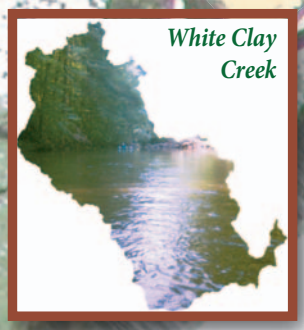
Water-Friendly Landscape Design: A Prescription for Healthy Watersheds

Delaware Water Policy Forum Series No. 5



held at the University of Delaware Newark campus, Friday, October 21, 2005

Co-Sponsored by:

Water Resources Agency, Institute for Public Administration, University of Delaware

Delaware Water Resources Center

Longwood Graduate Program for Public Horticulture/University of Delaware

Delaware Department of Natural Resources & Environmental Control

IPA

WRA water resources agency

DWRC Delaware Water Resources Center

THE LONGWOOD GRADUATE PROGRAM Public Horticulture

DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

November 25, 2005

Dear Water Colleagues:

We are pleased to deliver the proceedings of the Delaware Water Policy Forum Series No. 5 titled: *Water-Friendly Landscape Design: A Prescription for Healthy Watersheds.* The forum was held on Friday, October 21, 2005, at John M. Clayton Hall on the University of Delaware campus in Newark, Delaware. The Delaware Water Resources Center (DWRC), the Water Resources Agency (WRA) in the Institute for Public Administration (IPA) at the University of Delaware, Longwood Graduate Program for Public Horticulture at the University of Delaware, and the Delaware Department of Natural Resources and Environmental Control (DNREC) co-sponsored the event.

This policy forum, the fifth in a series that examines statewide water policy issues, was designed to explore current practices that incorporate water-friendly landscape design into a variety of settings, including the public realm, university campuses, and residential yards. Over 100 attendees heard the speakers discuss a variety of techniques that can be incorporated into the landscape to encourage nonpoint source pollution reduction in order to increase the health of our watersheds. Forum speakers, panelists, and presenters included representatives of the Delaware Water Resources Center, Institute for Public Administration Water Resources Agency (IPA-WRA), University of Connecticut Natural Resources Management and Engineering, New Castle County Cooperative Extension, Delaware Center for Horticulture, University of Delaware Facilities Planning and Construction, Villanova University Civil and Environmental Engineering, Longwood Graduate Program, Delaware Nature Society, Naamans Creek Watershed Association, and DNREC.

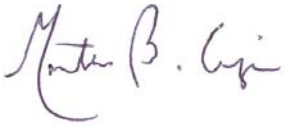
The keynote address kicked off the day with a discussion of a research project that demonstrates the water quantity and quality benefits of developing urban residential subdivisions with Best Management Practice (BMP) nonpoint source controls. The following panels of speakers provided expertise on research and tools that contribute to increasing the overall health of the watershed through work with state and local government agencies, BMP implementation on the University of Delaware and Villanova campuses, and residential Smartyards and rain gardens throughout the watershed. The day concluded with a discussion of DNREC's restoration efforts at local stream and wetland areas in the state.

We thank the speakers and participants who committed their time to attend this event. Special thanks are offered to the Water Policy Forum's organizing committee for their contributions, namely: Jonathan Barton, Amy Boyd, Martha Corrozi, Christi Desisto, Andrew Homsey, Gerald Kauffman, Dr. Jerome Lewis, Dr. Robert Lyons, Nicole Minni, Lori Schnick, Nancy Scott, Dr. Tom Sims, Kevin Vonck, and Melissa Zechiel.

These proceedings can be found online at *www.wr.udel.edu*. We urge you to mark your calendars for October 2006, the planned date of the next annual Delaware Water Policy Forum. We are looking for ideas concerning topics and your favorite speakers; please provide us with any recommendations.

Regards,

Dr. J. Thomas Sims
Director
University of Delaware
Delaware Water Resources Center



Martha B. Corrozi
Watershed Analyst
Water Resources Agency
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Proceedings Editor: Melissa Zechiel, Graduate Research Assistant, Water Resources Agency, Institute for Public Administration, University of Delaware.

AGENDA

7:30	**Registration and Refreshments**
8:30	**Welcoming Remarks** *Dr. Jerome Lewis, Director, IPA, UD* *Dr. J. Thomas Sims, Director DWRC, UD*
8:50	**Keynote Speaker – Nonpoint Education for Municipal Officials (NEMO) Paired-Watershed Research** *Dr. Jack Clausen, Associate Professor, Natural Resources Management and Engineering, University of Connecticut*
9:30	**Panel – New Ideas in the Public Realm** *Moderator: Dr. J. Thomas Sims, Director, DWRC, UD* • **Enhancing Delaware's Highways** *Sue Barton, Extension Specialist and Instructor, Plant and Soil Sciences Department, UD* • **Urban Watersheds Are Thirsting for Green -Wilmington Greening Program** *Gary Schwetz, Director of Programs, Delaware Center for Horticulture and Former Fellow, Longwood Graduate Program*
10:20	**Break**
10:35	**Panel – Building a Watershed-Sustainable Campus** *Moderator: Gerald J. Kauffman, P.E., Director of Watershed Policy, IPA-WRA, UD* • **Design and Constructability of Campus Bioretention Areas** *Tom Taylor, Chief Landscape Engineer, Facilities Planning and Construction, UD* • **Villanova University Stormwater Best Management Demonstration and Research Park** *Dr. Robert Traver, Associate Professor, Civil and Environmental Engineering, Villanova University*
11:35	**Panel – What Makes a Yard "Smart"?** *Moderator: Dr. Robert Lyons, Coordinator, Longwood Graduate Program and Professor, Department of Plant and Soil Sciences, UD* • **Smartyards 1-2-3** *John Harrod, Outreach Coordinator, Delaware Nature Society* • **UD Raingarden – When It Rains, It Pours** *Elaine Grehl, Graduate Research Assistant, IPA-WRA, UD and Former Fellow, Longwood Graduate Program* • **Delaware's First Raingarden** *Dr. Marianne Cinaglia, Past President, Naamans Creek Watershed Association*
12:30	**Lunch** **Stream and Wetland Restoration in Delaware:** **Featuring Pike Creek Stream Restoration at Three Little Bakers and a Wetland Complex at Christ the Teacher Catholic School** *Stephen Williams, Ecological Restoration Coordinator, Office of the Secretary,DNREC*

