Kentucky Geological Survey
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UNIVERSITY OF KENTUCKY

MAP AND CHART 89

Series XII, 2005

Generalized Geologic Map
for
Land-Use Planning:
Estill County, Kentucky

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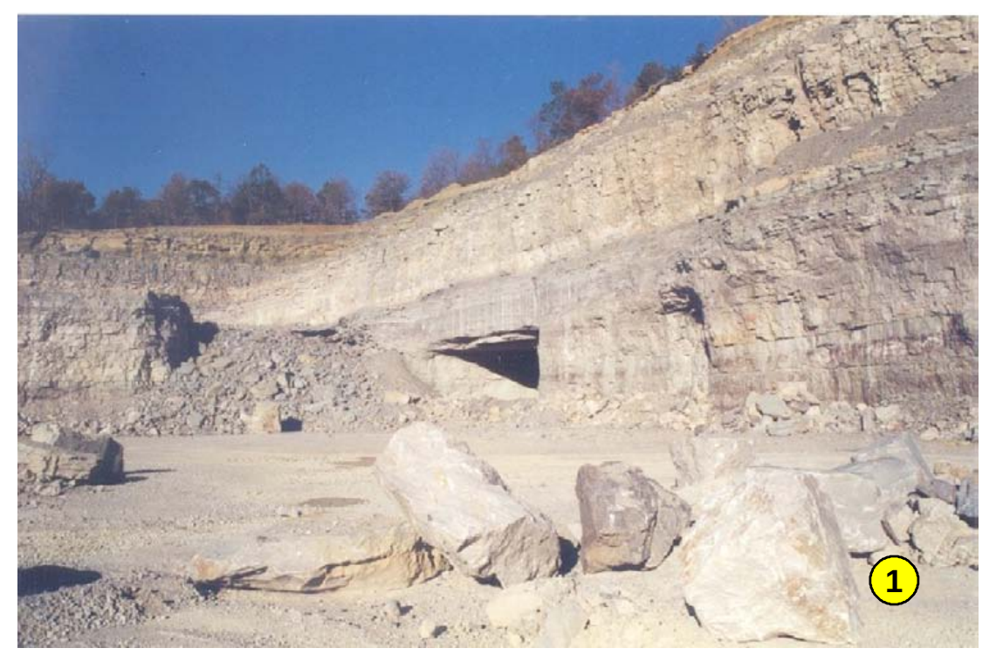
Kentucky Geological Survey

For Planning Use Only

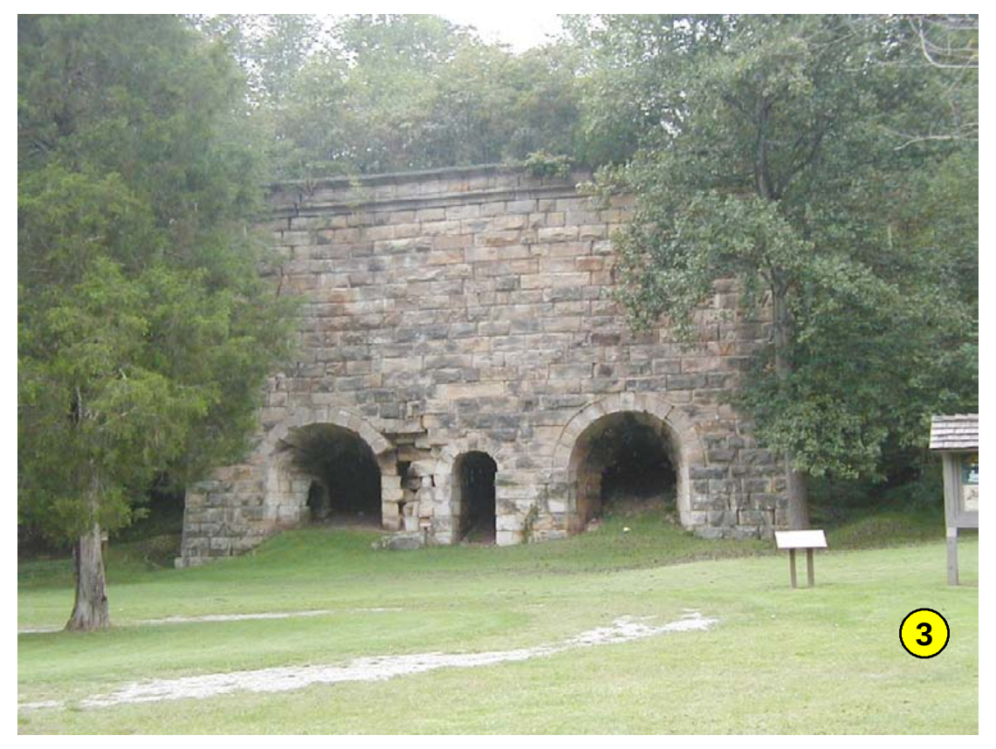
This map is not intended to be used for selecting individual sites. Its purpose is to inform land-use planners, government officials, and the public in a general way about geologic bedrock conditions that affect the selection of sites for various purposes. The properties of thick soils may supercede those of the underlying bedrock and should be considered on a site-to-site basis. At any site, it is important to understand the characteristics of both the soils and the underlying rock. For further assistance, contact the Kentucky Geological Survey, 859.257.5500. 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.

