WATER SUPPLIES IN WESTERN KENTUCKY DURING 1984

by Clyde J. Sholar and Pamla A. Wood

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CONVERSION FACTORS

For use of readers who prefer to use metric units, conversion factors for terms used in this report are listed below:

Multiply	By	To obtain
acre	4,047	square meter (m^2)
acre-foot (acre-ft)	1,233	cubic meter (m^3)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
foot (ft)	0.3048	meter (m)
gallon (gal)	0.003785	cubic meter (m^3)
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
gallon per minute (gal/min)	0.06308	cubic meter per second (m^3/s)
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter [(L/s)/m]
inch (in.)	25.4	millimeter (mm)
inch per year (in/yr)	25.4	millimeter per year (mm/a)
mile (mi)	1.609	kilometer (km)
million gallons (Mgal)	3,785	cubic meter (m^3)
million gallons per day (Mgal/d)	3,785	cubic meters per day (m^3/d)
square foot per day (ft^2/d)	0.09290	square meter per day (m^2/d)
square mile (mi^2)	2.590	square kilometer (km^2)

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level".

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ABSTRACT

An inventory was conducted between April and October 1985 of major public supply systems and of self-supplied commercial and industrial water systems in a 27-county area in western Kentucky. These systems, because they withdraw at least 10,000 gallons per day, are regulated by the Kentucky Natural Resources and Environmental Protection Cabinet (Division of Water) through a permitting program. The major purpose of the inventory was to evaluate the adequacy of these water systems to meet demands during times of drought.

A total of 101 permitted systems were inventoried. The inventory indicated that these systems withdrew 116.3 million gallons per day in 1984. Permitted systems frequently sell water to smaller, permit-exempt systems. In all, the study showed that 111 public facilities supplied 33.1 million gallons per day to 471,500 people in the study area. Bowling Green Municipal Utilities in the Green River basin was the largest single public supplier with 11,760 residential connections. It supplied 5.05 million gallons per day to 48,000 people, and also sold over 1.7 million gallons per day to about 30,000 people through the Warren County Water System. Residential per capita use averaged 70 gallons per day for the study area. Comparisons of ground- and surface-water use indicated the Lower Ohio River basin had the highest percentage of surface-water use at 97 percent, and the Mississippi River basin had the highest percentage of ground-water use at 41 percent.

Sources of water were generally adequate throughout the study area. Only two public water supply systems, Franklin Water Works and Greenville Utilities Commission, had inadequate sources during drought periods. Sources for two industries, also in the Green River basin, are inadequate. Several water systems could not be evaluated for their susceptibility to droughts because adequacy of their source was unknown. This was attributed to lack of available low-flow or ground-water information. However, none of these systems experienced problems during drought periods in recent years.

Six systems may have potential problems with their treatment plant capacities because they are operating at greater than 80 percent of design capacity. Three of these systems are in the Green River basin, two are in the Lower Cumberland River basin, and one is in the Tennessee River basin.

INTRODUCTION

Kentucky usually has an abundant water supply because of the large amount of precipitation and numerous streams and reservoirs in the State. However, the supply of water is not constant because of seasonal and areal variation in precipitation. These factors plus increased water demands during summer and fall occasionally lead to water shortages for some systems.

Effective water resource planning requires information about adequacy of supply. Thus a cooperative study between the U.S. Geological Survey and the Kentucky Natural Resources and Environmental Protection Cabinet (KNREPC), Division of Water, was begun in 1984 to gather more information about adequacy of water supplies during droughts in a 27-county area in western Kentucky (fig. 1).

Purpose and Scope

The purpose of this report is to provide an inventory of major public water systems, major self-supplied commercial and industrial water systems, their sources of supply, and to evaluate the adequacy of these systems to meet demands in times of drought.

The scope is limited to the evaluation of public water systems and self-supplied water systems that withdrew at least 10,000 gal/d or purchased at least 5,000 gal/d in a 27-county area in western Kentucky.

Description of Study Area

The study area included the 27 counties in western Kentucky listed below:

Allen	Edmonson	McCracken
Ballard	Fulton	Metcalfe
Barren	Graves	Monroe
Butler	Grayson	Muhlenberg
Caldwell	Hickman	Ohio
Calloway	Livingston	Simpson
Carlisle	Logan	Todd
Christian	Lyon	Trigg
Cumberland	Marshall	Warren

Figure 1 shows the study area and the major drainage basins. The study area includes all of the Mississippi embayment, and parts of the Mississippian Plateaus and Western Coal Field physiographic regions in Kentucky (fig. 2).

Data Collection and Presentation

The information for this report was taken from inventory forms sent to and received from public water systems and from self-supplied water systems between April and October 1985 and was based on 1984 data. These inventory forms contained basic information about the water systems such as county name, system or industry name, source of water, intake location, and storage capacity. Additional information was requested such as existing or potential problems facing the system and alternate supply sources, if any. Examples of inventory forms used in the study are included in tables 30-31, in the "Supplemental Data" section.

The data in this report are presented by river basin as delineated by Seaber and others (1984). The study area includes parts of the Green, Lower Cumberland, Tennessee, Mississippi, and Lower Ohio River basins. For convenience Cumberland County, a small part of the study area in the Upper Cumberland River basin, was included in the Green River basin section of this report.

The basin sections include (1) a basin description, (2) hydrologic characteristics, and (3) comments about the public water systems and self-supplied commercial and industrial water systems that withdraw 10,000 gal/d or more or purchase 5,000 gal/d or more.

Tables are included that list average discharge, low-flow, and precipitation data for selected stations, and information about all major water systems within the basin. Definition of terms used in the tables are explained in the text for the first basin. A reference index is included in table 32, in the "Supplemental Data" section, that alphabetically lists the major water facilities in the study area.

Basin maps are provided that outline the basin, major subbasins (by hydrologic unit), and study area within each basin. Also included are maps presenting locations of the water withdrawals in relation to the hydrologic data stations. These are shown together because streamflow information from these stations were used in the evaluation of the surface-water withdrawals. The reader can also see withdrawal locations where streamflow information is limited or does not exist. Site numbers were assigned to water systems within each basin, according to magnitude of water withdrawals.

Streamflow, precipitation, runoff, and reservoir information are presented because of their importance in describing the hydrologic characteristics that directly influence the availability of water in the area. Daily streamflow, precipitation, and runoff information presented in this report was taken from U.S. Geological Survey annual reports and from Melcher and Ruhl (1984). Only data from daily stations in operation in 1984 are presented. Some data for stations outside the study area were included because they were used in system evaluations.

Low-flow partial-record information for this report was obtained from Sullavan (1984). Sullavan listed data for stream sites at which periodic measurements were made during periods of no storm runoff (base-flow conditions). Low-flow frequencies for these partial-record sites were approximated using these periodic measurements and frequency curves from continuous-record "index" gaging stations.

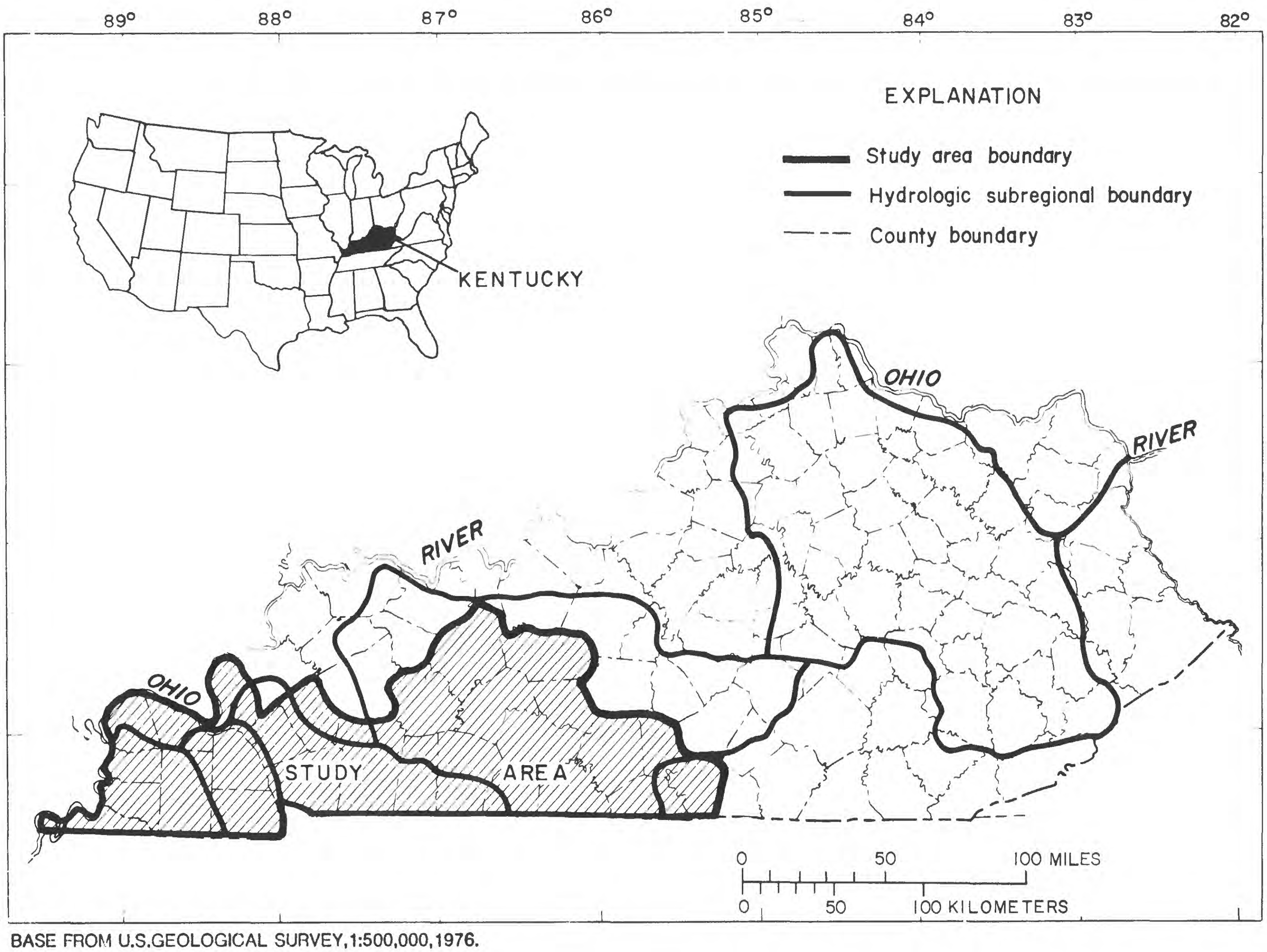


Figure 1.--Location of study area and major drainage basins in Kentucky.

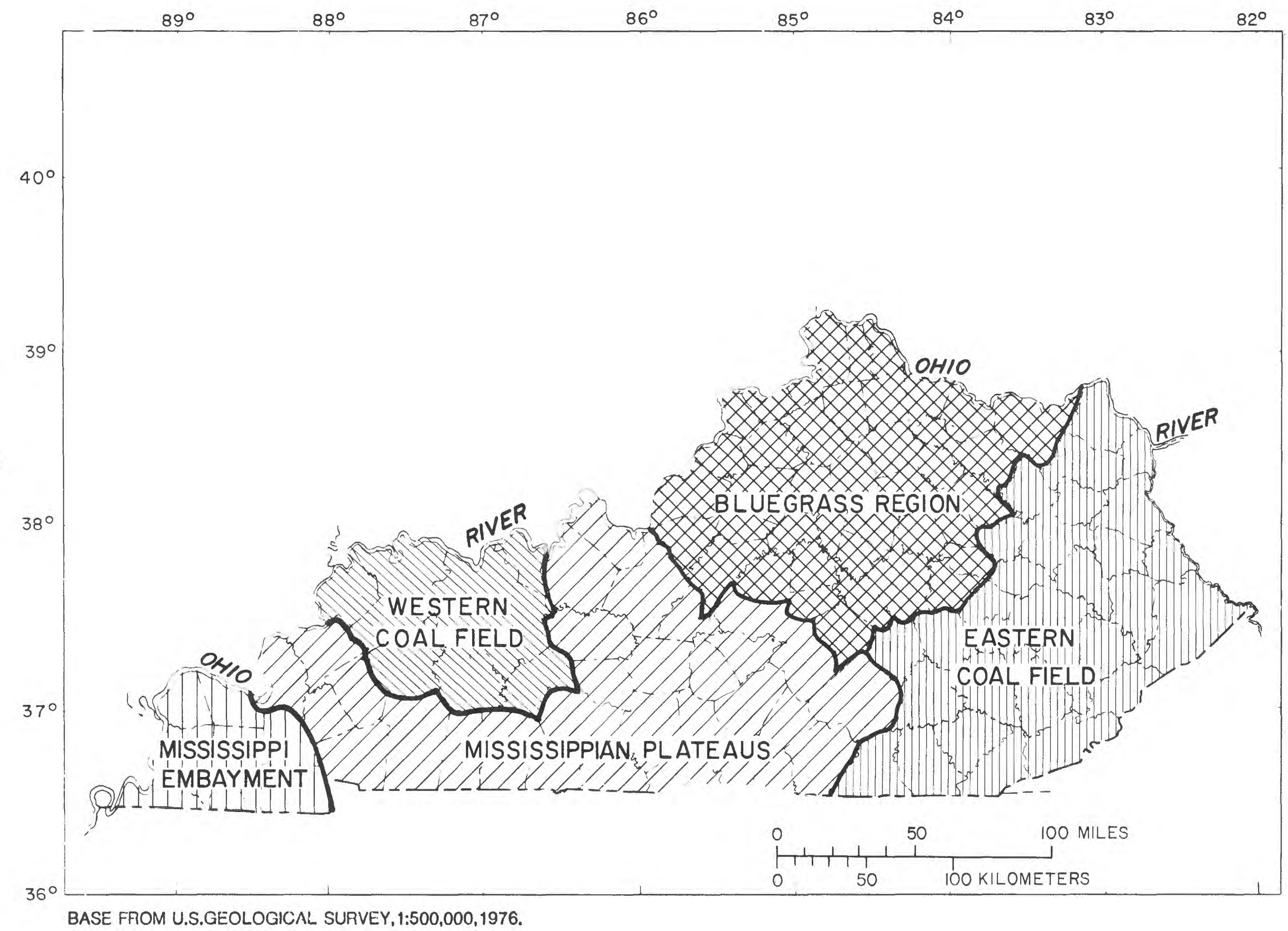


Figure 2.--Physiographic regions in Kentucky (modified from Fenneman, 1938).

Acknowledgments

The authors thank the operators of the water systems, city and county officials, and representatives of industry who were very cooperative in supplying information for this study. Special acknowledgment is given to Stanley J. Wentz of the Tennessee Valley Authority for his role in developing the study workplan and providing assistance throughout the project.

WATER SUPPLIES IN THE GREEN RIVER BASIN

Basin Description

The study area within the Green River basin includes all or major parts of Allen, Barren, Butler, Edmonson, Grayson, Metcalfe, Monroe, Muhlenburg, Ohio, Simpson, and Warren Counties and minor parts of Christian, Logan, and Todd Counties. The Green River basin in Kentucky and its major subbasins are shown in figure 3. Cumberland County, the only county in the study area that is in the Upper Cumberland River basin, is included in this section due to its geographic location.

The Green River basin is the largest basin in Kentucky. The Green River drains about 8,730 mi^2 in west-central Kentucky and about 412 mi^2 in northern Tennessee. It stretches 330 mi from its headwaters in Casey and Lincoln Counties to its confluence with the Ohio River near Owensboro. The basin varies in topography from a rolling plateau in the upper reaches of the Green River to a low, broad flood plain near the mouth. The physiographic regions in the basin (fig. 2) are the Western Coal Field and the Mississippian Plateaus.

The Western Coal Field comprises approximately the northwest quarter of the Green River basin. It is characterized by broad alluvial valleys and hilly uplands. The alluvial terraces and floodplains of the Ohio River, Green River, and their tributaries form the north and northwest boundaries of the Western Coal Field. This physiographic region is an extension of the structural basin that extends into Illinois and Indiana. Exposed rocks in the area are comprised of sandstone, siltstone, and shale with thin beds of limestone, dolomite, and coal.

The Mississippian Plateaus physiographic region makes up most of the Green River basin. The topography of the region is variable, but typically it is a rolling upland karst plain of low relief characterized by numerous sinkholes, subsurface drainage, and a low density of surface streams. Surface drainage in some areas is almost non-existent, and in other areas it is difficult to define drainage areas because subsurface drainage divides do not coincide with those of the surface drainage.

Hydrology

Surface Water

Tributary basins

The part of the Green River basin that is in Kentucky consists of all or part of the following tributary basins. Hydrologic unit codes and names, and drainage areas are from Seaber and others, 1984.

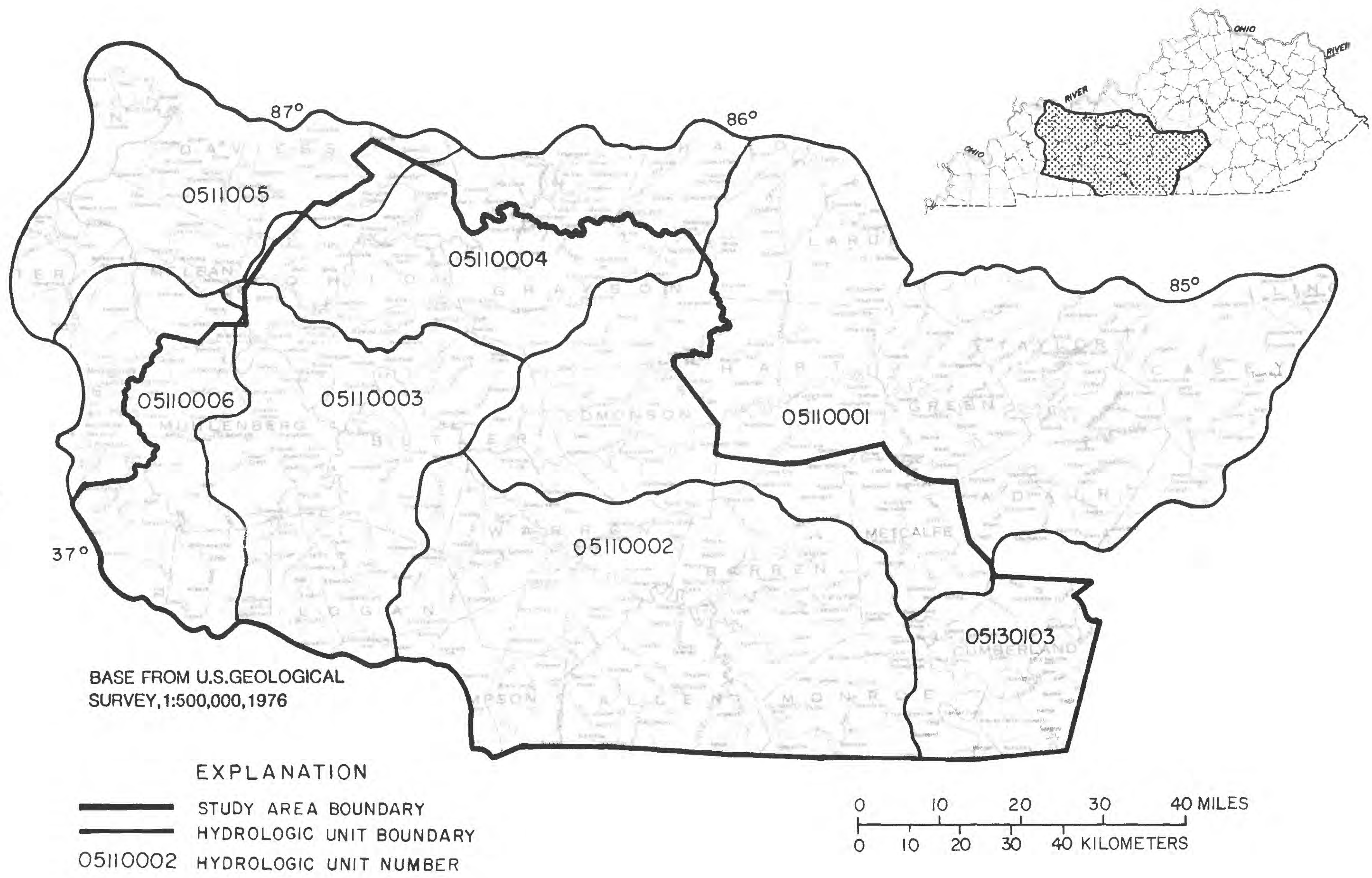


Figure 3.--Green River basin in Kentucky.

Hydrologic unit code	Hydrologic unit name	Drainage area (mi²)
05110001	Upper Green River basin	3130
05110002	Barren River basin	1818
05110003	Middle Green River basin	1010
05110004	Rough River basin	1070
05110005	Lower Green River basin	911
05110006	Pond River basin	784
05130113	Upper Cumberland River basin--Cumberland County only.	310

Major tributary streams

Major tributary streams draining the study area in the Green River basin are listed below for each tributary basin:

Upper Green River basin--Headwaters of the Green and Nolin Rivers, Big Reedy Creek, Little Reedy Creek, Bear Creek, and Rock Creek

Barren River basin--Barren River, Casper River, Little Barren River, Beaver Creek, Difficult Creek, Falling Timber Creek, and West Fork Drakes Creek

Middle Green River basin--Mud River, Muddy Creek, Indian Camp Creek, and Welch Creek

Rough River basin--Rough River, Caney Creek, and Muddy Creek

Lower Green River basin--South Fork Panther Creek

Pond River basin--Pond River and Cypress Creek

Upper Cumberland River basin (Cumberland County only)--Crows Creek, Big Renox Creek, and Marrowbone Creek

Streamflow data

Continuous-record stations.--Table 1 contains streamflow data and information for existing continuous-record (daily) stations in the Green River basin from Survey gaging-station records and from Melcher and Ruhl (1984). See figures 4 and 5 for locations.

Table 1.--Streamflow data for continuous-record stations in the Green River basin

USGS station No.	Station name and location (county)	Drainage area (mi^2)	Period of record	Average discharge (ft^3/s)	Low flow (ft^3/s) 7-day, 2-year	Low flow (ft^3/s) 7-day, 10-year
UPPER GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110001						
03310300	Nolin River at White Mills (LaRue).*	357	1960-82	492	51	37
03310400	Bacon Creek near Priceville (Hart).*	85.4	1960-82	58.7	9.3	6.0
03306000	Green River near Campbellsville (Taylor).*	682	1931-32 1964-82	1,106	11	1.8
03307000	Russell Creek near Columbia (Adair).*	188	1939-82	294	5.5	1.7
03308500	Green River at Munfordville (Hart).*	1673	1915-23 1928-31 1938-82	2,713	114	73
03311000	Nolin River at Kyrock (Edmonson).	703	1930-32 1939-50 1961 1982	929	73	52
03311500	Green River at Lock 6 at Brownsville (Edmonson).	2762	1925-31 1938-82	4,357	309	173
03311600	Beaverdam Creek at Rhoda (Edmonson).	10.9	1973-82	18.6	0.8	0.34
BARREN RIVER BASIN HYDROLOGIC UNIT CODE 05110002						
03313000	Barren River near Finney (Barren).	942	1942-50 1961-82	1,511	80	58
03313700	West Fork Drakes Creek near Franklin (Simpson).	110	1968-82	208	7.8	3.0
03314500	Barren River at Bowling Green (Warren).	1849	1938-82	2,588	143	69

Table 1.--Streamflow data for continuous-record stations in the Green River basin

USGS station No.	Station name and location (county)	Drainage area (mi^2)	Period of record	Average discharge (ft^3/s)	Low flow (ft^3/s) 7-day, 2-year	7-day, 10-year
MIDDLE GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110003						
03315500	Green River at Lock 4 at Woodbury (Butler).	5404	1938-82	8,374	563	294
ROUGH RIVER BASIN HYDROLOGIC UNIT CODE 05110004						
03318500	Rough River at Falls of Rough (Grayson).	504	1939-82	769	17	9.5
03318800	Caney Creek near Horse Branch (Ohio).	124	1957-82	187	0	0
03319000	Rough River near Dundee (Ohio).	757	1940-82	1,087	36	16
LOWER GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110005						
03320000	Green River at Lock 2 at Calhoun (McLean).*	7566	1930-82	11,160	663	362
POND RIVER BASIN HYDROLOGIC UNIT CODE 05110006						
03320500	Pond River near Apex (Christian).	194	1940-82	265	0.04	0
UPPER CUMBERLAND-LAKE CUMBERLAND BASIN HYDROLOGIC UNIT CODE 05130103 (Cumberland County only)--there are no continuous-record stations operated by the Survey in Cumberland County.						

* not in study area

Low-flow partial-record stations.--Table 2 contains low-flow data for sites in the Green River basin where measurements have been made and correlated with continuous-record index stations to produce low-flow frequency correlations (Sullavan, 1984). See figure 4 and 5 for locations. There are no low-flow partial-record stations in the Rough River basin (Hydrologic Unit Code 05110004), the Lower Green River basin (Hydrologic Unit Code 0110005), or the Pond River basin (Hydrologic Unit Code 05110006).

