POTENTIOMETRIC SURFACE OF THE MIDDENDORF AQUIFER IN SOUTH CAROLINA

NOVEMBER 2004

STATE OF SOUTH CAROLINA
DEPARTMENT OF
NATURAL RESOURCES

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

South Carolina Department of Natural Resources

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ABSTRACT

The potentiometric surface of the Middendorf aquifer for October and November 2004 shows that the generally southeastward ground-water flow is affected by several potentiometric lows. These cones of depression have developed because of ground-water pumping in the Florence-Hemingway area and around Bishopville, Sumter, Mount Pleasant, and Kiawah Island.

Comparing the November 2004 data with historical data shows that water levels near the outcrop areas of this aquifer have not changed significantly. In areas influenced by pumping, water levels have declined as much as 300 feet during various periods of record. The cone of depression at Florence has recovered approximately 66 feet since surface water began augmenting public supplies.

INTRODUCTION

The Middendorf aquifer is the source of water for many public, industrial, and agricultural supplies in the Coastal Plain of South Carolina. This important water resource is monitored by regularly measuring the nonpumping water levels in wells. The potentiometric surface of an aquifer is defined by the elevations at which water stands in tightly cased wells completed in the aquifer. This potentiometric-surface map was prepared by the Land, Water and Conservation Division of the South Carolina Department of Natural Resources (DNR), using data collected during late 2004. Trends in ground-water levels for selected wells are shown by hydrographs.

METHOD OF INVESTIGATION

The boundaries of the Middendorf 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 well logs), water-level data, water-chemistry data, and previous investigations. They acknowledged that the complex deposition of sediments in the Coastal Plain makes aquifer delineation problematic. This aquifer has been studied extensively by Cooke (1936), Siple (1957), Colquhoun and others (1983), Renken (1984), Aucott and Speiran (1985a and 1985b), Stringfield and Campbell (1993), Aucott (1988 and 1996), Aadland and others (1995), Hockensmith and Waters (1998), and Hockensmith (2003).

The potentiometric map presented here was constructed by using water levels measured in 132 wells in October and November 2004 (see table). Water-level measurements made during that period are likely to be representative of median aquifer conditions, whereas in other periods, such as late winter or mid-summer, measurements represent maximum and minimum levels, respectively. Data were collected by DNR, U.S. Department of Energy, South Carolina Department of Health and Environmental Control, and U.S. Geological Survey, Office of Ground Water, Ground-water Resources (USGS) personnel. Wells measured by previous investigators were used, where possible, to compare 2004 data with historical potentiometric maps.

The hydrographs were constructed from measurements by DNR and USGS. Where continuous records were available, daily mean water levels were plotted.

GEOHYDROLOGIC FRAMEWORK

The Coastal Plain formations of South Carolina compose a wedge of sediment that thickens from about 0 ft (feet) at the Fall Line to more than 4,000 ft at Hilton Head Island. The sediment consists 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 rock.

The Middendorf Formation is between the Black Creek Formation and the Cape Fear Formation, the latter being the oldest of the Cretaceous formations in the region. The Middendorf aquifer is composed mostly of permeable sediments of the Middendorf Formation (hence its name), but locally it includes sediment from underlying or overlying formations. In the updip areas, the aquifer is composed of sand interbedded with clay lenses deposited in an upper delta plain environment. Toward the coast, the aquifer is composed of thin- to thick-bedded sand and clay that were deposited in marginal marine or lower delta plain environments. In general, the Middendorf aquifer has coarser sand and less clay in the western part of the Coastal Plain than in the eastern part.

The Middendorf crops out along the Fall Line from Chesterfield County to Edgefield County, except for some areas in Aiken County where it not exposed. Its outcrop is narrowest in southwestern Edgefield County and widest in Chesterfield County. The aquifer dips southeastward near the Fall Line and southward along the coast. The top of the aquifer is at elevation 100, -700, and -1,700 ft msl (feet, referenced to mean sea level) at Aiken, Little River, and

Table showing water-level elevations during November 2004 in wells completed in the Middendorf aquifer in South Carolina

