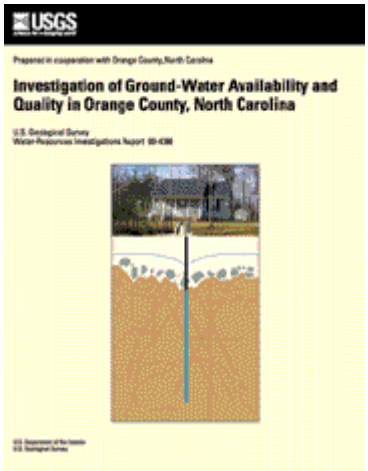
Department *of* Environment,
Agriculture, Parks & Recreation

2011 Annual Report

Orange Well Net

The Orange County Groundwater Observation Well Network

April 2011



2001 USGS report: *Investigation of Ground-Water Availability and Quality in Orange County, North Carolina.*

Introduction

In May 2005, the adopted Water Resources Initiative proposed the creation of a groundwater observation well network to continue the work of the previous decade of groundwater research in Orange County, and provide a network for the collection of information on local groundwater quality and quantity.

The goals of the network involve the utilization of a combination of bedrock and regolith wells spread across the nine main types of generalized bedrock geology present in Orange County. Regolith wells, completed in the unconsolidated material present above bedrock in the subsurface, are designed to monitor natural stresses on the quantity of groundwater available in storage which are caused by variations in climatic conditions. Bedrock wells are utilized to monitor changes in groundwater levels in the bedrock across the county. Taken together, the network, now called Orange Well Net, is designed to collect information concerning the amount of groundwater available locally in Orange County.

Project Progress

Early in the project, a decision was made to focus on the identification and utilization of existing bedrock wells instead of incurring the expense of installing new wells. Down hole video examination of several out-of-use supply wells was completed by County staff as a means of inexpensively determining the suitability of the well construction. Following a fairly extensive search and evaluation process, six bedrock water supply wells were determined to be suitable to use as relatively inexpensive observation wells. Three of the six wells are located on County-owned property. Memoranda of Agreement were completed with outside entities covering the long-term use of three wells located on private property. Staff secured the well heads at each of the six bedrock wells and the required downhole instrumentation, pressure transducers and data loggers, were subsequently deployed in each of the six wells.

Groundwater level data collection began at each of the six bedrock wells in late March 2010. Table 1 lists the well construction details for the six bedrock wells now included in Orange Well Net. Figure 1 illustrates the locations of these six wells.

Table 1. Orange Well Net Bedrock Well Details.

Bedrock Well Location	Casing Depth, ft.	Total Depth, ft.	Generalized Bedrock Geology
Millhouse Road	67	166	Epiclastics
Eno Confluence	37	~192	Felsic tuff
Rocky Ridge	67	560	Felsic lavas and tuffs (Dacite) [1]
Blackwood Farm	100	302	Felsic lavas and tuffs (Dacite)
Ray Road	21	~237	Felsic plutonics— East Farrington Granite [2]
Eubanks Road	33	~141	Mafic plutonics (Gabbro)

1—Main bedrock lithology in Orange County, by area
2—Younger pluton, which may yield higher radon concentrations

Instrumentation Used to Measure Groundwater Levels in Orange Well Net Bedrock Well.

Staff periodically downloads groundwater level data from each of the six bedrock observation wells now included in Orange Well Net. The collected data is formatted and then uploaded to the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Water Resources (DWR) groundwater level database web site:

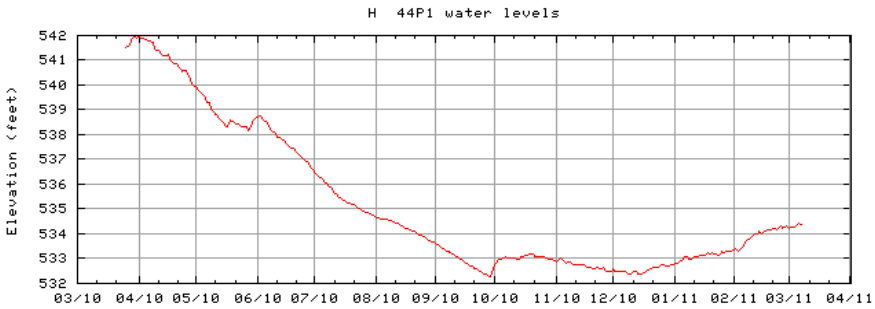
http://www.ncwater.org/Data_and_Modeling/Ground_Water_Databases/leveltable.php?tl=1&net=orange&inactive=

This web site is available to the general public and includes significant information regarding groundwater level conditions across North Carolina, and now includes the information collected from Orange Well Net.

