CUNNINGHAM CREEK Watershed plan

A plan to reduce bacteria and sediment in the water

Technical Document

March 2, 2018

Prepared by

VA Department of Environmental Quality

In Cooperation with

Local Stakeholders

and

Virginia Tech Biological Systems Engineering

ACKNOWLEDGEMENTS

We would like to acknowledge the following organizations for their participation and support in the development of this plan:

Fluvanna County

Fluvanna County Public Library

Rivanna Conservation Alliance

Thomas Jefferson Soil and Water Conservation District

USDA Natural Resources Conservation Service

VA Department of Forestry

VA Department of Game and Inland Fisheries

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1. INTRODUCTION

Cunningham Creek is located in Fluvanna County, Virginia. The watershed is largely agricultural and forested, with modest development to date. Beginning in 2006, the Virginia Department of Environmental Quality placed Cunningham Creek and its tributaries on the impaired waters list for bacteria and benthic impairments (Table 1-1) (VADEQ, 2006). The Cunningham Creek Watershed Plan describes the stakeholder-driven approach that was utilized to address these impairments. The plan follows the nine elements described in EPA's Handbook for Developing Watershed Plans to Restore and Protect Our Waters (EPA 2008). The decision to address these impairments using a watershed plan approach is documented below, followed by a description of watershed plan elements.

Table 1-1. Cunningham Creek impairment listings.

Impaired segment	Impairment	Length of impaired segment (miles)	Initial listing year
North Fork Cunningham Creek (VAV-H32R_CFK01A00)	Benthic	4.19	2012
X-tributary to NF Cunningham Creek (VAV-H32R_XCF01A10)	Benthic	0.59	2010
Middle Fork Cunningham Creek (VAV-H32R_CNM01A00) (VAV-H32R_CNM02A04)	Bacteria	7.49	2006 2004
Middle Fork Cunningham Creek (VAV-H32R_CNM01A00)	Benthic	3.47	2010
X-tributary to MF Cunningham Creek (VAV-H32R_XPA01A06)	Bacteria	3.77	2008
Cunningham Creek (VAV-H32R_CXB01A00)	Benthic	5.56	2012

1.1 Selection of a Watershed Plan Approach

Section 303(d) of the Clean Water Act (CWA) and the EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that do not meet water quality standards. EPA regulations and guidance, however, recognize that an impaired water may not need a TMDL if there are other pollution control requirements that are sufficient to meet water quality standards within a

reasonable period of time. Waterbodies where an alternative approach can be used instead of a TMDL for addressing an impairment can be classified as Category 4B in contrast to waterbodies requiring TMDLs, which are classified as Category 5 in Virginia's Water Quality Integrated Report.

Cunningham Creek is a candidate for a Category 4B listing and development of a watershed plan, for the following reasons:

1. The impairments identified in the Cunningham Creek watershed are moderate. The frequency of violations of the bacteria water quality standard is relatively low on the Middle Fork, while VA Stream Condition Index scores used to assess the health of the benthic community are often close to 60, suggesting marginal impairment. The moderate level of impairment suggests that these water quality problems could be addressed relatively easily and quickly through a series of corrective actions.
2. Land use in the watershed is dominated by forest, with very little development. There are a small number of farms in the watershed, most of which are well managed. The sources of pollution in the watershed are discrete and relatively limited. Working with local stakeholders, these sources and associated corrective actions could be easily identified and addressed.
3. Based on the benthic stressor analysis conducted as part of the watershed planning process, sediment is the primary culprit of the benthic impairments present in the watershed. One large historical source of sediment in the North Fork Cunningham Creek watershed is the Fluvanna Ruritan Dam, which is believed to have released a considerable volume of sediment into the creek as a result of erosion at the outlet as well as downstream streambank erosion. However, the dam is no longer believed to be an active source of sediment in the watershed, and is slated for a rehabilitation project in 2018-2019. Several additional sources of sediment have been identified in the watershed including a small development in the North Fork watershed. A lack of stabilization following completion of the development on approximately one acre of land has resulted in considerable sedimentation into the creek. This problem can be addressed quickly and at minimal cost.

Formally, the justification of a Category 4B listing requires the following six elements (Regis 2006).

1. Identification of segment and statement of the problem causing the impairment;
2. Description of pollution controls and how they will achieve water quality standards;
3. An estimate or projection of the time when water quality standards will be met;
4. Schedule for implementing pollution controls;
5. Monitoring plan to track effectiveness of pollution controls; and
6. Commitment to revise pollution controls, as necessary.

The nine elements of the watershed plan (discussed in the next section) cover the first five elements of the Category 4B listing justification and include some additional elements, like a public information component and interim milestones, which are not essential elements of the justification. The only element of the justification not explicitly addressed by the watershed plan is the commitment to adaptive management. Adaptive management, however, is an important component of the Cunningham Creek Watershed Plan.

1.2 Watershed Plan Elements

The EPA (2008) outlines nine key elements for inclusion in a watershed plan, listed below. The Cunningham Creek Watershed Plan includes all of these elements. The chapter addressing each element is provided in parenthesis in the list below. In addition to the nine elements, the plan also incorporates adaptive management techniques throughout. A description of how this plan integrates with other watershed plans and projects is also provided (Chapter 8). Utilizing this approach, the bacteria and benthic impairments in the watershed should be addressed within ten years.

Element A: Identification of causes and sources of pollution (Chapter 3);

Element B: Estimate of load reductions expected from management measures (Chapter 7);

Element C: Description of management measures to achieve load reductions and of the critical areas in which these need to be implemented (Chapter 5);

Element D: Estimate of the technical and financial assistance needed to implement plan (Chapters 5 and 7);

Element E: An information and education component used to enhance public understanding of the project (Chapter 5);

Element F: Schedule for implementing management measures (Chapter 7);

Element G: Description of interim measureable milestones to determine whether management measures are being implemented (Chapter 7);

Element H: Criteria for determining progress towards meeting water quality standards (Chapter 3); and

Element I: Monitoring component to evaluate effectiveness of implementation efforts over time (Chapter 7).

2. WATERSHED DESCRIPTION

2.1 Background

Cunningham Creek and its tributaries (North Fork, Middle Fork and South Fork Cunningham Creek) are located in Fluvanna County Virginia and are part of the James River Basin (Figure 2-1). There are 102 miles of perennial streams in the watershed, which totals approximately 23,210 acres (36.3 miles^2). Pasture, hay and forest are the predominant land uses in the watershed. According to the 2012 Census of Agriculture, the average farm size in Fluvanna County is 155 acres, with 43% of farmers identifying farming as their primary occupation. To date, there has been little development pressure in the watershed. However, Lake Monticello, located just north of the Cunningham Creek watershed, has seen considerable development in recent years, which has primarily been in the form of residential and strip commercial development.

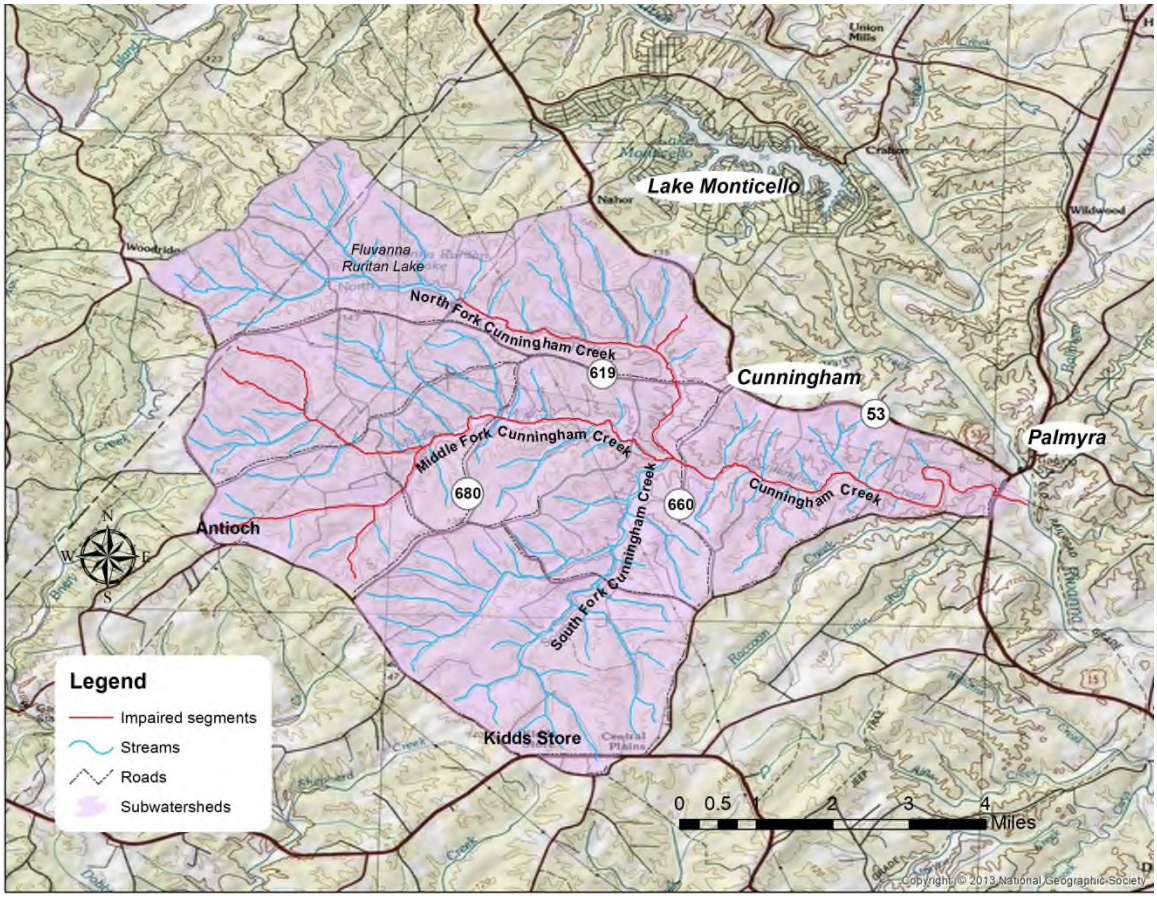

Figure 2-1. Location of the Cunningham Creek watershed and impaired stream segments.

2.2 Land Use

Table 2-1. Land use acreages in the Cunningham Creek watershed. Table also shows percent total watershed acreage for each land use category.

Land use	Watershed: Acres (% total acreage)				TOTAL
	NF Cunningham	*MF Cunningham*	*SF Cunningham*	*Cunningham*	
Water	77 (1.2%)	55 (0.7%)	6 (0.1%)	5 (0.1%)	143 (0.6%)
Developed impervious	126 (2.0%)	159 (2.1%)	90 (1.5%)	37 (1.1%)	412 (1.8%)
Developed pervious	195 (3.1%)	232 (3.1%)	124 (2.0%)	60 (1.8%)	611 (2.6%)
Forest/Tree/Wetlands	5,299 (83.7%)	5,942 (80.3%)	4,639 (75.4%)	2,648 (80.8%)	18,528 (80.0%)
Harvested/Disturbed forest	28 (0.4%)	84 (1.1%)	72 (1.2%)	17 (0.5%)	200 (0.9%)
Pasture	522 (8.2%)	807 (10.9%)	1,023 (16.6%)	449 (13.7%)	2,801 (12.1%)
Degraded riparian pasture*	13 (0.2%)	10 (0.1%)	24 (0.4%)	8 (0.3%)	55 (0.2%)
Cropland	0 (0%)	0 (0%)	162 (2.6%)	11 (0.3%)	174 (0.7%)
Scrub/shrub	70 (1.1%)	107 (1.4%)	10 (0.2%)	44 (1.3%)	230 (1.0%)
TOTAL	**6,329**	**7,395**	**6,150**	**3,280**	**23,154**

*Degraded riparian pasture is unfenced pastureland within 35 feet of a stream where livestock have access to the stream resulting in limited vegetation and active streambank erosion. These areas were identified from aerial imagery.

2.3 Soils and Geology

The Cunningham Creek watershed is located entirely within the Northern Inner Piedmont (45e) sub-division of the Piedmont (45) ecoregion. Ecoregion 45e is a dissected upland composed of hills, irregular plains, and isolated ridges and mountains. The Northern Inner Piedmont (45e) is characteristically underlain by highly deformed and deeply weathered Cambrian and Proterozoic feldspathic gneiss, schist, and melange. It is intruded by plutons and is veneered by clay-rich weathering products (i.e. saprolite). Ultisols occur widely and have developed from residuum; they are typically clay-rich, acid, and relatively low in base saturation (Omernik and Griffith, 2008).

The dominant soil type in Cunningham Creek watershed is Nason silt loam, comprising 36.7% of the watershed. The next most abundant soil types are Tatum silt loam at 27.2% and Manteo silt loam at 19.6%. Each of these soil types are comprised of rolling and undulant phases (USDA-NRCS, 2013a and 2013b). Soils of the Nason series are classified as fine, mixed, semiactive, thermic Typic Hapludults and are deep and well drained. They occur on uplands and are formed in material weathered from schist and other fine grained metamorphic rocks. Soils of the Tatum series are also classified as fine, mixed, semiactive, thermic Typic Hapludults. Similarly, they are deep and well drained soils. They occur in woodland areas and are formed in material weathered

from sericite schist, phyllite, and other fine grained metamorphic rocks. Soils of the Manteo are classified as loamy-skeletal, mixed, semiactive, thermic Lithic Dystrudepts. This series is shallow, somewhat excessively drained, and often found in hardwood woodlands. They formed in material weathered from very strongly acid serecite schist (USDA-NRCS, 2017).

2.4 Climate

Climate data for the Cunningham Creek watershed were based on meteorological observations made by the Palmyra 3S National Climatic Data Center station (446491) located 2.57 miles south of the watershed outlet. Average annual precipitation at this station is 41.8 inches; while the average annual daily temperature is 54.0°F. The highest average daily temperature of 74.1°F occurs in July while the lowest average daily temperature of 33.9°F occurs in January, as obtained from the NCDC 1981-2010 Climate Normals for this station (NOAA, 2017)

3. ADDRESSING THE IMPAIRMENTS

3.1 Water Quality Monitoring

The Virginia Department of Environmental Quality (VADEQ) currently uses a six-year rotation as the basis for their state-wide ambient water quality monitoring network, which includes such parameters as temperature, dissolved oxygen, specific conductance, pH, bacteria, and nutrients. As part of this system, a station is monitored for two years of every six-year period (two years on, four years off). VADEQ is also conducting biological monitoring at a network of monitoring stations across the Commonwealth in the fall and spring. These data are used to assess the health of the benthic community. VADEQ's biological assessment method is based on the Virginia Stream Condition Index (VSCI). This index includes eight biomonitoring metrics that consider the diversity, pollution tolerance, and abundance of organisms identified in each sample that is collected from the stream. The VSCI has a scoring range of 0-100, with a score of 100 representing the highest quality benthic community. VADEQ classifies sites with a VSCI of 60 or greater as "nonimpaired," while sites with a score below 60 are considered "impaired."

The VADEQ and volunteer biological and ambient monitoring stations in the Cunningham Creek watershed are shown in Figure 3-1. Data collected from three ambient water quality monitoring stations in the Middle Fork Cunningham Creek watershed were used to list Middle Fork Cunningham Creek and an unnamed tributary to Middle Fork Cunningham Creek as impaired by fecal bacteria. Additional data collected from two ambient water quality monitoring stations in South Fork Cunningham Creek and Cunningham Creek in 2016 and 2017 show exceedances of the state's water quality criteria for *E. coli* bacteria, that no more than 10% of samples shall exceed 235 cfu/100 ml. Table 3-1 provides a summary of the data collected from these stations. Data collected from six biological monitoring stations throughout the Cunningham Creek watershed were used to list Middle Fork Cunningham Creek, an unnamed tributary to North Fork Cunningham Creek, North Fork Cunningham Creek and Cunningham Creek as impaired for aquatic life use. Figure 3-2 shows the VSCI scores for the VADEQ monitoring stations. Rivanna Conservation Alliance maintains a robust monitoring program in the watershed, and has received Level III certification from VADEQ for both its biological and bacteria monitoring programs. This means that their data can be used for the purposes of listing and de-listing waterbodies. Rivanna

Conservation Alliance assisted VADEQ with supplemental monitoring during the watershed planning process in 2016 and 2017 including both biological and E. coli monitoring.

