PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF KENTUCKY, UNIVERSITY OF KENTUCKY
KENTUCKY GEOLOGICAL SURVEY
WALLACE W. HAGAN, DIRECTOR AND STATE GEOLOGIST

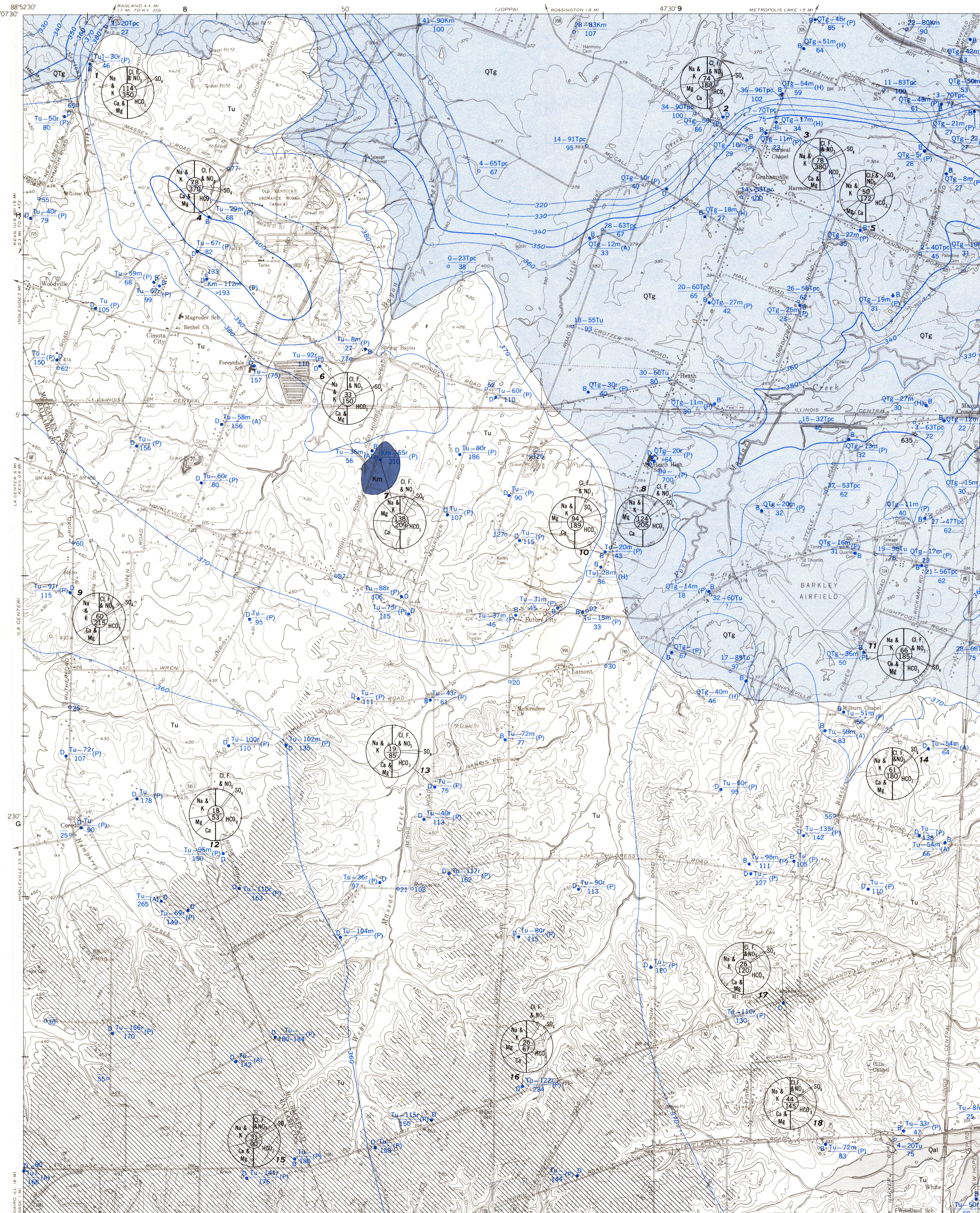
GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTER OF GEOLOGIC FORMATIONS

