



Petition for NPDES storm water permit could signal things to come

As the *WRRINews* went to press, the N.C. Division of Water Quality (DWQ) was drafting a response to a petition filed by the N.C. Coastal Federation to require Brunswick County to obtain an NPDES Storm Water Phase I permit prior to being issued authorizations for construction of the East-West Brunswick Regional Wastewater Treatment Facilities. The petition was filed in November under the NPDES Storm Water regulations (40 CFR Part 122) which provide that “any person may petition . . . to require an NPDES permit for a discharge which is composed entirely of storm water which contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States” and that “any person may petition . . . for the designation of a large, medium, or small municipal separate storm sewer system.”

The petition asks that Brunswick County obtain a storm water permit to regulate storm water discharges throughout the 201 Planning Area (essentially the service area) for the East and West Brunswick County Regional Wastewater Treatment Facilities, saying this area can be characterized as a medium municipal separate storm sewer system based on what population is projected to be in one year. Medium municipal separate storm sewer systems were regulated under the first phase of the NPDES storm water program.

The petition discusses waters within the service area that are on the state’s list

of impaired waters (303 [d] list) because of storm water runoff and shellfish sanitation reports concluding that shellfish closures in the area result from storm water runoff. The petition says that the same conditions exist within the East/West Brunswick service area that exist

within the service area of the South Brunswick Water and Sewer Authority, which has been required to obtain an NPDES Storm Water Phase I permit. That permit was required by an administrative law judge in a challenge brought by the Coastal Federation to a permit

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Director's Forum**Communicating research results: What we've learned***Kenneth H. Reckhow, Director, Water Resources Research Institute*

In the last issue of the *WRRRI News* we asked for feedback on the question "How should WRRRI disseminate results of its sponsored research?" We asked readers to complete an on-line survey about goals and methods for dissemination of research results, WRRRI's technical project completion reports, and possible alternatives to full, peer-reviewed reports.

Quite frankly, only a few people responded to our survey, but most of those who did apparently devoted serious attention to the issue. We received some very useful comments, and we thank those who took the time to respond.

While no decisions have been made about changes to WRRRI's current research report publication policy, we thought we would let you know what we have learned from the survey and from other communications we've received over the last few months.

The survey did not reveal a strong preference for replacing WRRRI's current technical completion reports with another form of publication. While some researchers feel strongly that WRRRI's reporting requirements are not commensurate with the level of funding the Institute is able to provide for individual projects, particularly for young faculty who need to focus on publishing in refereed journals, others feel that WRRRI's report series is highly respected and is an important part of the "gray literature" in water resources research.

If WRRRI did replace its current peer-reviewed technical completion reports with another form of publication, the slim preference is for short, minimally reviewed and edited reports. However, a significant percentage of respondents favored replacing research reports with some kind of journal (either, reviewed or non-reviewed) if the report series were discontinued.

Respondents to the survey overwhelmingly felt that "making research

results and data widely accessible" should be the primary goal of our research dissemination efforts, with "providing enough detail so that research can be duplicated and validity of methods can be evaluated" second.

Respondents also overwhelmingly felt that research results should be made available both in print and online.

Some respondents suggested alternatives to our current publication

policy that we had not thought of. We appreciate those suggestions and will remember them as we consider changes.

In addition to responses to our survey, we have recently received other communications that have prompted consideration of some modifications to the *WRRRI News*.

Increasingly, researchers are sending us off-prints of journal articles or copies

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The WRRRI News plus summaries of more than 100 WRRRI technical reports and frequently updated information on employment opportunities; conferences and workshops; and public hearings/meetings are available on the World Wide Web at:
<http://www2.ncsu.edu/ncsu/CIL/WRRRI>

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of reports and requesting that they be summarized in the newsletter. Those requests together with suggestions from some survey respondents that WRRI should be a "clearinghouse" for water research in the state, have led us to conclude that the newsletter should be playing a larger role in research communication. Therefore, beginning with the May/June issue, we will devote up to four pages of each issue to summaries of water research articles and reports sent to us by investigators.

Our summaries will be just that: we will not analyze or critique articles or reports. For each article or report summary, we will indicate the source and the level of review provided the original. We will have authors review the summaries of their articles and reports before they are published.

We will aim to provide summaries from many different researchers, and if it becomes necessary, we will limit the number of articles or reports by any one individual that we will accept for inclusion. While we will accept articles and reports from agencies and private entities, we intend to focus on academic research and will always devote at least half the space in any one issue to university investigators.

At this time, we request that researchers engaged in water resources research across North Carolina share with us their journal articles and reports. Please send them to Jeri Gray.

The American Water Resources Association announces its annual spring specialty conference

**Water Quality Monitoring
and Modeling
April 30- May 2, 2001
The Menger Hotel
San Antonio, TX**

Presentations will summarize both long-term and synoptic monitoring studies, modeling efforts, and the relationship between monitoring and modeling. For information go to web address: <http://www.awra.org/meetings/Texas2001/>

Storm Water permit petition *continued*

issued by the N.C. Division of Water Quality for construction of the South Brunswick Water and Sewer Authority's proposed sewer. (A public hearing on the South Brunswick storm water permit was scheduled for March 21, and the permit is to be issued by April 16.)

The petition for a storm water permit for the East/West Brunswick service area is the first to be filed in North Carolina under the NPDES storm water rules, but it will probably not be the last. It was clear in a workshop held by the N.C. Division of Water Quality in March, that local governments across the state expect a flood of petitions under the NPDES Storm Water Phase II program and that some local governments may even file petitions themselves.

On March 13, DWQ's Storm Water and General Permits unit held the last of its series of workshops on Phase II implementation issues. This final workshop focused on petition criteria. Under the Phase II rules, NPDES permitting authorities must adopt rules specifying what must be included in a petition to require a small unit of local government to get an NPDES Storm Water Phase II permit. (Petition criteria were not required under Phase I.) DWQ held the workshop to get stakeholders' views on what should be included and on how the petition process should work.

While stakeholders did discuss petition criteria, they also discussed various scenarios under which petitions might be filed and predicted that DWQ could be hard pressed to issue Phase II permits and respond to petitions at the same time.

Stakeholders expect that where local water quality conditions are an issue, environmental organizations and citizens groups will file increasing numbers of petitions to affect control of storm water.

They also expect that in situations where counties have been designated to obtain permits but municipalities that discharge to county systems* have not, counties may petition to have municipalities designated to obtain permits.

Some municipalities that expect they might be the subject of petitions, may ask to be designated as an operator of a storm sewer system and volunteer to obtain a storm water permit in order to be under the same rules as other Phase II permittees.

In addition to providing that citizens and others may petition to have a unit of local government designated as an operator of a storm sewer system and required to obtain a permit, the NPDES Storm Water regulations provide that operators of storm sewer systems may petition to require a permit for any discharge into its system. Therefore, the potential exists for municipalities to petition to require local operating units, such as universities, and industrial operations that have gotten certain exclusions under Phase I to obtain permits to discharge into their storm sewers.

When the NPDES Storm Water Phase II rules were published, they contained a list of local governments designated as operators of small municipal separate storm sewers (MS4's) that are to be required to obtain permits. However, the rules also require that states develop criteria for designating other MS4's and publish its own list of MS4's required to obtain permits.

The potential for petitions together with requirements for considering additional designations makes it clear that no one can say now who will end up being required to obtain Phase II permits.

