Kentucky Geological Survey
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UNIVERSITY OF KENTUCKY

MAP AND CHART 80
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Generalized Geologic Map for Land-Use Planning: Pulaski County, Kentucky

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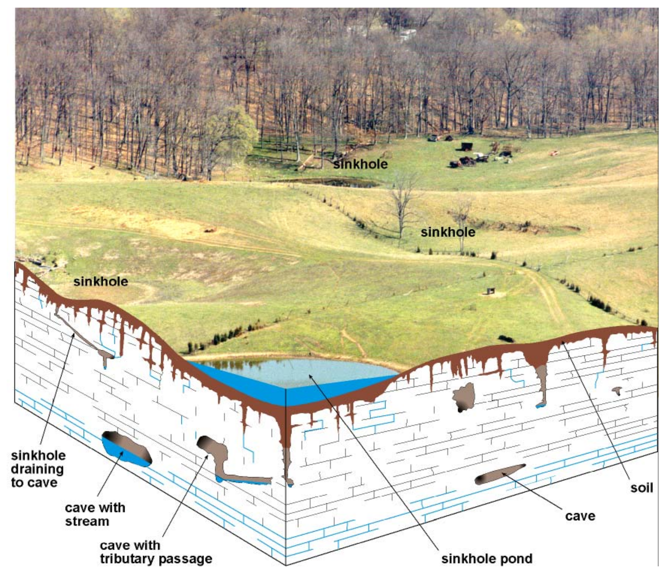
Acknowledgments

Geology adapted from Ciszak (2004a-b), Duncan and Stidham (2004), Hettinger and Stidham (2004), Murphy (2004a-d), Murphy and Stidham (2004a,-b), Yang (2004a-b), Yang and Stidham (2004a-e), Zhang (2004a-b), Zhang and Melton (2004), and Zhang and Stidham (2004).

Environmental Protection



Never use sinkholes as dumps. All waste, but especially pesticides, paints, household chemicals, automobile batteries, and used motor oil, should be taken to an appropriate recycling center or landfill.

Make sure runoff from parking lots, streets, and other urban areas is routed through a detention basin and sediment trap to filter it before it flows into a sinkhole.

Make sure your home septic system is working properly and that it's not discharging sewage into a crevice or sinkhole.

Keep cattle and other livestock out of sinkholes and sinking streams. There are other methods of providing water to livestock.

See to it that sinkholes near or in crop fields are bordered with trees, shrubs, or grass buffer strips. This will filter runoff flowing into sinkholes and also keep tilled areas away from sinkholes.

Construct waste-holding lagoons in karst areas carefully, to prevent the bottom of the lagoon from collapsing, which would result in a catastrophic emptying of waste into the groundwater.

If required, develop a groundwater protection plan (410KAR5:037) or an agricultural water-quality plan (KRS224.71) for your land use.

(From Currens, 2001)

Karst

The term "karst" refers to a landscape that is characterized by sinkholes, springs, sinking streams (streams that disappear underground) and underground drainage through solution-enlarged conduits or caves. Karst landscapes form when slightly acidic water from rain and snow-melt seeps through soil cover into fractured and soluble bedrock (usually limestone, dolomite or gypsum).

Sinkholes refer to depressions on the land surface where water drains underground. Usually circular and often funnel-shaped, they range in size from a few feet to hundreds of feet in diameter. Springs occur when water emerges from underground to become surface water. Caves are solution-enlarged fractures or conduits that are large enough for a person to enter.

Groundwater Availability

Limestone and siltstone are the predominant rock types found in the western two-thirds of Pulaski County. About three-fourths of the wells drilled in western Pulaski County yield enough water for a domestic supply, with some yields greater than 50 gallons per minute for wells penetrating 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 the 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 third of the county will produce enough water for a domestic supply. In low-lying areas bordering streams very few wells yield enough 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.

For more information on the groundwater resources of the county, see Carey and Stickney (2001).

PLANNING DEFINITIONS

FOUNDATION AND EXCAVATION

The terms "earth" and "rock" excavation are used in the engineering sense; earth can be excavated by hand tools, whereas rock requires heavy equipment or blasting to remove.

LIMITATIONS

Slight—A slight limitation is one that commonly requires some corrective measure but can be overcome without a great deal of difficulty or expense.

Moderate—A moderate limitation is one that can normally be overcome but the difficulty and expense are great enough that completing the project is commonly a question of feasibility.

