GROUND-WATER DEVELOPMENT ALTERNATIVES IN THE NATCHEZ AREA, MISSISSIPPI

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INTRODUCTION

The Natchez municipal water supply is obtained from aquifers that occur at depths of 400 feet and 600 feet in the strata of Miocene age. Several public water-supply wells obtain water from a deeper Miocene stratum that occurs at a depth of about 1,000 feet and some small water supplies are obtained from wells less than 200 feet deep that tap the post-Miocene sediments in the uplands. Most of the ground water used in the area is pumped from the Mississippi River alluvial aquifer for industrial use.

Although the Mississippi River is the western boundary of the City of Natchez, it has in the past not been used as a water-supply source because of treatment requirements and the availability of ground water. The largest source of surface water, excepting the Mississippi River, is the Homochitto River. These streams are not convenient sources of water for most of the county and for most uses the water would require treatment. Dependable surface-water supplies are limited in most of Adams County, and some streams have been subject to pollution for many years (Callahan and others, 1964, p. 21; Childress and others, 1976, p. 122).

Recently, the U.S. Geological Survey completed an appraisal of the current ground-water situation and of the potential for increasing the ground-water supply in the Natchez area (Boswell and Bednar, 1985). Ground-water data were needed for planning expansions of public water supplies and for efficient development of the area's water resources.

PURPOSE AND SCOPE

This paper summarizes a recently completed study of the ground-water resources of the Natchez area (Boswell and Bednar, 1985) and presents alternatives for the development of supplemental sources of ground water in the area.

The recent study included analysis of water-use trends and water-level declines, determination of the interrelations of water-bearing zones, identification of ground-water quality problem areas and determination of favorable areas for future ground-water development. This report includes data for two water wells that were not available during the recent study.

Description of the Area

The Natchez area includes the City of Natchez in the west-central part of Adams County, Mississippi, and adjacent parts of Concordia Parish, Louisiana. The town of Washington, Mississippi, is in the eastern part of the area and Vidalia, Louisiana, is immediately to the west (Fig. 1).

The study includes areas in the Loess (Bluff) Hills and in the Mississippi alluvial plain (Fig. 1). The alluvial plain is a nearly flat surface whereas the Loess Hills district is a rugged, highly dissected area. Drainage is by the Mississippi River and tributary streams.

GROUND-WATER DEVELOPMENT

Virtually all water used in the Natchez area and in Adams county is obtained from aquifers in the alluvial deposits of the Mississippi River and in the strata of Miocene and younger age that underlie the area (Table 1). The Mississippi River alluvial aquifer, a most prolific source of ground water, can yield up to several thousand gallons per minute to wells. Wells that tap the Miocene aquifers can produce up to about 1,000 gal/min.

The municipal water system at Natchez was established about 1889 when two wells were drilled for a water plant located at the base of the bluffs. The Devereaux Water Plant, located in the upland part of the area, started operation about 1940 and the old plant was later abandoned. Six wells at the Devereaux plant were supplemented by five wells drilled at other locations. In 1983, three wells at the Devereaux Water Plant were replaced with new 600-foot sand wells (Figure 2a, 2b, and Table 2).

Industrial water use was negligible until about 1938 when the first of several large industries located in the area. Most public and industrial water systems obtained water from wells that tap Miocene aquifers; however, all industrial water produced by the largest user of ground water, is pumped from the Mississippi River alluvial aquifer. The highest production reported from the aquifer was about 46 Mgal/d in 1955 (Mississippi Water Resources Policy Commission, 1955). In 1983, average pumpage was about 38 Mgal/d (K. G. Perkins, written commun., 1984).

Pumpage from Miocene aquifers increased from less than 1 Mgal/d before 1940 to about 5.3 Mgal/d in 1962 and to about 8.4 Mgal/d in 1980. Since 1980, pumpage from Miocene aquifers for public supplies has increased but industrial withdrawals have decreased, owing to conservation measures taken by some users and to operational changes by others. In 1983, the City of Natchez produced about 3.2 Mgal/d and industrial pumpage from the Miocene aquifers was about the same. Rural community water systems in Adams County produced an average of 0.95 Mgal/d. Total usage from Miocene aquifers in 1983 was about 7.4 Mgal/d.

GEOHYDROLOGY

Sediments exposed in Adams County are Miocene to Holocene (Recent) in age. The southward-dipping Miocene sediments contain freshwater to depths ranging from about 300 feet below sea level in northern Adams County to about 1,800 feet below sea level in the south (Fig. 3). The deep confined (artesian) Miocene aquifers are the main source of ground water for public supplies and for some industrial supplies. Water-bearing strata that occur below the Miocene aquifers do not contain freshwater and in the southern part of the county, the basal Miocene aquifer contains saline water.

Ground water occurs in shallow water-table aquifers in some places; however, much of the area is blanketed by loess, a material that does not yield significant quantities of water to wells. A shallow minor aquifer, the Natchez aquifer, underlies the loess and overlies the Miocene aquifer system in the uplands. The Mississippi alluvial plain is underlain by as much as 200 feet of sand, gravel, silt, and clay. The sand and gravel deposits form the Mississippi River alluvial aquifer.

Ground-water movement in the confined aquifers is generally southward, except in the Natchez area where movement is from all directions into a cone of depression (Fig. 4). Recharge for the major freshwater aquifers presently used at Natchez occurs in the northern and northeastern part of the county, and in adjacent areas. The Mississippi River alluvial aquifer is recharged by infiltration from the Mississippi River and tributary streams when at high stages, by precipitation on the land surface, and by flow from hydraulically connected Miocene and younger aquifers.

On the east side of the Mississippi River, the alluvial aquifer is not present at Natchez where the river impinges the bluffs (Fig. 1). To the north and south of Natchez, however, the alluvial aquifers are significant sources of ground water and are capable of yielding several thousand gallons of water per minute to wells. Ground water in the aquifer occurs under confined and unconfined conditions, depending on the position of the potentiometric surface relative to the base of surficial confining clay and silt beds. Under average climatic and recharge conditions, water levels in the alluvial aquifer recover to about the same level each spring, mostly as a result of hydraulic connection with the Mississippi River.

Pumping tests made using industrial wells in the alluvial aquifer south of Natchez (Callahan and others, 1963, p. 26) indicate transmissivity values ranging from 22,000 ft^2/d to 33,000 ft^2/d and hydraulic conductivities averaging about 250 ft/d. Specific capacities range from 28 to 148 (gal/min)/ft of drawdown, and typical wells produce about 2,000 gal/min although yields of 4,500 gal/min have been reported (Table 2). Comparable yields can be obtained from the alluvial aquifer in areas north of Natchez.

Overlying the confining clay beds that form the uppermost Miocene strata in the Natchez area are beds of post-Miocene gravel, sand, and clay. These deposits, together with the loess deposits that form the surface in the area, have a maximum thickness of about 250 ft. The sand and gravel beds form the Natchez aquifer (Boswell and Bednar, 1985), a source of water for shallow wells in the uplands. The aquifer is similar in lithology, thickness, and hydraulic characteristics to the Citronelle aquifers in southern Mississippi (Boswell, 1979).

Ground water in the Natchez aquifer is subject to drainage into the deep valleys and into the upper part of the Mississippi River alluvium. The aquifer is characterized by thin saturated zones and restricted drawdown space in wells. The largest production reported for a well in the aquifer is 366 gal/min (Table 2). Water-level measurements indicate that withdrawals have had little effect on water levels in the aquifer.

The principal confined freshwater aquifers in the Natchez area are sand zones in the Miocene deposits. Water-bearing strata that occur below the Miocene aquifers do not contain freshwater in Adams County and in the southern part of the county, the basal Miocene strata contain saline water.