** The N.C. Association of County Commissioners has sent a letter to the Division of Water Quality stating its position that counties are not subject to the Phase II program because they do not operate separate storm sewer systems. Counties maintain that in North Carolina drainage systems outside municipalities are owned and operated by the N.C. DOT. This situation is not common throughout the nation and was not anticipated when the Phase II rules were developed. Nevertheless, North Carolina has obtained a ruling from the U.S. EPA saying that N.C. counties are subject to Phase II. DWQ has asked the N.C. Attorney General for an advisory opinion.*

February action of the N.C. Environmental Management Commission

The N.C. Environmental Management Commission (EMC) did not meet in March due to State budget constraints. In February, the commission took the following action:

- Adopted a resolution calling on the N.C. General Assembly to provide funding for enhanced monitoring for mercury and increased public education efforts on mercury. The resolution was presented by Commissioner Marion Deerhake, chairman of the EMC's Air Quality Committee. She said that the State needs to conduct a comprehensive survey of mercury levels in North Carolina waters, particularly in the southeast where testing has found high levels of mercury in residents. She said that new laboratory equipment is needed to allow the Division of Water Quality to sample and measure mercury in surface water and sediment and that public awareness of exposure to mercury and the health effects of mercury needs to be increased.
- Approved groundwater standards for 18 substances, three of which are pesticides and 15 of which are used in the coal gasification process or are manufacturing process chemicals, and for 38 additional substances and approved a change in the biennial review of groundwater standards. New groundwater standards can be found on the Groundwater Section website at: <http://gw.ehnr.state.nc.us/rules.htm>
- Approved holding public hearings on draft temporary rules for lake shoreline and mainstem river riparian buffer protection in the Catawba Basin. The rules will protect a 50-foot wide riparian shoreline buffer along the mainstem lakes from Lake James to the NC/SC border. The rules do not apply to the Catawba River mainstem above Lake James or to any other streams in the Catawba Basin. Temporary buffer

rules for the Catawba Basin are being developed under special authority granted the EMC by the General Assembly. The legislation giving the EMC this authority requires public hearings before adoption of the temporary rule. Public hearings were scheduled to be held March 20 in Mt. Holly and March 22 in Valdese.

- Delegated to the director and staff of the Division of Water Quality the authority to approve local governments' stormwater management plans submitted under the Neuse River Basin Nutrient Sensitive Waters Rules.

According to the *Southeast Watershed Forum*, Crescent Resources, a land management and real estate development company owned by Duke Energy, is establishing permanent conservation easements on all its property along perennial streams that flow into the Catawba River. This is in addition to buffers on Crescent land on lakes along the Catawba.

N.C. DWQ leaning toward hybrid NPDES Phase II storm water permits

Under the NPDES Storm Water Phase II rule promulgated by EPA in October 1999, states must issue storm water permits to local government that are required to comply with the rule and to construction sites greater than 1 acre by March 2003. However, before a state can issue permits it must decide what kind of permit it will use and what conditions the permit will contain. The Phase II rule allows states the option of issuing general permits or individual permits. With a general permit, DWQ would write

one permit with one set of requirements, and local governments would apply to be covered by that permit, promising to comply with the requirements. With individual permits, each applicant would submit a proposal for what it intends to do and permit conditions would be tailored for each applicant.

At an NPDES Storm Water Phase II workshop in January, state regulators said they are considering what amounts to a cross between the general and individual permit approach. DWQ is considering a system of major and minor individual permits. The minor permit would function like a general permit by allowing applicants to select pre-determined program components from a menu of options. The major permit will be used for local governments that want to design their own storm water program to comply with NPDES requirements. All permits would have to be reviewed individually and would be subject to public comment and potentially public hearings if requested.

The State told workshop participants that they are leaning toward the major/minor individual permit approach for several reasons. They believe enforcement of a general permit would be very difficult and that fees for general permits are not adequate for the level of review required. DWQ also indicated that a general permit covering the range of situations found among local governments in North Carolina would be difficult to write and very large. Local governments would have a difficult time determining what they are required to do under such a permit.

DWQ has completed its current series of NPDES Storm Water Phase II workshops for stakeholders. The next series of workshops is scheduled for May. DWQ staff will hold those workshops statewide to present the Phase II rulemaking strategy and receive comments prior to finalizing the temporary rule language. Temporary rules are proposed for adoption in September, with permanent rulemaking following. For more information, log onto <http://h2o.enr.state.nc.us/su/stormwater.html>.

EPA releases Drinking Water Infrastructure Needs Survey

In February, the U.S. Environmental Protection Agency released the results of a survey conducted to document the 20-year capital investment needs of public water systems that are eligible to receive federal funds through Drinking Water State Revolving Funds. About 50,000 community water systems and 21,400 not-for-profit noncommunity systems are eligible. The survey reports infrastructure needs that are required to protect public health, including those needs to comply with Safe Drinking Water Act (SDWA) regulations.

According to the survey, public water supply systems need to invest \$150.9 billion in infrastructure during the 20-year period from January 1999 through December 2018. Transmission and distribution projects represent the largest category of need, with \$83.2 billion needed. About \$31.2 billion of the total national need (about 20%) is directly attributable to specific SDWA regulations. Projects to address microbiological contamination of drinking water will require investments of \$22.4 billion.

The EPA survey indicates that \$2.7 billion is needed in North Carolina to assure delivery of safe drinking water by public water supply systems (both community and noncommunity systems). The greatest need is for investment in transmission and distribution systems. Community water systems serving fewer than 10,000 people need to invest \$1.4 billion to deliver safe water—57.9% of the total investment needed by community water systems in the state.

The 1999 Drinking Water Infrastructure Needs Survey and report to Congress are available at website: <http://www.epa.gov/safewater/needs.html>.

Coalition urges Congress to commit to water infrastructure

In February, a coalition of drinking water and wastewater agencies, municipal and state government officials, engineers, and contractors calling itself the Water Infrastructure Network (WIN) released a report calling on Congress to commit to a five-year, \$57 billion federal investment in drinking water, sewer and stormwater infrastructure.

According to the report, *Water Infrastructure Now*, an average of \$11.5 billion in capitalization funds per year over the next five years is needed to close the gap between infrastructure needs and current spending by federal, state, and local governments.

The report also urges Congress to create a long-term, sustainable, and reliable source of federal funding for clean and safe water.

In an earlier report, *Clean & Safe Water for the 21st Century*, WIN said that nearly a trillion dollars in critical water and wastewater investments are needed over the next two decades and that financing the full investment locally would double or triple utility rates across the nation. Small, rural, and low-income communities would be hit the hardest,

the report says, since costs are high in small, dispersed systems. At least 22 percent of U.S. households would face hardship in paying their water and wastewater bills, according to the report.

WIN points out that the federal government has played a major role in funding other critical aspects of the nation's public works infrastructure, such as highways, airports, harbors and mass transit systems. Because of the importance of safe drinking water and adequate wastewater treatment to public health, the environment, and economic welfare, there is ample justification for a federal role in funding water infrastructure, WIN argues.

During the 106th Congress, Congressman Bob Borski and Congressman Sherwood Boehlert formed the bipartisan Water Infrastructure Caucus to address the nation's crisis in water infrastructure needs. The caucus now has 90 members and promised last fall to promote "Water 21," a plan to use the federal surplus to infuse \$50 billion over five years for drinking water and wastewater infrastructure.

Report concludes that climate change makes water demand management critical

According to a recently published report, continued reliance on current water resources engineering practice in the face of climate change may lead the nation to make incorrect and potentially dangerous or expensive decisions.

