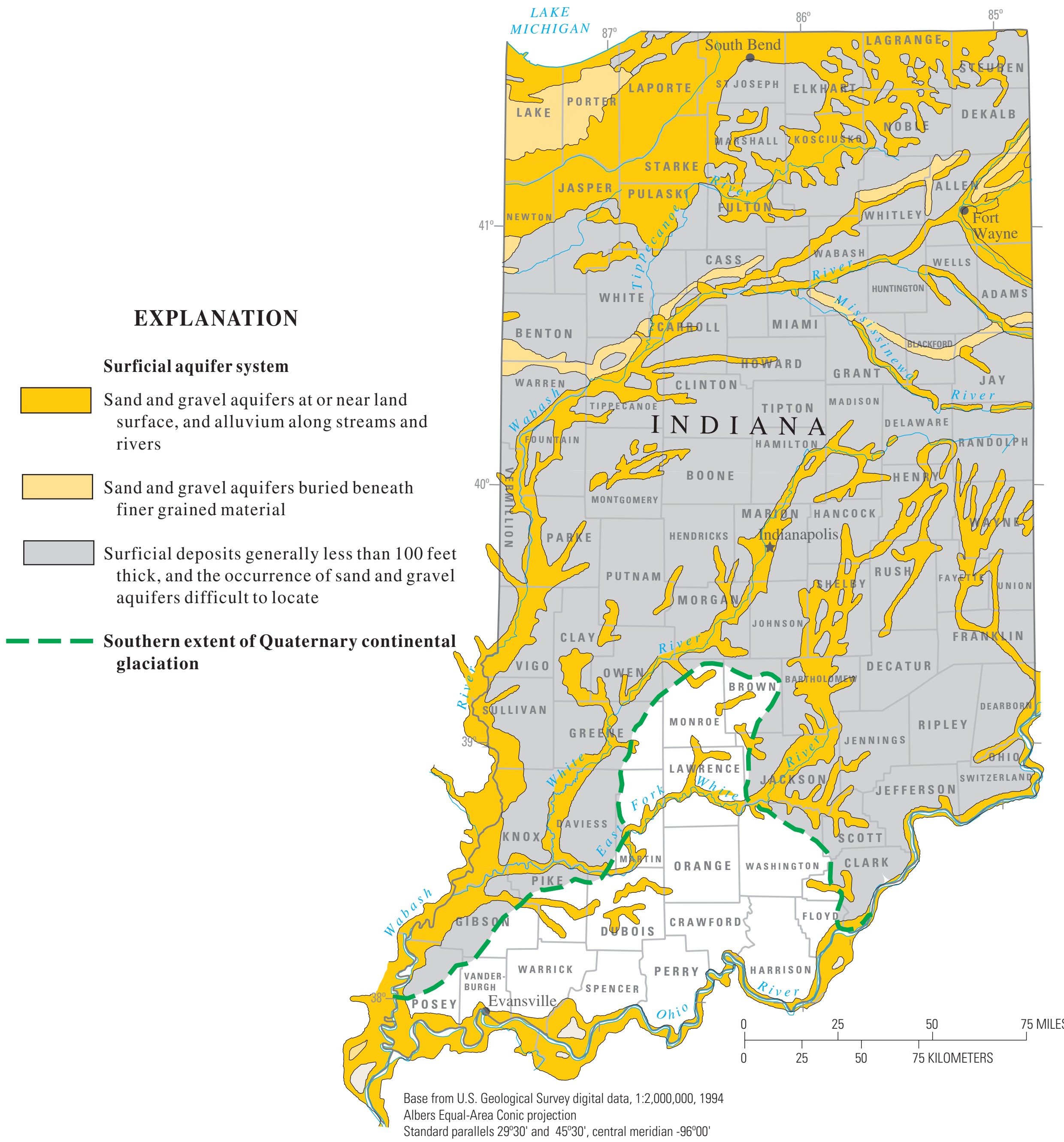


Figure 7. Extent of alluvial deposits in Indiana that were evaluated for possible withdrawals from stream-valley aquifers (source: Miller, 2000, fig. 4, p. K3). Some of the withdrawals from glacial sand and gravel aquifers were attributed to stream-valley aquifers in a subset of the sediments in the non-glaciated area.

Alluvial aquifers withdrawals of 102 Mgal/d in counties south of the extent of Quaternary continental glaciation were assigned to stream-valley aquifers associated with the Ohio River (fig. 9, table 3). The withdrawals were for self-supplied industrial uses (60.9 Mgal/d) and public-supply uses (40.8 Mgal/d). The revised total *Alluvial* aquifers withdrawals (21.6 Mgal/d, table 1) were attributed to *Alluvial* aquifer withdrawals that may be from areas north of the southern extent of Quaternary continental glaciation, and were used mostly for self-supplied industrial use (15.2 Mgal/d, table 3). Withdrawals from *Other* aquifers could not be attributed to stream-valley aquifers in Kentucky.

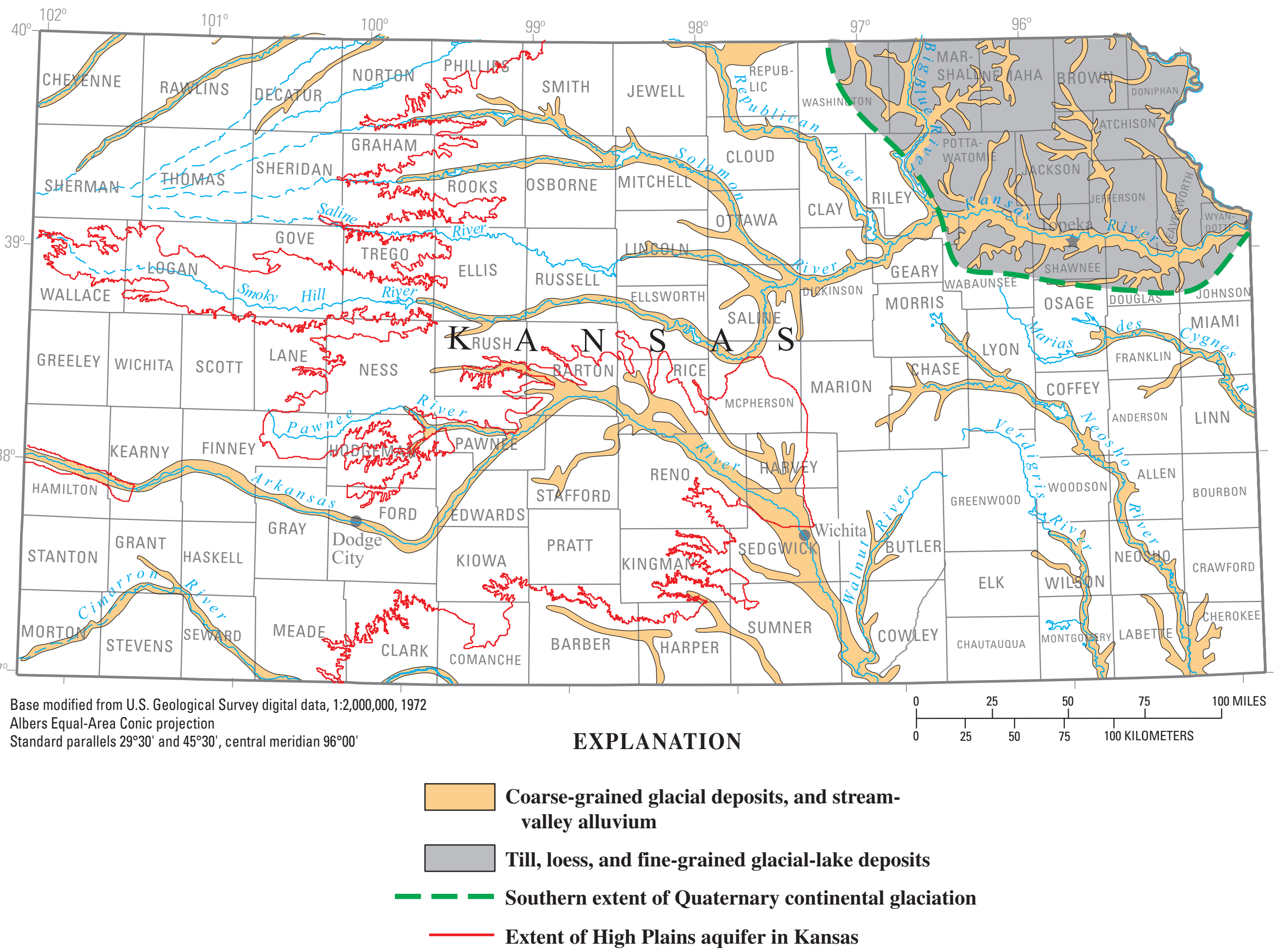


Figure 8. Extent of alluvial deposits in Kansas where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 4, p. D3). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits east of the High Plains aquifer and outside the glaciated region. (See fig. 1 for full extent of the High Plains aquifer.)

Louisiana

In 2000, total ground-water withdrawals for all categories of use in Louisiana were about 1,630 Mgal/d (Hutson and others, 2004). About 88 percent (1,430 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to four principal aquifers, including *Alluvial* aquifers, the Coastal lowlands aquifer system, the Mississippi embayment aquifer system, and the Mississippi River Valley alluvial aquifer (Maupin and Barber, 2005) (fig. 10, appendix 2). No withdrawals were from *Other* aquifers in Louisiana in 2000 (Maupin and Barber, 2005). Withdrawals from the Coastal lowlands aquifer system accounted for about 73 percent of the water withdrawals from principal aquifers in Louisiana.

Withdrawals of 2.93 Mgal/d from *Alluvial* aquifers were attributed to a stream-valley aquifer associated with the Red River (fig. 10, table 3). The withdrawals were for irrigation (2.77 Mgal/d) and public-supply (0.16 Mgal/d). Additional withdrawals of 3.85 Mgal/d from *Alluvial* aquifers were reassigned to the Coastal lowlands aquifer system (2.35 Mgal/d) and the Mississippi River Valley alluvial aquifer (1.51 Mgal/d) (fig. 10, table 1). All the reassigned withdrawals were for irrigation (table 3).

Missouri

In 2000, total ground-water withdrawals for all categories of use in Missouri were 1,780 Mgal/d (Hutson and others, 2004). About 95 percent (1,690 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to six principal aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* aquifers were 176 Mgal/d, accounting for 10 percent of withdrawals from principal aquifers. Withdrawals from *Alluvial* aquifers were for public-supply (106 Mgal/d), irrigation (59.0 Mgal/d), and self-supplied industrial (11.1 Mgal/d) uses (appendix 2). No withdrawals were from *Other* aquifers in Missouri in 2000 (Maupin and Barber, 2005).

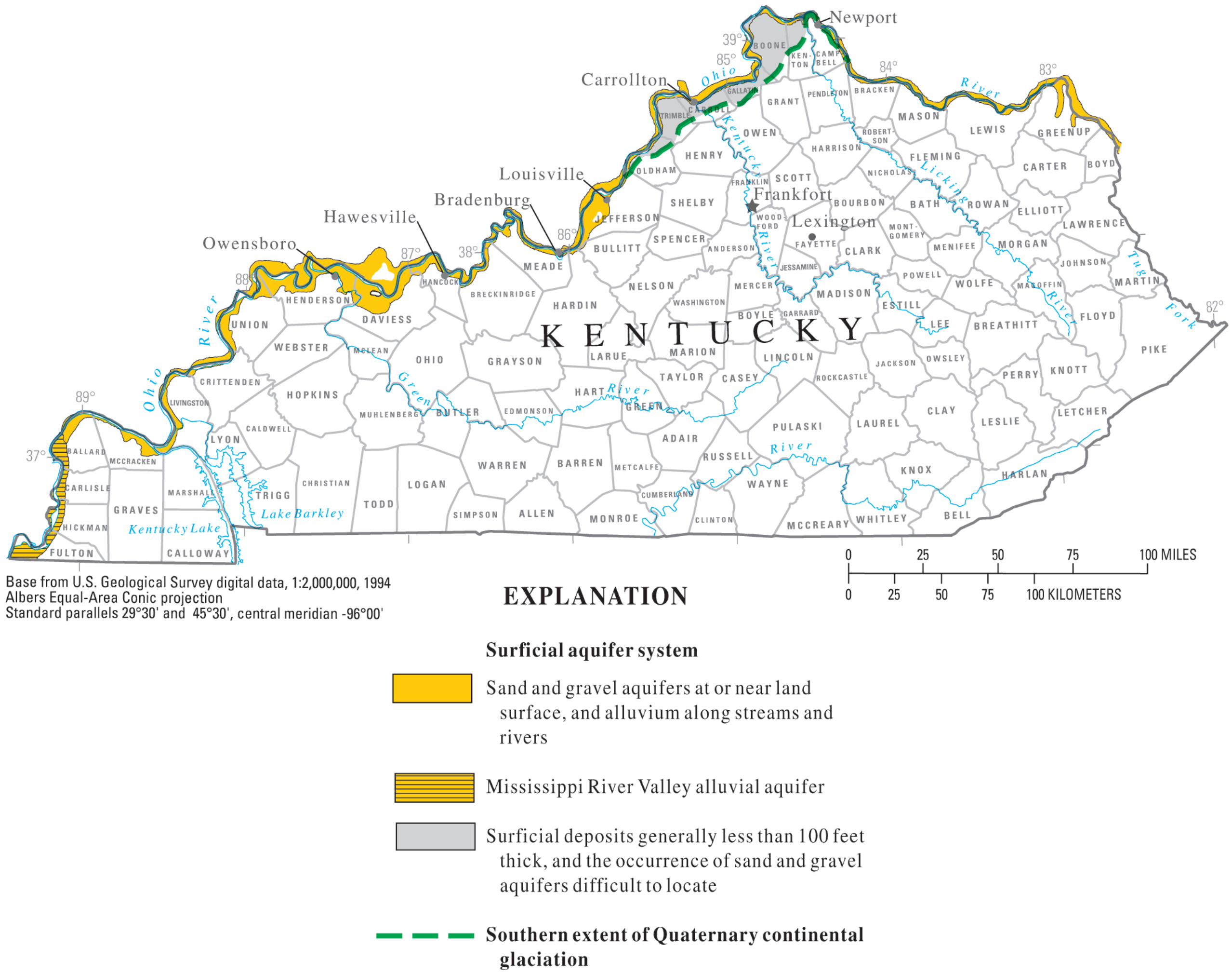


Figure 9. Extent of alluvial deposits in Kentucky where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 4, p. K3). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits along the Ohio River.

Withdrawals of 54.4 Mgal/d from *Alluvial* aquifers were attributed to stream-valley aquifers associated with the Missouri (50.1 Mgal/d), Mississippi (3.53 Mgal/d), Osage (0.40 Mgal/d), and South Grand (0.40 Mgal/d) Rivers (fig. 11, table 3). About 92 percent (50.1 Mgal/d) of the withdrawals were for public-supply. The revised total *Alluvial* aquifers withdrawals (122 Mgal/d, table 1) were attributed to withdrawals disaggregated from areas north of the line of Quaternary continental glaciation, and were used mostly for irrigation (57.2 Mgal/d) and public supply (55.8 Mgal/d, table 3).

Montana

In 2000, total ground-water withdrawals for all categories of use in Montana were 188 Mgal/d (Hutson and others, 2004). About 91 percent (171 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses and were assigned to five principal aquifers, including *Alluvial* aquifers (Maupin and Barber, 2005) (appendix 2). *Alluvial* aquifers withdrawals (33.6 Mgal/d) accounted for about 20 percent of total principal aquifer withdrawals. Most of the *Alluvial* aquifers withdrawals (21.7 Mgal/d), which originated in alluvium in the eastern half of the state, were used for irrigation purposes. No withdrawals were from *Other* aquifers in Montana in 2000 (Maupin and Barber, 2005) (appendix 2).

Withdrawals of 7.24 Mgal/d from *Alluvial* aquifers were attributed to stream-valley aquifers associated with the Yellowstone River (6.84 Mgal/d) and the Little Missouri River (0.40 Mgal/d) in southeastern Montana (fig. 12, table 3). Most of the withdrawals (5.52 Mgal/d) from the stream-valley aquifers were for irrigation. Withdrawals of 26.3 Mgal/d from *Alluvial* aquifers could not be disaggregated and assigned to a specific aquifer or aquifer system; therefore, the withdrawals remained assigned to *Alluvial* aquifers (table 1).

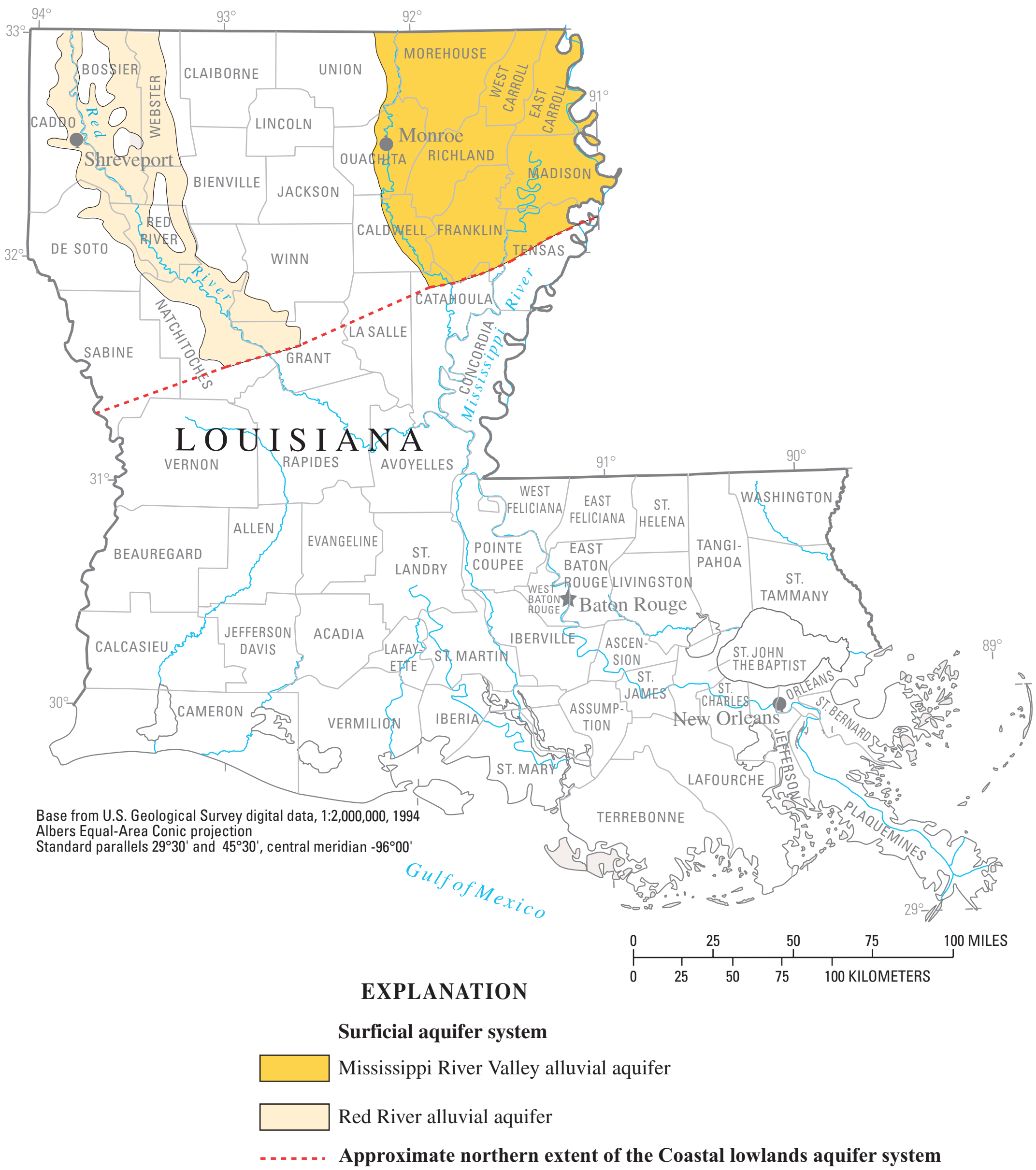


Figure 10. Extent of the Mississippi River Valley alluvial aquifer and the Red River alluvial aquifer in Louisiana where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers and other principal aquifers (source: Miller, 2000, fig. 23, p. F8). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits along the Red River.

Nebraska

In 2000, total ground-water withdrawals in Nebraska were about 7,860 Mgal/d (Hutson and others, 2004). About 98 percent (7,720 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and assigned to four principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* (150 Mgal/d) and *Other* (15.5 Mgal/d) aquifers accounted for about 2 percent of withdrawals from principal and *Other* aquifers (appendix 2). Most of the withdrawals from *Alluvial* aquifers were used for irrigation (92.2 Mgal/d); most of the withdrawals from *Other* aquifers (10.3 Mgal/d) were for public-supply use (appendix 2).

