DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
WILLIAM T. PECORA, DIRECTOR

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

HYDROLOGIC INVESTIGATIONS
ATLAS HA-178 (SHEET 1 OF 2)

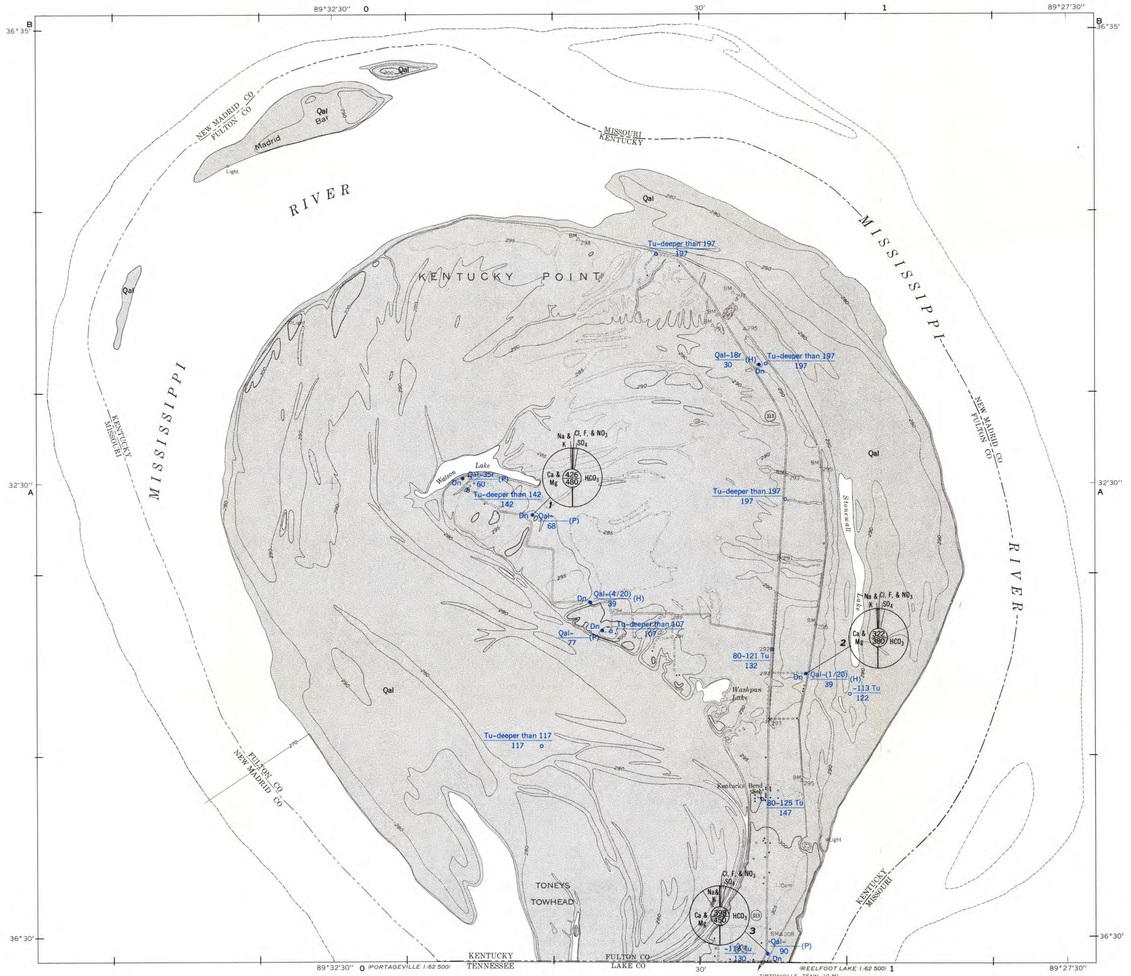
GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTER OF GEOLOGIC FORMATIONS

