2013 WRRI Annual Conference explores nutrient trading, the energy-water-security connection and a multitude of recent research projects

by Jeri Gray and Rhett Register

This year’s annual conference offered two days of advanced learning opportunities for professionals and students in the water community: More than 60 oral research presentations, twenty-seven entries in the NCWRA’s student poster competition, a new high school art competition, the NCWRA symposium on nutrient trading, and the Progress Energy Seminar featuring a distinguished panel discussion of the connection between water, energy, and security. Highlights of the conference are presented here and on pages 2-10.

Keynote: Trevor Clements, Water Resources Director at Tetra Tech, gave the conference keynote address entitled, “Integrated and Transdisciplinary Water Resources Research and Management.” In it, Clements spoke about a growing disconnection between science and policy and suggested ways in which water professionals can help to bridge the divide.

Clements defined the triple bottom line as, “a strong and prosperous economy, a healthy environment, and a high quality of life that includes addressing things like social justice and other elements.”

He used green infrastructure as an example.

“When you talk to folks that have to implement MS4 programs and they are being driven by a TMDL implementation program that requires a specific credit toward reducing pollutant loads,” he said, “they’re going to focus on the things that are easy, at hand and that they get a credit for in terms of pollutant reduction.”

“The majority of them will tell you they are building wet ponds to reduce the pollutant load. They’ll tell you that green infrastructure is just simply not cost effective.”

“Well that all makes sense in a siloed approach, in a status quo approach to things,” he continued. “But it doesn’t make sense in moving us towards a triple bottom line. It doesn’t make sense toward us really looking at making a better community and building resilience. How does...continued on page 2
Science writer and editor Rhett Register recently joined the North Carolina Water Resources Research Institute. His duties also include writing for North Carolina Sea Grant’s Coastwatch magazine.

“We were lucky to find someone like Rhett with a strong background in science, policy and writing who also has the capacity to cover the range of issues—from the mountains to the coast—that our state and WRRI must contend with,” says Nicole Wilkinson, Coordinator for Research and Outreach at WRRI. “Most people specialize in either freshwater or saltwater, so Rhett’s diversity makes him a great fit for this position that we share with NC Sea Grant,” she adds.

Register credits his birthplace, Jacksonville, Fla., for marking him with an early love for watery environments, with its easy access to beaches, rivers and springs. He has a background in writing about coastal planning and water resource issues.

“Working with WRRI and NC Sea Grant has allowed me to combine my love for the aquatic environment with my interest in writing and communications,” Register says.

Prior to joining WRRI, Register worked as a researcher with National Geographic magazine and at National Geographic Traveler, researching and covering topics as varied as the American Civil War and marine protected areas. He also has worked with Oregon Sea Grant and a community newspaper. He has taught English, including three years in Japan.

Register holds an undergraduate degree in English from the University of North Florida, and a master’s degree from the marine resource management, or MRM, program at Oregon State University.

He lives in Raleigh with his wife and son.
This year’s Progress Energy Seminar was held in conjunction with the Triangle Institute for Security Studies and the NCSU Energy and Security Initiative. It was organized to spread the message that water and energy are interlocking pieces of the foundation of secure societies and that countries ignore this interdependence at their own peril.

Leadoff speaker Steven Solomon evoked an image that could be emblematic of the United States’ lack of attention to the water-energy connection: A constant caravan of 8,000-gallon tanker trucks hauling increasingly scarce freshwater into booming shale oil and gas fields to supply the 2 to 4 million gallons needed for each shale well.

Solomon is author of *Water: The Epic Struggle for Wealth, Power and Civilization*. He warned that the nation’s growing demand for energy, together with the higher ratio of water-to-energy needed to develop alternative energy sources—including shale and most renewables—will create increasingly intense competition for water. He said that unless the country finds the political will to adopt a new paradigm of water efficiency and protection of freshwater ecosystems, this competition could drive up the cost of both energy and water and prevent the country from reaching its goal of energy independence.

Solomon said that the elected leaders of the nation were warned about this water-energy relationship in a U.S. Department of Energy report prepared by Sandia National Laboratories at the request of Congress and delivered in 2006. He said that the report was supposed to be followed by a “roadmap” for addressing energy-water issues but that the draft has “wallowed in bureaucratic limbo” for seven years and its fate is “an inside-the-beltline mystery.”

Moreover, Solomon said, limits to energy production imposed by water scarcity at home is only one threat to U.S. national security. Global water scarcity is creating a world of water haves and have-nots, and since water scarcity translates to food scarcity, more than 3 billion people now live in countries that may not be able to feed themselves within 15 years.

“If you look behind the headlines,” he said, “you will find that many regional conflicts, indeed the Arab Spring, were triggered by food price spikes. A crucial lesson from this is that water is not a standalone crisis. Water scarcity, food shortages, energy shortages and climate change are all intertwined, and the greatest danger to our security from this collision of crises is that states brought down by domestic unrest will become breeding grounds for terrorists.”

Other speakers presented startling insights into water/energy/security problems in other countries.

Thomas Lippman, author of *Saudi Arabia on the Edge*, said that the desert country is devoting an increasingly large share of its oil to produce electricity for desalination plants that must meet per capita water demand that is the third highest in the world.

“Because there is a water shortage in Saudi Arabia, there is an energy shortage,” Lippman said. He said that so much of Saudi Arabia’s oil is needed to power desalination plants and to provide feedstock for its important petrochemical industry, that the country is slipping in its oil export position.

continued on page 4
WRRI inaugurates water resources high school student art competition

Part of the 2013 WRRI Annual Conference was a display of art created by high school students to portray a water resource issue and solution to the issue. Students at JF Webb, Granville Central and South Granville schools entered their art in the first annual Water Resources High School Student Art competition organized by Nicole Wilkinson of WRRI and Teresa Baker, Recycling Coordinator for Granville County Schools. Winner of the first competition was Karla Rodriguez of Granville Central High School. Her creation “Water for the Next Generation” will be featured as cover art for the 2014 WRRI Annual Conference binder. Second place winner was Hayley McClure of South Granville High School. Logan Bradshaw of South Granville took third place.

Progress Energy continued from page 3

According to Keith Schneider, the conflict between energy and water is “equally perilous in China.” Schneider is editor of the online network, Circle of Blue. In China, the government’s ambition to become the 21st century’s greatest economic power, based largely on mining and burning of coal, is sucking water out of the agricultural sector charged with providing food for 1.3 billion people. In 1980, China’s agricultural sector used about 85% of the country’s total available water supply. By 2009, agriculture’s share was down to 63%, and its share is expected to drop to 51% by 2030.

