

**North Carolina  
Division of Water Resources  
Ground Water Management Branch  
2016 Annual Report**

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September 2016



**O29J, Eastern Correctional Center, Greene County**

## TABLE OF CONTENTS

1.0	Introduction .....	2
2.0	Purpose and Scope .....	2
3.0	Background .....	2
4.0	DWR Statewide Monitoring Well Network Overview .....	3
4.1	Description .....	3
4.2	Monitoring .....	4
4.3	Chloride Sampling .....	6
5.0	Well Network Statistics .....	6
5.1	Ground Water Data Collection .....	6
5.2	Triennial Chloride Sampling .....	6
5.3	Well Installation and Development .....	9
5.4	Well Maintenance .....	12
5.5	Acquired Network Wells .....	13
5.6	Automatic Water Level Recorders .....	14
5.7	Site Surveys .....	14
6.0	Local Monitoring Well Network Information .....	15
6.1	Orange County Monitoring Well Network .....	15
6.2	Guilford County Monitoring Well Network .....	16
7.0	Planned Activities .....	16
7.1	New Well Installation .....	16
7.2	Well Abandonment .....	16
8.0	Water Quality .....	17
9.0	Central Coastal Plain Capacity Use Area .....	19
10.0	Summary and Conclusions .....	22

## FIGURES

Figure 1	North Carolina Division of Water Resources Monitoring Stations June 2016
Figure 2	Drought Indicator Wells
Figure 3	Water Level Data Collected From 1967-2016
Figure 4	Chloride Decreases in the Cretaceous Lower Cape Fear Aquifer
Figure 5	Orange Well Net Orange County 2016
Figure 6	Monitoring Well Network Guilford Counties 2016

## TABLES

Table 1	Site Susceptibility Rating
Table 2	Site and Recorder Distribution by Region as of 6/30/16
Table 3	Solinst Telemetry System (STS) Distribution by Region as of 6/30/16
Table 4	Monitoring well Network Statistics (01-01-2005 through 06-30-2016)
Table 5	Chloride Field Analysis from 2015 Sampling Event
Table 6	Well Construction Information for 2016 FY Well Installation and Acquired Wells

## **TABLES (continued)**

Table 7	Well Development Information for 2016 FY
Table 8	Well Repair Information for 2016 FY
Table 9	Automatic Water Level Recorders as of 6/30/2016
Table 10	Orange Well Net Monitoring Well Information
Table 11	Orange Well Net Network Statistics
Table 12	Guilford County Monitoring Well Information
Table 13	Guilford County Monitoring Well Network Statistics
Table 14	2017 FY Network Expansions
Table 15	Summary of Field Parameters

## **APPENDICES**

Appendix A	Well Construction Records
Appendix B	Ground Water Sampling Protocol

### Acknowledgements

The author would like to thank colleagues in the North Carolina Division of Water Resources, Ground Water Management Branch, for providing summaries for their area of expertise, lists of work conducted in the 2016 FY including well repair and well development, and/or photographs for this report. Thanks are extended to Nat Wilson and Gabrielle Chianese for their contribution to the Central Coastal Plain Capacity Use Area Section, Amy Keyworth for her contribution to the Water Quality Section and Mark Durway for his contribution to the Chloride Section of this report. In addition a special thanks to Barbara Peck and the Ground Water Monitoring Unit staff, Tony Butz, Danny Edwards, Kevin McVerry, and Aiken Small for their part in providing information and photographs and maps to be incorporated in this report. An extended thanks goes to Aiken Small for his continued assistance in data compilation and map production. A very special thanks to Nat Wilson for creating a website/database where all needed information and statistical information were easily accessed. In addition, gratitude and appreciation are extended to Nat Wilson for his patience, time, and review of this report.



## **1.0 Introduction**

The State of North Carolina (the State) relies on ground water for approximately 50 percent of its drinking (potable) water use. In addition, the State has thousands of agricultural and industrial ground water users. The North Carolina Department of Environmental Quality (DEQ), Division of Water Resources (DWR), and preceding agencies have operated, installed, and monitored a statewide monitoring well network from the 1960s to the present. The operation of this monitoring well network is an essential part of DWR's mission to ensure that the State has an adequate water supply for its citizens. Information collected quarterly from this well network include the following:

- Evaluating climatic influences on the State's ground water supply, including effects of drought and recharge-discharge relationships;
- Monitoring human-induced impacts on the State's ground water supply, particularly in the regional aquifer systems of the Coastal Plain physiographic province. These effects include local and regional water level declines as well as migration of the fresh water-salt water interface within various aquifers;
- Providing supporting data for enforcement and creation of current and future ground water usage regulations, such as the Central Coastal Plain Capacity Use Area rules;
- Periodic sampling of the monitoring well network to establish background levels for constituents (e.g. nitrates, etc.); and
- Providing high quality ground water data to local governments, ground water professionals, and the general public to use in making informed decisions in ground water related issues.

Data collected from the network are available to the public through DWR's internet website, [www.ncwater.org](http://www.ncwater.org). These data include ground water levels, chloride measurements, well construction information, borehole log construction (lithological and geophysical), ground water monitoring station locations, and geophysical/lithological data collection from non-DWR well sites.

## **2.0 Purpose and Scope**

The 2016 Annual Report summarizes field activities and conclusions derived from activities performed or associated with the Ground Water Management Branch during the July 1, 2015 through June 30, 2016 fiscal year (2016 FY). These activities include the ground water monitoring well network water level and water quality data statistics, monitoring well installations including new installations and acquired wells, monitoring equipment usage and evaluations, site surveys, local monitoring well network information, and a summary of the Central Coastal Plain Capacity Use Area 2016 FY activities.

## **3.0 Background**

DWR and its predecessor agencies have operated the statewide Ground Water Resource

Monitoring Program from the 1960s to the present. The active monitoring well network has expanded by approximately thirty-eight percent (251 monitoring wells) by either installation or acquisition of new monitoring wells since 1998.

The U.S. Geological Survey (USGS) has also contributed to the monitoring of the State's ground water resources under a cooperative agreement between the State of North Carolina and the Federal government. The cooperative well network consists of 12 monitoring wells, many of which are also part of the DWR statewide network.

#### 4.0 DWR Statewide Monitoring Well Network Overview

##### 4.1 Description

The monitoring well network currently consists of 650 wells at 224 monitoring stations (sites), divided into six regions, comprising 65 counties (Figure 1). There are 49 wells located in the Piedmont and Mountain physiographic provinces (Piedmont and Mountain) and 601 wells located in the Coastal Plain physiographic province (Coastal Plain). The Coastal Plain relies more heavily on ground water supplies than either the Piedmont or Mountains. Subsequently, ground water monitoring and research have been more concentrated in the Coastal Plain.

In the past few years, more resources have been invested in monitoring the Piedmont and Mountain ground water conditions to better understand the impact of drought cycles on ground water supplies and their contribution to surface water flow. There are 40 DWR wells within the monitoring well network used to assess drought conditions in the 2016 FY (Figure 2).



**Graingers Station, Q25D  
Lenoir County**



**Northside Elementary  
School Station, C34L  
Warren County**



**Bodie Island Station, K2E  
Dare County**



Of the 224 monitoring stations, 81 are on State or Federal property, 55 are located on property owned by local governments, 85 are located on private property through agreements with landowners, and 4 stations are located on properties where the landowner indicates that the land property ownership may change. In the past, some wells have been abandoned at the landowner's request due to changes in land use or ownership. Due to the high cost of well construction, combined with the fact that the wells are most valuable when they are monitored

continuously over a period of decades, every attempt is made to put new stations in secure, stable locations. A scale has been developed to rank new and existing well sites for potential well abandonment due to land-use issues in the future (Table 1). It is preferred that new wells be installed at sites with a susceptibility rating of 1 or 2.

#### 4.2 Monitoring

The statewide monitoring network is divided into six regions (Figure 1). One staff member is responsible for each region. Staff member responsibilities include visiting the wells quarterly to collect water level data, collecting data from drought wells monthly if needed, performing routine site maintenance, keeping automatic data recorders in working order, and keeping sites accessible and



**Video-logging  
Deep Creek Campground Station, O97L  
Swain County**



**Video-logging  
Stillwell Building, Q94J  
WCU Campus**



esthetically pleasing. Additional site activities (i.e. recorder removal/replacement, site maintenance, video-logging, etc.) are conducted on an as needed basis.

Depth to ground water level measurements are collected from the network in two different ways. Manual water levels are measured using electronic water level indicators. Hourly water level measurements are collected using unvented pressure transducers. Hourly water level data are extremely valuable in assessing aquifer recharge, impacts of large storms on ground water conditions, and delineation of aquifer boundaries. Manual water level readings and daily automatic recorder water level data are typically published on the DWR website. However, hourly data is available upon request for specific wells. Table 2 summarizes site and recorder distribution by region.

In addition to the recorders mentioned above, Solinst Telemetry System (STS) recording units have been installed in twelve wells that are included in the Drought Indicator Well network. They consist of one



**Manual Water Level Collection  
Comfort Station, U26J  
Jones County**



**STS System  
Hornets Nest, Q66C  
Mecklenberg County**

pressure transducer, one barometer, and are powered by a twelve-volt battery. Data is collected by a controller unit that stores hourly readings. The readings are sent to the home station (DWR web page server) every reporting interval (currently 3 hours) via a cell phone modem. DWR uses the STS system on the Drought Indicator Well network to take the place of monthly visits. They are serviced every quarter or semi-annually depending on battery life. The STS data is especially helpful in keeping the Drought Indicator well water levels up to date ([www.ncwater.org/?page=345](http://www.ncwater.org/?page=345)). [Table 3](#) summarizes STS system information.

Four additional STS systems were purchased in the 2016 FY and will be installed in September-October 2016 (2017 FY).

### 4.3 Chloride Sampling

Triennial chloride samples are collected from select wells in the Coastal Plain. The samples are analyzed using the Quantab® field method. Field results are used to monitor the migration of the fresh water-salt water interfaces in the Coastal Plain aquifers. Additional chloride samples are collected for field analyses when new monitoring wells are installed and as needed for special projects. The next chloride sampling event will occur September-October 2018. However, select wells will be sampled for chlorides in September-October 2017 to better assess salt water encroachment conditions in the 2018 triennial chloride sampling event. Section 5.2 summarizes the 2015 chloride sampling event.

## 5.0 **Well Network Statistics**

### 5.1 Ground Water Data Collection

Depth to ground water was measured in 645 wells in the 2016 FY. [Table 4](#) contains DWR monitoring well network statistics from January 1, 2005 through June 30, 2015. Statistics may vary in comparison to previous years due to additional data entry in the DWR database as older field books are scanned and unrecorded data entered. [Figure 3](#) compares the number of wells monitored to the water level data collected from the network from 1967 to present. Hourly water level data is not included in this graph. Calendar year 2015 represents the most water level data collected in any single year since starting the monitoring well network operation. The 2016 data was collected from July 1, 2015 through June 30, 2016.

Archived water level recorder charts obtained from DWR and its predecessor agencies, with records dating from the 1960s through 1980s, continue to be digitized and data recorded into the DWR online database. Additional continued digitized information recorded in the database includes, but is not limited to, well construction records, well development information, chloride sampling events, memorandums of agreement, and field notes.

### 5.2 Triennial Chloride Sampling

A triennial chloride sampling event was performed in 2015. Ground water from 258 wells within the network were sampled for chlorides using Quantab® chloride titrators between

August 24, 2015 through October 29, 2015. Field data were collected for pH, conductivity, and salinity using YSI® portable probes.

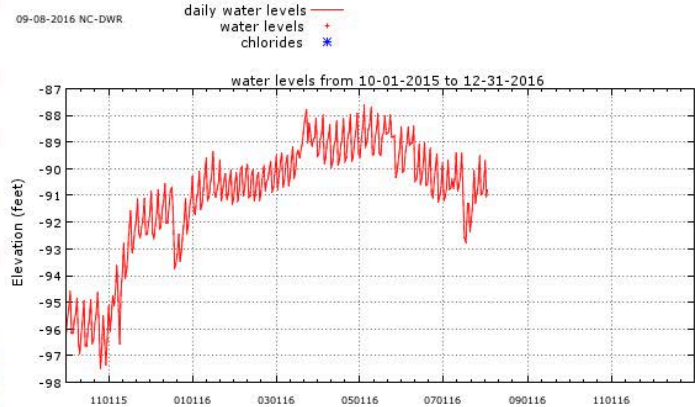
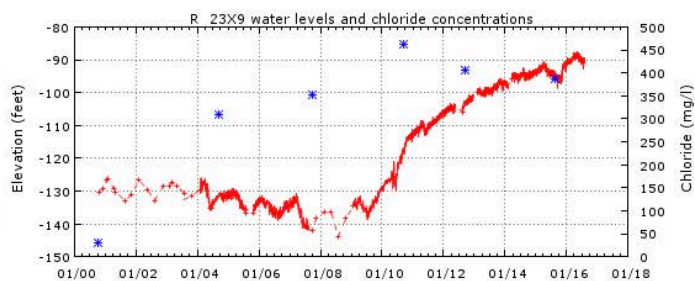
The intention of the triennial chloride sampling is to assess the position of the fresh water-salt water interface within each of the major coastal plain aquifers. Current results are compared to results of previous sampling events to evaluate potential landward migration of the fresh water-salt water interface due to aquifer overuse. Chloride sampling results are posted in the database and the DWR website. The following graph illustrates the typical database detail of parameters for a well hydrograph.

