Mill and Hawksbill Creek TMDL Implementation Plan:

A Plan to Reduce Bacteria in the Mill and Hawksbill Creek Watersheds

Prepared for:
Virginia Department of Conservation and Recreation

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Submitted by:
MapTech, Inc.,
3154 State Street,
Blacksburg, VA 24060

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Introduction

The Federal Clean Water Act (CWA) that became law in 1972 requires that all U.S. streams, rivers, and lakes meet certain water quality standards. The CWA also requires that states conduct monitoring to identify polluted waters or those that do not meet standards. Through this required program, the state of Virginia has found that many stream segments do not meet state water quality standards for protection of the five beneficial uses: fishing, swimming, shellfish, aquatic life (benthic), and drinking.

When a stream fails to meet the standards, it is listed as impaired on the CWA's Section 303(d) list. Hawksbill Creek (VAV-B39R-02) was listed as impaired on Virginia's *1998 303(d) Total Maximum Daily Load Priority List and Report* (DEQ, 1998) due to violations of the State's water quality standards for fecal coliform. This standard was changed to *E. coli* in 2003 because there is stronger correlation between concentrations of *E. coli* bacteria and incidence of gastrointestinal illness than there is with fecal colifrom. The impaired segment of Hawksbill Creek began at the confluence with Chub Run and continued downstream to the confluence with the South Fork Shenandoah River (9.40 miles). In the 2004 *Total Maximum Daily Load Priority List and Report* the segment was modified to include the area between the East Hawksbill Creek confluence upstream to its headwaters (12.26 miles). In the 2006 305(b)/303(d) Water Quality Assessment Integrated Report Hawksbill Creek was listed as impaired from its headwaters downstream to its confluence with the South Fork Shenandoah River (19.3 miles). The modified listing was based on violations of the new *E. coli* water quality standard. (Figure1)

Mill Creek (VAV-B38R-01) was listed as impaired on Virginia's *1998 303(d) Total Maximum Daily Load Priority List and Report* (DEQ, 1998) due to violations of the State's water quality standards for fecal coliform (the standard was changed to *E. coli* in 2003). The impaired segment includes Mill Creek from the headwaters to the confluence with the South Fork Shenandoah River (6.78 miles). The impairment listing remained on subsequent reports in 2002, 2004 and 2006. (Figure 1)

Hawksbill Creek and Mill Creek are part of the Shenandoah River Basin. The Mill Creek and Hawksbill Creek watersheds are located within USGS hydrologic unit code 02070005. The Mill Creek

watershed is approximately 8,178 acres. The Hawksbill Creek watershed is approximately 56,951 acres.

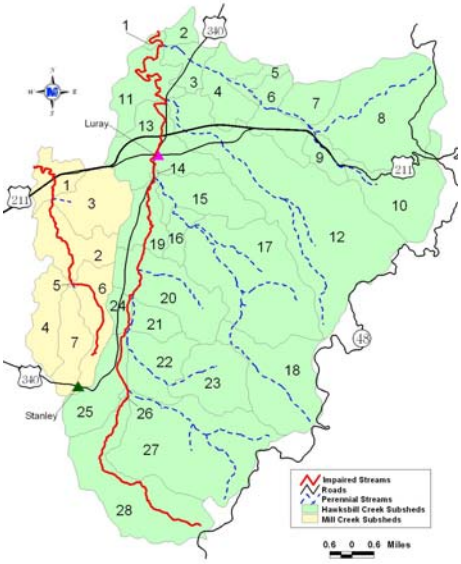

Figure 1. The impaired segments of Hawksbill Creek and Mill Creek.

The CWA and the U.S. Environmental Protection Agency (EPA) (40 CFR Part 130) both require that states develop a Total Maximum Daily Load (TMDL) for each pollutant. A TMDL is a "pollution budget" for a stream. That is, it sets limits on the amount of pollution that a stream can tolerate and still maintain water quality standards. A TMDL accounts for seasonal variations and must include a margin of safety (MOS). The TMDL process includes 3 different steps after a stream is listed on the impaired waters or 303(d) list. The first step is to conduct a TMDL study. The TMDL study results are explained in the Review of the TMDL Development Study section of this booklet.

Once a TMDL is developed and approved by the EPA and the State Water Control Board (SWCB), measures must be taken to reduce pollution levels in the stream. The second step in the process is the development of an Implementation Plan (IP), which has now been completed for the Mill and Hawksbill Creek watersheds. This plan outlines how the TMDL goals can be accomplished in the watersheds (drainage areas) with the impaired streams. The IP describes control

measures, which can include the use of better treatment technology and the installation of best management practices (BMPs), to be implemented in a staged process. This booklet summarizes the IP for the *E. coli* impairment in Hawksbill Creek and Mill Creek.

In fulfilling the state's requirement for the development of an Implementation Plan, a framework has been established for reducing *E. coli* levels, and achieving the water quality goals for the Hawksbill Creek and Mill Creek impaired segments. With successful completion of the IP, we continue on to the third step in the TMDL process to meet these water quality goals, which is implementation of the plan. Approval of the IP will increase the opportunities for funding during implementation, and will provide residents of the Mill and Hawksbill watersheds with a guide to improve water quality in their community and enhance their natural resources. The implementation of this plan will reduce levels of bacteria in Mill and Hawksbill Creek and their tributaries. The benefits of the implementation of this plan are described in detail in the Cost/Benefit Analysis chapter of this document. In short, the implementation of this plan may provide benefits to homeowners and farmers, as well as those that wish to swim in these creeks.