Paul Faeth, senior fellow at the Center for Naval Analyses, pointed out another policy disconnect that threatens water/energy/food security at home and across the world. He said that production of biofuels for vehicles—whose use is mandated in the United States and Europe—uses more water than production of conventional gasoline, and that 36 percent of the global increase in grain prices over the last five years can be attributed to the diversion of corn for production of biofuels.

David Schlobohm of the NCSU College of Engineering said that North Carolina, indeed the nation, needs an integrated water/energy/security policy in which it is understood that energy shares available water resources with other uses. He noted that the ability of governments to develop water use priorities and to allocate water to uses is essential to the efficient use of water, which is becoming increasingly important to national security.
ers should be allowed to aggregate and market nonpoint source reductions from agriculture and possibly urban runoff. Aggregation would create an economy of scale, he said. Next, best management practices should be in tested, approved broad categories that could be applied relatively easily to most nonpoint source reductions. Finally, Flatt said, there should be an insurance or set-aside in reserve for market failures or failures of the offsets.

Rich Gannon, who as Nonpoint Source Program Supervisor with the North Carolina Division of Water Quality helped create North Carolina’s nutrient strategies, echoed the challenges that Flatt mentioned and added a few.

Gannon suggested modifying the riparian buffer credit system, allowing an umbrella trading rule, and looking for ways of ensuring the forever nature of credits. He also called for more information.

“The science, the numbers to support loads coming from different land uses and land sources, and load reductions coming from various measures, both existing and emerging, is what we are in the greatest need of,” he said.

“Despite the challenges,” Gannon said, “We think trading is useful for improving cost effectiveness and efficiency of reductions,” he said.

Glenn Dunn, legal counsel for the Neuse River Compliance Association (NCRA) spoke about point source discharges on the Neuse River formed a compliance group to meet limitations on nitrogen discharge into the Neuse.

Through incentives and trading within the group, the Association has been able to stay well below its NPDES-allowed nitrogen discharge allocation limit. In 2012, that amount, arrived at by summing the total of each member’s allocation, was 1,184,165 pounds. In 2011, the group delivered less than half that amount—519,199 pounds—to the Neuse River estuary.

“The power of association may be the transferrable lesson from what has happened here,” Dunn said. “I watched wastewater plant operators sit down and talk to each other about how they can run their plants better and I saw the peer pressure to do better. That has had a lot to do with why this association has reduced its nitrogen as much as it has.”

Anne Coan, Director of Environmental Affairs for the North Carolina Farm Bureau Federation, cautioned that while agriculture is seen as the go-to credit source for trades because it is comparatively inexpensive and is common in many watersheds, farmers may be unwilling to participate. She said the creation of credits would involve a land transaction—either creating a permanent easement or selling the land in fee simple—and many farmers are not willing to break up the farm.

She also questioned the availability of agricultural land for generating credits.

“I think nearly 75 percent in the Falls Lake region is already buffered,” she said. “The big surprise may be that there is not a lot of agricultural land available.”

Dan Jewell, a landscape architect and president of Coulter Jewell Thames, PA, said that nutrient trading needs to become viable for North Carolina cities to grow efficiently. Raleigh is the fastest growing metropolitan statistical area in America according to recent census count, he said. In the next twenty years it is estimated that 1.2 million people will move here. Jewell said a nutrient offset program can help the area choose a more urban pattern of growth—one focused in areas that can support growth—rather than continuing the pattern of suburban sprawl.

He said that achieving urban nutrient reductions onsite in high-density urban areas is nearly impossible, but with nutrient offsets, cities can build denser in some areas and less dense in other areas.

Maggie Monast of the Environmental Defense Fund said that North Carolina is generating some important lessons about nutrient credit trading. These include, she said, showing the need for good science on nutrient loads and reductions and other ecosystem services, the need for finding ways to incorporate that science into trading structures (reduction goal, baselines, crediting procedures), and the need to avoid conflicts between different parts of the same strategy.
The first place $200 award in the NCWRA student poster contest went to Colin Bell, Graduate Student in the UNC-Charlotte Department of Civil and Environmental Engineering. The poster, “Urban stream nutrient and carbon quality responses to stormwater control measures” was co-authored by Sara McMillan, Assistant Professor; Department of Civil and Environmental Engineering; Sandra Clinton, Assistant Professor; Department of Geography and Earth Sciences; and Rafael Alonso Saldana, Undergraduate Student, Department of Biology.

The second place $150 award in the NCWRA student poster contest went to Ashleigh Hammac, Graduate Research Assistant in the Department of Soil Science at N.C. State University. The poster, “Quantification of effectiveness of Best Management Practices for nutrient management and surface water quality using a paired watershed design in Chatham County, North Carolina” was co-authored by Daniel Line, Extension Specialist, Department of Biological and Agricultural Engineering; Wesley Childres, Research Technician, Department of Soil Science; and Deanna Osmond, Professor and Soil Science Department Extension Leader.

The third place $100 award in the NCWRA student poster contest went to Marissa Roman of UNC-Wilmington. The poster, “Composition and Distribution of Phosphorous Forms in Sediments of Greenfield Lake,” was co-authored by Lawrence Cahoon, Professor, Biology and Marine Biology.

Honorable Mention and a $50 award in the NCWRA student poster contest went to Yari Johnson (no photo available), a PhD candidate in the Department of Forestry and Environmental Resources at N.C. State University. The poster, “Novel ways to assess forested wetland restoration in North Carolina using ecohydrological patterns from reference sites,” was co-authored by Ted Shear; Associate Professor; Department of Forestry and Environmental Resources; and April James, Assistant Professor; Department of Geography, Nipissing University, North Bay, Ontario, Canada.
Towards understanding needs for enhanced watershed management in North Carolina

Among the numerous sessions at this year’s WRRI Annual Conference were three focusing on a cooperative effort to assess the needs of groups working on watershed issues across North Carolina.

Funded in part by WRRI, the assessment is part of a commitment by N.C. State University—designated an EPA Center of Excellence for Watershed Management—to help communities identify watershed problems and develop and implement locally sustainable solutions. Cooperators in the initiative are WRRI, the UNC Institute for the Environment (IE), NCSU Cooperative Extension Watershed Education for Communities and Officials (WECO), NC DENR Division of Water Quality, and the Triangle J Council of Governments.

