

BACTERIA TMDL IMPLEMENTATION CONTROL STRATEGIES OF THE SOUTHEAST:
RECOMMENDATIONS FOR GEORGIA

by

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(Under the Direction of C. Ronald Carroll)

ABSTRACT

Since the inception of the Clean Water Act (CWA) more than 20 years ago, the reduction and elimination of non-point source pollutants and their sources has not been adequately addressed. Due to citizen lawsuits, the Environmental Protection Agency (EPA) is now under consent orders to follow, implement, and enforce Section 303(d) of the CWA to address this problem. Section 303(d) stipulates that States identify and set total maximum daily loads (TMDL) of pollutants that can be assimilated by a waterbody without violating its water quality standard; and requires that plans be developed to allocate these loads to different point and non-point sources.

Through the Initiative for Watershed Excellence: Upper Altamaha Pilot Project, I examine the issues associated with TMDL implementation plans for bacteria in the state of Georgia. Methods include reviewing relevant literature, policy, and water quality improvement projects in Georgia and in other Southeastern states: Alabama, North Carolina, South Carolina, and Virginia. This process also includes interviews with stakeholders and government officials in relevant areas. Goals consist of: 1) examining the issues associated with creating effective bacteria TMDL implementation plans; 2) showing control strategies in other states that could be implemented in Georgia to decrease inputs; 3) assimilating tools from other states that could improve the process of bacteria TMDL implementation planning in Georgia; and 4) highlighting opportunities for interstate collaborations to meet shared water quality improvement goals.

INDEX WORDS: bacteria, TMDL implementation, watershed management, non-point source pollution, Clean Water Act Sections 303(d) and 319, Southeastern U.S.

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CHAPTER 1

INTRODUCTION

Twenty years of federal regulation under the Clean Water Act (CWA) have led to significant improvements in water quality, particularly reducing inputs from point sources of pollution¹. However, water pollution from non-point sources continues to plague the waters of the United States. As a result, non-point source inputs have become the number one source of pollution for our rivers, streams, and lakes (Wall 2003). According to the US Environmental Protection Agency (USEPA), non-point sources account for 65-75 percent of pollution in the nation's most polluted waters (qtd. in Garovoy 2003).

Under the 1972 amendments to the Clean Water Act in Section 303(d), the USEPA was charged with initiating the Total Maximum Daily Load (TMDL) Program to deal with water pollution by requiring states to set ambient water quality standards for all streams and rivers and develop plans for achieving those standards. States must identify sources of point and non-point pollution that impair their surface waters and then allocate among those sources the amount of pollution each contributes to the impairment. For each impaired portion of a stream or river, states develop a TMDL plan that determines the total amount of each pollutant the surface waters can receive on a daily basis without exceeding the state's water quality standard. This pollution load, or total maximum daily load, is allocated among point and non-point sources. The contribution of the TMDL program for decreasing non-point sources of pollution has not met expectations by state and federal entities (Houck 1999). Since Houck's statement in 1999, EPA

¹ The Federal Water Pollution Control Act Amendments of 1972; as amended in 1977, became commonly known as the Clean Water Act.

has published final rules implementing the TMDL program in an effort to see greater success in the program (Birkeland 2001). Controversy and implementation problems still exist as the TMDL program struggles to improve surface water quality.

In the state of Georgia, pollution from non-point sources continues to threaten our waters. According to the 2002 Assessment Data for Georgia, non-point sources are the most probable source of impairment for rivers and streams impairing over 4,000 miles within the State² (USEPA 2002). A central barrier to success is the lack of adequate funds (National Research Council 2001), especially for implementation. The low priority in federal and state allocation of support persists because there is likely a perceived lack of urgency and concern from the general public and constituency. Therefore increasing public support is necessary for short and long term success of the TMDL program in Georgia.

Too little funding is only part of the problem, and the situation will not change quickly. In the meantime, the State of Georgia can explore creative and innovative options and strategies for increasing support and improving water quality through the TMDL program. Highlighting different methods and success stories of TMDL implementation may also spur further public interest and support. The goal of this thesis is to assist the State of Georgia and its citizens in realizing improved water quality by (1) providing a non-technical description of how the TMDL process has been conducted in Georgia and neighboring states and (2) by offering recommendations for improving the process. Although many pollutants contribute to impairment, I concentrate on bacterial contamination in order to provide better focus. Many of my results and conclusions have application to other pollutants.

Our neighboring states, and other across the nation, are dealing with these same issues of meeting Federal clean water requirements with little funding and resources available. Rather

² For further information about water quality assessments in Georgia: <http://www.gaepd.org/Documents/305b.html>

than “reinvent the wheel,” why don’t we learn from each other’s successes and failures? Sharing information will not only strengthen each state’s program, but will also prepare us for eventual cross-state TMDL implementation plans. Due to the nature of surface waters, one state’s actions will affect neighbors downstream and so on. If we can collaborate on these issues, we can conserve both time and resources while meeting mutual goals of water quality improvement. Therefore, I asked the question: what are other states in the Southeast doing about bacteria TMDL implementation?

Objectives

The objective of this thesis is to provide stakeholders in Georgia with a synthesis of bacteria TMDL control strategies and implementation programs that have proven successful in states of the Southeastern Piedmont: Alabama, North Carolina, South Carolina and Virginia. This study will augment the research and recommendations already being compiled and distributed by the bacteria TMDL Technical Advisory Group³ (TAG) and other stakeholder groups in Georgia.

TMDLs in Georgia

Through Section 303(d) of the Clean Water Act, states are required to assign each water body in the state a designated use and set water quality standards for each of these uses⁴. Total maximum daily loads (TMDLs) of pollutants are established for waters not meeting water

³ Organized by the Georgia Conservancy and the University of Georgia, the bacteria TAG meetings included a total of 60 university, state and federal scientists, local officials and members of non-profit groups.

⁴ Section 303(d) of the Clean Water Act establishes the federal TMDL program.

quality standards. If a water body does not support or only partially supports its designated use⁵ by violating water quality standards set for each use, it is considered “impaired” and a TMDL must be allocated for each impairment or pollutant (Risse et al. 2004). A TMDL, therefore, is a calculation of the maximum amount of a particular pollutant that a water body can assimilate while meeting water quality standards. Once the TMDL is set, the local government, or other third party entity, must produce and follow an implementation plan so that TMDLs are not exceeded. States are responsible for determining who will be charged with implementing the plans and how implementation plans will be developed. This charge is often assigned to and divided between quasi-governmental agencies, local communities and the state environmental agency. The Department of Natural Resources Environmental Protection Division (GAEPD) is responsible for facilitating the TMDL implementation planning process in Georgia. States must dictate what is required in a TMDL implementation plan to meet load reductions and other state-specific requirements⁶. In the State of Georgia, a TMDL implementation plan dictates implementation actions and strategies to meet load reduction requirements and identifies current and potential impairment sources. Active stakeholder and public involvement must also be included. As a requirement of Section 303(d), streams should be ultimately “de-listed” by meeting the water quality standard for its designated use. The process of TMDL implementation is particularly complex and burdensome for state and local governments, particularly do to high costs and little available guidance or financial support. In particular, there is no clear guidance from USEPA on TMDL implementation plan development and specifics on what should be

⁵ Georgia’s designated use categories: drinking, recreation, fishing, wild and scenic, or coastal fishing (set by GAEPD)

⁶ Chapter 3 will provide more information about what is required in Georgia after citizen suits mandated USEPA enforcement of the TMDL program in the State (similar to many other states).

included in the plan. These challenges, as well as more background on TMDL implementation in Georgia, will be discussed further in Chapter 3 of this thesis.

In 2002, the University of Georgia and the Georgia Conservancy convened a Technical Advisory Group (TAG) to generally assist the State with plans for meeting TMDL requirements. One area in which the TAG chose to focus is that of bacteria TMDL implementation (Radcliffe et al. 2006).

Bacteria TMDLs

Of the over 800 water bodies in Georgia that require TMDLs, Fecal coliform (FC) bacteria from the intestinal tracts of vertebrate animals are the most prevalent impairment or pollutant (Radcliffe et al. 2006)⁷. A total of 385 FC implementation plans have been completed in the State (Radcliffe et al. 2006)⁸. Overall, 48 segments have been delisted from the 2002 303(d) list (Booth, personal communication 2006).

FC bacteria are found in both urban and rural settings (Radcliffe et al. 2006; Mallin et al. 2000) and pathogenic forms pose a great risk to the health of our population (USEPA 2004) and to the expense of water treatment for our communities (Mallin et al. 2000). However, FC can be effectively managed by the implementation of control strategies such as structural and non-structural best management practices (BMPs). By focusing on TMDL implementation strategies, I hope to provide a useful product to the Georgia communities faced with the difficulties of bacteria TMDL control.

⁷ FC is used as an indicator of the presence of pathogenic bacteria in a water body. I will use the term “bacteria” very generally which may include pathogenic bacteria, FC, or E. coli, which is now the recommended USEPA standard (see Chapter 4 for more information).

⁸ Implementation plan completion does not mean actions are actually being implemented, just that the plan has been written.

Overview of Thesis

In Chapter 2, I discuss the methods used for collecting data from other States about the programs and strategies used in the implementation of bacteria TMDLs. I present a review of the Clean Water Act provisions that affect TMDL implementation efforts, and a review of Georgia's TMDL program, in chapter 3. Chapter 4 further explains the science, controversies, and challenges surrounding the standard for bacteria TMDL establishment and implementation.

Chapter 5 provides background information on best management practices, sources of bacteria impairment to surface waters, and current implementation efforts in Georgia. Chapter 6 consists of a review and analysis of best management practices and management measures that are being used in other states in the Southeastern Piedmont: Virginia, North Carolina, South Carolina, and Alabama. Emphasis is placed on programs and strategies that have a higher probability to succeed in Georgia's current social, political, and economic climate.

Chapter 7 recommends changes to the current TMDL implementation program in Georgia and management measures that can be implemented by communities and TMDL stakeholders to abate non-point source pollution from bacteria sources.

The final product of this project consists of the thesis text, and an informative website. The goal of the website echoes that of the thesis, but is presented in a more "user-friendly" format aimed at assisting bacteria TMDL stakeholders in improving surface water quality in the State. It is an extension of the current University of Georgia River Basin Center site and will provide stakeholders with my findings: bacteria control strategies from other Southeastern states that can be implemented throughout Georgia.

CHAPTER 2

METHODOLOGY

The objective of this guidance material is to present stakeholders with control strategies to reduce bacteria loading that can be applied successfully in the state of Georgia. In this chapter, I describe the process and methods used in the search and synthesis of bacteria TMDL implementation programs and control strategies in the following Southeastern piedmont states: South Carolina, North Carolina, Virginia, and Alabama; and factors I used in analyzing which of these might be applicable to Georgia.

The two search and synthesis methods used were a series of interviews with relevant stakeholders and a review of available literature and policy. The research can be divided into two phases:

Scoping

Initial scoping consisted of interviews and literature reviews conducted concurrently to determine what research had or was being conducted and which stakeholders would be valuable to interview. The scoping process determined the initial steps for problem definition and research, such as which states' TMDL programs should be considered and the criteria for selection.

The literature review section of the scoping process helped me understand the issues and research conducted in bacteria TMDL development and implementation. The literature can be divided into two categories: *policy* and *scientific research*. *Policy* includes laws, regulations,

and guidance published by the US Environmental Protection Agency (USEPA), the Georgia Environmental Protection Division (GAEPD) and relevant environmental regulatory agencies in other states. Existing TMDL implementation plans for Fecal coliform impairments in Georgia were also reviewed and are categorized with policy literature reviews. Policy was located through web searches on agency websites and through direct links provided by outreach organizations and professional associations, such as the National Association of Clean Water Agencies' TMDL e-library. *Scientific research* includes published peer-reviewed journal articles and ongoing research at Universities and state and federal agencies, such as gray literature reports. Journal articles were located using academic and scholarly databases. Ongoing research was located through web searches and scoping interviews with academics and state and federal agency employees.

The personal interview section of the scoping process contained the most potential for valuable information-gathering due to the infancy of TMDL implementation research¹. To determine which TMDL experts and stakeholders to interview, Technical Advisory Group (TAG) meeting minutes were reviewed; and informal interviews conducted with TAG members, Master's thesis advisory committee members and staff at the UGA River Basin Center (RBC)². Through these initial interviews, particular state and federal agency employees and academics were chosen for further scoping questions. These interviewees were chosen because of their experience with TMDL implementation. I attempted to gain information from different perspectives, such as USEPA, GAEPD, academic outreach, and state-based outreach groups such as Regional Development Centers (RDCs) and Resource Conservation and Development Councils (RC&Ds).

¹ Human Subjects/IRB permission obtained under project: 2006-10536-0.

² The UGA River Basin Center in the Institute of Ecology provides a wide range of services, educational opportunities and support on a local, national and international level: <http://www.rivercenter.uga.edu> .

The *BMP* component of *scoping* followed much of the same methodology as that used for *initial scoping*. General BMP background was first obtained through peer-reviewed scholarly journals and informal interviews with academics and agency staff. Existing bacteria TMDL implementation plans were also reviewed to gain knowledge of what was currently being done in the state of Georgia in terms of bacteria control strategies. National and international BMP databases were also reviewed for information on best management practices.

Case Studies

After the compilation of background information on BMPs and other control strategies used in bacteria abatement, selection of state programs began. Subsequent to reviewing literature and interviews from initial scoping, it was decided that state TMDL programs could be divided into two categories of pollution abatement: urban and rural (Hesterlee, personal communication 2006). While some states have successful overall programs, most were found to be particularly strong in either urban or rural bacteria source abatement. Therefore, I integrated this aspect into my scoping interview questions. Instead of asking my interviewee which state was successful with TMDL implementation as a whole, I would specify between successful urban versus rural implementation programs.

James M. Omernik's Level III Ecoregion delineations served as a guide to choose which states would serve as the best examples for Georgia's implementation program. Omernik's Ecoregions are based on perceived patterns of a combination of casual and integrative factors including land use, land surface form, potential natural vegetation, and soils (1987). Based on Omernik's maps (1987), I chose states that were located in similar ecoregions to Georgia, specifically the Southeastern Piedmont and Plains: Virginia, North Carolina, South Carolina, and

Alabama (Figure 1). These states also hold many similarities such as political and socioeconomic status. Population growth trends, for instance, are similar throughout the Southeastern piedmont (Hammer et al. 2004 and Brown et al. 2005), therefore, placing similar pressures on these states.

Throughout the course of my research, especially during the scoping interviews, the U.S. Northwest was constantly referred to as being a region of successful TMDL and water quality programs. In terms of making recommendations that could be immediately implemented in the state of Georgia, however, I hesitated in reviewing these Northwestern states. Depending on the state program, many impediments exist to implementation in Georgia from a level of “mindset” to legislative or legal barriers. I find some of these programs compelling, but want to separate between these and the programs of the Southeast that may have more immediate potential. While the states of the Northwest may differ in many ways from those of the Southeast, they have generally shown great progress and innovation in TMDL development and implementation. These programs should be kept in mind for further research about TMDL implementation strategies in Georgia; and will not be reviewed or recommended in this report.

After initial scoping of state TMDL programs was completed, contacts within each state program were selected for the interview process. State program interviews were heavily tailored to the individual state program. Many states, including Georgia, contract with private consultants, university researchers, or other state agencies for the development and/or implementation of TMDLs. Therefore, many of the “best” contacts for information about bacteria control strategies were not state environmental agency employees, but academic researchers or community members.

After state interviews began, it became apparent that an excellent source for innovative best management practices and similar water quality improvement projects would be found under 319 NPS programs and grants. Therefore, representatives of both the TMDL and 319 program were interviewed in each state. Through state agency and other initial interviews, “on-the-ground” contacts were made such as 319 project leaders, cooperative extension agents, or other stakeholders. Some states were more receptive in general to my project and therefore provided more information and assistance. From each state, three or four projects were identified as being innovative or useful to the State of Georgia’s TMDL implementation program. These projects were investigated in-depth and constitute the main body of this project. Response to the project differed in each state, therefore, data and results are not necessarily equal. Oftentimes the amount of information collected depended solely upon the willingness of the interviewee to share. This report should therefore not be viewed as a comparison of state programs, but rather a synthesis of what information is available.

Recommendations are made in regard to what could be immediately implemented in Georgia as bacteria BMP strategies and then what might be implemented in the future. Therefore this project is essentially looking at what needs to be done in Georgia to show measurable success with bacteria TMDLs.

To meet goals of stakeholder outreach, education, and information-sharing a website was created to describe the results of the project. A website is the most useful outreach tool in this case to reach a diverse audience of TMDL stakeholders. A benefit is that a website can also be updated as information and needs change in terms of bacteria TMDL implementation in the State of Georgia. Not only does the website contain descriptions of the control strategies and programs implemented in other states, it provides contact information and appropriate links for

further investigation by Georgia stakeholders. In such a growing field and with the ever-changing nature of information, this is the most appropriate approach for increasing awareness, education and communication on issues of bacteria TMDL implementation.

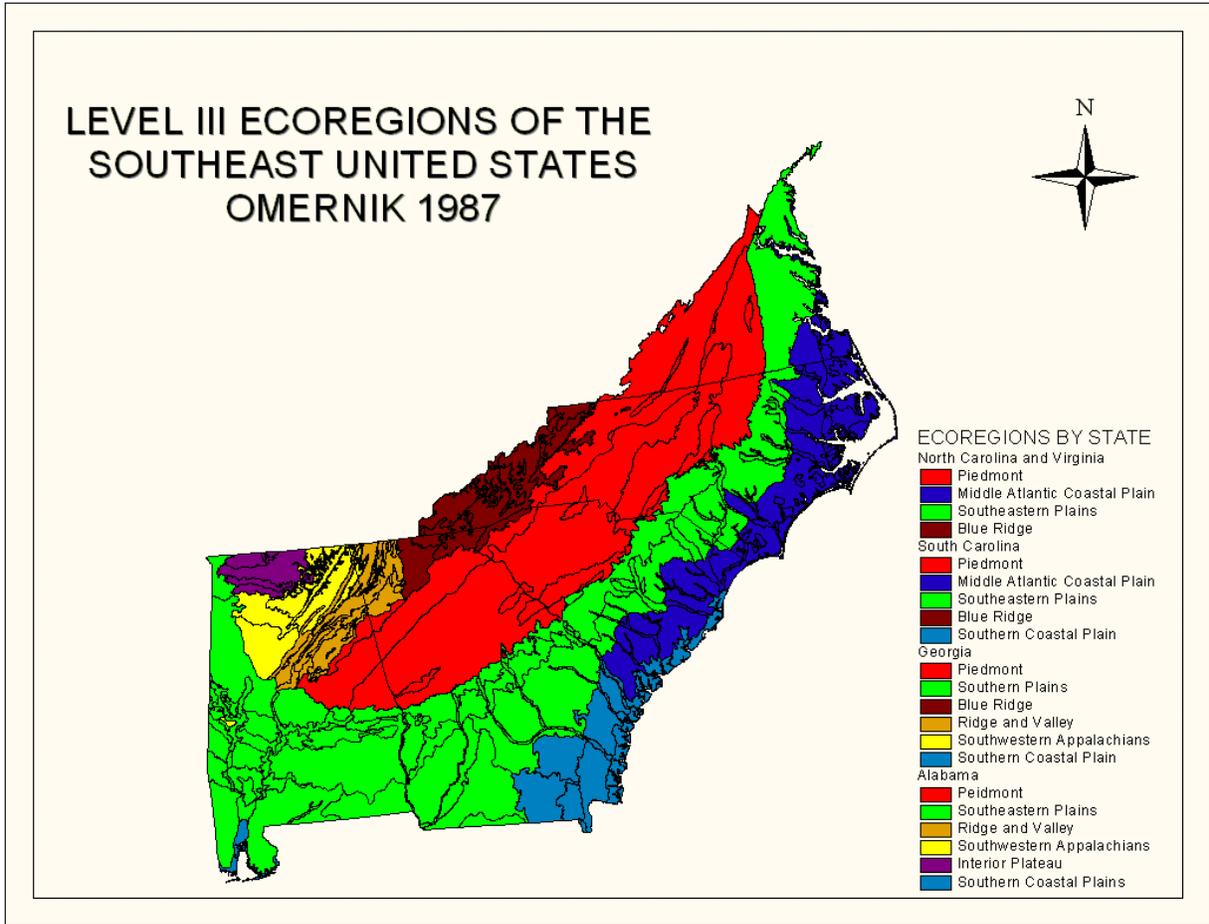


Figure 1: Level III Ecoregions of the Southeast United States, Omernik 1987

CHAPTER 3

REGULATORY BACKGROUND: TMDLS & NPS

In this Chapter, I provide background information about the legal and regulatory basis for total maximum daily loads (TMDLs) and Non-point Source (NPS) management programs.

The Clean Water Act Section 303(d)

The TMDL program was established to address pollution in surface waters of the U.S. through enforcement of ambient water quality standards. Specifically, the TMDL program would assist in the abatement of non-point sources of water quality impairment (Birkeland 2001; Garovoy 2003). USEPA's Water Quality Planning and Management Regulation established the program and policies that implement this section of the Clean Water Act (CWA) (2002d). First a State must assess the quality of all of its water bodies pursuant to Section 305(b). These water quality assessments include information on monitoring data and trends collected by the State, illustration of impairment sources and description of state programs implemented to address these water quality issues¹. Section 303(d) of the (CWA) then requires States to identify and list waters that are not meeting water quality standards, and therefore their designated use. The resulting list of "impaired" waters is referred to as the "303(d) list." Waters on this list are then required to have a total maximum daily load assigned to it which stipulates the amount of each pollutant that the water body can assimilate and still meet its designated use. Listed waters are prioritized with respect to designated use classifications and the severity of the pollution.

¹ More information on water quality assessment reporting under Section 305(b): <http://www.epa.gov/305b/>

The TMDL itself is a calculation intended to best estimate the amount of a pollutant that a water body can assimilate. It is the sum of the individual waste load allocations (WLAs) for point sources, load allocations (LAs) for non-point sources, a margin of safety (MOS) and natural background levels. Load allocation is a complex task. A margin of safety (MOS) accounts for the uncertainty surrounding the relationship between the pollutant loads and the quality of the receiving waterbody (USEPA 1991). The final calculation is $TMDL = WLA + LA + MOS$.

According to 40 CFR 130.7(b), TMDLs are required for waters where technology-based effluent limitations (i.e. the NPDES² permitting process) and other pollution control requirements (best management practices) required by local, State or Federal authority are not stringent enough for the water body to meet its designated use (USEPA 2002d). Therefore, the TMDL program is a regulatory tool designed to meet water quality standards in surface waters where existing efforts have been inadequate. While there are some TMDLs that do not include permitted point source dischargers, most do include both point and non-point sources of water quality impairment. After the development of a TMDL, NPDES permit holders may have to further limit their discharge loads to meet the new TMDL loading requirements. Regulatory actions may include issuance or revision of wastewater and stormwater permits to include conditions consistent with the TMDL. These permit conditions may be numeric effluent limitations or narrative requirements based on BMPs needed to achieve the necessary pollutant load reduction. This is where the TMDL program's "hammer" lies. If load reductions are still not met, municipalities may not be allowed by the permitting State to apply for increases in

² Under the Clean Water Act, the National Pollutant Discharge Elimination System program regulates point sources that discharge pollutants into the waters of the U.S. Industrial, municipal, and other facilities (not individual homes that are on sewer or septic) must obtain permits if their discharges go directly to surface waters. The program is administered by authorized states. (http://cfpub.epa.gov/npdes/home.cfm?program_id=45)

current discharges or additions of new dischargers, such as additional public sewage facilities, this would block future housing and business development.

If a state fails to set TMDLs, then USEPA itself must establish TMDLs for that state³. USEPA, therefore, has the final authority over the development and implementation of TMDLs. Until fairly recently, however, the program was essentially not being enforced. It was a series of citizen suits in Georgia and across the U.S. that pushed the USEPA and state agencies to begin listing waters and developing TMDLs⁴. According to USEPA, there have been about 40 legal actions in 38 states (2006b). This has resulted in USEPA being under court order or consent decrees in many states to ensure that either the State or USEPA is establishing TMDLs and subsequent implementation plans (2006b).

Beyond the planning phase, TMDL implementation is not outlined specifically in Section 303(d) and is essentially left up to the states. Some states include an implementation or watershed plan requirement in their regulations, but many just merely suggest the TMDL be implemented in some fashion with no further guidance. Implementation of TMDLs generally refers to any combination of regulatory, non-regulatory, or incentive-based actions that attain the necessary reduction in pollutant loading. Non-regulatory or incentive-based actions may include development and implementation of best management practices (BMPs), pollution prevention activities, and habitat preservation or restoration. Regulatory actions may include mandatory buffer requirements, prohibition of cattle in streams, or stormwater ordinances. While these sorts

³ CWA § 303(d)(2), 33 U.S.C. § 1313(d)(2)

⁴ To view current TMDL litigation status at the Federal level, visit <http://www.epa.gov/owow/tmdl/lawsuit.html>. In the State of Georgia, a TMDL lawsuit was filed by the Sierra Club et al. in 1994 and settled in 1997 with a consent decree establishing deadlines and a TMDL river basin schedule (Sierra Club v. EPA & Hankinson).

of regulatory actions are often politically unpopular, municipalities hold the authority to set and enforce them through police powers to protect public health, safety and welfare⁵.

Many challenges and difficulties arise in the TMDL program. The issue mostly stems from a lack of funding and weak prioritization at both the federal and state level. Oliver Houck explains that in most states, “TMDLs arrived on the doorstep like a litter of stray cats – with many unpleasant responsibilities and little money to provide for them” (1999). Bruce Anderson, an official with the Hawaii Department of Health, said in a letter, “in a period of declining state budgets, public demand for no new taxes, and resistance to regulation, we do not expect to obtain sufficient funding to establish scientifically-defensible numeric targets for polluted runoff control” (qtd. in Houck 1999). As illustrated by these quotes, a great deal of negativity and pessimism surround the TMDL program. There are central challenges to using this sort of regulatory mechanism to regulate water quality, such as enforcement of implementation actions. As Garovoy explains, there is little in Section 303(d) to compel either USEPA or the states to implement TMDLs, and the current Bush administration has put on hold USEPA rules designed to strength TMDL implementation (2003). These issues of implementation enforcement and fiscal support need to be addressed. Rather than focus on these controversies, however, this report attempts to provide realistic solutions to achieve on-the-ground success in the implementation of bacteria TMDLs in the state of Georgia.

The Clean Water Act Section 319

Complexity and controversy surround the issues of TMDLs in regard to NPS abatement, specifically in waters polluted exclusively by NPS. There is no direct mechanism for NPS

⁵ The Tenth Amendment of the U.S. Constitution grants police power authority to states (and in turn, local governments) for the adoption of laws and regulations to prevent the commission of crime, and secure the comfort, safety, morals, health and prosperity of citizens.

control similar to the NPDES permitting program for point source dischargers. Not only is Section 303(d) lacking an effective enforcement mechanism, but the Section itself contains potentially ambiguous language regarding whether or not Congress originally intended to regulate water polluted exclusively by non-point sources via TMDLs, or whether TMDLs apply only to water polluted exclusively by point sources or a combination of the two sources (Garovoy 2003). In 2002, partial regulatory control was established by the case of *Pronsolino v. Nastri*⁶ which affirmed EPA's authority to enforce non-point source TMDLs (Garovoy 2003). While this ruling affirms EPA's authority to regulate NPS, many issues still exist as to the ineffective enforcement provisions of the Clean Water Act, where very few hammers exist. Enforcement of TMDL implementation actions is essentially left to States and communities to establish (i.e. USEPA needs to be more specific about how exactly municipalities could enforce TMDL implementation actions, so it is not such a political and heated issue for local officials to shoulder). Whether USEPA eventually establishes guidance similar to that in the proposed "July 2000 rule," however, USEPA will still face issues about the breadth of its authority and the difficulty of establishing effective non-point source enforcement⁷. While this may be difficult for USEPA, it is almost impossible for state governments to achieve because of the political unpalatable situation of asking a state "to place its head into the jaws of public utility, a chemical plant, or local farmer" to establish permit limits (qtd. in Garovoy 2003). Due to the "political realities of regulating nonpoint source pollution, local-level watershed-based solutions hold the most promise for stemming the tide of nonpoint source pollution" (Garovoy 2003). Enforcement

⁶ The Pronsolino's had purchased forestland in California before the Clean Water Act was established. When they attempted to harvest the timber over 30 years later, California issued them a limited logging permit according to state regulations under the Clean Water Act. The Pronsolinos sued the USEPA, challenging its authority to regulate their logging (considered a NPS) under the CWA. (Garovoy 2003)

⁷ The July 2000 rule proposed by USEPA attempted to produce more uniform TMDL implementation plans (Total Maximum Daily Load Rule, 65 Fed. Reg. 43, 585-43, 670 (July 13,2000); 65 Fed. Reg. 43, 840 (July 14, 2000)).

of NPS control measures will continue to be a struggle for communities. Garovoy states that funds made available under Section 319 provide an incentive for states to establish TMDLs without USEPA intervention (2003). Therefore a combination of TMDLs and NPS management under Section 319 is the most logical and effective solution currently available.

Section 319(h) of the Clean Water Act authorizes federal grant funding to implement EPA-approved state NPS management programs⁸. 319 funds are allocated to each state to address NPS abatement strategies. Section 319 funds pay up to 60% of eligible project costs, with the applicant providing a 40% non-federal match⁹. The allocation of these funds varies a great deal from state-to-state.

319 funded projects are divided into two categories: base and incremental. Base projects involve research-oriented, demonstrative or educational purposes for identifying and preventing potential NPS areas in the state, where waters may be at risk of becoming impaired (NC DENR 2006). Incremental projects aim at restoring streams or other portions of a watershed that are already impaired and not presently satisfying their intended uses (NC DENR 2006). Incremental projects are therefore used by most states to implement TMDL or watershed-based plans to meet water quality standards and designated uses. In this report, both incremental and base projects were reviewed in Southeastern states because both types of projects may affect the implementation of control strategies for bacteria impairment.

Section 319 can be a useful tool to implement NPS control strategies and ensure improved water quality (USEPA 1991). Both State and local authorities may authorize the implementation of non-point source controls such as the installation of best management practices (BMPs) (USEPA 1991). According to USEPA, state non-point source management

⁸ as amended in 1987 to establish the Section 319 Nonpoint Source Management Program

⁹ The 40% non-federal match can be cash or in-kind services (<http://www.scdhec.net/eqc/water/pubs/319match.pdf>).

programs may include non-regulatory or regulatory programs for enforcement, technical assistance, financial assistance, education, training, technology transfer and demonstration projects.

Georgia's Program

18-20 percent of the water bodies in Georgia have been sampled by the GAEPD or an authorized sampling unit, representing over 71,000 river miles (Radcliffe et al. 2006)¹⁰. Of the 11,285 miles of streams and rivers assessed in Georgia, roughly 57 percent are impaired (USEPA 2002)¹¹. As of 2002, over 850 TMDLs had been developed in the state of Georgia (Risse et al. 2004).

Every two years, GAEPD publishes the 305(b) report on the quality of navigable state waters (Radcliffe et al. 2006). The report includes estimates of environmental impacts and socioeconomic costs of achieving water quality standards; a description of the nature and extent of the non-point sources of pollutants; and recommended programs to address each category of pollutant source.

The 303(d) list is then extrapolated from the 305(b) list to show only waters that either partially support or do not support their designated use and require TMDL development. Waters are either listed as supporting, partially supporting, or not supporting their designated use (see chapter 4 for more information on the bacteria standard in GA and the associated designated uses)¹².

¹⁰ see information on authorized monitoring in Chapter 7

¹¹ http://iaspub.epa.gov/waters/w305b_report_v2.state?p_state=GA

¹² When a water body is “delisted” from the 303(d) impaired waters list, it is not “removed” but given a new classification such as, “supporting” its designated use (Radcliffe, et al. 2006).

Non-point source (NPS) implementation is often voluntary due to the elusive nature of the sources of pollutant and resulting management challenges. The community can institute mechanisms such as a stormwater utility that will help the overall effect of NPS; and can also institute ordinances to control certain behaviors, such as pet waste ordinances under its police powers. Point source (PS) implementation, however, is where the state and community have the most enforcement powers. NPDES permits are given to municipal and industrial dischargers and are reviewed and reissued every 5 years. GAEPD has the final say in NPDES permit issuances. If the TMDL is not met, when the five year review arrives, the TMDL limits must either be incorporated into the permit or the permit may not be reissued by the State. The State may also choose to not issue any new permits in the community until the TMDL for the particular water body is met.

Within The Watershed Protection Branch of GAEPD, the TMDL Implementation Program coordinates implementation efforts and facilitates remediation through education, outreach and funding¹³. The river basins of Georgia are placed into five groups which follow a rotating 5 year schedule for TMDL development, planning, monitoring, modeling, permitting, and other water quality efforts. TMDL implementation planning generally follows a two-step process. The TMDL initial implementation plan includes a list of potential control strategies, BMP projects, and schedules. Revised TMDL implementation plans are then written to include the participation and support of local governments and stakeholder groups; these supercede the initial plan. Revised implementation plans are prepared by either GAEPD or contracted out to sixteen Regional Development Centers (RDCs). Which plans are developed by whom is dictated by the tiered TMDL process established by GAEPD (Radcliffe et al. 2006):

¹³ Further information about the role of GAEPD in TMDL implementation can be found in the bacteria TMDL TAG white paper at <http://www.georgiaconservancy.org/WaterQuality/TMDL.pdf>

- Tier 3 plans are developed in-house by GAEPD staff. This includes streams impaired due to natural conditions (i.e. wildlife), legacy sediments, and streams partially supporting designated uses.
- Tier 2 plans require more planning and community/stakeholder involvement, and are therefore contracted to RDCs. These are generally impaired streams that do not support their designated uses.
- Tier 1 plans are more complex than Tier 2; and may require further non-point source identification and BMP selection. GAEPD plans for Tier 1 reports to serve as supporting documentation for 319 grant monies.

One of the stipulations of the 1997 consent decree from the Sierra Club TMDL lawsuit was to complete a particular number of implementation plans within a particular time limit. With the conclusion of the consent decree in December 2005, GAEPD is now “slowing” the development of TMDL implementation plans. Emphasis is being placed on actually improving water quality, revising TMDL implementation plans to appropriately address water quality issues, and implementing methods of adaptive management to address changing needs and situations.

The State of Georgia is working to improve upon the development and implementation of TMDLs, bacteria in particular. In the following chapters, I will explore some management solutions and control strategies being implemented in other States of the Southeastern U.S. I will conclude this report by recommending which of these practices could be applied to the situation in Georgia and in what ways we could improve upon our current methods and programs associated with bacteria TMDL implementation.

CHAPTER 4

THE SCIENCE OF BACTERIA TMDLS

In this chapter I supply basic background information and explanation of the issues surrounding bacteria TMDL development and implementation. Essentially, the water quality standard for bacteria exists because of concern over people's health when they come into physical contact with high concentrations of potentially pathogenic bacteria from fecal sources, whether in drinking or recreational waters. In Georgia's 305(b) water quality assessment report for 2002, of the 57 percent impaired waters in the State, Fecal coliform (FC) is listed as the leading source of impairment (close to 4,000 total miles impaired) in the State (USEPA 2002). The two most probable sources of impairments are non-point sources and urban runoff (USEPA 2002). Various camps of thought exist about the nature of FC impairments in regard to a regulatory standard to protect public health, scientific considerations and site specificity. Whichever camp one is a member of, the fact remains that problems with the proper disposal of human and animal excrement will increase with our growing population. Issues involving the standard for bacteria and other considerations are only discussed briefly in this chapter and do not fall within the scope of this study which is focusing on the abatement and control of bacteria inputs, whatever the standard may be.

