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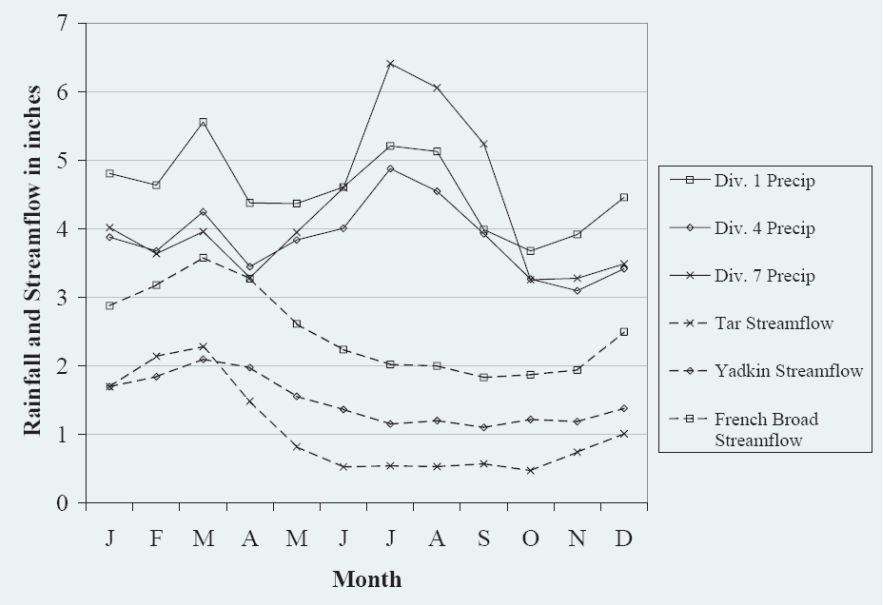
North Carolina's Abundant Water Resources: Supply, Use and Imbalances

by David H. Moreau, WRRI Director

North Carolina is blessed with abundant water resources. No place in the state has an average annual rainfall of less than 40 inches; coastal areas and all of the mountain areas exceed 50 inches a year, and a portion of the state in and near the Great Smoky Mountain National Park receive in excess of 80 inches in an average year. Nonetheless, in recent years, most notably 2002, North Carolina has experienced several widespread regional droughts when rainfall and streamflow dropped to record lows in many locations. Local imbalances between supply and demand have caused water in reservoirs to drop precipitously, triggering conservation programs in several cities. A perception has emerged that North Carolina is running out of water. Although the drought of 2005 affected only parts of the state, it reinforced that perception. Recent near-record rainfalls in Wake and other counties have once again shown the extremes to which water management in North Carolina must address itself.

This report examines the current state of water supply and water use in North Carolina. It begins with an examination of annual and monthly statistics on precipitation and streamflow. That discussion is followed by a brief summary of statewide water use.

Figure 1. Rainfall and streamflow by month within-year cycles are shown for selected climate divisions and streams.



The Supply

With more than 45 inches of average annual rainfall, North Carolina receives substantially more than many other parts of the country. Much of the area in the Midwest gets between 20 and 40 inches, and much of the arid West gets less than 20 inches a year.

Over the 70-year period from 1930 to 2000, the area-weighted average precipitation over the entire state was 49.6 inches per year. If that depth is multiplied by the land area of the state (48,700 sq. mi.), the volume would be about 115,000 million gallons per day (MGD). A similar estimate for streamflow, using gages on 16 selected streams, is 36,300 MGD. The difference is primarily that which returns to the atmosphere through evapotranspiration by crops, forests, and other vegetation. There is some direct evaporation from land and water surfaces, and a small amount is accounted for by a change in groundwater storage.

There are within-year cycles for both

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Angela Morgan Returns to WRRI

Angela Morgan has returned to WRRI as program coordinator. This position was previously held by Jennifer Craddock who has relocated with her husband to South Carolina.

As the program coordinator, Angela maintains the institute schedule for the annual call for proposals and report completion process. She also administers the official contract and grant files for WRRI.

