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Knox Creek and Pawpaw Creek Implementation Plan Summary

Prepared for:
Virginia Department of Environmental Quality (VADEQ)

Submitted September 10, 2007

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Introduction

The 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: recreation, aquatic life (benthic), wildlife, fishing/shellfishing, and drinking. Benthic is a term that describes the macroinvertebrate organisms (bugs) that live on the bottom of the stream; a benthic impairment indicates that pollutants have impaired the natural existence of these organisms.

When a stream fails to meet the standards, it is listed as impaired on the CWA's Section 303(d) list, also known as the Dirty Waters List. Knox Creek was first listed as impaired on the 1996 list, due to violations of Virginia's General Standard (not supporting aquatic life). It was listed again on the 1998 and 2002 lists. The 2002 list also reported Knox Creek as impaired for fecal coliform violations and fish tissue (Polychlorinated biphenyls—PCBs) violations. In 2004, Knox Creek was again listed for three impairments: General Standard (benthic), *E. coli* (a specific form of fecal coliform bacteria), and fish tissue (PCBs) (Figure 1). The PCB impairment will not be addressed in this report. Until fecal bacteria levels are reduced in Knox Creek, full immersion swimming is discouraged and water should be fully boiled before consumption.

Pawpaw Creek was first listed in 1994 as impaired due to violations of Virginia's General Standard (benthic). It has appeared on the 1996, 1998, 2002, and 2004 lists for not supporting aquatic life (Figure 1).

The majority of the Knox Creek and Pawpaw Creek watersheds are located in Buchanan County, Virginia with a small portion in Pike County, Kentucky. Pawpaw Creek flows into Knox Creek near Kelsa, VA. This watershed is part of the Tennessee/Big Sandy River basin, which drains via the Mississippi River to the Gulf of Mexico.

For every stream on the Dirty Waters List, the CWA and the U.S. Environmental Protection Agency (EPA) both require that states develop a Total Maximum Daily Load (TMDL) for each pollutant (40 CFR Part 130). A TMDL is a "pollution budget" for a stream. That is,

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List of Acronyms

AML Abandoned Mine Land
BMP Best Management Practice
BST Bacterial Source Tracking
cfu/100mL Colony forming units of bacteria per 100 millileters of water
CREP Conservation Reserve and Enhancement Program
CWA Clean Water Act
DMME Department of Mines, Minerals, and Energy
EPA Environmental Protection Agency
EQIP Environmental Quality Incentive Program
FTE Full Time Equivalent
IP Implementation Plan
Kg Kilogram
KYDEP Kentucky Department of Environmental Protection
PCB Polychlorinated biphenyls
NPS Non Point Source
NRCS Natural Resources Conservation Service
Section 303(d) List Dirty Waters List
SE/R-CAP Southeast Rural Community Assistance Project
SL-6 Grazing Land Protection System
SWCB Soil and Water Conservation Board
SWCD Soil and Water Conservation District
t/yr Metric tons per year
TDS Total Dissolved Soilds
TMDL Total Maximum Daily Load
VADCR Virginia Department of Conservation and Recreation
VADEQ Virginia Department of Environmental Quality
VCE Virginia Cooperative Extension
VDACS Virginia Department of Agriculture and Consumer Services
VDH Virginia Department of Health
VDOF Virginia Department of Forestry
WP-2T Streambank Protection
WP-4 Waste Storage Facility
WQIA Water Quality Improvement Fund

it sets limits on the amount of pollution that a stream can tolerate and still maintain water quality standards. The TMDL results are explained in the Review of the TMDL Development Study section of this booklet.