“Anecdotally, we saw gaps in needs, resources and funding but it hadn’t been formally documented,” says Nicole Wilkinson, Coordinator for Research and Outreach with WRRI, “so we decided to do a series of assessments to document who is working in the watersheds, what their needs are and how those needs can be met. This documentation can hopefully be used as a foundation for future efforts to obtain funding, and to focus existing funds and efforts in a strategic way.”

During the process of developing the initial online survey to be sent to paid watershed professionals, Ryan Cronk, a graduate student at UNC who worked on the project, identified 550 programs working on watershed issues across the state. These include Soil and Water Conservation Districts, nonprofits, state, federal, university-based and private programs, as well as local governments, and councils of governments.

Respondents indicated some of their biggest needs are more resources (such as funding and staff), skill-building for professionals and volunteers, and increasing local governments’ involvement in watershed issues.

Michele Drostin of the UNC-IE described the results of seven watershed volunteer focus groups held throughout the state. In these meetings volunteers said that:

- There is a need for a sustainable volunteer organizing framework.
- Volunteers with leadership qualities need support so they do not burn out.
- There is efficiency in pooling watershed resources and distributing them through a coordinated platform so volunteer energy can be used to protect watersheds instead of searching for/synthesizing information.
- While there is an assumption that involving school-aged children in watershed education will plant the seed for life-long interest in water resources, there is a disconnect between what is being offered and what teachers need, particularly in regards to watershed programming meeting core curriculum requirements.

Christy Perrin of WECO described information from a second online survey asking volunteers what motivated them to volunteer, what skills they want to develop and what actions they would take to build those skills and capacity.

More than 80 per cent of respondents said that a personal connection to the land and/or waterways motivated their work. Volunteers want to learn what technical resources are available and how they can access them and prefer receiving information via an email listserv, an interactive website or through a local, single-day workshop.

In analyzing the comments from all of the respondents — both professionals and volunteers — the study team determined that there is a need for a statewide network to help watershed stakeholders cross-train and address organizational skill deficiencies by partnering with other organizations that have strengths that are complementary to their own.

The study team plans to use the database they developed to create an online networking tool and central repository of information on watershed efforts in North Carolina and to develop a listserv for sharing information.

To view the working group’s full report or to join the email listserv, please contact Nicole Wilkinson at nicole_wilkinson@ncsu.edu.
Two years ago at the 2011 WRRI Annual Conference NCSU Assistant Professor Karl Wegmann presented interim results from his WRRI-funded research on the water quality effects of sediment sequestered by former millponds along Piedmont valley bottoms.

This year, Wegmann returned with additional results documenting the mechanism by which bank erosion of streams incised into these sediments provides a daily source of total suspended solids and turbidity to streams in the Neuse River basin.

Wegmann recounted history that can be read in the sedimentary units of stream banks in the Umstead State Park study area. Radiocarbon dating confirms the scenario.

With European settlement of the North Carolina Piedmont some 300 years ago, slash and burn agricultural practices began eroding soils at 50 to 500 times the rate of natural erosion. These practices modified soil magnetic properties, which helps differentiate “legacy” sediments from pre-European sediments.

At the same time as the extensive land use changes, an era of extensive milldam construction for waterpower began, with the creation of thousands of millponds along Piedmont streams. Within a 54 km² Umstead State Park study area, seven millponds on three streams flooded 180 acres of valley bottom.

The millponds began to trap eroding materials that would otherwise have been transported out of streams. In the study area, legacy sediments trapped behind millponds were on average 1.5 meters (or nearly 5 feet) thick.

Lyons said that using turbidity sensors upstream and downstream of the Cook’s Mill study site on Richland Creek, the investigators documented that turbidity increased through the reach. However, during the study, stream gages showed that water levels never reached the point on the banks where heavy erosion would be expected—the point at which pre-dam and millpond strata interface. How then do legacy sediments reach the stream, they asked?

To study steam bank change within the reach, over a period of 22 months Lyons performed 9 (TLS) scans of an 11.5-meter length of bank representative of banks in the study area. The scans were used to produce 3D models of the bank allowing him to detect cm-scale changes in the bank structure. These results, plus a bank saturation experiment, led the investigators to conclude that heavy rains saturate banks causing columns of legacy sediments to slump and eventually collapse to the bank toe. There, even small rain events can entrain fine-grained sediment into the stream and serve as a persistent source of TSS and turbidity.

Wegmann’s WRRI project also includes an investigation of nutrient concentrations in legacy sediments, their contributions to nutrients in streams in the Neuse River basin, and a possible interface with conditions in the Neuse Estuary. This part of Wegmann’s study will be documented in an upcoming WRRI report now under review. When the review is complete, the report will be available at go.ncsu.edu/70254.
Comparison of runoff quality and quantity from an urban commercial infill low impact development and a conventional development

Patrick Smith, of Soil and Environmental Consultants, PA, and Corinne Wilson, a master of science candidate in N.C. State University’s Biological and Agricultural Engineering program, described a unique circumstance that allowed them to directly compare conventional and Low Impact Development (LID).

Smith, design manager for a shopping center in North Raleigh, worked with Wilson to evaluate the performance of the project site after his company installed a cornucopia of LID technologies including three cisterns, an underground detention chamber, bioswales and an extensive infiltration system among others.

“This site integrates some stuff that we have learned over the years about wastewater treatment into treating stormwater,” said Smith. “We went into it with the idea that we not only wanted to meet but to drastically exceed what the quality and quantity requirements were.”

A site that was similar in both size and use adjacent to the redevelopment site provided an opportunity for direct comparison of LID with conventional development.

For 12 months Wilson monitored water quantity — including rainfall intensity and depth, peak flows and volume — and water quality — including nitrogen, phosphorus and total suspended solids — that entered and left both sites. Her results show that the LID site outperformed the conventional site in nearly every metric.

“We had a significantly lower runoff volume, peak flow rate, and runoff coefficient (the amount of runoff divided by the amount of rainfall) at the LID site,” said Wilson.

Though testing of water quality found nearly the same nutrient concentrations at both sites, the LID site had substantially lower nutrient loadings due to the greatly reduced volume of water that left the site.

Asked about the cost of the project, Smith went through the cost for each of the features including the underground detention chamber that cost nearly $340,000.