Water-Friendly Landscape Design: A Prescription for Healthy Watersheds
Delaware Policy Forum Series No. 5
University of Delaware, Clayton Hall
Friday, October 21, 2005

Welcome to the Delaware Policy Forum Series

Dr. Jerome Lewis, Director, Institute for Public Administration, University of Delaware
Dr. J. Thomas Sims, Director, Delaware Water Resources Center, University of Delaware

Biographies:

Dr. Jerome Lewis is the first Director of the University of Delaware's Institute for Public Administration (IPA), which was founded in 1973. Dr. Lewis is a member of the faculty in the School of Urban Affairs and Public Policy and teaches graduate courses in public administration and public policy. IPA links the research and resources of the University of Delaware with the management, information, and leadership needs of schools and local, state, and regional governments in the Delaware Valley. IPA provides assistance to agencies and local governments through direct staff assistance and research projects as well as training programs and policy forums.

Dr. J. Thomas Sims has had a long professional career at the University of Delaware as Director of the Delaware Water Resources Center (DWRC), Director of the Institute of Soil and Environmental Quality, a Professor of Soil and Environmental Chemistry, and currently as the Associate Dean for Academic Programs and Research in the College of Agriculture and Natural Resources. Dr. Sims earned a B.S. in 1975 from the University of Georgia in Agronomy, an M.S. in 1978 from the University of Georgia in Soil Fertility and Plant Nutrition, and a Ph.D. in 1982 from Michigan State University in Soil Chemistry. Dr. Sims has organized and participated as an invited speaker in 12 symposia at ASA/CSSA/SSSA national meetings and 26 symposia in international meetings and for other professional societies. He has also served as a technical advisor at state, regional, national, and international levels for agencies responsible for water quality protection [Cooperative Extension, local soil Conservation Districts, United States Department of Agriculture-National Resource Conservation Service (USDA-NRCS), United States Geological Survey (USGS), United States Environmental Protection Agency (USEPA)] on development and implementation of nutrient management strategies and environmental policies that prevent nonpoint source pollution of surface and ground waters.

Keynote Speaker – Nonpoint Education for Municipal Officials (NEMO) Paired-Watershed Research

Dr. Jack Clausen, Associate Professor, Natural Resources Management and Engineering, University of Connecticut

Abstract:

The Jordan Cove Urban Watershed Section 319 National Monitoring Program Project is a ten-year study (1995 – 2005) designed to determine the water quantity and quality benefits through the development of an urban subdivision using pollution prevention Best Management Practices (BMPs). This project was brought about because of water quality impairment in Jordan Cove and Long Island Sound.

The overall objective of the project is to demonstrate the water quantity and water quality benefits of developing urban residential subdivisions with BMP nonpoint source controls. There are a number of specific objectives related to the project:

- Reduce the amount of runoff and sediment, bacteria, Nitrogen (N), and Phosphorus (P) from residential developments during construction.
- Reduce the amount of runoff and sediment, bacteria, N, and P exported from residential developments.
- Demonstrate the use of residential nonpoint source controls for educational purposes.
- Investigate the effectiveness of individual BMPs including alternative driveway pavement treatments, grassed swales, roof runoff rain gardens, landscaping, reduced site imperviousness, and general good housekeeping practices.

The overall study design is the paired-watershed approach. Stormwater runoff from three watersheds -- control, traditional, and BMP -- is monitored as part of the study. The traditional watershed has been developed using "traditional" subdivision requirements. The BMP watershed has been developed using a BMP approach before, during, and after construction. The runoff from these two watersheds is compared to an existing residential control watershed. Dr. Clausen stated that a pristine area was not chosen for the control because they were looking for an area that wasn't anticipated to change. An un-developed area would be more likely to change as it could very likely be built up during the course of the project. A calibration period occurred from 1995–1999. Composite stormwater samples were analyzed for nitrate+nitrite N, ammonia-N, total Kjeldahl N, total phosphorus, total suspended solids, copper, lead, and zinc.

In the BMP area many techniques were utilized to achieve the low-impact development goal of reduced runoff. A grassed swale was installed, each house was planted with a raingarden, pervious pavers with a 12 percent open surface area were used for road and driveway surfaces, shared driveways reduced impervious surface cover, and a bio-retention depressed island cul-de-sac was built. Dr. Clausen noted that phased grading techniques could not be used because workers hit bedrock. This required a blaster to be brought in to excavate all of the basements and utility trenches at once. The unintended benefit of this was that each basement depression became a mini detention pond, and an earthen berm was formed at the down-stream end of the development, all of which held runoff and sediment. In the traditional area silt fences and hay bales were used, and some re-vegetation was done to prevent sediment runoff.

Project results indicate that the volume of stormwater runoff from the BMP watershed decreased during the construction period and remained lower during the post-construction period, while

nutrient and sediment levels increased somewhat during construction and remained higher than expected. Concentration peaks were associated with turf grass development. During construction, stormwater runoff from the traditional watershed increased. Traditional methods did work in reducing sediment runoff, but the BMP area is characterized by runoff that is delayed, with fewer spikes, and at lower levels than the traditional area.