System	Series	Formation	Thickness, in feet	Lithology	Topography and geologic setting	Hydrology
Quaternary	Pleistocene and Recent	Alluvium	0–20'±	Clay or silt near the surface grading downward into clayey gravel and (or) sand.	Occurs in upper reaches of streams. Rests on rocks ranging in age from Eocene to Pliocene(?) and Pleistocene.	Water bearing in unnamed creek north of White in southeast corner of quadrangle. The saturated thickness is only a few feet, and wells probably will be completed in underlying Eocene sand.
Quaternary	Pleistocene and Recent	Lake deposits	0–25'	Clay and silt. Gravel bars across upland streams.	Occurs in the lower reaches of West Fork of Massac Creek downstream from the 350-foot water-level contour.	Small gravel bar north of Mason Crossing may yield sufficient water for domestic use. Subject to flooding.
Quaternary	Pleistocene	Loess	0–17'	Tan to gray silt or clay.	Covers all upland and sloping sides of stream valleys.	Not an aquifer. When saturated by rainfall, transmits water to lower aquifers.
Quaternary	Pliocene(?) and Pleistocene	Silt	40–50'±	Brown clayey silt or very fine-grained sand and scattered medium- to coarse-grained sand and thin gravel lenses.	Gravel deposits and silt rest on several surfaces cut into rocks ranging in age from Cretaceous to Eocene, based on auger holes drilled by the Geological Survey. A thick silt deposit blankets the lower two levels of Pliocene(?) and Pleistocene gravel.	Yields from small diameter bored wells in this unit are reported adequate for domestic use, but probably will not meet peak demands for a modern home in area 2. Locally, gravel lenses in the fine-grained material may yield an adequate amount of water to large diameter bored wells for domestic needs. A gravel underlying the fine material would be the best to tap for most needs.
Quaternary	Pliocene(?) and Pleistocene	Gravel, sand, and silt	0–40'	Brown to brownish-red sandy chert gravel and beds of gray sandy gravel, silt, and clay.	Continental terrace deposits lying on two irregular surfaces cut at different levels into sediments of Eocene, Paleocene, and Cretaceous ages. The pre-Pliocene surface consists of channels and terraces cut by an intricate drainage system at an altitude of about 400 feet above sea level. At least one such channel occurs north of Grahamville (see cross section). In the Pliocene(?) and Pleistocene water-availability area, the gravel rests on an eroded surface that is below 330 feet in altitude.	Wells tapping the Pliocene(?) and Pleistocene gravel between the water-table contours of 320 to 350 feet north of Grahamville and northeast of the Old Kentucky Ordnance Works may supply sufficient water for domestic use. Largest yielding wells, which may supply industrial and public needs, should be drilled in the areas north of the 320-foot water-table contour and south of about the 350-foot water-table contour. The saturated thickness of the gravel ranges from 3 to about 40 feet and is thinner on the slope between the water-table contours of 320 to 350 feet. Several wells in adjacent Paducah West quadrangle are reported to be affected by droughts when wells are completed above a clayey silt. These wells should be developed in the gravel below the silt for an adequate domestic supply. The quality of water is soft to moderately hard.
Tertiary	Eocene, undifferentiated	Sand and clay	0–200'±	Red, brown, or white fine- to coarse-grained sand. Beds of white to dark-gray clay are distributed at random.	Underlies Pliocene(?) and Pleistocene gravel and younger deposits. Exposed in creek beds and railroad cuts in the southern half of the quadrangle.	An excellent aquifer south of Childress Road. Most wells obtain water from the Eocene sand at depths as great as 230 feet. Wells in the southern part of the quadrangle should be capable of furnishing domestic and most public and industrial needs. The upper sand thins north of Childress Road and may require wells to be deepened into the basal sand. The water is slightly acidic, soft, and generally contains less than 0.3 ppm of iron. An iron content of more than 0.3 ppm is probably derived from the well casing and may cause the staining of porcelain and textiles. The analysis of water and owners' reports of their water shows an objectionable amount of iron because of the reaction between the acidic ground water and the steel well casing and pump apparatus.
