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

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# Planning Guidance by Rock Unit Type

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Matthew M. Crawford, E. Glynn Beck, David A. Williams, and Daniel I. Carey

### Acknowledgments

Geology adapted from Ashcraft (2005), Ashcraft and Hosey (2005), Crawford (2005), Mullins (2005), Nelson (2005), Smith (2005a-c), Soils and Terry (2000), Toth (2005a-d), and Tyra and Venard (2000).

Thanks to George Kelley, Hopkins County Agriculture and Natural Resources Agent; Keith Cuneal, Madisonville Water Treatment Plant; David and Shawn Brumfield, Brumfield Farms; Doug Brown, Doug Brown Farm, for photo assistance; and Doug Blair, Dotki Mines, for photo assistance.



Coal mining is a vital part of the Hopkins County economy. A total of 804 million tons have been mined in the county, 435 million from underground mines and 369 from surface and undifferentiated mines. In 2006, 11.5 million tons were mined, 1.3 million from underground mines and 0.2 million from surface mines. Photo by Glynn Beck, Kentucky Geological Survey.



Lake Pee Wee is a 420-acre-lake constructed in the early 1950's to supply drinking water to the city of Madisonville. Currently, Lake Pee Wee provides drinking water to approximately 65 percent of the county. The lake holds 1.355 billion gallons of water and when necessary is recharged by pumping 9 million gallons of water per day from the Green River. Photo by Glynn Beck, Kentucky Geological Survey.



Traditional agriculture is a major part of the Hopkins County economy. Of the 353,433 acres in Hopkins County, 61,062 were used to grow corn, soybeans, and tobacco (Kentucky Agriculture Statistics, 2002-2003). Photo by Glynn Beck, Kentucky Geological Survey.



Poultry-litter storage buildings are used to assist farmers in meeting nutrient-management and water-quality guidelines set by the Kentucky Agriculture Water Quality Authority. Currently, approximately 150 chicken houses are in Hopkins County, and each poultry farm has at least one litter storage building. The above building is located on the Doug Brown Farm. Photo by Glynn Beck, Kentucky Geological Survey.



The presence of clayey to silty soils allows water to stand in row-crop fields. Fields are tilled in order to improve surface drainage in low-lying areas. Photo by George Kelley, Hopkins County Agriculture and Natural Resources agent.

