Initial Groundwater Management Plan for the Western Capacity Use Area

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Executive Summary

South Carolina's Groundwater Use and Reporting Act (Chapter 5, Section 49-5-60) gives the South Carolina Department of Health and Environmental Control (SC DHEC) the legal authority and mandate to establish and implement a local groundwater management program in the designated Western Capacity Use Area (WCUA).

Per the enabling legislation (Chapter 5, Section 49-5-20), "The General Assembly declares (Chapter 5, Section 49-5-20) that the general welfare and public interest require that the groundwater resources of the State be put to beneficial use to the fullest extent to which they are capable, subject to reasonable regulation, in order to:

- Conserve and protect these resources,
- Prevent waste, and to
- Provide and maintain conditions which are conducive to the development and use of water resources."

Since hydrogeologic conditions and the relative socioeconomic requirements of the State vary by area and region, groundwater management should be locally and/or regionally assessed, balancing all needs and interests (more information on the WCUA specifics and defining characteristics can be found in the Hydrogeologic Setting and Regional Description sections). In this regard, SC DHEC coordinates with local stakeholders to achieve the stated goals of the plan leading to sustainable use of the groundwater resources. Sustainable use is the key guiding principle, whereby South Carolina's groundwater resources are managed so that development meets present needs without compromising the ability of future generations to meet their needs.

Introduction

On November 8, 2018, the South Carolina Department of Health and Environmental Control Board, as established in Section 49-5-60, Capacity Use Designation, declared the whole of Aiken, Allendale, Bamberg, Barnwell, Calhoun, Lexington, and Orangeburg counties as the **Western Capacity Use Area** (Figure 1). The WCUA is the fifth of five currently declared Capacity Use Areas in South Carolina. Within the WCUA, no person shall withdraw, obtain, or otherwise utilize groundwater at or in excess of three (3) million gallons in any month for any purpose without first obtaining a Groundwater Withdrawal Permit from SC DHEC.

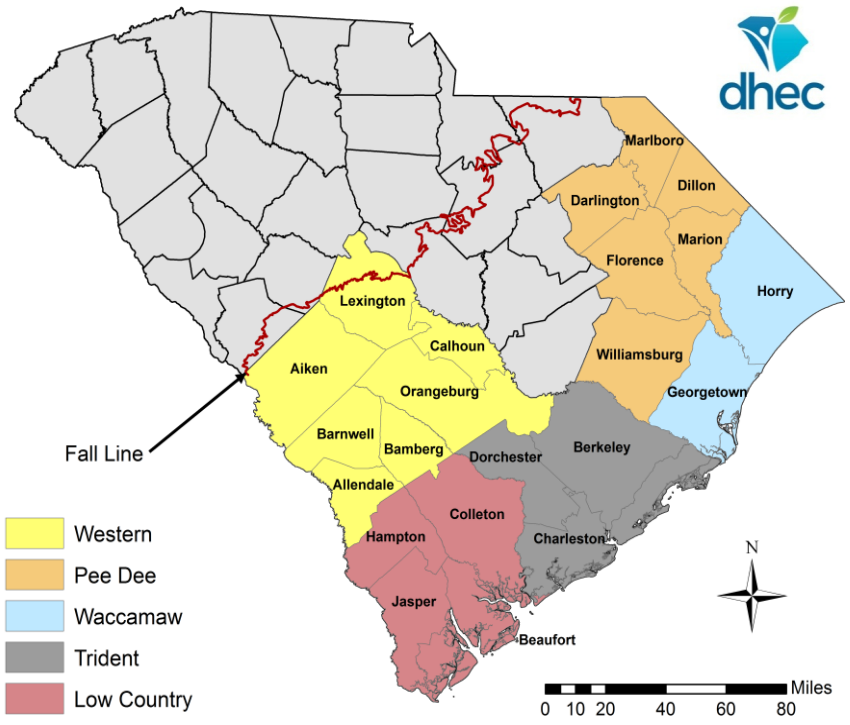


Figure 1: Capacity Use Areas and Associated Counties

The WCUA Groundwater Management Plan (GMP) will guide the initial groundwater management strategy and provide direction for future groundwater management goals by evaluating, as data become available, the hydrologic, environmental, social, and economic impacts of groundwater withdrawals on long-term sustainable levels for WCUA aquifers. Sustainable use meets present needs without compromising the ability of future generations to meet their needs and requirements. Therefore, in addition to the three statutory components of the Capacity Use program set forth in Chapter 5, Section 49-5-20, the three general goals of the GMP are:

1. Ensure sustainable use of the groundwater resource by management of groundwater withdrawals;
2. Monitor groundwater conditions to evaluate availability; and
3. Promote educational awareness of the resource and its conservation.

To accomplish these goals, the GMP addresses the following aspects of water use in the Western region:

- Current groundwater sources utilized;
- Current water demand by type and amount used;
- Current aquifer storage and recovery and water reuse;
- Projected population and growth;
- Projected water demand;
- Projected opportunities for aquifer storage and recovery, as well as water reuse;
- Projected groundwater and surface water options; and,
- Water conservation measures.

Planning is a multi-stage process that includes provisions for updating/amending as conditions change over time. The first plan establishes general goals. As more data are developed about the groundwater resources of the WCUA, more specific goals and withdrawal limits may be incorporated into the GMP. Modifications or updates to the goals and content of the GMP based on the quinquennial GMP Reports shall be made by SC DHEC authority or considered upon request by the WCUA Stakeholder Workgroup.

Groundwater management is locally and regionally conducted to best fit an area's need and incorporates the acknowledgement of regional differences that necessitate varying strategies. Quantitative thresholds that activate a specific management action cannot be explicitly stated and established in any GMP to then be equally applied to all users across all counties in a CUA due to large variations in hydrogeologic setting and groundwater conditions. Instead, the GMP utilizes several management strategies in conjunction to abate potential adverse effects, determine when certain management actions are necessary, and to adhere to the statutory framework as laid out in Chapter 5, Section 49-5-20.

Definitions

Adverse Effects: undesirable consequences of withdrawing groundwater that may include: changes in water quality, significant reduction in water level of the aquifer, saltwater intrusion, land subsidence, and decreases in stream flow

Aquifer Storage and Recovery (ASR): a process by which water is injected into an aquifer for storage and then subsequently withdrawn from the same aquifer from the same well or other nearby wells

Best Management Plan: a document that supports the design, installation, maintenance, and management of water conveyance systems and/or water withdrawal systems (water supply, commercial, industrial, agricultural, etc.), which promotes water conservation, and protects water quality

Farmland Acreage (USDA Definition): consists primarily of agricultural land used for crops, pasture, or grazing; including woodland and wasteland not actually under cultivation or used for pasture or grazing, provided it was part of the farm producer's total operation

Groundwater User: a person using groundwater for any purpose

Groundwater Withdrawer: any person withdrawing groundwater at or in excess of three (3) million gallons during any one month from a single well or multiple wells within a one-mile radius of any existing or proposed well

Irrigated Acreage (USDA Definition): all land watered by any artificial or controlled means, such as sprinklers, flooding, furrows or ditches, subirrigation, and spreader dikes including supplemental, partial, and preplant irrigation

Person: an individual, firm, partnership, association, public or private institution, municipality or political subdivision, local, state, or federal government agency, department, or instrumentality, public water system, or a private or public corporation organized under the laws of this State or any other state or county

Physiographic Province: a region having a particular pattern of relief features or land forms that differs significantly from that of adjacent regions

Reasonable Use: the use of a specific amount of water without waste that is appropriate under efficient practices to accomplish the purpose for which the appropriation is lawfully made

Stakeholder Workgroup: the SC DHEC designated committee, diverse in geographic and type-use representation, maintained as an advisory and collaborative partner concerning groundwater permitting, planning, education, and evaluation of the WCUA

Sustainable Use: use of ground water in a manner that can be maintained for an indefinite time without causing adverse environmental, economic, or social consequences

Water Quality: chemical, physical, biological, and radiological characteristics of the water and measure of the condition of water relative to the intended use

Water Reuse: water that is recycled and used more than once and is treated to a standard that permits the intended beneficial reuse

Reasonable Use Determination by Water Use Type

SC DHEC establishes reasonable use of groundwater and develops limits depending on several factors, including, but not limited to the purpose(s) for which the water is withdrawn, application of type-based formulae, technical reviews of hydrogeologic conditions, groundwater use trends, demands on the resource, and availability of alternative sources of water. Each water use type has its own guidelines and standardized procedures in reasonable use determination (Table 1).

Table 1: Generalized Water Quantity Permitting Section Reasonable Use Guidelines by Water Use Type

Water Use Type	General Reasonable Use Guidelines
Aquaculture (AQ)	• Size of operation (acreage) • Depth of holding ponds, lagoons, or lakes • Refill rates
Golf Course (GC)	• Based on current systematic and industry based standards • Application rates • Acreage irrigated • Duration of irrigation
Industry (IN)	• Based on current systematic and industry based standards • Variable based on size and type of industry
Irrigation (IR)	• Based on current systematic and industry based standards • Crop type • Irrigation method • Acreage irrigated • Duration of irrigation • Stress period buffering
Mining (MI)	• Based on current systematic and industry based standards • Variable based on size and type of industry
Hydro Power (PH)	• N/A
Thermo Power (PT)	• Based on current systematic and industry based standards • Availability of alternative water sources
Nuclear Power (PN)	• Based on current systematic and industry based standards
Water Supply (WS)	• Based on current systematic and industry based standards • Population served • Per capita use
Other (OT)	• Variable based on size and type of operation • Department approved Corrective Action Plans

Geo-Political Structure

The State of South Carolina is divided into ten official planning districts under the South Carolina Association of Regional Councils (SCARC). Each district is referred to as a Council of Governments (COG). The purpose of the COGs is to provide a "uniform geographical framework within which the planning, programming, and delivery of services by state, federal, and local government might be undertaken with maximum efficiency and effectiveness." Two separate COGs operate within the WCUA counties: Lower Savannah Council of Governments (LSCOG) and Central Midlands Council of Governments (CMCOG).

LSCOG governs six of the seven counties in the WCUA: Aiken, Allendale, Bamberg, Barnwell, Calhoun, and Orangeburg. LSCOG is currently governed by a 39-member board appointed by the participating county governments. LSCOG has 44 incorporated municipalities serving a total population of 315,087.

CMCOG governs four counties: Fairfield, Lexington, Newberry and Richland. Lexington county is represented by 18 of the 53-member board appointed by the participating county governments to serve on the COG. CMCOG has 29 incorporated municipalities, 14 of which are in Lexington, serving a total population of 763,329. Lexington county has 290,642 people, and in addition to the population of LSCOG, brings the total WCUA population to 605,729 (Figure 2).

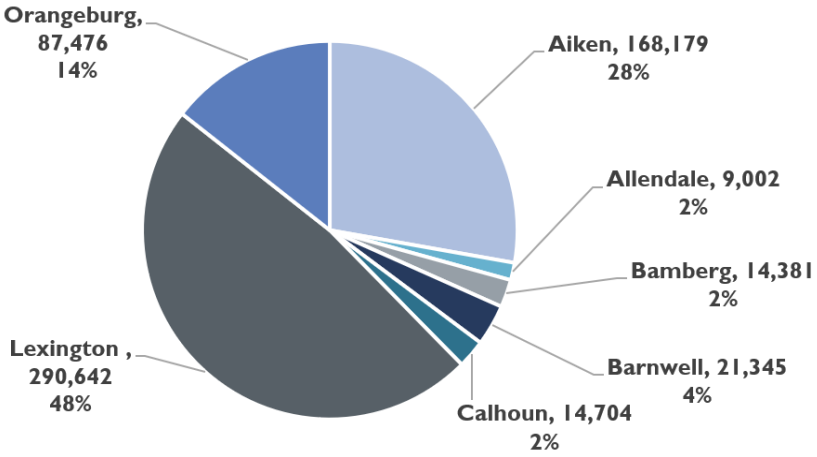


Figure 2: Population by County (U.S. Census Bureau, 2017)

Aiken, Bamberg, Lexington, and Orangeburg counties are governed by a Council-Administrator form of government. Allendale, Barnwell, and Calhoun counties are governed by a Council form of government. Cities, towns, and municipalities in the WCUA implement various forms of government, including Mayor/Council, Council/Manager, or Council only.

SC DHEC has permit authority for all groundwater withdrawals in the WCUA. Permits are issued after appropriate review in accordance with The Groundwater Use and Reporting Act, the Groundwater Use and Reporting Regulation, R.61-113, and the goals and management strategies developed in the GMP.

Hydrogeologic Setting

The Coastal Plain of South Carolina is part of the larger Atlantic Coastal Plain hydrogeologic system containing water-bearing, permeable sand or carbonate rock aquifers alternating with low-permeability confining units, usually consisting of clay or silt.

Aquifer Characteristics

The aquifers beneath the WCUA are composed of sediments deposited during the late Cretaceous to Tertiary periods. From oldest to youngest, the Cretaceous units are the Gramling, Charleston, McQueen Branch, and Crouch Branch aquifers; and the Tertiary units are the Gordon, Middle Floridan, Upper Floridan, and Surficial aquifers (Figure 3). In the WCUA, the confining units gradually thin and taper out to the northwest (geologically speaking, "up-dip"), causing the Surficial and Floridan aquifers to connect and form the Upper Three Runs aquifer, which then coalesces further "up-dip" with the Gordon aquifer to form the Steed Pond aquifer (Figure 3). As a result, the aquifers closest to the Fall Line are shallower, more interconnected, and show a greater degree of surface water interaction than those in the southeastern extent of the WCUA, where aquifers are more discrete and separated by confining units.

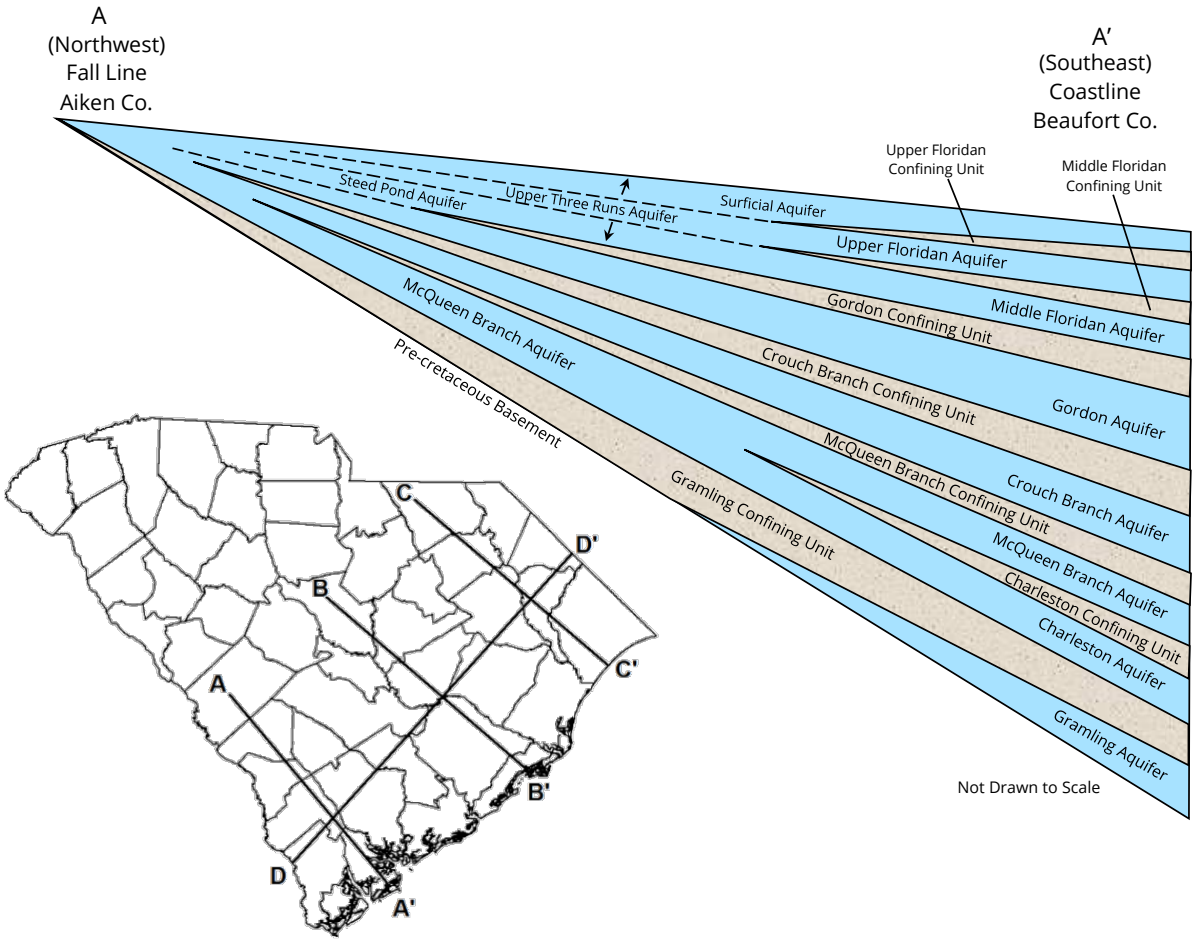
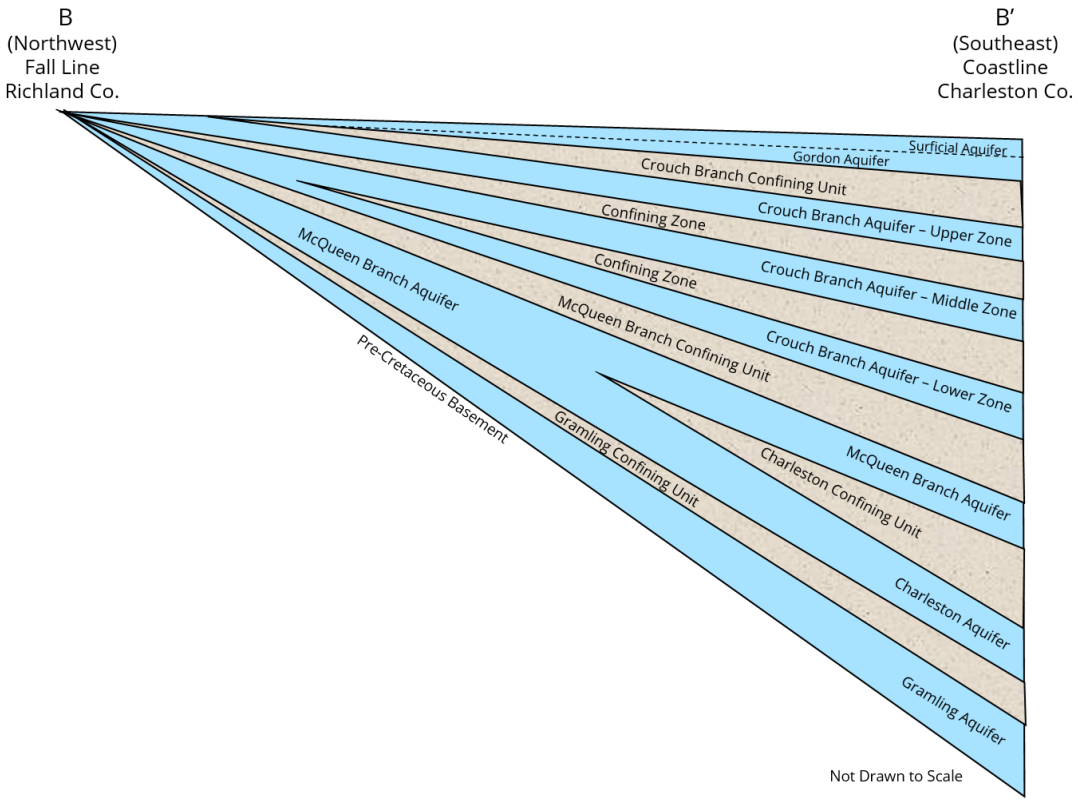
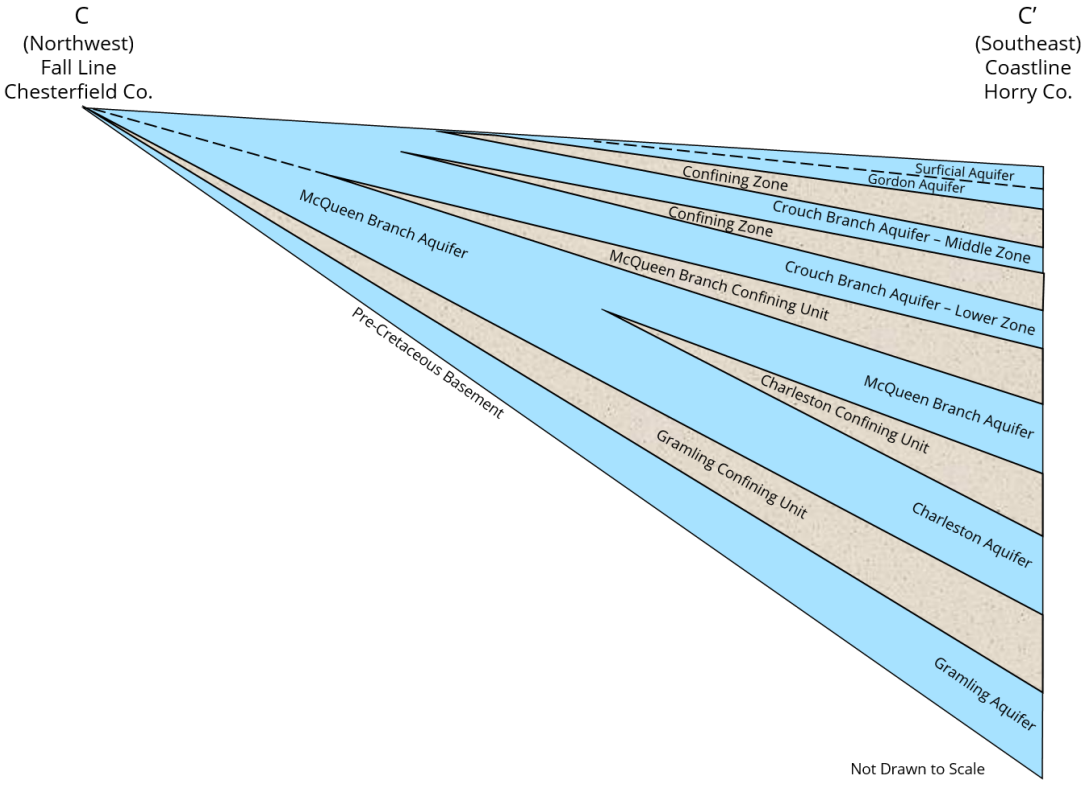
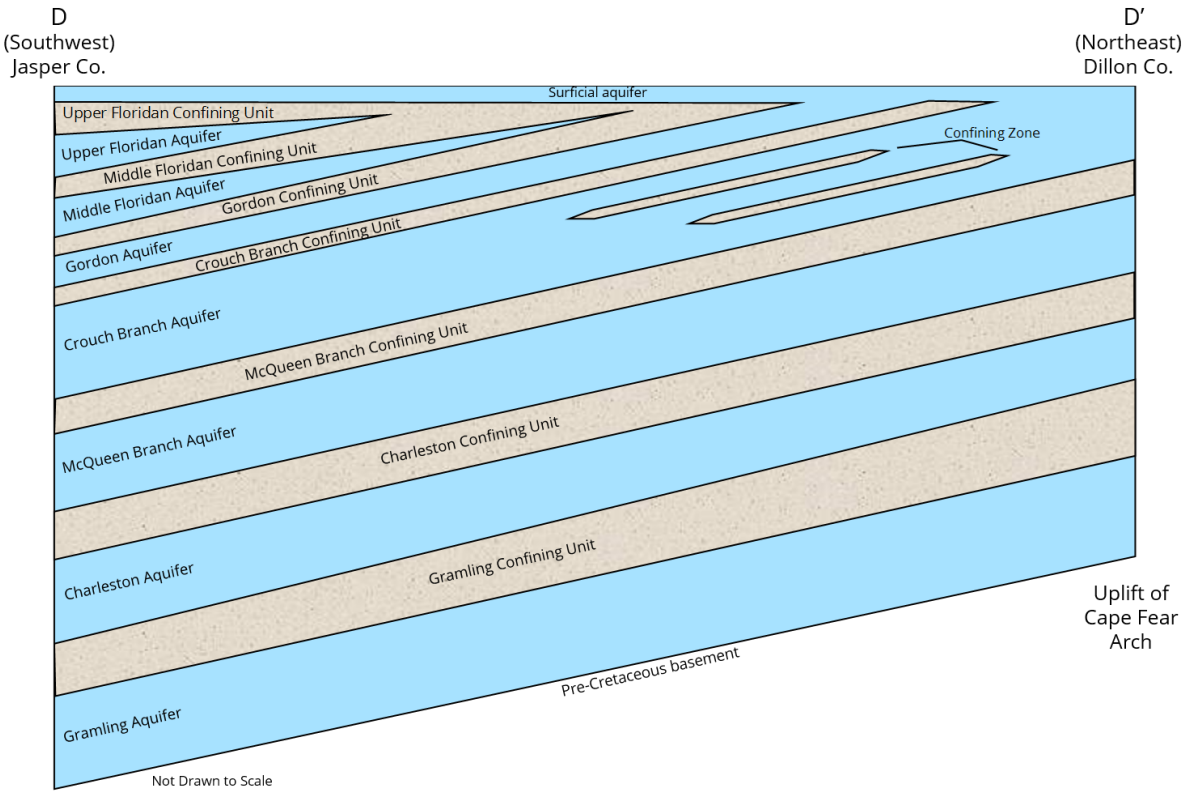


Figure 3: Generalized Cross Sections of South Carolina's Hydrogeologic Framework (Blue = Aquifers; Tan = Confining Units) (Not Drawn to Scale)


B
(Northwest)
Fall Line
Richland Co.
B′
(Southeast)
Coastline
Charleston Co.
Surficial Aquifer
Gordon Aquifer
Crouch Branch Confining Unit
Crouch Branch Aquifer – Upper Zone
Confining Zone
Crouch Branch Aquifer – Middle Zone
Confining Zone
Crouch Branch Aquifer – Lower Zone
McQueen Branch Aquifer
McQueen Branch Confining Unit
McQueen Branch Aquifer
Pre-Cretaceous Basement
Charleston Confining Unit
Gramling Confining Unit
Charleston Aquifer
Gramling Aquifer
Not Drawn to Scale


C
(Northwest)
Fall Line
Chesterfield Co.
C′
(Southeast)
Coastline
Horry Co.
Surficial Aquifer
Gordon Aquifer
Confining Zone
Crouch Branch Aquifer – Middle Zone
Confining Zone
Crouch Branch Aquifer – Lower Zone
McQueen Branch Aquifer
McQueen Branch Confining Unit
McQueen Branch Aquifer
Pre-Cretaceous Basement
Charleston Confining Unit
Gramling Confining Unit
Charleston Aquifer
Gramling Aquifer
Not Drawn to Scale



Aquifer Recharge

The recharge areas for the state's major aquifers are generally within the Upper Coastal Plain, an exception being surficial aquifers, which are recharged locally (Figure 4). Aquifers extending all the way to the coast are dependent on precipitation infiltrating in the recharge areas in the northwestern Coastal Plains further "up-dip" to continuously replenish groundwater supply. Groundwater in the major aquifers is replenished primarily by infiltration in the Upper Coastal Plain that then permeates slowly towards the coast in the southeastern direction (geologically speaking, "down-dip"). Consequently, the rate at which groundwater is replenished in the aquifers is controlled by the rate at which groundwater travels from the recharge areas, closer to the Fall Line, to the coast. Typical groundwater flow rates for silts to well-sorted sands range from 0.003 to 300 feet per day. This means that once water becomes part of the groundwater system, it may take from a few years to tens of thousands of years to reach the deeper aquifers located along the coast.

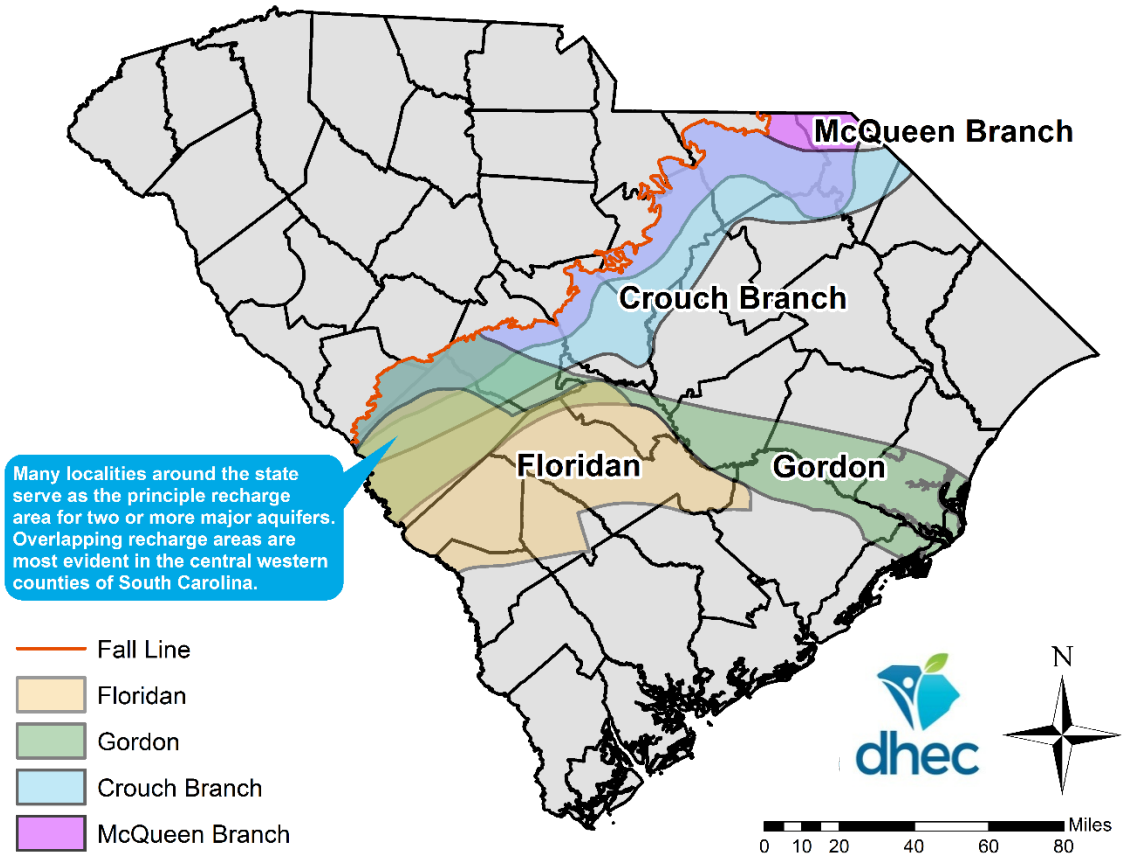


Figure 4: Major SC Aquifer Recharge Areas

Water Budget

A water budget is a generalized accounting of all water that flows in and out of a given system. A water budget can be described with the following equation:

Inflow – Outflow = Change in Water Storage

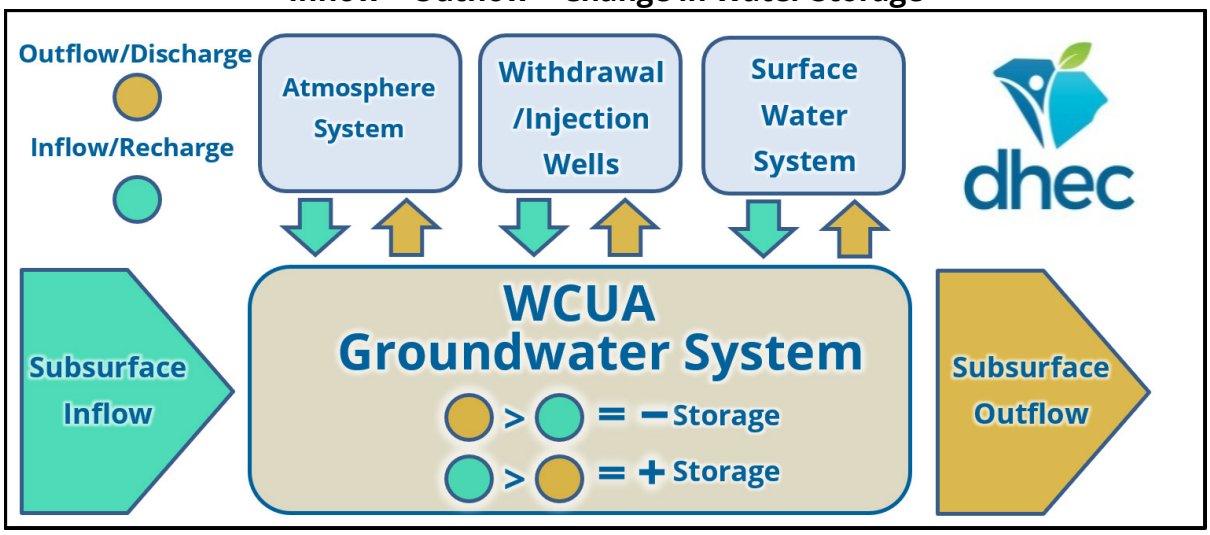


Figure 5: WCUA Generalized Water Budget

When the sum of all outflow components is greater than the sum of all inflow, there is a decrease in storage within a groundwater system (Figure 5). Groundwater storage increases when the opposite is true: the sum of inflow is greater than the sum of outflow. Any change in the components of inflow and/or outflow affects the budget's equilibrium and the various fluxes in and out of the entire system.

In a typical year, South Carolina receives most of its water from precipitation, and the remainder is predominantly surface and subsurface inflow from neighboring states. A relatively small amount of the inflow is attributed to injection wells, which are used to abate localized adverse effects or provide back-up storage. Outflow from the state's water budget is almost entirely attributed to evapotranspiration and to surface water discharge into the ocean. A small amount of the outflow is aquifer discharge into the ocean, and an even smaller amount is due to water withdrawals.

South Carolina receives relatively large amounts of water. However, most water never infiltrates below the root zone into the deeper subsurface to function as groundwater storage. A significant portion of water is taken up by plants within the root zone or discharged into surface water systems before infiltrating deep enough to enter the groundwater system. Therefore, the amount of water that enters as groundwater storage is limited. Inflow into the groundwater system is also heavily dependent on when and where precipitation occurs. The portions of the state where water infiltrates into the aquifers are known as recharge areas (Figure 4). Much of the WCUA acts as a recharge area for confined aquifers that extend to the coast. Weather patterns vary from year to year, so the total volume of water that enters the system is not a static number. Precipitation during hot, summer months when evapotranspiration is at its highest, contributes significantly less to aquifer recharge than if that same amount of precipitation fell during cool, winter months when evapotranspiration is at its lowest.

Variations in inflow and outflow necessitate an adaptive management approach to using and conserving groundwater resources. A water budget is a valuable tool and provides relevant information regarding water resource availability and management; however, a statewide or CUA-wide water budget cannot be used and applied in determining individual permit decisions.

Regional Description

The WCUA comprises seven counties: Aiken, Allendale, Bamberg, Barnwell, Calhoun, Lexington, and Orangeburg. Situated in the mid-southwestern region of South Carolina, it covers approximately 4,723 mi^2 (Figure 6). The largest of the counties, Orangeburg, covers a quarter of the total area; the smallest county, Calhoun, covers just 8.3%. Roughly 117 mi^2 (2.4%) of the WCUA is surface water coverage, and half of that area reflects the portions of Lake Murray in Lexington county. Bamberg county encompasses the least amount of surface water coverage with 2.2 mi^2 (1.9%) of WCUA's total surface water. The WCUA extends 100 miles from north to south and 103 miles in east to west directions.

