POTENTIOMETRIC SURFACE OF THE BLACK CREEK AQUIFER IN SOUTH CAROLINA NOVEMBER 2001

by
Brenda L. Hockensmith

ABSTRACT

The potentiometric surface of the Black Creek aquifer for November 2001 shows that ground water flows generally to the southeast in most of the Coastal Plain of South Carolina. Flow is locally affected by pumping, as indicated by potentiometric lows at Marion, Andrews, Georgetown, and Pawleys Island.

Comparing the November 2001 data with historical data shows that water levels near the outcrop areas of this aquifer are declining. In areas influenced by pumping, water levels have declined 55 to 204 feet (or even more) since the beginning of ground-water supply development. Water-levels have declined also as a result of the drought conditions that have persisted in South Carolina since 1998.

INTRODUCTION

The Black Creek 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 by regularly measuring the static 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 map of the potentiometric surface of the aquifer was prepared by the Land, Water and Conservation Division of the South Carolina Department of Natural Resources (DNR), using data collected during late 2001. For selected wells (indicated by *), trends in the ground-water levels are shown by hydrographs.

METHOD OF INVESTIGATION

The boundaries of the Black Creek 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), Aucott (1988 and 1996), Stringfield and Campbell (1993), and Hockensmith (1997).

The potentiometric map presented here was constructed by using water level data in 147 wells in November and December 2001 (see table). Water-level measurements made during this period are likely to be representative of median aquifer conditions, whereas other periods, such as late winter and midsummer, would represent maximum and minimum levels, respectively. Data were collected by DNR, the Environmental Protection Department of Westinghouse Savannah River Company, South Carolina Department of Health and Environmental Control (DHEC), and U.S. Geological Survey personnel. Wells used by Aucott and Speiran (1985b), Stringfield and Campbell (1993), and Hockensmith (1997) were used, where possible, to facilitate comparison of this map with the potentiometric maps made in 1982, 1989, and 1995. Data from additional wells also were used.

The hydrographs were constructed using data collected by DNR and U.S. Geological Survey personnel. Where continuous records were available, daily mean water levels were plotted.

HYDROGEOLOGIC FRAMEWORK

The Coastal Plain formations compose a wedge of sediments that thickens from 0 at the Fall Line to more than 4,000 ft (feet) at the coastline. These sediments consist of sand, clay, and limestone of late Cretaceous and younger ages that have been deposited on a pre-Cretaceous basement of metamorphic, igneous, and sedimentary rocks.

The Black Creek aquifer is composed mostly of permeable sediments of the Black Creek Formation (hence its name), which overlies the Middendorf Formation, but locally it may include sediments from underlying or overlying formations. The aquifer comprises thin- to thick-bedded sand and clay that were deposited in marginal-marine or delta-plain environments. The coarsest sand and least clay content are found in the western part of the Coastal Plain.

The aquifer crops out in the eastern Coastal Plain along a narrow band extending from Lexington County to Sumter County, then along a wider area from Sumter County to Dillon County. It dips southeastward toward the coast. The top of the aquifer is at elevations 300, -250, and -1,000 ft msl (referenced to mean sea level) at Aiken, Little River, and Charleston, respectively. Thickness ranges from about 100 ft near Aiken to more than 400 ft at the coast.

GROUND-WATER FLOW SYSTEM

The potentiometric surface of the Black Creek aquifer generally slopes toward the coast, and the direction of ground-water flow is southeastward. Where the aquifer crops out, it is recharged by precipitation. In the upper part of the Coastal Plain, where stream valleys are incised into the aquifer, those streams drain it. The convex curving of contour lines upstream near the Savannah and Congaree Rivers and the North and South Forks of the Edisto River show this. In the lower part of the Coastal Plain, the aquifer discharges into overlying aquifers or through pumping wells.

Dimpling this surface are cones of depression resulting from ground-water withdrawal. The potentiometric surface has been affected by pumping in southern Georgetown and northern Marion Counties. The lowest point on the potentiometric map, with a water level of -167 ft msl, occurs south of Pawleys Island.

