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

MAP AND CHART 150

Series XII, 2007

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

Daniel I. Carey

Acknowledgments

Geology adapted from Curl and Petersen (2005), Morris (2005), Murphy (2005a, b), Murphy and Petersen (2005), Nelson (2005a, b), Nelson and Petersen (2005a-c), Palmgreen (2005), Palmgreen and Murphy (2005), and Palmgreen and Petersen (2005). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for pond construction illustration. Mapped sinkhole data from Paylor and others (2004). Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base-map data.

Bath County Courthouse at Owingsville

Bath County, an area of 280 square miles in the Outer Bluegrass and Knobs Regions, was formed in 1811 and named after the springs in the area that were thought to have medicinal value. The 2005 population of 11,651 was 5.1 percent greater than the 2000 population.

The oldest bedrock in the county is limestones (units 3, 4, and 6) deposited in shallow seas 490 million years ago. The younger black shales (unit 5) were formed 400 million years ago when the sea floor was covered with an organic black muck. The sandstones, siltstones, and shales of units 7, 8, and 9 are 300 to 350 million years old. The unusually wide alluvium in the south and east reflect the relatively soft shale through which the streams carved their valleys.

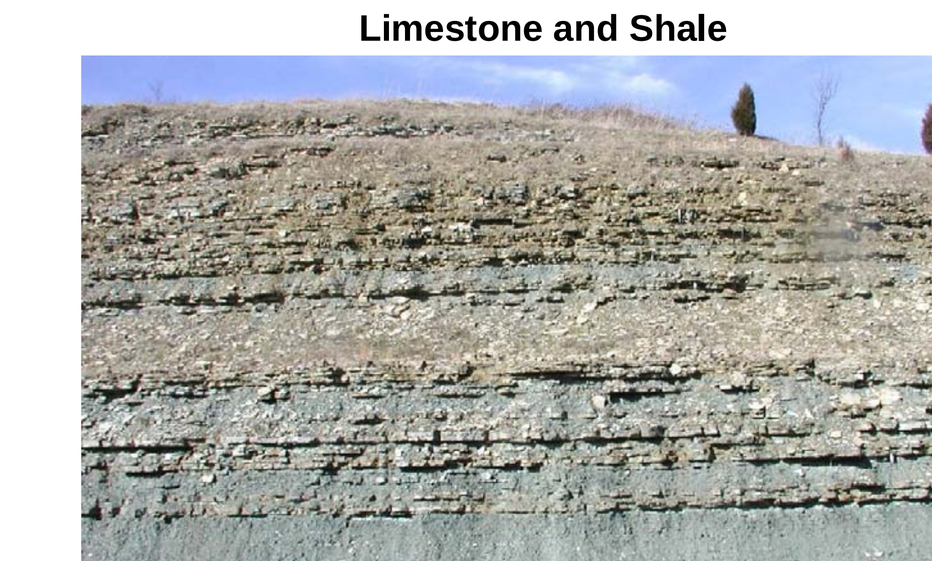
The highest elevation, 1,388 feet, is on Tater Knob, 6 miles southeast of Salt Lick in the Daniel Boone National Forest. The lowest elevation, 590 feet, is on the Licking River where it leaves the county.

Photo by Dan Carey, Kentucky Geological Survey.

Agriculture

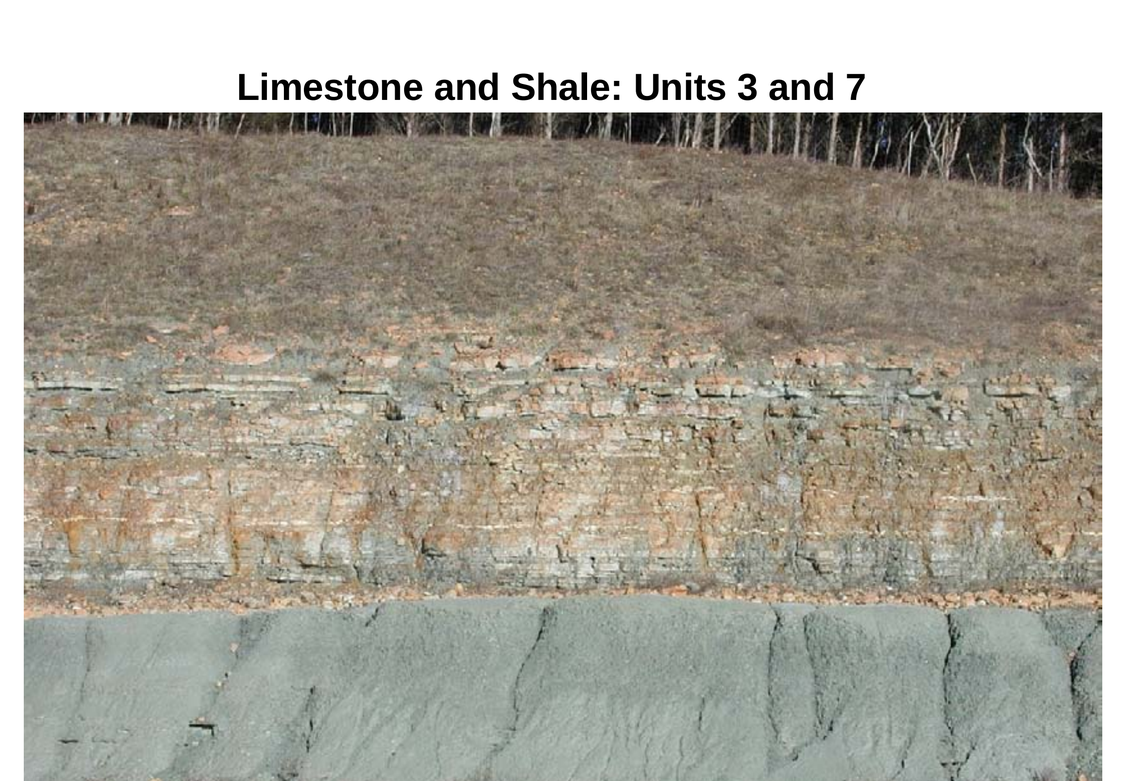
Limestones of units 3 and 4 provide soils for agriculture. As the shale content in the underlying rock increases, the terrain becomes more hilly. Photo by Dan Carey, Kentucky Geological Survey.