The Miocene sand strata in the Natchez area vary considerably in thickness and hydraulic characteristics. The principal water-bearing zones were designated the "400-foot sand" and "600-foot sand" by Callahan and others (1963) and a deeper zone was called "1,000-foot sand" by Boswell and Bednar (1985). Figures 5 and 6 show the stratigraphic positions of the three Miocene aquifers and the Natchez aquifer at Natchez. Driller's logs and geophysical logs for borings outside the environs of the city indicate that the 400-foot and 600-foot zones are a single aquifer, whereas the 1,000-foot zone persists as a separate water-bearing unit.

The average hydraulic conductivity for four aquifer tests made in the early 1960's using wells in the Natchez area was 96 ft/d--near the average for Miocene aquifers in Mississippi (Newcome, 1971, p. 17). Transmissivity (T) values, a function of aquifer thickness and permeability, range from 2,000 ft^2/d to 10,000 ft^2/d, averaging about 6,400 ft^2/d. In the Natchez area, T values generally are lower in the 400-foot zone than in the 600-foot zone.

The highest producing wells screened in the Miocene aquifers, completed in the 600-foot sand in 1983 by the City of Natchez, each produce about 750 gal/min (Table 2, wells C64, C71, and C73). Specific capacities for these wells indicate T values within the above range.

Several wells completed recently in the 1,000-foot sand (Table 2, wells C50, D40, E31, and D73) indicate that the zone is, at least locally, capable of large yields to wells. A rural water system well (Fig. 6) located several miles east of Natchez was determined to have a specific capacity of 40 (gal/min)/ft of drawdown, indicating a transmissivity of at least 10,800 ft^2/d. A second well (D73) was reported to produce more than 800 gal/min during testing.

WATER-LEVEL CHANGES

Water levels declined in the 400- and 600-foot sand from about 70 feet above sea level in 1939 to about sea level by 1955 and by 1961, had nearly stabilized, averaging about 10 feet lower in the 400-foot sand than in the 600-foot sand. By 1982, water levels were a few feet lower than in 1961 (Fig. 7).

The lowest water levels measured in 1982 were in wells one-half mile east of the Devereaux Water Plant at the Armstrong Rubber Company. The water level in a 600-foot sand well (Fig. 2, well C15) declined from about 15 feet above sea level in 1952 to about 30 feet below sea level in 1982. At the same location the water level in a 400-foot sand well (Fig. 2, well C16) declined to about 50 ft below sea level during this period. The deepest water level observed, 69 feet below sea level in a 400-foot sand well (Fig. 2, well C 18), was attributed to the pumping effect of a nearby well.

Water levels in the 400- and 600-foot sands in industrial wells 2½ miles southeast of the Devereaux Water Plant at Johns Mansville Corporation have remained essentially stable since 1961. Water levels have remained fairly stable about 4 miles northeast of the Devereaux Water Plant in wells at the Mississippi Power and Light Company generating plant.

Although water levels have not declined excessively in the Natchez area since 1961, the cones of depression in both the 400- and 600-foot sands have expanded. The expansion in the cone of depression in the 600-foot sand between 1963 and 1982 (Fig. 4) is attributed mostly to a broader distribution of withdrawals, and to a continuing adjustment of the potentiometric surfaces in both aquifers. The change in the cone of depression in the 400-foot sand is similar in size and depth to the change in the 600-foot sand.

WATER QUALITY

Average values for concentrations of most common constituents and for the properties of water in aquifers in the Natchez area do not exceed criteria for potable water supplies established by the Environmental Protection Agency (1976). The water is moderately high in dissolved-solids concentrations (250 to 500 mg/L) and hardness ranges from soft to very hard (Table 3). Recommended limits for concentrations of iron and manganese (0.30 and 0.05 mg/L, respectively) are exceeded in water from several wells. Color is visibly high (20-50 units) in water from several wells that tap the deeper Miocene sands and exceeds the recommended limit (75 units) in a few wells. Color in water from well C50 (Table 3) in the 1,000-foot sand exceeds recommended limits; however, as in the shallower aquifers, the quality improves northeastward. Analyses indicate that to the northeast and east water from the 1,000-foot sand is soft, comparatively low in dissolved solids, and has a pH of 7.0 units or higher. The iron content in all samples was less than 0.3 mg/L. Table 3 summarizes water-quality for aquifers in the Natchez area.

Saline Water and Aquifer Contamination

In Adams County, the base of the freshwater (water that contains less than 1,000 mg/L of dissolved solids) zone ranges from about 300 feet below sea level in the north to about 1,800 feet below sea level in the south (Fig. 3). The base of the 3,000 mg/L (slightly saline) zone ranges from about 600 feet below sea level in the north to about 1,900 feet in the south and the base of the moderately saline zone (3,000 - 10,000 mg/L) ranges from about 700 to about 2,000 feet below sea level (Gandl, 1982, Plates 2 and 3).

Several instances of freshwater-well contamination by oil-field brine in the Natchez area have been reported. The use of some shallow industrial and rural water association supply wells was discontinued because of brine contamination. Future instances can be expected where new wells are drilled into contaminated strata or where saltwater migrates into existing wells. "Slugs" of saltwater from long-abandoned pits or wells may be present almost anywhere in the subsurface of Adams County.

ALTERNATIVES FOR GROUND-WATER DEVELOPMENT

The 600-foot sand, the source for about 75 percent of the present public water supply at Natchez, can sustain moderate increases in withdrawals at the cost of deepening and enlarging the cone of depression. Available drawdown space for 600-foot sand wells in the deepest part of the cone of depression is presently more than 200 feet. Large wells have pumping drawdowns of 30 to 50 feet; therefore, about 150 feet of drawdown space remains to accommodate future well interference and water-level declines.

Geophysical logs for oil tests indicate that the 600-foot sand has the potential to yield as much water to wells to the northeast and east of Natchez and at places in the southern part of the city as at the Devereaux Water Plant. The 400-foot sand is not included in the logged interval on most of the geophysical logs available; however, the potential as a source of ground water is not large in the city, because (1) the sand is extremely variable in thickness and it is not capable of large yields to wells in the southern part of the city and (2) low static levels result in a severe limitation on pumping drawdown space in wells. Small yields are possible, however, and the aquifer is a supplemental source of water.

A well drilled by the city of Natchez in 1980 to the 1,000-foot sand (C50, 864 feet deep) produces water that is highly colored and moderately high in dissolved solids. The quality of water in the sand improves substantially to the north, northeast, and east and the aquifer is capable of large yields to wells. Two rural water system wells completed recently at locations about 6 miles east of Natchez (D73 and E31) produce water of good quality and both are capable of producing several hundred gallons per minute. Chemical analyses for several 1,000-foot sand wells (Table 3) indicate that in some areas the water would be suitable for general use without treatment.

The Natchez aquifer, also a supplemental source of water, is capable of sustaining moderate yields of up to several hundred gallons per minute to wells in some places. Two community water system wells (D19 and D45) were reported to pump 366 and 250 gal/min, respectively, and similar production could be expected at some other sites.

The Mississippi River alluvial aquifer is presently pumped heavily in the area south of Natchez; however, an area of several square miles north of Natchez that is underlain by the alluvial aquifer (Fig. 1) is available for development of very large public or industrial water supplies. Water treatment probably would be comparable with the treatment for water from the 600-foot sand. The depth of wells (200 feet versus 600 feet) and the pumping lift for water (about 200 feet less than from the Miocene aquifers at present and eventually perhaps about 400 feet less) would be considerably less. Another factor favoring the alluvial aquifer is the fact that it is replenished annually by recharge from precipitation and from the Mississippi River. In addition, the alluvial aquifer north of Natchez is separated from the alluvial aquifer south of the city and is not, therefore, subject to interference from the present industrial pumping.

