Water Resources Research Institute News
of The University of North Carolina

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Drought in Piedmont classified "exceptional," Governor calls for conservation

On June 24, the City of Greensboro instituted "Phase IIB, Level II" water conservation restrictions which prohibit most outdoor uses of water. Greensboro had been on somewhat less restrictive water conservation measures since December 2001. According to Greensboro Water Supply Manager Steve Drew, if the city had not instituted those measures when it did, it would now have only a 67-day supply of water left in its reservoirs. Furthermore, if Greensboro had not learned a lesson during the mid 1980s and established interconnections with neighboring communities from which it is now purchasing water, the city would have only 35 days of water left, said Drew.

Drew was one of the speakers at a drought conference on July 12 that provided the backdrop for a meeting of the N.C. Drought Monitoring Council and an announcement by Governor Mike Easley calling on North Carolinians across the state to conserve water.

Governor Easley issued a statement on July 12 asking the federal government to designate 54 North Carolina counties disaster areas due to severe drought throughout the state. On recommendation of the N.C. Drought Monitoring Council, the governor also called on all water systems and agricultural and industrial users in the Cape Fear River Basin, the Yadkin River Basin, and in Piedmont areas classified as in "exceptional" or "extreme" drought to reduce their water use by at least 20 percent through mandatory restrictions.

Greensboro is the "bull's eye" of the area in central Piedmont North Carolina that the U.S. Drought Monitor says is experiencing "exceptional drought" (see map page 4). The Drought Monitor's classification system is based on six key indicators, and "exceptional drought" is the highest classification. It indicates "exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies." (See http://drought.unl.edu/dm/archive/99/classify.htm for explanation of the classification system.)

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Director's Forum

Managing Drought Risk

Stuart S. Schwartz, Associate Director, Water Resources Research Institute

The persistent drought intensifying over central North Carolina and southern Virginia, provides a renewed focus on understanding and managing drought risk. Though familiar to many, the ubiquitous presence of the current drought tends to blur important distinctions between drought definitions, impacts, and risks. Droughts can be characterized in many different ways. Most commonly, drought is described by the departure of accumulated precipitation from long-term seasonal averages or climatology. These observed statistical anomalies are referred to as meteorological drought. Over varying time scales, unregulated rivers and streams naturally respond to meteorological drought with unusually low streamflows. Hydrologic drought refers to the departure of streamflows from their long-term averages. Meteorological drought and hydrologic drought refer to the frequency, duration, and magnitude of unusual dry anomalies in the hydrologic cycle.

The persistence of meteorological drought and hydrologic drought can lead to shortfalls between available water and the demand for moisture that is beneficially used by natural vegetation, aquatic ecosystems, cultivated crops, and by man. For non-irrigated agricultural lands, the shortfall between moisture supply (from precipitation and soil moisture) and crop needs is referred to as agricultural drought. Water supply drought portends the potential shortfall between supply (from surface water, groundwater, and reservoir storage) and demand in water systems serving our cities, municipalities, and suburbs.

We can do little more than quantify the intensity, duration, and spatial extent of meteorological and hydrologic droughts. We can however plan for and manage the impacts of agricultural and water supply drought through actions, investments, and behavioral choices that alter both the supply and the demand for water. Long-term strategic planning and short-term tactical response to drought must be based on the management of drought risk. That risk consists of the probability of meteorologic and hydrologic drought, and the consequences of agricultural and water supply drought.

We know that "more extreme" drought conditions are always possible and in fact have occurred. Proxy climate data clearly record historical droughts in North Carolina that were substantially more extreme than those observed in the 20th century. Climate measures reconstructed from tree rings record persistent dry conditions from 1746-1764 that are unprecedented in modern meteorological

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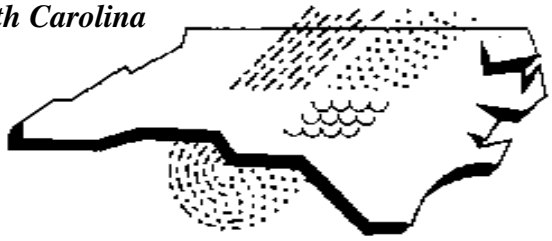

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records. Using centuries old bald cypress trees, David Stahle and his colleagues at the University of Arkansas Tree Ring laboratory have reconstructed proxy measures of moisture availability during the growing season in tidewater Virginia and North Carolina, back to the late 12th century. The most severe three-year drought, and the most severe growing season drought in their 800-year reconstruction, occurred in the late sixteenth century—coinciding precisely with the disappearance of the Lost Colony on Roanoke Island. The probability that severe meteorological droughts will occur is beyond our control. We can however exert considerable control over the risk and associated impacts from agricultural and water supply droughts, through drought management.

Fundamentally, drought management is the management of risks and reliability—such as the risk of imposing water use restrictions, or the reliably with which water for essential potable use, sanitary needs, and firefighting services will be provided. Like all risk management activities, drought management involves tradeoffs among, for example, the probability of satisfying unrestricted demands; the distribution and mitigation of impacts when demands cannot be fully met; and the costs to reduce, diversify, and mitigate undesirable outcomes when they inevitably occur. Thoughtful risk-based drought plans that integrate costs, risks, and impacts are essential tools in the effective management of water supply reliability.

Not all drought management plans integrate these risk-based tradeoffs. Some drought plans arbitrarily link familiar indexes of climatic drought with generic targets (e.g. 10%, 15%, etc.) for water use reductions, without any explicit consideration of risk. When such one-size-fits-all drought management plans are uncritically adopted—with the best of intentions—they result in a plan that has little likelihood of effectively mitigating the impacts of drought. During the 1999 mid-Atlantic drought ad hoc drought triggers decoupled from system-specific drought risk were used to implement water use restrictions in Maryland and Pennsylvania. Drought "declarations" were uniformly applied to both small community systems dependent on shallow wells (that are especially sensitive to modest meteorological droughts), and large municipalities protected by major reservoir systems. Confusing inconsistent messages resulted, in which water systems serving Pittsburgh and the Maryland suburbs of Washington D.C. were placed under water use restrictions—creating very real economic losses—despite the high reliability and low risk (achieved through substantial capital investment) designed into those municipal water supply systems.