Limestone and Shale



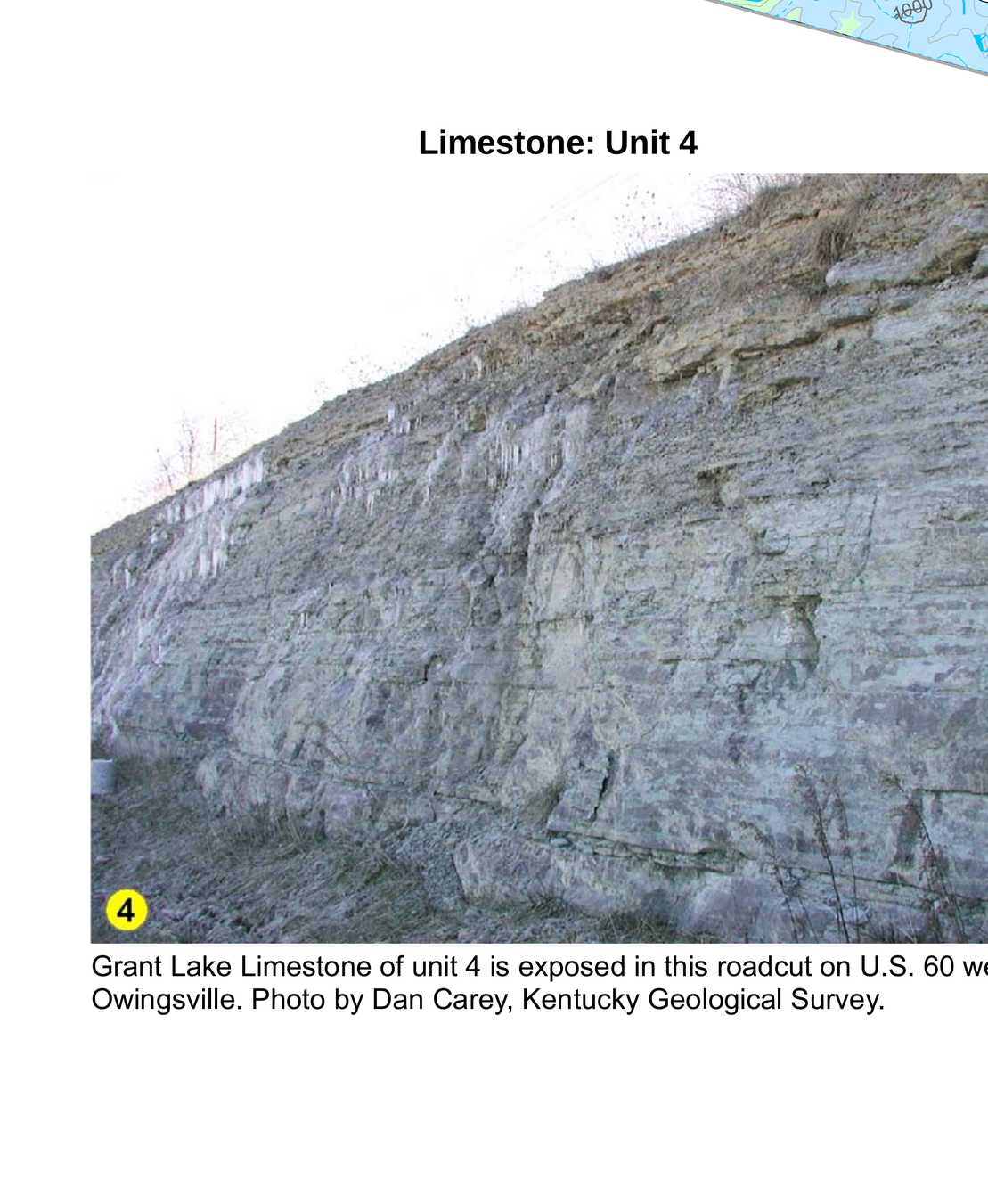
This roadcut on Ky. 11 exposes unit 4 (top), unit 3 (middle), and unit 6 (bottom). The shale content in the rock increases from top to bottom. Photo by Dan Carey, Kentucky Geological Survey.

Limestone and Shale: Units 3 and 7

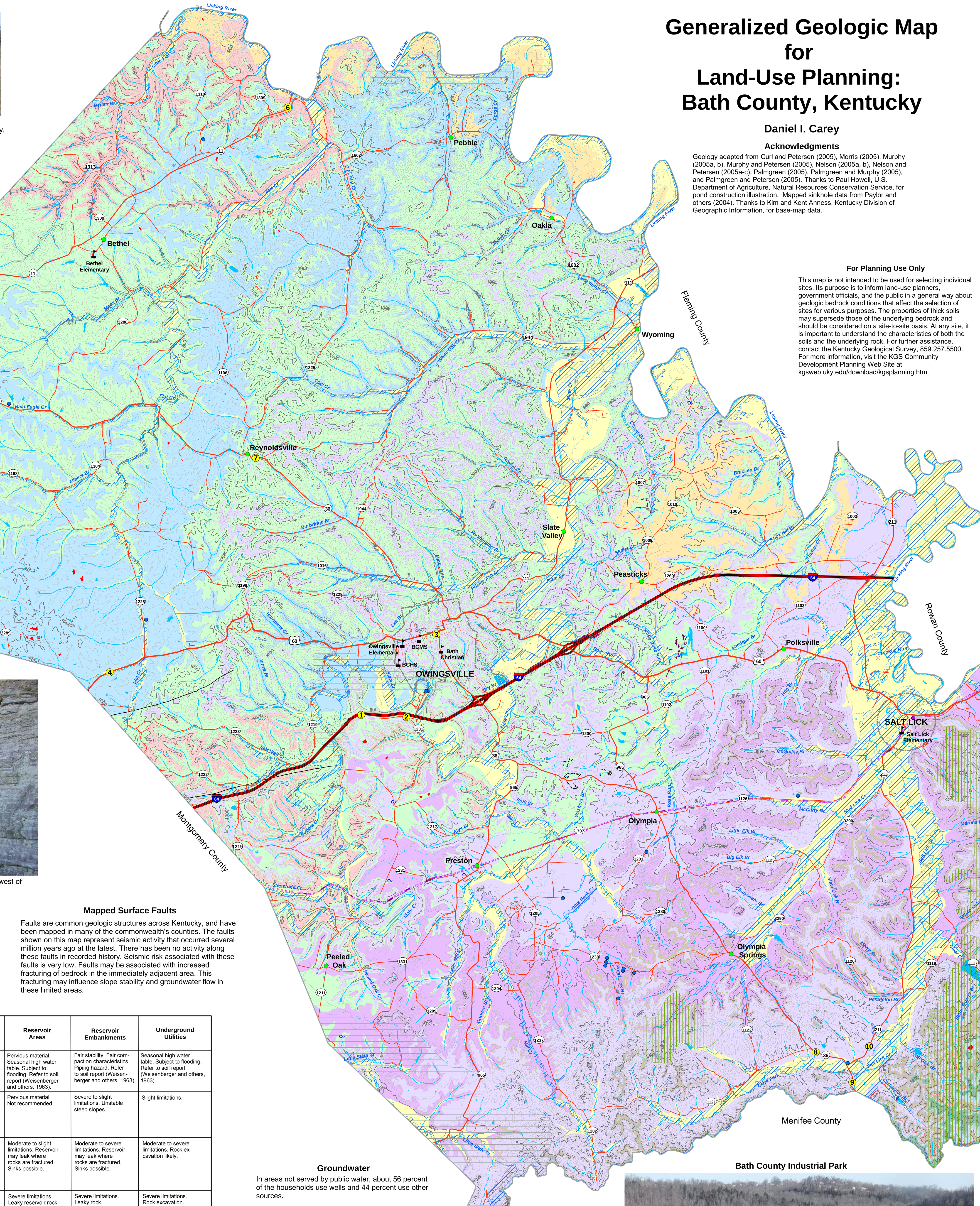


Limestone and shale (unit 3) lies above shale (unit 7) in this roadcut on I-64 west of Owingsville. Photo by Dan Carey, Kentucky Geological Survey.

Limestone: Unit 4



Grant Lake Limestone of unit 4 is exposed in this roadcut on U.S. 60 west of Owingsville. 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.

