

**Virginia Water Resources Research Center  
Annual Technical Report  
FY 2010**

# Introduction

The Virginia Water Resources Research Center (VWRRC) was established at Virginia Tech in 1965 as a federally authorized program. In 1982, the Virginia General Assembly authorized the VWRRC as a state agency under the Code of Virginia (§23-135.7:8).

## ***MISSION***

The VWRRC provides research and educational opportunities to future water scientists; promotes research on practical solutions to water resources problems; and facilitates timely transfer of water resources information to policy- and decision-makers and the general public.

## ***MISSION ELEMENTS***

### ***Research***

- Assisting university researchers in securing research support funds from public and private sources.
- Assisting university researchers in initiating and executing water resources research.

### ***Education***

Advancing educational opportunities for students in water-resources fields by helping university researchers provide undergraduate and graduate research experiences in water resources.

### ***Outreach***

- Maintaining and making available via the VWRRC website a publication series that synthesizes and reports on water resources science, engineering, and policy.
- Securing academic advisors to work in an advisory capacity with public and private sectors as requested.
- Initiating and participating in the development and execution of conferences and symposia on Virginia, regional, and national water issues.

### ***Program Administration***

Administrative oversight is provided by the Dean of the College of Natural Resources and Environment. A Statewide Advisory Board appointed by the Governor advises the VWRRC director on state water research and information priorities. Because of its multiple legislative authorities and administrative responsibilities, the VWRRC has a number of reporting responsibilities. In addition to the annual reporting requirements to the USGS and the National Institutes for Water Resources (NIWR), it presents an annual report to the Virginia Tech administration and the College of Natural Resources and Environment. Five-year reports and reviews are presented to the U.S. Geological Survey (USGS) and the State Council on Higher Education for Virginia (SCHEV).

### ***National Affiliations***

The VWRRC is affiliated with NIWR and the Universities Council on Water Resources (UCOWR).

## ***Programs of the VWRRC***

### ***Introduction***

Programs are structured to meet strategic goals of the VWRRC and are consistent with the VWRRC mission as authorized by the U.S. Congress through the Water Resources Research Act of 1984 (Public Law 98-242), and the Code of Virginia (§23-135.7:8). Programs in research and education are available to students and faculty at all Virginia colleges and universities. Outreach and collaborative programs include information transfer to policy/decision makers and citizens, and collaborative partnerships with state agencies and other water-interest groups.

### ***A. Research Programs***

- The VWRRC's statewide competitive grants program provides research funds to find practical solutions to water problems in Virginia and the region. The grant period begins July 1 and ends June 30 of the following year. The review criteria include (a) technical merit of the proposed project, (b) relevance to Virginia and the region, (c) relevance to contemporary water issues, and (d) ability to provide research opportunities for graduate and undergraduate students. A priority listing of water research needs for this competitive grants program is updated annually in consultation with the VWRRC State Advisory Board. These grants are designed to initiate research efforts with a high potential for expanded funding from additional sources.
- The VWRRC applies for external grants and conducts in-house research.
- The VWRRC facilitates research team building and interdisciplinary, multi-institute collaborative research.
- The VWRRC facilitates research opportunities to other university faculty and external contractors through a partnership with federal agencies that provides targeted funding from the USGS.

### ***B. Educational Programs***

- The VWRRC provides research opportunities to undergraduate students and assistantships to graduate students who participate in sponsored research. Also, numerous graduate and undergraduate students are supported through the VWRRC's competitive grants program in Virginia Tech academic departments, and at Virginia's other colleges and universities.
- In 1999, the VWRRC established the William R. Walker Graduate Research Fellowship to honor the many contributions of Dr. William R. Walker, the VWRRC's first director. The annual monetary award is intended for individuals preparing for a professional career in water resources and is provided to a new graduate student each year. Details of the program can be found on the VWRRC website: [http://www.vwrrc.vt.edu/walker\\_fellowship.html](http://www.vwrrc.vt.edu/walker_fellowship.html)
- The VWRRC coordinates the interdisciplinary Watershed Management Undergraduate Minor and a Watershed Management Graduate Certificate Program in collaboration with five colleges and ten departments at Virginia Tech.
- The VWRRC supports and advises the Virginia Tech Chapter of the American Water Resources Association.

