INFORMATION CIRCULAR 45

EFFECTS OF GROUND-WATER PUMPING IN PARTS OF LIBERTY AND McINTOSH COUNTIES, GEORGIA, 1966-70

by

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STATE OF GEORGIA
DEPARTMENT OF NATURAL RESOURCES
Joe D. Tanner, Commissioner

DIVISION OF EARTH AND WATER RESOURCES
THE GEOLOGICAL SURVEY OF GEORGIA
Sam M. Pickering, State Geologist and Division Director

PREPARED IN COOPERATION WITH THE U.S. GEOLOGICAL SURVEY
AND
U.S. FISH AND WILDLIFE SERVICE, BUREAU OF SPORT FISHERIES AND WILDLIFE

ATLANTA
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EFFECTS OF GROUND-WATER PUMPING IN PARTS OF LIBERTY AND McINTOSH COUNTIES, GEORGIA, 1966-70

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ABSTRACT

Industrial pumping near Riceboro has lowered the ground-water level enough to cause many wells, including some at Harris Neck and Blackbeard Island National Wildlife Refuges, to stop flowing. During 1968, water levels declined more than 11 feet near the center of pumping at Riceboro, 2 feet at Blackbeard Island, and 4 feet at Harris Neck National Wildlife Refuge. About 80 to 90 percent of this additional decline is attributed to the industrial pumping near Riceboro, but it is superimposed on a regional water-level decline of as much as 45 feet in the Liberty and McIntosh Counties area caused by withdrawal of ground water throughout the coastal area since 1880.

INTRODUCTION

In the 1880's, when the first wells were drilled into the principal artesian aquifer, the water level or potentiometric head was 30 to 50 feet above land surface in the Liberty and McIntosh Counties study area. Wells in that area and in most of coastal Georgia would flow at that time. Heavy pumping has lowered the water level 40 to 45 feet, so that in much of the area wells will no longer flow. Wells that flowed to maintain fresh-water ponds have now (1970) ceased to flow at both Blackbeard Island and Harris Neck National Wildlife Refuges in McIntosh County, and the ponds are beginning to dry up. The U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, requested the U. S. Geological Survey to determine the amount of water-level decline in wells at the refuges attributable to recent (1968-70) industrial pumping at Riceboro in Liberty County and the amount attributable to regional decline of water level caused by previous and continued pumping throughout the area. See Figure 1 for location of study area.

[1]Hydrologist, U. S. Geological Survey

METHOD OF INVESTIGATION AND ACKNOWLEDGMENTS

This report was based on interpretations of well hydrographs, potentiometric maps, and chemical analyses. The U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, cooperated in the investigation. Both this agency and the Interstate Paper Corp. kindly provided data pertinent to the study. The investigation was made under the supervision of John R. George, district chief, U. S. Geological Survey, Water Resources Division.

HYDROGEOLOGY

The principal artesian aquifer, of Eocene to Oligocene age, is the main water-bearing unit in coastal Georgia. It includes the Oligocene Series, a sandy, phosphatic limestone that is somewhat recrystallized and commonly porous, and the Ocala Limestone. The Oligocene Series is not generally drawn upon as a water source because of its tendency to cave in the uncased part of the well, although some wells are open to the Oligocene and produce some water.

Underlying the Oligocene Series is the Ocala Limestone of Eocene age. The Ocala is generally divided into two water-bearing zones that are separated by a soft, chalky nonwater-bearing limestone. The upper water-bearing zone is hard, white, recrystallized, fossiliferous limestone. The lower water-bearing zone is light gray limestone, softer and less permeable than the upper zone. The upper water-bearing zone yields most of the water to wells tapping both zones.

PRINCIPAL ARTESIAN AQUIFER

The principal artesian aquifer is one of the most

productive aquifers in the United States, producing more than one-quarter billion gallons of water per day to users in coastal Georgia. The amount of water still available from the principal artesian aquifer is exceedingly large. Even in the Brunswick area, where about 100 mgd (million gallons per day) of water is withdrawn from the aquifer; there is no actual dewatering of the aquifer, only a loss of pressure and a corresponding decline in water level.

GROUND-WATER WITHDRAWAL

Industrial pumpage at Riceboro accounts for 90 to 95 percent of the total water withdrawn in the study area. In March 1968, industry began pumping an average of 8.58 mgd of water from the principal artesian aquifer. Table 1 shows average daily ground-water withdrawal for each month of record.

Average withdrawal by all users within the study area is estimated to be less than 10 mgd. Industry at Riceboro, although the principal user in the study area, pumps much less water than most other major water users in coastal Georgia. Withdrawal from the aquifer in bordering Glynn County averages 100 mgd, in the Savannah-Chatham County area about 70 mgd, and in Wayne County about 45 mgd (Figs. 3 and 4).

WATER-LEVEL DECLINE

The height to which water from the principal artesian aquifer will rise above sea level when tapped by a tightly cased well is called its potentiometric head. In 1880, before development, the potentiometric head of the principal artesian aquifer was 30 to 70 feet above sea level in coastal Georgia and 45 to 65 feet above sea level in Liberty and McIntosh Counties, as shown in Figure 2. Subsequent increasingly heavy withdrawal in the entire coastal area lowered the water level considerably and formed cones of depression of the potentiometric surface around centers of pumping.

