Department of the Interior
United States Geological Survey

Prepared in cooperation with the
Mississippi Board of Water Commissioners
Jack W. Pepper, Water Engineer

WATER-RESOURCES INVESTIGATIONS 76-79
SHEET 1 OF 3 OPEN-FILE REPORT

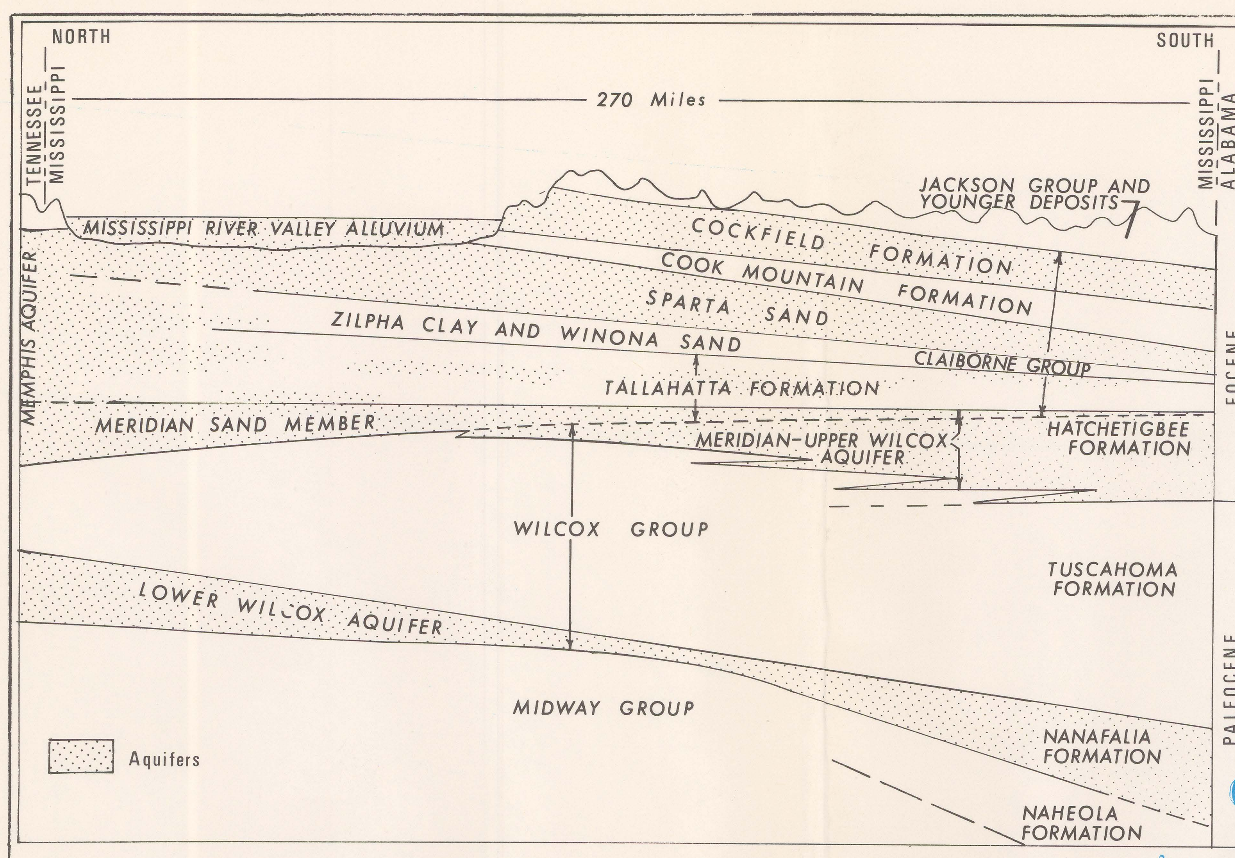


Figure 2.--Relation of Meridian-upper Wilcox aquifer to geologic and hydrologic units.