Only about 2 percent (2.61 Mgal/d) of the withdrawals from *Alluvial* aquifers in Nebraska were disaggregated and assigned to a specific stream-valley aquifer. The other approximately 98 percent of withdrawals (147 Mgal/d) remained assigned to *Alluvial* aquifers (table 1). Withdrawals from stream-valley aquifers were associated with the Big Blue (1.67 Mgal/d) and the Missouri (0.94 Mgal/d) Rivers (fig. 13, table 3). Most of the withdrawals were for

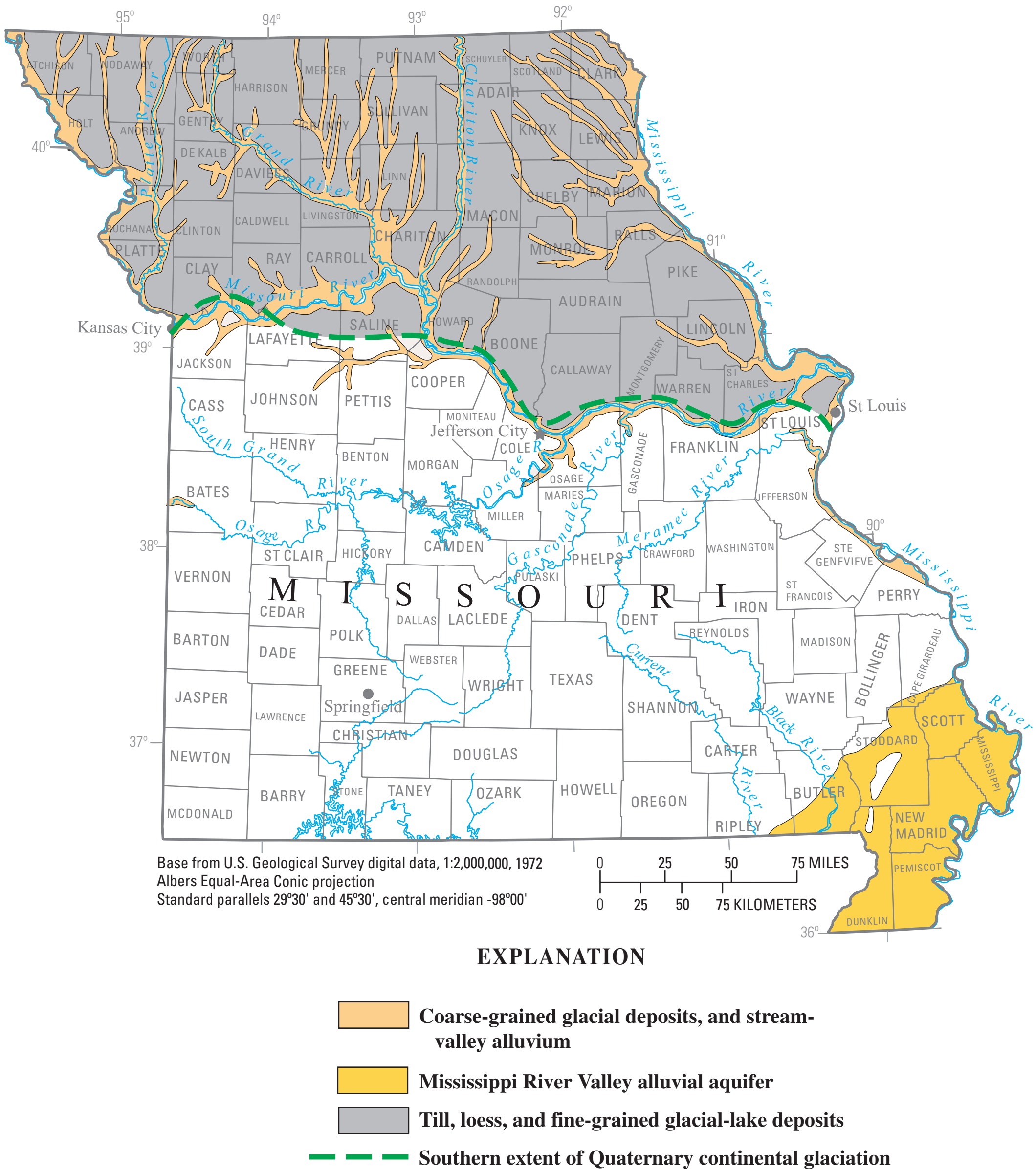


Figure 11. Extent of alluvial deposits in Missouri where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 4, p. D3). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits in the non-glaciated area north of the Mississippi River Valley alluvial aquifer, and also from small, unmapped stream-valley aquifers in Henry and St. Clair Counties.

self-supplied industrial (1.74 Mgal/d) and public-supply (0.80 Mgal/d) uses. No withdrawals from *Other* aquifers were attributed to stream-valley aquifers. All *Other* aquifer withdrawals (15.5 Mgal/d) were attributed to undifferentiated Pliocene-Pleistocene aquifers in southeastern Nebraska (table 4).

New Jersey

In 2000, total ground-water withdrawals for all categories of use in New Jersey were 584 Mgal/d (Hutson and others, 2004). About 84 percent (489 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to seven principal aquifers (Maupin and Barber, 2005) (fig. 14, appendix 2). No withdrawals were assigned to *Alluvial* or *Other* aquifers in New Jersey in 2000 (Maupin and Barber, 2005), and no withdrawals were attributed to stream-valley aquifers.

New Mexico

In 2000, total ground-water withdrawals for all categories of use in New Mexico were 1,540 Mgal/d (Hutson and others, 2004). About 97 percent (1,500 Mgal/d) of the withdrawals

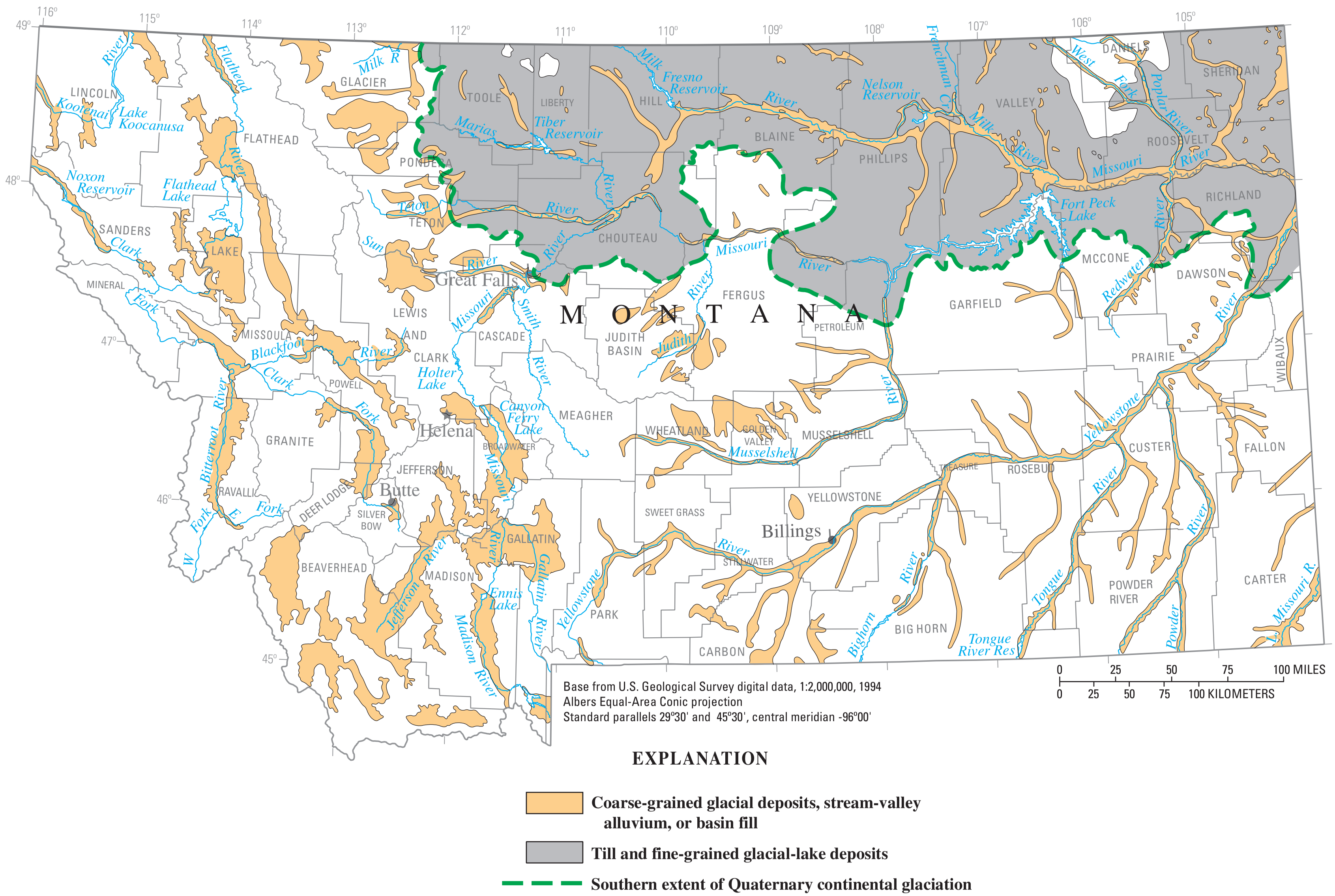


Figure 12. Extent of alluvial deposits in Montana where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 6, p. I3). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits outside of the glacial region, along the Yellowstone and Little Missouri Rivers.

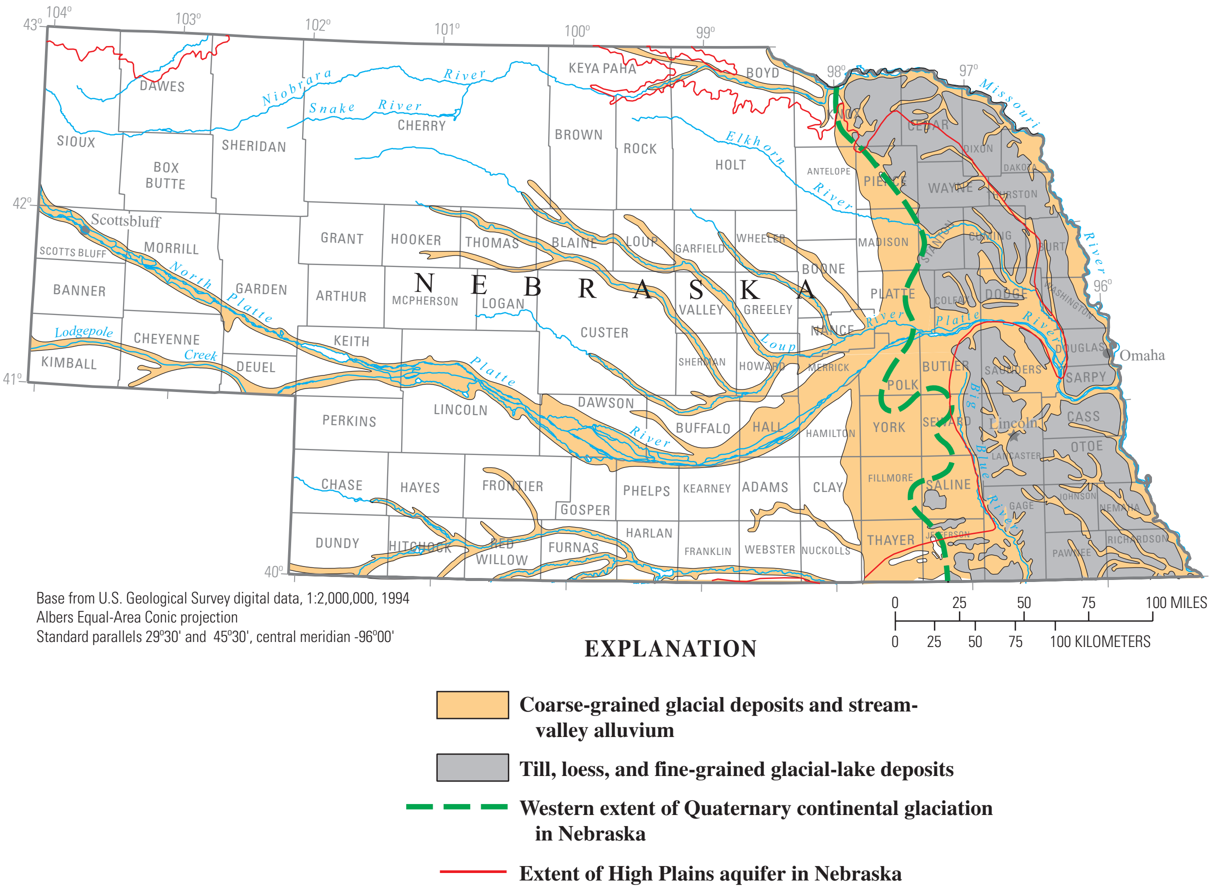


Figure 13. Extent of alluvial deposits in Nebraska where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 4, p. D3). Stream-valley aquifer withdrawals were identified from a subset of the alluvial deposits east of the High Plains aquifer and outside the glaciated region. (See fig. 1 for full extent of the High Plains aquifer.)

were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to six principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). The use category with the largest withdrawals was irrigation (1,230 Mgal/d), mostly from the High Plains aquifer system (498 Mgal/d), the Roswell Basin aquifer system (364 Mgal/d), the Basin and Range basin-fill aquifers (164 Mgal/d), and the Rio Grande aquifer system (136 Mgal/d) (fig. 15, appendix 2). No withdrawals were assigned to *Alluvial* aquifers in New Mexico in 2000 (Maupin and Barber, 2005). Withdrawals from *Other* aquifers were 83.9 Mgal/d and accounted for about 6 percent of withdrawals from principal and *Other* aquifers for the three uses. No withdrawals from *Other* aquifers could be attributed to stream-valley aquifers in New Mexico.

New York

In 2000, total ground-water withdrawals for all categories of use in New York were 893 Mgal/d (Hutson and others, 2004). About 84 percent (752 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses and were assigned to five principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). No withdrawals were assigned to *Alluvial* aquifers in New York in 2000 (Maupin and Barber, 2005). Withdrawals from *Other* aquifers (25.2 Mgal/d) accounted for about 3 percent of total withdrawals from principal and *Other* aquifers (appendix 2). Withdrawals from *Other* aquifers were mostly for self-supplied industrial (15.8 Mgal/d) and public-supply (9.20 Mgal/d) uses (appendix 2).

In Cattaraugus County, New York, withdrawals of 4.07 Mgal/d in an area of glacial sand and gravel aquifers were assigned to a stream-valley aquifers associated with the Allegheny River (fig. 16). All of the withdrawals were for public-supply uses (table 3) and resulted in an estimated reduction of withdrawals from glacial sand and gravel aquifers by less than 2 percent, to 259 Mgal/d (table 1). No withdrawals from *Other* aquifers were attributed to stream-valley aquifers.

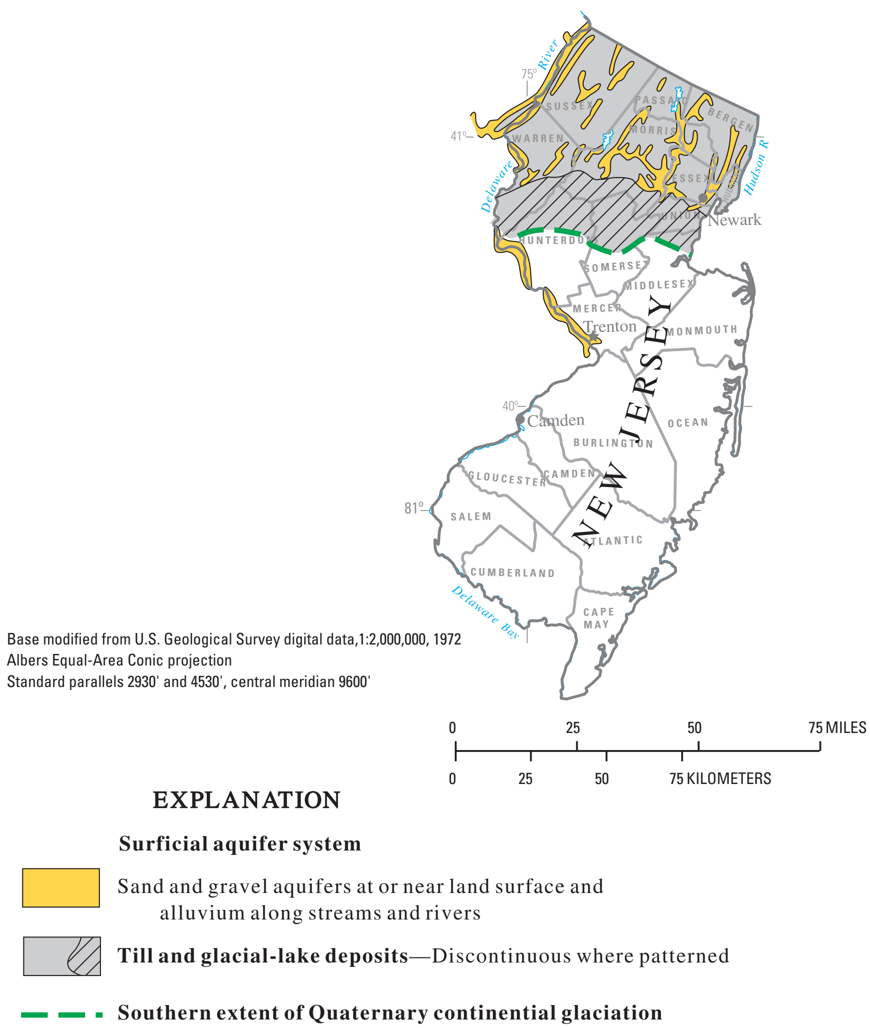


Figure 14. Extent of alluvial deposits in New Jersey where stream-valley aquifer withdrawals were investigated (source: Miller, 2000, fig. 6, p. L3).

North Dakota

In 2000, total ground-water withdrawals for all categories of use in North Dakota were 123 Mgal/d (Hutson and others, 2004). About 91 percent (112 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to three principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Most of the withdrawals (76.0 Mgal/d) in North Dakota were derived from glacial sand and gravel aquifers (appendix 2). Withdrawals from *Alluvial* (23.2 Mgal/d) and *Other* (7.06 Mgal/d) aquifers accounted for approximately 27 percent of withdrawals from principal aquifers and *Other* aquifers (appendix 2). *Alluvial* aquifer withdrawals were used mostly for irrigation (15.6 Mgal/d), and *Other* aquifer withdrawals were used mostly for public supply (4.28 Mgal/d).

Withdrawals from *Alluvial* aquifers in North Dakota could not be attributed to stream-valley aquifers. However, all withdrawals from *Alluvial* aquifers were disaggregated to aquifers and aquifer units that were north of the extent of Quaternary continental glaciation and, in some instances, identified as being a buried stream channel (appendix 3). The relatively small amount of withdrawals attributed to *Other* aquifers (7.06 Mgal/d) was attributed to aquifers and aquifer units in areas north of the southern extent of Quaternary continental glaciation (fig. 17, appendix 2). No withdrawals from *Other* aquifers were assigned to stream-valley aquifers.

Ohio

In 2000, total ground-water withdrawals for all categories of use in Ohio for 2000 were 878 Mgal/d (Hutson and others, 2004). About 77 percent (676 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to five principal and *Other*

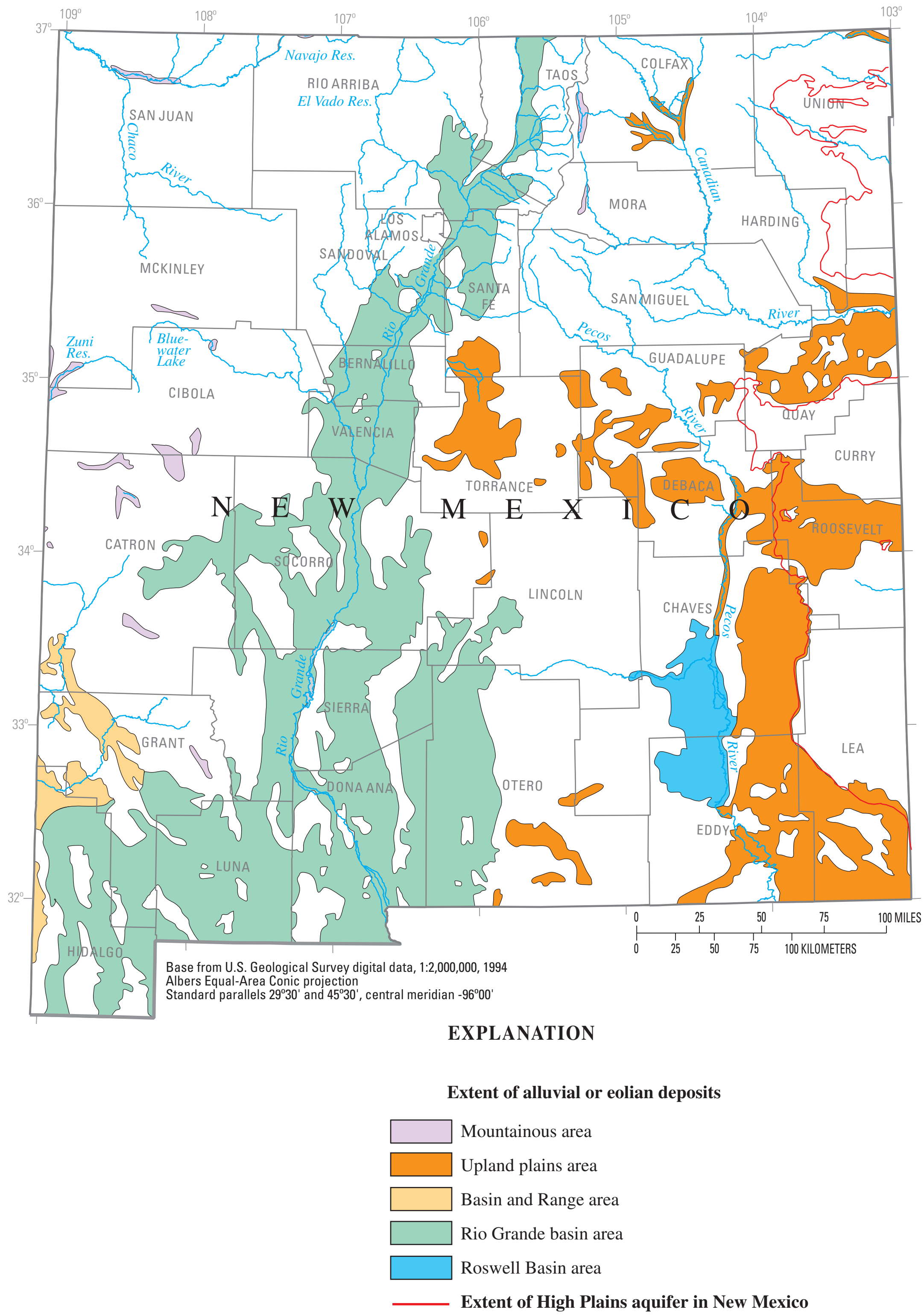


Figure 15. Extent of alluvial deposits in New Mexico where stream-valley aquifer withdrawals were investigated (source: Miller, 2000, fig. 18, p. C7). (See fig. 1 for full extent of the High Plains aquifer.)