By 1942, ground-water withdrawal in the coastal area of Georgia totaled about 140 mgd (Warren, 1944) and resulted in a lowering of the water level in the Liberty and McIntosh Counties study area of about 20 feet. Withdrawal then was centered in Savannah and Brunswick. With the addition of over 45 mgd of withdrawal at Jesup in 1954, the water level in the study area declined an average of 20 feet below the 1941 level. Figure 3 shows the potentiometric surface of the principal artesian aquifer in coastal Georgia for December 1967. The cones of depression on the potentiometric surface, as shown in Figure 3, are the result of heavy ground-water withdrawal at Savannah, Brunswick, and Jesup.

In March 1968, industry began pumping ground water in the Riceboro area, and the water level declined still further. The effect of this new pumping at Riceboro is shown by the potentiometric surface for December 1968 (Fig. 4). Although no cone of depression at Riceboro is shown using a 10-foot contour interval, comparison of potentiometric contours on this map with those in Figure 3 indicates a lowering (about 6 feet) of the potentiometric surface at Riceboro.

A map showing the water-level decline in the study area from December 1967 to December

Table 1. Average daily industrial ground-water withdrawal, in million gallons per day by months at Riceboro, March 1968 through September 1970

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1968	—	—	7.57	7.35	9.32	9.40	7.44	10.10	9.83	7.37	8.72	7.99
1969	8.22	7.73	7.92	8.04	7.99	8.69	7.65	9.22	8.57	9.33	9.45	9.45
1970	6.82	8.61	8.92	8.56	8.89	9.16	9.11	9.30	9.17	—	—	—

(Data provided by Charles Davis, Interstate Paper Corp.)

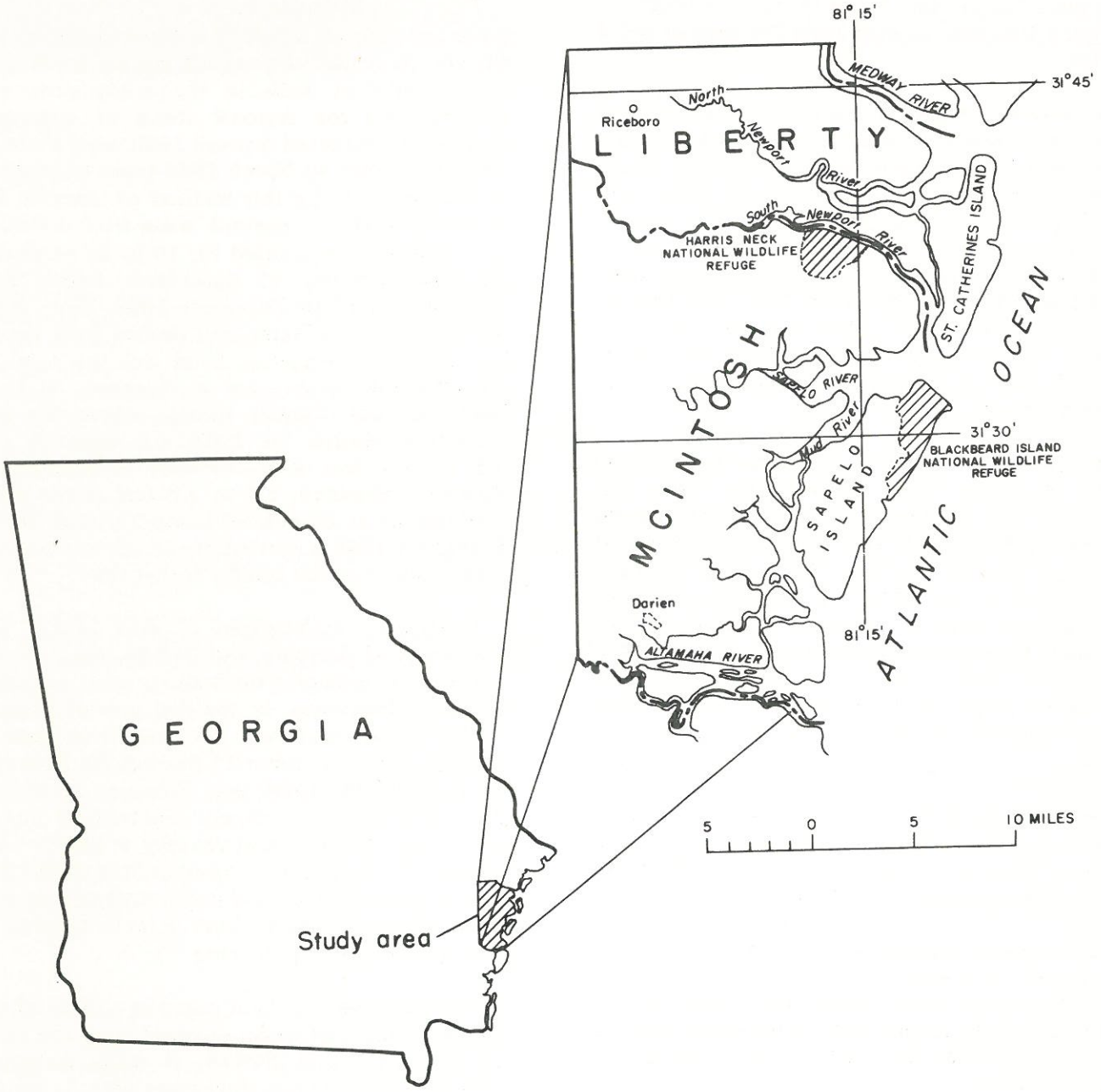

Figure 1.— Location of study area.