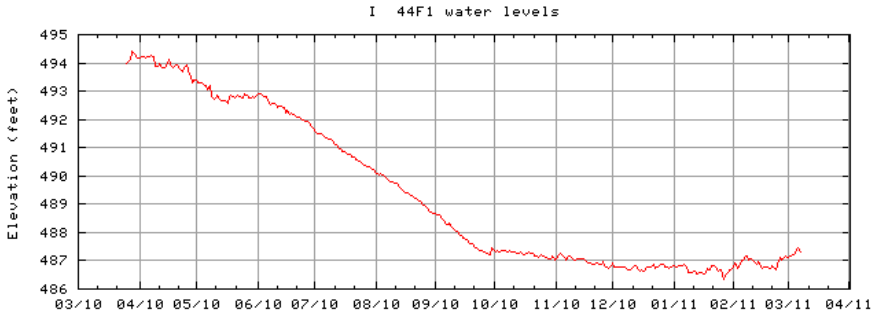
Groundwater Level Data

The groundwater level information collected from each of the six bedrock observation wells can be viewed at the above listed web site. The hydrographs, or groundwater level records, available at the DWR web site listed above and covering the period from late March 2010 through early March 2011 are provided below.

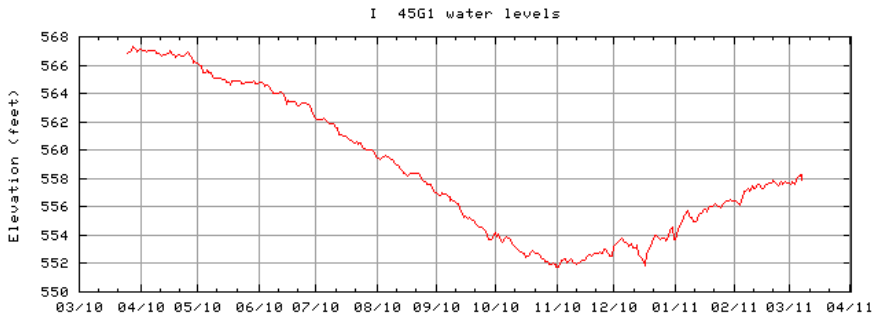
Blackwood Farm Well Hydrograph:



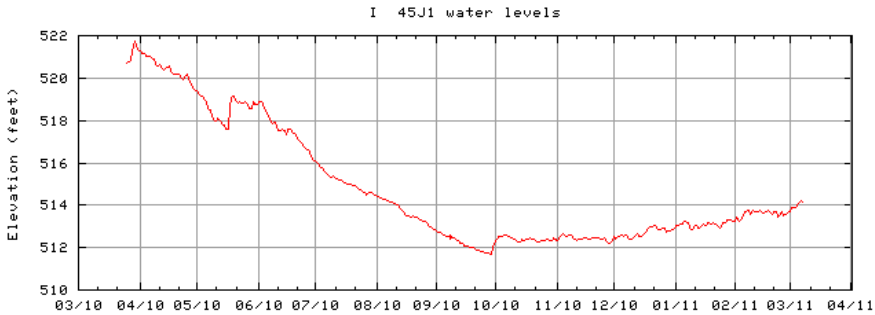
Millhouse Road Well Hydrograph:



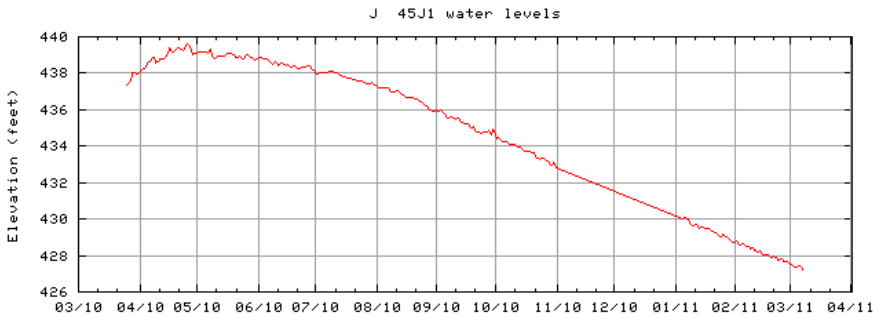
Rocky Ridge Road Well Hydrograph:



