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LID-MARC Mission

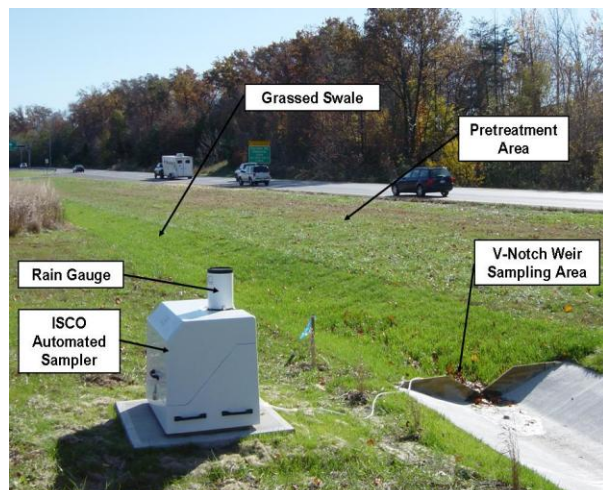
Provide research-based recommendations to government, industry and NGOs on green stormwater management practices, including bioretention and bioinfiltration. Work conducted by the Consortium ranges from the fundamental to the applied practical and focuses on a variety of land uses and climate conditions found among the Mid-Atlantic States.

Overview

Collectively, the LID-MARC partnership has more than 50 years of professional experience in stormwater management research, engineering, education, and extension. Technologies investigated include bioretention/bioinfiltration, vegetated swales, pervious pavements, infiltration trenches, wetlands, and green roofs.

Each of the three members brings a unique proficiency to the Consortium and combined, they have the expertise to address many of the complex challenges being faced by the stormwater profession. This expertise includes water quality and hydrology; field, laboratory, and modeling capabilities; and strong information dissemination tools. The location of the three group members provides continuity





along the mid-Atlantic region, but the differences allow different perspectives that be utilized as a model for climate variations and change.

Research Strategy

The Consortium will continue to work to address the many challenges of stormwater management from developed lands and the transportation infrastructure. Continued areas of interest include, development of appropriate performance metrics, design improvements, linear treatment systems, natural treatment trains, fundamental operational descriptions, climate change impacts, rainwater reuse, long-

term performance validation, and maintenance issues. Undergraduate and graduate education is a major component of the Consortium strategy.

Consortium Activities

In addition to numerous individual accomplishments, the Consortium has several specific collaborative projects:

- Research grant: **Watershed Impact of Stormwater Bioretention and Bioinfiltration BMPs**, sponsored by The Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), Date of Project: September 2007 to September 2009, Total Funding: \$442,787 (rfp.ciceet.unh.edu/projects/abstract.php?chosen=251)
- Trade journal article: “Bioretention and Bioinfiltration BMPs” by R.G. Traver, A.P. Davis, and W.F. Hunt in the October 2007 edition of *Stormwater*. (www.gradingandexcavating.com/sw0710_bioretention.html)
- Refereed journal article: “Bioretention Technology: An Overview of Current Practice and Future Needs,” by A.P. Davis, W.F. Hunt, R.G. Traver, and M. Clar, accepted with suggestions for *J. Environmental Engineering*.



Low Impact Development-Mid Atlantic Consortium

www.bae.ncsu.edu/stormwater/LID-MARC/index.html.

For more information, contact any of the Consortium members

ALLEN P. DAVIS

Department of Civil and Environmental Engineering
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College Park, MD 20742

EXPERIENCE:

Director Maryland Water Resources Research Center (August 2001 - Present).
Professor Department of Civil and Environmental Engineering,
University of Maryland (August 2000 - Present).
Visiting Scientist Animal and Natural Resources Institute, Agricultural Research
Service, USDA, Beltsville, MD (August 2001 - January 2002).
Associate Professor Department of Civil Engineering,
University of Maryland (August 1994 – August 2000).
Assistant Professor Department of Civil Engineering,
University of Maryland (August 1989 - August 1994).

