# Pee Dee Capacity Use Area: 2020 Groundwater Evaluation Report

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## Introduction

The Pee Dee Capacity Use Area (Pee Dee Area) was the fourth of five currently designated areas of South Carolina's Coastal Plain to be incorporated into the Capacity Use Program on February 12, 2004. It includes Darlington, Dillon, Florence, Marion, Marlboro, and Williamsburg counties (Figure 1). In the parts of the state designated as a Capacity Use Area, a groundwater withdrawer is defined as *a person withdrawing groundwater in excess of three million gallons during any one month from a single well or from multiple wells under common ownership within a one-mile radius from any one existing or proposed well* (SC Groundwater Use and Reporting Act, 2000)[1].

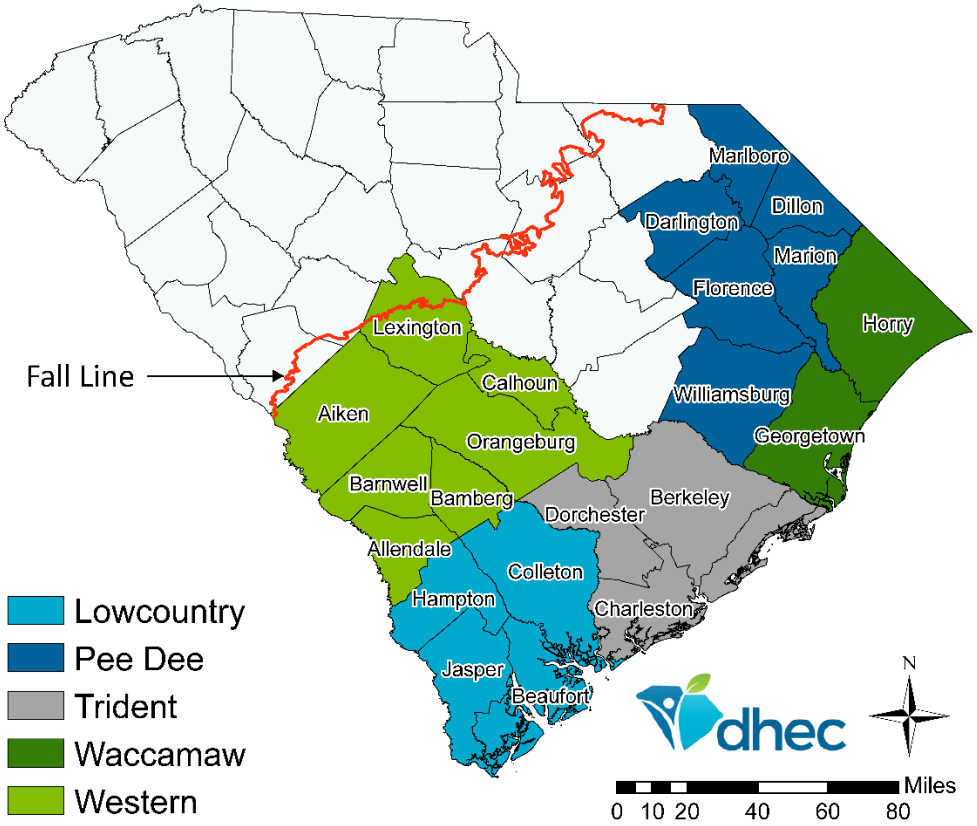



*Figure 1: Capacity Use Areas of the State of South Carolina*

### Regulatory History

In 1967, the S.C. Water Resources Planning and Coordination Act (Water Resources Act) established the S.C. Water Resources Commission (the Commission), which designated the Waccamaw Area, Horry and Georgetown counties, the first Capacity Use Area in 1979. In 1993, under the Water Resources Act, the responsibilities of the Commission were distributed to the S.C. Department of Health and Environmental Control (DHEC) and the S.C. Department of Natural Resources (DNR), and the Commission was dissolved. In 2000, the South Carolina Code of Law changed to include what is now the current Groundwater Use and Reporting Act[1]. Significant changes enacted by the new law were 1) groundwater assessments to determine the necessity of establishing a Capacity Use Area could be

initiated by DHEC as well as requested by local governments or non-governmental organizations within the state; and 2) a Groundwater Management Plan was now required for each Capacity Use Area. The Capacity Use Areas and associated counties were designated in the following order:

**1979**: Waccamaw Area
- Georgetown and Horry counites

**1981**: Lowcountry Area
- Beaufort, Colleton, and Jasper counties

**2002**: Trident Area
- Berkeley, Charleston, and Dorchester counties

**2004:** Pee Dee Area
- Darlington, Dillon, Florence, Marion, Marlboro, and Williamsburg counties

**2008**: Lowcountry Area
- Hampton county added to already designated area

**2018**: Western Area
- Aiken, Allendale, Bamberg, Barnwell, Calhoun, Lexington, and Orangeburg counties

The Initial Pee Dee Groundwater Management Plan[2] (PDGMP) was approved by the DHEC Board in August 2017. The three stated goals of the PDGMP are to:

- Ensure sustainable development of the groundwater resource by management of groundwater withdrawals;
- Protect groundwater quality from salt-water intrusion; and
- Monitor groundwater quality and quantity in an ongoing effort to evaluate changing groundwater conditions.

The PDGMP addressed achieving these goals by assessing the following aspects of groundwater use in the Pee Dee Area:

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

Following the guidelines set forth in the PDGMP, this document provides an evaluation of current groundwater use and recommendations for its management.

## Hydrogeologic Framework

The Pee Dee Area is located within the Upper and Lower Coastal Plain physiographic provinces of South Carolina (Figure 2). Groundwater and surface water sources are available and utilized in this area. The Coastal Plain of South Carolina is part of the larger Atlantic Coastal Plain principal aquifer. The Atlantic Coastal Plain extends north to south from New Jersey to Florida, and it extends east to west from the Fall Line to the coastline[3].

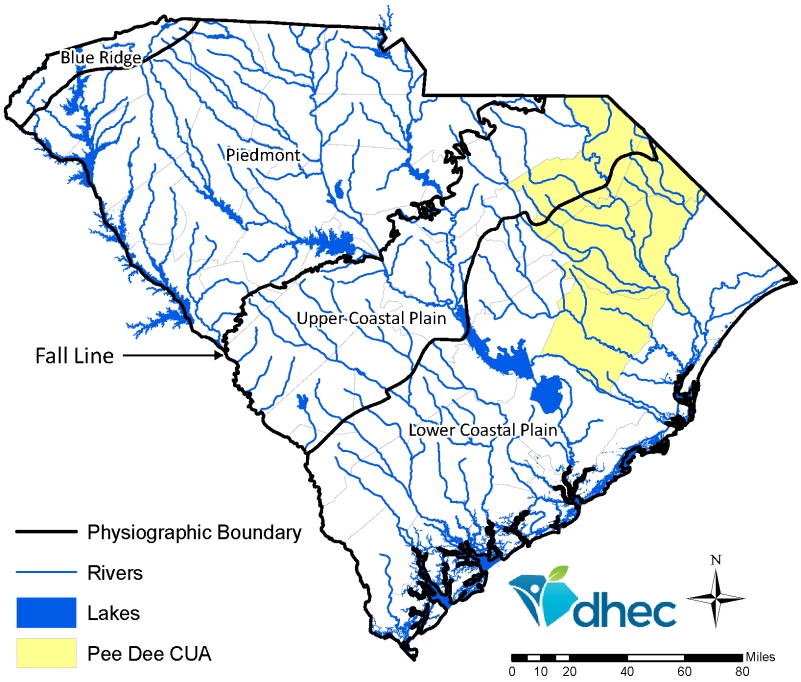
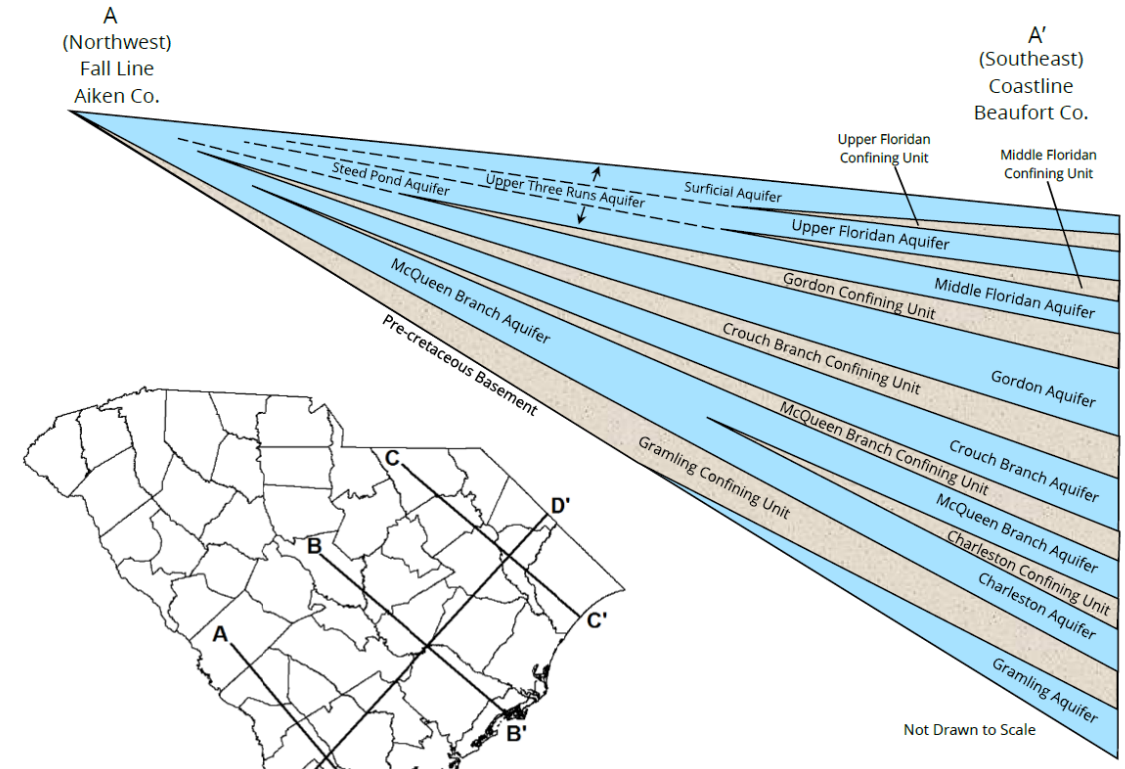


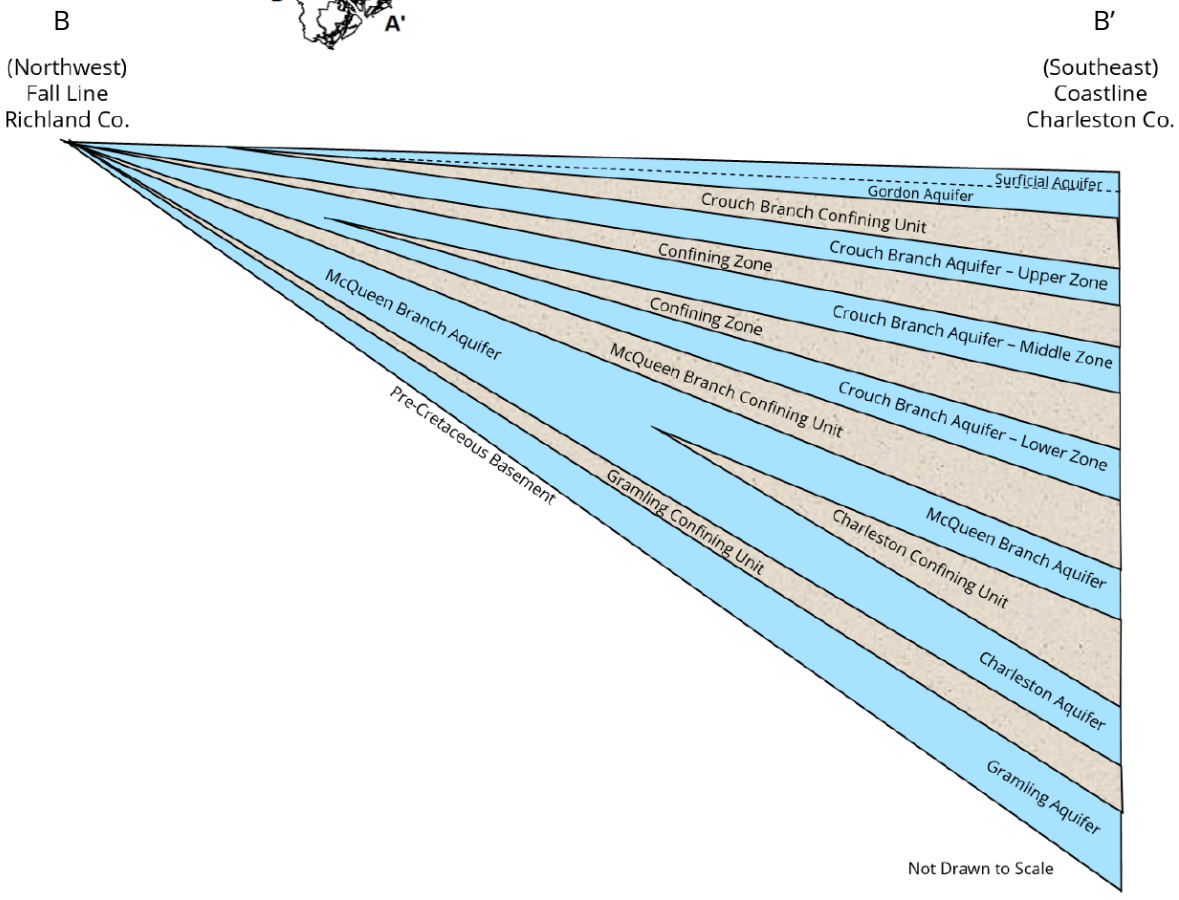

*Figure 2: Pee Dee Area Physiographic Provinces*

### Aquifers

The hydrogeologic framework of the South Carolina Coastal Plain consists of a wedge-shaped stratigraphy divided into alternating layers of water-bearing, permeable sand, or carbonate deposits (aquifers) with layers of fine-grained clays, silts, or low-permeability carbonate deposits (confining units) (Figure 3)[4]. The hydrogeologic units underlying the South Carolina Coastal Plain were deposited during the late Cretaceous to Tertiary Periods. From oldest to youngest, the Cretaceous units are Gramling, Charleston, McQueen Branch, and Crouch Branch[4]. The Tertiary units, in the same chronological order, are the Gordon, Floridan, and Surficial (Figure 3).

Beneath the Pee Dee Area, the Cretaceous aquifers are present in all six counties, except for the Gramling and Charleston aquifers, which only extend into Florence, Marion, and Williamsburg counties. The Floridan aquifer is absent in the Pee Dee Area. The Gordon aquifer is minimally present and located only in the southern half of Williamsburg county[4].


