Kentucky Geological Survey
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Generalized Geologic Map for Land-Use Planning: Johnson County, Kentucky

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MAP AND CHART 176

Series XII, 2007

Johnson County Courthouse at Paintsville

Johnson County, 262 square miles in the Eastern Kentucky Coal Field, was formed in 1843. The topography is rugged, with flat areas along larger streams. The highest point in the county, 1,508 feet, is Stuffley Knob, about 2 miles southeast of Oil Springs. The lowest elevation, 550 feet, is where the Levisa Fork leaves the county. The 2006 population of 24,098 was 2.8 percent greater than that of 2000. Photo by Dan Carey, Kentucky Geological Survey.

Paintsville Lake

Paintsville Lake offers 1,140 acres of boating, water sports, and fishing. The 242-acre state park provides camping and hiking facilities. Photo by Dan Carey, Kentucky Geological Survey.

Alluvial Valleys (Unit 1)

Johnson County is blessed with an abundance of water. Alluvial valleys (unit 1) of the Levisa Fork (above) and other large streams provide level land for building and agriculture (below). The possibility of flooding and drainage problems must be addressed for any land use in the floodplain. Photos by Dan Carey, Kentucky Geological Survey.

Groundwater

About 9,900 people, 40 percent of the population, in Johnson County rely on private domestic water supplies: 9,500 use wells and 400 use hauled water, cisterns, and other sources. Most drilled wells in valley bottoms are adequate for a domestic supply. Fewer than half of the wells drilled on hillsides are adequate for a domestic supply, except in areas south of Paintsville where about three-quarters of the wells on hillsides are adequate. Some wells on ridges or hilltops are adequate for a domestic water supply. In the southern part of the county in the Van Lear area, drilled wells more than 200 feet deep in valleys yield enough water for small municipal or industrial supplies. Most of the water from drilled wells is moderately to extremely hard and contains noticeable amounts of iron. In the eastern and southeastern half of the county, salty water can be found in bedrock wells less than 100 feet below the level of the principal valley bottoms. 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).

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.

