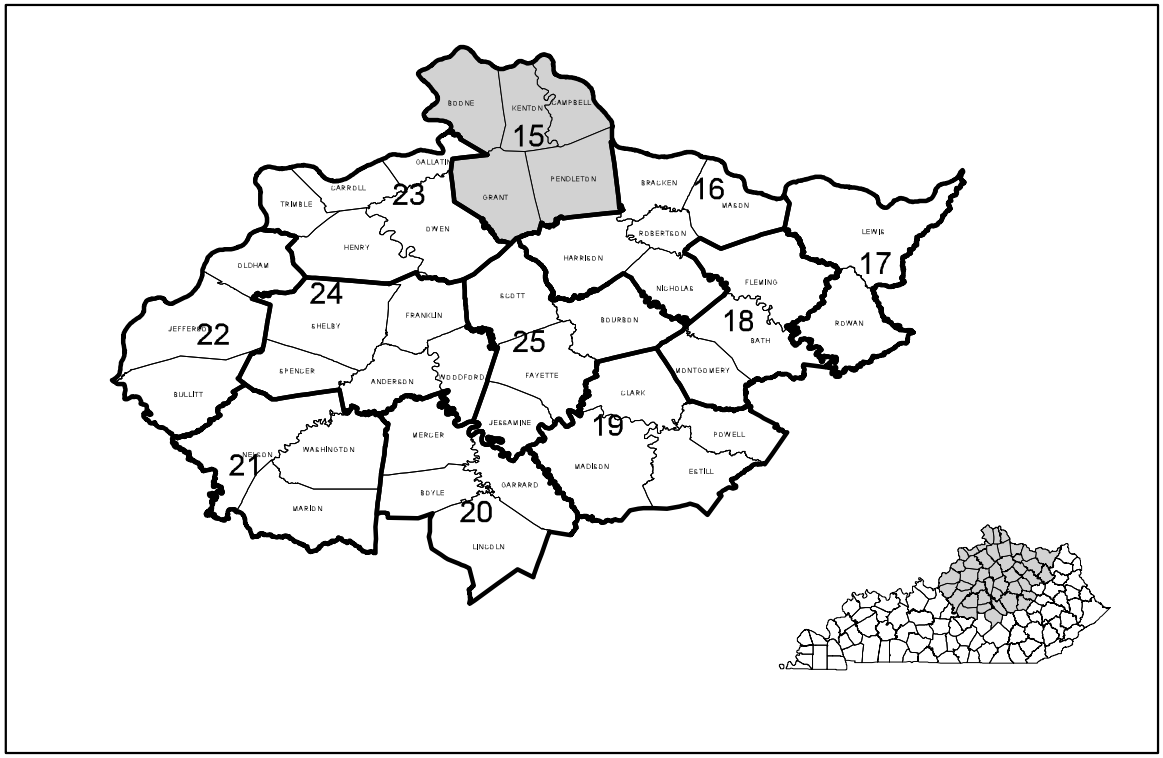
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

AVAILABILITY OF GROUND WATER IN BOONE, CAMPBELL, GRANT, KENTON, AND PENDLETON COUNTIES, KENTUCKY

By
W.N. Palmquist, Jr., and F.R. Hall

HYDROLOGIC INVESTIGATIONS
ATLAS HA-15



INDEX MAP OF THE BLUE GRASS REGION, KENTUCKY, SHOWING COUNTY GROUPS AND AREA OF THIS ATLAS

This is 1 of 11 atlases (HA-15 to HA-25) showing geology and availability of ground water in the Blue Grass region, Kentucky U.S. Geological Survey Water-Supply Paper 1533 contains a text description and illustrations providing further information on the occurrence and quality of ground water in the Blue Grass region.

