Virginia Water Resources Research Center

Annual Technical Report

FY 1998

Introduction

Research Program

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Federal Administration, Federal Information
Project Number	B-01
Start Date	03/01/1998
End Date	02/28/2001
Research Category	Water Quality
Focus Category #1	None
Focus Category #2	None
Focus Category #3	None
Lead Institution	Virginia Water Resources Research Center

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Leonard Shabman	Professor	Virginia Water Resources Research Center	01

Problem and Research Objectives

Throughout the reporting period the Center used the Section 104 program to support internal operations, miscellaneous outreach expenditures, and a small grant program. Research project funding, outreach, and educational programs were supported from university funds, direct state appropriations, and extramural grants. This use of 104 funds is critical to the management of the Center. In fact, the Center's objective in using funds from the 104 program has been to marginally supplement other funding sources. More importantly, 104 funds increase the budgeting flexibility in the support of the overall program of the Center. That flexibility is enhanced because the use of 104 funds is often less restrictive

than funds from our other sources. The presence of the 104 funds has also been instrumental in increasing the university and state commitment to the Center's programs. The 104 funds are offered and serve as evidence of the federal-state partnership and this is important in our fund raising efforts.

Methodology

N/A

Principal Findings and Significance

N/A

Descriptors

Water Institute Administration

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	An Integrated Water Quality Economic Model for Evaluating Alternative Development Scenarios in Virginia's Watersheds
Project Number	S-07
Start Date	03/24/1998
End Date	06/15/1999
Research Category	Water Quality
Focus Category #1	Economics
Focus Category #2	Models
Focus Category #3	Management and Planning

Lead Institution	Department of Agricultural and Applied Economics

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Theo Dillaha	Associate Professor	Biological Systems Engineering	01
Kurt Stephenson	Assistant Professor	Department of Agricultural and Applied Economics	01

Problem and Research Objectives

New residential housing can take many different forms. Residential development can be either large or small lots, disconnected or adjacent to existing development, and far or near existing infrastructure. While different settlement forms may have different environmental or social impacts, local governments may also be concerned about how new residential development patterns influence the cost of providing public services and land prices (and ultimately property tax revenue). The objective of this study is to identify the fiscal costs and the land price effects of different residential settlement patterns.

Methodology

An ongoing literature review and synthesis are helping to identify how spatial settlement form affects the costs of providing education, water/sewer service, emergency services and other public sector costs. More detailed modeling work is being conducted to identify how different residential settlement patterns influence the cost of providing water and sewer services. A computer simulation program has been developed to estimate the total annual cost of delivering water and sewer service to new residential housing units.

Principal Findings and Significance

The program can provide cost estimates at multiple scales -- individual housing developments to long-term system designs. In addition, examining the relationship of development patterns to fiscal costs, statistical models are being prepared to identify whether and how housing characteristics associated with different patterns of development influence property values.

Descriptors

Economic model, residential development

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Cameron, S. 1999. Two Costs Analyses in Resource Economics: Public Water and Sewer Costs of Alternative Land Settlement Patterns and Nitrogen Allowance Trading in Long Island Sound. M.S. Thesis, Department of Agricultural and Applied Economics, Virginia Tech, Blacksburg, Virginia (Expected date of completion, December 1999).

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Evaluating Flood Plain and Riparian Zone Restoration on Frequently Flooded Farmland
Project Number	S-01
Start Date	04/01/1998
End Date	03/31/2000
Research Category	Social Sciences
Focus Category #1	Floods
Focus Category #2	Economics
Focus Category #3	Agriculture
Lead Institution	Virginia Water Resources Research Center

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Leonard Shabman	Professor	Virginia Water Resources Research Center	01

Problem and Research Objectives

PROBLEM STATEMENT There currently exists no standard protocol for evaluating alternative uses of flood prone farm land. The assessment procedures adopted by federal agencies (described by the U.S. Water Resources Council's Principles and Guidelines for Water and Related Land Resources Planning) are best applied to evaluate structural water control alternatives. The conceptual evaluation procedures for agricultural flood protection projects in that document are sound, but there is no readily available

model for applying those principles. Also, the Principles and Guidelines do not discuss evaluation principles or modeling for reducing agricultural use of floodplains or for floodplain restoration. As a result, government agencies and affected publics each use their own data and their own procedures to consider the relative merits of the different strategies for addressing agricultural flood risk. A common evaluation protocol for comparing the benefits to the nation of different alternatives for managing flood risk on flood prone agricultural land needs to be developed and tested. OBJECTIVES 1. To develop a common analytical system for modeling the relative national benefits and costs of structural and non-structural agricultural flood hazard management strategies. 2. To test the ability of the modeling system to provide comparable analysis across different alternatives, by applying the model to a case study watershed flood risk management study.

Methodology

A modified version of a simplified assessment model, developed at Virginia Tech, for examining landowner return to forestation of frequently flooded soybean farmland is being used to assess the relative merits of a full range of alternative approaches to agricultural flood risk management. An application of the revised model to a specific case will demonstrate the value of the overall evaluation approach, while testing the comprehensiveness of the model.

Principal Findings and Significance

A computer model for evaluating the national economic justification for reforesting frequently flooded farm lands was developed. Costs of reforestation are the agricultural income foregone and the expenditures for the establishment of trees. The environmental services of the trees were defined. A money value calculation protocol for hunting leases, forest products, carbon sequestration, and nutrient trapping was developed. The model was applied to a case study watershed in Mississippi and reforestation was determined to be marginally justified. The report includes an implementation plan for encouraging voluntary reforestation by private landowners. The report provides detailed suggestions for creating and initiating markets for hunting leases, forest products, sequestered carbon and nutrient trapping so that market forces can secure the benefits of reforestation.

Descriptors

Flood management

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Alternative Small-Scale Water Supplies for Coalfield Communities
Project Number	S-02
Start Date	07/01/1998
End Date	06/30/1999
Research Category	Water Quality
Focus Category #1	Water Supply
Focus Category #2	Hydrology
Focus Category #3	Water Use
Lead Institution	Virginia Water Resources Research Center

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Thomas Burbey	Assistant Professor	Department of Geological Sciences	01
Dixie Reaves	Assistant Professor	Department of Agricultural and Applied Economics	01
Tamim Younos	Professional Staff	Virginia Water Resources Research Center	01

Problem and Research Objectives

Water stored in mine cavities and discharged freely through the portals in the coalfield counties of southwest Virginia can be a potential water source for a small community where other sources of water are scarce or not of acceptable quality. The goal of this project was to study the potential for developing mine cavity water as a potential source of drinking water in the coalfield counties of southwest Virginia. The overall goal of this project was to study the potential for developing mine cavity water as a potential source of drinking water. The project's components include hydrologic studies to determine sustainability of available water to meet community needs; legal and institutional issues related to developing mine cavity water; and water quality and water treatment options. Specific objectives of this study were to: 1. Determine if the water source is long-term sustainable to meet a near by community water demand using hydrologic studies. 2. Develop guidelines for developing mine cavity water as a drinking water source. 3. Determine water quality and water treatment options for a case study site.

