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

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

Bethany L. Overfield
University of Kentucky, boverfield@uky.edu

Randall L. Paylor
University of Kentucky

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

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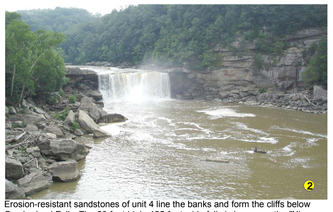
Acknowledgments

Geology adapted from Johnson (2003a, b), Curl (2006), Duncan (2006), Duncan and Stidham (2006), Patton and Stidham (2006), Yang and Stidham (2006), Zhang (2006a, b.), and Zhang and Stidham (2006a-d). Thanks to Kim and Kent Anness, Kentucky Division of Geographic Information, for base map data.

Water Resources

Sandstones of unit 4 form cliffs along the banks of Laurel River Lake. In addition to fishing and boating recreation, the lake provides about 2.7 million gallons of water per day to the city of Corbin. Photo by Bethany Overfield, Kentucky Geological Survey.



Erosion-resistant sandstones of unit 4 line the banks and form the cliffs below Cumberland Falls. The 60-foot-high, 125-foot-wide falls is known as the "Niagara of the South." Photo by Bethany Overfield, Kentucky Geological Survey.

Looking north up the valley of the Cumberland River from Ky. 90. The river traverses the county from east to west, providing recreation and drinking water for county residents (1.5 million gallons a day to the Williamsburg water plant). Photo by Randall Paylor, Kentucky Geological Survey.

Groundwater

Most wells drilled in valley bottoms are adequate for a domestic supply. Fewer than half the wells drilled on hillsides are adequate for domestic supply, and wells on ridges yield smaller quantities of water. In the westernmost quarter of the county, wells on hillsides commonly produce adequate water for domestic use, and half the wells on ridges yield enough water for a domestic supply. Deep wells penetrating sections of sandstone greater than 500 feet may yield enough water for small utilities or industrial supplies.

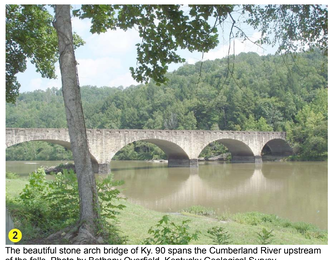
Most water obtained from drilled wells is extremely hard and contains noticeable amounts of iron, except in the westernmost quarter of the county, where the water is soft to moderately hard. Salty water may be found less than 100 feet below the level of the principal valley bottoms.

A few springs supply enough water for domestic use. Most springs produce less than 5 gallons per minute.

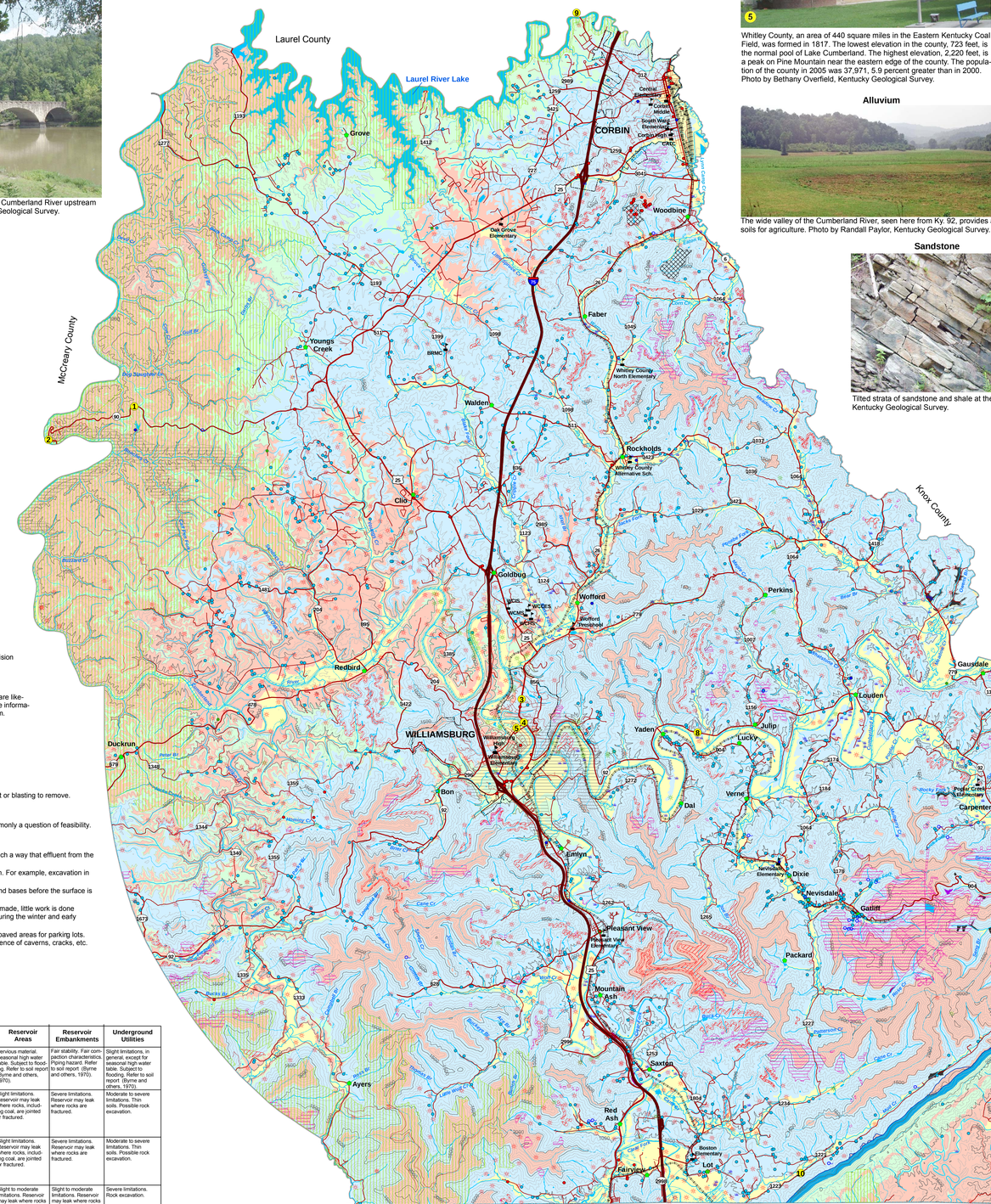
For more information on groundwater in the county, see Carey and Stickney (2004).