This project necessitated obtaining variances from the town for reduced road width, no sidewalks, no curb/gutter, use of an alternative paving surface, a one-way cul-de-sac, shared driveways, and a depressed island in the cul-de-sac. Homeowners in the BMP area have ten-year deed restrictions that require them to cooperate with the BMPs used. For example, they may not obstruct the flow of water to the swales or raingardens or remove the raingardens. An education program for BMP area residents included annual soil testing, providing lawn seed mix, and forming an owners association. However, surveys have found no noticeable difference in resident behavior between the areas or different years.

Biography:
Dr. Jack Clausen is an Associate Professor in the Department of Natural Resources Management and Engineering, College of Agriculture and Natural Resources at the University of Connecticut. Dr. Clausen is Interim Director of the Environmental Research Institute at the University. He received B.S., M.S., and Ph.D. degrees in Forest Hydrology from the University of Minnesota and has held faculty positions at both the University of Vermont and the University of Connecticut. Dr. Clausen is a member of the American Water Resources Association, Soil and Water Conservation Society, and Society of Wetland Scientists.

His research interests focus on nonpoint source pollution, and include monitoring, modeling, and assessment of BMPs. He also conducts research on wetland systems, most recently in Patagonia. He teaches courses on water quality, wetlands, nonpoint pollution, and modeling.

Panel – New Ideas in the Public Realm

Moderator: Dr. J. Thomas Sims, Director, Delaware Water Resources Center, University of Delaware

Enhancing Delaware's Highways

Susan Barton, Extension Specialist and Instructor, Plant and Soil Sciences Department, University of Delaware

Abstract:
Enhancing Delaware Highways is a project that began in 1998 investigating vegetation models conceived to restore Delaware's roadside landscapes to a more natural state, reflecting the regional flora. The University of Delaware, Delaware Center for Horticulture, and Rick Darke, LLC are working to evaluate vegetation models for aesthetic impact, installation and maintenance practicality, and economic input.

Enhancing Delaware Highways is in the process of developing and introducing alternatives to current roadside management strategies that rely heavily on mowing and non-native species. Traditionally, states have invested

significant resources in roadside vegetation projects focused on "wildflower plantings," which require annual reseeding or on exotic landscape plantings with high installation and maintenance costs. While considered standard practice, the use of turf grass poses a variety of problems. In addition to turning brown during dry weather, turf grass on slopes can lead to erosion. Mowing turf grass can create additional erosion and can also lead to damaged maintenance equipment. Mowing water-logged areas creates damage and can trap equipment in the mud. In contrast, native species plantings provide many benefits. In addition to being an attractive addition to roadsides, native species help prevent erosion and help with stormwater management. Their deep roots provide habitat and require less maintenance than exotics as they are already accustomed to the climate. In order to provide the department staff with examples of natural sites in Delaware, project members drove throughout the state looking for native species at places such as the Delaware Seashore State Park.

On the ground, the first step in restoring Delaware's highways to their natural states was to stop mowing. However, the department could not stop mowing completely. Dr. Barton discussed the results of a survey they gave to 4,500 licensed Delaware drivers, in which they ranked 16 landscaping schemes. The choice with an un-mowed edge was ranked lowest. However, the choice of an un-mowed planting with a mowed edge was ranked second only to the traditional mowed turf grass choice, and there was no significant difference between their rankings. Keeping a mowed edge is important because it makes the rest of an un-mowed area look purposeful, and not simply neglected. A training program was instituted for DelDOT maintenance employees to educate them on the benefits of not mowing. Informational flyers that were created for distribution to employees are also available to the public. Additional information is available in the Concept and Planning Manual, located on the DelDOT website.

Ms. Barton concluded her presentation by providing several tactics that are effective during the process of creating plantings that are more natural-looking. The following tactics proved effective: planting the native perennial Hibiscus in waterlogged areas; killing existing vegetation before establishing warm-season grass; mixing warm-season grass seed with sawdust to act as a growing medium and prevent weed seeds from thriving; and finally, understanding that every site is different.

Biography:

Susan Barton is an extension specialist in the Plant and Soil Sciences Department at the University of Delaware. She has worked closely for the past seven years with the Delaware Department of Transportation to research and implement new roadside vegetation management strategies. She teaches Nursery and Garden Center Management, New Student Colloquium, and coordinates the Landscape Horticulture Internship. She also works with the nursery and landscape industry, writing newsletters, organizing short courses, and conducting horticulture industry expos with the Delaware Nursery and Landscape Association. Ms. Barton received the Nursery Extension Award in 1995, from the American Nursery & Landscape Association.

Urban Watersheds Are Thirsting for Green – Wilmington Greening Program

Gary Schwetz, Director of Programs, Delaware Center for Horticulture and Former Fellow, Longwood Graduate Program

Abstract:

The Delaware Center for Horticulture (DCH) has a one-acre demonstration garden in Wilmington that is free to the public. Committed to urban development and making cities livable, the DCH Greening Program focuses on the built environment, with events like the Annual Tree Spree Fair, Arbor Day, and other planting events. DCH focuses on awareness and environmental change. Bringing about environmental change and sustainable stewardship of the land is a two-step process; first, building a case through documentation and research, and second, building awareness with various audiences from decision-makers to the general public. The benefit of trees and pervious green surfaces to erosion control, water quality, groundwater recharge, and stormwater management is well documented. Trees have also been shown to reduce urban violence, relieve stress, and reduce fear.