A
(Northwest)
Fall Line
Aiken Co.
A'
(Southeast)
Coastline
Beaufort Co.
Upper Floridan Confining Unit
Middle Floridan Confining Unit
Steed Pond Aquifer
Upper Three Runs Aquifer
Surficial Aquifer
Upper Floridan Aquifer
Middle Floridan Aquifer
Gordon Confining Unit
Gordon Aquifer
Crouch Branch Confining Unit
Crouch Branch Aquifer
McQueen Branch Confining Unit
McQueen Branch Aquifer
Charleston Confining Unit
Charleston Aquifer
Gramling Confining Unit
Gramling Aquifer
McQueen Branch Aquifer
Pre-cretaceous Basement
Not Drawn to Scale
A
B
C
D
A'
B'
C'
D'


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 Confining Unit
McQueen Branch Aquifer
Charleston Confining Unit
Charleston Aquifer
Gramling Confining Unit
Gramling Aquifer
McQueen Branch Aquifer
Pre-Cretaceous Basement
Not Drawn to Scale

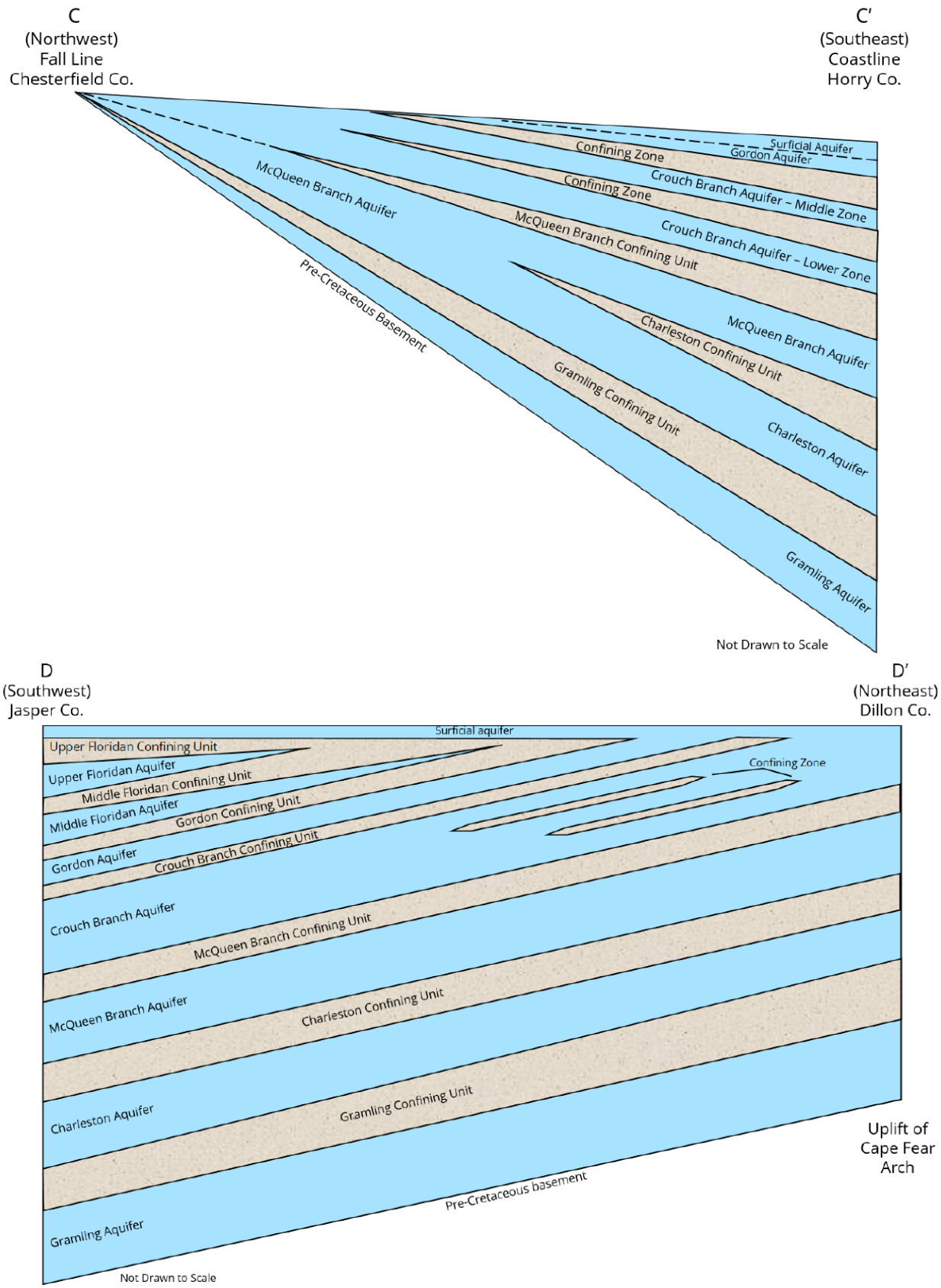



*Figure 3: Generalized SC Hydrogeologic Framework. Modified from Campbell, B.G., and A.L. Coes, eds. (2010).*

## Recharge Areas

The recharge areas for South Carolina aquifers are primarily located within the Upper Coastal Plain (Figure 4). The surficial aquifer receives direct recharge through infiltration of local precipitation and surface water bodies. Groundwater in the deeper aquifers is significantly replenished by precipitation and surface water infiltration in the recharge areas (Figure 4). Water that enters here then moves slowly 'down-dip' through the hydrogeologic framework towards the Atlantic Ocean. Consequently, the rate at which groundwater is replenished in the deeper aquifers of the Pee Dee Area is largely controlled by the rate at which groundwater travels from the recharge zones near the Fall Line. Typical groundwater flow rates for silts to well-sorted sands range from 0.003 to 300 feet per day[5]. This means that once the precipitation becomes part of the groundwater system, it may take from a few years to tens of thousands of years to reach some locations below the Pee Dee Area. Further 'up-dip' in the Pee Dee Area where aquifers are shallower, more interconnected, and the confining units pinch out, groundwater can more easily flow between the aquifers through leaky or thin confining units, as well as respond more rapidly to changes in climatic conditions at the surface.

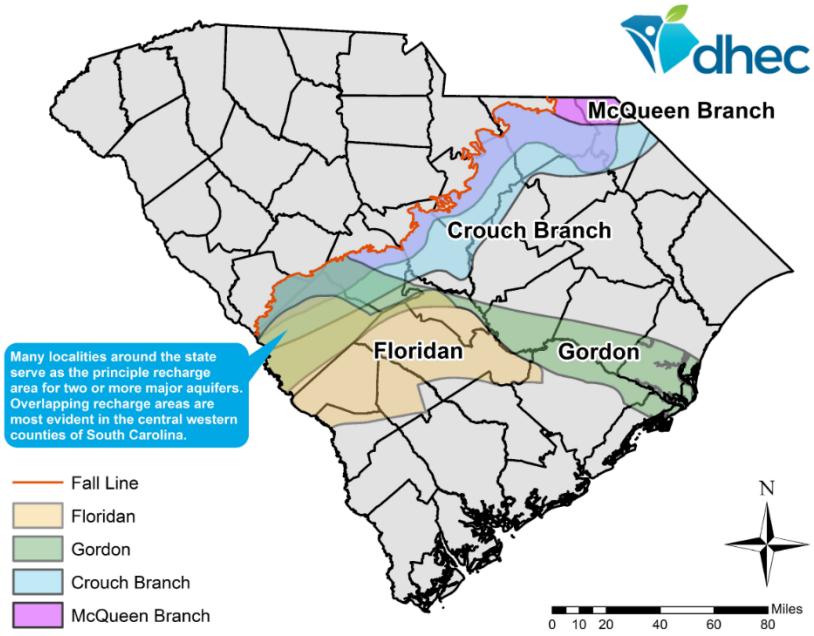



*Figure 4: Generalized Recharge Areas of SC Major Aquifers*

## Surface Water

The Pee Dee Area is located in two of South Carolina's major rivers basins: Pee Dee and Santee (Figure 5). Significant rivers that flow through the Pee Dee Area are the Little Pee Dee River, Great Pee Dee River, Black Creek, Lynches River, Black River, and Santee River (Figure 5). These rivers and their smaller tributaries are used as primary water sources or as alternatives to groundwater sources in the Pee Dee Area counties. Aside from small impoundments, there are no major lakes or reservoirs that exist entirely within the Pee Dee Capacity Use Area. The largest surface water impoundment in terms of volume and area is Lake Robinson which is located in both Darlington and Chesterfield counties.

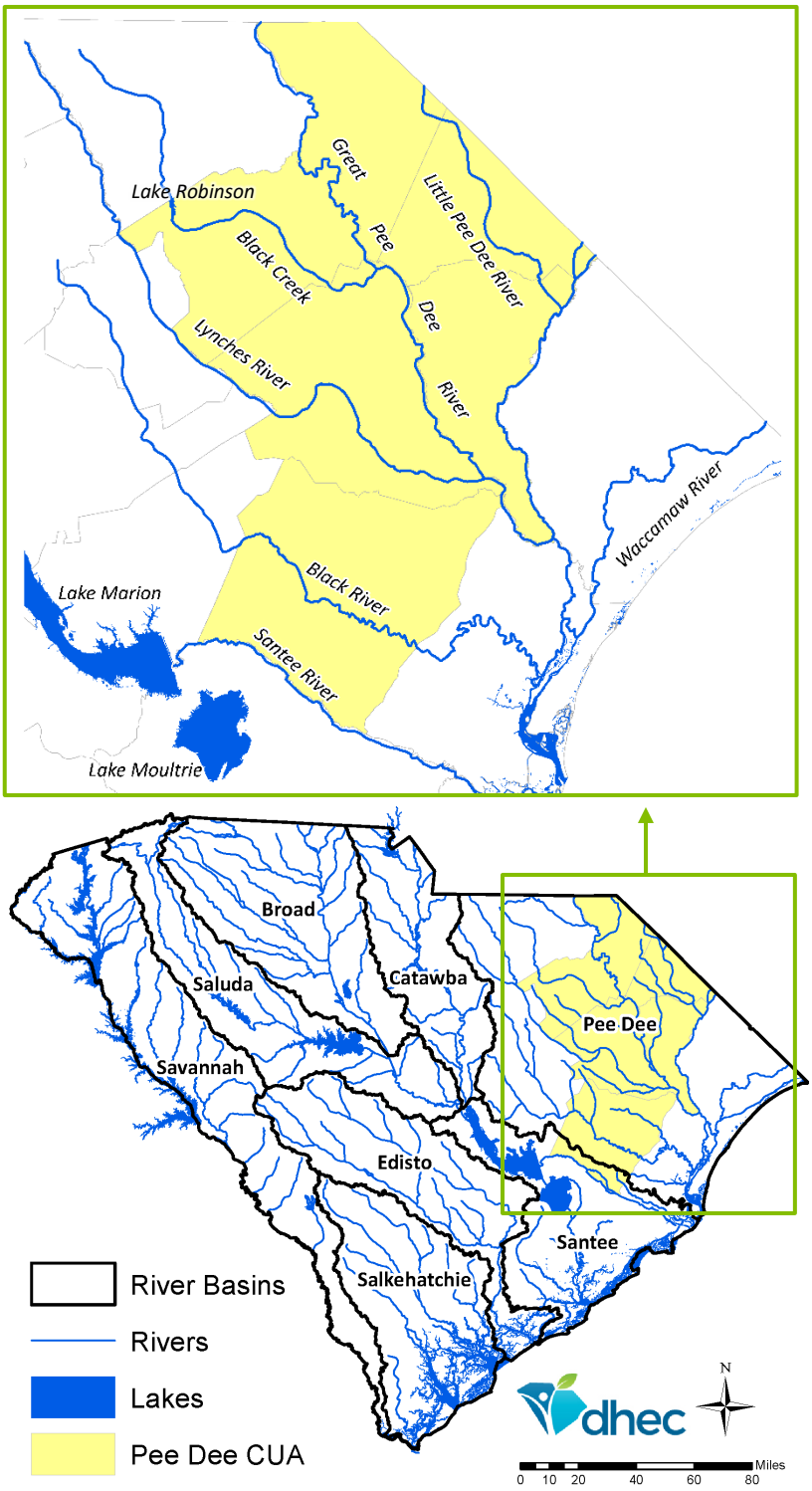



*Figure 5: SC Major River Basins and Water Bodies in the Pee Dee Area*

## Groundwater Trends

The following map displays the locations of 13 monitoring wells in the Pee Dee Area (Figure 6). The wells are maintained or previously maintained by DNR and/or the United States Geological Survey (USGS) as part of the SC Groundwater Monitoring Network and/or SC Groundwater Drought Monitoring Network. In total, the wells provide daily water level data from 1972-present (Figure 7-19). Ten of the wells did not begin reporting until after 2000. Of these 13 wells, according to DNR, five are screened in the Crouch Branch aquifer, and eight are screened in the McQueen Branch aquifer (Figure 6). There are not any long-term, monitoring wells screened in the Surficial, Gordon, Charleston, or Gramling aquifers within the Pee Dee Area. In 2019, DNR installed ten new surficial monitoring wells across the Coastal Plain and plans to install even more wells equipped with real-time monitoring equipment across the state in years to come.

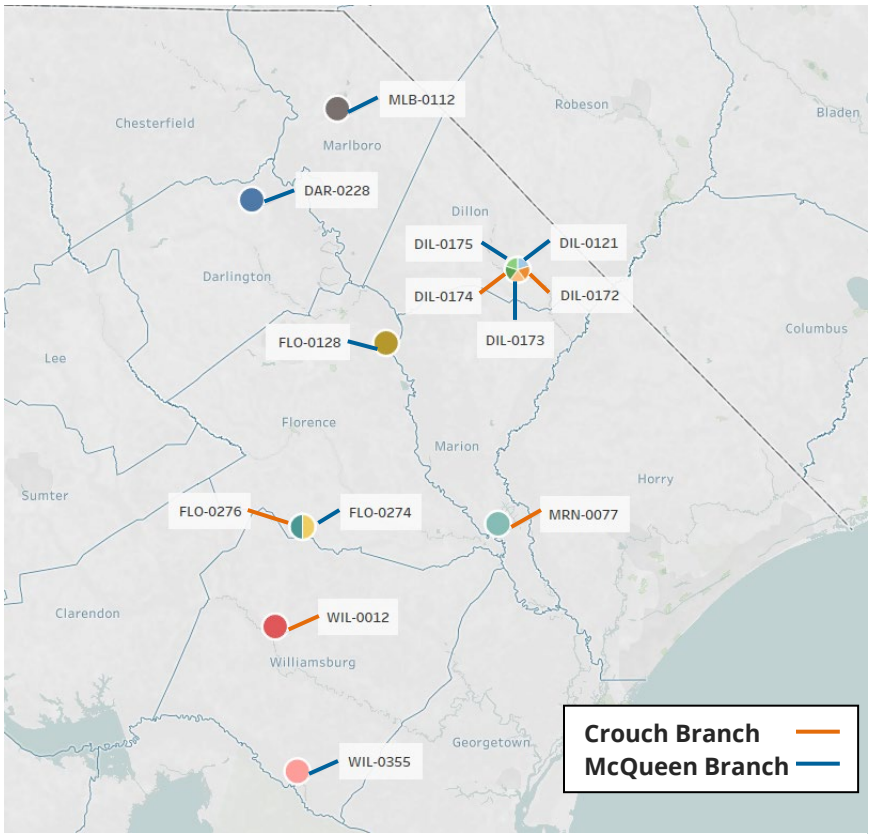



*Figure 6: Pee Dee Area Monitoring Wells (Well site location colors correspond to daily water level measurement graphs)*

Groundwater levels have declined since pre-development across the Pee Dee Area in the major underlying aquifers[6]. Among the five wells screened in the Crouch Branch aquifer, all exhibited declining trends in water levels for the entirety of their reporting history. MRN-0077, the longest reporting Crouch Branch well in the Pee Dee Area, declined 45.74 ft from 12.54 ft BLS (below land surface) in 1982 to 58.28 ft BLS in 2019 (Figure 17). MRN-0077 has declined steadily at 1.24 ft per year since it began reporting. Similarly, FLO-0276 declined 23.84 ft at a rate of 1.26 ft per year steadily since it began reporting in 2000 (Figure 15). DIL-0172, DIL-0174, and WIL-0012 have all been reporting for five years or less; and therefore, provide less insight into decadal long trends. DIL-0172 declined 3.15 ft at a rate of 0.63 ft per year (Figure 9); DIL-0174 declined 2.03 ft at a rate of 0.41 ft per year (Figure 11); and WIL-0012 declined 5.20 ft at a rate of 1.73 ft per year (Figure 18). On average, the wells screened in the Crouch Branch aquifer have water levels declining at a rate of 1.05 ft per year.

Among the eight wells screened in the McQueen Branch aquifer, six exhibited declining and two exhibited upward trends in water levels for the entirety of their reporting history. DIL-

0121 and FLO-0274 have recorded declines of 10.25 ft and 20.54 ft since 2000, respectively (Figure 8, Figure 14). Correspondingly, over the last two decades, DIL-0121 and FLO-0274 have declined at rates of 0.54 and 1.08 ft per year (Figure 8, Figure 14). DIL-0173, DIL-0175, and WIL-0355 have all been reporting for five years or less; and therefore, provide less insight into decadal long trends. DIL-0173 declined 2.15 ft at a rate of 0.54 ft per year (Figure 10); DIL-0175 declined 3.07 ft at a rate of 0.77 ft per year (Figure 12); and WIL-0355 declined 6.28 ft at a rate of 1.26 ft per year (Figure 19). MLB-0112 recorded daily water level measurements from 1972-2011 in a heavily surficially influenced location. During its recording period, MLB-0112 declined 1.36 ft at a rate of 0.05 ft per year (Figure 16). FLO-0128 has been recording data since 1982 and has recovered from its decadal long trend of declining water levels beginning in 2000 (Figure 13). FLO-0128's recovery may be attributed to local groundwater users transitioning to surface water options, and the wells proximity to a major surface water body (Great Pee Dee River) providing sufficient recharge for rebounding water levels. DAR-0228 has trended minimally upwards since it began recording in 1999; however, beginning in 2012 water levels have become much more variable between seasonal highs and lows, most likely due to increases in local pumping (Figure 7).