1968 is shown in Figure 5. The maximum water-level decline, 11.3 feet, was measured near the center of pumping. However, declines as much as 2 feet were measured 25 miles south of Riceboro. Declines of more than 8 feet in the vicinity of the pumping site were deleted from the map to avoid clutter.

As shown in Figure 5, the effect of pumping at Riceboro extends to southern McIntosh County. Water-level measurements in Glynn County, south of McIntosh County, showed that the water level was essentially unchanged during this period. Water-level-decline maps were also constructed for the Liberty and McIntosh Counties study area from December 1966 to December 1967 and December 1968 to December 1969; but the water-level decline was so slight and so uniform throughout the area, that no meaningful changes in water level could be shown.

As shown in Figure 5, the water-level decline from December 1967 to December 1968 was about 4 feet at Harris Neck National Wildlife Refuge and about 2 feet at Blackbeard Island National Wildlife Refuge. Water-level measurements made in well 35M13 at Harris Neck showed a December 1967 to December 1968 decline of 3.8 feet. Water-level measurements made in 1966 and 1970 indicate a general water-level decline of 5.0 feet at Harris Neck and 4.1 feet at Blackbeard Island National Wildlife Refuge during those 5 years.

Hydrographs record changes in water level over a period of time. Figure 5 shows the location of all wells referred to in the text, including those for which hydrographs are shown in this report.

Hydrographs for selected wells in the study area are shown in Figure 6. A steep decline in water level, beginning about March 1968, is shown on the hydrographs for all wells in the study area and coincides with the start of heavy industrial pumping at Riceboro.

Pumpage of ground water from the principal artesian aquifer in coastal Georgia is monitored. During 1968, there was no increase in groundwater withdrawal at any of the three major pumping sites: Savannah, Brunswick, or Jesup; and there was no new or added pumping of any major amount except at Riceboro. Hydrographs for wells at Savannah, Brunswick, and Jesup show no water-level decline during this period, which indicates that there was no increase in local pumping in these areas; the only water-level decline was in the Riceboro area (Fig. 5).

Extending hydrographs is one method to show predicted regional trends of water-level decline and the effects of added pumping on the water level. Hydrographs of wells in the study area were plotted, and the regional trend of water-level decline was projected through 1968 using a straight trend line prior to March 1968 (start of pumping at Riceboro). Using this method of analysis, it is estimated that the regional water-level decline in the study area accounted for 10 to 20 percent of the total amount of water-level decline from December 1967 to December 1968. Thus, 80 to 90 percent of the water-level decline from December 1967 to December 1968 was the result of the additional withdrawal at Riceboro. At Harris Neck National Wildlife Refuge, where the total water-level decline in 1968 was about 4 feet, 3.2 to 3.6 feet is attributable to pumping at Riceboro. Similarly, 1.6 to 1.8 feet of the water-level decline at Blackbeard Island National Wildlife Refuge for 1968 is attributable to the new pumping load imposed on the aquifer at that time.

Continuous hydrographs of wells 34M54, near the center of pumping, and 34N89, about 9 miles north of the pumping site indicate short periods of pumping shutdowns. In the first year of pumping at Riceboro, shutdowns occurred from June 30 through July 8, October 15 through 20, December 24 through 26, 1968, and February 18 through 22, 1969. Partial shutdowns occurred on September 1 and 2, 1968, and January 6 and 7, 1969. Increase in water level corresponding to the shutdowns show that ground-water pumping at Riceboro affects the water level in wells tapping the principal artesian aquifer (Fig. 7).

Although the effects of pumping and shutdowns on the water level lessen outward from the center of pumping, well 34N78, 9 miles distant, is affected by the longer shutdowns (Fig. 7). Shorter or partial shutdowns do not affect the water level in more distant wells; the 2-day partial shutdown in September is not noticeable on the daily hydrograph for well 34N89. The lag in time between shutdown and consequent rise in the water level also increases with distance from the center of pumping.

Pumping at Riceboro has definitely affected the water level in wells in the study area. The

