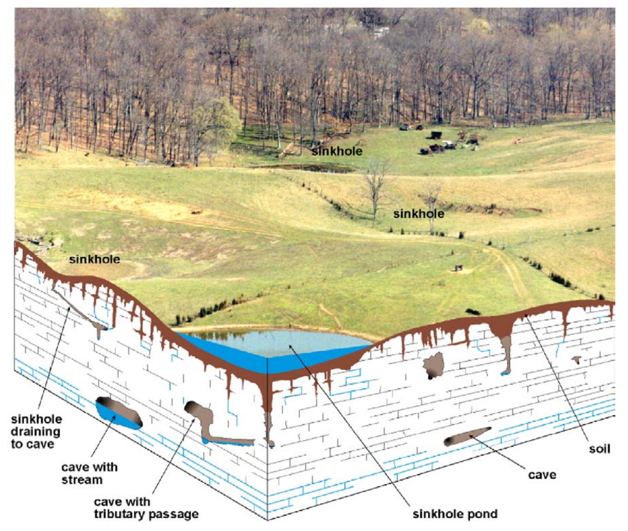
Kentucky Geological Survey
James C. Cobb, State Geologist and Director
UNIVERSITY OF KENTUCKY, LEXINGTON

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

Daniel I. Carey
Kentucky Geological Survey
Emma Witt
University of Kentucky

MAP AND CHART 148
Series XII, 2006

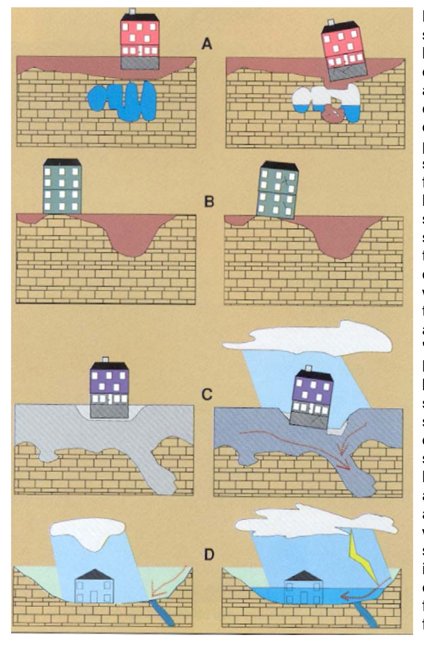
Environmental Protection



– Never use sinkholes as dumps. All waste, but especially pesticides, paints, household chemicals, automobile batteries, and used motor oil, should be taken to an appropriate recycling center or landfill.
– Make sure runoff from parking lots, streets, and other urban areas is routed through a detention basin and sediment trap to filter it before it flows into a sinkhole.
– Make sure your home septic system is working properly and that it's not discharging sewage into a crevice or sinkhole.
– Keep cattle and other livestock out of sinkholes and sinking streams. There are other methods of providing water to livestock.
– See to it that sinkholes near or in crop fields are bordered with trees, shrubs, or grass buffer strips. This will filter runoff flowing into sinkholes and also keep tilled areas away from sinkholes.
– Construct waste-holding lagoons in karst areas carefully, to prevent the bottom of the lagoon from collapsing, which would result in a catastrophic emptying of waste into the groundwater.
– If required, develop a groundwater protection plan (410KAR5:037) or an agricultural water-quality plan (KRS224.71) for your land use.

(From Currens, 2001)

Construction on Karst



Limestone terrain can be subject to subsidence hazards, which usually can be overcome by prior planning and site evaluation. "A" shows construction above an open cavern, which later collapses. This is one of the most difficult situations to detect, and the possibility of this situation beneath a structure warrants insurance protection for homes built on karst terrain. In "B," a heavy structure presumed to lie above solid bedrock actually is partially supported on soft, residual clay soils that subside gradually, resulting in damage to the structure. This occurs where inadequate site evaluation can be traced to lack of geophysical studies and inadequate core sampling. "C" and "D" show the close relationship between hydrology and subsidence hazards in limestone terrain. In "C," the house is situated on porous fill (light shading) at a site where surface- and groundwater drainage move supporting soil (darker shading) into voids in limestone (blocks) below. The natural process is then accelerated by infiltration through fill around the home. "D" shows a karst site where normal rainfall is absorbed by subsurface conduits, but water from infrequent heavy storms cannot be carried away quickly enough to prevent flooding of low-lying areas. Adapted from AIPG (1993).