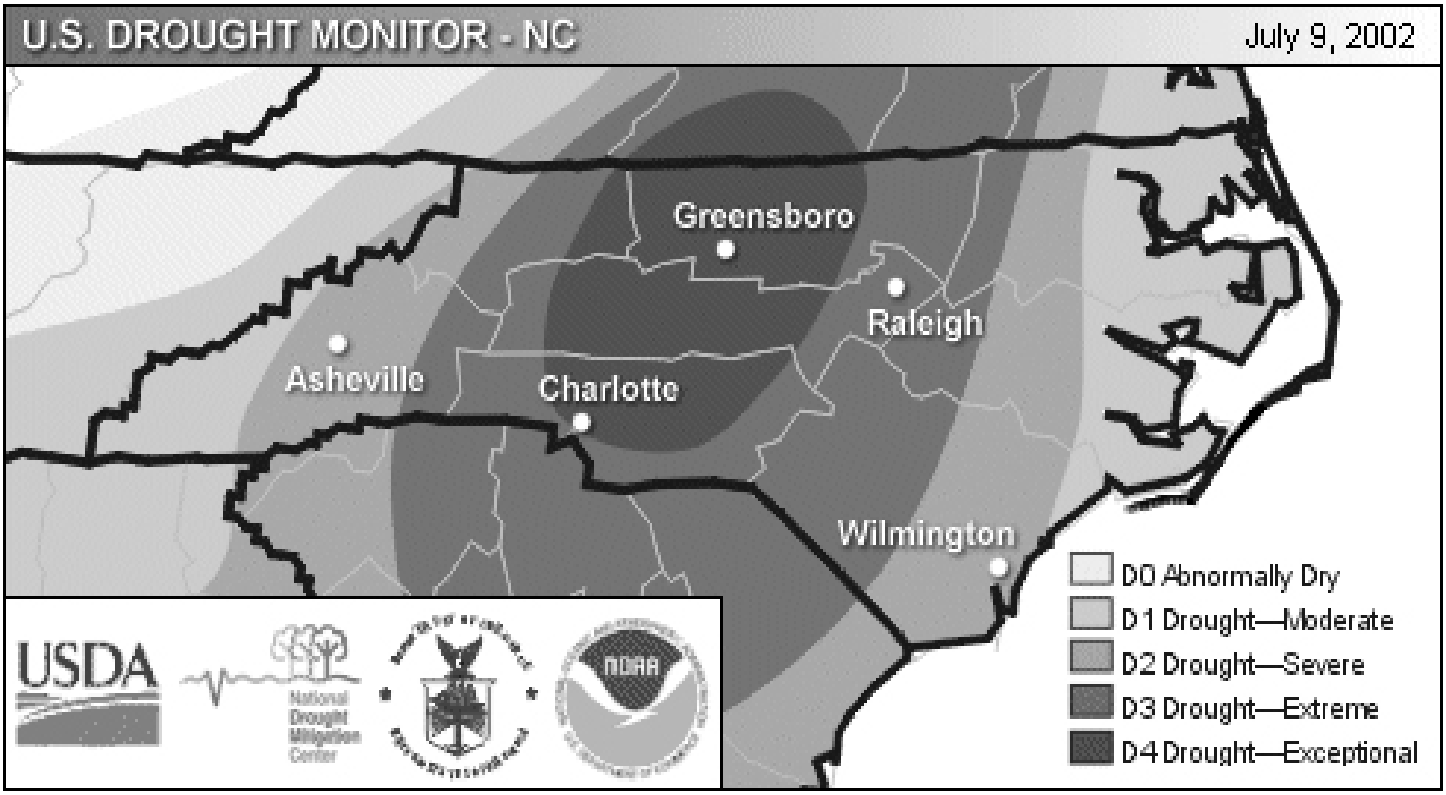
The drought of 2002 provides a timely opportunity to interpret current experiences through the lessons learned—and rediscovered—in national syntheses such as the U.S. Army Corps of Engineers' National Study of Water Management During Drought and the findings of the National Drought Policy Commission. These national studies identified critical elements common to successful drought plans. Foremost among them is the need for every drought plan to clearly identify and unambiguously articulate meaningful measurable objectives. For example, water use restrictions can be an essential instrument to achieve drought plan objectives, but "reducing water use" per se is not an *objective* of drought planning. Developing good planning objectives may be the most important and, paradoxically, the most often ignored step in the planning process.

National experience with prolonged drought, such as the 1987-1992 California drought, reinforces the conclusion that the success of drought response plans should be gauged by the minimization and equitable redistribution of the *impacts* of water shortages, not by the shortages themselves.

The overriding lesson from drought response planning throughout the United States is that the most effective tool in managing drought response is the confidence and cooperation of water users. This requires active stakeholder involvement and public education. Public participation is essential in both identifying clear management objectives, and evaluating credible, consistent strategies to achieve those objectives.

No drought plan can anticipate all of the possible impacts of severe droughts. The stresses and disruptions associated with the next drought will differ from any previously observed. Drought management plans therefore need to be dynamic, incorporating mechanisms to exercise, update, and revise the plan during non-drought conditions. Deficiencies in drought plans are best-identified and corrected under non-drought conditions, in the constructive atmosphere of a drought preparedness exercise. Like fire drills and war games, regular drought preparedness exercises maintain and improve readiness, and build the institutional knowledge and working relationships that are essential for successful drought management. This is standard practice in *all other* emergency management planning. The most effective plans for drought management maintain preparedness by treating drought operations as one of the normal modes of water system operations—albeit a mode of operation that occurs infrequently.

As we tighten our belts and wait for the most severe drought in recent memory to come to an end, we can confidently predict that an even more severe drought will occur sometime in the future. Water supply systems throughout the country have developed remarkably diverse solutions to the challenge of managing drought risk. Our challenge is to embrace the lessons learned from the drought of 2002, and incorporate them in the continual improvement of drought management plans that integrate and balance the risks, costs, and impacts of drought.



This map was taken from the website of the N.C. Drought Monitoring Council at http://drought.ncwater.org/

Drought continued

Greensboro may be the most hard-hit large city in North Carolina because of its limited reservoir capacity, but it is certainly not alone in feeling effects of a drought that is now in its fourth year. Eight-six water systems were reported under voluntary or mandatory water restrictions on July 10, and at least one community—Cherryville—was reported to be completely out of water and reliant on an emergency interconnection facilitated by a fire truck connecting two fire hydrants.

If anyone still needed convincing that North Carolina is experiencing a serious drought, reports presented at the July 12 conference and the unprecedented recommendations issued by the N.C. Drought Monitoring Council would have been persuasive.

Providing a bit of historical perspective, Ryan Boyles of the State Climate Office reminded the overflow audience that the current drought began in the summer of 1998 in the western part of the state, creeping east and intensifying.

Parts of western North Carolina have recovered somewhat from 1998 conditions and drought across most of the mountain region is now classified as only "severe" or "moderate." The Coastal Plain, likewise, is experiencing only "severe" or "moderate" drought. But in the Piedmont, where the majority of the state's population lives and where most large cities sit at the headwaters of streams, drought is "extreme" or "exceptional." More than 2.5 million people served by public water supply systems were affected by water use restrictions as of July 10.

Boyles said that over the last four years, many parts of North Carolina have gotten less than 75% of normal precipitation, which is like missing an entire year of rainfall. At Hickory, he said, conditions are worse, with only 50% of normal precipitation falling over the last four years.

Streamflows

Curtis Weaver with the U.S. Geological Survey described conditions revealed by the 200 streamflow gaging stations across the state. At many locations, Weaver said, streamflows are at less than 10% of normal and have been that way for many months.

The Flat River at Bahama, upstream of Durham's Lake Michie reservoir, set new record lows over the previous two months, with the seven-day average reaching lows that would be expected only every 100 years.

The South Yadkin near Mocksville has also reached 100-year seven-day average lows. The Trent River near New Bern has set a new daily low, and Big Bear Creek near Richfield in Stanly County is essentially dry.

During 1998-2001, record low daily flows were set at 65 sites across the state and record minimum seven-day average flows were set at 70 sites. By early July 2002, new record low daily flows and new record low seven-day average flows had been set at nine sites, mostly in the Piedmont. The USGS expects that as we head into fall, when streamflows are normally at their lowest, additional new record lows will be set.

continued

(Current streamflow conditions are available at the USGS N.C. District website: http://nc.water.usgs.gov/)

Groundwater

Nat Wilson with the N.C. Division of Water Resources (DWR) said that the system of 42 shallow or bedrock wells used by the State and USGS to monitor groundwater conditions across the state are "redefining the historic monthly minimum water level." Wilson said that these are wells with long records and that 14 have recorded new monthly minimums, reflecting declining groundwater conditions. The low groundwater conditions are obviously affecting streamflow, Wilson said, as below-normal low streamflows immediately return after rains.

DWR has been receiving reports from counties that many new wells are being drilled to replace shallow bored wells that have essentially run dry.

Corps reservoirs

Eric Farr with the Wilmington District of the U.S. Army Corps of Engineers reported on conditions of the reservoirs the Corps operates in North Carolina. The Corps has reduced outflows to minimum flows or minimum power generation at all of the Wilmington District projects, and the Southeast Power Administration has been purchasing power on the open market to offset the decrease in hydropower generation.

Over the past 46 months, inflows to Philpott Lake (Roanoke Basin) have been about 43% of average. The elevation of Philpott is 8 feet below the "guide curve," or the level at which the water conservation pool and the flood control volume are both at maximum.

Inflows to Kerr Dam (Roanoke Basin) have been below average for 46 of the last 49 months, with inflows over the last 12 months averaging about 31% of normal. The elevation of Kerr is 1.9 feet below the guide curve.