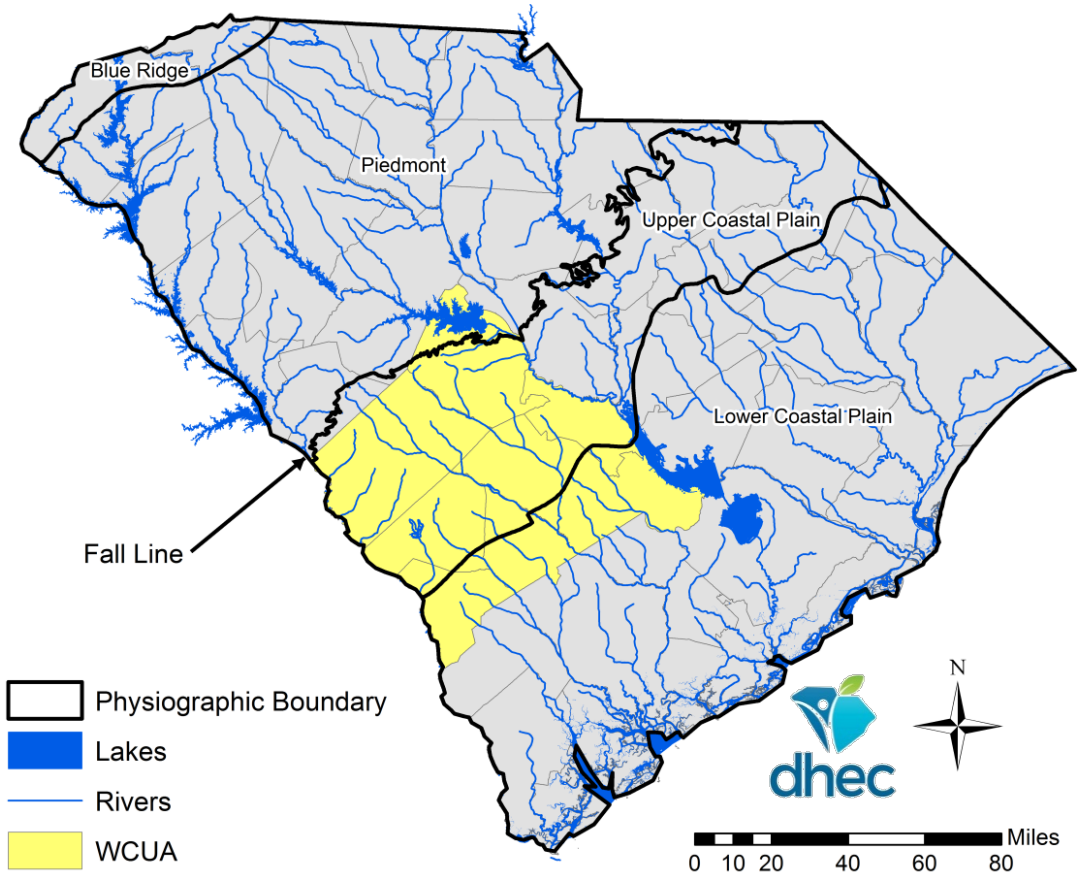


Figure 6: Physiographic Provinces of South Carolina and Major Water Bodies

The entirety of the southwestern border of the WCUA runs along the Savannah River. The northwestern border is vaguely defined by the Fall Line (the geologic boundary that separates the Piedmont from the Coastal Plains) with only portions of Lexington county extending beyond this boundary (Figure 6). Along the northeastern border, several water bodies define the WCUA's extent: Lake Murray, lower Saluda River, Congaree River, upper Santee River, and Lake Marion. The southeastern border is defined not by physiographic

features, but by political boundaries (county lines). The southeastern border is also bounded by the designated Lowcountry and Trident Capacity Use Areas (Figure 1). As a region, the WCUA principally lies within the physiographic province known as the Upper Coastal Plain. However, portions of Allendale, Bamberg, Barnwell, Calhoun, and Orangeburg counties extend into the Lower Coastal Plain, and a portion of Lexington county into the Piedmont. The boundary between the Upper and Lower Coastal Plains is the Orangeburg scarp, a terraced gradient that represents the inland extent of the ocean during the middle Pliocene epoch. The scarp separates different topographic and geologic regions of the state.

Surface Water

The WCUA is drained by five of the eight major river basins in South Carolina: Savannah, Edisto, Salkehatchie, Saluda, and Santee. Significant rivers within the WCUA include: lower Saluda, Congaree, upper Santee, Four Hole Swamp, North Fork Edisto, South Fork Edisto, Edisto, Little Salkehatchie, Salkehatchie, Coosawhatchie, and Upper Three Runs. There are no naturally formed lakes in the state, only lakes created by dammed river systems. The three largest lakes in the WCUA are Lake Murray, Lake Marion, and Par Pond. Surface water bodies incise and interact heavily with aquifer systems within the region, especially closest to the Fall Line. In some cases, the incised valleys isolate water-bearing units from the greater regional aquifer(s) (Figure 7). The intimate interconnectivity of surface and groundwater in the WCUA is a defining regional characteristic.

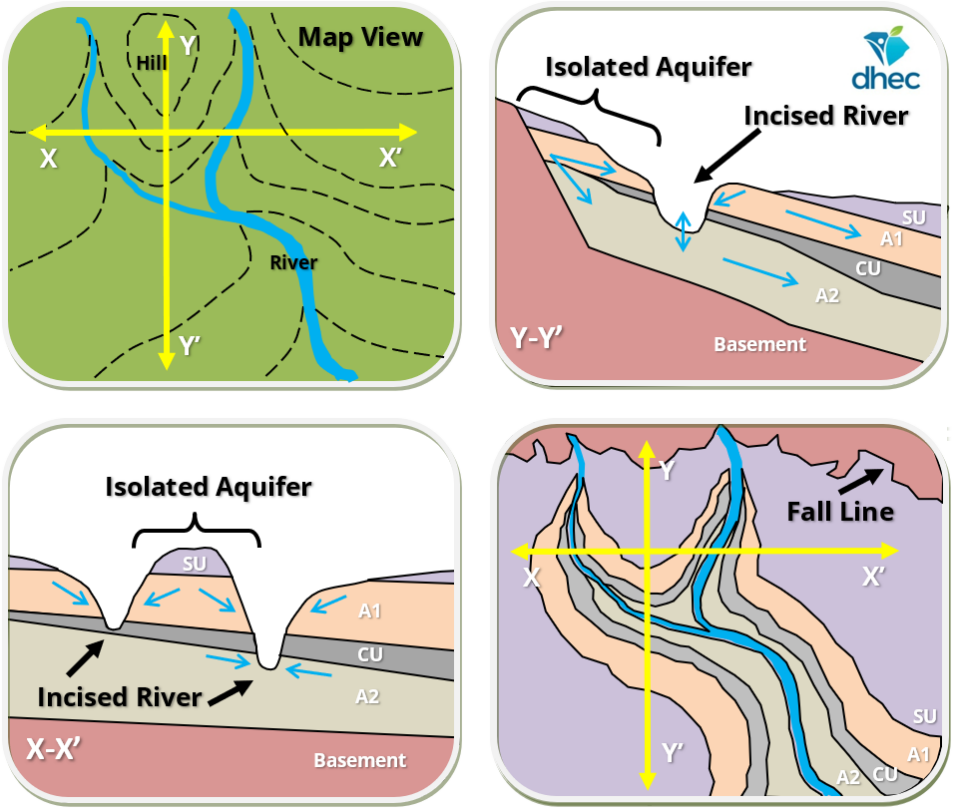


Figure 7: Isolated Aquifer Diagram (Top Left: Map View with Lines of Elevation; Top Right: Y-Y' Cross Section; Bottom Left: X-X' Cross Section; Bottom Right: Map View Showing Surface Exposure of Hydrogeologic Units) (SU=Surface Unit; A1=Aquifer 1; CU=Confining Unit)

Topography and Geology

Within the WCUA, the ground elevation ranges from 60 to 650 feet above mean sea level. In Aiken and Lexington counties, several hard-rock outcrops along the Fall Line expose the underlying granitic and gneissic bedrock of the Piedmont. Beginning at the Fall Line and traveling seaward, the topography transitions from undulating hills incised by stream valleys into low-relief plains with broad meandering rivers. The higher relief hills are predominantly composed of micaceous and kaolinitic sands with clay lenses deposited from marine to marginal marine environments. Much of the landscape has also been reworked by streams and rivers leaving behind fluvial deposits of fertile, loamy soils. The WCUA is scattered with isolated wetlands known as Carolina Bays, expansive floodplains, and cypress swamps with organic rich material underlying and surrounding these areas.

Climate

The Western Capacity Use Area, much like the entire southeastern United States, is characterized as a sub-tropical climate. The WCUA experiences warm, humid summers and mild winters. Proximity to the lower Appalachian Mountains and the Atlantic Ocean considerably affects the regional climate. The middle portion of the state is warmer and receives less rainfall than other areas of South Carolina. The WCUA does not receive as much of the cooling effects associated with the higher altitudes of the upstate or from the ocean breezes of the coast. Furthermore, the area is too far inland to be significantly influenced by coastal storm cells and is too far from the mountains to be influenced by the temperate rainforest conditions of the lower Appalachians. The average annual temperature of the seven-county area from (1981-2010) is 63.57°F with normal maximum and minimum annual temperatures of 75.73°F and 51.41°F, respectively (Figure 8). On average, the WCUA receives 47.78 inches of precipitation annually (Figure 8).

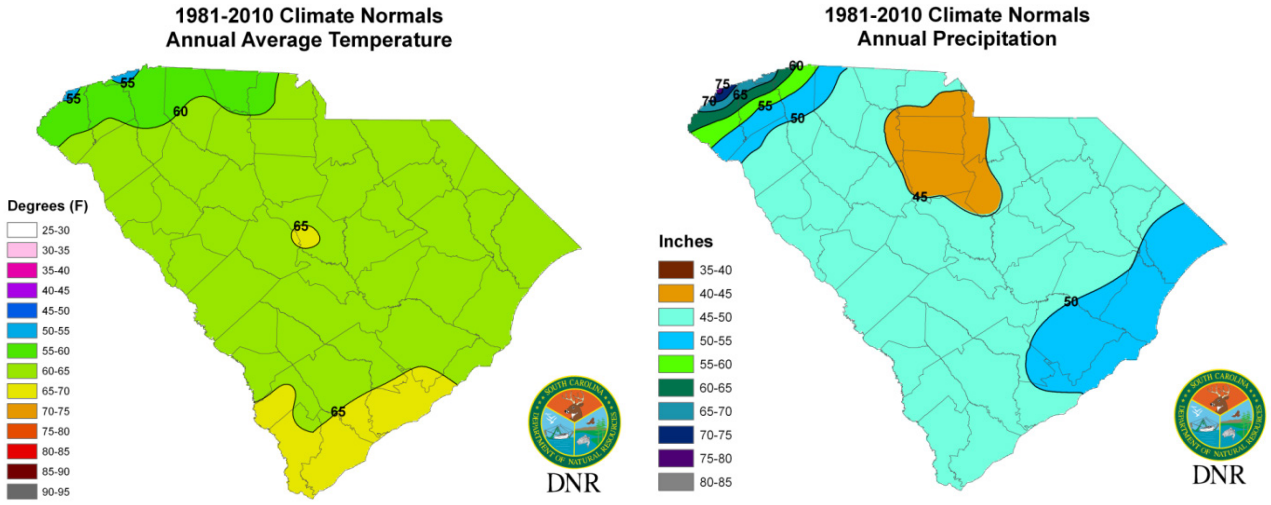


Figure 8: Climate Normals (1981-2010) (Left: Annual Average Temperature; Right: Annual Average Precipitation)

Climate has direct effects on South Carolina's aquifers, and the magnitude of those effects varies based on depth, location, and interconnectivity of the aquifers with the surface. Deeper aquifers are separated from the land surface by other aquifers and confining units, making them less susceptible to variations in climate patterns. Monitoring data demonstrate that groundwater levels rise during wetter periods and fall during drier periods. Figure 9 illustrates the impact that climate variation can have on water levels by comparing the 24-Month Standard Precipitation Index to Water Levels in Lex-0844. Lex-0844 is believed to have minimal impacts from nearby pumping and therefore, represents how the water levels in the Upper Coastal Plain respond to changes in recharge.

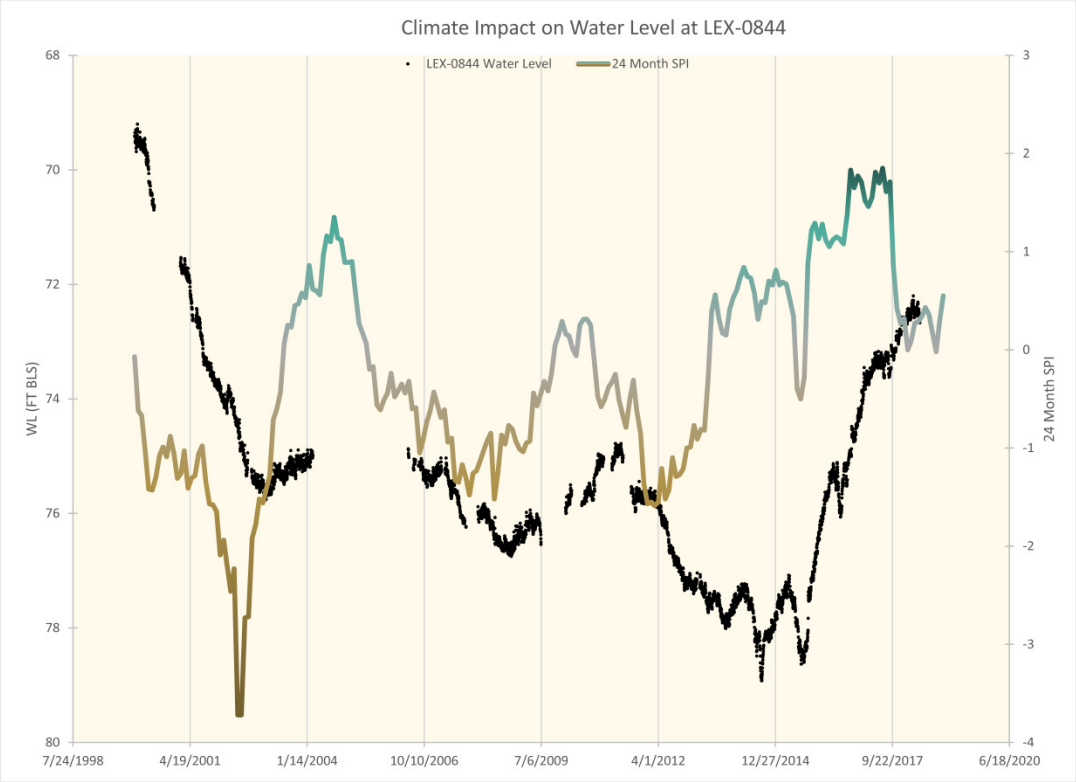


Figure 9: Climate Impact on Groundwater Levels (Black Dotted Line=Water Level in Feet Below Surface; Brown-Green Line: 24-Month SPI Where Brown is Drier and Green is Wetter)

Land Cover

The WCUA is predominantly a rural portion of the state with sparse regions of urban land cover. Most urban coverage is concentrated in eastern Lexington county, central and western Aiken county, and central Orangeburg county (Figure 10). In recent years these select regions have experienced population growth and concomitant increase in development and urban land cover; however, much of the seven-county area is covered in forest, wetlands, and farmlands (Figure 10).

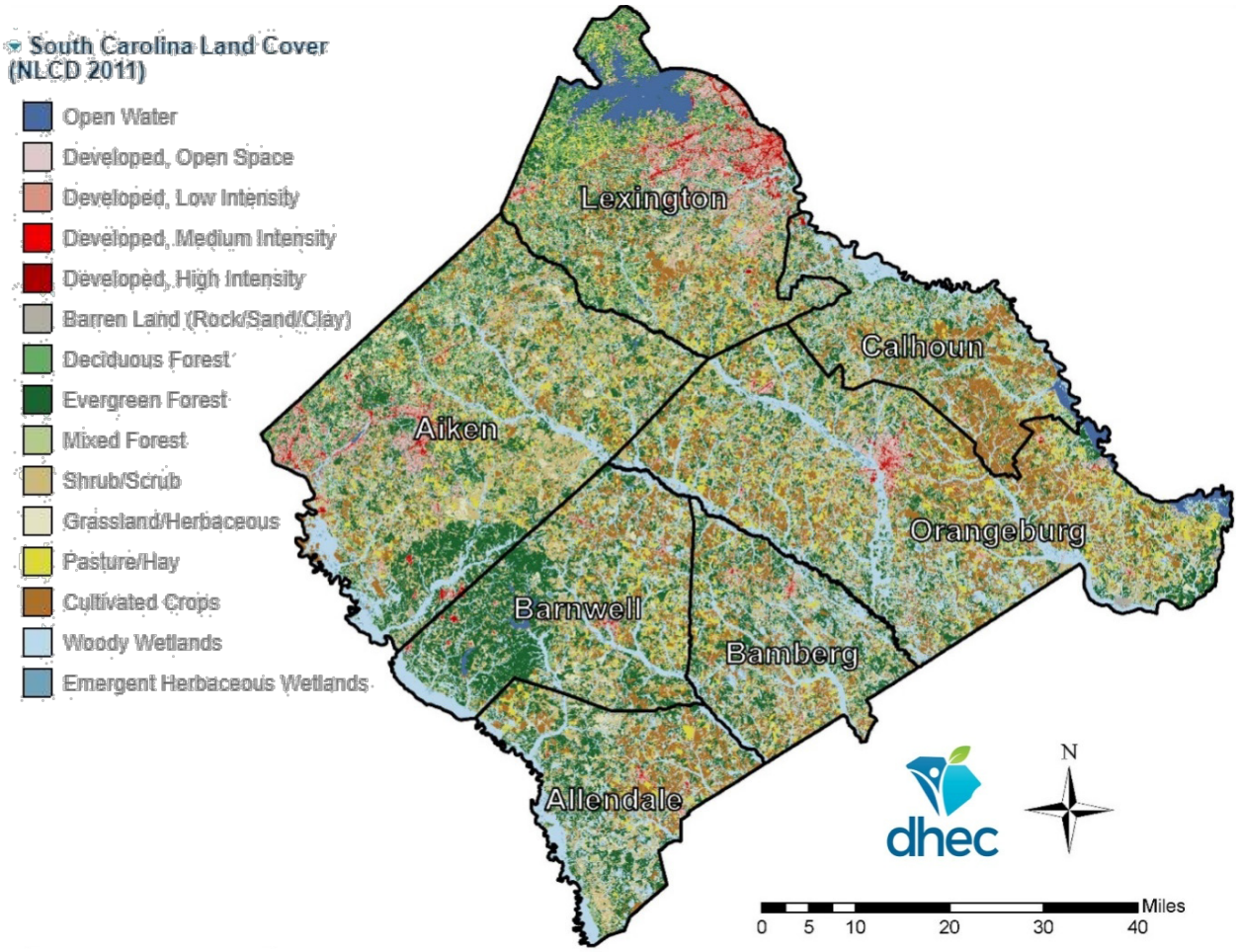


Figure 10: Western Capacity Use Area Land Cover (National Land Cover Database, 2011)

Per the latest USDA Census of Agriculture (2017), one-third (971,205 acres) of the land cover within the WCUA is used for farmland operations (Figure 11). Overall, there was a 6.2% increase in reported farmland operational use since 2002; however, the growth varied across the region. While Aiken, Calhoun, and Orangeburg counties reported increases, Allendale, Bamberg, Barnwell, and Lexington counties reported declines (Figure 11).

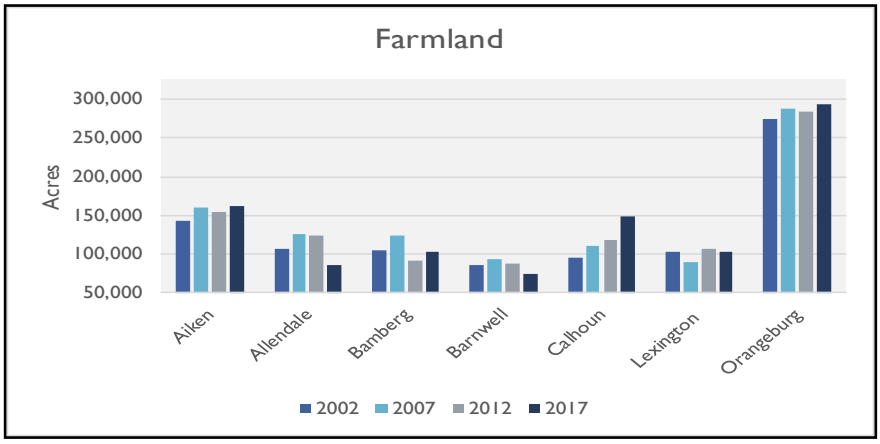


Figure 11: Farmland Operational Use Acreage by WCUA County (USDA, 2002-2017)

During the period of 2002 to 2017, agricultural cropland acreage reported to the USDA increased by 30.3%. Six of the seven counties reported increases in agricultural cropland, the exception being Allendale, which reported an overall decrease since 2002 (Figure 12). Total reported agricultural cropland acreage in 2017 was 366,394 acres.

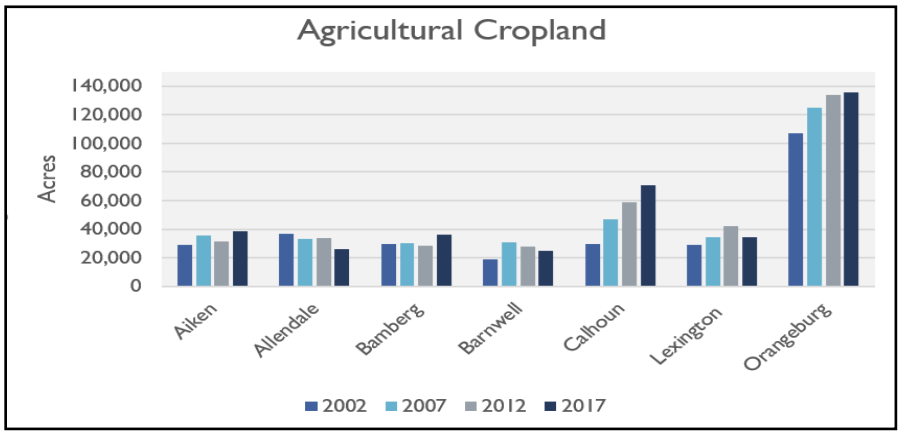


Figure 12: Agricultural Cropland Acreage by WCUA County (USDA, 2002-2017)

Irrigated acreage within the WCUA, as reported to the USDA, increased 134.7% during the period 2002 to 2017. All the counties have reported increases in irrigated acreage, except Allendale, which reported decreases in each census since the turn of the century (Figure 13). Total reported irrigated acreage in 2017 was 104,288 acres.

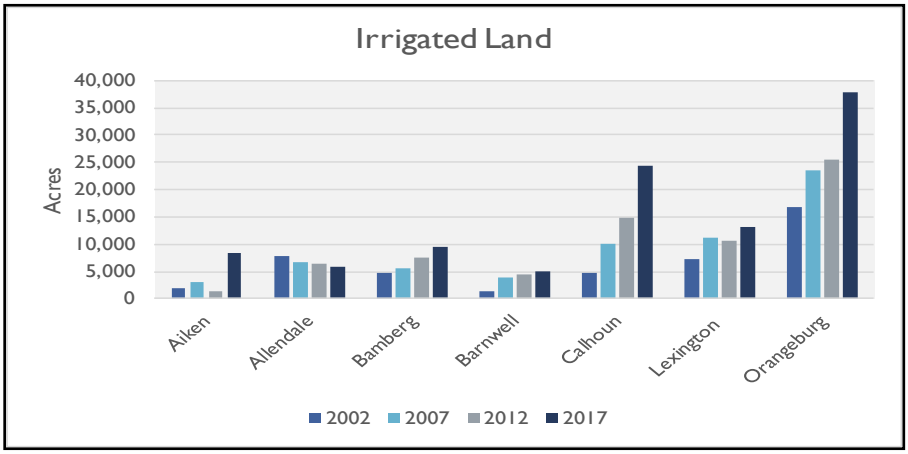


Figure 13: Irrigated Land Acreage by WCUA County (USDA, 2002-2017)

Groundwater Trends

A detailed review of groundwater trends in the seven Western Area counties may be found in the initial assessment[1]. Briefly, the SC DNR Groundwater Monitoring Network wells indicate long-term water level declines of up to 15 feet for the Floridan/Gordon, Crouch Branch, and McQueen Branch aquifers. Seasonal water level declines associated with increased reported water use during the summer months are also apparent in many of these water-level records. A map of the SC DNR Groundwater Monitoring Network wells along with the most current water level records for wells within the WCUA may be found in Appendix A.

SC DNR has prepared potentiometric surface maps of the coastal plain aquifers of South Carolina since the 1980s[2]. Appendix B contains a subset of these maps in the WCUA for the major aquifers beginning with data from 2001. Please note that measurements were not made in each aquifer for each year. Groundwater flow within all three major aquifers is generally to the southeast with a portion of the flow curving to the southwest in Aiken, Barnwell, and Allendale counties. There have been no major cones of depression apparent in the seven counties.

Current Groundwater Demand

There are 1,041 currently permitted Capacity Use wells in the WCUA (Table 2). One-third of these wells are located in Orangeburg county and nearly three-fourths are permitted for irrigation use. The number of irrigation wells exceeds those of other use categories for all of the WCUA with the exception of Aiken county in which the water supply category contains the highest number of wells.

Table 2: WCUA: Current Number of Wells by Permit Category and County

Water Use Category	Aiken	Allendale	Bamberg	Barnwell	Calhoun	Lexington	Orangeburg	Totals
Aquaculture (AQ)	0	0	0	0	0	0	0	0
Golf Course (GC)	4	0	0	0	1	2	3	10
Industry (IN)	45	3	0	2	1	10	9	70
Irrigation (IR)	50	44	64	44	164	80	308	754
Mining (MI)	0	0	0	0	1	10	1	12
Hydro Power (PH)	0	0	0	0	0	0	0	0
Thermo Power (PT)	0	3	0	0	0	0	2	5
Nuclear Power (PN)	0	0	0	0	0	0	0	0
Water Supply (WS)	92	12	13	24	8	20	21	190
Other (OT)	0	0	0	0	0	0	0	0
TOTAL	**191**	**62**	**77**	**70**	**175**	**122**	**344**	**1,041**

Water use reported for 2018 totaled 40,801 million gallons (MG) (Table 3). Aiken and Orangeburg counties reported the highest total reported water use comprising 20% and

[1] SC DHEC and SC DNR (2017). A Preliminary Assessment of the Groundwater Conditions in Aiken, Allendale, Bamberg, Barnwell, Calhoun, Lexington, and Orangeburg Counties, South Carolina. May 2017. Columbia, South Carolina.

[2] SC DNR Website. http://www.dnr.sc.gov/water/hydro/PubsDNRrep.htm. Accessed June 11, 2019.

28%, respectively, and Bamberg and Barnwell counties reported the least at roughly 7% each. The majority of reported water use was for irrigation (67.5%), followed by water supply (19.9%), industry (5.4%), mining (4.1%), thermal power generation (2.8%), and golf course irrigation (0.3%). Monthly reported water use for 2018 shows the seasonality inherent in irrigation, which increases during the spring months and peaks between June and August (Figure 14). Monthly reported water use for industry, water supply, thermo power and mining remained comparatively constant during 2018.

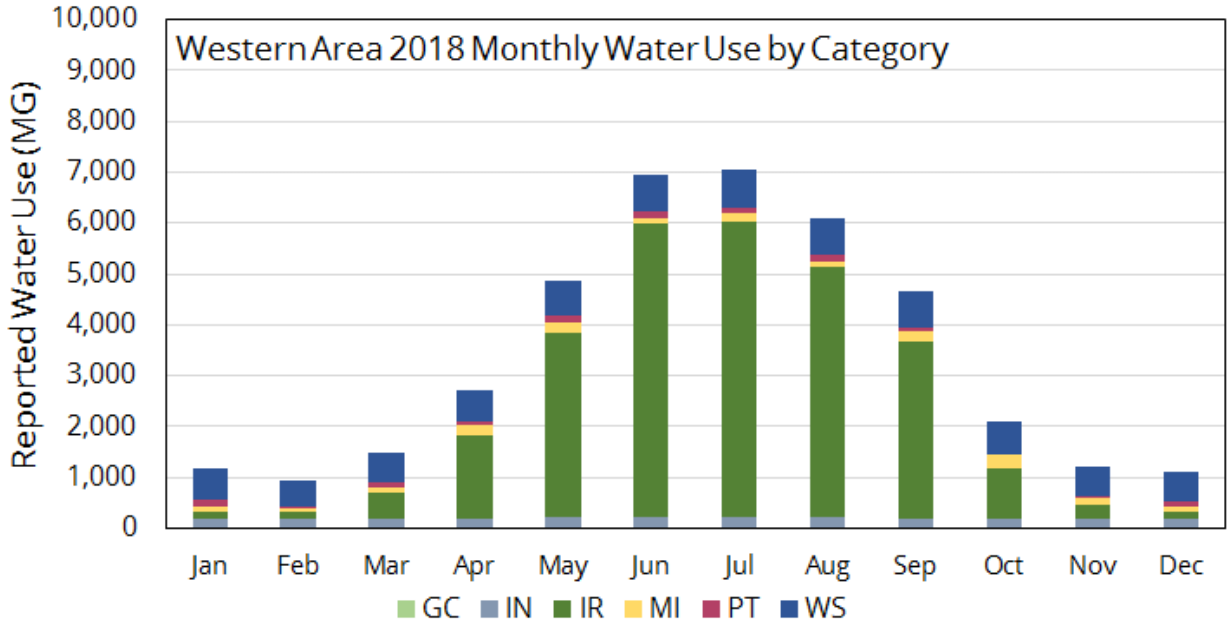


Figure 14: WCUA: Reported Monthly Water Use by Category, 2018

Table 3: WCUA: Reported Water Use[a] by Permit Category and County, 2018

Water Use Category	Aiken	Allendale	Bamberg	Barnwell	Calhoun	Lexington	Orangeburg	Totals	Percent Of Total
Aquaculture	0	0	0	0	0	0	0	0	0%
Golf Course	17	0	0	0	1	21	78	117	0.3%
Industry	620	739	0	133	3	345	376	2,215	5.4%
Irrigation	2,269	3,223	2,372	1,578	5,349	3,480	9,267	27,539	67.5%
Mining	0	0	0	0	0	1,212	463	1,675	4.1%
Hydro Power	0	0	0	0	0	0	0	0	0%
Nuclear Power	0	0	0	0	0	0	0	0	0%
Thermo Power	0	136	0	0	0	0	982	1,118	2.8%
Water Supply	5,034	468	339	1,023	378	523	372	8,137	19.9%
Other	0	0	0	0	0	0	0	0	0%
TOTAL	**7,941**	**4,566**	**2,711**	**2,734**	**5,731**	**5,581**	**11,538**	**40,801**	**100%**
Percent of Total	**19.5%**	**11.2%**	**6.6%**	**6.7%**	**14.0%**	**13.7%**	**28.3%**	**100%**	

[a]Water use is reported in Millions of Gallons (MG). For example, 9,210 is 9,210,000,000 gallons.

Historic Water Demand

Water use reported between 2001 and 2018 by county and by use category are presented in Figures 15 and 16. Total reported water use remained relatively stable from 2001 through 2013 with the exception of 2003 and 2013, during which the Western Area counties received increased precipitation during the spring growing season. Beginning in 2014, reported water use began to increase, reaching a maximum of 41,039 MG in 2017. The majority of this recent increase was within the irrigation use category (Figure 16), as all other use categories remained relatively constant, and reported industrial water use decreased.

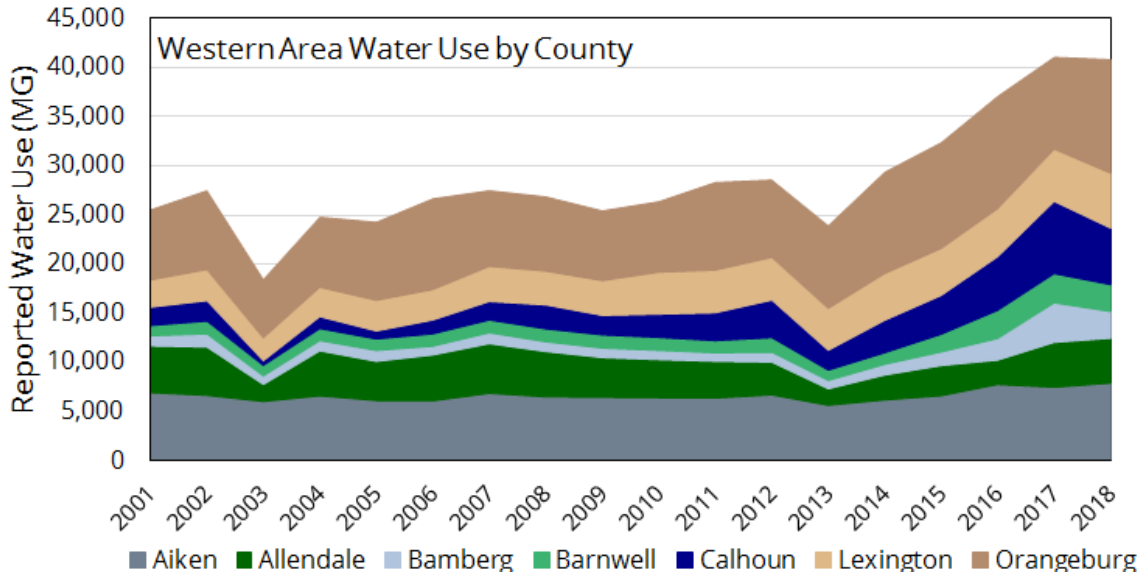


Figure 15: WCUA: Reported Annual Water Use by County, 2001-2018

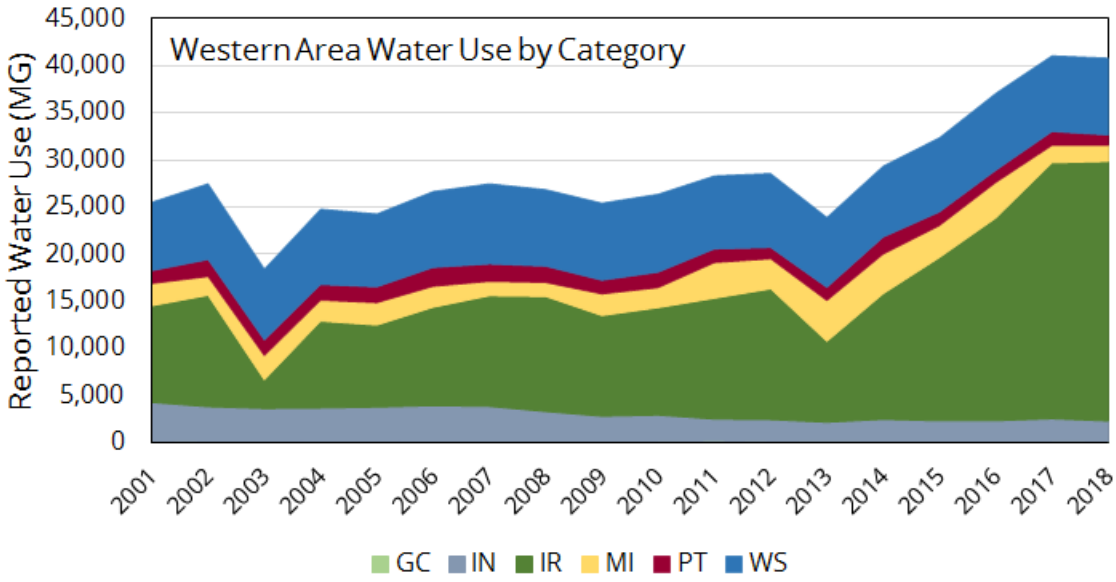


Figure 16: WCUA: Reported Annual Water Use by Category, 2001-2018

During the same period, the total population in the WCUA increased from 520,813 in 2001 to 610,177 in 2018 (Figure 17). This population change was the result of large population increases in Aiken and Lexington counties while Allendale, Bamberg, Barnwell, Calhoun, and Orangeburg counties experienced small decreases in population. Comparing the Western Area counties' historic reported water use (Figure 15) with changes in population (Figure 17) suggests that the increase in reported water use cannot be explained by population changes alone.

