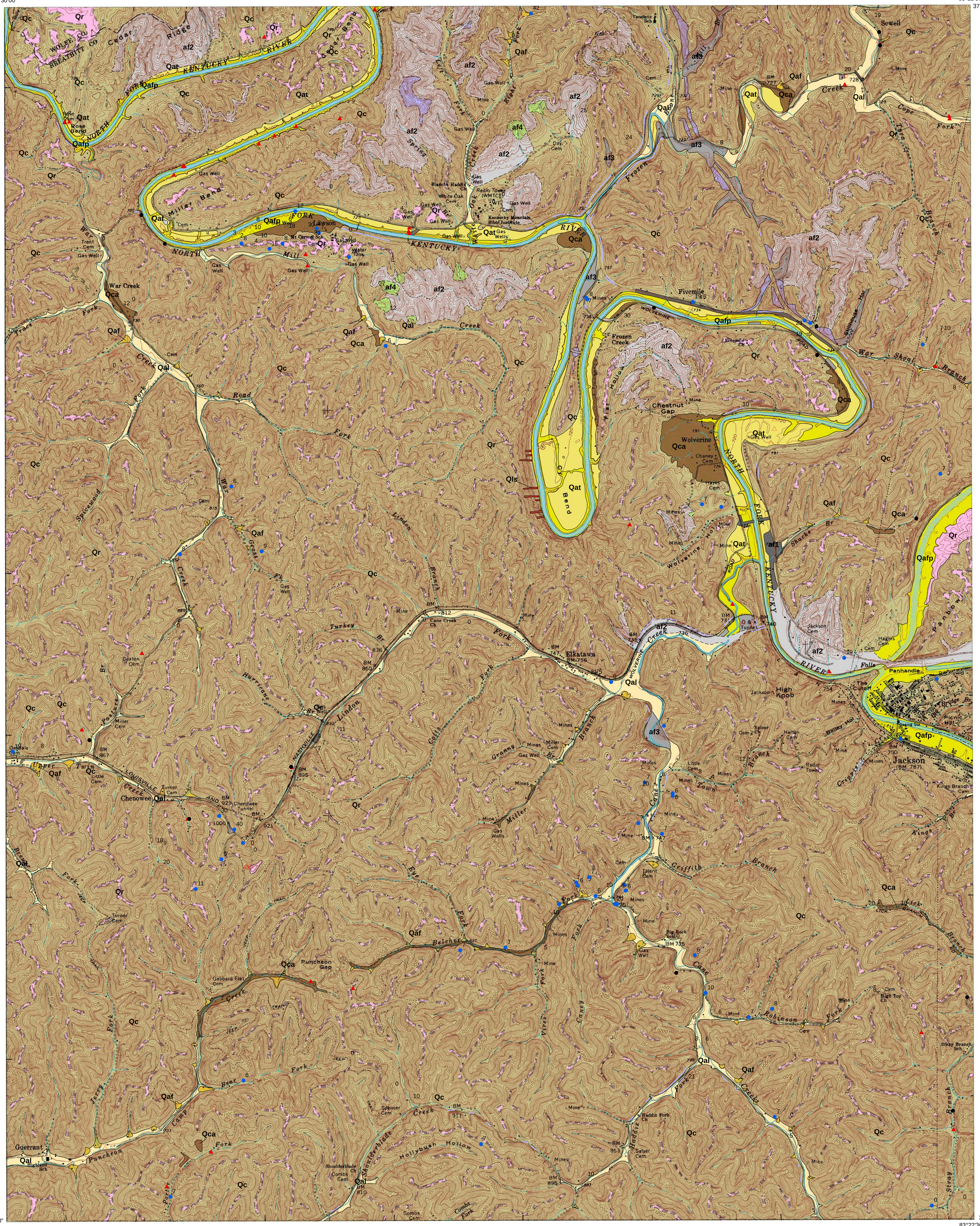
DRAFT GEOLOGIC QUADRANGLE
JACKSON QUADRANGLE, KY.
Series XII, 2010
GQ-205
Version 1.0
Contract Report 39

University of Kentucky
Kentucky Geological Survey



Kentucky Single Zone State Plane projection

Topographic base and cultural features are from
Kentucky Raster Graphics (Zone of confidence = 24 m)
Online linkage http://kymartian.ky.gov/krgmaps/drv/index.html

Topographic contours may not be current within areas of artificial fill.

