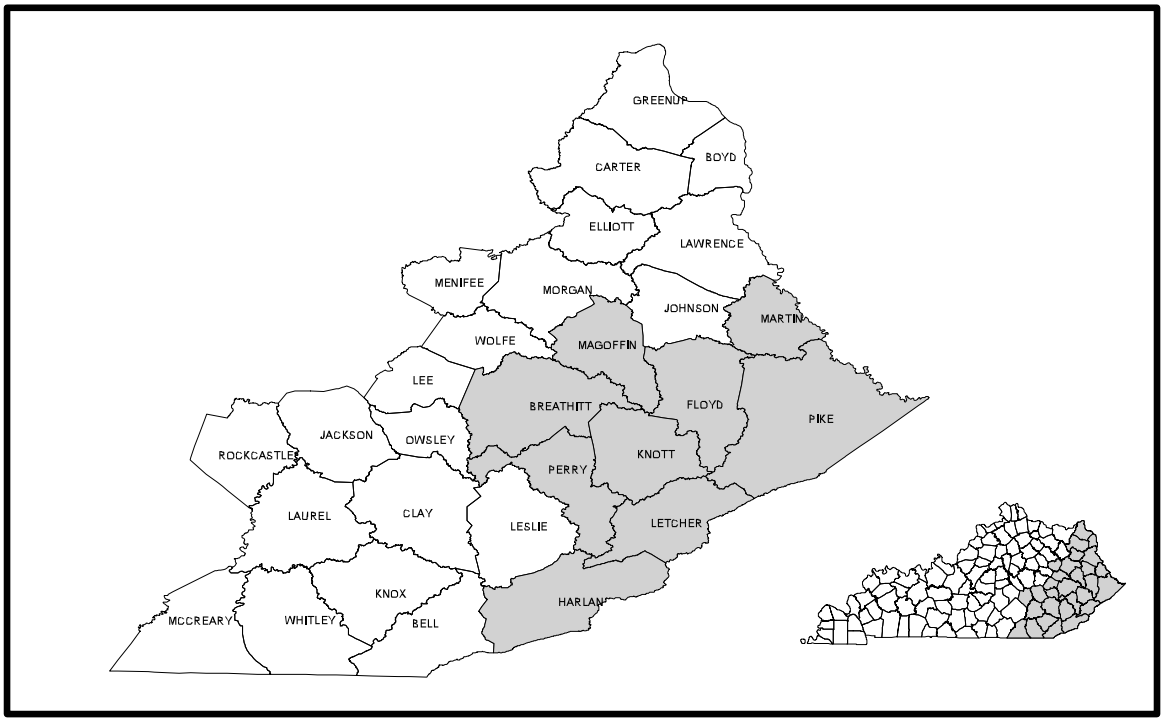
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF KENTUCKY
AND THE KENTUCKY GEOLOGICAL SURVEY
UNIVERSITY OF KENTUCKY

AVAILABILITY OF GROUND WATER IN BREATHITT, FLOYD HARLAN, KNOTT, LETCHER, MARTIN, MAGOFFIN, PERRY, AND PIKE COUNTIES, KENTUCKY

By
W.E. Price, Jr., Chabot Kilburn, and D.S. Mull

HYDROLOGIC INVESTIGATIONS
ATLAS HA-36



INDEX MAP OF THE EASTERN COAL FIELD REGION, KENTUCKY, SHOWING COUNTY GROUPS AND AREA OF THIS ATLAS

This is 1 of 3 atlases (HA-36, HA-37, HA-38) showing geology and availability of ground water in the Eastern Coal Field region, Kentucky U.S. Geological Survey Water-Supply Paper 1607 contains a text description and illustrations providing further information on the occurrence and quality of ground water in the Eastern Coal Field region.

