GROUND-WATER RESOURCES OF WILLIAMSBURG COUNTY, SOUTH CAROLINA

STATE OF SOUTH CAROLINA
DEPARTMENT OF NATURAL RESOURCES

LAND, WATER AND
CONSERVATION DIVISION

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES

DNR

WATER RESOURCES
REPORT 49
2008

GROUND-WATER RESOURCES OF WILLIAMSBURG COUNTY, SOUTH CAROLINA

by

Roy Newcome, Jr.

STATE OF SOUTH CAROLINA
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STATE OF SOUTH CAROLINA
The Honorable Mark H. Sanford, Governor

South Carolina Department of Natural Resources

Board Members

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GROUND-WATER RESOURCES OF WILLIAMSBURG COUNTY, SOUTH CAROLINA 2008

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ABSTRACT

Williamsburg County, S.C., has numerous substantial ground-water aquifers. Most are in sand-and-clay formations of Cretaceous Age, like the other counties of South Carolina's Coastal Plain. Wells as deep as 1,200 feet provide water of suitable quality for public supply, industry, and agriculture. Many wells produce more than 200 gallons per minute; the largest yield recorded is 1,900 gallons per minute.

Chemical analyses of the well water indicate dissolved-solids concentrations generally less than 300 milligrams per liter. The water is usually very soft and low in iron. Cloudiness caused by aragonite suspension has been an occasional problem.

Withdrawals from wells in the Hemingway and Andrews areas have caused depressions in the potentiometric surface in those localities. This can be ameliorated by reduction in pumpage or repositioning of wells. Artificial recharge, using surface water, is a potential means of restoring the artesian water level.

INTRODUCTION

Williamsburg County occupies 934 square miles in eastern South Carolina and is the sixth-largest county. It presents a tilted-square area one county removed from the coastline (Fig. 1). The estimated 2006 population of the county was 36,105 (U.S. Census Bureau), less than 1 percent of the total State population. The largest town is Kingstree (population 4,400). Hemingway, Lane, and Greeleyville have about 500 people each.

One-third of Williamsburg County is farmland, the main crops being soybeans, cotton, and corn. The county is two-thirds timberland, with oak-gum-cypress woods the most common and shortleaf pine not far behind.

DEVELOPMENT

Approximately 60 businesses and industries are located in Williamsburg County. Transportation needs are served by the CSX Railroad, which enters the county from the city of Sumter and connects the towns of Greeleyville and Lane, then trends northward through Salters, Kingstree, and Cades. Another branch of CSX enters the county from Charleston and Jamestown and goes northward through Andrews, Nesmith, and Hemingway. U.S. Highways 378 in the north and 521 in the south are connected by U.S. 52 which passes through Kingstree. The nearest commercial airports are at North Charleston, 53 miles south of Kingstree, Florence, 30 miles north of Kingstree, and Myrtle Beach, 52 miles east of Kingstree.

CLIMATE

The average annual rainfall in Williamsburg County is 48.4 inches. August is the wettest month, with slightly more than 6 inches, and November the driest, with 2.5 inches. Snow is virtually a nonoccurrence. July is the warmest month and January the coldest. The annual average air temperature is 63.4º F (Fahrenheit), and this determines the temperature of shallow ground water. The 246-day median growing season runs from mid-March to mid-November.

PHYSIOGRAPHY AND DRAINAGE

Williamsburg is a county of riverine swamps and Carolina bays. A quick perusal of the topographic maps covering the county (see Fig. 2) will impress the observer; there is little dry land. Land-surface elevations range between 5 and 90 ft (feet) above sea level, but most of the county is between 25 and 75 ft. All or part of 27 USGS (U.S. Geological Survey) topographic maps, at a scale of 1:24,000, are included in the coverage of Williamsburg County (Fig. 2).

The county is drained by the Santee River, which forms the southern border, and the Black River that flows southeasterly across the central part of the county and on which Kingstree, the largest town and the county seat, is located. Black Mingo Creek and its tributaries drain much of the northeast.

WATER SUPPLY

Five municipal water systems and two rural water systems serve Williamsburg County. Nearly half of the county's population is on these public water systems. All of the public supplies are obtained from wells (Table 1). The wells range in depth from less than 300 ft to nearly 1,100 ft and in yield from 140 to 1,050 gpm (gallons per minute). Wells also provide water for the parts of the population not on the major public systems. This includes numerous businesses, mobile-home parks, child-care centers, schools, and a few subdivisions. Last but not least are the many rural residences served by private wells.

Currently (2008) the public water systems pump an aggregate average of 2.7 mgd (million gallons per day).

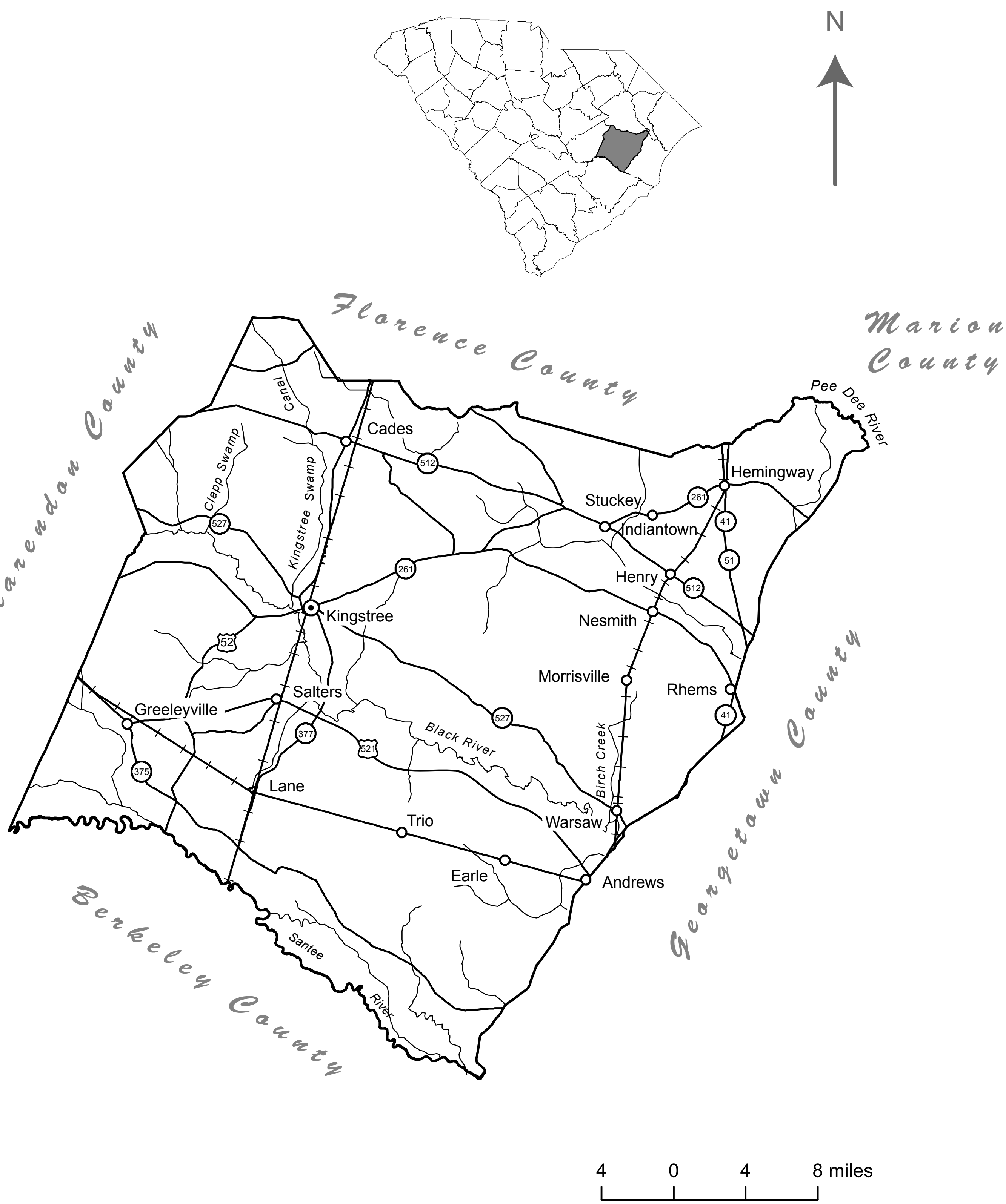
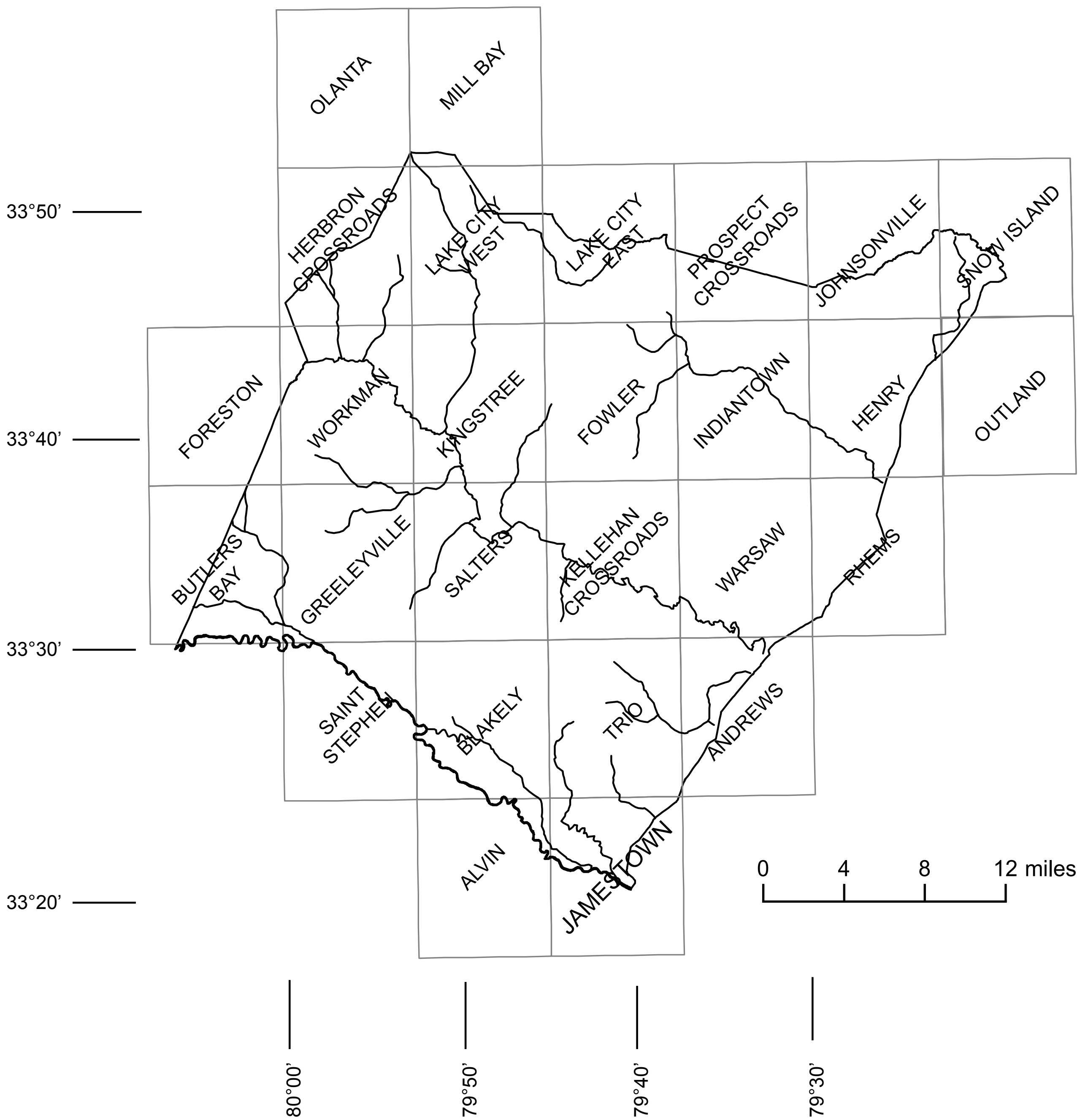