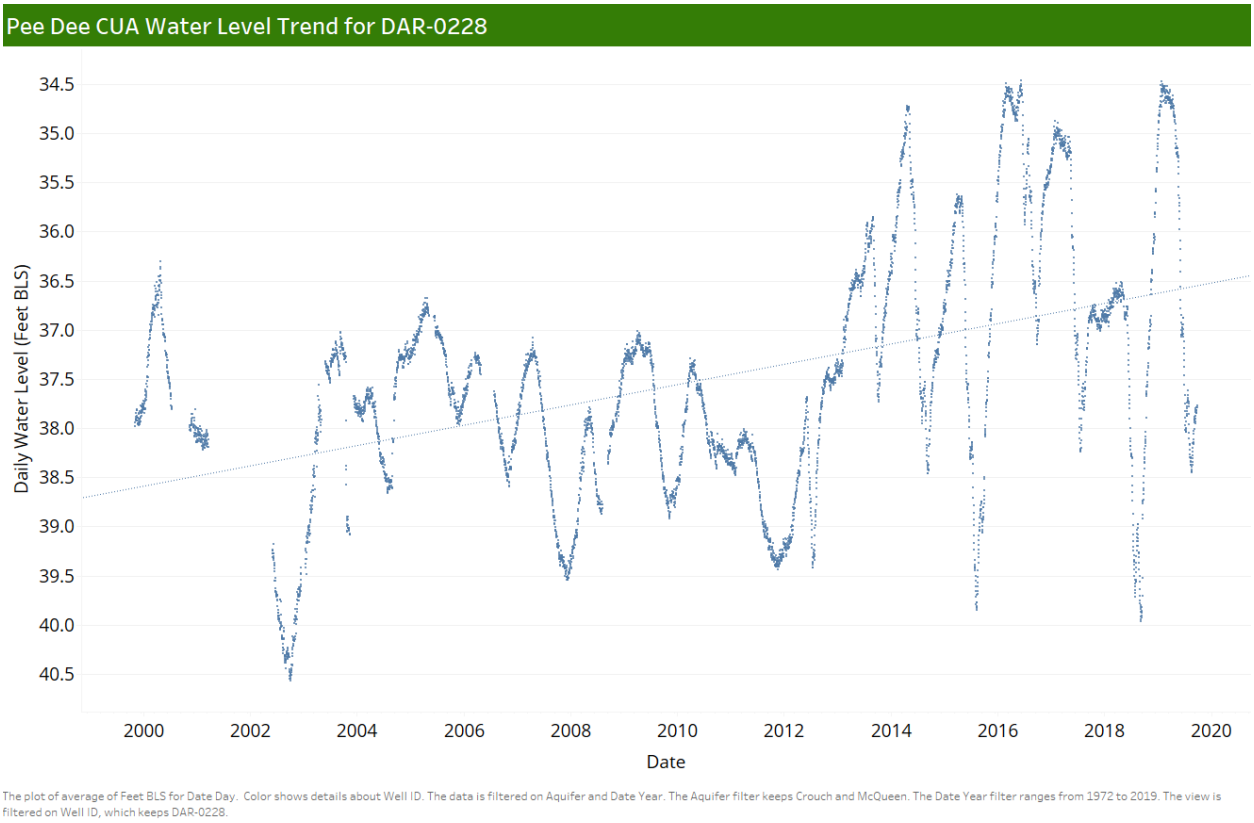



*Figure 7: Daily Water Level Measurements DAR-0228*

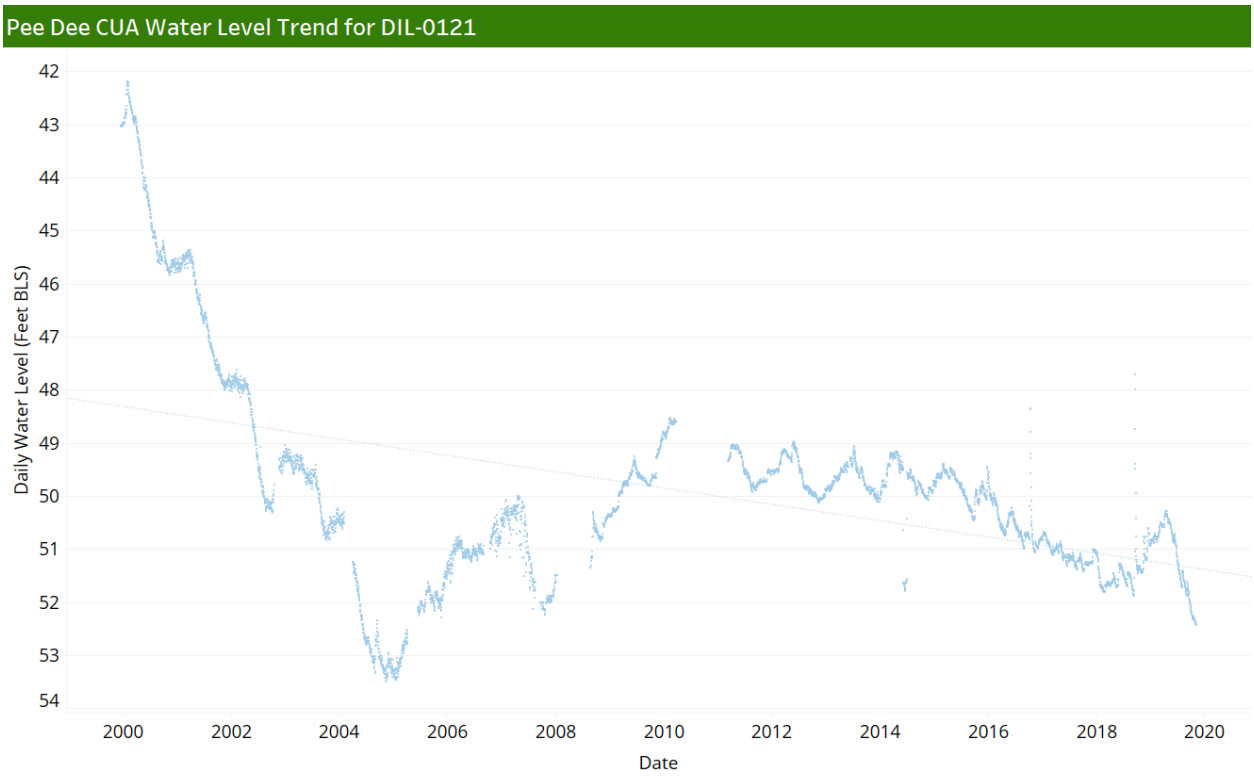



*Figure 8: Daily Water Level Measurements DIL-0121*

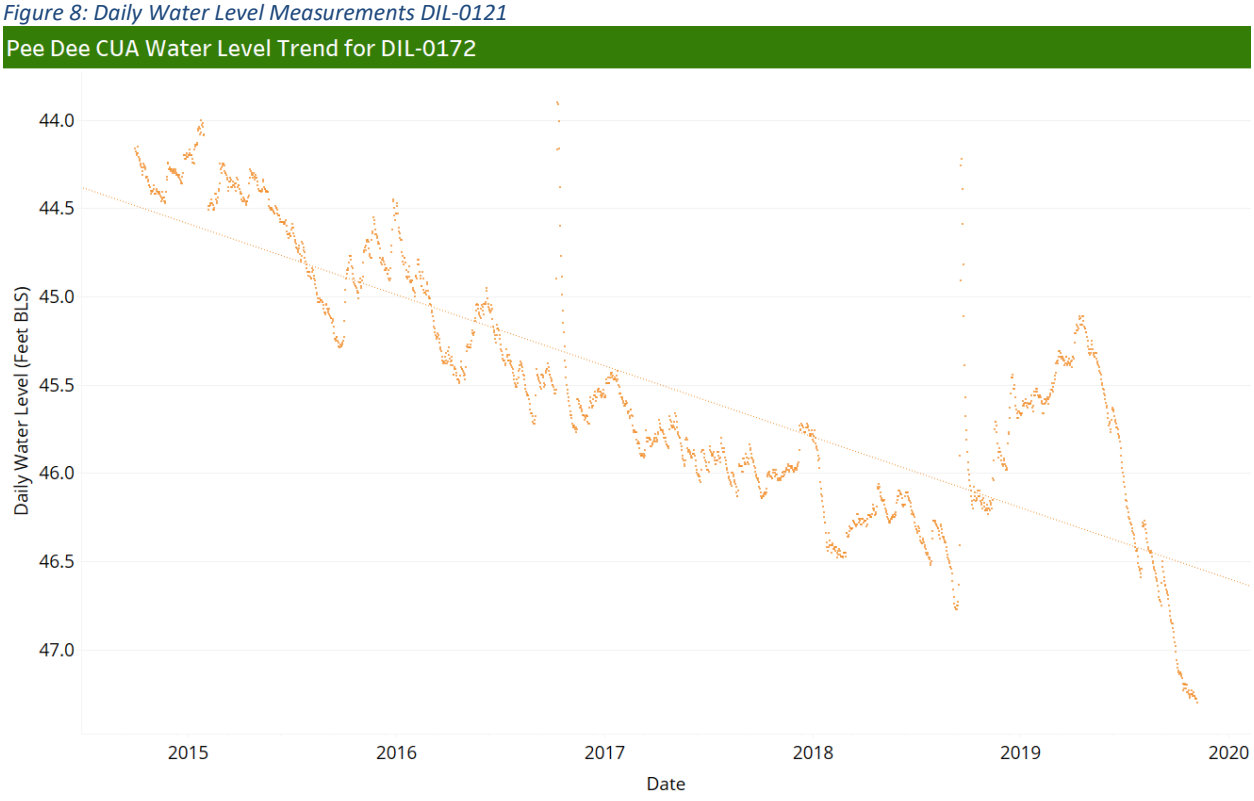



*Figure 9: Daily Water Level Measurements DIL-0172*

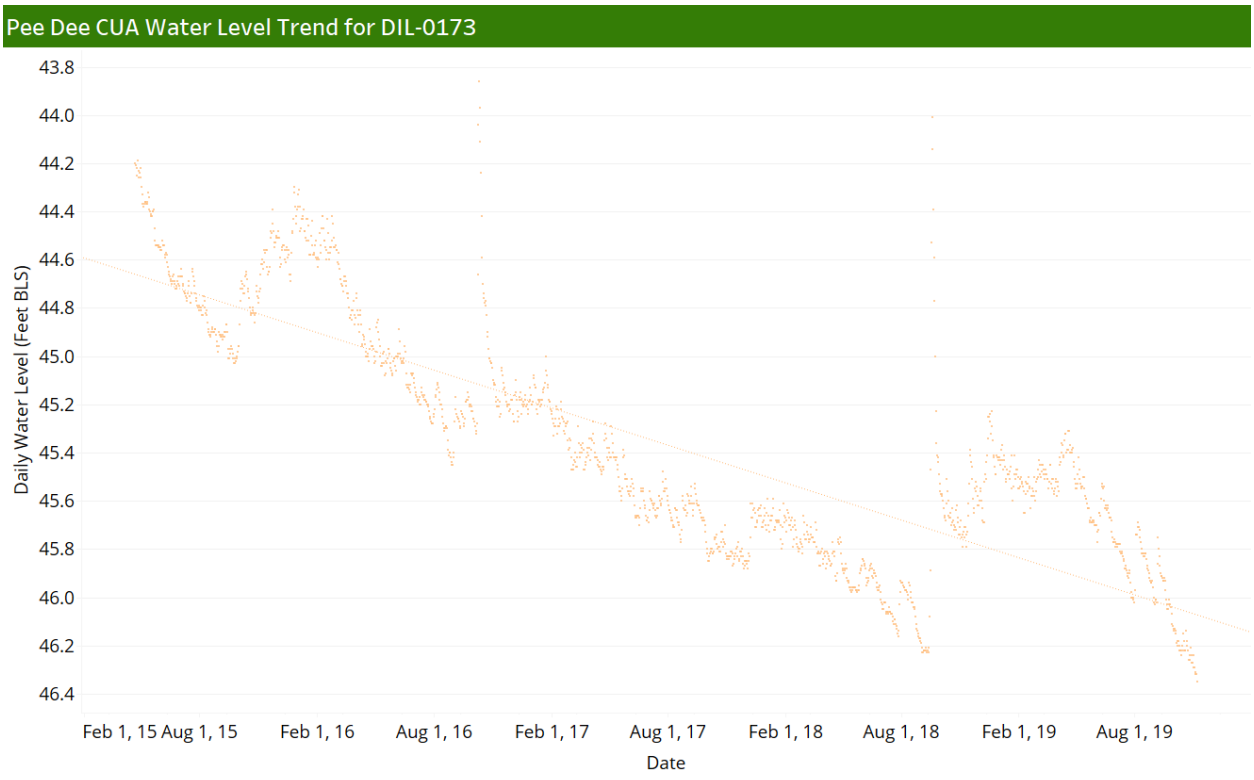



*Figure 10: Daily Water Level Measurements DIL-0173*

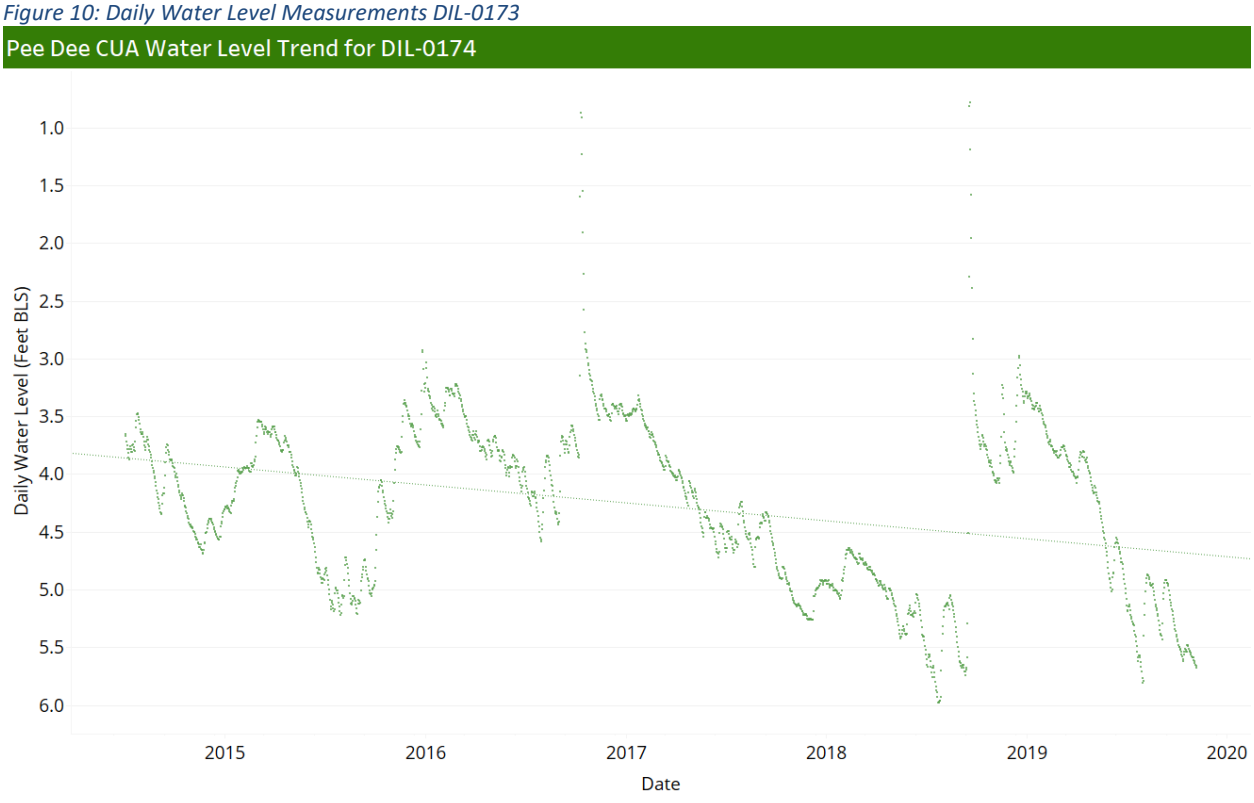
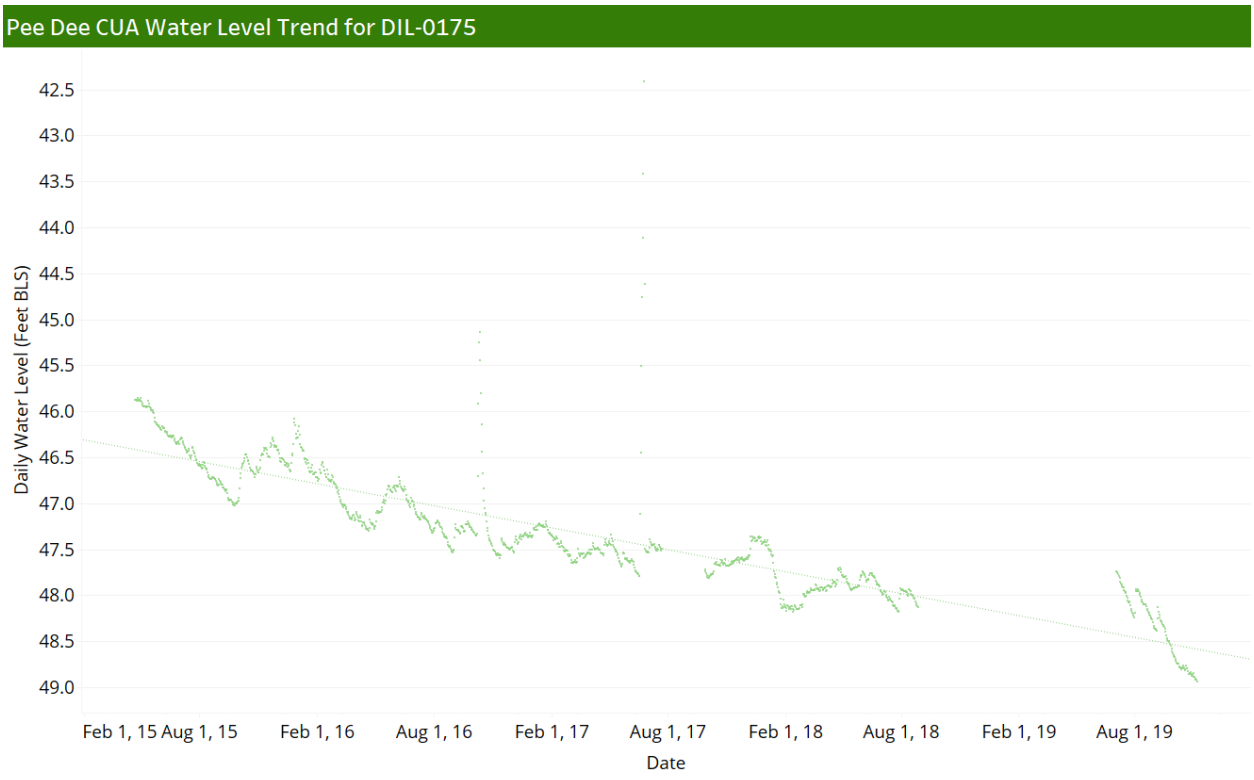



*Figure 11: Daily Water Level Measurements DIL-0174*




The plot of average of Feet BLS for Date Day. Color shows details about Well ID. The data is filtered on Aquifer and Date Year. The Aquifer filter keeps Crouch and McQueen. The Date Year filter ranges from 1972 to 2019. The view is filtered on Well ID, which keeps DIL-0175.