Field	Data
County	Craven
Quad <a href="#">link to framework</a>	R 23X9
Name <a href="#">link to logs</a>	Cove City
Latitude	35.172305
Longitude	-77.311178
Location Accuracy	GPS
Netname <small>(link to USGS data)</small>	
USGS ID	
Aquifer	Upper Cape Fear
Land Surface <small>NED elevation = 44.79 feet</small>	43.93
Date Constructed	09/29/2000
Measuring Point <small>(feet above land surface)</small>	2.85
Depth	869.00
Diameter	4.50
Yield	0.50
Exists?	y
Recorder Box?	y
Top of Screen	854.00
Bottom of Screen	864.00
Water Temperature <small>(degrees F)</small>	63.8
Number of Water Levels <small>(date * feet below land surface * elevation)</small>	3,815
<small>10/19/2000 to 08/03/2016</small>	** 999.99 feet below land surface value indicates dry well -222.22 feet above land surface value indicates a flowing well
Number of Chlorides <small>(date * chlorppm * sponcd_us/cm * satin_ppt * pH * comments)</small>	6
<small>10/04/2000 to 08/24/2015</small>	** -1 values equal no data ** a negative number other than -1 equals below detection limit of abs(number)

output files are tab-delimited text  
 NED = National Elevation Dataset, 1/3 arc second value  
 (-10 X 10 meter grid)

### DWR Monitoring Database Detail for R 23X9

[Show Map](#) -- [Monthly Statistics Plot](#) -- [Site Map](#) -- [Station Levels](#) -- [Water Levels vs. Withdrawals](#)



slope: +6.47 feet/year over this date range

Start Date:  End Date:

Hover over or click start and end date fields to change date range.

Sampling results indicate that there continues to be concern for salt-water encroachment, especially near larger pumping centers located near the fresh water-salt water interface (250 parts per million (ppm) chloride is considered salt water). The 2015 chloride field sampling results associated with wells near larger pumping centers illustrate these types of issues:

- Chloride concentrations from September 9, 2015 in the lower Castle Hayne aquifer well Q16G4 at the Godley Station continue to indicate salt water intrusion with levels of 554 ppm which exceed the 250 ppm threshold for salt



water. This station is located near PCS Phosphate Inc. at Aurora, NC in Beaufort County.

- Chloride concentrations from the Peedee aquifer well Y25Q4 at the Folkstone Station show an increase in chlorides from 227 ppm in September 2012 to 272 ppm on September 1, 2015 exceeding the 250 ppm threshold for salt water. Even though the September 12, 2012 results indicate levels below 250 ppm, samples collected July 9, 2011 (296 ppm), September 25, 2007 (252 ppm), and September 14, 2004 (266 ppm) each indicated chloride levels exceeding the 250 ppm threshold for salt water. This station is located near the ONWASA Dixon well field in Onslow County.



**Chloride Sampling Equipment**

- Chloride concentrations from the Upper Cape Fear aquifer well J22P5 at the Gold Point Station increased from 172 ppm on September 6, 2012 to 186 ppm on September 8, 2015. This station is located near the town of Robersonville in Martin County.

- Chloride concentrations from the Upper Cape Fear aquifer well R23X9 at the Cove City station in decreased from 405 ppm on September 11, 2013 to 388 ppm on August 24, 2015. The well still exceeds the 250 ppm threshold for salt water. This well is located near the town of Cove City, North Carolina.



**Quantab® Chloride Titrators**

Twenty samples were collected from the Cretaceous Lower Cape Fear Aquifer (Klcf). Field results indicate that between 2012 and 2015, Klcf chloride levels decreased in eleven of the twenty wells (Figure 4). The anomalous decreases may be in response to recent pumping

reductions within North Carolina's Central Coastal Plain Capacity Use Area and International Paper in Franklin, Virginia. This deviation from previous data trends is under investigation.

Table 5 summarizes the chloride field analysis to date for specific wells. Chloride sampling will take place in September and October 2018. However, select wells will be sampled for chlorides in September-October 2017 to better assess salt water encroachment conditions in the 2018 triennial chloride sampling event.

### 5.3 Well Installation and Development

From April 2016 through May 2016, the following monitoring wells were installed using the mud rotary drilling method:

- Holly Shelter Station, Pender County, four wells, Z29N1, Z29N2, Z29N3, and Z29N4; and
- Castle Hayne Park Station, New Hanover County, three wells, CC30E1, CC30E2, and CC30E3.

A pilot hole was advanced at the Holly Shelter Station, Pender County, and the Castle Hayne Park Station, New Hanover County. Each pilot hole was advanced using the mud rotary drilling method. Samples of the drill cuttings were collected at ten-foot intervals in order to assess the borehole lithology. In addition, a borehole geophysical log was obtained by lowering a probe into the borehole once the borehole was completed. The geophysical log makes a detailed record of the geologic formations in the borehole. Geophysical and lithologic log interpretation enabled



**Mud Rotary Drilling  
Castle Hayne Park Station, CC30E  
New Hanover County**



**Mud Rotary Drilling  
Calypso Station, S33C  
Duplin County**



the DWR staff to assess well screen intervals and the number of wells to be installed. The wells were installed using 4-inch PVC riser and 10 or 20 feet of 4 to 4.5-inch stainless steel continuous wire wrap V-slot screen. The wells were constructed of a gravel pack extending from the bottom of the screen to a minimum of five feet, but no more than ten feet, above the screen. A minimum of ten feet of bentonite overlays the top of the gravel pack in order to provide a sufficient bentonite seal in the well. [Table 6](#) summarizes the monitoring well construction information. These wells are included in [Figure 1](#). Well construction records for the 2016 FY installed wells are included in [Appendix A](#).



**Samples Collected from Drill Cuttings  
Holly Shelter Station, Z29N, Pender County**



**Well Development  
Holly Shelter Station, Z29N, Pender County**

Development removes fine-grained sediments from the vicinity of the well screen and ensures proper hydraulic connection with the aquifer. During development field data were collected for pH, conductivity, salinity, and temperature in thirty minute or hourly intervals. Field data exhibiting overall consistency was used to assist in the decision to stop well development. Monitoring wells developed in the 2016 FY are listed in [Table 7](#).

Chloride measurements were collected in each newly constructed monitoring well at the Holly Shelter Station after DWR well development in the 2016 FY. Although some development occurred after the Castle Hayne Park Station well drilling, DWR staff plans to further develop that station as well as redevelop several other existing monitoring wells in the 2017 FY.



**Well Development  
Nakina Station, EE390, Columbus County**





**Well Development  
Holly Shelter Station, Z29N  
Pender County**

#### 5.4 Well Maintenance

The well network requires continual maintenance to keep active monitoring stations usable. Many of the wells exceed 30 years in age and are constructed of materials that are susceptible to corrosion, especially in acidic or saline ground water conditions. Some older wells were constructed with outdated, less than desirable construction practices including backfilling boreholes with cuttings instead of neat cement or bentonite grout. Boreholes backfilled with cuttings form an inadequate seal and allow other aquifers to influence the water level and water quality in that well. Another outdated practice included well construction using telescoped casing. Telescoped casing uses a reducer to trim the well to a smaller diameter casing at depth apparently to save money during well construction. Telescoped wells are very susceptible to blockage at the depth of the reducer. Approximately 152 wells in the network were constructed with reducers. DWR has implemented a long-term program for replacing



**Corroded Well Casing in Need of  
Repair, East Lake Station, J7K, Dare  
County**



damaged or unsuitably constructed wells with new, properly constructed wells.

Wells repaired in the 2016 FY are listed in [Table 8](#).

### 5.5 Acquired Network Wells

DWR acquired eleven existing wells which were included into the monitoring well network in the 2016 FY. [Table 6](#) includes the detailed information about the acquired monitoring wells. These wells are also included in [Figure 1](#).



**Well Casing Repaired Using Flexible Rubber Boot, East Lake Station, J7K Dare County**



**Downloading Hobo data to Shuttle  
Cremo Station, F19V  
Bertie County**



**Hobo Including barometer, shuttle, and water level indicator  
Vaughan Elementary School Station  
C31Y, Warren County**



## 5.6 Automatic Water Level Recorders

Automatic water level recorders play an integral role in the DWR monitoring program. Hourly water level measurements are collected using unvented submersible pressure transducers.

They allow for economical collection of near-continuous data at remote well stations. Two primary recorders (Onset Computer's Hobo U20 and barometer, and STS) were utilized in the 2016 FY and are included in Table 2. Table 9 lists the recorders present on network wells on as of June 30, 2016. STS system photographs are included in Section 4.2.

## 5.7 Site Surveys

Concrete survey monuments continue to be installed at each of the 224 active monitoring well stations within the network. Monuments have been installed at 217 active stations and five of those stations have more than one monument. Monuments will be installed at seven stations in the Camp Lejeune military base in the 2017 FY.

All of the installed monuments, with the exception of the Holly Shelter and Castle Hayne Park stations, were surveyed using Survey Grade Global Positioning System (GPS) to calculate the most accurate horizontal and vertical location data possible. The monuments were surveyed during March, April, and December 2015 and a select number of sites were surveyed a second time in January 2016. DWR was unable to get elevations at three monitoring stations (New Lake M12L, Beach Grove School Field, M93L, and Woody Creek, M93R) due to the inability to acquire a satellite signal at the station's location. GPS surveying will be conducted again in the fall of the 2017 FY to provide a second set of



**Programming Hobo in the field  
Cremo Station, F19V  
Bertie County**



**Monument Installation  
Ragged Point Station, X25U, Onslow County**



horizontal and vertical data on selected monitoring well stations. Newly installed monitoring stations and Camp Lejeune stations where monuments have been installed will also be surveyed in the 2017 FY.

## 6.0 Local Monitoring Well Network Information

### 6.1 Orange County Monitoring Well Network

The creation of the Orange County Ground Water Observation Well Network, Orange Well Net (OWN), was proposed in May 2005. It was decided to utilize existing bedrock wells in lieu of installing new wells for monetary reasons. In March 2010, the OWN included six inactive bedrock wells for ground water data collection. In 2011, three regolith wells were added to the OWN as a result of a cooperative arrangement. In 2012, two bedrock wells, the Ray Road and Rocky Ridge wells were removed from the network and replaced with two bedrock wells, well 4D in Duke Forest and a well at the former Orange County 911 Center. The wells that were most recently added to the network are the Brumley East well, as the result of an agreement with the Triangle Land Conservancy, and the Duke Forest 4S and 4I wells, with the agreement (informal) of DWR and Duke Forest. [Table 10](#) summarizes the OWN well information. [Figure 5](#) is a map of the OWN well locations.

Ground water data is collected periodically from the OWN. This data is collected to assess ground water availability and concerns locally in Orange County. The data is formatted and uploaded to the DWR ground water database and is available to the public. [Table 11](#) is a summary of the OWN statistics from March 2010 through June 30, 2016. The 2011, 2012, and 2013 OWN Annual



**Monument Installation  
Montford Point Station, X24E, Onslow County**



**Leveling  
Hadnot Station, X24S, Onslow County**

Reports are available on the DWR website. Tom Davis (Water Resources Coordinator for the Orange County Department of Environment, Agriculture, Parks and Recreation), the OWN Annuals Reports, and information provided by the DWR database, are the sources for the Orange County Monitoring Well Network information provided herein.

## 6.2 Guilford County Monitoring Well Network

The Guilford County ground water monitoring network was established in 2002 and includes eight monitoring well stations located on public properties owned by Guilford County or the City of Greensboro. Each well site was selected to represent an area of the county and to minimize the influence of any existing water supply wells nearby. Table 12 summarizes the Guilford County monitoring well information. In addition, NC A&T State University uses the Knox Road Station for their hydrology class and the students use the data from this station for their course project.

Water levels are collected manually on the same day of each month. Hourly data is collected using the Global Water WL16 submersible transducer and is downloaded at the time of manual collection of depth to ground water levels. The data is formatted and uploaded to the DWR ground water database and is available to the public.

Table 13 summarizes the Guilford County monitoring well statistics from 2008 through June 30, 2016. Figure 6 is a site map of the Guilford County monitoring well locations. Gene Mao (Guilford County Department of Health and Human Services, Division of Environmental Health, Health, Environment, & Risk Assessment Unit), and information obtained from the DWR database, are the sources for the Guilford County Monitoring Well Network information provided herein.

