GEOLOGICAL SURVEY CIRCULAR 287

PUBLIC AND INDUSTRIAL WATER SUPPLIES OF THE JACKSON PURCHASE REGION, KENTUCKY

Prepared in cooperation with the
Agricultural and Industrial Development Board of Kentucky

UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

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PUBLIC AND INDUSTRIAL WATER SUPPLIES OF THE JACKSON PURCHASE REGION, KENTUCKY

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ABSTRACT

This report presents information on all public and industrial water-supply installations in the Jackson Purchase region of western Kentucky pumping more than 5,000 gpd. Maps, tables, and a geolpgic cross section show the location and source of the 32 supplies inventoried, the pumpage, the chemical quality of the water, and the structure of the rock formations underlying this area. The total daily pumpage of ground water for 29 supplies is about 4,600,000 gallons; the total daily pumpage of surface water for 3 supplies is about 7,800,000 gallons.

This region, covering 8 counties and including 2,396 square miles, lies west of the Tennessee River and Kentucky Lake. Most of the area is a rolling upland surface that stands 350 to 400 feet above sea level and is bordered by the wide flood plains of the Tennessee, Ohio, and Mississippi Rivers. Near the western edge of Kentucky Lake a belt of hills is the divide between drainage to the east and that to the north and west. The natural resources of this humid region, where the forest cover has been almost entirely removed, consist of a good soil cover, clay, gravel, and sand. Most of the 150,000 people in the region are engaged in agriculture and related business. Industrial activity has increased since 1948 and is continuing to increase at a high rate.

This region is on the northeastern margin of the Mississippi embayment of the Gulf Coastal Plain. Geologically, the embayment is a southward-pitching trough floored with rocks of Paleozoic age and filled with unconsolidated sand, clay, and gravel of Mesozoic and Cenozoic age. The dip of the bedrock floor and the overlying sediments is westward in the southern part of the Jackson Purchase, southwestward in the northeastern part, and southward in the northwestern part. The bedrock surface and the younger sediments on it dip 20 to 30 feet to the mile. Limestone and chert of Mississippian age crop out as a narrow band along the eastern boundary. The unconsolidated sands, clays, and gravels, ranging in age from Late Cretaceous to Recent, form the surface over the rest of the Jackson Purchase.

Along the eastern boundary of the Jackson Purchase region, at the edge of Kentucky Lake, rocks of Mississippian age yield water for two public supplies. The Fort Payne chert yields as much as 62 gpm; the St. Louis limestone yields as much as 26 gpm. Water from these bedrock formations varies much in quality; for samples that were collected the hardness ranged from 21 to 188 ppm.

Farther west, in the central part of Marshall and Calloway Counties and in the northern part of Ballard County, sands of the Ripley formation of Late Cretaceous age yield as much as 600 gpm to wells of 1 industrial and 4 public supplies. The hardness of water samples from this formation ranged from 30 to 182 ppm, the iron from 0.42 to 6.0 ppm, and the pH from 5.5 to 7.6.

In the central and western parts of the Jackson Purchase the Holly Springs sand of Eocene age is the chief source of ground water. Seventeen of the 32 large water users in the region pump water from this aquifer. Wells having continuous yields of 1,300 and 1,400 gpm have been developed in Fulton and Graves Counties. Water obtained from this formation has a hardness ranging from 10 to 55 ppm, iron from 0.09 to 1.8 ppm, and pH from 5.5 to 7.3.

The Grenada formation, overlying the Holly Springs sand in the southwestern part of this region, yields water to wells of 2 industrial supplies. The maximum yield of these wells is about 200 gpm. An analysis of water from one of the wells showed a hardness of 68 ppm; 0.54 ppm of iron, and a pH of 5.9.

Two industrial water supplies in the Tennessee River valley and 2 public supplies in the Mississippi River valley obtain water from the alluvial deposits. Yields as much as 250 gpm have been developed. Analyses of water from 4 wells in these deposits showed a hardness of 33 to 212 ppm, 0.18 to 36 ppm of iron, and pH from 5.5 to 7.1

Water pumped from these formations is treated at two-thirds of the public and industrial installations. Treatment includes aeration to reduce the iron content at one-third of the installations, chlorination to disinfect the water at two-thirds of them, and the addition of lime to raise the pH, for corrosion control, at one-third of them. Softening is a distinct step in water treatment at only 1 public and 1 industrial installation.

The temperature of ground water is generally between 57° and 64°F.

Surface water is used by only 1 public and 2 industrial supplies in this part of the State. These installations, however, pumped 2,841,401,000 gallons in 1951, which was 60 percent more than the total amount of ground water used by 29 supplies. Of this total 1,590,801,000 gallons was pumped from the Ohio River by the Paducah public supply and 1,250,600,000 gallons was pumped from the Tennessee River by 2 industries in Calvert City, mainly for cooling purposes.

The present rapid industrial expansion in the Jackson Purchase will greatly increase the use of both ground and surface water within the next few years, but the large reserves of ground and surface water should satisfy these additional demands.

INTRODUCTION

Scope and Purpose of Report

A statewide program of ground-water investigations is being conducted by the Ground Water Branch of the United States Geological Survey in cooperation with the Agricultural and Industrial Development Board of Kentucky. This report on the public and industrial water supplies of the Jackson Purchase region (fig. 1) is 1 of a series of 5 which will describe the public and industrial water supplies of the entire State. Work is in progress in the 4 remaining regions (fig. 1): the Bluegrass, Eastern Coal Field, Mississippian Plateau, and Western Coal Field.

This report covers the Kentucky part of what is commonly known as the Jackson Purchase, a tract of land bought from the Chickasaw Indians in 1818 and divided between Kentucky and Tennessee in 1820 along parallel 36°30'. Gen. Andrew Jackson of Tennessee was the outstanding figure in the negotiations with the Indians; hence, his name commonly is associated with the area. This section of Kentucky is bounded on the east by the Tennessee River and Kentucky Lake, on the north and west by the Ohio and Mississippi Rivers, and on the south by the Tennessee line. It includes 8 counties having a total area of 2,396 square miles.

The report presents basic data on the water supplies of 17 of the cities and larger towns in the region, of 13 large industries, and of 2 State parks. In 1951 these public water supplies served a total population of 79,506, about 2.7 percent of the population of the State. Municipal or industrial water supplies of less than 5,000 gpd have not been included in this report. In addition to data on pumpage, treatment, and storage facilities at the water plants, this report includes 30 chemical analyses of the water.

It is expected that the information here compiled will be useful for the planning of future development of the local water resources. Need for this information is increasing rapidly as a result of the present high rate of industrial expansion. Additional investigations of the water-bearing characteristics of all the aquifers in the Jackson Purchase region are being made and the results of these studies will be published upon completion of the field work.

Previous Investigations

This is the first detailed study of the public and industrial water supplies of the Kentucky part of the Jackson Purchase region undertaken. R. H. Lougbridge (1888) contributed one of the earliest reports on the geology of the area. The first report primarily concerned with water resources of this region, specifically ground-water resources, was Water-Supply Paper 164 of the U. S. Geological Survey, by L. C. Glenn (1906). This publication is a reconnaissance report on the geology and ground-water resources of western Tennessee and Kentucky and southern Illinois and does not contain detailed information about public and industrial water supplies. "Ground-water resources of western Tennessee" (Wells, F. G., 1933) describes water-bearing formations in Tennessee that occur also in the Jackson Purchase region of Kentucky. A report by J. K. Roberts and Benjamin Gildersleeve (1950), mainly on the geology and mineral resources of this region, contains a brief statement on water resources. A report 1/ by the present authors, provides detailed information on a small area east of Paducah. Work is now in progress on a detailed study of the ground-water resources of the Paducah area.

Methods of Investigation and Presentation of Data

The 32 public and industrial water supplies on which data are given were visited in 1951 and 1952 by the writers, who obtained information directly from the waterworks officials. Water samples were collected and sent to the regional laboratory of the Quality of Water Branch, U. S. Geological Survey, at Columbus, Ohio, for analysis.

Two maps, 1 cross section, and 4 tables summarize the data assembled on the public and industrial water supplies. Plate 1 shows location, source, and pumpage in gallons per day of the public and industrial supplies. The quality of water from 19 public and 5 in-

1/ Pree, H. L., Jr., and Walker, W. H., 1952, Memorandum on the geology and ground-water resources of the Calvert City-Gilbertsville area, Marshall County, Ky.: U. S. Geol. Survey open-file report.

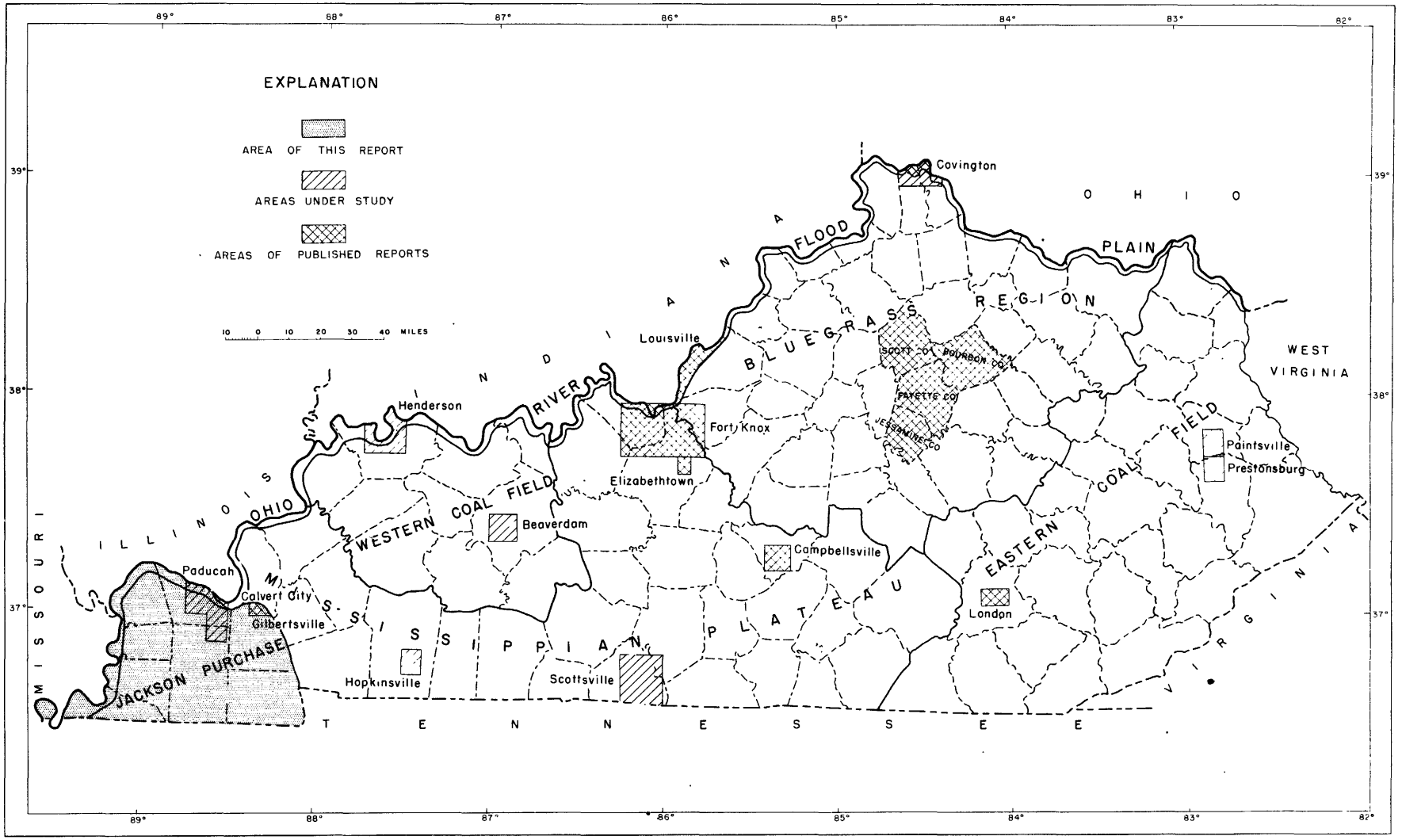

Figure 1.--Index map of Kentucky showing progress of ground-water investigations.

dustrial supplies is shown graphically in plate 2. Figure 2 is a geologic cross section across the Jackson Purchase region from southwest to northeast showing the thickness and altitude of the geologic formations. Table 1 is a generalized section of the geologic formations exposed or penetrated by wells. Table 2 shows the distribution of water from the larger public water supplies in the Jackson Purchase. Table 3 shows the cities, towns, and industries in this region served by ground water, the population served, the water-bearing formations, and the pumpage in gallons per year and gallons per day. Table 4 shows similar information for cities and industries using surface water. Tables 2, 3, and 4 and plates 1 and 2 are based on detailed data collected from officials of public and industrial water supplies which is tabulated under the heading "Descriptions and analyses."

Ground-water investigations are under the general supervision of A. N. Sayre, chief, Ground Water Branch, U. S. Geological Survey, and in Kentucky, under the direction of M. I. Rorabaugh, district engineer. This report was prepared under the supervision of E. H. Walker, geologist. All analyses, except where otherwise noted, were made at the Survey's regional laboratory at Columbus, Ohio, under the direction of W. L. Lamar, district chemist.

The water supplies described in this report are numbered to conform to the numbering system used by the Ground Water Branch throughout Kentucky. Under this system the State has been subdivided into rectangles bounded by 5-minute meridians of longitude and 5-minute parallels of latitude. Each rectangle has been assigned a number based on the longitude and latitude at its southeast corner. The well 8815-3700-1, for example, at Gilbertsville, is the first to have been enumerated in the rectangle bounded on the east by longitude 88°15' and on the south by latitude 37°00'. Surface-water supplies are designated by town names, or when out in the country, by capital letters. For example, the surface-water supply of the Pennsylvania Salt Manufacturing Co., north of Calvert City, the first to be inventoried in rectangle 8815-3700, is designated by the letter A.