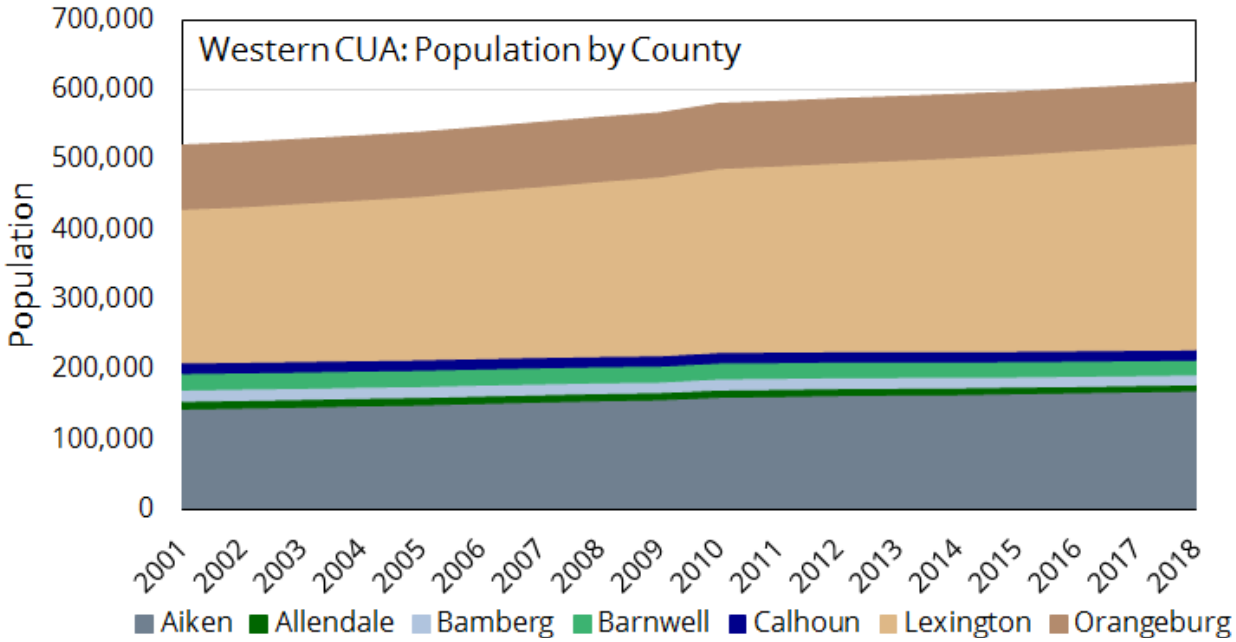


Figure 17: WCUA: Population by County, 2001-2018 (US Census Bureau)

Western Area Irrigation

The increase in reported water use for irrigation may be the result of several factors including an increased volume per well, an increased number of wells, or an increase in the number of acres irrigated in the Western Area counties. These factors cannot be isolated and analyzed individually. From 2002 to 2018, both the number of reporting irrigation wells and reported water use increased (Figure 18). Part of the rapid increase in number of wells and reported water use beginning in 2014 is at least partly due to greater public awareness during the initial assessment of the Western Area counties. Greater public awareness led to increased compliance with the reporting requirement of the Groundwater Use and Reporting Act (R.16-113). The increase in the number of irrigation wells and reported water use may not necessarily correspond to increased water withdrawal for each irrigation well (Figure 19).

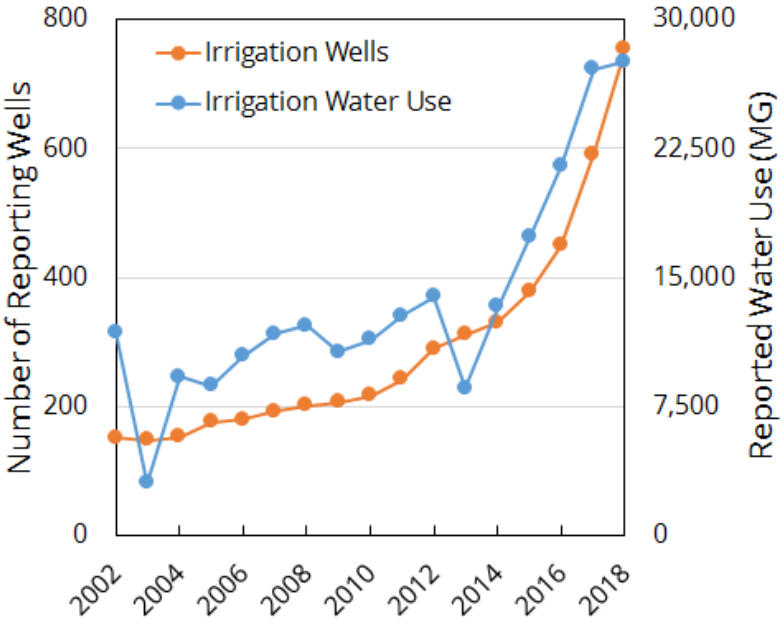


Figure 18: Number of Reporting Irrigation Wells and Reported Water Use for Irrigation from 2002-2018 for all Western Area Counties

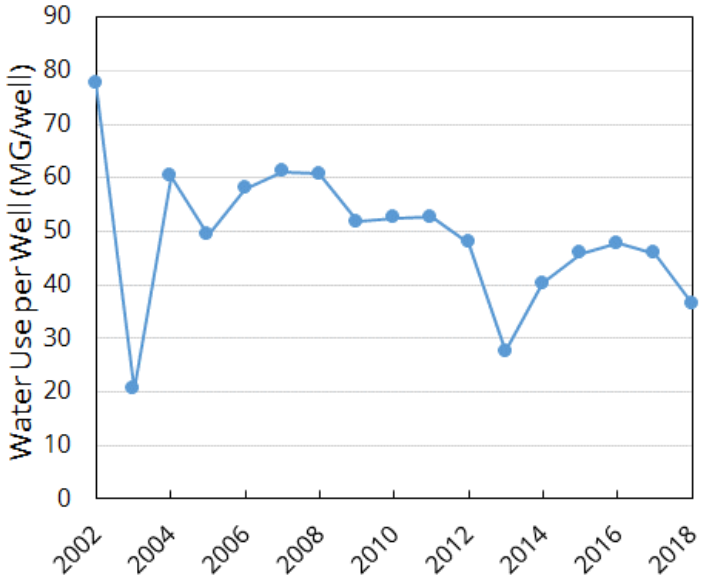


Figure 19: Reported Water Use Per Irrigation Well Reporting from 2002-2018 for all Western Area Counties. Calculated as Total Reported Water Use /Number of Reporting Wells

Groundwater Management Strategy

The Groundwater Management Plan outlines a process to establish and implement a local groundwater management program in the WCUA; the enabling legislation requires that the groundwater resources of the State be put to beneficial use to the fullest extent to which they are capable, subject to reasonable regulation, in order to conserve and protect these resources, prevent waste, and to provide and maintain conditions which are conducive to the development and use of water resources (Chapter 5, Section 49-5-20). In short, the goal is to develop and implement a sustainable use, adaptive-management strategy. Ultimately, SC DHEC will use all available scientific data that allow for informed permitting decisions and monitoring for potential adverse effects. The key strategies to achieve these goals are outlined below.

Strategy #1: Establish a Comprehensive Groundwater Monitoring Program

With increases in population, irrigated acreage, and a growing industrial base, water demand (from both surface and groundwater) continues to grow steadily. Although water level declines are a normal response to groundwater withdrawals, not stabilizing these declines may cause serious impairment to the aquifers and groundwater quality of the region. SC DHEC will pursue partnerships with local entities, groundwater users, and other agencies (both Federal and State) to facilitate the most effective use of resources in designing and maintaining a monitoring network for the WCUA. Both SC DNR and SC DHEC maintain several groundwater level monitoring locations in the WCUA.

Although the WCUA has the most extensive groundwater monitoring network of all the Capacity Use Areas, expanding the current network will allow more accurate monitoring of groundwater level conditions and facilitate science-based recommendations for strategies to address any stressed aquifer conditions in the area (see Appendix A). An expanded groundwater monitoring network is necessary to:

- Provide accurate data on the amount and rate of groundwater level changes;
- Provide groundwater withdrawers with timely and accurate information to effectively manage withdrawal activities;
- Establish the correlation between groundwater pumping and water level changes, both on the local and regional scale; and
- Guide management efforts to minimize potential impairment of the aquifers and track progress in reversing water level declines.

A goal for the comprehensive groundwater monitoring network should be a complete coverage and network of wells for each aquifer in each of the WCUA counties. Installation of wells in Bamberg county is especially critical, as there are no SC DNR monitoring stations in that area. Additional actions to achieve this goal include the following:

- Cooperate with local, state, and federal partners to expand groundwater monitoring networks and sharing of well data;

- Promote partnerships in the state to identify wells that may be incorporated and of benefit to the well network; and
- Identify wells scheduled for abandonment that may be incorporated and of benefit to the well network.

Strategy #2: Identify Geographic Areas of Concern and Level/Reduce Pumping Where Appropriate

Prior to each permit renewal cycle, SC DHEC will consider the best available information on the geologic and hydrogeologic characteristics of the aquifer(s) and groundwater withdrawals of the area to protect against or abate unreasonable, or potentially unreasonable, adverse effects on the aquifer(s) and water users of the WCUA. Measures that SC DHEC may require applicants, permit holders, and groundwater withdrawers to take may include, but not be limited to, the following:

- Reduce/Level groundwater withdrawals in areas of concentrated pumping;
- Reduce/Level groundwater withdrawals in areas where it is found to be in the public interest or general welfare, or to protect the water resource;
- Utilize other available freshwater aquifers than those currently used;
- Utilize conjunctive use of aquifers, or waters of less desirable quality, where water quality of a specific character is not essential;
- Utilize the groundwater model of the coastal aquifers that has been developed by the USGS and SC DNR to determine the potential for adverse effects;
- Prohibit the hydraulic connection of aquifers that could result in deterioration of water quality in freshwater aquifers;
- Implement abandonment of wells, which will be filled with cement grout, plugged, and sealed;
- Implement abandonment of wells that have penetrated zones of undesirable water quality where such wells are found to cause contamination of freshwater aquifers where undesirable water quality is defined as not meeting the standards for Class GB Waters as listed in *Water Classifications & Standards*, R.61-68.H.9;
- Implement construction and use of observation or monitoring wells;
- Implement reasonable and practical methods to conserve and protect the water resources and to avoid or minimize adverse effects of the quantity and quality of water available to persons whose water supply has been materially reduced or impaired as a result of groundwater withdrawals; and
- Implement such other necessary and appropriate control or abatement techniques as are technically feasible.

Strategy #3: Review Permit Applications Based on Demonstrated Reasonable Use

Proposed withdrawals will be evaluated considering reasonable use and need, aquifer(s) being utilized, potential adverse effects on adjacent groundwater withdrawers, previous

reported water use, anticipated demand for the proposed activities, availability of alternate water sources, and reported water use at facilities with similar activities. Applications for groundwater withdrawal will incorporate a "Water Use Plan" or a "Best Management Strategy" detailing actual or proposed water use activities and all conservation techniques for site specific water management including, but not limited, to:

- Provide appropriate documentation that the proposed water use is a beneficial use of the resource and necessary to meet the reasonable needs of the applicant;
- Describe in detail the applications for which the water is being withdrawn and approximate quantities utilized in each application;
- Identify the aquifer(s) currently utilized and the hydrogeologic (groundwater quality, specific capacity/yield, etc.) factors for utilization, and if a less utilized aquifer is suitable to meet the facility's need;
- Identify additional or alternate sources of water, including surface water, effluent, or recycled water, among others, suitable to meet the needs of the applicant and supplement, minimize, or eliminate groundwater sources;
- Identify reasonable and appropriate conservation methods or practices that maximize efficiency of current water use and reduce current water demand; and
- Identify any existing or anticipated adverse effects on other groundwater withdrawers, including public use, and strategies to eliminate or minimize these effects.

Strategy #4: Establish an Educational Plan for the General Public and Existing Groundwater Withdrawers

General public, stakeholder, and permittee education outreach and awareness are a cornerstone to the development of successful water management strategies. SC DHEC will coordinate with the Stakeholder Workgroup and other appropriate partners to develop educational resources, strategies, and incentives for conservation. An effective water management educational plan should incorporate the following:

- Provide audience-based public education and outreach programs;
- Provide best available information on current systematic and industry-based standards;
- Engage with state and local governments;
- Establish and promote conservation measures through:
    1. Enhanced water use efficiency;
    2. Identification of water losses and establishment of corrective actions; and
    3. Preparation for water shortages and implementation of appropriate responses.

Strategy #5: Manage Through Regulation and Planning

The Groundwater Use and Reporting Act provides for regulation of water withdrawals in South Carolina. Groundwater regulation is necessary to conserve and protect these

resources, prevent waste, and provide and maintain conditions which are conducive to the development and use of water resources. As data are developed on the groundwater resources of the designated Capacity Use Areas, the regulations will be reviewed to ensure adequate adherence to the legislative declaration of policy laid out in Title 49, Chapter 5-20.

SC DNR is responsible for developing and updating the State Water Plan. A groundwater model of the Coastal Plain aquifers has been developed by the USGS and SC DNR. As ongoing results of the modeling effort and the updates to the State Water Plan become available, they will help inform potential regulatory and policy changes and will be incorporated into this Groundwater Management Plan.

Strategy #6: Establish A Plan for Continual Stakeholder Engagement And Awareness Of Groundwater Development

As part of the permitting process, stakeholder involvement, comment, and recommendations will be incorporated during the public comment period of the permit application. SC DHEC requires groundwater withdrawers to publish a public notice for one day in a newspaper of general circulation within the CUA in which the groundwater is to be withdrawn. SC DHEC additionally publishes public notices for the entirety of the 30-day public comment period on the Environmental Public Notices page of the official SC DHEC website. Continuous engagement with stakeholders and other interested persons is important to promote awareness of groundwater development and general education. An effective plan for continued engagement should incorporate the following:

- Maintain a Stakeholder Workgroup that is diverse in geographic and type-use representation to serve in an advisory role and as a partner for engagement within the WCUA communities;
- Provide and maintain a Stakeholder Workgroup to receive direct notice of proposed permitting actions during the public notice period;
- Provide a Stakeholder Workgroup a forum for SC DHEC to present each quinquennial draft GMP Report, receive comments for consideration as the draft is finalized, and evaluate whether considerations are needed for an updated GMP and a reconvening of the Stakeholder Workgroup to do such; and
- Provide a Stakeholder Workgroup an annual update of water use and conditions in the WCUA.

Groundwater Management Plan Reports

Every five (5) years, total annual groundwater withdrawals will be compiled and compared to available aquifer potentiometric maps. The report will include the following information:

- Listing of all permitted withdrawers, permitted withdrawal limits, and average groundwater withdrawal;
- Evaluation of withdrawal by category and by aquifer; and
- Identification of the aquifer(s) and area(s) with observed and potential adverse effects and all withdrawers utilizing the aquifer(s).

Based on the information developed for the plan report, modifications of groundwater withdrawals in identified areas will be reviewed and subsequently the Groundwater Management Plan may be amended. The report will also evaluate, as information is developed, changes in water quality of the aquifers, available storage capacity of the aquifers, project future rates of withdrawal, and estimated future groundwater declines from the projected withdrawal rates. Through time, a safe sustainable yield for each aquifer will be developed and subsequent withdrawal limits will be based on this available yield. The final report and updated GMP will be shared with the stakeholders and the permit renewals will be issued consistent with the report and the plan.

Appendix A

South Carolina Department of Natural Resources
Groundwater Monitoring Network Hydrographs
Western Capacity Use Area Counties

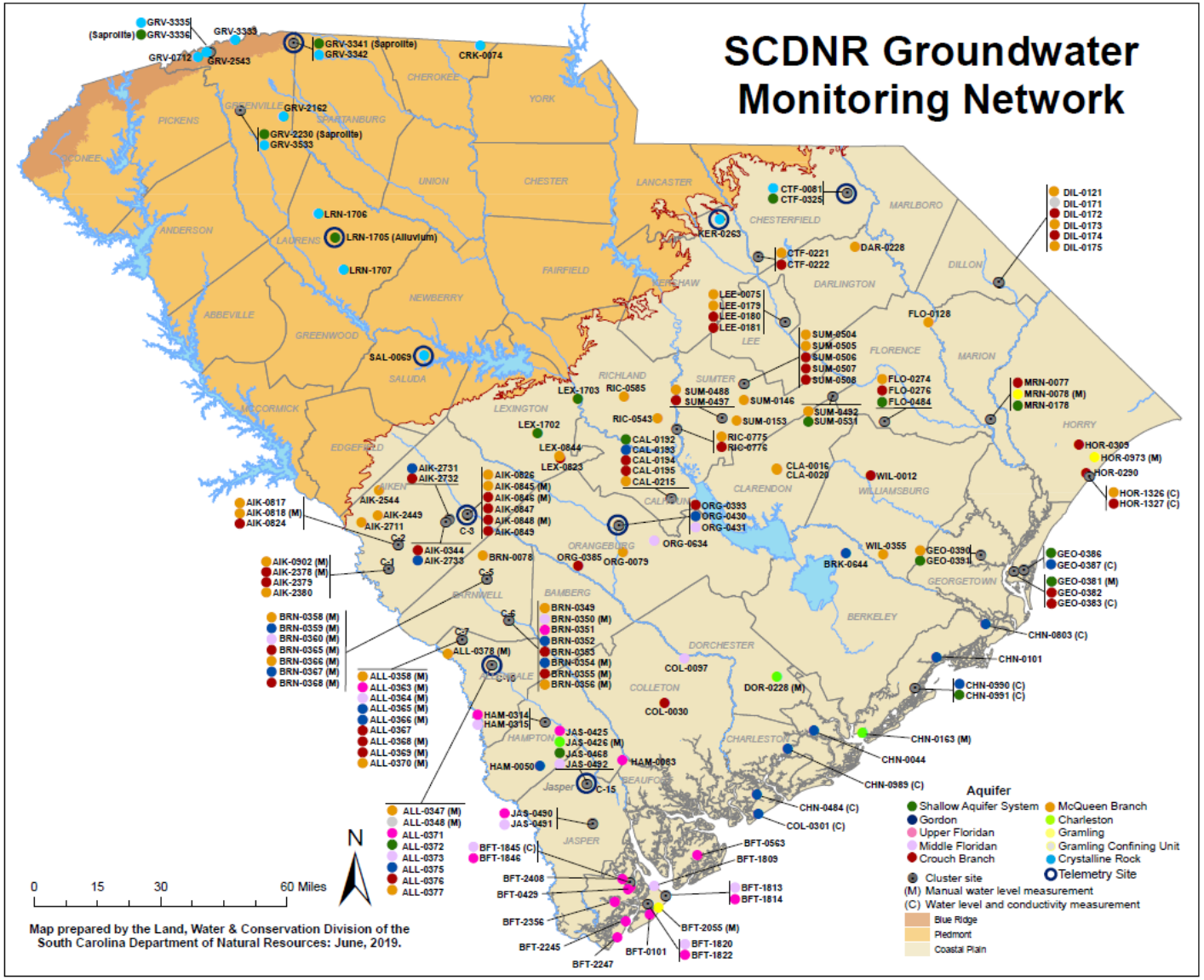
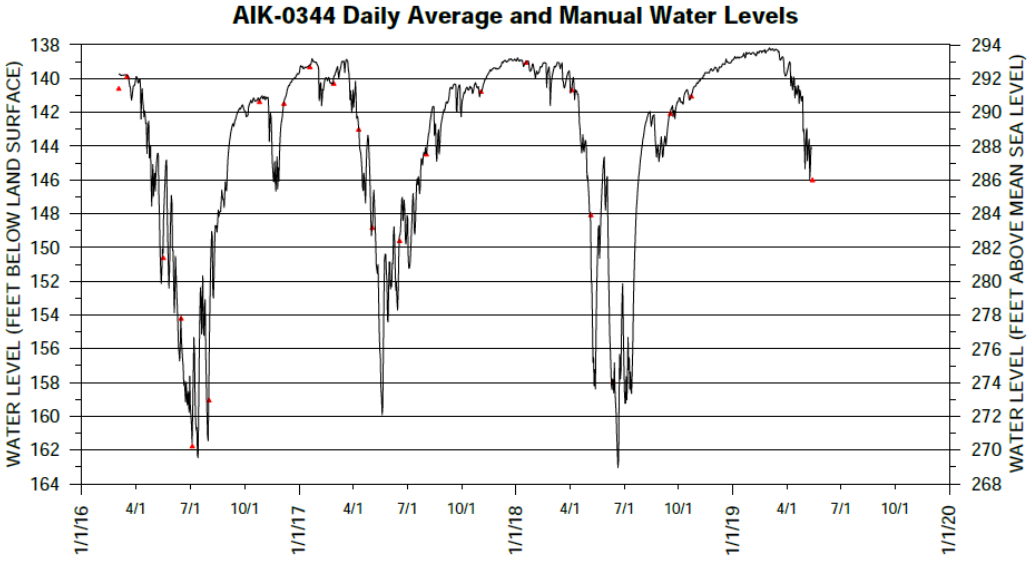


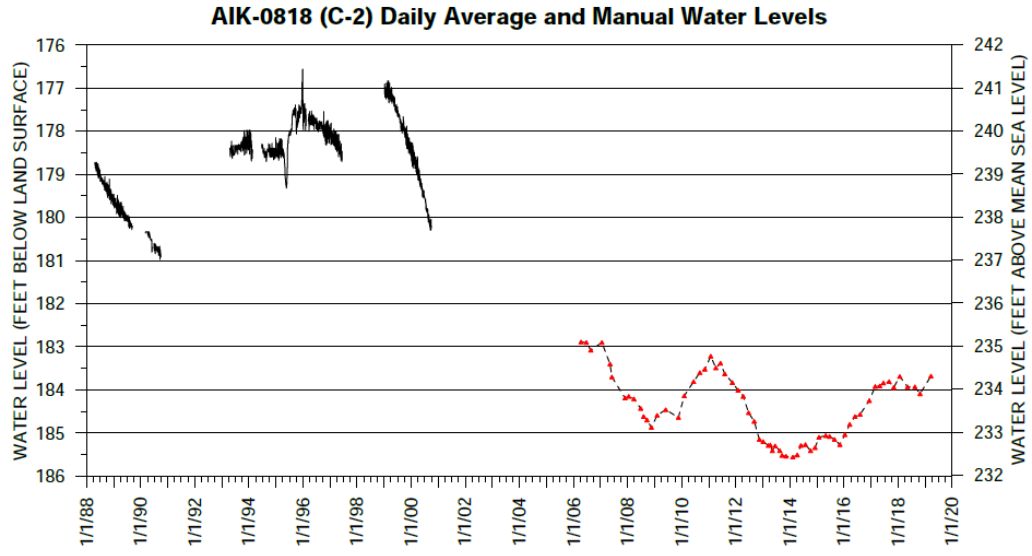
Figure A-20. Map indicating the locations of the wells in the SC DNR groundwater monitoring network. The following pages contain the current hydrographs for each Western Area County with the exception of Bamberg County in which there are no network wells.

Aiken County



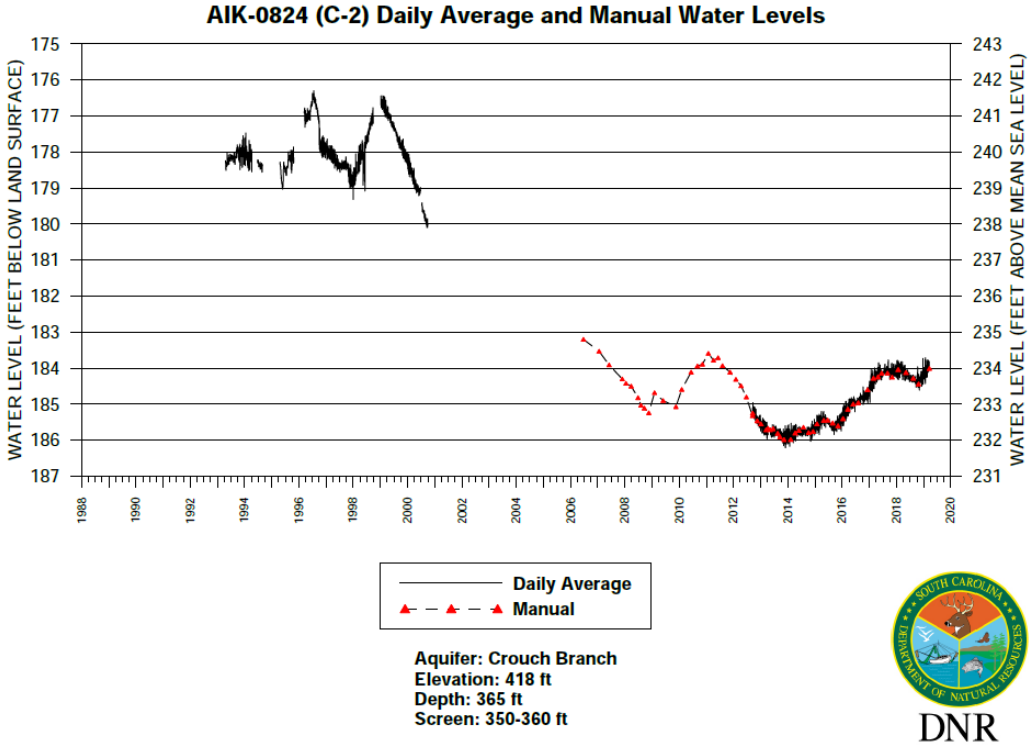
Aquifer: Crouch Branch
Elevation: 432 ft
Depth: 404 ft
Screen: 338-404 ft

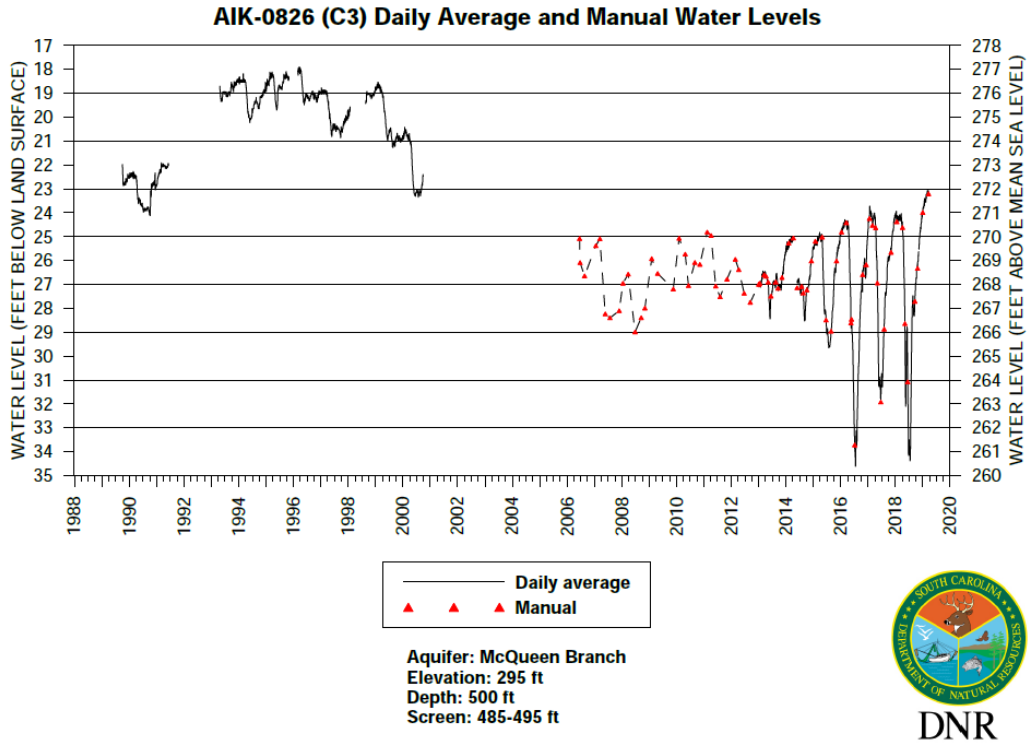
DNR

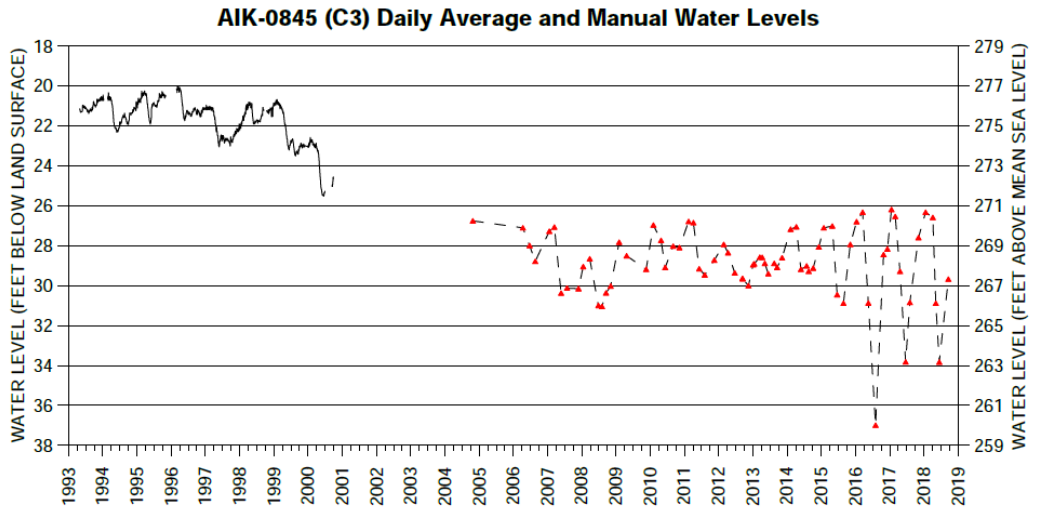


Aquifer: McQueen Branch
Elevation: 418 ft
Depth: 425 ft
Screen: 410-420 ft

DNR

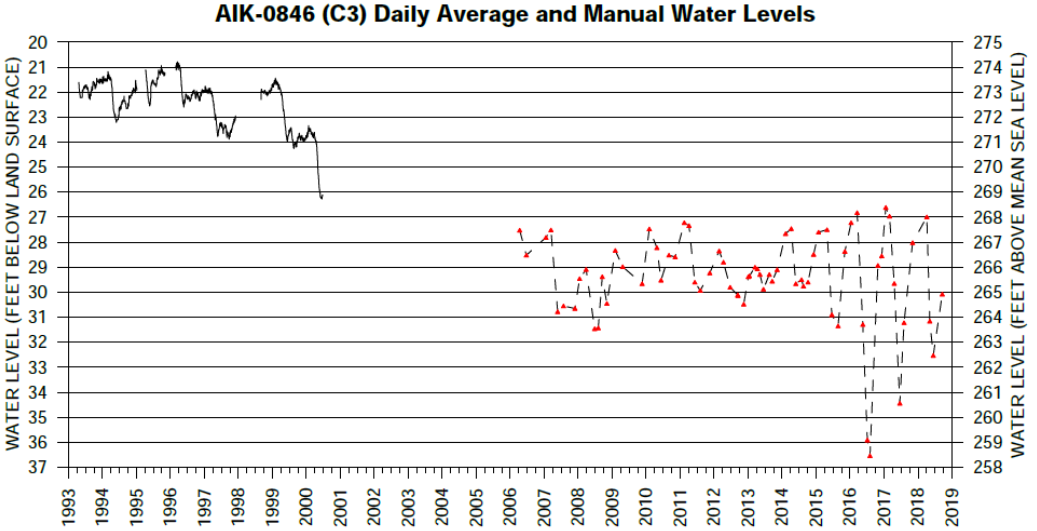

AIK-0824 (C-2) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
175 176 177 178 179 180 181 182 183 184 185 186 187
243 242 241 240 239 238 237 236 235 234 233 232 231
1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020
Daily Average
Manual
Aquifer: Crouch Branch
Elevation: 418 ft
Depth: 365 ft
Screen: 350-360 ft
DNR


AIK-0826 (C3) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
278 277 276 275 274 273 272 271 270 269 268 267 266 265 264 263 262 261 260
1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020
Daily average
Manual
Aquifer: McQueen Branch
Elevation: 295 ft
Depth: 500 ft
Screen: 485-495 ft
DNR



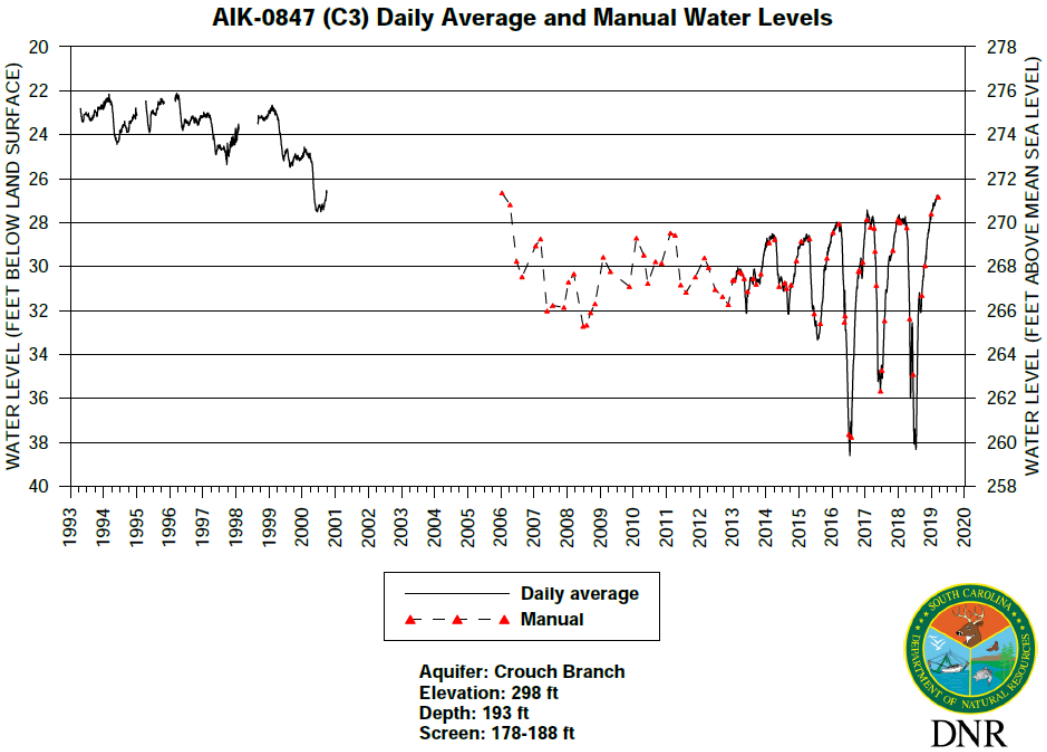
Aquifer: McQueen Branch
Elevation: 297 ft
Depth: 356 ft
Screen: 341-351 ft

DNR



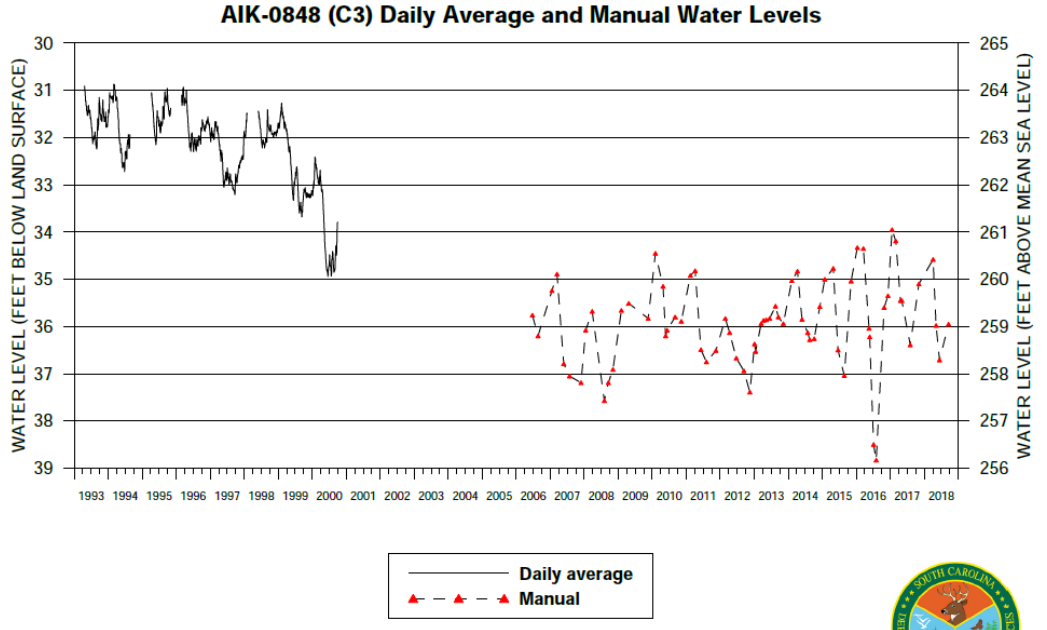
Aquifer: Crouch Branch
Elevation: 295 ft
Depth: 255 ft
Screen: 240-250 ft