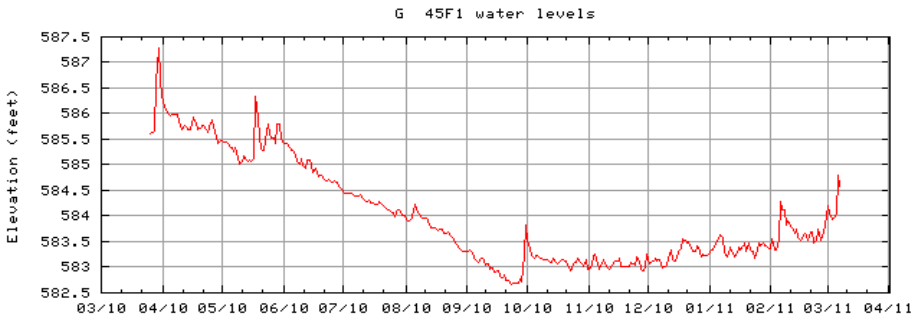
Eubanks Road Well Hydrograph:



Ray Road Well Hydrograph:



Eno Confluence Property Hydrograph:



Data Summary

Groundwater levels consistently decreased in all six observation wells throughout the 2010 growing season (April through October). Specifically, the Blackwood Farm observation well experienced a groundwater level decrease of nearly ten feet from April through October 2010. The groundwater level in the Millhouse Road well fell nearly seven feet during the same time interval. The Rocky Ridge observation well experienced a decrease of fifteen feet between April and November 2010. The groundwater level in the Eubanks Road well decreased approximately ten feet from April through October 2010. The observation well located in southern Orange County on Ray Road experienced a decrease in groundwater level of twelve feet from May 2010 through March 2011. Finally, the groundwater level in the Eno Confluence well decreased nearly five feet from April through late September 2010.

The collected data also shows that as of late March 2011, only a minor increase in groundwater levels has occurred in five of the six bedrock wells since Fall 2010. The groundwater level in the Ray Road well has continued to decline through the end of the current data record in early March 2011.

Discussion

Typically, groundwater levels decrease during the months of the growing season, due to a reduction in groundwater recharge. Groundwater recharge is reduced in part due to increased evaporation as a result of higher ambient temperatures. Another important factor is the increased use of water by plants during the growing season (transpiration). These factors typically result in significantly lower groundwater levels during the summer months in North Carolina and elsewhere in the Northern Hemisphere. The non-growing season, November through March, is the period during which significant groundwater recharge typically occurs. Groundwater recharge takes place when precipitation infiltrates into the ground and reaches the water table, rather than runoff, evaporate, or get used by plant life. This infiltration increases the amount of groundwater held in storage, raising groundwater levels in the regolith (upper) aquifer and then the underlying bedrock aquifer. Typically this recharge is then available for use during the subsequent growing season. Periods of drought or dry weather can of course reduce recharge which could then impact the amount of groundwater available during the growing season.

The groundwater hydrographs included herein are indicative of such a dry interval in Orange County. Dry hydrologic conditions have prevailed over the last twelve to fifteen months in the North Carolina Piedmont. According to information posted on the Orange Water and Sewer Authority (OWASA) web site, as of March 31, 2011, 35.97 inches of precipitation fell in the previous twelve months at their Carrboro location, while the average annual precipitation in Carrboro is 45.86 inches. According to the WRAL-TV web site, the fifty year annual average rainfall total for the Raleigh Durham International Airport is 42.53 inches, while the 2010 total was approximately 37 inches. Figure 2 presents monthly percent of normal precipitation figures for 2011 from the NC State Climate Office. This information illustrates that Orange County has experienced a decrease in the typical amount of precipitation in the last twelve to fifteen months.

One consequence of the recent decrease in precipitation in Orange County is a reduction in the amount of water available to recharge groundwater. The limited amount of groundwater recharge which has taken place since the 2010 growing season is demonstrated by the observation well hydrographs presented above. These records clearly show that groundwater levels are significantly lower in early 2011 than they were in early 2010, indicating a noticeable decrease in recharge. This may be of importance during the remainder of 2011 if dry conditions continue through the growing season. Once a greater amount of precipitation begins to occur, a time lag will pass before infiltration begins to reach the bedrock water table. As a result, it may take some time for an increase in precipitation, once it occurs, to raise groundwater levels in the Orange Well Net observation wells.