The report of the water sector assessment team of the National Assessment of the Potential Consequences of Climate Variability and Change concludes that as climate, precipitation, snowpack, and runoff patterns change, reliance on construction of infrastructure and on past hydrologic records for water resources management is dangerous.

Water: The Potential Consequences of

Climate Variability and Change states "with high confidence" that "water demand management and institutional adaptation are the primary components for increasing system flexibility to meet uncertainties of climate change."

This report makes a compelling case for re-examination of engineering design assumptions, operating rules, and contingency planning for water management systems.

An executive summary and the full report can be downloaded in pdf format from the Pacific Institute website at <http://www.pacinst.org/>.

Standard for arsenic in drinking water still up in air

As one of its final acts under the Clinton Administration, the U.S. EPA finalized a rule reducing the drinking water standard for arsenic from 50 parts per billion (micrograms per liter or $\mu\text{g/L}$) to 10 parts per billion. The rule was published in the *Federal Register* on January 22, 2001 (66 FR 6976) even though Congress had delayed the Safe Drinking Water Act deadline for setting a new standard to June 2001.

The new rule provided that all community water systems and non-transient non-community water systems must meet the maximum contaminant level of 10 $\mu\text{g/L}$ of arsenic within 5 years after the publication of the final rule. The rule also required that beginning with reports that are due by July 1, 2002, all community water systems must begin providing health information and arsenic concentrations in their annual consumer confidence report (CCR) if arsenic concentrations in their water exceed one-half the new standard.

However, on January 24, 2001, President George W. Bush issued in the *Federal Register* a memorandum directing heads and acting heads of executive departments and agencies to hold up any proposed or newly promulgated rules until an appointee of the new administration could review them. Except for rules required under a court-imposed deadline or rules considered necessary to protect public health or safety, rules that had been published in the *Federal Register* but had not yet taken effect were to be delayed for 60 days.

Meanwhile a number of groups, including the National Mining Association, have filed suits challenging the new arsenic rule, and at least one bill (S 223) has been introduced in Congress to repeal the rule.

What should the arsenic standard be?

The current standard for arsenic in drinking water of 50 $\mu\text{g/L}$ was set in

1975 and was based on a Public Health Service standard originally set in 1942. Over the next 20 years, studies began to implicate arsenic in skin cancer and internal cancers. In the 1996 Safe Drinking Water Act Amendments, Congress directed EPA to develop and implement a research plan and issue a new standard for arsenic based on the research by January 2001. Congress appropriated \$1 million per year in 1996 and 1997 for the studies.

In March 1999, the National Academy of Sciences released a report concluding that the current standard of 50 $\mu\text{g/L}$ for arsenic in drinking water did not protect public health and should be lowered as soon as possible. The report cited evidence that long-term exposure to low concentrations of arsenic in drinking water can lead to skin, bladder, lung, and prostate cancer as well as cardiovascular disease, diabetes, anemia and reproductive and development problems. However the report did not recommend a standard. EPA must consider many factors when setting a drinking water standard, including the availability of analytical methods, efficiency of treatment technologies, and cost of treatment options.

In May 2000 when EPA published its proposal to revise the arsenic standard, it proposed a new maximum contaminant level of 5 $\mu\text{g/L}$, a level favored by environmental groups. That proposal met with loud protest from water utilities, particularly those in western states where natural groundwater levels often exceed 100 $\mu\text{g/L}$, and from the mining industry. Both groups charge that EPA failed to balance the health risks of a 5 $\mu\text{g/L}$ standard against the cost of compliance.

The American Water Works Association Research Foundation issued a report saying that a 5 $\mu\text{g/L}$ standard would cost utilities nationwide around \$1.2 billion a year, with small groundwater systems bearing most of the compliance costs. That same report estimated that a 10 $\mu\text{g/L}$ standard would cost water

systems about \$495 million a year in additional compliance costs, again with small groundwater systems being hardest hit.

The final standard of 10 $\mu\text{g/L}$ published by EPA in January was not what environmental groups had hoped for, but it did not satisfy other critics either. The National Mining Association charges in its suit that the Clinton administration based its new arsenic standard on policy and not science and that it completely disregarded the implications of the standard for the business community.

It appears that debate over the arsenic standard will continue. The final say may come from the Office of Information and Regulatory Affairs (OIRA) in the White House Office of Management and Budget, which reviews all proposed regulations. In March, President Bush appointed John D. Graham as Administrator of OIRA. Graham (a graduate of both Wake Forest and Duke universities) was founding director of the Harvard Center for Risk Analysis. He is perhaps the nation's leading proponent of comparative risk analysis and cost-risk analysis.

Meanwhile in North Carolina

Meanwhile, in North Carolina, a proposal to change the state's groundwater standard for arsenic is going forward. Because private wells are not subject to the Safe Drinking Water Act, State groundwater standards are surrogate drinking water standards for those with private supplies. The Environmental Management Commission approved permanent rulemaking to reduce the allowable level of arsenic in groundwater from 0.05 mg/L (50 $\mu\text{g/L}$) to 0.00002 mg/L (0.02 $\mu\text{g/L}$) in September 1999. According to David Hance with the N.C. Groundwater Section, an economic analysis of the proposed standard is now being prepared, and the new standard may be sent to public hearing in late spring or early summer.

USGS Stream gaging program still struggling

Just a few years ago the stream gage—which provides streamflow information for flood forecasting, water quality modeling, and water use projections—was being called an endangered species (see *WRR I News* May/June 1998). Many stream gages operated by the U.S. Geological Survey were funded under a cooperative program in which USGS provides up to half the funds and cooperating state and local agencies provide the other half. About 30 percent of the stations were funded by other federal agencies. Beginning around 1989, federal agencies and state and local co-operators had shifted funds to other priorities and the number of stream gages had declined. At the same time, demand for streamflow information was increasing.

Because the USGS stream gaging network supports many public safety and environmental programs, the loss of gages alarmed USGS officials and other water resources professionals who took the issue to Congress. At the request of Congress, USGS developed a new plan for responding to the nation's need for streamflow information.

The new approach, which USGS has dubbed the National Streamflow Information Program (NSIP), calls for a federally funded base network of permanent core stream gages from which streamflow information can be delivered in real time, uncompromised by changing support from funding partners. Each gage in the base network will deliver real-time data and will be flood hardened to withstand the impact of a 200-year flood. In addition, rating curves (the relation between water level and streamflow) will be extended to include very low and very high stages for each stream gage location.

In addition to operating this core network, USGS will continue to work with partners to operate a cooperative network that would provide the breadth and depth of coverage needed by the user community.

Beyond the network itself, NSIP will provide intensive data collection in response to major floods and droughts;

periodic assessments and interpretation of streamflow data to better define statistical characteristics and trends; a system for real-time delivery of stream flow information to customers; and a program of research and development that takes advantage of new technology. Convenient and reliable access to all information products will be provided through the World Wide Web.

USGS has calculated that to meet the most important public needs for streamflow information, 439 new gages need to be installed, 876 need to be reactivated, and 278 need to be upgraded nationwide.

For two years in a row, the 106th Congress provided increases for the USGS stream gaging program. In its fiscal year 2001 Department of Interior appropriations bill, Congress included an increase of \$3.1 million for the Real-Time hazards initiative that supports stream gaging stations and related network activities and \$5 million for capital investments to improve the stream gaging network. This came on top of a \$2 million increase for the network in 2000. USGS says that fiscal year 2000 and 2001 increases have already allowed installation of 37 new gages, reactivation of 73, upgrading of 127, flood-hardening of 15, and development of rating curve extensions for 40. In addition, USGS will be able to provide full support for about 100 existing gages that are vital to the NSIP network.

