EVALUATION OF THE DROUGHT SUSCEPTIBILITY OF WATER SUPPLIES USED IN THE KENTUCKY RIVER BASIN IN 1988

By Clyde J. Sholar and Pamla A. Wood

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CONVERSION FACTORS

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

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Kentucky Natural Resources and Environmental Protection Cabinet

ABSTRACT

Major public water supply systems and self-supplied commercial and industrial water systems in the Kentucky River basin were inventoried to evaluate the adequacy of raw-water sources used in 1988 to meet demands on these systems during drought. All water systems that withdraw at least 10,000 gallons per day are regulated through a permitting program by the Division of Water, Kentucky Natural Resources and Environmental Protection Cabinet.

A total of 54 permitted water facilities were inventoried. The inventory indicated that these facilities withdrew more than 86.4 Mgal/d in 1988. The inventory indicated that 31 permitted public-water systems furnished water to an additional 39 public-water suppliers in the basin. These 70 public suppliers withdrew about 80 Mgal/d and furnished almost 40 Mgal/d to more than 554,000 people. Domestic per capita use averaged 72 gallons per day in the study area. The study indicated that almost 98 percent of the water withdrawn by the permitted facilities was from surface-water sources.

Sources of water were adequate to meet demands throughout the study area except for those of public suppliers at Lexington, Georgetown, and Stanford, which are likely to have water-supply shortages during drought conditions. Several water systems could not be evaluated for their susceptibility to droughts because the adequacy of their source was unknown. This was attributed to lack of streamflow or ground-water information. However, none of these systems had problems during drought periods in recent years. In addition, five systems may have water-supply problems because they are operating near or greater than 80 percent of design capacity of their treatment plants.

INTRODUCTION

A potential exists for significant water-supply shortages in the Kentucky River basin (fig. 1). About 95 percent of all water withdrawn is from surface-water sources (Sholar and Lee, 1988), and almost 98 percent of the water withdrawn by permitted water systems is from surface water. The Kentucky River, its tributaries, and reservoirs, supply most of the water to the users in the basin. In 1985, average total surface-water withdrawals in the Kentucky River basin exceeded the flow at the mouth of the Kentucky River about 4 percent of the time based on flow duration tables published by Quinones and others (1980). The U.S. Army Corps of Engineers (1978) estimated

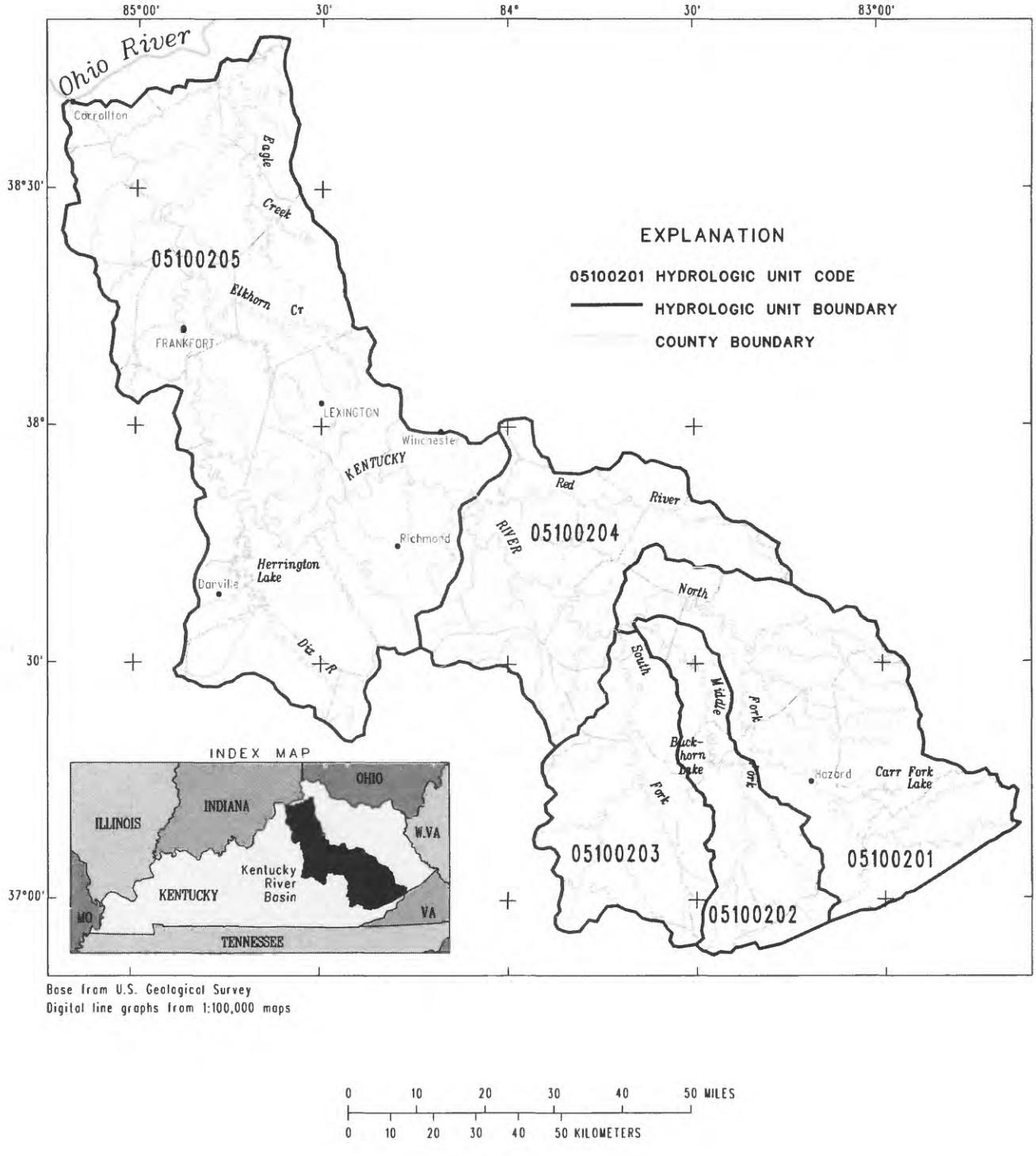

Figure 1.--Location of study area and major drainage basins.

that if the drought of 1930 was repeated, the level of the Kentucky River would fall below the primary water intake for Lexington, the largest city in the basin. Population in the basin is more than 660,000, or about 18 percent of the total population of the State (U.S. Dept. of Commerce, 1986). Future population and industrial growth in the basin is expected to be greater than in any other basin in the State. These factors, in addition to seasonal variation in precipitation and increased water demands during low-flow conditions, may lead to water shortages in the basin.

Effective water resource planning and management requires information about adequacy of supply. A cooperative study by the U.S. Geological Survey and the Kentucky Natural Resources and Environmental Protection Cabinet (KNREPC), Division of Water, was begun in 1988 to assess the adequacy of water supplies in the Kentucky River basin, especially during drought conditions.

Purpose and Scope

This report describes the results of a study to evaluate the adequacy of the major water supplies in the Kentucky River basin to meet demands in times of drought. The scope is limited to the evaluation of public-water systems and self-supplied industrial and commercial water systems that were permitted by the KNREPC to withdraw at least 10,000 gal/d in the Kentucky River basin during 1988. Future demand is not evaluated in this report.

Data Collection and Presentation

Water-use information for this report was taken from KNREPC, Division of Water files, augmented by mail-inventory of public-water systems, self-supplied industrial, and commercial water systems and was based on 1988 data. The inventory forms, which were mailed by and returned to KNREPC, Division of Water, contained 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.

The report includes (1) an explanation of methods used for water-system evaluation; (2) a basin description; and (3) details about the public-water systems and self-supplied industrial and commercial water systems that withdraw at least 10,000 gal/d or purchase 5,000 gal/d.

A map of the basin and major sub-basins by hydrologic unit is provided (fig. 1). Maps showing locations of the water withdrawals and hydrologic data stations are also included (figs. 3-5). These are shown because information from these hydrologic stations was used to evaluate surface-water withdrawals. Site numbers were assigned to water systems according to magnitude of water withdrawals in the basin.

Physiographic, streamflow, reservoir, precipitation, runoff, and ground-water information is presented because this information is needed to describe the hydrologic characteristics that directly influence the availability of water. Daily streamflow, precipitation, and runoff information was taken from

USGS annual reports and from Melcher and Ruhl (1984). Low-flow partial-record information 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. The average discharge, low-flow, reservoir, and precipitation data for the basin are included in tables 1-4. Information about all major water systems in the basin is included in tables 5-10.

Methods of Evaluating Drought Susceptibility

The availability of water at the point of withdrawal is a major concern, especially during drought periods when withdrawal rates usually increase. Therefore, the Water Resources Branch of the KNREPC, Division of Water developed a program to evaluate water systems. Water 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 water availability at the point of withdrawal during drought conditions. For those systems with more than one point of withdrawal, withdrawal amounts were combined and only one classification was assigned to the entire system. The 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 need to be made for response to possible shortage.