In addition to VADEQ and Rivanna Conservation Alliance monitoring in the watershed, the VA Department of Conservation and Recreation (VADCR) has also established a monitoring station in the watershed in support of its Healthy Watersheds Program. Through this program, VADCR conducted monitoring on an unnamed tributary of Middle Fork Cunningham Creek (VADEQ station 2-XPA000.57) to assess the overall health of the stream. As part of this program, VADCR identifies and counts fish and aquatic macroinvertebrates. They also document in-stream habitat and assess riparian zones. As a result of this monitoring, the unnamed tributary was identified as a "healthy water."

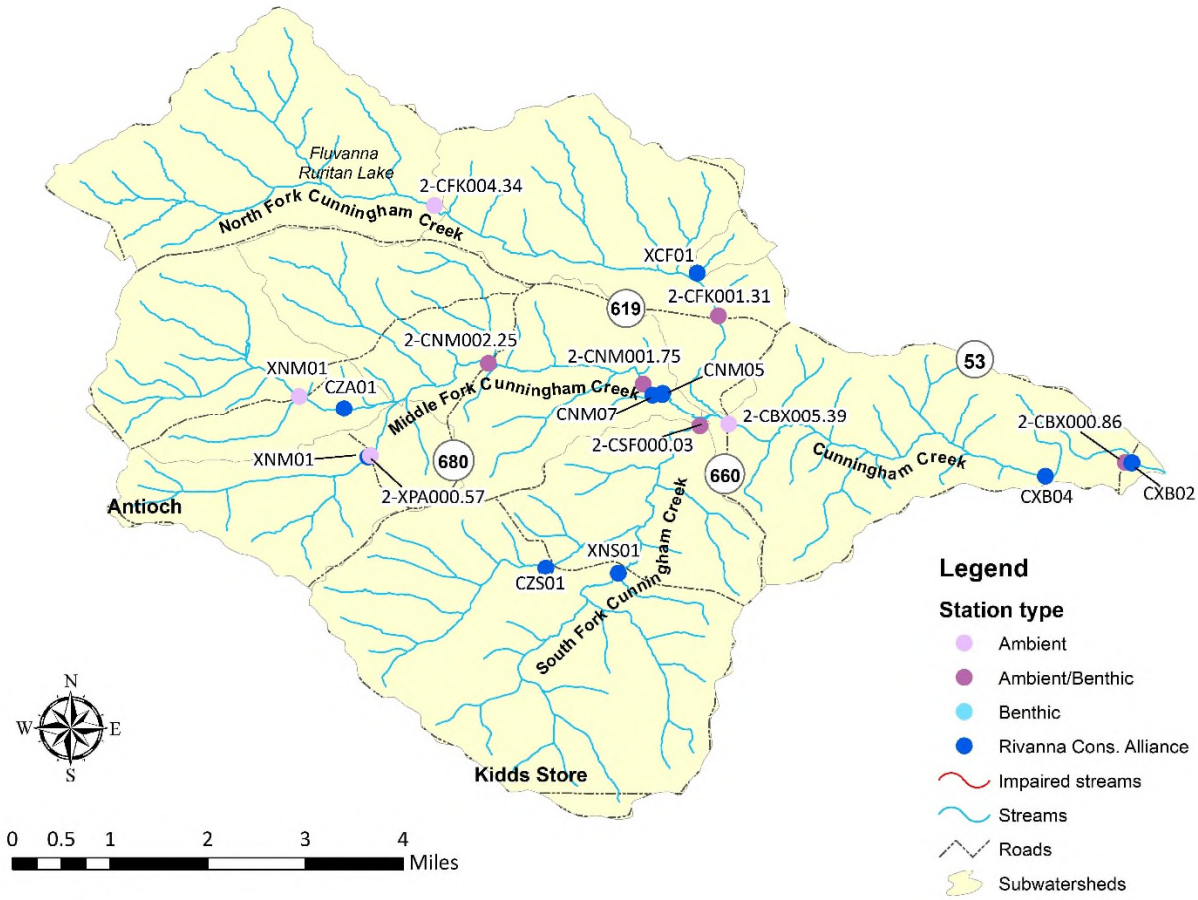

Figure 3-1. VADEQ and volunteer monitoring stations in the Cunningham Creek watershed.

Table 3-1. VADEQ ambient water quality monitoring stations in the Cunningham Creek watershed. Note: Exceedances of single sample maximum criteria are based on an E.coli concentration of 235 cfu/100mL.

Stream Name	DEQ Station ID	# of Samples	Period of Record	Exceedance Rate
NF Cunningham	2-CFK001.31	22	01/16 – 10/17	9.1%
	2-CFK004.34	34	04/04 – 10/16	0.0%
MF Cunningham	2-CNM001.75	22	01/16 – 10/17	4.6%
	2-CNM002.25	18	07/03 – 05/06	33.3%
	2-CNM004.16	12	07/04 – 05/06	16.7%
SF Cunningham	2-CSF000.03	21	02/16 – 10/17	14.3%
Cunningham	2-CXB000.86	22	01/16 – 10/17	4.6%
	2-CXB005.39	34	01/09 – 10/17	17.7%
X-trib, MF Cunningham	2-XPA000.57	12	07/03 – 05/05	16.7%

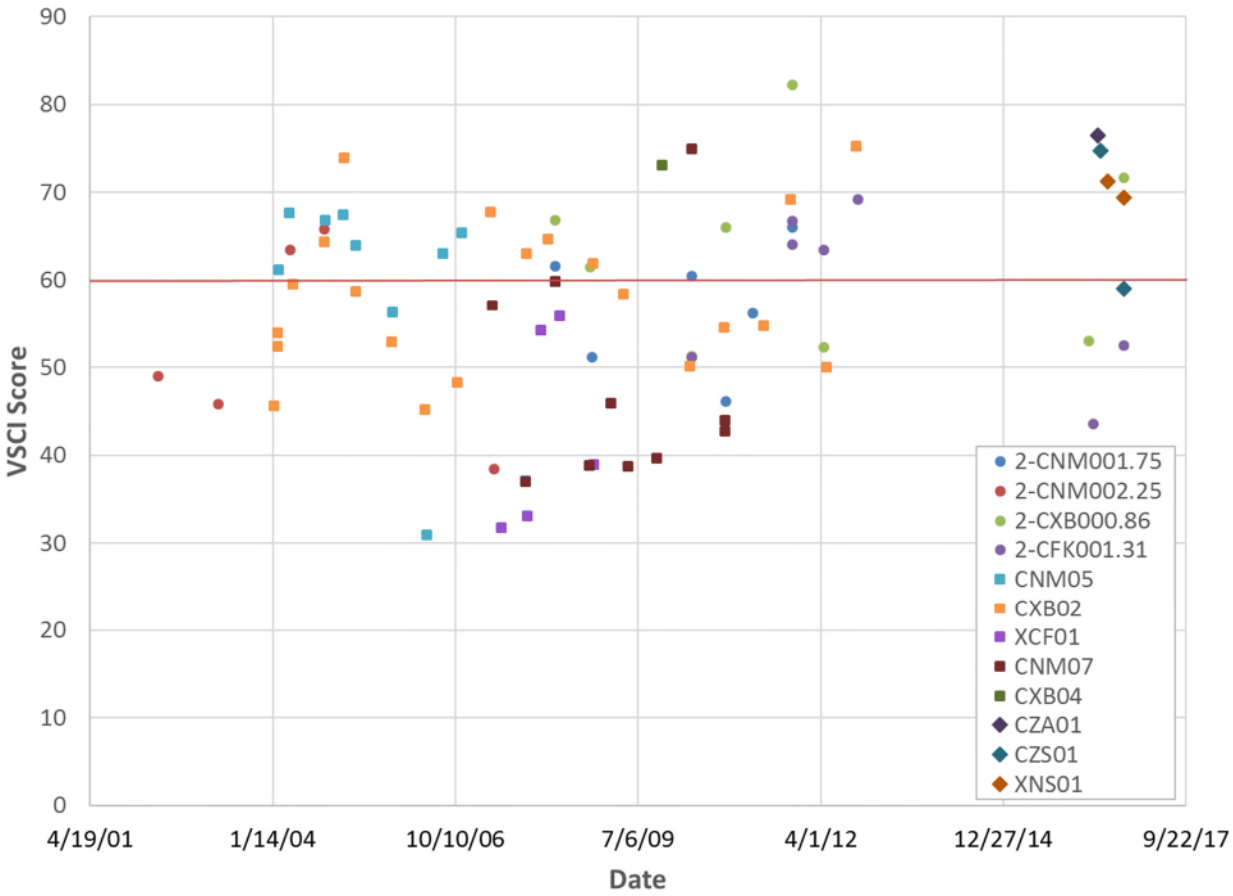

Figure 3-2. VSCI scores for Cunningham Creek and tributaries. Note: A score of 60 or higher is classified as non-impaired while scores below 60 are considered impaired.

3.2 Bacteria Source Assessment

Potential sources of bacteria considered in the development of the watershed plan included both point source and nonpoint source contributions. There are no point source contributions in the Cunningham Creek watershed from facilities permitted to treat human waste.

Nonpoint source pollution originates from sources across the landscape (e.g., agriculture and urban land uses) and is delivered to waterbodies by rainfall and snowmelt. In some cases, a precipitation event is not required to deliver nonpoint source pollution to a stream (e.g., pollution from leaking sewer lines or livestock directly defecating in a stream). Nonpoint sources of bacteria in the watershed included residential sewage treatment systems, land application of waste, livestock, wildlife, and domestic pets. Bacteria loads were represented either as land-based loads (where they were deposited on land and available for wash off during a rainfall event) or as direct loads (where they were directly deposited into the stream). Land-based nonpoint sources are represented as an accumulation of bacteria on the land, where some portion is available for transport in runoff. The amount of accumulation and availability for transport vary with land use type and season. The maximum accumulation was adjusted seasonally to account for changes in die-off rates, which are dependent on temperature and moisture conditions. Direct loads such as straight pipes are modeled similarly to point sources since they do not require a runoff event for delivery to the stream.

Bacteria sources and production rates in the Cunningham Creek watershed were assessed using information from the following sources: VADEQ, U.S. Census Bureau, Virginia Department of Conservation and Recreation (VADCR), Virginia Department of Game and Inland Fisheries (VADGIF), Virginia Cooperative Extension (VCE), Thomas Jefferson Soil and Water Conservation District (SWCD), public participation, published information and professional judgement. Potential nonpoint sources of fecal coliform in the Cunningham Creek watershed are summarized in Table 3-2 by source and the resulting estimated loadings from each source to the watershed are summarized in Table 3-3.

Table 3-2. Potential fecal coliform sources and daily fecal coliform production by source in the Cunningham Creek watershed.

Potential Source	Total Estimated Population	Fecal Coliform (FC) produced (x 10^6 cfu/head/day)	FC Production Rate Reference
Humans	2,480	2,950	1
Beef Cattle	412*	104,000	2
Goats	110	28,000	2
Sheep	27	12,000	2
Horses	104	420	2
Poultry	119	136	2
Hogs	4	10,800	2
Dogs	899	216	3
Deer	1,115	460	4
Raccoons	342	814	4
Muskrats	16	34	4
Beavers	56	0.2	4
Ducks (Offseason)	55	2,430	4
Ducks (Peak)	82	2,430	4
Geese (Offseason)	180	10	4
Geese (Peak)	251	10	4
Wild Turkeys	286	93	4
Coyotes	7	216	5
Bears	28	45	6

* cow-calf pairs

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2. ASAE. 2003. Manure Production and Characteristics. American Society of Agricultural Engineers Standard D384.1. St. Joseph, MI
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4. Tse, 2015. Examining the Influence of Wildlife Population and Fecal Coliform Density Variability on Virginia Bacterial TMDL Development. (Unpublished master's thesis.) Virginia Polytechnic Institute & State University, Blacksburg, VA
5. Assumed same FC production as dogs
6. MapTech, Inc. 2016. E. coli TMDL Development for South Fork Holston River in Smyth and Washington Counties, VA. Virginia Department of Environmental Quality, Richmond, VA

Table 3-3. Estimated annual fecal coliform bacteria load in the Cunningham Creek watershed by source.

Source		Annual Fecal Coliform Load (cfu/yr)	Percentage of Annual Load (%)
Land based sources	Failing septic systems	5.12×10^{13}	1.6%
	Pets	7.09×10^{13}	2.2%
	Livestock	2.71×10^{15}	84.0%
	Wildlife	3.24×10^{14}	10.1%
Direct sources	Permitted point sources	-	-
	Straight pipes	-	-
	Livestock in stream	4.51×10^{13}	1.4%
	Wildlife in stream	2.44×10^{13}	0.7%
TOTAL		**3.23×10^{15}**	**100%**

3.3 Benthic Stressor Analysis

Since a benthic impairment is based on a biological inventory, rather than on a physical or chemical water quality parameter, the pollutant responsible for the impairment is not explicitly identified in the assessment, as it is with physical and chemical parameters. In order to address the benthic impairments present in the watershed in this plan, a pollutant of concern needed to be identified. The process outlined in USEPA's Stressor Identification Guidance Document (USEPA, 2000) was used to identify the critical stressor(s) for Cunningham Creek and its tributaries. A list of candidate causes was developed from the listing information, biological data, published literature, and stakeholder input. Chemical and physical monitoring data from DEQ provided additional evidence to support or eliminate the potential candidate causes. Biological metrics and habitat evaluations in aggregate provided the basis for the initial impairment listing, but individual metrics were also used to look for links with specific stressors, where possible. Volunteer monitoring data, land use distribution, Virginia Base Mapping Project (VBMP) aerial imagery, Google Earth, and visual assessment of conditions in and along the stream corridor provided additional information to investigate specific potential stressors. Logical pathways were explored between observed effects in the benthic community, potential stressors, and intermediate steps or interactions that would be consistent in establishing a cause and effect relationship with each candidate cause. The candidate benthic stressors considered in the following sections are ammonia, pH, temperature, metals, toxic organic compounds, nutrients (dissolved oxygen), organic matter, streambed sedimentation, ionic strength (sulfates, conductivity, total dissolved solids), and flow/hydrologic modification. The

information in this section is adapted from the original Stressor Analysis Report for Cunningham Creek presented to the Technical Advisory Committee on March 21, 2016.

3.4 Analysis of Candidate Stressors for Upper Middle Fork (MF) Cunningham Creek

The suspected source of the benthic impairments in the Upper MF Cunningham Creek was listed as "natural sources" in the 2014 impaired waters fact sheets, but was described in 2002 DEQ biologist's field notes as being due to drought. The original listing was in 2004. The only DEQ monitoring station for biological monitoring in the impaired segment is 2-CNM003.82. A subsequent sample taken in 2003 was healthy, but no other samples have been taken at this site as road access is no longer available.

3.4.1 Possible Stressors

Hydrologic Modifications/Variability

Hydrologic modifications can cause shifts in the availability of water, sediment, food supply, habitat, and pollutants from one part of the watershed to another, thereby causing changes in the types of biological communities that can be supported by the changed environment. No flow monitoring gages were in the watershed.

Evidence for hydrologic variability being a most probable stressor in 2004 comes from both anecdotal information and from the record of annual rainfall in the area. On 04/29/02, DEQ monitors noted "drought conditions" at station 2-CNM003.82, which corresponded with a poor VSCI score for the one sample included in the 2004 assessment. Hydrologic variability is due to natural and human-induced changes in weather patterns that might affect survival and available habitat for benthic organisms. The annual CFSR rainfall totals generated for Cunningham Creek support the monitor's analysis of drought conditions during the period previous to the sample (2000-2002), as well as possibly in 2007-2008. However, the last 6 years show rainfall totals more in a normal range for this site. Therefore, hydrologic modifications and climate variability appear to be one of the stressors that led to the poor 2002 benthic sample in this sub-watershed.