EDUCATION:

Ph.D. University of Delaware. Civil (Environmental) Engineering, 1989
M.C.E. University of Delaware. Civil (Environmental) Engineering, 1986
B.S. University of Delaware. Agricultural Engineering; Minor: Civil Engineering, 1984

AWARDS & HONORS:

**Association of Environmental Engineering and Science Professors (AEESP) 2004
Distinguished Service Award** for Outstanding Service as Chair of the Government
Affairs Committee
**University of Maryland Engineering Research Center, Technology Extension Service
Award for Environmental Achievement** (April 1996).
National Science Foundation 1993 Young Investigator Award (June 1993).
E. Robert Kent College of Engineering Outstanding Teaching Award University of
Maryland, (December 1992).

PROFESSIONAL AFFILIATIONS:

Fellow, *American Society of Civil Engineers*
American Chemical Society, -Division of Environmental Chemistry
Association of Environmental Engineering and Science Professors

FUNDED RESEARCH:

Funded research from agencies including the National Science Foundation, the Cooperative Institute for Coastal and Estuarine Environmental Technologies (a NOAA-supported Center), the Maryland Water Resources Research Center, the Maryland State Highway Administration, the District of Columbia Department of Health, the Washington Suburban Sanitary Commission, the Prince George's County (MD) Government, and several local industries and firms.

REGISTRATION:

Professional Engineer, (Environmental Engineering), State of Maryland, No. 21143.

BOOK

1. Davis, A.P. and McCuen, R.M. *Stormwater Management for Smart Growth*, Springer, NY. ISBN 0-387-26048-X, 368 pages (2005).

REPRESENTATIVE PUBLICATIONS (of 69 refereed publications)

1. Davis, A.P., Shokouhian, M., Sharma, H., Minami, C., and Winogradoff, D. "Water Quality Improvement through Bioretention: Lead, Copper, and Zinc," *Water Environ. Res.*, **75**(1), 73-82 (2003).
2. Kim, H., Seagren, E.A., and Davis, A.P. "Engineered Bioretention for Removal of Nitrate from Stormwater Runoff," *Water Environ. Res.*, **75**(4), 355-367 (2003).
3. Hsieh, C.-h and Davis, A.P. "Evaluation and Optimization of Bioretention Media for Treatment of Urban Storm Water Runoff," *J. Environ. Eng., ASCE*, **131**(11), 1521-1531 (2005).
4. Hong, E., Seagren, E.A., and Davis, A.P. "Sustainable Oil and Grease Removal from Synthetic Storm Water Runoff Using Bench-Scale Bioretention Studies," *Water Environ. Res.*, **78**(2), 141-155 (2006).
5. Davis, A.P., Shokouhian, M., Sharma, H., and Minami, C. "Water Quality Improvement through Bioretention Media: Nitrogen and Phosphorus Removal," *Water Environ. Res.*, **78**(3), 284-293 (2006).
6. Sun, X. and Davis, A.P. "Heavy Metal Fates in Laboratory Bioretention Systems," *Chemosphere*, **66**(9), 1601-1609.
7. Hsieh, C.-h., Davis, A.P. and Needelman, B.A. "Bioretention Column Studies of Phosphorus Removal from Urban Stormwater Runoff," *Water Environ. Res.*, **79**(2), 177-184 (2007).
8. Flint, K. and Davis, A.P. "Pollutant Mass Flushing Characteristics of Highway Stormwater Runoff from an Ultra Urban Area," *J. Environ. Eng., ASCE*, **133**(6), 616-626 (2007).
9. Davis, A.P. "Field Performance of Bioretention: Water Quality," *Environ. Engg. Sci.*, **24**(8) 1048-1063, (2007).
10. Hsieh, C.-h., Davis, A.P. and Needelman, B.A. "Nitrogen Removal from Removal from Urban Stormwater Runoff through Layered Bioretention Columns," *Water Environ. Res.*, **79**(12) 2404-2411 (2007).
11. Davis, A.P. "Field Performance of Bioretention: Hydrology Impacts," *J. Hydrologic Engg., ASCE.*, **13**(2) 90-95 (2008).
12. Davis, A.P. "Field Performance of Bioretention: Hydrology Impacts," *J. Hydrologic Engg., ASCE.*, **13**(2) 90-95 (2008).
13. Li, H. and Davis, A.P. "Urban Particle Capture in Bioretention Media I: Laboratory and Field Studies," *J. Environ. Eng., ASCE*, **143**(6) 409-418 (2008).
14. Li, H. and Davis, A.P. "Urban Particle Capture in Bioretention Media II: Theory and Model Development," *J. Environ. Eng., ASCE*, **143**(6) 419-432 (2008).
15. Li, H. and Davis, A.P. "Heavy Metal Capture and Accumulation in Bioretention Media," *Environ. Sci. Technol.*, published on web, June 11, 2008.

