POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER, BEAUFORT, HAMPTON, AND JASPER COUNTIES, SOUTH CAROLINA MARCH AND JULY 1990

By

Constance E. Gawne

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POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER, BEAUFORT, HAMPTON, AND JASPER COUNTIES, SOUTH CAROLINA MARCH AND JULY 1990

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ABSTRACT

Potentiometric levels measured in about 180 wells during March and July 1990 were corrected for tidal effects, where necessary, and used to prepare maps of the potentiometric surface. The potentiometric surface for March was not notably low, reflecting near-average fall and winter precipitation. The map for July shows the regional decline of the potentiometric surface that would be expected in a summer of drought. In Beaufort County and northern Hampton County the decline was approximately the same as in the summer of 1986. In southern Hampton County and northern Jasper County the decline was greater, exceeding any previously recorded. Steepening of hydraulic gradients in Hampton County is evidence that the additional decline was caused by increased withdrawals of water from the aquifer. Summer water-level declines in southern Hampton County and northern Jasper County have been increasing since 1984. Levels in most wells have been recovering during the fall and winter recharge period. Levels in a few wells have failed to recover completely since 1986.

INTRODUCTION

Personnel of the South Carolina Water Resources Commission measured potentiometric levels in about 180 wells during the periods February 28-March 19 and July 17-August 3, 1990, in Beaufort, Hampton, and Jasper Counties, S. C. (Fig.1). These data are presented as maps of the potentiometric surface in the aquifer (Figs. 2 and 3) and compared with similar data from previous years. Potentiometric levels in March reflect winter recharge and low winter withdrawals, and are expected to be highest of the year. Those in July are lower because of decreased recharge and higher summer withdrawals. A map of water-level declines between March and July 1990 was also prepared (Fig. 4).

DATA

The table below shows the geographic distribution of wells used in preparing Figs. 2, 3, and 4:

	Number of Wells		
	Beaufort Co.	Hampton Co.	Jasper Co.
March 1990 (Fig. 2)	133	31	20
July 1990 (Fig. 3)	132	30	19
March, July (fig. 4)	113	30	18

The density of data points is much less in Hampton and Jasper Counties than in Beaufort County, and the accuracy of the maps is expected to reflect this disparity.

Individual potentiometric heads result from one or more of three factors: hydrology of the aquifer, withdrawals from wells, and tidal effects on wells near the coast. For most coastal wells, previous workers (Hayes, 1979, and Hassen, 1985) had calculated correction factors for tidal effects, and these were used to recalculate the 1990 data and obtain elevations above mean sea level. However, it is probable that not all tidally affected data were corrected. Corrections were made by using predictions from tide tables; actual tidal measurements were not available. Other likely sources of error include inaccurate information on well elevations and faulty water-level measurements owing to poor access into wells.

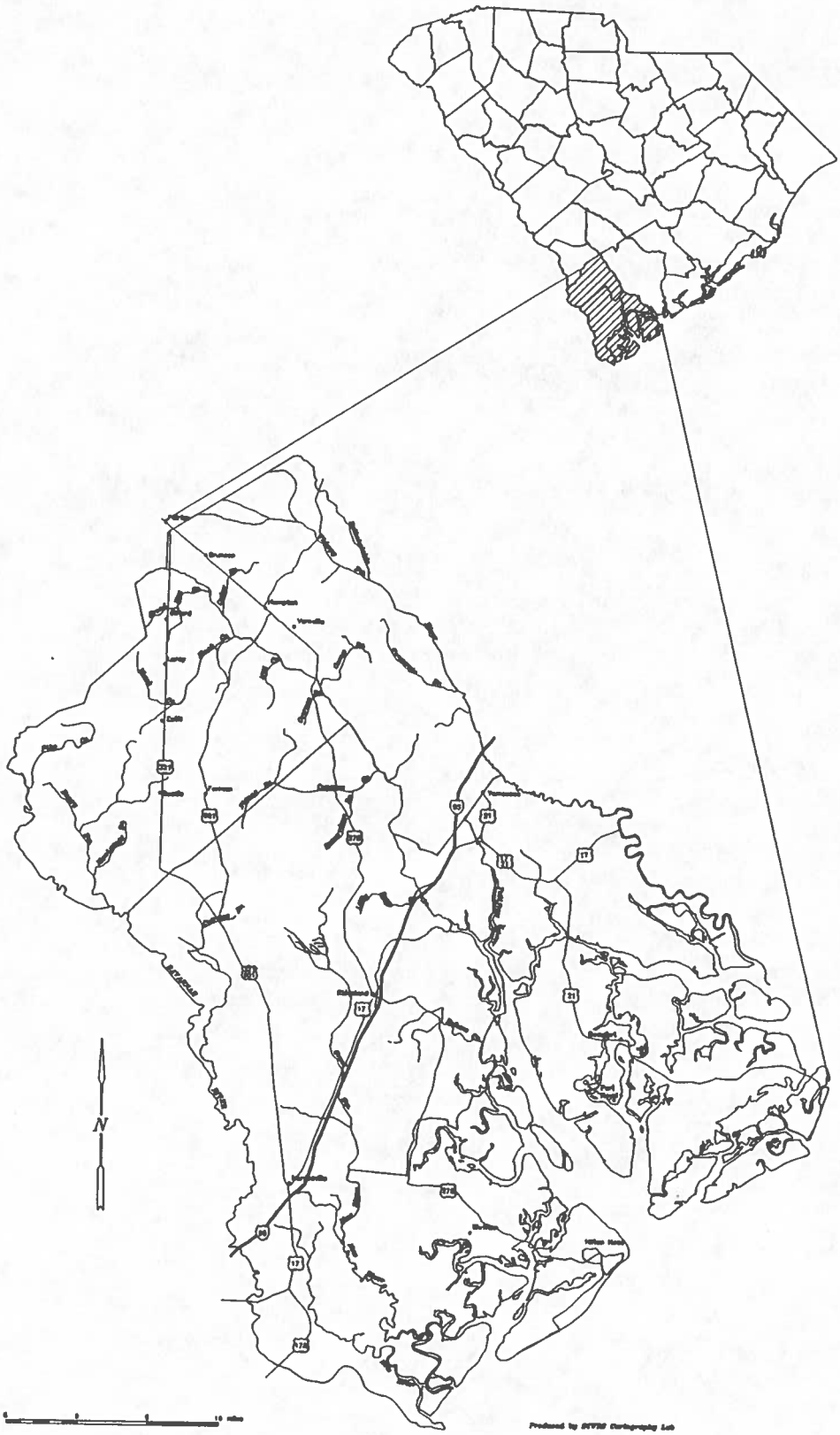


Figure 1. Location of Beaufort, Hampton and Jasper Counties.