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 2001 to 2004, in feet
AIK-430	39X-e1	331940	814435	197	1
AIK-643	38W-n1	332240	813820	215	0
AIK-817	40V-s2	332615	814612	233	-2
AIK-818	40V-s3	332615	814612	235	-1
AIK-826	36U-o1	333232	812908	270	-1
AIK-831	39U-y2	333036	814421	287	
AIK-845	36U-o2	333235	812908	270	0
AIK-864	39X-k25	331729	814029	176	1
AIK-865	39X-n62	331712	814320	171	8
AIK-866	39N-w2	332016	814231	199	0
AIK-871	38W-n3	332238	813827	219	-1
AIK-878	39X-k26	331729	814029	175	0
AIK-892	39W-w3	332015	814231	194	5
AIK-902	40W-q1	332110	814835	166	0
AIK-2380	40W-q4	332112	814833	166	0
AIK-2450	39U-r6	333129	814232	310	
ALL-347	35AA-q2	330129	812304	186	-7
ALL-348	35AA-q3	330129	812306	199	
ALL-358	37Z-t3	330647	813023	184	-6
ALL-370	37Z-x11	330648	813020	184	
ALL-377	35AA-q10	330129	812304	186	
BAM-83	31X-m12	331718	810235	175	2
BFT-10	27JJ-c1	321947	804228	145	-1
BFT-11	27II-s2	322109	804125	129	-4
BRK-245	18W-b1	332424	795602	29	-2
BRK-431	19Y-w3	331020	800219	9	
BRK-444	18AA-e4	330424	795935	-19	-16
BRN-243	37Y-o1	331209	813441	181	0
BRN-246	38Y-m1	331246	813727	177	0
BRN-303	38Y-b1	331445	813657	180	0
BRN-312	37W-u1	332041	813001	213	0
BRN-314	37Y-t1	331128	813048	185	-1
BRN-316	39Y-u1	331057	814043	167	0
BRN-327	37Y-o4	331209	813441	180	
BRN-330	33Y-m3	331249	813728	177	0
BRN-335	38Z-i3	330842	813628	179	0
BRN-349	34Y-x1	331042	811852	189	-2
BRN-356	34Y-x8	331044	811852	190	-2
BRN-366	35X-e6	331914	812428	209	-1

Table showing water-level elevations during November 2004 in wells completed in the Middendorf aquifer in South Carolina (continued)

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 2001 to 2004, in feet
BRN-370	38X-n56	331709	813806	181	1
BRN-379	38Y-o12	331239	813927	173	0
BRN-382	37W-u3	332041	813001	214	1
BRN-383	37X-t3	331128	813048	186	0
BRN-384	39Y-u3	331057	814043	167	1
BRN-385	37Y-f0	331347	813431	182	0
BRN-391	39X-u10	331511	814021	172	0
BRN-417	37Y-f8	331347	813431	182	
BRN-423	38Y-o10	331239	813927	172	0
BRN-430	38X-n58	331709	813806	180	1
BRN-438	39X-u9	331510	814021	173	1
BRN-932	35W-e4	332411	812451	262	37
BRW-1865	2Q-j6	335330	783523	64	-1
CAL-27	30R-j2	334836	805453	113	3
CHN-2	18CC-r1	325121	795741	-63	-20
CHN-14	18DD-k3	324730	795553	-87	-14
CHN-163	17DD-m5	324717	795218	-170	
CHN-172	19CC-x1	325048	800353	-20	-15
CHN-173	16CC-y1	325043	794937	-129	
CHN-174	20GG-e1	323451	800937	-69	-32
CHN-178	18DD-l3	324703	795635	-64	-17
CHN-186	20FF-v1	323602	800623	-112	-17
CHN-187	16DD-m2	324713	794718	9	-14
CHN-601	17DD-u7	324534	795056	-78	-6
CHN-603	16DD-q2	324637	794835	-14	-17
CHN-604	16DD-j1	324812	794517	-52	27
CHN-635	16DD-y3	324553	795000	-8	-13
CHN-814	20FF-q1	323610	800837	-32	-10
CHN-849	17DD-n1	324730	795354	-142	
CLA-3	21S-r2	334149	801218	83	-3
CLA-20	21S-m1	334159	801249	90	2
CLA-25	23T-v1	333542	802116	96	96
COL-50	26CC-d2	325443	803852	95	-8
CTF-44	19I-i1	343348	800151	166	
CTF-46	17H-m1	343711	795244	117	
CTF-81	17H-f1	343835	795441	104	
CTF-82	17I-o1	343214	795429	150	
DAR-82	20K-s3	342113	800701	185	1
DAR-87	19M-y1	341012	800406	151	2