The most favorable areas for new water-supply development from the Miocene aquifers are north, northeast, and east of the present city limits of Natchez, where the drawdown from present pumping is small. Factors that favor development in these areas include (1) the source of recharge is to the north, and the 400-foot and 600-foot aquifers merge in that direction; (2) the water-bearing sand beds are thicker to the north and east; (3) the 600-foot sand outside the city is less affected by pumping from existing wells; and (4) the 1,000-foot sand improves northeastward and to the east in chemical and physical quality and may not need treatment for most uses.

The Mississippi River alluvial aquifer, undeveloped north of Natchez, is capable of supporting very large withdrawals of ground-water. Well depths and pumping lifts would be less than for the Miocene aquifers.

SUMMARY

Ground-water withdrawals from the Miocene aquifers (mostly the 600-foot sand) in the Natchez area increased from about 5.3 Mgal/d in 1962 to about 8.4 Mgal/d in 1980 and declined slightly to 7.4 Mgal/d in 1982. Ground water use from the Mississippi River alluvial aquifer reached a maximum of about 46 Mgal/d in 1955 and declined to about 38 Mgal/d in 1983.

Although water levels in the 400- and 600-foot sands have declined nearly 100 feet since 1939 most of the declines had occurred by 1960. Since 1960 declines have been small. The potential is excellent for increasing the production of ground-water from the 600- and 1,000-foot sands to the north, northeast, and east, and southeast of Natchez and from the Mississippi River alluvial aquifer north of the city. In addition to being capable of very large yields to wells, pumping lifts in the alluvial aquifer in the future will be significantly smaller than from the Miocene aquifers.

Available data indicate that some increases in pumping withdrawals from the 600-foot sand in the city can be made and still maintain pumping levels within acceptable limits; however, large increases in pumping within the present cone of depression may result in excessive declines.

The water in the major aquifers is usable after treatment for most purposes and water from the 1,000-foot sand may be satisfactory without treatment. In freshwater aquifers the dissolved-solids concentrations average less than 500 mg/L and hardness ranges from soft to very hard. Iron and manganese concentration and color are present in objectionable concentrations in some wells in all aquifers. Mean silica concentration is highest in the 1,000-foot Miocene sand, and lowest in the alluvial aquifer.

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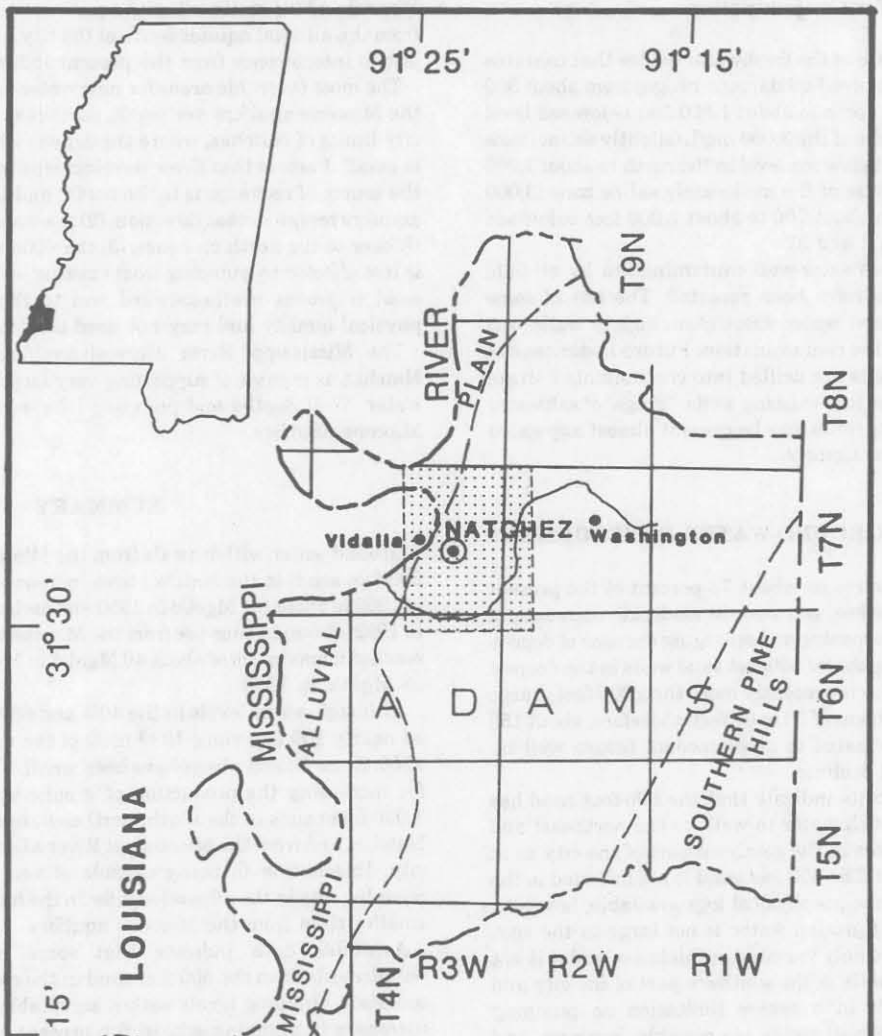

Figure 1.--Location of study area in Adams County Mississippi.

Table 1.--Geologic units and their lithologic characteristics in the Natchez area

System	Series	Group	Stratigraphic unit	Thickness (feet)	Physical character	Water-bearing properties
	Holocene	-	Alluvium	0-200+	Clay, silt, sand, and gravel.	Deposits in tributary streams may yield as much as 100 gpm. Mississippi River alluvium, 2000 gal/min or more with specific capacities of 30 to 150 gal/min per foot of drawdown. Recharge to the aquifer depends partly on on river stage.
Quaternary			Loess	0-50	Brown calcareous silt.	Unimportant as an aquifer. Prevents recharge to aquifers to aquifers, which restricts yield to streams.
?	Pleisto-cene and Pliocene		Natchez Formation and terrace deposits	0-80	Sand and gravel, mainly chert and quartz. Some grains of igneous rock.	Forms Natchez aquifer. Yield up to 350 gpm.
	Miocene and Oligocene		Hattiesburg Formation, Catahoula Sandstone and Chickasawhay Formation (undivided)	0-2200	Clay, sand, and gravel. Pea gravels of polished black chert.	Municipal and industrial supplies. Yields 100 to 800 '800 gal/min with specific capacities of 3 to 25 gal/min per foot of drawdown. Well in Natchez area are produced from irregular sand beds in Catahoula Sandstone.
		Vicksburg	Bucatunna Formation Byram Formation Glendon Formation Marianna Formation	160	Clay, marl, and limestone.	Unimportant as an aquifer.
	Oligocene		Forest Hill Sand	200	Fine sand and carbonaceous clay.	Unimportant as an aquifer
Tertiary		Jackson	Yazoo Formation	450	Clay.	Confining layer.
			Moody Branch Formation	25	Sandy marl.	Unimportant as an aquifer.
	Eocene	Claiborne	Cockfield Formation	570	Sand and clay.	Saline water.
			Cook Mountain Formation	150-250	Shale and sandy limestone.	Confining layer.
			Sparta Sand	900	Sand and shale.	Saline water.