## 7.0 **Planned Activities**

### 7.1 New Well Installation

Monitoring well network expansion efforts for the 2017 FY will be focused on Pender, New Hanover, Onslow, and Sampson counties. Table 14 summarizes the potential upcoming expansion of the network in 2017 FY.

### 7.2 Well Abandonment

Some wells throughout the network that cannot be used due to bad construction, screening in multiple aquifers, etc., may be abandoned during the 2017 FY.



## 8.0 Water Quality

The Ground Water Management Branch added some ground water quality staff members in December 2015. Among the responsibilities of these employees is to comply with Tasks 5 & 6 of the North Carolina 2016 FY Workplan for the Clean Water Act Section 106 Groundwater Grant (EPA).

### Task 5 - Characterize the State's Ground Water Resources, and Task 6 - Groundwater Monitoring Program

The Division of Water Resources conducts an active program of ground water monitoring that advances the DWR mission by improving DWR's knowledge in the following areas:

- 1 Impacts of land-applied wastes, artificial infiltration practices, or other human activities, including:
  - Potential impacts of these activities on the surficial aquifer and the secondary impacts to the deeper aquifers or surface waters;
  - The occurrence of "emerging contaminants" related to these activities; and
  - Effectiveness of regulations and permits for these activities.
- 2 Threats to ground water quality, including:
  - The existence, nature, and scope of emerging or existing threats;
  - Assessment of the causes and factors affecting naturally-occurring contamination, agricultural contamination, or contamination resulting from activities permitted by DWR; and
  - Tracking the status of ground water quality across the state.

The goal of all characterization, monitoring, and investigation efforts is to improve DWR's understanding of the causes and extent of problems, to minimize human exposure to contaminants, and identify areas where regulations or best management practices can be improved to prevent contamination from occurring.



**Water Quality Sampling Event  
Kinston Yards, Q27R  
Lenoir County**



**Water Quality Sampling Event  
Kinston Yards, Q27R  
Lenoir County**



The state has an extensive network of ground water monitoring stations which can be utilized as an ambient ground water monitoring network. Prior to December 2015, the Piedmont-Mountain Resource Evaluation Program sampled wells annually from a well network installed and constructed for the purpose of characterizing the relationship of water quality to underlying geology in the Piedmont and Mountain physiographic provinces. Less water quality monitoring occurred in the Coastal Plain in the last two decades.

The Ground Water Management Branch intends to collect samples from each active well in the statewide monitoring well network. In the 2016 FY, samples were collected from the Rose Hill, and Chinquapin monitoring stations in Duplin County, and the Six Runs, Halls, Turkey, and Ivanhoe monitoring stations in Sampson County. The samples were analyzed for the following parameters:



**Water Quality Sampling Event  
Kinston Yards, Q27R  
Lenoir County**

- Standard private well parameters – arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), fluoride (F), lead, (Pb) iron (Fe), magnesium (Mg), mercury (Hg), nitrates (NO<sub>3</sub>), selenium (Se), silver (Ag), sodium (Na), zinc (Zn), pH, and bacterial indicators;
- Ammonium (NH<sup>4</sup>), Total Kjeldahl Nitrogen (TKN), organic Nitrogen, and Phosphate (PO<sup>4</sup>);
- Volatile Organic Compounds (VOCs), and Pesticides (also consult with area agricultural experts on local practices);
- Major ions (Na, calcium (Ca), potassium (K), manganese (Mn), sulfate (SO<sup>4</sup>), (carbon trioxide (CO<sup>3</sup>), bicarbonate (HCO<sup>3</sup>) and chlorides (Cl);
- Metals
  - Dissolved (filtered in field) (geochemistry applications require dissolved metals)
  - Total (drinking water standards are based on total metals)
  - Cu and Zn, (in both swine permits and the standard private well suite)
  - Coal Ash Metals – this would incur only minor additional costs yet would increase our knowledge of naturally occurring contaminants of interest to the coal ash program.

- Note, at this time chromium analysis performed by the DWR lab is not sufficiently precise enough to satisfy coal ash program needs. Analysis for hexavalent chromium would need to be sent to a private lab at some cost.
  - Note, at this time the DWR lab analyzes for total vanadium. The 2L standard for vanadium (V) is under review and will probably be based on particular species of V, not total V.
- Field parameters
  - Specific Conductivity, pH, Dissolved Oxygen (DO), Temperature (<sup>0</sup>C), Oxidation-Reduction Potential (ORP)

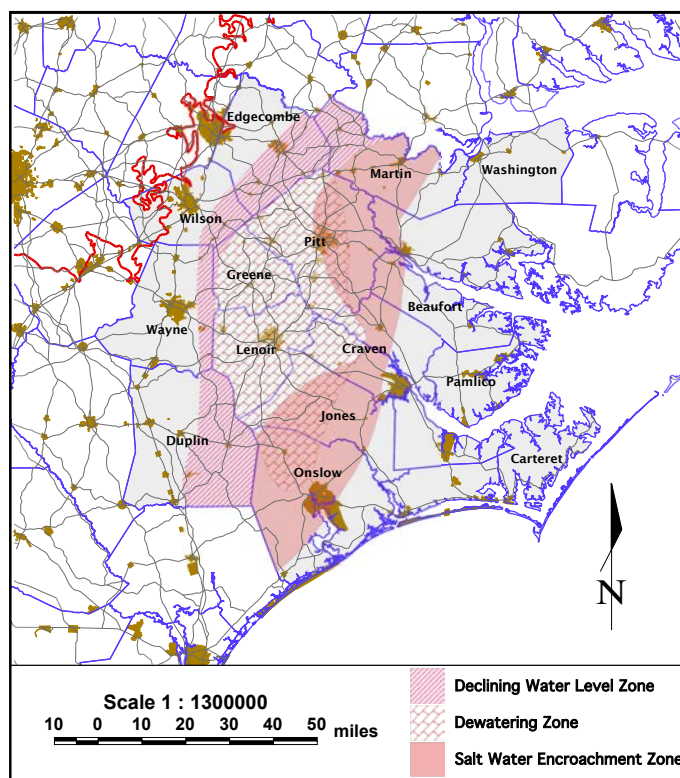
Analytical results will be presented in the forthcoming report "An Analysis of Water Quality in Division of Water Resources Network Wells in Sampson and Duplin Counties." A preliminary review of the data indicates no results of concern.

Ground water sampling protocol is included in [Appendix B](#). Field data information for the 2016 FY are included in [Table 15](#). Laboratory analytical results received for the 2016 FY are available upon request. In the 2017 FY, ground water samples will continue to be collected from wells in the monitoring well network and analyzed for the parameters referenced above. Analytical data will be available to the public through the DWR website in the 2017 FY.

## 9.0 Central Coastal Plain Capacity Use Area

The [Central Coastal Plain Capacity Use Area](#) (CCPCUA) is a 15-county region in the coastal plain that is an example of a water overuse situation. On August 1, 2002 the CCPCUA rules came into effect because of significant ground water depletion problems. As stated in 15A NCAC 2E .0501, "the intent of this Section [the CCPCUA rules] is to protect the long term productivity of aquifers within the designated area and to allow the use of ground water for beneficial uses at rates which do not exceed the recharge rate of the aquifers..." For many years, water was withdrawn from the deep confined aquifers, which are a primary source of water in the CCPCUA, at a rate that was greater than they were natural recharged. If this situation had been allowed to continue indefinitely, the aquifers

CCPCUA Cretaceous Aquifer Zones



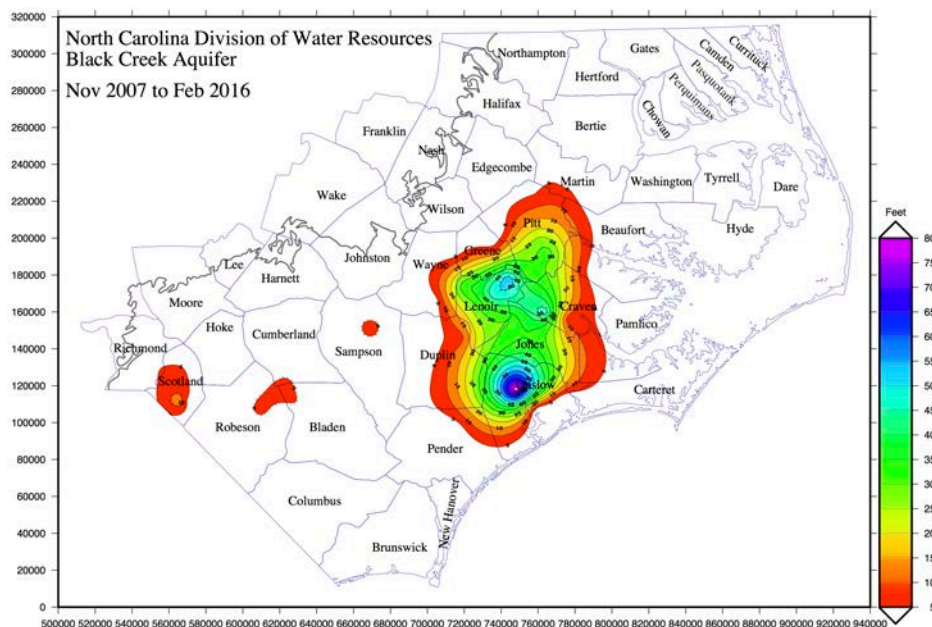
could have been permanently damaged, impairing their ability to function as a water supply.

The goal of the DWR is to regulate water withdrawals in the Central Coastal Plain (CCP) under the authority of the Environmental Management Commission (EMC). The following summarizes how these withdrawals are regulated:

- Water withdrawal permits are required for ground water users who withdraw greater than 100,000 gallons of water per day;
- Annual registration and reporting of withdrawals is required for surface and ground water withdrawals greater than 10,000 gallons per day;
- Counties included in the CCPCUA are Beaufort, Carteret, Craven, Duplin, Edgecombe, Greene, Jones, Lenoir, Martin, Onslow, Pamlico, Pitt, Washington, Wayne, and Wilson.

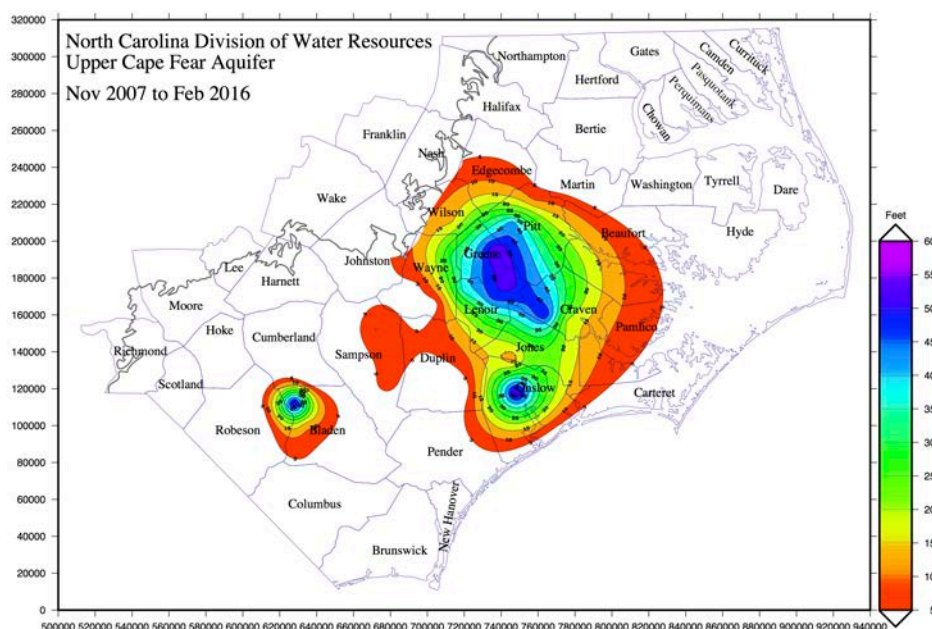
DWR collects depth to water level measurements and chloride sampling event data from monitor wells within the state’s well network and CCPCUA permitted wells to assess aquifer conditions. 15A NCAC 2E .0503 requires that DWR assess aquifer conditions in 2008, 2013 and 2018 to determine if CCPCUA rule changes are necessary. Through the CCPCUA permitting system, large ground water users (>100,000 gpd) in some parts of the capacity use area are required to progressively reduce withdrawals in 2008, 2013, and 2018 to allow the aquifers to recover. The managed withdrawals from these aquifers have allowed the aquifers to recover as depicted in the following recovery maps of the Upper Cape Fear Aquifer and the Black Creek Aquifer.