FSA NAIP 2008 aerial imagery (Zone of confidence = 1 m)
Online linkage ftp://ftp.kymartian.ky.gov/FSA_NAIP_2008_1M

Historic topographic maps (Zone of confidence = 24 m)
Online linkage

Mine Permit Boundary Maps (Existence confidence = low)
Online linkage
http://www.minepermits.ky.gov/mapsspatialdata/downmaps.htm

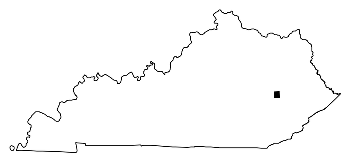
SCALE 1:24,000

5,000 2,500 0 5,000 10,000 Feet

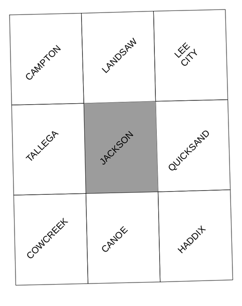
0.5 0.25 0 0.5 1 Miles

0.5 0.25 0 0.5 1 Kilometers

CONTOUR INTERVAL 20 FEET

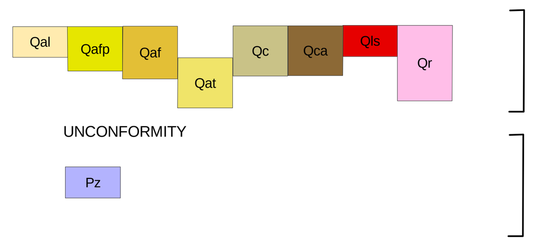


MAP LOCATION



7.5 MIN QUADRANGLE INDEX

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qal **Alluvium, stream-floodplain (Holocene)**
Unconsolidated sand, silt, gravel, boulders, and clay deposited by tributaries of the North Fork of the Kentucky River; occupies narrow valley bottoms, modern stream channels, and small floodplains; frequently flooded; as much as 25 feet thick. Local sand and gravel bars containing cobbles and boulders present near confluence of Frozen and North Fork of the Kentucky River. Sediment in this unit is locally derived and can be actively remobilized by flooding and erosion. Unit is dominated by sand with little or no clay present, particularly in Frozen Creek, Cope Fork, and War Creek. Contacts with adjacent colluvium and alluvial fans vary from sharp to poorly defined. Unit locally disturbed and filled by human activity.

Qafp **Alluvium, river floodplain (Holocene)**
Unconsolidated sand, silt, and clay deposited in floodplain by North Fork of the Kentucky River; surface mantled by silty clay and sandy silt, forms the lowest well-developed terrace; frequently flooded; as much as 25 feet thick. Sand generally predominates, with little or no clay observed. Typically upstream from Wolverine the alluvium contains less than 70% sand and more than 8% clay making the floodplain more cohesive. Downstream from Wolverine alluvium transitions to sand-dominated, with silt and traces of clay; cohesionless. Sandstone bedrock units are at or near the surface, contributing to the sandy nature of the floodplains. Unit overlies older unconsolidated deposits or bedrock; contact is typically sharp, drawn at scarp of next higher terrace (Qat) or colluvial slope (Qc).

Qat **Alluvium, low terrace (Holocene)**
Unconsolidated sand, silt, and clay, deposited in old floodplains by rivers; forms terrace above adjacent floodplain (Qafp or Qal). Percentages range from: Sand 55-60, silt 25-30, and clay 10-20. Contact with adjacent units varies from sharp to poorly defined; extents locally observed then extended based on topographic expression; distinguished by topographic expression and elevation from lower floodplain; floods rarely to infrequently.

Qaf **Alluvium, alluvial fans (Holocene)**
Unconsolidated sand, silt, clay, and gravel, deposited in alluvial fans by extensive precipitation and debris flow events. Form broad, fan-shaped deposits at the mouths of small valleys and ravines. Confined to coalescing tributary valleys, unit probably contains a mixture of alluvium and hill slope colluvium. Contact with adjacent alluvium and colluvial slopes varies from sharp to poorly defined.