Mineral Resources

Clay and coal from units 2 and 3 are important to the economy of the county. Mountaintop-removal coal mining is seen here near Pine Mountain. Balancing economic and environmental goals is sometimes difficult. Photo by Bethany Overfield, Kentucky Geological Survey.



The beautiful stone arch bridge of Ky. 90 spans the Cumberland River upstream of the falls. Photo by Bethany Overfield, Kentucky Geological Survey.



EXPLANATION

- School
- Water wells
  - Domestic
  - Monitoring
  - Public
  - Industrial
  - Agriculture
- Spring
- Wet area
- Gas well
- Oil and gas well
- County line
- Watershed boundary
- Railroad
- Geologic fault
- Incorporated city boundary
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Source-water protection area, zone 1
- Surface, auger, or undetermined mining
- Underground mining
- Public lands
- Quarry
- Artificial fill
- Landslide material
- Dump
- (4) Photo location
- 100-foot contour interval

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

Source-Water Protection Areas

Source-water protection areas are those in which activities are likely to affect the quality of the drinking-water source. For more information, see kgsweb.uky.edu/download/water/swapp/swapp.htm.

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	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.	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Byrne and others, 1970).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Byrne and others, 1970).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Byrne and others, 1970).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Byrne and others, 1970).	Severe limitations. Seasonal high water table. Subject to flooding. Refer to soil report (Byrne and others, 1970).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Byrne and others, 1970).	Slight to severe limitations, depending on type of activity and topography. Subject to flooding. Refer to soil report (Byrne and others, 1970).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Byrne and others, 1970).	Fair stability. Fair compaction characteristics. Piping hazard. Refer to soil report (Byrne and others, 1970).	Slight limitations, in general, except for seasonal high water table. Subject to flooding. Refer to soil report (Byrne and others, 1970).
2. Sandstone, siltstone, shale, underclay, coal	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, coals, and underclays. Possibility of underground coal-mine voids.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required.	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, including coal, are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Moderate to severe limitations. Thin soils. Possible rock excavation.
3. Shale, siltstone, sandstone, coal	Fair to good foundation material; difficult to excavate. Possible low strength associated with shales, coals, and underclays. Possibility of underground coal-mine voids.	Severe limitations. Thin soils and impermeable rock associated with shales.	Severe to moderate limitations. Rock excavation may be required. Possible radon occurrence.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep slopes.	Moderate to severe limitations. Rock excavation may be required. Possible steep 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, including coal, are jointed or fractured.	Severe limitations. Reservoir may leak where rocks are fractured.	Moderate to severe limitations. Thin soils. Possible rock excavation.
4. Sandstone, conglomerate, minor shale	Excellent foundation material; difficult to excavate.	Severe limitations. Thin soils.	Severe to moderate limitations. Rock excavation may be required.	Severe to moderate limitations. Rock excavation may be required.	Severe to moderate limitations. Rock excavation may be required.	Severe to moderate limitations. Rock excavation may be required.	Severe to slight limitations, depending on activity and topography.	Severe to slight limitations, depending on activity and topography. Slight limitations for 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.
5. Black shale*	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.	Severe limitations.	Severe limitations.	Slight limitations for small ponds.	Severe limitations. Poor strength and stability.	Moderate limitations. Poor strength. Wetness.
6. Limestone, dolomite, chert, siltstone, and shale	Excellent foundation material; difficult to excavate. Very steep slopes.	Severe limitations. Locally fast drainage through fractures. Danger of groundwater contamination. Very steep slopes.	Severe limitations. Rock excavation. Locally, upper few feet may be rippable. Drainage required. Very steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Rock excavation. Steep slopes.	Severe limitations. Steep slopes.	Severe limitations. Steep slopes.	Severe limitations. Leaky rock.	Severe limitations. Leaky rock.	Severe limitations. Rock excavation.
7. Silt, clay, sand, and gravel (high-level 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 degree of slope.	Slight limitations, depending on degree of slope.	Moderate to slight limitations, depending on activity and topography.	Slight limitations, depending on activity and topography.	Not recommended. Pervious material.	Severe to slight limitations. Unstable steep slopes.	Slight limitations.

