PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF KENTUCKY, UNIVERSITY OF KENTUCKY
KENTUCKY GEOLOGICAL SURVEY
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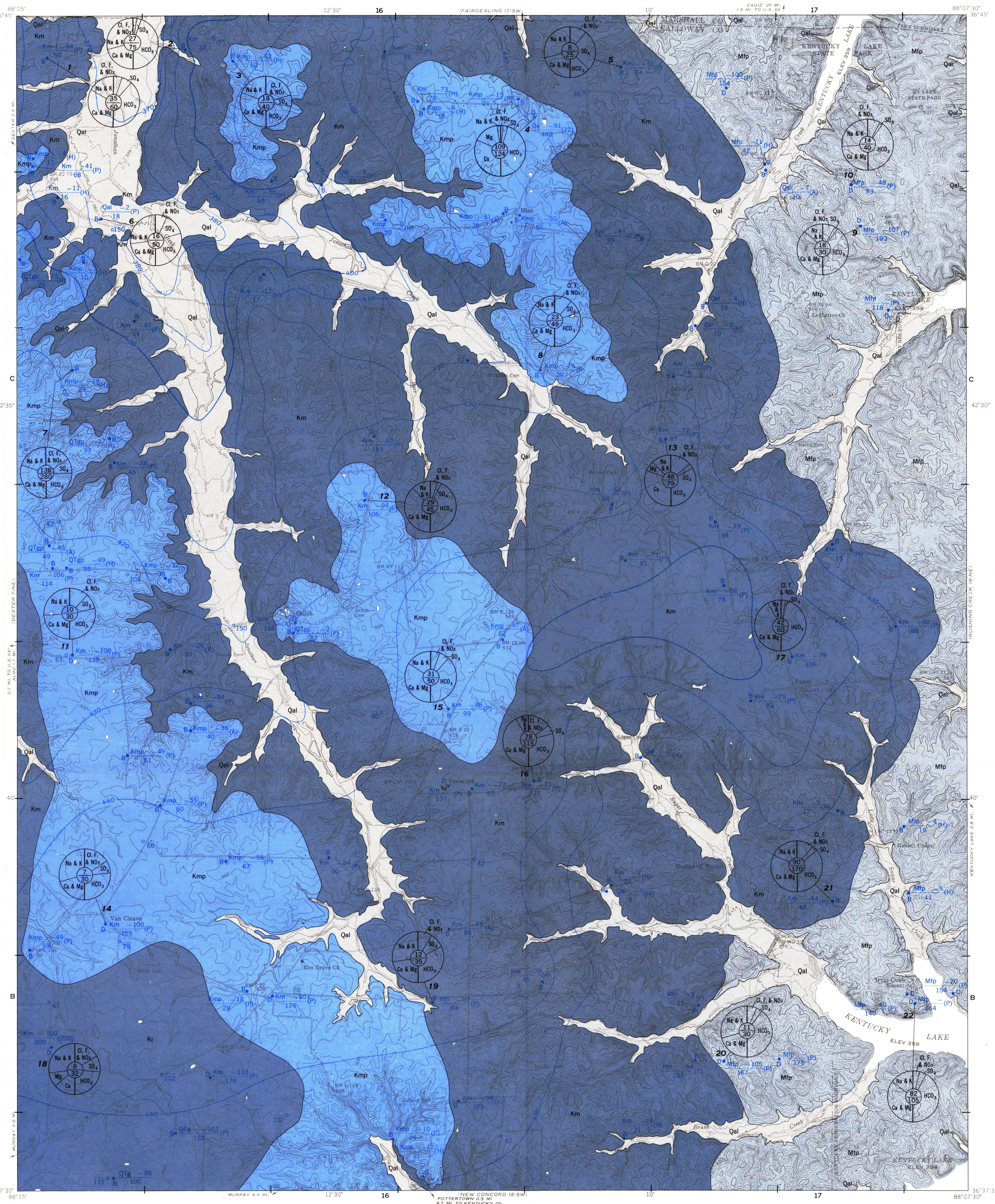
SYSTEM	SERIES	GROUP	FORMATION	SECTION	THICKNESS, IN FEET	LITHOLOGY	TOPOGRAPHY AND GEOLOGIC SETTING	HYDROLOGY
QUATERNARY	Pleistocene and Recent		Alluvium		0–20′	Medium- to dark-gray silt, sand, clay, and gravel; intermixed and interbedded.	Flood-plain deposits in the valley floors of the regional drainage system. The alluvium beneath the flood plain of Jonathan Creek is as thick as 20 feet but thins to less than 10 feet in many smaller tributary valleys.	Water-bearing in availability area 1. Yields adequate domestic supplies (500 gallons per day) to large-diameter dug or bored wells commonly less than 10 feet deep. The stream valleys intersect the main zone of saturation in underlying formations and the alluvium is saturated throughout the year. Wells could be deepened into the underlying water-bearing materials and obtain larger yields. A chemical analysis of one sample of water in alluvium showed the water to be soft and to contain 0.28 part per million of iron.
QUATERNARY	Pleistocene		Loess		0–10′	Yellowish-brown to gray noncalcareous unstratified silt; may be reworked with gravel at base.	Windborne deposits which mantle the uplands and drape down hillsides. As thick as 10 feet in the uplands; eroded or removed in places.	Yields little or no water to wells. Probably transmits some rainfall to underlying aquifers.
QUATERNARY / TERTIARY	Pleistocene / Pliocene(?)		Gravel and sand [1]		0–100′	Red to brown subangular to subrounded iron-stained chert pebbles, cobbles, and some boulders with a few quartz pebbles and poorly sorted generally crossbedded sand lenses. Boulders commonly in buried stream channels. Thin discontinuous beds of light-gray silty clay in places. Some iron-cemented gravel in buried channels.	Stream-laid deposits which blanket the uplands and fill deep channels in the west-central and south western parts of the quadrangle. Generally less than 50 feet thick in upland but as thick as 100 feet in buried channels. Exposed in hillsides, roadcuts, and tributary valley walls. The Pliocene(?) gravel rests unconformably on sediments of Cretaceous age.	Water bearing in places in availability area 2 where ground water is perched above cemented gravel, generally in buried channels, and where clay underlies the gravel in local areas. Although large-diameter bored or dug wells generally obtain adequate domestic supplies of water perched in gravel, only small amounts may be available in some places. In the southwestern part of the quadrangle in availability area 3, buried channels intersect the main zone of saturation and large supplies of ground water are available in the gravel. The water is commonly soft and contains only minor amounts of iron.
