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

MAP AND CHART 132
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Generalized Geologic Map for Land-Use Planning: Carter County, Kentucky

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Carter County Courthouse at Olive Hill

Carter County, with an area of 411 square miles, was established in the Eastern Kentucky Coal Field in 1838. Steep slopes are common in the county, and the elevation ranges from 542 feet, where the Little Sandy River leaves the county, to 1,300 feet on a ridge about 0.6 mile north of Interstate 64 on the Rowan County line.

The population in 2004, 27,459, was 2.1 percent more than in 2000. The cities of Olive Hill and Grayson, and the Rattlesnake Ridge Water District, provide public water to over 85 percent of county households. The majority of those not on public water rely on private water wells. The cities of Grayson and Olive Hill also provide wastewater treatment services for 20 percent of county residents. The 1,500-acre Grayson Lake provides for recreation and water supply.

Groundwater

In the eastern half of the county, most wells in valley bottoms produce enough water for domestic use. In the rest of the county groundwater becomes more scarce, with less than half of the wells drilled in valley bottoms able to produce enough water for a domestic supply. Throughout the county, wells on hillsides and ridges become progressively less productive away from valley bottoms. Most of the water from drilled wells is very to extremely hard and contains noticeable amounts of iron. Salty water is commonly found in wells drilled less than 100 feet below the level of the principal valley bottoms. A few springs supply enough 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).

EXPLANATION

Oil well
Gas well
Enhanced recovery well

Water wells
- Domestic
- Monitoring
- Public
- Industrial

Spring
Sinkhole
Wet area
Rock outcrop
Mine or quarry
County line
Watershed boundary
Geologic fault
Outcrop clay bed**
Mapped sinkhole
Mined area
Wildlife management area
State park
Source-water protection area, zone 1
Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
Incorporated city boundaries
Quarry
Designated flood zone* (FEMA, 2005)
Public lands
100-foot contour interval
Photo location

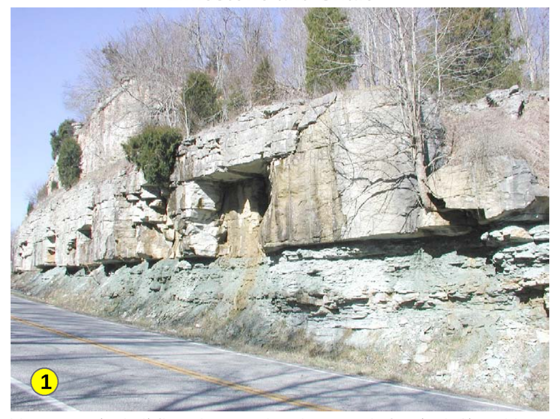
*Flood information is available from the Kentucky Division of Water, Flood Plain Management Branch, www.water.ky.gov/floods/.

**The outcrop line of the Olive Hill clay bed is an indicator not only of the clay, but the possible presence of old underground or surface mines.

Siltstone

Siltstone of unit 3 forms steep slopes in northwestern Carter County. Photo by Jerry Weisenfluh, Kentucky Geological Survey.

Limestone and Shale

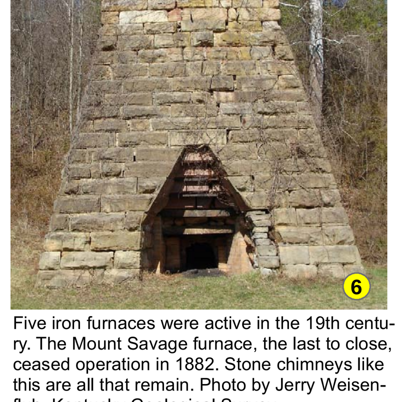


Limestone (unit 4) lies above red and green shales (unit 8) at this roadcut off Ky. 2 just north of Interstate 64. The shales quickly slake away when exposed, allowing massive limestone blocks to collapse. Photo by Dan Carey, Kentucky Geological Survey.

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.