In 2002, the University of Georgia River Basin Center and the Georgia Conservancy formed a Technical Advisory Group (TAG) to make recommendations for the future of bacteria TMDL development and implementation in the State. The bacteria TAG met on nine occasions and took comments from scientific experts on bacteria, local officials and stakeholders involved

in bacteria TMDL implementation. In June 2006, the TAG published a white paper titled *Scientific Basis for Bacterial TMDLs in Georgia*¹. An objective of this thesis is to augment the research on bacteria TMDL implementation already initiated by the TAG. In this background chapter on bacteria, therefore, I will reference the TAG's bacteria white paper as they have just completed much of the research on the issue of bacteria in Georgia.

The Problem with Bacteria

The water quality standard for bacteria is first and foremost an issue of public health and safety. The concern lies in identifying pathogenic bacteria or indicators of pathogenic bacteria to protect people from gastrointestinal illness in recreation waters (i.e. any recreational activity where ingestion of, or immersion in, the water is likely). Essentially, the main route of exposure to illness-causing organisms is during aquatic recreation is through accidental ingestion of fecally contaminated water (USEPA 2004). Through its studies to establish a water quality criteria for bacteria, USEPA focused on showing a correlation between indicator organisms and gastroenteritis, which describes a variety of diseases that affect the gastrointestinal tract and are rarely life-threatening² (USEPA 2004).

Many bacteria found in the intestinal tract serve a useful function in extracting nutrients from food. These bacteria are almost always non-pathogenic although some strains can cause illness. *Escherichia coli* (*E. coli*) for example are a ubiquitous and generally beneficial bacteria in the intestines of all warm-blooded animals; however, some strains can cause gastroenteritis. Pathogenic bacteria in the intestinal tract will be passed out in feces along with non-pathogenic

¹ The TAG white paper can be accessed at <http://www.georgiaconservancy.org/WaterQuality/TMDL.pdf> and was submitted to GAEPD to support the Assimilative Capacity Technical Advisory Committee as part of the GA Statewide Water Planning process.

² Symptoms include nausea, vomiting, stomachache, diarrhea, headache, and fever.

bacteria. In the U.S., a group of intestinal bacteria known as fecal coliform bacteria are used as indicators for fecal contamination of waters. Fecal coliform bacteria belong to a single family of bacteria, the Enterobacteriaceae, and because they are all gram negative rod-shaped bacilli are easily identified. Other bacteria found in the intestine are called coliform bacteria. Some of these coliform bacteria are pathogenic, for example cholera and some forms of hepatitis. Total coliform bacteria include fecal coliforms plus fecal coliforms. Because total coliform bacteria can include some species that are able to live and reproduce in warm waters, testing for total coliform bacteria is considered less reliable than just testing for fecal coliform bacteria (Carroll, personal communication 2006).

It is a common method amongst public health agencies to use indicator organisms because while they do not cause illness directly, they have demonstrated characteristics correlating them to the presence of pathogens (USEPA 2004). Therefore, if pathogenic bacteria are present, FC will be present; if FC is present, pathogenic present are likely to occur but may not always be present.

Controversy and heated academic discussion, therefore, dominate the issue of a standard for bacteria impairment. Disagreement exists over which indicator bacterium to use and how best to outline a standard to protect public health and allow for improvement of water quality.

Sources of Impairment

Identifying, regulating and controlling sources of bacteria pollution is difficult due to the ubiquitous nature of bacteria non-point source (NPS) pollution. Non-point sources are my focus due to the complex and ubiquitous nature of the pollution and pollutant. Sources of NPS bacteria impairment include runoff from fields with grazing livestock, pet waste, leaking and/or failing

septic systems, and other agricultural and urban runoff such as illicit discharges and leaking sewer lines (USEPA 2006a).

Pathogens and indicator bacteria are present in animal manure with infected cattle posing the most risk to human health (Radcliffe et al. 2006). Animal manure in particular contains high amounts of fecal coliform (Barker et al. 1994). Manure containing pathogenic bacteria can reach streams through runoff from field deposition, manure applied to fields as fertilizer, or by deposition while animals have access to streams (i.e. cattle standing in or near the streams) (Radcliffe et al. 2006). Since fecal coliforms do not survive for long outside of the intestinal tract, the risk is mainly when fresh manure is washed into a water body during a storm event or is directly deposited (Radcliffe, et al. 2006).

Intrusion of harmful bacteria from failing septic systems into groundwater, drinking water wells, and surface waters is a potential source of contamination and subsequent human illnesses. The issue lies in poor location and improper installation of systems, and/or poor maintenance. When properly sited, designed, installed, and maintained, septic systems effectively reduce or eliminate bacteria from the wastewater (Radcliffe et al. 2006 & USEPA 1997; 2002b). USEPA considers onsite systems to be a permanent part of the nation's wastewater management infrastructure (1997; 2002b). Hydraulic failure or surfacing of septic systems (wastewater rises to the surface) is fairly rare in Georgia (Radcliffe et al. 2006). Of greater concern in the state are "straight pipes" used by older homes that do not have a septic tank or drainfield and instead discharge directly into a nearby ditch or stream (Radcliffe et al. 2006).

Best management practices to abate these various sources of bacteria pollution will be discussed further in Chapter 5.

The final difficulty with bacteria impairment involves the source identification of contamination, particularly from non-point sources. Two methods dominate the field: bacterial source tracking (BST) to determine whether the bacteria are of animal or human origin and targeted sampling to identify the locations of the source. I will not discuss them further, but rather suggest the bacteria TMDL white paper be consulted for further information:

<http://www.georgiaconservancy.org/WaterQuality/TMDL.pdf>.

Scientific Issues to Consider

Various scientific issues and considerations should be researched and discussed when developing and implementing a bacteria standard for TMDLs in Georgia. The white paper compiled by the bacteria TAG covers most of these. I will therefore focus on those that relate to the implementation of control strategies for bacteria impairment.

When developing the bacteria standard for Georgia, and in other states, issues arise as to differences in bacteria growth and identification between regions. As will be described in the following section on USEPA guidance, the USEPA conducted background studies at sites in Pennsylvania and Oklahoma. However, some studies have shown that background levels of bacteria might be higher in sub-tropical waters because *E. coli* survive longer than expected in these conditions (Solo-Gabrielle et al. 2000; Desmarais et al. 2002; USEPA 2002). Dr. David Radcliffe, the lead author of the bacteria TAG white paper, has collected background data from two Georgia piedmont headwater streams in the Oconee River (2006). These streams had no anthropogenic source of FC contamination. Over the 3 year monitoring period, the state standard was exceeded on six occasions, showing that the standard can be exceeded under natural background conditions (Radcliffe et al. 2006). Studies with similar results were also conducted

by UGA scientist Dr. Georgia Vellidis, USDA-ARS scientist Dr. Richard Lowrance from the Southeast Watershed Research Laboratory, and Dr. Dwight Fisher from the USDA-ARS J. Phil Campbell, Sr. Natural Resource and Conservation Center (Radcliffe et al. 2006). Overall, the bacteria TAG found that normally reference streams would be under the standard, but may exceed it on occasion, meaning the background level may be higher in this region than in others (Radcliffe et al. 2006).

Particularly troublesome is the determination of animal versus human fecal contamination and how states are supposed to approach the issue. Provisions can be made for wildlife-impacted water bodies according to USEPA's 2002 guidance document. More research needs to be conducted to determine the actual risk to humans in these wildlife-dominated waters (Radcliffe et al. 2006).

According to Dr. C. Ronald Carroll, total coliform measures will also include some bacteria that have been growing outside the intestinal tract in the natural environment (personal communication, 2006). Complicating the surrogacy of coliforms as indicators, is the issue that both fecal and other coliforms can come from any mammal or bird making it difficult to distinguish between human and animal-caused impairment. In fact, "herbivorous vertebrates such as geese, pigs (mostly), beavers, and muskrats produce far more coliforms per pound than humans" (Carroll, personal communication 2006). Another issue of concern, according to Dr. Carroll, is the resistance of some coliform pathogenic bacteria to antibiotics. Of particular note are *Enterococcus faecalis* and *Enterococcus faecium* that are not only resistant pathogens but have long persistence times in warm waters and soils.

The Bacteria Standard

Federal Guidance

In the 1940s and 50s, the Department of the Interior (DOI) conducted studies which are now the foundation for the geometric mean standard of 200 cfu (colony forming units)/100 ml which is now commonly used among states (USEPA 1986). The studies focused on three freshwater beaches with large residential populations³. Through these studies, DOI was able to correlate a higher rate of gastrointestinal illness with a higher number of total coliforms present in the water body while individuals were swimming. In the 1960s, the Interior converted the recommended standard from total coliform to fecal coliform. From this conversion, the risk associated with the FC standard was determined to be approximately eight illnesses per 1,000 swimmers (USEPA 1986).

In the final rule for *Water Quality Standards for Coastal and Great Lakes Recreation Waters*, USEPA summarizes their current rule on the bacteria standard for waters of the US (freshwater and coastal) (2004). In 1986, USEPA published *Ambient Water Quality Criteria for Bacteria—1986*. According to these reports, USEPA based its 1986 water quality criteria for bacteria on levels of indicator bacteria, particularly *Escherichia coli* (E. coli) and enterococci, which demonstrate the possible presence of pathogens in fecal pollution that can cause gastrointestinal illness. The basis for the 1986 recommendation was a series of freshwater studies in the 1970s conducted at beaches on Lake Erie at Erie, Pennsylvania and on Keystone Lake near Tulsa, Oklahoma⁴. The results of the studies showed that both E. coli and enterococci showed a highly significant correlation with swimmer illness rate (E. coli $r^2 = 0.80$, enterococci

³ Two beaches Lake Michigan in Chicago (one with good water quality and one with poor) and one beach on the Ohio River in Kentucky (one with good water quality could not be found). Consult USEPA, 1986 or Radcliffe, et al. 2006 (bacteria TAG white paper) for more information.

⁴ To find further summarized information about the studies, consult the bacteria TMDL TAG white paper at <http://www.georgiaconservancy.org/WaterQuality/TMDL.pdf>.

$r^2= 0.74$), but FC showed no correlation ($r^2= -0.80$). Based on these studies, USEPA concluded that *E. coli* alone was the preferred indicator bacteria for a freshwater standard. In the 1986 guidance document, USEPA urges states to drop the FC standard and adopt the new *E. coli* standard for “primary contact⁵” waters. In 2002, USEPA released another document titled *Implementation Guidance for Ambient Water Quality Criteria for Bacteria* which continued to urge states to adopt the new *E. coli* standard.

Georgia’s Status

Thirteen states (not including Georgia) have adopted the Environmental Protection Agency’s guidance to use *E. coli* as indicator bacteria for harmful pathogens as opposed to FC (Radcliffe et al. 2006). According to Joel Hansel with USEPA, only Tennessee and Kentucky in Region IV have adopted the *E. coli* standard (personal communication 2006)⁶. While Georgia’s Environmental Protection Division (GAEPD) proposed a new freshwater bacteria standard based on *E. coli* (GAEPD 2002), they are maintaining that they will not adopt the new standard until USEPA’s guidance document is out of “draft” form and test methods for ambient waters and wastewater effluents are approved. Test methods have now been approved for ambient waters (Federal Register, 2003) and have been proposed for wastewater effluents (Federal Register, 2005). Controversy surrounds this issue as many other states are already adopting *E. coli* and/or enterococci. Due to the scope of my research, I do not wish to delve any farther into the issue. Instead, I reference much of this to the recently published *Scientific Basis for Bacterial TMDLs in Georgia* and encourage the State to adopt the bacteria TAG’s recommendations when dealing with this complex issue.

⁵ Primary contact waters are defined as water bodies where people engage, or are likely to engage, in swimming, water skiing, kayaking, and other activities where contact and immersion in the water is likely (USEPA, 1986).

⁶ USEPA Region IV: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee and 6 Tribes

Nonetheless, the current Georgia bacteria standard for fresh water is based on FC and the water body's designated use, which is fishing for most streams and rivers in Georgia (Radcliffe, et al. 2006). Standards are given in terms of a geometric mean of at least four samples collected from a given sampling site over a 30-day period at intervals of no less than 24 hours, and/or as a single sample maximum. Standards also vary depending on the "designated use" of the water body as specified by GAEPD (2004):

- Recreation: Not to exceed a geometric mean of 100 colony forming units (cfu)/100 milliliter (ml) for coastal waters or 200 cfu/100 ml for all other recreational waters.
- Drinking water supplies: For the months of May through October, not to exceed a geometric mean of 200 cfu/100 ml. For the months of November through April, not to exceed a geometric mean of 1,000 cfu/100 ml and not to exceed a single sample maximum of 4,000 cfu/100 ml. Note that drinking water levels are higher because it is assumed that drinking water will subsequently be treated to eliminate bacteria. The standard does not mean that it is safe to drink water with 1000 cfu/100 ml.
- Fishing:⁷ Same as the drinking water standard.
- Wild & Scenic Rivers:⁸ No alteration of natural water quality from any source.

For the listing of impaired streams on the 303(d) list, GAEPD uses bacterial geometric mean (GM) data when available. If there is not enough data for a geometric mean assessment, GAEPD uses the single maximum (SM) standard to evaluate results along with other available bacterial data. Waters in the state of Georgia are then placed on the partially supporting list if the standard is exceeded in one GM out of four quarterly GMs collected in one year. The "not supporting" list includes waters that exceeded the standard in two or more GMs out of four quarterly GMs.

⁷ Full title: "Fishing, propagation of fish, shellfish, game and other aquatic life;" this standard is also the same for the designated use of "Coastal Fishing."

⁸ These are technically specified as two separate standards, but are equal and thus grouped together in this report.

Some streams are currently listed based on a single sample that exceeded the SM water quality standard when the SM standard was used for listing (Radcliffe et al. 2006). Removal from the 303(d) impaired waters list is accomplished when enough samples are gathered to calculate at least four quarterly GMs in one year and less than 25% of the GMs could exceed the water quality standard.

Conclusion

The objective of this chapter was to identify some of the key issues, controversies, and background information necessary to discuss the bacteria TMDL standard in Georgia.

There are many more issues to cover such as alternatives for municipal treatment of wastewater, such as constructed wetlands (CWs). CWs have been very successful in communities in Georgia (Clayton County, City of Augusta, City of Gordon) and other states on municipal scales and with residential systems (discussed in Chapter 6). The focus of this report is on non-point sources of bacteria impairment, therefore, point sources will not be discussed in terms of control strategies and abatement.

Another area of future research lies outside of the Southeast, particularly in regard to the bacteria TMDL standard. For instance, Canada and some European Union countries have developed methods for developing a bacteria standard that should be reviewed further.

While many of us in the state of Georgia are frustrated by the bacteria standard issue, we must not let it paralyze us from continuing to implement control strategies that will decrease bacteria inputs no matter the current standard. While groups like the bacteria TAG develop recommendations for how to proceed, others can be implementing on-the-ground efforts to abate non-point sources of bacteria. This project will assist in encouraging further implementation of

bacteria TMDLs through the methods I outline in the following chapter on best management practices.

CHAPTER 5

BEST MANAGEMENT PRACTICES

This chapter is an overview of best management practices, particularly those employed in the abatement of surface water quality impairments from fecal coliform bacteria. Descriptions of potentially pathogenic bacteria from non-point sources are provided to clarify the setting for best management practice implementation. Furthermore, examples of bacteria-focused best management practices and bacteria TMDL implementation efforts are shown to illustrate current actions in the State of Georgia.

Background

A best management practice (BMP) is defined as: “. . . a practice or combination of practices that are determined (by state or designated area-wide planning agency) through problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable, (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals” (qtd. in Ice 2004). Water quality BMPs, specifically, are designed to control the delivery of pollutants from land use activities to water resources. Any two or more BMPs used together to control a pollutant from the same source constitute a BMP “system.” A BMP system can be tailored for a specific pollutant, source, geographical location, as well as an economic situation. According to Gale et al. (1996), BMP systems control non-point sources (NPS) more effectively than individual BMPs because they

can minimize the impact of the pollutant at several points: at the source, during transport from the source to the water body, and at the water body.

Essentially, best management practices can be divided into two categories: structural and non-structural. Structural BMPs are built structures or landscape features that are installed in a landscape to reduce or slow pollutant inputs into a water body. Examples of structural BMPs may be a constructed wetland to treat wastewater effluent or a stormwater retention pond in a residential subdivision. Non-structural BMPs may consist of policies to reduce pollutants before they enter waterways, land use planning and management, and outreach efforts. Non-structural and structural BMPs generally complement each other. Non-structural BMPs are often seen as preventative measures to be implemented before taking action through structural BMPs.

Throughout this report I often use “control strategies” and “best management practices” or “BMPs” interchangeably. My reason for using the term “control strategies” in place of BMPs is that I am attempting to broaden our view of BMPs to include more non-traditional and non-structural strategies like education and outreach.

Structural as well as non-structural BMPs are specific to an urban or agricultural setting. Examples specific to these environments are urban stormwater detention ponds and agricultural filter strips. In the following section, I elaborate on which best management practices can be used in the abatement of bacteria non-point source pollution for urban and rural settings as well as the nature of the pollutant sources themselves.

Bacteria Sources & Control Strategies

Fecal coliform bacteria in non-point source pollution¹ are from human and vertebrate animal sources such as urban runoff carrying pet waste, leaking septic systems and sewer lines, illicit discharges from non-point sources², wildlife, agricultural runoff and the accessibility of streams by cattle. Controlling pollution from non-point sources can be implemented through voluntary, incentive-based, or regulatory non-point source control programs aimed at reducing bacteria loads (Ice 2004).

Urban

The most common sources of urban bacteria pollution result from runoff or improper disposal of human and pet waste. Human waste can pollute water bodies by leaking from failing septic systems, faulty sewer lines, illicit discharges from residences into a stream, and Stormwater System Overflows (SSOs)³. Proper sewer line maintenance and repair is a constant water quality issue in urban environments.

In urban areas, stormwater resulting from various urban activities, such as construction and impervious pavement, that is collected in stormwater collection systems is considered a point source of water pollution under the Clean Water Act and is therefore regulated under the National Pollutant Discharge Elimination System (NPDES) stormwater permitting program⁴. Industrial dischargers, construction activities of a certain size, and multiple separate storm sewer systems (MS4s) are all covered under this program. Stormwater is an issue in regard to bacteria

¹ Discharges from industrial and municipal sources such as sewer outlets are considered point sources and are regulated through the NPDES permitting program.

² Illicit discharges from non-point sources may include illegal piping of waste from a residence to a stream or stormwater system. These types of illicit discharges are referred to as “straight pipes.” These can be fairly common in older homes in particular. In Virginia, researchers assumed that 10 percent of old houses and 2 percent of middle-aged houses within 45 m of streams used straight pipes (Benham et al. 2005).

³ A SSO is a release of untreated wastewater before the flow reaches a treatment plan. SSOs pose a significant threat to public health and water quality. (USEPA 2006a)

⁴ NPDES: Section 402 of the Clean Water Act; for more information on the NPDES stormwater program: http://cfpub.epa.gov/npdes/home.cfm?program_id=6

impairment because of the high volumes of pollutants that can be washed into surface waters during storm events. Many structural BMPs are available for dealing with stormwater. Most of the BMPs function by slowing the speed of the stormwater and allowing pollutants to settle out. One example of this is a stormwater detention pond which is often seen in areas near shopping centers and subdivisions where a great deal of impervious pavement is present and storm flow rates are high. Stormwater BMPs that assist in slowing the flow of pollutants into surface waters and allow pollutants to settle out will also assist in the abatement of NPS runoff from bacteria sources. Although point sources of bacteria, including urban stormwater runoff, will not be explored in-depth, an increase or advancement in stormwater BMPs will assist in decreasing inputs of bacteria pollution.

Pet Waste

Many pollutants can be found in stormwater runoff from urban areas. One such pollutant is pathogenic bacteria from pet waste. Pets and urban wildlife can be a significant source of bacteria impairment. This is exacerbated by the high densities of pets in urban areas. According to the American Pet Products Association, four in ten U.S. households include at least one dog and Americans owned 68 million dogs in 2000 (Watson 2002). Combine this number with surveys showing that 40 percent of people don't clean up their pet's waste (Swann 1999), and it is apparent that a high volume of feces potentially enters our surface waters. Non-human waste is a significant source of contamination. According to studies by Alderiso et al. (1996) and Trail et al. (1993), 95 percent of FC found in urban stormwater was of non-human origin. For wildlife sources of bacteria contamination such as from waterfowl populations, few measures can be taken to reduce inputs. Inputs from pet waste, however, can be abated through various control strategies. To identify human vs. non-human waste, molecular-based bacterial source tracking

(BST) can be used. This form of identification can be prohibitively expensive, especially for smaller communities. Various methods exist to identify NPS pollutant sources with less expensive methods, such as targeted sampling⁵.

Therefore, if high numbers of pet households exist in a watershed, it is reasonable to implement inexpensive, holistic control strategies to reduce inputs. The Center for Watershed Protection's Stormwater Center provides information for "animal waste collection" (or "scooping the poop strategies"). According to the Stormwater Center's review of current research on animal waste collection, the strongest need is for more education of pet owners about the importance of pet waste as a water quality pollutant (CWP n.d.). Educational tools can vary depending on the target population and the funding available. The most common tools are brochures, public service announcements, and signage in public parks, which are often the biggest "receptacle" for pet waste. Pet waste ordinances are becoming more and more common in urban communities. These ordinances usually focus on pet waste removal from public areas, but can also apply to private front lawns. Subdivisions and planned developments are enforcing these types of controls, generally for aesthetic reasons associated with lawn beautification. Also becoming more popular is the installation of designated dog parks where pets are allowed off-leash in a confined area. Various management options can be implemented in these parks to collect pet waste, as well as proper siting of the park in relation to surface water drainage areas. These control strategies for parks and educational campaigns will be examined further in the recommendations chapter.

⁵ For more information about various bacteria sampling methods, consult the bacteria TAG white paper and/or research conducted by Dr. Peter Hartel in UGA Crop and Soil Sciences: Hartel et al. 2006. "Targeted sampling and bacterial source tracking (BST) of Potato Creek between Griffin and Thomaston, Georgia, during baseflow and stormflow conditions. 319 Report to McIntosh Trail Regional Development Center, Griffin, GA. (being turned into a manuscript for the *Journal of Water and Health*); and McDonald, et al. 2006. "Identifying sources of fecal contamination inexpensively with targeted sampling and bacterial source tracking" *Journal of Environmental Quality*. 35:889-897.

On-site Wastewater Disposal Systems

Another ubiquitous source of bacteria contamination originates from systems designed for human waste disposal. While sewer systems are more common in urban residential areas, septic systems can be found in both urban and rural areas of Georgia due to the nature of sprawling development. According to the Metropolitan North Georgia Water Planning District, the number of septic systems in their 16-county area is estimated to be more than half a million with over 12,000 being added each year (2006). The bacteria Technical Advisory Group (TAG) estimates there are more than 1.5 million systems in the State, which probably represents more than 40 percent of the homes in Georgia (Radcliffe et al. 2006). The use of septic versus sewer is also considered a tool for limiting growth, and is employed by many counties fearing the encroachment of the metro Atlanta area. Septic systems are quite effective and beneficial to the environment if properly installed and maintained⁶.

Conventional septic systems consist of a tank to separate solids which are broken down by bacteria and the wastewater which is directed into an absorption field known as a drainfield or leachfield. The “filtered” wastewater is leached into the soil and does not pose risks to public health if sited properly depending upon drainfield size, soil type and other factors⁷. To properly maintain systems and avoid failures, the remaining solid waste in the tank must be pumped out every three to five years. If maintenance measures are performed, a drainfield can last up to twenty to thirty years. The greatest threat to surface water bacteria impairment originates from system failure when septage comes to the soil surface and results in overland flow. If sited improperly, groundwater contamination can occur in drinking water wells or seep into the water

⁶ More general information can be found through the National Environmental Services Center and the National Small Flows Clearinghouse.

⁷ For a more technical and in-depth overview of septic systems processes, consult the bacteria TAG paper at <http://www.georgiaconservancy.org/WaterQuality/TMDL.pdf>

table. Due to lack of knowledge about septic system performance and maintenance needs, many homeowners do not know there is a problem until failure occurs. At this point, costs to fix or replace the failing system can be high and present quite a burden for homeowners, and the surrounding community. In the state of Georgia, it costs approximately \$300-350 for a “pump-out” of a standard 1,000 gallon tank (Banks, personal communication 2006). Repairs to failing systems, which are generally focused on the drainfield, are charged by the foot. In a 3 bedroom home, this is estimated to cost about \$3300. However, Banks remarked that some repairs can cost upwards of \$20,000 depending upon the extent of failure and damage to the septic system (personal communication 2006).

In Georgia, as in many other states, the County Boards of Health and the State’s Department of Human Resources (DHR) regulate septic systems up to 10,000 gallon tank capacity. DHR rules establish a permitting and inspection system for installations and repairs; and certification requirements for contractors, inspectors, soil classifiers and pumpers⁸ (Metropolitan North Georgia Water Planning District 2006). DHR has also written a manual that details design criteria, site suitability parameters, as well as the installation and operational requirements for on-site sewage management systems⁹ (Metropolitan North Georgia Water Planning District 2006). It is the responsibility of the County Boards of Health to enforce these minimum requirements outlined by DHR¹⁰.

According to the Metropolitan North Georgia Water Planning District, a problem arose in the regulations when the duties of the county Boards of Health in regard to septic systems maintenance were amended by O.C.G.A. § 31-3-5 in 2000 (2006). The amendment removed the

⁸ Chapter 290-5-26 of the Rules of the GA Department of Human Resources, “On-Site Sewage Management Systems,” establishes statewide regulations.

⁹ Obtain a copy of the GADHR On-site sewage manual at <http://health.state.ga.us/programs/envservices/onsitemanual.asp>

¹⁰ On-site sewage rules for GA can be found at: <http://health.state.ga.us/programs/envservices/onsiterules.asp>

ability of the Boards of Health to require maintenance on non-mechanical septic systems, which do not require electricity or pumps to function; and are what most people think of when picturing a traditional septic system (Metropolitan North Georgia Water Planning District 2006). This amendment explicitly prohibits local health departments from enacting or enforcing a regular maintenance schedule to prevent malfunctions and failures. Property owners are still responsible for properly operating and maintaining the septic systems to increase life expectancy and prevent failures¹¹. There is no explicit requirement however, for the regular pump-out of systems, nor is there any sort of enforcement mechanism. The Georgia Department of Natural Resources Environmental Protection Division (GAEPD) regulates larger systems (more than 10,000 gallons of wastewater per day) and therefore has no enforcement authority over the smaller residential systems which make up the majority of systems in the State. Georgia also does not require homeowners when selling their homes to disclose whether or not they have a septic system to would be buyers. Because of these limitations on the authority of local governments, communities are attempting to prevent failures in other ways. The Metropolitan North Georgia Water Planning District, GADHR, and county Boards of Health are implementing efforts to educate homeowners on proper maintenance through education pamphlets, DVDs, and distribution of other advisory materials (Metropolitan North Georgia Water Planning District 2006).

Solutions for these various bacteria impairments will be explored in the recommendations chapter of this thesis.

Agriculture

Water pollution from agricultural sources creates an interesting regulatory problem especially in Southeastern states like Georgia that are home to many animal-based farming

¹¹ GA DHR Rules 290-5-26-.18

operations. Traditionally, agriculture is exempted from water quality regulations¹², even though it is believed to be the source of seventy percent of the degraded miles of river surveyed in the U.S. (Wall 2003). Livestock waste, specifically, is a major source of non-point source water pollution¹³. A 1989 summary of state non-point source water quality assessment conducted under the Clean Water Act's section 319 revealed that over one-third of all water impairments attributed to agricultural pollution were caused by animal waste (USEPA 2002). Bacteria from animal waste can reach surface waters through manure that is applied to fields, manure deposited on fields where animals are grazing, or deposition in streams where animals have access (Radcliffe et al. 2006).

Agricultural Sources of Bacteria

In terms of bacteria pollution, livestock grazing poses a risk to water quality. Various studies have been conducted to show the connections between livestock, bacteria, and best management practice effectiveness. Belsky et al. (1999) showed that livestock degrade riparian zones under all circumstances. In general, riparian BMPs such as grass filter strips and buffer areas are believed to reduce inputs of FC as well as other pollutants such as sediment. Some studies (Coyne et al. 1998; Desmarais et al. 2002), however, have indicated problems with the potential for regeneration or regrowth of pathogenic bacteria in sediments. This research is particularly important to this project because it reminds us of the need for BMP systems instead of individual BMP installation. For instance, filter strips will assist in reducing immediate inputs in the stream, while other measures such as alternative watering systems and rotational grazing

¹² While most NPDES regulations exclude agricultural stormwater runoff from permit requirements, some large facilities may be regulated under this program (such as CAFOs, see note below) (USEPA, http://cfpub.epa.gov/npdes/home.cfm?program_id=41)

¹³ By "livestock waste" I am not referring to CAFOs (confined animal feeding operations) which are regulated by the CWA as point sources. Grazing livestock, which deposit feces in the pastures and water bodies (if given access), are considered to be non-point sources of bacteria impairment.

will reduce the inputs of FC coming from the pastureland above the filter strips and therefore reducing the stress to the riparian BMPs.

The deposition of feces from cattle into streams is an important source of FC inputs to surface waters (Mostaghimi et al. 2002). Thomas (2002) found a dramatic improvement in water quality as a result of fencing cattle out of streams and riparian areas. Before fencing, FC units average over 51,000 cfu/100 ml which then decreased to 258 cfu/100 ml after fencing. Cattle also use riparian zones for shade in the hot summer months. Byers et al. (2005) found that cattle went to riparian areas in response to environmental stressors. When they provided cattle with water troughs, time spent in riparian areas by cattle reduced 40 to 96 percent, depending on the time of the year. By implementing best management practices such as fencing cattle out of streams and providing alternative shade and water sources, agricultural producers can greatly decrease the negative affect of cattle grazing in and around streams.

The practice of manure application, especially poultry litter, on fields and pasture land is potentially harmful to water quality. The issue with spreading manure is related to bacteria die-off rates. By providing storage facilities to store poultry litter, the bacteria are allowed time to die-off without getting washed into surface waters during a storm event. Hartel et al. (2000) found that in Georgia, poultry litter that is placed in “stack houses” for more than a few days had low levels of FC. Another useful best management practice is to compost poultry litter before applying it to fields. The high temperatures reached during composting will kill FC bacteria (Carroll, personal communication 2006). Combining these BMP options with a nutrient management plan can assist in overall reductions in FC inputs.

In the *National Management Measures to Control Nonpoint Pollution from Agriculture*, USEPA recommends the following management measures¹⁴ to alleviate the negative effects of grazing on water quality (2003):

- maintenance of riparian and upland area vegetation
- manage for deposition of fecal material away from water bodies and to enhance nutrient cycling by better manure distribution and increased rate of decomposition
- exclusion of livestock and/or controlling livestock access to and use of sensitive areas, such as streambanks, wetlands, estuaries, ponds, lake shores, soils prone to erosion, and riparian zones through the use of:
 - herding
 - installation of alternative drinking water sources
 - installation of hardened access points to prevent stream bank erosion for water consumption where alternatives are not feasible
 - placement of salt and additional shade, including artificial shelters, at locations and distances adequate to protect sensitive areas
 - stream crossings with hardened substrates
 - exclusionary practices, such as fencing, hedgerows, moats, and others

Difficult and complex issues, however, often pose barriers to implementation by farmers.

Funding for Agricultural BMPs

A central impediment is the availability of funds to implement management plans, and difficulties associated with obtaining funds such as lengthy applications and onerous contractual

¹⁴ This list of management measures is not exhaustive and only includes measures that can specifically abate bacteria impairment to water quality. More grazing management information can be found in Ch. 4 of USEPA's *National Management Measures to Control Nonpoint Pollution from Agriculture*, EPA-841-B-03-004. <http://www.epa.gov/nps/agmm/index.html>

agreements. Through federal agencies such as the United State Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) each state receives access to federal funds to assist in the implementation of best management practices¹⁵. The differences between states lies in the programs and support they each provide to agricultural producers as they apply for these federal monies, such as supplemental state-funded cost-share programs. The federal cost-share application process can often be onerous, time consuming, and confusing to agricultural producers and other interested parties. The Environmental Quality Incentives Program (EQIP) is commonly used to fund BMPs to protect or improve water quality from bacteria impairments¹⁶. The EQIP program is closely tied to the 1985 and 2002 Farm Bill. The application includes an EQIP plan of operations and a schedule for implementation of conservation practices, such as various structural BMPs. For example, if a plan of operations includes an animal waste storage facility, the participant must provide for the development and implementation of a comprehensive nutrient management plan (NRCS 2004). EQIP is a popular option among farmers, and therefore more competitive, because it requires only a one year contractual commitment. Natural Resources Conservation Service (NRCS) agents in each locality work with participants and these agreements can be up to ten years in duration.

Other FSA and NRCS sponsored programs include the Continuous Conservation Reserve Program¹⁷ (CRP) and the Conservation Security Program¹⁸ (CSP). Cost-share programs do require a great deal of will and compromise on the part of the farmer. Federal cost-share

¹⁵ The NRCS is a federal agency charged with assisting residents in the conservation of natural resources on private lands. NRCS focuses on providing private landowners with assistance and support to conserve their soil, water and other natural resources. NRCS staff also provide expertise and technical guidance to local, state and federal agencies and policymakers. <http://www.nrcs.usda.gov>

¹⁶ For more information: <http://www.nrcs.usda.gov/programs/eqip>. This online tool has been provided for farmers and ranchers to see if they qualify for the special cost-share payment rates under EQIP for limited resource farmers and ranchers; <http://www.lrfctool.sc.egov.usda.gov/>.

¹⁷ <http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=cep>

¹⁸ <http://www.nrcs.usda.gov/programs/csp/>

programs have attempted to make it less of a burden by “renting” the land being excluded by fencing or other similar best management practices. Some programs also provide funds for maintenance. With an increase in focused assistance from NRCS and county extension agents, familiarity and use of these funding mechanisms could increase.

Funding for Non-Point Source Water Quality BMPs

To assist in the implementation of BMPs in the State of Georgia and to complement existing federal cost-share programs, Georgia provides some financial incentives. These are administered by the GAEPD and are generally implemented with the assistance of CWA Section 319 water quality grants, similar to other state programs. In Georgia, the State Soil and Water Conservation Commission (SWCC) sponsors an Agricultural Conservation Incentive Program. This program funds practices such as exclusionary fencing, alternative watering systems, and critical area plantings¹⁹. The GA SWCC has implemented it as a water conservation program for irrigators (who irrigate with center pivot systems) (Risse, personal communication 2006). The GA SWCC’s Ag Lands Program²⁰ provides a cost-share match for BMPs implemented for 319-funded TMDL projects in the State, such as exclusionary fencing for livestock. According to Mark Risse, these 319 projects add flexibility in a few watersheds but are not used widely enough to offer a large impact across the State (personal communication 2006).