Acknowledgments

Acknowledgment is made to the owners and operators of public and industrial water supplies who furnished information on their respective installations. The following organizations contributed data: Tennessee Valley Authority, Kentucky Geological Survey, and Corps of Engineers, Department of the Army. The Layne-Central Co. of Memphis, Tenn., through T. M. Ragsdale, engineer, provided information that has been valuable in the preparation of this report. Local well drillers who furnished data are W. H. Ellis, Lovelaceville; R. B. Elrod, Future City; D. P. McNeely, Farmington; and Charles Yancy, Arlington.

GEOGRAPHY

Natural Features of the Region

The surface of the Jackson Purchase includes flood plains, rolling upland, and a belt of hills. The extensive flood plains bordering the rivers and larger tributaries range in altitude from about 260 to 360 feet. Most of the area back from the streams is a low and rolling plateau that rises gradually toward the east and ranges in altitude from 350 to 400 feet. In the western part of the region steep bluffs separate the flood plain of the Mississippi from the upland surface. Immediately west of Kentucky Lake a belt of hills extends north from the Tennessee State line. These ridges, as much as 600 feet in altitude, are formed of sands and gravels of Cretaceous age.

As the map (pl. 1) shows, major rivers border the region on all but the southern side. In the easternmost part of the area short and relatively steep streams drain the hilly zone to Kentucky Lake. A strip west of the hills drains northward by way of Clarks River to the Tennessee River 4 miles east of Paducah. Most of the streams in the central part of the area are tributary to Mayfield Creek which runs northward before turning west to the Mississippi. Several shorter streams on the northern and western margins of the region run directly to the Ohio and Mississippi Rivers. Of the streams within this region only the Clarke River and Mayfield Creek have a significant amount of flow during dry seasons.

Drainage in the valleys is sluggish; all the streams have meandered widely and have left ponds and sloughs marking the positions of former channels. In the western section marshy bottom lands and cypress swamps are extensive. Drainage ditches to open the bottoms for cultivation are common; through much of its course Mayfield Creek has been thus straightened.

The climate is of the humid continental type and essentially uniform throughout the area. United States Weather Bureau data at various local stations show an average annual precipitation of 47.5 inches. The heaviest rainfall usually occurs during the spring and winter; the lightest during the autumn. Average annual temperature is 59°F. During the summer, temperatures often exceed 100°F; although the winters usually are mild, temperatures occasionally fall below zero.

The original forest on the uplands probably consisted dominantly of oak and hickory, with a variety of other hardwood species. In the lowlands sycamore and other water-loving species were common, and great cypress swamps existed along the bottom lands of the Mississippi and Ohio River valleys. This original forest cover has been almost wholly removed to make way for farm crops, but second-growth cover occupies about 20 percent of the area.

The natural resources of the Jackson Purchase region, in addition to abundant water supplies, are clay, gravel, and sand. The most important commercial clay deposits, mined chiefly in Graves County from the Wilcox group, include ball, sagger, wad, and other high-grade ceramic types; the poorer grades of clays found at many other localities are used for making brick and drain tile. The extensive gravel and sand deposits of Pliocene(?) age, which blanket most of the area, furnish material for road construction. Sand and gravel from deposits along the Ohio, Tennessee, and Mississippi Rivers are used for molding and building purposes. The results of the few tests for oil and gas in this region do not offer much encouragement, but too few wells have been drilled thus far to justify any definite conclusions.

Development

The population of this region at the time of the 1950 United States census was 150,232, or 5 percent of the population of the State. The largest cities are Paducah with a population of 37,250, Mayfield with a population of 8,990, and Murray with a population of 6,035. These figures from the 1950 census do not include the large numbers of people who have migrated into this section since the latter part of 1950 when construction began on the United States Atomic Energy Commission plant west of Paducah. Great increases in population have taken place in the rural sections within 25 miles of the site of the new plant. Recent industrial developments by several companies in the last 2 years is also stimulating immigration to this region.

The business and industrial activities normal to this region are limited chiefly to the larger urban areas and related directly to agriculture. These include processing tobacco and meat and dairy products, and milling grains for feed. Other products are bricks, pottery, clothing, flashlight batteries, stoves, and sheet-metal products. Transportation by both river and railroad also is an important source of employment.

Large-scale industrial development has taken place in the northeastern part of this region since 1948. Factors influencing this development are the cheap power from Kentucky Dam; the proximity of limestone, coal, oil, and gas in adjacent regions; the availability of good water supplies, and cheap river transportation for both raw materials and finished products. An adequate labor market and an equable climate also have contributed to the industrialization of this region.

Most of the large industrial plants which have been built since 1948 are in Calvert City, near Kentucky Dam. The first two companies to locate new plants here in 1948 were the Pennsylvania Salt Manufacturing Co., chemical manufacturers, and the Pittsburgh Metallurgical Co., Inc., ferro-alloy manufacturers. In 1951 the National Carbide Co., Division of Air Reduction Co., Inc., began construction of a plant to manufacture calcium carbide. In 1952 the B. F. Goodrich Chemical Co. started building a plant to manufacture vinyl chloride monomer, an industrial chemical. Several other chemical manufacturers also are planning to locate plants in this area.

Further industrial activity began in 1950 with the announcement of plans for construction of a gaseous-diffusion plant on the Ohio River 12 miles northwest of Paducah, for the Atomic Energy Commission. Two steam-electric generating stations, now under construction, one east of the gaseous-diffusion plant and the other across the Ohio River near Joppa, Ill., will furnish power for the plant.

Recreational activities provided by Kentucky Lake, which was first filled in 1944, are growing steadily and by any estimate are a very important part of the regional economy.

Agriculture, diversified by climate and favored by soils, is still the most important economic activity in the region, and the industrial expansion and its accompanying large increase in population are creating a continuously greater demand for farm products, especially truck crops. Corn, wheat, hay, tobacco, and some cotton are the chief field crops. Fruits, such as apples, peaches, pears, and strawberries, are another large source of farm income. In addition to the larger areas being used for truck farming, more land is being used for dairy farming and the raising of dairy and beef cattle and pigs.

The farmers of the region are contending with two difficulties: a shortage of labor and summer droughts. Farms are being mechanized in order to utilize available labor to best advantage, and interest in the possibility of irrigating crops during the dry periods is becoming more widespread. It is not unlikely that irrigation will become an important practice in this region.

GEOLOGY

Structure

The Jackson Purchase includes the northeastern margin of the Mississippi embayment of the Gulf Coastal Plain. This is a geologic province of unconsolidated formations of sand and clay, filling a bedrock trough that deepens to the south. The cross section, figure 2, shows the coastal-plain formations dipping to the southwest about 20 to 30 feet to the mile. In the northern part of the area, near the head of the embayment, the formations dip southward.

Stratigraphy

Much of the information in the following description of formations is derived from the work of earlier authors, especially Wells (1933) and Roberts and Gildersleeve (1950).

The Fort Payne chert of Mississippian age is the oldest formation here used as a source of water. It consists of cherty limestone with some shale, but at the surface it

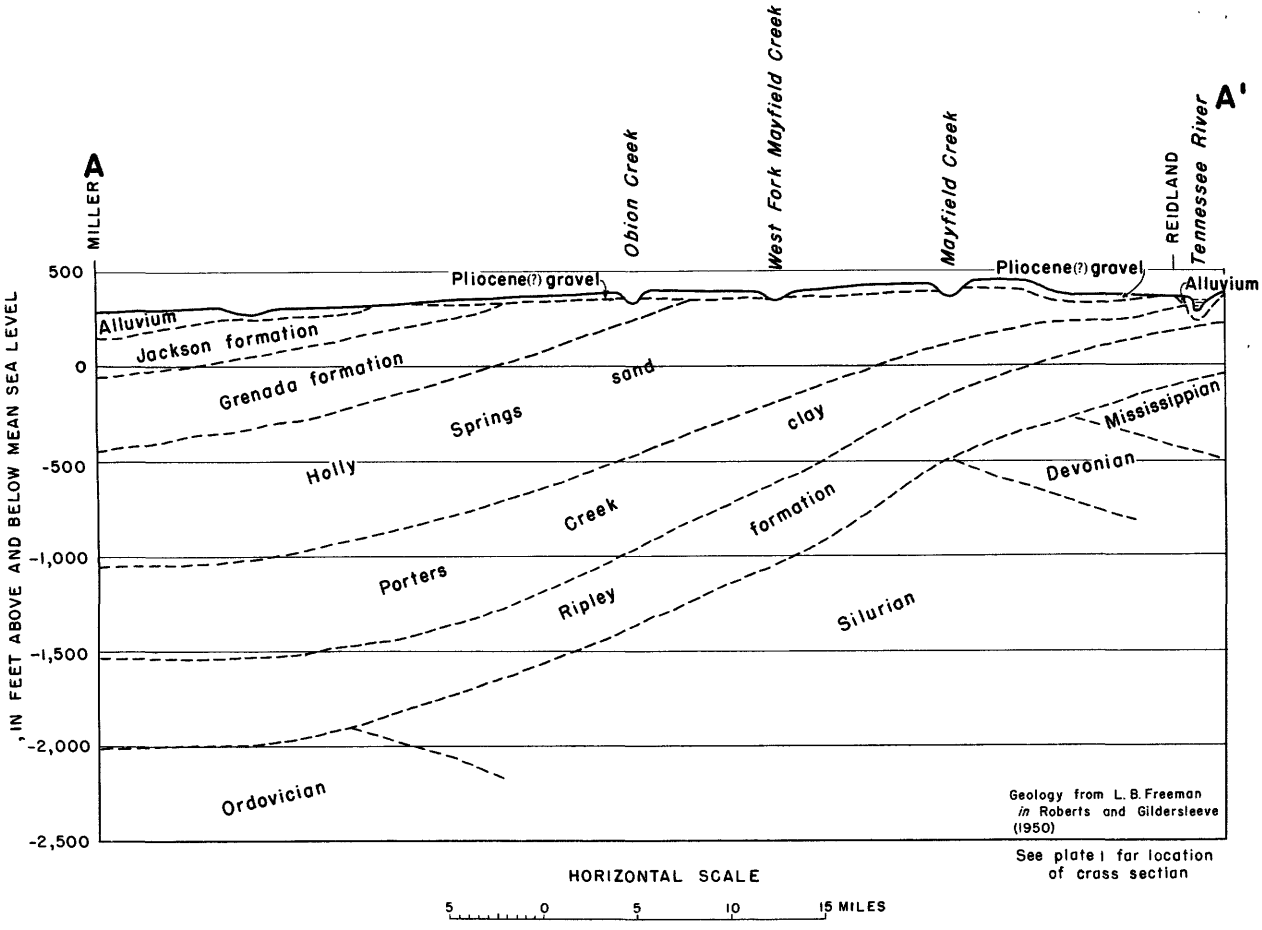

Figure 2.--Generalized geologic section southwest to northeast across the Jackson Purchase region from Miller, Fulton County, Ky., to the Tennessee River near Reidland, McCracken County, Ky.

weathers to a mass of chert fragments. The formation is known to be 200 feet thick but is exposed only at scattered localities along the western bank of Kentucky Lake. It is the source of water for the well at Kentucky Lake State Park at Aurora.

The Warsaw limestone of Mississippian age is a tan to gray crystalline limestone with some gray chert. This rock, which may attain a thickness of 100 feet in places, is exposed near Kentucky Dam along the eastern edge of Kentucky Lake. It is not the source of any water supplies in the Jackson Purchase region.

The St. Louis limestone of Mississippian age is known from drill holes to be as much as 400 feet thick. It crops out at a few places on the western bank of Kentucky Lake. The formation consists of dark-colored fine-grained limestone with much chert. At places, solution has opened up crevices in the limestone that serve to transmit and store water; many of these crevices are partly filled with gravel or sand and mud. The formation yields water to one well near Calvert City.

The Tuscaloosa (?) formation of Late Cretaceous age consists of angular chert pebbles set in a matrix of clay and sand. Recent work in the Gulf Coastal Plain has indicated that the formation described in the Jackson Purchase by Roberts and Gildersleeve (1950) may not be the equivalent and the true Tuscaloosa formation as defined by E. A. Smith and L. C. Johnson (1887) from localities in Tuscaloosa County, Ala. Therefore, in this report a question mark follows the name. The principal outcrops of the formation occur above those of the older rocks along the east side of Kentucky Lake. This formation reaches a thickness of 50 feet or more along the belt of outcrop and probably thins rapidly in a westerly direction. It is not known to yield water in this region and is unlikely to do so because of the large amount of clay.

In Tennessee the Eutaw formation, consisting of sand and clay, overlies the Tuscaloosa formation and in turn is overlain by the Selma chalk. Above the Selma is the Ripley formation. The Eutaw and Selma have not yet been clearly recognized in the Jackson Purchase region of Kentucky, and the sand and clay above the Tuscaloosa(?) formation are for the time being included in the Ripley formation. The Ripley formation of Late Cretaceous age, which crops out in the eastern part of the region, includes coarse and fine sand, much of it varicolored, and occasional lenses of clay. Many scattered beds of the sand are cemented and hard. The formation

Table 1.--Generalized section of the geologic formations exposed or penetrated in the Jackson Purchase region, Kentucky

Era	System	Series	Group	Formation	Thickness (feet)	Lithology	Water-bearing characteristics
Cenozoic	Quaternary	Recent		Alluvium	0-150	Clay, silt, sand, gravel, stream-deposited.	Yields large amounts of water to wells; water hard, with high dissolved solids, iron content.
		Pleistocene		Loess	0-40	Silt, gray to brown, occasional pebbles.	Yields little or no water.
	Tertiary	Pliocene(?)		Gravel	0-65	Gravel, well-rounded pebbles of chert set in matrix of sand, iron-stained.	Furnishes small amounts of water to farm wells.
		Eocene		Jackson formation	0-200	Clay, with sand. Sand, fine-grained, angular.	No information available; probably would yield small amounts of water.
			Wilcox	Grenada formation	0-400	Sand, fine-grained, angular; occasional lenses of clay.	Wells yield up to 200 gallons per minute. Water soft with fairly high iron content.
				Holly Springs sand	0-700	Sand, fine- to coarse-grained; occasional lenses of clay.	Most used source of ground water in region; wells yield up to 1,400 gallons per minute. Variable chemical properties.
		Paleocene	Midway	Porters Creek clay	0-500	Clay, dense, dark gray.	Impermeable; does not yield water to wells.
Mesozoic	Cretaceous	Upper Cretaceous		Ripley formation	0-500	Sand, fine- to coarse-grained; occasional lenses of clay.	Yields up to 600 gallons per minute. Hardness variable, high iron content.
				Tuscaloosa(?) formation	0-50	Gravel, angular chert, with clay matrix.	Probably will yield little or no water.
Paleozoic	Carboniferous	Mississippian	Meramec	St. Louis limestone	0-400	Limestone, fine-grained, gray to black, containing many chert nodules.	Known to yield up to 26 gallons per minute to wells.
				Warsaw limestone	0-100	Limestone, crystalline, tan to gray, with some chert.	No information available; probably would be similar to St. Louis limestone.
			Osage	Fort Payne chert	0-200	Limestone, shaly and very cherty. Weathers to loose, angular chert.	Water-bearing formation at favorable localities; one well yields 62 gallons per minute.

has been thinned by erosion in the extreme northern and eastern parts of this region, but it may be 500 feet thick at depth in the southwestern part of Fulton County. Wells yield as much as 600 gpm.