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 (Weisenberger and others, 1963).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Weisenberger and others, 1963).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Weisenberger and others, 1963).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Weisenberger and others, 1963).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Weisenberger and others, 1963).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Weisenberger and others, 1963).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Weisenberger and others, 1963).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Weisenberger and others, 1963).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Weisenberger and others, 1963).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (Weisenberger and others, 1963).	Seasonal high water table. Subject to flooding. Refer to soil report (Weisenberger and others, 1963).
2. Sand, silt, clay, 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 topography.	Moderate to slight limitations, depending on activity and topography.	Pervious material. Not recommended.	Severe to slight limitations. Unstable steep slopes.	Slight limitations.
3. Limestone/ dolomite, and shale*	Good to excellent foundation material; difficult to excavate.	Moderate to severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks. Danger of groundwater contamination.	Severe to moderate limitations. Rock excavation may be required.	Moderate to severe limitations. Rock excavation possible. Local drainage problems, especially on shale. Sinks possible. Avoid steep slopes.	Slight to moderate limitations, depending on topography. Rock excavation likely. Local drainage problems, especially on shale. Sinks possible.	Slight to moderate limitations, depending on topography. Rock excavation. Sinks common. Local drainage problems. Groundwater contamination possible.	Slight to moderate limitations. Rock excavation may be required.	Slight to moderate limitations, depending on activity and topography. Slight limitations for forest or nature preserve.	Moderate to slight limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Rock excavation likely.
4. Limestone	Good to excellent foundation material; difficult to excavate.	Moderate to severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks. 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 to moderate limitations, depending on topography. Rock excavation likely. Local drainage problems. 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 moderate 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. Black shale*	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. Low strength, slumping, and seepage problems.	Severe limitations. Low strength, slumping, and seepage problems.	Severe limitations. Low 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 for small ponds.	Severe limitations. Poor strength and stability.	Moderate limitations. Poor strength. Wetness.
6. Shale* and limestone/ dolomite	Fair to good foundation material; difficult to excavate. Slumps when wet. Avoid steep slopes.	Slight to severe limitations, depending on amount of soil cover and depth to impermeable rock.	Severe to moderate limitations. Rock excavation may be required. Slumps when wet. Avoid steep slopes. Possible shrinking and swelling shales.	Severe to moderate limitations. Rock excavation may be required. Slumps when wet. Avoid steep slopes.	Severe to moderate limitations. Rock excavation may be required. Slumps when wet. Avoid steep slopes.	Moderate to severe limitations, depending on topography. Rock excavation. Local drainage problems. Susceptible to landslides.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes.	Slight to moderate limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Slight to moderate limitations. Reservoir may leak where rocks are fractured.	Moderate to severe limitations. Rock excavation likely.
7. Shale*	Poor foundation material; easy to moderately difficult to excavate. Low strength and stability. May contain plastic clays.	Severe limitations. Low permeability.	Severe limitations. Low 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.	Moderate to severe limitations, depending on slopes. Strength, slumping, and seepage problems.	Slight to severe limitations, depending on activity.	Slight to moderate 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.
8. Siltstone, sandstone, and shale	Good to excellent foundation material; difficult to excavate.	Severe limitations. Thin soils.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Moderate to severe limitations. Rock excavation. Steep slopes.	Moderate to severe limitations, depending on activity and slope.	Slight to severe limitations, depending on activity. 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.
9. Sandstone	Excellent foundation material; difficult to excavate.	Severe limitations. Thin soils.	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 slope.	Slight to severe limitations, depending on activity. 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.

*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.

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.

Groundwater

In areas not served by public water, about 56 percent of the households use wells and 44 percent use other sources.

Some wells located in the Licking River Valley and the major creek valleys will produce enough water for a domestic supply, except during dry weather. In the upland areas of Bath County (80 percent of the county), most drilled wells will not produce enough water for a dependable domestic supply; some wells along drainage lines may produce enough water, except during dry weather. Throughout the county, groundwater is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet.

For more information on groundwater in the county, see Carey and Stickney (2002).

Additional Resources

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

ces.ca.uky.edu/Bath/ University of Kentucky Cooperative Extension Service
www.gwadd.org/ Gateway Area Development District
www.thinkkentucky.com/edis/cmnty/cw/cw118/ Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21011.html Kentucky Atlas and Gazetteer, Bath County
quickfacts.census.gov/qfd/states/21/21011.html U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the Kentucky Geological Survey

N

Scale = 1:48,000

1 inch equals 3/4 mile

0 0.5 1 2 3 4 Miles

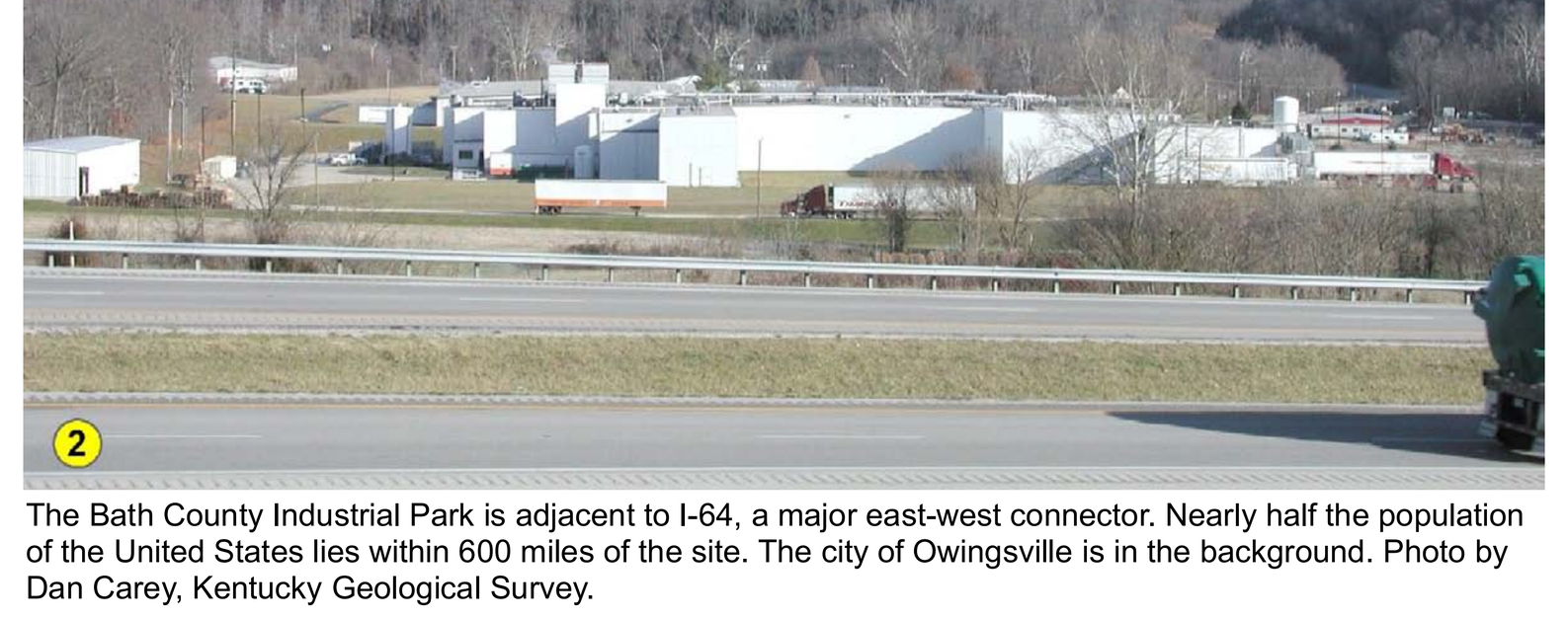
For information on obtaining copies of this map and other Kentucky Geological Survey maps and publications call our Public Information Center at 859.257.3896 or 877.778.7827 (toll free)