Severe—A severe limitation is one that is difficult to overcome and commonly is not feasible because of the expense involved.

LAND USES

Septic tank disposal system—A septic tank disposal system consists of a septic tank and a filter field. The filter field is a subsurface tile system laid in such a way that effluent from the septic tank is distributed with reasonable uniformity into the natural soil.

Residences—Ratings are made for residences with and without basements because the degree of limitation is dependent upon excavation and the depth of excavation. For example, excavation in limestone has greater limitation than excavation in shale for a house with a basement.

Highways and streets—Refers to paved roads in which cuts and fills are made in hilly topography, and considerable work is done preparing subgrades and bases before the surface is applied.

Access roads—These are low-cost roads, driveways, etc., usually surfaced with crushed stone or a thin layer of blacktop. A minimum of cuts and fills are made, little work is done preparing a subgrade, and generally only a thin base is used. The degree of limitation is based on year-around use and would be less severe if not used during the winter and early spring. Some types of recreation areas would not be used during these seasons.

Light industry and malls—Ratings are based on developments having structures or equivalent load limit requirements of three stories or less, and large paved areas for parking lots. Structures with greater load limit requirements would normally need footings in solid rock, and the rock would need to be core drilled to determine presence of caverns, cracks, etc.

Intensive recreation—Athletic fields, stadiums, etc.

Extensive recreation—Camp sites, picnic areas, parks, etc.

Reservoir areas—The floor of the area where the water is impounded. Ratings are based on the permeability of the rock.

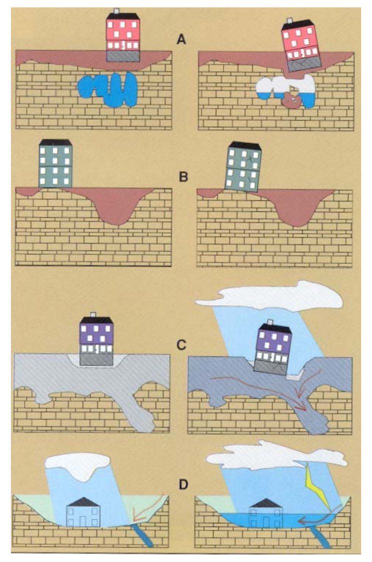
Reservoir embankments—The rocks are rated on limitations for embankment material.

Underground utilities—Included in this group are sanitary sewers, storm sewers, water mains, and other pipes that require fairly deep trenches.

