

# **Potential Solutions to Water Supply Problems in Priority Areas of Kentucky**

## **Ground Water Atlas Task 1 Summary Report**

prepared for the

**Water Resource Development Commission**

by the

**Kentucky Geological Survey**

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# **Ground Water Atlas**

## **Task 1 Summary Report**

### **Potential Solutions to Water Supply Problems in Priority Areas of Kentucky**

This document summarizes Task 1 of the Ground Water Atlas project being conducted by the Kentucky Geological Survey for the Water Resource Development Commission. Under task 1, hydrogeologists and engineers from the KGS provided an assessment and summary of water use across Kentucky, identified potential areas for ground water source development (priority areas), identified and evaluated potential solutions for ground water source development and protection, and developed proposals for the development and maintenance of ground water resources. The information from Task 1 was used in the development of the Strategic Water Resource Development Plan for the WRDC.

#### **INTRODUCTION**

Nearly 600,000 Kentuckians relied on private domestic water supplies in 1999 (Figure 1). An estimated 400,000 Kentuckians will still rely on private, domestic water systems in the year 2020 (Figure 2). We must ensure that those supplies are safe and reliable.

Private domestic supplies are predominant in many parts of eastern Kentucky, in the far western Purchase region, and in the Outer Blue Grass. Many public water systems in the Purchase region and along the Ohio River rely on ground water, and about 70 percent of private domestic systems rely on ground water. Private wells provided drinking water for 420,000 residents, primarily in the Jackson Purchase and Eastern Coal Field Regions (Figure 3). The remaining 175,000 residents, primarily in the outer Blue Grass Region and south-central Kentucky, relied on cisterns, hauled water, springs, or other sources (Figure 4).

Ground water has sometimes suffered from a bad image with regard to bacterial contamination, but investigations have revealed that usually it is not the ground water that is contaminated, but that contamination results from improperly handled samples, an improper distribution system, or improper well maintenance. Bacterial contamination generally occurs in hand-dug wells, improperly constructed wells, or poorly maintained wells, not in the aquifer. Properly constructed and maintained wells should provide a water source free of bacterial contamination.

In general, ground water is significantly less costly to develop than surface water, is less susceptible to contamination, and requires less treatment. Ground water systems are generally simpler to operate, and less costly to install, operate, and maintain than surface water systems. Operating costs are usually less impacted by inflation, and new ground water supplies can be developed in less time than surface water sources because there are fewer environmental issues and regulatory delays. Ground water systems can be installed incrementally, coinciding with user demands, thereby avoiding







# Percent of Households on Other Water Systems in 1999

## Commonwealth of Kentucky

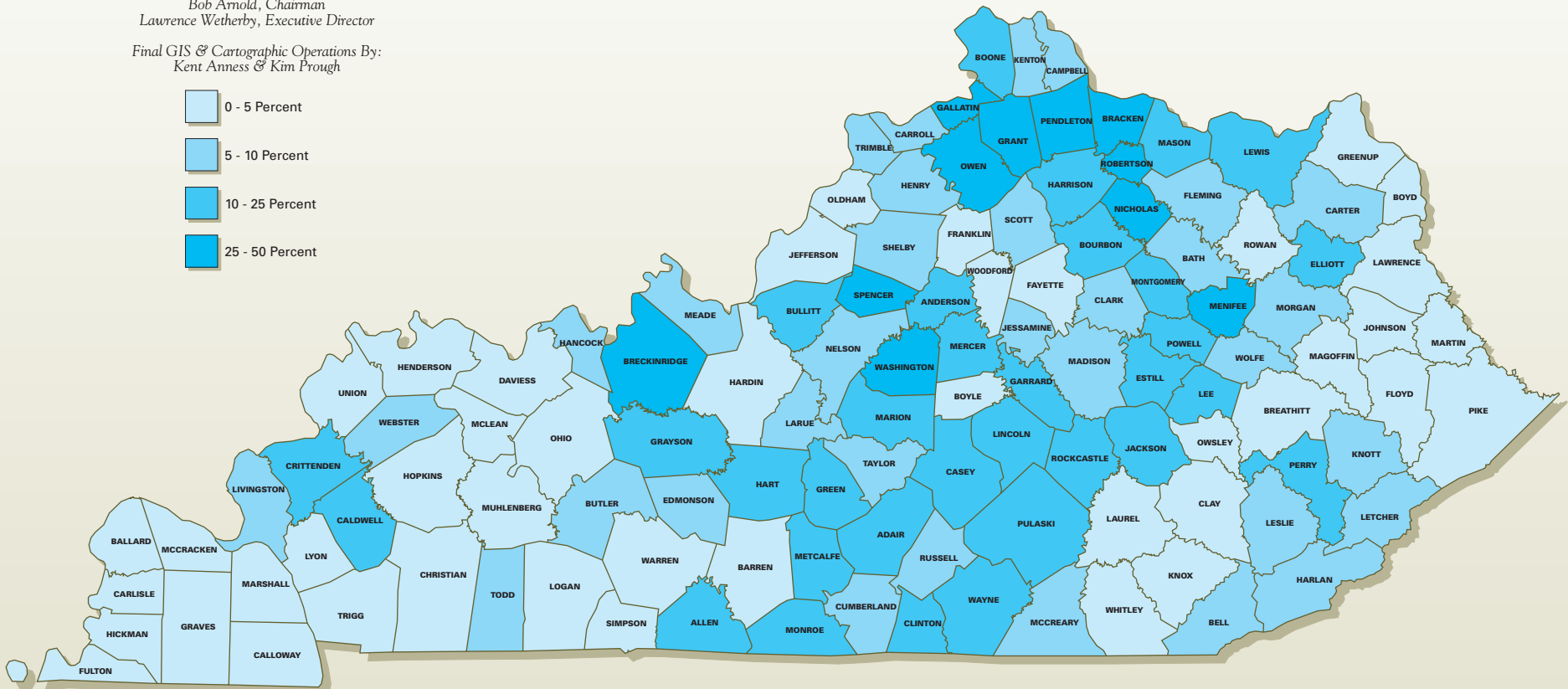
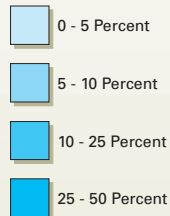
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the expense of over-capacity, and ensuring control over system development schedule and costs. Potential ground water sources can be identified, proven, and protected now, and put on line at a predictable price as the need arises.<sup>1</sup>

Ground water can be used either as a primary or a supplemental water supply source for industries, commercial, municipal, institutional, residential, agricultural, mine, and energy users. Ground water systems can be designed as a low-cost means to meet peak flow demands.<sup>2</sup>

## **OVERVIEW OF GROUND WATER RESOURCES IN KENTUCKY**

Ground water is precipitation that has drained down through the soil into the gravels and bedrock fractures and faults below. Ground water is found nearly everywhere, but useable, reliable quantities of ground water can only be tapped in sand, gravel, and rock formations which have sufficient void space to hold and conduct the water. These formations are known as aquifers. Ground water resources in the major regions of Kentucky are discussed below (Figure 5).

### ***Ground Water Resources of the Eastern Kentucky Coal Field Region<sup>3</sup>***

The Eastern Kentucky Coal Field Region comprises about 26 percent of Kentucky, an area of approximately 10,500 square miles. Water in the region is obtained from consolidated sedimentary rocks ranging in age from Devonian to Pennsylvanian and from unconsolidated sediments of Quaternary age. Sufficient ground water is present throughout the region, however, the quality and quantity of the water may vary widely from one location to another. Principal factors responsible for the availability of water in the region are depth, topographic location, and the rock type of the aquifer producing the water. In general, the yield of the well increases as the depth increases. Wells drilled in low areas and valleys usually produce more water than wells drilled on hillsides. Wells drilled on hillsides generally produce more water than wells on hilltops. Sand and gravel, present in thick beds in the alluvium along the Ohio River, form the most productive aquifer in the Eastern Coal Field. The most utilized and widespread sources of ground water are the thicker sandstone beds. These are good aquifers chiefly because joints, openings along the bedding planes, and inter-granular pore spaces are best developed in them. Shale also supplies water to many wells in the region, chiefly from joints and openings along bedding planes. Coals comprise a small percent of all rocks found in Eastern Kentucky, but yield a significant amount of water especially in areas that have been deep mined. Limestone yields water readily from solution cavities developed along joint and bedding-plane openings.

The availability of water in the region may be broadly characterized for the following subareas:

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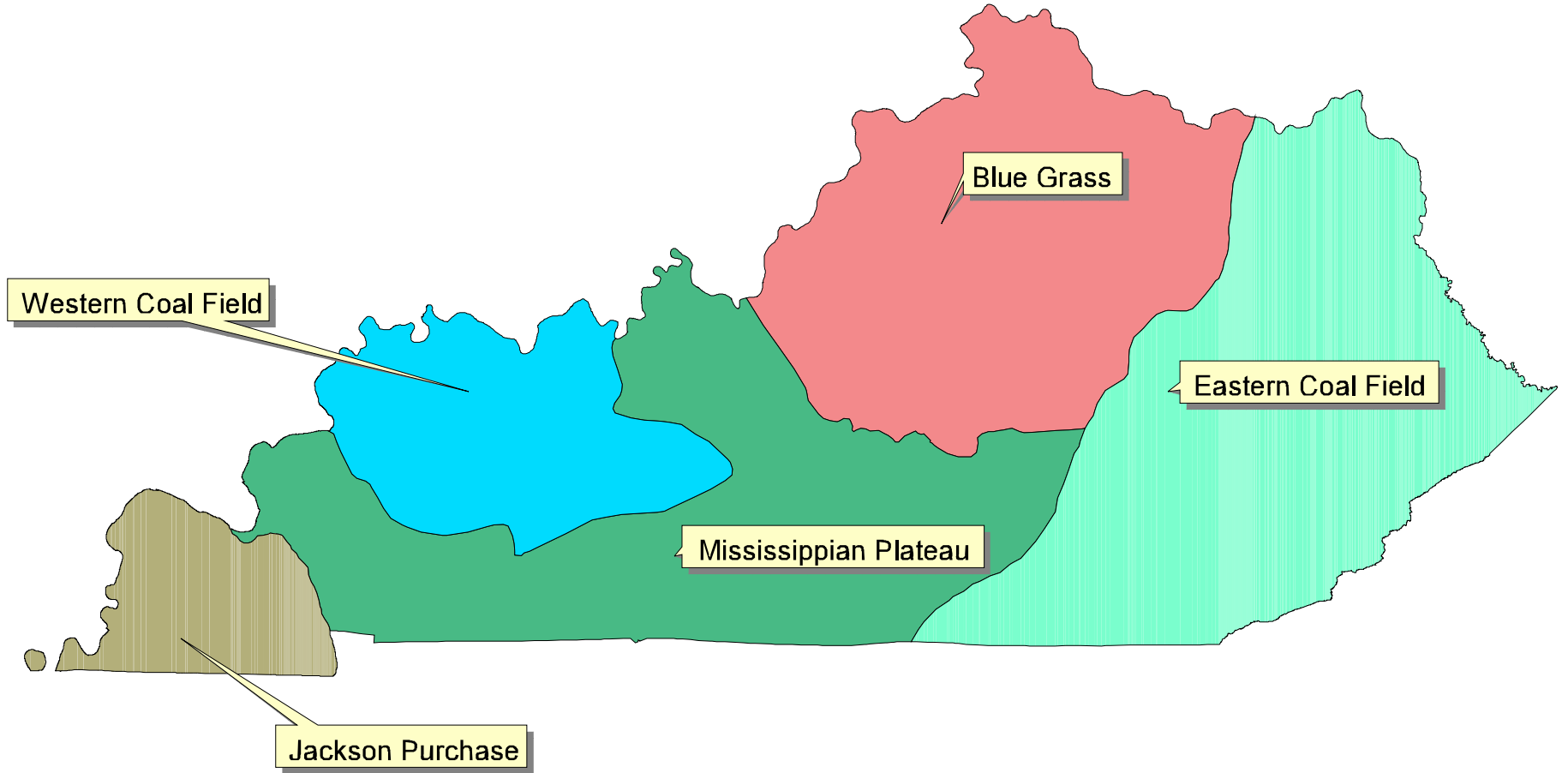
<sup>1</sup> Ground water vs. Surface water and Water Supply Economics, HydroSource Associates, Inc., 1998.

<sup>2</sup> Ibid.

<sup>3</sup> Reconnaissance of Ground-Water Resources in the Eastern Kentucky Coal Field Region, Kentucky, Price, W.E., Jr., D.S. Mull, and Chabot Kilburn, USGS Water Supply Paper 1607, 1962.



# REGIONS OF KENTUCKY



1. The Chattanooga shale. This formation underlies all of the Eastern Kentucky Coal Field, however it is only utilized where it is found near the surface in the extreme western edge of Rockcastle and Menifee counties. This black shale yields only enough water for a minimum domestic supply (100 to 500 gpd (gallons per day)).
2. Mississippian-Devonian rocks exposed along Pine Mountain in Bell, Harlan, Letcher and Pike counties. These rocks consist of shale, limestone and sandstone. The limestone yields water to springs, and faulted limestone and sandstone lying below drainage may yield several hundred gallons per minute to wells.
3. Mississippian rocks exposed along the western margin of the region in Rockcastle, Jackson, Lee, Menifee, Morgan, Elliott, Carter and Greenup counties. These rocks consist of thick limestone underlain by shale. The limestone yields enough water for a modern domestic supply (more than 500 gpd), and discharges as much as 100 gpm (gallons per minute) to springs. The shale yields only enough water for a minimum domestic supply.
4. Lee formation of Pennsylvanian age in the western third of this region and in the Pine Mountain area. This subarea is predominantly underlain by massive sandstones; it generally yields enough water for a modern domestic supply, and in some places, enough water for small public and industrial supplies. In the northern and western reaches of this formation the sandstone is less massive and shaly rocks are more prominent which generally yield only enough water for a minimum domestic supply.
5. Breathitt and Conemaugh formations of Pennsylvanian age covers over half of the area in the Eastern Kentucky Coal Field Region. Wells in the northern and western parts of this subarea that contain more shale than sandstone are sometimes adequate for domestic supply. In wells north of Pine Mountain and in the eastern part of this region (Pike, Martin, Floyd, Knott, Letcher, Perry, Magoffin counties), yield enough water for a domestic supply, and in many places, enough water for small public and industrial supplies.
6. Alluvium along the Ohio River in Greenup and Boyd counties. Mostly composed of glacial outwash sand and gravel, the alluvium is reported to yield as much as 360 gpm to wells.
7. Alluvium along the Big Sandy River and lower reaches of its Tug and Levisa Forks in Boyd, Lawrence, Johnson and Floyd counties. Where consisting mostly of sand, this alluvium may yield as much as 20 or 25 gpm to properly constructed screened wells.
8. Alluvium of Ohio River tributaries other than the big Sandy River and its Tug and Levisa Forks. This alluvium is found in stream valleys throughout Eastern Kentucky. It is generally too thin or fine grained to yield large quantities of water, but may furnish enough water for a minimum domestic supply.

The main contaminants of concern found naturally in the ground water throughout this region are sulfate, salt (sodium chloride), iron (Fe) and manganese (Mn). Salty water commonly occurs in this region at depths between 100 and 300 feet below ground surface. In some locations old abandoned oil and gas wells are responsible for contamination of shallow fresh water aquifers by salt water brought up from much deeper formations. High iron and manganese levels are found in the ground water in many wells which can produce objectionable taste and staining of laundry and porcelain fixtures. Often, coal mining aggravates these problems by increasing the amount of fresh surface area of the rocks exposed to oxidation which can increase the sulfate and metals concentrations in the ground water.

The ground water resource is utilized by over 50 percent of the citizens of Eastern Kentucky. Rural and sparsely populated areas are the main users of ground water due to the high cost of running supply lines and operating small public water systems. The Eastern Kentucky Coal Field is characterized by rugged topography. Population density is low at the county scale, but businesses and houses are concentrated along valley bottoms. Domestic wells in valley bottoms generally produce sufficient water for single-home use, but not for larger users such as communities, industry, or school systems.

Overall, ground water is an under-utilized resource in this region. The potential for growth is large, especially in the deeper aquifers in the Pine Mountain area and in the many abandoned deep mines found throughout this region. Recent efforts to locate high-yield wells and use water stored in mined-out coal seams have been relatively successful, and development of these sources may provide reliable, high-quality water to communities and industry in the Eastern Kentucky Coal Field.

### ***Ground Water Resources of the Blue Grass Region<sup>4</sup>***

The Blue Grass region comprises 43 counties in the north-central part of the state and covers an area of approximately 11,300 square miles or 28 percent of Kentucky. It is bounded on the northeast by the Ohio River and the State of Ohio, on the southeast by the Eastern Coal Field, on the southwest by the Mississippian Plateau, and on the northwest by the Ohio River and the State of Indiana.

In the Blue Grass region probably less than half of the attempts to obtain adequate domestic water supplies from wells drilled in bedrock have been successful. The most favorable areas for obtaining ground water in the bedrock are those where thick limestone beds containing little or no shale occur at and below stream level. Areas underlain by shale or interbedded shale and limestone generally are less favorable. In general, more of the wells drilled in valleys are successful than those drilled on ridgetops. Large supplies of ground water can be obtained in many places from the alluvium along the Ohio River, but the alluvium along tributary streams generally is too fine-grained to yield large quantities of water.

Ground-water quality in the Blue Grass region varies considerably from place to place and is determined by its geologic source. Because drilled wells generally are

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<sup>4</sup> Reconnaissance of Ground-Water Resources in the Blue Grass Region, Kentucky, Palmquist, W.N. Jr., and F. R. Hall, USGS Water Supply Paper 1533, 1961.

deeper, water from drilled wells is generally more highly mineralized than from shallow wells or dug wells. Water from springs is generally less mineralized than from dug wells. The water from drilled wells in the Blue Grass region generally is of the calcium bicarbonate type and is hard to very hard. About 12 percent of the wells are reported to yield water containing undesirable amounts of common salt, and about 20 percent of the wells yield water containing noticeable amounts of hydrogen sulfide.