Resources



The Tipton Ridge Quarry and Mine near Irvine produces aggregate from the dolomite and limestone unit. Photograph by Richard Smath, Kentucky Geological Survey.

The high-level gravel unit exposed here along Ky. 52 west of Irvine is mined locally for sand and gravel. This deposit was created by an ancient river that flowed through the area thousands of years ago. Valleys created by this paleoriver (ancient river) can still be seen around Irvine, and are excellent farming areas. Photograph by John F. Stickney, Kentucky Rural Water Association.



The Fitchburg Iron Furnace produced pig iron from 1870 to 1874, and was the largest furnace built in Kentucky. It had such a high capacity that the local timber and ore supply was depleted too rapidly, resulting in the closing of the furnace. Kentucky ranked third in the nation in iron production in 1830, and 11th in 1965. Photograph by John F. Stickney, Kentucky Rural Water Association.

This pond on a ridge of the Estill County Industrial Park was used to contain siltation from a nearby coal-processing plant, which is now abandoned. Photograph by John F. Stickney, Kentucky Rural Water Association.

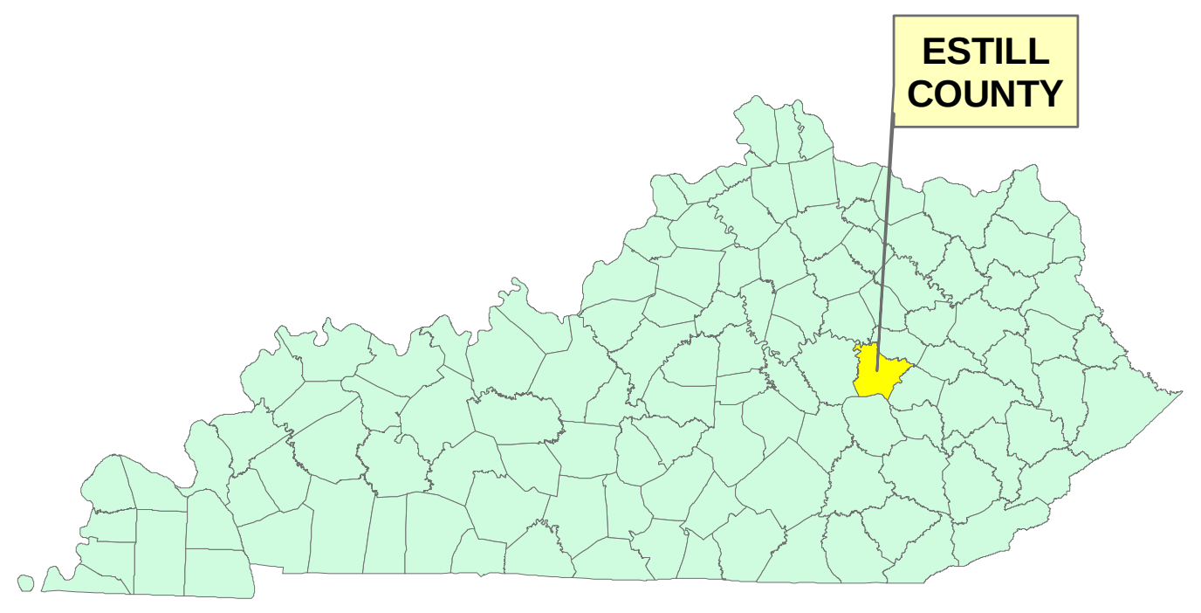
Groundwater

In the Kentucky River Valley in central Estill County, most drilled wells less than 100 feet deep will produce enough water for a domestic supply. In the larger creek valleys of the county, some wells will produce enough water for a domestic supply except during dry weather. In the upland areas of Estill County (about 70 percent of the county), most drilled wells will not produce enough water for a dependable domestic supply, except along drainage lines; these wells may produce enough except during dry weather. A few springs supply enough water for domestic use.