While these incentive programs assist in water quality improvements, the CWA 319NPS grant program in Georgia provides the major support for NPS water quality improvement efforts in the State²¹. 319 funds are allocated to each state to address NPS abatement strategies. Section 319 funds pay up to 60% of eligible project costs, with the applicant providing a 40% non-

¹⁹ O.C.G.A. § 2-6-52 (g)

²⁰ http://gaswcc.georgia.gov/00/channel_title/0,2094,28110777_30158446,00.html

²¹ For more information regarding the regulatory background of CWA Section 319, see Chapter 3 of this report.

federal match²². The allocation of these funds varies a great deal from state-to-state. In Georgia, the 319 program is administered by GAEPD. Michelle Vincent is the Unit Manager for the Grants Unit within the Watershed Protection Branch's Nonpoint Source Program and provided information regarding the program in the state of Georgia. The state of Georgia gives 90 percent of its 319 funds to external (outside of GAEPD) projects/contracts. Because of the high number of external contracts, the 319 application and implementation process is slower and the resulting annual draw-down rate is lower. The annual draw-down rate is used as a measure of success by the federal budget office (Barkley, personal communication 2006). If the draw-down rate is "slow," the federal budget office assumes that there is less "action" on the part of the State (Barkley, personal communication 2006). This can be deceiving, however, especially when many long-term projects are being implemented that may have greater overall water quality improvement affects. A three-year project, for instance, may not spend most of its allotted budget until the third year of implementation due to practical planning constraints (Barkley and Vincent, personal communication 2006).

In the case studies included in this report, 319 projects are highlighted as some of the more successful BMP implementation projects. These projects often include funding from federal agricultural cost-share programs, assistance for individual farmers to apply for cost-share monies, and/or State-sponsored environmental trust fund monies.

Role of BMPs in TMDL Implementation

TMDL implementation plans include a section on implementation strategies and actions – what best management practices will be implemented to achieve the TMDL. Clearly defined

²² The 40% non-federal match can be in the form of cash or in-kind services (<http://www.scdhec.net/eqc/water/pubs/319match.pdf>).

implementation actions and best management practices are essential to reducing surface water quality impairments and showing measurable success. Oftentimes, the BMP implementation information contained in the plan lacks site specificity, creativity, and practicality. BMP planning and implementation is very complex and the distinctions should be made among the non-use of available BMPs that could be effective if used, those BMPs that are not effective, and new BMPs that need to be developed and implemented.

Based on reviews of existing TMDL implementation plans and scoping interviews with TMDL implementation professionals²³, current BMP usage in Georgia can be categorized as follows:

- Agriculture: exclusionary fencing, etc.
- Septic and sewer inspection and maintenance programs
- Education and outreach programs
- Local city and county ordinances

This listing is very broad and general, and addresses most of the issues associated with bacteria TMDL implementation.

Examples from Georgia

Before reviewing control strategies and TMDL implementation projects in other states of the Southeast, examples from Georgia can illustrate some of the current efforts. The 16 RDCs of Georgia are essentially on the “front-lines” of TMDL implementation in the diverse urban and rural communities of the State. Therefore, two Regional Development Center (RDC) staff members from different regions of the State were interviewed about their experiences and

²³ Such as Bill Bumback, a former University of Georgia River Basin Center environmental planner and coordinator for the Georgia TAG on TMDL implementation.

successes. A professor and public service associate with the University of Georgia (UGA) Cooperative Extension Service was also interviewed for an understanding of current agricultural BMP implementation projects in the State focused on bacteria impairment sources.

The metropolitan area of Atlanta, Georgia (Metro Atlanta) has many unique water quality issues as its surrounding counties have cushioned increasing growth and development pressures. The exponential growth of the urban and suburban population creates a dilemma with the available surface water for consumption and correlative water quality. Dealing with the seemingly conflicting needs of Metro Atlanta is Matt Harper with the Atlanta Regional Commission (ARC). The ARC is the Regional Development Center (RDC)²⁴ for ten counties in the metro area of Atlanta. Harper made the distinction that the counties of the Atlanta area have better stormwater controls because of their MS4²⁵ requirements and sewer inspection and maintenance programs (personal communication 2006). For example, Cobb County is particularly proactive as they implement quarterly sewer line stream walks where they look for problems that may lead to discharges of waste into the nearby water body. A major problem in Atlanta, is the presence of a high number of septic systems in the Metro Area. Septic-to-sewer transition programs have become popular in some of the more affluent counties, like Gwinnett, but are generally too costly for many of the communities. The ARC has focused on public education and outreach as the “most efficient” way to improve water quality in the metro area (Harper, personal communication 2006). Education efforts have included everything from septic

²⁴ Regional Development Centers (RDCs) are sub-state districts created by the state government of Georgia. GAEPD contracts out most TMDL implementation with the RDCs. (see Chapter 3 of this Thesis for further explanation).

²⁵ Multiple Separate Storm Sewer systems are regulated under the NPDES permitting system, which establishes guidelines for municipalities (populations of more than 100,000) to minimize pollutants in stormwater runoff. Treating storm sewers and runoff like point sources, local governments must enact a comprehensive soil erosion and sedimentation control program, periodically screen and monitor water samples from local stream and storm sewer systems, and test for a number of parameters. (Clean Water Campaign, *Local Programs in Your Community*, http://www.cleanwatercampaign.com/community_programs/local_programs.html)

tank maintenance to proper pet waste disposal²⁶. Before implementation can be initiated, however, the ARC must first gain stakeholder support and buy-in into the TMDL process. This can be obtained using two tactics: virtual (internet-based web forums) public meetings and internet mapping sites (Harper, personal communication 2006). Internet mapping sites are online applications where a general citizen can “map their impaired stream.” GOOGLE EARTH in particular has a great software tool, which is relatively inexpensive for an organization or public entity and available for free download by the public (Harper, personal communication 2006). Increasing the use of such simple and inexpensive tools should increase the success of implementation efforts in urban environments.

Alternatively, Dr. Mark Risse, an Extension Engineer at UGA’s Agricultural Pollution Prevention Program is working with agricultural producers in Georgia to meet water quality goals. The Georgia Agricultural Pollution Prevention Program is a partnership between the State Pollution Prevention Assistance Division (P2AD) and UGA’s Cooperative Extension Service which provides education and technical assistance to the agricultural community²⁷. Risse is specifically focusing on bacteria NPS impairment by targeting one of the most “elusive” and growing sources: horse farms. Since horses are not considered to provide food or fiber, they are essentially unregulated, as opposed to cattle and other livestock (Risse, personal communication 2006). Horse farms are also therefore ineligible for federal cost-share programs such as those provided by NRCS for installation of best management practices. To complicate matters, according to Risse, many horse farmers in Georgia are essentially “hobby” farmers who are entering the industry as a “second” career and often have either limited or no previous

²⁶ Pet waste disposal is quite problematic, particularly in high-density residential areas. Matt Harper referred to having seen people disposing of pet waste by dumping it into storm drains (June 7, 2006).

²⁷ http://www.agp2.org/env_assess/

experience with farming of any kind. Therefore, Risse and his team saw a need for an outreach and education program focused on horse farmers and developed the Equine-A-Syst program.

Equine-A-Syst, modeled after the nationally recognized Farm-A-Syst²⁸ program, is a self-assessment and education program targeting horse farmers in Georgia (Risse, personal communication 2006). A pilot of the program is currently being implemented by Risse's team in Barrow and Oglethorpe counties with the Oconee Resource Conservation and Development Council²⁹ (RC&D). Taking advice from the State of Kentucky, Risse's team is looking at ways to gain eligibility for cost-share monies for horse farmers since horse farming is a top ten commodity in the State. The "Master Equine" program consists of coursework on horse farming with subtle environmental messages throughout. Participants must complete Equine-A-Syst and then work through the application process for NRCS cost-share monies. Thus far, participation response has been overwhelming (Risse, personal communication 2006).

Success in the use of education and outreach-based programs to encourage best management practices has occurred at the South Georgia Regional Development Center (RDC) with an environmental planner, Emily Perry Davenport. Much of Davenport's achievement stems from her close relationship with the South GA region as she grew up there and has a better understanding of the community's needs. This connection to the community and correlative success of environmental education and outreach is often forgotten, and is one of the simplest ways to meet our water quality goals.

²⁸ The National Farm-A-Syst program was developed at the University of Wisconsin and is cooperatively supported by the USDA Cooperative State Research, Education and Extension Service (CSREES), USDA Natural Resources Conservation Service (NRCS), and U.S. Environmental Protection Agency (EPA). Farm-A-Syst and Home-A-Syst are self-assessments to locate areas for improvement in water quality impacts from homes and farms. The program is used in many states and can be tailored to each states' needs.

²⁹ RC&Ds are a partnership between the USDA and rural communities. Through this entity, the USDA can provide technical and financial assistance for collaborative work.

Davenport related different projects and initiatives occurring within communities in the South GA RDC region. For all of their communities, the RDC has implemented a stormwater awareness program which includes (Davenport, personal communication 2006)

- curb markers;
- media involvement (cable shows);
- workshops with landscapers, developers and home builders associations;
- building partnerships within the community;
- strengthening working relationships with RC&Ds; and
- encouraging 319 project proposals for NPS abatement strategies.

In terms of agricultural-based projects, the South GA RDC works closely with NRCS agents (who have an acquaintance with local landowners) and the UGA Cooperative Extension Service. Davenport's successes involved situations where communities had taken the lead on outreach programs like stormwater management and septic pilot projects with the county health department (personal communication 2006).

Conclusion

Understanding the non-point sources of bacteria and which best management practices can be employed to abate these inputs will assist in the analysis and review of methods and practices other state have to offer. It is also particularly important to highlight innovative bacteria control strategies already being implemented in the State of Georgia. Analysis and recommendations can therefore include information on how programs and practices in other states can complement, update or change existing structures in Georgia.

CHAPTER 6

CASE STUDIES: CONTROL STRATEGIES OF THE SOUTHEAST

James M. Omernik's Level III Ecoregion delineations served as a guide to choose which states would serve as the best examples for Georgia's implementation program. Omernik's Ecoregions are based on perceived patterns of a combination of casual and integrative factors including land use, land surface form, potential natural vegetation, and soils (1987). Based on Omernik's maps (1987), I chose states that were located in similar ecoregions to Georgia, specifically the Southeastern Piedmont: Virginia, North Carolina, South Carolina, and Alabama (see Figure 1, Ch. 2). These states also hold many similarities such as political affiliations and socio-economic status. Population growth trends, for instance, are similar throughout the Southeastern piedmont (Hammer et al. 2004; Brown et al. 2005), therefore, placing similar pressures on these states.

In the following sections I present aspects of each State's program that could be useful and potentially beneficial to stakeholders in Georgia. When comparing TMDL and 319 NPS programs in other states, it is often a case of comparing apples and oranges. States allocate money and organize resources differently; therefore I am not attempting to pass judgment, but highlight particular structures and programs that are successful and have a possibility of adoption in Georgia.

Alabama

The State of Alabama has implemented several creative strategies to facilitate volunteers and 319 projects to meet water quality goals. According to Alabama's 2002 303(d) list, fecal coliform is the second most common impairment in the State. In Alabama, TMDL implementation plans are referred to as watershed management plans. The 319 grant allocation program provides funding for the majority of watershed management plan implementation efforts in the State.

Alabama uses various agencies and organizations to develop and implement its TMDL program. Alabama's Department of Environmental Management (ADEM) coordinates the state TMDL program and administers the state 319 monies and projects. According to Scott Hughes, the NPS 319 Program Manager at ADEM, roughly half of their 319 funds go to implementation projects; a quarter goes to the Clean Water Partnership, Alabama Water Watch, and other outreach programs; and the rest is allocated to water quality monitoring efforts conducted by ADEM (personal communication 2006). The 319 program has six staff members in charge of water quality efforts in ten river basins throughout the State (Hughes, personal communication 2006). The TMDL water quality department's engineers assist with efforts in the basins.

Troy State University provides assistance through environmental research, education and service to Alabama's water quality efforts through its Center for Environmental Research and Service (CERS). CERS coordinates the Alabama Nonpoint Source Water Quality Education Program and publishes the Alabama Water Watch and Alabama Nonpoint Source newsletters under contract to ADEM. Auburn University cooperative extension (ACES), alternatively, provides agricultural BMP and technical assistance throughout the State.

The Alabama Clean Water Partnership

The majority of TMDL and water quality efforts are led by quasi-governmental agencies or other entities. Much of this stems from water quality efforts receiving little to no funding from the General Assembly (Hughes, personal communication 2006). Resource Conservation and Development Councils (RC&Ds), USDA-NRCS, and Soil and Water Conservation Districts (SWCDs) all play a pivotal role in the implementation of TMDLs in the state of Alabama. The Alabama Clean Water Partnership (CWP), a statewide nonprofit established in 2001, coordinates statewide watershed planning and management efforts¹. In terms of TMDL development and implementation, the CWP acts as an inclusive and neutral forum for watershed stakeholders (Cleland 2006). A steering committee is in place in each major river basin to facilitate communication between stakeholders and activities (ADEM 2005). The designated CWP leverages human and financial capital to address TMDL development and implementation, education and outreach, Phase II stormwater, drinking water protection, and other water quality issues in the state of Alabama (Cleland 2006). Having local stakeholders as members of the CWP really assists the State with water quality improvement efforts because they are able to gain the trust of the community (Hughes, personal communication 2006). By organizing TMDL implementation from a non-governmental perspective, more non-traditional stakeholders may also join the TMDL implementation public participation process.

Alabama Water Watch

Alabama Water Watch (AWW) is a type of community-based monitoring in which citizens can provide large amounts of cost-effective and credible water quality data to resource

¹ Alabama Clean Water Partnership: www.cleanwaterpartnership.org

managers². Since the program was established in 1992, more than 4,000 citizens have become certified water monitors (Auburn University n.d.). According to Auburn University, they have tested 1,400 sites on 500 water bodies in Alabama and shared watersheds of neighboring states (n.d.). AWW volunteer monitors participate in CWP projects statewide and are having a significant affect on water quality improvement efforts in the State. William (Bill) Deutsch, at Auburn University, is now using AWW as a model for similar program across the world called Global Water Watch (GWW). As AWW grew, it took on more of a role in the development of TMDLs and other aspects of remediation. As of 2003, roughly forty experienced AWW volunteers have become certified trainers and quality assurance officers who conduct about ninety percent of the fifty to sixty workshops offered each year (Deutsch 2003). Highlights of the program include online data entry and GIS mapping as well as five volumes of “A Citizens Guide to Alabama Rivers.” Community-based programs such as AWW are an excellent solution for communities and states faced with a lack of funding for water quality efforts. By organizing volunteers and increasing the support for water quality improvements, multiple goals of outreach and measurable success can be met.

BMP Awareness Tools

Alabama’s RC&Ds have been particularly successful in stakeholder education of best management practices through “watershed tours.” In these watershed tours, local stakeholders such as farmers and homeowners are bused around the watershed to view various demonstration projects whether watering wells for livestock or alternative wastewater treatment facilities. Attendance and feedback have been high, and many of the highlights are outlined by Troy State University’s document on the Alabama NPS Management Program titled *Citizens Working*

² Emily Mills, AWW monitor coordinator, www.alabamawaterwatch.org

*Together to Protect and Restore Water Quality . . . success stories built upon innovation, cooperation, and commitment*³. During some of the watershed tours, stakeholders are taken to demonstrations at the Alternative Onsite Wastewater Training Center on the campus of the University of West Alabama.

Many alternatives to traditional septic systems are researched and implemented in Alabama because groundwater contamination from septage is relatively high due to the karst topography of the Tennessee Valley region of Alabama. Constructed wetlands and peat filters have been particularly popular. Demonstration projects exist for these alternatives and are often included in watershed tours. While many agricultural-based BMP projects exist in Alabama, I did not find any that were particularly new or innovative and am therefore not focusing on them in this report. To view past 319 projects for rural and urban NPS abatement, visit the Alabama NPS Management Program Reports at <http://www.adem.state.al.us/Education%20Div/Nonpoint%20Program/Annual%20Reports/WSNPSAnnualReport.htm>. Both watershed tours and demonstration projects of alternative BMPs are used as water quality improvement tools in Georgia. Increases in staff and financial support could increase the impact and breadth of these influential BMP awareness tools.

Urban Outreach Tools

319 watershed projects in the Middle Coosa River Watershed have focused on various stormwater and water quality control strategies. Watershed boundary and partner signs have been a particularly popular tool. The watershed boundary signs assist in alerting the public of where the watershed boundaries lie (ADEM 2005). The watershed partner signs are given to farmers who have participated in water quality efforts and to groups that are part of the Business

³ <http://www.adem.state.al.us/Education%20Div/Nonpoint%20Program/ResourceMat/Citizens.pdf>

Partners for Clean Water (ADEM 2005). Watershed boundary signs are used in Georgia by the Soil and Water Conservation Districts. Opportunity exists for increased signage on a sub-watershed and smaller scale. This can also be paired with a campaign amongst school children of “naming” unnamed streams and tributaries in their community, then creating signs to label “their stream.”

South Carolina

The Bureau of Water at South Carolina’s Department of Health and Environmental Control (DHEC), much like Georgia EPD’s Watershed Protection Branch, receives little budgetary support from its legislators, and has an up-hill battle of education and outreach with its citizenry. The biggest difference between the programs, therefore, is the structure of South Carolina’s TMDL implementation program and its allocation of 319 funds.

South Carolina’s success stems from focusing on what it can do, rather than suffer the “paralysis of analysis” that has overcome many states facing TMDL implementation pressures with little to no monetary or legislative support to meet TMDL implementation goals. For instance, according to Meredith Barkley, South Carolina is focusing their efforts on bacteria⁴ TMDL impairments because not only is this the most common impairment in the State, but is also one of the easiest to target and “fix” using best management practices and other management measures (personal communication 2006). These FC TMDLs are essentially “easier” to implement because of established structures and relationships with the Natural Resource Conservation Service (NRCS) and Soil and Water Conservation Districts (SWCDs).

⁴ South Carolina is currently using the FC bacteria standard. According to DHEC Senior Scientist, David Chestnut, there is discussion of adopting Enterococci for freshwaters instead of E. coli because it can be used for saltwater too and would reduce the number of indicators being used for the State’s bacteria standard (personal communication 2006).

NRCS and SWCDs are already well-known in the communities and are using cost-share monies, like the EQIP program. Therefore, DHEC can combine forces with them by providing matching 319 NPS funds for BMP installation and NPS abatement measures. DHEC assists in this coordination by organizing its Watersheds and TMDL program under four Watershed Managers who are in charge of all TMDL implementation efforts in their respective watershed (divided between eight river basins)⁵. Watershed Managers therefore coordinate implementation efforts by encouraging 319 project development and participation. TMDL implementation plans are only written when funding and support are available; are referred to as 319 watershed-based plans (Barkley, personal communication 2006).

South Carolina spends only 21 percent of its funds on projects externally with non-DHEC contractors. They must use the majority of their funds in-house because of the lack of state-sponsored funding. According to Meredith Barkley, the Bureau of Water's goal is to spend 50 percent of its 319 funds outside of DHEC (personal communication 2006). All of their internal projects (salaries, etc.) are funded for a year, creating a good draw-down rate that pleases the federal government (Barkley, personal communication 2006).

While it is important to highlight programs that South Carolina is currently implementing, the purpose of this thesis is to focus on programs that we are not already using in the state of Georgia. For instance, South Carolina's Clemson University Agricultural Extension service uses the Farm-A-Syst and Home-A-Syst programs to conduct water quality self-assessments to reduce non-point source pollution from farms and residences (Barkley, personal communication 2006). Georgia, however, has already implemented similar programs and actually taken them a step further, such as Dr. Risse's aforementioned Equine-A-Syst program.

⁵ Watershed managers are also assisted by two watershed analysts.

A particularly successful and innovative component of South Carolina's program is its Section 319 projects.

South Carolina's *2005 Annual Report on the South Carolina Nonpoint Source Pollution Management Program* provided useful initial information for various 319 projects throughout the State. USEPA enjoys seeing a combination of numbers (load reductions as a product of 319 project/BMP implementation) and personal stories like those outlined in the annual report (Barkley, personal communication 2006). For instance, South Carolina agricultural producer Troy Lalli commented that "I made improvements which would have been cost preventative without the help of the 319 program. My farm has made a 50% improvement in [water] quality since I started with this program." William L. Abernathy III, a cattle rancher, was more explicit about not only the benefits of the 319 NPS program, but the benefits of the best management practices: "My pastures are more usable and efficient, I have greatly improved property value as a cattle farm, and I have an improvement of total weight gain on calves. The large creek buffer provides greater range and larger area for wildlife." The combination of qualitative and quantitative data has proved a successful reporting style for the State of South Carolina.

Rural BMPS for TMDL Implementation

Clemson University county extension agent, Morris Warner, has been actively involved in and led many 319 projects in South Carolina. Among his record of 319 projects, is the first 319-funded TMDL implementation project in South Carolina's Coneross Creek and Beaverdam Creek watersheds, which started in 2002 (see http://www.rivercenter.uga.edu/research/bacteria_tmdl/documents/sc_coneross_beverdam_tmdl.pdf for the full report). The project was funded by Section 319 for two years at \$500,000; with a total cost of \$716,126 (although the project close-out report contains conflicting numbers).

Awarded to Clemson University, a partnership was formed between Clemson, USDA-NRCS, Oconee Soil and Water Conservation District and Oconee Cattlemen's Association to address issues associated with reducing FC loads in the Coneross and Beaverdam Creek watersheds. Land uses were identified as mostly rural (forested) and agriculture in both watersheds. Source assessments indicated FC NPS inputs from "failing septic systems and uncontrolled discharges, land application of poultry litter, cattle in streams and wildlife" (Warner 2005). Agricultural sources particularly included runoff from pastures, improper land application of animal waste and animals having access to creeks and streams (Warner 2005). Project objectives included developing farm plans and the implementation of BMPs to reduce FC from livestock operations; and implementation of practices outlined in SC Home-A-Syst to reduce FC from urban and rural residential sources (Warner 2005). The project resulted in a total of 78 agricultural BMPs on 16 farms installed at a total value of \$726,075.22; and 38 rural septic systems repaired at a total value of \$71,738.34 (Warner 2005). According to the Project Closeout Report, sampling sites in each creek watershed are now meeting the FC water quality standard (Warner 2005).

The Coneross and Beaverdam Creek TMDL implementation project is of particular importance not only because of its overall success, but the amount of qualitative data the project managers were able to gather to prove the benefit experienced by livestock operators and homeowners. The combination of qualitative and quantitative data to illustrate BMP successes strengthens the argument for continued TMDL implementation as a tool for improving water quality and is appreciated by EPA Region IV (Barkley, personal communication 2006).

In the Project Closeout Report, Morris Warner stated that "In many cases these practices have not only benefited water quality, but complimented the particular livestock operation and enabled them to move forward with their business plans" (2005). Through NRCS assistance, a

total of sixteen farms were contracted and farm plans developed with a total of ninety-two BMPs planned, and seventy-eight agricultural BMPs installed (Warner 2005).

Overall, the biggest obstacles arose with the education of rural residents and homeowners and the location of failing septic systems. Unlike agricultural producers, the average resident is not familiar with cost share assistance for septic tank repairs, does not know where to seek such opportunities and is generally weary of regulatory agency personnel (Warner 2005). Because of this situation, there is little to no preventative action taken with septic system failure. Therefore, Morris Warner states that “One of the most successful things we did was to solicit the help of certified septic contractors to inform individuals that contacted them for repairs [of these opportunities for assistance]” (2005). Warner reflected that public meetings and media campaigns did not seem to reach the needed audience (personal communication 2006).

In many respects, the Coneross and Beaverdam Creek Project is not “innovative.” It is a fairly standard project to meet TMDL load reductions through BMPs on agricultural and residential lands. By reporting qualitative data such as farmers’ and residents’ experience with the installation of BMPs, South Carolina is able to show water quality improvements. Another aspect of the project’s success is the ability of the project managers to identify the needs of the people in the watershed. The project managers realized that certain outreach tools would not be effective because of the lifestyles and characteristics of the residents.

Faith-based Septic Maintenance Outreach & Implementation

The Horse Range Swamp watershed is listed as a non-point source TMDL. The watershed contains no NPDES permitted discharge facilities and is partially supporting its designated use for recreation due to fecal coliform impairment. Forestry and agriculture are the major land uses in the watershed, and therefore potential non-point sources of impairment. A

more immediate health concern lies in the high number of septic systems and drinking water wells. According to project leader Harold Seabrook, “Virtually all of the homes in the watershed are old and all use individual septic tanks, many of uncertain age” (2004). Problems with the age of the systems are only exacerbated by the sandy, soggy soil of Orangeburg, South Carolina. This in turn leads to an increase in well water contamination, which is also the main source of drinking water for the watershed. The 319 project, therefore, intended to investigate sources of water quality impairment and reduce NPS pollution from bacteria by: monitoring water quality and inventorying land uses; educating and assisting with livestock and poultry BMPs; educating and assisting homeowners with septic systems and other homestead BMPs; and implementing a youth education program pertaining to the aforementioned NPS abatement measures (Seabrook 2004). To access the full report, please visit

http://www.rivercenter.uga.edu/research/bacteria_tmdl/documents/sc_fy01_project_10_horse_ranget.pdf.

According to Meredith Barkley, the project did not thoroughly investigate every non-point source, but made a great deal of improvements in terms of abating septic system problems through replacement or repair (personal communication, 2006). The project workplan (2004) outlines various educational outreach efforts in the watershed. For the purpose of this report, however, I am only focusing on the efforts of Harold Seabrook to repair and replace failing septic systems in the watershed through faith-based outreach methods.

Through informal interviews, project leaders found “a disturbing number of homeowners who displayed little or no familiarity with basic septic system preventive maintenance, or paid attention to their septic systems only when problems or obvious malfunction (spills or overflow) arise – by which time, septic leakage into the surrounding waters may have occurred” (Seabrook 2004).

Mr. Seabrook realized that many of the people in the watershed community used the church as their main source for information. Using the phonebook as a guide, Mr. Seabrook proceeded to write letters to every church in the watershed explaining the project and asking if he could come and speak with their members. Rockhill AME Church, specifically, provided the project with an opportunity to reach multi-age groups and families (Seabrook 2004). Through the church, the project leaders emphasized a family-focused program to encourage water-friendly practices around the homestead and farm (Seabrook 2004). Once being accepted by one church, it was then easier to gain the trust of other congregations as word quickly spread about his project. To assist in gaining the trust of the community, Harold Seabrook befriended a farmer of each race to accompany him on site visits. Seabrook could see a difference when he brought along these partners in the community as the residents looked more comfortable and were more willing to communicate with him and his assistants (personal communication 2006). Seabrook also commented that he thought it best to “know your audience.” When he approached farmers, for instance, he found it best to work with NRCS agents since they had a better connection with the farming community (Seabrook, personal communication 2006).

The project used Home-A-Syst and Farm-A-Syst to educate and assist homeowners and farmers with the management of possible bacteria non-point sources on their property. Self-assessments can work quite well when combined with an outreach professional who is assisting the homeowner or farmer by walking them through the steps of the self-assessment. What is most important is that they had gained some of the community’s trust prior to approaching them with the self-assessments. This is a critical step to reaching success. Therefore, I would like to highlight the method used of finding the community’s source of knowledge and presenting it in a format they can understand. In this situation it was in a church setting, but in another it may be

through a civic organization. Whatever the case may be, identifying with the audience and learning about their needs and their own avenues of knowledge will bring a project leader success in any outreach effort.

At the time of this report in July 2006, the project has six weeks remaining under its 319 contract (Barkley, personal communication 2006). Monitoring has been ongoing since the start of the project, and South Carolina has yet to see a significant decrease in FC counts⁶ (Barkley, personal communication 2006). Meredith Barkley is hopeful that they will start to see a declining trend in FC counts after this next monitoring period (personal communication 2006). Whether or not the efforts of Harold Seabrook assist in the delisting of stream segments in the Horse Range Swamp watershed remains to be seen. One can hope, however, that long-term benefits will be through the educational outreach efforts in the community.

Sub-surface Constructed Wetlands as a Septic System Alternative

Another Section 319 project focusing on the continued failure of septic systems uses individual sub-surface constructed wetlands to replace failing septic system drainfields in rural residences of South Carolina (visit http://www.rivercenter.uga.edu/research/bacteria_tmdl/documents/sc_constructed_wetland.pdf for the full report). The failure of septic systems in the rural counties of Laurens and Saluda was potentially caused or complicated by a problem with the soil suitability of the region⁷. According to the Project 19 South Carolina workplan, of the more than one hundred individual soils that occur in the project area, many are not well suited for septic tank use, particularly that of the drainfield, and directly contribute to the failure of many septic systems (Ninety Six 2000). While some of these siting issues could be alleviated by using better installation methods or

⁶ specific numbers must remain confidential until they are published by SC DHEC

⁷ According to Omernik's Level III Ecoregions, Laurens and Saluda counties in SC are located in the Piedmont, near the boundary for the SE coastal plain.

increasing or rotating the drainfield, sub-surface constructed wetlands introduce themselves as a viable option of on-site sewage disposal for individual homeowners (Bowdler, personal communication 2006).

The Ninety Six District Resource Conservation & Development Council, along with partners⁸, installed ten subsurface flow constructed wetland systems to replace failing septic system drainfields for individual homeowners in the Laurens and Saluda counties of South Carolina (Ninety Six 2000). The purpose of 319-funded Project 19 was to prevent FC bacteria from entering impaired streams and lakes through failing septic systems, while also providing education and outreach to homeowners and contractors on constructed wetland technology and bacteria non point source pollution abatement. The project period was 36 months from the date of the award in 2000. The total cost of Project 19 was \$115,000: \$67,000 federal and \$48,000 non-federal match.

To expound upon the details of the implementation of Project 19 and to ask questions about the follow-up and future success of the installed constructed wetland systems, I contacted Gordon Bowdler, a Soil Conservation Technician with the Saluda Co. NRCS. Not only was Gordon Bowdler directly involved with the implementation project as a NRCS staff member, but was also a recipient of a subsurface flow constructed wetland (CW) system. Bowdler stated that it was “the perfect situation” because it alleviated his problem with his own failing septic system and provided the project with an excellent demonstration site and more-than-willing homeowner (personal communication 2006). The drainfield area on Bowdler’s property is roughly a ¼ to ½ acre in size and serves a family of four. Luckily, he has also been able to observe the effectiveness of the system on his property over the four years since it has been installed.

⁸ Also partnered with the Upper Savannah Council of Governments, Laurens SWCD, Saluda SWCD, Piedmont Technical College Horticulture Department.

Bowdler stated that the maintenance is very simple (personal communication 2006). There is a manhole cover that opens up to a removable plastic filter which can be easily cleaned two to three times per year depending on use (Bowdler, personal communication 2006). The only time-consuming maintenance that should be done on the constructed wetland is the clearing of vegetation from the CW once a year in the winter (Bowdler, personal communication 2006). Bowdler experienced only minor problems after installation such as one blockage, which had to do with the size of stone used around header pipe and was easily fixed (personal communication 2006). Overall, it was considerably less maintenance than his previous septic system (Bowdler, personal communication 2006).

In a report from September 2001 titled *Design and Installation Considerations and Lessons Learned: Constructed wetlands for onsite wastewater disposal for single family dwellings*, USDA-NRCS and East Piedmont RC&D Council of South Carolina found in a water quality monitoring study (conducted by SC DHEC) that the CW treatment cell provided 99% FC reduction prior to in-soil wastewater disposal (i.e. being deposited into the soil, not septic) (Cain 2001)⁹. These FC removal rates are consistent with conventional septic systems (Smith et al. 2004). NRCS and the RC&D also provided information about the installation, design and lessons learned from the project. Particular problems were avoided by requiring that residence sites chosen for the CW study be in system failure; a full time residence; the homeowner agreed to the specification of wetland plats and to properly maintain the new system; located in at least 75 percent sunlight; and not prone to flooding (Cain 2001). At the conclusion of the year-long water quality study, the report states that “Although fecal coliform concentrations were frequently much greater than 400 mg/l after constructed wetland treatment, CWs consistently

⁹ See http://www.rivercenter.uga.edu/research/bacteria_tmdl/documents/sc_constructed_wetland.pdf for the full report.

produced greater than 99 % removal of fecal coliforms” (Cain 2001). While they admit to more research being needed, overall the study proposes CWs as an effective alternative treatment to reduce surface water contamination where conventional tile fields have failed (Cain 2001). Especially if combined with other best management practices to reduce NPS of FC, constructed wetlands could be a viable alternative for waste water treatment where septic systems are ineffective.

North Carolina

The State of North Carolina (NC) administers its 319 program through the Division of Water Quality (DWQ) in the Department of Environment and Natural Resources (DENR)¹⁰. Thirty percent of NC’s 319 funds are used “in-house” to support ongoing state non-point source programs, with the remaining seventy percent being allocated through a competitive grants process. In North Carolina, public and private nonprofits organizations are also eligible for funding as long as they show a connection with the community and potential for success and capability (Nimmer, personal communication 2006).

Another source of funding for water quality improvement projects in the state of North Carolina is the Clean Water Management Trust Fund¹¹ (CWMTF). The CWMTF was established by the General Assembly in 1996 (Article 18; Chapter 113A of the North Carolina General Statutes) with the purpose of issuing grants to local governments, state agencies and conservation non-profits to help finance projects that specifically address water pollution problems. Through my survey of 319 projects in North Carolina, I found that many of them also received funds from the CWMTF, such as the efforts on Crowders Creek.

¹⁰ NC 319 Program: http://h2o.enr.state.nc.us/nps/Section_319_Grant_Program.htm

¹¹ The Clean Water Management Trust Fund: <http://www.cwmtf.net/welcome.html>

The Ecosystem Enhance Program (EEP) has also provided water quality projects with support in North Carolina, such as the ongoing efforts on Newfound Creek. On July 22, 2003, the U.S. Army Corps of Engineers, Wilmington District, entered into a Memorandum of Agreement (MOA) with the North Carolina Department of Environment and Natural Resources and the North Carolina Department of Transportation to establish the EEP. The mission of EEP is to protect the natural resources of North Carolina through the assessment, restoration, enhancement and preservation of ecosystem functions and compensation for development impacts at the watershed level.

Horse Management: The REINS Program & Education Project

Similar to Georgia, horse production and ownership is a top commodity in the state of North Carolina. Over 250,000 horses are housed on nearly 65,000 farms. Overstocked paddocks are a particular problem and are often sources of sediment, nutrients and bacteria for receiving waters (Jennings et al. 2005).

In 1995, the Regional Equine Information Network System (REINS)¹² program was established by the North Carolina Cooperative Extension. REINS is coordinated by Extension Horse Husbandry at North Carolina State University (NCSU) and participating county extension agents. Extension agents organize volunteers and horse owners in a multi-county area to create regional REINS organizations. Through these extension agents, volunteers are able to assist in trainings and other methods to link educational efforts of the North Carolina Horse Council and the marketing support of the North Carolina Department of Agriculture and Consumer Services. REINS volunteers are horse producers in each county who receive 38 hours of training on horse management and science topics, teaching technique and program planning. Benefits to

¹² NC REINS Program: <http://www.ces.ncsu.edu/wayne/agriculture/livestock/REINS.html> or http://www.cals.ncsu.edu/an_sci/extension/horse/hhmain.html

volunteers include receiving specialized training and knowledge and connecting with other producers in their community. Over 110 REINS certified volunteers are organized into 14 regions servicing all 100 North Carolina counties. From numerous online sources and personal communication with Greg Jennings (NCSU professor and extension specialist), I found that the REINS program has been successful in disseminating equine information throughout the State. For example, in 2000, REINS volunteers provided over 15,000 hours of service to over 26,000 horse owners through conferences, tours, and on-farm demonstrations (Jennings et al. 2005).

