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

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Acknowledgments

Geology adapted from Crawford (2003, 2004), Johnson (2002a-c), Nelson (2001a-d, 2002a, b, 2003a, b), and Zhang, (2002a-c). Sinkhole illustration from Currens (2001). Sinkhole data from Paylor and others (2004).

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 supercede those of the underlying bedrock and should be considered on a site-to-site basis. At any site, it is important to understand 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 local area, visit our Land-Use Planning Internet Mapping Web Site at kgsmap.uky.edu/website/kyluplan/viewer.htm.

Water Resources

Pond Construction

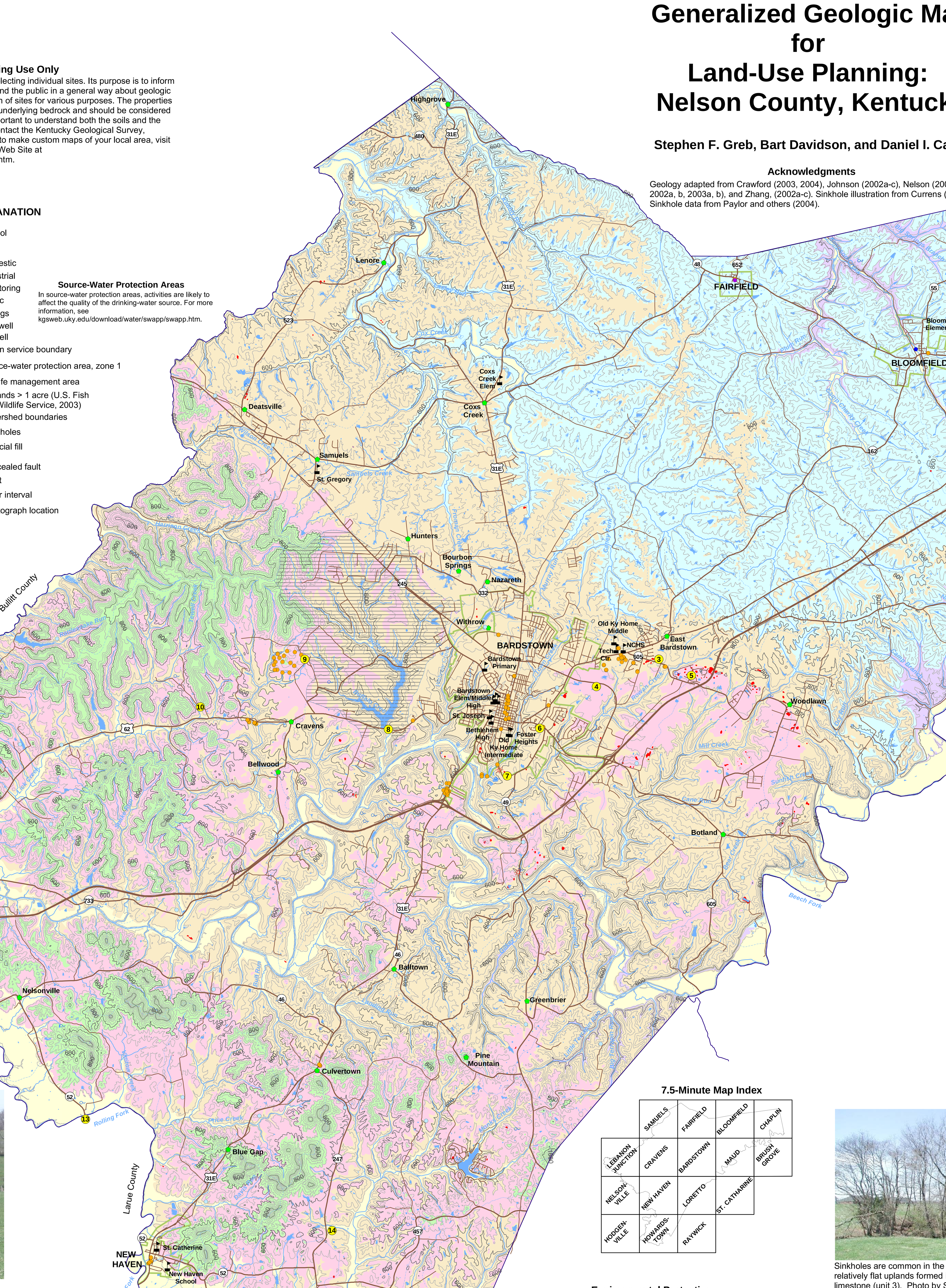
Groundwater

at depths less than 100 feet. Wells located in the rest of the larger valleys throughout the county will produce enough water for a domestic supply, except during dry weather. In upland areas (about 70 percent of the county), most drilled wells will not produce enough water for a dependable domestic supply, except for those along drainage lines, which may produce enough 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 (2005).