Throughout the county, groundwater is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet. For more information on groundwater in the county, see Carey and Stickney (2001).

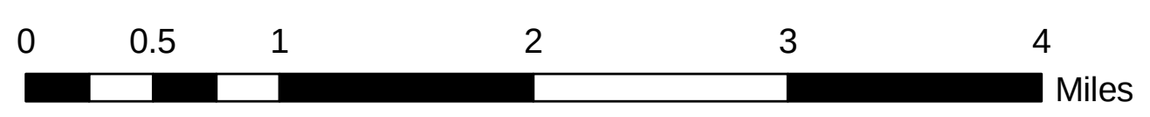
Development

New residential development near Hargett in northern Estill County along Ky. 82 makes use of relatively flat land with knob topography in the background. Photograph by John F. Stickney, Kentucky Rural Water Association.



Scale 1:48,000

1 inch equals 3/4 mile



Legend

- ⚑ School

Oil and Gas Wells

- ✳ Gas
- ✳ Oil and gas
- ● Oil
- ● Enhanced Recovery

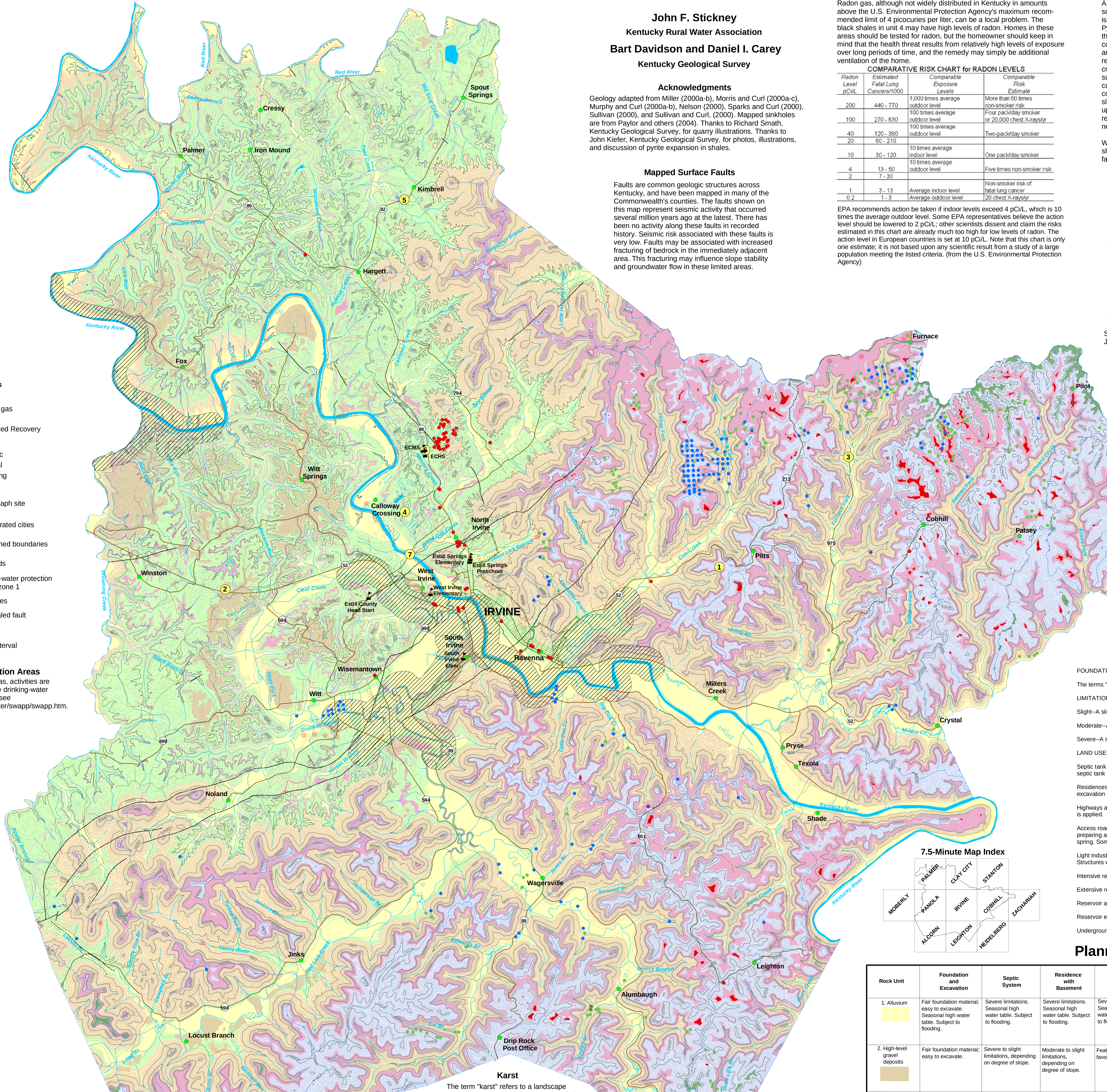
Water wells

- ○ Domestic
- ● Industrial
- ● Monitoring
- ○~ Spring
- ② Photograph site
- ▭ Incorporated cities
- ▭ Watershed boundaries
- ▨ Wetlands
- ▨ Source-water protection areas, zone 1
- 🟥 Sinkholes
- -------- Concealed fault
- ——— Fault

40-foot contour interval

Source-Water Protection Areas

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



Acknowledgments

Geology adapted from Miller (2000a-b), Morris and Curl (2000a-c), Murphy and Curl (2000a-b), Nelson (2000), Sparks and Curl (2000), Sullivan (2000), and Sullivan and Curl, (2000). Mapped sinkholes are from Paylor and others (2004). Thanks to Richard Smath, Kentucky Geological Survey, for quarry illustrations. Thanks to John Kiefer, Kentucky Geological Survey, for photos, illustrations, and discussion of pyrite expansion in shales.

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 limited areas.