HISTORICAL TRENDS

The potentiometric levels of the Black Creek aquifer have been recorded at least since 1917 (Cooke, 1936). Potentiometric maps of the Black Creek aquifer have been published by Aucott and Speiran (1985a and 1985b), Stringfield and Campbell (1993), and Hockensmith (1997). Aucott and Speiran (1985b) compared estimates of the predevelopment surface with November 1982 water levels and determined that Black Creek aquifer water levels had declined in excess of 75 ft in parts of Horry and Georgetown Counties, with smaller declines in Allendale, Florence, Marion, and Williamsburg Counties. Stringfield and Campbell (1993) published November 1989 water levels and observed that levels in Georgetown, Horry, northern Marion, and northeastern Williamsburg Counties had declined since 1982. November 1995 data (Hockensmith, 1997) showed additional declines and a generally southeastward ground-water flow influenced by large cones of depression near Marion, Andrews, Georgetown, and Pawleys Island. Historical water-level trends in 11 Black Creek aquifer wells are shown on the hydrographs.

Drought conditions have persisted in South Carolina since mid-1998 and caused water-level declines in this aquifer throughout the State. The diminished recharge from precipitation directly resulted in declines in areas near the outcrop, where the aquifer is subject to meteorological events. The drought indirectly caused additional declines where ground-water withdrawals increased to mitigate surface drought conditions.

Potentiometric contours in Aiken County and western Barnwell County show ground-water flow toward, and discharge into, the Savannah River, consistent with previous investigations (Aadland and others, 1995; Aucott and Speiran, 1985a and b; Clarke and West, 1997; Siple, 1967; Stringfield and Campbell, 1993; and Hockensmith, 1997). An average of 15 mgd (million gallons per day) of ground water was pumped from the Middendorf, Black Creek, and overlying aquifers in Aiken and Barnwell Counties during 2000 (J.E. Castro, DNR, written communication), but the extent to which pumping affects water levels is not discernible from the 2001 data, owing to the high transmissivity of the Black Creek aquifer, the distribution of measurements, and the effect of natural discharge to the Savannah River.

Wells in Aiken and Barnwell Counties probably are subject to meteorological events in addition to pumping (Clark and West, 1997). The hydrograph for AIK-825* shows a decline of 3 ft since November 1995. Declines in other Aiken County wells ranged from 1 to 6 ft during this same period. These declines reflect the effects of the drought conditions and related increases in pumping.

Eastern Barnwell County and western Allendale County also show water-level declines. In comparison to the western part of the county, water levels in eastern Barnwell County probably are affected by ground-water use more than by rainfall variations (BRN-353*), because the Black Creek is well confined in this area (Aadland and others, 1995). Water levels in BRN-353 have declined 10 ft since March 1996. Declines in other Barnwell County wells ranged from 1 to 10 ft between November 1995 and November 2001. In western Allendale County, water levels (ALL-369) have declined more than 20 ft from predevelopment levels and 8 ft since November 1995.

Black Creek aquifer water levels in Calhoun County reflect both ground-water discharge to streams and pumping-influenced discharge by industry, irrigation, and public supplies. The lower reaches of the Congaree River are incised into the Black Creek aquifer and its overlying confining beds. Potentiometric contours curve upstream in these stream sections and indicate areas where the Black Creek discharges to streams and increases surface-water flow. Ground-water withdrawals near the Congaree River (1.8 mgd) in Calhoun County intercept some water that otherwise would contribute to the river's base flow. Pumping-induced potentiometric patterns are not obvious, owing to the widely spaced observation points, but are superimposed upon the patterns formed by natural discharge.

Water levels in CAL-2, in southern Calhoun County, have declined 19 ft, to 116 ft msl, since November 1995. Predevelopment levels were estimated to be above 125 ft msl.