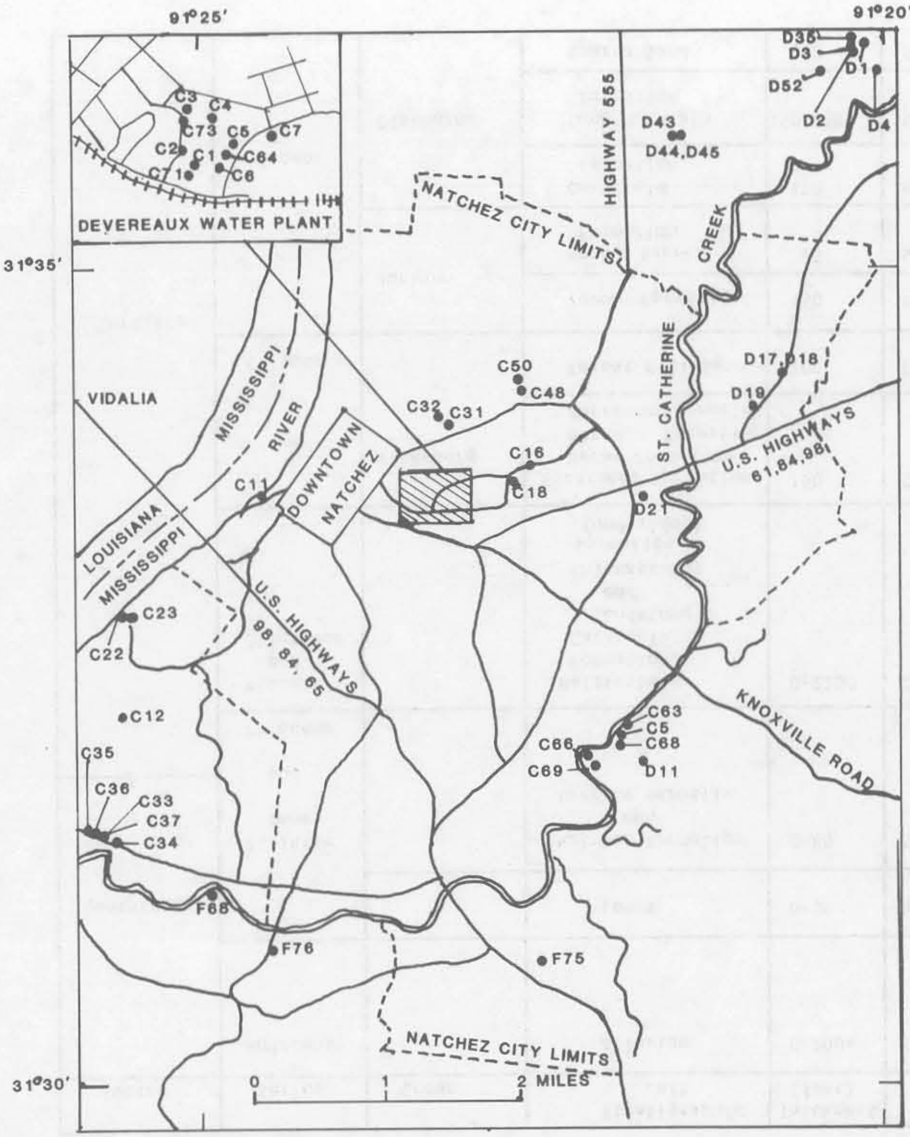

Figure 2a.--Location of wells in the Natchez area.

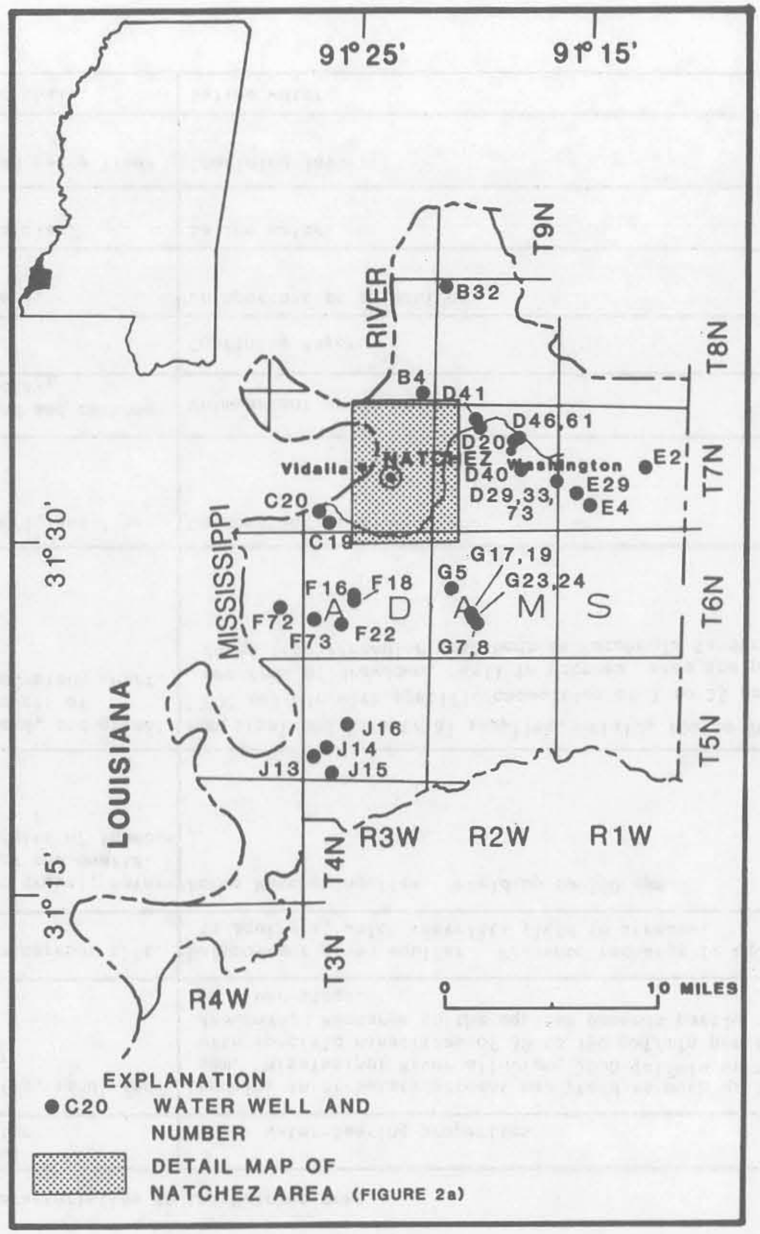

Figure 2b.--Locations of selected wells in Adams County, Mississippi.

Table 2.--Records of selected wells in Adams County, Mississippi

Water-Bearing Units: MRVA, Mississippi River alluvial aquifer; TRCS, Terrace deposits; MOCN, Miocene undifferentiated; CTHL, Catahoula Sandstone; NTCZ Natchez Aquifer.

Water Use: E, Electric Power; H, Domestic; I, Irrigation; N, Industrial; P, Public; R, Recreation; S, Stock; T, Institutional; U, Unused; Z, Other.