Radon

Radon gas can be a local problem, in some areas exceeding the U.S. Environmental Protection Agency's maximum recommended limit of 4 picocuries per liter. The limestones of unit 2 may contain high levels of uranium or radium, parent materials for radon gas. Homes in these areas should be tested for radon, but the homeowner should keep in mind that the threat to health results from relatively high levels of exposure over long periods, and the remedy may simply be additional ventilation of the home.

Radon Risk If You've Never Smoked (U.S. Environmental Protection Agency, 2005)

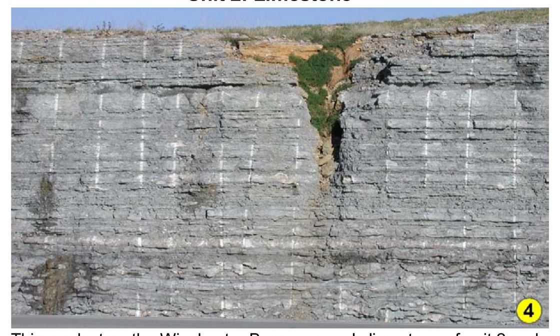
Radon Level	If 1,000 people who never smoked were exposed to this level over a lifetime*...	The risk of cancer from radon exposure compares to**...	WHAT TO DO:
20 pCi/L	About 36 people could get lung cancer	35 times the risk of drowning	Fix your home
10 pCi/L	About 18 people could get lung cancer	20 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 15 people could get lung cancer	4 times the risk of dying in a fall	Fix your home
4 pCi/L	About 7 people could get lung cancer	The risk of dying in a car crash	Fix your home
2 pCi/L	About 4 people could get lung cancer	The risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 2 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult.)
0.4 pCi/L		(Average outdoor radon level)	

Note: If you are a former smoker, your risk may be higher.
* Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).
** Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.

Karst Geology

Karst areas are indicated by sinkholes. 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.

Unit 2: Limestone



This roadcut on the Winchester Bypass reveals limestone of unit 2 and the process of sinkhole formation as percolating water infiltrates cracks and crevices and dissolves the limestone. Photo by Dan Carey, Kentucky Geological Survey.

Limestone Excavation

Excavation in limestone can be difficult, requiring specialized equipment. Photo by Dan Carey, Kentucky Geological Survey.

Trencher used by Winchester Municipal Utilities can cut 1,000 feet of 3-foot-wide, 8-foot-deep trench in 8 hours. Photo courtesy of Ronnie Leggett, Winchester Municipal Utilities.