SYSTEM	SERIES	GROUP	FORMATION	SECTION	THICKNESS, IN FEET	LITHOLOGY	TOPOGRAPHY AND GEOLOGIC SETTING	HYDROLOGY
QUATERNARY	Pleistocene and Recent		Alluvium		0-250	Light to dark gray lignitic fine- to medium-grained sand and clayey silt. Upper few feet is dark brown to black mucky silt.	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; its axis trends westward from near Anne Lynie to Watson Lake.	Water bearing in area 1. Shallow driven wells (less than 25 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 of many of the shallow wells each year. Iron and manganese are present in objectionable amounts. More than 0.3 ppm of iron and manganese imparts a disagreeable taste and may stain porcelain and textiles. The water is hard to very hard and contains a large amount of dissolved solids. Water systems may require iron removal and softener units.
						Light to dark gray lignitic pebbly sand. Contains an abundance of dark-colored grains in fine- to coarse-grained sand. Coarse sandy gravel in a major east-west trending buried channel. Gravel is derived from Paleozoic bedrock and from glacial outwash. Granular to small pebbles of white quartz are common.		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 and sand[1]		0-43	Reddish-brown sandy gravel. Upper part is silty clayey sand.	Underlies loess in upland. May crop out along the bluff in the badlands.	Not an important aquifer, although some wells are completed in the Pliocene(?) gravel at Brownville in the adjacent Hickman quadrangle. One auger hole encountered water-bearing gravel above clay just north of the State line. Water is very hard.
			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.	Occurs at depth under the upland and may underlie the alluvium in part of the area. Base of unit occurs about 220 feet below land surface north of Miller.	Not an important aquifer. The sand may supply sufficient water to wells for domestic use. The water is moderately hard. Iron is present in objectionable amounts; however, the high iron content may result from chemical reaction of the acidic ground water on steel casing and plumbing.
			Silt and sand		30	Gray sandy silt, lignitic.		
			Sand and clay		300	Fine- to coarse-grained sand and gray lignitic clay. The amount of sand varies greatly.	Base of unit occurs about 540 feet below land surface north of Miller.	An important undeveloped aquifer. No wells known to tap this unit in this area. Yields of more than 500 gpm may be possible. Locally, the unit contains a high percentage of clay and thus well yields would be lower. The water is soft to moderately hard and contains little dissolved material.
TERTIARY	Eocene		Clay		70	Gray lignitic clay and thin beds of sand.	Base of unit occurs about 620 feet below land surface north of Miller.	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.	Base of unit occurs about 990 feet below land surface north of Miller.	An important aquifer used for municipal supply at Hickman, Fulton-South Fulton and Tiptonville 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 1,000 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.
			Clay and basal sand		170 340 170	Gray lignitic clay. Contains thin beds of sand. Fine- to coarse-grained sand and minor beds of gray lignitic clay. Sand varies in thickness.	Base of unit occurs 1,324 feet below land surface in an oil-test hole north of Miller.	A minor aquifer in most of the Jackson Purchase owing to the small percentage of sand. However, a gamma-ray log indicates a larger percent of sand in this area of report and larger yields may be obtained. Some of the shallow aquifers give better yields than artesian aquifers and will be developed first. Water should be soft to moderately hard.
	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 limestone at base.	Marine deposit concealed beneath the sediments of Eocene age at depth greater than 1,100 feet.	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 Paleozic bedrock.	Three oil-test holes penetrated the Cretaceous at depth of 1,650 feet below the flood plain. The Cretaceous sediments rest on an eroded Paleozoic rock floor. Depth to the base of Cretaceous at Miller is 1,960 feet; at Bondurant, 1,985 feet; and at Hamby Pond, 1,907 feet.	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 Paleozic 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

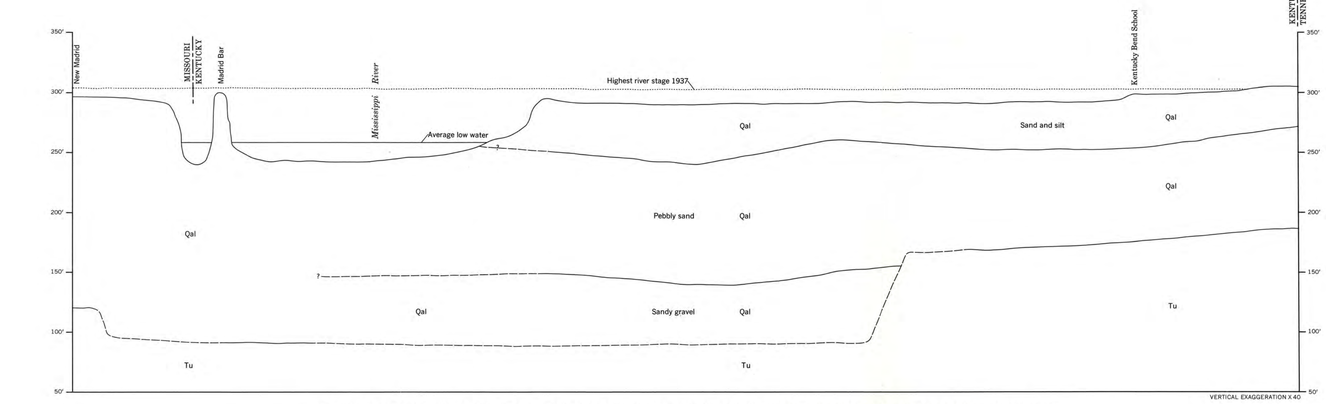


Base from U.S. Geological Survey, 1951
The Carter Coordinate System letters and numbers used to designate five-minute divisions of latitude and longitude are shown along the margins; tick marks indicate one-minute division.

