FINAL TECHNICAL REPORT

Cooperative Agreement G17AC00167

Period 7/1/2017 - 12/30/2019

Wells and Transboundary Conditions

at

Merchants Millpond State Park

In Support of the

NGWMN

Prepared by

N C Department of Environmental Quality
Division of Water Resources
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Overview of Work Planned and Accomplished

On 6/30/2017, the North Carolina Division of Water Resources (DWR) was awarded a $200,000 grant (G17AC00167) in support of the USGS National Ground-Water Monitoring Network (NGWMN). Grant funding was used to install six ground water monitoring wells at Merchants Millpond State Park in Gates County, NC. Originally, DWR proposed to install a second station along the NC-SC border; however, bid costs significantly exceeded available funding, thus a project modification was requested. The Merchants Millpond well station fills an important data gap within the Albemarle-Tidewater region of northeastern North Carolina and southeastern Virginia and is expected to help resolve transboundary issues related to correlation of hydrogeologic units and regional ground water use and availability. Figures showing the general study area and well locations are provided in Appendix A.

DWR completed the Merchants Millpond project during the period 7/1/2017 to 12/30/2019 at a total cost of $190,110. During this period, DWR also spent matching funds in the amount of $201,034 to drill twelve additional wells. These new wells have been equipped with Onset HOBO dataloggers and added to the NGWMN Registry.

Description of Work Accomplished under Each Objective

On 2/1/2018, DWR posted a request for proposal (NC Bid 16-7720) for the installation of up to seven wells at Merchants Millpond State Park along the NC-VA border. Wells along the NC-SC border were to be bid under a separate RFP, but when bids were received, it was evident there would be insufficient funds to drill both locations. DWR selected the NC-VA location over the NC-SC location for several reasons: First, a replacement monitoring station was needed in northeastern NC following the recent loss of the Sunbury station, located five miles east of Merchants Millpond. Second, ground water is the sole source of water supply in northeastern NC. And third, northeastern NC is one of the most rapidly growing areas of the state.

On 3/15/2019, DWR awarded a drilling contract to Toano Well and Pump Service, Inc. of Toano, VA, for a not-to-exceed amount of $200,000. Upon receiving a permit from the NC Division of Parks and Recreation (Permit 2017-0164), DWR coordinated with Merchants Millpond Park Superintendent Steve Rogers for drilling to begin, and on 6/3/2019, the first well was started. Wells were drilled by a mud rotary rig using bentonite and water-based drilling fluid. On the deepest well, cuttings samples were collected every ten feet, sieved, and described. Cuttings descriptions and well diagrams are provided with NC GW-1 well construction forms in the report appendices. Geophysical logs consisting of gamma, spontaneous potential, single point resistivity, and 16- and 64-inch normal resistivity, were then run. Each well was completed with 4" PVC casing with 10 ft of stainless steel screen. Surface casing was installed in wells over one hundred feet in depth. The total cost to drill the wells was $190,110 or approximately $101.94/ft. Following well completion, DWR measured water levels and

basic field parameters and installed an Onset HOBO datalogger in each well. The wells were then added to the NGWMN Registry. In addition to the Registry, well data including geophysical logs and other information can be accessed at www.ncwater.org/gwmb. Geophysical logs can be directly accessed at https://www.ncwater.org/?page=346. Specifications for the wells at Merchants Millpond are summarized below in Table 1, and an expanded well data table is provided in Appendix B. Well construction records, cutting descriptions, and geophysical logs are provided in Appendix C. NC DWR's data management plan which includes data collection, quality control, and storage procedures is provided in Appendix D.

Table 1. Wells constructed at Merchants Millpond State Park

NGWMN ID	Name	Depth (ft)	Screen Top (ft)	Screen Bottom (ft)	Sample Date	Water Level (ft)	Principal Aquifer Code	NC Aquifer Name	VA Aquifer Name
NCDWR:C16S5	MMSP	25	10	20	12/9/19	12.36	S	Surficial	Surficial
NCDWR:C16S4	MMSP	55	40	50	12/9/19	18.16	NACP	Yorktown	Yorktown-Eastover
NCDWR:C16S3	MMSP	205	190	200	12/9/19	32.28	CH	Castle Hayne	Piney Point
NCDWR:C16S2	MMSP	250	235	245	12/9/19	32.11	NACP	Beaufort	Aquia
NCDWR:C16S1	MMSP	460	445	455	12/9/19	49.68	NACP	Upper Cape Fear	Potomac
NCDWR:C16S6	MMSP	870	825	835	12/9/19	103.00	NACP	Lower Cape Fear	Potomac

S Surficial aquifer system (S100SURFCL) MMSP Merchants Millpond State Park
CH Castle Hayne aquifer (N400CSLHYN) NACP Northern Atlantic Coastal Plain aquifer system (S100NATLCP)

Description of Work Accomplished with DWR Matching Funds

Matching funds in the amount of $201,034 were expended by DWR in 2018 and 2019 for drilling services at other locations within the state. Drilling consisted of installing six wells at DWR's Clinton monitoring station at a cost of $99,770 (FY 2018), and six wells at DWR's West Carteret Water Corporation monitoring station at a cost of $101,264 (FY 2019). Drilling services were provided by A.C. Schultes of Carolina, Inc. of Rocky Point, NC. Well construction, sampling, logging, datalogger installation, and other tasks were performed in the same manner as at Merchants Millpond. The twelve wells were then added to the NGWMN Registry. Data for the new wells is accessible through the NGWMN Registry, or DWR website, www.ncwater.org/gwmb. Specifications for the in-kind services wells are summarized below in Table 2.

Table 2. Matching funds wells

NGWMN ID	Name	Depth (ft)	Screen top (ft)	Screen bottom (ft)	Water level date	Water level (ft)	Principal aquifer	Local aquifer (NC)
NCDWR:U35I1	Clinton	42	30	40	11/4/19	11.50	S	Surficial
NCDWR:U35I4	Clinton	112	93	103	11/4/19	46.10	NACP	Upper Black Creek
NCDWR:U35I6	Clinton	190	175	185	11/4/19	57.64	NACP	Black Creek
NCDWR:U35I5	Clinton	291	274	284	11/4/19	120.80	NACP	Upper Cape Fear
NCDWR:U35I3	Clinton	390	376	386	11/4/19	124.85	NACP	Lower Cape Fear
NCDWR:U35I2	Clinton	483	470	480	11/4/19	124.86	NACP	Lower Cape Fear
NCDWR:X19O6	WCWC	35	25	35	10/29/19	4.84	S	Surficial
NCDWR:X19O5	WCWC	110	90	100	10/29/19	9.13	NACP	Yorktown
NCDWR:X19O4	WCWC	170	150	160	10/29/19	26.70	CH	Castle Hayne

NCDWR:X19O3	WCWC	290	275	285	10/29/19	26.73	CH	Castle Hayne
NCDWR:X19O2	WCWC	355	340	350	10/29/19	26.59	CH	Castle Hayne
NCDWR:X19O1	WCWC	460	432	447	10/29/19	26.21	CH	Castle Hayne

S	Surficial aquifer system (S100SURFCL)	NACP	Northern Atlantic Coastal Plain aquifer system (S100NATLCP)
CH	Castle Hayne aquifer (N400CSLHYN)	WCWC	West Carteret Water Corporation

Work Done As Data Provider in Support of NGWMN

Work completed has consisted of well drilling under Objective 5.

Data Collection and Drilling Activities Completed

Six monitoring wells were drilled, cuttings samples were collected and described, and geophysical logging was performed. Wells have since been equipped with dataloggers and added to the NGWMN.

Methods Used for Data Collection

Methods used for data collection are provided in the Data Management Plan in Appendix D.

Procedures Used to Quality Assure Data Prior to Entry Into NGWMN

Data quality assurance procedures are provided in the Data Management Plan in Appendix D.

Table of New or Replacement Wells Added to the NGWMN

Information on new wells added to the NGWMN is tabulated in the tables above and in Appendix B.

Updates to Web Services

In February 2020, NC DWR advised USGS that it is in the process of shifting to a new server with separate domain for web services. NC DWR provided a new URL to USGS and data transmission between the agencies continues to function seamlessly.

Problems Serving Data to the NGWMN Data Portal

There have been no problems to date serving data to the NGWMN portal.

Well Construction Diagrams for New Wells

Well construction diagrams are provided in Appendix C.

Setting and Hydrogeology of Merchants Millpond Monitoring Station

The Merchants Millpond ground water monitoring station (Figure 1) consists of six wells and is located in Gates County, North Carolina at Merchants Millpond State Park (Lat 36.4406, Lon -76.6997). Site elevation is approximately 33 ft above mean sea level. Relative to nearby points of reference, the Merchants Millpond monitoring station is located approximately 48 miles west of the Atlantic Ocean 8 miles south of the North Carolina - Virginia state line.

The general region where the Merchants Millpond station is located is referred to in this report as the Albemarle-Tidewater area (Figure 2), and it consists of northeastern North Carolina and southeastern Virginia. The general boundaries of the Albemarle-Tidewater area are the James River and Chesapeake Bay to the north, the Atlantic Ocean to the east, the Albemarle Sound to the south, and the Chowan and Blackwater Rivers to the west. Elevation of the Albemarle-Tidewater area ranges from 0 to less than 100 ft above mean sea level. Terrain of area is generally flat to the east becoming dissected and gently rolling to the west.

The geology of the area consists of Recent to Cretaceous coastal plain sediments which dip and thicken eastward. The estimated depth to bedrock beneath the coastal plain sediments reaches approximately 1,600 ft below land surface at Merchants Millpond and 5,700 ft below surface along the NC Outer Banks near Kitty Hawk. Based on well records, basement bedrock consists of igneous and metamorphic bedrock, and in localized areas, Triassic basin sediments. The geology of the Albemarle-Tidewater area is complicated by multiple marine transgression and regression events, and structural and stratigraphic complexities related to the Chesapeake Bay impact crater of 35 million years ago.

Principal Aquifers within the Albemarle-Tidewater area consist of the Surficial, Castle Hayne, and Northern Atlantic coastal plain aquifer systems. Within these three systems are the Surficial, Yorktown, Castle Hayne, Beaufort, and Upper and Lower Cape Fear Aquifers, each of which is screened at the Merchants Millpond monitoring station. As shown in the previous chart, the six wells at Merchants Millpond range in depth from 25 to 870 feet deep.

Within the Albemarle-Tidewater area, chlorides and other dissolved solids generally increase in all aquifers with increasing depth and proximity to the Atlantic Ocean. Ground water quality in the six local aquifers at Merchants Millpond was tested in December 2019 for chlorides, specific conductance, salinity, and pH. Test results indicate that chlorides exceed the 250 mg/l drinking water standard in the Lower Cape Fear aquifer, as shown in the NC Wells Table in Appendix B.

Regional Hydrogeology and Transboundary Conditions

The Albemarle-Tidewater area is located in the Northern Atlantic Coastal Plain (Figure 4). Within this region, aquifer names may vary considerably from state to state, as is evident in the USGS aquifer correlation table provided as Figure 5. The absence of consistent, uniform naming conventions makes correlating units across state boundaries an involved process requiring comparison and association of well records, drilling and geophysical logs, water level records, and other data.

To use the NGWMN to resolve transboundary conditions between North Carolina and Virginia, well records for a broad area within the Merchants Millpond vicinity were compiled. These consisted of thirty-seven USGS monitoring wells in Virginia, as identified through the NGWMN, and fifteen wells in North Carolina. The NC wells include those at the Merchants Millpond, Four Mile Desert, Morgans Corner, and Moyock well stations, each of which belongs to NC DWR's ground water monitoring network. For each of the North Carolina and Virginia wells, location, elevation, construction details, and aquifer codes and names were tabulated. Well tables for each state are provided in Appendix B.

Next, water level data for each of the thirty-seven Virginia wells was downloaded from the NGWMN. Water levels were converted to water level elevation for each well. Data sets for each well were then compiled into multi-well data sets by aquifer type using the six main aquifer groups assigned by USGS. Water level data for the NC wells, though available through the NGWMN, was accessed directly from the NC Ground Water Monitoring Branch website. Well hydrographs for the four NC wells are provided in Appendix A as Figures 6 to 9 and for the VA wells as Figures 10 to 15. A simplified correlation chart of NC-VA aquifers for the Merchants Millpond area is provided below.

NC Aquifer Name	VA Aquifer Name (USGS name)
Surficial	Quaternary Group
Yorktown	Upper Chesapeake Group/Pliocene Series
Castle Hayne/Beaufort	Eocene Series
Upper Cape Fear	Upper Cretaceous
Lower Cape Fear	Patapsco Formation
Lower Cretaceous	Patuxent Formation

Although similarity in hydrograph signature can be seen in several of the shallow aquifer hydrographs (Figures 8, 10, 11), transboundary correlation between aquifers or geologic units is not feasible because of the significant distance between wells, limited log data, and lack of hydraulic connection between the unconfined or semi-confined aquifers. In the case of the Castle Hayne/Beaufort and Eocene Series wells (Figures 7, 8, 12) each of the three wells show modest water level decline over time and similar water level elevations, suggesting possible well-to-well correlation. On the other hand, transboundary relationships can be clearly inferred in the majority of the deeper

Cretaceous wells in both North Carolina and Virginia. Figures 7 and 8 show a decline in the Lower Cape Fear Aquifer of over 40 ft from the mid-1970s until around 2011, after which the water level begins to rebound. This decline is attributed to decades of ground water pumping at a paper mill in Franklin, Virginia. Then, in about 2010, the mill shut down, resulting in a water level rebound. This pattern of decline, followed by rebound, is evident in many of Virginia's deep wells also, such as in the Upper Cretaceous wells in Figure 13, well 4901 in Figure 15, and well 4801 in Figure 15. Interestingly, Lower Cretaceous well 4801 showed net water level decline of only 40 ft from 1968 to 2011 before rebounding 100 ft. Well hydrographs and other data accessed through the NGWMN, therefore, can be very useful in understanding transboundary conditions.

Acknowledgements

Special thanks are extended to Charles "Steve" Rogers, Park Superintendent at Merchants Millpond State Park, for accommodating field work and assistance with permitting, and to T. Scott Bruce, Geologist with Virginia Office of Water Supply, for assistance in geological interpretation and correlation.

Disclaimer

The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Geological Survey. Mention of trade names or commercial products does not constitute their endorsement by the U.G. Geological Survey.

Copies for USGS

PDF copies of this report are being submitted to:

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References

1) Subcommittee on Ground Water of the Advisory Committee on Water Information, 2009 (revised 2013), A national framework for ground water monitoring in the United States: Advisory Committee on Water Information, accessed January 2017, at https://acwi.gov/sogw/ngwmn_framework_report_july2013.pdf.

2) G17AC00167 Cooperative Agreement Application, NCDWR, 2017.

3) Cunningham, William L., Thomas E. Reilly, Daryll Pope, April 25, 2016, Use of the National Ground-Water Monitoring Network to Evaluate Selected Transboundary Aquifer Systems, presentation at NGWA Groundwater Summit, Denver, CO.

4) https://cida.usgs.gov/ngwmn/

5) http://www.ncwater.org/gwmb

6) Lautier, Jeff C., 1998, Hydrogeologic Framework and Ground Water Resources of the North Albemarle Region, North Carolina: NC Department of Environment and Natural Resources, Division of Water Resources, 61 p.

7) Status of Virginia's Water Resources, October 2018, A Report on Virginia's Water Resources Management Activities, Virginia Department of Environmental Quality, Commonwealth of Virginia, 49 p.