Figure 1. Location, towns, and major drainage of Williamsburg County, S.C.



U.S. Geological Survey 7 1/2 - minute topographic quadrangles

Figure 2. Topographic-map coverage of Williamsburg County.

Table 1. Wells used by the major public water-supply systems serving Williamsburg County, S.C.

System	Well name or location	Owner no.	Depth (feet)	Formation	Yield (gpm)	Electric log	Chemical analysis	Pumping test	County number	S.C. grid number	Date drilled
Greeleyville	Main Well	1	650	Black Creek	140		X		WIL-189	18U-e3	pre-1983
	New Well	2	695	Black Creek	300	X		X	WIL-201	18U-d1	9/1993
Hemingway	High tank	1	891	Middendorf	670	X	X		WIL-37	12S-c1	8/1970
	Tupperware	2	914	Middendorf	740	X	X	X	WIL-176	12S-h1	5/1986
	Industrial Park	3	886	Middendorf	750	X	X	X	WIL-213	12R-s1	4/2003
Kingstree	Hwy 377	1	670	Black Creek	450	X	X	X	WIL-75	16T-e2	3/1978
	Brockington St.	2	953	Middendorf	600	X	X	X	WIL-118	17S-u1	8/1976
	Stadium	3	716	Black Creek, Mid.	250	X	X		WIL-34	17S-t1	8/1969
	County Camp	6	1,072	Middendorf	1,050	X	X	X	WIL-203	16S-n6	11/1994
Lane	Rd S45-90 Well	2	694	Black Creek	260	X	X	X	WIL-177	17U-q1	5/1990
Stuckey	Main well	1	286	Black Creek	150		X		WIL-32	13S-il	6/1964
	New well	2	610	Black Creek	280	X		X	WIL-193	13S-j2	2/1991
South Williamsburg County Water System		1	1,129	Middendorf	950		X	X	WIL-207	18U-b1	11/2001
		2	1,052	Black Creek, Mid.	950	X		X	WIL-208	17T-w1	2/2002
Nesmith, Indiantown, Mooresville Water System		1	1,005	Black Creek, Mid.	700	X	X	X	WIL-211	13S-x1	8/2002
		2	1,025	Middendorf	600	X	X	X	WIL-212	13T-a5	9/2002

X means "In DNR files"

This pumpage is distributed as follows:

Greeleyville 0.101

Hemingway 0.413

Kingstree 1.021

Lane 0.768

Stuckey 0.029

South Williamsburg County Water System 0.281

Nesmith, Indiantown, Morrisville Water System 0.108

Sandridge Water System purchases water from Kingstree. The foregoing pumpage figures were furnished by DHEC (South Carolina Department of Health and Environmental Control). Two of the five wells supplying the town of Andrews (in Georgetown County) are located in Williamsburg County.

PREVIOUS STUDIES

The most comprehensive study of Williamsburg County's ground water was by Philip Johnson of the U.S. Geological Survey in 1978. His report described the resource in Clarendon and Williamsburg Counties (Johnson, 1978). In later years, Coastal Plain reports by the present writer touched on Williamsburg County (Newcome, 1989, 1993), as did potentiometric-contour maps by Stringfield (1989), Hockensmith and Waters (1998), and Hockensmith (2003, 2008).

The five counties that border Williamsburg County have had their ground-water resources described in specific county or multicounty reports. They are Florence County (Park, 1980); (Rodriguez and others, 1994); Marion County (Rodriguez and others, 1994); Georgetown County (Pelletier, 1985); Berkeley County (Park, 1985); Clarendon County (Newcome, 2006).

AQUIFERS AND WELLS

Five geologic formations are available to supply wells in Williamsburg County. They are, from shallowest to deepest, the Santee Limestone of Eocene age, the Black Mingo Formation of Paleocene age, and the Peedee, Black Creek, and Middendorf Formations of Cretaceous age. Shallow sand beds of Pleistocene age also are available for small supplies such as those for residential use and lawn irrigation. Water in all of the above, except the last mentioned, occurs under artesian conditions – that is, it is under pressure and rises in wells that penetrate the aquifer.

The highest yielding wells in and near Williamsburg County are those in the deepest of the above-listed formations, the Middendorf. Pumping tests indicate aquifer transmissivity (T) values averaging near 30,000 gpd/ft (gallons per day per foot of aquifer width) and ranging from 3,200 to 62,000. For those who prefer to express T in cubic feet per day per foot of aquifer width the foregoing T should be divided by 7.48. The average value of T for the Black Creek Formation pumping tests is near 12,000 gpd/ft, and the range is 1,700 to 80,000. No tests are available for the shallower Peedee Formation, Black Mingo Formation, and Santee Limestone in Williamsburg County.

DHEC records indicate that 143 wells were drilled in Williamsburg County in the year 2007. The following is a summary of their depth distribution:

Depth (ft)	Number of Wells
<50	3
50-100	73
101-200	26
201-500	40
>500	1

This table, with half of the wells between 50 and 100 ft in depth, suggests that the Black Mingo Formation is an important source of water for domestic supplies. Public-supply and industrial wells, on the other hand, produce water from the Black Creek and Middendorf Formations. In Williamsburg County, 16 municipal and rural water-system wells range in depth from 286 to 1,129 feet (Table 1). Black Creek Formation aquifers are screened in 7 of these wells and Middendorf aquifers in 9 wells. The Black Creek wells average 260 gpm in yield, and the Middendorf wells average 780 gpm.

Farm-irrigation wells yield 50 to 500 gpm in the county and are producing from the Black Creek Formation . Larger yields probably could be obtained from deeper wells in the Middendorf Formation. The largest Williamsburg County yield in DNR records, 1,900 gpm, is from an industrial well in the Middendorf 5 miles north of Kingstree.

DNR records show that at least 121 wells in Williamsburg County are capable of producing 120 gpm or more. There probably are others not in DNR records. Figure 3 shows the locations of wells capable of producing 200 gpm or more.

LOCATING THE AQUIFERS

The maps of Figure 4 portray the stratigraphic structure of the principal water-bearing formations of Williamsburg County. The shallowest formation that occurs throughout the county and supplies at least half of the wells drilled for domestic supplies is the Black Mingo Formation (A in Fig. 4). Between the base of the Black Mingo and the top of the Black Creek Formation (B in Fig. 4) lies the Peedee Formation that is mostly clay but contains significant sand aquifers in places. The Black Creek directly overlies the Middendorf Formation (C in Fig. 4). These two formations, with an aggregate thickness ranging from 1,000 ft at the northern extremity of the county to 1,500 ft at the southern extremity, are difficult to differentiate on drilling logs and geophysical logs.