A 319 project on horse manure and pasture management used the REINS network to disseminate knowledge about horse manure and pasture management BMPs through field days, demonstration sites, workshops, newsletters, and other educational programs (see http://www.rivercenter.uga.edu/research/bacteria_tmdl/documents/nc_final_report_319_horse_project.pdf for the full report)(Jennings et al. 2005). The goal of the project was “to improve water quality protection on and around horse operations by increasing the understanding of horse owners about best management practices that can be used on their farms” (Jennings et al. 2005). Over 300 horse owners and farm managers were reached through field days and meetings; and several thousand horse owners were provided information through newsletters and web sites. Project leaders reported that “horse owners are anxious to implement BMPs because of the potential for improved water quality in addition to on-farm cost savings . . . and typical small horse farm owners indicated that they can save approximately \$100 per year due to improved pastures” (Jennings et al. 2005). Several best management practices were installed on horse farms. BMPs that were successfully implemented on horse farms are (Jennings et al. 2005): pasture and waste management practices include nutrient and waste management, rotational stocking, rotational grassed exercise paddocks, passive and forced aeration compost systems and

manure storage facilities. Where appropriate, streambank protection measures included streambank exclusion, riparian buffers, stream crossings, and stream stabilization measures. Workshops, field days and demonstrations were also used to promote BMP implementation for equine waste and pasture management throughout the State.

While similar projects are being implemented in Georgia such as BMP demonstration sites and Risse's Equine-A-Syst program, Georgia can still learn a great deal from North Carolina's experiences with horse production management.

FC Impairment Assessment & Restoration on Crowders Creek

The Crowders Creek TMDL is of particular interest because it crosses the state line between North and South Carolina in the Catawba River Basin (based out of Charlotte), drains majority urbanized areas, and is impaired due to high levels of fecal coliform bacteria. Long-term restoration efforts are being planned for Crowders Creek. The following project is referred to in the implementation section of the Crowders Creek TMDL and will assist with the overall restoration of the watershed.

The incremental 319 project titled *Restoring and Assessing Fecal Coliform Impairment of Crowders Creek* proposes to restore the impaired section of the Crowder Creek watershed and lower its fecal coliform concentrations to acceptable stream standards (see http://www.rivercenter.uga.edu/research/bacteria_tmdl/states.htm#northcarolina for the full report). The project is also receiving monies through the CWMTF. To accomplish this goal, the project team, led by professor Dr. Jy S. Wu in Civil Engineering at the University of North Carolina – Charlotte (UNCC), will install new and/or retrofit existing structural BMPs and/or low impact design (LIDs) at strategic locations in the watershed for near-term FC reduction and restoration. The team also plans to develop a Watershed Restoration Plan for long-term FC

mitigation which will integrate current efforts in NC on TMDL modeling, Source Tracking, Load Duration Curves, and available GIS databases for FC source inventory. To implement the Watershed Restoration Plan effectively, the team plans to organize a series of workshops to educate the public about the plan, FC source reduction, and control measures (Wu and Allan n.d.).

To determine which BMPs to implement and install, the project team developed a suitability matrix for BMP selection. To reduce FC pollution from non-point sources, the project is focusing on structural BMPs with long residence times. Therefore, installation will include constructed wetlands, bioretention, vegetative strips, rain gardens, detention ponds, and riparian strip investigation (Wu and Allan n.d.). Structural BMPs of this nature collect stormwater during storm events and hold it or slow it down, allowing pollutants to settle out and reducing the impact of the “first flush” on nearby water bodies. These types of structural BMPs are also effective for FC removal because of the natural die-off process of FC bacteria within these systems. Dr. Wu stresses in the 319 proposal that additional factors will still need to be taken into account such as physical feasibility, community acceptance, and environmental constraints (Wu and Allan n.d.). In the proposal, Dr. Wu’s team also includes a review of these possible factors that may affect implementation or installation (Wu and Allan n.d.). Constructed wetlands and bioretention ponds, for instance, can often see an increase in FC counts because of animal populations using the BMPs as habitat.

One specific output of the project that is particularly useful to Georgia and other similar states is a searchable technical database for various types of structural BMPs addressing fecal coliform. As the project proposal states, “The database can be used not only to examine the

basin-wide fecal coliform removals, but also has potential applications to other watersheds of similar situations” (Wu and Allan n.d.).

Since the Crowders Creek project is not yet completed, the state of Georgia should pay close attention to the research and products that emerge from this FC BMP implementation strategy.

Urban BMPs: Mecklenburg County SWIM Program

The city of Charlotte in Mecklenburg County contains an increasing urban population and is facing many of the same growth and development pressures as Metro Atlanta. Foreseeing these pressures, Mecklenburg County created a Water Quality Program (WQP) about 30 years ago (Rozzelle, personal communication 2006). The goal of the WQP is to identify and eliminate pollution sources and improved surface water quality conditions. Bacteria and sediment are the major pollutants affecting the county. Bacteria impairment, specifically, is due primarily to failing sewer system lines (Rozzelle, personal communication 2006).

Assisting with the implementation of the Water Quality Program is the Surface Water Improvement and Management (SWIM) plan. In 1996, in response to degradation in surface water quality conditions, the Mecklenburg County Board of County Commissioners adopted a policy statement calling for all Mecklenburg County surface waters to be “. . . suitable for prolonged human contact and recreational opportunities and supportive of varied species of aquatic life” (SWIM 2006). Efforts to meet this policy statement are referred to as Surface Water Improvement and Management (SWIM). The SWIM initiative is already seeing measurable success in water quality improvement. One of their success stories is the TMDL Watershed Plan for Sugar, Little Sugar and McAlpine Creeks (Appendix A or http://www.rivercenter.uga.edu/research/bacteria_tmdl/documents/nc_sugar_tmdlip_nc.pdf).

Rusty Rozzelle, the program manager of the WQP, sees the TMDL program, while not perfect, as a “logical strategy” for improving surface waters (personal communication 2006). As Mr. Rozzelle disclosed, “Mecklenburg County sees surface waters a natural resource necessary for a livable community” and TMDLs are a tool to protect them (personal communication 2006).

Sugar, Little Sugar and McAlpine Creek are streams in heavily urbanized areas of Mecklenburg County impaired by bacteria pollution from point and non-point sources. TMDLs for fecal coliform were developed by Mecklenburg County for the streams through a twelve month stakeholder process including NC DENR, Sierra Club, Catawba RiverKeeper, and SC DHEC; and approved by EPA in March 2002. Various planning decisions and factors resulted in a successful and well-done implementation plan.

- 1) *Stakeholder “Ownership”*: The WQP and TMDL stakeholder group decided to give each responsible party ownership of their own section. In the layout of the plan (see Appendix A), each pollutant source is given its own section which outlines actions necessary to achieve reduction, monitoring, time frame, and estimated cost. In the section on failing septic systems, for instance, responsibility for implementation is given to the WQP and the County Health Department’s Individual Water and Wastewater Program. These two groups were given ownership of the implementation actions by asking them to write their section so that they knew what their responsibilities were and could already establish a working relationship to meet water quality goals. Mr. Rozzelle mentioned that choosing to ask each entity to write their own implementation sections delayed the project (by almost a year) because it was a low priority for most groups (personal communication 2006). He kept

pushing though, and the sections were eventually written (personal communication 2006). This assisted in confirming “reasonable assurance” that implementation would be carried out by those involved. Most of the groups had also been involved with the TMDL since the development stage, therefore making stakeholder buy-in smoother. Mr. Rozzelle stated that these factors of stakeholder ownership had the most to do with the project’s eventual success (personal communication 2006).

- 2) *Importance of Partnerships:* One especially important and unusual aspect of this TMDL implementation plan is the partnership with SCDHEC. The urban center of Charlotte-Mecklenburg is located directly above the border between the two Carolinas. Therefore, South Carolina is dealing with many of the same water quality issues of its upstream neighbor. One of SCDHEC’s watershed analysts, Wayne Hardin, actually lives in Charlotte (about an 1.5 hours away from Columbia, SC) and was able to attend the stakeholder meetings in Mecklenburg County. While this situation is unusual, Mr. Rozzelle maintained that SC DHEC has always been very involved, often more so than NC DENR. Mr. Rozzelle continued to praise SC DHEC by stating that in many ways they have a superior program to that of North Carolina in that they are very proactive and implement a great deal on-the-ground (personal communication 2006). Mr. Rozzelle also pointed to the relationship between Mecklenburg County WQP and the utility department. Because of the success of the planning partnership, the utility department is

now more proactive in responding to spills and implements more preventative maintenance measures.

- 3) *Logical Control Strategies:* Many of the BMPs used in the implementation of these TMDLs involved inspection, repair and maintenance of the urban sewer system. Mr. Rozzelle found that instituting a routine monitoring and stream assessment program assisted a great deal in measuring success and implementing BMPs appropriately. Mr. Rozzelle felt that the implementation of stream walks on all 600 or miles of streams in the watershed assisted in illustrating the stream system with GPS/GIS, identifying illicit discharges and other sources, and proved to be cost effective. WQP staff and temporary technicians were hired to conduct the stream walks. Volunteer groups also assist in stream walking and reporting of problems. The County is also implementing a septic-to-sewer transition program to assist in streamline wastewater treatment in the community.

Monthly monitoring is conducted on the stream segments to collect data to measure the success of the groups' efforts. To ensure proper documentation and communication of progress toward water quality goals, WQP is collecting data from the responsible entities and sharing it on a monthly basis to the general public through their website and on an annual basis to NC DENR and SC DHEC via written reports. This regimen will also assist WQP in its efforts to implement adaptive management and make modifications for maximum effectiveness. Thus far, fecal coliform has declined by 60-70% in the three watersheds.

While my goal is to find innovative control strategies for bacteria TMDL implementation, this project reminds me that sometimes it is not the control strategies that need

to be changed, but the process with which we implement them. As the state of Georgia strives to improve the implementation of TMDLs, it can take cues and learn from the successes, and failures, of other projects, such as this one.

Virginia

In many instances, the Commonwealth of Virginia's water quality programs cannot be compared to that of Georgia. Virginia, however, has implemented some very successful bacteria control strategies with subsequent monitoring and reporting successes. The Commonwealth of Virginia divides its TMDL program between two state agencies: the Department of Environmental Quality (DEQ) and the Department of Conservation and Recreation (DCR). VADEQ coordinates TMDL efforts and development of plans particularly involving point sources in urban environments and issues such as stormwater. VADCR collaborates with VADEQ on TMDL development and is responsible for the implementation planning process, voluntary NPS controls, and financial incentives to implement BMPs. Implementation plans for TMDLs, while not specifically required under the CWA, are required by VA state law under the 1997 Water Quality Monitoring, Improvement, and Restoration Act (WQMIRA).

One of the most relevant aspects of Virginia's program in terms of TMDL implementation is the Water Quality Improvement Act (WQIA) and subsequent Water Quality Improvement Fund (WQIF). The WQIA of 1997 intends to restore and improve the quality of state waters and to protect them from impairment and destruction for the benefit of current and future citizens¹³ (VADCR 2006b). The WQIF was created to assist in this goal by providing water quality improvement grants to local governments, soil and water conservation districts and

¹³ Section 10.1-2118 of the Code of Virginia

individuals for point and nonpoint source pollution prevention, reduction and control programs¹⁴ (VADCR 2006b). Bacteria TMDL projects in particular, however, may not be funded by WQIF because priority goes to projects focusing on excess nutrients in regard to the Chesapeake Bay (Lunsford, personal communication 2006). TMDL implementation projects are often funded by this fund, because projects must address impairments and have a better chance of receiving funding if they include an implementation plan (Sandberg, personal communication 2006). This program does still fund some implementation projects according to Charlie Lunsford, the TMDL program manager at VADCR, and compliments the 319 grants program in Virginia (personal communication 2006).

The 319 grants program in Virginia is administered by VADCR because of the NPS focus. Base 319 funds generally cover core NPS program elements, such as staff and positions and technical assistance (Sandberg, personal communication 2006). Incremental funds cover TMDL implementation projects. These projects are selected through a prioritization process for implementation needs, rather than having entities apply (Lunsford and Sandberg, personal communication 2006). Therefore, fewer projects are done each year, but receive more of a commitment, so Virginia still observes measurable success in meeting TMDL goals (Sandberg, personal communication 2006).

Virginia institutes a type of phased or staged TMDL implementation process, which allows for interim evaluation of management practices (Mostaghimi, et al. n.d.). Phased implementation was first suggested by USEPA in its 1991 guidance document: *Guidance for Water Quality-Based Decisions: The TMDL Process*. Phased TMDL implementation involves stream monitoring on a monthly basis to allow for the quantification of uncertainties that affect TMDL development. This process of staged implementation can sometimes take between ten to

¹⁴ Section 10.1-2128.B. of the Code of Virginia

fifteen years to complete and see to fruition (Brannan 2006). While initially time consuming, the process allows for the TMDL implementation plan to be improved to allow for full compliance for the final phase of implementation and essentially allow for greater efficiency.

Virginia also provides thorough guidance to stakeholders and local officials in the State through its *Guidance Manual for Total Maximum Daily Load Implementation Plans* (Guidance Manual) (Appendix B or <http://www.deq.state.va.us/tmdl/implans/ipguide.pdf>). According to Charlie Lunsford, they will be updating the guidance manual soon with more information relating to urban systems since they have now completed more implementation plans in urban environments (personal communication 2006). One of the most beneficial aspects of the Guidance Manual is the format. The document describes each “section” of the implementation plan, from the executive summary to potential funding sources. Therefore each section of the Guidance Manual details what should be included in that section of the implementation plan. In terms of the staged implementation process, the Guidance Manual explains that this is an “iterative process that first addresses those sources with the largest impact on water quality” (VADCR and VADEQ 2003). To provide an example, the Guidance Manual refers to the BMP of livestock exclusion. This would be a preferable BMP for the initial stage of the process due to its proven effectiveness in reducing bacteria loads from cattle deposits and additional buffering of the riparian zone. Combining this BMP with the elimination of straight pipes and other sources of human contamination would “attack” many of the potential non-point sources in the first stage of implementation. Since monitoring occurs simultaneously, the hope is that water quality improvements can be recorded as they occur and shed light on performance rates of particular NPS BMPs and other guidance for BMP implementation. Virginia’s TMDL

Guidance Manual will be analyzed and discussed more in the following chapter on recommendations for the state of Georgia.

Some of Virginia's successful implementation plans are summarized in the *TMDL Program Five Year Progress Report* from January 2005. The report can be accessed online at <http://www.deq.virginia.gov/tmdl>. A highlight of Virginia's overall program is the measurable success the State is seeing through on-the-ground water quality improvements. Much of this success stems from the State of Virginia's prioritization of funds and monitoring efforts to record successes through its method of staged implementation.

BMP Implementation Funding

The Commonwealth of Virginia has instituted some funding options and programs to assist with the installation and implementation of BMPs for water quality attainment. Similar to other state agencies, VADCR relies on Soil and Water Conservation Districts (SWCDs) to assist in delivering many of its funding programs for controlling and preventing NPS pollution. To further assist with communication, VADCR supplies Soil and Water Conservation Coordinators who serve as liaisons between VADCR and the SWCDs.

VADCR funds the Virginia Agricultural BMP Cost-Share Assistance Program¹⁵ in which SWCDs target more than \$1 million annually to address significant agricultural water quality problems in high priority watersheds (VADCR 2006). The cost-share program supports various BMPs in conservation planning (VADCR 2006). Funding is allocated in various ways: straight per-acre rate, cost-shared on a percentage basis up to 75 percent, or some practices are funded by a combination of state and federal funds (ex. USDA) which can often reduce the landowner's expense to less than 30 percent of the total cost. Because of high demand, VADCR stipulates certain factors such as the most an individual can receive is \$50,000 and the state cost-share

¹⁵ <http://www.dcr.virginia.gov/sw/swcds.htm>

payment, combined with federal payments, cannot exceed 75 percent of the total eligible costs. These funds can also apply to BMP demonstration projects.

Another monetary incentive provided by VADCR, is the Virginia Agricultural BMP Tax Credit Program. Started in 1998, the Tax Credit Program supports voluntary installation of BMPs that will address NPS water quality objectives. Once agricultural producers develop an approved conservation plan, they can take a credit against state income tax of 25 percent of the first \$70,000 spent on agricultural BMPs (VADCR 2006). The credit cannot exceed \$17,500 or the total state income tax obligation. Another tax credit offered by Virginia encourages the use of conservation equipment and conservation tillage equipment. Not only must the equipment meet state-established criteria, but the agricultural producer must have a nutrient management plan approved by the local SWCD (VADCR 2006).

VADEQ offers low interest loans to assist with agricultural BMP implementation costs associated with meeting water quality goals¹⁶. According to the VADEQ low interest loan website, the program provided a total of \$12,525,522.81 in low interest loans to 160 agricultural producers. The program also specifies 22 loan eligible BMPs. A useful chart indicating which BMPs are eligible for which funding assistance programs in Virginia is located at <http://www.deq.virginia.gov/cap/agchart.html>.

Creative funding options such as tax credits and low interest loans can assist in the successful implementation of agricultural BMPs. The state of Virginia provides an excellent example of funding options for agricultural producers. The dedication of state funds and support are central to the success of BMP implementation for water quality improvements.

¹⁶ For more detailed information about the program can be accessed at <http://www.deq.virginia.gov/cap/agindex.html>

The Center for TMDL and Watershed Studies

The Center for TMDL and Watershed Studies (the Center) and the Biological Systems Engineering Department at Virginia Polytechnic Institute and State University (VA Tech) are contracted by VADEQ to develop TMDLs and provide research on TMDL development and implementation. According to Kevin Brannan, a research associate at the Center in Biological Systems Engineering, VADEQ generally subcontracts out to private entities and consulting firms, and VA Tech is the only university in Virginia with which they work (personal communication 2006). The TMDL Center serves mostly in an advisory role to the state agencies and develops implementation plans for watersheds that are “new and different” and may require more research and expertise that the University is often better equipped to provide (Brannan, personal communication 2006).

The Center also publishes a great deal of research on issues involving monitoring and modeling for bacteria impairment, bacteria TMDL development and implementation, and other outreach and stakeholder involvement tools. In 2006, for instance, the Center will be publishing the EPA TMDL Clearinghouse through their website¹⁷. The EPA TMDL Clearinghouse will be a searchable database that will contain TMDL resource materials such as literature reviews, links to national and state TMDL guidance documents, and summaries of TMDL programs from around the nation (VA Tech 2006). Another great resource available through the Center is the Bacteria Source Load Calculator which is downloadable software designed to assist in the calculation of bacteria source loads when developing TMDLs and running watershed simulation models¹⁸. A great deal of the Center’s research, and its training workshops, examine models for source identification and BMP implementation. I do not address the various models and options

¹⁷ <http://www.tmdl.bse.vt.edu/site/knowledgebase/>

¹⁸ <http://www.tmdl.bse.vt.edu/>

in this report. I suggest the Center as a resource for further background information on this topic. The Center has also published information, research and lessons learned about their switch from the FC to E. coli standard. This may be beneficial for Georgia stakeholders as we make the bacteria standard transition in the future.

Because of the complex and ubiquitous nature of bacteria impairment, it has been the focus of the Center's work on TMDLs. The Center has completed 26 bacteria impairment TMDLs, and is currently developing TMDL implementation plans to address eleven TMDLs in three Virginia watersheds (VA Tech 2006). In terms of stakeholder involvement, the Center engages people through online forums to assist in the dissemination of information in implementation plan development between stakeholders. The Center's first implementation plan success was in 2001 on the Three Creeks Project in Southwest Virginia. Violations were cut in half in 3 years by implementing BMPs such as fencing out cattle, repairing septic systems, and eliminating straight pipes (Benham et al. 2006).

Pet Waste BMP Projects

Gene Yagow, a research scientist in Biological Systems Engineering at VA Tech and associate of the Center for TMDL and Watershed Studies, participated in a project focused on pet waste awareness. This particular project was led by the Upper Roanoke River Roundtable (URRR) which serves as an advisory group in the upper basin of the Roanoke River. Yagow chaired the water quality sub-committee of the URRR. The Upper Roanoke River Roundtable implemented a pet waste awareness project based on the high number of NPS TMDLs listing pets as probable sources, particularly in urban and suburban watershed¹⁹. According to the URRR, VADEQ found that from June 2002 – July 2004, nearly 50 percent of bacteria found in

¹⁹ More information about the URRR pet awareness project can be located at <http://www.upperroanokeriver.org/projects.shtml>

the Roanoke River near the River's Edge Park was from pet waste (n.d.). Mini-grants were awarded from the Virginia Environmental Endowment with matching funds from the Roanoke City Parks and Recreation Department and the Western Virginia Water Authority. The goals of the project included the installation of demonstration waste dispensers and receptacles, education of pet owners about the NPS affect, and consequent responsibility of owner to clean up after their pet, particularly in public areas near surface waters. Teaming with various state agencies and stakeholders, the project located 4 demonstration sites along greenways and public waterfront parks to place bag dispensers and pet waste receptacles (i.e. trash cans) (URRR n.d.). This project was simply an implementation of small, yet effective, BMPs to assist in the abatement of bacteria impairments due to pet waste. Simple tools were installed and outreach materials produced, such as the "nerdy guy" brochure²⁰. Yagow mentioned that while the project was low-funded and involved more committee action than public participation, the model could be easily applied to stakeholder group involvement in pet waste awareness campaigns (personal communication 2006).

Another project is a dog park BMP pilot in the bacteria impaired watershed of Four Mile Run in Northern Virginia²¹. This watershed faces many difficulties with bacteria impairment due to the high urban density and proximity to the Washington D.C. metropolitan area; and has identified pet waste as a major contributor to impairment. In the watershed, a dog population of 11,400 is estimated to contribute about 5,000 pounds of waste every day (CWP n.d.). Bacteria source identification studies involving BST are being implemented by the Northern Virginia Planning District Commission (NVPDC) and the Northern Virginia Regional Commission

²⁰ The "nerdy guy" pet waste brochure, originally produced by Washington State Dept. of Ecology: http://www.psat.wa.gov/Programs/Pie_Ed/Water_ed/PET_PSTR.pdf follow guidelines for distribution: <http://www.scdhec.gov/water/ms4/pubs/gis/Print%20Media/Washington-guidelines.pdf>

²¹ To learn more about Four Mile Run bacteria implementation projects: <http://www.novaregion.org/fourmilerun.htm>

(NVRC). The goals of the project include implementing a dog park pilot in the watershed to assist in future BMP installations for pet waste abatement. Some BMP design features planned for implementation include (NVRC 2004):

- Siting dog parks out of swales, steep slopes, stream and beaches
- Vegetated buffers between dog parks and waterways
- Incorporation of public outreach elements such as signage and informational brochures
- Vandal-resistant receptacles (pooch potties) to potentially connect to sewer lines
- Rimming down-slope edges with conventional BMPs such as infiltration-dependent facilities

One of the most important “points” to come out of this project is the connection made between designated dog parks and social mechanisms. Project leaders state that dog walkers have commented that “these parks foster socialization among neighbors and that positive peer pressure plays a significant role in keeping dog parks free of pet waste” (NVRC 2004). It is important to remember the role of social norms and mechanisms in enforcement of environmentally beneficial activities. Some people may never care about the water quality of streams, but may instead be swayed over an argument relating back to the health of their children or the aesthetics of their lawn. It is therefore imperative to learn what motivates people to follow social norms and use this to guide the implementation of bacteria control strategies.

Conclusion

The preceding case studies highlight current projects, tools and methods available in Alabama, South Carolina, North Carolina and Alabama for bacteria TMDL implementation. While not all of the projects are innovative or new to the State of Georgia, some of the methods

or tools used in other states could assist program improvement and development efforts in Georgia. These control strategies have a possibility of being implemented in Georgia due to the similar environment in which they are being implemented in other southeastern states. In the following chapter, recommendations are made specifying which control strategies and methods can be implemented in Georgia for bacteria TMDL implementation.

CHAPTER 7

RECOMMENDATIONS

To assist in reducing bacteria loads in impaired waters, my thesis synthesizes bacteria TMDL control strategies and implementation efforts in Georgia and neighboring and explores how we could adapt some of the methods used in other southeastern states to improve Georgia's program. Recommendations for Georgia are summarized in Table 1 at the end of this chapter. The following discussion of case studies and recommendations can be used to facilitate future research, and complement existing efforts.

Bacteria Standard

Fecal coliform bacteria are the number one source of impairment to surface waters in the State of Georgia. The bacteria Technical Advisory Group (TAG) published recommendations in regard to bacteria TMDL development and implementation for the State of Georgia in June 2006. I reference their research in regard to the science of bacteria TMDLs and issues surrounding indicator bacteria and the correlative standard used. Switching from the current broad fecal coliform (FC) standard to the new federal recommendation to restrict the standard to *E. coli* may improve protection for Georgia's residents from gastrointestinal illnesses (Radcliffe et al. 2006; USEPA 1986, 2002). Issues exist, however, as to whether or not *E. coli* underestimates potential health hazards from other, more long-lived bacteria (Carroll, personal communication 2006). Some pathogenic bacteria, such as *Enterococcus* species, from fecal waste have lifetimes in natural waters much longer than *E. coli* (Carroll, personal communication

2006). In order to decrease public health risks, more investigation regarding a bacteria standard is needed. While more costly and time-consuming, one solution may be to use a combination of indicator bacteria for Georgia's standard.

Learning from the mistakes and successes of other states in the Southeast will assist Georgia through this transition. While the issues and controversies surrounding the indicator bacteria used and resulting standards was not a major focus of this research, I encountered state agencies that are dealing with similar bacteria standard problems. Both Virginia and North Carolina have switched to the E. coli standard from the more inclusive fecal coliform. Virginia, in particular, has conducted a great deal of research on the advantages and disadvantages associated with this new standard. Both Kevin Brannan from the Watershed Studies Center and Charlie Lunsford with the NPS Program at Virginia's Department of Conservation and Recreation (VA DCR) commented that the new E. coli standard (established per USEPA recommendations) has made the meeting of water quality standards almost impossible throughout the State because the numeric standard is difficult to meet¹ (personal communication 2006). Lunsford stated that the new standard is impractical and unrealistic; and they will be reviewing and revising it in the future (personal communication 2006). In particular, Virginia is struggling to meet designated uses due to high levels of E. coli from wildlife deposition and natural background conditions (Brannan, personal communication 2006). These contacts could be consulted by researchers and agency staff members in Georgia as they investigate the adoption of an E. coli standard. Therefore, it would be in the best interest of the State of Georgia to keep open lines of communication with VADCR and the TMDL and Watershed Studies

¹ The E. coli standard for Virginia is currently 126 cfu/100 mL (calendar month geometric mean) and an instantaneous standard of 235 cfu/100 mL (Brannan, personal communication 2006).

Center at VA Tech. Brannan, in particular, expressed interest in collaborative work with the University of Georgia (UGA) River Basin Center (personal communication 2006).

TMDL Implementation Strategies²

Monitoring Solutions for Implementation Measures

The Georgia Department of Natural Resource's Environmental Protection Division's (GAEPD) TMDL implementation program applies adaptive management to the implementation process in an effort to abide by principles and concepts of phased or staged implementation. The TMDL program is implemented on a five-year rotational river basin schedule. As the program returns to a river basin every five years, implementation plans for that basin are reviewed and altered if necessary to either improve upon implementation efforts or de-list an impaired segment. This is an appropriate approach for Georgia, especially since many of the implementation plans written during the consent decree were rushed and may require extensive revisions to be "ready" for the implementation phase and show measurable water quality improvements.

A key component to any sort of adaptive management or phased implementation approach is the collection of consistent data to measure whether water quality improvements are occurring after the initiation of control strategies and management measures. Water quality monitoring is essential to this process; however, limited resources have precluded water quality monitoring for TMDL implementation in Georgia. The issue of supplying dedicated funding sources for the implementation of environmental controls and actions is a serious one in Georgia

² TMDL implementation plans are named various things depending upon the state program. The most used alternative term is "watershed-based plans." It is also important to note that just because an "implementation plan" exists, the plan is not necessarily being implemented yet. The approach to writing implementation plans and actual implementation action differs a great deal between states.

and will be explored more in the following section on “Funding.” In the face of inadequate funding, however, creative low-cost approaches for supplying monitoring data are necessary.

Efforts are currently underway amongst various groups in Georgia to improve volunteer monitoring programs³. While the Georgia Adopt-A-Stream is an excellent water quality monitoring and outreach program, it is not designed to provide the level of technical monitoring that is necessary for an adaptive management, proactive approach to TMDL development and implementation⁴. Either strengthening the technical component of the existing Adopt-A-Stream structure or creating another more technical monitoring effort (while leaving outreach and education efforts to the Adopt-A-Stream team) is one solution. An essential element to any monitoring solution is to align monitoring efforts with GAEPD’s river basin schedule to supplement efforts already underway by state-led monitoring staff; therefore reducing duplication and increasing efficiency. In this way, volunteer monitors could increase the current labor force working to collect TMDL data. Technical monitoring efforts could also be supplemented by providing modest support funds for graduate students to conduct technical monitoring and further research into cost-effective methods. These recommendations for modifying monitoring efforts would meet overall goals of de-listing streams in a more expeditious manner, illustrate water quality improvements, and highlight situations that require implementation plan revisions.

A successful volunteer monitoring model exists in Alabama that could be used as a template for Georgia. Alabama Water Watch (AWW), started by William Deutsch in 1992, provides water quality monitoring data for improvement efforts in Alabama, including TMDL development and implementation. Volunteers receive training in the more technical aspects of

³ Such groups are included, but not limited to: Adopt-A-Stream, the UGA River Basin Center, Upper Oconee Watershed Network (UOWN), and the Georgia River Network (GRN)

⁴ Georgia Adopt-A-Stream Program: <http://www.riversalive.org/aas.htm>

water quality monitoring. The program has been so successful, that it has been adopted in other states and countries⁵. AWW could be a useful model for Georgia monitoring efforts because of AWW's success in obtaining quality assurance approval for trainers and officers. The approval of monitoring efforts through the quality assurance process is integral for the use of data in the TMDL development and implementation process. According to federal and state regulations, entities other than the state must have approved Quality Assurance Project Plans (QAPP) if they want their data to be used in assessing TMDL streams, such as listing or de-listing impaired segments. USEPA offers a volunteer monitor's guide to QAPPs at <http://www.epa.gov/volunteer/qappcovr.htm>. The State of Georgia offers guidance for quality assurance data at http://www.gaepd.org/Documents/techguide_wpb.html (click on "Field Investigation Quality Assurance (Water Quality)"). Some argue that current unapproved monitoring efforts are supplying "trend data." While this data is useful to illustrate trends useful in making management decisions, such as whether or not certain BMP systems are reducing inputs, its use is limited and cannot be used in the listing and de-listing of streams. By organizing a large volunteer monitoring effort similar to AWW, the QAPP approval can essentially be distributed throughout the State so that groups are not supplying only trend data, but data that can be efficiently utilized in the TMDL process. When developing a technical monitoring volunteer effort in Georgia, I suggest using Alabama's Water Watch as a model for obtaining quality assurance approval to cover a network of monitors, and following GAEPD's river basin schedule to make the most out of adaptive management and phased implementation methodologies.

⁵ Powerpoint presentation on the successes of Alabama Water Watch:
<http://www.usawaterquality.org/volunteer/Outreach/05KYALWW.ppt>

Communication, Coordination & Ownership in Implementation Planning

One of the greatest challenges facing TMDL implementation is a lack of communication, coordination and ownership. While other states are struggling with these issues, there are some success stories.

Coordination

Alabama's Clean Water Partnership (CWP) referred to in Chapter 6 is an example of TMDL stakeholder coordination through a non-governmental initiative. The CWP also provides a neutral forum to discuss and mediate water quality issues because of its independence from vested public or private interests.

In many respects, the goals of the CWP align with those of the Georgia River Network (GRN), also a non-governmental organization (NGO). As the Georgia River Network continues to grow and expand their efforts to improve surface water quality in the State through outreach and citizen mobilization, they could possibly integrate some of the successful concepts and methods used by Alabama's CWP. Currently, GRN facilitates efforts and assists in communication between watershed groups (either already in existence or newly formed with help from GRN). With guidance from the CWP's experiences, GRN could consider including coordinators for each basin in GA to assist with TMDL implementation efforts. A GRN river basin coordinator could work in conjunction with outreach coordinators from GAEPD's TMDL implementation program. Currently, Georgia's TMDL implementation program provides a total of four (when all positions are filled) TMDL outreach coordinators to assist with implementation efforts throughout the State. These four outreach coordinators are then divided between the 16 Regional Development Centers (RDCs) who are contracted by GAEPD to develop TMDL

implementation plans. In order to see measurable improvements in water quality, we need to increase our state presence of guidance and technical assistance for TMDL implementation.

Ownership & Accountability

Ownership and accountability must be included as central elements of TMDL implementation plans. The concepts of ownership and accountability refer to assigning responsibility to appropriate entities and stakeholders for the development and/or implementation of actions to meet TMDL plan requirements. Mecklenburg County, which contains the metropolitan area of Charlotte, North Carolina, was able to include these elements. The Surface Water Improvement and Management (SWIM) initiative in Mecklenburg County coordinated the development of a bacteria TMDL implementation plan (or watershed plan) for Sugar, Little Sugar and McAlpine Creeks (Appendix A or

http://www.rivercenter.uga.edu/research/bacteria_tmdl/documents/nc_sugar_tmdlip_nc.pdf).

Overall, the implementation plan could be used as a template for urban TMDLs in Georgia. In particular, the elements of implementation ownership and accountability were strong and successful. Control strategies and management measures were organized and grouped according to which government entity or group would be responsible. Then each group was assigned ownership or responsibility and asked to write their own implementation action section to encourage communication and accountability. Rusty Rozelle, the program manager, commented that while this increased the length of the project and was frustrating at times; it was well worth it (personal communication 2006). I recommend that this implementation plan be reviewed by urban communities in Georgia with similar water quality management issues. Not only can the innovative aspects of BMP implementation be duplicated, but the template can be used to increase accountability and coordination – and water quality.

Communication

According to the bacteria TAG, a “disconnect” often exists between GAEPD and local stakeholders (Radcliffe et al. 2006). For example, the TAG stated that many local governments are frequently unaware of available assistance (Radcliffe et al. 2006). The Center for TMDL and Watershed Studies at VA Tech provides a central source for technical assistance to stakeholders and TMDL implementation project leaders. Through the Initiative for Watershed Excellence: Upper Altamaha Pilot Project, the University of Georgia (UGA) River Basin Center (RBC) can provide similar services through technical assistance and guidance. Therefore contacts made with researchers such as Kevin Brannan at the VA Tech Center could assist in the formation of similar guidance programs in Georgia through the UGA River Basin Center.

Virginia also provides the *Guidance Manual for Total Maximum Daily Load Implementation Plans* to assist communities with TMDL implementation plan development (Appendix B or <http://www.deq.state.va.us/tmdl/implans/ipguide.pdf>). One recurring theme I encountered during my research was the request and need for more specific guidance for plan development from regulatory agencies. The TMDL Implementation Plan guidance document produced by the State of Virginia’s Department of Conservation and Recreation (VADCR) and Department of Environmental Quality (VADEQ) could provide an excellent template for a similar material aimed at stakeholders and communities in Georgia. I suggest, of Virginia’s two agencies, that Georgia work with DCR because of their focus on NPS TMDLs, which is one of the greatest issues currently facing Georgia’s TMDL program. It should be of particular importance to stay in contact with DCR because Charlie Lunsford (VADCR NPS 319 program manager) stated they will be revising their TMDL implementation plan guidance soon to include more information about urban TMDL implementation (personal communication 2006). Another

benefit of Virginia’s guidance manual is that they have been using phased or staged implementation for TMDLs. This could assist Georgia in improving upon its own program. Virginia also uses many different sources of funding at the State and local levels and could provide useful information for future funding strategies in Georgia⁶.