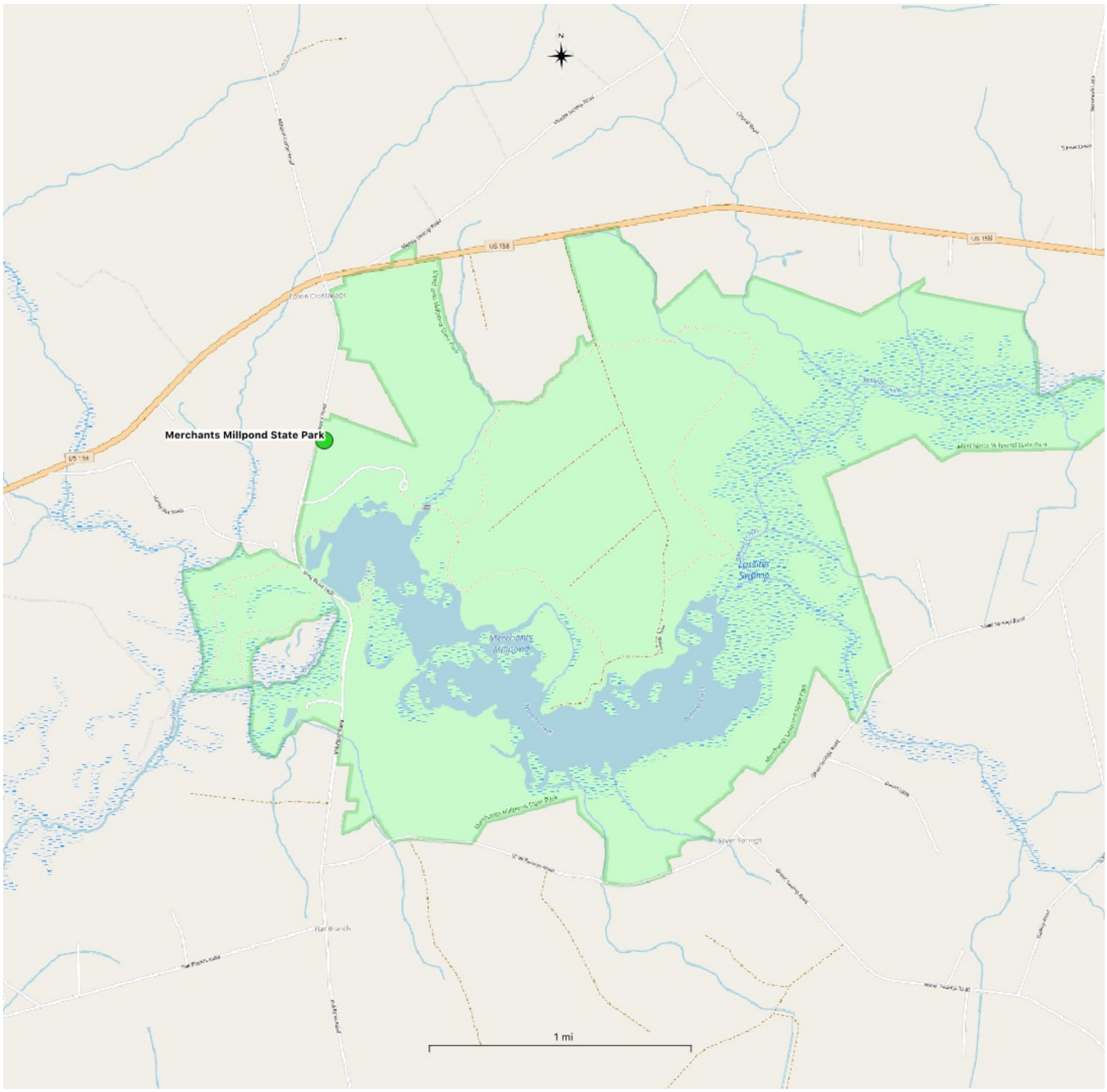
8) McFarland, E. Randolph and T. Scott Bruce, 2006, The Virginia Coastal Plain Hydrogeologic Framework, U. S. Geological Survey Professional Paper 1731, 119 p.

9) Trapp, Henry, Jr., and Marilee A. Horn, 1997, Ground Water Atlas of the United States, Hydrologic Investigations Atlas 730-L, Segment 11 Delaware, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, West Virginia: U.S. Geological Survey, --p. (https://pubs.usgs.gov/ha/730l/report.pdf).

APPENDIX A

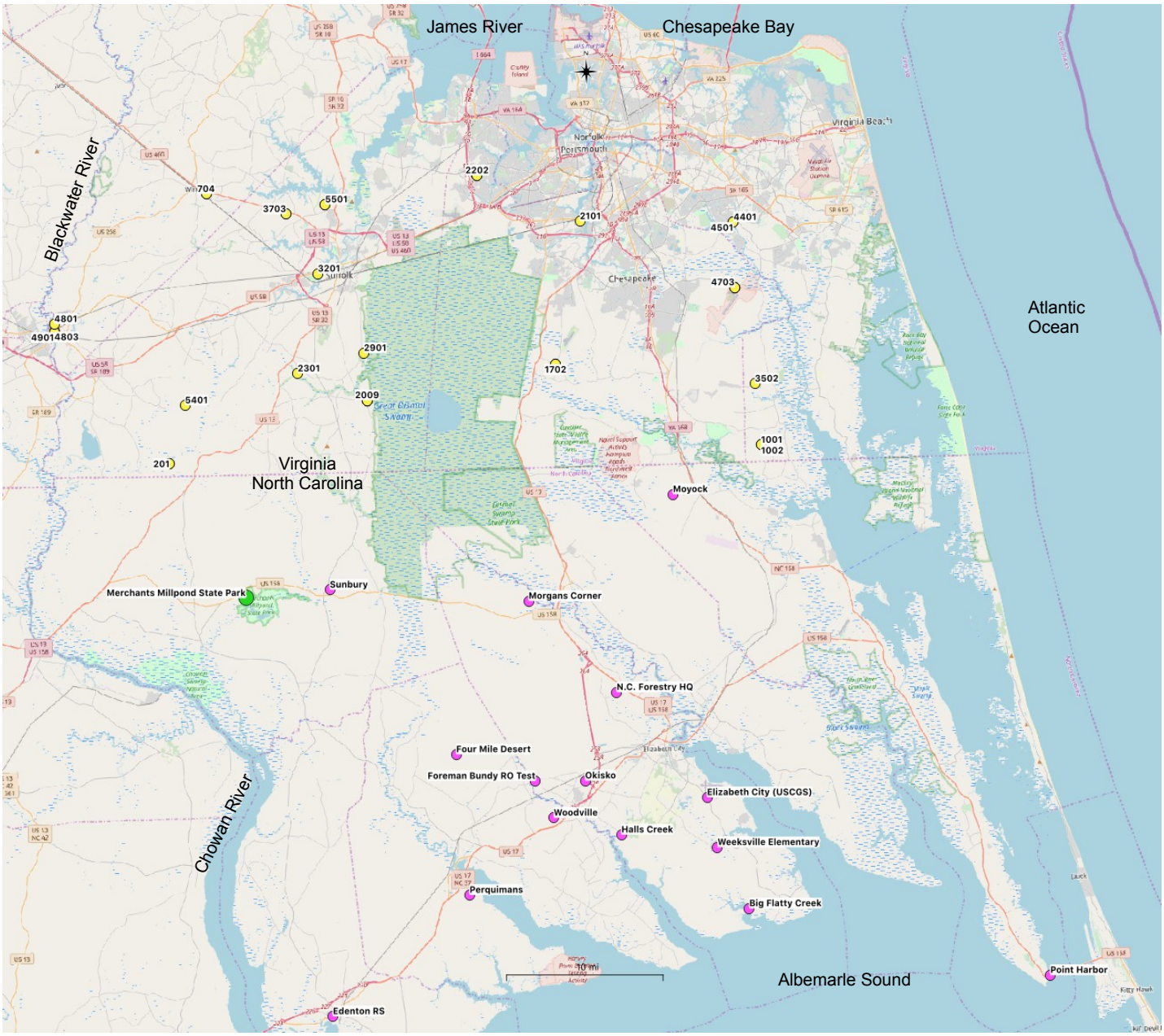
Figures

Figure 1. Merchants Millpond ground water monitoring station in Gates County, North Carolina



In 2019, six ground water monitoring wells were installed at Merchants Millpond State Park in Gates County, NC. These wells fill a data gap resulting from the loss of DWR's Sunbury station located five miles to the east of Merchants Millpond. Well cuttings, logs, persistent water levels, and periodic water quality data from the wells will be used to assess and track ground water use and availability throughout the Albemarle-Tidewater region and provide insight into NC-VA transboundary conditions such as correlation of hydrogeologic units from state to state.

Figure 2. The Albemarle-Tidewater area of northeastern North Carolina and southeastern Virginia



The Albemarle-Tidewater area is located in northeastern North Carolina and southeastern Virginia. The general area extends from the James River and Chesapeake Bay to the north, the Atlantic Ocean to the east, the Albemarle Sound to the south, and the Chowan and Blackwater Rivers to the west. Ground water data used in this report was accessed through the National Ground-Water Monitoring Network website, and includes well data for the following: Merchants Millpond monitoring station (green circle), selected NC DWR monitoring stations (magenta circles), and selected USGS wells in Virginia (yellow circles).

Note: Some well labels are not visible at this map scale . Coordinates for all wells referenced in this report are provided in Appendix B.

Figure 3. NC DWR Monitoring Well Network Statistics

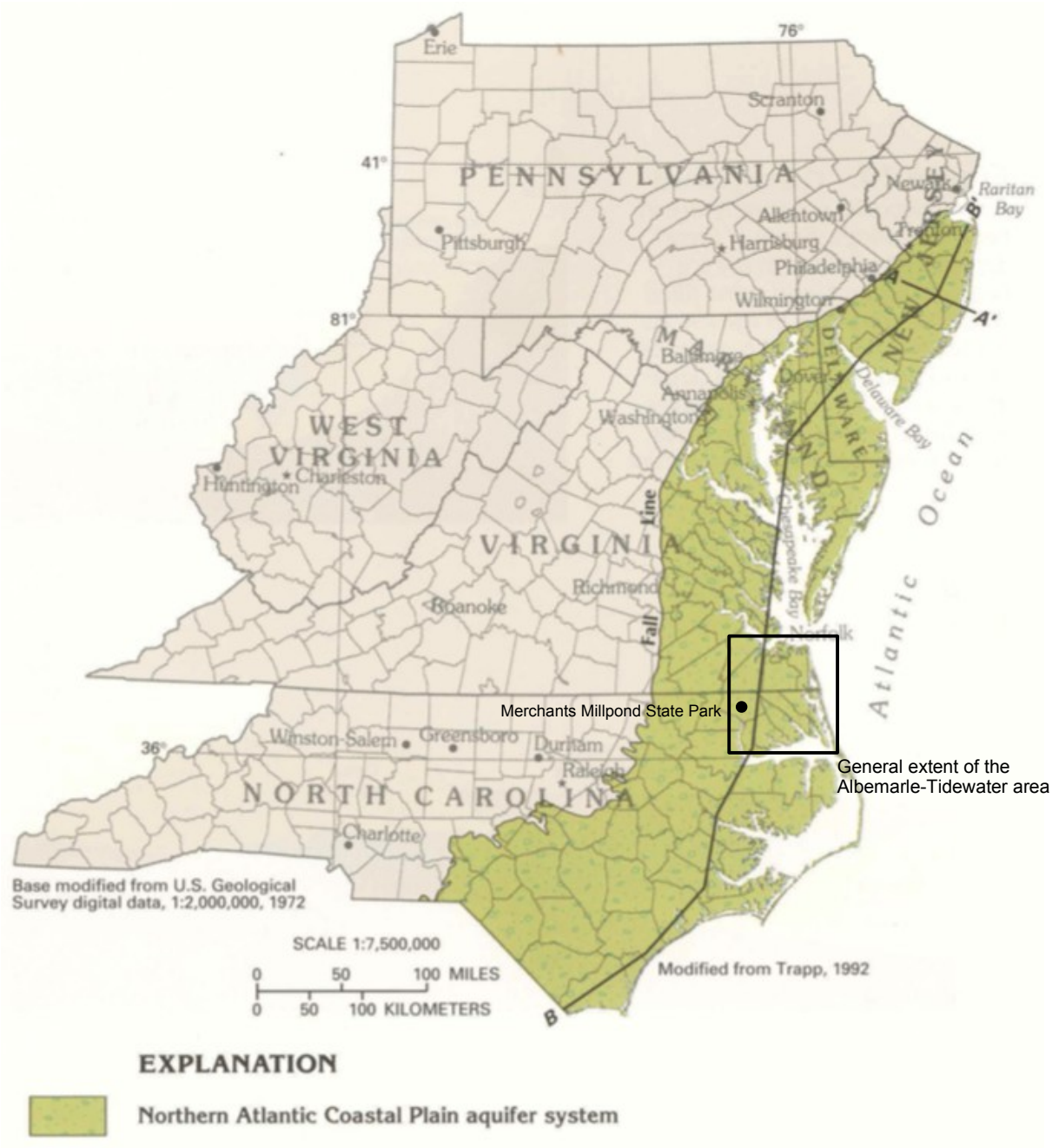
Monitoring Well Network Statistics for 2020-03-16

Parameter	Number	% of Network
Active Wells:	684	
Sites	229	3.0 wells per site
Counties	67	67% of State
Hobos deployed: (includes 215 barometers, hobo30 = 1 and hobo13 = 214)	778	113.7
Solinst STS deployed: (each STS requires two recorders, one barologger and levelogger -- an STS doesn't displace a need for a Hobo)	32	
Wells with Recorders (just number of wells being recorded, there may be mutiple recorders on a well)	577	84.4
Wells needing Recorders: (107 minus 101 wells that can't be recorded)	6	0.9
Total Recorders (usable: on wells or in offices -- doesn't include 2 recorders on wells but not operating)	965	141.1
Hobo recorders we need to buy (two per recordable well -- recorder and barometer), negative number means we have extra. We have 144 unused Hobos (either being repaired or waiting to be deployed).	-161	-23.5
GPSed; No GPS:	655	95.8
Painted; No Paint:	587	85.8
DWR Recorder Boxes Installed	262	38.3
Total Boxes includes DWR (262), USGS (48), and Other Methods (9) of Recorder Installation; No Boxes:	319	46.6
Wells with Reducers:	146	21.3
Wells with Signs; No signs:	560	81.9
Replacement Wells	21	3.1
New Wells or newly acquired wells (as of 1995-01-01): 324 constructed or acquired wells ; 268 constructed wells.	324	47.4
Owner Records; Sites missing Owners:	225	98.3% of sites
Monuments Installed; Sites missing Monuments:	229	100.0% of sites
Drought Wells	49	7.2
Time field recorded (total # of tapedowns = 65,301)	50,809	77.81% of total
Field Book Pages Uploaded (largest = 139,900 bytes) in wlfieldnotes	15,378	
Susceptibility (total of 225)	1: 81; 2: 59; 3: 81; 4: 4; 5:	
Internal Water Levels	2,602,746	
Public Water Levels	2,602,505	
Public Chlorides	4,531	
Hourly Water Levels	55,675,049	
Borehole Interpretations	859	
Geophysical Logs	3,590	
Log Curve Points	19,186,767	
GS Active (includes other cooperators)	46	
GS Coop Network wells	13	
GS Coop Network sites	13	
GS Coop Network counties	12	
GS Coop Network counties outside of DWR counties	4	
GS Coop Network at non-DWR sites	8	

Radio dial buttons will update map to item described.

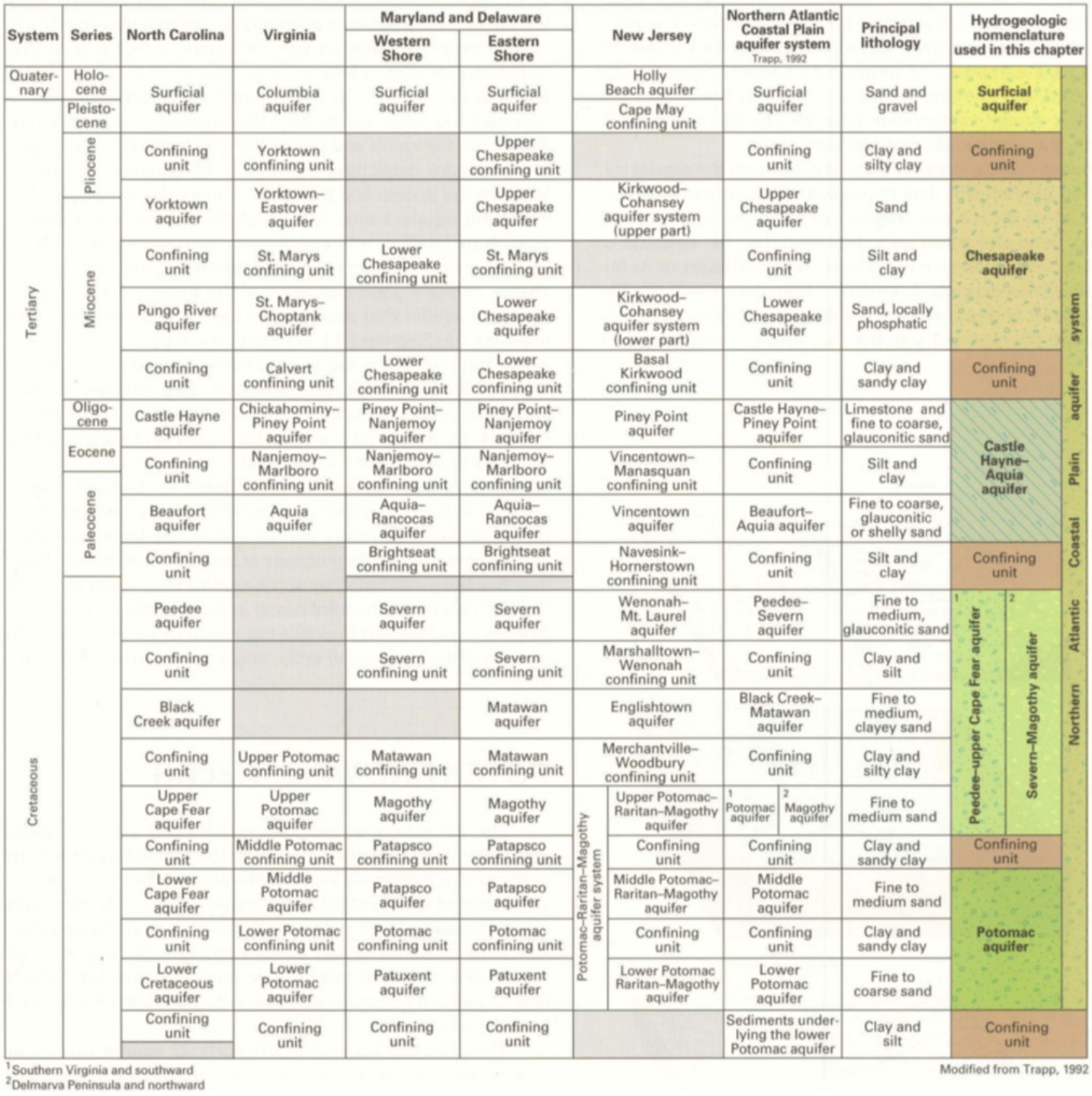
Maps and data from the NC DWR Ground Water Monitoring Branch website are available at ncwater.org/gwmb.