CRETACEOUS	Upper Cretaceous		McNairy Formation [2]		0–300′	Light-gray to red generally fine- to medium-grained but locally coarse-grained and crossbedded micaceous sand containing a few heavy minerals, and some light-gray to black silty and sandy lignitic clay. Sand is partially cemented in places; clay is generally in discontinuous beds ranging in thickness from fine laminae to beds as thick as 45 feet. Marcasite or pyrite commonly below clay beds and lignite occurs in thin beds in some parts of the formation. Gravelly or silty in lower part.	Deltaic deposits underlying the Pliocene(?) gravel and exposed in many places in the quadrangle. The formation thickens from only a few feet in the extreme eastern part of the quadrangle to as much as 300 feet in the western part. The McNairy Formation rests unconformably on an eroded Paleozoic rock surface except where possibly separated by the Tuscaloosa Formation.	Water bearing in availablity areas 1, 2, and 3. Yields a plentiful supply of water, as great as 250 gallons per minute to one drilled well in the main zone of saturation. The amount of perched water in the McNairy Formation, present in availabilty area 2 above beds of clay, is evidently adequate for domestic supplies. The shallow wells in availability area 2 tap the perched water; deeper wells reach the underlying main zone of saturation. Enough water is available in the main zone of saturation to fulfill the requirements of many industries. The water ranges in hardness from very soft to moderately hard and may contain iron in excess of 0.3 part per million in a few places. An iron content of more than 0.3 part per million, considered to be the objectionable limit, imparts a disagreeable taste to water and may cause staining of clothing and utensils.
CRETACEOUS	Upper Cretaceous		Tuscaloosa Formation		?	White well-rounded chert pebbles and cobbles in a tripolitic and sandy matrix.	Stream-laid deposits which fill channels and depressions in the eroded Paleozoic rock surface. Although not exposed in this quadrangle, the formation may be present in the subsurface in some places.	Probably will yield an adequate domestic supply if present in the quadrangle. The tripolitic matrix of the formation may clog well screens. The water may be hard and contain an objectionable amount of iron.
CARBONIFEROUS MISSISSIPPIAN	Meramec		Warsaw Limestone		30′±	All rocks below the Cretaceous are of Paleozoic age and are the bedrock of well drillers. Medium-gray very fossiliferous and porous chert containing bryozoa and crinoid stems in exposure. Probably grades downward into a fossiliferous cherty limestone in subsurface.	Consolidated marine sediments now weathered and leached to a chert rubble where exposed. The Warsaw Limestone crops out in the east valley wall of the easternmost tributary to Anderson Creek and in the valley wall of a small tributary to Kentucky Lake in the southeast corner of the quadrangle.	Not significant as an aquifer in this quadrangle. The Warsaw Limestone occurs above the main zone of saturation.