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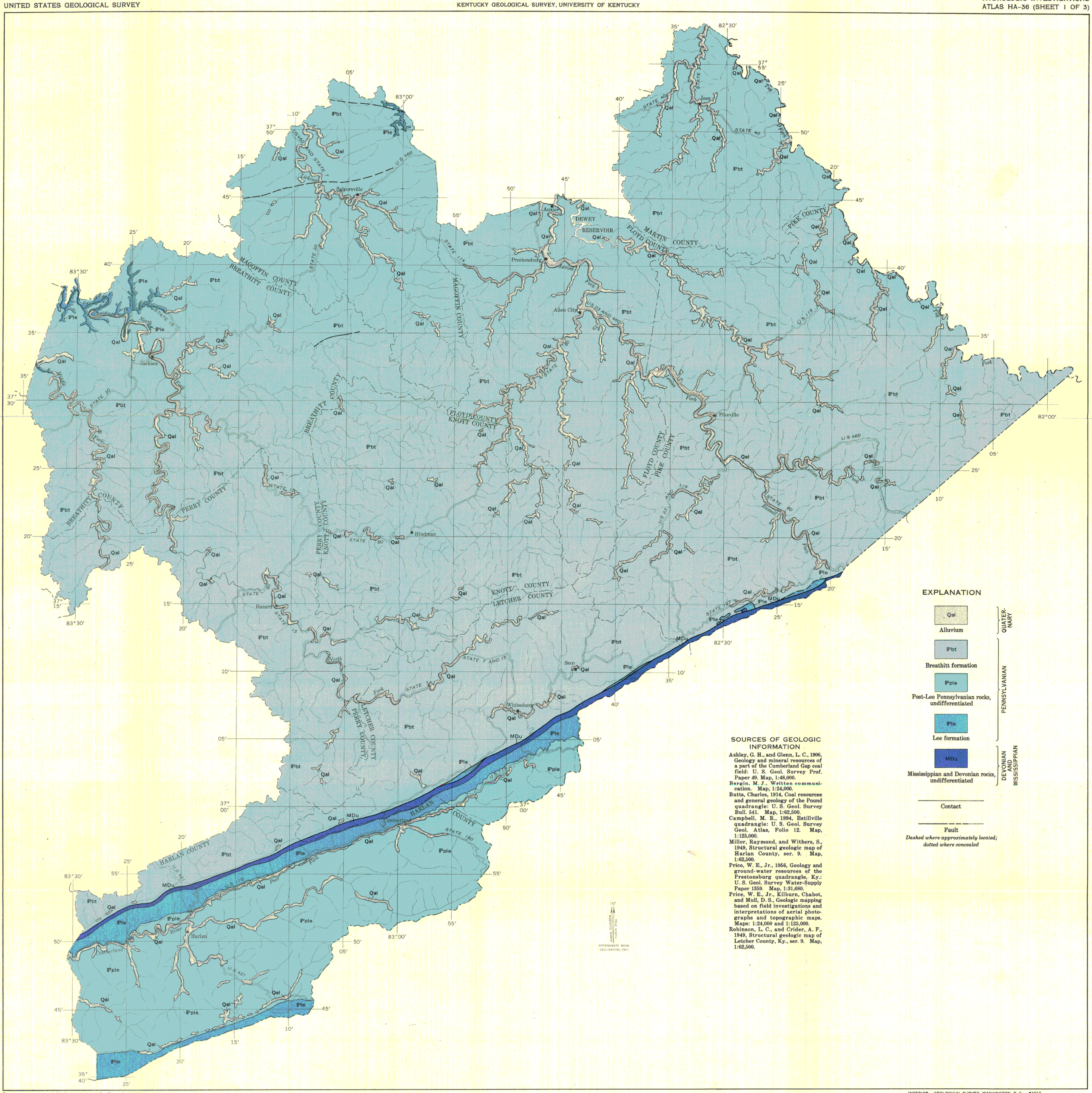
HYDROLOGIC INVESTIGATIONS
ATLAS HA-36 (SHEET 1 OF 3)



EXPLANATION

- Qal — Alluvium — QUATERNARY
- IPbt — Breathitt formation — PENNSYLVANIAN
- IPple — Post-Lee Pennsylvanian rocks, undifferentiated — PENNSYLVANIAN
- IPle — Lee formation — PENNSYLVANIAN
- MDu — Mississippian and Devonian rocks, undifferentiated — DEVONIAN AND MISSISSIPPIAN

Contact

Fault

Dashed where approximately located; dotted where concealed

SOURCES OF GEOLOGIC INFORMATION

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15° MAGNETIC NORTH TRUE NORTH
APPROXIMATE MEAN DECLINATION, 1961

Base maps are county highway maps and adjacent county groups may not match

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GEOLOGIC MAP OF BREATHITT, FLOYD, HARLAN, KNOTT, LETCHER, MARTIN, MAGOFFIN, PERRY, AND PIKE COUNTIES, KENTUCKY