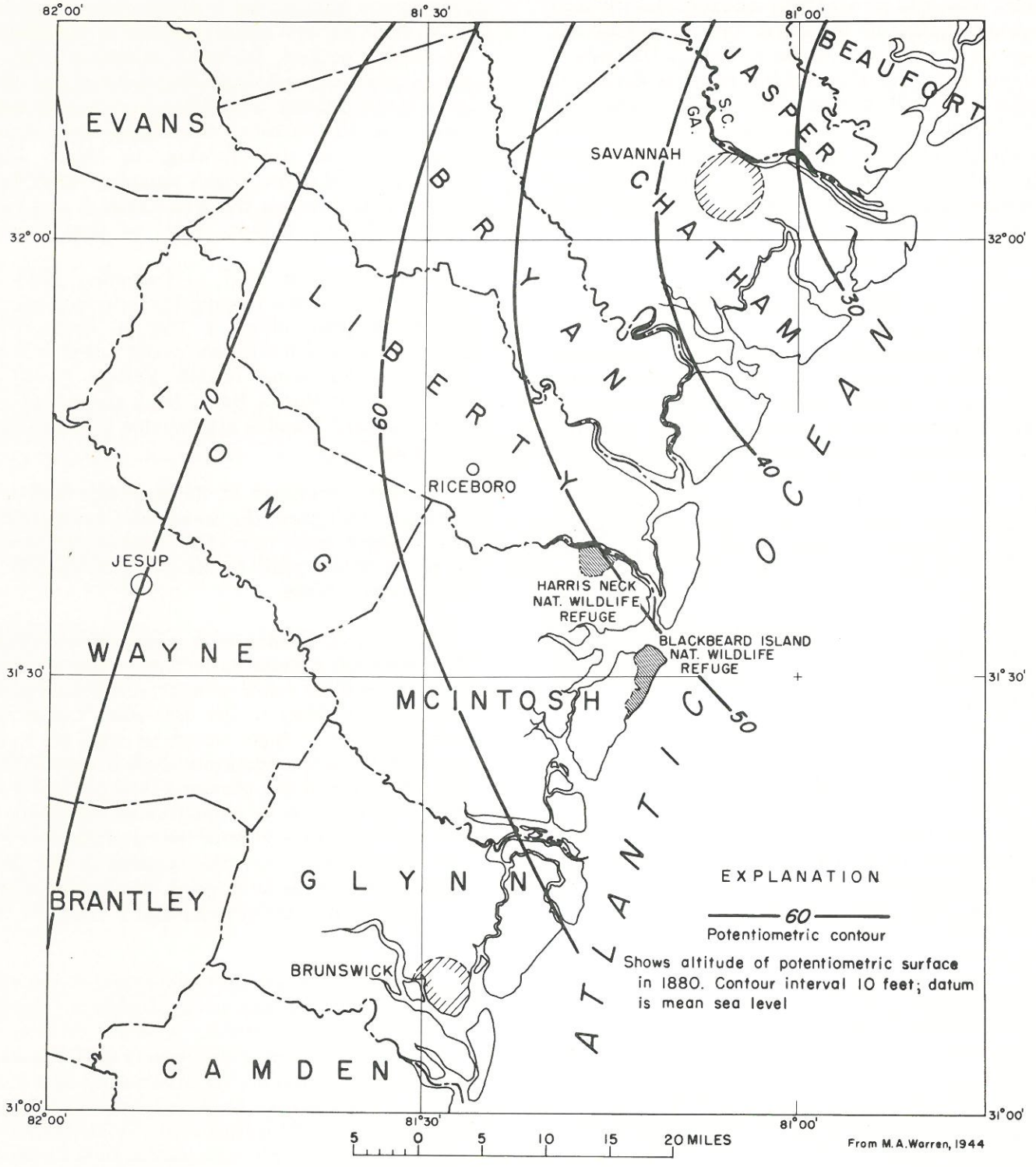

Figure 2.—Potentiometric surface of principal artesian aquifer, 1880.

water level has now (1970) assumed the trend of regional decline at the lower level caused by the increase in pumping. At the present (1970) rate of ground-water withdrawal, the regional decline in water level will remain about as it is now until steady-state conditions are reached. Any added pumping anywhere in coastal Georgia will lower the water level as a function of the amount of increase in pumping and distance from the study area.

QUALITY OF WATER

Heavy ground-water withdrawal sometimes causes deterioration of the quality of water. Heavy pumping of ground water in the Brunswick area has caused salt-water intrusion of the principal artesian aquifer there. Water from the principal artesian aquifer in Liberty and McIntosh Counties, like most water in the coastal area, is hard to very hard but otherwise of good quality. Table 2 shows chemical analyses of water from wells tapping the principal artesian aquifer in the Liberty and McIntosh Counties study area. All of these wells were sampled before pumping started at Riceboro and, therefore, provide background data to assess any change in quality that might be caused by an increase in pumping.

CONCLUSIONS

Ground-water levels in Liberty and McIntosh Counties have declined in response to heavy industrial pumping at Riceboro and in other coastal Georgia areas. Before development of the principal artesian aquifer, the potentiometric head was from 45 to 65 feet above sea level in Liberty and McIntosh Counties. By 1967, pumping in Savannah, Brunswick, and Jesup had lowered the water level in the Liberty and McIntosh Counties study area 40 to 45 feet below the original level, causing many wells to stop flowing. In March 1968, industry at Riceboro began pumping water from the aquifer, lowering the water level 2 to 11 feet more and causing more wells to stop flowing.

From December 1967 to December 1968 the water level in wells tapping the principal artesian aquifer declined about 4 feet at Harris Neck National Wildlife Refuge and about 2 feet at Blackbeard Island National Wildlife Refuge. About 3.4 feet of the decline at Harris Neck and 1.7 of that at Blackbeard Island is attributable to pumping at Riceboro.

Industrial pumpage at Riceboro has been fairly constant; therefore, the water level has stabilized. The regional trend now (1970) has about the same slope as it had prior to March 1968, though the water level is lower.

Water levels decline with increased withdrawal. This does not necessarily indicate depletion, but a greater depth to water in wells necessitates pumping to bring water to the user when the artesian head is no longer high enough to cause the well to flow. Increased pumping anywhere in coastal Georgia will further lower the water level in Liberty and McIntosh Counties as a function of the amount of increase and distance from the counties. However, recharge is adequate; the aquifer is not being dewatered; the water is good, and is available to any user for the cost of pumping.