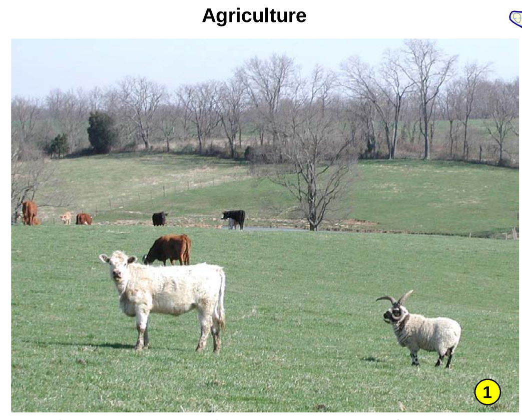
Since the late 1700's, Nelson County has been home to at least 37 distilleries, which is why Bardstown is known as the Bourbon Capital of the World. Good farmland for growing grain and "sweet" groundwater from limestone springs or mine-made impoundments are important for distilling bourbon. Photo by Stephen Greb, Kentucky Geological Survey.

Gethsemani

Our Lady of Gethsemani Abbey in the southern part of the county. The abbey is located along Monks Creek. The monastery has its own water-treatment plant. Photo by Stephen Greb, Kentucky Geological Survey.



Agriculture

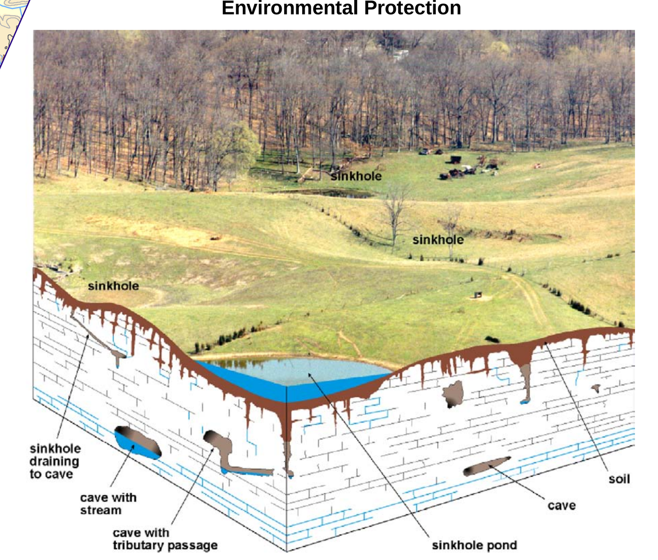


Agriculture is the dominant land use across much of the county. In the eastern part of the county, gently rolling topography is characteristic of limestone bedrock, but the topography is more dissected where the bedrock consists of interbedded shale and limestone, or shale. Photo by Stephen Greb, Kentucky Geological Survey.

Residential Construction

Population growth leads to residential construction, new roads, and water and sewer infrastructure. Depth and type of bedrock influence the cost of constructing that sewer and water lines, road beds, basements and recreation facilities. Increasingly, mixed land uses are juxtaposed, as in the case of this residential neighborhood next to a golf course, with industrial construction nearby. Photos by Stephen Greb, Kentucky Geological Survey.

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)

Floodplains and Wetlands

Broad floodplains are common along Rolling Fork and between the knobs in the western part of the county. These valleys are underlain by alluvium, which is unconsolidated sand and gravel, and those planning any construction here must carefully consider possible future flooding. Photo by Stephen Greb, Kentucky Geological Survey.

The J.C. Williams Wildlife Management Area is located in the floodplains of Beech Fork and Rolling Fork. Such areas are restricted from development. Wetlands in this and other areas are important because they moderate flooding, improve water quality, and provide habitat for wildlife. Photo by Stephen Greb, Kentucky Geological Survey.

Mineral Resources

The Laurel Dolomite (unit 3) has been quarried in several parts of the county for road metal (base), asphalt filler, aggregate, and concrete. Dolomite was used as a building stone for many stepping stones, foundations, walls, and historic homes in the county. Siltstone from the Borden Formation (unit 4) ("creekrock") has been used for stepping stones, foundations, and facing stones on buildings and houses (Peterson, 1966, 1968). Photo by Stephen Greb, Kentucky Geological Survey.

Karst Geology

Sinkholes are common in the Bardstown area along the margins of relatively flat uplands formed in thin shales (unit 5) but underlain by limestone (unit 3). Photo by Stephen Greb, Kentucky Geological Survey.

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 where 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.