Tertiary	Eocene, undifferentiated	Sand and clay	300'± / 100'±	White to gray sandy clay, clay conglomerate and boulders, scattered clay lenses and lenses of coarse red sand. Black to dark-gray lignitic clay, silt, or fine-grained sand. A bed of coarse-grained sand at the base of the Eocene sequence is apparently discontinuous.	Underlies the main body of Eocene sediments in the southern part of the quadrangle. May be exposed north of U.S. Highway 60 in several creeks.	An excellent aquifer in most of the quadrangle although probably will not yield as much water as the overlying aquifer. Most wells obtain water from sand lenses within the clay and from a basal sand. The aquifer may furnish sufficient water for domestic and locally will furnish water for public and industrial needs. Most wells will tap this unit north of Childress Road. Owing to the lack of subsurface data along U.S. Highway 60 west of Barkley Airfield, the separation of the lower and upper Eocene aquifers is in doubt. A thick coarse-grained sand at the junction of U.S. Highway 60 and Ky. Highway 996 may be either the basal sand of the upper unit or a sand within this unit. The water from this unit will be similar to that from the above unit.
Tertiary	Paleocene	Porters Creek Clay	160–200'	Dark-gray, slightly to very micaceous clay. Fine-grained clayey sand, commonly glauconitic, in the upper part. Glauconitic sand and clay at the base.	Underlies the entire quadrangle except north of Grahamville. The Eocene sediments rest on the Porters Creek Clay throughout the quadrangle. North of Barkley Airfield the Porters Creek Clay is overlain by Pliocene(?) and Pleistocene gravel. Formation thins north of Grahamville.	Not an aquifer. Retards the movement of water between the overlying aquifers and the Cretaceous sands.
Cretaceous	Upper Cretaceous	McNairy Formation[1]	300'	Dark-gray to black clay interlaminated with fine-grained sand. Mica and lignitic material are common. Clay is the most common lithology in upper part; sand and clay alternate throughout the middle and lower parts; sand generally present at base. May contain lenses of sandy gravel near base.	Underlies Porters Creek Clay in most of the quadrangle and Pliocene(?) and Pleistocene gravel north of Grahamville.	Capable of supplying adequate water for domestic and small commercial uses. The water is slightly basic, hard, and commonly contains more than 0.3 ppm of iron. Properly constructed wells in the basal sand may yield more than 100 gallons per minute.
Cretaceous	Upper Cretaceous	Tuscaloosa Formation	?	White rounded pebbles and cobbles in tripolitic matrix and lenses of tripolitic clay.	May occur in pockets in the eroded surface of the Paleozoic rocks.	Water-bearing character is not known. Generally this unit is a poor aquifer owing to the clayey nature.
Devonian and Mississippian		Devonian and Mississippian rocks, undifferentiated	500'±	All rocks below the Cretaceous units are of Paleozoic age and are the "bedrock" of drillers. The upper surface of the "bedrock" is deeply weathered forming a chert rubble which consists chiefly of angular or subangular chert blocks in a matrix of tripolitic clay or a clay where shale has cropped out and weathered. Argillaceous siliceous and cherty limestone interbedded with dark-gray chert. Limestone may be finely to coarsely crystalline. Black micaceous carbonaceous fissile shale.	Present at great depth throughout the quadrangle. Consolidated marine sediments underlying Cretaceous deposits. The pre-Cretaceous erosional surface slopes south on truncated subcrop of northward-dipping Paleozoic rocks.	Probably will yield large quantities of ground water for domestic and public supplies from gravel-like chert rubble and a lesser amount from solutional openings in limestone. One well tapped the bedrock at Heath High School, but it has not been used since 1954. The water is hard and contains objectionable amount of iron.