Qc **Colluvium undifferentiated, modern (Holocene)**
Unconsolidated sand, gravel, silt, clay, cobbles, and boulders; most commonly deposited by creep acting under the force of gravity on steep slopes. Sheetwash from high precipitation events can also contributes to deposition. Dominated by sand and silt, but can contain as much as 20% clay. Thickness ranges from 0 to 20 feet and varies depending on landscape position and underlying bedrock lithology. Typically colluvial deposits are thickest at the base of slopes (toe slopes) and thin and discontinuous toward the shoulder (higher side slopes). Thick colluvial troughs or wedges often flank bedrock outcrops or ledges on steep slopes.

Qca **Colluvial accumulation zones (Holocene)**
Unconsolidated colluvium, deposited by gravity forming a gentler slope than adjacent colluvium. Unit may be fan-shaped deposits near base of steep slopes or within concave slopes.

Qr **Residual soil (Holocene)**
Unconsolidated sand, silt, and clay, produced in place from weathering of underlying bedrock; primarily found on ridgetops and above large ledges of outcropping bedrock; developed where transport processes are insufficient to remove weathered material after production. Within this unit, original texture of weathered bedrock has been destroyed by weathering processes; pedogenic soil structure typically has been developed. Material mapped where slopes are inferred to be less than necessary to initiate significant colluvial movement.

Qls **Landslide deposits, modern (Holocene)**
Unconsolidated, complex accumulations of soil, weathered rock, rock, and vegetation derived from gravity-related processes including, slumps, earthflows, and debris flows. Processes can occur where water contributes to a plane of weakness within colluvial slopes or along stream banks; commonly at the soil-bedrock interface. Slide ages range from active to historic non-active. Erosion associated with deposits commonly observed along roadways and at cutbanks in streams. Unit indicated by a point symbol where too small to show on map.

Pz **Bedrock (Pennsylvanian)**
Consolidated sandstone, siltstone, shale, coal, and limestone of the Breathitt Formation and the Corbin Sandstone. Map unit as delineated represents road cuts Natural bedrock exposures and ridge tops covered by thin organic soils are not mapped. All other map units are underlain by highly weathered bedrock, weathered bedrock, and solid bedrock.

af1 **Artificial fill, engineered fill (Modern)**
Material designed and deposited for construction of roads, railroads, buildings and engineered structures. Map units are delineated only when they are large enough to be shown as polygons at the scale of 1:24000.

af2 **Artificial fill, mine spoil (Modern)**
Unconsolidated overburden and fill material generated from surface and underground coal mining processes. This includes material mined and restored from contour mining excess mine spoil placed in hollow fills, dry refuse, slurry ponds, and mountain top removal sites. Unit delineated by soil map analysis, modern aerial photography, mine maps, and historical topographic maps.

af3 **Artificial fill, other fill (Modern)**
Unconsolidated fill; includes materials cleared during maintenance of roads andwater ways. Some locations also have biodegradable material, collapsed and whole vehicle bodies, and appliances.

af4 **Artificial fill, hollow fill (Modern)**
Excess overburden generated during coal mining operations, placed in narrow valleys after coal removal. Material is typically graded and benched. Map unit based on identification from aerial photography and mine permit maps.

Map units **Qc**, **Qr**, **Qafp**, and **Qal** are primarily derived from the parent materials of the USDA soil series units. Delineation of these units was completed by field observations, existing bedrock geologic map, and slope percentage analysis.

Map units **Qaf**, **Qat**, **Qca**, **Qls**, **af1**, **and af3** are derived from field observation.

Map unit **af2** and **af4** were derived from soil series maps, known mined areas, mine permit maps, and aerial photography

*The Gradational contact inferred line symbology from the required FGDC standard style file masks some areas where the polygons are very thin, making them difficult to see.