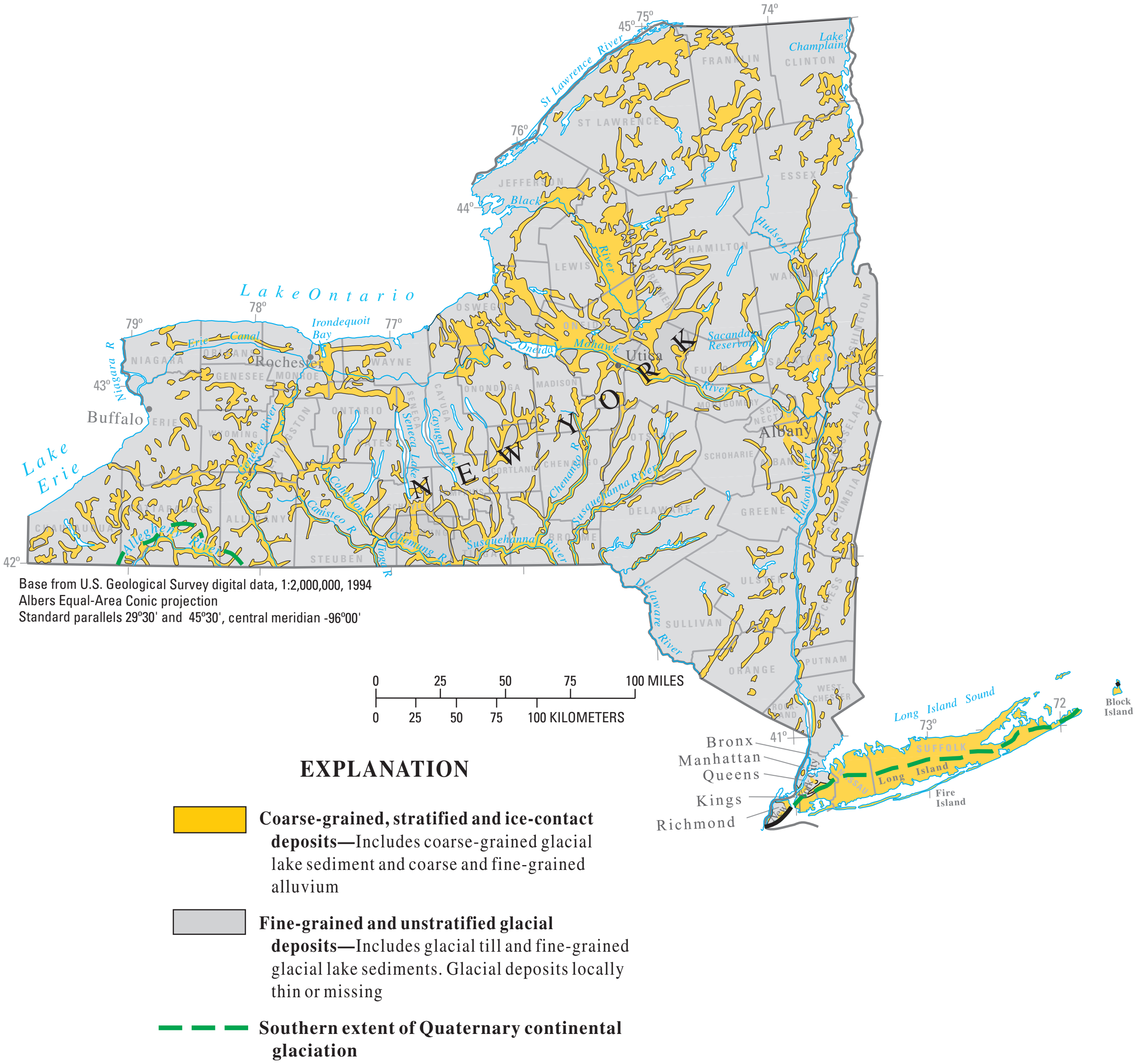


Figure 16. Extent of alluvial deposits in New York that were evaluated for possible withdrawals from stream-valley aquifers (source: Miller, 2000, fig. 9, p. M4). Some of the withdrawals from glacial sand and gravel aquifers were attributed to stream-valley aquifers in a subset of the sediments in the non-glaciated area.

aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* (53.0 Mgal/d) and *Other* (5.81 Mgal/d) aquifers accounted for about 9 percent of the total withdrawals from principal and *Other* aquifers. Withdrawals were used mostly for public supply from *Alluvial* aquifers (39.4 Mgal/d), and to a similar degree from *Other* aquifers (4.35 Mgal/d) (appendix 2). About 62 percent (421 Mgal/d) of withdrawals from principal and *Other* aquifers in Ohio were attributed to the glacial sand and gravel aquifers (appendix 2).

Alluvial aquifers withdrawals (53.0 Mgal/d) could not be attributed to stream-valley aquifers in Ohio (table 1). Withdrawals of 100 Mgal/d from glacial sand and gravel aquifers were disaggregated to stream-valley aquifers associated with various streams south of the extent of Quaternary continental glaciation (fig. 18, table 3). The reassignment reduced withdrawals from glacial sand and gravel aquifers in Ohio about 24 percent, from 421 to 321 Mgal/d (table 1). No withdrawals from *Other* aquifers were attributed to stream-valley aquifers in Ohio. Total withdrawals of 5.81 Mgal/d from the *Other* aquifers were attributed to Cambrian-Ordovician and unknown aquifers in Ohio (table 4).

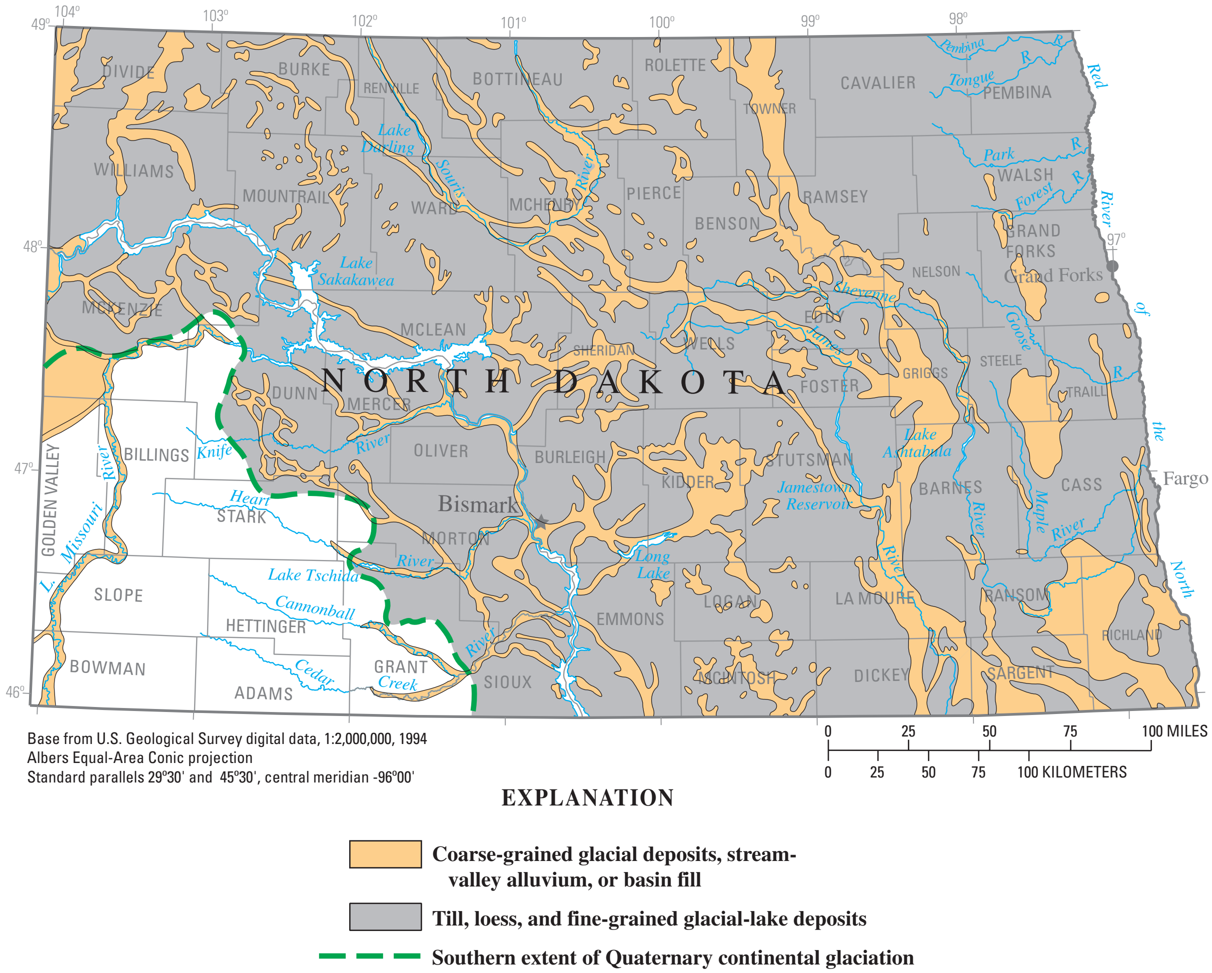


Figure 17. Extent of alluvial deposits in North Dakota where stream-valley aquifer withdrawals were investigated (source: Miller, 2000, fig. 6, p. I3). These sediments were evaluated for possible withdrawals associated with stream-valley aquifers. Although withdrawals from stream-valley aquifers may occur in North Dakota, no withdrawals could be definitively attributed to stream-valley aquifers.

Oklahoma

In 2000, total fresh ground-water withdrawals for all categories of use in Oklahoma were 771 Mgal/d (Hutson and others, 2004). About 89 percent (686 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to nine principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* (128 Mgal/d) and *Other* (19.3 Mgal/d) aquifers accounted for about 21 percent of withdrawals from principal aquifers and *Other* in Oklahoma in 2000 (appendix 2). Withdrawals were used mostly for irrigation from *Alluvial* aquifers (74.9 Mgal/d), and to a greater degree from *Other* aquifers (13.3 Mgal/d) (appendix 2).

All the withdrawals assigned to *Alluvial* aquifers in Oklahoma were disaggregated (tables 1 and 3). Withdrawals of 126 Mgal/d from *Alluvial* aquifers were attributed to six stream-valley aquifers associated with the Red (31.5 Mgal/d), Arkansas (26.0 Mgal/d), Cimarron (25.1 Mgal/d), North Canadian (24.3 Mgal/d), Canadian (12.9 Mgal/d), and Washita (6.38 Mgal/d) Rivers (fig. 19, table 3). About 97 percent of the withdrawals were for irrigation (74.2 Mgal/d) and public-supply (48.4 Mgal/d) uses (fig. 19, table 3). Withdrawals of 1.62 Mgal/d from *Alluvial* aquifers were disaggregated to five isolated, elevated terrace deposits that are disconnected from surface-water features but are still classified as *Alluvial* aquifers (table 3).

No withdrawals from *Other* aquifers in Oklahoma were attributed to stream-valley aquifers, but withdrawals were disaggregated to 31 aquifers or water-bearing units (table 4). Most of the withdrawals from *Other* aquifers were for public-supply (5.83 Mgal/d) and irrigation (13.3 Mgal/d) uses (table 4). About 42 percent (8.02 Mgal/d) of withdrawals from *Other* aquifers were attributed to the water-bearing unit, Cretaceous System.

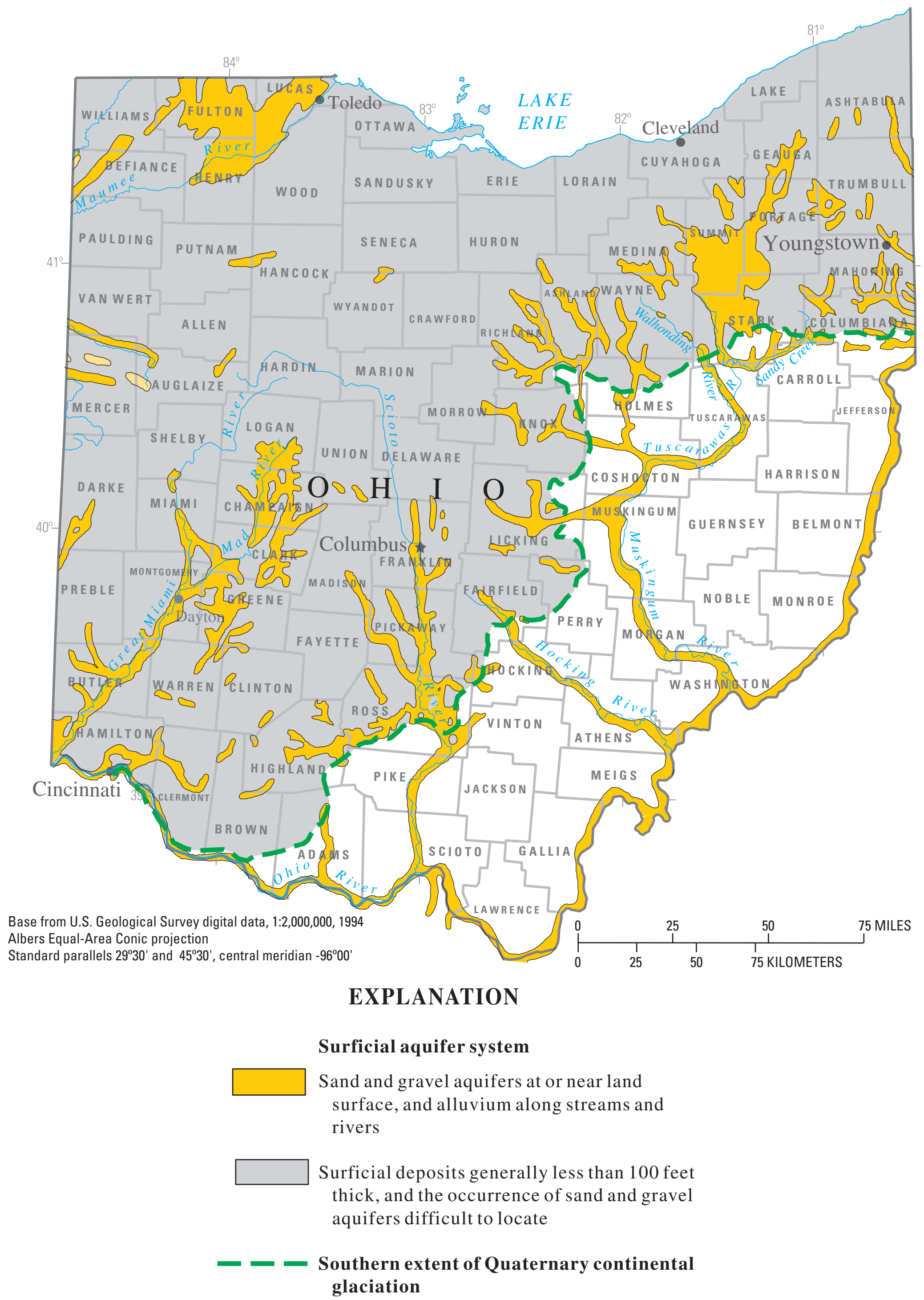


Figure 18. Extent of alluvial deposits in Ohio that were evaluated for possible withdrawals associated with stream-valley aquifers (source: Miller, 2000, fig. 4, p. K3). Some of the withdrawals from glacial sand and gravel aquifers were attributed to stream-valley aquifers in a subset of the sediments in the non-glaciated area.

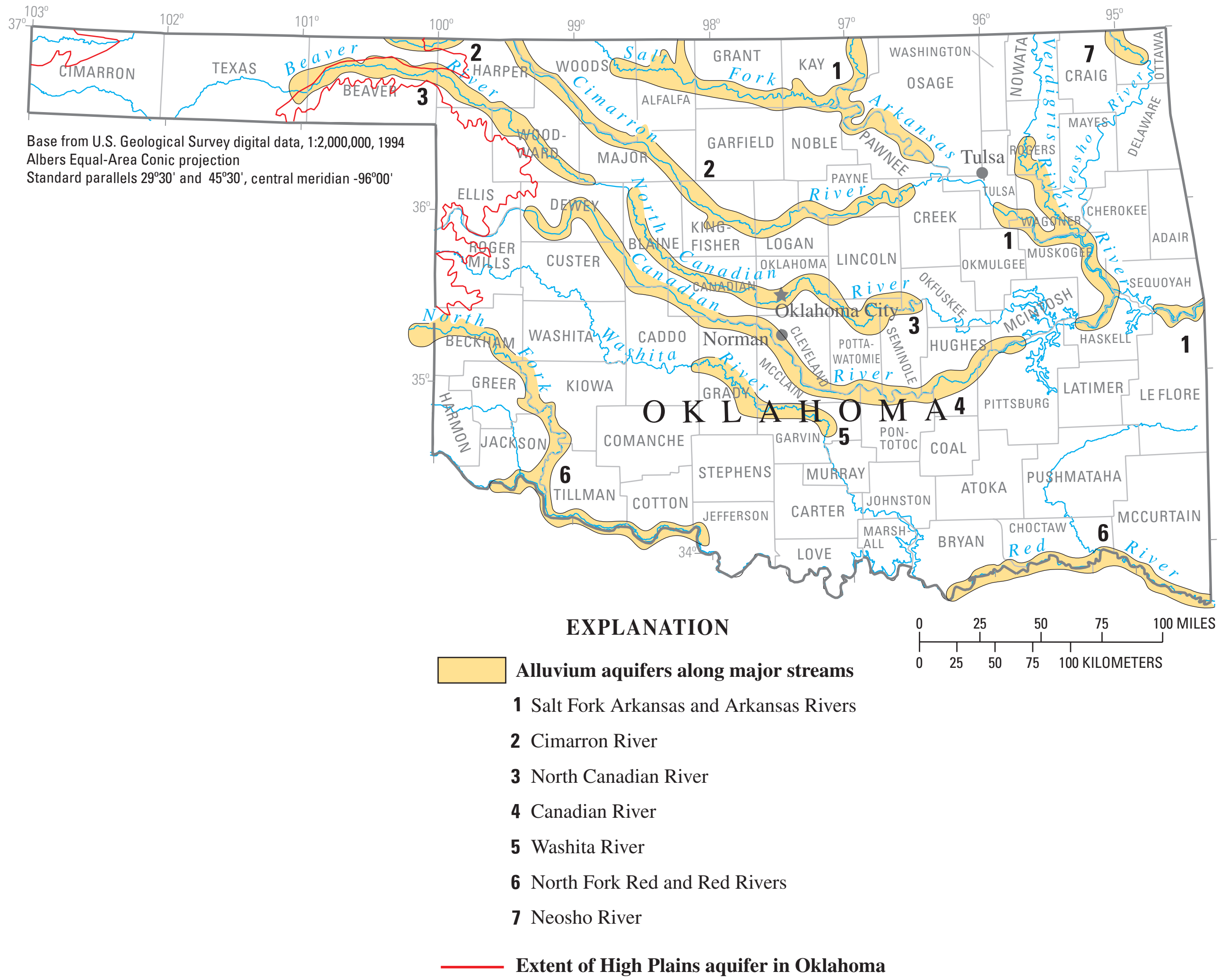


Figure 19. Extent of alluvial deposits along major streams in Oklahoma where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 11, p. E6). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits east of the High Plains aquifer. (See fig. 1 for full extent of the High Plains aquifer.)

Pennsylvania

In 2000, total ground-water withdrawals for all categories of use in Pennsylvania were 666 Mgal/d (Hutson and others, 2004). About 55 percent (368 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to nine principal aquifers, including Pennsylvanian aquifers and *Other* aquifers (Maupin and Barber (2005) (appendix 2). No withdrawals were assigned to *Alluvial* aquifers in Pennsylvania in 2000. Withdrawals from *Other* aquifers were about 30 percent (109 Mgal/d) of total withdrawals from principal and *Other* aquifers, and were 81.0 Mgal/d for public-supply, 28.2 Mgal/d for self-supplied industrial, and 0.10 Mgal/d for irrigation uses (appendix 2).

Withdrawals from Pennsylvanian (28.1 Mgal/d) and *Other* (42.1 Mgal/d) aquifers were disaggregated to stream-valley aquifers associated with the Allegheny (39.4 Mgal/d), Ohio (25.9 Mgal/d), Monongahela (3.35 Mgal/d), Beaver (1.43 Mgal/d), and Delaware (0.1 Mgal/d) Rivers, and other miscellaneous rivers (0.01 Mgal/d) (fig. 20, table 3). Withdrawals from all of these rivers were mostly for self-supplied industrial (44.6 Mgal/d) and public-supply (25.6 Mgal/d) uses. The disaggregation of withdrawals to stream-valley aquifers reduced withdrawals from the Pennsylvanian aquifers in Pennsylvania by 64 percent to 15.5 Mgal/d, and withdrawals from *Other* aquifers in Pennsylvania by 39 percent to 67.2 Mgal/d (table 1).

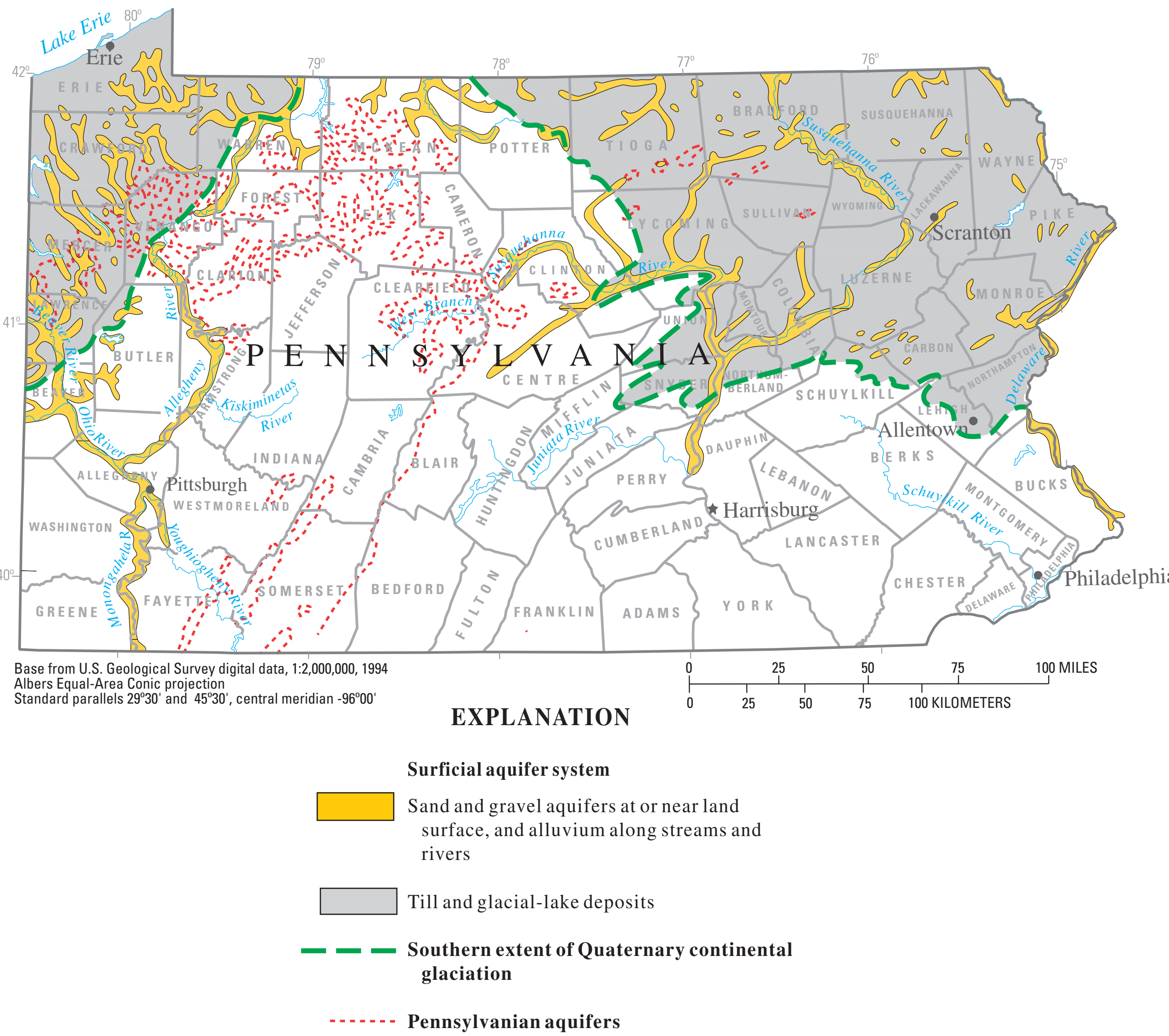


Figure 20. Extent of alluvial deposits in Pennsylvania that were evaluated for possible withdrawals associated with stream-valley aquifers (source: Miller, 2000, fig. 6, p. L3). Some of the withdrawals previously associated with *Other* and Pennsylvanian aquifers in the non-glaciated area were attributed to stream-valley aquifers.

