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

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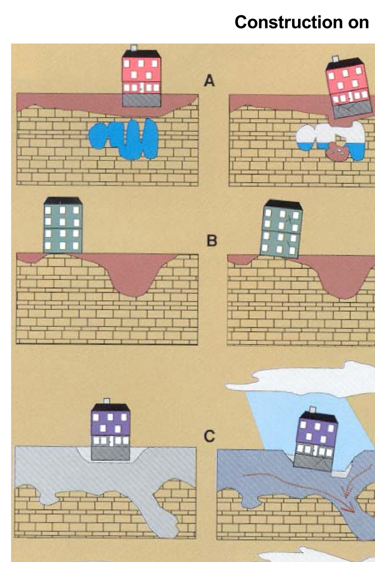
Acknowledgments

This publication is adapted from Johnson and Hopkins (1966). Identified sinkholes are from the U.S. Department of Agriculture—Natural Resources Conservation Service, Soil Survey Geographic database (SSURGO). Mapped sinkholes from Paylor and others (2004). Base map data thanks to Kim and Kent Anness, Kentucky Division of Geographic Information. Geology adapted Ciszak (2000), Nelson (2000a, b, 2001a, d), and Thompson (2000). Sinkhole diagram from Currens (2001).

Karst Geology

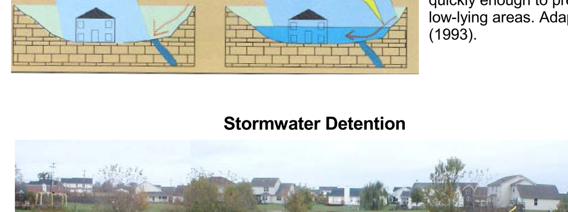
The term "karst" refers to a landscape characterized by sinkholes, springs, sinking streams (streams that disappear underground), and underground drainage through solution-enlarged conduits or caves. Karst landscapes form when slightly acidic water from rain and snowmelt seeps through soil cover into 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.

Construction on Karst



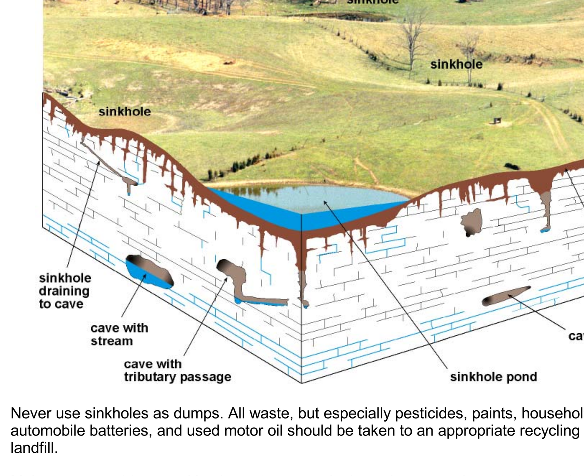
Limestone terrain can be subject to subsidence hazards, which usually can be overcome by prior planning and site evaluation. "A" shows construction above an open cavern, which later collapses. This is one of the most difficult situations to detect, and the possibility of this situation beneath a structure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

Stormwater Detention



This stormwater detention basin was developed around a natural sinkhole. The dam is to the left. The outlet throat of the sinkhole incorporates a sand filter. Sinkholes are often part of the natural flood detention system, and must be managed carefully to avoid creating additional flood damages as a result of development. Photo courtesy of Pattie Wilson, Versailles-Midway-Woodford County Planning Commission.

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 in the groundwater.

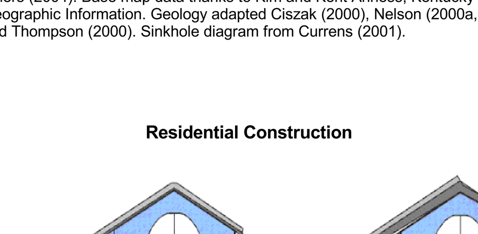
If required, develop a groundwater protection plan (410KAR5:037) or an agricultural water-quality plan (KRS224.71) for your land use.

(From Currens, 2001)

Environmental Protection

Using sinkholes for waste disposal, even in rural areas, can threaten valuable water resources. Photo by Dan Carey, Kentucky Geological Survey.