The map of the Black Creek Aquifer shows the areas where ground water levels have risen between 5 feet (red) to more than 75 feet (purple) from Nov. 2007 through Feb. 2016.





The map of the Upper Cape Fear Aquifer shows the areas where ground water levels have risen between 5 feet (red) to more than 55 feet (blue) from Nov. 2007 through Feb. 2016.



Based on analysis of water level and chloride concentration data gathered through January 2013 in the CCPCUA, and a thorough review of aquifer conditions, DWR concluded that no action needed to be taken by the EMC to alter either the reduction zone boundaries or rule language in 15A NCAC 2E .0503, but recommended the use of temporary permits under rule .0502. This may give certain permit holders a stable withdrawal rate which is higher than indicated by their reduction schedule and reduction zone, provided that all well construction and reporting criteria are met as specified in the 2013 CCPCUA Assessment Report.

DWR uses a series of criteria to judge each production well and aquifer conditions by individual permit in the permitting process. This enhanced permit application review allows the division to alter an individual permit holder’s reduction requirements if the permit holder can demonstrate they are using the ground water at a sustainable rate. As of September 2016, the following six permit holders have acquired temporary permits: Greene County Regional Water System, Town of La Grange, Belfast-Patetown Sanitary District, Northwestern Wayne Sanitary District, Southeastern Wayne Sanitary District, and Fork Township Sanitary District.

Although the CCPCUA rules require assessments to be produced in 2008, 2013, and 2018, the DWR staff will continue to constantly track aquifer conditions so as to best serve the permit holders in the region and to provide awareness of potential ground water supply issues. Another formal assessment will be conducted in 2018. Reports referencing the CCPCUA rules can be viewed by visiting the DWR website, [www.ncwater.org/CCPCUA](http://www.ncwater.org/CCPCUA).

## 10.0 Summary and Conclusions

DWR and its predecessor agencies have maintained and monitored a statewide network of ground water monitoring wells used to assess North Carolina's ground water supply since the 1960s.

Data collected from the monitoring well network are available to the public through DWR's Internet website, [www.ncwater.org](http://www.ncwater.org). These data include, but are not limited to, ground water levels, chloride measurements, well construction information, borehole log construction (lithological and geophysical), ground water monitoring station locations, and geophysical/lithological data collected from other (non-DWR) well sites.

The monitoring well network consists of 650 monitoring wells at 224 individual stations. From July 2015 through June 2016, ground water level data were collected from 645 wells within the network. These data include manual measurements taken quarterly from wells, plus hourly water levels collected using automatic data recorders from 508 wells.

Twelve STS systems have been installed as of 2016 FY on drought monitoring network wells. The addition of the STS systems replaces monthly site visits and improves the division's depiction of drought conditions. DWR intends to add four STS units in the 2017 fiscal year.

The triennial chloride sampling was performed on 258 wells in September-October 2015. Four additional samples were collected from the new well installation at Holly Shelter in June 2016. Sampling results indicated that there continues to be concern for saltwater encroachment especially near larger pumping centers located near the fresh-salt water interface. Decreases were observed in the Cretaceous, Lower Cape Fear aquifer in eleven of twenty wells. The anomalous decreases may be in response to recent pumping reductions within the CCPCUA and at International Paper in Franklin, Virginia. Triennial chloride sampling will occur again in September-October 2018.

Seven monitor wells have been installed at two different stations during the 2016 FY. Four monitoring wells were installed at Holly Shelter (Pender County) and three wells were installed at Castle Hayne Park (New Hanover County). At each site, borehole advancement, geophysical logging and well installation occurred. Chloride measurements were collected at Holly Shelter after well development by DWR. The Castle Hayne Park is scheduled for development and chloride sampling in the 2017 FY.

Eleven wells were acquired and added to the monitoring well network in the 2016 FY: Tater Hill, (E 76Q1 and E 76Q2) in Watauga County; Beach Grove School Field Well (M 93L1) and Woody Creek (M 93L1) in Haywood County; Oconaluftee Overlook (M 97S1), Smokemont Campground G1 (N 95G1), Smokemont Ranger Station (N 95G2), Clingmans Dome (N 97F1), and Deep Creek Campground (O 97L1) in Swain County; and CC Old Well (Q 94I1) and Stillwell Building (Q 94J1) in Jackson County.

No wells were abandoned during the 2016 FY.

There are two local networks whose water level data are currently being uploaded to the DWR database. The OWN in Orange County, and the Guilford County water level data can be viewed by the public on the DWR website.

Survey monuments continue to be installed at each of the well stations. Survey Grade GPS was performed on all active wells with installed monuments during the 2016 FY. Plans are to survey the newly installed stations, monuments installed at Camp Lejeune stations, and resurvey selected stations in the fall of the 2017 FY.

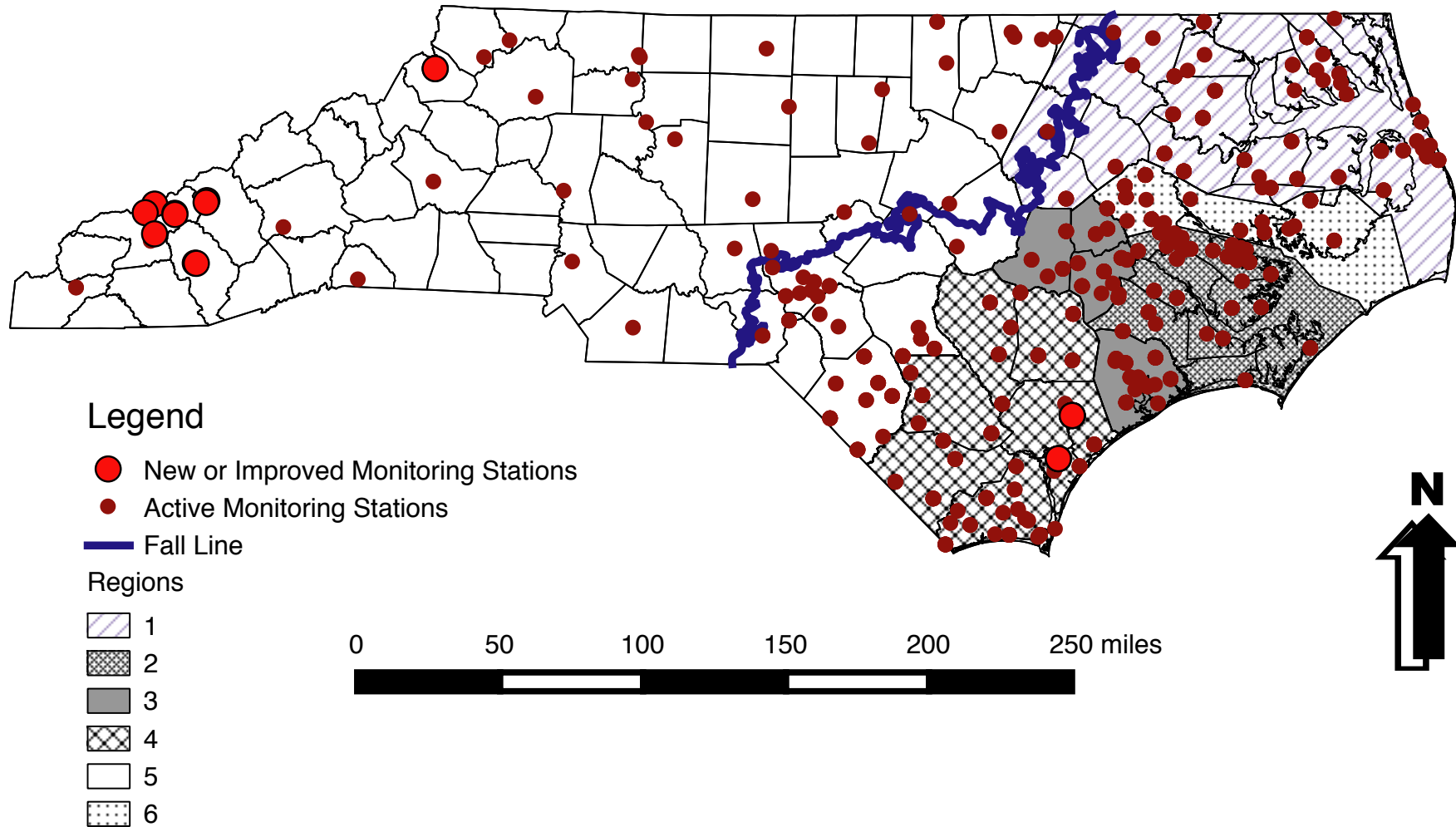
DWR has tentative plans to expand the monitoring well network by installing up to 23 wells at five sites in the 2017 FY.

Ground Water Management added ground water quality staff in December 2015. A main focus of these employees is to comply with Tasks 5 & 6 of the North Carolina 2016 FY workplan for the Clean Water Act Section 106 Ground Water Grant (EPA). Staff intends to collect samples from each active well in the statewide monitoring well network. In the 2016 FY, samples were collected from the Rose Hill, and Chinquapin monitoring stations in Duplin County, and the Six Runs, Halls, Turkey, and Ivanhoe monitoring stations in Sampson County. A preliminary review of the data indicates no results of concern.

Fifteen counties in the Central Coastal Plain are governed by the Central Coastal Plain Capacity Use Area rules. Data collected from the monitoring well network is being used to assess aquifer conditions and determine whether or not changes to the rules are warranted. Based on the results of the 2013 data assessment, DWR did not pursue rule changes. Instead, DWR is issuing temporary permits under rule .0502 which can ease withdrawal reduction requirements for certain permit holders, but adds other permit conditions.

