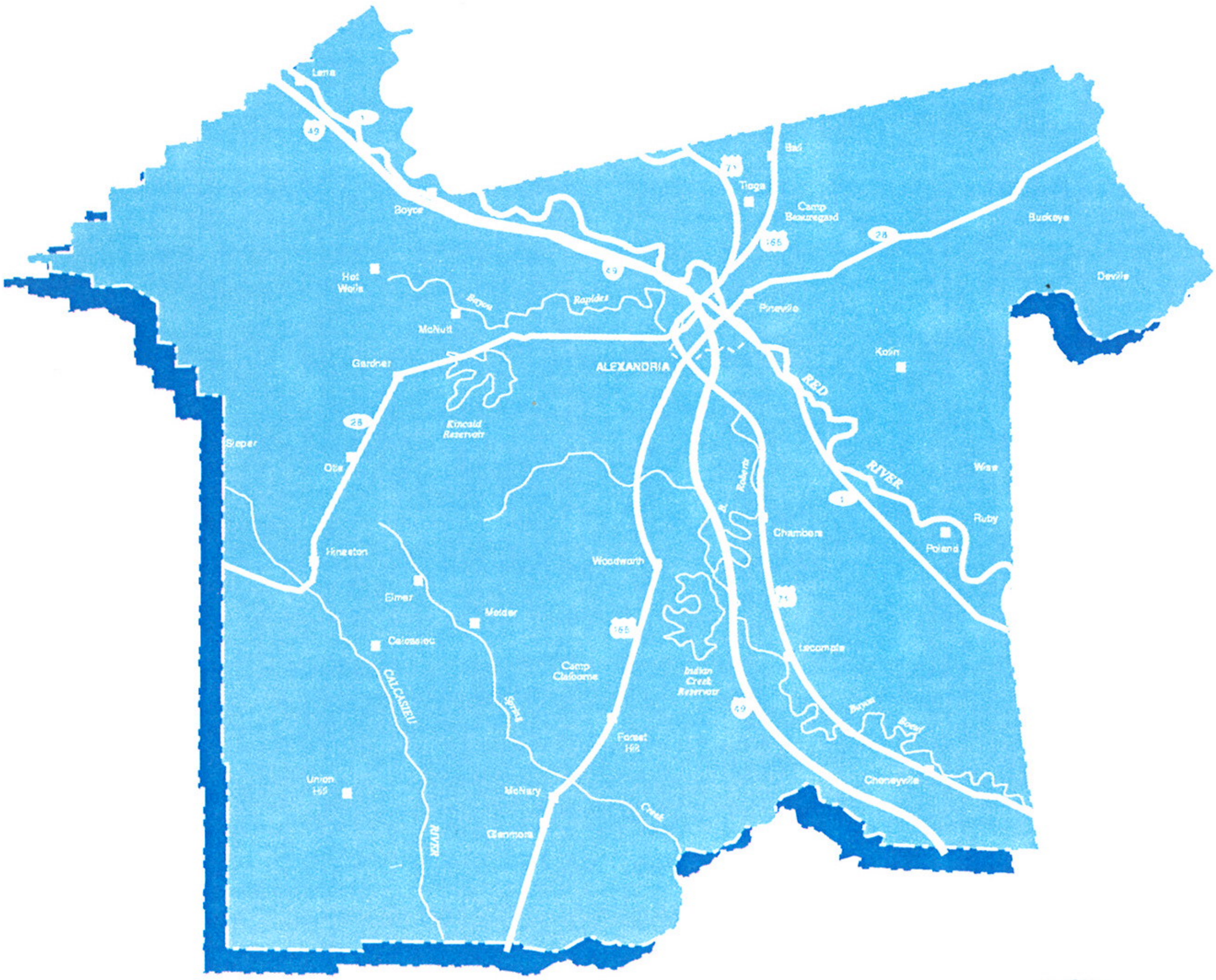
Hydrogeology and Water Resources of the Alexandria Area, Rapides Parish, Louisiana

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

Water Resources Technical Report No. 63



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WATER RESOURCES

TECHNICAL REPORT NO. 63

HYDROGEOLOGY AND WATER RESOURCES OF THE ALEXANDRIA AREA, RAPIDES PARISH, LOUISIANA

By

Charles W. Smoot and Robert B. Fendick, Jr.

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FIGURES

CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
inch	25.4	millimeter
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
foot per year (ft/yr)	0.3048	meter per year
foot per mile (ft/mi)	0.1894	meter per kilometer
foot squared per day (ft^2/d)	0.0929	meter squared per day
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
acre	4,047	meter squared
acre-foot (acre-ft)	1,233	cubic meter
mile (mi)	1.609	kilometer
gallon per minute (gal/min)	0.06308	liter per second
gallon per minute per foot [(gal/min)/ft]	0.207	liter per second per meter
million gallons per day (Mgal/d)	3,785	cubic meters per day

Transmissivity: In this report, the mathematically reduced form for transmissivity, foot squared per day (ft^2/d), is used for convenience. The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness [$(ft^3/d)/ft^2$]ft.

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows: °F = 1.8 (°C) + 32.

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality units:
milligrams per liter (mg/L)
microsiemens per centimeter at 25 degrees Celsius (µS/cm)

HYDROGEOLOGY AND WATER RESOURCES OF THE ALEXANDRIA AREA, RAPIDES PARISH, LOUISIANA

By Charles W. Smoot and Robert B. Fendick, Jr.

ABSTRACT

The City of Alexandria, in Rapides Parish, Louisiana, pumps water for public supply and industrial use from wells completed in aquifers consisting of unconsolidated sedimentary deposits that range in age from Pleistocene to Miocene. More than 80 percent of the water pumped by the City of Alexandria is from wells completed in the upland terrace and Carnahan Bayou aquifers. The wells are located within three public-supply well fields in and near Alexandria. These wells range from 90 to 2,150 feet in depth.

In the southern part of the study area, the base of freshwater generally is greater than 2,000 feet below sea level. Wells in this area could be completed in the Chicot, Evangeline, Williamson Creek, and Carnahan Bayou aquifers. A considerable volume of water could be pumped from these aquifers if the productivity is comparable to that in the Kisatchie well field. However, past intensive pumping has resulted in water-level declines in the aquifers in this area.

Kincaid Reservoir, Indian Creek Reservoir, and the Red River are potential alternative sources of water in the Alexandria area. Water from these surface-water bodies, however, would require some type of treatment to improve water quality for many water-supply uses.

INTRODUCTION

Alexandria, population 49,188 in 1990, is the largest city in Rapides Parish and is located in central Louisiana (fig. 1). In 1990, the City of Alexandria pumped an average of 23.2 Mgal/d of ground-water from three well fields (fig. 2); the municipal system used 13.1 Mgal/d for public supply, and industry used about 10.1 Mgal/d (J.K. Lovelace, U.S. Geological Survey, written commun., 1991). Although total ground-water withdrawal rates have averaged about 23 Mgal/d since 1970 (fig. 3), Alexandria officials believe that a possible increase in navigation on the Red River and the completion of Interstate Highway 49 could result in increased municipal and industrial withdrawals during 1990-2005 (Darrell Williamson, Assistant to the Mayor of Alexandria, oral commun., 1990). In response to this anticipated need, the U.S. Geological Survey (USGS), in cooperation with the City of Alexandria, evaluated the water resources of the Alexandria area.

Purpose and Scope

This report describes the hydrogeology and water resources of the Alexandria area, based on data and studies from the early 1940's to the early 1990's. This report also addresses the potential for additional development of ground- and surface-water resources in the Alexandria area.

The data presented include ground-water-level measurements and selected water-quality properties and constituents for ground- and surface-water samples. Well descriptions and previous water-quality and water-use data, geophysical logs, and aquifer-test data were reviewed and evaluated. The data are in computerized files of the USGS or are tabulated in cited references.

Description of Study Area

The study area is located in Rapides Parish (fig. 1). Land-surface altitudes in the parish range from about 50 ft to more than 260 ft above sea level. Alexandria, located approximately in the center of the State, is about 100 mi from Baton Rouge, Lake Charles, Shreveport, and Monroe, La. (fig. 1). The city is located along the southwestern bank of the Red River in the Red River alluvial flood plain. Major streams in the study area include the Red River, Calcasieu River, Bayou Rapides, Bayou Roberts, Bayou Boeuf, and Spring Creek. A series of locks and dams under construction will make the Red River navigable for barge traffic from the confluence with the Mississippi River to Shreveport. Other major surface-water bodies in the study area include Kincaid Reservoir and Indian Creek Reservoir (fig. 2).

The climate of central Louisiana is characterized by hot summers and mild winters. Humidity is high throughout the year, with an average annual temperature of 19°C. In 1990, Alexandria received about 59 inches of rainfall (Louisiana Monthly Climate Review, written commun., 1995), and the temperature ranged from -8°C recorded in December to 38°C recorded in June.

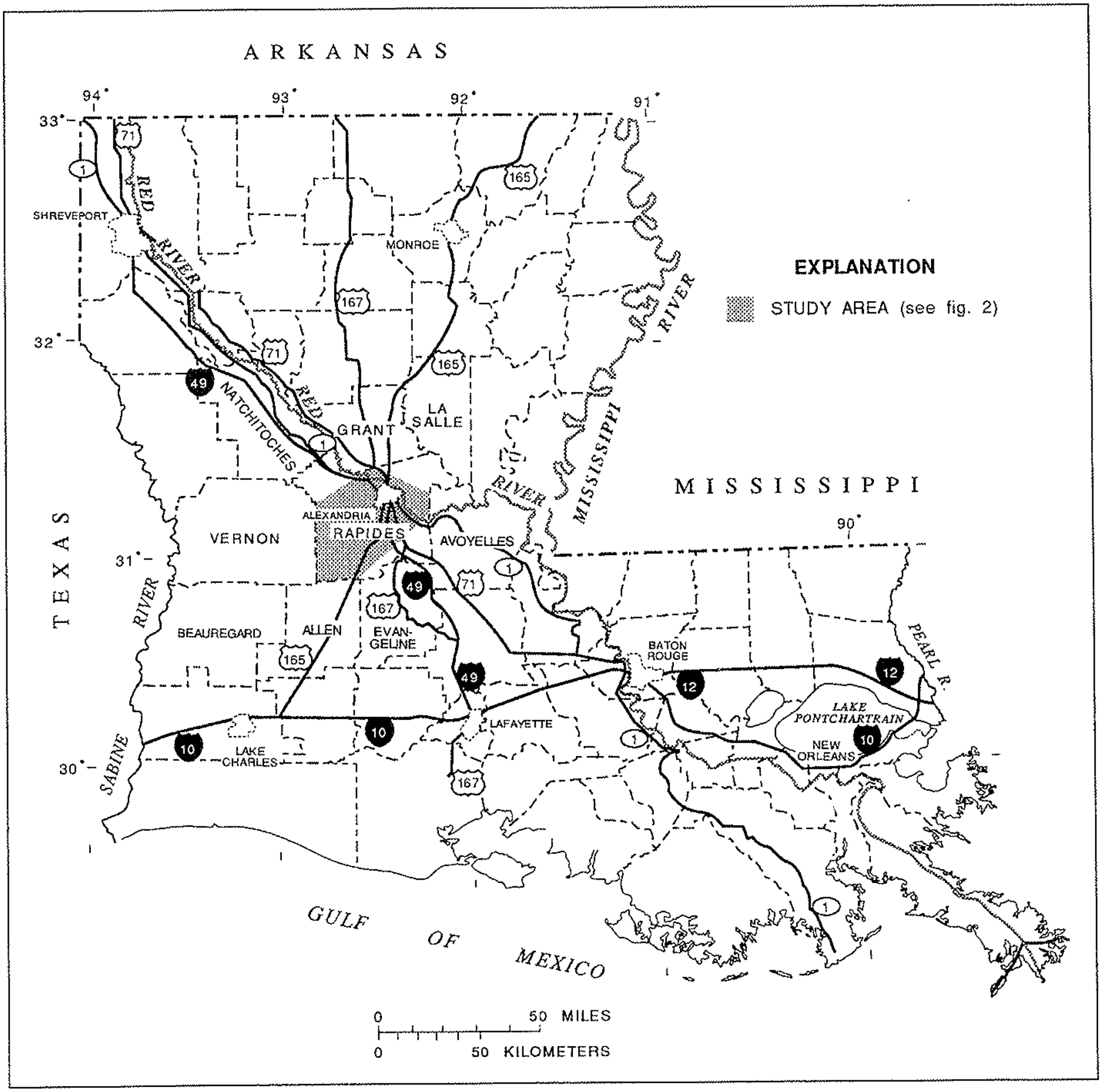
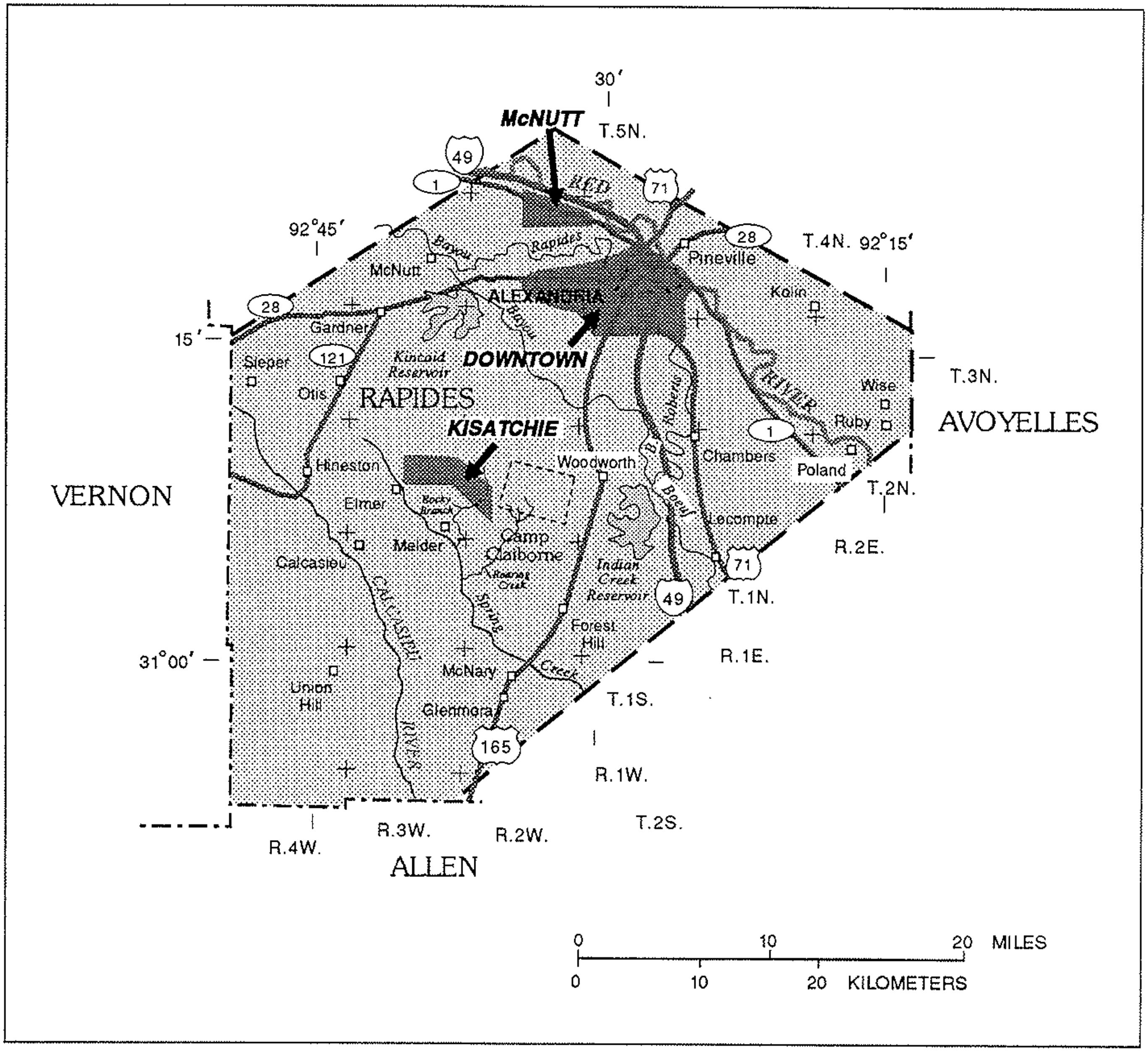