Planning Guidance by Rock Unit Type

Rock Unit	Foundation and Excavation	Septic System	Residence with Basement	Highways and Streets	Access Roads	Light Industry and Malls	Intensive Recreation	Extensive Recreation	Reservoir Areas	Reservoir Embankments	Underground Utilities
1. Alluvium, landslide, and terrace deposits.	Refer to soil report (Ross, 1974).	Refer to soil report (Ross, 1974).	Refer to soil report (Ross, 1974).	Refer to soil report (Ross, 1974).	Refer to soil report (Ross, 1974).	Refer to soil report (Ross, 1974).	Refer to soil report (Ross, 1974).	Refer to soil report (Ross, 1974).	Refer to soil report (Ross, 1974).	Refer to soil report (Ross, 1974).	Refer to soil report (Ross, 1974).
2. Shale, siltstone, sandstone, and coal	Fair to good foundation material; difficult to excavate. Possible expansive shales.	Severe limitations. Impermeable rock; thin soils.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.	Moderate limitations. Rock excavation; steep slopes.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.	Severe limitations. Steep slopes.	Slight to moderate limitations.	Slight limitations; reservoir may leak where rocks are fractured.	Moderate to severe limitations. Steep slopes possible; difficult excavation may be required; high porosity in sandstones or fractured rocks may result in leaky reservoir.	Moderate limitations. Highly variable amount of rock and earth excavation.
3. Shale, sandstone, limestone, and siltstone	Fair to good foundation material; difficult to excavate. Possible expansive shales.	Severe limitations. Impermeable rock; thin soils.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.	Moderate limitations. Rock excavation; steep slopes.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.	Severe limitations. Steep slopes.	Slight to moderate limitations.	Slight limitations; reservoir may leak where rocks are fractured.	Moderate to severe limitations. Steep slopes possible; difficult excavation may be required; high porosity in sandstones or fractured rocks may result in leaky reservoir.	Moderate limitations. Highly variable amount of rock and earth excavation.
4. Sandstone, conglomerate, and minor shale	Fair to good foundation material; difficult to excavate.	Severe limitations. Impermeable rock; thin soils.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes.	Moderate limitations. Rock excavation; steep slopes.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes.	Severe limitations. Steep slopes.	Slight to moderate limitations.	Slight limitations; reservoir may leak where rocks are fractured.	Moderate to severe limitations. Steep slopes possible; difficult excavation may be required; high porosity in sandstones or fractured rocks may result in leaky reservoir.	Moderate limitations. Highly variable amount of rock and earth excavation.
5. Limestone, shale, and siltstone	Fair to good foundation material; difficult to excavate. Possible expansive shales.	Severe limitations. Thin soils and impermeable rock; fast drainage through fractures to water table; possible groundwater contamination.	Moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes along major drainages. Possible expansion of shales.	Moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes along major drainages. Possible expansion of shales.	Slight limitations. Rock excavation. Steep slopes along major drainages.	Slight limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes along major drainages. Possible expansion of shales.	Moderate limitations. Steep to moderate slopes.	Slight limitations.	Slight to moderate limitations; reservoir may leak where rocks are fractured. Sinks possible.	Slight limitations; reservoir may leak where rocks are fractured.	Moderate limitations. Possibility of thin soils and rock excavation.
6. Limestone, dolomite, and shale	Fair to very good foundation material; difficult to excavate.	Severe limitations. Impermeable rock; locally fast drainage through fractures and sinks to water table; possible groundwater contamination.	Severe limitations. Rock excavation may be required. Steep slopes along major drainages.	Moderate limitations. Rock excavation; local drainage problems; sinks common.	Moderate limitations. Rock excavation; local drainage problems; sinks common.	Severe to slight limitations, depending on topography. Rock excavation; local drainage problems; sinks common. Groundwater contamination possible.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Moderate to severe limitations; reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations; reservoir may leak where rocks are fractured. Sinks possible.	Severe limitations. Possible rock excavation.
7. Dolomite and limestone/siltstone	Very good foundation material; difficult to excavate.	Severe limitations. Impermeable rock; locally fast drainage through fractures and sinks to water table; possible groundwater contamination.	Severe limitations. Rock excavation may be required. Steep slopes along major drainages.	Severe limitations. Rock excavation; possible steep slopes.	Severe to moderate limitations. Rock excavation. Possible steep slopes and narrow ravines.	Moderate to slight limitations, depending on topography. Rock excavation; local drainage problems; sinks common.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Slight to moderate limitations; reservoir may leak where rocks are fractured. Sinks possible.	Slight to moderate limitations; reservoir may leak where rocks are fractured. Sinks possible.	Severe limitations. Rock excavation.
8. Shale and dolomite	Fair to good foundation material; difficult excavation. Possible expansion of shales.	Severe limitations. Impermeable rock; locally fast drainage through fractures and sinks to water table; possible groundwater contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.	Moderate limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Slight to moderate limitations; reservoir may leak where rocks are fractured.	Slight to moderate limitations; reservoir may leak where rocks are fractured.	Severe to moderate limitations. Possible rock excavation.
9. Siltstone, dolomite and chert	Fair to good foundation material; difficult to excavate.	Severe limitations. Thin soils and impermeable rock; fast drainage through fractures to water table; possible groundwater contamination.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required.	Severe to slight limitations, depending on activity and topography. Possible steep wooded slopes.	Slight limitations; reservoir may leak where rocks are fractured.	Severe limitations; reservoir may leak where rocks are fractured. Sinks possible.	Severe to moderate limitations. Possible rock excavation.