The Porters Creek clay of Paleocene age overlies the Ripley formation. It is a dense dark-gray clay containing thin streaks of sand. The outcrop of this formation lies west of the East Fork of the Clarks River, and in the northern part of the area it turns toward the west. The formation has been thinned by erosion to a feather edge near its northern and eastern edges, but it increases in thickness to at least 500 feet at depth in the southwestern part of this region, about 50 miles away. The occasional thin layers of sand within it yield small amounts of water to wells. Except for these thin layers, however, this formation does not yield water, but confines the water in the sand of the underlying Ripley formation.

The Holly Springs sand of early Eocene age, which lies above the Porters Creek clay, consists mainly of fine to coarse sand of light color, with thin beds of varicolored clay. Indurated layers occur at the contacts between clay and sand and at abrupt changes in texture of the sand. The outcrop of this formation extends over more than 85 percent of this region but is so thoroughly covered by Pliocene(?) gravel and sand that exposures are rare except in gullies, in railroad and highway cuts, and in the clay pits in the

western third of Graves County. From a feather edge in the northern and eastern parts of this region the formation thickens to about 700 feet at depth in the southwestern part of Fulton County. It yields water to wells throughout a large area, and wells producing as much as 1,400 gpm are reported.

The Grenada formation of early Eocene age includes beds of fine-grained gray sand and light-gray to white clay. It is limited to the southwestern part of the area, mainly in Hickman and Fulton Counties. From its thin northeastern edge it increases in thickness to about 400 feet in southwestern Fulton County. Moderately large supplies of good water can be pumped from this formation, to judge from the 200-gpm yield reported for one well.

The Jackson formation, also of early Eocene age, consists of light-gray clay and fine-grained light-gray sand, both of which are hard in places. The formation is best seen along the bluffs of the Mississippi River where about 40 feet of it is exposed. It is not the source of any large water supplies and little is known about the quantity or quality of water that could be pumped from it.

As shown on the cross section, figure 2, the Pliocene(?) sediments, of late Pliocene or early Pleistocene age, form a mantle of gravel and sand as much as 65 feet thick over most of this region. The pebbles, largely of chert with small amounts of quartzite and limestone, are better rounded and sorted than those of the Tuscaloosa(?) formation. Pebbles and sand grains are coated with iron oxide. The deposits are unconsolidated except where thin layers of pebbles have been cemented by iron oxide to form hard layers reported by drillers as "shells." Erosion has worn them away on slopes, and streams have cut through and exposed them, as well as the underlying formations. These deposits yield sufficient water for domestic use, but their maximum potential yields have not been investigated.

Loess, or wind-blown silt, of Pleistocene age, covers the entire area except for stream valleys. The silt is gray or buff and unstratified. The loess reaches a maximum thickness of 40 feet close to the bluffs of the Mississippi River and thins to the east. It is too fine grained to yield useful quantities of water to wells.

Alluvial deposits exist along all the streams, and those in the valleys of the Mississippi, Ohio, and Tennessee Rivers are both thick and coarse. During the glacial epoch the Mississippi and Ohio Rivers cut deep channels, then later filled these channels with gravel and sand and an upper blanket of silt and clay. The coarse alluvium in the old channels is thought to extend about 100 feet below pool level at Paducah and to become thicker downstream. Somewhat similar conditions exist along the Tennessee River. At many places along the Mississippi and Ohio River valleys such deposits yield large amounts of water and they can be expected to do so when developed in this region.

The alluvium of the secondary streams has not been explored, but it is likely to be thinner and finer grained than that of the main rivers and thus not a potential source of large water supplies.

WATER RESOURCES

Utilization

The pumpage of water for public and industrial supplies is summarized in tables 2, 3, and 4 and shown graphically by block diagrams on plate 1. As the explanation shows, these diagrams are built of cubes, each of which represents 10,000 gallons of water pumped daily. Ground water is distinguished from surface water by stippling on the front of the blocks.

Water for public and industrial use is pumped from both surface- and ground-water sources. Water for the public supply at Paducah is pumped from the Ohio River, and that for the industrial supplies at Calvert City is pumped from the Tennessee River. Water for both public and industrial use in the rest of the region is pumped from ground-water sources.

The largest consumers are Paducah, Fulton, Mayfield, Murray, and Calvert City. Excepting Calvert City, these are the four largest cities in the Jackson Purchase. In these cities the water is used for domestic, commercial, and light industrial purposes. The water at Calvert City is used almost wholly for industrial purposes.

The total amount of water pumped from both surface- and ground-water sources in 1951 was about 4,540 million gallons. Of this total 1,699 million gallons was pumped from ground-water sources and 2,841 from surface-water sources. About 3,248 million gallons was used for industrial purposes, 914 million gallons was used for domestic purposes, and 377 million gallons was used for other public uses or was disposed of by leakage and waste. The distribution of water utilized by the seven public supplies for which metered records are available is shown below in table 2.

Pumpage data for the smaller cities and towns, which are included in table 3, are estimates based on capacities of pumps and daily periods of operation. They do not include the water used for industrial and commercial purposes or other public use or discharged by leakage or waste.

The pumpage of both ground water and surface water is increasing rapidly now and will increase more.

Table 2.--Annual distribution of water, in gallons, from the larger public water supplies in the Jackson Purchase region, Kentucky, 1951

	Domestic	Industrial and commercial	Other public uses, leakage, and waste	Total pumpage
Paducah	422,932,000	1,011,641,000	156,228,000	1,590,801,000
Mayfield	108,212,000	110,818,000	53,030,000	272,060,000
Fulton	82,419,000	44,632,000	89,262,000	216,313,000
Murray	81,400,000	83,400,000	38,717,000	203,517,000
Hickman	21,777,000	15,230,000	19,895,000	56,902,000
Clinton	13,981,000	6,096,000	13,263,000	33,340,000
Wickliffe	6,930,000	2,974,000	7,426,000	17,330,000
Total	737,651,000	1,274,791,000	377,821,000	2,390,263,000

Chemical Character of Water

This report includes 30 complete chemical analyses of water, 29 from ground-water sources and 1 from the Ohio River. Of these, 1 was collected and analyzed by the Layne-Central Co., 1 was collected and analyzed by the Tennessee Valley Authority, and 28 were collected and analyzed by the U. S. Geological Survey. The water samples collected and analyzed by the Geological Survey include one of treated surface water from the Ohio River at the Paducah public supply and one of treated ground water from the Holly Springs sand at the Mayfield public supply. The other samples collected were of untreated water.

The results of analysis of the dissolved substances in these samples are given in parts per million by weight. These figures can be converted to grains per gallon by multiplying by 0.0584.

Table 5 lists the elements and substances commonly found dissolved in water and summarizes their source and significance to the user of the water. Of these elements and substances the dominant ionic constituents are calcium, magnesium, sodium, potassium, bicarbonate (carbonate in some), sulfate, chloride, and nitrate. Small quantities of fluoride also are present in some waters. Although silica, iron, and manganese also occur in most waters, they probably do not occur in ionic form and therefore are not included in the ionic calculations. The ions of calcium, magnesium, sodium, and potassium are called cations or metallic ions and sometimes they are referred to loosely, as basic constituents. These cations possess one or two positive electrical charges. The ions of bicarbonate (including carbonate), sulfate, chloride, nitrate, and fluoride are called anions, and sometimes they are referred to as acidic constituents. These anions possess one or two negative charges.

The cations and anions will combine to form chemical compounds such as sodium chloride, which is common salt. However, this combination does not take place unit for unit by weight, for 22.997 ppm of sodium will combine exactly with 35.457 ppm of chloride. In order to express chemical combinations, as well as to show water analyses graphically, as on plate 2, the quantities may be expressed in chemical combining weights or equivalents per million. Parts per million may be converted to equivalents per million by dividing the parts per million by the reacting value of the constituent. Then, a unit equivalent of a cation, such as sodium, will combine exactly with a unit equivalent of an anion, such as chloride, to form the compound sodium chloride.

When parts per million are converted to equivalents per million, the sum of all the cations should equal the sum of all the anions within limits of practical analytical procedure, because these ions are in equilibrium. Thus, in the graphic plots on plate 2, the left-hand column of basic constituents and the right-hand column of acidic constituents are the same height. In these diagrams, the basic constituents are shown in the following order, from the bottom to the top: calcium, magnesium, and sodium and potassium together; the acidic constituents are shown in the following order: bicarbonate (including carbonate), sulfate, and chloride (including fluoride and nitrate). When the nitrate content is more than 10 ppm, it is shown separately, in solid black, at the top of the column. The total hardness of a water as calcium carbonate, in parts per million, is shown by a figure at the top of the magnesium block. The water analyses in this report also include values for dissolved-solids content, hardness, temperature, hydrogen-ion concentration, and specific conductance.

Table 2.--Pumpage and source of ground water pumped for public and industrial supplies in the Jackson Purchase region of Kentucky, 1951

County	City	Industry	Population served, 1951	Water-bearing formation and pumpage, in gallons per year						Total, by city, of average pumpage in gallons, per day
				Alluvium	Grenada	Holly Springs	Ripley	St. Louis	Fort Payne	
Ballard	Barlow	-	800	-	-	16,200,000	-	-	-	44,000
Do.	La Center	-	870	-	-	21,200,000	10,500,000	-	-	88,000
Do.	Wickliffe	-	1,030	17,330,000	-	-	-	-	-	47,000
Calloway	Hazel	-	500	-	-	-	10,000,000	-	-	27,000
Do.	Murray	-	8,011	-	-	-	203,517,000	-	-	834,000
Do.	do.	Murray Consumers Coal & Ice Co.	-	-	-	-	100,620,000	-	-	
Carlisle	Arlington	-	584	-	-	11,000,000	-	-	-	30,000
Do.	Bardwell	-	1,200	-	-	18,952,000	-	-	-	52,000
Fulton	Fulton	-	3,500	-	-	216,313,000	-	-	-	1,825,000
Do.	do.	Fulton Ice Co., Inc.	-	-	-	204,984,000	-	-	-	
Do.	do.	Fulton Pure Milk Co.	-	-	36,500,000	-	-	-	-	
Do.	do.	Illinois Central Railroad	-	-	-	192,000,000	-	-	-	
Do.	do.	O.K. Laundry-Cleaners	-	-	-	8,213,000	-	-	-	
Do.	do.	Parisian Laundry & Dry Cleaners	-	-	8,060,000	-	-	-	-	
Do.	Hickman	-	2,037	-	-	56,902,000	-	-	-	156,000
Graves	Mayfield	-	9,600	-	-	272,060,000	-	-	-	1,140,000
Do.	do.	Curlee Clothing Co.	-	-	-	5,460,000	-	-	-	
Do.	do.	Miller Dairy Products Corp.	-	-	-	24,000,000	-	-	-	
Do.	do.	Pet Milk Co.	-	-	-	115,000,000	-	-	-	
Do.	Water Valley	-	178	-	-	2,832,000	-	-	-	21,000
Do.	do.	Water Valley Canning Co.	-	-	-	5,023,000	-	-	-	

County	City	Industry	Population served, 1951	Water-bearing formation and pumpage, in gallons per year						Total, by city, of average pumpage in gallons, per day
				Alluvium	Grenada	Holly Springs	Ripley	St. Louis	Fort Payne	
Graves	Wingo	-	470	-	-	7,300,000	-	-	-	20,000
Hickman	Clinton	-	1,630	-	-	33,340,000	-	-	-	91,000
Do.	Columbus	-	350	10,950,000	-	-	-	-	-	30,000
Marshall	Aurora	Commonwealth of Kentucky, Kentucky Lake State Park	120	-	-	-	-	-	6,698,000	18,000
Do.	Benton	-	2,286	-	-	-	26,000,000	-	-	71,000
Do.	Calvert City	-	66	-	-	-	-	2,190,000	-	13,000
Do.	do.	Pennsylvania Salt Manufacturing Co.	-	2,550,000	-	-	-	-	-	
Do.	Gilbertsville	Commonwealth of Kentucky, Kentucky Dam Village State Park	200	32,918,000	-	-	-	-	-	90,000
Do.	Palma	Texas Gas Transmission Co.	-	-	-	-	19,890,000	-	-	54,000
Total			33,432	63,748,000	44,560,000	1,210,779,000	370,527,000	2,190,000	6,698,000	4,651,000

Table 4.--Pumpage and source of surface water pumped for public and industrial supplies in the Jackson Purchase region of Kentucky, 1951

