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

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Geology adapted from Conley (2003a-c), Johnson (2003a-c), Johnson and Sparks (2003), Mullins (2003), Mullins and Murphy (2003), Morris and others (2005), Duncan (2006), Nelson and others (2006a, b), and Zhang and Stidham (2006). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for photos. Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base-map data.

Knox County Courthouse at Barbourville

Knox County, 388 square miles in the Eastern Kentucky Coal Field, was formed in 1800. The area is generally mountainous. The highest elevation, 2,322 feet, is on a peak near the Knox-Bell County line about 2 miles south-southwest of Kayjay. The difference in elevation between this peak and the valley of Brush Creek, 1 mile east, is more than 1,100 feet. The lowest elevation, 890 feet, is where Collins Fork leaves the county. The 2006 population of 31,973 was 0.6 percent greater than that of 2000. Photo by Dan Carey, Kentucky Geological Survey.

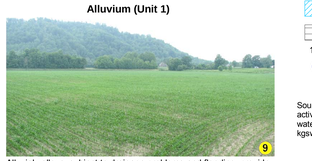
Union College

Union College, a liberal arts United Methodist college with 600 undergraduate and 300 graduate students, was founded in Barbourville in 1879. It has 20 buildings on a 100-acre campus. The faculty-to-student ratio is 1:13. Photo by Dan Carey, Kentucky Geological Survey.

Cumberland River

A drought in eastern Kentucky leaves the Cumberland River, seen from the Ky. 225 bridge, with low-water riffles and bars. The river, together with Laurel Lake, provides water to Barbourville Water & Electric. When rains are heavy, the 26-foot-high, 19,536-foot-long levee and floodgate system (below) protects downtown Barbourville from flooding. Photos by Dan Carey, Kentucky Geological Survey.

Alluvium (Unit 1)



Alluvial valleys, subject to drainage problems and flooding, provide level land and soils for agriculture and other compatible uses. Photo by Dan Carey, Kentucky Geological Survey.

Barbourville City Recreation Park

The Barbourville Recreation Park offers a wave pool, lazy river pool, water slide, fishing, paddle boats, putt-putt golf, exercise and walking tracks, tennis courts, sports fields, playground, picnic shelters, RV hook-ups, a wedding chapel, and more! Photo by Dan Carey, Kentucky Geological Survey.

Sandstone (Unit 5)

Sandstone, Siltstone, Shale, and Coal (Unit 3)

Sandstone (unit 5) forms cliffs (above left) and caps the highest hills in the county. Photos by Dan Carey, Kentucky Geological Survey.

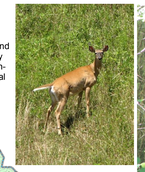
A thick sandstone bed lies above an equally thick shale bed (unit 3) in this roadcut along U.S. 25E near Barbourville. Trees and vegetation are fed by water seeping at the impermeable interface. Pockets where shale has collapsed can be seen; drainage and slope stability are concerns when constructing on shale (see discussion below right). Photo by Dan Carey, Kentucky Geological Survey.

Landslides

Hillside construction can cause earth movements if not properly planned. Photos by Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service.

Wildlife

Deer greet the visitor to field and forest. Photo by Dan Carey, Kentucky Geological Survey.



What Are the Factors That Cause Landslides?

Many factors contribute to landslides. The most common in eastern Kentucky are listed below:

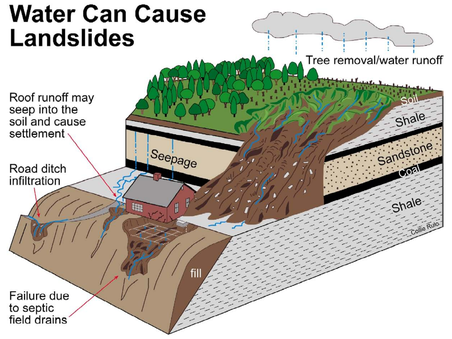
1. Steep slopes: Avoid when choosing a building site.
2. Water: Slope stability decreases as water moves into the soil. Springs, seeps, roof runoff, gutter downspouts, septic systems, and site grading that cause ponding or runoff are sources of water that often contribute to landslides.
3. Changing the natural slope by creating a level area where none previously existed.
4. Poor site selection for roads and driveways.
5. Improper placement of fill material.
6. Removal of trees and other vegetation: Site construction often results in the elimination of trees and other vegetation. Plants, especially trees, help remove water and stabilize the soil with their extensive root systems.