Methodology

The following procedures were used to achieve study objectives: 1. Field instrumentation to develop a rainfall-discharge relationship. 2. Hydrologic analysis analogous to spring flow in karst systems to

determine sustainability. 3. Collection of census data, field measurements, sampling, and laboratory analyses of water quality parameters pertinent to the design of drinking water systems. 4. Review of technical and institutional documents pertaining to this study. 5. Interviews with local, state, and federal agency personnel. 6. Interviews with technical and legal experts from the coal mining industry. 7. Review of information from package-water-treatment plant manufacturers. The study site is located in Dickenson County, near the borders of Russell and Buchanan counties where Late Paleozoic sequences of carbonate rock, sandstone, coal, and shale predominate. The mine cavity water source is a large underground coal mine (Moss #3) that lays underneath an area of about 12 square miles. The discharge from the mine portal (an 18-inch corrugated steel pipe) drains into Indian Creek (Russell Fork watershed) at Duty, Virginia. The portal itself is located in the Tiller Fork watershed and drains only a small part of the mine called the D section. The portal can be seen along a finger ridge about 15 feet above the mining access road that intersects State Route 601. The watershed is a property of the Clinchfield Coal Company, a subsidiary of the Pittston Coal Company. According to mining personnel and local citizens, water has been flowing from the mine portal close to thirty years, and many people have used the water for a variety of purposes, particularly during droughts. The site is located about two miles from Duty, Virginia, a small community that lacks a public water supply. There are 120 houses, two churches, and one school in the area that could benefit from mine cavity water. The total water demand for the community was estimated as 50,000 gallons/day.

Principal Findings and Significance

Hydrologic Studies The spring recession analysis revealed that flow within the aquifer is dominated by flow from diffuse fissures within the strata. While this water makes up approximately 95% of the flow from the portal, approximately 5% of the water flow comes directly from conduits within the aquifer and can be assumed to be surface influenced. A definite lag time of 9 days was established between significant rainfall events and influence upon flow. The estimate of the portion of the flow considered diffuse (or baseflow) was used to estimate discharge after long periods of little rainfall and a sustainable value of 6 L/s was calculated. Using historic rainfall data and results from recession analysis the sustainable flow for baseflow (dry periods) was estimated as 2.85 L/s (65,000 gallons per day). This baseflow estimate exceeds the water demand requirement of 50,000 gallons per day discussed earlier. Institutional, Water Quality Issues, and Water Treatment Options Briefly, institutional issues examined include the ownership of the source water and the ownership of a developed water system; liabilities in terms of compliance to the Safe Drinking Water Act and zoning ordinances; the Virginia Department of Health permit requirements; and financing small water systems. The information to meet objectives of this study was obtained by: 1) reviewing technical and institutional documents; 2) interviewing local, state, and federal agency personnel; 3) interviewing technical and legal experts from the coal mining industry; 4) collecting census data; 5) field measurements, sampling and laboratory analyses of water quality for all EPA regulated parameters for the study site; and 6) reviewing material from package-water treatment plant manufacturers. Water analyses results indicate a relatively excellent water quality for the Moss # 3 discharge. All parameters except for sodium, sulfate, TDS, and total coliform were within the EPA's drinking water standard requirements. These contaminants (except for total coliform) do not pose a major health threat under normal conditions. High sodium levels in potable water can be a concern for people with high blood pressure and heart disease. Sulfate can act as a laxative for those not accustomed drinking water with a high sulfate content. Total Dissolved Solids (TDS) is a cumulative measure of all dissolved ions in water and is often a result of high Ca and Mg concentrations. High TDS content is a nuisance that may cause scaling in pipes, staining bathroom fixtures, and reducing soap lathering. Based on the water quality analysis, water treatment options can be developed to remove any undesirable contaminants from the water. However, it is a matter of cost and the consumer demand as to what degree the water is treated. Our investigation shows that the case study site discharge requires

prefiltration, filtration, and disinfection to meet regulatory requirements. The prefiltration is needed as a preventative measure to prevent membrane filter fouling due to occasional turbidity spikes. The membrane filter for removal of bacteria, cysts, viruses, and dissolved solids can be selected from one of the three options: ultrafiltration, nanofiltration, or reverse osmosis. All three filters will fulfill the filtration requirement, but the cost and community preference of the desired level of treatment will determine which process is selected. Chlorine disinfection is the least expensive as well as the most effective. Toxic disinfection byproducts, such as trihalomethanes, will not form due to the low level of organics in the source water. The membrane filtration will remove any chlorine resistant pathogens, as well. Therefore, there is no reason to choose an alternative disinfectant. The mine cavity water quality data and the design capacity of 50,000 gallons per day were given to two packaged water treatment manufacturers that use different filtration processes and requested to provide information on water treatment systems and costs. Cost information for a third system was obtained from an existing water treatment plant. Cost estimates for the three plants were compared in the final report.

Descriptors

Water supply, mine-cavity water, springflow

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Anderson, E. T. 1999. Determining the Sustainability of Coal Mine Cavity Discharge as a Drinking Water Source. M.S. Thesis in Civil and Environmental Engineering, Virginia Tech, Blacksburg,Virginia. 147 pp.

Water Resources Research Institute Reports

Younos, T., B. W. Wright, D. W. Reaves. 1999. The Potential for Developing Mine Cavity Water for Water Supplies: Institutional and Water Quality Issues. VWRRC Special Report SR12-1999. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, Virginia. 48 pp.

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Developing Guidelines for Sustainable Small Drinking Water Systems in Virginia
Project Number	S-04
Start Date	07/01/1998
End Date	12/31/1999
Research Category	Water Quality

Research Category	Water Quality
Focus Category #1	Water Supply
Focus Category #2	Water Use
Focus Category #3	Management and Planning
Lead Institution	Virginia Water Resources Research Center

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Tamim Younos	Professional Staff	Virginia Water Resources Research Center	01

Problem and Research Objectives

A basic characteristic of the small water system is limited managerial and financial capacity, which constrains their ability to comply with rapidly evolving regulatory requirements within a financially stable framework. At present, the Virginia Department of Health (VDH) and existing organizations such as the Virginia Rural Water Association (VRWA) provide state-of-the-art knowledge on small water systems operation and maintenance to water systems across Virginia. However, a more systematic approach is needed to assure the long-term ability of small water systems to provide adequate water service while adapting to new or existing regulations and customer demands, and to meet the requirements of section 1420 of the Safe Drinking Water Act. Development of capacity development guidelines for assessing and enhancement of the technical, institutional, and financial capacity of a water system will address this deficiency. Capacity development encompasses the technical, institutional, and financial capacity of a water system to satisfy public health and safety requirements. Objectives The general goal of this project is to develop capacity development guidelines for small water systems in Virginia. Specific objectives of the project include the following: 1.Develop guidelines for public health performance appraisals of small water systems. 2.Develop guidelines for assessing restructuring strategies. 3.Develop guidelines for evaluating, financing, and rate setting options. 4.Develop a web-based information transfer network for small water systems.