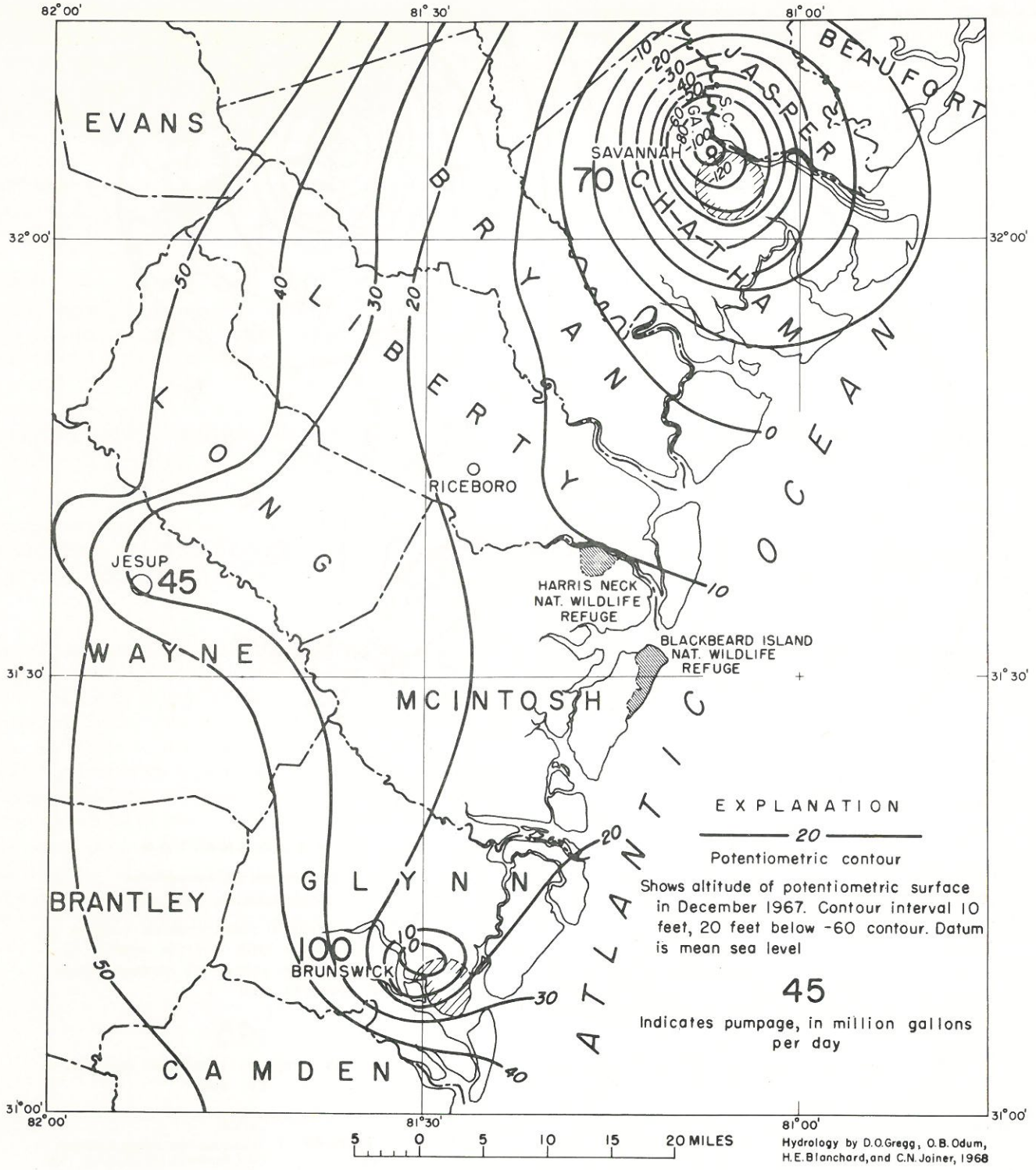

Figure 3.—Potentiometric surface of principal artesian aquifer, December 1967.

