

2009 VIRGINIA WATER RESEARCH CONFERENCE

Concurrent Session V

- (A) Conserving Water and Exploring Alternative Water Supplies
- (B) Stormwater (Part 2): Using Tools for Better Management



(A) Conserving Water and Exploring Alternative Water Supplies

- (1) **Modern Rainwater Collection Provides Additional Potable Water for a Poor Virginia Community** -- Douglas Phillips, *Southeast Rural Community Assistance Project, Inc.*
- (2) **Rainwater Harvesting as a Water Conservation Tool in Coastal Tourism Areas: Punta Cana, Dominican Republic** -- Caitlin Grady, *Humanities, Science, and Environment, Virginia Tech*
- (3) **Investigating the Relationship Between Education and Water Conservation in University Residence Halls** -- Tammy Parece, *Department of Geography, Virginia Tech*
- (4) **Carbon Footprint of Water Consumption: Case Study** -- Heather Poole, *Environmental Policy and Planning, Virginia Tech*



MODERN RAINWATER COLLECTION PROVIDES ADDITIONAL POTABLE WATER FOR A POOR VIRGINIA COMMUNITY

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In 2002 Mr. Jack Naylor of the Skyline Community Action Program (Skyline CAP) of Stanardsville, Virginia requested technical engineering assistance from SE-RCAP's Douglas Phillips, PE for the Morton Lane community, in the foothills of mountainous Greene County.

Here Skyline CAP's long effort from the 1990's was to provide single family home rehabilitation for residents who lived in poverty conditions and involved providing two major areas of need: 1) a second source of potable water to supplement an insufficiently producing existing community well; and 2) a solution to the onsite wastewater treatment in this several acre property with poor soils characteristics.

There never existed any sewage disposal system nor any running water for these dwellings where residents had used old deteriorated outhouses. Also the single potable water well drilled 15 years ago, had insufficient flow. All four of Morton Lane's homes lacked complete indoor plumbing and became eligible for complete (demolish and rebuild) rehabilitation. The project was managed by Naylor under the organized Indoor Plumbing and Rehabilitation (IPR) program administered statewide by Department of Housing and Community Development.

The coordination by Phillips and Naylor led to a joint effort between local and state governments; community action agencies; and contractors to provide innovative solutions to the small community's water and wastewater needs. This resulted in:

A Potable Water System -- To augment the existing well, Phillips helped procure funds to involve Rainwater Management Solutions, Inc (RMS) in the design and installation of an innovative rainwater harvesting project using a modern roof washing; filtering; and disinfection process.

An Onsite Wastewater System -- Phillips brought state health officials together, and a solution to inadequate soils was found by obtaining an easement from a willing neighbor. Phillips then designed a pumped mass drain field dispersal system.

Upon project completion and dedication in 2008, SE-RCAP's Phillips and Ed Crawford of RMS established detailed Operating and Maintenance Standard Operating (and emergency) Procedures, and spare components lists. These were all posted in the pump house, and efforts were made to educate the residents to simple operation of both the blended water system and the pumped mass drain field wastewater system.

RAINWATER HARVESTING AS A WATER CONSERVATION TOOL IN COASTAL TOURISM AREAS: PUNTA CANA, DOMINICAN REPUBLIC

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Most of the world's population is concentrated in coastal areas. Freshwater scarcities and saltwater intrusion into coastal aquifers are two of the problems that plague many coastal systems around the world. The island nation of the Dominican Republic builds much of its economy on the tourism sector throughout the northern and eastern coast lines. The need to preserve natural resources and study the impact of water demand in coastal areas is crucial to tourism economy and social welfare in the Dominican Republic. While tourism industry for this small island is booming, availability of adequate, water resources are now coming into question. There is a significant need for developing water supply management plans and accountability for water use or water consumption. Punta Cana, the study site for this research, is one of the several resort areas developed along the coastline and totally depends on groundwater to meet its increasing water demand. The goal of this study is to investigate the feasibility of rainwater harvesting as an alternative water source that will complement traditional centralized and

groundwater supplies in Punta Cana. An analysis of decentralized rainwater harvesting and the potential benefits in terms of water conservation and preventing saltwater intrusion will be discussed. Also, this study will explore the potential benefits of water savings on energy conservation that influence the carbon emission and climate change.