Two components of the VA TMDL implementation plan guidance manual could assist Georgia stakeholders in the inclusion and implementation of appropriate actions and management measures detailed in TMDL implementation plans: “Chapter 6.0: Linking the TMDL to Implementation: Detail of TMDL Analysis (p.18)” and “Table 6.1: BMPs applicable to bacteria (p.27)” (see Appendix B or <http://www.deq.state.va.us/tmdl/implans/ipguide.pdf>). “Detail of TMDL Analysis” refers to chapter 6 of the Guidance Manual and covers how to determine the level of effort needed for assessing implementation action needs and what management measures are needed for success. The chapter is divided into sections on the level of analysis needed (and how to identify it) and what resultant steps are needed for implementation. The guidance provided is in-depth and easy to understand and broadly applicable. Important concepts are introduced, such as planning for future impairments. For instance, in various implementation plans written in Virginia, control strategies recommended to reduce bacteria loadings could also reduce other pollutants such as sediment and nutrients that could occur in future TMDLs. Guidance also refers to properly estimating future costs associated with technical and administrative assistance that should be taken into account. One of the most useful aspects of Virginia’s implementation guidance chapter, is the table outlining BMPs that can be implemented to specifically reduce inputs of bacteria. In Table 6.1 (see Appendix B or <http://www.deq.state.va.us/tmdl/implans/ipguide.pdf>), best management practices

⁶ See pages 64-67 of the VA TMDL implementation guidance manual for funding information at the state and federal levels: Appendix E or <http://www.deq.state.va.us/tmdl/implans/ipguide.pdf>

include information such as which impairment source (i.e. agriculture or urban) they are best suited for, their efficiency (if available) and average cost. After reviewing many BMP manuals, I have concluded that this table in particular provides a good “overview” of available practices for bacteria abatement in a user-friendly format.

The examples and resources referred to are just a sampling of the guidance available in the Virginia manual. The manual has a great deal to offer for the improvement of TMDL implementation in the State of Georgia, and is therefore included as a recommendation of this project. Using a 319 grant, or similar funding source, a group or consortium like the UGA River Basin Center could develop an implementation manual for the State of Georgia using Virginia’s manual as a template.

Non-point Source 319 Program

Clean Water Act Section 319 NPS grants are a central funding source for TMDL implementation projects, at least for the non-point source pollution component. A common complaint is that the grant application process is onerous and lengthy; and the 40 percent match requirement poses difficulties. Despite these obstacles, there are many successful ongoing and planned 319 projects addressing various bacteria NPS sources in Georgia, such as failing septic systems and waste from agricultural livestock practices (Vincent, personal communication 2006). To strive towards water quality improvements and successful TMDL implementation in Georgia, the 319 program should also be reviewed and revised as necessary. Through my review of state programs, a trend emerged where state programs spent a sizable portion of their 319 funds in-house (or internally) to fund water quality positions and programs. While South Carolina strives to spend more 319 money externally (project grants awarded to a third party),

they are currently focusing on a balance between providing support at the State level and then assisting with projects at the community level (Barkley, personal communication 2006).

Spending a larger percent in-house to fund administrative costs could assist in providing more stakeholder guidance and assistance from the State level. While this recommendation may not be the perfect solution, it could be considered in a reevaluation of the current program. The goal of allocating the majority of 319 funds externally is beneficial for on-the-ground water quality improvements and could be worked towards as alternative state-supported funding solutions come to fruition.

There also existed a close connection between the 319 program and TMDL implementation efforts at the State level. Many of South Carolina Department of Health and Environmental Control 319 and TMDL staff positions are funded through 319 monies. South Carolina's "watershed managers" not only coordinate TMDL implementation efforts in their respective watershed areas, but also encourage 319 grant proposals to fund implementation projects. Georgia's program is structured similarly and is continuing to work toward goals of aligning the TMDL Implementation Coordinators with 319 program staff.

Another opportunity for improvement exists in the addition of state support for the 319 match requirement. Several smaller communities express concern over applying for 319 monies because of their inability to provide the amount of funds required under the 40 percent match requirement. Leveraging state funds to assist these communities to reduce their percent match with either a low-interest loan or grant could alleviate this issue. As will be discussed in the next section on funding, monies could be made available by dedicating trust funds from permitting fees or a similar impact-fee program.

Funding

A central impediment facing water quality improvements and TMDL implementation is the availability of funding at the State level. Much of this is due to the trust fund system in Georgia where environmental fees are not dedicated⁷. The issue of funding dedication stems from the Georgia Constitution which states that no funds may be “dedicated,” except by the Constitution itself (GWC 2005). Therefore the only solution, essentially, is to amend the Georgia Constitution (through placement on the ballot for public vote) to dedicate the funds specifically to the programs enforced by GAEPD (Edwards, personal communication 2006; ACCG 2006). Until this action occurs, current fees are not dedicated and are often redistributed to balance the budget by the General Assembly’s appropriations committee (Edwards, personal communication 2006).

Georgia has collected fees since the early 1990s from individuals, companies and local governments under environmental programs for the purpose of supporting the administration and enforcement of program activities (GWC 2005). These fees generate enough revenue to fully fund their designated programs, but are instead being used in whole or part to balance the State’s general fund (Edwards and Rooks 2005). Among southeastern states, Georgia is the only one not charging some type of NPDES permitting fee to assist in funding program costs. According to data collected by Todd Edwards in 2002, Georgia and Mississippi were the only two out of sixteen Southern states that were not implementing such fees⁸. Wendell Willard (49th) of the Georgia General Assembly co-sponsored HB 550 in the 2005 legislative session to provide for

⁷ This is a legal term meaning that money collected for a stated purpose must be used *only* for that purpose. For example, the state’s motor fuel tax is “dedicated” in the Constitution to “public roads and bridges” (GWC 2005).

⁸ GAEPD does not charge fees for the issuance of industrial stormwater, industrial surface water discharge or municipal stormwater permits (Edwards 2002).

fees and change certain provisions of the Georgia Water Quality Control Act⁹. HB 550 provides not only for NPDES permitting fees, but creates a provision whereby government entities would receive fee reductions when fees they had previously paid to environmental trust funds were not appropriated back to the correct department. I recommend that this bill be introduced again and passed to assist in TMDL implementation funding efforts. Problems do still exist in terms of actual appropriation of these funds in light of the constitutional dedication situation. The feasibility of the permitting fee legislation and dedication of said funds should be addressed by the Georgia General Assembly.

Each state structures their NPDES fee program differently. Alabama charges NPDES application fees that assist with supporting program staff, but do not directly impact the TMDL program (Hughes, personal communication 2006). North Carolina uses a portion of their permit fees to fund staff positions in water planning and TMDL development (Edwards 2002)¹⁰. South Carolina charges flat, annual permit fees which support staff positions and program costs for the NPDES state program since 1993 (Edwards 2002; Montebello, personal communication 2006)¹¹. According to Michael Montebello at SC DHEC, permit fees are now just seen as a cost of business and are considered an asset to the program (personal communication 2006). Virginia charges permitting fees that last for five years, and fund NPDES permitting administrative costs (Edwards 2002)¹². Research into funding from NPDES permitting fees and trust funds was not a primary piece of this project, but is an important aspect to the future success of TMDL implementation in the State of Georgia. While current information was gained from some of the states studied, it is no way exhaustive and could be an element of future research.

⁹ Locate HB 550 at http://www.legis.state.ga.us/legis/2005_06/sum/hb550.htm

¹⁰ North Carolina NPDES permit fees: http://h2o.enr.state.nc.us/su/Fee_schedule.html

¹¹ South Carolina program fees: see Regulation 61-30, Environmental Protection Fees

¹² Virginia's Department of Conservation and Recreation's website has more information about permit fee schedules: <http://www.dcr.virginia.gov>

North Carolina and Virginia have successfully implemented trust funds to pay for environmental regulatory and enforcement measures. The State of North Carolina supplements funding for water quality improvement projects through the Clean Water Management Trust Fund¹³ (CWMTF) as established in 1996 by Article 18, Chapter 113A of the North Carolina General Statutes¹⁴. The CWMTF issues grants to local governments, state agencies and conservation non-profits for projects specifically addressing water pollution problems, such as TMDL implementation. Alternatively, the State of Virginia utilizes Water Quality Improvement Funds (WQIF), established under the Water Quality Improvement Act (WQIA), to supplement funding for water quality efforts¹⁵.

What is important to note is that all of our neighboring states are leveraging fees and trust funds to improve water quality. Through our work in the Upper Altamaha watershed of Georgia at the UGA River Basin Center, we are encountering city and county leaders and officials who are concerned with implementing TMDLs not only for water quality reasons, but economic ones. These leaders and communities are asking for help from the State. A revision of limitations on expenditures and encouragement of new revenues, through fees for example, should be undertaken in Georgia.

Best Management Practices

Through my review of programs and practices implemented in Georgia, Alabama, North Carolina, South Carolina and Virginia; I found that the real difference lies not in which best management practices are being used, but in *how* they are being implemented.

¹³ <http://www.cwmtf.net/>

¹⁴

<http://www.cals.ncsu.edu/wq/SwineFarmZoningNotebook/PDFNorthCarolina/PDFNCPollutionStatutesandCode/CleanWaterManagementTrustFund.PDF#search=%22Clean%20Water%20Management%20Trust%20Fund%22>

¹⁵ <http://www.dcr.virginia.gov/sw/wqia.htm>

Outreach & Education

Under federal and state regulations, outreach and education efforts are required aspects of water quality implementation projects, whether through the NPDES permitting process or TMDL implementation planning. While this should allow for great successes in stakeholder and citizen educational opportunities, the requirement is often glossed over, and quickly checked off of the laundry list of “things to do,” resulting in ineffective outreach and unusable tools. Therefore the brochures and pamphlets are found in the trash can of the citizen or the storage closet of the project leader; and often never reach the audience that needs the information or assistance the most. While any effort is better than none at all, implementation efforts will never be successful without a strong, targeted outreach component.

A specific component of strong outreach campaigns involves targeting your audience and then “framing” the issue around the factors that are important to them. One project leader (and county extension agent) in South Carolina found that the “usual” forms of outreach, such as public meetings and media campaigns, did not work with his audience, owners of failing septic systems (Warner 2005). This was partially due to homeowners being generally wary of regulatory agency personnel (Warner 2005). Therefore, the project leader discovered that the best method for communicating with these homeowners was to solicit the help of certified septic contractors to inform individuals that contacted them about the 319-funded installation and repair project being led by Warner’s team (Warner 2005). By identifying where and how his audience could best be reached, the project leader could effectively reach the population that needed him most (or at least reach some of them). Sometimes this targeting aspect takes significant creativity, such as that involved in the “faith-based” septic outreach project in South Carolina led by Harold Seabrook (see chapter 6 for more information). These successful outreach projects

will hopefully inspire and guide more creative strategies in the State of Georgia. To assist in this process, USEPA has produced a helpful guidance document for watershed outreach campaigns: <http://www.epa.gov/owow/watershed/outreach/documents/getnstep.pdf>. Improving outreach campaigns to better serve the audiences intended will assist in the implementation of bacteria TMDLs.

Due to the voluntary nature of most NPS control measures, outreach must also contain social mechanisms to encourage implementation actions. One tactic involves creating situations where people essentially feel peer pressure or ownership, which encourages them to self-enforce water quality-friendly control measures and often convince others to do the same. One example of this is creating dog parks to centralize dog owners and then implement BMPs and outreach tools to encourage cleaning up pet waste for bacteria NPS abatement. Another method is one used in Alabama in which watershed boundary signs are installed to familiarize and connect residents with the watershed they impact. “Stream naming” can also be a useful tool to provide a sense of ownership to a community of its surface waters. Children in particular can take great pride in “naming” the stream that runs through their school’s property or neighborhood.

Increasing the attention, time and weight given to the impact of education and outreach in TMDL implementation is a central element to demonstrating measurable water quality improvements.

Urban TMDLs

Future research and data on urban control strategies and bacteria TMDL implementation will soon be coming out of 319 projects in North Carolina and Virginia Tech’s Center for TMDLs and Watershed Studies. While many of the TMDL implementation projects reviewed focused on best management practices for non-point sources from agriculture, there were two

projects in North Carolina that focused on abating bacteria NPS pollution from urban environments. The North Carolina SWIM TMDL Watershed Plan for Sugar, Little Sugar and McAlpine Creek located in and near the urban center of Charlotte provides a strong example for urban watershed communities in the State of Georgia. The implementation project offers comprehensive guidance as it included aspects of accountability, urban BMPs and adaptive management (with monitoring). The Crowders Creek project, similarly, hopes to provide sound guidance and research on best management practices for bacteria TMDLs in the urban environment surrounding the metropolitan area of Charlotte, North Carolina. Further information and descriptions of these BMPs can be found in Chapter 6 of this thesis, the Appendices and the project website at http://www.rivercenter.uga.edu/research/bacteria_tmdl.htm. The results of Crowders Creek implementation project will be relevant to urban communities of Georgia installing structural BMPs in a densely populated landscape. The technical FC BMP database in particular will be a useful tool for urban stakeholders and growing communities throughout the State of Georgia.

On-site Wastewater Treatment Control Strategies & Alternatives

In general, most soils in Georgia are suitable for septic systems (Radcliffe et al. 2006). As development pressures for residential housing increase; however, soils with shallow water tables are more commonly being used (Radcliffe et al. 2006). Combine this issue with the increasing density of septic systems in housing developments, and the risk of system failure and potential problems increases. At the very least, high housing density and limited space offer fewer options to homeowners for “switching” drainfields or other methods to increase and maintain the life of their systems. Hydraulic failure, or surfacing (water accumulating on the soil surface), is probably low; however, weak sampling suggest the need for further research and data

tracking and management (Radcliffe et al. 2006). Hydraulic failure in particular involves the greatest potential risk for surface water contamination. While septic systems may not be a major source of bacteria water quality impairment, the potential remains, and it is best to act proactively if the potential could increase with the combining factors of growing populations, densities, and lack of accountability.

On-site disposal of wastewater will be an issue as the population of Georgia continues to grow. With proper planning and implementation of best management practices; however, Georgia can avoid an accompanying decline in water quality from impaired on-site waste disposal. In general, the following areas need improvement for on-site wastewater management:

- Creative use of education and outreach methods;
- Regulatory controls and enforcement mechanisms, such as ordinances, for septic systems maintenance, management and inspections;
- Use of alternative systems to septic when faced with bad conditions, such as unsuitable soil types.

Improving efforts or implementation actions in any one of these areas will improve septic system performance; however, it is a combination of these factors that will see the most success. For instance, if homeowners are knowledgeable about septic systems, they will hopefully expect a higher quality of work out of septic contractors, home builders and developers. Focusing on tactics that are both proactive and reactive will assist in alleviating problems from past management and allowing for improvements in new installations and development.

Targeting specific audiences for septic outreach efforts and decreasing the use of generalized brochures and unsupervised self-assessments will improve current efforts in septic homeowner education. Through my review of state programs and implementation efforts in

regard to reducing bacteria impairment, I found that many states are using, or have used, the Home-A-Syst self-assessments to increase awareness of septic system issues among homeowners. While the “A-Syst” program has proven success as a national model in many respects, self-assessments may not be the “best” method for Georgia to use in the attainment of water quality improvements¹⁶. More importantly, self-assessment should not be the only method used. For instance, the self-assessment structure (that already exists in Georgia) could be combined with methods encouraging targeted outreach and individual attention. The REINS program in North Carolina or the Clean Water Partnership in Alabama described in Chapter 6 could be useful models to follow in creating a trained volunteer network to assist with self-assessments and water quality outreach and consultation. The most beneficial aspects of the A-Syst program are confidentiality and regulatory distance. To highlight these benefits and treat the issue as separate from “government control” could have success particularly with rural homeowners in Georgia. Trained volunteers from each community or region could assist homeowners with self-assessments of their onsite wastewater management systems. Without this kind of one-on-one support and motivation, self-assessments are often useless. According to Tina Pagán, of UGA Cooperative Extension Service, self-assessments are only used by residents if they already have a problem (such as septic system surface failure) or have someone to lead them through it (such as a NRCS agent) (personal communication 2006). These types of self-assessments are rarely proactive. From her experiences working with outreach materials such as the A-Syst program, Pagán emphasized that partnering with NRCS agents in order to have face-

16 More info about the national Home-A-Syst/Farm-A-Syst: <http://www.uwex.edu/farmasyst>. The national program is used by states as a model and tailored to the specific state’s needs, like Georgia’s A-Syst program (see the Georgia Agricultural Pollution Prevention Program at <http://www.agp2.org/> for further information).

to-face interaction and focusing on what issues are most important to the resident are useful tactics to combine with self-assessments (personal communication, 2006).

Various changes on the state and local levels in regard to regulations and rules could improve problems with the repair and maintenance of septic systems. Much research has and is being done into policy changes and other solutions for communities in Georgia. Therefore, I refer to these sources for policy recommendations for the State. For instance, the bacteria TAG recommends that state legislation (O.C.G.A. § 31-3-5(b)(6)) be changed to provide local health departments that currently hold permitting authority for non-mechanical residential sewage management systems with enforcement authority to perform inspections and require repairs and maintenance on these systems as necessary to prevent significant pollution contributions from these sources (Radcliffe et al. 2006). While this legislation makes it difficult to enforce septic system maintenance, it does not preclude a municipality or other entity separate from the local health department from enacting regulatory controls or measures to require maintenance. This type of actions is already being taken in Georgia communities, such as in Douglas County where the Water and Sewer Authority can disconnect water to houses if septic tanks aren't pumped every five years because of the proximity of septic systems to a drinking water source¹⁷. The Metropolitan North Georgia Water Planning District (Planning District), however, found that 75 percent of metro county health departments were not supportive of mandatory pump-out or inspection programs due to implementation problems such as lack of resources, enforcement, and capacity to dispose of septage (Metropolitan North Georgia Water Planning District 2006). Therefore the Planning District recommends, instead, a strong focus on homeowner education (Metropolitan North Georgia Water Planning District 2006). These are important issues that

¹⁷ Protecting a municipal drinking water source is within the rights of a city or county under police powers. More information about Douglas County's program can be found at <http://www.dca.state.ga.us/toolkit/ToolDetail.asp?GetTool=48>

need to be addressed. A graduate student at the UGA River Basin Center, Amanda Worthington, is exploring ways to fund septic system repairs through the State Revolving Fund¹⁸. I encourage the State of Georgia to follow the recommendations of groups like the bacteria TAG, the Planning District and researchers like Amanda Worthington as it explores solutions for failing septic systems in the State.

The use of alternative technologies and systems to replace conventional septic systems can be implemented, particularly under conditions where traditional methods may have failed. For this thesis I have focused on the alternatives being used in other southeastern states, particularly the sub-surface constructed wetlands project in South Carolina described in Chapter 6. Based on my research, sub-surface constructed wetlands, like those used in South Carolina, could be a viable option in a situation where conventional septic system drainfields are failing due to poor soil conditions¹⁹. Comments by several septic experts in Georgia referred to the high maintenance required with a constructed wetland. These comments were made mostly in regard to the vegetative maintenance that was referred to in the interview with South Carolina homeowner and NRCS agent, Gordon Bowdler in Chapter 6. Mr. Bowdler referred to the difficulty involved in maintaining the plant, elephant ears, but otherwise stated that overall maintenance was minimal and much less costly than his former conventional septic system (personal communication 2006). Larry West, a UGA professor in Crop and Soil Sciences, pointed out that when residents are out of town for an extended amount of time there may not be enough wastewater created to keep the sub-surface constructed wetland vegetation alive, and therefore may cause problems on return (personal communication 2006). These comments point again to the need for site-specificity. All systems require maintenance. The maintenance

¹⁸ consult http://www.rivercenter.uga.edu/research/bacteria_tmdl.htm for a link to Worthington's thesis.

¹⁹ For instance, this alternative may be successful in the coastal plain region of Georgia.

required for this alternative system may be more labor-intensive for the homeowner, but may also be less costly over the long term since the alternative drainfield will lengthen the life of the septic tank and overall systems. This alternative BMP may not be for everybody or every situation, and these maintenance requirements should be kept in mind when choosing which systems to install.

The installation of individual on-site wastewater treatment technologies (under 10,000 gallons) is regulated by the Georgia Department of Human Resources Division of Public Health, as discussed in the *Urban* section of the previous chapter. According to the *Manual for On-site Sewage Management Systems*,²⁰ published by the Department of Human Resources,²¹ and the “Approved Products”²² list, sub-surface constructed wetlands would qualify as an “Experimental On-site Sewage Management System.” In this case, experimental systems must apply for temporary approval from the Technical Review Committee for the installation of a limited number of systems to be evaluated over a prescribed period of time (Section G of the On-site Manual; GA DHR 2006). There is a provision allowing for the delegation of approval to the County for subsequent permit approvals once three installations of an experimental system have been permitted (Section G of the On-site Manual; GA DHR 2006). Upon completion of the experimental system installation, the permit holder must prepare final reports on the results and lessons-learned, which, upon review by the Technical Review Committee, can result in statewide approval as an alternative on-site sewage management system. In general, the process is fairly onerous, especially for an individual homeowner. It seems as though most of the applicants for

²⁰ The *Manual for On-site Sewage Management Systems* is accessible online at <http://health.state.ga.us/programs/envservices/onsitemanual.asp>

²¹ A staff member in the land use department of DHR suggested contacting Todd Jones (experimental units and aerobic treatment) or Scott Uhlich (director of the program) for more information regarding installation of alternative systems in the State of Georgia.

²² The approved products list is accessible online at <http://health.state.ga.us/programs/envservices/product.asp>

this process are manufacturers, research entities or organizations. Therefore, the best method for introducing individual sub-surface constructed wetlands as an alternative on-site system may be through a research university or other entity that could more easily access funding such as a 319 grant for implementation (like the project in South Carolina). While it is beneficial to require such stipulations to protect public health, introduction of alternative technologies should be researched, approved, and implemented in a more expeditious manner. Like many new methods and ideas, this lag-time is resulting from a general lack of will and effort at various levels. Especially in the face of failing conventional septic systems, residents should be able to implement innovative technologies and methods if the current system is not meeting their needs.

Pet Waste Programs

Various educational and regulatory methods exist for the abatement of water quality impairment from pet waste. Many ordinances and municipal programs are in place across the State of Georgia. However, these programs or ordinances are often un-enforced and not provided adequate support or respect from the local residents and citizenry. Similar to the issue of septic system maintenance, people are often unaware of the negative affect of pet waste on water quality. More importantly, they are often unaware of the cumulative affect. Maybe one small dog will not make a big difference, but it is the high number and density of all dogs and other pets that will degrade surface water quality throughout the watershed.

Education and the establishment of social mechanisms will be the most successful initial control strategies to implement in the fight against pet waste inputs. I refer to social mechanisms in this instance because it will take more than traditional methods to change people's behaviors. For instance, in the Swann (1999) survey in the Chesapeake Bay, 44 percent of dog walkers who did not clean up after their pets indicated they would still refuse to do so, even if confronted by

complaints from neighbors, threatened with fines or provided with more sanitary and convenient options for retrieving and disposing of dog waste. Another disconcerting fact about this survey in particular, is that it was conducted in the Chesapeake Bay area. Residents in the Chesapeake Bay area have been inundated by environmental outreach and education campaigns for years, and are potentially more aware of their individual and cumulative environmental impacts.

Therefore, I suspect that Georgians would be even more recalcitrant to ordinances for controlling pet waste. Speaking from my own personal experience as a Georgia native, I was shocked to learn about the impact of pet waste on water quality. The only times I have seen people clean up their dog's waste are in the confines of a dog park when they are feeling "peer pressure" to clean up the waste. In this case, people are frequently unconcerned or unaware of any water quality impact, and are instead more concerned about stepping in a pile of dog waste. The outcome is still the same, however, whether people are cleaning up waste for aesthetic, public health, or water quality reasons.

Because of the opportunity for peer pressure and other social mechanisms to be initiated, I encourage the use and installation of dog parks in public parks where appropriate. Particular consideration should be made to site the park in a location beneficial to water quality such as low grade or slope, significant distance from surface waters, and the use or installation of vegetated buffers. Not only should pet waste receptacles be placed in the park, but also along paths and trails in areas outside of the dog park, particularly along the path leading to the park. The easiest, and potentially cheapest, receptacles to install are simple metal trash cans with a plastic bag retrieval system. Oftentimes, dog park users will bring their own reused plastic grocery bags to refill the systems, therefore reducing the maintenance obligations of park managers. Because of the number of dog owners visiting the area, signs and information boards can be utilized to not

only remind people to clean up after their pet, but to also educate them on the impact of pet waste on water quality and public health. If the community has also initiated pet waste ordinances, these information kiosks at the dog parks can further educate the public on the pet waste laws and how they could be held accountable. The dog park pilot projects in Virginia, described in Chapter 6, could be used as models for implementation in Georgia. The Upper Roanoke River Roundtable, in particular, is a good model because of the small budget, proving that installation of these best management practices with little funding is possible. The Four Mile Run dog park BMP pilot provides a great deal of detailed, replicable information on its project at its website and should be encouraged as a source of information to groups in Georgia²³.

Another tool available to ease the implementation of a pet waste campaign is the availability of materials from communities who are already implementing successful campaigns. The Erase the Waste Campaign in Los Angeles County, California has developed a storm water toolbox with materials available for use by other communities, programs and organizations free of charge. While some of the materials may have to be adapted slightly to fit the needs of Georgia residents, many communities and states throughout the Southeast are already using them as a cost-effective solution for producing outreach materials and pet waste campaigns. Their materials can be accessed and downloaded, along with instructions and advice, at <http://www.waterboards.ca.gov/erasethewaste/index.html?counter=1075#toolbox>. The metro Atlanta – based Clean Water Campaign provides information on pet waste and other water pollutants at its website:

²³ <http://novaregion.org/fourmilerun.htm>

http://www.cleanwatercampaign.com/what_can_i_do/pet_waste_home.html²⁴. They have also published a pet waste brochure for use in the metro Atlanta area:

<http://www.cleanwatercampaign.com/resources/petwastefactsheet.pdf>.

Best management practices for the reduction of pet waste non-point source pollution are fairly simple and inexpensive to implement. The main issue lies in creating a social mechanism for further enforcement and behavior changes amongst pet owners. By using the models in Virginia as a guide, and the multitude of other resources available across the country, Georgia could begin to see an improvement in bacteria impairment from pet waste sources.

Agriculture

In terms of best management practices to reduce bacteria inputs from agricultural sources, there are three areas in which to focus improvements: innovative BMP systems, technical guidance and assistance from NRCS and county extension agents, and funding cost-share options for producers. The most important of these areas is guidance offered to agricultural producers from NRCS and county extension agents. These agents are often the best resources for efforts at the state level because of their knowledge of and relationship with the community and agricultural producers. In each state, 319 project leaders and regulatory agency staff commented that these agents were necessary partners for any sort of implementation project involving rural or agricultural communities. Federal support for NRCS technical staff has decreased significantly (Risse, personal communication 2006). Overall, the current Bush administration increased total funding to NRCS, but required that most of the money go to cost-share programs (Risse, personal communication 2006). According to Mark Risse, Georgia is

²⁴ The Clean Water Campaign is a cooperative, multi-agency public education initiative spearheaded by local governments in metro Atlanta, supported by the Metropolitan North Georgia Water Planning District and managed by the Atlanta Regional Commission. Its mission is to build awareness about water quality problems and solutions in the Atlanta region.

doing the best they can, but it is difficult to give out more money with cost-shares when the same or less personnel are available to provide administrative support (personal communication 2006). Increasing support at the state level for county extension agents could help with this burden on NRCS agents and essentially improve the allocation and implementation of cost-share funds and producer-oriented support. Options could include workshops, training, and technical support. Watershed tours and BMP demonstration projects are also successful tools for garnering support for installation participation and education.

The UGA Cooperative Extension Service is investigating ways to improve the current program. The Georgia Agricultural Pollution Prevention Program²⁵ provides education and technical assistance to the agricultural community through a partnership between the State Pollution Prevention Assistance Division (P2AD) and the UGA Cooperative Extension Service. Cooperative Extension and the UGA River Basin Center's Initiative for Watershed Excellence: Upper Altamaha Pilot Project are working together to pilot the State's first "watershed agent." A watershed agent can focus on water quality issues that extension agents generally do not have the time or mandate to address²⁶.

Dr. Mark Risse at the UGA Cooperative Extension Service is also organizing and implementing efforts to alleviate the negative impacts of livestock on water quality. In particular, the Equine-A-Syst pilot project shows great potential for success in Georgia. Combining this horse farmer education program with a volunteer mobilization effort like the REINS program in North Carolina could show measurable improvements in water quality on horse farms throughout the State. One of the most important aspects of the program is the use of

²⁵ Focus areas include animal waste management, land application, environmental assessment, sustainable agriculture, crop production, and green industry outreach. For more information, contact Dr. Mark Risse or visit <http://www.agp2.org>.

²⁶ Extension agents are essentially required to help farmers with productivity issues to keep them in business – not necessarily issues pertaining to water quality improvements (Risse, personal communication 2006).

horse producers as volunteer trainers. This strengthens the relationship between horse producers and extension agents and encourages communication and accountability. Programs such as these can also provide solidarity amongst horse producers, who often do not have the same outlets for meeting other producers (like the Cattlemen's Association) (Risse, personal communication 2006).

Continuing to combine management strategies into BMP systems will not only improve water quality, but also the efficiency of the individual best management practices. Based on current literature (Mostaghimi et al. 2002; Thomas 2002; Byers et al. 2005) and reviews of state programs and projects (particularly Clemson University County Extension Agent, Morris Warner in South Carolina), the exclusion and management of grazing livestock away from surface waters will have the greatest impact on the improvement of bacteria impaired streams. These best management practices can include exclusionary fencing, alternative shade sources, and alternative water sources. Kevin Brannan at VA Tech mentioned that oftentimes exclusionary fencing is abandoned after it's damaged in a flood because cost-share monies only cover the original installation and repairs can be quite costly (personal communication 2006). In Byers et al. (2005), however, cattle spent less time in riparian areas when alternative sources of shade and water were provided. Therefore, if exclusionary fencing is inappropriate or too costly, providing additional shade and water sources for cattle will still decrease direct deposition of feces into surface waters. Focusing on creative methods for implementing the necessary BMP systems could serve as the most efficient tactic for bacteria TMDL implementation when agricultural land uses and livestock exist.

Federal and State-funded cost-share programs are essential for agricultural BMP installation in the private sector. USDA-NRCS cost-share programs contain certain weaknesses.

According to Mark Risse with UGA Cooperative Extension Service, these federal programs will only fund on-farm BMPs so there are few opportunities for community-based initiatives and solutions for agricultural programs and producers (personal communication 2006). Virginia has implemented several state-funded cost-share programs to assist with the installation of agricultural best management practices. These funds are combined with federal cost-share programs and implemented through a partnership between VADCR and Soil and Water Conservation Coordinators and their Districts. Virginia has also explored creative options such as a BMP tax credit program and low interest loans. I did not thoroughly investigate whether these financial incentive programs would be feasible in the State of Georgia. However, it does seem like these options could complement existing efforts such as the Georgia Soil and Water Conservation Commission's Agricultural Conservation Incentive Program and the Ag Lands Program. These current efforts alone are not sufficient, and the development and implementation of a State cost-share program for Georgia is necessary to see increased successes (Risse, personal communication 2006). Various recommendations for improving agriculture cost-share programs and efforts in the State were discussed at the Georgia Water Resources Conference in 2001. Some of these relevant conference proceedings are provided on the thesis website at http://www.rivercenter.uga.edu/research/bacteria_tmdl.htm.

Final Thoughts

Through a review of general state programs and practices, South Carolina and Alabama both contain program aspects that could be implemented fairly easily in Georgia. Alabama utilizes innovative methods to organize volunteer labor to meet TMDL implementation goals. South Carolina utilizes federal 319 funds creatively to support state program costs and fund

community-based projects. North Carolina and Virginia have implemented programs that could serve as present and future goals of Georgia's TMDL implementation program. Mecklenburg County's urban TMDL implementation plan could and should be used as a template for appropriating ownership and showing measurable water quality improvement in an urban watershed. Virginia's guidance manual for TMDL implementation can serve as a template for a similar guidance material for TMDL stakeholders and responsible parties in the State of Georgia. Both North Carolina and Virginia have implemented state-sponsored funding programs for BMP installation and water quality improvement projects. Virginia can be tapped as a resource when developing a new bacteria indicator standard for E. coli. All of these states should be reviewed and consulted on the implementation and structure for trust funds, particularly in regard to NPDES permitting fees to support water quality improvement efforts. Further information about state contacts and resources is available at the project website:

http://www.rivercenter.uga.edu/research/bacteria_tmdl.htm.

Learning what our neighboring states are doing to address bacteria TMDLs is essential to the growth and progression of successful implementation strategies in the State of Georgia. What are they doing differently? What can we learn from them? What could they learn from us? These are questions we should be asking, and continue to ask, as we deal with bacteria TMDLs and surface water quality issues. While some of our watersheds are located within our state borders, many are not. Making connections and contacts now in neighboring states will assist us when we must develop and implement TMDLs on waters that cross state borders, such as the Savannah River. We will be prepared and will have information about programs and strategies already being implemented in our neighboring states.

Table 1: Recommendations for Georgia

TOPIC	RECOMMENDATION	CASE STUDY TOOL
TMDL Implementation Planning	Create a TMDL Implementation Guidance Manual for GA with the assistance of groups like the UGA River Basin Center & 319 funds	Virginia's TMDL implementation plan guidance manual
	Create Urban bacteria TMDL implementation plans that assign responsibility & accountability for implementation actions to show measurable water quality improvements	North Carolina's Mecklenburg County SWIM program and TMDL IP for Sugar, Little Sugar, and McAlpine Creeks
	Provide more technical support & guidance to assist stakeholder coordination efforts by using river basin coordinators to complement GAEPD's TMDL Implementation Program & the Georgia River Network water quality outreach efforts; also use lessons from the VA Tech Center for TMDL & Watershed Studies	Alabama's Clean Water Partnership; VA Tech Center for TMDL & Watershed Studies
	Increase use of qualitative reporting to show water quality improvements and supplement quantitative data reporting to USEPA	South Carolina Coneross & Beaverdam Creek TMDL Implementation project
	Create statewide technical (approved QAPP) volunteer monitoring network to provide usable data for TMDL development & implementation, aligned with GAEPD's River Basin Schedule. Can complement & focus existing efforts by Adopt-A-Stream and other volunteer groups	Alabama Water Watch
Bacteria Standard	Follow federal guidance and consider switch to use of E. coli as indicator bacteria; or consider using a combination of indicator bacteria depending on site conditions and other factors	Bacteria TAG white paper
	Use guidance and advice from other states to guide bacteria standard change	Virginia DCR, VA Tech Center for TMDL & Watershed Studies & North Carolina DEQ

TOPIC	RECOMMENDATION	CASE STUDY TOOL
NPS 319 Program	Program reevaluation to determine the appropriate allocation of funds to meet water quality improvement goals	South Carolina DHEC NPS 319 Program
	Increased coordination between the TMDL Implementation Program and the NPS 319 grant program	South Carolina DHEC Watersheds & Planning Department
	State-supported 319 match assistance to reduce the 40% requirement for communities unable to meet it	
Funding	Constitutional dedication of environmental trust funds	Fact sheets & documents
	Approve legislation (HB 550) providing for the establishment of NPDES permitting fees to fund water quality improvements	North Carolina & Virginia state programs
Outreach & Education	Increase the attention, time & weight given to the impact of education & outreach in TMDL implementation to assist in the demonstration of measurable water quality improvements	South Carolina: "faith-based" outreach project, Coneross & Beaverdam Creek outreach project
	Encourage ownership of water resource for citizens & stakeholders through methods such as stream naming & watershed boundary signs	Alabama outreach tools (Troy State University report)
On-site Wastewater Control Strategies & Alternatives	Increase awareness of septic systems and maintenance needs using creative outreach methods	South Carolina: "faith-based" outreach project, Coneross & Beaverdam Creek outreach project
	Use alternative systems to replace failing conventional septic systems	South Carolina: sub-surface constructed wetland project
	Encourage municipal adoption of creative regulatory enforcement controls	Metro Planning District Issues Working Paper; bacteria TAG white paper
	Explore & implement creative options for financing septic systems repairs	Amanda Worthington's thesis

TOPIC	RECOMMENDATION	CASE STUDY TOOL
Pet Waste Programs	Install dog parks to create social mechanisms for further enforcement & encourage behavior changes among pet owners	Virginia models: Four Mile Run Project, Upper Roanoke River Roundtable pet awareness project
	Increase awareness among pet owners through creative outreach methods	Other outreach resources
Agriculture	Encourage the installation of water quality BMPs such as exclusionary fencing, alternative shade & water sources, poultry composting & stack houses through cooperative 319 projects; combined with creative outreach tools & qualitative reporting of agricultural efficiency & water quality improvements	South Carolina: Coneross & Beaverdam Creek TMDL Implementation Project
	Facilitate more technical support & guidance for horse farmers	North Carolina REINS program; the Georgia Equine-A-Syst pilot
	Initiate a State-funded cost-share program for Georgia	Financial incentive programs in North Carolina & Virginia
	Use the extension agent template to provide support to agricultural producers in water quality improvement practices	The UGA River Basin Center's IWE pilot "watershed agent"

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APPENDIX A

NC: TMDL Watershed Plan for Sugar, Little Sugar and McAlpine Creeks

TMDL Implementation Strategy

for

Sugar, Little Sugar and McAlpine Creeks

developed by

TMDL Stakeholders Group

December 15, 2003

Goal of Implementation Strategy: Reduce fecal coliform bacteria levels and comply with N.C. water quality standards in accordance with the TMDLs developed for three (3) watersheds as approved on March 28, 2002.