Mr. Schwetz discussed how the Delaware Center for Horticulture has teamed up with the Delaware Department of Agriculture, the City of Wilmington and New Castle County to build upon the information that has already been collected with the Urban Forest Effects (UFORE) model developed by David Nowak and USDA Forest Service. In the United States, urban land use has doubled in the last 35 years. Our current demand for housing is rapidly consuming farmland and natural areas. Today Wilmington has less than 15 percent canopy cover remaining. UFORE is meant to shift people's attitudes concerning the importance of trees and green spaces. The model will quantify urban forest structure and functions, stormwater infiltration, and energy conservation. The project will include a statistical sample of the area, analysis of samples, a study of their carbon sequestration ability, inventories, and aerial photographs of the area's tree cover. The 2002 Wilmington Street Tree Inventory and Tree Stewardship Workshops have been a part of this project. The data model is compatible with Arc View software, and in 2006 a tree locator, species selector, and 100-year future effects models in SAS will be available in the public domain for download.

Biography:

Gary Schwetz is in his tenth year of service with the nonprofit Delaware Center for Horticulture, first as Greening Manager and now as the Director of Programs. Mr. Schwetz has found inspiration fostering numerous beautification projects in the city of Wilmington and the state of Delaware with partners including private and public agencies, municipalities, and community groups. He has previously worked as a Landscape Design and Project Manager in Central Pennsylvania and as a Design Engineer for New Holland Farm Equipment. He has contributed to several publications on the topic including *Regional Interpretation: Linking our Natural and Cultural Identities (1996), Enhancing Delaware Highways Landscape Planning and Concept Manual,* and *Brandywine Valley Scenic Byway Landscape*

Management Plan (in press) with Susan Barton and Rick Darke. Mr. Schwetz also consults through a design and planning coalition known as Regional Landscape Enhancement (RLE) which seeks to inspire private and public entities to incorporate environmentally sound practices into landscape development and management. RLE is currently active in work with Delaware Department of Transportation through the *Enhancing Delaware Highways* project. Mr. Schwetz actively participates in the Delaware Invasive Species Council and the Delaware Native Plant Society, and he shares his passion for plants with others through his skills as an accomplished photographer.

Panel – Building a Watershed-Sustainable Campus

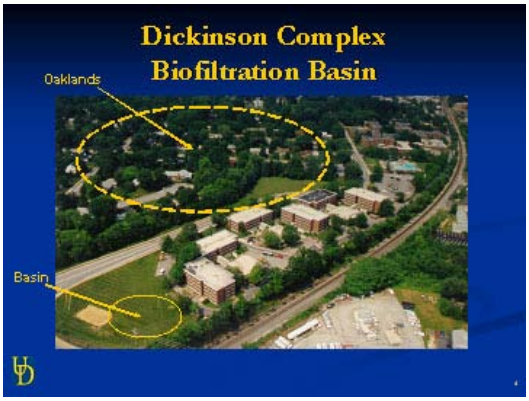
Moderator: Gerald J. Kauffman, P.E., Director of Watershed Policy, Water Resources Agency-Institute for Public Administration, University of Delaware

Biography:
Gerald Kauffman is the Director of Watershed Policy at the Water Resources Agency (WRA) of the Institute for Public Administration (IPA) at the University of Delaware. Mr. Kauffman is responsible for providing watershed technical and policy assistance to state and local governments in Delaware and the Delaware Valley through the University's public service, education, and research role. These responsibilities include appointments as the State Water Coordinator (by state law), the Delaware Co-coordinator for the Christina Basin Clean Water Partnership, and member of the New Castle County Resource Protection Area Technical Advisory Committee. Mr. Kauffman teaches courses in Regional Watershed Management, Water Resources Engineering, and Watershed Engineering, Planning, and Design and was co-founder of the University of Delaware's Experimental Watershed. Mr. Kauffman received a Master of Public Administration (MPA) degree with specialization in watershed policy from the University of Delaware's School of Urban Affairs and Public Policy. He earned a B.S. in Civil and Environmental Engineering with a concentration in water resources from Rutgers University and is a Certified Public Manager awarded by the Rutgers University Graduate Program in Public Administration. Mr. Kauffman is a registered Professional Engineer (P.E.) who has been licensed in four states (New Jersey – 1988, Wisconsin and Illinois – 1990, and Delaware – 2000) and has over twenty years of experience in water resources management.

Design and Constructability of Campus Bioretention Areas

Tom Taylor, Chief Landscape Engineer, Facilities Planning and Construction, University of Delaware

Abstract:



Stormwater management is a concern across the University of Delaware campus. One particular example of stormwater management practices is the Dickinson Complex Biofiltration Basin. As site improvements were accomplished at the Dickinson residence complex in 2001, additional impervious surfaces exceeded 5,000 square feet. The City of Newark, representing the Delaware Department of Natural Resources and Environmental Control (DNREC), was responsible for approvals in the execution of storm-water management systems. According to Tom Taylor, collecting the majority of the runoff from the new impervious surface was not practical, due to the existing topography and drainage systems. Instead, the University staff built a biofiltration

basin to collect, trap, and filter water from part of the surrounding Oaklands neighborhood, as well as a portion of the new runoff.

The bioretention basin was designed to collect the water from both sources, hold it for 24 – 48 hours, and let it percolate through a soil medium to provide filtration before it was deposited into the stormwater system for that area. The basin is filled with cranberry soil. To expedite the flow, a series of drain lines were retrofitted at a depth of 2 feet. Native species, which complement the overall look of the campus, were chosen for planting. Aesthetics are particularly important in stormwater management projects such as this one because of the high visibility of the area to students and visitors. Another stormwater management project at the University of Delaware is the Hollingsworth Project. This project took place at a site where a building was demolished in order to create a parking lot. Stormwater management was critical at this location to avoid the flooding of walkways. Plantings and the soil mix help to slow water and provide some level of cleaning before it enters the storm drains.

One problem faced throughout University stormwater management projects is the clay soil layer prevalent in the area. It is fairly impermeable and naturally adds to drainage issues caused by impervious man-made surfaces. The overall goals of University stormwater management are to abide by the rules that are in place, ensure the use of Best Management Practices (BMPs), create structures that are functional and pleasant, and a diverse habitat for fauna.