Nutrients

Excessive nutrient inputs can lead to increasing algal growth, eutrophication, and low dissolved oxygen (DO) concentrations that may adversely affect the survival of benthic macroinvertebrates.

In particular, dissolved oxygen levels may become low during overnight hours due to plant respiration. Sources of nitrogen include groundwater, residential wastewater and runoff, atmospheric deposition, and runoff associated with agricultural operations. Although there have been no biosolids applications or TP threshold exceedances in the Upper MF sub-watershed, the 2002 sample had a dominance of chironomids which may be indicative of elevated nutrients; algae has been visible in several ponds; at station 2-CNM004.16, 7 out of 12 samples had TN concentrations > 0.30 mg/L, but still rated as "optimal" by DEQ's ProbMon Condition Classes, while TP averaged 0.034 mg/L, and was rated as "fair." Therefore, nutrients were also determined to be a possible stressor to the biological community in 2004.

Organic Matter

Excessive organic matter can lead to low in-stream dissolved oxygen concentrations, which may adversely affect the survival and growth of benthic macroinvertebrates. Potential sources of organic matter include household wastewater discharges, spills, malfunctioning septic systems, livestock manures, and runoff from impervious areas. The 2002 sample had a high percentage of filterer-collector organisms, which could be indicative of elevated organic matter. Also, during the 07/04-05/06 period, ambient monitoring at 2-CNM004.16 had 2 out of 12 samples exceeding the *E. coli* single sample maximum criterion. Unfortunately, no BOD, COD, or DO samples were available to assess additional impacts from nutrients, although both the 2002 and 2003 samples had low MFBI metric values, which are not indicative of organic matter as a stressor. Although all the evidence is not supportive, the persistent visible algae on the ponds show the system is enriched and organic matter may have contributed to the stress in the 2002 sample. Since the 2003 sample was healthy even though algae persists even in current imagery, organic matter is listed only as a possible stressor.

3.4.2 Most Probable Stressor

Sediment

Excessive sedimentation can impair benthic communities through loss of habitat. Excess sediment can fill the pores in gravel and cobble substrate, eliminating macroinvertebrate habitat. Potential sources of sediment include residential runoff, forestry and agricultural runoffs, livestock access to streams, construction sites, and in-stream disturbances.

None of the samples had elevated TSS or turbidity concentrations, not unsurprisingly, as they are primarily ambient baseflow samples, and 20 species of fish were identified in a 1994 EMAP survey (VCU, 2015). However, the 2002 sample had a low percentage of haptobenthos organisms which might be indicative of habitat loss due to sediment, and on a March 2016 tour of the watershed, some bank stability issues were noted, along with considerable sediment deposition at 2-CNM004.16, although the flow was clear. Therefore, currently, sediment appears to be the most probable cause of stress, with possible contributions from nutrients.

3.5 Analysis of Candidate Stressors for Lower Middle Fork (MF) Cunningham Creek

The suspected source of the benthic impairments in the Lower MF Cunningham Creek was listed as “non-point sources” in the 2014 impaired waters fact sheets, with an original listing in 2010. Monitoring stations for biological monitoring in the impaired segment include DEQ stations 2-CNM001.75 and 2-CNM002.25, as well as StreamWatch stations 2-CNM05-SW and 2-CNM07-SW.

3.5.1 Possible Stressors

Nutrients

A dominance of chironomids, hydropsychids, and simuliids, which may be indicative of elevated nutrients were reported in 5 out of 7 samples prior to the 2010 assessment, and in 8 out of 10 samples since then. At station 2-CNM002.25 between 2003-2006, average TN = 0.418 mg/L, and average TP = 0.080 mg/L, with 2 exceedences of the TP screening threshold of 0.20 mg/L, along with 7 out of 53 samples that exceeded the fecal coliform bacteria WQS of 400 cfu/100 mL. Downstream, at station 2-CNM001.75 in 2015, TN averaged 0.275 mg/L and TP = 0.026 mg/L. Livestock with stream access were also in the watershed just above station 2-CNM002.25 prior to the 2010 assessment, which have since been replaced with a vineyard and a small horse and goat operation, all of which were fenced in the last couple of years. There have been no biosolids applications in the Lower MF sub-watershed. Therefore, nutrients were determined to be a possible stressor to the biological community in the 2010 assessment, but have since been addressed by a land use change and implementation of livestock exclusion fencing.

Organic Matter

Monitoring at 4 stations has reported 6 out of 7 samples prior to 2008 and 7 out of 16 samples since with a high percentage of filterer-collector organisms, which may be indicative of organic contributions. Additionally, 5 out of 20 samples (4 stations) had elevated MFBI values (also indicative of organic-loving organisms) prior to 2008 but 0 out of 6 samples since then. The upstream station prior to 2008 also had 4 out of 7 samples with tubificid and asellid organisms (indicative of sewage or possible rotting carcases), but with no detections of these organisms in the last 16 samples combined. Also, pre-2008, 9 out of 18 samples were reported with E. coli WQS exceedances, whereas neither of 2 samples taken in 2015 exceeded the WQS. There have been no exceedances of the minimum DO WQS either pre-2008 or since. Although organic matter appeared to contribute to the stress in the 2010 assessment, the effect of the organic contributions has diminished over time, and therefore organic matter is listed only as a possible stressor.

3.5.2 Most Probable Stressor

Sediment

The primary evidence for sediment as a stressor comes from the habitat metrics and field observations. A lack of riparian vegetation and sediment deposition were noted repeatedly at all 4 stations, with some bank stability issues noted at the upstream site (2-CNM002.25). In addition, embeddedness and lack of epifaunal substrate were most notable at the downstream DEQ site (2-CNM001.75); the LRBS (though only moderately indicative of enhanced sediment movement) was higher at 2-CNM001.75 than at the other 3 sites monitored around the larger Cunningham Creek watershed.

The most probable stressors in 2010 included sediment, nutrients, and possibly decomposing organic matter from pasture runoff and livestock access near 2-CNM002.25 prior to 2008. There may also have been some effects of construction and discharges from Tenaska prior to 2010.

Since then, however, a major offending livestock pasture area has been turned into a vineyard, with all remaining livestock fenced out, and the Tenaska discharge has been diverted to the Rivanna River. Also, since 2010, 150 acres of timber have been harvested in the sub-watershed, although stream buffers appear to have been kept in place. The most probable stressor currently is sediment due to lack of riparian vegetation.

3.6 Analysis of Candidate Stressors for an Unnamed Tributary (X-Trib) to North Fork (NF) Cunningham Creek

The suspected sources of the benthic impairment in the NF Cunningham Creek X-trib was listed as "municipal (urbanized high density area)" and non-point source in the 2014 impaired waters fact sheet. The listing station for this impaired segment was the StreamWatch station 2-XCF01-SW.

3.6.1 Possible Stressors

Nutrients

Monitoring data showed that 2 out of 2 pre-2008 samples had a dominance of chironomids which may be indicative of elevated nutrients; and 3 out of 5 samples lacked diversity with their dominant 2 organisms comprising more than 70% of all organisms. New home construction fertilization occurred beginning in 2005 with massive clearing along the northwest boundary of the sub-watershed, where at least 29 new houses and a few others just outside the sub-watershed boundary were built along Taylor Ridge Way and Chapel Court. Fertilizer from new lawn establishment may also be a contributor. Therefore, nutrients were determined to be a possible stressor to the biological community in 2010.

Organic Matter

Although no specific sources have been identified in this sub-watershed, 2 out of 2 benthic samples had a high percentage of filterer-collector organisms and a low fraction of scraper organisms, both of which could be indicative of organic contributions. Since no BOD, COD, or DO samples were available to assess additional impacts from organic matter, organic matter is listed only as a possible stressor.

3.6.2 Probable Stressor

Sediment

Both pre-2008 samples had low percentages of haptobenthos organisms which might be indicative of habitat loss due to sediment. On a March tour of the watershed, a continued lack of adequate vegetation on developments close to the sub-watershed were observed, as well as a recent denuding of the road outslope vegetation just upstream from the monitoring site. Sediment depositional areas below the road confirmed the excessive movement of sediment in this sub-watershed. The most probable stressor in 2010 was sediment from new home construction, while the most probable

stressor today is sediment from expanded new construction and poor vegetation establishment near the outlet. Other potential sources of stress include residential lawn fertilization and runoff from unknown livestock activity in an unbuffered feedlot off Taylor Ridge Way.

3.7 Analysis of Candidate Stressors for Lower North Fork (NF) Cunningham Creek

The suspected source of the benthic impairments in the Lower NF Cunningham Creek was listed as “non-point sources” in the 2014 impaired waters fact sheet. The only DEQ monitoring station for biological monitoring in the impaired segment is 2-CFK001.31. The 2012 listing was based on one poor benthic sample in 2010.

3.7.1 Possible Stressors

Nutrients

The 2010 sample had a dominance of chironomids and simuliidae organisms, which may be indicative of elevated nutrients; in 2015, TN has averaged 0.623 mg/L, rated as “optimal” by DEQ’s ProbMon Condition Classes, while TP averages 0.035 mg/L, rated as “fair”. There have been no biosolids applications or TP threshold exceedances in the Upper NF sub-watershed. There has been considerable new home construction, in addition to older homes on the boundary of the sub-watershed which may have some septic system maintenance issues, and fertilization of residential lawns, in general, may be contributors. Therefore, nutrients were determined to be a possible stressor to the biological community.

Organic Matter

The 2010 sample had a dominance of chironomids and simuliidae organisms, a high number of filterer-collector organisms and a low fraction of scrapers, which could also be indicative of organic contributions. Since then, in the most recent 6 samples, no dominance was observed and the number of filterer-collectors has been reduced. However, 2 of those samples still showed a low fraction of scrapers and 2 samples included tubificid and asellid organisms, generally associated with raw sewage. No exceedences of the minimum DO WQS have been monitored in 2015. Although no BOD or COD samples were available to assess additional impacts from organic matter, all of the available evidence is not supportive, so organic matter is only listed as a possible stressor.

3.7.2 Most Probable Stressor

Sediment

Between 2007 and 2011, DGIF dam inspectors noted a severely eroded gully in the Fluvanna Ruritan Lake outlet channel, whose sediment contribution may incrementally be moving downstream. Minor occurrences of low percentages of haptobenthos and embeddedness were reported. On a March 2016 tour of the watershed, some bank stability issues were noted, along with turbid water and sediment deposition at 2-CFK001.31, which was consistent with 3 out of 4 samples since 2011 rated with poor habitat scores for the sediment deposition metric. Although the 2015 measurement of the siltation index (LRBS) indicated normal bottom sediment characteristics, the most probable stressor is sediment arising from episodic upstream gully erosion near the lake outlet, residential development, and possibly minor contributions from timber harvesting.

3.8 Analysis of Candidate Stressors for Cunningham Creek

The suspected source of the benthic impairments in Cunningham Creek was listed as “non-point sources” in the 2014 impaired waters fact sheet. DEQ monitoring station 2-CXB000.86 and StreamWatch station 2-CXB02-SW were stations reporting violations of the General Standard for this stream segment.

3.8.1 Possible Stressors

Nutrients

A combination of chironomids, hydropsychids, and simuliids were dominant in 5 out of 8 samples pre-2010 and in 8 out of 10 samples since, which may be indicative of elevated nutrients. TN concentrations ranged from an average of 0.494 mg/L at station 2-CXB005.39 pre-2010, to 0.444 mg/L since then, to 0.38 mg/L at the downstream station, 2-CXB000.86. Similarly, TP concentrations ranged from an average of 0.082 mg/L at station 2-CXB005.39 pre-2010, to 0.045 mg/L since then, to 0.029 mg/L at the downstream station, 2-CXB000.86. Some older residential homes may contribute TN from septic system failures, and fertilization of residential lawns, in general, may also contribute nutrients. Several fields were permitted for biosolids application, but actual dates and rates of application are unknown. Additionally, there is livestock activity in and above the watershed. Therefore, nutrients were determined to be a possible stressor to the

biological community prior to 2010, but since then, TN and TP concentrations have been reduced by 23% and 65%, respectively, and show less evidence of being a stressor.

Organic Matter

In pre-2000, samples at station 2-CXB005.39, 13 out of 31 samples had COD values > 10 mg/L, and pre-2010, 5 out of 18 samples at both DEQ stations had elevated MFBI values indicative of organic-loving organisms, although none of the 4 samples taken since then have shown elevated MFBI values. In 2002, the sole exceedance of the minimum DO WQS was noted at the upstream station, 2-CXB005.39. During the pre-2010 period and in the period since then, about half of the samples showed a dominance of hydropsychids and simuliids, a low fraction of scrapers, and a high percentage of filterer-collectors, all of which could be indicative of organic contributions. Therefore, similar to nutrients, organic matter indicators have shown some decline since the listing period, so that organic matter is considered only to be a possible stressor.

3.8.2 Most Probable Stressor

Sediment

During both the pre-2010 period and since then, an abundant number of haptobenthos organisms have been counted which require a non-embedded substrate for habitat. Despite that and an LRBS siltation index in the normal range, about half of the samples have received poor riparian vegetation and sediment deposition habitat scores with all of the 5 samples since the 2012 assessment receiving poor scores for sediment deposition and 3 of the 5 noting poor scores for bank stability. Additionally, 258 acres of timber harvesting occurred in the watershed in 2014-15, although stream buffers appear to be intact which would minimize off-site sediment movement.

The most probable stressors in 2012 were TP and sediment from upstream watersheds as shown by elevated concentrations at station 2-CXB005.39 relative to station 2-CXB000.86, near the outlet. Minor impacts may have been related to isolated elevated ammonia (1) and specific conductivity (3) measurements collected in 2001 and 2002. The source of the ammonia and specific conductivity are unknown, and these data pre-date construction of the upstream Tenaska plant.

The most probable stressor currently is sediment. Although no dominant sources are evident from imagery, some sediment loading may occur from pasture runoff, periodic timber harvesting, and in-stream sediment transport, as evidenced by cloudy stream conditions at 2-CXB005.39 and

sediment deposits on the banks and in-stream at 2-CXB000.86. Many, if not all, livestock have been excluded from streams in this sub-watershed between 2009 and 2015 reducing all of the possible stressors.

3.9 Sediment Source Assessment

Potential sources of sediment considered in the development of the watershed plan included both point source and nonpoint source contributions. There are no permitted sources of sediment in the Cunningham Creek watershed. Land based and channel/streambank sediment sources were estimated from VADEQ's 2016 Nonpoint Source Assessment (VADEQ, 2016). The contributions from various land based sources within the watershed are shown in Table 3-4. Loading from pasture is the largest source of land based sediment in the watershed (39% of the total load). In addition, streambanks contribute sediment loads to Cunningham Creek and its tributaries, along with erosion from residential development, livestock access and possibly minor contributions from timber harvesting. In the past, episodic gully erosion downstream of the Fluvanna Ruritan Lake outlet contributed significant sediment loads to North Fork Cunningham Creek, and was most likely the cause of the benthic impairment on this impaired segment. However, staff from VADEQ, VADGIF and Thomas Jefferson SWCD visited the Fluvanna Ruritan dam and the impaired segment of the North Fork downstream from the outlet in October 2017 and concluded that active erosion below the dam (at the outlet and the streambanks downstream) has slowed substantially and additional streambank remediation or spillway modifications would not provide significant water quality benefits. Therefore, streambank and channel erosion will be reduced through implementation of control measures that address the land based sediment sources as well as those within the stream channel (e.g., livestock exclusion).

Table 3-4. Estimated annual sediment load in the Cunningham Creek watershed by source.

Source		Annual Sediment Load (tons/yr)	Percentage of Annual Load (%)
Land based sources	Residential/urban	75.4	4%
	Cropland	342.0	19%
	Pasture	695.8	39%
	Degraded riparian pasture	174.6	10%
	Forest	74.9	4%
	Harvested Forest	62.7	4%
	Transitional	202.9	11%
Streambank sources	Streambank erosion	153.8	10%
TOTAL		**1,782.1**	

3.10 Estimated Bacteria Load Reductions

Bacteria load reduction estimates for the Cunningham Creek watershed were calculated with load duration curves following EPA's *An Approach for Using Load Duration Curves in the Development of TMDLs* (USEPA, 2007). This approach involves calculating the allowable loadings over the range of flow conditions expected to occur in an impaired stream segment.