Puerto Rico

In 2000, total ground-water withdrawals for all categories of use in Puerto Rico were 137 Mgal/d (Hutson and others, 2004). About 99 percent (135 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to two principal (fig. 21) and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). No withdrawals were assigned to *Alluvial* aquifers in Puerto Rico in 2000. Withdrawals from *Other* aquifers were 33.2 Mgal/d, which accounted for about 25 percent of withdrawals from principal and *Other* aquifers for the three uses (appendix 2). Withdrawals from *Other* aquifers included 16.2 Mgal/d for public-supply, 14.4 Mgal/d for irrigation, and 2.60 Mgal/d for self-supplied industrial uses. No withdrawals could be attributed to stream-valley aquifers in Puerto Rico (fig. 21).

South Dakota

In 2000, total ground-water withdrawals for all categories of use in South Dakota were 222 Mgal/d (Hutson and others, 2004). About 88 percent (195 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to five principal aquifers, including glacial sand and gravel aquifers, *Alluvial* aquifers, and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* aquifers accounted for 21 percent (40.2 Mgal/d) of the withdrawals from principal aquifers and

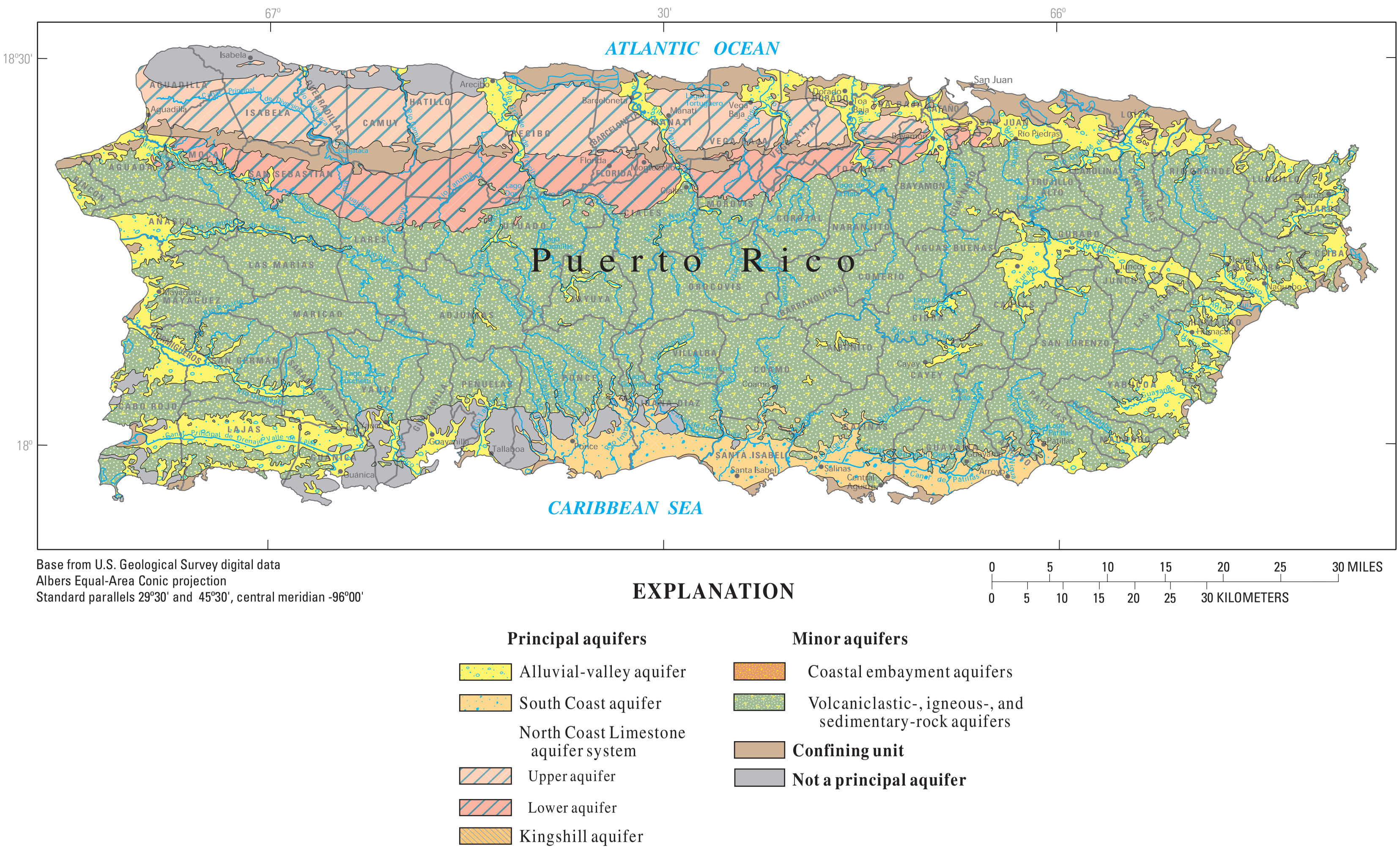
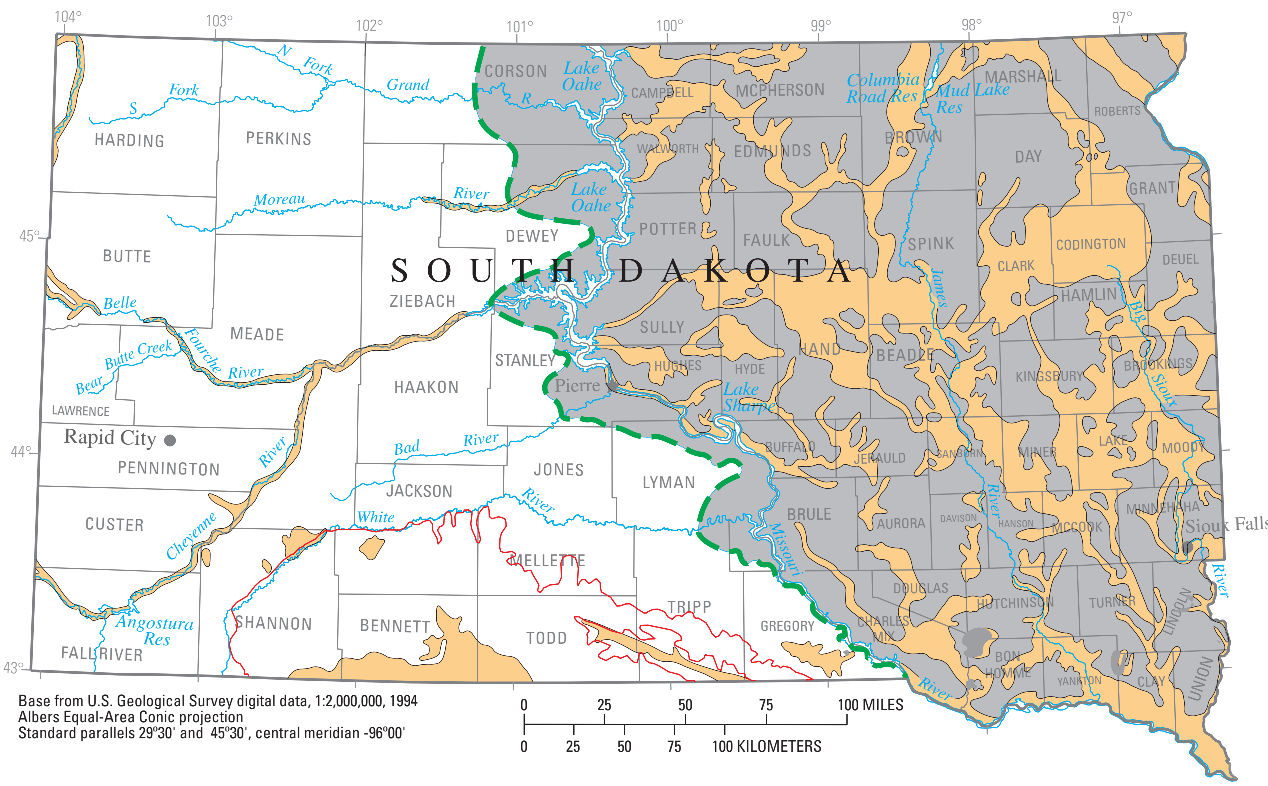


Figure 21. Extent of aquifers in the Commonwealth of Puerto Rico where stream-valley aquifer withdrawals were investigated (source: Miller, 2000, fig. 71, p. N24).

Other aquifers (appendix 2). About 62 percent (24.9 Mgal/d) of withdrawals from *Alluvial* aquifers were for irrigation uses. Glacial sand and gravel aquifers provided about 60 percent (118 Mgal/d) of the withdrawals from principal and *Other* aquifers for the three uses. Withdrawals from *Other* aquifers were only 1.90 Mgal/d in South Dakota in 2000 (appendix 2).

Withdrawals of 13.6 Mgal/d from *Alluvial* aquifers were disaggregated to stream-valley aquifers associated with the Cheyenne River (13.4 Mgal/d), White River (0.10 Mgal/d), Bear Butte Creek (0.08 Mgal/d), and Belle Fourche River (0.01 Mgal/d) (fig. 22, table 3). Most of the withdrawals were from stream-valley aquifers associated with the Cheyenne River, mostly for public-supply (13.2 Mgal/d) and self-supplied industrial (0.14 Mgal/d) uses (table 3).

About 66 percent of *Alluvial* aquifers withdrawals (26.6 Mgal/d) remained assigned to *Alluvial* aquifers (table 1). Nearly all of the revised total *Alluvial* aquifers withdrawals (26.5 Mgal/d) were attributed to *Alluvial* aquifer withdrawals in areas north of the line of Quaternary continental glaciation which generally follows the Missouri River (fig. 22, table 3). Most of these withdrawals (24.5 Mgal/d) were for irrigation. Irrigation withdrawals of 0.1 Mgal/d from *Alluvial* aquifers could not be disaggregated and assigned to a specific aquifer or aquifer system (table 3).



EXPLANATION

Coarse-grained glacial deposits, stream-valley alluvium, or basin fill

Till and fine-grained glacial-lake deposits

Southern extent of Quaternary continental glaciation

Extent of High Plains aquifer in South Dakota

Figure 22. Extent of coarse-grained glacial deposits, stream-valley alluvium, and basin fill in South Dakota where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 6, p. 13). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits north of the High Plains aquifer and outside of the glaciated region. (See fig. 1 for full extent of the High Plains aquifer.)

Tennessee

In 2000, total ground-water withdrawals for all categories of use in Tennessee were 417 Mgal/d (Hutson and others, 2004). About 92 percent (385 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to eight principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* and *Other* aquifers totaled 2.48 Mgal/d, representing less than 1 percent of total withdrawals from principal and *Other* aquifers (appendix 2). Withdrawals were used mostly for public supply (2.40 Mgal/d) from *Alluvial* aquifers and mostly for irrigation (0.04 Mgal/d) from *Other* aquifers (appendix 2).

Public supply withdrawals of 2.30 Mgal/d from *Alluvial* aquifers were attributed to a stream-valley aquifer associated with the Tennessee River (fig. 23, table 3). Withdrawals of 0.13 Mgal/d from *Alluvial* aquifers could not be disaggregated and assigned to a specific aquifer or aquifer system (tables 1 and 3). No withdrawals from *Other* aquifers could be assigned to stream-valley aquifers, but withdrawals were attributed to the Knox Dolomite (table 4).

Texas

In 2000, total fresh ground-water withdrawals for all categories of use in Texas were 8,470 Mgal/d (Hutson and others, 2004). About 95 percent (8,010 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to nine principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* (12.6 Mgal/d) and *Other* (310 Mgal/d) aquifers accounted for about 4 percent of withdrawals from principal and *Other* aquifers. Withdrawals were used mostly for irrigation from *Alluvial* aquifers (12.6 Mgal/d) and, to a lesser degree, from *Other* aquifers (283 Mgal/d) (appendix 2).

Alluvial aquifers supplied a small fraction (0.16 percent) of total withdrawals from aquifers in Texas (appendix 2). All withdrawals from *Alluvial* aquifers in Texas (12.6 Mgal/d) were attributed to a stream-valley aquifer associated with the Brazos River (fig. 24, table 1), and were used mostly for irrigation (table 3). No withdrawals from *Other* aquifers were attributed to stream-valley aquifers, but all withdrawals from *Other* aquifers were disaggregated to 13 aquifers and water-bearing units, (table 4). About 66 percent of the withdrawals from *Other* aquifers were attributed to the Bone Spring Limestone (204 Mgal/d). About 91 percent (283 Mgal/d) of withdrawals from *Other* aquifers were for irrigation use.

Utah

In 2000, total fresh ground-water withdrawals for all categories of use in Utah were 1,020 Mgal/d (Hutson and others, 2004). About 85 percent (868 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to five principal aquifers, including *Alluvial* aquifers, Basin and Range basin-fill aquifers, and *Other* aquifers (Maupin and Barber, 2005). Withdrawals from *Alluvial* and *Other* aquifers accounted for 7 percent (63.3 Mgal/d) of withdrawals from principal and *Other* aquifers for the three categories of use (appendix 2). About 78 percent (679 Mgal/d) of the withdrawals were from Basin and Range basin-fill aquifers and were mostly for irrigation (439 Mgal/d) and public-supply (208 Mgal/d) uses. Withdrawals from *Alluvial* aquifers

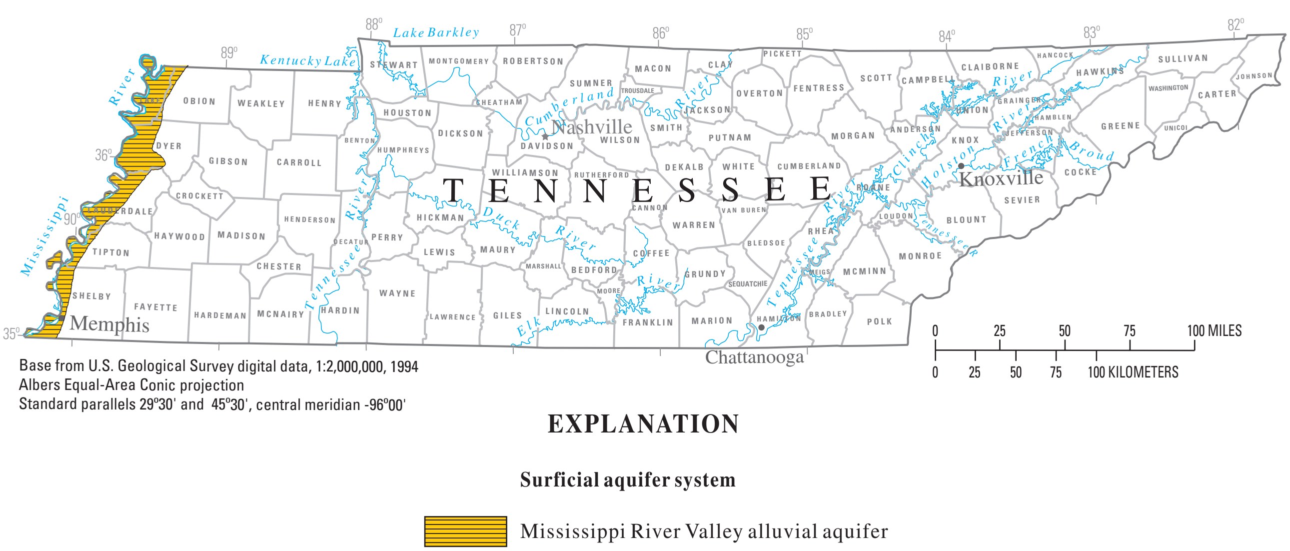


Figure 23. The surficial aquifer system in Tennessee that consists mainly of the Mississippi River Valley alluvial aquifer. No withdrawals from the Mississippi River Valley alluvial aquifer were disaggregated to stream-valley aquifers. Some withdrawals from *Alluvial* aquifers were disaggregated to stream-valley aquifers associated with the Tennessee River (source: Miller, 2000, fig. 4, p. K3).

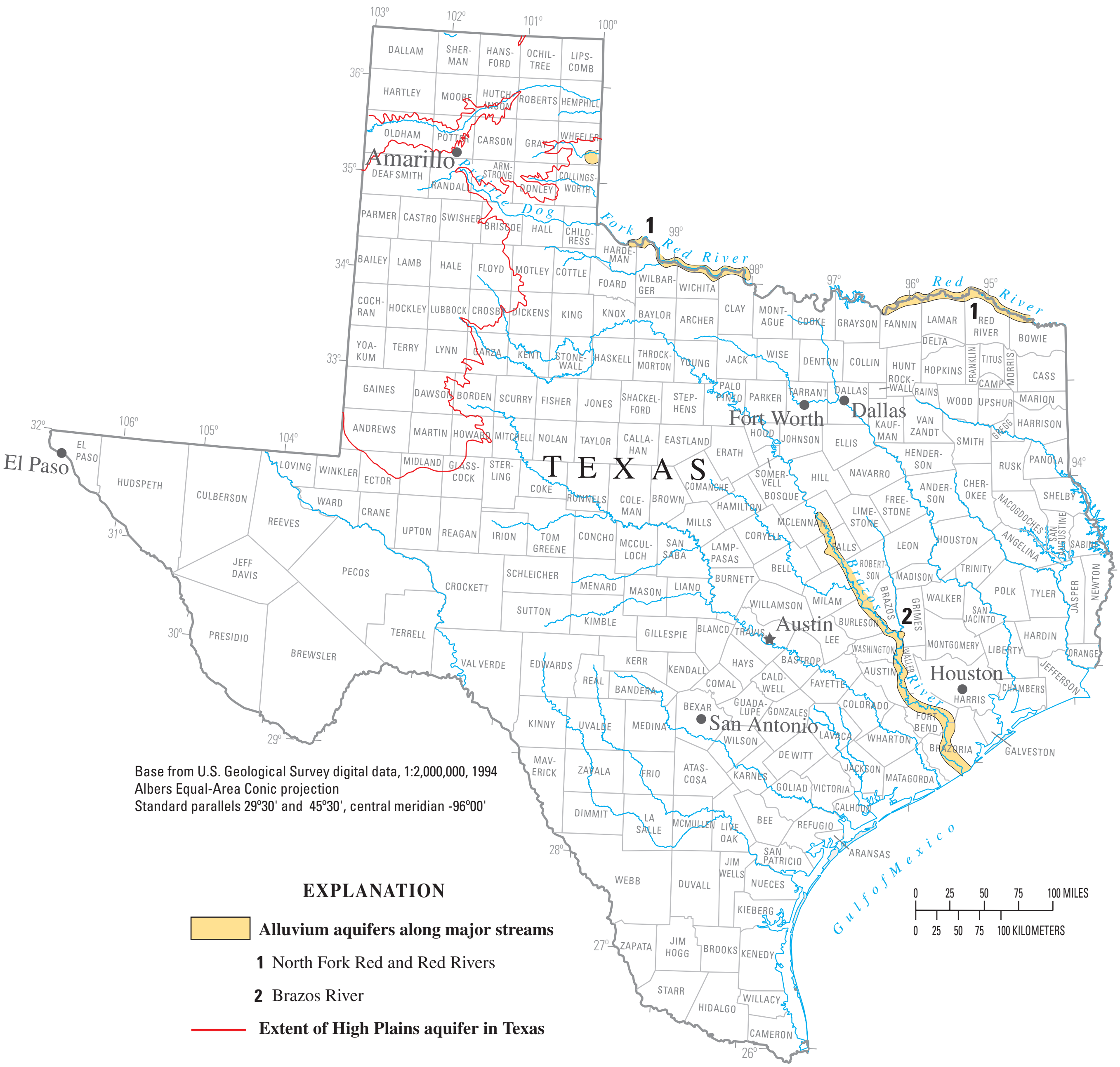


Figure 24. Extent of alluvial deposits along major streams in Texas where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 11, p. E6). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits east of the High Plains aquifer. (See fig. 1 for full extent of the High Plains aquifer.)

were used mostly for irrigation (22.9 Mgal/d). Withdrawals from *Other* aquifers were used mostly for public-supply (31.7 Mgal/d) (appendix 2).

Withdrawals of 24.8 Mgal/d from *Alluvial* aquifers in Utah were disaggregated to stream-valley aquifers associated with seven major rivers (fig. 25, table 3). Stream-valley aquifer withdrawals were mostly for irrigation (19.9 Mgal/d) and public-supply (4.48 Mgal/d) uses. About 82 percent of stream-valley aquifer withdrawals were from the Sevier (17.3 Mgal/d) and Fremont (3.12 Mgal/d) Rivers and were used mostly for irrigation.

