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

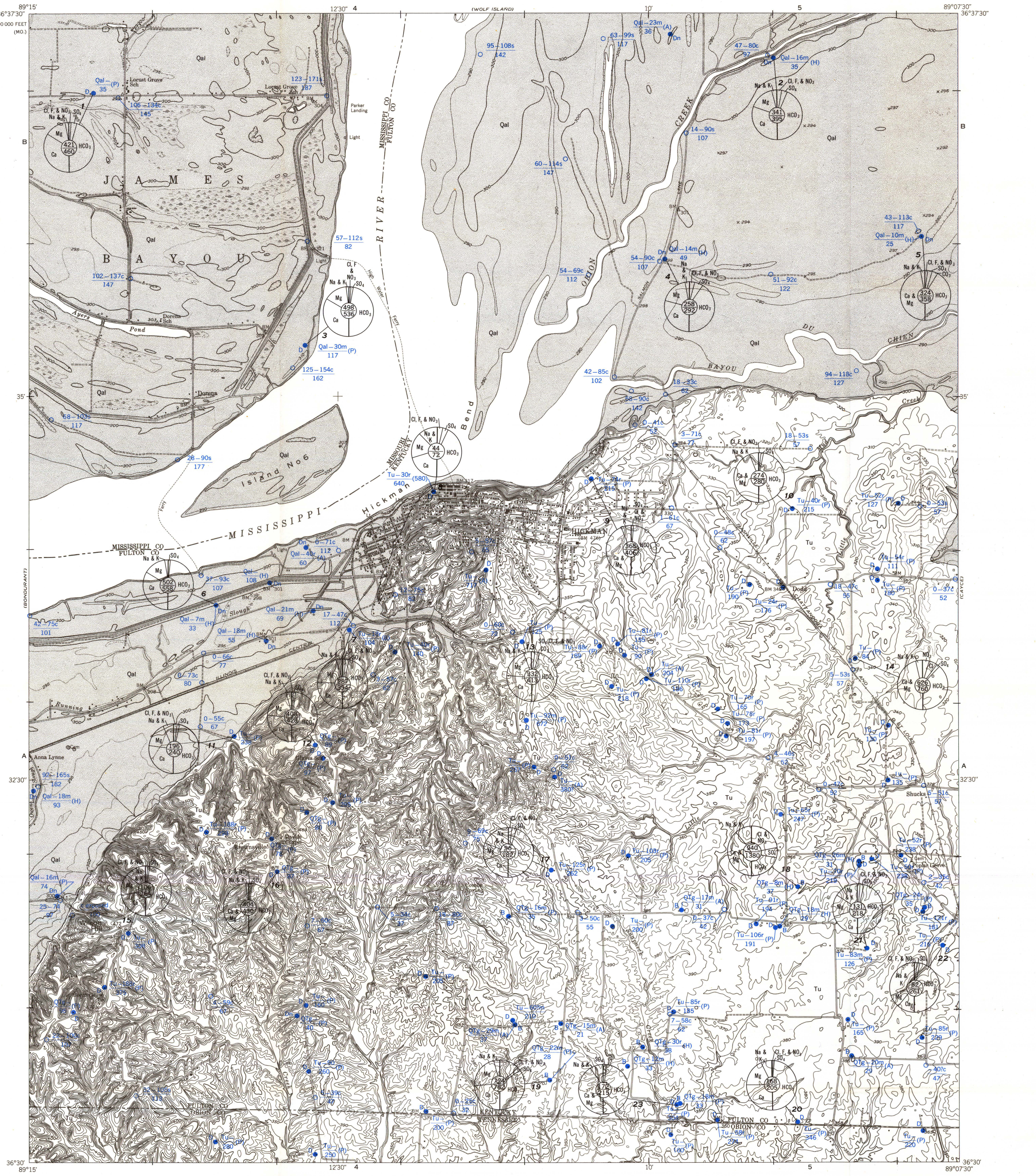
GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTER OF GEOLOGIC FORMATIONS