C. System is likely to have water shortage during drought conditions. Plans for response to shortage are necessary.

Water systems that relied solely on uncontrolled (unregulated) streams were classified by comparing average withdrawal rate to the expected minimum discharges which were not exceeded for 7-day periods for 10-year frequencies (7-day, 10-year low-flow conditions). The classes assigned to the unregulated streams are shown in the following chart:

Unregulated streams

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

Water systems that relied on regulated streams were classified with a wide range between classes due to more control over low-flow conditions. A regulated stream was defined as any stream reach in which flow was controlled by releases from upstream reservoirs. Classifications were determined by comparing average daily withdrawal rates to expected 7-day, 10-year low-flow conditions with minimum upstream releases, adjusted for intervening flow. The classes assigned to regulated streams are shown in the following chart:

Regulated streams

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

Water systems that relied on reservoirs were divided into two categories: (1) impounded streams with 7-day, 10-year low flows of zero; and (2) impounded streams with 7-day, 10-year low flows greater than zero. Systems that relied on reservoirs with zero inflow during drought were classified according to number of days of water stored and the size of the watershed in square miles. The number of days of water stored in the reservoir was determined by dividing the total amount of usable storage volume by the average daily withdrawal. The classes determined are shown in the following chart:

Reservoirs without inflow during drought

	Watershed size, in square miles			
Days stored	> 10	>5-10	1-5	<1
>350	A	A	B	C
201-350	A	B	B	C
100-200	B	B	C	C
<100	C	C	C	C

Water systems that relied on reservoirs with inflow during drought were classified by comparing the average withdrawal rates to the number of days of water stored and to inflow at the reservoir during 7-day, 10-year low-flow conditions. The classes are shown in the following chart:

Reservoirs with inflow during drought

Days stored	Percent of source used			
	<15	15-50	>50-75	>75-100
>200	A	A	A	B
91-200	A	A	B	B
51- 90	A	B	B	B
30- 50	B	B	B	C
<30	B	B	C	C

Classes were determined for ground-water supplies according to historical records of aquifer storage. If data sufficient to classify the sources did not exist, the drought susceptibility class was listed as unknown.

Acknowledgments

The authors thank the operators of the water systems, city and county officials, industry representatives, and KNREPC Division of Water personnel for their cooperation in supplying information for this study.

DESCRIPTION OF THE KENTUCKY RIVER BASIN

The Kentucky River basin is entirely in Kentucky and drains 6,873 square miles (Seaber and others, 1984) which includes all or part of 39 of the State's 120 counties (fig. 1). The Kentucky River originates in the mountainous terrain of southeastern Kentucky and flows northwesterly through the central part of the state to its junction with the Ohio River at Carrollton, Kentucky.

Physiographic Regions

The Kentucky River basin contains parts of the Eastern Coal Field, Knobs, Inner Bluegrass, and Outer Bluegrass physiographic regions (fig. 2) (Fenneman, 1938). Each of these regions has distinct underlying geology. The stream-flow characteristics and ground-water availability are closely related to the terrain and the underlying geology of each region.

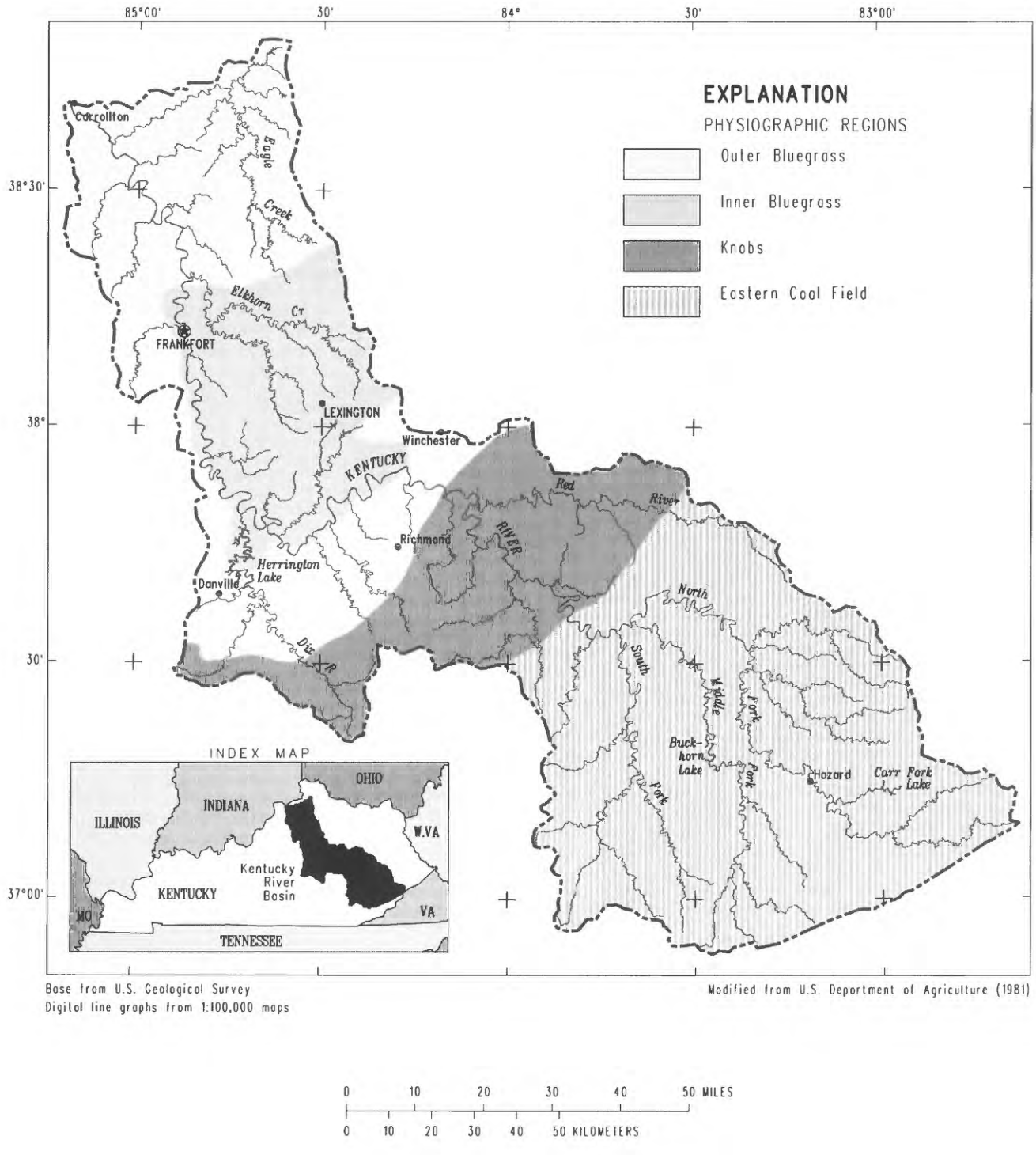

Figure 2.--Physiographic regions in the Kentucky River basin.

The Eastern Coal Field region is in the southeastern part of the basin where the headwaters of the Kentucky River originate. The topography is very rugged and consists of narrow valleys and steep-sided ridges, underlain by sandstones, siltstones, shales, and coals.

The Knobs region forms a narrow crescent-shaped area separating the Eastern Coal Field from the Bluegrass region. The Knobs region is characterized by conical and flat-topped hills, called knobs, which have sandy limestone and sandstone caprock overlying less resistant thin-bedded shales and limestones.

The Inner Bluegrass region, in the north-central part of the Kentucky River basin, is characterized by gently rolling upland underlain by thick-bedded limestone in which the Kentucky River and some of its tributaries are entrenched more than 350 feet. As a result of the weathering of the limestone an extensive area of karst topography exists in the Inner Bluegrass region. Thus, much of the drainage is underground.

The Outer Bluegrass region is in the northern half of the basin and encircles the Inner Bluegrass region. The Outer Bluegrass region is characterized by gently rolling terrain underlain by thin-bedded limestone with inter-bedded shale. The topography is similar to that of the Inner Bluegrass region except near streams where it is dissected and more rugged. Small sinkholes are common but most of the drainage is on the surface (Kentucky Natural Resources and Environmental Protection Cabinet, 1975).

Surface-Water Characteristics

The Kentucky River basin consists of the following tributary basins as delineated by the U.S. Geological Survey (Seaber and others, 1984).

Hydrologic unit code	Hydrologic unit name	Drainage area, in square miles
05100201	North Fork Kentucky River basin	1,310
05100202	Middle Fork Kentucky River basin	552
05100203	South Fork Kentucky River basin	741
05100204	Upper Kentucky River basin	1,070
05100205	Lower Kentucky River basin	3,200

Streamflow data and information for existing continuous-record (daily) stations in the Kentucky River basin are listed in table 1. Stream discharge and stage information are monitored by the U.S. Geological Survey at these stations. Locations of the stations are shown in figures 3-5.

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

Site number	Station name and location (county)	Drainage area, in square miles	Period of record	Average discharge, in cubic feet per second	Low flow, in cubic feet per second	
					7-day, 2-year	7-day, 10-year
HYDROLOGIC UNIT CODE 05100201						
1	Carr Fork near Sassafras (Knott)	60.6	1964-82	79.2	0.71	0.02
2	North Fork Kentucky River at Jackson (Breathitt)	1,101	1928-31 1938-82	1,360	24	3.1
HYDROLOGIC UNIT CODE 05100202						
3	Middle Fork Kentucky River near Hyden (Leslie)	202	1958-82	300	2.3	.28
4	Cutshin Creek at Wooton (Leslie)	61.3	1958-82	97.5	.91	.09
5	Middle Fork Kentucky River at Tallega (Lee)	537	1931-32 1940-82	730	6.1	.64
HYDROLOGIC UNIT CODE 05100203						
6	Red Bird River near Big Creek (Clay)	155	1972-82	296	2.2	.79
7	Goose Creek at Manchester (Clay)	163	1965-82	269	3.3	.73
8	South Fork Kentucky River at Booneville (Owsley)	722	1925-82	1,058	11	1.1
HYDROLOGIC UNIT CODE 05100204						
9	Kentucky River at Lock 14 at Heidelberg (Lee)	2,657	1926-31 1960-82	3,636	101	22
10	Red River near Hazel Green (Wolfe)	65.8	1954-82	89.2	.35	0
11	Red River at Clay City (Powell)	362	1931-82	483	13	3.7
HYDROLOGIC UNIT CODE 05100205						
12	Kentucky River at Lock 10 near Winchester (Madison)	3,955	1908-82	5,271	132	42
13	Dix River near Danville (Garrard)	318	1943-82	468	.45	0
14	Kentucky River at Lock 6 near Salvisa (Woodford)	5,102	1926-82	6,745	309	136
15	Kentucky River at Lock 4 at Frankfort (Franklín)	5,411	1926-82	7,111	337	175
16	South Elkhorn Creek at Fort Spring (Fayette)	24	1950-82	32.7	.63	0
17	Elkhorn Creek near Frankfort (Franklin)	473	1915-18 1940-82	609	22	6.5
18	Kentucky River at Lock 2 at Lockport (Henry)	6,180	1926-82	8,323	411	206

source: Melcher and Ruhl, 1984.