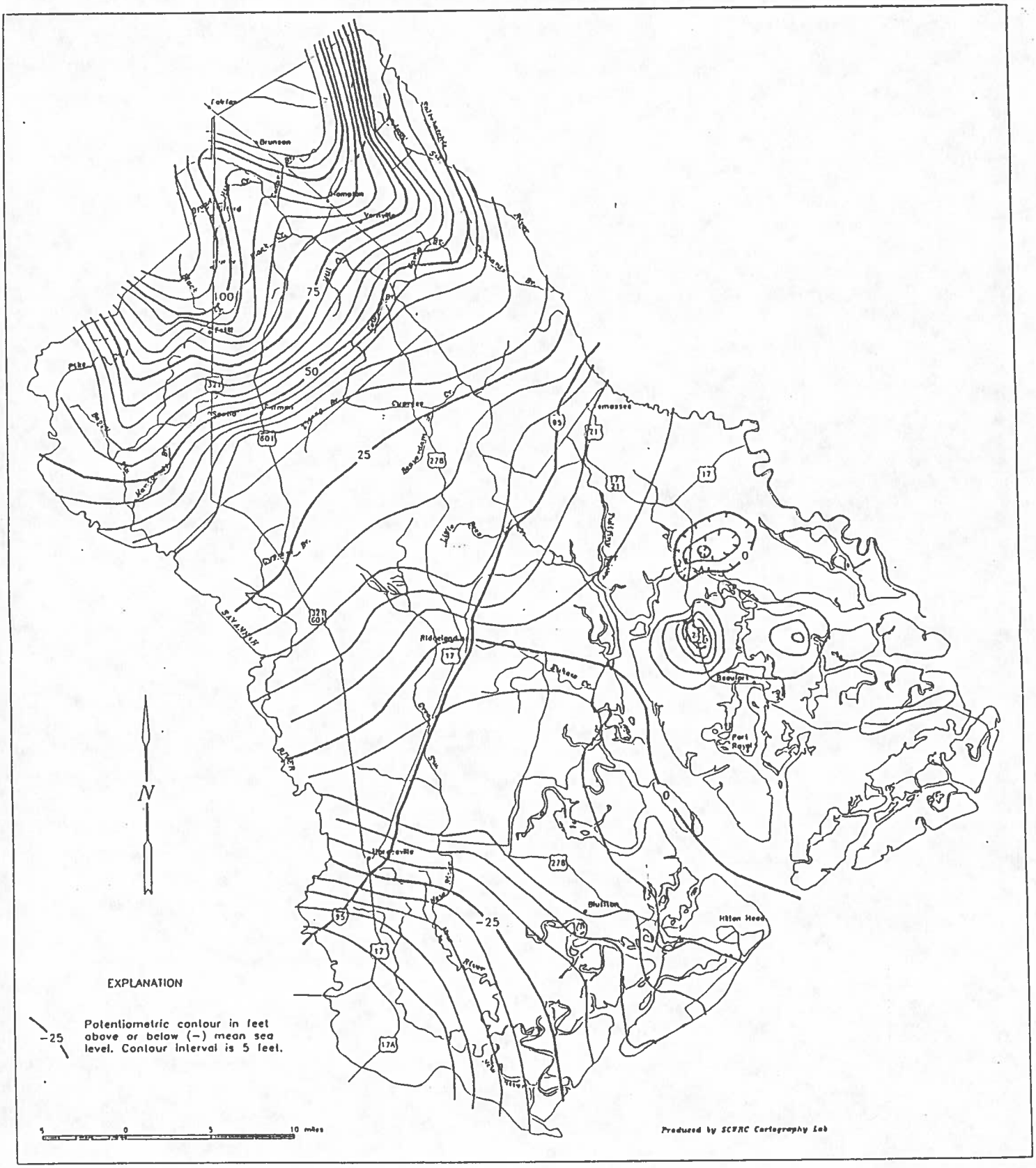


Figure 2. Potentiometric surface of the upper Floridan aquifer in March 1990.

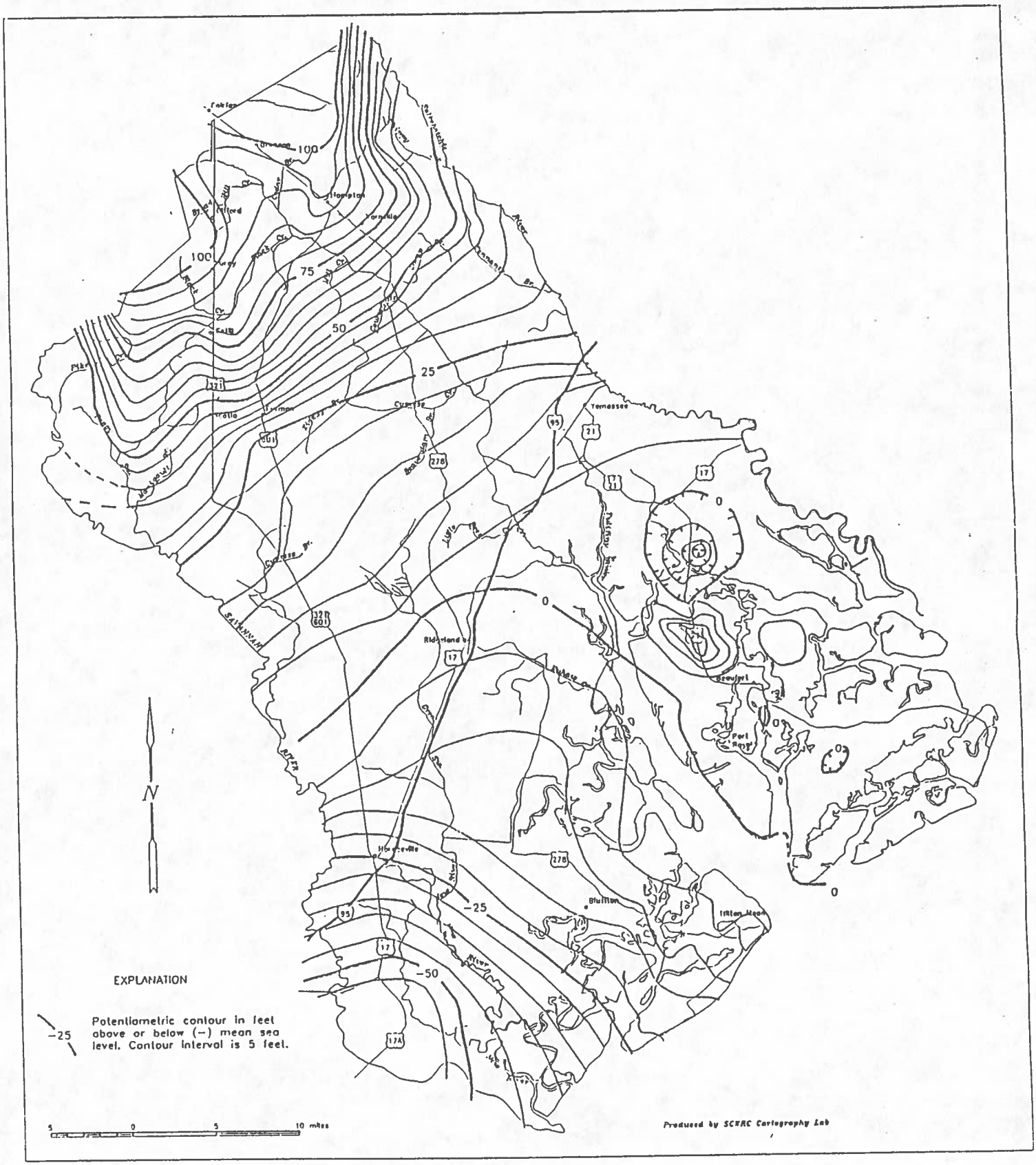


Figure 3. Potentiometric surface of the upper Floridan aquifer in July 1990.

COMPARISON OF POTENTIOMETRIC SURFACES

A number of features are common to both March and July maps. In northern Hampton County, contours are deflected strongly upstream along the Savannah, Coosawhatchie, and Salkehatchie Rivers, indicating that water is discharging from the aquifer into these streams. Comparison of the map of the upper surface of the Floridan aquifer compiled by Hayes (1979) with topographic maps shows that flood-plain levels lie lower than the aquifer surface; the depths to which filled bedrock valleys are cut into the aquifer are not known. On each map the regional hydraulic gradient is southeastward, steepest across western Hampton County, flattening out across northern Jasper and Beaufort Counties, and steepening and turning southwestward in southern Jasper and Beaufort Counties. North of the Broad River, Beaufort County has a very low regional hydraulic gradient, with recharge mounds on northern Port Royal Island and northern Ladies Island and a cone of depression north of the Coosaw River caused by the wells of Lobeco Products, Inc.

Figure 3 differs from Figure 2 in several respects. Contour lines are shifted northward, reflecting a general decline in potentiometric head. The recharge mounds on Port Royal Island and Ladies Island are lower, and the cone of depression north of the Coosaw River is larger and deeper. On Figure 2, a low linear mound extends across part of northern St. Helena Island. Figure 8 of Hassen (1985), a map of the potentiometric surface in eastern Beaufort County in March 1984, shows this mound extending southwestward the full length of the island, with its highest point near the southern end. On the potentiometric surface of July 1990 (Fig. 3) this mound is not distinguishable, and a small area on its March 1984 position is below sea level.

In July, the potentiometric surface under the Beaufort River is very near sea level at least as far north as the south edge of Beaufort. Two wells on the west shore of Ladies Island just south of Beaufort, BFT-471 and BFT-557, have shown water levels slightly below sea level in 1984 and 1985, as well as 1990. Previous maps (Hayes, 1979; Crouch and others, 1987) have shown the potentiometric surface higher than sea level under the Beaufort River; however, Hassen (1985) shows it as less than 1 foot above sea level, and the possibility exists that it drops below sea level during the greatest summer decline.

Figure 4 shows declines in potentiometric head between March and July 1990. More than 10 feet of decline occurred around Estill in Hampton County and in a small area of southern Jasper County. The latter decline, however, appears to be due as much to an unusually high head in March as to a low head in July. Declines of between 5 and 10 feet are seen in the western two-thirds of Hampton County and northwestern Jasper County, at the cone of depression north of the Coosaw River, on northern Ladies Island, and in the very large cone of depression centered in the Savannah area, including the southwestern end of Hilton Head Island. The remaining area generally experienced declines of between 1 and 5 feet. The hydraulic gradient along Hilton Head Island increased from 1.3 to 1.8 feet per mile.