DNR



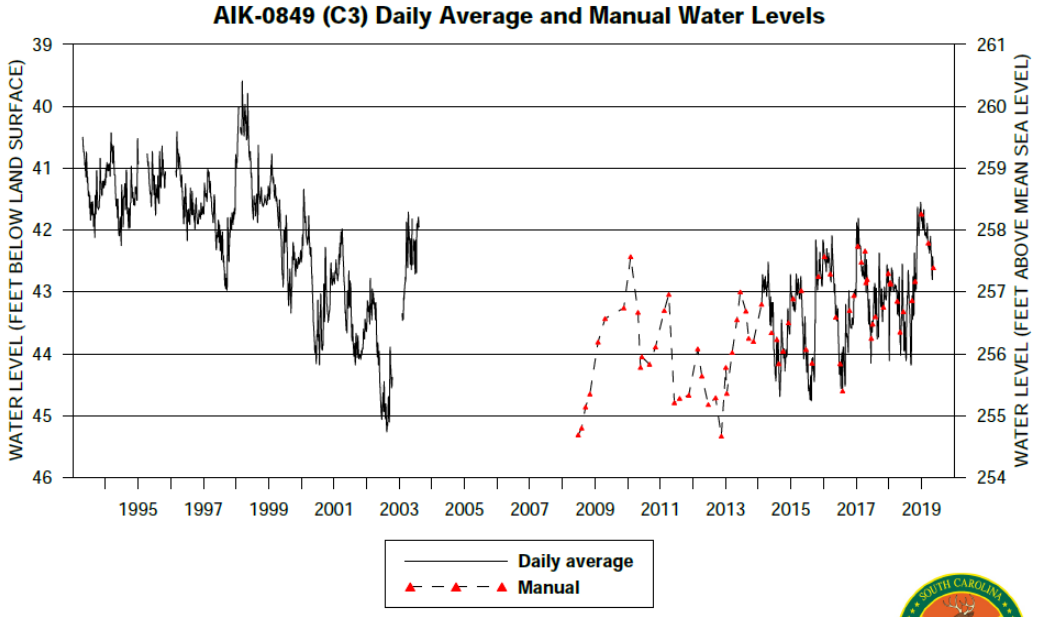
Aquifer: Crouch Branch
Elevation: 298 ft
Depth: 193 ft
Screen: 178-188 ft

DNR

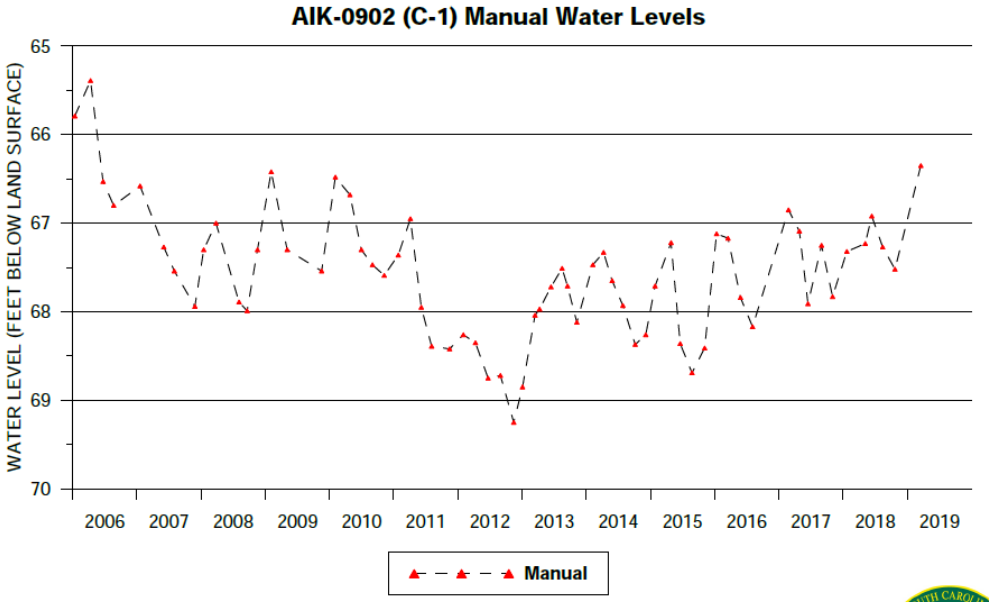


Aquifer: Crouch Branch
Elevation: 295 ft
depth: 131 ft
Screen: 116-126 ft

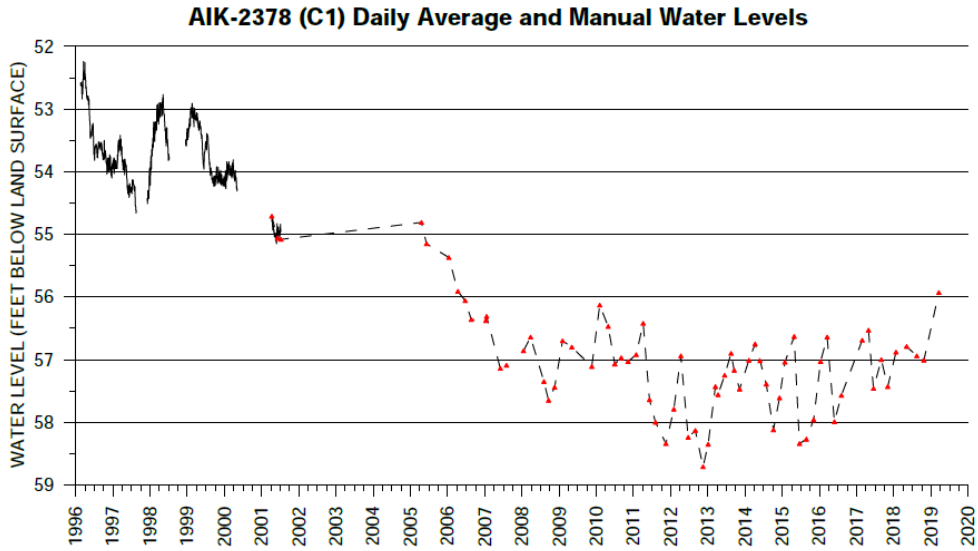
DNR


AIK-0849 (C3) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
39
40
41
42
43
44
45
46
261
260
259
258
257
256
255
254
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Daily average
Manual
Aquifer: Crouch Branch
Elevation: 300 ft
Depth: 97 ft
Screen: 82-92 ft

DNR

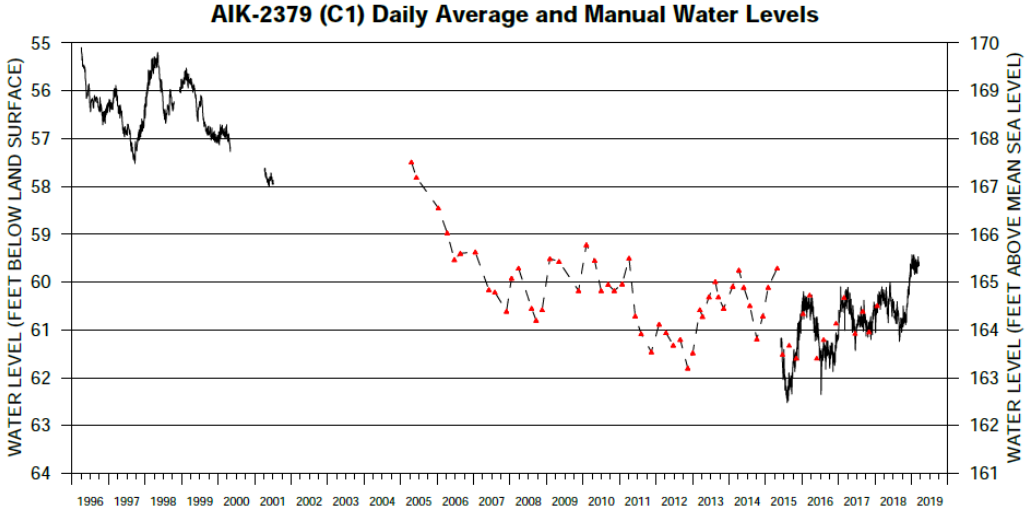

AIK-0902 (C-1) Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
65
66
67
68
69
70
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Manual
Aquifer: McQueen Branch
Elevation: 225 ft
Depth: 511 ft
Screen: 496-506 ft

DNR



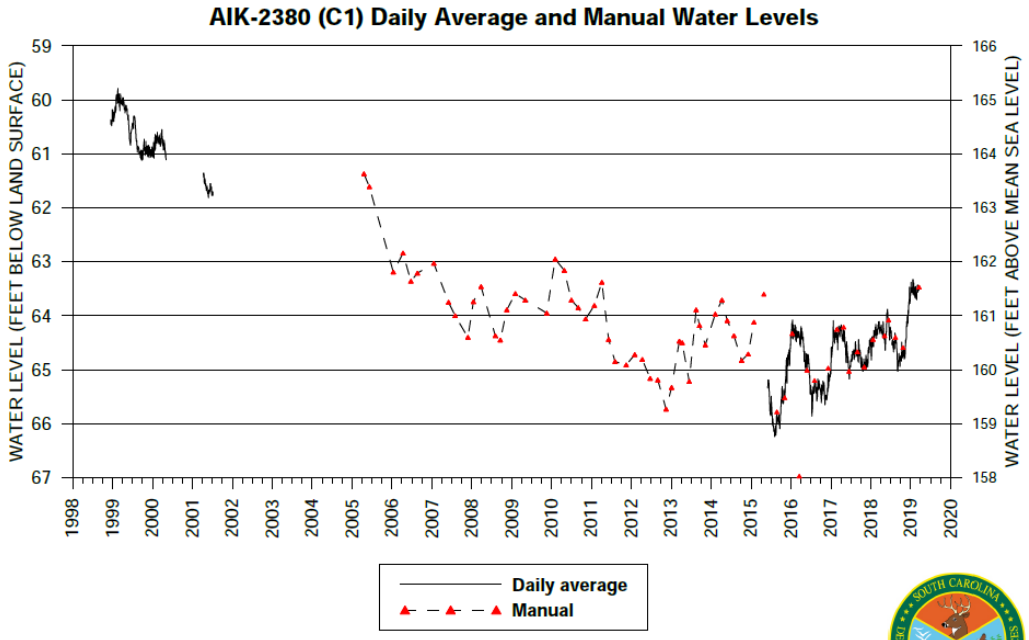
Aquifer: Crouch Branch
Elevation: 220.3 ft
Depth: 185 ft
Screen: 170-180 ft

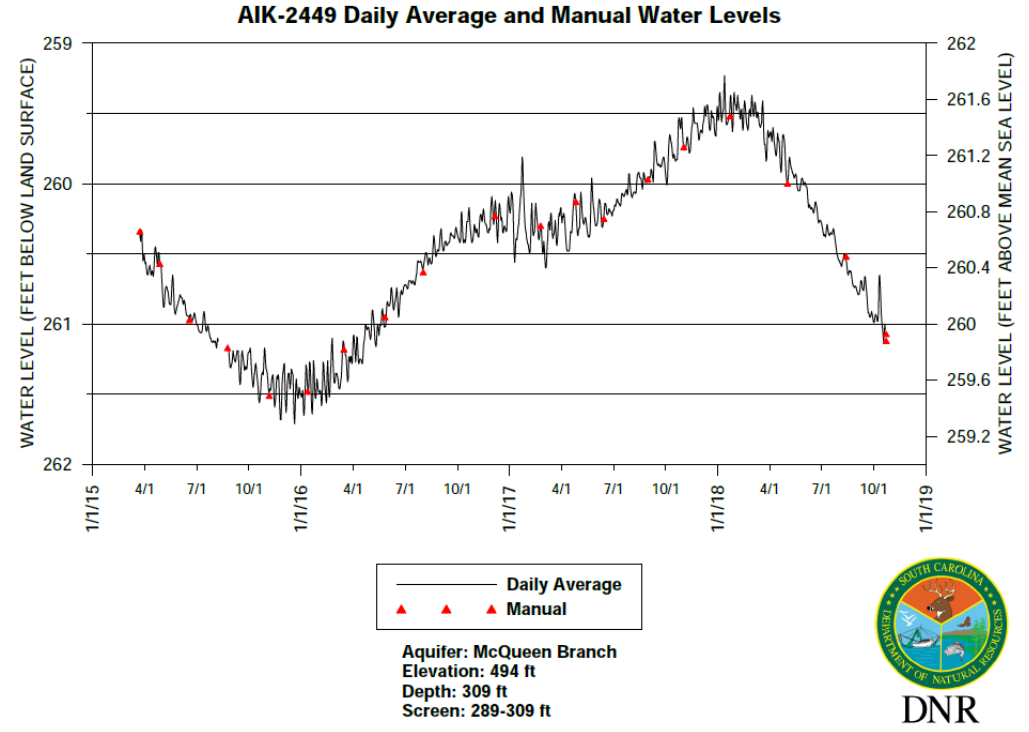
DNR

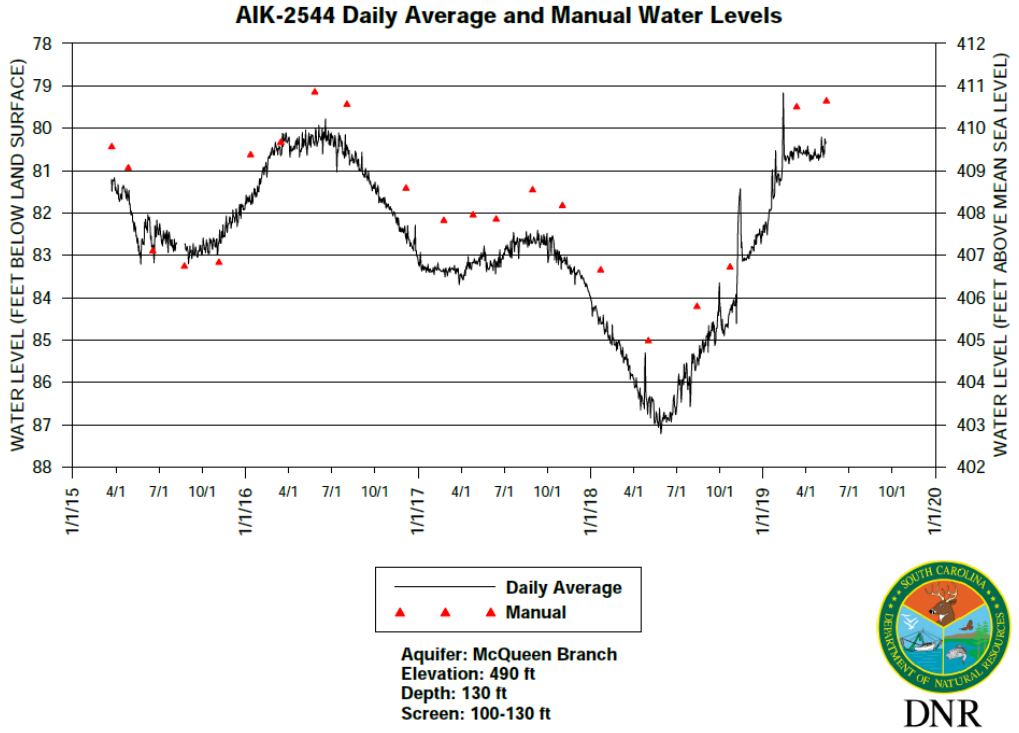


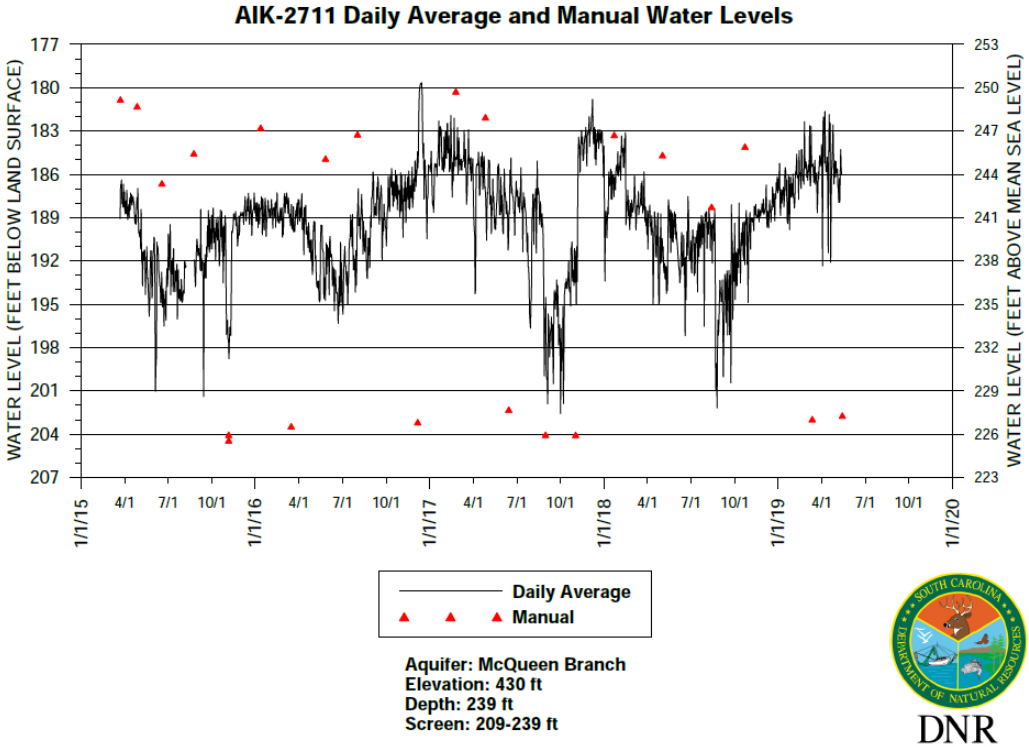
Aquifer: Crouch Branch
Elevation: 225 ft
Depth: 266 ft
Screen: 251-261 ft

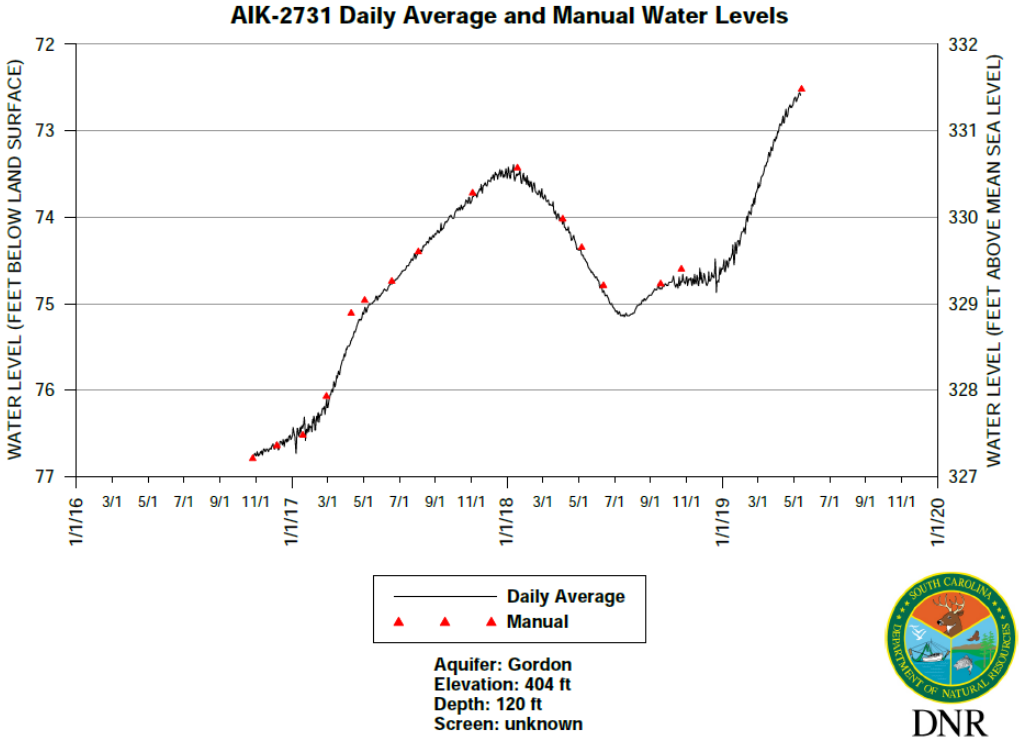
DNR

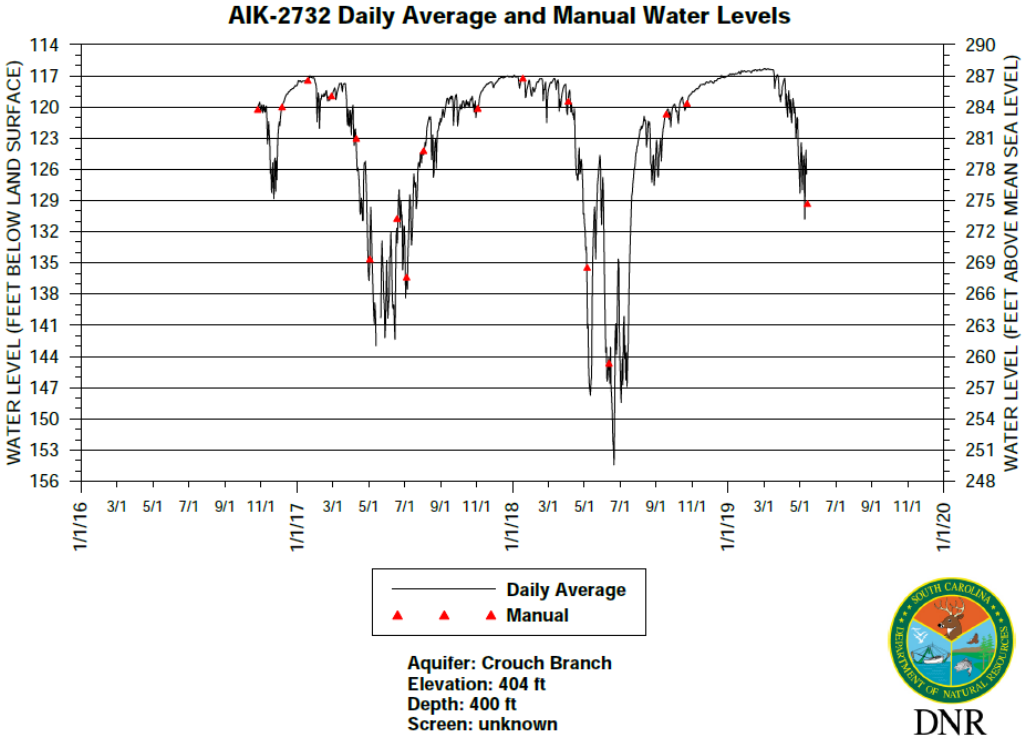

AIK-2380 (C1) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
59
60
61
62
63
64
65
66
67
166
165
164
163
162
161
160
159
158
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Daily average
Manual
Aquifer: McQueen Branch
Elevation: 225 ft
Depth: 385 ft
Screen: 370-380 ft
DNR

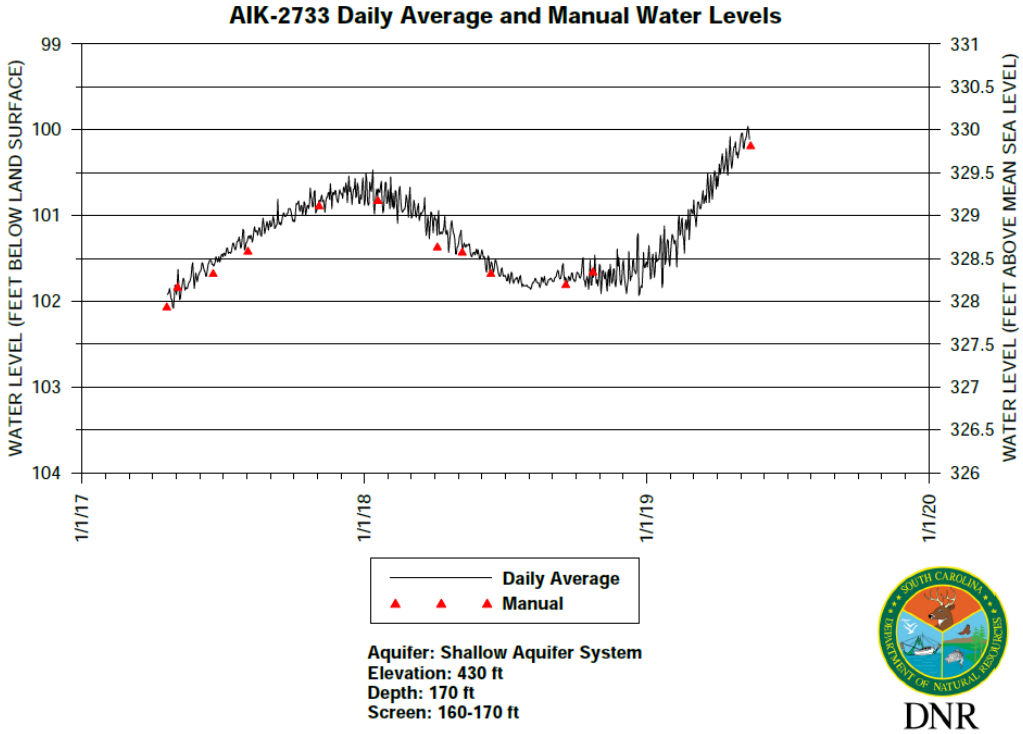

AIK-2449 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
259
260
261
262
262
261.6
261.2
260.8
260.4
260
259.6
259.2
1/1/15
4/1
7/1
10/1
1/1/16
4/1
7/1
10/1
1/1/17
4/1
7/1
10/1
1/1/18
4/1
7/1
10/1
1/1/19
Daily Average
Manual
Aquifer: McQueen Branch
Elevation: 494 ft
Depth: 309 ft
Screen: 289-309 ft
DNR


AIK-2544 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
78
79
80
81
82
83
84
85
86
87
88
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
412
411
410
409
408
407
406
405
404
403
402
1/1/15
4/1
7/1
10/1
1/1/16
4/1
7/1
10/1
1/1/17
4/1
7/1
10/1
1/1/18
4/1
7/1
10/1
1/1/19
4/1
7/1
10/1
1/1/20
Daily Average
Manual
Aquifer: McQueen Branch
Elevation: 490 ft
Depth: 130 ft
Screen: 100-130 ft
DNR

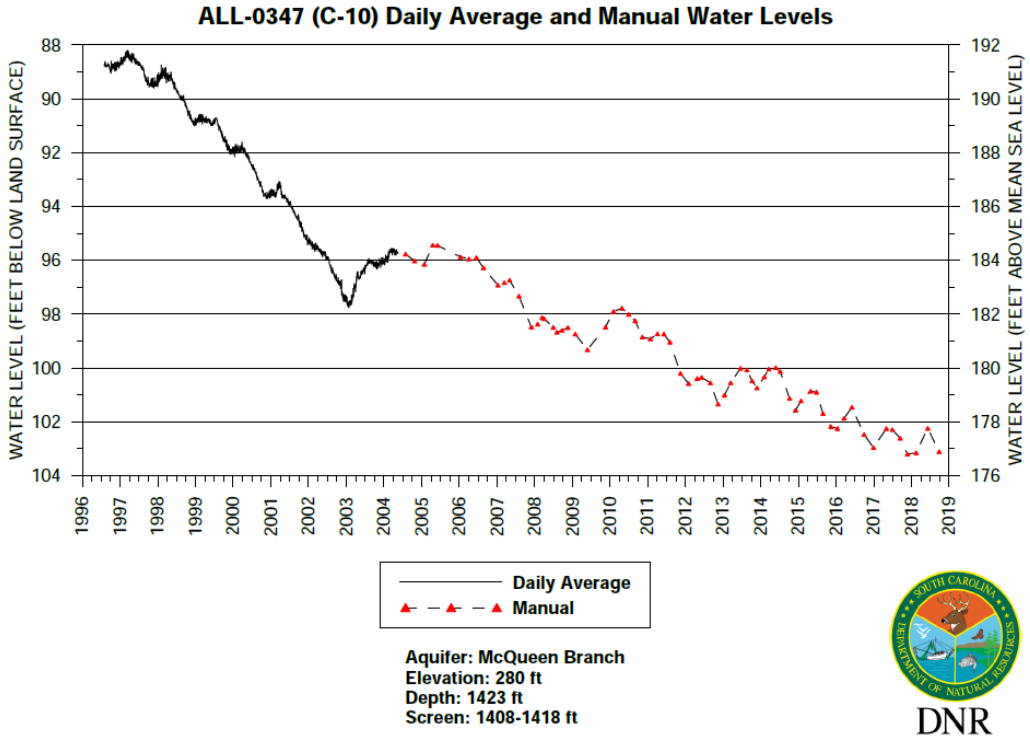

AIK-2711 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
177
180
183
186
189
192
195
198
201
204
207
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
253
250
247
244
241
238
235
232
229
226
223
1/1/15
4/1
7/1
10/1
1/1/16
4/1
7/1
10/1
1/1/17
4/1
7/1
10/1
1/1/18
4/1
7/1
10/1
1/1/19
4/1
7/1
10/1
1/1/20
Daily Average
Manual
Aquifer: McQueen Branch
Elevation: 430 ft
Depth: 239 ft
Screen: 209-239 ft
DNR

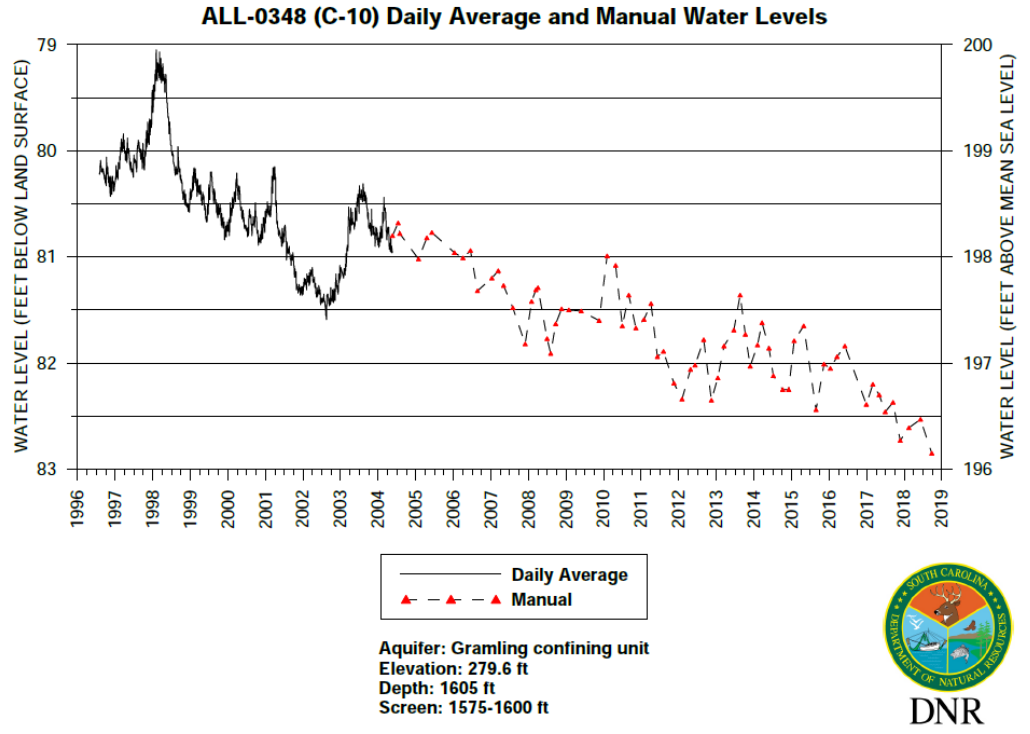

AIK-2731 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
72
73
74
75
76
77
332
331
330
329
328
327
1/1/16
3/1
5/1
7/1
9/1
11/1
1/1/17
3/1
5/1
7/1
9/1
11/1
1/1/18
3/1
5/1
7/1
9/1
11/1
1/1/19
3/1
5/1
7/1
9/1
11/1
1/1/20
Daily Average
Manual
Aquifer: Gordon
Elevation: 404 ft
Depth: 120 ft
Screen: unknown
DNR

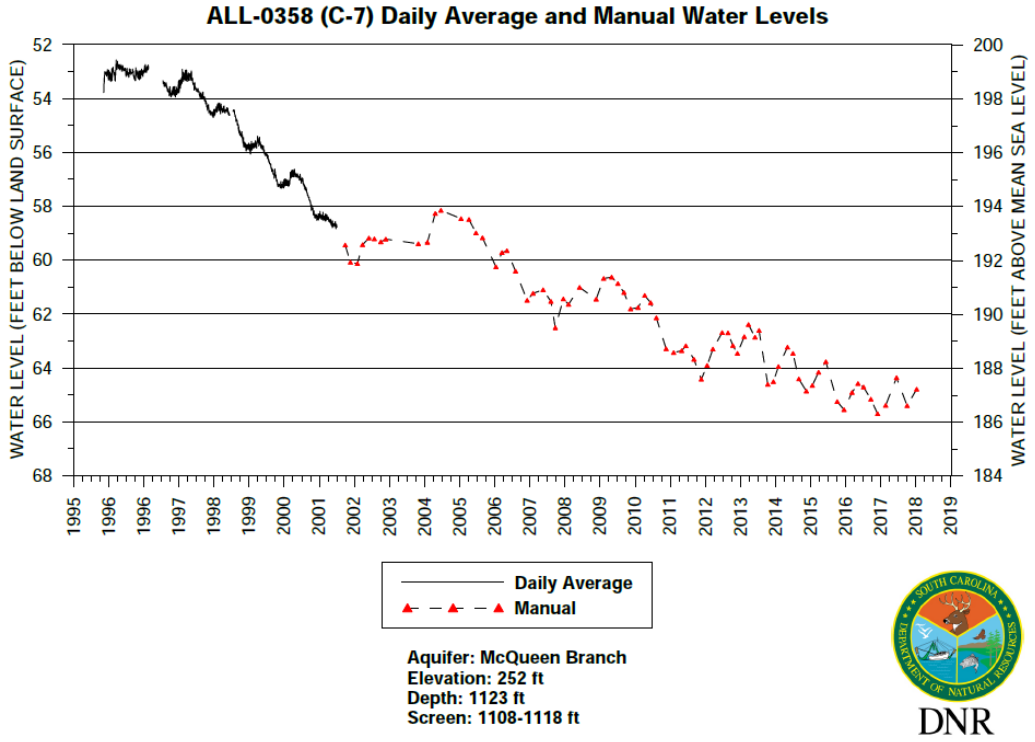

AIK-2732 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
114
117
120
123
126
129
132
135
138
141
144
147
150
153
156
290
287
284
281
278
275
272
269
266
263
260
257
254
251
248
1/1/16
3/1
5/1
7/1
9/1
11/1
1/1/17
3/1
5/1
7/1
9/1
11/1
1/1/18
3/1
5/1
7/1
9/1
11/1
1/1/19
3/1
5/1
7/1
9/1
11/1
1/1/20
Daily Average
Manual
Aquifer: Crouch Branch
Elevation: 404 ft
Depth: 400 ft
Screen: unknown
DNR

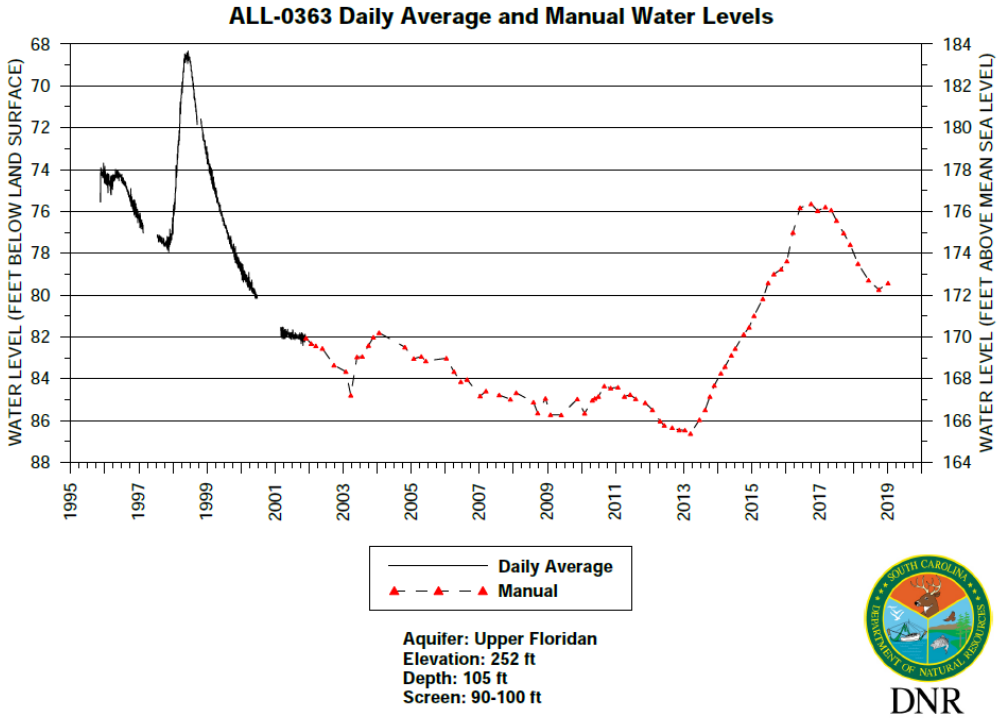

AIK-2733 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
99
100
101
102
103
104
331
330.5
330
329.5
329
328.5
328
327.5
327
326.5
326
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
1/1/17
1/1/18
1/1/19
1/1/20
Daily Average
Manual
Aquifer: Shallow Aquifer System
Elevation: 430 ft
Depth: 170 ft
Screen: 160-170 ft
DNR