Withdrawals of 0.77 Mgal/d from the Basin and Range basin-fill aquifers (fig. 25, table 1) were reassigned to *Alluvial* aquifers. The reassignment increased withdrawals from *Alluvial* aquifers for public-supply use from 8.20 to 8.97 Mgal/d in Utah in 2000, and decreased withdrawals from Basin and Range basin-fill aquifers for public-supply use from 208 to 207 Mgal/d. Consequently, the revised total withdrawals for

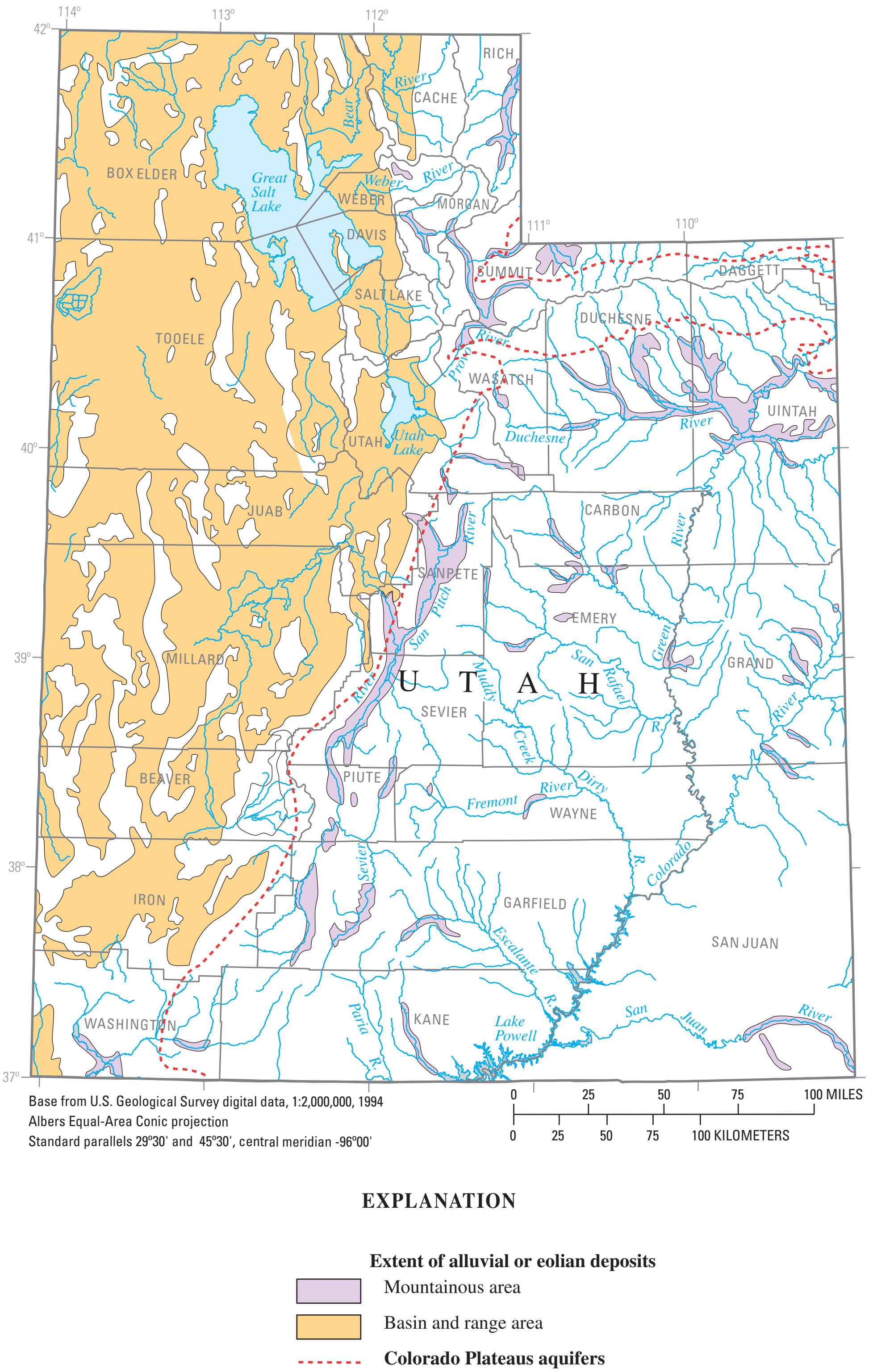


Figure 25. Extent of alluvial deposits in Utah where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 18, p. C7). Withdrawals from stream-valley aquifers were identified from a subset of the mountainous area alluvial deposits, and also from small, unmapped stream-valley aquifers along the Bear and Weber Rivers.

Alluvial aquifers in Utah, excluding withdrawals assigned to stream-valley aquifers, increased from 6.73 to 7.50 Mgal/d (tables 1 and 3), and total Basin and Range basin-fill aquifers withdrawals decreased from 679 Mgal/d to 678 Mgal/d (table 1). No withdrawals from *Other* aquifers in Utah in 2000 were attributed to stream-valley aquifers, but withdrawals generally were attributed to unspecified bedrock units or basin-fill alluvial aquifers (table 4).

West Virginia

In 2000, total ground-water withdrawals for all categories of use in West Virginia were 90.9 Mgal/d (Hutson and others, 2004). About 56 percent (51.3 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to five principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* and *Other* aquifers were 23.2 Mgal/d and accounted for 45 percent of withdrawals from principal and *Other* aquifers for the three uses (appendix 2). Withdrawals were used mostly for public supply from *Alluvial* (20.8 Mgal/d) and *Other* (1.58 Mgal/d) aquifers (appendix 2).

About 99 percent (21.3 Mgal/d) of the withdrawals from *Alluvial* aquifers in West Virginia were attributed to stream-valley aquifers associated with the Ohio (21.2 Mgal/d), Kanawha (0.09 Mgal/d), Monongahela (0.03 Mgal/d), and Potomac (0.01 Mgal/d) Rivers (fig. 26, table 3). All withdrawals from *Alluvial* aquifers for public-supply (20.8 Mgal/d) were attributed to the Ohio stream-valley aquifer. Withdrawals of 0.16 Mgal/d from *Alluvial* aquifers could not be disaggregated and assigned to a specific aquifer or aquifer system (table 1). Withdrawals of 1.72 Mgal/d from *Other* aquifers (table 4) were not attributed to stream-valley aquifers, but

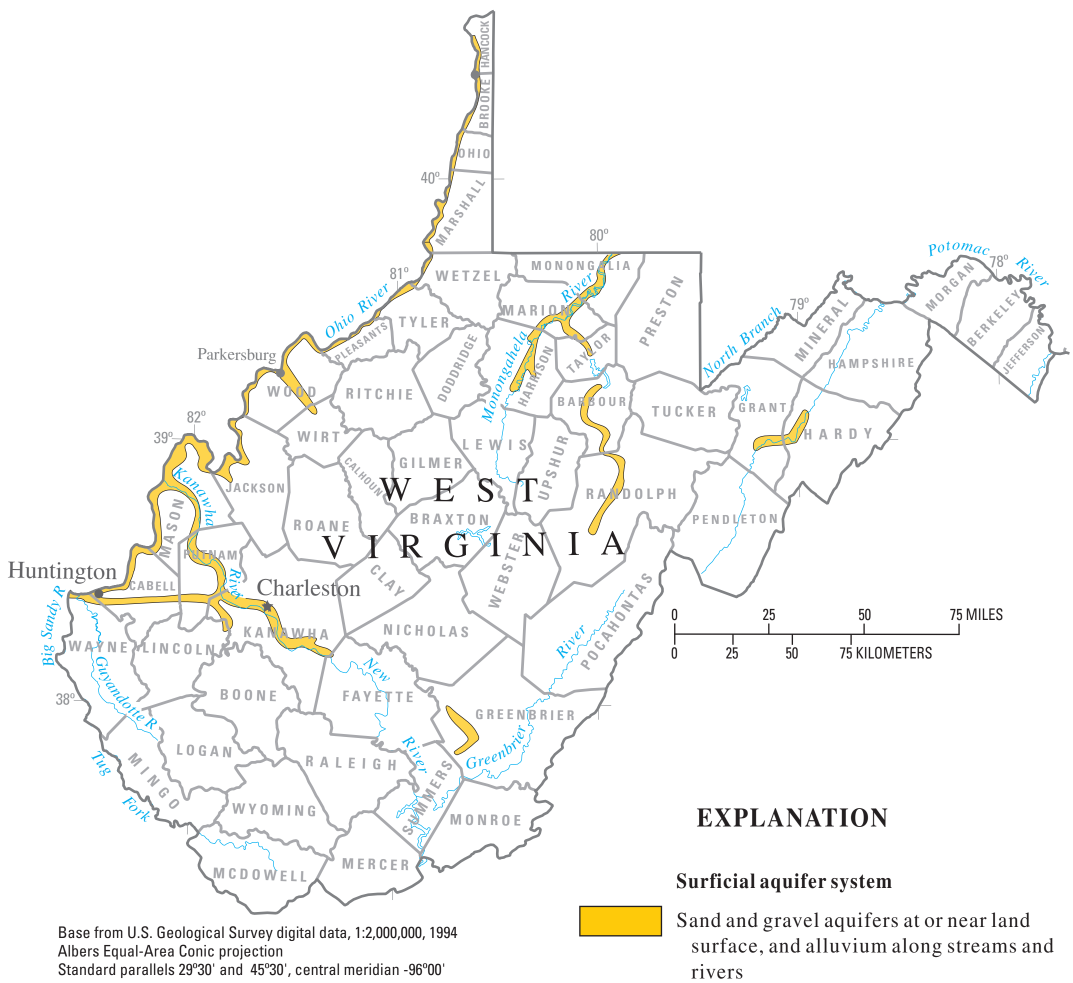


Figure 26. Extent of alluvial deposits in West Virginia where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 6, p. L3). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits.

were attributed to Appalachian Plateau aquifers along the eastern side of the State and to unnamed aquifers in areas labeled, “not a principal aquifer” in the atlas (Trapp and Horn, 1997).

Wyoming

In 2000, total ground-water withdrawals for all categories of use in Wyoming were about 541 Mgal/d (Hutson and others, 2004). About 88 percent (475 Mgal/d) of the withdrawals were for public-supply, self-supplied industrial, and irrigation uses, and were assigned to six principal and *Other* aquifers (Maupin and Barber, 2005) (appendix 2). Withdrawals from *Alluvial* aquifers accounted for 14 percent (67.1 Mgal/d) of the withdrawals from principal and *Other* aquifers in Wyoming. Withdrawals from the *Alluvial* aquifers were mostly for irrigation (50.4 Mgal/d), public-supply (15.7 Mgal/d), and self-supplied industrial (1.02 Mgal/d) uses. Withdrawals (3.30 Mgal/d) from *Other* aquifers accounted for less than 1 percent of the total principal and *Other* aquifer withdrawals, and were used mostly for irrigation (2.42 Mgal/d) (appendix 2).

About 14 percent (9.59 Mgal/d) of withdrawals from *Alluvial* aquifers were disaggregated to stream-valley aquifers associated with the Niobrara River (5.77 Mgal/d), Sand Creek (2.67 Mgal/d), and Belle Fourche River (1.15 Mgal/d) (fig. 27, table 3). The withdrawals were used mostly for irrigation (9.58 Mgal/d). Withdrawals of 57.5 Mgal/d from *Alluvial* aquifers could not be disaggregated and assigned to a specific aquifer or aquifer system (tables 1 and 3). No withdrawals from *Other* aquifers were attributed to stream-valley aquifers.

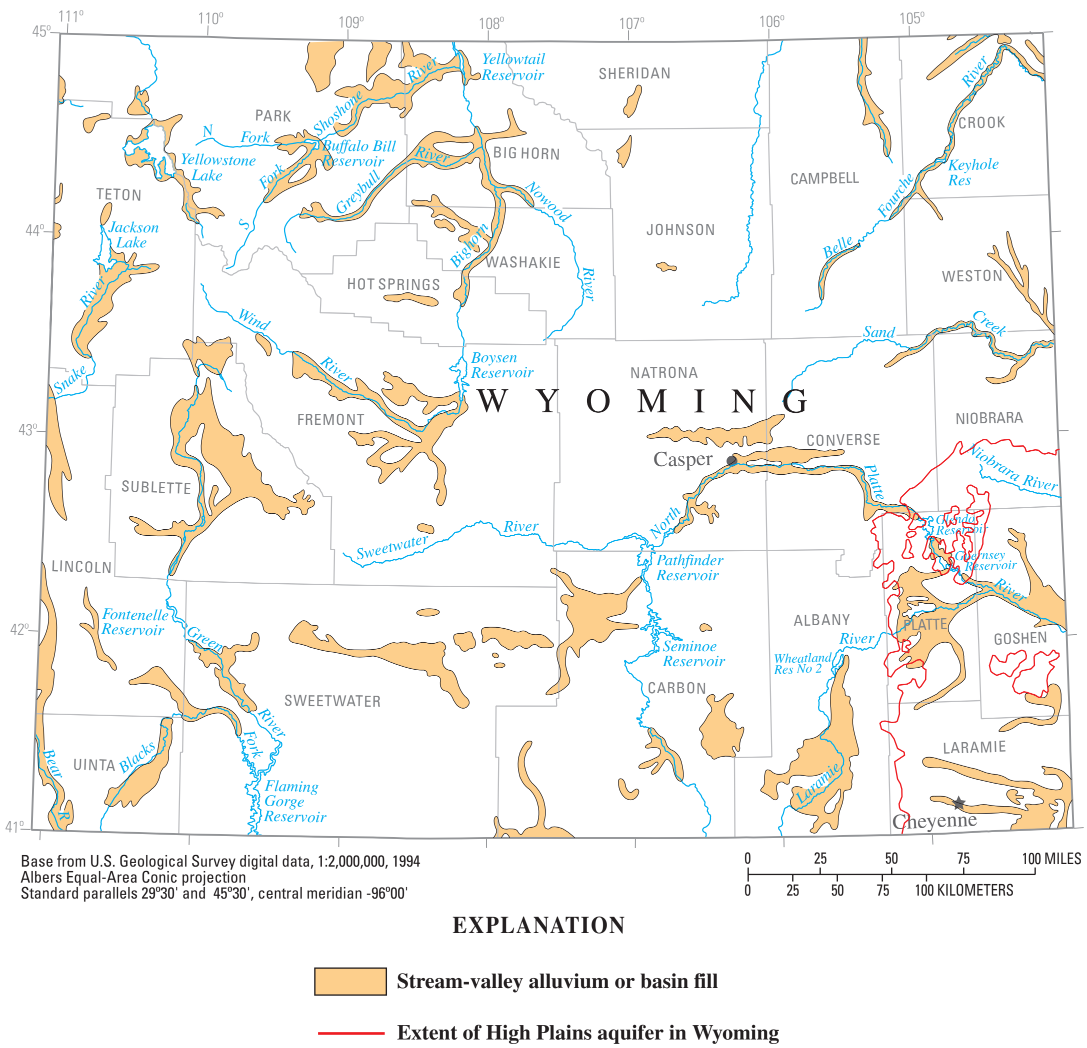


Figure 27. Extent of stream-valley alluvium and basin-fill deposits in Wyoming where withdrawals from *Alluvial* aquifers were associated with stream-valley aquifers (source: Miller, 2000, fig. 6, p. I3). Withdrawals from stream-valley aquifers were identified from a subset of the alluvial deposits along Sand Creek and the Belle Fourche Rivers and from unmapped sediments along the Niobrara River. (See fig. 1 for full extent of the High Plains aquifer.)

Water-Resources Regions

The 21 water-resources regions in the United States are geographic areas (hydrologic areas based on surface topography) that contain either the drainage area of a major river, such as the Missouri region, or the combined drainage areas of a series of rivers, such as the Texas-Gulf Region, which includes a number of rivers draining into the Gulf of Mexico (fig. 28) (Seaber and others, 1987). The regions were defined to provide a standardized base for use by water-resources organizations in locating, storing, retrieving, and exchanging hydrologic data.

Analysis of withdrawals from *Alluvial,* selected principal, and *Other* aquifers assigned 1,560 Mgal/d to stream-valley aquifers associated with major rivers, creeks, and areas where multiple streams are present. Stream-valley aquifer withdrawals were identified in eight water-resources regions (table 5).

Arkansas-White-Red Region

Withdrawals of 532 Mgal/d were assigned to stream-valley aquifers associated with 10 major rivers (table 5) in five states in the Arkansas-White-Red Region. Withdrawals from stream-valley aquifers associated with the Arkansas River in Arkansas, Colorado, Kansas, and Oklahoma accounted for about 74 percent (395 Mgal/d) of withdrawals from stream-valley aquifers in the region. About 19 percent (100 Mgal/d) of the withdrawals were from stream-valley aquifers associated with rivers in Oklahoma. About 80 percent (423 Mgal/d) of the withdrawals from stream-valley aquifers in the region were used for irrigation (table 5).

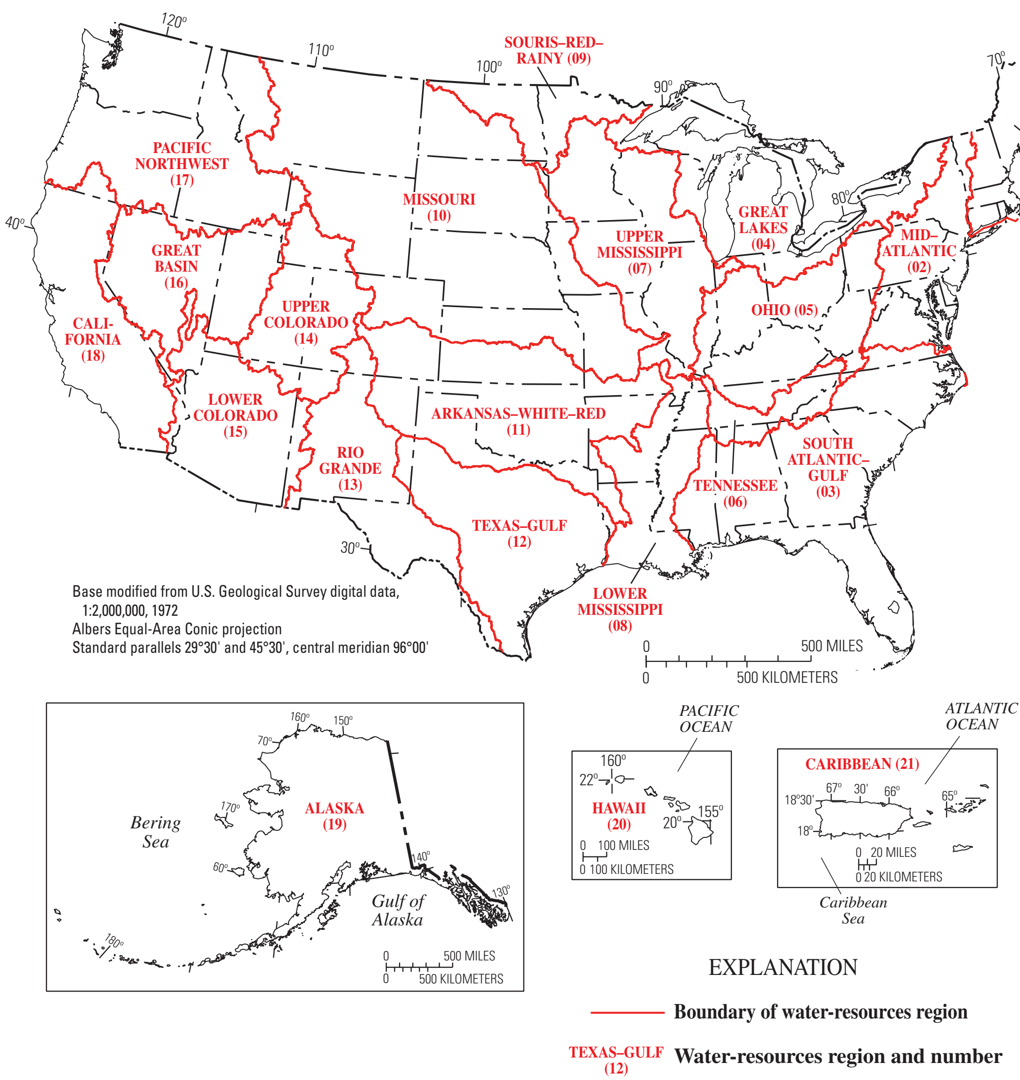


Figure 28. Water-resources regions of the United States (Seaber and others, 1987).

Table 5. Estimated withdrawals from stream-valley aquifers associated with major rivers, creeks, and areas by water-resources region, 2000.

[Values are rounded]

Major river, creek, or area	Withdrawals, in million gallons per day, by water-use category			
	Irrigation	Public supply	Self-supplied industrial	Total
Arkansas-White-Red Region				
Arkansas River	328	44.6	22.1	395
Canadian River	8.27	4.59	.01	12.9
Cimarron River	17.8	12.9	.06	30.7
Neosho River	.21	.33	.01	.55
North Canadian River	12.4	11.4	.44	24.3
Ouachita-Saline River	.05	.14	.02	.21
Red River	41.9	9.78	.26	51.9
Verdigris River	.00	.13	.00	.13
Walnut River	8.90	.57	.05	9.52
Washita River	5.43	.95	.00	6.38
Total	**423**	**85.4**	**22.9**	**532**
Mid-Atlantic Region				
Delaware River	.00	.10	.00	.10
Potomac River	.00	.00	.01	.01
Total	**.00**	**.10**	**.01**	**.11**
Missouri Region				
Bear Butte Creek	.08	.00	.00	.08
Belle Fourche River	1.16	.00	.00	1.16
Big Blue River	.31	2.91	1.67	4.89
Cheyenne River	.05	13.2	.14	13.4
Kansas River	3.01	1.53	3.04	7.58
Little Missouri River	.32	.08	.00	.40
Marais des Cygnes River	.00	.05	.00	.05
Missouri River	1.30	47.4	2.34	51.0
Niobrara River	5.77	.00	.00	5.77
Osage River	.33	.07	.00	.40
Republican River	64.3	9.40	.10	73.8
Saline River	2.74	.55	.00	3.29
Sand Creek	2.66	.00	.01	2.67
Smoky Hill River	21.2	8.56	.02	29.8
Solomon River	18.9	3.31	.00	22.2
South Grand River	.21	.19	.00	.40
South Platte River	387	5.87	10.8	404
White River	.05	.05	.00	.10
Yellowstone River	5.20	1.54	.10	6.84
Total	**515**	**94.7**	**18.2**	**628**
Ohio Region				
Allegheny River	.00	17.1	26.3	43.5
Beaver River	.00	1.13	.30	1.43
Hocking River	.00	4.32	.00	4.32
Kanawha River	.00	.00	.09	.09
Lower East Fork White River	.00	1.09	.10	1.19
Miscellaneous rivers and creeks	.00	.25	.00	.25
Monongahela River	.00	.91	2.47	3.38
Muskingum River	.00	15.7	1.98	17.7
Ohio River	2.61	130	88.4	221
Sandy Creek	.00	1.32	.28	1.60
Scioto River	.00	6.60	.01	6.61
Tuscarawas River	.12	17.4	14.2	31.7
Wabash River	.37	.43	.00	.80
Walhonding River	.00	8.18	.00	8.18
Total	**3.1**	**205**	**134**	**342**

Table 5. Estimated withdrawals from stream-valley aquifers associated with major rivers, creeks, and areas by water-resources region, 2000—Continued.

[Values are rounded]

Major river, creek, or area	Withdrawals, in million gallons per day, by water-use category			
	Irrigation	Public supply	Self-supplied industrial	Total
Tennessee Region				
Tennessee River	0.00	2.30	0.00	2.30
Texas-Gulf Region				
Brazos River	12.6	.01	.00	12.6
Upper Colorado Region				
Bear River	.89	.00	.00	.89
Duchesne River	.89	.00	.00	.89
Fremont River	3.12	.00	.00	3.12
Provo River	.89	.53	.00	1.42
San Pitch River	.00	.22	.47	.69
Sevier River	14.0	3.30	.00	17.3
Miscellaneous rivers in mountainous areas	9.85	3.86	.94	14.7
Weber River	.09	.43	.00	.52
Total	**29.7**	**8.34**	**1.41**	**39.5**
Upper Mississippi Region				
Mississippi River below St. Louis	.41	4.02	.29	4.72
Grand Total	**984**	**400**	**177**	**1,560**

Mid-Atlantic Region

Withdrawals of 0.11 Mgal/d were assigned to stream-valley aquifers in the Mid-Atlantic Region (table 5). Withdrawals from stream-valley aquifers were associated with the Delaware River (0.10 Mgal/d) in Pennsylvania and the Potomac River (0.01 Mgal/d) in West Virginia. About 91 percent (0.10 Mgal/d) of the withdrawals were used for public-supply uses (table 5).