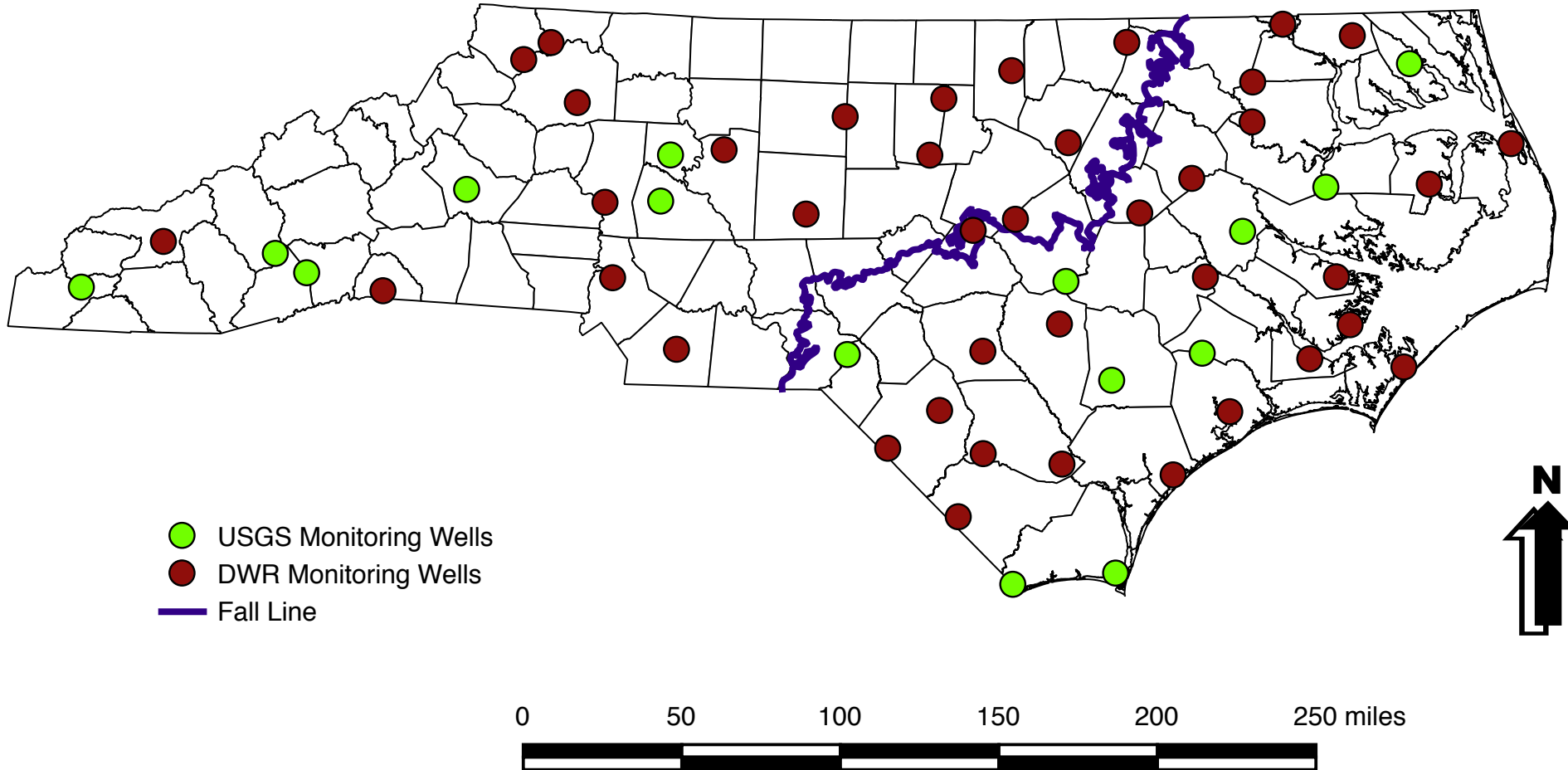
## **FIGURES**

# Figure 1: North Carolina Division of Water Resources Monitoring Stations June 2016



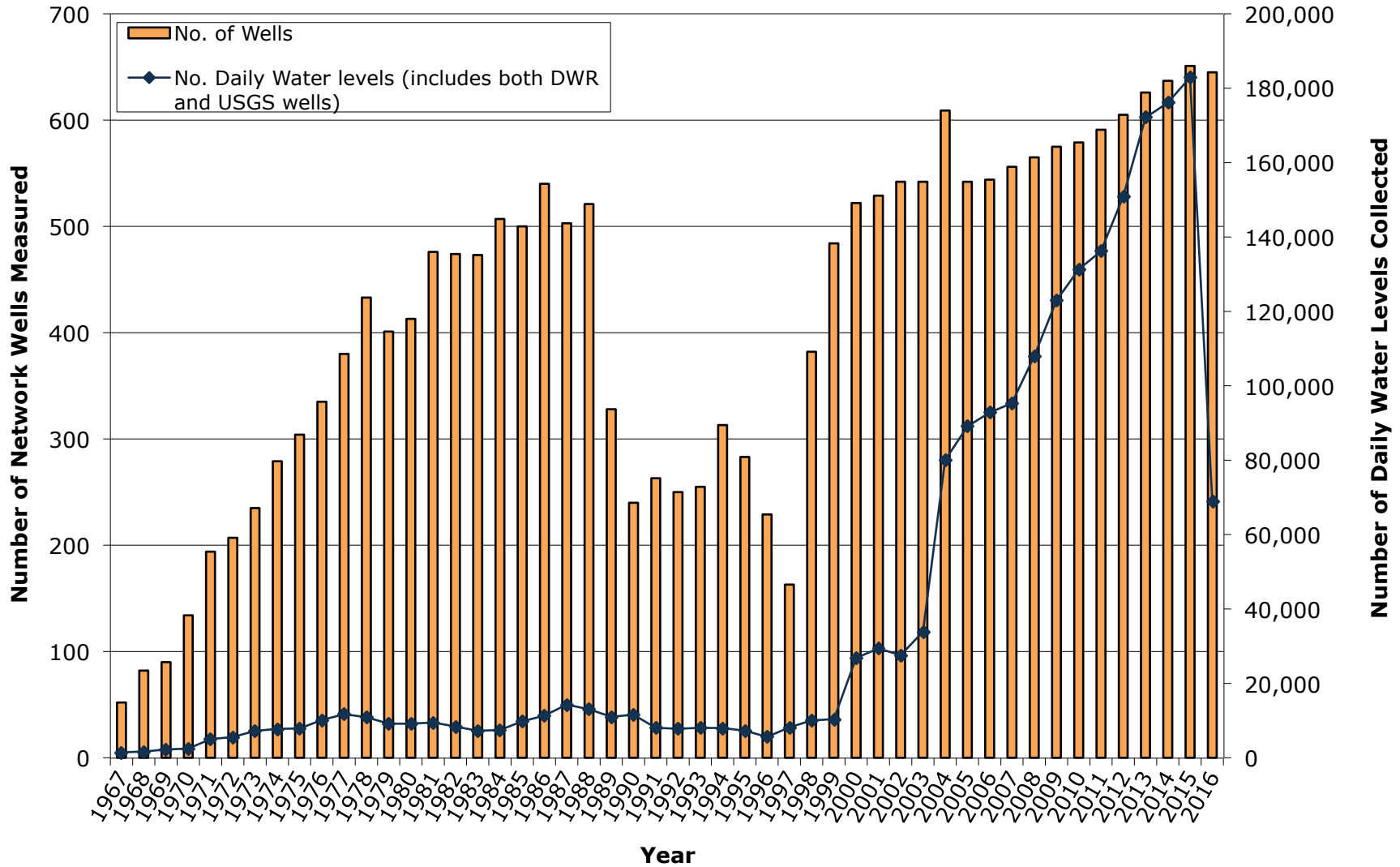


# Figure 2: Drought Indicator Wells



**FIGURE 3**

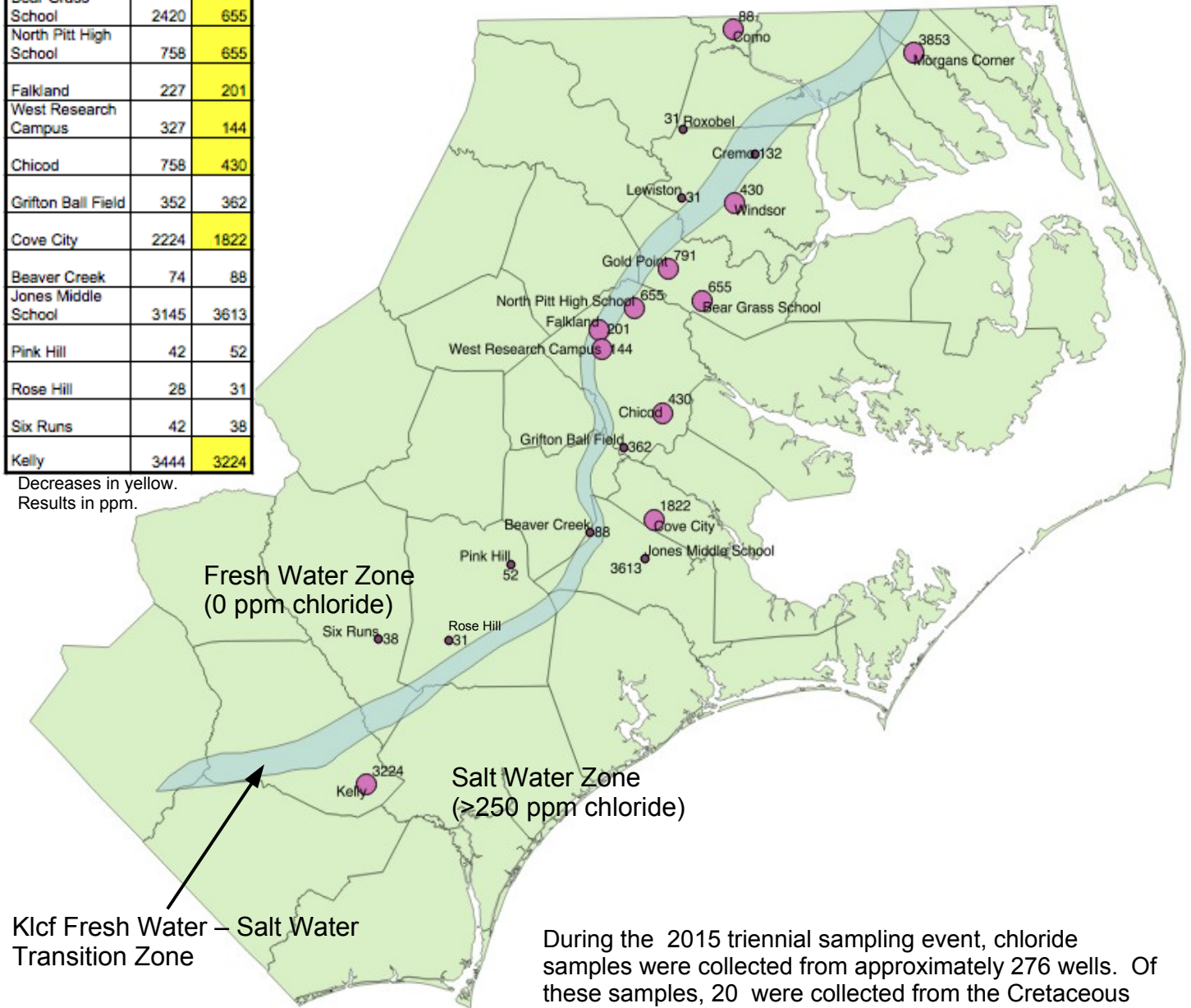
Water Level Data Collected from 1967-2016 (Plot includes both DWR and USGS Data)



MONITORING STATION	CHLORIDES	
	2012	2015
Como	93	88
Morgans Corner	5095	3853
Roxobel	28	31
Cremo	126	132
Lewiston	35	31
Windsor	1220	430
Gold Point	892	791
Bear Grass School	2420	655
North Pitt High School	758	655
Falkland	227	201
West Research Campus	327	144
Chicod	758	430
Griton Ball Field	352	362
Cove City	2224	1822
Beaver Creek	74	88
Jones Middle School	3145	3613
Pink Hill	42	52
Rose Hill	28	31
Six Runs	42	38
Kelly	3444	3224

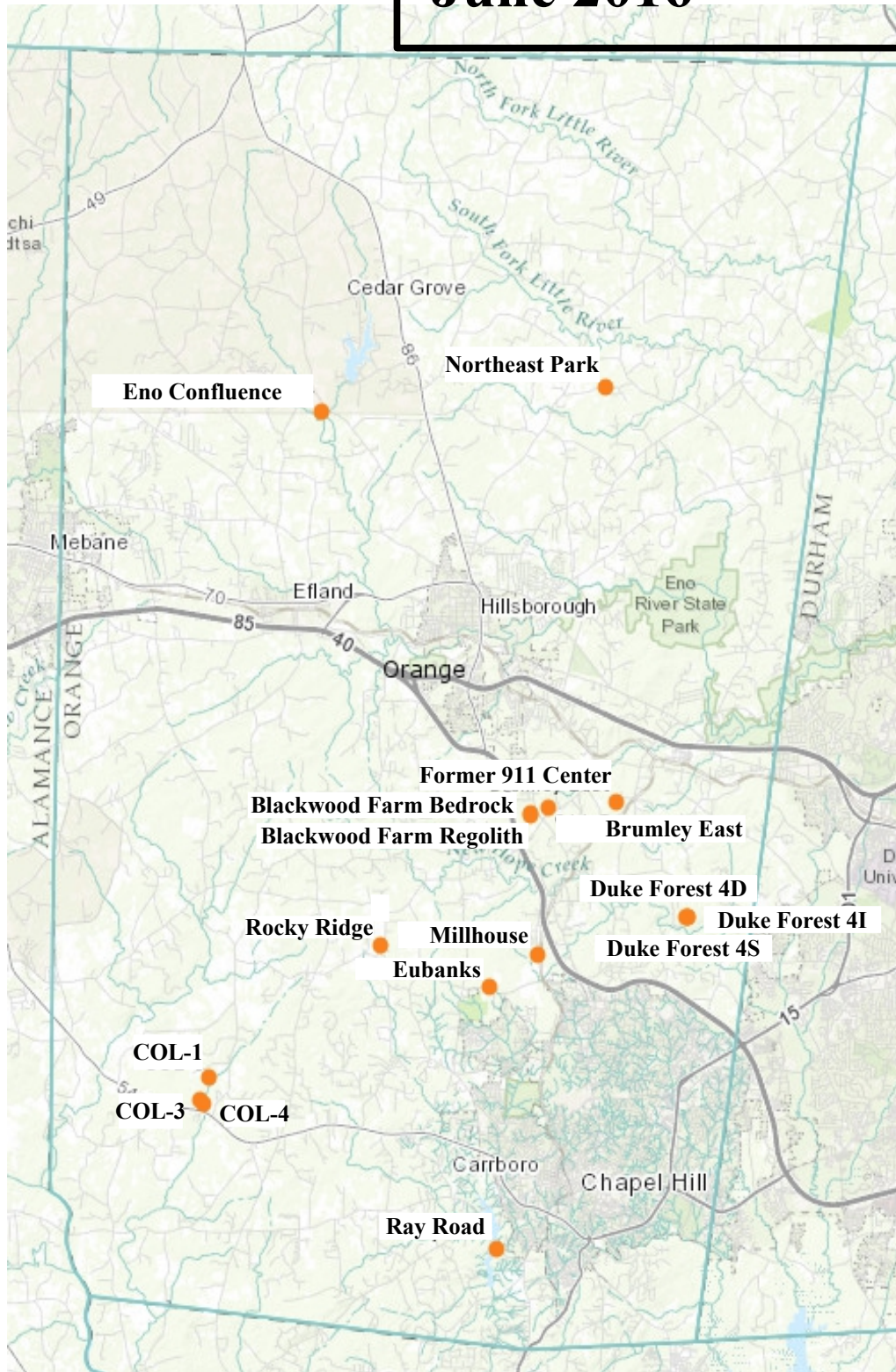
Decreases in yellow.  
Results in ppm.