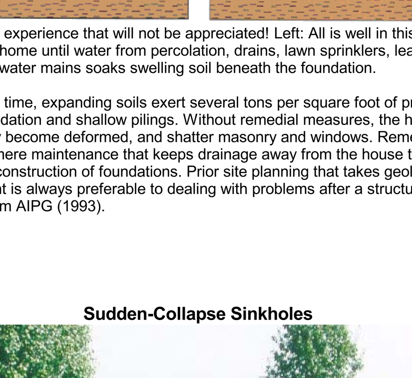
Residential Construction



An uplifting experience that will not be appreciated! Left: All is well in this newly built home until water from percolation, drains, lawn sprinklers, leaking sewers, or water mains soaks swelling soil beneath the foundation.

Right: With time, expanding soils exert several tons per square foot of pressure on the foundation and shallow pilings. Without remedial measures, the house will actually become deformed, and shatter masonry and windows. Remedies vary from mere maintenance that keeps drainage away from the house to expensive reconstruction of foundations. Prior site planning that takes geology into account is always preferable to dealing with problems after a structure is built. From AIPG (1993).

Sudden-Collapse Sinkholes



Sinkhole cover collapse. After perhaps years of slow settlement, soils over bedrock solution channels collapse rapidly and wash out, leaving sinkholes such as this. This phenomenon occurs throughout the Inner Bluegrass karst landscape. Photo courtesy of Jim Currens, Kentucky Geological Survey.

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. The term "rippable" means excavating rock using a ripper attachment on a bulldozer.

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 natural 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.

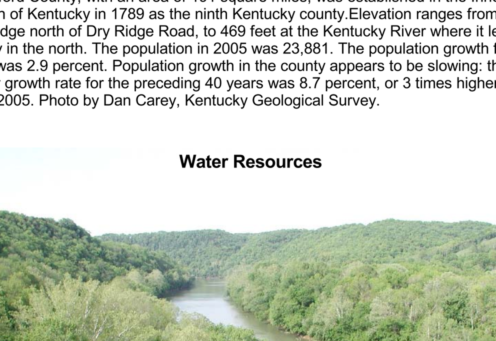
Planning Guidance by Rock Unit Type

Rock Unit	Foundation and Excavation	Septic Tank Disposal System	Residence with Basement	Highways and Streets	Access Roads	Light Industry and Malls	Intensive Recreation	Extensive Recreation	Reservoir Areas	Reservoir Embankments	Underground Utilities
1. Alluvium	Fair to good foundation material. Easily excavated.	Refer to soil report (McDonald and others,1983).	Refer to soil report (McDonald and others,1983).	Refer to soil report (McDonald and others,1983).	Refer to soil report (McDonald and others,1983).	Refer to soil report (McDonald and others,1983).	Refer to soil report (McDonald and others,1983).	Refer to soil report (McDonald and others,1983).	Refer to soil report (McDonald and others,1983).	Refer to soil report (McDonald and others,1983).	Refer to soil report (McDonald and others,1983).
2. High-level (ancient) river deposits	Good foundation material. Easily excavated.	Slight to moderate limitations. Variable thickness and permeability; underlain by impervious rock.	Slight limitations.	No limitations.	No limitations.	No limitations.	No limitations.	No limitations.	Not applicable.	Not applicable.	Slight limitations.
3. Limestone	Excellent foundation material. Difficult to excavate.	Severe limitations. Impermeable rock; locally fast drainage through fractures; danger of ground-water contamination.	Severe limitations. Rock excavation; steep slopes.	Severe limitations. Rock excavation; steep slopes.	Moderate limitations. Rock excavation; steep slopes; narrow ravines. Slight limitations where topographically suitable.	Not applicable.	Not applicable.	Moderate to slight limitations. Steep wooded slopes. Slight limitations for forest reserve or natural history park.	Slight limitations. Reservoir might leak where rocks are faulted.	Severe limitations.	Severe limitations. Rock excavation.
4. Limestone, irregularly bedded	Excellent foundation material. Difficult to excavate.	Severe limitations. Impermeable rock; locally fast drainage through fractures; danger of ground-water contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable; sinks common; 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; locally, upper few feet may be rippable; sinks common; local drainage problems.	No limitations.	No limitations.	Severe limitations. Leaky reservoir rock; locally, conditions may be favorable; sinks common.	Severe limitations.	Severe limitations. Rock excavation.
5. Limestone, evenly bedded	Excellent foundation material. Difficult to excavate.	Severe limitations. Impermeable rock; locally fast drainage through fractures; danger of ground-water contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable; solution channels common; local seepage problems.	Slight to moderate limitations. Rock excavation; locally, upper few feet may be rippable; solution channels common; local seepage problems.	Slight limitations. Local drainage problems.	Slight to moderate limitations. Rock excavation; locally, upper few feet may be rippable; solution channels; local seepage problems.	No limitations.	No limitations.	Severe to moderate limitations. Leaky reservoir rock; locally, conditions may be favorable; solution channels common.	Severe limitations.	Severe limitations. Rock excavation.
6. Shale and limestone, interbedded	Good to excellent foundation material. Moderately difficult to difficult to excavate.	Severe limitations. Impermeable rock.	Slight to moderate limitations. Earth and rock excavation; poor drainage.	Slight to moderate limitations. Earth and rock excavation; local seeps; subgrade requires drainage.	Slight limitations. Local seeps.	Slight limitations. Rock generally rippable in shallow cuts; local seeps.	No limitations.	No limitations.	Slight limitations. Most favorable sites are in this unit; locally, impermeable rock and underlain by fissured limestone.	Slight limitations.	Moderate limitations. Highly variable amount of rock and earth excavation.

