Kentucky Geological Survey
James C. Cobb, State Geologist and Director
UNIVERSITY OF KENTUCKY, LEXINGTON

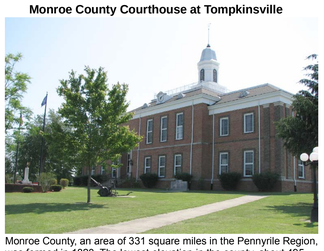
Generalized Geologic Map for Land-Use Planning: Monroe County, Kentucky

Daniel I. Carey

Acknowledgments

Geology adapted from Johnson (2004a, b), Lambert (2004), Mullins (2004a, b), Mullins and Thompson (2004), Smith (2004), and Thompson (2004a, b). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for pond construction illustration. Mapped sinkhole data from Paylor and others (2004). Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base-map data.

Monroe County Courthouse at Tompkinsville

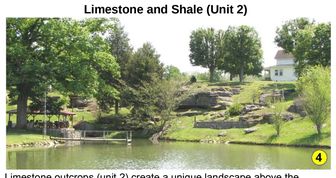


Monroe County, an area of 331 square miles in the Pennyrile Region, was formed in 1820. The lowest elevation in the county, about 495 feet, is where the Cumberland River crosses the state line. The highest elevation, 1,141 feet, is near Persimmon. The estimated 2006 population of 11,771 was 0.1 percent greater than that of 2000.

Mill Creek Lake

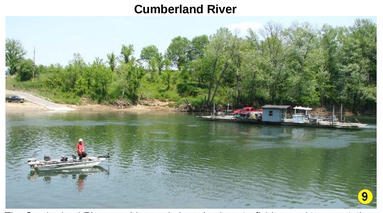
The 113-acre Mill Creek Lake serves as the city's reservoir and fishing hole. The adjacent recreation area offers picnic areas, sports facilities, and wooded areas for hiking. Photo by Dan Carey, Kentucky Geological Survey.

Limestone and Shale (Unit 2)



Limestone outcrops (unit 2) create a unique landscape above the spring-fed pond at this beautiful home. Photo by Dan Carey, Kentucky Geological Survey.

Cumberland River

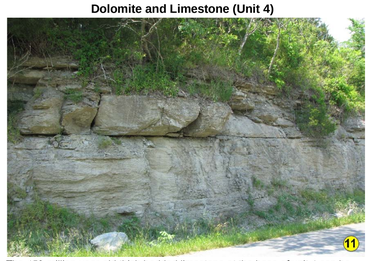


The Cumberland River provides soul-cleansing beauty, fishing, and transportation. The last free 24-hour ferry in Kentucky operates at McMillians Landing near Otia. Photo by Dan Carey, Kentucky Geological Survey.

For information on obtaining copies of this map and other Kentucky Geological Survey maps and publications call our Public Information Center at 859.257.3896 or 877.778.7827 (toll free)

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

Dolomite and Limestone (Unit 4)



The 450-million-year-old thick-bedded limestone at the base of unit 4 can be seen along Ky. 100 near Meshack. Photo by Dan Carey, Kentucky Geological Survey.

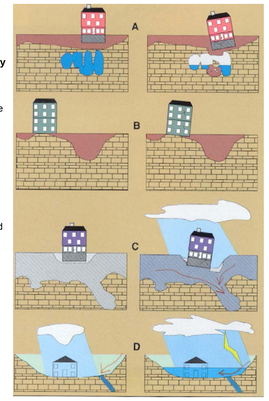
Limestone and Shale (Unit 2)

Limestone (unit 2) of the Salem-Warsaw Formation in the Monroe Quarry. Photo by Dan Carey, 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 supersede 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.

Construction on Karst



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).

Shale, Siltstone, and Limestone (Unit 3)

Shale, siltstone, and limestone of unit 3 can be seen along Ky. 100 (right). Siltstone is present in the steep hills of the Cumberland River basin in the east. In the west, limestone and shale predominate in the unit and the terrain is less rugged. Photo by Dan Carey, Kentucky Geological Survey.

Silt, Sand, Gravel, Boulders (Unit 6)

The exact source of the anomalous sandstone residue of unit 6 beneath the airport is still uncertain. Photo by Dan Carey, Kentucky Geological Survey.

7.5-Minute Quadrangle Map Index

Mineral Resources

Construction aggregate and agricultural lime are produced from limestones (unit 2) at the Monroe County Quarry operated by Scotty's Contracting and Stone. Limestone lies at the foundation of virtually every economic and development activity in the county. Photo by Dan Carey, Kentucky Geological Survey.

Agriculture and Timber

Areas underlain by limestones of unit 2 (upper left) have soils for a strong agriculture and provide attractive sites for homes. Thoughtful planning can minimize conflicting interests. Alluvial valleys of unit 1 (upper right) also provide broad areas for agriculture. With nearly 60,000 head of cattle, Monroe County is one of the leading producers in the state. Annual agriculture revenue is nearly $35 million. The more rugged terrain of unit 3 produces timber for lumber and wood products industry (left). Photos by Dan Carey, Kentucky Geological Survey.