County	City	Industry	Population served, 1951	Source of water and pumpage, in gallons per year		Total, by city, of average pumpage, in gallons per day
				Ohio River	Tennessee River	
McCracken	Paducah	-	44,800	1,590,801,000	-	4,358,000
Marshall	Calvert City	-	-	-	-	3,426,000
Do.	do.	Pennsylvania Salt Manufacturing Co.	-	-	777,600,000	
Do.	do.	Pittsburgh Metallurgical Co., Inc.	-	-	473,000,000	
Total			44,800	1,590,801,000	1,250,600,000	7,784,000

Table 5.--Elements and substances commonly found in ground water

Constituent	Source	Significance
Silica (SiO_2)	Siliceous minerals present in essentially all formations.	Forms hard scale in pipes and boilers. Inhibits deterioration of zeolite-type water softeners.
Iron (Fe)	The common iron-bearing minerals present in most formations.	Oxidizes to a reddish-brown sediment. More than about 0.3 ppm stains laundry and utensils reddish brown, is objectionable for food processing, beverages. Larger quantities impart taste and favor the growth of iron bacteria.
Manganese (Mn)	Manganese-bearing minerals.	Rarer than iron; in general has same objectionable features; brown to black stain.
Calcium (Ca) and magnesium (Mg)	Minerals that form limestone and dolomite and occur in some amount in almost all formations. Gypsum also a common source of calcium.	Cause most of the hardness and scale-forming properties of water; soap consuming.
Sodium (Na) and potassium (K)	Feldspars and other common minerals; ancient brines, sea water; industrial brines and sewage.	In large amounts give salty taste; objectionable for specialized industrial water uses.
Bicarbonate (HCO_3) and carbonate (CO_3)	Action of carbon dioxide in water on carbonate minerals.	In combination with calcium and magnesium forms carbonate hardness which decomposes in boiling water with attendant formation of scale and release of corrosive carbon dioxide gas.
Sulfate (SO_4)	Gypsum, iron sulfides, and other rarer minerals, common in waters from coal-mining operations and many industrial wastes.	Sulfates of calcium and magnesium give bad taste, form hard scale.
Chloride (Cl)	Found in small to large amounts in all soils and rocks; natural and artificial brines, sea water, sewage.	In large enough amounts gives salty taste; objectionable for various specialized industrial uses of water.
Fluoride (F)	Various minerals of widespread occurrence, in minute amounts.	In water consumed by children, about 1.5 ppm and more may cause mottling of the enamel of teeth; about 1.0 ppm seems to reduce decay of teeth.

Table 5.--Elements and substances commonly found in ground water--Continued

Nitrate (NO_3)	Decayed organic matter, sewage, nitrate fertilizers, nitrates in soil.	Values higher than the local average may suggest pollution. There is evidence that more than about 45 ppm NO_3 may cause methemoglobinemia ("blue baby") of infants, sometimes fatal; waters of high nitrate content should not be used for baby feeding.

The dissolved solids are the residue remaining after evaporation of a water sample at 180°F for 1 hour. These represent the approximate quantity of total substances in solution, although the value reported may include some organic matter and water of crystallization. The U. S. Public Health Service recommends that the total solids of a potable water supply be limited to 500 ppm for a water of good quality.

In this area the hardness of water used for domestic purposes usually receives more attention than any other characteristic. Hard water is usually recognized by the large amount of soap required to produce lather and by the scum of insoluble salts formed when the water is heated. Hardness is due chiefly to the salts of calcium and magnesium, although aluminum iron, manganese, and free acid can contribute to it. The hardness caused by calcium and magnesium equivalent to the bicarbonate or carbonate in a water is called carbonate hardness; the hardness caused by other compounds of calcium and magnesium is called noncarbonate hardness. In this report, waters ranging in hardness from 0 to 60 ppm are considered soft; those between 61 and 120 ppm are medium hard; those between 121 and 200 ppm are hard; those above 200 ppm are very hard.

The temperature of a water sample was obtained at the time the sample of water was taken. It was not recorded at installations such as Wickliffe, Murray, and Calvert City, where it was not possible to get water samples directly out of the wells. At these installations, temperature measurements would not have represented the temperature of water pumped out of the ground.

The hydrogen-ion concentration, of which pH is a measure, is useful in determining the scale-forming or corrosive tendencies of the water. The pH of neutral water is 7.0. This does not mean, however, that a water of pH 7.0 contains no dissolved solids or gases. Decreasing values of pH denote increasing hydrogen-ion concentration; increasing values of pH denote decreasing hydrogen-ion concentration. When the value of pH is lower than 7.0 the water is acid; when it is higher than 7.0 the water is alkaline.

The specific conductance of a water is a measure of the ability of the water to conduct an electric current. This property is of no consequence in itself in regard to water treatment. The conductivity test, however, is used as an indication of the dissolved solids in the water. It provides a convenient means of showing relative concentrations, but does not provide a good check on the accuracy of the analyses.

Ground Water

Most of the ground water available in the region occurs in the unconsolidated deposits, in some places under water-table conditions, but generally it is confined under artesian pressure which causes the water to rise in the hole when the water-bearing formation is penetrated. At many locations along the valleys of the Tennessee, Ohio, and Mississippi Rivers relatively impermeable silt and clay lie as a blanket on the water-bearing sand and gravel and may confine the water in them. At the outcrop of the unconsolidated sands of the Cretaceous and Tertiary aquifers the water in wells stands at the level of the water table, the top of the saturated zone. These formations descend west and south beneath beds of clay and the water is thus confined in them under artesian pressure. All the deep wells used for the large supplies described in this report are artesian.

The scattered reports of water levels in the past that are presented in this report do not reveal any important long-term changes in water levels in this region. As part of a long-range investigation, water-level measurements currently being made in a number of wells will be continued.

Fort Payne Chert

The Fort Payne chert, exposed only along the eastern border of the Purchase, is the source of only one large water supply. At Kentucky Lake State Park, near Aurora, 6,698,000 gallons was pumped in 1951. This well, no. 8805-3645-9, has a yield of 62 gpm, but most wells that penetrate the Fort Payne chert have yields of less than 10 gpm. The chemical analysis of water from well 8805-3645-9 shows the water from this formation to be of good quality, soft, with only 0.18 ppm of iron, and no other substances in objectionable amounts. It is aerated, chlorinated, and filtered. The water temperature, when the sample was taken in October 1951, was 59°F.

St. Louis Limestone

The only two wells deriving water from the St. Louis limestone are near Calvert City in the northeastern part of the region. Well 8820-3700-64, at Calvert Heights, a mile south of Calvert City, is 375 feet deep and is reported to yield 26 gpm. The water level was reported to be 80 feet below the land surface in 1949, or at altitude 318. In 1952 a well was drilled for Calvert City, about 2 miles south of town, to a depth of 245 feet. Here the static water level in May 1952 was 113 feet below the land surface, at altitude 337. This well was surged and treated with dry ice to clear mud and silt from the water-bearing passages, and then during a 3-hour pumping test it yielded a maximum of 120 gpm. However, toward the end of the test the yield fell off to 25 gpm.

Analysis shows the water from the well at Calvert Heights to be of the calcium bicarbonate type, and hard; the iron content was 0.35 ppm. If large amounts of water are pumped from wells in limestone, some part of this water probably enters from the overlying alluvium. The water from alluvium contains as much as 36 ppm of iron (see analysis of water from well 8820-3700-6, p. 55) and therefore the water from heavily pumped wells in limestone may show gradual increases in iron content.

Ripley Formation

In Calloway and Marshall Counties and in the northern part of Ballard County, sands of the Ripley formation constitute the principal aquifers for municipal and industrial water supplies. The total pumpage of water from this formation during 1951 was 370,527,000 gallons. Of this total 250,017,000 gallons was pumped for the municipal supplies of Hazel, Murray, Benton, and LaCenter; and 120,510,000 gallons was pumped for industrial supplies in Murray and Palma. Wells yielding as much as 600 gpm have been developed in the thicker sands at Murray, but yields at Benton, Palma, and LaCenter are less than 300 gpm. Water levels in inventoried wells in this formation range from about 10 to 150 feet below land surface. Drawdowns caused by pumping wells in this formation are great. Pumping the municipal well at Benton for 2 hours at 250 gpm causes a drawdown of 12 feet in an observation well 250 feet away. The possibilities of developing other large supplies in this formation are good, especially in the southeastern part of the region.

As shown on plate 2 and by the tabulated analyses, water from the Ripley formation at Hazel, Murray, and Benton is low in dissolved-solids content and is soft to medium hard; at Palma the dissolved-solids content is high and the water is hard. The waters are generally of the calcium bicarbonate type, and contain 0.42 to 6.0 ppm of iron. The waterworks officials report that the water is corrosive, and the analysis of water at Murray in Calloway County shows a pH of 5.5 Temperatures of water discharged from the wells range from 58° to 61°F. Treatment of all these supplies includes aeration and addition of lime. At Palma the water is softened.

Holly Springs Sand

The Holly Springs sand is the principal aquifer used in the central and western parts of the region and yields water to wells for 17 public and industrial supplies. During 1951, a total of 1,210,779,000 gallons was pumped at these installations.

Many of the wells will yield more water than can be taken from them by means of the pumps now installed, which have pump capacities as small as 18 gpm.

Pumpage in Fulton during 1951, ranging from 25 to 1,300 gpm per well, was 621,510,000 gallons. An additional 208,000,000 gallons was pumped in South Fulton, Tenn. The total withdrawal of 829,510,000 gallons from this 4-square-mile area caused a maximum drawdown of about 6 feet during the summer, when the largest amount of water was being pumped. Water levels returned to about their highest stage of the year by the end of December. Well 8835-3630-7 at the Illinois Central Railroad yards, pumping at the rate of 600 gpm, causes a drawdown of 6 feet in an observation well 87 feet away after 3 hours of continuous pumping.

The total pumpage in Mayfield in 1951 was 416,520,000 gallons. No information is available on drawdowns in this area.

At Bardwell, where the total pumpage for 1951 was 18,952,000 gallons, well 8900-3650-1, after pumping 300 gpm for 3 hours, causes a drawdown of 10 feet in an observation well 50 feet away.

The water from this formation, as shown by analyses from 14 wells, is of the calcium magnesium bicarbonate type. Hardness has a considerable range, 10 to 123 ppm; the average hardness is about 37 ppm. Iron is present in quantities ranging from 0.09 to 1.8 ppm. Water from 5 of the wells had more than 10 ppm of nitrate, derived perhaps from the lignite and peaty material that occurs in streaks through the formation. The quality of the water varies considerably, even in one locality. At Mayfield, for example, the range of hardness in water from 4 wells is from 12 to 55 ppm; and the range in dissolved solids from 49 to 167 ppm.

For the water at Hickman an analysis made by the Layne-Central Co. in 1944 is presented, as well as an analysis made in 1951 by the U. S. Geological Survey. The two analyses, made 6 years apart, show insignificant changes in composition, illustrating the fact that the character of water from deep wells usually varies little in the course of time.

The water is treated where thought desirable or necessary. Of 17 supplies, 6 employ no treatment. At 10 of the remaining 11, the water is chlorinated and at 4 it is aerated and filtered or allowed to settle. Lime is added to the water pumped at 3 localities. The pH of water samples taken from the Holly Springs sand ranges from 5.5 to 7.3. The analyses of raw and finished water at the public water plant in Mayfield show the decrease in iron and increase in pH

brought about by aeration and addition of lime. The temperatures of water from this formation range from 56° to about 64°F.

Grenada Formation

The Grenada formation is a minor source of ground water in Fulton and southern Hickman Counties, in the southwestern part of the Jackson Purchase. A total of 44,560,000 gallons was pumped in 1951 at 2 industrial water-supply installations in Fulton. The largest yield of a well in this formation was reported to be 200 gpm.

One analysis of water from the Grenada formation is included in this report and is shown graphically on plate 2. The water pumped by the Fulton Pure Milk Co. had 178 ppm of dissolved solids, 0.54 of iron, and a hardness of 68 ppm. It is therefore more mineralized and harder than water in the Holly Springs sand at greater depth. The temperature of the water on July 5, 1951, was 61°F.

Alluvial Deposits

The ground-water supplies at the Pennsylvania Salt Manufacturing Co's. plants at Calvert City, at Gilbertsville in the valley of the Tennessee River, and at Wickliffe and Columbus in the valley of the Mississippi River are pumped from alluvial deposits. Both wells at Wickliffe are said to have capacities of 250 gpm, and the well at Gilbertsville has a reported capacity of more than 200 gpm. The well of the Pennsylvania Salt Manufacturing Co., 2 miles north of Calvert City, yielded 195 gpm during a pumping test in 1948.

Very large amounts of water can be obtained from installations of several wells, as shown by the dewatering operations at the site of the Shawnee Steam Plant on the south bank of the Ohio River 12 miles northwest of Paducah. To insure dry working conditions at this spot, the water level in a stratum of gravel and sand 22 feet thick, about 52 feet below the original land surface, had to be lowered in an excavation 300 by 400 feet. From 1,300 well points spaced 3 feet apart around the edges of the excavation, water was pumped at a maximum rate of about 5,000 gallons per minute from May 1951 when pumping began through the end of December 1951. A total of 1,086,000,000 gallons was pumped during this period. The water level was lowered about 35 feet in the excavation area and then kept near this lower level by continuous pumping at 5,000 gallons per minute.

In general, water from the alluvial deposits, as shown in the analyses of water from wells at Columbus, Wickliffe, Shawnee Steam Plant, Pennsylvania Salt Manufacturing Co. near Calvert City, and Gilbertsville, is of the calcium magnesium bicarbonate type. Analyses generally show greater hardness and dissolved-solids content than those of water from the other deposits. Hardness in the samples analyzed ranged from 33 to 212 ppm and averaged 119. The average value of dissolved solids, which ranged from 114 to 299 ppm was 185 ppm. The iron content ranged from 0.18 to 36 ppm. The temperature of the water from the public and industrial supply wells ranged from 25° to 60°F; the temperature of the water pumped at the site of the Shawnee Steam Plant ranged from 57° to 67°F. The higher temperatures of the water pumped from the steam-plant excavation probably are due to mixtures of ground water and rain falling on the excavation, and do not always represent true temperatures of water in the alluvium at this site.