Over the last 49 months, inflows to Jordan Lake (Cape Fear Basin) have been about 73% of average. However, if September 1999 (Hurricane Floyd) is removed from the average, inflows to Jordan since June 1998 average 60% of normal. In May and June of 2002, inflows to Jordan were 10% and 7% of normal respectively. On July 10, the elevation of Jordan was 4.9 feet below the guide curve, and only 38% of the water quality pool (the volume available for downstream releases) remained. Releases have been reduced to meet a target of 300 cubic feet per second (as compared to the normal 600 cfs) at Lillington. Farr said that without significant rain, the water quality pool in Jordan will be depleted by September.

Over the past 49 months, inflows to Falls Lake (Neuse Basin) have been about 81% of average. Excluding the huge inflows during September 1999, inflows to Falls since June 1998 are at 52% of normal. Since January 2002, inflows to Falls have averaged 20% of normal. The elevation of Falls is 3.9 feet below guide curve. Sixty-four percent of the water supply pool remains, but only 58% of the water quality pool remains. Releases have been reduced, and the target flow at Clayton has been temporarily waived. The Corps projects that the level of Falls may drop below the City of Raleigh's highest water supply intake by August.

Over the last 48 months, inflows to W. Kerr Scott Reservoir (Yadkin Basin) have been about 54% of average. W.K. Scott is operated differently than other Corps reservoirs, with a provision for recovery of the reservoir level during mild droughts and a provision for maintenance of a specific level even during extended drought. The reservoir's elevation dropped below the guide curve for the first time since December 2001 on June 18, 2002. The minimum flow target for Wilkesboro has been modified.

Duke Energy operations

Duke Energy operates 11 multi-purpose reservoirs in the Catawba River Basin. According to Bill Stroud with Duke Energy, the company expected drought when the most recent La Niña event began making itself evident. Managers saved the last rains associated with the fading 1998 El Niño event and instituted a drought management plan based on an assumed three-year drought. However, Stroud said, despite Duke's careful management, longer-than-expected drought conditions are taking a toll on hydropower generation. In the last full year of operation, the company was able to generate only 39% of its long-term average. Through conservation, Duke has been able to maintain lake levels to a large degree (Lake Norman is at about the same level it was this time last year), but without significant rain in the Catawba Basin, lake levels will drop.

"I'm running out too," said Stroud.

Water quality impacts

Coleen Sullins, Chief of the N.C. Water Quality Section, described the consequences of the extended drought for stream water quality.

When there is an extended period of dry weather, a heavy load of pollutants builds up on hard surfaces. The first rain after a long dry period washes a high concentration of pollutants into streams that are at extremely low-flow conditions. The lack of dilution results in high concentrations of pollutants in the water column, and negative effects on aquatic life are inevitable.

In addition, wastewater discharge permit limits assume a certain flow volume in streams. When low flows drop to levels never before experienced, permitted wastewater discharges result in a higher pollutant concentration than water quality models anticipated.

Moreover, less water in streams results in higher water temperatures and lower dissolved oxygen. With less water in streams, flow slows and waters in reservoirs, behind dams (such as the Cape Fear locks and dams) and in estuarine areas are more likely to stratify, resulting in oxygen depletion in bottom waters.

As a result of all these consequences of drought, algae blooms and fish kills are more likely. As a result of algae blooms in water supply reservoirs, public water supplies may begin to see problems

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Drought *continued*

with taste and odor in finished drinking water.

In coastal areas, less freshwater flow means that salt water will intrude further upstream. Some industries and water supplies may have problems with salt or brackish water at their water intakes.

Agricultural and forestry impacts

According to Donald Buysse with the N.C. Department of Agriculture and Consumer Services, soil moisture was adequate over most of the state at planting time, so most crops got off to a good start. However, soil moisture conditions by early July were "short to very short" over 72% of the state and some crops, particularly corn, were at a critical juncture. The most hard-hit agricultural sector is hay and pasture, with some pasture land going dormant and cattle producers selling herds early for lack of feed. Estimates are that losses in the hay/pasture sector will reach $57 million and that losses in tobacco crops could reach $51 million. Buysse said that total possible losses to agriculture in North Carolina have been estimated at $170 million.

Carl Johnson with the N.C. Division of Forest Resources said that trees planted last winter are showing signs of extreme stress and that an entire year of planting could be lost, with accompanying economic losses to private landowners who paid for the plantings.

Johnson said that because of the drought, conditions are ripe for wildfires and that wildfire management is more difficult than normal because more fires are being caused by lightening than by human carelessness, which can be counteracted with public education and information.

Smoke management may be a big challenge for Forest Resources in the coming months, said Johnson, because forest fires in the eastern part of the state can ignite dry organic soils which create heavy smoke.

Economic impacts

Dr. Michael Walden, NCSU William Neal Reynolds Professor of Agricultural and Resource Economics, said that in addition to agricultural and forestry losses, the state will see losses in other sectors of the economy because of the drought.

Fish production is likely to be negatively affected as are all industrial activities that rely significantly on water, such as electric generation. As hydropower is replaced by more expensive fuels, both the electric industry and consumers are likely to feel the pinch.

Curtailed water-based recreation will affect many people in the recreation and tourism industry in direct and indirect ways, Walden said.

Decreased water sales will affect the operating budgets of public water systems, most operated by municipalities already feeling the economic pain of state budget problems.

If the drought continues, the economic picture becomes bleaker. Land values could decline, and with land values, revenue to federal, state, and local governments from reduced tax base. Farmers could be forced into bankruptcy, putting a strain on financial institutions and causing further losses in industries directly dependent on agricultural production. Water suppliers would be forced to increase the price of water, placing a disproportionate burden on low-income consumers and increasing the cost of industrial production.

"Water is a basic input to the economy," said Walden. "Higher water prices and lower water availability would make North Carolina's economy less competitive.

"For every 10% reduction in the availability of water, we could expect an $85 to $100 million reduction in income to the state."

The Outlook

Many months of above-average precipitation are needed to alleviate the current hydrological drought. How likely is it North Carolina will begin to receive above-average rainfall in the near future? Not very, according to State Climatologist Sethu Raman. The return of El Niño in the Pacific offers hope that the state will return to more normal rainfall conditions over the winter, but, so far, indications are that the warm episode will be much weaker than the 1997-98 El Niño, offering no indication that above-average rainfall is likely.

City of Concord receives USTfields grant

The City of Concord, NC, will receive one of 40 pilot grants under a new EPA program aimed at cleaning up and redeveloping commercial properties contaminated by leaking underground storage tanks (LUST).

These pilot projects, called USTfields, involve abandoned or underused industrial and commercial properties with perceived or actual contamination from LUST. EPA launched the USTfields initiative because statutory restrictions prevent the "Brownfields" program from addressing LUST sites. The pilots are being awarded to states and tribes to demonstrate what can be accomplished in the assessment and cleanup—and ultimate reuse—of petroleum-impacted sites when federal, state, tribal, local and private entities work together.

According to Susan Cannon with Concord's Planning and Community Development Department, Concord will receive $100,000 to remove at least 5 tanks and clean up 3 sites at the intersection of Cabarrus Avenue and Old Charlotte Road where a roundabout is planned as part of the city's Gateway to Center City revitalization project. The contaminated area is very close to Irish Buffalo Creek and is therefore ranked a high risk site by the State. The revitalization project is partly aimed at boosting "come-back" efforts by several older neighborhoods and providing better safety in an area with high pedestrian traffic.

Environment-related legislation in the N.C. General Assembly

The progress of legislation can be tracked on the General Assembly website: http://www.ncga.state.nc.us/

Legislation passed:

H 1578 AN ACT TO REMOVE THE SUNSET ON THE SCRAP TIRE DISPOSAL TAX.

S 1078 AN ACT TO IMPROVE AIR QUALITY IN THE STATE BY IMPOSING LIMITS ON THE EMISSION OF CERTAIN POLLUTANTS FROM CERTAIN FACILITIES THAT BURN COAL TO GENERATE ELECTRICITY AND TO PROVIDE FOR RECOVERY BY ELECTRIC UTILITIES OF THE COSTS OF ACHIEVING COMPLIANCE WITH THOSE LIMITS.

