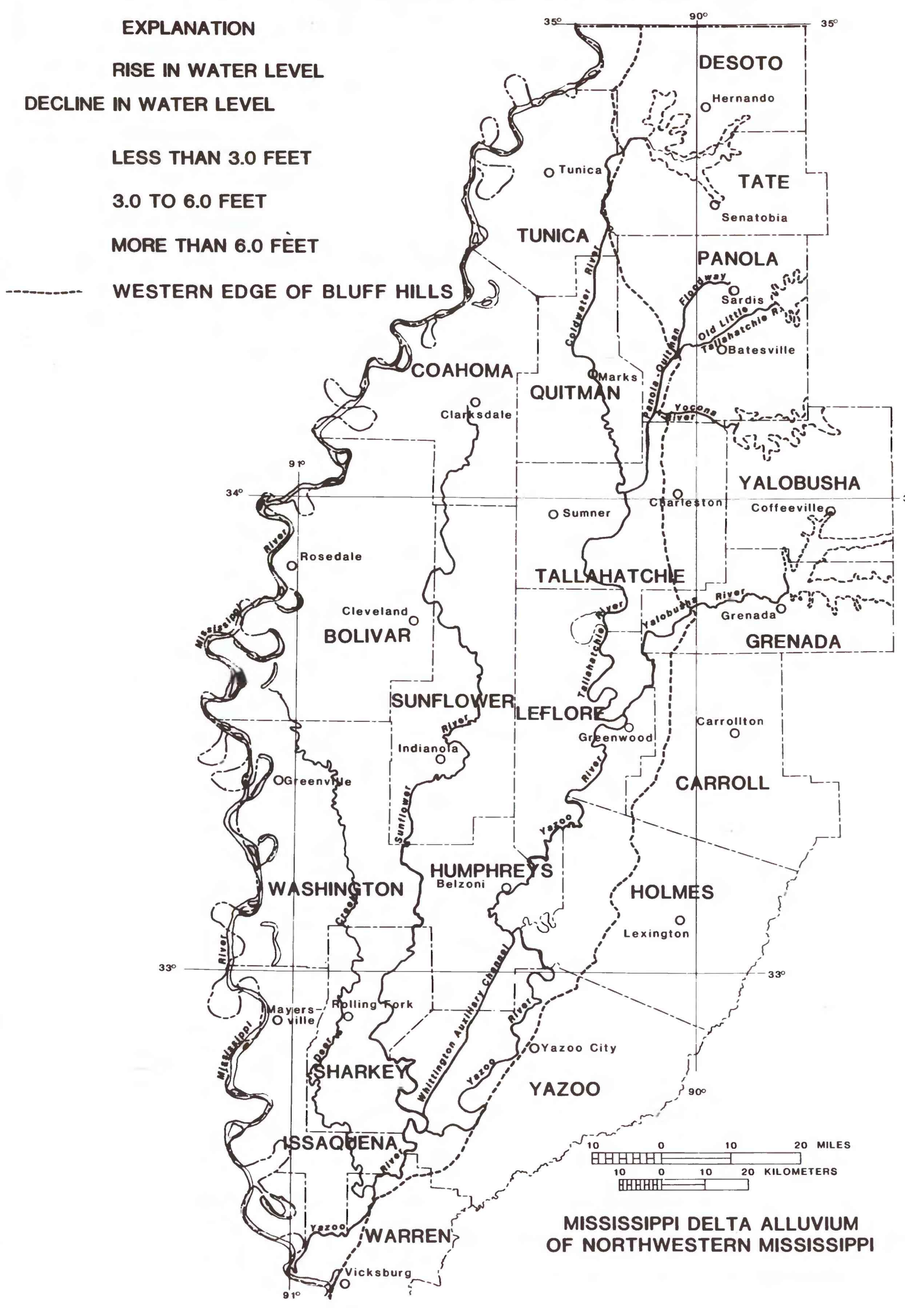
Department of the Interior
United States Geological Survey

Prepared in cooperation with the
Mississippi Department of Natural Resources
Bureau of Land and Water Resources

WATER-RESOURCES INVESTIGATIONS REPORT 84-4346

## WATER-LEVEL CHANGE MAP SEPTEMBER 1980-SEPTEMBER 1983




MISSISSIPPI DELTA ALLUVIAL
OF NORTHWESTERN MISSISSIPPI

## INTRODUCTION

The Mississippi River Valley alluvium extends over an area of about 7,000 square miles in northwestern Mississippi. This area, known locally as the Delta, is extremely productive agriculturally due to the fertile soil, favorable climate, and plentiful water. Cotton, rice, soybeans, and catfish are all grown in abundance. The Delta possesses all the characteristic features of an active alluvial plain--low relief, oxbow lakes, abandoned stream channels, natural levees, backswamp areas and bayous. Land surface slopes gently southward. the study area, extending from near Memphis, Tennessee, south to Vicksburg, Mississippi, is bordered on the west by the Mississippi River and on the east by the Bluff Hills.

