DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
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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		0–40′	Gray, commonly clayey silt and sand containing lenses of red to brown gravel. Gravel lenses may be cemented by iron-bearing material in bottoms of stream channels. Underlain in some places by a plastic gray clay of Eocene age.	Flood-plain deposits along the West Fork Clarks River and its tributaries, and the North and South Forks Duncan Creek. Thickness in major flood plain averages less than 30 feet; thinner deposits are in the tributaries.	Water bearing in availability area 1. Yields adequate domestic supplies (500 gallons per day) to large diameter dug or bored wells. Water table fluctuates with seasonal rainfall. Saturated zone extends downward into underlying Eocene sand. Analysis of one water sample shows the water is soft and contains objectionable amounts of iron. More than 0.3 part per million iron, considered to be the objectionable limit, may stain the laundry and plumbing fixtures.
QUATERNARY	Pleistocene		Loess		0–10′	Tan to gray unstratified silt and clay; locally contains small concretions of iron-bearing material. Base grades downward into sand or rests on gravel.	Windborne deposits which mantle the upland and drape down hillsides. May be 10 feet thick in uplands; thinner or removed by erosion in most upland tributary valleys.	Generally only slightly permeable. Probably transmits some rainfall to underlying aquifers. Yields little or no water to wells.
QUATERNARY / TERTIARY	Pleistocene / Pliocene(?)		Gravel, sand, and clay[1]		0–80′	Red to brown micaceous, poorly sorted sand and gravel; gravel consists of angular to rounded chert pebbles and cobbles; sand is mostly of quartz but contains minor amounts of opaque minerals. Includes lenses of crossbedded sand, iron-cemented zones, and beds of white to pink clay in places.	Old stream deposits in the upland above 500 foot altitude and terrace deposits along the flood plain of the West Fork Clarks River. Commonly concealed by a cover of loess but exposed in hillsides or road cuts. Average thickness is about 50 feet but probably more than 80 feet in the upland in the southeastern part of the quadrangle and less than 30 feet in the terraces; grades into Recent alluvium in flood plain.	Water bearing in availability area 2. Yields adequate domestic supplies (500 gallons per day) to large-diameter dug or bored wells, generally less than 50 or 60 feet deep in the uplands and less than 30 feet deep on the terraces. Shallow water-bearing zones are perched above lentils of clay or cemented sand. Saturated zone extends downward into underlying Eocene sand except where clay underlies the gravel. Water is commonly soft but may be hard in places. Iron content is rarely objectionable. The nitrate content is extremely high at some locations. More than 45 parts per million nitrate is considered harmful in water fed to infants and may cause methemoglobinemia ("blue baby" disease) which is sometimes fatal.
TERTIARY	Eocene, undifferentiated		Sand and clay		0–200′	White, fine- to coarse-grained, poorly sorted basal sand overlain by a light- to dark-gray clay conglomerate in a clayey, fine-grained sandy matrix. Plant remains and subangular clay fragments are common in lower part. Upper sand is medium grained, crossbedded, and oxidized to shades of red.	Continental deposits exposed in many stream valleys beneath gravel at altitudes as high as 500 feet in some places. May be more than 250 feet thick along western border of the quadrangle; thins to the east and probably is absent in extreme northeastern part of the quadrangle.	Water bearing in availability areas 1, 2, and 3. Yields a plentiful supply of water to both small-diameter drilled wells and large-diameter bored wells. Properly constructed wells should yield as much as 100 gallons per minute in the western part of availability area 3. Shallow water-bearing zones are perched above clay beds and confined water is probably present below clay beds in some places. Water is generally soft but may be moderately hard in a few places. Iron content is rarely objectionable.
TERTIARY	Paleocene	Midway	Porters Creek Clay		200–250′	Dark-gray to black micaceous, commonly massive clay with a conchoidal fracture in lower part; gray micaceous clay containing thin beds of fine-grained sand in upper part. Slightly glauconitic and fossiliferous in some zones. Gray to greenish-gray very glauconitic clayey sand or micaceous sandy clay at base. Where exposed on slopes, may be overlain by thin deposits of colluvium (rock material moved by gravity).	Marine deposits concealed beneath Eocene sediments. Small exposures are present in northern tributaries to the North Fork Duncan Creek. Thickness ranges from about 200 feet in the east to 250 feet in the western part of the quadrangle. The shallow marine deposit of glauconite at base of Porters Creek Clay may be as much as 20 feet thick.	Generally not water bearing. Significant only to hold up water in overlying aquifers or to confine deeper water in underlying aquifers. Sand beds may yield some water to wells. Overlying colluvial deposits may yield small supplies in places.
CRETACEOUS	Upper Cretaceous		McNairy Formation[2]		300′±	Gray to white micaceous fine- to medium-grained sand, commonly lignitic; may contain zones of laminated dark-gray or black clay. A coarser basal sand may be present in some places.	Deltaic deposits concealed by the Porters Creek Clay. Thickness probably 300 feet or more.	Water bearing in entire quadrangle at depths ranging from about 200 feet in east to more than 500 feet in west. Yields a sufficient supply of water for farm use to one drilled well in this quadrangle. Furnishes municipal supplies to towns of Benton and Murray, Kentucky a few miles east of this area. Water is confined and rises to a reported altitude of about 400 feet. Water level in well recovers rapidly after pumping. Water is moderately hard and generally contains iron in objectionable amounts.
CRETACEOUS	Upper Cretaceous		Tuscaloosa Formation		0–50′	White gravel consisting of well-rounded, tripolitic chert pebbles and cobbles.	Stream deposits, that fill depressions and channels in the eroded Paleozoic rock surface; may or may not be present in this quadrangle.	Probably will yield a sufficient supply of water for farm use to drilled wells. Not tapped in this area. Water is probably hard and may contain an objectionable amount of iron.
DEVONIAN	Lower and Middle Devonian		Devonian rocks undifferentiated		200′±	All rocks below the Cretaceous are of Paleozoic age and are the "bedrock" of well drillers. Light-gray to white chert and limestone; tripolitic chert rubble is common in upper part. Grades down into gray crystalline, cavernous limestone and dolomite. Underlain by older Paleozoic rocks.	Consolidated marine deposits concealed at depth. Irregular rock surface and chert rubble zone significant of pre-Cretaceous weathering and leaching. Chert rubble zone may be as much as 300 feet thick in some places.	Probably will yield an abundant supply of water from chert rubble or from crevices and caverns in limestone at depths ranging from 500 to 800 feet. Not tapped in this area. Water is probably hard and may contain objectionable amounts of iron in some places.