Some legislation introduced:

1541 AN ACT TO DELINEATE THE NOLICHUCKY RIVER BASIN AND TO REQUIRE THAT THE ENVIRONMENTAL MANAGEMENT COMMISSION DEVELOP AND IMPLEMENT A SEPARATE BASINWIDE WATER QUALITY MANAGEMENT PLAN FOR THE NOLICHUCKY RIVER BASIN, AS RECOMMENDED BY THE ENVIRONMENTAL REVIEW COMMISSION. (1st edition 6/06/02) Provides that all land in North Carolina that lies in the counties of Avery, Mitchell, or Yancey; that is located west of the eastern continental divide; and that drains into the Cane River, the North Toe River, the South Toe River, the Nolichucky River, or any tributary of any of those rivers is designated the Nolichucky River Basin. Provides that the Nolichucky River Basin shall be considered a major river basin and that the EMC shall develop and implement a separate basinwide water quality management plan for the Nolichucky River Basin and shall not include the Nolichucky River Basin in any basinwide water quality management plan that is developed for the French Broad River Basin.

H 1568 AN ACT TO AMEND THE SEDIMENTATION POLLUTION CONTROL ACT OF 1973, AS RECOMMENDED BY THE ENVIRONMENTAL REVIEW COMMISSION. (2nd edition 6/25/02) Requires that erosion and sedimentation control plans include a schedule for inspection of the area covered by the plan after each phase of the plan has been completed and after establishment of temporary ground cover. The person submitting the erosion and sedimentation control plan or his agent must perform inspections and post a record of the inspections on site, certifying that work has been completed in accordance with the plan and is being maintained properly. Increases the fee for review of erosion and sedimentation control plans by personnel of the State Land Quality Section to $150 per acre of disturbed land. Removes provision that the Sedimentation Control Commission (SCC) has sole jurisdiction over land disturbing activities conducted by local governments. Provides that the SCC may review erosion and sedimentation control plans approved by local erosion and sedimentation control programs and require revised plans and may take inspection and enforcement action if local programs have failed to do so. Provides that exposed slopes must be planted or provided with ground cover, devices or structures sufficient to restrain erosion within 10 working days (was 15) or 21 calendar days (was 30) of completion of any phase of grading, whichever period is shorter. Provides that a local government may submit to the SCC a request for a limited erosion and sedimentation control program in which the local government would perform inspections of land-disturbing activities and the SCC (the Land Quality Section) would be responsible for plan review and other components of the program. A local government that established a limited erosion and sedimentation control program would be required to establish a fee to be charged persons submitting erosion control plans that would cover a payment of $120 per acre of disturbed land inspected under its program into the Department of Environment and Natural Resources' Sedimentation Account and could cover cost of its inspection activities. Provides that two or more units of local government may establish a joint limited program. Provides that the Secretary of DENR may assess a civil penalty of up to $10,000 for the first day of a violation of the Sedimentation Pollution Control Act (SPC). Provides that DENR shall report to the Legislative Environmental Review Commission on implementation of the SPCA each year and shall include an analysis of how well the implementation is preventing sedimentation of waters of the State, whether fees and civil penalties are adequate to properly administer and enforce the act, and a review of the effectiveness of local erosion and sedimentation control programs.

H 1772 AN ACT TO ESTABLISH THE ROANOKE RIVER BASIN ADVISORY COMMITTEE AND THE ROANOKE RIVER BASIN BI-STATE COMMISSION AND TO APPROPRIATE FUNDS FOR THEIR SUPPORT. (1st edition 6/13/02) Establishes the Roanoke River Bi-State Commission composed of 9 members from N.C. and 9 from Virginia to facilitate communication among stakeholders and advise legislative and administrative bodies on problems of the Roanoke River Basin. Establishes a 19-member Roanoke River Basin Advisory Committee to advise the N.C. delegation to the Commission. Provides that Virginia and N.C. share funding of commission, appropriates $50,000 for 2002-2003 for committee and commission, and provides that if Virginia repeals legislation establishing the commission, the commission will terminate.

July action of the N.C. Environmental Management Commission

At its regular meeting on July 11, the N.C. Environmental Management Commission took the following action:

■ Elected Charles Peterson vice chairman of the commission.

■ Approved proceeding with permanent rulemaking, including publication in the *N.C. Register*, to establish the competitive bidding process and qualifications of environmental services firms, engineers, and engineering firms for performance-based cleanups at leaking petroleum underground storage tank (LUST) sites (15A NCAC 2P .0408).

■ Approved round three allocations for water supply storage in Jordan reservoir. The actions include:

❍ Allocating an additional 11.0 million gallons per day (MGD) for Cary and Apex for a total level I allocation of 32.0 MGD. (Level I allocations are made on the basis of a 20-year planning horizon and withdrawals are expected to begin within 5 years. Level II allocations are made on a 30-year planning basis.)

❍ Converting Chatham County's 2.0 MGD level II allocation to level I for a total level I allocation of 6.0 MGD.

❍ Allocating 10.0 MGD to the City of Durham as a level I allocation.

❍ Maintaining the Town of Holly Springs' current level II allocation at 2.0 MGD.

❍ Allocating an additional 1.0 MGD to the Town of Morrisville and converting the town's current 0.5 MGD level II allocation to level I for a total level I allocation of 3.5 MGD.

❍ Maintaining Orange County's current 1.0 MGD level II allocation.

❍ Reducing the Orange Water and Sewer Authority's level II 10.0 MGD allocation to 5.0 MGD.

❍ Allocating an additional 2.0 MGD to Wake County for a total level I allocation of 3.5 MGD.

❍ Allocating no water supply storage to the City of Fayetteville, Harnett County, or the City of Sanford.

❍ Imposing no additional conditions on Jordan water supply storage for the purposes of drought management or water supply emergencies because existing laws and policies already provide for these contingencies.

New commissioner Dr. Frank Shaw, who is from Fayetteville, voted against the allocations, questioning the ability of planned releases, especially during drought conditions, to maintain water quality downstream in the Cape Fear River.

■ Approved the final Neuse River Basinwide Water Quality Plan, the final Chowan River Basinwide Water Quality Plan and the final Pasquotank River Basinwide Water Quality Plan. The plans can be downloaded at the Basinwide Planning unit's webpage: http://h2o.enr.state.nc.us/basinwide/index.html. During presentation of the latter two plans, it was announced that EPA has expressed concern about the lack of visibility and activity in the Albemarle-Pamlico National Estuary Program (formerly known as the Albemarle-Pamlico Estuarine Study [APES]), and, as a result, the program has been moved to the secretary's office, and a new director, Bill Crowell, has been named.

■ Approved the nutrient response model for Jordan Lake. The model was developed to help determine what nutrient limitations should be placed on wastewater dischargers upstream of Jordan. In 1997, the North Carolina General Assembly passed the Clean Water Responsibility Act which required wastewater treatment facilities in nutrient sensitive watersheds to meet strict limits on the discharge of nitrogen and phosphorus. Later legislation allowed dischargers to delay implementation of the limits while a model was being developed to determine whether the specific limits were needed. In 1999, the EMC granted implementation extensions and approved a proposal from seven local governments (Burlington, Graham, Greensboro, Mebane, Orange Water and Sewer Authority, Pittsboro, and Reidsville, later joined by Apex and Cary) to develop the model. The model confirms that nitrogen is a nutrient of concern in Jordan (contradicting traditional wisdom). According to Michelle Woolfolk, head of the modeling unit of the Division of Water Quality, the next step is to develop a nutrient management plan for Jordan Lake. A proposed timeline was presented for development and adoption of a nutrient management plan; however, the EMC did not adopt the schedule. The EMC's Water Quality Committee is to discuss implementation issues at its September meeting.

■ Adopted amendments to wastewater discharge rules to deal with emergencies related to foot-and-mouth disease and terrorism (15A NCAC 2H .0103 and .0106)

■ Adopted rules providing for development in isolated wetlands. New state rules allowing impacts to isolated wetlands and waters became necessary following a U.S. Supreme Court decision that removed isolated wetlands from jurisdiction of the U.S. Army Corps of Engineers and essentially negated the federal program which would have allowed the impacts.