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

For Planning Use Only

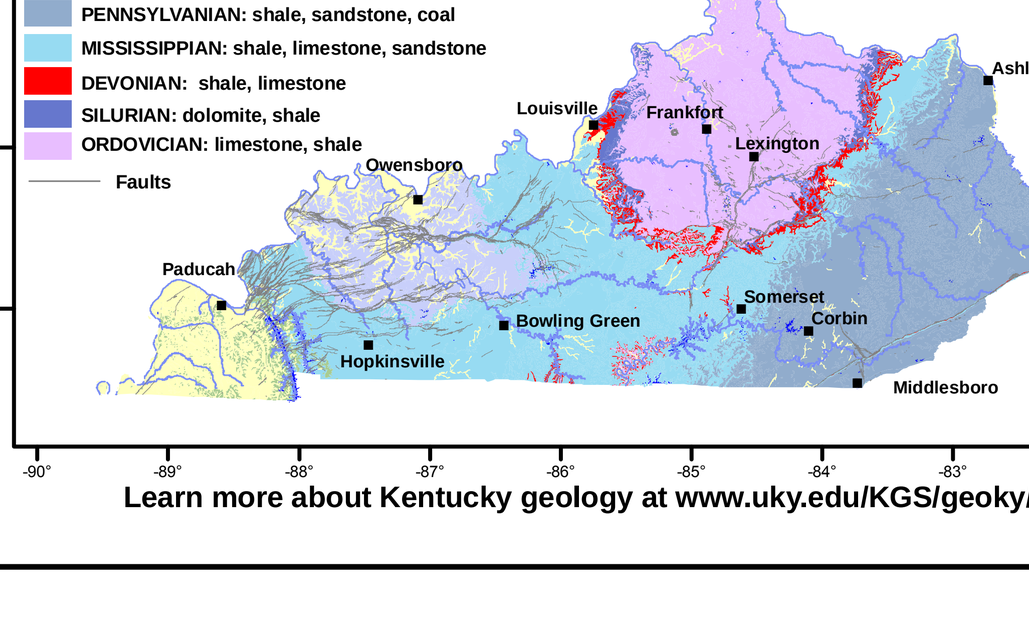
This map is not intended to be used for selecting individual sites. Its purpose is to inform land-use planners, government officials, and the public in a general way about geologic bedrock conditions that affect the selection of sites for various purposes. The properties of thick soils may supersede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

Bath County Industrial Park



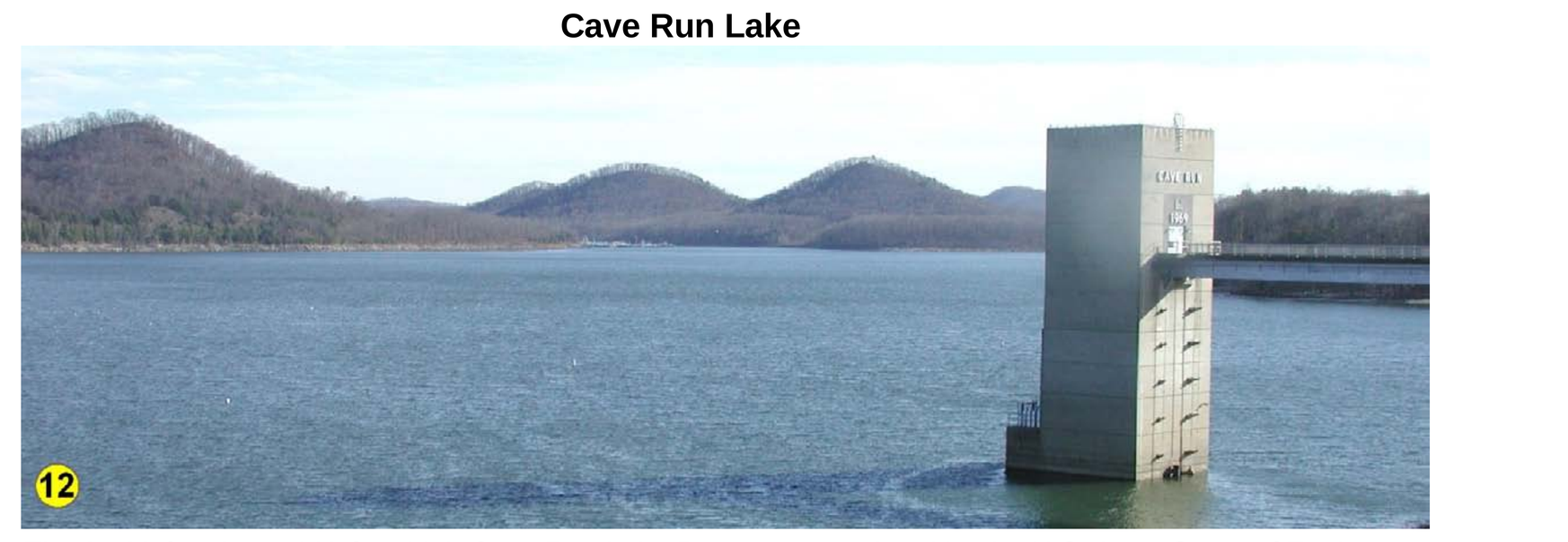
The Bath County Industrial Park is adjacent to I-64, a major east-west connector. Nearly half the population of the United States lies within 600 miles of the site. The city of Owingsville is in the background. Photo by Dan Carey, Kentucky Geological Survey.