What Are Some Ways to Prevent Landslides?

1. Seek professional assistance prior to construction.
2. Proper site selection: Some sloping areas are naturally prone to landslides. Inspect the site for springs, seeps, and other wet areas that might indicate water problems. Take note of unusual cracks or bulges at the soil surface. These are typical signs of soil movement that may lead to slope failure. Also be aware of geologically sensitive areas where landslides are more likely to occur.
3. Alter the natural slope of the building site as little as possible during construction. Never remove soil from the toe or bottom of the slope or add soil to the top of the slope. Landslides are less likely to occur on sites where disturbance has been minimized. Seek professional assistance before earth-moving begins.
4. Remove as few trees and other vegetation as possible. Trees develop extensive root systems that are very useful in slope stabilization. Trees also remove large amounts of groundwater. Trees and other permanent vegetative covers should be established as rapidly as possible and maintained to reduce soil erosion and landslide potential.
5. Household water disposal system: Seek professional assistance in selecting the appropriate type and location of your septic system. Septic systems located in fill material can saturate soil and contribute to landslides.
6. Proper water disposal: Allowing surface waters to saturate the sloping soil is the most common cause of landslides in eastern Kentucky. Properly located diversion channels are helpful in redirecting runoff away from areas disturbed during construction. Runoff should be channeled and water from roofs and downspouts piped to stable areas at the bottom of the slope.

(From U.S. Department of Agriculture, Natural Resources Conservation Service, no date)

Water Can Cause Landslides



Slope Failure

Mass movements or landslides of surficial materials are frequent and costly geologic hazards in eastern Kentucky. 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.

Virtually all units containing shale on slopes are subject to landslides.

Gravity is the main driving force, but water nearly always plays a critical role by adding weight and lubricating the particles in the weathered shale. Cutting into or overloading a slope with structures and fill can also be major contributing factors.

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. Relict landslides can also be easily reactivated. Look for unusual bulges or cracks in the slope, tilted or curved trees, springs coming out onto the hillside, and tilted and cracked sidewalks, streets, and retaining walls.

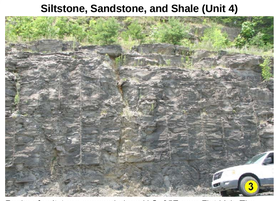
Mapped Surface Faults

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.

Sandstone (Units 3 and 5)

Sandstone intrudes on the landscape in the rugged hills of eastern Knox County. Sandstone lies in massive boulders on a hillside along Ky. 718 (above) and arches over Acorn Fork Road (below). Photos by Dan Carey, Kentucky Geological Survey.

Siltstone, Sandstone, and Shale (Unit 4)



Rocks of unit 4 are exposed along U.S. 25E near Flat Lick. The terrain of unit 4 (below) is gently rolling. Photos by Dan Carey, Kentucky Geological Survey.

Coal

Hollow fills are a vestige of mining operations on hilltops in the east. Coal has made a significant contribution to the local economy: 75.3 million tons, 25.5 million tons from surface mines and 34.5 million tons from underground mines, was produced from 1890–2004. Photo by the U.S. Department of Agriculture, Farm Services Administration, National Aerial Imagery Program (2004).

Groundwater

About 11,000 residents of Knox County rely on private domestic water supplies: 10,400 use wells and 600 use other sources. Most wells in valley bottoms produce enough water for a domestic supply. Fewer than half the wells drilled on hillsides are adequate for a domestic supply. Wells on hilltops and ridges yield smaller quantities of water. Most of the water from drilled wells is extremely hard and contains noticeable amounts of iron. Salty water may be found in wells drilled into bedrock less than 100 feet below the level of the principal valley bottoms. Water quality and quantity is slightly better in the far eastern end of the county, where drilled wells more than 200 feet deep in valleys may yield enough water for small municipal or industrial supplies. A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5 gallons per minute.

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

Additional Resources

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

www.knoxcochamber.com Knox County Chamber of Commerce
www.knoxcountyky.com Knox County Fiscal Court
www.knox.k12.ky.us/ Knox County Schools
www.barbourville.com Barbourville
ces.ca.uky.edu/Knox/ University of Kentucky Cooperative Extension Service
www.cvadd.org/ Cumberland Valley Area Development District
www.thinkkentucky.com/edis/cmnty/index.aspx?cw=028 Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21121.html Kentucky Atlas and Gazetteer, Knox County
quickfacts.census.gov/qfd/states/21/21121.html U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the Kentucky Geological Survey

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Duncan, R.S., 2006, Spatial database of the Corbin quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-231. Adapted from Pulfett, W.P., 1963, Geology of the Corbin quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-231, scale 1:24,000.