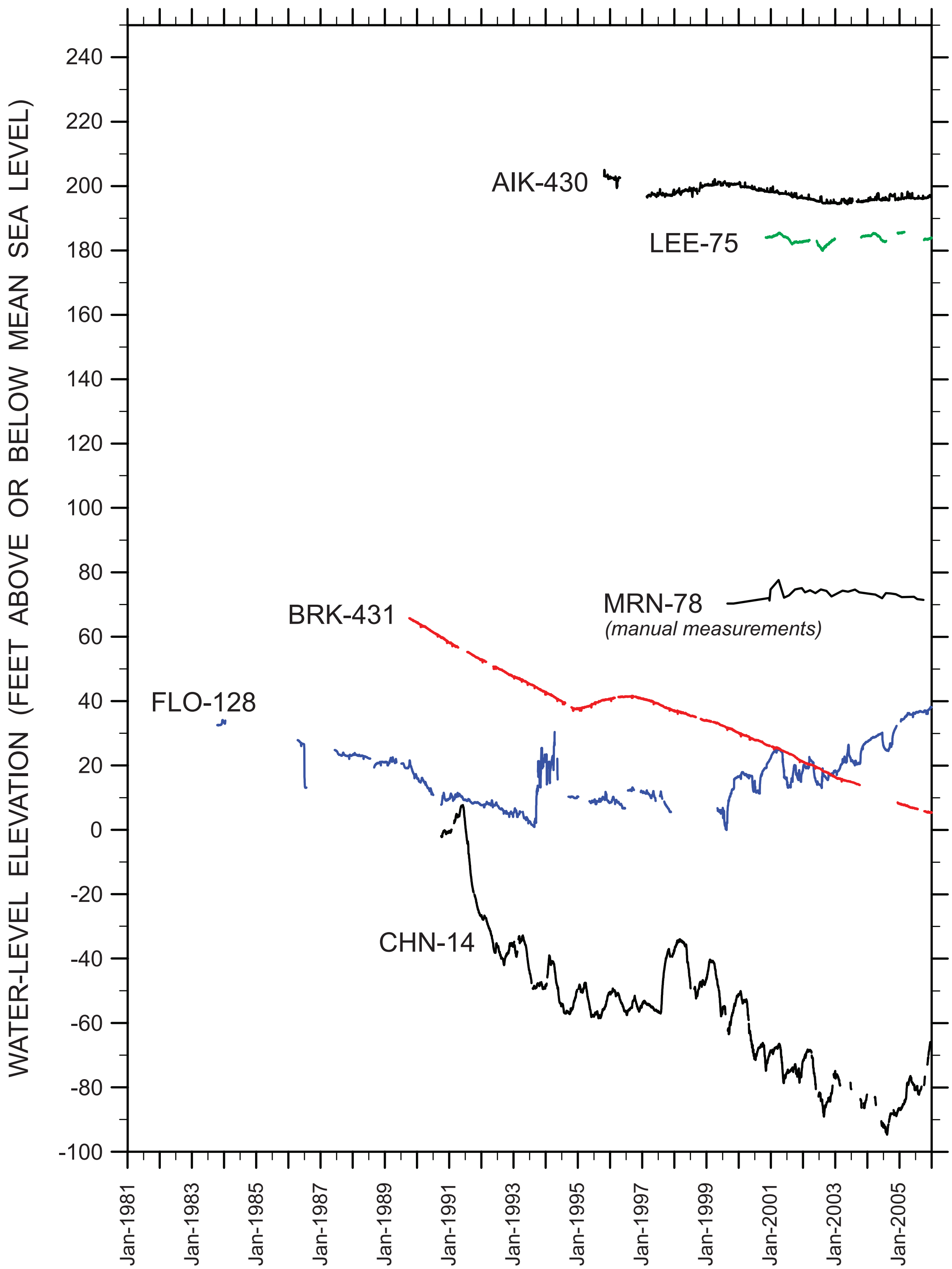
Table showing water-level elevations during November 2004 in wells completed in the Middendorf aquifer in South Carolina (continued)