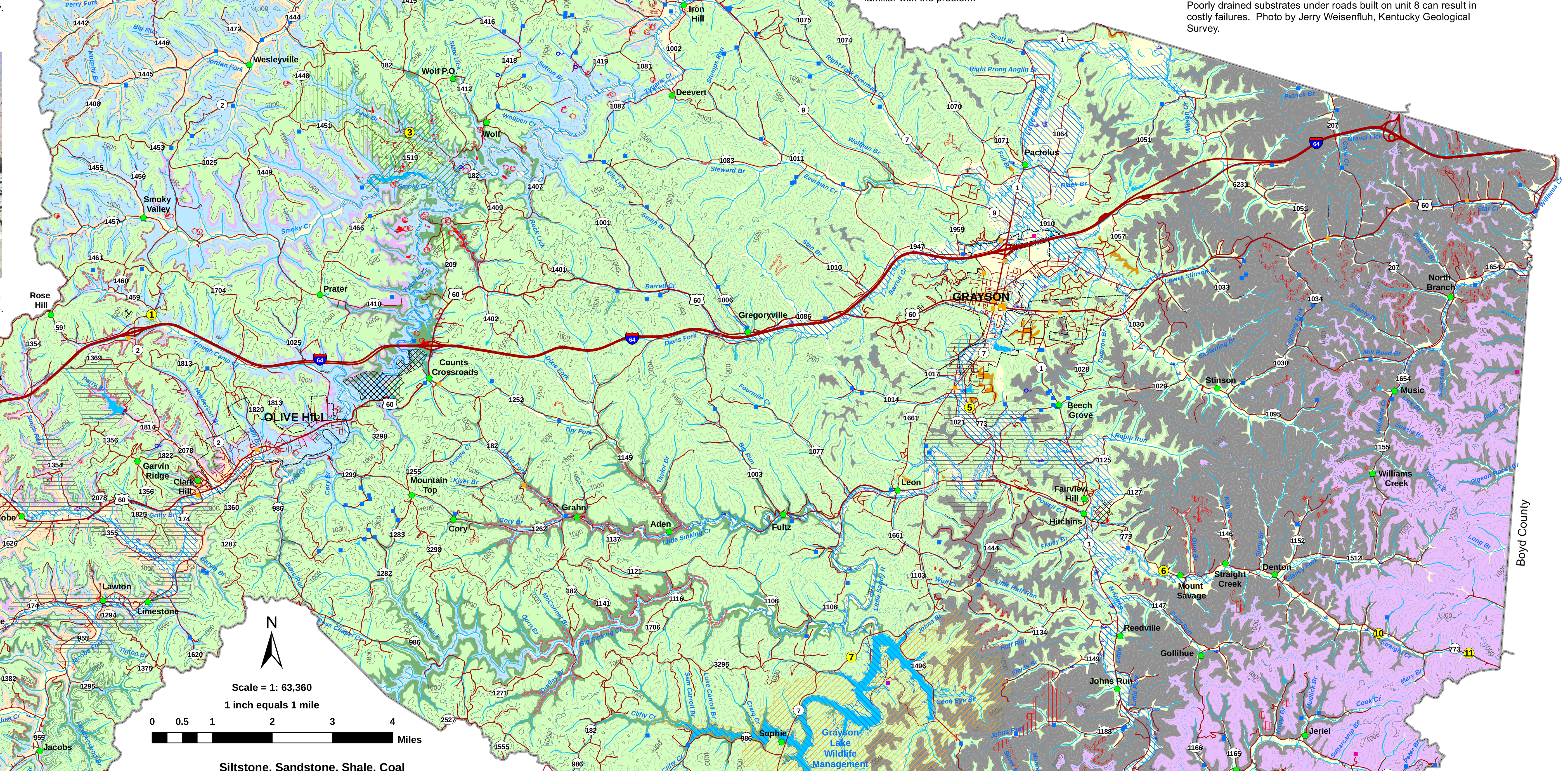
Stone Blast Furnace



Five iron furnaces were active in the 19th century. The Mount Savage furnace, the last to close, ceased operation in 1882. Stone chimneys like this are all that remain. Photo by Jerry Weisenfluh, Kentucky Geological Survey.