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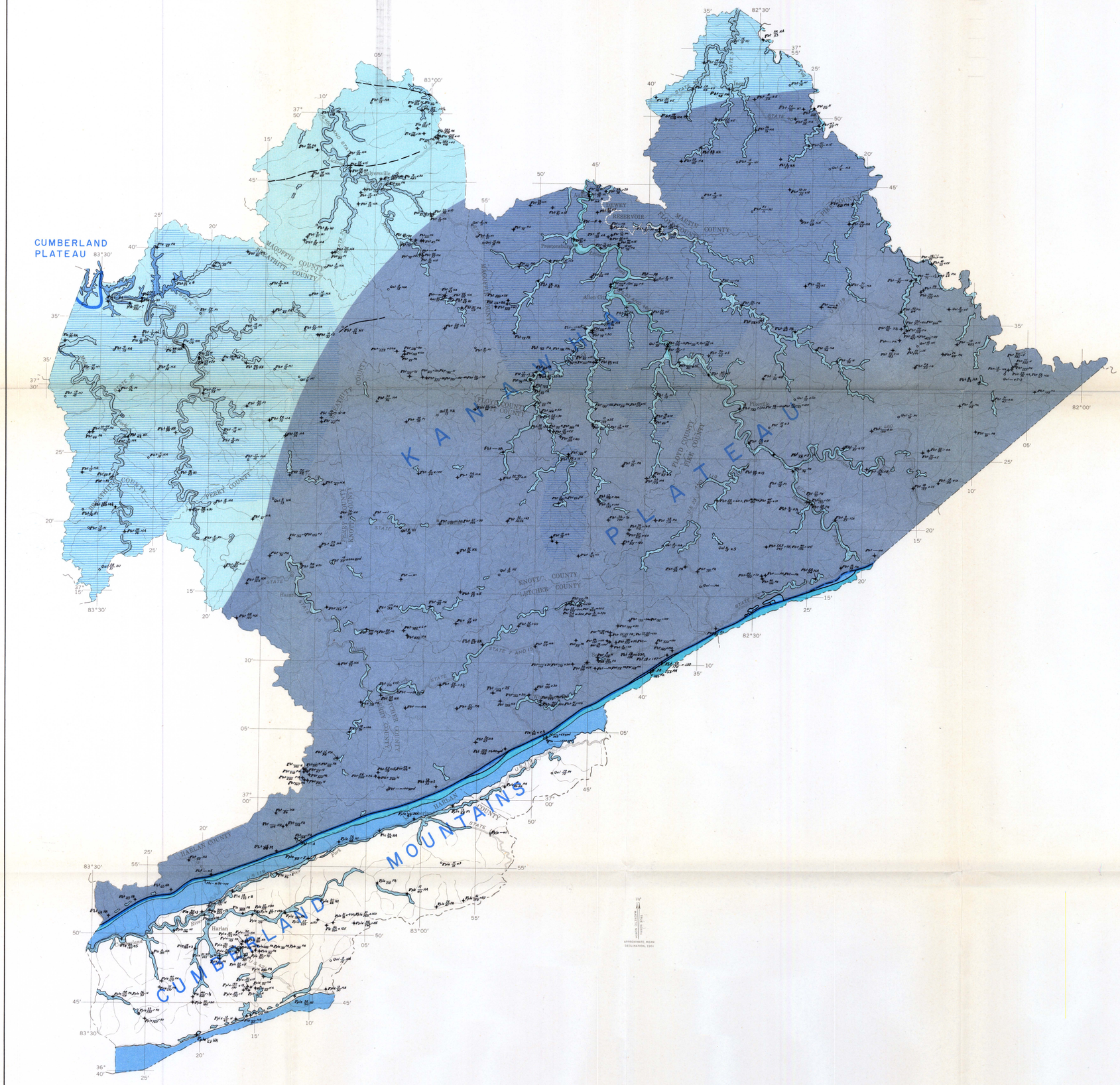