In North Carolina, 15 new stream gaging sites have been proposed for the NSIP network. However, more than 20

existing gages are in imminent danger of being shut down in the Roanoke River Basin due to loss of cooperators. Ten are scheduled to be discontinued at the end of April. For information go to web address: <http://nc.water.usgs.gov/rt/html/roanoke.html>.

With the \$8.1 million 2001 increase, fiscal year 2001 expenditures for the stream gaging network were \$14.9 million. USGS has estimated that capital costs for fully implementing the envisioned network will be about \$64 million, and that annual operating costs for the network will be \$78 million a year. Obviously, large funding increases are needed to make the envisioned network a reality.

In March Steve Blanchard with USGS, said that while President Bush's budget had not yet been released, USGS did not expect to see any additional funding for the stream gaging network in the president's budget. [Indeed, Washington insiders say that USGS water programs are targeted for significant reductions, including elimination of the Water Resources Research Institute program, under the Bush budget.] However, Blanchard said, the 2000 and 2001 increases for the stream gaging network came from Congress and many of the same people responsible for those increases are still in place.

Information about the NSIP network, including maps of streamgaging locations, nationwide and in states can be found at <http://water.usgs.gov/nsip>.

The Interstate Council on Water Policy and the U.S. Geological Survey announce CENTRAL & SOUTHEASTERN STREAMGAGING WORKSHOPS

May 11, 2001 - St. Louis, MO, Wyndham Mayfair Hotel

May 24, 2001 - Orlando, FL, Rosen Plaza Hotel

These workshops are designed to bring together cooperators and users of USGS streamgaging information to examine the existing and potential gaging station network to critique the goals this network seeks to address and to delineate the appropriate responsibility for financially supporting components of this network.

There is no fee, but registration is requested. For information call Susan Gilson, Executive Director, ICWP, at 202/218-4133.

The Chlorophyll a standard: A primer

The North Carolina Administrative Code Section 15A NCAC 2B .0200 Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina contain the following standards:

.0211 Fresh Surface Water Classifications and Standards (3) (A) Chlorophyll a (corrected): not greater than 40 µg/L for lakes, reservoirs and other slow-moving waters not designated as trout waters, and not greater than 15 µg/L for lakes, reservoirs and other slow-moving water designated as trout waters (not applicable to lakes and reservoirs less than ten acres in surface area).

.0212 Tidal Salt Water Classifications and Standards (3) (A) Chlorophyll a (corrected): not greater than 40 µg/L in sounds, estuaries, and other slow-moving waters.

What is chlorophyll a?

The pigment chlorophyll is what allows plants—and algae—to convert water and carbon dioxide to organic compounds in the presence of light (photosynthesis). To enhance their ability to capture light at different wavelengths, algae have evolved several kinds of chlorophyll and accessory pigments, with chlorophyll a being the predominant kind. All plant cells have chlorophyll a. Chlorophyll d is found only in marine red algae. Chlorophylls b and c are found in fresh water.

Why measure chlorophyll a?

Water quality managers are really interested in measuring the amount of microscopic algae in waters. However, directly measuring algal biomass requires counting the numbers of different kinds of algal cells and estimating their volumes. This analysis is expensive and time-consuming. Studies in which algae have been measured directly have

consistently shown a strong statistical correlation between concentrations of chlorophyll a and algal biomass. Therefore, chlorophyll a is measured as a surrogate for algal biomass.

How much algae (and chlorophyll a) is too much?

The answer to this question depends upon how people expect to be able to use a river, lake, estuary, or other waterbody. If people expect to catch trout from a stream or lake, then high water clarity must be maintained, and water clarity decreases rapidly as algal biomass (and chlorophyll a concentrations) increase. Water clear enough for trout may also be suitable to for drinking without filtration (but with other treatment).

If, on the other hand, people want to catch bass from a stream or lake, then the waters must produce more food in the form of algae and the creatures that feed on algae. Because of higher levels of biomass, these waters will be more turbid than waters of a trout stream or lake. These waters will not be suitable for use as drinking water without filtration, and they may be subject to low oxygen in bottom water and to growth of nuisance plants such as water hyacinth. Such conditions are ideal for bass fishermen. However, others may not find these conditions charming, and, in terms of chlorophyll a, it may (depending on a number of factors) be only a short step from these conditions to a sharp decline in clarity, transition to species that cause algal scums, an increase in macrophyte problems, more frequent fishkills, and a public perception that the waters are not suitable for human contact.

How was North Carolina's chlorophyll a standard established?

In the early 1970s, the Chowan River Estuary and other waterbodies in the state experienced algae blooms that interfered with industrial water supply, fishing and recreational use. The (then)

N.C. Division of Environmental Management proposed a rule that would give the State the authority to limit nutrients in waterbodies where “excessive algae activity results in or is expected to result in interference with established water uses.” However, it was expected that this “narrative” standard might be difficult and resource-intensive to apply. Therefore, the State called on WRRI to convene a group of university and agency experts to advise the (then) Department of Natural and Economic Resources on a numeric standard for controlling algae.

After conducting a review of literature relating various levels of nutrient enrichment of water bodies to chlorophyll a concentrations, the Division of Environmental Management put before the group of experts a suggested standard of 50 µg/L for freshwater lakes and reservoirs, 20 µg/L for trout waters, and 100 µg/L for sounds, estuaries and other slow moving waters.

However, a study of nutrient enrichment of 69 North Carolina lakes completed by Dr. Charles M. Weiss and Dr. Edward J. Kuenzler of UNC-Chapel Hill under a WRRI grant suggested that the proposed standard might be too high for North Carolina waters. The Weiss/Kuenzler study showed that several trout water lakes in the state had growing season concentrations of less than 5 µg/L chlorophyll a. While admitting that the effect of allowing increased chlorophyll a levels in these trout lakes was unknown, the group settled on a standard of 15µg/L chlorophyll for trout lakes. The minutes of their meeting reflected that the group felt additional study of the standard for trout lakes should be conducted and that additional protection for these lakes beyond the chlorophyll a standard should be considered.

Based on results of the Weiss/Kuenzler study that correlated chlorophyll a concentrations with algal cell density reflective of various levels of enrichment, the group also concluded that 50 µg/L was too high for non-trout

waters. They settled on a number that, according to the Weiss/Kuenzler study, marked the point at which some lakes began to experience problems such as algal scums, growth of macrophytes, and episodes of low oxygen in bottom waters— 40 µg/L.

Dr. Donald Stanley, a member of the advisory group, related his observations that chlorophyll a concentrations exceeded 100 µg/L in the Pamlico Estuary during the winter with no observable problems.

The group also discussed considerations for applying the chlorophyll a standard: How should sampling be conducted and what should constitute a violation? Algae are often not evenly distributed over an area. Therefore if only one sample were required, it probably would not reflect average conditions across the entire area. Some experts felt that sampling should be conducted across a geometric grid and that the sampling mean should statistically significantly exceed the standard value to constitute a violation. It was recognized, however, that this approach would allow for exceedances of the 40 µg/L concentration in some areas of the water body. That raised the question of whether it is desirable to control chlorophyll a concentrations in all areas of a waterbody or to control only the average concentration.