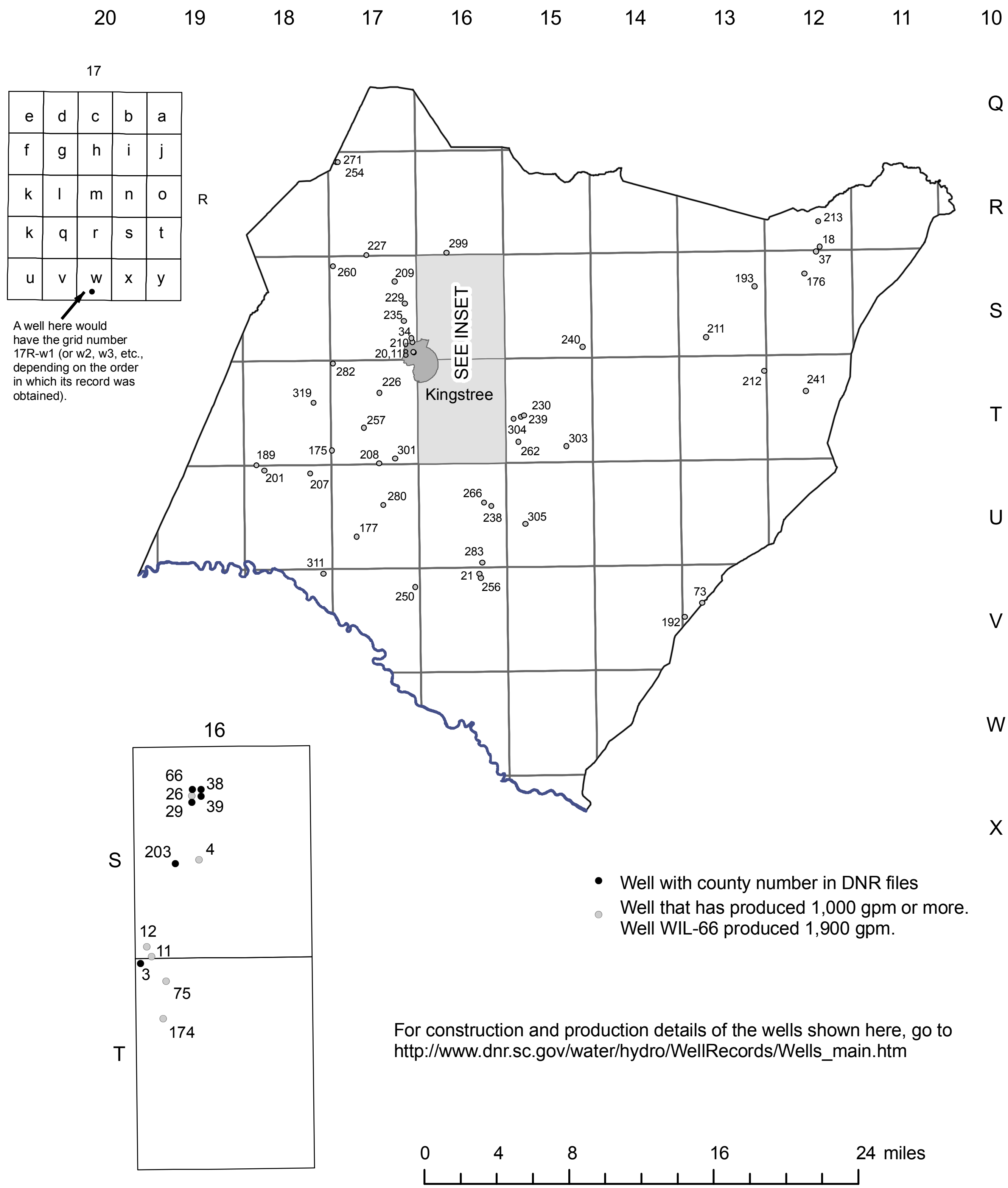


Figure 3. Wells in Williamsburg County capable of producing 200 gallons or more.

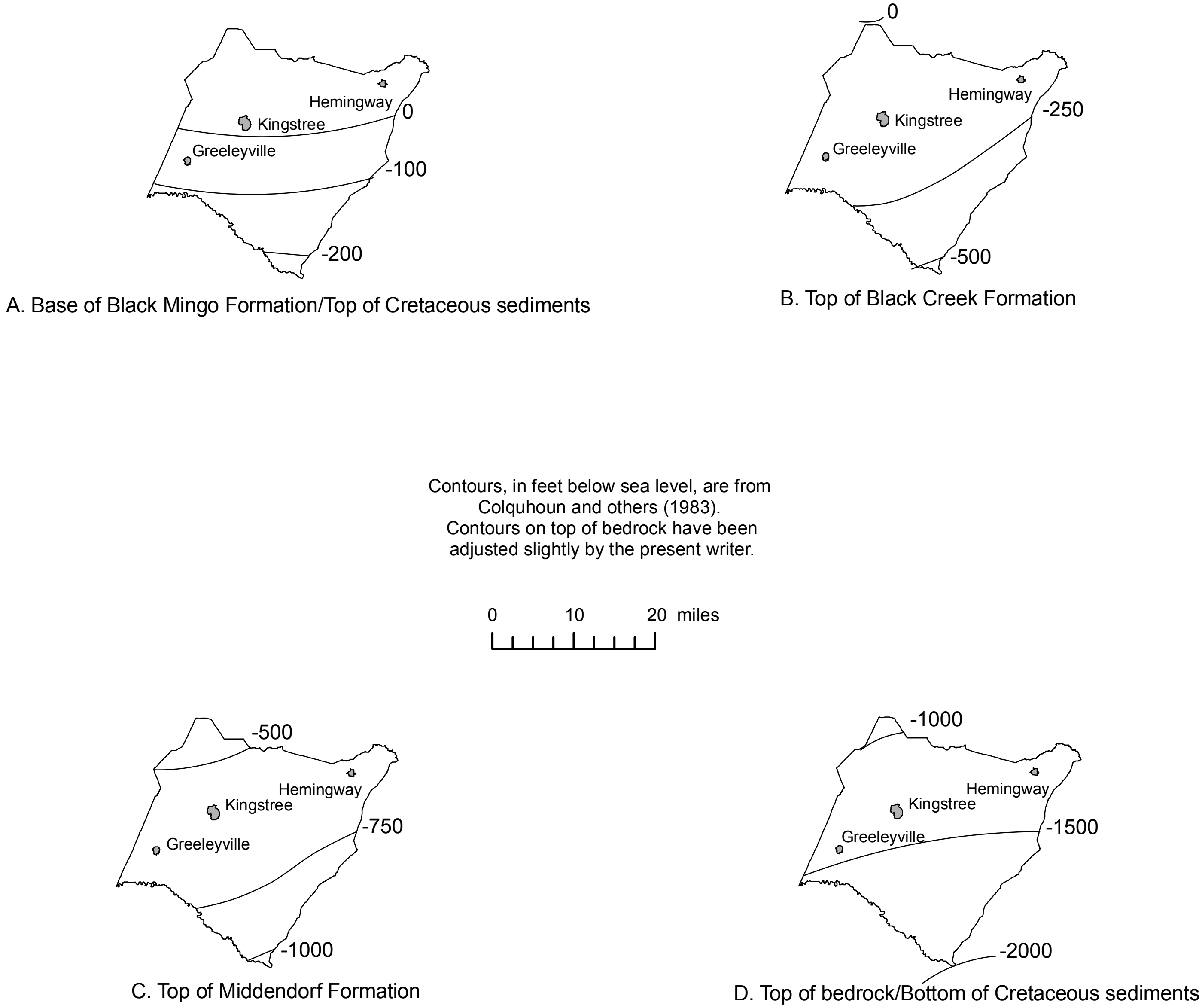


Figure 4. Structure-contour maps relating to the major aquifers in Williamsburg County.

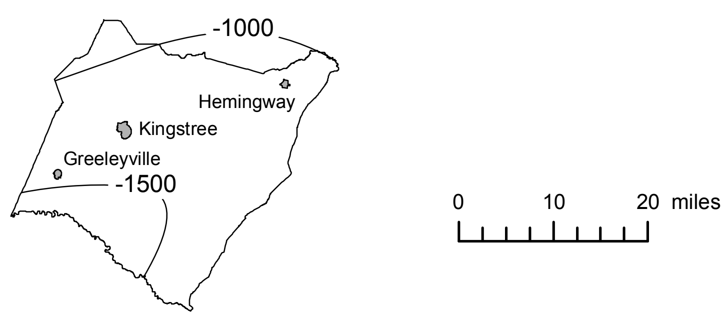


Figure 5. Contours depicting the deepest extent (in feet below sea level) of freshwater in Williamsburg County.

The few wells in the region (none in this county) that penetrate all of the formations and reach the top of bedrock indicate that freshwater is available from all of the aquifers above bedrock in the western half of Williamsburg County but not in the eastern half. At the county's southern extremity the 1,000-ft-thick Middendorf may have no freshwater aquifers in the bottom 750 ft. More information is needed to better define the lower limit of freshwater occurrence. Meanwhile, the map of Figure 5 (from Newcome, 1989, Fig. 7) is offered as a reasonable approximation. Compare it with the maps of Figure 4.

Moving from the geographical delineation of aquifer systems (Fig. 4) to specific location of aquifers leads us to geophysical logging of wells – most especially to electrical logging – by which the differences among sand, clay, and rock on a graph of the electrical resistance reveal the depth and thickness of the aquifers at the site examined. In addition, the magnitude of the resistance provides information on the water quality. The map of Figure 6 shows the locations of 24 electrical logs of wells in Williamsburg County and nearby in adjacent counties. These logs, selected on the bases of depth and clarity, provide sand intervals (as interpreted by this writer) that are listed in Table 2.