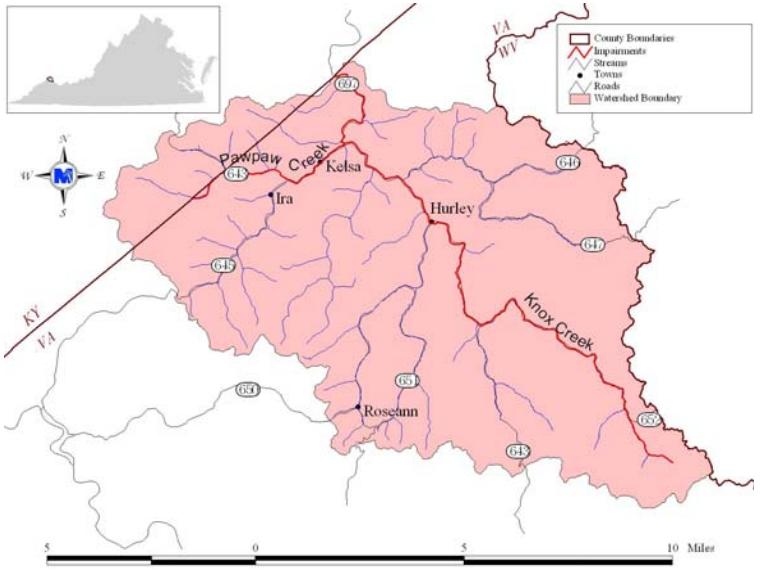

Figure 1. The impaired segments of Knox Creek and Pawpaw Creek (2004).

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 next step in the process is the development of an Implementation Plan (IP). This plan dictates 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 General Standard (benthic) impairments in Knox and Pawpaw Creeks, and the *E. coli* impairment in Knox Creek.

The General Standard is meant to protect the health of aquatic life. The health of the aquatic life is measured through assessment of the benthic macroinvertebrate community, which is integral to the food chain that

supports higher-level organisms (fish). It also serves as a fallback monitoring program to identify problems that are not detected by the ambient monitoring system (for example: pollutant discharges that occur intermittently or isolated incidents of pollutant discharge, etc). The specific pollutant being addressed for the Knox Creek General Standard TMDL is Total Dissolved Solids (TDS); the specific pollutants being addressed for the Pawpaw Creek General Standard TMDL are TDS and sediment.

The prevention of pollutant travel to these streams has relevance in downstream waterbodies as well as in Knox Creek and Pawpaw Creek. Pawpaw Creek is a tributary of Knox Creek, which then flows into Tug Fork. Tug Fork has a benthic impairment and any progress toward preventing pollutants from traveling to Knox and Pawpaw Creeks will also benefit the health of Tug Fork.

In fulfilling the state's requirement for the development of a TMDL IP, a framework has been established for reducing *E. coli* levels (for Knox Creek only), TDS levels, and sediment levels (for Pawpaw Creek only) and achieving the water quality goals for the Knox Creek and Pawpaw Creek impaired segments. With successful completion of the IP, Virginia begins the process of meeting these water quality goals, and natural resources will be enhanced. Additionally, approval of the IP will increase the opportunities for funding during implementation.

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

Key components of the implementation plan are:

- Review of the TMDL Development Study
- Public Participation
- Assessment of Needs
- Implementation
- Costs and Benefits
- Stakeholders' Roles and Responsibilities

Review of the Total Maximum Daily Load (TMDL) Study

The greatest portion of the Knox and Pawpaw Creek watershed is located in Buchanan County, Virginia with a small portion in Pike County, Kentucky. In 2004, the estimated human population within the

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. An important first step in correcting the existing water quality problem is recognizing that there *is* a problem and that the health of citizens is at stake. While it is unreasonable to expect that the natural environment (streams and rivers) can be made 100% free of risk to human health, it is possible and desirable to minimize man-made 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. The picture below is Knox Creek in Hurley, Virginia.

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. If deemed a problem, the Commissioner can order the producer to submit an agricultural stewardship plan to the local soil and water conservation district, pay a fine of up to up to $5,000 per day, or even shut down all or part of an agricultural activity. 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.

DMME regulates all land-disturbing, mining, reclamation from coal-mining and gas well drilling operations. Their duties include isssuing and enforcing permits and assessing reclamation efforts. The pictures below show before and after a gob pile reclamation.

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

Knox Creek and Pawpaw Creek watersheds was 3,878. The major land use in these watersheds is forest.

Bacterial Source Tracking (BST) is intended to aid in identifying the fecal bacteria sources (human, pets, livestock, or wildlife) of fecal contamination in water bodies. The BST results were used to determine the distribution of fecal bacteria in Knox Creek. All four sources were present in the Knox Creek stream samples with human being the dominant . (Pawpaw Creek did not require BST as it does not have a bacteria impairment.) The BST results provided insight into the likely sources of fecal contamination and distribution of fecal bacteria, and will improve the chances for success in implementing solutions. (Figure 2)

