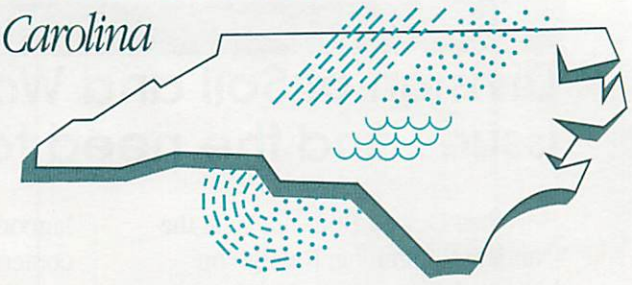
Water Resources Research Institute News

of The University of North Carolina



ISSN 0549-799X

Number 295 September/October1995

Nationally acclaimed Tar-Pamlico River Nutrient Management Plan appears to be back on track

Earlier this year it looked as if North Carolina's heralded Tar-Pamlico Nutrient Management Strategy—put together and agreed to by regulators, point-source dischargers and environmental groups and based on a nutrient trading scheme—was in danger of collapse. The Pamlico-Tar River Foundation (PTRF) and the N.C. Environmental Defense Fund (EDF) had refused to sign on to Phase II of the plan, criticizing it for relying too heavily on nutrient reductions from nonpoint sources and lack of "enforceable, measurable targets" for accomplishing the nonpoint source reductions planned. EDF had even mentioned the possibility of a lawsuit.

However, representatives of both PTRF and EDF indicated potential support for a revised draft of Phase II of the plan presented to the N.C. Environmental Management Commission's Water Quality Committee in September. The new draft details strategies for reducing nutrient loading for each major nonpoint source category and ways in which each category will be held accountable for its reduction goal.

The Phase II plan covers the period 1995-2004. It sets out an overall nitrogen reduction goal of 30 percent from 1991 conditions, sets out annual nitrogen reduction targets for point source and nonpoint source categories, calls for annual reports to the EMC on reduction progress and possible adjustment of targets beginning in 1997, and recommends enactment of mandatory best management practices for nonpoint sources if 60 percent of reduction targets are not met by 1999.

According to David Harding of the N.C. Division of Environmental Management's Water Quality staff, who presented the plan to the Water Quality Committee, two important measures for controlling nonpoint source nitrogen will be incorporated: establishment of riparian buffers and targeting of problem watersheds and problem facilities for implementation

Continued page 2

IN THIS ISSUE **Sept/Oct 1995**

	Page
Division of Soil and Water Conservation faces tough issues and need to target Cost Share funding	2
September action of the N.C. Environmental Management Commission	5
EMC gets update on swine operations	6
Legislative changes to Administrative Procedure Act will significantly extend time needed to adopt regulations	6
Water-related courses offered by N.C. universities spring semester	7
Duke University establishes Center for Hydrologic Science	7
Environment-related legislation passed by the N.C. General Assembly	9
WRRI reports available	12
Hollow-Fiber Nanofiltration for Treatment of a Surface Water High in Natural Organic Matter	
An Evaluation of Wetlands Permitting and Mitigation Practices in North Carolina	
Water Resources Research 1995-96 Seminar Series	14

Plus Water Resources Conditions . . . Conferences and Workshops . . . Publications Received . . . and more

Division of Soil and Water Conservation faces tough issues and the need to target Cost Share funding

When Dewey Botts spoke at the "Nutrient Summit" in Raleigh on August 15, he was introduced as "the man on the hot seat" by Deputy Secretary of Environment, Health and Natural Resources Steve Levitas. The "hot seat" Levitas referred to is the one Botts occupies as Director of the N.C. Division of Soil and Water Conservation (DSWC), a position he has held for just over a year.

DSWC is not a regulatory agency, so the position of director has not traditionally been one of high visibility in connection with controversial environmental issues. However, this summer, when huge animal waste lagoons began failing and spilling their contents into streams, the agency and its director were thrust into the spotlight.

DSWC administers guidelines adopted by the N.C. Soil and Water Conservation Commission (SWCC) in 1993 for certifying compliance with design and operational standards for animal waste lagoons. It manages the process by which the SWCC authorizes "Technical Specialists" to certify animal waste management facilities and plans. Under the Agricultural Cost Share Program, it also helps counties pay the salaries of Cost Share technicians, who work in Soil and Water Conservation Districts and many of whom are authorized to certify animal waste management facilities and plans.

Because of these responsibilities, DSWC has been sharing the heat for the lagoon failures—along with the

continued

Tar-Pamlico Nutrient Management Plan continued

of best management practices. Harding also said that in Phase II of the Tar-Pamlico management effort, more attention will be paid to atmospheric sources of nitrogen. He indicated an airshed model for the basin and methods for identifying and quantifying sources of atmospheric nitrogen to the river and estuary will be developed.

Water Quality Committee Chairman Charles Peterson congratulated the Water Quality staff on the revised plan, saying it "puts the money where the problems are."

Doug Rader of the N.C. Environmental Defense Fund said that in revising the plan, the Water Quality staff has "done a great job in dealing with the worst water quality problems." Rader said EDF wants to see inclusion of a 1997 interim goal of accomplishing 30 percent of the ultimate reduction goal. He said that with some changes to incorporate interim strategies, EDF can support the plan and said the Tar-Pamlico plan may serve as a model for other basinwide management strategies, including the Neuse.

Water Resources Research Institute News
of The University of North Carolina

ISSN 0549-799X
Number 295
September/October 1995
Published bimonthly

This newsletter is financed in part by the Department of the Interior, U.S. Geological Survey, as authorized by the Water Resources Research Act of 1984. Thirty-one hundred copies of this newsletter and Annual Program were printed at a cost of $2,390.58 or 77 cents per copy.

EMAIL SUBSCRIPTIONS TO WRRI NEWS AVAILABLE

Anyone with an Email account and connectivity to the Internet can have the WRRI News delivered bimonthly via Email.
To subscribe, send an Email message to: listserv@ncsu.edu
In the message say: subscribe WRRI-NEWS Your Full Name
If you would like to comment on any article in the News or submit an article or announcement to be considered for the News, send an Email message to: WRRI-NEWS@ncsu.edu

WRRI NEWS AVAILABLE ON WRRI homepage

The WRRI NEWS plus summaries of a number of WRRI reports and other information products are accessible through the WRRI homepage on the World Wide Web. URL is http://www2.ncsu.edu/ncsu/CIL/WRRI

WRRI offices are located at 1131 Jordan Hall on the North Carolina State University campus. Mailing address: Box 7912, NCSU, Raleigh, NC 27695-7912
Telephone: (919) 515-2815 Email: water_resources@ncsu.edu

WRRI Staff:
Director / David H. Moreau
Associate Director / Robert E. Holman
Newsletter Editor and Tech. Transfer Spec. / Jeri Gray
Business and Administrative Officer / Linda Lambert
Secretary / Eva Gray
Accounting Technician / Frances Yeargan

Division of Environmental Management (DEM), which is responsible for regulation of animal operations, and the Natural Resources Conservation Service (NRCS, formerly Soil Conservation Service), whose technical standards for lagoon construction and waste management were adopted by the N.C. Environmental Management Commission and whose field personnel certify facilities and plans.

DSWC District personnel (along with personnel of NRCS and DEM) were pressed into service when Governor James B. Hunt, Jr. ordered an emergency inspection of lagoons to spot imminent failures. In addition, DSWC has been ordered by the governor to take specific actions to help correct problems with the state's animal waste management program, including requiring its own Technical Specialists to perform post-construction inspections of lagoons before issuing certifications and reworking its animal waste management guidelines to tighten criteria for who may certify compliance.

Water quality protection role

While the lagoon failures brought into focus the role DSWC plays in animal waste management efforts, its key role in the state's total water quality protection effort—and another reason for the elevated temperature in Dewey Botts' office—may not be clear to people outside the agricultural community. Since agricultural nonpoint source pollution accounts for more than half of all impaired stream mileage in North Carolina (according to the state's 1990-91 305(b) report) and since efforts to stem agricultural pollution have been largely voluntary, technical assistance and cost-sharing programs administered by DSWC represent a significant part of the state's efforts to control nonpoint source water quality problems.

The division administers more than $8 million a year in state-appropriated Agricultural Cost Share funds aimed at preventing water quality problems by helping agricultural operators install best management practices (BMPs).* In addition, as the agency designated to implement agricultural BMPs funded by the association of point-source dischargers under the Tar-Pamlico Nutrient Management Plan, DSWC is a key player in a water quality initiative recognized nationally for its innovative nutrient trading strategy.

As the person ultimately responsible for these crucial water quality protection programs, Botts feels a burning responsibility for additional accountability for program effectiveness. Adoption of the basinwide water quality management approach has created the need for data on nonpoint source control efforts to support water quality modeling. Moreover, with its specific nutrient reduction goals and recommendations for mandatory BMPs if goals are not met, Phase II of the Tar-Pamlico Nutrient Management Plan (see article on page 1) has made documentation of BMPs and targeting of voluntary efforts urgent. Botts says he welcomes the responsibility to make these programs more accountable. "Taxpayers deserve to know where their money goes and what they're getting for their money in terms of water quality," he says.

Improving accountability for Cost Share Programs

Neither the Agricultural Cost Share Program nor the Tar-Pamlico Nutrient Management Plan requires farmers to install BMPs, and one of the most important tasks of DSWC is to elicit cooperation of farmers in protecting water quality. It does this by working through 96 local Soil and Water Conservation Districts, whose Supervisors are trusted members of the local agricultural community. The availability of financial and technical assistance and advocacy of farmer neighbors have encouraged thousands of farmers across the state to install best management practices to control soil erosion and animal waste runoff.

However, District records of precisely where BMPs have been installed have not been computerized, making data needed for water quality modelling unavailable. In addition, while Districts try to target their Cost Share funds to the farms where they will do the most good, they can work only with farmers who volunteer to participate. If the farmers with the worst problems or in the most critical place for stream protection do not volunteer, then funds will not be targeted in the most effective manner.

It is now up to Botts to implement a new data management system to track BMP implementation and a strategy to target critical agricultural operations for help. He will soon bring some "new faces" on board at DSWC to help with these tasks, including former NRCS Deputy State Conservationist Cecil Settle, who will coordinate District operations and help to better integrate nonpoint source pollution control efforts into District programs. And as it traditionally has, DSWC will work closely with the NRCS to document and track all BMPs installed since 1992 (because 1991 is the base year for the Tar-Pamlico nutrient reduction goals).

One of the goals, Botts says, is to get data on BMPs and problem areas into the state's geographic information system so that "each District will be able to throw a map up on the wall and see the hot spots and where BMPs need to go."

Facing the deadline for animal waste management plans

But, orders to strengthen animal waste management guidelines and pressures to beef up accountability of Cost Share programs aren't the only thermic issues DSWC faces. Simmering on a back burner is a December 31, 1997, deadline by which existing

continued page 4

**North Carolina is one of only a few states to supplement its cost share program for agricultural nonpoint source pollution control. Most states rely solely on the federal cost share program.*

The N.C. Division of Soil and Water Conservation AT A GLANCE

The Division of Soil and Water Conservation administers a comprehensive statewide program for conserving the state's soil and water resources. It serves as staff for the N.C. Soil and Water Conservation Commission (SWCC) and assists the 96 local Soil and Water Conservation Districts. The Division is staffed by 46 employees and is divided into five program areas:

District Programs. This section supports the activities of the 96 local Soil and Water Conservation Districts across the state. District programs receive guidance from five volunteer "supervisors," 3 elected and 2 appointed by the SWCC. At the District level, counties and the state join with the federal Natural Resources Conservation Service in a partnership that provides technical assistance for soil and water conservation activities to farmers in all 100 counties. Districts also help to distribute state Cost Share funding.

Non-point Section. More commonly known as the Agriculture Cost Share Section, this section is responsible for the voluntary adoption of best management practices (BMPs) to control agricultural nonpoint source pollution. The Cost Share Program is currently funded by the State from the General Fund at $8,235,000. From this fund, $1,325,000 is earmarked to provide technical personnel to local Districts by sharing the cost on a 50-50 basis. Across North Carolina, 115 technical personnel funded through the Cost Share Program work closely with the NRCS to install BMPs to protect water quality. The remaining dollars ($6,910,000) are used to cost share with landowners up to 75% of the cost of installing BMPs. For the period Aug 1984 through June 30, 1995, BMPs installed under the N.C. Cost Share Program have saved 3.78 million tons of soil; captured in storage systems more than 24 million pounds of nitrogen and 12.8 million pounds of phosphorous; and protected stream banks with 2.59 million feet of livestock exclusion systems.

This section also provides technical and administrative support for Clean Water Act Section 319 projects and the Tar-Pamlico Nutrient Management Plan.

Watershed Section. The Watershed Planning section supports implementation of Public Law 566 Small Watershed Projects under the NRCS. These projects address watershed scale natural resource problems such as flooding, erosion and water quality. This program brings about $3 million in federal funds to North Carolina annually.

Soil Survey Section. Through this section, the Division provides technical assistance as part of the Cooperative Soil Survey, which also includes counties and the NRCS.

Wetlands Mapping. The Division provides field truthing for the U.S. Fish and Wildlife Service's wetland mapping under the National Wetland Inventory Act. The entire state, except for 13 quads on the South Carolina line, have been completed.

animal operations above a certain size (100 cattle, 250 swine, 75 horses, 1,000 sheep, 30,000 birds with a liquid waste system) are required to have certified animal waste management systems in place.

DSWC is responsible for providing technical assistance and cost-share funds to help existing animal operations—mainly smaller ones—comply.** (Cost share funds are not available for new or expanding animal operations.) This year the General Assembly appropriated to the division an extra $0.5 million in cost share funds and designated almost $0.5 million for technical assistance to help existing animal operations get waste management systems into place, but, Botts says, it's not enough. He says that even the additional $2 million the division asked for in cost share funds would not be enough.

For one thing, existing swine operators aren't the only ones who need help complying with the deadline. Botts says there are 600 dairy operations in the state that need waste management systems and 595 of them don't have the systems they need. Waste management systems for dairies, which are located mainly in the western part of the state, are going to be more difficult and more expensive to install, he says. The only option in many cases is an upright slurry system, which costs $60,000 at a minimum. If all the dairies that need help got the $15,000 per year maximum allowable between now and Dec 31, 1997, nearly all the cost share funds available at current levels would be consumed.

That would leave nothing for other needs, including the abandoned lagoon problem. As large, more economically efficient swine operations force down the price of pork, small swine producers are forced either to expand or leave the market. Increasingly, they leave the market,*** and when they do they often abandon waste lagoons. Botts says there's no way to know how many abandoned lagoons there may be across the state, but they pose bigger environmental problems than their owners know, and they need to be properly closed.

With so many needs, DSWC has had to set priorities for Cost Share funding. Botts says a county-by-county assessment of problems and a priority rating of facilities has been done. District supervisors will write all animal operations affected by the 1997 deadline, remind them of the deadline, tell them where they are on the district's priority list and perhaps even when to come in for assistance. In this way, Botts says, they hope to target funds where they will do the most good.

What happens if facilities at the top of the priority list don't respond? Like some on the regulatory side of the issue, Botts mentions the term "bad actor." He says that when the

continued next page

** *NRCS, NCDA Regional Agronomists, and the Cooperative Extension Service also provide technical assistance*

*** *According to the 1994 North Carolina Agricultural Statistics, the number of agricultural operations raising hogs decreased by 20% between 1990 and 1993.*

deadline for voluntary compliance has passed, noncompliant facilities will face regulatory action.

What happens to animal production facilities left out of compliance when Cost Share funding runs out? This may be the toughest question Botts faces. He notes that many caught in the regulatory squeeze will be smaller operations and says this is where his sympathies lie.

"My background is a family dairy farm, and I feel for these people. Some of them will have to spend their own money," he says. "One state I know of has bought out some animal operations—that is given them a small amount to get out of the animal production business and into another line of production. Otherwise, I don't know."

September action of the N.C. Environmental Management Commission

At its regular meeting in September, the N.C. Environmental Management Commission (EMC) took the following action:

* Approved the New River Basinwide Water Quality Management Plan.

* Approved holding **public hearings on proposed rules for reuse of reclaimed wastewater.** Representatives of municipalities and municipal wastewater treatment plants and several members of the EMC have advocated new rules that will facilitate reuse of reclaimed water to help solve both water supply and wastewater disposal problems. The proposed rules address the level of treatment required and standards for wastewater that is to be reused, reuse options, and standards for piping. **Hearings have been scheduled for Nov 8, 7 pm at the Catawba Valley Auditorium in Hickory; Nov 9, 7 pm at the Ground Floor Hearing Room of the Archdale Bldg in Raleigh; Nov 15, 7 pm at the Pitt County Agricultural Center in Greenville; and Nov 16, 7 pm at the New Hanover High School in Wilmington. For information or a copy of the rules, call Don Safrit of the Water Quality Section of DEM at 919/733-5083 Ext 519 or Debbie Strickland at 919/733-5083 Ext 520.**

* Approved the form and content of the Sewer Moratorium Public Notice required by Senate Bill 643 (Act to Provide for Prior Notice of Sewer System Moratoria to the Affected Unit of Government and to the Public. See July/Aug News p 5).