“On this site, that was instrumental in making this project go forward because unless you had that stormwater volume control underground, the site just didn’t work from a financial standpoint,” Smith said. “But it was a burden the developer was willing to bear.”

Unprecedented cyanobacteria blooms in the Cape Fear River

Michael Mallin, Research Professor at UNC-Wilmington, presented results of an ongoing study funded by the Lower Cape Fear River Program and conducted in cooperation with the N.C. Division of Water Quality on unprecedented toxic cyanobacteria blooms in the Cape Fear River system.

Cyanobacteria are microscopic, photosynthetic organisms that form large colonies under the right conditions. Some species create a toxin that has been linked to the death of people, cattle and dogs.

Mallin and his team have been sampling the Cape Fear River system in some 35 locations for nearly 17 years. It has only been in the last four that they have seen evidence of blooms.

“Historically, massive blooms have been depressed in the river because of Piedmont turbidity or blackwater color,” he said. “But in the past four years—2009 to 2012—we have had very substantial surface blooms of Microcystis aeruginosa.”

Blooms—some up to 10 miles long — occur June through September when water temperatures rise above 78 degrees Fahrenheit. They are composed of colonies of small cells embedded in a gelatinous matrix. Organisms that feed on algae, like zooplankton and invertebrates, cannot break down cyanobacteria because of their gelatinous coating.

“It’s a food chain dead end,” said Mallin. “The animals don’t get any nutrition out of these blooms.”

The blooms’ decomposition also pulls oxygen from the water. In 2011, the decomposition of a bloom in Northeast Cape Fear River caused dissolved oxygen levels to fall below 1 milligram per liter. Most fish and shellfish need at least 4 milligrams per liter to survive.

There are also human health and economic concerns. According to Mallin, the City of Wilmington and parts of Brunswick County draw their drinking water from the area where the blooms occur. In 2009, he said, metabolites from the blooms forced Brunswick County to increase their levels of water treatment to control taste and odor problems arising from the blooms.

A swimming advisory was also issued, said Mallin, after the Division of Public Health found high levels of microcystin — a toxin associated with the blooms — in samples taken near Lock and Dam 1.

Mallin credits the trend of rising nutrient levels, particularly ammonia, in the river as a probable cause for the blooms. He points to the high number of CAFO’s and NPDES dischargers in the region as the source of the nutrients.

“Interestingly,” he said, “the Cape Fear River is not considered to be nutrient sensitive waters by the state so there are no total nitrogen or total phosphorous controls on it.”

While the state has chlorophyll a criteria for waterways, Mallin says that the integrated depth sampling used for chlorophyll a collection on the Cape Fear River underestimates the massive blooms that occur on the surface.
Presentations focus on new wrinkles in hydropower

Hydropower is cheap, clean, and can be ramped up very quickly to meet high-value peak electric demand. On the other hand, hydropower depends on stream flows, which are variable and may be growing in variability because of climate change. This puts producers of hydropower at risk of revenue fluctuations and higher costs for alternative power to meet customer demand.

However, according to Hydro Research Foundation Fellow Benjamin Foster of UNC-Chapel Hill, hydropower producers can minimize the risk of financial instability due to stream flow variability by entering into weather-based derivative contracts that hedge against production risk.

While there are a number of weather derivatives traded over the counter, Foster evaluated the ability of an index insurance contract to minimize Dominion Energy’s weather-related risk for its hydropower operations on the Roanoke River. In such a contract, the parties come to an agreement on a threshold (strike) at which a payment will be made and the price (tick) per unit of the underlying index. Based on 100-year simulations of stream flow data, Foster identified an index by modeling future reservoir elevation, power production, and revenues for Dominion’s John H. Kerr Reservoir, Lake Gaston and Roanoke Rapids facilities and optimized several contract structures for “filling the valleys” in the utility’s hydropower revenues.

Although hydropower revenues suffer from variability, hydroelectric dams are being promoted as a source of grid reserves for incorporating highly variable wind energy. Installed wind generating capacity is growing rapidly in the United States, and as wind generating capacity increases, so does the requirement for reserve capacity to offset hourly shortfalls in forecast wind energy. Hydropower, due to its flexibility and low variable costs, is seen as the perfect complement to wind: reservoirs act as “batteries” storing energy, and hydropower facilities can go from zero to maximum generating capacity in minutes. In addition, hydropower facilities can generate at reduced capacity without the huge loss of efficiency typically associated with thermal power plants.

However, a sticky wicket haunting the paring of wind power and hydropower is that reservoirs are generally multi-purpose, meaning flood control, recreation, water supply, and environmental management must all be considered in their operation. UNC-CH PhD student Jordan Kern examined the potential for the paring of wind power with Dominion Power’s hydropower facilities on the Roanoke River to increase disturbances to ecological flows downstream. Kern’s study used a hydrologic-economic model interfaced with a virtual electricity market, with results suggesting that as wind penetration increases, changing price dynamics could “incentivize” dams to more frequently sell generation reserves, which would change the timing of water releases. He simulated natural river flows, current releases, and releases under three levels of average wind penetration in Dominion’s larger electric power system: 5%, 15% and 25%. Kern said that while the addition of wind power to the facilities could progressively increase flashiness downstream, those changes would likely be small compared to the original impact of reservoir construction.

Both Foster and Kern are students of Dr. Greg Characklis in the Water Engineering and Management Program in the Department of Environmental Sciences and Engineering at the University of North Carolina- Chapel Hill.

Management strategies for North Carolina’s estuarine shoreline

At a session focusing on emerging issues for North Carolina’s estuarine areas, Lisa Schiavinato, co-director of the N.C. Coastal Resources Law, Planning, and Policy Center, presented early results of a study the center is conducting in partnership with N.C. Sea Grant, the UNC School of Law, and the National Sea Grant Law Center. She said the study has identified estuarine shoreline stabilization, water availability, compliance monitoring and enforcement, and wastewater infrastructure as issues local governments in the inner coast region will face in the near future.

Discussing one aspect of the study, Schiavinato said that state and local governments should develop and implement strategies to accommodate future shoreline development, while preserving the natural environment that both attracts residents and tourists and provides habitat for fish and wildlife. Currently, the most common form of estuarine shoreline stabilization is hard structures like bulkheads and riprap revetments, which can have the unintended consequence of impacting wetlands that provide a wide range of ecosystem services. Controlling shoreline erosion by using vegetation and other natural materials would, in many cases, allow for development while preserving or creating these important wetlands. Unfortunately, she said, permitting and legal issues as well as lack of marine contractor and homeowner awareness currently discourage use of “softer” shoreline protection techniques such as marsh sills and living shorelines.

