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

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

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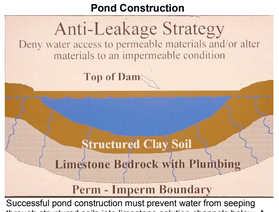
Acknowledgments

Geology adapted from Patton (2000), Zhang (2000, 2006), Crawford (2004), Murphy (2004a, b, 2006), Peterson (2004a–c), Hettinger and Peterson (2006), Hettinger and others (2006), Yang (2009a, b), Yang and others (2006), Yang and Zhang (2006), and Zhang and Melton (2006). Mapped sinkholes from Paylor and others (2004). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for pond construction illustration. Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base-map data.

Casey County Courthouse at Liberty

Casey County, an area of 446 square miles in the Pennyrile and Outer Bluegrass Regions, was formed in 1807. It is an area of broad valleys, steep hillsides, and numerous long, flat-topped ridges. The highest elevation, 1,789 feet, is near the Pulaski County line on Green River Knob. The lowest elevation, 710 feet, is where the Green River leaves the county. The 2005 population of 16,277 was 5.2 percent greater than that of 2000. 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 three units horizontal to one 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.

Groundwater

In the uplands of far eastern Casey County about three-fourths of the wells drilled yield enough water for a domestic supply. In the rest of the county, very few wells yield enough water for a domestic supply; in a few lowland areas bordering streams, a few wells may meet domestic needs. Because of perched water bodies with limited recharge zones, many wells in this area go dry in late summer and fall.

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

For more information on groundwater in the county, see Carey and Stickney (2005).

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.

Rock Unit 4 Terrain

Areas underlain by rocks of unit 4 provide soils and level land on ridgetops for row-crop agriculture and home sites. Photo by Dan Carey, Kentucky Geological Survey.

Alluvium—Unit 1

Wide alluvial valleys are characteristic of areas underlain with erosive shales. They provide level land for agriculture, but may be subject to poor drainage and flooding. Photo by Dan Carey, Kentucky Geological Survey.

Shale and Siltstone—Unit 6

Erosion-resistant siltstone of unit 6 forms steep hillsides and cliffs; erodible shale forms flatter slopes. A roadcut along U.S. 127 (below) shows the siltstone and underlying shale. Photos by Dan Carey, Kentucky Geological Survey.

Limestone, Minor Shale and Siltstone—Unit 5

Thick limestones overlying shale create a rolling terrain along Ky. 70 in southeastern Casey County. Photo by Dan Carey, Kentucky Geological Survey.

Siltstone, Shale, Limestone (Unit 7) Siltstone, shale, and limestone of unit 7 are exposed along U.S. 127 (right). Photo by Dan Carey, Kentucky Geological Survey.

Water Resources

Casey County is blessed with an abundance of water. Lake Liberty provides water for Liberty Water Works, fishing recreation for residents, and a resting place for geese. Photo by Dan Carey, Kentucky Geological Survey.

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.

Scale = 1:63,360
1 inch equals 1 mile

0 0.5 1 2 3 4 Miles

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 limestones of unit 5 and shales of unit 8 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.

Radon Ventilation

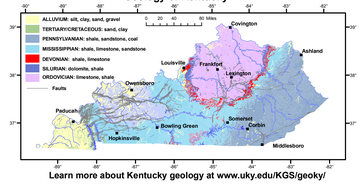
Ventilation system removes radon from the basement area of this home. Photo by Dan Carey, Kentucky Geological Survey.

Additional Resources

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

www.libertycaseycounty.com/ Liberty–Casey County
www.kyhometown.com/liberty/ Liberty
ces.ca.uky.edu/Casey/ University of Kentucky Cooperative Extension Service
www.lcadd.org/ Lake Cumberland Area Development District
www.thinkkentucky.com/EDIS/cmnty/index.aspx Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21045.html Kentucky Atlas and Gazetteer, Casey County
quickfacts.census.gov/qfd/states/21/21045.html U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the Kentucky Geological Survey

Geology of Kentucky



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

Limestone and Dolomite—Unit 3

The Boyle Dolomite of unit 3 is seen in this roadcut on U.S. 127. Water seeps from the surface through cracks, dissolving the rock and creating underground flow paths for pollutants from the surface. Photo by Dan Carey, Kentucky Geological Survey.