* Approved holding a public hearing on two options for application of an alternative management strategy for Thorpe Reservoir, Hurricane Creek and Laurel Branch in Jackson County. Public hearings had been held on a proposal to designate the waterbodies as High Quality Waters. Jackson County requested consideration of an alternative management strategy, so the issue will return to rule-making. (For information on the public hearing and the alternative strategy, call Steve Zoufaly with the Water Quality Section at 919/733-5083 Ext 566.)

* Approved reclassification of Tranters Creek in Beaufort, Pitt and Martin counties from WS-IV & WS-IV Critical Area (CA) Swamp Nutrient Sensitive Waters (NSW) to C NSW. Approved reclassification of Stokely Hollow in Madison County from WS-II and WS-II CA to C.

* Approved holding public hearings on air quality rules pertaining to acid rain procedure amendments, permit rules corrections, changes in transportation facility requirements, definition of volatile organic compound and use of recycled solvents. (For information on air quality rules call Thomas Allen in the Air Quality Section at 919/733-1489.)

Members of the N.C. Environmental Management Commission

In September, new and reappointed members of the EMC were sworn in. Following is a list of current EMC members, with new members starred. Those reappointed have two stars.

David H. Moreau, Chairman, Chapel Hill
Charles L. Baker, Charlotte
Daniel V. Besse, Winston-Salem
*Douglas S. Boykin, Wilmington
*Moses Carey, Jr., Chapel Hill
*Franklin S. Clark, III, Fayetteville
**Carla E. DuPuy, Charlotte
**Robert Epting, Chapel Hill
Will B. Fowler, Newport
Alice D. Garland, Raleigh
Dennis C. Loflin, Denton
*Edwin S. "Jim" Melvin, Greensboro
*Jeffrey V. Morse, Valdese
**Charles H. Peterson (current vice chair), Pine Knoll Shores
*Ryan D. Turner, Carrboro
Richard V. Watkins, Apex
Lawrence R. Zucchino, Raleigh

CLEAN WATER ACT UPDATE

The Senate received the House Clean Water Act reauthorization bill (H.R. 961, see May/June NEWS) on May 18 and referred it to the Senate Committee on Environment and Public Works, where it remains. No CWA reauthorization bill has emerged from the Senate.

In July, the House passed H.R. 2099, which provides appropriations for independent agencies. That bill cut EPA's operating funds by 34% and carried riders prohibiting EPA from spending funds to enforce a number of major programs until the CWA is reauthorized. Prohibited enforcement included CWA section 404 (wetlands), stormwater permitting programs, and compliance schedules for combined sewer overflows or sanitary sewer overflows.

In September, the Senate Appropriations Committee moved to restore some of EPA's funding and stripped H.R. 2099 of many of its riders. Senate floor action on the appropriations bill was expected as the NEWS went to press.

EMC gets update on swine operations

At the Environmental Management Commission's Sept meeting, Division of Environmental Management (DEM) Director Preston Howard presented an update on inspection of swine lagoons and reactions by Governor James B. Hunt, Jr. and the General Assembly to the summer's series of swine lagoon failures.

Inspections

Howard said that DEM personnel and personnel of the N.C. Division of Soil and Water Conservation and the Natural Resources Conservation Service have inspected 2,615 of the estimated 4,500 swine facilities in the state. At 100 facilities, discharges from lagoons were discovered. At 62 of those 100 facilities, discharges were flowing through man-made conveyances, an activity expressly prohibited by N.C. law and subject to fine.

Governor Hunt's orders

Howard said Governor Hunt has ordered that DEM give priority to completing inspection of swine operations (by Dec 1) and use all enforcement tools available to deal with those out of compliance, including requiring individual permits. The Governor has also said that all operations found in significant noncompliance should be subject to biannual inspections. "We're going after the bad actors," said Howard. "We're not going after more regulations for those who are doing it right."

General Assembly actions

Reactions to the swine lagoon failures in the General Assembly include passage of Senate Bill 974, which requires certification of those who land apply swine waste, and establishment of the 18-member Blue Ribbon Study Commission on Agriculture Waste in the General Assembly (See H 898 Studies Act of 1995, p 11).

Adequacy of responses questioned

Some members of the EMC questioned whether actions of the governor and the General Assembly will be adequate to control environmental problems created by swine operations.

EMC member Robert Epting described flying over eastern North Carolina and seeing a "checker board" of new concentrated swine operations including concrete pads for barns and lagoons but no cleared land for waste application, as the state's waste application rules require.

Epting also said that as DEM attempts to levy fines and otherwise deal with swine operations where lagoon failures and conditions of noncompliance have been documented, it is discovering that some operations are owned by "shades," partnerships or corporations where there are no assets.

"Equity in land is being used to finance construction," Epting said. "In these cases, I wonder if there is anyone to hold responsible."

"I see a need to speed up regulation of these operations," said Epting. Referring to the legislature's recent changes in the Administrative Procedure Act, Epting said, "It is amazing that the legislature has tied the hands of this Commission and prevented us from doing anything about this problem on a timely basis."

Commissioners Lawrence Zucchino and Will Fowler also predicted that the new administrative procedures will "come back to haunt" legislators in connection with the swine industry issue. Fowler said that if IPB, "the largest packer in the world," locates in eastern North Carolina as planned, the already rapid pace of swine operation expansion in the state will increase.

Legislative changes to APA will significantly extend time needed to adopt regulations

At its September meeting, the Environmental Management Commission learned from EMC Counsel Frank Crawley how recently enacted changes to the state's Administrative Procedure Act (see H 230, p 10) will affect rulemaking.

After Dec 1, 1995, several additional steps will be required before an agency can promulgate a permanent rule. Agencies must now publish a Notice of Rulemaking in the State Register 60 days before the text of the proposed rule is published. The agency must take public comment on the Notice of Rulemaking.

An agency must now also prepare and have approved by the Office of State Budget and Management (OSBM) (or obtain from the OSBM) a fiscal note for any rule that would have a substantial economic impact ($5 million in a 12-month period) and is not identical to a required federal regulation. If a fiscal note is required, it must be published with the text of the proposed rule, and public comment must be taken for 60 days.

Rules now must be approved by the Rules Review Commission (RRC). If the RRC objects to a rule it does not become effective. Even if the RRC approves a rule, it does not become effective until the 31st day of the next regular session of the General Assembly and only then if a bill objecting to it has not been filed or has been filed and defeated. If a bill objecting to a rule is filed and no action is taken on it, then the rule becomes effective only when the General Assembly adjourns.

According to Preston Howard, DEM Director, it is conceivable that a year could pass between the time the RRC approves a rule and the time the next General Assembly convenes. For that reason, he said, it can now take up to two years for a rule to become effective. Howard predicted that the delay will sometimes work against the regulated community. He noted that as of Jan 1, 1997, land applicators of swine waste must undergo training and be certified, and that rules to implement the training and certification program will have to be adopted and put into place before any certifications can be issued.

Water-related courses offered by N.C. universities spring semester

Duke University

School of the Environment

ENV 240 Fate of Organic Chemicals in the Aquatic Environment
ENV 242 Environmental Aquatic chemistry
ENV 290 Physical Oceanography
ENV 298.10 Environmental Fluid Mechanics
ENV 312 Wetland Ecology and Management
ENV 313 Advanced Topics in Environmental Toxicology
ENV 330L Environmental Monitoring and Instrumentation

For additional information call Ms Berti Belvin at (919) 613-8070. Non-degree students should contact the continuing education staff in the Duke admissions office (919) 684-6259.

Center for Hydrological Science

CEE 265A Engineering & Environmental Geophysics
GEO 218 Geological Fluid Mechanics
ENV 232 Microclimatology
ENV 356 Environmental Fluid Mechanics
CEE 227 Groundwater Hydrology and Contaminant Transport
CEE 265B Models of Contaminant Transport
GEO 271 Sedimentary Geochemistry
GEO 272 Biogeochemistry
ZOO 216 Limnology
CEE 220 Water Resources Systems Planning and Management

For information call Stuart Rojstaczer, Director, Center of Hydrologic Science at (919) 684-3159.

Duke University establishes Center for Hydrologic Science

Duke faculty are launching a new Center for Hydrological Science that will coordinate the faculty's interests in the science and engineering of water. The center, supported with startup funding from the university, will include five faculty centered in Civil and Environmental Engineering, three at the School of the Environment, two in Geology and one in Mathematics. The center was formally established July 1 to coordinate research and develop a coherent graduate program for PhD study in hydrology.

Initially, the center will sponsor visiting speakers and research seminars to facilitate the sharing of information and research. Graduate fellowships in hydrological sciences will be provided by the university. Stuart Rojstaczer, an assistant professor of geology, will direct the center. He also holds appointments in the School of the Environment and the School of Engineering. (The center's World Wide Web site: http://www.geo.duke.edu/hydro.htm)

Department of Civil and Environmental Engineering

CEE 123L Water Resources Engineering
CEE 242 Environmental Aquatic Chemistry
EGR 24L Introduction to Environmental Engineering

East Carolina University

Department of Geology

GEOL 5710 Groundwater Hydrology
GEOL 5711 Groundwater Hydrology Lab

For course information contact Scott Snyder, Chairman at (919) 328-6360.

N. C. Agricultural and Technical State University

Department of Civil Engineering

CIEN 360 Hydrology
CIEN 510 Environmental Engineering Design
CIEN 614 Stream Water Quality Modeling

For course information contact Emmanuel Nzewi, Chairman at (910) 334-7737.

Department of Natural Resources and Environmental Design

AGEN 624 Water Resources Engineering
AGEN 714 Applied Hydrology

North Carolina State University

Department of Soil Science

SSC 461 Role of Soil in Environmental Management
SSC 562 Environmental Applications of Soil Science
SSC 522 Soil Chemistry

Department of Forestry

FOR 520 Watershed Hydrology

Biological and Agricultural Engineering

BAE 472/572 Irrigation and Drainage

Department of Marine, Earth and Atmospheric Sciences

MEA 101 Geology I
MEA 110 Geology I lab
MEA 130 Introduction to Weather and Climate
MEA 135 Introduction to Weather and Climate lab
MEA 140 Natural Hazards and Global Change
MEA 200 Introduction to Oceanography
MEA 210 Introduction to Oceanography lab
MEA 220 Marine Biology
MEA 250 Introduction to Coastal Environments
MEA 251 Introduction to Coastal Environments lab
MEA 312 Physical Meteorology
MEA 314 Meteorology lab II
MEA 323 Earth System Chemistry
MEA 430 Scientific Issues and Global Problems
MEA 467 Marine Meteorology
MEA 469 Ecology of Coastal Resources
MEA 493M Coastal Issues and Scientific concepts
MEA 512 Satellite Meteorology
MEA 520 Principles of Biological Oceanography
MEA 526 Air-Sea Interaction
MEA 568 Ocean Circulation
MEA 591B Adaptations to the Marine Environment
MEA 591E Paleoceanography
MEA 592D Seismic Sequence Stratigraphy
MEA 592B Surficial Processes
MEA 572J Cyclical Events in Earth History
MEA 663 Advanced Geophysical Fluid Dynamics
MEA 674 Marine Geochemistry

continued next page

NCSU students may sign up for courses listed above through the TRACS system. Degree students at other universities participating in the inter-institutional program may sign up through inter-institutional registration. Non-degree students may sign up through the NCSU Division for Lifelong Education (919) 515-2261 (non-credit) or (919) 515-2265 (credit).

University of North Carolina at Chapel Hill
Department of Geology

GEOL 125 Coastal Sedimentary Environments
GEOL 139 Rivers Systems of East Coast North America
GEOL 163 Applied Hydrology
GEOL 164 Geochemistry of Natural Waters

Department of Environmental Sciences and Engineering
ENVR 200 Environmental Organic Chemistry
ENVR 176L Subsurface Process Lab
ENVR 281 Applied Mathematical Modelling
ENVR 278 Geostatistics for Spatial/Temporal Environmental Phenomena
ENVR 274 Physical/Chemical Treatment Processes
ENVR 275 Biological Treatment Processes
ENVR 277 Water and Wastewater Treatment Lab
ENVR 217 Systems Analysis in Environmental Planning
ENVR 272 Design of Water Systems

Students enrolled at Duke and NCSU may register inter-institutionally. Contact the Registrar's Office at (919) 962-3954. Others should apply to UNC-CH's Evening College at (919) 962-1134.

University of North Carolina at Charlotte
Department of Geography & Earth Sciences

ESCI 3000 Physical Meteorology
ESCI 3251 Synoptic Meteorology
ESCI 4150 Applied Climatology
ESCI 5222 Watershed Science Topics
GEOG 6020 Pollution Climatology

For course information call the department at (704) 547-2293. Individuals wishing to enroll should contact the UNC-C Office of the Registrar (704) 547-2287.

University of North Carolina at Wilmington
Center for Marine Science Research

CHEM 475 Chemical Oceanography
CHEM 476 Chemical Analysis of Natural Waters
CHEM 377 Environmental Chemistry
GLY 150 Introduction to Oceanography
GLY 426/526 Geohydrology
GLY 550 Marine Geology
BIO 238-01 Biology of the Sea
BIO 362-01 Marine Biology
BIO 457-01 Ichthyology
BIO 468-01 Planktonology
BIO 472-01 Marine Phycology
BIO 481-01 Marine Invertebrate Zoology
BIO 485-01 Introduction to Coastal Management
BIO 485-02 Mariculture
BIO 485-03 Undersea Technology
BIO 495-03 Seagrasses and Salt Marshes
BIO 495-05 Wetlands
BIO 495-06 Marine Chemical Ecology
BIO 495-09 Biology of Manatees and Dugongs
BIO 562-01 Coastal Ecosystems

For course information contact the Center for Marine Science Research at (910) 256-3721.

Grants available to help schools build and improve environmental library collections

Available to K-12 schools throughout North Carolina, the Project Tomorrow Grant Program provides financial support to develop model environmental education library collections that provide resources for the integration of environmental education in the teaching of North Carolina's competency based curriculum. With the support of the N.C. Department of Public Instruction and financial backing from The Duke Power Company Foundation, the U.S. Environmental Protection Agency, and the N.C. Department of Environment, Health, and Natural Resources, the N.C. Office of Environmental Education expects to award as much as $35,000 to schools in 1996. Applications for the 1996 Project Tomorrow Grant Program are now available. For a copy, contact the Office of Environmental Education at 800-482-8724 (733-0711 in Raleigh). Proposal deadline is March 1996.

Also available from the Office of Environmental Education in an electronic format (Microsoft Works on either Mac or DOS disk) is the Environmental Education Correlation Guide to selected environmental education programs that have been correlated to the N.C. Department of Public Instruction's Standard Course of Study.

North Carolina Water Resources Association

NCWRA

North Carolina Section of the American Water Resources Association

Upcoming 1995-96 Luncheon Forums

November 28, 1995
Bonnie E. Cone University Center, UNC-Charlotte
Competition & Privatization of Municipal Biosolids (Sludge)

January 22, 1996
Jane S. McKimmon Center, Raleigh
Animal Waste and Water Quality Issues

April 22, 1996
Duke University
Water Quality Issues

September 16, 1996
Jane S. McKimmon Center, Raleigh
Coastal Site Issues

For more information about upcoming forums or information about joining NCWRA, contact Bob Holman at WRRI (919/515-2815) or Jean Spooner at the NCSU Water Quality Group (919/515-8240).

Water Resources Research Institute

of The University of North Carolina

ANNUAL PROGRAM

CURRENT RESEARCH JULY 1, 1995 TO JUNE 30, 1996

The Water Resources Research Institute is a unit of The University of North Carolina system headquartered in Jordan Hall on the North Carolina State University campus.

It is one of 54 state water institutes authorized by the Water Resources Research Act of 1964 to administer and promote federal/state partnerships in research and information transfer on water-related issues.

The mission of WRRI is threefold: to identify the state's ever-changing research needs, to motivate and support research by qualified scientists, and to provide for technology transfer.

Institute Staff:
David H. Moreau
Director
Robert E. Holman
Associate Director
Jen Gray
Technology Transfer Specialist
Linda Lambert
Business & Administrative Officer
Eva Gray
Secretary
Frances Yeargan
Accounting Technician

NEW RESEARCH

NCSU researchers study how well vegetated buffers reduce pollutants in runoff from fields where poultry litter has been applied

Wendell Gilliam has been studying the problem of nonpoint source water pollution in North Carolina for 26 years, recently focusing his research on the effectiveness of grass and riparian buffers in removing pollutants from agricultural runoff. While Gilliam knows buffers can be useful in protecting water quality, he sounds a note of caution about relying on current data to design buffers to protect streams near fields where animal waste is applied.

Gilliam says that while it has been shown that buffers can be effective, most previous research on buffer effectiveness has been on fields where inorganic fertilizers have been applied, and nutrients associated with organics in animal waste behave differently than inorganic nutrients. Phosphorous from animal waste moves through soils more easily than inorganic phosphorous, and nitrogen in animal waste must be mineralized to inorganic forms before it can be taken up by plants. It is possible, then, that nutrients in animal wastes may move off site more easily than inorganic nutrients. Furthermore, he says, a major concern associated with land application of animal wastes is bacterial contamination of waters, and virtually nothing is known about the ability of planted or natural buffers to remove bacteria from runoff.