3.10.1 Flow Duration Curve

Development of a Load Duration Curve (LDC) starts with the derivation of a flow duration curve. Six flow measurements were collected at each of four locations in the Cunningham Creek watershed between November 2015 and October 2016 (Table 3-5). These limited flow data were used to select an appropriate reference stream with a long-term, continuous flow record to develop a suitable surrogate flow duration curve.

Table 3-5. Location and range of flow measurements taken between Nov. 2015 and Oct. 2016 in the Cunningham Creek watershed.

USGS Site	DEQ Monitoring Station	Range of Flows (cfs)
USGS 0203401091 NF Cunningham Creek at RT 619 at Cunningham, VA	2-CFK001.31	1.63 – 11.2
USGS 0203402386 Cunningham Creek at RT 693 near Cunningham, VA	2-CNM001.75	1.70 – 14.4
USGS 0203403597 SF Cunningham Creek above mouth near Cunningham, VA	2-CSF000.03	1.18 – 11.3
USGS 0203404512 Cunningham Creek at RT 15 at Palmyra, VA	2-CXB000.86	5.68 – 45.7

Criteria used to select the surrogate stream were proximity, comparable watershed size, similar land use distribution, and a strong correlation between the Cunningham Creek flow data and the surrogate stream. USGS stream gages with long-term, continuous records of flow that were considered are listed in Table 3-6. While Fine Creek has the closest drainage area to Cunningham Creek watershed (36.2 mi^2) and the flow gage on the Rivanna River is just ½ mile upstream of the Cunningham Creek confluence, the linear regressions between Hardware River and the Cunningham Creek observed flow data were the strongest with R^2 values ranging from a minimum of 0.952 (NF Hardware) and a maximum of 0.984 (MF Hardware), (Figures 3-3 to 3-6). Also, land use distribution in the Hardware River watershed is similar to that in Cunningham Creek watershed. Therefore, the USGS flow gage on Hardware River was selected to develop the flow duration curve.

Table 3-6. Streams with USGS flow gages considered as surrogate streams for development of a flow duration curve for the Cunningham Creek watershed.

USGS Sites on Candidate Surrogate Streams	Period of Record	Drainage Area (mi^2)	Distance to Cunningham Creek Outlet (miles)
USGS 02036500 Fine Creek at Fine Creek Mills, VA	1944 - 2017	22.4	30.0
USGS 02030000 Hardware River below Briery Run near Scottsville, VA	1938 - 2017	116	10.9
USGS 02038850 Holiday Creek near Andersonville, VA	1966 - 2017	8.5	36.2
USGS 02034000 Rivanna River near Palmyra, VA	1934 - 2017	663	0.5

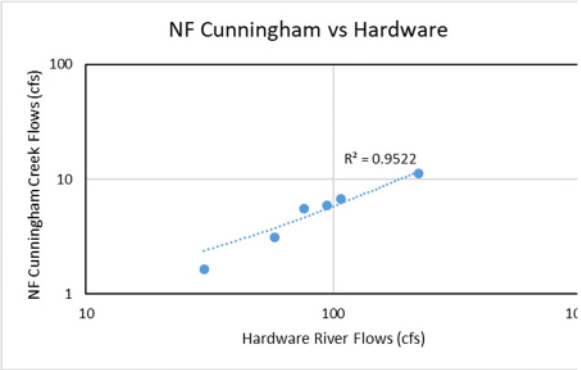

Figure 3-3. Flow regression for North Fork Cunningham Creek and Hardware River.

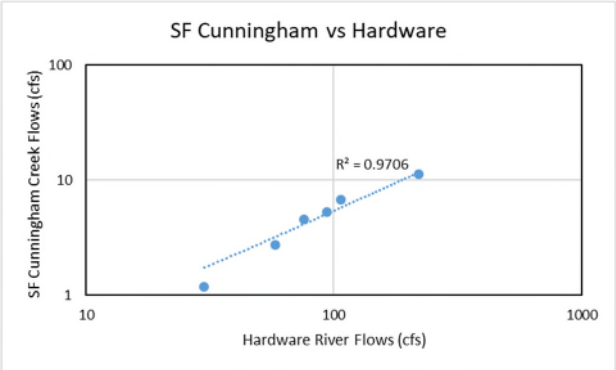

Figure 3-5. Flow regression for South Fork Cunningham Creek and Hardware River.

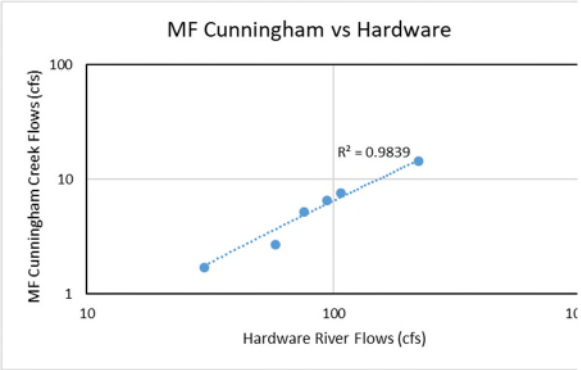

Figure 3-4. Flow regression for Middle Fork Cunningham Creek and Hardware River.

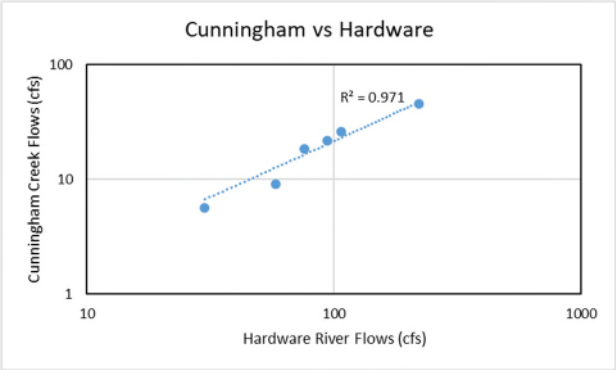

Figure 3-6. Flow regression for Cunningham Creek and Hardware River.

A flow duration curve was developed for Hardware River based on daily flow records from the period of record at USGS gage 02030000. Using the example described in Appendix A of EPA's *An Approach for Using Load Duration Curves in the Development of TMDLs* (USEPA, 2007), the curve was divided into five hydrologic condition classes (Figure 3-7). Flow duration curves were then developed for each of the Cunningham Creek monitoring stations using ratios of the Cunningham Creek drainage areas (Table 2-1) and the Hardware River drainage area (74,240 acres).

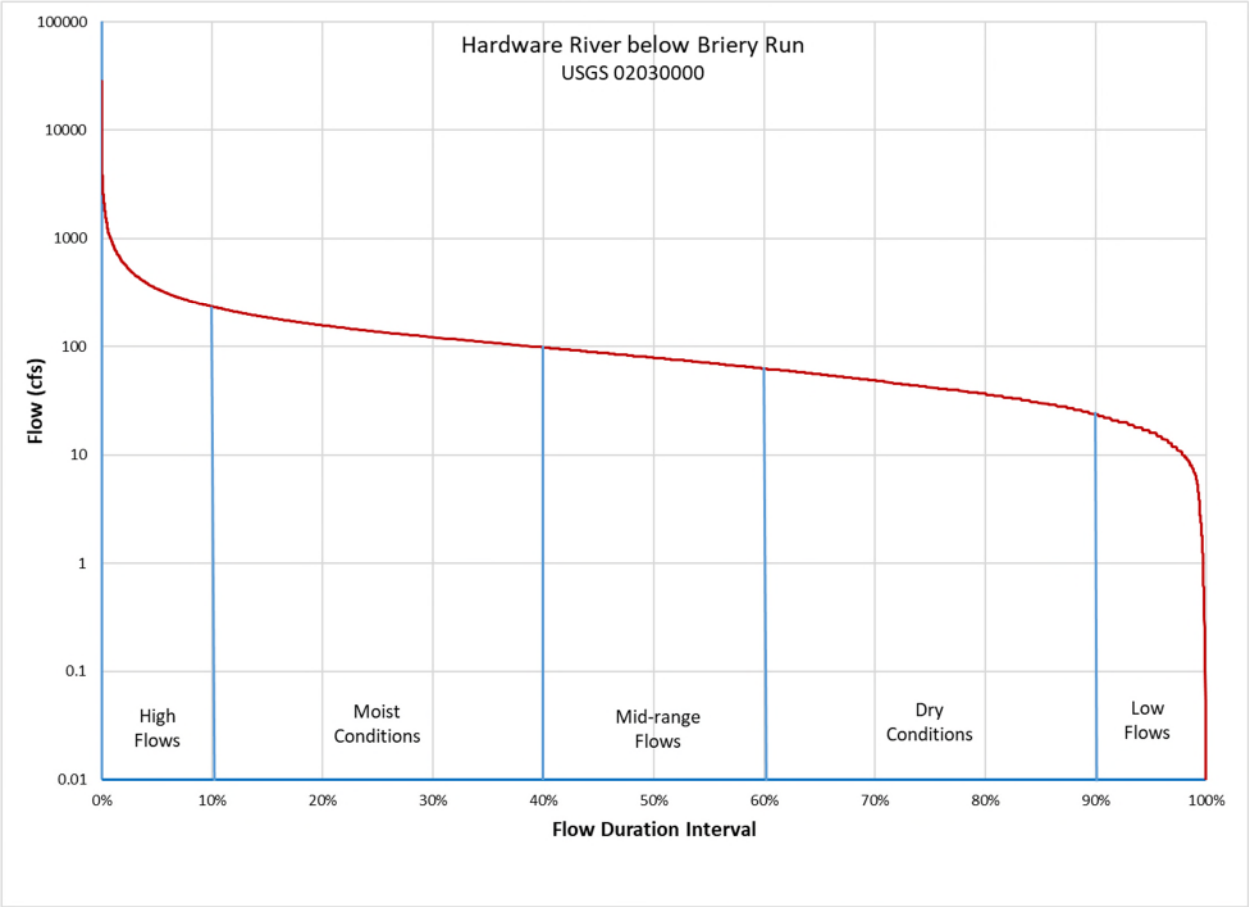

Figure 3-7. Hardware River flow duration curve.

3.10.2 Load Duration Curves

A Load Duration Curve (LDC) was developed for each Cunningham Creek monitoring station that had a greater than 10% exceedance rate of VADEQ's single sample *E. coli* maximum criterion of 235 cfu/100mL, and had monitoring data from 2008 - 2017. The latter condition was applied because of a decrease in beef cattle in the watershed over the past ten years, particularly in the Middle Fork Cunningham Creek watershed.

Using the Hardware River flow duration curve to develop each LDC, VADEQ's single sample *E. coli* maximum criterion of 235 cfu/100mL was multiplied by the area-weighted stream flow at each of the applicable Cunningham Creek monitoring stations to determine the allowable bacteria load across all flow conditions (Figures 3-8 and 3-9). Each water quality sample was converted to a load (cfu/day) by multiplying the observed *E. coli* concentration by the corresponding flow from the day the sample was collected. The loads are plotted as points and can be compared to the LDC (water quality criterion) to determine

the number of exceedances. *E. coli* loads above the LDC indicate exceedances of the water quality criterion.

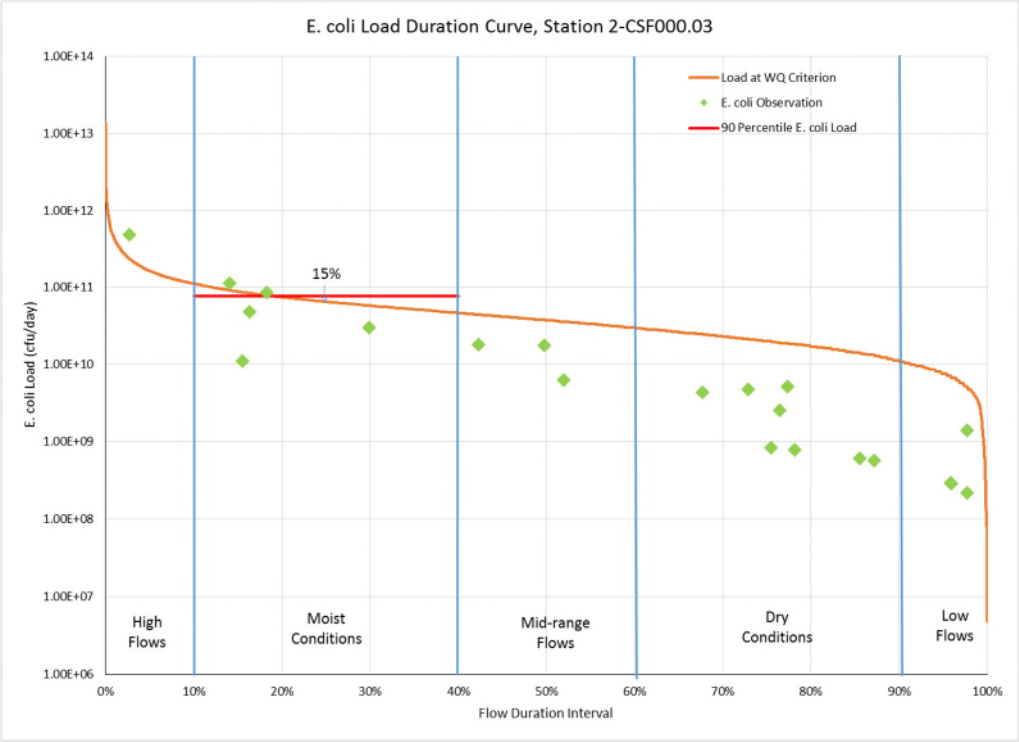

Figure 3-8. *E. coli* load duration curve and observations, SF Cunningham Creek, station 2-CSF000.03.

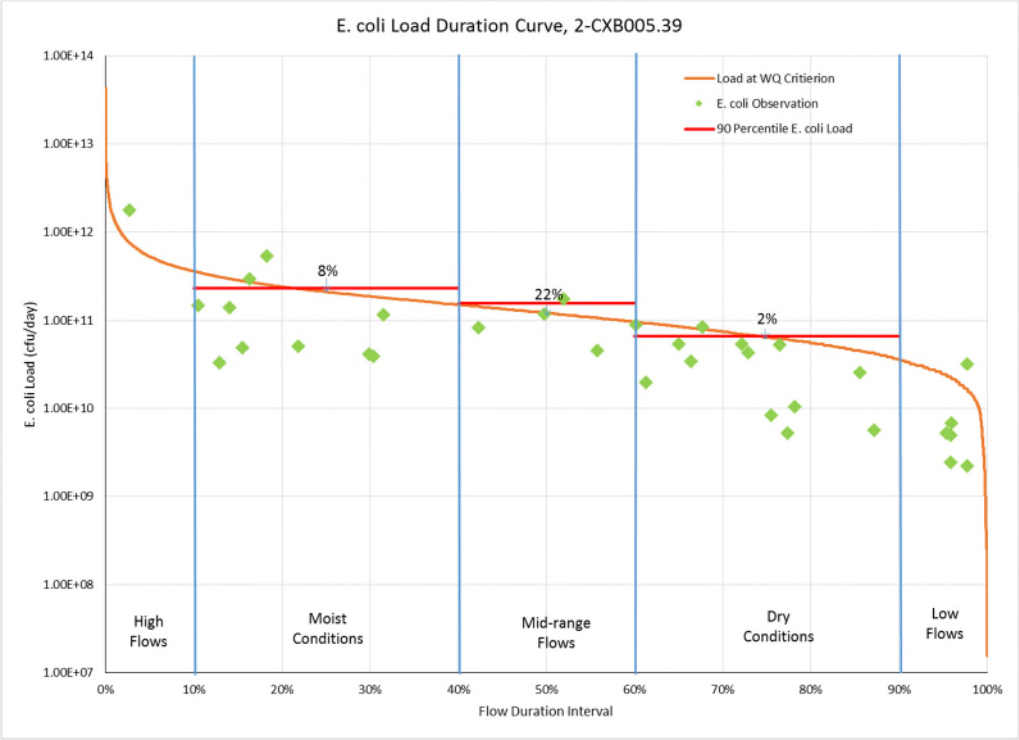

Figure 3-9. *E. coli* load duration curve and observations, Cunningham Creek, station 2-CXB005.39.