| Rock Unit                                | Foundation and Excavation  | Septic Tank Disposal System   | Residence with Basement  | Highways and Streets  | Access Roads   | Light Industry and Mills   | Intensive Recreation  | Extensive Recreation  | Reservoir Areas   | Reservoir Embankments   | Underground Utilities   |
|--|--|---|--|---|--|--|---|---|---|---|---|
| 1. Alluvium and lacustrine deposits      | Fair foundation material. Refer to soil report (Farr and others, 1977).  | Severe limitations. Refer to soil report (Farr and others, 1977).       | Seasonal high water table. Refer to soil report (Farr and others, 1977).   | Poorly to moderately well sorted. Refer to soil report (Farr and others, 1977).   | Refer to soil report (Farr and others, 1977).        | Refer to soil report (Farr and others, 1977).  | Moderate to severe limitations. Refer to soil report (Farr and others, 1977). | Moderate limitations. Refer to soil report (Farr and others, 1977). | Refer to soil report (Farr and others, 1977).                       | Moderate permeability. Refer to soil report (Farr and others, 1977).    | Refer to soil report (Farr and others, 1977).                             |
| 2. Gravel                                | Excellent foundation material. Moderate excavation. Unit is very fine.   | Slight to moderate limitations. Variable permeability and permeability. | Severe to moderate limitations. Shallow water table may be present.  | No limitations.   | No limitations.                                      | No limitations.  | No limitations.   | No limitations.   | Severe limitations.   | Severe limitations.   | Slight limitations. Variable thickness.                                   |
| 3. Loess (clayey silt)                   | Fair to good foundation material. Easy to excavate. May swell and compact depending on moisture content (Finch, 1968). | Slight to moderate limitations. Variable permeability and permeability. | Severe to moderate limitations. Shallow water table may be present. May swell and compact differently depending on moisture content (Finch, 1968). | No limitations.   | No limitations.                                      | No limitations.  | No limitations.   | No limitations.   | Slight limitations. Unit does not compact well; sandy silty rocks.  | Slight limitations.   | No limitations.   |
| 4. Sandstone, limestone, shale, and coal | Fair to good foundation material. Difficult to excavate.   | Severe limitations. This soil and responsible rocks.                    | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes.   | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes. Coal and clay layers may present problems. | Moderate limitations. Rock excavation. Steep slopes. | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes. | Moderate to severe limitations. Steep slopes. Clay layers may be unstable.    | Slight to moderate limitations.                                     | Slight limitations. Reservoir right bank where rocks are fractured. | Severe limitations. Coal beds and expanding clays may present problems. | Moderate limitations. Highly variable types of rock and earth excavation. |
| 5. Shale and sandstone                   | Fair to good foundation material. Difficult to excavate.   | Severe limitations. This soil and responsible rocks.                    | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes.   | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes. Coal and clay layers may present problems. | Moderate limitations. Rock excavation. Steep slopes. | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes. | Moderate to severe limitations. Steep slopes. Clay layers may be unstable.    | Slight to moderate limitations.                                     | Slight limitations. Reservoir right bank where rocks are fractured. | Severe limitations. Coal beds and expanding clays may present problems. | Moderate limitations. Highly variable types of rock and earth excavation. |
| 6. Sandstone, shale, limestone, and coal | Fair to good foundation material. Difficult to excavate.   | Severe limitations. This soil and responsible rocks.                    | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes.   | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes. Coal and clay layers may present problems. | Moderate limitations. Rock excavation. Steep slopes. | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes. | Moderate to severe limitations. Steep slopes. Clay layers may be unstable.    | Slight to moderate limitations.                                     | Slight limitations. Reservoir right bank where rocks are fractured. | Severe limitations. Coal beds and expanding clays may present problems. | Moderate limitations. Highly variable types of rock and earth excavation. |
| 7. Sandstone, shale, and coal            | Fair to good foundation material. Difficult to excavate.   | Severe limitations. This soil and responsible rocks.                    | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes.   | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes. Coal and clay layers may present problems. | Moderate limitations. Rock excavation. Steep slopes. | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes. | Moderate to severe limitations. Steep slopes. Clay layers may be unstable.    | Slight to moderate limitations.                                     | Slight limitations. Reservoir right bank where rocks are fractured. | Severe limitations. Coal beds and expanding clays may present problems. | Moderate limitations. Highly variable types of rock and earth excavation. |
| 8. Sandstone, silty shale, and coal      | Fair to good foundation material. Difficult to excavate.   | Severe limitations. This soil and responsible rocks.                    | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes.   | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes. Coal and clay layers may present problems. | Moderate limitations. Rock excavation. Steep slopes. | Severe to moderate limitations. Difficult excavation; upper few feet may be rippled. Steep slopes. | Moderate to severe limitations. Steep slopes. Clay layers may be unstable.    | Slight to moderate limitations.                                     | Slight limitations. Reservoir right bank where rocks are fractured. | Severe limitations. Coal beds and expanding clays may present problems. | Moderate limitations. Highly variable types of rock and earth excavation. |

\*Coal beds and underlays should not be used for foundations or reservoir embankments because of the presence of expanding clays in coal and underlays and the weakness of the underlays when they become wet.