Because he believes that land application of waste from concentrated animal operations poses the largest nonpoint source threat to water quality in the state, Gilliam says it is crucial to base recommendations for animal waste best management practices on better information than is now available. His current WRRI project is aimed at providing that information.

Using sites equipped and instrumented for previous research on buffer effectiveness, Gilliam and co-investigators Robert Mikkelsen and John Parsons will evaluate the effectiveness of grass and riparian buffers in removing nutrients and fecal coliform bacteria from runoff from a field where poultry litter has been applied. They have already begun incorporating poultry litter at two six-plot sites previously used for research on runoff from fields not receiving animal waste. They will compare the effectiveness of buffers in cleaning up runoff from waste-treated fields with their performance in previous research.

Building on hydrologic and chemical data produced by previous research and new data gathered in the current project, the investigators will also evaluate the latest version of the GLEAMS runoff model and will develop and test routines for simulating flow of water and chemicals through grass and riparian buffers.

The investigators intend to provide information to predict the effectiveness of buffers under a range of site conditions and to design requirements for buffers between streams and areas receiving animal waste.

Grass and Riparian Buffer Treatment of Runoff from Land Receiving Animal Waste (70146)
J.W. Gilliam, J.R. Parsons, & R.L. Mikkelsen, North Carolina State University
July 1, 1995 to June 30, 1996
Funded by WRRI

WRRI BOARD OF DIRECTORS

Members of the Board of Directors of the Water Resources Research Institute are appointed by the President of the University of North Carolina system. The Board establishes Institute policy, and the Chairman of the Board makes appointments to the Technical Committee.

Ralph K. Cavin, Dean of College of Engineering, North Carolina State University (Acting Chairman)
Durward F. Bateman, Dean of College of Agriculture and Life Sciences, North Carolina State University
Russell F. Christman, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill
Milton S. Heath, Jr., Associate Director, Institute of Government, University of North Carolina at Chapel Hill
Charles G. Moreland, Vice Chancellor for Research, Outreach, and Extension, North Carolina State University
David H. Moreau, Director, Water Resources Research Institute (Secretary)

WRRI ADVISORY COMMITTEE

The Advisory Committee of the Water Resources Research Institute is composed of representatives from state and federal programs, local government, industry, environmental organizations, private consultants, water and wastewater treament plants, the university research community and others. The committee advises the Institute on the need for water-related research in North Carolina, the region, and the nation.

Steven J. Levitas, Assistant Secretary for Environmental Protection, N.C. Department of Environment, Health, and Natural Resources (Chairman)
C. Dewey Botts, Director, Division of Soil and Water Conservation, N.C. Department of Environment, Health, and Natural Resources
William Eaker, Director, Environmental Program, Land-of-Sky Regional Council
George T. Everett, Executive Director, Chemical Industry Council of North Carolina
Richard Gallo, State Conservationist, USDA Natural Resources Conservation Service
Charles H. Gardner, Director, Division of Land Resources, N.C. Department of Environment, Health, and Natural Resources
Edward A. Holland, Planning & Resource Administrator, Orange Water & Sewer Authority
William E. Holman, Lobbyist, North Carolina Sierra Club and Conservation Council of N.C.
William J. McCabe, Design Engineering Department, Duke Power Company
John N. Morris, Jr., Director, Division of Water Resources, N.C. Department of Environment, Health, and Natural Resources
George J. Oliver, Manager, Environmental Services, Carolina Power & Light Company
Douglas Rader, Senior Scientist, N.C. Environmental Defense Fund
Edmund P. Regan, Fiscal Analyst, N.C. Association of County Commissioners
A. Terry Rolan, Director, Department of Water Resources, City of Durham
Linda Sewall, Director, Division of Environmental Health, N.C. Department of Environment, Health, and Natural Resources
Carl Simmons, Director, Department of Public Utilities, City of Raleigh
Robert J. Sperberg, District Engineer, Wilmington District, Corps of Engineers, U.S. Department of the Army
Paula S. Thomas, Environmental Policy Specialist, N.C. League of Municipalities
James F. Turner, District Chief, Geological Survey, U.S. Department of Interior
Christopher D. Ungate, Manager, Clean Water Initiative, Tennessee Valley Authority
Charles Wakild, Director, Environmental Affairs, Federal Paper Board

INSTITUTE RESEARCH PRIORITIES

Priorities established by the WRRI Advisory Committee for the current research year reflect a growing awareness by policy makers, administrators, and the public of the need to focus on basinwide water quality management strategies and to identify and devote resources to the most pressing problems. Topics given highest priority by the Advisory Committee are:

- understanding basinwide processes and effects and developing effective basinwide management strategies;
- evaluating and further developing nonpoint source management approaches, with attention to the role of riparian buffers;
- assessing and responding to microbial and disinfection by-product threats to drinking water safety;
- building awareness of the need for water conservation and reuse and assessing reuse potential;
- improving methods for wetland creation and restoration and improving mitigation practices, including banking;
- addressing water quality threats from concentrated animal operations;
- assessing risk from groundwater contamination and balancing risk against cost of remediation.

NEW RESEARCH

UNC Chapel Hill research focuses on predicting disinfection by-products from knowledge of source water

It is well documented that when water containing significant amounts of natural organic matter (NOM) is disinfected with chlorine, a variety of disinfection by-products (DBPs) is produced. Some of these DBPs have been shown to be carcinogenic or mutagenic, and it is believed that more by-products are formed than have been identified so far. EPA is in the process of regulating harmful by-products of disinfection in drinking water, and water supply managers face difficult decisions about how to treat water to kill bacteria and other microbiological contaminants without creating unacceptable levels of chemical by-products.

Research has produced some general knowledge about DBP formation. It has been shown that higher total organic carbon in a source water and longer chlorine contact times lead to higher concentrations of trihalomethanes—one class of DBPs. However, the components of natural organic matter and, therefore, how it reacts when it comes into contact with chlorine varies from place to place and from season to season at any one place. There is currently no way for water managers and regulators to predict what kinds or what concentrations of by-products will be produced when water from any particular source is disinfected at any particular time. That means water managers ordered to reduce DBPs in drinking water have a moving target if they try to pretreat water to remove DBP "precursors" before chlorination. And, it means they do not know if they have been successful until finished drinking water emerges from the end of the treatment train.

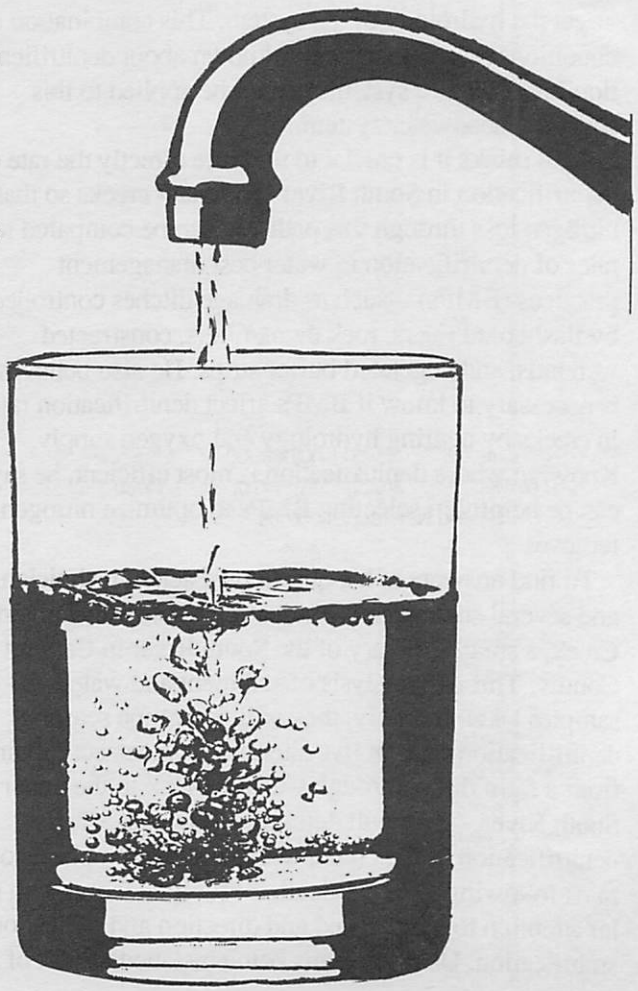
If source water could be sampled and the natural organic matter characterized as to its geochemical properties, and if certain properties could be tied to production and concentrations of specific disinfection by-products, then water managers could potentially adjust treatment processes to prevent the production of DBPs.

In this project, Russell F. Christman of the Department of Environmental Sciences and Engineering at UNC Chapel Hill will test a technique that he believes will permit prediction of levels of selected classes of by-products from a knowledge of the amount of total organic carbon in a water supply that is produced within the water body and the amount that is transported into the water supply from the watershed area.

The technique Christman will explore combines use of the emerging process of capillary electrophoresis to separate components of NOM based on their charge density and the use of substances known to react with specific possible components of NOM to increase detection of these components. To test his hypothesis that this process can characterize NOM according to its geochemical properties, Christman will process samples of water from six highly protected water supplies and six less protected water supplies. He expects that NOM from protected sources, which will have been generated within the source itself, will exhibit markedly different geochemical properties than NOM from less protected sources, which will have bound up nutrients, trace metals, minerals, and other anthropogenic contaminants from outside the water source. Chlorination of the water samples and analysis for by-products will allow correlation of by-products with geochemical characteristics of NOM.

If this research proves fruitful, subsequent research will focus on development of field models of the separation system for on-site measurements.

A New Method for Characterizing Aquatic Organic Matter (70142)
Russell F. Christman, University of North Carolina at Chapel Hill
May 1, 1995 to June 30, 1996
Funded by WRRI



NEW RESEARCH

Researcher at Institute of Marine Sciences will study what happens to nitrogen from ag runoff to South River

Past research focusing on freshwater streams has shown that the natural breakdown of nitrogenous compounds (denitrification) in bottom sediments and water and the consequent loss of nitrogen to the atmosphere helps to mitigate the harmful effects of nitrogen loading from agricultural fields to stream systems. There is evidence that the amount of nitrogen breakdown that takes place is determined by a number of physical and chemical parameters, including availability of oxygen in bottom sediments, inputs of nitrogen, and frequent changes in water inputs and outflows in a system (hydrology).

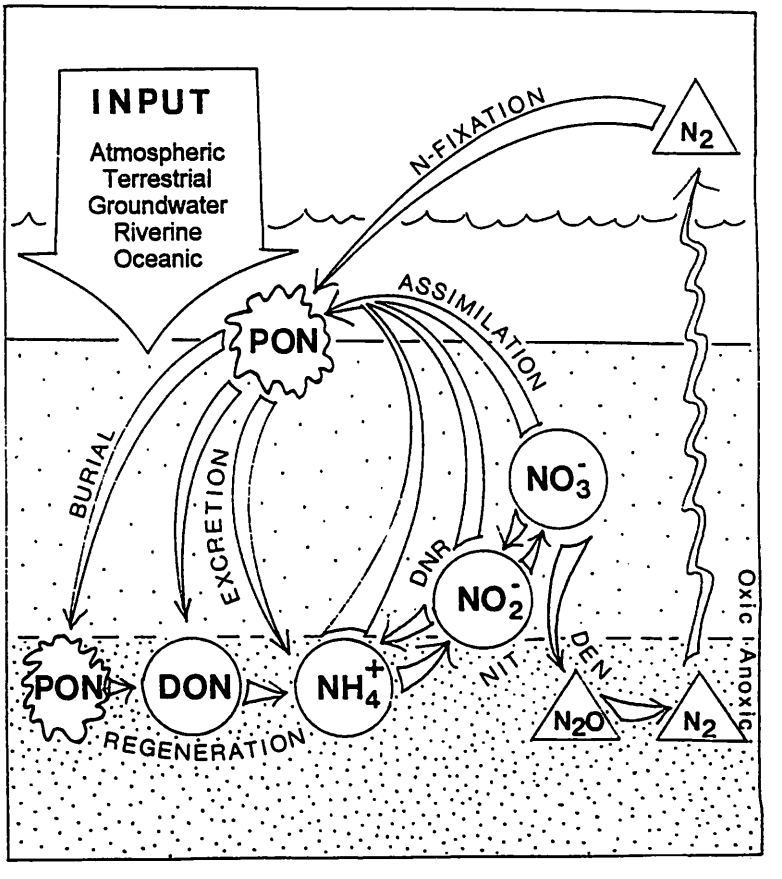
Hans Paerl of the UNC Institute of Marine Sciences thinks it is important to know how much, when, and where denitrification takes place in Coastal Plain headwater creeks of the South River, which flows into the nutrient-threatened Neuse River estuary. Headwaters of South River drain Open Grounds Farm, an extensive row crop and cattle operation. In these headwater creeks, seasonal loading of nitrogen from agricultural fields can be high, oxygen-depressing freshwater/saltwater stratification is common, and winds constantly affect the hydrology of the system. This combination of conditions means that what is known about denitrification in freshwater systems cannot be applied to this estuarine headwater system.

Paerl thinks it is crucial to measure directly the rate of denitrification in South River headwater creeks so that nitrogen loss through this pathway can be compared to rates of denitrification in water best management practices (BMPs)—such as drainage ditches controlled by flashboard risers, rock dams/filters, constructed wetlands, and vegetated buffer strips. He also believes it is necessary to know if BMPs affect denitrification rates in creeks by altering hydrology and oxygen supply. Knowing where denitrification is most efficient, he says, can be helpful in selecting BMPs to optimize nitrogen removal.

To find answers to his questions, Paerl, a technician, and several students are conducting a study on Culvert Creek, a small tributary of the South River in Carteret County. Through analysis of sediment and water samples taken monthly, they will determine seasonal denitrification rates at five sites along a transect running from a farm ditch, through Culvert Creek to the upper South River. They will determine how rain affects denitrification in the creek, with particular emphasis on rains following field application of fertilizer and with particular attention to wind speed and direction and indications of stratification. Using systems being installed as part of an EPA BMP-monitoring program, they will also measure denitrification in four drainage ditches controlled by flashboard risers, rock dams/filters, constructed wetlands, and vegetated buffer strips.

By comparing rates of denitrification in creeks and various water management practices, Paerl expects to provide useful information for selecting and operating agricultural BMPs to reduce the effects of nitrogen loading to South River and the Neuse River Estuary. In addition, improved estimates of the role denitirfication plays in riverine and estuarine nitrogen budgets will result.

Denitrification Dynamics of an Estuarine Headwater Creek Receiving Agricultural Runoff: The South River Estuary, NC (70139)
Hans W. Paerl, UNC-CH Institute of Marine Sciences
Jan 1, 1995 to Dec 31, 1995
Funded by WRRI



The availability of nitrogen for use by algae in estuaries is controlled by inputs of nitrogen as well as internal nitrogen cycling, including remineralization, coupled nitrification-denitrification and (in some cases) nitrogen-fixation.

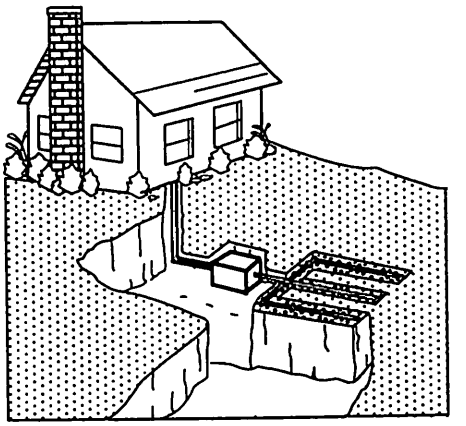
NEW RESEARCH

NCSU scientist will study whether inorganic constituents of wastewater can reduce capability of soils to transmit water through septic drainfields

Because it is often prohibitively expensive to extend public wastewater services to rural and suburban areas, North Carolinians rely heavily on septic systems for disposal of household wastewater. By the year 2000 there may be more than two million septic systems in use in the state. It is therefore crucial to understand factors that contribute to septic system failure and to develop strategies for preventing failure and restoring failing systems.

Design, siting, installation and operational inadequacies, including overloading and lack of maintenance, are known to account for many septic system problems. Drainfield clogging due to biomat formation is also known to prevent infiltration of wastewater and cause failure of systems that have been used for many years. However, while it is known that the ability of soil to transmit water depends on the properties of the liquid applied to soil as well as properties of the soil itself, little research has been done on the effect that inorganic constituents of wastewater may have on the saturated hydraulic conductivity (K_{sat}) of soils.

Building on his many years of research on on-site wastewater disposal on North Carolina soils, Aziz Amoozegar of the NCSU Department of Soil Science will study which inorganic constituents of wastewater can alter the physical and chemical properties of three different North Carolina soils so as to affect the rate of wastewater movement through them. Since it is known that sodium applied to soil can destroy soil structure and reduce the ability of soil to transmit water, Amoozegar will also explore the possibility of reversing drainfield damage caused by sodium through application of lime or other materials containing calcium.