### ***C. Outreach and Collaborative Programs***

- The VWRRC provides administrative support for the Virginia Water Monitoring Council.
- The VWRRC publishes research reports, symposia proceedings and citizen education booklets. It provides funding for the publication of outreach efforts.
- The VWRRC publishes a quarterly newsletter, *Virginia Water Central*. It features scientific and educational articles, legislative information, and water news of interest. The newsletter is available to the public at <http://www.vwrcc.vt.edu/watercentral.html> and electronic copies are provided via email to more than 680 people.
- The VWRRC sponsors or co-sponsors symposia, workshops, and seminars addressing contemporary water resources issues.
- The VWRRC facilitates peer reviews for state programs when requested.
- The VWRRC website (<http://www.vwrcc.vt.edu/>) serves as a repository of the Center's publications, houses an academic expert database, provides updated news and information relevant to water resources, and manages website links for several collaborative partners, including the Virginia Water Monitoring Council, the Virginia Department of Conservation and Recreation Stormwater BMP Clearinghouse, and the Clinch Powell Clean Rivers Initiative.
- The VWRRC has Twitter and Facebook sites to facilitate information exchange related to water resources and related news at the VWRRC.

# Research Program Introduction

## *Research Program*

The research program of the VWRRC is supported through

- its annual appropriation from the Commonwealth of Virginia,
- external funding through grants and contracts, and
- a portion of overhead generated by external funding.

The USGS 104B Federal funds provided to the VWRRC are not allocated to support research, but are used to support the outreach and information dissemination programs of the VWRRC

During FY2010, the VWRRC did not fund any new research projects through its state-supported competitive grant program because of decreases in the state budget allocation. For this USGS reporting period (March 2010 - February 2011), funding for four facilitated grants, including one USGS 104G grant, passed through USGS to the VWRRC and were managed by the VWRRC. Basic information regarding these four grants and resulting products are described in the following section.

community structure and diversity, and denitrification potential as affected by hydrologic design and soil properties in wetlands created in Chesapeake Piedmont, USA

# Denitrifying bacterial community structure and diversity, and denitrification potential as affected by hydrologic design and soil properties in wetlands created in Chesapeake Piedmont, USA

## Basic Information

<b>Title:</b>	Denitrifying bacterial community structure and diversity, and denitrification potential as affected by hydrologic design and soil properties in wetlands created in Chesapeake Piedmont, USA
<b>Project Number:</b>	2010VA142G
<b>Start Date:</b>	9/1/2010
<b>End Date:</b>	8/31/2011
<b>Funding Source:</b>	104G
<b>Congressional District:</b>	VA-11
<b>Research Category:</b>	Water Quality
<b>Focus Category:</b>	Wetlands, Water Quality, Hydrogeochemistry
<b>Descriptors:</b>	
<b>Principal Investigators:</b>	Changwoo Ahn

## Publications

There are no publications.

## **Interim report on the progress of the project**

May 12, 2011

Title of the project: *Denitrifying Bacterial Community Structure and Diversity, and Denitrification Potential as Affected by Hydrologic Design and Soil Properties in Wetlands*” (USGS Award # G10AP00139, Duration 09/01/1 – 08/31/11)

PI: Dr. Changwoo Ahn, Environmental Science and Policy, George Mason University

Co-PI: Dr. Mary Voytek, USGS.

The project has been supporting a Master’s student, Rita Peralta who has been working on the lab analyses of soil samples. Rita is majoring in Environmental Science and Policy.

Wetland soils have been collected for the months of October, December 2010 and April 2011. DEA assays were completed within a week of each sampling. For the April 2011 DEA measurements of nitrous oxide emissions, using the Shimadzu 8A electron capture detector gas chromatograph (ECD GC), were delayed due to possible contamination of the column and detector by other products emitted in the samples. Troubleshooting of the ECD GC required heating of the detector and column overnight and adjustment of the settings to process samples at a higher temperature (320C).

DNA extractions have been completed through December 2010 samples. April 2011 soils will be processed beginning on May 11, 2011. Molecular analysis for October 2010 soils is complete. The qPCR procedure was completed for all samples through December 2010. Fingerprinting of the denitrifying bacterial communities using TRFLP was completed for October 2010 samples. Fingerprinting of Dec 2010 soils was delayed initially due to mechanical problems with the sequencer.

Soil moisture, pH, SOM and CHN analysis was completed for all soils through December 2010. Bulk density samples were collected and processed in November 2010. Soils collected on April 2011 have been air dried and will be processed for pH, SOM and CHN in the coming weeks.

The analyses have taken much longer time than we expected. Thus, we will be requesting a no-cost extension of the project soon.

## Information Transfer Program Introduction

The VWRRC supports timely dissemination of science-based information to policy and decision-making bodies and citizens. The VWRRC used its USGS 104B funds to support expert personnel with responsibilities related to the VWRRC's outreach and collaborative programs. In FY 2010, the USGS 104B funds supported:

- Preparation and electronic publication of the newsletter Virginia Water Central.
- Partial support for organizing the 2010 Virginia Stormwater Symposium.
- Partial administrative support for the Virginia Water Monitoring Council.
- Partial support for production and management of the VWRRC webpage, VWRRC Facebook, VWRRC Twitter, and Virginia Water Radio.

