Prepared in cooperation with the
MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY
Office of Land and Water Resources

INTRODUCTION

As part of a program to document and evaluate any changes in the potentiometric surface (water level) of the major aquifers in Mississippi, the U.S. Geological Survey, in cooperation with the Mississippi Department of Environmental Quality, Office of Land and Water Resources, measures water levels at about 5-year intervals in wells completed in the Mississippi River alluvial aquifer in a 21-county study area in northwestern Mississippi. This water-level map report, the ninth in a series of published map reports for the Mississippi River alluvial aquifer, includes:

- a general discussion of the regional setting, hydrogeology, ground-water levels and changes, and water quality and use;
- a potentiometric-surface map (fig. 1), based on water-level data collected in 362 wells during October through December 1988;
- a water-level change map (fig. 2), based on calculated changes in water levels measured in 336 wells between September 1983 and October through December 1988 and on a comparison of the potentiometric-surface map for 1988 (fig. 1) with the previously published potentiometric-surface map for 1983 (Sumner, 1985); and
- hydrographs of selected observation wells (fig. 3).

Previously published water-level map reports for the Mississippi River alluvial aquifer were based on measurements made in 1978 (Dalsin, 1978a); in September 1980 (Wasson, 1980); in April and September 1981 and in April and September 1982 (Darden, 1981, 1982a, 1982b, 1983); and in April and September 1983 (Sumner, 1984, 1985). Most of the earlier maps were based on measurements made twice annually, generally in spring preceding the irrigation season, and in fall following the irrigation season. This water-level map is based on measurements made primarily in fall. The potentiometric-surface contours in figure 1 are based on measurements made during a 3-month period in 1988 rather than during a 1-month period as in 1983. The contours are believed representative of the potentiometric surface during October through December 1988 because water level changes were relatively small (less than 5 feet) during the 3-month period. The change contours in figure 2 are based on calculated changes in water levels measured in wells between September 1983 and October through December 1988. Additional control used to prepare the water-level change map was obtained by a comparison of the September 1983 and the 1988 potentiometric-surface maps.

GENERAL DESCRIPTION OF STUDY AREA

In northwestern Mississippi, the Mississippi River alluvial aquifer underlies about 7,000 square miles in all or parts of 19 of the 21 counties shown in figures 1 and 2. The study area is locally known as the "Delta". Three additional counties are included in figures 1 and 2 to show the western edge of the loess-covered Bluff Hills.

The Delta is characterized as an alluvial plain that has a nearly flat southward-sloping surface, many oxbow lakes, meandering stream channels, natural levees, backswamp areas, and bayous. The Delta is the center of the State's thriving catfish farming and processing industry and includes the State's most productive and cultivated farmland. The enriched soil was deposited by the flood waters of the Mississippi, Yazoo, Tallahatchie, and Coldwater Rivers. The humid subtropical climate of the Delta is marked by long summers and short winters. Precipitation generally averages 52 inches annually and usually is greatest during winter or early spring and least during the fall (Bettandorff and Leake, 1976). Average monthly precipitation ranges from 6.2 inches in March to 2.4 inches in October.

HYDROGEOLOGY

The Mississippi River alluvium consists of alluvial and terrace deposits of Quaternary age that range in thickness from about 80 to about 240 feet and has an average thickness of about 140 feet (Sumner and Wasson, 1990). Deposited by the flood waters of the Mississippi River and its tributaries, the alluvium generally grades upward from gravel and coarse sand in the lower part to silt and clay in the upper part. The alluvium generally is thickest (in many places more than 150 feet) in the central parts of the Delta and thinnest (in most places less than 100 feet) in the periphery of the Delta, primarily along the Bluff Hills and the Mississippi River (Sumner, 1985).