Radon Ventilation

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

Clark County Courthouse at Winchester

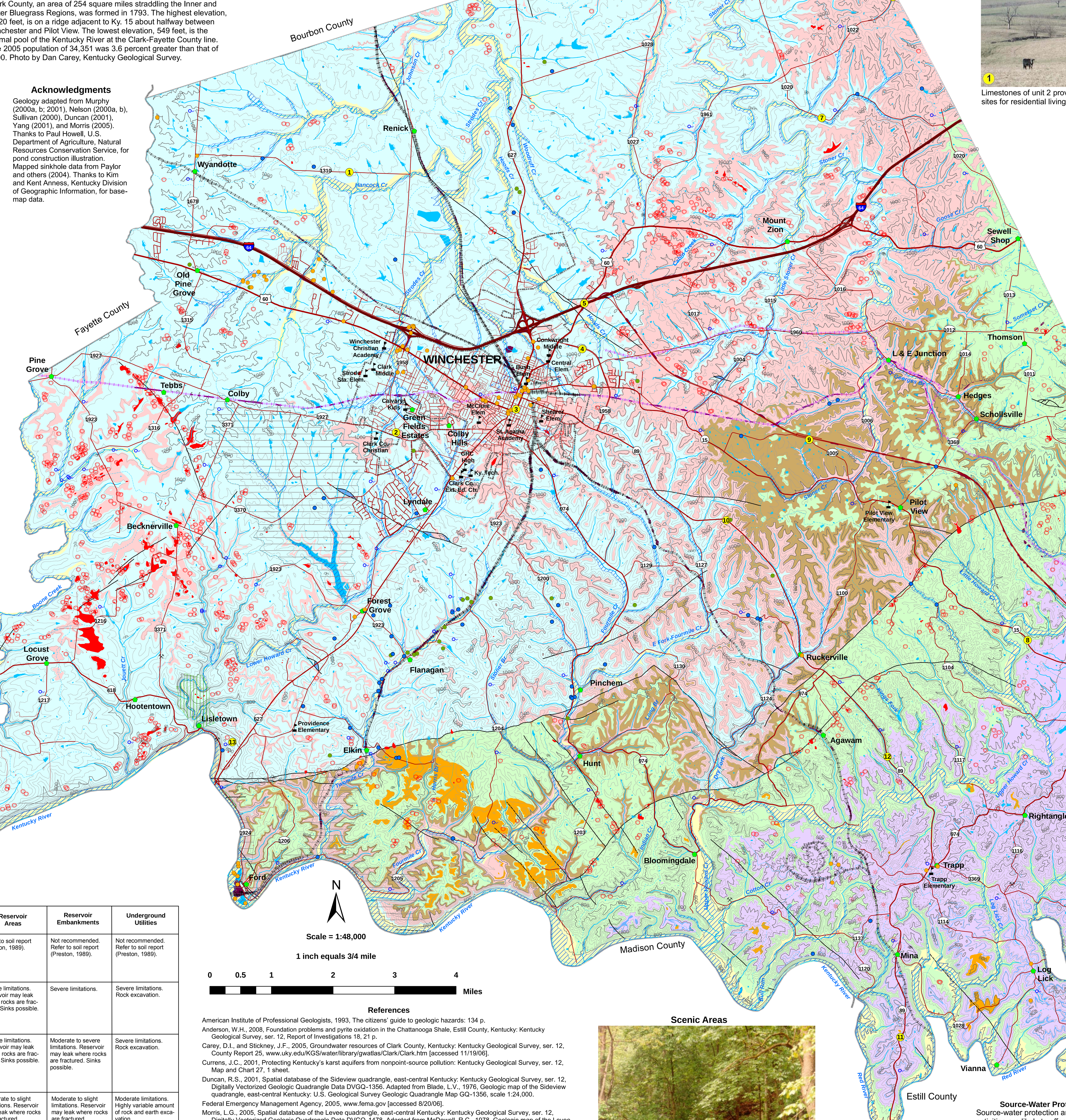
Clark County, an area of 254 square miles straddling the Inner and Outer Bluegrass Regions, was formed in 1793. The highest elevation, 1,120 feet, is on a ridge adjacent to Ky. 15 about halfway between Winchester and Pilot View. The lowest elevation, 549 feet, is the normal pool of the Kentucky River at the Clark-Fayette County line. The 2005 population of 34,351 was 3.6 percent greater than that of 2000. Photo by Dan Carey, Kentucky Geological Survey.

Acknowledgments

Geology adapted from Murphy (2000a, b; 2001), Nelson (2000a, b), Sullivan (2000), Duncan (2001), Yang (2001), and Morris (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.

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.



EXPLANATION

- School
- Water wells
  - Domestic
  - Monitoring
  - Agricultural
- Gas well
- Mine or quarry
- Sinkhole
- Rock outcrop
- Spring
- Geologic fault
- Concealed geologic fault
- Railroad
- Abandoned railroad
- County line
- Incorporated city boundary
- Watershed boundary
- Designated flood zone* (FEMA, 2005)
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Source-water protection area, zone 1
- Public lands
- Mapped sinkholes
- Artificial fill
- 4 Photo location

40-foot contour interval

*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.