Joseph Kalo, also a Center co-director, discussed the group’s work on water sustainability. Threats to the health of the coast’s groundwater aquifers, he said, are overexploitation, saltwater intrusion and pollution. To address groundwater sustainability, the state and local governments must first address the issues inadequate data about present usage, inadequate regional cooperation, absence of comprehensive planning, and legal limitations on water re-use.

The full report including recommendations on how government can address emerging inner coast issues, will be available online later this summer at: www.nccoastallaw.org/.
Researchers look at stormwater control measures for use as retrofits in urban areas

Findings from a WRRI-funded project by North Carolina State University researchers may help communities meet new nitrogen and phosphorus export rules.

Researchers William F. Hunt, III, and Kathy DeBusk of the Department of Biological and Agricultural Engineering and Upton Hatch of the Department of Agricultural and Resource Economics looked at nine North Carolina watersheds in seven cities to determine what kind of stormwater control measures (SCMs) could most effectively reduce pollutant export from existing urban areas.

The impetus for the project was the Jordan Lake Nutrient Management Strategy—the first set of nutrient management regulations in the nation to mandate a reduction of nitrogen and phosphorus from new as well as existing development. To meet the rules, city planners will have to retrofit many areas with SCMs.

The project focused on determining what SCMs are most economically and physically feasible for use as retrofits in urban areas.

Researchers used GIS, topographical and land-use data as well as on-site observations to look for potential SCM retrofit opportunities in each watershed. The SCMs they considered were: bioretention, wet ponds, stormwater wetlands, vegetated swales, sand filters, green roofs, blue roofs, cisterns, level spreader/filter strip combinations, proprietary devices, downspout daylighting, street sweeping, underground detention and permeable pavement.

The group estimated the annual load of nitrogen and phosphorus entering each of the proposed SCMs. They then used three evaluation metrics to calculate the annual reduction provided by each practice. The sum removal of all possible retrofits was the possible annual reduction in nitrogen and phosphorus from the watershed.

Besides site-specific SCMs, the group also looked at larger-scale practices. These included residential community-oriented SCMs such as rain gardens, rain barrels and permeable pavement driveways as well as regional SCMs like the construction of wetlands.

The researchers looked at construction, materials, implementation, design, permitting, land acquisition as well as operation and maintenance costs to determine the overall cost for each SCM.

Based on their analysis the group found that:

- Land uses most easily retrofitted with stormwater practices were commercial and industrial.
- There is a point of diminishing returns when employing these practices in urban watersheds. This point varies based on watershed characteristics, the number and types of retrofits and pollutant of interest.
- Level spreader-vegetated filter strips, stormwater wetlands and bioretention were uniformly the three practices to reduce nitrogen and phosphorus loads at the lowest cost.
- The use of larger, regional SCMs were more cost effective compared with site-specific approaches based on cost per pollutant removal.
- Results indicate that retrofitting urban areas with SCMs may reduce nitrogen and phosphorus loading by the mandated amounts but achieving larger reductions as may be called for if current rules do not improve water quality would be very difficult.

Regardless of watershed size, location or characteristics, retrofitting urban areas with SCMs promises to be an expensive task.

Details of this study can be found in the project's final report, available at go.ncsu.edu/50382.
Environment-related legislation that passed through “crossover” in the N.C. General Assembly

The regular session of the 2013-2014 North Carolina General Assembly convened on January 9. Crossover — or the date by which bills not required to pass through finance or appropriations committees must “cross over” from one chamber to the other — was on May 16. Below is a list of some of the environment-related bills that made it through this session’s crossover:


H 94 AN ACT TO AMEND CERTAIN ENVIRONMENTAL AND NATURAL RESOURCES LAWS TO (1) CLARIFY THAT EXTENDED DURATION PERMITS FOR SANITARYLANDFILLS AND TRANSFER STATIONS AUTHORIZED BY S.L. 2012-187 ARE PERMITS FOR OPERATION AS WELL AS CONSTRUCTION; (2) CLARIFY THE PROCESS FOR APPEALS FROM CIVIL PENALTIES ASSESSED BY A LOCAL GOVERNMENT THAT HAS ESTABLISHED AND ADMINISTERS AN EROSION AND SEDIMENTATION CONTROL PROGRAM APPROVED UNDER G.S. 113A-60 AND PROVIDE THAT CIVIL PENALTIES ASSESSED BY A LOCAL GOVERNMENT PURSUANT TO THE SEDIMENTATION POLLUTION CONTROL ACT OF 1973 SHALL BE REMITTED TO THE CIVIL PENALTY AND FORFEITURE FUND; (3) REPEAL THE REQUIREMENT FOR AIR POLLUTION PERMIT HOLDERS TO SUBMIT A WRITTEN DESCRIPTION OF PLANS TO REDUCE EMISSIONS OF AIR CONTAMINANTS BY SOURCE REDUCTION OR RECYCLING; (4) ADD A FACTOR FOR CONSIDERATION IN ASSESSING SOLID WASTE PENALTIES; (5) CLARIFY THOSE UNDERGROUND STORAGE TANKS THAT ARE NOT REQUIRED TO PROVIDE SECONDARY CONTAINMENT UNTIL JANUARY 1, 2020; AND (6) DIRECT THE COMMISSION FOR PUBLIC HEALTH TO ADOPT RULES TO PROVIDE FOR NOTICE OF KNOWN CONTAMINATION TO APPLICANTS WHO SEEK TO CONSTRUCT NEW PRIVATE DRINKING WATER WELLS. http://www.ncga.state.nc.us/Sessions/2013/Bills/House/PDF/H94v2.pdf