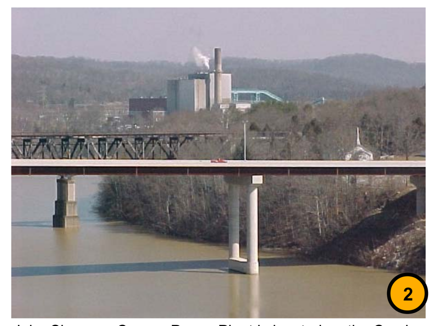
Residential Construction



Limestone terrain can be subject to subsidence hazards, which usually can be overcome by prior planning and site evaluation. "A" shows construction above an open cavern, which later collapses. This is one of the most difficult situations to detect, and the possibility of this situation beneath a structure warrants insurance protection for homes built on karst terrain. In "B," a heavy structure presumed to lie above solid bedrock actually is partially supported on soft, residual clay soils that subside gradually, resulting in damage to the structure. This occurs where inadequate site evaluation can be traced to lack of geophysical studies and inadequate core sampling. "C" and "D" show the close relationship between hydrology and subsidence hazards in limestone terrain. In "C," the house is situated on porous fill (light shading) at a site where surface and groundwater drainage move supporting soil (darker shading) into voids in limestone (blocks) below. The natural process is then accelerated by infiltration through fill around the home. "D" shows a karst site where normal rainfall is absorbed by subsurface conduits, but water from infrequent heavy storms cannot be carried away quickly enough to prevent flooding of low-lying areas. Adapted from AIPG (1993).

The Nancy Oil Field in Pulaski County was developed in the mid- to late-1980's, primarily from the Knox Formation, at depths of around 1,900 feet. Many of these wells produced hundreds of barrels per day initially, but most (including Zimmerman No. 2 shown here) are now producing a few barrels per day on timers. Photo by Jeff Adams, Somerset Oil, Inc.

A large sinkhole along Ky. 27 near Somerset, approximately 50 feet in diameter. Sinkholes found near any construction project, whether industrial or residential, must be carefully considered and require special management. Photo by Bart Davidson, Kentucky Geological Survey.

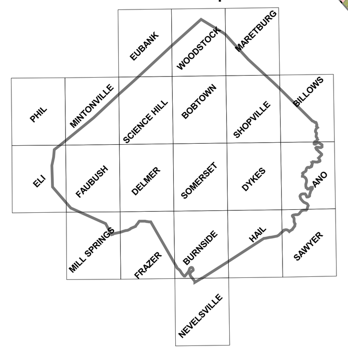


John Sherman Cooper Power Plant is located on the Cumberland River near Burnside. This plant uses over 600,000 tons of coal per year, with sources in eastern Kentucky and Tennessee. Photo by Bart Davidson, Kentucky Geological Survey.

Short Creek near Stab. This is one of the best examples of a karst window in Kentucky, where a section of an underground river is exposed at the surface. Photo by Bart Davidson, Kentucky Geological Survey. 6

