

## SUMMARY OF WATER-RESOURCES CONDITIONS

Precipitation

Precipitation amounts for the first quarter, October through December, of the 2002 water year were well below average across the State. Average precipitation amounts are mean monthly values based on data from 1971 through 2000, the 30-year base period used by the National Weather Service. Precipitation amounts varied from 6.02 (Asheville) and 6.63 (Charlotte) inches below average in the western part of the State, to 6.33 (Greensboro) and 4.82 (Raleigh) inches below average in the central part of the State, to 7.14 (Elizabeth City) and 7.54 (Wilmington) inches below average in the eastern part of the State. Rainfall data collected at six key National Weather Service stations (figs. 1 and 3) indicate that below-average rainfall amounts were recorded for all months, in all the Provinces of North Carolina, during the first quarter.

The second quarter of the 2002 water year, January through March, brought continued dry conditions to the State. However, above-average monthly mean rainfall occurred in a line from Charlotte to Elizabeth City as a result of a regional weather system that moved across the State in late January. Rainfall was below average at all index sites in February and above average at all index sites except Asheville and Greensboro in March. The most rainfall during the quarter was reported in Elizabeth City at 3.42 inches above average. Below average quarterly rainfall was recorded in Asheville (3.18 inches below average), Charlotte (1.24 inches below average), Greensboro (1.84 inches below average), Raleigh (0.10 inch below average), and Wilmington (2.98 inches below average).

The third quarter, April through June, again brought below-average amounts of rainfall across the State. Only Elizabeth City recorded 2 months of above-average precipitation. Quarterly precipitation amounts declined further below average during the third quarter at all the index sites across the State with the exception of Asheville, which was below average but not as severely as during the previous quarter. Raleigh and Wilmington were affected the most by lack of rain, recording 5.00 and 5.54 inches below average for the quarter. The remaining index sites also reported less severe conditions ranging from 1.01 to 4.18 inches below average for the quarter—Asheville (1.01 inches), Charlotte (4.18 inches), Greensboro (3.67 inches), and Elizabeth City (1.42 inches).

Rainfall conditions were close to the mean values in the central and eastern parts of the State during the fourth quarter, July through September. Index sites at Raleigh, Wilmington, and Elizabeth City all recorded above-average monthly rainfall for July and August. Index sites at Charlotte and Greensboro also reported above-average monthly rainfall in August. Above-average rainfalls were recorded for Wilmington (3.12 inches above the mean) and Elizabeth City (1.53 inches above the mean) for the entire quarter. The remaining index sites recorded below-average conditions ranging from 0.65 to 2.28 inches below average for the quarter—Asheville (1.76 inches), Charlotte (2.28 inches), Greensboro (1.01 inches), and Raleigh (0.65 inches).

In summary, drought conditions in North Carolina, which began in 1998, continued through 2002 with below-average annual rainfall at each of the six index sites. Mandatory and voluntary water restrictions were established in many regions of the State due to extremely low public-water supplies. The National Weather Service reported the following total annual rainfall amounts for the 2002 water year at these selected stations: Asheville, 35.07 inches (11.97 inches below average); Charlotte, 29.18 inches (14.33 inches below average); Greensboro, 30.29 inches (12.85 inches below average); Raleigh, 33.78 inches (9.27 inches below average); Elizabeth City, 43.37 inches (3.61 inches below average); and Wilmington, 44.13 inches (12.94 inches below average).

Ground Water

Cross sections illustrating the simplified geology and Coastal Plain aquifers of North Carolina are shown in figure 2. Ground-water levels in the surficial aquifer of the Coastal Plain Province and in the weathered surficial layer (regolith) of the Piedmont and Blue Ridge Provinces of North Carolina respond to climatic influences. The continual discharge of ground water to streams, evapotranspiration to the air by plants, or movement of ground water to deeper aquifers is a function of periodic ground-water recharge by precipitation. Water levels in the unconfined aquifers generally decline throughout the growing season and are typically highest during the winter months when evapotranspiration losses are lowest. In addition to seasonal changes, water levels in deeper, confined aquifers in the Coastal Plain also can respond to pumping. Locations of wells discussed in this report are shown in figures 4-10, p. 41-47.

### Index Wells

Water levels in index observation wells in the Blue Ridge, Piedmont, and Coastal Plain Provinces (fig. 1) provide a general indication of ground-water fluctuations in the shallow aquifers of these provinces. Hydrographs of monthend water levels in these index observation wells (fig. 11) include mean monthend water levels for the period of record and record high and low monthend water levels during the 2002 water year. Real-time plots of data for these wells can be accessed online at <http://nc.waterdata.usgs.gov/nwis/gw>, and long-term records are available for comparison online at <http://groundwaterwatch.usgs.gov/>.

Water levels in the Blue Ridge index well NC-144 (fig. 11) were below the mean for the period of record (1981-2002) throughout the entire 2002 water year. New period of record minimums were observed from June through September (fig. 11). This indicates below-average ground-water storage. New period-of-record (1982-2002) minimums were observed throughout the entire 2002 water year in the Piedmont index well NC-142 (fig. 11). In the Coastal Plain index well NC-160 (fig. 11), water levels were near the period of record (1976-2002) mean from January through May, but below the mean for the remainder of the 2002 water year.