### ***Ground Water Resources of the Mississippian Plateau Region***<sup>5</sup>

The Mississippian Plateau region includes 30 counties in the central part of the Commonwealth covering an area of about 11,800 square miles. It is bounded on the east by the Eastern Coal Field, on the north and northeast by the Blue Grass region and the Ohio River, on the north and northwest by the Western Coal Field and the Ohio River, on the west by the Jackson Purchase and on the south by the State of Tennessee. The surficial bedrock geology of the Mississippian Plateau region is chiefly limestone, shale, and sandstone ranging in age from Ordovician to Pennsylvanian. Alluvial deposits of sand and gravel of Quaternary age occur along the Ohio River and its tributaries. Included in the region are three major physiographic units--the Mammoth Cave plateau, the Pennyroyal plain, and the Knobs. The region is drained by the Cumberland, Tennessee, and Green Rivers, all of which are tributary to the Ohio River.

More than half of the wells in the region yield supplies adequate for modern domestic use, and a few wells yield more than 1,000 gpm (gallons per minute). Springs are an important source of water supply in the Mississippian Plateau region with many large springs located in the Pennyroyal plain. Some of these springs were measured maximum flows were as high as 150,000 gpm. Many small springs occur in the Mississippian rocks of Chester and Osage ages. Observation wells and springs show conditions, such as lithology of the aquifer, topographic situation, distance from streams and sinkholes, and height of water level above stream level, are factors which control the occurrence of ground water in the Mississippian Plateau region.

Where the aquifer consists of sandstone, shale, and impure limestone the largest supplies of water are obtained close to streams from wells in which the water level is not far above the local perennial stream level. In karst areas, where the aquifers consist of relatively pure limestone, the largest yields are obtained from drilled wells distant from streams but in which the water level is not far above the local perennial stream levels. Some high-yield wells may be obtained in karst areas close to streams if the well encounters a large conduit, but most wells in this topographic situation yield little or no water.

Water obtained from wells and springs in many limestone aquifers is subject to pollution. Water is transmitted through solution openings in limestone at rates up to 1 mile per day, and is not subject to any filtering action. Nearly all wells and springs in the Mississippian Plateau region that obtains water from cavernous limestone is hard and becomes turbid after intensive rainfall, indicating that very little settling

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<sup>5</sup> Reconnaissance of Ground-Water Resources in the Mississippian Plateau Region, Kentucky, Brown, R.F., and T.W. Lambert, USGS Water Supply Paper 1603, 1963.

action takes place. To be safe for domestic consumption all water supplies obtained from cavernous limestone should be treated to eliminate bacterial pollution. Common salt (sodium chloride) and hydrogen sulfide are the two naturally occurring constituents most often encountered in objectionable amounts in the ground water in the Mississippian Plateau region.

### ***Ground Water Resources of the Western Kentucky Coal Field Region<sup>6</sup>***

In the Western Coal Field region of Kentucky, water is obtained from consolidated sedimentary rocks of Mississippian and Pennsylvanian ages and from unconsolidated sediments of Cenozoic age. Pennsylvanian rocks crop out in more than 95 percent of the area and consist of shale and sandstone interbedded with some limestone and coal. The Pennsylvanian strata are divided into four formations. They are, in ascending order: the Caseyville sandstone and the Tradewater, Carbondale, and Sturgis formations. The Anvil Rock sandstone member of the Sturgis formation and the Caseyville sandstone are the only bedrock aquifers in the region that are known to yield more than 100 gpm to wells. Most bedrock wells produce enough water for a modern domestic supply, more than 500 gpd, and few yield so little water as to be inadequate for hand pumps and bailers, less than 100 gpd.

Unconsolidated Cenozoic deposits range from latest Pliocene to Recent in age and consist of clay, silt, sand, and gravel. High gravels, tentatively considered to be late Pliocene and early Pleistocene in age, and loess of Pleistocene age are locally exposed, but nearly all of the alluvium is of late Pleistocene and Recent ages. The alluvium along the Ohio River generally yields from a few hundred to as much as 1,000 gpm to single vertical wells and as much as several thousand gallons per minute to wells that have multiple horizontal screens. Alluvium in the tributaries of the Ohio River generally is finer grained than that of the Ohio Valley. The highest known yield from a well in the alluvium of the tributaries is 56 gpm; other wells yield enough for domestic supplies.

Availability of ground water in the region depends on the character and thickness of the aquifer penetrated, and, where the aquifer is bedrock, on the depth of the water-bearing bed, and to a certain extent on the topographic situation. Most bedrock aquifers in the Western Coal Field region are sandstone and may vary greatly in thickness and composition within short distances. The region is divided into four areas of ground-water availability. Area 1 is confined to the Ohio Valley, most of which is underlain by relatively thick sections of sand and gravel that yield at least 50 gpm to most wells at depths of less than 150 feet. In area 2, most wells yield enough water for a modern domestic supply from depths of less than 300 feet. This area includes the largest part of the bedrock outcrop in the region, some of the alluvium area along the Ohio River, and much of the alluvium area along the larger tributaries. In area 3 which is found in several areas in the northern and southern section of this region, most wells fail to supply enough water for domestic use from depths of less than 300 feet, probably because they penetrate

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<sup>6</sup> Reconnaissance of Ground-Water Resources in the Western Coal Field Region, Kentucky, B.W. Maxwell and R.W. Devaul, USGS Water Supply Paper 1599, 1962.

thick sections of unfractured shales or well-cemented sandstone. In area 4 the yield of wells is unpredictable, commonly because of faulting. This area runs in a thin half mile wide zone across the entire region from the town of Dundee in Ohio County, west to the town of The Rocks in Union County along the Ohio River. A faulted area south of Charleston in Hopkins County is also in region 4.

The water in the shallow bedrock aquifer of the region is mostly of the sodium bicarbonate or the calcium bicarbonate type. Saline water has been encountered at depths as shallow as 100 feet, but fresh water has been obtained at depths approaching 1,000 feet. Water from the bedrock is soft to moderately hard, but it may contain undesirable amounts of iron. Most water from the alluvium is of the calcium bicarbonate type and is generally harder and contains more iron than water from the bedrock.

### ***Ground Water Resources of the Jackson Purchase Region<sup>7</sup>***

This Jackson Purchase region yields ground-water of suitable quality and quantity for many industrial, public supply, and irrigation uses in addition to furnishing domestic supplies throughout the area. Throughout the Purchase region wells yielding more than 200 gpm can be obtained with at least half of the region having the ability to produce more than 1,000 gpm to individual wells. There are few locations without at least one good aquifer within 500 feet of the surface, in some areas there are two or more aquifers at different depths.

The availability of ground-water is controlled by the stratigraphy and structure of the aquifers that range in age from Paleozoic to Quaternary. Water is pumped from bedrock of Paleozoic age, the Tuscaloosa and Ripley formations of Cretaceous age, sands of Eocene age, gravel of Pliocene age, and alluvium of Quaternary age. Most of the Paleozoic rocks are limestone, dolomite, and chert that were deposited in shallow seas. The Cretaceous through Holocene sands, clays, and gravels are mainly deltaic, continental, or lagoonal type sediments.

The gravellike rubble zone at the top of Paleozoic limestone or chert, or solutional openings in these rocks, may yield 1,000 gpm or more. The concentration of dissolved solids in the water is commonly less than 250 mg/L (milligrams per liter). Sands of the McNairy Formation can yield 500 to more than 1,000 gpm in the southeast quarter of the region; elsewhere, the formation contain substantial amounts of clay and yields are less. The dissolved solids in the water commonly are less than 100 mg/L.

Sands of the Wilcox Formation generally yield sufficient water for domestic use and yield as much as 600 gpm to individual wells. In most areas the formation contains too much clay to be an important aquifer for large supplies. The dissolved solids in the water commonly are less than 70 mg/L. Sands of the Tallahatta Formation of the Claiborne Group can yield more than 1,000 gpm in about half of the region. Sand beds in the Sparta Sand of the Claiborne Group can yield more than 1,000 gpm in the eastern part of its area of occurrence; however, the formation grades westward into clay, and yields

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<sup>7</sup> Subsurface Geology and Ground-Water Resources of the Jackson Purchase Region, Kentucky, R.W. Davis, T. W.M. Lambert, and Arnold J. Hansen, Jr., USGS Water Supply Paper 1987, 1973.

near the Mississippi River are much less. The dissolved solids in water from the two formations commonly are less than 70 mg/L.

Sands of the undivided Cockfield through Jackson Formation are known to yield 300 gpm; however, larger yields may be obtained. The dissolved solids in the water are commonly less than 100 mg/L; near the Mississippi River, however the water increases in hardness, which results in an increase in the dissolved solids.

Gravel deposits of Pliocene(?) and Pleistocene ages west of Paducah should yield more than 1,000 gpm. The dissolved solids in the water are commonly less than 250 mg/L. South of Paducah, gravel deposits generally yield only sufficient water for domestic use. The alluvium gravel and sand deposits along the Tennessee and Mississippi Rivers can yield more than 1,000 gpm at most places. The dissolved-solids concentration in water from the Tennessee River alluvium commonly is less than 200 mg/L; the dissolved solids in water from the Mississippi River alluvium are commonly less than 500 mg/L. The alluvium of the Ohio River can yield 1,000 gpm at places.

There is no regional long-term trend of either rising or falling water levels in wells tapping the aquifers in the region. Water levels rise in wet years and decline in dry years. The amount of recharge by precipitation is estimated to be from 4.8 to 7.2 inches of precipitation yearly, or 10-15 percent of the annual average precipitation.

The availability of water in different parts of the region was determined chiefly by analyzing well data that was compiled by the United States Geological Survey in the late 50's and early 60's. Additional ground water information gathered over the last 40 years are assimilated into this report. The USGS Water Supply Paper titled "Reconnaissance of Ground-Water Resources of the Jackson Purchase Region, Kentucky, 1962" is by far the most comprehensive report on ground water in this region and is utilized extensively in this report. The value of this information for economic development can best be depicted in the following situation. In the mid-sixties, less than one-seventh of the farms in some areas of the Jackson Purchase had wells because many farmers, lacking information about local ground-water conditions, believe it is cheaper to buy water for cisterns than to have a well drilled. More than 95 percent of the farmers in these areas bought water throughout the year.

In the Jackson Purchase Region, aquifers yield water of sufficient quality and quantity to supply communities, industries, and households. In areas where ground water is plentiful, it may have significant advantages over surface water. Wells can be located close to the point of use, thereby reducing distribution costs. Ground water generally does not contain suspended sediments or contaminants from human activities, and is therefore simpler to treat for human consumption. And finally, ground water supplies are less vulnerable to disasters such as flooding, earthquakes, landslides, and accidental chemical spills.

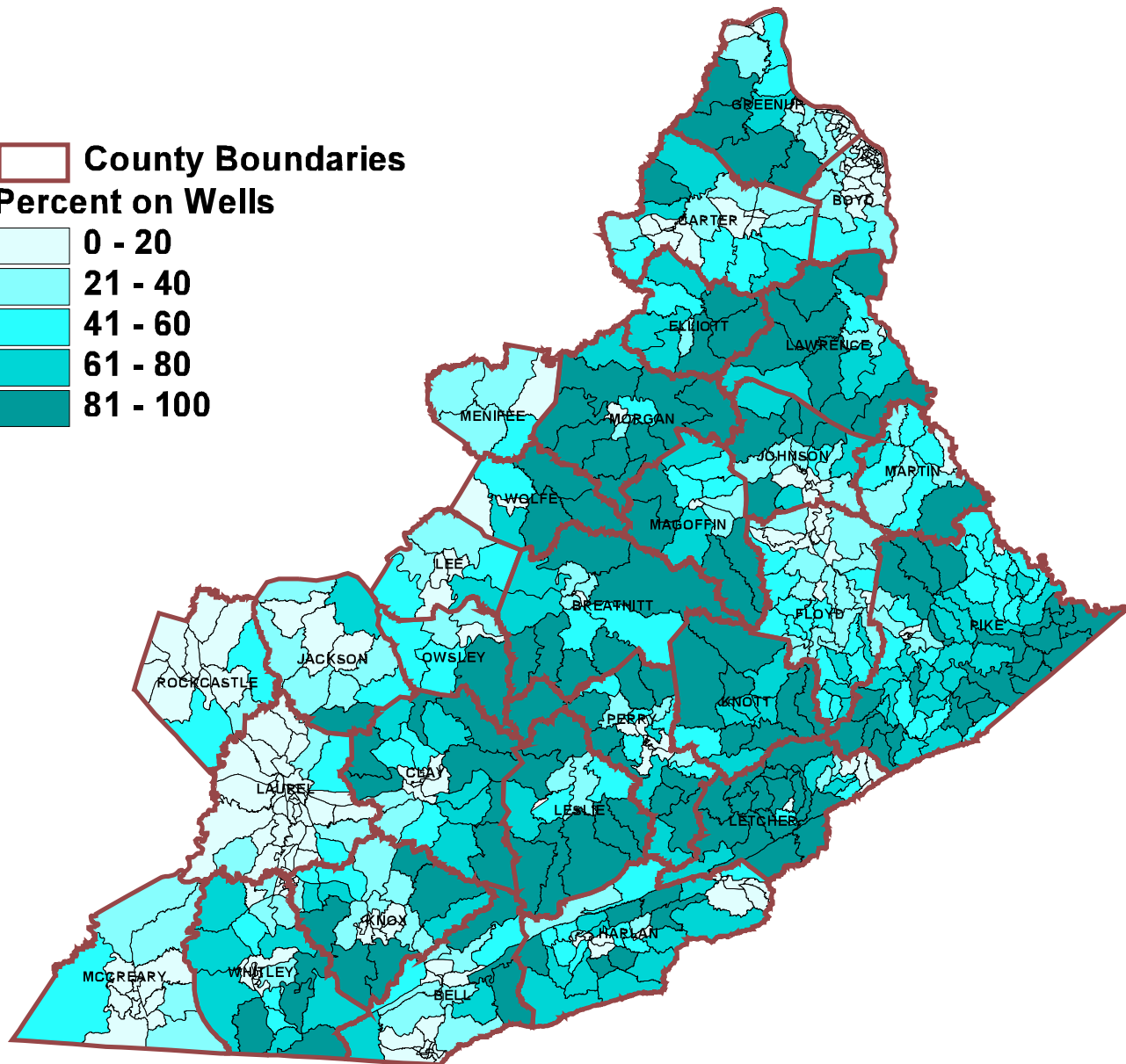
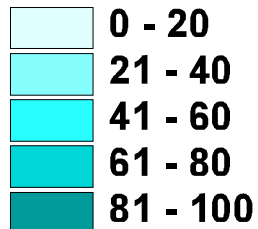
## **PRIORITY AREAS OF KENTUCKY**

Over the last several decades it has become widely recognized that the lack of water supplies is a major problem that inhibits diversified economic development in the Eastern Kentucky Coal Field and other regions of the state. Over half the domestic wells in the state are in the Eastern Coal Field--Figure 6. In addition, recent droughts have

# Private Well Use

 County Boundaries

Percent on Wells





demonstrated that many water supplies across the state are having difficulty supplying water for current needs. City and county governments, and area development districts have struggled to develop adequate water supplies for individuals, small communities, larger population centers, and industry for many years. Eastern Kentucky (25 percent of the state) is hampered by steep terrain and highly dissected topography that limit the occurrence and distribution of surface water, and by underground conditions that make it difficult to locate adequate ground-water supplies. Limestone areas of the state (55 percent) suffer from the irregular distribution of ground water and surface water because of the characteristic of karst (sinkhole and cave) terrain. The Western Kentucky Coal Field region (15 percent) has limited surface water away from the major rivers, and has a complex subsurface that makes it difficult to locate adequate ground-water supplies.

In 1999, the Kentucky Rural Water Association (KRWA) and the Kentucky Division of Water identified the following communities having water supply problems:

***Eastern Kentucky:***

- City of Manchester (Clay County): drought vulnerable
- City of Hindman (Knott County): system is expanding and is likely drought vulnerable
- Beech Fork Water Commission (Powell County): water quality
- Ary-Dwarf-Rowdy area (Breathitt/Perry Counties): water supply and quality
- City of Whitesburg (Letcher County): drought and water quality
- Lynch, Kitt communities (Harlan County): water supply and quality.
- Hyden/Leslie County Water District: water supply.
- Letcher County Water and Sewer District: water supply.
- Jackson County: water supply.
- City of Hazard (Perry County): back-up supply, drought vulnerable.

***Bluegrass:***

- Bath County Water District: drought vulnerable
- Owingsville Water District: drought vulnerable
- North Middleton Utilities: drought vulnerable
- Mount Sterling Water and Sewer Systems: drought vulnerable
- Nicholas County Water district: drought vulnerable
- Pendleton County Water Districts: drought vulnerable

***Central Kentucky:***

- Elizabethtown Municipal Water Works Plant A: drought vulnerable
- Bullitt County general: drought vulnerable
- Nelson County general: drought vulnerable
- Larue County general: drought vulnerable
- Bowling Green: drought vulnerable

***Western Kentucky:***

- Fordsville (Ohio County): drought vulnerable
- Franklin (Simpson County): drought vulnerable
- Todd County Water District: drought vulnerable
- Russellville, Oak Grove, Adairville, Auburn (Logan County): drought vulnerable

Two approaches to identifying and developing potential water supplies to solve these problems have been proposed: (1) in the coal field regions, the use of water reservoirs in abandoned, underground coal mines; and, (2) across the entire Commonwealth, the development of high-yield water wells located along linear features in the earth's surface. These two sources are proposed to meet water-supply needs where present ground-water supplies are inadequate, and where surface water from rivers and reservoirs and associated pipelines are inadequate or uneconomical to meet present and projected water-supply demands. As discussed in the proposals below, both of these techniques have great potential to enhance water supplies.

## **POTENTIAL SOLUTIONS TO WATER SUPPLY PROBLEMS IN PRIORITY AREAS OF KENTUCKY**

Three recommendations are presented below. The first two--Water Supplies from Abandoned Underground Coal Mines in Kentucky and Hydrogeologic Evaluation of High-yield Well Potential in Kentucky--are potential solutions to water supply problems in priority areas. The third-- Provide Quality- and Quantity-assurance Support for Small, Private Water Systems--would apply to private, domestic water supplies throughout the state.