Woodford County Courthouse in Versailles

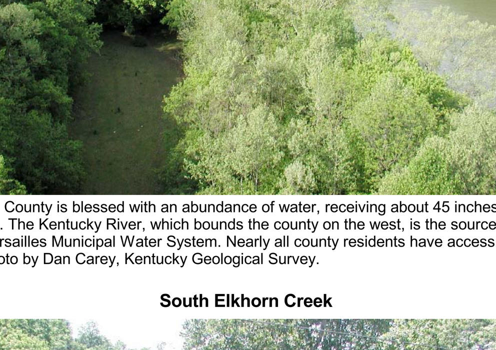
Woodford County, with an area of 191 square miles, was established in the Inner Bluegrass Region of Kentucky in 1789 as the ninth Kentucky county.Elevation ranges from 1,000 feet on a ridge north of Dry Ridge Road, to 469 feet at the Kentucky River where it leaves the county in the north. The population in 2005 was 23,881. The population growth from 2000 to 2005 was 2.9 percent. Population growth in the county appears to be slowing: the average 5-year growth rate for the preceding 40 years was 8.7 percent, or 3 times higher than that of 2000-2005. Photo by Dan Carey, Kentucky Geological Survey.

Water Resources



Woodford County is blessed with an abundance of water, receiving about 45 inches of rain each year. The Kentucky River, which bounds the county on the west, is the source of water for the Versailles Municipal Water System. Nearly all county residents have access to public water. Photo by Dan Carey, Kentucky Geological Survey.

South Elkhorn Creek



South Elkhorn Creek bounds the county on the northeast. It provided power for many early grain mills, and is still used by Weisenberger Mills. Maintaining the water quality of this semi-urban stream requires continued vigilance. Photo by Dan Carey, Kentucky Geological Survey.

Groundwater

In karst areas such as Woodford County, stormwater runoff can flow underground through large solution channels. This groundwater flow does not follow the topography of the surface, and water from one watershed may flow underground and reappear in an adjacent watershed. A knowledge of the groundwater flow, gained through dye-trace studies, is required to manage stormwater and to protect water quality and drinking-water sources. For more about dye traces in the area, see Currens and Ray (1996).

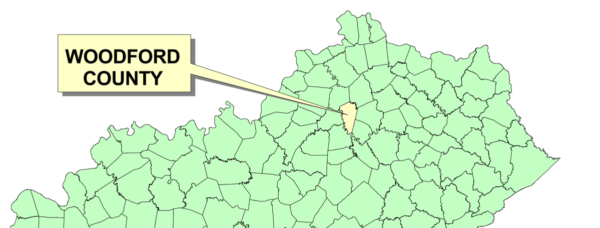
In the Kentucky River, South Fork of Elkhorn Creek, Clear Creek, Glenns Creek, and their major tributaries, most wells drilled in the valleys will produce enough water for a domestic supply at depths of less than 100 feet. Wells located in the smaller creek valleys throughout the county and the uplands of the far eastern part of the county will produce enough water for a domestic supply except during dry weather. In the upland area of western and far southern Woodford County, which encompasses 40 percent of the county, most drilled wells will not produce enough water for a dependable domestic supply. Some wells in this area drilled along drainage lines may produce enough water for a domestic supply, except during dry weather. Throughout the county ground water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet. For more about the groundwater resources of the county, see Carey and Stickney (2001).