Table 2.--Low-flow data for partial-record stations in the Green River basin

USGS station No.	Station name and location (county)	Drainage area (mi^2)	Low flow (ft^3/s) 7-day, 2-year	Low flow (ft^3/s) 7-day, 10-year
UPPER GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110001				
03306850	Russell Creek at Columbia (Adair).*	126	5.5	1.7
03307295	Big Pitman Creek near Summerville (Green).*	126	1.4	0.3
03309100	Wet Prong Buffalo Creek near Mammoth Cave (Edmonson).	2.26	1.0	0.8
03310600	Dog Creek near Mammoth Cave (Edmonson).	8.12	1.6	1.1
03311100	Bylew Creek near Mammoth Cave (Edmonson).	5.16	.6	.4
03312100	Bear Creek near Roundhill (Edmonson).	137	.9	.5
BARREN RIVER BASIN HYDROLOGIC UNIT CODE 05110002				
03313900	Trammel Creek near Scottsville (Allen).	93.4	8.3	4.5
03315265	Gasper River near Richelieu (Warren).	160	4.2	1.7
03315300	Gasper River at Hadley (Warren).	190	3.0	1.0

Table 2.--Low-flow data for partial-record stations in the Green River basin-Continued

USGS station No.	Station name and location (county)	Drainage area (mi^2)	Low flow (ft^3/s) 7-day, 2-year	Low flow (ft^3/s) 7-day, 10-year
MIDDLE GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110003				
03315810	Muddy Creek at Dunbar (Butler).	94.3	0	0
03316200	Wolf Lick Creek near Lewisburg (Logan).	116	.3	0
UPPER CUMBERLAND-LAKE CUMBERLAND BASIN HYDROLOGIC UNIT CODE 05130103				
03414080	Crocus Creek near Bakerton (Cumberland).	108	1.2	.4

* not in study area

Reservoirs

Reservoirs in the Green River basin are as follows:

Basin	Storage capacity acre-ft	Storage capacity Mgal
Rough River Lake	305,000	99,430
Green River Lake	723,200	235,763
Nolin Lake	609,000	198,534
Barren River Lake	815,000	265,690
Lake Malone	14,250	4,645
Lake Herndon	8,000	2,608
Luzerne Lake	520	170

Green River Dam is in Taylor County about 26 mi upstream from Greensburg, and the lake extends into Casey and Adair Counties. The lake receives runoff from 682 mi^2 of drainage area.

Nolin Dam is in Edmonson County 7.8 mi above the confluence of the Nolin and Green Rivers. The drainage area upstream of the dam is 703 mi^2.

The Barren River Lake is in Allen, Barren, and Monroe Counties in south-central Kentucky. The dam is about 10 mi southeast of Scottsville, Ky., on the Barren River. The drainage area upstream of the dam is 940 mi^2.

The drainage area upstream of Rough River Lake is in Breckinridge, Hardin, and Grayson Counties. The dam is in Breckinridge and Grayson Counties, 89.3 mi above the mouth of Rough River and 6 mi upstream from the Falls of Rough. The lake receives runoff from a drainage area of 454 mi^2.

Precipitation and runoff

Mean annual precipitation ranges from 47 to 52 in/yr at the continuous-record stations (table 3) in the basin. Average runoff ranges from 9.33 in/yr at station 03310400 Bacon Creek near Priceville to 25.68 in/yr at station 03313700 West Fork Drakes Creek near Franklin.

Ground Water

The availability of ground water and a general overview of the water-bearing characteristics and the distribution of the geologic formations in the basin are described in several reports by Maxwell and Devaul, (1962), Devaul and Maxwell, (1962), and Brown and Lambert, (1962). The following is a list of the water-bearing rocks in the basin and a brief summary for each aquifer taken from published atlases and other reports referenced:

1. Alluvium of Quaternary age
2. Rocks of Pennsylvanian age
3. Chesterian rocks of Late Mississippian age
4. Meramecian rocks of Late Mississippian age
5. Osagean rocks of Early Mississippian age
6. Rocks of Devonian, Silurian, and Ordovician ages.

The principal aquifer along the bottoms of the Green River is the alluvium of Quaternary age. The alluvium yields as much as 100 gal/min to wells and potentially higher yields are possible where the saturated thickness is greatest. Ryder (1973) reported a transmissivity of 1,600 ft^2/d and a storage coefficient of 8×10^{-5} at one site near Rockport. No large production wells are known in the Green River bottoms in the area of study.

Rocks of Pennsylvanian age in the Western Coal Field consist of a thick sequence of shales and sandstones with minor amounts of limestones and coal. Saltwater occurs at shallow depths below stream level throughout most of the area. Locally, freshwater is present in deep buried channels near the base of the Pennsylvanian sediments. For example, well depths are 275 ft at Beaver Dam, 740 ft at Nortonville, and 800 ft at White Plains. Well yields in the Pennsylvanian sandstones may be as high as 100 gal/min, but they generally average less than 10 gal/min. The water is generally soft and is a sodium bicarbonate type.

Table 3.--Precipitation and runoff data for selected stations in the Green River basin

USGS station No.	Station name and location (county)	Mean annual precipitation (in/yr)	Average runoff (in/yr)
UPPER GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110001			
03310300	Nolin River at White Mills (LaRue) *	48	18.72
03310400	Bacon Creek near Priceville (Hart).*	50	9.33
03306000	Green River near Campbellsville (Taylor).*	48	22.02
03307000	Russell Creek near Columbia (Adair).*	52	21.24
03308500	Green River at Munfordville (Hart).*	50	22.02
03311000	Nolin River at Kyrock (Edmonson).	50	17.95
03311500	Green River at Lock 6 at Brownsville (Edmonson).	50	21.42
03311600	Beaverdam Creek at Rhoda (Edmonson).	49	23.17
BARREN RIVER BASIN HYDROLOGIC UNIT CODE 05110002			
03313000	Barren River near Finney (Allen).	51	21.78
03313700	West Fork Drakes Creek near Franklin (Simpson).	47	25.68
03314500	Barren River at Bowling Green (Warren).	50	19.01
MIDDLE GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110003			
03315500	Green River at Lock 4 at Woodbury (Butler).	50	21.04
ROUGH RIVER BASIN HYDROLOGIC UNIT CODE 05110004			
03318500	Rough River at Falls of Rough (Grayson).	47	20.72
03318800	Caney Creek near Horse Branch (Ohio).	48	20.48
03319000	Rough River near Dundee (Ohio).	47	18.96
LOWER GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110005			
03320000	Green River at Lock 2 at Calhoun (McLean),*	48	20.03
POND RIVER BASIN HYDROLOGIC UNIT CODE 05110006			
03320500	Pond River near Apex (Christian).	47	18.55

* not in study area

The Chesterian rocks of Late Mississippian age generally furnish adequate water for domestic use. Water occurs in sandstone, limestone, and discontinuous layers of shale. Many springs yield up to 100 gal/min, but some yield less than 2 gal/min.

Meramecian rocks of Late Mississippian age have the most potential for ground-water development in the Green River basin. Well yields of at least 500 gal/min and high spring flows have been reported. Spring flows are an indication of how much water is available within a ground-water karst basin, but they do not indicate the volume of ground-water storage. Brown and Lambert (1962) estimated that only 2 percent of the inventoried wells in the area yield more than 50 gal/min. These wells were randomly chosen for data and were not located for maximum yields. Water from limestone is generally moderately hard to very hard and it contains excessive sulfate locally. Ground water in karst areas is highly susceptible to pollution because of direct recharge, through openings such as sinkholes, to the ground-water system.

The Osagean rocks of Early Mississippian age occur in the southeast part of the basin. Most wells are less than 100 ft deep and furnish sufficient water for domestic use. Large supplies of water are not available from the impure limestones and shales.

Rocks of Devonian, Silurian, and Ordovician ages are not important aquifers throughout the area. An important spring horizon in limestones of Silurian age occurs in Barren and Allen Counties.

Major Water Users

Permitted water users.

The following facilities, listed by magnitude of use, have been issued permits by the Kentucky Division of Water to withdraw water in the Green River basin and from the Upper Cumberland River basin in Cumberland County. Of the total amount of water withdrawn by these facilities, 94 percent was surface water and 6 percent was ground water.

Site No.	Permitted facilities	1984 Average withdrawal (gal/d)
1	Bowling Green Mun. Util.	8,806,000
2	Peabody Coal Ken Prep Plant*	4,128,000
3a,3b	Glasgow Water Plant #1 & #2	3,282,400
4	Central City Water & Sewer	2,241,700
5	Franklin Water Works	2,135,400
6	Peabody Coal Gibralter Mine	1,800,000
7	Kentucky Ag. Energy	1,720,000
8	Russellville Mun. Water Syst.	1,554,000
9	Ohio County Water Dist.	1,216,500
10	Leitchfield Water Works	829,000
11	Tompkinsville Water Works	565,000

Site No.	Permitted facilities	1984 Average withdrawal (gal/d)
12	TVA Paradise Coal Washing	550,000
13	Greenville Util. Commission	500,000
14	Edmonson Co. Water Dist.	478,400
15	Morgantown Water Syst.	465,900
16	Warren County Water Dist.*	424,400
17	Hartford Mun. Water Works	415,000
18	Scottsville Water Dept.*	383,600
19	Todd County Water Dist.	324,200
20	Burkesville Water Works	299,000
21	Logan Aluminum	186,200
22	Peabody Coal Alston Mine	166,000
23	Auburn Water Dept.	158,000
24	Rochester Water Dist.	152,400
25	Nestaway-Coated Met. Products*	133,600
26	Peabody Coal River Queen Mine	115,200
27	Beaver Dam Mun. Water Syst.*	108,600
28	Marrowbone Water Dist.	85,000
29	Caneyville Mun. Water Works	80,000
30	Fordsville Water Dist.	63,800
31	Vermont American Corp.	60,900
32	Rockport Water Works	60,000
33	Rough River State Park	35,000
34	AMCA Processing	30,000
35	Dogwood Ridge Farms	26,000
36	Glasgow Foods, Inc.*	20,300
37	Concord Farms	18,000
38	Auburn Hosiery Mills	15,000
39	Squire Lyle Farms	11,000
40	Southwind Mining	10,000
	TOTAL	33,663,500

* Facility also uses water purchased from another permittee. Amount purchased is not shown here.

Sources of water for public supplies and for self-supplied commercial supplies.

Table 4 shows permitted public water suppliers and self-supplied commercial water suppliers in the Green River basin. The source(s) of water and the amounts withdrawn are listed for each permittee. Systems purchasing water from permitted facilities are indented below the supplier. Their purchased water is shown in parentheses and is part of the average withdrawal shown for the permittee. Permittees are listed alphabetically within each hydrologic unit or tributary basin. Locations of these systems are shown in figure 4.

Table 4.--Public water suppliers and self-supplied commercial water suppliers in the Green River basin

[Drought susceptibility class--A. System unlikely to experience water shortage during drought conditions. B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage. C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary. Dashes (---) in columns mean data not available.]

Site No.	System name and town (county)	Source of supply	Latitude and longitude of intakes	Drought susceptibility class (A-C)	Average withdrawal or use (gal/d)	Treated storage (gal)	Treatment plant design capacity (gal/d)
	UPPER GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110001						
14	Edmonson Co. Water Dist. Brownsville (Edmonson)	Green River (Regulated)	37 12 08 86 15 35	A	478,400	1,440,000	500,000
	Brownsville Mun. Water Syst. Brownsville (Edmonson)				(74,800)	200,000	0
	BARREN RIVER BASIN HYDROLOGIC UNIT CODE 05110002						
23	Auburn Water Dept. Auburn (Logan)	Black Lick Cr. at Blue Hole Spr.	36 51 42 86 42 35	Unknown	158,000	90,000	200,000
1	Bowling Green Mun. Util. Bowling Green (Warren)	Barren River (Regulated)	36 59 58 86 25 29	A	8,806,000	11,000,000	14,400,000
	Warren County Water Dist. Bowling Green (Warren)				(2,997,100)	150,000	0
5	Franklin Water Works [1] Franklin (Simpson)	Drakes Cr.	36 43 20 86 33 09	C	2,135,400	1,175,000	2,500,000
	Simpson Co. Water Dist. Bowling Green (Simpson)				(559,200)	500,000	0
3a	Glasgow Water Plant #1 [2] Glasgow (Barren)	Beaver Cr.	37 01 45 85 54 30	Unknown	1,739,700	2,000,000	2,600,000
3b	Glasgow Water Plant #2 Glasgow (Barren)	Barren River Lake	36 54 00 86 03 45	A	1,542,700	2,000,000	6,000,000
	Edmonton Water Works Edmonton (Metcalfe)				(125,000)	510,000	250,000
	Fountain Run Water Dist. #1 Fountain Run (Monroe)				(22,000)	200,000	0
	N. Barren Water Assoc. Glasgow (Barren)				(107,900)	100,000	0
	Park City Water Works Park City (Barren)				(43,100)	360,000	0
	Scottsville Water Dept. Glasgow (Allen)				(93,400)	0	0
18	Scottsville Water Dept. Scottsville (Allen)	Calvert Spr.	36 43 26 66 04 28	B	383,600	761,000	720,000
	Allen Co. Water Dist. Scottsville (Allen)				(38,500)	0	0
11	Tompkinsville Water Works Tompkinsville (Monroe)	Mill Creek Lake	36 41 00 85 42 10	A	565,000	1,100,000	1,500,000
	Monroe Co. Water Dist. Tompkinsville (Monroe)				(141,000)	312,000	120,000
16	Warren County Water Dist. Bowling Green (Warren)	Plum Spr.	37 01 25 86 23 38	A	424,400	---	600,000
	MIDDLE GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110003						
4	Central City Water & Sewer Central City (Muhlenberg)	Green River (Regulated)	37 19 27 87 07 03	A	2,241,700	1,985,000	4,000,000
	Muhlenberg Co. Water Dist. #1 Greenville (Muhlenberg)				(1,107,200)	1,820,000	1,500,000
	Drakesboro Water Dept. Drakesboro (Muhlenberg)				(80,900)	155,000	100,000
	Muhlenberg Co. Water Dist. #2 Graham (Muhlenberg)				(75,800)	50,000	72,000
	Muhlenberg Co. Water Dist. #3 Bremen (Muhlenberg)				(350,200)	500,000	600,000
	Sacramento Water Works Sacramento (McLean)				(86,600)	60,000	0
13	Greenville Util. Commission Greenville (Muhlenberg)	Luzerne Lake	37 12 46 87 11 47	C	500,000	650,000	709,000
15	Morgantown Water Syst. Morgantown (Butler)	Green River (Regulated)	37 13 31 86 40 40	A	465,900	650,000	800,000
	Butler Co. Water Syst. Bowling Green (Butler)				(199,800)	325,000	500,000

Table 4.--Public water suppliers and self-supplied commercial water suppliers in the Green River basin-Continued

[Drought susceptibility class--A. System unlikely to experience water shortage during drought conditions. B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage. C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary. Dashes (---) in columns mean data not available.]

Site No.	System name and town (county)	Source of supply	Latitude and longitude of intakes	Drought susceptibility class (A-C)	Average withdrawal or use (gal/d)	Treated storage (gal)	Treatment plant design capacity (gal/d)
	MIDDLE GREEN RIVER BASIN-Cont. HYDROLOGIC UNIT CODE 05110003						
9	Ohio County Water Dist. Hartford (Ohio)	Green River (Regulated)	37 20 01 86 47 33	A	1,216,500	1,250,000	2,073,600
	Beaver Dam Mun. Water Syst. Beaver Dam (Ohio)				(434,700)	0	0
	Rough River Water Syst. Narrows (Ohio)				(97,800)	100,000	100,000
24	Rochester Water Dist. Rochester (Butler)	Green River (Regulated)	37 12 53 86 53 42	A	152,400	100,000	144,000
	Huntsville-So. Hill Huntsville (Butler)				(23,000)	50,000	0
32	Rockport Water Works Rockport (Ohio)	Green River (Regulated)	37 19 56 87 59 55	A	60,000	55,000	288,000
8	Russellville Mun. Water Syst. Russellville (Logan)	Lake Herndon (Spring fed)	36 53 47 86 57 03	B	1,554,000	3,000,000	2,500,000
	North Logan Water Dist. Russellville (Logan)				(107,200)	100,000	0
	Lewisburg Water Works Lewisburg (Logan)				(84,700)	100,000	108,000
	East Logan Water Dist. Auburn (Logan)				(158,200)	200,000	0
	ROUGH RIVER BASIN HYDROLOGIC UNIT CODE 05110004						
27	Beaver Dam Mun. Water Syst. Beaver Dam (Ohio)	Wells	37 24 11 86 52 37	A	108,600	250,000	115,000
29	Caneyville Mun. Water Works Caneyville (Grayson)	Lake	37 26 48 86 26 07	B	80,000	128,000	144,000
30	Fordsville Water Dist. Fordsville (Ohio)	City Reservoir	37 37 54 86 43 00	B	63,800	125,000	144,000
17	Hartford Mun. Water Works Hartford (Ohio)	Rough River (Regulated)	37 27 10 86 54 40	A	415,000	200,000	500,000
	Centertown Water Syst. Centertown (Ohio)				(85,600)	60,000	144,000
10	Leitchfield Water Works Leitchfield (Grayson)	Rough River Reservoir	37 23 55 86 23 07	A	829,000	775,000	1,000,000
	Grayson Co. Water Works Leitchfield (Grayson)				(154,600)	275,000	266,700
33	Rough River State Park Falls of Rough (Grayson)	Rough River Reservoir	37 36 20 86 30 15	A	35,000	350,000	200,000
	POND RIVER BASIN HYDROLOGIC UNIT CODE 05110006						
19	Todd County Water Dist. Elkton (Todd)	Settles Lake (Spring fed)	36 55 49 87 11 29	B	324,200	577,000	1,036,800
	Elkton Water Works Elkton (Todd)				(182,100)	250,000	0
	UPPER CUMBERLAND RIVER BASIN HYDROLOGIC UNIT CODE 05130103 (Cumberland County only)						
20	Burkesville Water Works Burkesville (Cumberland)	Cumberland River (Regulated)	36 46 36 85 21 47	B	299,000	1,021,000	403,200
	South Cumberland Water Dist. Burkesville (Cumberland)				(100,000)	100,000	0
28	Marrowbone Water Dist. Marrowbone (Cumberland)	Cumberland River (Regulated)	36 47 08 85 24 54	B	85,000	150,000	430,000

[1] Franklin Water Works has an in-stream impoundment which holds approximately a 25-day supply. The 7-day, 10-year low flow of Drakes Creek would serve 92 percent of the town's needs, but its flow is affected by industrial withdrawal upstream.

[2] Two sources, Beaver Creek and Barren River Lake, supply one distribution system which includes all systems listed below Glasgow Water Plant #2.

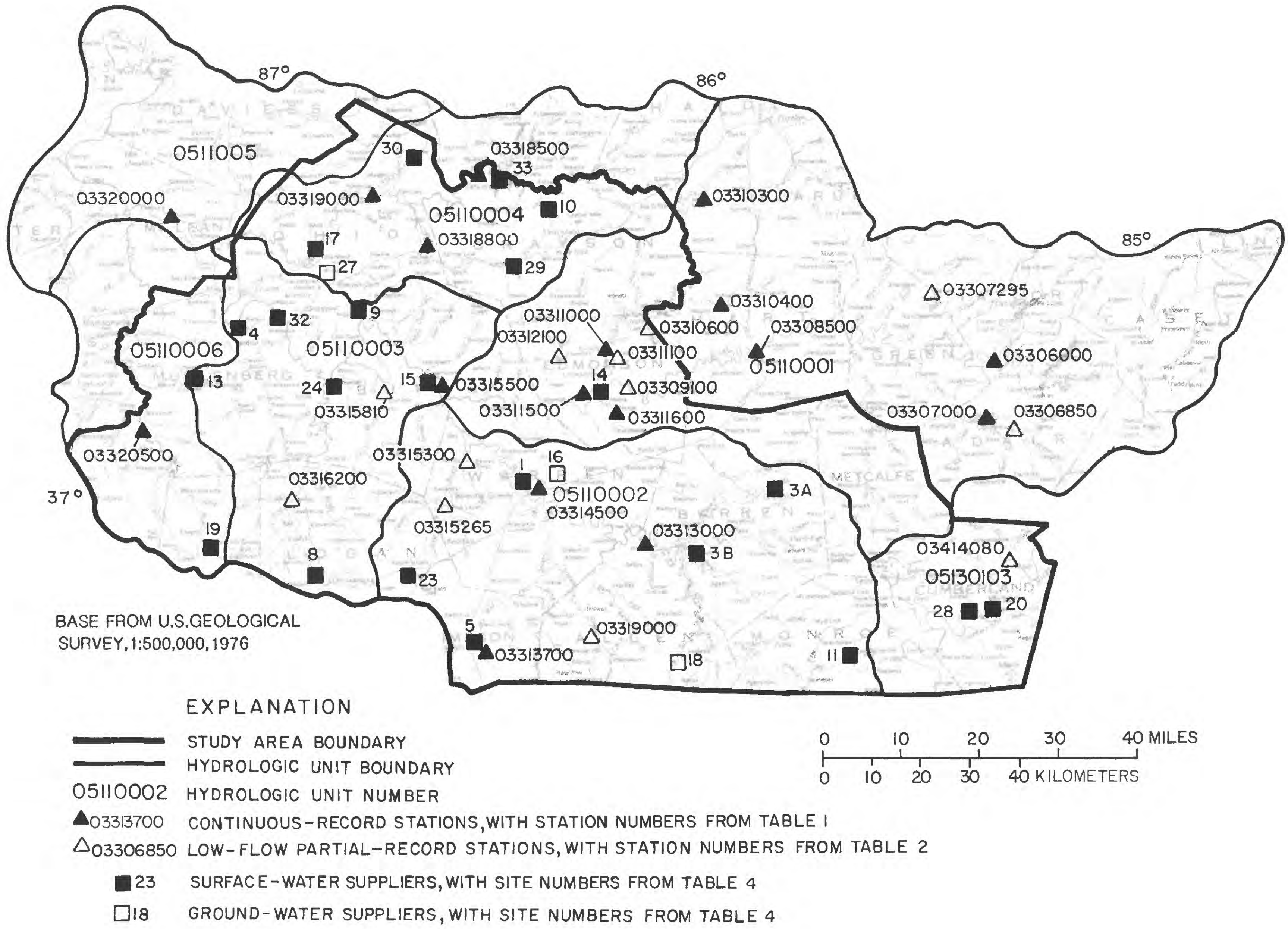


Figure 4.--Public water suppliers, self-supplied commercial water suppliers, and data sites in the Green River basin in Kentucky.

The availability of water is a major concern, especially during drought periods when water withdrawal rates usually increase. Therefore, water-supply systems were evaluated and grouped into three classes of susceptibility to water shortages during drought conditions. Systems were classified by comparing average withdrawal rates to availability at the point of withdrawal. These drought susceptibility classes are:

A. System unlikely to experience water shortage during drought conditions.
B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage.
C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary.

Classes were determined for ground-water supplies according to historical records of aquifer storage. Ground-water records indicated that a short-term drought of less than 2 or 3 years would have little effect on the ground-water supplies for most wells in the study area. Where enough data did not exist to classify the ground-water sources, the drought susceptibility class was listed as unknown.

Systems relying solely on flow from non-regulated streams were classified by comparing average rate of withdrawal to the expected 7-day, 10-year low-flow conditions. The following chart shows how classes were assigned to the non-regulated streams:

Percent of source used	Drought classification
<10	A
10-50	B
>50	C

Systems relying on regulated streams were classified with a wider range between classes due to more control over low-flow conditions. A regulated stream is defined as any stream reach in which flow is determined by releases from upstream reservoirs. The following chart shows how classes were assigned to regulated streams:

Percent of source used	Drought classification
<20	A
20-65	B
>65	C

Systems relying on reservoirs were classified by comparing average withdrawal rates to water stored and to inflow at the reservoir during 7-day, 10-year low-flow conditions. Amount of storage was divided by average use to determine days of water stored. The following chart shows how classes were determined for reservoirs:

Days stored	Percent of source used		
	<15	15-50	>50
>90	A	A	B
51-90	A	B	B
30-50	B	B	B
<30	B	B	C

The evaluation showed that Franklin Water Works and Greenville Utilities Commission systems are likely to experience water-supply problems during drought conditions. Six other systems have the potential for problems during an extended drought. In addition to the availability of the water source during drought conditions, the treatment plant design capacity is an important factor to consider when determining if a water-supply system can meet demands during times of increased water use. Treatment plant capacities are adequate for most of the systems in the Green River basin, but average withdrawal is greater than 80 percent of capacity in the following systems: Edmonson County Water District, Franklin Water Works, and Rochester Water District. The "80 percent of capacity" is classified by the Kentucky Division of Water, Drinking Water Branch, as an indicator that a system is likely to experience difficulties if water use increases. Edmonson, Franklin, and Leitchfield have new plants under construction. Beaver Dam Municipal Water System operates at near capacity, but is not subject to overloading because peak needs are met by purchases from Ohio County Water District.

Use of water distributed by permitted public suppliers and by self-supplied commercial suppliers.

Table 5 shows the use of water that is distributed by permitted public supply systems and by the self-supplied commercial supply systems in the Green River basin. The per capita use was determined by dividing the residential use by the value listed for the population. In most cases, commercial and industrial use was determined and the difference between these combined uses and average withdrawal was listed as residential use. Where leakage or municipal use was known or estimated, residential plus commercial and industrial use will not equal total withdrawals. Systems purchasing water are indented below the supplier.

Table 5.--Use of water in the public supply systems and in the self-supplied commercial supply systems in the Green River basin

[Dashes (---) in columns mean data not available.]