PLANNING GUIDANCE 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 and without 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 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

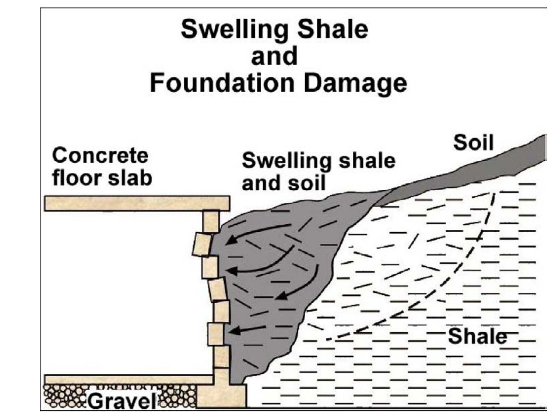
Rock Unit	Karst Potential Rating	Foundation and Excavation	Septic System	Residence with Basement	Highways and Streets	Access Roads	Light Industry and Malls	Intensive Recreation	Extensive Recreation	Reservoir Areas	Reservoir Embankments	Underground Utilities
1. Silt, sand, and gravel	None, but on-site 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. Refer to soil report (Arms, 1971).	Water in alluvium may be in direct contact with basements. Refer to soil report (Arms, 1971).	Slight limitations. Refer to soil report (Arms, 1971).	Slight to moderate limitations. Refer to soil report (Arms, 1971).	Slight to moderate limitations. Avoid construction in floodplain. Refer to soil report (Arms, 1971).	Refer to soil report (Arms, 1971).	Refer to soil report (Arms, 1971).	Refer to soil report (Arms, 1971).	Not recommended. Refer to soil report (Arms, 1971).	Not recommended. Refer to soil report (Arms, 1971).
2. Limestone	High.	Good to excellent foundation material. Difficult excavation.	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 limitations. Rock excavation possible. Local drainage problems, especially on shale. Sinks common and caves possible.	Moderate limitations. Rock excavation. 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, depending on activity and topography. Possible steep wooded slopes.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Slight limitations for forest or nature preserve.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate limitations. Possible rock excavation.
3. Limestone, dolomite, and shale	High.	Fair to good 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 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 likely. Local drainage problems. Sinks common.	Slight to severe limitations, depending on topography. Rock excavation. Sinks common. Local drainage problems. Groundwater contamination possible.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes. Sinks common.	Slight to severe limitations, depending on activity and topography. Possible steep wooded slopes.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate limitations. Possible rock excavation.
4. Siltstone and shale*	Low.	Fair to good foundation material. Moderately difficult to excavate.	Moderate to severe limitations. Impermeable rock. Possible thin soils.	Moderate to severe limitations. Rock excavation; locally, upper few feet may be rippable.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.*	Moderate limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation; locally, upper few feet may be rippable. Steep slopes. Possible expansion of shales.*	Severe limitations. Steep slopes.	Slight to moderate limitations.	Slight limitations. Reservoir may leak where rocks are fractured.	Moderate limitations.	Moderate limitations. Possible rock excavation.
5. Shale*	Low.	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.	Severe to slight limitations, depending on activity and topography.	Slight limitations for small ponds.	Severe limitations. Poor strength and stability.	Moderate limitations. Possible rock excavation.
6. Limestone and shale*	Medium.	Fair to good foundation material. Difficult to excavate.	Severe to moderate limitations. Impermeable rock. Locally fast drainage through fractures and sinks. Possible groundwater contamination.	Moderate to severe limitations. Rock excavation may be required.	Moderate limitations. Rock excavation possible. Possible drainage and slumping problems on shale.* Sinks common and caves possible.	Moderate limitations. Rock excavation likely. Local drainage problems. Sinks common.	Slight to severe limitations, depending on topography. Rock excavation possible. Sinks common. Local drainage problems. Possible groundwater contamination.*	Severe to slight limitations, depending on activity and topography. Possible wooded slopes. Sinks common.	Severe to slight limitations, depending on activity and topography. Possible wooded slopes.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate limitations. Possible rock excavation.
7. Siltstone, dolomite, and limestone	Medium.	Fair to good foundation material. Difficult to excavate.	Severe limitations. Thin soils and impermeable rock. Fast drainage through fractures and sinks to water table, with possible contamination.	Moderate to severe limitations. Rock excavation may be required.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required. Possible steep slopes.	Severe to moderate limitations. Rock excavation may be required.	Severe to slight limitations, depending on activity and topography. Possible wooded slopes.	Slight limitations. Reservoir may leak where rocks are fractured.	Severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate limitations. Possible rock excavation.