### Natural-Effects Wells

Ground-water levels in North Carolina were influenced by a wide range of rainfall across the State during the 2002 water year. Overall, the State endured drought conditions for the fifth consecutive year, although rainfall conditions improved for part of State. The effects of the drought conditions on recharge to the ground-water system was most evident in extreme period-of-record lows observed in the two Piedmont wells and a Coastal Plain well throughout the entire 2002 water year. The Blue Ridge wells did indicate an overall pattern of declining water levels during the last 5 years. However, during the last 2 years, conditions remained relatively stable. The water level in Blue Ridge well NC-191 (p. 90) also began to decline after the previous year's recovery. The lowest water level in 21 years (period of record) was recorded in Piedmont well NC-142 (p. 106), preceded by a 5-year decline. Since 1997, the daily-mean water level in well NC-142 has declined more than 10 feet (ft), indicating a substantial loss of ground-water storage. The lowest water level in 13 years was recorded in Piedmont well NC-193 (p. 236). Water levels in Coastal Plain climatic-effects well NC-148 (p. 290) were typical of seasonal fluctuations for the 22-year period of record. Daily-mean water levels in Coastal Plain terrane-effects well NC-194 (p. 246) fluctuated about 1.19 ft during water year 2002, and recorded a period-of-record low water level (p. 247).

### Induced-Effects Wells

Ground-water withdrawals in the Coastal Plain have resulted in declining water levels in confined aquifers in some areas of the Coastal Plain for a number of years. This declining trend is shown by the long-term record from several induced-effects observation wells that tap four of the major aquifers in eastern North Carolina — the Castle Hayne, Black Creek, upper Cape Fear, and lower Cape Fear aquifers (fig. 2).

The record of observation well NC-212 (p. 49) shows the fluctuations of water levels in the Castle Hayne aquifer resulting from changes in pumping at a large mining and manufacturing operation in the eastern part of Beaufort County. Major pumping activities have occurred in this area for more than three decades. The fluctuation in the water level as a result of pumping is about 35 ft for water year 2002. The areal cone of depression resulting from this pumping has covered more than 3,000 square miles (mi<sup>2</sup>) (Coble and others, 1989).

The record of observation well NC-139 (fig. 10) in Carteret County shows the effects of seasonal pumping from the Castle Hayne aquifer in order to meet increased demand for water in the coastal area during the summer months. The decline in water levels in the long-term record (p. 88) indicates that annual recharge to the aquifer is less than the amount of water withdrawn. Observation well ON-227 (p. 178), completed in the Castle Hayne aquifer in Onslow County, shows a similar long-term, water-level decline with more recent drawdown resulting from expanding well fields in the area.

Water levels in the Castle Hayne aquifer are not declining everywhere throughout the eastern Coastal Plain. This is especially true in the areas of the aquifer that are not covered by extensive confining units (Strickland and others, 1992). The water levels in Castle Hayne well NC-52 (p. 174) in Onslow County exhibit climatic-effect fluctuations. Although well NC-52 is near water-supply wells at U.S. Marine Corps Camp Lejeune, no effects of withdrawals from these wells can be observed in the

long-term record.

Ground-water withdrawals, estimated at 134 million gallons per day over 15 counties, have resulted in water-level declines in the State's central Coastal Plain (Walters, 1997). The aquifers most affected in this 9,250-mi<sup>2</sup> area, which extends from Bertie County in the north to Pender County in the south, are the Peedee, Black Creek, upper Cape Fear, and lower Cape Fear aquifers. Examples of the long-term effects of these withdrawals can be observed in data from several wells. Water levels recorded in well NC-128 (p. 164) indicate the effects of pumping from the Black Creek aquifer in Lenoir County. Water-level declines of as much as 4 ft per year have been recorded in well NC-128 until 1998 when water levels started to recover. The period of record hydrograph for well NC-128 (p. 165) shows a long-term decline of almost 80 ft from 1972 to 1997. Well ON-256 (p. 184) in Onslow County is also in the Black Creek aquifer. Declines of about 2 ft per year have been observed in this well during the last 8 years.

Withdrawals for public and industrial use from the upper Cape Fear aquifer in Bladen County have caused water levels to decline in well NC-177 (p. 218). Prior to 1992, the rate of water-level decline in well NC-177 was about 1.7 ft per year. In mid-October 1992, major withdrawals for industrial use (from the same aquifer) began in northwestern Bladen County; as a result, the rate of decline in well NC-177 was about 6.3 ft per year between late 1992 and 1996. Between late 1996 and 2001, the rate of decline in well NC-177 was about 3 ft per year (Strickland, 1995, 1999). The water level began to recover in January 2002, most likely as a result of pumping reductions.

Water-level declines in well NC-155 (p. 122), which is completed in the lower Cape Fear aquifer in Hertford County, result primarily from major withdrawals in Virginia that began in the 1940's. These withdrawals have caused a regional cone of depression in the lower Cape Fear aquifer, which extends about 30 miles into North Carolina (Coble and others, 1989). Water-level records from well NC-155 indicate that the maximum (drawdown) rate of decline of 4 ft per year occurred in the late 1980's. From 1993 to 1998, the rate of decline decreased to less than 2 ft per year. A slight recovery in water levels was observed from late 1998 through mid-2000; however, recent data for the 2001 water year indicate a return to declining water levels at a rate of more than 2 ft per year.