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

Hydrology by T. W. Lambert, 1965

SCALE 1:24 000
1 MILE
1 KILOMETER
CONTOUR INTERVAL 10 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL
KENTUCKY
MAP LOCATION



GENERALIZED GEOLOGIC SECTION FROM THE TENNESSEE STATE LINE ALONG STATE HIGHWAY 313 AND THROUGH MADRID BAR

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

Water in Quaternary alluvium

The alluvium is water bearing at depths commonly less than 20 feet, although during the rainy season the water table rises to within a few feet of the flood plain. Driven wells, about 25 feet in depth, furnish perennial domestic supplies; shallow wells near the Mississippi River are reported to be dry during low river stages. Small-diameter jetted wells, about 80 feet deep, furnish sufficient water for domestic and/or stock uses. The saturated thickness of alluvial deposits beneath the flood plain of the Mississippi River ranges from about 80 feet to more than 200 feet. Although the alluvium consists of silt and clay in places and is not suitable for the development of shallow water supplies, a well can tap deeper alluvial sand or the sand of Eocene age. Water from alluvial wells contains an objectionable amount of iron and manganese and is hard to very hard. Ground water of better quality occurs in the underlying Eocene sand at depths of 200 feet or more. This area has a large potential ground-water source for demands of irrigation or of industries

Test hole

80-125 Tu / 147 — Saturated thickness of alluvial gravel; Depth to top of Eocene rocks; Geologic unit underlying alluvium; Depth of test hole

Dn — Water well

Dn, *Driven or jetted well, generally 1 1/4- to 2 1/2-inch steel casing with drive point or well screen on lower end*

Qal -(5/8)m 50 (H) — Aquifer (see below); Water level in well, in feet below land surface; m, if measured, r, if reported. Upper figure is the level measured in April of 1965; lower figure is level measured in October of 1965; Yield, in gallons per minute, or adequacy (see below); Depth of well, in feet below land surface

AQUIFER SYMBOL

Qal ..... Alluvium of Quaternary age

YIELD OR ADEQUACY

(P) ..... Well reported adequate for power pump for domestic and/or stock supply
(H) ..... Well reported adequate for hand pump or bailer

QUALITY

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

EXPLANATION

Qal ..... Alluvium of Quaternary age
Tu ..... Sand or clay of Eocene age

AVAILABILITY OF GROUND WATER IN PARTS OF THE NEW MADRID SE HUBBARD LAKE, AND BONDURANT QUADRANGLES, JACKSON PURCHASE REGION, KENTUCKY-TENNESSEE

An abundance of ground water for domestic, irrigation, and industrial supplies is available in the southwestern part of Fulton County, Kentucky. This valuable resource has not been exploited and will furnish sufficient amounts of water for future industrial developments and public demands.

The most important aquifers (geologic formations that yield water) are the alluvial deposits and the sands of the Eocene formations. Less important aquifers are the deeper Cretaceous sediments and the Paleozoic limestones and dolomites. An auger hole in the upland also found water-bearing Pliocene(?) gravel above Eocene clay. Several wells in the upland in the adjacent Hickman quadrangle tap Pliocene(?) gravel and furnish sufficient water for domestic use.

The depth to the main zone of saturation in the Quaternary alluvium ranges from a few feet below land surface near the valley wall in the southeastern corner of Bondurant quadrangle to more than 25 feet below land surface near the Mississippi River. The maximum thickness of the alluvium may be 250 feet. The saturated thickness ranges from about 80 to more than 200 feet. Most driven wells tap an upper sand, while jetted wells tap the underlying pebbly sand. 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.

Very little water is withdrawn from the alluvium in this area. Probably more than three-fourths of the wells are equipped with pitcher pumps. The most productive wells yield about 5 gallons per minute, but large yields for industrial demands can be obtained from wells designed and constructed to pump a greater quantity of water.