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 2001 to 2004, in feet
DAR-226	21K-l1	342204	801121	208	-3
DAR-228	17J-m1	342732	795248	135	4
DAR-231	19K-e1	342455	800455	190	-1
DIL-121	10L-c1	341943	791702	43	-5
DIL-132	10J-g2	342857	791854	87	
DOR-88	21BB-m3	325739	801207	14	-14
DOR-211	25Z-b1	330925	803118	149	
DOR-228	21BB-d1	325742	801207	13	-15
FLO-128	13M-p3	341144	793450	31	15
FLO-146	16M-w1	341011	794718	-24	38
FLO-147	13P-d1	335934	793328	10	
FLO-153	18N-i2	340813	795619	86	-3
FLO-209	16M-h2	341310	794318	-17	66
FLO-274	16Q-s1	335120	794559	10	-3
JAS-426	30FF-o2	323705	805944	135	-5
KER-82	22J-y7	342511	801930	206	1
KER-87	24K-p1	342107	802918	224	3
KER-113	24K-q2	342112	802850	215	
KER-148	23K-i1	342349	802119	229	
LEE-23	21M-b1	341405	801103	193	4
LEE-60	21N-q1	340636	801334	171	2
LEE-74	21K-v1	342045	801136	215	11
LEE-75	21M-k1	341406	801104	185	2
LEE-79	22M-l1	341240	801625	110	
LEX-806	35S-b1	334410	812108	273	
LEX-838	35Q-o3	335205	812426	455	
LEX-844	32S-b4	334446	810627	292	-1
MLB-27	13I-h1	343348	793207	112	1
MLB-31	13G-w1	344008	793236	156	3
MLB-39	14I-y2	343024	793926	90	2
MLB-110	15J-d2	342935	794310	64	5
MLB-112	15H-l2	343715	794115	130	3
MLB-131	14G-l1	324212	793626	196	4
MRN-68	13M-a1	341447	793001	22	-1
MRN-69	12L-y1	341506	792950	29	2
MRN-78	10Q-p2	335143	791950	73	-2
ORG-79	29V-v1	332445	805053	159	-3
ORG-374	32T-j1	333835	810537	204	
ORG-383	31W-l5	332205	810152	170	-14

Table showing water-level elevations during November 2004 in wells completed in the Middendorf aquifer in South Carolina (continued)

Well number	Grid number	Latitude, in degrees, minutes, and seconds *	Longitude, in degrees, minutes, and seconds *	Water level elevation above or below (-) mean sea level, in feet *	Change in water level from 2001 to 2004, in feet
ORG-389	31W-s4	332145	810159	162	-9
RIC-293	29Q-n1	325249	805342	113	2
RIC-305	28O-y2	340030	804939	247	
RIC-543	27Q-m1	335230	804209	137	1
RIC-585	29P-t4	335656	805027	199	2
SUM-69	23P-t1	335611	802047	115	13
SUM-119	22P-y2	335504	801917	88	-8
SUM-132	22P-y1	335506	801924	75	-6
SUM-133	23Q-r6	335152	802247	103	
SUM-153	23Q-r1	335154	802236	73	-8
SUM-161	22Q-e2	335458	801927	78	-10
SUM-230	24S-d2	334417	802811	109	
SUM-296	25S-l1	334238	803156	82	-13
WIL-176	12S-h1	334353	792744	-28	-4
Other Wells:					
Middendorf/Black Creek aquifers					
MRN-9	11M-p2	340957	792430	-23	
Middendorf/Cape Fear aquifers					
BFT-454	27KK-d1	321455	804353	151	-12
BFT-2055	27KK-r14	321129	804214	149	-13
HOR-973	5S-fl	334317	785410	107	
Cape Fear aquifer					
BFT-2380	28LL-j7	320848	804543	56	
BRW-1878	2Q-j2	335335	783520	103	-1

* Latitude and longitude locations for wells are generally estimated from topographic maps, unless surveyed or located by global positioning system.



Hydrographs of selected wells

Charleston, respectively. Thickness ranges from 0 ft at the Fall Line to more than 300 ft in Dorchester County.

GROUND-WATER FLOW

The potentiometric surface of the Middendorf aquifer slopes irregularly toward the coast, thus the direction of ground-water flow is generally southeastward. In areas where the aquifer crops out it is recharged directly by rainfall. In the upper Coastal Plain, stream valleys are incised into the aquifer; where contours are deflected upstream near the Great Pee Dee, Congaree, Wateree, and Savannah Rivers, the aquifer discharges to those rivers. In the lower Coastal Plain the aquifer discharges only into overlying aquifers and through pumping wells.

Dimpling this surface are cones of depression caused by pumping. The potentiometric surface has been most affected by pumping in Berkeley, Charleston, Colleton, Florence, Lee, Sumter, and Williamsburg Counties. The lowest point on the potentiometric surface, -170 ft msl, is at Mount Pleasant.