EXPLANATION

- Contact
- Gradational contact inferred*
- Gradational contact
- Inferred contact
- Inferred contact questionable
- Incised scarp
- Landform observation and soil sample
- Landform observation
- Landslide location (deposit to small to be mapped as unit polygon)
- Bedrock face
- 23 KGS database, number indicates depth to bedrock in feet (some locations unconfirmed).
- 23 KGS database with lithology, number indicates depth to bedrock in feet (some locations unconfirmed)

DISCLAIMER

GEOLOGIC SUMMARY

GEOLOGIC SETTING

The Jackson 7.5-minute quadrangle is located in Breathitt and Wolfe Counties, Ky., and lies on the western margin of the Eastern Kentucky Coal Field of the Appalachian Basin. This map shows the distribution of surficial, engineering soils above bedrock and the relationship between the surficial geology and the underlying bedrock. The bedrock geology consists of gently dipping sedimentary rocks of Pennsylvanian age. These rocks are dominantly sandstone, siltstone, shale, coal, and limestone of the Breathitt Group and the Corbin Sandstone. In place sandstone bedrock caps many hilltops and forms steep scarps. Siltstone and shale typically form gentle slopes or when capped by sandstone form eroded rock faces set back under the sandstone portion of the exposures.

ECONOMIC GEOLOGY

Coal, oil, and natural gas are the principal mineral resources of the Jackson 7.5-minute quadrangle. Coal mining has a history of more than 100 years. Breathitt County has produced approximately 212 million tons of coal from a variety of surface and underground mining methods. According to the Kentucky Geological Survey web site (www.uky.edu/KGS), in 2006 Breathitt County produced approximately 3 million tons of coal; it ranks 10th out of 25 Eastern Kentucky Coal Field counties for which production data are available. In 2007, Breathitt County produced 8,561 barrels of oil and 467,248 cubic feet of natural gas.

GEOMORPHOLOGY

The units described on this map reflect natural processes collectively operating as a dynamic geomorphic system (Newell, 1978; Outerbridge, 1987). The primary mechanisms of sediment transport and deposition in this area are flowing water (alluvial processes) and gravity/mass-movement (colluvial processes), which are complexly interrelated. The map units in this area have been delineated based on the primary process generating the deposit or material. Delineation and identification of all maps units is restricted by the map scale of 1:24,000.

The bedrock (Pz) of the quadrangle is comprised of laterally discontinuous, nearly horizontal layers of shale, sandstone, siltstone, and coal. Each of the bedrock lithologies has different mechanical strengths, has different permeabilities, and weathers at different rates. Slopes developed on different lithologies have different slope angles, with slopes underlain by sandstone being typically steeper. Weathering of some shale-dominated bedrock units has been observed to be relatively rapid, with some areas becoming weathered rock (saprolite) in only a few years, whereas other, more sandstone-dominated bedrock ledges exhibit little significant change over a timescale of decades and remain essentially consolidated. Partially weathered rock includes softer, weaker materials produced by the weathering processes, mixed with pebble- to boulder-sized fragments of intact bedrock with typical bedrock structures and properties; this material is included in the bedrock (Pz) as mapped in this study. Water infiltrates along joints and other fractures in bedrock, concentrating initial weathering near these planes of discontinuity. Bedrock underlies the entire map area. Weathered rock discontinuously underlies each different type of map unit on the map; the distribution of weathered rock (saprolite) is not delineated or differentiated on this map.

Complete weathering of the bedrock results in development of a residual soil (Qr) that has no bedrock structure, but has developed pedogenic—or soil—structure. This occurs where the rate of weathering is faster than the rate of erosion of the weathered material. These materials are typically found on ridge tops, the convex-upward shoulders of some hillsides, and in the upland cores of some meanders of the larger streams in the quadrangle.

On steeper slopes, the weathered material moves downhill under the force of gravity relatively soon after being produced. Slow downhill creep of these colluvial materials is common on steep slopes throughout the quadrangle. The threshold slope angles of colluvial processes vary depending on the properties of the weathered material, which in turn are related to the original source bedrock ledges upslope. The unit tends to be relatively thin, with a delicate and dynamic balance/equilibrium between sediment input and output along the slope. Locally, natural or human-induced concentrations of water, steepening of slope materials, addition of materials to the top of slopes, or excavation/erosion of material from the base of slopes can destabilize the slowly moving colluvial materials and result in more rapid and discreet landslide events (Qls), such as slumps, debris flows, earth slides and rock falls. Collectively, the processes acting in these steeper slopes represent a complex and dynamic colluvial transport zone (Qc), transporting material irregularly and variably downhill primarily under the force of gravity.