Site No.	System name and town (county)	Population	Connections: Commercial and industrial	Connections: Residential	Average commercial and industrial use (gal/d)	Average residential use (gal/d)	Residential use per capita (gal/d)
	UPPER GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110001						
14	Edmonson Co. Water Dist. Brownsville (Edmonson)	9,700	0	2,900	0	403,600	40
	Brownsville Mun. Water Syst. Brownsville (Edmonson)	800	70	300	33,000	41,800	50
	BARREN RIVER BASIN HYDROLOGIC UNIT CODE 05110002						
23	Auburn Water Dept. Auburn (Logan)	1,470	50	540	25,000	125,000	85
1	Bowling Green Mun. Util. Bowling Green (Warren)	48,000	300	11,760	700,000	5,048,100	105
	Warren County Water Dist. Bowling Green (Warren)	29,570	35	1,100	1,159,400	1,745,500	60
5	Franklin Water Works Franklin (Simpson)	14,700	215	5,575	945,700	504,400	35
	Simpson Co. Water Dist. Bowling Green (Simpson)	5,970	72	1,740	391,400	167,800	30
3a,3b	Glasgow Water Plant #1 & #2 Glasgow (Barren)	11,450	735	6,000	1,072,000	1,230,800	105
	Edmonton Water Works Edmonton (Metcalfe)	1,600	5	895	10,000	115,000	70
	Fountain Run Water Dist. #1 Fountain Run (Monroe)	475	25	140	2,500	18,500	40
	N. Barren Water Assoc. Glasgow (Barren)	1,000	10	340	9,000	78,900	80
	Park City Water Works Park City (Barren)	500	5	240	8,600	30,000	60
	Scottsville Water Dept. Glasgow (Allen)	970	50	340	93,400	50,500	50
18	Scottsville Water Dept. Scottsville (Allen)	4,280	240	1,620	82,300	240,600	55
	Allen Co. Water Dist. Scottsville (Allen)	800	5	305	4,800	33,700	40
11	Tompkinsville Water Works Tompkinsville (Monroe)	4,000	<5	2,000	28,000	396,000	100
	Monroe Co. Water Dist. Tompkinsville (Monroe)	1,690	10	500	11,200	125,800	75
16	Warren County Water Dist. Bowling Green (Warren)	4,030	0	285	0	379,900	95
	MIDDLE GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110003						
4	Central City Water & Sewer Central City (Muhlenberg)	6,000	0	2,200	0	700,000	115
	Muhlenberg Co. Water Dist. #1 Greenville (Muhlenberg)	11,105	---	3,700	149,900	894,100	80
	Drakesboro Water Dept. Drakesboro (Muhlenberg)	1,100	0	340	0	80,900	75
	Muhlenberg Co. Water Dist. #2 Graham (Muhlenberg)	815	<5	255	10,600	85,200	80
	Muhlenberg Co. Water Dist. #3 Bremen (Muhlenberg)	4,420	45	1,200	164,500	185,700	42
	Sacramento Water Works Sacramento (McLean)	1,540	0	515	0	86,600	55
13	Greenville Util. Commission Greenville (Muhlenberg)	5,720	475	1,780	145,900	320,600	55
15	Morgantown Water Syst. Morgantown (Butler)	2,500	70	660	181,500	72,600	30
	Butler Co. Water Syst. Bowling Green (Butler)	3,010	30	1,040	21,000	154,200	50

Table 5.--Use of water in the public supply systems and in the self-supplied commercial supply systems in the Green River basin-Continued

Site No.	System name and town (county)	Population	Connections: Commercial and industrial	Connections: Residential	Average commercial and industrial use (gal/d)	Average residential use (gal/d)	Residential use per capita (gal/d)
	MIDDLE GREEN RIVER BASIN-Cont. HYDROLOGIC UNIT CODE 05110003						
9	Ohio County Water Dist. Hartford (Ohio)	8,200	50	2,650	130,100	553,900	70
	Beaver Dam Mun. Water Syst. Beaver Dam (Ohio)	2,560	225	900	104,100	300,200	115
	Rough River Water Syst. Narrows (Ohio)	1,090	0	330	0	97,800	90
24	Rochester Water Dist. Rochester (Butler)	1,600	<5	500	2,300	127,100	80
	Huntsville-So. Hill Huntsville (Butler)	520	0	156	0	23,000	45
32	Rockport Water Works Rockport (Ohio)	930	5	400	2,000	53,000	65
8	Russellville Mun. Water Syst. Russellville (Logan)	8,580	695	2,440	590,000	600,000	70
	North Logan Water Dist. Russellville (Logan)	1,300	10	370	16,200	75,000	60
	Lewisburg Water Works Lewisburg (Logan)	1,100	50	400	14,400	57,600	50
	East Logan Water Dist. Auburn (Logan)	2,550	15	760	53,800	88,600	35
	ROUGH RIVER BASIN HYDROLOGIC UNIT CODE 05110004						
27	Beaver Dam Mun. Water Syst. Beaver Dam (Ohio)	640	55	225	26,000	75,000	115
29	Caneyville Mun. Water Works Caneyville (Grayson)	745	0	325	0	80,000	107
30	Fordsville Water Dist. Fordsville (Ohio)	1,200	40	270	19,000	44,800	35
17	Hartford Mun. Water Works Hartford (Ohio)	3,100	0	1,000	0	329,400	105
	Centertown Water Syst. Centertown (Ohio)	900	0	400	0	85,600	95
10	Leitchfield Water Works Leitchfield (Grayson)	6,000	200	1,040	271,000	403,400	65
	Grayson Co. Water Works Leitchfield (Grayson)	2,340	25	755	41,000	93,100	40
33	Rough River State Park Falls of Rough (Grayson)	200	<5	0	35,000	0	NA
	POND RIVER BASIN HYDROLOGIC UNIT CODE 05110006						
19	Todd County Water Dist. Elkton (Todd)	2,255	0	850	0	142,100	65
	Elkton Water Works Elkton (Todd)	1,850	50	770	40,000	120,300	65
	UPPER CUMBERLAND RIVER BASIN HYDROLOGIC UNIT CODE 05130103 (Cumberland County only)						
20	Burkesville Water Works Burkesville (Cumberland)	2,100	0	810	0	190,000	90
	South Cumberland Water Dist. Burkesville (Cumberland)	1,550	5	455	12,000	80,000	50
28	Marrowbone Water Dist. Marrowbone (Cumberland)	1,545	19	600	4,200	80,800	50

The following public water suppliers in the Green River basin provide 5,000 gal or more of water per day per industrial, commercial, or institutional user. Users are shown indented under the name of the supplier.

- Beaver Dam Mun. Water Syst.
  - Beaver Dam Industries
  - Nestaway
  - Royal Crown Bottling
  - Thomas Industries
  - Youngs Manufacturing
- Bowling Green Mun. Util.
  - Western Kentucky University
  - Warren County Water Dist.
    - Badd Co.
    - FMC
    - General Motors
    - Kroger Co.
    - Western Kraft
- Burkesville Water Works
  - S. Cumberland
    - Burnside State Park
- Franklin Water Works
  - Brown Printing
  - Dayton Walther
  - Fortune Plastics
  - James B. Downing
  - Kendall
  - Kentucky Ag. Energy Corp.
  - Lenk Co.
  - Sealed Power
  - Weyerhauser
  - Simpson County Water Dist.
    - Aconda American Brass
- Glasgow Water Plant #1 & #2
  - Dairyman Inc. Cheese
  - Dairyman Inc. Whey
  - Eaton Axle Corp.
  - Glasgow Foods, Inc.
  - P.R. Mallory Capacitor
- Glasgow Water Plant #1 & #2 (cont.)
  - R.R. Donnelly Co.
  - Tyson Bearing
  - Edmonton Water Works
    - Metcalfe Industries
    - Topps Manufacturing
- Leitchfield Water Works
  - Bell Cheese
  - Campbell Hausfield
  - Emory Dairy Farm
  - Hoover Universal
  - Tell City Chair
  - Vermont American
- Morgantown Water Syst.
  - Kane
  - Kellwood
  - Morgantown Plastics
- Ohio County Water Dist.
  - Peabody Coal, Ken, and Homestead Mines
- Russellville Mun. Water Syst.
  - Bilt Rite Products
  - Coca Cola Co.
  - Emerson Electric Co.
  - E.R. Carpenter Co.
  - Illinois Tool Works Co.
  - Red Kap Industries
  - Rockwell International
- Scottsville Water Dept.
  - General Electric
  - Kirsch and Co.
  - Washington Overall
- Tompkinsville Water Works
  - Beldon
  - Waggner Apparel

Self-supplied industrial water users.

Table 6 shows self-supplied industrial water users with a permit issued by the Kentucky Division of Water to withdraw water in the Green River basin. Figure 5 shows the location of these water facilities. The source of water and amounts withdrawn are listed for each facility. The SIC code (Standard Industrial Classification code) is a four-digit code established by the U.S. Bureau of Census to classify establishments by the type of activity in which they are engaged.

The evaluation showed that Kentucky Agricultural Energy and Logan Aluminum are likely to experience water-supply problems during drought conditions. Many users withdraw from ground and surface water of unknown availability at the source, but none of these users have experienced problems in the past during drought periods.

Table 6.-- Permitted self-supplied industrial water users in the Green River basin

[SIC=Standard Industrial classification code. Drought susceptibility class--A. System unlikely to experience water shortage during drought conditions. B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage. C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary. Dashes (---) in columns mean data not available.]

Site No.	Facility name and town (county)	Employees	SIC code	Source(s)	Latitude and longitude	Drought susceptibility class (A-C)	Average withdrawal (gal/d)	Storage capacity (gal)
	UPPER GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110001							
31	Vermont American Corp. Leitchfield (Grayson)	160	3425	Well	37 29 22 86 17 08	Unknown	56,000	1,000
	BARREN RIVER BASIN HYDROLOGIC UNIT CODE 05110002							
38	Auburn Hosiery Mills Auburn (Logan)	100	2252	Blue Lick Cr.	36 51 45 86 42 33	Unknown	15,000	0
37	Concord Farms Scottsville (Allen)	4	0251	Spring	36 41 07 86 13 10	Unknown	18,000	20,000
35	Dogwood Ridge Farms Adolphus (Allen)	16	0251	Springs	36 41 40 86 17 32	Unknown	26,000	1,150,000
36	Glasgow Foods, Inc. Glasgow (Barren)	140	2015	Well	36 59 03 85 54 51	Unknown	20,300	0
				Glasgow Water Plant			323,700	
7	Kentucky Ag. Energy Franklin (Simpson)	100	2869	Drakes Cr.	36 41 43 86 33 01	C	1,360,000	1,220,000
				Arrow Spr.	36 40 47 86 33 43	B	360,000	
39	Squire Lyle Farms Scottsville (Allen)	2	0251	Trammel Fork	36 46 37 86 18 00	A	11,000	11,000
	MIDDLE GREEN RIVER BASIN HYDROLOGIC UNIT CODE 05110003							
34	AMCA Processing Greenville (Muhlenberg)	---	1211	Mine Works Lake	37 12 38 87 06 00	Unknown	30,000	0
21	Logan Aluminum Russellville (Logan)	250	3353	Spa Lake	36 56 55 87 01 40	C	186,200	2,000,000
22	Peabody Coal Alston Mine Centertown (Ohio)	190	1211	Green River (Regulated)	37 25 15 87 06 03	A	166,000	1,584,200
6	Peabody Coal Gibralter Mine Central City (Muhlenberg)	27	1211	Green River (Regulated)	37 21 42 87 07 36	A	1,800,000	0
2	Peabody Coal Ken Prep Plant Beaver Dam (Ohio)	31	1211	Ken Freshwater	37 18 21 86 56 34	Unknown	2,928,000	0
				Pond Run Cr.	37 17 54 86 55 26	Unknown	1,200,000	0
26	Peabody Coal River Queen Mine Greenville (Muhlenburg)	---	1211	Green River (Regulated)	37 22 13 87 20 23	A	115,200	0
12	TVA Paradise Coal Washing Drakesboro (Muhlenberg)	100	0725	Green River (Regulated)	37 15 35 86 82 26	A	550,000	0
	ROUGH RIVER BASIN HYDROLOGIC UNIT CODE 05110004							
25	Nestaway-Coated Met. Products Beaver Dam (Ohio)	---	3481	Wells	37 24 35 86 53 24	Unknown	133,600	0
				Beaver Dam Mun. Water			22,500	
40	Southwind Mining Beaver Dam (Ohio)	---	1211	Impoundment #1	37 25 51 86 47 59	Unknown	10,000	0

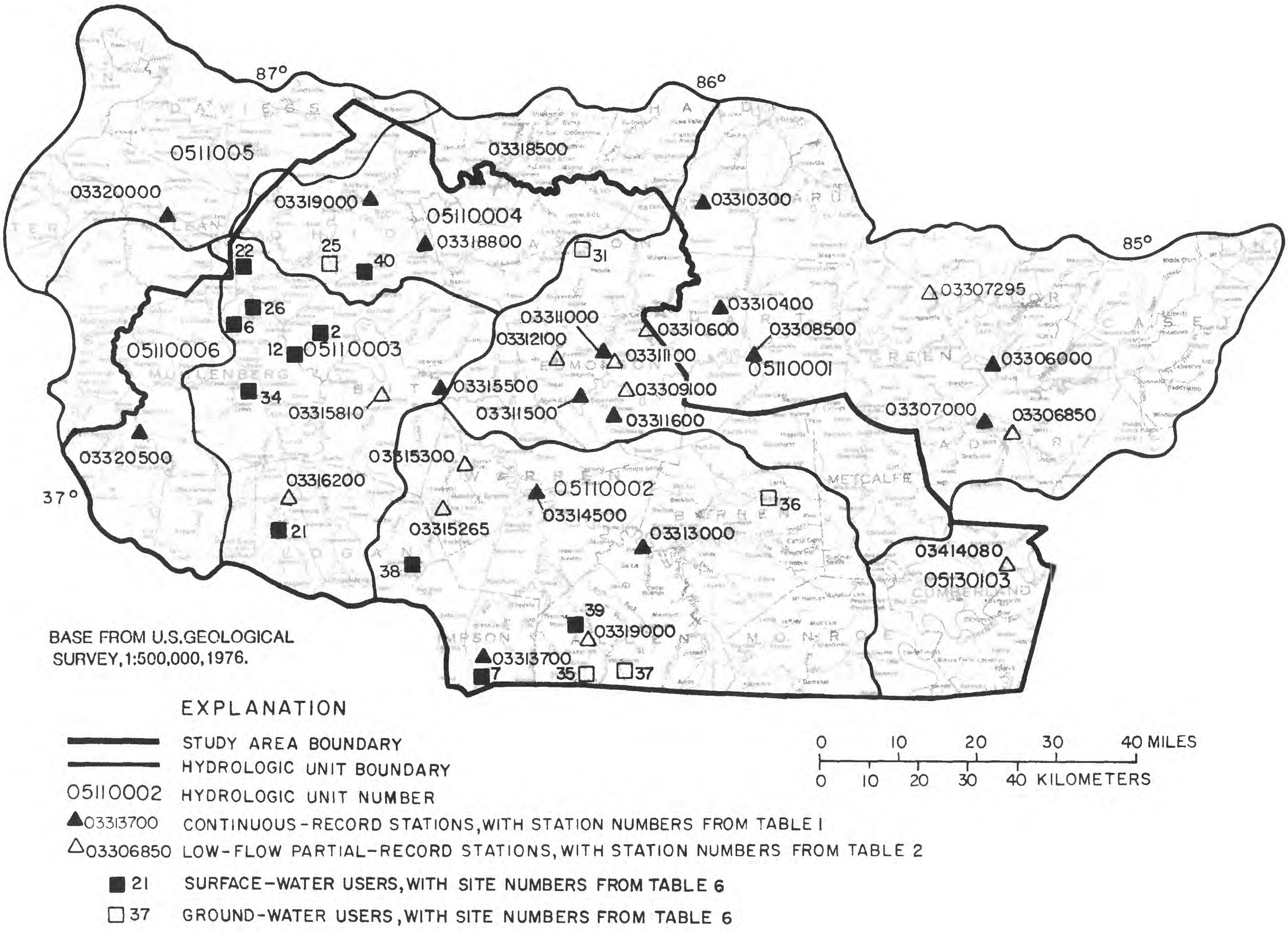


Figure 5.--Self-supplied industrial water users and data sites in the Green River basin in Kentucky.

WATER SUPPLIES IN THE LOWER CUMBERLAND RIVER BASIN

Basin Description

The part of the Lower Cumberland River basin that is in Kentucky includes all or major parts of Lyon, Trigg, and Christian Counties, approximately the southern half of Logan and Todd Counties and minor parts of Livingston, Caldwell, and Simpson Counties. A map of the area drained by the Lower Cumberland River in Kentucky is shown in figure 6.

Altitudes in the Lower Cumberland River basin range from 302 ft above NGVD of 1929 at the confluence of the Cumberland and Ohio Rivers to 863 ft at Pine Knob in Christian County. Mean altitude above NGVD of 1929 is approximately 500 ft.

The Lower Cumberland River basin lies predominantly within the Mississippian Plateaus physiographic region. The region is underlain mostly by cavernous limestone which locally contains chert beds and nodules. The areas in Lyon and Trigg Counties surrounding Lake Barkley are hilly. The remainder of the basin is mostly rolling to hilly but some relatively flat areas occur in the eastern part of the basin. Karst topography with subsurface drainage and numerous springs is common throughout the basin. Evaluation of ground water-surface water relations and water quality are complicated because of the subsurface drainage in the karst terrain. Also the potential for ground-water contamination is increased in karst areas.

Hydrology

Surface Water

Tributary basins

The part of the Lower Cumberland River basin that is in Kentucky covers 1,920 mi² and consists of all or parts of the following tributary basins as delineated by the Survey (Seaber and others, 1984).

Hydrologic unit code	Hydrologic unit name	Drainage area (mi²)
05130205	Lower Cumberland River basin	1237
05130206	Red River basin	683

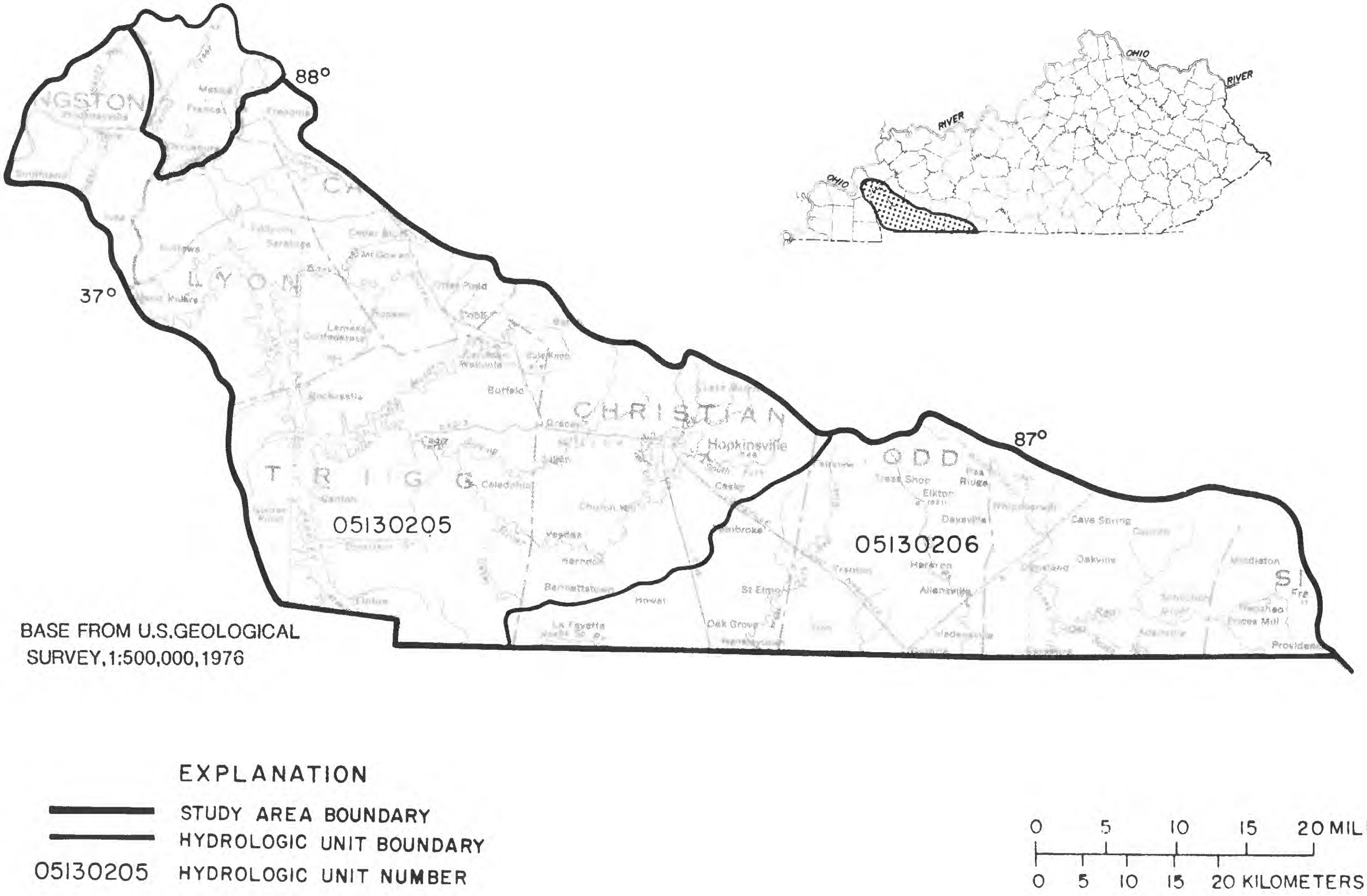


Figure 6.--Lower Cumberland River basin in Kentucky.

Major tributary streams

Major tributary streams draining the study area in the Lower Cumberland River basin are listed below for each tributary basin:

Lower Cumberland River basin--Little River, Claylick Creek, Crooked Creek, Sandy Creek, and Sugar Creek

Red River basin--Red River, Whippoorwill Creek, Elk Fork, and West Fork Red River

Streamflow data

Continuous-record stations.--Table 7 contains streamflow data and information for existing continuous-record stations in the Lower Cumberland River basin from gaging-station records and from Melcher and Ruhl (1984). See figures 7 and 8 for locations.

Table 7.--Streamflow data for continuous-record stations in the Lower Cumberland River basin
[Dashes (---) in columns mean data not available.]

USGS station No.	Station name and location (county)	Drainage area (mi^2)	Period of record	Average discharge (ft^3/s)	Low flow (ft^3/s) 7-day, 2-year	Low flow (ft^3/s) 7-day, 10-year
LOWER CUMBERLAND RIVER BASIN HYDROLOGIC UNIT CODE 05130205						
03438000	Little River near Cadiz (Trigg).	244	1940-82	345	21	11
03438220	Cumberland River near Grand Rivers (Livingston).	17,598	1940-82	27,150	---	---
RED RIVER BASIN HYDROLOGIC UNIT CODE 05130206						
03435140	Whippoorwill Cr. at Claymour (Todd).	20.8	1973-82	34.2	0.01	0

Low-flow partial-record stations.--Table 8 contains low-flow data for sites in the Lower Cumberland River basin where measurements have been made and correlated with continuous-record index stations to produce low-flow frequency correlations (Sullavan, 1984). See figures 7 and 8 for locations.

Table 8.--Low-flow data for partial-record stations in the Lower Cumberland River basin

USGS station No.	Station name and location (county)	Drainage area (mi^2)	Low flow (ft^3/s) 7-day, 2-year	7-day, 10-year
LOWER CUMBERLAND RIVER BASIN HYDROLOGIC UNIT CODE 05130205				
03438167	Dry Creek near Lamasco (Lyon).	34.6	0	0
03438170	Eddy Creek near Lamasco (Lyon).	71.7	4.7	3.4
03438470	Livingston Creek near Dycusburg (Livingston).	112	6.1	3.4
RED RIVER BASIN HYDROLOGIC unit code 05130206				
03435100	Red River near Adairville (Logan).	229	13	5.8

Reservoirs

The most significant reservoir in the Lower Cumberland River basin is Barkley Lake. Barkley Dam is on the Cumberland River at mile 30.6 in Lyon and Livingston Counties near Grand Rivers, Kentucky. The Lake is over 118 mi long, covers 93,400 acres and provides a storage capacity of 2,082,000 acre-ft (678,732 Mgal) at the maximum regulated level. The hydroelectric facility at the dam is capable of producing 582 million kilowatt-hours of energy annually.

Precipitation and runoff

Table 9 contains precipitation and runoff data for continuous-record streamflow sites in the Lower Cumberland River basin.

Table 9.--Precipitation and runoff data for selected stations in the Lower Cumberland River basin

USGS station No.	Station name and location (county)	Mean annual precipitation (in/yr)	Average runoff (in/yr)
LOWER CUMBERLAND RIVER BASIN HYDROLOGIC UNIT CODE 05130205			
03438000	Little River near Cadiz (Trigg).	47	21.64
03438220	Cumberland River near Grand Rivers (Livingston).	45	29.66
RED RIVER BASIN HYDROLOGIC UNIT CODE 05130206			
03435140	Whippoorwill Cr. at Claymour (Todd).	48	19.25

Ground Water

The availability of ground water and the distribution of geologic units in the Lower Cumberland River basin are discussed in Brown and Lambert, (1962). A brief summary of water-bearing characteristics of aquifers of Quaternary and Late Mississippian ages follows:

1. Alluvium of Quaternary age
2. Chesterian rocks of Late Mississippian age
3. Meramecian rocks of Late Mississippian age.