WILLIAM F. HUNT

Department of Biological and Agricultural Engineering
North Carolina State University
Raleigh, NC 27695-7625

EXPERIENCE:

Assistant Professor & Extension Specialist Department of Biological and Agricultural Engineering
N.C. State University (September 2003 - Present).

Extension Associate Department of Biological and Agricultural Engineering
N.C. State University (June 1997 - September 2003).

EDUCATION:

Ph.D. Pennsylvania State University. Agricultural and Biological Engineering, 2003
M.S. North Carolina State University. Biological and Agricultural Engineering, 1997.
B.S. North Carolina State University. Economics, 1995.
B.S. North Carolina State University. Civil Engineering, 1994

AWARDS & HONORS:

USDA National Service Award & National CREES Award, 1999
Outstanding Specialist Award & Outstanding Specialist Team Award – NCACES, 2003
The Grange Award for Outstanding Extension Program in ANR/CRD (NCSU), 2005
NC Water Conservationist of the Year (Governor’s Award), 2006
Academy of Outstanding Faculty in Extension and Engagement, 2007
ASABE Nolan Mitchell Award (Extension Professional of the Year), 2008

PROFESSIONAL AFFILIATIONS:

American Society of Civil Engineers
American Society of Agricultural and Biological Engineers
North Carolina Association of Cooperative Extension Specialists (NCACES)

FUNDED RESEARCH:

Funded research from agencies including the North Carolina Department of Environment and Natural Resources (including US EPA 319(h) grants), NOAA’s CICEET program, the Water Resources Research Institute of North Carolina, North Carolina Department of Transportation, North Carolina Division of Coastal Management (NOAA-supported grant), Interlocking Concrete Pavement Association, NC Coastal Federation, United States Marine Corps, the City of Charlotte, NC, and various other municipalities, counties, and local organizations.

REGISTRATION:

Professional Engineer, (Civil Engineering – Water Resources), North Carolina, No. 26036.

PEER REVIEWED JOURNAL ARTICLES

1. *W.F. Hunt, A.R Jarrett, J.T. Smith, L.J. Sharkey.* 2006. “Evaluating Bioretention Hydrology and Nutrient Removal at Two Field Sites in North Carolina.” *Journal of Irrigation and Drainage Engineering.* 132(6)600-608.

2. W.F. Hunt, C.S. Apperson, S.G. Kennedy, B.A. Harrison, W.G. Lord. 2006. "Occurrence and relative abundance of mosquitoes in stormwater retention facilities in North Carolina, USA." *Water Science and Technology*. 52(6-7):315-321.
3. E.Z. Bean, W.F. Hunt, D.A. Bidelspach. 2007. "A Field Survey of Permeable Pavement Surface Infiltration Rates." *J. Irrigation and Drainage Engineering*. 133(3): 249-255.
4. E.Z. Bean, W.F. Hunt, D.A. Bidelspach. 2007. "Evaluations of Four Permeable Pavement Sites in Eastern North Carolina for Runoff Reduction and Water Quality Impacts." *Journal of Irrigation and Drainage Engineering*. 133(6): 583-592.
5. A.M. Hathaway, W.F. Hunt, G.J. Jennings. 2008. "A Field Study of Green Roof Hydrologic and Water Quality Performance." *Transactions of the ASABE*. 51(1): 37-44.
6. Hunt, W.F., J.T. Smith, S.J. Jadlocki, J.M. Hathaway, P.R. Eubanks. 2008. Pollutant Removal and Peak Flow Mitigation by a Bioretention Cell in Urban Charlotte, NC. *Journal of Environmental Engineering*. 134(5):TBD (in press)
7. Collins, K.A., W.F. Hunt, J.M. Hathaway. 2008. Hydrologic Comparison of Four Types of Permeable Pavement and Standard Asphalt in Eastern North Carolina. *Journal of Hydrologic Engineering*. 134(6): TBD (in press)