[1] May contain beds of Clayton (Paleocene) age at top

EXPLANATION

Gravel, Sand, Loess, Clay or shale, Mica, Glauconite, Carbonaceous material, Chert rubble, Limestone, Cherty limestone



MAP SHOWING AVAILABILITY OF GROUND WATER, LOCATION OF WELLS, AND QUALITY OF WATER

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

Hydrology by T. W. Lambert, 1964

SCALE 1:24 000
1 ½ 0 1 MILE
1 .5 0 1 KILOMETER
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

TRUE NORTH, MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1966

KENTUCKY
QUADRANGLE LOCATION

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 use in each area. 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. The shallowest aquifer is underlain by deeper aquifers whose geologic and water-bearing properties are described in the generalized columnar section

Qal

AREA 1
Water in Quaternary alluvium

No wells tap the alluvium near White in the southeastern part of the quadrangle. The zone of saturation extends downward into the underlying Eocene sand which is about 40 feet thick. Four feet of saturated gravel occurs at the base of the alluvium in a 75-foot test hole near White

QTg

AREA 2
Water in Pliocene(?) and Pleistocene gravel

The Pliocene(?) and Pleistocene gravel, where it underlies the area below an altitude of 390 feet above sea level, will yield sufficient water for domestic and stock uses and for some industrial and commercial uses. Properly constructed wells should yield from 30 to 400 gpm (gallons per minute.) The saturated thickness of the gravel, based on augered test holes, ranges from 3 to 40 feet or more. The aquifer is developed mostly by small-diameter bored wells, but these are being replaced by 24-inch-diameter bored wells or by drilled wells

Tu

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

Abundant quantities of ground water are available in the Eocene sands at depths ranging from only a few feet below the land surface in many stream valleys to depths slightly greater than 100 feet in the area shown by diagonal ruling. The zone of saturation, which is several hundred feet thick and contains several beds of sand, extends downward to the underlying Porters Creek Clay. The water in the basal sand, confined by beds of clay, is under artesian conditions and will rise in wells to the altitude of the local water table

In the southern part of the quadrangle, wells probably can obtain yields greater than 500 gpm. Some small-diameter drilled or jetted wells as deep as 200 feet or more penetrate the main zone of saturation. Large-diameter bored wells designed for small pumping capacities generally penetrate only a few feet below the water table and will yield adequate supplies for domestic use. Larger yields may be obtained by deeper penetration into the aquifer

Km

AREA 4
Water in McNairy Formation

In the northwest part of the quadrangle, the Porters Creek Clay is present at a shallow depth, and the thin overlying Eocene sand yields little or no water. Wells in this area are drilled into the McNairy Formation underlying the Porters Creek Clay. Two jetted wells yield adequate supplies for domestic use; one drilled well supplied the now abandoned Kentucky Ordnance Works from sand in the McNairy Formation. The extent of thinning of the Eocene sands has not been determined

Area boundary

635
Oil-test well
Figure below line is depth of test well

20
Test hole
In availability area 3, only depth of test hole is shown

28–68Tpc / 75
Saturated thickness of gravel
Depth to base of gravel
Geologic unit underlying gravel (see aquifer symbols below)
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 or 8-inch vitrified clay pipe, open at the bottom*

QTg–17m(P) / 23
Aquifer (see below)
Water level, in well, in feet below land surface; m, if measured, r, if reported
Yield, in gallons per minute, or adequacy (see below)
Depth of well, in feet below land surface

AQUIFER SYMBOLS

- QTg — Sand and gravel of Pliocene(?) and Pleistocene age
- Tu — Sand of Eocene age, undifferentiated
- Tpc — Porters Creek Clay of Paleocene age
- Km — McNairy Formation of Cretaceous age
- Du — Devonian rocks, undifferentiated
- [ ] — Brackets indicate probable aquifers where not definitely known

YIELD OR ADEQUACY

- (75) — Gallons per minute
- (P) — Well reported adequate for power pump for domestic and (or) stock supply
- (H) — Well reported adequate for bailer or hand pump
- (A) — Abandoned or destroyed

350
Water-level contour

Shows altitude of the water level in the main zone of saturation. Queried where indefinite. 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 beneath and will rise to the altitude of the contour in wells penetrating 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 made in the summer of 1964

QUALITY

Cl, F, & NO_3; SO_4; Na & K; 26 / 120; HCO_3; Ca & Mg; 17

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 ppm (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 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. All wells sampled contained less than 45 ppm of nitrate. Water containing more than 45 ppm of nitrate may cause a type of methemoglobinemia in infants ("blue baby" disease), sometimes fatal, and should not be used in infants' formulas

AVAILABILITY OF GROUND WATER IN THE HEATH QUADRANGLE, JACKSON PURCHASE REGION, KENTUCKY

Large undeveloped supplies of ground water are available for domestic and industrial use in the area of the Heath quadrangle. This atlas, one of a series that includes the entire Jackson Purchase region in western Kentucky, presents nontechnical information about ground water in an area west of Paducah, Ky.