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. Refer to soil report (Preston, 1989).	Severe limitations. Failed septic systems can contaminate groundwater. Refer to soil report (Preston, 1989).	Water in alluvium may be in direct contact with basements. Refer to soil report (Preston, 1989).	Slight limitations. Refer to soil report (Preston, 1989).	Slight to moderate limitations. Refer to soil report (Preston, 1989).	Slight to moderate limitations. Avoid construction in flood-plain. Refer to soil report (Preston, 1989).	No limitations. Possible flooding. Refer to soil report (Preston, 1989).	No limitations. Possible flooding. Refer to soil report (Preston, 1989).	Refer to soil report (Preston, 1989).	Not recommended. Refer to soil report (Preston, 1989).	Not recommended. Refer to soil report (Preston, 1989).
2. Limestone	Excellent foundation material; difficult to excavate.	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 common. Local drainage problems.	Slight limitations. Local drainage problems from seeps or springs. Sinks common.	Slight to moderate limitations, depending on topography. Rock excavation possible. Sinks common. Local drainage problems.	Slight limitations.	Slight limitations.	Severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Severe limitations.	Severe limitations. Rock excavation.
3. Limestone, dolomite, and shale	Good to excellent foundation material; moderately difficult to difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks. Danger of groundwater contamination.	Moderate to severe limitations. Rock excavation; locally, upper few feet may be rippable. Drainage required.	Moderate limitations. Rock excavation possible. Possible drainage problems. Sinks possible.	Moderate limitations. Rock excavation possible. Possible drainage problems. Sinks possible.	Slight to severe limitations, depending on topography. Rock excavation. Sinks common. Local drainage problems.	Slight to severe limitations, depending on topography.	Slight limitations, depending on activity and topography. Possible steep wooded slopes. No limitations for nature or forest preserve.	Severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Severe limitations. Rock excavation.
4. Shale, limestone	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.	Moderate to severe limitations. Rock excavation may be required. Avoid steep slopes.	Severe to moderate limitations. Rock excavation may be required. Slumps when wet. Avoid steep slopes.	Severe to moderate 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.	Moderate to slight limitations, depending on type of activity and topography. Possible steep wooded slopes.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Highly variable amount of rock and earth excavation.
5. Siltstone	Good foundation material; moderately difficult to excavate.	Severe limitations. Impermeable rock.	Severe limitations. Rock excavation. Poor drainage.	Slight to moderate limitations. Subgrade requires drainage. Rock excavation.	Slight limitations. Subgrade requires drainage. Shallow cuts can be ripped.	Slight limitations. Local seeps.	Slight limitations, depending on activity.	Slight limitations.	Slight limitations where topographically suited.	Moderate to slight limitations.	Moderate limitations. Rock excavation. In narrow trenches, pneumatic equipment required. Locally, blasting required.
6. Shale*	Fair to poor foundation material; easy to moderately difficult to excavate. Possible pyrite expansion in shales. Plastic clay presents particularly poor foundation conditions.	Severe limitations. Low permeability.	Severe limitations. Low strength, slumping, and seepage problems. Possible swelling of shales.	Moderate to severe limitations. Low strength, slumping, and seepage problems.	Moderate to severe limitations. Low strength, slumping, and seepage problems.	Moderate to severe limitations. Low strength, slumping, and seepage problems.	Severe to slight limitations, depending on activity and topography.	Moderate to slight limitations, depending on activity and topography.	Slight limitations. Reservoir may leak where rocks are fractured. Most ponds on shale are successful.	Severe limitations. Poor strength and stability.	Moderate limitations. Poor strength, wetness.
7. Dolomite	Excellent foundation material; difficult to excavate.	Severe limitations. Impermeable rock.	Severe limitations. Rock excavation may be required.	Severe limitations. Rock excavation may be required.	Severe limitations. Rock excavation may be required.	Moderate to slight limitations, depending on topography. Rock excavation. Local drainage problems.	Moderate to slight limitations, depending on activity and topography.	Moderate to slight limitations, depending on activity and topography.	Moderate limitations; reservoir may leak where rocks are fractured.	Moderate limitations; reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation.
8. High-level gravel deposits	Fair foundation material; easy to excavate.	Severe to slight limitations, depending on soil cover.	Moderate to slight limitations, depending on degree of 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.	Fair stability. Pervious material subject to piping.	Slight limitations.
9. Sandstone (0.2-2 feet)	Excellent foundation material; difficult to excavate.	Severe limitations.	Severe to moderate limitations. Rock excavation may be required.	Severe to moderate limitations. Rock excavation may be required.	Severe to moderate limitations. Rock excavation may be required.	Severe to moderate limitations. Rock excavation may be required.	Slight to moderate limitations, depending on activity.	Slight to moderate limitations, depending on activity.	Moderate to slight limitations; reservoir may leak where rocks are fractured.	Moderate to slight limitations; reservoir may leak where rocks are fractured.	Severe limitations. Rock excavation.