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this document is to describe the actions that will be taken by the City of Charlotte and Mecklenburg County to reduce fecal coliform bacteria levels in Sugar, Little Sugar and McAlpine in accordance with the Total Maximum Daily Loads (TMDLs) approved for these three (3) watershed areas effective March 28, 2002 Creek. Appendix A contains a map of these watersheds. Appendix B contains the source reduction targets by watershed. The ultimate goal of this document and the TMDL is to meet the N.C. water quality standard for fecal coliform bacteria as described below. Efforts to meet this standard will continually evolve as more data is collected concerning sources of fecal coliform bacteria and resulting water quality impacts. As these efforts change this document will be revised after review and approval by the TMDL advisory group discussed in Section 5.2 of this document. Approved revisions to this document as well as data relating to the effectiveness of efforts to reduce fecal coliform levels will be maintained at the Mecklenburg County Water Quality Program's (MCWQP) website: <http://waterquality.charmeck.org>

N.C. Water Quality Standard for Fecal Coliform Bacteria (15A NCAC 02B .0211):

“Organisms of the fecal coliform group: fecal coliforms shall not exceed a geometric mean of 200/100 ml. (MF count) based upon at least five consecutive samples examined during any 30 day period, nor exceed 400/100 ml. in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the membrane filter technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results, the MPN 5-tube dilution technique shall be used as the reference method.”

1.2 Background

Section 303(d) of the Federal Clean Water Act requires each state to list those waters within its boundaries for which technology-based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop TMDLs for those water bodies that are not meeting designated uses. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a water body based on the relationship between pollution

sources and in-stream water quality conditions so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources.

North Carolina's 2000 303(d) list identifies Sugar Creek (from source to NC/SC border), Little Sugar Creek (from source to NC/SC border) and McAlpine Creek (from source to NC/SC border) as water bodies that do not meet the minimum water quality standard for fecal coliform, due to point sources, urban runoff and storm sewers.

MCWQP in cooperation with the N.C. Department of Environment and Natural Resources (NCDENR) developed TMDLs for Sugar, Little Sugar and McAlpine Creeks in Mecklenburg County that were subsequently approved by the United States Environmental Protection Agency (USEPA) on March 28, 2002. These TMDLs were developed out of a stakeholders' process that included representatives from the following organizations:

- Mecklenburg County Water Quality Program (MCWQP)
(Rusty Rozzelle, David Kroening)
- Charlotte Mecklenburg Utilities (CMU)
(Barry Gullett, Bob Pearson)
- Charlotte Storm Water Services
(Steve Jadlocki)
- Mecklenburg County Storm Water Services
(Dave Canaan)
- N.C. Department of Environment and Natural Resources (NCDENR)
(Michelle Woolfolk)
- Sierra Club
(Rick Roti)
- Catawba Riverkeeper
(Donna Lisenby)
- Private Consultants
(Bill Kreutzberger, Marshall Taylor)
- University of North Carolina at Charlotte
(Dr. J.Y. Wu)
- City of Greensboro
(David Phlegar)
- S.C. Department of Health and Environmental Control (SCDHEC)
(Wayne Hardin)

Under the current regulations, no implementation strategy is required for the TMDLs developed for Sugar, Little Sugar and McAlpine Creeks; however, the stakeholders' believe that such a strategy is necessary to enact the source reduction scenarios defined in the TMDLs and reduce in-stream fecal coliform levels. This Implementation Strategy has been developed to fulfill that objective.

2.0 SOURCE REDUCTION

2.1 Wastewater Treatment Plants

2.1.1 Actions Necessary to Achieve Reduction

There are three (3) wastewater treatment plants (WWTPs) in the TMDL watersheds including the Irwin, Sugar and McAlpine plants, which are owned and operated by Charlotte Mecklenburg Utilities (CMU). The source reduction target established in the TMDL for the these WWTPs is a daily maximum fecal coliform concentration in their effluent of 1000 c.f.u./100ml. To achieve this target, the disinfection systems at the Sugar and Irwin Creek WWTPs are to be upgraded, incorporating the TMDL target into their design criteria. The McAlpine Creek WWTP will incorporate the TMDL target as a design criteria at the time of the next capacity expansion.

As an interim plan until capital improvements upgrades are completed, each WWTP will set the TMDL target as an operating goal taking into account that physical facilities are not in place to always allow it to be met. This could require additional chemical usage and potential changes in standard operating practices (SOP's).

2.1.2 Monitoring

Capital construction will be monitored through CMU's established Capital Improvement Program (CIP) process. CMU will continue to monitor and report daily fecal coliform concentrations in plant effluent through the established Discharge Monitoring Reports (DMRs) required by NCDENR. Data from these DMRs will be provided to MCWQP for measuring the effectiveness of efforts to meet the established TMDL targets.

2.1.3 Time Frame

Sugar and Irwin Creek WWTPs are expected to fully implement the TMDL targets upon completion of disinfection system upgrades no later than July 2006.

The next major upgrade or expansion to the McAlpine Creek WWTP is not firmly scheduled at this time but is expected to be completed by 2012. CMU will evaluate requirements to reach the TMDL targets and consider an earlier implementation.

2.1.4 Estimated Cost

The estimated cost to upgrade the disinfection systems at Sugar Creek and Irwin Creek WWTPs is approximately \$4,600,000. Costs to upgrade McAlpine Creek are not known at this time.

2.2 Sanitary Sewer Overflows

2.2.1 Actions Necessary to Achieve Reduction

CMU owns and operates the sanitary sewer collection systems that serve the TMDL watersheds. The source reduction target established in the TMDL for this sewer collection system includes reducing the number of sanitary sewer overflows (SSOs) by 33% in Irwin, Sugar and Upper McAlpine Creeks; 25% in Little Sugar and Lower McAlpine Creeks; and a 3 hour maximum flow time for all overflows in the TMDL watersheds. Table 1 indicates the source reduction targets for the percent and number of SSOs allowed by TMDL watershed.

Table 1: SSO Source Reduction Targets by Watershed

TMDL Watershed	Original Source Distribution	Source Reduction Target %	Source Reduction Target #
Irwin Creek	55 SSOs; 228 hour duration	33%; 3 hour duration	36 SSOs; 103 hour duration
Sugar Creek	86 SSOs; 371 hour duration	33%; 3 hour duration	57 SSOs; 165 hour duration
Little Sugar Creek	93 SSOs; 443 hour duration	25%; 3 hour duration	69 SSOs; 206 hour duration
Upper McAlpine Creek	40 SSOs; 206 hour duration	33%, 3 hour duration	21 SSOs; 39 hour duration
Lower McAlpine Creek	39 SSOs, 195 hour duration	25%, 3 hour duration	31 SSOs; 93 hour duration

CMU is undertaking an aggressive program to reduce sewer overflows. Program elements include:

- Capital projects to provide additional capacity;
- Capital projects to rehabilitate/replace existing infrastructure;
- Fat, Oil, and Grease (FOG) program enhancements to reduce the number of FOG related blockages;
- Root removal/control program;
- Review/revise engineering standards and practices; and
- Review/revise collection system operation and maintenance practices.

2.2.2 Monitoring

CMU will monitor the number of overflows and volume by basin and will report these to the public annually as part of the Wastewater Performance Report. Data will also be provided to MCWQP for measuring the effectiveness of efforts to meet the established TMDL targets.

2.2.3 Time Frame

Effective October 2003, CMU initiated efforts to reduce overflows, including pilot projects in several areas. Significant reductions in the number and volume of overflows are expected to occur beginning immediately. By 2008, CMU expects that overflows will be greatly reduced. However, it is also expected that overflow prevention/reduction will be an ongoing effort. At this time, it is not possible to accurately project the time required to meet the TMDL goals.

2.2.4 Estimated Cost

Costs include capital costs of sewer rehabilitation and replacement, lift station upgrades, and construction of flow equalization facilities as well as implementation costs of the FOG program and additional operating costs for collection system operation and maintenance. Capital costs are expected to exceed \$150,000,000 over the next five years. Additional operation and maintenance costs estimates are not available at this time.

2.3 Failing Septic Systems

2.3.1 Actions Necessary to Achieve Reduction

There are an estimated 10,587 septic systems located in the TMDL watersheds, which are all privately owned and operated. The local septic system failure rate is estimated at 1% indicating that within the TMDL watersheds there may be 106 failing systems. The source reduction target established in the TMDL for these septic systems is to reduce the number of failing systems by a minimum of 60% in the Irwin, Sugar and Little Sugar Creek watersheds, 80% in the Upper McAlpine Creek watershed and 40% in the Lower McAlpine Creek watershed. Table 2 indicates the source reduction targets for the percent and number of failing septic systems to be eliminated by TMDL watershed.

Table 2: Septic System Source Reduction Targets by Watershed

TMDL Watershed	Original Source Distribution	Source Reduction Target %	Source Reduction Target #
Irwin Creek	30 failing septic systems	60%	18 failing systems to be eliminated
Sugar	43 failing septic	60%	26 failing systems

Creek	systems		eliminated
Little Sugar Creek	26 failing septic systems	60%	16 failing systems to be eliminated
Upper McAlpine Creek	3 failing septic systems	80%	2 failing systems to be eliminated
Lower McAlpine Creek	35 failing septic systems	40%	14 failing systems to be eliminated

In order to eliminate failing systems from the TMDL watersheds, the following actions will be taken by MCWQP working in cooperation with the Mecklenburg County Health Department.

1. Chronic areas where septic system failures commonly occur will be identified by working closely with the Health Department’s Individual Water and Wastewater Program, which is responsible for enforcement of N.C. septic system rules in Mecklenburg County (15A NCAC 18A .1900). These chronic problem areas will include areas with poor soil conditions, older systems and/or systems with a history of repairs and failures. A GIS map will be produced showing these areas.
2. Stream evaluations and monitoring for fecal coliform bacteria will be performed in the problem areas identified in #1 above to determine if failing systems are impacting water quality
3. Follow-up investigations will be conducted to identify and eliminate problems detected under #2 above in cooperation with the Mecklenburg County Health Department

2.3.2 Monitoring

Fecal coliform monitoring will be performed for the purpose of identifying streams that have been negatively impacted by discharges from failing septic systems. This will be accomplished by collecting fecal coliform bacteria samples during ambient flow conditions in stream sections below identified problem areas for failing septic systems. If lab results indicate elevated bacteria counts, follow up sampling and stream survey activities will be performed to isolate source(s). All failing septic systems found to be sources of fecal coliform will be targeted and actions taken to ensure that discharges are eliminated through cooperation with the Mecklenburg County Health Department. Monthly reports will be developed including all monitoring data collected and number and location of problems corrected.

To address future septic system failures, the problem areas identified in #1 above will be surveyed and sampled every two (2) years and actions taken to eliminate all sources of fecal coliform bacteria.

2.3.3 Time Frame

The GIS map identifying potential problem areas will be completed prior to January 31, 2005. Stream evaluations and monitoring in the identified problem areas to identify and eliminate failing septic systems will begin on February 1, 2005 and be completed by October 31, 2007.

2.3.4 Estimated Cost

The estimated cost for completion of all activities is \$12,288, which includes all personnel costs associated with field inspections (\$9,288) and sampling costs (\$3,000). This does not include the unknown costs to property owners associated with septic system repairs or connections to the municipal sewer service. It also does not include costs to CMU that may be associated with making sewer service available to residents with failing systems.

2.4 Illicit Discharges/Dry Weather Flows

2.4.1 Actions Necessary to Achieve Reduction

The TMDL watersheds contain piped storm water flow with an unknown number of storm drain outfalls to surface waters. A study conducted between June 2000 and October 2000 of 168 of these outfalls revealed 33 with dry weather flow. Based on the data collected from this study, a fecal coliform load rate was calculated and a reduction target established. A detailed description of the study can be found in Section 2.2.3 of the TMDL Document. Based on this study, the TMDL specifies that contributions to fecal coliform loads from dry weather flows from storm drain systems are to be reduced in TMDL watersheds as follows:

- Irwin Creek – Reduce fecal load by 60%
- Sugar Creek – Reduce fecal load by 60%
- Little Sugar Creek – Reduce fecal load by 60%
- McAlpine Creek above Sardis Rd. – Reduce fecal load by 82%
- McAlpine Creek below Sardis Rd. – Reduce fecal load by 40%

Table 3 indicates the source reduction targets for the percent and number of dry weather flows to be eliminated by TMDL watershed.

Table 3: Dry Weather Flow Source Reduction Targets by Watershed

TMDL Watershed	Original Source Distribution	Source Reduction Target %	Source Reduction Target #
Irwin Creek	70 outfalls with dry weather flow	60%	42 outfalls with dry weather flow to be eliminated
Sugar	105 outfalls with	60%	63 outfalls with

Creek	dry weather flow		dry weather flow to be eliminated
Little Sugar Creek	191 outfalls with dry weather flow	60%	115 outfalls with dry weather flow to be eliminated
Upper McAlpine Creek	65 outfalls with dry weather flow	82%	53 outfalls with dry weather flow to be eliminated
Lower McAlpine Creek	92 outfalls with dry weather flow	40%	37 outfalls with dry weather flow to be eliminated

To achieve these source reduction targets, the perennial and intermittent streams and storm water outfalls in the six square mile sub-basins in each of the TMDL watersheds will be systematically field evaluated for the presence of dry weather flows. This represents 680 stream miles to be evaluated. All dry weather flows detected through this evaluation process will be monitored for the presence of fecal coliform bacteria. Flow rates will also be measured and fecal loads established. In addition, instream monitoring will be performed during the stream evaluations to identify illicit discharges directly to streams not originating from storm drain outfalls. Follow up efforts will be initiated and State and local ordinances enforced to ensure the elimination of illegal discharges of fecal coliform bacteria from these dry weather flows as well as other water quality problems detected.

2.4.2 Monitoring

Sampling for fecal coliform bacteria will be performed when dry weather flows are detected as well as at all tributary confluences and at the 50 acre drainage terminus. Monthly reports will be developed including all monitoring data collected and number and location of problems identified and eliminated.

To address future discharges of fecal coliform bacteria from dry weather flows, an ongoing field evaluation and sampling program will be initiated following the completion of the initial evaluation effort in order to identify and eliminate future illegal discharges.

2.4.3 Time Frame

There are a total of 48 six square mile sub-basins in the TMDL watersheds. These sub-basins will be evaluated over a three (3) year period from February 1, 2005 through October 31, 2007. Follow up actions will be performed as necessary to eliminate dry weather flows and illicit discharges using applicable State and local regulations.

2.4.4 Estimated Cost

The estimated cost for completion of all activities is \$329,826, which includes all personnel costs associated with field evaluations (\$274,176), monitoring costs (\$44,150), equipment costs for the purchase of four (4) handheld computers with GPS capabilities (\$10,000) and costs associated with travel to the Watershed Initiative workshop (\$1,500). This does not include unknown costs associated with the elimination of dry weather flows.

2.5 Exfiltration from Sanitary Sewer Pipes

2.5.1 Background

The TMDL target for exfiltration from sanitary sewer pipes is to reduce the average fecal coliform concentration in ground water from 58 c.f.u./100 ml to 5 c.f.u./100ml. As part of the TMDL development process, an investigation of the fecal coliform concentration around sanitary sewer lines was conducted in order to assess the possibility of leaking sanitary sewer pipes. A detailed description of the study can be found in Section 2.2.5 of the TMDL Document. Essentially the conclusion of this study was that the presence of fecal coliform was found in groundwater in the vicinity of sanitary sewer lines only where the line was above the water table. Obviously, sewer lines situated below the water table do not have the potential for exfiltration unless the line is under pressure flow. It is noteworthy that no fecal coliform was detected in ground water where the sewer line was below the water table.

The initial study of exfiltration from sanitary sewer pipes was extremely limited in extent and duration. A total of nine (9) sites were installed and monitored from November 2000 through December 2000. At each site a well was installed both down-gradient and up-gradient of the sewer line. Of the nine (9) sites, four (4) were installed at locations where the sewer line had the potential for leakage, in other words, where the sewer line was above the water table. It is highly questionable whether nine (9) isolated sites are representative of a sanitary sewer collection system that covers hundreds of square miles. However, fecal coliform was only detected at sites where the sewer line was above the water table and no fecal coliform was detected in the up-gradient wells at these sites.

2.5.2 Additional Assessment

Based upon the results of the study, it is apparent that the critical factor regarding the potential for exfiltration from sanitary sewer lines is the position of the line with respect to the water table. It is impractical to install ground water monitoring wells in sufficient density to provide a

direct assessment of the position of the water table throughout the TMDL watersheds. However, indirect methods provide a reasonable solution to determining the position of sewer lines relative to the water table. Based upon the previously discussed study an estimate of the average longitudinal profile of the water table near perennial streams can be made. From this estimate, a GIS coverage representing the water table surface can be compiled for all perennial streams in the TMDL watersheds. This coverage, in combination with a three dimensional digital representation of the sanitary sewer infrastructure (in development), will be used to develop a database of sections of the infrastructure located above the water table.

Upon development of the database described above, a prioritization scheme will be applied to each section of sanitary sewer infrastructure. This scheme will be based upon the following attributes:

- Installation date of the sewer line;
- Composition of the sewer line;
- Location in watersheds within historically high in-stream fecal coliform concentrations;
- Longitudinal distance from the creek;
- Soil type; and
- Distance sewer line is above the water table.

2.5.3 Actions Necessary to Achieve Reduction

Until the assessment of the entire sanitary sewer collection system is complete, an accurate estimation of the actions necessary is not feasible. However, at a minimum a combination of the following activities will be necessary to attain the allocation specified in the TMDL:

- Video inspection of lines to determine their condition;
- Slip-lining of pipes; and
- Replacement of old and/or damaged pipes that are beyond repair.

2.5.4 Monitoring

No additional monitoring is foreseen at this time.

2.5.5 Time Frame

All of the sections of the sanitary sewer collection system identified in Section 2.5.2 will be investigated by December 2008. The time frame for the completion of repairs to failing systems is not currently known but will be dependant on the extent of rehabilitation required and the severity of the problem.

2.5.6 Estimated Cost

Unknown until assessment is completed.

3.0 MEASURING SUCCESS

3.1 Use of Water Quality Data to Measure Success

The success of the Implementation Strategy will be measured through the use of “source” and “instream” data. Each of the fecal coliform sources identified in the TMDL have a source reduction target as previously described in this document. Source data relating to these targets will be collected by MCWQP on a monthly basis from the respective responsible agencies and compared to the target established in the TMDL to determine the success of program activities. The overall target for the TMDL is to meet the N.C. water quality standard for fecal coliform bacteria as described in Section 1.1. Measuring the success of efforts to meet this target will be achieved by using the ambient instream water quality monitoring data collected monthly by MCWQP at the five (5) compliance monitoring sites specified by the NCDENR as described in Table 4. This monitoring will be performed during ambient flow (dry weather) conditions following at least three (3) consecutive days measuring less than 0.1 inches of precipitation. This data will be compared to a target of 200 c.f.u./100 ml. to gauge the success of program efforts.

Table 4: NCDENR Water Quality Monitoring Sites in the TMDL Watersheds

Site Number	Description
C8896500	Irwin Creek @ Irwin Creek WWTP
C9050000	Sugar Creek @ N.C. 51 in Pineville
C9210000	Little Sugar Creek @ N.C. 51 in Pineville
C9370000	McAlpine Creek @ Sardis Rd. in Charlotte
C9680000	McAlpine Creek @ S.C. SR 2964 near Camp Cox, S.C.

In addition, MCWQP will obtain flow data for each sampling event from the USGS gauging stations specified in Table 5 for calculation of fecal coliform loads for each site. This load data will be compared to TMDL loads described in Table 6 as an additional measure of success. All data will be posted on the MCWQP web site monthly beginning in July 2004.

Table 5: USGS Gauging Stations in the TMDL Watersheds

Station Number	Description
02146300	Irwin Creek @ Irwin Creek WWTP
02146381	Sugar Creek @ N.C. 51 in Pineville
02146530	Little Sugar Creek @ N.C. 51 in Pineville
02146600	McAlpine Creek @ Sardis Rd. in Charlotte
02146750	McAlpine Creek below McMullen Creek in Pineville

Table 6: TMDL Loads for Sugar, Little Sugar and McAlpine Creeks

Watershed	Critical Condition	TMDL (fecal coliform count/30 days)
Sugar Creek	July 1, 1999	9.3×10^{12}
Little Sugar Creek	December 21, 1999	6.9×10^{12}
McAlpine Creek	September 6, 1999	1.2×10^{13}

3.2 NCDENR Sampling

Data collected by NCDENR from the monitoring sites listed in Table 4 will be obtained from the Mooresville Regional Office (MRO) on a quarterly basis. This data will be compared with data collected by MCWQP for consistency.

3.3 Time Frame

Beginning February 1, 2005 through October 31, 2007, source data relating to the established targets will be collected by MCWQP on a monthly basis from the respective responsible agencies (including CMU) and compared to the source reduction targets and milestones established in the TMDL to determine the success of program activities. The long-term target for the TMDL is to meet the N.C. water quality standard for fecal coliform bacteria. Beginning February 1, 2005 through October 31, 2007, MCWQP will perform monthly instream monitoring for fecal coliform bacteria at the five (5) compliance sites specified by the NCDENR as described in Table 4 to measuring the success of efforts to meet this long-term target.

3.4 Estimated Cost

The estimated cost for measuring the success of TMDL source reduction activities is \$31,536, which includes personnel (\$20,736) and lab costs (\$10,800).

4.0 DOCUMENTATION

4.1 Records

Documentation of progress toward fulfilling the source reduction targets and the resulting water quality improvements is extremely important at several levels including:

- The public/local citizens interested in water quality improvement.
- Local agencies responsible for components of the implementation.
- State agencies responsible for assessing water quality and adjusting programs to address concerns.

- Federal agencies, primarily the USEPA, responsible for oversight of State programs and ultimately responsible for TMDL implementation.

To ensure effective documentation and communication of results at all levels, data will be collected and summarized by MCWQP and made available on a monthly basis to the general public via the website and on an annual basis to NCDENR and the S.C. Department of Health and Environmental Control (SCDHEC) via written reports. This reporting regimen will ensure adequate assessment of the TMDL Implementation Strategy and the timely implementation of TMDL modifications for maximum effectiveness.

4.1.1 Documentation Methods & Reporting Frequency

The following documentation methods and reporting frequency will be used to measure TMDL effectiveness and report results:

- Monthly “TMDL Monitoring Reports” including data collected from source and instream compliance monitoring activities. This information will be posted monthly on MCWQP’s website.
- Annual “Source Reduction Reports” for each of the major fecal coliform sources included in the TMDLs. This information will be posted annually on MCWQP’s website and a written copy will be made available to NCDENR and SCDHEC.
- Annual “Water Quality Reports” that use the annual Source Reduction Reports to summarize water quality information regarding compliance with the fecal coliform TMDLs. This information will be posted annually on MCWQP’s website and a written copy will be made available to NCDENR and SCDHEC.

Effective source and instream monitoring and reporting are essential to the success of the TMDL Implementation Strategy. Each agency responsible for a source category will collect data and transmit to MCWQP for summary and inclusion on its website. For instance, CMU will provide monthly reports to MCWQP for its source monitoring of the number, location, frequency, volume and duration of all SSOs. In addition, fecal coliform levels in overflows will be periodically documented by CMU and reported to MCWQP since good local information was not available for this category in developing the TMDL. Table 7 provides the key indicators for the source categories and the agency responsible for collecting and transmitting data to MCWQP on a monthly basis.

Table 7: Data Reporting Requirements

Key Indicators	Responsible Agency	Data to be Reported
SSOs	CMU	location, frequency, volume and duration of overflows
WWTPs	CMU	days with fecal coliform levels exceeding 1000 cfu/100 ml.
Septic Tanks	MCWQP	number of systems evaluated, number failing, and number of failing systems improved/ eliminated
Dry weather flows	MCWQP	number identified with fecal coliform and number eliminated

MCWQP will be responsible for collecting and making available all data relating to instream compliance monitoring at the sites listed in Table 4. This monitoring will be performed monthly and made available via MCWQP’s website.

Source and instream compliance monitoring data will be summarized by MCWQP in a monthly TMDL Monitoring Report and posted on the website monthly. A summary of this information will be included in an annual Source Reduction Report that will also be placed on the website and made available via hard copy to NCDENR and SCDHEC. This annual report will include a summary of instream compliance monitoring data and a comparison to the target of 200 c.f.u./100 ml. An annual Water Quality Report will be produced that summarizes the Source Reduction Reports and one year of instream compliance monitoring data to assess the level of compliance with N.C. water quality standards. Source information will also be used with the HSPF model to update the model and determine whether the model results match the instream monitoring results in assessing compliance.

MCWQP will provide information and participate in the basinwide plan development processes of both NCDENR and SCDHEC to ensure that the information is appropriately used in the assessments and plans developed at the State level.

4.1.2 Maintaining Records/Sharing Information With Stakeholders

Each agency listed in Table 7 will be responsible for maintaining records concerning the activities performed to fulfill this Implementation Strategy and meet the allocation assigned to their source category. In addition, the agency will be responsible for submitting monthly data to MCWQP as described in Table 7. MCWQP will be responsible for maintaining data for each of the instream compliance sites described in Table 4 and updating

the website on a monthly basis to include all source and instream data collected for the TMDL. MCWQP will also be responsible for developing and submitting all annual and biannual reports to NCDENR and SCDHEC as described above.

4.2 Time Frame

To ensure effective documentation of the implementation of the Implementation Strategy, data will be collected and summarized by MCWQP and made available on a monthly basis to the general public via MCWQP's website and on an annual basis to NCDENR and DHEC via written reports beginning February 1, 2005 through October 31, 2007.

4.3 Estimated Cost

The estimated cost for documentation of TMDL effectiveness is \$19,008, which includes personnel costs for completion of all reports.

5.0 ADAPTIVE MANAGEMENT

5.1 Assessing the Need for Change

A TMDL advisory group will be developed effective February 1, 2005 for the purpose of reviewing program activities and data and assessing the need for change. This group will consist of a representative from MCWQP, CMU, Charlotte Storm Water Services, NCDENR, and SCDHEC. In addition, a private citizen from the City of Charlotte with an interest and knowledge of the TMDL program will be selected to serve on the committee. The MCWQP representative will take the lead in setting up the meetings, establishing agendas and providing all necessary background information. The purpose of this group will be to assess the effectiveness of the Implementation Strategy at meeting TMDL targets and changing the strategy as necessary to ensure the fulfillment of all TMDL objectives. This frequency may be reduced to twice annually in following years based on need.

5.2 Adaptation of TMDL

The TMDL advisory group will adapt the TMDL Implementation Strategy as necessary to ensure that source reduction targets are effectively and efficiently fulfilled and that progress is being made toward achieving the ultimate goal of compliance with the N.C. water quality standard for fecal coliform bacteria. These changes will be made as necessary during each February meeting of the group following a minimum of one year of implementation of the TMDL. All changes will be communicated to the

agencies responsible for the implementation of the TMDL in the form of an annual report. This report will be posted on the web and made available to both NCDENR and SCDHEC for comment and input.

5.3 Time Frame

A TMDL advisory group will be developed effective February 1, 2005 for the purpose of reviewing program activities and data and assessing the need for change. Meetings of the advisory group will be held at a minimum of twice a year from February 1, 2005 through October 31, 2007. Adaptations to the Implementation Strategy will be made as need and communicated to the necessary agencies. These changes will also be communicated to NCDENR and SCDHEC.

5.4 Estimated Cost

The estimated cost for the adaptive management component of the Implementation Strategy is \$4,896, which includes all personnel costs associated with conducting TMDL advisory group meetings and generating necessary reports.

6.0 PUBLIC PARTICIPATION & OUTREACH ACTIVITIES

6.1 Community Education & Involvement

Between February 1, 2005 and October 31, 2007, MCWQP in cooperation with SCDHEC, CMU and Charlotte Storm Water Services will conduct workshops for the general public for the purpose of describing the TMDLs for Sugar, Little Sugar and McAlpine Creeks and explaining efforts that will be undertaken to reduce fecal coliform levels through the Implementation Strategy. The workshop will also seek involvement by the general public in volunteer efforts to improve water quality conditions in Charlotte-Mecklenburg streams such as the “Adopt-A-Stream Program.” The workshop will be publicized through media releases as a positive step toward addressing elevated bacteria levels in Charlotte-Mecklenburg streams.

6.2 Staff Development Phase

The success of the Implementation Strategy will depend upon cooperation between MCWQP, CMU and Charlotte Storm Water Services at all staff levels. Staff will need to be adequately informed of the TMDL program and the specific requirements of the Implementation Strategy. Staff will also need to be informed of their specific duties and responsibilities toward fulfilling the Implementation Strategy, including providing the

necessary reports and information. This will be achieved by holding a series of staff workshops conducted annually in February 2005, 2006 and 2007. These workshops will be tailored to each specific agency and will involve participation by staff at all levels. The purpose of these workshops will be to inform staff of the actions they will need to take to ensure the success of the Implementation Strategy.

6.3 Time Frame

Between February 1, 2005 and October 31, 2007, three (3) workshops will be held annually for the general public and one (1) workshop will be held annually for each agency responsible for a source reduction target and milestone.

6.4 Estimated Cost

The estimated cost for the adaptive management component of the TMDL is \$7,920, which includes personnel costs associated with conducting all public outreach meetings and presentations as well as coordinating volunteer activities.

7.0 COST-BENEFIT ANALYSIS OF ELIMINATION OF FECAL COLIFORM SOURCES

7.1 Cost-Benefit Analysis

Using the data collected through stream monitoring and assessments, a cost-benefit analysis of the elimination of the various sources of fecal coliform bacteria in the watersheds will be conducted. The purpose of this analysis will be to determine the most cost effective method of eliminating fecal coliform sources detected in the watersheds through direct stream evaluation. Established fecal coliform loading rates will be compared to the costs to eliminate sources, which might include illicit discharges, septic systems failures, sanitary sewer overflows, illicit connections, domestic animals, and leaking sanitary sewer lines. Actual costs associated with the elimination of each source will be determined through interaction with the source owner including CMU, private landowners, businesses, etc. The results of the analysis will be used to prioritize limited funds for elimination of the greatest fecal coliform load for the least expenditure. It is anticipated that the results of this study will be applicable to other similar sized municipalities in the U.S.

7.2 Time Frame

Efforts will begin with the initiation of stream assessment and monitoring activities on February 1, 2005 and continue through the completion of all follow up activities on October 31, 2007.

7.3 Estimated Cost

The estimated cost for completion of the cost benefit analysis is \$16,200, which includes personnel costs.

8.0 SCHEDULE & TOTAL COST ESTIMATE

8.1 Time Frame and Cost Estimate

Table 8 provides a summary of the source reduction activities to be performed, time frame and measure of success for reducing fecal coliform bacteria levels in Sugar, Little Sugar and McAlpine Creek in accordance with the TMDLs. Table 9 provides a cost estimate for TMDL implementation over the next five (5) years.