Because an abundant quantity of ground water is available from the alluvium, the sands of the Eocene formations in the bottomlands have not been tapped for water supply. Only one well in the area is known to tap an upper Eocene sand and this well is in the upland in the southeastern corner of the Bondurant quadrangle. Three important Eocene aquifers are available for development by industry. In an oil-test hole north of Miller, these aquifers are at depths of 200-540 feet, 610-990 feet, and 1,200-1,320 feet. Wells tapping the deeper sand in the Eocene underlying the flood plain may have a sufficient head to flow at the land surface.

The shallowest water-bearing unit that will yield a dependable supply of ground water is shown on the water-availability map. For example, the color pattern for area 1 at Miller in the southwestern corner of the Bondurant quadrangle indicates that the shallowest source of a dependable supply is the main zone of saturation in the alluvium, the upper surface of which occurs a few feet below land surface. Well data indicate the depth of wells and the depth to water in the alluvium; chemical analyses indicate the chemical composition of the water. The explanation indicates other aquifers that may be tapped and geologic cross sections show the occurrence of the various geologic units beneath the surface.

The quality of the water from the alluvium in the main zone of saturation is considered to be good for most uses although some objectionable constituents are present. The concentration of dissolved solids ranges between 250 to 550 ppm (parts per million) and the water is hard to very hard. 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 content of the water from the alluvium may limit the use of the water unless it is treated for removal. Owing to the shallowness of the water table, shallow wells are susceptible to pollution, which is suggested by nitrate concentrations that are appreciably higher than the average for the Jackson Purchase region. The temperature of the water ranges from 58° to 62°F throughout the year and makes it useful as a coolant.

The quality of the water from the Eocene is excellent for many uses. The concentration of dissolved solids is less than 150 ppm and decreases with depth. Water from the municipal wells at Hickman, about 4 miles east of this area, contains about 70 ppm of dissolved solids. The water is slightly acidic and is somewhat corrosive. Water from shallow drilled wells may contain objectionable amounts of iron which is probably the result of a chemical reaction of acidic ground water on steel well casing and pump equipment. Large concentrations of iron are rarely present in water from shallow wells that have plastic casing and plastic plumbing. Water from deep wells may also contain objectionable amounts of iron. The temperature of the water ranges from 58° to 64°F.

The following table shows the iron and manganese content, in parts per million, and the hydrogen-ion concentration, expressed as pH, of the water analyses shown by circular diagrams on the maps. 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	18	4.6	17	6.1	6.8	0.67	12	0.42	4.3	8.8
Manganese content	—	—	—	—	0.29	—	6.3	0.13	—	—
pH	7.1	7.2	7.1	7.1	7.1	6.7	6.9	6.4	7.2	7.3

Analysis number	11	12	13	14
Iron content	9.6	0.40	14	5.6
Manganese content	—	2.7	—	0.41
pH	6.8	7.4	7.0	6.6

Selected References

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INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1967—W97148

New Madrid SE and western Hubbard Lake quadrangles

AVAILABILITY OF GROUND WATER IN PARTS OF THE NEW MADRID SE, HUBBARD LAKE, AND BONDURANT QUADRANGLES JACKSON PURCHASE REGION, KENTUCKY-TENNESSEE

By
T. W. Lambert

1967

HYDROLOGIC INVESTIGATIONS
ATLAS HA-178 (SHEET 1 OF 2)

