DEPARTMENT OF INTERIOR
UNITED STATES GEOLOGICAL SURVEY

EXPLANATION

200 — POTENTIOMETRIC SURFACE CONTOUR--Shows altitude at which water level would have stood in tightly cased wells. Dashed where approximately located. Contour interval 50 feet. Hachures indicate depressions. Datum is National Geodetic Vertical Datum of 1929

AQUIFER RECHARGE AREA BOUNDARY

OBSERVATION WELL--Well in which water-level or artesian-pressure measurement was made in Fall, 1982

HOUSTON CO. Q-7 OBSERVATION WELL FOR WHICH HYDROGRAPH IS SHOWN

WITHDRAWAL RATES AT MAJOR PUMPING CENTERS (in million gallons per day)

0.25 - 0.49 0.50 - 0.99 ≥ 1.00

POTENTIOMETRIC SURFACE, GROUND-WATER WITHDRAWALS, AND RECHARGE AREA FOR THE LISBON AQUIFER IN ALABAMA, FALL 1982

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INTRODUCTION

The U.S. Geological Survey began a nationwide program in 1978, termed Regional Aquifer-System Analysis (RASA), to study a number of the major aquifer systems that provide a significant part of the country's water supply. One of the aquifer systems chosen for study was the thick and extensive sequence of sands of Cretaceous and early Tertiary age that underlies the Coastal Plain of the Southeastern United States. This system, which extends from Mississippi eastward to South Carolina, is called the Southeastern Coastal Plain aquifer system. It can be divided hydrogeologically into several separate aquifers. The map presented here, one of a series that portray the potentiometric surface, ground-water withdrawals, and recharge areas for aquifers in Alabama that are included in the regional system, deals with the Lisbon aquifer.

HYDROGEOLOGY

The Lisbon aquifer includes all or part of the Ocala Limestone, the Yazoo Clay, Moodys Branch Formation, Gosport Sand, the Lisbon, Tallahatta, Hatchetigbee, and Bashi Formations of Eocene age, and the upper sands of the Paleocene Tuscahoma Formation. One or more of these formations may be absent or may not be part of the aquifer at any one geographical location. The aquifer was named the Lisbon Formation because that formation is the predominant water-bearing zone within the aquifer in most areas across the State.

The Lisbon aquifer is composed mostly of unconsolidated sand and clay beds, and locally of consolidated carbonate rocks. It is underlain by clays in the upper part of the Tuscahoma Formation in southeastern Alabama, and in the middle part of that formation from Coffee and western Geneva Counties through Choctaw County. The degree of confinement in the lower confining bed decreases from east to west. The upper confining layer consists of clays, limestones, and residuum in the Yazoo Clay. Confinement by this layer increases from east to west, and the aquifer may be essentially unconfined east of the Choctawhatchee River (Walter, 1976, chap. 4, p. 7). The area of direct recharge for the aquifer (outcrop) extends across the State from Houston and Henry Counties westward to Choctaw County in a slightly curving band 20 to 30 miles wide.

The Lisbon aquifer as herein defined includes both the Upper Wilcox and Lisbon aquifers of Walter (1976). He separated those aquifers on the basis of a layer of clay and claystone within the Tallahatta Formation in western and central Alabama that he considered an effective confining bed. However, because the clays are absent in eastern Alabama, and because there are few data available from Alabama to confirm whether the clays constitute a regionally effective aquaclude, this study will consider both of Walter's named aquifers as belonging to the same aquifer, while recognizing the potential for possible subdivision.

The recharge (outcrop) area of the aquifer extends across the State from Houston and Henry Counties westward to Choctaw County in a slightly curving band 20 to 30 miles wide. Recharge of the Lisbon aquifer occurs by the infiltration of water from precipitation in the outcrop area, or by upward leakage from the underlying aquifer. Discharge from the aquifer occurs in as many as four ways: water may 1) leak upward or downward into adjacent aquifers, 2) emerge at the land surface as springs, 3) be withdrawn from wells, or 4) be intercepted by streams in the recharge area.

Potentiometric Surface

The accompanying map depicts the potentiometric surface of the Lisbon aquifer based on water-level measurements made primarily in the fall of 1982, and in some instances on stream stage. The potentiometric surface map illustrates, by means of contour lines, the altitude of the water table or the elevation to which water would rise in a tightly cased well tapping an artesian (confined) aquifer. The potentiometric surface depicted generally represents an average for the aquifer; the water-level altitude in any particular well may differ from the average to some extent depending on well depth and local geology. The orientation and shape of the contour lines are influenced by the geologic structure of the aquifer, the rate at which water passes through the aquifer (its transmissivity), and the location of discharge points such as wells, springs, or streams. Ground-water flow in the aquifer is approximately perpendicular to the contour lines.

