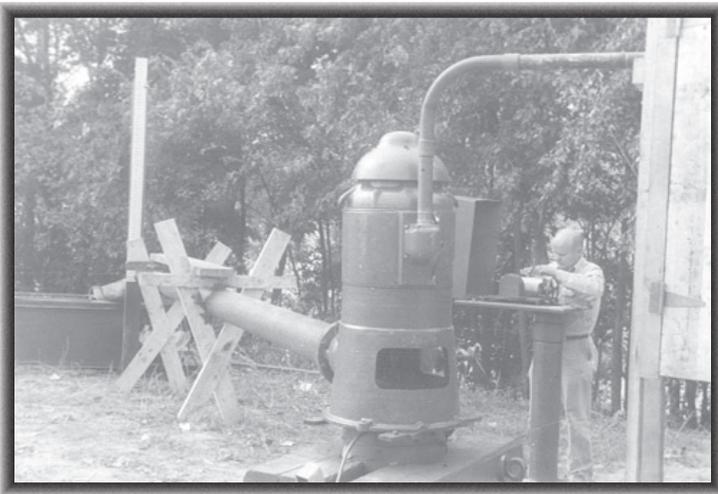


In cooperation with the Louisville Water Company

Summary of Available Hydrogeologic Data for the Northeast Portion of the Alluvial Aquifer at Louisville, Kentucky



Open-File Report 2006-1146

Cover Photographs.

Top left—Checking water levels in observation well with graphical recorder, 1956. (Photograph from U.S. Geological Survey project files).

Bottom right—Measuring water level in observation well, 2003.
(Photograph by Christy Reuter, U.S. Geological Survey, September 2003).

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By Michael D. Unthank and Hugh L. Nelson Jr.

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

U.S. Department of the Interior
P. Lynn Scarlett, Acting Secretary

U.S. Geological Survey
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Conversion Factors, Datum, and Abbreviations

Inch/Pound to SI

Multiply	By	To obtain
Length		
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
square foot (ft ²)	929.0	square centimeter (cm ²)
square foot (ft ²)	0.09290	square meter (m ²)
Volume		
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m ³)
gallon (gal)	3.785	cubic decimeter (dm ³)
gallon per day per foot [(gal/d)/ft]	0.00115	square meter per day (m ² /d)
gallon per day per square foot [(gal/d)/ft ²]	0.0408	meter per day (m/d)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m ³ /s)

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

$$^{\circ}\text{F}=(1.8\times^{\circ}\text{C})+32$$

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

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

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

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius ($\mu\text{S}/\text{cm}$ at 25°C).

Concentrations of chemical constituents in water are given in milligrams per liter (mg/L).

Abbreviations

CaCO_3 – calcium carbonate

CBOD5 – carbonaceous biochemical oxygen demand

ICP – inductively coupled plasma

KDOW – Kentucky Division of Water

KGDR – Kentucky Groundwater Data Repository

KWSC – Kentucky Water Science Center

LWC – Louisville Water Company

N - Nitrogen

NTU – nephelometric turbidity units

NWIS – Nation Water Information System

THM – trihalomethane

USGS – U.S. Geological Survey

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Summary of Available Hydrogeologic Data for the Northeast Portion of the Alluvial Aquifer at Louisville, Kentucky

By Michael D. Unthank and Hugh L. Nelson Jr.

Abstract

The hydrogeologic characteristics of the unconsolidated glacial outwash sand and gravel deposits that compose the northeast portion of the alluvial aquifer at Louisville, Kentucky, indicate a prolific water-bearing formation with approximately 7 billion gallons of ground-water storage and an estimated sustainable yield of over 280 million gallons per day. This abundance of ground water and the need to properly develop and manage this resource has prompted many past investigations (since 1956), which have produced reports, maps, and data files covering a variety of topics relative to the movement, availability, and use of ground water in this area. These data have been compiled into a single report to assist in future development and use of the ground-water resources.

Available ground-water data for the alluvial aquifer at Louisville, Kentucky, from Beargrass Creek to Harrods Creek, were compiled from the U.S. Geological Survey National Water Information System and the Kentucky Groundwater Data Repository. Data contained in these databases include ground-water well-construction details and historical ground-water levels, drillers' logs, and water-quality information. Additional data and information were gathered from project files at the U.S. Geological Survey–Kentucky Water Science Center and files at the Louisville Water Company. Information contained in these files included data from area pumping tests describing aquifer characteristics and ground-water flow.

Data describing current conditions of the ground-water system in the northeast portion of the alluvial aquifer also are included. Ground-water levels from a network of observation wells show recent trends in the flow system, and information from the Kentucky Division of Water–Groundwater Branch lists current permitted ground-water withdrawals in the area.

Introduction

A large area of Louisville, Ky., lies within the alluvial valley of the Ohio River. The alluvium consists of unconsolidated glacial outwash sand and gravel deposits and forms a

productive, spatially restricted aquifer that is hydraulically connected to the Ohio River. The northeast portion of the alluvium—a 6.4-mi reach running from Beargrass Creek upriver to Harrods Creek as shown in figure 1—is an especially prolific water-bearing formation with the total ground-water storage in the area estimated at 7 billion gal (Rorabaugh, 1956). This portion of the alluvium is approximately 3,000-ft wide at each end and tapers to a width of approximately 1,000 ft in the middle of the 6.4-mi. reach. The average thickness of the alluvial deposits is about 100 ft. Estimated sustainable water supplies, derived from induced flow from the Ohio River, range from 280 to 400 Mgal/d for this portion of the aquifer (Rorabaugh, 1956).

The ground-water resources in the northeast portion of the alluvial aquifer at Louisville have long been the subject of intense research and investigation. Past investigations have produced reports, maps, and data files that cover a variety of topics relative to the movement, availability, and use of ground water in this area because of the abundance of ground water and the need to properly develop and manage this resource. No comprehensive assessment of existing hydrogeologic data for this portion of the alluvial aquifer has been done by the U.S. Geological Survey (USGS) since 1956; hydrogeologic data collected since 1956 have not been summarized or presented in a collective report until now. As water-resource managers plan for the future water-supply needs of the Louisville area, the USGS and the Louisville Water Company (LWC) recognized the need to compile, review, and update existing hydrogeologic data for the alluvial aquifer.

Purpose and Scope

The purpose of this report is to summarize available data and information on the ground-water resources of the northeast portion of the alluvial aquifer at Louisville, Ky., since 1956. Locations and a summary of the available water-level data for the current observation-well network, and information on wells in both the USGS National Water Information System (NWIS) and the Kentucky Groundwater Data Repository (KGDR) are included.