Figure 4. Regional extent of the Northern Atlantic Coastal Plain aquifer system



(Map source: Trapp, Henry, Jr., and Marilee A. Horn, 1997, Ground Water Atlas of the United States, Hydrologic Investigations Atlas 730-L, Figure 18 with annotations)

Figure 5. Regional aquifers in the Northern Atlantic Coastal Plain



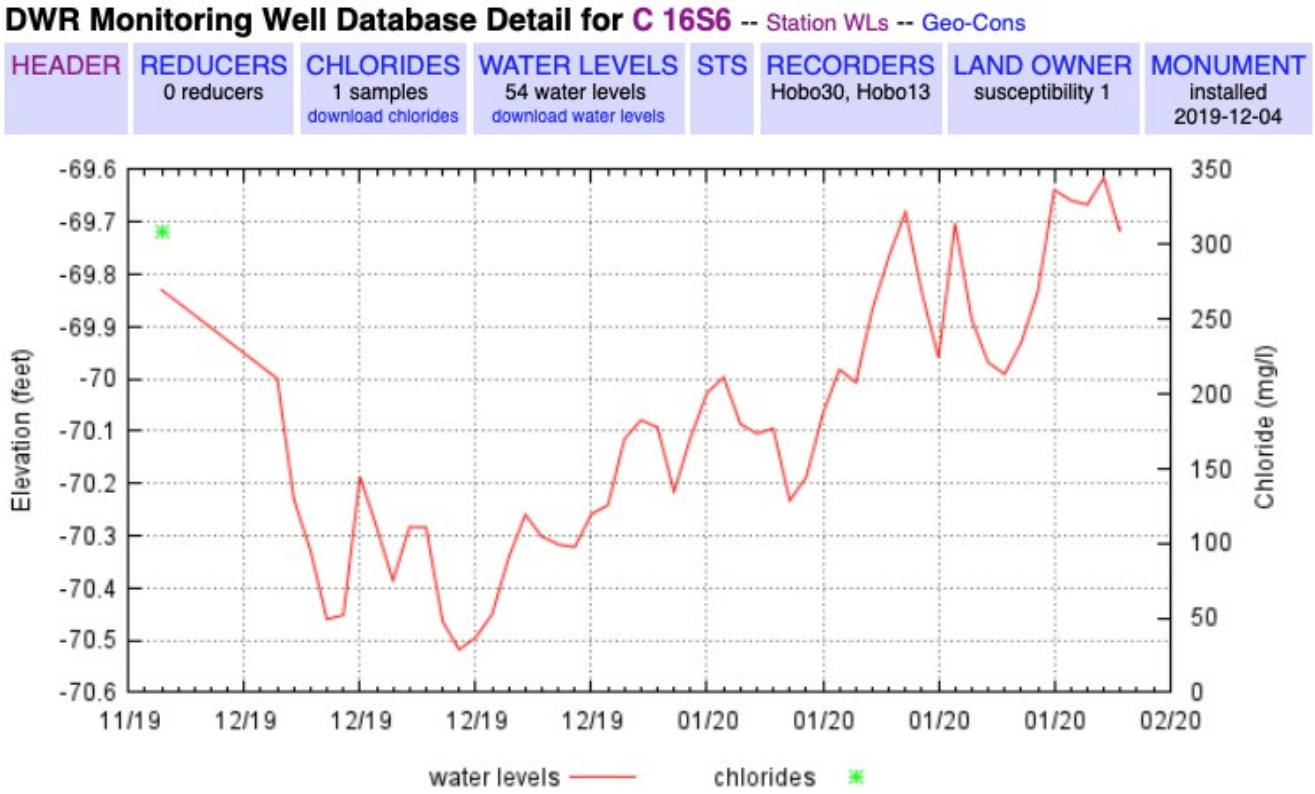
System	Series	North Carolina	Virginia	Maryland and Delaware: Western Shore	Maryland and Delaware: Eastern Shore	New Jersey	Northern Atlantic Coastal Plain aquifer system (Trapp, 1992)	Principal lithology	Hydrogeologic nomenclature used in this chapter
Quaternary	Holocene	Surficial aquifer	Columbia aquifer	Surficial aquifer	Surficial aquifer	Holly Beach aquifer	Surficial aquifer	Sand and gravel	Surficial aquifer
Tertiary	Pleistocene					Cape May confining unit			
	Pliocene	Confining unit	Yorktown confining unit		Upper Chesapeake confining unit		Confining unit	Clay and silty clay	Confining unit
	Miocene	Yorktown aquifer	Yorktown–Eastover aquifer		Upper Chesapeake aquifer	Kirkwood–Cohansey aquifer system (upper part)	Upper Chesapeake aquifer	Sand	Chesapeake aquifer
		Confining unit	St. Marys confining unit	Lower Chesapeake confining unit	St. Marys confining unit		Confining unit	Silt and clay	
		Pungo River aquifer	St. Marys–Choptank aquifer		Lower Chesapeake aquifer	Kirkwood–Cohansey aquifer system (lower part)	Lower Chesapeake aquifer	Sand, locally phosphatic	
		Confining unit	Calvert confining unit	Lower Chesapeake confining unit	Lower Chesapeake confining unit	Basal Kirkwood confining unit	Confining unit	Clay and sandy clay	Confining unit
	Oligocene	Castle Hayne aquifer	Chickahominy–Piney Point aquifer	Piney Point–Nanjemoy aquifer	Piney Point–Nanjemoy aquifer	Piney Point aquifer	Castle Hayne–Piney Point aquifer	Limestone and fine to coarse, glauconitic sand	Castle Hayne–Aquia aquifer
	Eocene	Confining unit	Nanjemoy–Marlboro confining unit	Nanjemoy–Marlboro confining unit	Nanjemoy–Marlboro confining unit	Vincentown–Manasquan confining unit	Confining unit	Silt and clay	
	Paleocene	Beaufort aquifer	Aquia aquifer	Aquia–Rancocas aquifer	Aquia–Rancocas aquifer	Vincentown aquifer	Beaufort–Aquia aquifer	Fine to coarse, glauconitic or shelly sand	
		Confining unit		Brightseat confining unit	Brightseat confining unit	Navesink–Hornerstown confining unit	Confining unit	Silt and clay	Confining unit
Cretaceous		Peedee aquifer		Severn aquifer	Severn aquifer	Wenonah–Mt. Laurel aquifer	Peedee–Severn aquifer	Fine to medium, glauconitic sand	[1] Peedee–upper Cape Fear aquifer / [2] Severn–Magothy aquifer
		Confining unit		Severn confining unit	Severn confining unit	Marshalltown–Wenonah confining unit	Confining unit	Clay and silt	
		Black Creek aquifer			Matawan aquifer	Englishtown aquifer	Black Creek–Matawan aquifer	Fine to medium, clayey sand	
		Confining unit	Upper Potomac confining unit	Matawan confining unit	Matawan confining unit	Merchantville–Woodbury confining unit	Confining unit	Clay and silty clay	
		Upper Cape Fear aquifer	Upper Potomac aquifer	Magothy aquifer	Magothy aquifer	Potomac–Raritan–Magothy aquifer system: Upper Potomac–Raritan–Magothy aquifer	[1] Potomac aquifer / [2] Magothy aquifer	Fine to medium sand	
		Confining unit	Middle Potomac confining unit	Patapsco confining unit	Patapsco confining unit	Confining unit	Confining unit	Clay and sandy clay	Confining unit
		Lower Cape Fear aquifer	Middle Potomac aquifer	Patapsco aquifer	Patapsco aquifer	Middle Potomac–Raritan–Magothy aquifer	Middle Potomac aquifer	Fine to medium sand	Potomac aquifer
		Confining unit	Lower Potomac confining unit	Potomac confining unit	Potomac confining unit	Confining unit	Confining unit	Clay and sandy clay	
		Lower Cretaceous aquifer	Lower Potomac aquifer	Patuxent aquifer	Patuxent aquifer	Lower Potomac Raritan–Magothy aquifer	Lower Potomac aquifer	Fine to coarse sand	
		Confining unit	Confining unit	Confining unit	Confining unit		Sediments underlying the lower Potomac aquifer	Clay and silt	Confining unit

[1] Southern Virginia and southward
[2] Delmarva Peninsula and northward

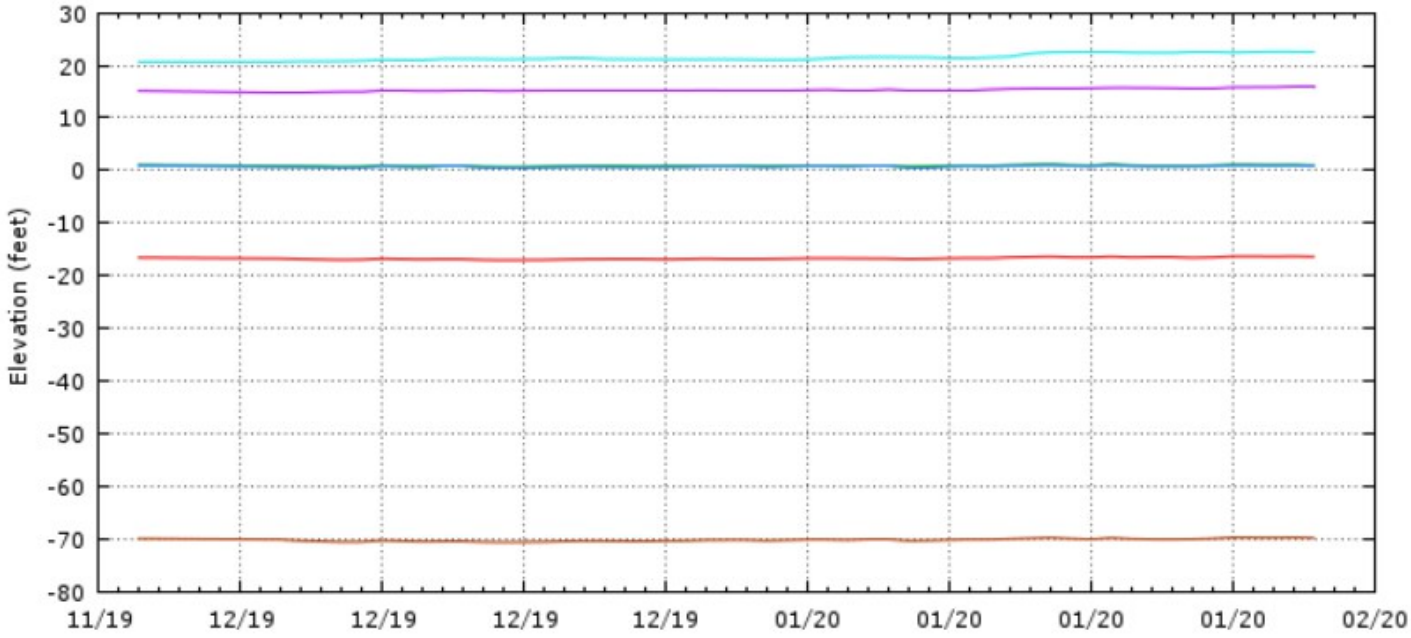
Modified from Trapp, 1992

(source: Trapp, Henry, Jr., and Marilee A. Horn, 1997, Ground Water Atlas of the United States, Hydrologic Investigations Atlas 730-L, Figure 21)

Figure 6. Merchants Millpond well hydrographs (Gates County, NC)

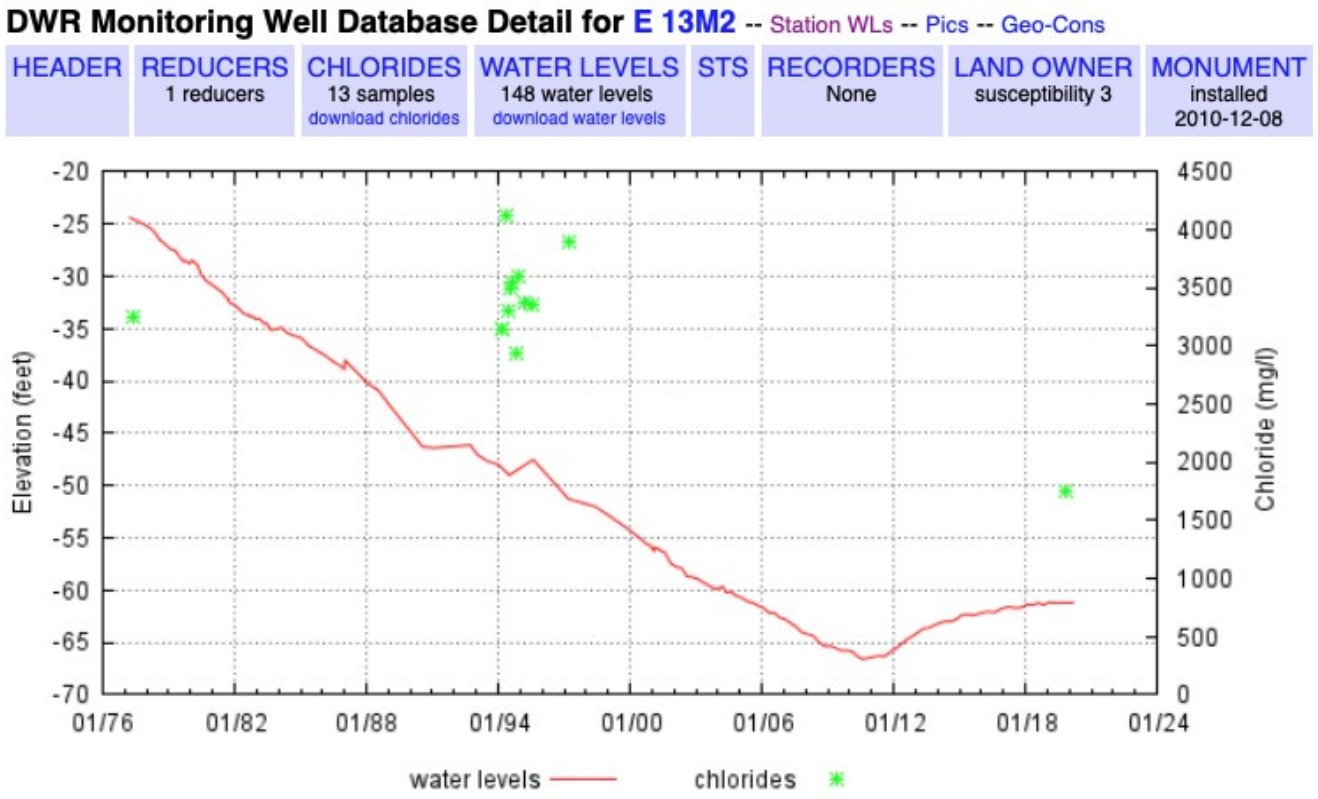


The hydrograph above shows water level fluctuations in the Cretaceous Lower Cape Fear aquifer over an 8-week period. Water levels are corrected for barometric pressure variation, resulting in highly accurate data. At reduced scale (below) the level of detail shown above is not apparent.