TESTING THE WELLS AND AQUIFERS

The rate at which a well can be pumped is dependent upon three factors: (1) transmissivity of the aquifer; (2) well construction; (3) well efficiency. Transmissivity, which is the number of gallons per day that will pass through each foot of the aquifer's width under unit hydraulic gradient, is determined by the aquifer's hydraulic conductivity (K) and thickness (m); $T=Km$. Obviously, the greater the transmissivity the greater is the potential yield of wells. Next to be considered is the construction of the well. The greater the proportion of the aquifer thickness that is screened with properly selected well screen (optimum size of openings), the greater is the rate at which water can pass into the well. Finally, if the foregoing requirements are met the well remains only to be adequately developed to achieve good efficiency. An efficient well is one that has a specific capacity (yield in gallons per minute for each foot of water-level drawdown while pumping) commensurate with the aquifer transmissivity. More on this later.

Well development usually entails "surge" pumping at various rates and for various periods (hours or days) to move the finer aquifer material near the well through the well screen and out of the well. An envelope of gravel commonly is installed around the well screen to help in this "filtering" process. The result is an increase in the effective well diameter and a minimum amount of sand or silt continuing to pass through the well screen and into the water supply.

Pumping tests provide the data needed to calculate transmissivity, specific capacity, and well efficiency. Pumping a well for several hours (preferably 24) at a constant rate and measuring the water level frequently while pumping and during a recovery period (hopefully equal in length to the pumping period) constitutes a pumping test.

Table 3 contains the results of 35 pumping tests (Locations on Fig. 7) in Williamsburg County and nearby in adjacent counties (Berkeley, Clarendon, Florence, Georgetown, and Marion). The tests are all on wells screened in the Black Creek or Middendorf Formations. Two of the wells, FLO-247 and 259, are screened in both formations (Table 3). Very few of these tests were available to Johnson at the time of his report in 1978. The median T for the 21 Black Creek Formation tests is 12,000 gpd/ft; for the 12 Middendorf tests it is nearly 30,000 gpd/ft. Specific capacities of the wells ranged from less than 1 to 24 gpm per foot of drawdown, and well efficiencies from 25 to 100 percent. The importance of well efficiency cannot be overemphasized. For example, a well that is only 50-percent efficient will have twice the water-level drawdown of a well that is fully efficient (100 percent). This results in a significant increase in pumping cost. Calculation of well efficiency involves several variables, but a reasonable approximation can be obtained by dividing the T by 2,000 to obtain the ideal specific capacity and then dividing that into the actual specific capacity, which is the gallons per minute yielded for each foot of water-level drawdown during pumping at a constant rate (Newcome 1997).

A few of the pumping tests of Table 3 revealed the nearby presence of hydrologic boundaries, which are sources of recharge or discharge. Recharge boundaries may be thickening or increased permeability of the aquifer, drainage from another aquifer, or a surface source of water. Discharge boundaries may be thinning or pinching out of the aquifer, loss of water through a confining bed, or decreased permeability. Discharging effects on three tests possibly are caused by thinning of the aquifer in some direction or some other interruption in flow. The four tests for which a recharging boundary is indicated may be near a thickening of the aquifer or may be receiving leakage from a shallower or deeper aquifer.

All the tests are considered to represent artesian aquifers, although in only one test (GEO-214, near Andrews) was an observation well available to permit calculation of the storage coefficient (S).

EFFECTS OF PUMPING

The drawdown effects of pumping – for various periods of time and at various distances – can be calculated, using the hydraulics values produced by pumping tests. These effects can be shown as graphs (Fig. 8) that, in general, cover the transmissivity values determined for Williamsburg County aquifers (Table 3). For example, if a well completed in an artesian aquifer having a transmissivity of 10,000 gpd/ft is pumped for 10 consecutive days at 200 gpm it will cause about 12 ft of drawdown in that aquifer at a distance of 1,000 ft from the pumped well (Fig. 8A). This type of information is essential in the spacing of wells to avoid undue pumping interference.

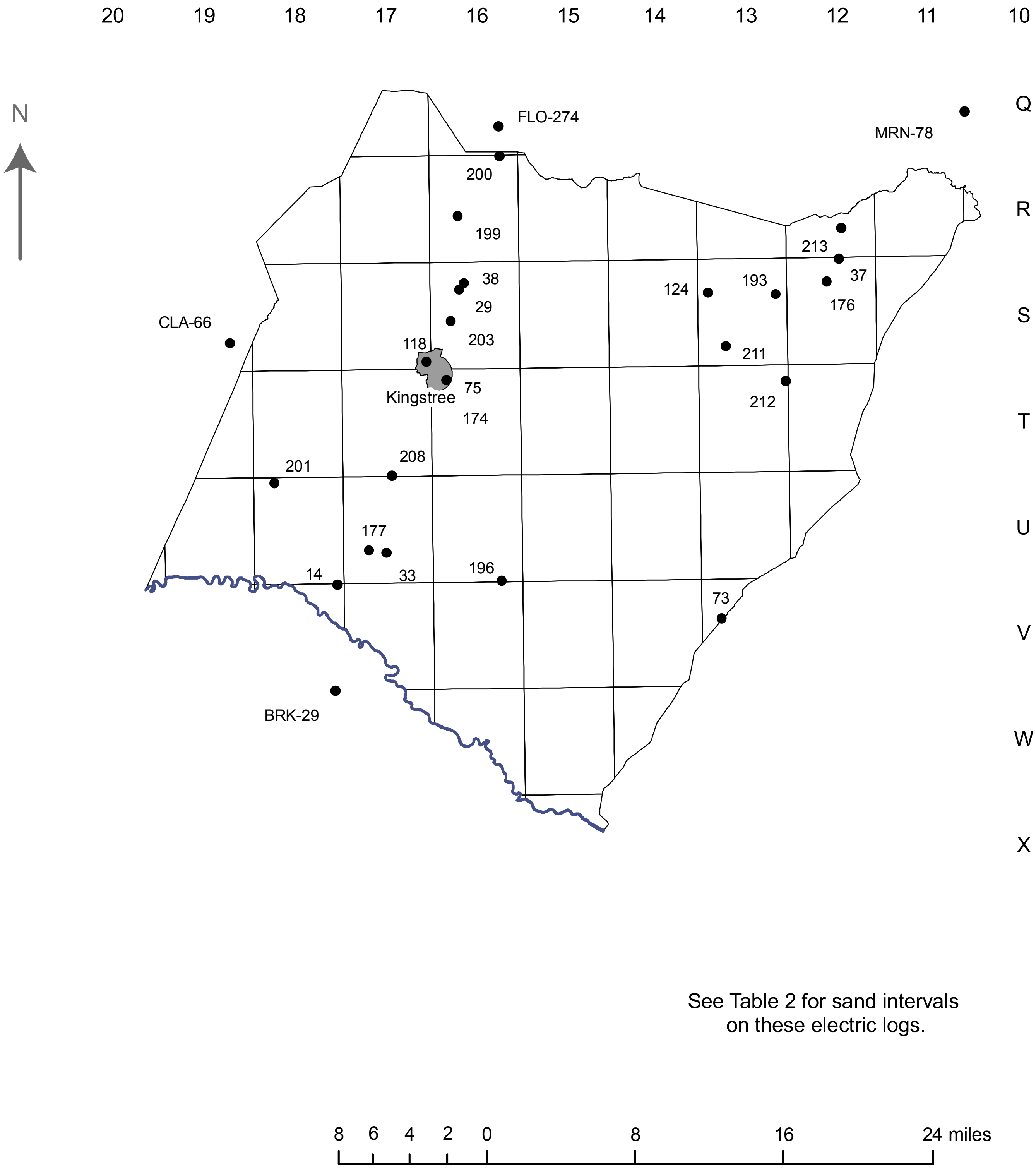


Figure 6. Selected wells for which electric logs are available in and near Williamsburg County.

Table 2. Freshwater-sand intervals indicated by electric logs of wells in and near Williamsburg County (see Fig. 6 for locations)

County well number	WIL-14	WIL-29	WIL-33	WIL-37	WIL-38	WIL-73	WIL-75	WIL-124	WIL-174	WIL-176	WIL-177	WIL-193	WIL-196
S.C. grid number	18V-a1	16S-g3	17U-r1	12S-c1	16S-d1	13V-g1	16T-e2	13S-f1	16T-f1	12S-h1	17U-q1	13S-j2	16U-v1
Elevation, in feet MSL	60	60	65	55	60	20	65	40	60	40	78	53	58
Log depth (ft)	660	1,318	790	890	1,092	848	1,262	415	720	918	692	703	248
Sand intervals, in feet	176-234	200-220	130-144	40-60	210-225	110-160	303-360	142-180	-97	50-75	62-88	205-290	186-223
below land surface	556-652	446-500	152-222	130-164	433-495	500-530	538-558	208-282	104-113	440-460	138-175	445-462	238-246
		706-814	348-378	319-377	659-690	552-590	598-660	388-412	222-233	836-866	348-378	490-510	
		883-896	430-480	454-474	700-730	675-690	666-678		413-422	875-920	510-565	572-610	
		1,030-1,050	564-678	521-540	930-962	740-770	730-769		465-472		595-645		
		1,065-1,182	740-790	610-620	976-1,000		886-1,216		492-526		668-692		
		1,212-1,318		650-704	1,038-1,048				535-543				
				800-884					614-640				