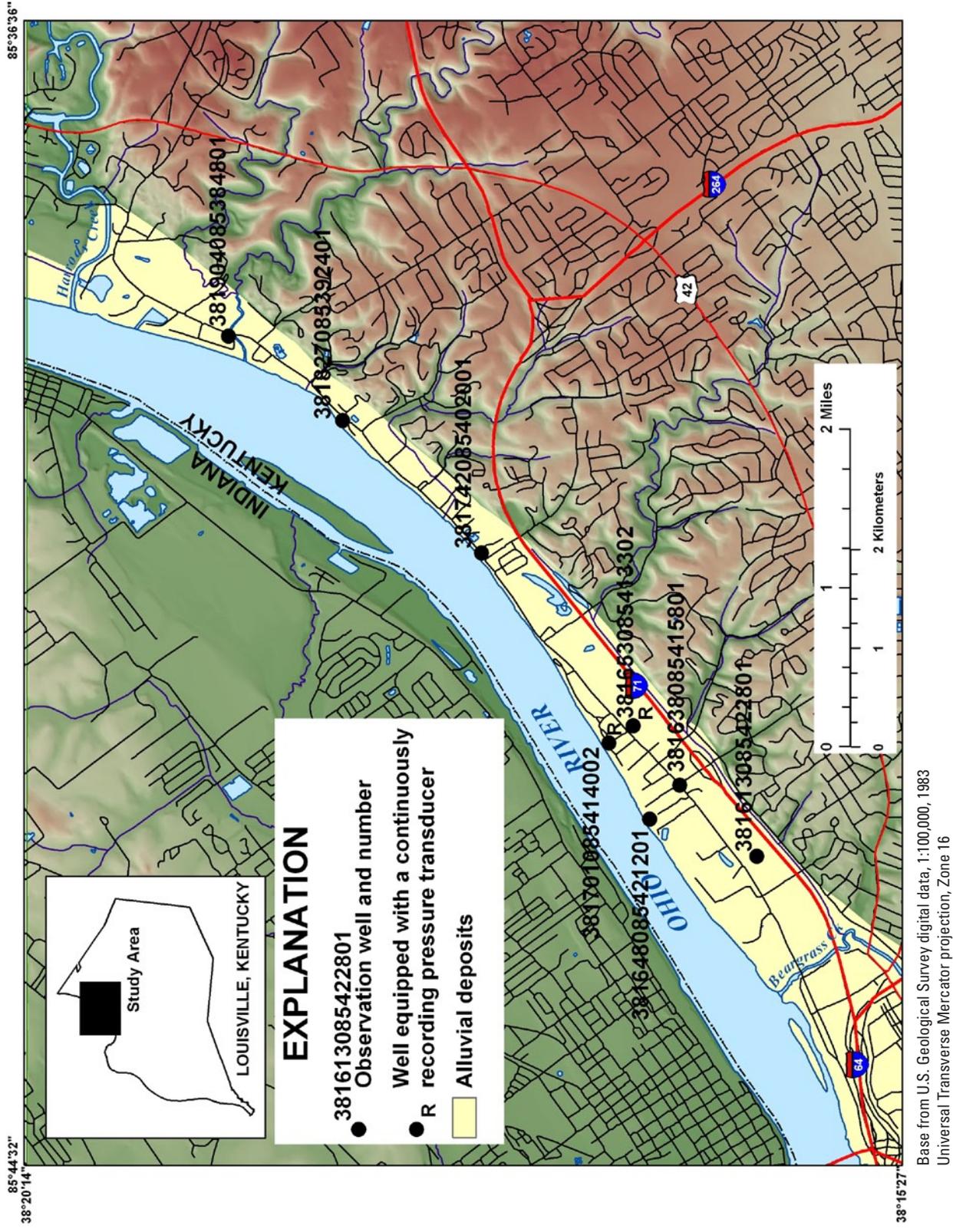


Figure 1. Extent of study area with alluvial deposits highlighted and location of current observation-well network in the northeast portion of the alluvial aquifer at Louisville, Kentucky.

Water-quality data are tabulated for wells in the study area with emphasis on sampling results from the pumping tests conducted at the LWC Zorn Avenue pump station. A summary of hydrogeologic characteristics for the alluvial deposits includes information from drillers' logs, calculated transmissivities, and bedrock elevations.

Previous Investigations

Ground-water quantity and the origin, movement, and general quality of the ground-water resources of the alluvial deposits in the Louisville area were investigated by Hamilton (1944), Palmquist and Hall (1960), and Gallaher and Price (1966). Ground-water quantity, quality, and resource development with special emphasis on induced infiltration for the northeast portion of the alluvial aquifer was studied by Rorabaugh (1956). Starn and Mull (1994) compiled an annotated bibliography of USGS reports on the ground-water resources and geohydrology of the Louisville area.

Available Hydrogeologic Data

A thorough attempt was made to compile published and unpublished data and identify all possible sources of information for the alluvial aquifer in the northeast portion of Louisville, Ky. The types of data compiled include water levels and well-construction details from the current USGS observation-well network and other area wells, water quality, aquifer-test results and aquifer characteristics, and ground-water use. Information and data were sought through personal contact with the Kentucky Division of Water (KDOW), a number of individual consulting engineering firms, and several local past and present ground-water users in the study area. Additional data were compiled from the files of the USGS and the LWC; the KGDR was queried for all pertinent records on wells in the study area.

Alluvial Aquifer Observation-Well Network

The locations of the wells in the current (2006) alluvial aquifer observation-well network are shown on figure 1. Well-construction details and dates of water-level monitoring for each well are included in table 1 (at back of report). This network of eight observation wells was reactivated in November 1997 to monitor ground-water levels for this portion of the alluvial aquifer. The continued operation and maintenance of the network is part of a cooperative data-collection program developed with the LWC. Water levels are measured at each well on a quarterly basis; two wells (wells 4 and 5 on fig. 1) are equipped with continuously recording pressure transducers set to record water levels and water temperature every 30 minutes. Quarterly water-level measurements and water-level and temperature data from the recording pressure transducers are

stored in the USGS NWIS. Hydrographs of a subset of water level data for the alluvial aquifer observation-well network stored in NWIS are shown in figures 2a and b. Data for these wells are available online at <http://waterdata.usgs.gov/ky/nwis/inventory>.

Well Information Stored in the U.S. Geological Survey National Water Information System and the Kentucky Groundwater Data Repository

Well-construction information and measured water levels in the alluvial aquifer that are stored in the USGS NWIS database are listed in table 1. Locations of listed wells are shown in figure 3. The USGS NWIS database contains a variety of data on ground-water conditions and wells in Kentucky as reported through data-collection activities and project investigations done over the years by USGS Kentucky Water Science Center (KWSC) personnel. Similarly, construction information and water levels stored in the KGDR are listed in table 2 (at back of report). The KGDR was initiated in 1990 by the Kentucky Geological Survey under a mandate from the Kentucky legislature. It was established to archive and disseminate ground-water data collected by State agencies, other organizations, and independent researchers. While data in the USGS NWIS database may be part of the KGDR, the KGDR contains many more entries that are not stored in the USGS NWIS database. Certified well drillers in Kentucky are required to submit to the KDOW well logs and descriptive schedules for wells they install. The KDOW, in turn, submits this information to the KGDR for archiving. Wells that are stored in both the USGS NWIS database and the KGDR are highlighted in table 2.

Water Quality

Numerous water-quality analyses for the alluvial aquifer are available for wells in the study area. Data are stored in the KGDR, project files at the USGS KWSC, and files at the LWC. The locations of 13 select wells with water-quality data are shown in figure 4. The majority of the water-quality data are single sample results for wells in the southwest section of the study area as shown in figure 4. Multiple sample results are available for a subset of wells that were sampled over time as part of extended aquifer tests. Data are listed by site and sample date in tables 3-6 (at back of report).