Sites in the Kentucky River basin where low-flow measurements have been made and data correlated with continuous-record index stations to produce low-flow frequency correlations are listed in table 2. Locations of these sites are shown in figures 3-5.

Many artificial lakes and reservoirs in the Kentucky River basin were constructed to help meet water-supply needs and to help protect against floods. Fifteen reservoirs in the basin have a volume greater than 325 Mgal or a surface area greater than 100 acres. Total combined volume of these 15 reservoirs is 93,200 Mgal and the total combined surface area is 6,530 acres (Kentucky Natural Resources and Environmental Protection Cabinet, 1975).

The three largest reservoirs in the basin are Herrington Lake, Buckhorn Lake, and Carr Fork Lake (fig. 1). Herrington Lake is a privately-owned reservoir with a usable storage volume of 40,100 Mgal. Buckhorn and Carr Fork Lakes are federal impoundments with storage volumes at seasonal pool of 7,100 and 2,100 Mgal, respectively (U.S. Department of Agriculture, 1981). Reservoirs used for water supply in the basin are listed in table 3.

Precipitation and Runoff

Mean annual precipitation ranges from 44 to 49 in/yr at the continuous-record streamflow stations in the basin. Average runoff ranges from 16.77 to 25.93 in/yr. Precipitation and runoff data are listed in table 4.

Ground-Water Characteristics

The availability of ground water in the Kentucky River basin is closely related to the geology of underlying rocks. Principal bed-rock aquifers in the basin are the sandstones of Pennsylvanian age and limestones of Ordovician age. A general overview of the water-bearing characteristics and the distribution of the geologic units in the basin are presented in reports by Hall and Palmquist, (1960a,b,c), Palmquist and Hall, (1960a,b,c), Kilburn and others, (1962), and Price and others, (1962).

Water-bearing rocks of Pennsylvanian age underlie the Eastern Coal Field region and consist of sandstone, siltstone, shale, and coal. The greatest depths of freshwater in the Kentucky River basin are in the Eastern Coal Field region (Hopkins, 1966). Well depths commonly range from 75 to 200 feet, but may exceed 400 feet. Yields to wells may exceed 200 gal/min but are generally only 1 to 5 gal/min. Ground water is used mainly for domestic and stock supplies, but some wells produce adequate water for small public and industrial supplies. Water is also used for coal washing and for water flooding necessary for secondary recovery of oil (Faust, 1985).

Water-bearing rocks of Ordovician age underlie the Inner and Outer Bluegrass regions and consist of limestone and shale. Well depths normally range from 50 to 200 feet. Water with high chloride concentrations may be found at depths greater than 200 feet below land surface (Hopkins, 1966). Ground water is withdrawn mostly for domestic and stock use because yields to

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

Site number	Station name and location (county)	Drainage area, in square miles	Low flow, in cubic feet per second	
			7-day, 2-year	7-day, 10-year
HYDROLOGIC UNIT CODE 05100201				
1	North Fork Kentucky River at Whitesburg (Letcher)	66.4	4.4	2.0
2	North Fork Kentucky River at Blackey (Perry)	131	1.7	.2
3	Rockhouse Creek near Letcher (Letcher)	51.5	.9	.3
4	Line Fork at Defeated Creek (Letcher)	40.8	.9	.3
5	North Fork Kentucky River at Cornettsville (Perry)	322	9.4	3.5
6	Troublesome Creek at Dwarf (Perry)	59.9	.3	0
7	Balls Fork at Ary (Perry)	45.4	.2	0
8	Quicksand Creek at Lunah (Breathitt)	101	.3	0
9	Quicksand Creek at Quicksand (Breathitt)	203	1.6	.1
HYDROLOGIC UNIT CODE 05100202				
10	Middle Fork Kentucky River at Asher (Leslie)	70.6	.4	0
11	Greasy Creek at Napier (Leslie)	37.7	.4	.1
12	Greasy Creek at Hoskinston (Leslie)	95	.7	.1
HYDROLOGIC UNIT CODE 05100203				
13	Red Bird River near Spring Creek (Clay)	52.7	1.9	.9
14	Red Bird River near Big Creek (Clay)	125	.9	.1
15	Goose Creek at Gooserock (Clay)	49.6	.4	.2
16	Collins Fork at Bluehole (Clay)	67.4	.1	0
17	South Fork Kentucky River at Oneida (Clay)	486	2.3	.1
18	Sexton Creek at Taft (Owsley)	71	1.1	.5
HYDROLOGIC UNIT CODE 05100204				
19	Sturgeon Creek near Heidelburg (Lee)	96.4	.3	0
20	South Fork Station Camp Creek near Drip Rock (Jackson)	41.4	.2	0
21	Station Camp Creek at Wagersville (Estill)	116	.4	0

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

Site number	Station name and location (county)	Drainage area, in square miles	Low flow, in cubic feet per second	
			7-day, 2-year	7-day, 10-year
HYDROLOGIC UNIT CODE 05100204--Continued				
22	Redlick Creek near Station Camp (Estill)	69.5	0.2	0
23	Red River near Pine Ridge (Wolfe)	142	3.2	.9
HYDROLOGIC UNIT CODE 05100205				
24	Otter Creek near Ford (Madison)	63.5	1.1	.3
25	Boone Creek near Locust Grove (Fayette)	41.8	0	0
26	Silver Creek near Richmond (Madison)	98.5	1.0	.4
27	Paint Lick Creek at Paint Lick (Garrard)	54.4	0	0
28	Paint Lick Creek near McCreary (Garrard)	97.6	0	0
29	Sugar Creek near Buckeye (Garrard)	41.5	0	0
30	Dix River above Copper Creek near Crab Orchard (Lincoln)	43.5	.1	0
31	Dix River below Copper Creek near Crab Orchard (Lincoln)	70.6	.1	0
32	Dix River near Stanford (Lincoln)	160	.1	0
33	Hanging Fork Creek near Stanford (Lincoln)	46.9	0	0
34	Hanging Fork Creek near Hubble (Lincoln)	91.1	0	0
35	Clear Creek near Mortonsville (Woodford)	61.1	0	0
36	Benson Creek at Frankfort (Franklin)	107	0	0
37	North Elkhorn Creek at Switzer (Scott)	265	1.9	.6
38	South Elkhorn Creek near Woodlake (Woodford)	156	11	4.2
39	Six Mile Creek near Defoe (Henry)	42.6	0	0
40	Six Mile Creek near Lockport (Henry)	76.5	0	0
41	Drennon Creek at Drennon Springs (Henry)	82.5	0	0
42	Eagle Creek near New Columbus (Owen)	124	0	0
43	Eagle Creek near Holbrook (Grant)	258	.1	0
44	Ten Mile Creek at Folsom (Grant)	68.4	0	0

source: Sullavan, 1984.

Table 3.--Water-supply reservoirs in the Kentucky River basin

[Listed by Hydrologic Unit and magnitude of average storage]

Reservoir name (Water-system supplied)	Average storage, in million gallons
HYDROLOGIC UNIT CODE 05100201	
Buckhorn Lake (Buckhorn Lake State Park)	7,100
Impoundment on Lost Creek (Lost Mountain Mining)	76
Impoundment on North Fork KY River (Whitesburg Municipal Water)	1
Impoundment on Fugate Fork (Arch on the North Fork)	unknown
Impoundment on Nix's Branch (Arch on the North Fork)	unknown
HYDROLOGIC UNIT CODE 05100202	
Impoundment on Greasy Creek (Shamrock Coal Prep. Plant #2)	47
Impoundment on Middle Fork KY River (Hyden-Leslie County Water District)	40
Impoundment on Middle Fork KY River (Lee Company, Inc. #31)	unknown
Impoundment on Greasy Creek (Blossom Coal Company)	unknown
HYDROLOGIC UNIT CODE 05100203	
Bert Combs Lake (Manchester Municipal Water)	305
HYDROLOGIC UNIT CODE 05100204	
Campton Lake (Campton Water Plant)	138
Impoundment on Mill Creek (Natural Bridge State Park)	16
HYDROLOGIC UNIT CODE 05100205	
Herrington Lake (Danville City Water Works) (Northpoint Training Center)	40,100
Bullock Pen Lake (Bullock Pen Water Division)	803
Reservoir #4 (Kentucky American Water Company	748

Table 3.--Water-supply reservoirs in the Kentucky River basin--Continued

[Listed by Hydrologic Unit and magnitude of average storage]

Reservoir name (Water-system supplied)	Average storage, in million gallons
HYDROLOGIC UNIT CODE 05100205	
Winchester Reservoir (Winchester Municipal Utilities)	243
Impoundment on Cowbell Creek (Berea College Water Department)	149
Impoundment on East Fork Silver Creek (Berea College Water Department)	87
Impoundment on North Elkhorn Creek (Georgetown Municipal Water)	33
Lower Thomas Lake (Owenton Water Works)	19
Stanford Reservoir (Stanford Water Works)	10
Impoundment on Elkhorn Creek (Old Grandad Distilling)	4
Impoundment on Glenn's Creek (Old Taylor Distilling)	1
Impoundment on Glenn's Creek (Old Crow Distilling)	<1
Lake Vega (Lexington Bluegrass Army Depot)	unknown
Butler Lake (Ski Butler)	unknown

wells are usually about 2 to 10 gal/min. However, wells that produce as much as 300 gal/min are reported in the Inner Bluegrass region, and some are adequate for public and industrial supplies (Faust, 1985).