Figure 1. Study area in Rapides Parish and selected highways and cities, Louisiana.



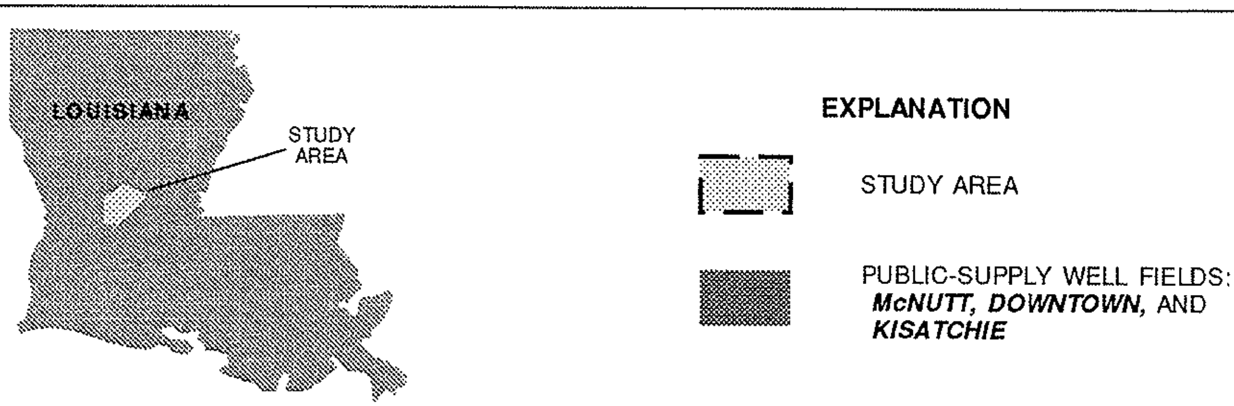


Figure 2. Study area and public-supply well fields in the study area, Rapides Parish, Louisiana.

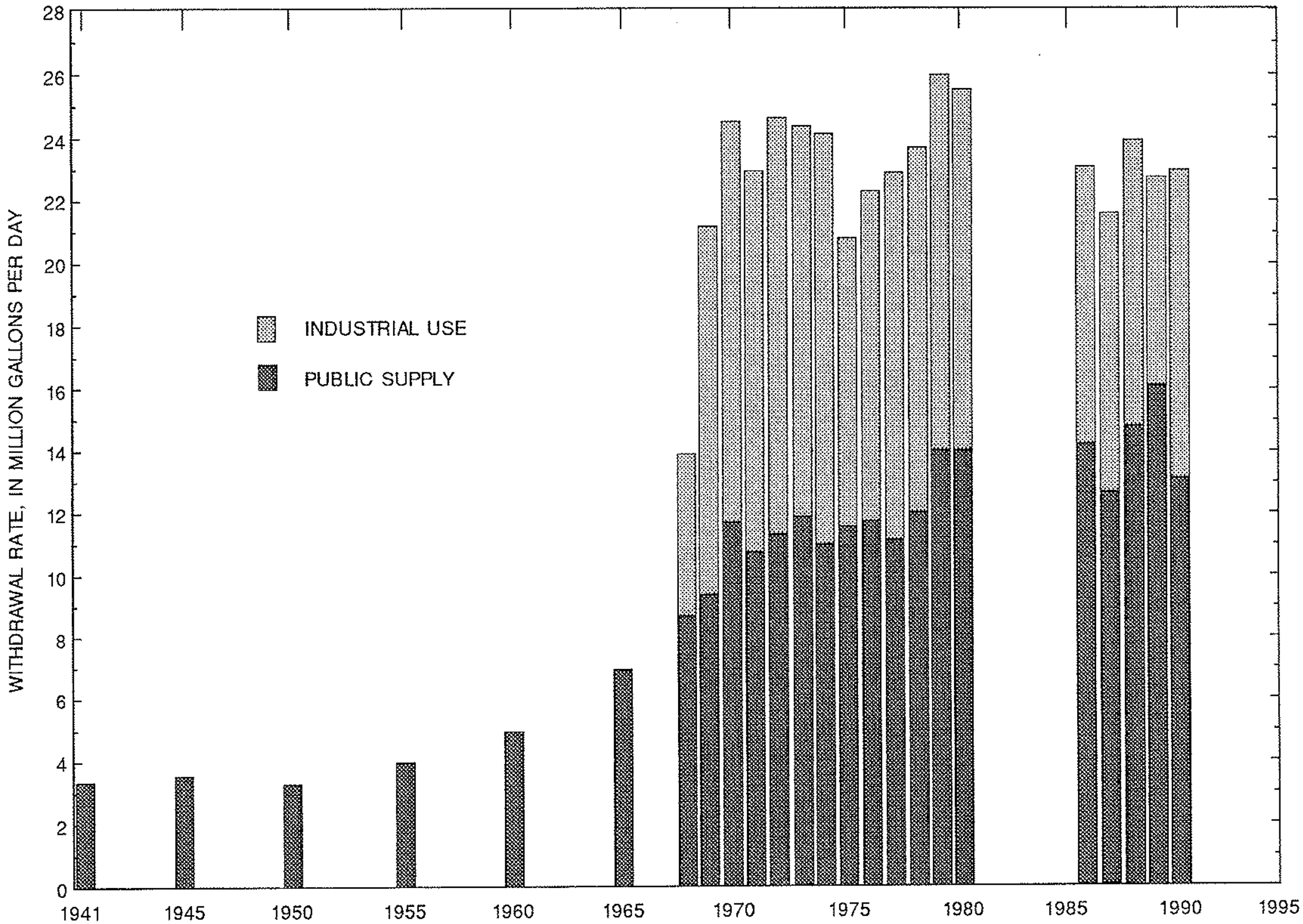


Figure 3. Ground-water withdrawal rates for public supply and industrial use by the City of Alexandria, Louisiana, 1941-90. (J.K. Lovelace, U.S. Geological Survey, written commun., 1991)

Previous Investigations

The geology and hydrogeology of central Louisiana, including Rapides Parish, were first described by Veatch (1906). Fluoride in the ground water of Avoyelles and Rapides Parishes was discussed by Maher (1939). Also, Maher (1940a) described the ground-water resources of Rapides Parish, prepared a preliminary report on the ground-water conditions at Alexandria (1940b), reported on the ground-water conditions at Camp Claiborne in Rapides Parish (1942a), and prepared a memorandum on ground-water conditions in the Alexandria area (1942b). Klug (1955) reported on the geology and ground-water resources in the Alexandria area. An areal investigation of the ground- and surface-water resources of Rapides Parish was reported by Newcome and Sloss (1966). Rogers (1981) reported on the predevelopment and postdevelopment of the water resources in the Kisatchie public-supply well-field area (hereinafter referred to as the Kisatchie well field) near Alexandria (fig. 2).

Acknowledgments

The assistance of Darrell Williamson, Assistant to the Mayor of Alexandria; Sonny Craig, Utility Director; and Charles Miller, Superintendent of the Water Department, is greatly appreciated. Thanks also are given to Zahir "Bo" Bolourchi, Chief of the Water Resources Section, Louisiana Department of Transportation and Development, for his assistance in the publication of this report.

HYDROGEOLOGY

The aquifers in the study area are in unconsolidated sedimentary deposits of Quaternary age and Tertiary age (fig. 4). The hydrogeologic units are discussed from youngest to oldest and include the following aquifers: the Red River alluvial aquifer, the upland terrace aquifer, and the Chicot aquifer system (fig. 5); the Evangeline aquifer; and the Jasper aquifer system (including Williamson Creek and Carnahan Bayou aquifers) (fig. 6). Fresh ground water (water containing less than 250 mg/L of chloride) is present in the southwestern part of the parish to depths greater than 3,000 ft below sea level (fig. 6, pl. 1).

<table>
<tr><th>System</th><th>Series</th><th colspan="2">Stratigraphic unit</th><th colspan="2">Hydrogeologic unit</th></tr>
<tr><td>Quaternary</td><td>Pleistocene</td><td colspan="2">Red River alluvial deposits
Northern Louisiana terrace deposits
Unnamed Pleistocene deposits</td><td colspan="2">Red River alluvial aquifer and/or surficial confining unit
Upland terrace aquifer and/or surficial confining unit
Chicot aquifer system and/or surficial confining unit</td></tr>
<tr><td rowspan="7">Tertiary</td><td>Pliocene
?</td><td rowspan="6">Fleming Formation</td><td>Blounts Creek Member</td><td colspan="2">Evangeline aquifer</td></tr>
<tr><td rowspan="6">Miocene</td><td>Castor Creek Member</td><td colspan="2">Castor Creek confining unit</td></tr>
<tr><td>Williamson Creek Member</td><td rowspan="3">Jasper aquifer system</td><td>Williamson Creek aquifer</td></tr>
<tr><td>Dough Hills Member</td><td>Dough Hills confining unit</td></tr>
<tr><td>Carnahan Bayou Member</td><td>Carnahan Bayou aquifer</td></tr>
<tr><td>Lena Member</td><td colspan="2">Lena confining unit</td></tr>
<tr><td colspan="2">Catahoula Formation</td><td colspan="2">Catahoula aquifer</td></tr>
</table>

Figure 4. Stratigraphic and hydrogeologic units in Rapides Parish and adjacent areas, Louisiana (modified from McWreath and Smoot, 1989).

The Red River Valley (fig. 5), in Rapides Parish, is underlain by Red River alluvial deposits. Terrace deposits of Pleistocene age mantle most of the sediments in the parish outside of the Red River Valley. In and south of the study area, these deposits are referred to as the upland terrace aquifer or the Chicot aquifer system, depending on location (fig. 5).

In the southern part of Rapides Parish the Evangeline aquifer subcrops through the Kisatchie well field. The Evangeline aquifer and Jasper aquifer system are separated by the Castor Creek confining unit (fig. 4). The Castor Creek confining unit is predominantly clay to sandy clay, but may contain sand of ample thickness for a large-yield well at a few locations. However, these sands probably are not of sufficient areal extent to provide sustained large yields and, therefore, are not further discussed in this report. The Williamson Creek and Carnahan Bayou aquifers of the Jasper aquifer system are separated by the Dough Hills confining unit, and the Carnahan Bayou and Catahoula aquifers are separated by the Lena confining unit.