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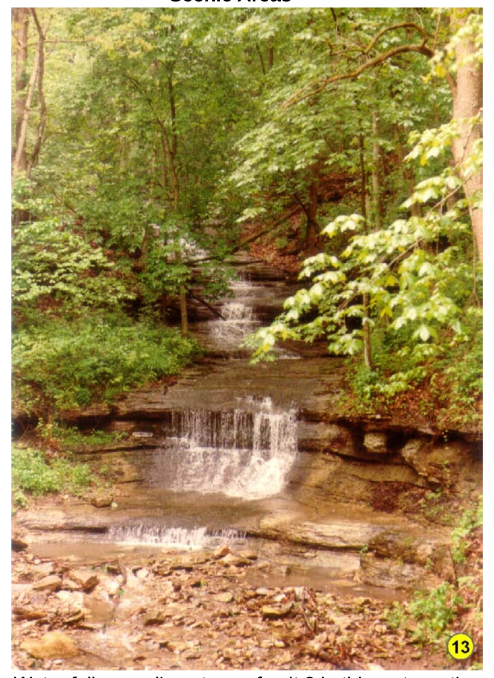
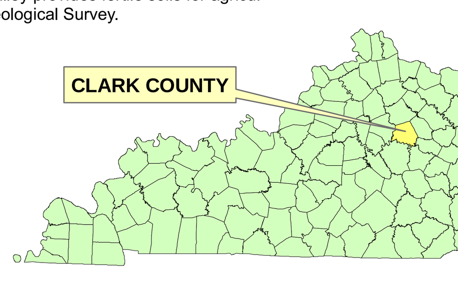
Scenic Areas



Water falls over limestone of unit 2 in this wet weather tributary to the Kentucky River, one of many scenic areas along the river. Photo by Terry Hounshell, Kentucky Geological Survey.

Unit 1: Alluvium

Alluvium in the Upper Howard Creek Valley provides fertile soils for agriculture. Photo by Dan Carey, Kentucky Geological Survey.



Community Development

Recently developed residential area near Winchester. Housing, agriculture, industry, and recreation all vie for space in the community. Development that is compatible with the geologic setting can help reduce development costs and conflicting interests. Photo by Dan Carey, Kentucky Geological Survey.

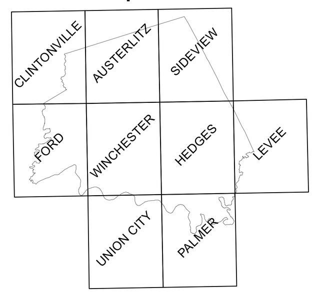
Unit 2: Limestone

Limestones of unit 2 provide soils for a strong agricultural economy and attractive sites for residential living. Photo by Dan Carey, Kentucky Geological Survey.

Transportation

Interstate 64 is a major transportation artery for business, industry, and agricultural products. Photo by Dan Carey, Kentucky Geological Survey.