The principal aquifer in the Lower Cumberland River basin below Barkley Dam is alluvium of Quaternary age. The saturated thickness of the alluvium ranges from less than 25 ft along the bluffs to more than 150 ft in some of the buried channels. Yields greater than 1,000 gal/min are available in places where the saturated thickness exceeds 50 ft. The water is generally hard to very hard and contains iron in excess of 0.3 mg/L (milligrams per liter).

Chesterian rocks of Late Mississippian age occur along the northern edge of the Lower Cumberland River basin. These rocks are mostly limestone. Well yields in the limestones are generally adequate for domestic use.

The Meramecian limestones of Late Mississippian age occur in a belt that averages about 15 mi wide in the Lower Cumberland River basin. Wells in this area will yield as much as 500 gal/min and some springs have a high discharge.

Generally, water from the limestone is moderately hard to very hard and it contains excessive sulfate locally.

Ground water was formerly an important source of water within the area. However, since the construction of Barkley Dam and other smaller dams, many ground-water sources for public supplies have been abandoned. Now, the major source of public water supplies in the Lower Cumberland River basin is surface water.

Major Water Users

Permitted water users.

The following facilities, listed by magnitude of use, have been issued permits by the Kentucky Division of Water to withdraw water in the Lower Cumberland River basin. Of the total amount of water withdrawn by these facilities, 86 percent was surface water and 14 percent was ground water.

Site No.	Permitted facilities	1984 Average withdrawal (gal/d)
1	Hopkinsville Water & Sewer Works	3,543,000
2	Barkley Lake Water Dist.	969,000
3	Princeton Water Dept.	869,800
4	Cadiz Mun. Water Co.	375,000
5	Adairville Water Works	335,000
6	Oak Grove Utility Co.	300,000
7	Eddyville Water Dept.	275,800
8	Kentucky State Penitentiary	260,500
9	Guthrie Water Works	240,000
10	Kuttawa Water Supply	185,000
11	Three Rivers Rock Co.	125,000
12	Pembroke Water Works	73,000
13	Trenton Water Works	65,000
14	Princeton Hosiery Mill*	22,200
	TOTAL	7,638,300

* Facility also uses water purchased from another permittee. Amount purchased is not shown here.

Sources of water for public supplies and for self-supplied institutional water supplies.

Table 10 shows permitted public and self-supplied institutional water suppliers in the Lower Cumberland River basin. Locations of these systems are shown in figure 7. Systems using surface water generally have adequate supplies, but Oak Grove Utility Company may have to rely more heavily on Hunter Spring, with unknown capacity, during prolonged drought. Guthrie Water Works should also be prepared for problems during prolonged drought.

Treatment plants at Oak Grove Utility Company and Barkley Lake Water District are operating at greater than 80 percent capacity and these systems could experience difficulties if water use increases.

Table 10.--Public water suppliers and self-supplied institutional water suppliers in the Lower Cumberland River basin

[Drought susceptibility class--A. System unlikely to experience water shortage during drought conditions. B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage. C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary. Dashes (---) in columns mean data not available.]

Site No.	System name and town (county)	Source of supply	Latitude and longitude of intakes	Drought susceptibility class (A-C)	Average withdrawal or use (gal/d)	Treated storage (gal)	Treatment plant design capacity (gal/d)
	LOWER CUMBERLAND RIVER BASIN HYDROLOGIC UNIT CODE 05130205						
2	Barkley Lake Water Dist. Cadiz (Trigg)	Barkley Lake	36 48 24 B7 57 28	A	969,000	1,300,000	1,000,000
	Christian Co. Water Dist. Hopkinsville (Christian)				(29,000)	22,500	32,400
4	Cadiz Mun. Water Co. Cadiz (Trigg)	Cadiz Spr.	36 51 34 87 50 17	A	375,000	700,000	500,000
7	Eddyville Water Dept. Eddyville (Lyon)	Barkley Lake	37 04 34 8B 05 44	A	275,B00	792,000	400,000
	Fredonia City Water Works Fredonia (Caldwell)				(111,000)	50,000	0
1	Hopkinsville Water & Sewer Works Hopkinsville (Christian)	N. Fork Little River.	36 52 30 B7 2B 12	Unknown	3,543,000	7,213,000	B,000,000
	Christian Co. Water Dist. Hopkinsville (Christian)				(217,000)	225,000	324,000
8	Kentucky State Penitentiary Eddyville (Lyon)	Barkley Lake	37 02 45 8B 04 32	A	260,500	360,000	500,000
10	Kuttawa Water Supply Kuttawa (Lyon)	Barkley Lake	37 03 1B 8B 07 38	A	185,000	6B0,000	720,000
	Lyon County Water Dist. Kuttawa (Lyon)				(67,600)	200,000	0
3	Princeton Water Dept. Princeton (Caldwell)	Barkley Lake	37 01 37 88 03 26	A	869,800	1,300,000	2,000,000
	Barkley Lake Water Dist. Eddyville (Lyon)				(23,300)	---	---
	RED RIVER BASIN HYDROLOGIC UNIT CODE 05130206						
5	Adairville Water Works Adairville (Logan)	Red River	36 39 43 86 51 11	A	335,000	150,000	750,000
	South Logan Water Assoc. Adairville (Logan)				(230,000)	200,000	0
9	Guthrie Water Works Guthrie (Todd)	Merriweather Spr.	36 38 43 87 12 38	B	240,000	440,000	449,300
6	Oak Grove Utility Co. Clarksville (Christian)	Hunter Spr.	36 39 18 B7 22 48	Unknown	150,000	7,500	350,000
		West Fork Red River.	36 39 06 B7 22 41	B	150,000		
12	Pembroke Water Works Pembroke (Christian)	Wells	36 46 30 B7 21 21	Unknown	73,000	75,000	158,400
13	Trenton Water Works Trenton (Todd)	Wells	36 43 33 87 15 40	Unknown	65,000	200,000	2B8,000

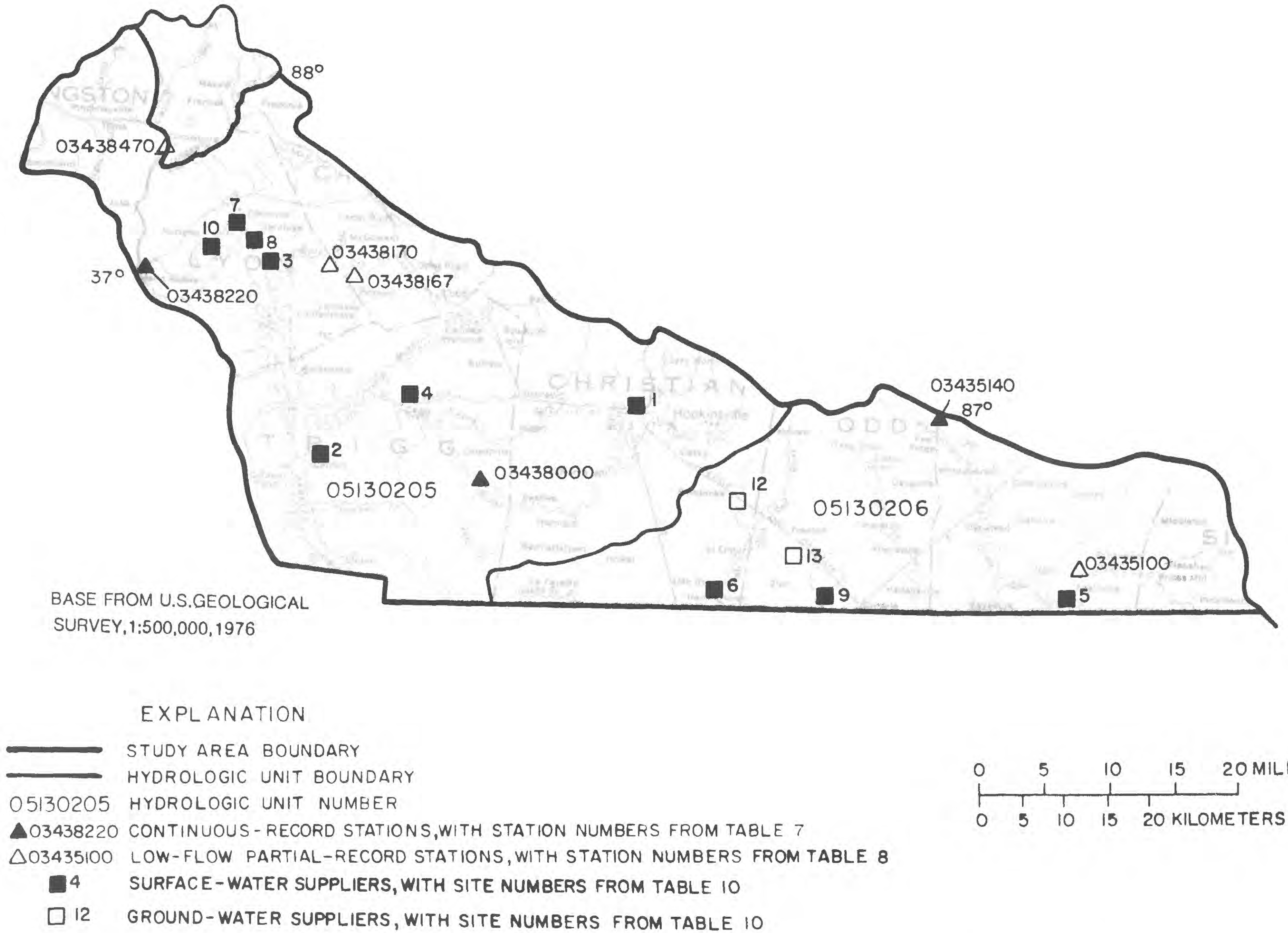


Figure 7.--Public water suppliers, self-supplied institutional water suppliers, and data sites in the Lower Cumberland River basin in Kentucky.

Use of water distributed by permitted public suppliers and by self-supplied institutional suppliers.

Table 11 shows the use of water that was distributed by permitted public and institutional supply systems in the Lower Cumberland River basin.

Table 11.--Use of water in the public supply systems and in the self-supplied institutional supply systems in the Lower Cumberland River basin

Site No.	System name and town (county)	Population	Connections: Commercial and industrial	Connections: Residential	Average commercial and industrial use (gal/d)	Average residential use (gal/d)	Residential use per capita (gal/d)
	LOWER CUMBERLAND RIVER BASIN HYDROLOGIC UNIT CODE 05130205						
2	Barkley Lake Water Dist. Cadiz (Trigg)	10,000	425	2,300	140,000	780,000	80
	Christian Co. Water Dist. Hopkinsville (Christian)	550	0	255	0	27,500	50
4	Cadiz Mun. Water Co. Cadiz (Trigg)	3,900	185	1,120	37,000	306,000	80
7	Eddyville Water Dept. Eddyville (Lyon)	2,040	0	680	0	164,800	80
	Fredonia City Water Works Fredonia (Caldwell)	1,080	0	325	0	111,000	105
1	Hopkinsville Water & Sewer Works Hopkinsville (Christian)	32,810	1,455	9,485	980,000	1,460,000	45
	Christian Co. Water Dist. Hopkinsville (Christian)	3,630	25	1,000	37,000	168,600	46
8	Kentucky State Penitentiary Eddyville (Lyon)	1,000	0	1	0	252,900	NA
10	Kuttawa Water Supply Kuttawa (Lyon)	950	20	335	19,500	91,300	87
	Lyon County Water Dist. Kuttawa (Lyon)	760	<5	265	25,000	40,600	55
3	Princeton Water Dept. Princeton (Caldwell)	10,480	40	3,300	105,100	761,400	85
	Barkley Lake Water Dist. Eddyville (Lyon)	390	0	130	0	23,300	60
	RED RIVER BASIN HYDROLOGIC UNIT CODE 05130206						
5	Adairville Water Works Adairville (Logan)	1,100	10	390	60,000	45,000	40
	South Logan Water Assoc. Adairville (Logan)	2,000	0	630	0	204,700	100
9	Guthrie Water Works Guthrie (Todd)	2,030	70	610	45,000	175,000	85
6	Oak Grove Utility Co. Clarksville (Christian)	2,990	0	510	0	300,000	100
12	Pembroke Water Works Pembroke (Christian)	800	0	270	0	73,000	90
13	Trenton Water Works Trenton (Todd)	690	0	230	0	65,000	95

The following public water suppliers in the Lower Cumberland River basin provide 5,000 gallons or more of water per day per industrial or commercial user. Users are shown indented below supplier.

Adairville Water Works
  Odoms Sausage
Barkley Lake Water Dist.
  Lake Barkley State Park
Christian Co. Water Dist.
  Pennyrile State Park
Cadiz Mun. Water Co.
  Elk Brand Manufacturing
  Hoover Universal
Guthrie Water Works
  Bardcok Corp.
  Koppers Co.
Hopkinsville Water & Sewer Works
  Blue Lake Block Co.
  C & F Stamping
  Duraco Products Inc.
  Ebonite
  Faultless Casters
  Flynn Enterprises

Hopkinsville Water & Sewer Works (cont.)
  Hopkinsville Stone
  Hopkinsville Milling Co.
  Pellon Corp.
  Phelps Dodge
  Plymouth Tube
  Superior Graphite Co.
  Thomas Industries
  United Shoe Machinery
  White Hydraulics
  Christian Co. Water Dist.
    Pennyrile State Park
Kuttawa Water Supply
  Lyon County Water Dist.
    S.S. Asphalt
Princeton Water Dept.
  Princeton Hosiery Mill
  Special Metals

Self-supplied industrial water users.

Table 12 shows self-supplied industrial water users permitted by the Kentucky Division of Water to withdraw water in the Lower Cumberland River basin. Figure 8 show the location of these water facilities.

Table 12.--Permitted self-supplied industrial water users in the Lower Cumberland River basin

[SIC=Standard Industrial Classification code. Drought susceptibility class--A. System unlikely to experience water shortage during drought conditions. B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage. C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary. Dashes (---) in columns mean data not available.]

Site No.	Facility name and town (county)	Employees	SIC code	Source(s)	Latitude and longitude	Drought susceptibility class (A-C)	Average withdrawal (gal/d)	Storage capacity (gal)
	LOWER CUMBERLAND RIVER BASIN HYDROLOGIC UNIT CODE 05130205							
14	Princeton Hosiery Mill Princeton (Caldwell)	265	2254	Well	37 06 37 87 53 25	Unknown	22,200	0
				Princeton Water Dept.			(15,500)	0
11	Three Rivers Rock Co. Smithland (Livingston)	---	1422	Cumberland River (Regulated)	37 11 12 88 22 55	A	125,000	1,000,000

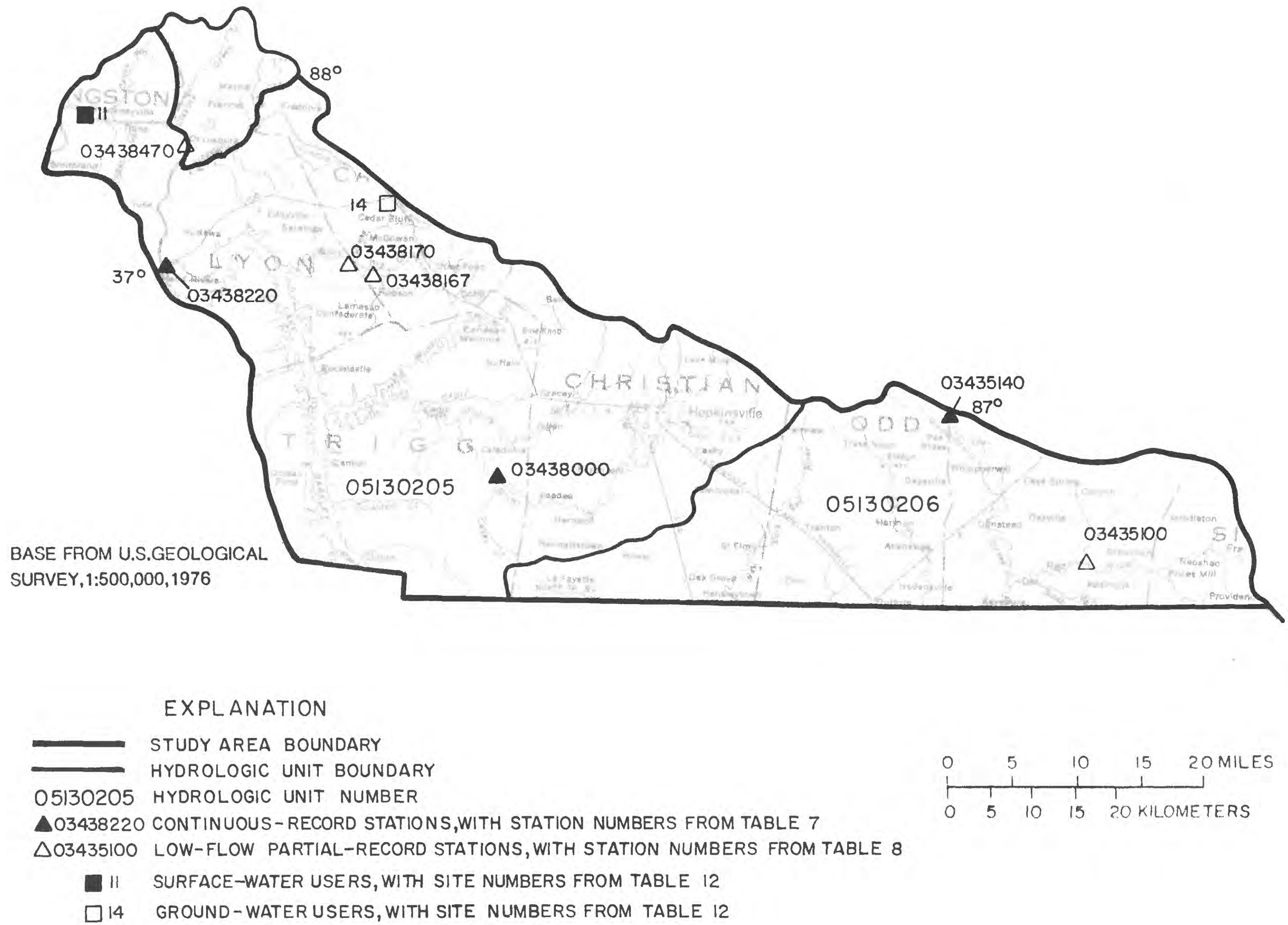


Figure 8.--Self-supplied industrial water users and data sites in the Lower Cumberland River basin in Kentucky.

WATER SUPPLIES IN THE TENNESSEE RIVER BASIN

Basin Description

The study area includes all of the Tennessee River basin in Kentucky. It includes all of Marshall, most of Calloway, and minor parts of Lyon, Trigg, Livingston, McCracken, and Graves Counties. A map of the study area and basins drained by the Tennessee River basin in Kentucky is shown in figure 9.

The Tennessee River basin drains approximately 1,000 mi^2 of the Mississippi embayment region in Kentucky. The embayment is a structural trough that contains unconsolidated deposits of gravel, sand, silt, and clay which dip to the southwest in Kentucky.

The drainage basins are relatively flat, and streams generally flow to the north but bend westward in the northern part of the area. The major streams have an irregular pattern and they meander across wide, shallow valleys. Many of these streams are sluggish in their lower reaches due to fairly flat slopes and have been channelized to improve flow.

The land in the Tennessee River basin is rolling to flat. Slopes developed on the unconsolidated sediments and extensive cultivation of the land leads to serious erosion and sediment loadings to streams in the basin.

Southwest of Murray, along the Kentucky-Tennessee border, altitudes reach approximately 640 ft above NGVD of 1929. Altitudes of about 325 ft above NGVD of 1929 occur in the Blizzard Ponds Drainage Canal south of Paducah. From the higher altitudes of southwest Calloway County, a ridge extends northward to near Paducah and then westerly toward Wickliffe to divide the Jackson Purchase into the major river basins of the Tennessee, Mississippi, and Ohio Rivers.

The interior of the Tennessee River basin is drained by the Clarks River and the West Fork Clarks River which join southeast of Paducah.

Hydrology

Surface Water

Tributary basins

The part of the Tennessee River basin that is in Kentucky covers 1,071 mi^2 of land and water area and consists of all or part of the following tributary basins as delineated by the Survey (Seaber and others, 1984).

Hydrologic unit code	Hydrologic unit name	Drainage area (mi^2)
06040005	Lower Tennessee River basin	398
06040006	Kentucky Lake basin	673

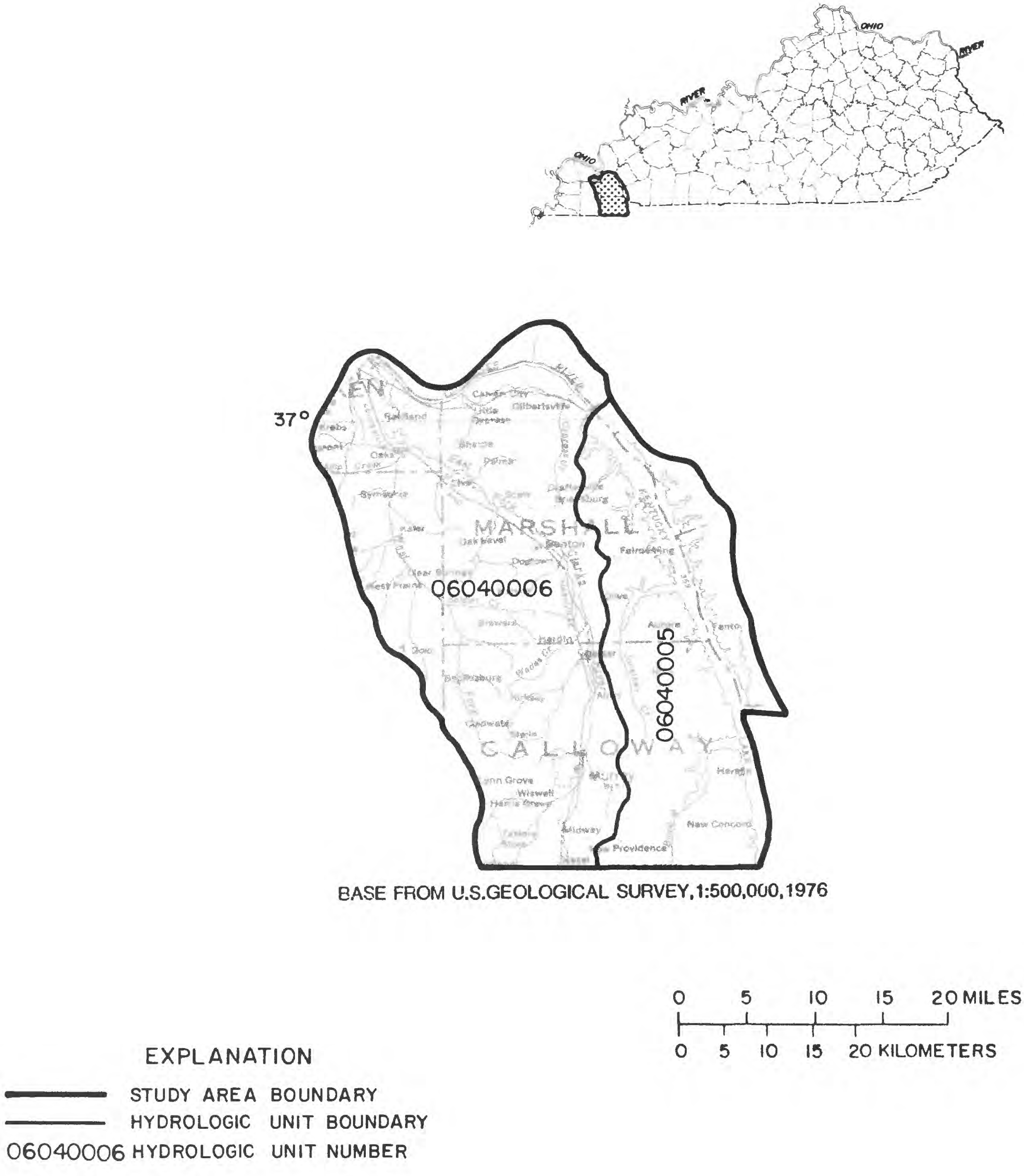


Figure 9.--Tennessee River basin in Kentucky.

Major tributary streams

Major tributary streams draining the Tennessee River basin in Kentucky are listed below for each tributary basin:

Lower Tennessee River basin--Blood River and Jonathan Creek

Kentucky Lake basin--Clarks River, West Fork Clarks River, Camp Creek, Cypress Creek, Island Creek, Middle Fork Creek, Soldiers Creek, Wades Creek, Watch Creek, and Wildcat Creek

Streamflow data

Continuous-record stations.--Table 13 contains streamflow data and information for the existing continuous-record station in the Tennessee River basin from gaging-station records and from Melcher and Ruhl (1984). See figures 10 and 11 for locations. There are no Survey continuous-record stations in the Lower Tennessee River basin (Hydrologic Unit Code 06040005).