■ Approved reclassifying the Swift Creek watershed (Edgecombe, Franklin, Nash, Vance and Warren counties in the Tar-Pamlico River Basin) to Class C Outstanding Resource Waters/Nutrient Sensitive Waters (NSW), Class C NSW+ and Water Supply IV NSW+.

July action of the EMC's Water Quality Committee

At an extended meeting on July 10, the Water Quality Committee spent three hours discussing issues related to the NPDES Stormwater Phase II rules that were raised during public hearings in June. The issues involved criteria for designating urban areas for participation in the program, what kinds of stormwater controls can be required for existing development, and what to require for petitions to designate areas to implement stormwater controls. Check the Stormwater and General Permits Unit website: http://h2o.enr.state.nc.us/su/stormwater.html for the latest iteration of the Phase II rules. Temporary rules are due to be adopted in October and applications from federally designated "MS4's," (municipalities that operate separate storm sewer systems) are due to be submitted in March 2003.

In other action, the Water Quality Committee:

- Approved Water Supply Watershed Protection Ordinances for the Town of East Bend and the City of Goldsboro.

- Approved seeking permission from the full EMC to hold public hearings on proposals to reclassify a section of Richland Creek in Haywood County (French Broad River Basin) to Class B Trout and a section of He Creek, Jerry Branch, and Henry Fork in Burke County (Catawba River Basin) to WS-V Outstanding Resource Waters.

- Approved submitting the Annual Report on the Coastal Habitat Protection Plans (CHPPs) to the Environmental Review Commission and the Joint Legislative Commission on Seafood and Aquaculture. The annual report and development of Coastal Habitat Protection Plans are required by the Fisheries Reform Act of 1997. According to Dianne Reid, who presented the report, development of the Coastal Habitat Protection Plans is behind schedule, and the General Assembly will be asked to extend the deadline for the final plans by one year to July 2004. For information on the CHPPs visit the Division of Marine Fisheries website at: http://www.ncfisheries.net/habitat/chpp1.htm. Water Quality Chief Coleen Sullins told the committee that implementation issues associated with coastal habitat plans are complex and that staff wants to begin talking with the EMC and the Coastal Resources Commission about the issues—possibly in October with a joint meeting.

- Approved with some additions a presentation to be made to the N.C. Coastal Resources Commission in response to its request for a report on its 1999 petition for rulemaking (see Jan/Feb 2000 WRRI News: http://www2.ncsu.edu/ncsu/CIL/WRRI/news/jf00crc.html). According to Alan Clark with the DWQ Planning Branch, although no rulemaking has been undertaking as a direct response to the CRC's petition, many actions have been undertaken by the EMC that address issues identified by the CRC and its N.C. Estuarine Shoreline Protection Stakeholders group.

- Helped the Town of Ocracoke work out a plan for expanding its solid waste collection site what will avoid the necessity of a major variance to the Tar-Pamlico River Riparian Buffer Rules.

- Heard that the municipalities of Archdale, High Point, Jamestown and Randleman and the counties of Randolph and Forsyth—all located in the Randleman Lake watershed—have developed a map that combines USGS stream information and USDA soils information and that will be used to identify streams for buffer protection in the Randleman watershed. The Piedmont Triad COG carried out the project for the local governments.

North Carolina ferries monitor water quality

by Hans W. Paerl, Kenan Professor of Maine and Environmental Sciences, UNC-CH Institute of Marine Sciences, Morehead City, NC
hpaerl@email.unc.edu

The University of North Carolina at Chapel Hill's Institute of Maine Sciences and Duke University's Marine Lab are jointly developing ferry-based water quality monitoring as a regional and national tool for assessing estuarine and coastal ecosystem health.

In 2000, following massive flooding that inundated Pamlico Sound due to hurricanes Dennis, Floyd and Irene, the N.C. Department of Environment and Natural Resources (Hurricane Floyd Relief Funds) helped establish a pilot water quality monitoring program using the N.C. Department of Transporta-tion's ferries. The long-term goals of the FerryMon program are to:

- assess and predict the relationships between human nutrient and pollutant inputs, algal blooms, and associated water quality changes, and ecosystems response;
- provide information critical to long-term water quality and fishery management; and
- develop FerryMon as a national model for real-time assessment of coastal water quality.

Three N.C. DOT ferries crossing the Neuse River Estuary and Pamlico Sound are equipped with automated water quality monitoring systems. The Cedar Island-Ocracoke crosses the southern Pamlico Sound and Ocracoke Inlet and the Swan Quarter-Ocracoke Ferry crosses the central Pamlico Sound each several times a day. The Neuse River Ferry makes 40 crossing each day between Cherry Point and Minnesott

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FerryMon *continued*

Beach. These strategic crossings cover a broad spectrum of Albemarle-Pamlico Estuarine System water quality conditions, including periodic algal blooms, low oxygen bottom water, and periodic fish kills.

A flow-through, automated system continuously monitors surface waters along the ferry route for temperature, salinity, pH, dissolved oxygen, turbidity, chlorophyll (algal growth), and geographic (GPS) position. A discrete sampler collects nutrient and algal composition, organic matter, and total suspended solid samples. All this takes place below deck, in the ferries' sea chest where instrumentation shares a water intake with the ferry's cooling system. Data are sent to a computer and at night the data are transmitted via cell phone to the laboratory for processing and use by water quality mangers and researchers.

FerryMon provides a unique, long-term and cost-effective "real-time" observing system to evaluate status and trends in Albemarle-Pamlico system water quality. The data will be used to develop a long-term database for gaging change and constructing predictive water quality models needed to advise policy, regulatory, and management action. The FerryMon system can also be used to provide real-time, ground-truthing data for calibration of aircraft and satellite-based remote sensing of estuarine and coastal productivity and health, both regionally and nationally.

Having successfully completed the proof-of-concept stage, the goal for FerryMon is to increase coverage of the estuarine system and ensure funding beyond 2002. FerryMon can serve as a national model for large-scale, long-term, intensive water quality monitoring of a range of estuarine and coastal waters traversed by ferries and other vessels (e.g., Long Island Sound, Chesapeake Bay, Puget Sound).

A more detailed description of the FerryMon program can be found at www.marine.unc.edu/Paerllab/ferrymon.html.

City of Shelby implements certified environmental management system

The City of Shelby's Wastewater Treatment Division has become North Carolina's second governmental entity to receive certification for implementing an international environmental management standard (EMS) that conforms to ISO 14001. The City of Gastonia was the first to receive the certification.

In order to become certified to ISO 14001, an organization must develop a plan to meet certain standards. An EMS is a tool that provides organizations a method to systematically manage their environmental activities. An EMS follows a Plan-Do-Check-Act cycle and can be used by a wide range of organizations.

Shelby's Wastewater Treatment Division began development of its EMS in July 2001, when it was accepted into the N.C. Department of Environment and Natural Resources, Division of Pollution Prevention and Environmental Assistance (DPPEA) Environmental Management System Development Course for Government Agencies. The EMS will help in reducing the facility's impacts on the environment and become a more efficient entity and a role model for others.

The City of Shelby Utilities Wastewater Treatment Division operates a 6 million gallon-per-day wastewater treatment facility, including a compost facility that processes biosolids for beneficial reuse. The wastewater is discharged into the First Broad River.

National Research Council says less than 8% of oil pollution comes from tanker and pipeline spills

About 29 million gallons of petroleum reach North American ocean waters each year as a result of human activities. Less than 8% can be attributed to tanker or pipeline spills. Nearly 85% comes from land-based runoff, polluted rivers, airplanes, and small boats and jet skis. That is the conclusion of a new report from the National Research Council (NRC).

Oil exploration and extraction are responsible for only 3% of the petroleum that enters the sea. Another 47 million gallons seep into the ocean naturally from the sea floor.