Detailed analyses were done on water samples from well 381652085420301. This was the pumped well for the 1979-82 and 1995-97 aquifer tests at the LWC Zorn Avenue Plant. Results of the water-quality sampling from these tests are summarized in table 7 (at back of report).

4 Summary of Available Hydrogeologic Data for the Northeast Portion of the Alluvial Aquifer at Louisville, Kentucky

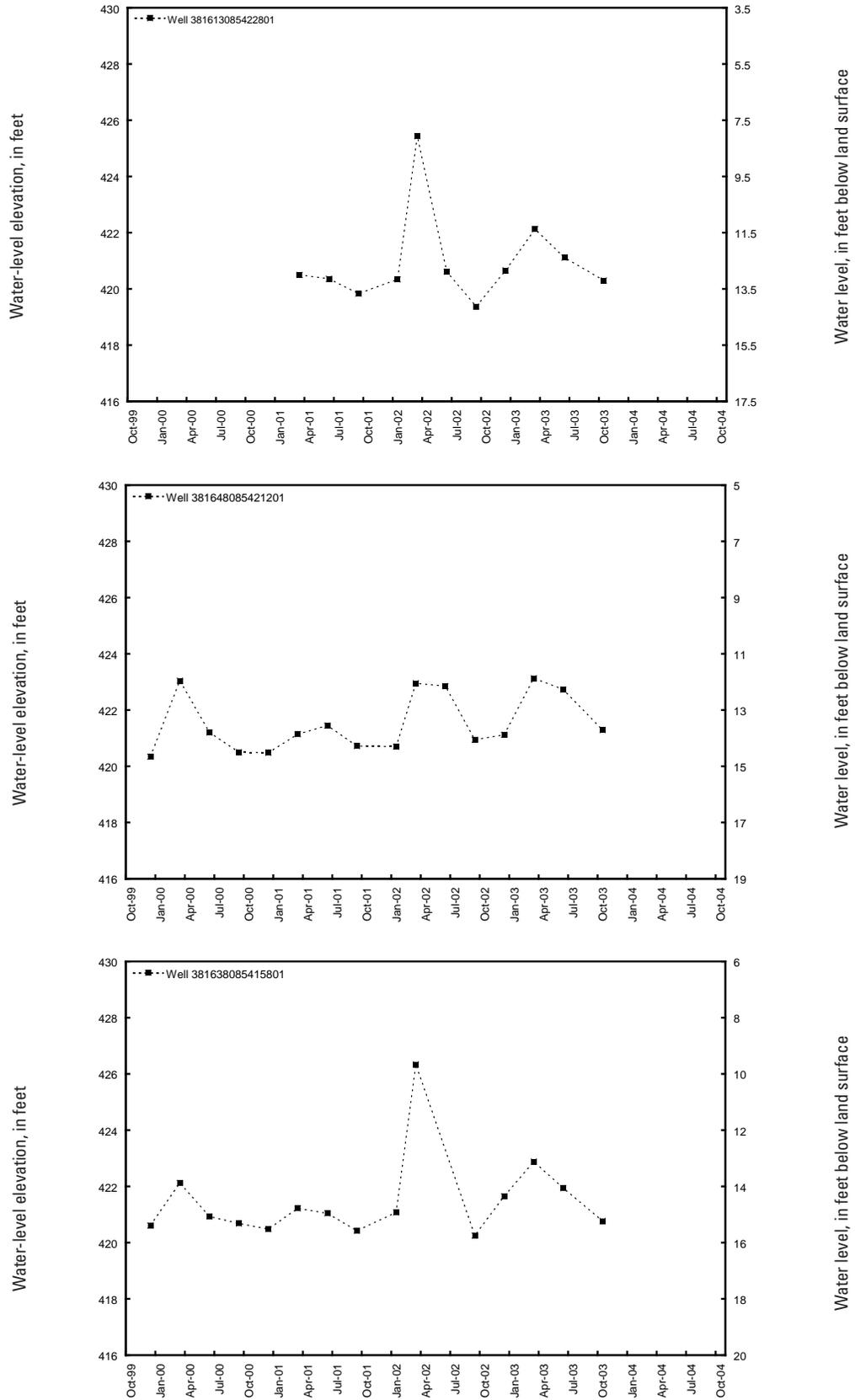


Figure 2a. Water levels for wells measured quarterly in the observation-well network in the northeast portion of the alluvial aquifer at Louisville, Kentucky.