### ***Water Supplies from Abandoned Underground Coal Mines in Kentucky***

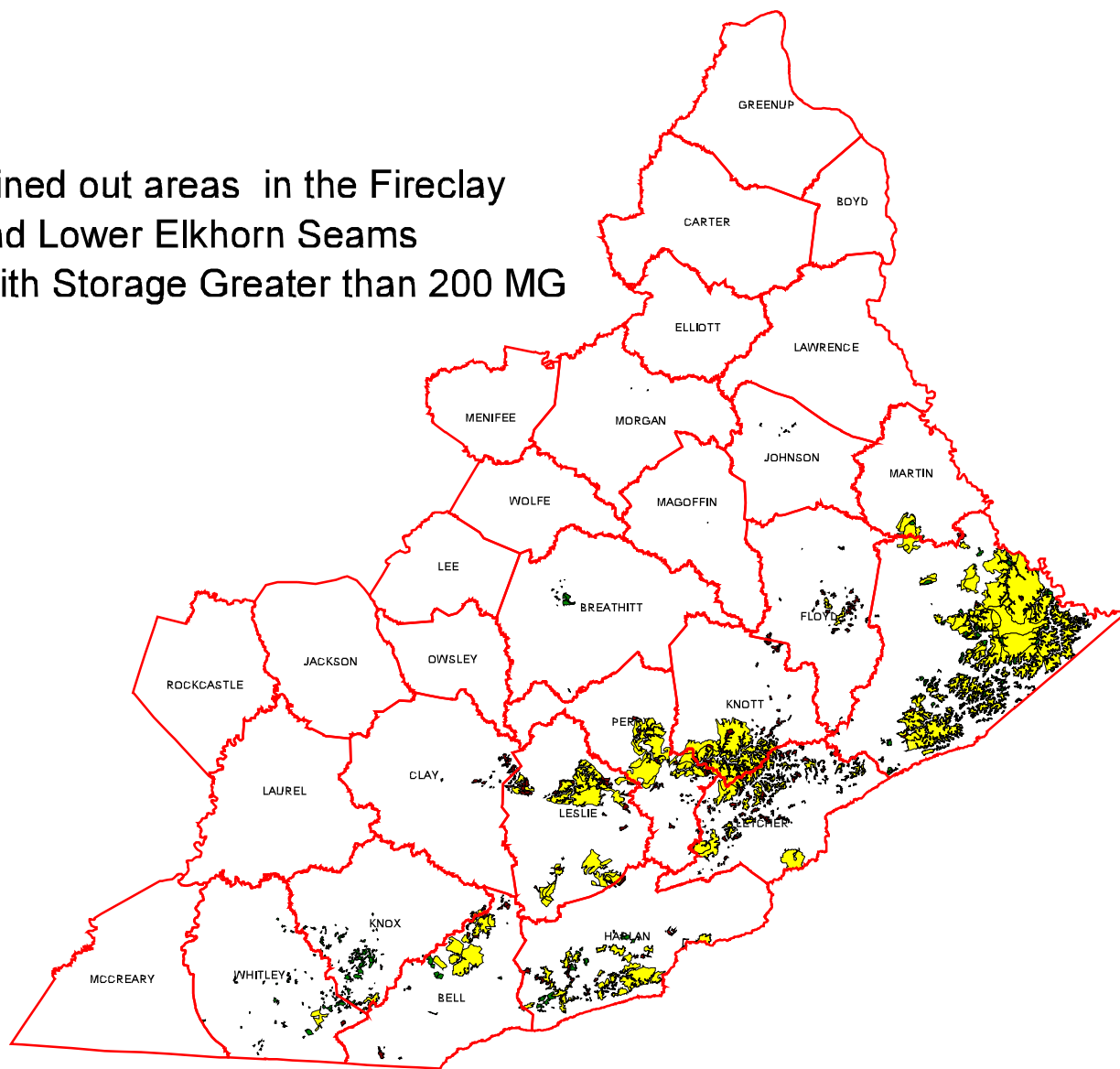
Conservative estimates indicate that water from abandoned underground coal mines could provide water for as many as 250,000 people in eastern Kentucky. Two of the six seams which have been mapped represent 160 billion gallons of potential water storage (Figure 7). Initial studies of abandoned underground coal mines in Johnson, Martin, Knott and Letcher counties show that favorable sites exist but need to be "proven out".

Although preliminary investigations have apparently confirmed the value of this resource at several locations, the feasibility of using abandoned underground coal mines as municipal water supplies throughout Appalachia needs further development. Underground mines which have potential for development as water supplies, and are also in proximity to population centers with the greatest water demands need to be identified.. The following questions need be addressed for the region:

- Are underground mines a viable source for major water supplies?
- What water-quality problems may inhibit use of mine water (such as poor water quality or abrupt changes in water quality)?
- What are the challenging issues for existing water supplies that currently use mine water?
- What difficulties might inhibit an accurate determination of water supply conditions within underground mines?
- Is hydrogeologic data and mine information from existing mines sources transferable to untested potential deep-mine water supplies?

The work would be divided into two separate phases: Phase I is a reconnaissance phase, during which the location and general characteristics of abandoned mines would be compiled and reviewed for potential detailed study. Phase II would consist of more

Mined out areas in the Fireclay  
and Lower Elkhorn Seams  
with Storage Greater than 200 MG



Abandoned Deep Mines

detailed evaluations of selected mines including pumping tests to determine the supply capacity of the mines, and detailed laboratory analysis of deep-mine water quality.

This study would be a continuation and expansion of work performed in 1998-99 funded by the Kentucky River Authority that was restricted to the upper Kentucky River basin. The present proposal encompasses all of Appalachia, KY, where deep mines are present and a genuine need for water exists.

## **SCOPE OF WORK**

### ***PHASE I, Reconnaissance***

During this phase of the study, county officials would be contacted to identify and prioritize communities and residential cluster areas requiring source development. County officials, mining companies and local citizens would be consulted because they have proven to be the most reliable sources of information for locating abandoned mines with potentially large storage capabilities. Local residents are also valuable for locating wells, adits and outflows which could be used as monitoring points for water levels, flow measurements and water quality analysis. Once a mine is located, topographic, geologic and mine maps would be used to define the areal extent of the mine, the thickness and contour of the coal seam, locations of seals and entry barriers, and the percentage of coal removal from the mined area. The areal extent of the mine multiplied by the thickness of the coal seam and the percentage of coal removal equals the total void space in the mine available for water storage. Measured water levels (when available) would be used to show how much of the mine is actually flooded, resulting in a reasonable estimate of the actual volume of water in storage.

For those mines which have been identified as possible sources, as well as those mines yet to be characterized, field measurements of water quality parameters (pH, specific conductance and temperature) would be taken at every possible monitoring point. All potential sources would then be compared on the basis of physical characteristics, accessibility, storage volume and field water quality parameters to establish suitability for further detailed study. Selection for detailed study would also be based on proximity to areas with greater water supply needs and the amount of cooperation among local governments, agencies and citizens.

The objectives of reconnaissance are:

- To identify those underground mines which may have potential as major water supplies.
- To define the physical characteristics of the mine related to water supply issues.
- Estimate the storage capacity of the mine.
- Take initial flow measurements and field water quality analysis.
- The results of these four objectives would then be used to select those mines which are the best candidates for more detailed evaluation.

### ***PHASE II, Detailed Study***

The purpose of detailed study is to more closely examine an underground mine's ability to supply large water quantities of usable quality in areas where water is needed.

### *Water quantity*

The most important factor controlling the ability of a mine to supply large quantities of water is the rate of recharge to the mine void. Even if a mine has an extremely large volume of water in storage, the mine will run dry if pumped faster than the recharge rate over an extended period of time. A first-order estimate of recharge rate can be calculated for those mines located above the elevation of the local surface drainage system by “walking the outcrop” of the mine and totaling the flow from all observed outflow points. By assuming that there is no change in mine-water storage, then the amount of water leaving the mine (outflow) should be equal to the amount of water entering the mine (recharge). However, this approach can lead to an underestimation of mine recharge because it is based on the assumption that all outflows are observable and measurable. The most accurate method for calculating recharge for an underground mine is to pump a large quantity of water out of storage, then monitor the rate of recovery.

High volume pumping tests would be performed at priority sites with pumping durations ranging from three to five days. Results from previous tests show recharge rates ranging from 150,000 to 450,000 gpd. These recharge rates are above the daily usage of many water systems in Appalachia such as Wheelwright (130,000 gpd), Fleming-Neon (100,000 gpd) and Hindman (140,000 gpd). This indicates that single, deep-mine supplies may be adequate for intermediate size population centers.

Monitoring of water levels and outflows over an extended period of time are necessary to accurately assess seasonal variations in mine-water storage. Water level probes would be installed into deep-mine monitoring wells as a method for gathering long-term storage-capacity information.

Another important goal of this study with respect to water quantity is to develop a model for estimating the rate of recharge to a mine based on the areal extent of the mine and the topography of the surface which may provide the recharge. Such a model should be transferable to other mines which are untested and, therefore, provide a less expensive approach to estimating water yield from an untested mine. Data collected from high capacity pumping tests at several sites would be compared to link recharge rates with physical characteristics of both the mines and the surface areas above them.

### *Water quality*

A comprehensive chemical analysis of mine water quality is necessary to determine the suitability of the water for potential treatment and subsequent use. Initially, before a pumping test is performed, a water quality sample would be collected and tested for common elements such as calcium, iron, magnesium and sulfate; and common contaminants such as organic and volatile organic compounds that have been associated with mining activities and may subsequently limit the use of mine water for public supplies. Additional samples would be collected during pumping tests at priority sites in order to detect any changes in water quality through time as water from different parts of the mine are drawn to the pump station. Occasional sampling during periods of draught or high outflow may also be needed to detect any seasonal variations in water quality.

In order to perform the pump tests described above, it may be necessary to drill monitoring wells and wells large enough to accommodate high capacity pumps. Pump tests which require drilling are contingent on the availability of funds as well as obtaining permission from the landowner to drill on their property.

### **DELIVERABLES**

A written report would be prepared which would contain a list of mines and descriptions of their characteristics with regard to supplying drinking water. Physical characteristics would include: mine water quality, hydrogeologic characteristics which define storage and recharge capabilities, and location. Other characteristics would include proximity to population centers in need of supplies, accessibility to water in storage, surface and mineral ownership and proximity to current or future mining which could be detrimental to development as a water supply source.

### ***Hydrogeologic Evaluation of High-yield Well Potential in Kentucky***

Remote sensing methodology and drilling techniques have been used to locate a high-yield well in Breathitt County which would provide a source of water for the community of Oakdale. These techniques offer promise for locating high-yield wells (e.g., greater than 30 gpm) across Kentucky. Initial work on this project was funded by the University of Kentucky E. O. Robinson Trust, and the Kentucky River Authority.

Water wells in coal-bearing strata which underlie much of Appalachia typically produce small amounts of water that are barely adequate for most domestic uses. For example, a well that can produce 500 gpd is often adequate for a household family of four. However, many residential wells cannot meet this demand and also suffer from the lack of suitable water quality.

The availability of inexpensive, high-quality water supplies that produce significant quantities of water is vital to the economic progress in Appalachia. While the role of water distribution systems that rely on surface water is important in many areas, the vast majority of the coal field is relatively undeveloped, and the extension of water lines is often cost prohibitive. Therefore, ground water remains a viable source of water in many areas.

There are wells in eastern Kentucky that have been estimated to produce water in quantities greater than 72,000 gpd (50 gpm). The successful drilling of these wells has been largely fortuitous. It is important that techniques be developed to deliberately locate such high-yield wells because these wells could provide enough water to supply small public supplies, schools, and industries.

### **REMOTE SENSING AS AN EXPLORATION TOOL**

The majority of ground water used for domestic water supply is obtained from relatively shallow wells (less than 150 feet in depth) in fractured bedrock. The bedrock consists mainly of shale, sandstone, siltstone, coal, and to a minor extent, limestone (Price and others, 1962). Water can be stored in all of these rock types. However, the rapid movement of water is primarily controlled by secondary fractures such as joints or

faults that penetrate through the rock near the land surface (Wyrick and Borchers, 1981; Kipp and Dinger, 1987).

Joints and faults in the earth's crust may extend for tens of feet up to several miles in length. The more lengthy of these features, called linear terrain features, fracture traces, or lineaments, can be seen on different types of aerial photographs and satellite imagery. These features may collect, store, and transport large amounts of ground water that can provide sufficient water to communities and related industry.

Little effort has been made in the past to determine the ground-water resource potential as it relates to high-yield wells. Recent efforts using satellite imagery within the Upper Kentucky River Basin have resulted in 3 out of 4 wells producing more water than 90 percent of the recorded wells, and having enough water to supply from 50 to 250 homes per well. The purpose of this study is to continue to identify the geologic factors that influence the location of high-yield water wells, and use this information to exploit ground-water resources throughout Appalachia, KY.

Exploiting geologic features such as fractures traces and lineaments is a common technique used for the exploration of subsurface fluids, including ground water (Siddiqui and Parizek, 1971; Mabee and Hardcastle, 1994) and petroleum (Driscoll, 1986). Fractures traces are generally linear expressions on the earth's surface that are less than 1 mile in length, and those greater than a mile are termed lineaments. Linear features that are not readily apparent on the ground can often be distinguished at high altitudes. Currently, private vendors as well as foreign agencies have made available high-resolution satellite photo's and radar images. These data can be used to create detailed surficial analysis for linear features that can be related to high-production ground-water zones.

### **SCOPE OF WORK**

The following objectives are proposed:

- Complete lineament designation and interpretation for Kentucky. The Kentucky Geological Survey has completed lineament designation and interpretation for about 50 percent of Appalachia, KY. Lineament designation and interpretation for the rest of Kentucky needs to be completed.
- Drilling and exploration program. Recent developments in drilling technology have made available some very promising exploration methods. Drilling rigs capable of drilling inclined wells are now available in Kentucky. Inclined exploration wells should be drilled to incorporate greater, more accurate geologic coverage of priority production well sites in pursuit of large, water-producing fractures.
- Perform statistical analysis of well-yield test data to determine the success and significance of the data and exploratory techniques. Statistical analyses of well-yield data from the KGS data base should be performed as the lineament coverage increases. Presently there are 14,200 well records, with a sample population of 3,456 that contain well-yield data. The data obtained in this project can be compared to well-yield data for wells in similar terrain to evaluate remote sensing and lineament tracing techniques versus conventional methods.

### **PRODUCTS**

This project has far reaching implications for water supply issues in Kentucky. Successful use of linear-terrain-feature analysis to determine areas of high-yield wells would provide a valuable tool for the development of water supplies. This could aid in

economic development and the overall improvement of the quality of life for the residents. The technology developed here would be useful to consultants, local, and state agencies in developing dependable, high-quality ground-water supplies, particularly for isolated communities in Appalachia and rural Kentucky.

Specific products would include a GIS database of (1) well locations and (2) lineament maps, and accompanying data for each well drilled. Site specific data for each well site would include well construction data, well yields, and water-quality data. Well yields for drilled sites would be statistically evaluated with respect to well yields currently in the data base to assess the degree of success in using lineament analyses and drilling techniques. Interpretive remarks would be made concerning the entire process of defining productive linear-terrain features, field reconnaissance of drilling sites (geologic and topographic features), and techniques from drilling high-yield water wells.

### *Quality- and Quantity-assurance Support for Private Water Systems*

Some citizens of the Commonwealth have not been able to benefit from public water service because of economics or simple geographical constraints. Others are pleased with the water provided by their existing wells or other systems. For the long-term health and economic well-being of the public, we propose that, as a first step in implementing the concept of "universal jurisdiction", a local management entity (city, water district, private company) be designated to provide a voluntary, fee-based service for the systematic, periodic inspection, testing, and servicing of private, small, domestic water systems. The goal is to raise the level of quality assurance for these systems to that of public water systems. Objectives of the program would be to:

- Provide cost-effective periodic water sampling and water system inspections to owners of private water supplies.
- Provide results of water testing and system inspections to the owners so that they understand the current condition of their water systems.
- Provide practical advice on the best and most cost-efficient solutions to water quality and water quantity problems.
- Make follow-up visits to determine if the solution appears to be successful.
- Advise homeowners on the installation of new private water supplies.

KRS 211.345 already requires the Cabinet for Health Services to provide testing services. They are provided through local health departments acting as the Cabinet's agent. These services are not as available as they need to be, however, since there is no funding source other than scarce local health tax dollars. Therefore, local health departments are hesitant to promote these services. If these services were provided on a cost-reimbursement basis, the cost would be around \$65 to \$70. This cost estimate would address issues that currently exist with test result validity. We therefore **recommend that the WRDC ask for the statutory authority to allow local health departments to charge a fee for these services, and request an appropriation to subsidize the cost.**



In the case of private, domestic water wells, we recommend that continued support be provided so that training courses and educational programs can be developed by such groups as the DOW--Ground water Branch, the Kentucky Ground Water Association, and others, to assist certified water-well drillers in their well-servicing activities.

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## **APPENDIX I**

### **SUMMARY OF PRIVATE WATER SUPPLIES AND GROUND WATER RESOURCES BY COUNTY AND AREA DEVELOPMENT DISTRICT (1999)**

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## BLUEGRASS AREA DEVELOPMENT DISTRICT

699 Perimeter Drive  
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About 42,000 people, or 7 percent, in the region rely on private domestic water systems: 11,600 on wells and 29,400 on hauled water and other sources.