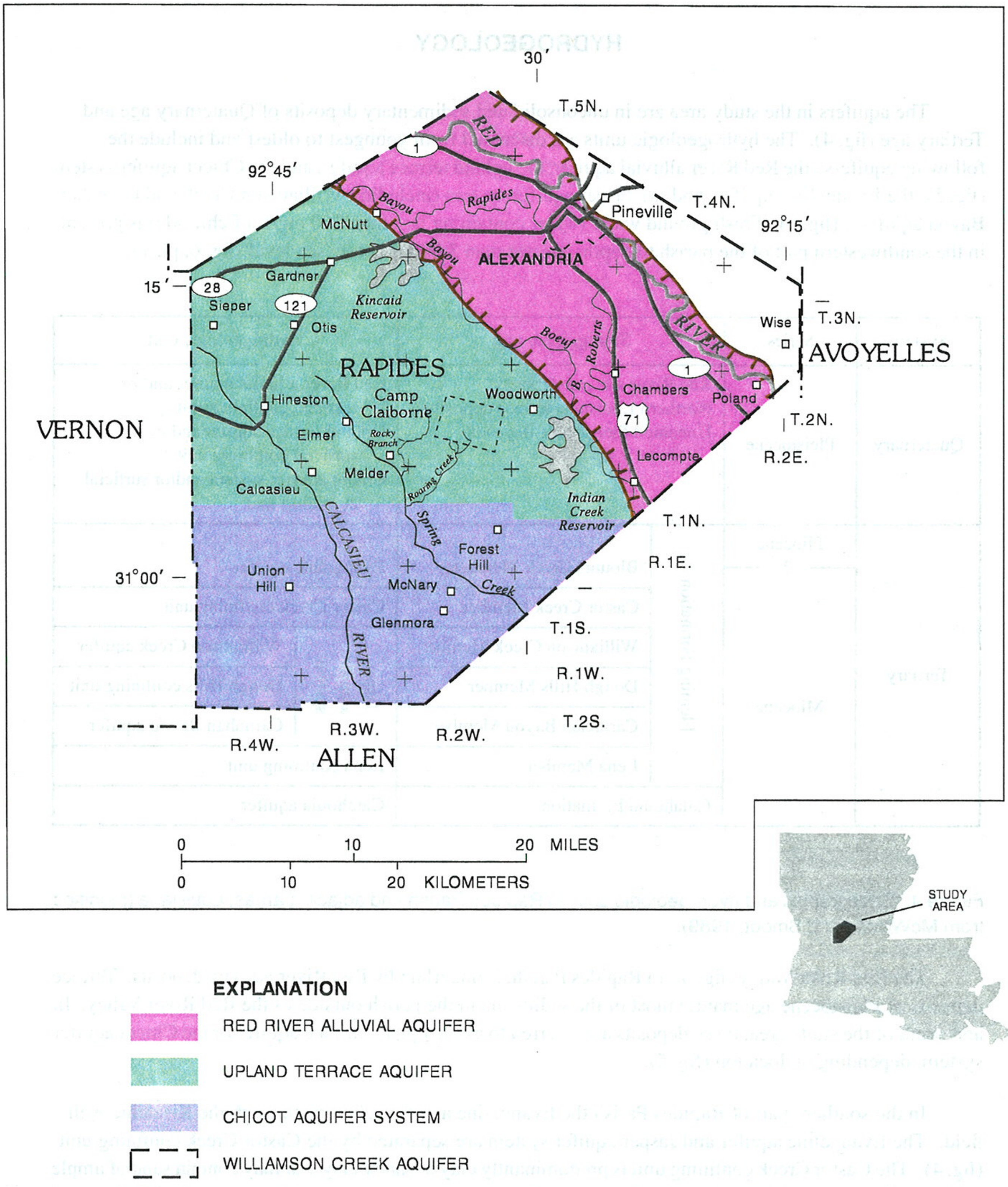
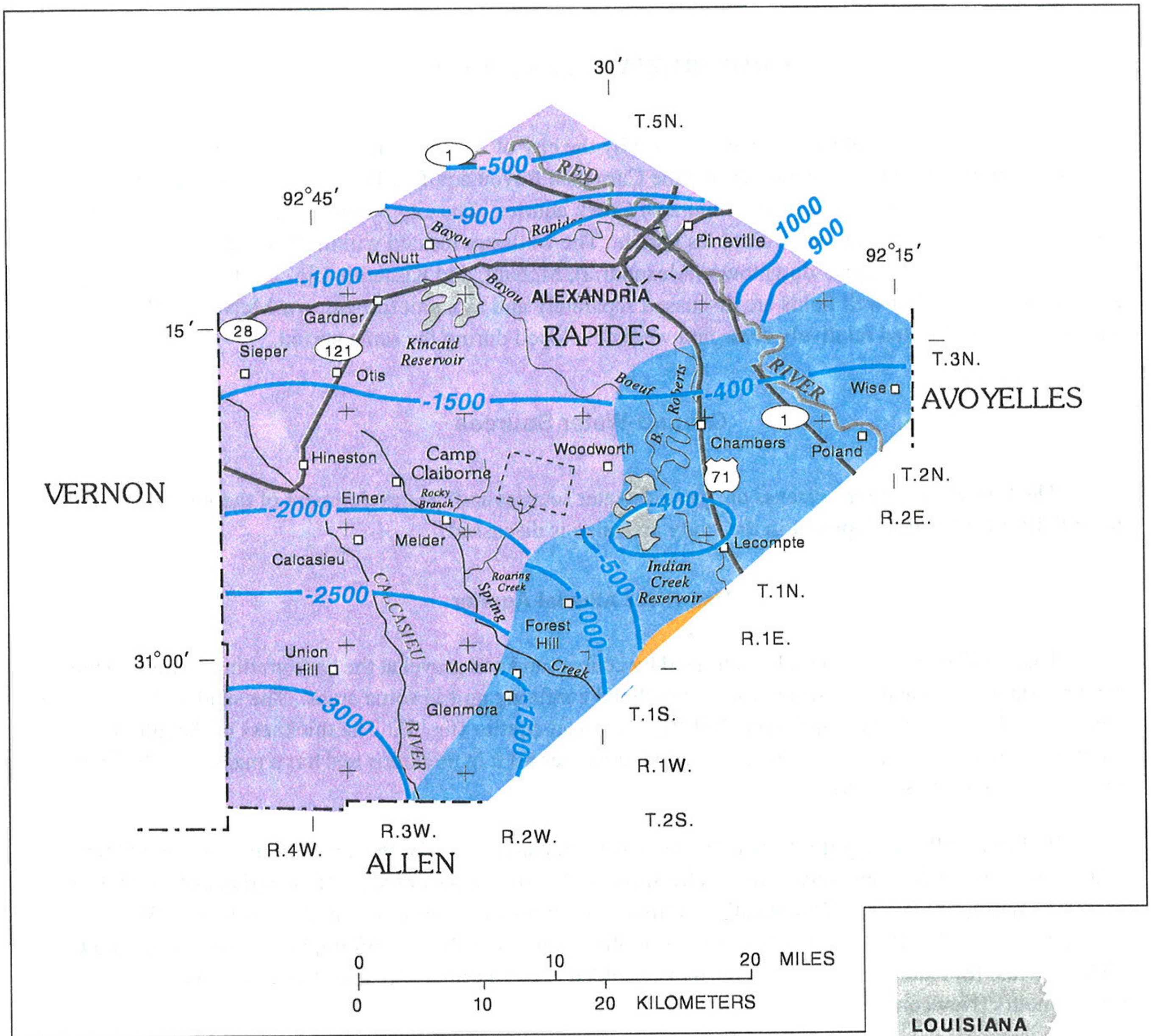


Figure 5. Location of the Red River alluvial aquifer, upland terrace aquifer, and Chicot aquifer system in the study area.



EXPLANATION

BASE OF FRESHWATER PRESENT IN THE:

EVANGELINE AQUIFER

WILLIAMSON CREEK AQUIFER

CARNAHAN BAYOU AQUIFER

-400 BASE-OF-FRESHWATER CONTOUR--Shows altitude of the base of freshwater. Freshwater is defined as water containing less than 250 milligrams per liter of chloride. Contour interval variable. Datum is sea level

Figure 6. Altitude of the base of freshwater in the study area (from Smoot, 1988).

GROUND-WATER RESOURCES

More than 80 percent of the water pumped by the city of Alexandria for public supply is from wells completed in the upland terrace aquifer and the Carnahan Bayou aquifer. Less than 20 percent is pumped from the Evangeline aquifer and the Williamson Creek aquifer. The city pumps freshwater from 62 wells completed in these four aquifers in Rapides Parish. The wells are located within three public-supply well fields in and near Alexandria: downtown (Alexandria), McNutt, and Kisatchie (fig. 2). In this report, the downtown and McNutt well fields are discussed separately and as a unit (downtown-McNutt well field) because they are located relatively close and were developed during the same period.

Ground-Water Sources

The following sections discuss the ground-water sources and the development of these sources. The potential for further development in the study area also is discussed.

Red River Alluvial Aquifer

The Red River alluvium is characterized by coarse sand and gravel at the base grading upward to fine sand overlain by silt and clay which forms a surficial confining unit in some areas. The sand and gravel deposits in the lower part compose the Red River alluvial aquifer (fig. 5). The thickness of the alluvial aquifer varies. In the Alexandria area, the aquifer averages 50 ft in thickness and has a maximum thickness of 110 ft (Rogers, 1983, p. 8).

Red River alluvial aquifer tests indicate that the transmissivity for the aquifer ranges from 2,000 to 27,000 ft^2/d; hydraulic conductivity ranges from 100 to 300 ft/d; and storage coefficient ranges from 0.0006 to 0.001 (Whitfield, 1980, p. 7), indicating confined conditions for the aquifer in the study area. Wells completed in the Red River alluvial aquifer generally yield 250 to 1,700 gal/min, but have been tested at higher yields; for example, a well that normally yielded 1,700 gal/min was tested at 2,800 gal/min for several hours (Newcome and Sloss, 1966, p. 28).

In the study area, the Red River alluvial aquifer provides water for agricultural and aquacultural purposes. Less than 1.5 Mgal/d of water was pumped from the Red River alluvial aquifer in 1990 (Lovelace, 1991, p. 89). Water in the Red River alluvial aquifer typically is a calcium-magnesium bicarbonate type. Whitfield (1980, p. 11) reported that concentrations of hardness as calcium carbonate[1] generally range from 200 to 600 mg/L, and concentrations of dissolved iron generally range from 0.5 to 10 mg/L. Results of water-quality analyses of samples from four wells completed in the Red River alluvial aquifer are listed in the appendix, table 1.

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[1] The U.S. Environmental Protection Agency (1976, p. 75) classifies hardness as follows: Water having hardness of 0-75 mg/L is considered soft, 75-150 mg/L is moderately hard, 150-300 mg/L is hard, and more than 300 mg/L is very hard. In Louisiana, water that is hard or very hard and (or) that contains an iron concentration exceeding 0.3 mg/L generally is treated for public supply.

Upland Terrace Aquifer and Chicot Aquifer System

In this report, the Pleistocene deposits in the central and northwestern part of the study area will be referred to as the upland terrace aquifer, and the Pleistocene deposits in the southern part of the study area will be referred to as the Chicot aquifer system (fig. 5). The upland terrace aquifer and Chicot aquifer system are characterized by sand and gravel at the base grading upward to fine sand, silt, and clay. The aquifers, which mostly are overlain by a surficial confining unit of clay or silt (Rogers, 1981, p. 10), range from less than 75 to more than 150 ft in thickness. The overlying clay ranges from 0 to 85 ft in thickness.

The hydraulic characteristics of the upland terrace aquifer were determined from 2- to 30-day aquifer tests at two wells in the Kisatchie well field. Transmissivity is 13,400 ft^2/d at each well; hydraulic conductivities are 170 and 200 ft/d; and storage coefficients are 0.06 (R-902) and 0.07 (R-901) (Rogers 1981, p. 23). Water in the upland terrace aquifer within the study area generally is unconfined. In the study area, the original yield of wells completed in the upland terrace aquifer ranges from 305 to 750 gal/min of water (appendix, table 2).

In the study area, the upland terrace aquifer is relatively undeveloped except in the Kisatchie well field where 24 wells have been installed. The town of Forest Hill (fig. 5) pumps water from the Chicot aquifer system for public supply and many nearby plant nurseries also pump water from the Chicot aquifer system for irrigation.

The altitude of the water table (fig. 7) in the upland terrace aquifer and Chicot aquifer system is greater than 160 ft above sea level in the area northwest of the Kisatchie well field and is less than 100 ft above sea level near the lower end of Spring Creek. Hydrographs of three wells (R-847, R-851, and R-1027) completed in the upland terrace aquifer are shown in figure 8. In the Kisatchie well field, the water level in well R-847 has fluctuated between 45 and 60 ft below land surface since 1972 after declining from 40 to 55 ft below land surface during 1968-72, in response to the development of the Kisatchie well field in 1968. Northwest of the well field, the water level in well R-851 increased about 3 ft during 1966-90. This increase in water level probably resulted from above average rainfall and subsequent recharge. Southeast of the well field, the water level in well R-1027 declined about 2 ft during 1972-90, in response to nearby pumping.

Water in the upland terrace aquifer and Chicot aquifer in Rapides Parish generally is soft, acidic, and contains low concentrations of dissolved solids. Results of water-quality analyses for samples from three wells completed in the upland terrace aquifer are listed in the appendix, table 1.

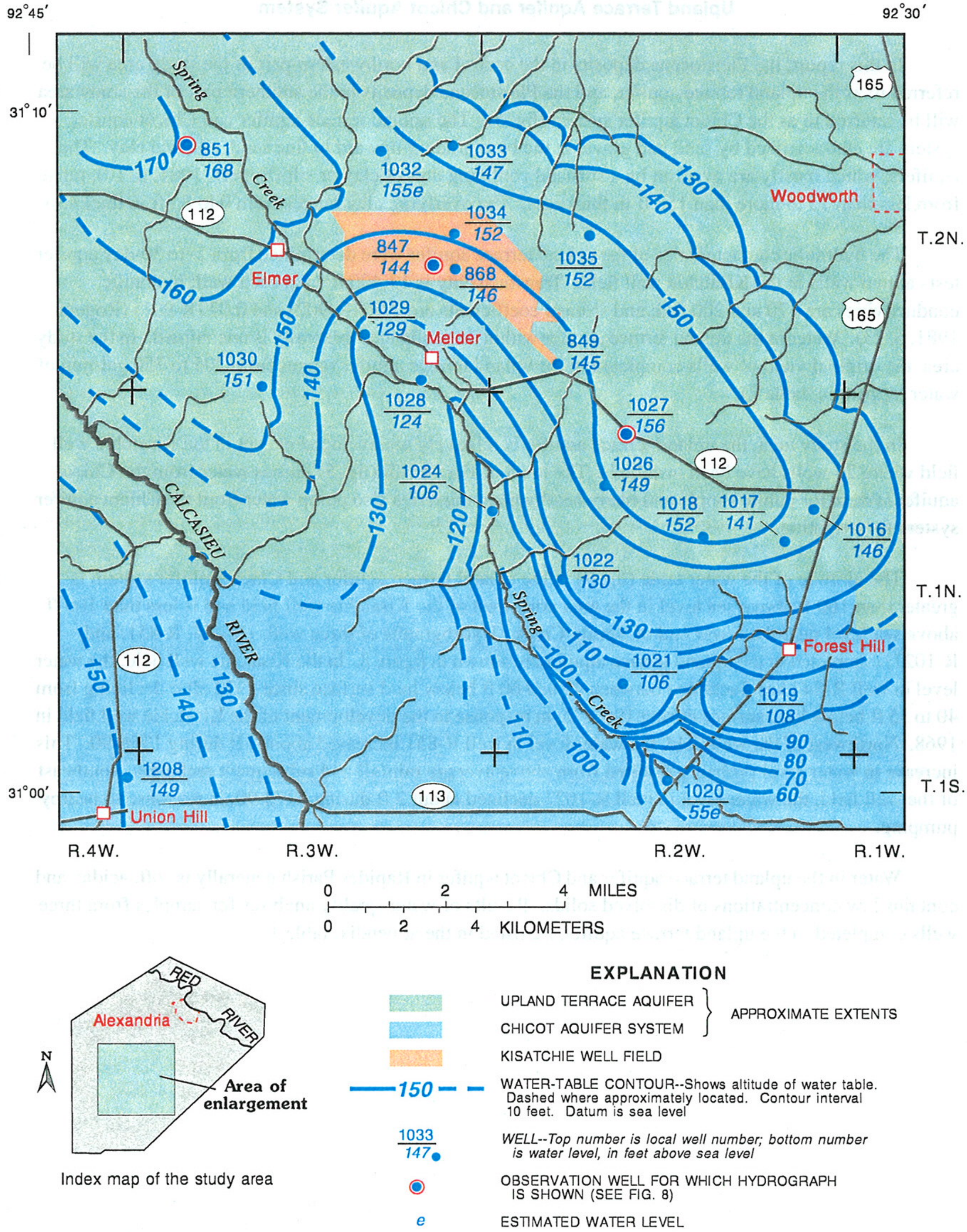

Figure 7. Altitude of water table in the upland terrace aquifer and Chicot aquifer system in the study area, November 1990.