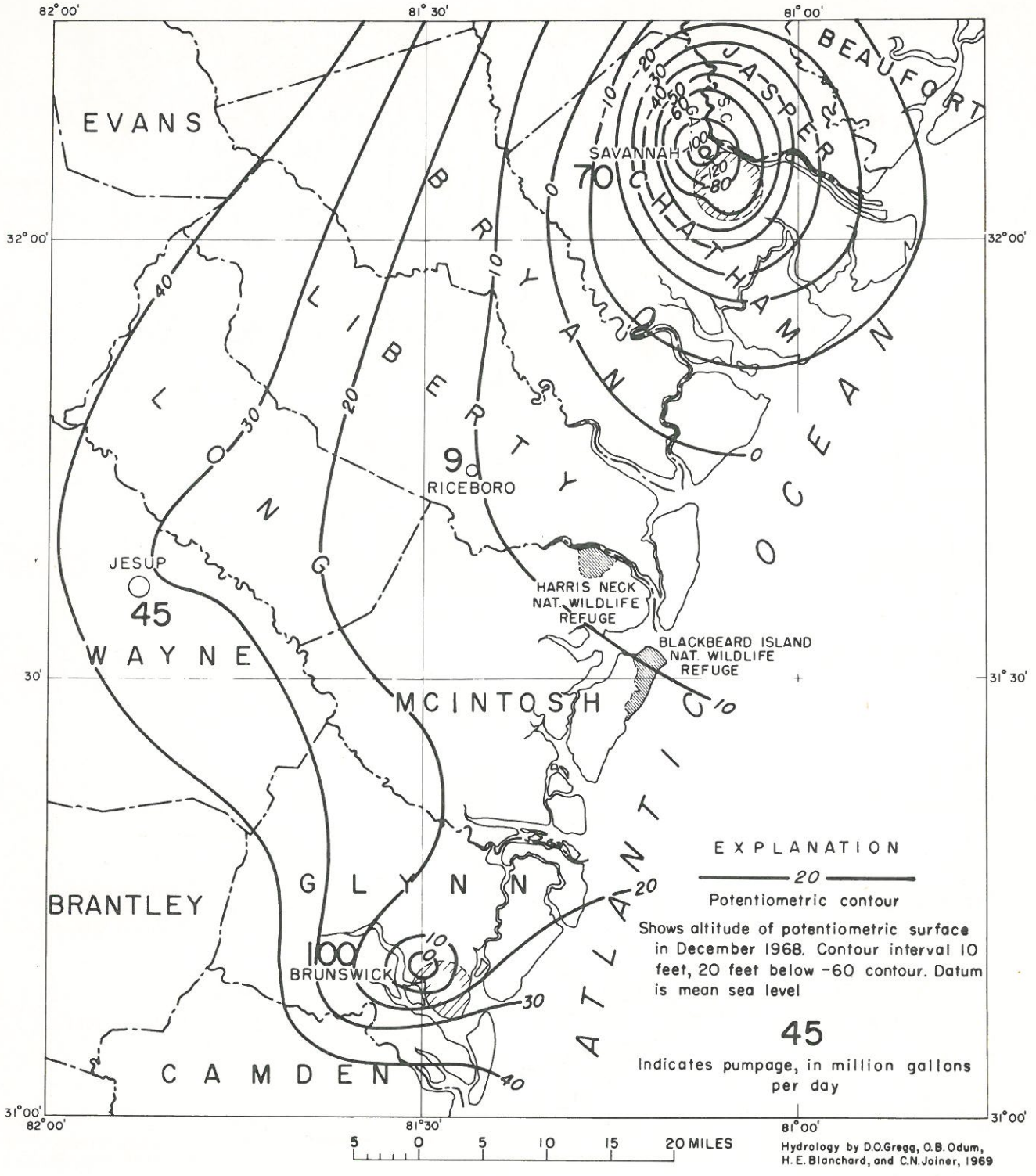

Figure 4.—Potentiometric surface of principal artesian aquifer, December 1968.

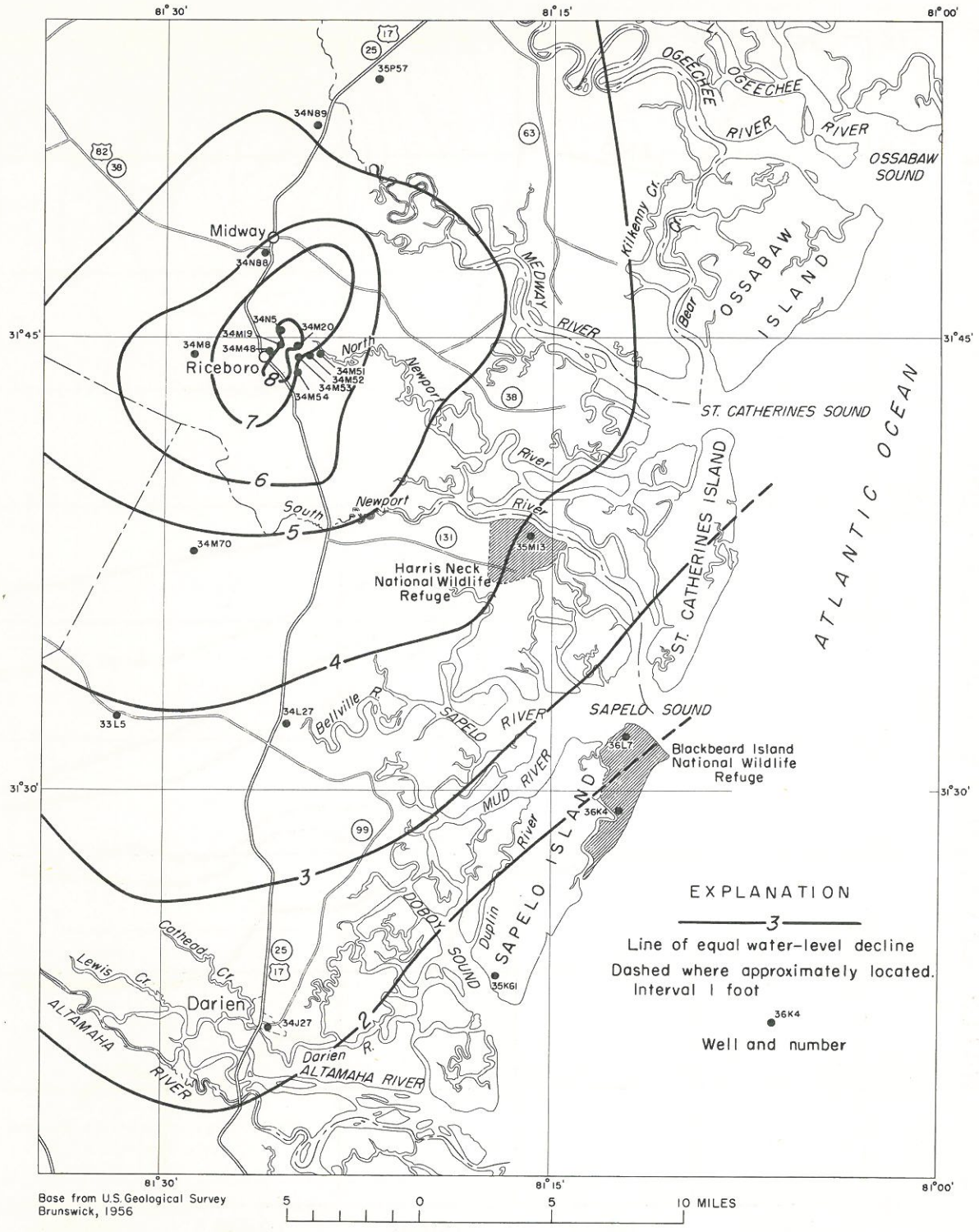

Figure 5.—Water-level decline, December 1967 to 1968, and location of wells.