This booklet is an abbreviated version of the full IP report, which can be obtained by contacting the Virginia Department of Environmental Quality (DEQ) or the Virginia Department of Conservation and Recreation (DCR) offices. Agency contact information can be found on the back of this pamphlet.

Key components of the implementation plan are discussed in the following sections:

- Review of the TMDL Development Study
- Process for Public Participation
- Assessment of Needs
- Implementation, and
- Cost/Benefit Analysis

Review of the TMDL Development Study

Hawksbill Creek and Mill Creek watersheds are located in Page County, Virginia. Additionally, Hawksbill Creek runs through the Town of Luray. The Department of Biological Systems Engineering at Virginia Tech was contracted to develop the *E. coli* bacteria TMDL for Mill Creek. George Mason University and Tetra Tech, Inc. prepared

the *E. coli* TMDL for Hawksbill Creek. These TMDLs were approved in 2004 and 2005 respectively by the USEPA and are posted at www.deq.virginia.gov. The first step in developing the implementation plan was to review these TMDL studies. The results of the TMDL studies were used to determine the water quality goals and associated pollutant reductions that would need to be addressed in the implementation plan.

In addition to performing analyses of fecal bacteria and *E. coli* concentrations for the TMDL, a water quality analysis method called Bacteria Source Tracking (BST) was performed on water samples from both Mill and Hawksbill Creeks. BST is intended to aid in identifying the sources of fecal contamination in water bodies (*i.e.*, human, pets, livestock, or wildlife). The BST results provided insight into the likely sources of fecal contamination and the distribution of fecal bacteria in the creeks. Having this information will improve the chances for success in implementing solutions by allowing better targeting of the sources of bacteria in the watersheds. Figures 2 and 3 show the load weighted average BST results for Mill Creek and Hawksbill Creek respectively. These averages were calculated from the 12 monthly samples collected during TMDL development. The weighting process favors the values that are associated with highest *E. coli* concentrations because those concentrations often exceed the water quality standard and it is more important to know what the dominant sources of bacteria are when *E. coli* exceeds the water quality standard. A summary of the final *E. coli* allocations for the different sources in the watersheds that resulted from the TMDL study is given in Table 1. The correction of straight pipes and failing septic systems is a requirement of the *E. coli* TMDL. In addition, the majority of livestock in both watersheds will need to be excluded from the creeks. Runoff carrying *E. coli* into the creeks after rain events must also be addressed. Reductions to wildlife fecal bacteria will not be addressed in this project. Rather, the objective of this plan will be to address those sources of bacteria that can be attributed to human activities including land use and natural resource management.

These TMDL studies were conducted because Hawksbill and Mill Creeks were not meeting state water quality standards for the recreation use (swimming). In order to meet the water quality goals established by the TMDL studies, any water sample from the stream must be equal to or less than 235 colony forming units per 100 milliliters (cfu/100mL) at all times. Over all the samples collected within a 30 day period, the geometric mean of this data must be equal or less than 126 cfu/100mL.

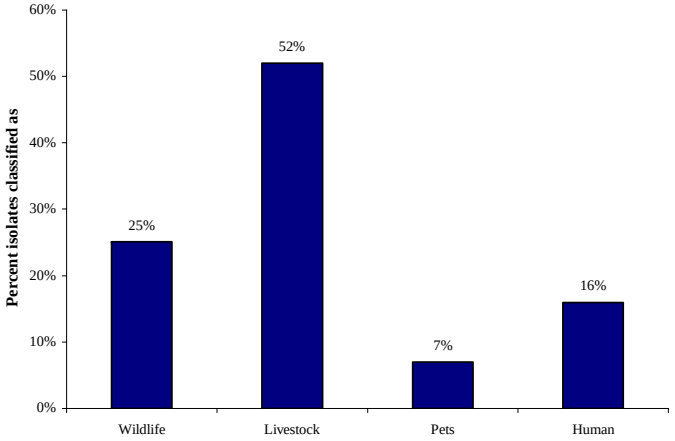

Figure 2. Load weighted averages for fecal coliform concentrations and fecal sources conducted by DEQ during development of the TMDL for Mill Creek at station 1BMLC000.40.

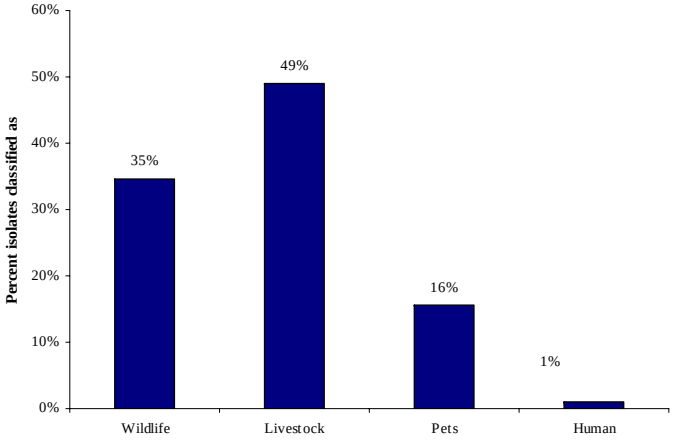

Figure 3. Load weighted averages for fecal coliform concentrations and fecal sources conducted by DEQ during development of the TMDL for Hawksbill Creek at station 1BHKS000.96.

Table 1. Bacteria load reductions allocated in TMDLs for Mill Creek and Hawksbill Creek.

Impairment	Failed Septic Systems and Straight Pipes	Direct Livestock Access to Stream	Nonpoint Sources	Direct Wildlife Access to Stream
Mill Creek	100%	100%	100%*	0%
Hawksbill Creek	100%	97%	97%	0%

* A 40% reduction is required from forest lands which are primarily inhabited by wildlife.