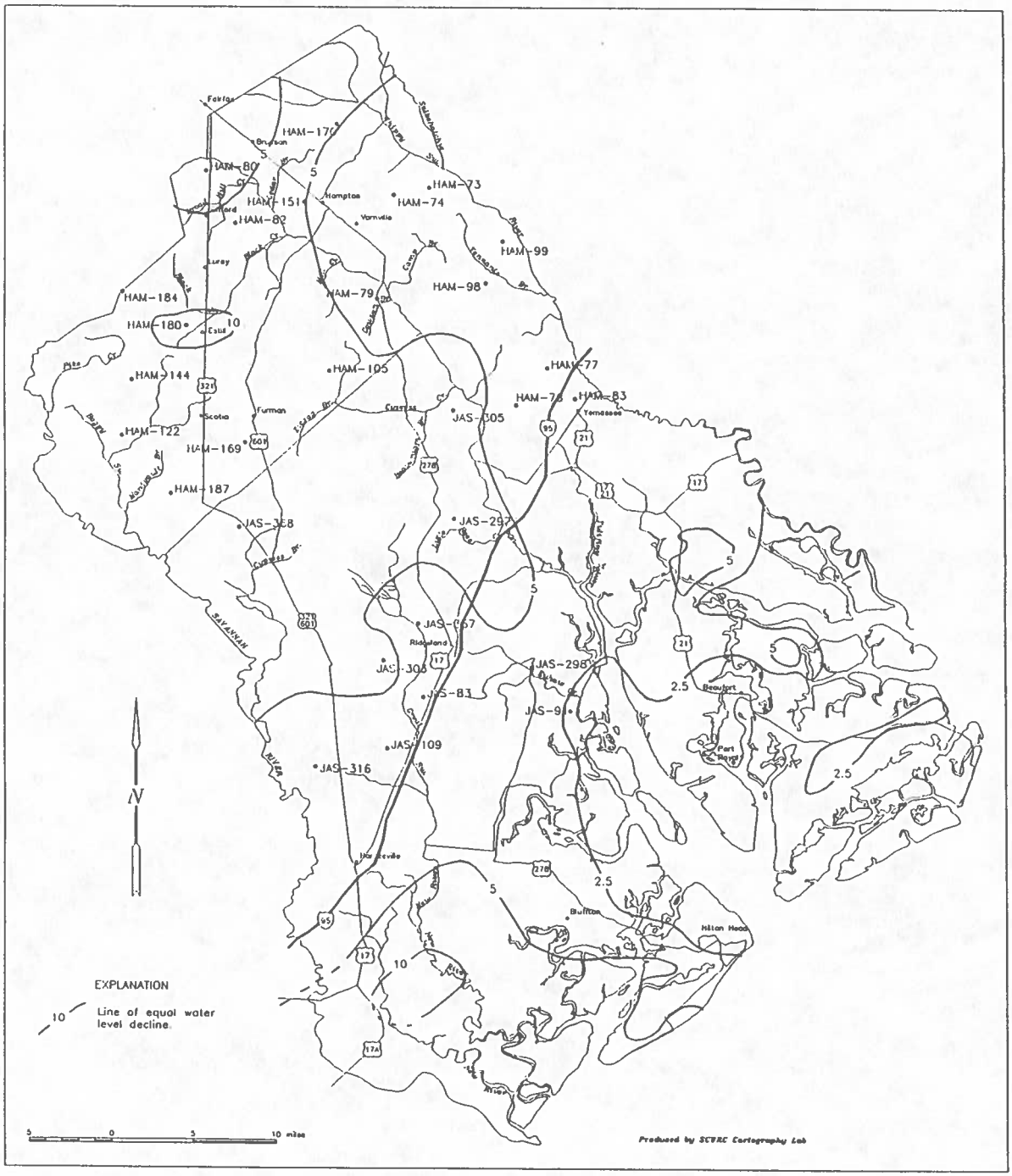


Figure 4. Seasonal declines in potentiometric head in the upper Floridan aquifer from March to July 1990.

Comparison of Figure 3 with the map of the July 1986 potentiometric surface (Crouch and others, 1987) shows a generally similar configuration. Minor differences are seen in Beaufort County east of the Broad River: the recharge mound on northern Port Royal Island is near the same height as in 1986, the cone of depression north of the Coosaw River is deeper, and the mound on Ladies Island is lower. The greatest difference is seen in northern Jasper County and southern Hampton County, where corresponding contour lines lie approximately 5 miles farther north in 1990 than in 1986. Table 1 presents data for March and July of 1986 and 1990, water level declines for each year, and differences between the two years. Winter water levels were lower in 1990 than in 1986. Declines were generally greater in 1990, and significantly higher declines were seen in northern Jasper County and adjoining areas of Hampton County.

Hydraulic gradients were calculated for eight well pairs in Hampton and northern Jasper Counties (Table 2, Fig. 5). In July 1990 the general southeastward gradient across northwestern Hampton County was steeper by about 0.5 foot per mile than in July 1986 (Table 1, Fig. 5, well pairs A-C). The gradients across northern Jasper County (well pairs E-H) were no more than 0.1 foot per mile steeper, and in one case (well pair F) less steep. The break in gradient, and the difference in gradient between July 1986 and July 1990, were less in eastern Hampton County (well pairs D and H).

LONGER-TERM TRENDS IN HAMPTON AND JASPER COUNTIES

Graphs of water-level trends since 1981 have been prepared for a number of wells in Hampton and Jasper Counties, with March and July data shown separately. The most common pattern, as exemplified by wells HAM-80, HAM-108, and JAS-297 (Fig. 6A, 6B, 6c), is one in which March levels are relatively consistent, July levels decrease, and the decline between March and July increases with time. A few wells, exemplified by Ham-105, JAS-316, and possibly HAM-79 (Fig. 6D,6E,6F), show a downward trend in March potentiometric levels as well.

Precipitation records from Allendale and Bamburg Counties, which are recharge areas for the Floridan aquifer, are shown in Figure 7A and 7B, in addition to records from Hampton and Jasper Counties (Fig. 7C, 7D). Figure 8 shows part of the data summarized as November-March (non-growing season) and April-July (growing season up to the July measurement period). Comparison with well records in Figure 6 shows that for most wells March levels correspond closely to total post growing-season precipitation in the aquifer recharge areas. 1989-1990 winter precipitation in these areas was not unusually low, and March 1990 potentiometric heads were likewise within the range of variatcn seen from 1981 through 1989. July potentiometric heads for 1981 through 1984 appear to vary with precipitation. This reflects some combination of summer recharge, varying with precipitation in Allendale and Bamburg Counties, and summer withdrawals, which may be expected to be greater in years of low precipitation in Hampton

TABLE 1

COMPARISON OF POTENTIOMETRIC LEVELS FOR SELECTED WELLS, MARCH AND JULY 1986 AND 1990

HAMPTON COUNTY

WELL	73			74			77			78		
YEAR	MARCH	JULY	DECL	MARCH	JULY	DECL	MARCH	JULY	DECL	MARCH	JULY	DECL
1986	57.2	52.8	4.4	83.0	79.2	3.8	27.2	25.4	1.8	17.7	15.9	1.9
1990	56.8	53.0	3.8	82.8	78.5	4.2	26.5	23.7	2.8	16.4	13.1	3.3
1990-1986	-0.4	0.2	-0.7	-0.2	-0.7	0.4	-0.7	-1.4	1.0	-1.3	-2.8	1.5

WELL	79			80			82			83		
YEAR	MARCH	JULY	DECL	MARCH	JULY	DECL	MARCH	JULY	DECL	MARCH	JULY	DECL
1986	59.6	56.1	3.5	98.9	95.4	3.5	98.6	92.4	6.2	11.7	10.1	1.5
1990	57.7	53.4	4.3	98.8	95.7	3.1	97.9	92.1	5.8	10.3	8.1	2.2
1990-1986	-1.9	-2.7	0.8	-0.1	0.3	-0.4	-0.7	-0.3	-0.3	-1.4	-2.0	0.6

WELL	98			99			105			108		
YEAR	MARCH	JULY	DECL	MARCH	JULY	DECL	MARCH	JULY	DECL	MARCH	JULY	DECL
1986		38.3		34.3	34.1	0.2	47.5	42.7	4.8	104.0	94.9	9.0
1990	39.1	37.5	1.6	35.8	35.5	0.4	42.9	36.5	6.3	101.7	91.5	10.2
1990-1986		-0.8		1.3	1.4	0.2	-4.6	-6.2	1.5	-2.3	-3.4	1.1