### Explanation

- School
- Corporate boundary
- Topographic contour: 20-foot interval
- Artificial fill
- Surface-mined area (includes the Springfield No. 9, Herrin No. 11, and Baker No. 13 coal beds)
- Underground-mined area (includes the Springfield No. 9 and Herrin No. 11 coal beds)
- Wetlands > 1 acre
- Fault
- Concealed fault
- Oil well
- Gas well
- Secondary recovery well
- Spring
- Water well
- Trover Foundation, Regional Medical Center (see photography)

### Groundwater

About 2,300 people in Hopkins County rely on private domestic water supplies: 1,200 use wells and 1,100 use other sources. In Hopkins County, most wells that penetrate sandstones at depths of less than 300 feet are adequate for a domestic supply. In the areas surrounding Nortonville and south of Richland, most wells produce less than 100 gallons per day at depths of less than 300 feet. In southwestern Hopkins County, south of Charleston, a thin, highly faulted zone running east-west yields unpredictable amounts of water to drilled wells. Generally, groundwater is hard, and sometimes iron or salt may be present in objectionable amounts. Often groundwater becomes saltier with depth north of the highly faulted zone. For additional information, see Carey and Stickney (2001).

### 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 excavation with a ripper attachment on a bulldozer.

**LIMITATIONS**  
Slight – A slight limitation is usually one that 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 constitutes 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 backfill. A minimum of cuts and fills are made, little work is done preparing a subgrade, and generally only a thin base is used.  
Light industry and mills – Ratings are based on developments having structures or equivalent load limit requirements that 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.

### 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, Western Kentucky Office, 1401 Corporate Ct., Henderson, KY 42420, 270.827.3414 or 3404.