In field studies, five different kinds of simulated wastewater, whose inorganic chemical composition has been determined, will be applied to two soils and one saprolite. Tap water will be used as a reference. Infiltration rate for each soil/solution combination will be evaluated and K_{sat} will be measured. K_{sat} of the various soils/solution combinations will also be measured in the laboratory. Data analyses will be performed to identify the inorganic constituents and other properties responsible for changes in infiltration rate or K_{sat}. At the end of the infiltration studies, undisturbed soil samples will be collected from the depth where K_{sat} was measured and extracted in the laboratory for determination of cations and anions in the wastewater. Following a resting period, lime or gypsum solution will be applied to the infiltration areas of the field sites and infiltration rates will be measured to determine if infiltration capacity can be restored (if it was lost due to chemicals).

These studies are expected to produce information for making recommendations to septic tank owners as to the potential for certain chemicals to damage drainfields and lead to system failure.

(In a related study, Amoozegar will also evaluate whether pretreatment of wastewater improves the performance of drip wastewater systems, currently being evaluated as an alternative system by the N.C. Division of Environmental Health.)

Impact of Wastewater Quality on the Long-term Acceptance Rate of Soils for On-site Wastewater Disposal Systems (70140)
Aziz Amoozegar, North Carolina State University
Mar 1, 1995 to June 30, 1996

NEW RESEARCH

NCSU researchers will study whether Nags Head septic tanks are degrading groundwater in Cape Hatteras National Seashore

Elevated soundside bacterial counts and dense algae blooms in ditches near park-adjacent residential development indicate that septic systems in the highly developed town of Nags Head may be degrading water quality in adjacent areas of the Cape Hatteras National Seashore. Shellfish beds have been closed in several soundside locations, and algae blooms in ditches that direct surface and groundwater to park marsh and stream habitat suggest that nutrient enriched waters are entering the Seashore.

The water table in the Nags Head area is less than 3 feet below the land surface, leaving a very limited space

continued next page

NEW RESEARCH

UNC investigator will study bioremediation of sites contaminated by manufactured gas tars

Across the United States, there are estimated to be between 1,500 and 3,000 former manufactured gas plant (MGP) sites contaminated with tars derived from coal and oil. More than 30 of these sites have been discovered in North Carolina. Pollutants of most concern include polycyclic aromatic hydrocarbons (PAH), some of which are known to be carcinogenic. All of the carcinogenic PAH are characterized by high molecular weight and very low solubility in water. Although these compounds readily form nonaqueous phases and bind tightly to soil constituents, water that comes into contact with them can become toxic. Tars associated with MGP sites have been discovered both in the subsurface and as sediment in surface waters. As a result, MGP sites pose a threat to both surface and groundwater quality.

While some PAH in contaminated soils can be degraded into harmless compounds by bacteria, high molecular weight PAH do not yield easily to bioremediation and are not entirely removed by the process. Therefore, what might be a low-cost cleanup method for MGP sites may not satisfy cleanup standards because of the carcinogenic PAH left behind.

In a new project building on his ongoing research, Michael Aitken of the UNC-Chapel Hill Department of Environmental Sciences and Engineering will evaluate methods to overcome the factors he believes limit the biodegradation of high molecular weight PAH. Specifically, he will study the ability of several different surfactants to pry PAH loose from soils and make them available for bacterial degradation, and will also study the addition of other chemicals to enhance the growth of PAH-degrading organisms.

Aitken's research will consist of bench-scale slurry-phase bioremediation of contaminated soil from a MGP site. He will operate a two-stage bioreactor system in which contaminated soil will first undergo conventional treatment and will then be treated with (1) a surfactant alone, (2) the surfactant in conjunction with a supplemental growth substrate, and (3) the supplemental growth substrate alone. Aitken's hypothesis is that neither surfactant nor supplemental substrate alone will achieve the desired level of bioremediation but that both will do the job.

If Aitken can demonstrate methods to degrade carcinogenic PAH to levels lower than now possible, then bioremediation could be considered for many of the MGP sites in North Carolina. That would mean contaminants could be permanently rendered harmless, which is not the case if a site must be capped and isolated or if the soil is excavated and landfilled. Bioremediation may also be more acceptable to the public or to regulatory officials than alternative methods of destroying the contaminants, such as incineration.

Slurry Phase Bioremediation of Contaminated Soil from a Former Manufactured Gas Plant Site (70144)
Michael D. Aitken
University of North Carolina at Chapel Hill
July 1, 1995 to June 30, 1996
Funded by WRRI

Cape Hatteras National Seashore research continued

between septic leach fields and groundwater. In addition, extremely sandy, porous soils greatly decrease effluent retention time. Once effluent reaches groundwater, natural flow processes transport nutrients and microorganisms directly to discharge zones on the ocean and sound.

The continued health of the unique vegetative communities and habitats found in the Seashore is linked to water quality; moreover, visitor health and safety may be threatened by groundwater from septic fields flowing into public recreation sites. There is an urgent need to determine if groundwater quality on Bodie Island within the Seashore is being degraded by septic effluent and identify the sources and pathways of degrading constituents. This project is aimed at providing that information.

David Evans of the NCSU Department of Marine, Earth and Atmospheric Sciences and Aziz Amoozegar of the NCSU Department of Soil Science will establish shallow groundwater monitoring transects to define the flow patterns of shallow groundwater in the park and the park-adjacent Nags Head area. They will sample and analyze groundwater to determine background conditions and to track substances indicative of septic effluent, particularly nitrate, phosphate, and fecal coliform bacteria. In addition, they will monitor rainfall (to measure recharge) and measure groundwater levels throughout the year to document the effect of disposal of waste from seasonal residents and visitors on water table elevations. They will also sample surface water on both the ocean and sound sides of the island several times to establish ambient surface water quality and provide a basis for comparison to conditions downgradient from septic fields. Finally they will prepare an interpretive report of their findings and recommend if additional study needs to be done.

Assessing the Impact of Septic Discharge on Water Quality on the Cape Hatteras National Seashore (70147)
David G. Evans and Aziz Amoozegar, North Carolina State University
May 1, 1995 to April 30, 1997
Funded by WRRI and the National Park Service

NEW RESEARCH

UNC researcher will perform bench-scale assessments of activated carbon adsorption and membrane separation technologies for controlling precursors of disinfection by-products

EPA is expected soon to promulgate the Information Collection Rule (ICR) to support regulation of disinfection by-products (DBPs) under the Safe Drinking Water Act. The ICR will likely require water utilities that serve more than 100,000 customers and that use a surface water source with a DBP precursor concentration, as measured by total organic carbon (TOC), of more than 4 milligrams per liter to test technologies to remove this TOC. Based on size and recent TOC measurements, four N.C. utilities may be required to perform either or both bench-scale and pilot-scale tests of two technologies: activated carbon adsorption and membrane separation. Because water utility personnel do not have the expertise to perform these tests, consulting firms, which are geared more for pilot-scale than bench -scale testing, will probably have to be hired.

Although EPA may not require it, bench-scale testing prior to pilot-scale testing would be useful for several reasons. First, test procedures are not well established, and it would be helpful to evaluate test protocol on specific waters before spending large sums for pilot plant tests. Second, the ICR will require evaluation of seasonal influences on the production of DBPs, and bench-scale testing lends itself more to seasonal start-ups and shutdowns than larger pilot plant operations. Finally, smaller utilities in North Carolina will eventually be required to comply with the same DBP limits now facing large utilities, and information generated by bench-scale tests on waters with characteristics similar to their sources will be of benefit to them.

In this project, Dr. Francis A. DiGiano of the UNC-Chapel Hill Department of Environmental Sciences and Engineering in the School of Public Health will demonstrate the usefulness of bench-scale testing for assessing the effectiveness and cost of activated carbon adsorption and membrane separation for DBP precursor control and will develop valuable information for design and planning of pilot-scale testing. At the same time, he will evaluate which of these two technologies might produce the best results at the four N.C. water utilities subject to the ICR.

In the first year of the study, DiGiano will focus on the water utilities of Raleigh and Durham and the second year on the water utilities of Greensboro and Fayetteville. Seasonally, he will obtain samples of water that has been treated by conventional chemical coagulation-sedimentation and filtration (but not chlorination) from the water treatment plants and characterize the water as to its TOC, DBP formation and other related water quality parameters. He will also use samples for both the standard protocol for bench-scale testing of activated carbon adsorption (rapid, small-scale column test) and for modified versions of this protocol. Building on his knowledge base from previous research, DiGiano will also develop a protocol for bench-scale testing of membrane separations.

Bench-scale testing of these technologies is expected to indicate how well each removes TOC. In addition, estimates will be made of the capital costs (related to the size of the treatment units and the life of activated carbon or membranes) and operational costs (related to the frequency of regeneration of activated carbon or the frequency of membrane cleaning).

Compliance with EPA's Information Collection Rule for North Carolina Surface Water Supplies: Bench-scale Testing of the Efficacy of Carbon Adsorption and Membrane Separation (70145)
Francis A. DiGiano, University of North Carolina at Chapel Hill
July 1, 1995 to June 30, 1996
Funded by WRRI

NEW RESEARCH

Duke University scientist will develop method to assess reproductive damage to fish from chemical contaminants

Streams and other surface water in North Carolina are vulnerable to a variety of chemical contaminants from both point and nonpoint sources. Although many of these contaminants are not acutely toxic, recent research indicates chronic exposure to them may affect the reproductive health of fish. This possibility is of particular concern to managers of North Carolina's declining fishery resource. Assessing the reproductive hazard that chemical contaminants pose to Southeastern freshwater fish requires new techniques validated for use with these warmwater species.

To shed light on the effects of chemical contaminants on fish reproduction, Richard Di Giulio of Duke University's School of the Environment will build on previous research in which he identified biochemical and physiological responses of fish (biomarkers) to exposure to bleached kraft mill effluent (BKME). In this

continued next page

CONTINUING RESEARCH

NCSU engineers study natural remediation of petroleum contaminated groundwater and soil

In 1993, the N.C. Environmental Management Commission adopted new groundwater regulations that allow "natural remediation" of gasoline contaminated sites that pose no threat to human health or the environment. A clean-up plan using natural remediation would call for removing the source of contamination and heavily contaminated soil and allowing dissolved contaminants to be degraded by soil microorganisms. In order to decide when it is appropriate to use natural remediation, regulators need to know how fast the contaminant plume will spread and how quickly it might be degraded by soil microorganisms. Most research on biodegradation of gasoline constituents have been done in the laboratory. In earlier studies, NCSU engineers Robert C. Borden and Morton A. Barlaz found that biodegradation rates in laboratory experiments may be much greater than actual rates in the field. In ongoing research, they are attempting to discover what causes the difference in biodegradation rates and what factors control the rate of biodegradation of petroleum contaminants in soil and groundwater. Previously, the engineers conducted extensive field studies at a gasoline-contaminated site near Rocky Point where they found iron-reducing bacteria in the soil breaking down benzene, toluene, ethylbenzene and xylene isomers (BTEX), which are constituents of gasoline. In the current phase of the project, they are continuing monitoring of "microcosms" constructed with aquifer material from the Rocky Point site to determine the effects of varying amounts of iron-rich minerals on biodegradation and the effect of blending soil to distribute clay throughout the sand matrix. From their studies, the researchers intend to evaluate the importance of iron reduction on the natural attenuation of dissolved BTEX in the subsurface.

Influence of Iron Reduction on the Natural Bioremediation of Petroleum Spills (70132)
Robert C. Borden and Morton A. Barlaz, North Carolina State University
July 1, 1993 to Dec 31, 1995
Funded by WRRI

Method for assessing reproductive damage to fish continued

study he will use in vitro techniques developed in earlier research to evaluate reproductive impacts to fish in the Pigeon River resulting from exposure to BKME. In vitro methods use organs, tissues or cells from living organisms for testing. For this project gonadal tissue from fish will be used to evaluate steroid biosynthetic capacity, and livers will be used to screen for estrogenic effects and genotoxicity. Biomarkers previously identified will be used to track and quantify exposure to BKME for correlation with in vitro data.

Feral fish for the study will be collected above and at several locations below the outfall of a bleached kraft mill at Canton, NC, and from pristine reference rivers. In addition to field studies with feral fish, controlled studies will be conducted using fish exposed to constant dilutions of BKME for extended time periods in the artificial outdoor streams at the National Council for Air and Stream Improvement's experiment facility in New Bern.

The overall goal of the project is to develop an efficient methodology for screening and monitoring the reproductive impacts of aquatic pollutants on fish in North Carolina surface waters.

This study comes at a time when paper mills in North Carolina and elsewhere are planning process changes in response to proposed regulations mandating reduction of chlorinated organic compounds in effluents. The study will provide essential baseline data for future reference as mills implement changes.

However, while this study focuses on BKME, the approaches to be developed are potentially highly applicable to other sources of pollution, including nonpoint sources, as well.

In Vitro Methods for Screening and Evaluating Reproductive Impacts of Aquatic Pollutants on Fish (70141)
Richard T. Di Giulio, Duke University
June 1, 1995 to June 30, 1996
Funded by WRRI

CONTINUING RESEARCH

NCSU scientist investigates summer draw-down to control hydrilla in Lake Gaston

With the exotic *Hydrilla verticillata* spreading and the cost of herbicide treatment climbing in Lake Gaston, power companies that use the lake and the Corps of Engineers are assessing the feasibility of a summer draw-down to control the aquatic weed. Research has shown that a short-term summer draw-down can suppress vegetative growth and tuber production of hydrilla. However, the possible effect of a draw-down on desirable aquatic vegetation was not known. In research drawing to a close, Stratford Kay of the NCSU Department of Crop Science has evaluated how short-term exposure to summer drying conditions would influence the survival, growth

continued next page

CONTINUING RESEARCH

UNC-Wilmington scientists studying potential for algal blooms in Cape Fear and New rivers find unusual conditions

In a project that began in the spring of 1994, Michael Mallin and Lawrence Cahoon of UNC-Wilmington have been analyzing and experimenting with water samples from the Cape Fear River upstream and downstream of Wilmington and from the New River near Sneads Ferry. The purpose of their experiments was to determine which nutrient (phosphorous or nitrogen) and which seasonal conditions favor algal growth in the rivers.

They have found that upstream of Wilmington, where the Cape Fear is highly colored and turbid, there are high nutrient concentrations but low chlorophyll *a* concentrations, which are indicative of low algal growth. In this section of the Cape Fear, they have concluded, algal growth is held in check primarily by lack of light in the water column.

In estuarine conditions downstream from Wilmington, where waters are less highly colored and are well mixed by wind, tide, and river current, things are more complex. Analysis of samples from that location indicated that algal growth is higher. Experiments indicated that nitrogen is limiting in late summer and phosphorous, in spring. The investigators also suspect that weather and winds may play a role in controlling algal growth in the estuary area by periodically increasing turbidity and causing light limitation.

In the New River Estuary, which is heavily impacted by sewage effluent, the investigators found high phosphorous concentrations, as expected, and nitrogen limitation. However, they also found evidence of significant silica limitation. The investigators say this is the first reported incidence of silica limitation in a North Carolina estuary. They point out these conditions are representative of advanced eutrophication and that they lead to a change in the kind of algae that dominate the system.

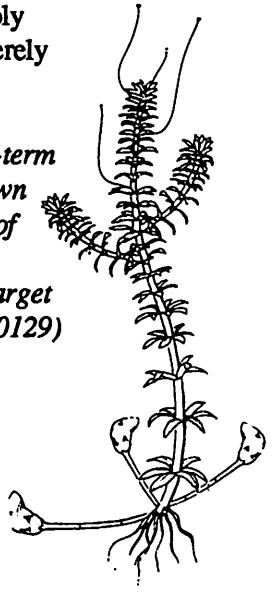
In the second year of this project, investigators are shifting their attention on the Cape Fear downstream, from the river to the estuary. They will focus on demonstrating that in the lower estuary, nitrogen is limiting in summer and phosphorous, in spring. Conclusive evidence of this limitation regime would have implications for management of wastewater inputs to the estuary.

On the New River, investigators will seek to confirm their hypothesis that algal growth is limited by nitrogen year-round and secondarily by silica. They will also examine the structure of the algae community to determine if a shift toward noxious and toxic species is taking place.

Nutrient Limitation and Eutrophication Potential of the Cape Fear and New River Estuaries (70136)
Michael A. Mallin and Lawrence B. Cahoon, University of North Carolina at Wilmington
May 15, 1994 to June 30, 1996
Funded by WRRI

Hydrilla research continued

and biomass production of two submersed plants (fanwort and Eurasian watermilfoil), one floating-leaf species (watershield), and two emergent species (waterwillow and soft rush). All these plants have been found in Lake Gaston. Results indicate that a drawdown very likely will have an adverse impact on submersed species but that emergent and floating-leaf vegetation probably would not be severely affected.