Angela provides administrative support to the WRRI director and other staff members. She helps the WRRI staff stay informed of schedules, task priorities, and upcoming event information. Since Angela oversees registration and other logistics of WRRI workshops, conferences and seminars, she is one of the first people you will see if you attend one of these events.

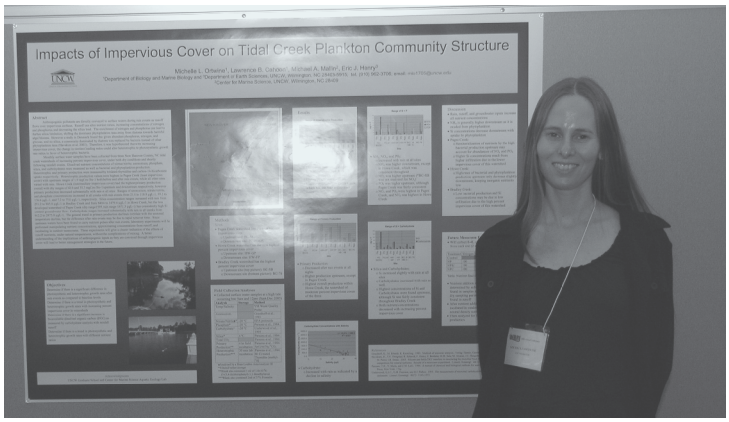
WRRI is glad to have Angela back as part of its staff. If you would like to welcome her or have questions for her, she may be reached at angela_morgan@ncsu.edu or 919-513-1203.

NCWRA Poster Contest Winners

Each year at the WRRI Annual Conference, board members of the North Carolina Water Resources Association (NCWRA) sponsor a undergraduate and graduate student poster contest. The standardized judging criteria were in the categories of organization, text and visual elements. During the Annual Conference luncheon on April 5, NCWRA Past President Beth Wrege presented the following student poster winners:

Undergraduate Student Posters:

- 1st place ($75): Genevieve A. Romanello (presenter) and Brant W. Touchette, of Elon University, presented a poster titled "Plant-Water Relations In A Freshwater Juncus Marsh: Consequences Of Summer Drought In Overall Plant Water Stress And Biomass."
- 2nd place ($50): Adam Frank (presenter), Laura Iannacone, Gwendolyn Turner and Brant W. Touchette, of Elon University, presented a poster titled "A Comparison of Growth and Productivity in Freshwater Wetland Plants Under Water Stressed Conditions."



Michelle L. Ortwine, graduate student at UNC Wilmington, was the first place graduate student winner of the NCWRA student poster contest.

Graduate Student Posters:

- 1st place ($100): Michelle L. Ortwine (presenter), Lawrence B. Cahoon, Michael A. Mallin, and Eric J. Henry, of UNC Wilmington, presented a poster

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Abundant Water *continued from page 1*

precipitation and streamflow, and there is considerable variability of both from year to year. Within year cycles are shown in Figure 1 for selected climate divisions and streams. Climate Division 1 covers the southwestern portion of the state, Division 4 covers a portion of the Piedmont, and 7 covers a substantial portion of the coastal plain from the Tar River south. Rainfall is highest in Division 1 in the winter; but in Divisions 4 and 7, it occurs in July. As a result of high evapotranspiration during summer months, streamflows show a pronounced cycle with low summer flows and high winter flows.

Table 1. Water Withdrawals and Estimated Consumptive Use in 2000

	Withdrawals, MGD			Percent Consumptive Use	Consumptive Use, MGD		
	Ground	Surface	Total		Ground	Surface	Total
Public Supply	166	779	945	26.1	43.3	203.3	246.5
Domestic - self supplied	189	0	189	23.3	44	0	44
Industrial - self supplied	26	267	293	14.2	3.6	38	41.6
Irrigation	66	221	287	71.5	47.1	158.3	205.4
Livestock	89	32	121	93.3	83.1	30.1	113.2
Mining	36	0	36	7.7	2.8	0	2.8
Thermoelectric	0	7854	7854	2.0	0	157.1	157.1
Aquaculture	8	0	8				
Total	580	9154	9734		224	587	811

Sources:
(1) Year 2000 withdrawals taken from Hutson, et al, *Estimated Use of Water in the United States in 2000*
(2) Consumptive use based on percentages for the South Atlantic Gulf region in 1995 as reported by Solley, Pierce, and Perlman, *Estimated Water Use in the United States in 1995*

Year-to-year variability in precipitation is large. Over the period 1955-2004, maximum annual deviations or rainfall below average values at five major airports ranged from 12.7 inches at Greensboro to 17.4 inches at Wilmington. By contrast maximum annual deviations above average ranged from 14.0 inches at Asheville to 20.2 inches at Charlotte.