H 238 (=S 207) AN ACT TO PROTECT THE FISCAL HEALTH OF NORTH CAROLINA’S WATER AND SEWER SYSTEMS. Provides that “The Local Government Commission shall have authority to impound the books and records associated with the water and/or sewer enterprise system of any unit of local government or public authority, assume full control of all its affairs, or take any lesser actions deemed necessary by the Commission when, for three consecutive fiscal years, the audited financial statements of the unit or public authority demonstrate that the unit or public authority meets any one of the following three criteria: (i) the enterprise system experienced negative working capital; (ii) the enterprise system experienced a quick ratio of less than 1.0; or (iii) the unit or public authority experienced a net loss of revenue in the enterprise system using the modified accrual budgetary basis of accounting . . . When the Commission takes action under this section, the Commission is vested with the powers of the governing board as the Commission shall deem necessary, which may include all powers of the governing board as to he operation of the enterprise system, including, but not limited to, setting rates, negotiating contracts, collecting payments that are due, suspending service to nonpaying customers, resolving disputes with third parties, and transferring the ownership of the enterprise system.” http://www.ncga.state.nc.us/Sessions/2013/Bills/House/PDF/H238v1.pdf

H 573 AN ACT TO BROADEN THE PERMITTED USE OF STORMWATER FEES. Provides that “For purposes of operating a public enterprise under this Article, a county is authorized to do any of the following activities within its stormwater management program: (1) Purchase property for the purpose of demolishing flood-prone buildings. (2) Implement flood damage reduction techniques that result in improvements to private property in accordance with subsection (c) of this section, to include: a. Elevating structures or their associated components. b. Demolishing flood-prone structures. c. Retrofitting flood-prone structures.” http://www.ncga.state.nc.us/Sessions/2013/Bills/House/PDF/H573v2.pdf


H 396 AN ACT TO ENACT THE PRIVATE WELL WATER EDUCATION ACT AT THE REQUEST OF THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES. Directs the Commission for Public Health to adopt rules governing the sampling and testing of well water and the reporting of test results. Also, requires local health departments to educate citizens for whom new private drinking water wells are constructed and for citizens who contact local health departments regarding testing an existing well on

continued on page 13
Environment-related continued from page 12

all of the following: (1) The scope of the testing required pursuant to this Article. (2) Optional testing available pursuant to this Article. (3) The limitations of both the required and optional testing. (4) Minimum drinking water standards. http://www.ncga.state.nc.us/Sessions/2013/Bills/House/PDF/H396v2.pdf

H 710 AN ACT TO PERMIT WATER UTILITIES TO ADJUST RATES FOR CHANGES IN COSTS BASED ON THIRD-PARTY RATES AND TO AUTHORIZE THE UTILITIES COMMISSION TO APPROVE A RATE ADJUSTMENT MECHANISM FOR WATER AND SEWER UTILITIES TO RECOVER COSTS FOR WATER AND SEWER SYSTEM IMPROVEMENTS. http://www.ncga.state.nc.us/Sessions/2013/Bills/House/PDF/H710v3.pdf

H 894 AN ACT AUTHORIZING CITIES AND COUNTIES TO ALLOCATE EXCESS STORMWATER CAPACITY FOR URBAN REDEVELOPMENT PROJECTS. Allows cities and counties to calculate its stormwater infrastructure capacity and, where excess capacity exists, allocate the excess capacity to urban redevelopment projects. The allocation authorized under the subsection may be used in lieu of on-site storage requirements. http://www.ncga.state.nc.us/Sessions/2013/Bills/House/PDF/H894v1.pdf

H 938 AN ACT TO (1) CLARIFY THE FUNCTIONAL VALUE OF ISOLATED WETLANDS AND INTERMITTENT STREAMS, (2) DIRECT THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES AND THE DEPARTMENT OF TRANSPORTATION TO JOINTLY PETITION THE WILMINGTON DISTRICT OF THE UNITED STATES ARMY CORPS OF ENGINEERS TO ALLOW FOR GREATER FLEXIBILITY AND OPPORTUNITY TO PERFORM WETLANDS MITIGATION BEYOND THE IMMEDIATE WATERSHED WHERE DEVELOPMENT WILL OCCUR, AND (3) DIRECT THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES AND THE ENVIRONMENTAL MANAGEMENT COMMISSION TO REVIEW FEES CHARGED BY THE ECOSYSTEM ENHANCEMENT PROGRAM. http://www.ncga.state.nc.us/Sessions/2013/Bills/House/PDF/H938v2.pdf

H 74 AN ACT TO PROVIDE FOR THE PERIODIC REVIEW AND EXPIRATION OF RULES. http://www.ncleg.net/Sessions/2013/Bills/House/PDF/H74v2.pdf

S 638 AN ACT TO ENACT THE NORTH CAROLINA FARM ACT OF 2013 TO: … (3) DECREASE THE FREQUENCY OF THE AGRICULTURAL WATER USE SURVEY; … (8) REPEAL THE STATE SULFUR CONTENT STANDARDS FOR GASOLINE; … (11) PROVIDE THAT A WATER QUALITY PERMIT IS NOT REQUIRED FOR ACTIVITIES IN WETLANDS THAT ARE NOT WATERS OF THE UNITED STATES; (12) EXPAND THE AGRICULTURAL DAM EXEMPTION TO THE DAM SAFETY ACT; (13) ALLOW A LANDOWNER TO WITHDRAW WATER FOR AGRICULTURAL USE DURING WATER SHORTAGE EMERGENCIES UNDER CERTAIN CONDITIONS; AND (14) DIRECT THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES AND THE DEPARTMENT OF TRANSPORTATION TO JOINTLY PETITION THE WILMINGTON DISTRICT OF THE UNITED STATES ARMY CORPS OF ENGINEERS TO ALLOW FOR GREATER FLEXIBILITY AND OPPORTUNITY TO PERFORM WETLANDS MITIGATION BEYOND THE IMMEDIATE WATERSHED WHERE DEVELOPMENT WILL OCCUR. http://www.ncleg.net/Sessions/2013/Bills/Senate/PDF/S638v2.pdf


S 163 AN ACT TO ENHANCE THE PROTECTION OF LANDOWNERS’ WATER RIGHTS. Notably provides that, “neither the State nor any political subdivision of the State shall adopt rules or ordinances to limit a landowner from withdrawing and using water as otherwise allowed under the common or statutory law of the State from any of the following: (1) Surface water sources located wholly on the landowner's property, including, but not limited to, impoundments constructed by or owned by the landowner and captured stormwater. (2) Groundwater sources, including, but not limited to, wells constructed on the landowner's property, springs, and artesian wells.” http://www.ncga.state.nc.us/Sessions/2013/Bills/Senate/PDF/S163v2.pdf