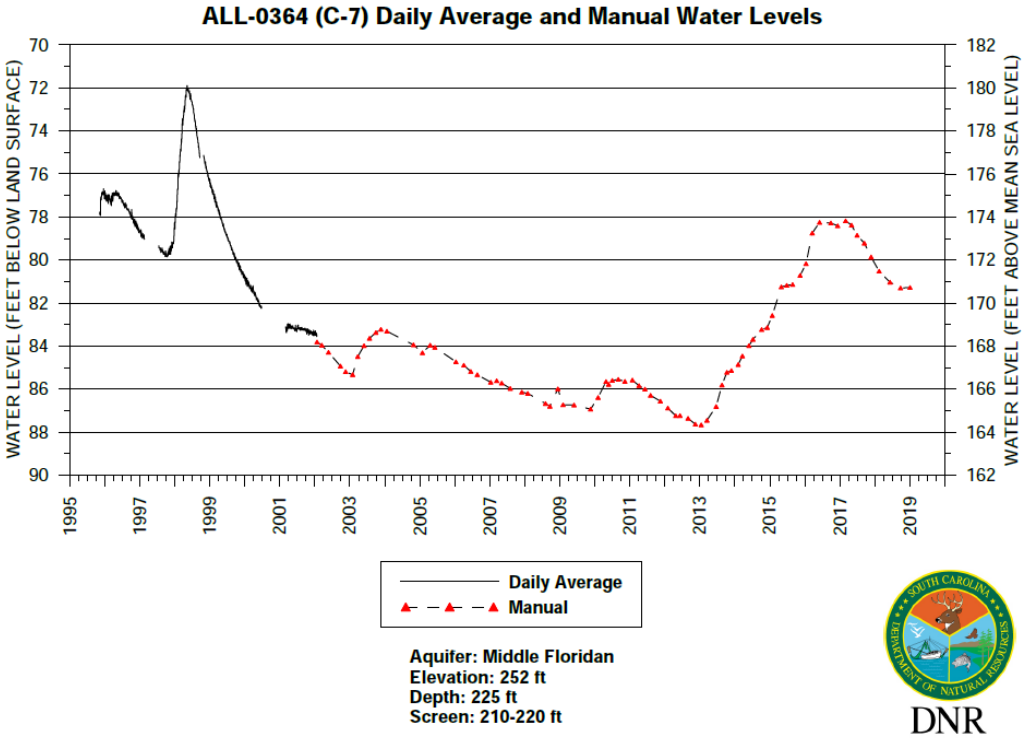
Allendale County



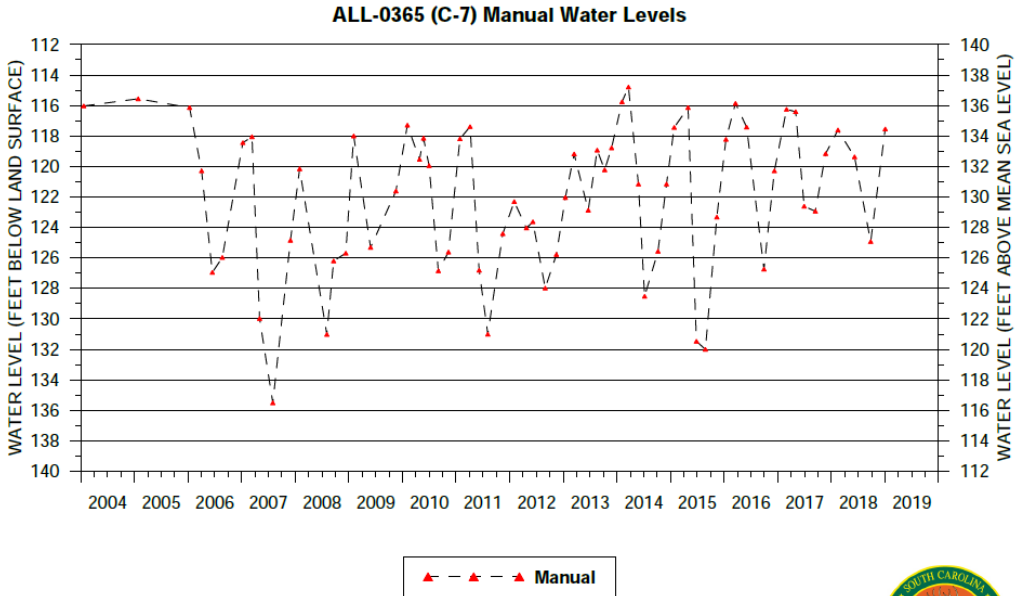



ALL-0358 (C-7) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
52
54
56
58
60
62
64
66
68
200
198
196
194
192
190
188
186
184
1995
1996
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Daily Average
Manual
Aquifer: McQueen Branch
Elevation: 252 ft
Depth: 1123 ft
Screen: 1108-1118 ft
DNR

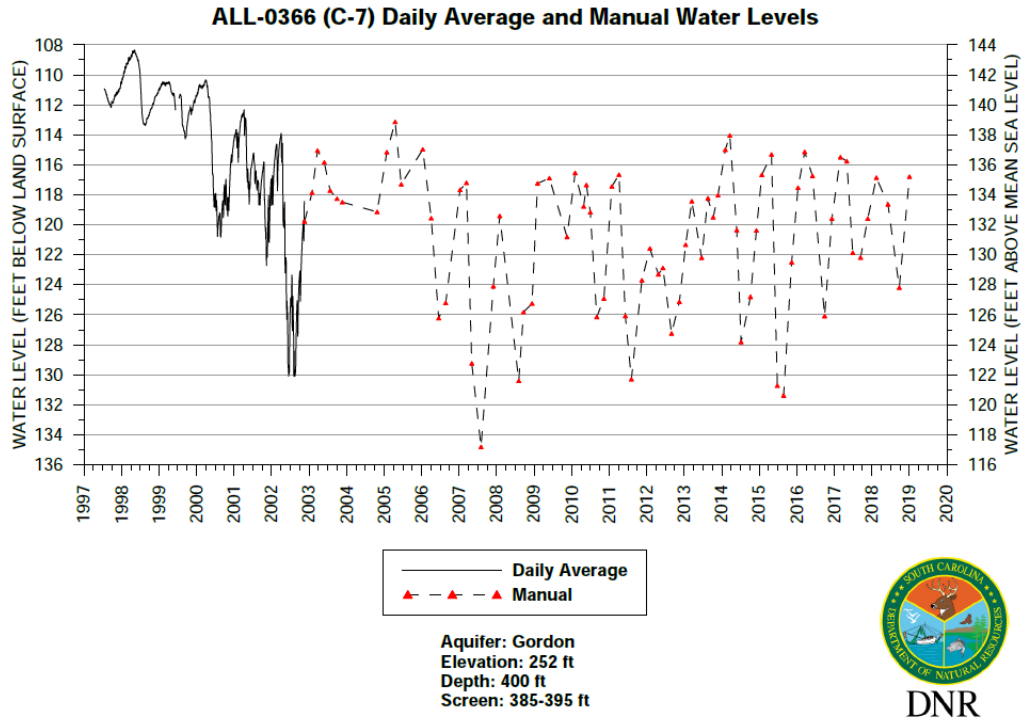

ALL-0363 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
68
70
72
74
76
78
80
82
84
86
88
184
182
180
178
176
174
172
170
168
166
164
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Daily Average
Manual
Aquifer: Upper Floridan
Elevation: 252 ft
Depth: 105 ft
Screen: 90-100 ft
DNR

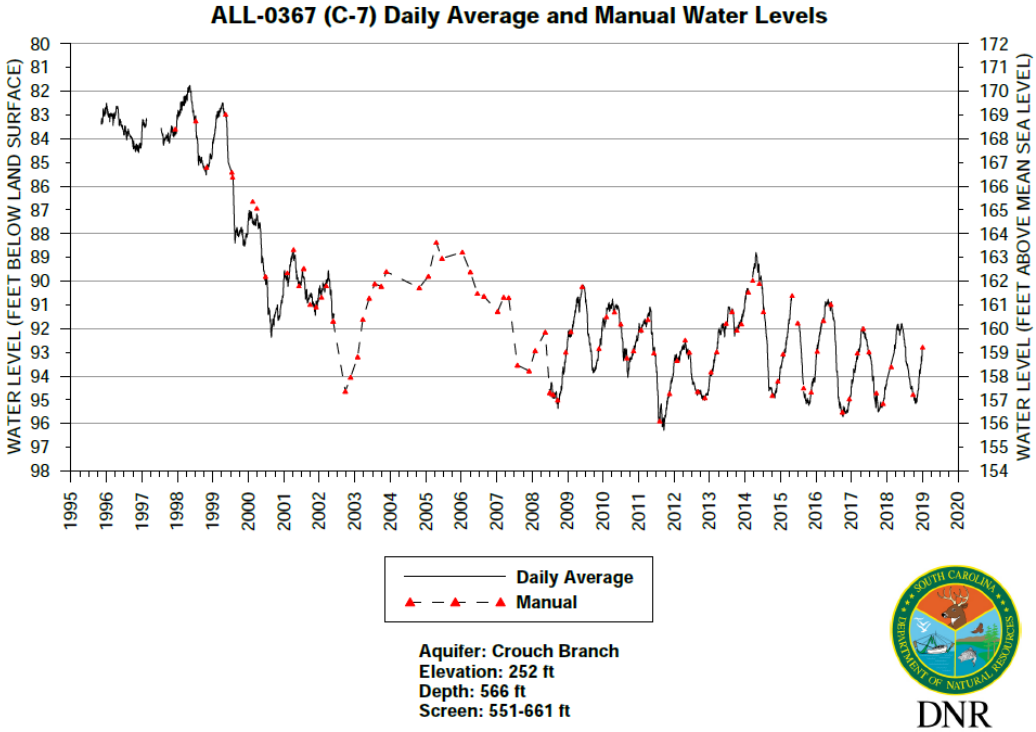

ALL-0364 (C-7) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
70 72 74 76 78 80 82 84 86 88 90
182 180 178 176 174 172 170 168 166 164 162
1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015 2017 2019
Daily Average
Manual
Aquifer: Middle Floridan
Elevation: 252 ft
Depth: 225 ft
Screen: 210-220 ft

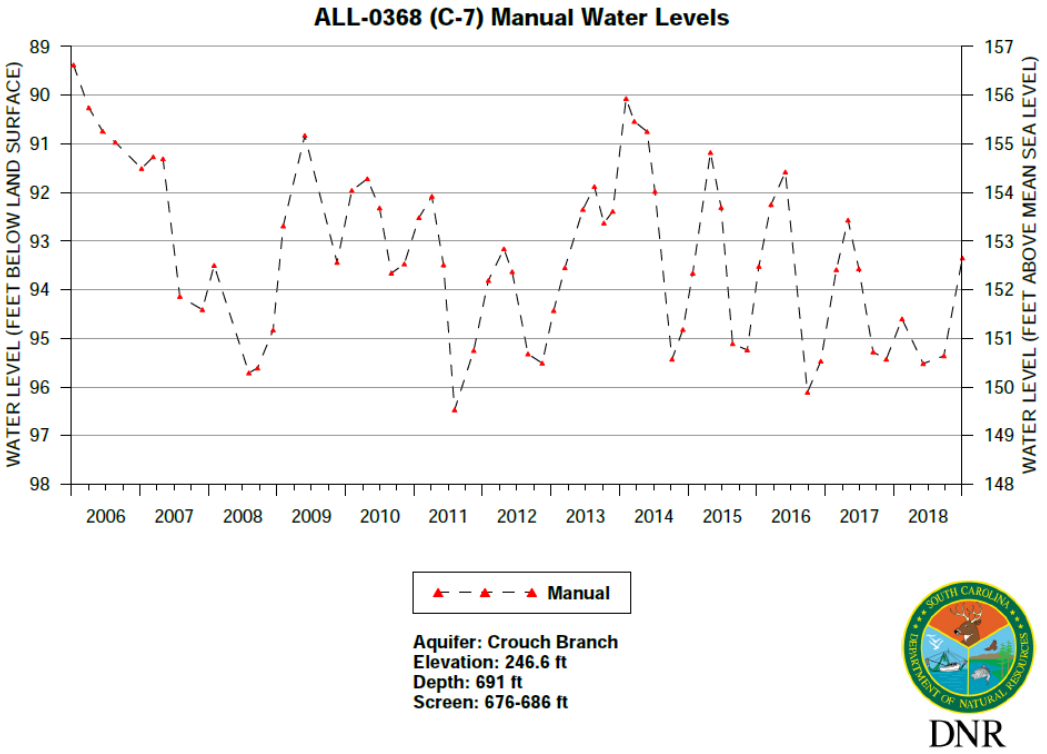
DNR

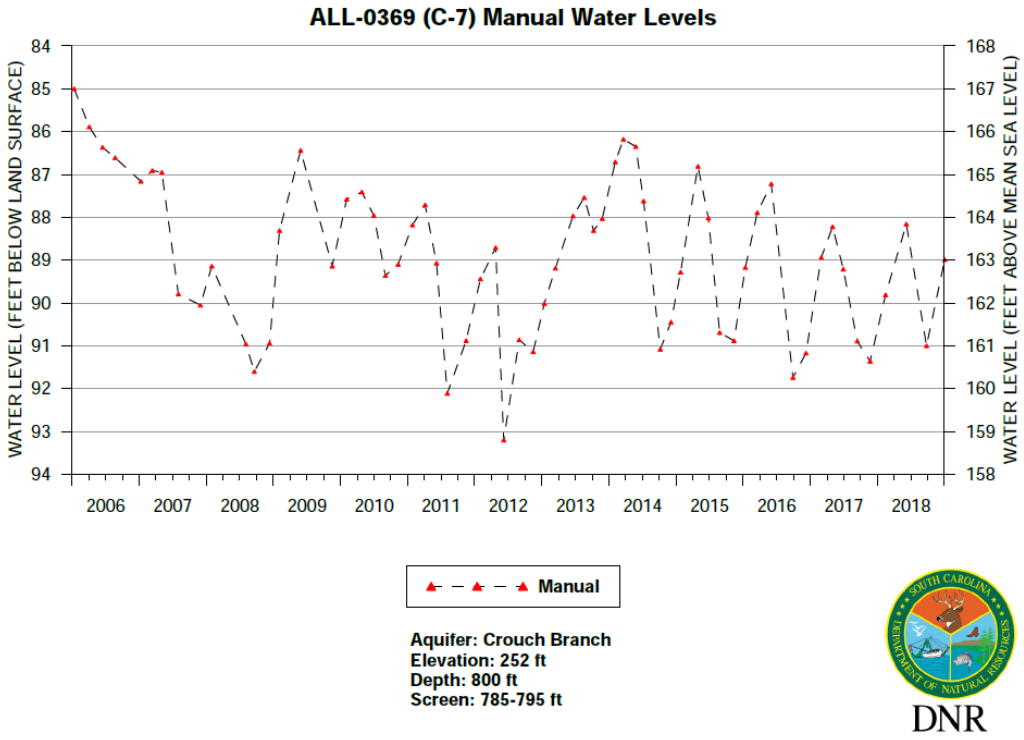

ALL-0365 (C-7) Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
112 114 116 118 120 122 124 126 128 130 132 134 136 138 140
140 138 136 134 132 130 128 126 124 122 120 118 116 114 112
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
Manual
Aquifer: Gordon
Elevation: 252 ft
Depth: 333 ft
Screen: 318-328 ft

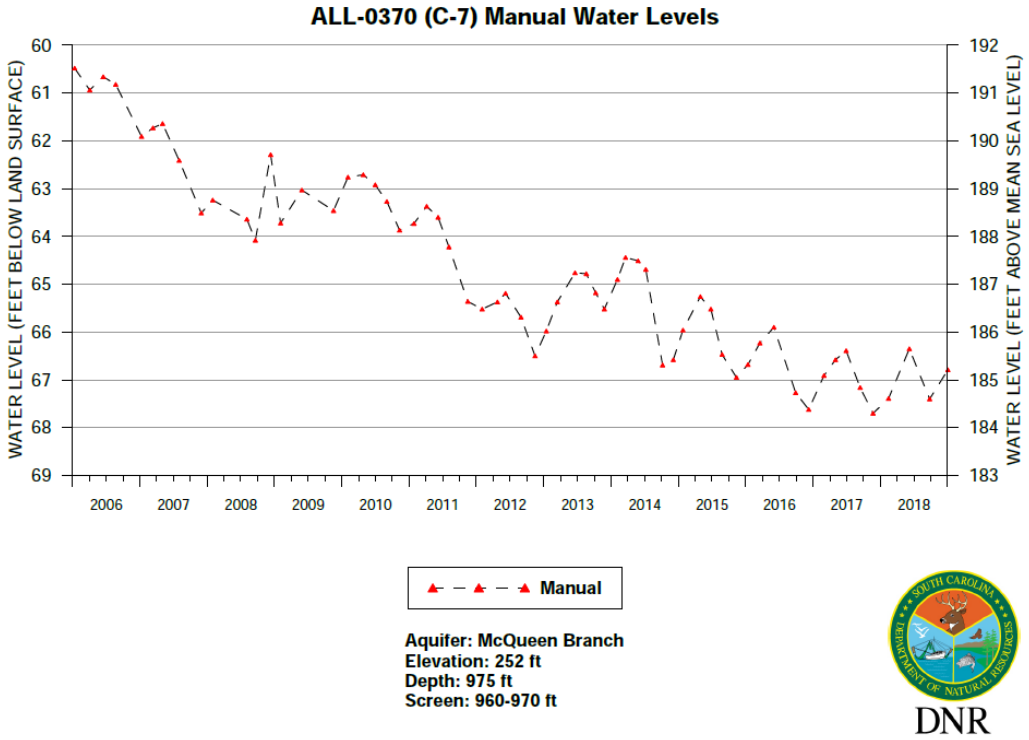
DNR

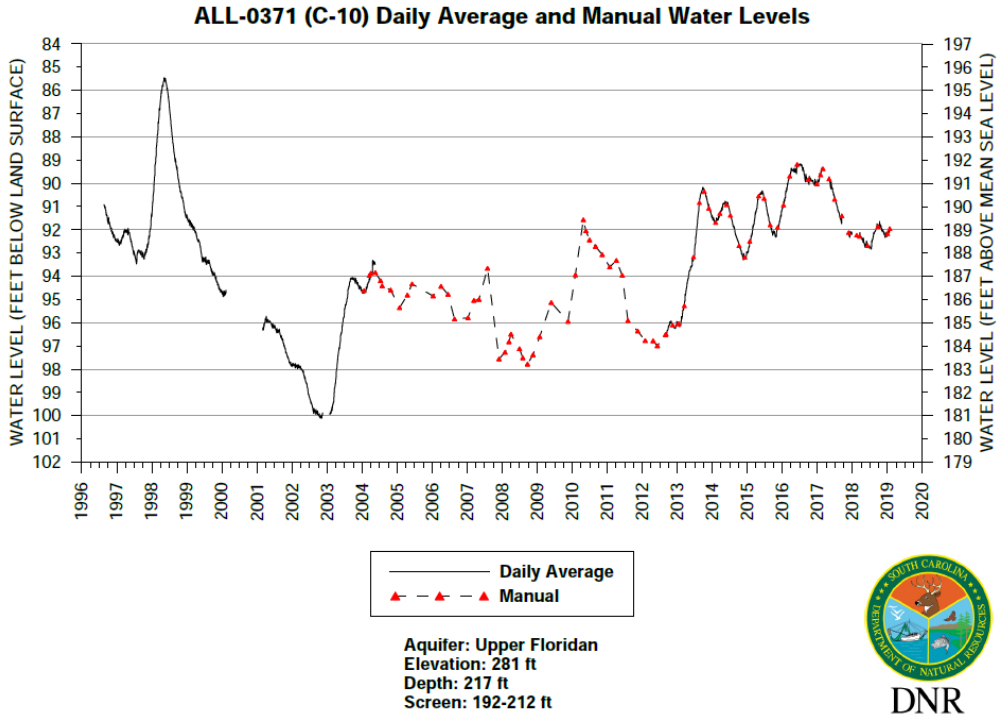

ALL-0366 (C-7) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
Daily Average
Manual
Aquifer: Gordon
Elevation: 252 ft
Depth: 400 ft
Screen: 385-395 ft
DNR

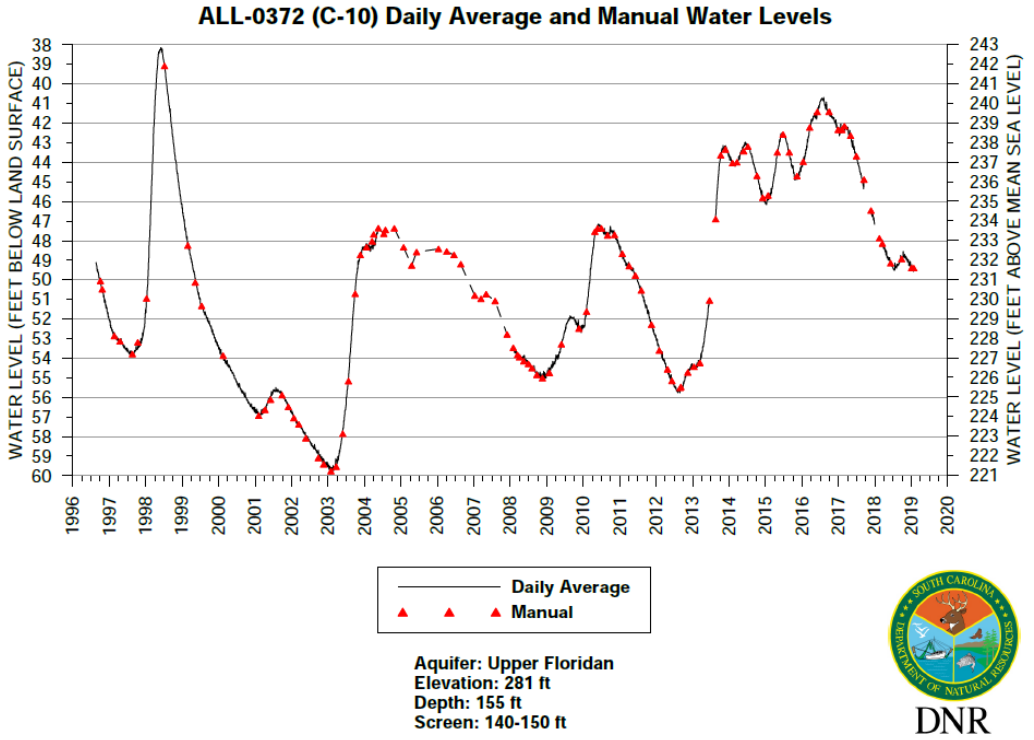

ALL-0367 (C-7) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
Daily Average
Manual
Aquifer: Crouch Branch
Elevation: 252 ft
Depth: 566 ft
Screen: 551-661 ft
DNR

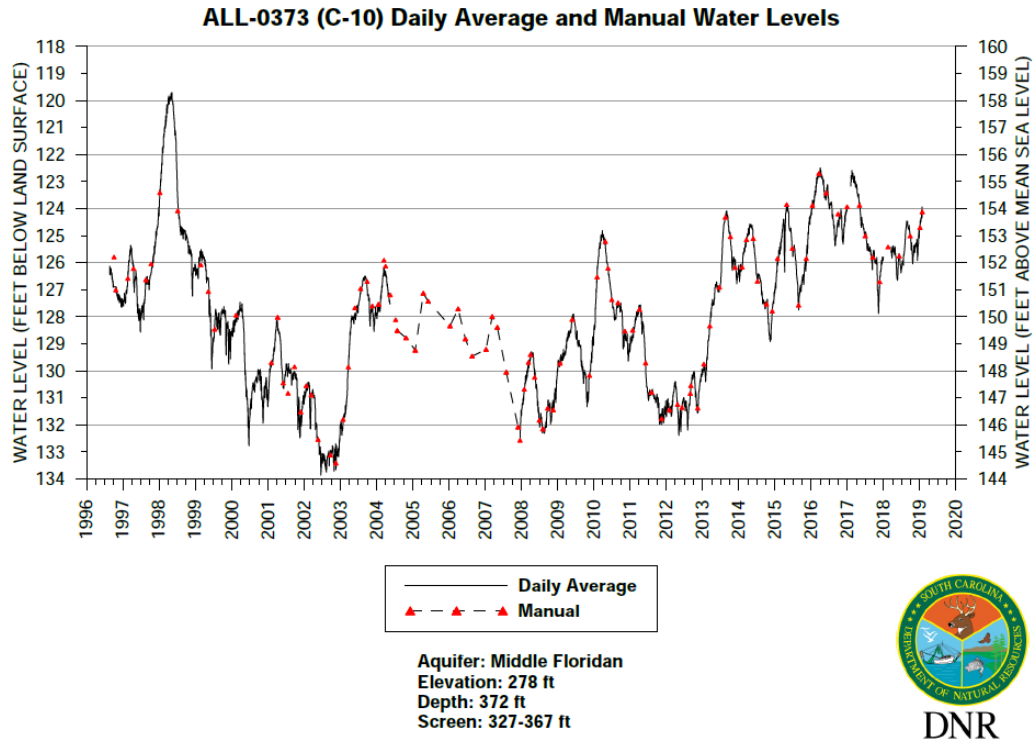

ALL-0368 (C-7) Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
89
90
91
92
93
94
95
96
97
98
157
156
155
154
153
152
151
150
149
148
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Manual
Aquifer: Crouch Branch
Elevation: 246.6 ft
Depth: 691 ft
Screen: 676-686 ft
DNR

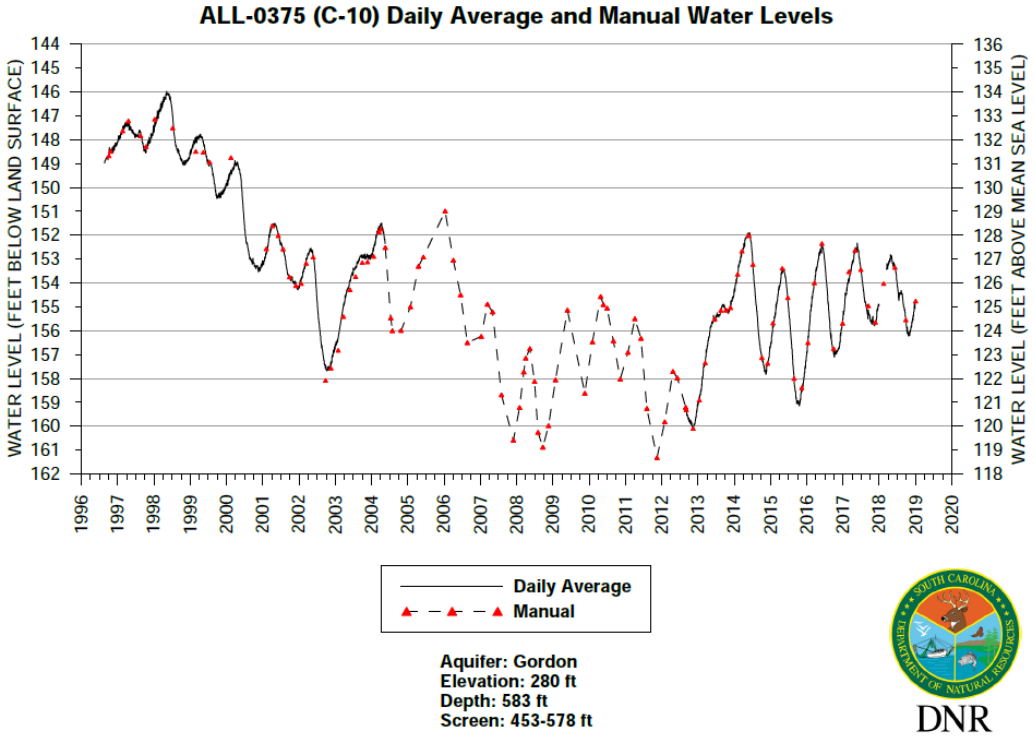

ALL-0369 (C-7) Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
84
85
86
87
88
89
90
91
92
93
94
168
167
166
165
164
163
162
161
160
159
158
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Manual
Aquifer: Crouch Branch
Elevation: 252 ft
Depth: 800 ft
Screen: 785-795 ft
DNR


ALL-0370 (C-7) Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
60
61
62
63
64
65
66
67
68
69
192
191
190
189
188
187
186
185
184
183
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Manual
Aquifer: McQueen Branch
Elevation: 252 ft
Depth: 975 ft
Screen: 960-970 ft
DNR

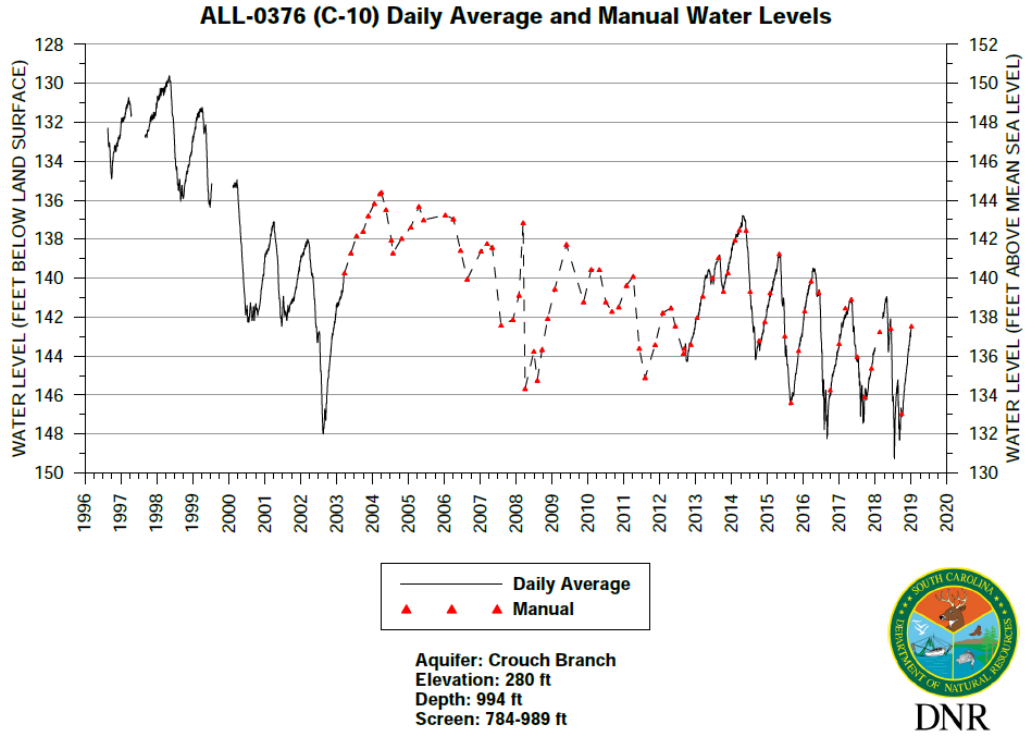

ALL-0371 (C-10) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
197
196
195
194
193
192
191
190
189
188
187
186
185
184
183
182
181
180
179
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Daily Average
Manual
Aquifer: Upper Floridan
Elevation: 281 ft
Depth: 217 ft
Screen: 192-212 ft
DNR


ALL-0372 (C-10) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
Daily Average
Manual
Aquifer: Upper Floridan
Elevation: 281 ft
Depth: 155 ft
Screen: 140-150 ft
DNR

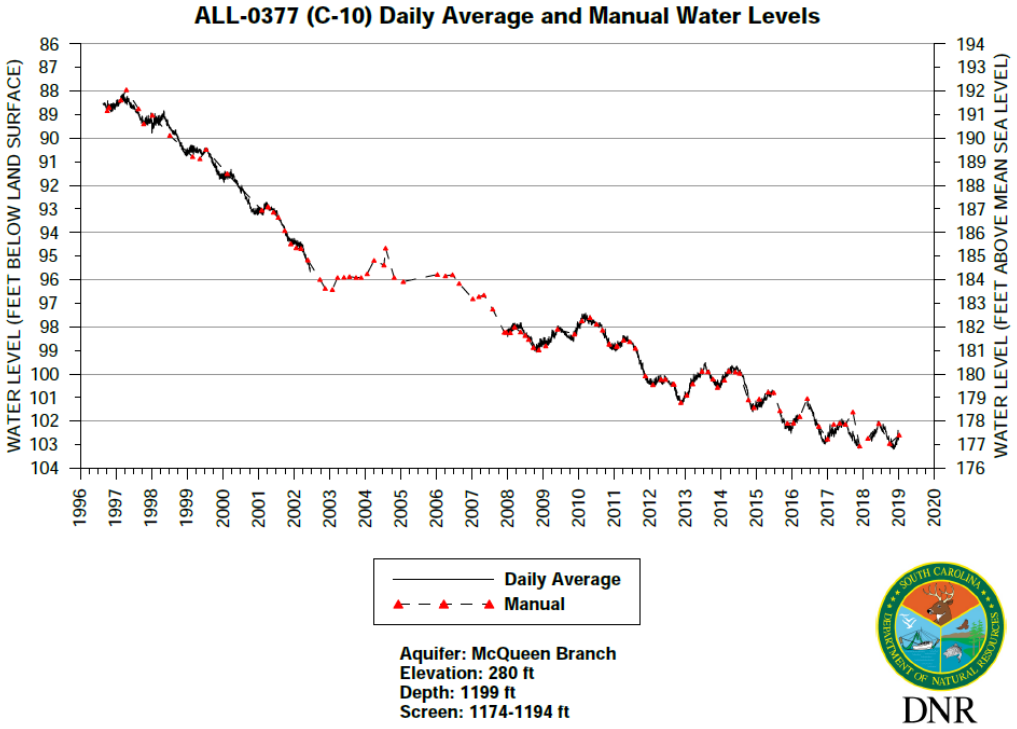

ALL-0373 (C-10) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
Daily Average
Manual
Aquifer: Middle Floridan
Elevation: 278 ft
Depth: 372 ft
Screen: 327-367 ft
DNR

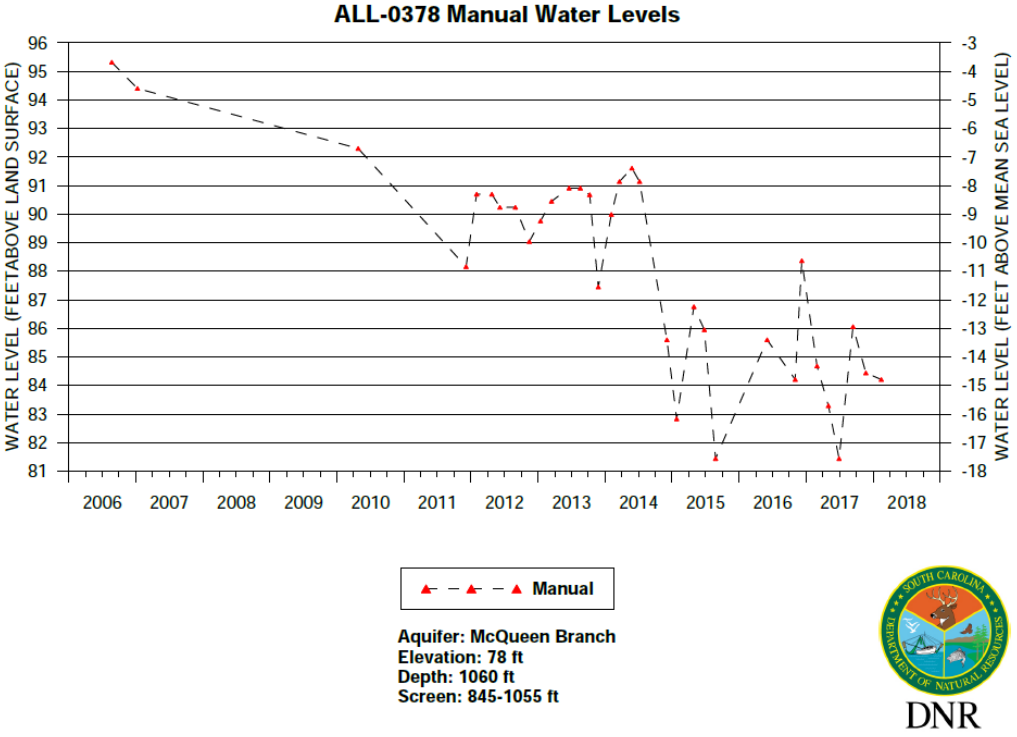

ALL-0375 (C-10) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162
136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Daily Average
Manual
Aquifer: Gordon
Elevation: 280 ft
Depth: 583 ft
Screen: 453-578 ft