WELL NO.	LOCATION: SECTION	LOCATION: TOWNSHIP	LOCATION: RANGE	OWNER	DATE DRILLED	ALTITUDE (FT)	WELL DEPTH (FT)	CASING DIAM (IN)	SCREEN LENGTH (FT)	AQUIFER	WATER LEVEL: DEPTH (FT)	WATER LEVEL: DATE	PUMP (GPM)	WATER USE	ANALYSIS	ELECTR LOG
B004	08	08N	03W	A B DILLE	1961	260	760	4	20	CTHL	220	06-61		H	B	
B032	09	08N	03W	FRANK JUNKIN	1968	85.	120	4		MRVA		-	50	H	B	
C001	16	07N	03W	NATCHEZ	1939	220	451	16	50	CTHL	262	10-81	200	P	B	
C002	16	07N	03W	NATCHEZ	1939	238	607	16	60	CTHL	243	06-82	305	U	B	
C003	16	07N	03W	NATCHEZ	1939	232	444	16	45	CTHL	265	09-55	300	P	B	
C004	16	07N	03W	NATCHEZ	1939	214	608	16	60	CTHL	242	06-76	250	P	B	
C005	16	07N	03W	NATCHEZ	1949	212	421	16	50	CTHL	194	04-49	400	P	B	
C006	16	07N	03W	NATCHEZ	1948	212	656	16	60	CTHL	241	05-76	524	U	B	
C007	16	07N	03W	NATCHEZ	1953	210	613	16	60	CTHL	158	08-53	200	P	B	
C011	15	07N	03W	NATCHEZ	1926	90.	400	18		CTHL	66	03-61		U		
C012	27	07N	03W	BILL STAHLMAN	1952	230	600	4		CTHL	230	06-82		H		
C019	54	07N	03W	NATCHEZ PORT	1961	78.	507	10	20	CTHL	92	06-82		N	B	087
C020	27	07N	03W	NATCHEZ PORT	1961	100	142	4		CTHL	50	06-61	70	N	B	
C022	26	07N	03W	J M JONES LBM	1961	60.	280	6	20	CTHL	44	09-61	150	N	B	
C023	26	07N	03W	JONES LUMBER CO		160	370	8		CTHL	134	06-61		U		
C031	16	07N	03W	NATCHEZ	1964	210	442	16	60	CTHL	248	06-82	500	P		
C032	16	07N	03W	NATCHEZ	1964	210	575	16	60	CTHL	228	10-81	503	P		
C033	54	07N	03W	DIAMOND INTER CORP	1965	90.	655	12	40	CTHL	32	07-83	350	N		
C034	28	07N	03W	DIAMOND INTER CORP	1964	90.	674	12	94	CTHL	90	12-65	350	N		
C035	54	07N	03W	DIAMOND INTER CORP	1965	90.	679	12	40	CTHL	81	10-83	350	N		
C036	54	07N	03W	DIAMOND INTER CORP	1966	90.	150	18	30	MRVA	77	11-66	500	N		
C037	29	07N	03W	DIAMOND INTER CORP	1970	90.	560	16	71	CTHL	96	04-70	500	N		098
C048	16	07N	03W	NATCHEZ	1980	183	578	16	61	CTHL	207	10-81	500	P	B	145
C050	16	07N	03W	NATCHEZ	1980	210	864	16	71	CTHL	159	10-81	536	P	B	148
C063	48	07N	02W	JOHNS MANVILLE	1958	119	599	16	60	CTHL	114	10-81	560	N		
C064	16	07N	03W	NATCHEZ	1983	205	650	16	50	CTHL	203	01-83	750	P		202
C065	48	07N	02W	JOHNS MANVILLE	1946	119	402	12	50	CTHL	69	12-61	250	U	B	
C066	48	07N	02W	JOHNS MANVILLE	1946	119	428	12	45	CTHL		-		U		
C067	48	07N	02W	JOHNS MANVILLE	1947	117	436	12	44	CTHL	69	06-82		U		
C068	48	07N	02W	JOHNS MANVILLE	1953	118	595	16	60	CTHL	97	11-53	488	N		
C069	48	07N	02W	JOHNS MANVILLE	1957	119	597	16	60	CTHL	105	09-57	480	N		
C071	16	07N	03W	NATCHEZ	1983	240	655	16	50	CTHL	247	06-83	750	P		251
C073	16	07N	03W	NATCHEZ	1983	220	616	16	61	CTHL	230	08-83	750	P		
D001	12	07N	02W	MISS POWER & LT	1951	192	456	12	75	CTHL	89	06-82	490	U		
D002	14	07N	02W	MISS POWER & LT	1949	215	324	12	60	CTHL	94	03-61	510	E		
D003	14	07N	02W	MISS POWER & LT	1949	215	499	12	45	CTHL	142	06-82	480	E		
D004	14	07N	02W	MISS POWER & LT	1951	189	477	12	60	CTHL	77	03-61	500	E		
D011	87	07N	02W	JOHNS MANVILLE	1947	124	429	12	44	CTHL	66	04-61	300	U		
D013	87	07N	02W	JOHNS MANVILLE	1955	119	600	16	60	CTHL	111	06-55	638	N	B	
D017	57	07N	02W	OAKLAND WTR WKS	1951	160	161	6	22	NTCZ	84	06-82	165	P		
D018	57	07N	02W	OAKLAND WTR WKS	1951	160	165	4	23	NTCZ	115	10-56	65	P		
D019	57	07N	02W	OAKLAND WTR WKS	1956	160	135	10	32	NTCZ	87	07-56	366	P		
D020	22	07N	02W	ADAMS CO W A	1966	260	543	12	60	MOCN	152	06-82	472	P		068
D021	71	07N	02W	NATCHEZ TRACE	1948	140	100	2		NTCZ	21	01-68		U		
D029	27	07N	02W	ST CATHERINE	1967	200	410	8	20	CTHL	230	06-82	295	N		
D033	47	07N	02W	T L JAMES	1972	340	447	4	10	CTHL	241	06-82		U		
D035	13	07N	02W	MISS POWER & LT	1974	182	355	12	50	CTHL	90	07-74	400	N		121
D040	44	07N	02W	BRYANDALE INC	1977	293	1030	4	7	CTHL	221	06-82	75	P		138
D041	22	07N	02W	ADAMS CO W A	1978	240						-		U		139
D043	17	07N	02W	BROADMOOR UTL	1960	200	180	6	20	CTHL	107	09-81	150	U		
D044	17	07N	02W	BROADMOOR UTL	1962	200	180	4	20	CTHL	107	09-81	50	U		
D045	17	07N	02W	BROADMOOR UTL	1979	205	150	10	15	CTHL	111	06-82	250	P		141
D046	27	07N	02W	ADAMS CO W A	1979	240	958	12	60	CTHL	205	10-81	500	P	B	163
D052	12	07N	02W	MISS POWER & LT	1981	200	483	12	79	CTHL	119	11-81	500	N	B	159
D073	44	07N	02W	ADAMS CO W A	1984	325	1058	16	36	CTHL	252	01-85	500	P		276
D061	27	07N	02W	ADAMS CO W A	1979	275	971	12	61	CTHL	194	01-80	500	P		
E002	46	07N	01W	CHEVRON OIL CO	1946	385	490	10	60	CTHL	248	08-57	465	U	B	
E004	62	07N	01W	SERO PUNCHES	1961	405	513	3		CTHL	277	06-61		Z	B	088
E029	38	07N	01W	ADAMS CO W A	1984	418	1220	6	20	CTHL	343	05-84		U	B	
E031	38	07N	01W	ADAMS CO W A	1984	418	1186	16	60	CTHL	349	12-84	500	P	B	275
F016	20	06N	03W	INTP APER CO	1958	54.	201	30	50	MRVA	52	03-58	20	N	B	
F018	20	06N	03W	INT PAPER CO	1952	73.	232	18	60	MRVA	98	08-60	20	N	B	
F022	19	06N	03W	INT PAPER CO	1955	85.	264	30	60	CTHL	107	10-60	20	N	B	
F068	10	06N	03W	INT PAPER CO	1969	110				MRVA		-		U		096
F072	07	06N	04W	ANDERSON FARMS	1972		130	3		CTHL	22	07-72		H		
F073	22	06N	03W	ANDERSON FARMS	1972		115	4	10	CTHL	15	08-72		H		
F075	02	06N	03W	TRINITY HIGH SC	1973	190	800	7	20	CTHL	205	10-73		H		116
F076	07	06N	03W	ST CATHERINE	1960	100	165	4	20	CTHL	122	09-81	60	N		
G005	38	06N	02W	ADAMS CO W A	1966	280						-		U		067
G007	41	06N	02W	ADAMS CO W A	1966	220	267	10	50	CTHL	62	05-66	300	U		069
G008	41	06N	02W	ADAMS CO W A	1966	220	267	10	50	CTHL	62	05-66	300	P		070
G017	09	06N	02W	ADAMS CO W A	1973	356	569	12	60	CTHL	345	06-73	412	P		
G019	41	06N	02W	ADAMS CO W A	1973	245	140	4		CTHL		-		U		118
G023	41	06N	02W	ADAMS CO W A	1974	226	878	12	40	CTHL	165	10-74	450	U		122
G024	41	06N	02W	ADAMS CO W A	1974	227	888	12	40	CTHL	163	10-74	450	P		123
J013	30	05N	03W	MCCANN FARMS	1978	47.	135	18	60	MRVA	10	07-78	4500	I		
J014	29	05N	03W	MCCANN FARMS	1978	46.	150	18	60	MRVA	7	07-78	5000	I		
J015	31	05W	03N	MCCANN FARMS	1978	75.	150	18	60	MRVA	4	07-78	4500	I		
J016	19	05N	03W	MCCANN FARMS	1978	110	165	18	60	MRVA	18	07-78	4500	I		