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1960

GEOLOGIC MAP OF BOONE, CAMPBELL, GRANT, KENTON, AND PENDLETON COUNTIES, KENTUCKY (COUNTY GROUP 15)

Scale 1:125 000

1 0 1 2 3 4 5 6 7 8 9 10 Miles

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EXPLANATION

Pleistocene and Recent	Qal	Alluvium	QUATERNARY
Pliocene or Pleistocene	QTi	Irvine(?) formation	TERTIARY OR QUATERNARY
Upper Ordovician	Om	Maysville group	ORDOVICIAN
	Oe	Eden group	
Middle Ordovician	Ocy	Cynthiana formation	
	Ol	Lexington group	

Contact

Geology adapted from the following:

Geologic map of Boone County: Kentucky Geol. Survey, ser. 6, 1931. Map, 1:62 500, W. H. Shideler.
Map of areal and structural geology of Campbell County: Kentucky Geol. Survey, ser. 6, 1931. Map, 1:62 500, W. H. Shideler.
Map of areal and structural geology of Grant County: Kentucky Geol. Survey, ser. 6, 1931. Map, 1:62 500, M. S. Chappars and F. S. Withers.
Map of areal and structural geology of Kenton County: Kentucky Geol. Survey, ser. 6, 1931. Map, 1:62 500, W. H. Shideler.
Map of areal and structural geology of Pendleton County: Kentucky Geol. Survey, ser. 6, 1931. Map, 1:62 500, P. H. Dunn and F. S. Withers

Base from general county highway maps of Kentucky, 1950, Kentucky State Highway Department, State-wide Planning Survey

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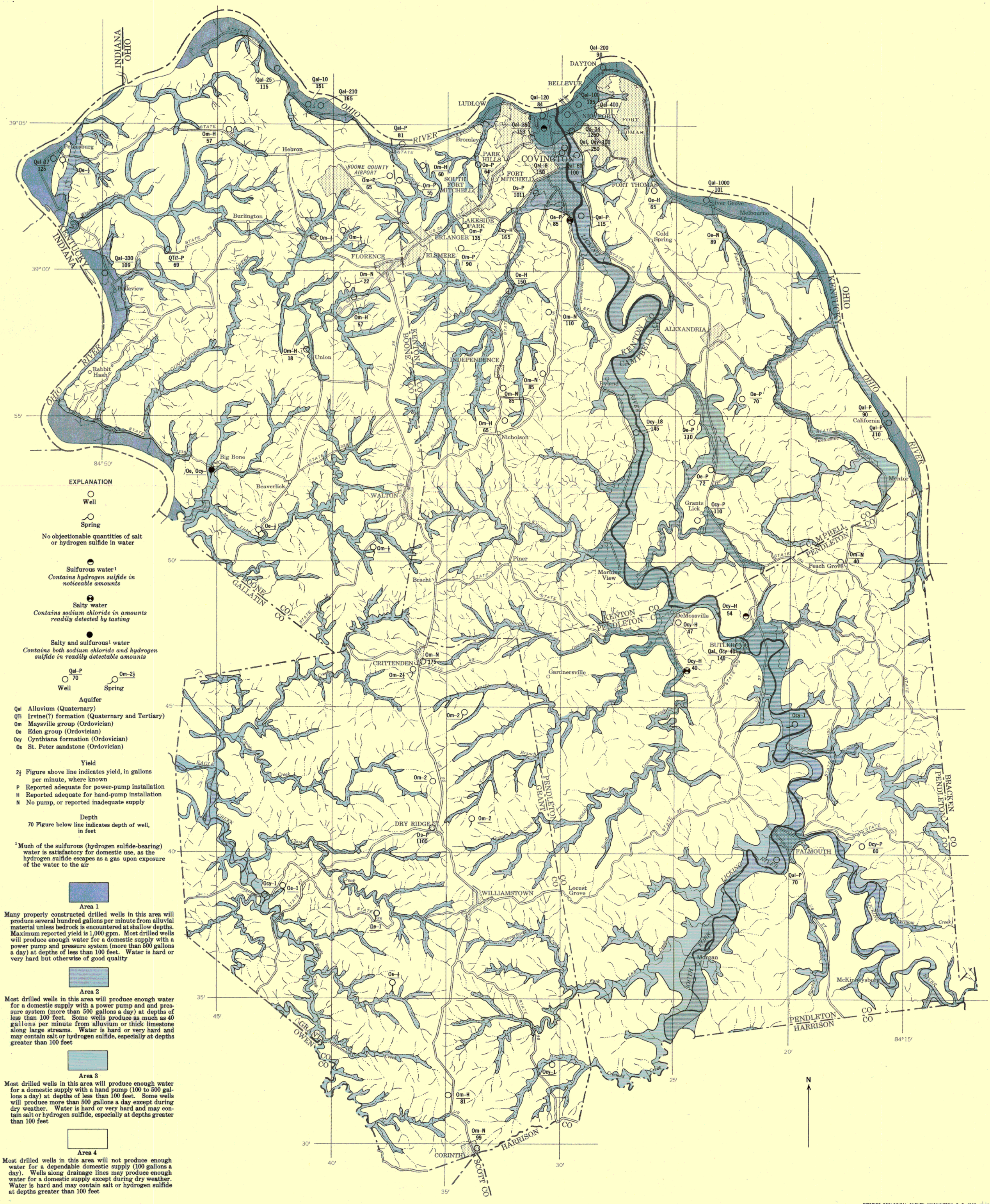
HYDROLOGIC INVESTIGATIONS
ATLAS HA-15 (SHEET 2 OF 3)



