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 efforts[1]. 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

managers[2]. 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 bacteria[4] 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_beaverdam_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_range.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 counts[6] (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 region[7]. 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 partners[8], 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 Fund[11] (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 streamback 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 citizens[13] (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 programs[14] (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 Program[15] 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 goals[16]. 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 website[17]. 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 models[18]. 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 watershed[19]. 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 receptables, 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" brochure[20]. 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 Virginia[21]. 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.