Estimated populations and private water service for the seventeen counties in the region are given below:

County	1999 Pop	On Private	2020 Pop	On Private
Anderson	18,800	4,700 (25%)	25,100	4,800 (19%)
Bourbon	19,200	3,300 (17%)	18,800	2,300 (12%)
Boyle	26,100	2,100 ( 8%)	27,300	500 ( 5%)
Clark	32,100	600 ( 2%)	35,600	0 ( 0%)
Estill	15,400	3,100 (20%)	15,300	2,600 (17%)
Fayette	230,300	700 ( 0%)	238,300	0 ( 0%)
Franklin	45,300	1,800 ( 4%)	46,100	1,800 ( 4%)
Garrard	14,200	1,700 (12%)	18,200	1,600 ( 9%)
Harrison	17,400	1,700 (10%)	18,800	1,300 ( 7%)
Jessamine	36,400	3,600 (10%)	46,500	3,700 ( 8%)
Lincoln	22,500	3,400 (15%)	26,100	3,100 (12%)
Madison	60,500	4,800 ( 8%)	72,800	5,100 ( 7%)
Mercer	20,700	1,700 ( 8%)	22,900	1,100 ( 5%)
Nicholas	7,100	900 (13%)	7,400	400 ( 6%)
Powell	12,900	3,200 (25%)	15,100	3,600 (24%)
Scott	30,200	3,000 (10%)	44,600	3,600 ( 8%)
Woodford	22,700	1,600 ( 7%)	27,000	1,300 ( 5%)
Region	632,000	42,000 ( 7%)	706,000	37,000 ( 5%)

### Anderson County

About 4,700 people in Anderson County rely on private domestic water supplies: about 800 on wells and 3,900 on other sources.

In the valley bottoms of the Kentucky and the Salt Rivers and their major tributaries, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the smaller creek valleys throughout the county will produce enough water for a domestic supply except during dry weather. In the areas above the stream valleys throughout Anderson County, which encompasses approximately 60% of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines which may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.



### **Bourbon County**

About 3,300 residents of Bourbon County rely on private domestic water supplies: 1,000 on wells and 2,300 on other sources.

In the valleys of the South Fork of the Licking River, Stoner and Hinkston Creek and their major tributaries most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in upper reaches of the larger creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of eastern and southern Bourbon County which encompasses 30 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines which may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Boyle County**

About 2,050 residents of the county rely on private domestic water supplies: 700 on wells and 1,350 on other sources.

In the northern half of the County within the larger creek and river valleys most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. In the rest of Boyle County wells located in the larger creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Boyle County, which encompasses 85 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the County ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Clark County**

About 650 people in Clark County rely on private domestic water supplies: 200 on wells, and 450 on other sources.

In the larger stream valleys of northwestern Clark County and along the thin Kentucky River valley, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. In the larger creek valleys throughout the county and in the southwestern corner of the county, some wells will produce enough water for a domestic supply except during dry weather. In the upland areas of Clark County, which encompasses 50 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Estill County**

About 3,100 residents of Estill County rely on private domestic water supplies: 800 on wells and 2,300 on other sources.

In the Kentucky River valley in central Estill County, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. In the larger creek valleys throughout the county, some wells will produce enough water for a domestic supply except during dry weather. In the upland areas of Estill County, which encompasses 70 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet. A few springs supply sufficient quantities of water for domestic use.

### **Fayette County**

About 700 residents of Fayette County rely on private domestic water supplies: 400 on wells and 300 on other sources.

In the North and South Fork of Elkhorn Creeks, Hickman Creek and Boone Creek and their major tributaries, most drilled wells in the valleys will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the creek valleys and the uplands of the northern and western two-thirds of the county and in the upper reaches of the creek valleys in the eastern third will produce enough water for a domestic supply except during dry weather. In the upland areas of the eastern third of Fayette County, which encompasses only 10 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines which may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Franklin County**

About 1,800 residents of Franklin County rely on private domestic water systems: 500 on wells and 1,300 on other sources.

In the valley bottoms of the Kentucky River and Elkhorn Creek and their major tributaries, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the smaller creek valleys throughout the county and the uplands of the southeastern part of the county will produce enough water for a domestic supply except during dry weather. In the upland area of the rest of Franklin County, which encompasses 40 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Garrard County**

About 1,600 residents of Garrard County rely on private domestic water supplies: 300 on wells, and 1,300 on other sources.

In the Dix River valley and parts of the Kentucky River valley, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the creek valleys of the county will produce enough water for a domestic supply except during dry weather. In the upland areas of Garrard County, which encompasses 75 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Harrison County**

About 1,700 people in Harrison County rely on private domestic water supplies: 200 on wells and 1,500 on other sources.

In the valleys of the Licking River, South Fork of the Licking River, and Silas Creek most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the larger creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Harrison County, which encompasses 65 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Jessamine County**

About 3,600 residents of Jessamine County rely on private domestic water supplies: 800 on wells, and 2,800 on other sources.

In the Kentucky River, South Fork of Elkhorn Creeks, Hickman Creek and Jessamine Creek and their major tributaries, most drilled wells in the valleys will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the creek valleys and the uplands of the northern two-thirds of the county will produce enough water for a domestic supply except during dry weather. In the southern thirds of Jessamine County, which encompasses only 15 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines which may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Lincoln County**

About 3,400 residents of Lincoln County rely on private domestic water supplies: 1,500 on wells, and 1,900 on other sources.

In the northern end of Lincoln County, north of highway 150, in the valleys of Hanging Fork of the Dix River and the Dix River, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. In most of Lincoln County wells located in the creek and river valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Lincoln County, which encompasses 80 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Madison County**

About 4,800 residents of Madison County rely on private domestic water supplies: about 1,000 on wells, and 3,800 on other sources.

Within the thin Kentucky River valley along the northern edge of Madison County and in the lower reaches of the valleys of the larger creeks that empty into the Kentucky River most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. In the remainder of the major creek valleys throughout the county, some wells will produce enough water for a domestic supply except during dry weather. In the upland areas of Madison County, which encompasses 70 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Mercer County**

About 1,700 people in Mercer County rely on private domestic water supplies: 400 on wells and 1,300 on other sources.

In the bottoms of the Salt, Dix, and Kentucky Rivers most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. In the larger creek and river valleys and a limited area between Harrodsburg and Shakertown, wells will produce enough water for a domestic supply except during dry weather. In the upland areas of Mercer County, which encompasses 65 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Nicholas County**

About 900 residents of Nicholas County rely on private domestic water supplies: 300 on wells and 600 on other sources.

In the Licking River valley and in the valley of the main trunk of Hinkston Creek most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in many of the larger creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Nicholas County, which encompasses 85 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Powell County**

About 3,200 residents of Powell County rely on private domestic water supplies: 1,400 on wells and 1,800 on other sources.

In the main stem of the Red River valley in central Powell County, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. In the larger creek valleys throughout the county, some wells will produce enough water for a domestic supply except during dry weather. In the upland areas of Clark County, which encompasses 60 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet. A few springs supply sufficient quantities of water for domestic use.

### **Scott County**

About 3,000 residents of Scott County rely on private domestic water supplies: 900 on wells and 2,100 on other sources.

In the North and South Fork of Elkhorn Creeks and their major tributaries, most drilled wells in the valleys will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the creek valleys of the northern half of the county and in the upper reaches of the creek valleys and some of the upland areas in the southern half will produce enough water for a domestic supply except during dry weather. In the upland areas of the northern two-thirds of Scott County, which encompasses 50 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

## **Woodford County**

About 1,600 residents of Woodford County rely on private domestic water supplies: about 800 on wells and 800 on other sources.

In the Kentucky River, South Fork of Elkhorn Creeks, Clear Creek and Glenss Creek and their major tributaries, most drilled wells in the valleys will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the smaller creek valleys throughout the county and the uplands of the far eastern part of the county will produce enough water for a domestic supply except during dry weather. In the upland area of western and far southern Woodford County, which encompasses 40 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

**BARREN RIVER AREA DEVELOPMENT DISTRICT**

177 Graham Avenue  
P.O. Box 90005  
Bowling Green, KY 42102-9005  
(502) 781-2381

About 22,000 people, or 9 percent, in the region rely on private domestic water systems: 16,200 on wells and 5,800 on hauled water and other sources.

Estimated populations and private water service for the ten counties in the region are given below:

<b>County</b>	<b>1999 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Allen	16,600	3,200 (19%)	20,000	3,600 (18%)
Barren	37,200	4,500 (12%)	42,200	4,600 (11%)
Butler	11,800	1,200 (10%)	12,700	1,100 ( 9%)
Edmonson	11,500	600( 5%)	13,600	500 ( 4%)
Hart	16,900	1,200 ( 7%)	19,400	600 ( 3%)
Logan	26,400	5,300 (20%)	29,000	3,800 (13%)
Metcalfe	9,500	2,900 (30%)	10,200	2,400 (24%)
Monroe	10,900	600 ( 5%)	9,700	0 ( 0%)
Simpson	16,300	800 ( 5%)	17,700	500 ( 3%)
Warren	83,200	1,700 ( 2%)	94,700	900 ( 1%)
Region	240,000	22,000 ( 9%)	269,000	18,000 ( 7%)

**Allen County**

About 3,200 people in Allen County rely on private domestic water supplies: about 1,800 on wells, and 1,400 on other sources.

In the uplands of northwestern Allen County and in the lowlands of the southern reaches of Trammel Creek and the Barren River and its major tributaries, more than three-quarters of the drilled wells are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels which are a common feature in limestone rich areas such as are found in Allen County. In approximately 80 percent of the county most wells are inadequate for domestic use except a few wells in lowlands areas bordering streams which yield enough water for a domestic supply.

Numerous springs with flows ranging from a few gallons per minute too as high as 20,000 gpm are found in the county but are prominent in the limestone beds along the Barren River and its tributaries.

### **Barren County**

About 4,500 people in Barren County rely on private domestic water supplies: 3,800 on wells, and 700 on other sources.

In the northern half of Barren County except in the lowlands of Beaver Creek, more than three-quarters of the drilled wells are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels, which are a common feature in limestone rich areas such as Barren County. In the southern half of the county and along the low-lying areas along Beaver Creek, most wells are inadequate for domestic use except a few wells in lowland areas bordering streams that yield enough water for a domestic supply.

Numerous springs with flows ranging from a few gallons per minute to 2,000 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter

### **Butler County**

About 1,200 people in Butler County rely on private domestic water supplies: 800 on wells and 400 on other sources.

In the northern two-thirds of Butler County most wells from depths of less than 300 feet are adequate for a domestic supply. Wells located in the Green River flood plain can produce as much as 100 gallons of hard water per minute. Most wells obtain their water from thick sandstone layers and will yield as much as 60 gpm. In the southern third of the county only a few wells yield enough water for a domestic supply. In the central section of the county moderately mineralized water may be obtained locally from deep sandstone formations at depths of 1200 feet.

Generally, ground water is hard to very hard and iron and salt may be present in objectionable amounts. Often ground water becomes saltier with depth.

### **Edmonson County**

About 550 people in Edmonson County rely on private domestic water supplies: 350 on wells and 200 on other sources.

In this highly karstic, limestone rich county, most of the drilled wells in the southern half of Edmonson County are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels with adequate wells producing as deep as 500 feet. In the uplands of the northern half of the county less than half the drilled wells yield enough water for a domestic supply. In low-lying areas of the Nolin River, Bear Creek, and Dog Creek and their main tributaries, most wells are inadequate for domestic use with the exception of a few wells that yield enough for a domestic supply from depths of 150 feet or more.

Springs with flows ranging from a few gallons per minute to 50,000 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.



### **Hart County**

About 1,150 people in Hart County rely on private domestic water supplies: 750 on wells and 400 on other sources.

In the limestone rich area of southwestern Hart County most drilled wells are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels. Depths of adequate wells range up to 500 feet. In the southern half and parts of north central Hart County, about three-fourth of the wells drilled yield enough water for a domestic supply. In the remaining areas of the county only a few wells yield enough water for a domestic supply except in the lowland areas bordering streams where yields are sometimes sufficient for some wells to meet the supply needs for domestic use.

Springs with flows ranging from a few gallons per minute to 35,000 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter. The larger springs in the county have sufficient flows to be utilized for public or industrial water supplies.

### **Logan County**

About 5,300 people in Logan County rely on private domestic water supplies: 4,400 on wells and 900 on other sources.

In the southern half of Logan County more than three-quarters of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels. In the low-lying areas of the Red River and its main tributaries most wells are inadequate for domestic use unless the well intercepts a major solution opening in the limestone in which the yield could be very large. Ground-water in the northern half of the county is not as prevalent as in the southern half of the county. Only a few wells in the northern half of the county yield enough water for a domestic supply.

Springs with flows ranging from a few gallons per minute to 2636 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

### **Metcalf County**

About 2,900 people in Metcalf County rely on private domestic water supplies: 2,300 on wells and 600 on other sources.

In the northwest and north-central area of Metcalf County more than three-quarters of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels. In the southern third of the county and along the low-lying areas in the East and South Fork of the Little Barren River, only a few wells yield enough water for a domestic supply.

Numerous springs with flows ranging from a few gallons per minute to 5,000 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

### **Monroe County**

About 550 people in Monroe County rely on private domestic water supplies: 400 on wells and 150 on other sources.

In the north-west and north-central area of Metcalfe County more than three-quarters of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels. In the southern third of the county and along the low-lying areas in the East and South Fork of the Little Barren River, only a few wells yield enough water for a domestic supply.

Numerous springs with flows ranging from a few gallons per minute to 5,000 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

### **Simpson County**

About 800 people in Simpson County rely on private domestic water supplies: 620 on wells and 180 on other sources.

In the limestone rich area of Simpson County more than three-quarters of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels. In the low-lying areas in the Red River, Drakes Creek, Lick Creek, and Sulphur Fork valleys, most wells are inadequate for domestic use unless the well intercepts a major solution opening in the limestone in which the yield could be very large.

Springs with flows ranging from a few gallons per minute to 2930 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

### **Warren County**

About 1,700 people in Warren County rely on private domestic water supplies: 1,100 on wells and 600 on other sources.

In most of the regions of Warren County more than three-quarters of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels. In the northwest corner of the county and in low-lying areas of the Barren River and its main tributaries most wells are inadequate for domestic use unless the well intercepts a major solution opening in the limestone in which the yield could be very large.

Springs with flows ranging from a few gallons per minute to 2000 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

**BIG SANDY AREA DEVELOPMENT DISTRICT**

Municipal Building - 2<sup>nd</sup> Floor  
North Lake Drive  
Prestonsburg, KY 41653  
(606) 886-2374

In 1999 an estimated 70,800 people, or 43 percent, in the region relied on private domestic water systems: 67,000 on wells and 3,800 on hauled water and other sources.

Estimated populations and private water service for the ten counties in the region are given below:

<b>County</b>	<b>1999 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Floyd	42,800	13,700 (32%)	42,000	5,500 (13%)
Johnson	24,200	9,900 (41%)	24,500	2,900 (12%)
Magoffin	13,900	4,900 (35%)	15,200	3,000 (20%)
Martin	11,900	3,900 (33%)	10,600	2,000 (19%)
Pike	72,000	38,200 (53%)	70,400	16,200 (23%)
Region	165,000	70,800 (43%)	163,000	30,000 (18%)

**Floyd County**

About 13,700 people, 32 percent, in Floyd county rely on private domestic water supplies: 12,600 on wells and 1,100 on hauled water, cisterns and other sources.

Some wells in the relatively thick sandy alluvium that is present along much of the Levisa Fork produce 20 to 25 gpm, which is more than adequate for domestic supplies. More than three-quarters of the wells drilled in valley bottoms and almost three-quarters of the wells drilled on hillsides are adequate for domestic supply needs. Only some wells on hilltops and ridges are adequate for domestic needs. Drilled wells more than 200 feet deep in valleys may yield enough water for small municipal or industrial supplies.

Ground water obtained from most wells is moderately hard and contains noticeable amounts of iron. In the northwestern two-thirds of the county, salty water may be found in wells less than 100 feet below the level of the principal valley bottoms. A few springs supply sufficient quantities of water for domestic use, usually produces less than 5 gpm.

### **Johnson County**

About 9,900 people, 41 percent, in Johnson county rely on private domestic water supplies: 9,500 on wells and 400 on hauled water, cisterns and other sources.

Most drilled wells in valley bottoms are adequate for a domestic supply. Fewer than half of the wells drilled on hillsides are adequate for a domestic supply except in areas south of Paintsville where about three-quarters of the wells on hillsides are adequate for domestic water supply. Some wells on ridges or hilltops are adequate for a domestic water supply. In the southern part of the county in the Van Lear area, drilled wells more than 200 feet deep in valleys yield enough water for small municipal or industrial supplies.

Most of the water from drilled wells is moderately to extremely hard and contains noticeable amounts of iron. In the eastern and southeastern half of the county salty water can be found in bedrock wells less than 100 feet below the level of the principal valley bottoms. A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5 gpm.

### **Magoffin County**

About 4,900 people, 35 percent, in Magoffin county rely on private domestic water supplies: 4,700 on wells and 200 on hauled water, cisterns and other sources.

Most wells drilled in valley bottoms are adequate for domestic use. Fewer than half of the wells drilled on hillsides are adequate for domestic supply and even less of the wells on hilltops and ridges produce enough water for a domestic supply. Wells in the southern third of the county generally produce slightly more water with the potential to produce yields great enough to supply small municipal or industrial supplies in wells below 200 feet.

Most of the water obtained from drilled wells is extremely hard and contains noticeable amounts of iron. Salty water may be found from 50 to several hundred feet below the level of the principal valley bottoms. Ground-water quality is slightly better in the southern third of the county with moderately hard water and salty water found occasionally in the 100-foot and deeper range.

A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5 gpm.

### **Martin County**

About 3,900 people, 33 percent, in Martin county rely on private domestic water supplies: 3,800 on wells and 100 on hauled water, cisterns and other sources.

Most wells drilled in valley bottoms are adequate for a modern domestic supply. Nearly three-quarters of the wells drilled on hillsides are adequate for a domestic supply except in the northern third of the county where only half of drilled wells on hillsides produce enough water for domestic use. Wells on hilltops and ridges yield smaller quantities of water. In the central and southern two-thirds of the county, drilled wells

more than 200 feet deep in valleys may yield enough water for small municipal or industrial supplies.

Ground water obtained from most drilled wells in this area is moderately to extremely hard and contains noticeable amounts of iron. Salty water may be found in wells drilled less than 100 feet below the level of the principal valley bottoms, except in the northern third of the county where salty water can be found as shallow as 50 feet.

A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5 gpm.