Surface Water

Two large sources of surface water, the Ohio and Tennessee Rivers, are used for public and industrial water supplies. At Paducah 1,590,801,000 gal was pumped during 1951 from the Ohio River for the public supply. An addition to the treatment plant that will increase its capacity from 8 mgd to about 12 mgd will be completed in 1953, and further enlargement to about 17 mgd is proposed. The treatment of the raw water is described under "Descriptions and analyses." A spot sample of treated water collected May 14, 1951, was of the calcium bicarbonate type. It had 0.26 ppm of iron, 134 ppm of dissolved solids, a hardness of 102 ppm, and a pH of 7.5.

Two steam-electric generating stations being built, one on each side of the Ohio River about 12 miles below Paducah, will be in operation by 1954. The temperature of the 1,250,000 gal of river water that will be used each minute at these plants for cooling will be raised 5°F before being returned to the river.

The Tennessee River is used as a source of water for two industrial plants currently in operation and will be used by others now under construction and proposed. The Pennsylvania Salt Manufacturing Co. and the Pittsburgh Metallurgical Co., Inc., 1 mile north of Calvert City, pumped a total of 1,250,600,000 gal in 1951. The Pennsylvania Salt Manufacturing Co. pumped 777,600,000 gal for cooling and boiler-feed water. Surface water used at this plant for boiler-feed water requires treatment as listed in the section on "Descriptions and analyses." Water used for cooling is not treated but is pumped directly from the river to the distribution system. The Pittsburgh Metallurgical Co., Inc., pumped 473,000,000 gal in 1951, of which 459,000,000 gal was used for cooling purposes and 14,000,000 gal was for other purposes in the plant. Treatment of water for the other needs is given in the section on "Descriptions and analyses."

In addition to these plants now in operation, other plants under construction or planned will use large amounts of river water, mostly for cooling. The new plants being built by the National Carbide Co., Division of Air Reduction Co., Inc., and the B. F. Goodrich Chemical Co., and the addition to the Pennsylvania Salt Manufacturing Co. under construction in 1952 will require an additional pumpage of 6,000,000,000 gal per year, which is about 16,500,000 gpd. This water

will be used mainly for cooling purposes and most of it will be returned to the river free of additional pollution.

Other available sources of surface water have not been developed. The largest of these are the Mississippi River and Kentucky Lake. In other parts of the Purchase, smaller quantities of water are available along the Clarks River and Obion, Mayfield, and Bayou de Chien Creeks.

Fuller data on surface-water supplies in this region are available from several sources. Discharge and gage-height data for all major streams are published yearly in water-supply papers prepared by the Surface Water Branch of the U. S. Geological Survey. Data on water temperatures, chemical quality of river water, and on stream-flow measurements are on file in the office of the Surface Water Branch, U. S. Geological Survey, Louisville, Ky. Other agencies that collect and compile surface-water data are the Tennessee Valley Authority, Knoxville, Tenn., the Illinois Geological Survey, Champaign, Ill., the Corps of Engineers, Memphis, Tenn., and the Mississippi River Commission, Vicksburg, Miss.

DESCRIPTIONS AND ANALYSES

The following descriptions and analyses include the detailed information gathered on the water supply of each city, town, or industry, arranged alphabetically by county, and within each county alphabetically by city or town. Where available, complete information was gathered, but not all communities and industries have kept records of the amount of water pumped, the static water levels in wells, and the drawdowns during pumping. The material is listed according to the following plan:.

1. Name of county.

2. Name of city or town.

3. Population served; in most towns this is an estimate based on the number of customers or meters, or in the case of the State parks, on the average number of people occupying the facilities throughout the year.

4. Ownership of waterworks, whether private or public.

5. Source of supply, whether ground water or surface water, location number and location of supply; for ground-water supplies, brief descriptions of wells, including depth, diameter, date drilled, water-bearing formation, static water level, and yield, are given.

6. Description of treatment, including the reason for each phase of treatment, and location of treatment plant.

7. Rated capacity of treatment plant.

8. Location and capacity of storage reservoirs, elevated tanks, and standpipes.

9. Total distribution of water for 1951. In most of the smaller towns, this is an approximate quantity based on an estimated average daily consumption.

10. Average pumpage, in gallons per day, for each month, or maximum and minimum monthly pumpage. These figures are not given for any supply where pumpage records are not available.

11. Annual distribution by use, including domestic; industrial and commercial; and other public use, leakage, and waste. These data are given only where actually supplied by the waterworks officials from their own records.

12. Chemical analyses of the water. Except where otherwise noted, all analyses were made by the U. S. Geological Survey. Reliable analyses made before 1950 by others than the U. S. Geological Survey have been included in this report as a basis for comparing quality of samples of a water taken at different times.

Barlow

Population served: 800.
Ownership: Municipal.
Source: Two wells on Main Street, between Broadway and Railroad Street, Barlow.

Well 8900-3700-1. Depth, 145 feet; diameter, 4 inches; date drilled, 1927; water-bearing formation, Holly Springs; static water level (reported), 93 feet below land surface, 1938; yield, 38 gallons per minute.

Well 8900-3700-2. Depth, 155 feet; diameter, 8 inches; date drilled, 1927; water-bearing formation, Holly Springs; static water level (reported), 93 feet below land surface, 1938; yield, 38 gallons per minute.

Treatment: None.
Storage: 80,000-gallon elevated tank at wells.
Total distribution of water for 1951: 16,200,000 gallons.
Average daily pumpage, 1951: 44,000 gallons.

Analysis, well 8900-3700-1

(Collected Oct. 22, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	13	Fluoride (F)	0.1
Iron (Fe)	.13	Nitrate (NO_3)	11
Manganese (Mn)	.00	Dissolved solids	105
Calcium (Ca)	10	Hardness as $CaCO_3$	
Magnesium (Mg)	5.5	Total	48
Sodium (Na)	17	Noncarbonate	0
Potassium (K)	.8	Temperature (°F.)	59
Aluminum (Al)	-	pH	7.3
Bicarbonate (HCO_3)	76	Specific conductance at 25° C. (micromhos)	174
Sulfate (SO_4)	3.6		
Chloride (Cl)	8.5		

La Center

Population served: 870.
Ownership: Municipal.
Source: Two wells on Broadway, between Second and Third Streets, La Center.
Well 8855-3700-1. Depth, 146 feet; diameter, 8 inches; date drilled, 1935; water-bearing formation, Holly Springs; yield (reported, 250 gallons per minute.
Well 8855-3700-2. Depth, 300 feet; diameter, 8 inches; date drilled, 1935; water-bearing formation, Ripley; yield (reported), 125 gallons per minute.
Treatment: None.
Storage: Elevated tank, 87,000 gallons, at wells.
Total distribution of water for 1951: 31,700,000 gallons.
Average daily pumpage, 1951: 88,000 gallons.

Analysis, well 8855-3700-1, 2

(Collected Feb. 15, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	13	Fluoride (F)	0.0
Iron (Fe)	.41	Nitrate (NO_3)	14
Manganese (Mn)	.00	Dissolved solids	107
Calcium (Ca)	8.8	Hardness as $CaCO_3$	
Magnesium (Mg)	4.9	Total	42
Sodium (Na)	18	Noncarbonate	0
Potassium (K)	.4	Temperature (°F.)	48
Aluminum (Al)	.9	pH	5.9
Bicarbonate (HCO_3)	58	Specific conductance at 25° C. (micromhos)	174
Sulfate (SO_4)	3.9		
Chloride (Cl)	11		

Wickliffe

Population served: 1,030
Ownership: Kentucky Water Service Co., Inc., Somerset, Kentucky.
Source: Two wells on First Street, between Court and Ohio Streets, Wickliffe.

Well 8905-3655-1. Depth, 149 feet; diameter, 8 inches; date drilled, 1930; water-bearing formation, alluvium; yield, 250 gallons per minute.

Well 8905-3655-2. Depth, 134 feet; diameter, 10 inches; date drilled, 1941; water-bearing formation, alluvium; static water level (reported), 50 feet below land surface, 1941; yield, 250 gallons per minute.

Treatment: Chlorinated at wells to disinfect water.
Storage: Reservoir, 35,000 gallons, at wells; elevated tank, 38,000 gallons, on Fourth Street between Wisconsin and Clay Streets.
Total distribution of water for 1951: 17,330,000 gallons.
Average daily pumpage, 1951: 47,000 gallons.

Average pumpage, in gallons per day, 1951

January	43,200	May	45,000	September	48,200
February	47,100	June	50,100	October	47,200
March	41,000	July	48,300	November	53,700
April	38,900	August	58,800	December	48,600

Breakdown of annual distribution as to use:

Domestic	6,930,000 gallons
Industrial and commercial	2,974,000 gallons
Other public use, leakage, and waste	7,426,000 gallons

Analysis, well 8905-3655-1, 2

(Collected July 3, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	20	Fluoride (F)	0.1
Iron (Fe)	1.1	Nitrate (NO_3)	.1
Manganese (Mn)	-	Dissolved solids	177
Calcium (Ca)	31	Hardness as $CaCO_3$	
Magnesium (Mg)	13	Total	130
Sodium (Na)	9.8	Noncarbonate	27
Potassium (K)	1.4	Temperature (°F.)	-
Aluminum (Al)	-	pH	6.6
Bicarbonate (HCO_3)	127	Specific conductance at 25° C. (micromhos)	297
Sulfate (SO_4)	24		
Chloride (Cl)	10		

CALLOWAY COUNTY

Hazel

Population served: 500.
Ownership: Municipal.
Source: Two wells on Main Street (Fourth Avenue), between Gilbert and Center Streets, Hazel.

Well 8815-3630-9. Depth, 303 feet; diameter, 6 inches; date drilled, 1936; water-bearing formation, Ripley; static water level (reported), 148 feet below land surface, 1936; yield, 60 gallons per minute.

Well 8815-3630-12. Depth, 305 feet; diameter, 8 inches; date drilled, May 1951; water-bearing formation, Ripley.

Treatment: Aerated to precipitate iron; lime added to raise pH; chlorinated to disinfect water; pumped to clear well to permit solids to settle. Treatment plant adjacent to wells.
Rated capacity of treatment plant: 128,000 gallons per day.
Storage: Clear well, 11,000 gallons; elevated tank, 50,000 gallons. Both located near wells.
Total distribution of water for 1951: 10,000,000 gallons.
Average daily pumpage, 1951: 27,000 gallons.

Analysis, well 8815-3630-12

(Collected July 5, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	34	Fluoride (F)	0.2
Iron (Fe)	6.0	Nitrate (NO_3)	.1
Manganese (Mn)	-	Dissolved solids	79
Calcium (Ca)	7.2	Hardness as $CaCO_3$	
Magnesium (Mg)	4.4	Total	36
Sodium (Na)	2.2	Noncarbonate	0
Potassium (K)	4.5	Temperature (°F.)	62
Aluminum (Al)	-	pH	7.5
Bicarbonate (HCO_3)	46	Specific conductance at	
Sulfate (SO_4)	4.2	25° C. (micromhos)	95.5
Chloride (Cl)	2.2		

Murray

Population served: 8,011.
Ownership: Municipal.
Source: Two wells at Second and Elm Streets, Murray.

Well 8815-3635-1. Depth, 254 feet; diameter, 7 inches; date drilled, 1936; water-bearing formation, Ripley; yield, 600 gallons per minute.

Well 8815-3635-2. Depth, 256 feet; diameter, 7 inches; date drilled, unknown; water-bearing formation, Ripley; yield, 600 gallons per minute.

Treatment: Aerated over coke to precipitate iron; lime added to raise pH; chlorinated to disinfect water; pumped to clear well to permit solids to settle. Treatment plant adjacent to wells.
Rated capacity of treatment plant: 1,728,000 gallons per day.
Storage: Elevated tank, 1,250,000 gallons.
Total distribution of water for 1951: 203,517,000 gallons.
Average daily pumpage, 1951: 558,000 gallons.

Average pumpage, in gallons per day, 1951

January	529,000	May	619,000	September	588,000
February	542,000	June	571,000	October	584,000
March	546,000	July	564,000	November	520,000
April	537,000	August	607,000	December	483,000

Breakdown of annual distribution as to use:

Domestic	81,400,000 gallons
Industrial and commercial	83,400,000 gallons
Other public use, leakage, and waste	38,717,000 gallons

Analysis, wells 8815-3635-1, 2

(Collected Feb. 14, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	17	Fluoride (F)	0.0
Iron (Fe)	1.4	Nitrate (NO_3)	.2
Manganese (Mn)	.09	Dissolved solids	56
Calcium (Ca)	6.4	Hardness as $CaCO_3$	
Magnesium (Mg)	3.3	Total	30
Sodium (Na)	2.2	Noncarbonate	15
Potassium (K)	.3	Temperature (°F.)	-
Aluminum (Al)	.6	pH	5.5
Bicarbonate (HCO_3)	18	Specific conductance at	
Sulfate (SO_4)	18	25° C. (micromhos)	81.9
Chloride (Cl)	1.2		

Ownership: Murray Consumers Coal and Ice Co.

Source: One well, 8815-3635-4, at South Fourth and Vine Streets, Murray. Depth, 247 feet; diameter, 8 inches; water-bearing formation, Ripley; yield, 325 gallons per minute.

Treatment: Flows through rapid sand filter to remove solids. Treatment plant adjacent to well.

Storage: None.

Total distribution of water for 1951: 100,620,000 gallons.

Maximum monthly .... July ..... 14,508,000 gallons

Minimum monthly .... February .... 3,276,000 gallons

Average daily pumpage, 1951: 276,000 gallons.

CARLISLE COUNTY

Arlington

Population served: 584.
Ownership: Municipal.
Source: Two wells on Railroad Street, between N. Depot and S. Depot Streets, Arlington.

Well 8900-3645-1. Depth, 105 feet; diameter, 6 inches; date drilled, 1934; water-bearing formation, Holly Springs; static water level (reported), 7.5 feet below land surface, 1934; yield, 415 gallons per minute.