Variability in rainfall is reflected in variability of streamflow. Lowest annual flows for 16 representative gages used in this analysis fell in the range of 20-55 percent of average annual flow. Unregulated portions of the Tar, Lumber, and Waccamaw Basins and the moderately regulated Lower Neuse Basin have the lowest values.

The lowest estimated statewide streamflow rate over a 53-year period of record was 20,200 MGD or 51 percent of the average.

Water Use in 2000

The only statewide estimate of water use is the one prepared every five years in a cooperative effort between the North Carolina Division of Water Resources (Department of Environment and Natural Resources) and the United States Geological Survey (USGS). The latest estimate available is the one for 2000. Results are summarized in Table 1.

Total withdrawals in 2000 were estimated to be 9,734 MGD, 81 percent of which was for thermoelectric power generation. Surface water withdrawals account for 94 percent of the total.

Total withdrawals, however, like those reported in the 2000 report, overstate the impact of use on water availability. A very large percentage of water that is withdrawn for various uses is returned to streams, lakes, and ponds for further use. In the 1995 and earlier reports, USGS included estimates of consumptive use as well as withdrawals. Consumptive use is that amount that is withdrawn, used, and not returned to lakes and streams. The 1995 percentages of withdrawals that are used consumptively are also shown in Table 1. When those percentages are applied to the 2000 withdrawals, estimated

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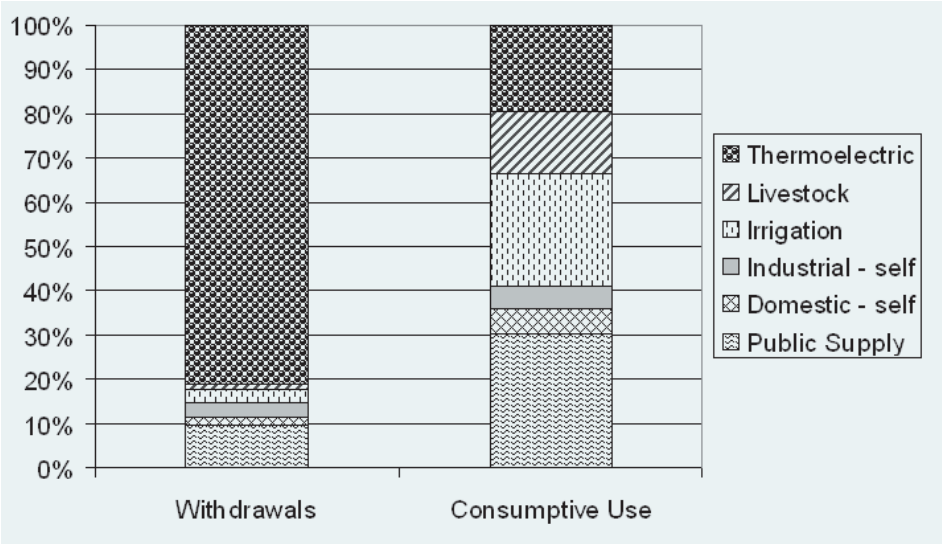
Figure 2. Distribution of Water Use in North Carolina by User Class in 2000 - Withdrawals and Consumptive Use