Radon

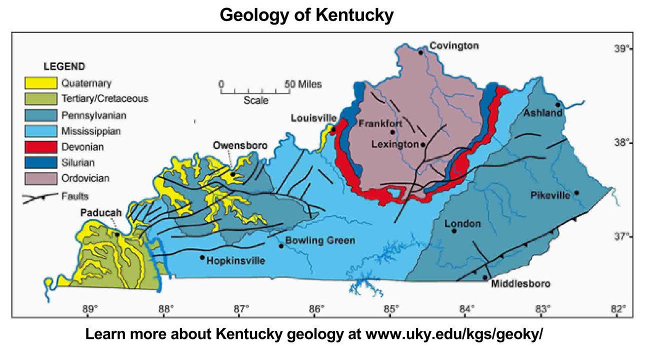
Radon gas can be a local problem, although it is not widely distributed in Kentucky in amounts above the Environmental Protection Agency's maximum recommended limit of 4 picocuries per liter. Unit 5 on the map, the Tanglewood Limestone, may contain high levels of uranium or radium, parent materials for radon gas. The Tanglewood and several other limestones in the state contain apatite, a phosphate mineral. Uranium is sometimes part of the apatite crystal structure, and when the limestone weathers away the phosphates containing uranium can become concentrated in the soil and ultimately give rise to high levels of radon. A few areas of high radon concentrations are known in the Bluegrass Region. 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 of time, and the remedy may simply be additional ventilation of the home.

Radon Level pCi/L	Estimated Fatal Lung Cancers/1000	Comparable Exposure Level	Comparable Risk Estimate
200	440-770	1,000 times average outdoor level	More than 60 times non-smoker risk
100	270-630	100 times average outdoor level	Four pack/day smoker or 20,000 X-rays /yr
40	120-380	100 times average outdoor level	Two-pack/day smoker
20	60-210		
10	30-120	10 times average outdoor 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 picocuries per liter, 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)