# Information Dissemination

## Basic Information

<b>Title:</b>	Information Dissemination
<b>Project Number:</b>	2006VA97B
<b>Start Date:</b>	3/1/2010
<b>End Date:</b>	2/28/2011
<b>Funding Source:</b>	104B
<b>Congressional District:</b>	9th
<b>Research Category:</b>	Not Applicable
<b>Focus Category:</b>	None, None, None
<b>Descriptors:</b>	
<b>Principal Investigators:</b>	Stephen H. Schoenholtz

## Publications

### 1. THESIS AND DISSERTATIONS

Jocelyn Fraga Muller. 2006. The Role of Multidrug Efflux Pumps in the Stress Response of *Pseudomonas aeruginosa* to Organic Contamination. Ph.D., Civil and Environmental Engineering, Virginia Tech.

Constance A. Sullivan. 2007. Biomarker responses in fathead minnows (*Pimephales promelas*) during exposure to Exceptional Quality biosolids. M.S. Thesis. The College of William and Mary.

### 2. JOURNAL ARTICLES

Eisenbies, M.H., W.M. Aust, J.A. Burger, M.B. Adams. 2007. Forest operations, extreme flooding events, and considerations for hydrologic modeling in the Appalachians - a review. *Forest Ecology and Management*. 242: 77-98.

Eisenbies, M.H., M.B. Adams, W.M. Aust, J.A. Burger. 2007. Bibliography concerning forest water yields, flooding issues, and the hydrologic modeling of extreme flood events. USDA Forest Service General Technical Report (in press).

Sullivan, C.A., C. L. Mitchelmore, R. C. Hale and P.A. Van Veld. 2007. Induction of CYP1A and DNA damage in the fathead minnow (*Pimephales promelas*) following exposure to biosolids. *Science of the Total Environment* (in press).

Kaurish, F., T. Younos. 2007. Developing a Standardized Water Quality Index for Evaluating Surface Water Quality. *Jour. American Water Resources Association*, 43(2):533-545.

Younos, T., V. J. Harwood, J.O. Falkinham, H. Shen. 2007. Pathogens in Natural and Engineered Water Systems: Emerging Issues. *Water Resources Impact* 9(3):11-14.

### 3. CONFERENCE PROCEEDINGS

Ikuma, K., J.F. Muller, A.M. Stevens, C. Hagedorn and N.G. Love. 2007. Evaluating the extent of pollution-induced antibiotic resistance in environmental bacterial strains. To be presented by Nancy

## Information Dissemination

Love at the AWRA 2007 Summer Specialty Conference on Emerging Contaminants of Concern in the Environment, Vail, Colorado, June 25-27, 2007.

Schwartz, B.F. and M.E. Schreiber. 2005. New applications of differential Electrical Resistivity Tomography and Time Domain Reflectometry to modeling infiltration and soil moisture in agricultural sinkholes. Proceedings of the Tenth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, Austin TX.

Zhao, Z., K. F. Knowlton and N. G. Love. 2007. Dairy Manure Estrogens with Advanced Treatments. 2007 ADSA/PSA/AMPA/ASAS Joint Meeting. July 8-12. San Antonio, Texas. In press.

Zhao, Z., K. F. Knowlton, N. G. Love and Y. Fang. 2007. Advanced Treatment to Reduce the Estrogen Content of Dairy Manure. World Environmental and Water Resources Congress. May 15-19, 2006. Tampa, Florida.

Zhang, Y., S. Triantifylloidou, and M. Edwards. 2007. Impact of GAC filters on Water Quality and Lead and Copper Leaching in Homes. To be presented at the Universities Forum, AWWA Annual Conference in Toronto, Canada.

Sullivan, C.A. C.L. Mitchelmore, R.C. Hale and P.A. Van Veld. 2006. Cytochrome P4501A induction and DNA Damage in *Pimelphales promelas* during exposure to Exceptional Quality biosolids. 27th Annual Meeting of the Society of Toxicology and Chemistry. Montréal, Quebec, Canada. November 5-9, 2006

Schwartz BF and Schreiber ME. 2006. Integrating Differential Electrical Resistivity Tomography and Time Domain Reflectometry as a tool for modeling soil moisture and infiltration in sinkholes. Geological Society of America Annual Meeting Oct 21-24, 2006, Philadelphia PA.

Schwartz BF and Schreiber ME. 2006. Combining Differential Electrical Resistivity Tomography and Time Domain Reflectometry to model soil moisture and infiltration in sinkholes. SEG Conference, Vancouver, BC, August 2006.

Schwartz BF, Schreiber ME. 2005. Using Time Domain Reflectometry and 2-D Differential ERT to Monitor Changes in Soil Moisture in Mantled Agricultural Sinkholes. Geological Society of America Abstracts with Programs. GSA Annual Meeting, Salt Lake City UT Oct 15-19, 2005.