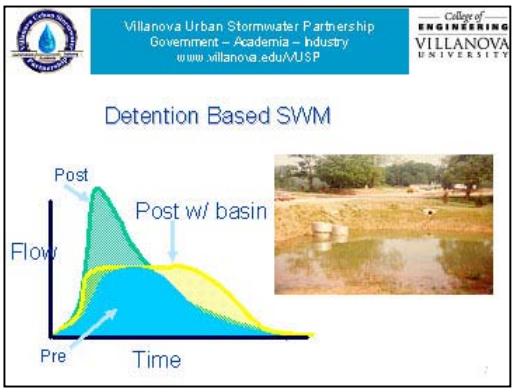
Biography:
Tom Taylor received a B.S. in Ornamental Horticulture and an M.S. in Agronomy from the University of Delaware. Mr. Taylor began employment at the University of Delaware in 1974 as Superintendent of Grounds and Movers. In 1996, Mr. Taylor became the Landscape Engineer, enabling him to concentrate full-time on landscape design, site improvements, hardscape projects, and assistance with developing landscape standards for the University of Delaware campus. Whenever impervious surface areas are increased, one of Mr. Taylor's roles is to work with a civil engineering firm to develop a workable, maintainable, and aesthetically pleasing stormwater system.

Villanova University Stormwater Best Management Demonstration and Research Park

Dr. Robert Traver, P.E., Associate Professor, Civil and Environmental Engineering, Villanova University

Abstract:
The mission of the Villanova Urban Stormwater Partnership is to advance the evolving comprehensive stormwater management field and to foster the development of public and private Partnerships through research on innovative stormwater management (SWM) Best Management Practices (BMPs), Directed Studies, Technology Transfer, and Education. Dr. Traver's presentation focused on how to incorporate BMPs within a campus environment and the results from monitoring BMPs instituted at Villanova University.

On the Villanova University campus an increase in impervious surface has increased runoff, which in turn leads to flooding. An additional challenge is the direct connection of impervious surfaces to stormwater drainage. This makes it difficult to filter, treat, slow down, or reduce the volume of runoff. Currently, detention-based stormwater management is being adapted. Previous configurations were designed for storm events with high precipitation that occur only rarely. Dr. Traver emphasized the need to design BMPs for storms of less than one inch of rainfall. Storm events in the Villanova area of less than one inch tend to occur at least 12 times per year.



Current Villanova research projects include stormwater wetlands, a bioinfiltration traffic island, porous concrete, and an infiltration trench. The bioinfiltration traffic island, or basin, is part of a 1.2-acre watershed. The area is used as a student parking lot and road; fifty percent of this area is impervious cover. The traffic island allows for stormwater infiltration and is relatively inexpensive. With three watershed inches of rainfall, 60 percent of the runoff is removed. After a storm with six inches of rainfall, much higher volume than for what the island was designed, the traffic island drained in two days. Flow exposures have been cut by one-third, creating less stream bank erosion. Other concerns of the project are caring for the plants, removing invasive species, and maintaining the traffic island's drainage capacity.

Dr. Traver concluded his presentation by summing up many of the lessons that were learned as a result of this project. These include:

- Basins with small capture volumes can be just as effective as those designed for larger storm events and do not need to be designed based on six-inch inch storm events.
- Projects should focus on paved areas where the majority of runoff originates.
- Stormwater management can have attractive, good neighbor solutions that balance aesthetics and function.
- The rate of infiltration in a basin like this is seasonal and maintained by the bio-soil system.
- Surface water quality will depend on the volume captured.
- Some phosphorus is still produced by the basin due to vegetation, but the basin still showed an overall reduction in phosphorus runoff.

***Biography*:**
Dr. Robert G. Traver received a B.S. in Civil Engineering from the Virginia Military Institute (VMI) in 1978. Upon graduation he was employed for three years by Yerkes Associates, a consulting engineering firm, as a project engineer. He then obtained his M.S. in Civil Engineering at Villanova 1982. After teaching for three years at VMI, he earned his Ph.D. in Civil Engineering at Penn State in 1988. Dr. Traver has been a member of the Water Resources and Environmental Engineering Program at Villanova since 1988. He is a registered professional engineer and a Diplomat of the Academy of Water Resource Engineers. He teaches graduate courses in hydrology, hydraulics, and urban stormwater management and undergraduate courses in all facets of water resources.

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 BMPs. In order to enable continuing study into advancing research in these areas, Dr. Traver founded the *Villanova Urban Stormwater Partnership* and serves as its director.

Dr. Traver continues to be involved with the implementation of stormwater policy. He has participated with a team study [sponsored by Pennsylvania Department of Environmental Resources (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 Symposiums held at Villanova. He frequently speaks to gatherings that include both engineers and municipal officials. As of August 2003, the Commonwealth of Pennsylvania appointed him to the oversight committee for Pennsylvania's "new" BMP manual.

Panel – What Makes a Yard "Smart"?

Moderator: Dr. Robert Lyons, Coordinator, Longwood Graduate Program and Professor, Department of Plant and Soil Sciences, University of Delaware

Biography:

Dr. Robert Lyons currently oversees the professional development and research projects of ten M.S. students enrolled in one of the most unique programs in the country geared toward developing leaders in the field of public horticulture (*www.udel.edu/longwoodgrad).* He received his B.A. in Biological Sciences from Rutgers College of Rutgers University, and went on to earn an M.S. and Ph.D. from the University of Minnesota, both in Horticultural Science. Dr. Lyons has experience as a Distinguished Professor with the Department of Horticultural Science, North Carolina State University; Director of JC Raulston Arboretum, North Carolina State University; Professor with the Department of Horticulture, Virginia Tech; and Director of the Virginia Tech Horticulture Gardens.