# FIGURE 4 CHLORIDE DECREASES in the Cretaceous Lower Cape Fear Aquifer



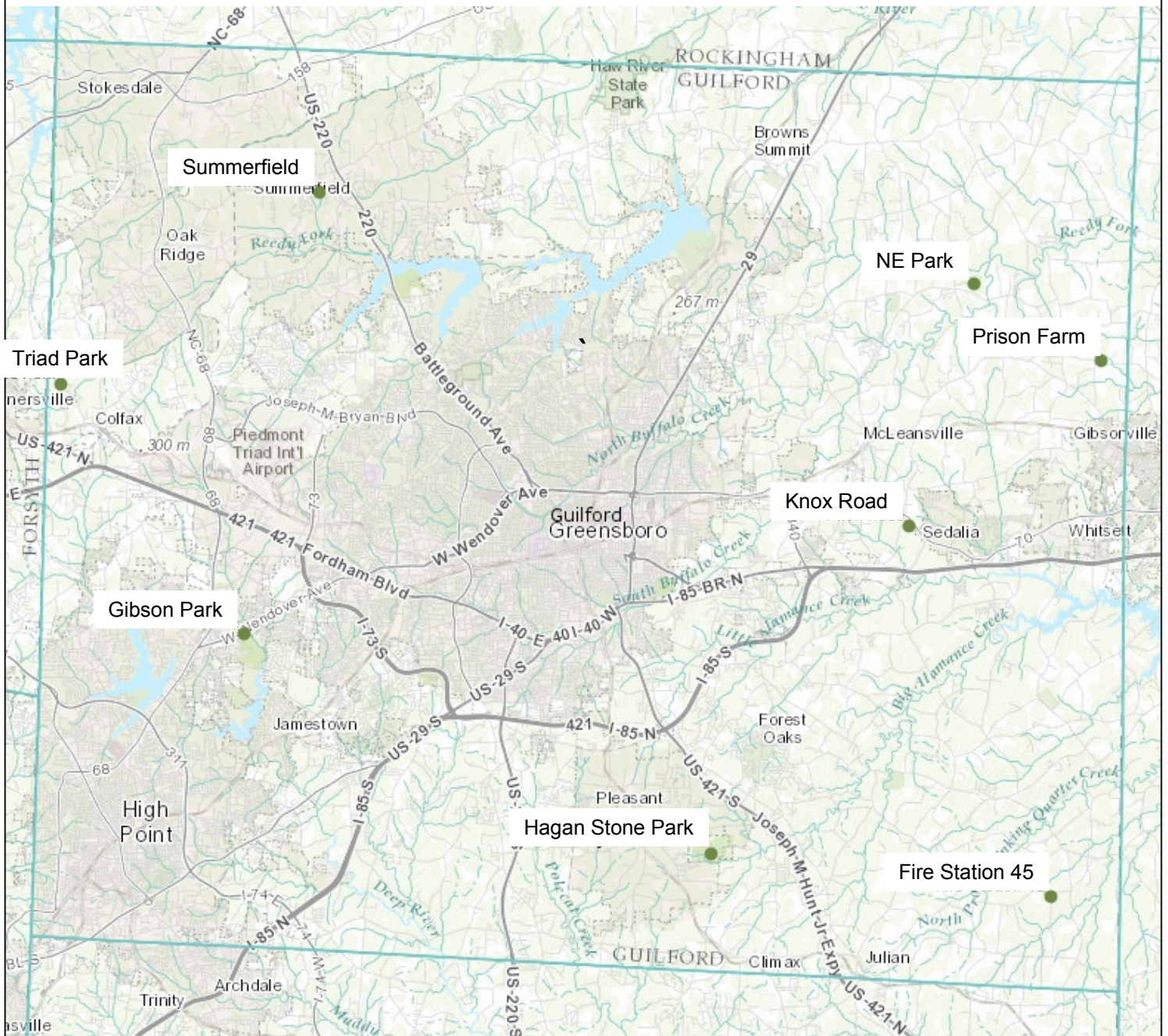
During the 2015 triennial sampling event, chloride samples were collected from approximately 276 wells. Of these samples, 20 were collected from the Cretaceous Lower Cape Fear Aquifer (Klcf). Testing showed that between 2012 and 2015, Klcf chloride levels decreased in eleven of the twenty wells. The anomalous decreases may be in response to recent pumping reductions within North Carolina's Central Coastal Plain Capacity Use Area and at International Paper in Franklin, Virginia. This deviation from previous data trends is under investigation.

# Figure 5 Site Map Orange Well Net Orange County June 2016





# Figure 6 Site Map Monitoring Well Network Guilford County June 2016



## **TABLES**

**TABLE 1**  
**Site Susceptibility Rating**  
**North Carolina Division of Water Resources**  
**Ground Water Management Branch**  
**2016 Annual Report**

Susceptibility Rating	Description
1	<b>Secure</b> —station is located on State or Federal government property
2	<b>Secure</b> —station is located on local government or school property
3	<b>Moderately secure</b> —station is located on private property, but landowner does not give any indication that land use or property ownership may change
4	<b>Tenuous</b> —station is located on public or private property and landowner is giving indications that land use or property ownership may change
5	<b>Imminent threat</b> —station is on public or private property and landowner desires abandonment of well station.

**TABLE 2**  
**Site and Recorder Distribution by Region as of 6/30/16**  
**North Carolina Division of Water Resources**  
**Ground Water Management Branch**  
**2016 Annual Report**

<b>Region</b>	<b>Parameter</b>	<b>Number</b>	<b>% of Region</b>	<b>% of Network</b>
1	Wells	138		21.2
	Sites	48		21.4
	Hobos	123	89.1	18.9
	All Recorders	123	89.1	18.9
2	Wells	142		21.8
	Sites	31		13.8
	Hobos	133	93.7	20.5
	All Recorders	133	93.7	20.5
3	Wells	94		14.5
	Sites	28		12.5
	Hobos	81	86.2	12.5
	All Recorders	81	86.2	12.5
4	Wells	140		21.5
	Sites	41		18.3
	Hobos	80	57.1	12.3
	All Recorders	80	57.1	12.3
5	Wells	96		14.8
	Sites	61		27.2
	Hobos	80	83.3	12.3
	All Recorders	80	83.3	12.3
6	Wells	40		6.2
	Sites	15		6.7
	Hobos	34	85.0	5.2
	All Recorders	34	85.0	5.2



**TABLE 3**  
**Solinst Telemetry System (STS) Distribution by Region as of 6/30/16**  
**North Carolina Division of Water Resources**  
**Ground Water Management Branch**  
**2016 Annual Report**

<b>Region</b>	<b>Station Name</b>	<b>Well Number</b>	<b>Date Installed</b>
1	Lewiston	H22I3	6/20/2013
5	Bryson City	O97W2	2/18/2014
5	Columbus	R82I1	2/19/2014
5	Rowland	Z47R5	4/24/2014
4	Clarendon	DD42N1	4/24/2014
1	Manteo Airport	I4W5	6/4/2014
4	Topsail Beach	BB28J5	6/12/2014
5	NC Zoo	M53L1	6/19/2014
5	Monroe	U62A1	7/2/2014
5	Troutman	L67U2	8/27/2014
5	Hornets Nest	Q66C1	10/7/2014
1	Como	B20U8	10/14/2014

**TABLE 4**  
**Monitoring Well Network Statistics (01-01-2005 through 06-30-2016)**  
**North Carolina Division of Water Resources**  
**Ground Water Management Branch**  
**2016 Annual Report**

<b>Parameter</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
Number of monitored wells	542	544	556	565	575	579	591	605	626	637
Manual water levels (tapedowns)	2,633	2,744	2,627	2,468	2,558	2,911	2,628	2,955	3,269	2,706
Daily water levels (automatic recorders)	89,088	92,827	95,329	107,969	122,962	131,317	136,208	150,912	172,111	176,111
Total hourly water levels	2,141,368	2,229,355	2,294,909	2,593,630	2,961,371	3,163,188	3,276,496	3,622,891	4,128,993	4,225,684
Chloride Samples	17	22	175	12	17	251	21	274	13	10
Geophysical & lithologic logs at new stations	2	1	3	1	1	0	2	1	1	1

**TABLE 4 (Continued)**  
**Monitoring Well Network Statistics (01-01-2005 through 06-30-2016)**  
**North Carolina Division of Water Resources**  
**Ground Water Management Branch**  
**2016 Annual Report**

<b>Parameter</b>	<b>2015</b>	<b>2016</b>
Number of monitored wells	651	645
Manual water levels (tapedowns)	3,143	1,487
Daily water levels (automatic recorders)	182,907	68,886
Total hourly water levels	4,389,822	1,572,449
Chloride Samples	7	276
Geophysical & lithologic logs at new stations	2	2



<b>TABLE 5</b> <b>Chloride Field Analysis from 2015 Sampling Event</b> <b>Wells Q16G4, Y25Q4, J22P5 and R23X9</b> <b>North Carolina Division of Water Resources</b> <b>Ground Water Management Branch</b> <b>2016 Annual Report</b>		
<b>Station</b>	<b>Date</b>	<b>Chlorides (ppm)</b>
Godley Station Q16G4	09/09/2015	554
	09/21/2012	352
	10/04/2010	531
	10/01/2007	564
	09/15/2004	137
	10/07/1999	91
	07/14/1998	174
	02/23/1981	No Reading Available
Folkstone Station Y25Q4	09/01/2015	272
	09/12/2012	227
	07/09/2011	296
	09/25/2007	252
	09/14/2004	266
	10/12/1999	35
	08/06/1998	11
	09/25/1982	No Reading Available
Gold Point Station J22P5	09/08/2015	186
	09/06/2012	172
	10/04/2010	54
	09/24/2007	162
	09/30/2004	BDL of 28 **
	09/15/2004	BDL of 28
	06/10/2002	10
Cove City Station R23X9	08/24/2015	388
	09/11/2012	405
	09/20/2010	463
	10/05/2007	352
	09/13/2004	309
	10/04/2000	30
Chloride Level for Salt Water		250

\*\*Collected after well development

**TABLE 6  
Well Construction Information for 2016 FY Well Installation and Acquired Wells  
North Carolina Division of Water Resources  
Ground Water Management Branch  
2016 Annual Report**

Well ID	Station Name	Date Installed	Well Diameter (inches)	Well Depth (ft bls)	Screened Interval (x to y ft bls)	Measuring Pt. (MP) (ft)	Aquifer	Water Level Date Measured (from MP) (ft)
CC 30E1	Castle Hayne Park	05/11/2016	4	45	30-40	-	NDY	-
CC 30E2		05/17/2016	4	330	245-265	-	NDY	-
CC 30E3		05/17/2016	4	110	95-105	-	NDY	-
Z 29N1	Holly Shelter	04/25/2016	4	47	32-42	-	NDY	-
Z 29N2		05/04/2016	4	710	675-685	-	NDY	-
Z 29N3		05/04/2016	4	150	135-145	-	NDY	-
Z 29N4		05/11/2016	4	445	430-440	-	NDY	-
<b>Wells Construction Information for Wells Acquired in 2016 FY</b>								
E 76Q1	Tater Hill	8/13/2015*	6.25	350	27-350	2.80	Br	64.13 (05/02/2016)
E 76Q2	Tater Hill	8/13/2015*	4	40	20-40	3.25	Bs	32.91 (05-02-2016)
M 93L1	Beach Grove School Field Well	12/08/2015*	8	172	74-174	1.50	Br	5.55 (04/20/2016)
M 93R1	Woody Creek	12/08/2015*	8	70	35-70	1.73	Br	8.62 (04/20/2016)
M 97S1	Oconaluftee Overlook	12/08/2015*	6	50	24-50	1.25	Br	35.39 (05/04/2016)
N 95G1	Smokemont Campground G1	12/08/2015*	8	65	48-65	0.87	Br	8.62 (05/04/2016)
N 95G2	Smokemont Ranger Station	12/08/2015*	8	94	10-94	0.91	Br	11.68 (05/04/2016)
N 97F1	Clingmans Dome	12/08/2015*	6			0.34	Br	28.68 (05/04/2016)
O 97L1	Deep Creek Campground	12/08/2015*	8	112	24.5-112	0.67	Br	7.60 (05/04/2016)
Q 94I1	CC Old Well	01/29/2016*	4	21	1-21	2.70	Bs	5.99 (05/03/2016)
Q 94J1	Stillwell Building	01/29/2016*	4	201	85-201	2.16	Br	19.22 (05/03/2016)

NDY – Not Determined Yet

\* Date of start of water level collection

**TABLE 7  
Well Development Information for 2016 FY  
North Carolina Division of Water Resources  
Ground Water Management Branch  
2016 Annual Report**