[1]Age undetermined. Estimates of age range from Pliocene or older to Pleistocene
[2]May contain beds of Clayton age in upper part

EXPLANATION

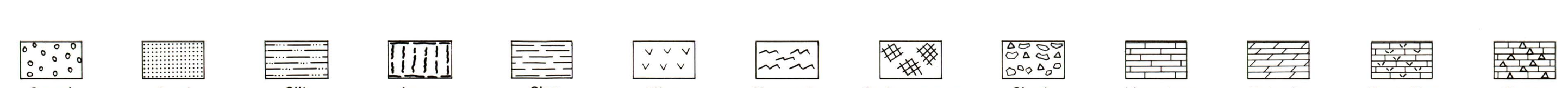


FIGURE 2.—GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTER OF GEOLOGIC FORMATIONS

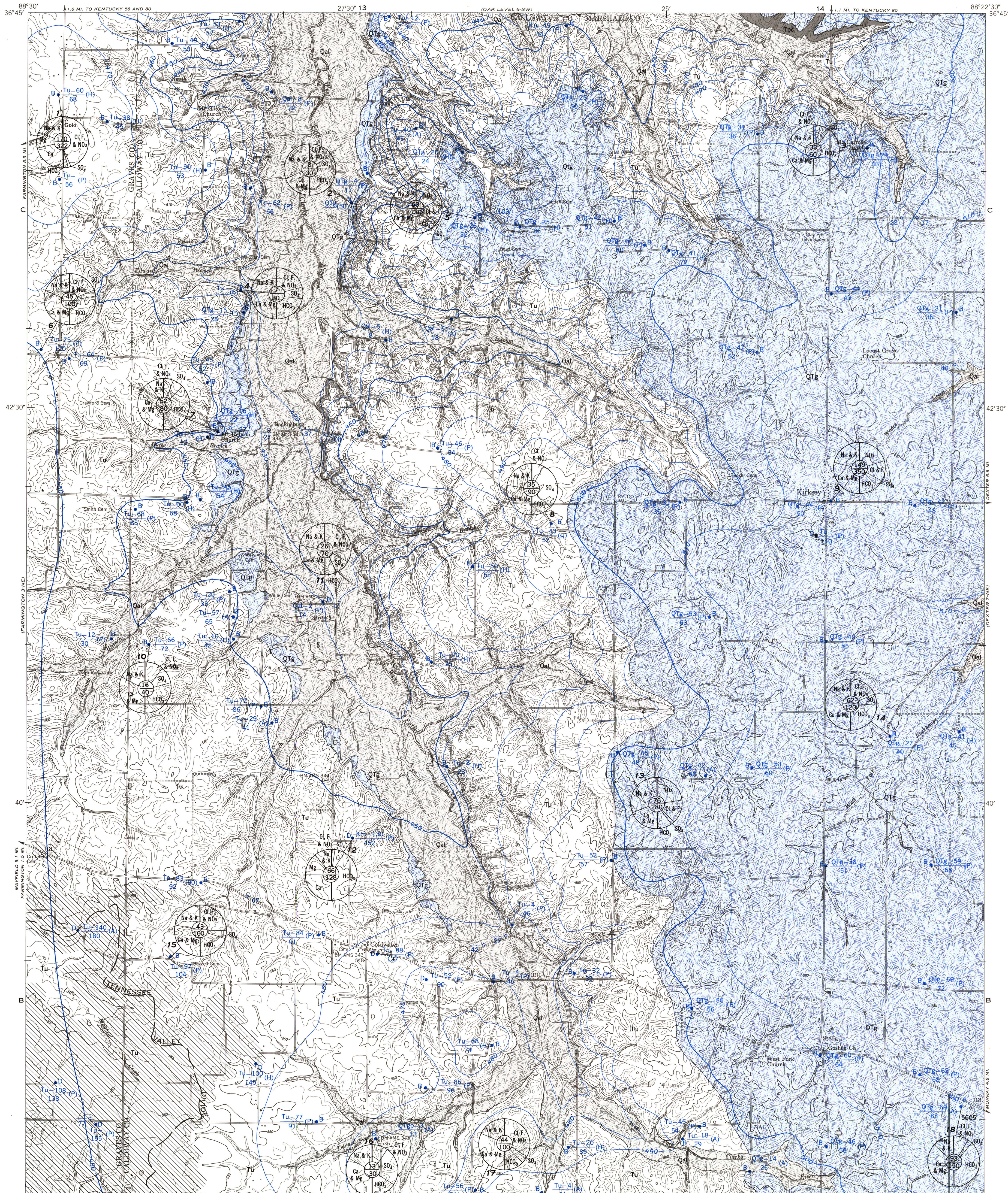


FIGURE 1.—MAP SHOWING AVAILABILITY OF GROUND WATER, LOCATION OF WELLS AND SPRINGS, AND QUALITY OF WATER

Base by Tennessee Valley Authority and U.S. Geological Survey, 1951

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

Hydrology by J. H. Morgan, 1962

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 1964

QUADRANGLE LOCATION

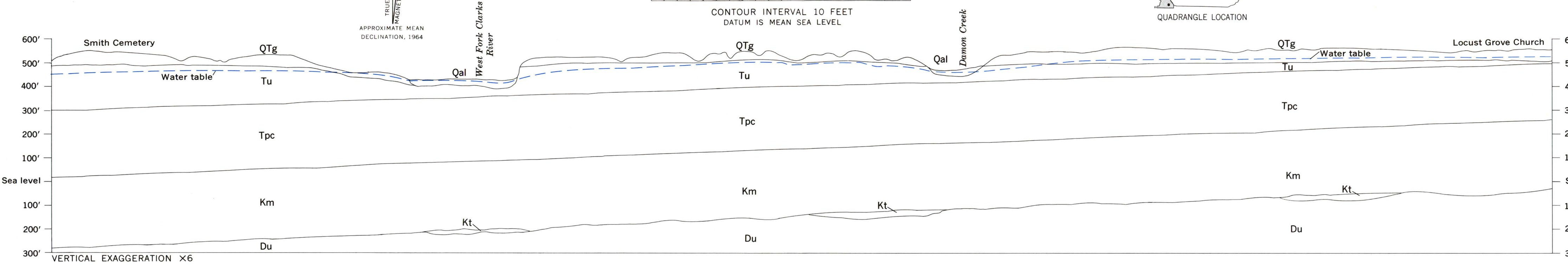


FIGURE 3.—GENERALIZED GEOLOGIC SECTION ALONG A NORTHEAST-TRENDING LINE FROM A POINT NEAR SMITH CEMETERY TO A POINT NEAR LOCUST GROVE CHURCH

EXPLANATION

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

Qal

AREA 1
Water in Quaternary alluvium

The alluvium is water bearing in area 1 at shallow depths, commonly less than 10 feet. The zone of saturation extends into the underlying sand and clay of the Eocene Series (see fig. 3). Shallow large-diameter bored or dug wells are terminated in water-bearing alluvium or deepened into underlying sand. Small-diameter drilled or jetted wells which are cased through the alluvium obtain water through well screens placed in underlying coarse sand. Enough water is available from alluvium for a domestic supply (500 gallons per day); the deeper Eocene sand probably yields sufficient amounts for a larger supply. Where Eocene clay is in contact with alluvium, wells can be deepened through the clay, generally only a few feet thick, into saturated sand, commonly present beneath them. In the valleys of the North and South Forks of Duncan Creek, the alluvium may rest on the Porters Creek Clay which is about 250 feet thick in this area. The water in area 1 is generally soft and contains iron in some places