*Figure 12: Daily Water Level Measurements DIL-0175*

The plot of average of Feet BLS for Date Day. Color shows details about Well ID. The data is filtered on Aquifer and Date Year. The Aquifer filter keeps Crouch and McQueen. The Date Year filter ranges from 1972 to 2019. The view is filtered on Well ID, which keeps FLO-0128.

*Figure 13: Daily Water Level Measurements FLO-0128*

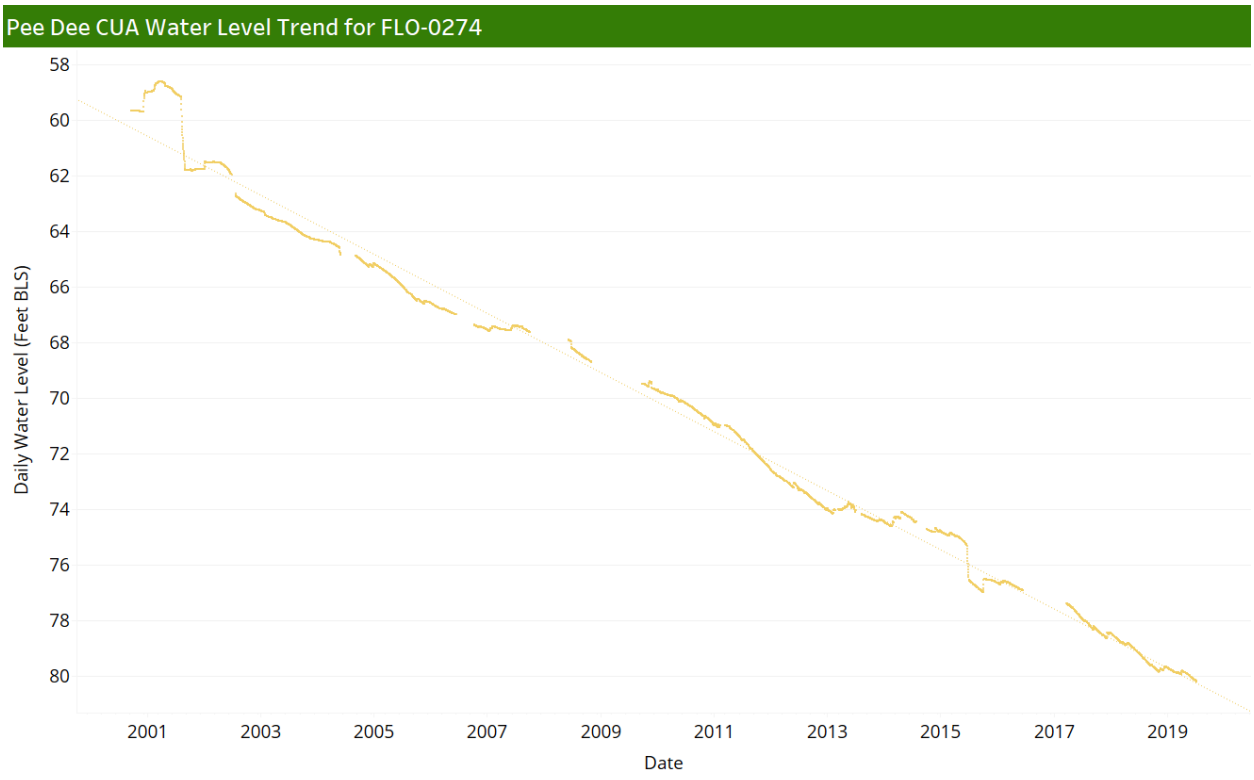
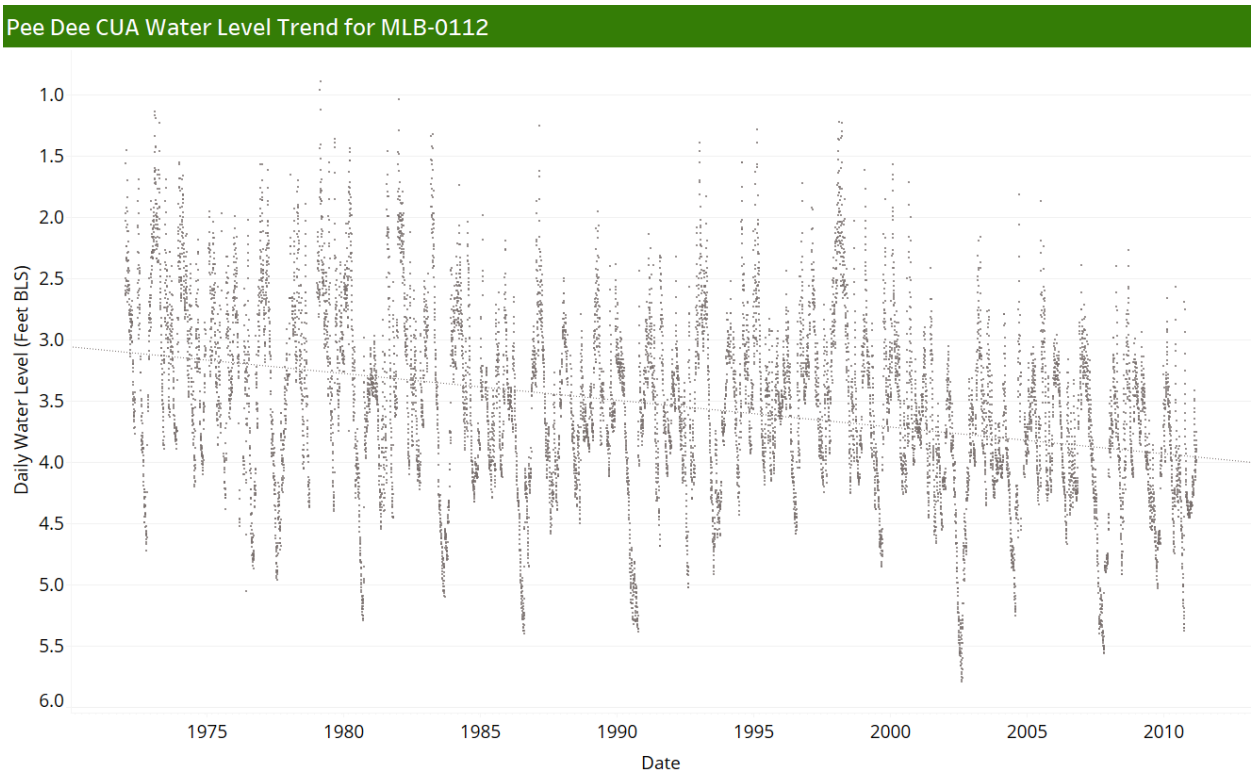


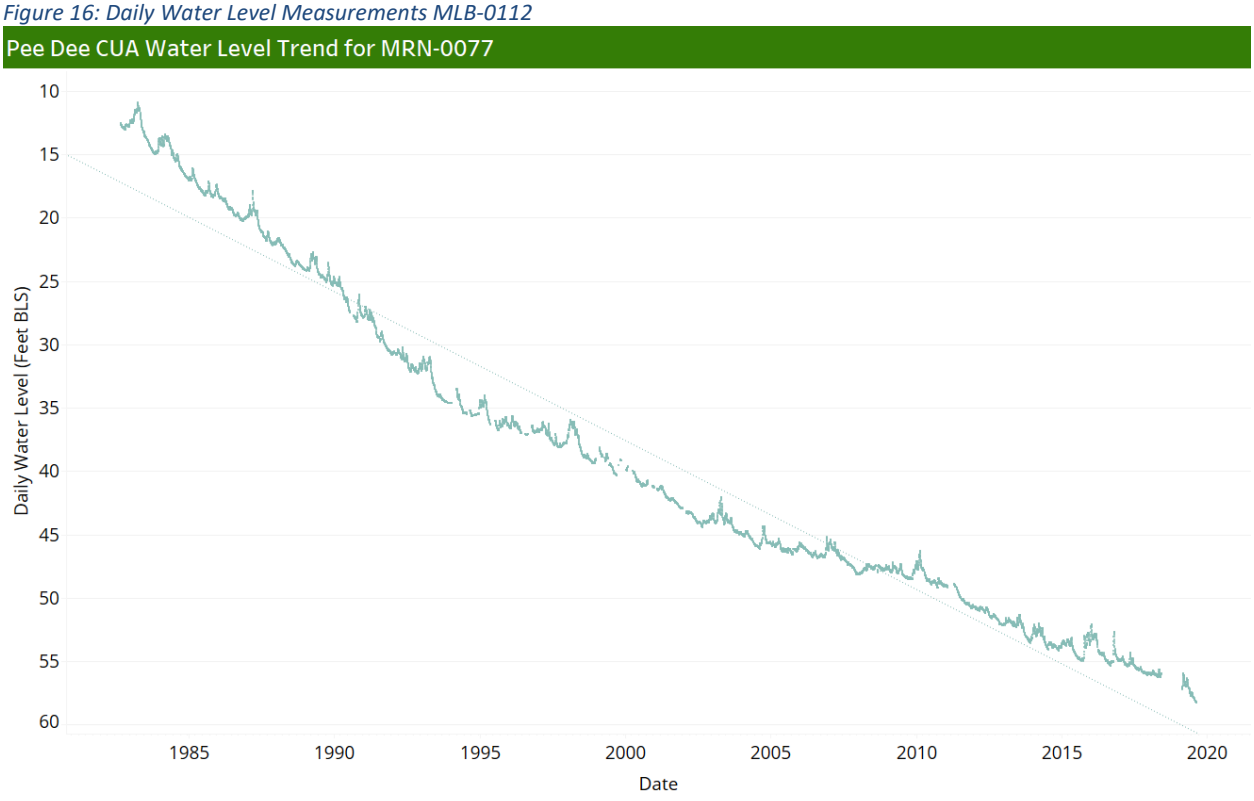

*Figure 14: Daily Water Level Measurements FLO-0274*

*Figure 15: Daily Water Level Measurements FLO-0276*




The plot of average of Feet BLS for Date Day. Color shows details about Well ID. The data is filtered on Aquifer and Date Year. The Aquifer filter keeps Crouch and McQueen. The Date Year filter ranges from 1972 to 2019. The view is filtered on Well ID, which keeps MLB-0112.

*Figure 16: Daily Water Level Measurements MLB-0112*




The plot of average of Feet BLS for Date Day. Color shows details about Well ID. The data is filtered on Aquifer and Date Year. The Aquifer filter keeps Crouch and McQueen. The Date Year filter ranges from 1972 to 2019. The view is filtered on Well ID, which keeps MRN-0077.

*Figure 17: Daily Water Level Measurements MRN-0077*

*Figure 18: Daily Water Level Measurements WIL-0012*

*Figure 19: Daily Water Level Measurements WIL-0355*

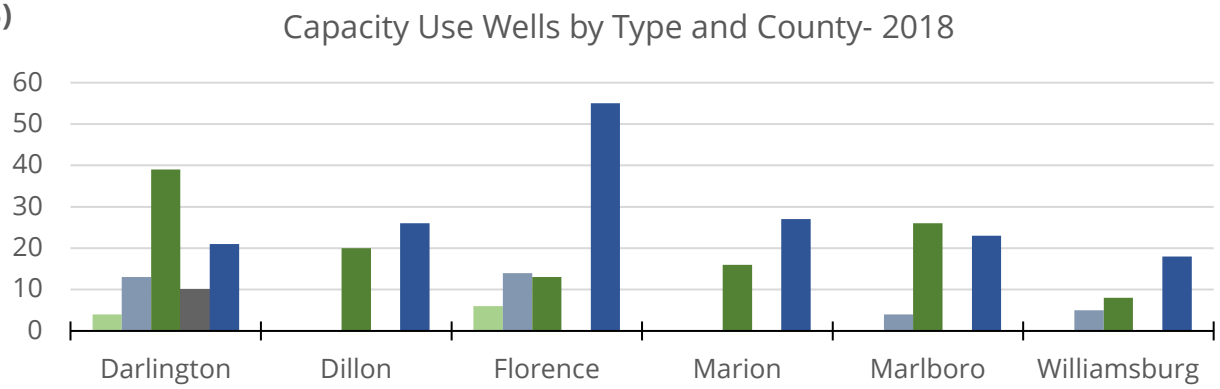
## Current Groundwater Demand

The Pee Dee Area currently has 348 permitted Capacity Use wells (Figure 20 A-C). Almost half of the wells are permitted for water supply with zero permitted for aquaculture, mining, hydro power, thermo power, and other use categories. Half of wells are permitted in Florence and Darlington counties. The least number of permitted wells are located in Williamsburg county.