His accomplishments include receiving the 2001 American Landscape & Nursery Association (ANLA) Chadwick Outstanding Undergraduate Educator Award; the 1999 National Outstanding Undergraduate Educator Award/American Society for Horticultural Science (ASHS); and the 1996 Virginia Tech W.E. Wine Award for excellence in undergraduate education.

Dr. Lyons has given over 300 talks to professional and nonprofessional horticulture organizations primarily throughout the South, with special emphasis on the diversity, cultivation, and landscape use of herbaceous landscape plants; was an invited speaker for an urban landscaping conference in Merano, Italy (2001); and the primary photographer and front page contributor for the North Carolina Cooperative Extension's *Successful Gardener* monthly newsletter. He has published three book chapters, 31 refereed journal papers, and 18 abstracts and was an invited seminar speaker at Michigan State and Iowa State Universities. Dr. Lyons was the Associate Editor for *HortTechnology* from 1997 – 2003, and in 1999 he conceptualized, solicited, managed, and edited seven manuscripts for the theme issue entitled, "Arboreta and Gardens – Teaching Labs for Undergraduates (*HortTechnology* 9(4): 548 – 576).

Smartyards 1-2-3

John Harrod, Outreach Coordinator, Delaware Nature Society

Abstract:
Smartyards, a unique component of the Delaware Nature Society's Backyard Habitat program, is an incentive-based effort to encourage homeowners to improve water quality by planting native, water-friendly plants and reducing or eliminating the need for chemical fertilizer and pesticide applications. While many efforts, such as the Total Maximum Daily Loads (TMDL) process, are underway at both federal and state levels, public understanding of nonpoint source pollution issues is necessary to cultivate awareness and create solutions. Smartyards helps individuals understand their own impact on the health of waterways by making the connection between land use practices and water quality.

There are 20 million acres of lawn in the United States., which have little biodiversity. Areas such as meadows and flower beds have significantly more species diversity than lawns. Integrating beds of grasses or flowers into a lawn is one way to add biodiversity. Mr. Harrod addressed the benefits of reducing turf grass lawns and provided the audience with some simple alternatives.

Lawns do not have high infiltration rates and can contribute to local runoff problems. Homeowners use ten times more fertilizer per acre than farmers. Additionally, homeowners often apply fertilizers when the soil pH is at a level that makes it impossible for plants to absorb such fertilizers. The extra fertilizer is then washed away in the next rain. Forty to 60 percent of the nitrogen in applied fertilizer seeps into groundwater or streams. The excess nitrogen from over fertilization causes eutrophication when it reaches waterways. Compost is a natural alternative to chemical fertilizer and is now available in a convenient pellet form.

Aside from fertilization, mowing grass to the appropriate height is important in maintaining a healthy lawn. Grass that is cut too short will become stressed and is more likely to die. When grass is maintained at a higher height it provides more shade to the ground and this in turn helps prevent weed growth.

To increase species diversity and reduce runoff, planting beds can be incorporated into a lawn. Planting beds can start off small, as simple borders around a lawn. Creating planting beds of native species is a good alternative to lawns, and beds tend to thrive because they require less water, fertilizers, and pesticides. Native plants also can attract beneficial native insects to control pest insect populations.

Installing rainbarrels or ponds on a property are useful methods for collecting lawn runoff. Shade ponds also make an attractive addition to any yard and do not require pumps. Mosquito larvae in shade ponds can be controlled by having fish such as the Eastern Mosquito Fish. Other options for non-chemical pest control are bats and toads. To encourage insect-eating bats in a yard, a bat house should be placed about 15 feet above the ground, facing east where it will receive 4-5 hours of sunlight for warmth. Toads will eat slugs, and prefer cool, shady areas. An overturned flower pot with a hole cut in the side can make a good home for toads.

Additional assistance from the Delaware Nature Society's Backyard Wildlife Habitat program is available for those looking to make a yard more diverse, wildlife-friendly, and environmentally sensitive.

Biography:
John Harrod joined the Delaware Nature Society in 2004 as the Backyard Habitat Coordinator. He is responsible for administering the Backyard Habitat program to reduce nonpoint source pollution and promote habitat enhancement and biodiversity conservation. He manages programs and volunteers to cultivate a stewardship ethic among the general population and those in the private sector. Mr. Harrod has a B.S. in Horticulture from Texas A&M University and an M.S. in Public Horticulture from the University of Delaware's Longwood Graduate Program. Mr. Harrod has worked in design-build nursery and landscape businesses and in botanical gardens including the Lady Bird Johnson Wildflower Center in Austin, Texas. He also writes and lectures on environmentally responsible land management.

UD Raingarden – When It Rains, It Pours

Elaine Grehl, Graduate Research Assistant, Water Resources Agency-Institute for Public Administration, University of Delaware and Former Fellow, Longwood Graduate Program

Abstract:
A city block generates nine times more runoff than that of a forest of equal size. Runoff results in contamination and erosion (due to increased velocity of flow). A raingarden is an area of increased bioinfiltration that can reduce runoff. Rain gardens are defined as a landscaped garden sited in shallow topographic depressions that receive the stormwater from one or more impervious surfaces, such as roofs, roadways, or parking lots. Rain gardens provide many benefits including: promoting the infiltration of stormwater to recharge groundwater, creating bird and butterfly habitats, enhancing sidewalk appeal, protecting rivers and streams, reducing garden maintenance, and conserving water. Ms. Grehl discussed her study that documents the design and installation process of implementing a rain garden on the University of Delaware's Newark campus within the University's Experimental Watershed. The Experimental Watershed lies within the White Clay Creek Wild and Scenic River watershed in Newark, Delaware. The raingarden is located on campus adjacent to the Delaware Geologic Survey building on the University of Delaware's Newark campus.

