

# Well Maintenance at South Carolina NGWMN sites and Expanding the South Carolina Groundwater Monitoring Network



Prepared By

Brooke Czwartacki

South Carolina Department of Natural Resources, Hydrology Section

217 Fort Johnson Road

Charleston, SC 29412

843-953-9334

[czwartackib@dnr.sc.gov](mailto:czwartackib@dnr.sc.gov)

Final Technical Report

Award Number G19AC00182

Award period: 9/30/2019 – 9/29/2021

Report Date December 31, 2021

## **Summary**

The South Carolina Department of Natural Resources (SCDNR) serves as a data provider to the National Ground Water Monitoring Network (NGWMN). SCDNR has been providing groundwater level information since 2015. During that first year of award and participation, SCDNR added wells and set up web services to serve information through the NGWMN data portal. A second agreement during 2017-2018 included filling gaps in existing well records by digitizing historical paper records of lithology and historical water-level measurements. Tidal corrections for wells that exhibit tidal fluctuations were also calculated during that period. A third agreement during 2018-2019 expanded the South Carolina groundwater monitoring network by adding 12 wells across the South Carolina Coastal Plain. Finally, a fourth one-year agreement was entered in 2019 to expand the network through drilling activities and to perform maintenance on existing NGWMN sites. Due to delays and work interruption because of the COVID-19 pandemic, SCDNR was granted a one-year no cost extension of budget and performance periods. SCDNR was able to fulfill funded obligations with the extension. The contents of this report summarize projects completed during the most recent 2019-2021 grant cycle.

## **Well Registry Maintenance**

Updating and maintaining information served to the NGWMN portal is an ongoing task. Additional or missing water-level measurements have been added to the Access databases at sites that were no longer meeting criteria or those needing updates. Several wells have been turned off or removed from the Well Registry management interface. These wells were not meeting criteria for surveillance wells. Other wells have been destroyed, altered, or are now inaccessible. Field visits are ongoing to identify wells that are not being regularly measured.

Water level data are processed in accordance with SCDNR's standard operating procedures and reviewed for accuracy prior to being entered to the Oracle database. These data are available on the SCDNR Hydrology Section data viewer webpage and the NGWMN data portal.

## Project Summaries

### **Objective 4 - Project 1: Repair or install protective well-head housings at NGWMN Sites**

Repairs or replacements of protective well-head covers were needed state-wide to ensure the integrity of well construction and to provide protection to aquifers (Figure 1). Damaged or under-protected wellheads can lead to contamination of an aquifer due to the chance of accidental or intentional debris falling or being thrown into the well. Wells that can no longer be locked are at a greater risk for theft or vandalism.

A contractor was hired to inspect and repair, replace, or install protective housings for fifteen wells. Figure 1 shows the location of wells that were included in this project. The repairs made at each site are described with a before and after picture showing the various types of repairs or replacements that were completed.