Methodology

Objective 1: Public Health Performance Appraisal To assess the potential value of the Public Health Performance Appraisal (PHPA) process to Virginia, a survey was performed of all Virginia small water system permit holders. The intent was to collect information regarding each of the areas of the PHPA and to use this data to determine if the weaknesses suggested by the NCR report held true in Virginia. Additionally, it was intended that the assumptions made by the report could be somewhat tested by the actual SDWA violations reported on the survey by the respondents to the survey. In February 1999, an 8-page, 85-question survey was mailed to each of the 3781 small water system permit holders in Virginia. The addresses for these permits were provided by the Virginia Department of Health (VDH) via their website. Each respondent was given between two and three weeks to return the survey in a postage-paid envelope. A total of 542 surveys were returned. Of these, 499 contained usable data, and 43 were returned because the water system was either out of business, had merged with another, or was no longer located at the address used. This represents a return rate of 13.3%. A survey of this kind of organization (small business) typically yields a return rate of between 10-20% (Paxson, 1995). The return rate obtained was thus considered adequate for the purpose of this study. The data was compiled

in a computer database and analyzed using SPSS software (SPSS, 1996). Objective 2. Restructuring Strategies The problem is simple. A strategy must be formulated that will foster the development of technical, managerial, and financial capacities for small public water systems (SPWS)in Virginia. The solution is not so simple. The new strategy must ensure that Virginians receive consistent, clean water, and are confident in its quality. The SPWS's must be motivated to buy into the new strategy, using the resources available to develop capacities. These systems appear hesitant to relinquish control over their resources, but at the same time, must remain operational. The state, motivated by federal legislation, must increase control over new water systems, as well as aiding established water systems in acquiring and maintaining capacity. There are numerous possible solutions to this problem, many of which were addressed in this study. The question, "Is there a simple solution that will address all of the objectives, and fulfill all of the needs of all interest groups?," was addressed by evaluating various options. Objective 3. Financing and Rate Setting Options The workbook and guidelines developed are aimed primarily at small water utilities and work best for systems that are metered and have no more than two user classifications. It is designed to help the user "fill in the gaps" in order to make educated decisions using existing utility records. Facilities design and costing will still require specialists, as well as an occasional outside review of rate structures. The workbook is, by necessity, broad in approach. The workbook is based on analytical techniques from a wide range of existing resources. These include the Virginia Department of Health Waterworks Permit Application Comprehensive Business Plan Section, previous work by Shinn and Randolph (1989), and various works from the American Water Works Association and the Rural Community Assistance Program, Inc. The workbook is organized into three modules. Each module consists of three or more detailed spreadsheets and accompanying instructions. The instructions are generally step-by-step and include background information and explanatory figures as necessary. The appendices also contain resource information for water systems. Objective 4. Developing Information and Technology Transfer Network The Virginia Interactive Technology Assistance Network (VIATAN) is a pilot project that aims to develop and test an electronic interactive problem solving service for small water systems. The VAITAN is challenged to develop a website with information that is beneficial and easy to use. Content is the vital component of the website. The presented information must match the needs of the users. A 1997 report, Safe Water From Every Tap: Improving Water Service to Small Communities, by the National Research Council identifies three areas where assistance is most needed: 1) affordable treatment technologies, 2) assistance in obtaining financial stability, and 3) training opportunities for operators. These three subject areas and others are addressed in the VAITAN's website. Because plenty of information is already available from the Internet, the VIATAN's website is designed to serve as a directory for online resources. A section which includes chat rooms and other online assistance services helps facilitate the sharing of information by water experts at the local, state, and national levels.

Principal Findings and Significance

Findings: Objective 1. Public Health Appraisal In 1994 the Environmental Protection Agency (EPA), recognizing the unique problems that face small water supply systems, asked the National Research Council (NRC) to perform a study of these problems and to make recommendations for minimizing them. The results of the study were reported in the 1997 publication, Safe Water from Every Tap: Improving Water Service to Small Communities. NRC's primary recommendation regarding these problems was to require Public Health Performance Appraisals (PHPA) of all small water systems. The PHPA consists of documenting and evaluating the following: (1) Issuance of health orders (2) Water quality (3) Certification of operators (4) Sanitary surveys (5) Water system plans The NRC recommends a water system plan contain: (1) Evaluation of existing system characteristics (2) System standards (3) Analysis of the supply source (4) Source protection (5) Operational and maintenance program (6) Emergency response program (7) Quality of supplied water (8) Improvement program (9)

Financial viability To assess the potential value of the Public Health Performance Appraisal (PHPA) process to Virginia, a survey was performed of all small water system permit holders in Virginia. An 8-page, 85-question survey was mailed to each of the 3781 small water system permit holders in Virginia. The intent was to collect information regarding each of the areas of the PHPA and to use this data to determine if the weaknesses suggested by the NCR report held true in Virginia. Additionally, it was intended that the assumptions made by the report could be somewhat tested by the actual Safe Drinking Water Act violations reported on the survey by the respondents. The Virginia Small Water Systems Survey analysis identified several weaknesses among Virginia's small water systems. Of notable concern were the areas of future planning, financial management by non-community water systems, preventative maintenance, and emergency preparation. It was noted that significant relationships exist between the SDWA violations and financial management, preventive maintenance, operations, and emergency preparation practices. However, this relationship is somewhat counter intuitive in that, systems that show higher levels of these practices actually have violated the SDWA more frequently. It is likely that this finding is the result of improvements in management practices following a violation. In other words, if a system is cited for a violation, they respond by improving their management practices in these four areas presumably to prevent future violations. Of additional interest is the role that operator certification plays in water systems. Systems with at least one certified operator reported a higher level of system knowledge, an increased level of preventive maintenance practices, and the use of emergency preparation practices. This lends support to a more comprehensive operator certification requirement that would encompass all small water systems. Finally, the survey supported the usefulness of record keeping. Systems with better records demonstrated a higher level of system knowledge. Additionally, systems with records pertaining to the regulation requirements were significantly less likely to have violated the SDWA. This would support the NCR's recommendation for increased system record keeping and planning. Findings: Objective 2. Restructuring Strategies The Safe Drinking Water Act Amendments of 1996 (SDWA) added Section 1420 to motivate states to improve the capacity of their small water systems. The objective is to increase compliance with the National Primary Drinking Water Standards as well as provide information and guidance to small water systems. The goals of this study were to investigate various options for consolidation and restructuring of small water systems as a component of capacity development for small water systems in Virginia and propose a strategy for capacity development and restructuring of public small water systems in Virginia. The study details the concept of capacity development, an overview of capacity development initiatives in several other states, and different approaches for consolidation and restructuring of small water systems by public and private sectors. Literature indicates that many of the small public water systems, especially those functioning as ancillary operations to other businesses, do not have the resources or the motivation to expand. Many small public water systems could benefit from revenue growth or cost cutting ventures available to larger water systems, but small systems do not have the access to capital or are limited by geographic location. After careful consideration of the different approaches by public and private organizations, the needs and motivations of those interested in capacity development, and the available resources, it was concluded that a new approach, i.e., the implementation of a co-operative operations and management for small water systems will be most suitable in Virginia. The co-operative as a body will decide and implement the most cost-effective operational, administrative, managerial, and technical options for its members. Co-operatives have been used in many industries, mainly in agriculture, to protect and improve on utilizing scarce resources and to guarantee returns to all interested parties based on the level of use. Similar to the agricultural co-ops, the water systems co-op is an attempt to pool the resources of many small water systems (small businesses) to reach their objectives. This report discusses the concept of co-operatives, and presents a strategy to form a Small Water Systems Co-Operative model for Virginia. The report details the co-op activities and responsibilities, co-op management, co-op administration, financial management, technical assistance, merits of the proposed water systems co-operative, and implementation and marketing strategy. The report concludes with a recommendation that the Virginia Department of Health (or a sub-contractor) take the lead and provide start up costs to