DNR


ALL-0376 (C-10) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
128 130 132 134 136 138 140 142 144 146 148 150
152 150 148 146 144 142 140 138 136 134 132 130
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Daily Average
Manual
Aquifer: Crouch Branch
Elevation: 280 ft
Depth: 994 ft
Screen: 784-989 ft

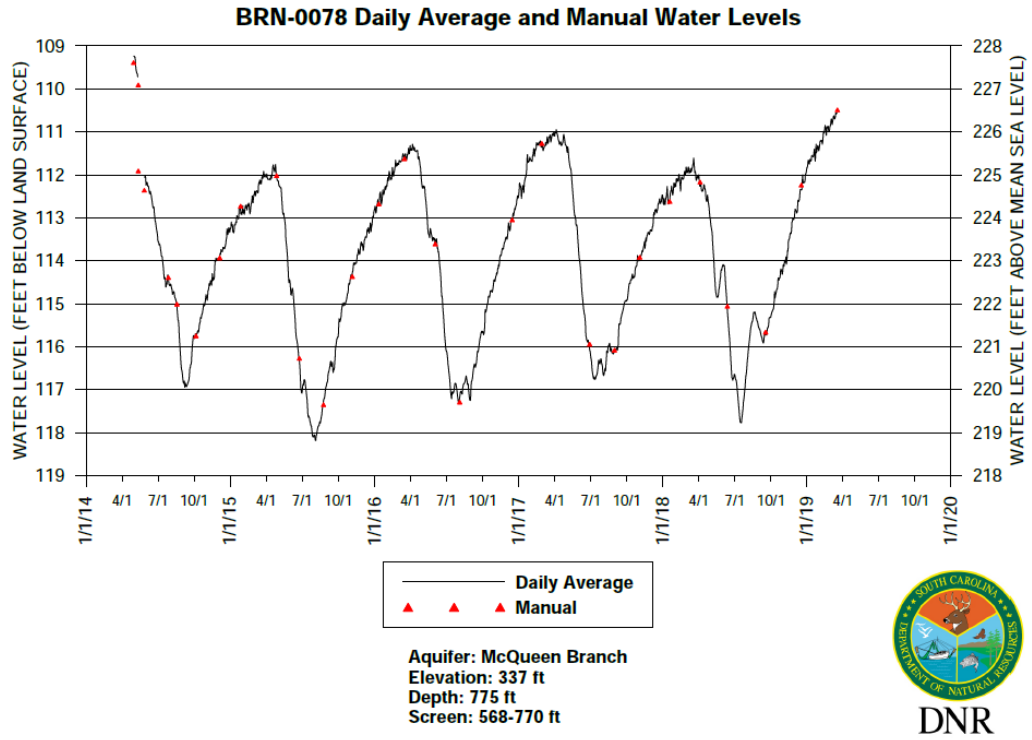
DNR

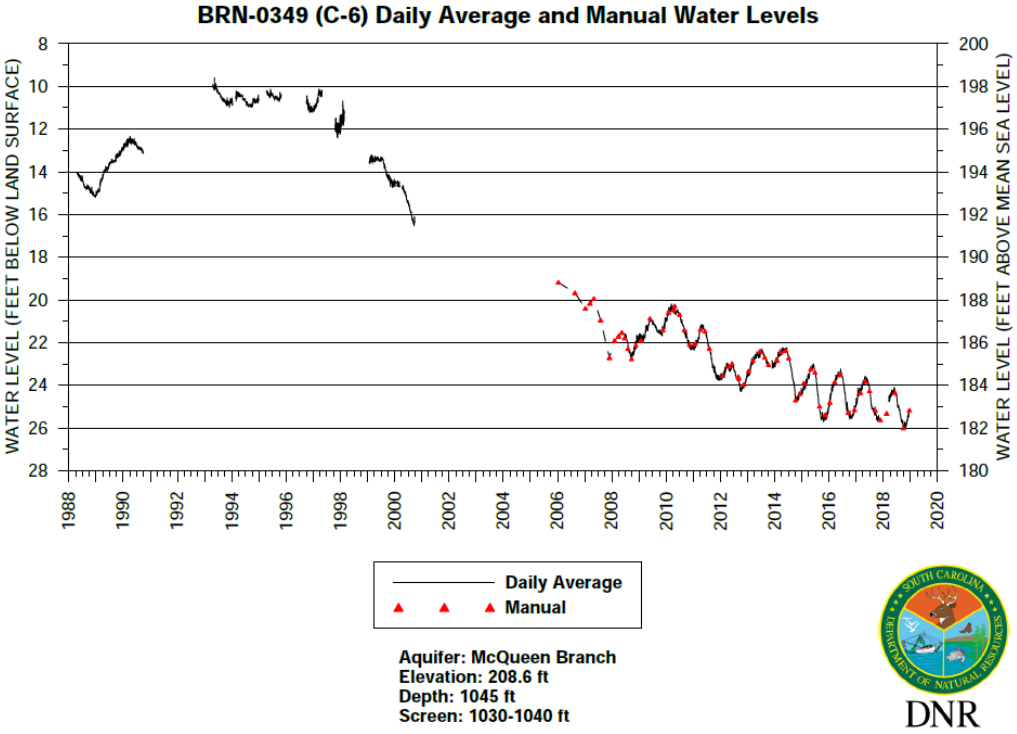

ALL-0377 (C-10) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104
194 193 192 191 190 189 188 187 186 185 184 183 182 181 180 179 178 177 176
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Daily Average
Manual
Aquifer: McQueen Branch
Elevation: 280 ft
Depth: 1199 ft
Screen: 1174-1194 ft
DNR

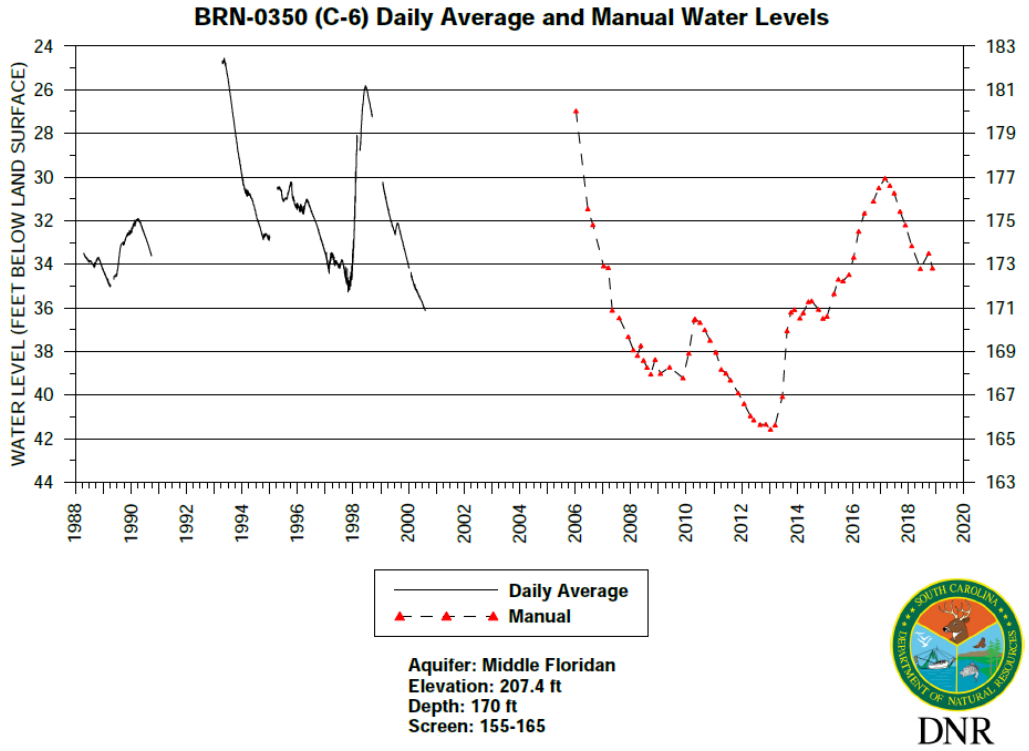

ALL-0378 Manual Water Levels
WATER LEVEL (FEETABOVE LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
96 95 94 93 92 91 90 89 88 87 86 85 84 83 82 81
-3 -4 -5 -6 -7 -8 -9 -10 -11 -12 -13 -14 -15 -16 -17 -18
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Manual
Aquifer: McQueen Branch
Elevation: 78 ft
Depth: 1060 ft
Screen: 845-1055 ft
DNR

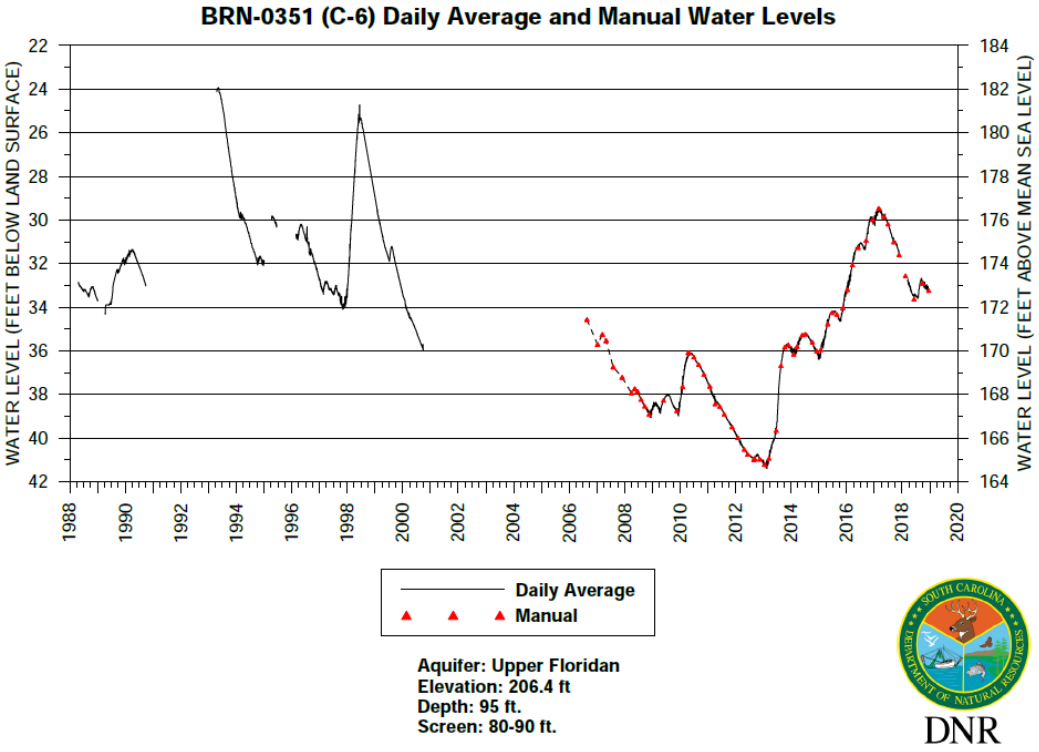
Barnwell County

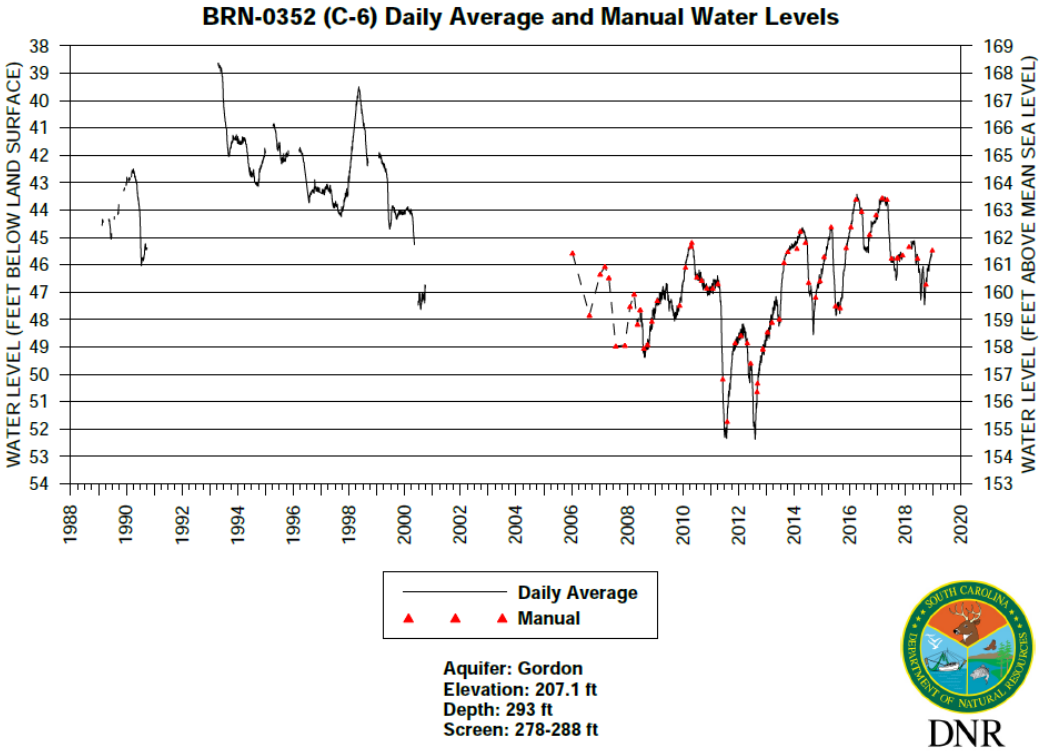
Note: There are no wells in the SC DNR Groundwater Monitoring Network in Bamberg county.

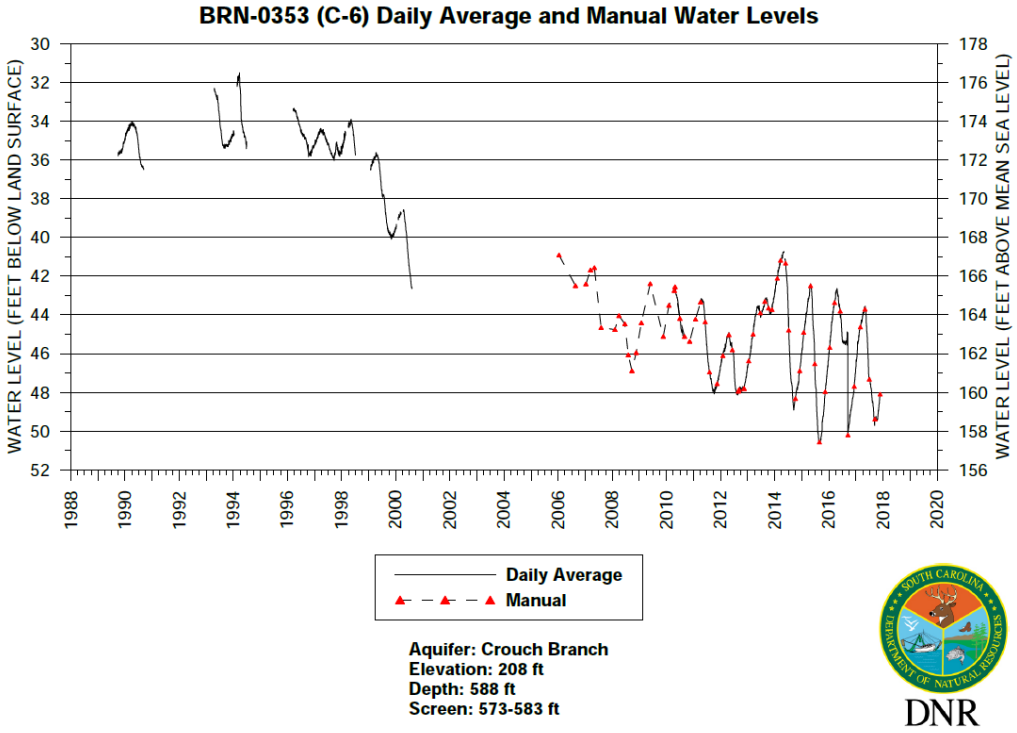


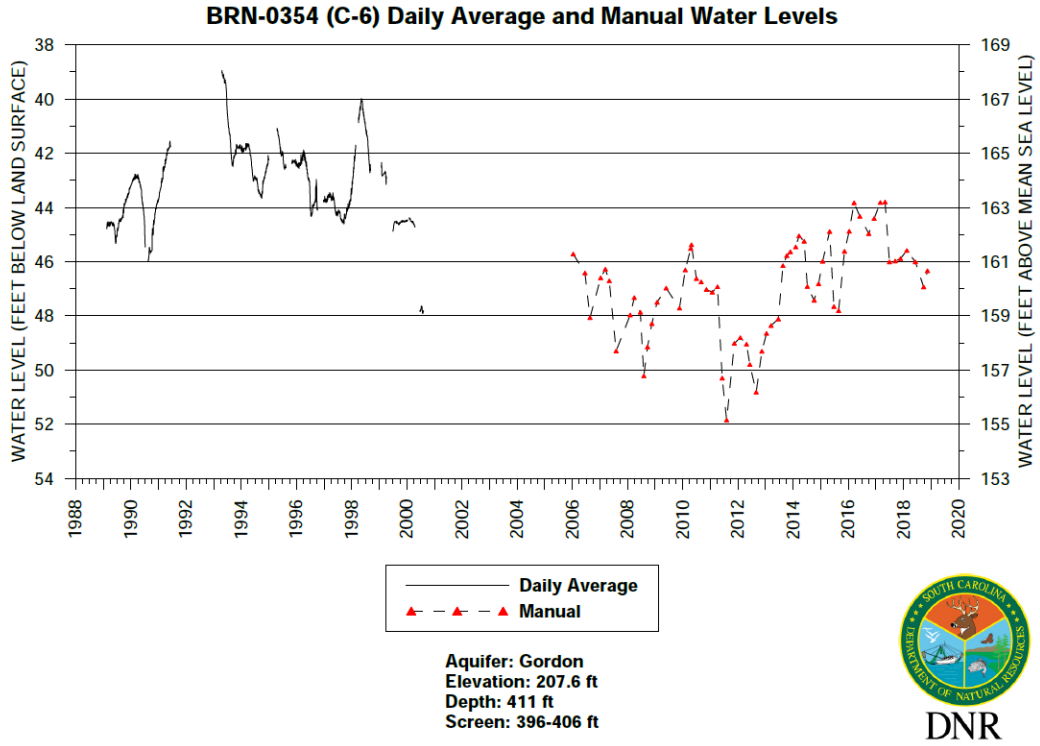


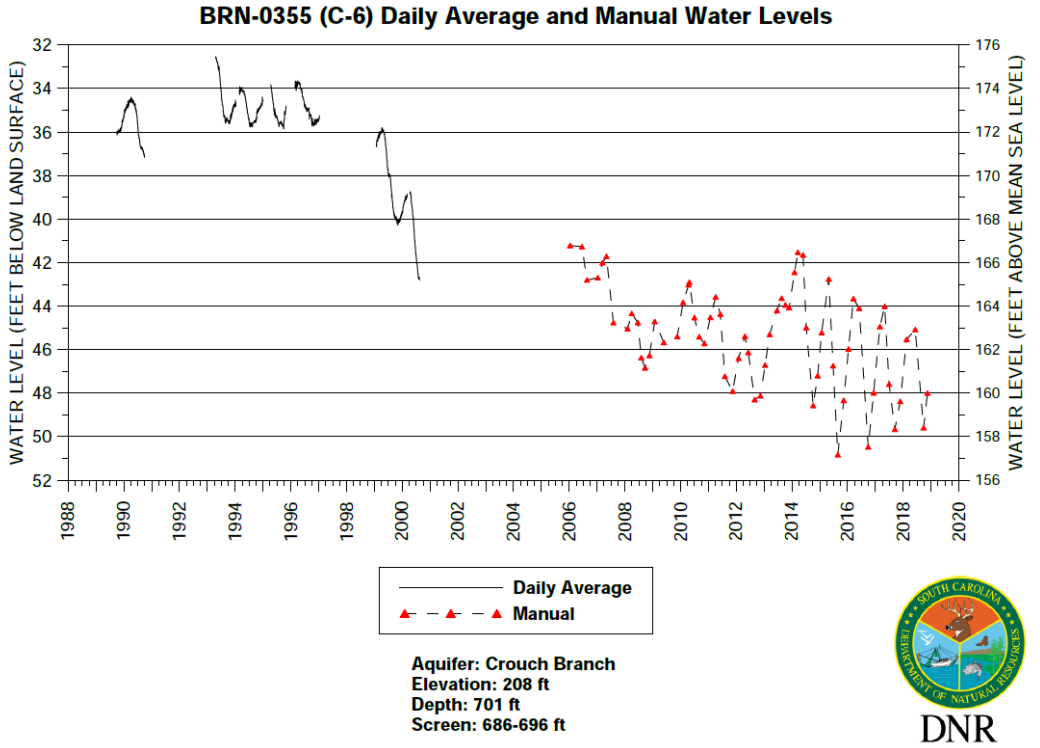

BRN-0350 (C-6) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
24
26
28
30
32
34
36
38
40
42
44
183
181
179
177
175
173
171
169
167
165
163
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Daily Average
Manual
Aquifer: Middle Floridan
Elevation: 207.4 ft
Depth: 170 ft
Screen: 155-165
DNR

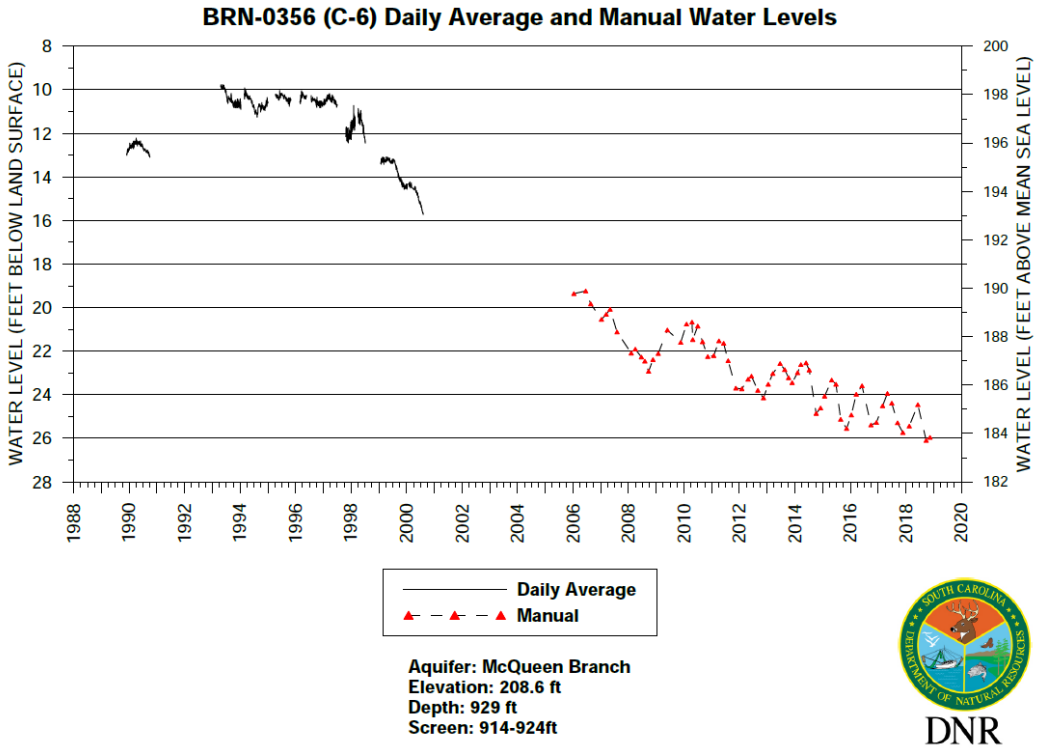

BRN-0351 (C-6) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
22
24
26
28
30
32
34
36
38
40
42
184
182
180
178
176
174
172
170
168
166
164
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Daily Average
Manual
Aquifer: Upper Floridan
Elevation: 206.4 ft
Depth: 95 ft.
Screen: 80-90 ft.
DNR

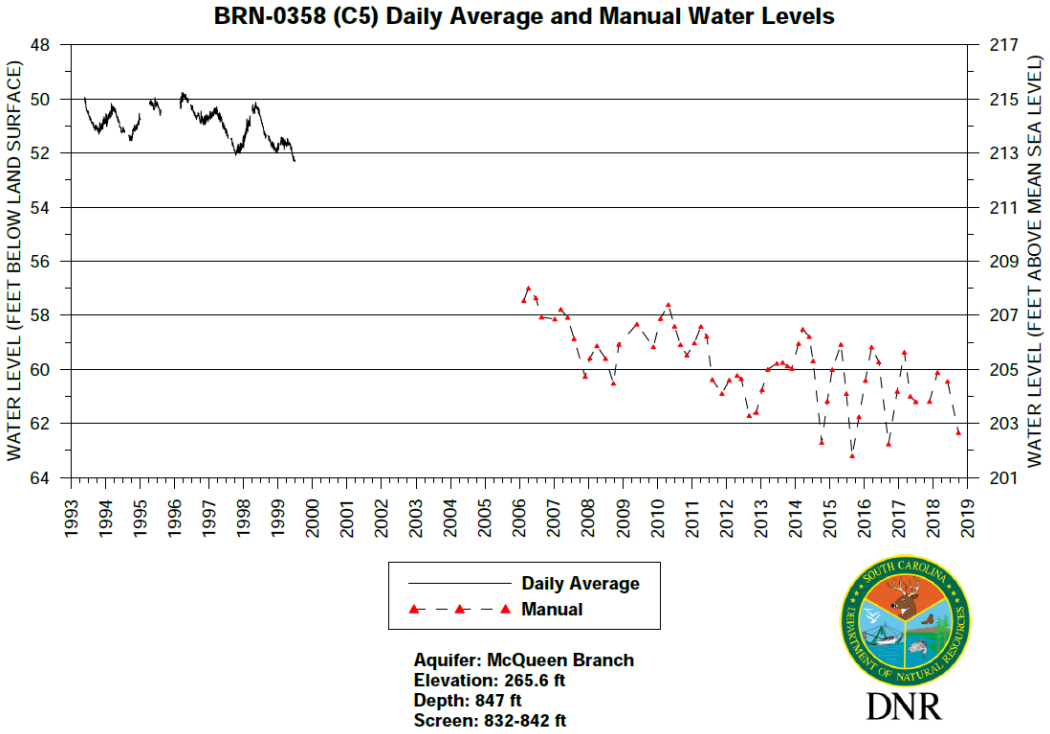

BRN-0352 (C-6) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54
169 168 167 166 165 164 163 162 161 160 159 158 157 156 155 154 153
1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020
Daily Average
Manual
Aquifer: Gordon
Elevation: 207.1 ft
Depth: 293 ft
Screen: 278-288 ft
DNR

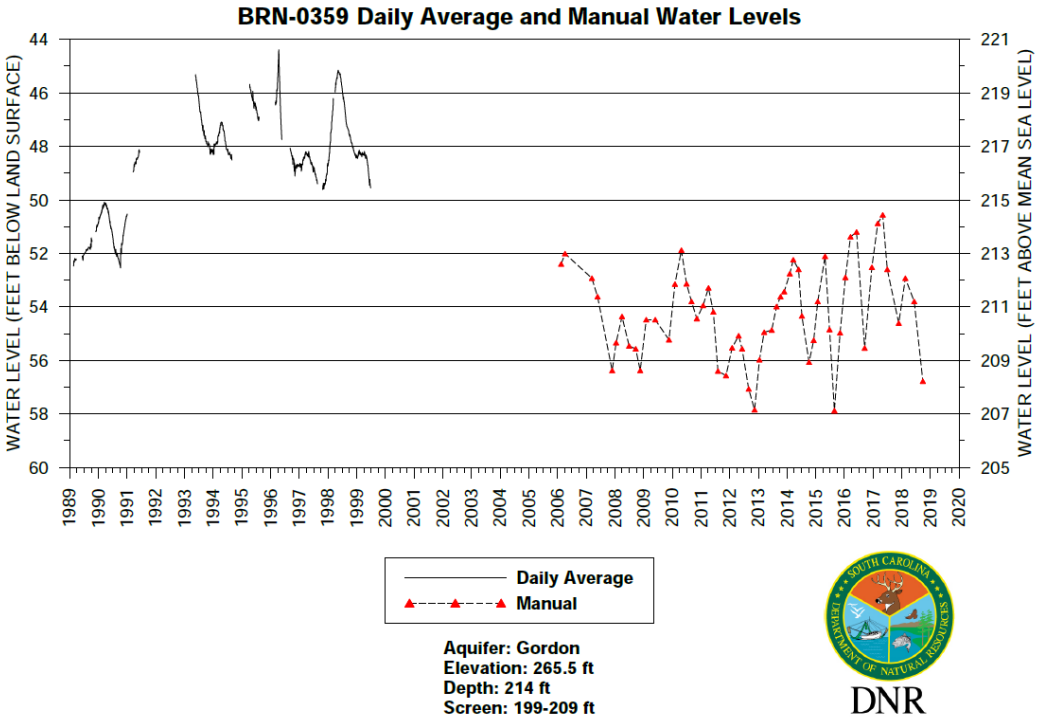

BRN-0353 (C-6) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
30 32 34 36 38 40 42 44 46 48 50 52
178 176 174 172 170 168 166 164 162 160 158 156
1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020
Daily Average
Manual
Aquifer: Crouch Branch
Elevation: 208 ft
Depth: 588 ft
Screen: 573-583 ft
DNR

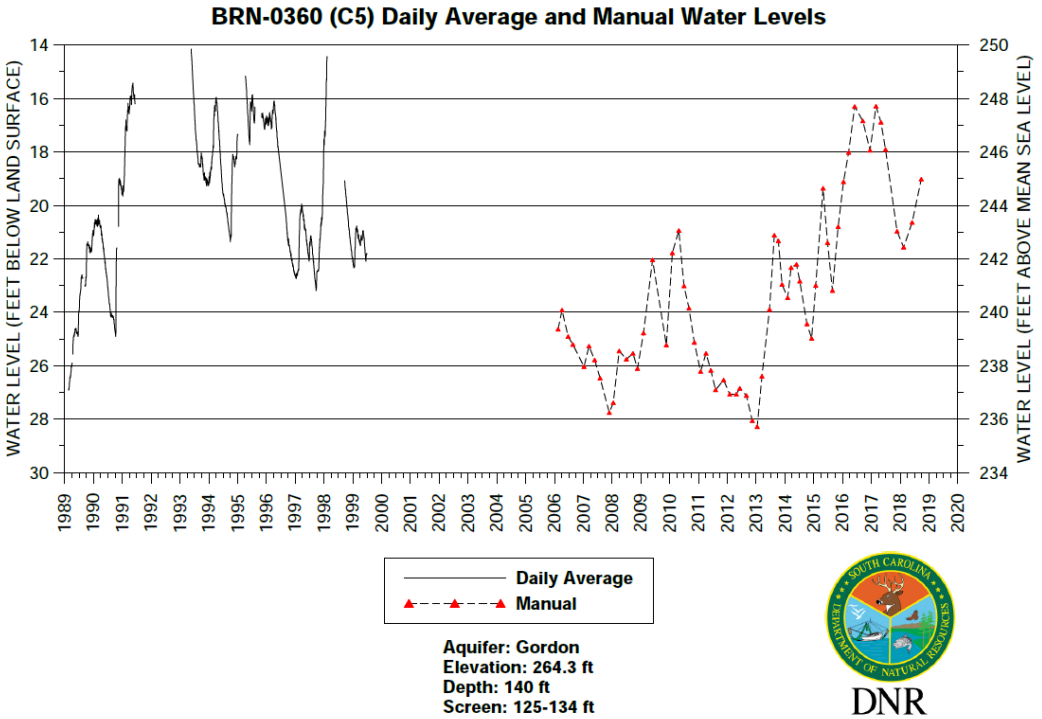

BRN-0354 (C-6) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
38
40
42
44
46
48
50
52
54
169
167
165
163
161
159
157
155
153
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Daily Average
Manual
Aquifer: Gordon
Elevation: 207.6 ft
Depth: 411 ft
Screen: 396-406 ft
DNR

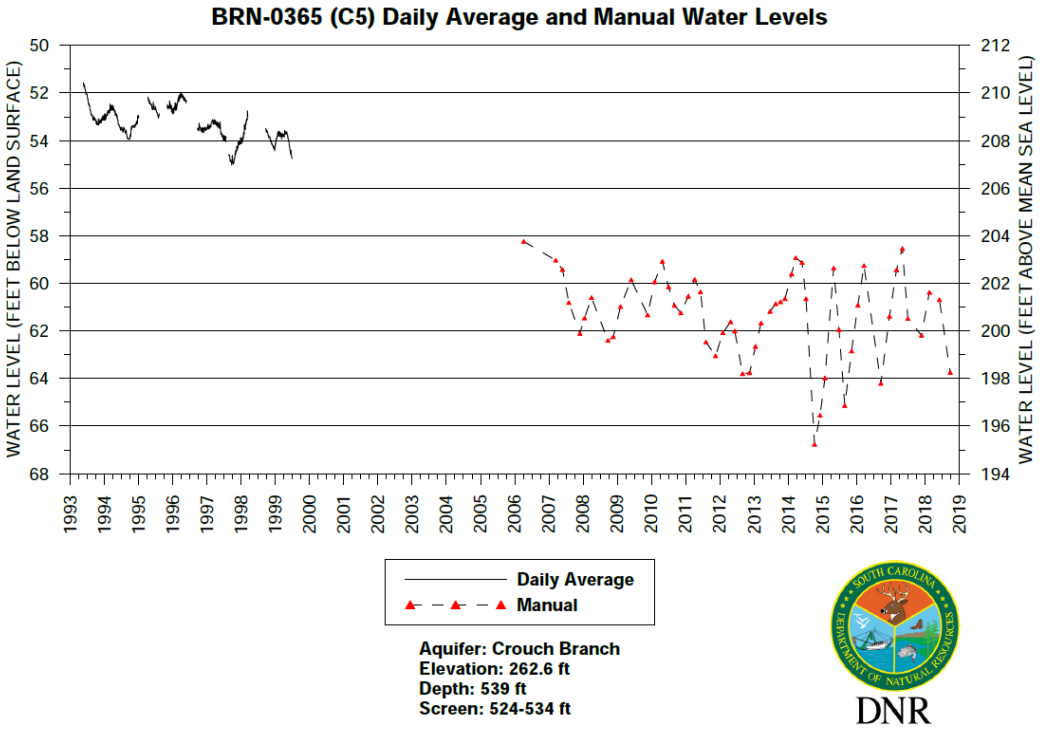

BRN-0355 (C-6) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
32
34
36
38
40
42
44
46
48
50
52
176
174
172
170
168
166
164
162
160
158
156
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Daily Average
Manual
Aquifer: Crouch Branch
Elevation: 208 ft
Depth: 701 ft
Screen: 686-696 ft
DNR

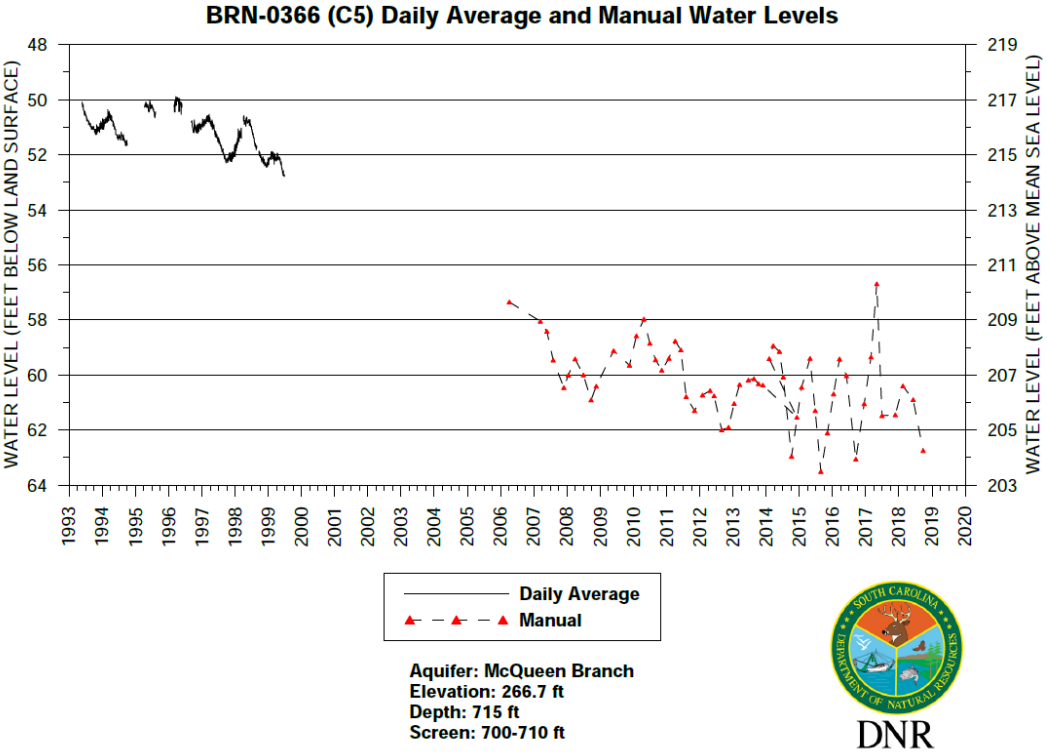

BRN-0356 (C-6) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
Daily Average
Manual
Aquifer: McQueen Branch
Elevation: 208.6 ft
Depth: 929 ft
Screen: 914-924ft
DNR