Black Shale—Unit 8

The black shale of unit 8 contains enough organic matter to burn. It is unstable on slopes, breaks down quickly when exposed, and may swell when wet and shrink when dry. Photo by Dan Carey, Kentucky Geological Survey.

Mineral Resources

Casey Stone Co. excavates the St. Louis Limestone in unit 5 for aggregate and agricultural limestone. Photo by Dan Carey, Kentucky Geological Survey.

Timber Resources

Sustainably managed and harvested hardwoods can contribute to the local economy for generations. Photo by Dan Carey, Kentucky Geological Survey.

EXPLANATION

- School
- Geologic fault
- Concealed geologic fault
- Railroad
- County line
- Incorporated city boundary
- Watershed boundary
- Public lands
- Designated flood zone (FEMA, 2005)
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Source-water protection area, zone 1
- Quarry
- Mapped sinkholes
- Landslide deposits
- Secondary recovery well
- Gas well
- Oil well

Water wells
- Domestic
- Monitoring
- Public
- Agricultural

- Severely eroded area
- Rock outcrop
- Sinkhole
- Wet area
- Spring
- 50-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/.

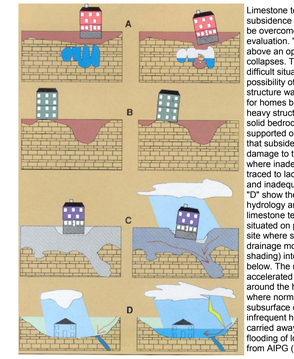
Source-Water Protection Areas

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.

For Planning Use Only

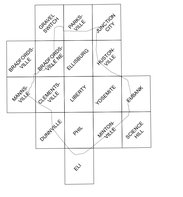
This map is not intended to be used for selecting individual sites. Its purpose is to inform land-use planners, government officials, and the public in a general way about geologic bedrock conditions that affect the selection of sites for various purposes. The properties of thick soils may supersede 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. 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.

Karst Subsidence



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).