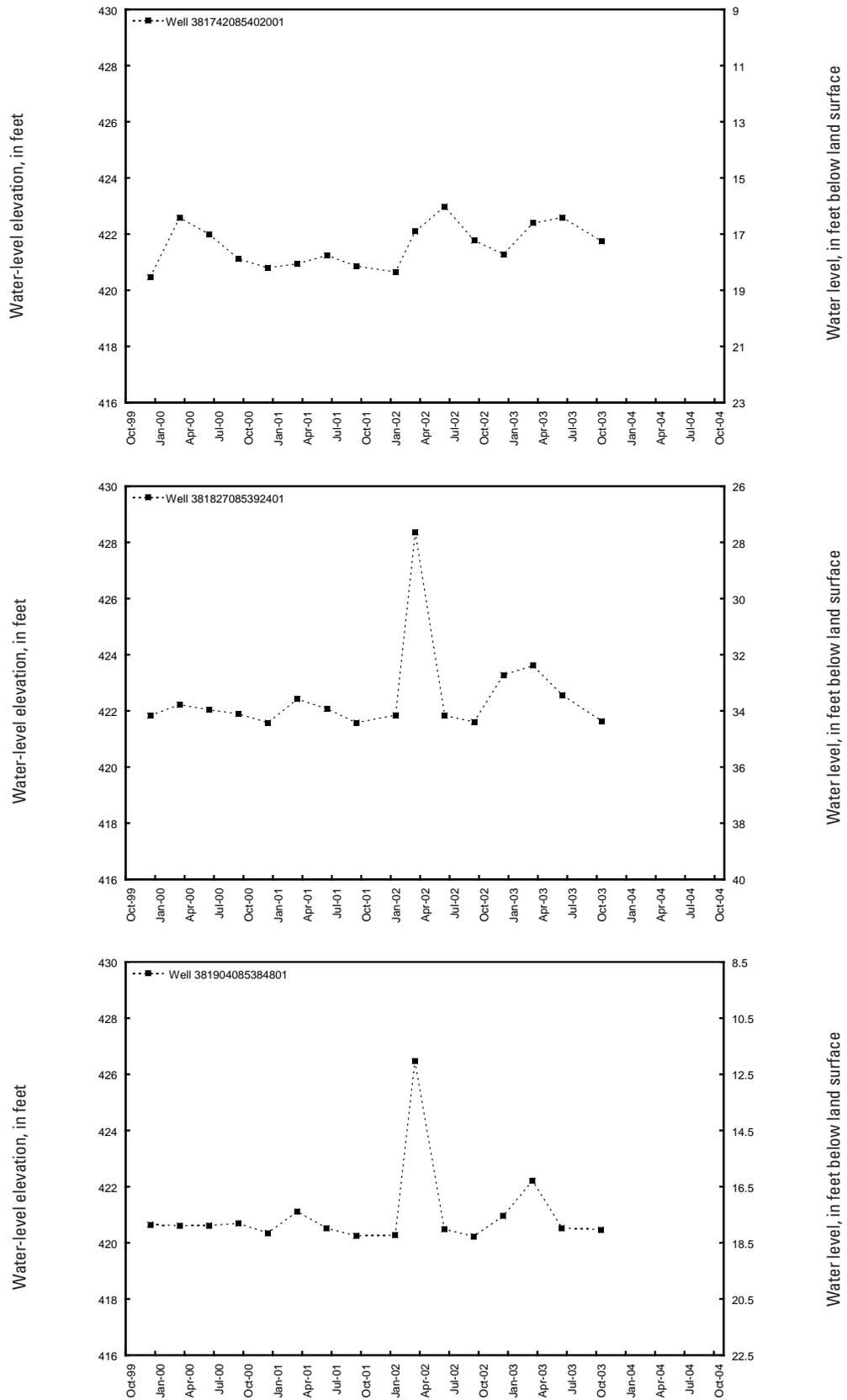


Figure 2a. Water levels for wells measured quarterly in the observation-well network in the northeast portion of the alluvial aquifer at Louisville, Kentucky.—*Continued*