CARBONIFEROUS MISSISSIPPIAN	Osage		Fort Payne Formation [3]		0–150′	Medium- to dark-gray chert rubble in a tripolitic matrix with interbedded medium-gray residual clay in exposure. Grades downward into black or dark-gray siliceous limestone and interbedded chert. Glauconitic shale in basal part.	Marine deposits underlying the McNairy Formation in much of the quadrangle and exposed as badly leached and weathered chert rubble in several stream valleys near Kentucky Lake. The formation, thinned by the pre-Cretaceous erosion to the west, is probably absent in the western part of the quadrangle where the Chattanooga Shale is in contact with the overlying Cretaceous sediments (fig. 3).	Water bearing in the eastern half of the quadrangle at depths ranging from only a few feet near Kentucky Lake to about 300 feet or more in some central parts of the quadrangle. Yields adequate domestic supplies to shallow large-diameter bored or dug wells in water-bearing chert rubble and to small-diameter drilled wells tapping water-filled crevices in deeper limestone. The water is generally soft but contains objectionable amounts of iron which may require iron-removal treatment in some places.
DEVONIAN	Upper Devonian		Chattanooga Shale		0–130′	Black micaceous and siliceous shale, partially indurated. Where the shale is in contact with the overlying Cretaceous sediments, it may be highly weathered.	Shales underlying the rocks of Mississippian age except in the western part of the quadrangle where the Mississippian rocks have been removed by pre-Cretaceous erosion. Absent in some extreme western parts of quadrangle (fig. 3).	Not significant as an aquifer. Confines ground water in the underlying Devonian rocks.
DEVONIAN	Lower and Middle Devonian		Devonian rocks		1000′±	White to gray finely to coarsely crystalline limestone and dolomite, siliceous and silty in zones, and white to dark-gray thin to thick interbedded slightly calcareous chert, in part dolomoldic.	Consolidated marine sediments present in the entire quadrangle. The Devonian rocks underlie the Chattanooga Shale except where they may be in contact with the overlying Cretaceous sediments in the extreme westernmost parts of the quadrangle. The rock, probably fractured and cavernous limestone in much of the area, may have been weathered and leached to a chert rubble where it is in contact with the Cretaceous sediments.	Water bearing in the entire quadrangle at depths ranging from about 400 feet in the eastern part to about 300 feet in the western part. The water fills crevices and solution openings in the limestone and rises in the wells to altitudes of about 420 feet. Wells drilled from land surfaces lower than 420 feet in altitude into the Devonian rocks may flow. The one well tapping the Devonian aquifers in this quadrangle is pumped at a rate of 750 gallons per hour. The water from this well is moderately hard and contains an objectionable concentration of iron.