Well 8900-3645-2. Depth, 115 feet; diameter, 6 inches; date drilled, 1936; water-bearing formation, Holly Springs; yield, 300 gallons per minute.

Treatment: Chlorinated at well to disinfect water.
Storage: 50,000-gallon elevated tank at corner of College and Second Streets.
Total distribution of water for 1951: 11,000,000 gallons.
Average daily pumpage, 1951: 30,000 gallons.

Analysis, well 8900-3645-2

(Collected July 5, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	12	Fluoride (F)	0.0
Iron (Fe)	.24	Nitrate (NO_3)	13
Manganese (Mn)	-	Dissolved solids	201
Calcium (Ca)	26	Hardness as $CaCO_3$	
Magnesium (Mg)	14	Total	123
Sodium (Na)	16	Noncarbonate	26
Potassium (K)	1.1	Temperature (°F.)	60
Aluminum (Al)	-	pH	6.7
Bicarbonate (HCO_3)	118	Specific conductance at 25° C. (micromhos)	328
Sulfate (SO_4)	36		
Chloride (Cl)	12		

Bardwell

Population served: 1,200.
Ownership: Municipal
Source: Two wells on Front Street at Elsey Avenue, Bardwell.
Wells 8900-3650-1, 2. Depth, 125 feet; diameter, 6 inches; date drilled, 1921; water-bearing formation, Holly Springs; yield, 200 and 300 gallons per minute, respectively.
Treatment: Chlorinated to disinfect water; lime added to raise pH; pumped to clear well to permit solids to settle. Treatment plant adjacent to wells.
Storage: Clear well, 30,000 gallons, near wells; elevated tank, 30,000 gallons, on E. Bodkin Street, off U. S. Highway 62, in Bardwell.
Total distribution of water for 1951: 18,952,000 gallons.
Average daily pumpage, 1951: 52,000 gallons.

Average pumpage, in gallons per day, 1951

January	45,000	May	43,000	September	59,000
February	64,000	June	52,000	October	47,000
March	48,000	July	47,000	November	57,000
April	51,000	August	54,000	December	56,000

Analysis, well 8900-3650-1

(Collected Feb. 15, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	26	Fluoride (F)	0.0
Iron (Fe)	.09	Nitrate (NO_3)	8.8
Manganese (Mn)	-	Dissolved solids	94
Calcium (Ca)	8.8	Hardness as $CaCO_3$	
Magnesium (Mg)	4.4	Total	40
Sodium (Na)	13	Noncarbonate	0
Potassium (K)	.5	Temperature (°F.)	59
Aluminum (Al)	-	pH	6.5
Bicarbonate (HCO_3)	61	Specific conductance at 25° C. (micromhos)	152
Sulfate (SO_4)	4.6		
Chloride (Cl)	7.5		

FULTON COUNTY

Fulton

Population served: 3,500.
Ownership: Municipal.
Source: Two wells at Water and Norman Streets, Fulton.
Well 8850-3630-2. Depth, 425 feet; diameter, 8 inches; water-bearing formation, Holly Springs; static water level, 20 feet below land surface, November 19, 1945; yield, 1,300 gallons per minute.
Well 8850-3630-3. Depth, 627 feet; diameter, 6 inches; water-bearing formation, Holly Springs; static water level, 16 feet below land surface, May 4, 1929; yield, 650 gallons per minute.
Treatment: Aerated to precipitate iron; chlorinated to disinfect water; pumped to clear well to permit solids to settle. Treatment plant adjacent to wells.
Rated capacity of treatment plant: 1,500,000 gallons per day.
Storage: Clear well, at pumping station, 300,000 gallons; elevated tank, at Thetford and Browder Streets, 200,000 gallons.
Total distribution of water for 1951: 216,313,000 gallons.
Average daily pumpage, 1951: 593,000 gallons.

Average pumpage, in gallons per day, 1951

January	556,000	May	629,000	September	610,000
February	583,000	June	640,000	October	582,000
March	566,000	July	663,000	November	521,000
April	577,000	August	645,000	December	542,000

Breakdown of annual distribution as to use:
Domestic ..... 82,419,000 gallons
Industrial and commercial ..... 44,632,000 gallons
Other public use, leakage, and waste ..... 89,262,000 gallons

Analysis, well 8850-3630-3

(Collected Aug. 6, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	12	Fluoride (F)	0.0
Iron (Fe)	.43	Nitrate (NO_3)	.1
Manganese (Mn)	-	Dissolved solids	38
Calcium (Ca)	3.2	Hardness as $CaCO_3$	
Magnesium (Mg)	1.5	Total	14
Sodium (Na)	4.7	Noncarbonate	0
Potassium (K)	.6	Temperature (°F.)	60
Aluminum (Al)	-	pH	7.1
Bicarbonate (HCO_3)	24	Specific conductance at 25° C. (micromhos)	47.7
Sulfate (SO_4)	2.1		
Chloride (Cl)	2.4		

Ownership: Fulton Ice Co., Inc.
Source: One well, 8850-3630-14, at Fourth and West Streets, Fulton. Depth, 460 feet; diameter, 8 inches; date drilled, 1948; water-bearing formation, Holly Springs; yield, 390 gallons per minute.
Treatment: Chlorinated at well to disinfect water.
Storage: None.
Pumpage, 1951: 24 hours per day for 12 months.
Total distribution of water for 1951: 204,984,000 gallons.
Average daily pumpage, 1951: 562,000 gallons.

Ownership: Fulton Pure Milk Co.
Source: One well, 8850-3630-6, on Fourth Street, near Lake Street, Fulton. Depth, 107 feet; diameter, 6 inches; water-bearing formation, Grenada; static water level, 0.56 foot below land surface, April 13, 1951; yield, 200 gallons per minute.
Treatment: None.
Total distribution of water for 1951: 36,500,000 gallons.
Average daily pumpage, 1951: 100,000 gallons.

Analysis, well 8850-3630-6

(Collected July 5, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	14	Fluoride (F)	0.0
Iron (Fe)	.54	Nitrate (NO_3)	6.0
Manganese (Mn)	-	Dissolved solids	178
Calcium (Ca)	17	Hardness as $CaCO_3$	
Magnesium (Mg)	6.3	Total	68
Sodium (Na)	24	Noncarbonate	36
Potassium (K)	3.0	Temperature (°F.)	61
Aluminum (Al)	-	pH	5.9
Bicarbonate (HCC_3)	40	Specific conductance at 25° C. (micromhos)	282
Sulfate (SO_4)	42		
Chloride (Cl)	29		

Ownership: Illinois Central Railroad.
Source: Three wells in Fulton.

Well 8850-3630-7. Near Carr and Fourth Streets. Depth, 407 feet; diameter, 10 inches; water-bearing formation, Holly Springs; static water level, 18 feet below land surface, November 19, 1945; yield, 600 gallons per minute.

Well 8850-3630-8. Near roundhouse, Cemetery Road and Cook Avenue. Depth, 520 feet; diameter, 10 inches; date drilled, 1942; water-bearing formation, Holly Springs; yield, 600 gallons per minute.

Well 8850-3630-9. Near roundhouse. Cemetery Road and Cook Avenue. Depth, 498 feet; diameter, 10 inches; date drilled, 1944; water-bearing formation, Holly Springs; yield, 600 gallons per minute.

Treatment: Chlorination at all wells to disinfect water.
Storage: Five elevated tanks, 435,000-gallon total capacity: One 100,000-gallon tank near Vine and Cedar Streets; one 100,000-gallon tank near Fourth and Carr Streets; two 100,000-gallon tanks near roundhouse, Cemetery Road and Cook Avenue; one 35,000-gallon tank in north end of railroad yards.
Total distribution of water for 1951: 192,000,000 gallons.
Average daily pumpage, 1951: 526,000 gallons.

Analysis, well 8850-3630-7

(Collected Feb. 14, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	14	Fluoride (F)	0.0
Iron (Fe)	.23	Nitrate (NO_3)	.1
Manganese (Mn)	.00	Dissolved solids	36
Calcium (Ca)	2.8	Hardness as $CaCO_3$	
Magnesium (Mg)	.90	Total	10
Sodium (Na)	3.8	Noncarbonate	0
Potassium (K)	.6	Temperature (°F.)	60
Aluminum (Al)	.2	pH	5.5
Bicarbonate (HCO_3)	21	Specific conductance at	
Sulfate (SO_4)	.9	25° C. (micromhos)	44.9
Chloride (Cl)	1.9		

Analysis, well 8850-3630-8

(Collected Feb. 14, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	12	Fluoride (F)	0.0
Iron (Fe)	.17	Nitrate (NO_3)	.2
Manganese (Mn)	.00	Dissolved solids	37
Calcium (Ca)	3.8	Hardness as $CaCO_3$	
Magnesium (Mg)	1.1	Total	14
Sodium (Na)	3.6	Noncarbonate	0
Potassium (K)	1.1	Temperature (°F.)	60
Aluminum (Al)	.2	pH	5.6
Bicarbonate (HCO_3)	24	Specific conductance at	
Sulfate (SO_4)	1.3	25° C. (micromhos)	50.2
Chloride (Cl)	2.5		

Ownership: O. K. Laundry-Cleaners.
Source: One well, 8850-3630-11, at State Line and Mulberry Streets, Fulton. Depth, 440 feet; diameter, 6 to 4 inches; date drilled, 1949; water-bearing formation, Holly Springs; yield, 25 gallons per minute.
Treatment: None.
Pumpage, 1951: 35,000 gallons per day, 4 days per week; 6,000 gallons per day, 3 days per week.
Total distribution of water for 1951: 8,213,000 gallons.
Average daily pumpage, 1951: 22,000 gallons.

Ownership: Parisian Laundry and Dry Cleaners
Source: One well, 8850-3630-10, on Fourth Street, near Lake Street, Fulton. Depth, 128 feet; diameter, 4 inches; water-bearing formation, Grenada; yield, 80 gallons per minute.
Treatment: None.
Pumpage: 35,000 gallons per day, 4 days per week; 5,000 gallons per day, 3 days per week.
Total distribution of water for 1951: 8,060,000 gallons.
Average daily pumpage, 1951: 22,000 gallons.

Hickman

Population served: 2,037.
Ownership: Kentucky Water Service Co., Inc., Somerset, Kentucky.
Source: Two wells at Exchange and Tennessee Streets, Hickman.
Well 8910-3630-1. Depth, 630 feet; diameter, 6 inches; water-bearing formation, Holly Springs; static water level, 8 feet below land surface, April 4, 1951; yield, 300 gallons per minute.
Well 8910-3630-2. Depth, 640 feet; diameter, 8 inches; water-bearing formation, Holly Springs; yield, 490 gallons per minute.
Treatment: Aerated to precipitate iron; chlorinated to disinfect water. Treatment plant at wells.
Storage: Elevated tank, 35,000 gallons, on Moscow Avenue, near Troy Avenue.
Total distribution of water for 1951: 56,902,000 gallons.
Average daily pumpage, 1951: 156,000 gallons.

Average pumpage, in gallons per day, 1951

January	145,400	May	173,000	September	156,900
February	194,700	June	135,500	October	137,900
March	160,400	July	180,500	November	131,800
April	128,900	August	195,200	December	132,000

Breakdown of annual distribution as to use:

Domestic	21,777,000 gallons
Industrial and commercial	15,230,000 gallons
Other public use, leakage, and waste	19,895,000 gallons

Analysis, well 8910-3630-2
(Collected Oct. 10, 1944. Analyzed by
Layne-Central Co., for city of Hickman.)

	Parts per million		Parts per million
Silica (SiO_2)	14	Fluoride (F)	0.00
Iron (Fe)	1.5	Nitrate (NO_3)	-
Manganese (Mn)	-	Dissolved solids	90
Calcium (Ca)	12	Hardness as $CaCO_3$	
Magnesium (Mg)	5.0	Total	55
Sodium (Na)	-	Noncarbonate	0
Potassium (K)	-	Temperature (°F.)	-
Aluminum (Al)	.05	pH	6.5
Bicarbonate (HCO_3)	-	Specific conductance at	
Sulfate (SO_4)	.50	25° C. (micromhos)	-
Chloride (Cl)	2.0		

Analysis, well 8910-3630-2

(Collected Feb. 14, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	11	Fluoride (F)	0.0
Iron (Fe)	1.8	Nitrate (NO_3)	.8
Manganese (Mn)	-	Dissolved solids	66
Calcium (Ca)	9.6	Hardness as $CaCO_3$	
Magnesium (Mg)	4.9	Total	44
Sodium (Na), Potassium (K)	6.9	Noncarbonate	0
Aluminum (Al)	-	Temperature (°F.)	64
Bicarbonate (HCO_3)	62	pH	6.1
Sulfate (SO_4)	4.4	Specific conductance at	
Chloride (Cl)	2.2	25° C. (micromhos)	113

GRAVES COUNTY

Mayfield

Population served: 9,600.
Ownership: Municipal.
Source: Three wells at Twelfth and Walnut Streets, Mayfield.

Well 8835-3640-1. Depth, 254 feet; diameter, 18 inches; date drilled, 1927; water-bearing formation, Holly Springs; static water level (reported), 35 feet below land surface, April 6, 1927; yield, 1,400 gallons per minute.

Well 8835-3640-2. Depth, 258 feet; diameter, 18 inches; date drilled, 1934; water-bearing formation, Holly Springs; yield, 1,300 gallons per minute.

Well 8835-3640-3. Depth, 246 feet; diameter, 18 inches; date drilled, 1945; water-bearing formation, Holly Springs; yield, 1,200 gallons per minute.

Treatment: Aerated to precipitate iron; chlorinated to disinfect water; lime added to raise pH. Treatment plant adjacent to wells.
Storage: Reservoir, 90,000 gallons, adjacent to wells; elevated tank, 90,000 gallons, at Thirteenth and Walnut Streets.
Total distribution of water for 1951: 272,060,000 gallons.
Average daily pumpage, 1951: 745,000 gallons.