This report is one in a series of reports that describes the results of a study to measure and analyze water-level changes occurring in the alluvial aquifer. Water-level measurements have been made twice each year since September 1980, preceding and following the annual pumping season. Water-level altitudes in observation wells and altitudes of some stream stages were used to prepare the potentiometric map. The depth-to-water map was prepared using water-level measurements made in September 1983. The water-level change map was prepared using water-level measurements made in September 1980 and September 1983. The hydrologic maps in this report were prepared by the U.S. Geological Survey in cooperation with the Mississippi Department of Natural Resources, Bureau of Land and Water Resource, using water-level measurements made in about 500 wells in the alluvial aquifer.

## ALLUVIAL AQUIFER

The Mississippi River valley alluvium in northwestern Mississippi, of Quaternary age, was deposited by the ancestral Mississippi River and its tributaries on an eroded Tertiary surface. The alluvium generally follows the typical alluvial stratigraphic sequence, gradually becoming finer-grained upward from gravels at the base to sands to silt and clays in the upper part. The lower coarse clastic deposits make up the alluvial aquifer, which averages 120 feet in thickness. The upper fine deposits, averaging 20 feet in thickness, are relatively impermeable, with local exceptions. The topography of the underlying irregular Tertiary surface controls the thickness of the alluvium because there is little surface relief in the Delta. The alluvium generally is thickest in the interior of the Delta (often greater than 150 feet thick) and thinnest along the Bluff Hills (usually less than 100 feet thick) at the eastern margin of the Delta.

High hydraulic conductivities are found in the alluvial aquifer because of the unconsolidated nature of these deposits. This fact, combined with the substantial thickness of sand and gravel accounts for the large yields to wells (more than 3,000 gallons per minute for many wells) possible from this aquifer.

The alluvial aquifer is recharged from three sources:

- Rivers and streams in the Delta, particularly the Mississippi River and Yazoo-Tallahatchie-Coldwater River system,
- Underlying aquifers in the Sparta Sand and Cockfield Formation, and
- Precipitation on the more sandy areas of the Delta, particularly along the Bluff Hills.

## WATER-LEVEL CHANGE MAP SEPTEMBER 1982-SEPTEMBER 1983

The water-level change map shows the net change in ground-water levels from September 1980 to September 1983. A 3-year period was chosen for this water-level change map to illustrate long-term changes in water levels. Ground-water levels declined in the interior of the Delta as the result of heavy pumpage for irrigation during the past 3 years. A lower stage in the Mississippi River in September 1983 as compared to September 1980 produced a corresponding decline in ground-water levels within a narrow strip along the Mississippi River. Areas of ground-water level rise are primarily the residual effects of an extremely wet spring in 1983. Relatively low irrigation pumpage in 1983 also contributed to ground-water level rises. Significant declines occurred in Bolivar, Sunflower, Tallahatchie, Humphreys, Leflore, and Coahoma Counties, where water levels declined more than 6 feet in some areas. Most of the decline from September 1980 to September 1983 was due primarily to heavy pumpage during the 1982 growing season.

The aquifer can be divided into two general areas based on this map and previous water-level change maps. In the first area, the central Delta, water levels have declined gradually in recent years with slight seasonal recoveries. In the second area, the peripheral Delta, water-level changes have been more pronounced and bidirectional than in the first area, fluctuating markedly with the seasons, much as before aquifer development. This phenomenon stems from the fact that the central part of the Delta is removed from the major sources of recharge, whereas the periphery of the Delta is closer to these sources and thus much more responsive to sudden changes in stream stages and precipitation.

Due to the areal distribution of confined conditions in the alluvial aquifer during September 1983, water-level changes in areas other than the interior of the Delta represent changing confined pressure, rather than a significant change in aquifer storage. Conversely, water-level changes in the unconfined interior represent long-term changes in storage.

Irrigation pumpage during this 3-year period was relatively heavy. Rice and catfish farming accounted for most of this pumpage. Rice acreage increased to a record 340,000 acres in 1981, fell to 260,000 acres in 1982, and to 155,000 acres in 1983. About 80 percent of the rice acreage in the Delta is irrigated by ground water, the remainder with surface water. The annual water application to rice averages 4.3 acre-feet/acre. Catfish acreage was 53,000 acres in 1981 and 60,000 acres in 1982 and 1983. Ground water is the sole source of water for catfish farming in the Delta. The annual water application to catfish ponds averages 7.5 acre-feet/acre.