County well number	WIL-199	WIL-200	WIL-201	WIL-203	WIL-208	WIL-211	WIL-212	WIL-213	BRK-29	CLA-66	FLO-274	MRN-78	
S.C. grid number	16R-n1	16R-b1	18U-d1	16S-n6	17T-w1	13S-x1	13T-a5	12R-s1	18W-a4	19S-s1	16Q-s1	10Q-p2	
Elevation, in feet MSL	73	73	76	75	75	50	35	52	60	90	75	30	
Log depth (ft)	326	550	670	1,097	1,222	1,215	1,068	981	1,250	500	1,050	1,225	
Sand intervals, in feet	252-268	158-169	146-158	230-248	100-167	166-195	153-185	120-128	65-110	22-55	15-50	315-356	
below land surface	290-326	210-232	168-209	274-300	258-278	420-450	215-250	465-492	128-142	80-91	60-86	372-402	
		292-326	312-338	377-425	292-312	463-478	288-300	603-618	450-485	94-101	100-116	433-454	
		331-360	355-370	477-513	335-360	535-570	433-472	792-876	628-640	103-108	158-170	505-528	
		379-495	620-638	520-533	555-584	732-805	483-523		687-745	111-120	185-203	720-777	
		504-540		753-766	590-610	912-952	583-615		760-787	185-202	236-258		
				1,080-1,097	675-700	975-995	838-863		842-860	248-260	280-325		
					707-789		873-925		1,060-1,100	285-305	372-384		
					837-858		1,004-1,014		1,124-1,240	310-321	389-403		
					885-899					460-476	408-416		
					1,015-1,055						446-494		
											508-578		
											672-688		
											886-901		
											1,024-1,040		

Table 3. Results of pumping tests of wells in and near Williamsburg County

County well no.	S.C. grid no.	Location	Elec. log	Depth (ft)	Formation/ aquifer thick. (ft)	Date of test	Duration (hr) (dd/recov)	Static WL (ft)	Q (gpm)	T (gpd/ft)	S	Sp. cap. (gpm/ft)	Well effic. (percent)	Hydrol. bound.
WIL-11	16S-y1	Kingstree (Brooks Street)		530	BC/	5/23/1977	5/2	34	153	5,500		3.5	100	
WIL-12	16S-y2	Kingstree (2nd Ave.)		525	BC/65	5/271977	5/2	48	108	8,200		4.7	100	
WIL-26	16S-g2	Kingstree, 5 mi NNE		755	M/	1/4/1961	24/	+14	700	21,000		10	100	
WIL-33	17U-r1	Lane (Seaboard Road)	X	641	BC/50	6/2/1969	24/	3	150	3,400		1.1	70	
WIL-73	13V-g1	Andrews, NW edge	X	768	BC/90	5/12/1975	48/	63	375	6,000		3.9	100	
WIL-75	16T-e2	Kingstree, SE part	X	670	BC/120	5/1/1978	72/95	29	754	22,000		10	100	D
WIL-118	17S-u1	Kingstree, NW part	X	953	M/40	11/15/1976	24/1	29	500	3,200		3.5	100	R
WIL-124	13S-f1	Stuckey, 3 1/2 mi w	X	260	BC/58	7/13/1981	24/1.5	16	150	2,300		0.9	80	
WIL-174	16T-f1	Kingstree, 1 1/2 mi S	X	640	BC/85	4/18/1994	24/2	34	402	6,400		2.5	80	
WIL-176	12S-h1	Hemingway, 1 1/2 mi SW	X	914	M/50	5/14/1986	24/4	42	753	38,000		13	70	
WIL-177	17U-q1	Lane, W side	X	694	BC/115	5/1990	12/20	16	250	3,700		1.3	70	
WIL-192	13V-o2	Andrews, NW corner	X	792	BC/95	1/7/1975	48/2	71	354	5,000		2.3	90	R
WIL-193	13S-j2	Stuckey	X	610	BC/105	2/27/1991	24/1	57	250	37,000		5.8	30	D
WIL-201	18U-d1	Greeleyville	X	695	BC/150	6/7/1994	24/1	18	301	8,400		4.1	100	
WIL-203	16S-n6	Kingstree, 3 mi NNE	X	1,072	M/90	11/14/1994	24/4	125	1,000	6,000		3.9	100	
WIL-207	18U-b1	Greeleyville, 3 mi E		1,129	M/	12/10/2001	24/14	50	952	30,000		8.2	55	
WIL-208	17T-w1	Salters, 2 1/4 mi SW	X	1,052	M/135	3/17/2002	24/15	67	952	42,000		17	80	
WIL-211	13S-x1	Stuckey, 5 mi SW	X	1,005	M/100	8/14/2002	24/12	66	700	62,000		21	70	
WIL-212	13T-a5	Nesmith	X	1,025	M/80	9/11/2002	24/24	55	600	53,000		6.6	25	
WIL-213	12R-s1	Hemingway	X	886	M/70	4/1/2003	24/	86	710	35,000		7.2	40	
WIL-221	16S-f1	Kingstree, 4 mi N		480	BC/75	2/21/2002	5/	45	27	4,200		1.8	85	
WIL-223	15R-s1	Cades, 5 1/2 mi E		340	BC/40	2/6/2002	5/	59	19	1,700		0.8	95	
BRK-26	15X-15	Jamestown	X	885	BC/60	6/28/1981	30/15	18	160	6,000		2.1	70	
BRK-245	18W-b1	St. Stephen	X	1,260	M/	7/21/1980	24/	+5	305	23,000		13	100	
CLA-61	18R-b1	Turbeville, 6mi SE	X	393	BC/50	8/1986	19/	26	608	27,000		4.8	35	R?
CLA-66	19S-s1	Manning, 10 mi E	X	500	BC/	6/23/1997	24/4	23	80	7,700		2.1	55	
CLA-74	19S-j1	Foreston, 7 mi NNE		420	BC/60	12/31/2002	6/	25	24	4,000		2.5	100	
FLO-155	12R-b2	Johnsonville, 1 mi N	X	880	M/50	10/8/1976	2/	56	620	18,000		10	100	
FLO-247	15Q-p3	Lake City (Hwy 341E)	X	618	BC,M/120	8/3/1983	24/7.5	33	751	26,000		15	100	
FLO-250	16Q-t3	Lake City	X	584	BC,M/	8/12/1982	24/14	36	751	47,000		10	45	
FLO-296	16Q-s3	Lake City (Rae St.)		590	BC/225	5/18/1993	24/2	66	1100±	80,000		24	60	
GEO-214	12W-r2	Andrews, 8 mi SE	X	825	BC/110	2/28/1983	24/6	88	210	3,000	0.00001	1	65	R?
GEO-220	11S-s2	Oatland, 3 mi SE	X	430	BC/50	8/16/1983	24/	42	112	6,000		1.3	45	D
MRN-78	10Q-p2	Brittons Neck, 3 mi S	X	537	BC/22	4/30/1982	/60	17	32	7,000		<1	30±	
MRN-78	10Q-p2	Brittons Neck, 3 mi S	X	768	M/38	4/24/1982	/0.5	25	35	12,000		<1.5	25±	

Explanation of table-heading abbreviations:

Elec. log - Electric log. X indicates that one is on file.

Formation/aquifer thick. (ft) - BM is Black Mingo Fm, BC is Black Creek Fm, M is Middendorf Fm. Thickness is given when it is apparent on electric log.

Duration (dd/recov) - Hours of drawdown and recovery.

Static WL (ft) - Nonpumping water level.

Q (gpm) - Pumping rate, in gallons per minute, for test.

T (gpd/ft) - Transmissivity, in gallons per day per foot of aquifer width. Divide by 7.48 to obtain units of cubic feet per day per foot.

S - Storage coefficient, dimensionless.

Sp. cap. (gpm/ft) - Specific capacity in gallons per minute produced for each foot of water-level drawdown.

Well effic. (percent) - Well efficiency, the specific capacity achieved compared with what it should be for the indicated transmissivity.

Hydrol. bound. - Hydrologic boundary; R, a source of recharge; D, discharge (a barrier to flow)