Geology of Kentucky

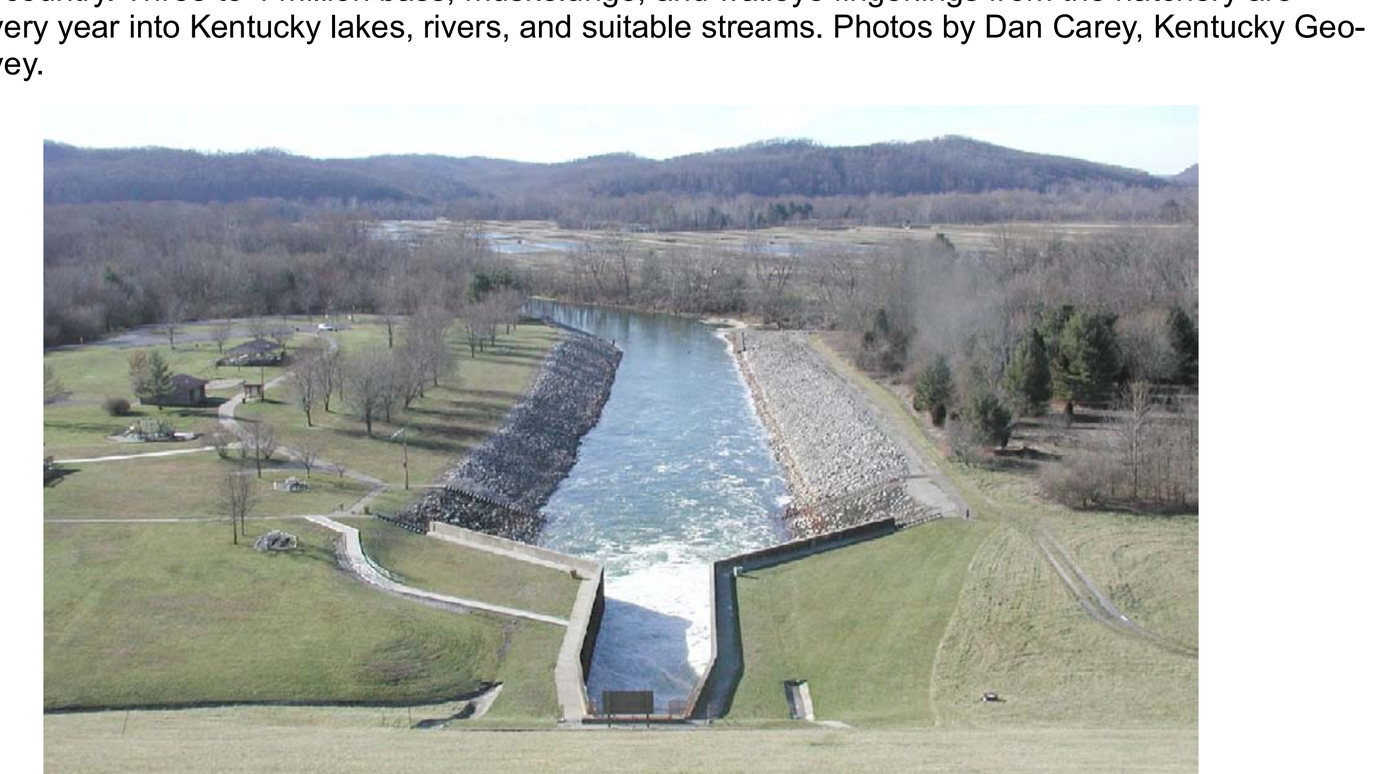


Learn more about Kentucky geology at www.uky.edu/KGS/geoky/

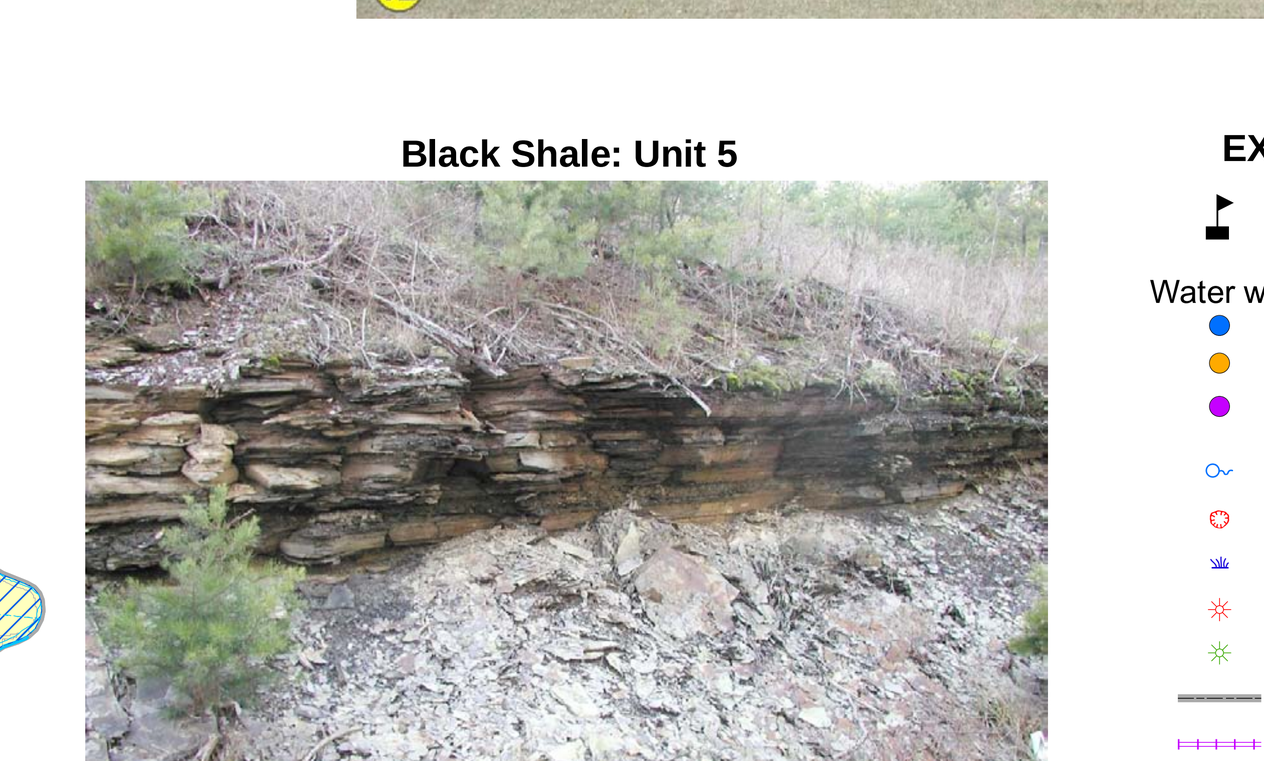
Cave Run Lake



The 2,700-foot-long, 148-foot-high Cave Run Lake Dam was completed by the U.S. Army Corps of Engineers in 1974. The lake provides flood control and recreation. The recreation pool is 8,270 acres and 48.1 miles long. Below the dam lies the Minor E. Clark Fish Hatchery, one of the largest state-owned, warm-water fish hatcheries in the country. Three to 4 million bass, muskelunge, and walleye fingerlings from the hatchery are released every year into Kentucky lakes, rivers, and suitable streams. Photos by Dan Carey, Kentucky Geological Survey.



Black Shale: Unit 5



The black shale (unit 5) is exposed at this roadcut. Photo by Dan Carey, Kentucky Geological Survey.

EXPLANATION

School

Water wells
- Domestic
- Monitoring
- Public

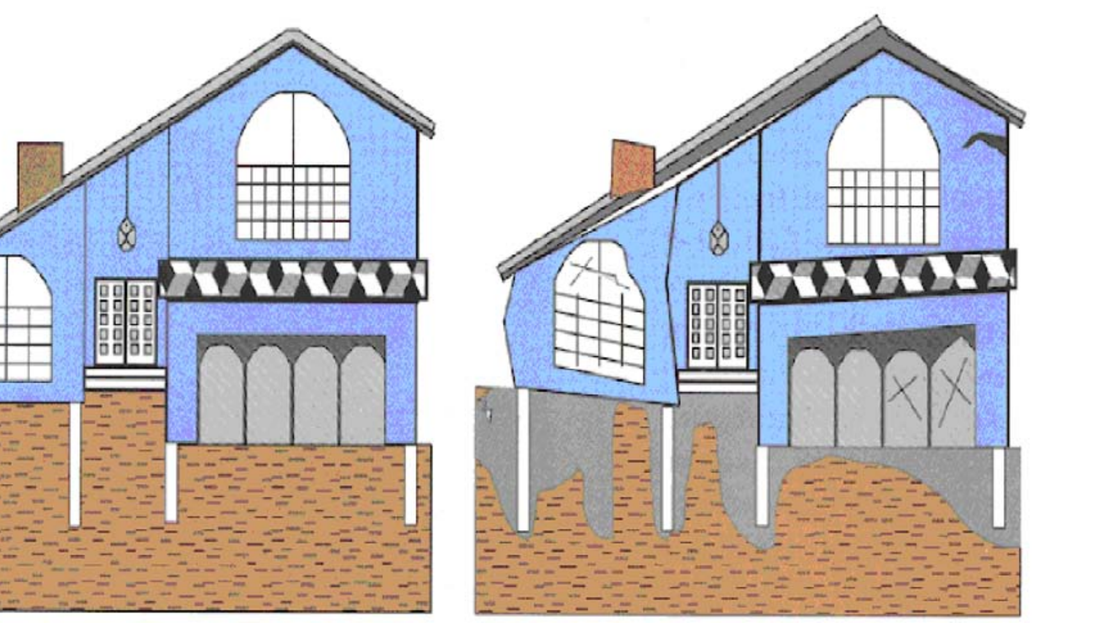
Spring
Sinkhole
Wet area
Gas well
Oil well
County line
Abandoned railroad
Watershed boundary
Geologic fault
Concealed geologic fault
Mapped sinkhole
Artificial fill
Mine waste
Pioneer Weapons Wildlife Management Area
Daniel Boone National Forest
Source-water protection area, zone 1
Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
Incorporated city boundaries
Designated flood zone* (FEMA, 2005)
40-foot contour interval
4 Photo location