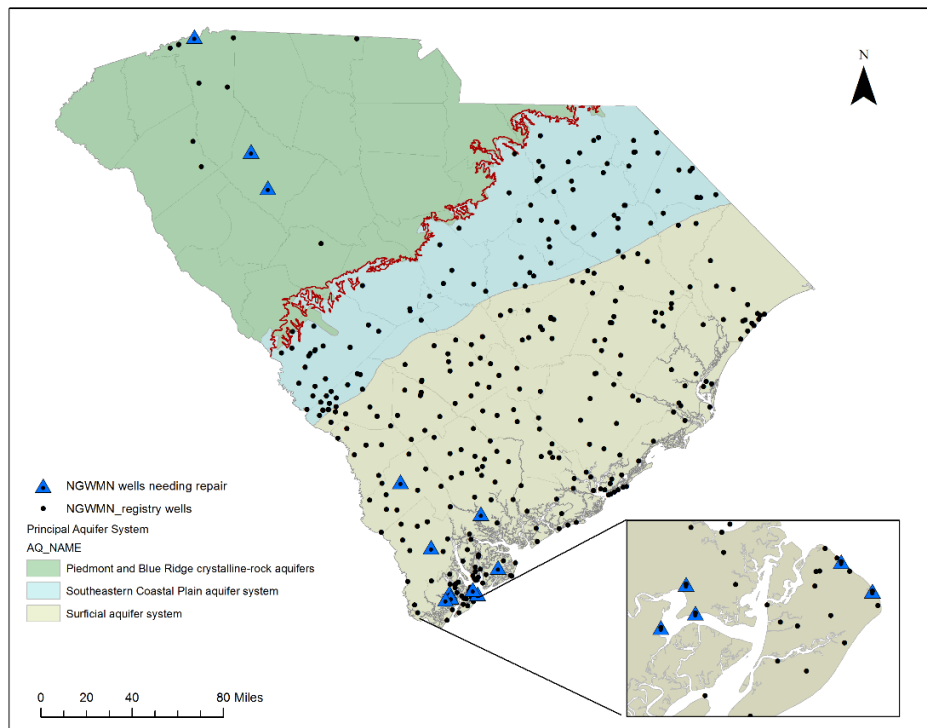


Figure 1. Locations of NGWMN registry wells where housings were replaced, repaired, or added under Objective 4.

1. BFT-2311 (22KK-k1):

Description of repairs: Well is in the parking lot of a public boat landing. The lid was missing, and the well was not visible to vehicles. A taller, lockable metal protective casing was installed as well as a small concrete pad. Reflective tape and bollards increase the visibility and protect the well from vehicle damage. The pre-repair picture is shown on the left and the post-repair picture is shown to the right.



2. BFT-1813 (27KK-j5) and BFT-1814 (27KK-j6):

Description of repairs: Both wells are located at a privately accessed historic site. Only one well is shown, but both wells are similar in construction and condition. The steel was crumbling and could no longer be locked. New metal enclosures were added that accommodate a pad lock. The pre-repair picture is shown on the left and the post-repair picture is shown to the right.



3. BFT-2356 (29KK-m6):

Description of repairs: Well is in the backyard of a resort property and did not have a lockable lid. A new lockable lid was welded on, and the well was painted to blend in with the landscape. The pre-repair picture is shown on the left and the post-repair picture is shown to the right.



4. BFT-0563 (25II-m2):

Description of repairs: Well is in a right-of-way near an intersection. Well top was repaired so it could lock, and the well was painted yellow to increase visibility. The pre-repair picture is shown on the left and the post-repair picture is shown to the right.





5. BFT-2305 (29KK-b8):

Description of repairs: Well is in a secure area below a water tower, but the lid was damaged and could not be closed. A new lockable lid was welded on, the well was painted, and reflector taped was added to increase visibility. The pre-repair picture is shown on the left and the post-repair picture is shown to the right.



6. BFT-2200 (27JJ-w3):

Description of repairs: Well is in a right-of-way between two properties. The existing well casing was bent and hidden in brush. Vegetation had been cleared at the time of repairs. A locking metal enclosure was added as well as a small concrete pad. The pre-repair picture is shown on the left and the post-repair picture is shown to the right.



7. COL-0092 (26FF-e1):

Description of repairs: Well is located adjacent to the shoulder of a highway and was not visible to highway maintenance equipment. The existing metal casing was painted yellow for high visibility and a small concrete pad was added. Pre-repair picture is shown on the left and the post-repair picture is shown to the right.



8. GRV-3333 (48B-d3):

Description of repairs: This well is in a right of way adjacent to Gap Creek Road. Due to the location, the options were limited because the well needed to remain below grade. Attempts were made to remove the existing metal vault, but damage to the well was too much of a risk. A welder was contracted to fit a new metal plate into the existing ground vault. A recessed handle allows access to the well, and a chain was added to reduce the occurrence of theft. Pre-repair picture is shown on the left and the post-repair pictures (2) are shown middle and right.