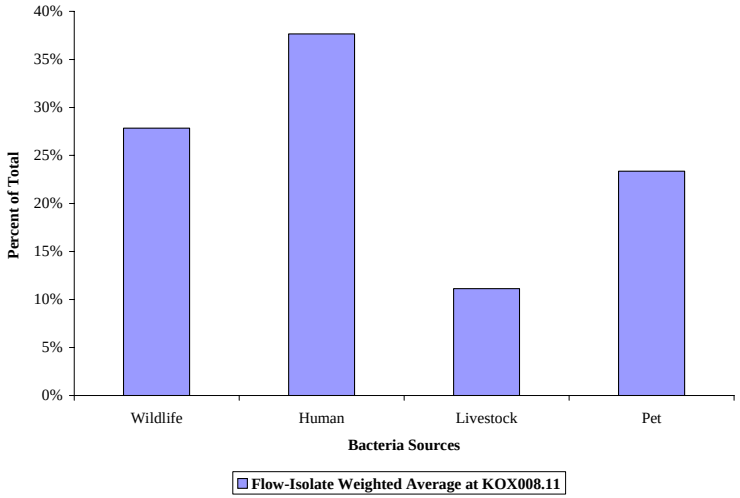

Figure 2. The BST results for Knox Creek.

Knox Creek does not meet the current state water quality standards for the recreation use (swimming). Any water sample from the stream must be equal to or less than 235 colony forming units per 100 millileters (cfu/100mL). If two or more samples are collected in one month the geometric mean of this data must be equal or less than 126 cfu/100mL.

A summary of the Stage I and Stage II (Final) *E. coli* allocations from the TMDL study is given in Table 1. The Stage I scenario results in 10.5% violations of the single sample bacteria standard (235 cfu/100mL), which may allow for de-listing. Stage II is the scenario that will meet both bacteria standards (0% violations). The correction of straight pipes and failing septic systems are a requirement of the *E. coli* TMDL and will benefit the General Standard (benthic) TMDLs by reducing TDS and solids from entering the streams. Reductions to wildlife fecal bacteria will not be addressed in this project (gray in Table 1).

Table 1. *E. coli* bacteria load reductions scenarios for Knox Creek.

Stage	Direct Wildlife	NPS Forest Wetland	Direct Livestock	NPS Ag	NPS Res	Direct Human
Stage I	0%	0%	89%	98%	98%	100%
Stage II (Final)	87%	94%	89%	99.5%	99.5%	100%

TDS and sediment come from erosion of land surfaces, straight pipes, and point sources. The land uses used in the analyses are Abandoned Mine Land (AML), Active Mine Land, Cropland, Forest, Disturbed Forest, Pasture, Reclaimed Mine Land, Residential, Roads, and Water from both Virginia and Kentucky. The final TDS loads and percent reductions required in the Knox Creek watershed and in the Pawpaw Creek watershed are shown in Table 2.

Table 2. TDS existing and allocated loads for Knox Creek and Pawpaw Creek (kg/yr).

Stream	Total Annual Existing Loading	Total Annual Allocation Loading	Overall Percent Reduction
Knox Creek	1.832E+07	7.98E+06	56.44%
Pawpaw Creek	3.350E+06	2.71E+06	19.10%

The final sediment reductions recommended in the Pawpaw Creek watershed are shown in Table 3. Reductions of sediment from AML, cropland, disturbed forest, streambank erosion, and straight pipes are recommended. A Stage I recommended goal is to reduce AML and disturbed forest sediment loads by 34% and correct all straight pipes.

organizations such as Virginia Cooperative Extension to educate the public.

Achieving the goals of this effort (improving water quality and removing Knox Creek and Pawpaw Creek from the Dirty 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 legislation to address these pollutants.

Governmental Responsibilities

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. The state agencies responsible for regulating activities that impact water quality include: VADEQ, VADCR, VDH, DMME, VCE, VDOF, and Virginia Department of Agriculture and Consumer Services (VDACS).

VADEQ 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.

VADCR holds the responsibility for addressing nonpoint sources (NPS) of pollution. Historically, most VADCR 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. It should be noted that VADCR does not have regulatory authority over the majority of NPS issues addressed here.

The success of the implementation measures will be determined by monitoring conducted by VADEQ through the agency's monitoring program. VADEQ will monitor at five monitoring locations in the Knox Creek watershed, with the possible addition of another station upstream of 6AKOX017.97 for ambient monitoring. All of the stations will be monitored on a monthly basis during implementation (Figure 6).