The report says that while oil slicks and birds blackened by oil get the most public attention, it is consumers of oil—not the ships that transport it—who are responsible for most of what finds its way into the ocean. For example, runoff from cars and trucks is increasing in coastal areas where the population is growing and roads and parking lots are expanding to accommodate it. Rivers polluted by oil in wastewater or the improper disposal of petroleum products are a significant source of oil in the sea as well. In addition, older two-stroke engines still found on many recreational boats and jet skis were purposely designed to discharge gasoline and oil. Land runoff and recreational boating account for nearly three-quarters of the 25 million gallons of petroleum released into the sea annually through consumption of petroleum. Other sources of oil from human activities include military and commercial jets that occasionally jettison excess fuel over the ocean and ships that release oil from their engines while in port or at sea.

More than one-half of the land-based oil contamination along the North American coastline occurs between Maine and Virginia, where there are dense seaside populations, many cities,

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several refineries, and high energy use, the report says. About 20% of the land-based petroleum entering North American coastal waters ends up in the Gulf of Mexico. The gulf also receives most of the oil and gas that is emitted by recreational boats and jet skis.

The report recommends that to better monitor how much oil consumers and industry are depositing in the ocean, federal agencies should work with state and local environmental bureaus to develop a system for documenting sources of runoff. In addition, the U.S. Environmental Protection Agency should continue efforts to phase out older, inefficient two-stroke engines, which power many jet skis and other small watercraft.

Studies used by the NRC for its report show that the amount of petroleum released to North American and global waters is less than previously thought but that the environmental effects of a major oil spill are longer lasting than once thought and that even small amounts of petroleum can seriously damage marine life and ecosystems. A spill's influence depends of the type and amount of toxins present in the petroleum product being released. The riskiest toxins are a class of organic compounds known as polycyclic aromatic hydrocarbons, or PAHs. Growing evidence suggest that PAHs can have adverse effects on marine species at very low concentrations. This means chronic releases from runoff and recreational boating may inflict more damage than previously thought.

The report recommends that the U.S. Coast Guard and U.S. Maritime Administration should work with ship owners domestically and internationally through the International Maritime Organization to expand and enforce shipping standards that already have contributed to a decline in oil spills and operational discharges.

The report, *Oil in the Sea: Inputs, Fates and Effects*, is available on the internet at http://www.nap.edu. Copies are available for purchase from the National Academy Press (202) 334-3313 or 1-800-624-6242.

WRRI reports available

WRRI has recently published peer-reviewed technical completion reports on research projects for which it provided funding. Single copies of WRRI reports are available free to federal/state water resource agencies, state water resources research institutes, and other water research institutions with which exchange agreements have been made. Single copies of publications are available to North Carolina residents at a cost of $4 per copy prepaid ($6 per copy if billed) and to nonresidents at a cost of $8 per copy prepaid ($10 per copy if billed). Send requests to WRRI, Box 7912, North Carolina State University, Raleigh, NC 27695-7912 or call (919) 515-2815 or email: water_resources@ncsu.edu.

***Assessment of Trace Element Concentrations in Municipal Wastewater Treatment Plant Discharges in North Carolina* Report 337 May 2002**

Howard S. Weinberg, Philip C. Singer, and Steven J. Cook
UNC-CH Department of Environmental Sciences and Engineering

This project was designed to identify the sources of problems faced by several wastewater treatment plants with regard to compliance on the levels of cadmium, mercury and cyanide in their effluents. The goals of the project were to investigate the issue of non-compliance, to evaluate and modify where necessary the current analytical methodologies for these 3 components, and to establish exact and precise protocols for accurate determination of these components in wastewaters.

Historical records were evaluated for the levels of the three components in the effluents of each wastewater treatment plant. The laboratory facilities at each site were explored, the supervisors questioned on their facilities and techniques, and their documented procedures examined. A comprehensive survey of plant effluents using precise protocols for sample handling, collection, and analysis was conducted, with samples being split between three laboratories for a comparison of quality control. A more focused study involving simultaneous use of different analytical techniques was conducted on issues surrounding cyanide measurement.

The investigators concluded that when fully implemented, the quality assurance (QA) protocols for sample handling, collection, and analysis of cadmium in wastewater effluents results in the collection of accurate and reliable data. In cases where detectable levels of cadmium were found in the effluents of wastewater treatment plants, these levels were also present in the plant prior to disinfection.

In the case of mercury, the QA procedures that were implemented indicated serious misgivings about the use of the existing cold-vapor atomic absorption methodology for the determination of this element at levels close to the instrument detection limit (0.2 ppb). Results indicate that for practical purposes, a detection limit of less than 0.5 ppb mercury in wastewater is inappropriate when utilizing the approved methodology (EPA Method 245.1, 245.2 or Standard Method 3500 Hg) and that utilities cannot be held accountable for laboratory reported results that fail QA criteria. If the 0.012 ppb limit is to be enforced, then samples must be analyzed by EPA Method 1631 or equivalent.

Although there was some disparity between various analytical laboratories on levels of cyanide in the same sample, a trend emerged revealing potential interference from chlorination (high levels after chlorination, negligible levels before) and the potential presence of artifacts (disparity between the results using two different analytical techniques in the same analytical laboratory). A more detailed investigation of the potential sources of artifacts in the wastewater at plants employing terminal chlorination revealed that currently practiced protocols were insufficient to determine or remove the apparent high

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Weinberg et al continued

levels of cyanide (as determined by existing methodologies currently either EPA Method 335.2 or Standard Method 4500CN). Furthermore, matrix recovery standards exhibited a wide range of values on the same sample analyzed at different laboratories. This basic failure in QA necessitates a complete re-evaluation of the current practiced procedures.

The investigators say that utilities need to become acquainted with QC criteria and be more proactive in determining to their satisfaction that contract laboratories are performing appropriate QC. This report provides the criteria to guide them in selection of contract laboratories and to ensure that analytical data reported has the associated QC parameters.

Biologically Mediated Nitrogen Dynamics in Eutrophying Estuaries: Assessing Denitrification, N_2 Fixation, and Primary Productivity Responses to Proposed N Loading Reductions in the Neuse River Estuary
Report 339 May 2002

Michael F. Piehler, Suzanne P. Thompson, Julianne Dyble, Pia H. Moisander, John M. Fear and Hans W. Paerl
Institute of Marine Sciences, University of North Carolina-Chapel Hill

The investigators used experimental manipulations to predict the effects of reducing the ratio of dissolved inorganic nitrogen (DIN) to dissolved inorganic phosphorus (DIP) in the Neuse River Estuary on the structure and function of the native phytoplankton community. They conducted dilution bioassays throughout 1997 and 1998 at one site in the Neuse River Estuary and one upstream site. They also assessed spatial and temporal rates of denitrification—an important sink for nitrogen— in the Neuse River Estuary using the acetylene block technique. Results of the study provide information regarding the likelihood for success of North Carolina's nutrient management strategy for the Neuse River Estuary and experimentally based predictions about potential unanticipated collateral effects on the nutrient cycling and microbial community structure and function in the estuary.

The results indicate that a 30% reduction in nitrogen levels is likely to decrease phytoplankton productivity in the upper estuary. Reduction in levels of both nitrogen and phosphorus that may result from implementation of proposed Best Management Practices would likely lead to further reduction in phytoplankton productivity. Reduction of phosphorus levels is expected to be less effective at reducing phytoplankton productivity than reduction of nitrogen in the upper estuary. None of the nutrient reductions tested decreased phytoplankton productivity significantly at the riverine site.

Results indicate that should reduction of nitrogen levels in the estuary lead to decreased ratios of dissolved inorganic nitrogen to phosphorus, nitrogen-fixing cyanobacteria may be more active during periods in which they are cycling in the estuary. However, N_2 fixation revealed by the study was confined to a relatively narrow temporal window.

Projections using current models of the kinetics of nitrate utilization by denitrifiers indicate that a reduction in nitrogen levels in the estuary will not decrease the percentage of nitrogen removed via denitrification.

As a whole, the results of this study support the likelihood of success of nitrogen management in the Neuse River watershed to control phytoplankton productivity. The investigators say they found little to indicate that unanticipated detrimental effects of nitrogen management (e.g. a decrease in the importance of denitrification as a sink or an increase in the abundance and distribution of nitrogen-fixing cyanobacteria) are likely to be major concerns.