Schwartz, BF, Schreiber ME, Orndorff, W. 2005. New applications of differential Electrical Resistivity Tomography and Time Domain Reflectometry to modeling infiltration and soil moisture in agricultural sinkholes, Tenth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, Austin TX, Sept 2005.

Adams, M.B., M.H. Eisenbies (presenter), W.M. Aust, J.A. Burger. 2007. Hydrologic modeling approaches to evaluate forest management effects on extreme flooding events. Dean's Forum on the Environment, Virginia Tech, Blacksburg, VA. February 26, 2007.

Eisenbies, M.H. 2007. Wetlands and flooding. Class lecture provided to Forested Wetlands Class, Virginia Tech, 2007.

Eisenbies, M.H. 2006. Silviculture and flooding. Class lecture provided to class on Forest Soils and Hydrology at Virginia Tech. Fall Semester, 2006

## Information Dissemination

Sullivan, C. 2007. Biomarker responses in fathead minnow exposed to biosolids. Pacific Northwest Chapter of the Society of Environmental Toxicology and Chemistry. Port Townsend WA April 12-14 2007.

### 4. **VWRRC SPECIAL REPORTS**

SR33-2007: Report of the Academic Advisory Committee to the Virginia Department of Environmental Quality: Freshwater Nutrient Criteria for Rivers and Streams.

SR32-2007: Pathogen Research Symposium: Pathways and Monitoring in Natural and Engineered Systems (Nov. 1, 2006, symposium report).

SR31-2006: Analysis of Sinkhole Susceptibility and Karst Distribution in the Northern Shenandoah Valley, Virginia: Implications for Low Impact Development (LID) Site Suitability Models.

SR30-2006: Report of the Academic Advisory Committee to the Virginia Department of Environmental Quality: Freshwater Nutrient Criteria for Rivers and Streams.

### 5. **VIRGINIA WATER CENTRAL**

Virginia Water Central, January 2007 (No. 40), 32 pp.

Virginia Water Central, September 2006 (No. 39), 31 pp.

Virginia Water Central, June 2006 (No. 38), 34 pp.

### 6. **VIRGINIA WATER CENTRAL**

Virginia Water Central, December 2007 (No. 43)

Virginia Water Central, September 2007 (No. 42)

Virginia Water Central, May 2007 (No. 41)

### 7. **CONFERENCE PROCEEDINGS**

Walker, J.L. (ed.). 2008. Proceedings of the 2006 Virginia Water Science and Technology Symposium. October 1-3, 2006. P12-2008. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, Virginia. 127 pp. <http://www.vwrcc.vt.edu/proceedings.html>

Constantinescu, A. (ed.). 2008. Proceedings of the 2007 Virginia-West Virginia Water Research Symposium. November 26-30, 2007. P13-2008. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, Virginia. 355 pp. <http://www.vwrcc.vt.edu/proceedings.html>

8. Warren, P. M. and T. Younos. 2008. Analysis of Nutrient-Response Characteristics to Support Criteria Development for Constructed Reservoirs. VWRRC SR37-2008. 38 pp. [http://www.vwrcc.vt.edu/special\\_reports.html#2008](http://www.vwrcc.vt.edu/special_reports.html#2008)
9. Gowland, D. and T. Younos. 2008. Feasibility of Rainwater Harvesting BMP for Stormwater Management. VWRRC SR38-2008. 23pp. [http://www.vwrcc.vt.edu/special\\_reports.html#2008](http://www.vwrcc.vt.edu/special_reports.html#2008).
10. Grady, C. and T. Younos. 2008. SR39-2008. Analysis of Water and Energy Conservation of Rainwater Capture System on a Single Family Home. VWRRC SR39-2008. 23 pp. [http://www.vwrcc.vt.edu/special\\_reports.html#2008](http://www.vwrcc.vt.edu/special_reports.html#2008)
11. Adams, E. and T. Younos. 2008. Community-Based Sustainable Development Planning. VWRRC SR41-2008. 16 pp. [http://www.vwrcc.vt.edu/special\\_reports.html#2008](http://www.vwrcc.vt.edu/special_reports.html#2008).
12. Young, K., T. Younos, R. Dymond and D. Kibler. 2009. Virginia's Stormwater Impact Evaluation Project: Developing an Optimization Tool for Stormwater Runoff BMPs. VWRRC SR44-2009.