initiate a demonstration project that will produce sufficient data and offer an incentive for many potential participants. Once a successful co-op is established in a selected region it would create an incentive for many other small water systems to form regional co-operatives. It is suggested that for long-term implementation, the Virginia Department of Health should make grants and loans to small water systems conditional on the basis of participation in a cooperative. Findings: Objective 3. Financing and Rate Setting Options In an effort to enhance financial evaluation and performance for small water systems, a user-friendly guide and spreadsheets with detailed instructions were developed for evaluating capital improvement financing options and water rate setting. The major objective of the guide and spreadsheet program is to provide assistance that will allow small systems to obtain, organize, and use data necessary to identify capital needs, budgeting, and setting water rates. The guide is presented in three modules. Module 1, Estimating Capital Needs, consists of three worksheets, 1A, 1B, and 1C in which the capital improvements to be made within the next five years are entered, the costs adjusted for inflation, and the impact of the various methods of financing presented. Module 2, Budgeting, consists of worksheets 2A, 2B, and 2C in which water revenues for the next budget year are projected, an annual budget of revenues and expenses is completed, and a financial viability analysis summary is performed based on budget information. Module 3, Setting Water Rates, consists of worksheets 3A, 3B, 3C and 3A(2), 3B(2), 3C(2) for residential and commercial water systems, respectively, in which a general customer usage profile is developed, current rates are checked for equity, and new rates are set by the user based on the information presented in the previous modules and local considerations. The guide provides the needed assistance for small water systems to do the necessary financial planning, presents the resources to obtain necessary data, and simplifies the financial planning process in general. Upon completion of the process outlined in the guide, the water system will have a wealth of needed information stored within the spreadsheets and available for future financial planning. Appropriate data updates will also allow the system to continue to assess its financial health over time. Findings: Objective 4. Technology and Information Transfer Network The VAITAN website (www.vwrrc.vt.edu/sws) that is being developed lists various topic areas such as: Regulations Technological Assistance Financial Assistance Risk Management Seminars, Conferences, and Training Opportunities Publications Database of Experts Online Assistance (includes chat rooms) and links to other websites. Within each topic, there is a section of government websites, non-government websites, and other websites. The government sites are divided into United States Government and Virginia Government. The non-government section lists organizations with information about small water systems. The section referred to as Other Sites includes websites developed specifically to provide information on particular issues and not about a particular organization or agency. Under each agency, organization, or website name, either the mission statement or a brief description is provided. This information can be particularly important for describing resources with which the user is unfamiliar. Contact information is also provided in case the user cannot find the desired information or in the event the link does not take the user to the site. To help in navigating through the various websites, different sections of probable use to small water systems are presented with a hyperlink.

Descriptors

Small water systems, Capacity development

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Garcia, K., T. Younos, C. Thompson. 1999. Restructuring Strategies for Small Water Systems: Virginia Small Water Systems Cooperative. VWRRC Special Report SR15-1999. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, Virginia. 30 pp. Keuhl, D., J. Randolph, T. Younos. 1999. The Virginia Small Water Systems Survey: An Assessment of Public Health Performance Appraisals. VWRRC Special Report SR16-1999. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, Virginia. 64 pp. Williams, A. L. 1999. A Guide for Financing and Rate Setting Options for Small Water Systems. VWRRC Special Report SR-17-1999. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, Virginia. 56 pp.

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	A Study of Cost-Effectiveness and Risk Assessment of Integrating Telemetry Technology into Small Drinking Water Systems
Project Number	S-03
Start Date	08/01/1998
End Date	12/31/1999
Research Category	Engineering
Focus Category #1	Water Supply
Focus Category #2	Water Use
Focus Category #3	Management and Planning
Lead Institution	Virginia Water Resources Research Center

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Dixie Reaves	Assistant Professor	Department of Agricultural and Applied Economics	01
Tamim Younos	Professional Staff	Virginia Water Resources Research Center	01

Problem and Research Objectives

According to a 1997 National Research Council report, rural small water systems incur more operational problems than larger systems due to limited budgets which limit facility monitoring. These problems can manifest in a number of ways including greater quantities of water loss due to leaks and other facility failures. Water loss and the associated monetary value constitute operational risks to the water system that are reflected in its overall operating cost. Rural small water system facilities typically consist of numerous pumping, treatment, and storage units connected to customers by extensive piping networks. These facility components require frequent monitoring to establish operating conditions including indicators of risk events. Monitored components are typically situated remote to a common decision-making location, such as an administration office, where monitoring data are utilized to make operating decisions including responses to risk events. Presently, the vast majority of rural small water systems employ manual facility monitoring which entails acquiring operational data by human observation and movement between monitoring locations. Difficult terrain often increases monitoring effort. For example, rural small water systems in western Virginia are typically located throughout a county of mountainous terrain with a single county office serving as the common decision-making location. It is believed that remote control facility monitoring can be a useful risk reduction tool, but information about its cost-effectiveness for small water systems is lacking. No applicable case studies or commonly accepted method of cost-effectiveness analysis for this application was discovered during the literature review phase of this project nor by the American Water Works Association Research Foundation during a comprehensive literature review conducted pursuant to the preparation of Automation Management Strategies for Water Treatment Facilities. This project has two primary objectives. The first is to develop a computer model that calculates a measure of small water system operating cost as a function of monitoring type and that generates output necessary to describe remote control monitoring cost effectiveness. The second is to structure the model such that important information about the physical, personnel/operational, and fiscal subsystems of a user's small water system with either monitoring type can be displayed. After development and verification, the model will be used to estimate operating costs and remote control monitoring cost effectiveness for the Tazewell County, Virginia water system. Accomplishing these objectives requires developing a cost-calculating model and a cost-effectiveness methodology that can accommodate situations specific to each rural small water system.