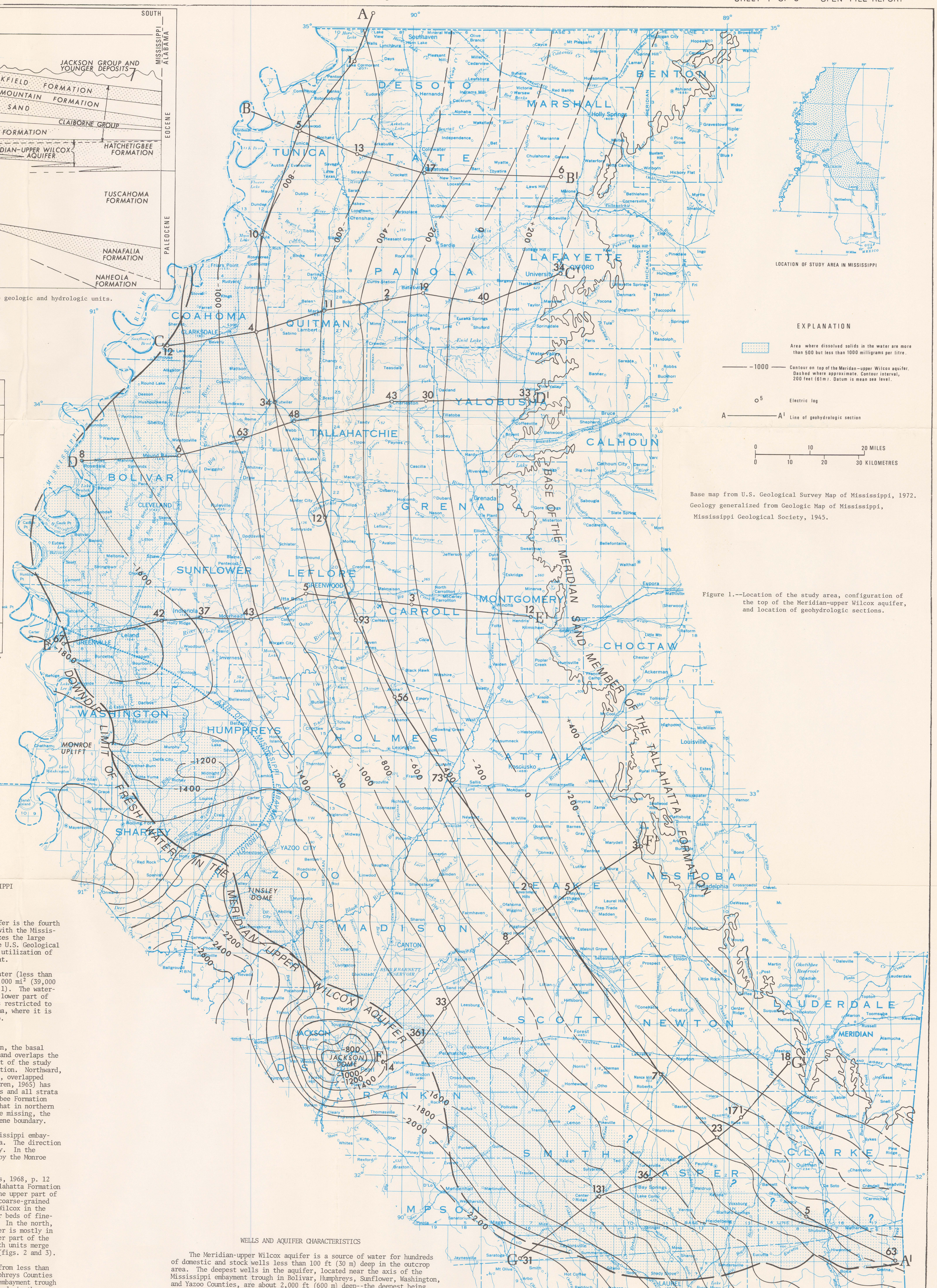
Table 1.--Stratigraphic units and major aquifers.