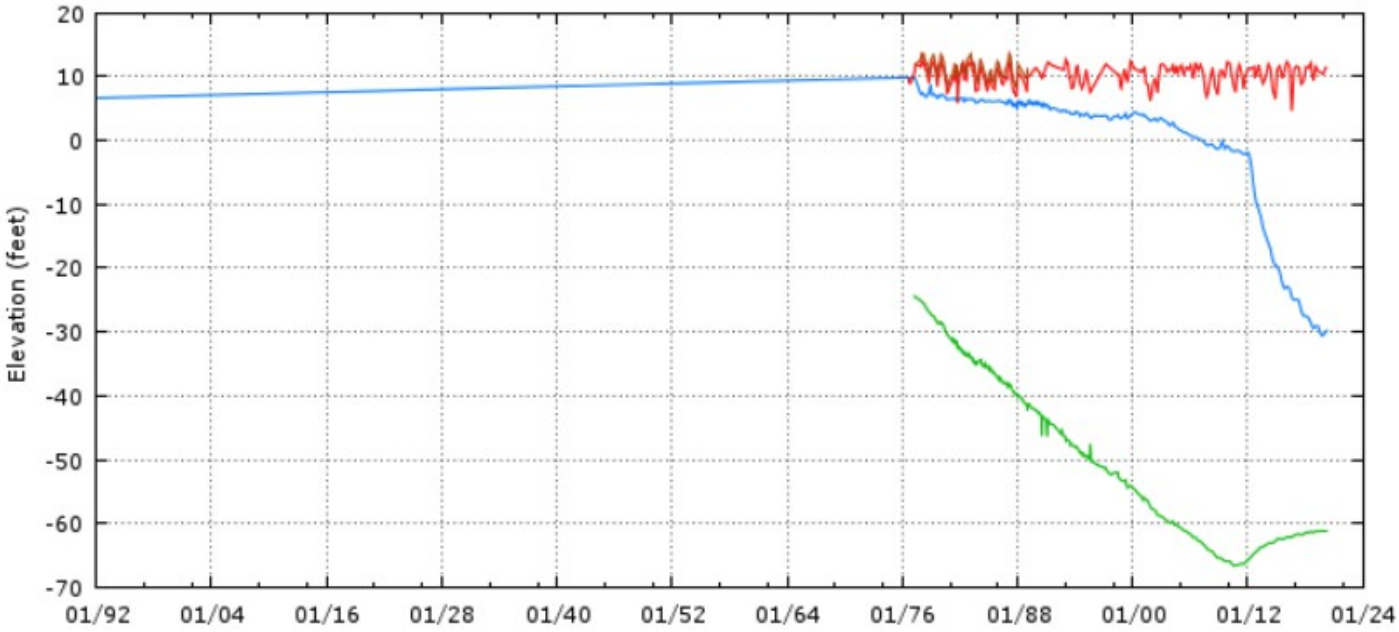


Six data recorders and a barometric pressure sensor were installed in the Merchants Millpond wells in November 2019. From top to bottom, the line traces above are for the following aquifers: Surficial, Yorktown, Castle Hayne and Beaufort (overlapping), Upper Cape Fear, Lower Cape Fear.

Figure 7. Four Mile Desert well hydrographs (Perquimans County, NC)

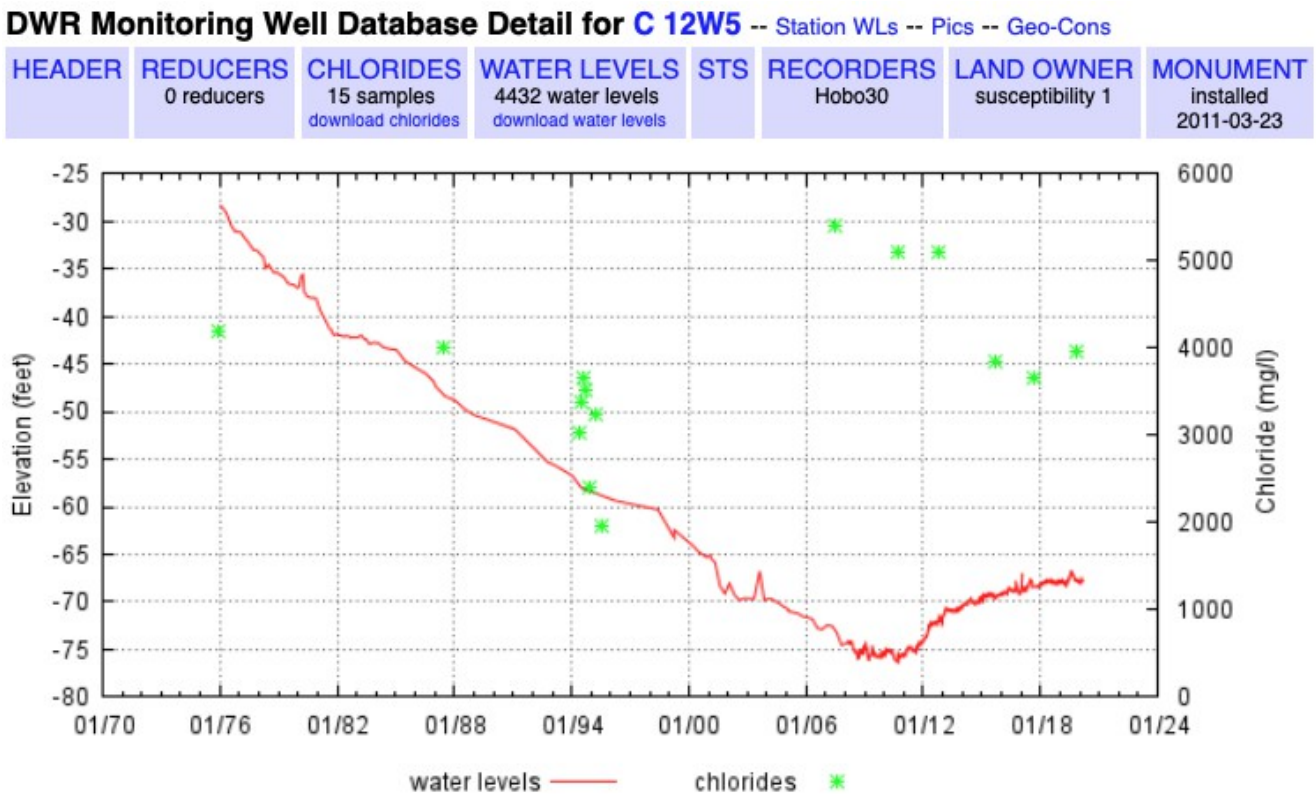


This Lower Cape Fear well shows 40 ft of water level decline over a 33 year period followed by a rebound beginning around 2011. This hydrograph signature is present in many of the deep aquifer wells in northeastern NC and southeastern VA. The cause is attributed to heavy pumping at a paper mill in Franklin, Virginia.

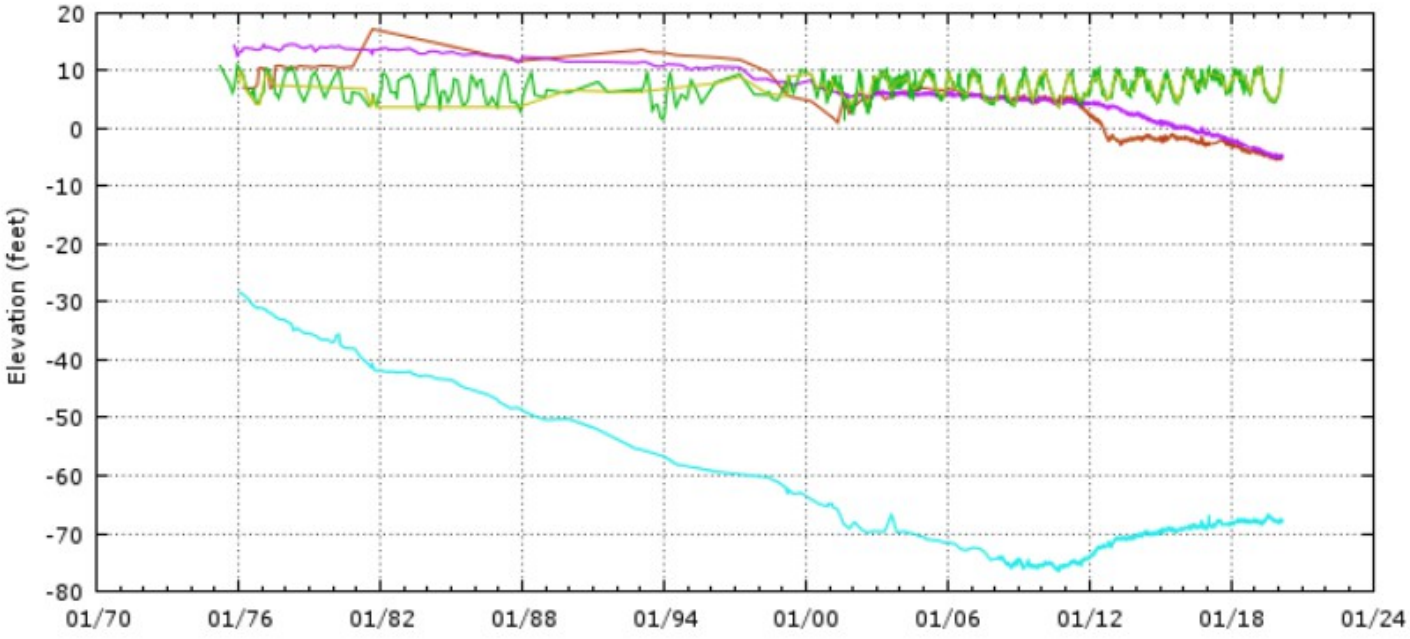


From top to bottom, the line graphs above are for the following aquifers: Yorktown (2 wells), Castle Hayne, Lower Cape Fear. In 2012, water level declines accelerated in the Castle Hayne when the aquifer became the source for a reverse osmosis water supply plant.

Figure 8. Morgans Corner well hydrographs (Pasquotank County, NC)

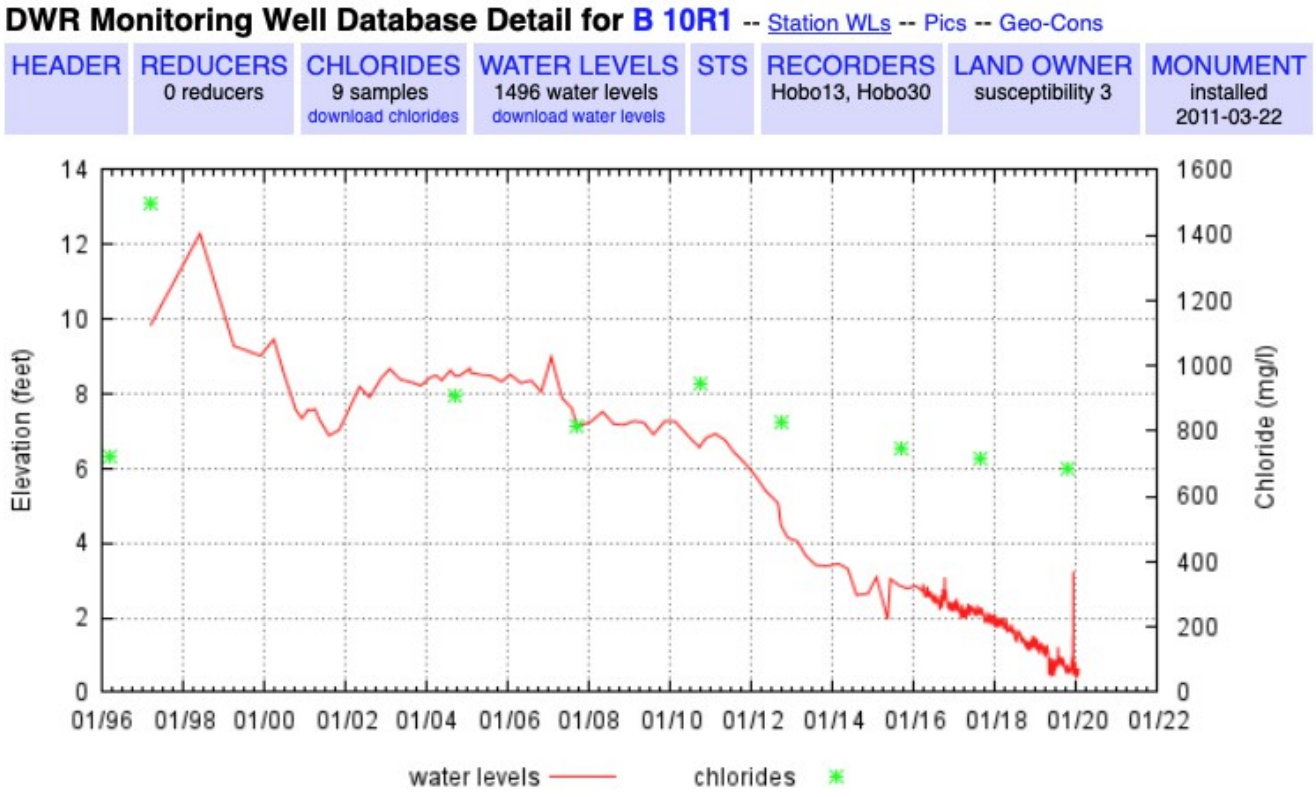


This hydrograph of the Lower Cape Fear aquifer shows a water level decline followed by a slight rebound beginning around 2011. The decline is attributed to pumping at a paper mill in Franklin, Virginia, followed by a rebound when the mill closed.



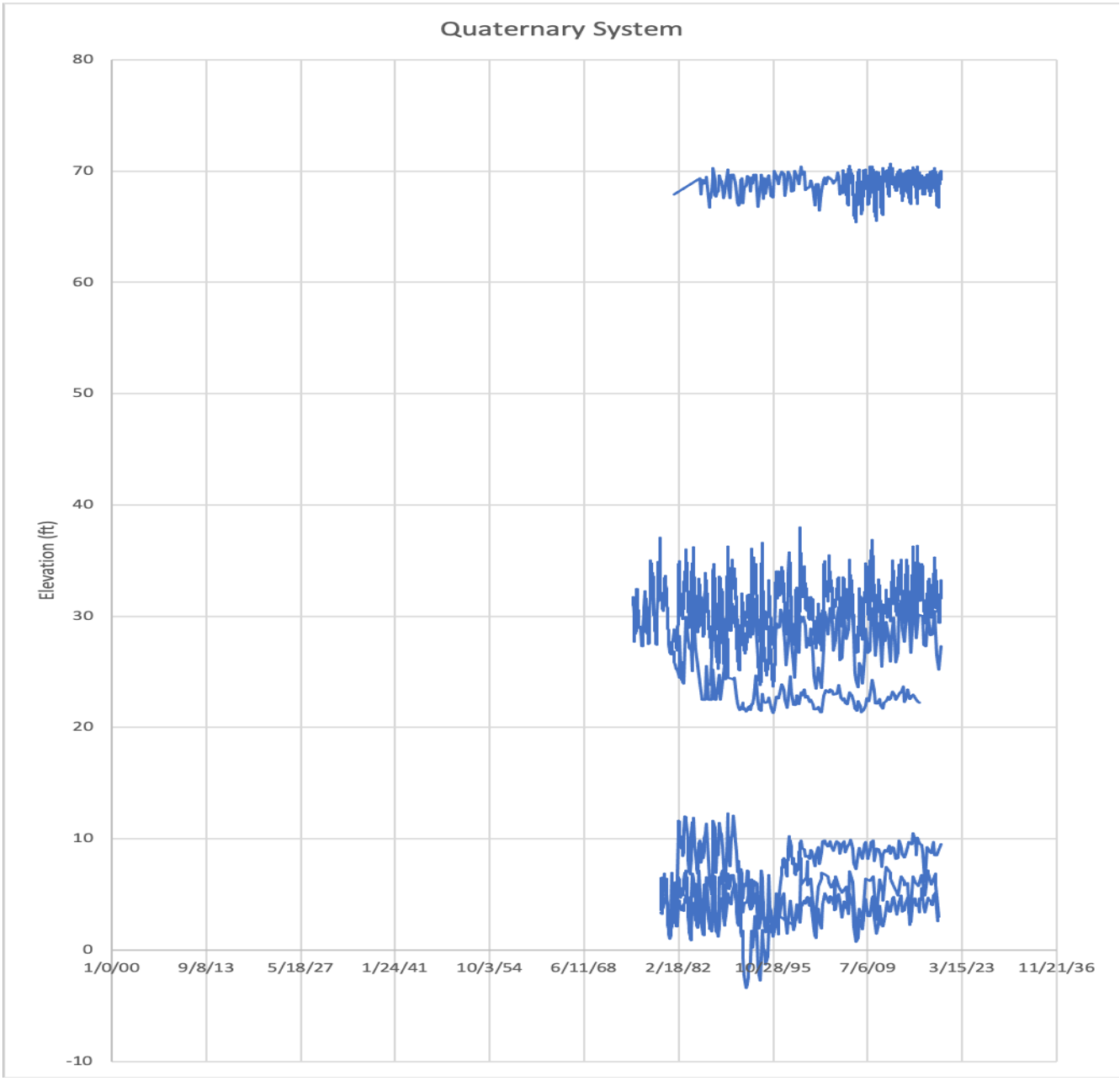
From top to bottom, the line graphs above are for the following aquifers: Yorktown (2 wells, green), Castle Hayne (purple), Upper Cape Fear (brown), Lower Cape Fear (light blue).

