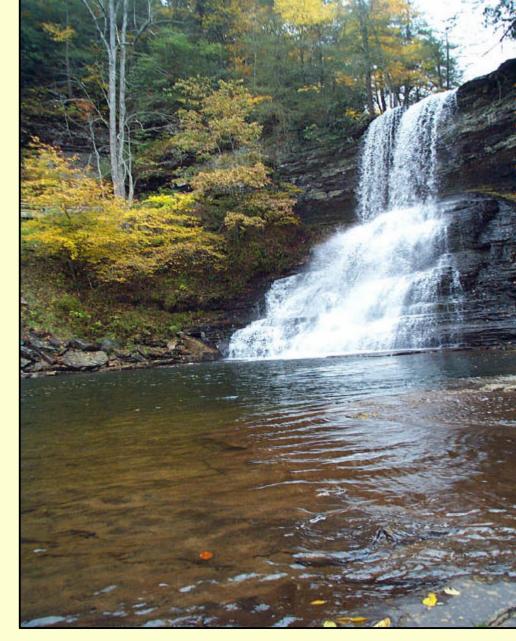
# Center for TMDL and Watershed Studies at Virginia Tech

Brian L. Benham

USDA-CSREES
National Water Quality Meeting

February 8, 2005











### What is a TMDL?

- Required by 1972 Clean Water Act Section 303(d)
- The maximum amount of pollutant that can enter a water body without negatively affecting its beneficial uses
  - Fishing, swimming, wildlife habitat, aquatic life, shellfish habitat

TMDL = point sources + nonpoint sources + margin of safety

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### What does developing a TMDL involve?

- Identifying and quantifying pollutant sources, accounting for temporal and spatial distribution
  - Existing and future conditions
- Linking pollutant sources with in-stream WQ
- Defining maximum allowable pollutant load (TMDL)
- Developing pollutant allocation scenarios







### Top Sources of Water Quality Impairment

Streams and Rivers

Lakes

Estuaries

Agriculture

Point Sources

**Habitat Modification** 

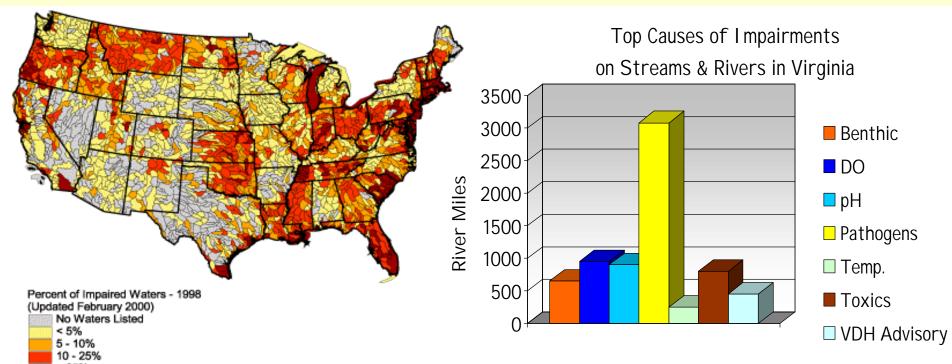
Agriculture

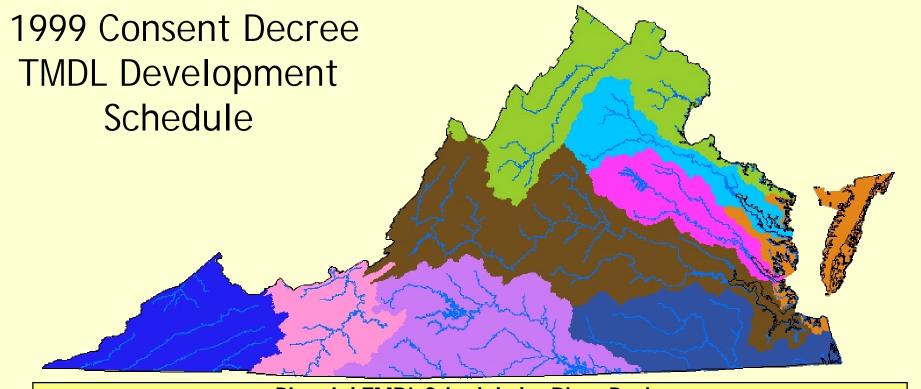
Point Sources

Urban Runoff

Urban Runoff
Point Sources
Agriculture

EPA Fact sheet No. 841-F-96-004A





Biennial TMDL Schedule by River Basin							
River Basin	2000	2002	2004	2006	2008	2010	Totals
Potomac-Shenandoah	2	15	9	15	21	4	66
James	0	5	5	6	26	12	54
Rappahannock	1	1	11	0	1	0	14
Roanoke	6	3	6	9	8	8	40
Chowan & Dismal Swamp	0	0	0	5	1	0	6
Tennessee & Big Sandy	4	4	6	10	8	4	36
§mall Coastal & Chesapeake	0	0	6	5	0	0	11
York	0	0	4	2	0	2	8
New	0	2	0	7	3	0	12
Totals	13	30	47	59	68	30	247