At the base of steep slopes and above resistant bedrock ledges, where lower slope angles exist and natural colluvial input exceeds natural erosion, relatively thick deposits of colluvial material can accumulate (Qca). Under natural conditions, these deposits are somewhat more stable than the adjacent steeper colluvial transport zones, but natural or artificial modification of the slopes or increased water content can result in destabilization or large failures (Qls) of the material. Figure 1 illustrates these relationships.

Alluvial processes have eroded the valleys in the quadrangle, and provide the primary mechanism for removing significant quantities of sediment from the map area. Stream erosion removes colluvial material from the base of slopes, facilitating continuing colluvial erosion of many of the hill slopes in the area. The region has a dendritic drainage network, comprised of streams at a variety of scales, including rills, brooks, creeks, and a small river. The smallest fluvial features are rills and intermittent brooks, which are active only following high precipitation events. Combined with groundwater-fed springs and seeps, these contribute flow to produce small perennial brooks, which typically flow at the bottom of steep v-shaped valleys and have no floodplain or only small scale, ephemeral alluvial deposits. These small-scale deposits are too small to illustrate on a map of this scale. In slightly larger valleys, colluvial toe-slope deposits (Qca) are intermingled with small alluvial deposits (Qal); these are mapped as Qca where slope angles trending toward the stream channel suggest colluvial processes predominate, and are mapped as Qal where slope angles trending downhill parallel the valley axis suggest alluvial deposition predominates. Alluvial fans (Qaf) are commonly developed where small brooks and creeks enter the valleys of larger creeks. These alluvial fans result from a combination of steady-state alluvial processes and sudden catastrophic debris flow events following high-precipitation events; they can also be closely associated with the Qal and Qca toe-slope deposits in larger brook valleys and smaller creek valleys.

The creeks have well-developed floodplain deposits (Qal), where the stream has enough size and contributing drainage area to erode laterally as well as downward, resulting in relatively flat-bottomed valleys. Under natural conditions, these streams will meander across the width of the valley; human activity had commonly modified or constrained the location and migration of the stream channels. The alluvial deposits in these valleys are typically a combination of a lower channel-deposited coarse-grained unit, overlain by a finer-grained unit resulting from subsequent overbank deposition. The materials in these creek floodplains are locally derived, from erosion of sediment from adjacent hillsides and colluvial deposits. Small placements of artificial fill and human-generated debris are commonly associated with these deposits, and are in many cases too small to map or differentiate.

The North Fork of the Kentucky River is the primary stream draining the study area, with a contributing drainage area of approximately 1100 square miles where it enters the Jackson quadrangle. The North Fork has a well developed floodplain (Qafp), which is comprised of two parts: a lower coarse-grained unit deposited by the active flow of the meandering channel, and an upper finer-grained unit deposited subsequently by overbank processes. The materials in this river floodplain are both locally and regionally derived, and include sediment eroded from throughout the upstream reaches of the North Fork. Downstream from Wolverine, the North Fork floodplain and the floodplains of tributary creeks contain significantly more sand than other regional streams, because of the dominance of sandstone bedrock exposed in those valleys. The predominance of non-cohesive sand in these deposits has resulted in development of distinctive landforms, such as narrower floodplains, more pronounced swale and swell topography in the floodplains, truncated levees, collapsing stream banks, and lower-angle slopes adjacent to channels and in terrace scarps. Locally in these sand-dominated areas, the overbank material and underlying channel-derived material are difficult or impossible to distinguish. Whereas these areas flood as frequently as floodplains elsewhere in the region, the resulting overbank deposition is inferred to be much sandier due to the contribution of sandier source material and higher energy flow on the narrower floodplains. Figure 2 illustrates the features of a cohesionless floodplain and Figure 3 shows features observed in the transition from cohesive to cohesionless floodplain.

Along the larger creeks and the North Fork, older alluvial deposits are preserved as terraces (Qat), which represent older abandoned floodplain deposits. The terrace deposits typically contain more clay and have more mature soil development than the adjacent, younger floodplain deposits.