A)

| Use Category | Darlington | Dillon | Florence | Marion | Marlboro | Williamsburg | Total (%) |
|---|---|---|---|---|---|---|---|
| **Aquaculture (AQ)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 (0%) |
| **Golf Course (GC)** | 4 | 0 | 6 | 0 | 0 | 0 | 10 (3%) |
| **Industry (IN)** | 13 | 0 | 14 | 0 | 4 | 5 | 36 (10%) |
| **Irrigation (IR)** | 39 | 20 | 13 | 16 | 26 | 8 | 122 (35%) |
| **Mining (MI)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 (0%) |
| **Other (OT)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 (0%) |
| **Hydro Power (PH)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 (0%) |
| **Nuclear Power (PN)** | 10 | 0 | 0 | 0 | 0 | 0 | 10 (3%) |
| **Thermo Power (PT)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 (0%) |
| **Water Supply (WS)** | 21 | 26 | 55 | 27 | 23 | 18 | 170 (49%) |
| **Total (%)** | 87 (25%) | 46 (13%) | 88 (25%) | 43 (12%) | 53 (15%) | 31 (9%) | 348 |

B)




C)

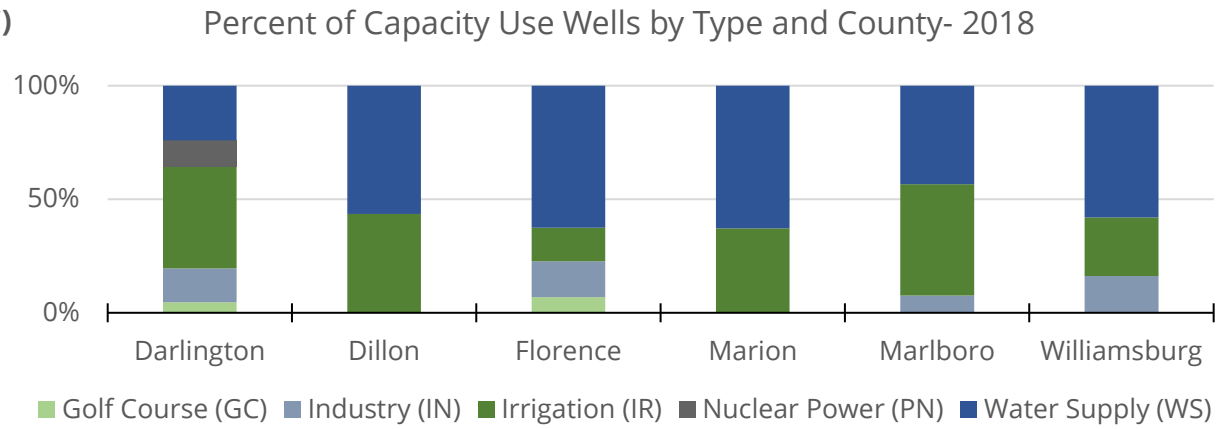
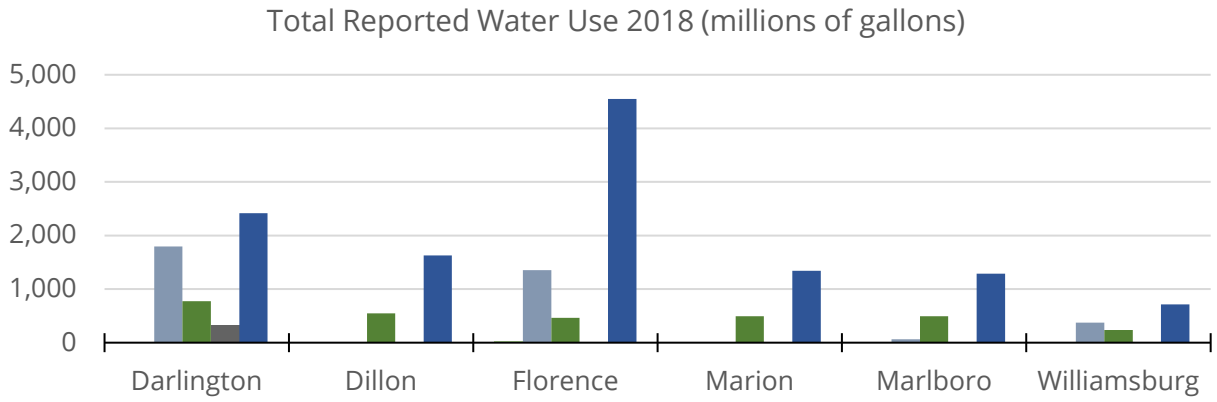



*Figure 20 (A-C): Table and Graphs of Pee Dee Capacity Use Area Permitted Wells by Type and County -2018*

A)

| Use Category | Darlington | Dillon | Florence | Marion | Marlboro | Williamsburg | Total (%) |
|---|---|---|---|---|---|---|---|
| **Aquaculture (AQ)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 (0%) |
| **Golf Course (GC)** | 0 | 0 | 33 | 0 | 0 | 0 | 33 (0.2%) |
| **Industry (IN)** | 1,794 | 0 | 1,353 | 0 | 63 | 374 | 3,584 (19%) |
| **Irrigation (IR)** | 776 | 545 | 465 | 495 | 492 | 238 | 3,011 (16%) |
| **Mining (MI)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 (0%) |
| **Other (OT)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 (0%) |
| **Hydro Power (PH)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 (0%) |
| **Nuclear Power (PN)** | 334 | 0 | 0 | 0 | 0 | 0 | 334 (2%) |
| **Thermo Power (PT)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 (0%) |
| **Water Supply (WS)** | 2,417 | 1,626 | 4,547 | 1,344 | 1,288 | 714 | 11,936 (63%) |
| **Total (%)** | 5,321 (28%) | 2,171 (11%) | 6,398 (34%) | 1,839 (10%) | 1,843 (10%) | 1,326 (7%) | 18,898 |

B)

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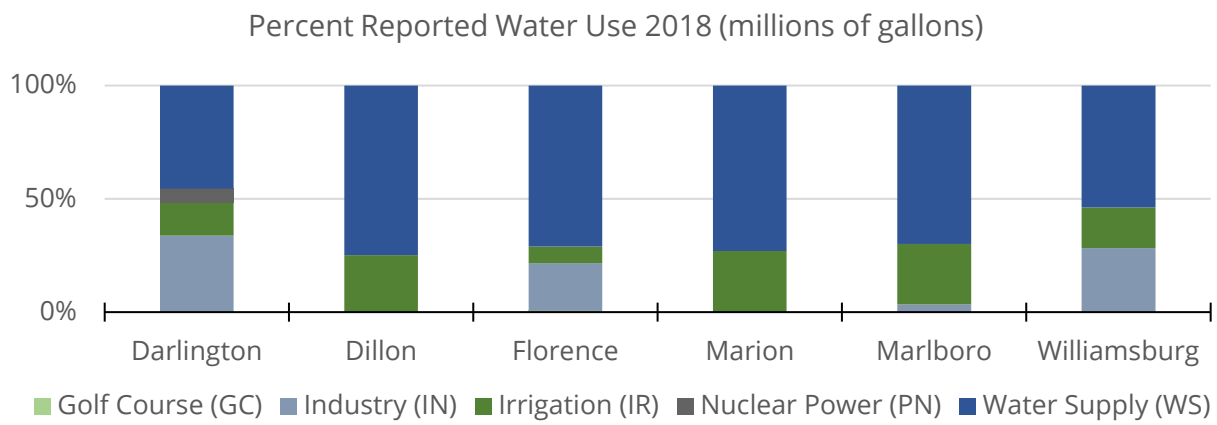


*Figure 21(A-C): Table and Graphs of Pee Dee Capacity Use Area Reported Water Use by Type and County - 2018*

In every county, water supply has the largest current demand on groundwater in the Pee Dee Area (Figure 21 A-C). Water supply accounts for 63% of current demand for the entire region (Figure 21 A). Out of all six counties, Florence has the largest demand on groundwater at 34%, and Williamsburg has the smallest demand at 7% (Figure 21 A-C).

## Darlington County Demand Details

Darlington county has 29 permitted facilites that own a total of 87 wells (Table 1). The total reported withdrawals for 2018 were 68% of the total permitted annual withdrawal limits for the county. The largest source of groundwater for the county is the McQueen Branch aquifer supplying 99% (5,266.46 MGY) of the total reported water use for 2018, followed by the Crouch Branch aquifer at 1% (51.49 MGY) (Table 1).

| Facility | Permit | Aquifer(s) | Permit Amount | 2018 Reported Water Use |
|---|---|---|---|---|
| Fox Creek Golf Club | 16GC001 | Crouch Branch | 50 | 0 |
| Fiber Industries, LLC – Palmetto Plant | 16IN001 | McQueen Branch | 500 | 53 |
| Sonoco Products Company/Hartsville Complex | 16IN005 | McQueen Branch | 1,758 | 1,679 |
| Nucor Steel - Darlington | 16IN006 | McQueen Branch | 315 | 61 |
| Roger Brothers Farm | 16IR016 | McQueen Branch | 381 | 194 |
| Les Galloway Farms | 16IR017 | McQueen Branch | 40 | 48 |
| Les Galloway Farms | 16IR018 | McQueen Branch | 30 | 33 |
| James N. Chapman Farms, LLC | 16IR030 | McQueen Branch | 46 | 26 |
| Lawson Turf Farms | 16IR041 | McQueen Branch | 79 | 32 |
| David Segars Farm – Allen Road Fields | 16IR042 | McQueen Branch | 36 | 20 |
| David Segars Farm – Bay Road Fields | 16IR081 | McQueen Branch | 93 | 77.46 |
| Woodard Farms, Inc. | 16IR082 | McQueen Branch | 244 | 73 |
| Windham Farm | 16IR084 | McQueen Branch | 54.7 | 3.5 |
| Mark White Farms | 16IR085 | Crouch Branch | 30 | 12 |
| Randolph Farm | 16IR086 | McQueen Branch | 63 | 39.5 |
| Tolson Farms | 16IR087 | Crouch Branch | 60 | 39 |
| LIGHT Farms, LLC | 16IR088 | Crouch Branch | 34 | 0.4 |
| David Aycock Farm | 16IR089 | McQueen Branch | 140 | 27 |
| Tyler Segars Farm | 16IR090 | McQueen Branch | 30 | 10 |
| Ryan Galloway Farm | 16IR091 | McQueen Branch | 75 | 42 |
| Les Galloway Farms | 16IR092 | McQueen Branch | 60 | 62 |
| Lawson Turf Farms | 16IR095 | McQueen Branch | 50 | 16 |
| William N. Chapman Farms, LLC | 16IR097 | McQueen Branch | 50 | 14 |
| Joel D. Chapman Farms | 16IR098 | McQueen Branch | 20 | 6 |
| Duke Energy Progress, Inc./H.B. Robinson SEP | 16PN001 | McQueen Branch | 663 | 334 |
| | | Crouch Branch | 0.6 | 0.09 |
| Darlington Co. Water and Sewer Authority | 16WS001 | McQueen Branch | 1,800 | 1,628 |
| City of Darlington | 16WS002 | McQueen Branch | 375 | 290 |
| City of Hartsville | 16WS003 | McQueen Branch | 712 | 498 |
| Town of Lamar | 16WS005 | Crouch Branch | 40 | 0 |
| | | McQueen Branch | 40 | 0 |
| | | **Total** | 7,869.3 | 5,317.95 |

*Table 1: Current Permitted Groundwater Withdrawers - Darlington County (Numbers reported in MGY)*

## Dillon County Demand Details

Dillon county has 15 permitted facilites that own a total of 46 wells (Table 2). The total reported withdrawals for 2018 were 62% of the total permitted annual withdrawal limits for the county. The largest source of groundwater for the county is the McQueen Branch aquifer supplying 78% (1,693 MGY) of the total reported water use for 2018, followed by cross-aquifer-screened wells in McQueen-Charleston at 16% (352 MGY), and then Crouch-McQueen at 6% (126 MGY) (Table 2).

| Facility | Permit | Aquifer(s) | Permit Amount | 2018 Reported Water Use |
|---|---|---|---|---|
| FPI Properties, LLC – Sellers Farm | 17IR001 | McQueen Branch | 348 | 181 |
| FPI Properties, LLC – Catfish Bay Farm | 17IR017 | McQueen Branch | 300 | 210 |
| Q&Q Farms, Inc. | 17IR018 | McQueen Branch | 23 | 4 |
| Little Pee Dee Farms/Bunker Hill Road Field | 17IR019 | McQueen Branch | 49.7 | 17 |
| Little Pee Dee Farms/Freestates Road Field | 17IR020 | McQueen Branch | 54 | 12 |
| Little Pee Dee Farms/McPhaul New Ground Fields | 17IR021 | McQueen Branch | 140 | 44 |
| P&S Farms/Sherwood Tract | 17IR022 | McQueen Branch | 50 | 25 |
| Daniel Baxley Farms/Minturn Road Tracts | 17IR023 | McQueen Branch | 86 | 22 |
| Glasdrum Farms/John's House Tract | 17IR024 | McQueen Branch | 34 | 8 |
| Jack Leggette Farms/State Line Farm | 17IR025 | McQueen Branch | 100 | 9 |
| Sinclair Farm | 17IR026 | McQueen Branch | 13.52 | 14 |
| City of Dillon | 17WS001 | McQueen Branch | 554 | 334 |
| Town of Latta | 17WS003 | Crouch-McQueen | 175 | 126 |
| Trico Water Company, Inc. | 17WS004 | McQueen Branch | 1,500 | 748 |
| | | McQueen-Charleston | | 352 |
| Border Courts Inc./South of the Border | 17WS005 | McQueen Branch | 70 | 65 |
| | | **Total** | 3,497.22 | 2,171 |

*Table 2: Current Permitted Groundwater Withdrawers - Dillon County (Numbers reported in MGY)*

## Florence County Demand Details

Florence county has 20 permitted facilites that own a total of 88 wells (Table 3). The total reported withdrawals for 2018 were 60% of the total permitted annual withdrawal limits for the county. The largest source of groundwater for the county is the McQueen Branch aquifer supplying 71% (4,516 MGY) of the total reported water use for 2018, followed by the Crouch Branch aquifer at 18% (1,151.516 MGY), then wells screened across the Crouch-McQueen at 9% (591 MGY), and lastly, the Charelston aquifer at 2% (142 MGY) (Table 3).

| Facility | Permit | Aquifer(s) | Permit Amount | 2018 Reported Water Use |
|---|---|---|---|---|
| Traces Golf Club | 21GC005 | Crouch Branch | 154 | 33 |
| Wellman Plastics Recycling, LLC | 21IN002 | Crouch Branch | 900 | 114 |
| | | Crouch-McQueen | | 152 |
| | | Charleston | | 91 |
| McCall Farms, Inc. | 21IN002 | Crouch Branch | 600 | 295 |
| | | McQueen Branch | | 219 |
| Clarios | 21IN010 | Charleston | 76 | 51 |
| Nan Ya Plastics Corporation, America, Lake City Plant | 21IN012 | Crouch Branch | 100 | 0.016 |
| | | Crouch-McQueen | 500 | 38 |
| | | McQueen Branch | | 394 |
| Cane Branch Turf Farm, LLC | 21IR012 | Crouch Branch | 40 | 21 |
| Tolson Farms | 21IR014 | McQueen Branch | 25 | 19 |
| Goodland Farms | 21IR015 | Crouch-McQueen | 135 | 193 |
| HMS Investment Properties | 21IR052 | Crouch-McQueen | 54 | 105 |
| FLO Fund Domestic, LLC/Grist Mill Farm | 21IR053 | McQueen Branch | 500 | 74 |
| Kelley Farms Partnership | 21IR054 | McQueen Branch | 50 | 27 |
| Floyd Farms | 21IR055 | McQueen Branch | 140.4 | 28 |
| City of Johnsonville | 21WS001 | Crouch Branch | 269.72 | 178 |
| City of Florence | 21WS002 | Crouch Branch | 1,140 | 394 |
| | | McQueen Branch | 4,800 | 3,196 |
| City of Lake City | 21WS005 | McQueen Branch | 661 | 559 |
| Town of Pamplico | 21WS007 | Crouch Branch | 150 | 41.5 |
| | | Crouch-McQueen | | 31 |
| Town of Scranton | 21WS008 | Crouch-McQueen | 50 | 44 |
| Town of Olanta | 21WS009 | Crouch Branch | 75 | 0 |
| | | Crouch-McQueen | | 28 |
| Town of Coward | 21WS010 | Crouch Branch | 93 | 53 |
| WestRock CP, LLC | 21WS011 | Crouch Branch | 65 | 22 |
| | | **Total** | 10,578.12 | 6,400.516 |

*Table 3: Current Permitted Groundwater Withdrawers - Florence County (Numbers reported in MGY)*

## Marion County Demand Details

Marion county has 10 permitted facilites that own a total of 43 wells (Table 4). The total reported withdrawals for 2018 were 63% of the total permitted annual withdrawal limits for the county. The largest source of groundwater for the county is the McQueen Branch aquifer supplying 60% (1,096 MGY) of the total reported water use for 2018, followed by the Crouch Branch aquifer at 25% (468 MGY), then wells screened across the McQueen-Charleston at 14% (263 MGY), and lastly, the Charelston aquifer at 1% (15 MGY) (Table 4).

| Facility | Permit | Aquifer(s) | Permit Amount | 2018 Reported Water Use |
|---|---|---|---|---|
| Drew Farms | 33IR026 | Crouch Branch | 201 | 219 |
| Steve Baxley & Sons, LLC | 33IR054 | McQueen Branch | 302.4 | 43 |
| Steve Baxley & Sons, LLC | 33IR055 | McQueen Branch | 66.5 | 10 |
| FPI Colorado, LLC – Maidendown Bay Farm | 33IR056 | McQueen Branch | 125 | 66 |
| FPI Colorado, LLC – 10 Mile Bay Farm | 33IR057 | McQueen Branch | 318.5 | 143 |
| FPI Properties, LLC – Thousand Oaks Farm | 33IR058 | Charleston | 122.5 | 15 |
| Grand Strand Water & Sewer Authority – City of Marion | 33WS001 | McQueen Branch | 706 | 272 |
| | | McQueen-Charleston | | 185 |
| Marco Rural Water Company, Inc. | 33WS002 | Crouch Branch | 675 | 158 |
| | | McQueen Branch | | 332 |
| | | McQueen-Charleston | | 78 |
| Grand Strand Water & Sewer Authority – City of Mullins | 33WS003 | Crouch Branch | 390 | 91 |
| | | McQueen Branch | | 220 |
| Grand Strand Water & Sewer Authority – Town of Nichols | 33WS004 | Crouch Branch | 20 | 0 |
| | | McQueen Branch | | 10 |
| | | **Total** | 2,926.9 | 1,842 |

*Table 4: Current Permitted Groundwater Withdrawers - Marion County (Numbers reported in MGY)*