EVALUATION OF WATER SUPPLIES FOR DROUGHT SUSCEPTIBILITY IN THE KENTUCKY RIVER BASIN

There are 54 permitted public-water suppliers, self-supplied industrial, and commercial water users in the Kentucky River basin (table 5). Water withdrawal permits are issued by the Kentucky Division of Water. Of the total amount withdrawn by these facilities, about 98 percent was surface water and about 2 percent was ground water.

Table 4.--Precipitation and runoff data for selected stations in the Kentucky River basin

Site number	Station name and location (county)	Period of record	Mean annual precipitation, in inches per year	Average runoff, in inches per year
HYDROLOGIC UNIT CODE 05100201				
1	Carr Fork near Sassafras (Knott)	1964-82	48	17.75
2	North Fork Kentucky River at Jackson (Breathitt)	1928-31 1938-82	48	16.77
HYDROLOGIC UNIT CODE 05100202				
3	Middle Fork Kentucky River near Hyden (Leslie)	1958-82	48	20.17
4	Cutshin Creek at Wooten (Leslie)	1958-82	48	21.60
5	Middle Fork Kentucky River at Tallega (Lee)	1931-32 1940-82	48	18.46
HYDROLOGIC UNIT CODE 05100203				
6	Red Bird River near Big Creek (Clay)	1972-82	49	25.93
7	Goose Creek at Manchester (Clay)	1965-82	47	22.41
8	South Fork Kentucky River at Booneville (Owsley)	1925-82	48	19.90
HYDROLOGIC UNIT CODE 05100204				
9	Kentucky River at Lock 14 at Heidelberg (Lee)	1926-31 1960-82	48	18.58
10	Red River near Hazel Green (Wolfe)	1954-82	46	18.41
11	Red River at Clay City (Powell)	1931-82	46	18.12
HYDROLOGIC UNIT CODE 05100205				
12	Kentucky River at Lock 10 near Winchester (Madison)	1908-82	47	18.10
13	Dix River near Danville (Garrard)	1943-82	47	19.99
14	Kentucky River at Lock 6 near Salvisa (Woodford)	1926-82	46	17.95
15	Kentucky River at Lock 4 at Frankfort (Franklin)	1926-82	46	17.85
16	South Elkhorn Creek at Fort Spring (Fayette)	1950-82	44	18.50
17	Elkhorn Creek near Frankfort (Franklin)	1915-18 1940-82	44	17.48
18	Kentucky River at Lock 2 at Lockport (Henry)	1926-82	46	18.29

source: Melcher and Ruhl, 1984.

Table 5.--Water users with withdrawal permits in the Kentucky River basin

Site number (figures 3-5)	Permitted facilities	Average withdrawal 1988, in gallons per day
1a, 1b, 1c	Kentucky American Water Company	40,813,000
2	Frankfort Plant Board	6,389,000
3	Richmond Water, Gas, and Sewer	4,468,000
4	Danville City Water Works	3,951,000
5a, 5b	Winchester Municipal Utilities	3,496,000
6	Nicholasville Water Department	2,395,000
7a, 7b	Georgetown Municipal Water	2,192,000
8	Versailles Municipal Water	2,111,000
9	Hazard Water Department	1,901,000
10	Berea College Water Department	1,648,000
11	Ancient Age Distilling	1,366,000
12	Lawrenceburg Municipal Water	1,364,000
13	Harrodsburg Municipal Water	1,273,000
14	Austin Nichols Distilling	1,244,000
15	Southeast Coal Company, Incorporated	1,000,000
16	Irvine Municipal Utilities	910,000
17	Lancaster Municipal Water Works	863,000
18	Manchester Municipal Water	816,000
19a, 19b	Owenton Water Works	716,000
20	Lance Coal Corporation	683,000
21	Wilmore Utilities	673,000
22	Jackson Municipal Water Works	610,000
23	Bullock Pen Water Division	501,000
24	Stanton Municipal Water Works	474,000
25	Hyden-Leslie County Water District	439,000
26	Stanford Water Works	432,000
27	Beattyville Water Works	421,000
28	Lost Mountain Mining	414,000
29	Lee Company, Incorporated #31	306,000
30a, 30b	Blue Diamond Mining, Incorporated	272,000
31	Whitesburg Municipal Water	267,000
32	Northpoint Training Center	206,000
33a, 33b	Fleming-Neon Water System	197,000
34	Clay City Water Works	181,000
35	Blossom Coal Company	180,000

Table 5.--Water users with withdrawal permits in the Kentucky River basin--Continued

Site number (figures 3-5)	Permitted facilities	Average withdrawal 1988, in gallons per day
36	Hindman Municipal Water Works	176,000
37	Booneville Water & Sewer	171,000
38	Campton Water Plant	141,000
39	Sierra Coal Company	128,000
40	Lexington Bluegrass Army Depot	127,000
41	Stamping Ground Water Works	112,000
42	Shamrock Coal Prep. Plant #2	87,000
43a, 43b	Arch on the North Fork	79,000
44	Buckhorn Lake State Park	65,000
45	Natural Bridge State Park	56,000
46	East Kentucky Power Cooperative	34,000
47a, 47b	Old Crow Distilling	25,000
48	Lake Coal Company	22,000
49	Ski Butler, Incorporated	21,000
50	Old Grandad Distilling	18,000
51	Midway Junior College	17,000
52	Haymond Water Company	9,000
53	Pine Mountain Settlement School	4,000
54	Old Taylor Distilling	3,000
	Total	86,467,000

Evaluation of Public-Water Suppliers

The permitted public-water suppliers in the Kentucky River basin are listed in table 6. The source(s) of water, location of intakes, drought susceptibility class, average withdrawal or use, treated storage and treated plant design capacity are listed for each permittee. Permittees are listed alphabetically within each hydrologic unit or tributary basin. Locations of these systems are shown in figure 3.

The inventory indicated that 31 permitted public-water suppliers withdrew about 80 Mgal/d during 1988. Of this amount, about 8.2 Mgal/d was purchased by 39 smaller permit-exempt systems.

Evaluation for drought susceptibility indicated that Kentucky-American Water Company, Georgetown Municipal Water, and Stanford Water Works are likely

Table 6.--Drought susceptibility of public-water suppliers in the Kentucky River basin

[A, system unlikely to have 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 have shortage during drought conditions. Plans for response are necessary; *, system has multiple sources of water with one distribution system; systems purchasing water are indented below supplier with amount purchased shown in parentheses]

Site number	System name (county)	Source of supply	Latitude and longitude of intakes	Drought susceptibility class (A-C)	Average withdrawal or use, in gallons per day	Treated storage, in gallons	Treatment plant design capacity, in gallons per day
Hydrologic Unit Code 05100201							
27	Beattyville Water Works (Lee)	N. Fk. KY River	37 34 07 83 42 20	A	421,000	675,000	1,000,000
	Southside Water Association (Lee)				(60,000)		
9	Hazard Water Department[1] (Perry)	N. Fk. KY River	37 14 52 83 10 45	B	1,901,000	2,800,000	4,000,000
	Vicco Water Supply (Perry)				(170,000)		
33a	Fleming-Neon Water System (Letcher)	Deep Mine Well	37 13 05 82 41 11	A	190,000	198,000	360,000
33b		Deep Mine Well	37 12 38 82 39 50	*	7,000	*	*
52	Haymond Water Company (Letcher)	Well nr. Potter's Fork	37 11 03 82 41 20	A	9,000	10,000	20,000
36	Hindman Municipal Water Works[2] (Knott)	2 Wells nr. Troublesome Cr.	37 20 03 82 58 25	Unknown	176,000	250,000	250,000
22	Jackson Municipal Water Works (Breathitt)	N. Fk. KY River	37 32 44 83 22 09	B	610,000	625,000	1,500,000
31	Whitesburg Municipal Water (Letcher)	Impoundment on N. Fk. KY River	37 06 50 82 49 14	B	267,000	500,000	500,000
Hydrologic Unit Code 05100202							
25	Hyden-Leslie County Water Dist. (Leslie)	Impoundment on M. Fk. KY River	37 08 29 83 22 47	A	439,000	625,000	485,000
Hydrologic Unit Code 05100203							
37	Booneville Water & Sewer (Owsley)	S. Fk. KY River	37 28 10 83 40 31	B	171,000	408,000	360,000
18	Manchester Municipal Water (Clay)	Bert Combs Lake (Beech Cr.)	37 10 03 83 42 30	B	816,000	875,000	1,000,000
	Hima Sibert Water District (Clay)				(77,000)		
	No. Manchester Water District (Clay)				(191,000)		
Hydrologic Unit Code 05100204							
38	Campton Water Plant (Wolfe)	Campton Lake (Hiram Br.)	37 44 42 83 32 48	A	141,000	315,000	276,000
34	Clay City Water Works (Powell)	Red River	37 51 50 83 56 00	A	181,000	350,000	250,000
16	Irvine Municipal Utilities (Estill)	KY River	37 41 44 83 58 21	A	910,000	850,000	3,000,000
	Estill County Water District (Estill)				(467,000)		
24	Stanton Municipal Water Works (Powell)	Red River	37 51 40 83 52 17	B	474,000	1,000,000	720,000
	Clay City Water District (Powell)				(50,000)		
Hydrologic Unit Code 05100205							
10	Berea College Water Department[3] (Madison)	Impoundments on E. Fk. Silver Cr. and Cowbell Cr.	37 32 34 84 14 33	A	1,648,000	600,000	3,010,000
	S. Madison Water District (Madison)				(350,000)		
23	Bullock Pen Water Division (Grant)	Bullock Pen Lake (Bullock Pen Cr.)	38 47 55 84 38 26	A	501,000	515,000	750,000
4	Danville City Water Works (Boyle)	Herrington Lake (Dix River)	37 41 38 84 44 02	A	3,951,000	2,000,000	5,000,000
	Hedgeville Water District (Boyle)				(90,000)		
	Junction City Water System (Boyle)				(380,000)		
	Lake Village Water Association (Boyle)				(130,000)		
	Perryville Water District (Boyle)				(165,000)		
	Parksville Water District (Boyle)				(192,000)		