Significant placements of artificial fill (af1, af3) have been noted in the quadrangle. These have substantially modified and/or obscured the natural landforms where they have been placed. These fill materials can be extremely variable and have a wide range of geotechnical properties; they were not formally characterized during this study.

GEOTECHNICAL BEHAVIOR

Major properties of surficial materials recorded during mapping include (1) moisture, texture, Munsell color, and soil structure using standard USDA Soil Survey (Soil Survey Manual, 1993) terms defined by percentages of sand, silt, and clay and (2) field identification based on the Unified Soil Classification System (Standard Practice for Description and Identification of Soils, 1993) for soil properties as cohesion, consistency, plasticity, and dilatancy. This data is from field inspection and is useful for preliminary consideration of how surficial deposits may behave during natural or human processes. This data is stored in a geodatabase at Kentucky Geological Survey. (www.uky.edu/KGS)

The Quaternary deposits identified exhibit a wide range of grain size that result in varying geotechnical behaviors. Grain-size distribution, soil thickness, clay content, and soil moisture are the primary factors affecting the geotechnical behavior of units. The grain-size distributions of unconsolidated sediments are controlled by the bedrock from which the materials are derived and conditions under which the materials were deposited.

Fluvial processes produce moderately sorted deposits and colluvial processes produce poorly sorted deposits. Mass wasting events produce landforms with an internal structure ranging from highly unstable rock on rock deposits, to apparently stable fine grain to coarse grain matrix supported boulders.

The bedrock lithology influences the type of material in the deposits. Combinations of sand, silt and clay affect the cohesiveness and permeability of the map units. Eight percent clay is required to make the deposit cohesive and over 25% clay makes the deposit relatively impermeable (Transportation Research Board, 1996) affecting shear strength of the deposit. A sandy matrix of colluvium (sandstone makes up greater than 50 percent of the bedrock) typically has higher porosity and is well drained, making it more stable than colluvium derived from clay-rich rocks (Newell, 1978). Whereas a colluvium whose matrix is rich in clay and silt (sandstone is less than 33 percent of the bedrock) is poorly drained and easily saturated and mobilized (Newell, 1978).

Floodplain materials with 80% sand and only a trace of clay, typical along the North Fork of the Kentucky River downstream from Wolverine are cohesionless and non plastic. Floodplains with less than 70% sand and more than 8% clay particles, upstream from Wolverine, make the floodplain material cohesive.

HAZARDS

The highly dissected topography in the Jackson area has a history of mass wasting. The thick sequences of interbedded sandstone, siltstone, and shale in the Breathitt Group have fractures and joints from stress release and tectonic activity. When seepage through these joints causes differential weathering of the underlying, degradable, rock such as shale, the potential for rockfalls and landslides is increased. Hillsides are covered by varying thicknesses of colluvium that are susceptible to failure as landslides, including creep, slumps, and debris flows. Natural processes such as heavy precipitation, stream erosion, freeze-thaw cycles, and snow melt can increase the potential for mass movement. Also, artificial modification such as increasing the slope, cutting toe slope, and/or overloading the slope for road or home construction may increase the risk of landslides.

Flooding is a frequent (every one to five years) occurrence in the narrow stream valleys confined by steep slopes. Low terraces flood less frequently (10 or more years) and are prone to flooding during high-magnitude, low-frequency precipitation and snow melt events.

LAND USE

The topography in the Jackson area severely limits developable sites. Housing developments and transportation corridors take advantage of naturally occurring flat sites but often encroach into adjacent, less stable landforms. Though these landforms appear stable, loading a deposit with structures, truncating the toe of a deposit, saturating the materials with septic system lead beds, or concentrating the drainage from structures or pavement may destabilize and activate mass movement events. Other types of flat surfaces may consist of artificial fill with biodegradable or compressible buried material.

Thickened deposits of unconsolidated material are formed by processes such as mass wasting, gradual creep, and development or mining operations. The density of these deposits is unpredictable; some are very stable while others can be easily reactivated. Many structures and /or roads are benched into the slopes along narrow valleys, tiered commonly as much as a few hundred feet up the slope, or placed on questionable fill. Modifying the shape, the loading, or the vegetation cover can alter how these deposits behave during various weathering processes.