Base maps are county highway maps and adjacent county groups may not match

EXPLANATION

Qal	Alluvium	QUATERNARY
Pbt	Breathitt formation	PENNSYLVANIAN
Pple	Post-Lee Pennsylvanian rocks, undifferentiated	PENNSYLVANIAN
Ple	Lee formation	PENNSYLVANIAN
MDu	Mississippian and Devonian rocks, undifferentiated	DEVONIAN AND MISSISSIPPIAN

Contact

Fault
Dashed where approximately located; dotted where concealed

KANAWHA SECTION

The Kanawha section is a highly dissected area characterized by narrow valleys and irregular steep-sided ridges. Although shale is the predominant rock type, beds of sandstone form resistant ledges in the sides and on the tops of hills and underlie many of the broad valleys. Because most of the people live along the streams, nearly all wells are drilled in the valley bottoms. Rocks in this area generally yield ample supplies of water for domestic use

Water in alluvium

Dug wells.—Nearly all wells in the alluvium are dug. Most dug wells are adequate for a minimum domestic supply with bucket or hand pump (more than 100 gpd). A few are adequate for a modern domestic supply with a power pump (more than 500 gpd). Ground water obtained from most dug wells in this area is soft.
Drilled wells.—Because the alluvium in many places contains much sandy material and has a saturated thickness of about 30 feet, screened wells yielding as much as 20 to 25 gpm probably could be developed in it. Most screened wells would be adequate for a modern domestic supply. Water from wells drilled in the alluvium is moderately hard and contains large amounts of iron

Water in alluvium

Dug wells.—Nearly all wells in the alluvium in this area are dug. Most dug wells are adequate for a minimum domestic supply. A few are adequate for a modern domestic supply. Water obtained from most dug wells in this area is moderately hard and contains noticeable amounts of iron
Drilled wells.—Screened drilled wells probably can be developed in the alluvium where sandy material is present and the saturated thickness is at least several feet. Some of these wells may yield enough water for a modern domestic supply, but most probably would be adequate only for a minimum domestic supply. Few screened wells have been developed in the alluvium because they are expensive and probably would yield only small quantities of water

Water in the Breathitt formation (subarea 1)

Drilled wells.—Most wells drilled in valley bottoms are adequate for a modern domestic supply. Nearly all wells in valleys are adequate for a minimum domestic supply.
Fewer than half the wells drilled on hillsides are adequate for a modern domestic supply. More than three-quarters of the wells on hillsides are adequate for a minimum domestic supply.
Wells on hilltops and ridges yield smaller quantities of water.
Most of the water obtained from drilled wells is extremely hard and contains noticeable amounts of iron. Salty water may be found from 50 to several hundred feet below the level of the principal valley bottoms.
Dug wells.—Most wells dug in valleys are adequate for a minimum domestic supply. A few wells dug in valleys are adequate for a modern domestic supply.
About half the wells dug on hills are adequate for a minimum domestic supply. A few wells dug on hills are adequate for a modern domestic supply.
Springs.—A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5 gpm

Water in the Breathitt formation (subarea 2)

Drilled wells.—More than three-quarters of the wells drilled in valley bottoms are adequate for a modern domestic supply. Nearly all wells in valleys are adequate for a minimum domestic supply.
Almost three-quarters of the wells drilled on hillsides are adequate for a modern domestic supply. Nearly all wells on hillsides are adequate for a minimum domestic supply.
Nearly all wells drilled on hilltops are adequate for a minimum domestic supply. Some wells on hilltops or ridgetops are adequate for a modern domestic supply.
Drilled wells more than 200 feet deep in valleys may yield enough water for small municipal or industrial supplies.
Ground water obtained from most drilled wells in this area is moderately hard and contains noticeable amounts of iron. In places in the northern part of the area and along the northwestern margin of the area, salty water may be found in wells tapping the Breathitt formation less than 100 feet below the level of the principal valley bottoms. Elsewhere, salty water in drilled wells probably will not be found less than 200 feet below the level of the principal valley bottoms.
Dug Wells.—Most wells dug in valleys are adequate for a minimum domestic supply. A few wells dug in valleys are adequate for a modern domestic supply.
About half the wells dug on hills are adequate for a minimum domestic supply. A few wells dug on hills are adequate for a modern domestic supply.
Springs.—A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5 gpm

Water in the Lee formation (subarea 2)