9. LRN-1706 (43K-k1):

Description of repairs: The standpipe height for the well was extended from approximately 1 inch above land surface to 2.8 feet above land surface through the installation of a 6 in. PVC well extender, coupler, and extension pipe. An 8-inch by 8-inch metal well enclosure with a lockable hinged lid was installed over the well. Metal plates welded to the enclosure were secured to an existing concrete pad using masonry screws. A lock was installed to secure the well. Pre-repair picture is shown on the left and the post-repair picture is shown to the right.



10. LRN-1707 (43K-k1):

Description of repairs: A section of concrete was removed around the wellhead to clear enough space to install an aluminum locking collar. Solinst leveloggers were recessed into the existing 6-inch sanitary seal using steel washers to support the data logger at or just above the surface of the sanitary seal to allow for the locking collar to fit over the equipment. The well is secured with a lock attached to the locking collar. Pre-repair picture is shown on the left and the post-repair picture is shown to the right.





11. HAM-0314 (32DD-e2):

Description of repairs: This well is constructed of PVC and although capped, it could not be locked. The repairs included adding a lockable metal enclosure over the existing PVC riser. A small concrete pad was poured to support the metal housing. Pre-repair picture is shown on the left and the post-repair picture is shown to the right.



12. HAM-0315 (32DD-e3):

Description of repairs: This well is constructed of PVC and although capped, it could not be locked. The repairs included adding a lockable metal enclosure over the existing PVC riser. A small concrete pad was poured to support the metal housing. Pre-repair picture is shown on the left and the post-repair picture is shown to the right.



13. JAS-0490 (30HH-g7):

Description of repairs: This well is constructed of PVC and although capped, it could not be locked. The repairs included adding a lockable metal enclosure over the existing PVC riser. A small concrete pad was poured to support the metal housing. Pre-repair picture is shown on the left and the post-repair picture is shown to the right.



14. JAS-0491 (30HH-g8):

Description of repairs: This well is constructed of PVC and although capped, it could not be locked. The repairs included adding a lockable metal enclosure over the existing PVC riser. A small concrete pad was poured to support the metal housing. Pre-repair picture is shown on the left and the post-repair picture is shown to the right.



**Objective 4 - Project 2: Pump NGWMN wells to maintain connection to aquifer**

The purpose of this project was to pump wells to ensure that they were connected to the aquifer and collecting accurate data. Four wells were chosen and funded for this project (Figure 2). The wells were selected because they showed minor to no seasonal fluctuation and a generally consistent downward trend. Under the supervision of SCDNR staff, a drilling contractor installed a temporary submersible pump to purge the wells. Wells were pumped for a period that would remove greater than one well volume of water. A static water level was collected immediately before pumping and water level drawdown was monitored using an electric tape during pumping. A handheld multiprobe instrument was used to monitor groundwater temperature and specific conductance. Pumping ended when field measurements of temperature and specific conductance stabilized for a period of more than 5 minutes. This field information is not provided in this report but can be available upon request. Pumping information for each well was recorded during well purging and is shown in table 1.