How sampling should be done and what constitutes a violation were not addressed in the standard that was finally proposed. Following public hearings during which the only concern expressed was that the standard should not apply to small lakes such as farm ponds, the N.C. Environmental Management Commission adopted the following standard on August 9, 1979:

Chlorophyll a: not greater than 40 µg/l for lakes, sounds, estuaries, reservoirs, and other slow-moving waters not designated as trout waters, and not greater than 15 µg/l for lakes, reservoirs, and other slow-moving waters designated as

trout waters (not applicable during the months of December through March; not applicable to lakes and reservoirs less than 10 acres in surface area).

According to Boyd Devane with the N.C. Division of Water Quality, the December-March exclusion was dropped in 1989, presumably to enable the State to better address situations in which ill effects were observed throughout the year.

What constitutes a violation of the chlorophyll a standard?

The language of the chlorophyll a standard does not specify when exceedances of the 40 µg/L level are to be considered a violation of the standard. According to Devane, from the initial adoption of the standard, the Environmental Management Commission has not enforced single exceedances of the 40 µg/L concentration, as it might with other standards. Instead, it has used the chlorophyll a number as an indicator of when to expect water quality problems. The standard itself states:

The Commission or its designee may prohibit or limit any discharge of waste into surface waters if, in the opinion of the Director, the surface waters experience or the discharge would result in growths of microscopic or macroscopic vegetation such that the standards established pursuant to this Rule would be violated or the intended usage of the waters would be impaired."

Devane says that the expert committee that developed the original chlorophyll a standard considered it not a numerical threshold but a "good indication of when problems with over-enrichment were imminent or possible." He observes that since the chlorophyll a standard is now being used to set numerical total maximum daily loads

(TMDLs) and establish nutrient reduction targets, the standard could benefit from a modernized review conducted as part of the "Triennial Review" of water quality standards.

How is chlorophyll a measured?

While regulatory agencies and scientists follow methods prescribed by the American Public Health Association's *Standard Methods for the Examination of Water and Waste Water*, this reference offers a variety of options for measuring chlorophyll a. Different water body types and different situations require different methods.

Sampling may be done by "grabbing" one discrete sample at the desired depth (usually used if algae are thought to be evenly distributed throughout the water column) or by using one of several ways to get an integrated sample (used if algae are distributed unevenly either vertically or horizontally in the water column).

Once a sample is taken it must either be kept cool and dark and must be delivered to a lab within 24 hours, or it must be filtered and the filter preserved. When filtering is used, the volume filtered must be carefully measured and recorded. There are many decisions to be made about how to filter a sample and how to preserve it. Filtering requires skill and care.

Once a sample is in the lab, chlorophyll must be extracted from the algal cells into a solvent. Some algal species resist removal of all the pigment, and a number of solvents and methods have been developed to try to recover all chlorophyll.

Once chlorophyll has been extracted, measurement of chlorophyll a concentration may be done in one of three ways: spectrophotometrically, fluorometrically, or by high pressure liquid chromatography (HPLC).

HPLC is the only way to completely separate all the different chlorophyll pigments and quantify each individually.

continued next page

WRRR report available

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

Data Collection to Support a Simplified Bacterial Regrowth Model for Distribution Systems Report No. 331 February 2001

Francis A. DiGiano, Weidong Zhang, Donald E. Francisco, and Melissa Wood
Department of Environmental Sciences and Engineering, UNC-Chapel Hill

Many studies have shown that water quality deteriorates within drinking water distribution systems. Several studies have shown that people drinking conventionally treated tap water that complies with all drinking water standards are significantly more likely to develop gastro-intestinal illness than people who drink water treated by reverse osmosis.

The most well documented water quality problem in distribution systems is regrowth of bacteria. Bacterial regrowth has been associated with the likelihood of waterborne illness, enhanced pipe

corrosion, and taste and odor problems. The presence of biodegradable organic matter in finished water is a key factor in regrowth. Urbanization leading to stormwater runoff from paved areas and sequential use and return of waters to rivers increase the absolute mass of biodegradable organic matter in source waters. Unless water treatment plants include a process for removing biodegradable organic matter (which is not yet common practice), then there is greater potential for bacterial regrowth in drinking water distribution systems.

In addition, urbanization leads to an increase in the water service area and greater complexity in operation of the distribution system. The result is often an increase in water residence time and a reduction in disinfectant residual at some locations. With less disinfectant residual, bacterial regrowth is likely to increase.

The growth of free bacteria in distribution networks cannot be explained solely by the multiplication of cells in bulk water during residence. Free bacteria most likely originate instead from biofilm on surfaces of pipes. The relatively rough surface of the pipe wall encourages attachment of cells and provides protection from the action of disinfectant. Moreover, the disinfectant may be chemically reduced near the surface due to reactions with the pipe material.

Some fraction of attached bacteria is susceptible to detachment both because of their physiological state and the shearing action of water moving through the distribution system. Once released, bacteria are exposed to disinfectant. However, disinfectant action can be quite slow—especially when the residual disinfectant concentration is low—and detached bacteria could survive for long distances in the distribution system.

The cause and effect relationship between bacterial regrowth and water quality parameters has not been well established because many interdependent variables are involved. However, distribution system hydrodynamics, mean residence time, temperature, pipe materials, the amount of utilizable carbon

Chlorophyll a primer *continued*

However, HPLC is expensive and time-consuming.

Most labs use either spectrophotometry or fluorometry. Spectrophotometry measures the amount of light absorbance at specific wavelengths and must be sensitive in the red and far-red wavelengths to detect chlorophyll a adequately. Fluorometry measures the amount of light emitted at a particular wavelength upon exposure to light at a different wavelength. Fluorometry is 10 to 100 times more sensitive than spectrophotometry; however, the fluorometer must be calibrated against a spectrophotometer and is subject to interferences from other pigments and other interferences. In fact, neither spectrophotometry or fluorometry produces a highly accurate measure of chlorophyll a because of interferences from other pigments, including breakdown products from “dead” chlorophylls.

No method of measuring chlorophyll a accounts for all sources of interference or variation. Every method addresses some interferences but ignores others.

For this reason some experts support the reporting of “total chlorophyll pigments.” Reporting total chlorophyll gets rid of the interference problem. Moreover comparisons of total chlorophyll with chlorophyll a show strong statistical correlations.

References

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- Godfrey, Paul and Jeff Schloss. 2000. “Chlorophyll Methods: Let Me Count the Ways . . .” *Volunteer Monitor* Fall '00.
- McGhee, R.F. ND. “Experiences in Developing a Chlorophyll a Standard in the Southeast for the Purpose of Protecting Lakes, Reservoirs and Estuaries.” Unpublished.
- Weiss, Charles M. And Edward J. Kuenzler. 1976. *The Trophic State of North Carolina Lakes*. Report No. 119 of The University of North Carolina Water Resources Research Institute. Raleigh, NC.

for substrate, inactivation rate by disinfectants, and choice of disinfectant have been identified as important.

Efforts to elucidate the causes of bacterial regrowth and predict regrowth in distribution systems have typically involved collection of field data and statistical interpretation of the data. However, this approach is limited by the low frequency of sampling and the low number of sampling sites, both of which are restricted by cost.

The alternative to a field-based approach is to develop a deterministic mathematical model for prediction of bacterial regrowth. This research project was an intermediate step toward the long-term goal of developing such a model.