Methodology

Rural small water systems can be thought of as consisting of three major interrelated subsystems, the physical subsystem, the personnel/operational subsystem, and the fiscal subsystem. These systems are operated with the goals of minimizing cost and risk while supplying potable water to customers. The composition and interrelationships among the subsystems will change with the type of monitoring employed - either manual or remote control. The physical subsystem consists of all physical features that

comprise or affect rural small water systems. These are water supply facility mechanical components such as pumps, treatment units, storage tanks and transmission pipes; geographic features such as topography, surface type and other natural and anthropogenic features that define the overall physical setting. General infrastructure includes roads, electric lines, and other infrastructure. Existing communication infrastructure includes telephone and radio systems. Remote control communication infrastructure includes satellite and radio systems that may exist or may be established specifically for remote control facility monitoring data transmission. The personnel/operational subsystem consists of all personnel and operational tasks that comprise or affect rural small water. This subsystem can be thought of as the operational organization and procedures that govern the system's decision-making process. The operational organization can be described as the correspondence between system personnel and operational tasks. These tasks can be further segregated into routine and non-routine tasks, where non-routine tasks are predominantly those necessary to respond to risk events. The fiscal subsystem consists of the relationships among, and execution and recording of all money receipts and disbursements. An important goal of small water system operation is risk minimization. In this context, risk events can be thought of as operational excursions (risk events) such as pipe breakage or storage tank overflow that cause water loss, or as the cost associated with these risk events. Rural small water system operational decisions to minimize risk typically require measuring system conditions at numerous remote locations and periodically conveying descriptive data to a central decision-making location. Thus, monitoring frequency and response time affect the quantity of risk incurred. Risk-event duration and risk are inversely proportional to monitoring frequency and directly proportional to response time. Monitoring frequency and response time are functions of the type of system monitoring (manual or remote). Manual facility monitoring consists of water supply system operational data acquisition by human observation and movement between monitoring locations. This typically involves motor vehicle travel to monitoring locations for observation and reporting back to the decision-making location via telephone or two-way radio when risk events are detected. Manual facility monitoring response time is a function of monitoring frequency and travel time. For example, if routine facility monitoring involves observing storage tank water level, an inspector might drive by to the tank at five-day intervals, visually observe the water level, and report this level to the decision-making location at the time of travel for routine conditions or by telephone or two-way radio immediately for risk-events. Using this example scenario, the response time could be as long as five days. Remote control facility monitoring consists of water supply system operational data acquisition by electronic sensing and telemetric data transmission between monitoring locations and a common decision-making location. This typically involves periodic data acquisition at monitoring locations and real-time telemetric transmission to the decision-making location via telephone, radio or satellite link. Again, for example, if routine facility monitoring involves observing storage tank water level, remote control facility monitoring, could acquire and transmit tank level data to the decision-making location hourly, giving a maximum response time of essentially one hour. The general approach to constructing the cost model was dictated by the project objectives and situational framework. In order to accommodate the numerous cost-affecting variables within the physical, personnel/operational and fiscal water system subsystems, an integrated GIS/MIS-based model comprising three primary subroutines - GIS, MIS, and telemetry data transmission analysis subroutine - was established as the general model structure. The subroutines are linked by the general model structure through the GIS operating platform.

Principal Findings and Significance

The general approach to constructing the cost model was dictated by the project objectives and situational framework. In order to accommodate the numerous cost-affecting variables within the physical, personnel/operational, and fiscal water system subsystems, an integrated GIS/MIS-based model comprising three primary subroutines - GIS, MIS and telemetry data transmission analysis

subroutine - was established as the general model structure. The subroutines are linked by the general model structure through the GIS operating platform. The physical subsystem is catalogued by the GIS; the personnel/operational subsystem is catalogued by the MIS; and the fiscal subsystem is represented by the model parameters, variables, and structure including the telemetry data transmission analysis subroutine. The telemetry data transmission analysis subroutine performs calculations to determine costs associated with different methods of remote monitoring data transmission. The model functions to enable comparison of cost and other aspects of water system operation that vary with the type of monitoring employed (manual or remote control) by working in either of two modes. In the integrated mode the model calculates a measure of overall operational cost (e.g., unit cost of water delivered) that can be used for direct comparison or for generating cost-effectiveness curves. In addition to operating in the integrated mode, each subroutine can be engaged independently to perform calculations or display information about corresponding aspects of the water system. The primary risk (cost) variable is monitoring response time, which varies as a function of the extent of remote control monitoring technology employed. The model will calculate total system operating cost with risk incorporated into cost by defining it as the cost of treated water lost from the supply system due to risk events. The model subroutines must be able to manage all relevant physical and operational information, provide data storage and retrieval, and generate outputs that serve as inputs for subsequent subroutines, as necessary. The model operates through the GIS platform which links the MIS and data transmission subroutines to create the integrated model that is accessed as an object-oriented system in Visual Basic. The primary purpose of the integrated model is to generate and display the cost-effectiveness relationships. Cost effectiveness can be described by engaging the model for different extents of remote control monitoring to generate a cost-effectiveness curve. The model will generate the necessary curves in both tabular and graphic forms.

Descriptors

Telemetry, Small water systems, Water Supply

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Grady, B.M., W. Farley, T. Younos. 1999. Telemetry Options for Small Water Systems. VWRRC Special Report SR14-1999. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, Virginia. 23 pp.

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Uncertainty, Sensitivity and Risk in the Mississippi, Missouri, and Illinois Rivers Flow Frequency Study
Project Number	S-08
Start Date	09/01/1998
End Date	08/31/2000
Research Category	Climate and Hydrologic Processes
Focus Category #1	Water Quantity
Focus Category #2	Methods
Focus Category #3	Water Supply
Lead Institution	University of Virginia

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Jacob Haimes	Professor	University of Virginia	01

Problem and Research Objectives

The study addresses the following five objectives: 1. Large Basin Hydrology Issues 2. Hydroclimatological Analysis of Mississippi/Missouri Basin Floods 3. Non-Stationary: Land Use Changes and Channel Modifications 4. Integrating and Communicating Different Types of Uncertainty 5. Implications of Uncertainty on Floodplain Management

Methodology

Meeting Objective 1 (IWR) - Data Analysis and Model Building Review and empirically assess the hydrologic modeling of large basins. Meeting Objective 2 1) (IWR) - Literature Review Review the literature and evaluate models that can be used to analyze hydroclimatological causes of extreme floods in the Mississippi-Missouri Basin. Review previous models of climate change to discuss implications of climate change for flooding on the Mississippi and Missouri Rivers. The effect of climate change on flooding probabilities can then be assessed. 2)(IWR)Model Analysis Based on an existing study of General Circulation Models (GCM), examine and evaluate the range of climate scenarios and effect on extreme events using the VIC-2L model. Meeting Objective 3 (IWR) - Literature Review Review studies of the effects of land use changes and channel modifications on downstream discharges for flood events, particularly the effects on floods of return period of 2 years or more. Coordinate with the St.

