POTENTIOMETRIC MAP OF THE FLORIDAN AQUIFER AND TERTIARY SAND AQUIFER IN SOUTH CAROLINA - 1998

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South Carolina Department of Natural Resources
Water Resources Report 23
2001

ABSTRACT

The potentiometric surface of the Floridan aquifer and its updip clastic equivalent, the Tertiary sand aquifer, shows a generally southeastward ground-water flow affected by several potentiometric depressions. Cones of depression have developed because of ground-water pumping in the Summerville-Charleston area, and at Walterboro and Eutawville. Water levels in Jasper and Beaufort Counties continue to be affected by pumping in the Savannah, Ga. area.

Comparing the 1998 data with historical data shows that water levels near the outcrop areas have not changed significantly. In areas influenced by pumping, water levels have declined 40 to 95 feet during various periods of record.

INTRODUCTION

The Floridan aquifer and its updip clastic equivalent, the Tertiary sand aquifer, is the source of water for many public, industrial, and agricultural supplies in much of the Coastal Plain of South Carolina. This important water resource is monitored regularly by measuring the static water levels in wells. The potentiometric surface is defined by the elevations at which water stands in tightly cased wells completed in the aquifers. This potentiometric map was prepared by the Land, Water and Conservation Division of the South Carolina Department of Natural Resources (SCDNR), using data collected in late 1998.

METHOD OF INVESTIGATION

The boundaries of the Floridan aquifer and the Tertiary sand aquifer used in this investigation are those defined by Aucott, Davis, and Speiran (1987), who delineated the aquifer on the basis of geologic data (primarily geophysical logs of wells), water levels, water chemistry, and previous investigations. They acknowledged that the complex deposition of sediments in the Coastal Plain makes aquifer delineation uncertain. Indeed, SCDNR is currently redefining the hydrogeology of the South Carolina Coastal Plain on the basis of palynological and hydrogeological data from a network of wells and coreholes in the State. This aquifer has been studied by Cooke (1936), Siple (1957), Colquhoun and others (1983), Renken (1984), Aucott and Speiran (1985a, and 1985b), and Aucott (1996). Regional and local studies include Siple (1975), Johnson (1978), Hayes (1979), Crouch and others (1985), Davies and others (1985), Hassen (1985), Park (1985), Crouch and others (1987), Meadows (1987), Hughes and others (1989), Logan and Euler (1989), Gawne (1990), Whiting and Park (1990), Garza and Krause (1992), Gawne (1994), and Aadland and others (1995).

The potentiometric map presented here was constructed by using water levels measured in 364 wells during November and December 1998. Corrections were made for tidally influenced wells when their tidal-efficiency was known (primarily Beaufort, Jasper, and Colleton Counties), using methods derived by Gawne (1997).

GEOHYDROLOGIC FRAMEWORK

The Coastal Plain formations of South Carolina compose a wedge of sediments that thickens from 0 at the Fall Line to more than 4,000 ft (feet) at Hilton Head Island on the coast. These sediments consist of sand, clay, and limestone of late Cretaceous and younger ages that were deposited on a pre-Cretaceous basement complex of metamorphic, igneous, and consolidated sedimentary rocks.

The Floridan aquifer generally includes the Cooper Formation, the Ocala Limestone, and the Santee Limestone (Aucott and others, 1987). These units range from Oligocene to middle Eocene in age. The updip limit of this aquifer extends from central Allendale County through northern Colleton County, central Berkeley County south of Lake Moultrie, and eastward through southern Georgetown County (Aucott, and others, 1987, as modified from Miller, 1985).

Locally, three subdivisions of the Floridan aquifer are recognized; the upper, middle, and lower Floridan. The upper Floridan corresponds to the highly permeable, bioclastic limestone of the Ocala Limestone. The middle Floridan corresponds to the permeable portion of the lower Ocala Limestone and the upper Santee Limestone (Crouch and others, 1987; Gawne, 1994; Gawne and Park, 1992; and Ransom and White, 2000). The lower Floridan corresponds to the lower permeable sections of the Santee Limestone and the upper part of the Black Mingo Formation.

The Tertiary sand aquifer is divided into two parts: the upper unit and the lower unit. The upper unit is the sand facies equivalent of the Floridan aquifer. The updip limit extends from northwestern Allendale County to Orangeburg and curves eastward into southern Georgetown County (extended Floridan aquifer). It is composed of sediments from the Barnwell, McBean, and Congaree Formations and ranges in age from Early to Late Eocene. The lower unit consists of clastic sediments of Early Eocene and Paleocene ages and includes part of the Black Mingo Group.

