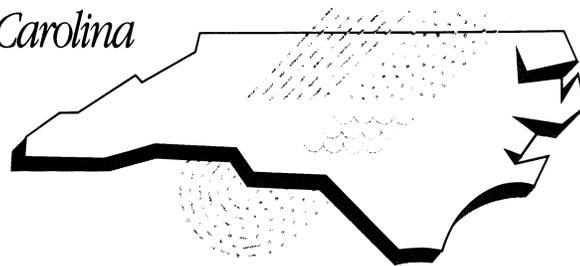


Water Resources Research Institute News

of The University of North Carolina



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Groundwater study to be conducted for Bladen County area

At its December 12, 2003, meeting, the N.C. Environmental Management Commission (EMC) directed the N.C. Division of Water Resources (DWR) to conduct a Capacity Use Investigation of the area in and around Bladen County and to provide a report and recommendations in 18 months. Dewatering of the Upper Cape Fear Aquifer underlying the Bladen County area appears to be imminent, and without declaring a Capacity Use Area, the EMC has no authority to limit groundwater withdrawals from the aquifer.

On December 11, DWR's Nat Wilson had presented to the EMC's Water Allocation Committee (WAC) a proposal for a four-and-one-half year Capacity Use Investigation. Wilson reminded the WAC that one of the required components of a Capacity Use Investigation is recommendations on the boundaries of the area. He said that without more detailed mapping of all the hydrogeologic units in the Bladen County area, particularly the Upper Cape Fear Aquifer, establishing justifiable boundaries will be difficult.

However, the committee rejected DWR's recommendation. David Moreau, chairman of the EMC and member of the WAC, said that DWR has presented evidence of imminent dewatering of the Upper Cape Fear Aquifer and that it is the responsibility of the EMC to protect the aquifer. He said that with the constrained State budget and the evident urgency of the situation, postponing action until DWR has completed a large-

scale hydrologic study that might cost as much as \$1 million is "not a responsible approach."

At its October meeting, the WAC had heard a report from Wilson on groundwater levels in the Upper Cape Fear Aquifer underlying Robeson, Bladen, Cumberland, and Sampson counties. According to Wilson, declines in water levels in the Upper Cape Fear Aquifer have been documented since monitoring wells were installed in 1970. After 1992, levels began to decline

dramatically. About 1996, the decline slowed and levels stabilized except for an area near the Smithfield Packing pork processing operation at Tar Heel. A cone of depression (an area of reduced "head" or water pressure) centered on Smithfield Packing is evident on the potentiometric surface map of the aquifer.

In December, Wilson reported to the committee that new information suggests water levels at Tar Heel may be stabilizing, although the new information also

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Director's Forum

Sedimentation control in North Carolina: A dialogue

Kenneth H. Reckhow, Director, Water Resources Research Institute

"Every time I read another story in the newspaper about sediment pollution in streams after a major rainstorm, I wonder whether the Sedimentation Control Commission is doing its job," I said to my wife, Ellen, last week.

"Well, you're the chair," she pointed out. "Why don't you do something about it?"

"Like what?" I inquired.

"Well," Ellen responded. "Can't you pass tougher rules that require better erosion control?"

"Yes, we could." I acknowledged. "We keep improving our technologies and we've funded some pretty good research at WRR I; the problem is that additional controls are costly, and you know as well as I that there's a trade-off. You have to convince people that the benefits justify the costs. Plus, you also have to recognize that the people who bear the costs of sediment control may not be the same people who appreciate the benefits. Maybe that is why state lawmakers maintain the cap on fees the State program can charge and use general funds to help support the program. Lawmakers must feel that, since developers bear the costs of implementing erosion and sediment controls, taxpayers should help pay for the State's sedimentation and erosion control program."

"Now that really doesn't make sense," Ellen exclaimed. "Do you know that our sedimentation program in Durham – the program that your Sedimentation Control Commission has just announced as the *local program of the year* – sets its fees so that they cover the program's cost? Our County Commission believes that user fees are the fairest way to proceed when you can isolate the subgroup – in this case, the group of people who are involved in land distur-

bance activities. All of the citizens don't need to subsidize the costs of development."

"That seems reasonable," I acknowledged. "At the state level, we're trying to encourage the creation of more local programs, but many local governments are content to let the state provide the service."

"Well, that still doesn't prevent you from setting state plan review fees at a level that avoids state subsidies." Ellen urged. "After all, the citizens of Durham contribute taxes to the state's general fund. So, some Durham citizens, like some citizens in other communities with local programs, pay twice—once for their local program and once to subsidize

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the State program. That's not fair; the state needs a user fee that adequately covers costs."

"It's hard to argue that point," I admitted. "And, if the fee was set properly, we could hire enough staff at the state level to inspect sites frequently enough to avoid many of the problems we currently have."

"Actually, Ken," Ellen noted, "This may be a really good time to propose lifting the cap on the State plan review fee, since North Carolina is faced with another tight budget year. Moving funding from the State general fund to user fees would free up scarce state dollars."

"Oh no," I groaned. "That means I have to lobby the politicians."

"That's nothing to dread; it's just the democratic process," Ellen responded as she directed me to take out the trash.

Ellen Reckhow is chairman of the Durham County Board of Commissioners

Library provides information on brake-pad contamination

U.S. Environmental Protection Agency, the San Francisco Estuary Project, and the Bay Area Stormwater Management Agencies Association have funded development of the Brake Pad Partnership Technical Reference Library. The library is a collection of literature relevant to the fate, transport, and environmental importance of copper in vehicle brake pads. The collection is designed to be a resource for the Brake Pad Partnership and professionals interested in the relationship of vehicle-related pollutant releases and surface water quality. The collection is cataloged online at <http://www.tdcenvironmental.com/brake/html/catalog.HTM>. Some of the literature is available online. Some is available from EPA Region Nine: <http://www.epa.gov/region09/library/about.html>.

Bladen County groundwater study *continued*

reveals high chloride concentrations in some of Smithfield Packing's wells. High chloride concentrations suggest that salt water is either being drawn upward from the Lower Cape Fear Aquifer or is intruding from the freshwater-saltwater interface in the Upper Cape Fear Aquifer.

Wilson said that although water levels in the Upper Cape Fear Aquifer seem to be stabilizing, if another business opens in the former Alamac facility (that closed and stopped withdrawing water in 1999) and resumes withdrawing water, levels could begin to drop again quickly.

According to Wilson's report, water levels near Tar Heel lie at the top of the

Upper Cape Fear confining unit, suggesting that pumping levels may have dropped into the aquifer. If pumping levels are below the top of the aquifer, then the aquifer is being dewatered. Dewatering of the Upper Cape Fear Aquifer will not only diminish the aquifer's ability to yield water but may also allow saltwater to intrude from the Lower Cape Fear Aquifer into the Upper Cape Fear freshwater aquifer in an area underlying Elizabethtown.

Wilson's report also makes it clear that a Capacity Use Investigation will not address the problem of domestic shallow wells in Bladen County that went dry during the recent drought. These wells draw water from the surficial or unconfined aquifer, not the deeper Upper Cape Fear Aquifer.

Important announcement for all those who receive WRRR mailings!!

In an effort to make more efficient use of our shrinking funds, WRRR has begun phasing out hard copy mailings of seminar, workshop, and conference brochures.