Figure 9. Moyock well hydrograph (Currituck County, NC)



This hydrograph of the Lower Cape Fear aquifer shows a general trend of continuing water level decline. Unlike in Figures 7 and 8, the rebound beginning around 2011 is not evident. As water supply in Currituck County is obtained entirely from shallower aquifers, the reason for the continuing decline in this deep well is unclear.

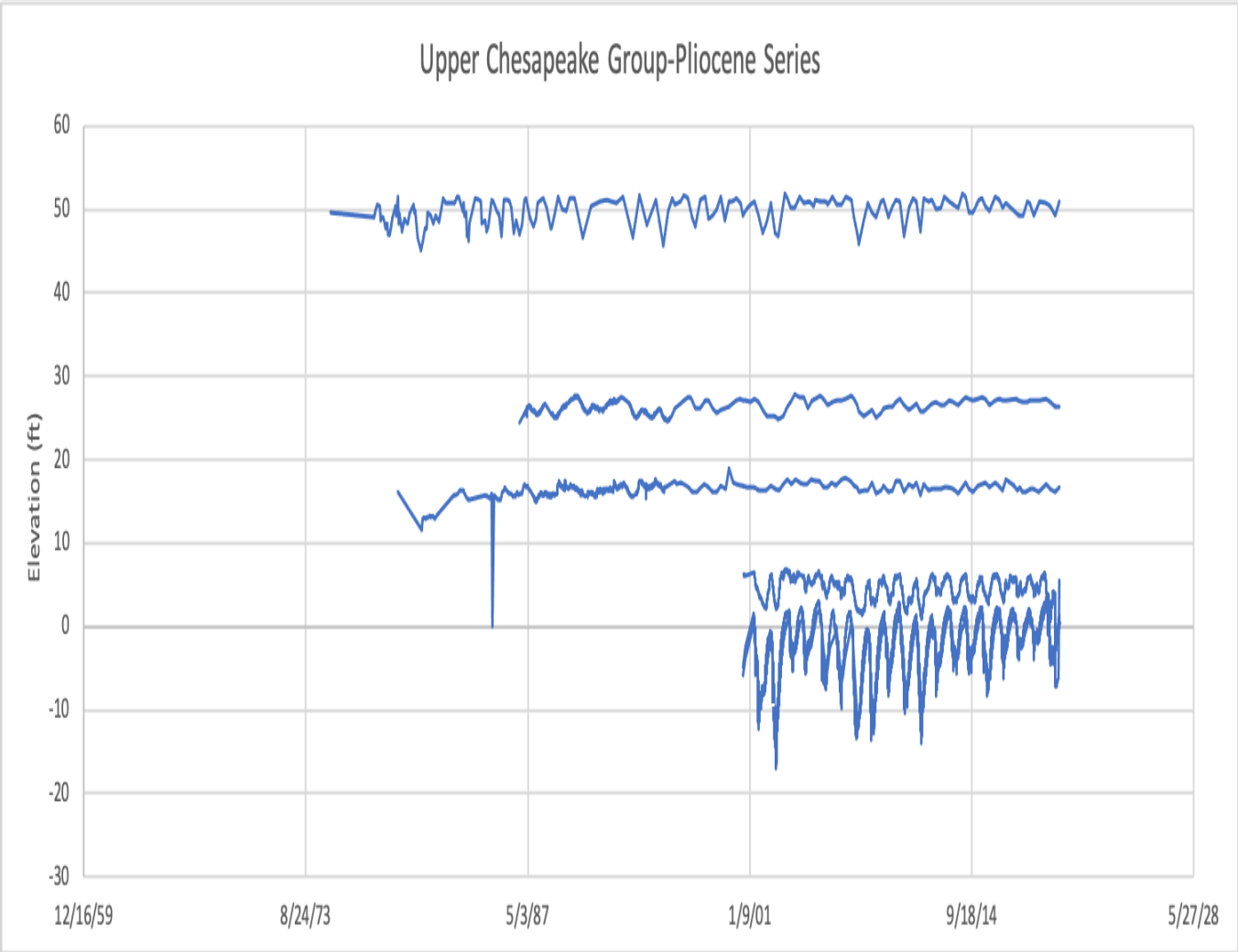
Figure 10. Quaternary Group wells (Virginia)



North Carolina equivalent aquifer: Surficial

Well ID for graphs in this group: 0701 (top); 2901, 2009, 1002, 5501, 2201, 1001 (no order)

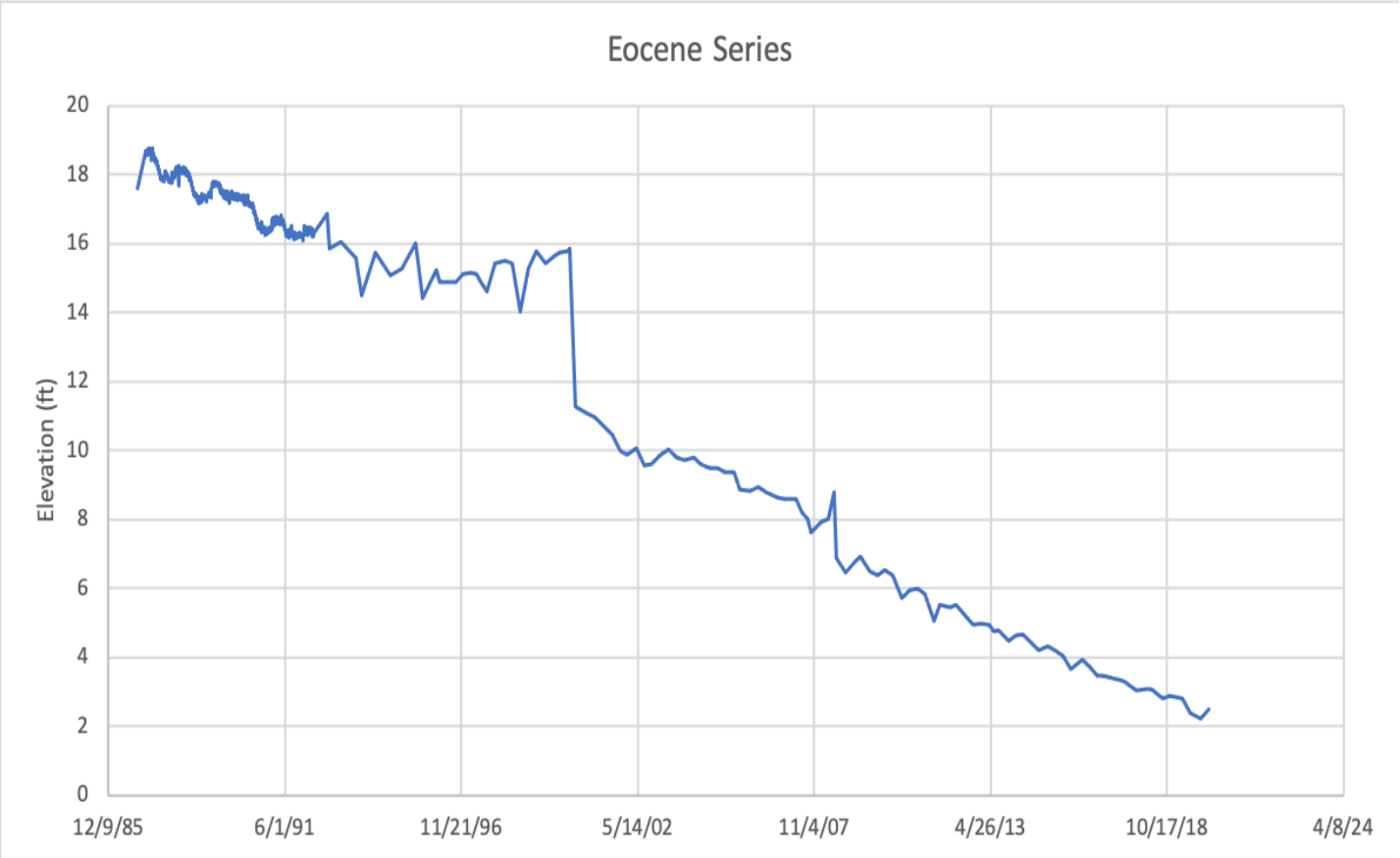
Figure 11. Upper Chesapeake Group-Pliocene Series wells (Virginia)



North Carolina equivalent aquifer: Yorktown

Well ID for each graph (top to bottom): 2301, 2008, 4803, 3502, 4501, 4401 overlapping (?)

Figure 12. Eocene Series well (Virginia)



North Carolina equivalent aquifer: Castle Hayne/Beaufort

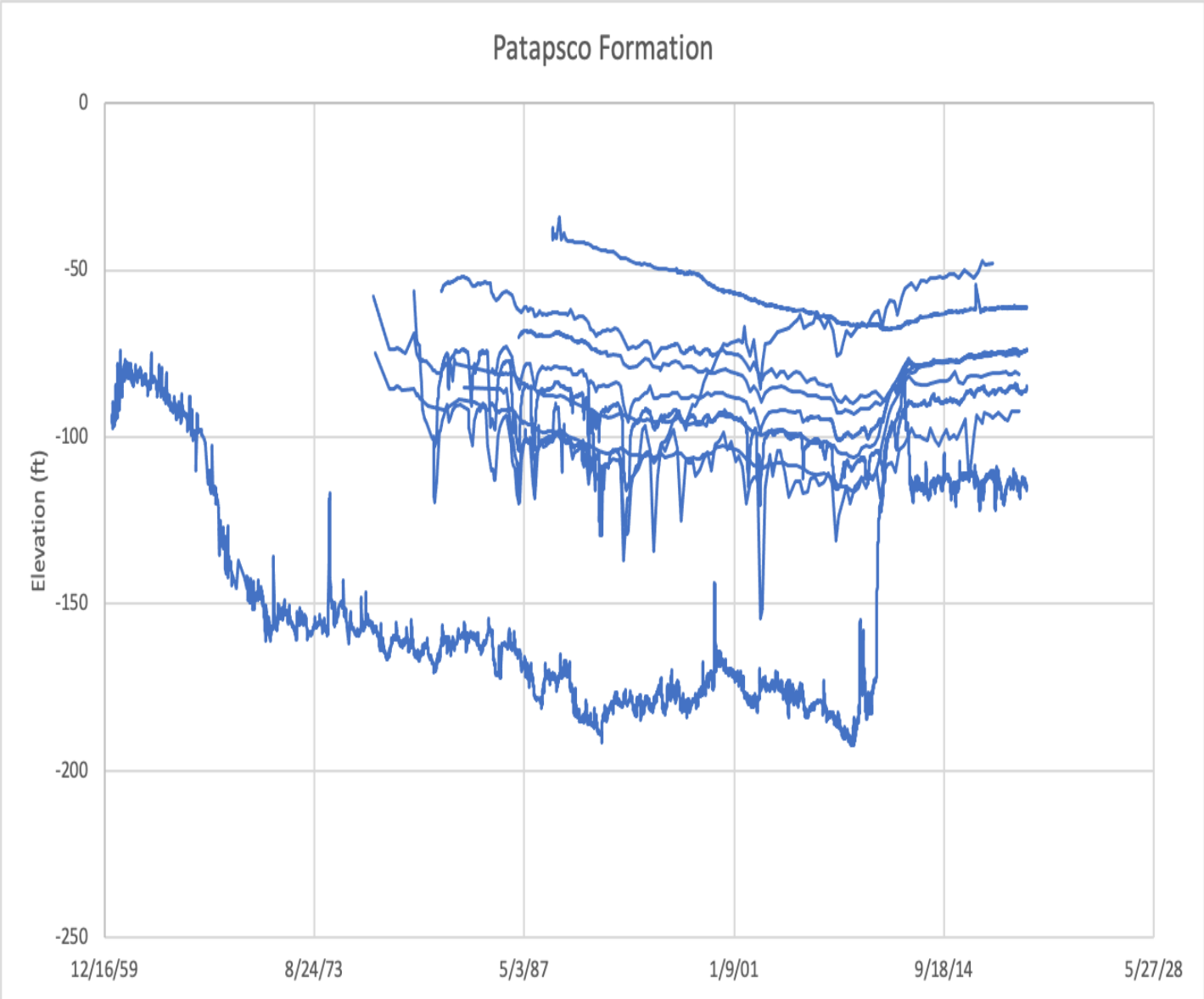
Well ID for graph: 2006

Figure 13. Upper Cretaceous Series wells (Virginia)

North Carolina equivalent aquifer: Upper Cape Fear

Well ID for graphs in this group (no order): 702, 3703, 2203, 2004, 2101, 1701, 4702, 4708

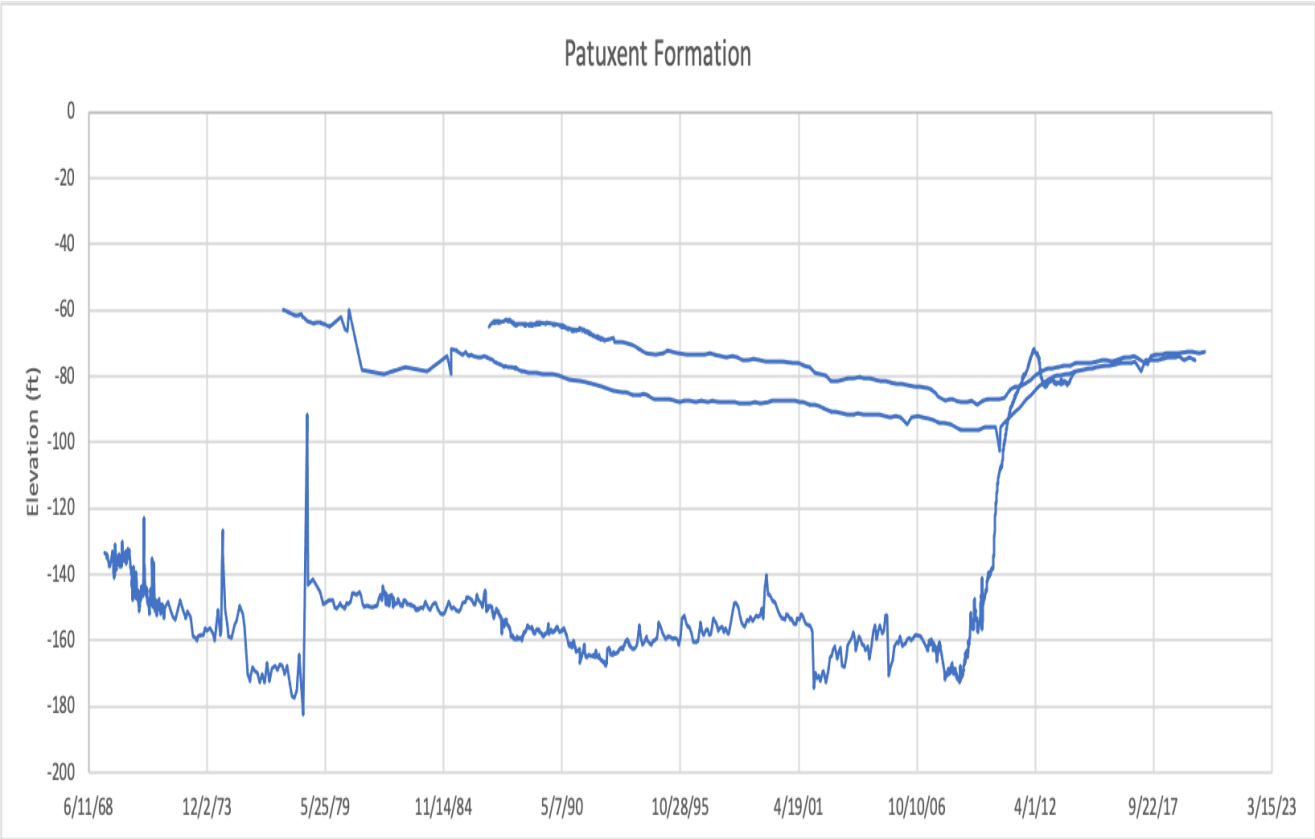
Figure 14. Patapsco Formation wells (Virginia)



North Carolina equivalent aquifer: Lower Cape Fear

Well ID for graphs in this group: Top and bottom wells are 4707 and 4901, respectively.
Well ID for other graphs (no order): 3201, 5502, 202, 3702, 704, 5401, 2003, 2202

Figure 15. Patuxent Formation wells (Virginia)



North Carolina equivalent aquifer: Lower Cretaceous

Well ID for each graph (top to bottom): 2002, 201, 4801

APPENDIX B

Well Table

NC Wells Table (USGS NGWMN Cooperative Agreement G17AC00167, 2017-2019)