SYSTEM	SERIES	GROUP	FORMATION	SECTION	THICKNESS, IN FEET	LITHOLOGY	TOPOGRAPHY AND GEOLOGIC SETTING	HYDROLOGY
QUATERNARY	Pleistocene and Recent		Alluvium		0–200	Brown to gray very slightly sandy clayey silt and locally gray hard clay. Gray to brown fine sand. Locally very silty. Pebbles at surface above clayey silt are missing.	Flood plain and terrace deposits filling the valley of the Mississippi River. Known to be as thick as 200 feet, but may be as thick as 250 feet in a deep buried channel. Buried channel is at least 3 miles wide.	Water bearing in Area 1. Shallow driven wells (less than 50 feet) tap the upper alluvial sand and are equipped with pitcher pumps. These wells yield sufficient water for a modern domestic supply except during droughts or when they are near the Mississippi River where the water level drops below the bottoms land of many of the shallow wells each year. Iron and manganese are present in objectionable amounts. Water is very hard and contains a large amount of dissolved solids. Water systems may require iron removal and softener units.
						Gray lignitic pebbly sand. Contains abundant colored grains in fine- to coarse-grained sand. Gravel is derived from Paleozoic rocks and from glacial outwash. Granules to small pebbles of white quartz are common. Coarse sandy gravel locally.		Water-bearing gravelly sand is tapped by several jetted wells and driven wells. Unit will yield large amount of water to industrial and municipal demands. Best area for large development is in the buried channel. Water is similar in quality to that above.
	Pleistocene		Loess		0–85	Dark brown to gray clayey silt. Contains calcareous concretions.	Occurs in upland areas. Forms vertical walls at head of valleys. May blanket hillsides.	Not an aquifer. When saturated, transmits water to underlying units.
	Pliocene(?)		Gravel, sand, and silt[1]		0–43	Reddish-brown sandy gravel. Upper part is silty clayey sand. Sandy silt south of Bayou du Chien in eastern half of quadrangle.	Underlies loess in upland. Crops out along the bluff in the badlands.	Not an important aquifer, although drilled wells are completed in gravel southwest of Hickman. Some dug wells tapping sandy silt yield adequate water for domestic use south of Bayou du Chien.
TERTIARY	Eocene		Clay		100±	Green clay and siltstone.	Crops out along base of upland bluffs unless covered by slumped material.	Not an aquifer. Clay retards the downward movement of water.
			Sand		90±	Gray fine sand.	Underlies either the above unit or the alluvium.	An important aquifer tapped by domestic wells and by one industrial well. Potential yield is unknown. Water is very hard.
			Silt and sand		30±	Gray sandy silt, lignitic.	Underlies the entire area.	No wells are known to tap this horizon.
			Sand and clay		300	Fine- to coarse-grained sand and gray lignitic clay. The amount of sand varies greatly.	Underlies the entire area. Top of unit is 120 feet altitude at Hickman, Ky.	An important aquifer tapped by domestic wells. Yields of more than 500 gpm may be possible. Locally, the unit contains a high amount of clay and thus well yields will be lower. The water is moderately hard to hard and contains about 200 ppm of dissolved solids.
			Clay		40–70	Gray lignitic clay and thin beds of sand.	Base of unit occurs about 620 feet below land surface north of Miller, Ky.	Not an important aquifer.
			Sand and minor beds of clay		380	Fine- to coarse-grained sand. Includes beds of gray lignitic clay as thick as 30 feet.	Top of unit is about −170 feet altitude at Hickman. Thickness is based on oil test near Miller in Bondurant quadrangle.	An important aquifer used for municipal supply at Hickman, Fulton-South Fulton and Union City in the surrounding area. Wells at Hickman tap the upper part of the aquifer at a depth of 620 feet and are pumped at 600 gpm. Wells tapping the full thickness of this unit may have yields more than 1000 gpm. Wells tapping this unit in the flood plain may have a static water level near land surface or possibly may even flow. The water is soft and the concentration of dissolved solids is low.
			Sand and clay		340 (170)	Gray lignitic clay. Contains thin beds of sand.	Top of unit is about −550 feet altitude at Hickman.	A minor aquifer in most of the Jackson Purchase owing to the small percentage of sand. However, a gamma-ray log in the Bondurant quadrangle indicates a larger percent of sand in this area. Water should be soft to moderately hard.
					(170)	Fine- to coarse-grained sand and minor beds of gray lignitic clay. Sand varies in thickness.		
	Paleocene	Midway	Porters Creek Clay		320	Dark gray to black micaceous clay containing beds of fine-grained glauconitic sand in upper part. Slightly glauconitic in some zones. Gray to greenish-gray. Very glauconitic clayey sand, sandy clay, or fossiliferous limestone at base.	Marine deposit; top is about −900 feet altitude at Hickman.	Not an aquifer. The thick section of clay retards the movement of water between the overlying Eocene sand and the underlying Cretaceous sediments.
CRETACEOUS	Upper Cretaceous		Cretaceous sediments, undifferentiated[2]		300+	Dark-gray lignitic clay and sand. Basal gravel on top of Paleozoic bedrock.	Deltaic and possible marine deposits. Cretaceous sediments rest on an eroded Paleozoic rock floor. Altitude of the Cretaceous base is estimated 1,500 feet below mean sea level.	Contains water with a high concentration of dissolved solids. Water is possibly hard to very hard and has an objectionable amount of iron. In southeastern Missouri, many public-supply wells tap the Cretaceous sediments as a source of water supply. Additional supplies of highly mineralized water may be obtained from underlying Paleozoic bedrock.