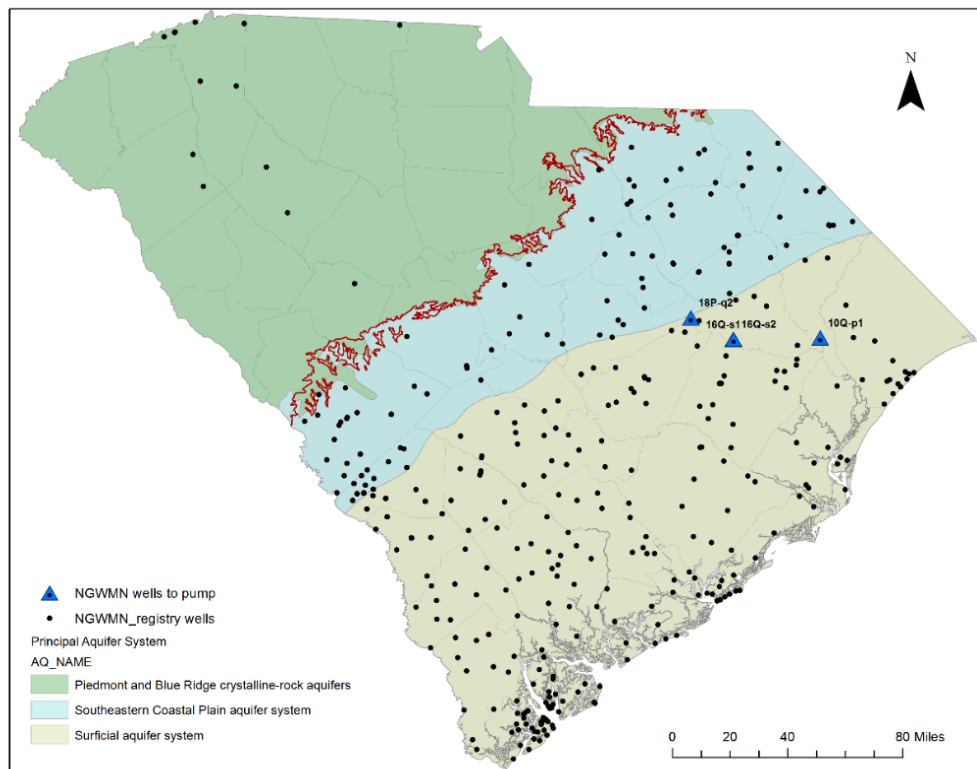


Figure 2. Locations of NGWMN registry wells and wells to be purged. Wells 16Q-s1 and 16Q-s2 are located at the same site.



Table 1. Well construction, pumping details and drawdown for each well.

SCDNR Site No.	NGWMN Site Name	Well Depth (ft)	Casing Diameter (in)	Static Water Level Start (ft)	Depth Pump Set (ft)	Pump Rate (gpm)	Drawdown (ft)	Pumping duration (min)	Date Pumped
16Q-s1	FLO-0274	560	4	79.50	120	0	>40	0	6/23/21
16Q-s2	FLO-0276	250	4	99.00	120	7.5	9.09	42	6/24/21
10Q-p1	MRN-0077	356	6 to 3	57.98	120	2.0	34.21	145	6/23/21
18P-q2	SUM-0492	522	4	74.50	120	3.5	37.37	143	6/24/21

Three wells, (FLO-0276 – 16Q-s1; MRN-0077- 10Q-p1; SUM-0492 – 24Q-l2) pumped smoothly and are considered well connected to the aquifer in which they are completed. The McQueen Branch well (FLO-0274 – 16Q-s1) would not yield water after several attempts. The water level dropped below the pump intake within the first minute of pumping. The well did not recover after several minutes. We returned to the well the following day and the water level had risen approximately 9 feet after 21 hours. Due to time and equipment constraints with the contractor, we were not able to attempt pumping again. Also, lowering the pump was not an option. It is suspected that this well is that the well screen is clogged with sediment, the screen is not in the correct location, or the casing is damaged. SCDNR plans to inspect this well with a down-hole camera to identify problems and then re-develop it with air. This well has been taken off-line in the NGWMN Registry until the problem can be identified and fixed.

Figure 3A-D shows two-to-three-year hydrographs of the wells pumped for this project. This period was selected to identify changes that may have occurred from pumping the wells during a period before and after pumping. With the exception of FLO-0274 (Fig. 3 A), water level in the wells recovered quickly (within several minutes). Loggers were re-deployed immediately and programmed to begin logging during the same day. Hydrographs of the three successfully pumped wells show similar water level trends and fluctuations (short and longer term) when compared to the shown period of record before pumping. A gap in the record at FLO-0276 (Fig. 3 B) occurred directly after pumping because the logger was not programmed when it was returned to the well.