Drilled wells.—Most wells drilled in valley bottoms are adequate for a modern domestic supply. Nearly all wells in valley bottoms are adequate for a minimum domestic supply.
Fewer than half the wells drilled on hillsides are adequate for a modern domestic supply. Nearly all wells on hillsides are adequate for a minimum domestic supply.
Fewer than three-quarters of the wells drilled on hilltops and ridges are adequate for a minimum domestic supply. About a third of the wells on hilltops or ridgetops are adequate for a modern domestic supply.
Deep wells penetrating the entire thickness of the Lee formation where it exceeds 500 feet in thickness may yield enough water for small municipal or industrial supplies.
Most of the water in this area is moderately hard and contains noticeable amounts of iron. Salty water may be found, in wells in this area, at depths ranging from 50 feet to several hundred feet. Nearly all wells tapping the Lee formation yield salty water where the Lee lies beneath the Breathitt formation and below the principal drainage.
In northern Magoffin County, however, some wells may penetrate the entire thickness of the Lee formation under these conditions and yield fresh water.
Dug wells.—Most wells dug in valley bottoms are adequate for a minimum domestic supply. A few wells dug in valley bottoms are adequate for a modern domestic supply.
About half the wells dug on hills are adequate for a minimum domestic supply. A few wells dug on hills are adequate for a modern domestic supply.

Salty water

Drilled wells.—Salty water may be found in wells drilled into the Breathitt formation or Lee formation in this area less than 100 feet below the level of the principal valley bottoms

CUMBERLAND MOUNTAIN SECTION

The Cumberland Mountain section consists of two parallel mountain ridges trending to the northeast. Between them lies a rugged hilly area similar in topography to the Kanawha section, but of much greater relief. Because most of the people live along streams, nearly all wells are drilled in valley bottoms. Rocks in this area generally yield ample supplies of water for domestic use

Water in alluvium

Dug wells.—Wells in the alluvium in this area are dug. Most dug wells are adequate for a minimum domestic supply. A few are adequate for a modern domestic supply

Water in post-Lee Pennsylvanian rocks (subarea 2)

Drilled wells.—More than three-quarters of the wells drilled in valley bottoms are adequate for a modern domestic supply. Nearly all wells drilled in valley bottoms are adequate for a minimum domestic supply.
About three-quarters of the wells drilled on hillsides are adequate for a modern domestic supply. Nearly all wells drilled on hillsides are adequate for a minimum domestic supply.
Nearly all wells drilled on hilltops are adequate for a minimum domestic supply. About a third of the wells drilled on hilltops are adequate for a modern domestic supply.
Wells drilled 200 feet or more below the level of the principal valley bottoms may yield enough water for small municipal or industrial supplies.
Probably few wells in this area drilled less than 300 feet below the level of the principal valley bottoms will yield salty water.
Dug wells.—Most wells dug in valley bottoms are adequate for a minimum domestic supply. A few wells dug in valley bottoms are adequate for a modern domestic supply.
About half the wells dug on hills are adequate for a minimum domestic supply. A few wells dug on hills are adequate for a modern domestic supply.
Springs.—A few springs supply sufficient quantities of water for domestic use. Almost all springs yield less than 5 gpm

Water in the Lee formation

Drilled wells.—Most wells drilled in valley bottoms are adequate for a modern domestic supply. Nearly all wells drilled in valley bottoms are adequate for a minimum domestic supply.
Nearly all the wells drilled on hillsides are adequate for a minimum domestic supply. Some wells drilled on hillsides are adequate for a modern domestic supply.
Wells drilled on hilltops yield smaller quantities of water than wells drilled on hillsides.
Wells in valley bottoms drilled through the entire thickness of the Lee formation may yield enough water for small municipal or industrial supplies.
Ground water obtained from most drilled wells in this area is soft but contains noticeable amounts of iron. Wells penetrating the full thickness of the Lee formation near the base of Pine Mountain or Cumberland Mountain probably will yield fresh water. Where the top of the Lee formation lies several hundred feet below the level of the bottoms of the principal valleys, the Lee formation may contain salty water.
Dug wells.—Most wells dug in valley bottoms are adequate for a minimum domestic supply. A few wells dug in valley bottoms are adequate for a modern domestic supply.
About half the wells dug on hills are adequate for a minimum domestic supply. A few wells dug on hills are adequate for a modern domestic supply.
Springs.—Springs supply sufficient quantities of water for domestic use. Most springs yield less than 5 gpm