HISTORICAL TRENDS

The potentiometric levels of the Middendorf aquifer have been recorded since 1917 or earlier (Cooke, 1936). Aucott and Speiran (1985a and b) compared estimates of the predevelopment surface with November 1982 water levels and determined that Middendorf aquifer water levels had declined throughout the northeastern two thirds of the Coastal Plain. Stringfield and Campbell (1993) published November 1989 water levels and observed that levels in Berkeley, Charleston, Dorchester, Kershaw, and Williamsburg Counties had further declined since 1982. Hockensmith and Waters (1998), using November 1996 data, showed additional declines and a generally southeastward ground-water flow influenced by large cones of depression in the Florence-Hemingway area and around Mount Pleasant. Historical water-level trends in six Middendorf aquifer wells are shown on the hydrographs. Hockensmith (2003) noted that by 2001, the cones of depression in Florence and Charleston Counties had expanded and deepened.

The worst multiyear drought on record, from June 1998 through August 2002, caused significant effects on hydrologic conditions in South Carolina. Historical low flows were recorded in 2001 for numerous regulated and unregulated streams (Kiuchi, 2004). Many of the large lakes, originally built for hydroelectric power or flood control, were at their lowest levels near the end of the drought: some were substantially below desired operating levels (Gellici and Badr, 2004). Water levels in selected Coastal Plain wells averaged declines of 8.7 ft (Gellici and Harwell, 2004) as a direct result of this meteorological event or, indirectly, because of increased ground-water pumping in response to the rainfall and surface-water deficit.

The region most affected by ground-water pumping is centered at Mount Pleasant, in Charleston County, where the cone of depression has expanded and deepened since 2001. The potentiometric surface declined to -129 and -170 ft msl, in CHN-173 and CHN-163. Predevelopment levels were estimated near 130 ft msl (Aucott, 1988); therefore, a decline of about 300 ft has occurred in this area. Ground-water withdrawals by Mount Pleasant Waterworks (MPW) increased from an average of 6.2 mgd (million gallons per day) in 2001 (Greg Hill, MPW, written communication, 2002) to 7.8 mgd in 2005 (Newcome, 2005). Beginning in 2004, MPW began supplementing its water supply with surface water from the Charleston Water System: about 2 and 4 mgd were purchased in 2004 and 2005 (Jim Ouellet, MPW, oral communication).

Water levels in CHN-14 (see hydrograph) showed a decline of more than 93 ft between June 1991 and August 2004, to a low of -95 ft msl in August 2004, and -87 ft msl in November 2004. Other wells in the cone of depression also show water-level declines since 1996. The hydrograph for BRK-431 shows the effects of pumping from Summerville prior to November 1994, when water levels declined an average of 5.3 ft per year to a minimum of 38 ft msl. From November 1994 through August 1996, water levels recovered at a rate of 2.5 ft per year to a maximum of 42 ft msl. Since August 1996, water levels have declined at a rate of about 4 ft per year to 9 ft msl in November 2004. Water levels in BRK-444, which is closer to the major pumping centers, declined 44 ft between November 1996 and November 2004. In CHN-2, water levels declined 91 ft, to -63 ft msl, between 1989 and 2004.

The cone of depression in southern Charleston County, around Kiawah and Seabrook Islands, has also deepened since 2001. These islands are primarily resort communities for which a large portion of the water is used for golf-course and lawn irrigation. Water use by Kiawah Island Utilities increased from 1.9 to 2.4 mgd between 2000 and 2005, part of which was provided by ground water (Newcome, 2000; and Newcome, 2005). Consequently, water levels in CHN-174 and CHN-186 declined 32 and 17 ft, to -69 and 112 ft msl, respectively, from 2001 to 2004. The cone of depression may be deeper than apparent from the 2004 data because the well that indicated a -119 ft msl water level in 2001 was not measured in 2004. Predevelopment water levels for CHN-174 were at least 148 ft msl, thus indicating total declines of 217 to 260 ft.

Ground-water pumpage continued to increase in Berkeley, Charleston, and Dorchester Counties despite several water utilities switching to, or supplementing with, surface water during the mid-1990's. Total pumpage from aquifers in Charleston County increased from 9.10 mgd in 2001 to 10.43 mgd in 2004. Pumpage for public-supply and golf-course irrigation increased by 0.73 and 0.70 mgd, in that order, during this period. Total ground-water pumpage in Berkeley and Dorchester Counties increased from 2.38 to 3.58 mgd and from 2.70 to 4.25 mgd, respectively, with most of that by industry (Bristol, 2001; and Childress and Bristol, 2005); however, the quantity withdrawn from the Middendorf aquifer is not known.

Water levels in northern Berkeley County also have declined. Water levels in BRK-245, in St. Stephen, were 80, 31, and 29 ft msl in 1996, 2001, and 2004, in that order. Water levels were influenced by pumping for public and industrial supplies in the St. Stephen area, in addition to the regional pumping effects.