Erathem	System	Series	Group	Mississippi: Northern part	Mississippi: Central part	Major aquifers
Cenozoic	Quaternary	Pleistocene and Holocene		Mississippi River alluvium and terrace deposits	Alluvium and terrace deposits, undifferentiated	Mississippi River valley alluvial aquifer
Cenozoic	Tertiary	Eocene	Jackson Group	Undifferentiated	Undifferentiated	
			Claiborne Group	Cockfield Formation	Cockfield Formation	Cockfield Formation
				Cook Mountain Formation	Cook Mountain Formation Gordon Creek Shale Member Potterchitto Sand Member Archusa Marl Member	
				Sparta Sand	Sparta Sand	Sparta Sand
				Zilpha Clay	Zilpha Clay	
				Winona Sand	Winona Sand	
				Tallahatta Formation	Tallahatta Formation Neshoba Sand Member Basic City Shale Member Meridian Sand Member	Meridian-upper Wilcox aquifer
			Wilcox Group	Undifferentiated	Hatchetigbee Formation Bashi Marl Member	Meridian-upper Wilcox aquifer
		Paleocene			Tuscahoma Formation	
					Nanafalia Formation Fearn Springs Member	lower Wilcox aquifer
			Midway Group	Porters Creek Clay Tippah Sand Lentil	Naheola Formation Porters Creek Clay Matthews Landing Marl Member	
				Clayton Formation	Clayton Formation	
Mesozoic	Cretaceous	Upper Cretaceous	Selma Group	Undifferentiated	Undifferentiated	

(In part from Cushing and others, 1970, Table 1, and Berggren, 1965, Figure 1).

To convert English units to International System units

Multiply	By	To obtain
feet(ft)	0.3048	metres(m)
miles(mi)	1.609	kilometres(km)
square miles(mi^2)	2.590	square kilometres(km^2)
gallons per minute(gal/min)	.06309	litres per second(l/s)
million gallons per day (Mgal/d)	.044	cubic metres per second(m^3/s)
feet per mile(ft/mi)	.189	metres per kilometre(m/km)
gallons per minute per foot of drawdown[(gal/min)/ft]	.21	litres per second per metre [(l/s)/m]
cubic feet per day per square foot[(ft^3/d)/ft^2]	.305	cubic metres per day per square metre[(m^3/d)/m^2]
cubic feet per day per foot [(ft^3/d)/ft]	.093	cubic metres per day per metre [(m^3/d)/m]



Base map from U.S. Geological Survey Map of Mississippi, 1972.
Geology generalized from Geologic Map of Mississippi, Mississippi Geological Society, 1945.

Figure 1.--Location of the study area, configuration of the top of the Meridian-upper Wilcox aquifer, and location of geohydrologic sections.

THE MERIDIAN-UPPER WILCOX AQUIFER IN MISSISSIPPI

INTRODUCTION

This description of the Meridian-upper Wilcox aquifer is the fourth in a series of aquifer atlases prepared in cooperation with the Mississippi Board of Water Commissioners. The report summarizes the large amount of unpublished data available in the files of the U.S. Geological Survey and describes the extent, character, and present utilization of the aquifer, and its potential for additional development.

The Meridian-upper Wilcox aquifer contains fresh water (less than 1,000 milligrams per litre of dissolved solids) in a 15,000 mi^2 (39,000 km^2) area in northwestern and central Mississippi (fig. 1). The water-bearing zone extends into Tennessee, where it forms the lower part of the Memphis aquifer; into northern Arkansas, where it is restricted to the Carrizo Sand of the Claiborne Group; and into Alabama, where it is mostly in the Hatchetigbee Formation of the Wilcox Group.

GEOLOGY AND HYDROLOGY

The Meridian Sand Member of the Tallahatta Formation, the basal unit of the Claiborne Group (table 1), was deposited on and overlaps the eroded surface of the Wilcox Group. In the southern part of the study area the uppermost Wilcox unit is the Hatchetigbee Formation. Northward, the Hatchetigbee cannot be identified, and the truncated, overlapped Wilcox beds are progressively older. Recent work (Berggren, 1965) has shown the Wilcox Group to be of Paleocene and Eocene ages and all strata below the Bashi Marl Member at the base of the Hatchetigbee Formation are assigned to the Paleocene; therefore, it is likely that in northern Mississippi, where some of the younger Wilcox beds may be missing, the base of the Meridian Sand Member marks the Paleocene-Eocene boundary.

The strata dip westward toward the axis of the Mississippi embayment trough in the northern and western parts of the area. The direction of dip changes gradually to the southwest in Wayne County. In the southwestern part of the area the structure is affected by the Monroe uplift and the Jackson and Tinsley Domes (fig. 1).