[1] Age undetermined. Estimates of age range from Pliocene or older to Pleistocene
[2] May contain beds of Clayton age at the top

EXPLANATION

Gravel, Sand, Loess, Clay, Mica, Glauconite, Carbonaceous material, Limestone



Island No. 6 not present and sand bar at Hickman Bend lengthened 1966
Base from 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

APPROXIMATE MEAN DECLINATION, 1968

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

Hydrology by T. W. Lambert, 1966

SCALE 1:24 000
1 ½ 0 1 MILE
1 .5 0 1 KILOMETER
CONTOUR INTERVAL 10 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL

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

The alluvium is water bearing in Area 1 at depths commonly less than 20 feet, although during wet seasons the water table rises within a few feet of the flood plain. Driven wells, about 25 to 50 feet in depth, furnish adequate perennial domestic supplies; shallow wells near the Mississippi River and its tributaries may have water levels below the suction lift of a pitcher pump. Small-diameter jetted wells furnish sufficient water for domestic and/or stock uses. The saturated thickness of alluvial deposits beneath the flood plain of the Mississippi River may be as thick as 125 feet or more. Although the alluvium consists of silt and clay in places and is not suitable for the development of shallow water supplies a well may tap deeper alluvial sandy gravel or sand of Eocene age. Water from alluvial wells contains an objectionable amount of iron and manganese and is very hard. Ground water of better quality occurs in the underlying Eocene sand where separated from the alluvium by Eocene clay

Tu

AREA 2
Water in Eocene sand

Abundant quantities of ground water are available from the Eocene sand at depths ranging from about 100 feet east of Dodd to more than 300 feet along the bluff of the Mississippi River and along the Tennessee State line. Large-capacity wells for industrial purposes will tap Eocene sand below −300 feet altitude. The potential maximum yield of the shallow Eocene aquifers is unknown. The specific capacity of the deep aquifer is probably about 30 gallons per minute per foot of drawdown. In the upland a thick blanket of windblown silt, called loess and sandy gravel or sandy silt of Pliocene (?) age overlies the Eocene sediments. Numerous jetted wells, about 90 feet deep, tap the Pliocene (?) gravel in the Brownsville area. In the eastern half of the quadrangle south of Bayou du Chien, dug wells, shored up with brick or stone, tap a sandy silt phase of the Pliocene (?) gravel. Most of the dug wells are abandoned; although many wells are reported to yield sufficient water for domestic use. These shallow dug wells may be contaminated by surface runoff