Process for Public Participation

The actions and commitments described in this document are drawn together through input from citizens of the watershed, county government, the Page County Water Quality Advisory Committee, DEQ, DCR, Virginia Department of Health (VDH), Virginia Cooperative Extension (VCE), the Natural Resources Conservation Service (NRCS), Virginia Department of Forestry (DOF), Shenandoah Valley Soil and Water Conservation District (SVSWCD), and MapTech, Inc. Every citizen and interested party in the watershed area is encouraged to become involved in the implementation process and contribute in any way that helps in restoring the health of the streams.

Public participation took place on three levels. First, open meetings were held to inform the public of the end goals and status of the project. Second, specialized working groups were assembled to discuss specific implementation strategies for different sources of bacteria in the watersheds. The working groups included: residential/urban, agricultural and government. Third, a Steering Committee was formed with representation from DEQ, DCR, VDH, SVSWCD, DOF, the Page County Water Quality Advisory Committee, and representatives from the working groups.

Assessment of Needs: Recommended Actions

Agricultural BMPs

Streamside fencing is one of the best ways to reduce bacteria levels in the stream. This will remove direct livestock defecation in the stream and prevent the trampling of the stream banks. The quantity of streamside fencing needed was determined through spatial analyses of land uses, the stream network, and archived data. Additionally, input

from local agency representatives and citizens were used to verify the analyses.

The length of fencing required on perennial streams in the Mill and Hawksbill Creek watersheds is approximately 30,752 and 108,076 feet, respectively. In order to accomplish these goals, the state cost-share program for agricultural best management practices (BMPs) was utilized in the implementation plan. The total fencing needed was divided up among the different BMPs offered through the state cost-share program that included a fencing component. There are 10 Grazing Land Protection Systems (SL-6) and one Stream Protection System (WP-2T) needed to meet the livestock exclusion goal for Mill Creek. Thirty four Grazing Land Protection Systems (SL-6) and five Stream Protection System (WP-2T) are needed for Hawksbill Creek. Both the Grazing Land and Stream Protection practices include a 35-ft buffer component. These vegetated or forested buffers will provide an additional water quality benefit by trapping bacteria moving towards the streams through runoff. Therefore, these practices will provide some of the best water quality benefits in terms of reducing both direct (cows defecating in the stream) and land- based (runoff of manure into the stream during rain events) contributions of bacteria to the stream.

The agricultural working group determined that the fencing practices offered through the state cost-share program would not be practical in all cases in the watershed. In particular, areas where flooding occurs frequently, or areas where a 35-ft buffer is not possible were identified as problematic. The working group decided to include polywire fencing (no cost-share) in the implementation plan in order to fully meet the fencing needs. This type of fencing could be replaced easily

should flooding wash it out. In addition, since cost-share would not be available for landowners who installed this type of fencing, a 35-ft buffer would not be required. A total of five polywire fencing systems are needed to meet the livestock exclusion goal for Mill Creek, while 19 are needed in Hawksbill Creek.

Due to the large reductions needed on land-based loads of *E. coli* bacteria, additional BMPs for pasture and cropland are also needed. Estimates of all agricultural BMPs needed for Stage I, the first five years (de-listing from the 303(d) list) in the watershed are listed in Table 2. Impaired stream segments can be de-listed or removed from the 303(d) list when their bacterial violation percentage is less than 10.5%.

Table 2. Agricultural land based reduction BMPs required for delisting.

Control Measure	Unit	Mill Creek	Hawksbill Creek	Total
Improved Pasture Management	Acre	3,940	10,809	14,749
Poultry Waste Storage Facilities/ Composting Bins	System	1	7	8
Manure Incorporation	Acre	0	838	838
Vegetated Buffers – Cropland	Acres	0	9	9

Residential BMPs

All failing septic systems and straight pipes must be identified and replaced during implementation since a 100% load reduction from direct and nonpoint source (NPS) human waste is required to meet the TMDL goals. In addition, straight pipes are illegal in the Commonwealth of Virginia. The estimated numbers of straight pipes and failing septic systems were reported in the TMDL studies and are shown in Table 3.

Table 3. Estimated residential waste treatment systems in the Mill and Hawksbill Creek watersheds.

Watershed	Houses with Standard Septic Systems	Potential Failing Septic Systems	Potential Straight Pipes
Mill Creek	242	51	6
Hawksbill Creek	2,329	92	12

The Mill Creek and Hawksbill Creek TMDLs call for large reductions to land-based residential loads. In order to achieve these reductions, the BMPs in Table 4 must be implemented. The Pet Waste Program shown in the table includes distributing information on how pet waste should be disposed of, and installing pet waste stations at public parks like what is currently in place along the Hawksbill Greenway. An additional Pet Waste Composter program is also proposed to help eliminate pet waste in homeowner's yards instead of just in public places. The program includes the distribution of pet waste composters to households in the watersheds with pets. This could be accomplished through partnerships with local stores selling pet food, the Page County Animal Shelter and the SPCA.

In order to encourage homeowners to properly maintain their septic systems, a septic tank pumpout program will be initiated. Information on septic system maintenance will be distributed in the watershed, encouraging homeowners to pump their septic tank out every 3-5 years. Additionally, financial assistance will be provided through cost-share for homeowners to pump out their septic tanks. While there are not sufficient funds to assist every homeowner in the watersheds with a pumpout, it is expected that this program will raise local awareness and lead homeowners to assume responsibility for maintaining their systems. In turn, this will help to prevent septic system failures in the future.