## Marlboro County Demand Details

Marlboro county has 23 permitted facilites that own a total of 53 wells (Table 5). The total reported withdrawals for 2018 were 44% of the total permitted annual withdrawal limits for the county. The largest source of groundwater for the county is the McQueen Branch aquifer supplying 92% (1,143 MGY) of the total reported water use for 2018, followed by the Crouch Branch aquifer at 8% (104 MGY) (Table 5).

| Facility | Permit | Aquifer(s) | Permit Amount | 2018 Reported Water Use |
|---|---|---|---|---|
| Mohawk Industries, Inc.-Oak River | 34IN003 | McQueen Branch | 175 | 63 |
| Arborgen, Inc./SC Supertree Nursery | 34IR001 | Crouch Branch | 150 | 83 |
| Hinson Farm | 34IR002 | McQueen Branch | 6.48 | 5 |
| Richard Rogers Farms | 34IR003 | McQueen Branch | 169 | 106 |
| FPI Carolinas, LLC – Bennettsville Farm | 34IR015 | McQueen Branch | 60 | 28 |
| Charles M. Rogers Farm | 34IR016 | McQueen Branch | 60 | 0 |
| Burroughs Farms | 34IR019 | McQueen Branch | 101 | 28 |
| Douglas H. and Margaret H. Newton Farms | 34IR020 | McQueen Branch | 48 | 9 |
| Patrick Rogers Farms/Green Barn Tract | 34IR021 | Crouch Branch | 25 | 21 |
| Frank Rogers Farms/Hwy 38 Tract | 34IR022 | McQueen Branch | 125 | 40 |
| Steve O'Neal Farms/Hwy 38 Tract | 34IR023 | McQueen Branch | 37 | 5 |
| Glasdrum Farms/Bottom Farm | 34IR024 | McQueen Branch | 61 | 22 |
| CMB Farms, LLC | 34IR025 | McQueen Branch | 59 | 68 |
| Patrick Rogers Farms/Crosland Towable | 34IR026 | McQueen Branch | 56 | 33 |
| Douglas O'Tuel Farm/Hickory Grove Tract | 34IR027 | McQueen Branch | 68 | 7 |
| Frank Rogers Farms | 34IR028 | McQueen Branch | 28.8 | 18 |
| Patrick Rogers/Hebron Church Farm | 34IR029 | McQueen Branch | 27.15 | 20 |
| Patrick Rogers – Hamer Farm | 34IR030 | McQueen Branch | 27.15 | 0 |
| City of Bennettsville | 34WS001 | McQueen Branch | 803 | 0 |
| Marlboro Water Company, Inc. | 34WS002 | McQueen Branch | 480 | 423 |
| Town of McColl | 34WS003 | McQueen Branch | 120 | 142 |
| Wallace Water Company, Inc. | 34WS004 | McQueen Branch | 100 | 85 |
| Town of Clio | 34WS050 | McQueen Branch | 50 | 41 |
| | | **Total** | 2,836.58 | 1,247 |

*Table 5: Current Permitted Groundwater Withdrawers - Marlboro County (Numbers reported in MGY)*

## Williamsburg County Demand Details

Williamsburg county has 15 permitted facilites that own a total of 31 wells (Table 6). The total reported withdrawals for 2018 were 40% of the total permitted annual withdrawal limits for the county. The largest source of groundwater for the county is the Charleston aquifer supplying 35% (460 MGY) of the total reported water use for 2018, followed by wells screened across the McQueen-Charleston at 31% (412 MGY), then the McQueen Branch aquifer at 22% (284 MGY), then the Crouch Branch aquifer at 9% (125 MGY), and lastly, the wells screened across the Crouch-McQueen at 3% (42 MGY) (Table 6).

| Facility | Permit | Aquifer(s) | Permit Amount | 2018 Reported Water Use |
|---|---|---|---|---|
| DSM Nutritional Products, LLC | 45IN001 | McQueen Branch | 900 | 56 |
| | | Charleston | | 287 |
| Williamsburg Co. Development/Town of Kingstree | 45IN003 | McQueen Branch | 109 | 27 |
| Irwin McIntosh Farms, Inc. | 45IR002 | McQueen Branch | 200 | 97 |
| McKenzie Farms | 45IR003 | Crouch-McQueen | 24 | 6 |
| Ferison Farm | 45IR025 | Crouch Branch | 18 | 11 |
| CCD Sod, LLC | 45IR027 | Crouch Branch | 173.5 | 67 |
| Tyron Farm, LLC (CCD Sod, LLC) | 45IR028 | Crouch Branch | 62.4 | 28 |
| H & F Farms | 45IR029 | McQueen-Charleston | 105 | 30 |
| Town of Hemingway | 45WS001 | Charleston | 288 | 154 |
| Town of Kingstree | 45WS002 | McQueen Branch | 430 | 96 |
| | | Charleston | | 19 |
| Town of Greeleyville | 45WS003 | Crouch Branch | 54.2 | 0 |
| | | Crouch-McQueen | | 36 |
| Town of Lane | 45WS004 | Crouch Branch | 41 | 19 |
| Town of Stuckey | 45WS005 | McQueen Branch | 36 | 8 |
| Williamsburg Co Water & Sewer Authority – South System | 45WS006 | McQueen-Charleston | 432 | 293 |
| Williamsburg Co Water & Sewer Authority – Combined System | 45WS007 | McQueen-Charleston | 432 | 89 |
| | | **Total** | 3,305.1 | 1,323 |

*Table 6: Current Permitted Groundwater Withdrawers - Williamsburg County (Numbers reported in MGY)*

## Aquifer Demand

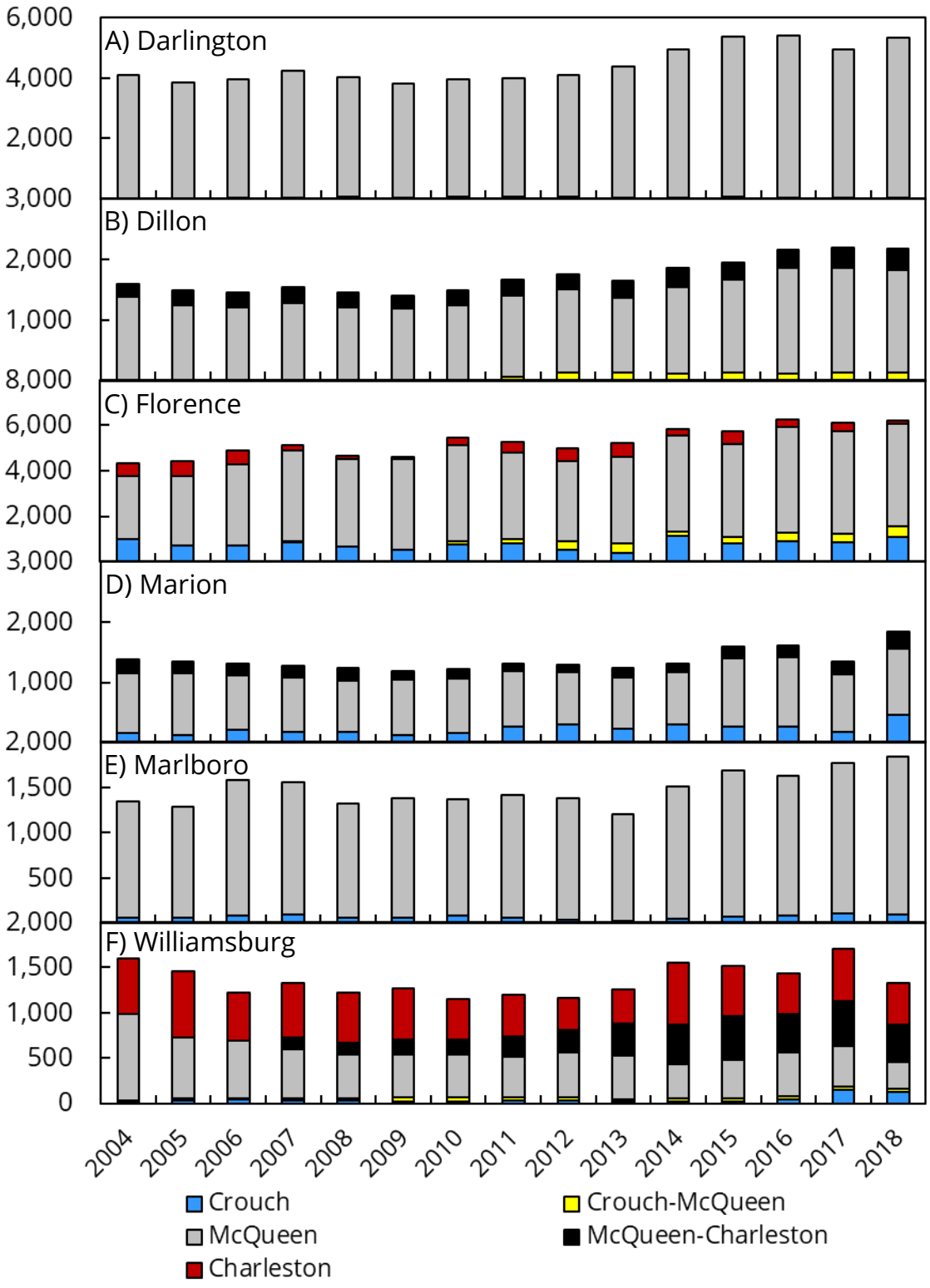


*Figure 22: Reported Water Use by Aquifer from 2004 to 2018. Please note the different scales on the vertical axes.*

The majority of Pee Dee Area wells are screened within the McQueen Branch aquifer—formerly classified as the Middendorf aquifer (Figure 22, Figure 23). For the 2018 reporting year, the McQueen Branch aquifer was also the most heavily used groundwater source in terms of volume at 14,598 MG, followed by the Crouch Branch at 1,898 MG, McQueen-Charleston at 1,026 MG, Crouch-McQueen at 759 MG, and the Charleston at 616 MG (Table 1-6). Since the designation of the Pee Dee Area, reported groundwater withdrawal from the McQueen Branch and Crouch Branch aquifers have increased while demand from the Charleston Aquifer has declined (Figure 22). Of note, reported water use from wells screened across the Crouch-McQueen aquifers have seen a 5-fold increase from 141 MG to 759 MG, and reported water use from wells screened across the McQueen-Charleston aquifers has doubled from 433 MG to 1,026 MG (Figure 22).

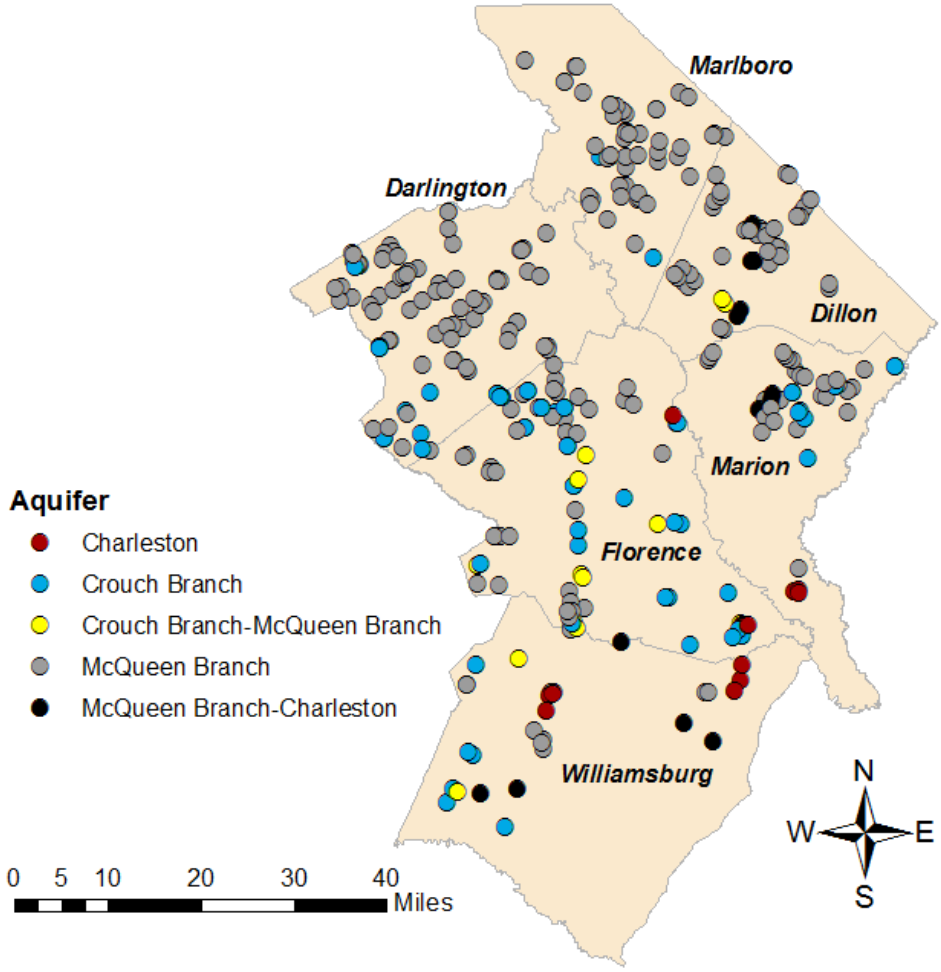


*Figure 23: Map of Pee Dee Capacity Use Wells by Aquifer Source*

## Past Use Comparison

From the formation of the Pee Dee Capacity Use Area in 2004, reported water use was relatively constant through 2012 followed by an increase of just over 3,000 MGY to a high of 18,897 MGY in 2018 (Figure 24). Florence and Darlington counties have the highest reported water use comprising more than 60% of the Pee Dee Area's total. Dillon, Marion, Marlboro, and Williamsburg counties make up the remainder ranging from 8% to 11% of the total. Over the same period, population in the Pee Dee Area increased from its designation in 2004 to a high of 333,970 in 2010 (Figure 25). Then from 2011 through 2018, the Pee Dee Area population declined to a 14-year low of 323,603. The overall population increase from 2004 to 2010 was driven by a census-driven correction to the estimates for Darlington and Dillon Counties in 2010 and a continual (2004 – 2018) population increase in Florence County. Beginning in 2011, however, population decreases were seen in all Pee Dee counties, except Florence (Figure 25).

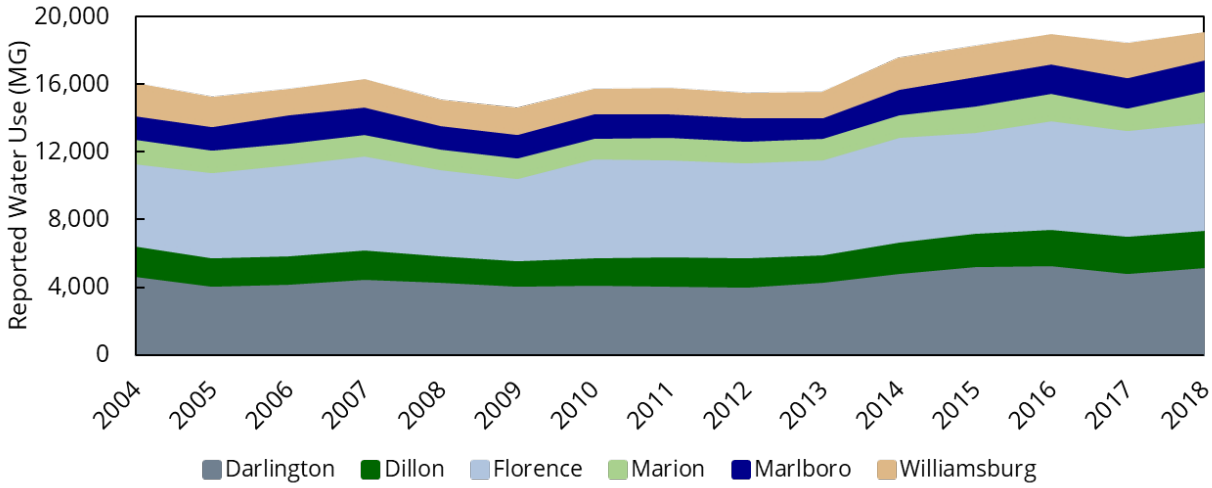


*Figure 24: Historic Water Use by County from 2004 to 2018*

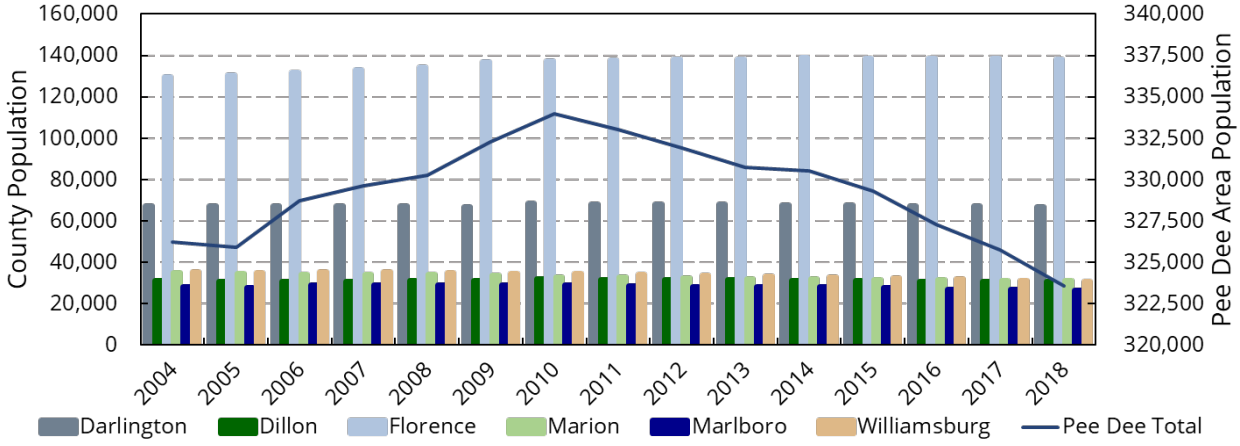


*Figure 25: Population estimates and census data for the Pee Dee Area counties from 2004 to 2018 (United States Census Bureau; www.census.gov)*