Missouri Region

Withdrawals of 628 Mgal/d were assigned to stream-valley aquifers associated with 20 rivers or creeks (table 5) in seven states in the Missouri Region. Withdrawals from stream-valley aquifers associated with the South Platte River in Colorado were 404 Mgal/d and accounted for about 64 percent of withdrawals from stream-valley aquifers in the region. About 82 percent (515 Mgal/d) of the withdrawals were used for irrigation (table 5).

Ohio Region

Withdrawals of 342 Mgal/d were assigned to stream-valley aquifers associated with 13 rivers and creeks (table 5) and a group of three rivers and creeks (miscellaneous rivers and creeks) in seven states in the Ohio Region. Withdrawals from stream-valley aquifers associated with the Ohio River in six states accounted for about 65 percent (221 Mgal/d) of withdrawals from stream-valley aquifers in the region. About 59 percent (202 Mgal/d) of the withdrawals were from stream-valley aquifers in Kentucky and Ohio. About 60 percent (205 Mgal/d) of the withdrawals from stream-valley aquifers in the region were used for public supply (table 5).

Tennessee Region

Withdrawals of 2.30 Mgal/d were assigned to stream-valley aquifers (table 5) associated with the Tennessee River in the Tennessee Region. All of the withdrawals were for public-supply uses in Tennessee.

Texas-Gulf Region

Withdrawals of 12.6 Mgal/d were assigned to stream-valley aquifers (table 5) associated with the Brazos River in the Texas-Gulf Region. Almost all of the withdrawals were for irrigation uses in Texas.

Upper Colorado Region

Withdrawals of 39.5 Mgal/d were assigned to stream-valley aquifers in the Upper Colorado Region (table 5). Only the states of Colorado and Utah have stream-valley aquifer withdrawals in this region. The stream-valley aquifers were associated with seven major rivers in Utah and miscellaneous rivers in mountainous areas in Colorado. Withdrawals from stream-valley aquifers associated with the Sevier River accounted for about 44 percent (17.3 Mgal/d) of withdrawals from stream-valley aquifers in the region. About 75 percent (29.7 Mgal/d) of the withdrawals from stream-valley aquifers in the region were used for irrigation (table 5).

Upper Mississippi Region

Withdrawals of 4.72 Mgal/d were assigned to stream-valley aquifers associated with the Mississippi River below St. Louis in Illinois and Missouri in the Upper Mississippi Region (table 5). About 85 percent (4.02 Mgal/d) of the withdrawals were for public-supply uses (table 5).

Summary

The U.S. Geological Survey National Water Use Information Program compiles estimates of fresh ground-water withdrawals in the United States on a 5-year interval. In the year-2000 compilation, withdrawals were reported from principal aquifers and aquifer systems, including two general aquifers—*Alluvial* and *Other* aquifers. Withdrawals from *Alluvial* and *Other* aquifers were the 10th and 11th largest within the ranking of total withdrawals from principal aquifers and aquifer systems. Further differentiation and identification of water-use data categorized by *Alluvial* and *Other* aquifers was needed to determine whether another potentially important group of aquifers—stream-valley aquifers—provides substantial amounts of water for public-supply, self-supplied industrial, and irrigation uses. In 2004, an investigation was initiated to estimate withdrawals from stream-valley aquifers. In addition to examining *Alluvial* and *Other* aquifers, the investigation examined selected principal aquifers where appropriate.

Stream-valley aquifers are alluvial aquifers located in the valleys of major streams and rivers. Stream-valley aquifers are long but narrow aquifers that are in direct hydraulic connection with associated streams; they have limited extent compared to most principal aquifers, but are important sources of ground water. Withdrawals from this widespread aquifer group were not specifically identified in the year-2000 compilation.

Based in large part on information published in U.S. Geological Survey reports, preliminary analysis of withdrawal data and hydrogeologic and surface-water information indicated areas in the United States where possible stream-valley aquifers were located. The report focused on 24 states and the Commonwealth of Puerto Rico. Withdrawals reported from *Alluvial* aquifers and (or) *Other* aquifers in 22 states and the Commonwealth of Puerto Rico were investigated. Two additional states—Arkansas and New Jersey—were investigated because withdrawals reported from other principal aquifers in these two states may be from stream-valley aquifers.

States in the study area were selected by generally excluding areas that lie completely within the maximum extent of Quaternary continental glaciation, areas west of the Rocky Mountain/Colorado Plateau region, and areas coincident with the North Atlantic Coastal Plain aquifer systems, Basin and Range basin-fill aquifers, and Northern Rocky Mountains Intermontane Basins aquifer system. In these excluded areas, stream-valley aquifers and their withdrawals typically cannot be differentiated from other principal aquifers consisting of the same types of materials.

Twenty states were determined to have withdrawals from stream-valley aquifers. The results of the analysis indicate that stream-valley aquifer withdrawals (about 1,560 Mgal/d) are comparable to withdrawals from the 10th most productive principal aquifers in the United States. Of the 1,560 Mgal/d of withdrawals attributed to stream-valley aquifers, 1,240 Mgal/d were disaggregated from *Alluvial* aquifers, 116 Mgal/d from *Other* aquifers, 150 Mgal/d from glacial sand and gravel aquifers, 28.1 Mgal/d from Pennsylvanian aquifers, and 24.9 Mgal/d from the Mississippi River Valley alluvial aquifer.

Five states, including Colorado (552 Mgal/d), Kansas (384 Mgal/d), Oklahoma (126 Mgal/d), Kentucky (102 Mgal/d), and Ohio (100 Mgal/d), accounted for 81 percent of estimated stream-valley aquifer withdrawals. Of the total withdrawals from stream-valley aquifers, about 63 percent (984 Mgal/d) were used for irrigation, 26 percent (400 Mgal/d) were used for public-supply, and 11 percent (177 Mgal/d) were for self-supplied industrial uses. The largest estimated water withdrawals were from stream-valley aquifers associated with the South Platte (404 Mgal/d), Arkansas (395 Mgal/d), and Ohio (221 Mgal/d) Rivers.

The estimates of stream-valley aquifer withdrawals presented in this report represent an approximation of the minimum rate of withdrawals from stream-valley aquifers in the United States; nevertheless, this estimate provides a quantitative assessment on their importance. As such, this estimate may be useful for researchers evaluating ground-water resources at regional and national scales.

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Appendix 1

Appendix 1. Sources of water-use and related information and methods of analysis, by state.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
Arizona	No information.	Arizona is typical of most southwestern states with principal aquifers that are generally thick and continuous. Aquifers with these characteristics may offer sufficient supplies from deep levels, but locally may be under declining and stressed conditions. Ground-water withdrawals were assigned to principal aquifers using a method that compared the boundaries of HUC's, or river basin boundaries with the boundaries of the aquifers. The boundaries of the two compared relatively well, and ground-water withdrawals were assigned to the respective aquifers. Parts of some river basins were located within the extent of more than one aquifer, which required sites to be closely examined to determine which aquifer was the source of water. Arizona did not report withdrawals for *Alluvial* aquifers because the Basin and Range basin-fill aquifers are composed of unconsolidated sand and gravel material and would make the distinction of withdrawals from *Alluvial* aquifers impossible to identify (fig. 3). Parts of Arizona are illustrated in the atlas as mountainous area (fig. 3). In other states, mountainous area was associated with a stream-valley aquifer; however, the mountainous area deposits in Arizona are coincident with the Colorado Plateaus aquifers, a sandstone principal aquifer. No disaggregation of stream-valley aquifers was made from this principal aquifer. A substantial amount of ground water (88.2 Mgal/d), most of which was used for public-supply (58.3 Mgal/d), was reported from *Other* (appendix 2). No conclusive data were present that indicated that withdrawals from *Other* aquifers could be attributed to a stream-valley aquifer. Arizona has been defined by two geographic provinces, the Plateau Uplands Province, and the Basin and Range Province (Robson and Banta, 1995, p. C6, fig. 1). A transitional region called the Central Highlands Province is located between the two Provinces. This transitional region contains similar features to the two other provinces such as mountain ranges separated by basins (Northern Arizona University, 1999). Ground-water withdrawals from *Other* aquifers (88.2 Mgal/d) (fig. 3, appendix 2) were determined to be from the Central Highlands Province and not associated with a stream-valley aquifer (table 4) (Saeid Tadayon, U.S. Geological Survey, oral commun., 2005).
Arkansas	The Arkansas Soil and Water Conservation Commission (ASWCC) monitors water-use data in Arkansas in cooperation with the USGS. Water users that withdraw more than 0.05 Mgal/d from ground water must report their water use to ASWCC by completing a water-use registration form. Public supply, self-supplied industrial, and irrigation users complete these forms. In addition, the Arkansas Department of Health, Division of Engineering, supplements the public-supply information, and the Arkansas Industrial Development Foundation supplements the information about self-supplied industries.	The atlas lists and illustrates three stream-valley aquifers in addition to the Mississippi River Valley *alluvial* aquifer (Renken, 1998, p. F8, fig. 23). *Alluvial* aquifers associated with the Arkansas, Ouachita-Saline, and Red Rivers have characteristics that typify stream valley aquifers, and for this study withdrawals were assigned to them from the total reported for the Mississippi River Valley alluvial aquifer. Twenty-eight of 75 counties in Arkansas were identified as having potential stream-valley aquifer withdrawals. The Red stream-valley aquifer is present in Lafayette, Miller, Columbia, Little River, Hempstead, Sevier, and Howard counties (fig. 4). The Ouachita-Saline stream-valley aquifer is present in Pike, Hempstead, Hot Springs, Clark, Nevada, Dallas, Ouachita, Calhoun, Union, Saline, Grant, Cleveland, Bradley, Lincoln, and Drew counties. The Arkansas stream-valley aquifer is present in Crawford, Sebastian, Franklin, Logan, Johnson, Pope, Yell, Perry, Conway, Pulaski, and Faulkner counties. In Pulaski County, site-specific data were used to disaggregate withdrawals from the Mississippi River Valley alluvial aquifer to stream-valley aquifers associated with the Arkansas River. Withdrawals originally attributed to the Mississippi River Valley alluvial aquifer in counties where the Arkansas, the Ouachita-Saline, and the Red Rivers are present (and the Mississippi River Valley alluvial aquifer is absent), were considered for reassignment to stream-valley aquifers associated with the Arkansas, Ouachita-Saline, and Red Rivers. The ages of deposits (Recent, Holocene, and Pleistocene) also were used to identify and separate wells screened in potential stream-valley aquifer deposits. In certain instances, withdrawals were evaluated from specific wells to determine whether the source was from a stream-valley aquifer or an isolated alluvial deposit. Eight-digit HUC information associated with each well was used to verify that wells were located within watersheds associated with stream-valley aquifers.

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
Colorado	In Colorado, water-use data for all categories of the 2000 compilation were provided by the Colorado Division of Water Resources, the Colorado Geological Survey, and the Colorado Water Conservation Board. Public-supply data also were provided by the USEPA, the Castle Pines Metropolitan District, Castle Rock, the Centennial Water and Sanitation District, the Cherokee Metropolitan District, the East Cherry Creek Valley Water and Sanitation District, the Greenwood Plaza Water District, the Bell Mountain Ranch Water and Sanitation District, the Stonegate Metropolitan District, the Parker Water and Sanitation District, and the Willows Water District. Irrigation data were provided by the Northern Colorado Water Conservancy District, the Central Colorado Water Conservancy District, and the Lower South Platte Water Conservancy District. The Office of the State Engineer in the Colorado Department of Natural Resources provided pumpage data for irrigation, public-supply, and self-supplied industrial wells.	Alluvial and eolian deposits along the South Platte River are thick and continuous (fig. 5). Well records in the area typically have an aquifer designation that reflects either the surface eolian material or the surface or underlying alluvium. In Colorado, a portion of the withdrawals assigned to *Alluvial* aquifers were later determined to be in eolian sands. Withdrawals from these deposits are specifically identified as not being from a stream-valley aquifer but belonging to *Alluvial* aquifers as defined in the 2000 compilation. For this report, USGS differentiated wells that are screened in eolian material from those screened in alluvium. The availability of more detailed information enabled the determination of withdrawals from stream-valley aquifers associated with the South Platte River (Rick Arnold, U.S. Geological Survey, written commun., 2005). Withdrawals that were assigned to *Other* aquifers in Maupin and Barber (2005) were disaggregated to stream-valley aquifers associated with the South Platte and Arkansas Rivers (table 3) and to miscellaneous bedrock aquifers (table 4).

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
Illinois	The Illinois State Water Survey (ISWS) has had a comprehensive program to inventory water use throughout the State since 1978; its Public-Industrial-Commercial Survey Database was a source of water-use data used in this report. The Illinois Water Inventory Program (IWIP) data base of water-using facilities includes locations and amounts of water withdrawn from surface- and ground-water sources, facility types, SIC codes, HUC's, and aquifer codes. Location information is stored by principal meridian, township, and range. For this investigation, the ISWS provided public-supply and self-supplied industrial withdrawals for 2000 from the principal aquifer, glacial sand and gravel aquifers. Irrigation data were obtained from the 2000 compilation.	Glacial sand and gravel aquifers accounted for 65 percent of total aquifer withdrawals (appendix 2). However, some of these withdrawals were from wells located south of the extent of Quaternary continental glaciation and hence, may represent withdrawals from stream-valley aquifers. Total withdrawals from *Other* aquifers were 10.9 Mgal/d. No further aquifer information was available about *Other* aquifers that would indicate there were any qualifying stream-valley aquifer withdrawals included in this amount (P.C. Mills, U.S. Geological Survey, oral commun., 2005). Most of Illinois lies north of the extent of Quaternary continental glaciation; therefore, only 16 of 102 counties were of interest for this study (fig. 6). Withdrawals from the sand and gravel aquifers, where located south of the extent of Quaternary continental glaciation, primarily represent production from stream-valley aquifers. Information about public supply and self-supplied industrial withdrawals were provided by township-range blocks that provided greater detail than county data, but not as much detail as site-specific information. There are 139 township-range blocks south of the extent of Quaternary continental glaciation. Blocks containing sand and gravel aquifers buried beneath finer grained material were identified and excluded from this analysis because such deposits do not meet the requisite criteria for stream-valley aquifers. In addition, blocks within the extent of the Mississippi River Valley alluvial aquifer were identified in this analysis and withdrawals were assigned accordingly (table 3). Ground-water irrigation withdrawal information from the 2000 compilation data base was examined for the following counties whose total land area is south of the extent of Quaternary continental glaciation: Alexander, Johnson, Massac, Pope, Pulaski, Union, and Hardin. Withdrawal data from Pulaski County were not used because pumpage from sand and gravel aquifers buried beneath finer grained material could not be differentiated from stream-valley aquifers associated with either the Mississippi or the Ohio Rivers. Alexander County is within the extent of the Mississippi River Valley alluvial aquifer and also was excluded from this analysis. To assign pumpage, the withdrawal information was combined with irrigation well inventory data. In Massac and Union Counties, the well inventory data showed that 100 percent of the wells were screened in stream-valley aquifer deposits. Well inventory data for the other three counties were not available. Overall, 92 percent of irrigation wells in Illinois are screened in sand and gravel deposits (Bowman and Collins, 1987). For wells north of the extent of Quaternary continental glaciation, sand and gravel deposits were classified as glacial sand and gravel aquifers. Sand and gravel deposits located south of the extent of Quaternary continental glaciation were classified as either stream-valley aquifer deposits or buried valley deposits. Counties with buried valley deposits were excluded from the analysis. In Johnson and Pope Counties, which are south of the extent of Quaternary continental glaciation and do not contain outwash deposits, 92 percent of the irrigation wells are assumed to be screened in stream-valley aquifer deposits. Thus, the total county irrigation withdrawals for glacial sand and gravel aquifers was reduced by 8 percent (a conservative estimate) and assigned to stream-valley aquifers associated with either the Mississippi (below St. Louis) or the Ohio Rivers.

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
Indiana	Water users in Indiana that withdraw over 0.1 Mgal/d must register by reporting monthly withdrawals on an annual basis with the Indiana Department of Natural Resources (IDNR), Division of Water, Section of Water Use. Although the IDNR does not require flow meters, nearly all the public suppliers and some of the industrial facilities use flow meters. The IDNR data base has information about each facility with regards to SIC code, county, HUC, and aquifer. SIC codes are critical for facility classification because a facility that is labeled as "industrial" by one agency may be labeled as "commercial" by another and the facility can only be correctly categorized by using SIC code. For Indiana, data for 2000 were obtained from the IDNR, which had recently upgraded its data base information system, rather than use data from the 2000 compilation.	Parts of sand and gravel aquifers in Indiana that are south of the extent of Quaternary continental glaciation have the characteristic string-like shape of a stream-valley aquifer and do not appear to represent outwash deposits (fig. 7). Buried glacial deposits underlie much of the northern two-thirds of Indiana where they are typically embedded with till deposits that can be 10 to 400 ft deep. Discontinuous sand and gravel deposits are present as isolated lenses, also in glaciated areas (Fenelon and others, 1994). South of the extent of Quaternary continental glaciation, stream-valley aquifers are generally the most reliable source of ground water (P.M. Buszka, U.S. Geological Survey, oral commun., 2005). Eight out of 92 counties are located south of the extent of Quaternary continental glaciation: Crawford, Harrison, Lawrence, Orange, Perry, Spencer, Vanderburgh, and Warrick. Parts of Brown, Clark, Dubois, Floyd, Gibson, Greene, Martin, Monroe, Pike, Posey, and Washington Counties are bisected by the extent of Quaternary continental glaciation. All 19 counties listed were considered eligible to have withdrawals from stream-valley aquifers (fig. 7). Site-specific information was developed by mapping well locations and aquifer boundaries. South of the extent of Quaternary continental glaciation, withdrawals were assigned to a stream-valley aquifer for wells that were screened in units defined as glacial sand and gravel in IDNR data bases and located in areas shown in the atlas as alluvium along streams and rivers. Evansville, which is the third largest city in Indiana, is located along the Ohio River, and its primary source of water supply is from surface water. However, most of the other communities along the Ohio River withdrew ground water, which explains the relatively large amount of public-supply withdrawals (P.M. Buszka, U.S. Geological Survey, oral commun., 2005).
Kansas	The Kansas Department of Agriculture-Division of Water Resources (DWR) requires users with water rights to report withdrawals annually to establish and enforce water appropriations; DWR is the source of irrigation and public-supply withdrawals data used by the USGS for the 2000 compilation and this report. The Kansas Water Office (KWO) requires public suppliers to report withdrawals annually; KWO is the source for public supply and self-supplied industrial withdrawals data. The USGS assists these State agencies with water-use data collection, evaluation, and publication. Together these three agencies maintain data bases with site-specific information on water use in Kansas.	Withdrawals were assigned to a specific stream-valley aquifer by using HUC and KWO basin information available for individual wells. As an illustration, at the 8-digit HUC level, a well might be identified as being in the Prairie Dog basin. A review of the basin name at the 6-digit HUC level or the KWO basin name shows that withdrawals from this well should be assigned to the Republican stream-valley aquifer. Kansas is one of the eight States that depends heavily upon the High Plains aquifer for water that is mostly used for irrigation. In the western part of Kansas, stream-valley aquifers are embedded with the High Plains aquifer, and withdrawals from one are indistinguishable from the other. Glaciated areas in the northeastern part of Kansas are outside the study area and were not investigated for stream-valley aquifer withdrawals. In the eastern part of Kansas, wells that are screened in alluvium and located in close proximity to, and in hydraulic connection with, the near-by rivers were assigned to the appropriate stream-valley aquifers (C.V. Hansen, U.S. Geological Survey, oral commun., 2005) (fig. 8).

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
Kentucky	By statute, Kentucky has authority to regulate withdrawals from public waters. The Kentucky Natural Resources and Environmental Protection Cabinet, Division of Water (KDOW), Water Quantity Section, administers the water-withdrawal-permit program. Industrial and public suppliers that withdraw over 0.01 Mgal/d are required to have a permit. Irrigation withdrawals are exempt from the permit requirement. Site-specific data were provided by 267 public water-supply facilities and 120 industrial facilities to the USGS.	Irrigation estimates for crop and non-crop (golf courses) were developed at the state level. Ground-water withdrawals were computed as 4 percent of the total estimated withdrawals. The estimated 4 percent ground-water withdrawal allocation is not spatially referenced, and the aquifer systems in Kentucky have not been extensively delineated. Therefore, the entire irrigation estimate of 1.24 Mgal/d ground-water withdrawals for crop and non-crop irrigation remains in *Other* aquifers as presented in Maupin and Barber (2005). Site-specific data for public water-supply and industrial facilities were aggregated at the county level. The northern border of Kentucky is defined by the Ohio River (fig. 9). Alluvial deposits along the Ohio River are the most intensively used in Kentucky. The towns of Owensboro, Hawesville, Brandenburg, Louisville, and Carrollton are located along the Ohio River and depend upon large surface-water supplies from the river and on ground-water supplies from shallow wells screened in the alluvium adjacent to the river. A dependable supply is ensured by constructing wells near the river to induce infiltration. In Kentucky, alluvium is mapped in a narrow band along the Ohio River. This band corresponds to the area shown as a stream-valley aquifer in the atlas (Lloyd and Lyke, 1995, p. K3, fig. 4). From the 2000 compilation, *Alluvial* aquifers withdrawals (123 Mgal/d) were assigned to alluvial aquifers located along the Ohio River. The southern extent of the Quaternary continental glaciation extends into Kentucky in places along the Ohio River. Boone, Carroll, Gallatin, Kenton, Oldham, and Trimble Counties are bisected by the southern glacial extent. Because withdrawals in bisected counties could not be differentiated as north or south of the line, the combined ground-water withdrawals (21.6 Mgal/d) from these counties were not assigned to a stream-valley aquifer (table 3). The remaining *Alluvial* aquifers withdrawals (102 Mgal/d, entirely south of the extent of Quaternary continental glaciation) were assigned to stream-valley aquifers associated with the Ohio River (table 3), and likely represent a conservative estimate because of the omission of withdrawals from the bisected counties.
Louisiana	Wells are assigned to aquifers and aquifer systems, and the data are stored as part of the Louisiana Department of Transportation and Development's (DOTD) water-resources program. Information about well location, ground-water source (aquifer name), and withdrawals are made available as part of the cooperative water-use program in Louisiana. The DOTD aquifer names are not similar to the aquifer names that are defined by the USGS in the atlas, but they do correspond to aquifer names within GWSI. A cross-reference of the 145 State aquifer names to the five principal aquifers located in Louisiana was built to facilitate the association of withdrawals from each well to the appropriate principal aquifer in the USGS water-use data set.	Louisiana aquifer withdrawal data were derived from site-specific information. Withdrawals were segregated on the basis of the local aquifer names that correspond to stream-valley aquifers mapped in the atlas (Renken, 1998, p. F8, fig. 23). Following the convention defined in the atlas, a portion of the withdrawals assigned by DOTD to the Red River alluvial aquifer (2.35 Mgal/d) were located within the extent of and, therefore, assigned to the Coastal Lowlands aquifer system (table 1). Withdrawals from alluvial aquifers associated by DOTD with the Ouachita River (1.51 Mgal/d) and grouped with *Alluvial* aquifers were confirmed to be within the extent of and reassigned to the Mississippi River Valley alluvial aquifer. This refinement reduced the total withdrawals from *Alluvial* aquifers in 2000 by 3.85 Mgal/d. The refinement increased withdrawals to the Coastal Lowlands aquifer system and the Mississippi River Valley alluvial aquifer by 2.35 and 1.51 Mgal/d, respectively (table 1).