Average pumpage, in gallons per day, 1951

January	654,900	May	615,000	September	900,500
February	701,800	June	797,000	October	738,000
March	646,500	July	754,000	November	853,200
April	702,500	August	844,100	December	764,000

Breakdown of annual distribution as to use:

Domestic	108,212,000 gallons
Industrial and commercial	110,818,000 gallons
Other public use, leakage, and waste	53,030,000 gallons

Analysis, well 8835-3640-3

(Raw water sample collected Feb. 14, 1951. Finished water sample collected May 14, 1951)

	Raw water	Finished water
	Parts per million	Parts per million
Silica (SiO_2)	17	16
Iron (Fe)	.64	.30
Manganese (Mn)	-	.00
Calcium (Ca)	14	14
Magnesium (Mg)	4.6	7.5
Sodium (Na)	27	22
Potassium (K)		1.3
Bicarbonate (HCO_3)	36	34
Sulfate (SO_4)	29	31
Chloride (Cl)	23	22
Fluoride (F)	.0	.1
Nitrate (NO_3)	24	24
Dissolved solids	157	155
Hardness as $CaCO_3$		
Total	55	69
Noncarbonate	24	-
Temperature (°F.)	56	-
pH	6.2	6.8
Specific conductance at 25° C. (micromhos)	251	254

Ownership: Curlee Clothing Co.
Source: One well, 8835-3640-4, on West Water Street, at South Tenth Street, Mayfield. Depth, 125 feet; diameter, 8 inches; date drilled, 1927; water-bearing formation, Holly Springs; yield (reported), 350 gallons per minute.
Treatment: None.
Storage: 120,000-gallon reservoir adjacent to well.
Total distribution of water for 1951: 5,460,000 gallons.
Average daily pumpage, 1951: 15,000 gallons.

Analysis, well 8835-3640-4

(Collected Feb. 14, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	17	Fluoride (F)	0.0
Iron (Fe)	.26	Nitrate (NO_3)	14
Manganese (Mn)	.00	Dissolved solids	144
Calcium (Ca)	10	Hardness as $CaCO_3$	
Magnesium (Mg)	3.4	Total	40
Sodium (Na)	26	Noncarbonate	8.6
Potassium (K)	.7	Temperature (°F.)	59
Aluminum (Al)	.7	pH	5.7
Bicarbonate (HCO_3)	37	Specific conductance at 25° C. (micromhos)	222
Sulfate (SO_4)	10		
Chloride (Cl)	31		

Ownership: Miller Dairy Products Corp.
Source: One well, 8835-3640-6, at 800 South Sixth Street, Mayfield. Depth, 180 feet; diameter, 6 inches; date drilled, 1940; water-bearing formation, Holly Springs; yield, 200 gallons per minute.
Treatment: None.
Storage: 1,000-gallon pressure tank.
Pumpage: 60,000 gallons per day in winter; 72,000 gallons per day, 6 months per year.
Total distribution of water for 1951: 24,000,000 gallons.
Maximum monthly .... July ..... 2,232,000 gallons
Minimum monthly .... February .... 1,680,000 gallons
Average daily pumpage, 1951: 65,000 gallons.

Analysis, well 8835-3640-6

(Collected June 5, 1952)

	Parts per million		Parts per million
Silica (SiO_2)	15	Fluoride (F)	0.1
Iron (Fe)	.21	Nitrate (NO_3)	6.1
Manganese (Mn)	.00	Dissolved solids	76
Calcium (Ca)	4.8	Hardness as $CaCO_3$	
Magnesium (Mg)	2.7	Total	23
Sodium (Na)	15	Noncarbonate	0
Potassium (K)	.7	Temperature (°F.)	60
Bicarbonate (HCO_3)...	35	pH	6.1
Sulfate (SO_4)	6.3	Specific conductance at	
Chloride (Cl)	10	25° C. (micromhos) ..	122

Ownership: Pet Milk Co.
Source: Two wells on Paducah highway (U. S. Highway 45) at Hausman Street, Mayfield.

Well 8835-3645-4. Depth, 185 feet; diameter, 16 inches; date drilled, 1934; water-bearing formation, Holly Springs; static water level, 36 feet below land surface, May 1, 1948; yield, 500 gallons per minute.

Well 8835-3645-5. Depth, 185 feet; diameter, 8 inches; date drilled, 1934; water-bearing formation, Holly Springs; static water level, 34 feet below land surface, May 1, 1948; yield, 400 gallons per minute.

Treatment: None.
Storage: Reservoir, 53,000 gallons; elevated tanks, 113,000 gallons, adjacent to wells.
Pumpage: October-March, 88,000 gallons per day; April-September, 540,000 gallons per day.
Total distribution of water for 1951: 115,000,000 gallons.
Average daily pumpage, 1951: 315,000 gallons.

Analysis, well 8835-3645-4

(Collected Oct. 22, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	16	Fluoride (F)	0.1
Iron (Fe)	.26	Nitrate (NO_3)	3.2
Manganese (Mn)	.00	Dissolved solids	49
Calcium (Ca)	3.4	Hardness as $CaCO_3$	
Magnesium (Mg)	.8	Total	12
Sodium (Na)	5.7	Noncarbonate	0
Potassium (K)	1.1	Temperature (°F.)	58
Aluminum (Al)	-	pH	6.0
Bicarbonate (HCO_3)	18	Specific conductance at 25° C. (micromhos)	57.0
Sulfate (SO_4)	4.4		
Chloride (Cl)	3.5		

Water Valley

Population served: 178.
Ownership: Municipal.
Source: One well, 8845-3630-1, near U. S. Highway 45 in Water Valley. Depth, 182 feet; diameter, 3 inches; date drilled, 1930; water-bearing formation, Holly Springs; yield, 18 gallons per minute.
Treatment: Chlorinated to disinfect water; lime added to raise pH.
Storage: Reservoir, 3,000 gallons; pressure tank, 400 gallons.
Total distribution of water for 1951: 2,832,000 gallons.
Average daily pumpage, 1951: 8,000 gallons.

Analysis, well 8845-3630-1

(Collected Sept. 19, 1952)

	Parts per million		Parts per million
Silica (SiO_2)	23	Fluoride (F)	0
Iron (Fe)	.24	Nitrate (NO_3)	20
Manganese (Mn)	.41	Dissolved solids	153
Calcium (Ca)	12	Hardness as $CaCO_3$	
Magnesium (Mg)	5.1	Total	51
Sodium (Na)	23	Noncarbonate	35
Potassium (K)	1.1	Temperature (°F.)	60
Aluminum (Al)	-	pH	6.9
Bicarbonate (HCO_3)	19	Specific conductance at 25° C. (micromhos)	246
Sulfate (SO_4)	26		
Chloride (Cl)	33		

Ownership: Water Valley Canning Co.
Source: One well, 8845-3630-4, near U. S. Highway 45 in Water Valley. Depth, 220 feet; diameter, 6 inches; date drilled, 1945; water-bearing formation, Holly Springs; yield, 80 gallons per minute.
Treatment: Aerated to precipitate iron, and filtered through sand to remove iron and other solids.
Storage: 4,000-gallon pressure tank located adjacent to well.
Total distribution of water for 1951: 5,023,000 gallons.
Average daily pumpage, 1951: 13,000 gallons.

Wingo

Population served: 470.
Ownership: Municipal.
Source: Two wells at Locust and Main Streets, Wingo.

Well 8840-3635-1. Depth, 152 feet; diameter, 8 inches; date drilled, June 1935; water-bearing formation, Holly Springs; static water level, 72 feet below land surface, June 4, 1935; yield, 290 gallons per minute.

Well 8840-3635-2. Depth, 151 feet; diameter, 8 inches; date drilled, July 1935; water-bearing formation, Holly Springs; yield, 250 gallons per minute.

Treatment: Chlorinated at the wells to disinfect the water.
Storage: Elevated tank, 75,000 gallons, at Main Street and U. S. Highway 45, Wingo.
Total distribution of water for 1951: 7,300,000 gallons.

Maximum monthly .... August ..... 930,000 gallons
Minimum monthly .... February ... 500,000 gallons

Average daily pumpage, 1951: 20,000 gallons.

Analysis, well 8840-3635-1

(Collected July 5, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	13	Fluoride (F)	0.0
Iron (Fe)	.20	Nitrate (NO_3)	3.0
Manganese (Mn)	-	Dissolved solids	42
Calcium (Ca)	3.2	Hardness as $CaCO_3$	
Magnesium (Mg)	1.2	Total	13
Sodium (Na)	5.9	Noncarbonate	0
Potassium (K)	1.3	Temperature (°F.)	59
Bicarbonate (HCO_3) ...	19	pH	5.9
Sulfate (SO_4)	5.2	Specific conductance at	
Chloride (Cl)	3.2	25° C. (micromhos) ..	58.2

HICKMAN COUNTY

Clinton

Population served: 1,630.
Ownership: Kentucky Water Service Co., Inc., Somerset, Kentucky.
Source: Two wells at Depot and Short Streets, Clinton.

Well 8855-3640-1. Depth, 280 feet; diameter, 10 inches; date drilled, June 1937; water-bearing formation, Holly Springs; static water level, 28 feet below land surface, June 9, 1937; yield, 360 gallons per minute.

Well 8855-3640-2. Depth, 296 feet; diameter, 8 inches; date drilled, 1929; water-bearing formation, Holly Springs; used as standby well.

Treatment: Chlorinated at wells to disinfect water.
Storage: Clear well, 60,000 gallons, adjacent to supply wells; 40,000-gallon elevated tank, near Kentucky Highway 51, at southern city limits.
Total distribution of water for 1951: 33,340,000 gallons.
Average daily pumpage, 1951: 91,000 gallons.

Average pumpage, in gallons per day, 1951

January	56,000	May	65,000	September	119,000
February	73,000	June	73,000	October	110,000
March	68,000	July	119,000	November	110,000
April	74,000	August	122,000	December	109,000

Breakdown of annual distribution as to use:

Domestic	13,981,000 gallons
Industrial and commercial	6,096,000 gallons
Other public use, leakage, and waste	13,263,000 gallons

Analysis, well 8855-3640-1

(Collected Feb. 14, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	19	Fluoride (F)	0.0
Iron (Fe)	.20	Nitrate (NO_3)	.6
Manganese (Mn)	-	Dissolved solids	78
Calcium (Ca)	9.6	Hardness as $CaCO_3$	
Magnesium (Mg)	3.6	Total	39
Sodium (Na) } Potassium (K) }	9.6	Noncarbonate	0
Aluminum (Al)	-	Temperature (°F.)	62
Bicarbonate (HCO_3) ...	64	pH	6.2
Sulfate (SO_4)	1.7	Specific conductance at 25° C. (micromhos) ..	125
Chloride (Cl)	3.5		

Columbus

Population served: 350.
Ownership: Municipal.
Source: One well, 8905-3645-1, in Polk Circle, east of Hoover Parkway, Columbus. Depth, 225 feet; diameter, 6 inches; date drilled, 1928; water-bearing formation, alluvium; yield, 70 gallons per minute.
Treatment: Chlorinated to disinfect water and lime added to raise pH. Water hand treated at well.
Storage: Clear well, 36,000 gallons, and elevated tank, 24,000 gallons, at supply well.
Total distribution of water for 1951: 10,950,000 gallons.
Average daily pumpage, 1951: 30,000 gallons.

Analysis, well 8905-3645-1

(Collected Feb. 15, 1951.)

	Parts per million		Parts per million
Silica (SiO_2)	16	Fluoride (F)	0.1
Iron (Fe)	.18	Nitrate (NO_3)	2.0
Manganese (Mn)	-	Dissolved solids	299
Calcium (Ca)	60	Hardness as $CaCO_3$	
Magnesium (Mg)	15	Total	212
Sodium (Na) + Potassium (K)	40	Noncarbonate	0
Aluminum (Al)	-	Temperature (°F.)	57
Bicarbonate (HCO_3)	354 *	pH	7.1
Sulfate (SO_4)	2.7	Specific conductance at 25° C. (micromhos)	539
Chloride (Cl)	2.5		

*Note: This sample was collected from the reservoir in which chlorine and lime are added by hand. The high bicarbonate (HCO_3) content indicated by the analysis probably results from lime which had been added before the sample was taken.

McCRACKEN COUNTY

Paducah

Population served: 44,800.
Ownership: Municipal.
Source: Ohio River (intake at foot of Washington Street).
Treatment: Pumped into settling basin; prechlorinated to control algae and slime; coagulated with alum to settle suspended solids; lime added to raise pH; activated carbon added to eliminate taste and odor; rapid sand filtration to remove suspended matter; postchlorinated to disinfect water; ammonia added to insure chlorine stability; final adjustment of pH (by adding lime) to about 8.3 to prevent corrosion.
Capacity of treatment plant: 8,000,000 gallons per day.
Storage:
Raw water: Settling basin, 1,500,000 gallons; coagulation tank, 1,400,000 gallons; standpipe, 300,000 gallons. Located at First and Washington Streets.
Finished water: Clear well, 740,000 gallons, at First and Washington Streets; reservoir, 5,000,000 gallons, near U. S. Highway 45, 5 miles southwest of Paducah.
Total distribution of water for 1951: 1,590,801,000 gallons.
Average daily pumpage, 1951: 4,358,000 gallons.

Average pumpage, in gallons per day, 1951

January	3,860,000	May	4,684,000	September	4,353,000
February	4,185,000	June	4,592,000	October	4,322,000
March	3,728,000	July	4,527,000	November	4,523,000
April	4,148,000	August	5,335,000	December	4,033,000

Breakdown of annual distribution as to use:

Domestic	422,932,000 gallons
Industrial and commercial	1,011,641,000 gallons
Other public use, leakage, and waste	156,228,000 gallons

Analysis, Ohio River Water

(Finished water collected May 14, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	3.3	Fluoride (F)	0.0
Iron (Fe)	.26	Nitrate (NO_3)	1.6
Manganese (Mn)	.00	Dissolved solids	134
Calcium (Ca)	34	Hardness as $CaCO_3$	
Magnesium (Mg)	4.4	Total	102
Sodium (Na)	4.4	Noncarbonate	-
Potassium (K)	1.4	Temperature (°F.)	-
Aluminum (Al)	-	pH	7.5
Bicarbonate (HCO_3) ..	68	Specific conductance at	
Sulfate (SO_4)	41	25° C. (micromhos) ..	226
Chloride (Cl)	6.5		

Regular determinations at treatment plant, 1950

Determinations	Raw water			Finished water		
	Average	Maximum	Minimum	Average	Maximum	Minimum
Alkalinity as $CaCO_3$ (ppm)	65	88	50	68	90	58
pH	7.4	7.8	6.8	8.3	8.6	7.8
Hardness as $CaCO_3$ (ppm)	66	90	54	72	101	62
Turbidity	150	700	30	5	8	0

Shawnee Steam Plant (Dewatering operation during construction)

Ownership: Tennessee Valley Authority.