According to EPA guidance (USEPA, 2007), the allowable loading capacity for each flow condition is calculated at the midpoint of the flow class. For example, the allowable loading capacity for "moist conditions" is the *E. coli* load on the LDC at the flow duration interval of 25% (middle percentile of the 10 – 40th percentile class). The estimated existing load under each hydrologic flow regime is calculated as the 90th percentile of measured *E. coli* concentrations multiplied by the flow at the midpoint of the hydrologic flow regime class. For example, in calculating the existing loading under moist conditions, the 25th percentile exceedance flow is multiplied by the 90th percentile of *E. coli* concentrations measured within the 10 – 40th percentile class. Estimated existing loads (90th percentile *E. coli* loads) were calculated in the moist, mid-range, and dry conditions classes for each monitoring station where observed *E. coli* loads exceed the LDC (Figures 3-8 and 3-9, Table 3-7). The "high flows" and "low flows" hydrologic conditions were not considered because these extreme flows do not represent typical conditions (USEPA, 2007). From the results (Table 3-7), the percent reduction of bacteria load needed in South Fork Middle Creek is 15% and a 22% reduction is needed in Cunningham Creek at monitoring station 2-CBX005.39.

Table 3-7. Estimated existing *E. coli* load, allowable load, and percent reduction needed under different flow condition classes for the Cunningham Creek watershed.

Station ID	Flow Condition Class	Allowable Load (cfu/day)	Estimated Existing Load (90th percentile) (cfu/day)	Percent Reduction Goal
2-CFS000.03	Moist	6.54×10^{10}	7.70×10^{10}	15%
2-CXB005.39	Moist	2.11×10^{11}	2.30×10^{11}	8%
2-CXB005.39	Mid-Range	1.21×10^{11}	1.56×10^{11}	22%
2-CXB005.39	Dry	6.47×10^{10}	6.61×10^{10}	2%

3.11 Process for Estimating Sediment Load Reductions

Based on the benthic stressor analysis conducted as part of the watershed planning process, the Cunningham Creek benthic impairments are minor and the causes of excess sediment are fairly apparent and discrete. In addition, it was believed that in many cases, the causes of bacteria and benthic impairments were related. Consequently, it is likely that the bacteria reduction goals established in the plan would also result in restoration of the benthic community. Therefore, a sediment endpoint was defined by identifying the discrete sources of sediment in the watersheds and necessary corrective actions, and then

calculating the associated sediment load reductions (Table 3-8). This approach combines both a narrative and a quantitative goal as defined by corrective actions. Based on input from the TAC and considerable watershed reconnaissance, it was determined that this was the most suitable approach to address sediment loading in these watersheds.

Table 3-8. Estimated existing sediment load, allowable load, and percent reduction needed based on prescribed corrective actions by subwatershed.

Subwatershed	Estimated existing load (tons/yr)	Allowable Load (tons/yr)	Percent Reduction Goal
Cunningham Creek	257	169	34%
North Fork Cunningham Creek	329	221	33%
Middle Fork Cunningham Creek	430	317	26%
South Fork Cunningham Creek	767	540	30%

For the Upper Middle Fork Cunningham Creek impaired segment (VAV-H32R_CNM02A04) listed originally in 2004, the extended drought of 2000-2002 in the area appears most responsible for the poor 2002 benthic sample, since recent annual rainfall appears normal and the last (2003) benthic sample had a VSCI score in the healthy range.

For the Lower Middle Fork Cunningham Creek impaired segment (VAV-H32R_CNM01A00) listed originally in 2010, there may have been some effects of construction and discharges from Tenaska prior to 2010. However, since then the Tenaska discharge has been diverted to the Rivanna River. Also, the major offending livestock pasture area (just above the benthic monitoring site) has been turned into a vineyard, with all remaining livestock fenced out. Addressing the lack of riparian vegetation should provide adequate sediment load reductions to restore the benthic community in the Lower Middle Fork Cunningham Creek watershed.

For the unnamed tributary to the North Fork Cunningham Creek impaired segment (VAV-H32R_XCF01A10) listed originally in 2010, the most probable stressor is sediment from isolated expanded construction with poor vegetation establishment near the watershed outlet. Implementing residential stormwater practices and enhancing erosion and sediment control measures in developed areas such Taylor Ridge Way, Capel Court, and Cunningham Court will provide sediment load reductions in the unnamed tributary to North Fork Cunningham Creek.

For the Lower North Fork Cunningham Creek impaired segment (VAV-H32R_CFK01A00) listed originally in 2012, the major sediment influence appears to be one or more episodic gully erosion incidents in the outlet channel below the Fluvanna Ruritan Dam, where between 2007 and 2011, DGIF dam inspectors repeatedly noted severely eroded gully, whose sediment load may incrementally be moving downstream. As noted in Section 3.3, active erosion below the dam has slowed substantially and should no longer be a significant source of sediment in Lower North Fork Cunningham Creek.

For the Cunningham Creek mainstem impaired segment (VAV-H32R_CXB01A00) listed originally in 2012, five of the eight VSCI scores were above 60, while the other three were between 50 and 60, indicating a minor impairment. Control measures needed to reduce the bacteria loads by 22% (Table 3-7) will also provide reductions to the sediment load throughout the Cunningham Creek watershed.

4. PUBLIC PARTICIPATION

Collecting input from the public on conservation and outreach strategies to include in the watershed plan was a critical step in this planning process. Since the plan will be implemented by watershed stakeholders on a voluntary basis, local input and support are the primary factors that will determine the success of this plan. Initial outreach for this effort began with a plan for development of a TMDL for the Cunningham Creek watershed. As DEQ worked with local stakeholders on this process, it was determined that TMDL development was not the most suitable approach to address the impairments in the watershed. Following this decision, stakeholders who had been initially engaged in support of TMDL development continued to participate in Technical Advisory Committee meetings to develop a TMDL alternative for Cunningham Creek.

4.1 Public Meetings

A public meeting was held on the evening of February 29, 2016 at the Fluvanna County Library to kick off the development of a TMDL. This meeting served as an opportunity for local residents to learn more about the water quality impairments facing Cunningham Creek and how the TMDL process may be used to address them. This meeting was publicized through a press release published in local papers, email announcements, postcards mailed to riparian landowners, and letters sent to DEQ permit holders in the watersheds. Approximately 20 people attended the meeting.

The final public was held on March 6, 2018 at the Fluvanna County Library. Approximately 20 people attended.

4.2 Technical Advisory Committee

The initial role of the Technical Advisory Committee (TAC) was to review pollutant source assessments for the watershed and discuss the development of allocation scenarios and associated pollutant reduction goals to be established in the TMDL. This group met a total of seven times during watershed plan development: March 22, 2016, April 25, 2016, May 1, 2017, August 1, 2017, September 19, 2017, October 11, 2017 and January 18, 2018. During the second TAC meeting, the group discussed a series of options with respect to a path forward for the project. The group agreed to take a one-year hiatus from TMDL

development so that VADEQ and the Rivanna Conservation Alliance (RCA) could collect additional biological and bacteria data in the watersheds. This decision was made based on concerns expressed at the first TAC meeting regarding the availability of recent water quality data from several of the tributaries of Cunningham Creek included within the TMDL watershed area. A "memorandum of responsibilities" was developed outlining monitoring responsibilities and commitments for 2016-2017. The group reconvened in May, 2017 to review the results of monitoring data collected in the watersheds. These data indicated that bacteria impairments in the watershed appear to be shifting, with the mainstem of Cunningham Creek improving to the point of a potential de-listing, and a potential listing of the South Fork in the 2020 assessment. In addition, the RCA benthic data did not indicate a benthic impairment on the North Fork Cunningham Creek, while the VADEQ benthic data suggested a minor impairment on the mainstem and the North Fork. Based on input from the committee, it was clear that there are a few farms in the watershed with livestock access to the stream that are likely to be the source of the bacteria issues. Consequently, the group agreed that a watershed plan could be the best route to take. Following this decision, the role of the group changed within the planning process. During watershed plan development, the TAC's primary roles were to discuss/review suitable conservation practices and outreach strategies to address the water quality issues in the watershed, identify any obstacles (and solutions) related to BMP implementation, and to provide estimates on the type, number, and costs of BMPs.

The TAC discussed specific agricultural best management practices that could be used to address problem areas in the watershed. Different practices discussed included livestock exclusion, pasture management, and cover crops and continuous no till. The TAC assisted with development of estimates for fencing systems in the watershed. The committee concluded that very few farmers (if any) would be willing to install fencing with a setback over 35 feet, predicting that about 90% of farmers would prefer this option. The group agreed that the remaining 10% would opt for the 15 foot setback due to space constraints. There is also room for fencing innovations as some farmers may have issues with maintaining fencing that meets the specifications established by state and federal cost share programs. In addition, some farmers may not want to set fencing back even 15 feet from the stream.

The committee agreed that many pastures in this area are overstocked with cattle, and that most farmers are reluctant to adopt rotational grazing as a new management strategy. Therefore, the cattle graze the same land all year round and farmers have to feed hay for most all of the winter. The committee believed that this should be an area of focus during outreach with farmers due to the many benefits for their cattle and their overall operation in terms of productivity and ease of management. It was noted that acres of cropland in the watershed has increased over the past few years, so it would be a good idea to include a few cropland BMPs in the plan. It was noted that there is one field that is deep tilled and left uncovered in the watershed (about 20 acres). This site would benefit from a cover crop. The group discussed opportunities for continuous no till in the watershed as well. It was estimated that 200-300 acres is already under no till or low till right now. The estimate of 10% of cropland seemed appropriate to participants.

During the fifth TAC meeting, the committee discussed estimates for septic system BMPs needed in the watershed. These estimates were developed in consultation with local Health Department staff. The group agreed with the estimates and noted that there are no opportunities for connection to public sewer in the watershed, with the sewer line ending at the high school. The group liked the idea of including a pump out program in the plan as a way to identify failing systems, and agreed that the goal of 25% of homes in the watershed seemed appropriate.

The group discussed opportunities to manage pet waste in the watershed. Participants noted that there is one park in the watershed, but that pets aren't allowed there. There are a number of hunting dog kennels scattered throughout the watershed, including one with around 100 dogs in the North Fork Cunningham Creek watershed. A larger pet waste composting facility could be included for an operation of this size. There may be a couple of additional opportunities for large scale composting at dog kennel operations in the watershed (maybe 2-3 total). The group discussed how smaller scale backyard pet waste composters function, and agreed that there may be a few opportunities for these in a couple of subdivisions in the watershed (Taylor Ridge, Cunningham Meadows and Fox Hollow). The group discussed opportunities for pet waste stations in the watershed. These will be limited since there are no parks where pets are walked in the watershed. These stations should really include a trash receptacle in addition to a bag dispenser or pet owners will

just leave bags of waste on the side of the road. Maintaining these stations will be an issue. The Fox Hollow subdivision does not have a homeowners' association, so perhaps one of the other two subdivisions should be considered for pet waste stations instead. If they have HOAs, they could be approached about maintaining the stations. A targeted pet waste campaign could be initiated in these subdivisions. This effort could include a small number of several different types of practices (5 composters, 2 rain gardens, one pet waste station). Rivanna Conservation Alliance could lead this effort, and coordinate bacteria monitoring below the subdivisions to demonstrate water quality improvements following implementation.

The committee discussed opportunities for stormwater retrofits to existing infrastructure. One participant noted that the county is working with Tenaska now to address issues with three stormwater structures that are overgrown and no longer functioning as designed. This could be a good opportunity for a public private partnership if Tenaska agreed to go above and beyond what is required with respect to stormwater management on the property. However, upon further discussion, participants felt like it might be better to explore other opportunities for retrofits since Tenaska has sufficient funds available to make these upgrades on their own.

The TAC had expressed concerns about runoff of sediment from forest harvesting in the watershed. Working with the Department of Forestry (VADOF), VADEQ developed an estimate of an average rate of non compliance of 5% with respect to requirements for forestry BMP implementation as a component of harvesting activities. VADOF staff also noted that the last VADOF audit in the Central Region showed 91% compliance with their guidance for forest harvesting BMP implementation. Most issues with erosion come from log landing pads and skid trails and roads. There is typically anywhere from 50-250 acres harvested per year in the watershed. Additional BMPs needed will be vegetative establishment, water bars (diversion) and putting down gravel on steeper slopes on haul roads. These are the things that are typically overlooked or not implemented to the full extent needed.

The TAC agreed on a 10-year timeline for implementation efforts. They felt that a larger portion of the work would be done at the outset of the project, with those more resistant waiting longer to adopt. Consequently, the group felt that within the first five years of the

project, approximately 60% of implementation goals would be accomplished, with the remaining 40% accomplished in the second five years.

The committee suggested that farm tours and field days, working closely with extension, were the best forms of education and outreach for the agricultural community in the area. The Farm Bureau should be involved in any agricultural outreach. Mailings would also be effective based on the size of the watershed. A participant from the SWCD noted that this watershed is going to be tough in terms of outreach based on the experiences that the SWCD has had in the area when trying to promote BMPs. They recently attempted to hold a field day for farmers in the watershed and had to cancel it after nobody signed up. Community meetings might be another possibility. It was noted that there are not many really progressive farmers in the watershed to help lead the charge. There is a CSA in the watershed, Layz S, that could be good to work with. One on one outreach is possible, but the SWCD does not want to appear too regulatory, and felt that showing up on someone's farm (cold calling) may turn them off. They suggested putting articles in the Fluvanna Review.

The TAC discussed concerns about downstream impacts of the Fluvanna Ruritan Dam on multiple occasions. Committee members noted erosion from the emergency spillway of the dam over the years along with streambank erosion downstream of the outlet. Participants discussed plans for a dam rehabilitation from by the owners (VA Department of Game and Inland Fisheries) and asked for additional information on associated plans to address water quality impacts from the dam. VADEQ staff followed up with the Department of Game and Inland Fisheries (VADGIF) and visited the Ruritan Dam site to assess downstream impacts and erosion at the outlet of the dam. Rehabilitation plans for the dam do not include streambank restoration or removal of downstream sediment deposits. The project plans do include some repairs at the outlet of the dam where a concrete structure is deteriorating. During the site visit, a large amount of erosion was observed below the dam's emergency spillway where a large hole (25 ft deep/across) has formed. It appeared that any active erosion from this "hole" has stopped since it is now down to rock (there is no soil left to erode). The streambank on the other side of the gas line right of way below the dam is relatively stable. There is vegetation growing on the toe of the bank, and there is a steep slope above, so the height of the bank at the site is to be

expected. The overall conclusion from the site visit was that the scour of the spillway of the dam has contributed sedimentation to Cunningham Creek in the past, but that it appears active erosion below the dam has slowed significantly. It is also understood that the reservoir has functioned as a sedimentation basin since it was built in the 1950's and actually has resulted in less-than-natural sediment transport downstream in the form of somewhat "sediment-starved" water. Though this water could pose an increased potential for erosion, it could also help to appropriately distribute the slug of sediment that likely occurred during discrete events in the past.

5. IMPLEMENTATION ACTIONS

An important part of the watershed plan is the identification of specific best management practices and associated technical assistance needed to improve water quality in the watersheds. Since this plan is designed to be implemented by landowners on a voluntary basis, it is necessary to identify management practices that are both financially and technically realistic and suitable for this particular community. As part of this process, the costs and benefits of these practices must be examined and weighed. Once the best practices have been identified for implementation, we must also develop an estimate of the number of each practice that would be needed in order to meet the water quality goals with respect to *E.coli* and sediment in the creeks.

5.1 Identification of Best Management Practices

Potential best management practices, their associated costs and efficiencies, and potential funding sources were identified through input from the working groups and literature reviews. Measures that can be promoted through existing programs were identified, as well as those that are not currently supported by existing programs and their potential funding sources. Some best management practices had to be included in order to meet the water quality goals (e.g. livestock stream exclusion), while others were selected through a process of stakeholder review and analysis of their effectiveness in these watersheds. These measures are discussed in sections 5.1.1 and 5.1.2, respectively.