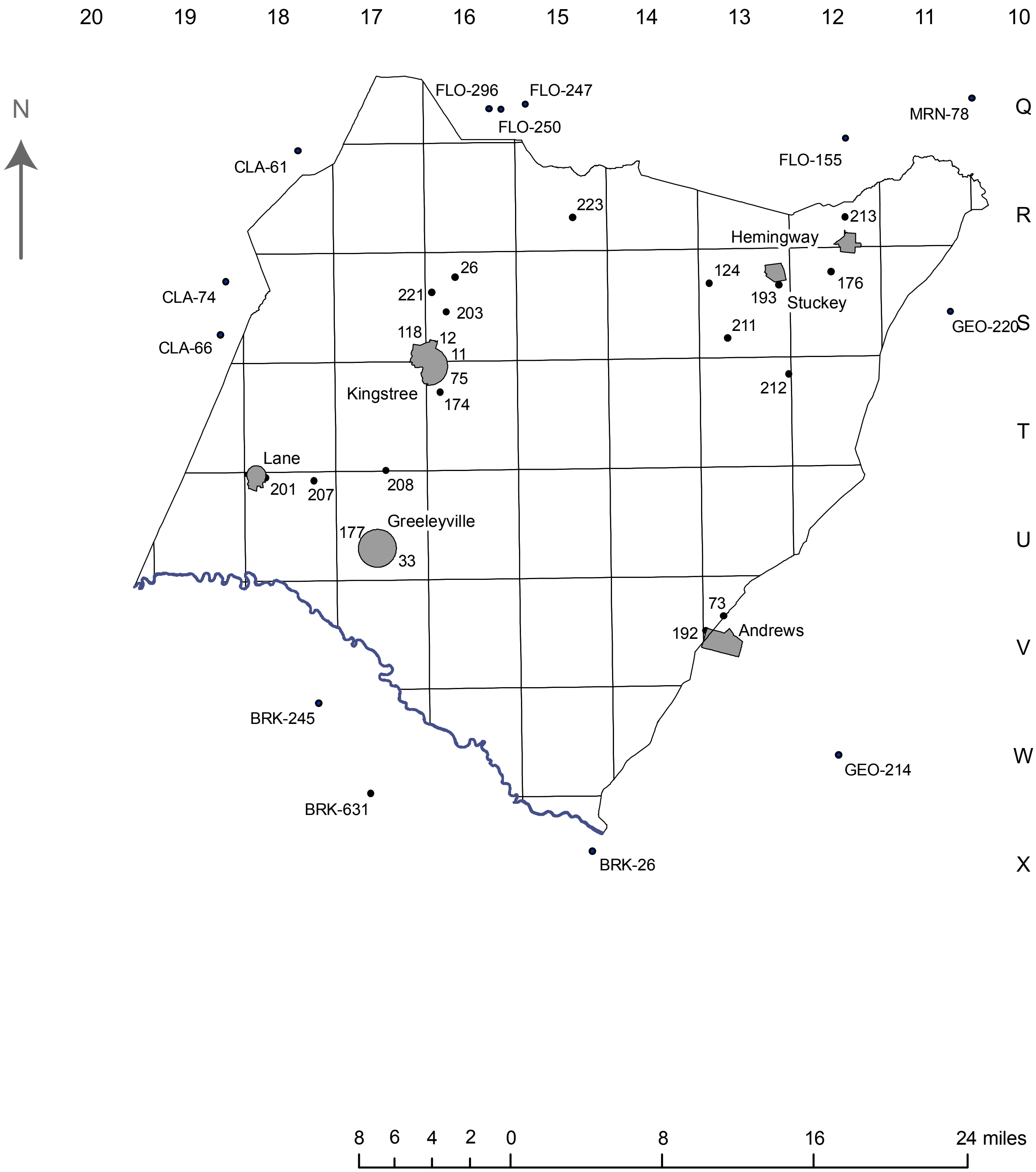
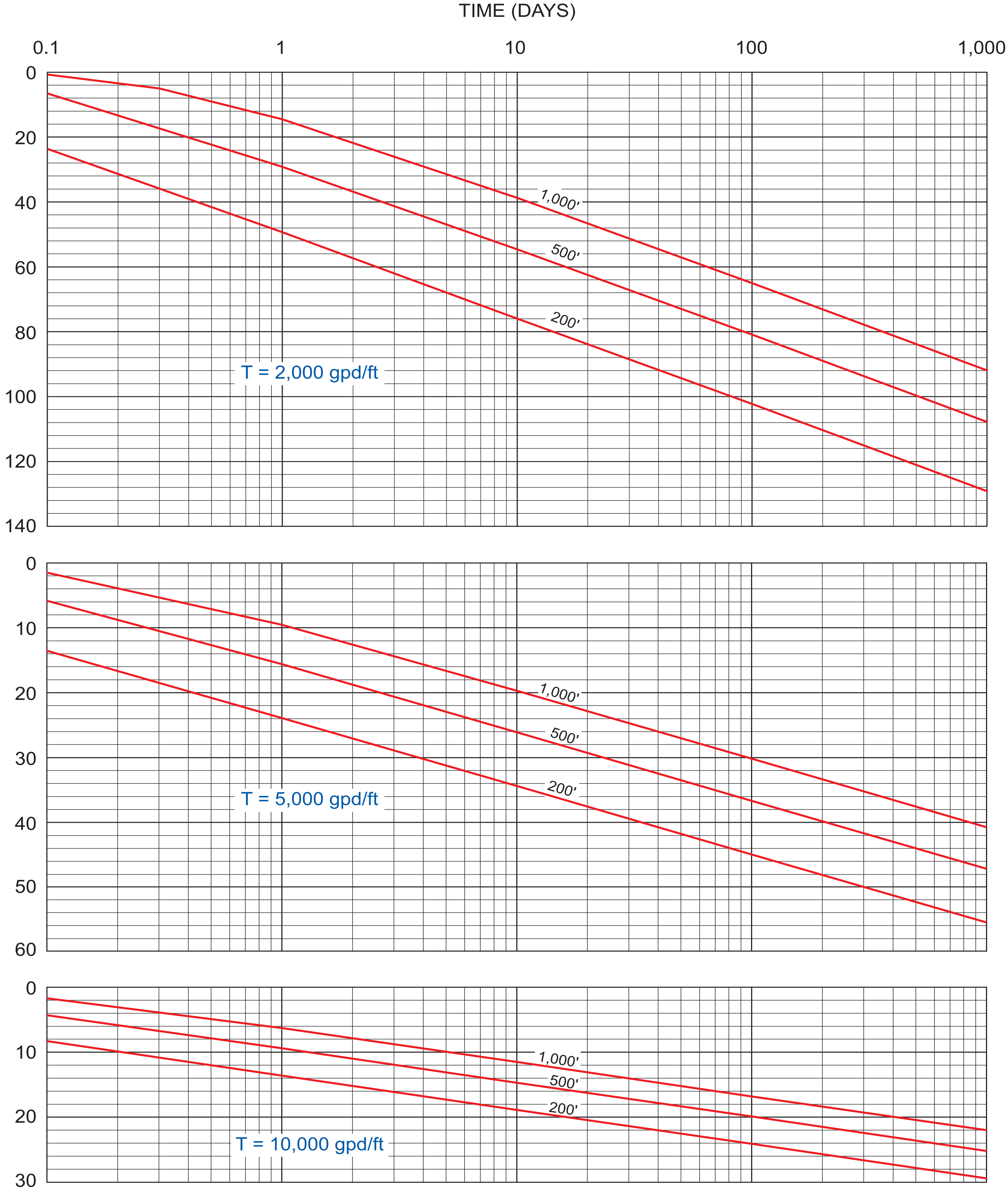


Figure 7. Wells for which pumping-test results are given in Table 3.



ASSUMED CONDITIONS

- Pumping rate: 200 gpm. Transmissivity as indicated. Storage coefficient: 0.0002 (artesian)
- For other pumping rates, the drawdown will vary in direct proportion. For example, doubling the pumping rate will double the drawdown at a given distance and time.
- Transmissivity is given here in gallons per day per foot of aquifer width. To convert to cubic feet per day per foot (ft^2/d), divide by 7.48.

Figure 8A. Predicted pumping effects, at various times and distances, for aquifers in Williamsburg County.

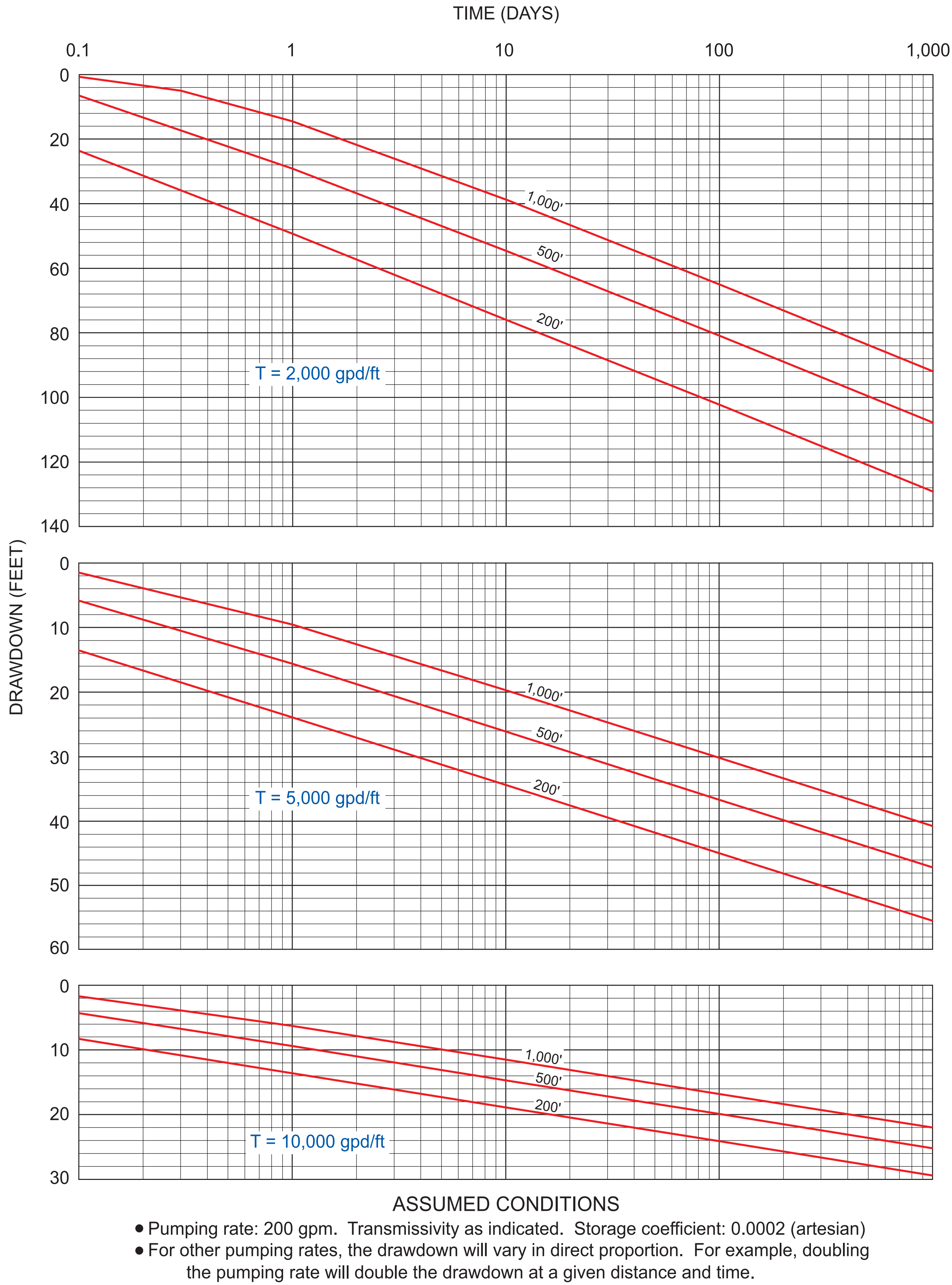


Figure 8B. Predicted pumping effects, at various times and distances, for aquifers in Williamsburg County.