The cone of depression in northern Florence County, first mapped in 1989 (Aucott and Speiran, 1985b), recovered significantly in 2004. Water levels rose 66 ft in FLO-209, from -84 ft msl in 2001 to -17 ft msl in 2004. In FLO-146, water levels rose 38 ft from -62 ft msl in 2001 to -24 ft msl in 2004. The recovery is a result of supplementing Florence's water supply, an average of 13 mgd in 2005 (Newcome, 2005) from 29 Cretaceous wells exclusively, by about 40 percent with surface water from the Great Pee Dee River beginning March 2004 (Forest Whitington, City of Florence, oral communication, 2007).

Water levels in FLO-128 (see hydrograph) declined from 61 ft msl in 1959 (Aucott and Speiran, 1984) to 0 ft msl in August 1999 and recovered to 31 ft msl by November 2004. This well is subject to interference from nearby industrial pumpage.

Middendorf water levels in northern Marion County declined from predevelopment levels between 50 and 75 ft msl (Aucott and Speiran, 1985a) to less than 30 ft msl in MRN-68 and MRN-69 in 2004. The Marco Rural Water Company and the city of Marion pump water from both the Black Creek and Middendorf aquifers, and combined pumpage by the utilities averaged 3.5 and 2.9 mgd in 2000 and 2005, respectively (Newcome, 2000 and 2005). Water levels in MRN-9, a well screened in both aquifers, were -22 ft msl and had recovered 3 ft from 2001. Contours of the Middendorf are drawn to reflect the estimated effects of pumping; however, the pumping effects are thought to be greater in the overlying Black Creek aquifer. Water levels in southern Marion County (MRN-78) declined 2 ft since 2001.

The water level in WIL-176, in eastern Williamsburg County, declined 20 ft since November 1989, to -28 ft msl. Water levels were 54 ft msl for WIL-37 in 1970 (Aucott and Speiran, 1984), and total water-level decline in this area was about 80 ft by November 2004. Ground-water pumpage for public supply in Williamsburg County, much of which is from the Middendorf aquifer by the town of Hemingway, increased from 1.51 to 1.89 mgd between 2001 and 2004. Countywide, ground-water pumpage increased from 4.15 to 4.43 mgd between 2001 and 2004 (Bristol, 2001; and Childress and Bristol, 2005).

Water-level declines in Sumter County are a result of pumping in and around the city of Sumter. November 2004 data (SUM-69, SUM-119, SUM-132, SUM-153, and SUM -161) indicate that water levels declined between 6 and 13 ft since 2001. Declines as great as 52 ft have occurred since the predevelopment state of about 125 ft msl (Aucott and Speiran, 1985a). Average ground-water pumping in 2005 exceeded 15 million gallons per day for Sumter (the State's largest municipal ground-water user) and nearby High Hills Water District (Newcome, 2005), most of which is from the Middendorf aquifer. Because the median transmissivity of the Middendorf aquifer is about 45,000 gpd/ft (gallons per day per foot) (Newcome, 1993), a shallow cone of depression exists about the city, although it is not apparent from the data distribution.

A cone of depression about Bishopville is indicated by data from LEE-79. The November 2004 water level was 110 ft msl and, when compared to the three nearest wells (LEE-23, LEE-60, and LEE-75), suggests a relative decline of about 61 ft. Bishopville pumps an average of 1.5 mgd from five Middendorf wells (Newcome, 2005), which is 79 percent of the average 1.9 mgd of ground water used in Lee County.

Near the outcrop area, most wells in Calhoun, Chesterfield, Kershaw, Lee, Lexington, Marlboro, and Richland Counties recovered between November 2001 and November 2004. Recoveries were less than 5 ft and are attributed to the end of the drought. Pumping-induced potentiometric patterns are not obvious owing to the widely spaced observation points and are superimposed upon the patterns formed by natural discharge.

Water-level changes in Aiken and Barnwell Counties between 2001 and 2004 were inconsistent, because water levels in this region are sensitive to rainfall and pumping. Changes ranged from -2 to 8 ft. Water levels in AIK-430 (see hydrograph) declined from about 200 ft msl in January 1999 to a minimum water level of 194 ft msl in May 2003 and recovered about 1 foot by late 2004. In southeastern Barnwell County, water levels are affected by ground-water use more than by rainfall variations (Clark and West, 1997) because the Middendorf is well confined in this area (Aadland and others, 1995). Water levels in BRN-349 declined 2 ft since November 2001 and 10 ft since November 1996. Ground-water users in Aiken and Barnwell Counties pumped 18.83 and 2.78 mgd, respectively (Childress and Bristol, 2005), from the Middendorf and overlying aquifers in 2004. The extent to which pumping affects water levels is not discernible from the 2004 data, owing to the high transmissivity of the Middendorf aquifer, the distribution of measurements, and the effect of natural discharge to the Savannah River.