5.1.1 Control Measures Implied by the Pollution Source Assessment

The reductions in bacteria and sediment identified in the pollutant source assessment dictated some of the control measures that must be employed during implementation in order to meet the pollutant reductions needed to address the water quality impairments.

Livestock Exclusion

In order to meet the bacteria reductions needed in direct deposition from livestock, some form of stream exclusion is necessary. Fencing is the most obvious choice; however, the type of fencing, distance from the stream bank, and most appropriate management strategy for the fenced pasture are less obvious. While it is recognized that farmers will want to minimize the cost of fencing and the amount of pasture lost, the inclusion of a streamside buffer strip helps to reduce bacteria, sediment and nutrient loads in runoff. The

incorporation of effective buffers (35 foot minimum width) could reduce the need for more costly control measures. From an environmental perspective, the best management scenario would be to exclude livestock from the stream bank 100% of the time and establish permanent vegetation in the buffer area. This prevents livestock from eroding the stream bank, provides a buffer for capturing pollutants in runoff from the pasture, and establishes (with the growth of streamside vegetation) one of the foundations for healthy aquatic life. From a livestock-production perspective, the best management scenario is one that provides the greatest profit to the farmer. Obviously, taking land (even a small amount) out of production is contrary to that goal. However, a clean water source has been shown to improve milk production and weight gain. Clean water will also improve the health of animals (*e.g.*, cattle and horses) by decreasing the incidence of waterborne illnesses and exposure to swampy areas near streams. State and federal conservation agencies including DCR and the Natural Resources Conservation Service offer several options with respect to livestock exclusion in their agricultural cost share programs that offer farmers some flexibility.

Septic Systems and Straight Pipes

The 100% reduction in loads from straight pipes and failing septic systems is a pre-existing legal requirement. The options identified for correcting straight pipes and failing septic systems included: repair of an existing septic system, installation of a septic system, and installation of an alternative waste treatment system. It is anticipated that a significant portion of straight pipes will be located in areas where an adequate site for a septic drain field is not available. In these cases, the landowner will have to consider an alternative waste treatment system.

5.1.2 Control Measures Selected through Stakeholder Review

In addition to the control measures that were prescribed through the source assessment, a number of measures were needed to control fecal bacteria and sediment from land-based sources. Various scenarios were developed and presented to the TAC. All scenarios began with the best management practices that were prescribed through the pollutant source assessment such as livestock exclusion and eliminating straight pipes. Next, a series of established best management practices were examined by the TAC, who considered both their economic costs and the water quality benefits that they produced. The majority of these practices are included in state and federal agricultural cost share programs that

promote conservation. In addition, innovative and site specific practices suggested by the TAC were considered. The final set of BMPs identified and the efficiencies used in this study to estimate needs are listed in Table 5-1.

Table 5-1. Best management practices and associated pollutant reductions.

BMP Type	Description	Bacteria Reduction Efficiency	Sediment Reduction Efficiency	Reference
Direct deposit	Livestock exclusion from waterway	100%	N/A	1
Pasture	Streamside buffer (35 feet)	LU* Change + 52.69%	LU Change + 52.69%	2a,3
	Improved pasture management	50%	30%	4,3
	Rotational grazing with livestock exclusion systems	50%	30%	4,3
	Aforestation of hay and pasture land	LU change	LU change	5
	Critical area stabilization	75%	75&	4
Cropland	Small grain cover crops	20%	20%	2a,3
	Continuous no-till	64%	64%	2a,3
	Long term vegetative cover on cropland	LU change	LU change	5
Streambank	Streambank stabilization	N/A	44.88	3
Urban & Residential	E&S** Controls	N/A	77%	3
	Pet waste disposal station	100%	N/A	1
	Pet waste treatment system	100%	N/A	1
	Pet waste education program	25%	N/A	6
	Large scale pet waste treatment system	25%	N/A	6
	Rain garden	N/A	55%	3
Septic systems	Septic tank pumpout	5%	N/A	2b,3
	Connection to public sewer	100%	N/A	1
	Septic system repair	100%	N/A	1
	Septic system replacement	100%	N/A	1
Forestry	E&S Controls on harvested sites	N/A	86%	7

* LU – land use ** E&S – Erosion and Sediment

References

1. Removal efficiency is defined by the practice
2. Bacteria reduction efficiency assumed to be equal to a) sediment or b) nitrogen reduction efficiency
3. Chesapeake Assessment Scenario Tool - BMP effectiveness values by land use and pollutant
4. VADEQ, 2017. Guidance Manual for Total Maximum Daily Load Implementation Plans. Available at http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDL/TMDLImplementation/TMDLImplementationPlanGuidanceManual.aspx
5. Based on differential loading rates to different land uses
6. Adapted from Swann, C. 1999. A survey of residential nutrient behaviors in the Chesapeake Bay. Widener Burrows, Inc. Chesapeake Bay Research Consortium. Center for Watershed Protection. Ellicott City, MD
7. Adapted from Lakel, et al. 2010. Sediment trapping by streamside management zones of various widths after forest harvest and site preparation. Forest Science 56(6):541-551.

5.2 Quantification of Control Measures

The quantity of control measures recommended during implementation was determined through spatial analyses, modeling alternative implementation scenarios, and using input from the TAC. Data on land use and stream networks were used in spatial analyses to develop estimates of the number of control measures recommended overall, in each watershed, and within smaller subwatersheds. Data from the VADCR Agricultural BMP Database showing where best management practices are already in place in the watersheds were considered when developing these estimates. In addition, census data were used in order to quantify septic system repairs and replacements needed. Estimates of the amount of residential on-site waste treatment systems, streamside fencing and number of full livestock exclusion systems were made through these analyses. The quantities of additional control measures were determined through modeling alternative scenarios and applying the related pollutant reduction efficiencies to their associated bacteria and sediment loads.

Implicit in this watershed plan is the need to avoid increased delivery of pollutants from sources that have not been identified as needing a reduction, and from sources that may develop over time. One potential for additional sources of the pollutants identified is future residential development. Care should be taken to monitor development and its impacts on water quality. Where residential development occurs, there is potential for additional pollutant loads from pet waste, failing septic systems, sewer line overflows and leaks.

5.2.1 Agricultural Control Measures

Livestock Exclusion BMPs

In order to stabilize streambanks and reduce *E.coli* concentrations in Cunningham Creek and its tributaries, livestock must be excluded from the stream. Consequently, this plan includes a recommendation of excluding all livestock from the stream. To estimate fencing needs, the perennial stream network was overlaid with land use using GIS mapping software (ArcView v.10.4.1). Stream segments that flowed through or were adjacent to land use areas that had a potential for supporting cattle (*e.g.,* pasture) were identified using 2015 VBMP Orthophotography and the 2011 National Hydrography Dataset (NHD) streams layer. If the stream segment flowed through the land-use area, it was assumed that fencing was needed on both sides of the stream. If a stream segment flowed adjacent to

the land-use area, it was assumed that fencing was required on only one side of the stream. Not every land-use area identified as pasture has livestock on it at any given point in time. However, it is assumed that all pasture areas have the potential for livestock access. Following GIS analyses of fencing needs, the VADCR Agricultural BMP Database was queried to identify the amount of livestock exclusion systems already in place in the watershed. Any fencing already in place was subtracted from the length of fencing needed to accomplish direct deposition reductions in the implementation plan (Table 5-2). A map of potential streamside fencing required for streams in the watersheds is shown in Figure 5-1.

Table 5-2. Livestock exclusion systems in the watershed tracked through the VADCR Agricultural BMP database: *July 1999 – November 2017*. NOTE: Table does not include data from systems that were not installed through government cost share programs. CRP and EQIP data were not available.

Subwatershed	Practice	Extent installed (linear ft)	Total # of practices
Cunningham Creek	Stream exclusion with grazing land management (SL-6)	1,400	1
NF Cunningham Creek		3,102	2
SF Cunningham Creek		14,707	4
MF Cunningham Creek		6,098	3
TOTALS		**25,307**	**10**

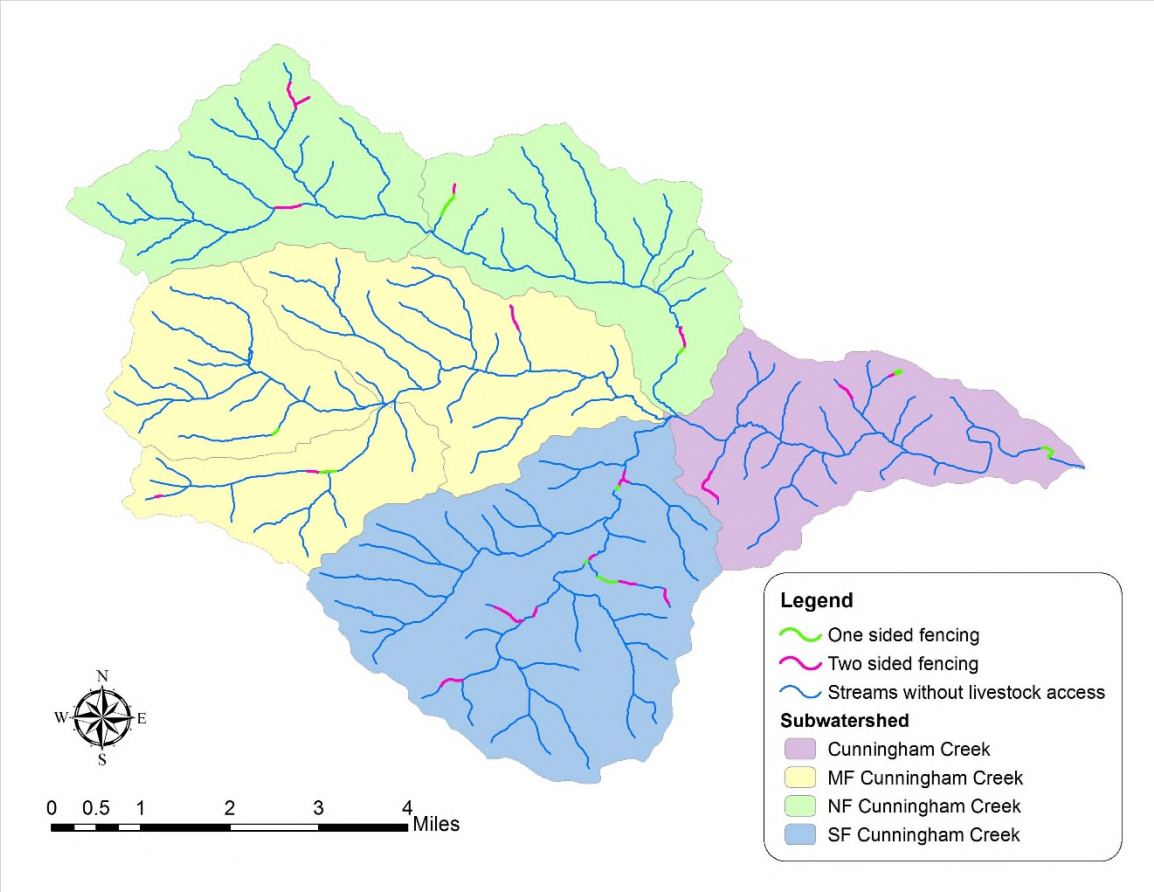

Figure 5-1. Potential stream exclusion fencing by subwatershed.

It is expected that the majority of livestock exclusion fencing will be accomplished through the VA Agricultural BMP Cost Share Program and federal NRCS cost-share programs. Landowners have a number of options when it comes to installing livestock exclusion fencing through these programs. Some applicable cost-shared BMPs for livestock exclusion in the programs are the LE-1T (Livestock Exclusion with Riparian Buffers for TMDL Implementation), the LE-2T (Livestock Exclusion with Reduced Setback for TMDL Implementation), the SL-6 (Stream Exclusion with Grazing Land Management) the SL-6AT (Small Acreage Grazing System), and CREP (the Conservation Reserve Enhancement Program).

In order to develop an estimate of the number of fencing systems needed in the watersheds, tax parcel data was utilized in conjunction with local data from the VADCR Agricultural BMP Database to determine typical characteristics (e.g., streamside fencing length per practice) of livestock exclusion systems in the region. In addition, input was collected from the TAC, NRCS and the Thomas Jefferson SWCD regarding typical components of each

system, associated costs, and preferred fencing setbacks. These characteristics were then utilized to identify the mix of fencing practices available through state and federal cost share programs to include in the watershed plan (Table 5-4).

Table 5-3. Stream fencing needs summary.

Sub-watershed	Total length of streambank in pasture/hay (ft)	Fencing inst. to date (ft)	Fencing still needed (ft)	Fencing still needed (miles)
Cunningham Creek				
1	10,141	1,400	8,741	1.66
Subtotals	***10,141***	***1,400***	***8,741***	***1.66***
North Fork Cunningham Creek				
2	3,256	340	2,916	0.55
3	0	0	0	0
4	10,176	2,762	7,414	1.40
Subtotals	***13,432***	***3,102***	***10,330***	***1.95***
South Fork Cunningham Creek				
5	28,856	14,707	14,149	2.68
Subtotals	***28,856***	***14,707***	***14,149***	***2.68***
Middle Fork Cunningham Creek				
6	6,334	3,400	2,934	0.56
7	3,198	2,698	2,623	0.50
8	433	0	433	0.08
Subtotals	***9,965***	***6,098***	***5,990***	***1.13***
TOTALS	**62,394**	**25,307**	**39,210**	**7.43**

Table 5-4. Estimate of full streamside exclusion fencing systems needed by subwatershed.

Sub-watershed	LE-1T fencing		LE-2T fencing	
	Linear feet	Systems	Linear feet	Systems
Cunningham Creek				
1	7,867	2.7	874	0.3
Subtotals	**7,867**	**2.7**	**874**	**0.3**
North Fork Cunningham Creek				
2	2,624	3.6	292	0.4
3	0	0	0	0
4	6,673	1.8	741	0.2
Subtotals	**9,297**	**5.4**	**1,033**	**0.6**
South Fork Cunningham Creek				
5	12,734	7.2	1,415	0.8
Subtotals	**12,734**	**7.2**	**1,415**	**0.8**
Middle Fork Cunningham Creek				
6	2,641	0.9	293	0.1
7	2,361	1.8	262	0.2
8	390	0.9	43	0.1
Subtotals	**5,391**	**3.6**	**599**	**0.4**
Totals	**35,289**	**18.9**	**3,921**	**2.1**

The VADEQ Non-Point Source BMP Implementation Program includes a series of livestock exclusion practices that may be used to meet exclusion goals in priority implementation watersheds. Livestock Exclusion with Riparian Buffers (LE-1T) offers 85% cost share for off stream watering, establishment of a rotational grazing system, stream crossings, and stream exclusion fencing with a 35-foot setback (required). Based on discussions with the TAC, it was determined that this practice would be the most appealing to producers in the watershed due to the high cost share rate and the buffer setback requirement. Greater buffer setbacks were discussed, but TAC members felt that even with additional financial incentives, a setback greater than 35 feet would be unlikely. It was estimated that approximately 90% of fencing in the watershed would be installed using this practice. The SL-6 practice may also be used to meet the 35-foot fencing setback goal, but TAC members thought that the higher cost share rate (85% versus 80%) would generate more interest.

The SL-6AT practice is similar to the LE-1T practice, but is intended specifically for horse operations and includes 50% cost share. This practice includes streamside fencing, establishment of grazing paddocks, development of heavy use, or sacrifice areas and establishment of walkways to facilitate herd movement. The TAC discussed potential application of this practice in the watershed due to the fact that there are a few horse farms in the area. No specific opportunities for implementation were identified, but TAC members recommended that this practice be considered in planning efforts should the opportunity for its implementation be identified.

A livestock exclusion practice with a reduced setback requirement is offered through VADEQ's cost share program. The Livestock Exclusion with Reduced Setback Practice (LE-2T) only requires a 10 foot setback for stream fencing. Cost share is provided for stream fencing and cross fencing, stream crossings, and off stream waterers at a rate of 50%. TAC members thought that this practice would be applicable in a limited number of situations, but that the lower cost share rate would be a deterrent to producers. It was estimated that 10% of livestock exclusion would be completed through the LE-2T practice.