Table 6.--Drought susceptibility of public-water suppliers in the Kentucky River basin--Continued

[A, system unlikely to have 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 have shortage during drought conditions. Plans for response are necessary; *, system has multiple sources of water with one distribution system; systems purchasing water are indented below supplier with amount purchased shown in parentheses]

Site number	System name (county)	Source of supply	Latitude and longitude of intakes	Drought susceptibility class (A-C)	Average withdrawal or use, in gallons per day	Treated storage, in gallons	Treatment plant design capacity, in gallons per day
Hydrologic Unit Code 05100205--Continued							
6	Nicholasville Water Department (Jessamine)	KY River	37 50 25 84 29 07	A	2,395,000	2,000,000	3,600,000
26	Stanford Water Works (Lincoln)	Standford Res. (Neal's Cr.)	37 29 15 84 40 38	C	432,000	1,200,000	760,000
	McKinney Water District (Lincoln)				(161,000)		
2	Frankfort Plant Board (Franklin)	KY River	38 11 06 84 52 22	A	6,389,000	17,000,000	18,000,000
	Elkhorn Water District (Franklin)				(90,000)		
	Farmdale Water District (Franklin)				(500,000)		
	N. Shelby County Water District[4] (Shelby)				(285,000)		
	N. E. Woodford County Water District (Woodford)				(74,000)		
	Peaks Mill Water District (Franklin)				(141,000)		
	U.S. 60 Water District (Shelby)				(199,000)		
7a	Georgetown Municipal Water (Scott)	Royal Spring	38 12 30 84 33 41	C	1,532,000	1,465,000	4,000,000
7b		Impoundment on N. Elkhorn Cr.	38 13 00 84 33 46	*	660,000	*	*
13	Harrodsburg Municipal Water (Mercer)	KY River	37 49 02 84 43 21	A	1,273,000	1,000,000	4,000,000
	Burgin Water Department (Mercer)				(52,000)		
	Lake Village Water Association (Boyle)				(195,000)		
	N. Mercer Water District (Mercer)				(300,000)		
1a	Kentucky American Water Company (Fayette)	KY River	37 54 07 84 22 39	C	33,045,000	9,200,000	60,000,000
1b		Res. #4 (E. Hickman Cr.)	37 58 44 84 26 47	*	5,546,000	*	*
1c		KY River	37 54 07 84 22 39	*	2,222,000	*	*
	S. Elkhorn Water District (Jessamine)				(325,000)		
	Spears Water Company (Jessamine)				(350,000)		
	Midway Municipal Water Works (Woodford)				(100,000)		
17	Lancaster Municipal Water Works[5] (Garrard)	KY River	37 43 41 84 34 20	A	863,000	1,250,000	1,440,000
	Garrard County Water District (Garrard)				(404,000)		
	Crab Orchard Water District (Lincoln)				(178,000)		
12	Lawrenceburg Municipal Water (Anderson)	KY River	38 02 33 84 50 32	A	1,364,000	1,325,000	2,250,000
	Alton Water District (Anderson)				(102,000)		
	S. Anderson Water District (Anderson)				(110,000)		
	Stringtown Water District (Anderson)				(60,000)		
19a	Owenton Water Works[6] (Owen)	Lower Thomas Lake (N. Fk. Severn Cr.)	38 31 18 84 51 00	B	688,000	305,000	750,000
19b		Severn Cr.	38 28 05 84 55 00	*	28,000	*	*
	Trivillage Water District (Owen)				(204,000)		
3	Richmond Water, Gas, and Sewer (Madison)	KY River	37 52 58 84 10 33	B	4,468,000	4,400,000	7,500,000
	Kingston Terrill Water District (Madison)				(337,000)		
	Kirksville Water Association (Madison)				(150,000)		
	Milford Water District (Madison)				(157,000)		
	Waco Water District (Madison)				(300,000)		
	Whitehall Water District (Madison)				(334,000)		

Table 6.--Drought susceptibility of public-water suppliers in the Kentucky River basin--Continued

[A, system unlikely to have 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 have shortage during drought conditions. Plans for response are necessary; *, system has multiple sources of water with one distribution system; systems purchasing water are indented below supplier with amount purchased shown in parentheses]

Site number	System name (county)	Source of supply	Latitude and longitude of intakes	Drought susceptibility class (A-C)	Average withdrawal or use, in gallons per day	Treated storage, in gallons	Treatment plant design capacity, in gallons per day
Hydrologic Unit Code 05100205--Continued							
41	Stamping Ground Water Works[7] (Scott)	N. Elkhorn Cr.	38 15 16 84 42 22	B	112,000	750,000	220,000
8	Versailles Municipal Water [8] (Woodford)	KY River	38 01 34 84 52 15	A	2,111,000	2,500,000	2,000,000
	S. Woodford Co Water District (Woodford)				(205,000)		
21	Wilmore Utilities (Jessamine)	KY River	37 51 45 84 37 30	A	673,000	750,000	1,000,000
5a	Winchester Municipal Utilities (Clark)	KY River	37 53 40 84 15 40	A	1,861,000	3,700,000	5,500,000
5b		Winchester Res. (Lower Howard Cr.)	37 56 51 84 13 48	*	1,635,000	*	*
	E.Clark Co. Water District (Clark)				(133,000)		
	Boonesboro Water Association (Clark)				(398,000)		

[1]Hazard Water Department's drought susceptibility class is based on a minimum release from Carr Fork Lake of 3,231,360 gallons per day.

[2]Hindman Municipal Water Works also purchases water from Beaver-Elkhorn Water District outside of the Kentucky River basin, amount not included in table.

[3] Berea College Water Department also has access to an impoundment in Red Lick Creek. This additional source, not permitted in 1988, makes Berea unlikely to have water shortage drought.

[4] North Shelby County Water District also purchases from Shelbyville Municipal Water and Sewer Commission outside of the Kentucky River basin, amount not included in table.

[5] Lancaster Municipal Water Works also owns two lakes with 70 million gallons storage.

[6] Owenton Water Works has used water from a Kentucky Fish and Wildlife lake in past years.

[7] Stamping Ground Water Works also has a spring-fed impoundment. This source, not permitted in 1988, has unknown capacity.

[8] Versailles Municipal Water is connected to and uses Kentucky American Water Company as a backup source.

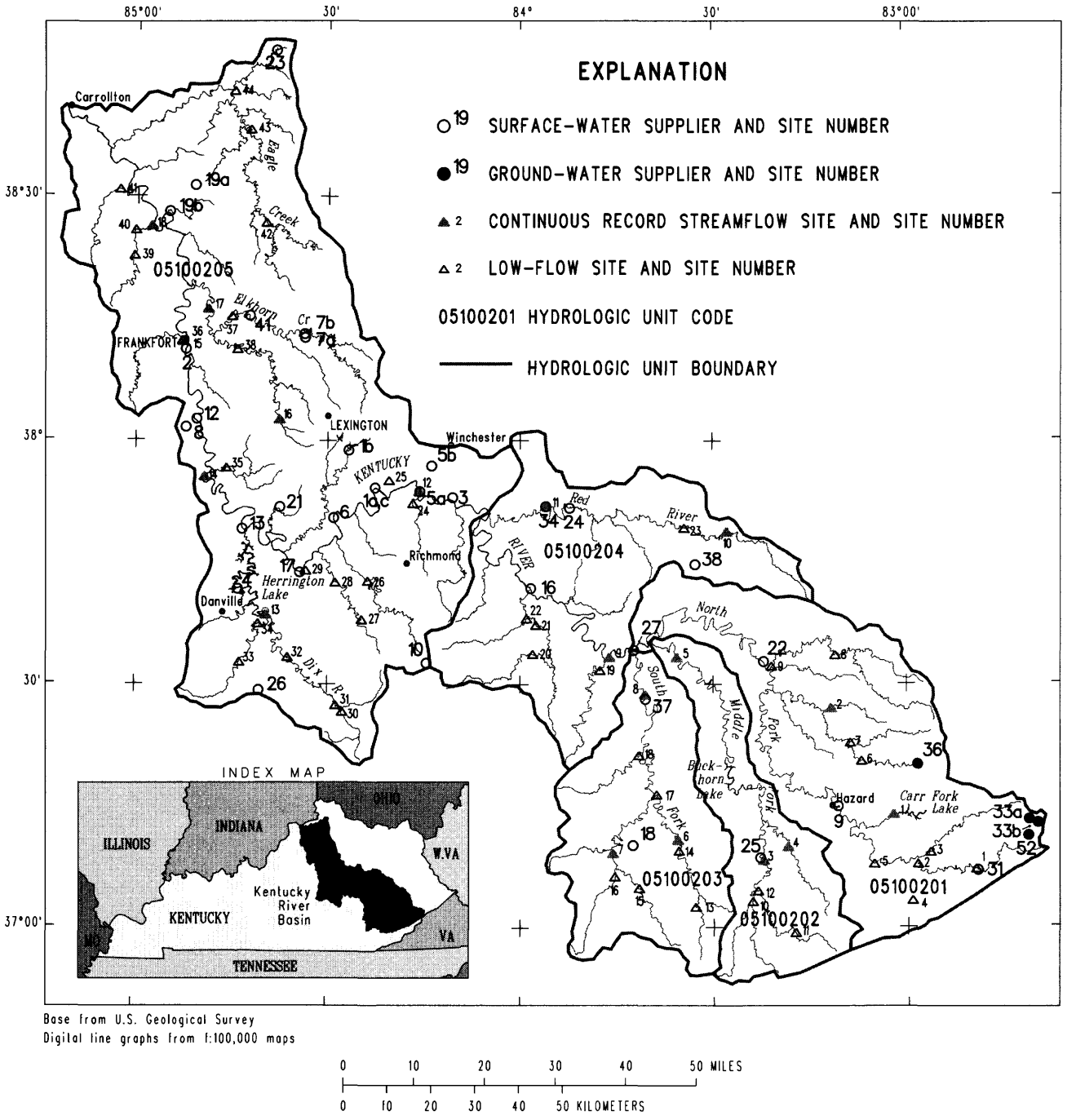

Figure 3.--Public-water suppliers and data sites.

to have water-supply shortages during drought conditions. Officials of the Kentucky-American Water Company are pursuing alternatives for increasing their water supply. They are conducting aquatic and downstream-user studies to determine the effect of withdrawing impounded water below the 7-day, 10-year low-flow level. The KNREPC may allow Kentucky-American Water Company access to water below the 7-day, 10-year low-flow level, depending on the outcome of these studies. Several alternatives are being considered for Georgetown Municipal Water, and Stanford Water Works has constructed a second reservoir since 1988. Additionally, nine other public-water supplies in the Kentucky River basin have the potential for water-availability problems during drought situations.

