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

Daniel I. Carey
University of Kentucky, carey@uky.edu

Richard E. Sergeant
University of Kentucky, richard.sergeant@uky.edu

Peter Eclov
University of Kentucky

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

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Daniel I. Carey and Richard E. Sergeant
Kentucky Geological Survey

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Acknowledgments

Geology adapted from Crawford (2002a-e), Toth and Crawford (2002), Bhattarai (2004a, b), and Conley (2005a-c). Mapped sinkhole data from Paylor and others (2004). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for pond construction illustration.

Ohio River

The Ohio River plays an important role in the Meade County economy, providing transportation, water resources, and alluvial plains for agriculture and industry. The old meander cutoff shown below provides a beautiful, peaceful valley for rural living. Photos by Dan Carey, Kentucky Geological Survey.

Historic Landmarks

Construction of Doe Run Inn, using local limestones, began in 1780 and finished in 1821. The inn provides rooms for parties, overnight guests, and delicious home-style cooking. Photo by Rick Sergeant, Kentucky Geological Survey.

Agriculture

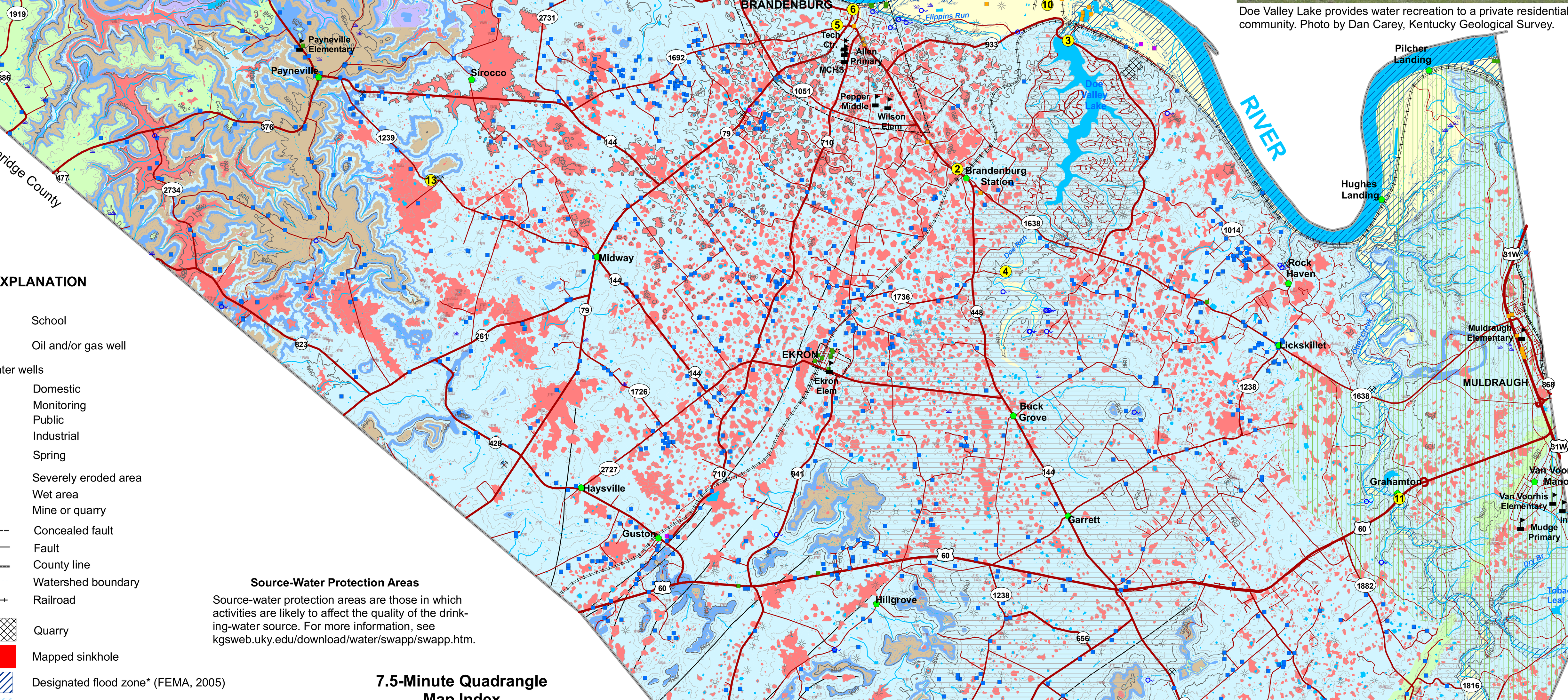
The Ohio River alluvium provides a good setting for agricultural facilities such as chicken houses. Photo by Dan Carey, Kentucky Geological Survey.