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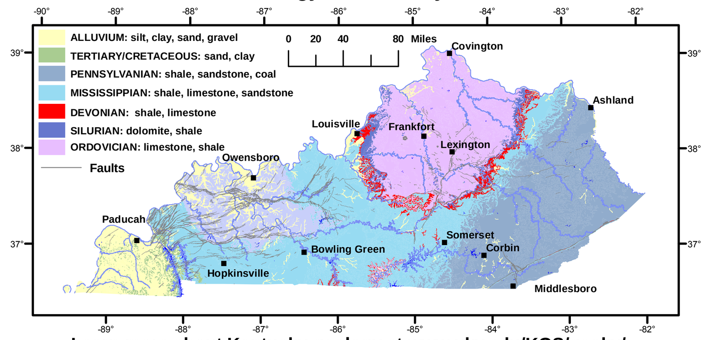
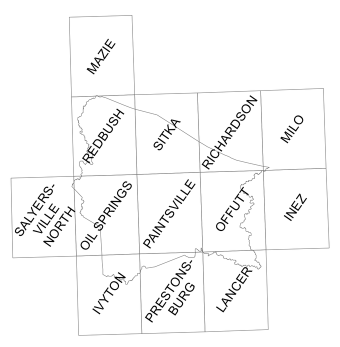
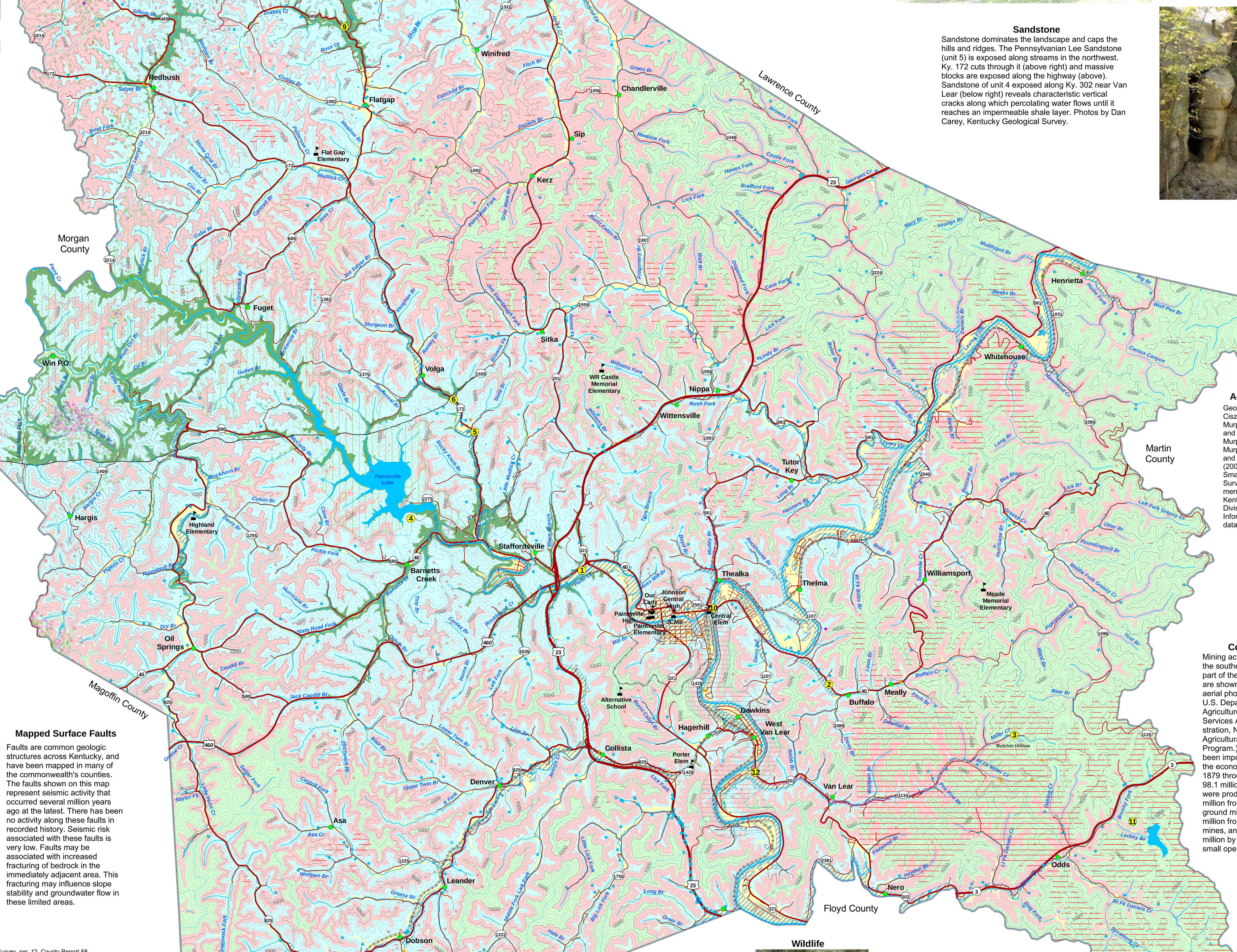
Geology of Kentucky



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

7.5-Minute Quadrangle Map Index





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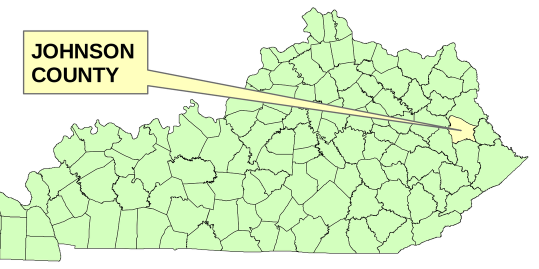
Scale = 1: 48,000

1 inch = 3/4 mile

0 0.5 1 2 3 4 Miles

Loretta Lynn's Homeplace in Butcher Hollow

Photo by Dan Carey, Kentucky Geological Survey.