Table 4. All residential and urban BMPs recommended to meet the delisting requirement for the Mill Creek and Hawksbill Creek impairments.

Residential Control Measure Description	VA Cost-Share Practice Number	Mill Creek	Hawksbill Creek	Total
Septic Systems Pump-out Program	RB-1	160	776	936
Failing Septic System Corrections:				
Septic System Repair	RB-3	20	37	57
Septic System Installation/ Replacement	RB-4	16	41	57
Alternative Waste Treatment System Installation	RB-5	15	14	29
Straight Pipe Corrections:				
Septic System Installation	RB-4	3	3	6
Alternative Waste Treatment System Installation	RB-5	3	9	12
Residential Pet Waste Education Program	NA	1	1	2
Residential Pet Waste Composter	NA	485	1,095	1,580
Vegetated Buffers	NA	2	10	12

Technical Assistance

Technical assistance needed for the project was measured in full time equivalents (FTEs), with 1 FTE being equal to one full time position. 2 FTEs are needed per year during the first 5 years of the implementation period of this project. It is estimated that only 1 FTE will be needed in the last 10 years of the project. The SVSWCD will be in charge of the technical assistance during the implementation of these BMPs and will administer cost-share for BMP implementation.

Implementation

Costs

Potential funding sources available during implementation were identified during plan development. Detailed descriptions can be obtained from the SVSWCD, DCR, NRCS, and VCE. Sources include:

- Federal Clean Water Act 319 Incremental Funds
- Virginia Agricultural Best Management Practices Cost-Share Program
- Virginia Agricultural Best Management Practices Tax Credit Program
- Virginia Agricultural Best Management Practices Loan Program
- Virginia Small Business Environmental Assistance Fund Loan Program
- Virginia Water Quality Improvement Fund
- Community Development Block Grant Program
- Conservation Reserve Program (CRP)
- Conservation Reserve Enhancement Program (CREP)
- Environmental Quality Incentives Program (EQIP)
- Wildlife Habitat Incentive Program (WHIP)
- Wetland Reserve Program (WRP)
- Clean Water State Revolving Fund

Timeline and Milestones

The end goals of implementation are restored water quality of Hawksbill and Mill Creeks and the removal of these streams from Virginia's Section 305(b)/303(d) list. Progress toward end goals will be assessed during implementation through tracking of BMP installations and continued water quality monitoring.

Expected progress in implementation is established with two types of milestones: *implementation milestones* and *water quality milestones*. Implementation milestones establish the amount of BMPs installed each year, while water quality milestones establish the corresponding improvements in water quality that can be expected. The milestones described here are intended to achieve full implementation within 15 years. Timelines with pollutant reductions expected are shown in Figures 4 and 5.

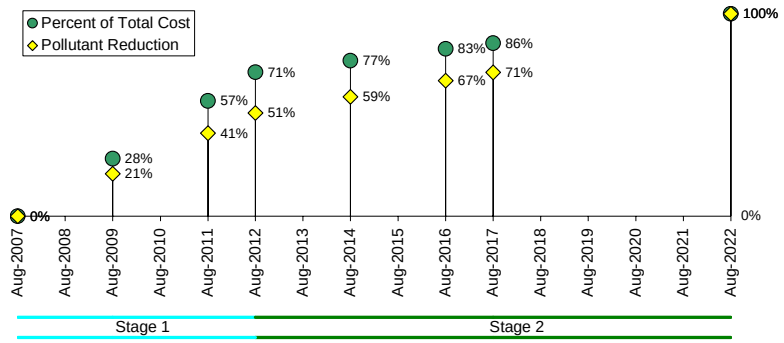

Figure 4. Timeline for implementation in the Mill Creek watershed.

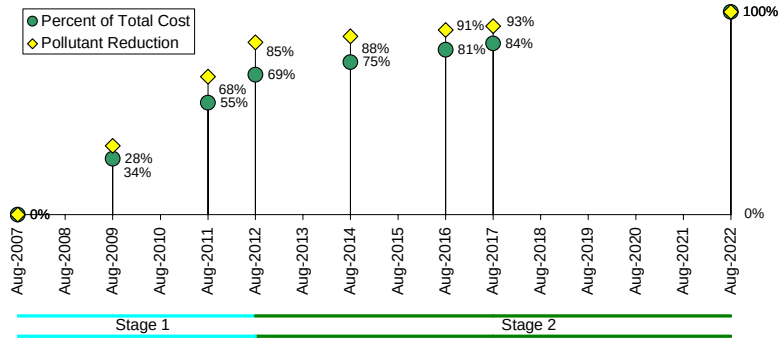

Figure 5. Timeline for implementation in the Hawksbill Creek watershed.

Following the idea of a staged implementation approach, resources and finances will be concentrated on the most cost-efficient control measures first. These measures will be the focus of Stage I. Following Stage I implementation, the Steering Committee should evaluate water quality improvements and determine how to proceed to complete implementation during Stage II. Stage II documents BMPs that are necessary for the stream to fully comply with the TMDL allocation requirements. The Department of Environmental Quality's *E. coli* bacterial standard states that there can be no exceedances of either the geometric mean (126 cfu/100 ml) or the instantaneous (235 cfu/100 ml) values. Complying with the standard requires BMPs that are more costly and difficult to implement.

Tables 5 and 6 show the types and quantities of BMPs to be installed for each impairment during each stage. It is anticipated that the de-listing of the impaired segments from the Section 303(d) list will occur by 2012.