Effects of a Short-term Summer Drawdown for Management of Monoecious Hydrilla on Nontarget Aquatic Plants (70129)
Stratford H. Kay
North Carolina State University
April 1, 1993 to Sept 30, 1995
Funded by WRRI

Continuing Research

NCSU investigators develop hydrologic simulations to help identify wetlands

Much of the controversy over wetlands delineation involves determining whether wetland hydrology exists on sites that are flooded or saturated only part of the year. While soil and plant types can indicate the existence of wetland hydrology, using soil and plant indicators is not possible on sites that have been altered. On such sites, direct evaluation of hydrology through water table monitoring is necessary; however, variability of weather may make it necessary to monitor water tables for long periods to be sure results represent response to average weather conditions. Because monitoring for long periods is usually not an option, investigators in the Department of Biological and Agricultural Engineering at NCSU are working to develop reference wetland simulations which can be used to identify and delineate wetlands. R. Wayne Skaggs, G.M. Chescheir, and D.M. Amatya are developing and testing reference wetland simulations for a range of sites in nonriverine, poorly drained interstream flats using the shallow water-table model

continued next page

CONTINUING RESEARCH

UNC-Charlotte earth scientists examine performance of stormwater retention ponds for protecting water quality

Preliminary study of stormwater retention ponds led UNC-Charlotte earth scientists Randall D. Forsythe, Craig Allan and John Diemer to suspect that as these ponds age they could become sources rather than sinks of pollution. In 1993, they launched an effort to evaluate retention ponds built by the Soil Conservation Service in the Derita area of Charlotte in the 1950s. They determined that more than 30 percent of the Derita detention basins have elevated background turbidities, indicating high levels of suspended sediments and the potential for discharges from the ponds to become sources of surface water pollution. The most commonly used model for predicting pond pollutant removal efficiency does not account for the effects of sediment resuspension. This discovery together with projections for construction of hundreds, perhaps thousands, more ponds across the Piedmont suggested a critical need for better performance evaluation criteria and strategies to maintain detention ponds.

To produce the understanding of pond life and performance needed, the scientists studied sediment accumulation in 20 wet detention ponds representing a range of characteristics and found evidence that using background sediment deposit rates to predict pond life may not result in an accurate prediction. As the project comes to a close, the investigators are concluding studies on one failing detention pond in an effort to discover why sediment is resuspended in older detention ponds and how resuspended sediment and seepage from failing ponds may affect downstream water supplies and habitats.

In situ Investigation of Sediment Resuspension and Seepage Losses from a Stormwater Retention Basin in the Piedmont of North Carolina (70134)
Randall Forsythe, Craig Allan, John Diemer, University of North Carolina at Charlotte
June 1, 1993 to Dec 31, 1995
Funded by WRRI

Wetlands research continued

DRAINMOD and the water table response model WATERCOM.

Simulation studies and field tests conducted in the first phase of the project indicate proposed methods are feasible. In the second year of the project, investigators will complete analyses and testing with two years of field data. They will also ask the U.S. Corps of Engineers and the Natural Resources Conservation Service, who will be principal users of the methods being developed, to provide review and feedback.

Development of Methods for Evaluating Wetland Hydrology (70137)
R.W. Skaggs, G.M. Chescheir, and D.M. Amatya, North Carolina State University
May 15, 1994 to June 30, 1996
Funded by WRRI

THE NORTH CAROLINA URBAN WATER CONSORTIUM

In order to address research needs of specific groups, WRRI promotes partnership arrangements. One such partnership is the N.C. Urban Water Consortium.

WRRI in cooperation with several of North Carolina's larger cities established the Urban Water Consortium to provide a program of research and development and technology transfer on water problems that urban areas share. Through this partnership, WRRI and the State of North Carolina help individual facilities and regions solve problems related to local environmental or regulatory circumstances.

The Consortium program is administered by the Institute. Participating cities support and guide the program through annual dues and enhancement funds, which are matched by state funds, and representation on an advisory board. Membership in the Consortium is limited to cities or special districts in North Carolina.

The program initially received support from the N.C. Department of Environment, Health, and Natural Resources and appropriations from the N.C. General Assembly. Current Consortium members are the Orange Water and Sewer Authority, Raleigh, Durham, High Point, Burlington, Winston-Salem, Charlotte, and Greenville.

Urban water research needs cover a broad range of topics. Problems addressed with Consortium support are described on the following pages.

NEW RESEARCH
UNC-Chapel Hill investigator will create model to optimize operation of Durham's water supply reservoirs

The water supply system for the City of Durham is a complicated collection of two water reservoirs in different watersheds, several pumping stations and transmission mains, and two treatment plants, each with clearwells, finished water pumping stations, and transmission mains. This complexity presents challenges in operation. With so many pumping stations, most with a different electric cost, it is not obvious which pumping scheme will minimize energy costs. Both reservoirs use hydraulically driven pumps when reservoir inflows are high to avoid electric costs; however, these pumps consume substantial amounts of water forcing a tradeoff between conserving water and electricity. In addition, while the two reservoirs provide enough water to meet demand in normal and wet years, a problem may arise during drought years, particularly as demand increases. Finally, as reservoirs are drawn down close to working volume limits, water quality deteriorates, giving rise to higher treatment cost and risk of customer complaints. Therefore, the city must determine optimal operation not with full reservoir capacity but with restricted capacity. To assist the City of Durham in addressing these interrelated issues, Donald Lauria of the UNC-Chapel Hill Department of Environmental Sciences and Engineering will develop a mathematical optimization model with which the city will be able to determine optimal patterns of operation for given scenarios. While principles and advantages of such models have been described in the technical literature for years, advances in computer hardware and software have recently made complex optimization models feasible and practicable. This will be the largest and most comprehensive application of a zero-one (0,1) mixed integer programming (MIP) model ever made for the type system serving the City of Durham.

Optimization Model for Durham Reservoir System (50209)
Donald T. Lauria, University of North Carolina at Chapel Hill
July 1, 1995 to June 30, 1997
Funded by the City of Durham through the Urban Water Consortium

CONTINUING RESEARCH
NCSU scientists continue to evaluate agricultural use of lime-stabilized wastewater sludge

In a project that began in 1993, Bill Rogers and Fred Cox of the Department of Soil Science at North Carolina State University have conducted tests at Agricultural Research Station fields and NCSU greenhouses to determine if lime-stabilized wastewater biosolids (sludge) can be used as an agricultural liming agent. They have conducted several different experiments with the lime-stabilized sludge product Lime Plus and a commercial dolomitic agricultural lime to compare effects on soil properties and plant growth.

Results of greenhouse and field experiments to date indicate that lime-stabilized sludge seems to increase soil pH more quickly than agricultural lime and raises pH to a higher level. Plants grown with lime-stabilized sludge had higher calcium and lower magnesium concentrations than plants grown with agricultural lime. This indicates that continued use of lime-stabilized sludge could result in a calcium-magnesium imbalance and that overuse of the material could result in a magnesium deficiency if magnesium is low initially.

Rogers and Cox are now conducting studies to determine more accurately the residual effect of lime-stabilized sludge and its potential for maintaining a higher soil pH in comparison with agricultural lime.

Use of Lime-Stabilized Product as an Agricultural Liming Agent (50183)
F.R. Cox, North Carolina State University
Jan 1, 1993 to Dec 31, 1995
Funded by the Charlotte-Mecklenburg Uitilities Department through the Urban Water Consortium

Continuing Research
NCSU hydrogeologist studies nitrates in groundwater at wastewater sludge application site

In the first phase of this project, Charles W. Welby of the NCSU Department of Marine, Earth and Atmospheric Sciences has studied the routes of nitrate movement into groundwater and to surface water from sludge application fields at Raleigh's Neuse River wastewater treatment plant and from a dairy waste application site at NCSU's Randleigh Dairy Farm.

In phase two of the project, Welby is studying the rate at which nitrate from commercial fertilizer moves to shallow groundwater under normal cropping conditions at the Neuse River site. Data from these studies will allow the investigator to compare the amounts of nitrates and rates of movement of nitrates that reach groundwater from fields treated with artificial fertilizer, animal waste, and sewage sludge.

A Study of Nitrate Movement to Ground Water at the Neuse River Wastewater Treatment Plant Facility Phase II (50202)
Charles W. Welby, North Carolina State University
Sept 1, 1994 to Oct 31, 1995
Funded by the City of Raleigh through the N.C. Urban Water Consortium

NEW RESEARCH

UNC-Chapel Hill scientists will investigate apparent violation of trace element limits by several N. C. wastewater treatment plants

A number of municipal wastewater treatment plants in North Carolina appear to periodically violate their discharge limits for mercury, cadmium and cyanide. The apparent violations may stem from the fact that the permitted discharge levels for these contaminants tend to be close to their practical limits of quantitation using conventional analytical procedures.

In this project, Philip Singer and Howard Wienberg of the UNC-Chapel Hill Department of Environmental Sciences and Engineering will develop a protocol for analyzing these trace contaminants and, using the protocol, will determine whether or not the levels of trace contaminants in the effluents of a group of wastewater treatment facilities actually do violate their permitted levels. Utilities to be included in the study are the cities of Burlington, Durham, Greenville, High Point, Raleigh and Winston-Salem; the Charlotte Mecklenburg Utility District (CMUD); and the Orange Water and Sewer Authority (OWASA).

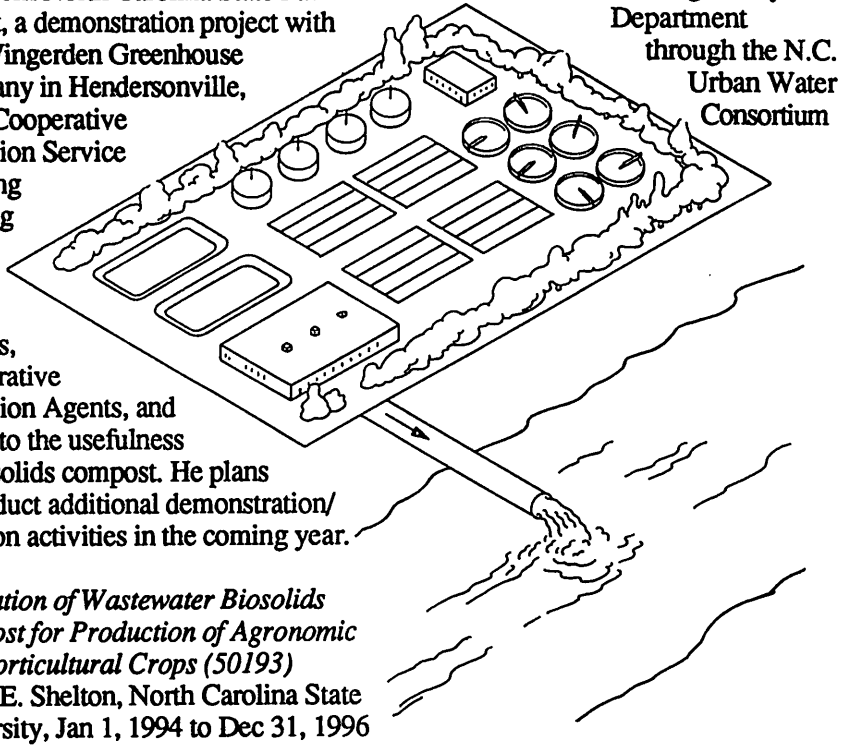
The investigators will meet with EPA scientists and staff of the N.C. Division of Environmental Management to determine appropriate sample handling, analytical techniques and expectations for measurement of these trace contaminants. They will then develop an analytical protocol to identify key issues and possible sources of error in measuring trace contaminants in wastewaters and propose an approach for resolving these issues. Once the protocol is adopted, the investigators will apply it to samples from each participating utility. The final phase of the project will involve analysis of influent and effluent samples and samples from elsewhere in the treatment plant in an effort to identify potential sources of mercury, cadmium and cyanide.

Assessment of Trace Element Concentrations in Municipal Wastewater Treatment Plant Discharges in North Carolina (50210)
Philip C. Singer and Howard S. Wienberg, University of North Carolina at Chapel Hill
Sept 1, 1995 to Feb 28, 1997
Funded by the N.C. Urban Water Consortium

CONTINUING RESEARCH

NCSU scientist continues evaluation of uses of "biosolids" compost

In a project begun in 1994, James E. Shelton of the NCSU Soil Science Department continues to evaluate the potential for use of compost made with wastewater "biosolids" for growing agronomic and horticultural crops. In previous research Shelton has evaluated the use of biosolids compost produced by the Charlotte-Mecklenburg Utility Department (CMUD) for sod production and for the production of dwarf nandina. Currently, Shelton is using CMUD compost to grow burley tobacco, a sensitive indicator species, to determine the bioavailability of heavy metals in the compost. He is also continuing to experiment with the use of biosolids compost to grow greenhouse and nursery crops, currently focusing on the production of potted tomatoes. The purpose of the greenhouse/nursery studies is to determine the concentration of wastewater biosolids compost that can be used in potting media. In the past year, the investigator organized a Western North Carolina State Fair exhibit, a demonstration project with Van Wingerden Greenhouse Company in Hendersonville, and a Cooperative Extension Service planning meeting to introduce farmers, Cooperative Extension Agents, and others to the usefulness of biosolids compost. He plans to conduct additional demonstration/eduction activities in the coming year.



Evaluation of Wastewater Biosolids Compost for Production of Agronomic and Horticultural Crops (50193)
James E. Shelton, North Carolina State University, Jan 1, 1994 to Dec 31, 1996
Funded by the Charlotte-Mecklenburg Utility Department through the N.C. Urban Water Consortium

CONTINUING RESEARCH

NCSU researchers compare stormwater cleansing ability of pond and pond-wetland system

In a project launched in January 1993, NCSU investigators are continuing to collect data to compare the pollutant removing effectiveness of a wet detention pond (on Davis Drive) and a combined pond-wetland system (on Piedmont Parkway) in High Point's City Lake watershed and to predict pollutant removal efficiencies of ponds and pond-wetland systems.

Since 1993, inflow and outflow from 15 storms have been analyzed at the Davis Pond, and sampling at this site have been terminated. Since 1994, inflow and outflow from 11 storms has been analyzed at the Piedmont pond-wetland system. Investigators are using contaminant concentrations and flow data to determine pollutant loads and removal efficiencies for each structure on an event basis, a monthly basis, a seasonal basis, and an annual basis. Tracer tests, sediment analyses, nutrient analyses, temperature/DO profiles, and pesticide analyses are providing information on the processes controlling pollutant removal in the structures.

Investigators have completed calibration of the MINLAKE (Minnesota Lake Water Quality Management Model) model for the Davis Pond and are performing sensitivity analysis. They will examine methods of optimizing pond performance by varying different parameters. Sampling at the Piedmont pond-wetland system continues, and grab sampling of Piedmont tributaries will be done to determine the variance between monitored and unmonitored inflow parameters. MINLAKE will be calibrated to estimate the pollutant removal efficiency of this system as well.

Evaluation of Ponds and Wetlands for Protection of Public Water Supplies (50184)
Sarah L. Liehr and Robert C. Borden, North Carolina State University
Jan 1, 1993 to Jan 31, 1996
Funded by WRRI, the Urban Water Consortium, and the City of High Point

NEW RESEARCH

NCSU engineers expand investigation of effectiveness of stormwater structures to different configurations, different land uses

For the last two years, Robert Borden and Sarah Liehr of the NCSU Department of Civil Engineering have been examining the pollutant removal efficiency of two stormwater detention ponds in the City of High Point's water supply watershed. One structure, a detention pond, drains 1,258 acres of farmland and woodland. The other structure, a pond-wetland system, drains 1,220 acres that includes a petroleum tank farm, industrial acreage and open space.

The investigators have found that the pollutant removal efficiencies of the ponds are quite different and believe the difference is related to concentration of pollutants in runoff and timing of runoff. The information they have collected and the pollutant removal models they are developing for these two ponds will be useful for evaluating the water quality benefits of stormwater ponds. However, it will be difficult to evaluate the effectiveness of stormwater ponds in areas where land use is substantially different from the areas currently being studied or of stormwater structures with different physical configurations.

In this project, the researchers will collect data from three new ponds the City of High Point is building: Regency, a shallow pond/wetland system receiving runoff from a 4,000 acre developing watershed; Mall A, a pond receiving runoff from a heavily developed 800 acre watershed; and Mall B, a medium size pond receiving runoff from a 150-acre shopping mall. They will monitor the mall ponds for 15 months and the pond/wetland for 18 months. They will use monitoring results to calculate the overall removal efficiency of each structure and evaluate the relative performance of the different control devices. They will also calibrate the lake water quality model, MINLAKE to each structure, perform continuous simulations for the monitoring period, and use simulation results to estimate seasonal and long-term treatment efficiencies for each structure.