6 Summary of Available Hydrogeologic Data for the Northeast Portion of the Alluvial Aquifer at Louisville, Kentucky

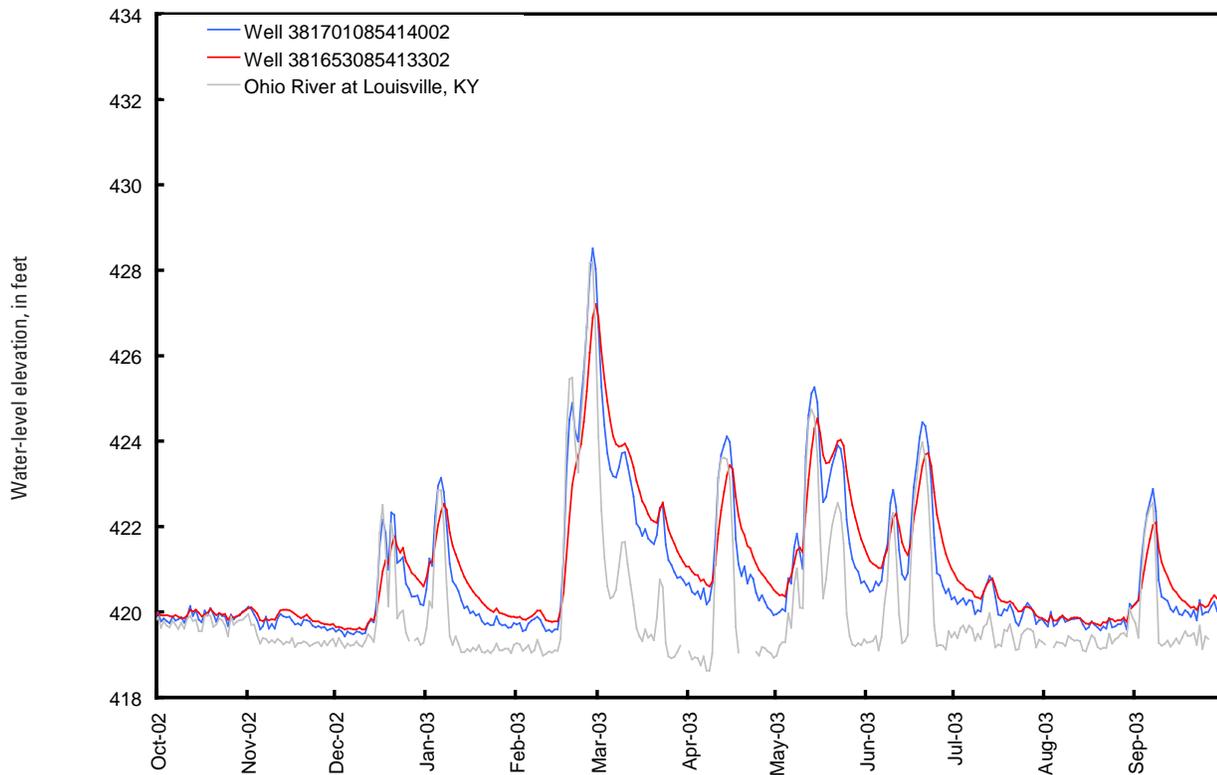
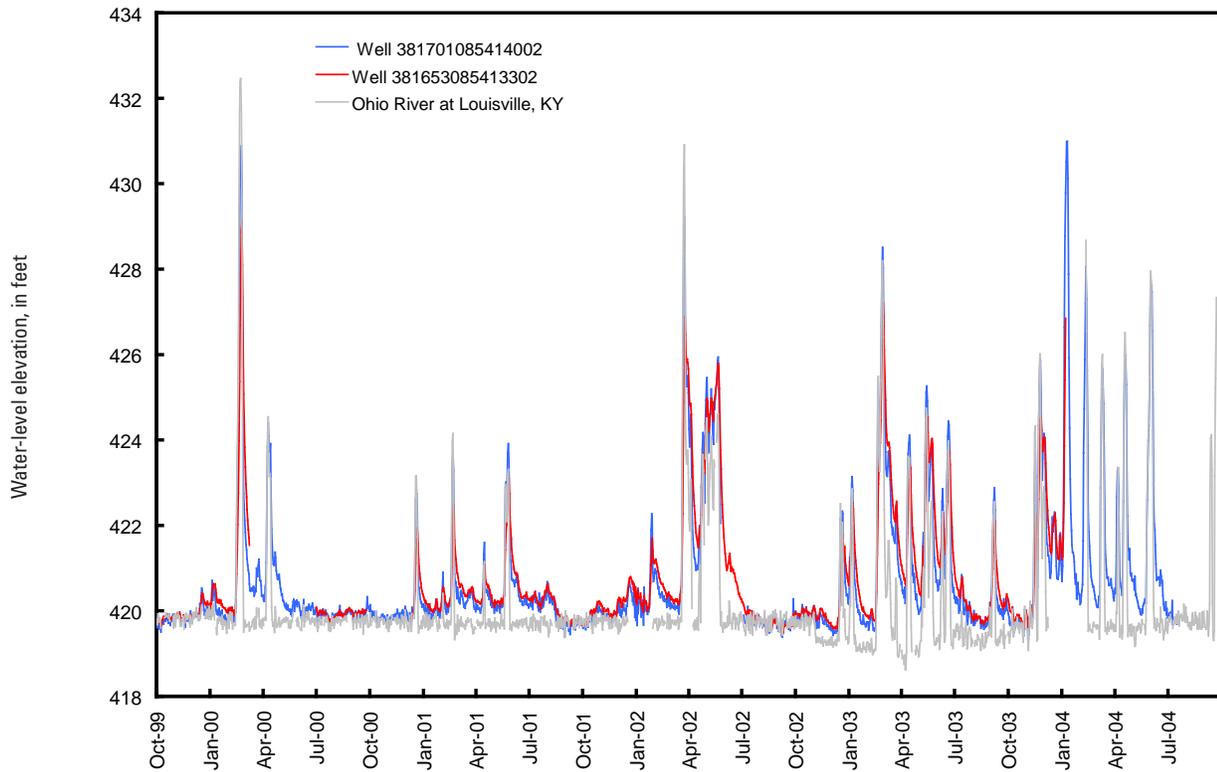
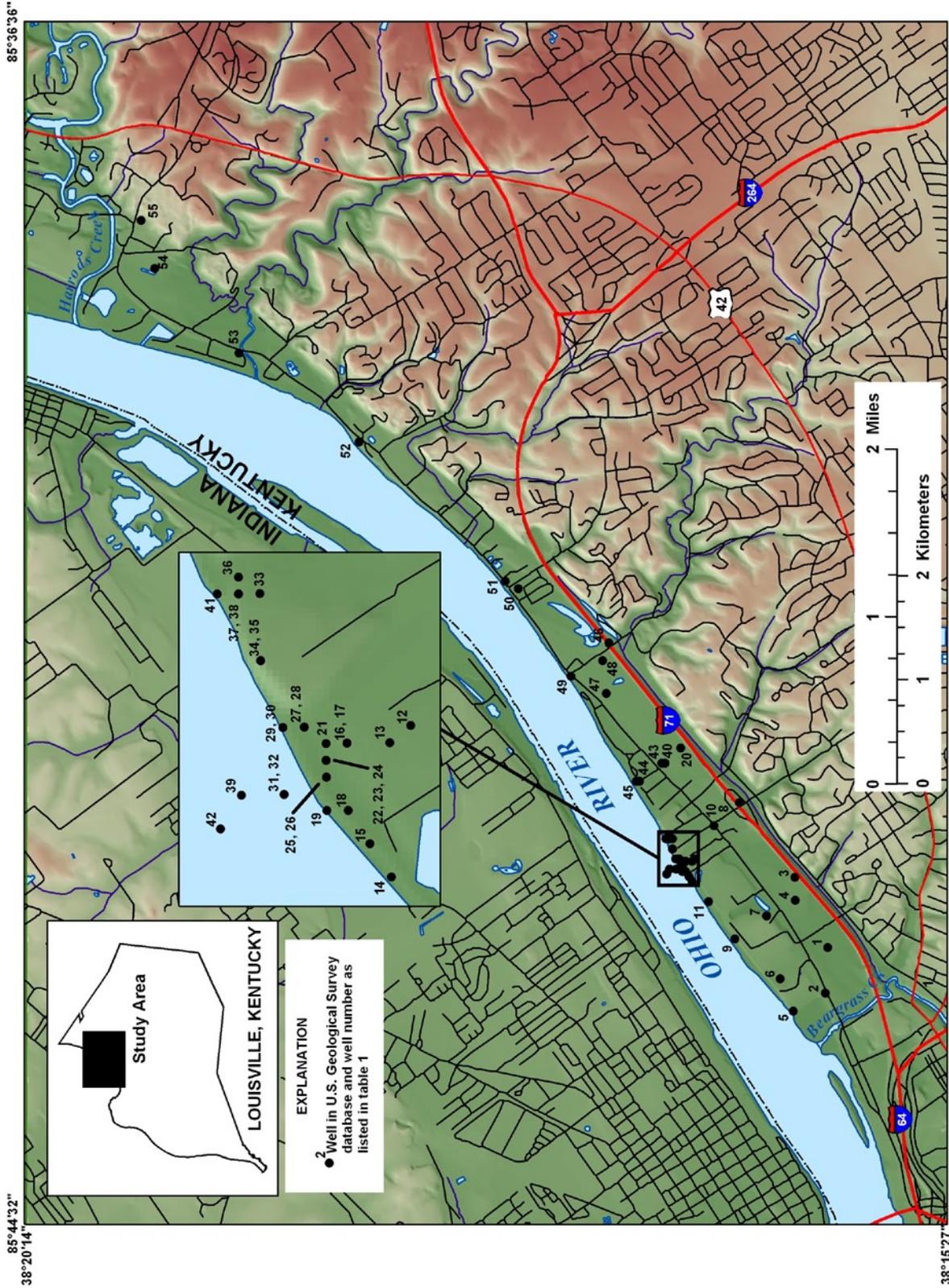
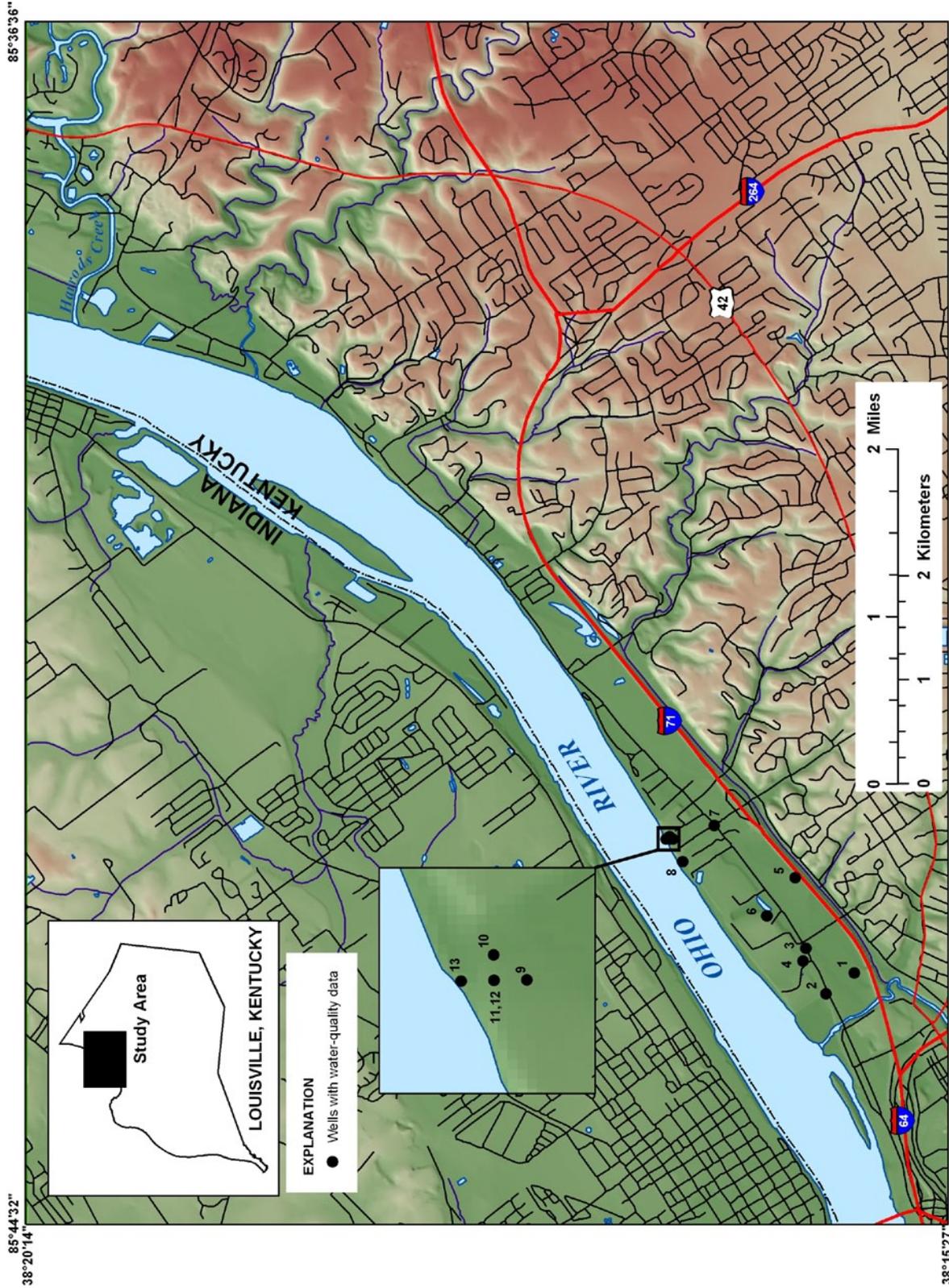