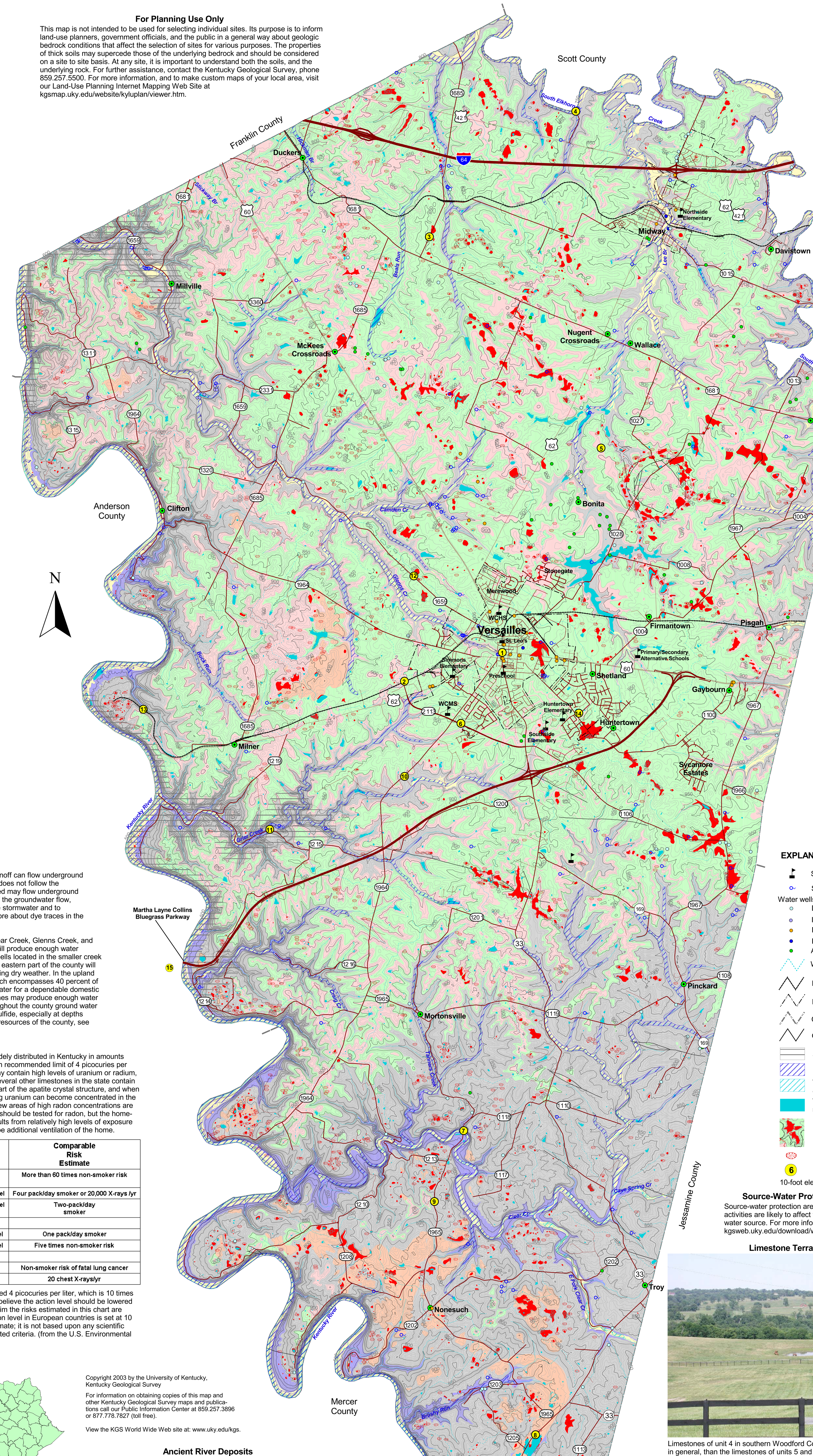
Geology of Kentucky



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

For Planning Use Only

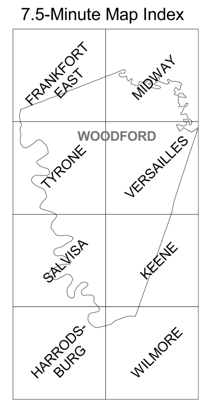
This map is not intended to be used for selecting individual sites. Its purpose is to inform land-use planners, government officials, and the public in a general way about geologic bedrock conditions that affect the selection of sites for various purposes. The properties of thick soils may supersede those of the underlying bedrock and should be considered on a site to site basis. At any site, it is important to understand both the soils, and the underlying rock. For further assistance, contact the Kentucky Geological Survey, phone 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.



Scale 1:48,000
1 inch equals 3/4 mile

Miles
Kilometers

7.5-Minute Map Index



EXPLANATION

School
Spring
Water wells
Domestic
Industrial/Commercial
Monitoring
Public
Agriculture
Watershed boundary
Railroad
Incorporated city boundary
County boundary
Geologic fault line
Source-water protection area, zone 1
Designated flood zone (FEMA, 2004)
Wetlands > 1 acre , (U.S. Fish & Wildlife Service, 2003)
Water or area of sinkhole flooding
Mapped sinkholes
Soil survey sinkholes
Photo location
10-foot elevation contour interval

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.

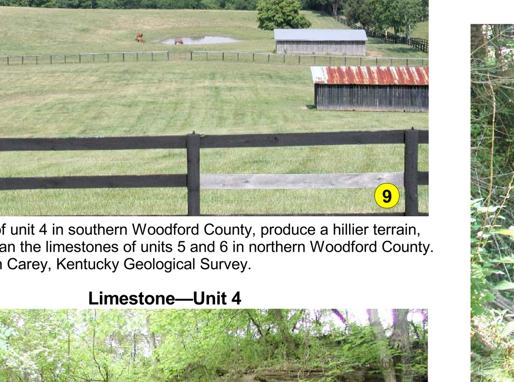
Ancient River Deposits

High-level deposits—silt, clay, sand, and gravel of unit 2—along Mundys Landing Road are remnants of the ancient Kentucky River that flowed here 5 million years ago. At that time, the land was uplifted, diverting the river to its current course (Jillson, 1946). Photo by Dan Carey, Kentucky Geological Survey.