Karst Geology

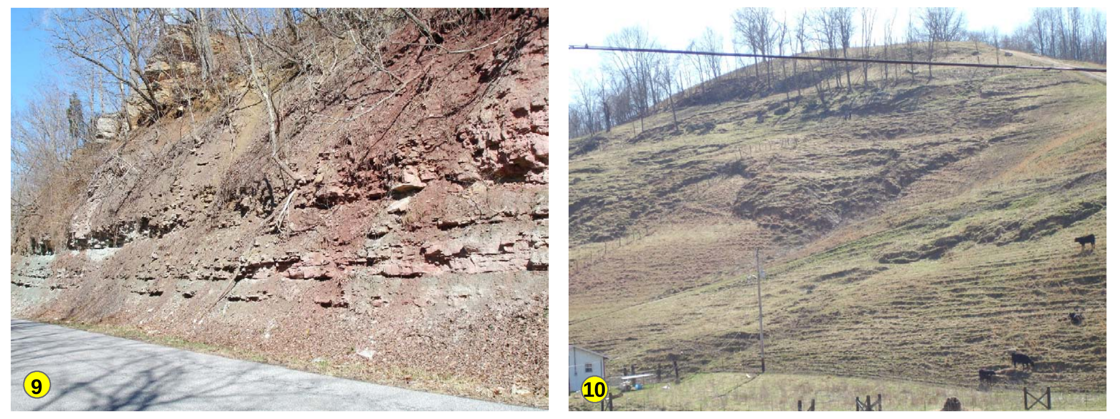
Some areas of the county are underlain by karst limestone. The term "karst" refers to a landscape characterized by sinkholes, springs, sinking streams (streams that disappear underground), and underground drainage through solution-enlarged conduits or caves. Karst landscapes form when slightly acidic 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.



Acknowledgments

Geology adapted from Lambert and Sparks (2005), Murphy (2005a, b), Murphy and Petersen (2005), Nelson and Curl (2002a, b), Nelson and Petersen (2005a, b), Palmgreen (2005), Petersen (2002), Plauché (2002a, b, 2005), Plauché and Petersen (2006), and Smith (2002). Mapped sinkhole data from Paylor and others (2004). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for landslide illustrations.

Red and Green Shales

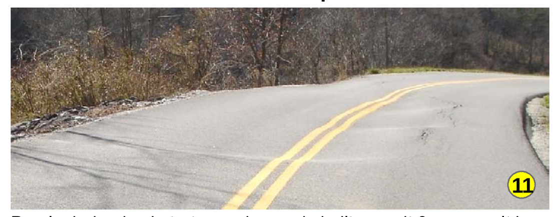


Red and green shales (unit 8) are low strength, sensitive to moisture, and prone to slumping and landslides. Hillslopes with little stabilizing vegetation show extensive downslope movement of soil material that can damage structures built too close to the hill. Cattle can exacerbate the soil movement. Photos by Jerry Weisenfluh, Kentucky Geological Survey.

Swelling and Shrinking Shales

A problem of some concern in this area is the swelling of some of the clays and shales. Expanding shale can cause 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.

Road Slump



Poorly drained substrates under roads built on unit 8 can result in costly failures. Photo by Jerry Weisenfluh, 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.

What Are the Factors That Cause Landslides?

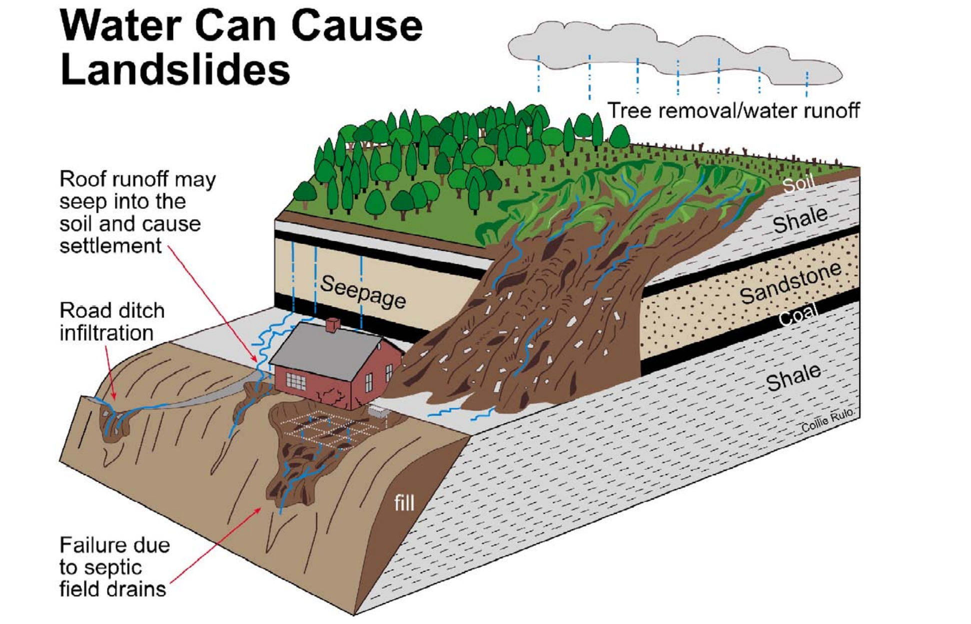
Many factors contribute to landslides. The most common in eastern Kentucky are listed below:

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.