WELL	122			144			151			180		
YEAR	MARCH	JULY	DECL	MARCH	JULY	DECL	MARCH	JULY	DECL	MARCH	JULY	DECL
1986	63.1	57.4	5.7	77.9	71.0	7.0	95.6	90.1	5.5	87.3	78.5	8.9
1990	63.8	57.7	6.2	77.8	71.2	6.6	95.3	89.3	6.1	84.8	73.4	11.4
1990-1986	0.7	0.3	0.5	-0.1	0.2	-0.4	-0.3	-0.8	0.6	-2.5	-5.1	2.5

JASPER COUNTY

WELL	91			109			297			298		
YEAR	MARCH	JULY	DECL	MARCH	JULY	DECL	MARCH	JULY	DECL	MARCH	JULY	DECL
1986	-0.8	-3.0	2.2	-2.6	-2.9	0.3	18.6	16.3	2.3	1.1	1.0	0.1
1990	-6.0	-8.3	2.3	-3.5	-8.0	4.5	17.9	9.4	8.5	-1.1	-5.3	4.2
1990-1986	-5.2	-5.3	0.1	-0.9	-5.1	4.2	-0.7	-6.9	6.2	-2.2	-6.3	4.1

WELL	303			305			316		
YEAR	MARCH	JULY	DECL	MARCH	JULY	DECL	MARCH	JULY	DECL
1986	8.8	5.7	3.1	26.3	22.9	3.4	3.0	1.1	1.9
1990	5.3	-1.9	7.3	26.5	18.8	7.7	-1.2	-2.0	0.8
1990-1986	3.5	-7.6	4.19	0.2	-4.1	4.32	-4.2	-3.1	-1.1

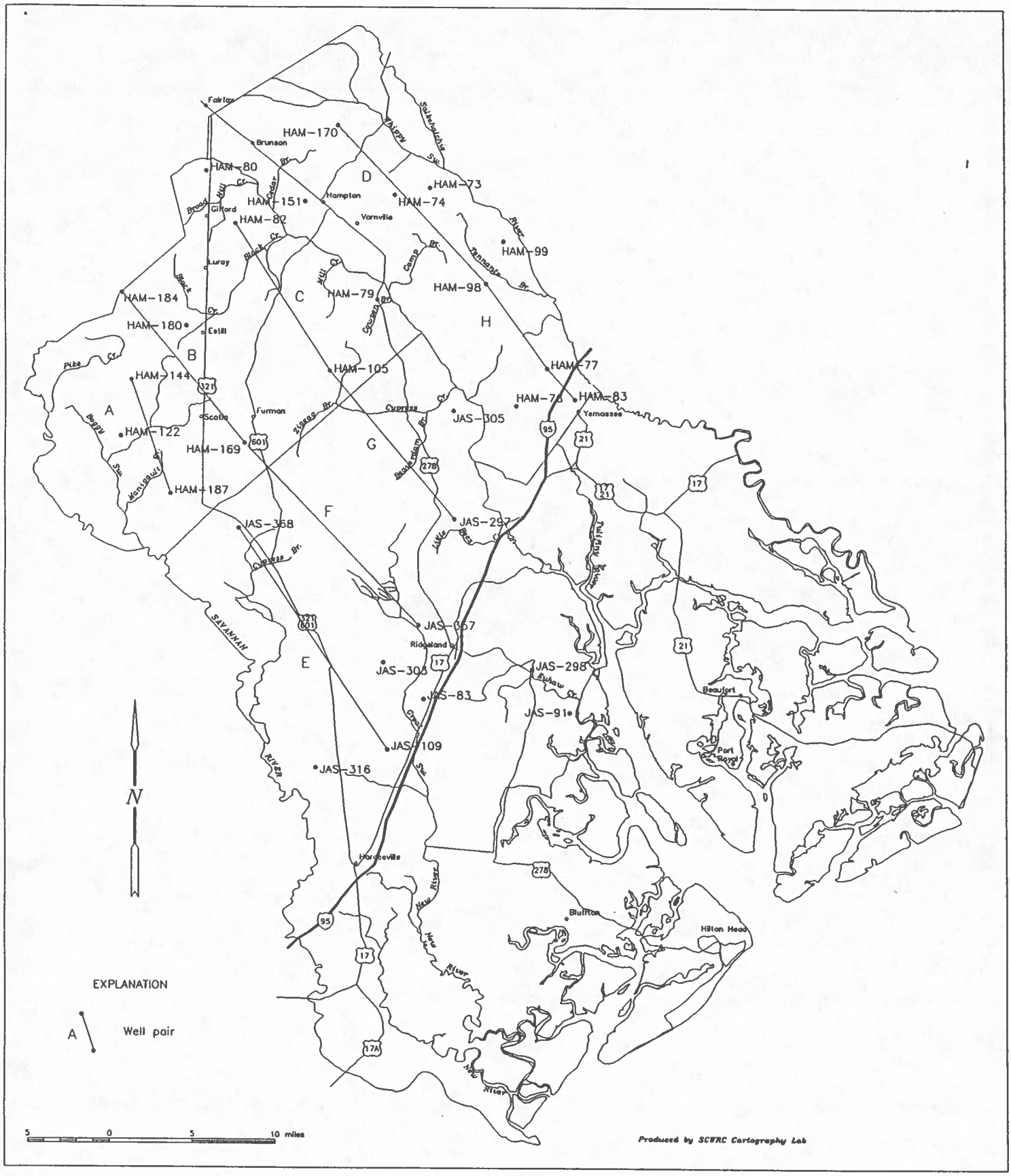
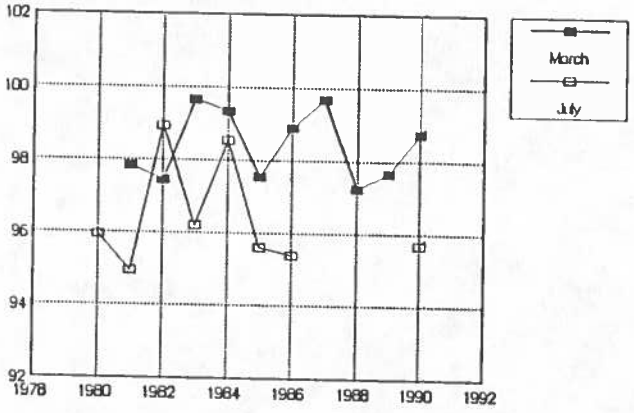


Figure 5. Locations of wells and well pairs listed in Tables 1 and 2.