For sale by U.S. Geological Survey, price $1.00 per set

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HYDROLOGIC INVESTIGATIONS
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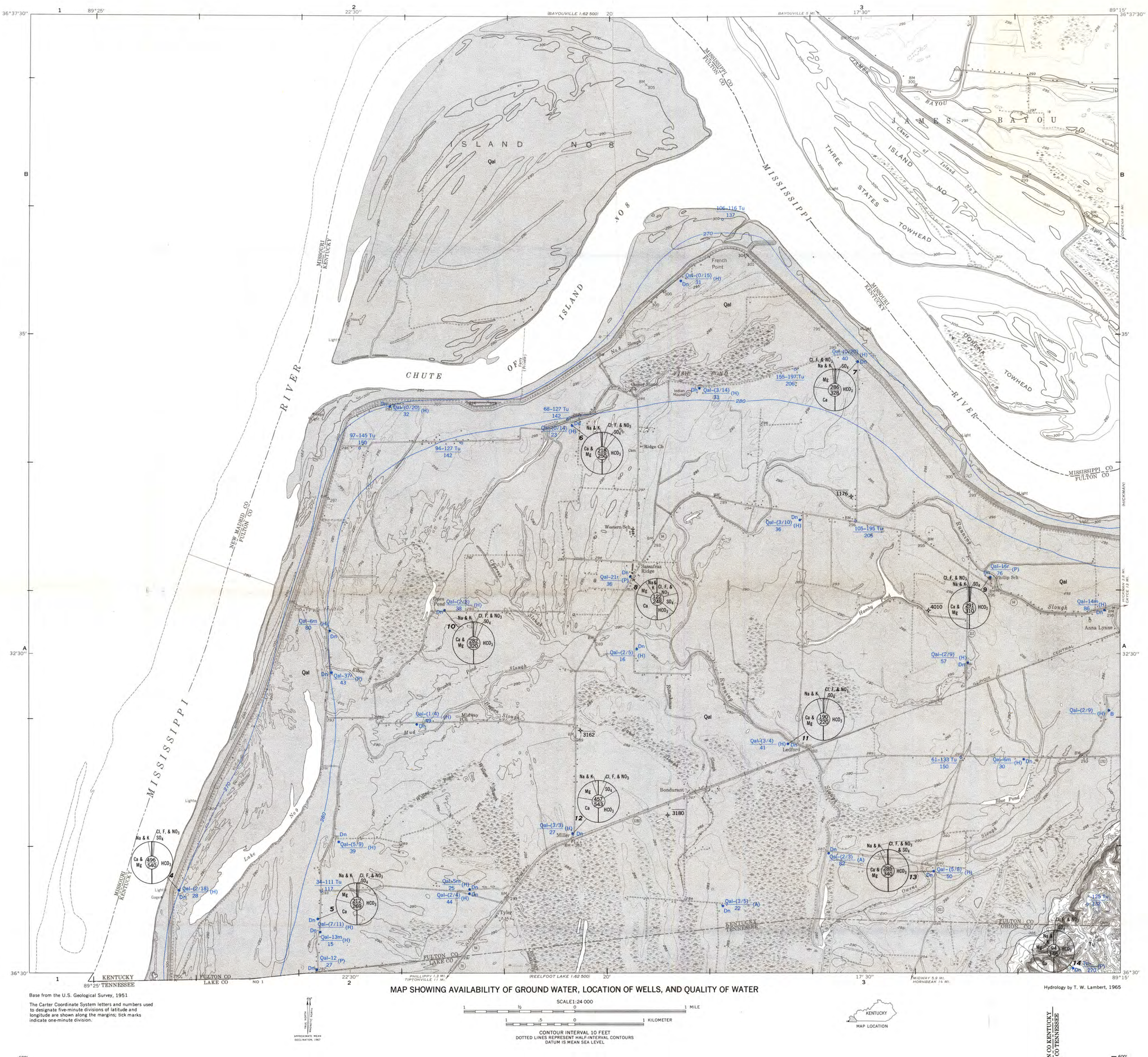


MAP SHOWING AVAILABILITY OF GROUND WATER, LOCATION OF WELLS, AND QUALITY OF WATER

Hydrology by T. W. Lambert, 1965

Base from the 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 division.

SCALE 1:24 000
1 MILE
1 KILOMETER

CONTOUR INTERVAL 10 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL

KENTUCKY
MAP 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 the rainy seasons the water table rises to within a few feet of the flood plain. Driven wells, about 25 feet in depth, furnish perennial domestic supplies; shallow wells near the Mississippi River are reported to be dry during low river stages. Small diameter jetted wells, about 80 feet deep, furnish sufficient water for domestic and/or stock uses. The saturated thickness of alluvial deposits beneath the flood plain of the Mississippi River ranges from about 80 feet to more than 200 feet. Although the alluvium consists of silt and clay in places and is not suitable for the development of shallow water supplies, a well can tap deeper alluvial sand or the sand of Eocene age. Water from alluvial wells contains an objectionable amount of iron and manganese and is hard to very hard. Ground water of better quality occurs in the underlying Eocene sand at depths of 200 feet or more. This area has a large potential ground-water source for demands of irrigation or of industries

Tu

AREA 2
Water in Eocene sand

Abundant quantities of ground water are available in the Eocene sand at depths ranging from about 270 to more than 1,500 feet. One well 270 feet deep taps the Eocene. The water is moderately hard and contains an objectionable amount of iron, which may be caused by the reaction between acidic ground water on steel casing and pump apparatus. More than 0.3 ppm of iron imparts a disagreeable taste to water and may cause staining of porcelain and textiles