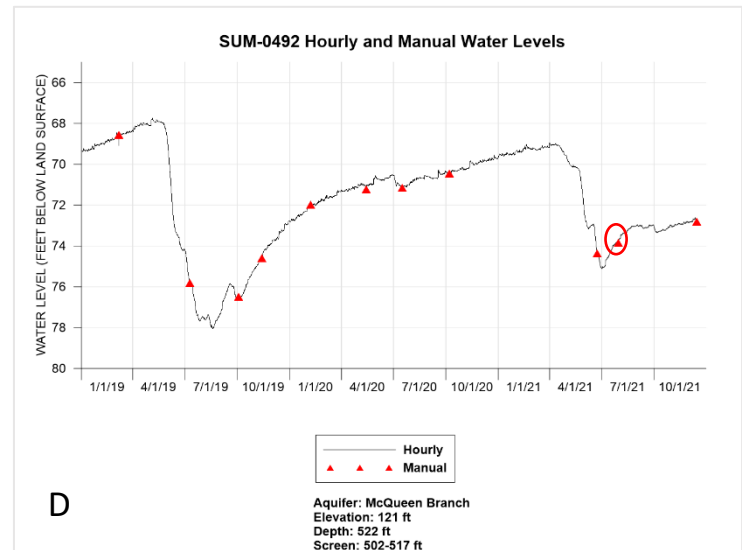
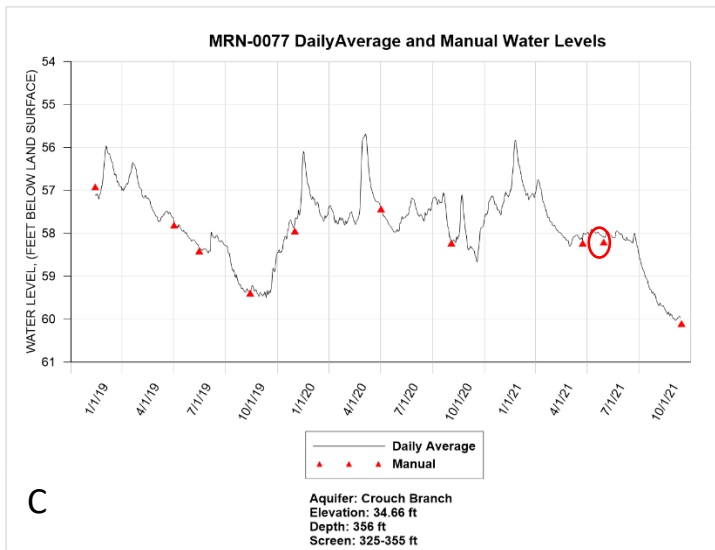
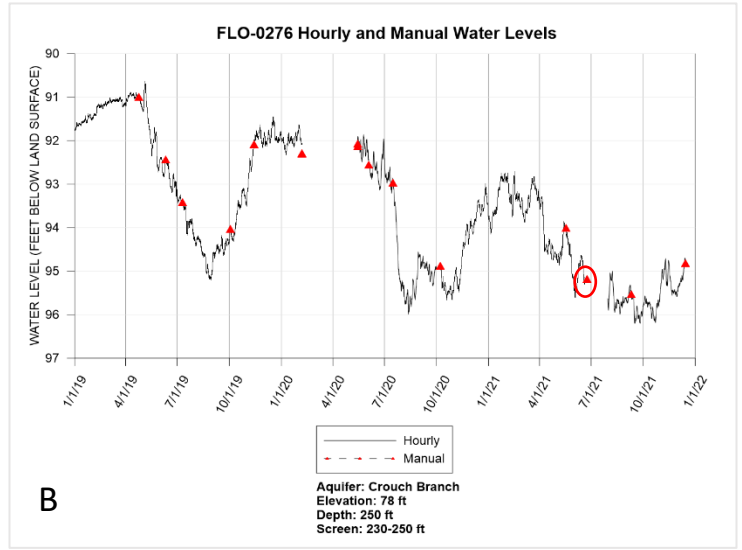
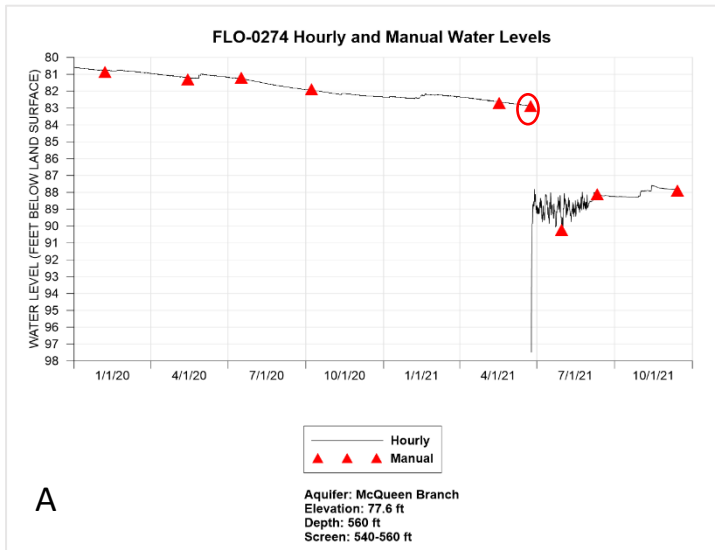