### EPA Estimated TMDL Funding Needs (Aug. 01)

- Total: \$16 to \$66 billion thru 2015
  - Required monitoring: \$17 million per year
  - TMDL Development: \$1 billion over 15 years (for known impairments)
  - TMDL Implementation: \$1 to 4.4 billion per year

Source: "The National Costs of the Total Maximum Daily Load Program (Draft Report)" http://www.epa.gov/owow/tmdl/coststudy/costfact.html







### **Mission Statement**

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.



### **Objectives**

- Address watershed management and planning issues by
  - conducting basic and applied research to improve the science and procedures for developing, evaluating, and implementing watershed management plans,
  - providing training in the development and implementation of accurate, effective, achievable TMDLs, and
  - facilitating participation in the TMDL process by increasing awareness and understanding of NPS pollution and water quality issues.







# Targeted clientele

- Policy and decision makers
- Scientists and engineers
- Consulting professionals
- Stakeholders
- Students

National and international opportunities







# Services and products

The Center's services and products reflect the Land-Grant missions

- Teaching
- Research
- Extension/Outreach







# Teaching

- Graduate level course
  - BSE 5324 TMDL Development and Implementation
  - Goals
    - Educate engineering students in the basic technical skills/knowledge
    - Educate non-engineers about components/process
  - Course delivery:
    - On campus Fall semesters
    - Via distance learning outlets beginning 2005







# Teaching cont.

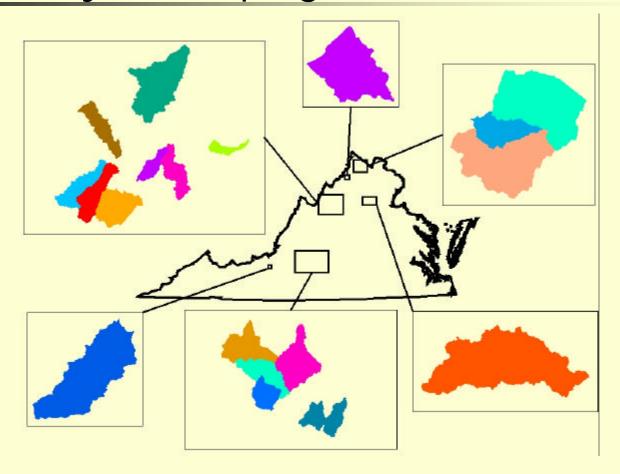
- Graduate students
  - MS, PhD, and postdoc
  - Project funded
- Undergrad internships (Center Fellows)
  - Computer Science
  - Engineering
  - English technical writing







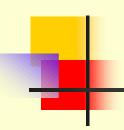
# Actively developing TMDLs



- Developed 25 TMDLs, currently developing 16
- Biological and benthic impairments







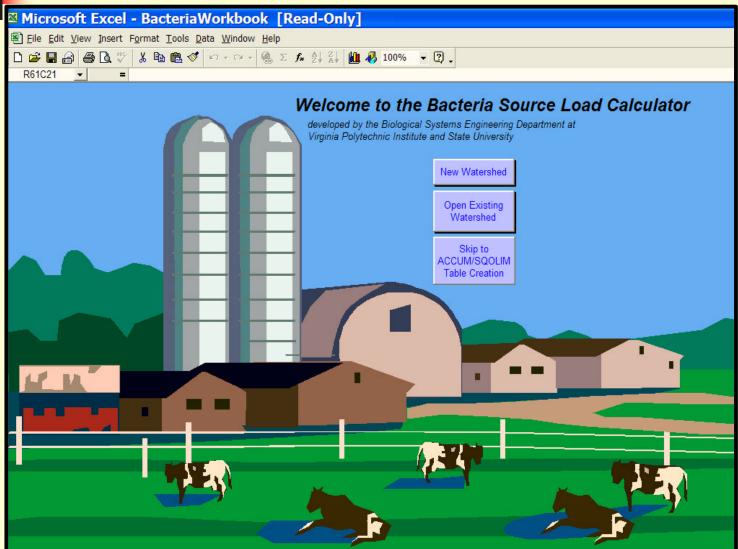
### Research

- Improve watershed and water quality modeling
- Improve information on BMP effectiveness and related process of aquatic ecosystem recovery
- Improve monitoring systems and technology
- Provide technical support and information transfer
- Develop web-based national TMDL knowledgebase Clearinghouse