QUALITY OF THE WATER

The chemical quality of ground water in Williamsburg County is generally good. Chemical analyses of water from 30 wells are listed in Table 4. Locations of those wells are shown on Figure 9. The formations represented by the analyses are Black Mingo (2 analyses), Peedee (1), Black Creek (17), and Middendorf (10). Except for the two Black Mingo samples and one from the Black Creek Formation, the water is very soft; the median hardness for Black Creek and Middendorf samples being 6 mg/L (milligrams per liter) and 5 mg/L, respectively. Median dissolved-solids values for all samples are less than 300 mg/L. There have been reports of "cloudy" water from some wells. This has been identified as a colloidal suspension of aragonite, as reported by Johnson (1978, p. 40). Only three of the samples in Table 4 had iron concentrations greater than the 0.3-mg/L recommended maximum.

WATER LEVELS

Potentiometric-contour maps of the Black Creek and Middendorf Formations in the South Carolina Coastal Plain were produced by Hockensmith (2003 and 2008) and reflect water levels in November 2001 and November 2004, respectively. Figure 10 of this report shows the Williamsburg County portion of Hockensmith's latest maps and permits a comparison of the two chief aquifer-bearing formations in this county. It can be quickly seen that in the western part of the county there is little difference in the Black Creek and Middendorf water levels. In the east, cones of water-level depression exist in the Black Creek Formation at Andrews and in the Middendorf Formation at Hemingway. The cone at Andrews is much the more developed, but it has recovered about 15 ft in the 3-year period 2001-04. The cone in the Middendorf at Hemingway is much less developed and was little changed from 2001 to 2004.

SUMMARY AND CONCLUSIONS

Williamsburg County is underlain by sand-and-clay formations of Cretaceous age that are the principal sources of water for the wells that supply the communities, industries, and agriculture of the county. Many rural residential supplies are obtained from shallower aquifers of Paleocene, Eocene, and Pleistocene ages. The unconsolidated formations extend to depths of 1,000 to 2,000 ft below sea level in Williamsburg County (Fig. 4) and are underlain by Paleozoic bedrock –similar to that at the surface in the Piedmont of South Carolina. Potable water can be obtained as deep as 800 to 1,500 ft below sea level (Fig. 5).

Substantial aquifers are available throughout Williamsburg County. They are variable in thickness and extent and are best identified from geophysical logs and drilling samples. Table 2 contains numerous examples of freshwater-sand intervals indicated on electrical logs.

Many large-yield wells have been constructed in the county. Figure 3 shows the locations of all wells for which DNR has records of 200-gpm or greater yields. The largest reported yield is 1,900 gpm. Most of the large wells that are drilled are for crop irrigation and have yields of 200 to 400 gpm.

Controlled-pumping tests have indicated widely varying aquifer-transmissivity values, which are dictated by a combination of aquifer thickness and hydraulic conductivity (permeability). The transmissivity, in turn, limits the specific capacity of a well (gpm per foot of water-level drawdown). Specific capacity is also limited by the well efficiency. A 50-percent-efficient well, for example, will require twice the drawdown of a 100-percent efficient well to produce the same yield. This increases the cost of pumping. Table 3 shows the variation in transmissivity, specific capacity, and well efficiency in wells for which pumping tests are available. The hydraulic values determined by pumping tests can be used in predicting pumping effects for various times and distances, as illustrated in Figure 8.

The chemical quality of well water in Williamsburg County is generally good. Hardness and iron content are low. Dissolved-solids concentrations of 32 samples average 280 mg/L, well below the 500 mg/L recommended maximum level but higher than the average levels in Clarendon County to the west and Florence County to the north. This may be at least partly due to the considerably greater average depth of the sampled wells in Williamsburg County. Georgetown County, on the east, had higher dissolved solids than Williamsburg County for wells of comparable depth. Cloudiness of the water has been reported in some wells and has varied with time in its persistence. It was identified before 1978 (year of Johnson's report) as being "a colloidal suspension of aragonite (CaCO3)." See Johnson (1978, p. 40) for a more in-depth discussion.

Artesian water levels for the major aquifer systems have been affected by pumping over the years. Serious drawdown effects are exhibited on potentiometric maps in the vicinities of Andrews and Hemingway (see Fig. 10). The water levels may be restored by reducing pumpage, repositioning of wells, or resorting to artificial recharge from surface-water sources as in Horry County in the northeast.

Table 4. Chemical analysis of water from wells in Williamsburg County (constituents and hardness are in milligrams per liter)

County well no.	S.C. grid no.	Location	Date	Depth (ft) /formation	Silica	Iron	Man-ganese	Calcium	Magne-sium	Sodium	Potas-sium	Bicar-bonate	Sulfate	Chloride	Fluoride	Nitrate	Dissolved solids	Hard-ness	pH	Analyst
2	12R-v2	Hemingway	3/1959	456/BC	14	0.25	0.01	8.4	3.6	162	12	393	23	31	1.0	0.5	470	36	8.6	U
5	16S-n8	Hemingway	1/1955	550/BC	24	.13	-	2.1	.2	79	2.6	173	7.5	3.0	2.2	.9	216	6	8.5	U
11	16S-y1	Hemingway, Well 5	1/1955	530/BC	34	.12	.00	1.6	.2	77	3.0	168	8.3	3.5	1.5	.00	210	5	8.8	U
14	18V-a1	Lane	4/1969	660/BC	13	.18	-	1.5	.3	91	3.2	219	7.2	3.3	2.2	.2	231	5	8.5	U
18	12R-v1	Hemingway	6/1984	550/BC	13	.10	.00	.9	.4	135	1.6	368	6.1	48	1.8	.01	391	4	8.6	WRC
25	16S-g1	Kingstree	8/1960	670/M	21	.48	.00	3.4	.4	72	2.8	160	9.5	15	1.8	.00	212	11	8.4	U
31	16V-f1	Lane, 5 mi SE	5/1969	972/M	15	.18	-	1	.1	75	1.5	173	11	5.2	.8	.1	202	3	9.1	U
32	13S-i1	Stuckey, Well 1	6/1984	286/BC	18	.01	.00	3	1.2	99	9.2	324	5.6	10	2.2	.00	328	13	8.5	WRC
33	17U-r1	Lane, Well 1	6/1984	641/BC	16	.00	.04	.8	.3	87	3.7	214	7.9	2.2	2.0	.00	208	12	9.1	WRC
34	17S-t1	Kingstree, Well 3	6/1984	716/BC	22	.00	.06	1.2	.2	67	3.1	173	7.0	3.2	1.4	.00	192	5	9.0	WRC
37	12S-c1	Hemingway, Well 1	6/1984	891/BC	15	.00	.01	.6	.5	135	1.6	370	5.6	29	1.8	-	374	4	8.6	WRC
52	16T-y1	Salters, 2 mi E	5/1969	450/BC	17	.09	-	30	4.5	32	5.4	184	9.4	6.5	.4	.4	176	92	7.9	U
54	11S-h2	Outland	2/1969	325/BC	26	.06	.01	1.5	.4	150	8.3	380	7.2	10	2.3	.1	400	5	8.3	U
66	16S-d2	Kingstree	1/1970	750/M	15	4.6	-	2.3	.3	60	2.9	158	6.8	3.9	.9	.6	180	6	8.5	U
73	13V-g1	Andrews	4/1977	768/BC	16	.13	.00	5.3	.4	160	5.1	400	9.4	14	1.7	-	422	15	8.5	U
75	16T-e2	Kingstree, Well 1	6/1984	670/BC	25	.00	.05	1.2	.4	90	5.4	227	5.2	4.8	1.4	.00	247	7	8.8	WRC
115	19U-k1	Greeleyville, 3 mi SSW	4/1980	119/BM	10	.02	.01	3.8	1.6	3.0	1.5	-	13	5.5	.13	-	121	101	8.0	WRC
118	17S-u1	Kingstree, Well 2	6/1984	953/M	25	.00	.06	1.7	.57	75	3.4	216	30	48	1.4	.00	293	8	8.0	WRC
119	14W-p1	Andrews, 9 mi SW	10/1981	90/BM	-	.5	.05	-	-	-	-	106	-	5	-	-	130	84	7.3	DHEC
124	13S-f1	Stuckey, 4 mi W	7/1981	260/PD	-	.29	<.01	8.8	.92	113	8.8	141	7.5	4.0	1.8	.2	240	26	7.9	Com
174	16T-f1	Kingstree, 2 mi SSW	12/1983	650/BC	38	<.01	<.01	.9	.23	99	6.2	242	11	3.4	1.3	.00	280	13	9.1	WRC
176	12S-h1	Hemingway, Well 2	5/1986	914/M	-	<.1	<.1	1.4	.38	216	1.9	325	9.2	33	1.8	<1.0	435	5	8.0	Com
177	17U-q1	Lane, Well 2	10/1990	694/BC	-	<.05	.05	2.2	.3	60	3	126	10	<5	1.9	<.1	140	7	8.2	Com
189	18U-e3	Greeleyville	6/1984	650/BC	15	.00	.05	.9	.25	72	3.8	176	7	1.7	1.3	.00	191	4	9.1	WRC
192	13V-o2	Andrews, Well 5	1/1975	792/BC	16	.01	.00	2	.00	146	146	298	1	12	1.6	-	328	5	8.8	Com
203	16S-n6	Kingstree, 3 mi N, Well 6	12/1994	1,072/M	-	.05	.05	1.9	.3	70	20	188	<5	26	1.4	<.1	190	6	7.7	Com
211	13S-x1	Williamsburg Co. W&S Well 1 Stucky, 4 mi SW	8/2002	1,005/M	-	.05	-	1.2	.2	149	-	311	7.2	24	1.6	-	390	4	8.5	Com
212	13T-a5	Williamsburg Co. W&S Well 2 Stucky, 5 mi S	9/2002	1,025/M	-	.06	<.01	<1	.2	165	-	494	2.5	24	2.4	<.5	440	<2.5	8.5	Com
207	18U-b1	South Williamsburg Co. Water System Greeleyville, 3 mi E	12/2001	1,129/M	-	.04	<.01	1.5	-	-	-	269	12	30	1.8	<.02	352	-	7.5	Com
213	12R-s1	Hemingway, 1.5 mi N	4/2003	886/M	-	.16	<.01	1.3	-	189	1.7	323	7	36	1.5	<.5	403	3	-	Com