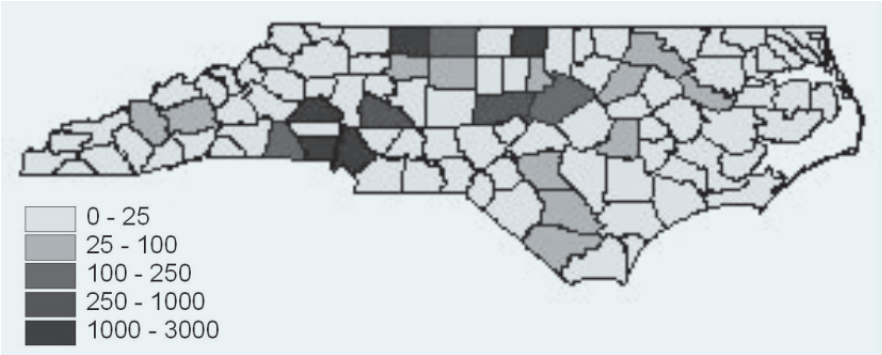


Abundant Water *continued from page 3*

consumptive use is only 811 MGD, only 8.3 percent of withdrawals.

Differences between withdrawals and consumptive use have important implications for relative magnitudes of uses by the several water-using sectors as illustrated in Figure 2. Thermoelectric power plants account for over 86 percent of withdrawals, but, according to the estimates in Table 1, 98 percent of that water is returned to lakes and streams for further use. When measured by consumptive use, thermoelectric plants account of 19 percent of the total. Public supply is the largest class of consumptive users, amounting to 25 percent of the total.

Figure 3. Withdrawals of Surface Water in Year 2000 in MGD (million gallons per day)



Differences between withdrawals and consumptive use are also very significant in drawing conclusions about the relationship of supply and demand in North Carolina. Annual withdrawals in 2000 were 27 percent of average annual streamflow, 48 percent of the lowest annual statewide streamflow on record. That comparison, however, is very misleading. Total consumptive use in 2000 is estimated to be 811 MGD, about 2.2 percent of averaged annual streamflow and about 4.0 percent of the lowest statewide flow.

Local Imbalances

It is clear from the preceding discussion that North Carolina as a whole is endowed with a generous supply of water relative to its use. Well-known recent events are evidence that such a condition does not hold true at all locations within the state. Withdrawals and consumptive uses are not uniformly distributed across the landscape of North Carolina, and the available supply at points of use depends very much on where those points are located within river basins and over ground water aquifers.

A large portion of withdrawals is concentrated in a few counties as illustrated in Figure 3. Catawba, Cleveland, Chatham, Person, Rowan, and Stokes are among the counties that withdraw the largest quantities of water. All of them are host to thermoelectric power plants. Urban counties are also large users, and a few counties have very large self-supplied industrial users. Some of the major urban demand centers, including Raleigh, Durham, High Point, and Greensboro are located in headwater areas of river basins with relatively small upstream drainage areas. In drought years, supplies from nearby streams in those areas are inadequate to provide uninterrupted supply.

Meeting growing demands in the large urban centers in an economically efficient manner will require an increasing number of transfers of water from more distant areas within basins and more transfers from one basin to another. Transfer of water from one basin to another, even transfers within basins, and development of reservoirs in one political jurisdiction to serve needs in another jurisdiction have created very intense public controversies. Such transfers should not be made without careful consideration of a range of potential adverse effects on donor basins now and in the future. Conditions may be needed to limit transfers to certain times when adverse effects could not otherwise be avoided. More intense planning will be needed in those areas to determine needs, explore alternatives, assess impacts on donor basins, and establish conditions that limit the extent to which adverse effects could be realized.

The General Assembly recognized the pressing need for transfers when it passed the Interbasin Transfer Act in 1993. In doing so, it established a process by which a number of important issues related to transfers must be investigated and provided to the public before any transfer is made. Careful consideration should be given to potential adverse effects on metropolitan development before setting arbitrary limits on potential transfers or allowing downstream parties unqualified vetoes on those proposals.

NCWRA *continued from page 2*

titled "Impacts of Impervious Cover on Tidal Creek Plankton Community Structure."

- ❑ 2nd place ($75): Emma Hardison (presenter), Michael O'Driscoll, Mark Brinson, and Richard Rheinhardt, of East Carolina University, presented a poster titled "Physical Response of Coastal Plain Streams to Storm Events Across an Urban Land-Use Gradient."
- ❑ 3rd place ($50) tie included: Melissa A. Kenney (presenter), Kenneth H. Reckhow, and Robert T. Clemen, of Duke University, presented a poster titled "Results of the North Carolina Lake User Survey."