Mapped Surface Faults

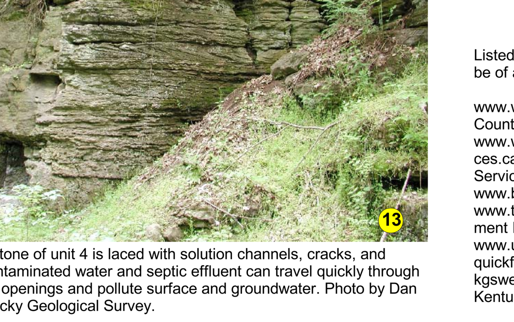
Faults are common geologic structures across Kentucky, and have been mapped in many of the Commonwealth's counties. The faults shown on this map represent seismic activity that occurred several million years ago at the latest. There has been no activity along these faults in recorded history. Seismic 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.

Limestone Terrain



Limestones of unit 4 in southern Woodford County, produce a hillier terrain, in general, than the limestones of units 5 and 6 in northern Woodford County. Photo by Dan Carey, Kentucky Geological Survey.

Limestone—Unit 4



Porous limestone of unit 4 is laced with solution channels, cracks, and crevices. Contaminated water and septic effluent can travel quickly through underground openings and pollute surface and groundwater. Photo by Dan Carey, Kentucky Geological Survey.

Falling Springs Arts & Recreation Center

Located at the County Park, Falling Springs is a state of the art recreation center, complete with 3 court gymnasium, indoor pool, outdoor splash pool, therapy pool, fitness center, aerobics room, meeting rooms, and a 310 seat performing arts theater. The Woodford County Park is also home to 9 baseball and softball fields, 2 pavilions, a cross country course, and the Community Stadium (football/soccer). Bike paths provide access to the park for young and old. Photo by Dan Carey, Kentucky Geological Survey.

Rural Development

Limestones of unit 5 provide fertile soils for agriculture and desirable sites for residential development. Careful planning can preserve and enhance the value of the land and minimize conflicting interests. Photo by Dan Carey, Kentucky Geological Survey.

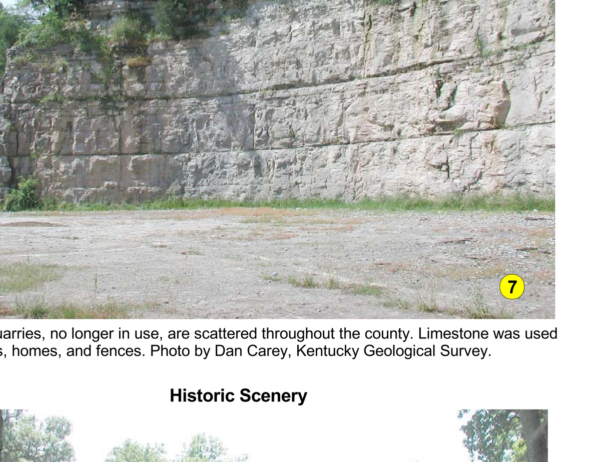
Horse Farms

The Inner Bluegrass of Kentucky is the thoroughbred capital of the world. Farmland has come under increasing pressure from urban expansion. One of the efforts to preserve the land is the Purchase of Development Rights (PDR) program, which pays farm owners the difference between the agricultural value and the development value in return tor the owners ceding development rights in perpetuity. Photo by Dan Carey, Kentucky Geological Survey.

Urban Expansion

Once the new by-pass was completed, residential development quickly followed. Photo by Dan Carey, Kentucky Geological Survey.

Mineral Resources



Limestone quarries, no longer in use, are scattered throughout the county. Limestone was used to build roads, homes, and fences. Photo by Dan Carey, Kentucky Geological Survey.

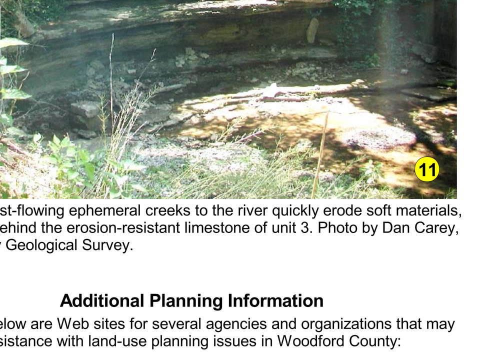
Historic Scenery

Down many country lanes, visitors can find oak trees older than the county overlooking historic stone fences built of local limestone. The fences are preserved through regulation in Historic Districts. Photo by Dan Carey, Kentucky Geological Survey.