Paul District to estimate the effects of land use changes on uncertainty in estimates of unimpaired discharge. Meeting Objective 4 1) (UVA) Methodology Development Develop procedures to analyze and explain the relationship between uncertainty and variability, particularly in the stage-frequency curve. Many different flood scenarios can affect the stage-frequency curve, i.e., ice influences and levee failures. If these scenarios are modeled as stage, then the resulting stage-frequency curve is computed as probability weighted average of the stage frequency curves from each of the scenarios. Alternatively, a single stage frequency curve is computed based on the randomly occurring stages due to any scenarios. The uncertainty in the resulting stage frequency curve will be significantly different depending on whether or not flood stages result from variable flood scenarios or randomness. 2) (UVA) Methodology Development Develop procedures to communicate and explain risk and uncertainties to planners, engineers, decision-makers, and the general public. This section will also develop a report that explains the different sources of uncertainty in the Mississippi/Missouri River Flood Frequency Study. Meeting Objective 5 1) (IWR)Regulatory/Procedural and Interpretation Review Corps of Engineers' and other state and federal government agency procedures and regulations to determine which policy issues may be affected by uncertainty in stage or discharge levels. These procedures can include levee certification, flood insurance, flood warning and evacuation, navigation reliability and reservoir operating rules. 2) (UVA/IWR) Model Development Hydrologic uncertainties may be "swamped" by economic, institutional and other uncertainties. Develop a model to evaluate the effects of uncertainty on cost/benefit/risk analysis and tradeoffs for flood management policies. The models can be used in a later follow-on case study involving levee certification at a particular location.

Principal Findings and Significance

The primary goal was integrating and communicating different types of uncertainty into the flood-frequency study. The results of this study are relevant to the design criteria of flood protection structures, specifications for the 50-, 100-, and 500-year floodplains, to flood insurance programs, and to levee recertifications. Two graphical methods were developed to represent model uncertainty and were demonstrated to facilitate analysis: · Alternative Tree. An alternative tree is a representation of the different modeling and parameter alternatives available to modelers in the study. Though all possible alternatives can never be analyzed, studied and researches alternatives are highlighted through the alternative tree. . Impact Table. The impacts of some of the alternatives on the flood-frequency curve and flood-plain boundaries can be approximated and shown in an impact table and associated figure. The outcome also highlights areas where more scientific and engineering investigation is warranted in future years. Some preliminary results of the application of the developed methods are: · Levee failure/floodfighting may affect flood stages by up to 3 ft. at some locations. · Ice-influenced flows may affect flood stages by up to 2 ft. at some locations. · Further investigation is required to ascertain the impact of long-term climate change on flood stages. Furthermore, it was concluded that the uniformity of information to be used between cases is important in comparing cases using the developed method.

Descriptors

Modeling, Risk Management, Uncertainty

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Rolf Olsen. 1999. Flood Risk Management of a System of Levees. Ph.D. dissertation, University of Virginia.

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Developing Student Water Quality Specialists to Serve Communities in Virginia
Project Number	S-06
Start Date	12/15/1998
End Date	12/15/1999
Research Category	Water Quality
Focus Category #1	Education
Focus Category #2	Methods
Focus Category #3	None
Lead Institution	Virginia Water Resources Research Center

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Leonard Shabman	Professor	Virginia Water Resources Research Center	01
Alan Raflo	Research Associate	Virginia Water Resources Research Center	01

Problem and Research Objectives

The Service Training for Environmental Progress (STEP) project entitled "Developing Student Water-quality Specialists to Serve Virginia Communities" seeks to develop a well-rounded and repeatable training process for college-level students who serve summer-long, water-resource-related internships in Virginia communities. The project is supported by a grant from the National Environmental Education and Training Foundation. The specific project objectives are: 1) Develop a training package for university students to learn basic concepts and practices related to water quality and water-pollution prevention, and to learn how to transfer such information to citizens or community groups in Virginia. 2) Place students who took the training package in three actual community projects. 3) Evaluate the value of the training package to these projects, and incorporate lessons learned into a revised training process available for use with Summer 2000 internships.

Methodology

STEP is using existing educational materials or workshops to address the following subject and skill areas: A. Working in Communities 1. Rural Areas 2. Urban Areas 3. Introduction to specific host communities B. Virginia Water Resource Information 1. Surface Water (fresh) 2. Surface Water (coastal and estuarine) 3. Groundwater C. Water Policy Information D. Water Skills/Methods E. Safety F. Communication Issues and Skills G. STEP Administrative Procedures

Principal Findings and Significance

The training package used in Summer 1999, was evaluated by the Summer 1999 interns and by a group of water-quality specialists and environmental educators. Some training elements (materials, workshops, or specific speakers) used in 1999 were very successful, but others were not, either because they ultimately were not applicable to the students' internships or because the presentation was weak. The overall package, however, seems to be appropriate and feasible. STEP will use the evaluations from this summer to add or delete elements to strengthen the package, especially in the area of pollution causes and prevention.

Descriptors

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

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Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	A Water Quality Academic Advisory Committee for the Virginia Water Quality Assessment Process
Project Number	S-05
Start Date	01/01/1999
End Date	03/30/2000
Research Category	Water Quality
Focus Category #1	Ecology

Focus Category #2	Surface Water
Focus Category #3	Management and Planning
Lead Institution	Virginia Water Resources Research Center

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Leonard Shabman	Professor	Virginia Water Resources Research Center	01