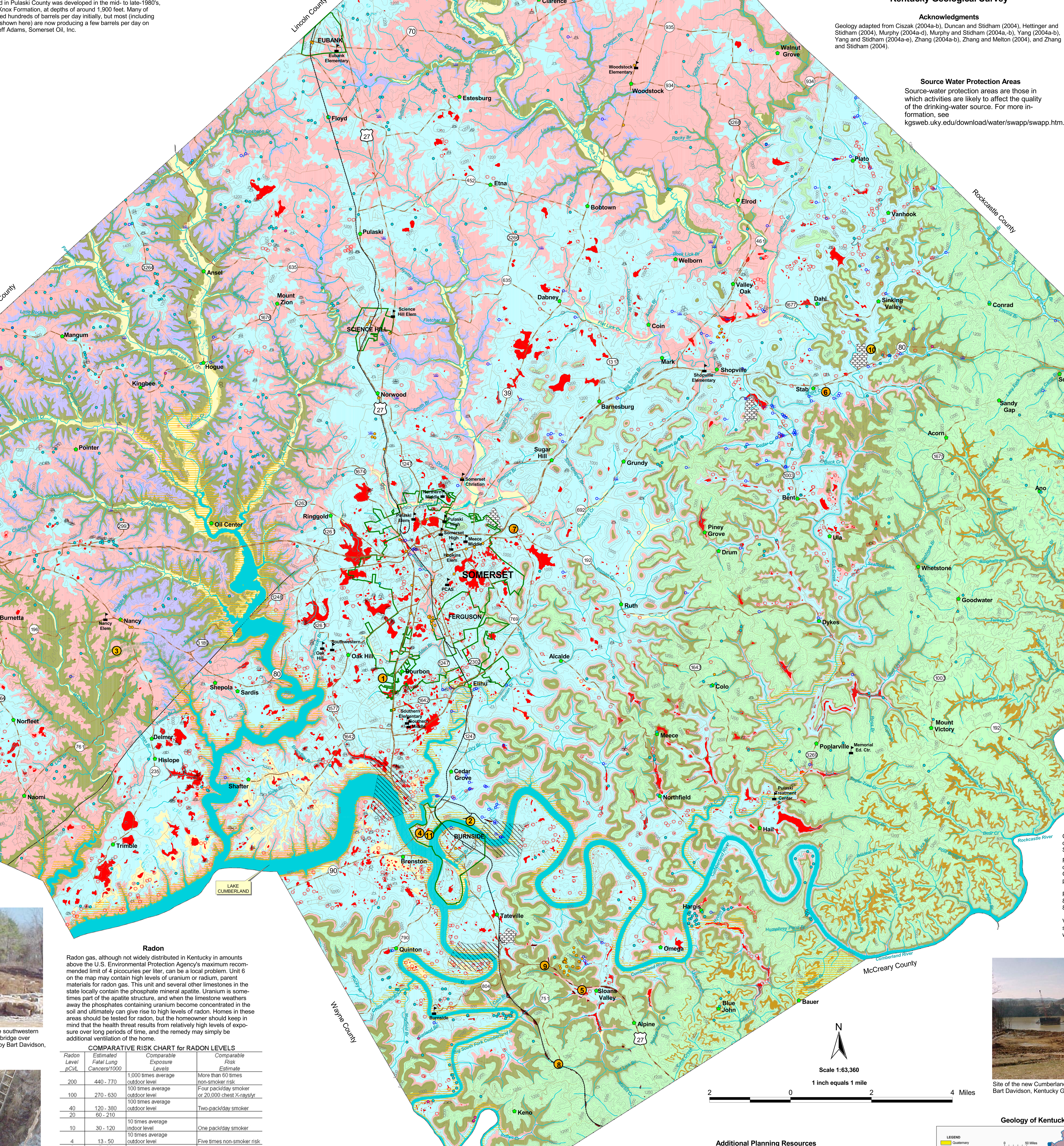
Mapped Surface Faults

Faults are common geologic structures across Kentucky, and have been mapped in many of the Commonwealth's counties. The faults shown on this map represent seismic activity that occurred several million years ago at the latest. There has been no activity along these faults in recorded history. Seismic risk associated with these faults is very low. Faults may be associated with increased fracturing of bedrock in the immediately adjacent area. This fracturing may influence slope stability and groundwater flow in these fractured limestones.



For Planning Use Only

This map is not intended to be used for selecting individual sites. Its purpose is to inform land-use planners, government officials, and the public in a general way about geologic bedrock conditions that affect the selection of sites for various purposes. The properties of thick soils may supersede those of the underlying bedrock and should be considered on a site to site basis. At any site, it is important to understand both the soils and the underlying rock. For further assistance, contact Bart Davidson, Kentucky Geological Survey, 859-257-5500 x162. For more information, and to make custom maps of your local area, visit our Land-Use Planning Internet Mapping Web Site at kgsmap.uky.edu/website/kyluplan/viewer.htm.



Source Water Protection Areas

Source-water protection areas are those in which activities are likely to affect the quality of the drinking-water source. For more information, see kgsweb.uky.edu/download/water/swapp/swapp.htm.

EXPLANATION

School

Soil Survey Observations
- Severe erosion
- Rock outcrop
- Sinkhole
- Wet area

Oil and Gas Wells
- Gas well
- Oil and gas well
- Oil well
- Class II injection well

Spring

Water Wells
- Domestic
- Industrial
- Monitoring
- Public

Quarry

Incorporated city

Wetlands > 1 acre (U.S. Fish & Wildlife Service, 2003)

Wildlife management area

Source water protection area, zone 1

Mapped sinkholes

Artificial fill

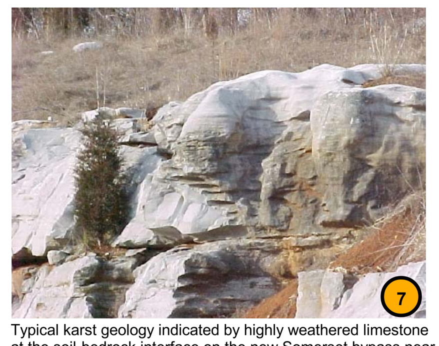
Faults
- Concealed fault
- Fault

Railroad

County line

Photo location

50-foot contour interval



Typical karst geology indicated by highly weathered limestone at the soil-bedrock interface on the new Somerset bypass near the intersection of Ky. 80. Photo by Bart Davidson, Kentucky Geological Survey. 7

Keno Bridge, near the southern tip of Pulaski County on Ky. 751, spans a railroad cut of Pennsylvanian rocks (sandstones and shales) and Mississippian rocks (shales and limestones). Photo by Bart Davidson, Kentucky Geological Survey. 8

A large inactive landfill near Sloans Valley in southern Pulaski County. Locating landfills in a karst setting (sinkholes, springs, caves, and underground streams) requires careful planning. Photo by Bart Davidson, Kentucky Geological Survey. 9

This highwall in a limestone quarry shows the variability of rock types within a single formation (Slade Formation). Dolomite, limestone, and shale layers are visible. Photo by Richard Smath, Kentucky Geological Survey.