Figure 3 A-D. Hydrographs of wells pumped for Objective 4. On each graph, the manual measurement (red triangle) with red circle is the manual water level collected immediately prior to pumping well.

### ***Objective 5 - Project 3: Construction of a monitoring well in Richland County, South Carolina***

#### **McQueen Branch Monitoring Well in Richland County, South Carolina**

A new well was drilled at the SCDNR Wateree Range, at 1000 Hezekiah Road in Eastover (Figure 4). The coordinates are 33.944158, -80.665659. The new well is completed in the Southeastern Coastal Plain aquifer system (local aquifer: McQueen Branch) and is assigned SC county number RIC-0799 (NGWMN Site Name 26P-p3).

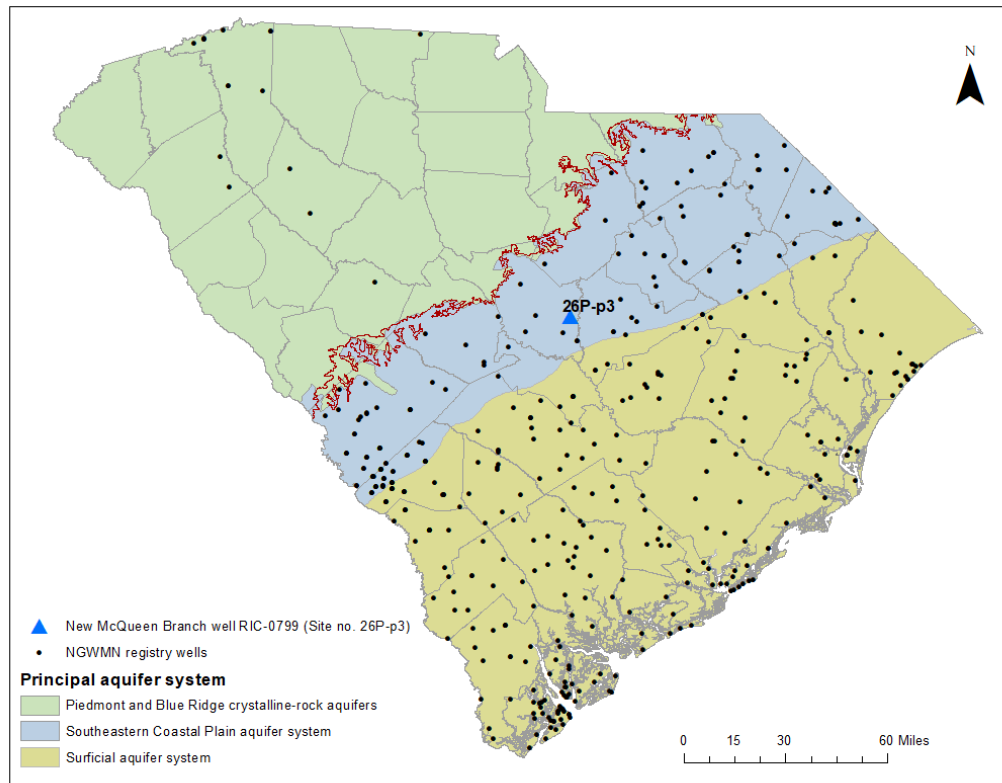


Figure 4. Location of new McQueen Branch well RIC-0799 (NGWMN Site Name 26P-p3).