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. The black shales in unit 4 may have 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

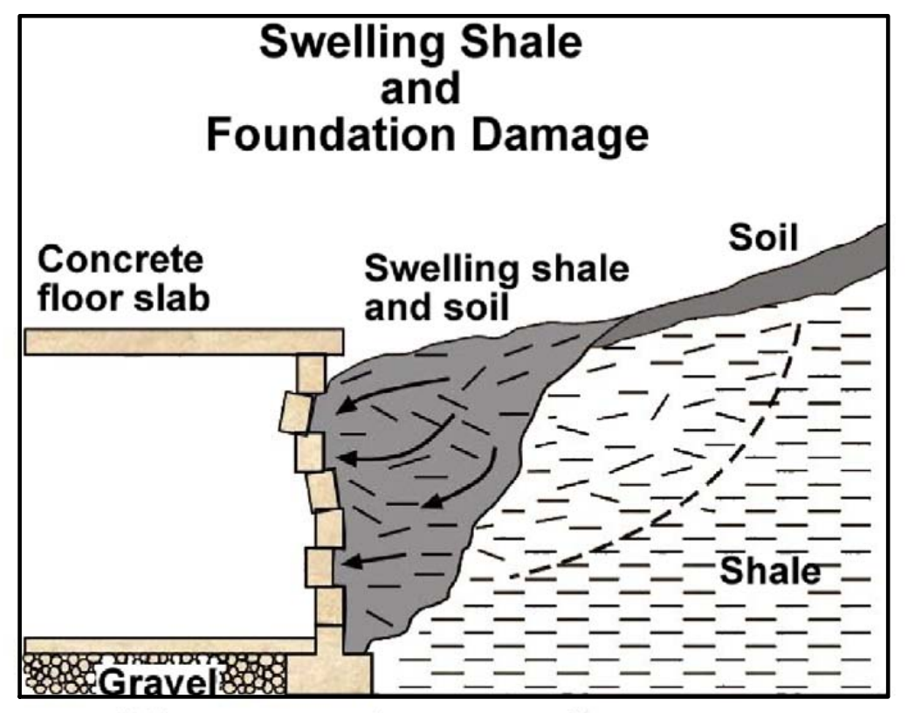
Radon Level pCi/L	Estimated Fatal Lung Cancers/1000	Comparable Exposure Levels	Comparable Risk Estimate
200	440 - 770	1,000 times average outdoor level	More than 60 times non-smoker risk
100	270 - 630	100 times average outdoor level	Four pack/day smoker or 20,000 chest X-rays/yr
40	120 - 380	100 times 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)

Swelling Shales and Soils

A problem of considerable concern in Estill County is swelling of some of the clay minerals in shales in units 3, 4, and 6. This process is exacerbated when the shale contains the mineral pyrite (fool's gold). Pyrite is a common mineral and can be found distributed throughout the black shale, although it is not always present and may be discontinuous both laterally and horizontally. In the presence of moisture and oxygen, pyrite oxidizes and produces sulfuric acid. The acid reacts with calcium carbonates found in water, the rock itself, crushed limestone, and concrete. This chemical reaction produces sulfate and can form the mineral gypsum, whose crystallization can cause layers of shale to expand and burst, backfill to swell, and concrete to crack and crumble. It can heave the foundation, the slab and interior partitions resting on it, and can even damage upper floors and interior partitions. This phenomenon has been responsible for extensive damage to schools, homes, and businesses in Kentucky.

