2006

Generalized Geologic Map for Land-Use Planning: Bracken and Robertson Counties, Kentucky

Richard A. Smath
University of Kentucky, rsmath@uky.edu

Daniel I. Carey
University of Kentucky, daniel.carey@uky.edu

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

https://doi.org/10.13023/kgs.mc125.12

KGS

MAP AND CHART 125

Series XII, 2006

Generalized Geologic Map for Land-Use Planning: Bracken and Robertson Counties, Kentucky

Richard A. Smath and Daniel I. Carey

Acknowledgments

Geology adapted from Harper (2002), Nelson (2001, 2002a-c), Petersen (2005), Plauche (2002a, b), Smith (2002), Sparks (2001), and Zhang (2002a,b).

Rock Slide

Remnants of a slide seen at the base of this roadcut along Ky. 8 reveal the instability of unit 2 overlying unit 3. Photo by Dan Carey, Kentucky Geological Survey.

Slope Failure

Mass movements or landslides of surficial materials are by far the most frequent and most costly geologic hazards in the northern Kentucky area. Northern Kentucky has the greatest monetary loss per capita caused by landslides in the country. 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 of the mass movements in northern Kentucky occur in colluvium—the weathered soil and rock materials that crumble from the bedrock as it weathers. The lower slopes of unit 2 are commonly thickly mantled with colluvium.

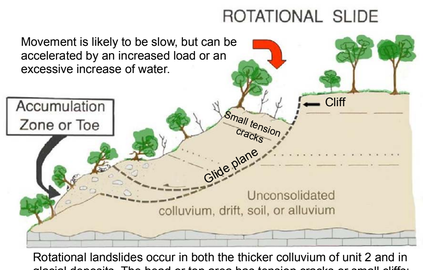
Shales of unit 2 and adjacent unit 3 will break down and weather rapidly when exposed to air and water. These shaly units tend to swell considerably when exposed to water. For this reason, plumbing trenches under walls and foundations should be prevented from accumulating water. Units 2 and 3 may share a translational landslide.

Gravity is the main driving force, but water nearly always plays a critical role by adding weight and lubricating the particles in the colluvium. Cutting into or overloading a slope with structures and fill can also be major contributing factors.

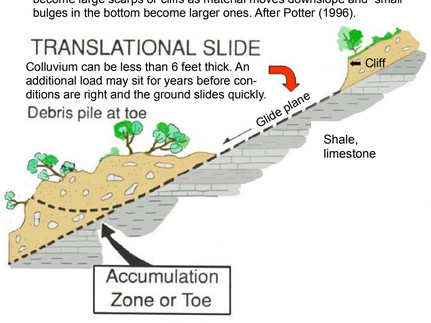
Precautions include taking care of all surface-water runoff by making certain that all runoff from roof, gutters, patios, sidewalks, and driveways is carried well away from and not toward the house; diverting drainage from areas sloping toward the house; cutting into natural slopes as little as possible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

For more information, see Potter (1996).

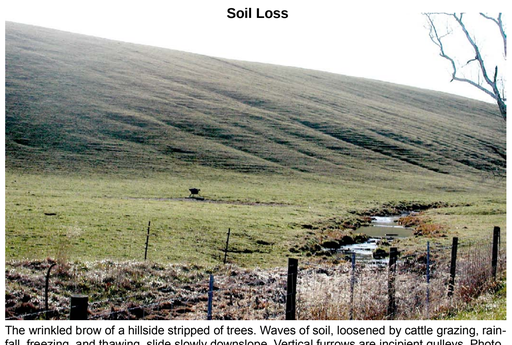


Rotational landslides occur in both the thicker colluvium of unit 2 and in glacial deposits. The head or top area has tension cracks or small cliffs; the toe or bottom has transverse ridges or bulges. A principal glide plane connects the top to the bottom. Small tension cracks in the top become large scarps or cliffs as material moves downslope and small bulges in the bottom become larger ones. After Potter (1996).