### Software created to assist in developing TMDLs

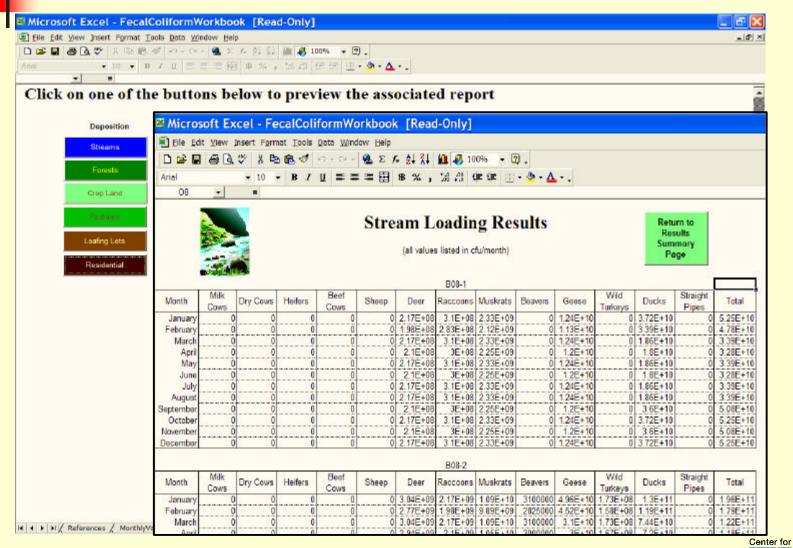


Center for

and Watershed Studies



### Software created to assist in developing TMDLs







### Outreach

- Develop and deliver educational programs
  - Workshops
  - Short courses
  - Conferences
- Develop resource materials:
  - Fact sheets
  - Multi-media resource materials
  - Web-based resources
  - Scholarly publications







# Outreach programs

- Educational Programs
  - "ABC's of TMDLs"
  - "TMDL Modeling Workshop"
  - "TMDLs: What, Why, and How"
  - TMDL Public Meetings
- Audiences
  - Professional conferences academics, practioners
  - State and federal agency staff
  - Civic organizations
  - Local Soil and Water Conservation Districts





### Example Virginia Cooperative Extension Publications

Virginia Cooperative Extension

2002



Biological Systems Engineering

PUBLICATION 442-550

### TMDLs (Total Maximum Daily Loads) -Terms and Definitions

Brian Benham, Kevin Brannan, Theo Dillaha, Saied Mostaghimi, and Gene Yagow\*

The definitions of TMDL-related terms presented here are intended to provide the reader with a working knowledge of terms that apply to Virginia's TMDL program. This is the first in a series of Virginia Cooperative Extension publications that deal specifically with TMDLs. The federal Clean Water Act requires States to develop TMDLs for streams, rivers, lakes and estuaries that do not or are not expected to meet applicable water quality standards. This glossary is designed to assist the reader in understanding and interpreting TMDL related information that may come from sources as varied as governmental agencies, environmental groups, consulting firms,

### Glossary of Terms

Acute exposure - a single exposure to a toxic substance that results in severe biological harm or death. Acute exposures are usually characterized as lasting no longer than a day. Longerterm lower level exposures are referred to as chronic exposure.

Acute toxicity - an adverse effect that usually occurs shortly after exposure to a pollutant. Lethality to an organism is the usual measure of acute toxicity. Where death is not easily detected, immobilization is considered equivalent to death.

Algae - aquatic organisms, ranging in size from single-celled forms to the giant kelp.

Allocations - best estimates of current and future pollutant loads (both nonpoint and point sources) entering a waterbody. Pollutant load estimates can range from reasonably accurate measurements to gross estimates, depending on the availability of data, and the techniques used for predicting specific loads, (see Load Allocation and Waste Load Allocation)

Allocation Scenario - proposed combination of point source and nonpoint source pollutant loads being considered to meet a water

Ambient water quality - level of water quality constituents collected as part of a routine monitoring program.

Ammonia - (NH3) an inorganic nitrogen compound. In water, ammonia levels in excess of the recommended limits may harm Anthropogenic - involving the impact of humans on nature; specifically items or actions induced, caused, or altered by the presence and activities of humans.

Antidegradation policy - Virginia's antidegradation policy protects water quality at three levels or "tiers." Tier 1 specifies that existing instream water uses and the level of water quality to protect the existing uses shall be maintained and protected. This means that, as a minimum, all waters should meet adopted water quality standards. Tier 2 protects water that is better than specified water quality standards. Only in limited circumstances may water quality be lowered in these waters. Tier 3 are exceptional waters where no new, additional or increased discharge of sewage, industrial wastes or other pollution are allowed. These waters must be specifically listed in Virginia's water quality stan-

Aquatic ecosystem - the living and nonliving components of a water body, i.e. its physical, chemical, and biological components.