The base of the Floridan dips southeastwardly and is at elevation 300, -600, and -1,400 ft msl (referenced to mean sea level) at Aiken, Walterboro, and Hilton Head Island, respectively. Thickness ranges from 0 at the updip limit to more than 1,000 ft at Hilton Head Island.

The upper Floridan is the major aquifer of Beaufort, Jasper, and southern Hampton Counties. The lower Floridan is the major source of water for Colleton and northern Hampton Counties. The middle Floridan is also a source of water supply in north-central Hampton County, and especially for recent developments in Beaufort County. For the preparation of this map, water-level data from upper Floridan wells in Beaufort and Jasper Counties and most of Hampton County were used. Data from middle and/or lower Floridan wells were used, within the boundary shown for the Floridan aquifer, except for these areas. Elsewhere, data were used from wells in the Tertiary sand aquifer.

GROUND-WATER FLOW

The potentiometric surface of the Floridan aquifer system dips, in general, toward the coast and defines a southeastward regional ground-water flow. Water levels in Aiken, Barnwell, and northern Allendale Counties are not contoured because data are sparse and commonly represent unconfined-aquifer conditions that are influenced by surface topography. The highest water level was noted in Aiken County, exceeding 380 ft msl. In areas where the aquifer crops out, it is recharged by rainfall. In the updip sections, where stream valleys are incised into the aquifer, it is drained by those streams. This is shown by the convex curving of contour lines upstream along the Santee, Savannah, Salkehatchie, and Little Salkehatchie Rivers, and the North and South Forks of the Edisto River. In the downdip sections, the aquifer discharges into overlying aquifers or through pumping wells.

Dimpling this surface are cones of depression resulting from concentrated ground-water withdrawal. The potentiometric surface has been affected by pumping in Berkeley, Charleston, Colleton, Dorchester, and Orangeburg Counties. The greatest impact of ground-water withdrawals is in Jasper and Beaufort Counties, where water flows toward Savannah as a result of the estimated average withdrawals of 70 to 80 million gallons per day near this city. Potentiometric levels are lower than -70 ft msl near Savannah and are the lowest measured.

HISTORICAL TRENDS

Potentiometric levels of the Floridan aquifer system have been observed since 1916 (Siple, 1975). Aucott and Speiran estimated predevelopment potentiometric levels (1985b). When they compared their predevelopment potentiometric map with a map of November 1982, they noted declines in Barnwell, Beaufort, Berkeley, Charleston, Colleton, Dorchester, Jasper, and Orangeburg Counties (Aucott and Speiran, 1985a). The 1998 data show that the potentiometric surface has continued to decline throughout most of the areal extent of the aquifer since development began.

A comparison of the potentiometric surface from 1998 with that of predevelopment indicates little decline in water levels in Allendale, Bamberg, and Barnwell Counties. These observations are confirmed by comparing the 1998 map with that of Logan and Euler (1989) for August 1985 for the three counties.

Orangeburg County shows declines ranging from minimal to more than 40 feet between predevelopment and 1998. In southern Orangeburg County (ORG-26), water levels were higher than 115 ft msl in October 1956 (Aucott and Speiran, 1984) and 113 ft msl in November 1982 (Aucott and Speiran, 1984), correcting for a 1998-revised land surface datum (lsd), and 112 ft msl in November 1998. Little change occurred in southeastern Orangeburg County (ORG-9), where water levels were nearly the same in March 1946 and November 1998. In Eutawville (ORG-92), near Lake Marion, water levels were 80 ft msl in September 1965, 60 ft msl in November 1982 (both adjusted for revised 1998 lsd), and 38 ft msl in November 1998, for a total decline of 42 feet. Water levels declined 20 feet from predevelopment levels to 155 ft msl in 1998 near Orangeburg. Similarly, the water level in a well in south-central Orangeburg County (ORG-40) had declined more than 20 feet since 1959.

Water levels in Dorchester County have declined since development began, as evidenced in a shift in contour lines toward the northwest. In western (DOR-168) and central (DOR-58) Dorchester County, water levels have declined more than 3 and 14 feet, respectively, since 1982. Aucott and Speiran (1985) noted declines of more than 25 feet by 1982 near Summerville. Assuming predevelopment levels above 40 ft msl near Summerville (Aucott and Speiran, 1985b), and levels below -30 ft msl in 1998, water levels declined more than 70 feet in this area.