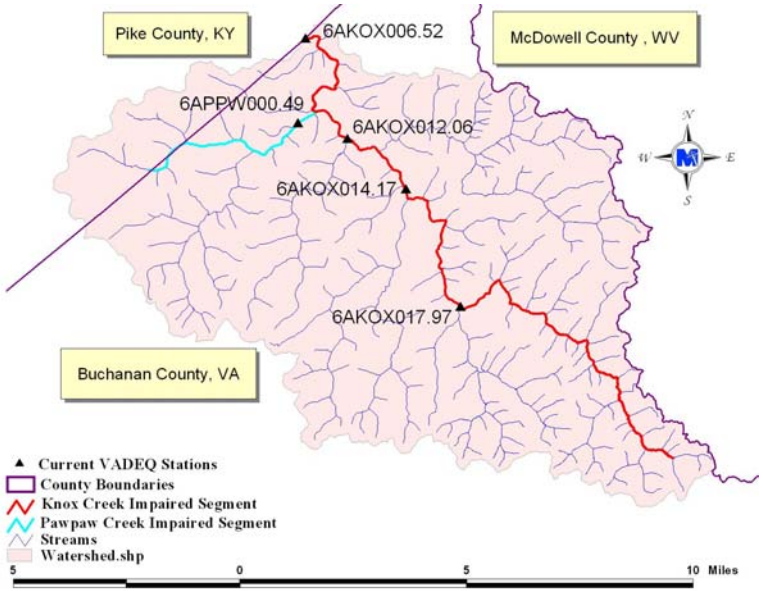

Figure 6. VADEQ monitoring stations in the Knox Creek watershed.

Education

Personnel from the Big Sandy SWCD, along with the FTEs, will initiate contact with stakefolders in the Knox Creek watershed to encourage the installation of BMPs. This one-on-one contact will facilitate communication of the water quality problems and the corrective actions needed. The FTEs will conduct a number of outreach activities in the watershed to encourage community support and participation in reaching the industrial program milestones, and to make the community aware of the TMDL requirements. Such activities will include information exchange through newsletters, mailings, field days, organizational meetings, etc. The FTEs will work with

Table 3. Sediment existing and allocated loads for Pawpaw Creek.

Sediment Source	Existing Loads t/yr	Reductions (%)	Allocated Loads t/yr
Virginia Area:			
AML	4,289	59	1,758
Active Mined	0.60	0	0.60
Cropland	1,211	57	520.5
Forest	1,257	0	1,257
Forest Disturbed	2,799	58	1,176
Pasture	17.06	0	17.06
Reclaimed	0.65	0	0.65
Residential	0.20	0	0.20
Salted Roads	3.06	0	3.06
Kentucky Area:	620.47	0	620.47
Streambank Erosion (VA & KY)	81.44	13	70.85
Straight pipes (VA only)	2.94	100	0.00
Point Sources (VA only)	4.99	0	4.99
Watershed Total	**10,287.41**	**47.2**	**5,429.38**

Process for Public Participation

The actions and commitments described in this document are drawn together through input from citizens of the watershed, county governments, resource extraction companies, VADEQ, VADCR, Department of Mines, Minerals, and Energy (DMME), Virginia Department of Health (VDH), Virginia Cooperative Extension (VCE), the Natural Resources Conservation Service (NRCS), Kentucky Department of Environmental Protection (KDEP), Big Sandy Soil and Water Conservation District (BSSWCD), 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 these 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, as well as provide a forum for soliciting participation in the smaller, more targeted meetings. Second, working groups were assembled from communities of people with common concerns. Third, a Steering Committee was formed with representation from VADEQ, VADCR, VDH, DMME, BSSWCD, KYDEP, representatives from the working groups, and MapTech.

Assessment of Needs

Industrial BMPs

Resource extraction (coal mining and gas well drilling) companies in the Knox Creek watershed are regulated by the DMME. They are required to follow environmental and safety regulations in order to prevent negative impacts on the environment and human health. The companies must pay a bond up front for each permit, which is held until the active site is sufficiently reclaimed. If not, the money is forfeited over to DMME and they reclaim the land. Reclaimed land in the Knox Creek watershed has been used for grazing pasture for livestock and for residential purposes. More information can be found at http://www.mme.state.va.us/Dmm/default.htm. The pictures below show before and after an acid mine drainage site reclamation.