Water levels have declined in southern Darlington County and northern Florence County. In DAR-98 and DAR-118, water levels have declined 4 and 7 ft, respectively, since November 1995.

Declines also have occurred in southern Florence County. Near Lake City, water levels have declined 13 ft since November 1995 in FLO-276 as a result of Lake City pumping an average of 1.2 mgd (Newcome, 2000). Declines for FLO-114 and FLO-207 were 12 and 8 ft, respectively, for the same period.

A cone of depression in northern Marion County persists, with a water level of -25 ft msl. The towns of Marion and Mullins and the Marco Rural Water Company obtain part of their water supply from the Black Creek aquifer and pumped an average of 2.0, 1.1, and 1.5 mgd, respectively, during 2000 (Newcome, 2000). Withdrawals there increased about 10 percent between 1995 and 2001 (Newcome, 1995). Predevelopment levels were estimated at between 50 and 75 ft msl (Aucott and Speiran, 1984 and 1985a) in this area, and the total water-level decline is between 75 and 100 ft.

Water levels are declining in southern Marion County (MRN-77*). Predevelopment levels near the well were estimated to be higher than 45 ft msl (Aucott and Speiran, 1984). Total decline has been more than 55 ft, probably as a result of pumping at Johnsonville (2 mgd in 2001, DHEC water-use data) and the regionalized influence of the Georgetown County cone of depression. In November 2001, the water level in MRN-77 was -10 ft msl and had declined 8 ft since 1995.

The cones of depression in Georgetown and eastern Williamsburg Counties are coalescing to form a regional cone of depression. The Johnsonville area was the center of a cone of depression in 1995; however that cone is less discernible in 2001 data because of the effect of greater pumping in Georgetown County and the loss of observation points near Johnsonville. Distinct cones remain at Andrews, Georgetown, and Pawleys Island within the regional cone of depression.

Although the cone of depression persists at Andrews, in western Georgetown County, with a water level of -154 ft msl, the hydrograph of GEO-193* shows that water levels have recovered by 60 ft since the record low of -214 ft msl in March 1992. This is a result of diminished pumping by Andrews from an average of 1.5 mgd in 1995 (Newcome, 1995) to 1.1 mgd in 2000 (Newcome, 2000), most of which is for industrial use. Estimated predevelopment levels were above 50 ft msl (Aucott and Speiran, 1985a); therefore, November 2001 data represent a total decline of more than 204 ft.

GEO-131* shows some recovery that is the result of diminished pumping in coastal Georgetown County north of Pawleys Island. In 1995, Georgetown County Water and Sewer District's average pumpage was 1.0 mgd from four wells (Newcome, 1995), but by 2000 they had placed these wells on standby.

Other wells show the cones of depression deepening in southern Georgetown County as a result of increased pumping. The hydrograph for GEO-77* shows that water levels have declined 76 ft since 1976. GEO-86 showed a water level of -153 ft msl. The level in GEO-89, south of Pawleys Island, declined 103 ft to -167 ft msl between 1987 and November 2001 and is best discernible from the potentiometric map. CHN-182*, located on the southern flank of the cone of depression at Hampton Plantation, shows a decline of 31 ft since 1986. The 33-percent increase in pumping by Georgetown County Water and Sewer District between 1994 and 2000 has contributed to this deepening cone.

Along the southern coast of Horry County, water levels continue to recover, as shown in the hydrograph for HOR-290*. Since 1988, when most of the public water suppliers in Horry County began conversion to surface water, potentiometric levels in HOR-290 have recovered 101 ft to -51 ft msl. Other wells in the area show recoveries ranging from 6 to 13 ft since 1995.