The water-availability map is a graphic representation of the occurrence and quality of water in the shallowest aquifer that will yield water in adequate amounts for domestic use. The availability of ground water at a particular site may be determined from the pattern on the map and a study of data on wells near the site. The chemical quality of the water is shown by circular diagrams.

The aquifers in the Heath quadrangle will provide adequate ground water for domestic and industrial uses. Wells tapping the Eocene sands may yield more than 500 gallons per minute. The aquifer, consisting of at least 60 feet of saturated sand, is present at the junction of U.S. Highway 60 and Ky. Highway 996. A similar thickness of sand occurs south of U.S. 60. Wells in Eocene sand north of U.S. Highway 60 may not supply large amounts of water.

The Pliocene(?) and Pleistocene gravel will meet the demands for most domestic uses. It will supply several hundred gallons a minute to properly constructed wells. The gravel ranges in thickness from 3 to 40 feet. Based on a specific capacity of 10 gallons per minute per foot of drawdown, the yield may range from 30 to 400 or more gallons a minute.

It should be noted that the water level (320 feet above mean sea level) in Pliocene(?) and Pleistocene gravel north of Grahamville is approximately the same as that of the McNairy Formation. Under heavy pumping, recharge would be from the Pliocene(?) and Pleistocene gravel at higher altitudes near Grahamville and from the McNairy Formation below the gravel.

Several wells tap the McNairy Formation and Devonian rocks in the northern part of the quadrangle, but little is known about the yield of these aquifers.

The quality of the water from the Cretaceous and Tertiary sediments is excellent for most uses. The temperature of the ground water is approximately the same as the mean annual air temperature of 60°F.

The quality of the water is the same in each of the various units of the Pliocene(?) and Pleistocene gravel. The water is moderately hard and has an iron content of less than 0.3 ppm (part per million). Iron in excess of 0.3 ppm may cause staining of porcelain and textiles. The water from this gravel has a higher nitrate content in this quadrangle than that from the older aquifers.

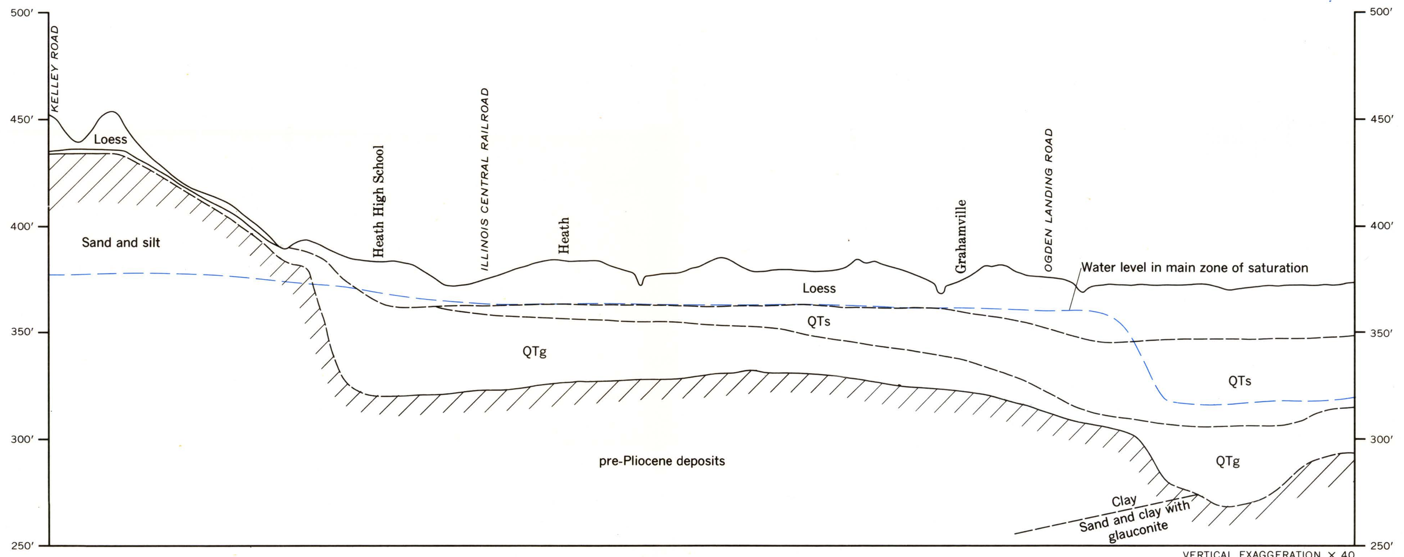
The water from the Eocene aquifers is soft, low in dissolved solids, and slightly acidic. Water samples collected from plastic-cased wells (4-inch diameter) have a much lower iron content than those from steel-cased wells. Most of the water that is pumped from 2- to 3-inch jetted wells equipped with steel casings and "sucker rod" pumps contains large amounts of iron and is not typical of the water from the Eocene aquifer. Many 2- to 3-inch wells have been abandoned because of the high iron content and the owners have had to buy water from water haulers for their cisterns. No water samples were collected from jetted wells in the Eocene aquifer.