Several models for predicting bacterial regrowth exist. However they all include mathematical descriptions of sub components that affect the concentration of bacteria in water that are far too detailed for the current knowledge of microbial processes. Investigators on this study seek to develop a simplified model that includes a stochastic element to account for the uncertainty in mechanistic descriptions of various components (such as bacterial growth, detachment and disinfection rates). The eventual goal is to calibrate and verify such a model with water quality data from both the Durham and Raleigh distribution systems.

The first objective of this research was to add a year of data to databases for each system developed from 15 months of sampling in a previous project. The parameters included were total organic carbon, biodegradable dissolved organic carbon (BDOC), disinfectant concentration (free or combined chlorine) bulk water disinfectant demand, heterotrophic plate count (HPC—indicative of bacteria growth), and temperature.

The second objective was to conduct a tracer test in the Durham distribution system to determine not only the mean water residence time but also the fraction of water reaching each station from each of two water treatment plants. The water quality results together with mean residence time measurements will allow

for development of a simplified bacterial regrowth model for the distribution system.

The final objective was to review existing bacterial regrowth models and from this review to decide upon simplifications of the mechanistic description that are consistent with the current understanding of the processes to be modeled.

Field measurements from September 1998 through August of 1999 confirmed previous findings that elevated HPC occurs at stations with low free or combined chlorine concentrations and that low residual concentrations are associated with long mean residence time. Although BDOC was less than 0.5 mg/L, it was sufficient to produce regrowth at stations with low disinfectant residual.

A mechanistic model of regrowth was developed for a long section of pipe of a fixed diameter under steady-state flow conditions. The model included bacterial growth and attachment to the pipe wall, subsequent bacterial detachment, and chlorine inactivation of bacteria in bulk solution. The model showed that regrowth is very sensitive to the free chlorine dosage in finished water. Decreasing the chlorine dosage from 0.7 to 0.5 mg/L increased the HPC by several orders of magnitude. Once a biofilm was established on the pipe, neither increasing the chlorine dosage nor decreasing the BDOC in the finished water reduced regrowth substantially over 100 hours of simulation.

The authors say that their research shows that bacterial regrowth is more likely to be seen at locations with long water residence time. They say that while this is probably the result of a net accumulation to these points in the distribution system, residence time is still a key factor determining the extent to which bacteria can regrow because it determines the extent to which disinfectant residual is depleted. They say more information is needed on the variation of residence time at any location. Variability in residence time can be examined by seasonal tracer tests and by a hydraulic model of the distribution system. They

say their proposed bacterial regrowth model needs to be interfaced with a hydraulic model to produce a practical tool to assess the spatial and temporal variation in regrowth.

Publications

The Center for Transportation and the Environment has posted pdf versions of a number of final project reports on its website, including:

Assessment of Highway Impacts on Ecological Function in Palustrine Forested Wetlands in the Upper Coastal Plain of North Carolina (1977) <http://www.itre.ncsu.edu/cte/nunnery-richardson1997.PDF>

Development of Guidelines for Restoration of Forested Wetlands in North Carolina (1997) <http://www.itre.ncsu.edu/cte/shear1997.PDF>

Economic Analyses of and Institutional Mechanisms for Wetlands Mitigation and Banking in North Carolina (1998) http://www.itre.ncsu.edu/cte/rip_wetlands.html#cubbageabt (pdf document in three parts at this address)

Environmental Compliance Costs: Where the Rubber Meets the Road (1997) <http://www.itre.ncsu.edu/cte/smith1997.PDF>

Low Light as a Possible Impediment to River Herring Migration (1999) <http://www.itre.ncsu.edu/cte/moser.pdf>

The U.S. EPA has announced availability of the *Stressor Identification Guidance Document (EPA 822-B-00-025)*, which is designed to assist water quality managers in identifying unknown causes of biological impairments in any type of water body. This guidance will also help investigators identify where evidence is weak or lacking and needs to be developed to be able to successfully identify the stressors. Copies of the document may be obtained from the U.S. EPA National Center for Environmental

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

Following are some environment-related bills introduced in the N.C. General Assembly as of March 16. For details of the bills, visit the General Assembly website: <http://www.ncga.state.nc.us/>.

- H 219 AN ACT TO APPROPRIATE FUNDS FOR ENVIRONMENTAL ASSISTANCE FOR FARMERS. Appropriates from the General Fund to the Department of Agriculture and Consumer Services \$688,969 for the 2001-2002 fiscal year and \$603,369 for the 2002-2003 fiscal year for assistance to farmers in evaluation of the impact of environmental regulations on agriculture.
- H 308 AN ACT TO PROVIDE FOR FAIR GEOGRAPHIC REPRESENTATION IN APPOINTING MEMBERS TO THE ENVIRONMENTAL MANAGEMENT COMMISSION.
- H 326 AN ACT TO AMEND THE LAW RELATING TO THE CERTIFICATION OF WELL CONTRACTORS. Prohibits offers and work by uncertified contractors. Shortens time for certificate renewal to 30 days and requires Well Contractors Certification Commission to refuse to issue certificates to applicants who have not paid penalties assessed against them, have not completed restoration work on past violations, or have a history of significant noncompliance. Raises maximum civil penalty to \$5,000.
- H 418 AN ACT TO ACKNOWLEDGE STATE POLICY THAT BEACH PRESERVATION AND RESTORATION ARE IN THE PUBLIC INTEREST AND THAT WHERE ECONOMICALLY AND ENVIRONMENTALLY JUSTIFIED BEACH PRESERVATION AND RESTORATION CONSTITUTE A PUBLIC PURPOSE, TO ESTABLISH THE NORTH CAROLINA BEACH PRESERVATION AND RESTORATION COMMISSION, TO ESTABLISH THE BEACH PRESERVATION AND RESTORATION FUND, AND TO APPROPRIATE FUNDS TO THE BEACH PRESERVATION AND RESTORATION FUND.
- H 570 AN ACT TO DISAPPROVE THE AMENDMENTS TO THE ADMINISTRATIVE RULE ENTITLED "TAR-PAMLICO RIVER BASIN-NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY: AGRICULTURAL NUTRIENT CONTROL STRATEGY.
- H 609 AN ACT TO DISAPPROVE THE AMENDMENTS TO THE ADMINISTRATIVE RULE ENTITLED "STANDARDS OF CONSTRUCTION: WATER-SUPPLY WELLS" ADOPTED BY THE ENVIRONMENTAL MANAGEMENT COMMISSION.
- H 612 AN ACT TO DISAPPROVE THE ADMINISTRATIVE RULE RECLASSIFICATION BY THE ENVIRONMENTAL MANAGEMENT COMMISSION OF CERTAIN WATERS IN THE NEUSE RIVER BASIN BELOW FALLS LAKE DAM THAT WOULD HAVE THE EFFECT OF ALLOWING THE TOWN OF WAKE FOREST TO WITHDRAW ADDITIONAL WATER FROM THE NEUSE RIVER.
- S 32 AN ACT TO INCLUDE BEACH NOURISHMENT AND BEACH MANAGEMENT PRACTICES AS PURPOSES FOR WHICH GRANTS MAY BE MADE FROM THE CLEAN WATER MANAGEMENT TRUST FUND.
- S 202 AN ACT TO AMEND THE PROCESS BY WHICH FISHERY MANAGEMENT PLANS ARE REVISED, AS RECOMMENDED BY THE JOINT LEGISLATIVE COMMISSION ON SEAFOOD AND AQUACULTURE.
- S 203 AN ACT TO RAISE THE CAP ON THE AMOUNT OF FUNDS THAT MAY BE USED TO ADMINISTER THE FISHERIES RESOURCE GRANT PROGRAM, AS RECOMMENDED BY THE JOINT LEGISLATIVE COMMISSION ON SEAFOOD AND AQUACULTURE.
- S 204 AN ACT TO REPEAL THE SUNSETS ON THE LICENSING PROVISIONS OF THE FISHERIES REFORM ACT OF 1997 AND THE MARINE FISHERIES AMENDMENTS OF 1998 AND TO EXTEND THE MORATORIUM ON ISSUING NEW SHELLFISH LEASES IN CORE SOUND BY ONE YEAR TO OCTOBER 1, 2002, AS RECOMMENDED BY THE JOINT LEGISLATIVE COMMISSION ON SEAFOOD AND AQUACULTURE.
- S 205 AN ACT TO STAGGER THE TERMS OF THE MEMBERS OF THE MARINE FISHERIES COMMISSION, AS RECOMMENDED BY THE JOINT LEGISLATIVE COMMISSION ON SEAFOOD AND AQUACULTURE.
- S 216 AN ACT TO APPROPRIATE FUNDS FOR THE CAPITAL AND OPERATIONAL COSTS OF ESTABLISHING THE MOUNTAIN ISLAND EDUCATIONAL STATE FOREST TO BE LOCATED IN LINCOLN AND GASTON COUNTIES.
- S 265 AN ACT TO AMEND THE LAWS REGARDING NONHAZARDOUS SOLID WASTE MANAGEMENT BY PROHIBITING THE DEPARTMENT OF TRANSPORTATION FROM BURNING YARD TRASH AND OTHER ORGANIC SOLID WASTE IN HIGHWAY CONSTRUCTION AND MAINTENANCE PROJECTS AND REQUIRING THE DEPARTMENT OF TRANSPORTATION TO RECYCLE OR REUSE THIS WASTE.