NGWMN ID	Name	Funding Source	NC Aquifer Code	NC Aquifer Name	VA Aquifer Name	Principal Aquifer Code	Principal Aquifer System	National Aquifer Code	Well Replaced and Gap Filled	NGWMN Well Replaced	Estimated Depth (ft)	Completed Depth (ft)	Estimated Cost	Estimated Cost/Foot	Actual Cost	Completed Cost/Foot	Water Level Date	Water Level (ft)	Water Quality Date	Screen Top (ft)	Screen Bottom (ft)	Chloride (ppm)	SC (µs)	salinity (ppt)	pH
NCDWR:C16S5	Merchants Millpond 5	USGS - NGWMN (G17AC00167)	S	Surficial	Surficial	S	Surficial	S100SURFCL	Sunbury (C15S7)	none	35	25	$3,355.00	$95.86	$2,725.00	$109.00	12/9/19	12.36	12/4/19	10	20	<32	162.3	0.1	5.58
NCDWR:C16S4	Merchants Millpond 4	USGS - NGWMN (G17AC00167)	Ty	Yorktown	Yorktown-Eastover	NACP	Northern Atlantic Coastal Plain	S100NATLCP	none	none	120	55	$8,075.00	$67.29	$5,995.00	$109.00	12/9/19	18.16	12/4/19	40	50	<32	166.9	0.08	6.16
NCDWR:C16S3	Merchants Millpond 3	USGS - NGWMN (G17AC00167)	Tch	Castle Hayne	Piney Point	CH	Castle Hayne	N400CSLHYN	Sunbury (C15S6)	none	270	205	$12,875.00	$47.69	$22,345.00	$109.00	12/9/19	32.28	--	190	200	--	--	--	--
NCDWR:C16S2	Merchants Millpond 2	USGS - NGWMN (G17AC00167)	Tb	Beaufort	Aquia	NACP	Northern Atlantic Coastal Plain	S100NATLCP	none	none	330	250	$14,795.00	$44.83	$27,250.00	$109.00	12/9/19	32.11	12/4/19	235	245	32	931	0.5	8.63
NCDWR:C16S1	Merchants Millpond 1	USGS - NGWMN (G17AC00167)	Kucf	Upper Cape Fear	Potomac	NACP	Northern Atlantic Coastal Plain	S100NATLCP	Sunbury (C15S5)	none	570	460	$22,475.00	$39.43	$50,140.00	$109.00	12/9/19	49.68	12/3/19	445	455	53	1161	0.6	8.01
NCDWR:C16S6	Merchants Millpond 6	USGS - NGWMN (G17AC00167)	Klcf	Lower Cape Fear	Potomac	NACP	Northern Atlantic Coastal Plain	S100NATLCP	Sunbury (C15S4)	none	900	870	$32,845.00	$36.49	$81,655.00	$93.86	12/9/19	103	12/2/19	825	835	308	2049	1	8.11
Total											**2225**	**1865**	**$94,420.00**	**$50.63**	**$190,110.00**	**$101.94**									
NCDWR:U35I1	Clinton	NC DWR (In-Kind Match)	S	Surficial	n/a	S	Surficial	S100SURFCL	n/a	none	n/a	42	n/a	n/a	n/a	n/a	11/4/19	11.50	10/10/19	30	40	<32	104.3	0.1	5.35
NCDWR:U35I4	Clinton	NC DWR (In-Kind Match)	Kubc	Upper Black Creek	n/a	NACP	Northern Atlantic Coastal Plain	S100NATLCP	n/a	none	n/a	112	n/a	n/a	n/a	n/a	11/4/19	46.10	10/10/19	93	103	<32	71.1	0	5.27
NCDWR:U35I6	Clinton	NC DWR (In-Kind Match)	Kbc	Black Creek	n/a	NACP	Northern Atlantic Coastal Plain	S100NATLCP	n/a	none	n/a	190	n/a	n/a	n/a	n/a	11/4/19	57.64	10/10/19	175	185	<32	70.8	0	5.64
NCDWR:U35I5	Clinton	NC DWR (In-Kind Match)	Kucf	Upper Cape Fear	n/a	NACP	Northern Atlantic Coastal Plain	S100NATLCP	n/a	none	n/a	291	n/a	n/a	n/a	n/a	11/4/19	120.80	10/10/19	274	284	<32	136.3	0.1	6.03
NCDWR:U35I3	Clinton	NC DWR (In-Kind Match)	Klcf	Lower Cape Fear	n/a	NACP	Northern Atlantic Coastal Plain	S100NATLCP	n/a	none	n/a	390	n/a	n/a	n/a	n/a	11/4/19	124.85	10/10/19	376	386	<32	238.1	0.1	7.11
NCDWR:U35I2	Clinton	NC DWR (In-Kind Match)	Klcf	Lower Cape Fear	n/a	NACP	Northern Atlantic Coastal Plain	S100NATLCP	n/a	none	n/a	483	n/a	n/a	n/a	n/a	11/4/19	124.86	10/10/19	470	480	<32	388.3	0.2	7.16
Total												**1508**			**$99,770.00**	**$66.16**									
NCDWR:X19O6	WCWC	NC DWR (In-Kind Match)	S	Surficial	n/a	S	Surficial	S100SURFCL	n/a	none	n/a	35	n/a	n/a	n/a	n/a	10/29/19	4.84	9/24/19	25	35	<32	210.5	0.1	6.17
NCDWR:X19O5	WCWC	NC DWR (In-Kind Match)	Ty	Yorktown	n/a	NACP	Northern Atlantic Coastal Plain	S100NATLCP	n/a	none	n/a	110	n/a	n/a	n/a	n/a	10/29/19	9.13	9/24/19	90	100	<28	485	0.2	7.38
NCDWR:X19O4	WCWC	NC DWR (In-Kind Match)	Tch	Castle Hayne	n/a	CH	Castle Hayne	N400CSLHYN	n/a	none	n/a	170	n/a	n/a	n/a	n/a	10/29/19	26.70	9/24/19	150	160	<28	496	0.2	7.26
NCDWR:X19O3	WCWC	NC DWR (In-Kind Match)	Tch	Castle Hayne	n/a	CH	Castle Hayne	N400CSLHYN	n/a	none	n/a	290	n/a	n/a	n/a	n/a	10/29/19	26.73	9/24/19	275	285	<28	469	0.2	6.84
NCDWR:X19O2	WCWC	NC DWR (In-Kind Match)	Tch	Castle Hayne	n/a	CH	Castle Hayne	N400CSLHYN	n/a	none	n/a	355	n/a	n/a	n/a	n/a	10/29/19	26.59	9/24/19	340	350	<28	440.7	0.2	7.03
NCDWR:X19O1	WCWC	NC DWR (In-Kind Match)	Tch	Castle Hayne	n/a	CH	Castle Hayne	N400CSLHYN	n/a	none	n/a	460	n/a	n/a	n/a	n/a	10/29/19	26.21	9/24/19	432	447	<28	433.8	0.2	6.82
Total												**1420**			**$101,264.00**	**$71.31**									

Abbreviations

ft	depths measured from top of casing or marked measuring point
n/a	not applicable
ppt	parts per thousand
SC	specific conductance
--	not sampled
WCWC	West Carteret Water Corporation

Notes

Merchants Millpond wells were drilled during 2019 by Toano Well and Pump Service, Inc. of Toano, VA (Charles N. "Bo" Dozier, NC Certified Well Contractor 4088-A)

Drilling Invoices

Toano Well	8/5/19	Invoice 4500	$108,455.00	Merchants Millpond	(wells 1,2 3,4,5)
Toano Well	11/14/19	Invoice 4603	$81,655.00	Merchants Millpond	(well 6)
Total			$190,110.00		

VA Wells Table (USGS NGWMN Cooperative Agreement G17AC00167, 2017-2019)															
USGS Name	USGSID	Map ID	Latitude	Longitude	County	National Aquifer System	National Aquifer Code	Local Aquifer Name (Virginia)	Local Aquifer Code	Equivalent Aquifer (North Carolina)	Depth (ft)	Elevation (ft)	Top Screen (ft)	Bottom Screen (ft)	Distance to MMSP (mi)
56A 10 SOW 088A	363345076470201	0201	36.56265249	-76.78356869	Suffolk City	NACP	S100NATLCP	Patuxent Formation	217PTXN	Lower Cretaceous	1081	45	1050	1060	9
56A 12 SOW 088B	363345076470202	0202	36.56265249	-76.78356869	Suffolk City	NACP	S100NATLCP	Patapsco Formation	217PPSC	Lower Cape Fear	601	45	570	580	10
57C 25 SOW 149A	364814076440701	0701	36.80403855	-76.73495754	Isle of Wight County	NACP	S100NATLCP	Quaternary System	110QRNR	Surficial	26	70	16	26	25
57C 26 SOW 149B	364814076440702	0702	36.80403855	-76.73495754	Isle of Wight County	NACP	S100NATLCP	Upper Cretaceous Series	211CRCSU	Upper Cape Fear	380	70	370	380	25
57C 28 SOW 149D	364814076440704	0704	36.80403855	-76.73495754	Isle of Wight County	NACP	S100NATLCP	Patapsco Formation	217PPSC	Lower Cape Fear	807	70	797	807	25
62A 2 SOW 097A	363537076061001	1001	36.56561363	-76.10426796	Virginia Beach City	NACP	S100NATLCP	Quaternary System	110QRNR	Surficial	76	7.57	66	76	34
62A 3 SOW 097B	363537076061002	1002	36.56556086	-76.10427351	Virginia Beach City	NACP	S100NATLCP	Quaternary System	110QRNR	Surficial	24	7.76	20	24	34
60B 3 SOW 090A	363836076201701	1701	36.64348377	-76.33771914	Chesapeake City	NACP	S100NATLCP	Upper Cretaceous Series	211CRCSU	Upper Cape Fear	855	16	824	834	25
60B 4 SOW 090B	363836076201702	1702	36.64348377	-76.33771914	Chesapeake City	NACP	S100NATLCP	Upper Cretaceous Aquifer System	211CRAQU	Upper Cape Fear	556	16	525	535	25
58A 77 SOW 180A	363655076332002	2002	36.61542906	-76.55522757	Suffolk City	NACP	S100NATLCP	Patuxent Formation	217PTXN	Lower Cretaceous	1209	34.02	1199	1209	30
58A 78 SOW 180B	363655076332003	2003	36.61542906	-76.55522757	Suffolk City	NACP	S100NATLCP	Patapsco Formation	217PPSC	Lower Cape Fear	880	34.02	850	860	15
58A 79 SOW 180C	363655076332004	2004	36.61542906	-76.55522757	Suffolk City	NACP	S100NATLCP	Upper Cretaceous Series	211CRCSU	Upper Cape Fear	710	33.97	700	710	15
58A 81 SOW 180E	363655076332006	2006	36.61542906	-76.55522757	Suffolk City	NACP	S100NATLCP	Eocene Series	124EOCN	Castle Hayne/Beaufort	329	34	319	329	15
58A 83 SOW 180G	363655076332008	2008	36.61542906	-76.55522757	Suffolk City	NACP	S100NATLCP	Upper Chesapeake Group	121CSPKU	Yorktown	165	33.84	155	165	15
58A 84 SOW 180H	363655076332009	2009	36.61542906	-76.55522757	Suffolk City	NACP	S100NATLCP	Quaternary System	110QRNR	Surficial	20	33.87	10	20	14
60C 41 SOW 164	364615076182101	2101	36.77098177	-76.30549627	Chesapeake City	NACP	S100NATLCP	Upper Cretaceous Series	211CRCSU	Upper Cape Fear	928	10	770	928	32
59C 29 SOW 163A	364852076252201	2201	36.81459309	-76.42244543	Chesapeake City	NACP	S100NATLCP	Quaternary System	110QRNR	Surficial	35	15	25	35	30
59C 30 SOW 163B	364852076252202	2202	36.81459309	-76.42244543	Chesapeake City	NACP	S100NATLCP	Patapsco Formation	217PPSC	Lower Cape Fear	948	15	938	948	30
59C 31 SOW 163C	364852076252203	2203	36.81459309	-76.42244543	Chesapeake City	NACP	S100NATLCP	Upper Cretaceous Series	211CRCSU	Upper Cape Fear	631	15	621	631	30
57B 8	363834076382301	2301	36.64098447	-76.63439726	Suffolk City	NACP	S100NATLCP	Upper Chesapeake Group	121CSPKU	Yorktown	65	45	50	65	14
58B 13	363928076332901	2901	36.65792848	-76.55772767	Suffolk City	NACP	S100NATLCP	Quaternary System	110QRNR	Surficial	15	40		15	17
58B273 SOW 169F	364348076363201	3201	36.73014982	-76.60856308	Suffolk City	NACP	S100NATLCP	Patapsco Formation	217PPSC	Lower Cape Fear	661	26	541	640	21
62A 23 SOW 209B	363714076063502	3502	36.62074879	-76.10938537	Virginia Beach City	NACP	S100NATLCP	Pliocene Series	121PLCN	Yorktown	100	10.39	88	98	35
57C 22 SOW 099B	364703076383702	3702	36.78431615	-76.64328707	Suffolk City	NACP	S100NATLCP	Patapsco Formation	217PPSC	Lower Cape Fear	694	72	684	694	24
57C 23 SOW 099C	364703076383703	3703	36.78431615	-76.64328707	Suffolk City	NACP	S100NATLCP	Upper Cretaceous Series	211CRCSU	Upper Cape Fear	478	72	468	478	24
61C 44 SOW 210B	364558076074401	4401	36.76620463	-76.12862069	Virginia Beach City	NACP	S100NATLCP	Upper Chesapeake Group	121CSPKU	Yorktown	107	5.77	92	102	39
61C 43 SOW 210A	364558076074501	4501	36.76618518	-76.12868736	Virginia Beach City	NACP	S100NATLCP	Upper Chesapeake Group	121CSPKU	Yorktown	197.5	5.68	182.5	192.5	39
61B 5 SOW 091B	364227076074702	4702	36.70764998	-76.12937859	Chesapeake City	NACP	S100NATLCP	Upper Cretaceous Series	211CRCSU	Upper Cape Fear	1060	15	1040	1060	37
61B 6 SOW 091C	364227076074703	4703	36.70764998	-76.12937859	Chesapeake City	NACP	S100NATLCP	Upper Cretaceous Aquifer System	211CRAQU	Upper Cape Fear	780	15	760	780	37
61B 13 SOW 091F	364227076074707	4707	36.70764998	-76.12937859	Chesapeake City	NACP	S100NATLCP	Patapsco Formation	217PPSC	Lower Cape Fear	1390	15	1370	1380	37
61B 14 SOW 091G	364227076074708	4708	36.70764998	-76.12937859	Chesapeake City	NACP	S100NATLCP	Upper Cretaceous Series	211CRCSU	Upper Cape Fear	1113	15	1093	1103	37
55B 36	364125076544801	4801	36.69042838	-76.91301617	Isle of Wight County	NACP	S100NATLCP	Patuxent Formation	217PTXN	Lower Cretaceous	860	37	720	860	21
55B 62 SOW 096B	364101076544803	4803	36.68376179	-76.91301617	Isle of Wight County	NACP	S100NATLCP	Upper Chesapeake Group	121CSPKU	Yorktown	30.8	27	25	30	21
55B 16	364059076544901	4901	36.68320624	-76.91329395	Isle of Wight County	NACP	S100NATLCP	Patapsco Formation	217PPSC	Lower Cape Fear	306	25	285.5	305.5	21
56A 11 SOW 089	363653076455401	5401	36.61487401	-76.76467962	Suffolk City	NACP	S100NATLCP	Patapsco Formation	217PPSC	Lower Cape Fear	861	79	830	840	13
58C 61 SOW 159A	364731076355501	5501	36.79209378	-76.59828533	Suffolk City	NACP	S100NATLCP	Quaternary System	110QRNR	Surficial	25	40	20	25	25
58C 62 SOW 159B	364731076355502	5502	36.79209378	-76.59828533	Suffolk City	NACP	S100NATLCP	Patapsco Formation	217PPSC	Lower Cape Fear	575	40	555	575	25

Notes/Abbreviations

Northern Atlantic Coastal Plain aquifer system (NACP)
Merchants Millpond State Park monitoring station (MMSP)
feet (ft)
miles (mi)
Distance to MMSP is approximate
Map ID corresponds to labels on Figure 1
Equivalent North Carolina aquifer name based on Trapp, Henry, Jr., and Marilee A. Horn, 1997, Ground Water Atlas of the United States, Hydrologic Investigations Atlas 730-L, Figure 21

APPENDIX C

Well Construction Records, Cuttings Descriptions, and Geophysical Logs

WELL CONSTRUCTION RECORD (GW-1)

1. Well Contractor Information:

Charles A Dozier
Well Contractor Name

4088-A
NC Well Contractor Certification Number

Todd Well & Pump Service Inc
Company Name

2. Well Construction Permit #: _____
List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:
☐Agricultural ☐Municipal/Public
☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)
☐Industrial/Commercial ☐Residential Water Supply (shared)
☐Irrigation ☐Wells > 100,000 GPD

Non-Water Supply Well:
☑Monitoring ☐Recovery

Injection Well:
☐Aquifer Recharge ☐Groundwater Remediation
☐Aquifer Storage and Recovery ☐Salinity Barrier
☐Aquifer Test ☐Stormwater Drainage
☐Experimental Technology ☐Subsidence Control
☐Geothermal (Closed Loop) ☐Tracer
☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 6-17-19 **Well ID#** _____

5a. Well Location:

NC DEQ / UPPER CAPE FEAR Wtlnd
Facility/Owner Name Facility ID# (if applicable)

Physical Address, City, and Zip

Cumberland
County Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

_____ N _____ W

6. Is(are) the well(s): ☑Permanent or ☐Temporary

7. Is this a repair to an existing well: ☐Yes or ☑No
If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. For Geoprobe/DPT or Closed-Loop Geothermal Wells having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: _____

9. Total well depth below land surface: 467 **(ft.)**
For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: _____ **(ft.)**
If water level is above casing, use "+"

11. Borehole diameter: _____ **(in.)**

12. Well construction method: Rotary
(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use Only:

14. WATER ZONES

FROM	TO	DESCRIPTION
440 ft.	450 ft.	Sand
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
0 ft.	175 ft.	10 in.	Sch40	PVC

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3 ft.	440 ft.	4.5 in.	SDR17	PVC
450 ft.	455 ft.	4.5 in.	SDR17	PVC

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
440 ft.	450 ft.	4 in.	.020	Sch40	Stainless
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
170 ft.	0 ft.	Bonseal	Pumped
435 ft.	0 ft.	quick grout	Pumped
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
467 ft.	435 ft.	Silica	Tremmie
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
ft.	ft.	
ft.	ft.	See Attached
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

Signature of Certified Well Contractor

7-22-19
Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well construction info (add 'See Over' in Remarks Box). You may also attach additional pages if necessary.