Table 13.--Streamflow data for the continuous-record station in the Tennessee River basin

USGS station No.	Station name and location (county)	Drainage area (mi^2)	Period of record	Average discharge (ft^3/s)	Low flow (ft^3/s) 7-day, 2-year	7-day, 10-year
KENTUCKY LAKE BASIN HYDROLOGIC UNIT CODE 06040006						
03609500	Tennessee River near Paducah (McCracken).	40,200	1965-82	64,840	12,700	8190

Low-flow partial-record stations.--There are no low-flow partial-record stations in the Tennessee River basin.

Reservoirs

The only major reservoir in the Tennessee River basin is Kentucky Lake. Kentucky Lake dam is 22 mi above the mouth of the Tennessee River in Marshall County. This is the largest reservoir available to control floods on the Ohio and Lower Mississippi Rivers. During the major flood season a storage capacity of 4,000,000 acre-ft (1,304,000 Mgal) is reserved for regulating the discharge from the Tennessee River into the Ohio River.

The Tennessee River flows along the east and north periphery of the Mississippi embayment region of Kentucky to join the Ohio River at Paducah, Ky. The discharge of the Tennessee River is regulated by Tennessee Valley Authority dams including the Kentucky Lake Dam near Calvert City. Regulation of the flow in the lower Tennessee River began in 1944 to help control flooding. Kentucky Lake extends 184.3 mi upstream. This reservoir is about 75 ft deep at the dam; and, with the lake at full pool level, the water surface covers 160,000 acres or approximately 250 mi^2.

Precipitation and runoff

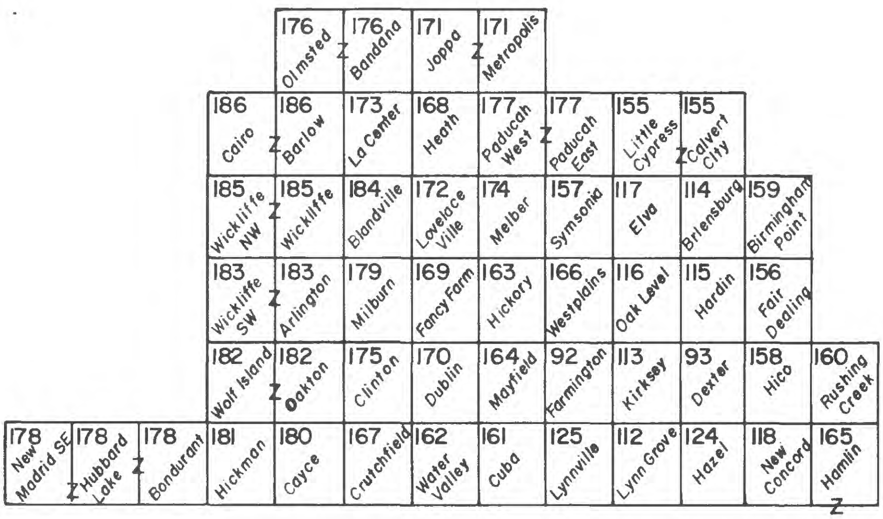
Table 14 contains precipitation and runoff data for the continuous-record station in the Tennessee River basin.

Table 14.--Precipitation and runoff data for selected stations in the Tennessee River basin

USGS station No.	Station name and location (county)	Mean annual precipitation (in/yr)	Average runoff (in/yr)
KENTUCKY LAKE BASIN HYDROLOGIC UNIT CODE 06040006			
03609500	Tennessee River near Paducah (McCracken).	45	21.64

Ground water

Various reports have been written on the water resources of the Mississippi embayment region that contains the Tennessee River basin. The summaries for the following aquifers in the basin were taken from Davis and others (1971) and from the Hydrologic Atlases (see index below) which have been published for each topographic quadrangle in the Mississippi embayment region:



Index to Hydrologic Atlases for the Mississippi embayment region in Kentucky.

The principal aquifers in the Tennessee River basin are as follows:

1. Alluvium of Quaternary age
2. Gravel of Pliocene and Pleistocene ages
3. Claiborne Group and Wilcox Formation of Eocene age
4. McNairy Formation of Late Cretaceous age
5. Mississippian and Devonian bedrock of Paleozoic age.

The principal aquifer is the alluvium of Quaternary age along the Tennessee River. The alluvial deposits below Kentucky Dam are 1 to 2 mi wide, about 10 mi long, and 50 to 100 ft in thickness. Wells with yields of 100 gal/min or more may be obtained from saturated thickness of 50 to 100 ft. Specific capacities are as high as 195 (gal/min)/ft of drawdown at a pumping rate of 703 gal/min. Iron concentrations generally exceed 0.3 mg/L in the water from the alluvium.

The gravel of Pliocene and Pleistocene ages is a principal aquifer in a small area at Symsonia and a minor aquifer from Hazel toward Reidland. Gravel is perched on top of an impervious clay. The saturated thickness at Symsonia is 35 ft, but commonly it is less than 10 ft throughout the basin. City wells at Symsonia were pumped at 140 gal/min with a specific capacity of 23 (gal/min)/ft of drawdown. Water from the gravel is excellent in quality. It is low in dissolved solids and is soft to moderately hard.

The basal sands of the Claiborne Group and the Wilcox Formation of Eocene age in the western part of Calloway County are important sources of water. Yields as large as 600 gal/min are available from individual wells, and the water is excellent in quality.

The McNairy Formation of Late Cretaceous age occurs throughout most of the Tennessee River basin and lies west of the Paleozoic bedrock along Kentucky Lake. This formation is about 300 ft in thickness. The formation is entirely composed of sand near the Tennessee State line but it grades to thinly interbedded deltic clay and sand northward toward Benton and Paducah. Layers of extremely fine-grained sand, up to 30 ft thick, occur below the deltic sand and clay in places above the Paleozoic bedrock. Yields are as much as 1,145 gal/min in the southern part of the area, but decrease to about 200 gal/min in the Paducah area. Specific capacities range from 26 (gal/min)/ft of drawdown at Murray to about 1 (gal/min)/ft of drawdown near Paducah. The water is good to excellent in quality; however, iron concentrations exceed 0.3 mg/L in some supplies.

Bedrock of Paleozoic age occurs along Kentucky Lake. Its surface dips to the west beneath the McNairy Formation of Cretaceous age. Wells tap either limestone or a weathered limestone that is mostly chert rubble. Wells as deep as 585 ft are located within the basin. Yields as high as 200 gal/min with a specific capacity of 8 (gal/min)/ft of drawdown have been obtained from individual wells in the Mississippi embayment region. The potential yields of the Paleozoic aquifer are unknown, but a well was pumped at 1,084 gal/min with a specific capacity of 360 (gal/min)/ft of drawdown in a bedrock aquifer north of Paducah in extreme southern Illinois.

Major Water Users

Permitted water users.

The following facilities, listed by magnitude of use, have been issued permits by the Kentucky Division of Water to withdraw water in the Tennessee River basin. Of the total amount of water withdrawn by these facilities, 62 percent was surface water and 38 percent was ground water.

Site No.	Permitted facilities	1984 Average withdrawal (gal/d)
1	Penwalt Corp.	8,000,000
2	B. F. Goodrich Chemical*	5,141,200
3	Murray Water Syst.	2,297,100
4	GAF Corp.*	1,500,000
5	Reed Crushed Stone	1,460,000
6	SKW Alloys	1,296,000
7	Vanderbilt Chemical Corp.	1,100,000
8	Airco Carbide	1,005,000
9	Calvert City Water & Sewer	904,300
10	North Marshall Water Dist.	820,000
11	Reidland Water Dist.	650,000
12	Benton Water & Sewer Syst.	650,000
13	Jonathan Creek Water Assoc.	300,000
14	Grand Rivers Water Syst.	86,000
15	Lake City Water Dist.	60,000
16	Symsonia Water Dist.	50,000
17	Panorama Shores Water Assoc.	30,000
18	Ohio River Steel Corp.	22,000
	TOTAL	25,371,600

* Facility also uses water purchased from one or more permittees. Amount purchased is not shown here.

Sources of water for public supplies.

Table 15 shows permitted public water suppliers in the Tennessee River basin. Locations of these water systems are shown in figure 10. For each supplier shown here, sources are sufficient for present usage. With the exception of Reidland Water District, which is operating at 80 percent capacity, each supplier's treatment capacity is also adequate.

Use of water distributed by permitted public suppliers.

Table 16 shows the use of water that was distributed by permitted public supply systems in the Tennessee River basin.

Table 15.--Public water suppliers in the Tennessee River basin

[Drought susceptibility class--A. System unlikely to experience water shortage during drought conditions. B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage. C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary.]

Site No.	System name and town (county)	Source of supply	Latitude and longitude of intakes	Drought susceptibility class (A-C)	Average withdrawal or use (gal/d)	Treated storage (gal)	Treatment plant design capacity (gal/d)
	KENTUCKY LAKE BASIN HYDROLDGIC UNIT CODE 06040005						
14	Grand Rivers Water Syst. Grand Rivers (Livingston)	Kentucky Lake	37 00 58 BB 14 55	A	B6,000	365,000	201,000
13	Jonathan Creek Water Assoc. Benton (Marshall)	Kentucky Lake	36 47 32 8B 08 50	A	300,000	450,000	950,000
15	Lake City Water Dist. Grand Rivers (Livingston)	Kentucky Lake	37 00 58 88 15 16	A	60,000	135,000	157,200
17	Panorama Shores Water Assoc. Murray (Calloway)	Wells	36 40 51 B8 07 31	A	30,000	1,500	4B,000
	LOWER TENNESSEE RIVER BASIN HYDROLOGIC UNIT CODE 06040006						
12	Benton Water & Sewer Syst. Benton (Marshall)	Wells	36 51 47 88 20 57	A	650,000	650,000	1,370,000
	Hardin Water Syst. Benton (Marshall)				(90,000)	80,000	150,000
	West Marshall Water Dist. Benton (Marshall)				(25,000)	0	0
9	Calvert City Water & Sewer Calvert City (Marshall)	Wells	30 02 30 88 21 00	A	904,300	1,800,000	1,700,000
3	Murray Water Syst. Murray (Calloway)	Wells	36 36 21 88 18 10	A	2,297,100	3,250,000	5,000,000
	Dexter Almo Heights				(50,000)	55,000	0
	South 641 Water Dist.				(26,500)	75,000	144,000
	Murray Water Dist. #1				(84,900)	0	0
	Murray Water Dist. #2				(25,700)	0	0
	Murray Water Dist. #3				(30,000)	0	0
10	North Marshall Water Dist. Benton (Marshall)	Wells	36 56 40 88 18 20	A	820,000	500,000	2,000,000
11	Reidland Water Dist. Paducah (McCracken)	Wells	37 01 00 88 31 51	A	650,000	687,000	750,000
16	Symsonia Water Dist. Symsonia (Graves)	Wells	36 55 12 88 31 05	A	50,000	75,000	150,000

Table 16.--Use of water in the public supply systems in the Tennessee River basin

Site No.	System name and town (county)	Population	Connections: Commercial and industrial	Connections: Residential	Average commercial and industrial use (gal/d)	Average residential use (gal/d)	Residential use per capita (gal/d)
	KENTUCKY LAKE BASIN HYDROLOGIC UNIT CODE 06040005						
14	Grand Rivers Water Syst. Grand Rivers (Livingston)	1,000	0	310	0	85,000	B5
13	Jonathan Creek Water Assoc. Benton (Marshall)	3,600	<5	1,000	135,000	135,000	40
15	Lake City Water Dist. Grand Rivers (Livingston)	580	20	280	20,000	40,000	70
17	Panorama Shores Water Assoc. Murray (Calloway)	330	0	108	0	30,000	90
	LOWER TENNESSEE RIVER BASIN HYDROLOGIC UNIT CODE 06040006						
12	Benton Water & Sewer Syst. Benton (Marshall)	5,200	250	1,640	195,000	340,000	65
	Hardin Water Syst. Benton (Marshall)	800	85	290	15,500	62,000	80
	West Marshall Water Dist. Benton (Marshall)	450	<5	160	300	23,500	50
9	Calvert City Water & Sewer Calvert City (Marshall)	3,500	45	955	626,200	146,900	40
3	Murray Water Syst. Murray (Calloway)	22,890	80	5,100	1,005,800	1,073,700	50
	Dexter Almo Heights	860	5	280	10,000	40,000	45
	South 641 Water Dist.	900	10	255	3,100	22,900	25
	Murray Water Dist. #1	1,200	0	390	2,100	82,800	65
	Murray Water Dist. #2	400	5	130	1,000	24,000	60
	Murray Water Dist. #3	550	5	160	7,800	18,000	35
10	North Marshall Water Dist. Benton (Marshall)	9,500	5	3,195	220,000	550,000	60
11	Reidland Water Dist. Paducah (McCracken)	7,000	17	52,010	0	650,000	90
16	Symsonia Water Dist. Symsonia (Graves)	1,000	0	225	0	50,000	50

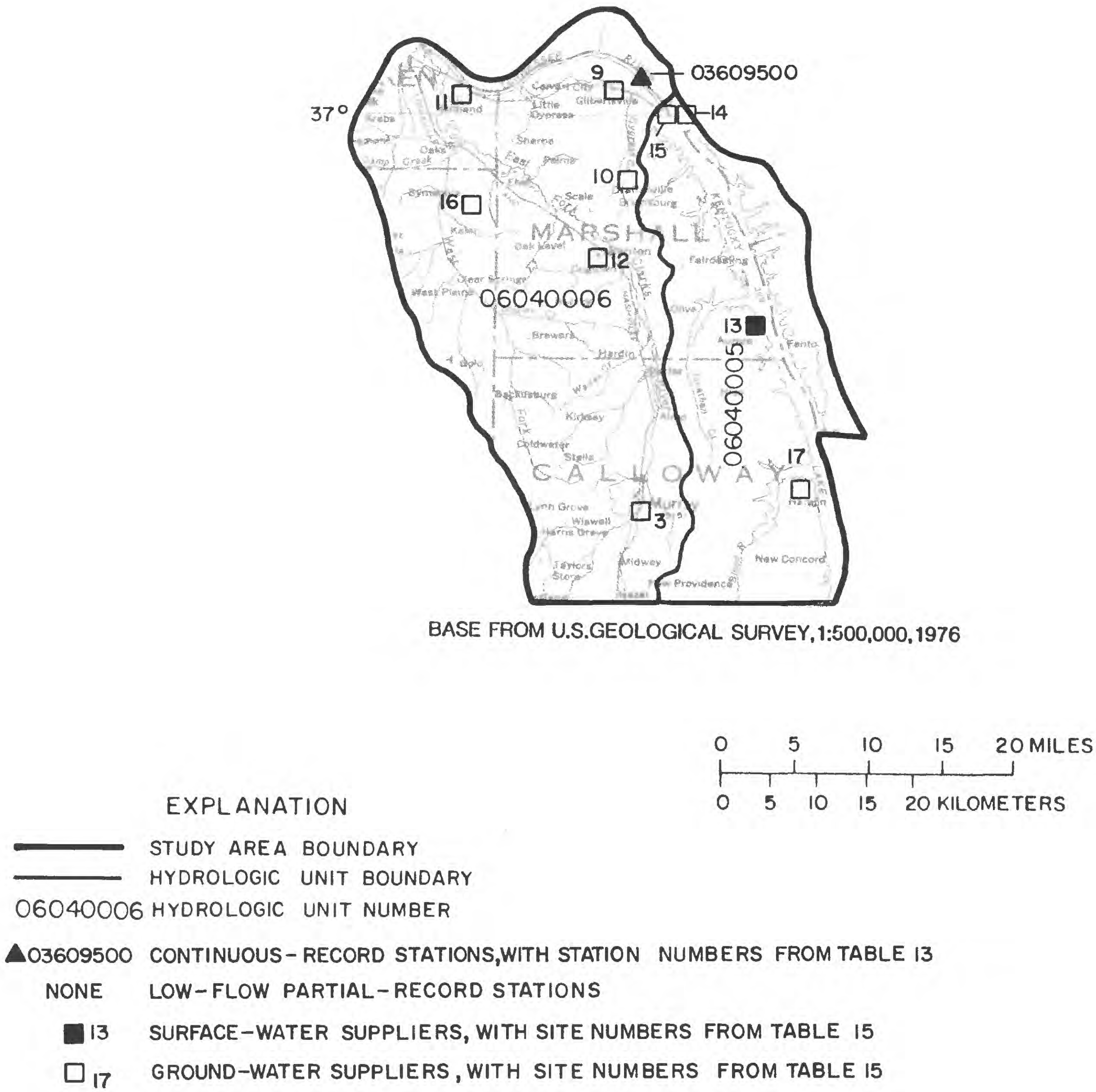


Figure 10.--Public water suppliers and data sites in the Tennessee River basin in Kentucky.

The following public water suppliers in the Tennessee River basin provide 5,000 gallons or more of water per day per industrial, commercial, or institutional user. Users are shown indented under the name of the supplier.

Benton Water & Sewer Syst.
- Consolidated Aluminum

Calvert City Water & Sewer
- Rail Service

Murray Water Syst.
- Fisher Price Toys
- Kroger Construction
- Murray Ice Co.

Murray Water Syst. (cont.)
- Murray Silica Sand
- Murray State University
- Ryan Milk Co.

North Marshall Water Dist.
- Kentucky Dam (TVA)
- Kentucky Dam Village
- West Kentucky Battery Co.

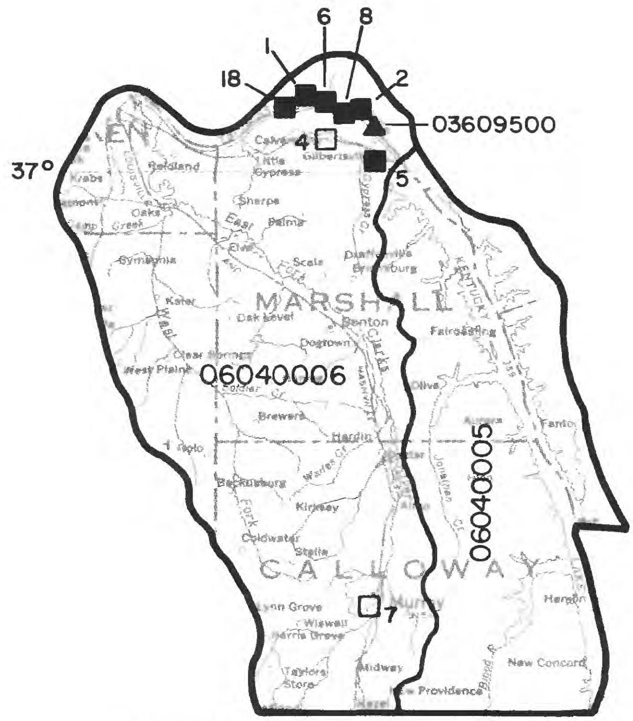
<u>Self-supplied industrial water users.</u>

Table 17 shows self-supplied industrial water users permitted by the Kentucky Division of Water to withdraw water in the Tennessee River basin. Figure 11 shows the location of these water facilities.

Table 17.--Permitted self-supplied industrial water users in the Tennessee River basin

[SIC=Standard Industrial Classification code. Drought susceptibility class--A. System unlikely to experience water shortage during drought conditions. B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage. C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary. Dashes (---) in columns mean data not available.]

Site No.	Facility name and town (county)	Employees	SIC code	Source(s)	Latitude and longitude	Drought susceptibility class (A-C)	Average withdrawal (gal/d)	Storage capacity (gal)
	TENNESSEE RIVER BASIN HYDROLOGIC UNIT CODE 06040006							
8	Airco Carbide Calvert City (Marshall)	---	2819	Tennessee River (Regulated)	37 01 03 88 20 12	A	1,005,000	10,000
2	B.F. Goodrich Chemical Calvert City (Marshall)	250	2824	Tennessee River (Regulated)	37 03 13 88 19 05	A	5,141,200	0
				Calvert City Water & Sewer.	37 03 13 88 19 05		132,200	
18	Ohio River Steel Corp. Calvert City (Marshall)	120	3312	Tennessee River (Regulated)	37 03 05 88 23 30	A	22,000	35,000
1	Penwalt Corp. Calvert City (Marshall)	---	2812	Tennessee River (Regulated)	37 04 33 88 22 01	A	8,000,000	0
5	Reed Crushed Stone Gilbertsville (Livingston)	---	1422	Private Reservoirs	37 02 30 88 22 55	Unknown	1,460,000	0
6	SKW Alloys Calvert City (Marshall)	100	3313	Tennessee River (Regulated)	37 03 31 88 20 50	A	1,296,000	0
4	GAF Corp. Calvert City (Marshall)	103	2843	Wells	37 03 43 88 21 39	Unknown	1,500,000	0
				Penwalt Corp.			391,500	
				Calvert City Water & Sewer.			58,500	
7	Vanderbilt Chemical Corp. Murray (Calloway)	35	2812	Wells	36 38 54 88 17 44	Unknown	1,100,000	0



BASE FROM U.S.GEOLOGICAL SURVEY, 1:500,000, 1976

0 5 10 15 20 MILES

0 5 10 15 20 KILOMETERS

EXPLANATION

STUDY AREA BOUNDARY

HYDROLOGIC UNIT BOUNDARY

06040006 HYDROLOGIC UNIT NUMBER

▲ 03609500 CONTINUOUS-RECORD STATIONS, WITH STATION NUMBERS FROM TABLE 13

NONE LOW-FLOW PARTIAL-RECORD STATIONS

■ 2 SURFACE-WATER USERS, WITH SITE NUMBERS FROM TABLE 17

□ 7 GROUND-WATER USERS, WITH SITE NUMBERS FROM TABLE 17

Figure 11.--Self-supplied industrial water users and data sites in the Mississippi River basin in Kentucky.

WATER SUPPLIES IN THE MISSISSIPPI RIVER BASIN

Basin Description

The part of the Mississippi River basin that is in Kentucky includes all or major parts of Fulton, Hickman, Carlisle, and Graves Counties, approximately the southern half of Ballard County and minor parts of McCracken and Calloway Counties. The study area and tributary basins drained by the Mississippi River basin in Kentucky are shown in figure 12.

The Mississippi River basin drains approximately 1,250 mi² of the Mississippi embayment region. The streams in the basin generally flow northwest to west and they meander across wide, shallow valleys. Many of these streams are sluggish in their lower reaches due to fairly flat slopes and have been channelized to improve flow.

The land in the Mississippi River basin is rolling to flat. Slopes developed on the unconsolidated sediments and extensive cultivation cause serious erosion and sediment loadings to streams in the basin.

Altitudes range from 640 ft southeast of Mayfield along the Kentucky-Tennessee border, to about 275 ft above NGVD of 1929 in the Mississippi flood plain. From the higher elevations in southwest Calloway County, a ridge extends northward to near Paducah and then westerly to about Wickliffe to divide the area into the major river basins of the Tennessee, Mississippi, and Ohio Rivers.

Hydrology

Surface Water

Tributary basins

The part of the Mississippi River basin that is in Kentucky covers 1,250 mi² and consists of all or parts of the following tributary basins as delineated by the Survey (Seaber and others, 1984).

Hydrologic unit code	Hydrologic unit name	Drainage area (mi²)
08010100	Lower Mississippi River basin	157
08010201	Bayou de Chien basin	952
08010202	Obion Creek basin	141

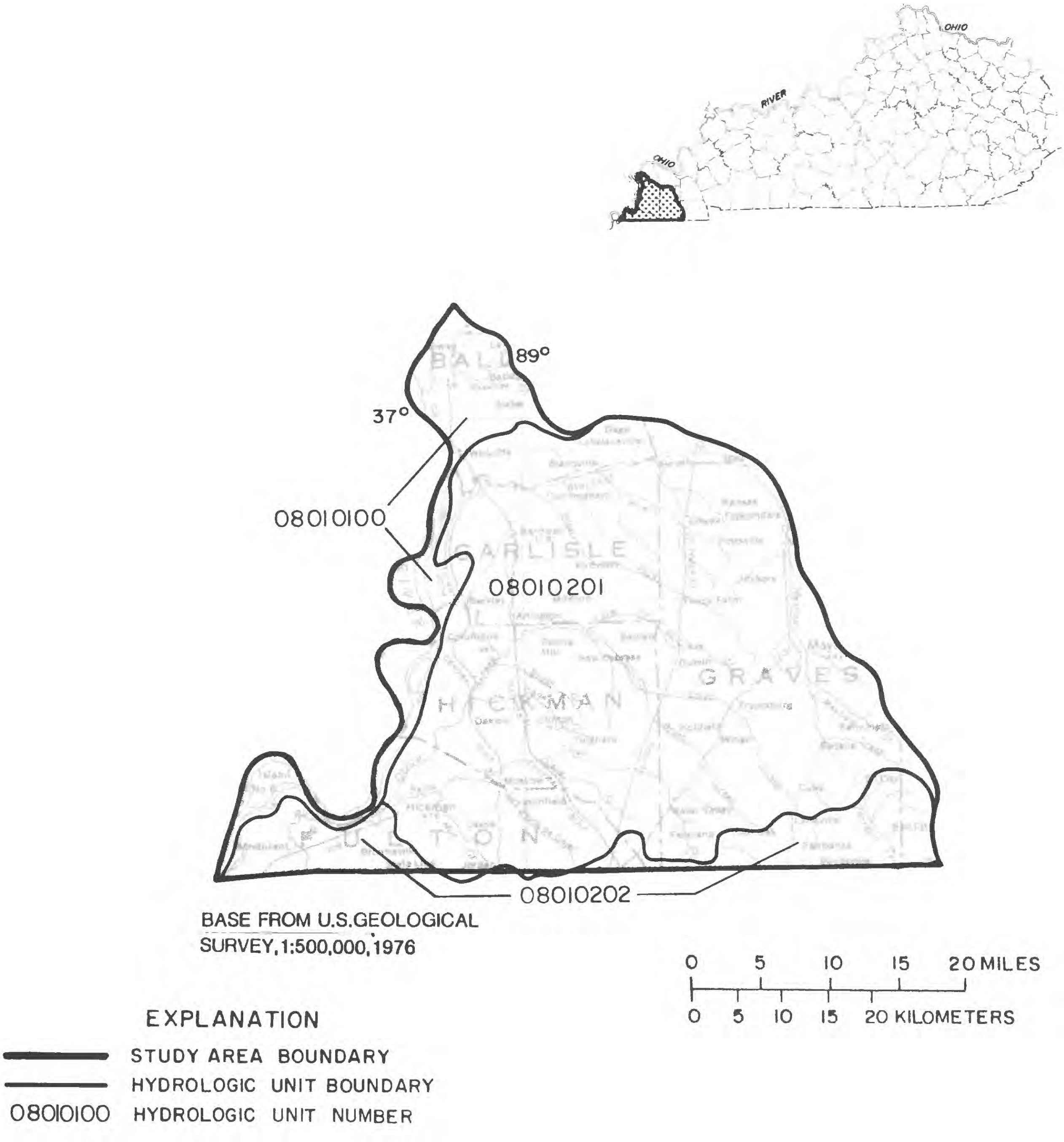


Figure 12.--Mississippi River basin in Kentucky.