7.5-Minute Quadrangle Map Index



Planning Guidance by Rock Unit Type

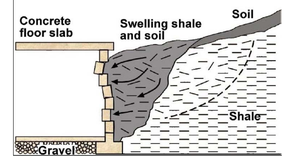
Rock Unit	Foundation and Excavation	Septic System	Residence with Basement	Highways and Streets	Access Roads	Light Industry and Malls	Intensive Recreation	Extensive Recreation	Reservoir Areas	Reservoir Embankments	Underground Utilities
1. Silt, sand, and gravel	Fair foundation material; easy to excavate. Seasonal high water table. Subject to flooding.	Severe limitations. Seasonal high water table subject to flooding. Refer to soil report (Evans and Fehr, 1994).	Water in alluvium may be in direct contact with basements. Seasonal high water table subject to flooding. Refer to soil report (Evans and Fehr, 1994).	Slight limitations. Refer to soil report (Evans and Fehr, 1994).	Slight limitations. Refer to soil report (Evans and Fehr, 1994).	Moderate to slight limitations. Avoid construction in floodplain. Refer to soil report (Evans and Fehr, 1994).	No limitations. Possible flooding. Refer to soil report (Evans and Fehr, 1994).	No limitations. Possible flooding. Refer to soil report (Evans and Fehr, 1994).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Evans and Fehr, 1994).	Fair stability. Fair compaction. Piping hazard. Refer to soil report (Evans and Fehr, 1994).	Slight limitations. Seasonal high water table. Refer to soil report (Evans and Fehr, 1994).
2. Sand and gravel (terrace deposits)	Good foundation material; easy to excavate.	Severe to moderate limitations. Possible groundwater contamination.	Slight limitations.	No limitations.	No limitations.	No limitations.	No limitations.	Slight limitations.	Not applicable.	Not applicable.	Slight limitations.
3. Limestone, dolomite	Excellent foundation material; difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures; 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.	Moderate limitations. Rock excavation.	Slight to moderate limitations, depending on topography. Rock excavation; locally, upper few feet may be rippable. Sinks common; local drainage problems.	No limitations.	Moderate to slight limitations. Steep wooded slopes. Potential for forest reserve or natural history park.	Severe limitations. Leaky reservoir rock; locally, conditions may be favorable. Sinks common.	Severe limitations.	Severe limitations. Rock excavation.
4. Limestone, siltstone, shale, sandstone	Good to excellent foundation material; moderately difficult to difficult to excavate.	Moderate to severe limitations. Impermeable rock.	Severe limitations. Rock excavation.	Severe limitations. Rock excavation.	Severe to moderate limitations. Rock excavation.	Slight to moderate limitations, depending on topography. Rock excavation.	Slight to moderate limitations, depending on topography.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation.
5. Limestone, minor shale, minor siltstone	Good to excellent foundation material; moderately difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks to groundwater table; danger of contaminated.	Severe limitations. Rock excavation may be required.	Slight to moderate limitations. Rock excavation. Local drainage problems. Sinks possible.	Slight limitations. Rock excavation. Local drainage problems. Sinks possible.	Moderate to slight limitations. Rock excavation. Local drainage problems; possible groundwater contamination. Sinks possible.	Slight to moderate limitations, depending on activity and topography.	Slight limitations, depending on activity and topography.	Slight limitations. Leaky reservoir rock. Locally, conditions may be favorable. Sinks possible.	Slight limitations. Leaky reservoir rock.	Severe to moderate limitations. Rock excavation.
6. Shale* and siltstone**	Siltstone, fair to good foundation material; difficult to excavate. Shale, fair to poor; easy to moderately difficult to excavate.	Severe limitations. Low permeability.	Severe limitations. Rock excavation. Siltstone: severe limitations. Low strength, slumping, and seepage problems.	Moderate to severe limitations. Rock excavation. Local drainage problems on shale.	Slight to moderate limitations. Rock excavation. Local drainage problems on shale.	Slight to moderate limitations. Rock excavation. Local drainage problems.	Moderate to slight limitations, depending on activity and topography.	Moderate to slight limitations, depending on activity and topography.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Siltstone: rock excavation. Shale: poor strength, wetness.
7. Siltstone, shale, limestone	Good to excellent foundation material; difficult to excavate.	Moderate to severe limitations. Impermeable rock.	Severe limitations. Rock excavation.	Severe limitations. Rock excavation.	Severe limitations. Rock excavation.	Severe limitations. Rock excavation.	Severe to moderate limitations, depending on activity and topography.	Severe to slight limitations, depending on activity and topography. Slight limitations for forest preserve.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation.
8. 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.

*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.
**Erosion-resistant siltstones are at the top of the unit, usually in cliffs or steep hillsides. Erosive shales are at the bottom of the unit on gentler slopes.

Swelling and Shrinking Shales

A problem of some concern in Casey County is the swelling of some of the clay minerals in shale units 6 and 8. The 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 damage upper floors and interior partitions. This phenomenon has been responsible for extensive damage to schools, homes, and businesses in Kentucky. During times of drought, these same shales may shrink, causing foundations to drop. Anyone planning construction on these shales should seek professional advice from a geologist or engineer familiar with the problem.

Swelling Shale and Foundation Damage



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). Photo by John Kiefer, Kentucky Geological Survey.

Slope Failure

Virtually all units containing shale on slopes are subject to landslides. Shales will break down and weather rapidly when exposed to air and water. Gravity is the main driving force, but water nearly always plays a critical role by adding weight and lubricating the shale. Cutting into or overloading a slope with structures and fill can also be major contributing factors. The failure of the slope may be rapid, but more commonly is a slow almost imperceptible movement, called creep, of a few inches per year. Whether rapid or slow, the end results and damage are similar and costly: broken plumbing, cracked walls and foundations, cracked streets and sidewalks, and commonly total loss of the structures.

Precautions include taking care of all surface-water runoff by making certain that all runoff from roofs, gutters, patios, sidewalks, and driveways is carried well away from and not toward the house; diverting drainage from areas sloping toward the house; cutting into natural slopes as little as possible and avoiding the use of fill; and trying to place the foundation of the structure on undisturbed bedrock. When in doubt, consult an engineering geologist or a geotechnical engineer.

Slope failure on unit 8. Photo by Dan Carey, Kentucky Geological Survey.

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