The gas well drilling companies are required to install sumps or ponds to collect runoff from gas well areas. The roads leading to the wells must be maintained and must have water bars to divert water from the roadway. More information can be found at http://www.dmme.virginia.gov/Dgo/default.htm.

The Virginia Department of Forestry (VDOF) is in charge of regulating all logging operations of commercial or private entities. There is a zero tolerance for sedimentation in nearby streams. Some BMPs that are

the tools needed for extending the life of their systems and reducing the overall cost of ownership. The average septic system will last 20 - 25 years if properly maintained. Proper maintenance includes: knowing the location of the system components and protecting them (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. Below is a picture of a failing septic 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, residential, and industrial practices recommended in this document are expected to provide economic benefits, as well as environmental benefits, to the landowner.

Stakeholders' Roles and Responsibilities

Monitoring

The Steering Committee, BSSWCD, VDH, and VADEQ will assess progress toward end goals during implementation through tracking of control measure installations and continued water quality monitoring.

will be implemented to control sediment and TDS will also serve to reduce delivery of other pollutants to the stream from upland locations.

Fresh clean water is the primary nutrient for livestock (horses, cattle, sheep, etc.). 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. The picture below shows cattle drinking from an alternative water source.

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%. 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 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

recommended for logging areas are: not harvesting trees near streams (leaving a vegetated stream buffer), water bars, hardened stream crossings (culverts, bridges), and seeding and mulching bare areas upon completion. More information on logging BMPs can be found at http://www.dof.virginia.gov/wq/index-bmp-guide.shtml.

The Knox Creek and Pawpaw Creek TMDLs require large reductions to bacteria and TDS land-based loads as well as reductions to sediment loads in Pawpaw Creek. In order to meet these strict requirements, the BMPs (Best Management Practices - BMPs) in Table 4 must be implemented.

Agricultural BMPs

Streamside fencing is required on perennial and intermittent streams that are next to pasture in the Knox Creek watershed. This will remove direct livestock defecation in the stream and prevent the trampling of the stream banks. The quantity of streamside fencing required during implementation 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. Below is a picture of a calf not excluded from the stream and the resulting muddy, trampled stream bank.

The BSSWCD preformed a ground truth survey of the areas estimated to need cattle streamside fencing. The length of fencing required on perennial and intermittent streams in the Knox Creek watershed is approximately 4,106 feet. Based on this spatial analysis of landuse,

there are 13 Grazing Land Protection Systems (SL-6), 2 Hardened Crossings, and 1 Stream Protection System (WP-2T) required to ensure the exclusion of livestock from the streams. In the Pawpaw Creek watershed, ground-truth survey showed no need for cattle fencing. While these estimates may be conservative (high) for a non-agricultural watershed, through staging (targeting) of the implementation efforts, any available funding will be directed, as needed, to efforts that are likely to have the largest impact first. Based on the TMDL and BST analyses, major efforts should be directed at correcting straight-pipes and failing septic systems.

Due to the strict reductions on land-based loads of fecal bacteria, additional BMPs are required on pasture and cropland. Improved pasture management includes the maintenance of an adequate forage height (3-inch minimum) during the growing season, control of woody vegetation, and distribution of manure through managed rotational grazing. Manure incorporation is a practice in which farmers spread manure and then disk the land. The disking mixes manure with soil and has shown to keep manure and nutrients on the land longer. A vegetated buffer is an area next to a stream where cattle are not allowed and vegetation is established. The area between the fence and stream filters bacteria from runoff from adjacent land. Buffers must be 35 feet from the stream on average to be eligible for any state cost-share money. Estimates of all agricultural BMPs needed for full implementation in the watershed are listed in Table 4. The VADCR labels are shown in parenthesis.

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 goal. The estimated numbers of straight pipes and failing septic systems were reported in the TMDL and are shown in Table 4.

The Knox Creek and Pawpaw Creek TMDLs require large reductions to land-based residential pollutant loads. In order to meet these strict requirements, the BMPs in Table 4 must be implemented. The Residential Education Program includes distributing information on how pet waste should be disposed of, along with posting signs and supplying trashcans and pick-up bags. A septic tank pump-out program addressing 200 systems within the entire watershed is included. An infiltration trench is a shallow trench filled with gravel covered with

Benefits

The primary benefit of implementation is cleaner waters in Virginia. Specifically, fecal contamination in Knox 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, the return of a healthy aquatic community is a goal of this project. Streambank protection will improve the aquatic habitat in these waters. The vegetated buffers that are established will also serve to reduce sediment and TDS as well as other pollutants transport to the stream from upslope locations. The picture below shows a buffer area planted with tree saplings for the CREP program. In areas where pasture management is improved, soil and TDS losses should be reduced and infiltration of precipitation should be increased, decreasing peak flows downstream. The aquatic life will return to Knox and Pawpaw Creeks with appropriate and diverse populations to allow for healthy fish populations. These improvement will benefit Tug Fork and the Big Sandy River.

