SUMMARY OF WATER-RESOURCES CONDITIONS

Precipitation

Precipitation during water year 2003 was considered above average throughout most of North Carolina, in contrast to the drought conditions that occurred during water years 1998 through 2002. Precipitation amounts at the six index stations for the first quarter of water year 2003 (October through December) were well above average across the State except at the Wilmington station. Precipitation amounts were 3.39 (Asheville) and 4.57 (Charlotte) inches above average in the western part of the State, 5.68 (Greensboro) and 8.78 (Raleigh) inches above average in the central part of the State, and 7.47 (Elizabeth City) inches above average and 2.32 (Wilmington) inches below average in the eastern part of 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. Data collected at the six key National Weather Service stations (figs. 1 and 3) indicate that above-average precipitation was recorded for all months during the first quarter at Charlotte, Greensboro, Raleigh, and Elizabeth City.

Precipitation totals for the second quarter of the 2003 water year (January through March) were generally lower than those reported in the first quarter. However, above-average monthly mean precipitation occurred at Charlotte, Greensboro, Raleigh, and Elizabeth City during the second quarter. Precipitation was below average at all index sites in January and above average at all index sites in February. The most precipitation during the quarter was reported in Greensboro at 3.46 inches above average. Above-average conditions also were reported at Charlotte (0.69 inch above average), Raleigh (0.18 inch above average), and Elizabeth City (1.27 inches above average) during this period. Asheville had the least amount of recorded precipitation at 2.48 inches below average followed by Wilmington at 1.35 inches below average for the second quarter.

Precipitation amounts were above average across the State also during the third quarter (April through June). Charlotte had the greatest amount of precipitation during this period with a total of 24.00 inches for the quarter or 13.97 inches above average. Asheville reported a total of 19.81 inches or 7.52 inches above average. Precipitation amounts were 6.66 (Greensboro) and 2.78 (Raleigh) inches above average in the central part of the State, and 6.64 (Wilmington) and 6.37 (Elizabeth City) inches above average in the eastern part of the State. All six key National Weather Service stations indicate that above-average precipitation amounts were recorded for all months during the third quarter in all three provinces of North Carolina.

Precipitation conditions were above average in the western and central parts of the State during the fourth quarter (July through September). Although most of the index sites recorded above-average monthly precipitation, Wilmington (4.95 inches) reported below-average precipitation for the entire quarter. The remaining index sites reported above average for the quarter, Asheville (8.83 inches), Charlotte (10.00 inches), Greensboro (12.25 inches), Raleigh (5.09 inches), and Elizabeth City (1.38 inches).

In summary, from October 2002 to September 2003, above-average annual precipitation occurred across the State except in Wilmington. The National Weather Service reported the following annual precipitation amounts for the 2003 water year at these selected stations: Asheville, 64.30 inches (17.26 inches above average); Charlotte, 72.74 inches (29.23 inches above average); Greensboro, 71.19 inches (28.05 inches above average); Raleigh, 59.88 inches (16.83 inches above average); Elizabeth City, 63.47 inches (16.49 inches above average); and Wilmington, 55.09 inches (1.98 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. 10–16.

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. 10) 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 (351808082374302, TR-065; figs. 8, 10 and p. 346) recovered from period-of-record low water levels during water year 2002, to average (for period of record 1981-present) and above-average conditions during water year 2003. The daily mean water level rose about 13 feet (ft) from October 2002 to June 2003, indicating a significant increase in ground-water storage for the shallow saprolite aquifer. Similar recovery conditions were observed during water year 2003 in the Piedmont index well NC-142 (355359080331701, DV-025; figs. 8, 10 and p. 128). Water levels in well NC-142 rose from period-of-record lows recorded in water year 2002, to above-average conditions for water year 2003. The water level rose by more than 8 ft from October 2002 to July 2003, indicating a significant increase in ground-water storage for the shallow saprolite aquifer. In the Coastal Plain index well NC-160 (353219077153801 PI-532; figs. 9, 10 and p. 264), water levels also recovered from below-average conditions in the fall of 2002, to above-average conditions for much of water year 2003. A water-level rise of more than 6 ft was recorded from October 2002 to September 2003, indicating a significant increase in storage for the shallow surficial aquifer.

