

The Center for TMDL and Watershed Studies at Virginia Tech:
Activities and Accomplishments

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Abstract

The Center for TMDL and Watershed Studies at Virginia Tech (the Center) is committed to improving the quality and effectiveness of watershed planning processes, including TMDLs, as well as expanding the professional expertise needed for their development, evaluation, and implementation. The Center conducts basic and applied watershed planning and watershed management research, and provides educational programming tailored to the specific needs of stakeholders, government personnel, and technical professionals. Personnel associated with the Center provide expertise on scientific, engineering, sociological, economic, and policy issues related to watershed management and the TMDL process. The Center's mission, products, and services reflect the service-oriented Land-Grant University missions of teaching, outreach, and research. The Center is actively involved in developing TMDLs and TMDL implementation plans in situations where the methodology and guidance to develop such deliverables are not well defined. To date, the Center has developed 25 TMDLs in Virginia, addressing both bacterial and biological impairments. The Center has developed and delivered TMDL workshops to a variety of audiences, prepared supporting TMDL-specific extension publications, and developed and delivered a graduate level course in TMDL development and implementation. In addition, the Center has partnered with the U.S.EPA to develop a web-based TMDL knowledgebase, the TMDL Clearinghouse.

Introduction

The Total Maximum Daily Load (TMDL) program, which is mandated by the Clean Water Act, is a watershed management process that integrates watershed planning with water quality assessment and protection. Water bodies in violation of state water quality standards are referred to as "impaired." Pollutant-specific TMDL plans are required for impaired water bodies. The TMDL development process includes three steps: identifying the sources of the pollutants causing water quality impairments; quantifying the pollutant contribution from each source; and determining the pollutant reduction from each source required to meet applicable water quality standards. Across the nation, the U.S.EPA is under court ordered consent decrees to ensure that tens of thousands of TMDLs are developed in the next 10 to 15 years. Some 636 TMDLs must be developed by 2010 in Virginia alone. These TMDLs only address existing water quality impairments. However, as additional water quality monitoring data are collected, and additional ambient water quality standards are developed and promulgated, more TMDLs will be required.

Like most of the Virginia TMDLs, the majority of impairments being addressed in TMDLs across the nation are due to nonpoint source (NPS) pollution. Since passage of the Clean Water Act in 1972, great progress has been made towards the control of point source pollution. Consequently, the science and technology required for creating TMDL plans that address point source pollution impairments are well developed. The same is not true for impairments due to nonpoint sources.

Nonpoint source pollution control science, technology, and expertise are lacking. As a result, the quality and consistency of TMDL plans addressing NPS impairments may suffer. A great need exists for basic research to develop NPS pollution control and assessment technologies; applied research to address specific scientific and policy components of the TMDL process; and training of scientists, engineers, and planners who can develop and implement TMDLs that address both point and nonpoint sources of pollution.

Public and private costs associated with TMDL development and implementation over the next 15 years are estimated to be \$1 billion for development of TMDL plans, \$255 million for additional monitoring to support TMDLs, and \$13.5 to \$64.5 billion for TMDL implementation, a total cost of approximately \$15 to \$66 billion nationally (USEPA, 2001). Both research and outreach efforts are needed to ensure these public and private funds are invested wisely and result in measurable water quality improvement. The Center for TMDL and Watershed Studies at Virginia Tech was created to serve this need. The goal of this paper is to inform the reader about the Center for TMDL and Watershed Studies and some of the efforts of its membership.

Center's Mission, Objectives, and Membership

The mission of the Center for TMDL and Watershed Studies (hereafter, the Center) is to conduct interdisciplinary research, teaching, and outreach to improve the integrity of the Nation's waters and watersheds by advancing the science, tools, and expertise available for developing, evaluating, and implementing watershed planning and management processes. The objectives of the Center are to:

- conduct basic and applied research to improve the science and procedures used to develop, evaluate, and implement watershed management plans, including TMDL plans, that address water quality issues;
- provide training in the development and implementation of accurate, effective, achievable TMDLs; and
- facilitate participation in the TMDL process by increasing awareness and understanding of NPS pollution and water quality issues.

Center Membership

The Center's membership is composed primarily of faculty and staff at Virginia Tech. Establishment of the Center for TMDL and Watershed Studies at a major research university such as Virginia Tech provides the atmosphere necessary for integrating an array of disciplines to holistically address the TMDL process. To

address an array of watershed planning and TMDL-related issues, faculty from four colleges (College of Agriculture and Life Sciences, College of Engineering, College of Natural Resources, and College of Architecture & Urban Studies), representing a dozen disciplines, are active in the Center. A current listing on faculty affiliated with the Center is available upon request. In addition to Virginia Tech, faculty from the University of Virginia, West Virginia University, and Penn State are involved in ongoing Center projects.

Description of the Center's Scope and Programs

The Center has developed TMDL expertise first hand by developing more than 25 TMDLs for fecal coliform and aquatic life (benthic) impairments in Virginia since 2000. Team members have made more than 60 presentations at TMDL public meetings associated with these TMDLs. These presentations were designed to inform, involve, and educate the public about TMDLs and the integral role they, as stakeholders, play in improving water quality. A conservative estimate places the number of stakeholders reached directly at these TMDL public meetings at more than 2,000. Virginia's Department of Conservation and Recreation (DCR) and Virginia's Department of Environmental Quality (DEQ) are the agencies responsible for the state's TMDL program. Anecdotal evidence from both agencies reflects that the Center's involvement with and engagement of stakeholders throughout the TMDL development process has been instrumental in developing quality TMDL plans that have stakeholder support and, as a result, have a greater likelihood of being implemented and ultimately improving water quality.