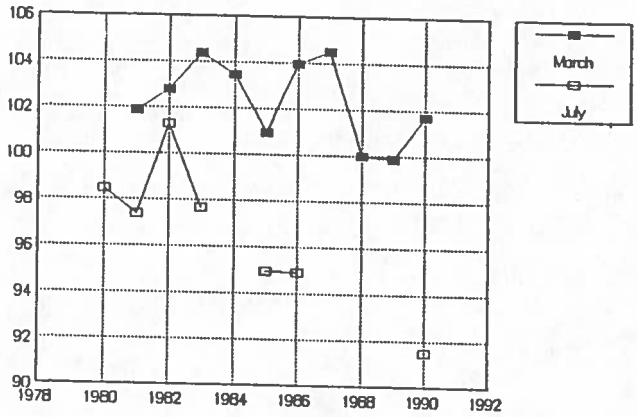
TABLE 2

SUMMER HYDRAULIC GRADIENTS FOR SELECTED WELL PAIRS

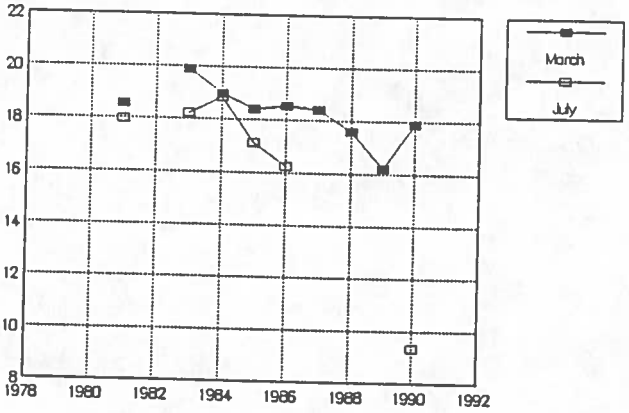
PAIR	YEAR	WELL 1 WATER LEVELS (ELEVATION, FT)	WELL 2 WATER LEVELS (ELEVATION, FT)	VERTICAL CHANGE (FT)	DISTANCE (MILES)	GRADIENT (FT/MILE)	GRADIENT (RATIO)
A		HAM-144	HAM-187		7.5		
	1986	71.0	39.2	31.8		4.2	0.00080
	1990	71.2	37.5	35.7		4.8	0.00090
B		HAM-184	HAM-169		11.5		
	1986	99.7	31.1	68.6		6.0	0.00113
	1990	100.4	25.8	74.6		6.5	0.00123
C		HAM-82	HAM-105		10.0		
	1982	100.4	47.5	52.9		5.3	0.00100
	1983	96.4	46.4	50.0		5.0	0.00094
	1984	97.1	49.5	47.6		4.7	0.00089
	1986	92.4	42.6	49.8		4.9	0.00093
	1990	92.1	36.6	55.5		5.5	0.00104
D		HAM-170	HAM-98		13.0		
	1986	99.5	38.3	61.2		4.7	0.00089
	1990	101.3	37.5	63.8		4.9	0.00093
E		HAM-368	JAS-109		15.3		
	1986	26.7	-2.9	29.6		1.9	0.00037
	1990	22.2	-8.0	30.2		2.0	0.00038
F		HAM-169	JAS-357		15.7		
	1986	31.1	2.3	28.8		1.8	0.00035
	1990	25.8	-1.2	27.0		1.7	0.00033
G		HAM-105	JAS-297		11.3		
	1981	45.4	18.0	27.6		2.4	0.00045
	1983	46.4	18.2	28.2		2.5	0.00047
	1984	49.5	18.9	30.6		2.7	0.00051
	1986	42.7	16.3	26.4		2.3	0.00044
	1990	36.6	9.4	27.2		2.4	0.00046
H		HAM-98	HAM-83		9.1		
	1981	39.6	9.8	29.8		3.3	0.00062
	1982	40.6	12.1	28.5		3.1	0.00059
	1983	39.3	11.0	28.3		3.1	0.00059
	1984	40.1	11.1	29.0		3.2	0.00060
	1986	38.2	10.1	28.1		3.1	0.00059
	1990	37.5	8.1	29.4		3.2	0.00061