Northern coastal and inland Horry County wells show declines since November 1995. In northern coastal Horry County, water levels have declined 1 to 3 ft since November 1995, after showing recovery during the early 1990's. Hydrographs for HOR 269* and HOR-346*, near North Myrtle Beach, and the hydrograph for BRW-1862*, near Calabash, N. C., show similar trends. HOR-309, located between Conway and Myrtle Beach, has declined 9 ft since November 1995. The cause of this decline is not apparent from the water-use data. At -55 ft msl, potentiometric levels are at least 90 ft below the level measured in a Myrtle Beach well in 1941 (Aucott and Speiran, 1984). Near Aynor (HOR-225) and Green Sea (HOR-977), water levels have declined 3 ft since 1995.

Water levels in the Black Creek aquifer at Walterboro are lower than those of 1995, on the basis of data from COL-30. The water level in this well in November 2001, at 49 ft msl, has declined 2 ft from November 1995.

Water-level declines in Sumter County are a result of pumping in and around the city of Sumter. According to Cooke (1936), predevelopment levels in the area exceeded 160 ft msl. November 2001 data (SUM-133) indicate that water levels have declined more than 54 ft, to 106 ft msl in this area. Water levels in SUM-206 have declined 8 ft since November 1995. Average ground-water pumping in 2000 exceeded 15 million gallons per day for the city and nearby Shaw Air Force Base (Newcome, 2000); part of this is from the Black Creek aquifer.

SUMMARY AND CONCLUSIONS

The potentiometric map of the Black Creek aquifer, constructed by using water-level data from 147 wells measured during late 2001, shows a generally southeastward ground-water flow affected by several potentiometric lows. These potentiometric lows have developed because of ground-water pumping around Andrews, Marion, Georgetown, and Pawleys Island.

Historical data show that water levels have declined as a result of the drought conditions that have persisted in South Carolina since mid-1998, particularly near the outcrop area, and fluctuations have occurred in areas influenced by pumping. The lowest point on the potentiometric surface occurs south of Pawleys Island and is -167 ft msl. This is closely followed by lows at Andrews and Georgetown, of -154 and -153 ft msl, respectively. The cone of depression about Marion remains a major feature. Water-level recovery continues in southern Horry and northeastern Georgetown Counties as a result of public water suppliers who discontinued ground-water withdrawals in favor of surface water.