In 1995, the U.S. Geological Survey (USGS), in cooperation with the South Carolina Department of Natural Resources (SCDNR), cored a borehole to bedrock (557 ft; feet) in the Coastal Plain of South Carolina at Webber Elementary School, in the Town of Eastover, Richland County. The core was drilled as part of the USGS Southeastern Coastal Plain Project with the objectives of understanding the geologic characteristics of the study area and delineating the major aquifers and confining units. The core hole was eventually backfilled and completed as a monitoring well in the McQueen Branch aquifer and is now included in the NGWMN.

A long-term goal of the SCDNR is to return to strategic core holes in the Coastal Plain to construct monitoring wells in each of the major aquifers. The original proposal for the current project was to return to the school to complete wells in two other aquifers—the Crouch Branch aquifer (50 ft), which overlies the McQueen Branch, and the surficial aquifer (250 ft). The purpose of these wells was to monitor changes in groundwater storage and to understand



hydrostatic head relationships among the three aquifers. Unfortunately, numerous attempts to contact the school district about the prospect of drilling at the school were unsuccessful. Upon consultation with staff hydrologists, and with permission from the USGS, it was decided that the well site should be moved to a different location. Property owned by SCDNR and located 4.5 miles NNE of the school was determined to be best suited for the new site. In addition to its proximity to the school, an added advantage was that an existing domestic well at the site, which was completed in the Crouch Branch aquifer, had recently been rehabilitated and converted to a monitoring well. A decision was made to use the funding provided by the NGWMN to drill a monitoring well in the McQueen Branch aquifer to a depth of 320 ft at this new site.

Drilling commenced on June 17, 2021 and was completed on June 23, 2021. An 8-inch borehole was drilled with a mud-rotary system to 330 feet by AAA Well Drilling, Inc. of Lexington County, South Carolina, who was awarded the contract through a bidding process overseen by SCDNR's Procurement Office. Prior to installing the well casing and well screen, a suite of geophysical logs was obtained from the borehole using a Century logging unit operated by SCDNR. The suite included a gamma-ray log, 16- and 64-inch normal resistivity logs, a single-point resistance log, and a spontaneous-potential log.

The well was constructed using 4-inch, threaded, schedule-40, PVC well casing that was installed from three feet above land surface to 308 ft bls (below land surface) (Figure 5). Attached to the bottom of the casing, from 308–318 ft, was a 10-ft section of 4-inch diameter, slotted PVC screen with a slot size of 0.010 inches. The bottom of the screen was capped with PVC and casing centralizers were attached to the casing about every 40 feet to keep the casing and screen centered in the borehole.

Following insertion and alignment of the casing and screen, a filter pack (sand #2) was placed around the well screen from 298–318 ft bls using a tremie-pipe method of emplacement. A 10-ft bentonite seal was then placed above the filter pack in the interval from 288–298 ft by washing bentonite pellets through a tremie line. Following emplacement of the bentonite seal, the well was grouted with a bentonite slurry from 40–288 ft and with Portland Type I neat cement from 40 ft to land surface using a tremie-pipe method. After the grout had time to set, the well was developed using compressed air until a clear, sandfree discharge was achieved. A 6-inch square, protective steel enclosure, constructed with a lockable, hinged cap was inserted over the wellhead and cemented into place. A 3-ft by 3-ft concrete pad, approximately 4 inches thick, was poured around the well.

The initial water level in the well, measured on June 25, 2021, was 87.46 ft bls. Lithology information, well construction details, and water level at the completion of well development for this well was added to the NGWMN portal. The well was equipped with a Solinst Levelogger™ Edge Water Level Datalogger programmed to record water levels every hour, on the hour. The automatic data recorder is downloaded at the time of site visit, and manual tape-down measurements confirm the data recorder is functioning properly within an established error tolerance. Data are processed in accordance with SCDNR's standard operating procedures and reviewed for accuracy prior to being uploaded to the Oracle database and being made available on the SCDNR webpage and the GWMN data portal.