Coal companies that reclaim mined lands adequately so sediment and TDS losses are minimal will receive their entire bond in return. The continued remining of AML will provide water quality benefits through the reclamation of the site after all resources are removed. In addition to allowing the aquatic community to thrive, the control measures that

Costs and Benefits

Costs

Associated cost estimates of agricultural, residential, and industrial BMPs were calculated by multiplying the unit cost by the number of units in each watershed (Table 4).

Table 7 shows the estimated cost of installing the recommended agricultural BMPs as $0.5 million. Residential BMP costs sum to $3.6 million. Coal companies, logging operators, and the gas well companies will cover the costs of the industrial BMPs as they continue operations in the watershed ($23.2 million).

It was determined by the BSSWCD 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. The maximum total cost to provide technical assistance during implementation is expected to be $1.5 million (Table 7). Factoring in technical assistance costs, the total cost for full implementation in both watersheds comes to $32 million.

Table 7. Total estimated costs to meet the Knox Creek and Pawpaw Creek TMDLs in Millions of US dollars.

Stream Stage	Ag BMPs	Res. BMPs	Ind. BMPs	Streambank Stabilization	FTEs	Total
Knox Creek						
Stage I	0.23	2.81	4.37	0.0	0.88	8.29
Stage II	0.23	0.12	13.10	0.0	0.25	13.70
Knox Total	*0.47*	*2.93*	*17.47*	*0.0*	*1.13*	*21.99*
Pawpaw Creek						
Stage I	0.01	0.63	1.43	1.64	0.25	3.97
Stage II	0.01	0.01	4.29	1.64	0.13	6.08
Pawpaw Total	*0.03*	*0.64*	*5.72*	*3.29*	*0.38*	*10.05*
Grand Total	0.50	3.57	23.18	3.29	1.50	32.04

soil and grass into which runoff is diverted. It is recognized that space for stormwater runoff treatment is limited; therefore, these BMPs should be considered if the required water quality levels have not been met after the easier and less expensive BMPs are implemented.

Table 4. Control measures (BMPs) needed in the Knox and Pawpaw Creek watersheds with associated costs.

Best Management Practice	Unit	Cost/ Unit	Knox	Pawpaw
Agricultural:				
Grazing Land Protection System (SL-6)	System	$4,000	13	0
Stream Protection System (WP-2T)	System	$2,000	1	0
Improved Pasture Management	Acre	in SL-6	117.3	13
Waste Storage Facility (WP-4) – Horses	System	$27,000	14	1
Manure Incorporation	Acre	$20	377.3	0
Vegetated Buffer	Acre	$700	40	1
Residential:				
Septic Systems Pump-out Program	System	$250	158	42
Septic System Repair	System	$3,000	80	30
Septic System Installation/Replacement	System	$6,000	374	105
Alternative Waste Treatment System Installation	System	$11,400	24	15
Residential Pet Waste Program	Program	$3,750	1 for both watersheds	
Infiltration Trench	Acres-Treated	$5,285	12	0
Erosion and Sediment Control	Acres-Treated	$2,000	20	3
Vegetated Buffers	Acres	$700	37	6.6
Industrial:				
Reclamation of AML	Acre	$10,000	1,583.2	502
Dirt Road Stabilization	Acre	$10,000	37.3	1.8
Forest Harvesting BMPs	Acre	$10,000	126	68
Streambank Stabilization	Feet	$440	0	7,470

Full-Time Equivalents (FTEs)

To determine the number of FTEs considered necessary for technical assistance during implementation, the number of BMPs required per year was divided by the number of BMPs that one FTE can process in a

year. The number of FTEs required was calculated from historical work records. As a result, 4.5 FTEs are needed per year during the first five years of implementation, and 1.5 FTEs per year will be needed for the second five years (6 – 10) in the Knox and Pawpaw Creek watersheds. The BSSWCD will be in charge of the technical assistance during the implementation of these BMPs. The first picture below is a dirt haul road. The second picture is a surface mining site.