The Meridian-upper Wilcox aquifer (Hosman and others, 1968, p. 12 and pl. 5) comprises the Meridian Sand Member of the Tallahatta Formation and discontinuous hydraulically connected sand beds in the upper part of the Wilcox Group (table 1). The Meridian is a fine- to coarse-grained sand that is commonly micaceous. The upper part of the Wilcox in the central and southern parts of the area includes irregular beds of fine- to medium-grained sand that are hydraulically connected. In the north, the upper part of the Wilcox is sandy clay and the aquifer is mostly in the Meridian Sand Member. In the extreme north, the upper part of the Tallahatta Formation above the Meridian is sandy, and both units merge into the lower part of the Memphis aquifer in Tennessee (figs. 2 and 3).

The aggregate sand thickness of the aquifer ranges from less than 50 ft (15 m) to about 500 ft (150 m). In Holmes and Humphreys Counties the Meridian Sand Member accumulated in the Mississippi embayment trough to a maximum thickness of about 500 ft (150 m), and the beds in the upper part of the Wilcox are not a significant part of the aquifer. In Clarke County the other extreme occurs--the Meridian Sand Member in places is less than 20 ft (6 m) thick but the hydraulically connected upper Wilcox sand and clay beds in the Hatchetigbee Formation are more than 400 ft (120 m) thick. Individual sand beds of the upper Wilcox are commonly less than 50 ft (15 m) thick (figs. 3-9).

Figure 10 shows the area where the deepest fresh water is in the Meridian-upper Wilcox and where the underlying lower Wilcox (Boswell, 1975) contains fresh water. The next shallower major aquifer, the Sparta Sand of the Claiborne Group (Newcome, 1976), overlies about three-fourths of the area where the Meridian-upper Wilcox contains fresh water (fig. 10).

WATER USE

The Meridian-upper Wilcox aquifer is the source of ground water for over 100 municipal, community, and institutional water systems in northwestern and central Mississippi (table 2 and fig. 11). The largest withdrawal of ground water from the aquifer is at Greenwood, where about 5 Mgal/d (260 l/s) was pumped in 1975. The total withdrawal in Mississippi in 1975 was about 34 Mgal/d (1,400 l/s).

Utilization of the aquifer has been minimal in some areas because the water is corrosive or contains iron (fig. 12 and 13), and better water is available from the lower Wilcox aquifer. In some of these areas the aquifer is a reserve source for very large supplies of water.

RECHARGE, MOVEMENT, AND WATER LEVELS

The Meridian-upper Wilcox aquifer crops out in the hills of northern and east-central Mississippi. The exposed sand beds are recharged by rainfall. Ground water moved from the recharge areas toward the west and south before withdrawals began. Beginning about 1896, free-flowing wells were constructed in the aquifer in the Mississippi Alluvial Plain, and by 1939 an extensive depression in the potentiometric surface (Brown, 1947, p. 39 and pl. 12) had become the focus of ground-water movement in the aquifer in northwestern Mississippi. Since 1939, withdrawals for public and industrial water supplies have increased and the depression has become deeper and larger (fig. 14).

The altitude difference between the recharge area and the relatively low Mississippi Alluvial Plain produced artesian pressures that may have been capable of supporting water levels more than 150 ft (46 m) above the alluvial plain before the aquifer was used extensively. The highest measured head was 143.2 ft (43.6 m) above land surface in Yazoo County (figs. 15 and 16, well B103). This was measured in 1954, and heads were greater in earlier years.

Long-term water-level trends indicate an average decline of about 1 ft (0.3 m) per year (figs. 15 and 16). In some localities near the recharge area the water levels have not changed significantly, because of the availability of precipitation for recharge, absence of pumping, and high hydraulic conductivity.

In extreme northwestern Mississippi the entire section from the base of the Meridian Sand Member to the top of the Sparta Sand is mostly sand and pumpage of about 188 Mgal/d (8.2 m^3/s) in 1975 at Memphis, Tenn., (Criner and Parks, 1976, in press) has contributed to water-level decline in the connected aquifers to the south.