For Planning Use Only

This map is not intended to be used for selecting individual sites. Its purpose is to inform land-use planners, government officials, and the public in a general way about geologic bedrock conditions that affect the selection of sites for various purposes. The properties of thick soils may supersede those of the underlying bedrock and should be considered on a site-to-site basis. At any site, it is important to understand the characteristics of both the soils and the underlying rock. For further assistance, contact the Kentucky Geological Survey, 859.257.5500. For more information, visit the KGS Community Development Planning Web Site at kgsweb.uky.edu/download/kgsplanning.htm.

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).

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

Wildlife

Cooling one's feet in August. Photo by Dan Carey, Kentucky Geological Survey.

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.

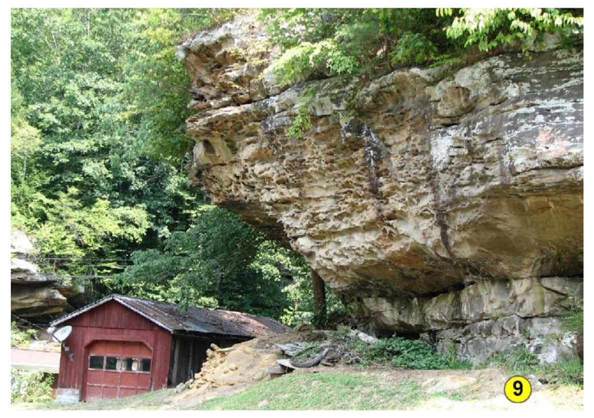
Intensive recreation—Athletic fields, stadiums, etc.

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.



Sandstone

Sandstone dominates the landscape and caps the hills and ridges. The Pennsylvanian Lee Sandstone (unit 5) is exposed along streams in the northwest. Ky. 172 cuts through it (above right) and massive blocks are exposed along the highway (above). Sandstone of unit 4 exposed along Ky. 302 near Van Lear (below right) reveals characteristic vertical cracks along which percolating water flows until it reaches an impermeable shale layer. Photos by Dan Carey, Kentucky Geological Survey.

EXPLANATION

- School
- Water wells
  - Industrial
  - Domestic
  - Monitoring
  - Public
  - Agriculture
- Spring
- Gas well
- Oil well
- Secondary recovery injection well
- Railroad
- Abandoned railroad
- Watershed boundary
- Mined areas (may not include all mining)
- Source-water protection area, zone 1
- Designated flood zone** (FEMA, 2005)
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Public lands
- Incorporated city boundaries

100-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/.

Acknowledgments

Geology adapted from Ciszak and others (2005), Murphy (2005a-h), Murphy and Thompson (2005), Murphy and Tyra (2005), Murphy and Yang (2005), and Smith and Petersen (2006). Thanks to Meg Smath, Kentucky Geological Survey, for editorial improvements. Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base-map data.

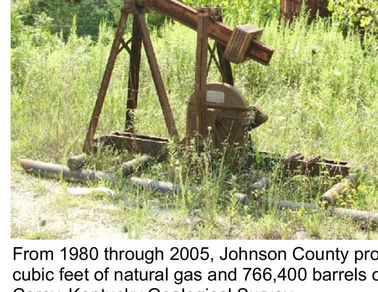
Source-Water Protection Areas

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.

Coal

Mining activities in the southeastern part of the county are shown in this aerial photo (right, U.S. Department of Agriculture, Farm Services Administration, National Agricultural Imagery Program.) Coal has been important to the economy. From 1879 through 2004, 98.1 million tons were produced: 58 million from underground mines, 29 million from surface mines, and 11.1 million by early small operations.

Oil and Gas



From 1980 through 2005, Johnson County produced 21.7 billion cubic feet of natural gas and 766,400 barrels of oil. 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 Johnson County:

www.johnsoncountyky.com Johnson County
www.paintsville.org City of Paintsville
www.paintsvilleherald.com *Paintsville Herald*
www.kyhometown.com/paintsville/ Paintsville/Johnson County
www.johnsoncountypva.com Johnson County Property Valuation Administrator
ces.ca.uky.edu/Johnson/ University of Kentucky Cooperative Extension Service
www.bigsandy.org/ Big Sandy Area Development District
www.thinkkentucky.com/EDIS/cmnty/index.aspx?cw=058 Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21115.html Kentucky Atlas and Gazetteer, Johnson County
quickfacts.census.gov/qfd/states/21/21115.html U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the 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.