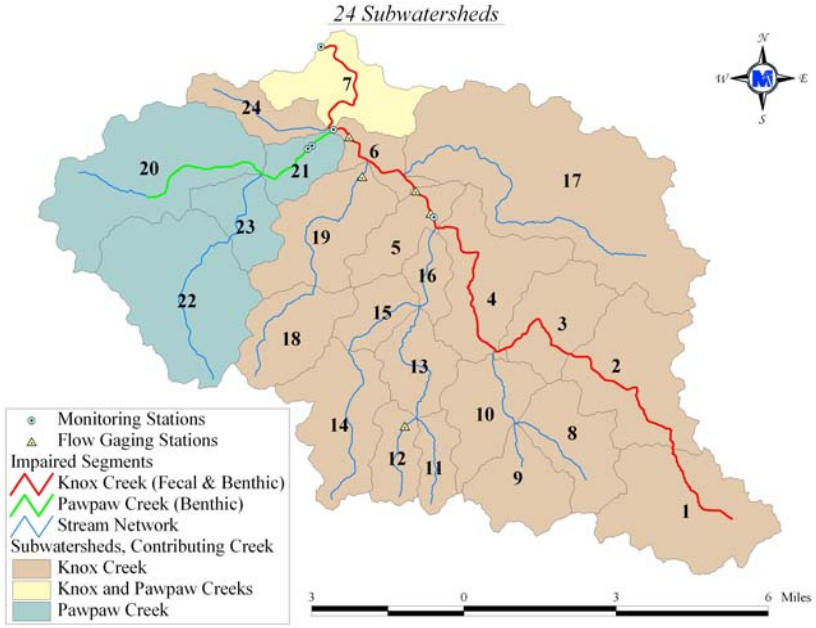

Figure 5. The location of the Knox Creek and Pawpaw Creek subwatersheds and impairments.

Table 6. Targeting subwatershed order for residential waste BMPs and streamside fencing.

Stream	Straight Pipe and Failing Septic Systems	Streamside Fencing
Knox Creek (all subwatersheds)	2, 3, 1, 4, 5, 6, 7, 17, 22, 10, 20, 14, 9, 19, 8, 13, 15, 12, 23, 16, 21, 11, 18, 24	19, 10, 22, 2, 8, 23, 12, 4, 21, 17, 11, 9, 5, 3, 13, 14, 24, 1, 16, 20, 15, 7, 18, 6
Pawpaw Creek	22, 20, 23, 21	22, 23, 21, 20

Table 5. Stage I and Stage II BMP installation goals for Knox Creek and Pawpaw Creek.

Best Management Practice	Unit	Stage I	Stage II
Agricultural			
Grazing Land Protection System (SL-6)	System	50%	50%
Stream Protection System (WP-2T)	System	50%	50%
Improved Pasture Management	Acre	50%	50%
Waste Storage Facility (WP-4) – Horses	System	50%	50%
Manure Incorporation	Acre	50%	50%
Vegetated Buffer	Acre	50%	50%
Residential			
Septic Systems Pump-out Program (RB-1)	System	100%	0%
Septic System Repair (RB-3)	System	100%	0%
Septic System Installation/Replacement (RB-4)	System	100%	0%
Alternative Waste Treatment System Installation (RB-5)	System	100%	0%
Residential Pet Waste Program	Program	ongoing	
Infiltration Trench	Acres-Treated	0%	100%
Erosion and Sediment Control	Acres-Treated	0%	100%
Vegetated Buffers	Acres	50%	50%
Industrial			
Reclamation of AML	Acre	25%	75%
Dirt Road Stabilization	Acre	25%	75%
Forest Harvesting BMPs	Acre	25%	75%
Streambank Stabilization	Feet	50%	50%

Targeting

The purpose of targeting BMPs is to identify subwatersheds where BMP installation would result in the greatest return in water quality improvement. Targeting ensures optimal utilization of resources. Efforts should be made to prioritize outreach in the targeting order (Table 6). However, interested people should not be turned away if their land is within a low ranking subwatershed.

The subwatersheds of the Knox Creek watershed are shown in Figure 5. Table 6 shows the subwatershed order for targeting streamside fencing and straight pipe corrections in the watershed.