The Mississippi River alluvial aquifer includes about 80 to 180 feet of sand and gravel deposits (Sumner and Wasson, 1990). The alluvial aquifer is covered in areas by clay deposits, which average about 20 feet in thickness. The alluvial aquifer is relatively shallow (less than 200 feet below land surface) and contains water under either confined or unconfined conditions. Water in the alluvial aquifer generally is under unconfined conditions where water levels are more than about 20 feet below land surface. In some areas where water levels in tightly cased wells stand above the base of the clay cap, water in the aquifer is confined. Confined ground-water conditions vary with location, recharge, and the presence or absence of clay confining units.

The alluvial aquifer, 1 of the 14 major aquifers in the State, is an important and prolific source of water. Transmissivity and hydraulic conductivity values determined by aquifer tests of the alluvial aquifer at six sites in the Delta range from 12,000 to 51,000 feet squared per day[1] and from 130 to 400 feet per day, respectively; the central 50 percent (25- to 75-percentile values) of transmissivity and hydraulic conductivity values ranges from 19,000 to 43,000 feet squared per day and from 200 to 400 feet per day, respectively (Slack and Darden, 1991). The alluvial aquifer is in hydraulic connection with the Mississippi River; consequently, water in the aquifer is recharged by and discharged to the Mississippi River generally on a seasonal basis. The four primary sources of recharge to the alluvial aquifer are (1) leakage of streamflow during periods of high stages from the Mississippi River (the western boundary) and large rivers draining the interior of the Delta, such as the Yazoo, Tallahatchie, and Coldwater Rivers; (2) precipitation on the land surface, particularly on the sandy areas; (3) underflow from the Bluff Hills, which are about 100 to 200 feet higher than the alluvial plain (Sumner and Wasson, 1990); and (4) upward leakage from the underlying Sparta Sand and Cockfield Formation of Tertiary age. Ground water generally moves southward in the alluvial aquifer. The exchange of water between the Mississippi River alluvial aquifer and the rivers in the Delta is dependent upon water levels in the aquifer and stage in the rivers and varies seasonally; this exchange greatly affects the quality of water in the aquifer.

GROUND-WATER LEVELS AND CHANGES

Water levels in wells in the eastern, western, and northern periphery of the Mississippi River alluvial aquifer in the Delta were slightly higher or about the same in 1988 as in 1983. It is to be noted, though, that 1983 was an unusually wet year with anomalously high water levels in the alluvial aquifer, and the summer of 1988 was marked by a severe drought, which contributed to unusually low water levels in the aquifer that fall. In contrast, water levels in the central and in the southern parts of the Delta were significantly lower in 1988 than in 1983. From September 1983 to October through December 1988, water levels in wells screened in the aquifer were between about 8 and 48 feet below land surface. Lower ground-water levels coincided with low river and stream stages in the southern part of the Delta. Generally, water levels in wells in areas near the Mississippi River and large streams in the Delta directly reflect the stage of the nearby rivers (Dalsin, 1978a).

Both large and small cones of depression, as indicated by the hachured contours on figure 1, have developed in the potentiometric surface of the Mississippi River alluvial aquifer. Large withdrawals from wells in and near heavily pumped areas have resulted in large cones of depression near the following locations:

- in an area centered along the border between Sunflower and Leflore Counties, between Indianola and Greenwood;
- in central Washington County, southeast of Greenville; and
- in Warren County, north and west of Vicksburg.

Several relatively small cones of depression in the potentiometric surface of the alluvial aquifer have developed at the following locations:

- in southern Tunica County;
- in Bolivar County near Rosedale;
- in Sunflower County north of the large cone in Sunflower and Leflore Counties;
- in northern Humphreys County;
- in southeastern Washington County;
- in northwestern Washington County; and
- in northwestern Sharkey County.

These cones of depression may be due to the increase in local ground-water withdrawals between 1983 and 1988.