24. SUBMITTAL INSTRUCTIONS

Submit this GW-1 within 30 days of well completion per the following:

24a. For All Wells: Original form to Division of Water Resources (DWR), Information Processing Unit, 1617 MSC, Raleigh, NC 27699-1617

24b. For Injection Wells: Copy to DWR, Underground Injection Control (IUC) Program, 1636 MSC, Raleigh, NC 27699-1636

24c. For Water Supply and Open-Loop Geothermal Return Wells: Copy to the county environmental health department of the county where installed

24d. For Water Wells producing over 100,000 GPD: Copy to DWR, CCPCUA Permit Program, 1611 MSC, Raleigh, NC 27699-1611

WELL CONSTRUCTION RECORD (GW-1)

1. Well Contractor Information:

Charles N Oozier
Well Contractor Name

4088-A
NC Well Contractor Certification Number

Todd Well & Pump Service Inc
Company Name

2. Well Construction Permit #: _____
List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:
☐Agricultural ☐Municipal/Public
☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)
☐Industrial/Commercial ☐Residential Water Supply (shared)
☐Irrigation ☐Wells > 100,000 GPD

Non-Water Supply Well:
☑Monitoring ☐Recovery

Injection Well:
☐Aquifer Recharge ☐Groundwater Remediation
☐Aquifer Storage and Recovery ☐Salinity Barrier
☐Aquifer Test ☐Stormwater Drainage
☐Experimental Technology ☐Subsidence Control
☐Geothermal (Closed Loop) ☐Tracer
☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed 6-26-2019 **Well ID#** _____

5a. Well Location:

NC DEQ BEAUFORT WELL #2
Facility/Owner Name Facility ID# (if applicable)

Physical Address, City, and Zip

GATES
County Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

_____ N _____ W

6. Is(are) the well(s): ☑Permanent or ☐Temporary

7. Is this a repair to an existing well: ☐Yes or ☑No
If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. For Geoprobe/DPT or Closed-Loop Geothermal Wells having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: _____

9. Total well depth below land surface: 235 (ft.)
For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: _____ (ft.)
If water level is above casing, use "+"

11. Borehole diameter: 10 (in.)

12. Well construction method: Rotary
(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use Only:

14. WATER ZONES

FROM	TO	DESCRIPTION
235 ft.	245 ft.	Sand
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
100 ft.	0 ft.	10 in.	Sch 40	PVC

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3' ft.	235 ft.	4.5 in.	SDR17	PVC
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
235 ft.	245 ft.	4 in.	.020	Sch 40	Stainless
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
100 ft.	0 ft.	Bentseal	Tremmie / pumped
228 ft.	0 ft.	Bentseal	" "
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
253 ft.	235 ft.	Silica	Tremmie
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
ft.	ft.	See Attached
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

_____ 7-22-19
Signature of Certified Well Contractor Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well construction info (add 'See Over' in Remarks Box). You may also attach additional pages if necessary.

24. SUBMITTAL INSTRUCTIONS

Submit this GW-1 within 30 days of well completion per the following:

24a. For All Wells: Original form to Division of Water Resources (DWR), Information Processing Unit, 1617 MSC, Raleigh, NC 27699-1617

24b. For Injection Wells: Copy to DWR, Underground Injection Control (IUC) Program, 1636 MSC, Raleigh, NC 27699-1636

24c. For Water Supply and Open-Loop Geothermal Return Wells: Copy to the county environmental health department of the county where installed

24d. For Water Wells producing over 100,000 GPD: Copy to DWR, CCPCUA Permit Program, 1611 MSC, Raleigh, NC 27699-1611

WELL CONSTRUCTION RECORD (GW-1)

1. Well Contractor Information:

Charles A Dozier
Well Contractor Name

4088-A
NC Well Contractor Certification Number

Jamo well & Pump Service Inc
Company Name

2. Well Construction Permit #: _____
List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:
- ☐ Agricultural
- ☐ Geothermal (Heating/Cooling Supply)
- ☐ Industrial/Commercial
- ☐ Irrigation
- ☐ Municipal/Public
- ☐ Residential Water Supply (single)
- ☐ Residential Water Supply (shared)
- ☐ Wells > 100,000 GPD

Non-Water Supply Well:
- ☑ Monitoring
- ☐ Recovery

Injection Well:
- ☐ Aquifer Recharge
- ☐ Aquifer Storage and Recovery
- ☐ Aquifer Test
- ☐ Experimental Technology
- ☐ Geothermal (Closed Loop)
- ☐ Geothermal (Heating/Cooling Return)
- ☐ Groundwater Remediation
- ☐ Salinity Barrier
- ☐ Stormwater Drainage
- ☐ Subsidence Control
- ☐ Tracer
- ☐ Other (explain under #21 Remarks)

4. Date Well(s) Completed: 6-28-19 **Well ID#** _____

5a. Well Location:

NC DEQ/CASTLE HAYNE WELL #3
Facility/Owner Name

Facility ID# (if applicable)

Physical Address, City, and Zip

COLUMBUS
County

Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

_____ N _____ W

6. Is(are) the well(s): ☑ **Permanent** or ☐ **Temporary**

7. Is this a repair to an existing well: ☐ Yes or ☑ No
If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. For Geoprobe/DPT or Closed-Loop Geothermal Wells having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: _____

9. Total well depth below land surface: 205 **(ft.)**
For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: _____ **(ft.)**
If water level is above casing, use "+"

11. Borehole diameter: 10 **(in.)**

12. Well construction method: Rotary
(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use Only:

14. WATER ZONES

FROM	TO	DESCRIPTION
190 ft.	200 ft.	Brown Limestone
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
0 ft.	100 ft.	10 in.	Sch 40	PVC

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3 ft.	190 ft.	4.5 in.	SDR17	PVC
200 ft.	205 ft.	4.5 in.	SDR17	PVC

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
140 ft.	200 ft.	4" in.	.020	Sch 40	Stainless
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
183 ft.	0 ft.	Bentseal	Tremmie/Pumped
ft.	ft.		
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
210 ft.	183 ft.	Silica	Tremmie
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
ft.	ft.	See attached
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

Signature of Certified Well Contractor

7-22-19
Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well construction info (add 'See Over' in Remarks Box). You may also attach additional pages if necessary.

24. SUBMITTAL INSTRUCTIONS

Submit this GW-1 within 30 days of well completion per the following:

24a. For All Wells: Original form to Division of Water Resources (DWR), Information Processing Unit, 1617 MSC, Raleigh, NC 27699-1617

24b. For Injection Wells: Copy to DWR, Underground Injection Control (IUC) Program, 1636 MSC, Raleigh, NC 27699-1636

24c. For Water Supply and Open-Loop Geothermal Return Wells: Copy to the county environmental health department of the county where installed

24d. For Water Wells producing over 100,000 GPD: Copy to DWR, CCPCUA Permit Program, 1611 MSC, Raleigh, NC 27699-1611

WELL CONSTRUCTION RECORD (GW-1)

1. Well Contractor Information:

Charles A Dozier
Well Contractor Name

4088-A
NC Well Contractor Certification Number

Todd Well & Pump Service Inc
Company Name

2. Well Construction Permit #: _____
List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:
- ☐ Agricultural
- ☐ Municipal/Public
- ☐ Geothermal (Heating/Cooling Supply)
- ☐ Residential Water Supply (single)
- ☐ Industrial/Commercial
- ☐ Residential Water Supply (shared)
- ☐ Irrigation
- ☐ Wells > 100,000 GPD

Non-Water Supply Well:
- ☑ Monitoring
- ☐ Recovery

Injection Well:
- ☐ Aquifer Recharge
- ☐ Groundwater Remediation
- ☐ Aquifer Storage and Recovery
- ☐ Salinity Barrier
- ☐ Aquifer Test
- ☐ Stormwater Drainage
- ☐ Experimental Technology
- ☐ Subsidence Control
- ☐ Geothermal (Closed Loop)
- ☐ Tracer
- ☐ Geothermal (Heating/Cooling Return)
- ☐ Other (explain under #21 Remarks)

4. Date Well(s) Completed: 7-1-2019 **Well ID#** _____

5a. Well Location:

NC DEQ / Yorktown
Facility/Owner Name

Well #4
Facility ID# (if applicable)

Physical Address, City, and Zip

Gates
County

Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

_____ N _____ W

6. Is(are) the well(s): ☑ **Permanent** or ☐ **Temporary**

7. Is this a repair to an existing well: ☐ **Yes** or ☑ **No**
If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. For Geoprobe/DPT or Closed-Loop Geothermal Wells having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: _____

9. Total well depth below land surface: 60 **(ft.)**
For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: _____ **(ft.)**
If water level is above casing, use "+"

11. Borehole diameter: 10" **(in.)**

12. Well construction method: Rotary
(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use Only:

14. WATER ZONES

FROM	TO	DESCRIPTION
40 ft.	50 ft.	Clay & Sand
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3 ft.	40 ft.	4.5 in.	Sch 40	PVC
50 ft.	55 ft.	4.5 in.	Sch 40	PVC

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
40 ft.	50 ft.	4" in.	.020	Sch 40	Stainless
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
35 ft.	0 ft.	Benseal	Pumped / Trimmie
ft.	ft.		
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
34 ft.	60 ft.	Silica	Trimmie
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
ft.	ft.	
ft.	ft.	See attached
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

Signature of Certified Well Contractor

7-22-19
Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well construction info (add 'See Over' in Remarks Box). You may also attach additional pages if necessary.

24. SUBMITTAL INSTRUCTIONS

Submit this GW-1 within 30 days of well completion per the following:

24a. For All Wells: Original form to Division of Water Resources (DWR), Information Processing Unit, 1617 MSC, Raleigh, NC 27699-1617

24b. For Injection Wells: Copy to DWR, Underground Injection Control (IUC) Program, 1636 MSC, Raleigh, NC 27699-1636

24c. For Water Supply and Open-Loop Geothermal Return Wells: Copy to the county environmental health department of the county where installed

24d. For Water Wells producing over 100,000 GPD: Copy to DWR, CCPCUA Permit Program, 1611 MSC, Raleigh, NC 27699-1611

WELL CONSTRUCTION RECORD (GW-1)

1. Well Contractor Information:

Charles M Dozier
Well Contractor Name

4088-A
NC Well Contractor Certification Number

Todd Well & Pump Service Inc
Company Name

2. Well Construction Permit #: _____
List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:
- ☐ Agricultural
- ☐ Geothermal (Heating/Cooling Supply)
- ☐ Industrial/Commercial
- ☐ Irrigation
- ☐ Municipal/Public
- ☐ Residential Water Supply (single)
- ☐ Residential Water Supply (shared)
- ☐ Wells > 100,000 GPD

Non-Water Supply Well:
- ☑ Monitoring
- ☐ Recovery

Injection Well:
- ☐ Aquifer Recharge
- ☐ Aquifer Storage and Recovery
- ☐ Aquifer Test
- ☐ Experimental Technology
- ☐ Geothermal (Closed Loop)
- ☐ Geothermal (Heating/Cooling Return)
- ☐ Groundwater Remediation
- ☐ Salinity Barrier
- ☐ Stormwater Drainage
- ☐ Subsidence Control
- ☐ Tracer
- ☐ Other (explain under #21 Remarks)

4. Date Well(s) Completed: 7-1-19 **Well ID#** _____

5a. Well Location:

NC DEQ/ SURFICAL WELL #5
Facility/Owner Name | Facility ID# (if applicable)

Physical Address, City, and Zip

CATES
County | Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

_____ N _____ W

6. Is(are) the well(s): ☑ Permanent or ☐ Temporary

7. Is this a repair to an existing well: ☐ Yes or ☑ No
If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. For Geoprobe/DPT or Closed-Loop Geothermal Wells having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: _____

9. Total well depth below land surface: 30' (ft.)
For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: _____ (ft.)
If water level is above casing, use "+"

11. Borehole diameter: 10 (in.)

12. Well construction method: Rotary
(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use Only:

14. WATER ZONES

FROM	TO	DESCRIPTION
10 ft.	20 ft.	Sand
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3 ft.	10 ft.	4" in.	Sch 40	Stainless
20 ft.	25 ft.	4" in.	Sch 40	Stainless

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
10 ft.	20 ft.	4" in.	Sch 40	.020	Stainless
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
~~8~~ 10 ft.	0 ft.	Bensear	Tremmie / Pumped
ft.	ft.		
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
8 ft.	30 ft.	Silica	Poured
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
ft.	ft.	
ft.	ft.	See Attached
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

Signature of Certified Well Contractor — Date: 7-22-19

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well construction info (add 'See Over' in Remarks Box). You may also attach additional pages if necessary.

24. SUBMITTAL INSTRUCTIONS

Submit this GW-1 within 30 days of well completion per the following:

24a. For All Wells: Original form to Division of Water Resources (DWR), Information Processing Unit, 1617 MSC, Raleigh, NC 27699-1617

24b. For Injection Wells: Copy to DWR, Underground Injection Control (IUC) Program, 1636 MSC, Raleigh, NC 27699-1636

24c. For Water Supply and Open-Loop Geothermal Return Wells: Copy to the county environmental health department of the county where installed

24d. For Water Wells producing over 100,000 GPD: Copy to DWR, CCPCUA Permit Program, 1611 MSC, Raleigh, NC 27699-1611

WELL CONSTRUCTION RECORD (GW-1)

For Internal Use Only:

1. Well Contractor Information:

CHARLES N. DOZIER, II
Well Contractor Name

NCWC 4088-A
NC Well Contractor Certification Number

TOANO WELL AND PUMP SERVICE, INC-
Company Name

2. Well Construction Permit #: _____
List all applicable well construction permits (i.e. UIC, County, State, Variance, etc.)

3. Well Use (check well use):

Water Supply Well:	
☐Agricultural	☐Municipal/Public
☐Geothermal (Heating/Cooling Supply)	☐Residential Water Supply (single)
☐Industrial/Commercial	☐Residential Water Supply (shared)
☐Irrigation	☐Wells > 100,000 GPD
Non-Water Supply Well:	
☐Monitoring	☐Recovery
Injection Well:	
☐Aquifer Recharge	☐Groundwater Remediation
☐Aquifer Storage and Recovery	☐Salinity Barrier
☐Aquifer Test	☐Stormwater Drainage
☐Experimental Technology	☐Subsidence Control
☐Geothermal (Closed Loop)	☐Tracer
☐Geothermal (Heating/Cooling Return)	☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 9/25/19 **Well ID#** 6

5a. Well Location:

MERCHANT'S MILLPOND
Facility/Owner Name

Lower Cape Fear
Facility ID# (if applicable)

STATE OF NORTH CAROLINA
Physical Address, City, and Zip

176 MILL POND ROAD, GATESVILLE, NC 27938

County

Parcel Identification No. (PIN)

5b. Latitude and longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

_____ N _____ W

6. Is(are) the well(s): ☑**Permanent** or ☐**Temporary**

7. Is this a repair to an existing well: ☐Yes or ☑No
If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. For Geoprobe/DPT or Closed-Loop Geothermal Wells having the same construction, only 1 GW-1 is needed. Indicate TOTAL NUMBER of wells drilled: _____

9. Total well depth below land surface: 870 **(ft.)**
For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: _____ **(ft.)**
If water level is above casing, use "+"

11. Borehole diameter: _____ **(in.)**

12. Well construction method: Rotary mud
(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

14. WATER ZONES

FROM	TO	DESCRIPTION
ft.	ft.	
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
0 ft.	800 ft.	10 in.	SCH 40	PVC

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3 ft.	815 ft.	4.5 in.	SDR17	PVC
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
815 ft.	825 ft.	4 in.	.020		SS
ft.	ft.	in.			