  Melanie Markusic (presenter) and R. A. McLaughlin, of North Carolina State University, presented a poster titled "Effects of Design Changes on Sediment Retention Basin Efficiency."
- ❑ Honorable Mention ($25): Sara K. McMillan (presenter), Michael F. Piehler, Suzanne P. Thompson and Hans W. Paerl, of UNC Chapel Hill, presented a poster titled "Denitrification Dynamics in Coastal Headwater Streams: Influence of Dissolved Organic Carbon and Nitrate."

Disaster Study Committee Produces a Slate of Legislative Proposals

by Carla Burgess, freelance writer

A new Emergency Operations Center for North Carolina and a state emergency response fund to be tapped during hurricanes and other natural disasters are urgent necessities identified by a subcommittee of the Joint Study Committee on Emergency Preparedness and Disaster Management Recovery. Two legislative proposals to fulfill these needs are being introduced during the General Assembly short session, which convened in May. The joint study committee was charged with assessing North Carolina's level of preparedness for responding to natural disasters. It has been meeting regularly since February with an initial focus on improvements that could be made immediately.

During its deliberations, the Subcommittee on Disaster Preparedness Issues identified as a serious weakness the lack of a dedicated funding source for disaster preparation and recovery. For example, the N.C. Division of Emergency Management lacks the discretion in its budget to activate the National Guard or to even buy bottled water before, during or after an emergency. The agency must request such funds on a piecemeal basis to the General Assembly and Governor's office, which must identify and divert funds from other state agencies' budgets, often in the midst of the crisis.

Legislative proposals arising from the subcommittee's work include a bill to create a special revenue fund for emergency response. The bill specifies an initial $20 million appropriation to this newly created State Emergency Response Fund for the fiscal year beginning July 1. If the fund contains less than $20 million at the beginning of each subsequent fiscal year, it must be replenished restore the total balance to $20 million. Over the past 11 years, state and local government agencies spent an average of $25 million each year on disaster preparation, response and recovery efforts.

The governor would be authorized to draw from the emergency fund when necessary without authorization from the legislature. Funds could be used for start-up costs for the State Emergency Response Team operations—including the purchase of critical emergency supplies such as water and other staples, generators and transportation services; any remainder could be used to provide state matching funds for federal disaster assistance.

A second proposal that emerged from the subcommittee requested the appropriation of $8.24 million from the General Fund to the Department of Crime Control and Public Safety to share construction costs for a new Readiness Center for the North Carolina National Guard in Raleigh—in exchange for space for a new state Emergency Operations Center within the building. The current EOC is housed in the basement of the Administration Building in Raleigh, which has insufficient space to accommodate state emergency agencies, the Federal Emergency Management Agency and other disaster response staff together during a disaster.

"In the time of crisis you need all of your resource agencies together, physically co-located so that they can respond more effectively," said Norma Mills, chief of staff to N.C. Senate President Pro Tem Marc Basnight. Mills was one of the speakers at WRRI's Ninth Annual Conference April 4-5. She spoke from personal experience of cramped quarters in the EOC during emergencies and inefficiency in communicating with other critical staff that had to be stationed elsewhere.

The National Guard has received $35 million in federal funds to build the Readiness Center. Construction is set to begin in 2007. It would be cheaper for the state to share costs with the National Guard than to build a stand-alone facility. The EOC would occupy a separate floor within the facility containing about 48,700 square feet. The current space is only half of that. In addition to the EOC, the building would also house the N.C. Division of Emergency Management's Raleigh-based employees, who are currently spread among three separate locations.

The disaster preparedness subcommittee, as well as three other subcommittees (Building Code Issues, Energy Security Issues and Public Health and Bioterrorism), will continue meeting in the coming months to develop additional recommendations in time for the 2007 legislative session. The next slate of issues under consideration by the disaster subcommittee include:

- ❑ Development of a proposal for the design and implementation of a mandatory statewide certification program for professional emergency management staff in North Carolina.
- ❑ Examination of the current capabilities to serve hospitals, nursing homes and special-needs citizens during disasters and associated evacuations. This investigation will result in recommendations for the provision of new resources—including additional staff—to adequately develop, review and monitor disaster plans and preparation.