Water in rocks of Mississippian and Devonian ages

Drilled wells.—Wells drilled into Mississippian rocks lying below drainage in faulted areas may yield as much as several hundred gallons per minute. Wells that are drilled through the Mississippian rocks downdip from their outcrop on Pine and Cumberland Mountains may yield large quantities of water.
Springs.—Springs from Mississippian rocks, principally limestones will yield more than 50 gpm; most, however, yield less than 10 gpm.
Devonian shales yield small amounts of water to wells or springs

Drilled well
Dug well
Drilled well yielding salty water
Spring

Pple 53/43 H A c25
Depth to water, in feet, below land surface
Type of pump
Adequacy
Yield
Depth of well, in feet, below land surface
Formation

TYPE OF PUMP

H Hand-powered pump-bucket, bailer, pitcher, or force
P Power pump
N No pump
F Flowing

ADEQUACY

A Adequate
I Inadequate

YIELD

e Estimated - from pump capacity if a well
r Reported
m Measured
50 Gallons per minute where known
600 gpd Gallons per day where known, when less than 1 gpm

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SCALE 1:250 000
4 0 4 8 12 MILES

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HYDROLOGIC INVESTIGATIONS
ATLAS HA-36 (SHEET 3 OF 3)

SYSTEM	SERIES	FORMATION	SYMBOL	SECTION	THICKNESS (IN FEET)	MINOR DIVISIONS	CHARACTER OF MINOR DIVISIONS	GENERAL CHARACTER OF FORMATIONS	TOPOGRAPHY	HYDROLOGY
QUATERNARY	Pleistocene and Recent	Alluvium	Qal		0–102	Flint Ridge flint	Flint Ridge flint Flint, unfossiliferous; in bed 10 feet thick.	Alluvium Clay, silt, fine sand, and minor amounts of medium to coarse sand and gravel.	Alluvium Forms narrow flood plains and underlies terraces. At least one well-developed terrace is present along the principal streams of the region.	Alluvium Yields more than 100 gpd to most dug wells. Screened wells yielding as much as 20 or 25 gpm may be developed along the lower sections of the Levisa and Tug Forks. Water is soft or moderately hard; may contain large amounts of iron at depth.
PENNSYLVANIAN		Breathitt formation, post-Lee Pennsylvanian rocks			0–3500±	Magoffin beds[1]	Magoffin beds Limestone, crinoidal, ranging in thickness from about 2 to 30 inches overlain by a bed of shale as much as 70 feet thick. The shale is partly calcareous, sparsely fossiliferous, and contains ellipsoidal limestone concretions that are locally extensive enough to form a continuous ledge.	Breathitt formation or undifferentiated post-Lee Pennsylvanian rocks Sandstone, siltstone, and claystone in alternating beds. Interbedded with lesser amounts of coal, clay, limestone, and chert. Sandstones are gray and are characterized by an abundance of minerals of the clay-mica type and rock fragments. In the upper part of the formation, the sandstones are feldspathic. Sandstones, siltstones, and claystones contain plant fragments. Siltstones are gray and micaceous; claystones are dark and light gray and contain ironstone at many places. Clays commonly underlie coal beds. Calcareous rocks make up a very small part of the formation, but several zones contain large siltstone or sandstone concretions cemented with calcareous material, and at least one limestone, the magoffin member, is widespread.	Breathitt formation or undifferentiated post-Lee Pennsylvanian rocks The Breathitt formation underlies the valleys and forms the hills of almost all the area northwest of Pine Mountain. Undifferentiated post-Lee Pennsylvanian rocks underlie the narrow valleys and form high, rugged hills southeast of Pine Mountain in Letcher and Harlan Counties. Black Mountain, 4,139 feet, the highest point in the State, is carved from undifferentiated post-Lee Pennsylvanian rock, in Harlan County.	Breathitt formation or undifferentiated post-Lee Pennsylvanian rocks In western Perry, most of Breathitt, northern Magoffin and northern Martin Counties yields more than 500 gpd to most wells drilled in valley bottoms. Yields more than 500 gpd to almost half the wells drilled on hillsides and smaller quantities of water to wells on hilltops. In remainder of area yields more than 500 gpd to more than three-quarters of the wells drilled in valley bottoms. Yields more than 500 gpd to about three-quarters of the wells drilled on hillsides. Yields more than 100 gpd to nearly all wells on ridges. Sandstone yields water to most wells. Shale also yields water to many wells, and coal yields water to a few. Near-vertical joints and openings along bedding planes yield most of the water to wells. Chemical character of ground water ranges widely. Shallow ground waters in the northern part of the area may be salty.