[1] Age undetermined. Estimates of age range from Pliocene or older to Pleistocene.

[2] May contain beds of Clayton age at top

[3] Basal part of Fort Payne Formation includes the New Providence Shale

FIGURE 2.—GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTER OF THE GEOLOGIC FORMATIONS



Base by Tennessee Valley Authority and U.S. Geological Survey, 1955

The Carter Coordinate System letters and numbers used to designate five-minute divisions of latitude and longitude are shown along the margins; tick marks indicate one-minute divisions

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1965

FIGURE 1.—MAP SHOWING AVAILABILITY OF GROUND WATER, LOCATION OF WELLS, AND QUALITY OF WATER

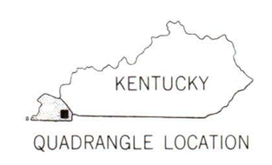
Hydrology by J. H. Morgan, 1963

SCALE 1:24 000

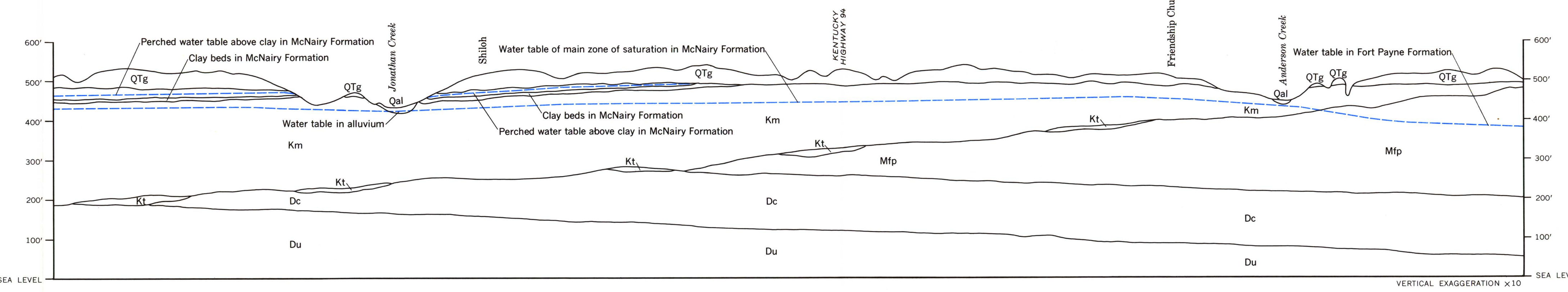
1 ½ 0 1 MILE

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL



QUADRANGLE LOCATION



Qal .... Alluvium of Quaternary age
QTg .... Gravel and sand of Pliocene(?) age
Km .... McNairy Formation of Cretaceous age
Kt .... Tuscaloosa Formation of Cretaceous age
Mfp .... Fort Payne Formation of Mississippian age
Dc .... Chattanooga Shale of Devonian age
Du .... Devonian rocks, undifferentiated

FIGURE 3.—GENERALIZED GEOLOGIC SECTION ALONG A NORTHEAST-TRENDING LINE THROUGH JONATHAN CREEK, SHILOH, AND ANDERSON CREEK

EXPLANATION

The water-availability areas on this map show the occurrence and availability of ground water in the shallowest aquifer that may yield adequate amounts of water for domestic supply. As considered in this report an adequate domestic supply will furnish approximately 500 gallons per day from a well equipped with a power pump and pressure-distribution system. The shallowest aquifer is underlain by deeper aquifers whose depths and water-bearig properties are described in the generalized columnar section, figure 2

Qal

AREA 1
Water in Quaternary alluvium

The alluvium is water bearing in area 1 at depths commonly less than 5 feet. The stream valleys intersect the underlying main zone of saturation and the alluvium is saturated throughout the year. Several small springs and seeps flow perennially in the valley floor of Jonathan Creek due to shallow water discharging along the valley wall. Large-diameter bored or dug wells, some as deep as 20 feet in alluvium, yield adequate domestic supplies of ground water. Wells in alluvium could be deepened into underlying saturated sediments to obtain larger yields

Kmp

AREA 2
Perched water in the McNairy Formation

Shallow ground water, commonly less than 50 feet deep, is perched in the McNairy Formation in area 2 above either cemented gravel or beds of clay. Where tributary valleys are eroded sufficiently deep, the perched water is only a few feet below the land surface. South of Independence School in the western part of the quadrangle, partially cemented Pliocene(?) gravel fills an old east-west channel and perches water there at a depth of about 50 feet; where clay in the McNairy Formation is in direct contact with overlying Pliocene(?) gravel, perched water is commonly present in the gravel. Large-diameter bored or dug wells tapping the perched water range in depth from about 10 feet to 60 feet, and although these wells generally obtain adequate amounts of water for domestic supplies, only small quantities of water may be available in some places. Larger supplies can be obtained from the underlying main zone of saturation in the McNairy Formation; the depth can be determined from either the water-level contours or from the well data for the deeper wells in this area