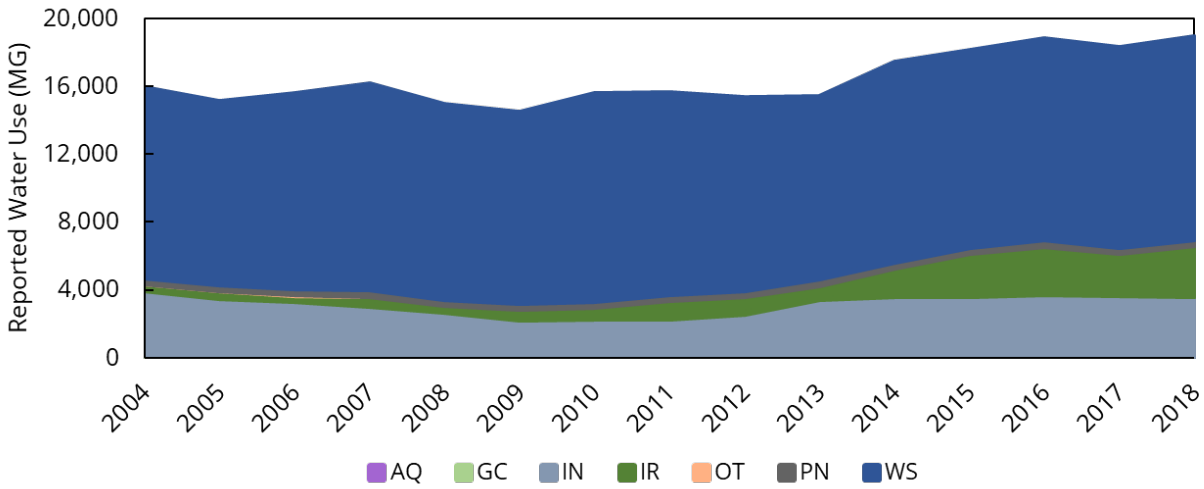


*Figure 26: Pee Dee Area Reported Water Use by Use Category from 2004 to 2018*

Reported groundwater withdrawal for water supply use was the largest use category for the Pee Dee Area from 2004 to 2018 (Figure 26). The increase in reported water use beginning in 2013 was the result of a marked increase in the volumes reported under the irrigation category (Figure 26). The remaining water use categories, except for industry, remained comparatively constant. Reported industrial water use declined from 2004 to 2009, leveled between 2009 and 2012, and increased to its current level from 2012 to 2013. Figure 27 A-F indicates that there are no common patterns in water use among the Pee Dee counties except as discussed for water supply and irrigation use.

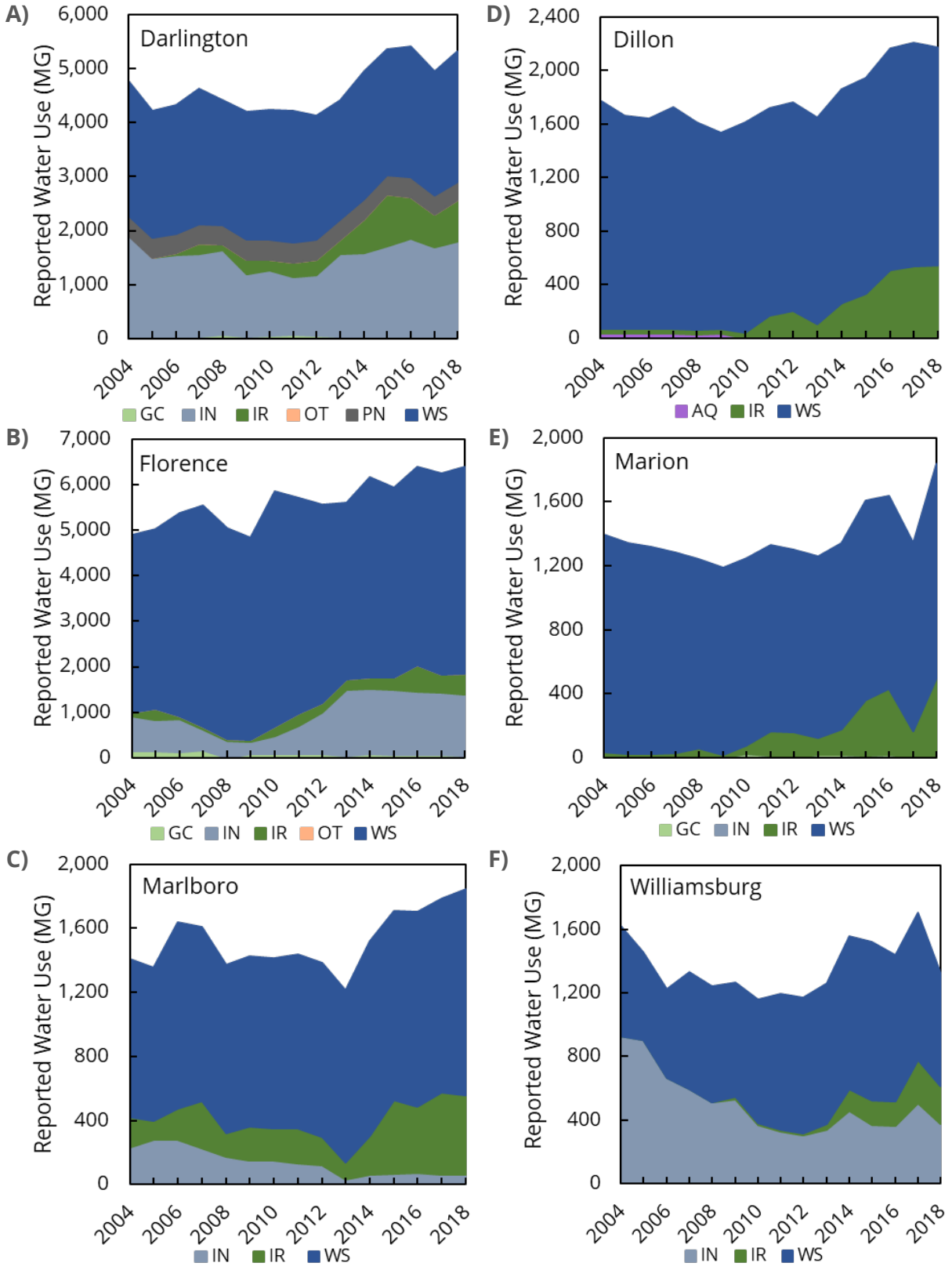


*Figure 27 (A-F): Reported Water Use for Each Pee Dee County by Use Category from 2004 to 2018*

## Changes to Groundwater Flow in the Pee Dee Area

The major aquifers below the Pee Dee counties are the Crouch Branch, McQueen Branch, and Charleston Aquifers. The McQueen Branch and Charleston aquifers together are known as the Midville Aquifer System (please refer to the Hydrostratigraphic Section of this report) and formerly classified as the Middendorf aquifer under historical nomenclature[7]. Groundwater flows within an aquifer from areas of high pressure to low pressure. Pressure within an aquifer is a combination of the overburden pressure of the aquifer material (rock, sand, soil, etc.) and water above the point at which the pressure is measured. The pressure of water within an aquifer can be determined by measuring the level of water within a well that has been drilled to and screened within the aquifer. These water level measurements can be combined to generate a contour map of the water levels known as a potentiometric map. DNR has been making water level measurements and publishing potentiometric maps for the aquifers and aquifer systems of South Carolina since 1987—providing a vital, long-term record of the condition of South Carolina's aquifers. DHEC uses this record as one tool to determine whether groundwater withdrawals in a Capacity Use Area "presents potential adverse effects to the natural resources" or "pose a significant threat to the long-term integrity of a groundwater source"[1].

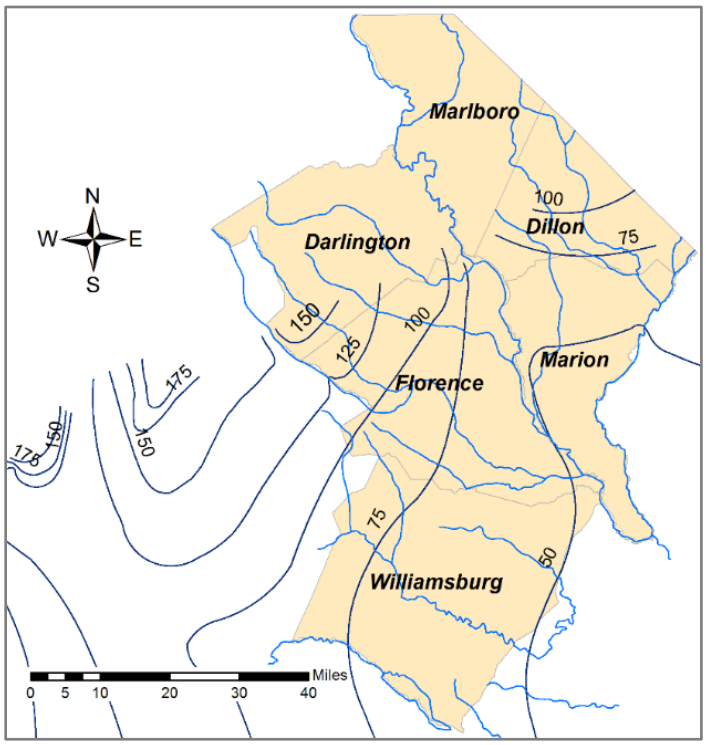


*Figure 28: Pre-Development Potentiometric Map of the Crouch Branch. Lines pass through points of equal groundwater pressure converted to feet relative to mean sea level (MSL). Equipotential lines were digitized from United States Geological Survey WRIR 84-4208.*

## Crouch Branch Aquifer

Groundwater flow below the Pee Dee Area prior to development reflected the underlying aquifer properties and topography, as well as the influence of local rivers on groundwater pressure in the aquifer (Figure 28). Groundwater flow paths are perpendicular to equipotential lines. Therefore, pre-development groundwater flow within the Crouch Branch was generally to the ESE. In Dillon County, the flow direction was to the south. The elevation of the pre-development potentiometric surface ranged between 50 and 150 feet above MSL.

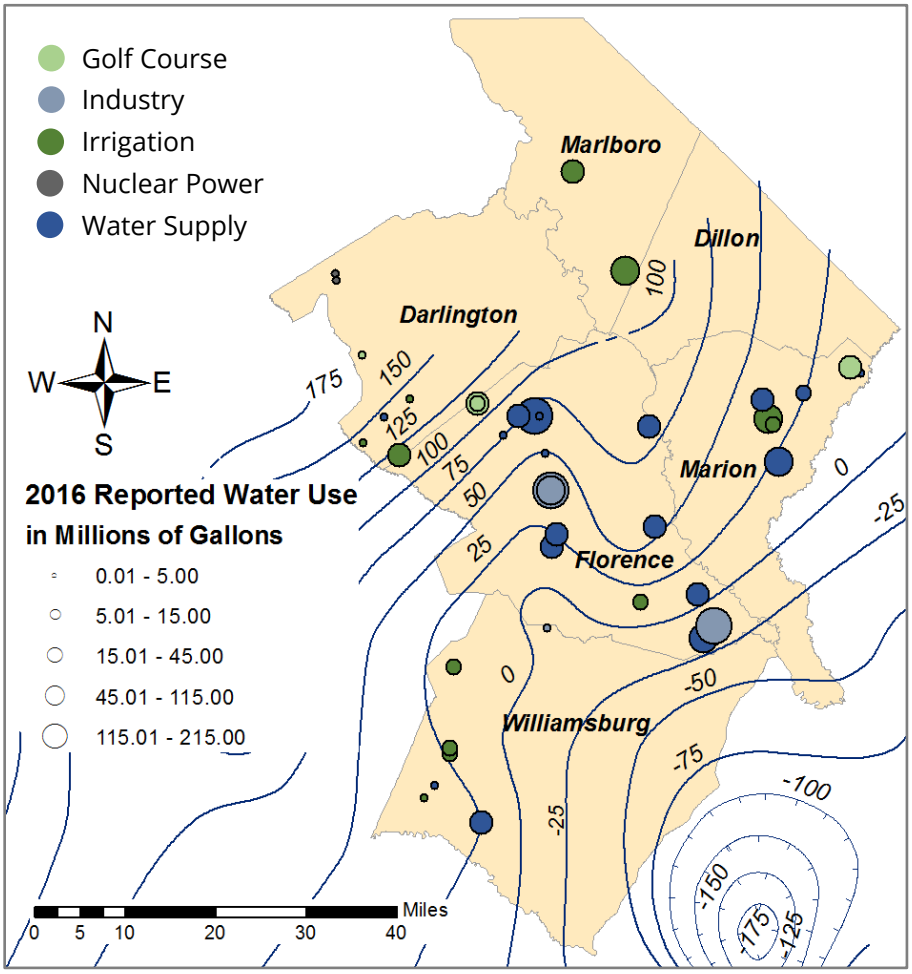


*Figure 29: 2016 Reported Water Use and Potentiometric Map of the Crouch Branch Aquifer below the Pee Dee Capacity Use Area (Wachob, Gellici, and Czwartacki, 2017). Equipotential lines are in feet relative to MSL. Circles represent locations of Capacity Use wells finished in the Crouch Branch Aquifer. The colors indicate the water use category and the relative sizes are reported water use in MG.*

Pee Dee Area groundwater withdrawal from the Crouch Branch aquifer has resulted in a significant lowering of the potentiometric surface from pre-development conditions (Figure 29). The 2016 potentiometric map of the Crouch Branch aquifer published by DNR indicates that there has been an overall lowering of groundwater levels (Figure 29) of up to 125 feet with a potentiometric surface ranging from -75 feet MSL in the south to -150 feet MSL in the north of the Pee Dee Area. This result is supported by the long-term groundwater profiles recorded by DNR's monitoring well network (plots of groundwater levels may be found in the Groundwater Trends section of this report). Although no major cones of depression were found in the Crouch Branch aquifer below the Pee Dee Area, it should be noted that the cone of depression found below Georgetown, SC, does extend into the eastern portion of Williamsburg County (Figure 29).

## McQueen Branch/Charleston Aquifers (Middendorf Aquifer)

This section of the report refers to the Midville Aquifer System (McQueen Branch and Charleston aquifers) as the Middendorf aquifer for ease of comparison with the DNR potentiometric maps. The pre-development conditions in the Middendorf aquifer are similar to those found in the Couch Branch (Figure 30). The direction of groundwater flow was generally to the ESE with a southerly flow in Marlboro and Dillon Counties. The elevation of the pre-development Middendorf aquifer potentiometric surface ranged from 50 to 250 feet above MSL.