## Information Dissemination

- [http://www.vwrrc.vt.edu/special\\_reports.html#2009](http://www.vwrrc.vt.edu/special_reports.html#2009)
13. Lohani, V. K. and T. Younos. 2008. Implementation and Assessment of an Interdisciplinary NSF/REU Site in Watershed Sciences and Engineering. Full paper In: Proceedings of the American Society of Engineering Education (ASEE) Annual Conference, Pittsburg, PA, June 23-25, 2008.
  14. Younos, T., C. Grady, T. Chen and T. Parece. 2009. Conventional and Decentralized Water Infrastructure: Energy Consumption and Carbon Footprint. Extended Abstract In: Proceedings of the American Water Resources Association 2009 Spring Specialty Conference Managing Water Resources and Development in a Changing Climate (Ed. H. Toniolo). 10pp. May 4-6, Anchorage, Alaska. ISBN: 1-882132-79-3.
  15. Younos, T., V. K. Lohani, M. Licher (Editors). 2008. NSF REU 2008 Proceedings of Research: Research Opportunities in Interdisciplinary Watershed Sciences and Engineering, 90 pp. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, Virginia  
[http://www.vwrrc.vt.edu/nsf\\_reu.html](http://www.vwrrc.vt.edu/nsf_reu.html)
  16. Lohani, V.K. and T. Younos. 2009. Assessment of Learning Experiences of Undergraduate Researchers in an NSF/REU site on watershed Sciences and Engineering. Abstract, In: Proceedings of the American Water Resources Association 2009 Spring Specialty Conference Managing Water Resources and Development in a Changing Climate. Anchorage, Alaska, May 4-6, 2009.
  17. Jin Y, Hu Z, Wen Z. 2009. Enhancing anaerobic digestibility and phosphorus recovery of dairy manure through microwave-based thermochemical pretreatment. *Water Research*. (accepted)
  18. Tang J, Jin Y, Wen Z. 2009. Effects of mixing on biogas production and pathogen reduction of dairy manure anaerobic digestion. March 9, 2009. In: Southwest Virginia Science Forum. Blacksburg, Virginia.
  19. Jin Y, Mukhopadhyay B, Wen Z. 2009. Molecular Assessment of the Fate of Pathogenic Organisms in Dairy Manure during anaerobic treatment. In: ASABE (American Society of Agricultural and Biological Engineers) 2009 Annual Conference, Reno, NV. June 21 - 24, 2009.
  20. Huntington, T.G., A.D. Richardson, K.J. McGuire, and K. Hayhoe. 2009. Climate and hydrological changes in the northeastern United States: recent trends and implications for forested and aquatic ecosystems. *Canadian Journal of Forest Research* 39: 199-212.
  21. Tetzlaff, D., J. Seibert, K.J. McGuire, H. Laudon, D. Burns, S.M. Dunn, and C. Soulsby. 2009. How does landscape structure influence catchment transit time across different geomorphic provinces? *Hydrological Processes* 23(6): 945-953.
  22. Manley, S.W., R.M. Kaminski, P.B. Rodrigue, J.C. Dewey, S.H. Schoenholtz, P.D. Gerard, and K.J. Reinecke. 2009. Soil and nutrient retention in winter-flooded ricefields with implications for watershed management. *Journal of Soil and Water Conservation*. 64(3):173-183. DOI: 10.2489/jswc 64.3.173.
  23. McFarlane, K.J., S.H. Schoenholtz, and R.F. Powers. 2009. Plantation management intensity affects belowground carbon and nitrogen storage in northern California. *Soil Science Society of America Journal*. 73(3): 1020-1032.
  24. Dent, L., D. Vick, K. Abraham, S.H. Schoenholtz, and S. Johnson. 2008. Summer temperature patterns in headwater streams of the Oregon Coast Range. *Journal of American Water Resources Association*. 44(4):803-813. DOI: 10.1111/j.1752-1688.2008.00204.x
  25. Kelly, C.N., S.H. Schoenholtz, and M.B. Adams. 2008. Factors controlling soil nitrogen and carbon transport through riparian areas in Appalachian watersheds: role of vegetation in nutrient loss and water quality. In Proceedings of AWRA Summer Specialty Conference, Virginia Beach, VA, June 30-July 2, 2008. [http://www.awra.org/proceedings/0806pro\\_toc.html](http://www.awra.org/proceedings/0806pro_toc.html)
  26. ***Virginia Water Central***

Virginia Water Central, April 2008 (No. 44), 36pp.

Virginia Water Central, June 2008 (No. 45), 42pp.

## Information Dissemination

Virginia Water Central, September 2008 (No. 46), 34pp.

Virginia Water Central, December 2008 (No. 47), 31pp.