Last year we stopped mailing announcements of Water Resources Research Seminars.

This year, we will not mail a brochure for the WRRR Annual Conference. Conference information is on our website (see below).

If you want to receive information on workshops, conferences, and seminars, and other water-related announcements, **you must subscribe to the WRRR-News listserve.**

To subscribe to the WRRR-News listserve: send an email message to mj2@lists.ncsu.edu.

Put nothing in the subject line.

In the body of the message say only: subscribe WRRR-News

The WRRR newsletter will continue to be mailed in hard copy format for the foreseeable future. However, the newsletter is also accessible on line, and an email announcement is sent on the WRRR-News listserve each time a new issue goes online. The newsletter and all workshop, seminar, and conference information are on our website:

<http://www2.ncsu.edu/ncsu/CIL/WRRR>

North Carolina universities join major initiative in hydrologic sciences

With partial membership funding from WRI, The University of North Carolina and Duke University have become partners in the Universities Consortium for Advancement of Hydrologic Science, Inc. (CUAHSI). The University of North Carolina is represented in CUAHSI by Dr. Lawrence E. Band, Voit Gilmore Distinguished Professor and Chair of the Department of Geography at UNC-Chapel Hill. Dr. Band is chairman of CUAHSI's Standing Committee on Hydrologic Observatories. Duke University is represented in CUAHSI by Dr. Miguel Medina, Professor and Director of Duke's Center for Hydrologic Science.

Incorporated in June 2001, CUAHSI has a grant from the National Science Foundation (NSF) to develop a science plan for infrastructure to facilitate research and education across the broad spectrum of hydrologic sciences. The Hydrology Program within the Geosciences Division of NSF is funding this planning effort in recognition that addressing global water issues—including the effect on water resources of human activities and global change—requires a fuller understanding of the hydrologic cycle. This understanding can be provided only by building a science infrastructure to support interdisciplinary research that addresses spatial and temporal variability across a pertinent range of scales.

CUAHSI's vision for infrastructure to support greater understanding of the chemical, biological, and physical processes that drive the hydrologic cycle closely resembles the National Ecological Observatory Network (NEON) that NSF currently proposes to fund for cross-cutting research in ecological science. The CUAHSI vision includes:

- Supporting development of and providing information on new measurement technology.

- Operating a hydrologic information technology program to provide hydrologic scientists access to new data and computer programs for visualization and analysis of data.

- Establishing and maintaining a network of Long-Term Hydrologic Observatories where research can be conducted on pressing hydrologic problems.

“Hydrologic observatories” is the term CUAHSI uses to describe river basin-scale field laboratories that will make possible hydrologic data collection, analysis, and synthesis in a manner not currently feasible.

Each hydrologic observatory will consist of the drainage basin of a river that is regionally significant and large enough that the spatial and temporal variability of the two-way feedbacks between the land surface and atmosphere can be studied for regional (mesoscale) storm systems.

Each observatory will be carefully characterized with respect to structure of watersheds, including high resolution topography, channel network pattern and morphology, soil, aquifer, land use/land cover and socioeconomic information. State-of-the-art and cutting-edge instrumentation will be deployed. This instrumentation will perform measurement, monitoring and analysis of basic stores, fluxes and transformation of water and associated biogeochemical constituents within large watersheds across a spectrum of scales. It will also provide tracer and isotopic characterization of flowpath activity and residence times.

Each observatory will be provided facilities to integrate, manage, and disseminate information, and the interdisciplinary environment necessary to achieve an intellectual synthesis.

The envisioned network of hydrologic observatories will collect long-term data across multiple media (including

streams, groundwater and atmosphere) and spatial scales (such as field plots and watersheds). Long term data collection of this kind will permit more accurate water quantity and quality predictions and will illuminate the impacts of regional changes in land cover, climate, pollution, and water management programs, such as large-scale water transfers.

CUAHSI also envisions that the hydrologic observatories network will support undergraduate, graduate and public education in hydrological sciences and facilitate transfer and application of research results to agencies and the private sector.

Through its standing committees, CUAHSI is currently examining all major scientific issues in the field of hydrologic science and those that are closely related to hydrology in the fields of atmospheric science, biogeochemistry, and ecology. CUAHSI's standing committees are focusing planning efforts so that the hydrologic infrastructure ultimately proposed will advance those sciences to the maximum extent possible.

For more information on CUAHSI, visit website: <http://www.cuahsi.org>

For information on NEON see NSF website: <http://www.nsf.gov/bio/neon/start.htm>

EPA will withdraw 2002 TMDL Rule

In December 2002, the U.S. EPA announced that it will withdraw the July 2000 final rule that revised the Total Maximum Daily Load (TMDL) program. EPA said that “the 2000 rule was determined to be unworkable based on reasons described by thousands of comments and was challenged in court by some two dozen parties.”

EPA Administrator Christie Whitman said “We have an existing TMDL program and this action will not stop ongoing implementation of that program. EPA and states will continue to cooperate to identify impaired waters and set protective standards for those waters.”

December action of the N.C. Environmental Management Commission

At its regular meeting on December 12, 2002, the N.C. Environmental Management Commission (EMC) took the following action:

- Adopted a permanent rule establishing the competitive bidding process and qualifications of environmental services firms, engineers, and engineering firms for performance-based cleanups at leaking petroleum underground storage tank (LUST) sites (15A NCAC 2P. 0408).
- Approved revisions to several air quality rules to meet objections by the Rules Review Commission (RRC). Among the rules the RRC objected to was one requiring stack testing to be done by a person qualified by training or experience in the field of air pollution testing. According to the RRC, the EMC does not have authority to set education and training requirements. Several members of the EMC expressed concern that this lack of authority can undermine effectiveness of the commission's rules. They asked EMC counsel Frank Crawley to determine who does have authority to set education and training requirements. Commissioner Charles Peterson suggested that if the EMC cannot set education and training requirements to assure effective implementation of its rules, perhaps the commission should ask for such authority from the legislature.
- Returned to the Air Quality Committee for reconsideration an amendment to an air quality rule covering hot mix asphalt plants. The EMC it had approved this amendment in October. According to Commissioner Dan Besse, who served as hearing officer, a paragraph was added to the proposed rule amendment following public hearings. The paragraph was added in response to a public comment noting that the rule as

proposed would inadvertently remove control of fugitive emissions from hot mix asphalt plants. After the EMC adopted the rule amendment, the Carolina Asphalt Pavement Association (CAPA) asked that it be withdrawn from review by the Rules Review Commission. The CAPA believes that the rule violates the Administrative Procedure Act because it addresses subject matter not addressed in the proposed text of the rule and produces an effect that could not reasonably have been expected based on the proposed text. Besse said that the rule will be re-noticed with new language.

- Approved holding public hearings on amendments to seven nitrogen oxide emission standard rules and two air quality permitting rules.
- Approved publishing public notice and holding public hearings on a rule to establish groundwater standards in 15A NCAC 2L. 0202 for benzoic acid, Bis(chloroethyl)ether (BCEE), Dibenzofuran, Dibromochloromethane, Ethyl Acetate, Hexachlorobutadiene, 2-Hexanone, 1,1,2,2-Tetrachloroethane, and 1,2,4-Trichlorobenzene.
- Approved the priority list and Intended Use Plan (funding list) for loans to municipalities during 2003 to fund wastewater projects. The loans come from the State Revolving Fund provided by the federal government and matched by State funds. According to Bobby Blowe, head of the Construction Loans and Grants Section of the N.C. Division of Water Quality, the list includes names of communities that will be required to comply with NPDES Stormwater Phase II requirements. Although Phase II communities are not on the Intended Use Plan, the State Revolving Fund may be able to provide some financial assistance for stormwater planning this year.