Problem and Research Objectives

The federal Water Pollution Control Act (PL92-500), commonly known as the Clean Water Act, last authorized by the Water Quality Act of 1987 (PL100-4), establishes a process for states to develop information on the quality of nation's water resources and to report the information to the U.S. Environmental Protection Agency (EPA), to the U.S. Congress, and to the citizens. The requirements for this process are found in Sections 106(e), 204(a), 303(d), 305(b), and 314(a) of the Clean Water Act. The Virginia Department of Environmental Quality (DEQ) is required to prepare the biennial 305 (b) water quality assessment report and the 303(d) Total Maximum Daily Load (TMDL) priority list report for submission to the EPA. These reports are used to assess the general condition of the state's waters [305(b)] and to identify specific waters so impaired that remedial actions must be taken to meet water quality standards [303(d)]. The reports are submitted to EPA on April 1 of even numbered years. A 1996 Joint Legislative Audit and Review Committee (JLARC) report on the Virginia Department of Environmental Quality (DEQ) and the Chesapeake Bay Foundation's report "Virginia's Waters Still at Risk" identified critical areas that the DEQ should address to improve the quality of its 303(b) and 305 (d) reports. Some of the concerns expressed about the water quality assessment reports, such as determining waters of the state impaired by nutrient over enrichment, were not included in previous 303 (d) reports because Virginia does not have water quality standards for nutrients. Other concerns, such as the determination of impaired waters based on monitoring data, require the DEQ to review existing procedures to determine if improvements can be made. In 1997, the Virginia General Assembly in the Water Quality Monitoring, Information and Restoration Act (WQMIR) directed the DEQ to develop the 303(d) and 305(b) reports in consultation with universities. Also, WQMIR requires the DEQ to "develop and publish a procedure governing its process for defining and determining impaired waters and shall provide for public comment on the procedure" with the assumption that these 303(d) procedures will be developed after consultation with scientists from state universities. Objectives To meet the WQMIR academic consultation requirements, the DEQ requested the Virginia Water Resources Research Center (VWRRC) to organize and administer a Water Quality Academic Advisory Committee (WQAAC). The WQAAC serves as an independent advisory body to the DEQ and its activities are coordinated by the VWRRC. The responsibility of the WQAAC is to review and evaluate scientific merits of the DEQ's existing and evolving water quality assessment procedures. Based on review, where deemed necessary, the WQAAC will make recommendations to the DEQ to improve its assessment guidelines.

Methodology

The WQAAC initiated its review and worked in parallel with the DEQ as the DEQ planned to meet the EPA deadlines for reporting. The WQAAC reviewed the guidelines that were also sent out for public notice. In that review the WQAAC agreed to respond to eight priority questions posed by the DEQ. Based on that review, a meeting held in December 1997 with DEQ staff, and building on its own deliberations, the WQAAC identified other issues for recommendations to the DEQ. These issues may be related to water quality monitoring and assessment but may not be specifically discussed in the guidelines. The WQAAC decided to comment on these issues as long as they bear on the quality and utility of the 305 (b) and 303 (d) reports. Water quality assessment is as much art as science and is as much policy judgment as it is analysis. Also both the art and the science of water quality assessment are continuously changing. The WQAAC recognizes that our advice can be only that - advice -- and the final determination of how the assessment program will be conducted and the decisions that must be made rest with the responsible state agencies. We also understand that a more perfect monitoring and assessment system will only be developed over an extended period of time with much trial and error and, perhaps, with additional financial resources. For these reasons we chose to categorize our suggestions into short-term and long-term actions for the state. In developing these recommendations individual WQAAC members worked with the DEQ staff, but all findings and recommendations were reviewed by the full WQAAC before submission to the DEQ. Occasionally, the WQAAC did not reach an internal consensus. In these cases the VWRRC has assured that issues of disagreement are highlighted.

Principal Findings and Significance

Overall the WQAAC made 17 findings and recommendations to the DEQ. In making these findings and recommendations, the WQAAC recognized that the assessment process is a work in progress and that there are few "correct" ways to approach the assessment challenge. In addition, the WQAAC was sensitive to the reality that assessment rests on both science and on policy judgments. As an overall summary, the WQAAC did not recommend that the DEQ make immediate changes to its assessment guidelines. However, the WQAAC did recommend a number of future actions. These are summarized below: a. The DEQ carefully explain the logic of its assessment approaches and the logic employed to list waters as impaired by organizing its arguments. This might be accomplished by using concepts from the risk assessment literature and by improved explanations of current use of statistical inference procedures. b. Three new Technical Advisory Committees (TAC) be formed to address pressing issues and to help the DEQ to make future modifications to the guidelines and assessment practices. These TACs would focus on nutrient enrichment criteria, sediment contamination, and monitoring strategy. Long term strategies to further develop the monitoring program were suggested by the WQAAC and might be considered by the monitoring TAC. c. The DEQ conduct a review of certain practices to determine whether long-term adjustments are warranted. Such review was suggested for the criteria for shellfish contamination, bio-monitoring, and model development and use for the TMDL process. d. Based on a review of the current monitoring program and its costs, the DEQ should find ways to redesign its program to increase sampling frequency and locations while limiting costs. Costs might be limited by increased cooperative work with others. From this effort, the DEQ would enhance its ability to define the geographic extent of impairment, categorize long-term trends in water quality, and support the modeling requirements for the TMDL process.

Descriptors

Water quality, Assessment and planning

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Shabman, L. A., C. Hershner, H. I. Kator, E. P. Smith, L.A. Smock, T. Younos, S. L. Yu, C. E. Zipper. 1998. Report of the Water Quality Academic Advisory Committee. Prepared for the Virginia Department of Environmental Quality, Division of Water Program Coordination, Assessment and Planning. VWRRC Special Report No. SR8-1998. Virginia Water Resources Research Center, Virginia Tech, Blacksburg, Virginia. 27 pp.

Conference Proceedings

Other Publications

Information Transfer Program

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Web-Based Daily News
Description	The VWRRC displays on its website state-wide and regional water related news on a daily basis. Every day the information is extracted and posted on VWRRC website (http:colon;//www.vwrrc.vt.edu. The web-based daily news is very popular with state and local agency personnel and interested citizens.
Start Date	03/01/1998
End Date	02/28/1999
Type	Newsletter
Lead Institution	Virginia Water Resources Research Center

Principal Investigators

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Basic Project Information

Basic Project Information	
Category	**Data**
Title	Water Central - Bimonthly Newsletter
Description	In 1998, the Virginia Water Resources Research Center launched a new bimonthly newsletter 'Water Central' to replace the Water News that was published for 25 years but was discontinued in 1994 due to budget cuts. The first issue of the Water Central was printed in June 1998. During the reporting period (3/1/98 to 2/28/99) five issues of a 16-page newsletter were printed. The hard copy is distributed to about 2700 subscribers free of charge. About 10 percent of thr readership are from states other than Virginia. A Web-version of the newsletter was initiated on August 1998. At present, all issues are available on the Water Center website (http:colon;//www.vwrrc.vt.edu). Currently, 140 people are notified by e-mail when the most recent issue of the newsletter is posted on the Water Center website.
Start Date	06/30/1998
End Date	02/28/1999
Type	Newsletter
Lead Institution	Virginia Water Resources Research Center