Groundwater

About 550 people in Monroe County rely on private domestic water supplies: 400 use wells and 150 use other sources. In the northwestern and north-central area of Monroe County, more than three-quarters of the drilled wells in uplands are adequate for a domestic supply. Yields as high as 50 gallons per minute 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 for a domestic supply. Numerous springs with flows ranging from a few gallons per minute to 5,000 gallons per minute are found in the county. Minimum flows generally occur in early fall, maximum flows in late winter. For more information on groundwater in the county, see Carey and Stickney (2004).

Radon Ventilation

Ventilation system removes radon from the basement area of this home on unit 5. Photo by Dan Carey, Kentucky Geological Survey.

Radon

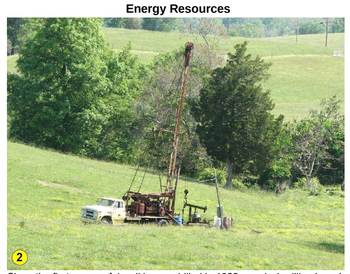
Radon gas can be a local problem, in some areas exceeding the U.S. Environmental Protection Agency's maximum recommended limit of 4 picocuries per liter. The shales of unit 5 and limestones of units 2, in particular, may contain high levels of uranium or radium, parent materials for radon gas. Homes in these areas should be tested for radon, but the homeowner should keep in mind that the threat to health results from relatively high levels of exposure over long periods, and the remedy may simply be additional ventilation of the home.

Radon Risk If You've Never Smoked (U.S. Environmental Protection Agency, 2005)

Radon Level	If 1,000 people who never smoked were exposed to this level over a lifetime*...	The risk of cancer from radon exposure compares to**...	WHAT TO DO:
20 pCi/L	About 36 people could get lung cancer	35 times the risk of drowning	Fix your home
10 pCi/L	About 18 people could get lung cancer	20 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 15 people could get lung cancer	4 times the risk of dying in a fall	Fix your home
4 pCi/L	About 7 people could get lung cancer	The risk of dying in a car crash	Fix your home
2 pCi/L	About 4 people could get lung cancer	The risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 2 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult.)
0.4 pCi/L		(Average outdoor radon level)	

Note: If you are a former smoker, your risk may be higher.
* Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).
** Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.

Energy Resources



Since the first successful well in was drilled in 1922, nearly 1 million barrels of oil have been pumped from beneath the county. Production was greatest during the 1960's. Photo by Dan Carey, Kentucky Geological Survey.

Pond Construction

Successful pond construction must prevent water from seeping through structured soils into limestone solution channels below. A compacted clay liner or artificial liner may prevent pond failure. Getting the basin filled with water as soon as possible after construction prevents drying and cracking, and possible leakage, of the clayey soil liner. Ponds constructed in dry weather are more apt to leak than ponds constructed in wet weather. A geotechnical engineer or geologist should be consulted regarding the requirements of a specific site. Other leakage prevention measures include synthetic liners, bentonite, and asphaltic emulsions. The U.S. Department of Agriculture–Natural Resources Conservation Service can provide guidance on the application of these liners to new construction, and for treatment of existing leaking ponds.

Dams should be constructed of compacted clayey soils at slopes flatter than 3 units horizontal to 1 unit vertical. Ponds with dam heights exceeding 25 feet, or pond volumes exceeding 50 acre-feet, require permits. Contact the Kentucky Division of Water, 14 Reilly Rd., Frankfort, KY 40601, telephone: 502.564.3410. Illustration by Paul Howell, U.S. Department of Agriculture–Natural Resources Conservation Service.

Black Shale (Unit 5)

The 400-million year old Devonian Chattanooga Shale along Ky. 100 contains enough organic matter to burn. It breaks down quickly when exposed, and may swell when wet and shrink when dry. Photo by Dan Carey, Kentucky Geological Survey.

Additional Resources

Listed below are Web sites for several agencies and organizations that may be of assistance with land-use planning issues in Monroe County:
monroecounty.virtualave.net/—Tompkinsville/Monroe County Chamber of Commerce
ces.ca.uky.edu/monroe/—UK Cooperative Extension Service
www.bradd.org/—Barren River Area Development District
www.uky.edu/KentuckyAtlas/21171.html—Kentucky Atlas and Gazetteer
quickfacts.census.gov/qfd/states/21/21171.html—U.S. Census data
www.bae.uky.edu/ext/Residential/Radon/QandA.htm—Radon in the home
kgsweb.uky.edu/download/misc/landuse/mainkyuplan.htm—Planning information from the Kentucky Geological Survey

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.