- Approved a North Carolina Clean Water Revolving Fund Loan (State money only) for the Town of Farmville and Emergency Revolving Loan for the Town of Columbus. Several commissioners were not satisfied with information presented to justify the emergency loan to Columbus, citing concerns that a sewer line extension requested to serve a pocket of failing septic tanks could be used to provide new capacity for growth. The loan fund is to be used only to address water quality problems.

- Approved initiating a Capacity Use Investigation for an area around Bladen County (see article page 1).

- Approved publishing a notice of rulemaking to establish a process for declaratory rulings. Language for the rule is to be presented in February or March.

December action of the EMC's Water Quality Committee

At its regular meeting on December 11, 2002, the N.C. EMC's Water Quality Committee (WQC) took the following action:

- Approved proceeding with a proposed reclassification of two sections of the Rocky River in Chatham County to WS-III Critical Area.
- Approved a revised site plan for a previously approved major variance from the Neuse River Riparian Area protection rule for the Willow Place Townhomes in Raleigh.
- Approved holding public meetings to receive comment on the draft Yadkin-Pee Dee River Basinwide Water Quality Plan (meetings were held in January 2003). As part of this basinwide plan, a management strategy will be updated for High Rock Lake.

continued

Water Quality Committee *continued*

Located on the mainstem of the Yadkin River in Rowan and Davidson counties, High Rock Lake is the largest and most upstream of the Yadkin-Pee Dee chain lakes. Its 3,850-square mile watershed lies within seven subbasins. According to the draft Yadkin-Pee Dee basinwide plan, water quality concerns for High Rock Lake date back to the mid-1970s, and the need for nutrient reduction strategies to address problems due to accelerated eutrophication has been apparent since the mid-1990s. The High Rock Lake watershed contains 76 registered animal operations, 68 of which are cattle operations. A large percent of the state's total capacity for dairy production is found in the watershed, mostly in Iredell County, although dairy production is declining. There are also 155 permitted wastewater dischargers in the watershed, 23 of which have a permitted flow of one million gallons per day or more. Eight facilities discharge directly to the lake or to streams in the immediate area, including the City of Salisbury, the City of Lexington, the City of Thomasville, the City of High Point, and the ColorTex Finishing plant. Recent increased monitoring of High Rock Lake has resulted in the determination that the lake is "impaired." Blue-green algae, associated with taste and odor problems in drinking water, dominated samples taken in summer 1999. While both nitrogen and phosphorus are routinely present in High Rock Lake in concentrations high enough to support algal blooms, management strategies focus on reducing phosphorus concentrations in order to limit algal growth. Phosphorus limits on dischargers into the Abbotts Creek arm of the lake (High Point Westside, Thomasville, and Lexington) will take effect in 2004. A percent DO (dissolved oxygen) saturation TMDL must be developed for High Rock Lake and will require the development of a nutrient response

continued

Recommendations made for improvement of NCDOT mitigation program

The North Carolina Department of Transportation (NCDOT) alters more wetlands and riparian areas and undertakes more compensatory mitigation than any other single entity in the state. Until recently, there had been no comprehensive independent evaluation of NCDOT's mitigation projects. However, in March 2002 the second of two reports on evaluation of mitigation sites and the NCDOT mitigation program in general was published by the Center for Transportation and the Environment and NCDOT's Joint Environmental Research Program. The evaluation was conducted by East Carolina University scientists Richard D. Rheinhardt and Mark M. Brinson. Their reports reveal significant weaknesses in NCDOT's mitigation program. However, the reports also point out that, nationwide, policy rather than science determines the direction of mitigation and that NCDOT's mitigation program is constrained by often inflexible regulations and social and economic

factors. The report also points out that restoration science is constantly evolving and that wetlands restoration and creation practices that seem obviously inappropriate today may have once been state-of-the-art. But, say the authors, "NCDOT has the opportunity to take the national lead in applying new technical information and approaches for the field of wetland mitigation as a whole."

Mitigation background

In order to receive a permit for activities in wetlands, those conducting activities are required first to do whatever is possible to avoid the impacts by modifying the proposed project. If it is determined that some impact is unavoidable, then those conducting the activities must do whatever is possible to minimize the impact. Assuming that unavoidable impacts to wetlands and riparian areas will occur due to roadbuilding, utility construction, and other vital activities

continued

Water Quality Committee *continued*

model and a watershed loading model. An 18-month field study to prepare for development of the TMDL will be conducted during the current basinwide planning cycle.

■ Decided not to send the draft permanent rule to implement the federal NPDES Phase II Stormwater Program to the full EMC for adoption the following day (Dec 12). The EMC had adopted a temporary rule to implement the program in October with the expectation that some parts of the rule would be significantly revised before a permanent rule was proposed. Some revisions presented by DWQ staff did not meet with the WQC's approval. Specifically, a new rule was developed to create a program based on EMC authority to implement a State stormwater program in urban jurisdictions that do not own or operate the

stormwater systems within their borders. (Language in the federal rule makes the federal program inapplicable to jurisdictions that do not own their own stormwater systems, primarily counties.) Language in the temporary rule providing options for voluntary implementation by counties was removed. The WQC was concerned that if the new rule covering counties were held up, there would be nothing in the original rule to address stormwater in unincorporated urban areas. A revised proposed permanent rule to implement the NPDES Phase II Stormwater Program is to be presented to the WQC and the full EMC in February.

■ Directed staff to bring to the committee in February a proposed permanent rule to implement riparian buffer protection in the Catawba basin.

even after avoidance and minimization, the only way to achieve the national goal of no net loss of wetlands is to require that those conducting the activities compensate for losses by preserving, restoring, enhancing, or creating other wetlands or riparian areas.

Requirements for mitigation projects are negotiated with the U.S. Army Corps of Engineers under the Clean Water Act Section 404 regulations, with oversight from the U.S. EPA and input from States through their 401 Water Quality Certification programs. Included in these requirements may be “mitigation ratios” or the credits per unit area that are given for a specific mitigation practice for a specific wetland type. Some practices are preferred over others (preservation being at the top of the list and creation being at the bottom). However, according to authors of the report, “negotiations to compensate for unavoidable impacts have become much more complex and usually go beyond the use of simple ratios between the permitted wetland and the one targeted for mitigation.”

NCDOT mitigation program

There are approximately 50 NCDOT compensatory wetland mitigation sites in the ground across North Carolina and another 150 sites on the drawing board. For their study the scientists evaluated 49 NCDOT sites where restoration, creation, and/or preservation of wetlands had taken place and for comparative purposes studied 11 “reference” sites (various wetlands types in natural states) in 1999. Some of the mitigation sites were large areas where more than one type of mitigation had been carried out, giving a total of 71 actual mitigation sites. Evaluation of the sites was aimed at assessing the likelihood that the sites would achieve some level of structure and functioning similar to natural, self-sustaining wetland ecosystems and to provide recommendations for improvements. Five sites were examined in greater detail.