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

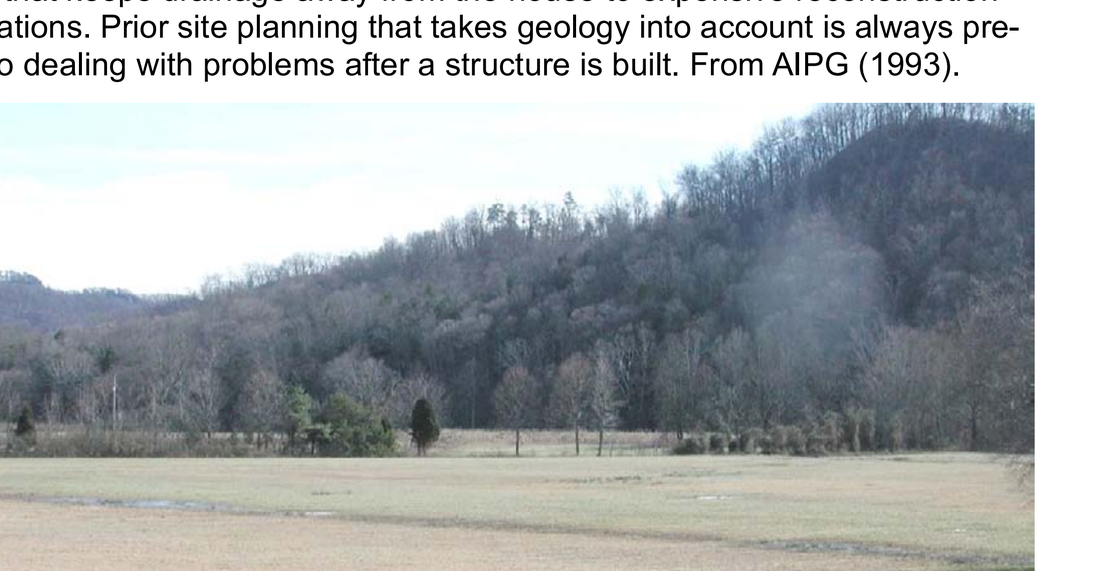
Source-Water Protection Areas

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

Residential Drainage



An uplifting experience that will not be appreciated! Left: All is well in this newly built home until water from percolation, drains, lawn sprinklers, leaking sewers, or water mains soaks swelling soil beneath the foundation. Right: With time, expanding soils exert several tons per square foot of pressure on the foundation and shallow pilings. Without remedial measures, the house will actually become deformed, and shatter masonry and windows. Remedies vary from mere maintenance that keeps drainage away from the house to expensive reconstruction of foundations. Prior site planning that takes geology into account is always preferable to dealing with problems after a structure is built. From AIPG (1993).

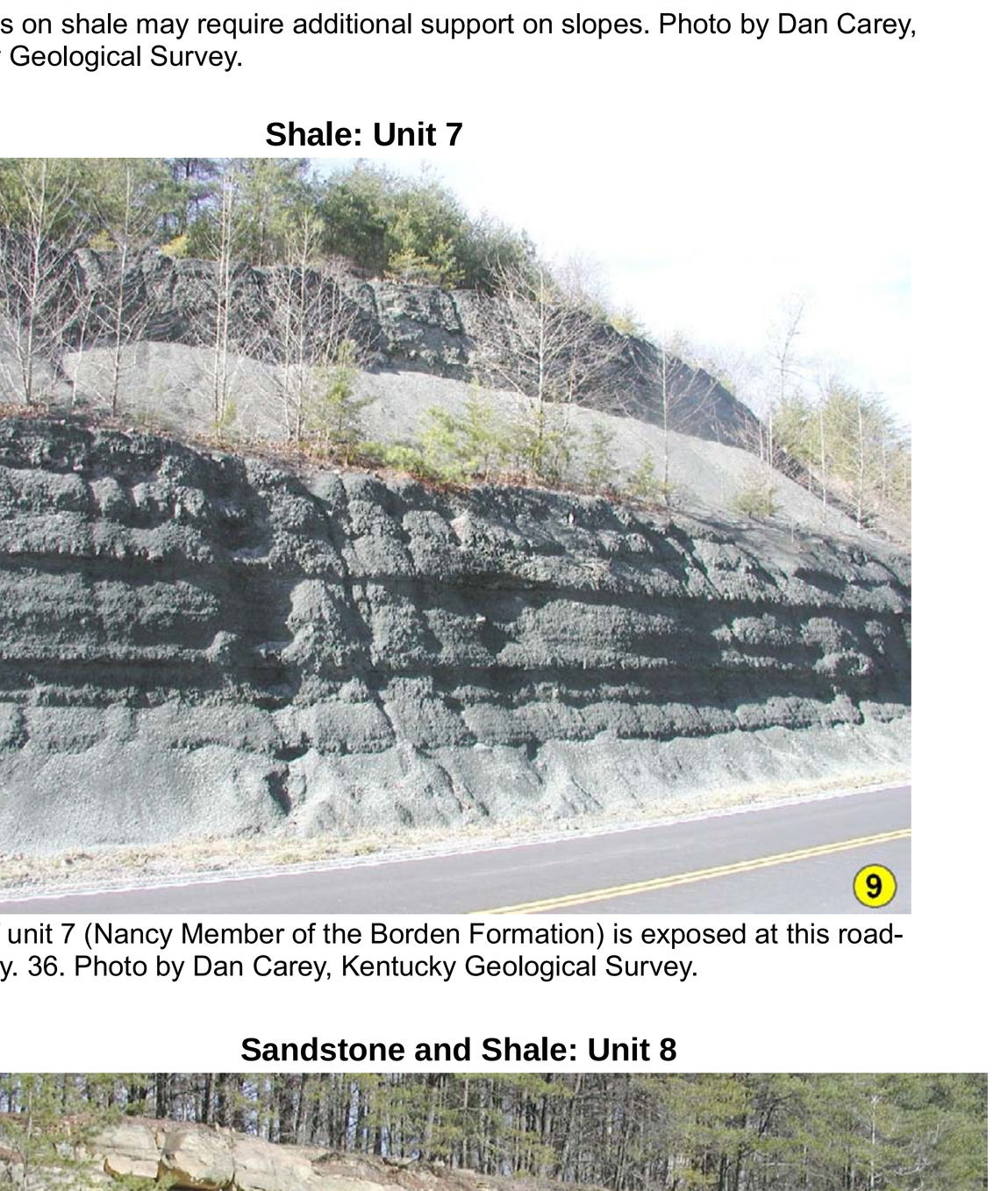


Areas underlain by shales of unit 7 provide flat land for development and soils for agriculture but drain poorly. Photo by Dan Carey, Kentucky Geological Survey.

Slope Stability

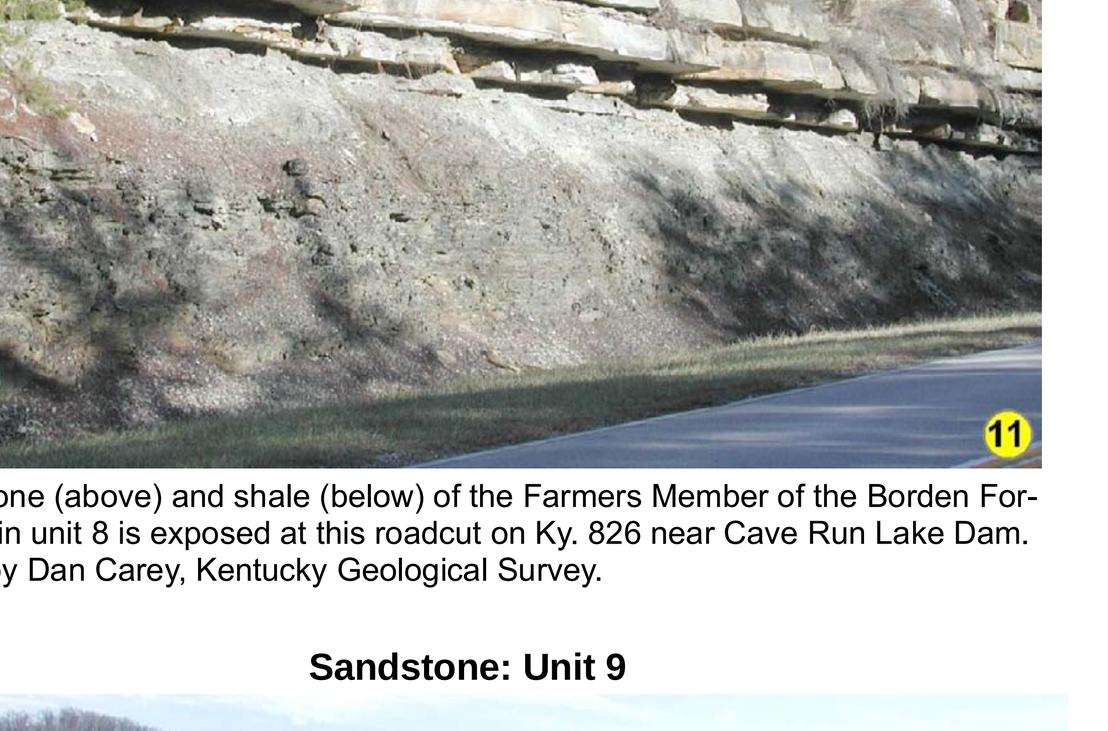
Roadbeds on shale may require additional support on slopes. Photo by Dan Carey, Kentucky Geological Survey.