## DEPTH-TO-WATER MAP

The depth-to-water map shows the approximate depth to water below land surface in September 1983. Water levels generally were nearest land surface along the edges of the Delta, near the sources of major recharge to the aquifer. Deeper water levels were found in the interior of the Delta, where recharge is slower.

Both confined and unconfined conditions occur in the alluvial aquifer. Because the upper confining layer is approximately 20 feet thick, water levels deeper than about 20 feet commonly identify unconfined areas. Thus, the depth-to-water map shows that the aquifer generally was unconfined in the interior of the Delta and generally was confined along the periphery during September 1983. A continuation of the present large drafts will cause water levels to decline further and the unconfined zone to increase areally. Continued water-level declines will cause reductions in possible well yields due to reductions in the saturated aquifer thickness in addition to increasing lift costs and forcing well pumps to be lowered.

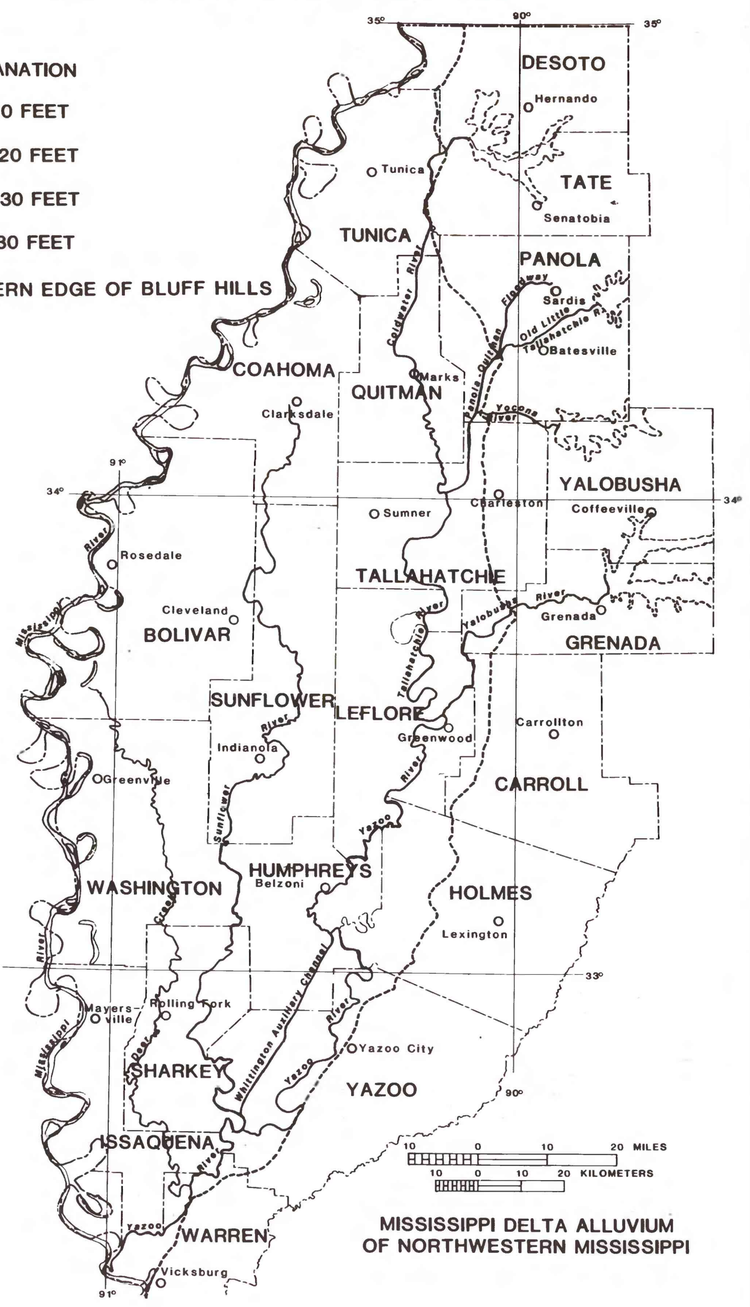
## POTENTIOMETRIC MAP

The September 1983 potentiometric map shows the ground-water surface of the alluvial aquifer following the 1983 growing season. The general flow pattern in the aquifer is made up of two components - a north to south axial flow and an east to west transaxial flow from the periphery of the Delta inward toward the Sunflower River. The latter component is particularly pronounced in the central Delta.