Evaluation of Ponds and Wetlands for the Protection of Public Water Supplies Continuation (50211)
Robert C. Borden and Sarah K. Liehr
North Carolina State University
Jan 1, 1996 to Dec 31, 1997
Funded by the N.C. Urban Water Consortium and the City of High Point

CONTINUING RESEARCH
Project investigates potential for pesticides in water supplies

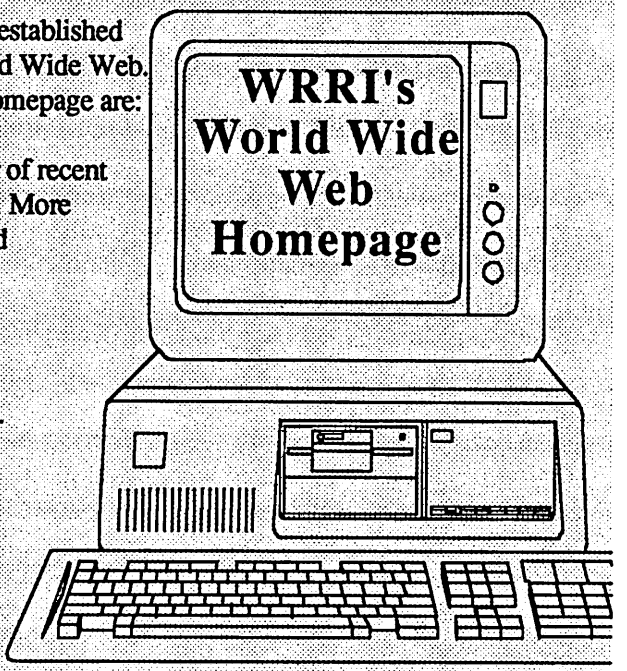
In this project, Robert E. Holman of WRRI is investigating the potential amount, type, and source of pesticides detected in water supply watersheds for Durham, Greenville and Orange Water and Sewer Authority. Agricultural cropland and the type and amount of crops grown in the watersheds have been determined from Department of Agriculture records. The type and amount of pesticide used on particular crops have been determined. Boundaries and hydrology for each watershed have been digitized for use in a Geographic Information System. Estimates of pesticide loading for each watershed have been determined. In the second phase of this study, sampling for 11 pesticides is being conducted for one year. The sampling sites have been expanded to include the water intakes of Burlington, Charlotte, High Point, Raleigh and Winston-Salem. This study phase is to determine the relationship between the estimated pesticide loading versus actual sampling results.

Evaluation of Pesticides in Three Water Supply Watersheds (50189)
Robert E. Holman, Water Resources Research Institute of The University of North Carolina
Nov 1, 1992 to June 30, 1996
Funded by the N.C. Urban Water Consortium

URL=http://www2.ncsu.edu/ncsu/CIL/WRRI

During 1994-95, WRRI established a homepage on the World Wide Web. Available through our homepage are:

- Summaries of a number of recent WRRI technical reports. More summaries will be added as time allows.
- The *WRRI NEWS*
- Some WRRI fact sheets. Other will be added.
- The 1995-96 WRRI Annual Program
- Links to homepages of other state water institutes, federal and state agencies dealing with water resources, and the Universities Water Information Network (UWIN).



In time, we hope to also make available our water resources expertise directory and our listing of water resources research projects being conducted throughout the University of North Carolina system.

Eventually, we expect all these documents will be searchable by keyword.

Student Intern Program

WRRI has undertaken four intern projects with state and federal agencies.

The first effort is sponsored by the N.C. Office of Waste Reduction. Three interns are supported through this project, and the students work by assisting the staff during on-site audits and preparing reports on the methods of pollution prevention employed by different industries. All graduating interns in this project have gained employment with government or industry in the pollution prevention sector.

The second effort is sponsored by the N.C. Division of Land Resources, Land Quality Section. One intern is supported through this project, and the student works directly with the staff education specialist and provides presentations to schools and the regulated community. The individual also helps to develop new materials to support the educational focus of the Land Quality section.

The third effort is sponsored by the National Oceanic and Atmospheric Administration. NOAA's Marine Fisheries Center in Beaufort, NC, is supporting three minority intern students during the summer. These interns work directly with the research staff on projects of mutual interest that involves the development of both field and laboratory experience.

The last effort is sponsored by the U.S. Geological Survey. The USGS District Office in Raleigh is supporting two intern students during the summer. These interns work with the research staff on stormwater and geochemistry projects in the Raleigh and Charlotte offices.

TECHNOLOGY TRANSFER

WRRI disseminates information and promotes adoption of new technology and practices through publication of newsletters and technical completion reports on its projects and through sponsorship and co-sponsorship of conferences, workshops and seminars. Technology transfer activities carried out during 1994-95 are reported on these pages.

WRRI TECHNICAL REPORTS

In 1994-95, WRRI published 15 peer-reviewed technical completion reports:

WRRI-281 *Treatability Assessment of Jordan Lake*
WRRI-282 *Assessment of Municipal Sludge Management Practices in North Carolina*
WRRI-283 *Prediction of Pollutant Movement from Poorly Drained Soils*
WRRI-284 *Effects of Urbanization and Land Use Changes on Low Streamflow*
WRRI-285 *Movement and Dissipation of Toxicants and Water in Natural Soil Environments*
WRRI-286 *Reduction in Sediment and Chemical Load from Agricultural Field Runoff by Vegetative Filter Strips*
WRRI-287 *Anaerobic iodegradation of Hazardous Organics in Groundwater Down Gradient of a Sanitary Landfill*
WRRI-288 *An Improved Viral Indicator of Fecal Contamination and Treatment Process Efficiency to Meet New EPA Drinking Water Regulations*
WRRI-289 *Wetland Restoration and Creation: Development of a Handbook Covering Six Coastal Wetland Types*
WRRI-290 *An Experimental Investigation of Hot Water and Cosolvent Flushing for Remediation of NAPL-Contaminated Aquifers*
WRRI-291 *Nitrogen Loading Sources and Eutrophication of the Neuse River Estuary, North Carolina: Direct and Indirect Roles of Atmospheric Deposition*
WRRI-292 *Feasibility of Wastewater Reuse at the National Spinning Company, Inc. in Washington, North Carolina*
WRRI-293 *Improvement of the Nanofiltration Membrane Process by Addition of Powdered Activated Carbon for Enhanced Removal of Precursors to Disinfection Byproducts in Small Water Utilities*
SRS-15 *Groundwater Geochemistry of the Castle Hayne Aquifer in the Region of Capacity Use Area No. 1, Northeastern North Carolina*
SRS-16 *Use of Lime-Treated Wastewater Sludge-Soil Mixtures for Daily Cover in Solid Waste Landfills*

WRRI reports are distributed to libraries, and synopses of reports are published in the WRRI newsletter and distributed to interested research faculty, other state water institutes, and relevant government agencies.

Single copies of WRRI reports are made 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.

An updated listing of all WRRI publications, including technical reports, is published annually and may be obtained by calling the Institute office.

NEWSLETTERS

WRRI publishes two newsletters. The *WRRI NEWS* is published every other month and sent to nearly 3200 federal and state agencies, university personnel, multi-county planning regions, city and local officials, environmental groups, consultants, businesses and individuals. The *NEWS* regularly covers a wide range of water-related topics from current federal and state legislation and regulatory activities to new research findings and listings of water-related publications.

The WRRI NEWS is available free of charge to residents of North Carolina. To be added to the mailing list, call or write WRRI.

Email subscriptions to the WRRI NEWS are also available to anyone with an Internet address. To subscribe, send an Email message to: listserv@ncsu.edu. In the message say: subscribe WRRI-NEWS your full name.

An electronic version of the newsletter is also accessible on WRRI's World Wide Web homepage: URL=http://www2.ncsu.edu/ncsu/CIL/WRRI

The *Urban Water Consortium News* is published annually and distributed to members of the Urban Water Consortium who use the newsletter to keep their constituencies (city councils, county commissions, etc.) informed about the activities of the consortium and about water-related issues affecting municipalities. The newsletter carries descriptions of research funded through the consortium as well as news about water-related projects undertaken independently by members, and state and federal programs and legislation.

The Institute also produces a newsletter, *Sediments*, for the N.C. Sedimentation Control Commission to provide information and assistance to the regulated community and to facilitate communication among personnel of state and local erosion and sediment control programs. This newsletter is free. To be added to the mailing list contact WRRI or Toby Vinson in the N.C. Land Quality Section at (919) 733-4574.

Workshops and Conferences

During 1994-95, WRRI sponsored, helped plan and executed two conferences, 2 workshops and 3 forums.

Environmental Impact Prediction Conference. In October, WRRI, the N.C. Supercomputing Center, Cray Research Inc., the U.S. Environmental Protection Agency and the National Institute for Environmental Health Sciences presented a two-day conference on utilizing computer models to help predict environmental impact. Approximately 175 people attended.

Water Reuse: The Next Step Forum. In November, WRRI and the N.C. Water Resources Association conducted a forum on water reuse. Forty-nine people attended.

Composting in the Carolinas Conference. In January, WRRI, the N.C. Department of Environment, Health, and Natural Resources, North Carolina State University, the S.C. Department of Health and Environmental Control, and Clemson University conducted a three-day conference on composting in North Carolina and South Carolina. The focus was on issues associated with composting of municipal solid waste, yard wastes, biosolids and other organic wastes. About 180 attended.

Erosion and Sediment Control Workshop for Local Programs. In January, WRRI, the N.C. Sedimentation Control Commission and the N.C. Land Quality Section presented a two-day workshop to allow local programs to get together and exchange ideas and practices utilized at the local level. Seventy-eight attended.

Water Quality Trends: NAWQA Perspective Forum. In February, WRRI and the N.C. Water Resources Association presented a forum on the U.S. Geological Survey's National Water Quality Assessment (NAWQA) program. Forty-two attended.

Stormwater Management Opportunities for Small Communities Workshop. In April, WRRI, Land-of-Sky Council of Governments, and the N.C. Division of Environmental management conducted a stormwater conference to provide up-to-date information on stormwater management in North Carolina and assist local government officials in developing comprehensive stormwater management programs. About 55 people attended.

N.C. Wetlands Task Force: Overview and Perspectives Forum. In May, WRRI and the N.C. Water Resources Association presented a forum on the results of a task force appointed by Secretary Jonathan Howes of the N.C. Department of Environment, Health, and Natural Resources to evaluate current regulations in North Carolina affecting wetlands. Sixty-two attended.

WRRI TECHNICAL COMMITTEE

The Technical Committee, composed of university faculty, reviews and makes recommendations on research proposals and in other ways lends professional expertise to the Institute's programs

David H. Moreau, Director, Water Resources Research Institute (Chairman)

Michael D. Aitken, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill

Morton A. Barlaz, Department of Civil Engineering, North Carolina State University

Mark M. Brinson, Department of Biology, East Carolina University

Stephen W. Broome, Department of Soil Science, North Carolina State University

Lawrence B. Cahoon, Department of Biological Sciences, University of North Carolina at Wilmington

B.J. Copeland, Director, UNC Sea Grant College Program of The University of North Carolina

Francis A. DiGiano, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill

David G. Evans, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University

Robert E. Holman, Associate Director, Water Resources Research Institute

George J. Kriz, Associate Director, Agricultural Research Service, North Carolina State University

G.B. Reddy, Department of Plant Science & Technology, N.C. Agricultural & Technical State University

Donald W. Stanley, Institute for Coastal and Marine Resources, East Carolina University

Philip W. Westerman, Department of Biological and Agricultural Engineering, North Carolina State University

Jy Wu, Department of Civil Engineering, University of North Carolina at Charlotte

Water Resources Research Seminar Series

Each year a number of research faculty engaged in projects funded by WRRI present a seminar on their work. This year about 200 university faculty and students and personnel of federal, state, and local agencies attended nine seminars presented by the following investigators:

Mark D. Sobsey, Department of Environmental Sciences and Engineering, UNC-Chapel Hill, *Viral Indicators of Fecal Contamination in Surface Waters*

Aziz Amoozegar, Department of Soil Science, NCSU, *Aerobic Pretreatment for On-Site Wastewater Disposal*

Donald E. Francisco, Department of Environmental Sciences and Engineering, UNC-Chapel Hill, *Evaluation of Test Animals for Toxicity Testing*

R. Wayne Skaggs, Department of Biological and Agricultural Engineering, NCSU, *Assessing Wetland Hydrologic Status*

Richard T. Di Giulio, School of the Environment, Duke University, *Biomarkers for Pulp and Paper Mill Effluent Exposure*

Fred R. Cox, Department of Soil Science, NCSU, *Lime-Plus as an Agricultural Liming Agent*

Mike Mallin, Department of Biological Science, UNC-Wilmington, *Nutrient Limits in the Cape Fear Estuary*

Carlyle Franklin, Department of Forestry, NCSU, *Nitrogen Cycling in Forest Filter Zones*

Stratford Kay, Department of Crop Science, NCSU, *Short-term Summer Drawdown as a Possible Tool for Management of Monoecious Hydrilla*

Environment-related legislation passed by the N.C. General Assembly

The N.C. General Assembly adjourned on July 27. It will reconvene May 21, 1996. In addition to ratified bills reported in the last issue of the NEWS, the following environment-related legislation was passed. Copies of bills can be obtained by calling the Printed Bills Office of the N.C. Legislature at (919) 733-5648. You must know the number of the bill you want.

S 52 AN ACT TO AMEND THE PROVISIONS OF CHAPTER 146 CONCERNING STATE-OWNED SUBMERGED LANDS. Provides that riparian or littoral property owners shall obtain easements for new structures on state-owned lands covered by navigable waters. Exempts structures that do not generate revenue and which accommodate no more than ten vessels, public utility structures, government structures, and structures on submerged lands created by dredging or excavation. Establishes terms for granting easements. Establishes procedure for computing easement purchase payments.

S 229 AN ACT TO REMOVE IMPEDIMENTS AND DISINCENTIVES TO DONATING CONSERVATION LAND OR PRESERVATION STRUCTURES OR SITES. Provides that conservation of land or water area or preservation of a structure or site pursuant to agreement is not extinguished by marketable record title. Provides that effective Jan 1, 1996, no deferred taxes will be owed and all present use value taxes will be extinguished for real property qualified for present use appraisal conveyed by gift to nonprofit organization and qualifying for exclusion from the tax base or conveyed by gift to unit of government.

S 388 AN ACT TO AMEND THE PESTICIDE LAW. Provides that to encourage cooperation of private property owners, the N.C. Pesticide Board may enter into agreements with owners to conduct sampling, testing, monitoring, and related activities on their property and provides that information obtained shall not be disclosed in a manner that would permit identification of an individual property owner unless the property owner gives permission. Makes it unlawful (1) for any person, for compensation, to apply a pesticide not registered pursuant to law and (2) to interfere with any State employee engaged in the performance of duties. Amends definition of "pesticide applicator" to add anyone who provides, for compensation, a service that includes application of pesticides, and removes from definition persons applying a general use pesticide not for compensation, and those employed by licensed pesticide applicators. Provides that no county, city or other political subdivision can adopt to continue any regulation of pesticides. Permits Pesticide Board to assess a $2,000 fine against any person violating or causing a violation of a provision of or rule adopted under GS 143. Provides that failure to pay fine within 30 days is grounds for denial, suspension, or revocation of any license or registration issued pursuant to GS 143.

S 491 AN ACT TO MODIFY THE MINIMUM STREAMFLOW REQUIRED IN THE LENGTH OF THE STREAM AFFECTED BY CERTAIN DAMS OPERATED BY SMALL HYDROELECTRIC POWER PRODUCERS. This law amends changes to the statutes enacted by S 1041 earlier in the session (see July/Aug NEWS). S 1041 established minimum streamflows in streams affected by small hydropower dams. This law provides that those minimum flows do not apply if the length of the stream affected (1) receives a discharge of waste from a permitted treatment works or (2) includes any part of a river or stream segment designated as part of the State Natural and Scenic Rivers System or designated as a part of the national Wild and Scenic Rivers System.

S 874 AN ACT TO CONFIRM THE WATER RIGHTS OF THE STATE IN THE ROANOKE RIVER BASIN AND TO MAKE CLARIFYING, CONFORMING, AND TECHNICAL CHANGES TO VARIOUS LAWS RELATING TO ENVIRONMENT, HEALTH, AND NATURAL RESOURCES. States that the State reserves and allocates to itself, as protector of the public interest, all rights in the water located in those portions of Kerr Lake and Lake Gaston that are in the State. Makes a number of technical corrections in various statutes.

S 908 AN ACT RELATING TO THE POWER OF WATER AND SEWER AUTHORITIES AND CITIES AND COUNTIES TO REQUIRE CONNECTIONS TO WATER AND SEWER SYSTEMS, THE NUMBER OF MEMBERS OF CERTAIN METROPOLITAN SEWERAGE DISTRICTS, AND THE POWERS OF THE STANLY AIRPORT AUTHORITY. Authorizes water and sewer authorities to require owners of developed property on which there are one or more residential dwelling units or commercial establishments located within the jurisdiction of the authority and within a reasonable distance of any water line or sewer collection line operated by the authority to connect the property and to fix charges for the connection (if the property is not being served by another political subdivision or by a public utility regulated the N.C. Utilities Commission). Provides the same authority for counties and cities. Provides for availability charges on improved property where water and sewer lines have been installed in counties of at least 40,000 population. Authorizes political subdivisions to require evidence of payment of connection fees as a condition for acquiring development or building permits.

S 917 AN ACT TO ALLOW MEMBERS OF THE SOIL AND WATER CONSERVATION COMMISSION AND SUPERVISORS OF SOIL AND WATER CONSERVATION DISTRICTS TO PARTICIPATE IN THE AGRICULTURE COST SHARE PROGRAM FOR NONPOINT SOURCE POLLUTION CONTROL AND TO ALLOCATE FUNDS FOR THE AGRICULTURE COST SHARE PROGRAM FOR NONPOINT SOURCE POLLUTION CONTROL TO BE USED FOR CAPITAL EXPENSES ASSOCIATED WITH DEVELOPING AGRICULTURE WASTE MANAGEMENT MEASURES. Adds to the duties and powers of the Soil and Water Conservation Commission "to create, implement and supervise the Agriculture Cost Share Program for Nonpoint Source Pollution Control" and to "review and approve or disapprove the application of a district supervisor for a grant under the Agriculture Cost Share Program for Nonpoint Source Pollution Control." Provides that members of commission may receive grants under the cost share program if the member does not vote on the application and if the Secretary of DEHNR approved the application. Provides that district supervisors may receive grants under the cost share program if the supervisor does not vote on the application and if the application is approved by the Soil and Water Conservation Commission. Designates $500,000 of funds appropriated to DEHNR for 1995-96 fiscal year for the Agriculture Cost Share Program to be used for capital expenses associated with developing agriculture waste management measures that reduce agricultural nonpoint source discharges.