Of the 71 mitigations examined, 19 were preservation sites and were automatically judged to be successful. Twenty-six (26) restoration or creation sites were judged ecologically successful, 9 were judged unsuccessful, 10 lacked enough data for judging success, 4 were too young to predict survival of vegetation, and 3 were just undergoing construction. Alteration of and failure to restore natural geomorphology was the major factor associated with lack of success. Wetland creations were generally unsuccessful because excavation of soil to reach the saturated zone inhibited growth of vegetation.

The scientists report that “compensatory wetland mitigation involving restoration and creation appears to have gravitated toward relatively narrow sets of conditions for hydrology and vegetation [set to meet definitions of jurisdictional wetlands], with little room for flexibility.” They say that, the restoration goal of establishing a hydrological regime to meet the jurisdictional definition of wetlands has discouraged restoration of non-wetlands to their historic natural condition. They identify as a major weakness of the mitigation program “restoration and creation of wetlands in which the A soil horizon is graded, redistributed, or removed to increase the period of saturation (in order to meet jurisdictional hydrologic criteria).”

The authors also express concern that, by failing to use information from reference sites in the vicinity of mitigation projects and identifying wetland types ambiguously, NCDOT may be altering the geographic distribution and frequency of wetland subclasses at the landscape scale.

Recommendations

In addition to a list of technical restoration and creation recommendations, the authors recommend the following programmatic changes:

- Redefine “mitigation” in a way that is compatible with scientific understand-

ing of ecosystem functions. Sites that have been severely altered should not be excluded from restoration simply because they still meet the jurisdictional definition of a wetland. This will require acceptance by regulatory agencies.

- Change success criteria to include the hydrologic regime of reference wetlands.
- Study restoration sites for long periods to obtain information to improve future restoration projects. Regulatory agencies should be willing to provide mitigation credit for studies of reference sites and long-term research.
- Use innovative means to restore lost functions that cannot be recovered through restoration due to socioeconomic limitations. As an alternative to complete restoration of deeply channelized streams, rehabilitate them by creating wetlands by methods such as redirecting ditches and tributary to flow through the former floodplain before discharging into the main channel.
- Track restoration within drainage basins according to hydrogeomorphic wetland classes.
- Preserve more streams through purchase or permanent conservation easements of headwater streams and buffers.
- NCDOT’s mitigation program could be improved if regulatory agencies adopted a broader, more flexible and scientifically based view of restoration.

An Evaluation of the Effectiveness of Existing North Carolina Department of Transportation Wetland Mitigation Sites and An Evaluation of North Carolina Department of Transportation Wetland Mitigation Sites: Selected Case Studies are available in pdf format at web address: http://www.itre.ncsu.edu/cte/rip_wetlands.html

Center for Watershed Protection suggests research directions to improve the utility of the Impervious Cover Model

In the mid 1990s, Tom Schueler and colleagues at the Center for Watershed Protection (CWP) surveyed studies that documented a relationship between watershed impervious cover and various indicators of stream quality. They subsequently integrated findings from about 24 studies into the Impervious Cover Model (ICM), which has since become widely used in watershed planning and management. Because it has been used to support restrictive regulations and zoning, the ICM has become the subject of debate. Schueler and colleagues have therefore undertaken an updated review of the strength of evidence for and against the ICM. They recently published the results of two parts of their review, "Is Impervious Cover Still Important," in the center's online newsletter and on the center's website.

The first part of their review, "A Review of Recent Urban Stream Research" identifies important gaps in the understanding of the relationship between impervious cover and stream quality and of the potential for best management practices to mitigate effects of imperviousness. The authors make recommendations for research that could make the ICM model more useful for watershed managers.

The review

The CWP review found more than 225 studies that measured 26 different urban stream indicators in various regions of North America. Fifty studies directly tested the impervious cover/stream indicator relationship, with most using biological indicators of stream health.

Another 150 or so documented differences in stream indicators between urban and non-urban watersheds, lending indirect support for the ICM. Other studies involve the use of engineering models using impervious cover to predict stream indicators, with relationships developed and derived from prior empirical research.

Some insights from the review

The authors say that while the balance of recent research generally supports the ICM, the review has provided important insights for interpreting and applying the ICM.

- Statistically speaking, the influence on stream quality of impervious cover in the 1-10% range is relatively weak (a lot of variability) compared to other factors including forest cover, riparian continuity, historical land use, soils, agriculture, acid mine drainage, and a host of other stressors.

- The relationship between impervious cover and stream indicators is stronger when impervious cover is in the 10-25% range and very strong above 25%.

- Forest cover is as useful as impervious cover as a predictor of stream quality in urban watersheds in humid regions of North America and in some regions is simply the reciprocal of impervious cover. The management implication of this insight is that the best way to manage stream health is to both minimize impervious cover and maximize preservation of native forest cover.

- Riparian forest continuity (a proportion of the stream network with a fixed width of mature stream-side forest) is related to some indicators of stream

Streamflow increased sharply in 1970s, USGS reports

Streamflow in the conterminous United States increased sharply around 1970 according to a recent study by the U.S. Geological Survey (USGS). The results show marked increases in low to moderate streamflow, and less significant increases in high streamflow. This conclusion is based on an analysis of streamflow records from 400 USGS streamgages from 1941 to 1999.

The study, entitled "A step increase in streamflow in the conterminous United States" by Gregory McCabe and David Wolock, was published in the December 24, 2002, issue of *Geophysical Research Letters*. A description of the study can be viewed at the web site: <http://ks.water.usgs.gov/Kansas/pubs/abstracts/dmw.grl.v29.html>.

The abrupt rise in streamflow occurred mostly in the eastern U.S. and coincided with an increase in precipita-

tion. The identification of an abrupt rise in streamflow, rather than a gradual increase, is important because an abrupt change signals a climate system shift that likely will remain relatively constant until a new shift occurs, according to report co-author David Wolock. Abrupt shifts in climate are common and often related to changes in ocean temperatures and circulation patterns; such changes in climate frequently persist for decades at a time.

The study results suggest that decision makers exploring future plans for water management or flood mitigation need to consider that future streamflow conditions may be different from past conditions. Robust water and flood planning demands an understanding of climate variation and the resulting wide range of potential future streamflow conditions.—*USGS press release*

quality (aquatic insect and fish diversity) in urban watersheds.

- The ICM predicts the average behavior of a group of indicators over a range of impervious cover and should not be expected to predict the fate of individual indicators or species, in particular sensitive or endangered species.
- The ICM is not useful in arid and semiarid climates.
- Use of the ICM requires accurate estimates of the total impervious area over a subwatershed. Impervious cover is not constant over time, so it is important to get estimates from the most recent possible mapping data.