There are two principal cones of depression in the alluvial aquifer, one in Humphreys and southeastern Washington Counties and the other straddling the Sunflower-Leflore County line. Both cones are slightly larger than in April 1983 (Sumner, 1983) due to seasonal irrigation pumpage.

Another prominent feature found on this and previous September potentiometric maps (Wasson, 1980; Darden, 1982a and 1983) of the alluvial aquifer is the ridge of high water levels roughly paralleling the Mississippi River. This ground-water divide was formed as the stage of the Mississippi River dropped from its spring high, draining a part of the spring recharge from the aquifer in the process.

## DEPTH-TO-WATER SEPTEMBER 1983

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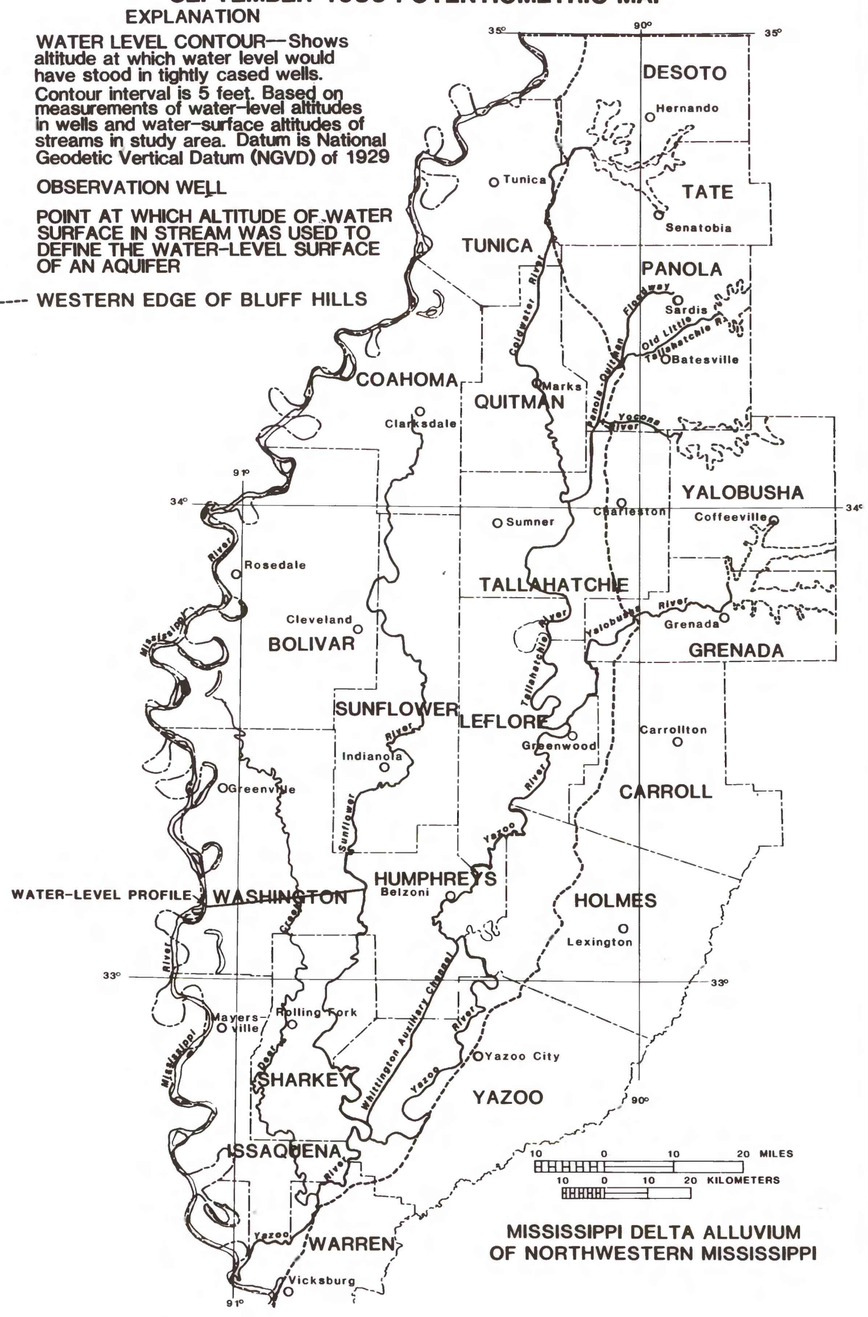
## SEPTEMBER 1983 POTENTIOMETRIC MAP