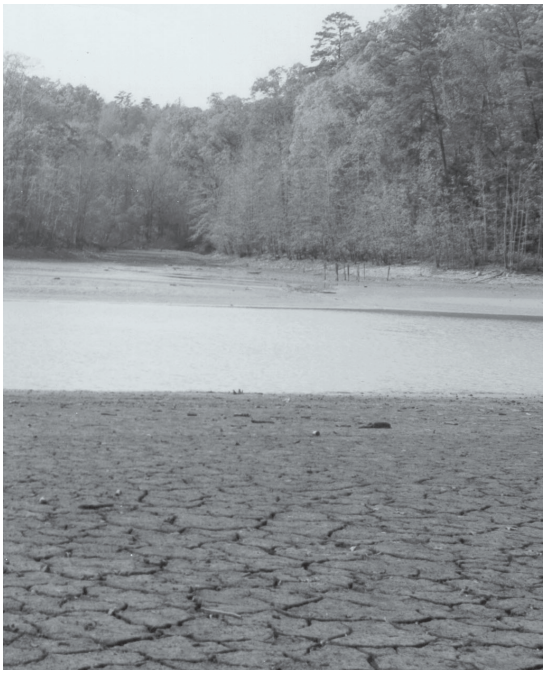
In sum, 11 bills arising from the joint study committee will be introduced during the short session, carrying total funding requests of nearly $68 million. Other proposals include recommendations to mandate the N.C. Building Code Council to study construction issues related to windborne debris during storms; to appropriate funds to purchase essential vaccines for children, flu vaccines for high-risk populations and antiviral medications; and to require an update of the state's Energy Emergency Plan.

Taking the Adventure Out of Disaster Response

by Carla Burgess, freelance writer

North Carolina experienced a string of debilitating natural disasters over a five-year period beginning with Hurricane Floyd, which devastated parts of eastern North Carolina through flooding in 1999; an ice storm in 2002 that immobilized the Piedmont; a statewide drought that peaked in 2002; and back-to-back hurricanes, Frances and Ivan, that caused flooding and mudslides in western North Carolina in 2004.

The response to some of these crises is still ongoing in many places—including removal of homes and swine lagoons in low-lying areas of the coastal plain and continued water restrictions across the state. Simultaneously, government leaders and industries are cooperating to try to fix the policy and planning failures that exacerbated damages. Such measures are key to reducing the impact of future natural disasters, said Robin Smith, the N.C. Department of Environment and Natural Resources (DENR) assistant secretary for planning and policy.



Smith delivered the luncheon address on day two of WRRI's Ninth Annual Conference April 4-5. Quoting polar explorer Roald Amundsen's definition of "adventure" as "bad planning", she said the state needs to take the adventure out of disaster response. "You can't plan away hurricanes, you can't plan away ice storms. Some degree of damage is inevitable," she said. "But it's just not smart to accept a higher level of damage than you have to."

After the Flood

Revised, comprehensive floodplain mapping is one of the most progressive, preventive actions that emerged as a direct result of Hurricane Floyd, said Smith. "You can have all sorts of good intentions about eliminating inappropriate uses in the floodplain, but if you don't know where the floodplain is, that's a lot harder to do," she said. Smith lauded the significant effort under way to revise floodplain maps in North Carolina's 100 counties and to have those maps accepted by the Federal Emergency Management Agency (FEMA) for federal flood insurance purposes. Much of the eastern third of the state, 27 counties as of May 2005, have Flood Insurance Rate Maps (FIRMs) completed and approved by FEMA. Mapping is in progress throughout the rest of the state—with elevation data collection and engineering in full swing. Previous floodplain maps were developed using manual cartographic methods, but the new maps are being created digitally, which will allow for greater accuracy in hazard analysis, better data for managing development in floodplains, and a more sophisticated, efficient means of creating updates. The new digital maps will be available online for anyone to review and download.