Targeting

The Mill Creek watershed was divided into 7 subwatersheds while the Hawksbill Creek watershed was divided into 28 subwatersheds (Figure 6). Targeting of critical areas for livestock fencing was accomplished through analysis of livestock population and the fencing requirements for each subwatershed. The subwatersheds were ranked in descending order based on the ratio of animals per fence length. If feasible, effort should be made to prioritize resources in the following order of subwatersheds.

The Page County Water Quality Advisory Committee, a local group established by the County Board of Supervisors, is currently planning to develop a subwatershed plan for the Mill Creek watershed. While this subwatershed plan will be more detailed than the implementation plan, and will address larger land use issues within the watershed, it will provide support for the implementation plan through the collection of additional information about the watershed that will allow for better targeting of implementation efforts. In addition, it is expected that the implementation plan may serve as a tool in the development of the subwatershed plan by providing information on watershed characteristics and actions that may be taken to improve water quality.

Table 5. Stage I and Stage II implementation goals for Mill Creek.

Control Measure	Unit	Stage I	Stage II
Agricultural			
Grazing Land Protection System (SL-6)	System	10	
Stream Protection System (WP-2T)	System	1	
Polywire Fencing (No Cost-share)	System	5	
Improved Pasture Management	Acres	3,940	85
Streamside Fence Maintenance	Feet	769	1,537
Waste Storage Facilities/ Composting Bins	System	1	
Retention Ponds - Pasture	Acres		2,520
Residential			
Septic Systems Pump-out Program (RB-1)*	System	160	319
Septic System Repair (RB-3)	System	20	
Septic System Installation/Replacement (RB-4)	System	16	
Alternative Waste Treatment System Installation (RB-5)	System	15	
Urban			
Residential Pet Waste Program	Program	1	ongoing
Residential Pet Waste Compost Program	Composter	485	
Vegetated Buffers	Acres	2	

*Financial assistance for septic tank pumpouts in the watershed will be provided to homeowners in the form of cost-share; however, it is expected that some additional funding will be necessary should all homeowners in the watershed decide to participate in the program as shown in the table above.

Table 6. Stage I and Stage II implementation goals for Hawksbill Creek.

Control Measure	Unit	Stage I	Stage II
Agricultural			
Grazing Land Protection System (SL-6)	System	45	
Stream Protection System (WP-2T)	System	6	
Polywire Fencing (No Cost-share)	System	25	
Streamside Fence Maintenance	Feet	2,702	5,404
Waste Storage Facilities/ Composting Bins	System	7	
Manure Incorporation	Acres	838	
Improved Pasture Management	Acres	10,809	
Vegetated Buffers – Cropland	Acres	9	
Retention Ponds - Pasture	Acres		5,500
Residential			
Septic Systems Pump-out Program (RB-1)*	System	776	1,553
Septic System Repair (RB-3)	System	37	
Septic System Installation/Replacement (RB-4)	System	41	
Alternative Waste Treatment System Installation (RB-5)	System	14	
Residential Education Program	Program	1	
Urban			
Residential Pet Waste Program	Program	1	ongoing
Residential Pet Waste Compost Program	Composter	1,095	
Vegetated Buffers	Acres	10	

* It is not anticipated that sufficient state and federal cost-share dollars will be available to fully fund the septic tank pumpout program to the extent shown above. It is expected that it will be necessary to gain financial and technical support for the program from other private and public funding sources.

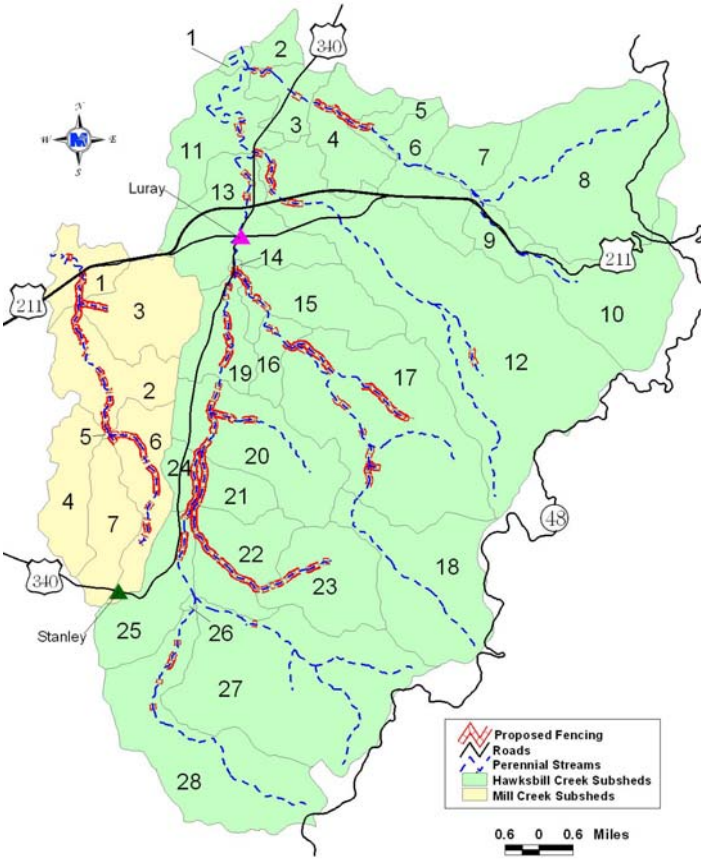

Figure 6. Subwatersheds, roads, perennial streams and area available for streamside fencing the Mill Creek and Hawksbill Creek watersheds.