Other possible sites for development and transportation corridors are former mining benches, hollow-fill deposits, and mined-out areas. Care must be taken to understand the distribution and compaction of mine spoil and hollow fill, location of burial high walls, and undisturbed bedrock near or at the planned development. Differential settling has caused significant damage to structures and roads that straddle the interface of bedrock and fill or spoil.

ACKNOWLEDGMENTS

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Field mapping was completed by Michael L. Murphy, Matthew M. Crawford, and Monte Rivers from May 2009 to May 2010, with assistance from Ron Counts, Scott Waninger, and William Andrews.

Subsurface information was compiled from data on file at the Kentucky Geological Survey

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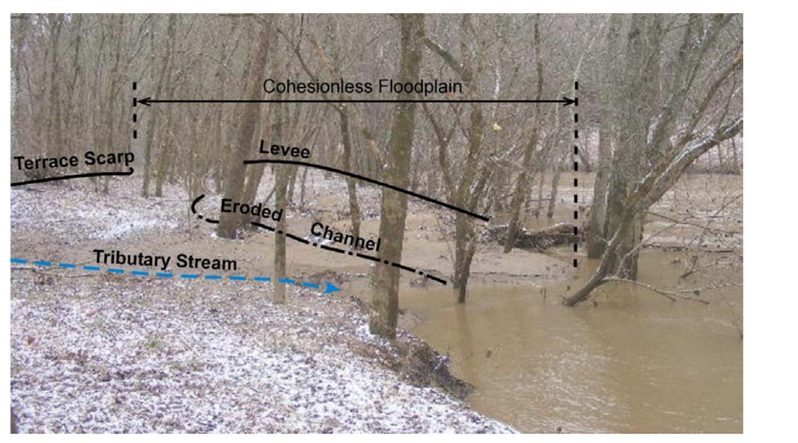

Figure 2. Cohesionless floodplain at Miller Bend with more than 90% sand and trace of clay. Lateral tributary stream and pore pressure cause levee to fail. As river rises, backwater fills the floodplain; as river recedes, water drains out and erodes the floodplain bottom.

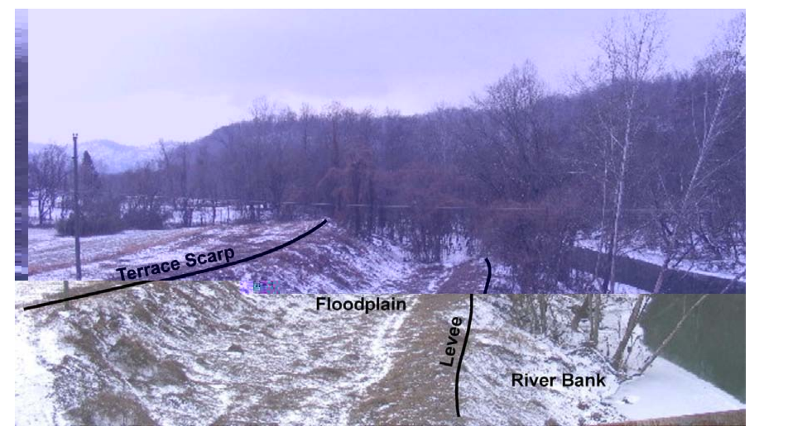

Figure 3. Transitional floodplain at bridge along Hwy 205 near Frozen Creek. With more than 5% clay, the levee is more competent. The floodplain is longitudinally confined by the levee. The floodplain is filled by overbank and backwater; the floodplain bottom does not erode.

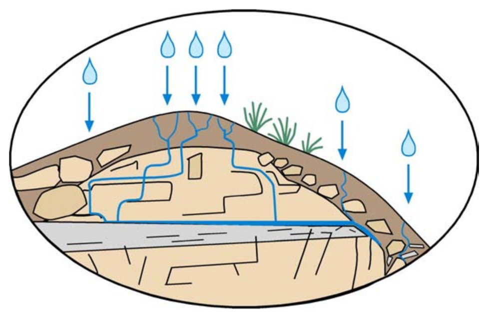

Figure 1A. Development of the Residual Soil (Qr). Influence of water on weathering of bedrock, soil development, and transport of Colluvium (Qc) by infiltration.