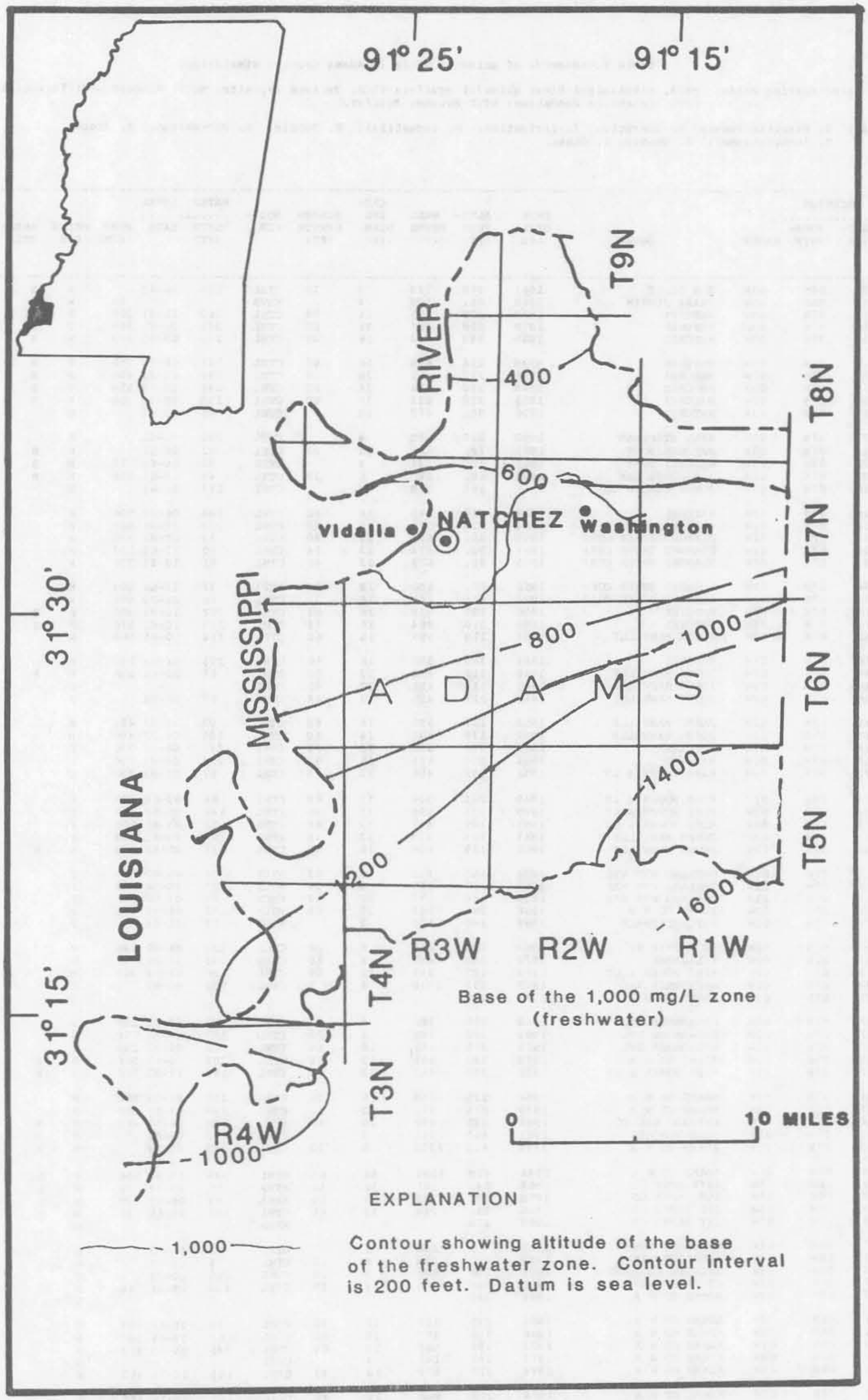

Figure 3.--Configuration of the base of the freshwater zone in Adams County, Mississippi (modified from Gandl, 1982).