Recharge and Discharge

Recharge of the Lisbon aquifer occurs by the infiltration of water from precipitation falling directly on the outcrop area, and probably by leakage from adjacent aquifers. Discharge from the aquifer occurs in as many as four ways: water may 1) leak upward or downward into adjacent aquifers, 2) emerge at the land surface as springs, 3) be withdrawn from wells, or 4) be intercepted by streams in the recharge area.

Streams in the unconfined zone of Alabama Coastal Plain aquifers act as ground-water drains due to their lower altitude relative to recharge areas. Large streams and rivers drain significant amounts of water from an aquifer, often controlling regional flow patterns. The flow patterns depicted on this map suggest that the major ground-water drains in the Lisbon aquifer are the Tombigbee, Alabama, Conecuh, Pea, Choctawhatchee, and Chattahoochee Rivers. Water entering the aquifer updip that is not intercepted by streams or pumpage has a longer flow path downdip through the confined part of the aquifer. Low permeability rocks and highly mineralized water far downdip present a barrier to flow, forcing fresh ground water recharging the deeper parts of the aquifer to leak upward into the overlying aquifer or to move updip and eventually discharge to the rivers.

Heavy pumpage can lower water levels locally, resulting in a depression in the potentiometric surface that causes the contours to be distorted from natural, unstressed conditions. In a graphic depiction of the potentiometric surface, the contour lines may bend around the pumping center, or even close around it as in the areas near Opp and Andalusia in Covington County.

GROUND-WATER USE

Major Pumping Centers

The Lisbon aquifer provides water for municipalities, irrigators, industries, and rural users across southern Alabama. Withdrawal rates by individual users are not large, however, and the only user known to withdraw water from the aquifer at an average rate of more than 1.0 million gallons per day (Mgal/d) is the city of Dothan. That city withdrew approximately 2.4 Mgal/d from the Lisbon aquifer in 1982. Several public suppliers use more than 0.25 Mgal/d. The total rate of withdrawal from the aquifer by all of these users was approximately 6.3 Mgal/d in 1982; individual rates are shown by pumpage category on the map. Irrigation in extreme southeastern Alabama may add significantly to the total amount withdrawn, although the exact withdrawal rates are not known. Walter (1976, chap. 4, p. 36; chap. 5, p. 28) estimated the total withdrawal from the aquifer by ground-water users of all types to be 17.6 Mgal/d in 1970.

Water-Level Fluctuations

Water-level observation wells have been monitored for several years to assess the effects of water withdrawals on the aquifer. The hydrographs shown are a record of water levels measured in some of those wells. Before production wells are drilled and withdrawal begins, an aquifer is in a state of "dynamic equilibrium," where water levels in the aquifer rise and fall in an annual cycle corresponding with seasonal changes in precipitation. Water levels may also show fluctuations of longer duration due to long-term departures from normal rainfall amounts. On the average, however, the water levels remain nearly the same because the amount of water that is entering the aquifer as recharge is also being naturally discharged, either to other aquifers, to the land surface as springs, or to streams in the aquifer recharge area. Pumping changes this balance and water levels usually begin to decline near major pumping centers. They will continue to decline until either an increase in recharge or a decrease in discharge balances the quantity of water being pumped.

The significance of whether an aquifer in the area of a pumping center reaches equilibrium is that, if equilibrium is attained, the current pumping rate for that center may be considered dependable. However, if water levels continue to decline, a condition could arise where further withdrawal from the aquifer at that rate would be impossible.