Cost / Benefit Analysis

Associated cost estimates of agricultural, residential, and urban BMPs were calculated by multiplying the unit cost by the number of units in each watershed.

Tables 7 and 8 show the estimated cost of installing the recommended agricultural BMPs as $3.7 million. Agricultural BMP costs sum to $3.71 million, residential BMP costs sum to $2.1 million. Urban BMPs will cost a total of $90,670. The total cost for Stage I for both watersheds is $4.80 million.

It was determined by the SVSWCD and the Steering Committee that it would require $50,000 to support the salary, benefits, travel, training, and incidentals for education of one technical FTE. With quantification analysis yielding a need for two technical FTEs per year for the first five years of implementation and one FTE per year for the subsequent ten years, the maximum total cost to provide technical assistance during implementation is expected to be $1.0 million (Tables 7 and 8). Factoring in technical assistance costs, the total cost for full implementation in both watersheds comes to $6.9 million (Table 9).

The primary benefit of this implementation is cleaner waters in Page County, and the rest of Virginia. Specifically, fecal contamination in Hawksbill Creek and Mill Creek will be reduced to meet water quality standards and allow for safe swimming. It is difficult to gauge the impact that reducing fecal contamination will have on public health, as most cases of waterborne infection are not reported or are falsely attributed to other sources. However, because of the reductions required, the incidence of infection from fecal sources, through contact with surface waters, should be considerably reduced.

Additionally, because of streambank protection that will be provided through exclusion of livestock from streams, the aquatic habitat will be improved in these waters. The vegetated buffers that are established will also serve to reduce bacteria runoff to the stream from upslope locations. In addition, as trees and shrubs in vegetated buffers grow, they serve as excellent shade sources for streams. This in turn reduces water temperature in the stream and increases dissolved oxygen, thereby improving aquatic habitat for numerous aquatic organisms. In areas where pasture management is improved, less bacteria will be washed into streams following precipitation events. Bacteria concentrations in the stream should be at or below the state standards.

Table 7. Costs to implement Stage I (years 1 - 5) for Mill Creek and Hawksbill Creek.

Impairment	Agricultural BMPs ($)	Residential BMPs ($)	Urban BMPs ($)	Technical Assistance ($)	Total ($)
Mill Creek	$607,600	615,000	$28,570	$125,000	1,376,000
Hawksbill Creek	$1,920,000	$1,067,000	$62,100	$375,000	$3,424,000
Total	**$2,528,000**	**$1,682,000**	**$90,670**	**$500,000**	**$4,800,000**

Numbers are rounded to four significant digits.

Table 8. Costs to implement Stage II (years 6 - 15) for Mill Creek and Hawksbill Creek.

Impairment	Agricultural BMPs ($)	Residential BMPs ($)	Urban BMPs ($)	Technical Assistance ($)	Total ($)
Mill Creek	$362,200	$71,100	$0	$125,000	$558,300
Hawksbill Creek	$815,900	$349,400	$0	$375,000	$1,540,000
Total	**$1,178,000**	**$420,500**	**$0**	**$500,000**	**$2,098,000**

Numbers are rounded to four significant digits.

Table 9. Total cost for implementation in the Mill Creek and Hawksbill Creek watersheds.

Impairment	Agricultural BMPs ($)	Residential BMPs ($)	Urban BMPs ($)	Technical Assistance ($)	Total ($)
Mill Creek	$969,800	$685,700	$28,570	$250,000	$1,934,000
Hawksbill Creek	$2,736,000	$1,417,000	$62,100	$750,000	$4,965,000
Total	**$3,706,000**	**$2,103,000**	**$90,670**	**$1,000,000**	**$6,899,000**

Numbers are rounded to four significant digits.

A clean water source has been shown to improve herd health. Fresh clean water is the primary nutrient for livestock. Many livestock illnesses can be spread through contaminated water supplies. A clean water source can prevent illnesses that reduce production and incur the added expense of avoidable veterinary bills.

Taking the opportunity to initiate an improved pasture management system in conjunction with installing clean water supplies will also provide economic benefits for the producer. Improved pasture management can allow a producer to feed less hay in winter months, increase stocking rates by 30 - 40% and, consequently, improve the profitability of the operation. Standing forage utilized directly by the grazing animal is always less costly and of higher quality than the same forage harvested with equipment and fed to the animal. In addition to reducing costs to producers, intensive pasture management can boost profits by allowing higher stocking rates and increasing the amount of gain per acre. In general, many of the agricultural BMPs being recommended will provide both environmental benefits and economic benefits to the farmer.

The residential programs will play an important role in improving water quality, since human waste can carry human viruses in addition to the bacterial and protozoan pathogens that all fecal matter can potentially carry with it. 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. Proper maintenance includes: knowing the location of the system components and protecting them (*e.g.,* 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 the entire system.

An important objective of the implementation plan is to foster continued economic vitality and strength. This objective is based on the recognition that healthy waters improve economic opportunities for Virginians, and a healthy economic base provides the resources and funding necessary to pursue restoration and enhancement activities. The agricultural and residential practices recommended in this document are expected to provide economic benefits, as well as environmental benefits, to the landowner.

Specifically, alternative (clean) water sources, exclusion of livestock from streams, intensive pasture management, and private sewage system maintenance will each provide economic benefits.

Monitoring

Improvements in water quality and implementation progress will be determined through monitoring conducted by the DEQ ambient monitoring program. This data will be supplemented by monitoring data from the National Park Service. The National Park Service stations are located in the headwaters of the Hawksbill watershed. Their data includes biological and chemical water quality parameters, which DEQ uses to determine overall water quality status, but does not use this data in its impairment assessment.