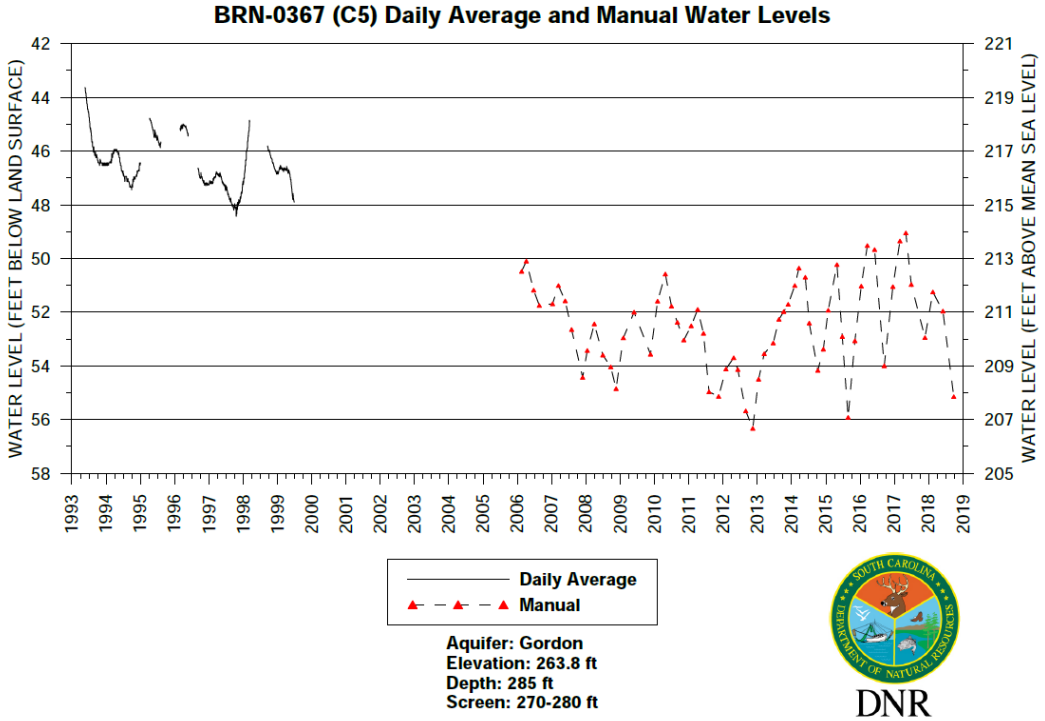

BRN-0358 (C5) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
Daily Average
Manual
Aquifer: McQueen Branch
Elevation: 265.6 ft
Depth: 847 ft
Screen: 832-842 ft
DNR

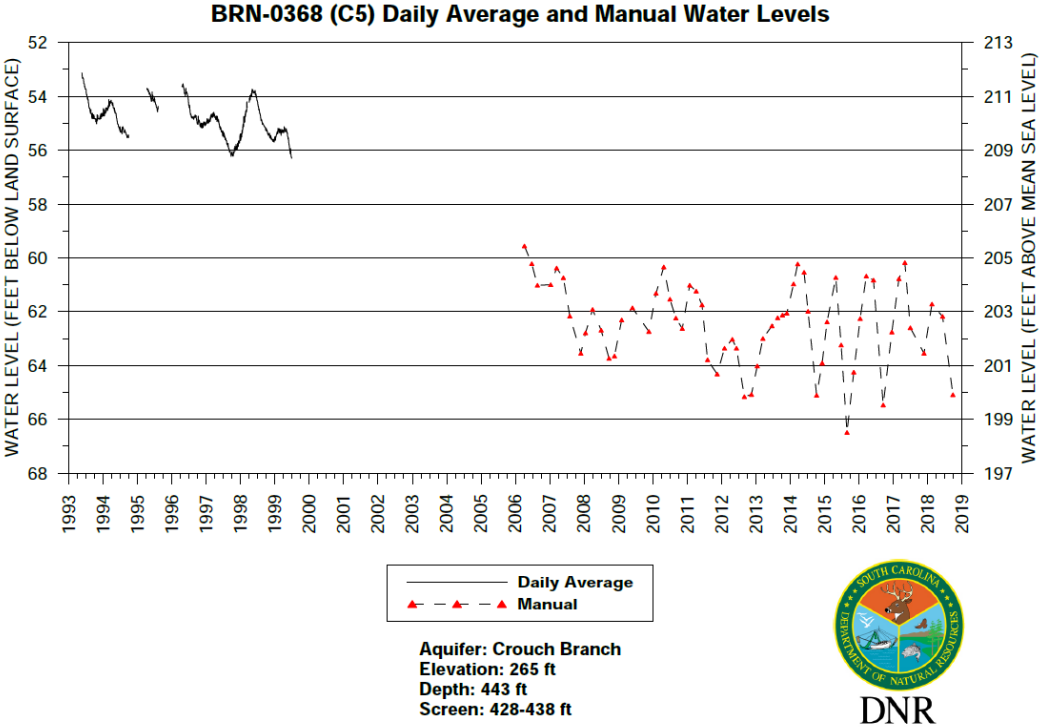

BRN-0359 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
44
46
48
50
52
54
56
58
60
221
219
217
215
213
211
209
207
205
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Daily Average
Manual
Aquifer: Gordon
Elevation: 265.5 ft
Depth: 214 ft
Screen: 199-209 ft
DNR


BRN-0360 (C5) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
14
16
18
20
22
24
26
28
30
250
248
246
244
242
240
238
236
234
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Daily Average
Manual
Aquifer: Gordon
Elevation: 264.3 ft
Depth: 140 ft
Screen: 125-134 ft
DNR

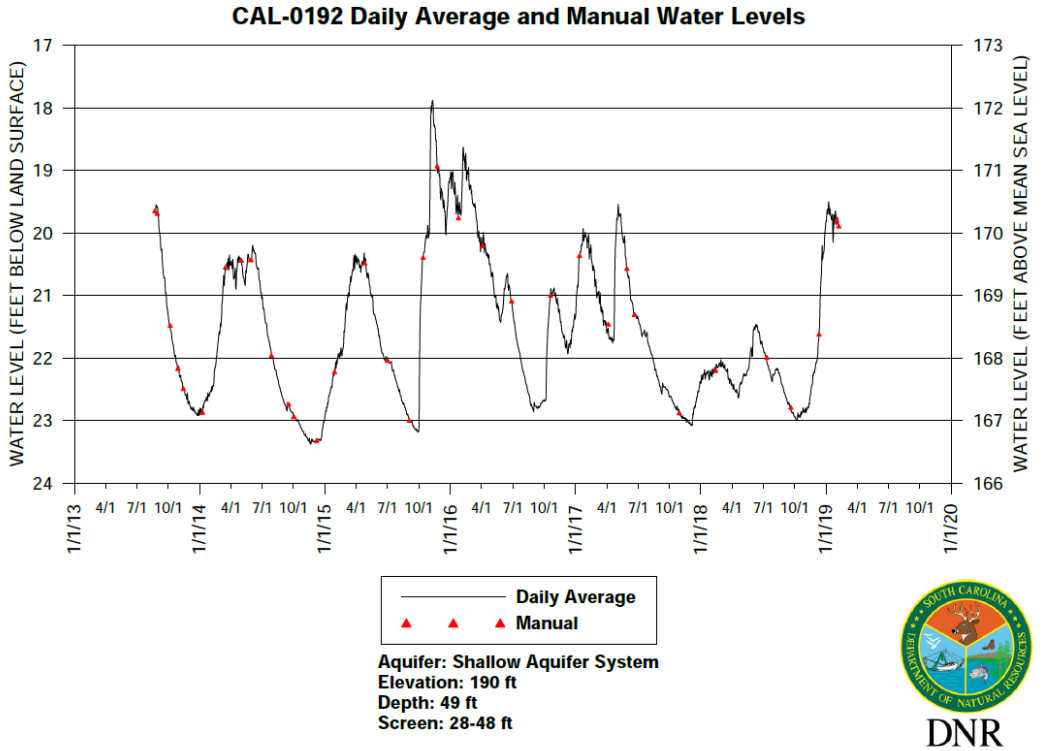

BRN-0365 (C5) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
50
52
54
56
58
60
62
64
66
68
212
210
208
206
204
202
200
198
196
194
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Daily Average
Manual
Aquifer: Crouch Branch
Elevation: 262.6 ft
Depth: 539 ft
Screen: 524-534 ft
DNR

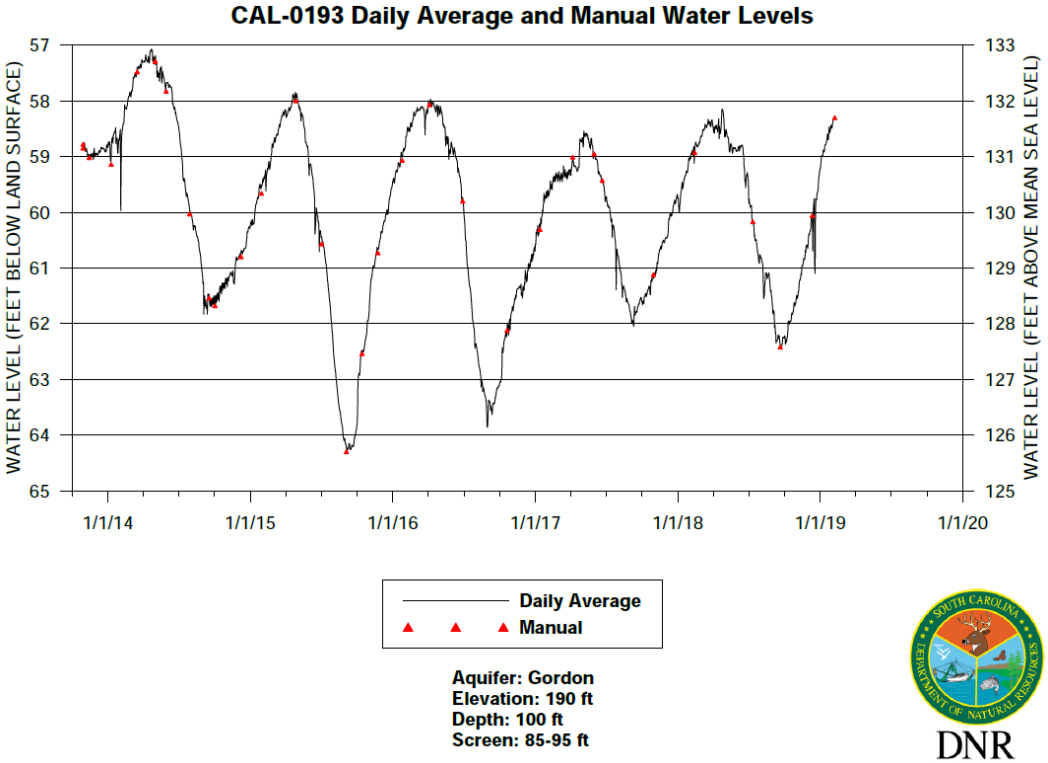

BRN-0366 (C5) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
48
50
52
54
56
58
60
62
64
219
217
215
213
211
209
207
205
203
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Daily Average
Manual
Aquifer: McQueen Branch
Elevation: 266.7 ft
Depth: 715 ft
Screen: 700-710 ft
DNR

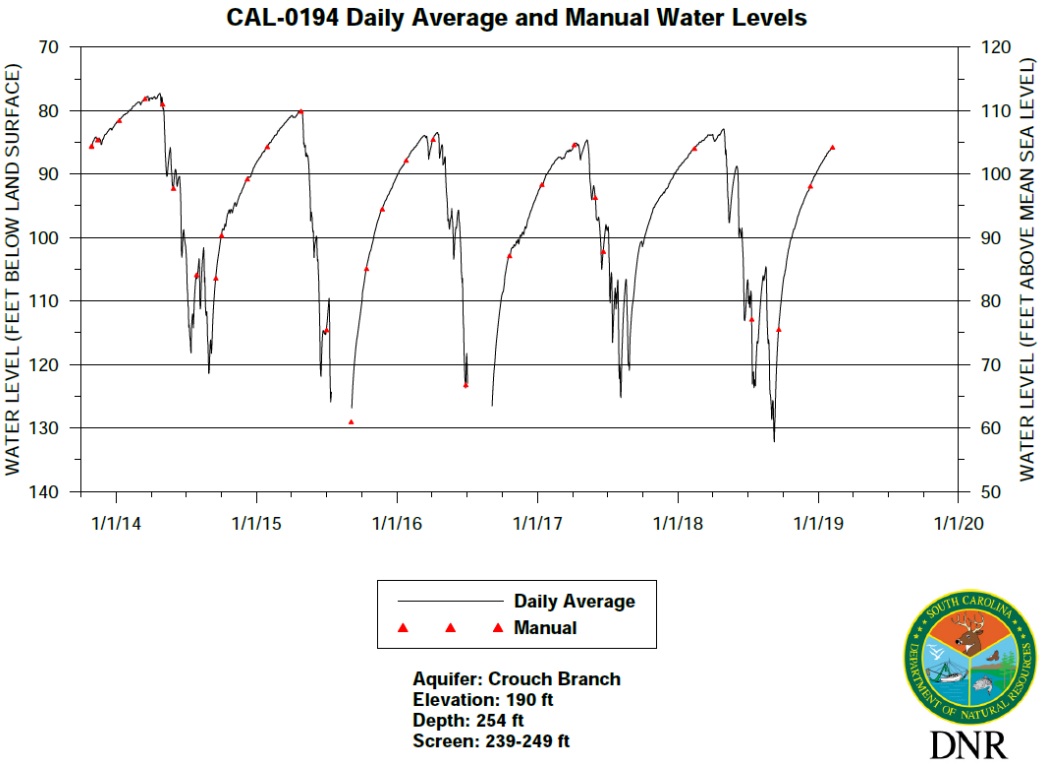

BRN-0367 (C5) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
42
44
46
48
50
52
54
56
58
221
219
217
215
213
211
209
207
205
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Daily Average
Manual
Aquifer: Gordon
Elevation: 263.8 ft
Depth: 285 ft
Screen: 270-280 ft
DNR

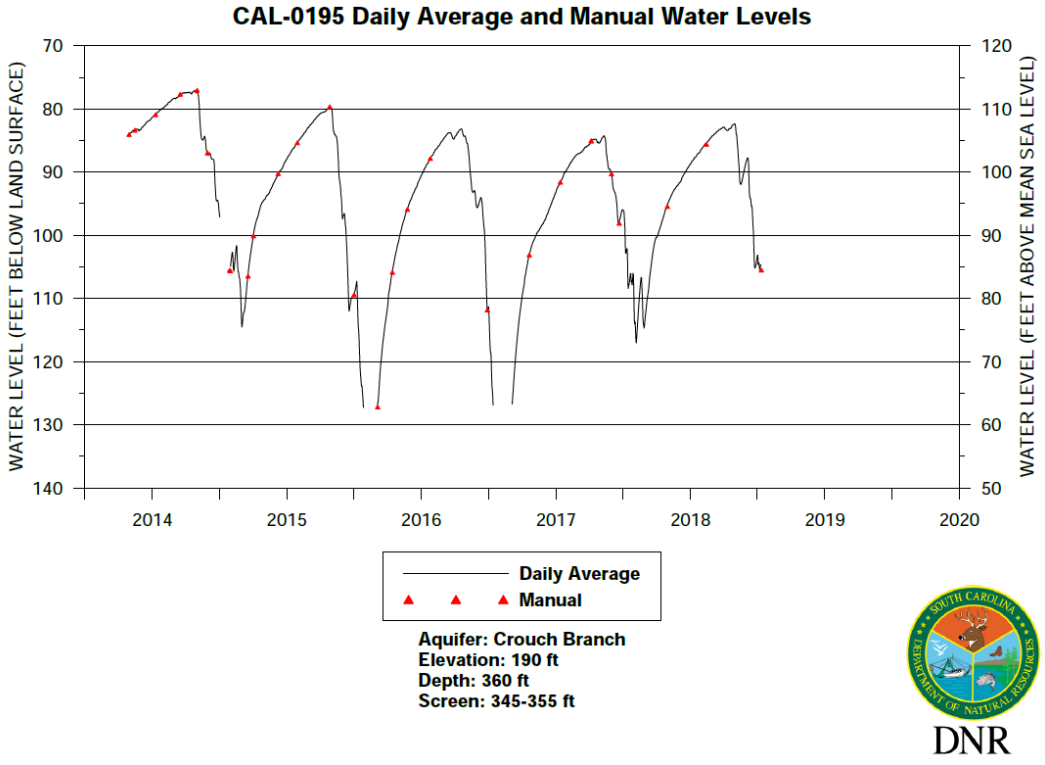

BRN-0368 (C5) Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
52
54
56
58
60
62
64
66
68
213
211
209
207
205
203
201
199
197
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Daily Average
Manual
Aquifer: Crouch Branch
Elevation: 265 ft
Depth: 443 ft
Screen: 428-438 ft
DNR

Calhoun County

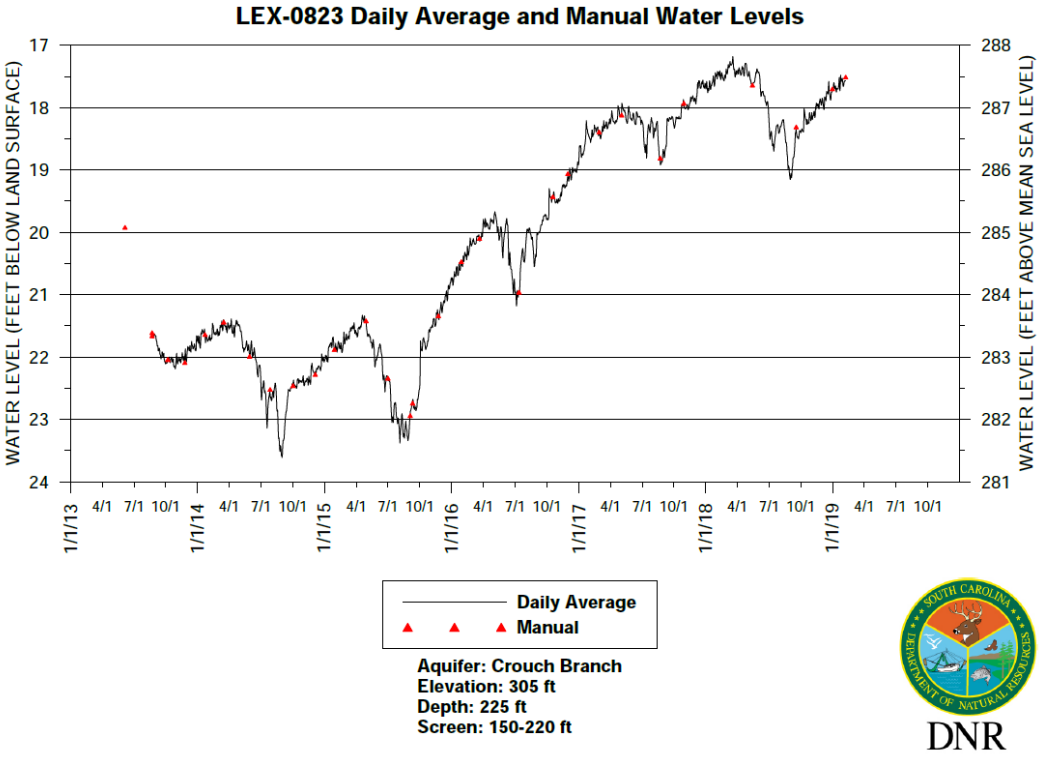




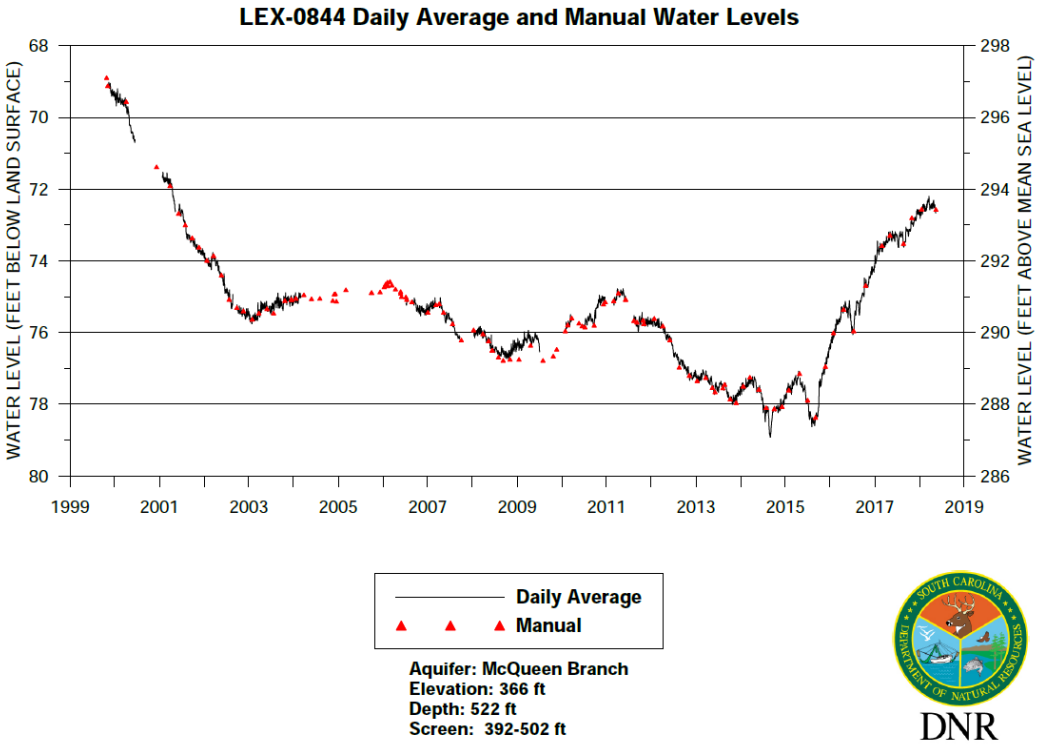

CAL-0194 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
70
80
90
100
110
120
130
140
120
110
100
90
80
70
60
50
1/1/14
1/1/15
1/1/16
1/1/17
1/1/18
1/1/19
1/1/20
Daily Average
Manual
Aquifer: Crouch Branch
Elevation: 190 ft
Depth: 254 ft
Screen: 239-249 ft
DNR


CAL-0195 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
70
80
90
100
110
120
130
140
120
110
100
90
80
70
60
50
2014
2015
2016
2017
2018
2019
2020
Daily Average
Manual
Aquifer: Crouch Branch
Elevation: 190 ft
Depth: 360 ft
Screen: 345-355 ft
DNR

Lexington County

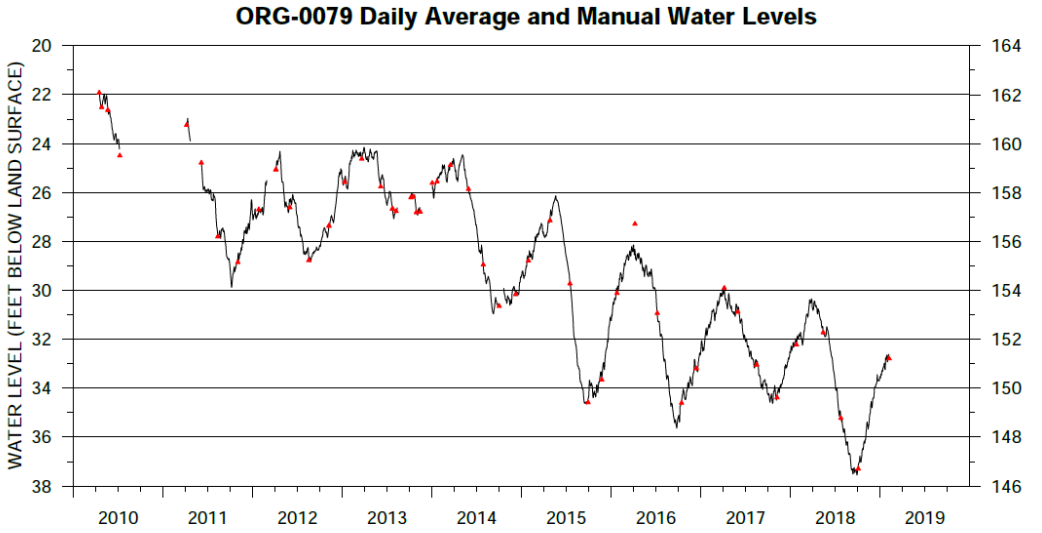


DNR



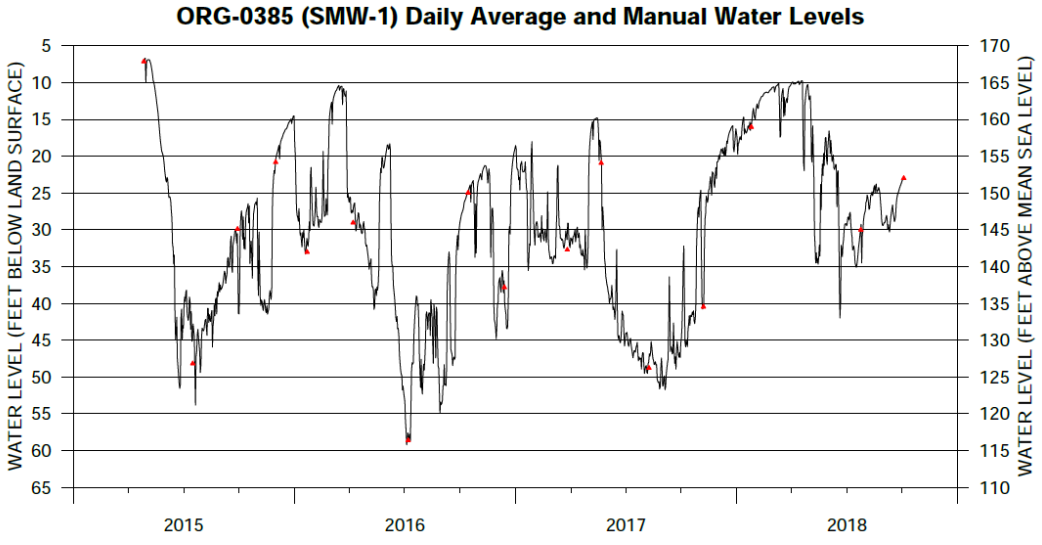
DNR

Orangeburg County



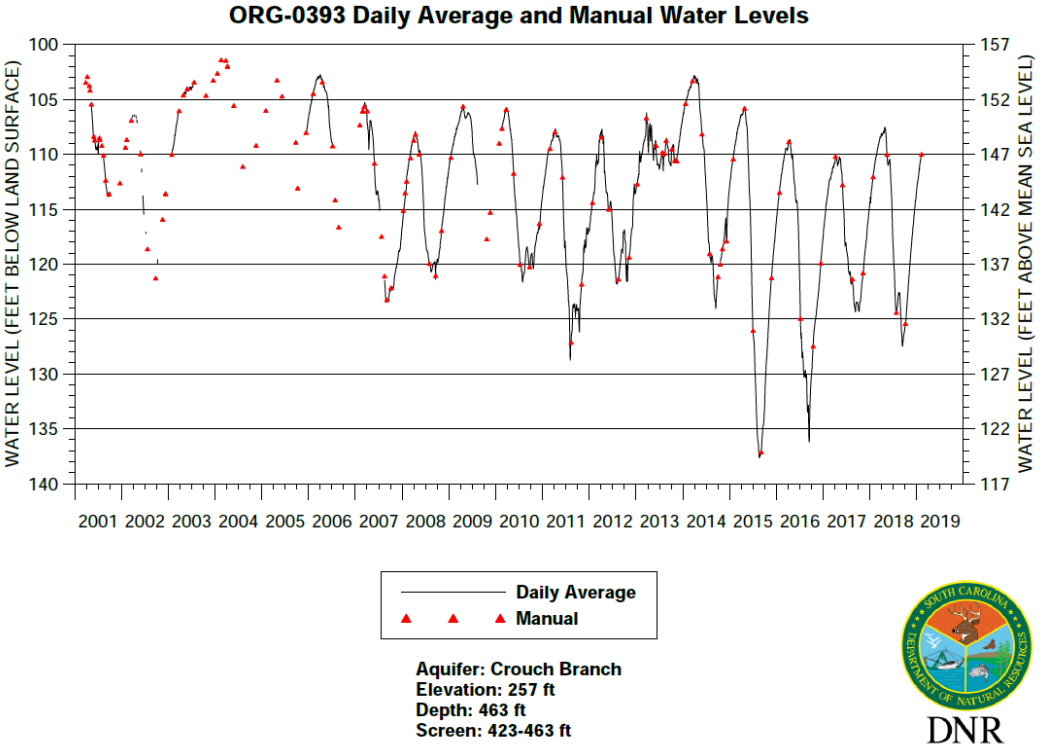
Aquifer: McQueen Branch
Elevation: 184 ft
Depth: 995 ft
Screen: 843-974 ft

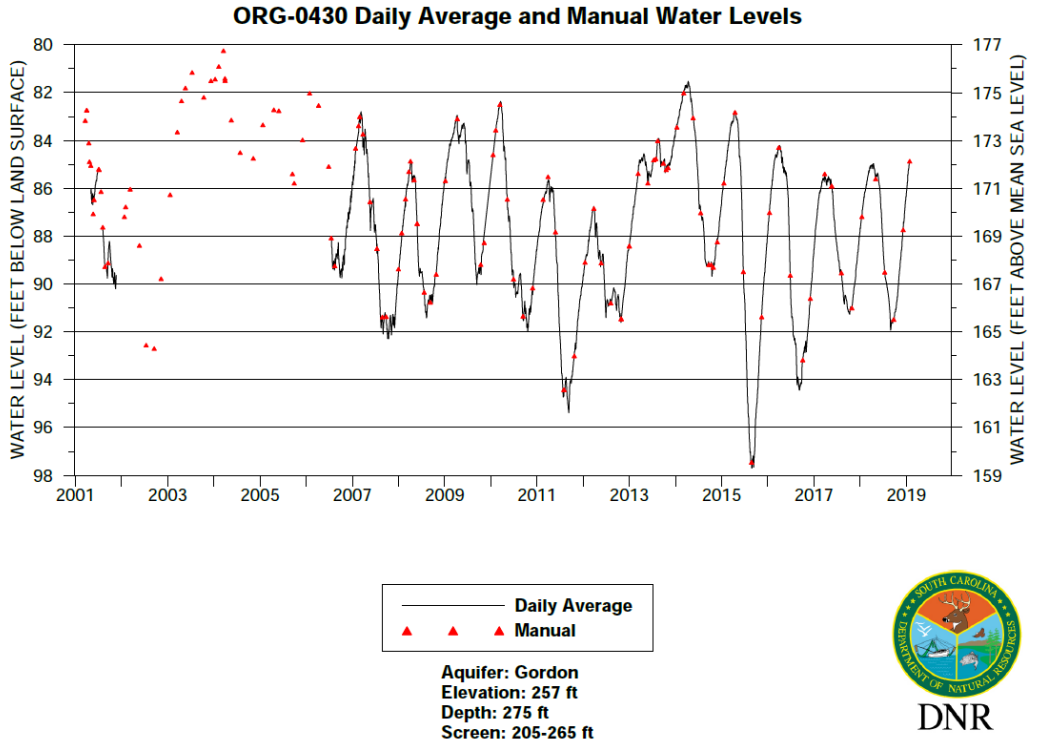
DNR

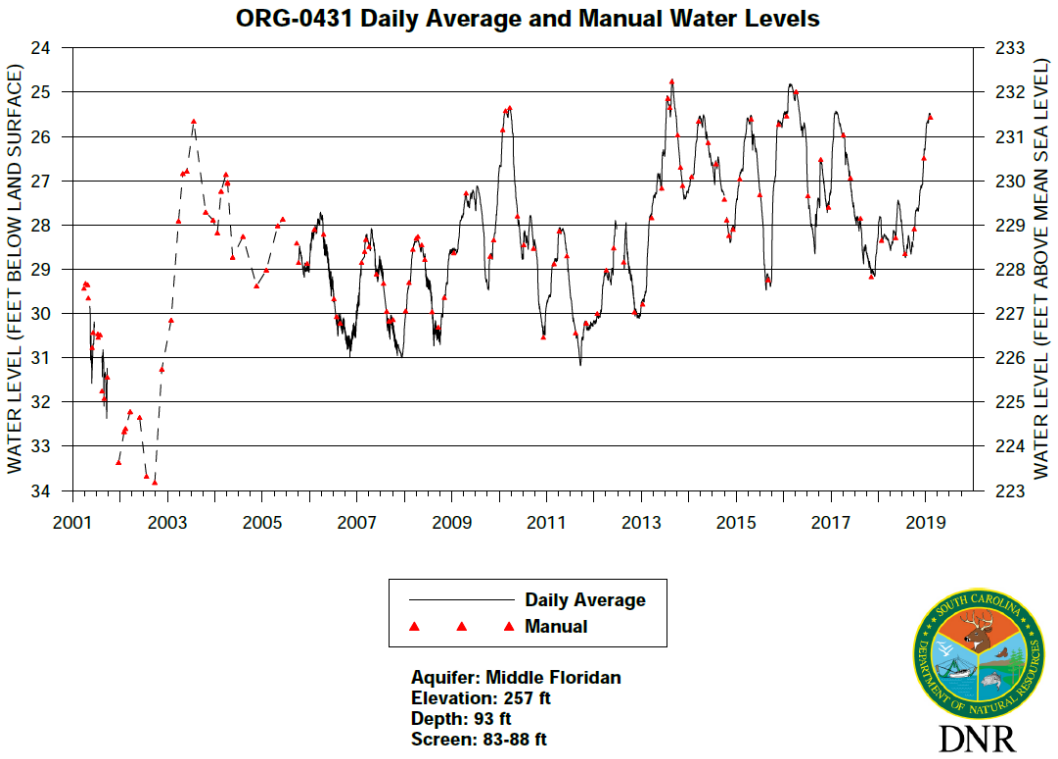


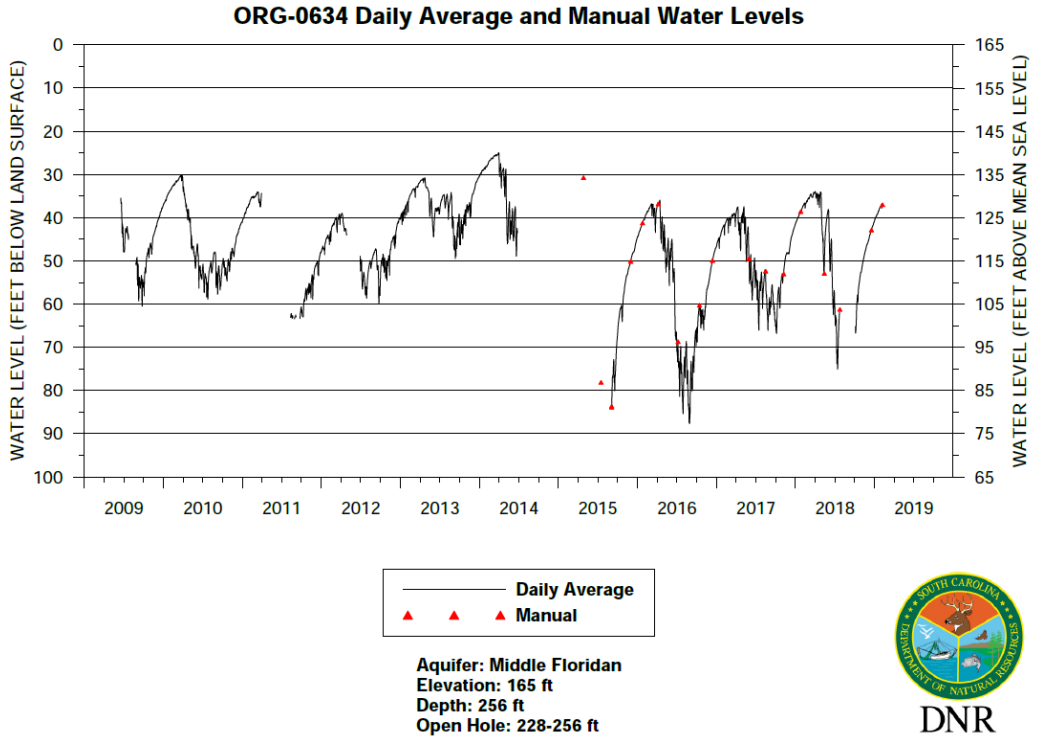
Aquifer: Crouch Branch
Elevation: 175 ft
Depth: 565 ft
Screen: 475-565 ft