<b>Well ID</b>	<b>Station Name</b>	<b>Date Developed</b>
Q30R1	Spring Creek Elementary School	07/06/2015 through 07/09/2015
Q30R2		
Q30R3		
Q30R4		
M97S1	Oconaluftee Overlook	03/07/2016
N95G1	Smokemont Campground G1	03/08/2016
N95G2	Smokemont Rangers Station	03/08/2016
M93R1	Woody Creek	04/13/2016
M93L1	Beach Grove School Field Well	04/14/2016
S35Q5	Halls	06/06/2016 through 06-08-2016
S35Q8		
S35Q9		
ZZ29N1	Holly Shelter	06/13/2016 through 06/15/2016
ZZ29N2		
ZZ29N3		
ZZ29N4		
Y34P3	Ivanhoe	06/29/2016
Y34P4		



**TABLE 8**  
**Well Repair Information for 2016 FY**  
**North Carolina Division of Water Resources**  
**Ground Water Management Branch**  
**2016 Annual Report**

<b>Well</b>	<b>Station</b>	<b>Date Repair Completed</b>	<b>Reason for repair</b>	<b>Specifics of Repair</b>
Y40G1	Dublin	7/30/15	Sink hole beside well	Sand was used to fill sink hole; water transported sand throughout hole to ensure all areas of the void were filled
V35T5	Six Runs	8/25/15	This is a flowing well that was leaking water due to a compromised valve fitting	The valve was capped off with a plug fitting
BB28J2	Topsail Beach	10/6/15	Base plate was rusted and the side rails of base plate had deteriorated	A new base plate was installed
BB28J4	Topsail Beach	10/6/15	Base plate was rusted and the side rails of base plate had deteriorated	A new base plate was installed
CC38B5	Lake Waccamaw	10/7/15	Concrete pad around the outer casing of well 5 had been compromised such that the outer casing had become loose and could be rocked back and forth	Existing concrete pad was removed and a new concrete pad was poured around the outer casing.
T29G4	Pink Hill	5/9/16	Base plate had been damaged	A locking cap and collar was installed in place of the shelter box and base plate
T29G5	Pink Hill	5/25/16	Base plate was rusted and the side rails of base plate had deteriorated	A new base plate was installed

<b>TABLE 9</b> <b>Automatic Water Level Recorders as of 6/30/2016</b> <b>North Carolina Division of Water Resources</b> <b>Ground Water Management Branch</b> <b>2016 Annual Report</b>	
<b>Recorder Type</b>	<b>Number in Service*</b>
HOBO U20 Water Level Logger (including separate barometer per station installed)	712 (includes 185 barometers)
Solinst Telemetry System (STS)	12

**\*As of June 30, 2016**

Note: Due to the large number of recorders employed by DWR, there are, at any given time, a number of units that are being serviced or replaced. These units are not reflected in the above totals.

**TABLE 10**  
**Orange Well Net Monitoring Well Information**  
**Orange County, NC**  
**North Carolina Division of Water Resources**  
**Ground Water Management Branch**  
**2016 Annual Report**

<b>Well No.</b>	<b>Well Name</b>	<b>Total Depth (ft bgs)</b>	<b>Casing Depth (ft bgs)</b>	<b>Top of Casing Elevation (ft)</b>	<b>Aquifer</b>	<b>Geology</b>
1	Millhouse Rd.	67	164.7	515.22	Br	Epiclastics
2	Eno Confluence Property	37	175.5	609.27	Br	Felsic Tuff
3	Former 911 Center	85	400	582**	Br	Altered Tuff
4	Blackwood Farm	100	302	557.44	Br	Felsic Lavas and Tuffs (Dacite)
5	Duke Forest 4D	85	400	427.82	Br	Felsic Plutonics
6	Duke Forest 4I	28.97	43.97	429.74	Br	Felsic Plutonics
7	Brumley East	108	605	-	Br	Mafic Lavas and Tuffs
8	Eubanks Road	33	145.7	531.15	Br	Mafic Intrusives (Gabbro)
9	Andrews Rd. (COL-1)	33	-	528	Bs	Felsic Tuff
10	Hwy 54 (COL-3)	43.7	-	528.18	Bs	Epiclastics
11	Orange Grove Rd (COL-4)	35.2	-	504.86	Bs	Epiclastics
12	Duke Forest DF-4S	17.9	-	428.81	Bs	Felsic Plutonics
13	Blackwood Farm (BFS)	45	-	556**	Bs	Felsic Lavas and Tuffs (Dacite)
14	Northeast Park (NES)	45	-	624**	Bs	Epiclastics

bgs – below ground surface

\* Ray Road Well – removed from network in 2012

\* Rocky Ridge Well – removed from network in 2012

\*\* Estimated Elevation



**TABLE 11**  
**Orange Well Net Network Statistics (2008 through 06-30-2016)**  
**North Carolina Division of Water Resources**  
**Ground Water Management Branch**  
**2016 Annual Report**

<b>Parameter</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>
Manual water levels (tapedowns)	3	18	49	68	59	54	52	75	43
Daily water levels (automatic recorders)	-	-	1,612	2,783	3,095	3,281	3,468	4,286	2,414
Total hourly water levels	-	-	38,802	66,689	74,065	78,636	83,090	102,643	57,630

**TABLE 12  
 Guilford County Monitoring Well Information  
 North Carolina Division of Water Resources  
 Ground Water Management Branch  
 2016 Annual Report**

<b>Station Name</b>	<b>Date Installed</b>	<b>Well Diameter (inches)</b>	<b>Well Depth (ft)</b>	<b>Screened interval (ft)</b>	<b>Aquifer</b>	<b>Measuring Point (MP) (ft)</b>	<b>Water Level Measured from MP (ft) Including Date Measured</b>
Gibson Park	04/15/2003	6.25	205	none	bedrock	2.2	24.20 (07/22/2015)
Hagan Stone Park	05/17/2003	6.125	100	none	bedrock	2.45	24.11 (07/22/2015)
Knox Road	10/09/2002	6.25	*	none	bedrock	1.8	22.39 (07/22/2015)
Prison Farm	05/14/2004	6.25	120	none	bedrock	3.0	15.03 (07/22/2015)
Station 45	12/15/2004	6.25	180	none	bedrock	2.8	27.09 (07/22/2015)
Summerfield	10/09/2002	6.25	103	none	bedrock	2.3	66.92 (07/22/2015)
Triad Park	10/02/2002	6.25	140	none	bedrock	1.7	35.05 (07/22/2015)
Northeast Park	06/24/2015	6.125	100	none	bedrock	2.2	18.64 (07/22/2015)

**TABLE 13**  
**Guilford County Monitoring Well Network Statistics (2005 through 06-30-2016)**  
**North Carolina Division of Water Resources**  
**Ground Water Management Branch**  
**2016 Annual Report**

<b>Parameter</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>
Number of monitored wells	6	7	7	7	7	7	7	7	7	7	8	8
Manual water levels (tapedowns)	-	28	14	28	35	77	77	56	63	49	69	39
Daily water levels (automatic recorders)	2,106	1,884	1,922	1,892	2,000	2,592	2,561	2,474	2,585	2,562	2,592	897
Total hourly water levels						3					36,415	21,594



<b>TABLE 14</b> <b>2017 FY Network Expansion</b> <b>North Carolina Division of Water Resources</b> <b>Ground Water Management Branch</b> <b>2016 Annual Report</b>			
<b>Station Name/Quad</b>	<b>County</b>	<b>Proposed New Well Screens (ft bls)</b>	<b>Aquifer</b>
		20-30	Surficial
		52-64	Peedee
Vicinity of Currie	Pender (Southern)	355-354	Black Creek
		602-612	Upper Cape Fear
		797-807	Lower Cape Fear
		819	Pilot Hole (Top of Basement)
		20-30	Surficial
Vicinity of		96-106	Castle Hayne
Myrtle Grove Rd and	New Hanover	163-173	Peedee
Indian Cove Ave.		490-500	Peedee (Salty)
		505	Pilot Hole (Top of Black Creek CU)
		20-30	Surficial
Vicinity of		86-96	Castle Hayne
River Park Rd.	New Hanover	119-129	Peedee
		460-470	Peedee (Salty)
		478	Pilot Hole (Top of Black Creek CU)
Wellfield 258	Onslow	720-730	Black Creek
		824-834	Upper Cape Fear
		20-30	Surficial
		82-92	Black Creek
Vicinity of Clinton	Sampson	256-266	Upper Cape Fear
		350-360	Lower Cape Fear
		430	Pilot Hole (Top of Basement)

<b>TABLE 15</b> <b>Summary of Field Parameters (Measured using a Hydrolab Quanta G)</b> <b>North Carolina Division of Water Resources</b> <b>Ground Water Management Branch</b> <b>2016 Annual Report</b>					
Station Name	Date	Dissolved Oxygen (ppmv or mg/L)	pH	Conductivity (mS/cm)	Temp °C
Chinquapin_W29D5	3/7/16	0.27	6.98	0.421	18.25
Halls_S35Q5	12/29/15	0.22	6.69	0.088	18.74
Halls_S35Q8	12/29/15	0.06	6.18	0.096	18.13
Halls_S35Q9	12/29/15	1.55	7.9	0.453	20.51
Ivanhoe_BLACKR@IVANHOE	3/15/16	6.3	7.09	0.108	20.55
Ivanhoe_Y34P2	3/15/16	0.08	8.05	0.08	17.76
Ivanhoe_Y34P3	3/10/16	0.21	6.89	0.273	17.86
Ivanhoe_Y34P4	1/14/16	0.14	9.38	0.895	17.05
Ivanhoe_Y34P7	1/14/16	0.07	7.51	0.424	17.8
Ivanhoe_Y34P9	1/14/16	0.09	8.15	1.88	19.82
RoseHill_V32V1	1/26/16	0.1	7.19	0.436	17.7
RoseHill_V32V10	2/18/16	0.23	7.89	0.325	18.94
RoseHill_V32V11	2/9/16	0.15	7.93	0.331	18.91
RoseHill_V32V3	3/29/16	0.18	7.07	0.494	16.91
RoseHill_V32V6	1/26/16	0.11	8.4	0.188	18.5
RoseHill_V32V9	1/26/16	5.32	4.44	0.667	14.56
SixRuns_V35T3	2/22/16	0.48	6.04	0.118	13.23
SixRuns_V35T4	2/22/16	0.05	8.57	0.43	17.19
SixRuns_V35T5	3/1/16	0.36	8.56	0.202	16.62
SixRuns_V35T6	2/22/16	0.19	8.58	0.198	16.09
SixRuns_V35T7	3/1/16	0.06	8.12	0.92	18.15
SixRuns_V35T8	3/1/16	0.1	8.7	0.207	17.8
SixRuns_V35T9	3/1/16	0.17	6.63	0.086	16.7
Turkey_U34B4	3/3/16	0.02	7.77	0.217	18.26
Turkey_U34B6	2/1/16	0.04	7.69	0.228	19.9
SpringCreek_Q30R2	6/9/16	0.08	6.1	0.056	19.6
SpringCreek_Q30R3	6/9/16	0.04	6.46	0.082	19.05
SpringCreek_Q30R4	6/21/16	3.54	4.72	0.059	19.53
Saulston_O30J4	6/29/16	0.56	4.69	0.034	19.34

## **APPENDICES**

**APPENDIX A**  
**WELL CONSTRUCTION RECORDS**



# WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

## 1. Well Contractor Information:

Jonathan Kamionka

Well Contractor Name

3465-A

NC Well Contractor Certification Number

Bill's Well Drilling Co.

Company Name

## 2. Well Construction Permit #:

List all applicable well permits (i.e. County, State, Variance, Injection, 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

### 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: 5-10-16 Well ID# Surficial

### 5a. Well Location:

NC-DENR

Holly Shelter Wildlife Boat Ramp

Facility/Owner Name

Facility ID# (if applicable)

7271 Shaw Hwy Burgaw, NC 28457

Physical Address, City, and Zip

Pender

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. Number of wells constructed: 1

For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

9. Total well depth below land surface: 47 (ft.)

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 4 (ft.)

If water level is above casing, use "+"

11. Borehole diameter: 9-7/8 (in.)

12. Well construction method: Mud Rotary

(i.e. auger, rotary, cable, direct push, etc.)

### FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) 10 Method of test: pump

13b. Disinfection type: HTH Amount: 1 CUP

For Internal Use ONLY:

### 14. WATER ZONES

FROM	TO	DESCRIPTION
32 ft.	42 ft.	sands
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.	32 ft.	4 in.	SDR17	PVC
42 ft.	47 ft.	4 in.	sch80	PVC

### 17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
32 ft.	42 ft.	4 in.	.020		SS
ft.	ft.	in.			

### 18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	25 ft.	bentonite	poured
ft.	ft.		
ft.	ft.		

### 19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
25 ft.	47 ft.	#3 gravel	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.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

### 21. REMARKS


### 22. Certification:

  
Signature of Certified Well Contractor

5-10-16

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 site details or well construction details. You may also attach additional pages if necessary.

### SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,  
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,  
1636 Mail Service Center, Raleigh, NC 27699-1636

### 24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed



# WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

## 1. Well Contractor Information:

Jonathan Kamionka

Well Contractor Name

3465-A

NC Well Contractor Certification Number

Bill's Well Drilling Co.

Company Name

## 2. Well Construction Permit #:

List all applicable well permits (i.e. County, State, Variance, Injection, 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

### 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: 5-6-16 Well ID# Black Creek

### 5a. Well Location:

NC-DENR

Holly Shelter Wildlife Boat Ramp

Facility/Owner Name

Facility ID# (if applicable)

7271 Shaw Hwy Burgaw, NC 28457

Physical Address, City, and Zip

Pender

County

Parcel Identification No. (PTN)

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. Number of wells constructed: 1

For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

9. Total well depth below land surface: 445 (ft.)  
For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 5 (ft.)  
If water level is above casing, use "+"

11. Borehole diameter: 9-7/8 (in.)

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

### FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) 20 Method of test: pump

13b. Disinfection type: HTH Amount: 1 cup

For Internal Use ONLY:

### 14. WATER ZONES

FROM	TO	DESCRIPTION
430 ft.	440 ft.	sands
ft.	ft.	

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

FROM	TO	DIAMETER	THICKNESS	MATERIAL
0 ft.	77 ft.	10 in.	sch80	PVC

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

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3 ft.	430 ft.	4.5 in.	SDR17	PVC
440 ft.	445 ft.	4 in.	sch80	PVC

### 17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
430 ft.	440 ft.	4 in.	.020		PVCSS
ft.	ft.	in.			

### 18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	410 ft.	bentonite	pumped
410 ft.	420 ft.	bentonite	poured
ft.	ft.		

### 19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
420 ft.	445 ft.	#3 gravel	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.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

### 21. REMARKS

### 22. Certification:

  
 Signature of Certified Well Contractor 5-6-16  
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 site details or well construction details. You may also attach additional pages if necessary.

### SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,  
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,  
1636 Mail Service Center, Raleigh, NC 27699-1636

### 24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed



# WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

## 1. Well Contractor Information:

Jonathan Kamionka

Well Contractor Name

3465-A

NC Well Contractor Certification Number

Bill's Well Drilling Co.

Company Name

## 2. Well Construction Permit #:

List all applicable well permits (i.e. County, State, Variance, Injection, 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

### 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: 5-9-16 Well ID# Peedee

### 5a. Well Location:

NC-DENR Holly Shelter Wildlife Boat Ramp

Facility/Owner Name Facility ID# (if applicable)

7271 Shaw Hwy Burgaw, NC 28457

Physical Address, City, and Zip

Pender

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. Number of wells constructed: 1

For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

9. Total well depth below land surface: 145 (ft.)

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 4 (ft.)

If water level is above casing, use "+"

11. Borehole diameter: 9-7/8 (in.)

12. Well construction method: Mud Rotary

(i.e. auger, rotary, cable, direct push, etc.)

### FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) 10 Method of test: pump

13b. Disinfection type: HTH Amount: 1 cup

For Internal Use ONLY:

### 14. WATER ZONES

FROM	TO	DESCRIPTION
130 ft.	140 ft.	sands
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.	130 ft.	4.5 in.	SDR17	PVC
140 ft.	145 ft.	4 in.	sch80	PVC

### 17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
130 ft.	140 ft.	4 in.	.020		PVC SS
ft.	ft.	in.			

### 18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0	110	bentonite	pumped
110	120	bentonite	poured
ft.	ft.		

### 19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
120	145	#3 gravel	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.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

### 21. REMARKS

### 22. Certification:

Signature of Certified Well Contractor [Signature] Date 5-9-16

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 site details or well construction details. You may also attach additional pages if necessary.

### SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,  
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,  
1636 Mail Service Center, Raleigh, NC 27699-1636

### 24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



# WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

## 1. Well Contractor Information:

Jonathan Kamionka

Well Contractor Name

3465-A

NC Well Contractor Certification Number

Bill's Well Drilling Co.

Company Name

## 2. Well Construction Permit #:

List all applicable well permits (i.e. County, State, Variance, Injection, 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

### 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: 5-4-16 Well ID# UpperCapeFear

### 5a. Well Location:

NC-DENR

Holly Shelter Wildlife Boat Ramp

Facility/Owner Name

Facility ID# (if applicable)

7271 Shaw Hwy Burgaw, NC 28457

Physical Address, City, and Zip

Pender

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. Number of wells constructed: 1

For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

9. Total well depth below land surface: 690 (ft.)

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 15 (ft.)

If water level is above casing, use "+"

11. Borehole diameter: 9-7/8 (in.)

12. Well construction method: Mud Rotary

(i.e. auger, rotary, cable, direct push, etc.)

### FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) 20 Method of test: pump

13b. Disinfection type: HTH Amount: 2 cup

For Internal Use ONLY:

### 14. WATER ZONES

FROM	TO	DESCRIPTION
675 ft.	685 ft.	sands
ft.	ft.	

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

FROM	TO	DIAMETER	THICKNESS	MATERIAL
0 ft.	64 ft.	10 in.	sch80	PVC

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

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3 ft.	675 ft.	4.5 in.	SDR17	PVC
685 ft.	690 ft.	4 in.	sch80	PVC

### 17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
675 ft.	685 ft.	4 in.	.020		PVC SS
ft.	ft.	in.			

### 18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	645 ft.	bentonite	pumped
645 ft.	660 ft.	bentonite	poured
ft.	ft.		

### 19. SAND/GRAVEL PACK (if applicable)

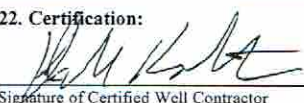
FROM	TO	MATERIAL	EMPLACEMENT METHOD
660 ft.	690 ft.	#3 gravel	poured
ft.	ft.		

### 20. DRILLING LOG (attach additional sheets if necessary)

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

### 21. REMARKS


### 22. Certification:



Signature of Certified Well Contractor

5-4-16

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 site details or well construction details. You may also attach additional pages if necessary.

### SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,  
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,  
1636 Mail Service Center, Raleigh, NC 27699-1636

### 24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.







# WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

## 1. Well Contractor Information:

Jonathan Kamionka

Well Contractor Name

3465-A

NC Well Contractor Certification Number

Bill's Well Drilling Co.

Company Name

## 2. Well Construction Permit #:

List all applicable well permits (i.e. County, State, Variance, Injection, 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

### 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: 5-17-16 Well ID# UpperCapeFear

### 5a. Well Location:

NC-DENR

Castle Hayne Park

Facility/Owner Name

Facility ID# (if applicable)

4700 Old Ave, Castle Hayne, NC 28429

Physical Address, City, and Zip

New Hanover

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. Number of wells constructed: 1

For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

9. Total well depth below land surface: 110 (ft.)

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 5 (ft.)

If water level is above casing, use "+"

11. Borehole diameter: 9-7/8 (in.)

12. Well construction method: Mud Rotary

(i.e. auger, rotary, cable, direct push, etc.)

### FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) 20 Method of test: pumping

13b. Disinfection type: HTH Amount: 1 cup

For Internal Use ONLY:

### 14. WATER ZONES

FROM	TO	DESCRIPTION
95 ft.	105 ft.	sands
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.	95 ft.	4.5 in.	SDR17	PVC
105 ft.	110 ft.	4 in.	sch80	PVC

### 17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
95 ft.	105 ft.	4 in.	.020		SS
ft.	ft.	in.			

### 18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	75 ft.	bentonite	pumped
75 ft.	85 ft.	bentonited	poured
ft.	ft.		

### 19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
65 ft.	110 ft.	#3 gravel	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.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

### 21. REMARKS

### 22. Certification:

Signature of Certified Well Contractor [Signature] Date 5-17-16

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 site details or well construction details. You may also attach additional pages if necessary.

### SUBMITTAL INSTRUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,  
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,  
1636 Mail Service Center, Raleigh, NC 27699-1636

### 24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



# WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

## 1. Well Contractor Information:

Jonathan Kamionka

Well Contractor Name

3465-A

NC Well Contractor Certification Number

Bill's Well Drilling Co.

Company Name

## 2. Well Construction Permit #:

List all applicable well permits (i.e. County, State, Variance, Injection, 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

### 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: 5-16-16 Well ID# #2

### 5a. Well Location:

NC-DENR

Castle Hayne Park

Facility/Owner Name

Facility ID# (if applicable)

4700 Old Ave, Castle Hayne, NC 28429

Physical Address, City, and Zip

New Hanover

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. Number of wells constructed: 1

For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

9. Total well depth below land surface: 270 (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: 9-7/8 (in.)

12. Well construction method: Mud Rotary

(i.e. auger, rotary, cable, direct push, etc.)

### FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) 1 Method of test: bail

13b. Disinfection type: HTH Amount: 1 CUP

For Internal Use ONLY:

### 14. WATER ZONES

FROM	TO	DESCRIPTION
245 ft.	265 ft.	sands
ft.	ft.	

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

FROM	TO	DIAMETER	THICKNESS	MATERIAL
0 ft.	65 ft.	10 in.	sch80	PVC

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

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3 ft.	245 ft.	4.5 in.	SDR17	PVC
265 ft.	270 ft.	4 in.	sch80	PVC

### 17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
245 ft.	265 ft.	4 in.	.020		SS
ft.	ft.	in.			

### 18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	225 ft.	bentonite	pumped
225 ft.	235 ft.	bentonited	poured
ft.	ft.		

### 19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
235 ft.	330 ft.	#3 gravel	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.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	

### 21. REMARKS

### 22. Certification:

  
Signature of Certified Well Contractor

5-16-16

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 site details or well construction details. You may also attach additional pages if necessary.

### SUBMITTAL INSTRUCTIONS

24a. **For All Wells:** Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,  
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. **For Injection Wells ONLY:** In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,  
1636 Mail Service Center, Raleigh, NC 27699-1636

### 24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.

**APPENDIX B**

**GROUND WATER SAMPLING PROTOCOL**



## Ground Water Sampling Protocol

Samples for the ambient monitoring program were collected in accordance with DWR procedures outlines in NCDWQ/APS 2006 in order to ensure that high quality, defensible data was collected. To ensure that only newly recharged ground water was being sampled, wells were pumped until three well volumes had been removed. Where a well's total volume was too high to feasibly pump out three volumes, wells were purged until water quality parameters that can be measured in the field (temperature, pH, specific conductance, and dissolved oxygen) stabilized. Both submersible and peristaltic pumps were used in the field at the sampler's discretion depending on the total depth of the well and the hydraulic head difference to be overcome. To prevent contamination introduced while sampling, nitrile gloves were worn during all sampling events. Pumps were decontaminated after each use. In addition, blanks and duplicate samples were collected to provide quality assurance information. Trip blanks were collected for each sampling trip, and equipment blanks were collected for each pump. Duplicate well samples were collected at 10% of all wells sampled.

The ground water was analyzed for a broad suite of water quality and water chemistry parameters. Data from the ambient monitoring program may be used to characterize ground water throughout the state as well as to address the concerns other programs and projects. Some examples of concerns within programs in DWR are saltwater intrusion due to over-pumping, the source of organic nitrogen found in surface water bodies, the impact of concentrated farming activities on drinking water supplies, and the levels of naturally occurring contaminants such as metals. Since most of these wells are somewhat geographically isolated from human activities, the water collected is more likely to represent ambient conditions and not contamination.

<b>Table of Sampling Parameters</b>	
<b>Parameter Group</b>	<b>Parameters</b>
Private Well Analytes (15A NCAC 18A .3803)	arsenic, barium, cadmium, chromium, copper, fluoride, lead, iron, magnesium, manganese, mercury, nitrate, nitrite, selenium, silver, sodium, zinc, pH
Nutrients*	Ammonia, total kjeldahl nitrogen, organic nitrogen, phosphorus
Metals (Dissolved and Total)*	Aluminum, antimony, beryllium, boron, calcium, cobalt, lithium, molybdenum, nickel, potassium, strontium, thallium, tin, titanium, vanadium
Major Ions	Bromide, chloride, fluoride, sulfate, carbonate, bicarbonate
Field Parameters	Specific conductivity, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature
Organic Compounds	Volatile organic compounds, Semi-volatile organic compounds, Pesticides
Other	Alkalinity, total organic carbon, turbidity, total dissolved solids, silica, sulfide

\*In addition to those required by 15A NCAC 18A .3803

References:

DCDWQ/APS, 2006, Quality Assurance/Quality Control and Standard Operating Procedures Manual for Sample Collection, December 2006

15A NCAC 18A Section .3800 - Private Drinking Water Well Sampling, .3803 - Sample Analysis