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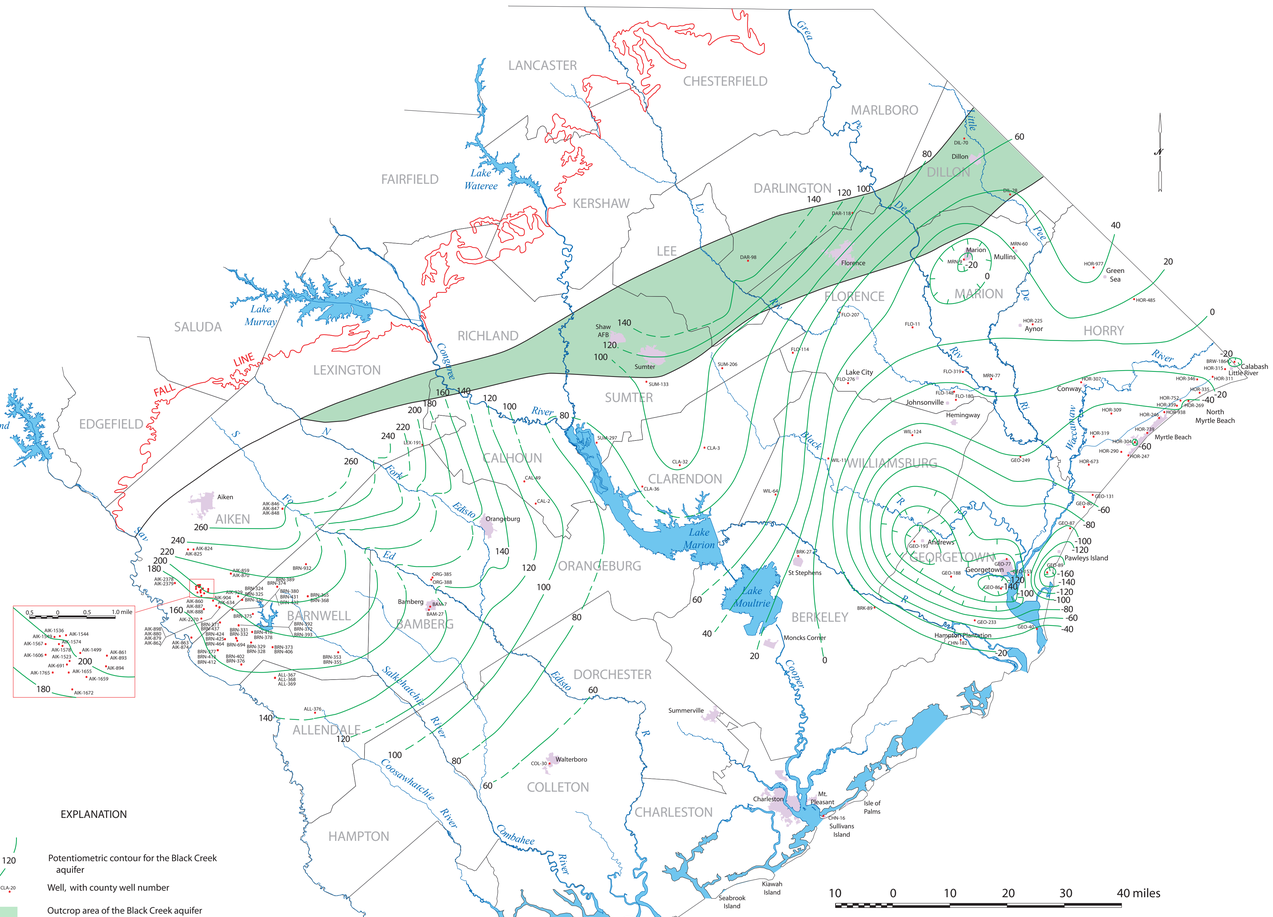


EXPLANATION

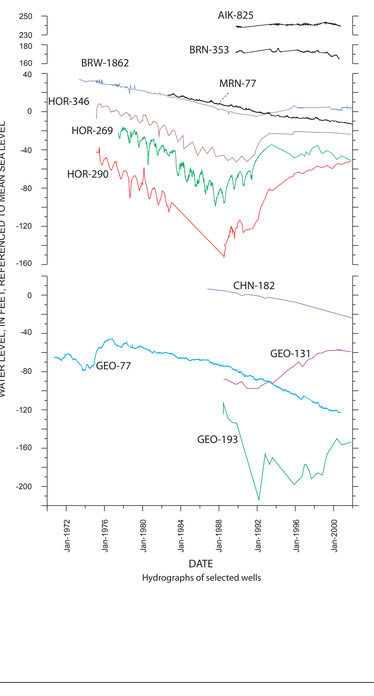
120 Potentiometric contour for the Black Creek aquifer