Treatment-Plant Capacity

Treatment-plant capacity is an important consideration when determining if a public water-supply system can meet demands during periods of increased water use. Treatment plant capacities are adequate for most public-supply systems in the Kentucky River basin, but during 1988 the average water withdrawal was near or greater than 80 percent of capacity at the following systems: Danville City Water Works, Hyden-Leslie County Water District, Manchester Municipal Utilities, Owenton Water Works, and Versailles Municipal Water. Plant capacity at Hyden-Leslie County Water District has been increased since 1988. Danville City Water Works, Manchester Municipal Utilities and Owenton Water Works are planning to increase the capacities of their treatment plants. Versailles Municipal Water has emergency water-supply back-up plans with the Kentucky-American Water Company at Lexington.

Water-System Leakage

Leakage in the water-distribution system can create or exacerbate shortages, especially during times of drought. The public-water supplies in the basin were surveyed to determine if they had a leak-detection program. Information about public-supply facilities with a leak-detection program are listed in table 7.

Use of Water Delivered by Permitted-Public Water-Suppliers

The amount of water delivered by category of use is needed for evaluation of drought susceptibility because demand is variable per type of use. However, most systems do not measure water use by category so the amount of water used in the commercial, industrial, and domestic categories was estimated. For this report, most estimates were verified by telephone conversations with the water-system managers.

The use of water delivered by permitted public-supply systems in the Kentucky River basin is listed in table 8. The per capita use was determined by dividing the average domestic use by the population served by the system. Leakage or public use was estimated if unknown. Domestic plus commercial and industrial use will not equal total withdrawals because leakage and public use is not shown in table 8.

Table 7.--Public-water suppliers with leak-detection programs in the Kentucky River basin

[*, site number not assigned--water is purchased from another supplier; 2/X, semi-annual]

Site number	Name	Frequency				Method			
		Daily	Monthly	Annual	Inter-mittent	Sales	Visual survey	Pressure	Leak detection equipment
Hydrologic Unit Code 05100201									
27	Beattyville Water Works		X			X			
*	Vicco Water Supply				X		X		
33a	Fleming-Neon Water System		X						X
36	Hindman Municipal Water Works	X						X	
31	Whitesburg Municipal Water	X							
Hydrologic Unit Code 05100202									
25	Hyden-Leslie County Water District	X	X				X		X
Hydrologic Unit Code 05100203									
18	Manchester Municipal Water	X						X	X
*	Hima Siebert Water District	X					X	X	
*	North Manchester Water District	X					X	X	
Hydrologic Unit Code 05100204									
16	Irvine Municipal Utilities	X				X			
24	Stanton Municipal Water Works	X				X			
*	Clay City Water District				X		X		
Hydrologic Unit Code 05100205									
23	Bullock Pen Water Division				X			X	
4	Danville City Water Works			X		X			
*	Junction City Water System		X			X			
*	Lake Village Water Association			2/X					X
*	Perryville Water District		X			X			
26	Stanford Water Wroks	X						X	
2	Frankfort Plant Board				X				X
*	Peaks Mill Water District			X			X		
1a	Kentucky-American Water Company	X							X
*	Spears Water Company	X					X		
17	Lancaster Municipal Water Works		X			X			
12	Lawrenceburg Municipal Water		X			X			
*	Stringtown Water District		X					X	
19a	Owenton Water Works				X				X
3	Richmond Water, Gas, and Sewer	X					X	X	
*	Kingston Terrill Water District	X	X				X	X	
*	Kirksville Water Association	X						X	
41	Stamping Ground Water Works	X			X	X			
*	South Woodford County Water District				X		X	X	X
21	Wilmore Utilities			X		X			
*	East Clark County Water District		X			X			
*	Boonesboro Water Association		X				X		

Table 8.--Use of water delivered by the public-supply systems in the Kentucky River basin

[Systems purchasing water are indented below the supplier]

Site number	System name (county)	Population	Average use, in gallons per day			
			Commercial	Industrial	Domestic	Per capita
Hydrologic Unit Code 05100201						
27	Beattyville Waterworks (Lee)	4,160	108,000	0	199,000	48
	Southside Water Association (Lee)	550	10,000	0	46,000	83
9	Hazard Water Department (Perry)	10,280	208,000	0	1,177,000	114
	Vicco Water Supply (Perry)	2,060	0	0	136,000	66
33a,b	Fleming-Neon Water System (Letcher)	2,300	59,000	0	118,000	51
52	Haymond Water Company (Letcher)	120	0	0	8,000	67
36	Hindman Municipal Water Works (Knott)	890	44,000	0	114,000	128
22	Jackson Municipal Water Works (Breathitt)	2,800	30,000	6,000	390,000	139
31	Whitesburg Municipal Water (Letcher)	1,530	40,000	0	200,000	130
Hydrologic Unit Code 05100202						
25	Hyden-Leslie County Water District (Leslie)	2,700	66,000	0	307,000	114
Hydrologic Unit Code 05100203						
37	Booneville Water and Sewer (Owsley)	2,500	17,000	0	128,000	51
18	Manchester Municipal Water (Clay)	6,900	110,000	5,000	329,000	48
	Hima Sibert Water District (Clay)	1,000	9,000	0	63,000	63
	North Manchester Water District (Clay)	2,310	38,000	6,000	117,000	51
Hydrologic Unit Code 05100204						
38	Campton Water Plant (Wolfe)	1,100	8,000	3,000	109,000	99
34	Clay City Water Works (Powell)	1,190	18,000	2,000	143,000	120
16	Irvine Municipal Utilities (Estill)	8,000	85,000	30,000	293,000	37
	Estill County Water District (Estill)	3,960	103,000	0	308,000	78
24	Stanton Municipal Water Works (Powell)	4,500	85,000	4,000	293,000	65
	Clay City Water District (Powell)	330	5,000	0	40,000	121
Hydrologic Unit Code 05100205						
10	Berea College Water Deptartment (Madison)	9,900	234,000	350,000	454,000	46
	South Madison Water District (Madison)	5,860	21,000	10,000	290,000	49
23	Bullock Pen Water Division (Grant)	5,300	35,000	0	416,000	78
4	Danville City Water Works (Boyle)	15,970	299,000	988,000	1,198,000	75
	Hedgeville Water District (Boyle)	1,090	0	0	81,000	74
	Junction City Water System (Boyle)	3,430	19,000	8,000	220,000	64
	Lake Village Water Association (Boyle)	1,620	10,000	0	81,000	50
	Perryville Water District (Boyle)	1,800	0	0	155,000	86
	Parksville Water District (Boyle)	2,580	4,000	0	169,000	65
6	Nicholasville Water Department (Jessamine)	14,360	190,000	276,000	862,000	60

Table 8.--Use of water delivered by the public-supply systems in the Kentucky River basin--Continued

[Systems purchasing water are indented below the supplier]

Site number	System name (county)	Population	Average use, in gallons per day			
			Commercial	Industrial	Domestic	Per capita
26	Stanford Water Works (Lincoln)	3,960	34,000	5,000	114,000	29
	McKinney Water District (Lincoln)	1,640	8,000	0	129,000	79
2	Frankfort Plant Board (Franklin)	36,810	1,938,000	153,000	1,632,000	44
	Elkhorn Water District (Franklin)	1,600	2,000	0	82,000	51
	Farmdale Water District (Franklin)	5,180	65,000	40,000	320,000	62
	North Shelby County Water District (Shelby)	7,040	3,000	0	268,000	38
	Northeast Woodford County Water District (Woodford)	1,820	5,000	0	51,000	28
	Peaks Mill Water District (Franklin)	2,030	3,000	0	123,000	61
	U.S. 60 Water District (Shelby)	2,250	6,000	0	173,000	77
7a,b	Georgetown Municipal Water (Scott)	12,150	44,000	110,000	1,819,000	150
13	Harrodsburg Municipal Water (Mercer)	8,790	80,000	211,000	334,000	37
	Burgin Water Department (Mercer)	1,010	2,000	3,000	45,000	45
	Lake Village Water Association (Boyle)	2,440	16,000	0	121,000	50
	North Mercer Water District (Mercer)	4,330	9,000	0	276,000	64
1a,b,c	Kentucky American Water Company (Fayette)	220,000	11,211,000	2,002,000	17,617,000	80
	South Elkhorn Water District (Jessamine)	3,910	3,000	0	286,000	73
	Spears Water Company (Jessamine)	5,450	0	0	301,000	55
	Midway Municipal Water Works (Woodford)	1,720	15,000	1,000	69,000	40
17	Lancaster Municipal Water Works (Garrard)	4,930	20,000	3,000	231,000	47
	Garrad County Water District (Garrard	5,710	44,000	0	287,000	50
	Crab Orchard Water District (Lincoln)	1,270	12,000	0	107,000	84
12	Lawrenceburg Municipal Water (Anderson)	9,180	44,000	448,000	524,000	57
	Alton Water District (Anderson)	1,250	2,000	0	90,000	72
	South Anderson Water District (Anderson)	1,650	0	1,000	100,000	61
	Stringtown Water District (Anderson)	540	2,000	0	52,000	96
19a,b	Owenton Water Works (Owen)	2,710	41,000	92,000	297,000	110
	Trivillage Water District (Owen)	3,200	61,000	0	122,000	38
3	Richmond Water, Gas, and Sewer (Madison)	17,160	1,244,000	191,000	1,372,000	80
	Kingston Terrill Water District (Madison)	5,040	17,000	7,000	253,000	50
	Kirksville Water Association (Madison)	2,170	30,000	0	94,000	43
	Milford Water District (Madison)	2,070	3,000	0	118,000	57
	Waco Water District (Madison)	4,950	0	0	264,000	53
	Whitehall Water District (Madison)	4,480	43,000	0	247,000	55
41	Stamping Ground Water Works (Scott)	640	10,000	0	94,000	146
8	Versailles Municipal Water (Woodford)	12,210	229,000	305,000	934,000	76
	South Woodford County Water District (Woodford)	2,280	4,000	0	152,000	67
21	Wilmore Utilities (Jessamine)	3,130	135,000	0	404,000	129
5a,b	Winchester Municipal Utilities (Clark)	21,450	356,000	623,000	1,394,000	65
	East Clark County Water District (Clark)	1,860	13,000	0	106,000	57
	Boonesboro Water Association (Clark)	3,120	64,000	8,000	302,000	97