EXPLANATION

Well

Spring

No objectionable quantities of salt or hydrogen sulfide in water

Sulfurous water[1]
Contains hydrogen sulfide in noticeable amounts

Salty water
Contains sodium chloride in amounts readily detected by tasting

Salty and sulfurous[1] water
Contains both sodium chloride and hydrogen sulfide in readily detectable amounts

Qal–P / 70 — Well
Om–2½ — Spring

Aquifer

- Qal Alluvium (Quaternary)
- QTi Irvine(?) formation (Quaternary and Tertiary)
- Om Maysville group (Ordovician)
- Oe Eden group (Ordovician)
- Ocy Cynthiana formation (Ordovician)
- Os St. Peter sandstone (Ordovician)

Yield

- 2½ Figure above line indicates yield, in gallons per minute, where known
- P Reported adequate for power-pump installation
- H Reported adequate for hand-pump installation
- N No pump, or reported inadequate supply

Depth

70 Figure below line indicates depth of well, in feet

[1]Much of the sulfurous (hydrogen sulfide-bearing) water is satisfactory for domestic use, as the hydrogen sulfide escapes as a gas upon exposure of the water to the air

Area 1

Many properly constructed drilled wells in this area will produce several hundred gallons per minute from alluvial material unless bedrock is encountered at shallow depths. Maximum reported yield is 1,000 gpm. Most drilled wells will produce enough water for a domestic supply with a power pump and pressure system (more than 500 gallons a day) at depths of less than 100 feet. Water is hard or very hard but otherwise of good quality

Area 2

Most drilled wells in this area will produce enough water for a domestic supply with a power pump and and pressure system (more than 500 gallons a day) at depths of less than 100 feet. Some wells produce as much as 40 gallons per minute from alluvium or thick limestone along large streams. Water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet

Area 3

Most drilled wells in this area will produce enough water for a domestic supply with a hand pump (100 to 500 gallons a day) at depths of less than 100 feet. Some wells will produce more than 500 gallons a day except during dry weather. Water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet

Area 4

Most drilled wells in this area will not produce enough water for a dependable domestic supply (100 gallons a day). Wells along drainage lines may produce enough water for a domestic supply except during dry weather. Water is hard and may contain salt or hydrogen sulfide at depths greater than 100 feet

AVAILABILITY OF GROUND WATER IN BOONE, CAMPBELL, GRANT, KENTON, AND PENDLETON COUNTIES, KENTUCKY (COUNTY GROUP 15)