A transitional landslide is a relatively thin sheet of colluvium that separates from the underlying bedrock and slides catastrophically downslope more or less as a coherent sheet until it abruptly stops and becomes a crumbled, disorganized pile of debris. Such failures are common on steeper slopes of shale-dominated units (units 2, 3) when both colluvium and the weathered, more permeable bedrock below become fully saturated with water. After Potter (1996).

Soil Loss



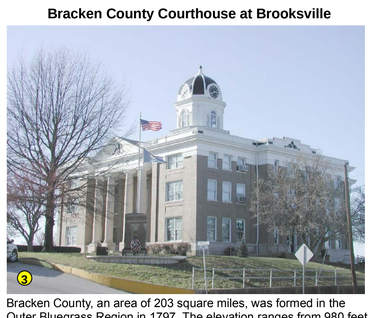
The wrinkled brow of a hillside stripped of trees. Waves of soil, loosened by cattle grazing, rainfall, freezing, and thawing, slide slowly downslope. Vertical furrows are incipient gulleys. Photo by Dan Carey, Kentucky Geological Survey.

Additional Planning Resources

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

ces.ca.uky.edu/bracken/ Bracken County, University of Kentucky Cooperative Extension Service
ces.ca.uky.edu/robertson/ Robertson County, University of Kentucky Cooperative Extension Service
www.kineticnet.net/kyrcd/ln.html Licking River Valley Resource Conservation and Development Council Inc.
www.state.ky.us/agencies/btrc/ Buffalo Trace Area Development District
www.thinkkentucky.com/edis/cmnty/cw101/ Bracken County—Economic Development Information System
www.thinkkentucky.com/edis/cmnty/cw121/ Robertson County—Economic Development Information System
www.uky.edu/KentuckyAtlas/21023.html Bracken County—Kentucky Atlas and Gazetteer,
www.uky.edu/KentuckyAtlas/21201.html Robertson County—Kentucky Atlas and Gazetteer
quickfacts.census.gov/qfd/states/21/21023.html Bracken County—U.S. census data
quickfacts.census.gov/qfd/states/21/21201.html Robertson County—U.S. census data
www.robertsoncountyky.com/ Robertson County government site
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the Kentucky Geological Survey

Bracken County Courthouse at Brooksville

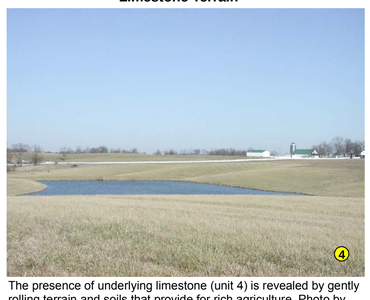


Bracken County, an area of 203 square miles, was formed in the Outer Bluegrass Region in 1797. The elevation ranges from 980 feet in the rolling hills of unit 2, to 455 feet in the alluvial plain (unit 1) of the Ohio River. The population in 2004 was 8,707, 5 percent higher than in 2000. Photo by Dan Carey, Kentucky Geological Survey.

Ohio River Transportation System

The Captain Anthony Meldahl Lock and Dam near Foster at mile 436.2 on the Ohio River is one link in the river transportation system operated by the U.S. Army Corps of Engineers. Photo by Dan Carey, Kentucky Geological Survey.

Limestone Terrain

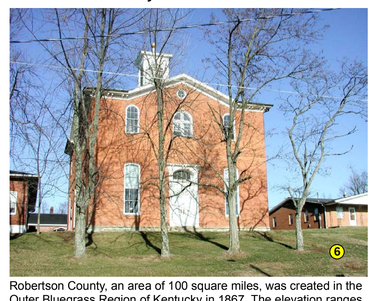


The presence of underlying limestone (unit 4) is revealed by gently rolling terrain and soils that provide for rich agriculture. Photo by Dan Carey, Kentucky Geological Survey.

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, 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.

Robertson County Courthouse at Mount Olivet



Robertson County, an area of 100 square miles, was created in the Outer Bluegrass Region of Kentucky in 1867. The elevation ranges from 1,009 feet in the steep rolling hills of unit 2 to 550 feet in the flat alluvial valley of unit 1. The population in 2004 was 2,308, 1.9 percent higher than in 2000. Photo by Dan Carey, Kentucky Geological Survey.