Historic Buildings

This 199-year-old structure on the Historic Register, built in 1807 using local limestone, is now the estate of a Kentucky eagle. Photo by Dan Carey, Kentucky Geological Survey.

Limestone



Steep, fast-flowing ephemeral creeks to the river quickly erode soft materials, leaving behind the erosion-resistant limestone of unit 3. Photo by Dan Carey, Kentucky Geological Survey.

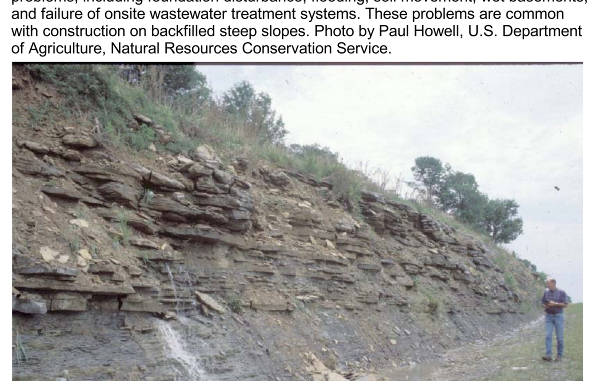
Additional Planning Information

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

www.woodfordcountyplanningandzoning.com—Versailles-Midway-Woodford County Planning Commission
www.woodfordchamber-ky.com/—Woodford County Chamber of Commerce
ces.ca.uky.edu/woodford/—University of Kentucky Cooperative Extension Service
www.bgadd.org/—Blue Grass Area Development District
www.thinkkentucky.com/edis/cmnty/cw117/—Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21239.html—Kentucky Atlas and Gazetteer
quickfacts.census.gov/qfd/states/21/21239.html—U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm—Planning information from the Kentucky Geological Survey

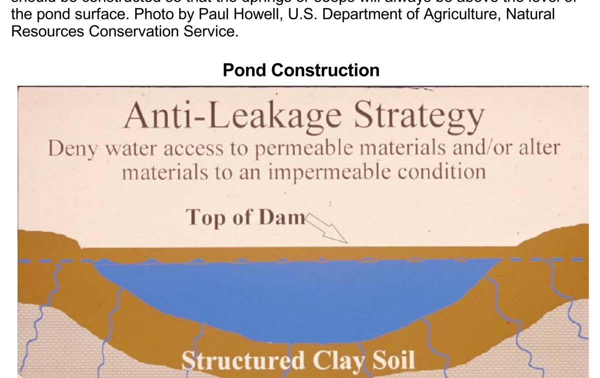
Seepage

Seepage at the boundary between overlying permeable and underlying impermeable rocks. Often not evident during dry-weather construction, it can produce a variety of problems, including foundation disturbance, flooding, soil movement, wet basements, and failure of onsite wastewater treatment systems. These problems are common with construction on backfilled steep slopes. Photo by Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service.

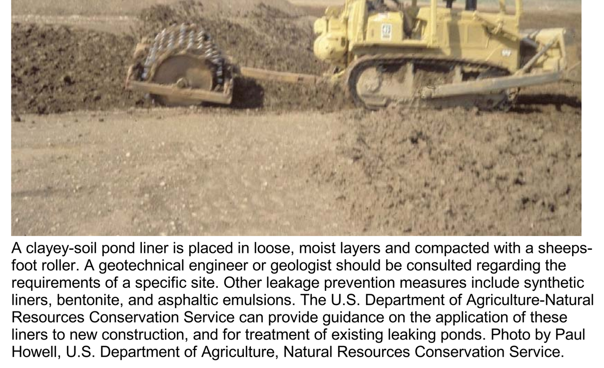


Seepage at the interface of units 5 and 6, permeable rock overlying relatively impermeable rock. Successful ponds are often located below this seepage zone. Ponds should be constructed so that the dprings or seeps will always be above the level of the pond surface. Photo by Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service.

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. Illustration by Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Management Service.



A clayey-soil pond liner is placed in loose, moist layers and compacted with a sheepsfoot roller. 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. Photo by Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service.

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.

Pond Maintenance

The U.S. Department of Agriculture, Natural Resources Conservation Service provides cost sharing to farmers through the Environmental Quality Incentive Program (EQIP) to help them address natural resource concerns. In this case, water quality is protected by maintaining a buffer area around the pond. Photo courtesy of Charles Farmer, USDA—NRCS.

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