Additional monitoring of coliform bacteria concentrations will be conducted in Hawksbill and Mill Creeks by citizen monitors on a yearly basis established by DEQ. Coliscan Easygel® will be used to perform monthly monitoring of Escherichia coli (*E. coli*) bacteria. This method has been approved for screening purposes by DEQ based on a comparison study with EPA-approved methods, and has accuracy and precision comparable to membrane filtration. This monitoring data may be used to gauge the success of implementation in reducing the amount of bacteria in the streams; however, it cannot be used for the purpose of delisting the streams based on observed improvements. Volunteers have been conducting monthly sampling September 2005 through July of 2007, with high likelihood of continuing another year (Tables 10 and 11). Preliminary data from this method suggests that the bacterial impairment may not extend into the headwaters on Park property, though DEQ is obligated to assess the entire stream reach

based on current stations (Table 12). Both the DEQ and Coliscan monitoring sites are shown in Figure 7.

The steering committee expressed a desire to have a well testing program because of the karst topography in the area. Karst topography is characterized by rocks (carbonate or dolomite) that are easily dissolved by water creating sinkholes on the land surface and numerous fissures and cavities in the rocks themselves. Areas that are underlain by karst features are more susceptible to contaminated ground water because contaminants in surface water are directed to it from the sinkholes and cavities found in the rock layer.

Table 10. Coliscan Monitoring Stations in Hawksbill Creek Watershed (overlaps FOSR and Friends of Page Valley Monitoring Sites).

Site ID	Description
FP-06	Hawksbill Creek
FP-07	Pass Run
FP-07B	Pass Run
FP-08F	Hawksbill at SR 629
FP-08E	East Branch at Stonyman Rd
FP-08M	Little Hawksbill at Nat'l Park Boundary
FP-08BQ	Chub Run on Farmview Rd
FP-18	Dry Run at Hinton Rd (SR718)
FP-18A	Dry Run at Brookstone Rd

Table 11. Coliscan Monitoring Stations in Mill Creek Watershed.

Site Description
Stella Lane
Mill Creek Crossroads
Big Oak Road
Big Oak Road Trib.
Shen. River @ Whitehouse
Hamburg

Table 12. DEQ's Monitoring Stations in the Mill and Hawksbill Watersheds.

Stream Name	Station ID	Location	Frequency	Type of Sampling
Mill Creek	1BMLC000.40	Rt. 647 Bridge	Monthly	Fecal and *E. Coli*
Hawksbill Creek	1BHKS000.96	Rt. 648 Bridge below Luray	Monthly	Fecal and *E. Coli*
Hawksbill Creek	1BHKS009.58	Rt. 629 Bridge	Monthly	Fecal and *E. Coli*
East Hawksbill Creek	1BEHC001.18	Rt. 642 Bridge	Monthly	Fecal and *E. Coli*
Pass Run	1BPSS000.02	At mouth, upstream of Rt. 648 Bridge	Monthly	Fecal and *E. Coli*

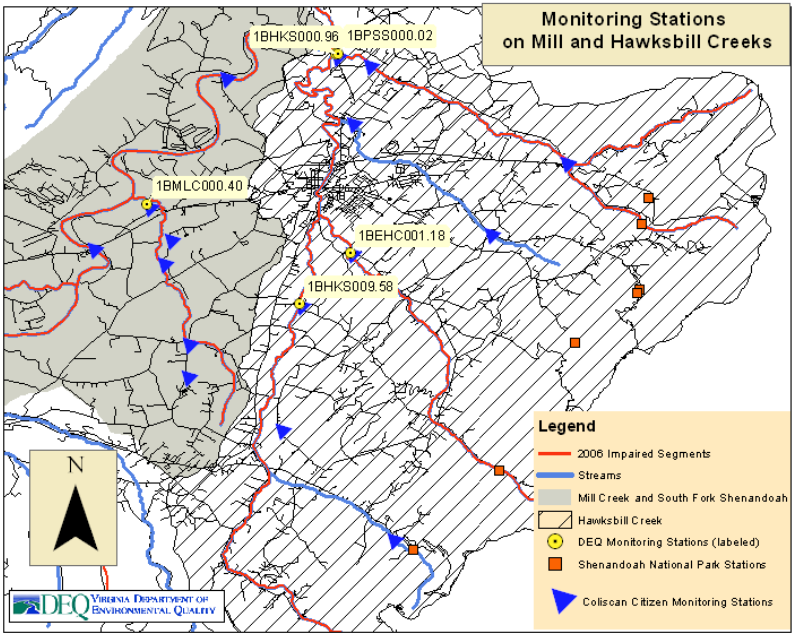

Figure 7. DEQ's Monitoring Stations in the Mill and Hawksbill Watersheds.

Education

Personnel from the Shenandoah Valley SWCD will initiate contact with farmers in both watersheds to encourage the installation of agricultural BMPs. This one-on-one contact will facilitate communication of the water quality problems and the corrective actions needed. The technical staff for the IP will conduct a number of outreach activities in the watershed to raise local awareness and encourage community support and participation in reaching the implementation plan milestones. Such activities will include information exchange through newsletters, postcard mailings, field days, presentations at local Ruritan and Rotary Clubs, and a display at the Page County Fair. The technical staff will work with organizations such as Virginia Cooperative Extension to sponsor farm tours and field days. In addition, technical staff will work with the Page County Water Quality Advisory Committee, which is already engaged in a number of education and outreach activities in the watershed. The committee will provide guidance to the technical staff on outreach methods.