The first step in this project was the selection of the site based on soil type, geographic location, accessibility, and limiting constraints. This site was chosen for a variety of reasons. The vicinity had previously been designed to channel water into the area, and a stormwater drain was already located on the site. The contributing drainage area into the raingarden is 1.42 acres. The infiltration rate of the soil is two inches per hour. The University of Delaware was willing to work with Ms. Grehl, and after much planning, construction began in spring of 2004.

When selecting a location for a raingarden it is important to choose an area where water does not already pond. This would indicate an area of low water infiltration. Additionally, the site should not be over a septic system, which could be overwhelmed by additional water infiltration. A good site will be in a sunny or partly sunny location, down slope of impervious surfaces (i.e. driveways, sidewalks, pavement), but relatively flat. The size will be determined by existing constraints from structures and utilities. Maximizing the square footage of a raingarden is beneficial, however, Ms. Grehl stressed the fact that every bit helps and that even a small raingarden has value. Plant selection and placement are also a crucial component of any raingarden design. The design should be functional, yet aesthetically pleasing. When designed, a raingarden should fit the client's needs and blend them with the plantings and the appropriate maintenance requirements. The University of Delaware Raingarden makes use of native plants and incorporates trees already present in other locations on the University of Delaware campus. Coordinating with all stakeholders, volunteers, contractors, and weather conditions was necessary during the design and installation process to ensure the project's success.

Biography:
Elaine Grehl is a native of Michigan and a graduate of Michigan State University (MSU) with a B.S. in Landscape Horticulture. Upon graduation from MSU, Ms. Grehl worked as a Design/Salesperson for English Gardens in Michigan. This led to her contact with plant grower Bogie Lake Greenhouses, where she was the General Manager. Before coming to the Longwood Graduate Program, Ms. Grehl was the Woodland Technician for the City of Novi, Michigan. There she worked with the Planning Department to review and propose site plan design alternatives to conserve existing natural resources. Ms. Grehl is a 2005 graduate of the University of Delaware's Longwood Graduate Program with an M.S. in Public Horticulture.

Delaware's First Raingarden

Dr. Marianne Cinaglia, Past President, Naamans Creek Watershed Association

Abstract:
Raingarden is a consumer-friendly name for a bioretention area or a stormwater management facility. Raingardens are designed and sized to retain some of the runoff from an individual property. In addition to being fashioned to add an appealing landscaped feature to a site, the gardens have two basic functions: (1) filter the pollutants from lawn chemicals, driveways, etc. that ordinarily flow into the storm runoff and (2) increase the absorption of rainwater into the groundwater. Raingardens are beneficial on both the up and down-slope sides of a property.

Dr. Cinaglia spoke specifically about the raingarden that was installed on her property. Prince George's County and the Maryland Department of Environmental Resources developed the practice of using rain gardens for water retention on individual lots as an alternative to the huge stormwater basins that are required in new residential and commercial developments. An Environmental Protection Agency (USEPA) sustainable development grant was used to plan and install three raingardens in Brandywine Hundred, including the raingarden on the Cinaglia property. A local engineering firm and a local landscape architectural firm planned and installed these gardens in 1999.

Raingardens are traditionally created in a low-lying area of a property. Specific layers of sand, soil, and organic mulch were used to fill in a 4-foot pit to help the garden absorb and store rainwater. The top of the finished garden is several inches lower than the surrounding ground level. Absorbent soil layers adjacent to the sides of the pit help some of the rainwater enter the groundwater system. These absorbent

soil layers are important to the design because the garden should drain within 48 hours of a storm event. Native trees, shrubs, and ground cover are incorporated into the design. Flowering plants add color and texture. Some examples of appropriate plants that could be used are: willow oak, red maple, and serviceberry trees; winterberry holly, spice bush, and summersweet shrubs; and iris, daylilies, and ribbon grass. For the greatest effectiveness, raingardens should be positioned away from house foundations and streams and where it can collect runoff from impervious surfaces. The raingarden on Dr. Cinaglia's property is adjacent to a driveway and also receives runoff from lawns uphill.
Raingardens require less time and work than a lawn. Mowing, reseeding, and pesticide application are eliminated, although periodic weeding and remulching are required. Although the required pit can be dug by hand, the use of a backhoe is a practical addition to construction of the garden.

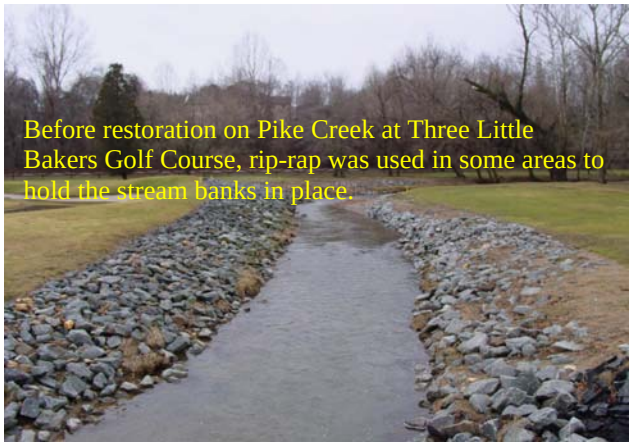
Biography:
Dr. Marianne Cinaglia is the Past President of the Naamans Creek Watershed Association and is interested in environmental issues involving groundwater and stormwater runoff. She taught high school biology in New Castle County schools and education (including science methods) at Rowan University. Dr. Cinaglia has a Ph.D. in Urban Affairs and Public Policy from the University of Delaware.