Streambank Restoration BMPs

Based on input from the TAC, a series of five streambank stabilization/restoration practices were included in the watershed plan (Table 5-5). These practices should be implemented at sites where streambanks have become incised and are actively eroding. It is expected that the majority of these practices will be implemented on agricultural properties where livestock no longer have access to the stream. In some cases, bank restoration may occur in concert with livestock exclusion fencing. Restoration activities may include grading and shaping of streambanks, stabilization of banks through vegetative plantings and installation of structures, and the installation of instream structures to properly direct streamflow in order to avoid future scouring and erosion of streambanks.

Table 5-5. Streambank restoration BMPs needed in the Cunningham Creek watershed.

Subwatershed	Streambank stabilization (feet)	Practices (#)
Cunningham Creek	500	1
NF Cunningham Creek	1,000	2
SF Cunningham Creek	500	1
MF Cunningham Creek	500	1

Land Based Agricultural BMPs

In order to meet bacteria and sediment reduction goals, best management practices to treat land-based sources of the pollutants must also be included in implementation efforts. Table 5-6 provides a summary of land based agricultural BMPs by watershed needed to achieve water quality goals.

Riparian Buffers

For modeling purposes, it was assumed that a typical vegetative buffer would be able to receive and treat runoff from an area two times its width. For example, a buffer that was 35 feet wide and 1,000 feet long would treat runoff from an area that was 70 feet wide and 1,000 feet long. Once you move beyond two times the buffer width, it was assumed that the runoff would be in the form of channelized flow rather than the sheet flow that a buffer can trap. Cropland buffers are recommended in fields adjacent to streams, but opportunities were not identified since most agricultural land adjacent to the streams was pasture.

Grazing Systems and Improve Pasture Management

Establishment of rotational grazing systems for cattle was recommended in conjunction with livestock exclusion projects. The majority of fencing programs will provide cost share for the establishment of cross fencing and alternative watering sources in order to establish these systems. In cases where livestock exclusion is not necessary, improved pasture management was prescribed. Like a grazing system, improved pasture management allows a farmer to better utilize grazing land and associated forage production. Improved pasture management includes:

- Implement a current nutrient management plan
- Maintain adequate soil nutrient and pH levels
- Manage livestock rotation to paddock subdivisions to maintain minimum grazing height recommendations and sufficient rest periods for plant recovery
- Maintain adequate and uniform plant cover (≥ 60%) and pasture stand density
- Locate feeding and watering facilities away from sensitive areas
- Manage distribution of nutrients and minimize soil disturbance at hay feeding sites by unrolling hay across the upland landscape in varied locations
- Designate a sacrifice lot/paddock to locate cattle for feeding when adequate forage is not available in the pasture system. Sacrifice lot/paddock should not drain directly into ponds, creeks or other sensitive areas and should not be more than 10% of the total pasture acreage.

- Chain harrow pastures to break-up manure piles after livestock are removed from a field at least twice a year to uniformly spread the manure load, or manage manure distribution through rotational grazing

Aforestation of Hay and Pasture Land

A small portion of hay and pasture land was identified for tree planting. This practice will be performed on pasture that is not well suited for grazing due to slope and other characteristics. The intent of including this practice is not to reduce the presence of agriculture in the watershed, but rather to optimize the use of suitable pastureland in the watershed and prevent runoff and soil loss from marginal pastures. Cost share funding is available for tree planting, and a flat rate payment per acre is also made through this practice depending on the length of the BMP contract.

Cropland Management Practices

There is very little cropland in the Cunningham Creek watershed, and most of it is well managed. However, several fields in the watershed were identified that would benefit from cropland BMPs. The TAC noted that both continuous no till and cover crops have historically been popular practices in the watersheds, and that a number of farmers remain interest in implementing these practices. A small amount of each practice is included in the plan in order to allow for continued promotion of these practices, particularly since cropland acreage has increased in the region in recent years. Continuous no till is included in the VA Agricultural Cost Share Program, where it is referred to as Continuous High Residue Minimal Soil Disturbance Tillage System. This practice is used to encourage producers to convert fields under some degree of tillage to a system of minimal soil disturbance that will maintain a minimum of 60% rain drop intercepting residue cover. Producers may receive an incentive payment based on the number of acres that they enroll in this practice through the cost share program. Cover crops are a very popular practice in the cost share program. The intent of this practice is to keep cover on cropland during time of year when it would otherwise be left barren. Not only does this minimize runoff and erosion from the soil surface, but it also decreases leaching of nitrogen through the soil. The practice includes specifications on planting and kill dates, along with appropriate seed mixes to be used. A flat rate payment is available through the cost share program in addition to a series of bonus payments for early planting and for planting pure stands of rye.

Table 5-6. Land based agricultural BMPs needed.

Land use	BMP	Acres				
		Cunningham	NF Cunningham	SF Cunningham	MF Cunningham	TOTAL
Pasture	Rotational grazing system	47	311	326	308	**992**
	Improved pasture management	410	224	721	509	**1,864**
	Aforestation of hay and pasture land	2	2	3	3	**10**
	Critical area stabilization	1	0	2	0	**3**
	Riparian buffers (35 feet)	6.5	7.7	10.6	4.5	**29.3**
Cropland	Continuous no-till	1	0	16	0	**17**
	Cover crops (annual acreage)	2	0	24	0	**26**
	Long term vegetative cover on cropland	0.5	0	8.5	0	**9**

5.2.2 Residential and Urban Control Measures

Failing Septic Systems and Straight Pipes

All straight pipes and failing septic systems must be identified and corrected during implementation based on preexisting legal requirements. Table 5-7 shows the estimated number of failing septic systems by watershed. The number of septic systems in the Cunningham Creek watershed was developed based on household estimates from the 2010 United States Census and Fluvanna County parcels data. With input from the TAC, it was determined that there were not any direct discharges of household sewage to waterbodies (straight pipes). Initially, a failure rate of 13% was used to develop estimates of failing septic systems in the watersheds. The TAC felt that this failure rate was inflated, and with input from the VA Department of Health, this rate was decreased to 2% of septic systems.

Table 5-7. Failing septic systems and straight pipes in the watershed.

Watershed	Total Septic Systems	Estimated Failing Septic Systems
Cunningham Creek	78	1.6
NF Cunningham Creek	305	6.1
SF Cunningham Creek	202	4.0
MF Cunningham Creek	314	6.3
TOTAL	**899**	**18**

Based on data collected from several existing septic system cost share programs in nearby counties (Augusta and Rockingham) and from discussions with local Health Department staff, it was estimated that 35% of failing septic systems could be corrected with a repair, and that the remaining 65% would need to be replaced. The VADEQ administers a septic BMP cost share program for targeted watersheds with approved implementation plans. This program provides cost share for two kinds of septic system repairs, those requiring a permit, and those consisting of an inspection and repair that does not require a permit. It was estimated that 29% of repairs would be minor in nature and thus not require a permit, while the remainder would be significant enough that one would be required. Of the systems that need to be replaced, a small portion will require alternative waste treatment systems due to the geology present at the site, or a lack of space necessary for a conventional drainfield. Table 5-8 shows a breakdown of the septic system repairs and

replacements based on input from the Fluvanna County Health Department. Based on existing conditions in the watersheds, it was estimated that approximately 6% of septic system replacements would be done with alternative waste treatment systems while the remaining 94% could be done using conventional septic systems. No opportunities for connection to public sewer were identified in the watershed. A septic tank pumpout program was also discussed as a good way to heighten local awareness of septic system maintenance needs and to locate failing septic systems. Such a program could be implemented on a limited basis, targeting homes in close proximity to the creeks. The estimates shown in **Error! Reference source not found.** are based on pumping out septic tanks for 25% of households in each watershed.

Table 5-8. Repairs and replacements of failing septic systems and straight pipes.

Description	Cunningham	NF Cunningham	SF Cunningham	MF Cunningham
Onsite sewage system repair	0.4	1.5	1	1.6
Full inspection and non-permitted onsite sewage system repair	0.2	0.6	0.4	0.6
Onsite sewage system installation/replacement	0.8	3.3	2.2	3.4
Onsite sewage system installation/replacement w/ pump	0.1	0.4	0.3	0.4
Alternative sewage system	0.1	0.2	0.2	0.3
Septic tank pumpout	19.5	76.3	50.5	78.5

Residential Stormwater and Pet Waste

There is very little developed land in the Cunningham Creek watershed; however, TAC participants agreed that bacteria and sediment from urban and residential areas should be addressed in a similar manner to agricultural sources. This presents a more comprehensive approach to management of the watershed, and assigns some degree of responsibility to all pollutant source sectors within the watershed. Urban/residential pollutant sources are primarily located in the North Fork Cunningham Creek watershed, where a series of relatively new residential developments are located. The TAC agreed that these developments would be the most suitable location for any stormwater management practices, and for a targeted pet waste education program and associated BMPs.

Residential and urban stormwater BMPs, and pet waste BMPs are identified for below in Table 5-9.

Table 5-9. Residential stormwater and pet waste BMPs for the North Fork Cunningham Creek watershed.

Land use	BMP	Units	Extent
Residential	Erosion and sediment controls	Acres	1.2
	Rain gardens	Gardens	2
	Pet waste disposal station	Stations	1
	Pet waste digester, composter, or fermenter	Composter	5
	Pet waste education program	Program	1
	Large scale pet waste treatment system	System	2

With input from the TAC and Fluvanna County staff, it was determined that there were several areas of land disturbance in the NF Cunningham Creek watershed on Taylor Ridge Way, Capel Court, and Cunningham Court contributing sediment to the creek. There are cut slopes at these sites with exposed soil that is actively eroding. These areas should be soil tested to determine if lime is required and how much. Topsoil should be added after an initial application of lime. The site should be timed so that the larger application of lime (or a single application if two tons per acre or less is required) is made six months before a fall seeding. A skid steer loader will be necessary to prepare the seedbed, and the site should be seeded to establish permanent cover.

A targeted pet waste education program will be implemented in order to encourage pet owners to pick up after their pets and facilitate proper disposal of pet waste. This program will include the development and distribution of educational materials, installation of a pet waste station with collection bags in one of the three neighborhoods identified by the TAC in the North Fork watershed, and the promotion of pet waste BMPs including pet waste composters. Further research will be needed to identify which neighborhood is the best fit for a pet waste station based on the existence and functionality of homeowners' associations in the developments. A pet waste composter allows a homeowner to collect their pet's waste and safely compost it outside. There are several types of composters, some requiring more maintenance than others. A septic tank composter (e.g. Doogie

Dooley® system) is inserted in the ground (2-4 feet below the surface) with a lid on top. Pet waste is added to the composter along with water and a special enzyme to accelerate decomposition. Traditional composters may also be used to treat pet waste. The TAC recommended including five pet waste composters to be distributed in target neighborhoods in the watersheds. In addition, the TAC discussed opportunities for large scale pet waste treatment systems in the watershed such as boarding facilities and breeders. Two kennels were identified in the North Fork watershed that might be suitable locations for these systems.

5.2.3 Forestry BMPs

During development of the watershed plan, several TAC participants voiced concerns about runoff of sediment from forest harvesting activities in the watersheds. Through consultation with VA Department of Forestry (DOF) staff, an estimated rate of non-compliance with recommended erosion and sediment control practices was developed. Results from a recent DOF audit of the Central Region and input from local DOF staff regarding typical conditions on harvested sites in the watershed was used to develop an estimated rate of 5%. DOF staff also provided input on annual acres of forest harvesting in the watershed, and land use acres were revised accordingly. The 5% non compliance rate was applied to harvested acres (annually) for each subwatershed to determine annual acreage of additional erosion and sediment control practices needed (Table 5-10).

Table 5-10. Forestry BMPs for the Cunningham Creek watershed.

Watershed	Acres	
	Harvested forest	Erosion and sediment control BMPs
Cunningham	16.6	0.8
NF Cunningham	27.6	1.4
MF Cunningham	84.3	4.2
SF Cunningham	71.5	3.6
Total	200	10

5.2.4 Fluvanna Ruritan Dam BMPs

As described in the summaries of the Technical Advisory Committee meetings in Chapter 4, the Virginia Department of Game and Inland Fisheries owns and operates the Fluvanna Ruritan Lake, which is located in the North Fork Cunningham Creek watershed. The 50-acre lake was constructed in 1956 with support from the Fluvanna Ruritan Club. It is open to the public and offers opportunities for fishing. Historically, the lake has been a source

of sediment in the North Fork watershed when releases from the dam through the emergency spillway have caused erosion within the spillway and the channel downstream. Based on several visits to the site during the planning process, it appears that the excessive rate of erosion observed in the past has slowed, making the lake less of a concern with respect to sediment for the time being. However, DGIF is undertaking a dam rehabilitation project at the lake, which is expected to begin in 2018. As part of this project, the height of the dam with be extended and capacity of the lake will be increased. Based on input from Fluvanna County government staff, there remains a concern that continued operation of the spillway with the increased capacity of the lake may lead to increased erosion from the spillway once again. In addition, county staff expressed concerns regarding current operation of the dam with respect to the direction of flow through the spillway. Staff noted that it appears that water is currently being directed to one side of the channel, which offers the potential for additional erosion to occur. Modifications to the auxiliary spillway to address this concern are not included in the planned rehab project, but DGIF intends to monitor the condition of the spillway for any changes that may occur over time. This monitoring will include onsite inspections and remote radio monitoring, which provides alerts to DGIF of spillway charging/flows exiting through the auxiliary spillway. Should the agency find that changes to the spillway are occurring as a result of increased erosion in the channel, DGIF will work to obtain funding for maintenance and necessary improvements.

5.3 Technical Assistance and Education

In order to get landowners involved in implementation, it will be necessary to initiate education and outreach strategies and provide technical assistance with the design and installation of various best management practices. There must be a proactive approach to contact farmers and residents to articulate exactly what the watershed plan means to them and what practices will help meet the goal of improved water quality. The TAC recommended several education/outreach techniques, which will be utilized during implementation.

The following general tasks associated with agricultural and residential programs were identified:

Agricultural Programs

- Make contact with landowners in the watersheds to make them aware of implementation goals, cost-share assistance, and voluntary options that are available to agricultural producers interested in conservation
- Provide technical assistance for agricultural programs (*e.g.*, survey, design, layout, and approval of installation).
- Develop educational materials & programs
- Organize educational programs (*e.g.*, County Fair, presentations at joint VCE events or club events)
- Distribute educational materials
- Handle and track cost-share
- Assess and track progress toward BMP implementation goals
- Coordinate use of existing agricultural programs and suggest modifications

Residential Programs

- Identify straight-pipes and failing septic systems (*e.g.*, contact landowners in older homes, septic pump-out program)
- Handle and track cost-share
- Organize educational programs (*e.g.*, demonstration septic pump-outs, pet waste education)
- Distribute educational materials (*e.g.*, informational pamphlets on watershed plan and on-site sewage disposal systems).
- Assess progress toward implementation goals

A critical component in the successful implementation of this plan is the availability of knowledgeable staff to work with landowners on implementing conservation practices. While this plan provides a general list of practices that can be implemented in the watershed, property owners face unique management challenges including both design challenges and financial barriers to implementation of practices. Consequently, technical assistance from trained conservation professionals is a key component to successful BMP implementation. Technical assistance includes helping landowners identify suitable BMPs for their property, designing BMPs and locating funding to finance implementation.

The staffing level needed to implement the agricultural and residential components of the plan was estimated based on discussions with stakeholders and the staffing levels used in similar projects. Staffing needs were quantified using full time equivalents (FTE), with one FTE being equal to one full-time staff member. It was determined that 1 FTE would be

needed to provide the technical assistance needed for agricultural and residential implementation. This position could be housed at the TJSWCD office, where they have considerable experience administering both agricultural and residential BMP cost share programs.