EXPLANATION

- School

Water wells
- Domestic
- Industrial
- Agriculture
- Monitoring
- Spring
- Oil well
- Gas well
- Incorporated city boundary
- Public lands
- Source-water protection area, zone 1
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Watershed boundaries
- Quarry
- Mapped sinkhole
- Geologic fault
- Concealed geologic fault
- 50-foot contour interval
- (4) Photo location

Geology of Kentucky

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

LAND-USE PLANNING TABLE 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 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 the 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. Clay, silt, sand, and gravel (alluvium)	Fair foundation material; easy to excavate.	Severe limitations. Failed septic systems can contaminate groundwater. Refer to soil report (Mitchell and Latham, 1982).	Water in alluvium may be in direct contact with basements. Refer to soil report (Mitchell and Latham, 1982).	Slight limitations. Refer to soil report (Mitchell and Latham, 1982).	Slight to moderate limitations. Refer to soil report (Mitchell and Latham, 1982).	Slight to moderate limitations. Avoid construction in flood-plain. Refer to soil report (Mitchell and Latham, 1982).	Refer to soil report (Mitchell and Latham, 1982).	Refer to soil report (Mitchell and Latham, 1982).	Refer to soil report (Mitchell and Latham, 1982).	Not recommended. Refer to soil report (Mitchell and Latham, 1982).	Not recommended. Refer to soil report (Mitchell and Latham, 1982).
2. Limestone and shale	Excellent foundation material; difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks. Danger of groundwater contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks common. Drainage required.	Slight to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks common. Drainage required.	Slight limitations. Local drainage problems from seeps or springs. Sinks common.	Slight to moderate limitations, depending on topography. Rock excavation; locally, upper few feet may be rippable. Sinks common. Local drainage problems.	Slight to moderate limitations, depending on activity and topography.	Slight to moderate limitations, depending on activity and topography.	Severe limitations. Leaky reservoir rock; locally, conditions may be favorable. Sinks common.	Severe limitations. Leaky rock. Locally, conditions may be favorable.	Severe limitations. Rock excavation.
3. Shale*, siltstone, limestone	Fair to good foundation material; easy to moderately difficult to excavate. Possible expansion of shales.	Severe limitations. Low permeability.	Moderate to severe limitations. Rock excavation; locally, upper few feet may be rippable. Possible expansion of shales.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. 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, depending on activity and topography.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Steep slopes.	Moderate limitations. Highly variable amount of rock and earth excavation.
4. Dolomite and limestone	Good to excellent foundation material; difficult to excavate.	Severe limitations. Locally fast drainage through fractures. Danger of groundwater contamination.	Severe limitations. Rock excavation may be required.	Severe limitations. Rock excavation. Possible steep slopes.	Moderate to severe limitations. Rock excavation. Possible steep slopes.	Slight to moderate limitations, depending on topography. Rock excavation. Local drainage problems.	Slight to severe limitations, depending on activity and topography.	Slight to severe limitations, depending on activity and topography.	Moderate to severe limitations. Reservoir might leak where rocks are fractured.	Moderate to severe limitations. Reservoir might leak where rocks are fractured.	Severe limitations. Rock excavation.
5. Black shale*	Fair to poor foundation material; easy to moderately difficult to excavate. Possible expansion of shales. Plastic clay is particularly poor foundation.	Severe limitations. Low permeability.	Severe limitations. Low strength, slumping, and seepage problems. Possible shrinking and swelling of shales.	Moderate to severe limitations, depending on slopes. Strength, slumping, and seepage problems.	Moderate to severe limitations, depending on slopes. Strength, slumping, and seepage problems.	Moderate to severe limitations, depending on slopes. Strength, slumping, and seepage problems.	Severe to slight limitations, depending on activity and topography. Strength, slumping, and seepage problems.	Moderate to slight limitations, depending on activity and topography.	Slight limitations. Reservoir may leak where rocks are fractured. Most ponds on shale are successful.	Severe limitations. Poor strength and stability.	Moderate limitations. Poor strength, wetness.
6. Silt, sand, gravel, boulders	Fair to good foundation material; easy to moderately difficult to excavate.	Severe limitations. Danger of groundwater contamination.	Slight to moderate limitations. Sandstone varies in size from gravel to boulder.	No limitations.	No limitations.	No limitations.	No limitations.	No limitations.	Not recommended. Pervious material.	Not recommended. Pervious material.	Slight limitations.

*Shales and clays in these units may shrink during dry periods and swell during wet periods, and cause cracking of foundations. On hillsides, especially where seeps and springs are present, they can also be susceptible to landslides.

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KGS

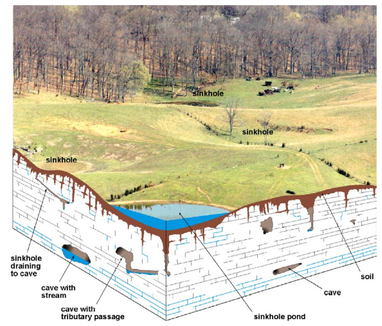
MAP AND CHART 166

Series XII, 2007

Karst Geology

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 snowmelt seeps through soil cover into fractured and soluble bedrock (usually limestone, dolomite, or gypsum). Sinkholes are depressions on the land surface into which 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 large enough for a person to enter.

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)