QTg

AREA 2
Water in Pliocene(?) gravel and sand

The Pliocene(?) gravel and sand are water bearing in area 2 at depths commonly less than 60 feet in the uplands and less than 15 feet along the terraces of the West Fork of Clarks River. The zone of saturation is continuous downward through the gravel and underlying Eocene sand to the Porters Creek Clay (see fig. 3) except where the Eocene sediments are not present near North Fork of Duncan Creek. Large-diameter bored or dug wells penetrating only a few feet of the zone of saturation will yield an adequate domestic supply (500 gallons per day). Both large-diameter and small-diameter wells can be bored or drilled into the underlying saturated sand of the Eocene Series and obtain larger yields sufficient for a commercial or small business supply. In some places cemented gravel or impermeable clay may perch a small body of water above the water table in this area. These small perched bodies usually have inadequate yields for a modern household supply, although a few may meet the requirements for a power-pump and pressure system. The water in area 2 is generally soft but may be moderately hard in places; iron is rare

Tu

AREA 3
Water in Eocene sand
Diagonal ruling shows areas where the water table is more than 100 feet below land surface

The sand in the Eocene Series, the shallowest water-bearing formation in area 3, is saturated at depths ranging from less than 50 feet in most valleys to more than 100 feet in the southwestern part of area 3. The zone of saturation, probably more than 150 feet thick, extends downward to the Porters Creek Clay (see fig. 3). Large-diameter bored wells are commonly present in areas where the water table is less than 100 feet below the land surface. Small-diameter wells are drilled in areas where the water table is at greater depths and in areas where dry, loose sand above the water table causes trouble during construction of large-diameter wells. An abundant supply of water is available in the Eocene sand, and properly constructed wells in the zone of satuation will yield enough water for a small municipal or industrial supply. Clay lenses and impermeable sand zones in the Eocene sediments confine water beneath, and perch water above, in some localities. The water in area 3 is generally soft and may contain minor amounts of iron in places

Tpc

AREA 4
Water in colluvium above Porters Creek Clay

A thin mantle of colluvium (rock material moved by gravity) occurs above the Porters Creek Clay in area 4 and may be water bearing in some places. This shallow water is generally inadequate for a domestic supply; however, large-diameter wells that are bored or dug several feet into the underlying Porters Creek Clay may provide sufficient storage space for a small supply. The McNairy Formation, a deeper aquifer about 200 feet beneath this area (see fig. 3) is known to yield a plentiful supply of moderately hard to hard water commonly containing undesirable amounts of iron in similar areas in adjacent quadrangles

Area boundary

5605
Oil-test well
Figure below line is depth of well

68
Test hole
Figure below line is depth of test hole

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

Spring

Tu–83 / 92 (5)
Aquifer (see below)
Water level, in feet below land surface
Yield in gallons per minute, or adequacy (see below)
Depth of well, in feet below land surface

AQUIFER SYMBOLS

Qal .... Alluvium of Quaternary age
QTg .... Gravel and sand of Pliocene(?) age
QTgp .... Perched water in gravel and sand of Pliocene(?) age.
Tu .... Sand of Eocene age, undifferentiated
Km .... McNairy Formation of Cretaceous age

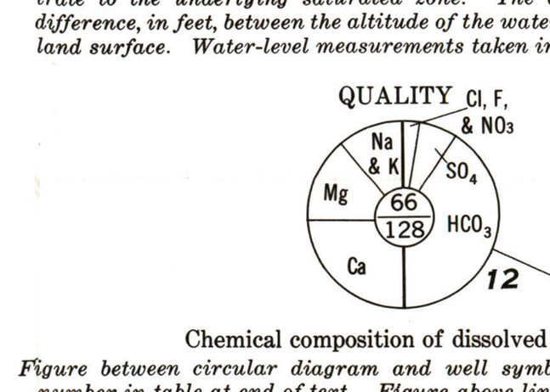
YIELD OR ADEQUACY

(5) .... 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

500
Water-level contour

Shows altitude of water level in the main zone of saturation. Contour interval 10 feet; datum is mean sea level. Where impermeable sediments occur in the subsurface at the altitude of the contour, the water is confined but will rise to the altitude of the contour in wells that penetrate to the underlying saturated zone. The depth to water is the difference, in feet, between the altitude of the water-level contour and the land surface. Water-level measurements taken in March 1962