7.5-Minute Quadrangle Map Index



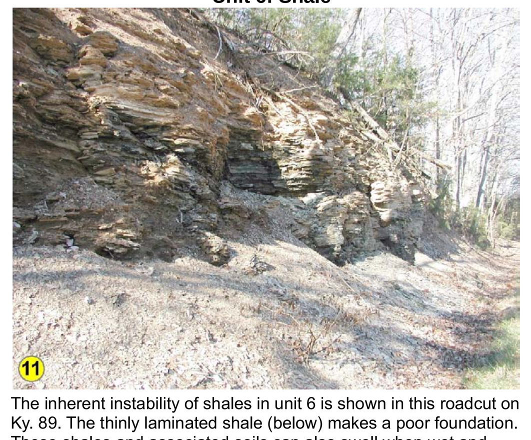
Unit 4: Shale and Limestone

Roadcut along Ky. 89 reveals shales and limestones of unit 4. As the shale content in the underlying rock increases, the topography becomes hillier (below). Photos by Dan Carey, Kentucky Geological Survey.

Slope Stability

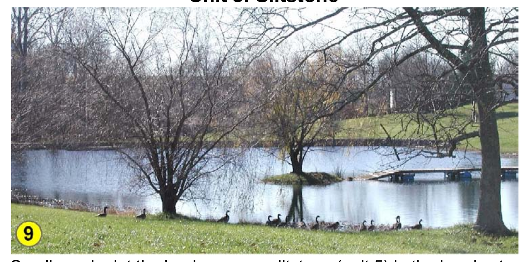
Shales of unit 4 slump and slide on slopes stripped of trees. Photo by Dan Carey, Kentucky Geological Survey.

Unit 6: Shale



The inherent instability of shales in unit 6 is shown in this roadcut on Ky. 89. The thinly laminated shale (below) makes a poor foundation. These shales and associated soils can also swell when wet and shrink when dry, causing foundation damage. Photos by Dan Carey, Kentucky Geological Survey.

Unit 5: Siltstone

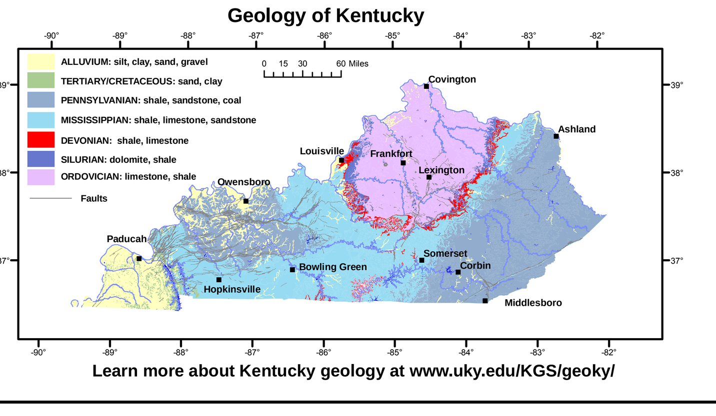


Small ponds dot the landscape on siltstone (unit 5) in the headwaters of Stoner Creek, providing habitat for geese and other wildlife. Photo by Dan Carey, Kentucky Geological Survey.

Unit 3: Limestone, Dolomite, and Shale

Interbedded dolomite and shale (unit 3) in a roadcut on Ky. 89. Shale weathers away leaving dolomite without support. Photo by Dan Carey, Kentucky Geological Survey.