Km

AREA 3
Water in the McNairy Formation

The McNairy Formation, predominately sand in this quadrangle, contains large quantities of ground water in the main zone of saturation which is the shallowest source for a dependable water supply in area 3. The ground water ranges in depth from only a few feet below the land surface in many stream valleys to more than 100 feet beneath the upland. Deep channels, filled with Pliocene(?) gravel and as deep as 100 feet, intersect the main zone of saturation in the southwest corner of the quadrangle and are saturated in the lower few feet. Large-diameter bored or dug wells penetrating only a few feet of the saturated zone yield adequate domestic supplies but could be deepened to obtain larger yields. Small-diameter drilled wells, as deep as 200 feet, penetrate deeply into the main zone of saturation and obtain water through well screens placed in coarse sand. Yields as great as 250 gallons per minute are obtained from properly constructed wells in the main zone of saturation

Mfp

AREA 4
Water in the Fort Payne Formation

The Fort Payne Formation, the shallowest source for a dependable ground-water supply in area 4, is water bearing at depths ranging from less than 10 feet in many stream valleys to more than 100 feet in higher areas between valleys. Small-diameter drilled wells, as deep as 190 feet, intersect water-filled crevices in the rock and are capable of obtaining large yields. Adequate domestic supplies can be obtained from large-diameter bored or dug wells where chert rubble underlies the stream valleys and ground water is at shallow depths. Small amounts of water may be available in the McNairy Formation in places in this area where sand is underlain by clay or other impermeable materials at the contact with underlying rock

Area boundary

o67
Test hole
Figure below line is depth of test hole

•D
Water Well
D, *Drilled well, generally steel casing with well screen on lower end*
B, *Bored or dug well, generally 24-inch concrete casing open at the bottom*

Km −100 (250) / 200
Aquifer (see below)
Water level in well, in feet below land surface
Yields in gallons per minute, or adequacy (see below)
Depth of well, in feet below land surface

AQUIFER SYMBOLS

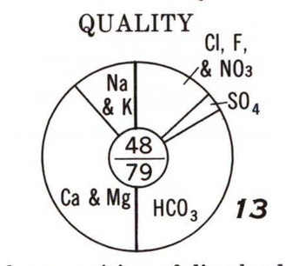
Qal .... Alluvium of Quaternary age
QTgp .... Perched water in gravel and sand of Pliocene(?) age
QTg .... Gravel and sand of Pliocene(?) age
Kmp .... Perched water in McNairy Formation of Cretaceous age
Km .... McNairy Formation of Cretaceous age
Mfp .... Fort Payne Formation of Mississippian age
Du .... Devonian limestone, undifferentiated

YIELD OR ADEQUACY

(250) .... Gallons per minute where known
(P) .... Well reported adequate for power pump for domestic and/or stock supply
(H) .... Well reported adequate for hand pump or bailer
(A) .... Abandoned

450
Water-level contour
Shows altitude of water level in the main zone of saturation. Contour interval 10 feet; datum is mean sea level. Depth to water is difference in feet between altitude of water-level contour and land surface. Water-level measurements taken in April 1963

QUALITY



Chemical composition of dissolved solids
Figure between circular diagram and well symbol refers to analysis number in table at end of text. Figure above line at center of circular diagram is carbonate hardness (calcium magnesium hardness, as $CaCO_3$) in parts per million; figure below line is dissolved solids in parts per million. Hardness of water is classified by the U.S. Geological Survey as follows: 0–60 ppm, soft; 61–120 ppm, moderately hard; 121–180 ppm, hard; 181 ppm or more, very hard. Dissolved solids in partial analyses are computed from specific conductances and are only approximate values. Areas of the segments of each circle are proportional to the mineral component in the dissolved solids in the water. Percentages are computed from equivalents per million of the anions and cations. Calcium and magnesium are shown as one segment in partial analyses

AVAILABILITY OF GROUND WATER IN THE HICO QUADRANGLE, KENTUCKY

An abundance of ground water for domestic supplies is available in the Jackson Purchase region in western Kentucky. The increasing demand for water in the expanding economy of the region requires that special consideration be given to these water resources. This report, one of a series that includes the entire Jackson Purchase region, provides detailed information concerning the ground water in the Hico quadrangle.