Implementation

Potential Funds

Potential funding sources available during implementation were identified during plan development. Detailed descriptions of each source can be obtained from the BSSWCD, VADCR, EPA, NRCS, VCE, and VADEQ. Sources include:

- Clean Water Act Section 319 Increment Funds
- Virginia Agricultural Best Management Practices Cost-Share, Tax Credit, or Loan Programs
- Environmental Quality Incentives Program (EQIP)
- Revolving Loan Programs
- Southeast Rural Community Assistance Project (SE/R-CAP)
- Water Quality Improvement Act (WQIA)
- Conservation Reserve Enhancement Program (CREP)
- Utilities Service Water and Waste Disposal Program

Timeline and Milestones

The end goals of implementation are restored water quality of Knox and Pawpaw Creeks and the removal of these streams from Virginia's Dirty Waters 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 10 years, leaving five years to assess water quality for de-listing. Timelines with pollutant reductions expected are shown in Figures 3 and 4.

Following the idea of a staged implementation approach, resources and finances will be concentrated on the most cost-efficient BMPs first. The Stage I goals will focus on the more cost-efficient BMPs. Three years are allowed for resources extraction permitting, and 10 to 15% of each of the industrial BMP are scheduled for each year. Following Stage I implementation, the Steering Committee should evaluate water

quality improvements and determine how to proceed to complete implementation during Stage II.

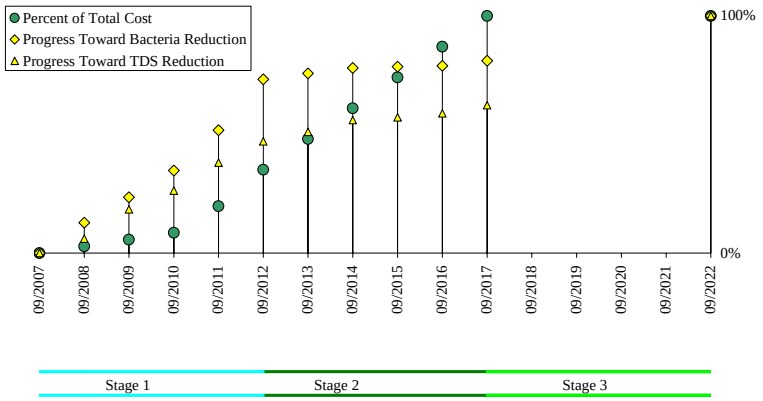

Figure 3. Timeline for implementation in the Knox Creek watershed.

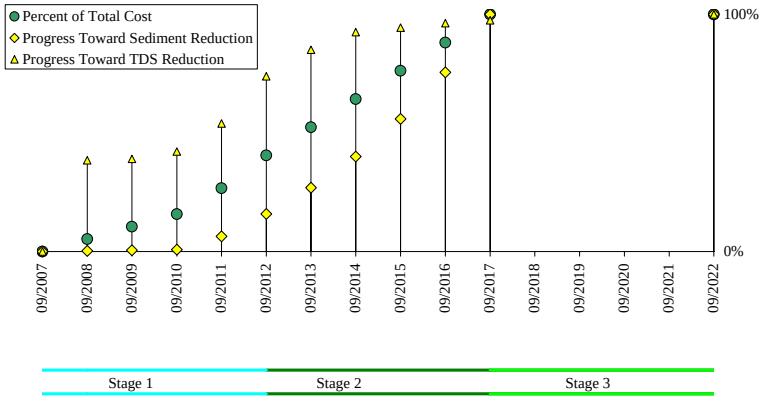

Figure 4. Timeline for implementation in the Pawpaw Creek watershed.

Following the idea of a staged implementation approach, resources and finances will be concentrated on the most cost-efficient BMPs first. The Stage I goals will focus on the more cost-efficient BMPs. A lag was included, to allow for three year resources extraction permitting, and 10 to 15% of each of the industrial BMP are scheduled for each year, following the 3-year lag. Following Stage I implementation, the Steering Committee should evaluate water quality improvements and determine how to proceed to complete implementation during Stage II.

Table 5 shows installation goals for Stage I and Stage II as a percent for each BMP. Stage I will end at the end of 2011; Stage II will be complete with all BMPs installed by 2016. It is anticipated that the de-listing of the impaired segments from the Dirty Waters List will occur by 2022. The picture below shows a straight pipe supplying untreated human waste to a creek.