Geology of Kentucky

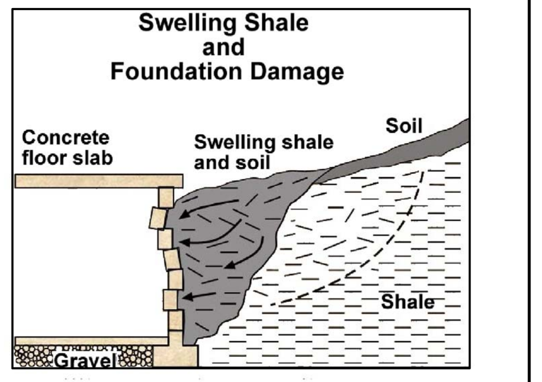


Learn more about Kentucky geology at www.uky.edu/KGS/geoky/

Swelling Shales and Soils

A problem of some concern is the swelling of some of the clay minerals in shales in unit 6. This process is exacerbated when the shale contains the mineral pyrite (fool's gold). Pyrite is a common mineral and can be found distributed throughout the black shale, although it is not always present and may be discontinuous both laterally and horizontally. In the presence of moisture and oxygen, pyrite oxidizes and produces sulfuric acid. The acid reacts with calcium carbonates found in water, the rock itself, crushed limestone, and concrete. This chemical reaction produces sulfate and can form the mineral gypsum, whose crystallization can cause layers of shale to expand and burst, backfill to swell, and concrete to crack and crumble. It can heave the foundation, the slab and interior partitions resting on it, and can even damage upper floors and interior partitions. This phenomenon has been responsible for extensive damage to schools, homes, and businesses in Kentucky.

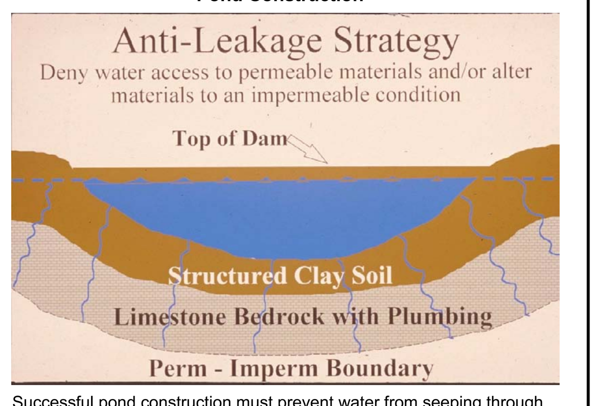
Anyone planning construction on these shales should seek professional advice from a geologist or engineer familiar with the problem.



Swelling shales should never be used for backfill. Illustration by John Kiefer, Kentucky Geological Survey.

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). Photograph by John Kiefer, Kentucky Geological Survey.

Pond Construction



Successful pond construction must prevent water from seeping through structured soils into limestone solution channels below. A compacted clay liner or artificial liner may prevent pond failure. Getting the basin filled with water as soon as possible after construction prevents drying and cracking, and possible leakage, of the clayey soil liner. Ponds constructed in dry weather are more apt to leak than ponds constructed in wet weather. A geotechnical engineer or geologist should be consulted regarding the requirements of a specific site. Other leakage prevention measures include synthetic liners, bentonite, and asphaltic emulsions. The U.S. Department of Agriculture–Natural Resources Conservation Service can provide guidance on the application of these liners to new construction, and for treatment of existing leaking ponds.

Dams should be constructed of compacted clayey soils at slopes flatter than 3 units horizontal to 1 unit vertical. Ponds with dam heights exceeding 25 feet, or pond volumes exceeding 50 acre-feet, require permits. Contact the Kentucky Division of Water, 14 Reilly Rd., Frankfort, KY 40601, telephone: 502.564.3410. Illustration by Paul Howell, U.S. Department of Agriculture–Natural Resources Conservation Service.

Groundwater

In the larger stream valleys of northwestern Clark County and along the thin Kentucky River Valley, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. In the larger creek valleys throughout the county and in the southwestern corner of the county, some wells will produce enough water for a domestic supply, except during dry weather. In the upland areas of Clark County, 50 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply unless they are drilled along drainage lines, in which case they 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 resources 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.

Additional Resources

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

www.winchesterky.com City of Winchester
www.imageswinchester.com Images of Winchester
www.tourwinchester.com Winchester–Clark County Tourism Commission
www.clarkpva.com Clark County Property Valuation Administrator
ces.ca.uky.edu/Clark/ University of Kentucky Cooperative Extension Service
www.bgadd.org/ Bluegrass Area Development District
www.thinkkentucky.com/edis/cmnty/cw/cw093/ Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21049.html Kentucky Atlas and Gazetteer, Clark County
quickfacts.census.gov/qfd/states/21/21049.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