Area boundary

Test hole

94–118c / 127
- Saturated thickness, in feet, of gravel or pebbly sand in Area 1; Pliocene(?) sandy gravel in Area 2
- Depth to top of Eocene strata, in feet below land surface
- Lithology of Eocene strata: c, clay or clayey sand; s, sand
- Depth of test hole, in feet below land surface

Water well

Dn, *Driven well, generally 1¼-inch steel casing with sand point on lower end; includes jetted wells in Area 1.*
D, *Drilled or jetted well, generally 2- to 3-inch steel casing with screen on lower end.*
B, *Dug well, shored with brick or stone.*

Qal–7m (H) / 33
- 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

Qal .... Alluvium of Quaternary age
QTg .... Sandy gravel or sandy silt of Pliocene(?) age
Tu .... Sand of Eocene age

YIELD OR ADEQUACY

(580) .... Yield, in gallons per minute
(P) .... Well reported adequate for power pump for domestic and/or stock use
(H) .... Well reported adequate for hand pump or bailer
(A) .... Abandoned or destroyed

QUALITY

Na & K, Cl, F, & NO_3, SO_4, Mg, Ca, HCO_3, 258/292, 4

Chemical composition of dissolved solids

Figure between circular diagram and well location refers to analysis number 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; 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 HICKMAN QUADRANGLE, KENTUCKY-MISSOURI-TENNESSEE

An abundance of ground water for domestic, irrigation, and industrial supplies is available in the west-central part of Fulton County, Kentucky. This valuable resource has not been used and will furnish sufficient amounts of water for future industrial developments and public demands. This atlas, one of a series that includes the entire Jackson Purchase region in western Kentucky, presents information about ground water in an area near Hickman.

The most important aquifers are the alluvial deposits of Quaternary age and the sands of Eocene age. Less important aquifers are the gravel or silt of Pliocene(?) age, the sands of Cretaceous age, and the limestone and dolomite of Paleozoic age.

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

The maximum thickness of the alluvium may be more than 200 feet, but only 165 feet of alluvium has been penetrated by test holes. Most driven wells tap an upper sand, while jetted wells tap an underlying pebbly sand. Driven and jetted wells are labeled as driven wells in the Mississippi River bottoms lands. The depth to the main zone of saturation in the Quaternary alluvium ranges from a few feet below land surface near the valley wall at Hickman to more than 25 feet below land surface near the Mississippi River at low-river stage. Normally throughout the year, the ground water flows from the valley wall toward the river. At high-river stage, the flow of ground water near the river is reversed and wells near the levee may flow. The bottom land north of Hickman is normally flooded each spring. The altitude of the maximum known flood is 316 feet (Hickman gage).

Very little ground water is pumped from the alluvium in this area. Most wells are equipped with small capacity pitcher pumps. The most productive wells yield about 15 gpm (gallons per minute), but larger yields for industrial use can be obtained from wells designed and equipped for this purpose.

Because an abundant quantity of ground water is available from the alluvium, the sands of the Eocene formations in the bottom lands have not been tapped for a water supply. Logs of oil-test holes in the adjacent Bondurant quadrangle, indicate several Eocene aquifers as potential sources of ground water. Wells tapping the deeper sand in the Eocene deposits underlying the flood plain may flow.

A minor aquifer is the gravel or silt of Pliocene(?) age which is tapped by several jetted wells around Brownsville. A few wells north of Brownsville are still in use, but recently many wells are being drilled into the underlying Eocene aquifers. Many dug wells tap the fine-grained facies of the Pliocene(?) gravel southeast of Hickman. They generally yield sufficient water for domestic use, except during long dry periods. Many small springs occur at the contact of the gravel with the underlying Eocene clay.