Major tributary streams

Major tributary streams draining the study area in the Mississippi River basin are listed below for each tributary basin:

Bayou de Chien basin--Brush Creek, Mayfield Creek, West Fork Mayfield Creek, Mud Creek, Obion Creek, Perry Creek, Wilson Creek, and Little Bayou de Chien

Lower Mississippi River basin--None

Obion Creek basin--Terrapin Creek

Streamflow data

Continuous-record stations.--Table 18 contains streamflow data and information for existing continuous-record stations in the Mississippi River basin from gaging stations and from Melcher and Ruhl (1984). See figures 13 and 14 for locations. There are no Survey continuous-record stations in the Obion Creek basin (Hydrologic Unit Code 08010201) or the Lower Mississippi River basin (Hydrologic Unit Code 08010100).

Flow data on Mayfield Creek, Obion Creek, and Bayou de Chien indicate that none of these streams exhibit large flows. The upper reaches of these streams approach zero flow during dry seasons. During wet seasons, however, flooding occurs in most of these sub-basins. Flooding occurs most often along Obion Creek. A flood control project for the Obion Creek watershed was authorized in 1958 and includes 1,103 acres of critical area stabilization, 121,000 acres of land treatment measures, 14 floodwater-retarding dams, and 43.8 mi of channel improvement.

Table 18.--Streamflow data for continuous-record stations in the Mississippi River basin

USGS station No.	Station name and location (county)	Drainage area (mi^2)	Period of record	Average discharge (ft^3/s)	Low flow (ft^3/s) 7-day, 2-year	Low flow (ft^3/s) 7-day, 10-year
BAYOU DE CHIEN BASIN HYDROLOGIC UNIT CODE 08010201						
07022500	Perry Creek near Mayfield (Graves).	1.72	1953-65 1968-82	1.78	0	0
07024000	Bayou de Chien near Clinton (Hickman).	68.7	1940-82	107	9.6	6.8

Low-flow partial-record stations.--Table 19 contains low-flow data for sites in the Mississippi River basin where measurements have been made and correlated with continuous-record index stations to produce low-flow frequency correlations (Sullavan, 1984). See figure 13 and 14 for locations. There are no Survey low-flow partial-record stations in the Obion Creek basin (Hydrologic Unit Code 08010201) and the Lower Mississippi River basin (Hydrologic Unit Code 08010100).

Table 19.--Low-flow data for partial-record stations in the Mississippi River basin

USGS station No.	Station name and location (county)	Drainage area (mi^2)	Low flow (ft^3/s) 7-day, 2-year	7-day, 10-year
BAYOU DE CHIEN BASIN HYDROLOGIC UNIT CODE 08010201				
07022600	Mayfield Creek at Mayfield (Graves).	95.1	0	0
07022370	Obion Creek near Arlington (Carlisle).	203	8.1	3.3

Reservoirs

There are no major reservoirs in the Lower Mississippi River basin.

Precipitation and runoff

Table 20 contains precipitation and runoff data for continuous-record streamflow sites in the Lower Mississippi River basin.

Table 20.--Precipitation and runoff data for selected stations in the Mississippi River basin

USGS station No.	Station name and location (county)	Mean annual precipitation (in/yr)	Average runoff (in/yr)
BAYOU DE CHIEN BASIN HYDROLOGIC UNIT CODE 08010201			
07022500	Perry Creek near Mayfield (Graves).	49	14.05
07024000	Bayou de Chien near Clinton (Hickman).	49	21.15

Ground Water

Various reports discuss the water resources of the Mississippi embayment region of Kentucky. The summaries for water-bearing rocks listed below that occur in the Mississippi River basin of the region were taken from Davis and others (1971) and from Hydrologic Atlases (see p. 42 for index of atlases) that have been published for each quadrangle in the region:

1. Alluvium of Quaternary age
2. Claiborne Group and Wilcox Formation of Eocene age
3. McNairy Formation of Late Cretaceous age
4. Mississippian and Devonian bedrock of Paleozoic age.

The principal aquifer in the bottoms of the Mississippi River is the alluvium of Quaternary age. It occurs east of the Mississippi River and extends into the valleys of the tributary streams. The alluvial fill of glacial outwash below the confluence of the Ohio River ranges from a narrow strip to more than 8 mi wide southwest of Hickman. The saturated thickness ranges from less than 25 ft along the bluffs to more than 200 ft in some buried channels. One thousand gallons per minute or more of water are available from wells in areas where the saturated thickness is greater than 50 ft. With saturated thicknesses between 25 and 50 ft, yields usually range from 250 to 1,000 gal/min. The water is hard to very hard and generally contains iron concentrations greater than 0.3 mg/L.

Rocks of the Claiborne Group of Eocene age dip from southwest Calloway County, northern Graves, and central Ballard county toward the Mississippi River. Sands of the Claiborne Group are continuous and extend into Tennessee and Missouri. The basal sand is the most important aquifer in Kentucky because its saturated thickness is about 400 ft in places and the chemical quality of the water is excellent. Yields greater than 1,000 gal/min occur in the basal sand in western Calloway County, the northeast third of Graves County, southwest McCracken County and the southern two-thirds of Ballard County. Similar yields are available from some of the upper sands east of the Mississippi River.

The aquifers below the Claiborne Group in the Mississippi River basin include those in the Wilcox Formation of Eocene age, McNairy Formation of Cretaceous age, and the bedrock of Paleozoic age. No wells tap these lower aquifers because of their depth below land surface. Yields greater than 500 gal/min are probably available from the Wilcox Formation. Yields from the McNairy Formation and Paleozoic bedrock probably would be less than 500 gal/min. One oil test hole in the bedrock of Paleozoic age has been converted to domestic use. The water in the domestic well is from the Wilcox Formation and its chemical quality is similar to that from basal sands in the Claiborne Group.

Major Water Users

Permitted water users.

The following facilities, listed by magnitude of use, have been issued permits by the Kentucky Division of Water to withdraw water in the Mississippi River basin. Of the total amount of water withdrawn by these facilities, 59 percent was surface water and 41 percent was ground water.

Site No.	Permitted facilities	1984 Average withdrawal (gal/d)
1	Westvaco Corp. (Wickliffe Mun. Water)	18,780,000
2	General Tire & Rubber Co.	9,000,000
3	Mayfield Water Syst.	1,298,000
4	Hickman Water Dept.	824,000
5	Fulton Mun. Water	580,000
6	Hickory Water Dist.	260,000
7	Consumer Water Dist.	250,000
8	Bardwell Water Syst.	155,300
9	Kentucky Water Service Co.	134,300
10	Fancy Farm Water Dist.	120,000
11	Barlow Water & Sewage Works	70,000
12	South Graves County Water Dist.	60,000
13	Wingo Water & Sewer	57,300
14	Hardeman Water Dist.	56,700
15	Arlington Water Dist.	50,000
16	Sedalia Water Dist.	42,000
17	Columbus Water Works	25,000
18	Cunningham Water Dist.	19,000
19	Deena Lamp Co., Inc.	18,000
	TOTAL	31,799,600

Sources of water for public supplies.

Table 21 shows permitted public suppliers in the Mississippi River basin. Locations of these systems are shown in figure 13. For each supplier shown here, the source of supply and treatment plant capacity is adequate for present usage.

Table 21.--Public water suppliers in the Mississippi River basin

[Drought susceptibility class--A. System unlikely to experience water shortage during drought conditions. B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage. C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary.]

Site No.	System name and town (county)	Source of supply	Latitude and longitude of intakes	Drought susceptibility class (A-C)	Average withdrawal or use (gal/d)	Treated storage (gal)	Treatment plant design capacity (gal/d)
	LOWER MISSISSIPPI RIVER BASIN HYDROLOGIC UNIT CODE 08010100						
11	Barlow Water & Sewage Works Barlow (Ballard)	Wells	37 03 15 89 02 45	A	70,000	111,000	500,000
	BAYOU DE CHIEN BASIN HYDROLOGIC UNIT CODE 08010201						
15	Arlington Water Dist. Arlington (Carlisle)	Wells	36 47 27 89 00 50	A	50,000	197,000	325,000
8	Bardwell Water Syst. Bardwell (Carlisle)	Wells	36 52 13 89 00 37	A	155,300	142,000	325,000
17	Columbus Water Works Columbus (Hickman)	Wells	36 45 32 89 06 11	A	25,000	45,000	100,000
7	Consumer Water Dist. Mayfield (Graves)	Wells	36 40 00 88 31 00	A	250,000	125,000	430,000
18	Cunningham Water Dist. Cunningham (Carlisle)	Wells	36 54 00 88 53 00	A	19,000	150,000	150,000
10	Fancy Farm Water Dist. Fancy Farm (Graves)	Wells	36 48 00 88 47 30	A	120,000	100,000	210,000
	Milburn Water Dist. Milburn (Carlisle)				(26,000)	85,000	0
14	Hardeman Water Dist. Mayfield (Graves)	Wells	36 45 54 88 35 54	A	56,700	50,000	432,000
4	Hickman Water Dept. Hickman (Fulton)	Wells	36 34 23 89 11 48	A	824,000	1,050,000	1,440,000
6	Hickory Water Dist. Hickory (Graves)	Wells	36 48 59 88 37 28	A	260,000	225,000	1,000,000
9	Kentucky Water Service Co. Clinton (Hickman)	Wells	36 40 17 88 59 48	A	134,300	388,500	550,000
3	Mayfield Water Syst. Mayfield (Graves)	Wells	36 44 09 88 37 57	A	1,298,000	750,000	3,300,000
16	Sedalia Water Dist. Sedalia (Graves)	Wells	36 38 26 88 31 02	A	42,000	100,000	195,000
12	South Graves County Water Dist. Wingo (Graves)	Wells	36 38 23 88 41 20	A	60,000	205,000	700,000
	Wickliffe Mun. Water Wickliffe (Ballard) (purchased from Westvaco Corp.)	Mississippi River. (Regulated)	36 56 57 89 05 44	A	(170,000)	350,000	750,000
13	Wingo Water & Sewer Wingo (Graves)	Wells	36 38 36 88 44 20	A	57,300	190,000	800,000
	ORION CREEK BASIN HYDROLOGIC UNIT CODE 08010202						
5	Fulton Mun. Water Fulton (Fulton)	Wells	36 30 40 88 52 41	A	580,000	700,000	2,000,000

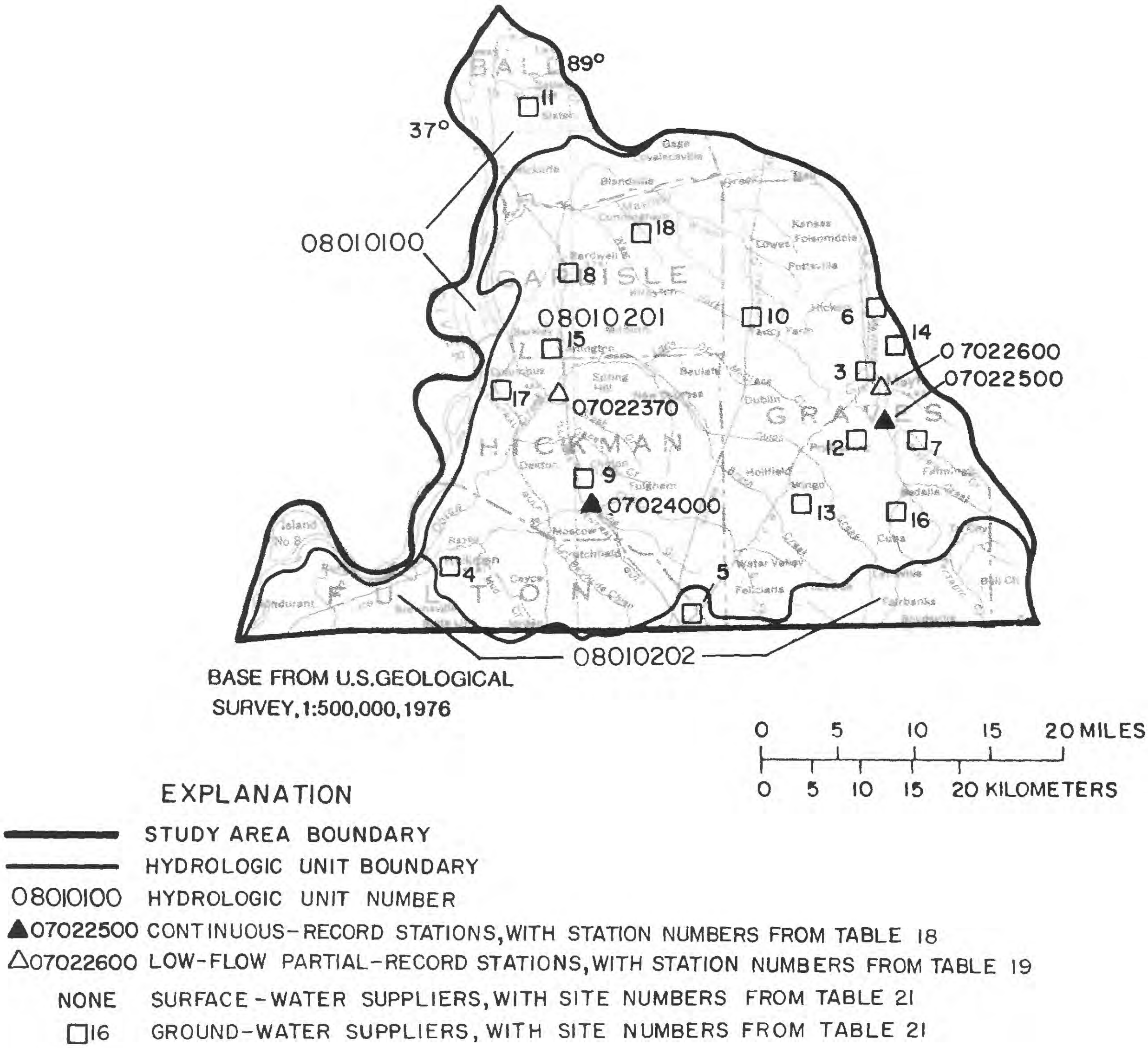


Figure 13.--Public water suppliers and data sites in the Mississippi River basin in Kentucky.

Use of water distributed by permitted public suppliers.

Table 22 shows the use of water that was distributed by permitted public supply systems in the Mississippi River basin.

Table 22.--Use of water in public supply systems in the Mississippi River basin

Site No.	System name and town (county)	Population	Connections: Commercial and industrial	Connections: Residential	Average commercial and industrial use (gal/d)	Average residential use (gal/d)	Residential use per capita (gal/d)
	LOWER MISSISSIPPI RIVER BASIN HYDROLOGIC UNIT CODE 08010100						
11	Barlow Water & Sewage Works Barlow (Ballard)	750	0	365	0	42,000	56
	BAYOU DE CHIEN BASIN HYDROLOGIC UNIT CODE 08010201						
15	Arlington Water Dist. Arlington (Carlisle)	700	15	235	5,000	45,000	65
8	Bardwell Water Syst. Bardwell (Carlisle)	1,200	65	480	11,500	143,800	120
17	Columbus Water Works Columbus (Hickman)	400	0	140	0	25,000	62
7	Consumer Water Dist. Mayfield (Graves)	2,630	15	835	2,500	247,500	95
18	Cunningham Water Dist. Cunningham (Carlisle)	300	<5	115	2,000	17,000	55
10	Fancy Farm Water Dist. Fancy Farm (Graves)	1,200	<5	370	27,600	66,400	55
	Milburn Water Dist. Milburn (Carlisle)	350	0	150	0	26,000	74
14	Hardeman Water Dist. Mayfield (Graves)	990	15	330	8,700	48,000	50
4	Hickman Water Dept. Hickman (Fulton)	4,000	135	1,225	584,000	240,000	60
6	Hickory Water Dist. Hickory (Graves)	3,825	5	955	70,100	189,900	50
9	Kentucky Water Service Co. Clinton (Hickman)	2,060	105	675	34,600	99,700	48
3	Mayfield Water Syst. Mayfield (Graves)	14,500	<5	4,580	60,000	1,238,000	85
16	Sedalia Water Dist. Sedalia (Graves)	520	0	160	0	40,000	75
12	South Graves County Water Dist. Wingo (Graves)	2,070	<5	625	4,000	56,000	27
	Wickliffe Mun. Water Wickliffe (Ballard) (purchased from Westvaco Corp.)	1,400	70	470	30,000	120,000	85
13	Wingo Water & Sewer Wingo (Graves)	800	30	245	4,000	31,900	40
	OBION CREEK BASIN HYDROLOGIC UNIT CODE 08010202						
5	Fulton Mun. Water Fulton (Fulton)	5,000	450	1,350	51,000	529,000	105

The following public water suppliers in the Mississippi River basin provide 5,000 gallons or more of water per day per industrial, commercial, or institutional user. Users are shown indented below supplier.

Fancy Farm Water Dist.
  Brown Thompson Sausage
  Ken Lake Provision Co.
Hickory Water Dist.
  General Tire & Rubber Co.
Hickman Water Dept.
  Sigri Carbon
Mayfield Water Syst.
  Ingersoll-Rand

Self-supplied industrial water users.

Table 23 shows self-supplied industrial water users permitted by the Kentucky Division of Water to withdraw water in the Mississippi River basin. Figure 14 shows the location of these water facilities. All supply sources are adequate for present usage.

Table 23.--Permitted self-supplied industrial water users in the Mississippi River basin

[SIC=Standard Industrial Classification code. Drought susceptibility class--A. System unlikely to experience water shortage during drought conditions. B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage. C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary.]

Site No.	Facility name and town (county)	Employees	SIC code	Source	Latitude and longitude	Drought susceptibility class (A-C)	Average withdrawal (gal/d)	Storage capacity (gal)
	LOWER MISSISSIPPI RIVER BASIN HYDROLOGIC UNIT CODE 08010100							
1	Westvaco Corp. Wickliffe (Ballard) Wickliffe Mun. Water Wickliffe (Ballard)	550	2611	Mississippi River (Regulated)	36 56 57 89 05 44	A	18,780,000	0
	BAYOU DE CHIEN BASIN HYDROLOGIC UNIT CODE 08010201							
19	Deena Lamp Co., Inc. Arlington (Carlisle)	60	3642	Wells	36 48 04 89 00 48	A	18,000	220,000
2	General Tire & Rubber Co. Mayfield (Graves)	500	3011	Wells	36 46 20 88 37 33	A	9,000,000	1,000,000

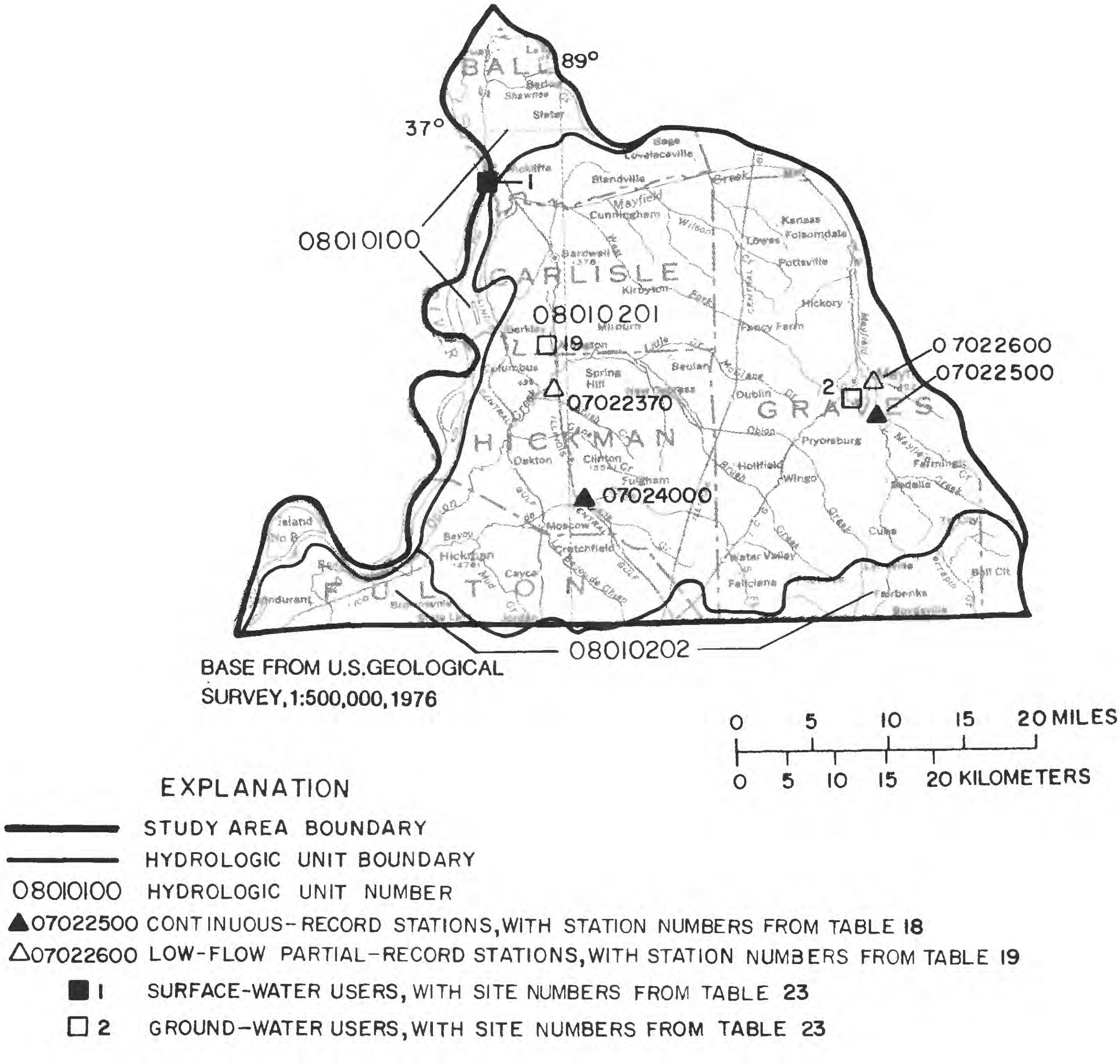


Figure 14.--Self-supplied industrial water users and data sites in the Mississippi River basin in Kentucky.

WATER SUPPLIES IN THE LOWER OHIO RIVER BASIN

Basin Description

The study area within the Lower Ohio River basin in Kentucky includes a major part of McCracken, Ballard, and Livingston Counties and a minor part of Christian County. A map showing the study area and basins in the study area drained by the Lower Ohio River basin in Kentucky is shown in figure 15. The physiographic regions in the study area of the Ohio River basin are the Mississippi embayment, Mississippian Plateaus, and the Western Coal Field (fig. 2).

The Mississippi embayment region in the Lower Ohio River basin includes the northeast part of Ballard county and the northwest part of McCracken County. The topography of this area is rolling to flat. The Mississippian Plateaus physiographic region is essentially the Tradewater River basin southwest of Tradewater River and a few small tributary streams to the Ohio River in Crittenden and Livingston Counties. This region is undulating to hilly and contains karst features in places. It includes the northern part of Livingston County, a major part of Crittenden County (not in the study area) and minor parts of Caldwell and Christian Counties. The Western Coal Field physiographic region is essentially the area of the Tradewater River basin northeast of the Tradewater River. The topography in this region typically is hilly to rolling, and all streams are minor tributaries to the Ohio River except the Tradewater River.