Principal Investigators

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Basic Project Information

Basic Project Information	
Category	**Data**
Title	Southwest Virginia Water Symposium'98
Description	The Southwest Virginia Water Symposium'98 was held at the Higher Education Center in Abingdon on October 29, 1998. The goal of the Water Symposium'98 was to provide an update and discuss accomplishments during the past two years (the first Southwest Virginia Water Symposium was held on October 1996). Topics presented at the symposium included plenary sessions on wellhead/water source protection strategies, drinking water supply strategies, and watershed protection strategies. A special plenary session was dedicated to the role of Extension and Agricultural Experiment Stations in dealing with water issues. In addition, two technical/educational sessions were organized around papers that were received in response to the 'Call for Papers'. More than 70 individuals attended the symposium. The symposium proceedings is available from the VWRRC.
Start Date	10/26/1998
End Date	10/26/1998
Type	Conferences
Lead Institution	Virginia Water Resources Research Center

Principal Investigators

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Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Household Wastewater Treatment - Alternative Methods
Description	The 3-hour workshop instructed by Patricia Miller from the Virginia Department of Health covered alternative on-site techniques for household wastewater treatment. Forty individuals attended the workshop that was held in Abingdon, Virginia.
Start Date	10/26/1998
End Date	10/26/1998
Type	Conferences
Lead Institution	Virginia Water Resources Research Center

Principal Investigators

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Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

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Other Publications

USGS Internship Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	N/A	1	1	9	11
Masters	N/A	7	N/A	7	14
Ph.D.	N/A	7	N/A	1	8
Post-Doc.	N/A	N/A	N/A	N/A	N/A
Total	N/A	15	1	17	33

Awards & Achievements

Publications from Prior Projects

Articles in Refereed Scientific Journals

Younos, T., A. Mendez, E. R. Collins, B.B. Ross. 1998. Effects of a Dairy Loafing Lot-Buffer Strip on Stream Water Quality. JAWAR, Vol. 34(5):1061-1070. Sherali, H.D., R. Totlani, G.V. Loganathan. 1998. Enhanced Lower Bounds for the Global Optimization of Water Distribution Networks. Water Resources Research, 34(7):1831-1841. Shukla, S., S. Mostaghimi, B. Petrauskas, and M. Al-Smadi. 1999. A multivariate technique for baseflow separation using water quality/quantity data. Journal of Hydrologic Engineering (ASCE) (In press) Shukla S., S. Mostaghimi, and J. A. Burger. 1999. Laboratory measurements and modeling N mineralization potential in Virginia Coastal Plain agricultural, fallow, and forest soils. Transactions of the ASAE (In press).

Book Chapters

Younos, T., C. Frago, T. Brown. 1998. Determination of Contamination Sources and Restoration Method for a Polluted Stream Using Monitoring Data. In: Rural Environmental Management, Polish Academy of Science, Publication No. 458. Warsaw, Poland. p. 517-524.

Dissertations

Shivaram Subramanian. 1999. Optimization Models and Analysis of Routing, Location, Distribution and Design Problems. Ph.D. Dissertation, Department of Industrial and Systems Engineering, Virginia Tech, Blacksburg, Virginia.

Water Resources Research Institute Reports

Younos, T. R. Bohdan, E. Anderson, K. Ramsey, N. Cook, B. Ross, T. Dillaha, J. Poff. 1998. Evaluation of Rooftop Rainfall Collection-Cistern Storage Systems in Southwest Virginia. VWRRC Special Report SR3-1998. 41 pp. Frago, C., T. Younos, A. Mendez, T. Brown. 1998. Batie Springs: Assessment and Restoration. VWRRC Special Report SR4-1998. 56 pp. Reaves, D. W. T. Younos, K.A. Ramsey. 1998. Economic Analysis of Water Hauling for Southwest Virginia Communities. VWRRC Special Report SR5-1998. 48 pp. Lovern, S.B., R. Bohdan, T. Younos, S. Mostaghimi, F. Smith. 1998. Wetland Restoration for Science Education - Glade Spring, Virginia. VWRRC Special Report SR6-1998. 47 pp. Wetzel, G.L., and T. Younos. 1998. Virginia Tech Landfill Detention Pond Area Evaluation. VWRRC Special Report SR7-1998. 53 pp. Report of the Water Quality Academic Advisory Committee. Shabman, L. (Chair), T. Younos, et al. 1998. VWRRC Special Report SR8-1998. 27 pp. Younos, T. S. Shukla, W. Tomlinson. 1998. Slussers Chapel Cave Preserve - A Study of Water Environment. VWRRC Special Report No. SR9-1998. 35 pp. Zipper, C. G. Holtzman, P. Darken, P. Thomas, J. Gildea, T. Younos. 1998. Long-Term Water Quality Trends in Virginia's Waterways. VWRRC Special Report SR-11, December 1998. 134 pp. Murphy, E.A., K. Stephenson. 1999. Inland Recreational Fishing Rights in Virginia: Implications of the Virginia Supreme Court Case - Kraft v. Burr. VWRRC Special Report SR13-1999. 19 pp. Younos, T., J.A. Poff (Editors). 1998. Proceedings of the Southwest Virginia Water Symposium'98. VWRRC, Virginia Tech, Blacksburg, Virginia. 89 pp.

Conference Proceedings

Younos, T., S. Mostaghimi, C. Newell, P. McClellan. 1998. Quality Assurance/Quality Control Plan for Agricultural Nonpoint Source Pollution Monitoring Research. Proc. of the National Water Monitoring Conference, The National Water Monitoring Council, U.S. Environmental Protection Agency,

Washington, D.C. pp. 341-350. Lovern, S. B., T. Younos, F. Smith, S. Mostaghimi. 1998. Wetland Restoration and Enhancement for Science Education. 1998. In: Proc. Southwest Virginia Water Symposium'98. Virginia Water Resources Research Center, Blacksburg, Virginia. pp. 51-58. Younos, T. and D.W. Reaves. 1998. Drinking Water for Isolated Communities. In: Proc. Southwest Virginia Water Symposium'98. Virginia Water Resources Research Center, Blacksburg, Virginia. pp. 14-18.

Other Publications

Shukla S. and S. Mostaghimi. 1998. A framework for evaluating BMP effects on N discharge from watersheds. Presented at the 1998 ASAE Annual International Meeting in Orlando, FL, Paper No. 982008. ASAE, 2950 Niles Road, St. Joseph, MI. Shukla S., M. Al-Smadi, B. Petrauskas, and S. Mostaghimi. 1998. A multivariate technique for baseflow separation. Presented at 1998 ASAE Annual International Meeting in Orlando, FL, Paper No. 983189. ASAE, 2950 Niles Road, St. Joseph, MI. Shukla S., S. Mostaghimi, and J. A. Burger. 1998. Quantification of N mineralization potential in agricultural and forest soils in a Virginia Coastal Plain watershed. Presented at the 1998 ASAE Annual Meeting in Orlando, FL, Paper No. 982013. ASAE, 2950 Niles Road, St. Joseph, MI.