S 151 AN ACT TO AMEND MARINE FISHERIES LAWS, AMEND THE LAW GOVERNING THE CONSTRUCTION OF TER-
MINAL GROINS, AMEND CAMA PERMITTING LAWS, AND CLARIFY THAT CITIES AND COUNTIES MAY ENFORCE ORDINANCES WITHIN THE STATE’S PUBLIC TRUST AREAS. Among other things, changes language to the application for a permit for the construction of a terminal groin from “an applicant…shall submit…(1) Information to demonstrate the structures or infrastructure are imminently threatened by erosion, and nonstructural approaches to erosion control, including relocation of threatened structures, are impractical” to “an applicant…shall submit…(1) Information to demonstrate the structures or infrastructure are threatened by erosion.” Adds: “The inlet management plan monitoring and mitigation requirements must be reasonable and are not required to address unduly speculative or remote matters or impose requirements whose cost outweigh the benefits. The inlet management plan is not required to address sea level rise.” Removes language calling for “Proof of financial assurance in the form of a bond, insurance policy, escrow account, or other financial instrument that is adequate to cover the cost of: a. Long-term maintenance and monitoring of the terminal groin. b. Implementation of mitigation measures as provided in the inlet management plan. d. Restoration of public, private, or public trust property if the groin has an adverse impact on the environment or property.” Adds: “(1) A city may regulate, restrict, or prohibit the placement, development, maintenance, repair, alteration, improvement, location, or use of structures, equipment, personal property, or debris upon the State’s ocean beaches located within or adjacent to the city’s jurisdictional boundaries.”

http://www.ncga.state.nc.us/Sessions/2013/Bills/Senate/PDF/S580v2.pdf

S 612 AN ACT TO PROVIDE REGULATORY RELIEF TO THE CITIZENS OF NORTH CAROLINA BY CREATING A FAST TRACK PERMITTING PROCESS FOR CERTAIN ENVIRONMENTAL PERMITS; BY CLARIFYING THE PREEMPTION OF CITY ORDINANCES AND CLARIFYING THAT SIMILAR RULES APPLY TO COUNTY ORDINANCES; BY CLARIFYING THE LAWS RELATING TO GROUNDWATER COMPLIANCE BOUNDARIES; BY EXTENDING THE TERMS OF CERTAIN ENVIRONMENTAL PERMITS; BY AMENDING THE ADMINISTRATIVE PROCEDURE ACT TO ELIMINATE THE REQUIREMENT THAT AN AGENCY PREPARE A FISCAL NOTE WHEN REPEALING A RULE; BY REQUIRING THE REPEAL OR REVISE OF EXISTING ENVIRONMENTAL RULES MORE RESTRICTIVE THAN FEDERAL RULES PERTAINING TO THE SAME SUBJECT MATTER; ... BY DIRECTING THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES AND THE DEPARTMENT OF TRANSPORTATION TO JOINTLY PETITION THE WILMINGTON DISTRICT OF THE UNITED STATES ARMY CORPS OF ENGINEERS TO ALLOW FOR GREATER FLEXIBILITY AND OPPORTUNITY TO PERFORM WETLANDS MITIGATION BEYOND THE IMMEDIATE WATERSHED WHERE DEVELOPMENT WILL OCCUR; BY CLARIFYING THAT THE DEFINITION OF “BUILT-UPON AREA” INCLUDES ONLY IMPERVIOUS SURFACES;... http://www.ncga.state.nc.us/Sessions/2013/Bills/Senate/PDF/S612v3.pdf

S 580 AN ACT TO ESTABLISH THE NORTH CAROLINA CONTAMINATION SOURCE REMOVAL AND DISPOSAL BOARD, AND TO DIRECT THE BOARD AND THE DIVISION OF WASTE MANAGEMENT OF THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES TO STUDY DEVELOPMENT AND IMPLEMENTATION OF A PILOT PROGRAM TO ALLOW A PUBLIC-PRIVATE PARTNERSHIP FOR THE SAFE AND EXPEDITED REMEDIATION OF PRE-1983 LANDFILLS AT LITTLE OR NO COST TO THE STATE. http://www.ncga.state.nc.us/Sessions/2013/Bills/Senate/PDF/S580v2.pdf

S 515 AN ACT TO REVISE THE NUTRIENT MANAGEMENT STANDARDS APPLICABLE TO THE JORDAN LAKE WATERSHED. Directs the Environmental Management Commission to repeal many of the rules associated with the Jordan Water Supply Nutrient Strategy and repeals some parts of session laws related to Jordan nutrient management. Directs the Legislative Research Commission to establish the Jordan Lake Study Subcommittee to consider all issues deemed relevant to addressing the water quality in Jordan Lake. At a minimum, the Subcommittee must: (1) Review the history of Jordan Lake and its nutrient loading issues. (2) Evaluate the current condition and uses of Jordan Lake. (3) Consider the potential future conditions and uses of Jordan Lake. (4) Review the development, policies, and content of the rules and Session Laws repealed in Subsections 2(a) and 2(b) of this act. (5) Review statutory law for the management of nutrients in the State. (6) Receive input from experts in nutrient management on strategies for management of nutrients in Jordan Lake. (7) Receive input from interested stakeholders, including local governments and representatives of agricultural, development, environmental, and other interests, on strategies for management of nutrients in Jordan Lake. (8) Develop recommendations, including legislative proposals, addressing water quality in Jordan Lake. The recommendations should include a projected timeline for implementation, including rule development by appropriate agencies, boards, and commissions. The recommendations shall consider the efficacy of a primary water quality strategy that focuses on treatment and remediation of Jordan Lake rather than upstream mitigation strategies, the projected costs, the distribution of cost-sharing between local governments within the affected basin, and an assessment of the likelihood in achieving measurable protection of the water quality in Jordan Lake. Directs the Commission to report any findings and recommendations to the 2014 Regular Session of the 2013 General Assembly. Directs

continued on page 15
Environment-related continued from page 14

the Department of Environment and Natural Resources and the Environmental Management Commission to consult with the United States Army Corps of Engineers and the United States Environmental Protection Agency to identify mitigation strategies that focus on treatment and remediation of the lake rather than upstream mitigation strategies. http://www.ncga.state.nc.us/Sessions/2013/Bills/Senate/PDF/S515v3.pdf