Industry

The wide Ohio River alluvium has ample space for large industrial development like this chemical plant. The river provides transportation and water. Photo by Dan Carey, Kentucky Geological Survey.

Mineral Resources

Limestone deposits are extracted from quarries along the Ohio River to provide aggregate for the construction industry. Photo by Dan Carey, Kentucky Geological Survey.



EXPLANATION

- School
- Oil and/or gas well

Water wells
- Domestic
- Monitoring
- Public
- Industrial
- Spring
- Severely eroded area
- Wet area
- Mine or quarry
- Concealed fault
- Fault
- County line
- Watershed boundary
- Railroad
- Quarry
- Mapped sinkhole
- Designated flood zone* (FEMA, 2005)
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Incorporated city boundaries
- Source-water protection area, zone 1
- Fort Knox Military Reservation

40-foot contour interval

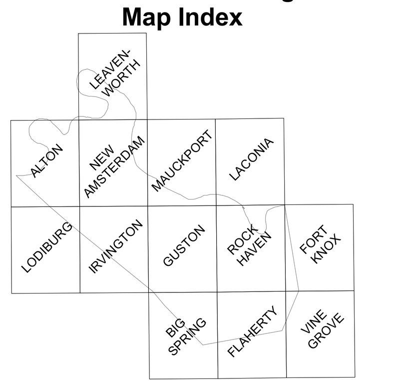
(4) Photo location

*Flood information is available from the Kentucky Division of Water, Flood Plain Management Branch, www.water.ky.gov/floods/.

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.