Figure 2b. Water levels for wells equipped with continuously recording pressure transducers in the observation-well network and the Ohio River, Louisville, Kentucky.



Base from U.S. Geological Survey digital data, 1:100,000, 1983
 Universal Transverse Mercator projection, Zone 16

Figure 3. Location of wells in the U.S. Geological Survey database for the northeast portion of the alluvial aquifer at Louisville, Kentucky.



Base from U.S. Geological Survey digital data, 1:100,000, 1983
Universal Transverse Mercator projection, Zone 16

Figure 4. Location of wells in the northeast portion of the alluvial aquifer at Louisville, Kentucky, with water-quality data.

Aquifer Test Results and Aquifer Characteristics

The most complete source of aquifer-test data for the alluvial aquifer is Rorabaugh (1956). In his report, Rorabaugh derived estimates of transmissivity (121,000 [(gal/d)/ft]), distance to a line source (400 ft), and coefficient of storage (0.0003) for the outwash and river deposits (alluvium) from the aquifer tests that were run just downstream of the LWC intakes at Zorn Avenue. In addition to the values derived from the aquifer tests, estimates of transmissivity for the study area were determined from laboratory permeability tests of alluvial deposits collected from Rorabaugh's 16 test-well installations. The locations of the wells and the associated transmissivity estimates are shown in figure 5. Based on the results from his investigations, Rorabaugh estimated the resource-development potential of the alluvial aquifer between Beargrass Creek and Harrods Creek to range from 280 to 400 Mgal/d, depending on ground-water temperature and the potential for pumped wells to induce flow from the river. While additional aquifer tests were done in the immediate area of Rorabaugh's tests (USGS and LWC testing during 1979-82, and LWC testing during 1995-97), aquifer characteristics were not calculated. Information and data from these tests are limited to the water-quality sampling results.

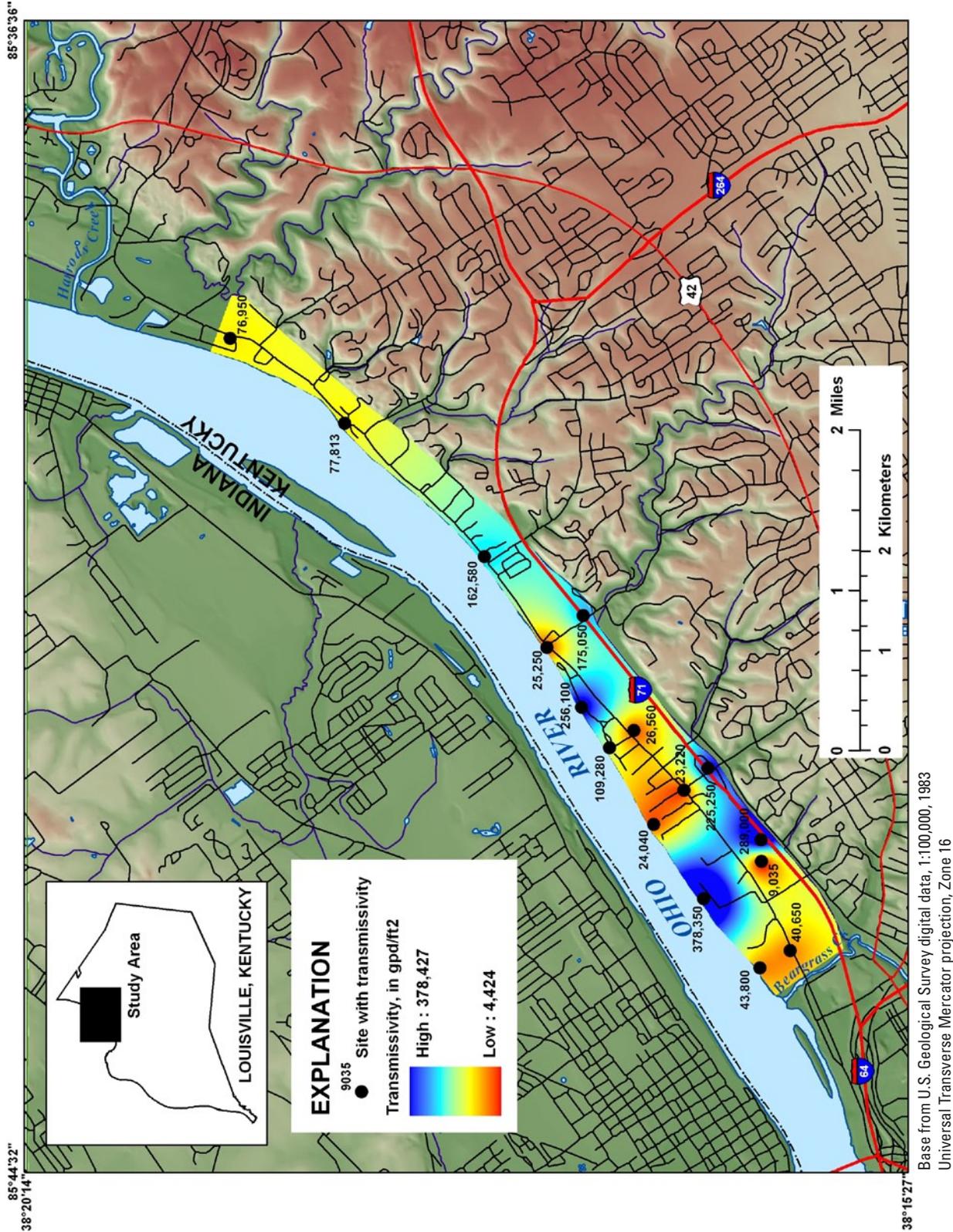
Physical descriptions of the alluvial deposits were compiled from drillers' logs for selected wells in the study area. A summary of the logs is presented in table 8 (at back of report) and is shown on figure 6.

Depth-to-bedrock contours were modified from map insets found in Price (1964) and are shown on figure 7.