Directions for research

The review also turns up a number of unanswered or unexamined questions about using imperviousness as an indicator of stream quality that suggest directions for research:

- Little attention has been paid to turf, which is considered pervious cover. However lawns have different properties than forests and farmlands and grass often covers the largest fraction of land in an urban watershed. Would the combined area of impervious cover and turf cover provide better predictions about stream health than impervious cover alone?
- Field investigations suggest a number of watershed variables may have supplemental value in predicting stream quality: the presence of extensive wetland and/or beaverdam complexes, the dominant form of drainage present, the average age of development and the proximity of sewer lines to the stream. Systematical testing of these variables in a controlled population of small watersheds might reveal variables that would make prediction more accurate.
- While many studies have shown a very strong negative association between

impervious cover and biodiversity, they have not established which stressor or combination of stressors contributes most to the decline. An accepted theory is that impervious cover changes stream hydrology, which degrades stream habitat, which leads to reduced biodiversity. Work is needed to define the relationship between impervious cover and the physical loss or alteration of the stream network, stream habitat measures, riparian continuity, and baseflow conditions during dry weather.

- The most hotly debated question about the ICM is whether application of practices such as stream buffers or stormwater BMPs can mitigate the impact of impervious cover. Few studies have looked at this question, and there are difficult technical and scientific issues involved in detecting the effect of watershed treatment. Because it is virtually impossible to control variation at the subwatershed level, it may be necessary to abandon the multiple watershed or paired watershed sampling approaches of the past and perform long-term longitudinal monitoring studies within individual subwatersheds to detect the effect of watershed treatment.
- Most researchers have been more interested in sensitive and impacted streams and have not paid attention to non-supporting streams. Consequently, there is little understanding of how stream indicators behave in the 25% to 100% impervious cover range. Research is needed to see how non-supporting streams respond to restoration efforts and to provide information to develop more realistic standards for non-supporting streams.

Two sections of the Center for Watershed Protection's article "Is Impervious Cover Still Important" are available at http://www.cwp.org/Impacts_Part1.PDF and http://www.cwp.org/Impacts_part2.pdf. A third section is to be published in April.

Effects of past agricultural land use called irreversible

French scientists investigated agricultural aftereffects in northeastern France where large areas were deforested for farming during the Roman occupation and thereafter abandoned to forest. They found that species richness and plant communities vary with intensity of former agriculture. Variations are linked to long-term changes of chemical and structural soil properties. They suggest that effects of past agricultural land use on forest biodiversity may be irreversible on an historical time scale.

J.L. Dupouey, E. Dambrine, C. Moares, and J.D. Laffite. 2002. Irreversible Impact of Past Land Use on Forest Soils and Biodiversity. *Ecology* 83 (11): 2978-2984.

Exotic species alter soil microbial community

Rutgers University scientists studied Japanese barberry and Japanese stilt grass in hardwood forests in northern New Jersey, sampling soils under the exotic species as well as under native blueberry. Their results indicate that exotic invasive plants have profound effects on both the structure and function of microbial communities in soils.

Peter S. Kourtev, Joan G. Ehrenfeld and Max Häggblom. 2002. Exotic Plant Species alter the Microbial Community Structure and Function in the Soil. *Ecology* 83 (11) 3152-3166.

GAO says invasive species plan poor

In a recent report the U.S. General Accounting Office says that the National Invasive Species Council's management plan is inadequate to deal with what scientists, academicians and industry leaders are recognizing as one of the most serious environmental threats of the 21st century.

INVASIVE SPECIES: Clearer Focus and Greater Commitment Needed to Effectively Manage the Problem. GAO-03-1. <http://www.gao.gov/new.items/d031.pdf>

Water Resources Research Institute of The University of North Carolina

Preconference Workshop

“Stormwater Solutions for North Carolina Communities”

12:00- 5:00 pm, Monday, March 31, 2003

Jane S. McKimmon Center, Raleigh, NC

Early Registration Fee: \$50

Four (4) PDH's available for PEs and Surveyors

12:00 - 1:00 Registration. Exhibits open.

1:00 - 1:10 Welcome & Introductions, *Dr. Greg Jennings, Associate Director, UNC Water Resources Research Institute*

1:10 - 1:30 Stormwater Regulations Affecting N.C. Communities
Mr. Bradley Bennett, Head, Stormwater and General Permits Unit, N.C. Division of Water Quality

1:30 - 2:00 Planning & Design for Stormwater, *Dr. Nancy White, Research and Extension Associate Professor, College of Design, NC State University*

2:00 - 2:45 BMPs for Construction, *Dr. Richard A. McLaughlin, Associate Professor of Soil Science, NC State University*

2:45 - 3:15 Break
Courtesy of N. C. Association of Environmental Professionals

3:15- 4:00 BMPs for Post-Construction, *Mr. Bill Hunt, Extension Specialist, Dept. Biological and Agricultural Engineering, NC State University*

4:00 - 5:00 Stormwater Program Case Studies:
Phase I Community — *Mr. Scott Bryant, Stormwater Manager, City of Greensboro, NC*
Phase II Community — *Mr. Dave Mayes, Head, Stormwater Services, City of Wilmington, NC*

2003 Annual Conference “Valuing North Carolina’s Water Resources”

8:00 am - 5:00 pm, Tuesday, April 1, 2003

Jane S. McKimmon Center, Raleigh, NC

Early Registration Fee: \$50 (Students \$30)

Seven (7) PDH's available for PEs and Surveyors

8:00 – 9:00 Registration

9:00 – 9:15 Welcome, *Dr. Kenneth H. Reckhow, Director, UNC Water Resources Research Institute*

9:15 – 9:45 The Environmental Value of North Carolina’s Water Resources, *Mr. Bill Holman, Executive Director, N.C. Clean Water Management Trust Fund*

9:45 – 10:15 The Economic Value of North Carolina’s Water Resources, *Dr. V. Kerry Smith, University Distinguished Professor of Agricultural and Resource Economics and Director of the Center for Environmental and Resource Economic Policy, NC State University*

10:15 – 10:45 Break (Posters and exhibits open)

10:45 – 12:15 Concurrent Sessions

12:15 – 1:30 Lunch (Posters and exhibits open)

1:30 – 3:00 Concurrent Sessions

3:00 – 3:30 Break (Posters and exhibits open)

3:30 – 5:00 Concurrent Sessions

Check WRRR website for full agenda with titles of papers in concurrent sessions: www2.ncsu.edu/ncsu/CIL/WRRR/2003conference.html

Register before March 14, 2003, for early registration fee.

Registration Form

2003 Water Resources Research Conference & Preconference Workshop

Name: _____ Affiliation: _____ Phone: _____

City: _____ State: _____ Zip: _____ Email: _____

I will attend:

_____ Preconference Workshop. Enclosed is my check for \$50 (\$70 after 3/14/03).

_____ Annual Conference. Enclosed is my check for \$50 (Students \$30) (\$70 and \$50 after 3/14/03). **Student?** _____
College or university

_____ Both the Preconference Workshop and Annual Conference. Enclosed is my check for \$100 (\$120 after 3/14/03).

_____ I would like to receive PDH credits, and my license number and type are:

**Make checks payable to WRRR and mail with registration form to:
Water Resources Research Institute, Box 7912, NC State University, Raleigh, NC 27695-7912**

Questions? Call WRRR at (919) 515-2815 or check our website: www2.ncsu.edu/ncsu/CIL/WRRR/2003conference.html

WRRRI report available

WRRRI has recently published a peer-reviewed technical completion report on research projects for which it provided funding. Single copies of WRRRI 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 WRRRI, Box 7912, North Carolina State University, Raleigh, NC 27695-7912 or call (919) 515-2815 or email: water_resources@ncsu.edu.