We strongly suggest that anyone planning construction on these shales seek professional advice from a geologist or engineer familiar with the problem.



Swelling shales should never be used for backfill. Illustration by John Kiefer, Kentucky Geological Survey.

Expanding shales in Irvine have damaged the foundation of the Estill County Middle School gymnasium. The floors had to be removed and the shales isolated from moisture and further oxidation by using an innovative process of covering them with resin. Other buildings are threatened by this problem, which is caused by the oxidation of pyrite in the shales. Photograph by John F. Stickney, Kentucky Rural Water Association.

Some shales, and the soils derived from them, swell when exposed to water or air. These swelling shales and soils can have severe impacts on building foundations and other structures (e.g., bridges, dams, roads). Photograph by John Kiefer, Kentucky Geological Survey.

Flooding

Kentucky River bottom land is excellent for growing crops, but is subject to seasonal flooding. Photo taken from the new bypass bridge near Irvine. Photograph by John F. Stickney, Kentucky Rural Water Association.

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 soil.

Residences--Ratings are made for residences with and without basements because the degree of limitation is dependent upon ease and required 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.

7.5-Minute Map Index

Planning Guidance by Rock Unit Type

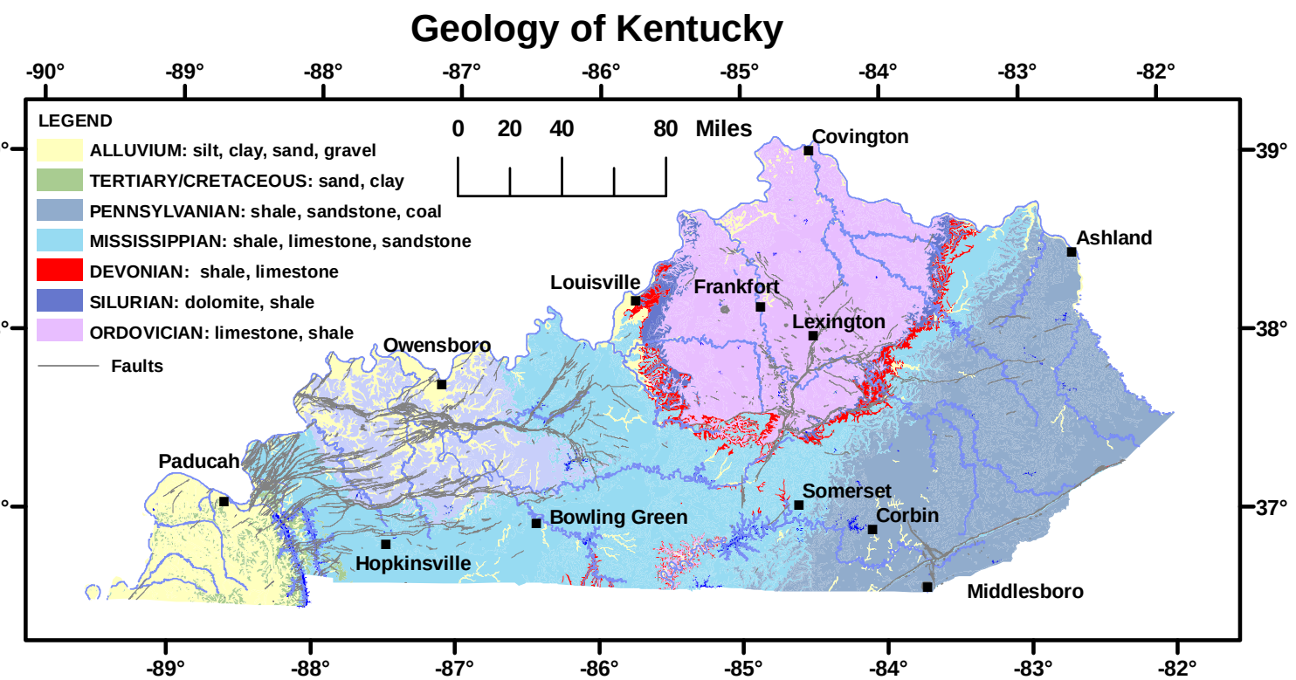
Rock Unit	Foundation and Excavation	Septic System	Residence with Basement	Highways and Streets	Access Roads	Light Industry and Malls	Intensive Recreation	Extensive Recreation	Reservoir Areas	Reservoir Embankments	Underground Utilities
1. Alluvium 🟨	Fair foundation material; easy to excavate. Seasonal high water table. Subject to flooding.	Severe limitations. Seasonal high water table. Subject to flooding.	Severe limitations. Seasonal high water table. Subject to flooding.	Severe limitations. Seasonal high water table. Subject to flooding.	Severe limitations. Seasonal high water table. Subject to flooding.	Severe limitations. Seasonal high water table. Subject to flooding.	Severe to slight limitations, depending on activity and topography. Subject to flooding.	Severe to slight limitations, depending on activity and topography. Subject to flooding. Slight limitations for forest or nature preserve.	Pervious material. Seasonal shallow water table. Subject to flooding.	Fair stability and compaction characteristics. Piping hazard.	Features generally favorable, except for seasonal high water table and subject to flooding.
2. High-level gravel deposits 🟫	Fair foundation material; easy to excavate.	Severe to slight limitations, depending on degree of slope.	Moderate to slight limitations, depending on degree of slope.	Features generally favorable.	Features generally favorable, depending on degree of slope.	Features generally favorable, depending on degree of slope.	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. Potential for forest or nature preserve.	Pervious material.	Fair stability. Pervious material subject to piping.	Features generally favorable.
3. Siltstone, shale, and limestone 🟧	Fair to good foundation material; difficult to excavate. Possible pyrite expansion in shales.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks 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. Potential for forest or nature preserves.	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.