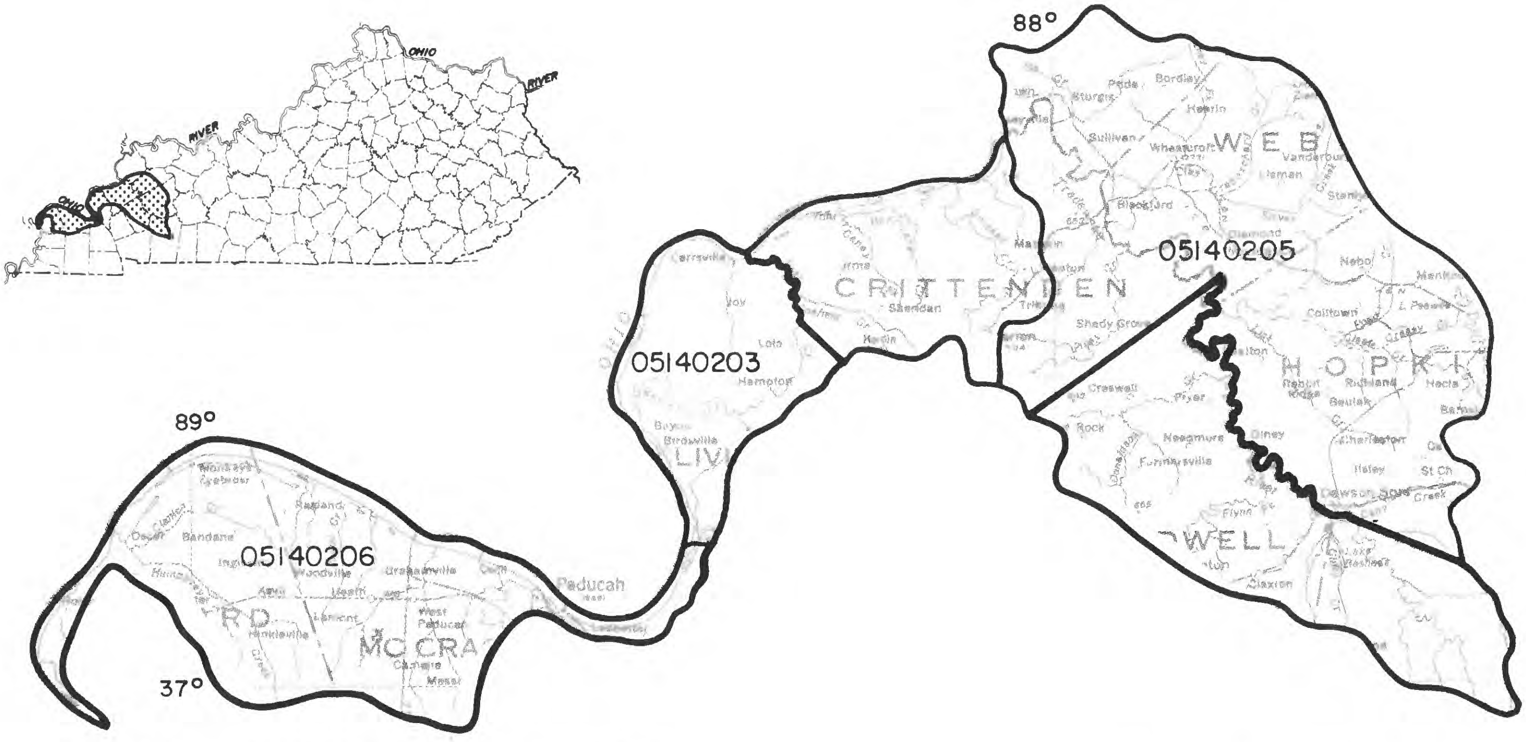
Hydrology

Surface Water

Tributary basins

The Lower Ohio River basin in Kentucky contains 762 mi^2 and consists of the following tributary basins as delineated by the Survey (Seaber and others, 1984).

Hydrologic unit code	Hydrologic unit name	Drainage area (mi^2)
05140203	Lower Ohio-Bay basin	145
05140206	Lower Ohio River basin	325
05140205	Tradewater River basin	292



BASE FROM U.S.GEOLOGICAL SURVEY, 1:500,000, 1976

0 5 10 15 20 MILES
0 5 10 15 20 KILOMETERS

EXPLANATION

STUDY AREA BOUNDARY
HYDROLOGIC UNIT BOUNDARY
05140206 HYDROLOGIC UNIT NUMBER

Major tributary streams

Major tributary streams draining the study area in the Lower Ohio River basin are listed below for each tributary basin:

Lower Ohio-Bay basin--Bayou Creek

Lower Ohio River basin--Deer Creek and Humphrey Creek

Tradewater River basin--Tradewater River, Donaldson Creek, Flynn Fork, Clifty Creek, and Caney Creek

Streamflow data

Continuous-record stations.--Table 24 contains streamflow data and information for existing continuous-record stations in the Lower Ohio River basin from gaging-station records and Melcher and Ruhl (1984). See figures 16 and 17 for locations. There are no Survey continuous-record stations in the Lower Ohio-Bay basin (Hydrologic Unit Code 05140203) and the Tradewater River basin (Hydrologic Unit Code 05140205).

Table 24.--Streamflow data for continuous-record stations in the Lower Ohio River basin
[Dashes (---) in columns mean data not available.]

USGS station No.	Station name and location (county)	Drainage area (mi^2)	Period of record	Average discharge (ft^3/s)	Low flow (ft^3/s) 7-day, 2-year	7-day, 10-year
LOWER OHIO RIVER BASIN HYDROLOGIC UNIT CODE 05140206						
03611260	Massac Creek near Paducah (McCracken).	14.6	1972-82	18.4	0.23	0.14
03611500	Ohio River at Metropolis, Ill. (McCracken).	203,000	1928-82	270,000	---	---

Low-flow partial-record stations.--Table 25 contains low-flow data for the site in the Lower Ohio River basin where measurements have been made and correlated with continuous-record index stations to produce low-flow frequency correlations. See figures 16 and 17 for locations. There are no Survey low-flow partial-record stations in the Lower Ohio-Bay basin (Hydrologic Unit Code 05140203) or the Tradewater River basin (Hydrologic Unit Code 05140205).

Table 25.--Low-flow data for the partial-record station in the Lower Ohio River basin

USGS station No.	Station name and location (county)	Drainage area (mi^2)	Low flow (ft^3/s) 7-day, 2-year	Low flow (ft^3/s) 7-day, 10-year
LOWER OHIO RIVER BASIN HYDROLOGIC UNIT CODE 05140206				
03613000	Humphrey Creek at LaCenter (Ballard).	44.2	0.2	0

Reservoirs

The only major reservoir in the Lower Ohio River basin that is in the study area is Lake Beshear. This reservoir has a storage capacity of 8,000 acre-ft (2,608 Mgal) and is located near the Caldwell-Christian County line in the Tradewater River basin.

Precipitation and runoff

Table 26 contains precipitation and runoff data for continuous-record steamflow sites in the Lower Ohio River basin.

Table 26.--Precipitation and runoff data for selected stations in the Lower Ohio River basin

USGS station No.	Station name and location (county)	Mean annual precipitation (in/yr)	Average runoff (in/yr)
LOWER OHIO RIVER BASIN HYDROLOGIC UNIT CODE 05140206			
03611260	Massac Creek near Paducah (McCracken).	45	17.11
03611500	Ohio River at Metropolis, Ill. (McCracken).	46	18.06

Ground Water

Various reports have been published on the water resources of the Lower Ohio River basin in Kentucky. Summaries from the water-bearing rocks listed below were taken from Davis and others (1971), from the applicable Hydrologic Atlases shown on the index on p. 42, and from Hydrologic Atlas 129 (Gallaher, 1964):

1. Alluvium of Quaternary age
2. Gravel of Pliocene and Pleistocene age
3. Claiborne Group and Wilcox Formation of Eocene age
4. McNairy Formation of Cretaceous age
5. Bedrock of Paleozoic age beneath the Mississippi embayment
6. Rocks of Pennsylvanian age
7. Rocks of Mississippian age
8. Rocks of Devonian age

The principal aquifer in the bottoms and flood plains of the Lower Ohio River basin is the alluvium of Quaternary age. In western Ballard County the saturated thickness of this alluvium is generally less than 25 ft. However, a buried channel north of Wickliffe contains deposits with saturated thickness of 100 ft or more. Yields as much as 1,000 gal/min or more are available from the thicker deposits of alluvium.

Gravel of Pliocene and Pleistocene ages is an important aquifer in northern Ballard and northwestern McCracken Counties. Yields of 500 to 1,000 gal/min are available in a belt between 1 and 5 miles wide in the Lower Ohio River basin. The saturated thickness in this belt ranges from 11 to 40 ft. One well in this belt has a specific capacity of 80 (gal/min)/ft of drawdown when pumped at 156 gal/min. Water is generally good in quality and normally does not contain objectionable amounts of iron as that from the alluvium.

The principal aquifers in central Ballard and southwestern McCracken Counties are the sands of the basal Claiborne Group and Wilcox Formation. Yields between 100 to 1,000 gal/min are available in most of the area. The water is excellent in chemical quality and low in dissolved solids and iron.

The McNairy Formation does not crop out in the Lower Ohio River basin in Kentucky; however, it is exposed in the hills north of the Ohio River in Illinois. In northern Ballard and McCracken Counties, it is covered by alluvium of Quaternary age and gravel of Pliocene and Pleistocene ages. Only a few domestic wells produce water from the McNairy Formation. Yields in Kentucky are generally less than 200 gal/min. The water is generally soft to moderately hard and contains less than 250 mg/L of dissolved solids. Iron concentrations may exceed 0.3 mg/L in places.

The bedrock of Paleozoic age underlies the McNairy Formation in Ballard and McCracken Counties. Wells with yields of 96 and 140 gal/min have been reported, but based on wells adjacent to the Ohio River in southern Illinois, the bedrock has a large potential yield. A well across the River from

Paducah was pumped at 1,084 gal/min with a specific capacity of 360 (gal/min)/ft of drawdown. The water is hard to very hard and generally contains iron in excess of 0.3 mg/L.

Rocks of Pennsylvanian age are mainly confined to northwestern Christian and Caldwell Counties. Most wells are dug and they yield only small quantities of water. Drilled wells near the base of the Pennsylvanian sandstones may yield as much as 100 gal/min. The water is soft to moderately hard. Locally, iron concentrations may exceed 0.3 mg/L.

Rocks of the Mississippian age comprise most of the area north of Paducah in the Lower Ohio River basin. Because of extensive faulting, not much is known about potential yield of these rocks, but spring flow indicate that several hundred gallons per minute could be developed in places. The water is moderately hard to hard.

Limestone below the Chattanooga Shale of Devonian age is known to yield freshwater at various depths. Near Ledbetter in southwestern Livingston County, freshwater occurs at 795 ft in a faulted zone where the fault displacement is about 3,000 ft.

Major Water Users

Permitted water users.

The following facilities, listed by magnitude of use, have been issued permits by the Kentucky Division of Water to withdraw water in the Lower Ohio River basin. Of the total amount of water withdrawn by these facilities, 97 percent was surface water and 3 percent was ground water.

Site No.	Permitted facilities	1984 Average withdrawal (gal/d)
1	Martin Marietta Energy Syst. (purchased from TVA)	11,000,000
2	Paducah Water Works	6,059,500
3	Ledbetter Water Dist.	200,000
4	LaCenter Mun. Water Dist.	180,000
5	Crofton Water Dept.	112,000
6	Kevil Water Dept.	95,000
7	Smithland Water & Sewer Syst.	62,000
8	Outwood ICF-MR	20,000
9	Bandana Water Dist.	14,200
10	TVA Shawnee AFBC	11,300
	TOTAL	17,754,000

Sources of water for public supplies and for self-supplied commercial supplies.

Table 27 shows permitted public suppliers and self-supplied commercial water suppliers in the Lower Ohio River basin. Locations of these systems are shown in figure 16. With the exception of the lake at Crofton, sources of supply are sufficient for present usage. All facilities are operating at less than 80 percent of capacity.

Table 27.--Public water suppliers and self-supplied commercial water suppliers in the Lower Ohio River basin

[Drought susceptibility class--A. System unlikely to experience water shortage during drought conditions. B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage. C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary.]

Site No.	System name and town (county)	Source of supply	Latitude and longitude of intakes	Drought susceptibility class (A-C)	Average withdrawal or use (gal/d)	Treated storage (gal)	Treatment plant design capacity (gal/d)
	LOWER OHIO-BAY BASIN HYDROLOGIC UNIT CODE 05140203						
7	Smithland Water & Sewer Syst. Smithland (Livingston)	Wells	37 08 31 88 24 22	A	62,000	196,000	311,000
	TRADEWATER RIVER BASIN HYDROLOGIC UNIT CODE 05140205						
5	Crofton Water Dept. Crofton (Christian)	Crofton Lake	37 02 23 87 29 24	B	112,000	150,000	332,000
	Christian Co. Water Dist. Hopkinsville (Christian)				(40,000)	225,000	324,000
8	Outwood ICF-MR Dawson Springs (Christian)	Wells	37 08 25 87 39 37	Unknown	20,000	100,000	144,000
	LOWER OHIO RIVER BASIN HYDROLOGIC UNIT CODE 05140206						
9	Bandana Water Dist. Bandana (Ballard)	Wells	37 08 40 88 56 40	A	14,200	70,000	20,000
6	Kevil Water Dept. Kevil (Ballard)	Wells	37 05 10 88 53 15	A	95,000	50,000	300,000
4	LaCenter Mun. Water Dist. LaCenter (Ballard)	Wells	37 04 30 88 58 30	A	180,000	75,000	280,000
3	Ledbetter Water Dist. Ledbetter (Livingston)	Wells	37 02 52 88 28 39	A	200,000	300,000	311,000
2	Paducah Water Works Paducah (McCracken)	Ohio River (Regulated)	37 05 48 88 36 50	A	6,059,500	10,300,000	12,000,000
	Hendron Water Syst. Paducah (McCracken)				(300,000)	250,000	0
	Lone Oak Water Dist. Paducah (McCracken)				(500,000)	150,000	775,000
	West McCracken Water Dist. Paducah (McCracken)				(283,500)	250,000	700,000
	Massac Water Assoc., Inc. Paducah (McCracken)				(66,000)	125,000	0

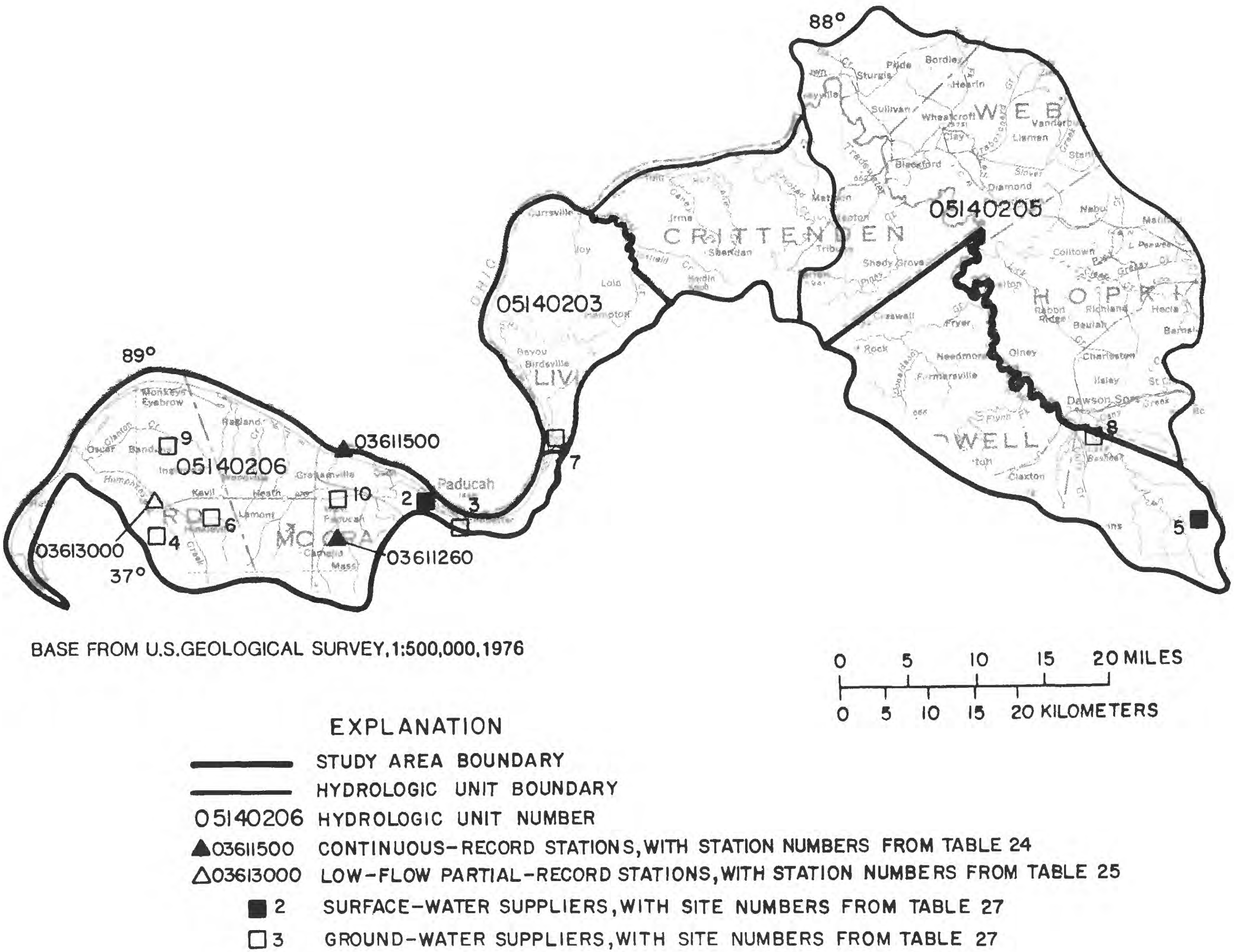


Figure 16.--Public water suppliers, self-supplied commercial water suppliers, and data sites in the Lower Ohio River basin in Kentucky.

Use of water distributed by permitted public suppliers and by self-supplied commercial suppliers.

Table 28 shows the use of water that was distributed by permitted public and self-supplied commercial supply systems in the Lower Ohio River basin.

Table 28.--Use of water in the public supply systems and in the self-supplied commercial supply systems in the Lower Ohio River basin

Site No.	System name and town (county)	Population	Connections: Commercial and industrial	Connections: Residential	Average commercial and industrial use (gal/d)	Average residential use (gal/d)	Residential use per capita (gal/d)
	LOWER OHIO-BAY BASIN HYDROLOGIC UNIT CODE 05140203						
7	Smithland Water & Sewer Syst. Smithland (Livingston)	780	30	230	12,400	49,600	65
	TRADEWATER RIVER BASIN HYDROLOGIC UNIT CODE 05140205						
5	Crofton Water Dept. Crofton (Christian)	1,490	<5	485	2,500	69,500	45
	Christian Co. Water Dist. Hopkinsville (Christian)	800	0	255	0	37,900	45
8	Outwood ICF-MR Dawson Springs (Christian)	210	0	1	0	20,000	95
	LOWER OHIO RIVER BASIN HYDROLOGIC UNIT CODE 05140206						
9	Bandana Water Dist. Bandana (Ballard)	300	0	100	0	14,200	45
6	Kevil Water Dept. Kevil (Ballard)	1,500	0	500	0	95,000	65
4	LaCenter Mun. Water Dept. LaCenter (Ballard)	1,300	0	465	0	180,000	140
3	Ledbetter Water Dist. Ledbetter (Livingston)	2,475	0	750	0	200,000	80
2	Paducah Water Works Paducah (McCracken)	38,000	1010	12,475	1,850,000	3,050,000	80
	Hendron Water Syst. Paducah (McCracken)	5,780	5	1,860	20,400	270,600	50
	Lone Oak Water Dist. Paducah (McCracken)	5,910	200	1,600	132,000	324,000	55
	West McCracken Water Dist. Paducah (McCracken)	2,000	30	600	177,700	92,300	45
	Massac Water Assoc., Inc. Paducah (McCracken)	1,290	<5	320	12,000	48,000	35

The following public water suppliers in the Lower Ohio River basin sell 5,000 gal or more of water per day per buyer (indented below supplier) for industrial use.

Paducah Water Works
- Coca Cola Bottling Co.
- Curtis Color Lab
- Federal Materials
- Florsheim Shoe Co.
- Hawley Products
- Illinois Central Gulf Railroad
- Metzger Packing Co.

Paducah Water Works (cont.)
- Owen Cleaners (main plant)
- Rental Uniform Service
- Wahl's Laundry (main plant)
- Hendron Water Syst.
  - Brown Plating

West McCracken Water Dist.
- Cablac Wire Corp.

Self-supplied industrial water users.

Table 29 shows self-supplied industrial water users permitted by the Kentucky Division of Water to withdraw water in the Lower Ohio River basin. Figure 17 shows the locations of these water facilities. No problems are know to exist with source availability or treatment plant capacity with these systems.

Table 29.--Permitted self-supplied industrial water users in the Lower Ohio River basin

[SIC=Standard Industrial Classification code. Drought susceptibility class--A. System unlikely to experience water shortage during drought conditions. B. System should be examined for susceptibility to water shortage during drought. Plans should be made for response to possible shortage. C. System is likely to experience water-supply shortage during drought conditions. Plans for response to shortage are necessary.]

Site No.	Facility name and town (county)	Employees	SIC code	Source	Latitude and longitude	Drought susceptibility class (A-C)	Average withdrawal (gal/d)	Storage capacity (gal)
	LOWER OHIO RIVER BASIN HYDROLOGIC UNIT CODE 05140206							
1	Martin Marietta Energy Syst. Oak Ridge (McCracken) (purchased from TVA Shawnee Steam Plant).	12B0	2819	Ohio River (Regulated)	37 06 55 88 49 40	A	11,000,000	750,000
10	TVA Shawnee AFBC* W. Paducah (McCracken).	70	4911	Well	37 08 33 88 46 37	Unknown	11,300	6,000

* This plant also uses Ohio River water for permit-exempt (power production) purposes.

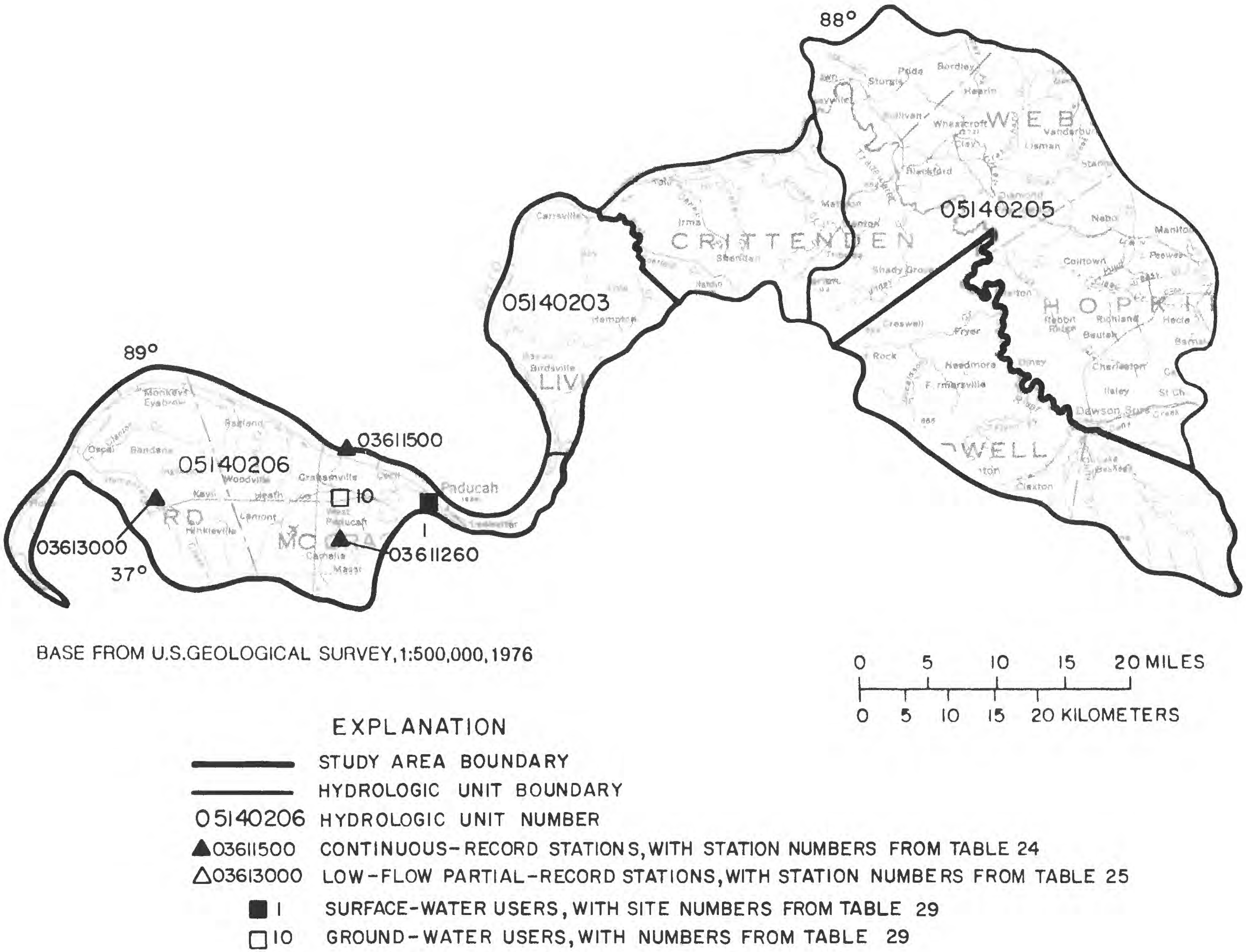


Figure 17.--Self-supplied industrial water users and data sites in the Lower Ohio River basin in Kentucky.