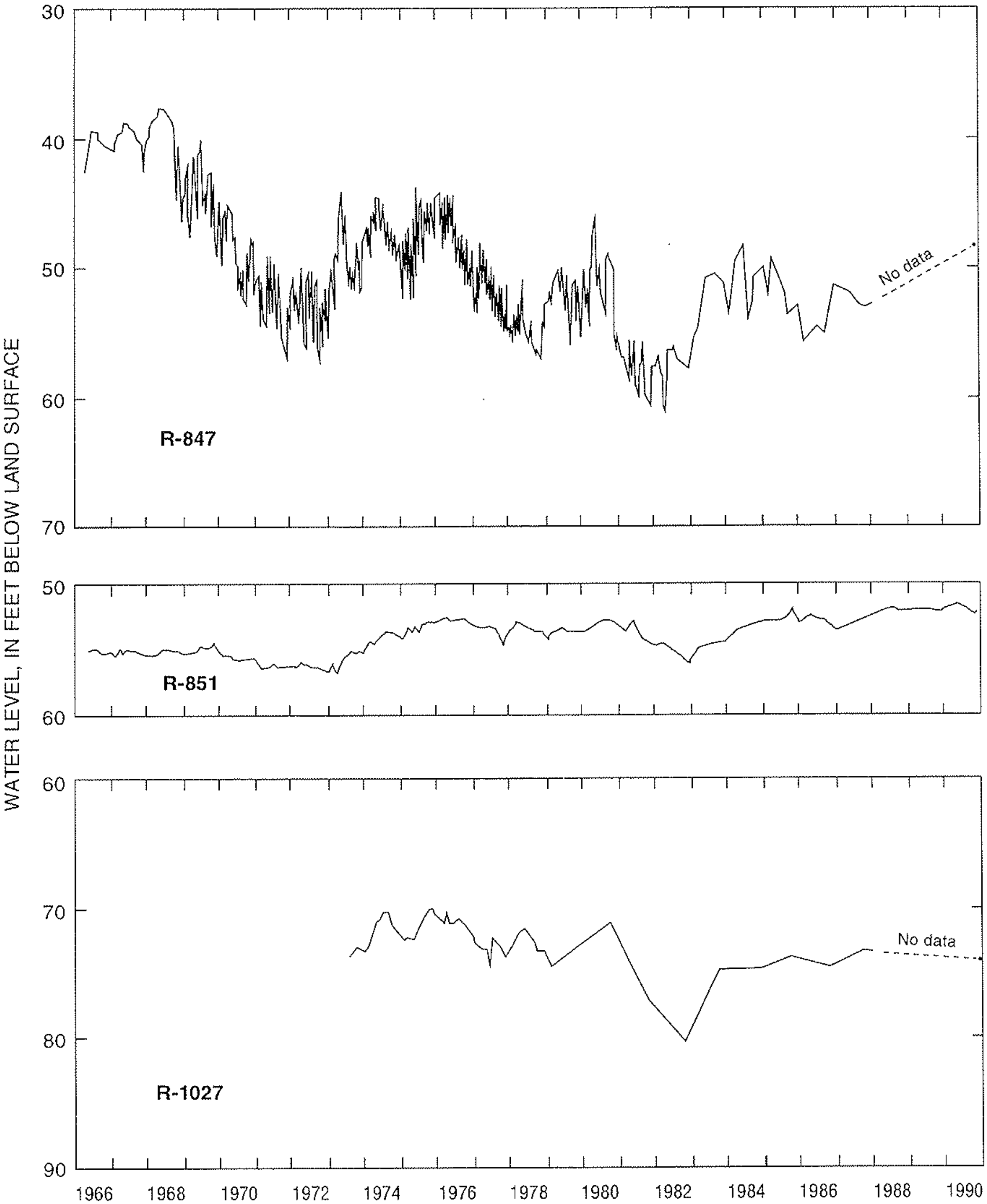

Figure 8. Water levels in wells R-847, R-851, and R-1027 completed in the upland terrace aquifer in Rapides Parish, Louisiana.

Evangeline Aquifer

The Evangeline aquifer subcrops along a northeast to southwest direction through part of the Kisatchie well field. It consists primarily of a deltaic sequence of fine to medium sand with interbedded silt, greenish-gray laminated clay and local beds of coarse sand (Whitfield, 1975, p. 12). The aquifer in the central part of the study area is about 225 ft thick at well R-852 and thickens southwestward to about 650 ft at well R-1207 (pl. 1).

Transmissivity and hydraulic conductivity at three wells tested in the Kisatchie well field range from 1,340 to 6,280 ft^2/d and from 49 to 100 ft/d, respectively (Rogers, 1981, table 2, p. 22). Whitfield (1975, p. 20) reported the hydraulic conductivity of the aquifer within nearby Allen and Beauregard Parishes ranges from 30 to 100 ft/d, which is comparable to values obtained at wells in the Kisatchie well field. The storage coefficient of the Evangeline aquifer in the study area is about 0.0002 (Whitfield, 1975, p. 20), indicating confined conditions. Wells completed in the Evangeline aquifer originally yielded 430 to 550 gal/min (appendix, table 2).

Three wells in the Kisatchie well field are completed in the Evangeline aquifer. The towns of Glenmora, Forest Hill, Lecompte, and McNary (fig. 2) also withdraw water for public supply from the Evangeline aquifer.

Water in the Evangeline aquifer generally is soft to moderately hard, slightly alkaline, and has low concentrations of iron and dissolved solids. Results of water-quality analyses for samples from two wells completed in the Evangeline aquifer are listed in the appendix, table 1.

Williamson Creek Aquifer

The Williamson Creek aquifer is recharged in a band across the northern part of the study area (fig. 9). The aquifer consists of generally well sorted, very fine to medium sands interbedded with greenish-gray clays (Whitfield, 1975, p. 29). The aquifer contains freshwater within nearly the entire study area. The aquifer is about 300 ft thick in Alexandria, increasing to 600 ft in the Kisatchie well field, and more than 800 ft near Union Hill, as shown on cross section A-A' (pl. 1).

Values for transmissivity and hydraulic conductivity from five aquifer tests in the Kisatchie well field ranged from 670 to 10,000 ft^2/d and from 20 to 130 ft/d, respectively (Rogers, 1981, table 2). The storage coefficient of the aquifer at well R-939 was 0.00013, indicating the Williamson Creek aquifer is confined in the Kisatchie well field.

The Williamson Creek aquifer is a source of freshwater from wells 300 to 500 ft deep in the metropolitan area of Alexandria and from wells 450 to 600 ft deep in the Kisatchie well field. The water systems of Elmer-Melder-Calcasieu, Hineston, Kolin-Ruby-Wise, and Woodworth (fig. 9) also pump water from the Williamson Creek aquifer. These water systems together pump an average of 0.65 Mgal/d from the Williamson Creek aquifer (J.K. Lovelace, U.S. Geological Survey, written commun., 1991).

The potentiometric surface map for the aquifer (fig. 9) shows the water-level altitude is at or below sea level in the Alexandria area (well R-18) and as much as 50 or more feet below sea level in the Kisatchie well field area (well R-932). The water level in the aquifer was approximately the same in downtown Alexandria in 1990 as during 1955-60; this is shown in the hydrograph of well R-18 (fig. 10). The water-level fluctuation in well R-18 during 1960-86 was in response to ground-water withdrawals from a nearby well. In some parts of the Kisatchie well field, the water level declined as much as 150 ft during 1968-79 due to increased ground-water withdrawals. This is shown in the hydrograph of well R-932 (fig. 10).

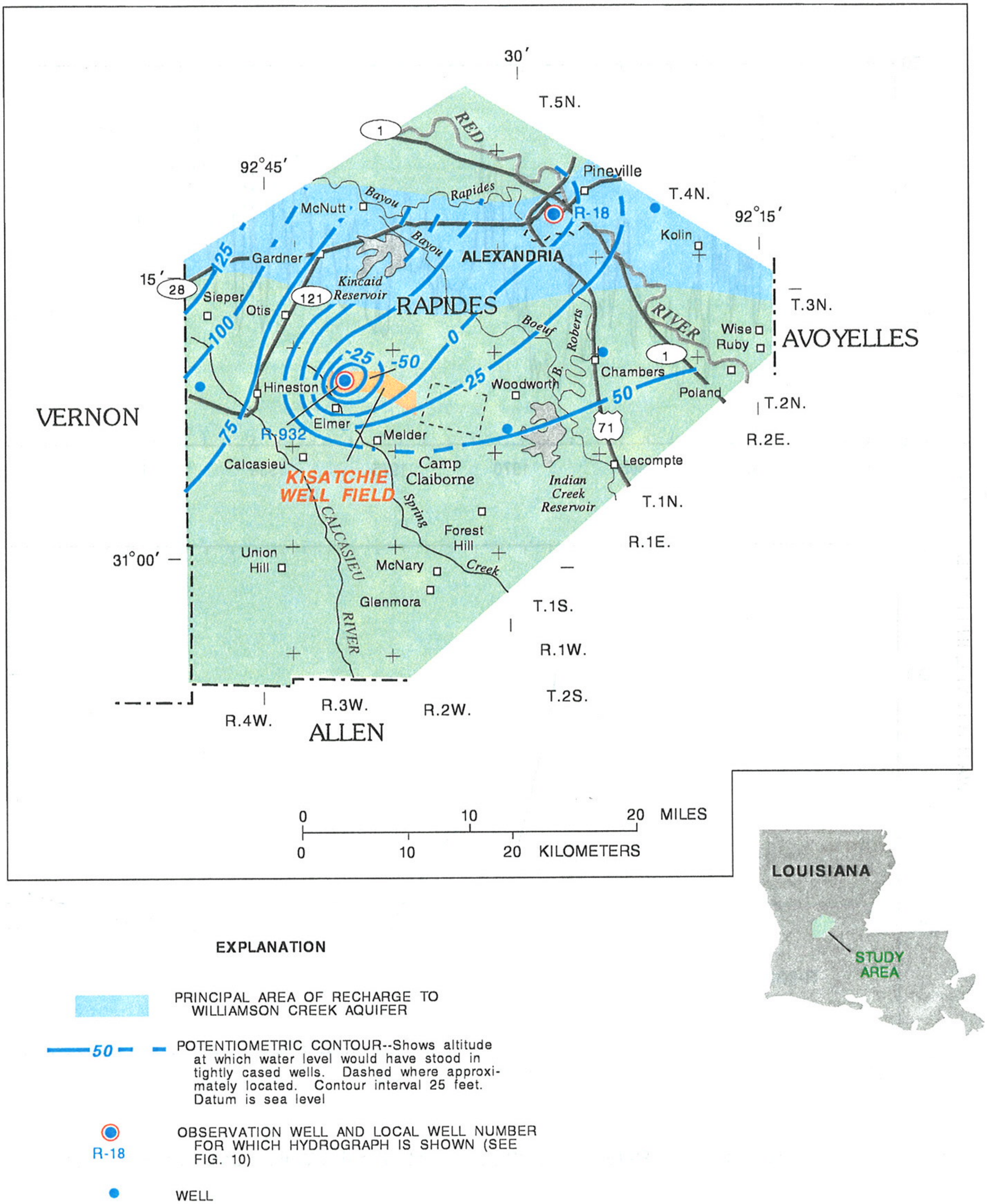

Figure 9. Potentiometric surface of the Williamson Creek aquifer in the study area, October and November 1989 (from Smoot and Seanor, 1992).