Two Allendale County wells (ALL-347 and ALL-358) show the minimum water levels for the period of record during late January 2003 (Agerton and others, 2007). Water levels in both wells declined more than 6 ft between 2001 and 2004.

Water levels in the Middendorf aquifer at Walterboro declined from 2001 in COL-50. The water level was 103 ft msl in November 1996 and November 2001 but was 95 ft msl in November 2004. Previous investigations noted water levels between 136 and 126 ft msl in 1982 and 1989, correspondingly. Aucott and Speiran (1985a) reported a water level of 150 ft msl in a well north of Walterboro, which suggests a decline of about 55 ft since 1980. Walterboro pumped an average of 1.9 mgd from 14 Cretaceous wells (Black Creek and Middendorf) in 2005. In light of the pumpage and the documented water-level declines, there is presumed to be a cone of depression about Walterboro; however, it is not evident owing to the paucity of data in this region.

Ground-water levels have declined in southern South Carolina. The water level in JAS-426 has declined 5 ft since 2001. Near Beaufort, BFT-10 and BFT-11 had declines of less than 3 ft since 2001. Wells BFT-454 (open to both the Middendorf and Cape Fear aquifers) and BFT-2055 (open only to the Cape Fear) on Hilton Head Island had similar water levels, 151 and 149 ft msl, respectively, in 2004 but had declined about 12 ft since 2001. They are influenced by the pumping from BFT-2155, on southern Hilton Head Island, that began in October 2001 and averaged 1.84 and 2.23 mgd, in 2004 and 2005, respectively (Kelley Ferda, South Island Public Service District, oral communication, 2007). In view of these data, the 150-ft potentiometric contour is drawn near Beaufort. This would indicate that ground-water flow becomes easterly or northeasterly in Jasper and Beaufort Counties.

There is a need for additional observation wells in several areas of the Coastal Plain. In constructing this map, several cones of depression are each defined by only one well (Hemingway and Bishopville) or inferred from historical data and water-use data (Marion). Some counties either had no observation wells (Georgetown, Hampton, and Horry) or only one (Colleton, Jasper, and Williamsburg). The boundaries of the cones of depression between Mount Pleasant and Hemingway are poorly known because of a paucity of observation wells. Lastly, the extent to which North Carolina or Georgia ground-water pumpage influences the aquifer is not known and, in light of pressures to provide sufficient water for all users, obtaining data in these areas should have high priority. Efforts should be intensified among ground-water users and governmental bodies to maintain existing observation wells and seek additional wells.

SUMMARY AND CONCLUSIONS

The potentiometric map for the Middendorf aquifer, constructed by using water-level data from 132 wells measured during late 2004, shows that the generally southeastward ground-water flow is affected by potentiometric lows around Bishopville, Florence, Hemingway, Kiawah Island, Mount Pleasant and Sumter.

Historical data show that water levels are stable near the aquifer's outcrop area and that fluctuations have occurred in areas influenced by pumping. Near the outcrop, wells have recovered since the cessation of a severe drought in 2002. The cone of depression about Mount Pleasant, where water levels have declined as much as 300 ft from the estimated predevelopment level, remains a major feature and has expanded and deepened because of increased pumping for public supplies and industrial uses. Data now indicate that a cone of depression exists about Bishopville. Water-level recoveries between 38 and 66 ft have occurred near Florence since public supplies began supplementing wells with surface-water use.

Potentiometric maps are only as good as the data available to construct them. A greater availability of observation wells, timely measurements, and periodic construction of potentiometric maps will provide improved understanding of the aquifer and subsequently allow better management of this resource.