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Johnson, T.L., 2003b, Spatial database of the Frakes quadrangle, and part of the Eagan quadrangle, southeastern Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1249. Adapted from Newell, W.L., 1975, Geologic map of the Frakes quadrangle, and part of the Eagan quadrangle, southeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1249, scale 1:24,000.

Johnson, T.L., 2003c, Spatial database of the Heidrick quadrangle, Knox and Laurel Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1501. Adapted from Trimble, D.E., and Smith, J.H., 1976, Geologic map of the Heidrick quadrangle, Knox and Laurel Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1501, scale 1:24,000.

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Mullins, J.E., 2003, Spatial database of the Scalf quadrangle, southeastern Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geol ogic Quadrangle Data DVGQ-1267. Adapted from Weis, P.L., 1975, Geologic map of the Scalf quadrangle, southeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1267, scale 1:24,000.

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Nelson, H.L., Jr., Patton, J.A., Hesley, J., Lambert, J.R., and Sparks, T.N., 2006b, Spatial database of the Blackwater quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geological Quadrangle Data DVGQ-304. Adapted from Stager, H.K., 1964, Geology of the Blackwater quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-304, scale 1:24,000.

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Source-Water Protection Areas

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

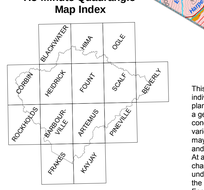
EXPLANATION

- School
- Gas well
- Oil well

Water wells
- Domestic
- Industrial
- Monitoring
- Public
- Livestock

- Spring
- Wet area
- County line
- Floodwall/levee
- Watershed boundary
- Railroad
- Abandoned railroad
- Fault
- Concealed fault
- Mapped mined areas (does not include all mining)
- Incorporated city boundaries
- Artificial fill
- Public lands
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Source-water protection area, zone 1
- 100-foot contour interval
- (4) Photo location

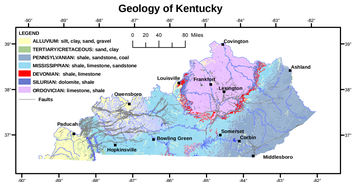
7.5-Minute Quadrangle Map Index



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, visit the KGS Community Development Planning Web Site at kgsweb.uky.edu/download/kgsplanning.htm.

Geology of Kentucky



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

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Scale = 1:63,360

1 inch = 1 mile

0 0.5 1 2 3 4 Miles

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. Seasonal high water table. Subject to flooding. Refer to soil report (Love, 1988).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Love, 1988).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Love, 1988).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Love, 1988).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Love, 1988).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Love, 1988).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Love, 1988).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Love, 1988).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Love, 1988).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (Love, 1988).	Slight limitations, in general, except for seasonal high water table. Subject to flooding. Refer to soil report (Love, 1988).
2. Sand, silt, clay, gravel, rock fragments (ancient river deposits and colluvium)	Fair to poor foundation material, depending on slope; easy to excavate.	Severe to slight limitations, depending on amount of soil cover.	Severe to slight limitations, depending on slope.	Severe to slight limitations, depending on slope.	Severe to slight limitations, depending on slope.	Severe to slight limitations, depending on slope.	Severe to slight limitations, depending on activity and topography.	Moderate to slight limitations, depending on activity and topography.	Pervious material. Not recommended.	Severe to slight limitations. Unstable slopes.	Slight to severe limitations, depending on slope.
3. Shale, siltstone, sandstone, and coal	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, coals, and underclays. Possibility of underground mine voids.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks, including coal, are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
4. Siltstone, sandstone, shale	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks, including coal, are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
5. Sandstone, siltstone, shale, coal, and underclay	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, coals, and underclays. Possibility of underground mine voids.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks, including coal, are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Severe to moderate limitations. Thin soils. Possible rock excavation.
6. Sandstone	Excellent foundation material; difficult to excavate.	Severe limitations. Thin soils.	Severe to moderate limitations. Rock excavation may be required. Steep slopes.	Severe to moderate limitations. Rock excavation may be required. Steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes and narrow ridges.	Moderate to severe limitations. Rock excavation may be required. Steep slopes.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation. Thin soils.