Publications and Information, 11029 Kenwood Road, Cincinnati, OH 45242 or (513) 489-8190. The document and a fact sheet are available on the EPA Website: <http://www.epa.gov/OST/biocriteria>

A workshop on Source Emission and Ambient Air Monitoring of Mercury was held in 1999. The workshop was sponsored by the U.S. Environmental Protection Agency and was conducted in collaboration with the Air and Waste Management Association (AWMA) International Specialty Conference on Mercury in the Environment. The purpose of the workshop was to discuss the state-of-the-science in source and ambient air mercury monitoring as well as mercury monitoring research and development needs. The workshop summary, *Workshop on Source Emission and Ambient Air Monitoring of Mercury (EPA/625/R-00/002)*, is now available. It may be ordered online at: <http://www.epa.gov/ttbnrml/Sumreps.htm>.

The U.S. Geological Survey has recently published *Investigation of ground-water availability and quality in Orange County, North Carolina (USGS WRI Report 00-42860)* by W.L. Cunningham and C.C. Daniel, III. A countywide inventory was conducted of 649 wells in nine hydrogeologic units in Orange County, NC. Estimates of ground-water availability and use were calculated and water-quality results were obtained from 51 wells sampled throughout the county from December 1998 - January 1999. The report is available from Kay Hedrick at (919) 571-4037 or khedrick@usgs.gov.

The U.S. EPA has announced availability of the draft **National Coastal Condition Report**. The report compiles several available data sets from different agencies and areas of the country and summarizes them to present a broad baseline picture of the condition of coastal waters. Go to website: <http://www.epa.gov/owow/oceans/cwap/index.html>

People

Dr. Viney P. Aneja of the NC State University Department of Marine, Earth, and Atmospheric Sciences has been selected to serve on the USDA/Natural Resources Conservation Service Task Force on Agricultural Air Quality. The task force provides advice and counsel to the Secretary of Agriculture on issues related to air quality and agriculture.

Lisa Martin has left her position as Executive Director of the Upper Neuse River Basin Association to become Director of Regulatory Affairs for the N.C. Home Builders Association.

Sherri Evans-Stanton has announced that she will leave her position as Deputy Secretary of the N.C. Department of Environment and Natural Resources to move with her family to Michigan.

Dr. David McNaught has joined Environmental Defense as a senior policy analyst for water quality issues in North Carolina and the Southeast. McNaught was formerly executive director of the N.C. Clean Water Management Trust Fund. He also served as executive director of the Pamlico-Tar River Foundation and on the N.C. Coastal Resources Commission.

Dr. Wendell Gilliam is retiring from the NC State Soil Science Department after 36 years of teaching and research. A William Neal Reynolds Professor, Gilliam is well known for his expertise on effectiveness of riparian wetlands and other vegetative filters for improving quality of agricultural drainage waters. He currently serves on the N.C. Sedimentation Control Commission.

NC Manure Management: 2001 and Beyond

April 12, 2001
Jane S. McKimmon Center
Raleigh, NC

This is a one-day conference to educate livestock and poultry producers, the N.C. Agri-businesses and the public of several issues that will affect animal operations for at least the next decade. Researchers and EPA personnel will present new information on

- # Statewide Manure/Nutrient Management
- # EPA's Proposed CAFO rules
- # Phosphorus Management
- # Environmentally Superior Technologies.

Conference fee of \$20 is payable at the door and covers lunch, breaks, and educational materials. Bring checks made payable to NCSU. Registration is due by April 10.

Register by phone, fax, or email: Kristel Page, NCSU Department of Biological and Agricultural Engineering, Phone: 919-515-2694; Fax: 919-515-6719; Email kjpage@unity.ncsu.edu

For more information contact Ron Sheffield, NCSU Department of Biological and Agricultural Engineering at 919-515-6784.

Drought persists in western North Carolina

The North Carolina Drought Monitoring Council report for March 5 said that extreme drought conditions persist over the western third of North Carolina and that numerous water systems in western North Carolina are still dealing with below normal water supplies. Mandatory water use restrictions are in effect for customers in Kannapolis, Concord, Harrisburg, Landis, China Grove and Clay County.

The council said that only limited improvements in water supply conditions may occur over the next several months and that water systems whose reservoirs do not refill by April are advised to plan for limited water supplies during the summer months.

On March 13, the U.S. Department of Agriculture declared 28 counties in central and western North Carolina disaster areas.

The U.S. Climate Prediction Center's report for March 15 said that while March storms brought some relief to drought areas in the Southeast, much more rain is needed. The center said that December 2000 - February 2001 was the second driest on record in North Carolina. Precipitation totals for May 1998 - February 2001 generally ranged from 2 to 4 feet below normal in all but the northern and southern fringes of the Southeast.

The Climate Prediction Center said that mature cold episode (La Niña) conditions continued in the tropical Pacific during February, as sea surface temperatures remained well below normal across the central equatorial Pacific. The center said that cold episode conditions are expected to gradually weaken throughout spring 2001 with near-normal conditions returning to the tropical Pacific during the summer. Cold episode conditions have influenced North Carolina's weather since 1998, bringing below normal precipitation except for that associated with increased hurricane activity.

In the Southeast, the weather service is forecasting a warm and relatively dry spring. Mid to late March rains and season rains, which usually return by June, could provide some relief, but long term deficits will likely continue to impact water supplies.