The public-water suppliers delivered almost 40 Mgal/d to more than 554,000 people in the basin. Estimates for domestic per capita use ranged from 29 gal/d for the Stanford Water System to 150 gal/d for the Owenton Water Works. The average per capita use for all public-water supplies in the basin was 72 gal/d. Some of the low per capita use values were attributed to water rationing during 1988. Owenton officials attributed their high per capita use to inaccuracies in their metering devices during part of the year.

Public-water suppliers delivered about 17.7 Mgal/d for commercial use and 5.9 Mgal/d for industrial use. About 16.8 Mgal/d or 21 percent of the water withdrawn by public supplies was lost in the distribution system or delivered for public uses.

The following public-water suppliers in the Kentucky River basin provided 5,000 gallons or more of water per day for industrial or commercial use in 1988. Major water users are listed in alphabetical order under the name of the supplier.

Berea College Water Department
- Berea Golf Club
- Dresser Industries
- Gibson Greeting Cards Co.
- Parker Seal Co.

Danville City Water Works
- American Greeting
- ATR Wire & Cable
- Phillips Lighting
- Rexnord
- RR Donnelley
- Whirlpool

Frankfort Plant Board
- Bendix Corporation
- General Electric
- Kenwell Inc.
- Topy Corp.
- Union Underwear

Georgetown Municipal Water
- Hoover Universal
- Johnson Control
- Production Platting

Harrodsburg Municipal Water
- Corning Glass
- Harrodsburg Health Club
- Shakertown
- Signet

Irvine Municipal Utilities
- CSX
- South East Coal

Lawrenceburg Municipal Water
- Boulevard Distillery
- Florida Tile
- General Cable
- Kraft Inc.
- Universal Fasteners
- Weber Farm

Nicholasville Water Department
- Adcom Metals
- Gulf State
- Linear Films
- NI Ind.
- Sergeant Green Leaf

Owenton Water Works
- Sprague Meter

Richmond Water, Gas, and Sewer
- Bluegrass Plating
- Exide
- Irvine Ind.
- North American Phillips
- Sherwin Williams

Winchester Municipal Utilities
- Ale 8 Bottling Co.
- Bunding Tubing
- Coors
- Freeman Lumber
- G&E Sylvania
- Pepsi Cola
- Rockwell
- Winchester Farms Dairy

Kentucky American Water Co.
  Central Ky Processing
  FMC Corporation
  General Electric
  IBM Corporation
  Pepsi Cola
  Rainbow Baking Co.
  Square D
  Toyota Motor Mfg.
  Trane Company
  VR Wesson

Evaluation of Self-Supplied Industrial Water Users

Self-supplied industrial water users are listed in table 9 and their locations are shown in figure 4. Permittees are listed alphabetically in each hydrologic unit. The source and amounts of water withdrawn are listed for each facility.

Self-supplied industrial water users in the basin withdrew about 5.8 Mgal/d during 1988. Most of these systems have adequate sources of water during drought conditions. Of those industries where drought-susceptibility classes were determined, only one industry had the potential for drought-related water-availability problems. Drought classes could not be determined for seven industries because adequate hydrologic data were unavailable.

Evaluation of Self-Supplied Commercial Water Users

Self-supplied commercial water users are listed alphabetically in table 10 and their locations are shown in figure 5. The source and amounts of water withdrawn are listed for each facility.

Seven self-supplied commercial facilities averaged withdrawing about 0.5 Mgal/d of water during 1988. Drought classes could be determined for only two of the commercial facilities because adequate low-flow data were not available. Treatment plant capacities were adequate for all the self-supplied commercial users that had treatment plants. The water withdrawn by Ski Butler, Inc. does not require treatment because it is used for snowmaking.

Table 9.--Drought susceptibility of self-supplied industrial water users in the Kentucky River basin

[A, system unlikely to have 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 have water shortage during drought conditions. Plans for response are necessary]

Site number	System name (county)	Source of supply	Latitude and longitude of intakes	Drought susceptibility class (A-C)	Average withdrawal or use, in gallons per day
Hydrologic Unit Code 05100201					
43a	Arch on the North Fork (Breathitt)	Impoundment on Fugate Fork	37 27 30 83 14 22	Unknown	44,000
43b	Arch on the North Fork (Breathitt)	Impoundment on Nix's Branch	37 29 11 83 13 08	Unknown	35,000
30a	Blue Diamond Mining, Inc. (Perry)	Deep Mine Well	37 02 48 83 10 25	Unknown	261,000
30b	Blue Diamond Mining, Inc. (Perry)	Deep Mine Well	37 01 45 83 07 13	A	11,000
48	Lake Coal Company (Letcher)	N. Fk. Ky. River	37 06 48 82 56 14	A	22,000
20	Lance Coal Corporation (Letcher)	Rockhouse Cr.	37 12 38 82 51 23	Unknown	683,000
28	Lost Mountain Mining (Perry)	Impoundment on Lost Cr.	37 20 03 83 13 45	B	414,000
39	Sierra Coal Company (Breathitt)	2 Wells nr. Spring Fork	37 32 52 83 03 25	Unknown	128,000
Hydrologic Unit Code 05100202					
35	Blossom Coal Company (Leslie)	Impoundment on Greasy Cr.	36 59 53 83 20 24	Unknown	180,000
29	Lee Company, Inc. # 31 (Leslie)	Impoundment on M. Fk. Ky. River	37 07 28 83 19 12	Unknown	306,000
42	Shamrock Coal Prep Plant # 2 (Leslie)	Impoundment on Greasy Cr.	36 58 18 83 16 50	A	87,000
Hydrologic Unit Code 05100203					
None					
Hydrologic Unit Code 05100204					
15	Southeast Coal Company, Inc. (Estill)	Ky. River	37 43 17 84 00 30	A	1,000,000
Hydrologic Unit Code 05100205					
11	Ancient Age Distilling Company (Franklin)	Ky. River	38 12 56 84 52 55	A	1,366,000
14	Austin Nichols Distilling (Anderson)	Ky. River	38 02 24 84 52 55	A	1,244,000
46	East Kentucky Power Cooperative (Clark)	Ky. River	37 51 46 84 07 23	A	34,000
47a	Old Crow Distilling (Franklin)	Impoundment on Glenn's Cr.	38 08 46 84 51 00	A	18,000
47b	Old Crow Distilling (Franklin)	5 Wells nr. Ky. River	38 08 14 84 51 18	A	7,000
50	Old Grandad Distilling (Franklin)	Impoundment on Elkhorn Cr.	38 12 47 84 48 02	A	18,000
54	Old Taylor Distilling (Franklin)	Impoundment on Glenn's Cr.	38 08 42 84 50 02	A	3,000