Ground-Water Use

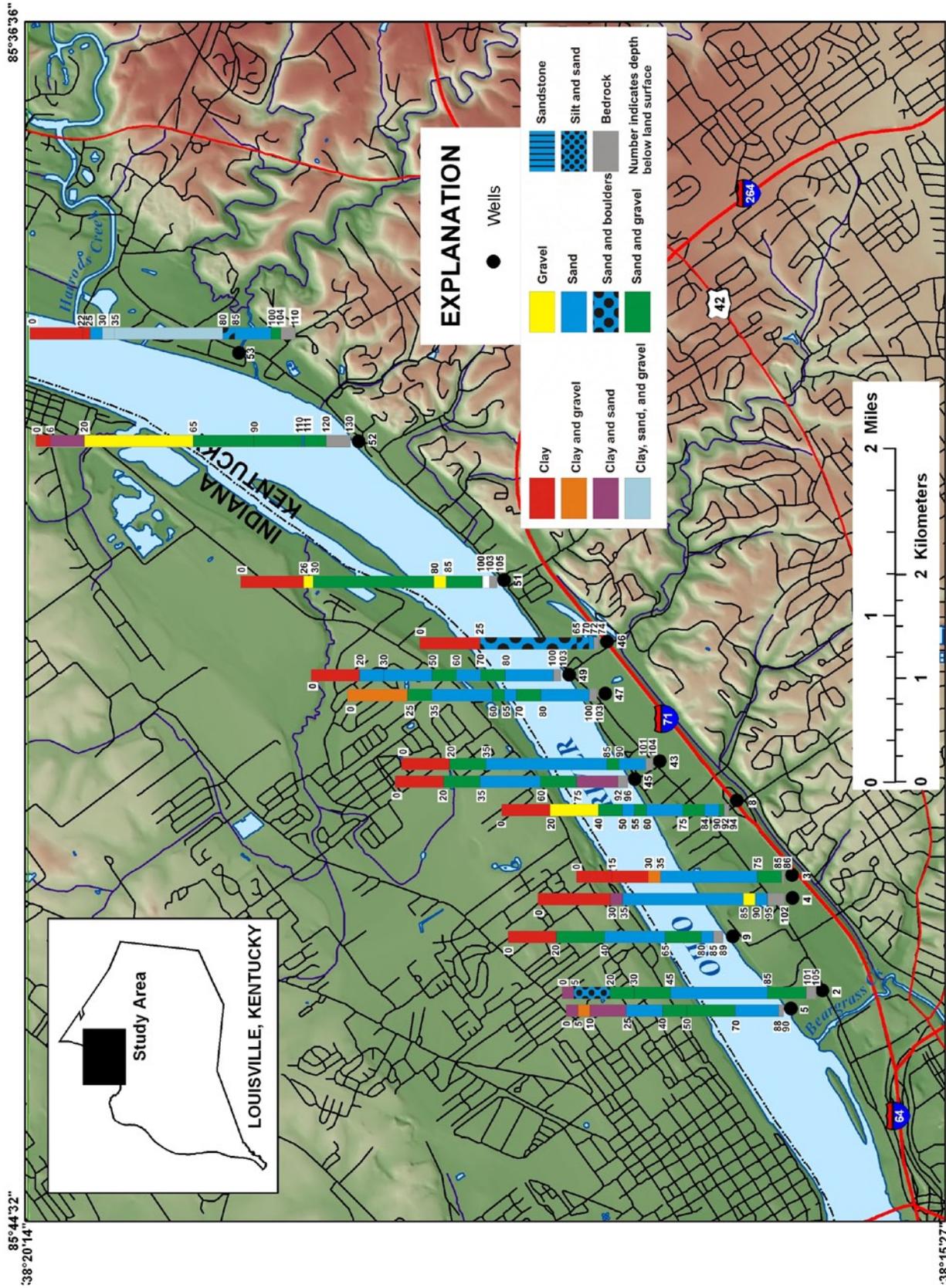
The quantity of ground water used throughout the study area is a small fraction of the total quantity available. Only nine of the wells included in this data compilation are currently (2006) being used or are planned to be used for commercial or industrial ground-water withdrawals. Seven of the nine wells currently are permitted to withdraw a total of 3.64 Mgal/d, but their combined withdrawal is approximately 0.60 Mgal/d. Two wells were recently installed in the study area, and operators are in the process of obtaining permits. Ground-water withdrawal permits are required for withdrawals greater than 10,000 gal/d; permits are issued by the KDOW.

Figure 8 shows the location, use, and permitted daily withdrawal volume for each permitted ground-water user.



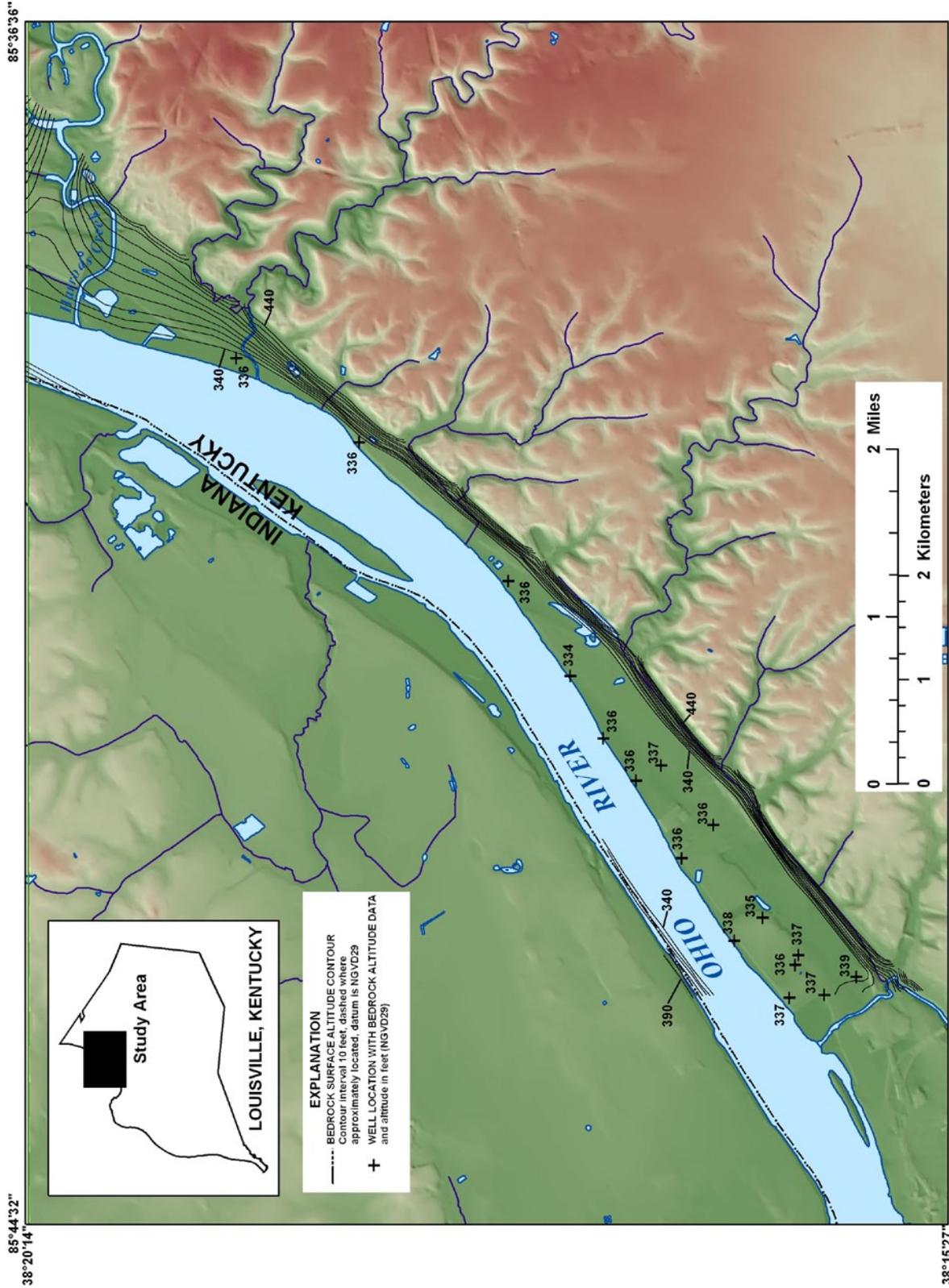
Base from U.S. Geological Survey digital data, 1:100,000, 1983
 Universal Transverse Mercator projection, Zone 16