In addition to conducting direct outreach programs through public meetings, members of the Center have developed and delivered technology transfer workshops to a variety of audiences including local, state, and federal agency personnel; elected officials; private sector consultants; and academics in one- to four-day modules at various professional meetings in Virginia, other states, and in Canada and South Korea. Workshops developed and delivered by team members address a range of issues including the basics of the TMDL program, potential impacts of the TMDL program on agricultural and urban interests, hydrologic and water quality modeling for TMDL development, and effective TMDL project management. The workshops have reached more than 1,000 clientele. The development and delivery of workshops is ongoing. The Center has also presented more than a dozen TMDL-related papers at various professional meetings, developed TMDL-specific Virginia Cooperative Extension publications (<http://ext.vt.edu/resources/anrpublications.html#DEPT52>), and developed a regional TMDL resource directory that is available through the USDA Mid-Atlantic Regional Water Quality Program (www.agnr.umd.edu/users/waterqual/).

To ensure that the Center's extension/outreach and research programs remain relevant and responsive, the Center continues to develop TMDLs in circumstances where the methodology to develop a specific type of TMDL is not well defined. The Center is currently developing 16 TMDLs in Virginia. Center members have published articles on topics ranging from bacteria source tracking to comparing the performance of watershed-scale models currently being used to develop TMDLs (Kern et al., 2002 and Im et al., 2004).

To address the Center's teaching mission, members of the Center have developed and are teaching a course on TMDL Development and Implementation. This course is offered by the Biological Systems Engineering department at Virginia Tech. The course includes such topics as: data sources, data collection, monitoring system design, project organization and management, public participation, modeling, and alternative TMDL development approaches. The examination and critique of case studies is emphasized. The course is organized around the development of TMDL plans by multidisciplinary student teams. The course typically includes students from the departments of Biological Systems Engineering, Civil and Environmental Engineering, and Urban Affairs and Planning. The course is team-taught by a multidisciplinary group of faculty.

Research conducted by the Center's membership covers an array of TMDL-related areas. An example of a research project directly related to TMDL implementation involved the development of Best Management Practice (BMP) assessment tools designed to assess the quality of agricultural BMPs. Quality assessments made with the tools are based upon visual observations made by a trained assessor rather than traditional assessment methods such as water quality monitoring. The BMP quality scores have the potential to be used as a surrogate measure for BMP performance, without the extensive water quality monitoring typically associated with performance quantification (Cunningham et al., 2005).

To improve the efficiency and consistency with which bacteria TMDLs are developed, the Center developed the Bacteria Source Load Calculator (BSLC). The BSLC is a software package that is used to characterize bacterial source inputs needed for a watershed-scale simulation fate and transport model in the TMDL allocation scenario development process. The BSLC uses externally generated inputs, such as land use distribution and livestock, wildlife, and human population estimates, to calculate monthly bacterial land loadings and hourly bacterial stream loadings. The BSLC and its underlying methodology have been used in the development of 21 bacterial TMDLs in Virginia. The BSLC software greatly simplifies the creation of required data files needed by watershed-scale simulation models and provides consistency in data development and processing (Zeckoski et al., 2005).

In addition to improving the efficiency of TMDL development efforts, the Center is involved in research designed to improve the effectiveness of TMDL implementation plans. In Virginia, TMDL implementation plans are required by state law – the Water Quality Monitoring, Information and Restoration Act (WQMIRA) legislation. In cooperation with Virginia's environmental regulatory agencies, the University of Virginia's Institute for Environmental Negotiation, and West Virginia University, the Center is developing TMDL implementation plans for two Virginia watersheds and one watershed that crosses from Virginia into West Virginia. Research associated with these efforts will result in an improved "road map" or process for eliciting informed, effective public involvement in the TMDL implementation plan development and execution process. Longer term studies to

track implementation progress effectiveness are being designed for these target watersheds.

In addition to these in-state implementation efforts, the Center has partnered with the U.S.EPA on a project designed to identify factors that contribute to successful implementation of TMDLs. This project involves the review of TMDL implementation efforts across the country. The final product of this effort will be a report that catalogs and discusses approaches and factors that enhance implementation success. In another partnership with EPA, the Center is developing a web-based TMDL knowledgebase, the TMDL Clearinghouse. The Center is developing the TMDL Clearinghouse in order to address the issues of constraints of time and resources, rapid advances in related science or engineering disciplines, and information overload that often make it difficult for TMDL agency personnel, developers, and stakeholders to find the relevant information they need. The Clearinghouse will be a repository for information and resources related to the successful development and implementation of TMDLs and watershed management plans. A central feature of the Clearinghouse will be a National TMDL Knowledgebase that will include TMDL and implementation plan metadata. The Center is in the process of identifying and gathering information and resources that address each step in the TMDL process, from watershed characterization through delisting. Members of the Center are surveying the information and resources, categorizing them, and developing critical reviews. Additionally, the TMDL Clearinghouse will contain a National TMDL Resource Directory that will facilitate easy access to educational, technical, and governmental organizations.

Summary

The Center for TMDL and Watershed Studies pursues innovative multidisciplinary approaches to address watershed management and watershed planning issues. Through its historic activities within Virginia and new projects that cross state borders, the Center is actively involved in improving TMDL development efficiency and implementation effectiveness. These improvements will reduce TMDL program costs and help accelerate improvements in water quality across the nation. The Center's website, <http://www.tmdl.net>, contains information about the current activities engaged in by the Center, a current list of Center members, the eventual home of the TMDL Clearinghouse, and a gateway to resources related to the Center's activities.

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