One water sample collected from a 2-inch well in the McNairy Formation has an iron content of 1.2 ppm and a hardness of 138 ppm. Water from one well tapping Paleozoic bedrock has an iron content of 1.4 ppm and a hardness of 124 ppm.

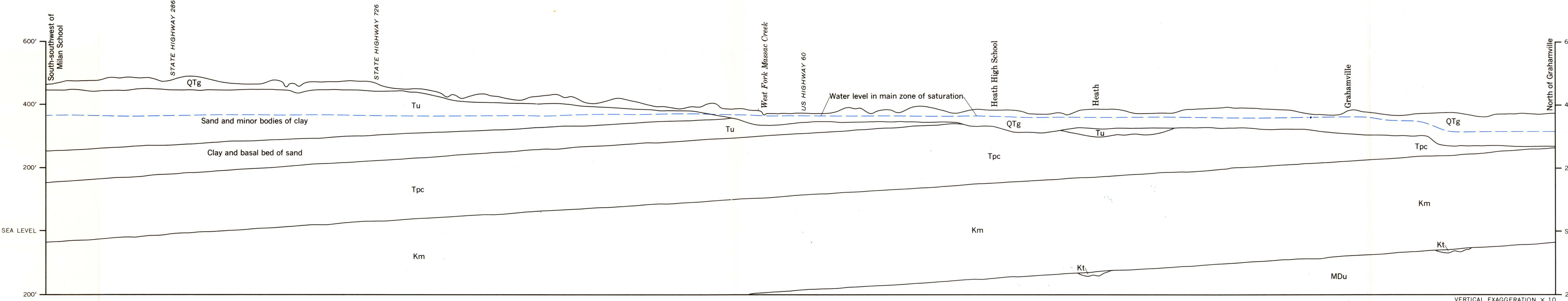
The following table shows the iron content in parts per million and the hydrogen-ion concentration, expressed as pH, of the water analyses shown by circular diagrams on the availability map. A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote alkalinity; values lower than 7.0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

Analysis number	1	2	3	4	5	6	7	8	9	10
Iron content	0.14	0.03	0.11	0.28	0.11	0.56	1.2	1.4	0.08	0.11
pH	6.8	6.5	7.9	6.7	6.9	7.4	7.6	7.6	6.8	7.0

Analysis number	11	12	13	14	15	16	17	18
Iron content	0.11	0.14	0.42	0.79	0.09	7.8	0.39	0.13
pH	7.5	6.1	6.3		6.5	6.3	6.4	6.8



GENERALIZED GEOLOGIC SECTION FROM NEAR KELLEY ROAD TO HEATH HIGH SCHOOL AND NORTHWARD ON KY. 996 TO EDGE OF QUADRANGLE



GENERALIZED GEOLOGIC SECTION FROM SOUTH-SOUTHWEST OF MILAN SCHOOL TO NORTH OF GRAHAMVILLE

- QTs — Silt of Pliocene(?) and Pleistocene age
- QTg — Gravel of Pliocene(?) and Pleistocene age
- Tu — Sand and clay of Eocene age, undifferentiated
- Tpc — Porters Creek Clay of Paleocene age
- Km — McNairy Formation of Cretaceous age
- Kt — Tuscaloosa Formation of Cretaceous age
- MDu — Devonian and Mississippian rocks, undifferentiated

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1966—W66073

AVAILABILITY OF GROUND WATER IN THE HEATH QUADRANGLE, JACKSON PURCHASE REGION, KENTUCKY

By
T. W. Lambert
1966