Table 8: Schedule

Source Reduction Activity	Initiation Date	Completion Date	Measure of Success
Wastewater Treatment Plants			
TMDL as Operational Goal at Plants	February 1, 2005	Ongoing	Discharge Monitoring Reports
Upgrades at Sugar & Irwin Plants	July 2005	July 2006	Discharge Monitoring Reports
Upgrades at McAlpine Plant	Unknown	2012	Discharge Monitoring Reports
Sanitary Sewer Overflows			
Systematic Reductions in Sewer Overflows	February 1, 2005	Ongoing	Number and Volume of Overflows
Failing Septic Systems			
GIS Map of Problem Areas	January 4, 2005	January 31, 2005	Completion of GIS map & identify problem areas
Field evaluations & monitoring	February 1, 2005	October 31, 2007	Identify failing septic systems
Follow up field evaluations & enforcement actions	February 1, 2005	October 31, 2007	Septic system discharges eliminated
Illicit Discharges/Dry Weather Flows			
Field evaluations & monitoring	February 1, 2005	October 31, 2007	Identify dry weather flows & illicit discharges
Follow up field evaluations & enforcement actions	February 1, 2005	October 31, 2007	Eliminate all illicit discharges
Exfiltration from Sanitary Sewer Pipes			
Investigation of Suspected Problem Areas	February 1, 2005	December 2008	Completion of Assessment

Completion of Necessary Rehabilitation Efforts	Dependant on Results of Assessment	Dependant on Results of Assessment	Completion of Rehabilitation
Measuring Success			
Collect & assess source data	February 1, 2005	October 31, 2007	Source reduction targets and milestones met
Collect & assess instream data	February 1, 2005	October 31, 2007	Instream target of 200 c.f.u./100 ml. met
Documentation			
Complete monthly TMDL Monitoring Report	February 28, 2005	October 31, 2007	Data available on website
Complete annual Source Reduction Report	February 1, 2005	October 31, 2007	Report available on website & hard copy to NCDENR & SCDHEC
Completion of annual Water Quality Report	February 1, 2005	October 31, 2007	Report available on website & hard copy to NCDENR & SCDHEC
Adaptive Management			
TMDL Advisory Group established & first meeting held (2 meetings per year)	February 1, 2005	October 31, 2007	Meeting held to discuss implementation of Implementation Strategy & measures of success
Ongoing meetings held	Twice a year	Twice a year	Review TMDL monthly reports & evaluate success of Plan
Revise Work Plan	As necessary	As necessary	Improve effectiveness of Plan at meeting TMDLs
Public Participation & Outreach Activities			
Public outreach workshop (3 workshops per year)	February 1, 2005	October 31, 2007	Involve community in activities to reduce fecal coliform levels
Staff workshop (1 workshop per year)	February 1, 2005	October 31, 2007	Inform staff from MCWQP and CMU of the measures necessary to implement Implementation Strategy
Cost-Benefit Analysis of Elimination of Fecal Coliform Sources			
Cost-Benefit Analysis	February 1, 2005	October 31, 2007	Complete written cost analysis report

Table 9: Cost Estimate for TMDL Implementation Over the Next Five (5) Years

Program Activities	Estimated 5 Year Cost⁽¹⁾
Wastewater Treatment Plants	\$4,600,000
Sanitary Sewer Overflows	\$150,000,000
Failing Septic Systems	\$12,288
Illicit Discharges/Dry Weather Flows	\$329,826
Exfiltration from Sanitary Sewer Pipes	Unknown at this time
Monitoring/Measuring Success	\$31,536

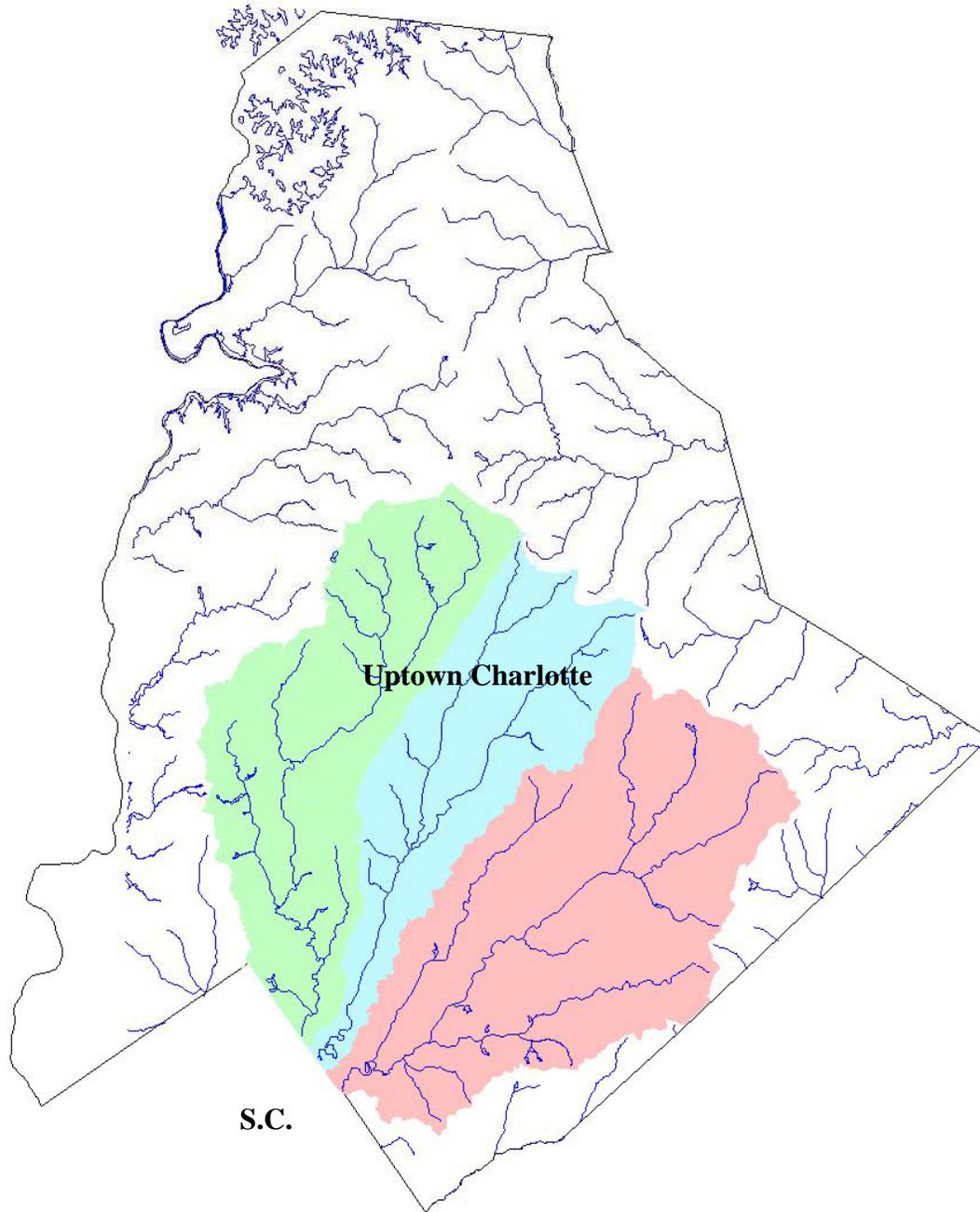
Documentation of Effectiveness of Efforts	\$19,008
Adaptive Management	\$4,896
Public Participation/Outreach Activities	\$7,920
Cost-Benefit Analysis	\$16,200
Totals	\$155,021,674

⁽¹⁾ Does not include private sector costs.

9.0 CONCLUSION

The objective of this TMDL Implementation Strategy is to reduce fecal coliform bacteria levels in Sugar, Little Sugar and McAlpine Creek and comply with N.C. water quality standards in accordance with the established TMDLs. This is a difficult task that will involve a great deal of trial and error as much remains unknown regarding fecal coliform bacteria in these streams and the methods that are effective at achieving the desired reductions. The ability to adapt strategies based on new and better data is essential to the success of this effort; therefore, this document will be subject to significant changes as this process moves forward. Equally important is the ability to effectively monitor and report successful source reduction measures. The objective of this Implementation Strategy is to learn what works and consistently apply those proven techniques toward achieving the desired reductions. In some situations, these techniques may be simple to apply but more often than not they will be time consuming and costly. The overriding objective of this Plan is to spend resources wisely based on a careful assessment of the problem and a thorough evaluation of outcomes.

Appendix A: Location of TMDL Watersheds



<h2>Legend</h2>		
	Meck. Co. Streams	
	Sugar Creek	
	Little Sugar Creek	
	McAlpine Creek	
	Mecklenburg County	
<p><small>This map comprises information from multiple sources. It is for illustrative purposes only and should not be used for regulatory decisions. MCDEP assumes no liability for damages caused by inaccuracies in this map or supporting data.</small></p> <p><small>For more information contact the Mecklenburg County Department of Environmental Protection.</small></p>		

Appendix B: Source Reduction Targets by TMDL Watershed

Little Sugar Creek

Source Category	Original Source Distribution	Source Reduction Target %	Source Reduction Target #
WWTP	No Daily Max	Max 1000 c.f.u./100 ml conc. In effluent	N/A
SSOs	93 SSOs; 443 hour duration	25% Reduction and 3 hour duration	69 SSOs; 206 hour duration
Wildlife	150 Geese 50 Ducks	N/A	N/A
Septic Systems	26 Failing Septic Systems	60% Reduction	16 Failing Septic Systems Eliminated
Dry Weather Flow	191 Outfalls with Dry Weather Flow	60% Reduction	115 Outfalls with Dry Weather Flow Eliminated
Sewer Exfiltration	58 c.f.u./100 ml in Ground Water	5 c.f.u./100 ml in Ground Water	N/A

Irwin Creek

Source Category	Original Source Distribution	Source Reduction Target %	Source Reduction Target #
WWTP	No Daily Max	Max 1000 c.f.u./100 ml conc. In effluent	N/A
SSOs	55 SSOs; 228 hour duration	33% Reduction and 3 hr duration	36 SSOs; 103 hour duration
Wildlife	N/A	N/A	N/A
Septic Systems	30 Failing Septic Systems	60% Reduction	18 Failing Septic Systems Eliminated
Dry Weather Flow	70 Outfalls with Dry Weather Flow	60% Reduction	42 Outfalls with Dry Weather Flow Eliminated
Sewer Exfiltration	58 c.f.u./100 ml in Ground Water	5 c.f.u./100 ml in Ground Water	N/A

Upper McAlpine Creek

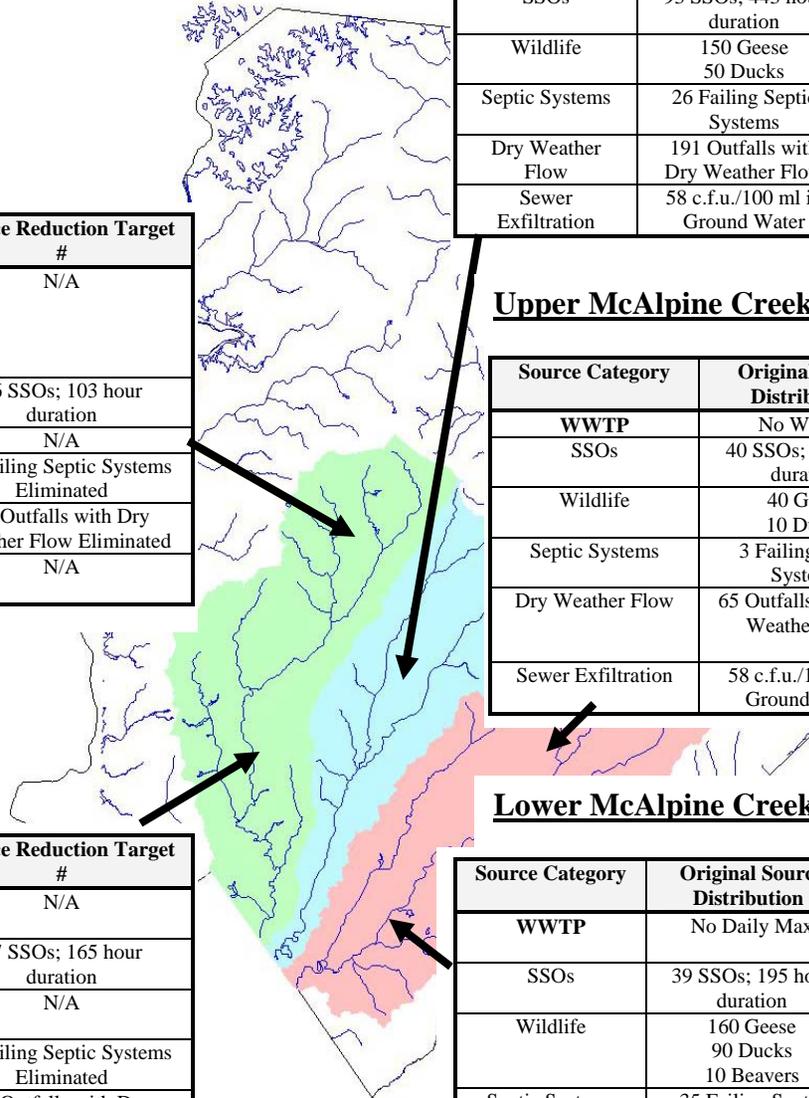
Source Category	Original Source Distribution	Source Reduction Target %	Source Reduction Target #
WWTP	No WWTP	-	-
SSOs	40 SSOs; 206 hour duration	33% Reduction and 3 hour duration	21 SSOs; 39 hour duration
Wildlife	40 Geese 10 Ducks	N/A	N/A
Septic Systems	3 Failing Septic Systems	80% Reduction	2 Failing Septic Systems Eliminated
Dry Weather Flow	65 Outfalls with Dry Weather Flow	82% Reduction	53 Outfalls with Dry Weather Flow Eliminated
Sewer Exfiltration	58 c.f.u./100 ml in Ground Water	5 c.f.u./100 ml in Ground Water	N/A

Sugar Creek

Source Category	Original Source Distribution	Source Reduction Target %	Source Reduction Target #
WWTP	No Daily Max	Max 1000 c.f.u./100 ml conc. In effluent	N/A
SSOs	86 SSOs; 371 hour duration	33% Reduction and 3 hour duration	57 SSOs; 165 hour duration
Wildlife	40 Geese 20 Ducks	N/A	N/A
Septic Systems	43 Failing Septic Systems	60% Reduction	26 Failing Septic Systems Eliminated
Dry Weather Flow	105 Outfalls with Dry Weather Flow	60% Reduction	63 Outfalls with Dry Weather Flow Eliminated
Sewer Exfiltration	58 c.f.u./100 ml in Ground Water	5 c.f.u./100 ml in Ground Water	N/A

Lower McAlpine Creek

Source Category	Original Source Distribution	Source Reduction Target %	Source Reduction Target #
WWTP	No Daily Max	Max 1000 c.f.u./100 ml conc. In effluent	NA
SSOs	39 SSOs; 195 hour duration	25% Reduction and 3 hour duration	31 SSOs; 93 hour duration
Wildlife	160 Geese 90 Ducks 10 Beavers	N/A	N/A
Septic Systems	35 Failing Septic Systems	40% Reduction	14 Failing Septic Systems Eliminated
Dry Weather Flow	92 Outfalls with Dry Weather Flow	40% Reduction	37 Outfalls with Dry Weather Flow Eliminated
Sewer Exfiltration	58 c.f.u./100 ml in Ground Water	5 c.f.u./100 ml in Ground Water	N/A



APPENDIX B

VA: Guidance Manual for TMDL Implementation Plans¹

¹ Partial document only. To access complete document: <http://www.deq.state.va.us/tmdl/implans/ipguide.pdf>

Guidance Manual for Total Maximum Daily Load Implementation Plans

Photo Courtesy of USDA NRCS

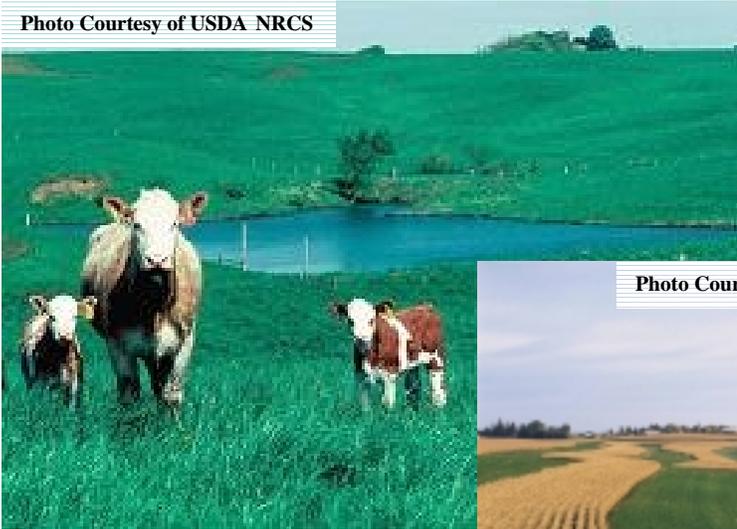
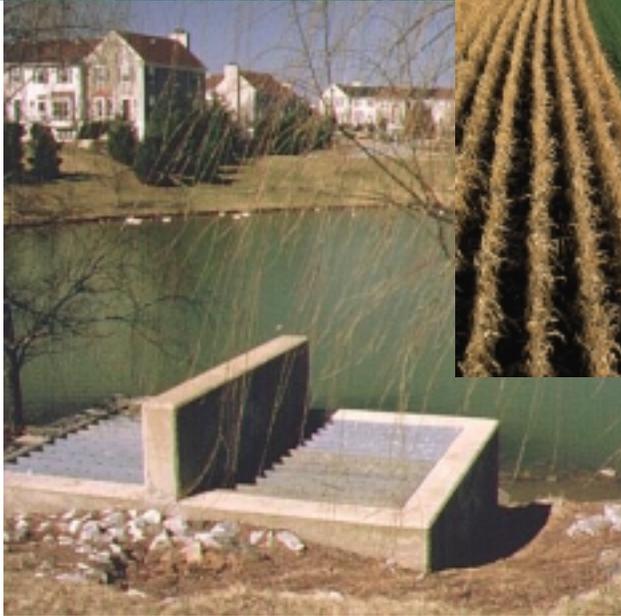


Photo Courtesy of USDA NRCS



***The Commonwealth of Virginia:
Department of Conservation and Recreation
Department of Environmental Quality***

July 2003

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List of Abbreviations Used in the Manual

BMP - Best Management Practice
BST - Bacterial Source Tracking
CPP - Continuing Planning Process
CREP - USDA Conservation Reserve Enhancement Program
CWA - Clean Water Act
EPA - United States Environmental Protection Agency
ESC - Erosion and Sediment Control
FC - Fecal coliform
FSA - Farm Service Agency
FTE - Full time equivalent
GIS - Geographic Information System
GWLF - Generalized Watershed Loading Functions
HSPF - Hydrologic Simulation Programs in Fortran
IP - Implementation Plan
LA - Load Allocation
MS4 – Municipal Separate Storm Sewer System
NAPP- National Aerial Photography Program
NPDES – National Pollutant Discharge Elimination System
NPS - Nonpoint source
NRCS - Natural Resources Conservation Service
PDCs - Planning District Commissions
PS - Point source
SWAP - Source Water Assessment Program
SWCD - Soil and Water Conservation District
SWM - Storm Water Management
SWMM - Storm Water Management Model
TMDL - Total Maximum Daily Load
UAA - Use Attainability Analysis
USDA - United States Department of Agriculture
USGS - U.S. Geological Survey
USLE - Universal Soil Loss Equation
DCR - Virginia Department of Conservation and Recreation
DEQ - Virginia Department of Environmental Quality
DOF - Virginia Department of Forestry
VCE - Virginia Cooperative Extension
VDACS - Virginia Department of Agriculture and Consumer Services
VDH - Virginia Department of Health
VPDES - Virginia Pollutant Discharge Elimination System
WLA - Waste load allocation
WQMIRA - Water Quality Monitoring, Information, and Restoration Act
WQMPs - Water Quality Management Plans
WWTP - Wastewater treatment plant

Introductory Statement

This manual provides guidance to local governments, soil and water conservation districts, planning district or regional commissions, community watershed groups, and state and federal agencies on developing Implementation Plans (IPs) for waters where TMDLs have been completed. It also addresses the requirements for IPs as outlined in Virginia's 1997 Water Quality Monitoring, Information, and Restoration Act (§62.1-44.19:4 through 19:8 of the Code of Virginia), or WQMIRA. In addition to the requirements of WQMIRA, this guidance manual addresses the requirements of IPs based on EPA's "Guidance for Water-Quality Based Decisions: The TMDL Process," "Supplemental Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories," and "Guidance for Developing Watershed-Based Plans for Impaired Waters."

This manual also outlines both the recommended and required components of an IP. These elements are listed on page 2. Information pertaining to state and federal guidance for IPs is presented in Chapter 3.

An IP is prepared at some point following development of the TMDL, and approval by EPA. The TMDL represents the maximum amount of pollutant that a water body (stream, lake, or estuary) can receive without exceeding water quality standards. TMDLs are pollutant-specific so that each water body in which multiple pollutants violate water quality standards will have multiple TMDLs. The TMDL consists of a waste load allocation (WLA) or point source contribution; a load allocation (LA) or nonpoint source (NPS) allocation; and a margin of safety (MOS). IPs are not necessarily pollutant-specific and should be designed to address multiple water quality problems within a water body or all water quality-impaired water bodies within a watershed.

Section 303(d) of the Clean Water Act and the EPA's Water Quality Planning and Management Regulation (40 CFR Part 130) require states to develop TMDLs for water bodies that are exceeding water quality standards. Once the TMDL has been developed, a TMDL report is prepared and distributed for public comment and then submitted to EPA for approval. Following this process, an IP should be developed to describe actions (*i.e.*, best management practices) to implement the allocations contained in the TMDL. In most cases, the WLAs would be addressed through the Virginia Pollutant Discharge Elimination System (VPDES) Program administered by the Virginia Department of Environmental Quality.

Revisions of this manual may be necessary due to statutory or regulatory changes. As changes occur, periodic additions or supplements will be prepared for inclusion into the manual. This manual and future revisions are available on the DEQ web site at <http://www.deq.state.va.us/tmdl> and the DCR web site at <http://www.dcr.state.va.us/>

6.0 IMPLEMENTATION ACTIONS

A number of state and federal requirements for IPs are listed in Chapter 3. WQMIRA requires necessary *corrective actions* as one of four elements included in an IP. EPA requires the description of the *implementation actions* and/or *management measures* as one of the minimum elements of an approvable IP. The terms “corrective actions,” “implementation actions,” and “management measures” are used synonymously to describe what is needed to achieve the TMDL. Other terms that may be used are “control measures” and “BMPs”. These terms are used interchangeably throughout this guidance manual.

This chapter explains how to select the appropriate implementation actions and how to quantify the overall implementation effort. By quantifying implementation actions needs, the costs and benefits of implementation can be assessed. The following sections discuss the methodology involved in assessing implementation needs and estimating costs and benefits.

Components of a TMDL Implementation Plan:

1. Executive Summary
2. Introduction
3. State and Federal Requirements for Implementation Plans
4. Review of TMDL Development
5. Public Participation
- 6. Implementation Actions**
7. Measurable Goals and Milestones
8. Stakeholders’ Roles and Responsibilities
9. Integration with Other Watershed Plans
10. Potential Funding Sources

THE IMPLEMENTATION ACTIONS chapter of the TMDL Implementation Plan addresses the following questions:

- What types and quantities of implementation actions will be needed to restore water quality?
- What types and quantities of technical assistance will be needed to implement the actions?
- What are the associated costs and benefits of implementing these actions?

An important element of the TMDL IP is to encourage voluntary compliance with implementation actions by local, state, and federal government agencies, business owners, and private citizens. In order to encourage voluntary implementation, information must be obtained on the types of actions and program options that can achieve the goals practically and cost-effectively. Potential implementation actions can be identified through review of the TMDL report, stakeholder input, literature review, and discussions with representatives from the following agencies: Soil and Water Conservation Districts (SWCDs), Natural Resources Conservation Service (NRCS), DCR, DEQ, VDH, Virginia Cooperative Extension (VCE), county governments, local Farm Bureaus, and area colleges and universities.

6.1 Linking the TMDL to Implementation

Linking the TMDL to implementation involves identifying appropriate actions to alleviate the impairment (identifying the implementation actions) and assessing the extent of each implementation action needed. The level of effort required to identify and select the appropriate implementation actions depends on the amount and type of data available from the development of the TMDL, the complexity of the watershed characteristics, and the complexity of the impairment(s) involved. This section is provided to help the planners identify the information already available and the information still needed to select appropriate implementation actions.

6.1.1 Detail of TMDL Analysis

TMDLs vary based on the degree and methodology of the analysis used to determine allocation results and load reductions. Examining the *monitoring*, the *source assessment*, and the *modeling* used to develop the TMDL will provide the information needed to assess the detail of the TMDL analysis.

A review of the TMDL report (see Chapter 4) provides information on the level of detail of the monitoring, source assessment, and modeling efforts involved in determining the TMDL. The level of detail of the TMDL analysis can then be used as one factor in determining the level of effort needed for assessing implementation actions needs. Some general guidelines are given here to identify the level of detail used to obtain the TMDL.

6.1.1.1 Low Detail TMDL Analysis

A simple TMDL analysis with low detail is one that involves *temporal monitoring*, *simple source assessment*, and *simple modeling*. An example of a low-detail TMDL analysis with simple modeling is a "load duration" TMDL analysis. In addition to available historical data, a low-detail TMDL analysis includes temporal monitoring. A simple source assessment includes waste load allocations to each permitted point source within the watershed and NPS load allocations to broad categories of sources within the watershed (*e.g.*, in a TMDL established for bacteria, reductions might be allocated to livestock, wildlife, and human sources based on BST).

LOW DETAIL OF TMDL ANALYSIS:

- **temporal monitoring**
- **simple source assessment**
- **simple modeling**

6.1.1.2 Intermediate Detail TMDL Analysis

An intermediate TMDL analysis involves *temporal and spatial monitoring*, a *rudimentary source assessment*, *assessment of delivery mechanisms*, and some *mid-range modeling*. A rudimentary source assessment includes identifying the point sources of pollution within the watershed and also categorizing the NPS loads based on land use. (Land use data can be obtained from government agencies such as the U.S. Geological Survey (USGS) and the Farm Service Agency (FSA). USGS provides access to its aerial photography products as part of the National Aerial Photography Program (NAPP) at <http://edc.usgs.gov/products/aerial/napp.html>. Additionally, land use data, such as Multi-Resolution Land Characteristics (MRLC) and National Land Cover Data (NLCD) are available from USGS at <http://edc.usgs.gov/products/landcover.html>. Information from FSA's Aerial Photography Field Office can be accessed from <http://www.apfo.usda.gov/>. These are some of the commonly used sources of land use data, however, other sources are often available and may be more appropriate for specific applications. County offices (*e.g.*, GIS departments) and regional representatives of government agencies can often provide useful input as to locally appropriate data.)

INTERMEDIATE DETAIL OF TMDL ANALYSIS:

- **temporal and spatial monitoring**
- **rudimentary source assessment**
- **assessment of delivery mechanisms**
- **mid-range modeling**

HIGH DETAIL OF TMDL ANALYSIS:

- **temporal and spatial monitoring**
- **extensive source assessment**
- **assessment of delivery mechanisms**
- **detailed modeling**

Assessment of delivery mechanisms consists of determining the pathway(s) of the pollutant to the

stream. Mid-range modeling might include monthly or annual loading models, such as GWLF or USLE, commonly used to model nutrients and sediment loadings.

6.1.1.3 High Detail TMDL Analysis

A highly detailed TMDL analysis involves *temporal and spatial monitoring* throughout the watershed, an *extensive source assessment*, *assessment of delivery mechanisms*, and *detailed modeling* of the pollution loads within the watershed. An extensive source assessment includes utilizing available land use studies (such as those previously cited), visual methods such as stream walks, geographic information system (GIS) tools, public or citizen information, and federal or state agency databases. An assessment of the delivery mechanisms determines the pathways from which the pollutant enters the surface waters. This approach provides a local verification process that will lower the level of effort needed to select the implementation actions. Models such as HSPF that are used in a highly detailed TMDL analysis are continuous watershed simulation models that require detailed input data.

6.1.2 Impairment and Watershed Characteristics

Classifying the TMDL analysis is only one factor when determining the level of effort needed for assessing implementation needs. This level of effort is also dependent upon the characteristics of the watershed and the complexity of the impairment.

The number of sources that contribute to the impairment and the land uses within the watershed define the *watershed characteristics* which are factors used to determine the level of effort for assessing implementation needs. For example, selecting implementation actions that address a stream segment impaired by a single identifiable source, such as livestock, will be relatively simple. But establishing BMPs that address multiple pollutant sources (such as sewer overflows and urban stormwater as well as industrial point sources) or multiple land uses within the watershed would be much more involved.

Watershed Characteristics that influence assessment of implementation needs can be defined by:

- **number of sources that contribute to the impairment(s)**
- **land uses within the watershed**

Characteristics of the Impairment that influence assessment of implementation needs can be defined by:

- **type of impairment(s)**
- **number of pollutants**

The type of impairment and the number of pollutants contribute to the complexity of the *impairment*. IPs developed for more than one pollutant, such as the IP developed for the Muddy Creek, Dry River, Pleasant Run, and Lower Dry River watersheds in Rockingham County (for fecal coliform and nitrate reductions), will involve a higher level of effort to assess implementation needs.

6.1.2.1 Low Complexity Impairment and Watershed Characteristics

A *single pollutant* from a *single source* where there is only one overwhelmingly predominant *land use* involved can be classified as an impairment and watershed of low complexity. A bacterial impairment caused by sewer overflow (single pollutant) in an urban watershed (single land use) is defined as a low complexity impairment.

Low Complexity of Impairment and Watershed Characteristics can be defined by:

- **single pollutant**
- **single source**
- **homogeneous land use**

6.1.2.2 Intermediate Complexity Impairment and Watershed Characteristics

A *single pollutant* that can be from a *single source* or *multiple sources* can be classified as an impairment and watershed of intermediate complexity. To be defined as an impairment of intermediate complexity from a single source, the pollutant source comes from *mixed land use*, such as bacterial impairment from agricultural and residential land uses. An impairment of intermediate complexity from multiple sources has more than one source of pollutant but only one *homogeneous land use*. For example, stream bank erosion from cattle and runoff from pastures are pollutant sources causing sediment impairment on agricultural land.

Intermediate Complexity of Impairment and Watershed Characteristics can be defined by:

- **single pollutant**
- **single source**
- **mixed land use**

or

- **single pollutant**
- **multiple sources**
- **homogeneous land use**

6.1.2.3 High Complexity Impairment and Watershed Characteristics

An impairment and watershed of high complexity is due to a *single pollutant* or *multiple pollutants* caused by *multiple sources* and/or *mixed land use*. All general standard (benthic) impairments can be defined as high complexity impairments because the health of aquatic communities, which is the gage by which this standard is measured, responds to a wide variety of environmental factors (stressors). The complexity of the relationship between the health of aquatic communities and the stressors impacting that health makes these impairments highly complex. A TMDL IP that addresses multiple pollutants for the same water body has a highly complex set of impairments.

High Complexity of Impairment and Watershed Characteristics can be defined by:

- **single or multiple pollutants**
- **multiple sources**
- **mixed land use**

6.1.3 Level of Effort for Assessing Implementation Actions

Figure 6.1 shows the level of effort for assessing implementation needs dependent on the type and amount of information available from the TMDL process. Column 1 of Figure 6.1 describes the detail involved in the TMDL analysis, with the characteristics of low, intermediate and high detail TMDL analyses in the shaded boxes. (These characteristics are discussed in Section 6.1.1.) Column 2 of Figure 6.1 displays the complexity of the impairment(s) and watershed characteristics identified during TMDL development. (These characteristics are discussed in Section 6.1.2.) Column 3 gives the level of effort for assessing implementation needs and the suggested tasks needed to select the appropriate implementation actions.

Figure 6.1 shows that if the TMDL analysis was conducted using minimal data (low detail analysis), a higher level of effort for assessing implementation needs (column 3) is required than for one in which the TMDL was determined using considerable data (intermediate or high detail analysis). Also, the level of effort required for assessing implementation actions for a TMDL increases with the complexity of the watershed characteristics and the impairments (column 2).

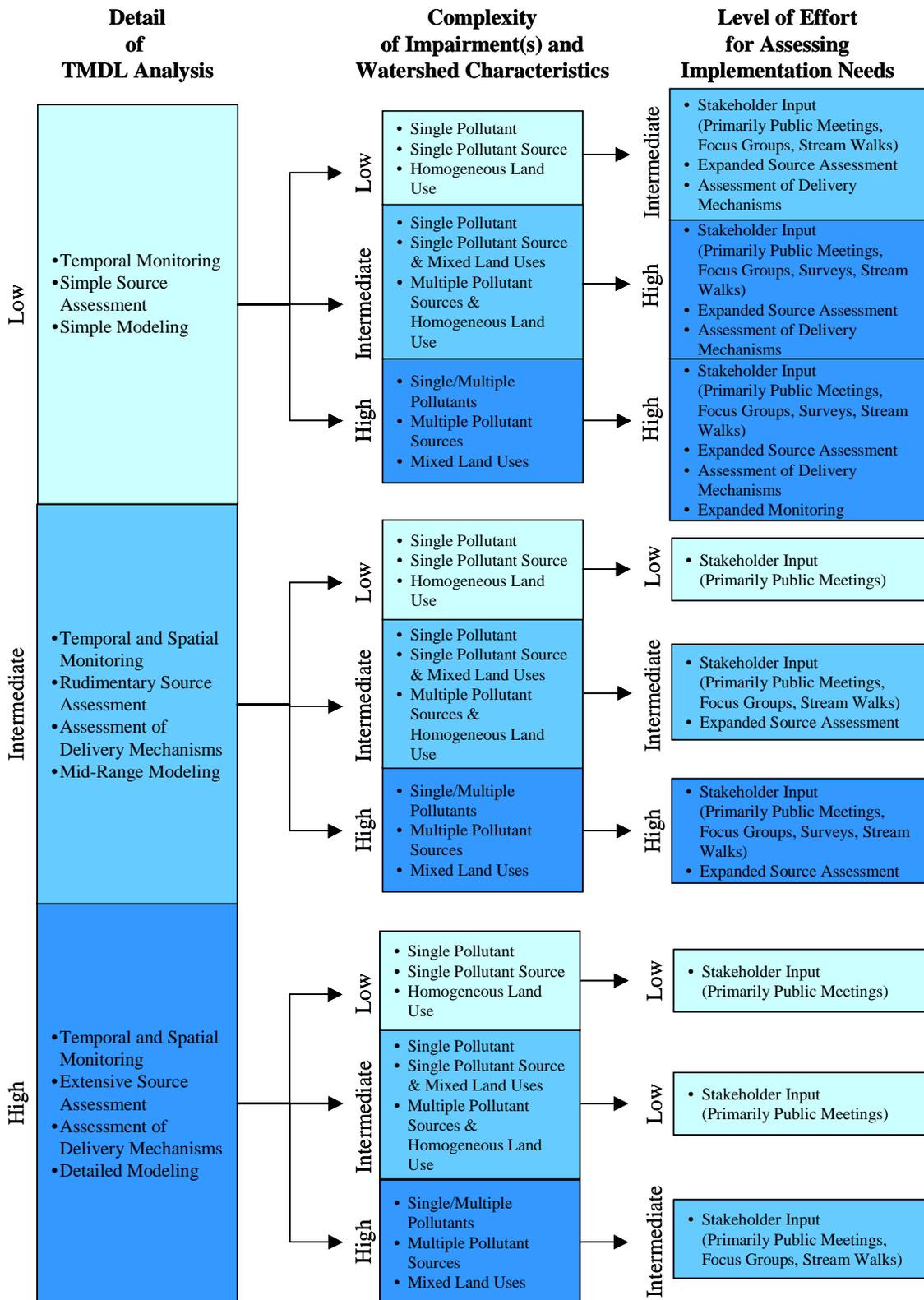


Figure 6.1 Relationships between TMDL development and the IP

6.1.3.1 *Low Detail of TMDL Analysis;*

Low Complexity Impairment and Watershed Characteristics

When load allocations were estimated using a simple (low detail) TMDL analysis and the complexity of the impairment is identified as low; the assessment of needs and costs, and the identification of funding sources can be achieved with stakeholder input, by expanding the source assessment, and by assessing the delivery mechanisms during implementation planning.

Stakeholder input and public involvement, such as public meetings (Section 5.1), focus groups (Section 5.2), and stream walks, will be needed during the development of the IP to assess the implementation needs.

Application of load duration methodology and BST during bacterial TMDL analysis provides identification of the pollution source (*i.e.*, humans, pets, and wildlife) but not the delivery mechanism within the watershed. An expanded source assessment could include the use of multiple-tracers for tracking the source of human wastewater, particularly in urban watersheds. The multiple tracer approach could include:

- chemical and biological tracers (such as conductivity, temperature, turbidity, dissolved oxygen, surfactants, chloride, bromide, and boron);
- optical brighteners;
- analysis of organic compounds frequently associated with human wastewater (caffeine, nicotine, metabolites, human pharmaceuticals, and detergent metabolites);
- fluorometric analysis for human wastewater plumes; and
- bacteria enumeration and source tracking.

6.1.3.2 *Low Detail of TMDL Analysis;*

Intermediate Complexity Impairment and Watershed Characteristics

If the TMDL analysis was generated with a low level of detail for an impairment of intermediate complexity, a high level of effort is needed to develop the IP. The assessment of needs, the assessment of the costs and benefits, and the identification of funding sources can be achieved with extensive stakeholder input, by expanding the source assessment, and by assessing the delivery mechanisms.

<p>STAKEHOLDER INPUT:</p> <ul style="list-style-type: none">• public meetings• focus groups• surveys• stream walks

A high level of effort requires public meetings (Section 5.1) and focus groups (Section 5.2) to address the needs of the TMDL IP. Surveys, along with stream walks, may also be helpful in identifying sources in the watershed. Appendix A provides

examples of surveys that were used for the TMDL IP in Muddy Creek, Dry River, Pleasant Run, and Lower Dry River watersheds in Rockingham County, Virginia.

The source assessment provided by the TMDL will most likely need to be expanded to address the complexity of the impairment and the watershed characteristics. Public information can be obtained from stakeholder input. Federal and state agency databases (EPA, USDA NRCS, DEQ, DCR, and local conservation districts) can provide land use information, as can stream walks and GIS analyses.