27. Parece, T., T. Younos and V. K. Lohani (Editors). NSF REU 2009 Proceedings of Research: Research Opportunities in Interdisciplinary Watershed Sciences and Engineering. VWRRC Special Report SR47-2009. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, Virginia. [http://www.vwrcc.vt.edu/special\\_reports.html](http://www.vwrcc.vt.edu/special_reports.html)
28. Grady, C., T. McCloskey, D. Gowland, and T. Younos, 2009. Rainwater Harvesting in Urban Environments: Opportunities and Challenges. In Proceedings: Universities Council on Water Resources (UCOWR) 2009 Annual Conference, July 7-9, Chicago. UCOWR, Southern Illinois University, Carbondale, Illinois.
29. Sprague, T., T. Parece, and T. Younos. 2009. An Analysis of the Upper Stroubles Creek Watershed Characteristics Using Geospatial Technologies. In Proceedings of 2009 Virginia Water Research Conference: Water Resources in Changing Climates, Richmond, VA. <http://www.vwrcc.vt.edu/proceedings.html>
30. DiBettito, S., T. Parece, and T. Younos. 2009. Longitudinal Analysis of the Impact of Urbanization on Stroubles Creek: Historical Perspective. In Proceedings of 2009 Virginia Water Research Conference: Water Resources in Changing Climates, Richmond, VA. <http://www.vwrcc.vt.edu/proceedings.html>
31. Grady, C., and T. Younos. 2009. Rainwater Harvesting as a Water Conservation Tool in Coastal Tourism Areas: Punta Cana, Dominican Republic. In Proceedings of 2009 Virginia Water Research Conference: Water Resources in Changing Climates, Richmond, VA. <http://www.vwrcc.vt.edu/proceedings.html>
32. Grady, C., and T. Younos. 2009. Rainwater Harvesting as a Water Conservation Tool in Coastal Tourism Areas: Punta Cana, Dominican Republic. In Proceedings of 2009 Virginia Water Research Conference: Water Resources in Changing Climates, Richmond, VA. <http://www.vwrcc.vt.edu/proceedings.html>
33. Parece, T., and T. Younos. 2009. Investigating the Relationship between Education and Water Conservation in University Residence Halls. In Proceedings of 2009 Virginia Water Research Conference: Water Resources in Changing Climates, Richmond, VA. <http://www.vwrcc.vt.edu/proceedings.html>
34. Poole, H., and T. Younos. 2009. Carbon Footprint of Water Consumption: Case Study. In Proceedings of 2009 Virginia Water Research Conference: Water Resources in Changing Climates, Richmond, VA. <http://www.vwrcc.vt.edu/proceedings.html>
35. Grady, C., and T. Younos. 2010. Water Use and Sustainability in *La Altagracia*, Dominican Republic. VWRRC SR49-2010. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, VA. [http://www.vwrcc.vt.edu/special\\_reports.html](http://www.vwrcc.vt.edu/special_reports.html)
36. Parece, T., S. DiBettito, T. Sprague, and T. Younos. 2010. The Stroubles Creek Watershed: History of Development and Chronicles of Research. VWRRC SR48-2010. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, VA. [http://www.vwrcc.vt.edu/special\\_reports.html](http://www.vwrcc.vt.edu/special_reports.html)
37. Younos, T., R. Hill, and H. Poole. 2009. Water Dependency of Energy Production and Power Generation Systems. VWRRC SR46-2009. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, VA. [http://www.vwrcc.vt.edu/special\\_reports.html](http://www.vwrcc.vt.edu/special_reports.html)
38. Warren, P.M., T. Younos, and J. Randolph. 2009. Implementing Watershed-Based Green Infrastructure for Stormwater Management: Case Study in Blacksburg, Virginia. VWRRC SR45-2009. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, VA. [http://www.vwrcc.vt.edu/special\\_reports.html](http://www.vwrcc.vt.edu/special_reports.html)
39. Young, K., T. Younos, R. Dymond, and D. Kibler. 2009. Virginia's Stormwater Impact Evaluation Project: Developing an Optimization Tool for Stormwater Runoff BMPs. VWRRC SR44-2009. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, VA. [http://www.vwrcc.vt.edu/special\\_reports.html#2009](http://www.vwrcc.vt.edu/special_reports.html#2009)