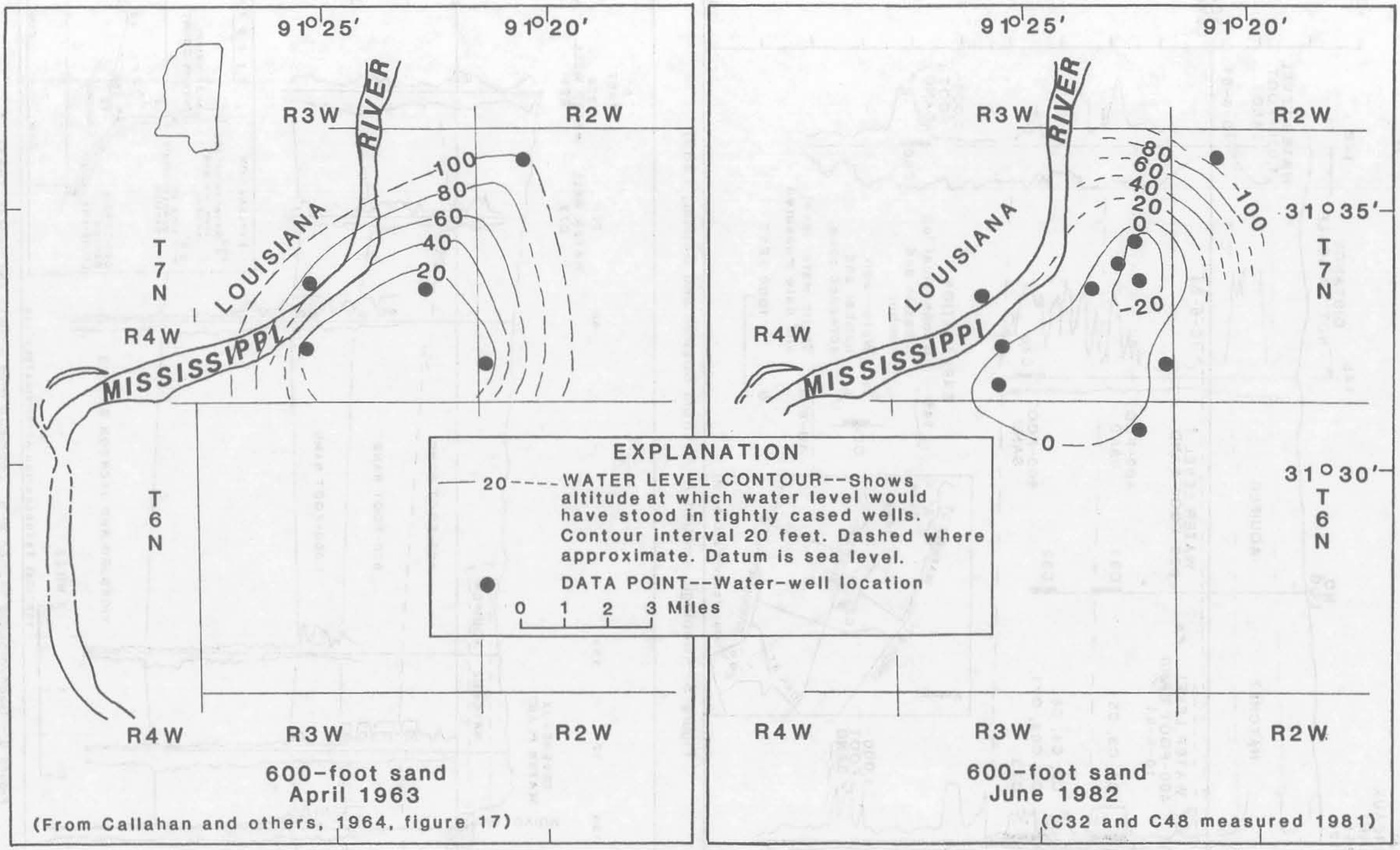

Figure 4.--Potentiometric surface in the 600-foot sand, April 1963 and June 1982 (from Boswell and Bednar, 1985)

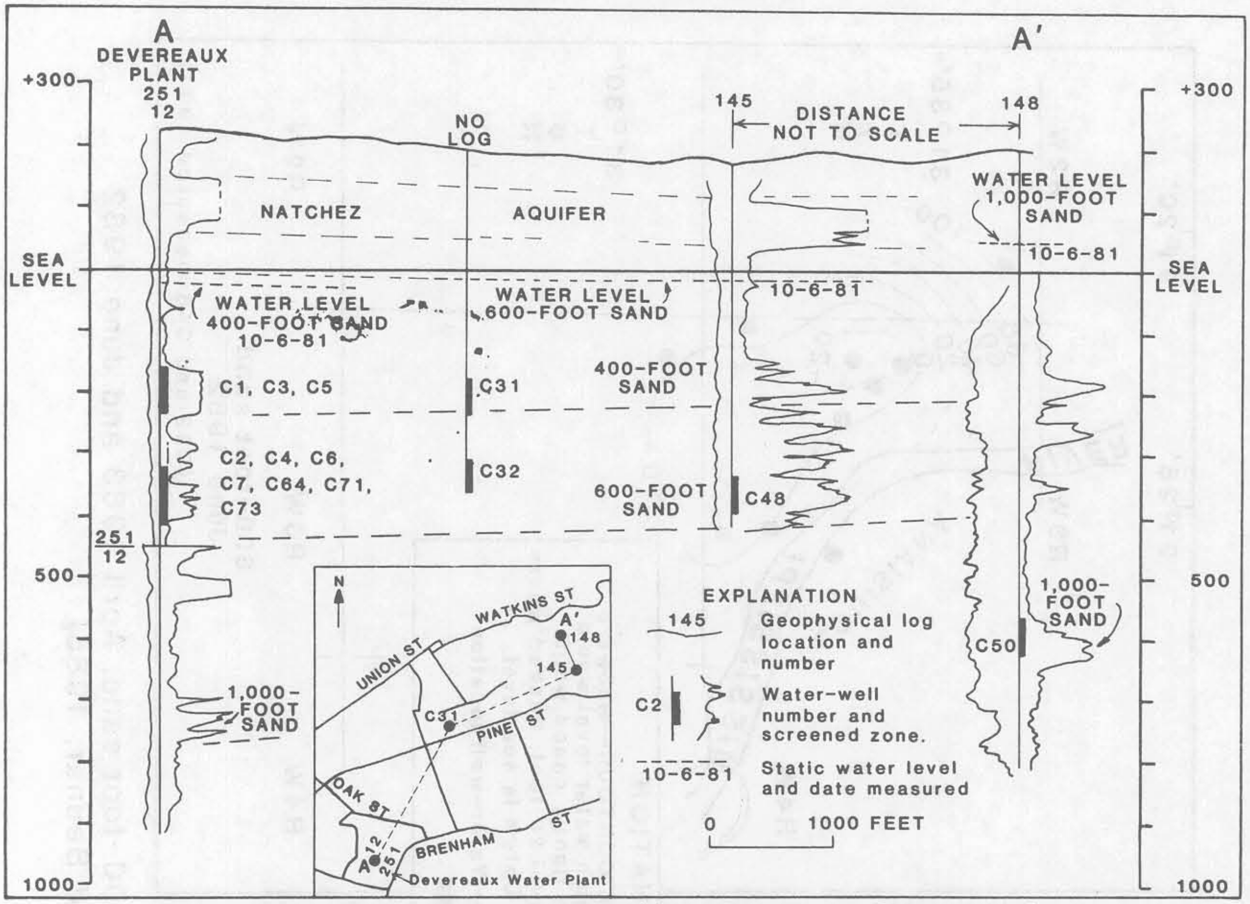

Figure 5.--Geologic section A-A' (from Boswell and Bednar, 1985).

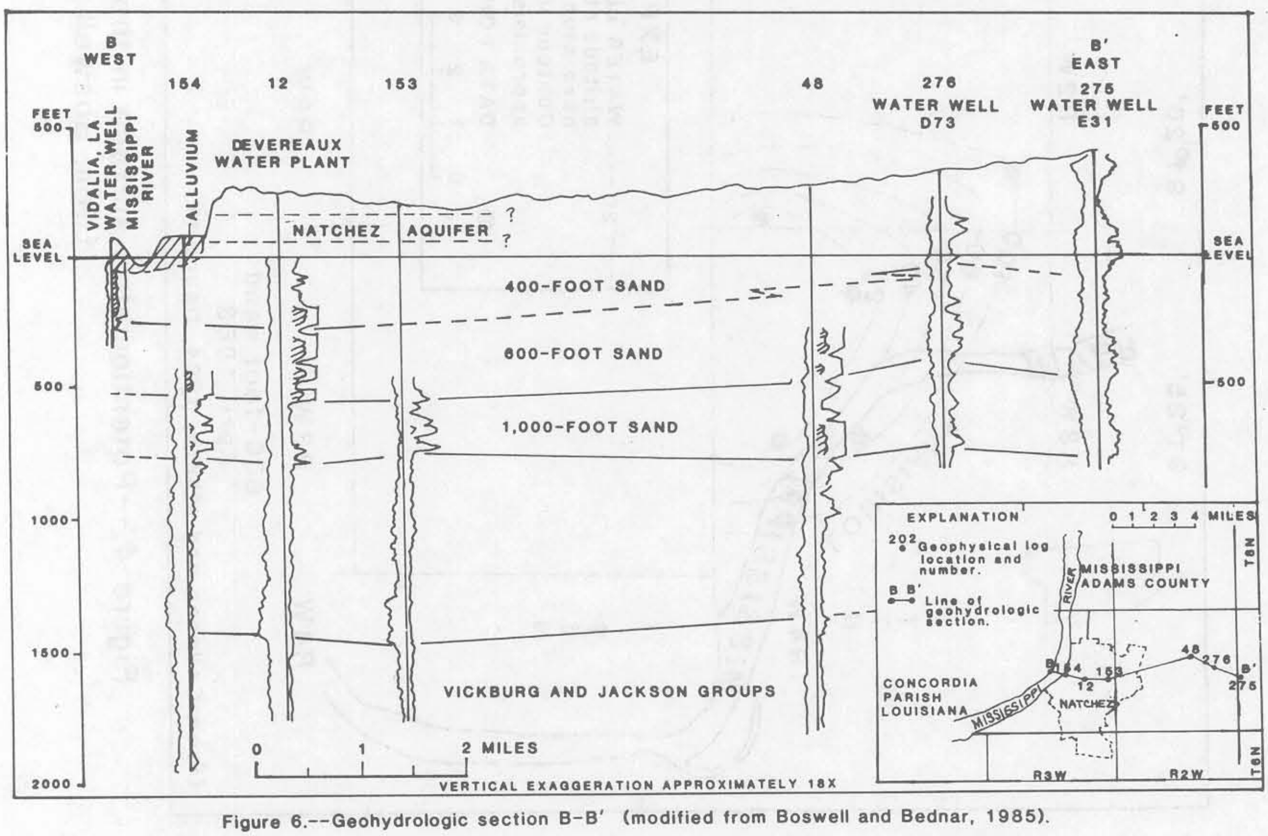

Figure 6.--Geohydrologic section B-B' (modified from Boswell and Bednar, 1985).