The investigators point out that all experiments conducted were relatively short term (ca 5 days) and of moderate volume, so they may not reflect changes that would occur on an ecosystem scale.

Studies

Researchers develop tool for determining cost-effective solid waste management strategies

If a community were required to reduce the volume of its solid waste going to landfills by a certain percent, what would be the least costly and most environmentally friendly way to meet that requirement? Until now answering that question would be exceedingly difficult, if not impossible. But, in a project for the U.S. EPA and the Research Triangle Institute, researchers have developed a computer decision support tool (DST) that will allow managers of municipal solid waste to determine optimum management strategies based on cost or environmental burdens, or a combination of both.

The work was performed by NCSU Department of Civil Engineering Professors Morton Barlaz and Downey Brill, Associate Professor Ranji Ranjithan, and graduate research assistants, including Kenneth W. Harrison, Robert D. Dumas and Eric Solano in collaboration with Keith Weitz of the Research Triangle Institute. Articles resulting from the work have been published by the *Journal of Life Cycle Analysis*, the *Journal of Computing in Civil Engineering*, and the *Journal of Environmental Engineering*.

Managers of municipal solid waste struggle to find strategies that address numerous concerns including cost, environmental performance, and social and political acceptability. For some time, computer tools have been available to provide managers useful information on cost and operational parameters, but these tools have not helped managers project the environmental consequences of their decisions, and they have required managers to evaluate strategies by manually defining and comparing one solution after another. Because there are so many components of municipal solid

waste and so many options for and constraints on managing them, a manual search process may not be likely to produce a good strategy.

Researchers on this project set out to develop easy-to-use solid waste management planning software that allows managers to identify alternative strategies that meet cost, energy, and environmental emissions objectives. The DST they developed is based on a life-cycle management approach, beginning with municipal solid waste generation and considering the inputs and effects to all life cycle stages resulting from management choices. It allows managers to study a municipal solid waste system of a given quantity and composition and to evaluate the relative cost and environmental performance of integrated strategies. Managers can, for instance, determine how the cost and environmental performance of a system will change if a specific material (such as glass or plastic) is added to or removed from a recycling program or if paper is recycled rather than combusted or landfilled with energy recovery.

The DST consists of several components:

- process models implemented as Excel spreadsheets using a combination of default and user-supplied data to calculate the cost and environmental coefficients on a per unit mass (ton) basis for each waste material modeled for each of 40 unit process (generation, collection, transfer separation, composting, combustion, refuse-derived fuel combustion, disposal in a landfill, and remanufacture in the case of recycling),
- equations representing the mass flow of each item through all possible combinations of unit processes
- an optimization model governed by mass flow equations based on the quantity and composition of waste entering each unit process, and
- a graphic user interface.

The DST considers municipal solid waste consisting of a combination of 42 possible waste items set out at the curb and how this waste is collected, treated, and disposed of or converted to a useful product through recycling. The waste items include mixed municipal solid waste generated in the residential, commercial, institutional and industrial sectors but not industrial process waste, sludge, construction and demolition, waste, pathological waste, agricultural waste, mining waste, and hazardous waste.

The manager can define some of the waste items, all of which have distinct properties that are considered in allocating cost and environmental parameters. The manager can also specify constraints, such as the use of existing facilities and a minimum recycling percentage. Managers can optimize on annual cost, electricity consumption, greenhouse gas equivalents, or emissions of carbon monoxide, carbon dioxide (fossil or biomass), nitrogen oxides, particulate matter, and sulfur dioxide.

The DST does not consider "upstream" life cycle activities such as raw materials extraction and manufacturing. When a material is recycled the DST calculates and includes the net (compared to manufacture from virgin resources) resource and energy consumption and environmental releases associated with manufacture of a new product. When liquid wastes are generated (landfill leachate), the DST considers the resource and energy consumption and environmental releases associated with treatment of the wastes. When solid waste must be landfilled or compost is produced and applied to land, the DST calculates and includes associated environmental emissions and energy demands. Total energy consumption and total emissions of carbon monoxide, fossil- and biomass-derived carbon dioxide, total oxides of nitrogen, total oxides of sulfur, particulate matter and green house gases are calculated.

The DST is meant to be a screening tool that managers can use to search for alternative strategies that meet cost and life-cycle emissions goals and is meant to be used in an iterative process. Managers can further evaluate the alternatives generated by this tool by analyzing such factors as facility siting and vehicle routing, design of individual unit processes, and financial considerations then, if necessary, return to the tool to investigate new strategies that address issues raised.

The researchers have used the DST to examine an array of scenarios, including a minimum cost scenario, one set of scenarios in which a given community is required to divert various percentages of waste from a landfill by recycling, and another set of scenarios in which various diversion rates are to be accomplished by recycling, yard waste composting and waste combustion. While the outcome of any scenario is highly dependent upon waste generation and composition and recycling participation rates, some general themes emerged from the scenarios. Selecting the minimum cost strategy results in a waste diversion rate of about 14%. Selecting a diversion rate at 0% results in increased cost for waste management.

Specifying the diversion to be accomplished by recycling alone and maximizing diversion results in a 26.5% diversion and a cost that is nearly double the minimum cost. Materials recovery at a mixed waste material recovery facility is revealed to be the most efficient (more material recovered per dollar) diversion-through-recycling option. Residential curbside recycling is revealed to be less efficient than multifamily and commercial recycling, likely because of the higher concentrations of materials available at each location in the non-residential sectors.

Specifying diversion to be accomplished by recycling, yard waste composting and waste combustion and maximizing diversion results in an 82.3% diversion possibility. The cost for the maximum diversion is more than double the minimum cost scenario and the increase in cost for the last increment of diversion (from 60% to 82.3%) is about 50%.

The solid waste management DST is now available to help communities

continued

Solid waste DST *continued*

evaluate their current management strategies and develop new ones based on their management goals.

Weitz, Keith, Morton Barlaz, Ranji Ranjithan, Downey Brill, Susan Thorneloe, and Robert Ham. 1999. Life Cycle Management of Municipal Solid Waste. *International Journal of Life Cycle Analysis* 4(4): 195-201.

Harrison, Kenneth W., Robert D. Dumas, Eric Solano, Morton A. Barlaz, E. Downey Brill, Jr., and S. Ranji Ranjithan. 2001. Decision Support Tool for Life-Cycle-Based Solid Waste Management. *Journal of Computing in Civil Engineering* 15 (1): 44-58.

Solano, Eric, S. Ranjii Ranjithan, Morton A. Barlaz, and E. Downey Brill. *In press*. Life Cycle-Based Solid Waste Management – 1. Model Development. *Journal of Environmental Engineering*.

Solano, Eric, Robert D. Dumas, Kenneth W. Harrison, S. Ranji Ranjithan, Morton A. Barlaz, and E. Downey Brill. *In press*. Life Cycle-Based Solid Waste Management – 2. Illustrative Applications. *Journal of Environmental Engineering*.

Corresponding author Morton Barlaz, Department of Civil Engineering, NC State University, barlaz@eos.ncsu.edu.

Selected Precipitation Summaries

Provided by the State Climate Office of North Carolina

Station	Departure from normal since July 1998
Asheville AP	-46.08" (76% of normal)
Tryon	-60.42" (77% of normal)
Hickory AP	-66.94" (66% of normal)
Charlotte AP	-45.42" (74% of normal)
Concord	-42.49 (78% of normal)
Danbury	-57.83 (70% of normal)
Greensboro WSO AP	-26.97" (84% of normal)
Fayetteville	-26.52" (86% of normal)
Raleigh/Durham AP	-10.55" (94% of normal)
Wilmington AP	-20.60" (91% of normal)
New Bern AP	-29.62" (87% of normal)

Personnel and organizational changes.

■ N.C. Secretary of Environment and Natural Resources (ENR) Bill Ross announced in May that **Alan Klimek** has appointed Director of the Division of Water Quality, effective June 1. Klimek had served as Director of the Division of Air Quality (DAQ) since 1996 and before that had served as Chief of the Air Quality Section of the former Division of Environmental Management. Previously he worked for 20 years in the Water Quality Section of DEM. **Keith Overcash**, Deputy Director of DAQ, will serve as acting director until a permanent appointment is made.