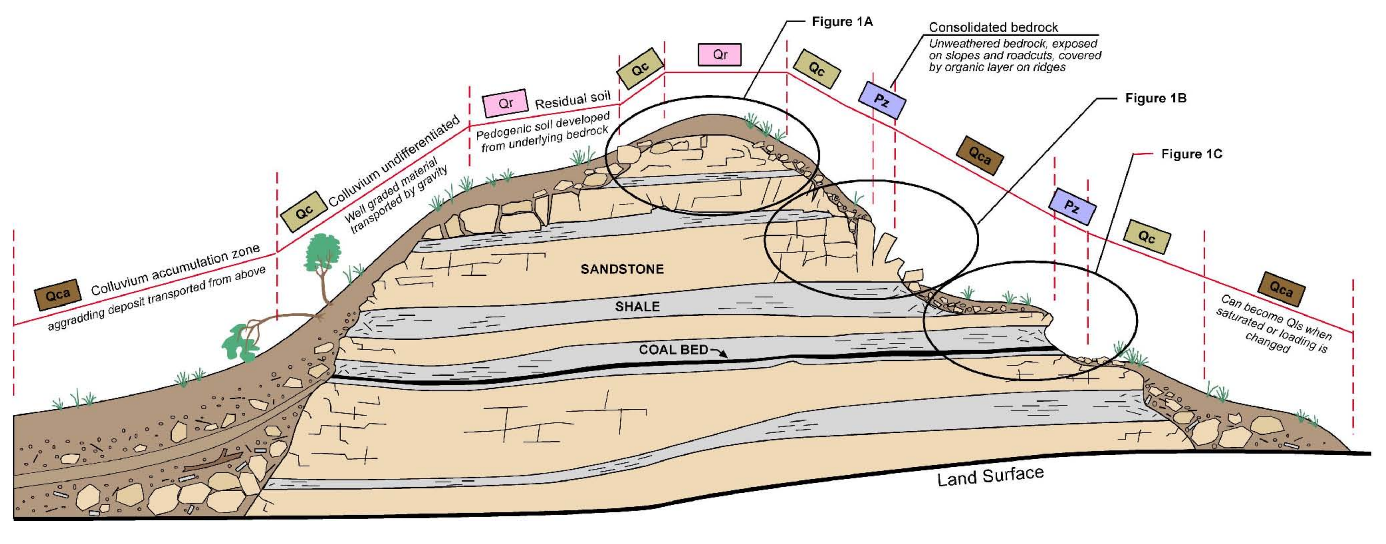

Figure 1. Conceptual model of the geomorphic processes in the Jackson 7.5-minute quadrangle.

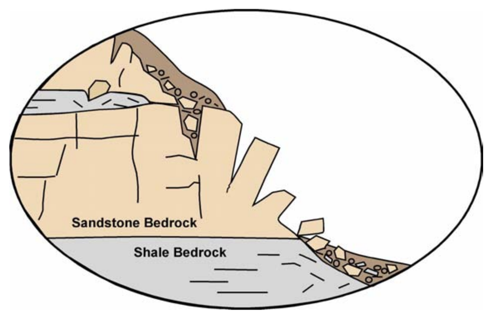

Figure 1B. Different types of Bedrock (Pz) exposed on hillside.

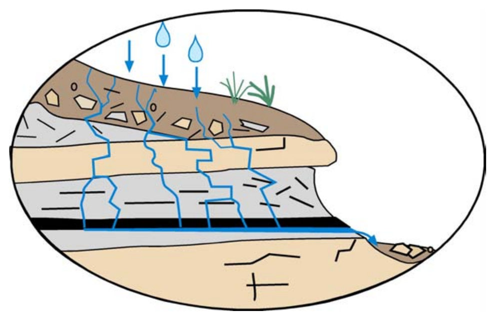

Figure 1C. Bedrock (Pz) outcrop and location of hillslope Colluvium Accumulation (Qca). Note infiltration of water with seep at impervious coal seam.

QUATERNARY GEOLOGIC MAP OF THE JACKSON 7.5–MINUTE QUADRANGLE, EASTERN KENTUCKY

By Michael L. Murphy, Monte Rivers, and Matthew M. Crawford

2010