6.1.3.3 *Low or Intermediate Detail of TMDL Analysis;*

High Complexity Impairment and Watershed Characteristics

If the TMDL analysis was generated with a low or intermediate level of detail for an impairment of high complexity, a high level of effort is needed to develop the IP. The assessment of needs, the assessment

of the costs and benefits, and the identification of funding sources can be achieved with extensive stakeholder input and by expanding the source assessments from the TMDL. In addition, assessment of delivery mechanisms and expanded monitoring is likely to be needed when a low detail TMDL analysis is provided.

The source assessments provided by the TMDL report need to be expanded to address the complexity of the impairment and the watershed characteristics. Public information can be obtained from stakeholder input, *e.g.*, public meetings (Section 5.1), focus groups (Section 5.2), surveys, and stream walks. Federal and state agency databases (EPA, USDA NRCS, DEQ, DCR, and local conservation districts) provide land use information, as can stream walks and GIS tools.

A source assessment includes identifying all of the sources within a watershed. For bacterial or sediment impairment, sources are typically separated into urban and rural components. For a nutrient impairment, atmospheric sources may also need to be considered. A source assessment for a general standard (benthic) impairment located in a mining area would include NPS from acid mine drainage (mine seeps) and runoff from abandoned mine lands. To expand the source assessment for a shellfish TMDL, a shoreline sanitary survey completed by the VDH, Bureau of Shellfish Sanitation, can be useful in identifying NPSs of pollutants. This survey includes a general description of the surveyed region as well as sewage pollution sources, non-sewage pollution sources, boating activity, and animal pollution within the surveyed area.

The development of an IP with only minimal monitoring and a highly complex impairment could be improved with expanded water quality monitoring. Water quality data will typically be needed at various points within the watershed on at least a bi-monthly basis. Monitoring sites should be chosen based on land use and hydrography to represent areas of comparable size, equally distributed sites throughout the watershed, and to isolate influences from pollutant sources (*e.g.*, human, wildlife, livestock, fertilizers).

6.1.3.4 Intermediate or High Detail of TMDL Analysis;

Low Complexity Impairment and Watershed Characteristics

For an impairment and watershed characteristics of low complexity with an intermediate or high level of detail involved in TMDL analysis; estimating the implementation actions needed, estimating the costs, and identifying funding sources can be achieved with stakeholder input because of efforts expended during the TMDL process to define sources and delivery mechanisms. This assessment can most likely be achieved through public meetings (Section 5.1).

6.1.3.5 Intermediate Detail of TMDL Analysis;

Intermediate Complexity Impairment and Watershed Characteristics

If the TMDL analysis was generated with an intermediate level of detail for an impairment of intermediate complexity, an intermediate level of effort is needed to develop the IP. The assessment of needs, the assessment of the costs and benefits, and the identification of funding sources can be achieved with moderate stakeholder input and by expanding the source assessment from the TMDL report.

In this case, public meetings (Section 5.1), focus groups (Section 5.2) and stream walks are needed to address the needs of the TMDL IP. Sources and their delivery mechanisms need to be identified. Stream walks and GIS can be used to identify sources.

6.1.3.6 *High Detail of TMDL Analysis;*

Intermediate Complexity Impairment and Watershed Characteristics

If the TMDL analysis was generated with a high level of detail for an impairment of intermediate complexity, a low level of highly specialized effort is needed to develop the IP. The assessment of needs, the assessment of the costs and benefits, and the identification of funding sources can be achieved with minimal stakeholder input and by using the existing source assessment from the TMDL report.

6.1.3.7 *High Detail of TMDL Analysis;*

High Complexity Impairment and Watershed Characteristics

If the TMDL analysis was generated with a high level of detail for an impairment of high complexity, an intermediate level of effort is needed to develop the IP. The assessment of needs, the assessment of the costs and benefits, and the identification of funding sources can be achieved with stakeholder input from public meetings (Section 5.1), focus groups (Section 5.2), and stream walks; and by using the existing source assessment and the existing monitored data from the TMDL report.

6.1.4 Draft and Approved TMDL Reports and TMDL Implementation Plans

For more information on draft TMDLs, approved TMDLs, and TMDL IPs for the state of Virginia, visit <http://www.deq.state.va.us/tmdl/tmdlrpts.html>.

6.2 *Assessment of Implementation Action Needs*

6.2.1 Identifying Implementation Actions

Implementation actions will need to be assessed based on cost, availability of existing funds, reasonable assurance of implementation, and water quality impact projections. Implementation actions chosen should be practical, cost-effective, equitable (*i.e.*, dealing fairly with all problem areas), and based on the best science and research that is available. Implementation of the identified corrective actions should be administered in a timely manner to efficiently and economically improve problem areas through staged implementation.

The cost of installing and administering implementation actions can be determined through discussions with local contractors as well as with representatives from focus groups (Section 5.2), the local SWCD, NRCS, DCR, DEQ, VDH, VCE, the local government, the local Farm Bureau, and local industries. Implementation actions that can be promoted through existing programs should be identified; the availability of these existing programs can be determined through discussions with personnel from SWCD, NRCS, DCR, DEQ, and VDH. Implementation actions that are not currently supported by existing programs (and their potential funding sources) should also be identified.

The allocations determined during TMDL development largely dictate the actions that must be employed during implementation. For example, for a bacterial TMDL that indicates 100% reduction in direct deposit from livestock, some form of stream exclusion will be necessary (*i.e.*, fencing may be the obvious solution; however, the type of fencing, the distance from the stream bank, and the most appropriate management strategy for the fenced pasture are important, though possibly less obvious, factors).

Some Virginia cost-share programs require participants to follow the specifications established by NRCS. For instance, for the example given above, fencing must be installed 25 feet from the stream bank at a minimum. Five-strand non-electric, or 2-strand electric, fencing is recommended for excluding cattle from a stream; fencing for other types of livestock may require additional or reduced deterrents.

Once the appropriate implementation actions have been determined, the next step is to gather information on costs for the equipment, structures, installation, and assistance that are necessary for the successful implementation of those actions. Unit costs for implementation actions can be determined through information from local contractors, focus group members, and local SWCD representatives. In addition, DCR maintains a database of costs related to corrective measures for pollutants related to agricultural practices (the Agricultural BMP Database.) Information from these sources should be gathered, and the average unit cost should be established. It may also be desirable to project the lowest estimated cost and the highest estimated cost for each necessary item to provide a range of expected costs.

Once the average unit cost is established, the number of total units that are needed must be multiplied by that cost. For example, if a stream segment needs 1000 feet of fencing as an implementation action, the 1000 feet must be multiplied by the average cost per foot of fencing to determine the cost of the implementation action. It is important to consider and add in any additional costs associated with the implementation of the corrective actions, as well as technical or administrative support and maintenance costs. For instance, in keeping with the example given above, while streamside fencing will effectively exclude livestock from the stream, this solution will also necessitate an alternative water source (*e.g.*, wells, spring developments, pumped stream water, or public water.)

It is important to consider future TMDL needs for the watershed when establishing an IP. For example, the first TMDL IPs in Virginia (which included the Muddy Creek, Dry River, Pleasant Run, and Lower Dry River watersheds in Rockingham County; Blackwater River watersheds in Franklin County; and Cedar, Hall/Byers, and Hutton Creek watersheds in Washington County) were developed for bacterial TMDLs. However, implementation practices recommended to reduce bacteria loadings could reduce other pollutants (*e.g.*, sediment and nutrients) addressed in future TMDLs. It is important to remember that a thorough implementation of a well-thought out plan will result in desired improvements to water quality.

Very often, there are ongoing costs associated with technical and administrative assistance, and these need to be carefully considered in order to come up with a reasonable cost estimate for the implementation. The SWCD, DCR staff, and members of focus groups (Section 5.2), can work together in determining reasonable figures for the number of man-hours needed for technical and administrative assistance, as well as the resulting costs for salary, benefits, travel, and training.

Tables 6.1 – 6.5 specify some of the BMPs that are effective in improving water quality, grouped according to impairment source. Appendix B provides descriptions of these BMPs.

**Table 6.1 BMPs applicable to bacteria
(for descriptions of these BMPs, please refer to Appendix B)**

BACTERIA

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE			EFFICIENCY	AVG COST	UNIT	NOTES
	AGRICULTURE	MINING	URBAN				
Animal waste management				75 %			
Artificial wetland/rock reed microbial filter							
Compost facility					\$5.00	cu. ft. storage	
Conservation landscaping							
Detention ponds/basins				25 %			
Diversions/earthen embankments					\$2.21	lin. ft.	
Drip irrigation							
Fencing				75 %	\$1.78	lin. ft.	does not include cost of charger & gates
Filtration (e.g., sand filters)				30 %			
Infiltration basin				50 %			
Infiltration trench				50 %			
Irrigation water management							
Lagoon pump out							
Land-use conversion							
Limit livestock access							
Litter control							
Livestock water crossing facility				100 %	\$27.40	lin. ft.	reduction in direct deposition

BACTERIA

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE			EFFICIENCY	AVG COST	UNIT	NOTES
	AGRICULTURE	MINING	URBAN				
Manufactured BMP systems							
Onsite treatment system installation							
Porous pavement				50 %			
Proper site selection for animal feeding facility							
Rain garden /bioretention basin				40 %			
Range and pasture management				50 %			
Retention ponds/basins				32 %			
Riparian buffer zones				43 – 57 %	\$547.00	acre	forested buffer w/o incentive payment
Septic system pump-out				5 %			
Sewer line maintenance (e.g., sewer line flushing)							
Stream bank protection and stabilization (e.g., riprap, gabions)				40 - 75 %	\$47.00	lin. ft.	40 % w/o fencing; 75 % w. fencing
Terraces					\$1.70	lin. ft.	
Vegetated filter strip					\$99.00	acre	
Waste system/storage (e.g., lagoons, litter shed)				80 – 100 %	\$27,272	system	
Water treatment (e.g., disinfection, flocculation, carbon filter system)							
Wetland development/enhancement				30 %	\$859.00	acre	includes creation and restoration

Sources: BMP Efficiencies Chesapeake Bay Watershed Model (Phase IV) August 1999; Draft FC and Nitrate TMDL IP for Dry River (2001); EPA (1998); EPA (1999b); Novotny (1994); Storm Water Best Management Practice Categories and Pollutant Removal Efficiencies (2003); USDA (2003); DCR (1999); DEQ/DCR (2001).

Table 6.2 BMPs applicable to metals
(for descriptions of these BMPs, please refer to Appendix B)

METALS

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE		EFFICIENCY	AVG COST	UNIT	NOTES
	MINING	URBAN				
Artificial wetland/rock reed microbial filter						
Avoid adding materials containing trace metals						
Conservation landscaping						
Detention ponds/basins						
Diversions/earthen embankments				\$2.21	lin. ft.	
Filtration (e.g., sand filters)						
Green rooftops						
Integrated pest management						
Land-use conversion						
Litter control						
Manufactured BMP systems						
Rain garden /bioretention basin						
Re-mining						
Retention ponds/basins						
Street sweeping						
Water treatment (e.g., disinfection, flocculation, carbon filter system)						

Sources: EPA (1999b); Novotny (1994); USDA (2003); DCR (1999); DEQ/DCR (2001).

Table 6.3 BMPs applicable to nutrients
(for descriptions of these BMPs, please refer to Appendix B)

NUTRIENTS*

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE			EFFICIENCY	AVG COST	UNIT	NOTES
	AGRICULTURE	MINING	URBAN				
Animal waste management				75%			
Compost facility					\$5.00	cu. ft. storage	
Conservation landscaping							
Conservation tillage							
Contour farming					\$5.00	acre	
Cover crops and rotations				15 – 35%			
Critical area planting					\$998.00	acre	
Crop rotations							
Crop/plant variety selection							
Detention ponds/basins				5 - 10%			
Diversions/earthen embankments					\$2.21	lin. ft.	
Drip irrigation							
Fencing				75%	\$1.78	lin. ft.	does not include cost of charger & gates
Field borders					\$100.00	acre	
Grassed waterways/swales				40-60%	\$1,875	acre	
Infiltration basin				50-70%			
Infiltration trench				50-70%			
Irrigation water management							

NUTRIENTS*

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE			EFFICIENCY	AVG COST	UNIT	NOTES
	AGRICULTURE	MINING	URBAN				
Lagoon pump out							
Land-use conversion							
Limit livestock access							
Litter control							
Livestock water crossing facility					\$27.00	lin. ft.	
Manufactured BMP systems							
Nutrient management				13 – 25 %	\$73.00	acre	
Onsite treatment system installation							
Porous pavement				50 – 70 %			
Proper site selection for animal feeding facility							
Rain garden/bioretention basin				40 – 60 %			
Range and pasture management				25 – 50 %			
Retention ponds/basins				30 – 50 %			
Riparian buffer zones				57 – 70 %	\$547.00	acre	forested buffer w/o incentive payment
Roof down-spout system					\$3.42	lin. ft.	
Septic system pump-out				5%			
Stream bank protection and stabilization (e.g., riprap, gabions)				40 – 75 %	\$47.00	lin. ft.	40% w/o fencing; 75% w/ fencing
Strip cropping							
Terraces					\$1.70	lin. ft.	

NUTRIENTS*

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE			EFFICIENCY	AVG COST	UNIT	NOTES
	AGRICULTURE	MINING	URBAN				
Vegetated filter strip					\$99.00	acre	
Waste system/storage (e.g., lagoons, litter shed)					\$27,272	system	
Water treatment (e.g., disinfection, flocculation, carbon filter system)							
Wetland development/enhancement				30 – 50 %	\$859.00	acre	includes creation & restoration

Sources: BMP Efficiencies Chesapeake Bay Watershed Model (Phase IV) August 1999; EPA (1998); EPA (1999b); Novotny (1994); Storm Water Best Management Practice Categories and Pollutant Removal Efficiencies (2003); USDA (2003); DCR (1999); DEQ/DCR (2001).

*Nutrients - No state water quality standards, potential stressors for benthic impairments.

Table 6.4 BMPs applicable to pH
 (for descriptions of these BMPs, please refer to Appendix B)

pH

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE	EFFICIENCY	AVG COST	UNIT	NOTES
	MINING				
Artificial wetland/rock reed microbial filter					
Avoid adding materials containing trace metals					
Conservation landscaping					
Land-use conversion					
Manufactured BMP systems					
Re-mining					
Water treatment (<i>e.g.</i> , disinfection, flocculation, carbon filter system)					
Wetland development/enhancement			\$858.00	acre	includes creation & restoration

Sources: Novotny (1994); USDA (2003); DCR (1999); DEQ/DCR (2001).

**Table 6.5 BMPs applicable to sediment
(for descriptions of these BMPs, please refer to Appendix B)**

SEDIMENT*

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE			EFFICIENCY	AVG COST	UNIT	NOTES
	AGRICULTURE	MINING	URBAN				
Conservation landscaping							
Conservation tillage							
Contour farming					\$5.00	acre	
Cover crops and rotations				15 %			
Critical area planting					\$998.00	acre	
Detention ponds/basins				10 %			
Diversions/earthen embankments					\$2.21	lin. ft.	
Drip irrigation							
Field borders					\$100.00	acre	
Grade stabilization (<i>e.g.</i> , chemical stabilization)							
Grassed waterways/swales				85 %	\$1,875	acre	
Infiltration basin				90 %			
Infiltration trench				90 %			
Land-use conversion							
Limit livestock access							
Livestock water crossing facility					\$27.40	lin. ft.	
Manufactured BMP systems							
Mulching/protective covers							
Rain garden /bioretention basin				85 %			
Retention ponds/basins				80 %			

SEDIMENT*

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE			EFFICIENCY	AVG COST	UNIT	NOTES
	AGRICULTURE	MINING	URBAN				
Riparian buffer zones				70 %	\$547.00	acre	forested buffer w/o incentive payment
Silt fencing							
Spillways: principal / emergency							
Stream bank protection and stabilization (<i>e.g.</i> , riprap, gabions)				40 - 75 %	\$47.00	lin. ft.	40% w/o fencing; 75 % w/ fencing
Street sweeping							
Strip cropping							
Terraces					\$1.70	lin. ft.	
Vegetated filter strip					\$99.00	acre	
Wetland development/enhancement				80 %	\$859.00	acre	includes creation & restoration

Sources: BMP Efficiencies Chesapeake Bay Watershed Model (Phase IV) August 1999; EPA (1998); EPA (1999b); Novotny (1994); Storm Water Best Management Practice Categories and Pollutant Removal Efficiencies (2003); USDA (2003); DCR (1999); DEQ/DCR (2001).

*Sediment - No state water quality standard, potential stressor for benthic impairment.

6.2.2 Quantifying Implementation Actions

An array of implementation actions is available for use during implementation, especially for land-based reductions. An implementation strategy outlining such items as practices stakeholders are most familiar with, anticipated level of public and private funding (*i.e.*, participation in cost-share program), and historical implementation in the particular watershed will enable the list of potential implementation actions to be reduced to a manageable level. Pollutant reductions associated with a combination of practices from this shortened list can then be evaluated. An implementation action could be different for practices that are funded through the State's cost-share program *vs.* private funds. Any practice installed through the use of cost-share programs must meet established specifications, usually resulting in a more complete system, whereas a stakeholder trying to minimize private costs would be inclined to install the minimum practice components that will achieve the implementation goals.

Steps needed to quantify implementation actions include:

- determine measurement unit(s) TMDL reductions will be based on (*e.g.*, length, system, acreage);
- quantify the measurement unit(s); and
- determine number of implementation actions based on each unit using information from implementation actions identification.

Measurement Units Determination

TMDL development methodology, required TMDL reductions, and available data are the key pieces of information used to decide the unit of measurement that TMDL reductions will be based on. Required reductions may be indicative of the level of modeling and source assessment during TMDL development and will affect the unit of measurement decision. Reductions may state that a source must be reduced by a defined amount without defining the pathway whereby the pollutant is reaching a stream (*e.g.*, runoff from a particular land use or ground water). The selection of the unit of measurement should be implicit when the reduction of impairment is linked to a particular pathway.

Unit Identification Should be Based On

- TMDL methodology
- TMDL reductions
- how TMDL reductions are stated
- available data



Review of available data to perform quantification analyses is necessary to determine the level of confidence that can be achieved. For example, if hydrography and land use data are not sufficient to estimate length of streamside fencing, an estimate of the number of livestock exclusion systems can be used based on the number of farmsteads in the watershed. Examination of historical data (*e.g.*, DCR's BMP Database) can lend insight into the unit of measurement that a practice has customarily been expressed in.

Measurement Unit Quantification

Possible methods to quantify the measurement units include estimates in the TMDL report, verbal communication with stakeholders, and/or spatial analyses. For instance, a stream walk during TMDL development may identify the

Unit Quantification Should be Based On

- the TMDL report
- stakeholder communication
- spatial analysis

number and location of straight pipes contributing bacteria to a stream. Another example is a TMDL allocation to eliminate previously identified mine seeps. Unit quantification may be achieved through verbal communication with stakeholders during IP development, assuming impairment complexity is low. Additional spatial analyses may be required if unit quantification cannot be determined using data from development of the TMDL or stakeholder input. Typical GIS data that is necessary in order to perform spatial analyses include: land use / land cover, stream network, soils, topography, utilities, property lines, farm tracts, easements, and building footprints.

Implementation Action Quantification

The number of units that represents an implementation action must be estimated, typically using historical data describing implementation actions that have been used in the area (utilizing sources such as DCR's BMP Database). The number of implementation actions is calculated by dividing the total units of measurement by the number of units per implementation action.

Implementation Action Quantification Should be Based On

- unit designation
- implementation strategy
- stakeholders' knowledge of practice
- databases

Quantification Examples

The following simplified examples are given to illustrate steps in the quantification process:

- 1) Bacteria reduction from livestock direct deposition;
- 2) Bacteria reduction from failed septic systems direct deposition; and
- 3) Phosphorous reduction from stormwater.

Quantification Example # 1: Direct deposition from livestock

Background

Fecal coliform TMDL
100% load reduction from cattle direct deposition

Requirements

Personnel: need GIS training, knowledge of agricultural operations
Software: GIS (e.g., ArcView), spreadsheet
Data Needs: land use, stream network, and farm tract GIS layers; Agricultural BMP Database

Measurement Units Determination

Cattle excluded from stream using fencing and hardened crossings
Measurement unit = length of streamside fencing and hardened crossing systems

Measurement Unit Quantification

Assume livestock will have occasional access to cropland (e.g., following the last cutting of hay for the season)

Spatial Analysis

Overlay stream network with land use to identify stream segments that flow through or adjacent to land use areas that have a potential for supporting cattle (e.g., pasture and cropland)



Sum fencing length for areas cows have access to one or both sides of stream
Overlay farm tract boundaries, land use, and stream network
Visually inspect results to determine number of stream crossings needed

Implementation Action Quantification

Summarize temporary fencing needed for cropland
Full livestock exclusion system needed on pastureland
Divide total streamside fencing length by average SL-6 streamside fencing length to calculate the total SL-6 systems needed
Agricultural BMP Database queried for average streamside fencing associated with SL-6 Grazing Land Protection Systems installed in area covered by Shenandoah Valley Soil and Water Conservation District (SVSWCD)
Divide total streamside fencing length by average SL-6 streamside fencing length to calculate the total SL-6 systems needed
Summarize hardened crossings needed from visual inspection

Quantification Example # 2: Direct deposition from failed septic systems

Background

Fecal coliform TMDL
100% load reduction from failed septic systems contributing directly to stream

Requirements

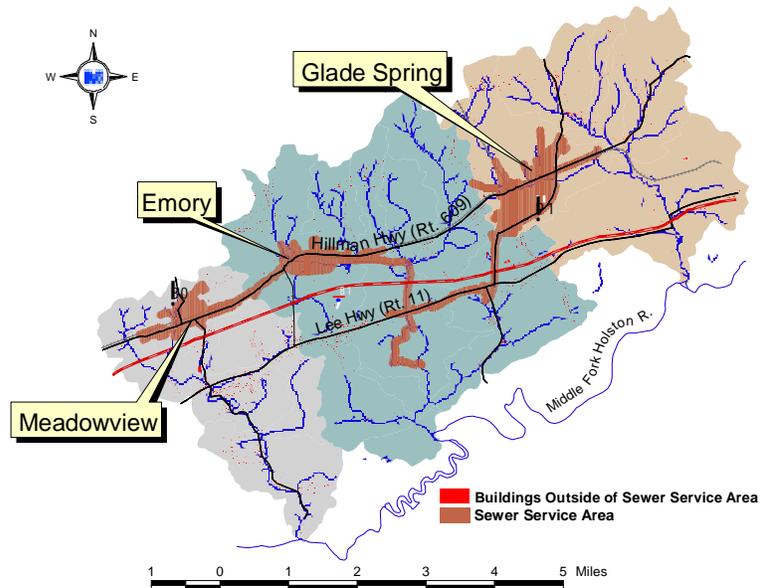
Personnel: need GIS training, knowledge of sewer treatment systems
Software: GIS (*e.g.*, ArcView), spreadsheet
Data Needs: stream network, sewer line, and building footprint GIS layers; sewer ordinance; septic system failure rate

Measurement Units Determination

Measurement unit = failing septic system

Measurement Unit Quantification

Sewer ordinance specifies houses 300' from sewer line must connect
Create 300' buffer around sewer line
Overlay buffer with building footprints to determine houses served by WWTP



Apply septic failure rate to remaining houses to determine total number of failing septic systems that cannot connect to sewer lines
Create 50' buffer around stream
Overlay 50' buffer and houses with failing systems to determine total failing systems contributing directly to stream

Implementation Action Quantification

Determine proportioning scheme for control measures (*e.g.*, based on high and low cost estimates of control measure solution)
Calculate number of pump-outs, new septic systems, and alternative treatment systems needed based on proportion scheme

Quantification Example # 3: Phosphorous reductions from stormwater

Background

Urban watershed
40% load reduction of phosphorous in stormwater

Requirements

Personnel: need GIS training, technically trained (*e.g.*, engineer)
Software: GIS (*e.g.*, ArcView), spreadsheet
Data Needs: zoning ordinances; stream flow; and stream network, soils, land use, topography, utilities, property lines, easements, structure, septic tank/drain field, and building footprint GIS layers

Measurement Units Determination

Measurement unit = retention basin system

Measurement Unit Quantification

Calculate area draining to all streams
Flag areas with a minimum of 15 acres of contributing watershed
Review land use and zoning ordinances for building site restrictions
Calculate buffers around existing site conditions imposing constraints on the location or construction of the basin such as:
 20' from any structure or property line
 100' from septic tank/drainfield
 50' from steep slope (*i.e.*, greater than 15%)
Overlay 15-acre contributing areas with buffers areas not appropriate for basin location, delete areas with overlap
Determine if soils for each site for appropriateness (*i.e.*, permeability, bedrock, Karst, embankment formation, *etc.*), delete areas not meeting criteria
 Review flow data to determine if baseflow is sufficient; delete areas not meeting criteria

Implementation Action Quantification

Visually inspect areas to determine total number of retention ponds that would be needed
Calculate impervious area for each drainage area to determine retention basin sizing
Divide total areas between three types of retention ponds based on sizing requirements

6.3 Assessment of Technical Assistance Needs

Sufficient technical assistance and education are keys to getting citizens involved in implementation. There must be a proactive approach by agencies to contact landowners in the impaired watershed(s) to articulate exactly what the TMDL process means to them and what will most practically get the job done. Several education/outreach techniques can be utilized during implementation. Articles describing the TMDL process, the reasons why there is a problem, the methods (*i.e.*, BMPs) through which the problem can be corrected, the assistance that is currently available for landowners to deal with the problem, and the potential ramifications of not dealing with the problem, should be made available through as many channels as possible (*e.g.*, newsletters and targeted mailings). Workshops and demonstrations can be organized to show landowners the extent of the problem, effectiveness of BMPs, and process involved in obtaining technical and financial assistance.

Agricultural

Historically, SWCDs and the NRCS have taken the lead for agricultural technical assistance in Virginia. The level of technical assistance that a full time equivalent (FTE) can be expected to provide during a year must be estimated using historical records or stakeholder assumptions. The Agricultural BMP Database can be utilized to quantify the number and type of agricultural control practices historically designed and implemented through the cost-share program by the local SWCD to estimate the average number of BMPs that an FTE can process in a year. If historical data is not available to determine FTE production, an estimate derived from focus group discussion will need to be utilized. Dividing the total implementation actions needed to be installed per year during implementation by the number of implementation actions that a FTE can process in a year will equal the number of FTE considered necessary for technical assistance during implementation. It is anticipated $\frac{3}{4}$ FTE will be dedicated to technical assistance on design and

installation of implementation actions and that the remaining ¼ FTE will be devoted to educational outreach. The same processes can be used to determine the number of administrative FTE to support the technical FTE per year.

The best forum for the agricultural community may be field days, pasture walks, and presentations offered through local farm groups. Emphasis should be placed on local farmers discussing their experiences with the cost-share programs, demonstrating the advantages of a BMP, and presenting monitoring results to demonstrate the problem. Farmers are more likely to be receptive to individualized discussions with local technical personnel or fellow farmers who have implemented the suggested BMPs than they will be to presentations made at a larger forum. The IP should describe the technical assistance and types of outreach actions identified for the watershed.

Potential technical assistance and educational outreach tasks associated with agricultural programs:

1. Make contacts with landowners in the watershed to make them aware of implementation goals and cost-share assistance programs.
2. Technical assistance for agricultural programs (*e.g.*, survey, design, layout, and approval of installation).
3. Handle and track cost-share.
4. Develop educational materials and programs, based on local needs.
5. Organize educational programs (*e.g.*, pasture walks, presentations at field days or grazing-club events).
6. Distribute educational materials (*e.g.*, informational articles in FSA or Farm Bureau newsletters, local media, *etc.*).
7. Assess and track progress toward BMP implementation goals.
8. Follow-up contact with landowners who have installed BMPs.
9. Coordinate use of existing agricultural programs and suggest modifications where necessary. Include costs for ongoing maintenance and technical assistance.

Residential

The VDH has been the primary organization for managing residential programs. However, depending on the extent of reductions needed, the VDH may not have resources to fully commit to implementation. In previous TMDL implementation projects, the local SWCD has taken the lead (with VDH consultation) on implementing residential implementation actions. Additional technical assistance may be provided through a homeowner's association. Historical work records for an agency/group can be utilized to determine the level of technical assistance that a full time equivalent (FTE) can be expected to provide during a year. If historical data is not available to determine FTE production, an estimate derived from focus group discussion will need to be utilized. Dividing the total implementation actions needed to be installed per year during implementation by the number of implementation actions that a FTE can process in a year will equal the number of FTE considered necessary for technical assistance during implementation. It is anticipated ¾ FTE will be dedicated to technical assistance on design and installation of implementation actions and that the remaining ¼ FTE will be devoted to educational outreach. The same processes can be used to determine the number of administrative FTE to support the technical FTE per year.

Small community meetings (similar to the small workshops proposed for the agricultural community) could be the best forums for educating homeowners about environmental issues and management considerations (e.g., septic system maintenance and disposal of pet waste). Generally, homeowners are unaware of the need for regular septic system maintenance. Notices using all media outlets should be posted regarding septic systems (e.g., a reminder to pump-out septic tank every three to five years). An educational packet can be included about septic system issues for new homeowners. Additionally, educational tools, such as a model septic system that can be used to demonstrate functioning and failing septic systems, and video of septic maintenance and repair will be useful in communicating the problem and needs to the public. The IP should describe the technical assistance and types of outreach actions identified for the watershed.

Potential technical assistance and educational outreach tasks associated with residential programs:

1. Identify failing septic systems and straight-pipes (e.g., stream walks, analysis of aerial photos, monitoring) and report to VDH.
2. Track septic system repairs/ replacements / installations.
3. Handle and track cost-share.
4. Develop educational materials and programs.
5. Organize educational programs (e.g., demonstration on septic pump-outs).
6. Distribute educational materials (e.g., informational pamphlets on TMDLs, and on-site sewage disposal systems).
7. Assess progress toward implementation goals.
8. Follow-up contact with landowners who have participated in the program(s).

6.4 Estimating Costs / Benefits

6.4.1 Costs

An associated cost for each implementation action (excluding technical assistance) is determined during implementation action identification (Section 6.2.1) using historical data, estimates from contractors and builders, and estimates from stakeholders. Multiplying the implementation action cost by the total number of implementation actions, based on results from implementation action quantification (Section 6.2.2), defines the associated cost of materials and labor for each implementation action installation. Separation of costs associated with agricultural, residential, and industrial direct and land-based sources will aid in cost ranking evaluation.

An average cost estimate for each category can be made based on the combination of practices chosen for implementation. For example, high and low cost estimations to fix failed septic systems and replace straight pipes in an impaired segment should be based on the combination of drain-field maintenance, new septic systems, or alternative waste treatment system. The highest cost will be amassed by replacing all failed septic systems and straight pipes with an alternative waste treatment. Contrarily, fixing all failed septic systems with drain-field maintenance and replacing all straight pipes with new septic systems would result in the lowest cost.

Ongoing costs associated with technical and administrative assistance need to be carefully considered in order to come up with a reasonable cost estimate for implementation. The SWCD, DCR staff, and members of focus groups (Section 5.2) can work together in determining reasonable costs for salary, benefits, travel, training, and incidentals for education of technical and administrative staff. Multiplying

these costs with the number of technical and administrative FTE from quantification analysis will provide the agricultural, residential, and industrial technical assistance costs for implementation.

SUMMARY OF STEPS FOR CALCULATING PROJECT COSTS

1. Identify/quantify the corrective actions that are needed
2. Research the unit costs
3. Multiply the unit cost by the number of units required
4. Include costs for ongoing maintenance and technical assistance

6.4.2 Benefits

The primary benefit of implementation is cleaner waters in Virginia, where pollution levels will be reduced to meet water quality standards. This is the primary benefit that should be recognized in the IP. However, the IP should point out that, in addition to and as a result of reducing the amount of specific pollutants, stakeholders can anticipate benefits within their watersheds which may include:

- improved public health,
- conservation of natural resources (*e.g.*, soil and soil nutrients),
- improved aquatic life,
- improved riparian habitat,
- reductions in the amount of flood damage,
- improved recreational opportunities, and
- greater economic opportunities (*e.g.*, improved agricultural production, reopening of shellfish beds, tourism, etc.).

An ancillary benefit is enhanced real estate values for farms, homes, and businesses located near water bodies with good water quality.

The majority of TMDLs being developed in Virginia are bacteria TMDLs. It is hard to gage the impact that reducing bacteria contamination will have on public health, as most cases of waterborne infection are not reported or are falsely attributed to other sources. However, the incidence of infection from pollutant sources, through contact with surface waters, should be reduced considerably, and this should be noted.

TMDLs are pollutant-specific, and a separate TMDL must be developed for each pollutant in a water body that violates water quality standards. In cases where TMDLs have been developed for multiple pollutants for a given water body, the IP should be designed to address the multiple pollutants concurrently. That will allow multiple pollutant problems to be handled at the same time and a system of BMPs to be designed and installed that have added benefits. For example, livestock stream exclusion is used as an implementation action to reduce bacteria loadings to a stream. In fencing off the stream, restoration of the riparian area (typically 25 to 35 feet) through implementation of buffers (grasses and/or trees) also benefits the aquatic habitat and makes progress towards reaching the general water quality standard (benthic) for the same stream. The vegetated buffers that are established reduce sediment and nutrient transport to the stream from upslope locations. These have been identified as the major stressors to benthic aquatic communities in the benthic TMDLs completed in Virginia to date. Stream exclusion that may place the fence at the top of the stream bank would reduce the bacteria

loading, but without the riparian buffer, the additional benefit of reducing sediment and nutrient loadings from the upland would be lost.

On a larger scale, for watersheds located within the Chesapeake Bay watershed, reducing sediment and nutrients loads as a result of BMPs that are installed to improve benthic and bacteria water quality impairments will help obtain implementation goals in the Tributary Strategies.

The main objective of the IP is restoring water quality in our streams with additional benefits that may include continued economic vitality and strength. Healthy waters can improve economic opportunities for Virginians, and a healthy economic base can provide the resources and funding necessary to pursue restoration and enhancement activities. The agricultural, residential, urban, or mining implementation actions recommended in the IP will often provide economic benefits to the landowner, along with the expected environmental benefits. For example, exclusion of cattle from streams leads to the development of alternative (clean) water sources. This provides an opportunity for intensive pasture management and improved nutrient management. Further details on these benefits can be found in existing TMDL IPs which include the Muddy Creek, Dry River, Pleasant Run, and Lower Dry River watersheds in Rockingham County; Blackwater River watersheds in Franklin County; and Cedar, Hall/Byers, and Hutton Creek watersheds in Washington County. Additionally, money spent by landowners, government agencies, and non-profit organizations in the process of implementing the IP will stimulate the local economy.

The residential programs will play an important role in improving water quality, since human waste can carry with it human viruses in addition to the bacterial and protozoan pathogens that all fecal matter can potentially carry. In terms of economic benefits to homeowners, an improved understanding of private sewage systems, including knowledge of what steps can be taken to keep them functioning properly and the need for regular maintenance, will give homeowners the tools needed for extending the life of their systems and reducing the overall cost of ownership. The average septic system will last 20-25 years if properly maintained. Proper maintenance includes; knowing the location of the system components and protecting them by not driving or parking on top of them, not planting trees where roots could damage the system, keeping hazardous chemicals out of the system, and pumping out the septic tank every three to five years. The cost of proper maintenance, as outlined here, is relatively inexpensive in comparison to repairing or replacing an entire system.

Cleaner waters in Virginia will result in improved public health, conservation of natural resources, improved aquatic habitat, and greater economic opportunities for Virginians. These benefits add up to a better quality of life in the Commonwealth of Virginia; the recognition of these effects and their applicability in watersheds will help to ensure a successful implementation.