The principal aquifers in the Hickman quadrangle are the sands of Eocene age. Sparse data indicate the Eocene sediments to be about 1,300 feet thick and to dip generally southward. The Eocene aquifers can be divided into a shallow sand, two deeper sands, and a basal sand. The shallow sand and the upper of the two deep sands, both of which occur above mean sea level are tapped for domestic and farm use. The lower of the deep sands is tapped by the municipal wells in Hickman. The bottoms of the city wells are about 300 feet below mean sea level, but more than 200 feet of sand may be present below the bottoms of the wells. The potential yields of the upper two sands may be more than 100 gpm. The yield of the lower of the two deep sands may be as much as 2,000 gpm. Hickman pumped an average of about 285,000 gallons per day in 1966. The basal sand is too deep for present development.

The water table in the Eocene deposits slopes from the east edge of the quadrangle toward the Mississippi River. The difference in head between each of the Eocene aquifers is not known. Wells tapping the deeper Eocene deposits in the bottom lands may flow. In addition, during floods on the Mississippi River, water levels in Eocene aquifers near the river may show a loading effect caused by the additional weight of the floodwater on the flood plain.

The Porters Creek Clay of Paleocene age, which underlies the Eocene sediments, is not an aquifer; instead, it retards the ground-water movement between the Eocene and underlying Cretaceous sediments. The clay, about 300 feet thick, occurs at an altitude of 900 feet below mean sea level at Hickman.

Sediments of Cretaceous age, below the Porters Creek Clay, are about 300 feet thick and rest on limestone and chert of Paleozoic age. No wells tap the Cretaceous near Hickman, but in southeastern Missouri, many municipal wells tap this strata for their water supply. Wells tapping this unit will flow if they are located in the flood plain. The top of the Paleozoic bedrock is about 1,500 feet below mean sea level at Hickman.

The quality of the water from the alluvium is considered to be adequate for most uses, although some objectionable constituents are present. Water is very hard and contains from 292 to 536 ppm (parts per million) of dissolved solids. Iron and manganese are present in objectionable amounts and may impart a disagreeable taste to the water. More than 0.3 ppm of iron and manganese may cause staining of porcelain and textiles. The high iron and manganese content of the water from the alluvium may limit its use without treatment. Owing to the shallowness of the alluvial water table, shallow wells are susceptible to pollution, which is suggested by those nitrate concentrations that are appreciably higher than the local average. The temperature of the ground water ranges from 58° to 62°F and makes it useful as a coolant.

The quality of water from the Pliocene(?) gravel is similar to that of the alluvium. Owing to the shallowness of the water table and the method of casing, dug wells in the silty phase of the Pliocene(?) gravel southeast of Hickman are susceptible to pollution. These wells are shored with brick or stone and may be polluted by surface runoff. Fortunately, most dug wells are now abandoned. Water has a hardness of about 700 to 900 ppm in the Pliocene(?) silty phase, and about 400 ppm in the gravel near Brownsville.

The water from the Eocene sands is excellent in quality and the quality improves with depth. The water from the shallow Eocene aquifer is moderately hard to hard and contains more than 200 ppm of dissolved solids; water from the deeper Eocene aquifer (about −300 feet altitude) is soft and contains less than 100 ppm of dissolved solids. The water in the shallow Eocene aquifers is generally basic. The water from the city wells at Hickman tapping the deeper sands is slightly acidic and contains 4.5 ppm of iron.