WELLS AND AQUIFER CHARACTERISTICS

The Meridian-upper Wilcox aquifer is a source of water for hundreds of domestic and stock wells less than 100 ft (30 m) deep in the outcrop area. The deepest wells in the aquifer, located near the axis of the Mississippi embayment trough in Bolivar, Humphreys, Sunflower, Washington, and Yazoo Counties, are about 2,000 ft (600 m) deep--the deepest being 2,106 ft (642 m). The highest production, 2,800 gal/min (180 l/s) is from a 210-ft (64 m) well in Grenada County. Table 2 shows well data for water-supply systems that produce water from the Meridian-upper Wilcox aquifer.

The coefficient of storage determined in 5 pumping tests made in the Meridian-upper Wilcox aquifer averaged 0.0002. Other hydraulic characteristics determined during 23 pumping tests are summarized in the following table.

	Transmissivity		Hydraulic conductivity		Specific capacity	
	(ft^3/d)/ft	(m^3/d)/m	(ft^3/d)/ft^2	(m^3/d)/m^2	(gal/min)/ft	(l/s)/m
High	17,400	1,620	110	34	29	6.1
Median	4,000	370	46	14	6	1.3
Low	150	14	9	2.7	.7	.15
No. of tests	23	23	22	22	16	16

Note: To convert transmissivity and hydraulic conductivity, in cubic feet per day, to the older terms of transmissibility and permeability, in gallons per day, multiply by 7.48.

Aquifer and well characteristics, such as those in the table, can be used in planning well spacing so as to minimize well interference and to provide the highest efficiency in producing water (fig. 17).

QUALITY

Water from the Meridian-upper Wilcox aquifer is a soft, sodium bicarbonate type. Generally, the water is of good quality (table 3).

The dissolved-solids concentration in the water increases downdip to the west and south. Figure 1 shows the approximate position of the 500 mg/l-1,000 mg/l zone and the position of the fresh water-salt water interface. In the western part of the area some sacrifice is made in water quality to take advantage of static levels many feet above the ground.

The aquifer is not used extensively in places in the northern part of the area owing to corrosiveness (fig. 12) and to the availability of noncorrosive water from deeper aquifers. Excessive iron in solution (more than 0.3 mg/l) is usual in the part of the area shown in figure 13. Figures 12 and 13 show where fluoride and color occur in undesirable concentrations. Anomolous high concentrations of iron and color may occur anywhere.

The temperature of water in shallow wells is about the same as the mean annual temperature, which ranges from 62°F (16.9°C) in De Soto County to 66°F (18.9°C) in Warren County. The depth-temperature relation for ground water in northern Mississippi (fig. 18) is based on a mean annual temperature of 64°F (17.8°C).

POTENTIAL FOR ADDITIONAL DEVELOPMENT

The depression in the potentiometric surface of the Meridian-upper Wilcox aquifer in northwestern Mississippi is a response to long-term withdrawals but not necessarily an indication of an impending critical ground-water situation. The volume of water flowing into the aquifer in northwestern Mississippi is larger than it was in 1939--a result of steeper hydraulic gradients. Water levels will continue to decline, hydraulic gradients will increase, and the volume of inflow will increase as pumping in the area continues to increase. The principal limiting factors for future withdrawals will be the cost of pumping from greater depths (in an area where static levels are now generally above land surface) and--in the western and southern part of the area--a degradation in water quality caused by the updip movement of saline water in response to pumping.

In Area I (fig. 19) the Meridian-upper Wilcox (mostly the Meridian Sand Member) is capable of yielding 1 Mgal/d (43.8 l/s) or more to individual wells and the production from well fields is limited principally by the pumping lift and the availability of enough area for proper spacing of wells (fig. 17).

In Area II the sand beds in the Wilcox Group become a significant part of the aquifer. The Wilcox sand beds generally are less productive than the Meridian Sand Member and wells producing 1 Mgal/d (43.8 l/s) are not common.

Area III is the area of low potential for the aquifer. The Meridian Sand Member is thin and irregular in thickness. Sand beds in the Wilcox share these characteristics.

In Areas I, II, and III, water from the aquifer needs treatment because of its corrosiveness or excessive iron content at many places; however, the increasing cost of producing water from deeper sources in the future may be greater than the cost of treating Meridian-upper Wilcox water. In Area IV, however, water from the aquifer likely will be used only for supplies that can tolerate more than 500 mg/l in dissolved solids and high color.

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1976

Jackson, Mississippi

Cartography by Frances M. Hester