Formation: BM, Black Mingo; PD, Peedee; BC, Black Creek; M, Middendorf

Analyst: U, U.S. Geological Survey; WRC, South Carolina Water Resources Commission; DHEC, South Carolina Department of Health and Environmental Control; Com, Commercial

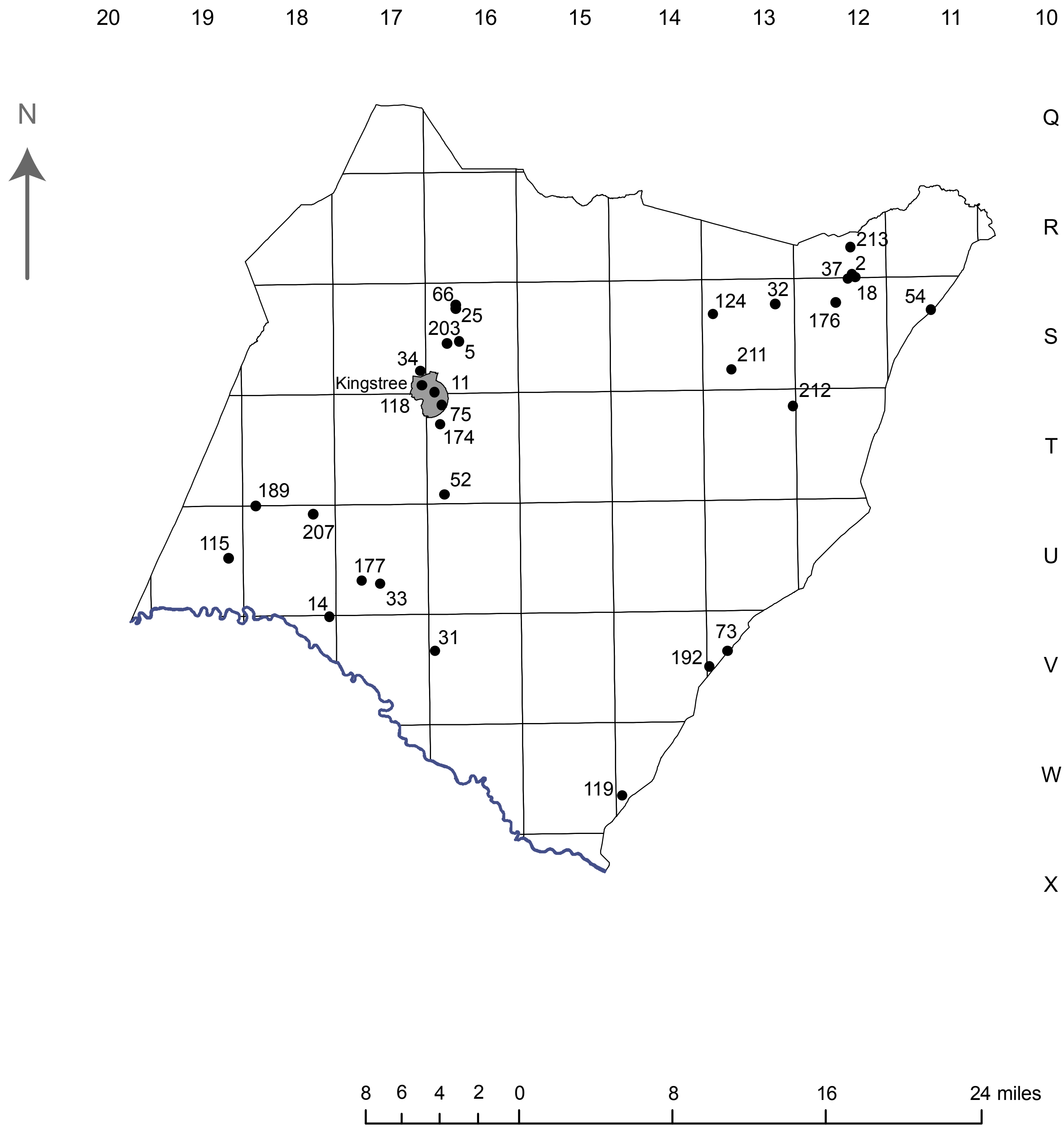


Figure 9. Wells for which chemical analyses are given in Table 4.

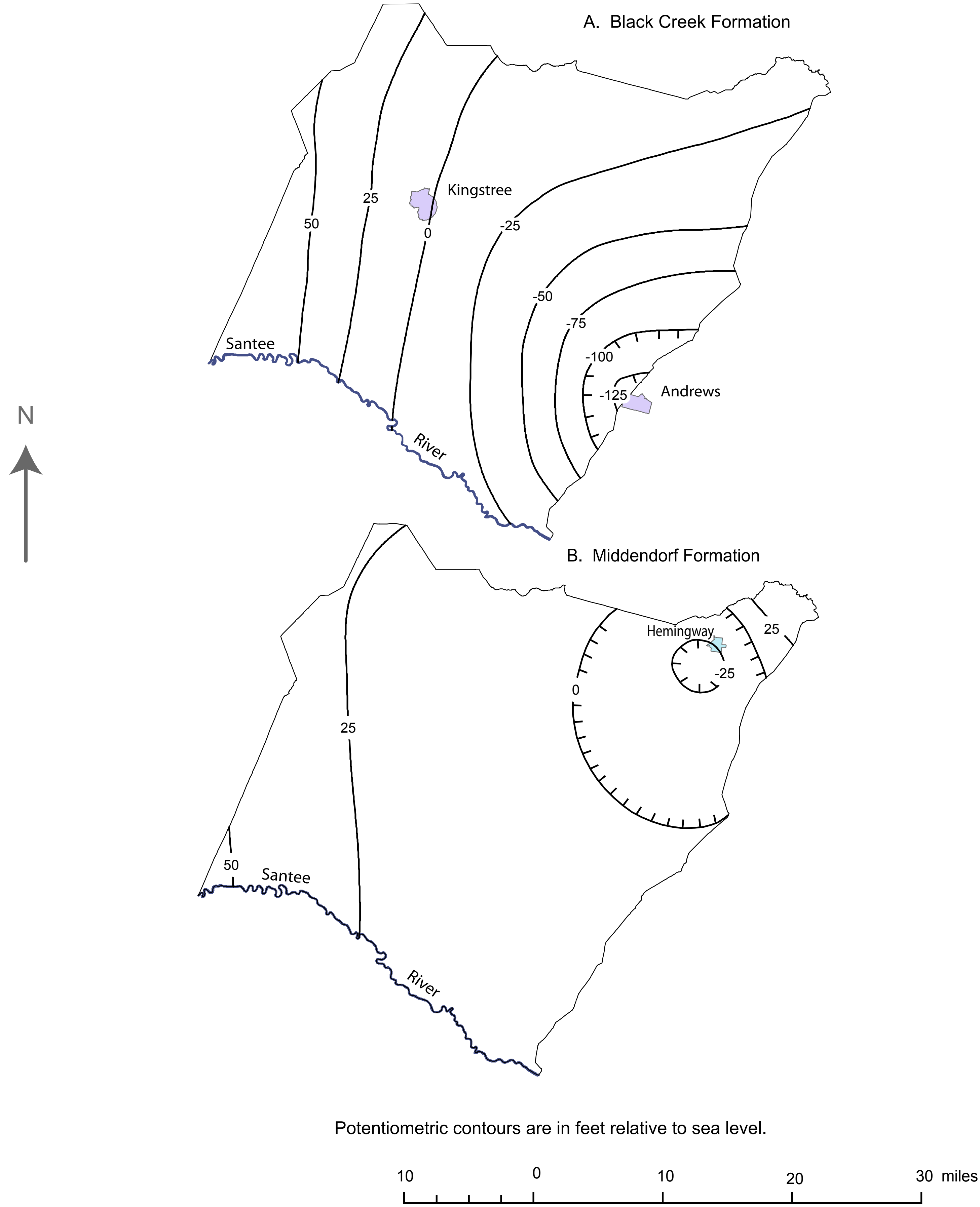


Figure 10. 2004 Potentiometric maps of the major water-producing formations of Williamsburg County (from Hockensmith, 2008 a, b).

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