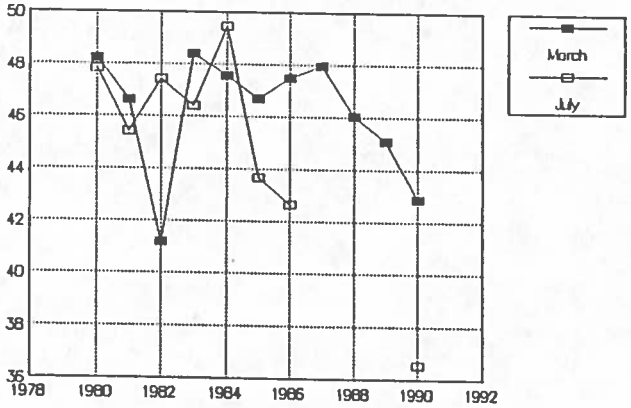
A. HAM-80



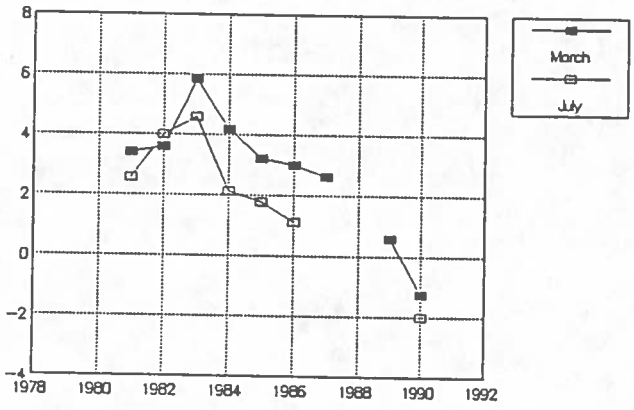
B. HAM-108



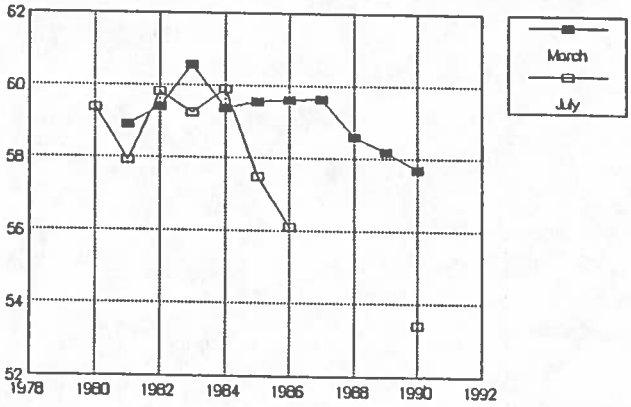
C. JAS-297



D. HAM-105

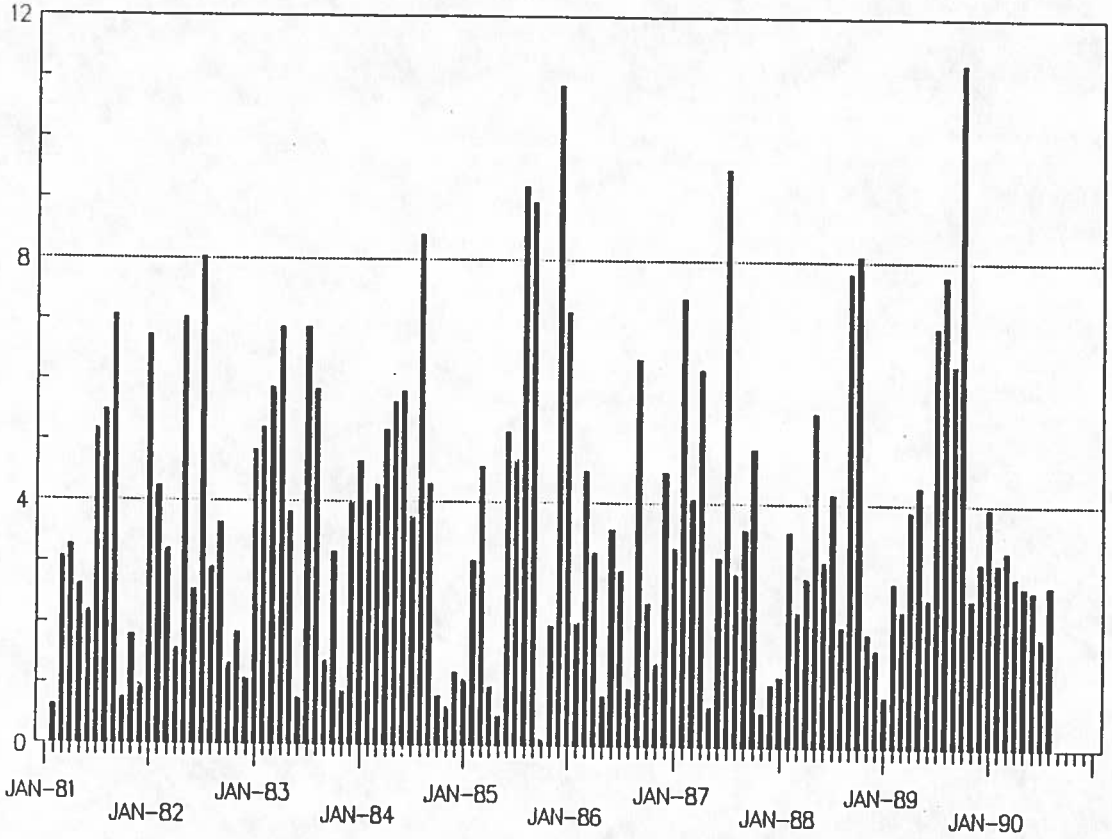


E. JAS-316

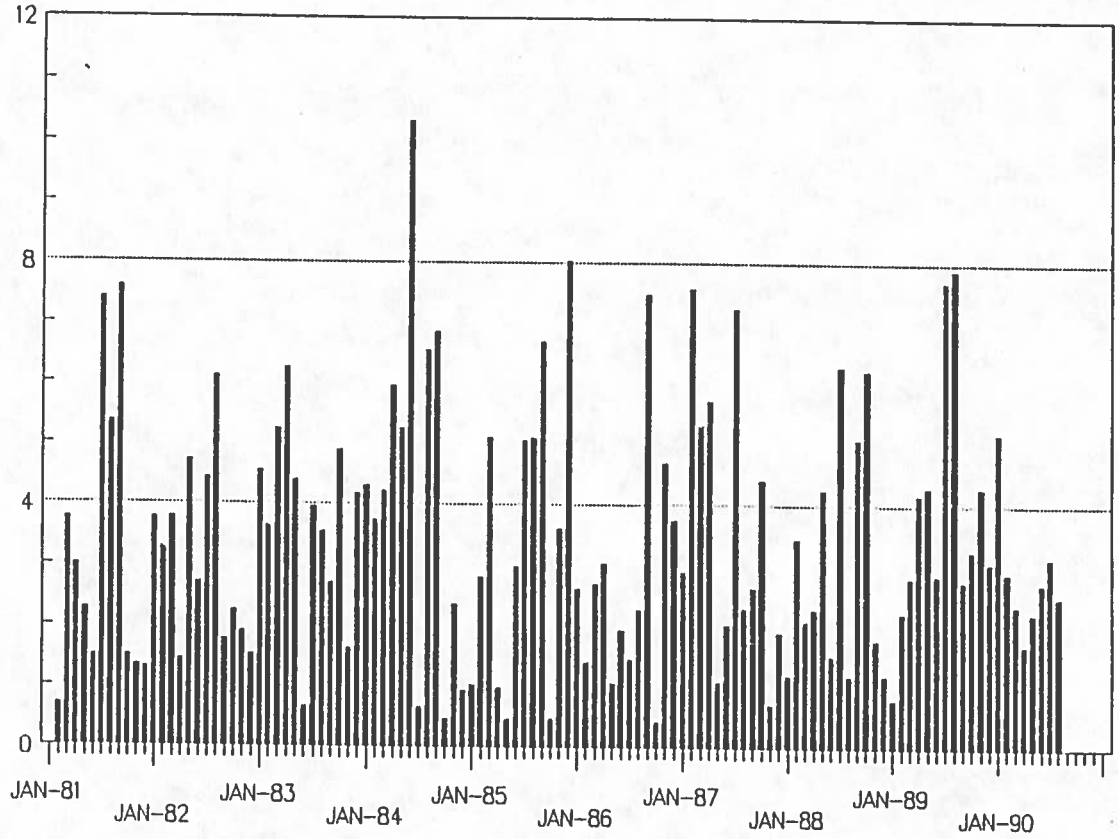


F. HAM-79

Figure 6. Potentiometric levels for March and July measured at selected wells.