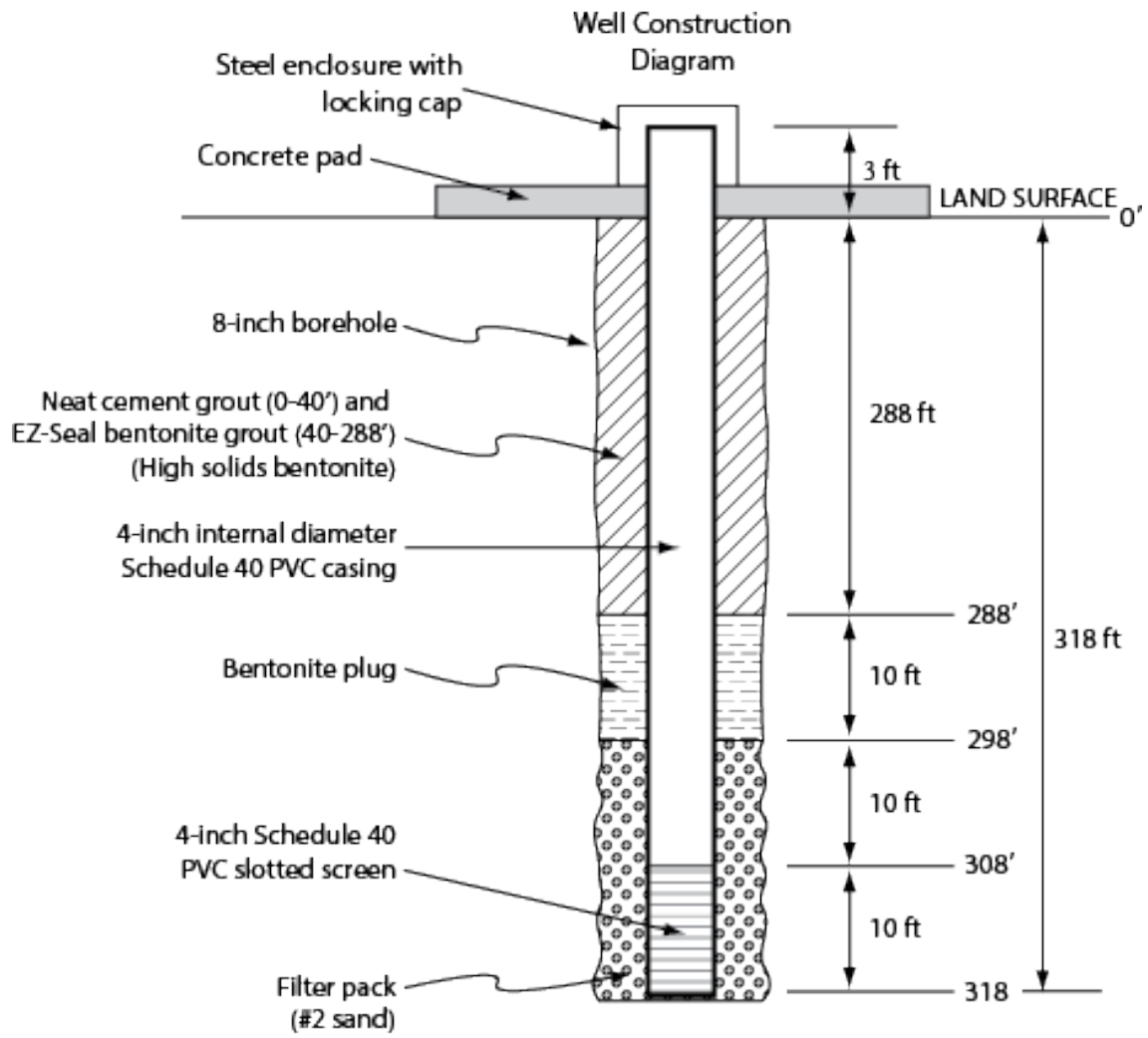


Figure 5. Well construction diagram for new well RIC-0799 (NGWMN Site Name 26P-p3).