In contrast to the many cones of depression, several small isolated mounds have developed in the potentiometric surface in the alluvial aquifer near the following locations (fig. 1):

- well B1 in Coahoma County;
- well C5 in Bolivar County;
- wells N40 and R105 in Bolivar County, and A109 and A112 in Washington County;
- wells B33 and C5 in Washington County; and
- well B43 in Issaquena County.

Although water levels may be highly variable from year to year, or even from season to season, regional seasonal fluctuations are evident from long-term records of water levels in selected observation wells (fig. 3). These fluctuations reflect changes in seasonal precipitation and seasonal pumpage that result in water levels being higher in the spring and lower in the fall.

Water levels in the Mississippi River alluvial aquifer generally declined from 1983 to 1988. Changes in the potentiometric surface of the alluvial aquifer during the 5-year period are shown in figure 2. Because the change contours were based, in part, on calculated changes at sites other than at observation wells, some of the water-level changes shown exceed those measured in the observation wells. Water levels measured in observation wells in the alluvial aquifer declined at an average rate of less than 1 foot per year between 1983 and 1988. During this period, declines of less than 5 feet occurred in most of the Delta; however water-level declines exceeded 10 feet in parts of Sunflower, Leflore, Bolivar, Washington, and Humphreys Counties.

Although water levels in most wells in the alluvial aquifer declined from 1983 to 1988, water levels in wells in some parts of the Delta increased. Areas where water levels increased or remained unchanged during this 5-year period were relatively small (only about 330 square miles or about 5 percent of the study area) and generally were located near the sources of recharge along the Mississippi River, meandering tributaries, and near the western edge of the Bluff Hills (fig. 2).

WATER QUALITY AND USE

Water in the Mississippi River alluvial aquifer generally is a hard, calcium bicarbonate type that commonly contains large concentrations of calcium, magnesium, iron, and manganese. Although the water may require treatment for the removal of hardness for some uses, the aquifer is an important source of freshwater (water with dissolved-solids concentrations less than 1,000 milligrams per liter). Dissolved-solids concentrations in the alluvial aquifer generally range from about 300 to 400 milligrams per liter. The dissolved-solids concentrations increase from north to south and from east to west in the alluvial aquifer (Dalsin, 1978b).

During 1985, 1,190 million gallons per day of water, more than 75 percent of all ground water used in the State, was withdrawn from wells completed in the Mississippi River alluvial aquifer (Callahan and Barber, 1990). Withdrawals from the aquifer in the Delta primarily are for agricultural uses (irrigation and non-irrigation). Irrigation, the largest use of water, principally is for rice, cotton, and soybeans. Non-irrigation agricultural use includes aquaculture (primarily catfish farming), livestock watering, and other farm uses. The second largest use of water from the aquifer is for aquaculture. Because of its availability, relative purity, and uniform temperature, ground water is used to fill and aerate catfish ponds. Ground water also is used for public supply for the City of Vicksburg and for cooling water in thermoelectric power plants in Clarksdale, Greenwood, and Yazoo City (Sumner and Wasson, 1990).

[1] Slack and Darden (1991) reported transmissivity in reduced units of feet squared per day. These units are equivalent to cubic feet per day per square foot times feet of aquifer thickness.

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

EXPLANATION

—— 80 - - POTENTIOMETRIC CONTOUR--Shows altitude at which water level would have stood in tightly cased wells. Dashed where approximately located. Hachures indicate depressions. Contour interval 10 feet. Datum is sea level

P18/75 • OBSERVATION WELL AND NUMBER--Wells are numbered alpha-numerically by county. Bottom number is water-level altitude, in feet