4. Shale and thin dolomite layers 🟩	Fair to poor foundation material; easy to moderately difficult to excavate. Possible pyrite expansion in shales. Plastic clay presents particularly poor foundation conditions.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks to water table; possible groundwater contamination.	Severe to moderate limitations. Rock excavation may be required. Possible radon occurrence. Plastic clay presents particularly poor foundation conditions.	Moderate limitations. Rock excavation. Local drainage problems. Plastic clay presents particularly poor foundation conditions, and will not hold up in high-angle roadcuts.	Moderate limitations. Rock excavation. Possible steep slopes. Local drainage problems. Plastic clay presents particularly poor foundation conditions, and will not hold up in high-angle roadcuts.	Severe to slight limitations, depending on topography. Rock excavation. Local drainage problems. Sinks common. Possible pyrite expansion in shales. Plastic clay presents particularly poor foundation conditions.	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. Potential for forest or nature preserve.	Severe to moderate limitations. Reservoir may leak where rocks are fractured. Plastic clay presents particularly good seal for water retention.	Severe to moderate limitations. Reservoir may leak where rocks are fractured. Plastic clay presents particularly good seal for water retention, but has a tendency to slump.	Severe to moderate limitations. Possible rock excavation.
5. Dolomite and limestone 🟪	Excellent 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.	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. Potential for forest or nature preserve.	Moderate to slight limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to slight limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Severe limitations. Rock excavation.
6. Shale, siltstone, and sandstone 🟦	Fair to good foundation material; difficult to excavate. Possible expansive shales.	Severe limitations. Thin soils. Impermeable rock.	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. Potential for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
7. Sandstone 🟩	Fair to good foundation material; difficult to excavate.	Severe limitations. Thin soils.	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. Potential for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are jointed or fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.

Karst

The term "karst" refers to a landscape 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 are 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.

Geology of Kentucky


-90°
-89°
-88°
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-83°
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39°
38°
37°
LEGEND
ALLUVIUM: silt, clay, sand, gravel
TERTIARY/CRETACEOUS: sand, clay
PENNSYLVANIAN: shale, sandstone, coal
MISSISSIPPIAN: shale, limestone, sandstone
DEVONIAN: shale, limestone
SILURIAN: dolomite, shale
ORDOVICIAN: limestone, shale
Faults
0 20 40 80 Miles
Covington
Ashland
Louisville
Frankfort
Lexington
Owensboro
Paducah
Hopkinsville
Bowling Green
Somerset
Corbin
Middlesboro

Learn more about Kentucky geology at www.uky.edu/KGS/geoky/

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