Stream and Wetland Restoration in Delaware: Featuring Pike Creek Stream Restoration at Three Little Bakers and a Wetland Complex at Christ the Teacher Catholic School

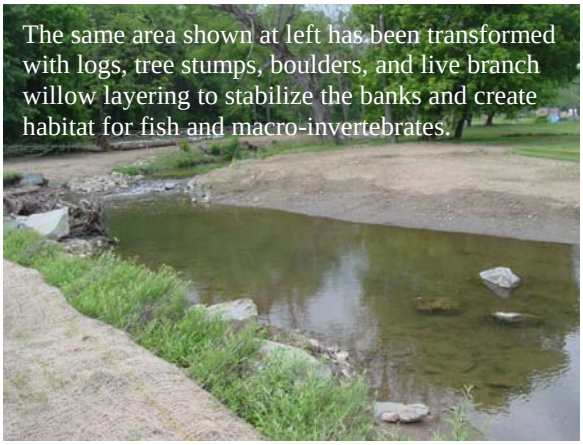
Stephen Williams, Ecological Restoration Coordinator, Office of the Secretary, Delaware Department of Natural Resources and Environmental Control

Abstract:
Water is Delaware's most precious natural resource. Delaware's waterways provide a haven for endangered species such as the Red Knot and Bog Turtle. The Red Knot pauses on the coast to feed on horseshoe crab eggs, which provide crucial energy for the rest of its migration. Homeowner's often unwittingly contribute to the degradation of this important resource by removing vegetation from alongside streams. Without a buffer zone, water quality suffers and important habitat is lost. The Delaware Department of Natural Resources and Environmental Control (DNREC) began ecological restoration work in the early 1990s with the conversion of some marginal agricultural fields into wetlands. Since then, efforts have expanded to include the restoration of tidal and freshwater wetlands, streams, man-made drainage channels (tax ditches), riparian corridors, and the connection of forest tracts. Recognizing the importance of ecological restoration, the Secretary of the Department established an Ecological Restoration and Protection Team in the fall of 2003. The Team brings together the expertise and resources from various agencies within and outside the Department to implement stream and wetland restoration projects and accomplish the goals of the restoration initiative.

The Team's most recent restoration project is the 5,000-feet Pike Creek project at Three Little Bakers Golf Course. As the largest stream restoration project ever implemented in Delaware, it incorporates a host of restoration techniques (e.g., rock toe and log toe protection, cross vanes, log vanes, root wads, riffle and pool sequences, and random bolder placement). Rock and log toes hold back the sides of the bank, while cross vanes, log vanes, and root wads control and re-direct the flow of the stream. Along with random boulder placement, this creates a natural looking stream with the ripples, runs, and pools that would be expected in a healthy stream.



Before restoration on Pike Creek at Three Little Bakers Golf Course, rip-rap was used in some areas to hold the stream banks in place.



The same area shown at left has been transformed with logs, tree stumps, boulders, and live branch willow layering to stabilize the banks and create habitat for fish and macro-invertebrates.

In addition to stream restoration, Delaware has developed a variety of innovative wetland restoration and construction techniques. Wetlands, like the one installed at Christ the Teacher Catholic School, near Glasgow, Delaware, provide habitat and are beneficial for stormwater management because they hold sediment and absorb nutrient runoff while increasing groundwater recharge. This project created wetlands in a pre-existing stormwater basin. A natural wetland system was replicated by first creating microtopography. Construction equipment was brought in to create variations in the terrain – "humps and bumps." Coarse woody debris was added to provide habitat structure, a long-term carbon source, and basking/loafing areas for reptiles and waterfowl. Straw and horse manure provide organic matter as a substrate for macro-invertebrates. The surrounding upland area has been seeded with warm-season grasses for buffers and filter strips and to provide additional wildlife habitat. The project was planted with nursery stock to further promote diversity. This special care provided opportunities for students to participate in planting events and learn about the principles of ecology and the importance of environmental stewardship.

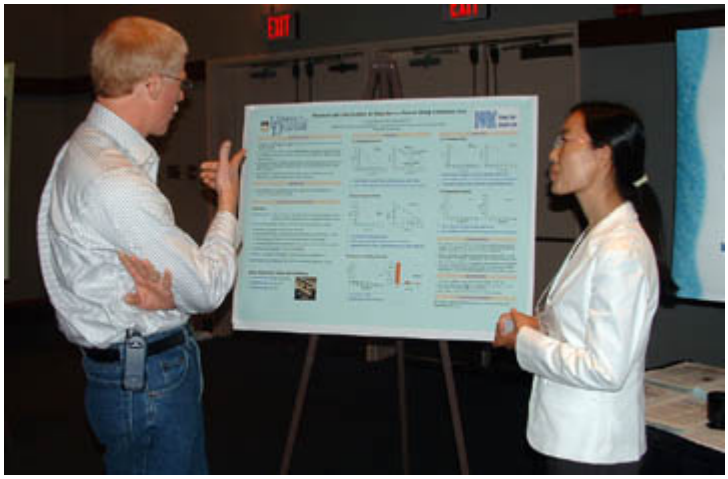
Biography:

Steve Williams serves as the Ecological Restoration Coordinator for the Department of Natural Resources and Environmental Control and is responsible for coordinating and implementing on-the-ground stream and wetland restoration projects that hopefully replicate what is found in a naturally functioning ecosystem. The main goals are to incorporate restoration techniques that reduce erosion, improve and maintain water quality, and provide wildlife habitat.

Exhibits

Conference participants had opportunities to view displays exhibited by the following organizations:

- White Clay Creek Wild and Scenic Management Committee
- DNREC Sediment and Stormwater Program Green Technology
- Water Resources Agency, Institute for Public Administration, University of Delaware
- Villanova Urban Stormwater Partnership
- DNREC Office of the Secretary: Stream and Wetland Restoration in Delaware
- Delaware Water Resources Center (DWRC)
- Delaware River Basin Commission



DWRC's graduate fellow, Liping Zhang, shown here speaking with City of Newark Water and Wastewater Director, Roy A. Simonson, about her research and the possibility of elemental iron barrier removal and inactivation of waterborne viruses in Newark's water system.

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