### **Pike County**

About 38,000 people, 53 percent, in Pike county rely on private domestic water supplies: 36,000 on wells and 2,000 on hauled water, cisterns and other sources.

More than three-quarters of the wells drilled in valley bottoms and almost three-quarters of the wells drilled on hillsides are adequate for domestic supply needs. Only some wells on hilltops and ridges are adequate for domestic needs. Drilled wells more than 200 feet deep in valleys may yield enough water for small municipal or industrial supplies.

Ground water obtained from most wells is moderately hard and contains noticeable amounts of iron. In the northwestern quarter of the county, salty water may be found in wells less than 100 feet below the level of the principal valley bottoms. In the rest of the county, salty water in wells probably will not be found less than 200 feet below the level of the principal valley bottoms.

A few springs supply sufficient quantities of water for domestic use, usually produces less than 5 gpm.

**BUFFALO TRACE AREA DEVELOPMENT DISTRICT**

327 West Second Street  
P.O. Box 460  
Maysville, KY 41056  
(606) 564-6894

About 15,300 people, or 28 percent, in the region rely on private domestic water systems: 6,600 on wells and 8,700 on hauled water and other sources.

Estimated populations and private water service for the five counties in the region are given below:

<b>County</b>	<b>1997 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Bracken	8,300	2,500 (30%)	8,550	1,200 (14%)
Fleming	13,300	2,600 (20%)	14,400	2,700 (19%)
Lewis	13,700	6,800 (50%)	15,100	5,300 (35%)
Mason	16,700	2,500 (15%)	15,600	1,700 (11%)
Robertson	2,160	900 (40%)	2,030	500 (24%)
Region	54,100	15,300 (28%)	55,700	11,400 (18%)

**Bracken County**

About 2,450 residents, 30 percent, of Bracken County rely on private domestic water supplies: about 450 on wells and 2,000 on other sources.

The alluvium along the Ohio River is the best source of ground water in the county. Many properly constructed drilled wells will produce several hundred gallons per minute from the alluvium, with most wells able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality.

In the lower third of the Licking River valley and the lower sections of the larger creek valleys discharging into the Ohio River in Bracken County most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the major creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Bracken County, which encompasses 80 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Fleming County**

About 2,600 residents, 20 percent, of Fleming County rely on private domestic water supplies: about 1,300 on wells and 1,300 on other sources.

Some wells located in the Licking River valley and the major creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Rowan County, which encompasses 70 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Lewis County**

About 6,750 residents, 50 percent, of Lewis County rely on private domestic water supplies: about 4,200 on wells and 2,550 on other sources.

The alluvium along the Ohio River is the best source of ground water in the county. Many properly constructed drilled wells will produce several hundred gallons per minute from the alluvium, with most wells able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality.

Some wells located in the major creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Lewis County, which encompasses 90 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Mason County**

About 2,500 residents, 15 percent, of Mason County rely on private domestic water supplies: about 500 on wells and 2,000 on other sources.

The alluvium along the Ohio River is the best source of ground water in the county. Many properly constructed drilled wells will produce several hundred gallons per minute from the alluvium, with most wells able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality.

In the lower sections of the larger creek valleys discharging into the Ohio River in Mason County most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the major creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Bracken County, which encompasses 70 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Robertson County**

About 870 residents, 40 percent, of Robertson County rely on private domestic water supplies: about 170 on wells and 700 on other sources.

In the Licking River valley most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the major creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Robinson County, which encompasses 90 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.



**CUMBERLAND VALLEY AREA DEVELOPMENT DISTRICT**

342 Old Whitley Road  
P.O. Box 1740  
London, KY 40743-1740  
(606) 864-7391

About 67,000 people in the region rely on private domestic water systems: 57,300 on wells, and 9,800 on hauled water and other sources.

Estimated populations and private water service for the eight counties in the region are given below:

<b>County</b>	<b>1999 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Bell	29,000	7,800 (27%)	26,600	5,300 (20%)
Clay	22,400	7,800 (35%)	23,100	3,000 (13%)
Harlan	34,900	16,800 (48%)	33,200	7,300 (22%)
Jackson	13,000	2,000 (15%)	14,500	0 ( 0%)
Knox	31,400	11,000 (35%)	34,800	5,900 (17%)
Laurel	51,500	5,100 (10%)	64,600	4,500 ( 7%)
Rockcastle	15,900	2,900 (18%)	17,100	0 ( 0%)
Whitley	34,900	14,000 (40%)	37,500	4,900 (13%)
Region	233,000	67,000 (29%)	251,000	31,000 (12%)

**Bell County**

About 7,800 people in Bell County rely on private domestic water supplies: 5,900 on wells and 1,900 on other sources.

Most wells drilled in valley bottoms are adequate for domestic supply. In central and southern Bell County fewer than half the wells drilled on hillsides and fewer wells on hilltops are adequate for a domestic supply. In the northern half of Bell County and along Pine Mountain where water is more plentiful three-quarters of the wells on hillsides and some wells on hilltops are adequate for a domestic supply. The northern half of the county also has the potential to produce high yielding wells below 200 feet that could provide sufficient water for small municipal or industrial supplies.

Ground water obtained from most drilled wells in this area is moderately hard and contains noticeable amounts of iron. Salty water probably will not be found less than 200 feet below the principal valley bottoms in the southern half of the county and 300 feet in the northern half of the county.

A few high volume springs are found east of Middlesboro and along Pine Mountain, which yield as much as 400 gallons per minute. Most springs in the rest of the county yield less than 5gpm.

### **Clay County**

About 7,800 people in Clay County rely on private domestic water supplies: 7,300 on wells, and 500 on other sources.

Most wells drilled in valley bottoms are adequate for a domestic supply. Fewer than half the wells drilled on hillsides are adequate for a domestic supply and wells on hilltops and ridges yield smaller quantities of water. In the western half of the county wells penetrating 500 feet or more of sandstone may yield enough water for small municipal or industrial supply.

Water obtained from most wells in this area is soft or moderately hard and contains noticeable amounts of iron. Salty water may be found in wells drilled less than 100 feet below the level of the principal valley bottoms.

A few springs supply sufficient quantities of water for domestic use, usually produces less than 5 gpm.

### **Harlan County**

About 16,800 people in Harlan County rely on private domestic water supplies: 14,000 on wells, and 2,800 on other sources.

Most wells drilled in valley bottoms are adequate for a domestic supply. About three-quarters of the wells drilled on hillsides and one-third of the well drilled on hilltops are adequate for a domestic water supply. Wells drilled 200 feet or more below the level of the principal valley bottoms may yield enough water for small municipal or industrial supplies. Probably few wells in this county drilled less than 300 feet below the level of the principal valley bottoms will yield salty water except in the small northwestern corner of the county north of Pine Mountain. North of Pine Mountain salty water can be found in the range of 200 feet below the principal valley bottoms. Wells drilled in the Pine Mountain area that reach limestone, may yield as much as several hundred gallons per minute.

Ground water obtained from most drilled wells in this area is soft but contains noticeable amounts of iron, except north of Pine Mountain where the water is moderately hard.

Some of the most productive springs in Eastern Kentucky are found along Pine Mountain in Harlan County. Limestone springs can yield more than 50 gpm but generally yield less than 10 gpm.

### **Jackson County**

About 2,000 people in Jackson County rely on private domestic water supplies: 1,400 on wells, and 600 on other sources.

In northern and western Jackson county most wells in the valley bottoms are located in limestone formations which in this area are adequate for domestic use. In the central and eastern parts of the county most drilled wells in the valley bottoms are set in sandstone, which usually produce enough water for domestic use. Most wells on hillsides produce enough water for domestic use and about half the wells drilled on

hilltops and ridges are adequate for domestic use. In far eastern Jackson County, water becomes more scarce with only some wells in the valleys and a few well on the ridges able to produce enough water for domestic use.

Most well water in Jackson County is moderately hard and contains noticeable amounts of iron. Some wells in Station Camp Creek valley produce very hard water that may contain hydrogen sulfide in objectionable quantities. Salt water can also be found at depths of 100 feet and greater below the principal valley bottoms in eastern, northern and western Jackson County.

A few springs supply sufficient quantities of water for domestic use. Most springs yield less than 5gpm except in the northern and western parts of Jackson county where limestone springs producing up to 100 gpm can be found.

### **Knox County**

About 11,000 residents of Knox County rely on private domestic water supplies: 10,400 on wells and 600 on other sources.

Most wells in valley bottoms produce adequate amounts of water for domestic supply. Fewer than half of the wells drilled on hillsides are adequate for a domestic supply. Wells on hilltops and ridges yield smaller quantities of water.

Most of the water from drilled wells is extremely hard and contains noticeable amounts of iron. Salty water may be found in wells drilled into bedrock less than 100 feet below the level of the principal valley bottoms. Water quality and quantity is slightly better in the far eastern end of the county with the potential for drilled wells more than 200 feet deep in valleys may yield enough water for small municipal or industrial supplies.

A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5gpm.

### **Laurel County**

About 5,100 people in Laurel County rely on private domestic water supplies: about 4,800 on wells, and 400 on other sources.

Some of the drilled wells in valley bottoms and a few wells on hillsides and ridges in the eastern third and northwestern quarter of Laurel County are adequate for domestic supply. In the rest of the county more than three-quarters of the drilled wells in valleys and most of the wells on hillsides and about half the wells on ridges are adequate for a domestic supply. This area also has the ability for deep penetrating wells with greater than 500 feet of sandstone to yield enough water for small municipal or industrial supplies.

Water obtained from most wells in this area is soft or moderately hard and contains noticeable amounts of iron. Only occasionally is salty water found in drilled wells in this area.

A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5gpm.

### **Rockcastle County**

About 2,900 people in Rockcastle County rely on private domestic water supplies: 1,100 on wells and 1,800 on other sources.

In the eastern half of the county, most of the wells drilled in valley bottoms are adequate for a domestic supply. About half the wells drilled on hillsides are adequate for a domestic supply. Wells on ridges and hills yield smaller quantities of water. In the western half of the county, fewer than half the wells drilled in valley bottoms are adequate for a domestic supply except where limestone is the predominant rock. In limestone rich areas, three-quarters of the wells drilled in the valleys or uplands can produce adequate amounts of water for domestic supplies. Throughout most of the county, wells on hillsides and ridges generally yield smaller quantities of water than wells drilled in valley bottoms.

Salty water may be found in wells drilled less than 100 feet below the level of the principal valley bottoms. At greater depths no fresh water probably will be found.

Springs in limestone may supply enough water for domestic use.

### **Whitley County**

About 14,000 residents of Whitley County rely on private domestic water supplies: 13,000 on wells, and 1,000 on other sources.

Most wells drilled in valley bottoms are adequate for a domestic supply. Fewer than half the wells drilled on hillsides are adequate for domestic supply and wells on ridges yield smaller quantities of water. In the western quarter of the county, wells on hillsides commonly produce adequate water for domestic use and half the wells on ridges yield enough water for domestic supply. Deep wells penetrating thick sections of sandstone greater than 500 feet may yield enough water for small utilities or industrial supplies.

Most water obtained from drilled wells is extremely hard and contains noticeable amounts of iron except in the western quarter of the county where the water is soft to moderately hard. Salty water may be found less than 100 feet below the level of the principal valley bottoms.

A few springs supply sufficient quantities of water for domestic use, usually produces less than 5 gpm.

**FIVCO AREA DEVELOPMENT DISTRICT**

P.O. Box 636  
3000 Louisa Street  
Catlettsburg, Ky 41129  
(606) 739-5191

About 26,000 people in the region rely on private domestic water systems: 24,500 on wells, and 1,500 on hauled water and other sources.

Estimated populations and private water service for the five counties in the region are given below:

<b>County</b>	<b>1999 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Boyd	48,000	2,400 ( 5%)	43,400	900 ( 2%)
Carter	26,700	4,000 (15%)	30,000	1,500 ( 5%)
Elliott	6,500	4,200 (65%)	6,300	3,150 (50%)
Greenup	36,800	5,500 (15%)	35,500	3,500 (10%)
Lawrence	15,700	9,400 (60%)	17,800	10,300 (48%)
Region	134,000	26,000 (19%)	133,000	19,000 (15%)

**Boyd County**

About 2,400 residents of Boyd County rely on private domestic wells for their water supply.

Most wells in valley bottoms are adequate for domestic supply however the volume of ground water available becomes progressively less on hillsides and ridges.

Quite a few high volume wells (>100gpm) are found along the Ohio River alluvium in northern Boyd county. The alluvium along the Big Sandy River also can provide adequate water for domestic use but often contains large amounts of iron.

In the southern and western half of the county, salt water may be found less than 100 feet below the level of the East Fork of the Little Sandy River valley bottom. Most of the water from drilled wells in the county other than the river alluvium is extremely hard and contains noticeable amounts of iron.

A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5 gpm.

**Carter County**

About 4,000 people in Carter County rely on private domestic water supplies: 3,100 on wells and 900 on other sources.

In the eastern half of the county most wells in valley bottoms produce adequate amount of water for domestic use. In the rest of the county ground water becomes more scarce with less than half of the wells drilled in valley bottoms able to produce sufficient quantities of water for a domestic supply. Throughout the county, wells on hillsides and ridges become progressively less productive as they move away from the valley bottoms.

Most of the water from drilled wells is very to extremely hard and contains noticeable amounts of iron. Salty water is commonly found in wells drilled less than 100 feet below the level of the principal valley bottoms.

A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5 gpm.

### **Elliott County**

About 4,200 residents of Elliott County rely on private domestic water supplies: 3,500 on wells and 700 on other sources.

Most wells in valley bottoms are adequate for domestic supply. In the southeastern half of the county, fewer than half of the wells on hillsides are adequate for domestic use and wells on hilltops produce smaller quantities of water. In the northwestern half of the county most of the wells drilled on hillsides are adequate for domestic supply and about half the wells on hilltops and ridges are adequate for domestic supply. Deep well penetrating thick sections of sandstone may yield enough water for small municipal or industrial supplies.

Water obtained from most wells of the northwestern part of the county is soft or moderately hard whereas most of the water from the southeastern part of the county is extremely hard. County wide, water contains noticeable amounts of iron. Salty water may be found less than 100 feet below the level of the principal valley bottoms.

A few springs supply sufficient quantities of water for domestic use, however yields are usually less than 5 gpm.

### **Greenup County**

About 5,500 people in Greenup County rely on private domestic wells for their water supply.

Most wells in valley bottoms in the eastern half of the county are adequate for domestic supply. In the western half of the county groundwater becomes more scarce with less than half of the wells drilled in valley bottoms able produce sufficient quantities of water for a domestic supply. Throughout the county, wells on hillsides and ridges become progressively less productive as they move away from the valley bottoms. Quite a few high volume wells (>50gpm) are found along the Ohio River alluvium in northern Greenup County.

Most of the water from drilled wells is very to extremely hard and contains noticeable amounts of iron. Salty water is commonly found in wells drilled less than 100 feet below the level of the principal valley bottoms.

A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5 gpm.

### **Lawrence County**

About 9,400 people in Lawrence County rely on private domestic wells for their source of water.

Most wells in valley bottoms produce adequate amounts of water for domestic supply. Fewer than half of the wells drilled on hillsides are adequate for a domestic supply. Wells on hilltops and ridges yield smaller quantities of water.

Most of the water from drilled wells is extremely hard and contains noticeable amounts of iron. In the northeast and southeast half of the county, salty water may be found in wells drilled into bedrock less than 100 feet below the level of the principal valley bottoms.

A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5gpm.

## GATEWAY AREA DEVELOPMENT DISTRICT

Main and Slate Streets  
P.O. Box 1070  
Owingsville, KY 40360  
(606) 674-6355

About 17,000 people in the region rely on private domestic water systems: 12,000 on wells, and 5,000 on other sources.

Estimated populations and private water service for the five counties in the region are given below:

<b>County</b>	<b>1999 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Bath	10,300	2,100 (20%)	10,900	2,100 (19%)
Menifee	5,600	2,000 (35%)	6,650	1,950 (29%)
Montgomery	21,100	1,100 ( 5%)	23,600	1,200 ( 5%)
Morgan	11,900	9,800 (82%)	12,600	5,700 (45%)
Rowan	18,300	2,400 (13%)	20,600	2,500 (12%)
Region	67,000	17,000 (25%)	74,000	13,000 (18%)

### **Bath County**

About 2,100 residents of Bath County rely on private domestic water supplies: 1,200 on wells, and 900 on other sources.

Some wells located in the Licking River valley and the major creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Bath County, which encompasses 80 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Menifee County**

About 2,000 residents of Menifee County rely on private domestic water supplies: 800 on wells and 1,200 on other sources.

Wells in alluvium in the valleys of Slate, Salt Lick, and Beaver Creeks yield only a minimum supply of slightly more than 100 gallons per day. The northwestern half of Menifee county lies in the Knobs physiographic region in which rocks in this area generally yield small supplies of water for domestic use. Wells on hills generally will yield smaller quantities of water than wells in valley bottoms. In the central and southeast half of the county usually adequate soft water can be found on broad ridges. Wells in the broad valleys supply adequate water for domestic use, chiefly through fractures.



Salty water may be found locally in a few wells drilled to depths of 100 feet below the level of the principal valley bottoms. Most ground water is moderately hard and contains noticeable amounts of iron.

Springs are commonly found at the base of sandstone and limestone formations in valley bottoms. Some springs supply enough water for domestic use however generally they have large seasonal variation in flow.

### **Montgomery County**

About 1,100 people in Montgomery County rely on private domestic water supplies: 250 on wells and 850 on other sources.

Some wells located in the major creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Montgomery County, which encompasses 80 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Morgan County**

About 9,800 people in Morgan County rely on private domestic water supplies: 8,200 on wells, and 1,600 on other sources.

Most wells drilled into bedrock in valley bottoms are adequate for domestic supply and some of the wells in the alluvium of the Licking River and its main tributaries provide adequate amounts of water. Fewer than half of the wells drilled on hillsides are adequate for domestic use and wells on hilltops produce even less water. In northwestern Morgan county a few deeper wells that penetrate thick sandstone beds of the Lee formation produce enough water for domestic use and may yield enough for municipal or industrial supplies.