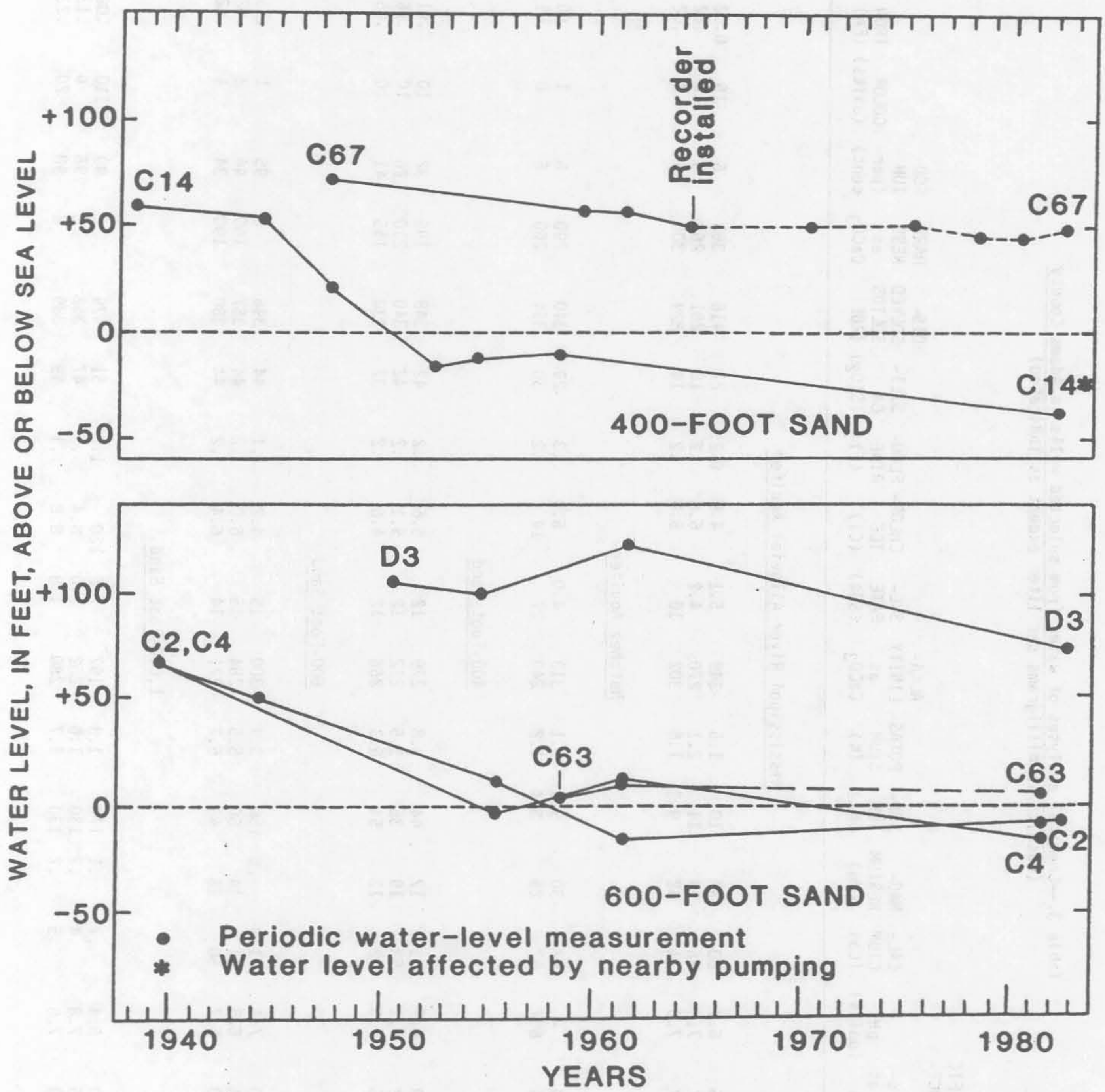

Figure 7.--Water-level trends in the Natchez area, Mississippi, 1938-82.

Table 3.--Chemical analyses of water from selected wells in Adams County
(Results in milligrams per liter except as indicated)

WELL No.	DATE	WELL DEPTH (ft)	SPECIFIC CONDUCTANCE (micromhos at 25°C)	pH (units)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	POTASSIUM (K)	ALKALINITY as $CaCO_3$	SULFATE (SO4)	CHLORIDE (Cl)	FLOURIDE (F)	SILICA (SiO_2)	DISSOLVED SOLIDS (ROE)	HARDNESS as $CaCO_3$	SODIUM (percent)	COLOR (units)	IRON (Fe)	MANGANESE (Mn)
Mississippi River Alluvial Aquifer																			
B32	4/83	120	675	6.9	80	37	10	1.5	349	5.1	4.9	0.2	27	416	360	6	15	0.02	0.01
F8	9/61	246	477	7.2	56	30	11	2.1	270	4.2	6.8	.2	18	281	263	8	-	.02	-
F18	9/61	235	537	7.3	71	32	9.3	1.8	302	10	8.0	.2	14	329	308	6	3	.02	-
Natchez Aquifer																			
D19	6/82	135	600	-	67	30	9.1	1.1	313	4.0	6.0	.3	29	340	290	6	1	.00	.00
D45	6/79	150	514	6.7	62	26	8.4	1.2	240	27	14	.2	30	354	260	6	0	.01	.08
400-Foot Sand																			
C1	3/61	457	538	6.7	51	17	44	3.8	279	12	5.6	.2	42	348	196	32	10	.91	-
C16	3/61	455	532	7.1	53	19	35	3.5	272	12	5.1	.2	42	340	210	26	10	.96	-
C65	12/61	406	496	7.5	42	12	54	6.3	266	12	4.6	.2	37	330	155	41	10	.05	-
600-Foot Sand																			
C33	6/82	655	600	7.1	1.3	.6	150	3.9	300	15	4.2	.1	44	398	6	95	1	.15	.03
C71	10/83	655	574	6.8	41	14	60	5.5	284	15	6.0	.2	44	357	160	44	2	.82	.23
C73	10/83	615	580	6.7	50	16	48	6.7	271	14	6.4	.2	44	360	190	34	1	.62	.29
1,000-Foot Sand																			
C50	4/83	864	750	8.4	.7	.1	170	1.8	197	7.6	120	1.8	51	479	2	99	110	.02	.01
D40	6/82	1053	515	7.8	.4	.2	130	1.6	262	2.0	8.4	.5	47	352	2	98	6	.13	.01
E29	5/84	1220	520	7.8	.5	.2	130	1.7	280	1.8	8.8	.1	49	389	2	98	20	.23	.02