*Shales and clays in these units can 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.

Whitley County Courthouse

Whitley County, an area of 440 square miles in the Eastern Kentucky Coal Field, was formed in 1817. The lowest elevation in the county, 723 feet, is the normal pool of Lake Cumberland. The highest elevation, 2,220 feet, is a peak on Pine Mountain near the eastern edge of the county. The population of the county in 2005 was 37,971, 5.9 percent greater than in 2000. Photo by Bethany Overfield, Kentucky Geological Survey.

Alluvium

The wide valley of the Cumberland River, seen here from Ky. 92, provides alluvial soils for agriculture. Photo by Randall Paylor, Kentucky Geological Survey.

Sandstone

Tilted strata of sandstone and shale at the crest of Pine Mountain on Ky. 1595 (above and left). Photos by Randall Paylor, Kentucky Geological Survey.

Sandstone, Siltstone, and Shale

This exposure at the junction of U.S. 25 and Ky. 296 in Williamsburg provides an impressive view of the sandstone, siltstone, and shale in units 3 and 4. Photo by Bethany Overfield, Kentucky Geological Survey.

Pine Mountain

Slope Stability

Reinforced concrete wall will provide support for this roadcut in unit 2 along Ky. 26. Photo by Bethany Overfield, Kentucky Geological Survey.

Rock gabions and a chain link fence provide stability to a cut slope in unit 2 along Doc Siler Road. Photo by Bethany Overfield, Kentucky Geological Survey.

What Are the Factors That Cause Landslides?

Many factors contribute to landslides. The most common in eastern Kentucky are listed below:

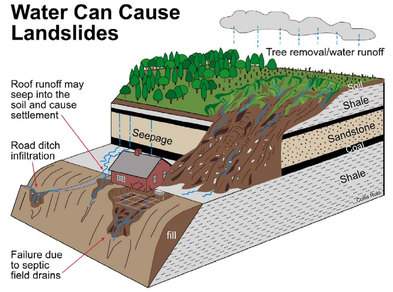
1. Steep slopes: Avoid when choosing a building site.
2. Water: Slope stability decreases as water moves into the soil. Springs, seeps, roof runoff, gutter downspouts, septic systems, and site grading that cause ponding or runoff are sources of water that often contribute to landslides.
3. Changing the natural slope by creating a level area where none previously existed.
4. Poor site selection for roads and driveways.
5. Improper placement of fill material.
6. Removal of trees and other vegetation: Site construction often results in the elimination of trees and other vegetation. Plants, especially trees, help remove water and stabilize the soil with their extensive root systems.

What Are Some Ways to Prevent Landslides?

1. Seek professional assistance prior to construction.
2. Proper site selection: Some sloping areas are naturally prone to landslides. Inspect the site for springs, seeps, and other wet areas that might indicate water problems. Take note of unusual cracks or bulges at the soil surface. These are typical signs of soil movement that may lead to slope failure. Also be aware of geologically sensitive areas where landslides are more likely to occur.
3. Alter the natural slope of the building site as little as possible during construction. Never remove soil from the toe or bottom of the slope or add soil to the top of the slope. Landslides are less likely to occur on sites where disturbance has been minimized. Seek professional assistance before earth moving begins.
4. Remove as few trees and other vegetation as possible. Trees develop extensive root systems that are very useful in slope stabilization. Trees also remove large amounts of groundwater. Trees and other permanent vegetative covers should be established as rapidly as possible and maintained to reduce soil erosion and landslide potential.
5. Household water disposal system: Seek professional assistance in selecting the appropriate type and location of your septic system. Septic systems located in fill material can saturate soil and contribute to landslides.
6. Proper water disposal: Allowing surface waters to saturate the sloping soil is the most common cause of landslides in eastern Kentucky. Properly located diversion channels are helpful in redirecting runoff away from areas disturbed during construction. Runoff should be channeled and water from roofs and downspouts piped to stable areas at the bottom of the slope.