EXPLANATION

- School
- Water wells
  - Domestic
  - Monitoring
  - Public
  - Spring
  - Watershed boundary
  - Railroad
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Designated flood zone* (FEMA, 2005)
- Incorporated city boundaries
- Source-water protection area, zone 1
- Mapped sinkholes
- Artificial fill

50-foot contour interval

4 Photo location

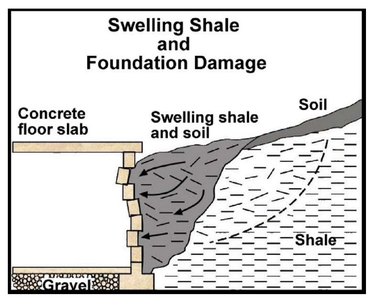
*Flood information is available from the Kentucky Division of Water, Flood Plain Management Branch, www.water.ky.gov/floods/.

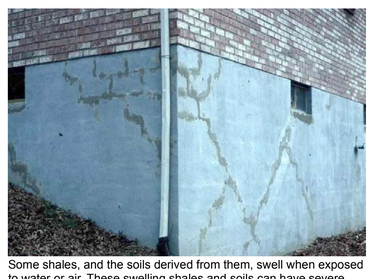
Source-Water Protection Areas

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.

Swelling and Shrinking Shales

A problem of considerable concern in this area is the swelling of some of the clay minerals in shale units 2 and 3. 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.

Shaly Limestone Terrain

Steep, rolling, knobby hills characterize the underlying shaly limestones of unit 2. Photo by Dan Carey, Kentucky Geological Survey.

Covered Bridge

Covered bridges, vestiges of a slower-paced life, are increasingly rare. This abandoned bridge spans Johnson Creek in southeastern Robertson County. Photo by Dan Carey, Kentucky Geological Survey.

Earthquake Hazard

Ground shaking (peak particle accelerations) caused by an earthquake in or near the county is minimal for structures situated on or tied into the bedrock foundation. In areas underlain by poorly consolidated soils, site-specific investigations should be conducted to assure that the building codes will conform to any ground deformation such as liquefication, landslides, or surface fault ruptures. See www.uky.edu/KGS/geologichazards/eqhazards.htm for more information.

Licking River at Blue Licks State Park

The Licking River has carved a large valley along its course. Here at Blue Licks State Park it cuts into the outer bank, undermining large trees. Photo by Dan Carey, Kentucky Geological Survey.

Groundwater in Bracken County

The Ohio River alluvium is the best source of groundwater in the county. Many properly constructed drilled wells will produce several hundred gallons per minute from the alluvium. Most wells will produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard, but otherwise of good quality. In the lower third of the Licking River Valley and the lower sections of the large creek valleys discharging into the Ohio River, most drilled wells will produce enough for a domestic supply at depths of less than 100 feet. Some wells located in the major creek 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 for a dependable domestic supply; some wells along drainage lines may produce enough water, except during dry weather. Groundwater in these areas is hard or very hard, and may contain salt or hydrogen sulfide, especially at depths gr eater than 100 feet. For more information about groundwater in the county, see Carey and Stickney (2004 a).

Groundwater in Robertson County

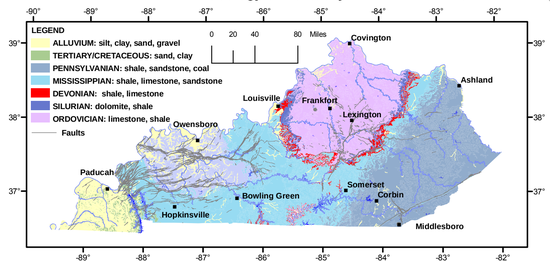
In the Licking River Valley, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the major creek valleys will produce enough water for a domestic supply, except during dry weather. In upland areas (90 percent of the county), most drilled 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 (2004b).