Area boundary

3162 — Oil-test well
Figure below line is depth of test well

Test hole
- Saturated thickness of alluvial gravel
- 94-127 Tu / 142 — Depth to top of Eocene rocks; Geologic unit underlying alluvium or Pliocene (?) gravel
- Depth of test hole

Dn — Water well
Dn, Driven or jetted well, generally 1 1/4- to 2 1/2-inch steel casing with drive point or well screen on lower end
B, Dug well, wooden casing

- Qal-(5/8)m / 50 (H) — Aquifer (see below); Water level in well, in feet below land surface; m, if measured, r, if reported. Upper figure is the level measured in April of 1965; lower figure is level measured in October of 1965
- Yield, in gallons per minute, or adequacy (see below)
- Depth of well, in feet below land surface

AQUIFER SYMBOLS

Qal — Alluvium of Quaternary age
Tu — Sand of Eocene age

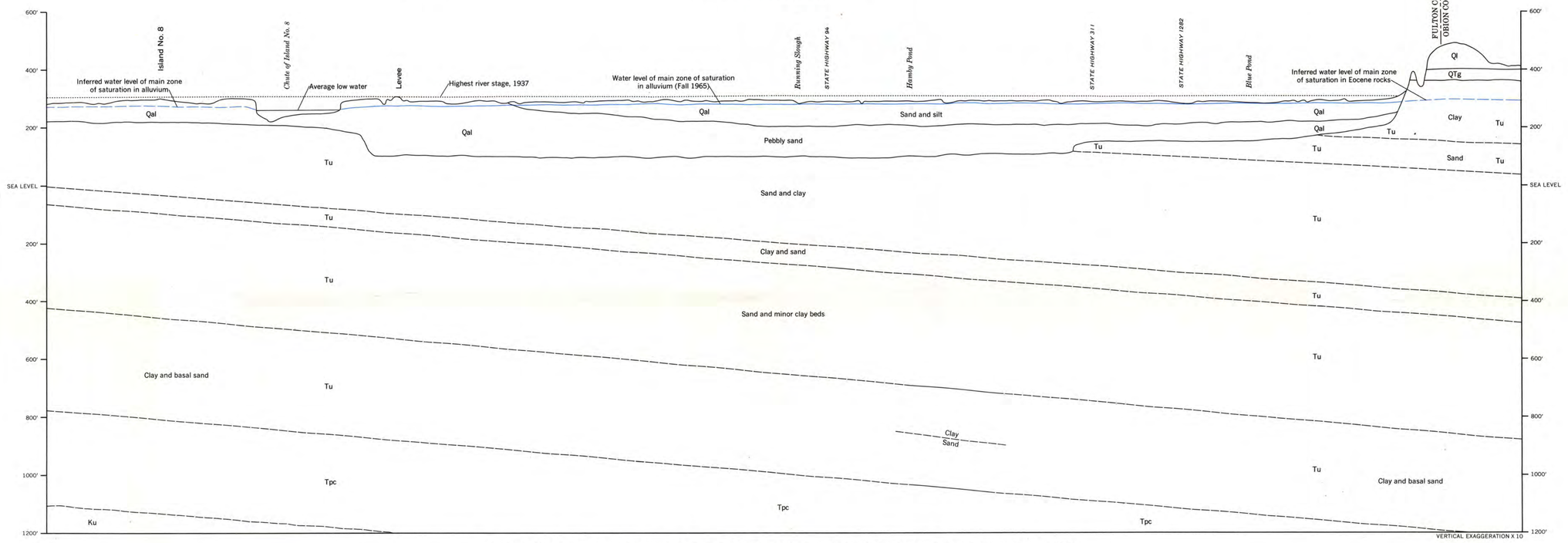
YIELD OR ADEQUACY

(P) — Well reported adequate for power pump for domestic and/or stock supply
(H) — Well reported adequate for hand pump or bailer
(A) — Abandoned

280 — 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 land surface and water-level contour. The water is confined where clay occurs at, or below, the altitude of the contour. Water-level measurements taken in October 1965

QUALITY

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



GENERALIZED GEOLOGIC SECTION FROM ISLAND NO. 8 TO UPLAND IN SOUTHEASTERN BONDURANT QUADRANGLE

EXPLANATION

Qal — Alluvium of Quaternary age
Ql — Loess of Pleistocene age
QTg — Gravel and sand of Pliocene (?) age
Tu — Sand and clay of Eocene age
Tpc — Porters Creek Clay of Paleocene age
Ku — Cretaceous sediments, undifferentiated

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Bondurant and eastern Hubbard Lake quadrangles

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