* See discussions of swelling shales and soils and slope stability

Swelling Shales and Soils

A problem of potential concern in Nelson County is swelling of some of the clay minerals in shales in units 4, 5, and 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 structures. This phenomenon has been responsible for extensive damage to schools, homes, and businesses in Kentucky.

We strongly suggest that anyone planning construction on these shales 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 foundations and other structures (e.g., bridges, dams, roads). Photograph by John Kiefer, Kentucky Geological Survey.

My Old Kentucky Home

My Old Kentucky Home State Park is located in Bardstown. Tourism-associated land uses are common in the Bardstown area. Photo by Stephen Greb, Kentucky Geological Survey.

Waste Disposal

Nelson County solid-waste disposal center. Locations for landfills must be carefully considered to avoid contamination of local groundwater aquifers. Photo by Stephen Greb, Kentucky Geological Survey.

Slope Stability

Part of Bernheim Forest (previously Knobs State Park) is located in the Knobs Region of western Nelson County. The knobs are steep-sided hills formed where resistant siltstones cap more easily eroded shales. Photo by Stephen Greb, Kentucky Geological Survey.

Steep slopes in the Knobs Region and in the eastern part of the county are susceptible to sliding and slumping because they are composed of thick shales (units 5 and 6). Builders should avoid cutting into the toe (base) of hills or past slides in these areas, cutting vegetation from stable slopes, or directing water toward the heads of slopes. Bent trees on slopes, hummocky (bumpy) topography, and water seeps at the base of slopes are indicators of past or potential movement. Photo by John Kiefer, Kentucky Geological Survey.

Radon

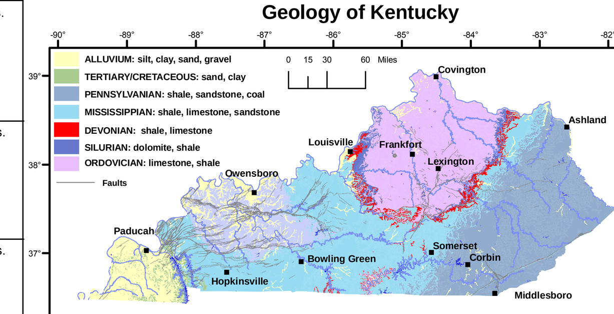
Radon gas, although not widely distributed in Kentucky in amounts above the U.S. Environmental Protection Agency's maximum recommended limit of 4 picocuries per liter, can be a local problem. The black shales in units 4, 5, and 6 may have high levels of radon. Homes in these areas should be tested for radon, but the homeowner should keep in mind that the health threat results from relatively high levels of exposure over long periods of time, and the remedy may simply be additional ventilation of the home.

COMPARATIVE RISK CHART for RADON LEVELS

Radon Level pCi/L	Estimated Fatal Lung Cancers/1000	Comparable Exposure Levels	Comparable Risk Estimate
200	440 - 770	1,000 times average outdoor level	More than 60 times non-smoker risk
100	270 - 530	100 times average indoor level	Four pack/day smoker or 20,000 chest X-rays/yr
40	120 - 380	100 times average outdoor level	Two pack/day smoker
20	60 - 210		
10	30 - 120	10 times average indoor level	One pack/day smoker
4	13 - 50	10 times average outdoor level	Five times non-smoker risk
2	7 - 30		
1	3 - 13	Average indoor level	Non-smoker risk of fatal lung cancer
0.2	1 - 3	Average outdoor level	20 chest X-rays/yr

EPA recommends action be taken if indoor levels exceed 4 pCi/L, which is 10 times the average outdoor level. Some EPA representatives believe the action level should be lowered to 2 picocuries per liter; other scientists dissent and claim the risks estimated in this chart are already much too high for low levels of radon. The action level in European countries is set at 10 picocuries per liter. Note that this chart is only one estimate; it is not based upon any scientific result from a study of a large population meeting the listed criteria. (from the U.S. Environmental Protection Agency)

Geology of Kentucky



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

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Additional Planning Resources

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

ces.ca.uky.edu/nelson/, UK Cooperative Extension Service-Agriculture agents.
www.kineticnet.net/kyrcd/kh.html, Kentucky Resource Conservation and Development (RC&D).
www.ltadd.org/, Lincoln Trail Area Development District.
www.thinkkentucky.com/edis/cmnty/cmntyindex.htm, Detailed County Statistics.
www.uky.edu/KentuckyAtlas/21215.html, Kentucky Atlas and Gazetteer.
quickfacts.census.gov/qfd/states/21/21215.html, U.S. Census data.
www.bardstowntourism.com/main.htm, General county information.
kgsweb.uky.edu/download/misc/landuse/mainkyluplan.htm, More county information.
www.kdfwr.state.ky.us, Kentucky Department of Fish and Wildlife.