Hydrographs from observation wells throughout most of the area of usage of the Lisbon aquifer show little change in water levels since monitoring began, indicating that equilibrium conditions exist nearly everywhere. However, the potentiometric surface map shows that there are three major pumping centers, Andalusia and Opp in Covington County, and Ashford in Houston County, where pumpage is causing significant diversion of water from what would be the normal flow pattern in the aquifer. Although there are insufficient data from wells in the area of greatest water-level declines to construct meaningful hydrographs, existing water-level data from some of these wells near Andalusia indicate declines of as much as 15 feet per year. The hydrograph for observation well Covington County M-4 shows significant water-level declines from 1968 to 1970, followed by 6 years of little decline, and subsequently a rapid recovery. The hydrograph reflects the discontinuation of pumping from wells screened in the Lisbon aquifer within the city of Anadalusia, which allowed the aquifer to recover in that area. The public supply system currently derives most of the water withdrawn from the Lisbon aquifer from wells to the northwest of the city. The severity of the depression in the potentiometric surface around the currently used wells is probably caused by mutual interference among them due to their close proximity to each other, which probably accounts for the noticeable depression near Opp as well.

Observation well Houston County Q-7 is located 6 miles south of Dothan, a major pumping center, and in an area of the State that has experienced increased ground-water withdrawals for irrigation in recent years. That the well has shown no water-level declines in an area of significant withdrawals probably indicates that the Lisbon aquifer is under unconfined conditions in southeastern Alabama, thereby allowing capture of more recharge than would normally be possible if the aquifer were confined. The combination of unconfined conditions, along with an aquifer thickness of about 430 feet in the region, probably allows substantial ground-water withdrawal at a pumping center with little lowering of the potentiometric surface any great distance from that center.

Similar conditions probably occur near Opp in Covington County. Despite a marked depression in the potentiometric surface around the Opp well field, the hydrograph for observation well S-2 shows little change in water level during the period of record, suggesting that even large withdrawals in the recharge area of the Lisbon aquifer are not likely to cause marked water-level declines except in the immediate area of the pumping center.

The city of Brewton in Escambia County is the only major ground-water user in Alabama that withdraws water from the Lisbon aquifer where it is strictly confined. Water levels measured in public supply wells there have declined at a rate of less than one-half foot per year since 1967, and current (1986) pumping rates can probably be sustained into the future.

Future Ground-Water Development

Current evidence suggests that the potential for future development of the Lisbon aquifer for public supply, industrial, or agricultural uses is good in areas where the aquifer is thick enough to allow large capacity wells. Except in Andalusia and Opp, there appears to be little stress on the aquifer over most of its extent in Alabama, and further prudent development of ground-water resources is possible in most areas. Location of new wells sufficiently distant from existing wells to avoid mutual interference probably would allow additional withdrawals even in the vicinities of Andalusia and Opp. Any ground-water development scheme in or near the aquifer outcrop must take into account the potential for pollution from agricultural, industrial, and urban sources, however.

Another factor governing aquifer development is the natural chemical quality of the water. Water from most of the Lisbon aquifer is generally suitable for most purposes. However, excessive chloride, bicarbonate, iron, or hardness may limit its use locally. Highly mineralized water, probably derived from underlying aquifers, is present in areas of faulting in Choctaw, Washington, Clarke, Monroe, and Wilcox Counties (Causey and McCain, 1971, p. 9; Newton and McCain, 1972, p. 6; Newton and others, 1972, p. 4; Walter, 1976, chap. 4, p. 25; chap. 5, p. 18). As a result, several municipalities in those areas depend on surface water for public supplies. Ground water with iron in excess of 0.3 milligrams per liter (mg/L) or hardness (as $CaCO_3$) greater than 180 mg/L is present locally throughout the area where the Lisbon aquifer is utilized (Scott and others, 1967; Turner and others, 1968, p. 9; Walter, 1976, chap. 4, p. 12).