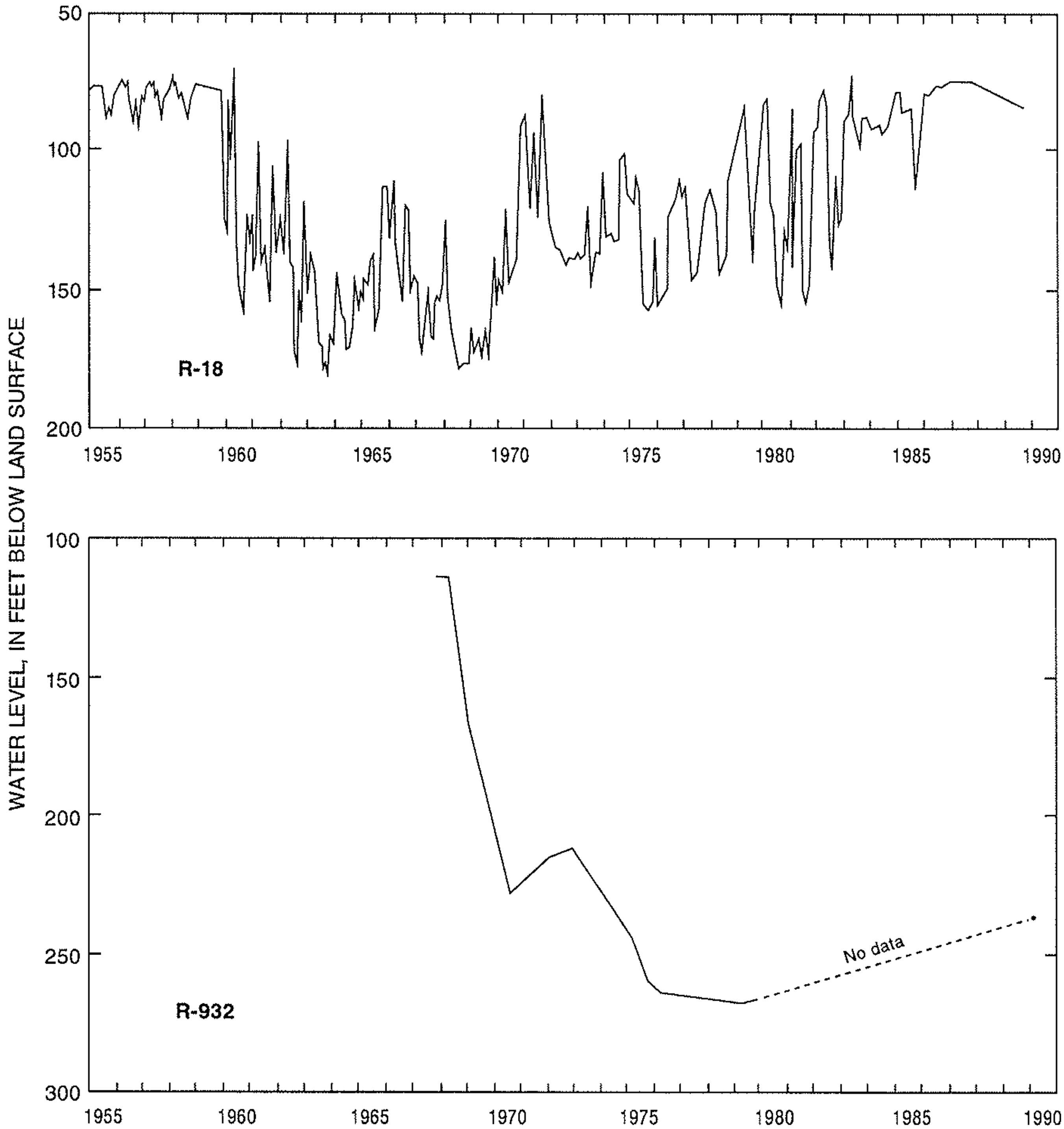

Figure 10. Water levels in wells R-18 and R-932 completed in the Williamson Creek aquifer in the study area.

In most of the study area, water in the Williamson Creek aquifer is soft, slightly alkaline, and has low concentrations of iron and dissolved solids. Locally, however, the water may be moderately hard. Results of water-quality analyses for samples from two wells completed in the Williamson Creek aquifer are listed in the appendix, table 1.

Carnahan Bayou Aquifer

The Carnahan Bayou aquifer crops out in northern Vernon Parish, southern Natchitoches Parish, northwestern Rapides Parish, and southern Grant Parish and dips to the southeast. Like the Williamson Creek aquifer, the Carnahan Bayou aquifer consists of generally well sorted, very fine to medium sands interbedded with greenish-gray clays. The dip from the northwestern part of the study area toward the southeast is about 65 ft/mi, as shown on cross section B-B' (pl. 1)

Transmissivity and hydraulic conductivity for the aquifer, based on aquifer tests at seven wells in the Kisatchie well field, ranged from 2,070 to 11,630 ft^2/d and from 60 to 110 ft/d, respectively (Rogers, 1981, table 2). Storage coefficients were about 0.00015, indicating confined aquifer conditions.

Based on limited data, it appears that a large cone of depression may have developed in the potentiometric surface of the Carnahan Bayou aquifer. This cone is the result of heavy municipal pumping in Alexandria and Pineville. The altitude of water in the center of the cone at Pineville is 225 ft below sea level; the cone primarily extends eastward, southward, and westward. Hydrographs of four wells completed in the Carnahan Bayou aquifer in Rapides Parish are shown in figure 11. In the downtown-McNutt well field, the water level in well R-825 declined about 65 ft during 1963-89. In the Kisatchie well field, the water level has declined almost 160 ft in well R-937 since 1968. A decline of about 4 ft/yr in well R-1056 at Otis, during 1977-90, and about 2 ft/yr in well R-1207 at Union Hill, during 1982-90, are the result of ground-water withdrawals in the study area.

Water in the Carnahan Bayou aquifer generally is a soft, slightly alkaline, sodium bicarbonate type with low concentrations of iron. Results of water-quality analyses for samples from six wells completed in the Carnahan Bayou aquifer are listed in the appendix, table 1.

The Carnahan Bayou aquifer is the most extensively developed aquifer in the study area. The City of Alexandria has 27 public-supply wells and Pineville has 8 public-supply wells completed in this aquifer. Other water systems in the study area pumping from the Carnahan Bayou aquifer are Elmer-Melder-Calcasieu, Gardner, and Sieper. Locations of public-supply or industrial wells and observation wells screened in the Carnahan Bayou aquifer in the study area are shown in figures 12 and 13.

Well Fields in the Study Area

In 1990, the public-supply water-well system in the Alexandria area consisted of 62 wells that ranged in depth from 90 to 2,150 ft below land surface (appendix, table 2). The wells are located in the downtown-McNutt and Kisatchie well fields. The 1990 yields for these 62 wells ranged from 80 to 1,000 gal/min. The combined pumping capacity for all 62 wells is about 33 Mgal/d. Within the downtown-McNutt well field, 37 wells have been plugged (appendix, table 3). Most of these wells or groups of wells have been replaced with a new well or wells in the same general area.

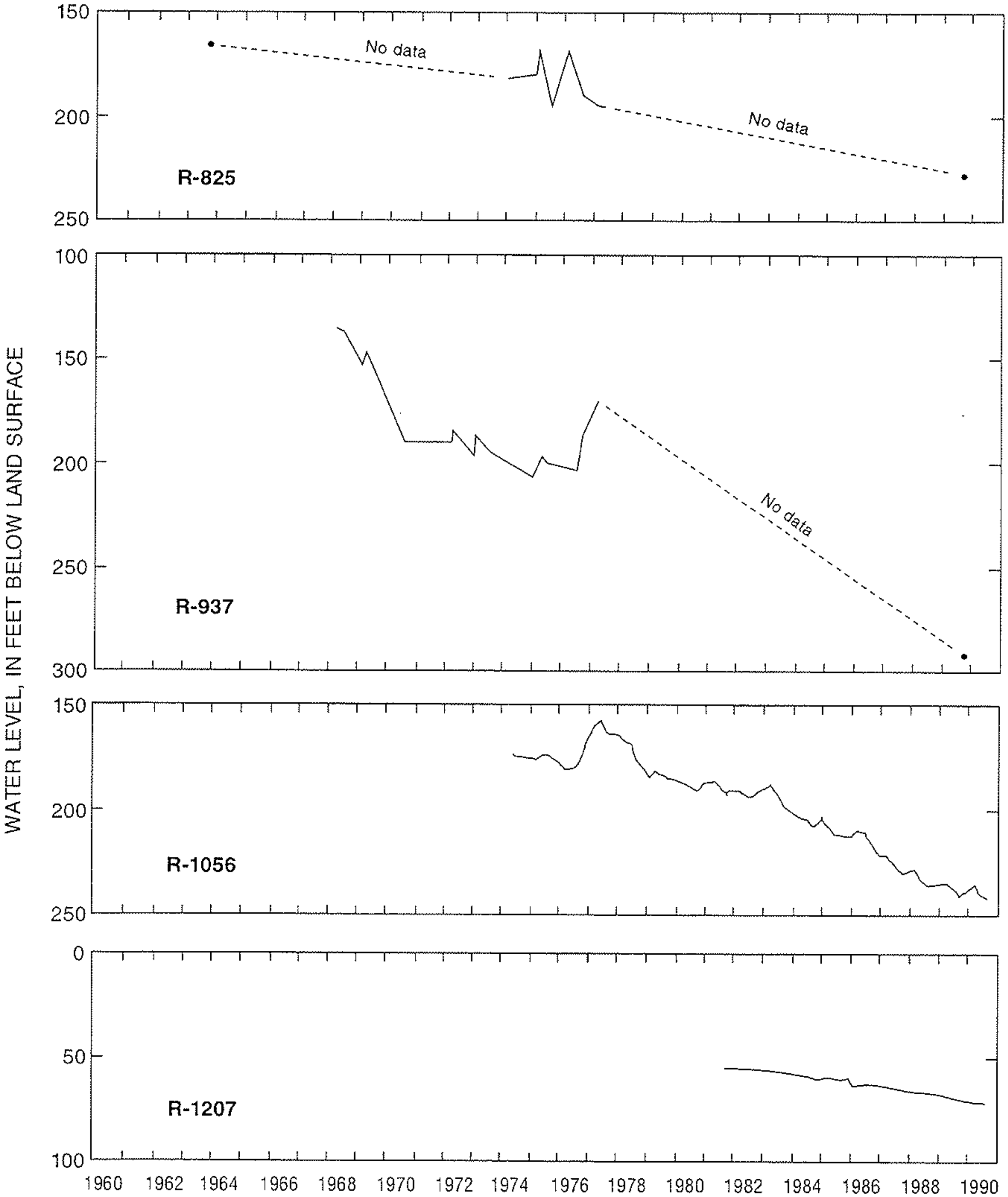

Figure 11. Water levels in wells R-825, R-937, R-1056, and R-1207 completed in the Carnahan Bayou aquifer in the study area.

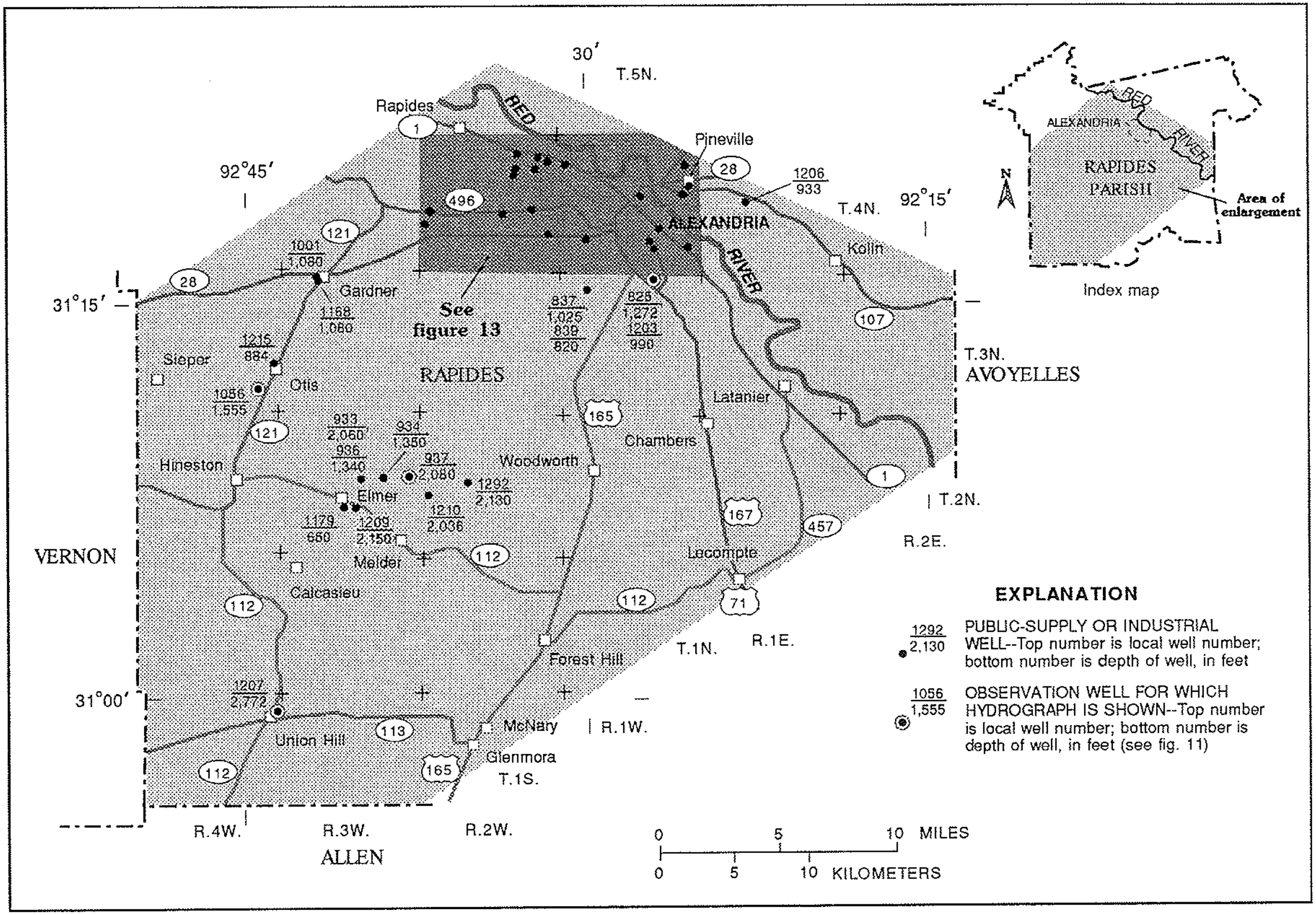

Figure 12. Location of public-supply, industrial, and observation wells completed in the Carnahan Bayou aquifer in the study area.