Most water from drilled wells is extremely hard and contains noticeable amounts of iron. Wells that are more than 100 feet below local drainage may be salty and in some areas as shallow as 50 feet below drainage.

A few springs supply sufficient quantities of water for domestic use, usually produces less than 5 gpm.

### **Rowan County**

About 2,400 people in Rowan County rely on private domestic water supplies: 1,700 on wells and 700 on other sources.

Some wells located in the Licking River valley and the major creek valleys and in far eastern Rowan County will produce enough water for a domestic supply except during dry weather. In the upland areas of Rowan County, which encompasses 70 percent of the county, most drilled wells will not produce enough water for a dependable

domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

**GREEN RIVER AREA DEVELOPMENT DISTRICT**

3860 U.S. Highway 60, West  
Owensboro, KY 42301  
(502) 926-4433

About 17,000 people in the region rely on private domestic water systems: 15,000 on wells, and 2,000 on other sources.

Estimated populations and private water service for the seven counties in the region are given below:

<b>County</b>	<b>1999 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Daviess	90,300	3,600 ( 4%)	94,100	3,800 ( 4%)
Hancock	9,200	2,300 (25%)	12,200	3,050 (25%)
Henderson	44,300	4,400 (10%)	44,200	4,000 ( 9%)
McLean	9,700	1,000 (10%)	9,500	600 ( 6%)
Ohio	22,000	2,200 (10%)	23,400	1,600 ( 7%)
Union	14,800	1,500 (10%)	17,300	1,700 (10%)
Webster	13,300	2,000 (15%)	12,600	1,400 (11%)
Region	204,000	17,000 ( 8%)	213,000	16,000 ( 8%)

**Daviess County**

About 3,600 people in Daviess County rely on private domestic water wells.

The alluvium along the Ohio River is the best source of ground water in the county. In northern Daviess County nearly all drilled wells from depths of less than 150 feet in the alluvium of the Ohio River valley are adequate for domestic use with most wells yielding more than 50 gallons per minute (gpm) with some wells yielding as much as 750 gpm. In most of central and southern Daviess County most wells from depths of less than 300 feet that penetrate sandstone are adequate for a domestic supply. In several small-localized areas in southern Daviess County, most wells yield little or no water.

Generally, ground water is hard to very hard and iron and salt may be present in objectionable amounts. Often in deep wells, ground water becomes too mineralized to use.

**Hancock County**

About 2,300 people in Hancock County rely on private domestic water systems: 1,800 on wells and 500 on other sources.

The alluvium along the Ohio River is the best source of ground-water in the county. In the northern edge of Hancock County nearly all drilled wells from depths of less than 150 feet in the alluvium of the Ohio River valley are adequate for domestic use. Most wells yield more than 50 gallons per minute (gpm) with some wells yielding as

much as 750 gpm. In the northern three-quarters of Hancock County most wells from depths of less than 300 feet that penetrate sandstone are adequate for a domestic supply. In the southern quarter of the county only a few well yield enough water for a domestic supply.

Generally, ground water is hard to very hard and iron and salt may be present in objectionable amounts. Often in deep wells, ground water becomes too mineralized to use.

### **Henderson County**

About 4,400 people in Henderson County rely on private domestic water supplies: 90 percent use wells, the remainder relying on other sources.

The alluvium along the Ohio River is the best source of ground water in the county. In northern Henderson County nearly all drilled wells from depths of less than 150 feet in the alluvium of the Ohio River valley are adequate for domestic use with most wells yielding more than 50 gallons per minute (gpm) with some wells yielding as much as 1,000 gpm. In the southern and central half of Henderson County most wells which penetrate sandstone's from depths of less than 300 feet are adequate for a domestic supply. In the highlands of the eastern part of the county and in western Henderson County in the area around Smith Mills, only a few well yield enough water for a domestic supply.

Generally, ground water is hard to very hard and iron and salt may be present in objectionable amounts. Often ground water becomes saltier with depth.

### **McLean County**

About 1,000 residents of McLean County rely on private domestic water systems: 900 on wells and 100 on other sources.

In McLean County most wells from depths of less than 300 feet are adequate for a domestic supply. Wells located in the Green River flood plain can produce as much as 100 gallons of hard water per minute. In a thin highly faulted zone running east west across the county between the towns of Beach Grove and Nuckols, yields to drilled wells are unpredictable due to the faulting.

Generally, ground water is hard to very hard and iron and salt may be present in objectionable amounts. Often ground water becomes saltier with depth.

### **Ohio County**

About 2,200 people in Ohio County rely on private domestic water supplies: 1,800 on wells and 400 on other sources.

In the southern and western two-thirds of Ohio County most wells from depths of less than 300 feet are adequate for a domestic supply. Wells located in the Green River flood plain can produce as much as 100 gallons of hard water per minute. Most wells obtain their water from thick sandstone layers and will yield as much as 60 gpm. In the north-eastern third of the county only a few well yield enough water for a domestic

supply except in the valley of the Rough River were most wells yield enough for a domestic supply. In a thin highly faulted zone running east west across the county between the towns of Beda and Dundee, yields to drilled wells are unpredictable due to the faulting. In the southern part of the county moderately mineralized water may be obtained locally from deep sandstone formations at depths of 1200 feet.

Generally, ground water is hard to very hard and iron and salt may be present in objectionable amounts. Often ground water becomes saltier with depth.

### **Union County**

About 1,500 people in the county rely on private domestic water supplies: almost all on wells.

The alluvium along the Ohio River is the best source of ground water in the county. In the northern and western edges of the county, nearly all drilled wells from depths of less than 150 feet in the alluvium of the Ohio River valley are adequate for domestic use. Most wells yield more than 50 gallons per minute (gpm) with some wells yielding as much as 1,000 gpm. In over half of Union County most wells that penetrate sandstone formations from depths of less than 300 feet are adequate for a domestic supply. In the highlands of the southeastern part of the county in the old Camp Breckinridge area and in the Grundy Hill area southwest of Uniontown, only a few wells yield enough water for a domestic supply. In a thin highly faulted zone running east west across the county between the towns of Givens and The Rocks, yields to drilled wells are unpredictable due to the faulting.

Generally, ground water is hard to very hard and iron and salt may be present in objectionable amounts. Often ground water becomes saltier with depth.

### **Webster County**

About 2,000 people in Webster County rely on private domestic water supplies: 1,500 on wells and 500 on other sources.

In Webster County most wells that penetrate sandstone formations from depths of less than 300 feet are adequate for a domestic supply. In the highlands of the northwestern part of the county in the old Camp Breckinridge area only a few wells yield enough water for a domestic supply. In a thin highly faulted zone running east west across the county between the towns of Sebree and Tilden, yields to drilled wells are unpredictable due to the faulting.

Generally, ground water is hard to very hard and iron and salt may be present in objectionable amounts. Often ground water becomes saltier with depth.

**KIPDA**  
 11520 Commonwealth Drive  
 Louisville, KY 40299  
 (502) 266-6084

About 30,000 people in the region rely on private domestic water systems: 14,000 on wells, and 16,000 on other sources.

Estimated populations and private water service for the seven counties in the region are given below:

<b>County</b>	<b>1999 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Bullitt	60,500	13,900 (23%)	78,100	14,100 (18%)
Henry	15,100	1,500 (10%)	18,300	1,800 (10%)
Jefferson	662,500	6,600 ( 1%)	652,000	0 ( 0%)
Oldham	41,100	2,900 ( 7%)	52,600	3,700 ( 7%)
Shelby	29,500	2,900 (10%)	37,400	2,200 ( 6%)
Spencer	10,000	1,000 (10%)	18,100	1,100 ( 6%)
Trimble	7,500	700 (10%)	9,050	900 (10%)
Region	826,000	30,000 ( 4%)	866,000	24,000 ( 3%)

**Bullitt County**

About 13,900 residents of Bullitt County rely on private domestic water supplies: about 6,950 on wells and 6,950 on other sources.

In the Salt River valley bottoms and in the bottoms of the larger tributaries, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the rest of the larger valleys and in the uplands of central Bullitt County will produce enough water for a domestic supply except during dry weather. In the remaining upland areas in Bullitt County which encompasses approximately 50 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines which may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

**Henry County**

About 1,500 residents of Henry County rely on private domestic water supplies: 600 on wells and 900 on other sources.

In some of the bottoms of the Kentucky River, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the smaller creek valleys and in some less productive areas along the Kentucky River will produce enough water for a domestic supply except during dry weather. In the upland

areas of Henry County, which encompasses approximately 70 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Jefferson County**

About 6,600 residents of Jefferson County rely on private domestic water supplies: about half on wells and half on other sources.

The alluvium along the Ohio River is the best source of ground water in the county. Many properly constructed drilled wells will produce over one thousand gallons per minute from the alluvium, with most wells able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality.

In the main sections of the larger creek valleys and on broad ridges in central Jefferson County, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the smaller creek valleys and in some broad ridges in southwestern and central Jefferson County will produce enough water for a domestic supply except during dry weather. In the upland areas of the rest of Jefferson County which encompasses approximately 30 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines which may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Oldham County**

About 2,900 residents of Oldham County rely on private domestic water supplies: 1,400 on wells, and 1,500 on other sources.

The alluvium along the Ohio River is the best source of ground water in the county. Many properly constructed drilled wells will produce several hundred gallons per minute from the alluvium, with most wells able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality.

In the main sections of the larger creek valleys, in some of the Ohio River bottoms, and on broad ridges in a limited area south of the towns of Skylight and Crestwood, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the smaller creek valleys and in some broad ridges in western and central Oldham County will produce enough water for a domestic supply except during dry weather. In the upland areas of the rest of Oldham County which encompasses approximately 50 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines, which may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Shelby County**

About 2,900 residents of Shelby County rely on private domestic water supplies: 900 on wells and 2,000 on other sources.

Ground-water resources in Shelby County are limited. Wells located in the larger valley bottoms throughout the county will produce enough water for a domestic supply except during dry weather. In the upland area Shelby County which encompasses approximately 80 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines which may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Spencer County**

About 1,000 residents of Spencer County rely on private domestic water supplies: about 200 on wells and 800 on other sources.

In the Salt River valley bottoms west of Taylorsville and in far eastern end of the county, most drilled wells in the valley will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the rest of the larger valleys throughout the county will produce enough water for a domestic supply except during dry weather. In the upland area Spencer County which encompasses approximately 60 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines which may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Trimble County**

About 700 residents of Trimble County rely on private domestic water supplies, 300 on wells and 400 on other sources.

The alluvium along the Ohio River is the best source of ground water in the county. Many properly constructed drilled wells will produce several hundred gallons per minute from the alluvium, with most wells able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality.

In the lower sections of the larger creek valleys and in some of the Ohio River bottoms, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the smaller creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Trimble County, which encompasses approximately 60 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.



**KENTUCKY RIVER AREA DEVELOPMENT DISTRICT**

381 Perry County Park Road  
Hazard, KY 41701  
(606) 436-3158

About 73,000 people in the region rely on private domestic water systems: 66,000 on wells, and 7,000 on other sources.

Estimated populations and private water service for the eight counties in the region are given below:

<b>County</b>	<b>1999 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Breathitt	15,600	10,500 (67%)	16,800	4,900 (29%)
Knott	17,500	15,100 (86%)	17,300	7,500 (43%)
Lee	7,900	2,000 (25%)	8,200	1,300 (16%)
Leslie	13,400	8,000 (60%)	12,800	3,700 (29%)
Letcher	26,500	18,500 (70%)	25,800	5,900 (23%)
Owsley	5,300	1,600 (30%)	5,600	1,100 (19%)
Perry	31,100	12,400 (40%)	32,100	4,500 (14%)
Wolfe	7,500	5,000 (67%)	8,750	4,150 (48%)
Region	125,000	73,000 (59%)	127,000	33,000 (26%)

**Breathitt County**

About 10,500 people in Breathitt County rely on private domestic water supplies: nearly all on water wells.

Most wells drilled in valley bottoms are adequate for a domestic water supply. Fewer than half the wells drilled on hillsides are adequate for a modern supply and wells on hilltops yield smaller quantities of water. In the eastern quarter of the county ground water is slightly more plentiful with the possibility of large enough yields in wells 200 feet or deeper for small municipal or industrial supplies.

Most of the water obtained from drilled wells is extremely hard and contains noticeable amounts of iron. Salty water may be found from 50 to several hundred feet below the level of the principal valley bottoms.

A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5 gallons per minute.

**Knott County**

About 15,100 people, or 6 of 7 households, in Knott county rely on private domestic water systems: 14,100 on wells and 1,000 on other sources.

Of those, about 84 percent rely on drilled wells, 9 percent on dug wells, and 7 percent on cisterns and other sources. The primary problem with private wells in Knott County is high levels of sulfur or iron.

Most wells drilled in valley bottoms and on hillsides are adequate for modern domestic supply; however, on ridge tops, only some wells are adequate for modern domestic use in terms of water quantity. Wells drilled in valleys to depths greater than 200 feet may yield enough water for small municipal or industrial supplies.

Ground water from most wells is considered moderately hard and contains noticeable amounts of iron. In the drainage basin of the Right Fork of Beaver Creek, of southeastern Knott County, salty water may be found at depths less than 100 feet below the level of the valley bottom. In the rest of Knott County salty water in wells probably will not be found less than 200 feet below the level of the principal valley bottoms.

A few springs supply sufficient quantities of water for domestic use, usually less than 5 gpm.

### **Lee County**

Almost 2,000 people in Lee County rely on private domestic water supplies: 1,300 on wells and 700 on other sources.

Throughout most of Lee county wells drilled in valley bottoms are adequate for domestic use. Yields to wells become progressively less on hillsides and ridges. Some wells drilled on ridges produce enough water for domestic use. Generally wells on broad ridges produce more water than wells on narrow ridges or hilltops.

Most wells drilled in the valley bottoms are completed in limestone, produce hard water often with noticeable amounts of iron. On hillsides and ridges wells are often completed in sandstone, contain soft to moderately hard water with noticeable amounts of iron. Salty water may be found at depths greater than 100 feet below the level of the Kentucky River.

A few springs supply sufficient quantities of water for domestic use. Most springs yield less than 5gpm except limestone springs that occur near stream level often produce 100 gpm or greater.

### **Leslie County**

About 8,000 people in Leslie County rely on private domestic water supplies: 7,400 on wells, and 600 on other sources.

Problems with existing private wells in Leslie County are various and scattered throughout the county. In certain areas there is a quantity problem while in other areas there is poor quality due to high concentrations of salt and various other minerals and metals.

Most wells drilled in valley bottoms are adequate for a domestic supply. In the northwestern half of the county fewer than half of the wells on hillsides and only some of the wells on hilltops are adequate for a domestic supply. In the southeastern half of the county about three-quarters of the wells drilled on hillsides are adequate for a domestic supply and some wells on hilltops or ridges meet the needs of a domestic supply. Also in the southeastern half of the county wells deeper than 200 feet in valleys may yield enough water for small municipal or industrial supply.

A few springs supply sufficient quantities of water for domestic use. Almost all ground water obtained from drilled wells in this area is moderately to extremely hard and contains noticeable amounts of iron. Salty water may be found in wells drilled less than 100 feet below the level of the principal valley bottoms, except in the south-eastern half of the county where salty water probably will not be found less than 200 feet. Springs yield less than 5 gpm.

### **Letcher County**

About 18,500 Letcher countians depend on private domestic water supplies: about 17,000 on wells, and 1,500 on other sources. The Sandlick area of Letcher County currently has problems with a lack of water in private wells. Most other areas of the county have high levels of iron or sulfur.

More than three-quarters of the wells drilled in valley bottoms and on mountainsides are adequate for a domestic supply. Some wells on ridges and mountaintops are adequate for domestic supply. Drilled wells more than 200 feet deep in valleys may yield enough water for small municipal or industrial supplies. In the area north of Pine Mountain, ground water from most drilled wells is moderately hard and contains noticeable amounts of iron. Salty water in drilled wells probably will not be found less than 200 feet above the principal valley bottoms.

In the area along Pine Mountain and south of the mountain, the water quality is slightly better with few wells less than 300 feet below the principal valley bottoms will yield salty water. The ground water is soft but contains noticeable amounts of iron. This area also contains limestone beds that when faulted and below drainage may yield several hundred gallons per minute. Springs in this area will yield 50 gpm, but generally yield less than 10gpm.

### **Owsley County**

About 1,600 people in Owsley County rely on private domestic water supplies: 1,450 on wells, and 150 on other sources.

Most wells drilled in valley bottoms are adequate for a domestic supply. Fewer than half the wells drilled on hillsides are adequate for a domestic supply and wells on hilltops and ridges yield smaller quantities of water. In the western half of the county wells penetrating 500 feet or more of sandstone may yield enough water for small municipal or industrial supply.

Water obtained from most wells in this area is soft or moderately hard and contains noticeable amounts of iron. Salty water may be found in wells drilled less than 100 feet below the level of the principal valley bottoms.

A few springs supply sufficient quantities of water for domestic use, usually produces less than 5 gpm.

### **Perry County**

About 12,400 residents of Perry County rely on private domestic water supplies: 10,300 on wells, and 2,100 on other sources.

Most rural Perry Countians have drilled wells. As is the case throughout the district, iron and sulfur are common problems. In the eastern half of Perry County more than three-quarters of the wells drilled in valley bottoms and on mountainsides are adequate for a domestic supply. Some wells on ridges and mountaintops are adequate for domestic supply. Drilled wells more than 200 feet deep in valleys may yield enough water for small municipal or industrial supplies. In the western half of the county most wells drilled in valley bottoms are adequate for domestic supply. Fewer than half the wells on hillsides are adequate to meet the needs for a modern domestic supply. Wells on mountaintops and ridges yield smaller quantities of water.

Almost all ground water obtained from most drilled wells in this area is moderately to extremely hard and contains noticeable amounts of iron. Salty water may be found from 50 to several hundred feet below the level of the principal valley bottoms, except in the eastern half of the county where salty water probably will not be found less than 200 feet.

A few springs supply sufficient quantities of water for domestic use, usually produces less than 5 gpm.

### **Wolfe County**

About 5,000 people in Wolfe County rely on private domestic water supplies: 4,500 on wells, and 500 on other sources.