F4 ◉ OBSERVATION WELL FOR WHICH WATER LEVELS ARE SHOWN IN FIGURE 3

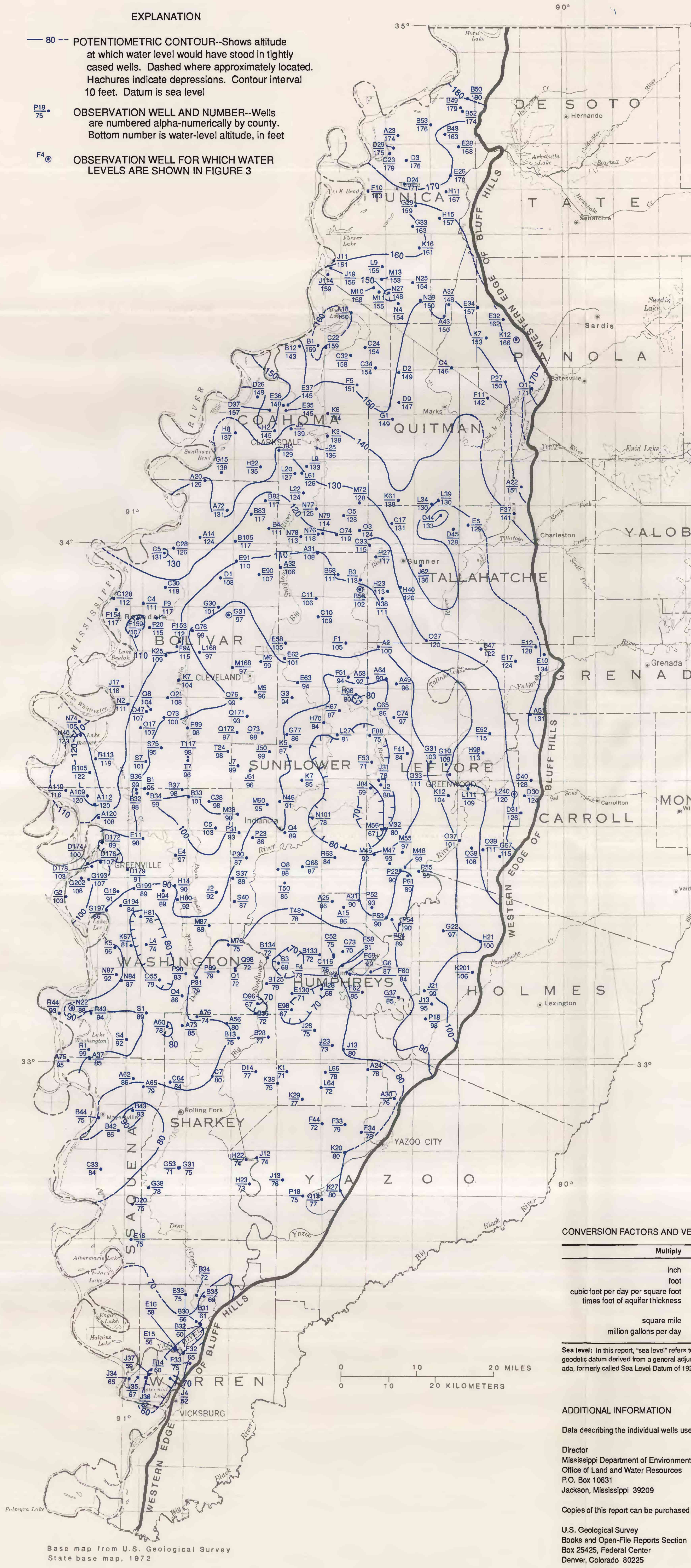
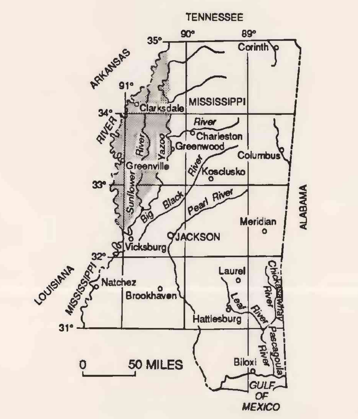


Figure 1.--Potentiometric-surface map of the Mississippi River alluvial aquifer, October through December 1988.