7.5-Minute Quadrangle Map Index



LAND-USE PLANNING TABLE DEFINITIONS

FOUNDATION AND EXCAVATION

The terms "earth" and "rock" excavation are used in the engineering sense; earthcan 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	Fair foundation material; easy to excavate.	Severe limitations. Failed septic systems can contaminate groundwater. Refer to soil report (Haagen, 2001).	Water in alluvium may be in direct contact with basements. Refer to soil report (Haagen, 2001).	Slight limitations. Refer to soil report (Haagen, 2001).	Slight to moderate limitations. Refer to soil report (Haagen, 2001).	Slight to moderate limitations. Avoid construction in floodplain. Refer to soil report (Haagen, 2001).	Refer to soil report (Haagen, 2001).	Refer to soil report (Haagen, 2001).	Refer to soil report (Haagen, 2001).	Not recommended. Refer to soil report (Haagen, 2001).	Not recommended. Refer to soil report (Haagen, 2001).
2. Limestone, dolomite, and shale	Good to excellent foundation material; difficult to moderately difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks to groundwater. Danger of groundwater contamination.	Severe to moderate limitations. Rock excavation may be required. Sinks common. Drainage required.	Moderate limitations. Rock excavation likely. Local drainage problems, especially on shale. Sinks common.	Moderate limitations. Rock excavation possible. Local drainage problems, especially on shale. Sinks common.	Slight to severe limitations, depending on topography. Rock excavation possible. Sinks common. Local drainage problems. Groundwater contamination possible.	Slight to moderate limitations, depending on activity and topography. Possible steep wooded slopes.	Slight limitations, depending on activity and topography.	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.	Moderate to severe limitations. Possible rock excavation.
3. Limestone, siltstone, shale, and sandstone	Fair to good foundation material; difficult to excavate.	Slight to severe limitations, depending on amount of soil cover and depth to impermeable rock.	Severe to moderate limitations. Rock excavation may be required. Drainage problems on shale.	Slight to moderate limitations. Rock excavation likely. Local drainage problems; subgrade may require drainage.	Slight limitations. Rock excavation possible. Local seeps.	Slight to moderate limitations, depending on topography. Rock excavation possible. Local seeps.	Slight limitations, depending on activity and topography.	Slight limitations, depending on activity and topography.	Moderate to slight limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate limitations. Highly variable amount of rock and earth excavation.
4. Limestone	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 may be required. Sinks possible.	Severe limitations. Rock excavation. Possible steep slopes.	Severe to moderate limitations. Possible rock excavation. Possible steep slopes.	Slight to severe limitations, depending on topography. Rock excavation.	Moderate to severe limitations, depending on activity and topography. Possible wooded slopes.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Severe limitations. Leaky reservoir; locally conditions may be favorable. Sinks possible.	Severe limitations. Leaky reservoir; locally conditions may be favorable. Sinks possible.	Severe limitations. Rock excavation.
5. Sandstone	Good to excellent foundation material; difficult to excavate.	Severe to moderate limitations, depending on amount of soil cover.	Severe to moderate limitations. Rock excavation likely; locally, upper few feet may be rippable.	Moderate limitations. Rock excavation likely.	Moderate limitations. Rock excavation likely.	Moderate limitations. Rock excavation likely.	Slight limitations, depending on activity and topography.	Slight limitations, depending on activity and topography.	Moderate limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Difficult to excavate.	Moderate to severe limitations. Highly variable amount of rock and earth excavation.
5. Sandstone and shale	Good to excellent foundation material; moderately difficult to excavate.	Severe limitations. Impermeable rock.	Severe to moderate limitations. Rock excavation may be required. Poor drainage.	Slight to moderate limitations. Rock excavation likely. Local drainage problems; subgrade may require drainage.	Slight limitations, depending on slope. Rock excavation possible. Local seeps.	Slight to moderate limitations, depending on topography. Rock excavation possible. Local seeps.	Slight to moderate limitations, depending on activity and topography. Possible steep wooded slopes.	Slight limitations, depending on activity and topography.	Slight limitations. Most favorable sites are on this unit. Locally, impermeable rock may be thin and underlain by fissured limestone.	Slight limitations.	Moderate limitations. Highly variable amount of rock and earth excavation.

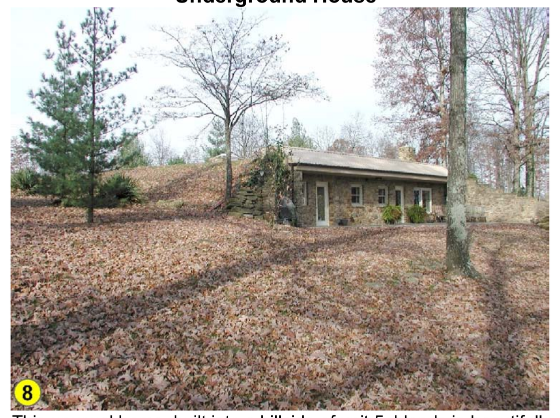
Unit 3

Unit 3, shown in this rock face, includes limestone, siltstone, shale, and sandstone. Photo by Dan Carey, Kentucky Geological Survey.

Meade County Courthouse at Brandenburg

Meade County, an area of 309 square miles in the Pennyrile Region, was formed in 1824. The lowest elevation, 383 feet, is the normal pool on the Ohio River. The highest elevations, slightly greater than 1,000 feet, are found on Bee Knob Hill, about 2.5 miles northwest of Flaherty. Most of Meade County is a karst (sinkhole) plain of low relief. Northwestern Meade County occupies part of a higher plateau, separated from the sinkhole plain by the Dripping Springs Escarpment. The 2005 population of 28,244 was 7.2 percent greater than in 2000. Photo by Dan Carey, Kentucky Geological Survey.

Underground House



This unusual home, built into a hillside of unit 5, blends in beautifully with the landscape. Advantages include low heating costs and protection from the weather. Skylights enhance interior lighting. Photo by Rick Sergeant, Kentucky Geological Survey.