North Carolina was the first state to enter into a partnership with FEMA under the Cooperating Technical Partnership (CTP) Initiative, in which the state assumed primary ownership of and responsibility for developing FIRMs for the state's communities. Prior to this change, FEMA's budget provided for only one annual updated flood study in a single North Carolina county, and more than half of North Carolina's FIRMs were at least a decade old. The state still receives some federal funding and in-kind technical assistance, with the majority allocated by the General Assembly. All the mapping projects statewide have been fully funded, according to the N.C. Floodplain Mapping Program.

The state is also taking extensive actions to relocate swine operations in floodprone areas in eastern North Carolina. Overflow from waste lagoons and associated water contamination was a severe problem during Hurricane Floyd. With the help of about $15 million in grants from the state's Clean Water Management Trust Fund, the N.C. Division of Soil and Water Conservation Program launched a voluntary buyout program to remove high-risk swine operations from the 100-year floodplain in 40 counties. In addition to decommissioning lagoons, participating swine producers must agree to restore buffers along streams and ditches and discontinue use of the site for intensive livestock production—these arrangements are defined as conservation easements. The land may still be used for low-intensity agriculture such as row crops and pasture-raised beef cows. As of May 2006, the state has spent about $11 million to purchase 28 conservation easements (encompassing 820 acres) and close 53 waste treatment lagoons.

Further, said Smith, there is now clearer guidance and communication between DENR staff on how swine farmers should operate during chronically wet periods, as well as incentives to operate responsibly. "There is much greater willingness on the part of the industry and individual producers to do things like pump and haul waste or to take animals off a farm that is experiencing high lagoon levels," said Smith. Farmers who take preventive steps will receive extra considerations during extremely wet periods. "If you did all the right things during the dry months—if you did as much spraying and irrigating as you could do, kept your lagoon levels down and you got into this bad spot having managed your farm responsibly—we're not going to take any enforcement action."

Drought: The Slow Disaster

Drought-related crises present their own unique challenges, said

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Adventure Out of Disaster *continued*

Smith, describing these situations as "slow disasters."

"Severe droughts are in some ways as difficult in a different way than the sudden emergencies," she said. "If you have a sudden event like a hurricane, people are immediately mobilized to take action and do something. With drought situations, things that creep up on you slowly, it's often much more difficult to get people both at the state level and the local level to act when they need to."

During the latter months of 2002, more than 200 municipalities—including most major cities—operated under some form of voluntary, mandatory or emergency water conservation. Reservoirs across North Carolina were at record or near record-low levels. In response to the drought, the legislature passed a law requiring state and local governments to address water supply issues and drought preparedness. A draft rule to establish minimum standards and practices for water shortage response planning, water use reporting, water conservation and water reuse during droughts and water-supply emergencies will make its way to N.C. Environmental Management Commission for adoption sometime this summer. (More information at www. ncwater.org.)

A positive outcome from recent drought experiences is that many water suppliers are now making ongoing water conservation an integral part of water supply planning, and they are building connections with other water systems and suppliers, said Smith.

May Action of the Environmental Management Commission

At its regularly scheduled meeting on May 11, 2006, the Environmental Management Committee (EMC) took the following action:

- ❑ Adopted the proposed new regulations to the Clean Air Interstate Rules (CAIR). The hearing officers held public hearings on the proposed new regulations. These new regulations are in response to the EPA requirement for states to limit the emissions of nitrogen oxides and sulfur dioxides and guideline rules for the state to use in developing their rules.
- ❑ Adopted Subchapter 2T for the waste not discharged to surface waters rules with the modifications based on public comments as presented in the hearing officers' report and repealed Section 15A NCAC 2H .0200 and Rules 15A NCAC 2H .0122 and .0123. Systems covered by 2H .0200 and the proposed Subchapter 2T include wastewater collection systems, animal waste management system wastewater residuals, and other non-discharge systems including wastewater irrigation, reclaimed water utilization, groundwater remediation and soil remediation projects. These rules have not been comprehensively updated since 1993. The intent of the proposed rules was to restructure the existing rules, make editorial changes, make the rules easier to follow, clarify requirements, and reflect current policy not previously addressed in the rules. The EMC encouraged professional geologists, professional engineers, and soil scientists to attend the Rules Review Commission meeting when this rule goes before them.
- ❑ Approved to reopen the comment period for 60 days for the proposed reclassification of the Neuse River to Class Water Supply V (WS-V). The hearing officers presented their report from the public hearings and comments. The reason for this reclassification is that the Town of Wake Forest decided to merge water systems with the City of Raleigh after the WS-IV recent reclassification, and neither municipality have used, currently use, or intend to use the waters as a public water supply source.
- ❑ Approved reclassification of the Uwharrie River (Montgomery and Randolph Counties, Yadkin-Pee Dee River Basin) to Class B (primary recreation). Water quality studies conducted in August 2004 showed that the waters proposed to be reclassified meet Class B criteria. This will then go before the Rules Review Commission in June and if approved, the effective date will be July 1, 2006.
- ❑ Approved to uphold the Administrative Law Judge's decision for Cathy Epps versus DENR, DAQ 2004-254, 05 HER 0130, Nash County.