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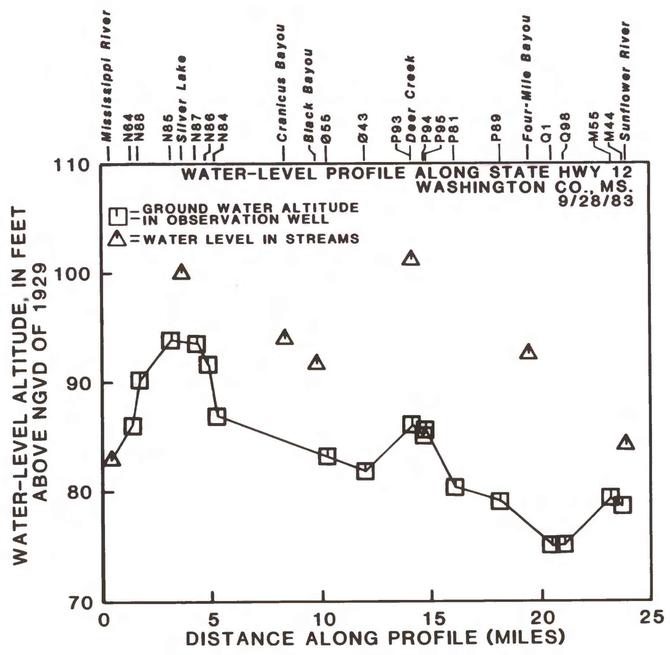


## WATER-LEVEL PROFILE

The water-level profile shows the water-level altitude in several wells and streams along a roughly east-west line in southern Washington County from the Mississippi River to the Sunflower River. (See potentiometric map for location of profile.) This profile is fairly typical of hydrologic conditions in the west-central Delta. There are several important features of this profile.

- There is a background west-to-east potentiometric slope (about 0.3 feet/mile) upon which the other features are superimposed. For typical values of hydraulic conductivity and porosity found in the alluvial aquifer, pore velocity is about 30 feet/year under this potentiometric gradient. This feature of the profile remains virtually constant year-round.
- The ground-water divide near the Mississippi River is the residual effect of high water levels present during the period of recharge. This peak will gradually dissipate with time.
- The ground-water divide centered on Deer Creek could be related to several different factors; recharge from Deer Creek, rainfall recharge through the sandy loam adjacent to Deer Creek, non-uniform pumpage distribution (little pumpage exists in a band paralleling Deer Creek due to the absence of rice cultivation in this sandy area), or a combination of the above factors. Direct recharge from Deer Creek is probably the least likely reason for this peak due to seeming lack of connection between stream and aquifer (head differential of 15 feet) shown in this profile.
- The ground-water level peak near the Sunflower River is probably due to recharge from this deeply incised stream.
- Surface water in the area, with the exception of the Mississippi River, is not intimately connected to the aquifer, as seen by the large head differentials between aquifer and streams. This is due to the relatively impermeable surficial clays.

## ADDITIONAL INFORMATION

The map showing the results of the September 1983 water-level measurements if the seventh of a series of semi-annual maps showing seasonal ground-water levels in the alluvial aquifer of the Delta. Data describing the individual wells used in this study may be obtained from the following:

Charles Branch, Director
Mississippi Department of Natural Resources
Bureau of Land and Water Resources
P.O. Box 10631
Jackson, MS 39209
(601) 961-5200

Garald G. Parker, Jr.
District Chief
U.S. Geological Survey
Water Resources Division
Suite 710, Federal Bldg.
100 W. Captiol Street
Jackson, MS 39269
(601) 960-4600

Black and white copies of this report can be purchased from:

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Lakewood, Colorado 80225
(303) 234-5888

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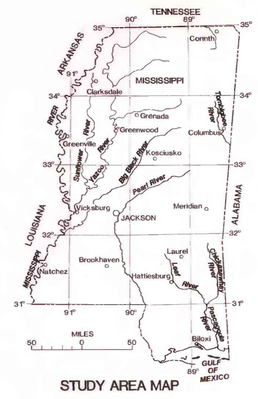
Wasson, B. E., 1980, Water-level map of the Mississippi Delta alluvium in northwestern Mississippi, September 1980: Bureau of Land and Water Resources Map 80-1.

Base maps modified from U.S. Geological Survey Map of Mississippi, 1972




STUDY AREA MAP

# WATER-LEVEL MAPS OF THE ALLUVIAL AQUIFER, NORTHWESTERN MISSISSIPPI SEPTEMBER 1983

BY D. M. SUMNER

U. S. GEOLOGICAL SURVEY

1985

JACKSON, MISSISSIPPI