Construction on Shale

Slope Stability

Shales provide a poor foundation and are unstable on slopes. Hillside construction of roads and homes on shale often requires additional support to ensure slope stability. Shale is exposed in a roadcut along Ky. 172; additional support was required to prevent pavement failure. Photos by Dan Carey, Kentucky Geological Survey.

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.

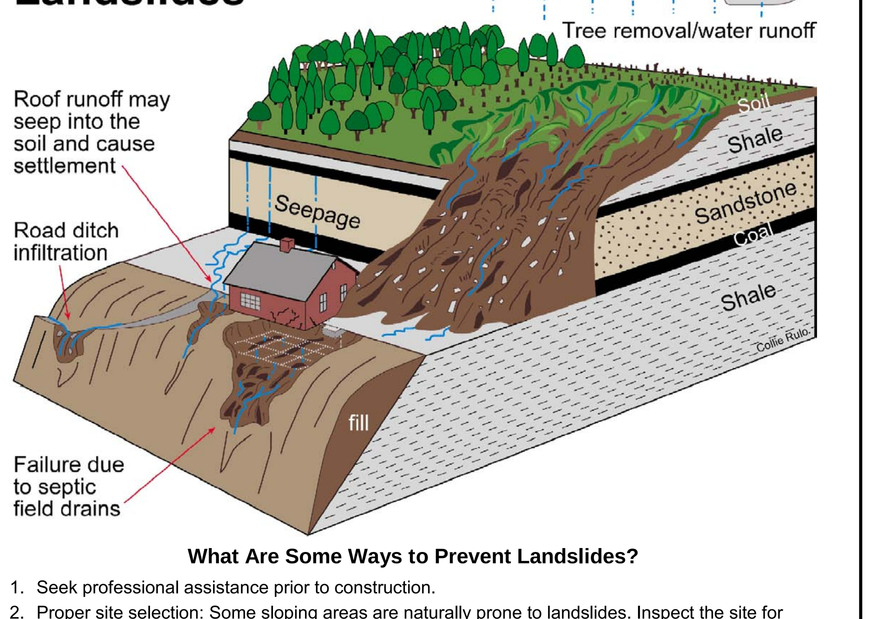
Precautions include taking care of all surface-water runoff by making certain that all runoff from roofs, gutters, patios, sidewalks, and driveways is carried well away from and not toward the house; diverting drainage from areas sloping toward the house; cutting into natural slopes as little as possible 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.

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)

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, clay, sand, and gravel (alluvium)	Fair foundation material; easy to excavate. Seasonal high water table. Subject to flooding. Refer to soil report (Waters and Abney, 2000).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Waters and Abney, 2000).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Waters and Abney, 2000).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Waters and Abney, 2000).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Waters and Abney, 2000).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Waters and Abney, 2000).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Waters and Abney, 2000).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Waters and Abney, 2000).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Waters and Abney, 2000).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (Waters and Abney, 2000).	Slight limitations, in general, except for seasonal high water table. Subject to flooding. Refer to soil report (Waters and Abney, 2000).
2. Shale, siltstone, sandstone, and coal	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, coals, and underclays.	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.
3. Sandstone, siltstone, shale, coal, and underclay	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, sparse 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.	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. Shale, siltstone, sandstone, thin coal, clay	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.
5. Sandstone	Excellent foundation material; difficult to excavate.	Severe limitations.	Severe to moderate limitations. Rock excavation. Steep slopes.	Severe to moderate limitations. Rock excavation. Steep slopes.	Severe to moderate limitations. Rock excavation. Steep slopes.	Severe to moderate limitations. Rock excavation. Steep slopes.	Moderate to severe limitations, depending on activity and topography.	Slight to severe limitations, depending on activity and topography. 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.