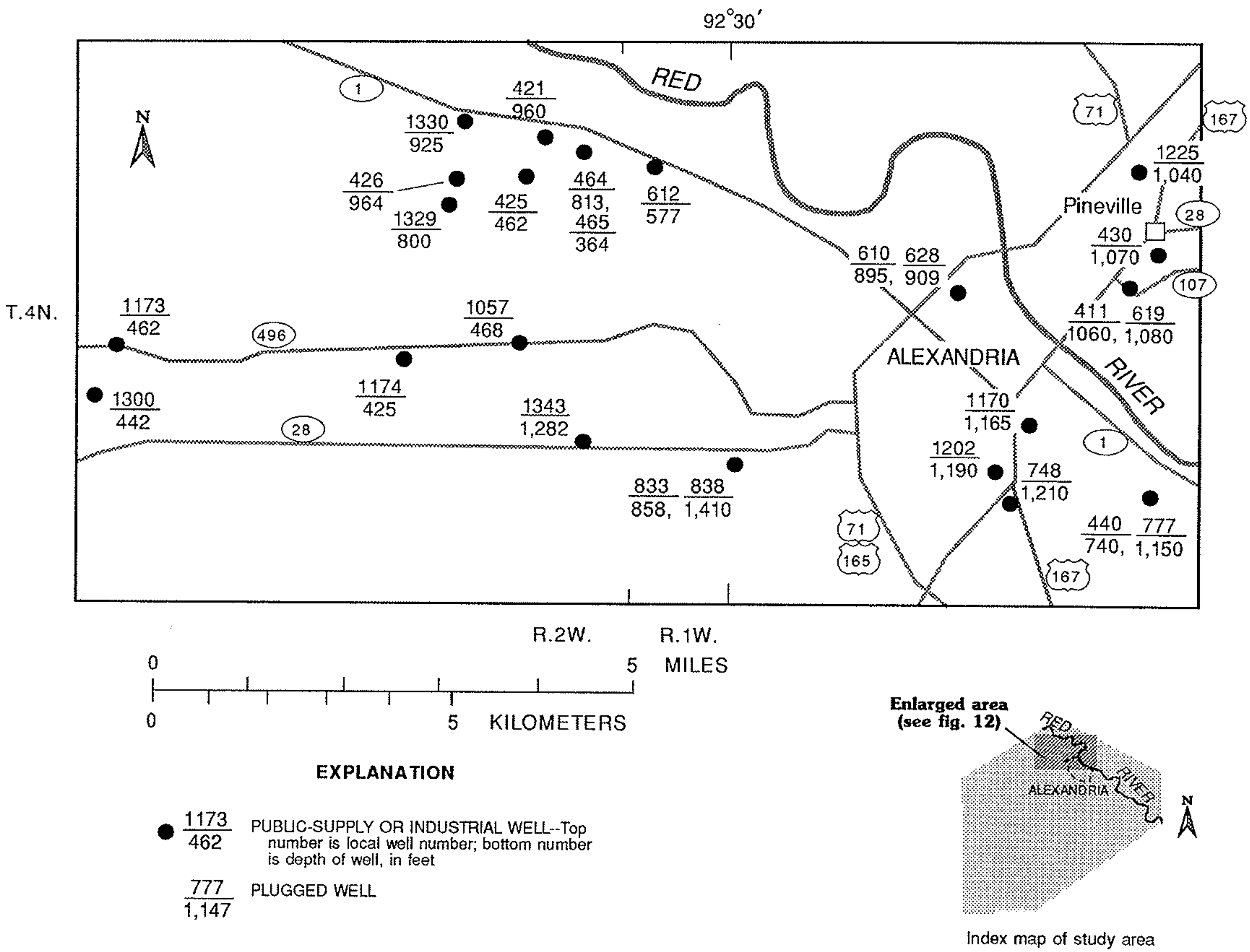

Figure 13. Location of public-supply or industrial wells completed in the Carnahan Bayou aquifer in the study area (see shaded area in fig. 12).

Downtown-McNutt Well Field

The 24 wells in the downtown-McNutt well field range in depth from 344 to 1,410 ft below land surface (appendix, table 2). Four of these wells are completed in the Williamson Creek aquifer, and 20 wells are completed in the Carnahan Bayou aquifer. Of the 24 wells, 18 were drilled before 1970. Four wells were installed after 1980 to replace older wells.

The yield of water from wells in the downtown-McNutt well field ranged from 80 to 500 gal/min in 1990 (appendix, table 2). The combined capacity of the four replacement wells is about 0.8 Mgal/d more than the highest reported capacity of the wells replaced.

In December 1990, five wells were out of service for repair or replacement. Four of these wells were completed in the Carnahan Bayou aquifer and the fifth was completed in the Williamson Creek aquifer. The combined capacity of the 19 wells in service was 8.3 Mgal/d.

Kisatchie Well Field

Wells in the Kisatchie well field range in depth from 90 to 2,150 ft below land surface (appendix, table 2). Of the 38 wells, 24 are completed in the upland terrace aquifer, 3 in the Evangeline aquifer, 1 in the Castor Creek confining unit, 3 in the Williamson Creek aquifer, and 7 in the Carnahan Bayou aquifer. Thirty-five wells were drilled between 1966 and 1968 (appendix, table 2).

The yield of water from wells in the Kisatchie well field ranged from 170 to 1,000 gal/min in 1990. The higher yields were from wells completed in the Carnahan Bayou aquifer, whereas the lower yields were from wells completed in the upland terrace aquifer. The yield and specific capacity have decreased in most of the wells completed in the upland terrace aquifer because of deterioration or incrustation of the well screens. In 1967, the yield from well R-910 was 500 gal/min, and the specific capacity was 38.7 [(gal/min)/ft]; in 1990, the yield was 170 gal/min, and the specific capacity was 9.9 [(gal/min)/ft] (appendix, table 2).

In December 1990, 11 wells were out of service for repair; 7 of these wells are screened in the upland terrace aquifer, 3 in the Evangeline aquifer, and 1 in the Castor Creek confining unit. The combined pumping capacity of wells in service was 19.3 Mgal/d.

Potential for Further Development

The potential exists for further development of ground-water sources in the study area. Locations and magnitudes of further development should take into account water-quality characteristics, thickness and extent of transmissive zones in the aquifers, and long-term response of the aquifers.

The Red River alluvial aquifer is a potential source of substantial volumes of water because it has a high transmissivity and storage coefficient, and is relatively undeveloped. However, treatment generally is needed to improve water quality for many water-supply uses. Additional information concerning water quality, hydraulic properties and possible effects of pumping would be useful if future large-scale development of the aquifer were to be considered.

Deeper aquifers throughout the study area may have potential for additional development. For example, in the southern part of the study area, the base of freshwater generally is greater than 2,000 ft below sea level (fig. 6). Wells in this area could be completed in as many as four aquifers: the Chicot, the Evangeline, the Williamson Creek, and the Carnahan Bayou. If the productivity of the aquifers in this area is comparable to that in the Kisatchie well-field area, water-supply potential would be considerable. However, water-level declines have resulted in areas of past intensive pumping from these aquifers.

Estimation of well yields in a particular location depends on sufficient site information. This information would include driller's and geophysical logs to determine depth to sands, sand thicknesses, and some water-quality characteristics. Other information, such as aquifer-test analyses, also would be needed to determine hydraulic properties of the aquifer at specific locations. Figure 14 is an example of how to use some of the hydraulic properties determined from aquifer-test analyses to estimate drawdown of water levels in an aquifer. This information could then be used to effectively locate wells and better manage the ground-water resources in the study area. A quantitative evaluation of long-term response of aquifer water levels would require a ground-water-flow model analysis.

SURFACE-WATER RESOURCES

Surface-water resources are an alternative to ground water for water supply, but are not greatly developed in Rapides Parish, except Bayous Rapides, Boeuf, and Roberts where water is withdrawn for agricultural irrigation. The streamflow in these bayous is maintained by ground-water discharge from the Red River alluvial aquifer and outflows from Kincaid and Indian Creek Reservoirs (fig. 2). Kincaid Reservoir and Indian Creek Reservoir are potential surface-water sources. Another potential source of surface water is the Red River.

Treatment of surface water can be more complex and expensive than treatment of ground water because surface water may require extensive filtration and treatment due to the presence of suspended matter, fecal bacteria, and chemical contamination. The type and extent of treatment may vary seasonally.

Kincaid Reservoir and Indian Creek Reservoir

Kincaid Reservoir is located west of Alexandria, and Indian Creek Reservoir is located south of the city (fig. 2). Kincaid Reservoir has a surface area of 1,920 acres and a storage capacity of 25,000 acre-ft (U.S. Soil Conservation Service, 1965). The gates on the reservoir are designed to automatically release 15 ft^3/s of water that is used for agricultural purposes (U.S. Soil Conservation Service, 1965, p. 12).

Indian Creek Reservoir has a surface area of 2,300 acres and a storage capacity of 24,500 acre-ft at a pool stage equal to the elevation of the spillway (86.5 ft above sea level). The storage capacity of the top 1 ft of the reservoir at elevation 86.5 ft is more than 2,000 acre-ft (Louisiana Department of Transportation and Development records). The gates on the reservoir are designed to automatically release 10 ft^3/s of water that is used for agricultural purposes (U.S. Soil Conservation Service, 1965, p. 12).

Several million gallons per day of water possibly could be withdrawn from either reservoir. However, sustained yields of the reservoirs are unknown. Water collected from Kincaid Reservoir and Indian Creek Reservoir on December 17, 1990, typically was soft, slightly acidic, and as indicated by specific conductance, contained low concentrations of dissolved solids (appendix, table 4). The principal treatment of the water would be to remove bacteria.

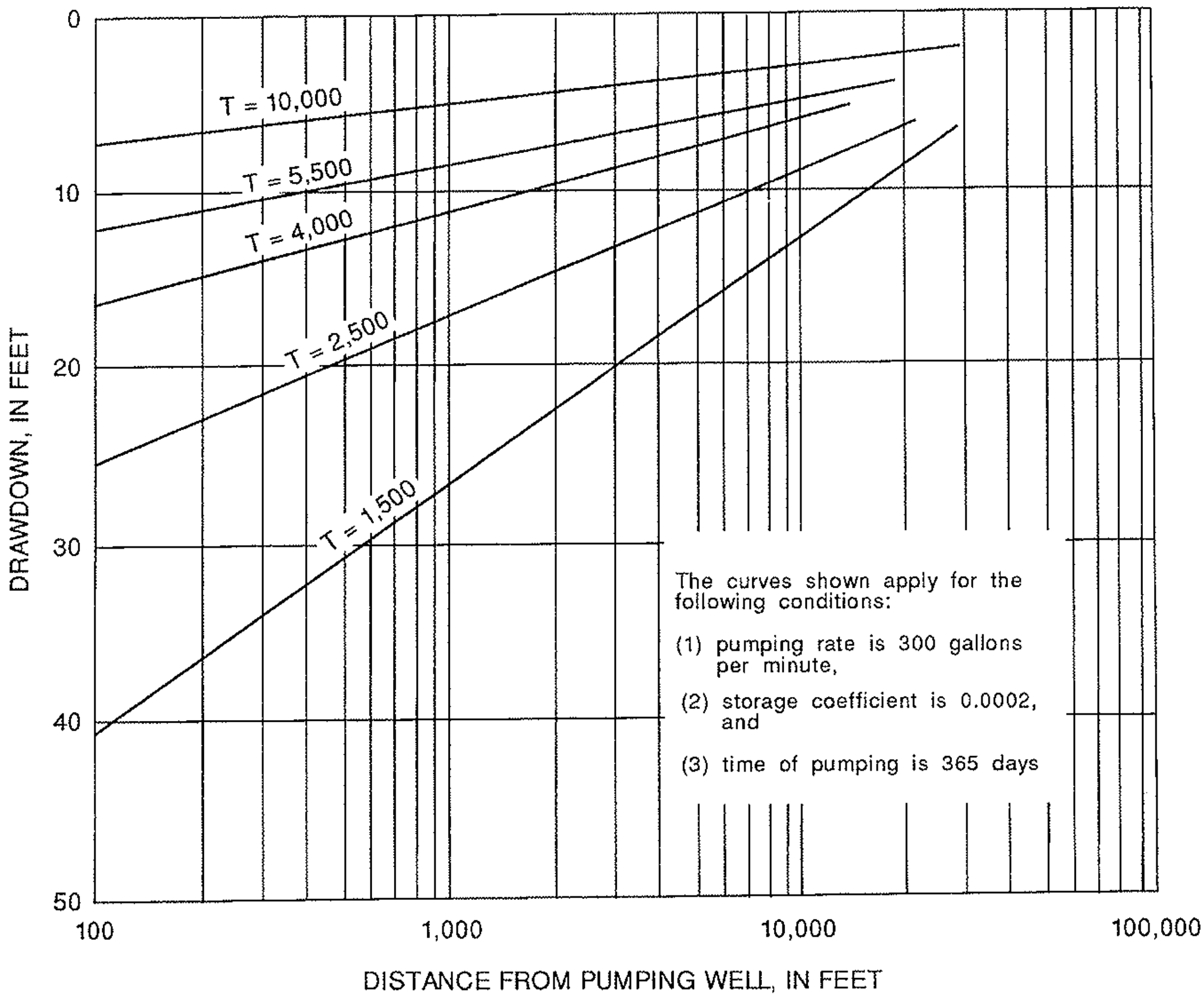

Figure 14. Theoretical drawdown of water levels in an aquifer under confined conditions based on the Theis (1935) equation.

Red River

The average annual flow in the Red River at Alexandria, during 1975-90, was 33,109 ft^3/s (Henry Noble, U.S. Army Corps of Engineers, Vicksburg District, oral commun., 1997), which is an indication of the river's potential for water supply. The water needs of Alexandria in 1990 were about 36 ft^3/s of water (23.2 Mgal/d), a small fraction of the river's flow.

Water from the Red River near Alexandria would have to be treated to remove suspended sediment and decrease hardness for use as a public supply. Less extensive treatment than that required for public supply might make the water usable for some industrial uses. Data for monthly water-quality samples collected during 1990 from the Red River at Alexandria are listed in the appendix, table 4. The concentration of suspended sediment in the water during periods of high flow can be more than 1,000 mg/L (appendix, table 4). During periods of low flow the hardness exceeds 250 mg/L. Also, taste and odor of the water could be affected by seasonal variation of the water quality.

SUMMARY AND CONCLUSIONS

In 1990, the City of Alexandria, Louisiana, pumped an average of 23.2 million gallons per day of water from wells completed in aquifers consisting of unconsolidated sedimentary deposits ranging in age from Pleistocene to Miocene. More than 80 percent of the water pumped by the City of Alexandria is from wells completed in the upland terrace and Carnahan Bayou aquifers. The wells are located within three public-supply well fields in and near Alexandria: downtown (Alexandria), McNutt, and Kisatchie. The downtown-McNutt well field consists of 24 wells, completed in either the Williamson Creek aquifer or Carnahan Bayou aquifer, that range in depth from 344 to 1,410 feet below land surface. The Kisatchie well field consists of 38 wells, completed in the upland terrace aquifer, Evangeline aquifer, Castor Creek confining unit, Williamson Creek aquifer, and the Carnahan Bayou aquifer. These wells range in depth from 90 to 2,150 feet below land surface.