May Action of the EMC Water Quality Committee

At its regularly scheduled meeting on May 10, 2006, the Water Quality Committee (WQC) of the EMC took the following action:

- ❑ Approved modifications to the following local governments' water supply watershed protection ordinances: City of Fayetteville, Guilford County, Forsyth County, City of Winston-Salem, and City of Trinity.
- ❑ Deferred approval of modifications to the City of Hickory water supply watershed protection ordinance to the next Water Quality Committee meeting in July. The Committee requested that representatives from the City of Hickory attend the meeting in July.
- ❑ Approved major variance from the Randleman Lake water supply watershed rules (15A NCAC 02B .0250) for area 2 of the Kersey Valley Landfill in High Point. The City of High Point proposed to expand their existing municipal solid waste landfill near Kersey Valley Road in High Point. The proposed expansion includes impacting approximately 2,000 linear feet of the intermittent stream channel within the landfill properties. The area 2 expansion has been included in long-range planning and property acquisitions by the City since the early 1980s.
- ❑ Approved to send to the EMC the draft Roanoke River Basinwide Water Quality Plan to be released for public review and comment. The final draft will be brought back to the Water Quality Committee for final approval in September along with a request to present to the EMC the following day.

More information is available at the EMC web site:
http://h2o.enr.state.nc.us/admin/emc/

Upcoming Events

August 2-4, 2006
2006 Annual Southeast Watershed Roundtable and North Carolina Statewide Roundtable
Crown Plaza Resort
Asheville, NC
Web: http://www.bae.ncsu.edu/programs/wqg/roundtable/

September 11, 2006, 11:30 am
NC Water Resources Association Forum:
McKimmon Center, Raleigh, NC
North Carolina Nutrient Criteria and the Reservoir Protection Act
Coleen Sullins, NC Division of Water Quality
Melissa Kenney, Duke University
Web: http://www.ncsu.edu/ncwra/

September 19-20, 2006
Fall Erosion and Sedimentation Control Planning and Design Workshop
New Bern, NC
Web: http://www.ncsu.edu/wrri/erosionseminars.html

September 24-28, 2006
14th National Nonpoint Source Monitoring Workshop: Measuring Project and Program Effectiveness
Minneapolis, MN
Web: http://www.ctic.purdue.edu/NPSWorkshop/NPSWorkshop.html

October 2-5, 2006
Stream Restoration in the Southeast: Accomplishments and Opportunities
The Westin Charlotte
Charlotte, North Carolina
Web: http://www.ncsu.edu/sri/2006conference/

November 12-15, 2006
2006 NC AWWA/WEA Annual Conference
Sheraton Four Seasons & Koury Convention Center
Greensboro, NC
Web: http://www.ncawwa-wea.org/

November 29-30, 2006
Fall Erosion and Sedimentation Control Planning and Design Workshop
Hickory, NC
Web: http://www.ncsu.edu/wrri/erosionseminars.html

December 4, 2006, 11:30 am
NC Water Resources Association Forum:
McKimmon Center, Raleigh, NC
Web: http://www.ncsu.edu/ncwra/

March 27-28, 2007
WRRI Annual Conference
McKimmon Center, Raleigh, NC

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