S 927 AN ACT TO PROVIDE THAT SMALL LANDFILLS FOR THE

DISPOSAL OF DEMOLITION DEBRIS ARE EXEMPT FROM THE PERMITTING REQUIREMENTS GENERALLY APPLICABLE TO LANDFILLS AND TO AUTHORIZE THE DEPARTMENT OF ENVIRONMENT, HEALTH, AND NATURAL RESOURCES TO GRANT A VARIANCE IN THE GEOGRAPHIC AREA SERVED BY A SANITARY LANDFILL UNDER CERTAIN CIRCUMSTANCES. Exempts from permitting requirements and rules governing sanitary landfills landfills of less than one acre that dispose of demolition debris generated on the same parcel of land where the landfill is located. Establishes requirements for such small demolition landfills. More as title indicates.

S 974 AN ACT TO REQUIRE A PERSON WHO PERFORMS THE LAND APPLICATION OF ANIMAL WASTE FROM SWINE PRODUCTION TO BE CERTIFIED. Provides that only an operator-in-charge who holds a valid certificate to operate an animal waste management system or person under the supervision of an operator-in-charge may land apply animal waste and that owner of land used for swine production is responsible for ensuring compliance. Provides that DEHNR in cooperation with the Cooperative Extension Service shall develop and administer a training and certification program for operators of animal waste management systems. Requires each applicant to complete six hours of instruction, to pass an exam and pay a $10.00 fee. Certification to be renewed annually and training to be completed once every five years. Civil penalty of up to $1,000 may be assessed for operating waste management system without certification or for fraud, deception, carelessness or incompetence in performance of duties.

H 230 EXPANSION AND CAPITAL IMPROVEMENTS APPROPRIATIONS ACT OF 1995. This bill contains several parts and sections related to environmental programs, including earmarking DEHNR funding for several specific purposes.

ANIMAL WASTE. Provides that of funds appropriated to DEHNR for 1995-96, $500,000 shall be used for capital expenses associated with developing agriculture waste management measures that reduce nonpoint source discharges and that priority for their use be given to small, family agricultural operations. Provides that of funds appropriated to DEHNR, $459,292 for 1995-96 and $424,972 for 1996-97 shall be used to conduct inspections, enforcement activities, and laboratory analyses to ensure that animal waste operations comply with regulations. Provides that of funds appropriated to DEHNR's Division of Soil and Water Conservation, $427,510 for 1995-96 and $427,510 for 1996-97 be used for staff and operating expenses to assist agricultural operation in meeting requirements for animal waste management, giving priority to small, family agricultural operations.

WATER DEVELOPMENT PROJECTS. Provides that of funds appropriated to DEHNR for 1995-96, $1,865,000 shall be used for water resources development projects listed and that $200,000 shall be used for small watershed projects listed.

AQUATIC WEEDS. Provides that of funds appropriated to DEHNR, $30,000 be used in 1995-96 to study aquatic weed infestation on a statewide basis. ($150,000 is set aside for aquatic plant control in water development section.)

MULTI-COUNTY WATER CONSERVATION AND INFRASTRUCTURE DISTRICT. Establishes the Multi-County Water Conservation and Infrastructure District as a public authority, with members being Bertie, Granville, Halifax, Martin, Northampton, Person, Vance and Warren counties. Provides for establishment and duties of governing board. Provides that all monies received by the State of North Carolina for sale of water under the Roanoke River Basin Compact, if enacted, shall be paid to this district. Provides for allocation of funds and provides that funds may be used for public purposes relating to infrastructure development, economic development, and water conservation.

ADMINISTRATIVE RULE-MAKING. Creates the Joint Legislative Administrative Procedure Oversight Committee. This committee is to receive reports from the Rules Review Commission (RRC), make available to members of the General Assembly (by placing them in a notebook in the Legislative Library) administrative rules approved, and review rules to which the RRC has objected "to determine if statutory changes are needed to enable the agency to fulfill the intent of the General Assembly." It is also to review existing rules to determine if they are necessary and to review the rule-making process. The committee is to meet at least quarterly.

Provides that permanent rules approved by the RRC becomes effective on the 31st legislative day of the next regular session of the General Assembly that begins at least 25 days after the date the Commission approved the rule, unless a bill disapproving the rule is introduced in either house. In that case, the rule becomes effective either when unfavorable final action is taken on the bill or when the General Assembly adjourns without ratifying the bill (unless a later effective date has been specified by the agency).

Provides that the Governor may make a permanent rule effective upon finding that it is necessary to protect public health, safety or welfare.

Provides that before publishing in the N.C. Register the proposed text of a permanent rule change that would have a substantial economic impact ($5 million in a 12-month period) and is not identical to a required federal regulation, an agency must obtain a fiscal note from the Office of State Budget and Management (OSBM) or prepare a fiscal note and have it approved by OSBM. Details required contents of fiscal note.

Revises procedure for adopting rules. Provides that to adopt a permanent rule, an agency shall (1) publish in N.C. Register a notice of rule-making and take comments on the notice until text of rule is published, (2) prepare or obtain a fiscal note, (3) publish the text of the proposed rule in the N.C. Register, (4) when required, hold a public hearing, and (5) accept oral or written comments. Revises requirements for holding public hearings.

Strengthens the role of RRC and expands the criteria RRC must consider when reviewing rules. Establishes procedures to be followed when RRC approves and objects to rules.

Provides that the Governor shall conduct review of administrative rule changes that would affect the expenditures or revenues of local governments before the proposed text is published in the N.C. Register. Establishes the scope of the Governor's review, including "the potential costs of the proposed change weighed against the potential risks to the public of not taking the proposed change." Provides that all requests for information and documents used to prepare fiscal notes are to be kept confidential until the Fiscal Research Division releases a fiscal note based on the documents.

Appropriates $207,000 for 1995-96 and $167,000 for 1996-97 to Office of State Budget and Management for implementation of new rule-making requirements.

H 281 AN ACT TO CREATE THE RESIDENTIAL PROPERTY DISCLOSURE ACT. Applies to transfers of residential real property of not less than one or more than four dwelling units with certain exceptions. Requires that the owner of the real property shall furnish to a purchaser a residential property disclosure statement in the language and form set forth in the law. The statement shall disclose those items which are required to be disclosed of which the owner has actual knowledge or state that the owner makes no representations as to the condition of the property. Items addressed are (1) abnormality or malfunction of water supply or sanitary sewage; (2) damage or abnormality of roof, chimneys, floors, foundation, basement or load-bearing walls or leak in roof or basement; (3) abnormality or

malfunctioning of plumbing, electrical, heating or cooling systems; (4) infestation of wood-destroying insects; (5) property's violation of zoning laws, restrictive covenants or building codes, any encroachment on adjacent property, and notice from any governmental agency affecting the property; (6) presence of lead-based paint, asbestos, radon gas, methane gas, underground storage tank, hazardous material or toxic material. Provides conditions for termination of real estate contract based on disclosure statement. Sets forth duties and limits of liability of owner. Provides that real estate broker or salesman acting as agent of owner has duty to inform owner of rights and obligations under the law.

H 718 AN ACT TO ESTABLISH A NORTH CAROLINA PARKS AND RECREATION AUTHORITY AND TO EARMARK FUNDS FOR THE PARKS AND RECREATION TRUST FUND AND THE NATURAL HERITAGE TRUST FUND. Establishes 9-member N.C. Parks and Recreation Authority to allocate funds from the Parks and Recreation Trust Fund and to develop private support for parks. Provides that 75% of the deed stamp tax received by the Department of Revenue is to go to the Parks and Recreation Trust Fund and that 25% is to go to the Natural Heritage Trust fund. Limits to 3% the amount of Trust Fund funds that can be used for operating expenses associated with managing capital improvement projects, acquiring land and administration of local grants program.

H 836 AN ACT TO EXPEDITE THE ENVIRONMENTAL PERMITTING PROCESS BY ALLOWING THE OPTION OF SUBMITTING PERMIT APPLICATIONS CERTIFIED BY A PROFESSIONAL ENGINEER AND ALLOWING THESE APPLICATIONS TO BE EXPEDITIOUSLY PROCESSED BY PROVIDING EARLY PUBLIC NOTICE, PUBLIC HEARING, AND TECHNICAL REVIEW, AND TO INCREASE THE MAXIMUM AMOUNT OF THE FEE THAT THE ENVIRONMENTAL MANAGEMENT COMMISSION MAY ASSESS FOR PROCESSING AN APPLICATION FOR A PERMIT UNDER THE WATER AND AIR QUALITY PROGRAMS. Provides that for environmental permit applications certified by a Professional Engineer, a completeness review be conducted within 10 days of receipt. For applications determined to be complete, notices must be published and required public hearings scheduled within 30 days. Requires that technical review be substantially complete by time of public hearing, if any, or by the close of the notice period. Requires permit decision be made within 30 days of the public hearing or close of notice period. Provides for handling of incomplete applications and circumstances under which application review may be halted. Requires EMC to adopt rules governing times for review of applications other than those certified by a PE.

H 873 AN ACT TO LIMIT THE SUBSTANCES THAT APPLICATORS OF PESTICIDES ARE AUTHORIZED TO APPLY AND TO PROVIDE FOR THE PESTICIDE APPLICATOR'S LICENSE TO BE REVOKED, SUSPENDED OR DENIED FOR VIOLATING THIS LIMITATION. Provides that pesticide applicators or their employees shall not apply any substance that has an active ingredient contained in a registered pesticide but is not registered as a pesticide pursuant to N.C. law or combine any substance whose application is prohibited under N.C. law with any other substance to apply as a pesticide. Provides that doing so is a misdemeanor subject to a fine of up to $1,000 per violation.

H 898 STUDIES ACT OF 1995. Provides for study by the Legislative Research Commission of, among other things, property issues and water issues. Provides that the legislative Research Commission may study uses of the Cape Fear River Basin, including increased economic development, the use of hydroelectric power, recreational uses, and improving water quality for citizens of southeastern North Carolina. Provides that the president Pro Tempore of the Senate may direct a Senate standing committee or select committee to study merging the Travel and Tourism Division of the Department of Commerce with the Division of Parks and Recreation of DEHNR.

Creates the 18-member Blue Ribbon Study Commission on Agriculture Waste in the General Assembly to study environmental effects of agriculture waste, waste management and disposal methods, economic impact of agriculture waste in areas of high concentration, implementation or recommendations of Swine Odor Task Force, regulatory activities of agencies with jurisdiction over agriculture industries, and beneficial uses of agriculture waste. Report to be filed prior to convening of the 1996 Regular Session of the 1995 General Assembly. Six members each to be appointed by Governor, President Pro Tempore and Speaker.

Directs the Environmental Review Commission to study consolidating environmental rule making and quasi-judicial functions into one, full-time environmental commission, patterned after the N.C. Utilities Commission. To be reviewed, at a minimum, are: Coastal Resources Commission, Environmental Management Commission, Commission for Health Services, Marines Fisheries Commission, Mining Commission, Sedimentation Control Commission, Soil and Water Conservation Commission, Water Pollution Control System Operators Certification Commission, Water Treatment Facility Operators Board of Certification, Wildlife Resources Commission, pesticide Board, Structural Pest Control Committee. Findings and recommendations to be reported on or before Feb 15, 1997.

Directs the N.C. Department of Environment, Health, and Natural Resources to conduct a study of its mission, authority, duties, structure, and permit process related to environmental programs and consider specific actions being undertaken by the Department and further proposals (listed) for coordinating and streamlining environmental regulatory and permit processes. In conducting the study, the Department shall select an equal number of representatives from local government, industry, small business and environmental groups to work with and advise it. Report due no later than Jan 1, 1996. Establishes the State and Local Government Fiscal Relations and Trends Study Commission to study fiscal responsibility of local governments, including structure, powers, finance and revenue options, and unfunded mandates; whether N.C.'s current system of shared responsibility for administering and financing public services is meeting the needs of the State and its communities; how that system might be improved to make the provision of public services more effective, efficient, and equitable; and identify trends affecting the fiscal resources of the State and local government. The Commission is to address, among other things, whether all or some portion of services provided by state and local governments could be more effectively and efficiently provided by the private sector, with or without some form of public-private partnership.

Directs the Environmental Review Commission to study the existing State toxic air pollutant control program and its relation to the federal hazardous air pollution control program and to consider whether there is overlap or duplication between these programs, benefits and costs of continuing both programs, and the role and activities of the Scientific Advisory Board on Toxic Air Pollutants of DEHNR. Report to be delivered upon convening of the 1996 Regular Session.

Directs the Environmental Review Commission to study plastics recycling and report no later than Feb 15, 1997.

Establishes the Legislative Study Commission on Wetlands to study the current wetlands regulatory program including the need to develop a statewide wetlands restoration and mitigation program and mitigation bank. The evaluation shall include a review of current wetlands rules and regulations and an assessment of any necessary changes that should be made in exchange for participation in a statewide mitigation bank.

WRRI reports available

WRRI has recently published reports on research 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 S tate University, Raleigh, NC 27695-7912 or call (919) 515-2815.

Report 293: Hollow-Fiber Nanofiltration for Treatment of a Surface Water High in Natural Organic Matter
by Francis A. DiGiano, Anne Braghetta, Bruce Utne, and James Nilson, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill

Safe Drinking Water Act regulations requiring control of disinfection byproducts (DBPs) are making it necessary for the water industry to re-examine the practice of water treatment. Current options for DBP control are to reduce or eliminate the use of chlorine or remove natural organic material (NOM) before it can react with chlorine to produce DBPs. However, reducing chlorine use is problematic because alternative disinfectants may not be as effective, and removing NOM would force substantial changes in current treatment practices. Membrane separation technology, and nanofiltration in particular, promises to remove not only NOM but also some organic chemicals of health concern. Nanofiltration membranes have a pore size on the order of 10^{-9} m and provide separation capabilities intermediate between ultrafiltration and reverse osmosis. While there are uncertainties about cost and scale of application of membrane technology, recent studies suggest that commercially available membrane modules are already competitive cost-wise with conventional treatment for small plants. One of the key factors influencing cost is the frequency with which membranes must be rinsed and/or cleaned to remove foulants. The result of membrane fouling is a decrease in the volume of water produced per unit area of membrane surface. The major foulant is NOM.

Little is known about the causes of fouling. The objective of this research project was to investigate the fouling of a hollow-fiber nanofiltration membrane by NOM and strategies to control it. Water typical of high NOM concentrations found in eastern North Carolina water supplies was obtained from the Tar River at the intake for the City of Tarboro and studied in bench-scale filtration tests. Greater decrease in water produced was observed with feed waters that contained high NOM concentrations and with operation at low cross-flow velocity. The addition of powdered activated carbon particles to the feed stream was found to provide a small degree of water production enhancement, apparently due to an increase in effective shear at the membrane surface. Some NOM fractions that associate with the membrane surface were removed by high-velocity rinsing but most of the fouling material required use of chemical cleaner. Some residual NOM remained and produced irreversible fouling. These results suggest that NOM solute association with the membrane surface was physicochemical in nature. The NOM fraction recovered with cleaning was generally in the greater-than-30,000-molecular-weight range.

NOM was subdivided into hydrophilic and hydrophobic fractions in order to investigate in more detail the compositional influence on fouling and rejection. The hydrophobic fraction of NOM was rejected by nanofiltration to a much greater extent than the hydrophilic fraction, but the hydrophobic fraction was nearly totally responsible for fouling. Pretreating NOM with a fixed dosage of powdered activated carbon but variable contact time reduced the decline in water production with longer contact time after all solutions were adjusted to the same NOM feed concentration. Longer contact time caused a shift in composition of the NOM to favor the higher molecular weight fractions, which produced more fouling.

Results indicate that NOM composition is important when estimating the performance of nanofiltration. High rejection of hydrophobic NOM fractions can be expected, but this will be accompanied by a decrease in water production and an increase in permeation of hydrophilic precursor material through the membrane. In the case of Tar River water, DBP maximum contaminant levels would be exceeded. The implications of NOM fouling for engineering design are three-fold: (1) pretreatment to lessen fouling may be needed if it is deemed too expensive to operate the membrane system otherwise; (2) more effective cleaning agents and cleaning protocol may be need to be explored; and (3) new membrane materials should be developed that are more resistant to fouling. Experimental techniques need to be devised to measure the sorption of NOM components onto membrane surfaces in order to better understand the type of cleaning agents needed to give the best results.