PEER REVIEWED EXTENSION PUBLICATIONS (REPRESENTATIVE of 15)

1. Hunt, W.F. and W.G. Lord. 2006. Bioretention Performance, Design, Construction and Maintenance. North Carolina Cooperative Extension Service Publication AG-588-05. Raleigh, NC. (12 pages)
2. Hunt, W.F. and L.L. Spzir. 2006. Permeable Pavement, Green Roofs, and Cisterns: Stormwater Practices for Low Impact Development. North Carolina Cooperative Extension Service Publication AG-588-06. Raleigh, NC. (8 pages)
3. Wossink, G and W.F. Hunt. 2003. An Evaluation of Costs and Benefits of Stormwater BMPs. North Carolina Cooperative Extension Service Publication AG-642. Raleigh, NC. (8 pages)
4. Hunt, W.F. and W.G. Lord. 2006. Maintenance Considerations for Stormwater Wetlands and Wet Ponds. North Carolina Cooperative Extension Service Publication AG-588-07. Raleigh, NC. (10 pages)
5. Hunt, W.F., C.S. Apperson, W.G. Lord, B. Harrison. 2005. Mosquito Control for Stormwater Facilities. North Carolina Cooperative Extension Service Publication AG-588-04. Raleigh, NC. (8 pages)

TECHNOLOGY TRANSFER

1. Manage the following Research Websites:
 - Water Harvesting/ Cisterns (www.bae.ncsu.edu/topic/waterharvesting)
 - Green Roof Research & Extension (www.bae.ncsu.edu/greenroofs)
 - Permeable Pavement Research (www.bae.ncsu.edu/topic/permeable-pavement)
 - Runoff Temperature (Stormwater Considerations for Mountains) (www.bae.ncsu.edu/topic/bmp-temperature)
 - Bioretention Research and Extension (www.bae.ncsu.edu/topic/bioretention)
2. Professional Development Workshops Conducted (Since 2002): 86 in 24 counties across North Carolina. 24 workshops in the following states: Alabama, California, Florida, Georgia, Illinois, Louisiana, Massachusetts, New Jersey, New Mexico, Ohio, South Carolina, Texas, and Vermont.
3. Conference Chair for the 2nd National Low Impact Development Conference (Wilmington, NC) in 2007.

ROBERT G. TRAVER

Department of Civil and Environmental Engineering
Villanova University
Villanova, PA 19085

EXPERIENCE:

Director	Villanova University Stormwater Partnership (July 2002- Present)
Professor	Department of Civil and Environmental Engineering, Villanova University (August 1988 – Present)
Military Officer	LTC (Retired) U.S. Army Reserve Officer (1978 – 1983)
Assistant Professor	Virginia Military Institute – Civil Engineering (1982-1984)
Project Engineer	Yerkes Associates, Bryn Mawr, PA (1978- 1981)

EDUCATION:

Ph.D.,	1988, Pennsylvania State University, Civil Engineering.
M.C.E.,	1982, Villanova University, Civil Engineering
B.S.C.E.,	1978, Virginia Military Institute, Civil Engineering

AWARDS & HONORS:

Schuylkill Action Network Education Award 2004
Water Resources Engineer of the Year 2005 by the Philadelphia Section of ASCE
Water Resources Assoc. of the Del. River Basin Ruth Patrick Education Award 2006
Diplomat – American Academy of Water Resources Engineers
Tau Beta Pi, Chi Epsilon

PROFESSIONAL AFFILIATIONS:

American Society of Civil Engineers	American Water Resources Association
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FUNDED RESEARCH:

Funded research from agencies including the Pennsylvania Department of Environmental Protection (including US EPA 319 grants, The William Penn Foundation, Growing Greener and Growing Greener II (Pa), and EPA Region III WCQA, and a CZM grant.