LOCATION MAP

EXPLANATION

AREA IN WHICH DECLINE IN POTENTIOMETRIC SURFACE EXCEEDS 10 FEET

AREA IN WHICH POTENTIOMETRIC SURFACE INCREASED OR REMAINED THE SAME

—-10-- LINE OF EQUAL CHANGE IN POTENTIOMETRIC SURFACE--Shows rise (+) or decline (-) in potentiometric surface. Dashed where approximate. Interval is variable

-7 ◉ WELL AND CALCULATED WATER-LEVEL RISE (+) OR DECLINE (-), IN FEET

Figure 2.--Water-level change map of the Mississippi River alluvial aquifer, September 1983 to October through December 1988.

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
inch	25.4	millimeter
foot	0.3048	meter
cubic foot per day per square foot times foot of aquifer thickness	0.09290	cubic meter per day per square meter times meter of aquifer thickness
square mile	2.590	square kilometer
million gallons per day	0.04381	cubic meter per second

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first order level net of both the United States and Canada, formerly called Sea Level Datum of 1929.

ADDITIONAL INFORMATION

Data describing the individual wells used in this study may be obtained from the following:

Director
Mississippi Department of Environmental Quality
Office of Land and Water Resources
P.O. Box 10631
Jackson, Mississippi 39209

District Chief
U.S. Geological Survey
100 West Capitol Street, Suite 710
Jackson, Mississippi 39269

Copies of this report can be purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Box 25425, Federal Center
Denver, Colorado 80225

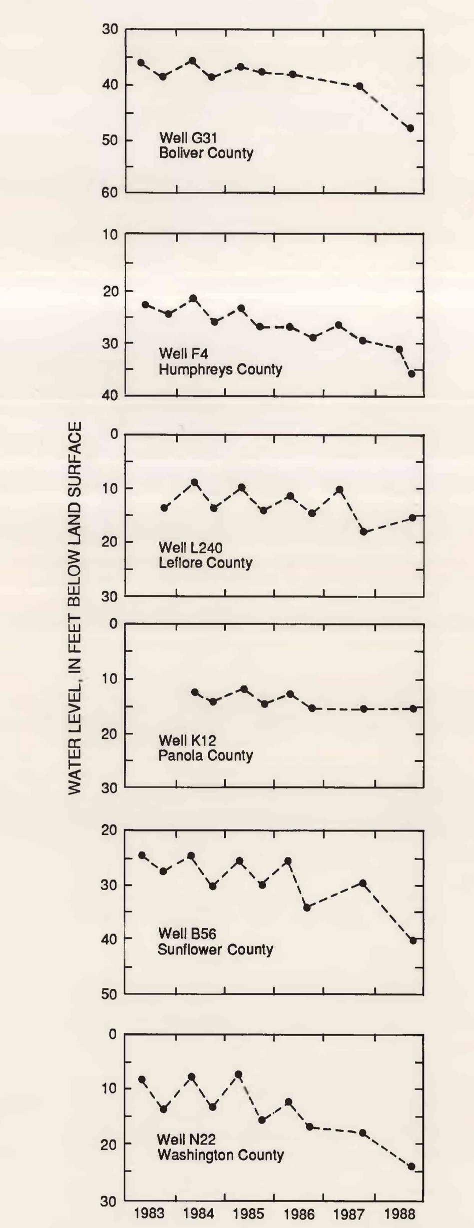


Figure 3.--Water levels in selected observation wells completed in the Mississippi River alluvial aquifer, 1983-88.

POTENTIOMETRIC-SURFACE MAP, OCTOBER THROUGH DECEMBER 1988, AND WATER-LEVEL CHANGE MAP, 1983-88, OF THE MISSISSIPPI RIVER ALLUVIAL AQUIFER IN NORTHWESTERN MISSISSIPPI

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1993

☆U.S. GOVERNMENT PRINTING OFFICE: 1993-0-758-139