Most wells in valley bottoms are adequate for domestic supply. Yields to wells become progressively less on hillsides and ridges. Deep wells penetrating over 500 feet of sandstone may yield enough water for small municipal or industrial supplies.

Water from drilled wells range from moderately to extremely hard and contains noticeable amounts of iron. In valley bottoms salty water may be encountered at depths of 100 feet.

A few springs supply sufficient quantities of water for domestic use. Most springs have large seasonal variations in flow commonly issue from the base of sandstone and limestone formations in valley bottoms.

## LAKE CUMBERLAND AREA DEVELOPMENT DISTRICT

Lakeway Drive  
P.O. Box 1570  
Russell Springs, KY 42642  
(606)-866-4200

About 38,000 people in the region rely on private domestic water systems: 24,000 on wells and 14,000 on hauled water and other sources.

Estimated populations and private water service for the ten counties in the region are given below:

County	1999 Pop	On Private	2020 Pop	On Private
Adair	16,200	4,900 (30%)	17,800	0 ( 0%)
Casey	14,500	5,100 (35%)	14,300	3,700 (26%)
Clinton	9,300	900 (10%)	9,200	800 ( 9%)
Cumberland	6,800	400 ( 6%)	6,600	100 ( 1%)
Green	10,500	500 ( 5%)	10,400	0 ( 0%)
McCreary	16,600	3,300 (20%)	18,400	3,100 (17%)
Pulaski	56,800	10,200 (18%)	65,900	5,300 ( 8%)
Russell	16,500	4,900 (30%)	18,100	3,400 (19%)
Taylor	22,500	3,400 (15%)	23,800	2,900 (12%)
Wayne	18,900	4,700 (25%)	20,900	4,200 (20%)
Region	189,000	38,000 (20%)	205,000	23,500 (11%)

### Adair County

About 4,900 people in Adair County rely on private domestic water supplies: 3,700 on wells and 1,200 on other sources.

About three-fourth of the wells drilled in the uplands of central Adair County yield enough water for a domestic supply with some yields greater than 50 gpm to wells from large solution openings in karst areas. In the rest of the county very few wells yield enough water for a domestic supply except in a few lowland areas bordering streams where yields are sufficient for a few wells to meet the supply needs for domestic use.

Numerous small springs and seeps are found throughout the county. Most discharge from small solution openings and joints in limestone or siltstone and are supported by shale layers. Flows are as much as 100 gpm, but most have minimum flows of less than 1 gpm.

### Casey County

About 5,100 people in Casey County rely on private domestic water supplies: 3,550 on wells, and 1,550 on other sources.

In the uplands of far eastern Casey County about three-fourth of the wells drilled yield enough water for a domestic supply. In the rest of the county very few wells yield enough water for a domestic supply except in a few lowland areas bordering streams where yields are sufficient for a few wells to meet the supply needs for domestic use. Due to perched water bodies with limited recharge zones many wells in this area go dry in late summer and fall.

Numerous small springs and seeps are found throughout the county. Most discharge from small solution openings and joints in limestone or siltstone and are supported by shale layers. Flows are as much as 20 gpm, but most have minimum flows of less than 1 gpm.

### **Clinton County**

About 900 residents of Clinton County rely on private domestic water supplies: 550 on wells and 350 on other sources.

In central and southeastern half of the county about three-quarters of the drilled wells yield enough water for domestic use. In low lying areas a few wells yield adequate amounts of water for a domestic supply except in areas close to the Cumberland River in the northwest corner of the county. In the northwest corner of the county most wells are adequate for a domestic supply, especially from wells that penetrate small solution openings within the limestone bedrock.

Springs are present throughout the county with flow rates ranging from several gallons per minute (gpm) too as high as 670 gpm. Some springs are sufficient to supply domestic needs however most springs go dry during extended dry periods in late summer and fall.

### **Cumberland County**

About 400 residents of Cumberland County rely on private domestic water supplies: 300 on wells and 100 on other sources.

In the bottoms along the Cumberland River many drilled wells will produce enough water for a domestic supply. In most of Cumberland County wells will not produce enough water for a domestic supply except in a few wells in lowland areas bordering streams which can yield enough for a domestic supply.

Small springs and wet weather seeps occur in many areas throughout the county. Flows generally do not exceed several gallons a minute and most go dry during extended dry periods in late summer and fall.

### **Green County**

About 500 people in Green County rely on private domestic water supplies: about 300 on wells and 200 on other sources.

In the limestone rich area of Green County more than three-quarters of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels. In the low-lying areas in the

Green and Barren River valleys, only a few wells yield enough water for a domestic supply.

Springs with flows ranging from a few gallons per minute to 318 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

### **McCreary County**

About 3,300 people in McCreary County rely on private domestic water supplies: 2,300 on wells, and 1,000 on other sources.

Most of the wells drilled in the valley bottoms and hillsides are adequate for a domestic supply. About half the wells drilled on hilltops and ridges are adequate for domestic needs. Deep wells penetrating thick sections of sandstone greater than 500 feet may yield enough water for small utilities or industrial supplies.

Water obtained from most wells in this county is soft or moderately hard and contains noticeable amounts of iron. Salty water may be found in wells drilled 100 feet below the level of the principal valley bottoms.

In the limestone valleys of western McCreary County, springs are occasionally found with flows as large as 100 gpm. Throughout the county most springs, however, yield less than 5 gpm.

### **Pulaski County**

About 10,200 residents of Pulaski County rely on private domestic water supplies: 4,600 on wells and 5,600 on other sources.

Limestone and siltstone are the prominent rock types found in the western two-thirds of Pulaski County. About three-fourth of the wells drilled in western Pulaski County yield enough water for a domestic supply with some yields greater than 50 gpm from wells from large solution openings in karst areas. In the low lying areas in western Pulaski County only a few wells yield enough water for a domestic supply except in a few lowland areas near Cumberland River where yields are sufficient for domestic supplies.

In the eastern third of the county, the geology changes to sandstone and shales. Less than half of the wells drilled in the eastern end of the county will produce enough water for a domestic supply. In low lying areas bordering streams very few wells yield adequate amounts of water for a domestic supply except in the limited area south of Burnside where most wells are adequate for a domestic supply, especially from wells that penetrate large solution channels within the limestone bedrock.

### **Russell County**

About 4,900 people in Russell County rely on private domestic water supplies: 4,000 on wells and 900 on other sources.

In the northwestern third of Russell County about three-quarters of the drilled wells yield enough water for domestic use. Throughout the rest of the county only a few

wells yield adequate amounts of water for a domestic supply except in areas close to the Cumberland River in the southern end of the county. In the southern end of the county most wells are adequate for a domestic supply, especially from wells that penetrate small solution openings within the limestone bedrock.

### **Taylor County**

About 3,400 people in Taylor County rely on private domestic water supplies: 2,200 on wells and 1,200 on other sources.

In the western half of Taylor County except in the lowlands of Big Pitman Creek, about three-fourth of the wells drilled yield enough water for a domestic supply. In the rest of the county very few wells yield enough water for a domestic supply except in a few lowland areas bordering streams where yields are sufficient for a few wells to meet the supply needs for domestic use.

Numerous small springs and seeps are found throughout the county. Most discharge from small solution openings and joints in limestone or siltstone and are supported by shale layers. Flows are as much as 20 gpm, but most have minimum flows of less than 1 gpm.

### **Wayne County**

About 4,700 residents of Wayne County rely on private domestic water supplies: 2,600 on wells and 2,100 on other sources.

In the eastern half of Wayne County most of the wells drilled in the valley bottoms are adequate for a domestic supply and less than half the wells drilled on hillsides and hilltops are adequate for domestic needs. In western half of the county about three-quarters of the drilled wells in the uplands yield enough water for domestic use. In low lying areas very few wells yield adequate amounts of water for a domestic supply except in areas close to lake Cumberland where some wells are adequate for a domestic supply, especially from wells that penetrate small solution openings within the limestone bedrock.



## LINCOLN TRAIL AREA DEVELOPMENT DISTRICT

P.O. Box 604  
Elizabethtown, Ky 42701  
(502) 769-2393

About 49,000 people in the region rely on private domestic water systems: 33,000 on wells, and 16,000 on hauled water and other sources.

Estimated populations and private water service for the eight counties in the region are given below:

County	1999 Pop	On Private	2020 Pop	On Private
Breckinridge	17,600	8,800 (50%)	19,600	8,800 (45%)
Grayson	23,600	4,000 (17%)	26,800	4,300 (16%)
Hardin	83,500	8,300 (10%)	86,200	5,200 ( 6%)
Larue	13,100	5,200 (40%)	14,700	5,100 (35%)
Marion	16,400	800 ( 5%)	17,400	900 ( 5%)
Meade	29,800	13,700 (46%)	42,900	15,900 (37%)
Nelson	36,300	3,300 ( 9%)	48,600	3,400 ( 7%)
Washington	10,700	4,800 (45%)	11,400	3,500 (31%)
Region	231,000	49,000 (21%)	268,000	47,000 (18%)

### Breckinridge County

About 8,800 residents of Breckinridge County rely on private domestic water supplies: 4,400 on wells and 4,400 on other sources.

In the northwestern edge of Breckinridge County nearly all drilled wells in the alluvium of the Ohio River valley are adequate for domestic use with many wells yielding several hundred gallons per minute (gpm). Compound horizontal wells set in the alluvium may yield 5,000 gpm that is sufficient for a community or industrial supply. In the northern third, central highlands, and southeastern edge of Breckinridge County most drilled wells are adequate for a domestic supply. Yields as high as 100 gpm have been reported from wells penetrating fault zones. Depths of adequate wells range from 100 to 300 feet. In the remaining areas of the county only a few wells yield enough water for a domestic supply except in the lowland areas bordering streams where yields are sometimes sufficient for some wells to meet the supply needs for domestic use.

### Grayson County

About 4,000 people in Grayson County rely on private domestic water supplies: 2,700 on wells, and 1,300 on other sources.

In the lowlands along the Rough River and the valleys draining into Caney Creek, and in the area extending 10 miles east and west from Leitchfield, most drilled wells are adequate for a domestic supply. Yields as high as 100 gpm have been reported from wells penetrating fault zones that are prominent in parts of Grayson County. Depths of

adequate wells range from 100 to 300 feet. In the remaining areas of the county only a few wells yield enough water for a domestic supply except in the lowland areas bordering streams where yields are sometimes sufficient for some wells to meet the supply needs for domestic use.

### **Hardin County**

About 8,300 people in Hardin County rely on private domestic water supplies: 7,600 on wells and 700 on other sources.

In northern Hardin County nearly all drilled wells in the alluvium of the Ohio River valley are adequate for domestic use with many wells yielding several hundred gallons per minute (gpm). Compound horizontal wells set in the alluvium may yield 5,000 gpm, which is sufficient for a community or industrial use. In the Rough River lowlands in the southwestern corner of Hardin County most drilled wells are adequate for a domestic supply. Depths of drilled wells range from 60 to 300 feet. In much of central, eastern and northern Hardin County except in the lowlands of the major creeks and rivers, about three-fourth of the wells drilled yield enough water for a domestic supply. In the rest of the county very few wells yield enough water for a domestic supply except in a few lowland areas bordering streams where yields are sufficient for a few wells to meet the supply needs for domestic use.

Springs with flows ranging from a few gallons per minute to 3128 gpm are found throughout the county. Many of the springs are of the depression type and yield more than 100 gpm when pumped.

### **Larue County**

About 5,200 people in Larue County rely on private domestic water supplies: 4,500 on wells, and 700 on other sources.

In the western and central two-thirds of Larue County except in the lowlands of Nolin River and its major tributaries, about three-fourth of the wells drilled yield enough water for a domestic supply. In the rest of the county very few wells yield enough water for a domestic supply except in a few lowland areas bordering streams where yields are sufficient for a few wells to meet the supply needs for domestic use.

Springs with flows ranging from a few gallons per minute to 1330 gpm are found throughout the county. Many of the springs are of the depression type and yield more than 100 gpm when pumped.

### **Marion County**

About 800 people in Marion County rely on private domestic water supplies: 250 on wells, and 550 on other sources.

Ground-water resources in Marion County are limited. Wells located in the larger valley bottoms throughout the county will produce enough water for a domestic supply except during dry weather. In the upland areas of Marion County, which encompasses approximately 80 percent of the county, most drilled wells will not produce enough water

for a dependable domestic supply except along drainage lines which may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Meade County**

About 13,700 people in Meade County rely on private domestic water supplies: 11,000 on wells, and 2,700 on other sources.

In northern Meade County nearly all drilled wells in the alluvium of the Ohio River valley are adequate for domestic use with many wells yielding several hundred gallons per minute (gpm). Compound horizontal wells set in the alluvium may yield 5,000 gpm, which is sufficient for a community or industrial supply. In the western corner of Meade County most drilled wells are adequate for a domestic supply. Depths of adequate wells range from 100 to 300 feet. In much of central and eastern Meade County except in the lowlands of the major creeks and rivers, about three-fourth of the wells drilled yield enough water for a domestic supply. In the lowlands very few wells yield enough water for a domestic supply except in a few lowland areas bordering streams where yields are sufficient for a few wells to meet the supply needs for domestic use.

Springs with flows ranging from a few gallons per minute to 2266 gpm are found throughout the county. Many of the springs are of the depression type and yield more than 100 gpm when pumped. The larger springs in the county have sufficient flows to be utilized for public or industrial water supplies.

### **Nelson County**

About 3,300 people in Nelson County rely on private domestic water systems, about half on wells, and half on other sources.

In the larger valley bottoms of the Rolling Fork and Beech Fork of the Salt River, most drilled wells in the valley will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the rest of the larger valleys throughout the county will produce enough water for a domestic supply except during dry weather. In the upland areas of Nelson County, which encompasses approximately 70 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Washington County**

About 4,800 people in Washington County rely on private domestic water supplies: 1,200 on wells, and 3,600 on other sources.

Ground-water resources in Washington County are limited. Wells located in the larger valley bottoms throughout the county will produce enough water for a domestic

supply except during dry weather. In the upland areas of Washington County, which encompasses approximately 85 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

**NORTHERN KENTUCKY AREA DEVELOPMENT DISTRICT**

7505 Sussex Drive, Suite 8  
Florence, KY 41042  
(606)-2831885

About 48,000 people in the region rely on private domestic water systems: 5,000 on wells, and 43,000 on hauled water and other sources.

Estimated populations and private water service for the eight counties in the region are given below:

<b>County</b>	<b>1999 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Boone	81,600	17,100 (21%)	128,000	25,600 (20%)
Campbell	86,900	5,700 ( 7%)	91,000	3,600 ( 4%)
Carroll	9,500	900 (10%)	9,700	800 ( 8%)
Gallatin	7,200	700 (10%)	11,200	900 ( 8%)
Grant	21,000	4,200 (20%)	31,400	4,400 (14%)
Kenton	145,700	11,700 ( 8%)	152,000	7,600 ( 5%)
Owen	10,200	3,400 (33%)	11,800	1,500 ( 8%)
Pendleton	14,300	4,700 (33%)	17,600	3,000 (17%)
Region	376,000	48,400 (13%)	453,000	47,400 (10%)

**Boone County**

About 17,100 residents of Boone County rely on private domestic water systems: 1,700 on wells and 15,400 on cisterns, hauled water, and other sources.

The alluvium along the Ohio River is the best source of ground water in the county. Many properly constructed drilled wells will produce several hundred gallons per minute from the alluvium, with most wells able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality.

In the lower sections of the larger creek valleys most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the smaller creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Boone County that encompasses approximately 70 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines which may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

**Campbell County**

About 5,700 people in Campbell County rely on private domestic water systems: about 700 on water wells, and 5,000 on cisterns, hauled water, and other sources.

The alluvium along the Ohio River is the best source of ground-water in the county. Many properly constructed drilled wells will produce several hundred gallons per minute from the alluvium, with most wells able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality.

In the Licking River valley and the lower sections of the larger creek valleys in Campbell County most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the smaller creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Campbell County that encompasses 60 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Carroll County**

About 900 people in the Carroll County rely on private domestic water supplies: 350 on wells, and 550 on hauled water or other sources.

The alluvium along the Ohio River is the best source of ground water in the county. Many properly constructed drilled wells will produce several hundred gallons per minute from the alluvium, with most wells able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality.

In the bottoms of the Kentucky River, Eagle Creek and in the lower sections of the larger creek valleys that drain into the Ohio River, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the smaller creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Carroll County that encompasses approximately 50 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Gallatin County**

About 700 people in Gallatin County rely on private domestic water systems: 100 on wells and 600 on hauled water and other sources.

The alluvium along the Ohio River is the best source of ground-water in the county. Many properly constructed drilled wells will produce several hundred gallons per minute from the alluvium, with most wells able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality.

In the bottoms of Eagle Creek and in the lower sections of the larger creek valleys that drain into the Ohio River, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the smaller creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Gallatin County that encompasses approximately 60 percent of the

county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Grant County**

About 4,200 residents of Grant County rely on private domestic water supplies: 450 on water wells and 3,750 on hauled water and other sources.

Ground-water resources in Grant County are limited. Wells located in the larger valley bottoms throughout the county will produce enough water for a domestic supply except during dry weather. In the upland area of Grant County that encompasses approximately 80 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Kenton County**

About 11,700 people in the Kenton County rely on private domestic water supplies: 1,200 on wells and 10,500 on hauled water or other sources.

The alluvium along the Ohio River is the best source of ground water in the county. Many properly constructed drilled wells will produce several hundred gallons per minute from the alluvium, with most wells able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality.

In the Licking River valley and the lower sections of the larger creek valleys in Kenton County most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the smaller creek valleys will produce enough water for a domestic supply except during dry weather. In the upland areas of Kenton County that encompasses approximately 60 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Owen County**

About 3,400 residents of Owen County rely on private domestic water supplies: 650 on wells and 2,750 on hauled water and other sources.