INVESTIGATING THE RELATIONSHIP BETWEEN EDUCATION AND WATER CONSERVATION IN UNIVERSITY RESIDENCE HALLS

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Universities and colleges are major consumers of natural resources. A U.S. Department of Energy study (1993) revealed that while buildings at the nation's colleges and universities represent only 5% of the nation's multi-building facilities, they consume 18.6% of their total energy use. Energy usage in university residence halls includes heating and cooling, heating water, and electricity for various uses by students. Water usage impacts energy use as electricity is used to treat, deliver and heat/cool water.

The objective of this research is to determine the relationship between education and environmentally relevant behavior in college students related to water and energy conservation. The results of the different strategies used in residence halls to redirect students' behavior from egocentric to altruistic and eco-centric, and the resultant effects on the water and electricity usage are examined. The research outcomes will reveal the various strategies' successes and can be used as a model by other universities for promoting water and energy conservation and behavior change.

CARBON FOOTPRINT OF WATER CONSUMPTION: CASE STUDY

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Water consumption has an indirect carbon footprint because energy is used to treat water and deliver it to the point of consumption. In the United States, 3-4% of total energy use is attributed to municipal water/wastewater treatment and distribution/discharge. Interest in reducing the carbon footprint of water consumption includes coping with carbon emissions and climate change and preserving water resources. This article addresses the potential of water and energy conservation in a single building to mitigate climate change impact. Results show the estimated carbon footprint for current water consumption in a case study building and estimated carbon footprint if a water conservation measure such as rainwater harvesting is implemented.



(B) Stormwater (Part 2): Using Tools for Better Management

- (1) **True Low Impact Development** -- Richard Street, *Spotsylvania County*
- (2) **Municipal Incentive Programs for Stormwater BMPs on Private Property** -- Dana Puzey, *Urban Affairs and Planning, Virginia Tech*
- (3) **Effect of Spatial Rainfall Data on the Performance of Hydrologic Models** -- Stephanie Rew, *Department of Civil and Environmental Engineering, University of Maryland*
- (4) **Effect of Location of Bioretention Facilities on Controlling Urban Storm Runoff Rate** -- Kristin Gilroy, *Department of Civil Engineering, University of Maryland*
- (5) **Using Landscape Plants for Phytoremediation** -- Mindy Ruby, *Filtterra Bioretention Systems*



TRUE LOW IMPACT DEVELOPMENT

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Low Impact Development (LID) has been around for many centuries under many different names and disguises. Most notably have been Backyard Conservation (NRCS), Permaculture

(1960's) and yet is turning into Better Site Designs as well as Green Development. No matter what title it is under the principal is still the same, conservation of resources.

This document is to help understand the true principals of LID from the home all the way to the entire development. Localities can require the developer to put in a certain percentage of LID practices however the major problem occurs when the developer has completed the project and the homeowners do not understand the value of LID practices. Then when you add the misconception that LID is something that has to be engineered the homeowners shy away from it because they usually do not have any money available for an engineer to design plans.

MUNICIPAL INCENTIVE PROGRAMS FOR STORMWATER BMP INSTALLATION ON PRIVATE PROPERTY

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Localities across the United States are facing escalating costs as existing stormwater infrastructure ages and surface water quality standards are more strictly enforced. One set of techniques to augment conventional municipal stormwater systems are broadly categorized as decentralized stormwater BMPs. These BMPs include rain gardens/bioretenion cells, rainwater harvesting, constructed wetlands, pervious pavers/pavement, and increased canopy cover among others. Decentralized BMPs have benefits beyond stormwater management, including aesthetic enhancement, habitat creation, environmental education, community development, and increased property values. This paper examines several incentive programs that target private landowners, community groups, and neighborhood groups as incentive recipients for the installation of decentralized stormwater BMPs on private property. The aspects addressed for each program include: structure, allowable BMPs, supporting legislation, program budget, funding, individual reward structure, and rules dictating BMP installation.