			IPbt			Fire Clay coal	Fire clay coal Coal containing a dark brown or olive gray flint clay parting, with conchoidal fracture. The parting generally occurs in the lower part of the coal, and is from 1 to 8 inches thick.			
			IPple			Kendrick shale[2]	Kendrick shale Shale, dark gray, calcareous; contains ironstone bands or nodules and large ellipsoidal concretions of silty limestone. Marine fossils occur in the base of the shale and in the limestone nodules. Averages about 25 feet in thickness.			
		Lee formation	IPle		270–1800±		Lee formation Sandstone, conglomeratic near top and bottom of formation, separated by claystones, siltstones, and a few thin coals. The sandstones are quartzose, massive, and crossbedded.	Lee formation Resistant sandstones form the high ridges of Pine and Cumberland Mountains in Harlan, Letcher, and Pike Counties. Underlies valleys in northwestern Breathitt County. Forms steep-walled valleys in a small area in northeastern Magoffin County.	Lee formation In Breathitt and Magoffin Counties yields more than 500 gpd to most wells in valley bottoms. Yields more than 500 gpd to almost half the wells drilled on hillsides, and more than 100 gpd to almost three-quarters of the wells on hilltops. In the Cumberland Mountain section yields more than 500 gpd to about three-quarters of the wells drilled in valley bottoms. Yields more than 500 gpd to about half the wells drilled on hillsides, and smaller quantities of water to wells on hilltops. Some wells flow. Yields water almost exclusively from sandstones, but shales supply water to a few wells. The highest yielding wells obtain water from near-vertical joints and openings along bedding planes. Intergranular pore spaces yield water slowly to joints and to wells intersecting poorly cemented zones. Yields soft or moderately hard water containing noticeable amounts of iron to most wells and salty water to very few wells.
MISSISSIPPIAN	Upper Mississippian	Pennington shale			168–1000±		Pennington shale Shale, gray, reddish and greenish, and greenish, fine-grained, thin-bedded sandstone. Includes a persistent bed of hard siliceous sandstone as much as 100 feet thick.	Pennington shale Forms moderate slopes along the face of Pine Mountain. Hard bed of sandstone within formation forms small cliff or ledge.	Pennington shale Yields little or no water to wells.	
		Glen Dean limestone Limestone of early Chester age Ste. Genevieve limestone St. Louis limestone Spergen limestone[3] Warsaw limestone	MDu		288–900±		Upper Mississippian limestones Limestone, light gray to tan, oolitic, especially in lower half; cherty near base; thick-bedded in lower half, thin-bedded in upper.	Upper Mississippian limestones Forms cliffs and steep slopes at and just below the crest of Pine Mountain.	Upper Mississippian limestones Yields as much as 50 or 100 gpm (gallons per minute) to springs in limestone.	
	Lower Mississippian	Price and Maccrady formations			151–500±		Price and Maccrady formations Shale, gray and greenish; in lower portion, predominantly reddish in upper part. May include brownish sandstone, or reddish sandstone within the uppermost 50 feet.	Price and Maccrady formations Forms moderate slopes along front of Pine Mountain.	Price and Maccrady formations May yield more than 500 gpd (gallons per day) to wells near the foot of Pine Mountain, but wells drilled into the formation throughout most of its outcrop area will yield little or no water.	
DEVONIAN		Chattanooga shale			300–700±		Chattanooga shale Shale, black, fissile.	Chattanooga shale Forms moderate slopes along base of Pine Mountain.	Chattanooga shale Yields essentially no water to wells.	

[1] Of Morse (1931)
[2] Of Jillson (1919)
[3] As used by Stockdale (1939)

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GENERALIZED COLUMNAR SECTION IN BREATHITT, FLOYD, HARLAN, KNOTT, LETCHER, MARTIN, MAGOFFIN, PERRY, AND PIKE COUNTIES, KENTUCKY

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