Sedimentation and Water Quality in Lake Jeanette, Greensboro, NC Special Report Series No. 22 November 2002

Craig A. Stow, James W. Wintergreen, and Rebecca D. Cason
Nicholas School of the Environment,
Duke University

Lake Jeanette is a small reservoir (surface area 272 acres) in Guilford County, NC, just north of downtown Greensboro. The reservoir was built in 1942 by Cone Mills Corp. as a water source for local operations. Into the 1980s, land use in this small watershed (7.6 square miles) was a mix of agricultural and forested land and a small proportion of residential and commercial development. However, the watershed is currently under active development with large tracts of land under conversion to high and medium density residential uses. This rapid development has raised concerns that conditions in the reservoir may be deteriorating as a result of these intense watershed activities. In particular, residents of the area have questioned whether land disturbance by construction activities may be causing accelerated sedimentation and eutrophication in the lake.

With funding from the City of Greensboro through the N.C. Urban Water Consortium, the investigators conducted a baseline evaluation of Lake Jeannette from the fall of 1998 through the spring of 2000. They monitored sediment and flow in the major tributaries (Richland Creek and South Creek),

analyzed seven sediment cores from the lake, conducted ambient monitoring during the summer, and calibrated a spreadsheet-based water quality model.

Results indicate that, during the study period, sediment loading to the lake was low and surface water quality was good. (The authors note that sampling occurred during a very dry period when loading from the watershed was also low.)

According to the North Carolina trophic state index, Lake Jeanette is mesotrophic, with relatively low nutrient and chlorophyll *a* concentrations. The mesotrophic designation may be strongly influenced by the low secchi transparency of the lake, which results from the brown stained waters, an indication of humic substances probably of terrestrial origin.

Sediment core analyses indicate that sediment accumulation has been relatively low and consistent over time in the main body of the lake but has accelerated in the northern arm near Richland Creek. Accretion rates are estimated at approximately a centimeter per year in the northern arm, though this is an average over the last 36 years. Projected areal losses in the region of the lake over the next 50 years range from approximately 15-20 percent, depending on assumptions regarding land use and sediment delivery.

Model estimates indicate that, while sedimentation could be accelerated by further watershed development, degradation of surface water quality, at least with regard to lake trophic status, should be minimal. However, they say that the sediment delivery ratio used in the model

is relatively uncertain and that studies during high-flow events would help reduce this uncertainty by producing a better estimate of the proportion of runoff-borne sediment that reaches the lake.

The authors recommend establishing a routine ambient monitoring program both in the lake and the tributaries to document any changes in water quality. They also recommend that Eutromod or a similar model should be adopted as part of the planning process for the watershed. They say that some of the literature-based values used in the model could be refined with site specific measurements and that future land-use changes could be incorporated into the model.

Expert system helps plan environmental monitoring

The Environmental Monitoring and Measurement Advisor (EMMA) funded by the National Science Foundation (NSF), is a web-based expert system that helps users to consider and answer all critical questions for environmental monitoring. It guides users through complex decisions to tailor their plans to meet specific project needs by considering the physical and chemical characteristics of the sampling site and target analytes, desired data quality, available budget, and their objectives. It combines decision criteria based on systematic planning, a user's specific project needs, and methods information from the new National Environmental Methods Index (NEMI). The software incorporates elements of EPA's Data Quality Objective (DQO) process, its new Performance and Acceptance Criteria (PAC) Process, and its new Triad Approach (see <http://clu-in.org/triad/>). The free methods selection module is linked from the NEMI web site (<http://www.nemi.gov>). EMMA is reached at <http://www.EMMA-ExpertSystem.com>.

Studies

Articles make the case for coordinated water resources research and management that recognize the needs of freshwater ecosystems

Burgeoning global population and climate change threaten to disrupt the critical cycling of water through local and regional freshwater ecosystems that sustains life on earth, say the authors of articles in two recent issues of *Ecological Applications*.

These threats present an urgent need for interdisciplinary research to help provide needed water for human use and at the same time sustain ecosystems. But, the scientists say, in spite of the obvious continuum of physical, chemical and biological processes that drive the cycling of water, at least six federal departments and 20 agencies carve the hydrologic cycle into discrete parts for the purpose of research and management. Moreover, few Americans are aware that the modern conveniences of drinking water and wastewater sometimes disrupt local hydrologic processes and can damage local freshwater ecosystems. The articles make some positive recommendations for balancing the needs of humans and freshwater systems.

In "Meeting Ecological and Societal Needs for Freshwater" and "Water in a Changing World," Duke University Ecologist Robert B. Jackson and co-authors argue for coordinated research and education at the national level. Research and education should be built on the recognition that only by understanding and sustaining the natural functioning of the hydrologic cycle and freshwater ecosystems can localities achieve sustainable water use.

The two articles provide a concise primer on the hydrologic cycle, freshwater ecosystems, global water use, and regional implications of potential effects of global climate change on the hydrologic cycle.

Water availability and use

The authors point out that renewable, available fresh water that is the foundation of life in terrestrial and freshwater ecosystems makes up only a tiny fraction of the global water pool—less than 1 percent. About 99 percent of all liquid fresh water is in underground aquifers. Three-quarters of that is in deep aquifers where recharge is on the order of 100 to 10,000 years and is therefore considered nonrenewable. Freshwater in rivers and lakes make up less than 0.01 percent of renewable freshwater.

More than two-thirds of the average 27.55 inches per year of precipitation that falls over land is recycled from plants and the soil. Because precipitation is greater than evaporation on land, 40,000 km³ of water returns to the oceans via rivers and underground aquifers. However, the geographical and temporal distribution of freshwater is not well matched to human needs. Nearly one-fifth of total global runoff is in remote, inaccessible rivers, and additional freshwater runs off in monsoons and floods that cannot be captured. Only an estimated 31 percent of global runoff is accessible to humans in renewable groundwater and base river flow, and in flood water that is captured and stored in reservoirs. Of this, humans currently appropriate about 54 percent for withdrawals and instream uses (including pollution dilution).

In spite of the fact that more than half of available freshwater runoff is appropriated for human use, billions of people lack safe drinking water and sanitation services. Furthermore, the global population is projected to increase by one-third over the next 30 years. While accessibility of freshwater may be

slightly increased, the amount of freshwater available per person on a global basis will decrease as population increases. Pollution will decrease usable water further.

Discounting the importance of freshwater ecosystems

Because freshwater is critical for human life and society, its use for drinking water, irrigation, and transportation has taken precedence over other life-support services that freshwater ecosystems provide, including food supply, flood control, purification of human and industrial wastes, and habitat for plant and animal life. Long-term provision of these services as well as the adaptive capacity of freshwater ecosystems to respond to future environmental alteration, such as climate change, is threatened when society fails to recognize that these ecosystems depend upon adequate quantity, quality, timing and temporal variability of water flow.

Lakes, wetlands, rivers, and their connected groundwaters have a common need for water within a certain range of quantity and quality. Freshwater systems have evolved to the rhythms of hydrologic variability and therefore need a range of natural variation to maintain resilience. Base flow, annual or frequent floods, rare and extreme floods, seasonality of flows and annual variability are all critical for regulating biotic production and diversity.