SUMMARY

Inventory results indicated that 101 permitted systems were withdrawing 116.3 Mgal/d in the 27-county area during 1984. An additional 43 permit-exempt systems were purchasing 10.3 Mgal/d from these 101 systems. These withdrawals are summarized below by river basin:

Basin	Systems withdrawing water	Total withdrawals (Mgal/d)
Green River	40	33.7
Lower Cumberland River	14	7.6
Tennessee River	18	25.4
Mississippi River	19	31.8
Lower Ohio River	10	17.8
Total	101	116.3

Sources of water were generally adequate throughout the study area. The evaluation showed only two public water-supply systems were likely to experience water-supply shortages during drought periods. Both of these systems, Franklin Water Works and Greenville Utilities Commission, are located in the Green River basin. Franklin Water Works has plans to construct a larger instream impoundment or drill a ground-water well for an alternate source of water that could be used, if needed. Two industrial systems in the Green River basin were found to be susceptible to water shortages during drought periods. Nine public systems could experience shortages during an extended drought and should be studied individually. Source adequacy could not be determined for several water systems withdrawing surface water, due to lack of available low-flow information. Also many ground-water sources could not be evaluated due to lack of available data. However, none of these systems experienced problems during droughts of recent years.

Six systems may have potential problems with their treatment plant capacities because they are operating at greater than 80 percent of design capacity. Three of these systems are in the Green River basin, two are in the Lower Cumberland River basin, and one is in the Tennessee River basin.

The inventory indicated that 111 public facilities supply 33.1 Mgal/d of water to 471,500 people in the study area. The services of these facilities range from 11,760 residential connections for 48,000 people at the Bowling Green Municipal Utilities in the Green River basin to 108 connections for 330 people at the Pamorama Shores Water Association in the Tennessee River basin. Residential water use per capita ranged from an average of 56 gal/d in the Tennessee River basin to an average of 75 gal/d in the Mississippi River basin. Average residential per capita use was 70 gal/d for the entire study area. Comparisons of ground- and surface-water use indicated that the Lower Ohio River basin had the highest percentage of surface-water use at 97 percent, and the Mississippi River basin had the highest percentage of ground-water use at 41 percent.

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page 75 follows

SUPPLEMENTAL DATA

page 77 follows

Table 30.--Public water-supply system inventory form

DROUGHT-RELATED WATER SUPPLY SURVEY

INSTRUCTIONS FOR SPECIFIC QUESTIONS ON THE WATER USE SURVEY

MUNICIPAL USERS

Note: You are welcome to use additional paper as necessary. If you have any questions or problems, please call Pamla Wood at the Kentucky Division of Water: 502-564-3410, extension 406.

1. Intake location: This information may be on your permit. If river mile (for streams) or latitude and longitude are not available, give geographic location.

   Other supply: Please state, on another piece of paper if necessary, whether other supply source is private or public. If more than one other source is used, please give amount supplied from each source.

2. 7-day, 10-year low flow refers to the lowest flow of historic record in seven consecutive days in any ten year period. This can be recorded in cubic feet per second or gallons per day.

3. Well yield vs. pumping rate: If pump test has been done, give the maximum sustained yield from the test. Otherwise, give pumping rate.

   Drawdown is the difference between the water level before and after pumping.

4. Give the maximum water available to your withdrawal system which existed under the worst recorded conditions.

19. Information concerning individual industries will be held confidential.

44. The average daily amount of water returned to a wastewater system is helpful in determining the amount of water consumed.

DROUGHT-RELATED WATER SUPPLY SURVEY

Commonwealth of Kentucky
NATURAL RESOURCE AND ENVIRONMENTAL PROTECTION CABINET
DIVISION OF WATER

WATER USER: ______________________ Location of Operation:

MAILING ADDRESS: ______________________ City: ____________

CITY: ____________ STATE: ______ ZIP: ______ County: ____________

Name and position of person to contact for further information (plant manager, owner, etc.):

______________________ Date: ____________

______________________ Phone: ____________

WATER USE DATA IS BASED ON 12-MONTH PERIOD BEGINNING: Month: ____ Year: _____

SEASONAL USE (if applicable): Month: ____ Year: ____ TO: Month: ____ Year: _____

*1. Source and amount of supply:

Names	Number	Intake Location (see instructions)	Average Daily Amount Withdrawn or Purchased on Operating Days	Percent of Total
Streams			GPD	%
			GPD	%
			GPD	%
Wells			GPD	%
Springs			GPD	%
Ponds or lakes			GPD	%
Other supplies (see instructions)			GPD	%
TOTAL	X	X		100 %

*2. What is the 7Q10 (7-day, 10-year low flow) of your stream? ________

*3. Well yield : ________gallons per minute or Pumping rate: ________ gallons per minute

Well drawdown : ______feet Depth to water table: ______ feet Depth of well(s) : ______ feet

*4. What is the reliable daily yield of your reservoir (ponds or lakes)? ________ GPD

How was this determined? (Check one): Estimated: ___ Calculated: ___

5. Do you expect major changes in your water supply source in the next 2 years? ___ 5 years? ____

Please explain: ______________________

____

6. Percent of water withdrawn which is Metered: ___ % Calculated: ____ %

7. Maximum daily average withdrawal : ____________ GPD

* See instructions for clarification

Table 30.--Public water-supply system inventory form-Continued

8. Maximum daily average withdrawal expected in 2 years : ____________ GPD; In 5 years: ____________ GPD
Please explain the reasons for expected changes:____
____

9. Normal pumping operation is ____ hours per day, ____ days per week, _____ weeks per year.
10. Peak use: _________ GPD Frequency of peak use: ___________ Approximate time(s) of peak use: _________
11. Maximum treatment plant capacity : ______________________GPM
12. Have you recently made or do you plan to make, in the next five years, any major facilities changes ? _____
Please explain any changes and give a completion date or anticipated completion date: ______________________
____

13. Population served: ______________________
14. Diameter of distribution lines: ______________________ Age: __________
15. Diameter of high service lines: ______________________Age: __________
16. Percent of water distributed which is: Metered: ___ % Estimated: ___ %

17. Service supplied to:

	Average Daily Amount (GPD)	Number of Connections
(A) Other towns or utility districts:	______________	__________
(B) Industry:	______________	__________
(C) Commercial:	______________	__________
(D) Residential:	______________	__________
(E) Used by city or lost in system:	______________	__________
TOTAL	______________	__________

18. Please list individual towns and districts to whom water is sold and the amount purchased by each:
______________________ ______________________
______________________ ______________________

*19. Please list industrial customers which use more than 2,000 GPD, and give amount puchased by each:
______________________ ______________________
______________________ ______________________

20. Please assist us in this survey effort by listing other municipal, commercial, or industrial water users in your county who may be withdrawing more than 10,000 GPD: __________ ______________________________________

21. Maximum impoundment or storage capacity for raw water, according to design specifications : ______________gallons
22. Has sedimentation been measured in the last 10 years? _____ If yes, what is the sedimentation rate? ______________
23. Current maximum impoundment or storage capacity (adjusted for sedimentation) : __________________ gallons
24. Maximum storage capacity for treated water : ____________________ gallons

25. Describe how and what water use records you maintain. Please specify whether any of these are computerized, and what sort of categories you use: ____
____

26. Do you prepare an annual water management and operations report? ____ If yes, please enclose the most recent copy.
27. Governing body (check one): Local government: ___ Private, reports to local government: ___
Private, separate from local government: ___ Other (specify): ___
28. Source of operating revenue: ______________________________________

29. Cost of water withdrawal: ______________ per ______
31. What is your present rate structure? (check one) Uniform : ___ Declining block: ___ Increasing block: ____
Varies by user: ___ Other: ______________________
32. Minimum cost per 1,000 gallons to residential: ______ Industrial: ______ Commercial: ______ Other: ______

MUNIC

Table 30.--Public water-supply system inventory form-Continued

33. Please give whatever test results are available **for raw water**, and date of test:

Contaminant	Level	Date	Contaminant	Level	Date	Contaminant	Level	Date
Barium	mg/l		Iron	mg/l		Nitrate	mg/l	
Chloride	mg/l		Lead	mg/l		Selenium	mg/l	
Chromium	mg/l		Magnesium	mg/l		Silver	mg/l	
Copper	mg/l		Manganese	mg/l		Sulfate	mg/l	
Fecal Coliform	ml		Methylene Blue Active Substances	mg/l		Total Dissolved Solids	mg/l	
Fluoride	mg/l		Mercury	mg/l		Zinc	mg/l	

34. What is the average level of dissolved oxygen in your water supply? ________ mg/l
35. How many times in the last 5 years has your system experienced some water shortage? __________
36. What water problems, if any, have you experienced? (For example water supply, water storage, water quality, turbidity, pump or system failure, or other). Please state the frequency and/or year of occurence:

____
____
____

37. Does your service area have a public information program relative to water conservation and the potential for supply shortage? (Please describe):_______________________________________

____

38. Does your system have an active leakage detection program? _____
39. What conservation measures and/or ordinances are in effect in your service area? ____________________
40. Alternate source(s) of water which have been used in time of shortage (give source type, amount, owner, and/or water district): ______________________________________
41. Potential alternate source(s) of water for future shortages (give source type, amount, owner and/or water district):

____
____

42. Present emergency or back-up supply agreements with other water systems (give source type, amount, owner and/or water district): ______________________________________

____

43. What percent of your customers use septic fields? _____% Percent with sewer service? _____% Other: _____%
44. Average amount of water returned to a wastewater system: __________ GPD
45. Do your sewer and water supply systems have combined billing? _____

Thank you for your cooperation. Please return completed questionnaire to Pamla Wood, Kentucky Divison of Water, Fort Boone Plaza, 19 Reilly Road, Frankfort, Kentucky 40601, **by April 8** if possible.
If you have questions, **call** 502-564-3410 extension 406.

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Table 31.--Self-supplied commercial, institutional, and industrial water-supply system inventory form

DROUGHT-RELATED WATER SUPPLY SURVEY

INSTRUCTIONS FOR SPECIFIC QUESTIONS ON THE WATER USE SURVEY

SELF-SUPPLIED COMMERCIAL AND INDUSTRIAL USERS

Note: You are welcome to use additional paper as necessary.
If you have any questions or problems, please call Pamla Wood
at the Kentucky Division of Water: 502-564-3410, extension 406.

1. Intake location: This information may be on your permit. If river mile (for streams) or latitude and longitude are not available, give geographic location.

   Other supply: Please state, on another piece of paper if necessary, whether other supply source is private or public. If more than one other source is used, please give amount supplied from each source.

2. 7-day, 10-year low flow refers to the lowest flow of historic record in seven consecutive days in any ten year period.

3. Well yield vs. pumping rate: If pump test has been done, give the maximum sustained yield from the test. Otherwise, give pumping rate.

   Drawdown is the difference between the water level before and after pumping.

4. Give the maximum water available to your withdrawal system which existed under the worst recorded conditions.

27. The average daily amount reused or recirculated may be based on the capacity of the pump used to pump recirculated or reused water, and the duration of that pumping.

28. "Total water use" is the sum of the average daily amount (shown in question 1 as "Total") plus amount reused or recirculated.

35. The average daily amount of water returned to a wastewater system is helpful in determining the amount of water consumed.

DROUGHT-RELATED WATER SUPPLY SURVEY

Commonwealth of Kentucky
NATURAL RESOURCE AND ENVIRONMENTAL PROTECTION CABINET
DIVISION OF WATER

WATER USER: ____________________ Location of Operation:

MAILING ADDRESS: ____________________ City: __________

CITY: __________ STATE: ______ ZIP: ______ County: __________

Name and position of person to contact for further information (plant manager, owner, etc):

____________________ Date: __________

____________________ Phone: __________

WATER USE DATA IS BASED ON 12-MONTH PERIOD BEGINNING: Month: ____ Year: ____

SEASONAL USE (if applicable): Month: ____ Year: ____ TO: Month: ____ Year: ____

*1 Source and amount of supply:

Names	Number	Intake Location (see instructions)	Average Daily Amount Withdrawn or Purchased on Operating Days	Percent of Total
Streams			GPD	%
			GPD	%
			GPD	%
Wells			GPD	%
Springs			GPD	%
Ponds or lakes			GPD	%
Other supplies (see instructions)			GPD	%
TOTAL	X	X		100 %

*2 What is the 7Q10 (7-day 10-year low flow) of your stream? __________

*3 Well yield : __________gallons per minute or Pumping rate: __________ gallons per minute

Well drawdown : ______feet Depth to water table: ______ feet Depth of well(s) : ______ feet

*4 What is the reliable daily yield of your reservoir (ponds or lakes)? __________ GPD

How was this determined? (Check one): Estimated: ___ Calculated: ___

5 Do you expect major changes in your water supply source in the next 2 years? ___ 5 years? ____

Please explain: ____________________

____

6 Percent of water withdrawn which is Metered: ___ % Calculated: ___ %

7 Maximum daily average withdrawal : __________ GPD

* See instructions for clarification

Table 31.--Self-supplied commercial, institutional, and industrial water-supply system inventory form-Continued

8. Maximum daily average withdrawal expected in 2 years : ____________ GPD; In 5 years: ____________ GPD
Please explain the reasons for expected changes: ____

____

9. Normal pumping operation is ____ hours per day, ____ days per week, _____ weeks per year.
10. Peak use: _________ GPD Frequency of peak use: __________ Approximate time(s) of peak use: _________
11. Average number of employees occupying this facility: ______ Hours per day: _____
12. Have you recently made, or do you plan to make, in the next five years, any major facilities changes ? _____
Please explain any changes and give a completion date, or anticipated completion date: ____________________

____

13. Major product(s) or service(s) (give the four digit Standard Industrial Classification number if known):

____

14 Major byproducts: ______________________________________
15. Major raw materials used: ___________________________
16. Minimum amount of water necessary to maintain a minimum production level : _______________ GPD

17. Water is used for:

Use	Percent of Total Use	Percent Recirculated (A)	Percent Consumed (B)	Percent Discharged (C)	Total (A + B + C)
Cooling or condensing					100 %
Processing (including process washing)					100 %
Domestic (including general sanitation)					100 %
Boiler					100 %
Lost in system					100 %
TOTAL	100 %	X	X	X	X

18 Please assist us in this survey effort by listing other municipal, commercial, or industrial water users in your county who may be withdrawing more than 10,000 GPD: ______________________________________

19 Maximum impoundment or storage capacity for raw water, according to design specifications : _____________ gallons
20. Has sedimentation been measured in the last 10 years? _____ If yes, what is the sedimentation rate? _____________
21. Current maximum impoundment or storage capacity (adjusted for sedimentation) : __________________ gallons

22. Describe how and what water use records you maintain. Please specify whether any of these are computerized, and what sort of categories you use: ____

____

23. Cost of water withdrawal: _____________ per ______

24. What percent of water is treated prior to use? ______%
Please specify the type of treatment being applied: ______________________________

Table 31.--Self-supplied commercial, institutional, and industrial water-supply system inventory form-Continued

25. How many times in the last 5 years has your system experienced some water shortage? __________

26. What water problems, if any, have you experienced (for example, water supply, water storage, water quality, pump or system failure, turbidity, or other) ? Please state the frequency and/or year of occurence:

____

____

____

*27. Average amount of water reused or recirculated on normal operating days: ____________ GPD

*28. Total water use (average daily withdrawal plus reuse): ____________ GPD

29. Have you recently made or do you plan to make, in the next five years, any major facilities or operational changes to improve water use efficiency ? _____ Please explain any changes and give completion date or anticipated completion date:

____

30. Based on available information and your water use/supply situation, do you think that the increased reuse or recirculation of water would be practical and cost-effective for your operation? _____ If yes; what legal, institutional, financial, and physical modifications, if any, would be needed to acheive this higher level of water reuse?

____

31. What conservation measures are used in addition to recirculation? ______________________________

32. Alternate source(s) of water which have been used in time of shortage (give source type, amount, owner, and/or water district):

____

____

33. Potential alternate source(s) of water for future shortages (give source type, amount, owner and/or water district):

____

____

34. Average daily effluent: ________________ GPD Type of treatment applied to effluent: ____________________

*35. Average amount of water returned to a wastewater system. ____________ GPD

36 Percent of total effluent returned to

Stream	_____ %	Name of stream:	______________________________
		Location on stream (river mile or geographic location):	____________
Well injection	_____ %		
Septic tank & field tile	_____ %		
Spray irrigation	_____ %	Gallons pumped per day.	______________
Public system	_____ %	Name of system	____________________
Other	_____ %	Specify if by sale, etc	____________________

Thank you for your cooperation. Please return completed questionnaire to Pamla Wood, Kentucky Divison of Water, Fort Boone Plaza, 19 Reilly Road, Frankfort, Kentucky 40601, **by April 8** if possible. If you have questions, call 502-564-3410 Extension 406.

* See instructions for clarification.

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Table 32.--Index of water systems in study area

System name	River basin	Figure-site number and(or) source(s), if purchased
Adairville Water Works	Lower Cumberland	7/ 5
Airco Carbide	Tennessee	11/ 8
Allen County Water District	Green	Scottsville Water Department
AMCA Processing	Green	5/34
Arlington Water District	Mississippi	13/15
Auburn Hosiery Mills	Green	5/38
Auburn Water Department	Green	4/23
Bandana Water District	Lower Ohio	16/ 9
Bardwell Water System	Mississippi	13/ 8
Barkley Lake Water District*	Lower Cumberland	7/ 2, Princeton Water Department
Barlow Water and Sewage Works	Mississippi	13/11
Beaver Dam Municipal Water System*	Green	4/27, Ohio County Water District
Benton Water and Sewer System	Tennessee	10/12
B.F Goodrich Chemical*	Tennessee	11/ 2, Calvert City Water and Sewer
Bowling Green Municipal Utilities	Green	4/ 1
Brownsville Municipal Water System	Green	Edmonson County Water District
Burkesville Water Works	Upper Cumberland	4/20
Butler County Water System	Green	Morgantown Water System
Cadiz Municipal Water Company	Lower Cumberland	7/ 4
Calvert City Water and Sewer	Tennessee	10/ 9
Caneyville Municipal Water Works	Green	4/29
Centertown Water System	Green	Hartfort Municipal Water Works
Central City Water and Sewer	Green	4/ 4
Christian County Water District	Lower Cumberland	Barkley Lake Water District, Hopkinsville Water and Sewer Works, Crofton Water Department
Columbus Water Works	Mississippi	13/17
Concord Farms	Green	5/37
Consumer Water District	Mississippi	13/ 7
Crofton Water Department	Lower Ohio	16/ 5
Cunningham Water District	Mississippi	13/18
Deena Lamp Company, Inc.	Mississippi	14/19
Dogwood Ridge Farms	Green	5/35

Table 32.--Index of water systems in study area-Continued

System name	River basin	Figure-site number and(or) source(s), if purchased
Drakesboro Water Department	Green	Muhlenberg County Water District #1
Dexter Almo Heights	Tennessee	Murray Water System
East Logan Water District	Green	Russellville Municipal Water System
Eddyville Water Department	Lower Cumberland	7/ 7
Edmonson County Water District	Green	4/14
Edmonton Water Works	Green	Glasgow Water Plant #2
Elkton Water Works	Green	Todd County Water District
Fancy Farm Water District	Mississippi	13/10
Fordsville Water District	Green	4/30
Fountain Run Water District #1	Green	Glasgow Water Plant #2
Franklin Water Works	Green	4/ 5
Fredonia City Water Works	Lower Cumberland	Eddyville Water Department
Fulton Muncipal Water	Mississippi	13/ 5
GAF Corporation*	Tennessee	11/ 4, Penwalt Corporation, Calvert City Water and Sewer
General Tire and Rubber	Mississippi	14/ 2
Glasgow Foods, Inc.*	Green	5/36, Glasgow Water Plant #1 and #2
Glasgow Water Plant #1	Green	4/ 3a
Glasgow Water Plant #2	Green	4/ 3b
Grand Rivers Water System	Tennessee	10/14
Grayson County Water Works	Green	Leitchfield Water Works
Greenville Utilities Commission	Green	4/13
Guthrie Water Works	Lower Cumberland	7/ 9
Hardeman Water District	Mississippi	13/14
Hardin Water System	Tennessee	Benton Water and Sewer System
Hartford Municipal Water Works	Green	4/17
Hendron Water System	Lower Ohio	Paducah Water Works
Hickman Water Department	Mississippi	13/ 4
Hickory Water District	Mississippi	13/ 6
Hopkinsville Water and Sewer Works	Lower Cumberland	7/ 1
Huntsville-South Hill	Green	Rochester Water District
Jonathan Creek Water Association	Tennessee	10/13
Kentucky Agricultural Energy	Green	5/ 7
Kentucky State Penitentiary	Lower Cumberland	7/ 8

Table 32.--Index of water systems in study area-Continued

System name	River basin	Figure-site number and(or) source(s), if purchased
Kentucky Water Service Company	Mississippi	13/ 9
Kevil Water Department	Lower Ohio	16/ 6
Kuttawa Water Supply	Lower Cumberland	7/10
LaCenter Municipal Water District	Lower Ohio	16/ 4
Lake City Water District	Tennessee	10/15
Ledbetter Water District	Lower Ohio	16/ 3
Leitchfield Water Works	Green	4/10
Lewisburg Water Works	Green	North Logan Water District
Logan Aluminum	Green	5/21
Lone Oak Water District	Lower Ohio	Paducah Water Works
Lyon County Water District	Lower Cumberland	Kuttawa Water Supply
Marrowbone Water District	Upper Cumberland	4/28
Martin Marietta Energy Systems	Lower Ohio	17/ 1, Tennessee Valley Authority
Massac Water Association, Inc.	Lower Ohio	Paducah Water Works
Mayfield Water System	Mississippi	13/ 3
Milburn Water District	Mississippi	Fancy Farm Water District
Monroe County Water District	Green	Tompkinsville Water Works
Morgantown Water System	Green	4/15
Muhlenberg County Water District #1	Green	Central City Water and Sewer
Muhlenberg County Water District #2	Green	Muhlenberg County Water District #1
Muhlenberg County Water District #3	Green	Central City Water and Sewer
Murray Water System	Tennessee	10/ 3
Murray Water District #1, #2, #3	Tennessee	Murray Water System
Nestaway-Coated Metallic Products*	Green	5/25, Beaver Dam Minicipal Water System
North Barren Water Association	Green	Glasgow Water Plant #2
North Logan Water District	Green	Russellville Municipal Water System
North Marshall Water District	Tennessee	10/10
Oak Grove Utility Company	Lower Cumberland	7/ 6
Ohio County Water District	Green	4/ 9
Ohio River Steel Corporation	Tennessee	11/18
Outwood ICF - MR	Lower Ohio	16/ 8

Table 32.--Index of water systems in study area-Continued

System name	River basin	Figure-site number and(or) source(s), if purchased
Paducah Water Works	Lower Ohio	16/ 2
Park City Water Works	Green	Glasgow Water Plant #2
Panorama Shores Water Association	Tennessee	10/17
Peabody Coal Alston Mine	Green	5/22
Peabody Coal Gibralter Mine	Green	5/ 6
Peabody Coal Ken Prep Plant	Green	5/ 2
Peabody Coal River Queen Mine	Green	5/26
Pembroke Water Works	Lower Cumberland	7/12
Penwalt Corporation	Tennessee	11/ 1
Princeton Hosiery Mill*	Lower Cumberland	8/14, Princeton Water Department
Princeton Water Department	Lower Cumberland	7/ 3
Reed Crushed Stone	Tennessee	11/ 5
Reidland Water District	Tennessee	10/11
Rochester Water District	Green	4/24
Rockport Water Works	Green	4/32
Rough River State Park	Green	4/33
Rough River Water System	Green	Ohio County Water District
Russellville Municipal Water System	Green	4/ 8
Sacramento Water Works	Green	Central City Water and Sewer
Scottsville Water Department*	Green	4/18, Glasgow Water Plant #2
Sedalia Water District	Mississippi	13/16
Simpson County Water District	Green	Franklin Water Works
SKW Alloys	Tennessee	11/ 6
Smithland Water and Sewer System	Lower Ohio	16/ 7
South Cumberland Water District	Upper Cumberland	Burkesville Water Works
South Graves County Water District	Mississippi	13/12
South Logan Water Association	Lower Cumberland	Adairville Water Works
South 641 Water District	Tennessee	Murray Water System
Southwind Mining	Green	5/40
Squire Lyle Farms	Green	5/39
Symsonia Water District	Tennessee	10/16
Three Rivers Rock Company	Lower Cumberland	8/11

Table 32.--Index of water systems in study area-Continued

System name	River basin	Figure-site number and(or) source(s), if purchased
Todd County Water District	Green	4/19
Tompkinsville Water Works	Green	4/11
Trenton Water Works	Lower Cumberland	7/13
TVA Paradise Coal Washing	Green	5/12
TVA Shawnee AFBC	Lower Ohio	17/10
Vanderbilt Chemical Corporation	Tennessee	11/ 7
Vermont American Corp	Green	5/31
Warren County Water District*	Green	4/16, Bowling Green Municipal Utilities
West Marshall Water District	Tennessee	Benton Water and Sewer System
West McCracken Water District	Lower Ohio	Paducah Water Works
Westvaco Corporation	Mississippi	14/ 1
Wickliffe Municipal Water	Mississippi	Westvaco Corporation
Wingo Water and Sewer	Mississippi	13/13

* System makes direct withdrawals and also purchases water.

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