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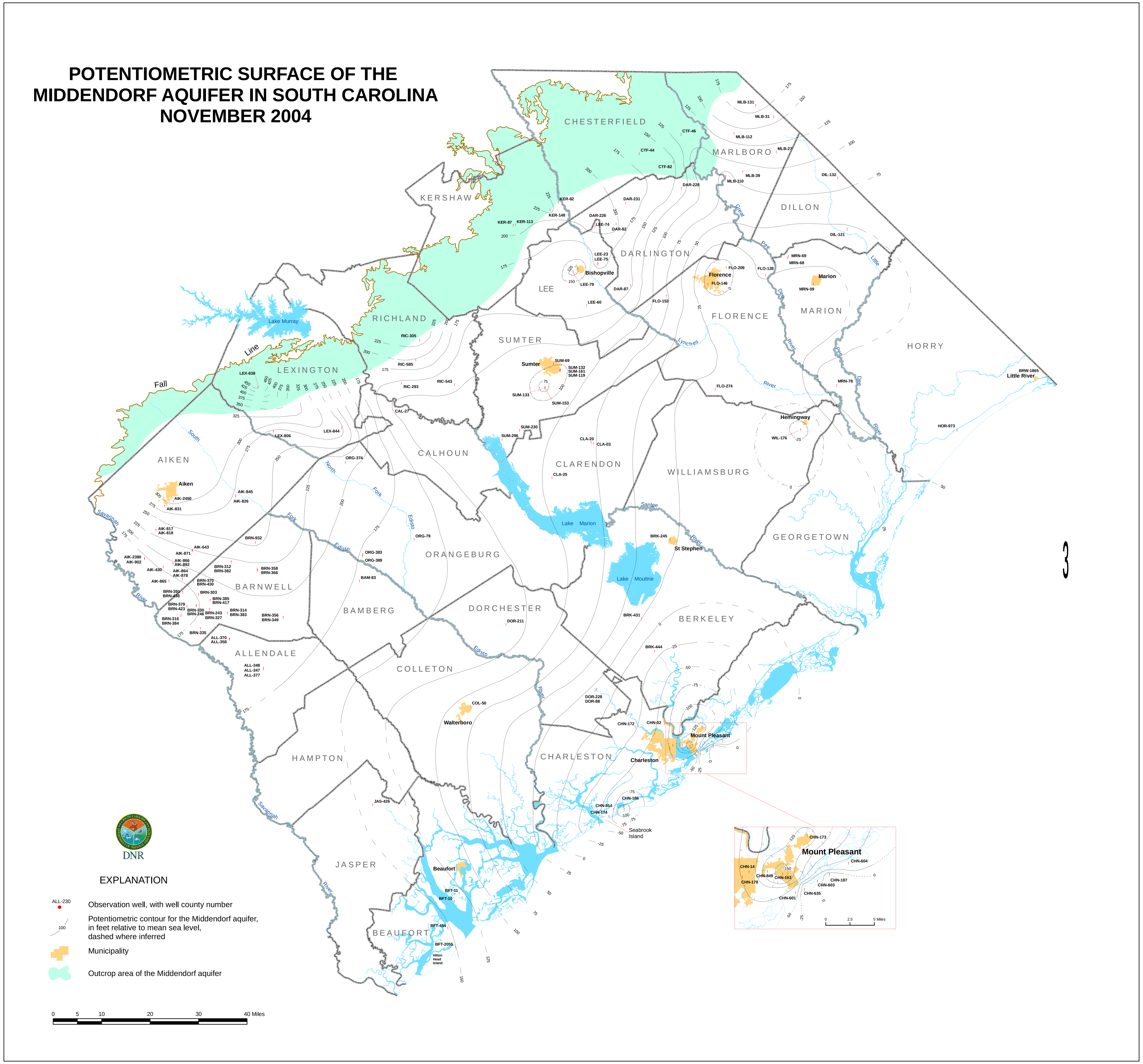
POTENTIOMETRIC SURFACE OF THE
MIDDENDORF AQUIFER IN SOUTH CAROLINA
NOVEMBER 2004
CHESTERFIELD
MARLBORO
KERSHAW
DILLON
DARLINGTON
LEE
FLORENCE
MARION
RICHLAND
SUMTER
HORRY
LEXINGTON
AIKEN
CALHOUN
CLARENDON
WILLIAMSBURG
ORANGEBURG
GEORGETOWN
BARNWELL
BAMBERG
DORCHESTER
BERKELEY
ALLENDALE
COLLETON
CHARLESTON
HAMPTON
JASPER
BEAUFORT
Lake Murray
Lake Marion
Lake Moultrie
Fall
Line
Bishopville
Florence
Marion
Sumter
Aiken
Hemingway
Little River
St Stephen
Walterboro
Mount Pleasant
Charleston
Seabrook Island
Beaufort
Hilton Head Island
DNR
EXPLANATION
Observation well, with well county number
Potentiometric contour for the Middendorf aquifer, in feet relative to mean sea level, dashed where inferred
Municipality
Outcrop area of the Middendorf aquifer
0 5 10 20 30 40 Miles

3