DNR


ORG-0393 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
100
105
110
115
120
125
130
135
140
157
152
147
142
137
132
127
122
117
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
Daily Average
Manual
Aquifer: Crouch Branch
Elevation: 257 ft
Depth: 463 ft
Screen: 423-463 ft
DNR


ORG-0430 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
80
82
84
86
88
90
92
94
96
98
177
175
173
171
169
167
165
163
161
159
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Daily Average
Manual
Aquifer: Gordon
Elevation: 257 ft
Depth: 275 ft
Screen: 205-265 ft
DNR

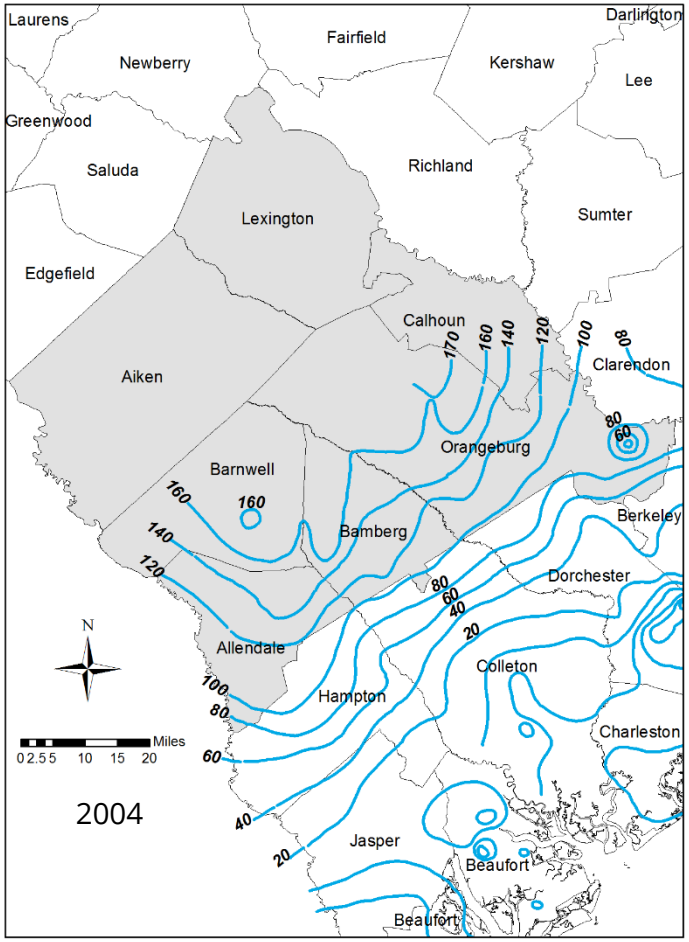

ORG-0431 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
24
25
26
27
28
29
30
31
32
33
34
233
232
231
230
229
228
227
226
225
224
223
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Daily Average
Manual
Aquifer: Middle Floridan
Elevation: 257 ft
Depth: 93 ft
Screen: 83-88 ft
DNR

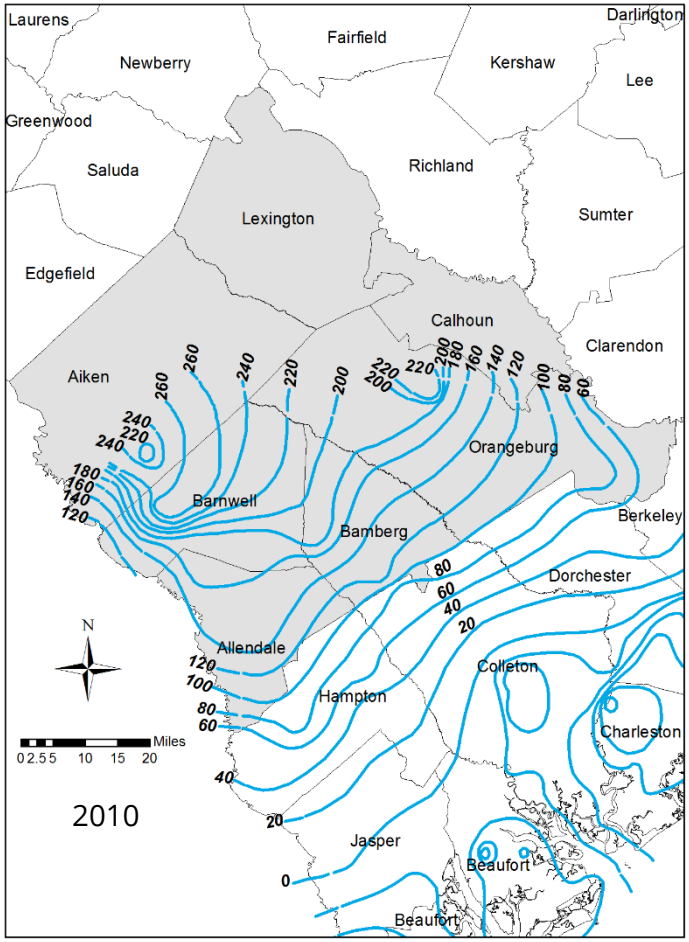

ORG-0634 Daily Average and Manual Water Levels
WATER LEVEL (FEET BELOW LAND SURFACE)
WATER LEVEL (FEET ABOVE MEAN SEA LEVEL)
0
10
20
30
40
50
60
70
80
90
100
165
155
145
135
125
115
105
95
85
75
65
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Daily Average
Manual
Aquifer: Middle Floridan
Elevation: 165 ft
Depth: 256 ft
Open Hole: 228-256 ft
DNR

Appendix B

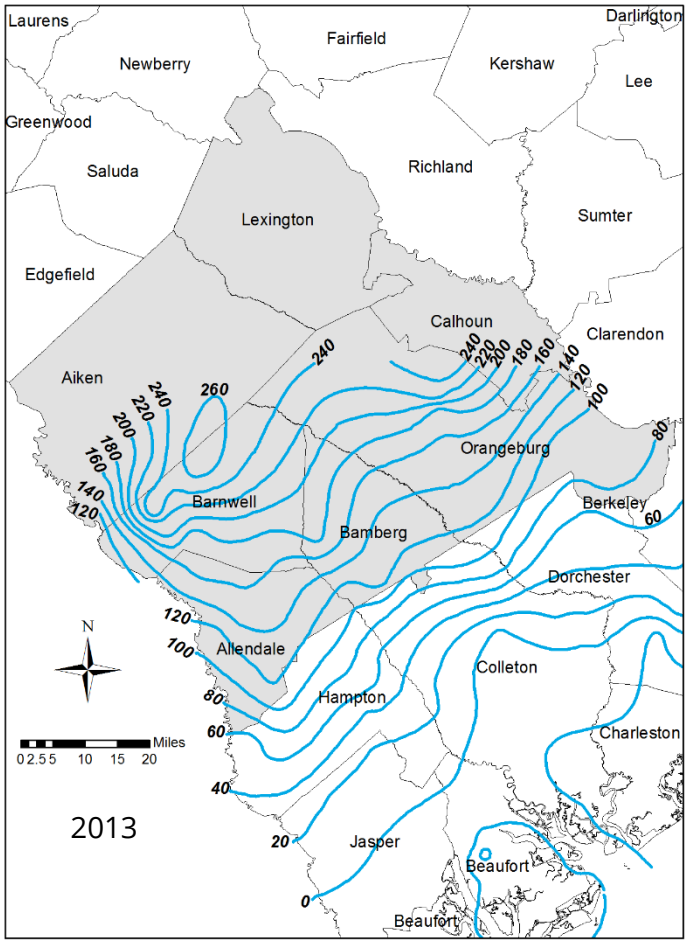
Historic Equipotential Maps
Western Capacity Use Area Counties

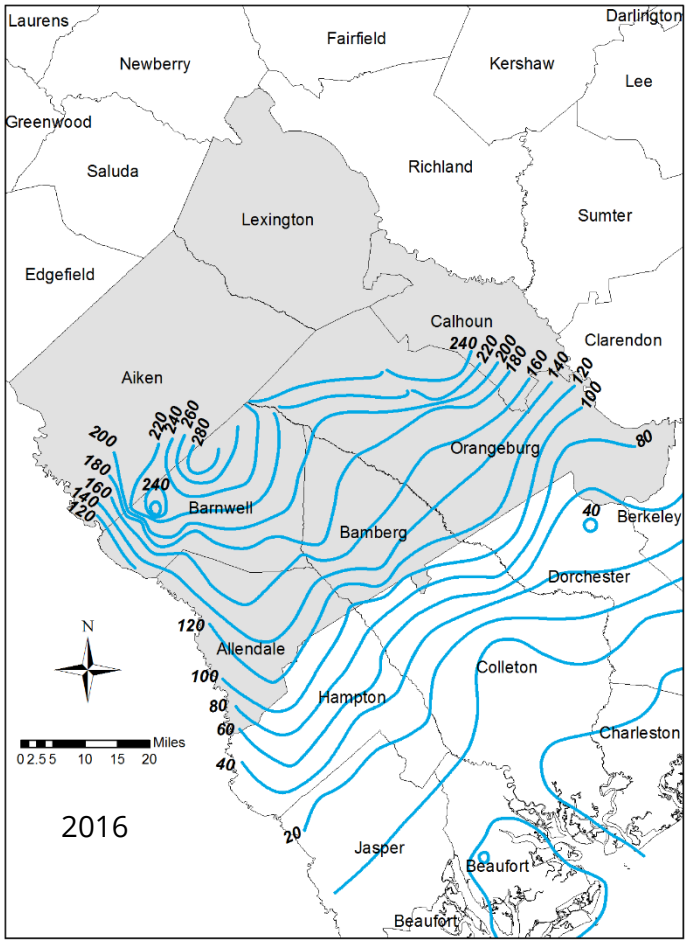
Floridan/Gordon Aquifer



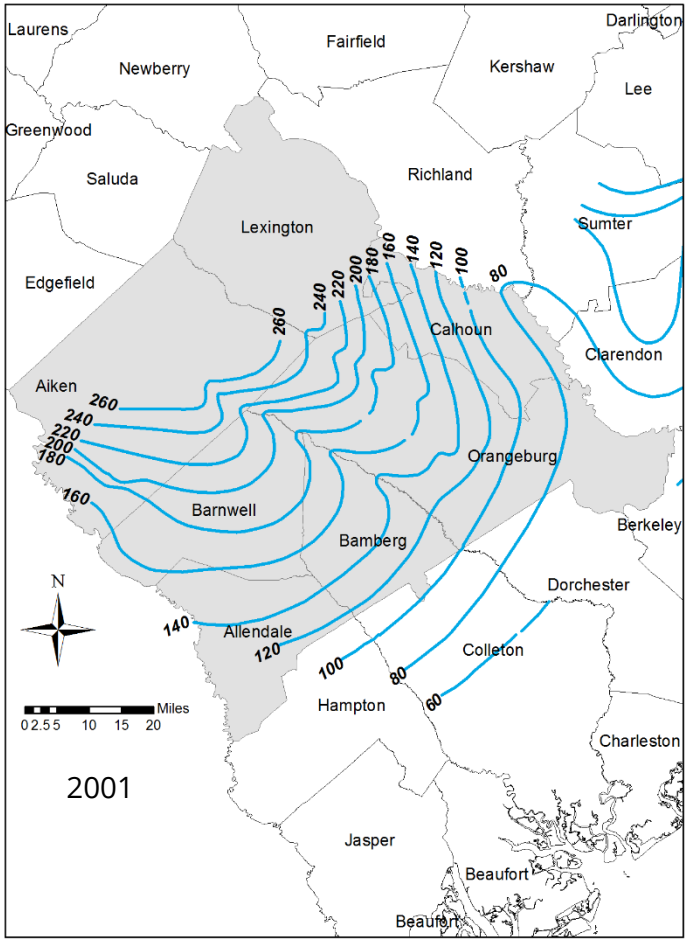


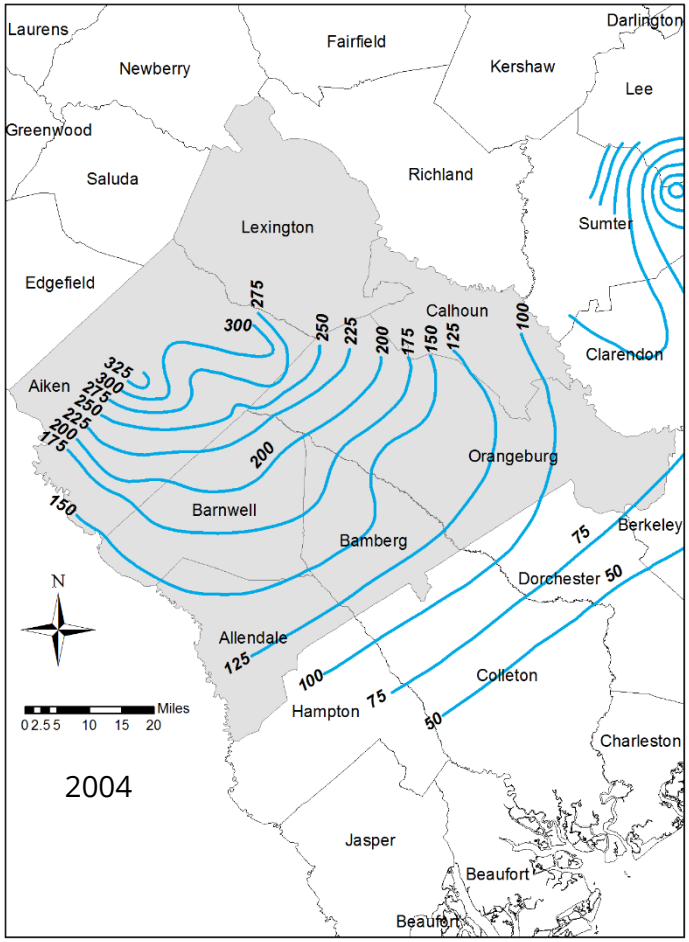
Equipotential Maps: The blue lines indicate water level relative to mean sea level (NAVD 88). The Western Area Counties are highlighted in gray.

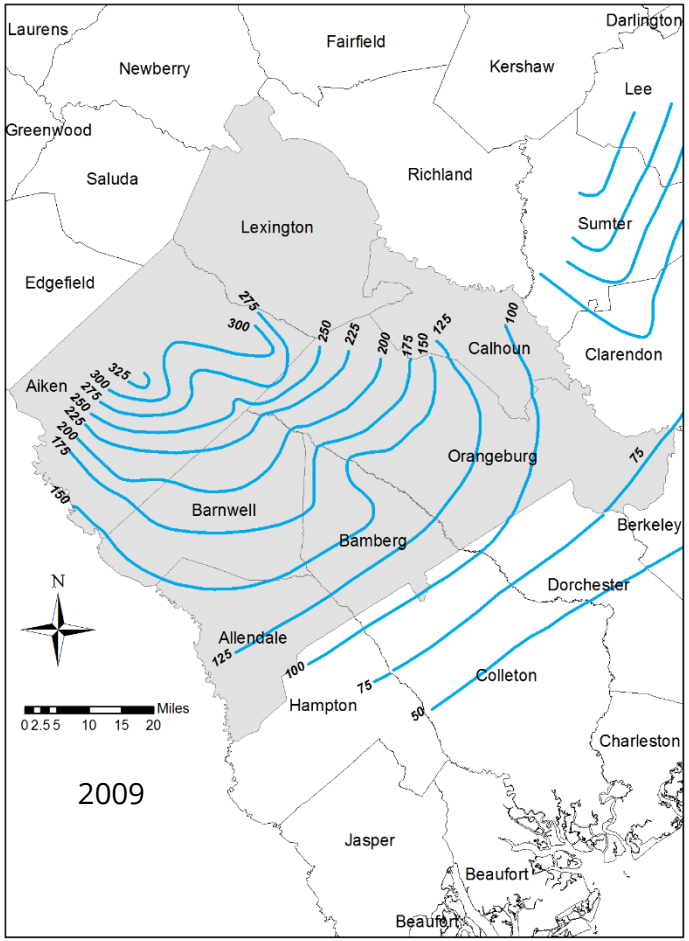

Laurens
Fairfield
Darlington
Newberry
Kershaw
Lee
Greenwood
Saluda
Richland
Lexington
Sumter
Edgefield
Calhoun
Clarendon
Aiken
Orangeburg
Barnwell
Berkeley
Bamberg
Dorchester
Allendale
Colleton
Hampton
Charleston
Jasper
Beaufort
Beaufort
N
Miles
0 2.5 5 10 15 20
2013

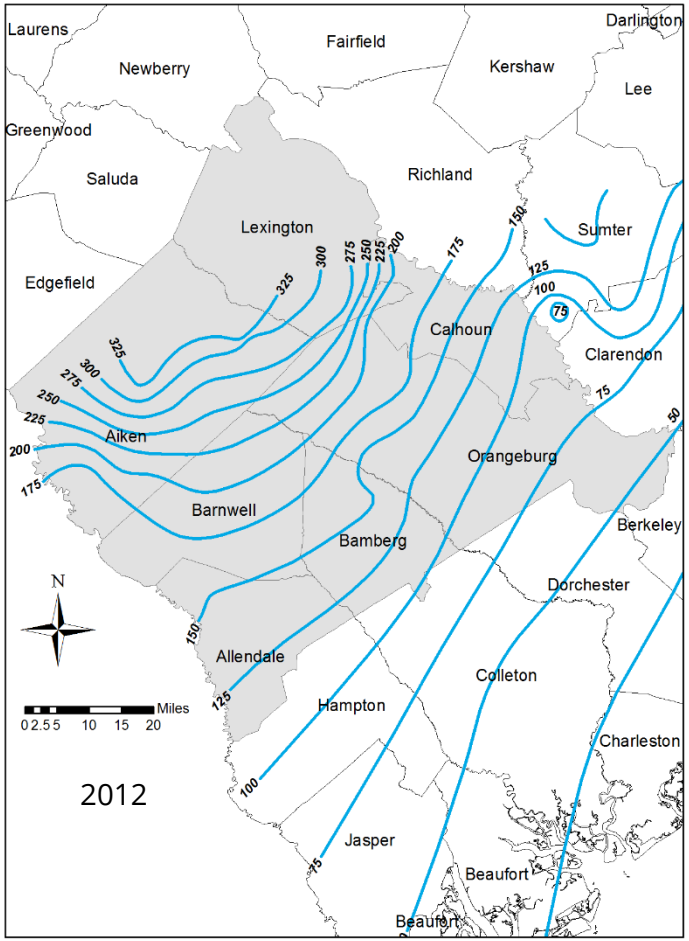

Laurens
Fairfield
Darlington
Newberry
Kershaw
Lee
Greenwood
Saluda
Richland
Lexington
Sumter
Edgefield
Calhoun
Clarendon
Aiken
Orangeburg
Barnwell
Berkeley
Bamberg
Dorchester
Allendale
Colleton
Hampton
Charleston
Jasper
Beaufort
Beaufort
N
Miles
0 2.5 5 10 15 20
2016

Crouch Branch Aquifer






Laurens
Newberry
Fairfield
Kershaw
Darlington
Lee
Greenwood
Saluda
Richland
Lexington
Sumter
Edgefield
Calhoun
Clarendon
Aiken
Orangeburg
Barnwell
Bamberg
Berkeley
Dorchester
Allendale
Colleton
Hampton
Charleston
Jasper
Beaufort
Beaufort
275
300
250
225
200
175
150
125
100
325
75
50
N
Miles
0 2.5 5 10 15 20
2009


Laurens
Newberry
Fairfield
Kershaw
Darlington
Lee
Greenwood
Saluda
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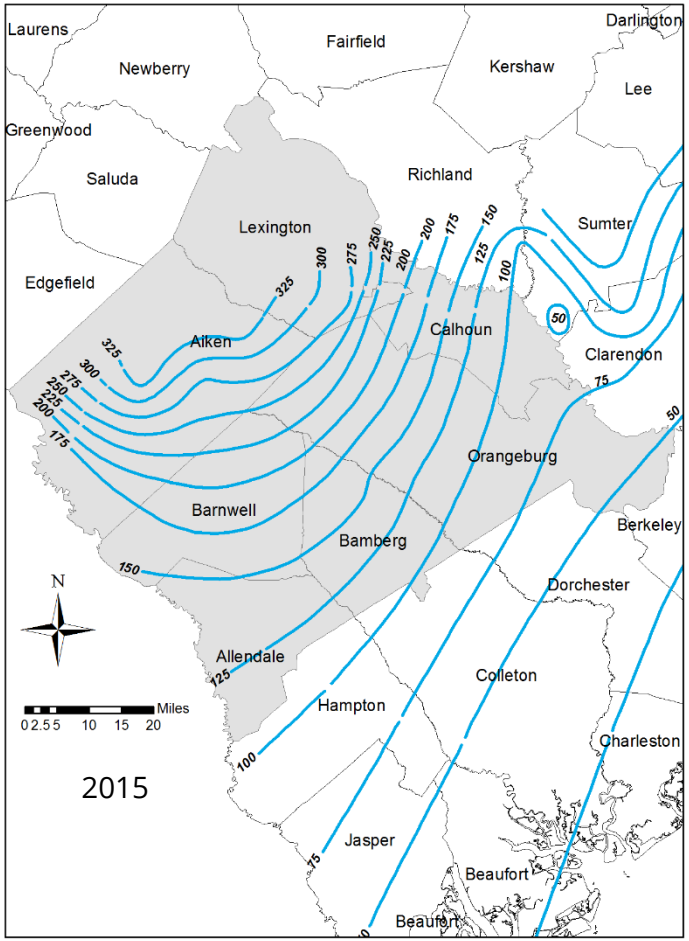
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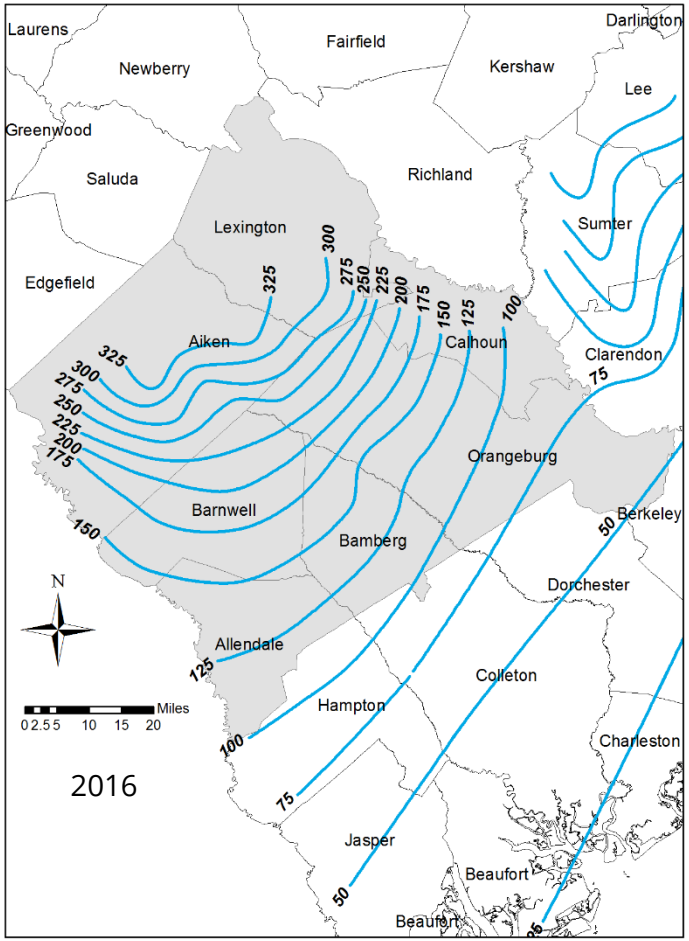
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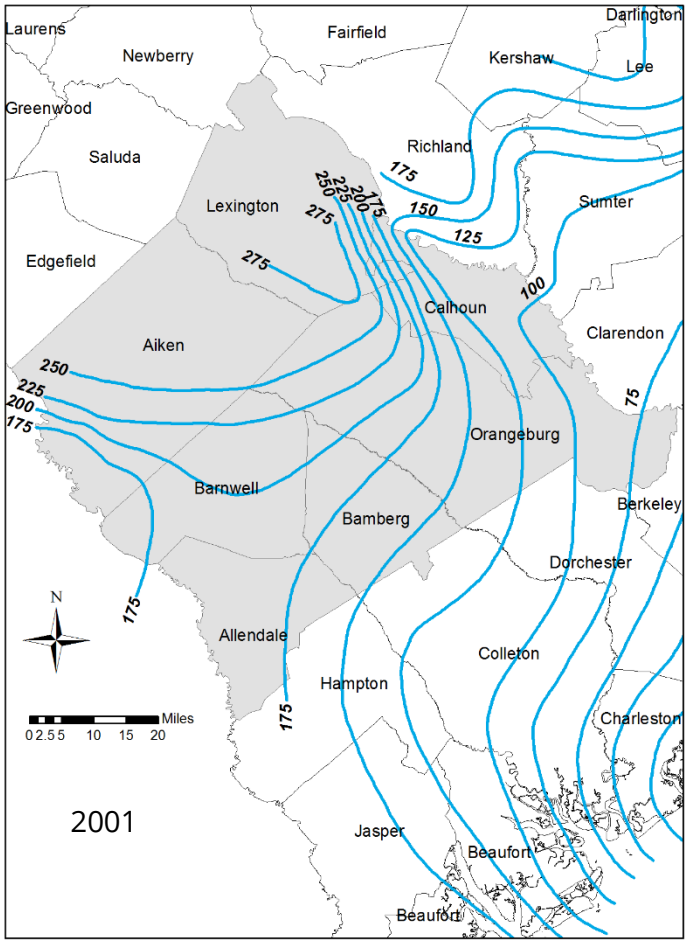

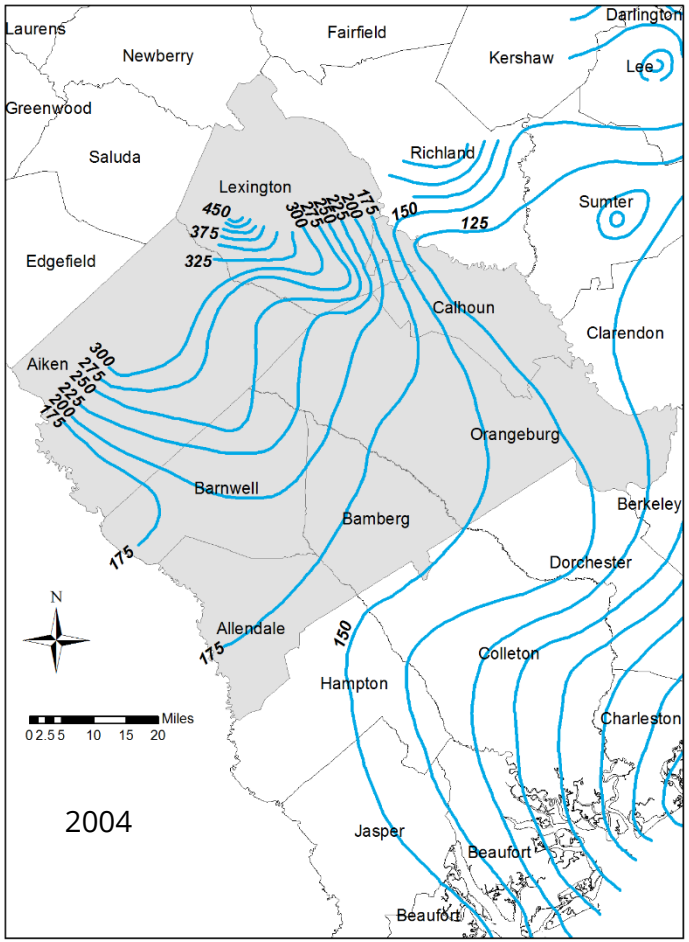

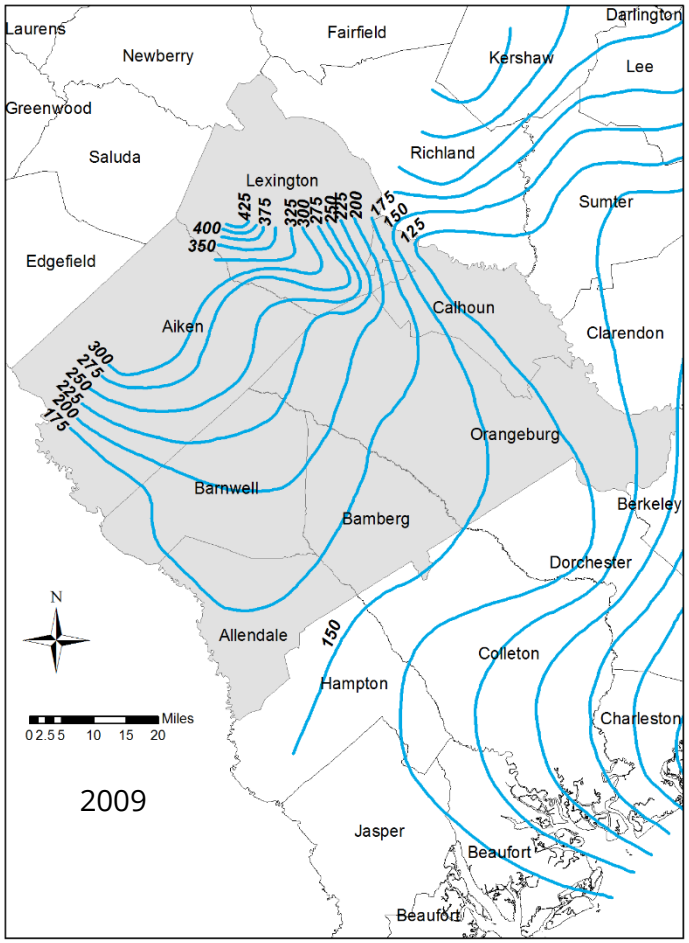
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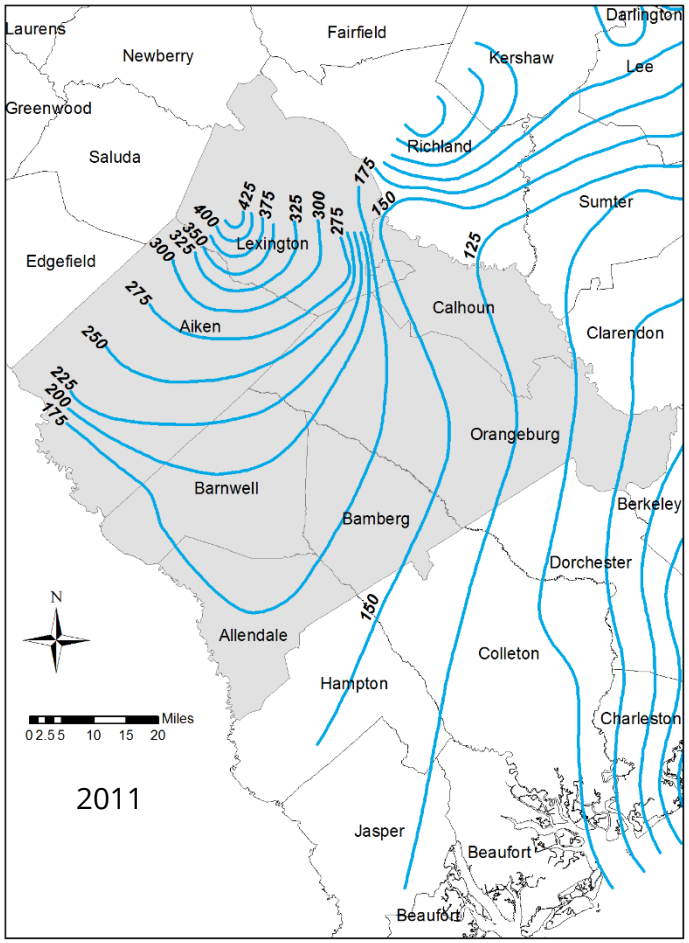
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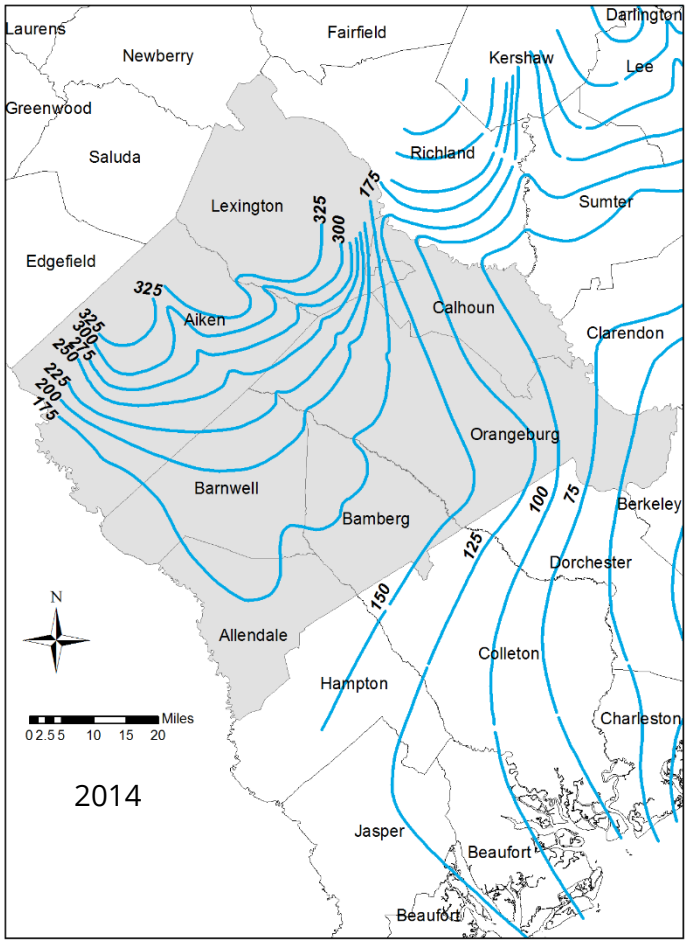
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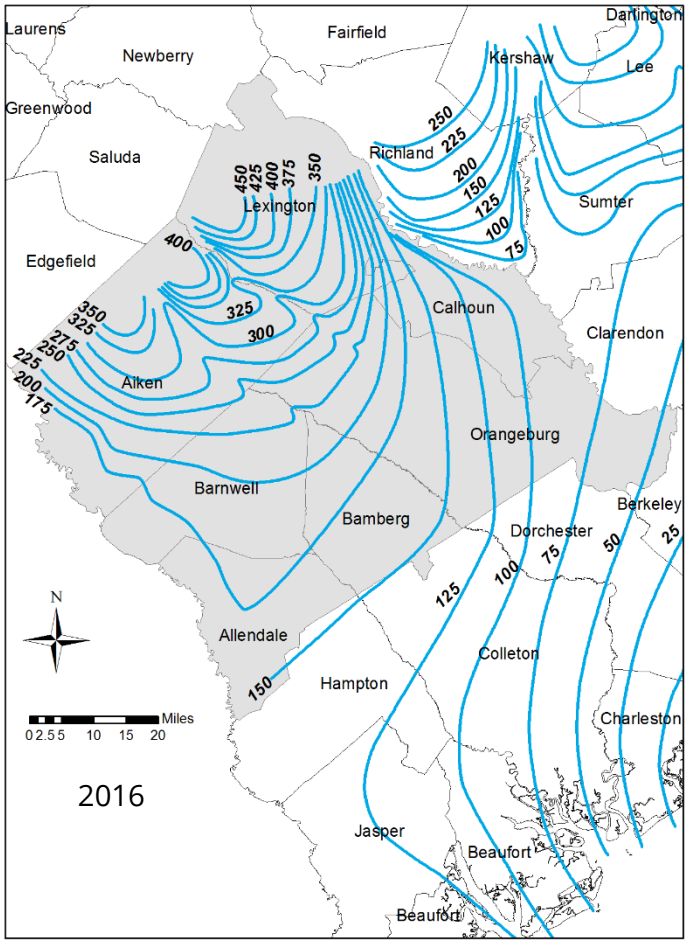
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