It is important to note that further analysis of groundwater trends is constrained by the limited amount of data which has been collected to date. Groundwater level monitoring is a long-term process. United States Geological Survey (USGS) Circular 1217, entitled *Ground-Water-Level Monitoring and the Importance of Long-Term Water-Level Data* (2003) states; “Typically, collection of water-level data over one or more decades is required to compile a hydrologic record that encompasses the potential range of water-level fluctuations in an observation well and to track trends with time.”

Finally, the hydrographs collected from two of the observation wells appear noticeably different from the other four hydrographs. The Ray Road and Eno Confluence well hydrographs appear to be different from the other hydrographs, indicating that factors that may not be important at the other four wells may be influencing the groundwater level in these two wells. The Ray Road observation well is located in proximity of University Lake, an OWASA reservoir. It is possible that the groundwater level in this well is influenced by the water level in the nearby reservoir. Further analysis of the groundwater level in the Ray Road well would be needed to determine if the lake level is impacting this well.

Similarly, the well located at the Eno Confluence Property is located in proximity to both the West and the East Forks of the Eno River. The hydrograph for this well, included above, appears to reflect a considerable amount of “flashiness” (rapid fluctuations, either up or down, in a short period of time) in the groundwater level. This is likely to be a result of fairly rapid increases and decreases in the flow of the Eno River as a result of precipitation in the upper Eno River watershed, indicating that the groundwater level in this area is fairly rapidly influenced by the water level in the Eno River.

Recommendations

- Groundwater level information should continue to be collected from the six bedrock observation wells which are included in Orange Well Net at this time. Currently, routine data collection from these six wells is occurring and little, if any, further expense is needed to continue this process. Additional data will significantly increase the quantity of available information for each of the six bedrock wells, thereby also increasing the quality and usefulness of the hydrographs for each of the wells.

- If opportunities arise to add additional bedrock observation wells to Orange Well Net, evaluation and consideration of each well should take place. The original design of the observation well network included bedrock observation wells in each of the nine general bedrock lithologies in Orange County. The cost to incorporate additional existing bedrock wells into the well network would be relatively minor.

- Currently, the NCDENR Division of Water Quality (DWQ) and the USGS are starting an investigation of the impact of biosolids on surface water and shallow groundwater conditions in southern Orange County. This investigation involves the installation of several regolith wells on biosolids applications fields owned by OWASA. Staff have worked with DWQ and USGS personnel and have received permission to install the downhole equipment needed to collect groundwater level information in three of the regolith wells involved in this study. This cooperative effort should prove to be another low-cost means of collecting additional groundwater level information. By deploying instrumentation in these wells, groundwater level information will begin to be collected from the regolith aquifer, adding to the locally available knowledge concerning groundwater in Orange County.

- Continue to upload groundwater level information to the DWR web site. This will allow the public to have access to the groundwater level information collected in Orange County at no cost to either the County or to members of the public.

- Continue to publicize Orange Well Net where appropriate. As more groundwater level information is collected, further use of the Orange Well Net data available on the DWR web site should be encouraged.

Orange Well Net Bedrock Well
on Eubanks Road.

Acknowledgements

This project has been greatly aided by the assistance of the following organizations:

- Association for the Preservation of the Eno River
- Duke Forest
- North Carolina Department of Environment and Natural Resources- Division of Water Resources
- North Carolina Geological Survey, in particular, Mr. Phil Bradley, Senior Piedmont Geologist
- The University of North Carolina at Chapel Hill