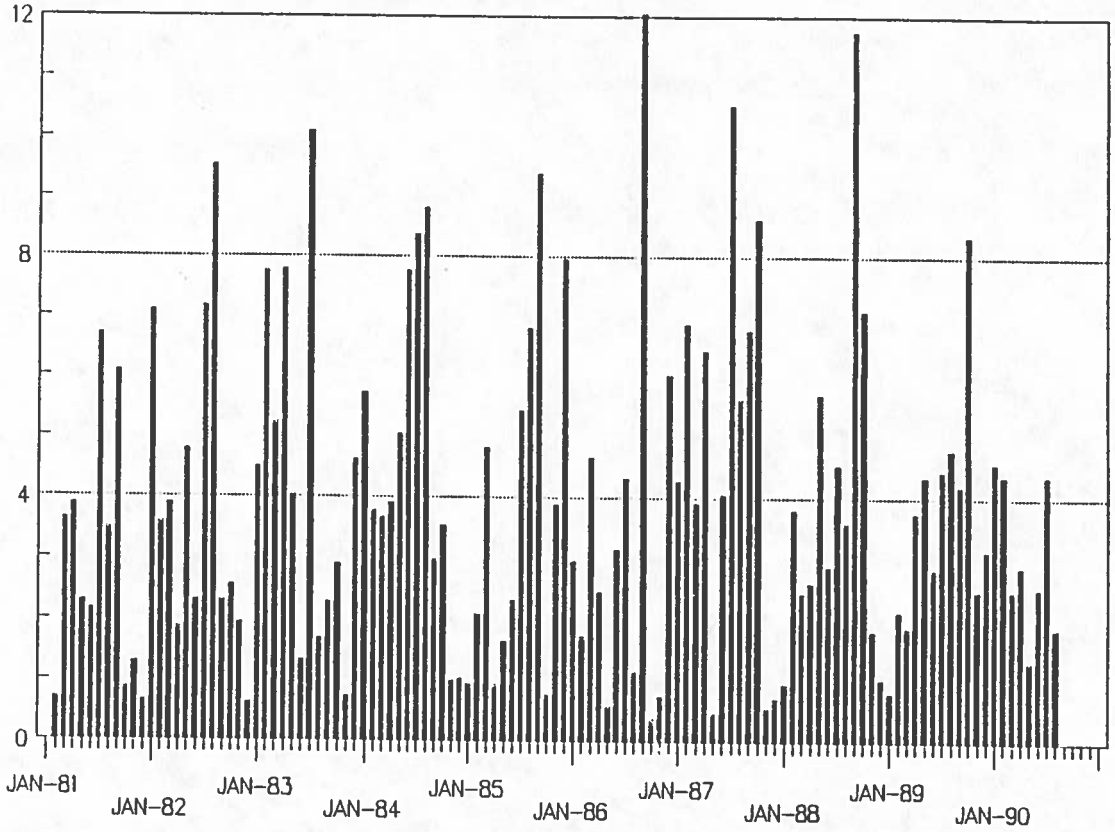


A. Allendale Station, Allendale County, S.C.

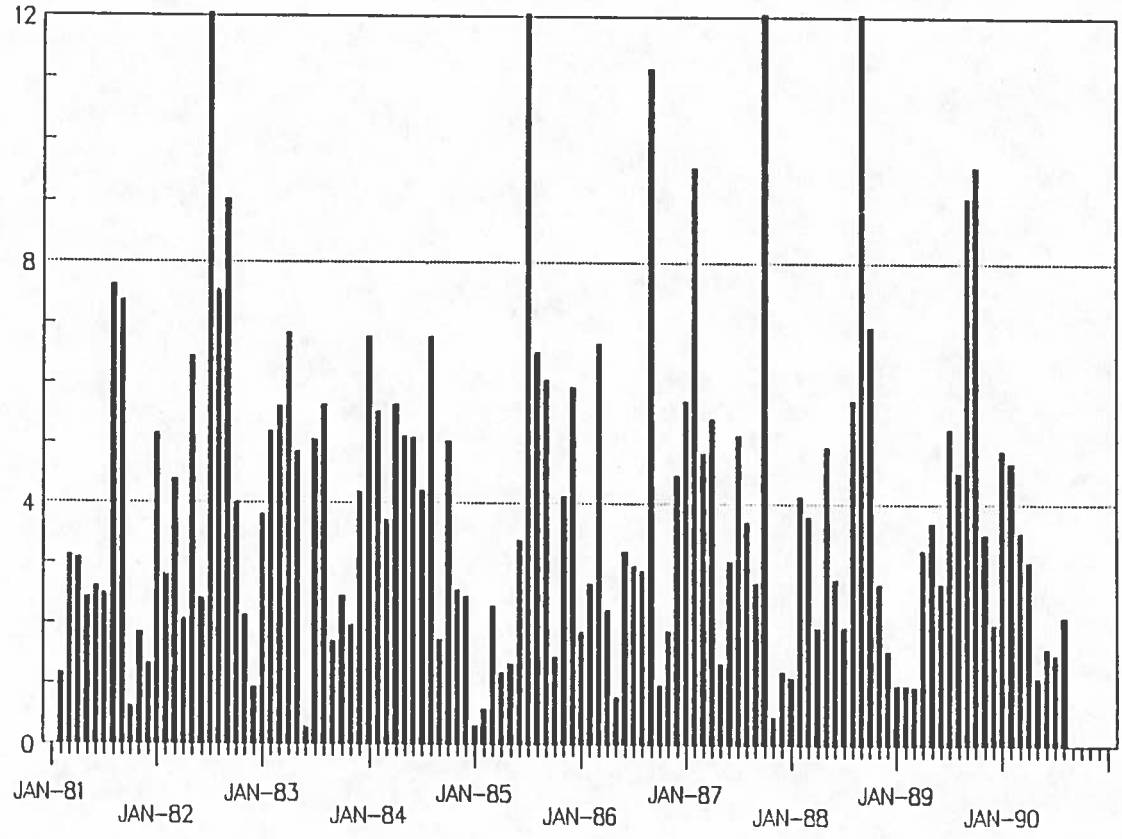


B. Blackville Station, Bamburg County, S.C.

Figure 7. Precipitation totals by month, January 1981-July 1990, in inches

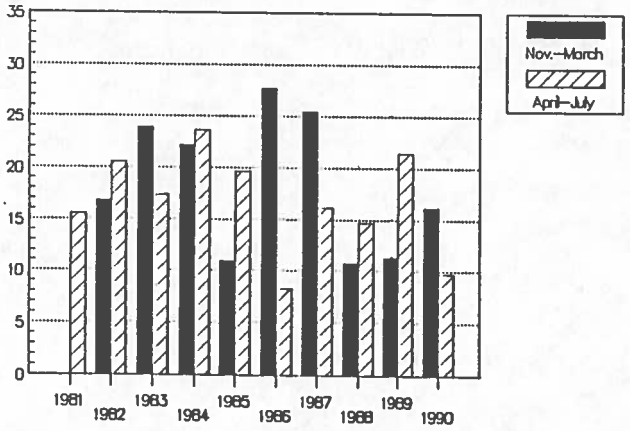


C. Hampton Station, Hampton County, S.C.

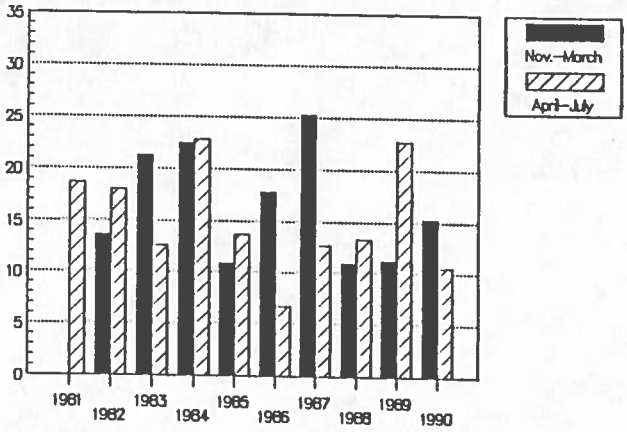


D. Ridgeland Station, Jasper County, S.C.

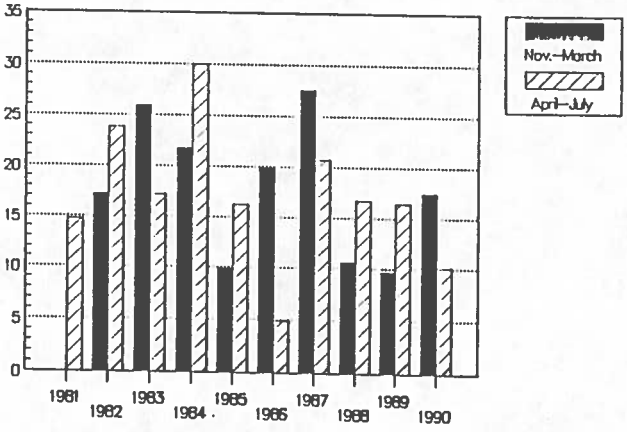
Figure 7 (Continued)



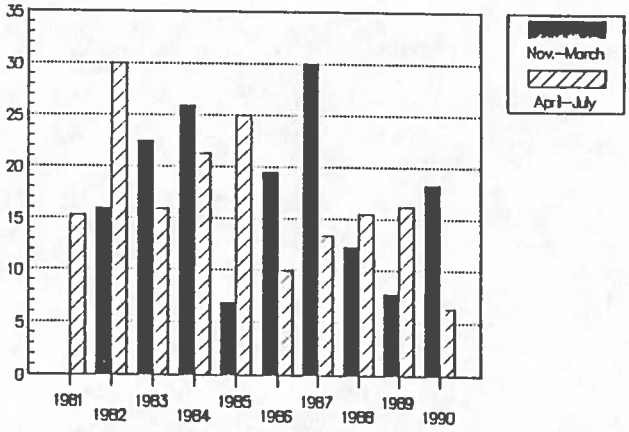
A. Allendale Station



B. Blackville Station



C. Hampton Station



D. Ridgeland Station

Figure 8. Precipitation totals for November-March and April-July, in inches

and Jasper Counties. The amount of summer recharge to the Floridan aquifer has not been investigated; typically, significant recharge to aquifers does not take place during the growing season because of heavy use by plants. In 1985, 1986, and 1990, summer declines appear out of proportion to precipitation variations, suggesting a change in the pattern of usage. The failure of potentiometric heads to recover completely in some wells during recent winters may be due to increased winter usage or to a lack of sufficient winter recharge to replace summer withdrawals.

CONCLUSIONS

The potentiometric surface of the upper Floridan aquifer declined throughout Beaufort, Hampton, and Jasper Counties between March and July 1990. In Beaufort County and northern Hampton County the decline appears to be no more than expected during an unusually dry summer. In Beaufort County, recharge mounds were lowered and the hydraulic gradient on Hilton Head Island steepened.

In northern Jasper County and southern Hampton County the decline in the potentiometric surface was out of proportion to that seen in the surrounding area and in the same area in previous years. This disparity appears to have been caused by increased usage of ground water in the area, as indicated by steepening of hydraulic gradients northwest of the area of decline. The potentiometric levels in a few wells failed to recover over three successive winters; continued monitoring is needed to determine if a long-term trend has begun.

REFERENCES

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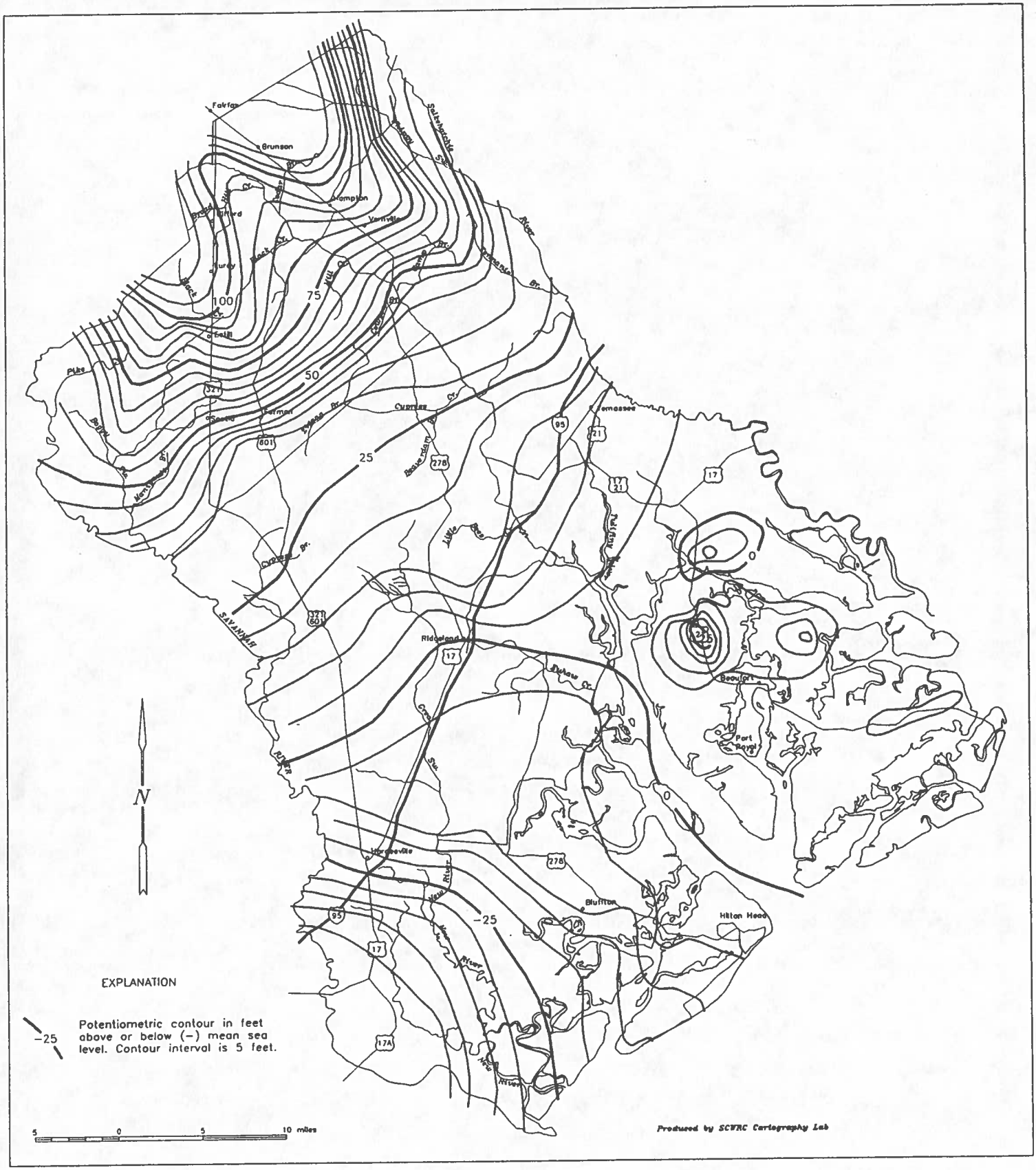

Figure 2. Potentiometric surface of the upper Floridan aquifer in March 1990.