Natural-Effects Wells

Ground-water levels in North Carolina were influenced by a wide range of rainfall across the State during the 2003 water year. Overall, the State recovered from the past 5 years of drought, to above-average rainfall conditions. The effects of the above-average rainfall on recharge to the ground-water system was most evident in recovery from extreme period-of-record lows observed in water year 2002, to average and above-average water levels in the two Blue Ridge wells, the two Piedmont wells, and a Coastal Plain well throughout most of the 2003 water year. In general, the recovery to average ground-water levels was observed within the first 6 months of the water year, across the State. The Blue Ridge wells had indicated an overall pattern of declining water levels during the last 5 drought years, and recovered to average conditions by early spring. The water levels in Blue Ridge wells NC-191 (351117083545001, CE-028; fig. 8 and p. 114) and well NC-144 (351808082374302, TR-065; figs. 8, 10 and p. 346) began to rise in the fall of 2002. Comparison of the daily low and high mean water levels for water year 2003 indicated an overall increase in storage of more than 13 ft each for wells NC-144 and NC-191. In Piedmont well NC-142 (355359080331701, DV-025; figs. 8, 10 and p. 128), the lowest water level in 21 years (period of record) was recorded in water year 2002; however, in water year 2003 the daily mean water level rose more than 8 ft from October 2002 to July 2003, indicating a substantial recovery of ground-water storage. Likewise in Piedmont well NC-193 (354057080362601, RO-149; fig. 8 and p. 330), the lowest water level in 13 years was recorded in water year 2002, and a recovery of more than 5 ft was recorded from October 2002 to June 2003. Water levels in Coastal Plain climatic-effects wells NC-148 (351849078163901, WA-154; fig. 9 and p. 394) and well NC-194 (345812079313401, SC-080; fig. 6 and p. 340) also responded to above-average rainfall conditions in water year 2003. Well NC-148 rose nearly 8 ft from November 2002 to August 2003, and well NC-194 rose more than 5 ft from October 2003 to September 2003.

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 (351934076481001, BO-200; fig. 9 and p. 59) 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 range of fluctuation in the water level as a result of pumping is about 35 ft for water year 2003. The areal cone of depression resulting from this pumping has covered more than 3,000 square miles (mi^2) (Coble and others, 1989).

The record of observation well NC-139 (344323076451301, CT-153; fig. 9 and p. 112) 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. 113) was observed until the mid-1990's, when water levels were more stable. Observation well ON-227 (fig. 5 and p. 234), completed in the Castle Hayne aquifer in Onslow County, shows a similar decline from late 1994 through 2002; however, water levels recovered about 3 ft during water year 2003.

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 (344425077272501, ON-035; fig. 5 and p. 230) 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 (CCP) (Walters, 1997). In August 2002, the North Carolina State Legislature designated those 15 counties as the CCP Capacity Use Area, whereby reductions in ground-water withdrawals in the Cretaceous aquifers, primarily the Black Creek and upper Cape Fear aquifers, are scheduled to begin by the year 2008. Examples of the long-term effects of these withdrawals can be observed in data from several wells. Water levels recorded in well NC-128 (351600077381001, NC-128; fig. 9 and p. 220) 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 began to recover. The period of record hydrograph for well NC-128 (p. 221) shows a long-term decline of almost 80 ft from 1972 to 1997. Well ON-256 (344139077211202, ON-256; fig. 5 and p. 240) in Onslow County is also in the Black Creek aquifer. Declines averaging about 2 ft per year have been observed since the well record began in late 1994 with no water level recovery in recent 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 (343840078550009, RB-183; fig. 6 and p. 268). 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 and continued to recover during water year 2003, most likely as a result of pumping reductions.

Water-level declines in well NC-155 (363026077001906, HF-085; fig. 9 and p. 176), 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 1999 to 2003.