## Information Dissemination

40. McDonnell, J.J., K.J. McGuire, P. Aggarwal, K.J. Beven, D. Biondi, G. Destouni, S. Dunn, A. James, J. Kirchner, P. Kraft, S. Lyon, P. Maloszewski, B. Newman, L. Pfister, A. Rinaldo, A. Rodhe, T. Sayama, J. Seibert, K. Solomon, C. Soulsby, M. Stewart, D. Tetzlaff, C. Tobin, P. Troch, M. Weiler, A. Western, A. Wörman, and S. Wrede. 2010. How old is streamwater? Open questions in catchment transit time conceptualization, modelling and analysis. *Hydrological Processes*, 24(12): 1745-1754.
41. Huntington, T.G., A.D. Richardson, K.J. McGuire, and K. Hayhoe. 2009. Climate and hydrological changes in the northeastern United States: recent trends and implications for forested and aquatic ecosystems. *Canadian Journal of Forest Research*, 39: 199-212.
42. Tetzlaff, D., J. Seibert, K.J. McGuire, H. Laudon, D. Burns, S.M. Dunn, and C. Soulsby. 2009. How does landscape structure influence catchment transit time across different geomorphic provinces? *Hydrological Processes*, 23(6): 945-953.
43. Piatek, K., S.F. Christopher, and M.J. Mitchell. 2009. Spatial and temporal dynamics of stream chemistry in a forested watershed impacted by atmospheric deposition. *Hydrology and Earth System Sciences*, 13: 423-439.
44. Christopher, S.F., R. Lal, and U. Mishra. 2009. Long-term no-till effects on carbon sequestration in the Midwestern U.S. *Soil Science Society of America Journal*, 73: 207-216.
45. Campbell, J.L., L.E. Rustad, E.W. Boyer, S.F. Christopher, C.T. Driscoll, I.J. Fernandez, P.M. Groffman, D. Houle, J. Kiebusch, A.H. Magill, M.J. Mitchell, and S.V. Ollinger. 2009. Consequences of climate change for biogeochemical cycling in forests of eastern North America. *Canadian Journal of Forest Research*, 39: 264-284.
46. Harrington, T.B., and S.H. Schoenholtz. 2010. Effects of logging debris treatments on five-year development of competing vegetation and planted Douglas-fir. *Canadian Journal of Forest Research*, 40: 500-510.
47. McFarlane, K.J., S.H. Schoenholtz, R.F. Powers, and S.S. Perakis. 2010. Soil organic matter stability in intensively managed Ponderosa pine stands in California. *Soil Science Society of America Journal*, 74: 979-992.
48. Slesak, R.A., S.H. Schoenholtz, and T.B. Harrington. 2010. Soil respiration and carbon responses to logging debris and competing vegetation. *Soil Science Society of America Journal*, 74: 936-946.
49. Slesak, R.A., T.B. Harrington, and S.H. Schoenholtz. 2010. Soil and Douglas-fir (*Pseudotsuga menziesii*) foliar nitrogen responses to variable logging-debris retention and competing vegetation control in the Pacific Northwest. *Canadian Journal of Forest Research*, 40: 254-264.
50. Slesak, R.A., S.H. Schoenholtz, T.B. Harrington, and B. Strahm. 2009. Dissolved carbon and nitrogen leaching following logging-debris retention and competing vegetation control in Douglas-fir plantations of western Oregon and Washington. *Canadian Journal of Forest Research*, 39: 1484-1497.
51. Floyd, W.C., S.H. Schoenholtz, S.M. Griffith, J.P. Wigington, Jr., and J.J. Steiner. 2009. Nitrate-N, landuse/landcover, and soil drainage associations at multiple spatial scales. *Journal of Environmental Quality*, 38(4): 1473-1482.
52. *Virginia Water Central*, April 2009 (No. 48), 48 pp.
53. *Virginia Water Central*, June 2009 (No. 49), 45 pp.
54. *Virginia Water Central*, August 2009 (No. 50), 46 pp.
55. *Virginia Water Central*, November 2009 (No. 51), 48 pp. plus 15-page news supplement.
56. *Virginia Water Central*, February 2010 (No. 52), 40 pp.
57. *Virginia Water Central*, May 2010 (No. 53), 48 pp. plus 17-page news supplement
58. *Virginia Water Central*, August 2010 (No. 54), 32 pp. plus 7-page news supplement
59. *Virginia Water Central*, February 2011 (No. 55), 35 pp
60. Poole, H., and S.F. Christopher. 2010. A Study of Water Infrastructure and Sustainability at Local Level. VWRRC Special Report SR50-2010. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, VA. [http://www.vwrcc.vt.edu/special\\_reports.html](http://www.vwrcc.vt.edu/special_reports.html)
61. McGuire, K.J., and McDonnell, J.J., 2010. Hydrological connectivity of hillslopes and streams: characteristic timescales and nonlinearities. *Water Resources Research* 46, W10543,