The occurrence of the shallowest water-bearing formation (aquifer) that may yield an adequate domestic supply of ground water is shown on the water-availability map (fig. 1). A large body of ground water underlies the entire quadrangle in the main zone of saturation, that part of the geologic formations completely saturated with water. In a few places, discontinuous beds of clay and cemented gravel above the main zone of saturation retard descending water above them. These small bodies of shallow ground water above the deeper saturated zone, here called "perched water," are usually large enough to sustain withdrawals for domestic use although in a few places only small amounts of water may be available.

As an example of how the map may be used to predict water conditions, the color pattern for area 2 at Hico in the north-central part of the quadrangle (see explanation on map) indicates that shallow ground water is perched above beds of clay. The explanation states that large-diameter bored or dug wells tapping the perched water generally yield adequate amounts of water for a domestic supply, and that the area is underlain by a large body of ground water in the main zone of saturation. The depth to the shallower perched water is shown by the well data at Hico; the depth to the underlying main zone is the difference in feet between the altitude of the land surface and the water-level contours, which show the upper surface of the underlying saturated zone. At Hico the difference is no greater than 90 feet, which is the estimated depth to the water table.

The McNairy Formation furnishes large amounts of ground water in this region. In the southwest corner of the quadrangle, one well in the McNairy Formation supplies water for several minnow-breeding ponds and is pumped at a rate of about 250 gallons per minute. The city wells at Murray, about 3 miles southwest of this area, are finished in this formation and have yields ranging from 600 to 1,145 gallons per minute.

The McNairy Formation is capable of yielding larger quantities of ground water than are presently being pumped but should an additional source be required, deeper aquifers can be tapped (fig. 2). Gravel in the Tuscaloosa Formation,' possibly present in discontinuous bodies above the Paleozoic bedrock in this area and known to furnish water to several commercial establishments in nearby areas, could be a source for a large supply of ground water. Large quantities of water are contained in crevices and enlarged openings in Devonian and Mississippian limestone or dolomite. Although only domestic supplies are presently being obtained from the Mississippian aquifers in this area, much larger supplies probably are available in the well-developed solutional openings. One well in this quadrangle, drilled through the Chattanooga Shale into the underlying Devonian aquifers, yields an adequate amount of water for a farm supply and probably would furnish a larger supply if the rate of pumping were increased. A large reserve of fresh water, evidently circulating to great depths, is available in the deeper aquifers.

The quality of the water is satisfactory for many uses. The water in the McNairy Formation and the Devonian or Mississippian rocks is generally soft or only moderately hard, and the concentration of dissolved minerals rarely reaches objectionable limits. The iron content, however, is as great as 8.1 parts per million in the water in the Devonian or Mississippian aquifers; greater concentrations of iron in these deeper rocks may be present in some places. The U.S. Public Health Service recommends that drinking water contain less than 0.3 part per million iron. The temperature of the ground water ranges from about 58°F to 62°F, and thus the water is useful as a coolant.

The following table shows the iron content, in parts per million, and the hydrogen-ion concentration, expressed as pH, of the water analyses shown by circular diagrams on figure 1. A pH of 7.0 indicates neutrality of a solution. Values greater than 7.0 denote alkalinity; values less than 7.0 indicate acidity. Corrosiveness of water generally increases with decreasing pH.

Analysis number	1	2	3	4	5	6	7	8	9	10
Iron content	0.78	0.01	0.04	2.70	0.28	0.28	0.05	0.08	2.50	8.10
pH	—	7.4	6.9	7.1	5.9	7.2	7.3	6.2	6.5	6.8

Analysis number	11	12	13	14	15	16	17	18	19	20
Iron content	0.23	0.14	0.26	0.37	0.14	0.16	0.04	0.29	0.12	6.90
pH	6.0	6.8	6.8	6.0	7.3	7.2	7.4	5.7	6.1	6.2

Analysis number	21	22
Iron content	1.40	0.65
pH	7.3	6.6

AVAILABILITY OF GROUND WATER IN THE HICO QUADRANGLE, KENTUCKY

By

J. H. Morgan

1965

For sale by U. S. Geological Survey, price 50 cents