Source: 1,300 well points, 8845-3705-14, spaced 3 feet on centers around excavation. Depth, 26 feet; diameter, 1.5 inches; water-bearing formation, alluvium; static water level, 321.70 feet above mean sea level, January 26, 1951. Water level during maximum pumpage, 288.81 feet above mean sea level, August 28, 1951; maximum yield, 8,785,000 gallons per day, August 28, 1951; average yield, 5,442,000 gallons per day.

Total pumpage for 1951: 1,086,000,000 gallons.

Note: A gravel and sand stratum, with an average thickness of 22 feet, underlies the steam plant area at a depth of approximately 52 feet. The water contained in this aquifer is under a considerable head, and before the excavation could be completed, the water level had to be lowered to insure dry working conditions. The dewatering was begun in May 1951, and continued during the year. The Ohio River, which lies a few hundred feet north of the project, contributed a large percentage of the total water pumped.

A water sample for chemical analysis was collected by Tennessee Valley Authority during a pumping test made of this aquifer in January 1951. The result of this analysis is included with the analysis of a sample collected by the U. S. Geological Survey on July 3, 1951.

Analysis, well 8845-3705-14

(Analyzed by Tennessee Valley Authority, Jan. 26, 1951.)

	Parts per million		Parts per million
Silica (SiO_2)	11	Fluoride (F)	-
Iron (Fe)	.20	Nitrate (NO_3)	4.4
Manganese (Mn)	.00	Dissolved solids	153
Calcium (Ca)	20	Hardness as $CaCO_3$	
Magnesium (Mg)	9.1	Total	88
Sodium (Na), Potassium (K)	25	Noncarbonate	0
Aluminum (Al)	-	Temperature (°F.)	58
Bicarbonate (HCO_3)	-	pH	6.9
Sulfate (SO_4)	7.2	Specific conductance at 25° C. (micromhos)	-
Chloride (Cl)	23		

Analysis, well 8845-3705-14

(Collected July 3, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	17	Fluoride (F)	0.0
Iron (Fe)	.49	Nitrate (NO_3)	2.4
Manganese (Mn)	-	Dissolved solids	169
Calcium (Ca)	21	Hardness as $CaCO_3$	
Magnesium (Mg)	8.0	Total	86
Sodium (Na)	25	Noncarbonate	0
Potassium (K)	1.6	Temperature (°F.)	60
Aluminum (Al)	-	pH	6.1
Bicarbonate (HCO_3)	114	Specific conductance at 25° C. (micromhos)	294
Sulfate (SO_4)	7.0		
Chloride (Cl)	31		

MARSHALL COUNTY

Aurora, Kentucky Lake State Park (P. O.: Hardin)

Population served: 120.
Ownership: Commonwealth of Kentucky.
Source: One well, 8805-3645-9, on Kentucky Highway 94, 0.75 mile southeast of Aurora. Depth, 175 feet; diameter, 10 inches; date drilled, 1948; water-bearing formation, Fort Payne; yield, 62 gallons per minute.
Treatment: Aerated to precipitate iron; chlorinated to disinfect water; filtered to remove solids. Treatment plant adjacent to well.
Storage: 30,000-gallon reservoir at well.
Total distribution of water for 1951: 6,698,000 gallons.
Average daily pumpage, 1951: 18,000 gallons.
Note: See text for discussion of populations served by State parks.

Analysis, well 8805-3645-9

(Collected Oct. 22, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	8.0	Fluoride (F)	0.0
Iron (Fe)	.18	Nitrate (NO_3)	1.0
Manganese (Mn)	.00	Dissolved solids	39
Calcium (Ca)	5.0	Hardness as $CaCO_3$	
Magnesium (Mg)	2.1	Total	21
Sodium (Na)	3.7	Noncarbonate	0
Potassium (K)	.6	Temperature (°F.)	59
Aluminum (Al)	-	pH	6.3
Bicarbonate (HCO_3)	34	Specific conductance at 25° C. (micromhos)	61.9
Sulfate (SO_4)	.7		
Chloride (Cl)	1.5		

Benton

Population served: 2,286.
Ownership: Municipal.
Source: Two wells on Poplar Street, between Sixth and Seventh Streets, Benton.
Wells 8820-3650-2, 3. Depth, 280 feet; diameter, 8 inches; date drilled, 1947; water-bearing formation, Ripley; static water level, 10.7 feet below land surface, January 31, 1950; yield, 250 gallons per minute per well.
Treatment: Aerated to remove iron; chlorinated to disinfect water; lime added to raise pH. Water treated at wells.
Storage: Elevated tank, 50,000 gallons, on Eleventh Street, between Elm and Poplar Streets, Benton.
Total distribution of water for 1951: 26,000,000 gallons.
Maximum monthly .... July ..... 2,800,000 gallons
Minimum monthly ..... February .... 2,200,000 gallons
Average daily pumpage, 1951: 71,000 gallons.

Analysis, wells 8820-3650-2, 3

(Collected Feb. 14, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	15	Fluoride (F)	0.0
Iron (Fe)	.63	Nitrate (NO_3)	.0
Manganese (Mn)	-	Dissolved solids	90
Calcium (Ca)	22	Hardness as $CaCO_3$	
Magnesium (Mg)	1.9	Total	64
Sodium (Na), Potassium (K)	4.5	Noncarbonate	6
Aluminum (Al)	-	Temperature (°F.)	59
Bicarbonate (HCO_3) ...	69	pH	7.0
Sulfate (SO_4)	12	Specific conductance at 25° C. (micromhos) ..	144
Chloride (Cl)	2.4		

Calvert City

Population served: 66.
Ownership: H. Vernon Duckett, Calvert City.
Source: One well, 8820-3700-64, in Calvert Heights, 0.75 mile southeast of Calvert City. Depth, 375 feet; diameter, 5 inches; date drilled, 1949; water-bearing formation, St. Louis; static water level (reported), 80 feet below land surface, 1949; yield, 26 gallons per minute.
Treatment: None.
Storage: 1,100-gallon pressure tank, adjacent to well.
Total distribution of water for 1951: 2,190,000 gallons.
Average daily pumpage, 1951: 6,000 gallons.

Analysis, well 8820-3700-64

(Collected Aug. 3, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	9.4	Fluoride (F)	0.2
Iron (Fe)	.35	Nitrate (NO_3)	4.0
Manganese (Mn)	.00	Dissolved solids	217
Calcium (Ca)	66	Hardness as $CaCO_3$	
Magnesium (Mg)	5.3	Total	188
Sodium (Na)	7.3	Noncarbonate	1
Potassium (K)	.6	Temperature (°F.)	-
Aluminum (Al)	-	pH	7.8
Bicarbonate (HCO_3)	226	Specific conductance at 25° C. (micromhos)	383
Sulfate (SO_4)	9.9		
Chloride (Cl)	6.0		

Ownership: Pennsylvania Salt Manufacturing Co.
Source: Tennessee River, 8820-3700-A, and one well, 8820-3700-6, 1 mile west of Kentucky Highway 95 and 2 miles north of Calvert City.
Well 8820-3700-6. Depth, 82 feet; diameter, 8 inches; date drilled, June 17, 1948; water-bearing formation, alluvium; static water level, 31.25 feet below land surface, June 17, 1948; yield, 195 gallons per minute.
Treatment:
Ground water (for domestic use): Settling tank; lime added for pH adjustment and softening; chlorinated to disinfect water; filtered through sand to remove precipitated solids and through activated charcoal to remove odors and tastes.
Surface water (for boiler-feed water): Flows over coke to remove free carbon dioxide and iron; alum added to flocculate solids; flows through sand filters to remove suspended matter; zeolite softener added to remove calcium and magnesium ions; deaerated to remove oxygen; phosphate added to prevent formation of scale; sodium sulfite added to remove remaining oxygen.
Surface water (for cooling use): None.
Capacity of treatment plant:
Ground water: 20,000 gallons per day.
Surface water: 64,800 gallons per day.
Storage:
Ground water: 8,000-gallon tank near well.
Surface water: None.
Total distribution of water for 1951:
Ground water: 2,550,000 gallons
Surface water: 777,600,000 gallons (23,652,000 gallons bypassed for boiler-feed water; 753,948,000 gallons used for cooling purposes, with no treatment)

Analysis, well 8820-3700-6

(Collected June 5, 1952.)

	Parts per million		Parts per million
Silica (SiO_2)	24	Fluoride (F)	0.2
Iron (Fe)	36	Nitrate (NO_3)	.0
Manganese (Mn)	.67	Dissolved solids	114
Calcium (Ca)	8.0	Hardness as $CaCO_3$	
Magnesium (Mg)	3.2	Total	33
Sodium (Na)	6.1	Noncarbonate	0
Potassium (K)	.6	Temperature (°F.)	60
Aluminum (Al)	-	pH	5.5
Bicarbonate (HCO_3)	42	Specific conductance at 25° C. (micromhos)	111
Sulfate (SO_4)	7.2		
Chloride (Cl)	7.8		

Ownership: Pittsburgh Metallurgical Co., Inc.
Source: Tennessee River, 8820-3700-B, 2 miles north of Calvert City, on Kentucky Highway 95.
Treatment:
For domestic use: Lime added for pH adjustment and softening; chlorinated to disinfect water; ferrous sulfate added to coagulate solids; filtered through sand to remove precipitated solids and through activated charcoal to remove odors and tastes. Treatment plant located near well.
For industrial use: None.
Capacity of treatment plant: 40,000 gallons per day.
Storage: 1,000-gallon pressure tank (for domestic supply only) near well.
Total distribution of water for 1951: 473,000,000 gallons.
Average daily pumpage, 1951: 1,296,000 gallons.
Breakdown of distribution as to use:

Domestic	14,000,000 gallons
Industrial (cooling)	459,000,000 gallons

Kentucky Dam Village State Park (P. O.: Gilbertsville)

Population served: 200.
Ownership: Commonwealth of Kentucky.
Source: One well, 8815-3700-1, on Kentucky Highway 282, 0.5 mile north of Kentucky Dam Village. Depth, 95 feet; diameter, 10 to 8 inches; date drilled, 1939; water-bearing formation, alluvium; yield, 200 gallons per minute.
Treatment: Aerated to remove free carbon dioxide and to precipitate iron; lime added to raise pH; activated carbon added to remove tastes and odors; alum added to flocculate solids; flows through sand filters to remove solids; chlorinated to disinfect water; calgon added to soften water and to prevent precipitation of calcium and magnesium; pumped to clear well. Treatment plant adjacent to well.
Capacity of treatment plant: 288,000 gallons per day.
Storage: Clear well, adjacent to supply well, 16,000 gallons; elevated tank, 0.4 mile south of Kentucky Dam Village, 100,000 gallons.
Total distribution of water for 1951: 32,918,000 gallons.
Average daily pumpage, 1951: 90,000 gallons.

Average pumpage, in gallons per day, 1951

January	73,000	May	103,000	September	60,000
February	93,000	June	104,000	October	69,000
March	86,000	July	87,000	November	92,000
April	90,000	August	131,000	December	97,000

Analysis, well 8815-3700-1

(Collected July 5, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	16	Fluoride (F)	0.1
Iron (Fe)	11	Nitrate (NO_3)	3.5
Manganese (Mn)	-	Dissolved solids	167
Calcium (Ca)	41	Hardness as $CaCO_3$	
Magnesium (Mg)	7.8	Total	135
Sodium (Na)	7.9	Noncarbonate	0
Potassium (K)	.8	Temperature (°F.)	59
Aluminum (Al)	-	pH	6.4
Bicarbonate (HCO_3)	168	Specific conductance at 25° C. (micromhos)	288
Sulfate (SO_4)	4.9		
Chloride (Cl)	6.8		

Palma

Ownership: Texas Gas Transmission Corp.
Source: One well, 8820-3655-5, on U. S. Highway 68, Palma. Depth, 180 feet; diameter, 6 inches; date drilled, August 1950; water-bearing formation, Ripley; yield, 300 gallons per minute.
Treatment: Sodium zeolite softener near well.
Capacity of treatment plant: 36,000 gallons per day.
Storage: Settling tank, 1,000 gallons; pressure tank, 1,000 gallons; elevated tank for emergency use, 60,000 gallons. Storage facilities near well.
Total distribution of water for 1951: 19,890,000 gallons.
Maximum monthly .... July ..... 2,790,000 gallons
Minimum monthly ..... February .... 1,008,000 gallons
Average daily pumpage, 1951: 54,000 gallons (36,000 gallons per day treated for use; 18,000 gallons per day wasted).

Analysis, well 8820-3655-5

(Collected Oct. 19, 1951)

	Parts per million		Parts per million
Silica (SiO_2)	9.8	Fluoride (F)	0.2
Iron (Fe)	.42	Nitrate (NO_3)	.2
Manganese (Mn)	.00	Dissolved solids	213
Calcium (Ca)	57	Hardness as $CaCO_3$	
Magnesium (Mg)	9.5	Total	182
Sodium (Na)	6.1	Noncarbonate	11
Potassium (K)	2.2	Temperature (°F.)	59
Aluminum (Al)	-	pH	7.6
Bicarbonate (HCO_3) ...	208	Specific conductance at 25° C. (micromhos) ..	372
Sulfate (SO_4)	14		
Chloride (Cl)	10		

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