Water Conservation help available

To help homeowners and water systems deal with drought conditions, the N.C. Division of Water Resources has prepared a webpage that provides advice for water systems on conservation plans and drought ordinances. Also provided are links to EPA's water conservation guidelines and other helpful links. Go to:

North Carolina Precipitation/Water Resources

	January	February
Rainfall (+/- average)		
Asheville	2.63" (-0.62")	2.73" (-1.18")
Charlotte	1.87" (-1.84")	2.19" (-1.65")
Greensboro	2.53" (-0.64")	2.51" (-0.81")
Raleigh	1.30" (-2.18")	2.34" (-1.35")
Wilmington	0.68" (-3.19")	2.28" (-1.42")
Streamflow		
Index Station (County, Basin)	January mean flow (CFS) (% of long-term median)	February mean flow (CFS) (% of long-term median)
Valley River at Tomotla (Cherokee, Hiwassee)	221 (60%)	338 (82%)
Oconaluftee River at Birdtown (Swain, Tenn)	444 (68%)	626 (85%)
French Broad River at Asheville (Buncombe, FB)	1,240 (55%)	1,259 (50%)
South Fork New near Jefferson (Ashe, New)	234 (52%)	188 (34%)
Elk Creek at Elkville (Wilkes, Yadkin/Pee-Dee)	30.7 (36%)	25.0 (24%)
Fisher River near Copeland (Surry, Yadkin/Pee-Dee)	89.6 (50%)	80.2 (40%)
South Yadkin River near Mocksville (Rowan, Yadkin/PD)	135 (35%)	149 (31%)
Rocky River near Norwood (Stanly, Yadkin/Pee-Dee)	288 (10%)	574 (17%)
Deep River near Moncure (Lee, Cape Fear)	246 (11%)	667 (22%)
Black River near Tomahawk (Sampson, Cape Fear)	403 (30%)	502 (37%)
Trent River near Trenton (Jones, Neuse)	58.2 (18%)	132 (34%)
Lumber River near Boardman (Robeson, Lumber)	777 (40%)	898 (39%)
Little Fishing Creek near White Oak (Halifax, Pamlico)	92.7 (39%)	161 (52%)
Potecasi Creek near Union (Hertford, Chowan)	102 (24%)	199 (38%)
Groundwater		
Index well (Province)	January depth below surface (ft) (departure from average for month)	February depth below surface (ft) (departure from average for month)
Blantyre (Blue Ridge)	38.63 (-5.95)	37.45 (-5.74)
Mocksville (Piedmont)	20.51 (-4.16)	20.12 (-4.27)
Simpson (Coastal Plain)	3.85 (-0.78)	3.23 (-0.22)

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

http://www.dwr.ehnr.state.nc.us/wsas/conserve/wc_main.htm.

Homeowners or others interested in water conserving landscaping can access online the publication *Xeriscape North Carolina* prepared by WRRI for the North Carolina Urban Water Consortium. Go to web address: <http://www2.ncsu.edu/ncsu/CIL/WRRI/uwc/publications.html>. The document is available in both html and pdf formats.

Websites

PubSCIENCE., sponsored by the U.S. Department of Energy's Office of Scientific and Technical Information and the U.S. Government Printing Office, is a free service that allows searching across a large compendium of peer-reviewed journals in the physical sciences and energy-related disciplines. PubSCIENCE is available at <http://pubsci.osti.gov>.

Conferences and workshops

Save Our State will hold its second forum of 2001 on **coastal issues** on Friday, May 18, at the Wilmington Hilton in Wilmington, NC. Topics to be covered include coastal geology, water quality, fisheries, beach renourishment and coastal economics. Early registration (before May 4) is \$40 for members and \$50 for nonmembers. Cost increases \$10 after May 4. Registration fee includes continental breakfast and lunch. To register please call Diana Dimsdale at 919-839-2111 or send an email to info@sosnc.org.

The NC State University Department of Forestry's Forestry Educational Outreach Program will present **Delineation of Piedmont and Coastal Plain Jurisdictional Wetlands: Indoor and Field Training for Foresters, Engineers and Landscape Architects** May 21-25, 2001, at the Brownstone Hotel in Raleigh and the Craven County Extension

2000-2001 Water Resources Research Seminar Series

Presentations take place 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. This schedule is also posted on the WRRI website, and any changes will be posted there (<http://www2.ncsu.edu/ncsu/CIL/WRRI/2000seminars.html>). For additional information contact Associate Director Robert Holman at (919) 515-2815 or Robert_Holman@ncsu.edu.

Presentations begin at 3 pm.

Tuesday, March 27, 2001

Jordan Hall

Assessment of Changing Land-use Practices on Basin Sediment Yields

Professor Jerry Miller

Department of Geosciences
Western Carolina University

Tuesday, April 24, 2001

Archdale Building

A Comparative Analysis of Compact and Low-Density Development

Associate Professor Philip Berke

Department of City and Regional Planning, UNC-Chapel Hill

Tuesday, May 22, 2001

Jordan Hall

Technical and Economic Evaluation of Alternative Animal Waste Management

Professor Michael Overcash

Department of Chemical Engineering N.C. State University

Facility in New Bern, NC. Accreditation units will be offered for foresters, engineers, and landscape architects. Registration fee is \$775 and includes materials, all lunches, breaks and field trip transportation. Registration deadline is May 14, 2001. A brochure with registration form in pdf format can be downloaded from the WRRI website at: <http://www2.ncsu.edu/ncsu/CIL/WRRI/wetlands.pdf>. For other information contact Susan Moore at (919) 515-3184 or susan_moore@ncsu.edu.

The NC State University Department of Soil Science is offering a **two-part fundamentals of hydrogeology course**. Fundamentals of Hydrogeology Part I: Principles and Practice will be taught June 18-20, 2001, and Part II: Applied Ground-Water Hydraulics will be taught June 20-22, 2001, at the Jane S. McKimmon Center in Raleigh. For information go to website: www.soil.ncsu.edu/training or contact Joni Tanner at (919) 513-1678 or joni_tanner@ncsu.edu.

The U.S. Environmental Protection Agency will present **Workshop on the Fate, Transport, and Transformation of Mercury in Aquatic and Terrestrial Environments** May 8-10, 2001, at West Palm Beach, Florida. For information visit website: <http://www.epa.gov/ttbnrml/hgfate2.htm>.

Listserv for onsite wastewater treatment issues

"Decentralized" is a national listserv hosted by the U.S. EPA for those who wish to discuss onsite/ decentralized wastewater treatment systems and management issues. Membership is open to the public. To subscribe, send an email message to: listserv@unixmail.rtpnc.epa.gov. In the body of the message write: subscribe decentralized your-first-name your-last-name. Leave the subject and cc lines of the message blank.

N.C. Sea Grant
NCSU Stream Restoration Institute
N.C. Cooperative Extension Service
announce

**Stream Repair and Restoration:
A Focus on the Urban Environment**

October 16-19, 2001
Jane S. McKimmon Center
Raleigh, NC

For information visit website:
www5.bae.ncsu.edu/programs/extension/wqg/sri

Registration information will be provided
on the website in May

Announcing workshops on
**Conservation Easements and
Other Land Preservation Techniques**

May 16, 2001
Carthage, NC

June 6, 2001
Greensboro, NC

For information visit website:
[http://www2.ncsu.edu:8010/unity/lockers/
project/waterprimer/
coneasementworkshops/](http://www2.ncsu.edu:8010/unity/lockers/project/waterprimer/coneasementworkshops/)

Sponsored by
N.C. Cooperative Extension Service
N.C. Division of Soil and Water Conservation
Conservation Trust for North Carolina
and others



2000 - 2001 Luncheon and Forum Schedule

April 9, 2001	Dam Removals in North Carolina
September 17, 2001	On-Site Wastewater Issues
December 3, 2001	Flood Plain Management

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

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