EFFECT OF SPATIAL RAINFALL DATA ON THE PERFORMANCE OF HYDROLOGIC MODELS

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Rain gage measurements have traditionally been used as input to hydrologic models. In most watersheds, the spatial density of rain gages is very low, meaning little detail about the spatial

characteristics of rainfall events are used in the models. In general, rain gage data are not adequate to develop unit hydrographs (UHs) or to reconstruct a storm response, especially for nonhomogeneous watersheds. The spatial and temporal characteristics of a storm will influence the watershed response, while storm movement, direction, and velocity will influence the hydrologic response. Therefore, spatial data about rainfall could improve hydrological models. The possibility of using spatial radar rainfall data, rather than point rain gage data, as input to UH development was investigated. The goal of this research was to determine whether knowledge of spatial characteristics of rainfall events could improve model predictions of hydrologic and watershed response. Variation in UHs derived using different rain gages in the same watershed was assessed and found to be significant. Spatially averaged rainfall hyetographs, including the Thiessen average rainfall and radar rainfall, were found to be more representative of the rainfall over the watershed and, therefore, the watershed response, than hyetographs developed from an individual rain gage. To evaluate the true impact of UH variation on design, peak flow rates were calculated and compared for UHs based on both point rainfall data and spatially averaged rainfall. The variation found in individual UHs was observed to carry over into designs made using those UHs.

SPATIO-TEMPORAL EFFECTS OF LOW IMPACT DEVELOPMENT PRACTICES

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Land development and urbanization in the U.S. and worldwide is causing environmental degradation. Traditional off-site stormwater management does not protect small streams. To mitigate the negative effects of land development, best management practices (BMPs) are being implemented into stormwater management policies for the purposes of controlling minor flooding and improving water quality. Unfortunately, the effectiveness of BMPs has not been extensively studied. The purpose of this research was to analyze the effects of location of two types of BMPs: cisterns and bioretention pits. A spatio-temporal model of a microwatershed was developed to determine the effects of BMPs on peak runoff rates and volumes for residential and commercial lots compared to predevelopment conditions. The results show that cisterns alone are capable of controlling rooftop runoff for small storms. The spatial location of BMP storage on a microwatershed influences the effectiveness of BMPs. The location is a factor in the peak reduction and a maximum volume of effective BMP storage exists for both hydrologic metrics. In regards to water quality, BMPs were effective in reducing small stream scour up to 98% for single storm events. These results provide guidelines for developing stormwater management policies that can potentially reduce degradation of first-order streams, lower the cost and maintenance of stormwater management requirements, enhance aesthetics, and increase safety.

USING LANDSCAPE PLANTS FOR PHYTOREMEDIATION

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Phytoremediation is an emerging technology that uses plants to degrade, extract, contain, or immobilize contaminants such as metals, pesticides, explosives, oil, excess nutrients, and pathogens from soil and water. Phytoremediation has been identified as a more cost effective, noninvasive, and publicly acceptable method of removing environmental contaminants than most chemical and physical methods.

Two nutrients commonly found in storm water runoff are nitrogen (N) and phosphorus (P). Both of these pollutants are also macronutrients needed for agronomic and horticultural plant growth, and are components of all complete fertilizers. Fertilizer application to residential, commercial, and municipal lawns and landscapes is a major non-point source of pollution with potential for reduction via phytoremediation.

The majority of plants currently used in phytoremediation applications, including storm water ponds (BMPs), riparian buffers, rain gardens, green roofs, constructed wetlands, etc., are herbaceous or non-woody. New storm water runoff systems, that incorporate woody landscape plants into the systems, are being designed for streetscapes and landscapes. Two research projects are currently being conducted at Virginia Tech to identify woody landscape plants with nutrient and heavy metal hyperaccumulation or phytoremediation potential. One project involves a nutrient uptake screening protocol for landscape trees and shrubs. The other project involves screening landscape plants in situ and in Filtterra stormwater management units to compare nutrient and heavy metal accumulation from landscape soil vs. the Filtterra unit substrate. Results from both projects are beginning to identify both native and non-native landscape plants that are hyperaccumulators with phytoremediation potential.