Shale: Unit 7



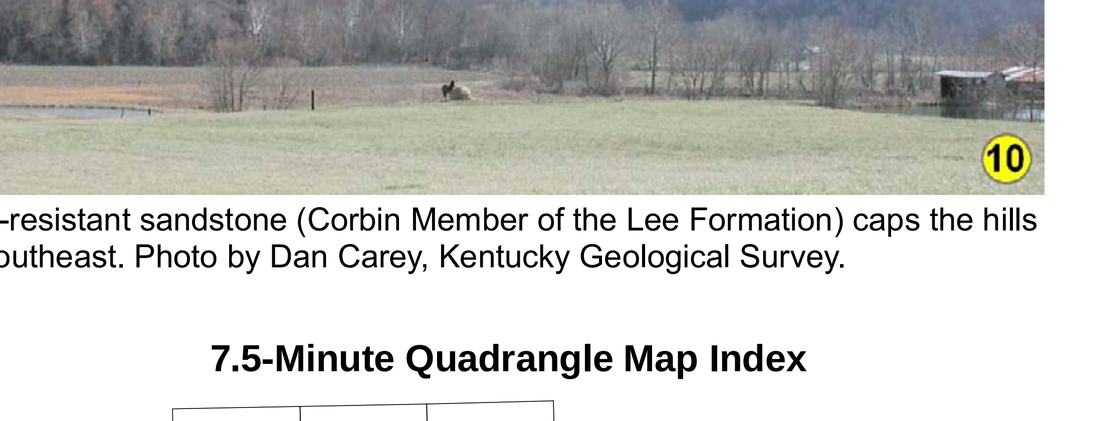
Shale of unit 7 (Nancy Member of the Borden Formation) is exposed at this roadcut on Ky. 36. Photo by Dan Carey, Kentucky Geological Survey.

Sandstone and Shale: Unit 8



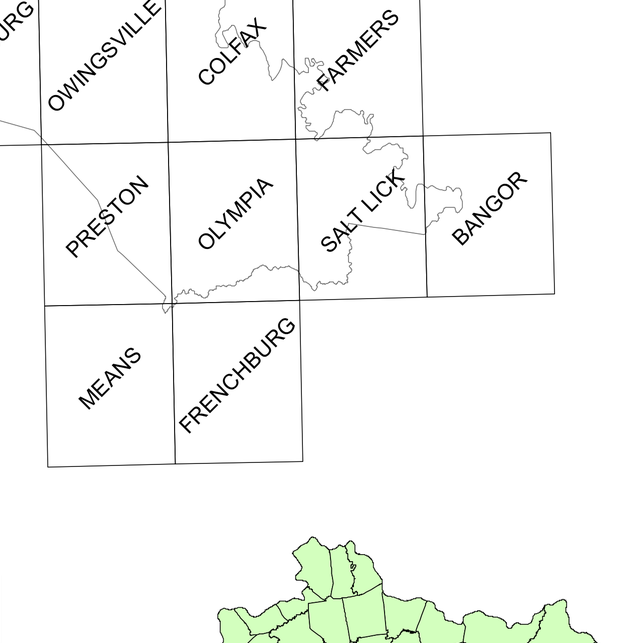
Sandstone (above) and shale (below) of the Farmers Member of the Borden Formation in unit 8 is exposed at this roadcut on Ky. 826 near Cave Run Lake Dam. Photo by Dan Carey, Kentucky Geological Survey.

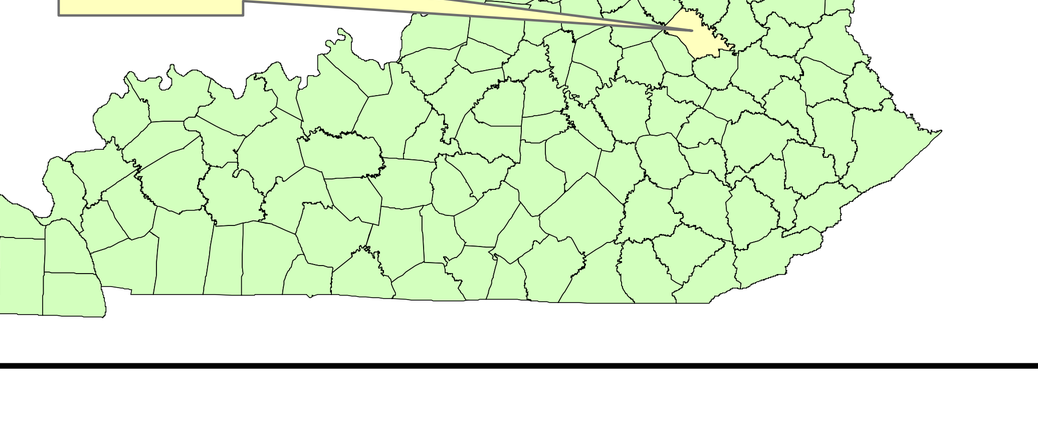
Sandstone: Unit 9



Erosion-resistant sandstone (Corbin Member of the Lee Formation) caps the hills in the southeast. Photo by Dan Carey, Kentucky Geological Survey.