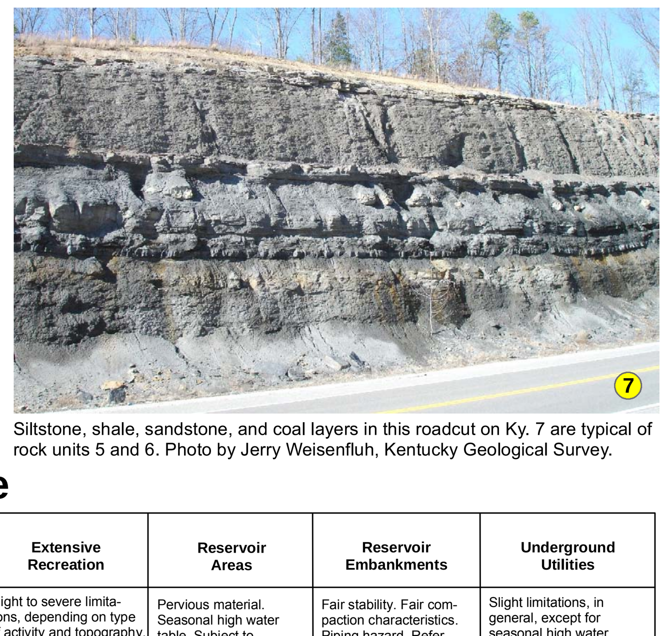
What Are Some Ways to Prevent Landslides?

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)



Siltstone, Sandstone, Shale, Coal



Siltstone, shale, sandstone, and coal layers in this roadcut on Ky. 7 are typical of rock units 5 and 6. Photo by Jerry Weisenfluh, Kentucky Geological Survey.

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 (Kelley and Newton, 1983).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (Kelley and Newton, 1983).	Slight limitations, in general, except for seasonal high water table. Subject to flooding. Refer to soil report (Kelley and Newton, 1983).
2. Clay, silt, sand, and gravel (terrace deposits)	Fair foundation material; easy to excavate.	Severe to slight limitations, depending on amount of soil cover.	Moderate to slight limitations, depending on slope.	Slight limitations.	Slight limitations, depending on slope.	Slight limitations, depending on slope.	Moderate to slight limitations, depending on activity and slope.	Slight limitations, depending on slope.	Pervious material. Not recommended.	Severe to slight limitations. Unstable steep slopes.	Slight limitations.
3. Siltstone, shale*	Excellent foundation material; difficult to excavate.	Severe limitations. Thin soils and impermeable rock associated with shales.	Moderate to severe limitations. Rock excavation. Very steep slopes.	Moderate to severe limitations. Rock excavation. Very steep slopes.	Moderate to severe limitations. Rock excavation may be required. Very steep slopes.	Moderate to severe limitations. Rock excavation may be required. Very steep slopes.	Moderate to severe limitations. Rock excavation may be required. Very steep 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. Thin soils. Rock excavation.
4. Limestone (limited to valley bottoms and sides)	Excellent foundation material; difficult to excavate.	Severe limitations. Locally fast drainage through fractures. Danger of groundwater contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks possible. Drainage required.	Slight to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks possible. Drainage required.	Slight limitations. Local drainage problems from seeps or springs. Sinks possible.	Slight to moderate limitations, depending on topography. Rock excavation; locally, upper few feet may be rippable. Sinks possible. Local drainage problems.	Slight to severe limitations. Rock excavation may be required.	Slight to moderate limitations, depending on activity and topography. Slight limitations for forest or nature preserve.	Severe limitations. Leaky reservoir rock. Locally, conditions may be favorable. Sinks possible.	Severe limitations. Leaky rock.	Severe limitations. Rock excavation.
5. Siltstone, sandstone, shale (sparse coal)*	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, sparse coals, and underclays.	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.
6. Sandstone, siltstone, shale, coal*	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, coals, and underclays. Possibility of underground coal-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.
7. Sandstone (limited to valley bottoms and sides)	Excellent foundation material; difficult to excavate.	Severe limitations. Thin soils.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible 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.
8. Units containing red and green shales*	Poor foundation material; easy to moderately difficult to excavate. Low strength and stability. May contain plastic clays.	Severe limitations. Thin soils and low permeability.	Severe limitations. Low strength, slumping, and seepage problems.	Severe limitations on slopes. Strength, slumping, and seepage problems.	Severe limitations on slopes. Strength, slumping, and seepage problems.	Severe limitations on slopes. Strength, slumping, and seepage problems.	Moderate to severe limitations, depending on activity.	Slight to severe limitations, depending on activity. Slight limitations for forest or nature preserve.	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 can 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.

