Kentucky Geological Survey
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UNIVERSITY OF KENTUCKY, LEXINGTON

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

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MAP AND CHART 162
Series XII, 2007

Limestone and Shale (Unit 4)

11

Limestone and shale of unit 4 are exposed at this roadcut on U.S. 127 near Hustonville. Areas underlain by these rocks generally provide a gently rolling terrain (below) and soils for a strong agricultural economy. Photos by Dan Carey, Kentucky Geological Survey.

10

Green River

8

The 370-mile-long Green River, longest in Kentucky, begins its journey in Lincoln County and drains an area of over 8,800 square miles in western Kentucky before entering into the Ohio River near Henderson. Along its course it provides flat alluvial land for agriculture (below). Photos by Dan Carey, Kentucky Geological Survey.

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Water Resources

7

The Stanford Reservoir and nearby Rice Lake provide water to Stanford Water Works and fishing to local residents. Photo by Dan Carey, Kentucky Geological Survey.

Groundwater

About 3,400 residents of Lincoln County rely on private domestic water supplies: 1,500 use wells and 1,900 use other sources. North of U.S. 150, in the valleys of Hanging Fork of the Dix River and the Dix River, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. In most of the county, wells located in creek and river valleys will produce enough water for a domestic supply, except during dry weather. In the upland areas (80 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 in the county, see Carey and Stickney (2004).

Mudstone, Dolomite, Shale (Unit 3)

1

Mudstone, siltstone, and shale of unit 3 can be seen in this roadcut on U.S 150. Photo by Dan Carey, Kentucky Geological Survey.

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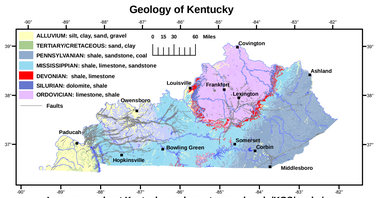
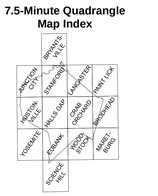
Geology of Kentucky



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

7.5-Minute Quadrangle Map Index



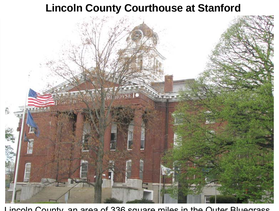
For information on obtaining copies of this map and other Kentucky Geological Survey maps and publications call our Public Information Center at 859.257.3896 or 877.778.7827 (toll free).

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

Pass With Care

The pace of life is slower in the country, out of the fast lane. Photo by Dan Carey, Kentucky Geological Survey.

Lincoln County Courthouse at Stanford



Lincoln County, an area of 336 square miles in the Outer Bluegrass and Mississippian Plateaus Regions, was formed in 1780 as one of Kentucky's three original counties. Muldraugh Hill, which runs south of Crab Orchard, Stanford, and Hustonville, is the most conspicuous topographic feature. The highest elevation, 1,440 feet, is a knob near the Casey County line about 3 miles northwest of Moreland. The lowest elevation, 760 feet, is where the Dix River leaves the county. The county population in 2006 was 25,439, 8.9 percent greater than that of 2000. Photo by Dan Carey, Kentucky Geological Survey.

Karst Geology

Karst areas in Lincoln County 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.

Dolomite (Unit 5)

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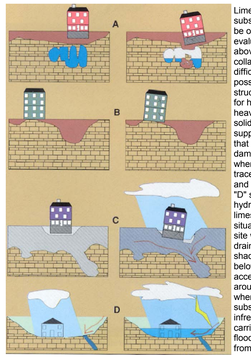
Areas underlain by dolomite (unit 5) provide gently rolling terrain for homesites and soils for agriculture. Wastewater treatment must be properly managed to prevent pollution of groundwater. Photo by Dan Carey, Kentucky Geological Survey.

Karst Subsidence



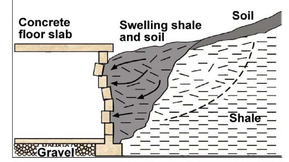
Limestone terrain can be subject to subsidence hazards, which usually can be overcome by prior planning and site evaluation. "A" shows construction above an open cavern, which later collapses. This is one of the most difficult situations to detect, and the possibility of this situation beneath a structure 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).

Swelling and Shrinking Shales

A problem of some concern in Lincoln County is the swelling of some of the clay minerals in shale units 6, 7, and 8. The 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 vertically 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 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.

Swelling Shale and Foundation Damage



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.

Shale, Siltstone, Limestone (Unit 6)

3

Shale in unit 6 is exposed along Shingle Block Road. This shale provides a poor foundation, may swell when wet and shrink when dry, and erodes easily. Unit 6 forms the slopes on Muldraugh Hill and is generally characterized by steep, tree-covered slopes except for a few ridgetops (below) capped by erosion-resistant siltstone or limestone. Photos by Dan Carey, Kentucky Geological Survey.

4

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.

Radon Ventilation

Ventilation system removes radon from the basement area of this home on unit 9. Photo by Dan Carey, Kentucky Geological Survey.