A cone of depression centered along the Interstate 26 corridor between Summerville and Charleston has deepened and enlarged since 1982. Water levels were estimated prior to development to be near 25 ft msl. The water level at CHN-460 was -38 ft msl in 1998, thus indicating a decline of as much as 63 feet since predevelopment and a measured decline of 21 feet since 1982. The 0 ft msl contour line encompasses a much greater area than that indicated in 1982 by Park (1985), particularly southwest of Charleston, where it extends into Colleton County. In southern Charleston County (CHN-220) the water level declined 20 feet from 1982 to 1998. Southwest of Charleston, water levels declined more than 16 feet and 12 feet in CHN-141 and CHN-44, respectively, in the same period. Little or no decline has been noted in northern Charleston County (CHN-102, CHN-237, and CHN-101) since 1982.

The greatest declines in Berkeley County were associated with the cone of depression around Summerville and Interstate Highway 26. Aucott and Speiran (1985) noted a decline of 50 feet from predevelopment levels to 1982 in the area east of Summerville, but an additional 5-foot decline may have occurred by 1998. Water levels near Jamestown (BRK-53), in Berkeley County, declined 10 feet by 1998 and were probably the result of quarry dewatering. The western part of the county experienced only small declines, as evidenced in wells BRK-47 and -48, which show declines of less than 4 feet since 1965. Another well located near Lake Moultrie (BRK-164) showed no change in 1998 from 1982 levels and appeared to be influenced by lake levels, which were nearly identical. The hydraulic gradient near Moncks Corner in 1998 appeared to be nearly that reported in 1985 by Meadows (1987) despite a switch to surface-water sources by some public water supplies in the area.

In Colleton County, the potentiometric surface was dominated by a cone of depression centered about Walterboro. This depression was present, with some fluctuation in depth, in July 1986 (Crouch and others, 1987), March 1991, July 1991, February 1992, November 1992, and November 1993 (Gawne, 1994). Prior to development, water levels were above 50 ft msl at Walterboro; but by 1982 they had declined to 25 ft msl. In 1998, water levels were lower than -30 ft msl, representing a total decline of 80 feet. Elsewhere in the county, the variations in water level were less dramatic. In northern Colleton County, water levels varied from a recovery of 1 foot (COL-219) to a decline of 7 feet (COL-232 and -97) compared with 1982. Water levels declined 11 feet along the eastern edge of the county (COL-96) and 8 feet in the southern section (COL-51) during the same period.

Hampton County showed water-level declines throughout the county. Water levels were higher than 100 ft msl prior to development (Aucott and Speiran, 1985), but they had declined to about 80 ft msl by 1998. Well HAM-74 showed a decline of 8 feet from 1976 to 1998. A well (HAM-80) in the northwestern part of the county showed winter water-level elevations above 97 ft msl between 1981 and 1990 (Gawne, 1990), but by 1998 levels had declined to 92 ft msl. Another well (HAM-105), located in central Hampton County, showed winter water levels generally above 46 ft msl until 1988, but they had declined to 43 and 38 ft msl in 1990 and 1998, respectively.

Beaufort County showed the influence of ground-water pumping in the greater Savannah area, with contour lines parallel to the coast and declining to the southwest. The highest water levels (+20) were located on northern Port Royal Island near the U.S. Marine Corp Air Station. Since 1982, water levels have declined 4, 6, and 14 feet on Hilton Head Island at wells BFT-704, -346, and -985, respectively. Water levels declined 11 feet in BFT-1210, located in northwestern Beaufort County, between 1982 and 1998. There was not a significant change in the potentiometric surface in Beaufort County from November 1993 (Gawne, 1994) to 1998.

Water-level declines were greatest in Jasper County. Predevelopment levels were estimated to be above 25 ft msl throughout the county, and ground-water flow was toward the southeast. The 1998 map shows water levels in the southwestern part of the county at below -70 ft msl, for a decline of more than 95 feet. In addition, the direction of ground-water flow has reversed and now is to the southwest. Documented declines were 7 to 11 feet between 1982 and 1998 (JAS-109, -111, -134, and -298). Water levels had declined 30 feet since predevelopment in the northwestern part of the county. The potentiometric surface in 1998 was similar to that noted by Gawne (1994) in November 1993.