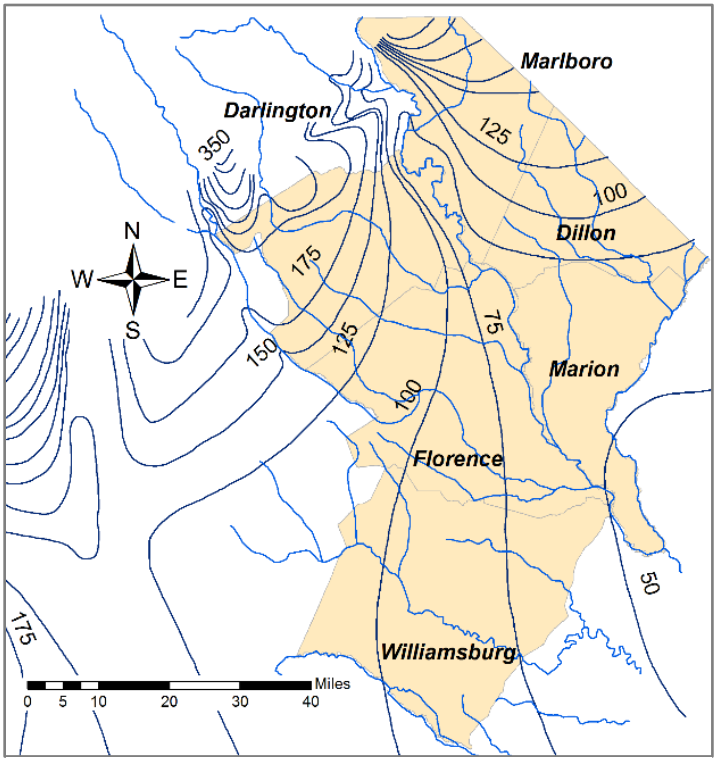


*Figure 30: Pre-Development Potentiometric Map of the Middendorf Aquifer. Equipotential lines are in feet relative to MSL.*

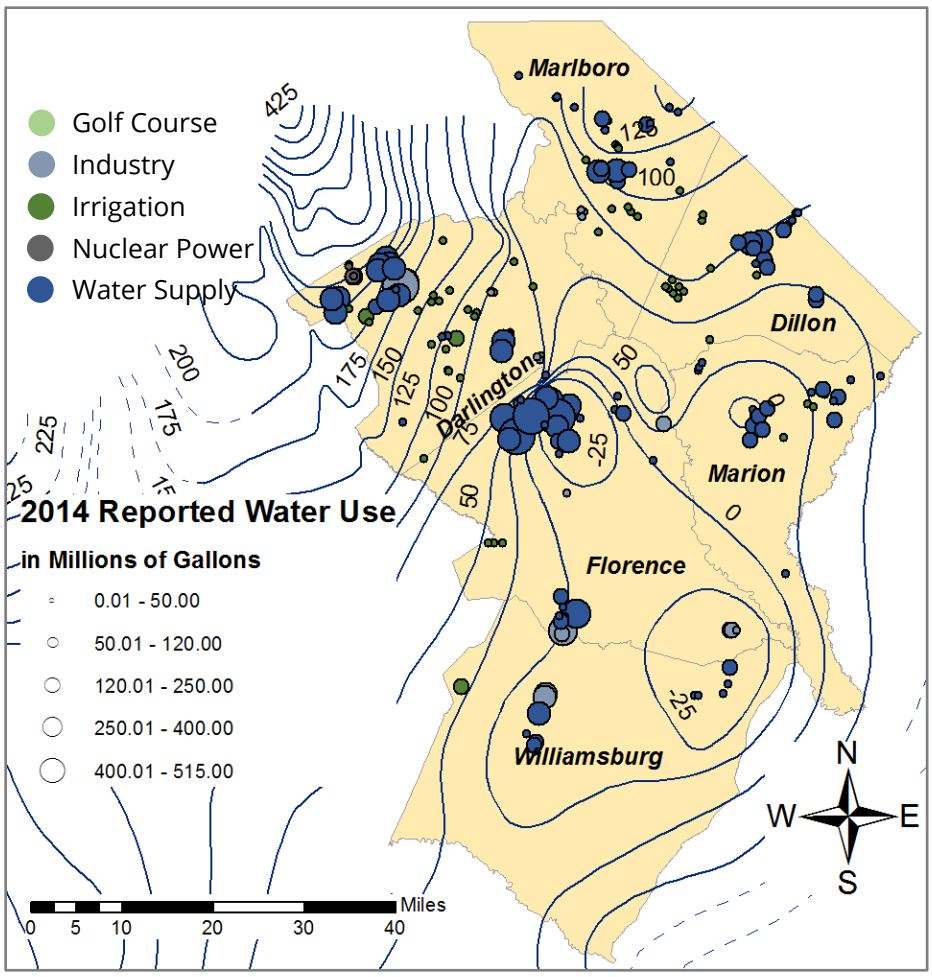


*Figure 31: 2014 Pee Dee Area Reported Water Use and Potentiometric Surface for the Middendorf Aquifer. Dashed lines indicate an estimate of the equipotential line location due to insufficient water level measurements in that area.*

As early as 1987, the potentiometric surface maps of the Middendorf aquifer have indicated that there is a pumping cone (or cone of depression) below Florence, South Carolina, that has persisted. The 2014 map provides evidence of the size and location of this pumping feature (Figure 31). The equivalent map for 2016 does not reflect this pumping feature due to a lack of water level measurements from Middendorf aquifer wells in the area of Florence (note the dashed line indicating a level of uncertainty) (Figure 32). Groundwater withdrawal from the Middendorf aquifer below the Pee Dee has resulted in changes similar to those found in the Crouch Branch aquifer. These changes include an overall lowering of the potentiometric surface by up to 125 feet (-75 to -200 feet MSL compared to a range of 50 to 250 feet MSL for pre-development), and a change in the direction of groundwater flow to a generally S to SE direction. The downward trend in groundwater levels is supported by the long-term groundwater profiles recorded by the DNR groundwater monitoring network found in the Groundwater Trends section of this report.

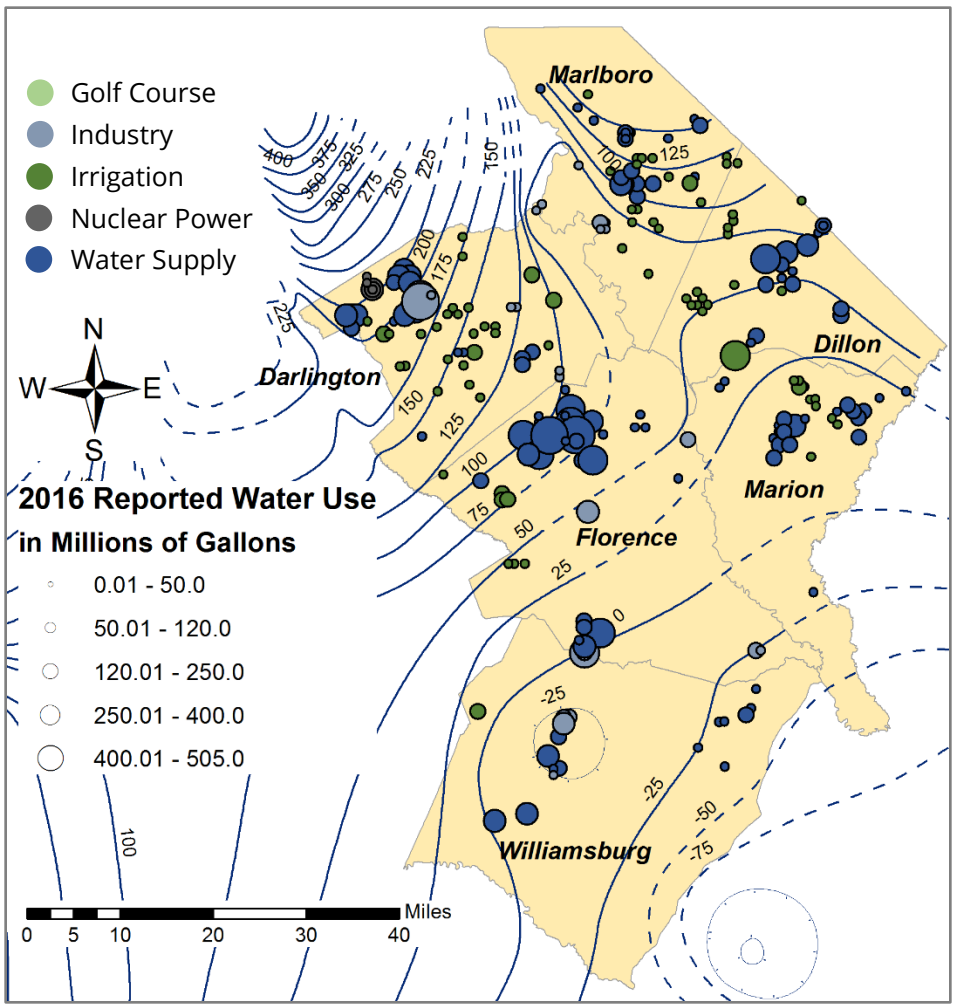


*Figure 32: 2016 Pee Dee Area Reported Water Use and Potentiometric Surface for the Middendorf Aquifer. Dashed lines indicate an estimate of the equipotential line location due to insufficient water level measurements in that area.*

## Groundwater Evaluation

Groundwater levels in both the Crouch Branch aquifer and Midville Aquifer System (McQueen Branch and Charleston aquifers) have declined below the Pee Dee Capacity Use Area since its designation in 2004. This is evidenced by the measurements of declining water levels of up to 50 feet from well monitoring networks (Figure 7-19). A comparison of the potentiometric surfaces from pre-development and 2016 also suggest a long-term lowering of the water levels as much as 125 feet (Figure 28-32). For the Crouch Branch aquifer, this decline is greatest below the ESE portion of Williamsburg County and is associated with the large pumping cone below Georgetown, SC (Figure 29). Due to the extent and depth of the persistent pumping cone below Georgetown, a hold was placed on the permitting of new wells or increases in permitted withdrawal rates from existing wells to the Crouch Branch Aquifer below Georgetown and Horry Counties[8].

The coastal plain aquifers of South Carolina (Figure 3) are comprised of unconsolidated sediments. Groundwater is found in the spaces between sediment grains. When large amounts of groundwater are removed, the sediment grains move closer together (or compact) resulting in land subsidence. In the southern Chesapeake Bay area, land subsidence of up to 4.8 millimeters per year (mm/yr) has been associated with large groundwater withdrawals[9]. In North Carolina and South Carolina, subsidence due to geologic processes is being exacerbated by large volume groundwater withdrawals[10].

### Cone of Depression under the City of Florence

When several large-volume wells are in close proximity in a single aquifer, the combined drawdown exceeds that of a single well (Figure 33). In the case of the McQueen Branch aquifer below the City of Florence, the combined pumping of many water supply wells has resulted in the development and persistence of a cone of depression as illustrated in Figure 31. The “depth” and lateral extent of a cone of depression depends on the volume of groundwater pumped as well as the properties of the aquifer material. The 2014 Map (Figure 31) indicates that the cone of depression is oval in shape with a central section approximately 15 miles (NW – SE) by 10 miles (NE – SW) at an elevation of -25 feet below MSL.

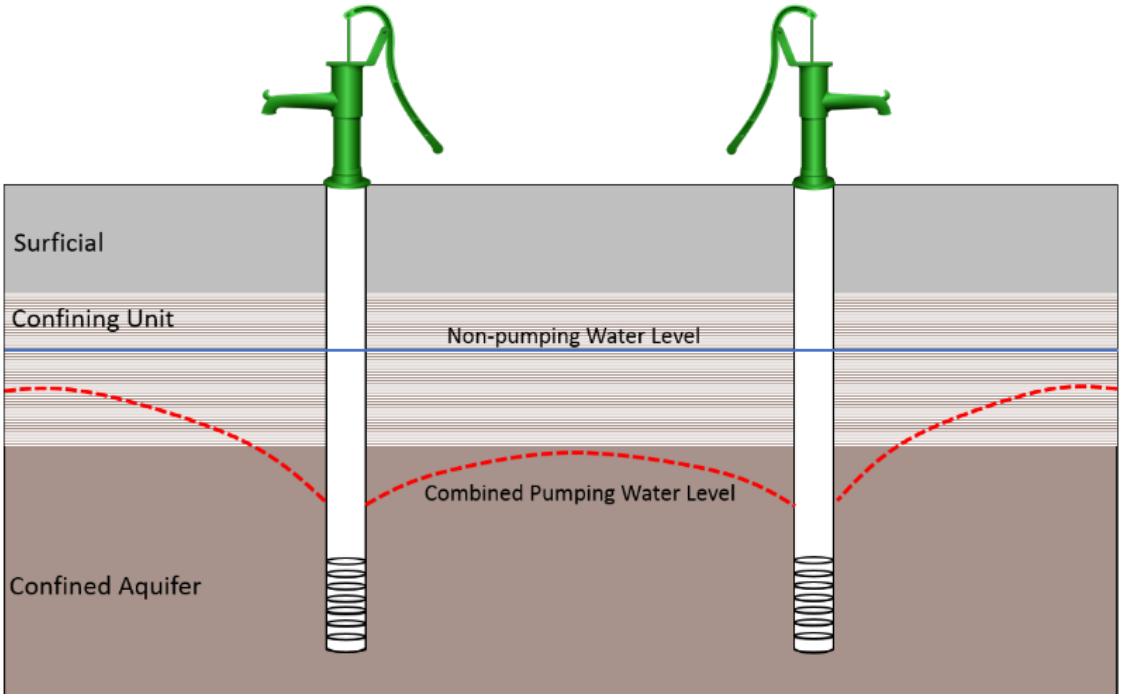


*Figure 33: Illustration showing the combined drawdown effect of wells pumped in close proximity to one another.*

The development of a cone of depression within an aquifer can create harmful effects. As discussed earlier, groundwater flows from high to low pressure, perpendicular to equipotential lines (lines of equal pressure). This means that a cone of depression changes the direction of groundwater flow toward the cone's deepest point (point of lowest pressure). The 2014 potentiometric map of the McQueen Branch Aquifer indicates groundwater is directed toward the center of the cone below the City of Florence. This change in the pattern of groundwater flow can interfere with the productivity of any wells that are located within the boundary of the cone.

## Wells Screened Across Aquifers

The aquifers of South Carolina are discussed in detail within the Hydrogeologic Framework Section of this report. Briefly, alternating layers of silts, sands, and carbonate rock are separated by layers of clays. A well that is screened from one aquifer, across a confining unit, and into the aquifer below draws water from both aquifers when pumped (Figure 34). This type of well construction can have two potentially harmful effects to the health of an aquifer. First, if one aquifer is stressed and the other is not, no protection is offered to the stressed aquifer because the pumping will not discern

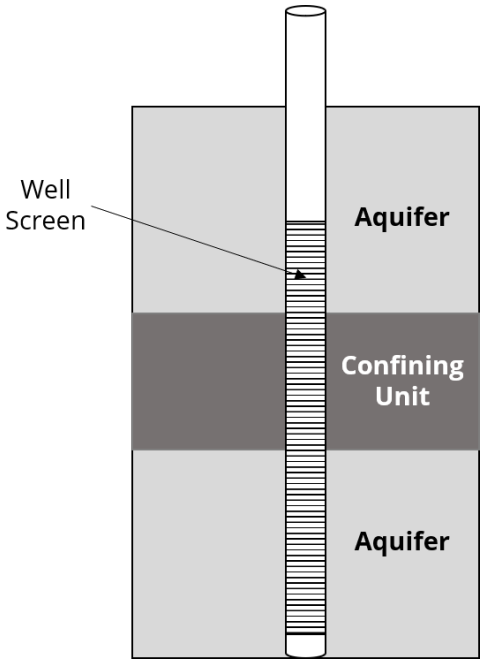


*Figure 34: Diagram of a Well Screened Across Multiple Aquifers*

between the two, resulting in further depletion of the aquifer of concern. Second, groundwater has a path to move freely between the aquifers. If the groundwater of one aquifer is contaminated, this migration of water could spread the contaminant further than if it were confined to a single aquifer. If the two aquifers have very different water chemistries (one suitable for drinking water and irrigation while the other is not, for example), the mixing of those waters could degrade the potable water in the same way as an introduced contaminant.

## Recommendations

In order to both protect groundwater below the Pee Dee Area counties from further lowering and the potential negative effects described previously, as well as to continue to develop groundwater as a resource, the following are the Department's recommendations.

1. Encourage the conjunctive use of surface water and groundwater to meet water demands in the Pee Dee CUA. Utilize groundwater as a supplemental and/or backup source if possible. The Department should engage permitted users to develop plans to transition to alternatives sources where the existence or potential for adverse effects arise.

2. New or modified Groundwater Withdrawal Permit Applications which propose to use the Crouch Branch aquifer in the in those areas of the Pee Dee Capacity Use area where the potentiometric surface has declined below Mean Sea Level should be diverted to the alternative aquifers when available as appropriate for the proposed use.

3. Each new and renewal permit for water supply wells should require that a water audit be conducted annually in accordance with the American Water Works Association policy statement for Water Loss Management, Metering and Accountability[11]. All permitted withdrawers should keep their Best Management Plan updated every 5 years on the same schedule as the permit renewals. BMP must take all reasonable actions to reduce the demand on the aquifers in the Pee Dee CUA.

4. Encourage groundwater withdrawers to discontinue using and properly abandon wells that have been screened across multiple aquifers. Ensure that all future wells are screened in the target aquifer only, with appropriate grouting at the surface and at each confining layer encountered during drilling.

5. Conduct a targeted public education campaign on water conservation practices and the extent of the current over-pumping evidence. Targeted public education means that each campaign is designed for a particular segment of the population in the Pee Dee Area. For all water users from agriculture to industry to water suppliers to residents, it should include information on the broad range of water conservation methods available to them.

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