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.

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.

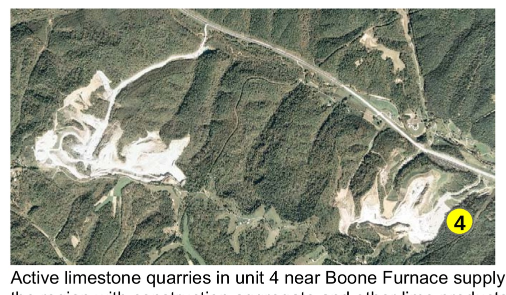
Underground utilities—Included in this group are sanitary sewers, storm sewers, water mains, and other pipes that require fairly deep trenches.

Mineral Resources

Flint clay, coal, and limestone are the principal mineral resources of Carter County. High-quality silica sand is a potential resource. Mining of the Olive Hill Clay occurred around the turn of the last century, primarily from small underground mines and to a lesser extent from strip mines. Coal has been surface and underground mined on a small scale in many places. Significant mining ended in 1965. Limestone mines and quarries are still active.

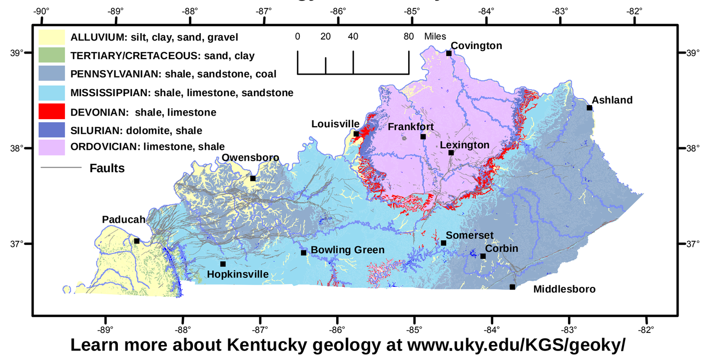
Limestone

Limestone bluff (unit 4) overlying steep slopes formed by unit 3. Photo by Dan Carey, Kentucky Geological Survey.



Active limestone quarries in unit 4 near Boone Furnace supply the region with construction aggregate and other lime products. Photo (2004) from the U.S. Department of Agriculture, Farm Services Administration.

Geology of Kentucky



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

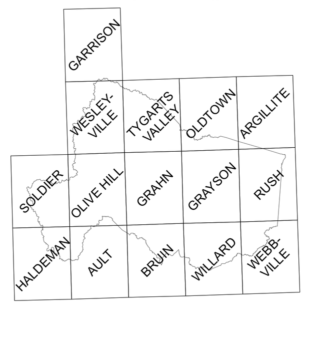
Carter Caves

Carter Caves State Resort Park is a popular attraction for tourism, golfing, and business meetings. Beautiful hiking trails and caves can be found in the steep-sided tributary valleys of Tygarts Creek, formed in units 4 and 7. Photo by Dan Carey, Kentucky Geological Survey.

Alluvium

Alluvium in the meandering floodplain valleys of the Little Sandy River, Tygarts, and other large creeks provides soils for agriculture, and level land for development above flood levels. Photo by Dan Carey, Kentucky Geological Survey.

7.5-Minute Quadrangle Index



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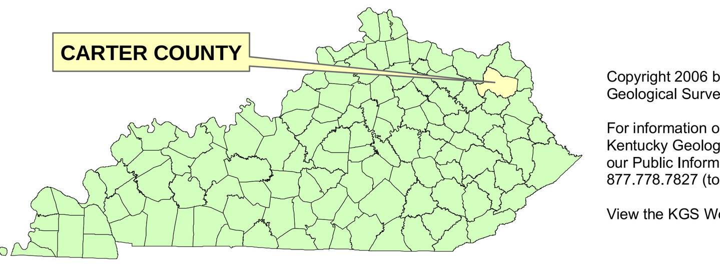
Additional Resources

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

ces.ca.uky.edu/carter/ University of Kentucky Cooperative Extension Service
www.fivco.org/ Fiveco Area Development District
www.thinkkentucky.com/edis/cmnty/cw035/ Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21043.html Kentucky Atlas and Gazetteer, Carter County
quickfacts.census.gov/qfd/states/21/21043.html U.S. census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the 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