## Information Dissemination

- doi:10.1029/2010WR009341.
62. Carey S.K., Tetzlaff D., Seibert J., Soulsby C., Buttle J., Laudon H., McDonnell J., McGuire K., Caissie D., Shanley J., Kennedy M., Devito K., Pomeroy J.W., 2010. Inter-comparison of hydro-climatic regimes across northern catchments: synchronicity, resistance and resilience. *Hydrological Processes* 24(24):3591-3602.
  63. Detty, J.M., McGuire, K.J., 2010. Threshold changes in storm runoff generation at a till mantled headwater catchment. *Water Resources Research* 46, W07525, doi:10.1029/2009WR008102.
  64. Tetzlaff, D., Carey, S., Laudon, H., McGuire, K., 2010. Catchment processes and heterogeneity at multiple scales - benchmarking observations, conceptualisation and prediction (Editorial). *Hydrological Processes* 24(16): 2203-2208.
  65. Detty, J. M., and McGuire, K.J., 2010. Topographic controls on groundwater dynamics: implications for hydrologic connectivity between hillslopes and riparian zones in a till mantled catchment. *Hydrological Processes* 24(16): 2222 - 2236.
  66. Evans, D.M., S.H. Schoenholtz, P.J. Wigington, Jr., and S.M. Griffith. 2011 Nitrogen mineralization in riparian soils along a river continuum within a multi-landuse basin. *Soil Science Society of America Journal* 75(2):719-728. Doi:10.2136/sssaj2010.0162.
  67. Slesak, R.A., S.H. Schoenholtz, T.B. Harrington, and N.A. Meehan. 2011. Soil carbon and nitrogen in response to biomass removal and vegetation control in Douglas-fir plantations of the Pacific Northwest. *Forest Science* 57(1):26-35.

## Outreach and Information Transfer Accomplishments

### **Newsletter**

Email distribution to approximately 680 recipients and announcement/availability on VWRRC website.

### **Special Notifications via VWRRC Listserv**

Notice about online water bills inventory from 2011 Virginia General Assembly (1/25/11)

### **Notifications via Virginia Water Monitoring Council (VWMC) Listserv**

Weekly water-related announcements are provided to approximately 530 members of the VWMC. Announcements include information about conferences, workshops, total maximum daily load (TMDL), public meetings in Virginia, job openings, newly published reports, information posted on websites, and other pertinent information.

### **VWRRC Website ([www.vtrrc.vt.edu](http://www.vtrrc.vt.edu))**

The VWRRC website is updated at least weekly and supports a Water News Grouper page, which is updated several times each week. The VWRRC website also currently serves as the portal for three other websites the VWRRC manages:

1. Virginia Water Monitoring Council (<http://www.vwrrc.vt.edu/vwmc/default.asp>)
2. Virginia Department of Conservation and Recreation Stormwater BMP Clearinghouse (<http://www.vwrrc.vt.edu/swc/>)
3. Clinch-Powell Clean Rivers Initiative (<http://www.vwrrc.vt.edu/cpcri/default.asp>)

**VWRRC is on Twitter** at <http://twitter.com/VaWaterCenter> and **Facebook** (<http://www.facebook.com/pages/Blacksburg-VA/Virginia-Water-Resources-Research-Center/186479556264?v=wall>)

### **Virginia Water Radio ([www.virginiawaterradio.org](http://www.virginiawaterradio.org))**

The VWRRC produces and hosts a weekly 5-minute radio show featuring summaries of recent water news, upcoming water events, and water-related sounds or music.

### **2010 Virginia Stormwater Symposium**

<http://vwrrc.vt.edu/symposium2010/index.html>

The 2010 Virginia Stormwater Symposium: Navigating Changes in Stormwater Technology and Policy was co-sponsored by the VWRRC and the Rice Center for Environmental Sciences at Virginia Commonwealth University (VCU) and held on the campus of VCU October 21. The theme of the symposium focused on understanding and managing stormwater. Invited experts from Virginia and beyond provided new insights into the technologies, policies, and economics of stormwater control. The symposium offered a poster session on basic and applied research related to stormwater. Symposium participants had opportunities to ask questions and contribute to group discussions. The symposium featured a one-day plenary session with seven invited speakers and a poster session with 28 volunteered posters, including 17 student posters. The symposium was attended by 188 participants.

### ***International Outreach Activities***

1. Co-organized international workshop on *Hydrological Regulation of Stream DOC in Northern Catchments*, April 11-15, 2010, Umea, Sweden.
2. Co-organized international workshop on *Hydrological Responses to Climate Change*, August 29-September 1, 2010, Avimore, Scotland.
3. Invited to visit with faculty at Costa Rica Institute of Technology to discuss a water resources exchange program and water resources research needs, August, 2010.

# USGS Summer Intern Program

None.

<b>Student Support</b>					
<b>Category</b>	<b>Section 104 Base Grant</b>	<b>Section 104 NCGP Award</b>	<b>NIWR-USGS Internship</b>	<b>Supplemental Awards</b>	<b>Total</b>
<b>Undergraduate</b>	13	0	1	0	14
<b>Masters</b>	3	1	0	0	4
<b>Ph.D.</b>	4	0	0	0	4
<b>Post-Doc.</b>	1	0	0	0	1
<b>Total</b>	21	1	1	0	23

# **Notable Awards and Achievements**

# Publications from Prior Years