Freshwater ecosystems and species have also evolved to accommodate annual cycles of sediment and organic matter inputs, thermal and light characteristics, chemical and nutrient characteristics, and biotic assemblages. Invertebrates, algae, bryophytes, vascular plants and bacteria that are responsible for much of the water purification, decomposition, and nutrient cycling in waterbodies are highly adapted to the specific sediment and organic matter conditions of their environment. These organisms decline or disappear if the

continued next page

type, size, or frequency of sediment inputs change. Water temperature regulates oxygen concentrations and the metabolism of aquatic organisms, which in turn influence nutrient cycling, distribution of dissolved gases and biota, and behavioral adaptations of organisms. Damming of streams changes downstream water temperature, often dramatically, changing the food web and biotic community. Natural nutrient and chemical conditions reflect local climate, bedrock, soil, vegetation type and topography. When additional nutrients are added by human activity, cultural eutrophication occurs, increasing productivity beyond the original state.

Communities of aquatic species reflect the environmental variation established by flow, sediment, thermal, light, and nutrient regimes as well as the presence of and interactions with other species in the system. Biotic and abiotic controls and feedbacks maintain species diversity that supports redundancy of ecological functions. This redundancy assures that primary production, decomposition, and nutrient cycling will continue during environmental stress. However, human alteration of environmental conditions can simplify this natural complexity and push functioning freshwater ecosystems beyond the bounds of resilience, destroying their ability to provide services on both short- and long-term scales. Nuisance algal blooms and invasion of nonnative species are common symptoms of ecosystem disturbance.

Climate change and implications for the hydrologic cycle

Global warming and climate change are widely expected to cause a general intensification of the earth's hydrological cycle in the next 100 years. In general, evapotranspiration, precipitation, and occurrence of storms are expected to increase and to bring significant changes in biogeochemical processes that influence water quality, especially cycling of carbon and nitrogen. However,

increases in average global precipitation will not uniformly increase freshwater availability, as greater evaporative demand on plant and soil water may more than offset increases in precipitation. In addition, land surface is expected to warm, increasing the likelihood of drought in continental regions. In general, many more regions, including the southeastern United States, could be drier.

The change in soil moisture, microbial processes in soils, and biogeochemical cycling coupled to hydrology may cause a shift in terrestrial productivity and plant species distributions. Decreased precipitation and decreased runoff could worsen water quality through concentration of pollutants and could affect aquatic biota, including phytoplankton at the base of the foodchain. Changes in carbon and nitrogen inputs to coastal areas could lead to depletion of oxygen in coastal water and promote harmful algae.

The rising sea level will push shores inland and increase saltwater intrusion into freshwater aquifers.

Human impacts that sever hydrologic and ecological connections already threaten the resilience of ecosystems. Rivers have been fragmented and separated from their floodplains. Wetlands have been drained and filled. Nonrenewable groundwater is being depleted. In many places, extraction of renewable groundwater exceeds recharge rates, lowering water tables and decreasing summer low-flow rates in rivers and streams, thereby reducing perennial stream habitat, increasing summer stream temperatures, and impairing water quality.

Growing demands for freshwater can increase these disconnections and risk severe failures in ecological systems and the services upon which humans depend.

Need for coordinated action

The authors say that rapidly unfolding trends in population and climate change will put dramatic pressure on freshwater

ecosystems. These developments present an unprecedented need for cross-cutting research to solve existing water problems and predict consequences of future efforts to manage water supply and water quality. The question we must begin to explore is: How can society extract the water resources it needs while not diminishing the important natural complexity and adaptive capacity of freshwater ecosystems? Traditional scientific boundaries between climatology, hydrology, limnology, ecology, and the social sciences divide understanding and make it impossible to answer that question. Sustainable water management requires a fusion of knowledge, a broader view of the dynamic nature of freshwater resources and the benefits they provide, and management focus on the basin and individual watershed scale.

The authors argue for a single panel of scientists and policy analysts or a central agency to develop a well-conceived national plan for water research and management that incorporates freshwater ecosystem needs along with water quantity and quality.

Jackson, Robert B., Stephen R. Carpenter, Clifford N. Dahm, Diane M. McKnight, Robert J. Naiman, Sandra L. Postel, and Steven W. Running. 2001. "Water in a Changing World." *Ecological Applications* 11:1027-1045. (A rewrite of this paper for a non-technical audience can be found in the Spring 2001 pdf edition of *Issues in Ecology* on the Ecological Society of America website: <http://www.esa.org/sbi/issue9.pdf>.)

Baron, Jill S., N. LeRoy Poff, Paul L. Angermeier, Clifford N. Dahm, Peter H. Gleick, Nelson G. Hariston, Jr., Robert B. Jackson, Carol A. Johnston, Brian D. Richter, and Alan D. Steinman. 2002. "Meeting Ecological and Societal Needs for Freshwater." *Ecological Applications* 12 (5):1247-1260.

*Dr. Robert Jackson is also author of the recent book **The Earth Remains Forever** published by the University of Texas Press.*

People

Dr. Hans Paerl is the recipient of the 2003 G. Evelyn Hutchinson Award of the American Society of Limnology and Oceanography given to recognize excellence in any aspect of limnology or oceanography. Paerl is Kenan Professor of marine biology and ecology with the UNC-CH Institute of Marine Sciences.

Keith Overcash, who had been serving as interim Director of the Division of Air Quality in the N.C. Department of Environment and Natural Resources, has been named to the position permanently.

Dr. J. Wendell Gilliam, William Neal Reynolds Professor of Soil Science at NC State University, received the Agronomic Service Award, presented at the 2002 annual meetings of the American Society of Agronomy, Crop Science Society of America and Soil Science Society of America in November, 2002.

Tom Poe, formerly Pretreatment Unit supervisor with the N.C. Division of Water Quality (DWQ), has taken a position with DWQ's Construction Grants and Loans Section in the Project Management Branch.

Callie Dobson, formerly with DWQ's Basinwide Planning Program, has taken a position as Executive Director of the Hiwassee River Watershed Coalition in Cherokee and Clay counties in North Carolina and Towns and Union counties in Georgia.

Dr. Devendra Amatya, formerly Research Associate in the Department of Biological and Agricultural Engineering at NC State University, has taken a position in Research Hydrology with the USDA Forest Service, Southern Research Station in Charleston, SC.

Milt Rhodes, formerly with the DWQ's Water Supply Watershed Program, has taken a position as Director of Town Planning with the NC Smart Growth Alliance.

End of year water supply status

According to the N.C. Drought Monitoring Council, above-normal precipitation since September associated with the EL Niño warm event in the Pacific has significantly reversed drought conditions across North Carolina. The State Climate Office expects above normal precipitation through the spring, which should allow water supplies across the state to

be in much better condition than last year. However, there is no confident forecast for the summer, and there is uncertainty as to whether winter precipitation will restore depressed groundwater conditions before summer. As long as groundwater levels remain low, North Carolina is susceptible to a quick onset of drought conditions during even short-term periods of dry weather. If rainfall returns to below normal, streamflows would not take long to fall because of low ground water levels.