In some of the bottoms of the Kentucky River and Eagle Creek, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Some wells located in the smaller creek valleys and in some less productive areas along the Kentucky River and Eagle Creek will produce enough water for a domestic supply except

during dry weather. In the upland areas of Owen County that encompasses approximately 80 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply except along drainage lines that may produce enough water except during dry weather. Ground water in these areas is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

### **Pendleton County**

About 4,700 residents of Pendleton County rely on private domestic water supplies, primarily on hauled water or other sources.

In the valley bottoms of the Licking River, South Fork of the Licking River, Ohio River and some of the major creeks most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the valley bottoms of the larger creeks will produce enough water for a domestic supply except during dry weather. In the upland areas of Pendleton County that encompasses approximately 60 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply, except along drainage lines which may produce enough water except during dry weather.

Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.



## PENNYRILE AREA DEVELOPMENT DISTRICT

300 Hammond Drive  
Hopkinsville, KY 42240  
(502) 886-9484

About 23,000 people in the region rely on private domestic water systems: 16,200 on wells and 6,800 on hauled water and other sources.

Estimated populations and private water service for the nine counties in the region are given below:

<b>County</b>	<b>1999 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Caldwell	13,300	2,000 (15%)	13,700	1,100 ( 8%)
Christian	66,700	9,200 (14%)	77,500	8,500 (11%)
Crittenden	9,350	2,800 (30%)	8,950	850 ( 9%)
Hopkins	45,700	2,300 ( 5%)	44,800	1,800 ( 4%)
Livingston	9,300	1,700 (18%)	9,300	900 (10%)
Lyon	6,800	1,000 (14%)	7,300	900 (12%)
Muhlenberg	32,000	2,900 ( 9%)	34,100	2,700 ( 8%)
Todd	11,200	400 ( 4%)	11,100	0 ( 0%)
Trigg	12,600	600 ( 5%)	16,000	800 ( 4%)
Region	207,000	23,000 (11%)	223,000	18,000 ( 8%)

### **Caldwell County**

About 2,000 people in Caldwell County rely on private domestic water supplies: 1,300 on wells and 700 on other sources.

In the southern and western two-thirds of Caldwell County more than three-quarters of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels or fault zones. In the low-lying areas of Eddy Creek most wells are inadequate for domestic use unless the well intercepts a major solution opening in the limestone in which the yield could be very large. Ground water in the sandstone and shale-rich northeastern third of the county is not as prevalent as in the rest of the county which is predominately limestone. Most wells in the northeastern part of the county are inadequate for a domestic supply, however some wells in sandstone formations yield enough water for a domestic supply when located in areas bordering streams.

Springs with flows ranging from a few gallons per minute to 2,000 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

### **Christian County**

About 9,200 people in Christian County rely on private domestic water supplies: 7,000 on wells and 2,200 on other sources.

In the southern half of Christian County more than three-quarters of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels. In the low-lying areas of the West Fork of the Red River and the Little River and its major tributaries, most wells are inadequate for domestic use unless the well intercepts a major solution opening in the limestone in which the yield could be very large.

Ground water in the northern half of the county is not as prevalent as in the southern half of the county except in the area west of US 41 between Hopkinsville and Crofton. Most drilled wells in the western central section of the county that obtain water from fault zones are adequate for a domestic supply and sometimes yield up to 100 gpm. Most wells in the rest of the northern half of the county are inadequate for a domestic supply. Some wells in sandstone formations yield enough water for a domestic supply.

Springs with flows ranging from a few gallons per minute to 3,000 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

### **Crittenden County**

About 2,800 people in Crittenden County rely on private domestic water supplies: 1,750 on wells and 1,050 on other sources.

On the northern edge of Crittenden County wells in the alluvium of the Ohio River Valley yield several hundred gallons per minute with compound horizontal wells having a potential yield as high as 5,000 gpm. In the western three-quarters of Crittenden County most of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels or fault zones. In the low-lying areas of Claylick and Livingston Creeks and the tributaries to the Ohio River, most wells are inadequate for domestic use unless the well intercepts a major solution opening in the limestone in which the yield could be very large. Ground water in the sandstone and shale rich eastern quarter of the county is not as prevalent as in the rest of the county which is predominately limestone. Most wells in the eastern part of the county are inadequate for a domestic supply, however some wells in sandstone formations yield enough water for a domestic supply when located in areas bordering streams.

Springs with flows ranging from a few gallons per minute to 1,400 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

### **Hopkins County**

About 2,300 people in Hopkins County rely on private domestic water supplies: 1,200 on wells and 1,100 on other sources.

In Hopkins County most wells, which penetrate sandstone's from depths of less than 300 feet are adequate for a domestic supply. In the areas surrounding Nortonville and south of Richland, most wells produce less than 100 gallons per day at depths of less

than 300 feet. In southwestern Hopkins County, south of Charleston, a thin highly faulted zone running east-west yields unpredictable amounts of water to drilled wells.

Generally, ground water is hard and sometimes iron or salt may be present in objectionable amounts. Often ground water becomes saltier with depth north of the highly faulted zone.

### **Livingston County**

About 1,700 people in Livingston County rely on private domestic water supplies: 1,100 on wells and 600 on other sources.

On the northern and western edge of Livingston County wells in the alluvium of the Ohio River Valley yield several hundred gallons per minute with compound horizontal wells having a potential yield as high as 5,000 gpm. In most of Livingston County drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels or fault zones. In the low-lying areas along the Cumberland and Tennessee Rivers and the tributaries to the Ohio River, most wells are inadequate for domestic use unless the well intercepts a major solution opening in the limestone in which the yield could be very large. In the uplands of the southern section of the county between the Tennessee and Cumberland Rivers most wells in gravel do not yield enough water for a domestic supply.

Springs with flows ranging from a few gallons per minute to 177 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

### **Lyon County**

About 1,000 people in Lyon County rely on private domestic water supplies: 850 on wells and 250 on other sources.

In the eastern and northern two-thirds of Lyon County more than three-quarters of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels. In the low-lying areas of Eddy Creek most wells are inadequate for domestic use unless the well intercepts a major solution opening in the limestone in which the yield could be very large. Wells in the uplands of the LBL in the southwestern quarter of the county generally do not yield enough water for domestic use. However in the lowlands adjacent to Kentucky and Barkley Lakes, three-fourths of the wells located within the bedrock yield enough for a domestic supply and can sometimes produce more than 5gpm.

Springs with flows ranging from a few gallons per minute to 1,280 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

### **Muhlenberg County**

About 2,900 people in Muhlenberg County rely on private domestic water supplies: 2,100 on wells and 800 on other sources.

Throughout 90 percent of the county, most wells from depths of less than 300 feet are adequate for a domestic supply. Wells located in the Green River flood plain can produce as much as 100 gallons of hard water per minute. Most wells obtain their water from thick sandstone layers and will yield as much as 60 gpm. In the southwestern corner of the county only a few well yield enough water for a domestic supply. In a small localized area north of Earles, most wells produce less than 100 gallons per day which is far less than is needed for a domestic supply. In the northern and eastern part of the county moderately mineralized water may be obtained locally from deep sandstone formations at depths of 1200 feet.

Generally, ground water is hard to very hard and iron and salt may be present in objectionable amounts. Often ground water becomes saltier with depth.

### **Todd County**

About 400 people in Todd County rely on private domestic water supplies: 325 on wells and 75 on other sources.

In the southern half of Todd County more than three-quarters of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels. In the low-lying areas of the Elk and West Forks of the Red River and along Spring Creek, most wells are inadequate for domestic use unless the well intercepts a major solution opening in the limestone in which the yield could be very large. Ground water in the northern half of the county is not as prevalent as in the southern half of the county. Most wells in the northern half of the county are inadequate for a domestic supply. Some wells in sandstone formations yield enough water for a domestic supply.

Springs with flows ranging from a few gallons per minute to 3,000 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

### **Trigg County**

About 600 people in Trigg County rely on private domestic water supplies: 480 on wells and 120 on other sources.

In the eastern two-thirds of Trigg County more than three-quarters of the drilled wells in the uplands are adequate for a domestic supply. Yields as high as 50 gpm have been reported from wells penetrating large solution channels. In the low-lying areas of the Little River and its major tributaries, most wells are inadequate for domestic use unless the well intercepts a major solution opening in the limestone in which the yield could be very large. Wells in the uplands of the LBL in the western third of the county generally do not yield enough water for domestic use. However in the lowlands adjacent to Kentucky and Barkley Lakes three-fourths of the wells yield enough for a domestic supply and can sometimes produce more than 5gpm.

Springs with flows ranging from a few gallons per minute to 3,000 gpm are found in the county. Minimum flow generally occurs in early fall, maximum flows in late winter.

**PURCHASE AREA DEVELOPMENT DISTRICT**

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About 41,000 people in the region rely on private domestic water systems: 38,000 on wells and 3,000 on hauled water and other sources.

Estimated populations and private water service for the eight counties in the region are given below:

<b>County</b>	<b>1999 Pop</b>	<b>On Private</b>	<b>2020 Pop</b>	<b>On Private</b>
Ballard	8,400	3,900 (47%)	9,100	3,900 (43%)
Calloway	29,400	9,100 (31%)	28,100	4,200 (15%)
Carlisle	5,400	3,000 (55%)	5,300	3,200 (51%)
Fulton	7,500	500 ( 6%)	7,200	100 ( 2%)
Graves	35,700	10,700 (30%)	38,400	8,400 (22%)
Hickman	4,900	2,800 (57%)	3,700	1,500 (40%)
McCracken	64,200	5,100 ( 8%)	63,800	3,200 ( 5%)
Marshall	30,000	6,000 (20%)	32,000	3,500 (11%)
Region	186,000	41,000 (22%)	188,000	28,000 (15%)

**Ballard County**

About 3,900 people in Ballard County rely on private domestic wells for their source of water.

Abundant quantities of ground water is available for domestic, irrigation, and industrial uses in Ballard County from depths of a few feet down to 600 feet. In general, the chemical quality of the water is good, but water from some aquifers contains objectionable amounts of iron and manganese. Water from alluvium is generally hard to very hard. Generally, depths to ground-water is under 100 feet except in the uplands of southern Ballard County where sufficient ground water is obtained at depths greater than 100 feet.

Water quality generally is good except in areas where downward percolation of surface water and fluids from domestic sewage-disposal systems, and other sources of domestic or industrial pollution have contaminated the aquifer. Ground water sometimes contains iron naturally in objectionable amounts from the deeper zones. In some formations with slightly acidic ground-water, a chemical reaction between the acidic ground-water and steel well casing and pump equipment will produce a high iron content in the water which is not naturally occurring.

## **Calloway County**

About 9,100 people in Calloway County rely on private domestic water supplies: 6,100 on wells, and 3,000 on other sources.

Abundant quantities of ground-water is available for domestic, irrigation, and industrial uses in Calloway County from depths of a few feet to below 700 feet with most wells less than 100 foot. A few wells obtain shallow perched water from gravel or alluvial deposits but these zones often will not yield sufficient water for an adequate domestic supply during periods of low rainfall, which is common in late summer and fall. In general, the chemical quality of the water is good, but water from some aquifers contains objectionable amounts of iron and manganese. Water from alluvium and limestone in this county is generally hard to very hard with moderate to high levels of dissolved solids. Water from the unconsolidated sand and/or gravel, non-alluvium aquifers are considered soft and slightly acidic with low dissolved solids.

Water quality generally is good except in areas where downward percolation of surface water and fluids from domestic sewage-disposal systems, and other sources of domestic or industrial pollution have contaminated the aquifer. In a few wells harmful amounts of nitrate have been detected. Ground water sometimes contains iron naturally in objectionable amounts from the deeper zones. In some formations with slightly acidic ground-water, a chemical reaction between the acidic ground-water and steel well casing and pump equipment will produce a high iron content in the water which is not naturally occurring.

## **Carlisle County**

About 3,000 people in Carlisle County rely on private domestic wells for their water supply.

Abundant quantities of ground water is available for domestic, irrigation, and industrial uses in Carlisle County from depths of a few feet down to 600 feet. In general, the chemical quality of the water is good, but water from some aquifers contains objectionable amounts of iron and manganese. Water from the thick Mississippi River alluvium is generally hard to very hard. Water from the non-alluvium aquifers are considered soft and slightly acidic with low dissolved solids. Generally, depths to ground-water is under 100 feet except in the uplands of Carlisle County where sufficient ground-water is obtained at depths greater than 100 feet. Yields in some of the deeper wells are greater than 1,000 gallons per minute which is sufficient for a community or industrial supply.

Water quality generally is good except in areas where downward percolation of surface water and fluids from domestic sewage-disposal systems, and other sources of domestic or industrial pollution have contaminated the aquifer. Ground water sometimes contains iron naturally in objectionable amounts from the deeper zones. In some formations with slightly acidic ground-water, a chemical reaction between the acidic ground-water and steel well casing and pump equipment will produce a high iron content in the water which is not naturally occurring.

### **Fulton County**

About 500 people in Fulton County rely on private wells for their water supply.

Abundant quantities of ground-water is available for domestic, irrigation, and industrial uses in Fulton County from depths of a few feet down to 1,500 feet. In general, the chemical quality of the water is good, but water from some aquifers contains objectionable amounts of iron and manganese. Water from alluvium is generally hard to very hard with moderate to high levels of dissolved solids. Water from the sand and/or gravel, non alluvium aquifers are considered soft and slightly acidic with low dissolved solids. Yields in some of the deeper wells (250-1,500 feet) are greater than 1,000 gallons per minute which is sufficient for a community or industrial supply.

Water quality generally is good except in areas where downward percolation of surface water and fluids from domestic sewage-disposal systems, and other sources of domestic or industrial pollution have contaminated the aquifer. Ground-water sometimes contains iron naturally in objectionable amounts from the deeper zones. In some formations with slightly acidic ground-water, a chemical reaction between the acidic ground-water and steel well casing and pump equipment will produce a high iron content in the water which is not naturally occurring.

### **Graves County**

About 10,700 people in Graves County rely on private domestic wells for their water supply.

Abundant quantities of ground-water is available for domestic, irrigation, and industrial uses in Graves County from depths of a few feet to below 700 feet with most wells set at the 100 foot range. A few wells obtain shallow perched water from gravel or alluvial deposits but these zones often will not yield sufficient water for an adequate domestic supply due to periods of low rainfall, which is common in late summer and fall. In general, the chemical quality of the water is good, but water from some aquifers contains objectionable amounts of iron and manganese. Water from alluvium is generally hard to very hard with moderate to high levels of dissolved solids. Water from the sand and/or gravel, non-alluvium aquifers are considered soft and slightly acidic with low dissolved solids. Yields in some of the deeper wells (250-1,500 feet) are greater than 1,000 gallons per minute which is sufficient for a community or industrial supply.

Water quality generally is good except in areas where downward percolation of surface water and fluids from domestic sewage-disposal systems, and other sources of domestic or industrial pollution have contaminated the aquifer. In a few wells harmful amounts of nitrate have been detected. Ground water sometimes contains iron naturally in objectionable amounts from the deeper zones. In some formations with slightly acidic ground-water, a chemical reaction between the acidic ground-water and steel well casing and pump equipment will produce a high iron content in the water which is not naturally occurring.

### **Hickman County**

About 2,800 people in Hickman County rely on private domestic wells for their water supply.

Abundant quantities of ground water is available for domestic, irrigation, and industrial uses in Hickman County from depths of a few feet down to 750 feet. In general, the chemical quality of the water is good, but water from some aquifers contains objectionable amounts of iron. Water from alluvium is generally hard to very hard. Water from the sand and/or gravel, non-alluvium aquifers are considered soft and slightly acidic with low dissolved solids. Generally, depths to ground water is under 100 feet except in the uplands and in the western part of the county where water is found in the 100 to 250 foot range. Yields in some of the deeper wells (250-750 feet) are greater than 1,000 gallons per minute which is sufficient for a community or industrial supply.

Ground water sometimes contains iron naturally in objectionable amounts from the deeper zones. In some formations with slightly acidic ground-water, a chemical reaction between the acidic ground-water and steel well casing and pump equipment will produce a high iron content in the water which is not naturally occurring.

### **McCracken County**

About 5,100 people in McCracken County rely on private domestic wells for their source of water.

Groundwater resources in McCracken County are abundant with fair to good water quality. All areas of the county have the ability to produce water from drilled wells at reasonable depths in quantities sufficient for domestic use. Multiple zones of production are common throughout the county. Depths to upper most production is between 30 and 200 feet. Generally, depths to ground-water is under 100 feet except in the uplands of south-western McCracken County where sufficient ground-water is obtained at depths greater than 100 feet.

Water quality generally is good except in areas where downward percolation of surface water and fluids from domestic sewage-disposal systems, and other sources of domestic or industrial pollution have contaminated the aquifer. Ground water sometimes contains iron naturally in objectionable amounts from the deeper zones. In some formations with slightly acidic ground-water, a chemical reaction between the acidic ground-water and steel well casing and pump equipment will produce a high iron content in the water which is not naturally occurring.

### **Marshall County**

About 6,000 people in Marshall County rely on private domestic wells for their water supply.

Groundwater resources in Marshall County are abundant with fair to good water quality. All areas of the county have the ability to produce water from drilled wells at reasonable depths in quantities sufficient for domestic use. Multiple zones of production are common throughout the county. Depths to upper most production is between 30 and 150 feet. A few wells obtain shallow perched water from gravel or alluvial deposits but



these zones often will not yield sufficient water for an adequate domestic supply during periods of low rainfall, which is common in late summer and fall. In general, the chemical quality of the water is good, but water from some aquifers contains objectionable amounts of iron and manganese. Water from alluvium and limestone in this county is generally hard to very hard with moderate to high levels of dissolved solids with some limestone wells in the eastern part of the county containing minor amounts of hydrogen sulfide. Water from the unconsolidated sand and/or gravel aquifers are considered soft and slightly acidic with low dissolved solids.

Water quality generally is good except in areas where downward percolation of surface water and fluids from domestic sewage-disposal systems, and other sources of domestic or industrial pollution have contaminated the aquifer. In a few wells harmful amounts of nitrate have been detected. Ground water sometimes contains iron naturally in objectionable amounts from the deeper zones. In some formations with slightly acidic ground-water, a chemical reaction between the acidic ground-water and steel well casing and pump equipment will produce a high iron content in the water which is not naturally occurring.