N

Scale 1:48,000

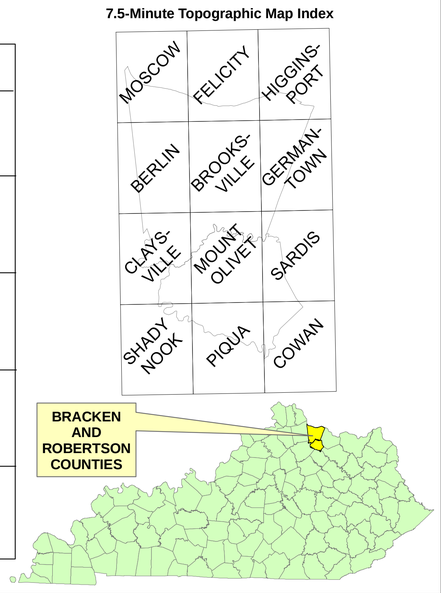
0 0.5 1 2 3 4 Miles

Geology of Kentucky



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

7.5-Minute Topographic Map Index



References Cited

Carey, D.I., and Stickney, J.F., 2004a Groundwater resources of Bracken County, Kentucky: Kentucky Geological Survey, ser. 12, County Report 12, www.uky.edu/KGS/water/library/gwatlas/Bracken/Bracken.htm [accessed 11/22/05].

Carey, D.I., and Stickney, J.F., 2004b Groundwater resources of Robertson County, Kentucky: Kentucky Geological Survey, ser. 12, County Report 101, www.uky.edu/KGS/water/library/gwatlas/Robertson/Robertson.htm [accessed 11/22/05].

Federal Emergency Management Agency, 2005, www.fema.gov [accessed 10/21/05].

Harper, A.S., 2002, Spatial database of the Mount Olivet quadrangle, Robertson and Bracken Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1404. Adapted from Wallace, R.M., 1977, Geologic map of the Mount Olivet quadrangle, Robertson and Bracken Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1404, scale 1:24,000.

Nelson, H.L., Jr., 2001, Spatial database of the Shady Nook quadrangle, northeastern Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1261. Adapted from Wallace, R.M., 1975, Geologic map of the Shady Nook quadrangle, northeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1261, scale 1:24,000.

Nelson, H.L., Jr., 2002a, Spatial database of the Berlin quadrangle, Bracken and Pendleton Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1256. Adapted from Luft, S.J., 1975, Geologic map of the Berlin quadrangle, Bracken and Pendleton Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1256, scale 1:24,000.

Nelson, H.L., Jr., 2002b, Spatial database of the Brooksville quadrangle, Bracken County, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-905. Adapted from Outerbridge, W.F., 1971, Geologic map of the Brooksville quadrangle, Bracken County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-905, scale 1:24,000.

Nelson, H.L., Jr., 2002c, Spatial database of the Claysville quadrangle, northeastern Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1341. Adapted from Luft, S.J., 1976, Geologic map of the Claysville quadrangle, northeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1341, scale 1:24,000.

Petersen, C., 2005, Spatial database of the Cowan quadrangle, northeastern Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1466. Adapted from Blade, L.V., 1978, Geologic map of the Cowan quadrangle, northeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1466, scale 1:24,000.

Plauche, S.T., 2002a, Spatial database of the Higginsport quadrangle, Ohio-Kentucky, and part of the Russellville quadrangle, Mason County, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1065. Adapted from Outerbridge, W.F., Weiss, M.P., and Obsborne, R.H., 1973, Geologic map of the Higginsport quadrangle, Ohio-Kentucky, and part of the Russellville quadrangle, Mason County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1065, scale 1:24,000.

Plauche, S.T., 2002b, Spatial database of the Sardis quadrangle, northeastern Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1091. Adapted from McDowell, R.C., 1973, Geologic map of the Sardis quadrangle, northeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1091, scale 1:24,000.

Potter, P.E., 1996, Exploring the geology of the Cincinnati/northern Kentucky region: Kentucky Geological Survey, ser. 12, Special Publication 22, 115 p.

Smith, P.C., 2002, Spatial database of the Germantown quadrangle, Mason and Bracken Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-971. Adapted from Outerbridge, W.F., 1971, Geologic map of the Germantown quadrangle, Mason and Bracken Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-971, scale 1:24,000.