North Carolina Precipitation/Water Resources

	Nov	Dec
Rainfall (+/- average)		
Asheville	4.23" (+0.41")	6.40" (+3.01")
Charlotte	4.38" (+1.02")	4.96" (+1.78")
Elizabeth City	5.77" (+2.84")	3.74" (+0.68")
Greensboro	4.36" (+1.40")	4.43" (+1.37")
Raleigh	3.56" (+0.59")	5.06" (+2.02")
Wilmington	3.06" (-0.20")	2.53" (-1.25")

Streamflow Index Station (County, Basin)	Nov mean flow (CFS) (% of long-term median)	Dec mean flow (CFS) (% of long-term median)
Valley River at Tomotla (Cherokee, Hiwassee)	470 (315%)	496 (202%)
Oconaluftee River at Birdtown (Swain, Tenn)	613 (168%)	723 (133%)
French Broad River at Asheville (Buncombe, FB)	1,800 (119%)	2,590 (117%)
South Fork New near Jefferson (Ashe, New)	426 (123%)	470 (121%)
Elk Creek at Elkville (Wilkes, Yadkin/Pee-Dee)	96.9 (155%)	117 (135%)
Fisher River near Copeland (Surry, Yadkin/Pee-Dee)	204 (137%)	184 (124%)
South Yadkin River near Mocksville (Rowan, Yadkin/PD)	294 (126%)	562 (162%)
Rocky River near Norwood (Stanly, Yadkin/Pee-Dee)	1,930 (327%)	3,170 (295%)
Deep River near Moncure (Lee, Cape Fear)	2,260 (407%)	3,360 (309%)
Black River near Tomahawk (Sampson, Cape Fear)	526 (136%)	606 (90%)
Trent River near Trenton (Jones, Neuse)	60.5 (99%)	88.5 (58%)
Lumber River near Boardman (Robeson, Lumber)	761 (89%)	994 (74%)
Little Fishing Creek near White Oak (Halifax, Pamlico)	181 (247%)	323 (233%)
Potocasi Creek near Union (Hertford, Chowan)	283 (882%)	427 (364%)

Groundwater Index well (Province)	Nov depth below surface (ft) (departure from average for month)	Dec depth below surface (ft) (departure from average for month)
Blantyre (Blue Ridge)	37.03 (-3.28)	34.73 (-1.13)
Mocksville (Piedmont)	20.92 (-2.97)	19.26 (-1.73)
Simpson (Coastal Plain)	3.65 (+1.30)	3.34 (+0.69)

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

Conferences and workshops

The U.S. EPA, the Chicago Botanic Garden, the Conservation Technology Information Center and others will present **A National Conference on Urban Storm Water: "Enhancing Programs at the Local Level,"** Feb 17-20, 2003, at the Westin Michigan Ave. in Chicago. For information go to website: <http://www.chicagobotanic.org/research/conference/stormwater/>

The National Groundwater Association will present **Endocrine Disrupting Chemicals and Pharmaceuticals in the Environment: What Does it Mean for Groundwater?** March 17-18, 2003, in Minneapolis, MN. This course will provide up to date knowledge in an easily absorbable fashion to equip the ground water professional with information for decisionmaking and policy formulation. The purpose of this course is to provide its attendees with an overview of the field of environmental endocrinology, elucidate sources and fate and transport concerns related to ground water and other media of these classes of compounds, and provide frameworks for examining health outcomes related to exposure to these compounds. For information go to website: <http://www.ngwa.org/e/course/030317181.shtml>

The U.S. EPA is sponsoring **Vapor Intrusion Seminar** at the Hyatt Regency in Atlanta, February 25-26. This free two-day seminar examines the potential for vapor intrusion of toxic and hazardous chemicals from contaminated soils or groundwater into indoor air pathways. At sites where soils or groundwater contain volatile or semi-volatile chemicals of concern, there is the potential for chemical vapors to migrate from the subsurface to overlying buildings. In extreme cases, these vapors may accumulate at concentrations that pose near-term safety hazards. The seminars will introduce new EPA guidance and enable

2002 - 2003 Water Resources Research Seminar Series

Following are the currently scheduled research seminars for 2002-2003. Presentations take place at 3 pm in the Ground Floor Hearing Room of the Archdale Building in downtown Raleigh or in Room 1132 of Jordan Hall on the N.C. State University campus. Licensed Professional Engineers and Surveyors can receive one Professional Development Hour for attending these seminars. There is no attendance fee, and registration is not required. For additional information email Jeri_Gray@ncsu.edu.

January 28, 2003, Jordan
"Technical, Economic, and Environmental Evaluation of Alternatives for Animal Waste Management in North Carolina"
Dr. Michael R. Overcash
 NC State University

February 25, 2003, Archdale
"Ultraviolet-based Processes for Meeting Water Quality Goals: Microbial and Chemical Contaminants"
Dr. Karl G. Linden
 Duke University

March 25, 2003, Jordan
"An Assessment of North Carolina Water Reuse Regulations"
Dr. Helene A. Hilger
 UNC-Charlotte

April 22, 2003, Archdale
"Using Natural and Landscaped Buffers to Reduce Pollution Loading from Agricultural Runoff"
Dr. Richard A. McLaughlin
 NC State University

May 20, 2003, Jordan
"From Pfiesteria to Micro Arrays: New Tools for Water Quality Assessment"
Dr. Parke A. Rublee
 UNC-Greensboro

the dissemination and exchange of state-of-the-science information to better understand indoor air vapor intrusion from groundwater. For more information and to register, see <http://www.epa.gov/ttbnrml/indoorair.htm>

The National Watershed Coalition will present the **Eighth National Watershed Conference, "Exploring Working Watersheds: Changes since Lewis & Clark,"** June 8-11, 2003, at the Harrahs Council Bluffs Casino & Hotel in Council Bluffs, IA. For information go to website: <http://www.watershedcoalition.org>.

Environment Canada and EPA's Office of Research and Development and TIO are co-sponsoring a free conference, **International Applied Phytotechnologies Conference**, in Chicago, March 3-5, 2003 This conference examines the state of science and engineering advances in phytotechnologies worldwide. The conference is designed to assist professionals in the regulatory community in determining feasibility of using phytotechnologies at contaminated sites, and explore designing, implementing, and monitoring site cleanups with plants. For information and to register, go to website: <http://www.epa.gov/ttbnrml/phyto.htm>.

ADVANCED EROSION AND SEDIMENTATION CONTROL DESIGN WORKSHOPS

February 18-19, 2003
Jane S. McKimmon Center
Raleigh NC

March 19-20, 2003
Holiday Inn Select
Hickory, NC

Purpose: This seminar is presented to familiarize design professionals who develop erosion and sedimentation control plans—including engineers, landscape architects, and surveyors—with erosion and sedimentation control principles and practices. Eleven (11) PDHs are available to professional engineers and land surveyors, and 10 continuing education units are available to landscape architects for completion of both days.

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

Deadline: Registrations will be taken on a first-come, first-served basis, but no registrations will be taken after February 11, 2003, for the Raleigh seminar, and March 7, 2003, for the Hickory seminar.

For additional information and a registration form go to website:

**[http://www2.ncsu.edu/ncsu/CIL/WRRI/
erosionseminars.html](http://www2.ncsu.edu/ncsu/CIL/WRRI/erosionseminars.html)**

Sponsored by

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



2002 - 2003 Luncheon and Forum Schedule

February 3, 2003
Post-Construction Stormwater BMPs: Good, Bad, and Ugly

April 7, 2003
Airborne Water Pollutants

September 8, 2003
Land Use & Water Quality Interactions Using GIS

December 1, 2003
Water Reuse

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

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

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