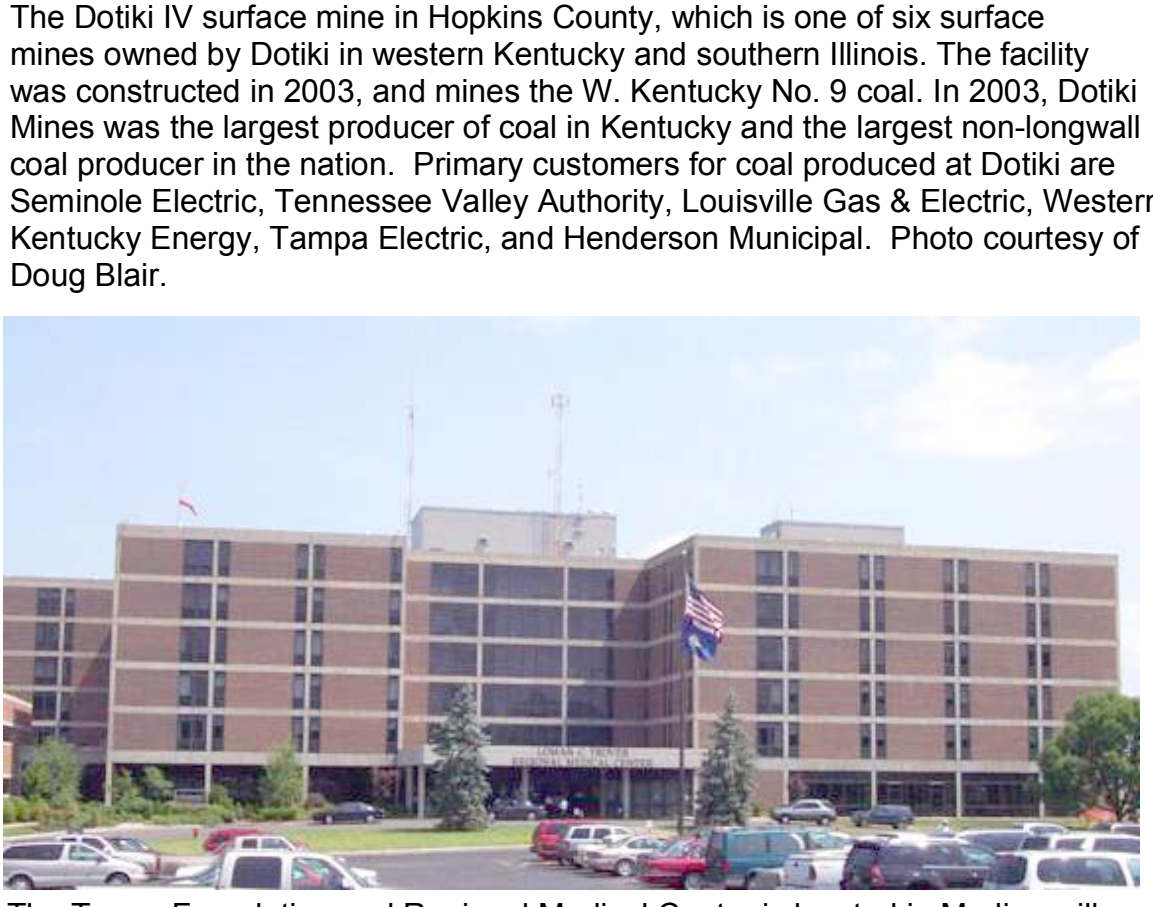
### Geologic Hazards

Hopkins County is located near the New Madrid and Wabash Valley Seismic Zones. Although the faults in the county are not considered active, precautions for earthquakes should be considered. Approximately 13 major earthquakes were recorded in the Madisonville area from 1974 to 2000. Earthquake prediction is not a defined part of seismology, but geologists and engineers know that earthquakes will cause damage, depending on magnitude, distance from the epicenter, and local geology. Areas of thick alluvium, lacustrine deposits, and other unconsolidated sediments are prone to the most damage because of ground-motion amplification and liquefaction. Liquefaction is the process which rock becomes saturated or loses shear strength, and is temporarily transformed into a fluid mass, resulting in structural damage.

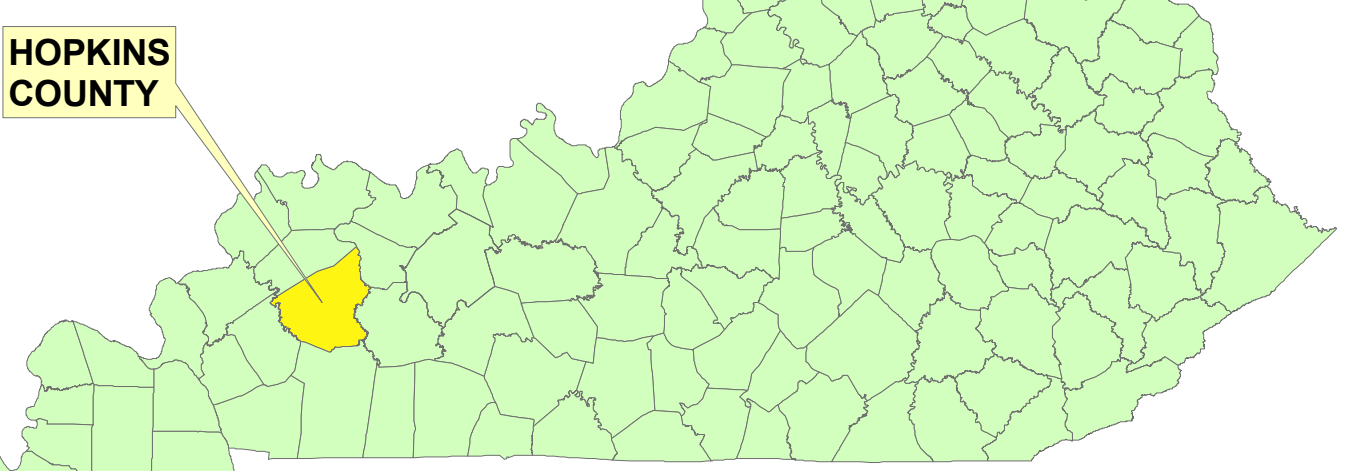
Flooding is also a geologic hazard in Hopkins County. Areas underlain by alluvium, unit 1 on the map, are subject to regular flooding (Beck and others, 2004). The Green River borders the extreme northeastern part of the county and also has the potential for flooding. Urban development on or near both of these areas intensifies runoff, so flooding potential should be considered when planning.