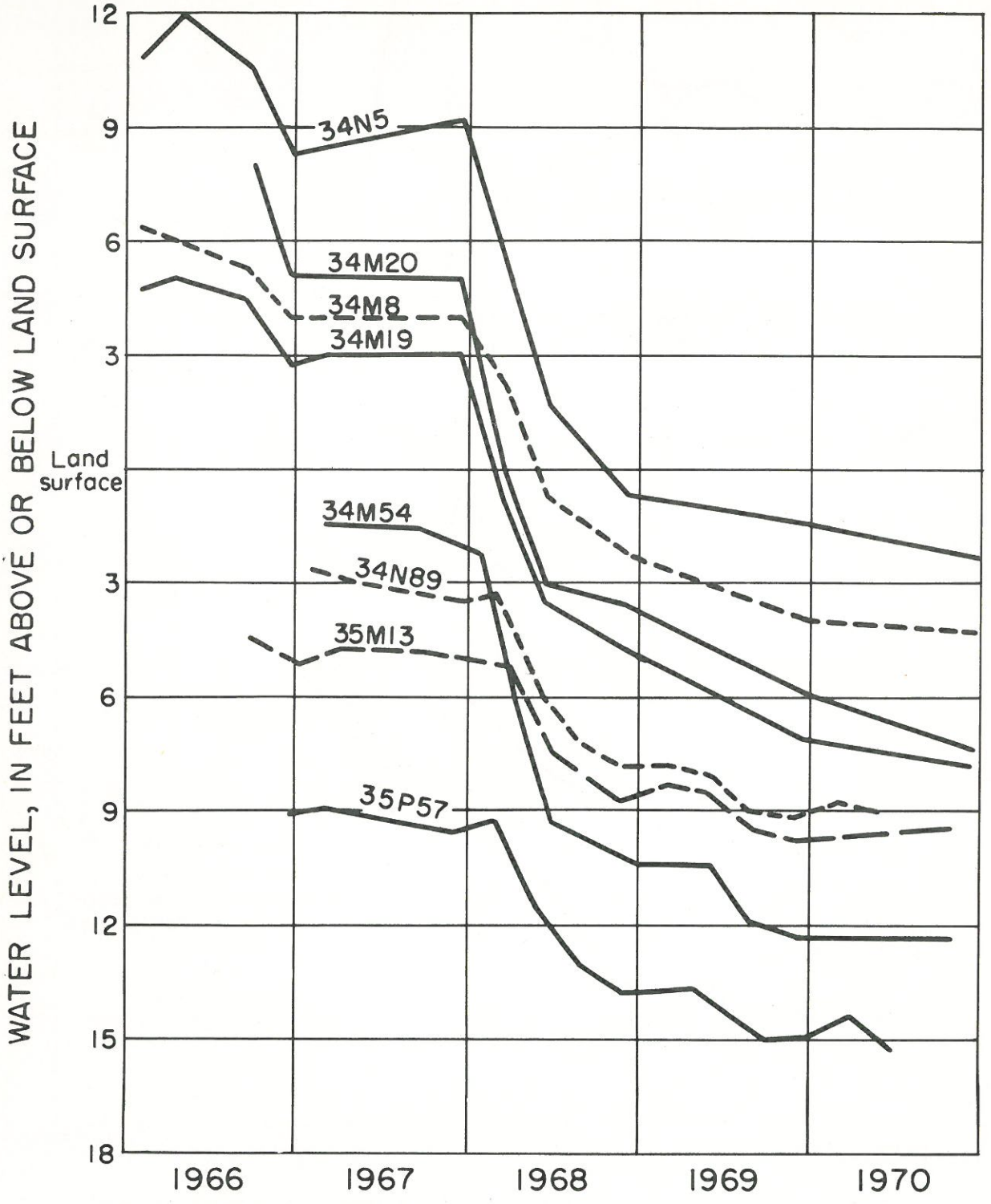

Figure 6.—Hydrographs of selected wells, 1966–70.