The Red River alluvial aquifer is a potential source of substantial volumes of water in Rapides Parish. However, treatment generally is needed to improve water quality for many water-supply uses.

Deeper aquifers throughout the study area may have potential for additional development. For example, in the southern part of the study area, the base of freshwater generally is greater than 2,000 feet below sea level. Wells in this area could be completed in the Chicot, Evangeline, Williamson Creek, and Carnahan Bayou aquifers. A considerable volume of water could be pumped from these aquifers if the productivity is comparable to that in the Kisatchie well field. However, water-level declines have resulted in areas of past intensive pumping from these aquifers.

In addition to surface-water use from Bayous Rapides, Boeuf, and Roberts, water could be withdrawn from several other sources: Kincaid and Indian Creek Reservoirs and the Red River. Several million gallons per day of water probably could be withdrawn from either reservoir. However, sustained yields of the reservoirs are unknown. The average annual flow in the Red River at Alexandria, during 1975-90, was 33,109 cubic feet per second, which is an indication of the river's potential for water supply.

Water from these surface-water bodies, however, would require some type of treatment to improve water quality for many water-supply uses. Treatment of water from either reservoir would be needed to remove bacteria. Water withdrawn from the Red River for water-supply use would require treatment to remove suspended sediment, decrease hardness, and improve taste and odor.

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APPENDIX

(TABLES 1-4)

Table 1. Properties and constituents in water from selected wells in Rapides Parish, Louisiana

[Analyses by U.S. Geological Survey; µS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; <, actual value determined to be less than value shown; --, no data]

Local well no.	Section, township, and range	Depth of well (feet below land surface)	Date	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (deg C)	Color (platinum cobalt units)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)
					Red River alluvial aquifer							
R-721	Sec. 18, T. 3 N., R. 1 W.	95	4-17-89	1,090	7.3	--	5	480	110	50	31	1.3
R-722	Sec. 50, T. 4 N., R. 1 W.	85	4-26-89	1,340	7.0	21.0	10	650	160	62	50	1.6
R-723	Sec. 7, T. 4 N., R. 1 W.	73	4-20-89	1,130	6.8	22.5	5	510	100	61	52	1.6
R-1103	Sec. 13, T. 4 N., R. 2 W.	88	6-13-90	--	6.7	22.0	5	580	140	60	87	2.4
					Upland terrace aquifer							
R-910	Sec. 14, T. 2 N., R. 3 W.	142	8- 1-88	80	6.2	20.5	0	26	7.0	2.0	8.9	1.2
R-927	Sec. 29, T. 2 N., R. 2 W.	122	7-29-83	46	6.2	19.5	5	10	2.5	.83	5.4	1.1
R-1208	Sec. 1, T. 1 N., R. 4 W.	117	10-26-81	54	--	--	0	10	1.9	1.3	8.0	1.3
					Evangeline aquifer							
R-903	Sec. 27, T. 2 N., R. 3 W.	277	2-26-69	343	7.9	21.0	5	140	48	5.9	20	2.4
R-926	Sec. 31, T. 2 N., R. 2 W.	344	8- 2-84	328	7.8	22.5	2	61	19	3.4	50	2.0
					Williamson Creek aquifer							
R-932	Sec. 22, T. 2 N., R. 2W.	466	3-26-90	471	7.5	--	0	18	6.0	.80	100	1.6
R-939	Sec. 15, T. 2 N., R. 2 W.	482	7-29-83	454	7.8	22.0	15	19	6.3	.80	92	1.5
					Carnahan Bayou aquifer							
R-421	Sec. 28, T. 4 N., R. 2 W.	960	7-28-83	--	7.2	26.0	15	2	.71	.03	100	1.7
R-465	Sec. 31, T. 4 N., R. 2 W.	364	7-28-83	1,040	7.2	20.5	17	12	4.3	.33	250	2.9
R-933	Sec. 15, T. 2 N., R. 2 W.	2,056	8- 2-84	454	8.2	33.0	3	1	.27	.10	110	1.0
R-936	Sec. 15, T. 2 N., R. 2 W.	1,336	7-29-83	679	7.9	30.0	15	4	1.3	.13	170	1.7
R-1207	Sec. 1, T. 1 N., R. 4 W.	2,772	12- 1-81	710	8.9	--	0	4	1.1	.30	160	1.9
R-1210	Sec. 19, T. 2 N., R. 2 W.	2,036	8-19-88	816	8.1	37.0	0	4	1.3	.10	200	2.0

Table 1. Properties and constituents in water from selected wells in Rapides Parish, Louisiana—Continued

Local well no.	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 deg C, dissolved (mg/L)	Nitrogen, nitrite, dissolved (mg/L as N)	Nitrogen, NO_2+NO_3, dissolved (mg/L as N)	Iron, dissolved (mg/L)	Manganese, dissolved (mg/L)
Red River alluvial aquifer										
R-721	522	3.9	60	0.5	21	558	<0.01	<0.02	6.5	0.074
R-722	709	.20	34	.5	19	644	<.01	<.02	25	.094
R-723	500	76	52	.4	29	683	<.01	<.02	.67	1.8
R-1103	703	69	85	.4	29	--	<.01	<.02	6.4	1.1
Upland terrace aquifer										
R-910	32	6.8	5.7	<.2	41	72	<.01	.15	<.010	<.010
R-927	20	.80	3.1	<.1	37	64	--	<.10	<.003	.83
R-1208	20	2,000	4.1	.0	38	71	--	--	<.010	.020
Evangeline aquifer										
R-903	176	6.2	3.8	.1	25	210	--	--	.010	.10
R-926	165	9.4	4.0	.4	17	204	--	--	.023	.012
Williamson Creek aquifer										
R-932	236	.40	14	1.1	17	289	<.01	.02	.030	.048
R-939	237	.90	11	.9	18	283	--	<.10	.004	.005
Carnahan Bayou aquifer										
R-421	222	.70	11	1.2	44	293	--	<.10	.010	.004
R-465	516	1.5	33	.5	42	636	--	<.10	.010	.009
R-933	226	10	14	1.	54	325	--	--	.020	<.010
R-936	370	2.8	12	1.1	49	454	--	<.10	.030	.003
R-1207	326	11	8.0	.8	57	440	--	--	.010	<.010
R-1210	300	--	76	1.3	60	502	<.01	<.02	.020	<.010

Table 2. Description, yield, and specific-capacity information for public-supply wells in Alexandria, Louisiana

[UPTC, upland terrace aquifer; EV, Evangeline aquifer; CK, Castor Creek confining unit; WC, Williamson Creek aquifer; CB, Carnahan Bayou aquifer; gal/min, gallons per minute; [(gal/min)/ft], gallons per minute per foot of drawdown; --, no data; >, greater than]

Local well no.	Location	Section, township, and range	Hydro-geologic unit	Depth of well (feet below land surface)	Well (year drilled)	Yield, original (gal/min)	Yield, 1990 (gal/min)	Specific capacity, original [(gal/min)/ft]	Specific capacity, 1990 [(gal/min)/ft]	Remarks
Downtown-McNutt well field area										
R-421	McNutt 2	Sec. 28, T. 4 N., R. 2 W.	CB	960	1943	420	[1]150	8.1	--	Out of service.
R-425	McNutt 4	Sec. 28, T. 4 N., R. 2 W.	CB	462	1942	360	223	4.4	--	
R-426	McNutt 3	Sec. 22, T. 4 N., R. 2 W.	CB	964	1943	320	310	2.4	--	
R-440	Broadway	Sec. 5, T. 4 N., R. 1 W.	CB	740	1961	350	--	9	--	Plugged and replaced.
R-464	U.S. Highway 1	Sec. 31, T. 4 N., R. 2 W.	CB	813	1952	290	300	16.1	--	
R-465	U.S. Highway 1	Sec. 31, T. 4 N., R. 2 W.	CB	366	1952	307	210	9.3	5.1	
R-610	Power plant	Sec. 10, T. 4 N., R. 1 W.	CB	895	1956	320	[1]300	8.0	--	Out of service.
R-612	Walnut Grove	Sec. 76, T. 4 N., R. 1 W.	CB	577	1956	302	220	14.5	--	
R-748	Lee and Masonic	Sec. 7, T. 4 N., R. 1 W.	CB	1,210	1959	709	500	18.1	--	
R-754	Lee and Masonic	Sec. 7, T. 4 N., R. 1 W.	WC	346	1959	335	[1]240	5.1	--	Plugged; will be replaced.
R-777	Broadway	Sec. 5, T. 4 N., R. 1 W.	CB	1,147	1962	425	[1]250	8	--	Plugged and replaced.
R-823	Sterkx	Sec. 47, T. 3 N., R. 1 W.	WC	432	1963	350	200	10.5	--	
R-825	Sterkx	Sec. 47, T. 3 N., R. 1 W.	CB	1,270	1963	250	80	>4	--	
R-833	Bayou Roberts	Sec. 10, T. 3 N., R. 1 W.	CB	858	1964	476	210	5.9	3.2	
R-837	Armory	Sec. 27, T. 4 N., R. 1 W.	CB	1,025	1964	584	130	7.8	--	
R-838	Bayou Roberts	Sec. 10, T. 3 N., R. 1 W.	CB	1,410	1965	575	490	9.9	5.0	
R-839	Armory	Sec. 27, T. 4 N., R. 1 W.	CB	820	1965	325	260	2.4	2.9	
R-875	Betty	Sec. 45, T. 3 N., R. 1 W.	WC	504	1967	393	250	8.5	--	
R-1202	Beech	Sec. 7, T. 4 N., R. 1 W.	CB	1,190	1982	500	500	10.6	--	Replaces well R-441B.
R-1203	Sterkx	Sec. 47, T. 3 N., R. 1 W.	CB	990	1982	500	500	5.7	--	Replaces well R-827.
R-1329	McNutt	Sec. 23, T. 4 N., R. 2 W.	CB	800	1989	300	300	5.8	--	Replaces well R-821.
R-1330	McNutt	Sec. 22, T. 4 N., R. 2 W.	CB	925	1989	400	400	5.7	--	Replaces well R-424.
R-1343	U.S. Highway 28	Sec. 54, T. 4 N., R. 2 W.	CB	1,282	1990	500	500	3.7	3.7	
R-1356	U.S. Highway 28	Sec. 54, T. 4 N., R. 2 W.	WC	380	1990	200	200	3.5	3.5	

Table 2. Description, yield, and specific-capacity information for public-supply wells in Alexandria, Louisiana—Continued

Local well no.	Location	Section, township, and range	Hydro-geologic unit	Depth of well (feet below land surface)	Well (year drilled)	Yield, original (gal/min)	Yield, 1990 (gal/min)	Specific capacity, original [(gal/min)/ft]	Specific capacity, 1990 [(gal/min)/ft]	Remarks
				Kisatchie well field area						
R-901	Kisatchie Forest	Sec. 32, T. 2 N., R. 2 W.	UPTC	119	1966	500	[1]300	17.9	--	Out of service.
R-902	Kisatchie Forest	Sec. 24, T. 2 N., R. 3 W.	UPTC	109	1966	450	[1]250	24.2	--	Out of service.
R-903	Kisatchie Forest	Sec. 27, T. 2 N., R. 3 W.	EV	277	1966	430	[1]200	4.8	--	Out of service.
R-905	Kisatchie Forest	Sec. 19, T. 2 N., R. 2 W.	UPTC	134	1967	500	400	21.8	22.3	
R-906	Kisatchie Forest	Sec. 19, T. 2 N., R. 2 W.	UPTC	135	1967	500	[1]400	38.6	--	Out of service.
R-907	Kisatchie Forest	Sec. 19, T. 2 N., R. 2 W.	UPTC	117	1967	500	540	36.3	19.1	
R-908	Kisatchie Forest	Sec. 13, T. 2 N., R. 3 W.	UPTC	138	1967	503	[1]350	28.4	--	Out of service.
R-909	Kisatchie Forest	Sec. 13, T. 2 N., R. 3 W.	UPTC	127	1967	500	400	19.6	21.6	
R-910	Kisatchie Forest	Sec. 14, T. 2 N., R. 3 W.	UPTC	142	1967	500	170	38.7	9.9	
R-911	Kisatchie Forest	Sec. 14, T. 2 N., R. 2 W.	UPTC	120	1967	500	200	19.3	7.8	
R-913	Kisatchie Forest	Sec. 15, T. 2 N., R. 2 W.	UPTC	133	1967	500	220	14.5	7.9	
R-914	Kisatchie Forest	Sec. 15, T. 2 N., R. 2 W.	UPTC	96	1967	500	350	17.7	7.2	
R-915	Kisatchie Forest	Sec. 22, T. 2 N., R. 2 W.	UPTC	90	1967	500	350	15.1	14.0	
R-916	Kisatchie Forest	Sec. 22, T. 2 N., R. 2 W.	UPTC	116	1967	500	410	20.9	12.2	
R-917	Kisatchie Forest	Sec. 27, T. 2 N., R. 2 W.	UPTC	112	1967	350	170	14.7	6.8	
R-918	Kisatchie Forest	Sec. 26, T. 2 N., R. 2 W.	UPTC	98	1967	490	[1]400	16.8	--	Out of service.
R-919	Kisatchie Forest	Sec. 26, T. 2 N., R. 2 W.	UPTC	123	1967	305	180	10.8	8.1	
R-920	Kisatchie Forest	Sec. 25, T. 2 N., R. 2 W.	UPTC	136	1967	500	450	20.0	16.1	
R-921	Kisatchie Forest	Sec. 24, T. 2 N., R. 2 W.	WC	558	1967	650	490	24.1	--	
R-922	Kisatchie Forest	Sec. 25, T. 2 N., R. 2 W.	UPTC	140	1967	700	520	35.0	11.4	
R-923	Kisatchie Forest	Sec. 30, T. 2 N., R. 2 W.	UPTC	122	1967	500	[1]420	23.2	--	Out of service.
R-924	Kisatchie Forest	Sec. 30, T. 2 N., R. 2 W.	UPTC	129	1967	500	300	29.9	14.6	
R-925	Kisatchie Forest	Sec. 31, T. 2 N., R. 2 W.	UPTC	186	1967	750	350	23.9	--	
R-926	Kisatchie Forest	Sec. 31, T. 2 N., R. 2 W.	EV	344	1967	503	[1]300	5.6	--	Out of service.