Scale 1:125 000

1 0 1 2 3 4 5 6 7 8 9 10 Miles

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HYDROLOGIC INVESTIGATIONS
ATLAS HA-15 (SHEET 3 OF 3)

SYSTEM	SERIES	GROUP	FORMATION	THICKNESS, IN FEET	SECTION	LITHOLOGY	TOPOGRAPHY	HYDROLOGY
QUATERNARY	PLEISTOCENE AND RECENT		ALLUVIUM	0-170		Clay, silt, sand, and gravel; average thickness less than 130 feet. Silt and fine sand grade downward to medium and coarse sand and gravel at Silver Grove, Campbell County. Silt, fine sand, and clay grade downward to coarse sand and 10 feet or more of gravel that rests on bedrock in the Covington-Newport area. Some fine-grained material may be in upper part in Boone County, but in many places alluvium is entirely sand and gravel. Mainly silt and fine sand and some coarser material, as much as 95 feet thick, in the Licking River valley but thinner upstream; thin and fine grained in most places in the tributaries.	Flood plains and terraces of the Ohio and Licking River valleys. Highest terraces are about 100 feet above normal pool level of the Ohio River. Flood plains and small terraces along tributaries.	Yields moderate to large quantities of water to drilled wells in the Ohio River valley, according to thickness and texture of the valley fill and type of well; yields 200 to 500 gpm (gallons per minute) to ordinary tubular wells and as much as 1,000 gpm to gravel-packed wells. Yields more than 3 million gpd (gallons per day) during the summer in the Covington-Newport area of the valley; yields little water from fine-grained material. Yields small to moderate amounts of water to drilled wells in the Licking River valley; most wells yield more than 500 gpd. Water is hard and near the valley walls of the Ohio and Licking may have a high iron content. Wells that penetrate the alluvium and enter bedrock obtain little additional water, and this water may contain objectionable amounts of salt or hydrogen sulfide.
TERTIARY (?) QUATERNARY	PLIOCENE(?) AND PLEISTOCENE		IRVINE(?) FORMATION	0-50±		Glacial sand and conglomerate and upland sand deposits which may be old river deposits of Pliocene age. Glacial conglomerate consists of about 50 feet of cemented well-rounded limestone pebbles and gravel with interlayered sand lenses in Boone and Campbell Counties. Glacial sand, about 20 feet thick, consists of fine- to medium-grained sand and some coarser material, calcareous in some places.	Fills of old stream channels in Boone and Campbell Counties. Upland surfaces and hillsides have typical surface expression.	Yields 100 to 500 gpd to drilled wells that penetrate thick sandy parts of the channel fill of cemented conglomerate and interlayered sand. Water is moderately hard. Glacial sand on uplands yields soft water to small springs and dug wells.
ORDOVICIAN	UPPER ORDOVICIAN	MAYSVILLE	MC MILLAN FORMATION	90-100		Thin- to medium-bedded argillaceous, in places rubbly, limestone with much interbedded, lumpy, and unevenly bedded bluish to gray calcareous shale. Thin limestone with shale partings in lower part (Bellevue limestone member).	Gently to moderately rolling upland away from major streams such as the Ohio and Licking Rivers. Moderately dissected upland where shale is predominant. Steep dissected slopes along large streams. Ledges of thick limestone beds on steep hillsides and bluffs along streams. Broad, flat valleys on upland where thick limestone beds are present; may have small sinkholes with minor underground drainage. Low hills on upland also may be capped by thick limestone beds. Flat ridges between steep-sided valleys cut into underlying shale of Eden group are capped by lower part of Maysville group.	Yields 100 to 500 gpd to drilled wells in valley bottoms and along streams on upland; yield no water to drilled wells on hillsides or ridgetops, but may yield some water to dug wells on ridgetops; yield water to small springs; yield little water from sandy zone near the base in Grant and Pendleton Counties. Water is hard and in valley bottoms may contain salt or hydrogen sulfide. The relatively impermeable shale prevents circulation of large quantities of ground water in joint and bedding-plane openings of relatively soluble underlying limestone. As a result, the limestone beds have few solutionally enlarged openings, and little water is available to wells and springs. However, near the base of the McMillan there is 25 feet or more of limestone with small amounts of shale (Bellevue limestone member). Where this limestone occurs at and below stream level in valley bottoms or along streams on the upland, fractures and bedding-plane openings have been enlarged by solution; many small springs flow from outcrops, and some drilled wells along streams yield more than 500 gpd.