Assimilative capacity - a measure of the ability of a natural body of water to effectively degrade and/or disperse chemical substances. Assimilative capacity is used to define the ability of a waterbody to naturally assimilate a substance without impairing water quality or degrading the aquatic ecosystem. Numerically, it is the amount of pollutant that can be discharged to a specific waterbody without exceeding water quality standards. (see Loading Capacity)

\*Assistant Professor and Extension Specialist, Research Associate: Professor, Professor, Research Scientist; Virginia Tech, respectively



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Virginia Cooperative Extension

2003



Biological Systems Engineering

PUBLICATION 442-556

### TMDLs (Total Maximum Daily Loads) for Benthic Impairments

Brian L. Benham, Jane L. Walker, and Gene Yagow\*

### What is a benthic impairment?

"Benthic" refers to the aquatic organisms living in or on the bottom of a body of water. Benthic organisms include crayfish, aquatic snails, clams, leeches, aquatic worms, certain insect larvae and nymphs (e.g., mayflies, dragonflies), and adult aquatic insects (e.g., riffle beetles). Changes in water quality generally result in changes in the types, numbers, or diversity of the benthic community.

In general, a water quality "impairment" exists if a body of water does not support its designated uses. (Italicized terms are defined in the boxes at the bottom of each page. See also TMDLs (Total Maximum Daily Loads): Terms and Definitions, VCE publication 442-550, http://www.ext.vt.edu/pubs/bse/442-550/442-550.html.) Virginia's water quality standards specify that surface waters are designated for the following uses: "recreational use" (e.g., swimming, fishing, and boating) and "aquatic life use" (e.g., viable fish populations). Water quality criteria protect these uses. The aquatic life use is protected by a general narrative water quality criterion: "All state waters ... shall be free from substances ... [which] interfere directly or indirectly with designated uses ... or are harmful to human, animal, plant, or aquatic life." Waters in which the benthic community is degraded violate this standard and are considered to have a "benthic impairment."

### How are benthic impairments determined?

The benthic macroinvertebrate community present in a body of water is periodically evaluated to determine if a benthic impairment exists. Benthic macroinvertebrates (macro-organisms that are large enough to see with the naked eye; invertebrate-lacking a backbone) are "living recorders" of past and present water quality conditions. The Virginia Department of Environmental Ouality (DEO) currently uses U.S. Environmental Protection Agency (EPA) approved methods to evaluate the benthic macroinvertebrate community in freshwater streams and rivers to determine compliance with the aquatic life use criterion. DEO biologists determine if the body of water is impaired by taking benthic macroinvertebrate surveys in the body of water in question and comparing them to benthic macroin vertebrate surveys from a reference site. The reference site has characteristics (e.g., similar location, elevation, geology, and hydrology) similar to the body of water being evaluated, and the DEQ has determined that it supports a viable, diverse benthic macroinvertebrate community. For more information on the procedures used to assess the benthic macroinvertebrate community see the EPA's Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates and Fish.

designated uses - uses specified in water quality standards for each body of water in the state.

water quality criteria - numerical and narrative criteria that, taken together, describe the water quality necessary to protect designated uses.

benthic macroinvertebrate - organisms living in or on the bottom of a water body that are visible without a microscope (macro) and lack backbones (invertebrates).

\*Assistant Professor and Extension Specialist, Department of Biological Systems Engineering; Research Associate, Virginia Water Resources Research Center, and Research Scientist, Department of Biological Systems Engineering, Virginia Tech



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### Animated multi-media education modules









### Center membership

- Faculty from four colleges at Virginia Tech
  - College of Agriculture and Life Sciences
  - College of Engineering
  - College of Natural Resources
  - College of Architecture & Urban Studies
  - More than a dozen disciplines
- University of Virginia, West Virginia University, and Penn State involved in ongoing Center projects.







# Requirements for 319 funding mirror TMDL process

- Identify the sources of pollutants
- Estimate load reductions expected to achieve WQS
- Describe NPS management measures to achieve load reductions
- Estimate the amounts of technical and financial assistance needed
- Provide information component
- Encourage public participation

- Provide a schedule for implementing the NPS management measures
- Describe interim, measurable milestones to assess implementation progress
- Identify a set of criteria for determining if loading reductions are being achieved
- Establish a monitoring component to evaluate implementation efforts

'irginia |¶∏Tech Addressing ambient water quality will involve TMDL or similar watershed planning process for the foreseeable future



### **Questions or Comments**



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