Stakeholders' Roles and Responsibilities

Achieving the goals of this effort (*i.e.,* improving water quality and removing these waters from the impaired waters list) is dependent on stakeholder participation. Both the local stakeholders who are charged with the implementation of control measures and the stakeholders who are responsible for overseeing our nation's human health and environmental programs must first acknowledge there *is* a water quality problem, and then make the needed changes in our operations, programs, and legislations to address these pollutants.

The EPA has the responsibility for overseeing the various programs necessary for the success of the Clean Water Act. However, administration and enforcement of such programs falls largely to the states. In the Commonwealth of Virginia, water quality problems are dealt with through legislation, incentive programs, education, and legal actions. Currently, there are six state agencies responsible for regulating activities that impact water quality with regard to this implementation plan. These agencies include: DEQ, DCR, VDH, VCE, DOF, and Virginia Department of Agriculture and Consumer Services (VDACS).

DEQ has responsibility for monitoring the waters to determine compliance with state standards, and for requiring permitted point dischargers to maintain loads within permit limits. They have the regulatory authority to levy fines and take legal action against those in violation of permits. Beginning in 1994, animal waste from confined animal facilities in excess of 300 animal units (cattle and hogs) has been managed through a Virginia general pollution abatement permit. These operations are required to implement a number of practices to prevent groundwater contamination. In response to increasing demand from the public to develop new regulations dealing with animal waste, in 1999 the Virginia General Assembly passed legislation requiring DEQ to develop regulations for the management of poultry waste in operations having more than 200 animal units of poultry (about 20,000 chickens) (ELI, 1999).

DCR holds the responsibility for addressing nonpoint sources (NPS) of pollution. Historically, most DCR programs have dealt with agricultural NPS pollution through education and voluntary incentive programs. These cost-share programs were originally developed to meet the needs of voluntary partial participation and not the TMDL-required 100% participation of stakeholders. To meet the needs of the TMDL program and achieve the goals set forth in the CWA, the incentive programs must be reevaluated to account for 100% participation. It should be noted that DCR does not have regulatory authority over the majority of NPS issues addressed here.

The Shenandoah Valley SWCD will provide outreach, technical and financial assistance to farmers and homeowners in the Hawksbill and Mill Creek watersheds through the Virginia Agricultural BMP Cost-Share and Tax Credit programs. Their responsibilities will include promoting implementation goals, available funding and the benefits of BMPs and providing assistance in the survey, design, layout, and approval of agricultural and residential BMPs. Education and outreach activities are a significant portion of their responsibilities. Specific education and outreach methods recommended by the working groups are described in section 5.3 of this document. The Shenandoah Valley SWCD will be eligible for technical assistance funding to support their duties.

Through Virginia's Agricultural Stewardship Act, the VDACS Commissioner of Agriculture has the authority to investigate claims that an agricultural producer is causing a water quality problem on a case-by-case basis (Pugh, 2001). If deemed a problem, the Commissioner can order the producer to submit an agricultural stewardship plan to the local soil and water conservation district. If a producer fails to implement the plan, corrective action can be taken which can include a civil penalty up to $5,000 per day. The Commissioner of Agriculture can issue an emergency corrective action if runoff is likely to endanger public health, animals, fish and aquatic life, public water supply, etc. An emergency order can shut down all or part of an agricultural activity and require specific stewardship measures. The enforcement of the Agricultural Stewardship Act is entirely complaint-driven.

VDH is responsible for maintaining safe drinking water measured by standards set by EPA. Their duties also include septic system regulation and, historically, regulation of biosolids land application. Like VDACS, VDH's program is complaint-driven. Complaints can range from a vent pipe odor that is not an actual sewage violation and takes very little time to investigate, to a large discharge violation that

may take many weeks or longer to effect compliance. In the scheme of this TMDL IP, VDH has the responsibility of enforcing actions to correct or eliminate failed septic systems and straight pipes, respectively.

State government has the authority to establish state laws that control delivery of pollutants to local waters. Local governments, in conjunction with the state, can develop ordinances involving pollution prevention measures. In addition, citizens have the right to bring litigation against persons or groups of people who can be shown to be causing some harm to the claimant. In hearing the claims of citizens in civil court, and the claims of government representatives in criminal court, the judicial branch of government also plays a significant role in the regulation of activities that impact water quality.

Successful implementation depends on stakeholders taking responsibility for their role in the process. While the primary role falls on the landowner, local, state and federal agencies also have a stake in seeing that Virginia's waters are clean and provide a healthy environment for its citizens. While it is unreasonable to expect that the natural environment (*e.g.*, streams and rivers) can be made 100% free of risk to human health, it is possible and desirable to minimize anthropogenic problems. Virginia's approach to correcting NPS pollution problems has been, and continues to be, encouragement of participation through education and financial incentives. However, if progress is not made toward restoring water quality using this voluntary approach, regulatory controls may be established and enforced.

List of Acronyms

BMP	Best Management Practice
CREP	Conservation Reserve and Enhancement Program
CWA	Clean Water Act
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentive Program
FTE	Full Time Equivalent
GWG	Government Working Group
IP	Implementation Plan
NPS	Non Point Source Pollution
NRCS	Natural Resources Conservation Service
RWG	Residential Working Group
SL-6	Grazing Land Protection System
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
DCR	Virginia Department of Conservation and Recreation
DEQ	Virginia Department of Environmental Quality
VCE	Virginia Cooperative Extension
VDACS	Virginia Department of Agriculture and Consumer Services
VDH	Virginia Department of Health
DOF	Virginia Department of Forestry
WP-2T	Streambank Protection