Potential engineering problems can be associated with some clay shales beneath coals and with lacustrine deposits high in clay content. Small landslides and slumps occur locally on steep slopes where these deposits are prevalent. Where clay-shale deposits are overlain by massive sandstone, slumping is most common where joints in the sandstone parallel the slope. Excavations in shale, for roads or building foundations, may over-steepen the slope and undercut the overlying sandstone, causing slides to occur, especially when the material is saturated with water. Outwash and lacustrine deposits with high clay content present engineering problems because rocks built on them tend to yield and push out under heavy traffic. Lacustrine deposits have good to poor compaction and moderate to high susceptibility to frost action. When the water table reaches the surface, the shrink-swell potential of lacustrine deposits is high.

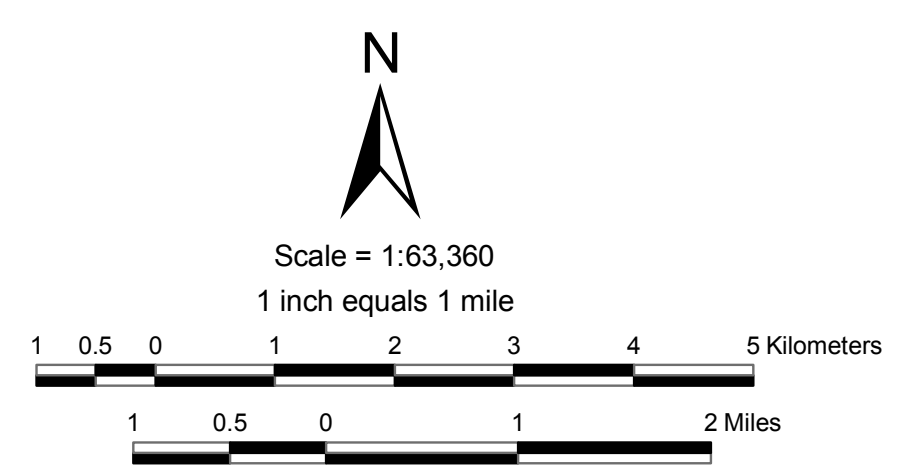
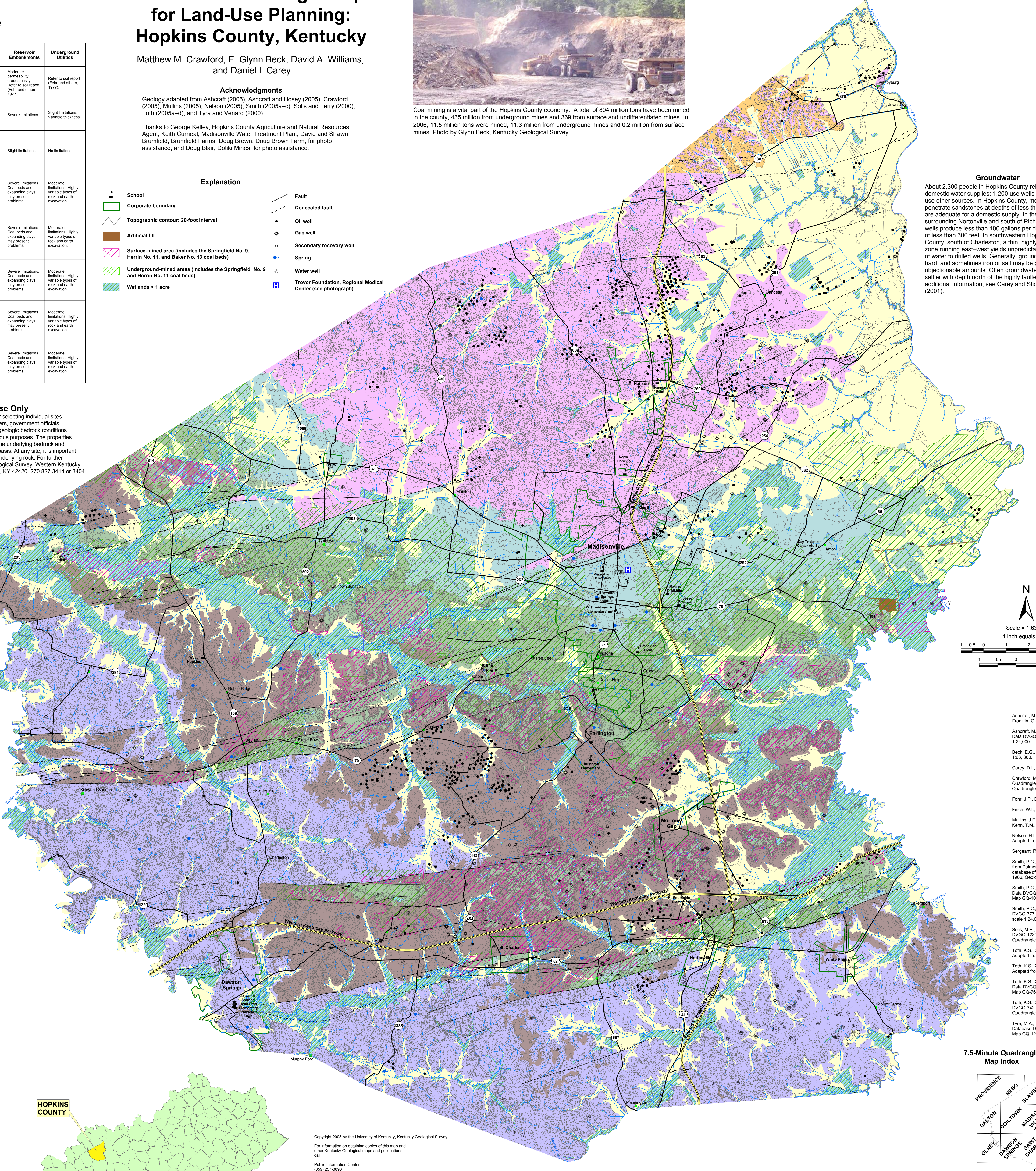
Surface subsidence above abandoned underground coal mines has caused structural damage in parts of the county. When strata above mined-out coal beds collapse, resulting property loss can be substantial. If the overlying strata are not of sufficient thickness and strength, or the underlay is too soft, the result will be surface movement, causing structural damage (Sergeant and others, 1988). Structural damage and property damage can include cracks in foundations, cracks and depressions in roads, curvature of walls, collapse of buildings, and damage to utility lines. The areas of working or abandoned underground coal mines are shown on the map.



The Trover Foundation and Regional Medical Center is located in Madisonville and is the largest employer in Hopkins County. The Regional Medical Center serves 12 surrounding counties in western Kentucky. Photo by Glynn Beck, Kentucky Geological Survey.



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### 7.5-Minute Quadrangle Map Index

|                |                |                   |                   |                |
|----------------|----------------|-------------------|-------------------|----------------|
| PROVIDENCE     | NEBO           | DAVIDSON          | BEECH GROVE       | CALHOUN        |
| DALTON         | COALTON        | MADISONVILLE WEST | MADISONVILLE EAST | SOUTH WERTS    |
| DAWSON SPRINGS | DAWSON SPRINGS | DAWSON SPRINGS    | DAWSON SPRINGS    | DAWSON SPRINGS |
| DIXON          | DAWSON SPRINGS | DAWSON SPRINGS    | DAWSON SPRINGS    | DAWSON SPRINGS |