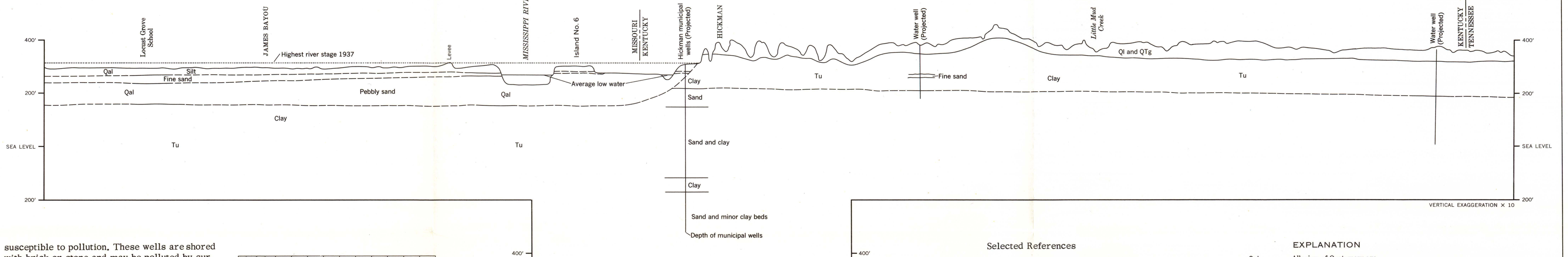
The following table shows the iron content, in parts per million, and the hydrogen-ion concentration, expressed as pH, of the water samples analyzed. A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote increasing alkalinity, values lower than 7.0 indicate increasing acidity. Corrosiveness of water generally increases as pH decreases.

Analysis number	1	2	3	4	5	6	7	8	9	10
Iron content	0.68	0.27	3.1	5.9	0.38	0.27	0.08	1.8[a]	—	—
Manganese content	.28	.16	.75	.20	—	1.2	.10	—	—	—
pH	7.5	7.2	7.4	7.5	8.4	7.6	7.6	6.1	7.0	7.6

Analysis number	11	12	13	14	15	16	17	18	19	20
Iron content	0.29	1.1	7.6	—	5.4	4.7	1.9	0.18	0.86[b]	4.3
Manganese content	.34	.40	1.1	—	.82	—	.30	—	.07[b]	.12
pH	6.4	7.0	8.4	6.9	7.7	—	6.9	7.4	7.5[b]	7.9

Analysis number	21	22	23
Iron content	0.05	6.0	—
Manganese content	.06	.05	—
pH	8.2	6.4	6.8

[a] 1951; in 1958, 4.5 ppm of iron
[b] In solution and sediment



GENERALIZED GEOLOGIC SECTION FROM LOCUST GROVE SCHOOL MISSOURI TO 2.2 MILES SOUTH OF POPULAR GROVE CHURCH KENTUCKY

EXPLANATION

Qal .... Alluvium of Quaternary age
Ql .... Loess of Pleistocene age
QTg .... Sandy gravel or silt of Pliocene(?) age
Tu .... Sand and clay of Eocene age
Tpc .... Porters Creek Clay of Paleocene age

Selected References

Grohskopf, J. G., 1955, Subsurface geology of the Mississippi Embayment of southeast Missouri: Missouri Geol. Survey and Water Resources, 2d ser., v. 37, 133 p.

Krinitzsky, E. L., and Wire, J. C., 1964, Ground water in alluvium of the lower Mississippi valley (upper and central areas): U. S. Corps of Army Engrs., Tech. Rept. 3-658, v. 2.

MacCary, L. M., and Lambert, T. W., 1962, Reconnaissance of ground-water resources of the Jackson Purchase region, Kentucky: U.S. Geol. Survey Hydrol. Inv. Atlas HA-13, 9 p.

Milhous, H. C., 1959, Well logs in Tennessee: Tennessee Div. Geol., Bull. 62, 606 p.

AVAILABILITY OF GROUND WATER IN THE HICKMAN QUADRANGLE, KENTUCKY-MISSOURI-TENNESSEE

By

T. W. Lambert

1968

For sale by U.S. Geological Survey, price 75 cents