7.5-Minute Quadrangle Map Index





Slope Failure

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

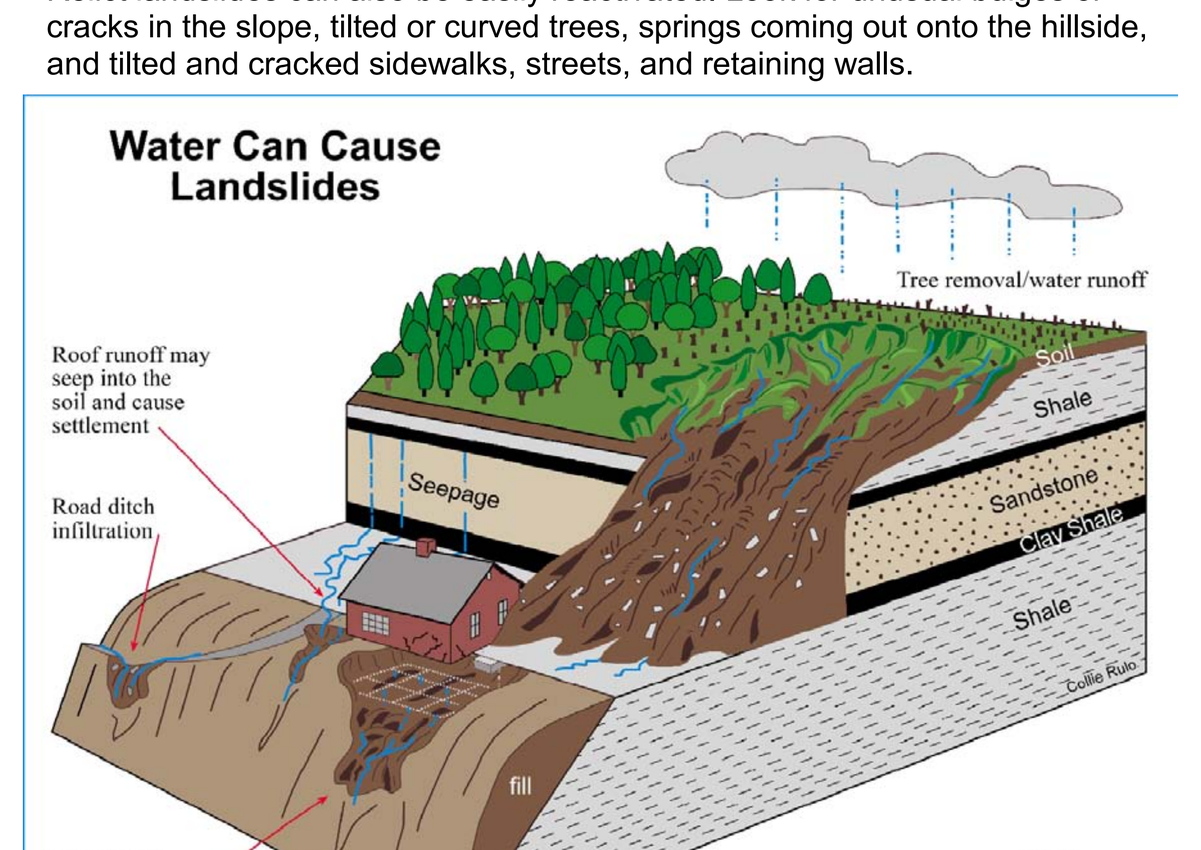
Virtually all units containing shale on slopes are subject to landslides.

Clay shales of unit 7 become plastic when wet and present particularly difficult problems for excavations and foundations. An engineering geologist or a geotechnical engineer should be consulted when clay shales are present.

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 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.

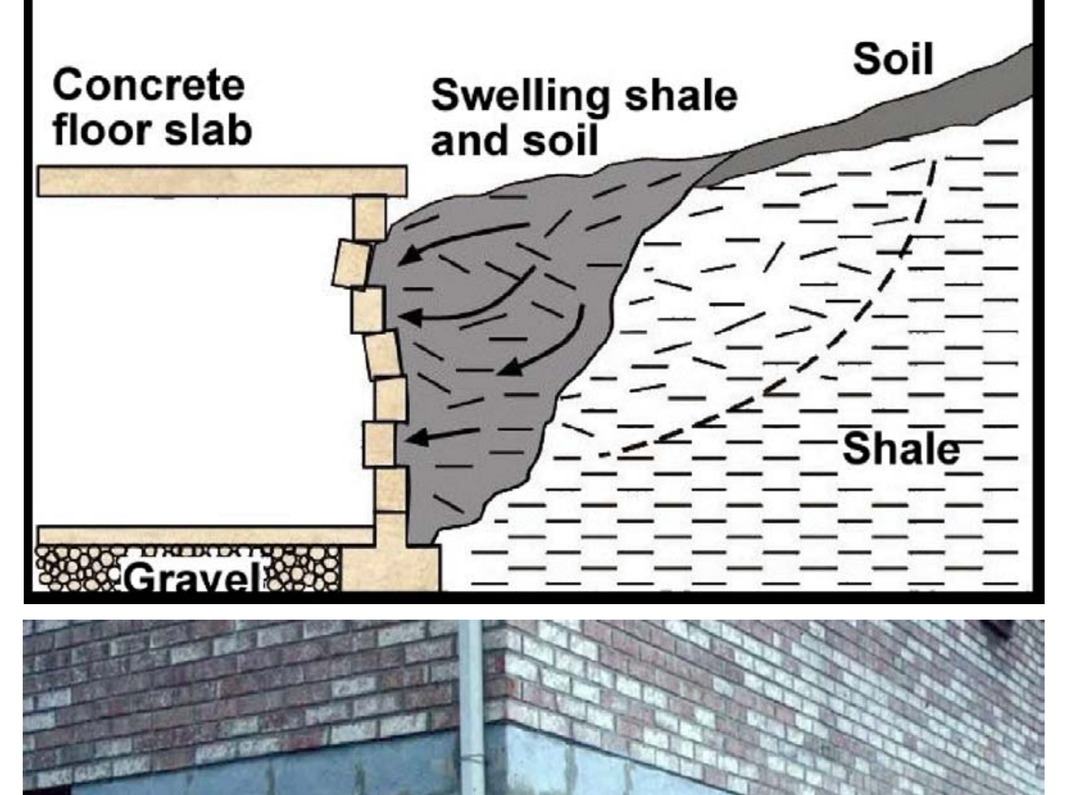
What Are Some Ways to Prevent Landslides?

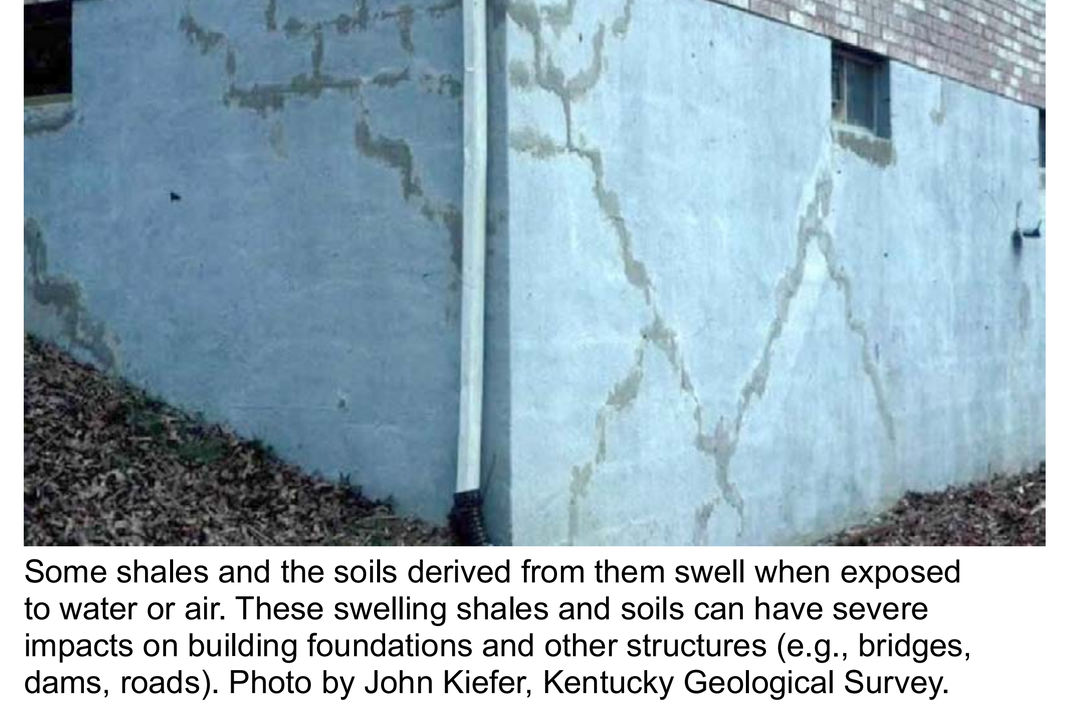
1. Seek professional assistance prior to construction.
2. Proper site selection: Some sloping areas are naturally prone to landslides. Inspect the site for springs, seeps, and other wet areas that might indicate water problems. Take note of unusual cracks or bulges at the soil surface. These are typical 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 perhaps the most common cause of landslides. 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)

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.





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.

References Cited

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