Excavation of large limestone blocks near the southwestern abutment construction site of the new Ky. 90 bridge over the Cumberland River near Bronston. Photo by Bart Davidson, Kentucky Geological Survey.

One of several entrances to Sloans Valley Cave in southern Pulaski County. There are many caves in Pulaski County, which are part of a complex underground drainage system typical of well-developed karst geology. Photo by Bart Davidson, Kentucky Geological Survey.

Radon

Radon gas, although not widely distributed in Kentucky in amounts above the U.S. Environmental Protection Agency's maximum recommended limit of 4 picocuries per liter, can be a local problem. Unit 6 on the map may contain high levels of uranium or radium, parent materials for radon gas. This unit and several other limestones in the state locally contain the phosphate mineral apatite. Uranium is sometimes part of the apatite structure, and when the limestone weathers away the phosphates containing uranium become concentrated in the soil and ultimately can give rise to high levels of radon. Homes in these areas should be tested for radon, but the homeowner should keep in mind that the health threat results from relatively high levels of exposure over long periods of time, and the remedy may simply be additional ventilation of the home.

COMPARATIVE RISK CHART for RADON LEVELS

Radon Level pCi/L	Estimated Fatal Lung Cancers/1000	Comparable Exposure Levels	Comparable Risk Estimate
200	440 - 770	1,000 times average outdoor level	More than 60 times non-smoker risk
100	270 - 630	100 times average outdoor level	Four pack/day smoker or 20,000 chest X-rays/yr
40	120 - 380	100 times average outdoor level	Two-pack/day smoker
20	60 - 210		
10	30 - 120	10 times average indoor level	One pack/day smoker
4	13 - 50	10 times average outdoor level	Five times non-smoker risk
2	7 - 30		
1	3 - 13	Average indoor level	Non-smoker risk of fatal lung cancer
0.2	1 - 3	Average outdoor level	20 chest X-rays/yr

EPA recommends action be taken if indoor levels exceed 4 pCi/L, which is 10 times the average outdoor level. Some EPA representatives believe the action level should be lowered to 2 pCi/L; other scientists dissent and claim the risks estimated in this chart are already much too high for low levels of radon. The action level in European countries is set at 10 pCi/L. Note that this chart is only one estimate; it is not based upon any scientific result from a study of a large population meeting the listed criteria. (from the U.S. Environmental Protection Agency)

Additional Planning Resources

Listed below are Web sites for several agencies and organizations that may be of assistance with land-use planning issues in Pulaski County:

www.pulaskicountygovt.com/–Pulaski County Government
ces.ca.uky.edu/pulaski/–University of Kentucky Cooperative Extension Service
www.lcadd.org/–Lake Cumberland Area Development District
www.thinkkentucky.com/edis/cmnty/cw116/–Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21199.html–Kentucky Atlas and Gazetteer, Pulaski County
quickfacts.census.gov/qfd/states/21/21199.html–U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm–Planning information from the Kentucky Geological Survey

Scale 1:63,360
1 inch equals 1 mile

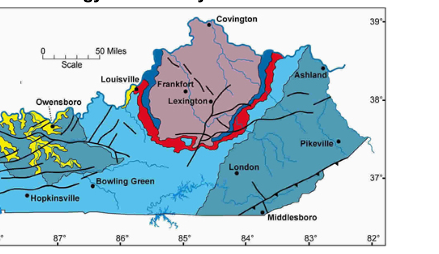
For information on obtaining copies of this map and other Kentucky Geological Survey maps and publications call:

Public Information Center
859.257.3896 or
877.778.7827 (toll free)

View the KGS World Wide Web site at:
www.uky.edu/kgs

Site of the new Cumberland River bridge on Ky. 90. Photo by Bart Davidson, Kentucky Geological Survey. 11

Geology of Kentucky



Learn more about Kentucky Geology at www.uky.edu/kgs/geology/

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