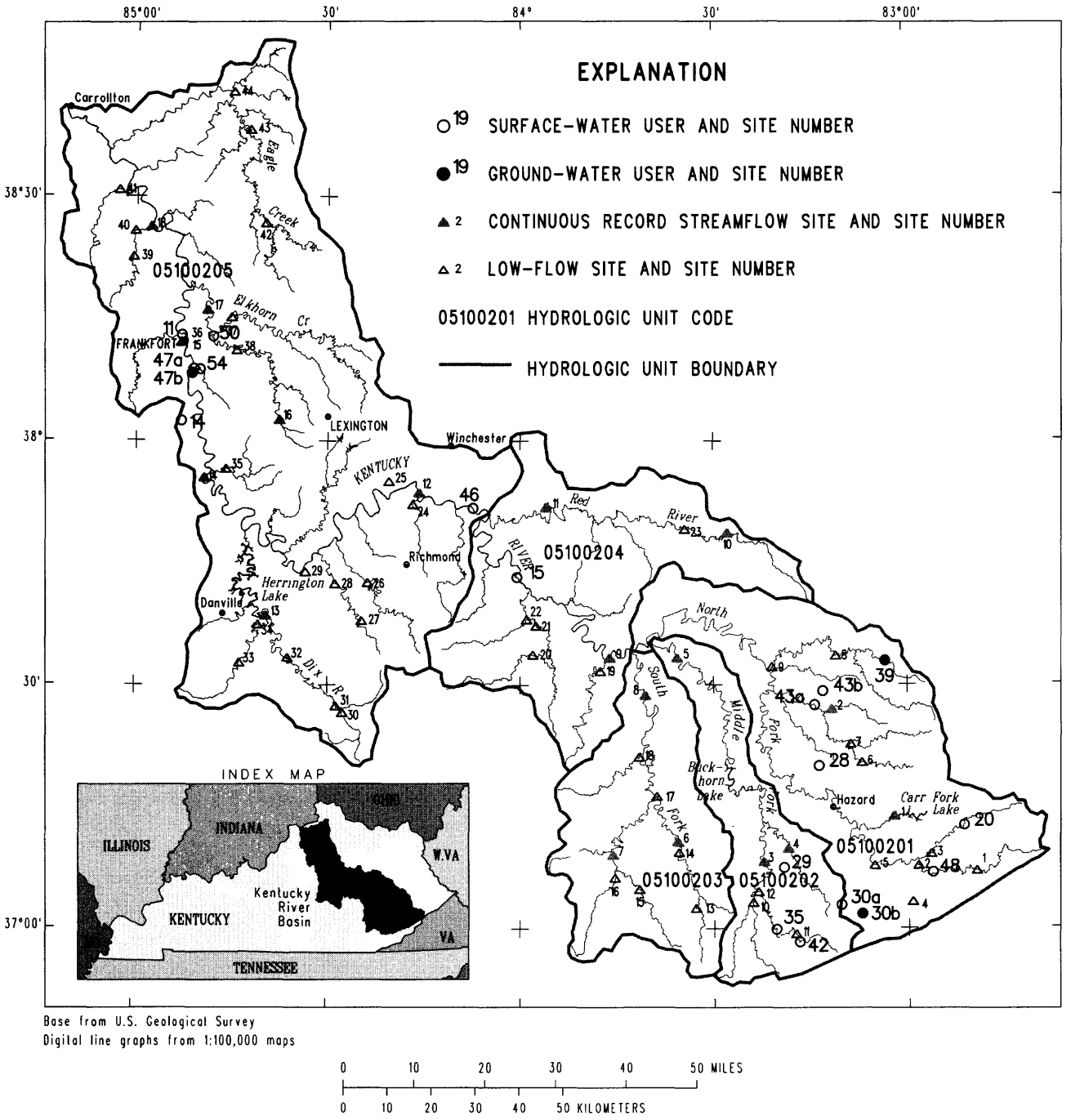

Figure 4.--Self-supplied industrial water users and data sites.

Table 10.--Drought susceptibility of self-supplied commercial water users in the Kentucky River basin

[A, system unlikely to have 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 have water shortage during drought conditions. Plans for response are necessary]

Site number	System name (county)	Source of supply	Latitude and longitude of intakes	Drought susceptibility class (A-C)	Average withdrawal or use, in gallons per day	Treated storage, in gallons	Treatment plant design capacity, in gallons per day
Hydrologic Unit Code 05100201							
44	Buckhorn Lake State Park (Perry)	Buckhorn Lake (M. Fk. Ky. River)	37 18 15 83 26 53	A	65,000	33,000	115,000
Hydrologic Unit Code 05100202							
53	Pine Mountain Settlement School (Harlan)	Limestone Br. of Isaacs Cr.	36 56 51 83 10 46	Unknown	4,000	33,000	350,000
Hydrologic Unit Code 05100203							
None							
Hydrologic Unit Code 05100204							
45	Natural Bridge State Park (Powell)	Impoundment on Mill Cr.	37 45 59 83 40 36	Unknown	56,000	53,000	1,060,000
Hydrologic Unit Code 05100205							
40	Lexington Bluegrass Army Depot (Madison)	Lake Vega	37 42 20 84 13 05	Unknown	127,000	875,000	720,000
51	Midway Jr. College (Woodford)	Well	38 08 49 84 40 46	Unknown	17,000	18,000	72,000
32	Northpoint Training Center (Boyle)	Herrington Lake (Dix River)	37 42 32 84 44 05	A	206,000	197,000	360,000
49	Ski Butler, Inc. (Carroll)	Butler Lake	38 40 00 85 09 00	Unknown	21,000	0	0

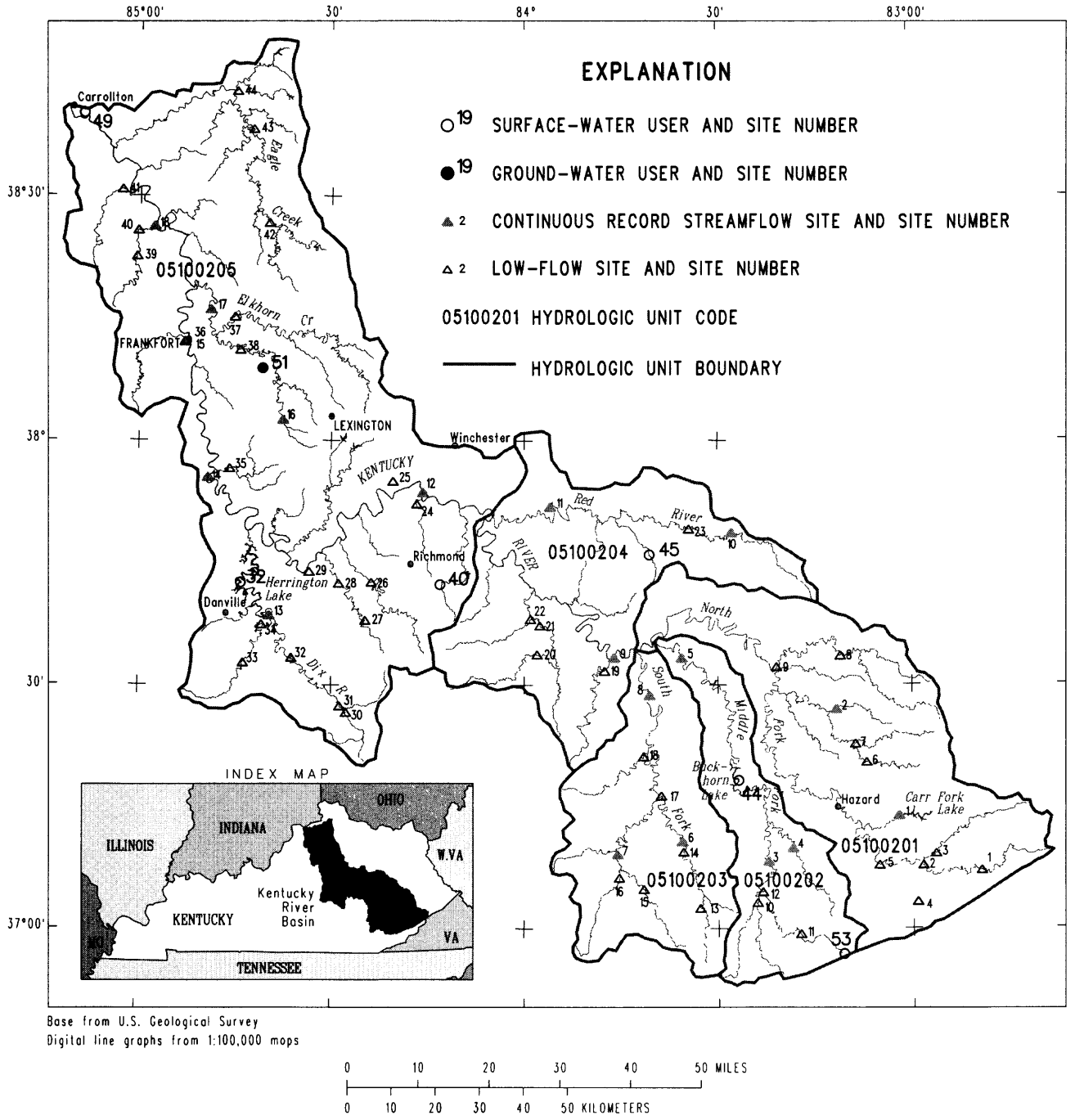

Figure 5.--Self-supplied commercial water users and data sites.

SUMMARY

Sources of water for public-water suppliers and self-supplied industrial and commercial water users were mostly adequate throughout the Kentucky River basin. The drought susceptibility evaluations indicated that three public-water suppliers are likely to have water-supply shortages during drought conditions. Systems likely to have shortages included the Kentucky-American Water Company--the largest public-supplier in the basin, Georgetown Municipal Water, and Stanford Water Works. These systems are considering options for responding to potential water shortages. No permitted self-supplied industrial or commercial water user was likely to have a water-supply shortage during drought situations. Several systems could not be evaluated for susceptibility to drought because streamflow or ground-water data were not available at the point of withdrawal.

Inadequate treatment plant capacities could present a problem for five public-water suppliers in the basin during periods of increased water demand. During 1988, the average withdrawals were near or greater than 80 percent of capacity at Danville City Water Works, Hyden-Leslie County Water District, Manchester Municipal Utilities, Owenton Water Works, and Versailles Municipal Water. Each of these systems has taken action since 1988 to either increase their treatment plant capacity or plan to do so, or have arranged to purchase additional water during shortages.

Inventory results indicated that 54 systems, with permits to withdraw at least 10,000 gal/d, withdrew more than 86.4 Mgal/d in the Kentucky River basin during 1988. There were 31 public-water suppliers with permits that withdrew about 80 Mgal/d. Of this amount, about 8.2 Mgal/d was purchased by 39 permit exempt public-water supply systems. In all, 70 public suppliers furnished water to more than 554,000 people or 84 percent of the population in the basin. Average domestic per capita use was estimated to be 72 gal/d.

Public-water suppliers delivered an estimated 50 percent of their withdrawals or almost 40 Mgal/d to domestic uses, 22 percent or 17.7 Mgal/d to commercial facilities, and about 7 percent or 5.9 Mgal/d to industries. The remaining 21 percent (16.8 Mgal/d) of the public-supplied deliveries included public uses such as fire fighting and losses in the distribution system. In addition, there were 16 self-supplied permitted industrial users with total average withdrawals of about 5.8 Mgal/d and 7 self-supplied commercial users that withdrew a total of about 0.5 Mgal/d.

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