Report 294: An Evaluation of Wetlands Permitting and Mitigation Practices in North Carolina
by Christopher Eric Pfeifer, Department of Environmental Sciences and Engineering, and Edward J. Kaiser, Department of City and Regional Planning, University of North Carolina at Chapel Hill

Wetlands development in North Carolina is regulated by Sections 404 and 401 of the Clean Water Act (CWA), as well as the state's Coastal Area Management Act (CAMA) and Dredge and Fill Act. CWA Section 404 requires permits for

development activities in jurisdictional wetlands, and Section 401 requires that states certify that a proposed activity will not result in a violation of state water quality standards. Permits issued under these laws require developers to avoid, minimize, and often compensate for wetland impacts. This report presents results of a study to characterize the effects of wetlands development permits on North Carolina's remaining wetland resource and to evaluate the adequacy of existing mitigation practices required by wetland permits to achieve no-net-loss of wetland acreage (used as a surrogate for wetland functions and values).

Study objectives were accomplished through a comprehensive review of records of wetlands permitting in North Carolina and on-site evaluation of 41 compensatory mitigation projects statewide. Permitting data for 1991-1993 were compiled from records of the N.C. Division of Environmental Management (DEM), N.C. Division of Coastal Management (DCM), N.C. Department of Transportation (DOT), and the U.S. Army Corps of Engineers, Wilmington District.

Review of wetland development permits revealed that only a small percentage of permits actually contain compensatory mitigation requirements. Wetland development activities authorized by Section 404 and state wetland permits affected, on average, about 717 acres of vegetated wetlands annually and led to the permanent loss of 507 acres per year. An average of 20 permits per year required compensatory mitigation through the creation, restoration, enhancement or preservation of wetlands. The average annual amount of compensation totalled 203 acres, which offset only 40 percent of the total area permanently impacted. The majority of uncompensated wetland impacts resulted from activities authorized under general permits, which are issued for categories of activities assumed to result in only minimal adverse environmental impacts, both individually and cumulatively. One particular general permit, Nationwide Permit 26 (for activities in isolated and headwater wetlands) was responsible for more than 60 percent of the total area of wetlands permanently impacted. However, only 5.4 percent of these impacts received compensation.

Evaluation of compensatory mitigation projects showed that the current approach to mitigating development impacts often limits the ability of wetland mitigation to provide ecologically meaningful compensation. Only 37 percent of the sites evaluated had met, or were likely to meet, the stated or implied goals for acreage and wetland community type. Regulatory preferences for on-site mitigation were judged frequently to compromise project success by requiring installation of compensatory wetlands in inappropriate settings, particularly highly developed or rapidly developing locations. Placing responsibility to plan, design, and implement compensatory wetland projects on permitees who typically have neither the desire nor the scientific and technical expertise to plan and implement the projects, appears to compromise further the quality and usefulness of many projects. Finally, the current regulatory approach leads to ad hoc or case-by-case application of compensatory mitigation, which not only leads to a lack of predictability for permit applicants but also prevents the integration of individual compensation efforts into a comprehensive mitigation strategy.

These results suggest that current mitigation practices are not sufficient to fully offset permitted wetland impacts or achieve no-net-loss of wetland acreage. The investigators recommend establishment of a state-level program for regulating non-tidal wetlands through a regional permit program similar to the CAMA permit program for tidal wetlands. They also recommend development of regional wetland restoration plans to maximize benefits from compensatory mitigation projects.

It is projected that by the end of this century, municipal and industrial water users will have spent between $2 billion and $3 billion to clean water intakes clogged by the zebra mussel, an exotic invader.

N.C. Sea Grant College Program
North Carolina State University
and others present

Innovative Stream Repair

A hands-on workshop on bioengineering and other stream restoration techniques

Oct 31 - Nov 1
Ramada Inn/Blue Ridge and
N.C. State University campus
Raleigh, NC

Traditional stream repair methods are costly and can destroy aquatic habitats along with the natural beauty of the stream. Bioengineering—the pairing of engineering principles and biological expertise—can reduce erosion and maintain a more natural stream.

This workshop combines classroom instruction with a field tour and demonstration to expose participants to several bioengineering techniques, including A-Jacks, lunkers and willow-post.

Registration fee of $140 includes lunches, breaks, handouts and bus transportation. Continuing Education Units are available to some professionals. Early registration is encouraged, as enrollment is limited.

For a brochure with registration form, call Barbara Doll, N.C. Sea Grant (919) 515-5287.

Water Resources Research 1995-96 Seminar Series

The Water Resources Research Institute (WRRI) is continuing a seminar series on current issues and research projects. Presentations take place either in the Ground Floor Hearing Room of the Archdale Building (downtown Raleigh) or in Room 1132 of Jordan Hall on the campus of N.C. State University. Seminars begin at 10:00 am.

Oct 23, 1995, Archdale Building
Evaluation of Wetland Permits and Mitigation Practices in North Carolina
Professor Edward Kaiser and Chris Pfeifer, Department of City and Regional Planning, UNC-Chapel Hill

Nov 20, 1995, Jordan Hall
A Study of Nitrate Movement to Ground Water at a Wastewater Treatment Facility
Professor Emeritus Charles Welby, Department of Marine, Earth and Atmospheric Sciences, NCSU

Jan 29, 1996, Archdale Building
Evaluation of Wastewater Biosolids Compost for Production of Agronomic and Horticultural Crops
Associate Professor James Shelton, Department of Soil Science, NCSU

Feb 27, 1996, Jordan Hall
Denitrification Dynamics of an Estuarine Headwater Creek Receiving Agricultural Runoff
Professor Hans Paerl, Institute of Marine Sciences UNC-Chapel Hill

Mar 25, 1996, Archdale
Cryptosporidium: Where do we stand?
Professor Emeritus Daniel Okun, Department of Environmental Sciences and Engineering UNC-Chapel Hill

April 23, 1996, Jordan Hall
Efficacy of Carbon Adsorption and Membrane Separation
Professor Fran DiGiano, Department of Environmental Sciences and Engineering, UNC-Chapel Hill

May 27, 1996, Archdale Building
Grass and Riparian Buffer Treatment of Runoff from Land Receiving Animal Waste
Professor Wendell Gilliam, Department of Soil Science, NCSU

The Groundwater Section (including the Pollution Control Branch) of the Division of Environmental Management has moved to the Parker Lincoln Building (old Westinghouse Building) on Capital Boulevard in Raleigh. The main phone number is 919/733-3221.

North Carolina Precipitation/Water Resources

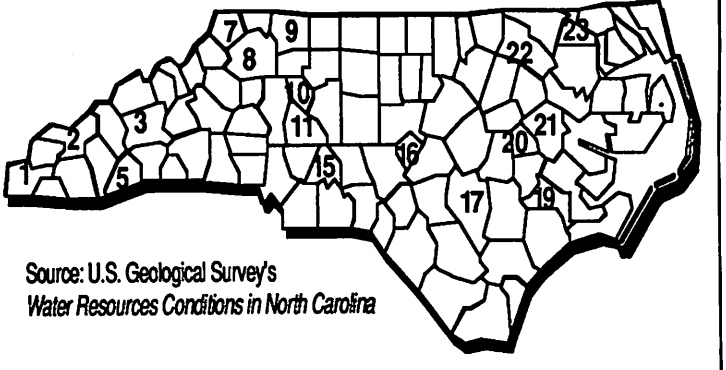
	July	August
Rainfall		
Asheville	3.61" (-0.91")	9.22" (+4.53")
Charlotte	4.56" (-0.64")	7.07" (+3.34")
Greensboro	2.39" (-2.12")	5.41" (+1.53")
Raleigh	3.29" (-0.72")	2.70" (-1.32")
Wilmington	8.74" (+0.61)	4.08" (-2.86")

Streamflow

Index Station (County, Basin)	July mean flow (CFS) (% of long-term median)	August mean flow (CFS) (% of long-term median)
1 Valley River at Tomotla (Cherokee, Hiwassee)	80 (72%)	98 (79%)
2 Oconaluftee River at Birdtown (Swain, Tenn)	253 (76%)	295 (93%)
3 French Broad River at Asheville (Buncombe, FB)	1730 (123%)	2,940 (217%)
7 South Fork New near Jefferson (Ashe, New)	323 (93%)	282 (93%)
8 Elk Creek at Elkville (Wilkes, Yadkin/Pee-Dee)	90 (142%)	56 (94%)
9 Fisher River near Copeland (Surry, Yadkin/Pee-Dee)	193 (130%)	113 (101%)
11 South Yadkin River near Mocksville (Rowan, Yadkin/PD)	340 (153%)	464 (232%)
15 Rocky River near Norwood (Stanley, Yadkin/Pee-Dee)	1468 (388%)	2242 (578%)
16 Deep River near Moncure (Lee, Cape Fear)	1943 (484%)	580 (86%)
17 Black River near Tomahawk (Sampson, Cape Fear)	1782 (415%)	168 (36%)
19 Trent River near Trenton (Jones, Neuse)	165 (185%)	6 (8%)
20 Contentnea Creek at Hookerton (Greene, Neuse)	1376 (526%)	161 (41%)
22 Little Fishing Creek near White Oak (Halifax, Pamlco)	197 (471%)	19 (43%)
23 Potecasi Creek near Union (Hertford, Chowan)	283 (741%)	5 (6%)

Groundwater

Index well (Province)	July depth below surface (ft) (departure from average for month)	August depth below surface (ft) (departure from (average for month)
5 Blantyre (Blue Ridge)	27.70 (+3.52)	28.26 (+3.88)
10 Mocksville (Piedmont)	15.04 (+2.50)	15.23 (+2.63)
21 Simpson (Coastal Plain)	4.38 (+1.41)	6.12 (-0.76)



Source: U.S. Geological Survey's *Water Resources Conditions in North Carolina*

The School of Renewable Natural Resources of the University of Arizona seeks an assistant research scientist for its Watershed Resources Program. Proficiency in Spanish highly desirable. Application review will begin Nov 1, 1995.Contact Richard H. Hawkins, Chair, Watershed Search Committee, School of Renewable Natural Resources, 325 Biological Sciences East, University of Arizona, Tucson, AZ 85721. (520-621-7273 or rhawkins@ag.arizona.edu).

Conferences and Workshops

The NCSU Industrial Extension Service will present **HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE TRAINING** Oct 23-27, 1995, at the Jane S. McKimmon Center in Raleigh. Courses satisfy requirements under OSHA's 29 CFR 1910.120 and RCRA's training mandate for personnel involved in corrective action and hazardous waste operations. For info call NCSU Continuing and Professional Education (919) 515-2261 or NCSU IES (919) 515-2358.

The NCSU Industrial Extension Service will present **HAZARDOUS WASTE MANAGEMENT FOR SMALL QUANTITY GENERATORS** at numerous locations across the state in October and November. For information call Bobbi Baird, IES, NCSU, (919) 515-3954.

The U.S. Environmental Protection Agency is presenting **AIR EMISSIONS CONTROL AT WASTE MANAGEMENT FACILITIES** Sept 6-7, 1995 in Atlanta; Sept 11-12, 1995, in Seattle; and Sept 14-15, 1995, in Denver. Major focus will be on technical aspects of implementing control technologies required by air rules for tanks, surface impoundments, and containers at hazardous waste facilities. For info contact Helen Genz, Eastern Research Group, Inc. 617-674-7250.

The N.C. Center for Geographic Information and Analysis (CGIA) and others will present **"EXPANDING THE VISION," THE 1996 N.C. GEOGRAPHIC INFORMATION SYSTEMS CONFERENCE**, Feb 8-9, 1996, at the Benton Convention Center in Winston-Salem, NC. For info contact CGIA at (919) 733-2090 or visit the CGIA WWW homepage at http://cgia.cgia.state.nc.us.

The Jefferson County (KY) Conservation District and others will present **SOIL BIOENGINEERING: AN INNOVATIVE APPROACH TO WATERSHED MANAGEMENT, STREAMBANK STABILIZATION, AND UPLAND SLOPE PROTECTION** Oct 12-13, 1995, at Jefferson Community College Southwest Campus in Louisville, KY. Registration due by Sept 30, 1995. For information call (502) 499-1900.

Duke University's School of the Environment is offering the following Professional Education courses this fall.

Fundamentals of Hydrogeology: Principles and Practice Nov 2-3, 1995, Ralph C. Heath, Instructor (register by Oct 12)

Applied Groundwater Hydraulics Dec 7-8, 1995, Ralph C. Heath, Instructor (register by Nov 16)

For additional information or to register by phone, call the Continuing Education Program at (919) 613-8080.

Publications received

Residents of North Carolina may borrow these publications from the Institute for two weeks. If you need copies to keep, please request them from the organizations issuing the publications. Addresses are provided for this purpose.

Groundwater

Evaluating BMPS to Control Nitrate Contamination in Ground Water. 1995. by Daniel E. Storm, Michael D. Smolen, Michael A. Kizer and Tharacad S. Ramanarayanan. Report A-127 of the University Center for Water Research, Oklahoma State University, Stillwater, OK 74078 (04-B)

Habitat Assessment/Restoration Physical Habitat Analysis Using the Riverine Community Habitat Assessment and Restoration Concept (RCHARC): Missouri River Case History. 1995. Technical Report EL-95-18 of the U.S. Army Corps of Engineers, Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199. (57 pages plus appendices) (02-I)

Soils

Soil Survey of Davie County, North Carolina. 1995. USDA Natural Resources Conservation Service (formerly Soil Conservation Service). 4405 Bland Road, Suite 205, Raleigh, NC 27609. (128 pages plus maps) (08-D)

Water Quality

National Conference on Urban Runoff Management: Enhancing Urban Watershed Management at the Local, County, and State Levels. EPA/625/R-95/003. U.S. Environmental Protection Agency, Center for Environmental Research Information, Cincinnati, OH 45268. (450 pages; 53 presentations) (04-D)

Water-Quality Characteristics of Streams in the Treyburn Development Area of Falls Lake Watershed, North Carolina, 1988-93. 1995. U.S. Geological Survey WRI Report 95-4094. Available from Open-File Reports Section, Box 25286, Mail Stop 517, Federal Center, Denver, CO 80225. (80 pages) (05-G)

Sediment-Water Column Nutrient Exchanges in Southern Chesapeake Bay Nearshore Environments (revised). Reprinted 1995. Bulletin 181b of the Virginia Water Resources Research Center, VPI&SU, 617 N Main St, Blacksburg, VA 24060-3397 (540/231-5624). Revision corrects a constant error that affected in-situ sediment solute flux calculations. (212 pages) (05-B)

Water-Quality Assessment of the Albemarle-Pamlico Drainage Basin, North Carolina and Virginia—Environmental Setting and Water Quality Issues. Open-File Report 95-136 of the U.S. Geological Survey, available from Open-File Reports Section, Box 25286, Mail Stop 517, Federal Center, Denver, CO 80225 (72 pages) (05-B)

Water Resources

Water Resources Data North Carolina Water Year 1994, Volume 1. Surface-Water Records. 1995. USGS/WRD/HD-94/244. U.S. Geological Survey. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. (578 pages) (unclassified)

Water Resources Data North Carolina Water Year 1994, Volume 2. Ground-Water Records. 1995. USGS/WRD/HD245. U.S. Geological Survey. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. (166 pages) (unclassified)

GAO Reports

ENVIRONMENTAL PROTECTION: EPA's Problems with Collection and Management of Scientific Data and Its Efforts to Address Them. GAO/T-RCED-95-174.

SUPERFUND: Natural Resource Damage Claims. GAO/T-RCED-95-182.

ENVIRONMENTAL PROTECTION: Current Environmental Challenges Require New Approaches. GAO/T-RCED095-190.

SUPERFUND: Risk Assessment Assumptions and Issues. GAO/T-RCED-95-206.

RURAL DEVELOPMENT: Patchwork of Federal Water and Sewer Programs Is Difficult to Use. GAO/RCED-95-160BR

ELECTRICITY SUPPLY: Consideration of Environmental Costs in Selecting Fuel Sources. GAO/RCED-95-187.

EPA AND THE STATES: Environmental Challenges Require a Better Working Relationship. GAO/RCED-95-64.

ANIMAL AGRICULTURE: Information on Waste Management and Water Quality Issues. GAO/RCED-95-200BR.

AGRICULTURE AND THE ENVIRONMENT: Information on and Characteristics of Selected Watershed Projects. GAO/RCED-95-218.

RADIOACTIVE WASTE: Status of Commercial Low-Level Waste Facilities. GAO/RCED-95-67.

SUPERFUND: Status of Natural Resource Damage Claims. GAO/T-RCED-95-239.

SUPERFUND: EPA's Use of Risk Assessments in Cleanup Decisions. GAO/T-RCED-95-231.

Miscellaneous

Stream-Gaging Cableways. Chapter A21, Book 3 (Applications of Hydraulics) of Techniques of Water-Resources Investigations of the United States Geological Survey. For sale by USGS Information Services, Box 25286, Federal Center, Denver, CO 80225. (56 pages) (08-C)

WATER RESOURCES RESEARCH INSTITUTE
OF THE UNIVERSITY OF NORTH CAROLINA
BOX 7912
NORTH CAROLINA STATE UNIVERSITY
RALEIGH, NC 27695-7912

NONPROFIT ORG.
U.S. POSTAGE
PAID
RALEIGH, NC
PERMIT NO. 549

ADDRESS CORRECTION REQUESTED

PRINTED MATTER