Orange Well Net Bedrock Well in Southern Orange County

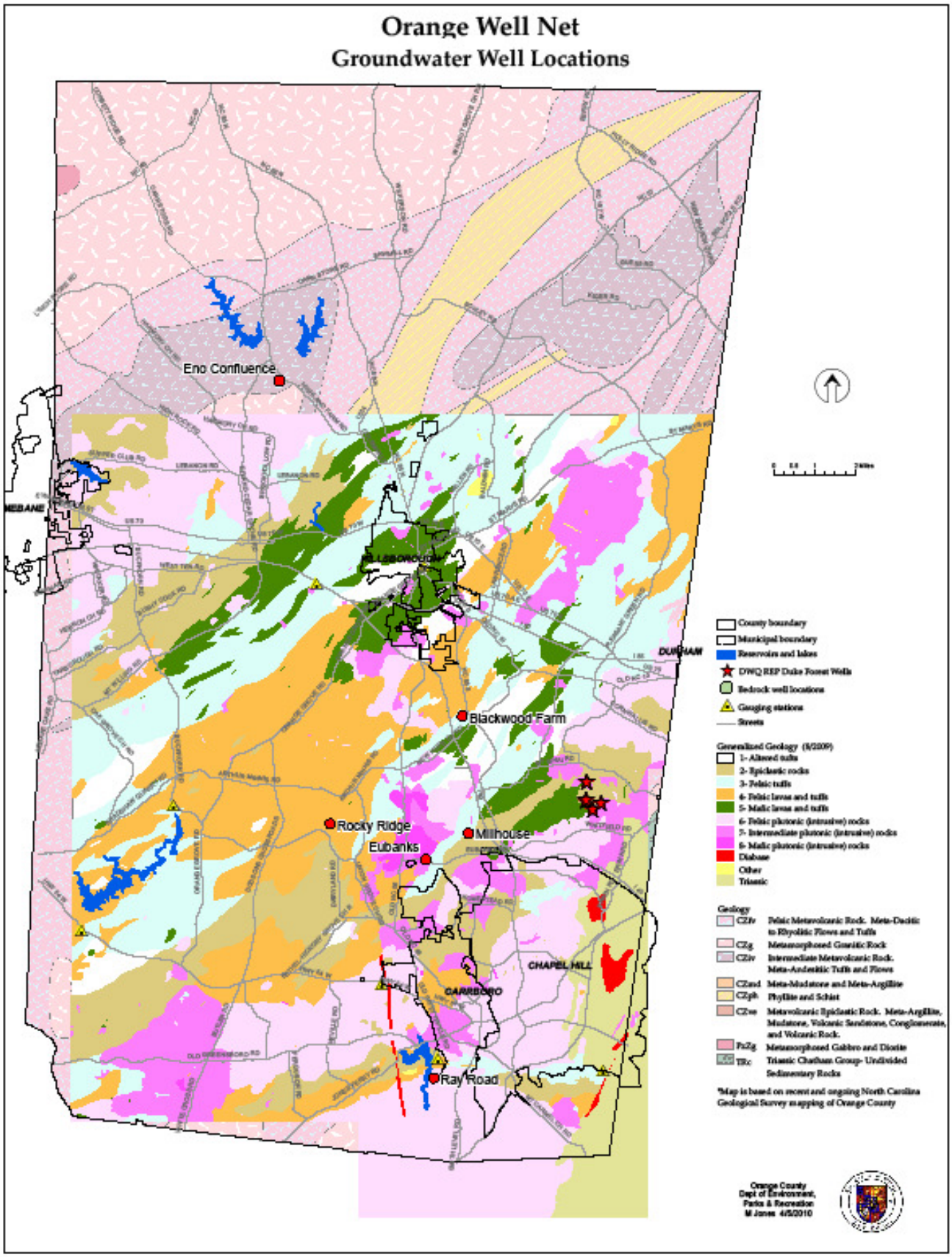
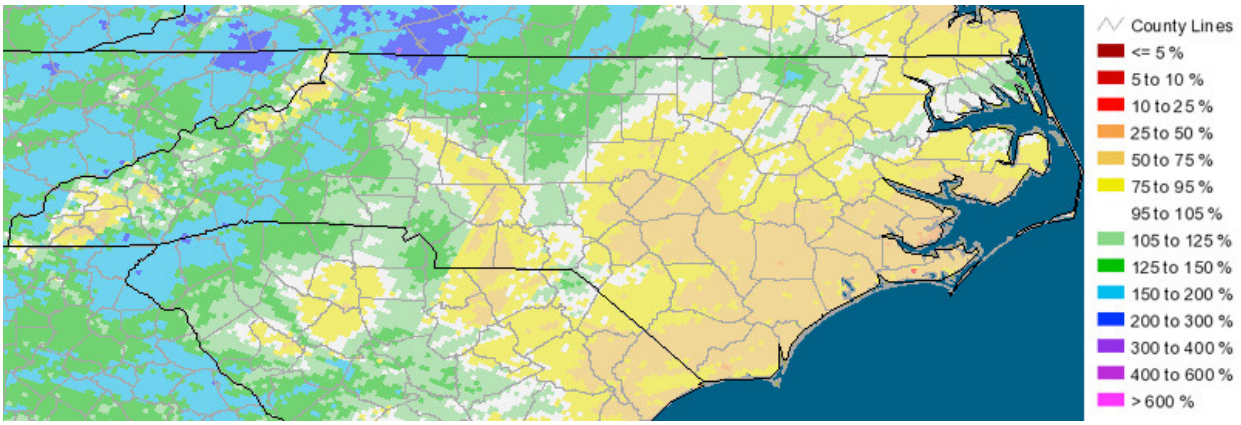
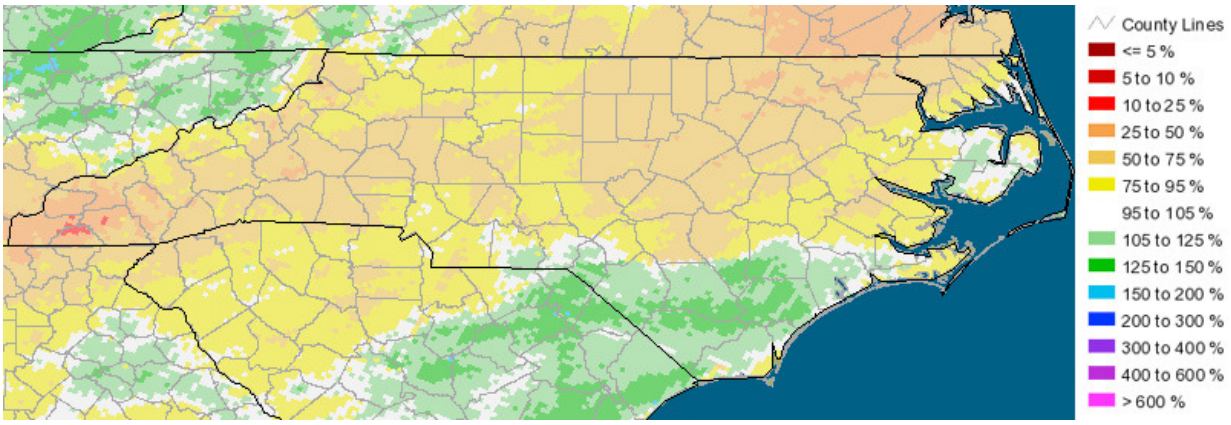