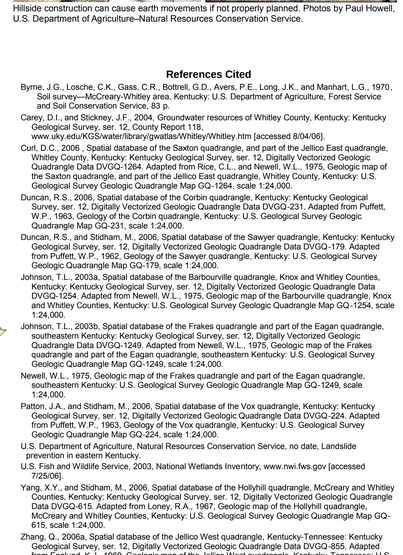
(From U.S. Department of Agriculture, Natural Resources Conservation Service, no date)

Water Can Cause Landslides

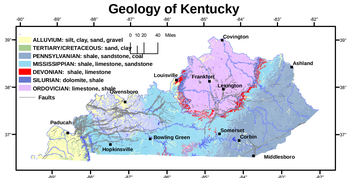


Landslides

Hillside construction can cause earth movements if not properly planned. Photos by Paul Howell, U.S. Department of Agriculture–Natural Resources Conservation Service.



Geology of Kentucky



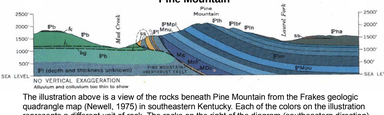
Learn more about Kentucky geology at www.uky.edu/KGS/geoky/

Additional Resources

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

www.kyhometown.com/williamsburg/ Williamsburg and Whitley County
ces.ca.uky.edu/Whitley/ University of Kentucky Cooperative Extension Service
www.cvadd.org/ Cumberland Valley Area Development District
www.thinkkentucky.com/edis/cmnty/cw110/ Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21235.html Kentucky Atlas and Gazetteer, Whitley County
quickfacts.census.gov/qfd/states/21/21235.html U.S. census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the Kentucky Geological Survey

Pine Mountain



The illustration above is a view of the rocks beneath Pine Mountain from the Frakes geologic quadrangle map (Newell, 1975) in southeastern Kentucky. Each of the colors on the illustration represents a different unit of rock. The rocks on the right of the diagram (southeastern direction) are tilted and pushed over the rocks on the left side of the diagram (northwestern direction). This movement can be seen all along the leading edge of Pine Mountain, which is more than 90 miles long. The fault block, which includes Pine Mountain, actually continues to the southeast into Virginia and Tennessee and is thousands of feet thick. Imagine the forces required to push this large a block of material! The force was provided by the collision of the North American continent with Africa and Europe at the end of the Paleozoic Era, more than 275 million years ago. The collision formed the Appalachian Mountains and a series of thrust blocks, each one pushed to the northwest over the next. Pine Mountain is the western-most thrust block.

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Duncan, R.S., 2006, Spatial database of the Corbin quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-231. Adapted from Puffett, W.P., 1963, Geology of the Corbin quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-231, scale 1:24,000.

Duncan, R.S., and Stidham, M., 2006, Spatial database of the Sawyer quadrangle, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-179. Adapted from Puffett, W.P., 1962, Geology of the Sawyer quadrangle, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-179, scale 1:24,000.

Johnson, T.L., 2003a, Spatial database of the Barbourville quadrangle, Knox and Whitley Counties, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-1254. Adapted from Newell, W.L., 1975, Geologic map of the Barbourville quadrangle, Knox and Whitley Counties, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-1254, scale 1:24,000.

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Zhang, Q., and Stidham, M., 2006c, Spatial database of the Williamsburg quadrangle, Whitley County, Kentucky: Kentucky Geological Survey, ser. 12, Digitally Vectorized Geologic Quadrangle Data DVGQ-616. Adapted from Tabor, R.W., 1967, Geologic map of the Williamsburg quadrangle, Whitley County, Kentucky: U.S. Geological Survey Geologic Quadrangle Map GQ-616, scale 1:24,000.