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 4 and shales of unit 9 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

Black Shale (Unit 9)

2

The 360-million year old New Albany Shale (unit 9) is exposed near Old Fall Lick Road. The black shales are high in organic matter and are thought to be a potential source of oil. The shale provides rolling land (below) for agriculture and home sites, but is unstable on slopes and requires drainage management. Photos by Dan Carey, Kentucky Geological Survey.

2

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.

EXPLANATION

- School
- Water wells
  - Agricultural
  - Domestic
  - Monitoring
  - Public
- Spring
- Gas well
- Oil well
- Wet area
- Gravel
- Rock outcrop
- Sinkhole
- Spoil
- Severely eroded area
- Abandoned railroad
- Railroad
- County line
- Watershed boundary
- Geologic fault
- Concealed geologic fault
- Designated flood zone* (FEMA, 2005)
- Source-water protection area, zone 1
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Incorporated city boundaries
- Public lands
- Mapped sinkhole
- 40-foot contour interval
- (4) Photo location

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.

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

N

Scale = 1:63,360
1 inch = 1 mile

0 0.5 1 2 3 4 Miles

Siltstone, Limestone, Shale (Unit 8)

5

Siltstone, limestone, and shale of unit 8 can be seen in this roadcut on Ky. 643. Areas underlain by these rocks in upland areas generally have rolling terrain (below) that provides for agriculture and attractive homesites. Thoughtful planning can reduce conflicting interests. Photos by Dan Carey, Kentucky Geological Survey.

6

Acknowledgments

Geology adapted from Carey and Hettinger (2000), Hettinger (2000), Nelson (2000a, b), Zhang (2000), Hettinger and Petersen (2006), Hettinger and others (2006), Murphy (2006a, b), Murphy and Petersen (2006), Yang (2006a, b), Yang and Petersen (2006), and Yang and Stidham (2006). Mapped sinkholes from Paylor and others (2004). Thanks to Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service, for pond construction illustration. Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base-map data. Thanks to Rick Sergeant, Kentucky Geological Survey, for photo assistance.

Additional Resources

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

www.lincolnky.com/ Lincoln County
lincolncountychamber.com/ Lincoln County Chamber of Commerce
www.kyhometown.com/stanford/ Stanford
ces.ca.uky.edu/Lincoln/ University of Kentucky Cooperative Extension Service
www.bgadd.org/ Bluegrass Area Development District
www.thinkkentucky.com/EDIS/cmnty/index.aspx?CW=012 Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21137.html Kentucky Atlas and Gazetteer, Lincoln County
quickfacts.census.gov/qfd/states/21/21137.html U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the 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.

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.

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 (Evans and Kelley, 2006).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Evans and Kelley, 2006).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Evans and Kelley, 2006).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Evans and Kelley, 2006).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Evans and Kelley, 2006).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Evans and Kelley, 2006).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Evans and Kelley, 2006).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Evans and Kelley, 2006).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Evans and Kelley, 2006).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (Evans and Kelley, 2006).	Seasonal high water table. Subject to flooding. Refer to soil report (Evans and Kelley, 2006).
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. Mudstone, claystone, limestone, dolomite, and shale	Good to excellent foundation material; difficult to excavate.	Severe to moderate limitations. Impermeable rock. Locally fast drainage through fractures and sinks to water table. Possible groundwater contamination.	Severe to moderate limitations. Rock ex-cavation possible.	Moderate to severe limitations. Rock ex-cavation possible. Local drainage problems. Sinks possible. Avoid steep slopes.	Slight to severe limitations, depending on topography. Rock excavation likely. Local drainage problems. Sinks possible.	Severe to slight limitations, depending on topography. Rock excavation. Sinks possible. Local drainage problems. Groundwater contamination possible.	Slight to moderate limitations. Rock excavation may be required.	Slight limitations, depending on activity and topography. Slight limitations for forest or nature preserve.	Slight to moderate 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 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; 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. Dolomite	Excellent foundation material; difficult to excavate.	Moderate to severe limitations. Impermeable rock. Locally fast drainage through fractures and sinks to water table, with possible contamination.	Severe limitations. Rock excavation.	Severe limitations. Rock excavation.	Moderate to severe limitations. Rock ex-cavation.	Severe limitations. Rock excavation. Sinks possible. Local drainage problems.	Slight to moderate limitations, depending on activity and topography.	Slight to moderate 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.
6. Shale* and siltstone/ limestone	Fair to good foundation material; difficult to excavate. Possible expansion of shales. Plastic clay is particularly poor foundation.	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. Sinks possible. Steep wooded slopes.	Slight to moderate limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	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*	Fair to poor foundation material; easy to moderately difficult to excavate. Possible expansion of shales. Plastic clay is particularly poor foundation.	Severe limitations. Low permeability.	Severe limitations. Low strength, slumping, and seepage problems. Possible shrinking and swelling of shales.	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.	Severe to slight limitations, depending on activity and topography. Strength, slumping, and seepage problems.	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.
8. Siltstone, limestone, 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. Black shale	Fair foundation material with drainage management; easy to moderately difficult to excavate. Low strength and stability if wet.	Severe limitations. Thin soils and low permeability.	Severe limitations unless kept dry through proper drainage management.	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 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. Most ponds on shale are successful.	Severe limitations. Poor strength and stability.	Moderate limitations. Poor strength. Wetness.

*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.