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
802 ft.	0 ft.	Bentonite	Tremmie
ft.	ft.		
ft.	ft.		

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
870 ft.	802 ft.	Silica Sand	Tremmie
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
ft.	ft.	
ft.	ft.	See Attached
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

21. REMARKS

22. Certification:

_____ 10-24-2019
Signature of Certified Well Contractor — Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:
You may use the back of this page to provide additional well construction info (add 'See Over' in Remarks Box). You may also attach additional pages if necessary.

24. SUBMITTAL INSTRUCTIONS

Submit this GW-1 within 30 days of well completion per the following:

24a. For All Wells: Original form to Division of Water Resources (DWR), Information Processing Unit, 1617 MSC, Raleigh, NC 27699-1617

24b. For Injection Wells: Copy to DWR, Underground Injection Control (IUC) Program, 1636 MSC, Raleigh, NC 27699-1636

24c. For Water Supply and Open-Loop Geothermal Return Wells: Copy to the county environmental health department of the county where installed

24d. For Water Wells producing over 100,000 GPD: Copy to DWR, CCPCUA Permit Program, 1611 MSC, Raleigh, NC 27699-1611

WELL INTERPRETATION					
	Quad	C16S (Composite log for Wells 1 - 6)			
	Well Name	Merchants Millpond State Park MW6			
	County	Gates			
	Lat	36.440501			
	Lon	-76.699652			
	Driller	Toano Well and Pump Service, Inc.			
	Log	Toano Well and Pump Service, Inc.			
	TD	870			
	Elevation	33			
	Completion date	6/3/2019 - 9/25/2019			
	Prepared by	dmd			
	Interpretation using		Interpretation using		
UNIT	Cuttings and Geophysical Logs		GWMB Framework (Drill)		
	Code/Depth (bls)	*Elev*	Depth (bls)	*Elev*	
Upper Tertiary CU	10002				
Upper Tertiary	10002				
Yorktown CU	68	*-35*			
Yorktown	78	*-45*			
Pungo River CU	10001				
Pungo River	10001				
Castle Hayne CU	184	*-151*			
Castle Hayne	190	*-157*			
Beaufort CU	202	*-169*			
Beaufort	225	*-192*			
Peedee CU	10000				
Peedee	10000				
Black Creek CU	10000				
Black Creek	10000				
Upper Cape Fear CU	325	*-292*			
Upper Cape Fear	340	*-307*			
Lower Cape Fear CU	563	*-530*			
Lower Cape Fear	621	*-588*			
Lower Cretaceous CU	10003				
Lower Cretaceous	10003				
Basement	10003				

Ground Water Management Branch Map Interface (return)
OpenLayers & MapServer

LAYERS | POT MAPS | KEY | FIND ADD | QUERY INFO | MAKE POTMAP | MAKE CS | FRAME WORK | DATA

NED & Hydrogeologic Framework Results for **fw-1**

measurements in feet	elevations	depths
Land Surface (1/3 arc sec NED)	33	0
Yorktown CU	9	24
Yorktown	1	32
Castle Hayne CU	-124	157
Castle Hayne	-151	184
Beaufort CU	-180	213
Beaufort	-200	233
Upper Cape Fear CU	-322	355
Upper Cape Fear	-366	399
Lower Cape Fear CU	-563	596
Lower Cape Fear	-594	627
Lower Cretaceous CU	-1,060	1093
Lower Cretaceous	-1,122	1155
Basement rock	-1,580	1613

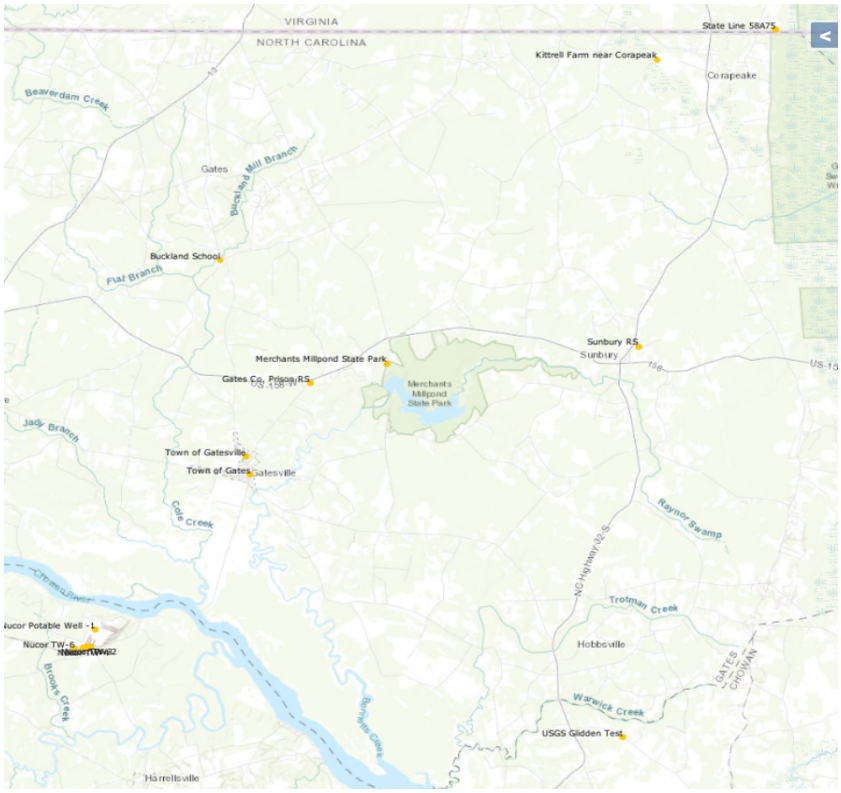
latitude: 36.440608
longitude: -76.699715

CODES	DESCRIPTION (for DWR Ground Water Website)	Example
10002	unit likely exists, but no data to pick elevation	unit above where log begins
10001	unit does not exist	usually includes Upper Tertiary
10003	unit likely exists, but not penetrated	unit deeper than total well depth
10000	unit does not exist and is not penetrated	well is outside boundary of unit
bls	below land surface	
TD	total depth (ft)	

LITHOLOGIC LOG

			Quad	**C16S (Composite log for Wells 1 - 6)**		
			Well Name	**Merchants Millpond State Park Research Station (Wells 1,2,3,4,5,6)**		
			County	**Gates**		
			Latitude	**36.440600**		
			Longitude	**-76.699700**		
			Driller	**Toano Well and Pump Service, Inc.**		
			Geophysical logs	**Toano Well and Pump Service, Inc.**		
			TD	**870'**		
			Elevation	**33'**		
			Completion date	**6/3/2019 - 9/25/2019**		
			Prepared by	**dmd**		
Depth (ft)			**Lithology**	**Color**		
0	-	10	silt and sand	moderate yellow brown (10 YR 5/4)		
10	-	55	silt and sand	light olive gray (5 Y 5/2)		
55	-	70	wood	dark brown (10 YR 2/2)		
70	-	80	silt	olive gray (5 Y 3/2) to light olive gray		
80	-	90	f-vc sand	olive gray		
90	-	195	silt with minor clay, sand, and shell fragments	olive gray		
195	-	210	sand and glauconite	olive gray		
210	-	220	silt	mix of olive gray, yellowish-gray (5 Y 7/2)		
220	-	230	limestone with minor sand, silt, and glauconite	predominantly yellowish-gray		
230	-	260	sand, silt and glauconite	mix of olive gray and yellowish-gray		
260	-	280	sand	mix of olive gray and yellowish-gray		
280	-	320	shell fragments, sand and silt	mix of olive gray and yellowish-gray		
320	-	340	sand	predominantly light gray (N7)		
340	-	350	clay and fine sand	dark to moderate reddish brown (10 R 3/4 to 10 R 4/6)		
350	-	525	f-vc sand with clay	light to light olive gray with occasional reddish brown stain		
525	-	580	vc sand with silt and clay	olive gray		
580	-	700	silt with minor sand	olive gray		
700	-	760	silt with minor sand	light olive gray		
760	-	850	f-m sand with silt and clay	light olive gray		
850	-	870	silt with sand	light olive gray		
		well	**screen**	**local aquifer name**		
		C16S5	10-20'	Surficial		
		C16S4	40-50'	Yorktown		
		C16S3	172-182'	Castle Hayne (?)		
		C16S2	235-245'	Beaufort		
		C16S1	445-455'	Upper Cape Fear		
		C16S6	825-835'	Lower Cape Fear		
		Munsell color based on samples when wet				
		f,c,vc = fine, coarse, very coarse grain size				

C16S
Merchants Millpond State Park MW6

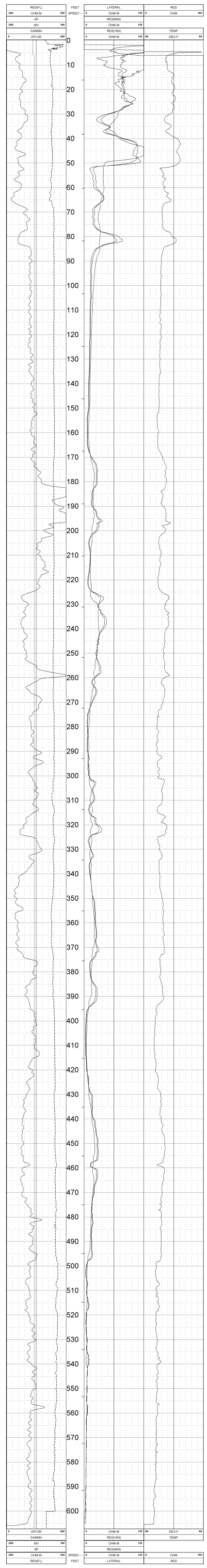


Century GEOPHYSICAL CORP.

COMPANY	: TOANO WELL AND PUMP INC	OTHER SERVICES:		UTM-E	: 36.44
WELL	: MMSP WELL 1			UTM-N	: -76.70
LOCATION/FIELD	:				
COUNTY	: GATES			TOWNSHIP	:
STATE	: NORTH CAROLINA			RANGE	:
				SECTION	:
DATE	: 06/06/19	PERMANENT DATUM	: GL		
DEPTH DRILLER	: 61			KB	:
LOG BOTTOM	: 607.100	LOG MEASURED FROM	: GL	DF	:
LOG TOP	: -0.300	DRL MEASURED FROM	: GL	GL	:
CASING DIAMETER	: 10.	LOGGING UNIT	: 001		
CASING TYPE	: PVC	FIELD OFFICE	:		
CASING THICKNESS	:	RECORDED BY	: BO DOZIER		
BIT SIZE	: 7.775	BOREHOLE FLUID	: MUD	FILE	: ORIGINAL
MAGNETIC DECL.	: 0	RM	: .179	TYPE	: 8144A
MATRIX DENSITY	: 2.65	RM TEMPERATURE	: 68.5	LGDATE	: 06/06/19
NEUTRON MATRIX	: SANDSTONE	MATRIX DELTA T	: 54	LGTIME	: 12:14
				THRESH	: 99999

6-5-2019

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS DISPLAY7_JL56



TOOL CALIBRATION MMSP WELL 1 06/06/19 12:14
TOOL 8144A TM VERSION 3002
SERIAL NUMBER 3102

	DATE	TIME	SENSOR		STANDARD Point1	STANDARD Point2	RESPONSE [CPS] Point1	RESPONSE [CPS] Point2
1	Jul19,18	10:09:33	GAMMA	[API-GR]	1.000	340.000	0.000	312
2	Jul19,18	11:09:20	RES(FL)	[OHM-M]	0.190	29.940	4774	42556
3	Jul19,18	10:09:02	SP	[MV]	0.000	335.000	322394	156003
4	Jul19,18	10:08:29	RES(16N)	[OHM-M]	0.000	1956.000	3768	450059
5	Jul19,18	10:08:36	RES(64N)	[OHM-M]	0.000	1983.000	3333	450229
6	Jul19,18	11:16:27	TEMP	[DEG-F]	34.000	185.000	165000	541500
7	Jul19,18	10:08:45	RES	[OHM]	0.000	944.000	21556	190048

APPENDIX D

Data Management Plan

Data Management Plan

Project: NCDWR-NGWMN Well Drilling
Funding Opportunity G17AC00167

Contacts: USGS
Daryll Pope, Tel (609) 771-3933, dpope@usgs.gov
Candice Hopkins, Tel (208) 387-1331, chopkins@usgs.gov
NCDWR
Nat Wilson, Tel (919) 707-9032, nat.wilson@ncdenr.gov
Mark Durway, Tel (919) 707-9018, mark.durway@ncdenr.gov

Budget: $200,000 (FY 2017/2019)
Project funding for well drilling with an in-kind match from NCDWR

Date: Updated March 17, 2020

Types of Data

Four data types will be collected during this project. These consist of ground water levels, ground water quality analyses, well drilling data, and locational data. At this time, NCDWR provides persistent data to the NGWMN from 684 wells. Principal aquifers monitored by these wells consist of the Surficial aquifer system, Castle Hayne aquifer, Northern Atlantic Coastal Plain aquifer system, and Lower Cretaceous aquifers.

Ground water levels will be acquired hourly or at other regular intervals, validated, and downloaded to the appropriate NCDWR database. Water level acquisition will typically be done by datalogger with periodic verification by water level tape. Water quality data will be collected at less frequent intervals and will consist primarily of chloride concentrations from discrete depth intervals within the aquifer.

Drilling data consisting of lithology, geophysical logs, and well construction specifications will be acquired during the drilling and well completion process. Lithology will be determined from washed and sieved drill cuttings collected at 10 ft intervals. Descriptions will be made with the aid of a microscope, grain size chart, hydrochloric acid for calcium carbonate recognition, and other equipment. Color will be determined by Munsell chart. Lithologic data and well specifications including total depth, casing and screen dimensions, and other information will be used to produce a drilling log. The geology of the well will be further evaluated after the well has been drilled to total depth using open-hole geophysical logging techniques. The geophysical data will be used to produce the following geophysical logs: gamma, spontaneous potential (SP), single-point resistivity (SPR), 16" normal resistivity, 64" normal resistivity. Lithologic descriptions, geophysical logging, drilling, and well completion will be overseen by a geologist and drilling will be performed by a certified well contractor.

Accuracy of locational data will be accomplished using survey grade GPS equipment to determine latitude, longitude, and altitude. Accuracy and geodetic reference systems used by NCDWR are: state plane coordinates and latitude/longitude, <0.05 ft; altitude, <0.1 ft; horizontal datum, NAD83; altitude datum, NAVD88.

Data and Metadata Standards

All data will be entered into NCDWR databases or the NGWMN Well Registry. NCDWR will enter and store data in the following databases:

Data Type	Database Tables
Ground Water Levels	gwb.dwr, gwb.dwrwatlev, gwb.dwrwatlevhourly
Ground Water Quality	gwb.dwrchloride
Well Logs	gwb.logs, gwb.logdata, gwb.resstafr
Well Location Latitude/Longitude and Altitude	gwb.dwr

The NCDWR ground water monitoring network uses the MariaDB database management platform. This platform is supported by branch and division level IT staff. The NCDWR Ground Water Monitoring Branch website is hosted by Apache web server. Internal database tables are used to maintain database quality control and allow for editing. Water level data meeting standards are unloaded to public tables listed above.

Policies for Access and Sharing

All data collected for the project will be available through the NGWMN Data Portal without restriction.

Policies and Provisions for Re-Use and Re-Distribution

There will be restriction on the use of the data through the portal. Any data obtained through the portal and redistributed is expected to cite the original source of the data as NCDWR through this USGS/NGWMN Cooperative.

Plans for Archiving and Preservation of Access

Paper copies of field forms used to collect data will be scanned and stored by NCDWR. Geophysical log data files (.las format or similar) will be provided by the driller and NCDWR will process and permanently store this data. This data will be included in regular system backups. This data and all databases will be backed up at least weekly. Washed and dried drill cuttings will be collected at 10 ft intervals for comparison and correlation to cuttings from other wells. Cuttings will be stored permanently.