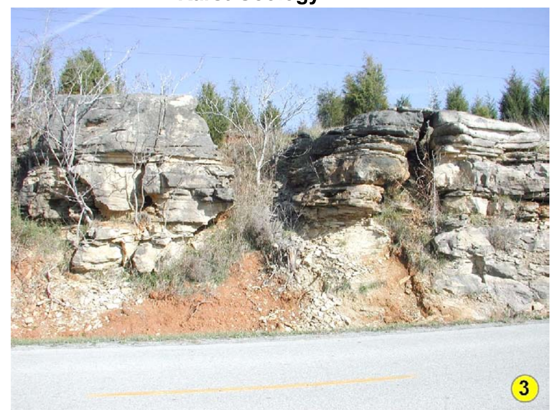
Unit 2–Limestone, Dolomite, and Shale

The karst landscape of unit 2 provides soils for a strong agricultural economy. Several sinkholes, similar to that shown in the photo below right, can be seen in the pasture above. Photo by Dan Carey, Kentucky Geological Survey.

Rural Residential Development

Unit 2 also provides attractive homesites for rural residential living. Thoughtful planning can reduce conflicting interests. Photo by Dan Carey, Kentucky Geological Survey.

Karst Geology



This old roadcut in the Salem Limestone (unit 2) reveals the dissolution process that creates underground cavities and, when the cavity roofs collapse, sinkholes. Photo by Dan Carey, Kentucky Geological Survey.

Doe Valley Lake

Doe Valley Lake provides water recreation to a private residential community. Photo by Dan Carey, Kentucky Geological Survey.

Sinkholes

Sinkholes are common in unit 2, often forming under or adjacent to houses with openings as small as 3 to 4 feet in diameter. Without proper management, they can form depressions that are tens of feet in diameter. Photo by Glynn Beck, Kentucky Geological Survey.

Otter Creek

Limestones of unit 2 outcrop along Otter Creek, looking upstream from the U.S. 60 bridge. Meade County is blessed with an abundance of water. Preventing water pollution is easier than correcting it. Photo by Dan Carey, Kentucky Geological Survey.

Groundwater

In northern Meade County, nearly all drilled wells in the Ohio River alluvium are adequate for domestic use, with many wells yielding several hundred gallons per minute. Compound horizontal wells in the alluvium may yield 5,000 gallons per minute, enough for a community or industrial supply. In the western corner of Meade County, most drilled wells 100 to 300 feet deep are adequate for a domestic supply. In much of central and eastern Meade County, except in lowlands of major creeks and rivers, about three-quarters of the wells yield enough for a domestic supply. In lowlands, very few wells yield enough for a domestic supply, except in a few areas bordering streams, where yields may be sufficient in a few wells. Springs with flows ranging from a few gallons per minute to 2,266 gallons per minute are found throughout the county. Many of the springs are of the depression type and yield more than 100 gallons per minute when pumped. Larger springs in the county have sufficient flows to be used for public or industrial water supplies. For more information on groundwater in the county, see Carey and Stickney (2004)

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.

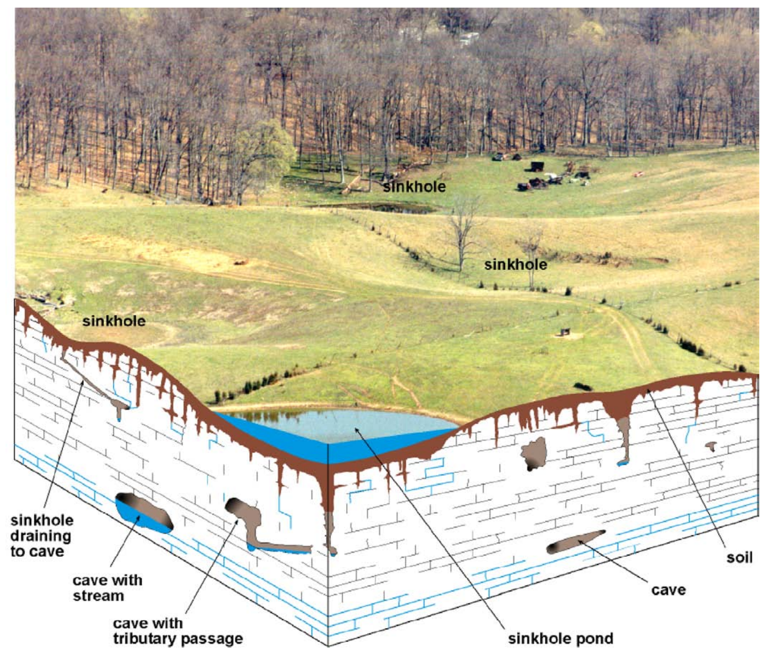
Dams should be constructed of compacted clayey soils at slopes flatter than 3 units horizontal to 1 unit vertical. Ponds with dam heights exceeding 25 feet, or pond volumes exceeding 50 acre-feet, require permits. Contact the Kentucky Division of Water, 14 Reilly Rd., Frankfort, KY 40601, telephone: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