S 76 AN ACT TO (1) AUTHORIZE THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES TO ISSUE PERMITS ON OR AFTER MARCH 1, 2015, FOR OIL AND GAS EXPLORATION AND DEVELOPMENT ACTIVITIES IN THE STATE, INCLUDING THE USE OF HORIZONTAL DRILLING AND HYDRAULIC FRACTURING TREATMENTS FOR THAT PURPOSE; (2) DIRECT THE MINING AND ENERGY COMMISSION TO STUDY DEVELOPMENT OF A COMPREHENSIVE ENVIRONMENTAL PERMIT FOR OIL AND GAS EXPLORATION AND DEVELOPMENT ACTIVITIES USING HORIZONTAL DRILLING AND HYDRAULIC FRACTURING TREATMENTS; (3) MODIFY APPOINTMENTS TO THE MINING AND ENERGY COMMISSION; (4) MODIFY PROVISIONS IN THE OIL AND GAS CONSERVATION ACT CONCERNING THE MINING AND ENERGY COMMISSION'S AUTHORITY TO SET "ALLOWABLES"; (5) ELIMINATE THE REGISTRATION REQUIREMENTS FOR PERSONS CONDUCTING LANDMEN ACTIVITIES IN THE STATE; (6) CLARIFY BONDING REQUIREMENTS ASSOCIATED WITH OIL AND GAS ACTIVITIES; (7) AMEND THE STATUTE GOVERNING SUBSURFACE INJECTION OF FLUID; (8) PROVIDE A TAX FOR THE SEVERANCE OF ENERGY MINERALS FROM THE SOIL OR WATER OF THE STATE, REPEAL OUTDATED OIL AND GAS TAX STATUTES, AND AUTHORIZE THE SUSPENSION OF PERMITS FOR FAILURE TO FILE A RETURN FOR SEVERANCE TAXES; (9) ASSIGN FUTURE REVENUE FROM ENERGY EXPLORATION, DEVELOPMENT, AND PRODUCTION OF ENERGY RESOURCES IN ORDER TO PROTECT AND PRESERVE THE STATE'S NATURAL RESOURCES, CULTURAL HERITAGE, AND QUALITY OF LIFE; (10) ENCOURAGE THE GOVERNOR TO DEVELOP THE REGIONAL INTERSTATE OFFSHORE ENERGY POLICY COMPACT; (11) AMEND THE ENERGY POLICY ACT OF 1975 AND THE ENERGY POLICY COUNCIL; AND (12) DIRECT THE MEDICAL CARE COMMISSION TO ADOPT RULES AUTHORIZING FACILITIES LICENSED BY THE DEPARTMENT OF HEALTH AND HUMAN SERVICES TO USE COMPRESSED NATURAL GAS AS AN EMERGENCY FUEL. http://www.ncga.state.nc.us/Sessions/2013/Bills/Senate/PDF/S76v5.pdf

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

The following is a summary of some of the environment-related legislation already passed during the regular session of the 2013-2014 North Carolina General Assembly.

H 488 (SL 2013-50) AN ACT TO PROMOTE THE PROVISION OF REGIONAL WATER AND SEWER SERVICES BY TRANSFERRING OWNERSHIP AND OPERATION OF CERTAIN PUBLIC WATER OR SEWER SYSTEMS THAT DO NOT FUNCTION AS JOINT OR REGIONAL WATER OR SEWER SYSTEMS TO A METROPOLITAN WATER AND SEWERAGE DISTRICT. Provides that, “All assets, real and personal, tangible and intangible, and all outstanding debts of any public water system operated by a subdivision of the State and body politic that serves a population greater than one hundred twenty thousand (120,000) people, according to data submitted pursuant to G.S.143-355 (l) for the year 2011, that is not operated as either a joint or regional public water system, shall be transferred to the metropolitan sewerage district in the county in which the public water system is located, to be operated as a Metropolitan Water and Sewerage District.” http://www.ncleg.net/Sessions/2013/Bills/House/PDF/H488v0.pdf

H 484 (SL 2013-51) AN ACT TO ESTABLISH A SYSTEM OF PERMITS FOR THE SITING AND OPERATION OF WIND ENERGY FACILITIES. http://www.ncleg.net/Sessions/2013/Bills/House/PDF/H484v0.pdf

S 24 (SL 2013-25) AN ACT TO AMEND THE GAMELAND BUFFER REQUIREMENT APPLICABLE TO CERTAIN NEW SANITARY LANDFILLS. Changes from one mile to 500 feet the allowable distance for the siting of a sanitary landfill from a “State game- land owned, leased, or managed by the Wildlife Resources Commission pursuant to G.S.113-306, when all of the following conditions apply: a. The disposal unit will only be permitted to accept construction and demolition waste. b. The disposal unit is located within the primary corporate limits of a municipality located in a county with a population less than 15,000. c. All portions of the game land within one mile of the disposal unit are separated from the disposal unit by a primary highway designated by the Federal Highway Administration as a U.S. Highway.” http://www.ncleg.net/Sessions/2013/Bills/Senate/PDF/S24v0.pdf
Upcoming Events

N. C. Chapter of the American Public Works Association
Annual Conference and Exposition
June 10-12, 2013
Wilmington, NC
Information at:
http://northcarolina.apwa.net/events/chapter/

North Carolina Water Resources Association
Upcoming luncheons and forums:
September 9, 2013
December 9, 2013
Jane S. McKimmon Center
Raleigh, NC
Topics to be announced soon.
Check out the sites below for additional information:
http://www.ncwra.org/ or
http://ncsu.edu/wrri/code/events.htm

North American Lake Management Society
22nd Annual Southeastern Lake and Watershed Management Conference and FLMS 24th Annual Technical Symposium
June 17-20, 2013
The Shores,
Daytona Beach Shores, Florida
More information available at

Save-the-Date
2014 WRRI Annual Conference and NCWRA Symposium
March 19-20, 2014
Jane S. McKimmon Center
Raleigh, NC
Check for the call for abstracts and other information at: go.ncsu.edu/wrriac

Water Education Summit: Making a Difference in Your Community
Where: Sheraton Read House Hotel, Chattanooga, TN
When: September 24-26, 2013
Website: www.h2osummit.org/

Water quality and availability are major issues affecting everyone from homeowners and farmers to community leaders and elected officials. The 2013 Water Education Summit in Chattanooga is your opportunity to network with and learn from leading educators working to improve all aspects of water resources protection and management. Topics will range from private well protection to farmer best management practices to youth education to watershed planning and low impact development. Presentations, discussions, workshops, and tours will emphasize innovative approaches for using information, technology transfer, and hands-on learning experiences to change behaviors and inspire water stewardship.