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
Missouri	The Missouri Department of Natural Resources (DNR) is the source for most of the water-use data collected for Missouri. Typically the DNR sends questionnaires to major users with facilities capable of pumping or diverting at least 100,000 gal/d. For public supply, the DNR, Division of Environmental Quality, provides information gathered as part of the Public Drinking Water Program and the Water Pollution Control Program. The data from these two programs are also the source of data for self-supplied industrial water use. The Missouri Agricultural Statistical Service and an irrigation specialist from the Missouri University Agricultural Extension Agency helped in the estimation of irrigation water use.	In Missouri, the extent of Quaternary continental glaciation divides the State roughly along the Missouri River (fig. 11). Although coarse-grained glacial deposits exist in the glaciated part of the State, withdrawals were not assigned to the glacial sand and gravel aquifers for the 2000 compilation (appendix 2); all withdrawals from alluvial deposits (either of glacial origin or otherwise) were assigned to the Mississippi River Valley alluvial aquifer and *Alluvial* aquifers (Maupin and Barber, 2005). Fifty-five of 115 counties in Missouri had withdrawals from wells screened in alluvial deposits. In general, the 55 counties are located in the northern half of the State. Withdrawals were not disaggregated to stream-valley aquifers in 39 of the 55 counties, as these counties are coincident with the extent of Quaternary continental glaciation. Withdrawals from these counties represent the majority of withdrawals that were assigned to *Alluvial* aquifers (122 Mgal/d). Withdrawals from alluvial aquifers associated with the Missouri River are an important source of water for users between the Iowa-Missouri state line and the confluence of the Missouri and Mississippi Rivers. The atlas provides a more complete description of the fluvial deposits along the Missouri River (Miller and Appel, 1997, p. D9). Several counties along the Missouri River, especially in the vicinity of Kansas City (Jackson County), were identified as having substantial withdrawals from alluvial aquifers associated with the Missouri River. Sixteen counties with potential stream-valley aquifer withdrawals are located along or south of the extent of Quaternary continental glaciation. These counties are Boone, Callaway, Cole, Cooper, Franklin, Gasconade, Henry, Jackson, Jefferson, Johnson, Moniteau, Osage, Perry, Pettis, St. Genevieve, and St. Clair. Stream-valley aquifer withdrawals from these counties were identified based on the knowledge gained from site-specific studies (Rich Huizinga, U.S. Geological Survey, written commun., 2005). Two counties with minor withdrawals, Henry and St. Clair, are not shown as having stream-valley aquifer deposits in the atlas. Alluvial deposits of local extent are not shown in the atlas, and some stream-valley aquifers are only delineated on smaller-spatial-scale maps.

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
Montana	The Montana Department of Natural Resources and Conservation provided most of the water-use data collected for the 2000 compilation. Public-supply information was obtained from the Safe Drinking Water Information System database maintained by the USEPA. Irrigation data were compiled from the USDA, National Agricultural Statistics Service, and the Montana Department of Agriculture, Montana Agricultural Statistics Service.	The extent of the Quaternary continental glaciation in Montana crosses the northern third of the State, and, in general, unconsolidated coarse-grained deposits from glacial or unknown origin are difficult to differentiate from stream-valley alluvium (fig. 12). Withdrawals from glacial sand and gravel aquifers (33.9 Mgal/d) were nearly equal to those from *Alluvial* aquifers (33.6 Mgal/d; Maupin and Barber, 2005). The Northern Rocky Mountains Intermontane Basins aquifer system (NRMIB) had withdrawals of 92.7 Mgal/d in 2000, and this principal aquifer consists of unconsolidated sand and gravel deposits that occur in similar geographic settings as the *Alluvial* aquifers and the glacial sand and gravel aquifers. During examination of the unconsolidated sand and gravel aquifers of Montana, no withdrawals from *Alluvial* aquifers were disaggregated to the NRMIB aquifer system or the glacial sand and gravel aquifers. Sixteen of the 57 counties in Montana are clearly located south of the extent of Quaternary continental glaciation, but not within the extent of the NRMIB aquifer system. These counties had withdrawals reported from *Alluvial* aquifers that could be defined as from a stream-valley aquifer. The 16 counties are Big Horn, Carbon, Carter, Custer, Fallon, Golden Valley, Judith Basin, Musselshell, Powder River, Prairie, Rosebud, Stillwater, Sweet Grass, Treasure, Wheatland, and Yellowstone. Ten of these counties contain either unconsolidated sand and gravel deposits clearly not associated with a river or possibly associated with multiple stream-valley aquifer units, making the disaggregation difficult. The remaining six counties (Carter, Fallon, Prairie, Rosebud, Sweet Grass, and Treasure) had withdrawals from *Alluvial* aquifers that were successfully disaggregated to a stream-valley aquifer. The majority of withdrawals from *Alluvial* aquifers were not disaggregated because of inconclusive data, or because withdrawals were from unconsolidated sand and gravel aquifers in mountain valleys or erosional basin areas.
Nebraska	Sources of information for public-supply data in Nebraska were the Nebraska Department of Health, the Nebraska Department of Water Resources, the City of Lincoln Water System, and the Metropolitan Utilities District in Omaha, Nebraska. Industrial information was provided by the Directory of Nebraska Manufacturers, published by the Nebraska Department of Economic Development (Nebraska Department of Economic Development, 2004). Both the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service and the Natural Resources Conservation Service provided irrigation information. The Nebraska Department of Water Resources maintains a data base of registered well data.	In Nebraska, the extent of Quaternary continental glaciation generally is north to south in the eastern one-fifth of the State. Coarse-grained glacial deposits are present in this glacial area, and withdrawals totaled 202 Mgal/d from glacial sand and gravel aquifers, mostly for irrigation uses. Fluvial deposits along rivers in the western three-fifths of the State overlie sand and gravel deposits of the High Plains aquifer, and withdrawals from the two deposits could not be differentiated. All withdrawals there were reported as from the High Plains aquifer. Stream-valley aquifer withdrawals were determined for an area just west of the extent of Quaternary continental glaciation and east of the High Plains aquifer boundary (approximately one-fifth of the State in size) as well as some areas directly contiguous with the Missouri River (fig. 13).

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
New Jersey	No information.	New Jersey withdrawals were evaluated because the atlas (Miller, 2000) showed the presence of a narrow band of alluvium along the Delaware River near the western edge of New Jersey and the eastern edge of Pennsylvania (Trapp and Horn, 1997, p. L6, fig. 12). No New Jersey withdrawals were attributed to *Alluvial* or *Other* aquifers in 2000 (Maupin and Barber, 2005), and thus stream-valley aquifer withdrawals, if present in New Jersey, would have to be disaggregated from aquifers other than these. The only geologically reasonable candidate for any such withdrawals would be the surficial aquifer system. However, withdrawals from the surficial aquifer system were minor (0.22 Mgal/d, appendix 2) and were for irrigation. The area of interest is composed of New York bedroom communities that are unlikely to have withdrawals from irrigation wells. Furthermore, wells in this area typically are cased to bedrock to protect against ground water contamination (John Nawyn, U.S. Geological Survey, oral commun., 2005). On the basis of this information, no withdrawals were attributed to stream-valley aquifers in New Jersey.
New Mexico	Site-specific and spatial data were provided by the New Mexico Office of the State Engineer (OSE). Data for public supply also were provided by the New Mexico Environment Department's Drinking Water Bureau, but not all of the facilities were required to report annual withdrawals.	Water-use estimates for New Mexico in 2000 were compiled using site-specific and spatial data. Data were lacking for areas not declared as a ground-water basin of concern or for facilities with pre-basin water rights. Survey questionnaires were sent to facilities to gather withdrawal data for public-supply and self-supplied industrial uses. Irrigation water-use estimates were derived by the OSE using data for irrigated cropping areas, including tabulated gross irrigated acreage for each individual crop, cropping patterns, source of water, and information about irrigation systems that are used on the crops.
New York	The New York Department of Health, Bureau of Public Water Supply Protection, was the source for public-supply data for 2000. The Bureau has information such as the public supplier name, city served, primary water sources, average daily populations, mean daily withdrawals in gallons per day, and locations of wells or intakes. Crop irrigation source agencies include the USDA, National Agricultural Statistics Service and the Natural Resources Conservation Service, and Cornell University, Department of Agricultural and Biological Engineering. Industrial data were obtained from Harris InfoSource and Planning and Management Consultants, Ltd.	The southern half of Long Island, New York, is south of the extent of Quaternary continental glaciation (Olcott, 1995, p. M4, fig. 9), and this area is blanketed by coarse-grained, stratified glacial outwash deposits. In this area alluvium cannot be differentiated from the underlying glacial material. In the western part of New York, two counties (Cattaraugus and Allegany) are dissected by the extent of Quaternary continental glaciation (fig. 16). In Allegany County, the area south of the extent is so small that identification of stream-valley aquifers would be difficult. Cattaraugus County has the Allegheny River entering from Pennsylvania and then leaving the county to the south, making a "half" circle. Public-supply wells withdraw water along the Allegheny River in this reach. Estimates of public-supply withdrawals from stream-valley aquifers associated with the Allegheny River in Cattaraugus County were made using corresponding data for population served and New York's public-supply per-capita water-use coefficient. Corresponding well construction information was not available for the categories of self-supplied industrial and irrigation, so estimates of water use could not be made for these two categories.

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
North Dakota	North Dakota aquifer data were derived from county estimates from the 2000 compilation. Public-supply and self-supplied industrial withdrawals were obtained from the purveyors and facility operators; irrigation withdrawals were estimated using permit data and reported pumpage data where available, and coefficients and ancillary data as necessary. The county ground-water withdrawals were subdivided between aquifers using documentation and information from reports completed as a product of a cooperative study between the USGS, North Dakota State Water Commission, and the North Dakota Geological Survey. This 25-year study of the ground-water resources in North Dakota was finished in the late 1980's and produced a three-part series for each of the 53 counties in the State. Each series describes the geology and ground-water resources at the county level. A listing of the county reports can be viewed from the North Dakota State Water Commission website under the topic of Reports and Publications (North Dakota State Water Commission, 2007). Some differences in terminologies and definitions of aquifers exist between the three-part series publications and USGS principal aquifer names. The differences were resolved prior to the allocation of total county ground-water withdrawals for public-supply, self-supplied industrial, and irrigation uses to the principal aquifers.	Almost all of North Dakota is north of the extent of Quaternary continental glaciation; only the southwestern corner is outside of this area (fig. 17). The counties that are entirely south of the extent of Quaternary continental glaciation and have delineations of coarse-grained alluvium in figure 6 of the atlas (Whitehead, 1996, p. I3) are Adams, Billings, Bowman, Golden Valley, Hettinger, and Slope. Nearly every other county in North Dakota that is north of the extent of Quaternary continental glaciation contains some part of a delineation of coarse-grained alluvium in figure 6 of the atlas. Some ground-water withdrawals in some parts of North Dakota were assigned to the *Alluvial* aquifers and are derived from deposits where ancient rivers once flowed and are now buried beneath glacial and shallow stream-valley deposits. There were several large ancient rivers which originated in the Rocky Mountains and flowed through North Dakota generally in a west to east and northeast direction. These "mega" rivers and their tributaries produced large deposits of stream-valley alluvium in a number of places. For example, a Little Missouri River aquifer in McKenzie County was identified in a three-part series document (North Dakota State Water Commission, 2007). These ancient stream-valley alluvial aquifers are not included in this compilation because they are not in direct hydrologic contact with present-day streams or rivers. Based on the dynamics of deposition of alluvial materials in North Dakota, and results of intensive 25-year ground-water studies in all counties, most of the withdrawals in 2000 from *Alluvial* aquifers were in counties that are within the extent of Quaternary continental glaciation (appendix 3). It was not possible to subdivide the 23.2 Mgal/d of withdrawals from *Alluvial* aquifers into specific stream-valley aquifer withdrawals in areas that are entirely outside of the glacial region.

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
Ohio	In Ohio, water users that withdraw over 0.1 Mgal/d must register their withdrawals with the Ohio Department of Natural Resources (ODNR), Division of Water. Through the Water Withdrawal Facility Registration Program, facilities provide information on withdrawal capacity, ground- or surface-water sources, location and type of water use, and location of discharge points. Registered users file annual reports of their water use. In addition, Ohio State University (2008) has created Extension Fact Sheets on the water resources of every county in the State (*http://ohioline.osu.edu/lines/ennr.html*). In the fact sheets, there are sections on surface-water resources, ground-water resources, and water use. Public suppliers provide information on the population served, source (ground or surface water), estimated daily usage, and treatment plant capacity for their facilities.	In the 2000 compilation, withdrawals both within and south of the extent of Quaternary continental glaciation were attributed to glacial sand and gravel aquifers, and it was for this principal aquifer that some stream-valley aquifer withdrawals were identified. Thus, for this study, withdrawals from glacial sand and gravel aquifers in that part of the State, located south of the extent of Quaternary continental glaciation, were disaggregated to specific stream-valley aquifers where supported by site-specific data. The Ohio counties located south of the extent of Quaternary continental glaciation illustrated in figure 18 as having alluvium along streams and rivers are Athens, Belmont, Carroll, Coshocton, Gallia, Jefferson, Lawrence, Meigs, Monroe, Morgan, Muskingum, Pike, Scioto, Tuscarawas, Vinton, and Washington Counties. Site-specific information used to disaggregate withdrawals included data from the ODNR, Division of Water. The Division has produced statewide maps for the unconsolidated aquifers of Ohio. These maps depict the approximate yield, in gallons per minute, with additional attributes for drift thickness, hydrogeologic settings, local names, and lithology. In these maps, buried valley deposits are differentiated from more shallow (surficial) alluvial deposits. The alluvial deposits generally coincide with the shallow sand and gravel aquifers and alluvium along streams and rivers, as shown in figure 18. The ODNR maps were used to select wells within the extent of alluvium along streams and rivers. In addition, county maps of flood prone areas were used as a quality assurance check to ensure that the aquifers were associated with an existing river and not a historic river valley.
Oklahoma	The Oklahoma Water Resources Board mails an annual water-use survey to collect withdrawal data from public supply, self-supplied industrial, and irrigation users. This information was used by the USGS for the 2000 compilation. In addition, Oklahoma City, the City of Tulsa and the Grand River Authority provided public-supply and self-supplied industrial water-use data directly to the USGS.	In most instances, the Oklahoma aquifer names corresponded exactly to the stream-valley aquifers mapped in the atlas, and withdrawals could be assigned accordingly. In other instances, ground-water withdrawals were assigned to stream-valley aquifers by using HUC information available from individual wells. Oklahoma aquifer names or knowledge about individual rock units were used to assign withdrawals to isolated terrace deposits when necessary (S.C. Christenson, U.S. Geological Survey, oral commun., 2005). Withdrawals from stream-valley aquifers in Oklahoma were associated with the Red, Arkansas, Cimarron, North Canadian, Canadian, and Washita Rivers (fig. 19). The atlas (Ryder, 1996) identified a potential stream-valley aquifer along the Neosho River, but no withdrawals from *Alluvial* aquifers were identified for this stream-valley aquifer.
Pennsylvania	For the 2000 compilation, the Pennsylvania Department of Environmental Protection (PADEP) provided withdrawal data from public-water systems. If data for the population served were available but water-use data were missing, withdrawals were estimated using a coefficient of 60 gallons per person per day. For some small counties, withdrawal data from the 1995 compilation were used. The PADEP, the United States Environmental Protection Agency, the Delaware River Basin Commission, and the Susquehanna River Basin Commission provided data about self-supplied industrial use. The Pennsylvania Department of Agriculture provided irrigation data. The PADEP provided irrigation data for selected golf courses, which are classified as a commercial activity in Pennsylvania.	Withdrawals from *Other* and the principal aquifer, Pennsylvanian aquifers, were disaggregated and associated with six stream-valley aquifers (table 3). Some wells within the extent of the Pennsylvanian aquifers were constructed with openings in the casings that were completed in unconsolidated sand and gravel deposits, which could potentially be assigned to a stream-valley aquifer (fig. 20). Wells were mapped to identify the appropriate river for an associated stream-valley aquifer, and all wells were south of the extent of Quaternary continental glaciation. Well construction information, including aquifer and depth, was used to confirm that a well met the criteria for consideration as a source of withdrawal from a stream-valley aquifer.

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
Puerto Rico	Data were provided from the Puerto Rico Aqueduct and Sewer Authority (PRASA), the Puerto Rico Department of Natural and Environmental Resources, the Puerto Rico Environmental Quality Board, and the Puerto Rico Department of Health (PRDOH).	Ground-water withdrawals for public supply and industrial uses were assigned to aquifers based on site-specific data; they also are summarized by "municipios," which are generally the equivalent to counties in the United States. Records that contained facility names and monthly production values were used to aggregate the withdrawals. Not all public-supply facilities were reported by PRASA, so estimates for smaller non-reporting facilities were estimated using data from PRDOH and a public-supply per-capita daily use coefficient of 68 gallons per person per day. Estimated irrigation withdrawals were compiled based on irrigated crop types, crop consumptive-use coefficients, sprinkler types, and acres irrigated. Locations of the principal aquifers, including Alluvial-valley aquifers, in Puerto Rico are shown in fig. 21. The 2000 compilation database did not afford Puerto Rico the opportunity to store withdrawals for *Alluvial* aquifers; therefore, Puerto Rico reported withdrawals for these types of aquifers in *Other*. The North Coast Limestone aquifer system provided the most ground water (58.9 Mgal/d) and the South Coast aquifer provided 43.3 Mgal/d. Both aquifers were relied upon mostly for public supply uses. Puerto Rico is divided into three physiographic areas: a northern area of karst topography, a central mountainous area and a southern coastal plain. The central mountainous area, called the Cordillera Central, contains rocks that consist of volcaniclastic igneous and sedimentary materials. The northern parts of Puerto Rico are underlain by gently sloping limestone deposits overlain with shallow Quaternary unconsolidated alluvial deposits. The southern areas have sedimentary deposits of the South Coast aquifer with few to no Quaternary unconsolidated alluvial deposits except in the most southwestern part of the island. Alluvial deposits consist of unconsolidated and weathered materials that originate from the underlying formations. Ground water mostly is unconfined in the alluvial valleys and in hydrologic contact with the surface-water features. Streams have gaining and losing reaches, expressed by flow conditions in sections that either contribute to, or gain from, the adjacent aquifer deposits (Miller and others, 1999, p. N24, fig. 71). The South Coast aquifer consists of alluvial and fan-delta deposits derived from erosion of the volcanic and sedimentary rocks of the Cordillera Central. The fan deltas have coalesced to form a continuous fan-delta plain that averages about 4 to 5 mi in width and 40 mi in length. The alluvial sediments in the South Coast aquifer do not fit the definition of a stream-valley aquifer; no withdrawals from the South Coast aquifer were disaggregated to stream-valley aquifers. Withdrawals for ground-water users (including self-supplied domestic) were reported in detail by municipio and aquifers (Molina-Rivera, 2005); figure 4 of that report illustrates ground-water provinces and aquifers of Puerto Rico and specifically those alluvial deposits that are composed of unconsolidated Quaternary age deposits. These deposits as seen in Molina-Rivera (2005, fig. 4) are located along the western and eastern coastline of the island, as well as in interior areas, and correspond generally with Quaternary Alluvial-valley aquifers shown in the atlas (fig. 20). Molina-Rivera (2005) further tabulates withdrawals by the ground-water provinces and by aquifer names, but does not expand on the physical properties of the aquifers. Descriptions of the Quaternary alluvial deposits in the atlas are generalized and do not specifically mention stream-valley aquifers. Therefore, deposits noted in Molina-Rivera (2005) with corresponding withdrawals could potentially be considered stream-valley aquifer withdrawals, and as such would be appropriate reductions from withdrawals reported from *Other* aquifers, North Coast Limestone aquifers, or South Coast aquifer systems. However, no stream-valley aquifer withdrawals were estimated for Puerto Rico for 2000 because of the lack of conclusive data.

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
South Dakota	South Dakota 2000 compilation data were collected and compiled through the cooperative effort of the USGS and the South Dakota Department of Environment and Natural Resources, (SDDENR), Water Rights Program. The SDDENR mailed a water-use questionnaire to each permitted water user requesting total withdrawals, acres (for irrigation sites), and the sources of withdrawals. The completed questionnaires were sent back to the State Office, where the irrigation data were compiled. The digital irrigation data were sent to USGS, along with the hard copy forms of the other types of water use, these data were then entered into the USGS Site-Specific Water Use Database System by USGS personnel.	Eastern South Dakota has plentiful shallow ground-water supplies, all of which are associated with counties east of the extent of Quaternary continental glaciation (fig. 22) and reported in Maupin and Barber (2005) as part of the glacial sand and gravel aquifers. The western half of South Dakota has fewer occurrences of shallow ground water in sufficient quantities for most purposes. Ground water is not a major source of water in most of western South Dakota (Agnew and others, 1962). The 2000 water-use data in South Dakota included owner name, water-use category, source, county, HUC, aquifer code, and withdrawal amount. Water use estimates by river basin were developed using aquifer code and county information. Withdrawals from alluvial deposits along the Missouri River were considered part of *Alluvial* aquifers in the 2000 compilation. However, sites that obtain water from these deposits are mostly within the extent of Quaternary continental glaciation, and, do not meet the definition of a stream-valley aquifer. For this report, withdrawals of 26.5 Mgal/d were determined to be from areas north of the line of Quaternary continental glaciation and were disaggregated from *Alluvial* aquifers (table 3). Only withdrawals of 0.1 Mgal/d from *Alluvial* aquifers were not disaggregated (table 3). Most of the remaining withdrawals that had been attributed to *Alluvial* aquifers were attributed to specific stream-valley aquifers (tables 1 and 3).
Tennessee	Public-supply data for the 2000 compilation were obtained from the Tennessee Department of Environment and Conservation (TDEC), Division of Water Supply. The TDEC regulates public-supply withdrawals and usage within Tennessee. The USDA, Natural Resources Conservation Service, collected site-specific data on irrigation withdrawals in Tennessee. The USGS collected industry withdrawal data for the 2000 compilation.	Withdrawals from *Alluvial* aquifers were disaggregated with site-specific data. Public-supply facilities provided well logs and location information that made it possible to identify the lithology of the aquifer that provides water to wells (J.K. Carmichael, U.S. Geological Survey, oral commun., 2005). Along the western border of Tennessee, alluvial deposits compose the Mississippi River Valley alluvial aquifer (fig. 23). Although not shown in the atlas, additional alluvial deposits of Holocene age are present in Hardin County along the Tennessee-Alabama border (J.K. Carmichael, U.S. Geological Survey, oral commun., 2005).
Texas	Most water use reported by the USGS in the 2000 compilation is collected by the Texas Water Development Board (TWDB). Definitions for categories of water use that are used by the TWDB differ slightly from those used by the USGS. Differences were resolved by requesting specific reports from TWDB along with information from a TWDB data base that maintains specific data about county and river basin withdrawals, water sources, and consumptive use. The TWDB tabulates all water-use data by consumptive use. Definitions that differ between TWDB and USGS include municipal (public supply), manufacturing (self-supplied industrial), and power (thermoelectric) water-use categories.	All withdrawals from *Alluvial* aquifers were assigned to stream-valley aquifers associated with the Brazos River (Dana Barbie, U.S. Geological Survey, oral commun., 2005) (fig. 24). The stream-valley aquifer associated with the Red River (on the Texas-Oklahoma border) is not utilized in Texas; water withdrawals in this area of Texas are obtained from surface-water sources (Dana Barbie, U.S. Geological Survey, oral commun., 2005).