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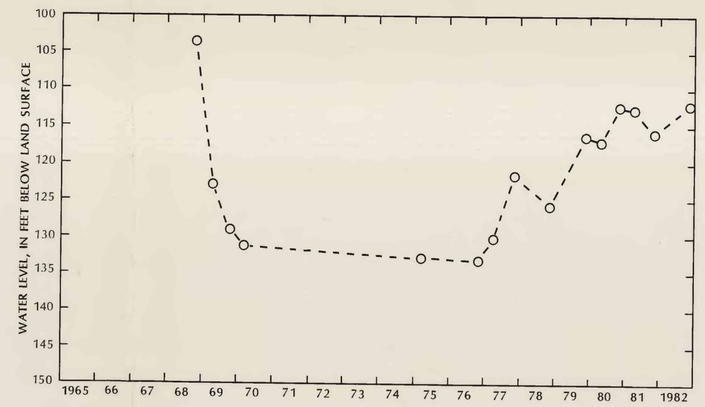
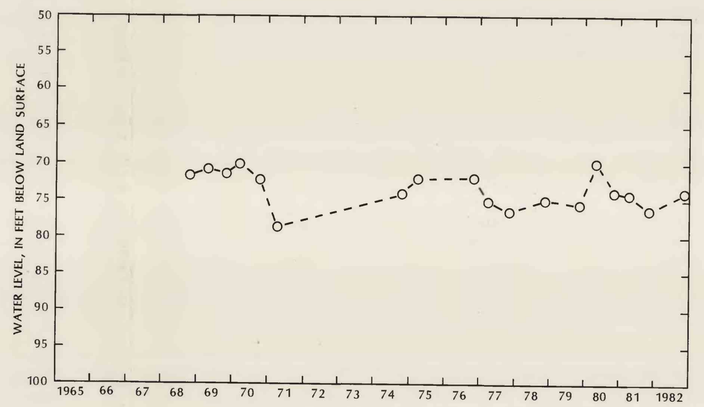
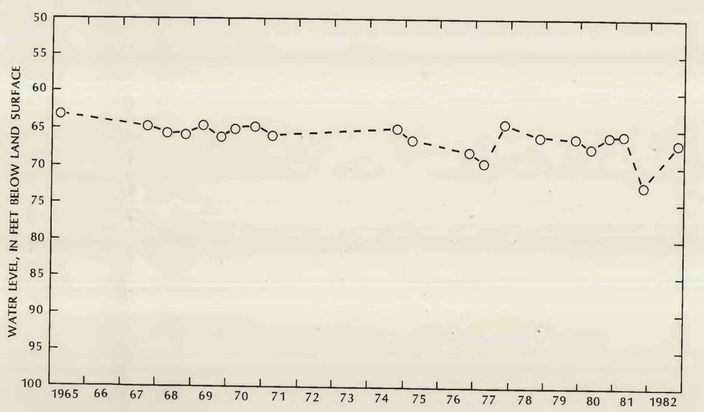


Hydrograph of water-level measurements for observation well M-4, Covington County.



Hydrograph of water-level measurements for observation well Q-7, Houston County.



Hydrograph of water-level measurements for observation well S-2 , Covington County.

Generalized correlation of hydrogeologic units and rock-stratigraphic units of the Southeastern Coastal Plain Aquifer System in Alabama

Period	Epoch	Hydrogeologic Unit	Rock - Stratigraphic Unit: Western Alabama	Rock - Stratigraphic Unit: Eastern Alabama
Tertiary	Eocene	Confining unit	Yazoo Clay	Ocala Limestone
		Lisbon aquifer	Moodys Branch Formation Gosport Sand Lisbon Formation Tallahatta Formation Hatchetigbee Formation Bashi Formation Upper part of Tuscahoma Formation	Moodys Branch Formation Gosport Sand and Lisbon Formations, undifferentiated Tallahatta, Hatchetigbee, and Bashi Formations, undifferentiated Upper part of Tuscahoma Formation
	Paleocene	Confining unit	Middle part of Tuscahoma Formation[1]	Middle part of Tuscahoma Formation
		Nanafalia - Clayton aquifer	Lower part of Tuscahoma Formation Nanafalia Formation Naheola Formation	Lower part of Tuscahoma Formation Baker Hill and Nanafalia Formations, undifferentiated Porters Creek Formation Upper part of Clayton Formation
		Confining unit	Porters Creek Formation Clayton Formation Prairie Bluff Chalk	Lower part of Clayton Formation[2]
Cretaceous	Late	Providence - Ripley aquifer	Ripley Formation	Providence Sand Ripley Formation
		Confining unit	Demopolis Chalk Mooreville Chalk	Demopolis Chalk / Mooreville Chalk / Blufftown Formation
		Eutaw aquifer	Eutaw Formation	Eutaw Formation
		Confining unit	Upper part of Gordo Formation	Upper part of Tuscaloosa Formation[2]
		Tuscaloosa aquifer	Lower part of Gordo Formation / Coker Formation (Tuscaloosa Group) Unnamed Early Cretaceous rocks[3]	Tuscaloosa Formation Unnamed Early Cretaceous rocks[3]
	Early	Confining unit	Pre - Cretaceous rocks	Pre - Cretaceous rocks
Pre - Cretaceous				

[1] May be only partially confining or absent in western Alabama
[2] May be only partially confining or absent in eastern Alabama
[3] Largely unstudied; may be locally hydraulically connected with overlying sediments