Table 2. Description, yield, and specific-capacity information for public-supply wells in Alexandria, Louisiana—Continued

Local well no.	Location	Section, township, and range	Hydro-geologic unit	Depth of well (feet below land surface)	Well (year drilled)	Yield, original (gal/min)	Yield, 1990 (gal/min)	Specific capacity, original [(gal/min)/ft]	Specific capacity, 1990 [(gal/min)/ft]	Remarks
				Kisatchie well field area—continued						
R-927	Kisatchie Forest	Sec. 29, T. 2 N., R. 2 W.	UPTC	122	1967	500	420	29.3	30.6	
R-928	Kisatchie Forest	Sec. 30, T. 2 N., R. 2 W.	UPTC	174	1967	750	530	42.4	39.6	
R-929	Kisatchie Forest	Sec. 20, T. 2 N., R. 2 W.	UPTC	164	1967	500	450	28.5	--	Out of service.
R-930	Kisatchie Forest	Sec. 32, T. 2 N., R. 2 W.	EV	225	1967	550	[1]350	17.4	--	Out of service.
R-932	Kisatchie Forest	Sec. 22, T. 2 N., R. 2 W.	WC	466	1967	750	580	17.3	--	
R-933	Kisatchie Forest	Sec. 15, T. 2 N., R. 2 W.	CB	2,060	1967	1,000	650	23.2	--	
R-934	Kisatchie Forest	Sec. 14, T. 2 N., R. 2 W.	CB	1,350	1967	1,000	650	18.1	--	
R-936	Kisatchie Forest	Sec. 15, T. 2 N., R. 2 W.	CB	1,340	1967	1,000	[1]600	11.3	--	
R-937	Kisatchie Forest	Sec. 13, T. 2 N., R. 2 W.	CB	2,080	1968	1,000	700	28.4	--	
R-938	Kisatchie Forest	Sec. 26, T. 2 N., R. 2 W.	CK	299	1968	425	[1]390	5.2	--	Out of service.
R-939	Kisatchie Forest	Sec. 15, T. 2 N., R. 2 W.	WC	482	1968	602	630	15.3	--	
R-1209	Kisatchie Forest	Sec. 27, T. 2 N., R. 2 W.	CB	2,150	1986	--	1,000	--	14.7	
R-1210	Kisatchie Forest	Sec. 19, T. 2 N., R. 2 W.	CB	2,040	1982	1,000	800	23.0	19.4	
R-1292	Kisatchie Forest	Sec. 16, T. 2 N., R. 2 W.	CB	2,130	1985	1,000	900	--	10.2	

[1] Well out of service and yield listed is last recorded.
[2] Owner's well number is R-912.

Table 3. Description of plugged and abandoned wells in Alexandria area, Louisiana

[Aquifer: WC, Williamson Creek; CB, Carnahan Bayou; CT, Catahoula; gal/min, gallons per minute; [(gal/min)/ft], gallons per minute per foot of drawdown; D, drillers'; E, electric; --, no data; >, greater than]

Local well no.	Location	Section, township, and range	Aquifer	Depth of well (feet below land surface)	Well (year drilled)	Yield, original (gal/min)	Specific capacity, original [(gal/min)/ft]	Sand intervals, containing freshwater[1] (feet below land surface)	Type of log	Remarks
R-1	St. Ann St. and levee	Sec. 9, T. 4 N., R. 1 W.	CB	1,140	1938	--	--	--	--	
R-2	4th and St. Ann Sts.	Sec. 9, T. 4 N., R. 1 W.	CB	1,090	1938	500	--	675-719	D	
R-3	4th and Monroe Sts.	Sec. 9, T. 4 N., R. 1 W.	CB	575	1938	--	--	--	--	
R-7	Water plant	Sec. 9, T. 4 N., R. 1 W.	CB	1,070	1935	400	3	1,032-1,074	D	Top of log at 675 feet.
R-8	5th and Monroe Sts.	Sec. 9, T. 4 N., R. 1 W.	CB	650	1938	--	--	--	--	
R-9	Monroe St. and levee	Sec. 9, T. 4 N., R. 1 W.	CB	743	1938	--	--	--	--	
R-10	Old power plant	Sec. 10, T. 4 N., R. 1 W.	CT	1,660	1937	--	--	308-328; 678-724; 880-908	D	Saltwater at 1,660 feet.
R-11	4th and Oak Sts.	Sec. 10, T. 4 N., R. 1 W.	CB	722	1937	420	8	308-328; 675-722	D	
R-12	Upper 3rd St.	Sec. 10, T. 4 N., R. 1 W.	CB	722	1938	473	9.3	678-722	D	
R-13	Monroe St.	Sec. 35, T. 4 N., R. 1 W.	CB	1,230	1938	--	--	--	--	
R-14	City Park	Sec. 42, T. 4 N., R. 1 W.	WC	345	1938	--	--	60-95; 304-345	D	
R-15	City Park	Sec. 7, T. 4 N., R. 1 W.	CB	1,200	1935	--	--	306-352; 1,157-1,205	D	
R-16	City Park	Sec. 7, T. 4 N., R. 1 W.	CB	1,210	1935	--	--	70-95; 240-300; 440-490; 500-530; 816-876; 1,110-1,130; 1,169-1,213	D	
R-17	Lee and Masonic Sts.	Sec. 42, T. 4 N., R. 1 W.	CB	1,190	1930	326	--	30-103; 300-345	D	
R-18	Lee and Masonic Sts.	Sec. 7, T. 4 N., R. 1 W.	WC	406	1930	--	--	--	--	Observation well.
R-20	City Park	Sec. 42, T. 4 N., R. 1 W.	WC	390	1921	--	--	24-85; 360-400	D	--
R-21	4th and St. James Sts.	Sec. 7, T. 4 N., R. 1 W.	CB	590	1890	--	--	--	--	--
R-404	Bolton and Rapides Sts.	Sec. 38, T. 4 N., R. 1 W.	WC	253	1941	300	--	--	--	Pumped sand.
R-405	9th and Madison Sts.	Sec. 9, T. 4 N., R. 1 W.	CB	1,100	1941	--	--	230-250; 545-575; 692-719; 1,037-1,103	D	
R-406	9th and Madison Sts.	Sec. 9, T. 4 N., R. 1 W.	CB	580	1941	--	--	550-582	D	Replaced by well R-607.
R-408	4th and Casson Sts.	Sec. 7, T. 4 N., R. 1 W.	WC	311	1941	--	--	40-91; 265-310	D	
R-409	4th and Casson Sts.	Sec. 7, T. 4 N., R. 1 W.	CB	780	1941	--	--	40-91; 265-310; 720-780; 910-1,027	D	

Table 3. Description of plugged and abandoned wells in Alexandria area, Louisiana—Continued

Local well no.	Location	Section, township, and range	Aquifer	Depth of well (feet below land surface)	Well (year drilled)	Yield, original (gal/min)	Specific capacity, original [(gal/min)/ft]	Sand intervals, containing freshwater[1] (feet below land surface)	Type of log	Remarks
R-410	Bolton and Rapides Sts.	Sec. 38, T. 4 N., R. 1 W.	CB	1,160	1942	--	--	--	--	
R-422	McNutt well field	Sec. 35, T. 4 N., R. 2 W.	CB	444	1942	340	4.4	40-120; 335-395; 410-440; 455-490	E	
R-423	McNutt well field	Sec. 23, T. 4 N., R. 2 W.	CB	994	1943	260	1.5	--	--	Replaced by well R-821.
R-424	McNutt well field	Sec. 22, T. 4 N., R. 2 W.	CB	930	1943	420	8.1	208-249; 266-290; 335-355; 502-534; 770-808; 905-930	E	
R-429	McNutt well field	Sec. 35, T. 4 N., R. 2 W.	CB	924	1943	--	--	40-125; 704-725; 872-924;	E	
R-441A	Beech St.	Sec. 7, T. 4 N., R. 1 W.	CB	825	1955	230	2	--	--	Replaced by well R-441B.
R-441B	Beech St.	Sec. 7, T. 4 N., R. 1 W.	CB	1,200	1967	230	4.5	45-102; 300-335; 440-465; 800-825; 1,050-1,070; 1,160-1,195; 1,245-1,270	E	
R-607	9th and Madison Sts.	Sec. 9, T. 4 N., R. 1 W.	CB	578	1956	235	4.4	547-575	E	
R-609	Broadway Park	Sec. 5, T. 4 N., R. 1 W.	(2)	--	1956	--	--	220-255; 717-742; 835-900; 1,130-1,150	E	Test hole.
R-611	U.S. Hwy. 1	Sec. 13, T. 4 N., R. 1 W.	(2)	1,204	1956	--	--	--	E	No sands >200-foot test hole.
R-613	U.S. Hwy. 1	Sec. 33, T. 4 N., R. 2 W.	CB	817	1956	502	7.7	220-325; 760-820; 835-860	E	
R-628	3rd St. and U.S. Hwy. 71	Sec. 14, T. 4 N., R. 1 W.	CB	909	1956	302	7.6	--	--	
R-726	U.S. Hwy. 1	Sec. 81, T. 2 N., R. 1 W.	(2)	63	1956	--	--	--	E	No sands >20-foot, test hole.
R-762	Lee and Masonic Sts.	Sec. 42, T. 4 N., R. 1 W.	CB	1,300	1960	510	3.7	--	--	
R-820	MacArthur Dr.	Sec. 32, T. 4 N., R. 1 W.	WC	225	1963	85	1.3	--	E	No sands >20 feet.
R-821	McNutt well field	Sec. 23, T. 4 N., R. 2 W.	CB	784	1963	260	4.3	--	--	Replaced by well R-1329.
R-827	Sterkx Rd.	Sec. 47, T. 3 N., R. 1 W.	CB	995	1964	184	4.8	--	--	Replaced by well R-1203.
R-834	U.S. Hwy. 28	Sec. 27, T. 4 N., R. 1 W.	(2)	1,708	1964	--	--	150-170; 195-290; 320-345; 410-470; 1,035-1,072	E	Test hole.
R-935	Kisatchie well field	Sec. 27, T. 2 N., R. 3 W.	WC	968	1967	350	2.8	--	--	

[1]Water with concentrations of less than 250 milligrams per liter chloride.
[2]Test hole; may involve more than one aquifer.

Table 4. Properties and constituents in water from selected surface-water sites in Rapides Parish, Louisiana, 1990

[μS/cm, microsiemens per centimeter at 25 degrees Celsius; deg C, degrees Celsius, NTU, nepholometric turbidity units; mg/L, milligrams per liter; <, actual value determined to be less than value shown; --, no data]

Date	Stage (feet)	Specific conductance (μS/cm)	pH, field (standard units)	Temperature, water (deg C)	Turbidity (NTU)	Sediment, suspended (mg/L)	Color (platinum-cobalt units)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
Red River at Alexandria											
1-23	22.84	186	7.2	14.5	160	--	120	57	16	4.2	11
2-27	24.02	204	7.1	16.0	130	461	100	61	18	3.8	15
3-14	--	216	7.4	19.0	200	--	80	70	22	3.7	14
4-13	31.27	424	7.7	17.5	140	1,060	--	110	33	7.7	35
5-15	36.30	461	7.3	22.5	250	--	30	140	42	8.6	36
6-19	27.98	291	7.5	30.0	--	--	30	85	26	4.9	18
7-10	20.74	395	7.2	31.0	110	297	30	120	34	7.8	30
8-28	20.43	586	7.4	31.0	11	--	10	170	50	12	52
9-26	20.21	643	8.0	28.0	7.2	--	10	190	51	14	57
10-23	--	209	7.1	19.0	100	210	80	62	19	3.4	14
11- 6	20.25	383	8.1	18.0	18	--	40	120	35	8.1	28
12- 4	20.48	468	7.6	15.5	55	--	60	110	31	9.1	40
Kincaid Reservoir near Alexandria											
12-17	--	31	6.0	17	--	--	0	10	2.0	1.1	4.3
Indian Creek Reservoir near Alexandria											
12-17	--	30	6.1	17	--	--	0	10	2.4	1.0	4.1

Table 4. Properties and constituents in water from selected surface-water sites in Rapides Parish, Louisiana, 1990--continued

Date	Potassium, dissolved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 105 deg C, suspended (mg/L)	Nitrogen, nitrite, total (mg/L as N)	Nitrogen, dissolved (mg/L as N)	Nitrogen, NO_2+NO_3, dissolved (mg/L as N)	Iron, dissolved (mg/L as Fe)	Manganese, dissolved (mg/L as Mn)
Red River at Alexandria												
1-23	2.6	48	13	15	--	--	478	0.05	--	--	--	--
2-27	2.4	55	19	14	0.20	6.7	--	.11	0.03	0.25	0.11	0.006
3-14	2.3	56	22	17	--	--	707	.06	--	--	--	--
4-13	2.8	69	52	51	.20	6.2	230	.09	<.01	.20	.090	.011
5-15	6.1	114	38	58	--	--	795	.06	--	--	--	--
6-19	3.0	70	26	27	--	--	288	.03	--	--	--	--
7-10	3.0	96	33	43	.20	6.1	250	.03	<.01	.30	.015	.003
8-28	4.0	122	65	66	--	--	17	<.01	--	--	--	--
9-26	3.7	157	62	70	--	--	23	<.01	<.01	<.02	--	--
10-23	2.2	56	15	18	<.10	6.0	130	.01	.01	.20	.065	.002
11- 6	3.2	124	27	31	--	--	31	.01	--	--	--	--
12- 4	3.8	80	57	56	--	--	75	.03	--	--	--	--
Kincaid Reservoir near Alexandria												
12-17	1.2	18	<.20	3.0	<.20	11	--	--	<.01	.07	.060	<.020
Indian Creek Reservoir near Alexandria												
12-17	1.5	16	.4	2.2	<.20	6.2	--	--	<.01	.06	.040	<.020