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
Utah	For the 2000 compilation, public-supply and self-supplied industrial data were obtained from either water purveyors or the State of Utah (Utah Department of Natural Resources, Division of Water Rights). Public water suppliers and self-supplied industrial users are required to submit yearly information about withdrawals and the source of ground water to the Division of Water Rights. Data also were obtained through oral communication with water system managers, industrial users, and county extension agents. Additional data about water suppliers is available on the World Wide Web (Utah Division of Water Rights, 2003). Information about geology and ground-water resources is available from the Utah Geological Survey (Utah Geological Survey, 2005). Ground-water withdrawals for irrigation were determined from pumpage inventories done annually by USGS. Withdrawals were determined directly from pumping wells during the irrigation season or by using electrical records to determine quantities of water pumped in areas where Utah conducts annual ground-water studies. These data were compiled from all of the major irrigated valleys in Utah (almost all are in the Basin and Range area) and published annually in “Ground-Water Conditions in Utah” (Burden, 2001). Water withdrawn from wells in less significant irrigation areas in the State were estimated from previously published data and current knowledge of irrigation practices in the area.	Most counties in Utah rely upon surface-water withdrawals for irrigation, and ground water is a relatively minor source of water. Coefficients of water use were used to estimate withdrawals only for surface-water irrigation withdrawals; ground-water withdrawals were reported to the State. In Utah, water from springs that flow over the land surface for a significant distance before entering canals and ditches is considered surface water. This definition has implications on the determination of stream-valley aquifer withdrawals in areas where springs are near rivers or streams, and flow for some distance before being diverted. They may be reported as surface-water diversions when in fact they are from a spring (ground-water) source. It is impractical to try to describe where all of these situations exist or determine the volumes of water that are affected by such conditions, but some ground-water withdrawals may be included with surface-water estimates to some extent. This situation does not have implications for withdrawals that were reported for wells, because they clearly represent a ground-water withdrawal and were assigned to an aquifer based on the 2000 compilation guidelines. Where possible, aquifers in areas delineated as “not a principal aquifer” (Robson and Banta, 1995, p. C4, fig. 11) were identified and classified in one of the principal aquifers. Stream-valley aquifer withdrawals were disaggregated from *Alluvial* aquifers that are depicted in the atlas as “Mountainous Areas” (fig. 25) located east of the Basin and Range area (Robson and Banta, 1995, p. C7, fig. 18). Withdrawals reported for *Alluvial* aquifers were identified in areas coincident with the Colorado Plateaus aquifers area, but were compiled separately and do not include withdrawals from the Colorado Plateaus aquifers (fig. 25). During this investigation, public-supply ground-water withdrawals (0.77 Mgal/d) were identified that were reported in Maupin and Barber (2005) as being from the Basin and Range basin-fill aquifers, but could also be reported as from *Alluvial* aquifers, and, therefore, were considered in this study. This adjustment increased the 2000 *Alluvial* aquifers withdrawals for public-supply uses from 8.20 Mgal/d to 8.97 Mgal/d, and reduced the Basin and Range basin-fill aquifers from 208 Mgal/d to 207 Mgal/d (appendix 2 shows original data from Maupin and Barber, 2005). No withdrawals from *Other* aquifers were identified as from stream-valley aquifers. Withdrawals from *Other* aquifers generally were from unspecified bedrock units or basin-fill alluvial aquifers (table 4) (Larry Spangler, U.S. Geological Survey, written commun., 2005).
West Virginia	In West Virginia, data for public-supply uses were available from the West Virginia Bureau of Health, Office of Environmental Health Services. The West Virginia Bureau of Employment provided county facility and employment data by SIC code. This information was used with a directory of West Virginia manufacturers to develop self-supplied industrial water use estimates. The USDA Census of Agriculture provided data that were used to determine irrigation water use. The West Virginia Geologic and Economic Survey provided legacy information that provided a quality check for all categories.	The atlas (Trapp and Horn, 1997) shows 25 counties that possibly could have stream-valley aquifer withdrawals, and seven of those counties could possibly have multiple stream-valley aquifer withdrawals. River basin delineations were used with the withdrawal data to differentiate between two different stream-valley aquifers within a county. All the public-supply withdrawals that were disaggregated were assigned to stream-valley aquifers associated with the Ohio River. The Ohio River Valley is generally long and narrow, and stream- valley aquifer deposits in alluvium along the River are well defined (fig. 26). Only in counties that contained a single stream-valley aquifer and no isolated alluvium could withdrawals for self-supplied industrial uses be assigned to a stream-valley aquifer with confidence. Withdrawals of 1.72 Mgal/d from *Other* aquifers (table 4) were attributed to Appalachian Plateau aquifers along the eastern side of the State, and to unnamed aquifers in areas labeled, “not a principal aquifer,” as seen in the atlas (Trapp and Horn, 1997, p. L4, fig. 7).

Appendix 1. Sources of water-use and related information and methods of analysis, by state—Continued.

[Noted figures and tables are included in the report. HUC, U.S. Geological Survey (USGS) hydrologic unit code; Mgal/d, million gallons per day; USEPA, U.S. Environmental Protection Agency; SIC, Standard Industrial Classification; GWSI, Ground Water Site Inventory; gals/d, gallons per day; USDA, U.S. Department of Agriculture]

State	Sources of information	Methods of analysis
Wyoming	The Wyoming Agricultural Statistics Service and the Wyoming Water Development Commission (WWDC) provide information on the number of acres that are in irrigation and the crop type. Data about public-supply water use were gathered by survey forms that were mailed by the WWDC. Public-water systems that had at least 15 service connections or serve at least 25 people for 60 days received the forms. The Wyoming Sate Engineer's Office provided geologic log information, which was used to assign aquifer units to wells. The U.S. Department of Labor, Bureau of Labor Statistics, provided county-level industrial information.	About 14 percent (9.59 Mgal/d) of total *Alluvial* aquifers withdrawals were disaggregated to stream-valley aquifers associated with the Niobrara River, Sand Creek, and Belle Fourche River (table 3) (fig. 27). The Niobrara stream-valley aquifer is not shown in the atlas; however, the small withdrawals associated with this river (5.77 Mgal/d) are consistent with the presence of a small stream-valley aquifer that could easily be overlooked in a regional analysis.

Appendix 2

Appendix 2. Estimated withdrawals for irrigation, public-supply, and self-supplied industrial uses from principal and *Other* aquifers in 24 States and the Commonwealth of Puerto Rico, 2000.

[Values have been rounded. Source: Maupin and Barber (2005)]

State	Aquifer or aquifer system	Withdrawals, in million gallons per day, by water-use category			
		Irrigation	Public supply	Self-supplied industrial	Total
Arizona	Basin and Range basin-fill aquifers	2,680	372	7.60	3,060
	Colorado Plateaus aquifers	37.6	38.6	12.2	88.4
	Other	29.9	58.3	.00	88.2
	Total	**2,750**	**469**	**19.8**	**3,240**
Arkansas	Edwards-Trinity aquifer system	.00	7.31	.23	7.54
	Mississippi embayment aquifer system	184	77.2	61.0	322
	Mississippi River Valley alluvial aquifer	6,320	40.5	5.74	6,370
	Ozark Plateaus aquifer system	1.23	7.16	.05	8.44
	Total	**6,510**	**132**	**67.0**	**6,710**
Colorado	*Alluvial* aquifers	482	5.55	8.77	496
	Colorado Plateaus aquifers	16.9	6.10	.28	23.2
	Denver Basin aquifer system	11.9	16.9	7.44	36.3
	High Plains aquifer	837	3.39	.71	841
	Other	89.4	18.4	6.44	114
	Rio Grande aquifer system	719	3.39	.02	723
	Total	**2,160**	**53.7**	**23.6**	**2,230**
Illinois	Cambrian-Ordovician aquifer system	3.79	116	29.8	149
	Glacial sand and gravel aquifers	140	181	91.9	413
	Mississippian aquifers	.00	1.20	3.18	4.38
	Other	.00	6.70	4.24	10.9
	Pennsylvanian aquifers	.00	1.09	.00	1.09
	Silurian-Devonian aquifers	5.77	47.6	2.51	55.9
	Total	**150**	**353**	**132**	**634**
Indiana	Glacial sand and gravel aquifers	50.6	309	94.9	455
	Mississippian aquifers	.37	1.16	1.35	2.88
	Other	.00	.08	.02	.10
	Pennsylvanian aquifers	.00	.09	.02	.11
	Silurian-Devonian aquifers	4.53	33.8	3.37	41.7
	Total	**55.5**	**345**	**99.7**	**500**
Kansas	*Alluvial* aquifers	327	81.3	27.1	435
	Glacial sand and gravel aquifers	.33	4.69	.07	5.09
	High Plains aquifer	2,830	70.2	17.4	2,920
	Lower Cretaceous aquifers	184	4.11	1.19	189
	Other	83.5	5.10	.48	89.0
	Ozark Plateaus aquifer system	.06	6.77	.29	7.12
	Total	**3,430**	**172**	**46.6**	**3,650**
Kentucky	*Alluvial* aquifers	.00	47.1	76.1	123
	Mississippi embayment aquifer system	.00	10.8	10.3	21.1
	Mississippian aquifers	.00	9.06	8.3	17.4
	Ordovician aquifers	.00	1.94	.38	2.32
	Other	1.24	.00	.00	1.24
	Pennsylvanian aquifers	.00	2.01	.03	2.04
	Total	**1.24**	**71.0**	**95.2**	**167**

Appendix 2. Estimated withdrawals for irrigation, public-supply, and self-supplied industrial uses from principal and *Other* aquifers in 24 States and the Commonwealth of Puerto Rico, 2000—Continued.

[Values have been rounded. Source: Maupin and Barber (2005)]

State	Aquifer or aquifer system	Withdrawals, in million gallons per day, by water-use category			
		Irrigation	Public supply	Self-supplied industrial	Total
Louisiana	*Alluvial* aquifers	6.62	0.16	0.00	6.78
	Coastal Lowlands aquifer system	557	280	199	1,040
	Mississippi embayment aquifer system	6.26	64.9	30.9	102
	Mississippi River Valley alluvial aquifer	221	7.27	54.3	282
	Total	**791**	**352**	**285**	**1,430**
Missouri	*Alluvial* aquifers	59.0	106	11.1	176
	Cambrian-Ordovician aquifer system	3.29	18.7	.48	22.5
	Mississippi embayment aquifer system	.00	10.2	.09	10.3
	Mississippi River Valley alluvial aquifer	1,300	11.7	3.68	1,310
	Mississippian aquifers	3.29	18.7	.48	22.5
	Ozark Plateaus aquifer system	19.2	113	13.4	145
	Total	**1,380**	**278**	**29.2**	**1,690**
Montana	*Alluvial* aquifers	21.7	11.1	.77	33.6
	Glacial sand and gravel aquifers	28.4	5.34	.11	33.9
	Northern Great Plains aquifer system	4.55	5.84	.58	11.0
	Northern Rocky Mountains Intermontane Basins aquifer systems	28.3	33.9	30.5	92.7
	Total	**83.0**	**56.1**	**31.9**	**171**
Nebraska	*Alluvial* aquifers	92.2	50.0	7.68	150
	Glacial sand and gravel aquifers	200	2.04	.01	202
	High Plains aquifer	7,050	191	25.2	7,270
	Lower Cretaceous aquifers	73.2	12.8	1.47	87.5
	Other	4.12	10.3	1.08	15.5
	Total	**7,420**	**266**	**35.4**	**7,720**
New Jersey	Early Mesozoic basin aquifers	1.62	55.6	10.2	67.4
	Glacial sand and gravel aquifers	.47	80.5	3.37	84.4
	Northern Atlantic Coastal Plain aquifer system	20.3	248	48.3	317
	Piedmont and Blue Ridge crystalline-rock aquifers	.01	5.45	.26	5.72
	Surficial aquifer system	.22	.00	.00	.22
	Valley and Ridge aquifers	.05	.92	.16	1.13
	Valley and Ridge carbonate-rock aquifers	.12	9.66	3.07	12.8
	Total	**22.8**	**400**	**65.3**	**489**
New Mexico	Basin and Range basin-fill aquifers	164	16.6	.08	181
	Colorado Plateaus aquifers	.59	12.0	.95	13.5
	High Plains aquifer	498	23.1	1.06	522
	Other	66.5	17.0	.38	83.9
	Pecos River Basin alluvial aquifer	.11	2.02	1.36	3.49
	Rio Grande aquifer system	136	171	3.75	311
	Roswell Basin aquifer system	364	21.1	1.17	386
	Total	**1,230**	**262**	**8.75**	**1,500**
New York	Glacial sand and gravel aquifers	16.4	175	71.6	263
	New England crystalline-rock aquifers	.17	7.40	.58	8.15
	New York and New England carbonate-rock aquifers	1.34	30.6	8.29	40.3
	New York Sandstone aquifers	.87	34.3	20.8	55.9
	Northern Atlantic Coastal Plain aquifer system	4.28	326	28.3	359
	Other	.25	9.20	15.8	25.2
	Total	**23.3**	**583**	**145**	**752**

Appendix 2. Estimated withdrawals for irrigation, public-supply, and self-supplied industrial uses from principal and *Other* aquifers in 24 States and the Commonwealth of Puerto Rico, 2000—Continued.

[Values have been rounded. Source: Maupin and Barber (2005)]

State	Aquifer or aquifer system	Withdrawals, in million gallons per day, by water-use category			
		Irrigation	Public supply	Self-supplied industrial	Total
North Dakota	*Alluvial* aquifers	15.6	4.29	3.25	23.2
	Glacial sand and gravel aquifers	52.6	20.6	2.83	76.0
	Northern Great Plains aquifer system	1.59	3.42	.34	5.35
	Other	2.34	4.28	.44	7.06
	Total	**72.2**	**32.6**	**6.86**	**112**
Ohio	*Alluvial* aquifers	.87	39.4	12.8	53.0
	Glacial sand and gravel aquifers	8.20	312	101	421
	Mississippian aquifers	.00	119	38.6	158
	Other	.06	4.35	1.40	5.81
	Pennsylvanian aquifers	.00	2.00	.65	2.65
	Silurian-Devonian aquifers	4.79	23.2	7.55	35.6
	Total	**13.9**	**500**	**162**	**676**
Oklahoma	Ada-Vamoosa aquifer	.06	3.99	.02	4.07
	Alluvial aquifers	74.9	49.3	3.55	128
	Arbuckle-Simpson aquifer	1.19	2.38	.61	4.18
	Blaine aquifer	19.7	.00	.69	20.4
	Central Oklahoma aquifer	5.25	25.6	.82	31.7
	Edwards-Trinity aquifer system	1.96	2.12	.18	4.26
	High Plains aquifer	400	13.5	.12	414
	Other	13.3	5.83	.17	19.3
	Ozark Plateaus aquifer system	.00	4.02	.28	4.30
	Rush Springs aquifer	49.7	6.20	.37	56.2
	Total	**566**	**113**	**6.81**	**686**
Pennsylvania	Early Mesozoic basin aquifers	.25	35.6	6.07	41.9
	Mississippian aquifers	.06	3.74	1.56	5.36
	New York and New England carbonate-rock aquifers	.00	2.04	.09	2.13
	Northern Atlantic Coastal Plain aquifer system	.00	2.56	.10	2.66
	Other	.10	81.0	28.2	109
	Pennsylvanian aquifers	.13	12.2	31.3	43.6
	Piedmont and Blue Ridge carbonate-rock aquifers	.10	17.0	9.93	27.0
	Piedmont and Blue Ridge crystalline-rock aquifers	.20	13.2	7.26	20.7
	Valley and Ridge aquifers	.37	18.5	26.8	45.6
	Valley and Ridge carbonate-rock aquifers	.16	25.7	44.0	69.9
	Total	**1.37**	**212**	**155**	**368**
Puerto Rico	North Coast Limestone aquifer system (Puerto Rico)	5.71	46.8	6.41	58.9
	Other	14.4	16.2	2.60	33.2
	South Coast (Puerto Rico) aquifer	15.6	25.5	2.15	43.3
	Total	**35.7**	**88.5**	**11.2**	**135**
South Dakota	*Alluvial* aquifers	24.9	15.1	.21	40.2
	Glacial sand and gravel aquifers	90.9	26.4	.17	118
	High Plains aquifer	16.7	2.46	.00	19.2
	Northern Great Plains aquifer system	.95	5.26	.07	6.28
	Other	.00	.51	1.39	1.90
	Paleozoic aquifers	3.40	4.35	1.32	9.07
	Total	**137**	**54.1**	**3.16**	**195**

Appendix 2. Estimated withdrawals for irrigation, public-supply, and self-supplied industrial uses from principal and *Other* aquifers in 24 States and the Commonwealth of Puerto Rico, 2000—Continued.

[Values have been rounded. Source: Maupin and Barber (2005)]

State	Aquifer or aquifer system	Withdrawals, in million gallons per day, by water-use category			
		Irrigation	Public supply	Self-supplied industrial	Total
Tennessee	*Alluvial* aquifers	0.03	2.40	0.00	2.43
	Mississippi embayment aquifer system	3.49	258	46.8	309
	Mississippi River Valley alluvial aquifer	1.34	.00	.00	1.34
	Mississippian aquifers	.47	17.3	6.35	24.1
	Ordovician aquifers	.56	2.91	.00	3.47
	Other	.04	.00	.01	.05
	Pennsylvanian aquifers	.26	.52	.00	.78
	Valley and Ridge aquifers	.00	10.4	.00	10.4
	Valley and Ridge carbonate-rock aquifers	1.17	28.7	3.19	33.0
	Total	**7.36**	**321**	**56.4**	**385**
Texas	*Alluvial* aquifers	12.6	.01	.00	12.6
	Blaine aquifer	23.5	.30	.00	23.8
	Coastal Lowlands aquifer system	356	531	86.3	973
	Edwards-Trinity aquifer system	280	402	46.8	729
	High Plains aquifer	5,080	75.2	52.8	5,200
	Other	283	24.1	2.80	310
	Pecos River Basin alluvial aquifer	109	10.0	1.10	120
	Rio Grande aquifer system	11.8	65.5	8.40	85.7
	Seymour aquifer	162	7.40	.60	170
	Texas coastal uplands aquifer	188	148	45.0	381
	Total	**6,500**	**1,260**	**244**	**8,010**
Utah	*Alluvial* aquifers	22.9	8.20	.47	31.6
	Basin and Range basin-fill aquifers	439	208	31.8	679
	Basin and Range carbonate-rock aquifers	.00	70.4	1.92	72.3
	Colorado Plateaus aquifers	7.23	42.5	.13	49.8
	Other	.00	31.7	.01	31.7
	Pacific Northwest volcanic-rock aquifers	.00	3.31	.00	3.31
	Total	**469**	**364**	**34.3**	**868**
West Virginia	*Alluvial* aquifers	.00	20.8	.68	21.5
	Mississippian aquifers	.00	.69	.19	.88
	Other	.00	1.58	.14	1.72
	Pennsylvanian aquifers	.00	9.98	8.30	18.3
	Valley and Ridge aquifers	.01	1.47	.23	1.71
	Valley and Ridge carbonate-rock aquifers	.01	7.08	.14	7.23
	Total	**.02**	**41.6**	**9.68**	**51.3**
Wyoming	*Alluvial* aquifers	50.4	15.7	1.02	67.1
	Colorado Plateaus aquifers	19.6	2.76	.38	22.7
	High Plains aquifer	281	9.89	1.94	293
	Northern Great Plains aquifer system	59.5	18.5	.63	78.6
	Other	2.42	.63	.25	3.30
	Paleozoic aquifers	.15	8.51	.00	8.66
	Upper Tertiary aquifers	.60	.92	.09	1.61
	Total	**413**	**57.2**	**4.31**	**475**

Appendix 3

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Appendix 3. Estimated withdrawals for irrigation, public-supply, and self-supplied industrial uses for aquifers and aquifer units disaggregated from withdrawals from *Alluvial* aquifers north of the extent of Quaternary continental glaciation in North Dakota, 2000.

[Values have been rounded]

Stream, river, or aquifer name	Withdrawals, in million gallons per day, by water-use category			
	Total	Irrigation	Public supply	Self-supplied industrial
Lower Apple Creek	0.16	0.05	0.00	0.11
Burlington	.04	.00	.04	.00
Cattail	.00	.00	.00	.00
Denbigh	.94	.59	.20	.15
Ellendale	.14	.00	.14	.00
Elliot	.19	.19	.00	.00
Glencoe Channel	.00	.00	.00	.00
Guelph	1.07	.76	.31	.00
Heart River aquifer	.01	.00	.01	.00
Hofflund	.13	.13	.00	.00
Inkster	.68	.68	.00	.00
Jamestown	.00	.00	.00	.00
Kenmare	.14	.00	.14	.00
Knife River	2.69	.00	.03	.00
Little Knife River	.38	.38	.00	.00
Lower Souris	.11	.11	.00	.00
Martin	.43	.43	.00	.00
McVille	.01	.00	.00	.01
Midway	7.47	6.32	1.15	.00
Milnor Channel	.02	.02	.00	.00
Missouri River	.07	.07	.00	.00
Napoleon	.16	.16	.00	.00
Northeast Missouri Buried Channel	.83	.00	.83	.00
New Rockford	4.90	4.90	.00	.00
New Town	.54	.53	.01	.00
Oakes	.05	.00	.05	.00
Oberon (Sheyenne River)	.10	.00	.00	.10
Shell Creek	.69	.17	.51	.01
Shell Valley	.04	.00	.03	.01
Sheyenne Channel	.52	.00	.32	.20
Strasburg	.42	.00	.42	.00
Strawberry Lake	.03	.03	.00	.00
Tobacco Garden Creek	.07	.00	.07	.00
Wahpeton Buried Valley	.13	.13	.00	.00
Windsor	.03	.00	.03	.00
Total	**23.2**	**15.6**	**4.29**	**.59**

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