Sparks, T.N., 2001, Spatial database of the Piqua quadrangle, northeastern Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1425. Adapted from Wallace, R.M., 1978, Geologic map of the Piqua quadrangle, northeastern Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1425, scale 1:24,000.

U.S. Fish and Wildlife Service, 2003, National Wetlands Inventory, www.nwi.fws.gov [accessed 10/25/05].

Zhang, Q., 2002a, Spatial database of the Felicity quadrangle, Ohio-Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1063. Adapted from Osborne, R.H., Weiss, M.P., and Outerbridge, W.F., 1973, Geologic map of the Felicity quadrangle, Ohio-Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1063, scale 1:24,000.

Zhang, Q., 2002b, Spatial database of the Moscow quadrangle, Ohio-Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1069. Adapted from Luft, S.J., Osborne, R.H., and Weiss, M.P., 1973, Geologic map of the Moscow quadrangle, Ohio-Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1069, scale 1:24,000.

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	Karst Potential Rating	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	None, but on-site karst investigation recommended where less than 25 feet thick over soluble rock.	Fair foundation material; easy to excavate.	Severe limitations. Failed septic systems can contaminate groundwater.	Water in alluvium may be in direct contact with basements.	Slight limitations.	Slight to moderate limitations.	Slight to moderate limitations. Avoid construction in flood-plain.	No limitations. Possible flooding.	No limitations. Possible flooding.	Consult with local soil scientist.	Not recommended.	Not recommended.
2. Shale*, limestone	Medium to low.	Fair to good foundation material; difficult excavation. 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. Possible steep slopes.	Moderate limitations. Rock excavation likely. Local drainage problems, especially on shale. Sinks common.	Slight to severe limitations, depending on topography. Rock excavation. Sinks common. Local drainage problems. Groundwater contamination possible.	Slight to moderate limitations, depending on activity and topography. Possible steep wooded slopes.	Slight 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. Sinks possible.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Possible rock excavation. Susceptible to landslides.
3. Limestone, shale*	High to medium.	Good to excellent foundation material; difficult to excavate.	Slight to severe limitations, depending on amount of soil cover and depth to impermeable rock.	Severe to moderate limitations. Rock excavation may be required.	Moderate limitations. Rock excavation possible. Local drainage problems, especially on shale. Sinks common and caves possible.	Moderate limitations. Rock excavation possible. Possible steep slopes. Slight limitations with suitable topography.	Slight to severe limitations, depending on topography. Rock excavation. Sinks common. Local drainage problems. Groundwater contamination possible.	Slight to moderate limitations. Rock excavation may be required.	Slight limitations, depending on activity and topography. Possible steep wooded slopes. No limitations for nature or forest 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.	Severe to moderate limitations. Possible rock excavation.
4. Limestone	High.	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 may be required.	Severe limitations. Rock excavation. Possible steep slopes.	Severe to moderate limitations. Possible rock excavation. Possible steep slopes and narrow ravines.	Slight to moderate limitations, depending on topography. Rock excavation possible. Sinks common. Local drainage problems.	Moderate to slight limitations, depending on activity and topography. Possible wooded slopes.	Severe to slight limitations, depending on activity and topography. Possible wooded slopes. Slight limitations for nature preserve.	Slight to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Slight to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Severe to moderate limitations. Possible rock excavation.
5. Clay, silt, sand, and gravel (high-level terrace deposits and glacial outwash)	None, but on-site karst investigation recommended where less than 25 feet thick over soluble rock.	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 degree of slope.	Slight limitations, depending on degree of slope.	Moderate to slight limitations, depending on activity and topography. Possible wooded slopes.	Slight limitations, depending on activity and topography. Possible wooded slopes. Slight limitations for nature preserve.	Not recommended. Pervious material.	Severe to slight limitations. Unstable steep slopes.	Slight limitations.

*Some of these shales can shrink during dry periods and swell during wet periods and cause cracking of foundations. On hillsides, especially where springs are present, they can also be susceptible to landslides.