CLA-20 Well, with county well number

Outcrop area of the Black Creek aquifer

November 2001 water-level elevations in wells completed in the Black Creek 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 1995 to 2001, rounded to nearest foot, (blank where 1995 data are unavailable)
AIK-634	39X-t4	331744	814104	175	
AIK-691	39X-d6	331959	814359	193	
AIK-824	40V-s5	332616	814515	237	
AIK-825	40V-s6	332616	814614	238	- 3
AIK-846	36U-o3	333233	812908	271	- 6
AIK-847	36U-o4	333234	812907	271	
AIK-848	36U-o5	333233	812907	265	
AIK-859	38W-n2	332238	813827	220	- 6
AIK-860	39X-n37	331712	814319	167	
AIK-861	39W-w1	332016	814231	205	
AIK-862	39X-k35	331729	814028	175	
AIK-863	40Y-k6	331252	814532	147	- 4
AIK-870	38W-n4	332238	813827	217	
AIK-874	40Y-k9	331251	814532	154	
AIK-879	39X-k27	331730	814028	175	
AIK-880	39X-k28	331730	814028	175	
AIK-887	39X-n63	331712	814319	169	
AIK-888	39X-n64	331712	814319	170	- 3
AIK-893	39W-w4	332016	814231	203	- 5
AIK-894	39W-w5	332016	814231	206	
AIK-898	39X-k36	331730	814028	175	- 1
AIK-904	39X-t6	331831	814138	169	
AIK-929	38X-c1	331911	813706	187	
AIK-1409	39W-x33	332020	814329	202	
AIK-1523	39W-x57	332005	814352	195	
AIK-1536	39W-y35	332051	814414	210	
AIK-1544	39W-y43	332052	814401	209	
AIK-1549	39W-y48	332048	814425	206	
AIK-1567	39W-y66	332036	814444	197	
AIK-1574	39W-y73	332036	814416	200	
AIK-1578	39W-y77	332033	814409	200	
AIK-1606	39W-y104	332016	814445	193	
AIK-1655	39X-d24	331944	814354	191	
AIK-1659	39X-d28	331937	814316	191	
AIK-1672	39X-d41	331914	814346	185	
AIK-1765	39X-e108	331944	814429	189	
AIK-2270	39X-x3	331545	814344	164	
AIK-2378	40W-q2	332109	814836	165	
AIK-2379	40W-q3	332109	814836	165	- 2
ALL-367	37Z-t8	330648	813020	155	
ALL-368	37Z-t9	330649	813020	155	
ALL-369	37Z-u10	330947	813021	155	- 8
ALL-376	35A-q9	330130	812303	141	
BAM-7	31X-m3	331742	810215	154	
BAM-27	31X-m6	331713	810228	157	
BRN-324	38X-t3	331839	813623	188	- 3
BRN-325	38X-t4	331838	813622	189	
BRN-326	38X-t5	331838	813622	188	
BRN-328	37Y-o5	331209	813441	172	- 5
BRN-329	37Y-o6	331209	813441	172	
BRN-331	33Y-m4	331251	813726	172	- 3
BRN-332	38Y-m5	331245	813723	168	
BRN-353	34Y-x5	331043	811854	164	
BRN-355	34Y-x7	331044	811855	164	- 9
BRN-365	35X-e5	331915	812428	204	- 7
BRN-368	35X-e8	331914	812428	204	
BRN-371	39X-u5	331511	814021	172	
BRN-372	38Y-b10	331446	813659	178	
BRN-373	37Y-t2	331128	813048	171	
BRN-374	37W-u2	332041	813001	213	
BRN-375	37X-p5	331630	813425	188	- 5
BRN-376	38Z-t4	330849	813627	162	
BRN-377	39Y-u2	331057	814043	162	- 4
BRN-378	37Y-t6	331347	813431	178	
BRN-380	38X-n57	331710	813806	180	
BRN-389	37W-u8	332041	813001	213	- 5
BRN-392	38Y-b4	331446	813658	178	
BRN-393	38Y-b5	331445	813658	178	- 3
BRN-402	36Z-t8	330848	813626	162	- 6
BRN-406	37Y-t4	331128	813048	171	- 6
BRN-412	39-u4	331057	814044	165	
BRN-413	39Y-u5	331057	814044	161	