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 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; and 181 ppm or more, very hard. Dissolved solids in partial analysis is computed from specific conductance and is an approximate value. Areas of the segments of each half 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. Nitrate shown separately if present in amounts greater than 45 ppm

EXPLANATION

Qal ...... Alluvium of Quaternary age
QTg ...... Gravel and sand of Pliocene(?) age
Tu ...... Eocene formations, undifferentiated
Tpc ...... Porters Creek Clay of Paleocene age
Km ...... McNairy Formation of Cretaceous age
Kt ...... Tuscaloosa Formation of Cretaceous age
Du ...... Devonian rocks, undifferentiated

AVAILABILITY OF GROUND WATER IN THE KIRKSEY QUADRANGLE, KENTUCKY

A plentiful supply of ground water for domestic purposes has been available since early in the settlement of the Jackson Purchase region in western Kentucky. The increasing demand for water for other purposes in our expanding economy has required that special consideration be given to the water resources of the area. To encourage wise development and conservation of this resource, the U.S. Geological Survey in cooperation with the Kentucky Geological Survey is conducting scientific investigations to expand the knowledge of the ground water in the region. This report, one of a series that includes the entire Jackson Purchase region, provides detailed information on the availability of ground water in the Kirksey quadrangle.

The shallowest ground-water source that may yield an adequate supply for domestic use is shown on an availability map (fig. 1). Although the main zone of saturation--that part of the rock material that is completely saturated with water--is continuous beneath the entire quadrangle, and is probably as thick as 150 feet in some places, the water table (the upper surface of the main zone of saturation) is in different geologic formations. Thus there are differences in the availability of the contained water. As an example of the usefulness of the map, the conditions near Coldwater in the southwestern part of the quadrangle are shown for area 3 where the water table is in the Eocene sand (see explanation of map); both small- and large-diameter wells yield enough water for a small municipal or industrial supply. The probable minimum depth of a well is the difference between the altitude of the land surface and the water table. At Coldwater the difference is 90 feet, which is the estimated depth to water and the minimum depth of a dependable well.

In a few places, the discontinuous beds of clay above the water table retard descending water above them. These local occurrence of ground water above the main zone of saturation, called "perched water," are usually inadequate for even a domestic supply, although during rainy seasons the amount available may be sufficient for many uses in the home or on the farm.

Should the shallowest water-bearing formation (aquifer) yield an insufficient supply, deeper formations can be tapped. (See fig. 2.) The McNairy Formation in Marshall and Calloway Counties is an excellent aquifer, yielding municipal supplies of water to the towns of Benton and Murray, Kentucky. The water in the formation, confined by the overlying Porters Creek Clay, will rise in wells to an altitude of about 400 feet above sea level. The Tuscaloosa Formation, which is not tapped by wells in this quadrangle and may not be present, is water bearing in areas where the gravel in the formation has been located. The Paleozoic rocks are not tapped by wells in the quadrangle but are an excellent source of ground water elsewhere in the Jackson Purchase region, where they are at lesser depths. Near the Ohio River in southern Illinois these rocks supply water to several homes, small businesses, and large industries. The McNairy, Tuscaloosa, and Paleozoic aquifers in the quadrangle are potential sources of large quantities of water.

The quality of water in the main zone of saturation is satisfactory for most uses. Except where the nitrate (NO_3) content is more than 45 parts per million (ppm), the concentration of dissolved solids rarely exceeds 150 ppm. The water is generally soft or only moderately hard, ranging from less than 10 ppm to about 90 ppm. It is slightly acidic and may be considered corrosive for some uses. The temperature of the ground water ranges from about 57° to 62°F. The water in the McNairy Formation may contain objectionable amounts of iron, but the iron content is reported to decrease with prolonged pumping.

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 higher than 7.0 denote increasing alkalinity; values lower than 7.0 indicate increasing acidity. Corrosiveness of water generally increases with decreasing pH.

Analysis number	1	2	3	4	5	6	7	8	9	10
Iron content	0.31	0.02	0.38	0.11	0.08	0.17	0.31	0.15	0.24	0.10
pH	6.8	—	6.3	5.3	6.2	6.4	6.7	6.6	—	5.8

Analysis number	11	12	13	14	15	16	17	18
Iron content	0.97	8.0	0.05	0.14	0.13	0.11	0.40	0.07
pH	5.5	6.5	6.0	6.4	6.5	5.7	—	6.7

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By
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1964

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