SUMMARY AND CONCLUSIONS

The potentiometric map for the Floridan aquifer and its updip equivalent, constructed by using water-level data from 364 wells measured during late 1998, shows that the generally southeastward ground-water flow is affected by several potentiometric lows. These potentiometric lows developed because of ground-water pumping around Charleston, Summerville, Walterboro, and Eutawville. In Jasper and Beaufort Counties, the ground-water flow reversed from its predevelopment direction and now flows southwestward toward Savannah, Ga.

Historical data show that water levels are stable near the aquifer outcrop area; but fluctuations have occurred in areas influenced by pumping. The greatest fluctuations occurred in southern Jasper County, where water levels have declined more than 95 ft from the estimated predevelopment level.

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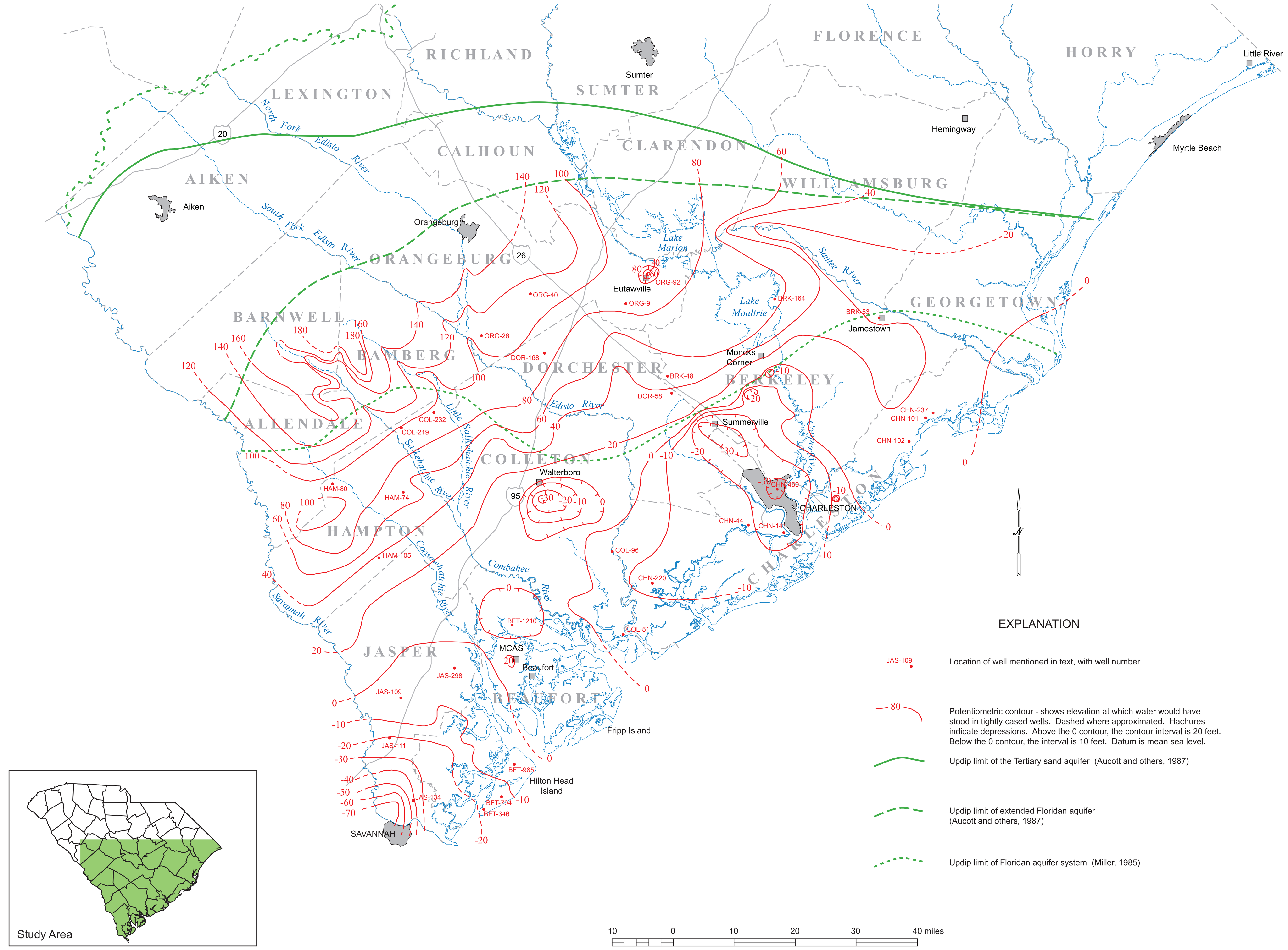

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