BRN-418	37Y-t9	331346	813431	178	- 5
BRN-424	38X-o11	331239	813927	168	- 4
BRN-425	38Y-o5	331239	813927	168	
BRN-431	38X-n59	331709	813806	180	- 2
BRN-432	38X-n60	331709	813806	180	
BRN-437	39W-u8	331511	814021	172	- 1
BRN-464	38Y-o13	331239	813927	168	
BRN-694	38Y-m35	331225	813712	169	
BRN-832	35W-e4	332411	812451	224	
BRK-27	18V-u1	332508	795526	19	
BRK-89	13X-b1	331709	794140	13	
BRW-1864	2Q-t2	333333	783522	35	
CAL-2	27T-q2	333323	804304	116	-19
CAL-49	28T-t2	333646	804507	103	
CHN-16	17DD-v1	324531	795122	7.4+	
CHN-182	12Y-r1	331203	792608	- 22	-15
CLA-3	21S-r2	334149	801218	87	
CLA-32	22T-b1	333906	801649	102	- 8
CLA-36	23U-d1	333451	802341	>95	
COL-30	27CC-j1	325347	804042	49	- 2
DAR-98	19M-y2	341010	800402	156	- 4
DAR-118	15L-o3	341717	794449	101	- 7
DIL-28	10L-a1	341946	791553	38	-29
DIL-70	11J-f1	342823	792405	66	
FLO-11	13P-e2	335944	793405	10	
FLO-114	18P-s1	335606	795601	66	-12
FLO-148	12R-b3	334952	792640	- 26	9
FLO-180	12R-i1	334837	792622	- 23	
FLO-207	16Q-m2	340210	794720	39	- 8
FLO-276	16Q-s2	335122	794600	8	-13
FLO-319	11Q-o1	335251	792500	- 14	
GEO-40	9Y-h1	331333	791218	- 35	
GEO-77	10W-c1	332415	791735	-121	-37
GEO-80	7U-q2	333158	790322	- 65	13
GEO-86	10X-d2	331947	791842	-153	
GEO-87	8V-j1	332846	790557	-103	-28
GEO-89	9W-k2	332207	791016	-167	
GEO-131	7U-i3	333346	790143	- 58	17
GEO-153	9W-o2	332148	791342	- 97	
GEO-188	12W-r1	332143	792742	-132	
GEO-193	13V-d2	332729	793451	-154	44
GEO-233	11Y-e3	331459	792332	- 66	-25
GEO-249	9T-e1	333949	791447	- 41	- 8
HOR-225	9P-c2	335955	791208	6	- 3
HOR-246	4R-y1	334518	784922	- 43	
HOR-247	6T-b1	333940	785507	- 51	11
HOR-269	3R-n4	334747	784357	- 51	- 3
HOR-290	6R-q2	334014	785623	- 51	13
HOR-304	5S-q2	334140	785353	- 61	
HOR-307	7Q-w2	335058	790327	- 24	
HOR-309	6R-q3	334607	785803	- 55	- 9
HOR-311	2Q-p5	335123	783927	- 11	
HOR-315	2Q-m3	335230	783710	- 8	
HOR-319	7S-l1	334239	790123	- 42	6
HOR-335	3R-b2	334900	784154	- 21	
HOR-339	4R-l1	334705	784505	- 31	7
HOR-346	3Q-r1	335102	784218	- 22	- 1
HOR-485	5Q-q2	334537	785329	- 19	1
HOR-673	7T-h2	333823	790221	- 49	10
HOR-739	5S-l6	334303	785136	- 56	
HOR-752	3R-o7	334752	784525	- 37	
HOR-938	4R-q1	334610	784824	- 46	
HOR-977	7N-j2	340824	790048	49	- 3
LEX-191	31S-n1	334208	810332	200	
MRN-9	11M-p2	340957	792430	- 25	7
MRN-60	10M-t1	341137	791923	22	22
MRN-77	10Q-p1	335143	791950	- 10	- 8
ORG-385	31W-l6	332208	810151	144	
ORG-388	31W-s3	332149	810203	134	
SUM-133	23Q-r6	335152	802247	106	
SUM-206	20Q-g1	335350	800856	98	- 8
SUM-297	25S-i2	334238	803156	71	
WIL-11	16S-y1	333956	794945	15	- 7
WIL-64	18U-e4	333431	795926	64	
WIL-124	13S-f1	334320	793423	- 45	-26



Hydrographs of selected wells

STATE OF SOUTH CAROLINA
The Honorable Mark Sanford, Governor

South Carolina Department of Natural Resources

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