REGISTRATION:

Professional Engineer, Pa, VA

PEER REVIEWED JOURNAL ARTICLES

1. Emerson, C., Traver, R., Long-Term and Seasonal Variation of Stormwater Infiltration Best Management Practices, ASCE Journal of Irrigation and Drainage – In Press.
2. Braga, A., Horst, M., Traver, R. “Temperature Effects on the Infiltration Rate through an Infiltration Basin BMP”, Journal of Irrigation and Drainage, ASCE, Nov\Dec 2007
3. Heasom, W., Traver, R. Welker, A., “Hydrologic Modeling of a Bioinfiltration Best Management Practice”, Journal of the American Water Resources Association. October 2006
4. Emerson C. , Welty, C., Traver, R. “A Watershed-scale Evaluation of a System of Stormwater

- Detention Basins”, *Journal of Hydrologic Engineering*, ASCE, May 2005
5. Syed A. Hashsham, S.A., Alm, E. W., Stedtfeld, R. D., Traver, R. G., and Duran, M., “Detection and Occurrence of Indicator Organisms and Pathogens”, *Water Environment Research*, Vol: 75, No: 6. 2004.
 6. Traver, R.G., Chadderton, R.A. “Effectiveness of a Wetland Best Management Practice: First Phase,” (with R. Chadderton), *Treatment Wetlands for Water Quality Improvement – Selected papers from Intecol Quebec 2000 Wetlands Conference*, CH2M HILL Canada Limited – Editor John Pries, 2002
 7. Traver, R.G. "Modeling Multiple Critical Depths," *Water Resources Bulletin, Journal of the American Water Resources Association*. Feb. 1994 Vol. 30, No.1, p.85-91.
 8. Traver, R.G., Miller, A.C. "Open Channel Interpolation Of Cross Sectional Properties," *Water Resources Bulletin, Journal of the American Water Resources Association*. October 1993 Vol.29, No.5, p.767-776.
 9. "Parameter Estimates For A Ground Water Model," (with M. Condon, W. Fergusson, and R. Chadderton), *Water Resources Bulletin, Journal of the American Water Resources Association*. February 1993 Vol.29, No.1, p.95-106

REPRESENTATIVE CONFERENCE PROCEEDINGS (Over 30 total)

1. Rea, M., Traver, R. Performance Monitoring of a Stormwater Wetland Best Management Practice, National Conference, World Water & Environmental Resources Congress 2005 (EWRI/ASCE)
2. Emerson, C., Traver, R., The Villanova Bio-Infiltration Traffic Island: Project Overview, National Conference, World Water & Environmental Resources Congress 2004 (EWRI/ASCE)
3. Traver, R., Infiltration Strategies for Low Impact Development, National Conference, World Water & Environmental Resources Congress 2004 (EWRI/ASCE)
4. Designing for Infiltration – (Primary Author) A Perspective EWRI (ASCE 2003) World Water & Environmental Resources Congress, Philadelphia, PA
5. “Development of a BMP Research and Demonstration Park,” *9th International Conference on Urban Storm Drainage*, Environmental and Water Research Institute, ASCE, 2002

PROFESSIONAL OVERVIEW

Dr. Traver's introduction to engineering practice was during the initial period of implementation of stormwater management in Pennsylvania. He incorporates this experience in his continuing research and consulting. While at Villanova Dr. Traver has conducted research on topics that include modeling of stream hydraulics, urban hydrology, water quality, and measures to mitigate stormwater effects of urbanization. Most recently he has been the main force in creating a Stormwater Best Management Practice Demonstration and Research Park on the Villanova Campus. Research is underway on a Stormwater Wetland, and four infiltration BMP's. To enable continuing study into advancing research in these areas, Dr. Traver founded the *Villanova Urban Stormwater Partnership*, and serves as its director.

Recognizing the link between policy and engineering, Dr. Traver continues to be involved with the implementation of stormwater policy. He has participated with a team study (sponsored by PaDER) to review the effects of Pennsylvania's water regulation from a watershed sustainability viewpoint, acted as a reviewer for Pennsylvania's BMP Handbook, and has served as Chair for the 1998, 1999, 2001, 2003, and 2005 Pennsylvania Stormwater Management Symposium's held at Villanova. He frequently speaks to gatherings that include both engineers and municipal officials. As of August 2003 he has been appointed by the Commonwealth to the oversight committee for Pennsylvania's "new" BMP manual. More recently he was selected to serve on ASCE's External Review Panel of the Corps investigation of Hurricane Katrina.