Figure 1. Generalized Geologic Map of Orange County with Locations of Well Net Bedrock Wells.

Precipitation for March 2011: Percent of Normal



Precipitation for February 2011: Percent of Normal



Precipitation for January 2011: Percent of Normal

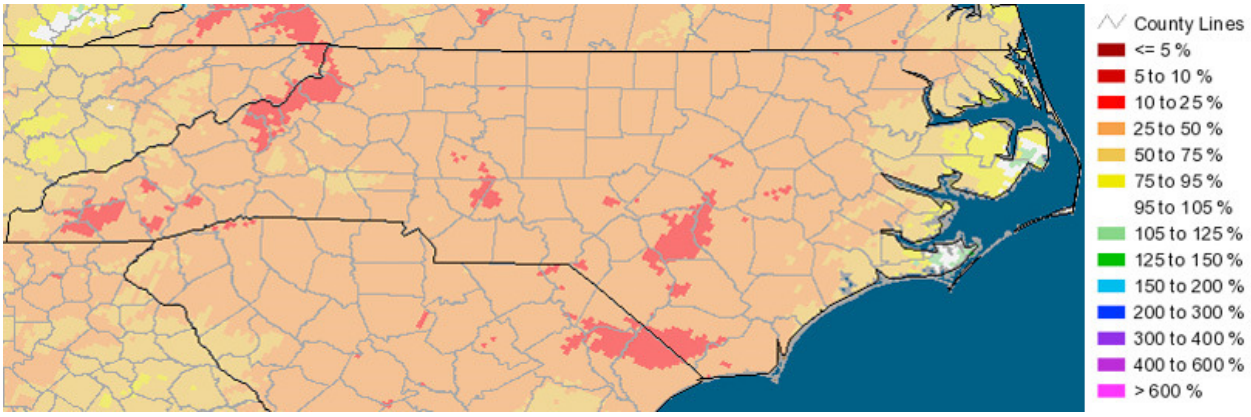


Figure 2. 2011 Monthly Precipitation Percent of Normal Figures
from State Climate Office of North Carolina web site
Based on estimates from NWS Radar. Data courtesy NWS/NCEP.