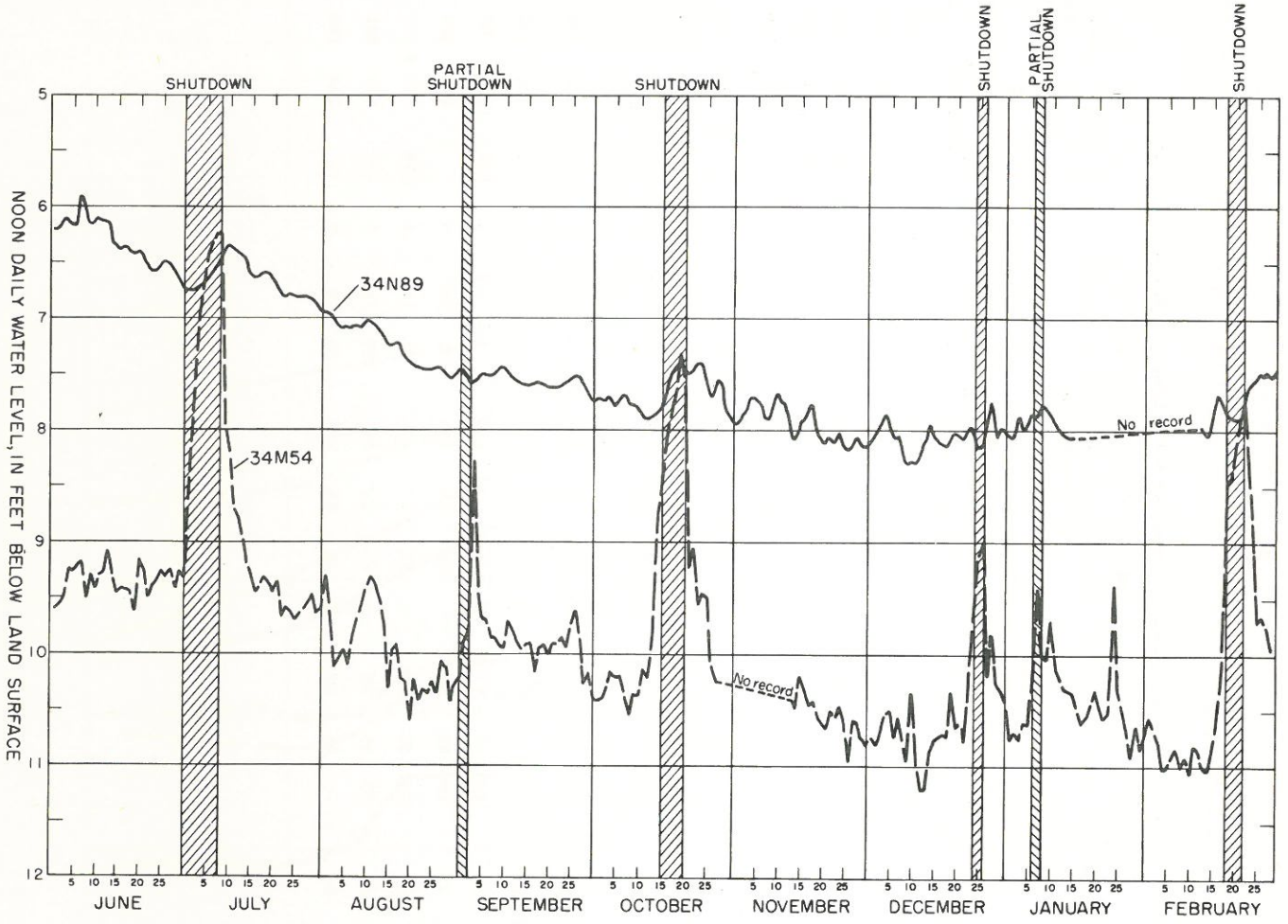

Figure 7.—Hydrographs of wells 34M54 and 34N89 for June 1968 through February 1969.

Table 2. Chemical analyses of water from wells in Liberty and McIntosh Counties, Ga.

(Analyses by U. S. Geological Survey)

Well Number	County	Date Sampled	Temperature (C°)	Silica (SiO_2)	Milligrams per liter											Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH
					Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Strontium (Sr)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Hydrogen sulfide (H_2S)	Dissolved Solids	Ca-Mg	Noncarbonate		
33L5	McIntosh	1-23-41	24	39	0.01	30	19	—	17	2.0	153	47	10	0.5	—	231	153	—	—	—
34J27	McIntosh	11-30-59	26	37	.14	53	27	—	24	2.6	150	138	24	.7	—	424	243	120	581	7.9
34L27	McIntosh	3-30-67	23.8	36	.08	30	19	0.57	18	2.3	148	51	19	.5	1.96	251	154	32	375	8.1
34M19	Liberty	3-29-67	22.8	36	.02	26	14	.46	17	3.2	146	35	8.0	.6	.94	208	123	4	309	7.9
34M48	Liberty	5-12-66	—	35	.25	27	15	—	15	3.0	148	35	4.0	.6	—	208	129	8	305	7.7
34M51	Liberty	10-20-66	—	43	—	23	15	—	16	3.3	132	39	5.4	.6	—	210	119	11	296	8.0
34M52	Liberty	3-28-67	23.8	34	.00	26	15	.42	16	3.1	146	34	8.0	.5	1.36	211	127	8	311	7.9
34M53	Liberty	3-28-67	24.0	54	.00	27	15	.45	16	3.1	146	34	6.0	.6	1.11	214	130	10	314	7.8
34M54	Liberty	3-29-67	23.4	36	.08	26	14	.44	16	3.1	148	34	7.0	.6	1.35	210	123	2	311	7.9
34M70	McIntosh	3-30-67	24.4	35	.04	30	17	.57	19	2.8	150	48	11	.6	4.17	233	146	22	351	7.9
34N88	Liberty	3-29-67	23.5	55	.04	22	11	.34	14	2.7	130	18	5.0	.6	1.19	176	100	0	258	7.9
34N89	Liberty	3-29-67	23.0	31	.00	18	9.9	.41	16	2.8	134	5.2	5.0	.4	4.69	149	86	0	230	8.0
35K61	McIntosh	7-7-61	28	37	.09	52	31	—	26	2.4	146	151	26	.6	—	418	257	138	602	7.9
35M13	McIntosh	3-29-67	23.1	33	.04	30	20	—	21	2.6	152	68	11	.4	6.76	262	158	34	390	7.8
36K4	McIntosh	5-26-41	26	37	.03	46	29	—	21	2.4	145	128	18	.7	—	374	234	—	—	—
36L7	McIntosh	11-16-67	—	33	—	37	23	.90	22	2.9	148	89	18	.9	—	349	188	66	469	8.0

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