■ Also in May, ENR Secretary Bill Ross announced that the **Albemarle-Pamlico Natural Estuary program** is being

North Carolina Precipitation/Water Resources

	May	June
Rainfall (+/- average)		
Asheville	3.42" (-0.99")	6.13" (+1.75")
Charlotte	4.18" (+0.52")	1.24" (-2.18")
Elizabeth City	1.48" (-2.95")	5.06" (+1.33")
Greensboro	2.96" (-0.99")	3.73" (+0.20")
Raleigh	1.13" (-2.66")	2.75" (-0.67")
Wilmington	2.42" (-1.98")	4.21" (-1.15")

Streamflow **Index Station** (County, Basin)	**May mean flow (CFS)** (% of long-term median)	**June mean flow (CFS)** (% of long-term median)
Valley River at Tomotla (Cherokee, Hiwassee)	315 (132%)	125 (71%)
Oconaluftee River at Birdtown (Swain, Tenn)	588 (109%)	265 (60%)
French Broad River at Asheville (Buncombe, FB)	1,470 (57%)	893 (49%)
South Fork New near Jefferson (Ashe, New)	223 (42%)	172 (36%)
Elk Creek at Elkville (Wilkes, Yadkin/Pee-Dee)	38.0 (25%)	23.5 (25%)
Fisher River near Copeland (Surry, Yadkin/Pee-Dee)	58.6 (26%) Rcrd Mnth Low	30.2 (18%) Rcrd Mnth Low
South Yadkin River near Mocksville (Rowan, Yadkin/PD)	89.5 (21%) Rcrd Mnth Low	38.7(13%) Rcrd Mnth Low
Rocky River near Norwood (Stanly, Yadkin/Pee-Dee)	153 (20%)	110 (22%)
Deep River near Moncure (Lee, Cape Fear)	116 (12%) Rcrd Mnth Low	75.1(14%) Rcrd Mnth Low
Black River near Tomahawk (Sampson, Cape Fear)	196 (38%)	74.2 (24%) Rcrd Mnth Low
Trent River near Trenton (Jones, Neuse)	30.8 (33%)	25.3 (35%)
Lumber River near Boardman (Robeson, Lumber)	240 (23%) Rcrd Mnth Low	133 (20%) Rcrd Mnth Low
Little Fishing Creek near White Oak (Halifax, Pamlico)	37.8 (34%)	5.26 (6%) Rcrd Mnth Low
Potecasi Creek near Union (Hertford, Chowan)	17.2 (14%)	3.93 (6%)

Groundwater **Index well (Province)**	**May depth below surface (ft)** (departure from average for month)	**June depth below surface (ft)** (departure from average for month)
Blantyre (Blue Ridge)	34.16 (-4.51)	34.82 (-4.63)
Mocksville (Piedmont)	22.01 (-5.86) Rcrd Mnth Low	22.68 (-5.95) Rcrd Mnth Low
Simpson (Coastal Plain)	5.94 (-1.28)	6.48 (-1.33)

Source: U.S. Geological Survey's *Water Resources Conditions in North Carolina http://nc.water.usgs.gov/monthly/*

moved from the Division of Water Quality to the new Office of Conservation and Community Affairs, that the **Wetlands Restoration Program** is being moved to the Secretary's Office, and that the **Division of Radiation Protection** is becoming a section of the Division of Environmental Health.

■ **Malcolm Blalock** is retiring as Deputy Director of the Division of Environmental Health on August 1. He will be replaced by **Mike Kelly** of the Division of Waste Management.

■ **James Eli Shiffer**, formerly environmental reporter for the Raleigh News & Observer, is now an editor running the N&O's Durham Office.

EPA publishes report on alternatives for treating arsenic in groundwater

A new EPA report, **Proven Alternatives for Aboveground Treatment of Arsenic in Groundwater** (EPA 542-S-02-002, June 2002, 63 pages), identifies and summarizes experiences with proven aboveground treatment alternatives for arsenic in groundwater and provides information on their relative effectiveness and cost.

The four technologies included in the report are precipitation/coprecipitation, adsorption, ion exchange and membrane filtration. The report describes the theory and operation of each technique, available project-specific performance and cost data, and limitations. The report also discusses special considerations for retrofitting systems to meet the lower arsenic drinking water standard (maximum contaminant level or MCL) of 10 µgl.

A hard copy can be ordered from the EPA Technology Innovation Office at http://www.clu-in.org/techdrct/techpubs.asp, or it can be downloaded in pdf format at the same site.

Emerging Contaminants in the aquatic environment: Risk and Regulatory Perspectives

October 3-4, 2002
Toxicology Building, NC State University, Centennial Campus, Raleigh, NC

A workshop sponsored by:
Society for Risk Analysis, Research Triangle Chapter
Society of Environmental Toxicology and Chemistry, Carolinas Chapter

Recently, environmental chemists have reported the occurrence of a variety of previously undetected contaminants in surface waters. These "emerging environmental contaminants" enter the aquatic environment from point and non-point sources, and include prescription and over-the-counter veterinary and human pharmaceuticals (e.g., analgesics, antibiotics, reproductive hormones, steroids) and numerous chemicals found in an array of personal care products and consumer items (e.g., antioxidants, detergents, antimicrobials and other disinfectants, fragrances). Little is known about the potential effects of these contaminants on humans and aquatic organisms at environmentally relevant concentrations, either singly or as components of complex mixtures. To date, risk assessment approaches have not been applied to evaluate this potential risk. Regulatory policy that addresses these contaminants will also be complicated by the differing mandates of FDA and EPA.

The objective of this workshop is to discuss the emerging environmental contaminants within the context of risk assessment and to explore the policy implications and possible management options. The 1½ day workshop will consist of presentations on research and regulatory perspectives with a ½ day devoted to each of three general topic areas: exposure assessment (identification, occurrence, sources, fate); effects assessment and risk characterization (human and ecological); and current legal framework and regulatory approaches to risk management. The workshop will conclude with a panel discussion aimed at identifying key data gaps and developing a set of recommendations for further research. A poster session is also planned.

For additional information, please contact either of the conference co-chairs: Woody Setzer (setzer.woodrow@epamail.epa.gov; 919-541-0128) or Jane Staveley (jstaveley@arcadis-us.com; 919-544-4535)

EROSION AND SEDIMENTATION CONTROL FOR CONSTRUCTION SITES SEMINAR

September 25-26, 2002
Holiday Inn-Select
Hickory, NC

October 23-24, 2002
Sheraton Grand
New Bern, NC

Purpose: This seminar is presented to familiarize design professionals who develop erosion and sedimentation control plans—including engineers, landscape architects, and surveyors—with erosion and sedimentation control principles and practices. Thirteen (13) PDHs are available to professional engineers and land surveyors, and 10 continuing education units are available to landscape architects for completion of both days.

Fee: $125.00. Covers materials, breaks, and lunches.

Deadline: Registrations will be taken on a first-come, first-served basis, but no registrations will be taken after September 13, 2002, for the Hickory seminar, and October 11, 2002, for the New Bern seminar.

For additional information and a registration form go to website:
http://www2.ncsu.edu/ncsu/CIL/WRRI/erosionseminars.html

Sponsored by
N.C. Sedimentation Control Commission; Land Quality Section, Division of Land Resources, N.C. Department of Environment and Natural Resources; and Water Resources Research Institute of The University of North Carolina

NCWRA
North Carolina Water Resources Association

2002 - 2003 Luncheon and Forum Schedule

September 16, 2002
Drought

December 2, 2002
Air Borne Water Pollutants

February 3, 2003
Geographic Information Systems

April 4, 2003
To Be Announced

All luncheon/forums take place at 11:30 am
at the Jane S. McKimmon Center on
the N.C. State University campus.
For registration information call WRRI (919/515-2815)

For information about NCWRA visit the website:
http://bae00du.bae.ncsu.edu/bae/programs/extension/wqg/ncwra/

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