			FAIRVIEW FORMATION	95-140		Alternating beds of limestone and shale. Limestone is gray and locally rubbly. Shale is lumpy, bluish to gray, and calcareous. Some thin beds of fine-grained sandstone or siltstone at the base in Pendleton and Grant Counties.		
		EDEN		220±		Lumpy blue calcareous shale and mudstone with thin, evenly bedded argillaceous limestone layers that are more common toward the base. Almost entirely shale in many places, but may be as much as one-half limestone in others. Arenaceous limestone and shale beds grade to fine-grained sandstone or siltstone beds in upper part in Grant and Pendleton Counties; these beds are the Garrard sandstone.	Rugged, dissected topography of long, narrow, steep-sided ridges between narrow, winding, V-shaped valleys with dendritic drainage pattern. Steep slopes covered with thin limestone slabs where shale eroded and washed away easily. Broad, flat valleys where underlying Cynthiana formation extends into Eden shale belt. Contrast with rolling uplands of outcrop area of Maysville group is striking except along large streams, where effect is masked by dissection.	Yields 100 to 500 gpd to drilled wells in broad valley bottoms; yields almost no water to drilled wells on hillsides or ridgetops, but may yield some water to dug wells on ridgetops; yields water to small springs and seeps; yields little water from well-cemented sandy zone near the top in Grant and Pendleton Counties. Water is hard and in valley bottoms may contain salt or hydrogen sulfide. Shale has small, poorly connected openings, and ground-water circulation is slow; little water is available to wells, and quality may be poor. The few thick limestone beds may yield water to small springs. On ridgetops, shale impedes downward percolation of water and supports water in lower part of soil and in weathered-rock zone just beneath soil. High up on the sides of many ridges is a zone of seeps and small springs; where the Maysville group caps the ridges, the zone is generally near or at the contact with the Eden group. Drilled wells on these ridges obtain a little water at the contact between soil and bedrock, but rarely at greater depths; if water is found at depth, it is mainly in small quantities and of poor quality. Dug wells, with large wall areas, are better suited for obtaining water from these bodies of water; however, many go dry in late summer and fall.
	MIDDLE ORDOVICIAN	LEXINGTON	CYNTHIANA FORMATION	120±		Thick, irregularly bedded crystalline limestone with interbedded thin shale. Very shaly in upper part; grades downward to limestone with small amount of shale.	Broad, flat valley bottoms along large streams in all counties; low hills in southern part of area.	Yields more than 500 gpd to drilled wells in broad valley bottoms. Water is hard and may contain salt or hydrogen sulfide. Fracture and bedding-plane openings in valley bottoms have been enlarged by circulating ground water. Some wide, flat areas have small sinkholes and some underground drainage.
				20		Thin- to thick-bedded fine- to coarse-grained limestone with some thin interbedded shale.	Valley bottoms along the Licking River is southeastern Pendleton County.	Yields more than 500 gpd to wells in valley bottoms. Water is hard and may contain salt or hydrogen sulfide.

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GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTER OF THE ROCKS IN BOONE, CAMPBELL, GRANT, KENTON, AND PENDLETON COUNTIES, KENTUCKY (COUNTY GROUP 15)

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ATLAS HA-15 (SHEET 3 OF 3)