Figure 5. Estimates of transmissivity from laboratory permeability-test results for selected wells in the northeast portion of the alluvial aquifer at Louisville, Kentucky. [M.I. Rorabaugh, unpub. data, 1947]



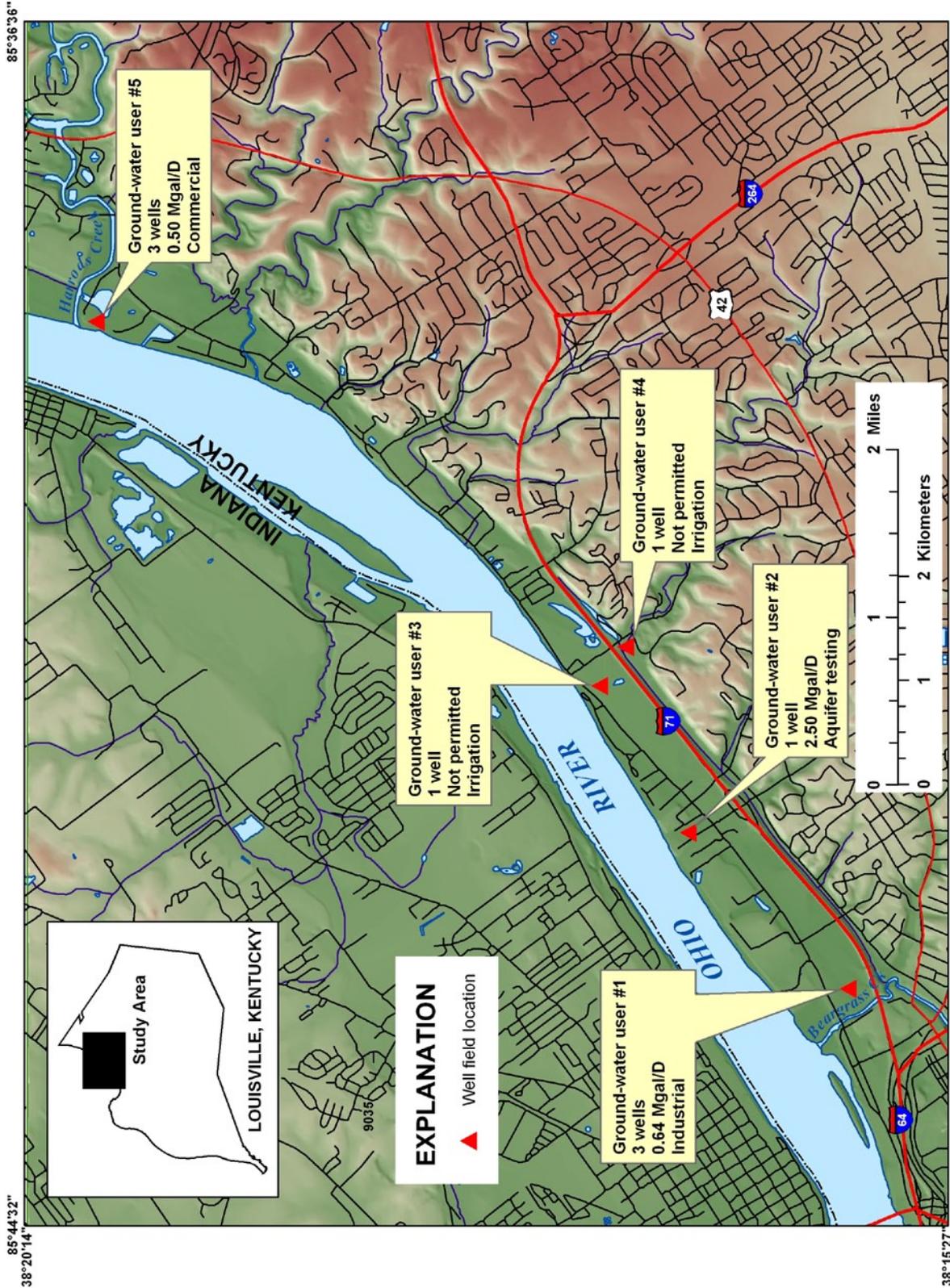
Base from U.S. Geological Survey digital data, 1:100,000, 1983
 Universal Transverse Mercator projection, Zone 16

Figure 6. Drillers' logs in the northeast portion of the alluvial aquifer at Louisville, Kentucky.



Base from U.S. Geological Survey digital data, 1:100,000, 1983
 Universal Transverse Mercator projection, Zone 16

Figure 7. Elevations of the bedrock surface beneath the northeast portion of the alluvial aquifer at Louisville, Kentucky.



Base from U.S. Geological Survey digital data, 1:100,000, 1983
Universal Transverse Mercator projection, Zone 16

Figure 8. Location of well fields and permitted ground-water pumpage in the northeast portion of the alluvial aquifer at Louisville, Kentucky.

Summary

The U.S. Geological Survey, in cooperation with the Louisville Water Company, has reviewed and compiled existing hydrogeological data for the northeast portion of the alluvial aquifer at Louisville, Kentucky. Available ground-water data (since 1956) for the alluvial aquifer from Beargrass Creek to Harrods Creek were compiled from the U.S. Geological Survey National Water Information System and the Kentucky Groundwater Data Repository. Additional data and information were gathered and reviewed from project files at the U.S. Geological Survey–Kentucky Water Science Center and files at the Louisville Water Company. The types of data compiled include ground-water well locations and construction details, historical water levels, drillers' logs, water-quality field parameters and laboratory analyses, and pumping-tests results. Current ground-water conditions are described by use of data from an active ground-water observation-well network and ground-water withdrawal information from the Kentucky Division of Water–Groundwater Branch.

Since 1956, investigations have produced reports, maps, and data files that cover a variety of topics related to the ground water in the northeast portion of the alluvial aquifer at Louisville, Kentucky. These data were compiled into a single report to assist in future development and management of the ground-water resources in this prolific water-bearing formation.

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