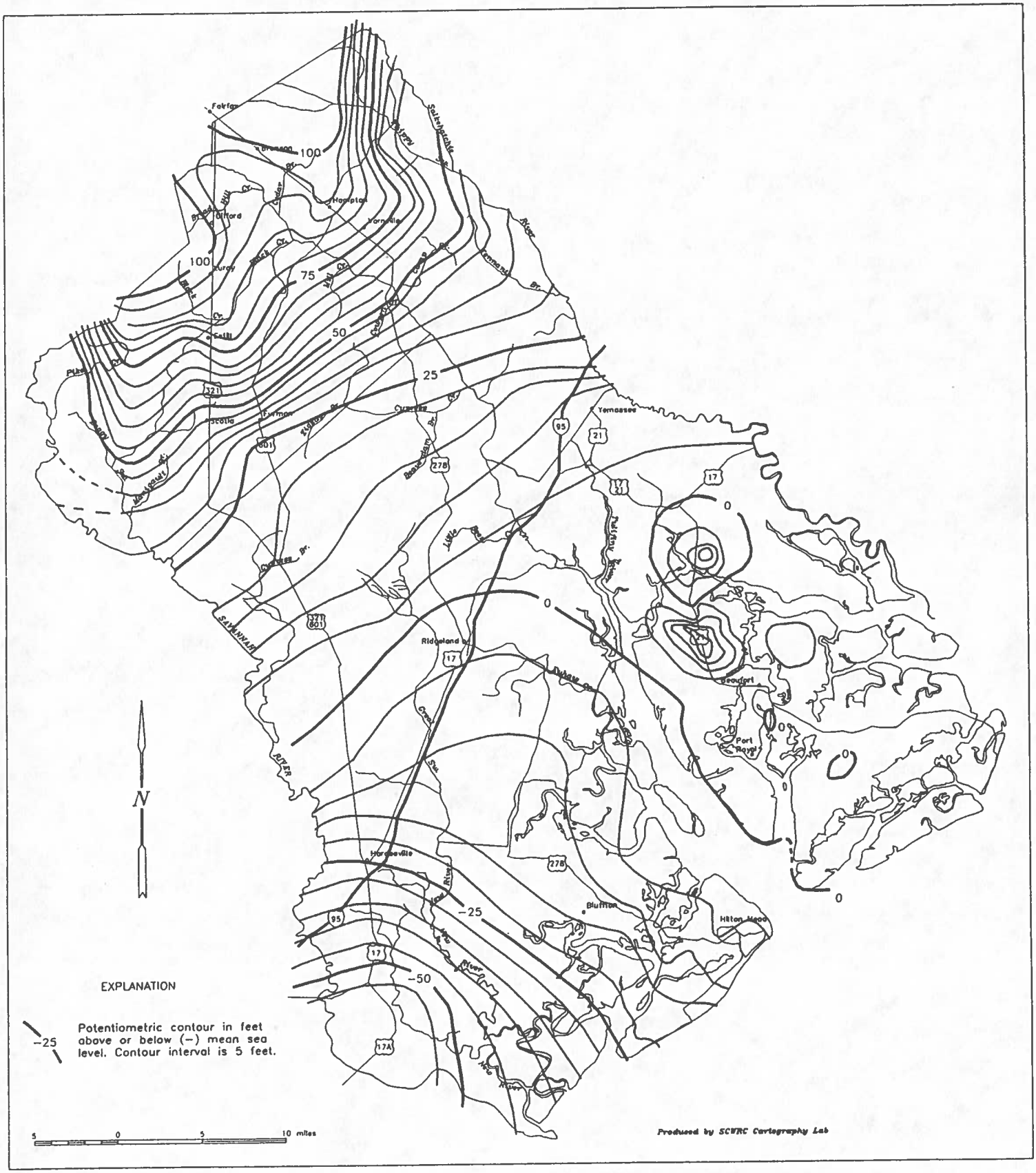

Figure 3. Potentiometric surface of the upper Floridan aquifer in July 1990.

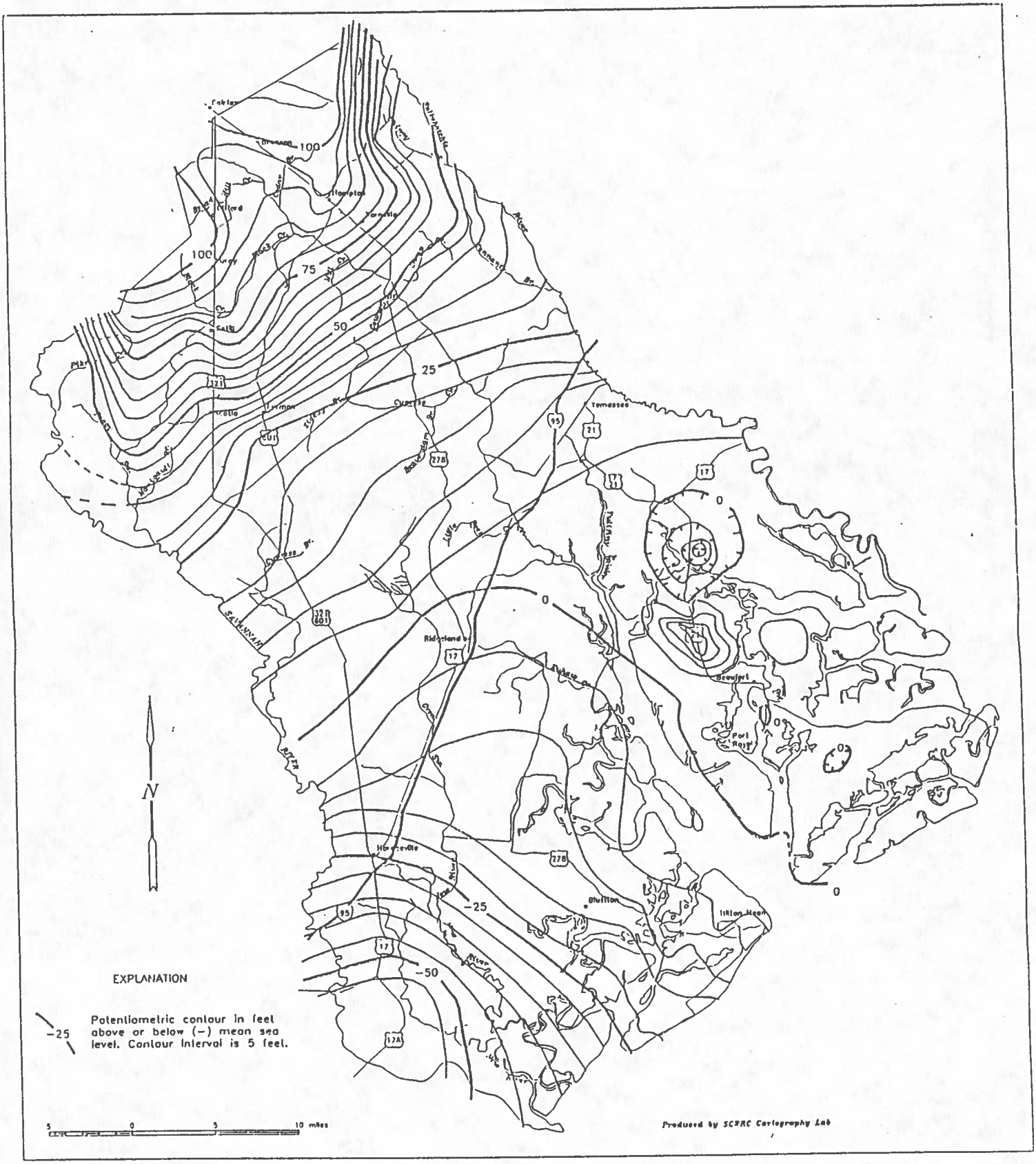

Figure 3. Potentiometric surface of the upper Floridan aquifer in July 1990.