Livestock enjoy a wade in this pond on unit 2. Photo by Dan Carey, Kentucky Geological Survey.

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.

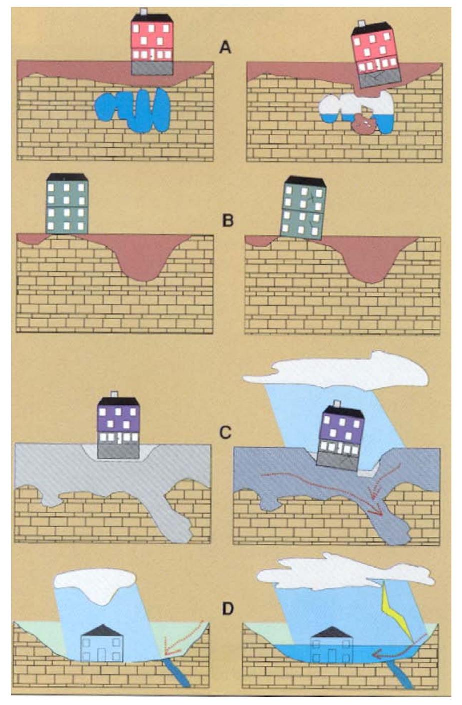
Environmental Protection



- 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)

Construction on Karst

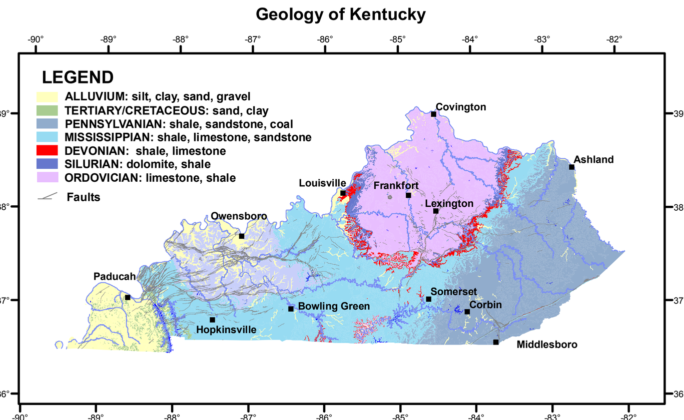


Limestone terrain can be subject to subsidence hazards, which usually can be overcome by prior planning and site evaluation. "A" shows construction above an open cavern, which later collapses. This is one of the most difficult situations to detect, and the possibility of this situation beneath a structure 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).

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 area, visit the KGS Land-Use Planning Internet Mapping Web Site at kgsmap.uky.edu/website/kyluplan/viewer.htm.

Geology of Kentucky



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

Scale 1: 63,360 1 inch equals one mile

0 0.5 1 2 3 4 Miles

Additional Resources

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

www.visitmeadecounty.org Meade County
ces.ca.uky.edu/meade/ University of Kentucky Cooperative Extension Service
www.ltadd.org/ Lincoln Trail Area Development District
www.thinkkentucky.com/edis/cmnty/cw/cw080/ Kentucky Economic Development Information System
kgsweb.uky.edu/download/kgsplanning.htm County planning data from the Kentucky Geological Survey
www.uky.edu/KentuckyAtlas/21163.html Kentucky Atlas and Gazetteer
quickfacts.census.gov/qfd/states/21/21163.html U.S. Census data
www.visitmeadecounty.org/ Local government site

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

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