6. COSTS AND BENEFITS

The costs of agricultural best management practices included in the watershed plan were estimated based on data for Fluvanna County from the VADCR Agricultural BMP Database, the 2017 NRCS Cost List and considerable input from Thomas Jefferson SWCD and NRCS staff.

The total cost of livestock exclusion systems includes not only the costs associated with fence installation, repair, and maintenance, but also the cost of developing alternative water sources for LE-1T, SL-6A and LE-2T practices. The cost of fence maintenance was identified as a deterrent to participation. In developing the cost estimates for fence maintenance shown in Table 6-1, a figure of $3.50/linear foot of fence was used. It was estimated that approximately 10% of fencing would need to be replaced every 10 years. Streambank restoration practice costs are included in this table since it is expected that these practices will be installed on agricultural properties in the watershed.

The majority of agricultural practices recommended in the watershed plan are included in state and federal cost share programs. These programs offer financial assistance in implementing the practices and may also provide landowners with an incentive payment to encourage participation. Consequently, when assessing costs it is important to consider both the potential cost to the landowner as well as the cost to state and federal programs. Table 6-1 shows total agricultural BMP costs by watershed.

The costs of recommended residential BMPs were estimated based on input from local VA Department of Health staff. Septic tank pumpout estimates were developed based on reported costs from septic BMP cost share programs administered by the TJSWCD in nearby Nelson and Albemarle Counties. Table 6-2 shows both residential septic and pet waste BMP cost estimates.

Additional input was collected from VA Department of Forestry regarding forestry related BMPs. An estimate of $35/acre for erosion and sediment controls was utilized to develop costs for each watershed, totaling $29 for Cunningham Creek, $48 for North Fork Cunningham Creek, $147 for Middle Fork, and $125 for South Fork. The total estimated forestry BMP cost for the watersheds is $350.

Table 6-1. Agricultural BMP implementation costs by watershed.

Practice	Cost share code	Units	Unit cost	Cost by Watershed				
				Cunningham	NF Cunningham	MF Cunningham	SF Cunningham	TOTAL
Livestock exclusion with riparian buffers	LE-1T	system	$31,516	$100,280	$165,964	$106,304	$223,102	$595,650
Livestock exclusion with reduced setback	LE-2T	system	$31,049	$10,924	$18,182	$11,662	$24,436	$65,204
Exclusion fence maintenance (10 yrs)	N/A	feet	$3.50	$3,059	$3,616	$2,097	$4,953	$13,724
Rotational grazing with livestock exclusion	LE-1T SL-6 LE-2T	Acres	$100	$4,700	$31,100	$30,800	$32,600	$99,200
Streambank restoration	N/A	Feet	$150	$75,000	$150,000	$75,000	$75,000	$375,000
Improved pasture management	EQIP (529,512)	acres	$225	$92,250	$50,400	$114,525	$162,225	$419,400
Aforestation of erodible pasture	FR-1	acres	$593	$1,185	$1,185	$1,778	$1,778	$5,925
Critical area stabilization	SL-11	acres	$2,570	$2,570	$0	$0	$5,140	$7,710
Small grain cover crops	SL-8B	acres	$80	$160	$0	$0	$1,920	$2,080
Long term vegetative cover on cropland	SL-1	acres	$300	$150	$0	$0	$2,550	$720
Continuous no till	SL-15A	acres	$100	$100	$0	$0	$1,600	$1,360
TOTAL ESTIMATED COST				**$290,378**	**$420,447**	**$342,165**	**$535,303**	**$1,585,973**

Table 6-2. Residential septic and pet waste BMP implementation costs by watershed.

Practice	Cost share code	Units	Unit cost	Cost by Watershed				
				Cunningham	NF Cunningham	MF Cunningham	SF Cunningham	TOTAL
Pet waste disposal station	PW-1	Station	$600	$0	$600	$0	$0	$600
Pet waste composter/digester	PW-2	Composter	$200	$0	$1,000	$0	$0	$1,000
Pet waste education program	N/A	Program	$1,000	$0	$1,000	$0	$0	$1,000
Large scale pet waste treatment system	N/A	System	$10,000	$0	$20,000	$0	$0	$20,000
Septic Tank Pump-out	RB-1	System	$300	$5,850	$22,890	$23,550	$15,150	$67,440
Septic Tank System Repair	RB-3	Repair	$5,000	$2,000	$7,500	$8,000	$5,000	$22,500
Septic System Inspection and Non-Permitted Repairs	RB-3R	Repair	$2,000	$400	$1,200	$1,200	$800	$3,600
Septic Tank System Installation or Replacement	RB-4	System	$8,000	$6,400	$26,400	$27,200	$17,600	$77,600
Septic Tank System Installation/Replacement w/ pump	RB-4P	System	$10,000	$1,000	$4,000	$4,000	$3,000	$12,000
Alternative On-site Waste Treatment System	RB-5	System	$24,000	$2,400	$4,800	$7,200	$4,800	$19,200
TOTAL ESTIMATED COST				**$18,050**	**$89,390**	**$71,150**	**$46,350**	**$224,940**

Cost estimates for residential stormwater BMPs and erosion and sediment control measures were developed with input from Fluvanna County local government staff. These practices are only needed in the North Fork Cunningham Creek watershed based on existing land uses. Erosion and sediment controls were estimated at a cost of $4,000/acre, while rain gardens were estimated at a cost of $10,000/garden. This brought the total estimated cost for residential stormwater implementation in the North Fork watershed to $24,800.

Table 6-3. Total BMP implementation costs by watershed.

Watershed	Cost ($)				
	Agricultural BMPs	Residential Septic/Pet Waste	Forestry BMPs	Res/Urban Stormwater BMPs	Total BMP Cost ($)
Cunningham	$290,378	$18,050	$29	$0	$308,457
NF Cunningham	$420,447	$89,390	$48	$24,800	$534,685
MF Cunningham	$342,165	$71,150	$147	$0	$413,462
SF Cunningham	$535,303	$46,350	$125	$0	$581,778
TOTALS	**$1,588,293**	**$224,940**	**$349**	**$24,800**	**$1,838,382**

Table 6-4. Staged BMP implementation costs by watershed. Note: Table shows costs associated with two stages of implementation. These stages are explained in greater detail in Chapter 7, Section 7.1.

Watershed	Stage 1 (Years 1-5)				Stage 2 (Years 5-10)			
	Agricultural BMPs	Residential Septic/Pet Waste BMPs	Forestry BMPs	Res/Urban Stormwater BMPs	Agricultural BMPs	Residential Septic/Pet Waste BMPs	Forestry BMPs	Res/Urban Stormwater BMPs
Cunningham	$193,106	$10,830	$17	$0	$97,272	$7,220	$12	$0
NF Cunningham	$218,853	$52,274	$29	$12,880	$201,593	$37,116	$19	$11,920
MF Cunningham	$223,502	$42,690	$88	$0	$118,663	$28,460	$59	$0
SF Cunningham	$251,428	$27,810	$75	$0	$283,875	$18,540	$50	$0
Total	**$886,890**	**$133,604**	**$210**	**$12,880**	**$701,402**	**$91,336**	**$140**	**$11,920**
Stage I Total Cost = $1,033,584					**Stage 2 Total Cost = $804,798**			

6.1 Technical Assistance

Technical assistance costs were estimated for 1 full time position using a cost of $60,000/position per year. This figure is based on the existing staffing costs included in the Virginia Department of Environmental Quality's grant agreements with the Soil and Water Conservation Districts across the state to provide technical assistance to landowners in TMDL implementation watersheds. Based on the 10-year timeline of this plan (described in great detail in the Implementation Timeline section of this plan), this would make the total cost of technical assistance approximately $600,000. When factored into the cost estimate for BMP implementation shown in Table 6-4, this would make the total cost of implementation approximately $2.43M.

6.2 Benefit Analysis

The primary benefit of implementing this plan will be cleaner water in Cunningham Creek and its tributaries. Specifically, *E. coli* contamination in the creeks will be reduced to meet water quality standards and sediment loading will be reduced so that Cunningham Creek can support a healthy biological community. It is hard to gage the impact that reducing *E. coli* 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 *E. coli* sources through contact with surface waters should be reduced considerably.

An important objective of the implementation plan is to foster continued economic vitality. 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 will provide economic benefits to the community, as well as the expected environmental benefits. Specifically, alternative (clean) water sources, exclusion of cattle from streams, improved pasture management, and private sewage system maintenance will each provide economic benefits to land owners. Additionally, money spent by landowners and state agencies in the process of implementing this plan will stimulate the local economy.

6.2.1 Agricultural Practices

It is recognized that every farmer faces unique management challenges that may make implementation of some BMPs more cost effective than others. Consequently, costs and benefits of the BMPs recommended in this plan must be weighed on an individual basis. The benefits highlighted in this section are based on general research findings. Additional economic costs and benefits analyses of these practices at the local level was identified as a much needed outreach tool by the steering committee and agricultural working group.

Restricting livestock access to streams and providing them with clean water source has been shown to improve weight gain and milk production in cattle (Zeckoski et al., 2007). Studies have shown that increasing livestock consumption of clean water can lead to increased milk and butterfat production and increased weight gain (Landefeld et al, 2002). Table 6-5 shows an example of how this can translate into economic gains for producers. Fresh clean water is the primary nutrient for livestock with healthy cattle consuming, on a daily basis, close to 10% of their body weight during winter and 15% of their body weight in summer. Many livestock illnesses can be spread through contaminated water supplies. For instance, coccidia can be delivered through feed, water and haircoat contamination with manure (VCE, 2000). In addition, horses drinking from marshy areas or areas where wildlife or cattle carrying Leptospirosis have access tend to have an increased incidence of moonblindness associated with Leptospirosis infections (VCE, 1998). A clean water source can prevent illnesses that reduce production and incur the added expense of avoidable veterinary bills.

Table 6-5. Example of increased revenue due to installing off-stream waterers (Surber et al., 2005).

Typical calf sale weight	Additional weight gain due to off-stream waterer	Price	Increased revenue due to off stream waterer
500 lbs/calf	5% or 25 lbs	$0.60 per lb	$15/calf

In addition to reducing the likelihood of animals contracting waterborne illnesses by providing a clean water supply, streamside fencing excludes livestock from wet, swampy environments as are often found next to streams where cattle have regular access. Keeping cattle in clean, dry areas has been shown to reduce the occurrence of mastitis and foot rot. The VCE (1998a) reports that mastitis costs producers $100 per cow in reduced quantity and quality of milk produced. On a larger scale, mastitis costs the U.S. dairy industry about

$1.7 billion to 2 billion annually or 11% of total U.S. milk production. While the spread of mastitis through a dairy herd can be reduced through proper sanitation of milking equipment, mastitis-causing bacteria can be harbored and spread in the environment where cattle have access to wet and dirty areas. Installation of streamside fencing and well managed loafing areas will reduce the amount of time that cattle have access to these areas.

Taking the opportunity to implement 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 to 40 % and, consequently, improve the profitability of the operation. With feed costs typically responsible for 70 to 80 % of the cost of growing or maintaining an animal, and pastures providing feed at a cost of 0.01 to 0.02 cents/lb of total digestible nutrients (TDN) compared to 0.04 to 0.06 cents/lb TDN for hay, increasing the amount of time that cattle are fed on pasture is clearly a financial benefit to producers (VCE, 1996). 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. Another benefit is that cattle are closely confined allowing for quicker examination and handling. In general, many of the agricultural BMPs recommended in this document will provide both environmental benefits and economic benefits to the farmer.

6.2.2 Residential Septic Practices

The residential programs will play an important role in improving water quality, since human waste can carry with it human viruses in addition to the bacterial and protozoan pathogens that all fecal matter can potentially carry. In terms of economic benefits to homeowners, an improved understanding of on-site sewage treatment systems, including knowledge of what steps can be taken to keep them functioning properly and the need for regular maintenance, will give homeowners the tools needed for extending the life of their systems and reducing the overall cost of ownership. The average septic system will last 20 to 25 years if properly maintained. 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 3 to 5 years. The cost of proper maintenance, as outlined here, is relatively inexpensive ($300) in comparison to repairing or replacing an entire system ($8,000 to $24,000). Additionally, the repair/replacement and pump-out programs will benefit owners of private sewage (*e.g.*, septic) systems, particularly low-income homeowners, by sharing the cost of required maintenance.

In addition to the benefits to individual landowners, the economy of the local community will be stimulated through expenditures made during implementation, and the infusion of dollars from funding sources outside the impaired areas. Building contractors and material suppliers who deal with septic system pump-outs, private sewage system repair and installation, fencing, and other BMP components can expect to see an increase in business during implementation. Additionally, income from maintenance of these systems should continue long after implementation is complete. As will be discussed in greater detail in Chapter 9, a portion of the funding for implementation can be expected to come from state and federal sources. This portion of funding represents money that is new to the area and will stimulate the local economy. In general, implementation will provide not only environmental benefits to the community, but economic benefits as well, which, in turn, will allow for individual landowners to participate in implementation.

6.2.3 Residential and Urban Stormwater Management Practices

The primary benefits of urban stormwater management practices to private property owners include flood mitigation and improved water quality. A 2004 study assessing the economic benefits of stormwater management showed that these services can be valued at up to 5% of the market value of a home (Braden and Johnston, 2004). In flood prone and waterfront communities these services can be assigned an even greater value by property owners (Thunberg and Shabman, 1991).

In addition, urban BMPs have a number of economic benefits to localities. Increased retention of stormwater on site can lower peak discharges, thereby reducing the drainage infrastructure needed to prevent flooding. This can result in cost savings to local governments through reduced engineering and land acquisition costs, and reduced materials and installation costs for stormwater culverts and streambank armoring to prevent scour. Additional savings may be realized by local governments through reduced pollution treatment costs, particularly in communities with combined sewers. By reducing storm

sewer flows through increased infiltration of stormwater, localities can subsequently reduce stormwater treatment costs, overflow damages and storage costs (Braden and Johnston, 2004). Lastly, implementation of urban BMPs greatly reduces soil erosion and sediment transport to our rivers, streams and lakes. A 1993 study of the economic cost of erosion-related pollution showed that national off-site damages from urban sediment sources cost between $192 million on $2.2 billion per year in 1990 dollar values (Paterson et al, 1993). This cost range would be far greater today if adjusted for inflation. By proactively implementing stormwater management practices to reduce the volume of stormwater runoff coming in to the North Fork of Cunningham, and to filter out the sediment that this runoff carries with it, the economic and environmental costs of erosion can be greatly reduced.

6.2.4 Watershed Health and Associated Benefits

Focusing on reducing bacteria and sediment loads in the Cunningham Creek watershed will have associated watershed health benefits as well. Reductions in streambank erosion, excessive nutrient runoff, and water temperature are additional benefits associated with streamside buffer plantings. In turn, reduced nutrient loading and erosion and cooler water temperatures improves habitat for fisheries, which provides associated benefits to anglers and the local economy. The economic benefits of a thriving fishery including stocking operations (put-and- take and put-and-grow) are substantial as noted in the section above.

Riparian buffers can also improve habitat for wildlife such as ground-nesting quail and other sensitive species. Data collected from Breeding Bird Surveys in Virginia indicate that the quail population declined 4.2% annually between 1966 and 2007. Habitat loss has been cited as the primary cause of this decline. As a result, Virginia has experienced significant reductions in economic input to rural communities from quail hunting. The direct economic contribution of quail hunters to the Virginia economy was estimated at nearly $26 million in 1991, with the total economic impact approaching $50 million. Between 1991 and 2004, the total loss to the Virginia economy was more than $23 million from declining quail hunter expenditures (VDGIF, 2009). Funding is available to assist landowners in quail habitat restoration (see Chapter 9).

7. MEASURABLE GOALS AND MILESTONES

Based upon the scope of work involved with implementing this watershed plan, the TAC agreed that full implementation and de-listing from the Virginia Section 305(b)/303(d) list could be expected within 10 years provided that full funding for technical assistance and BMP cost share were available. Described in this section are a timeline for implementation, water quality and implementation goals and milestones, and strategies for targeting of best management practices.

7.1 Milestone Identification

The end goals of implementation are restored water quality of the impaired waters and subsequent de-listing of the waters from the Commonwealth of Virginia's Section 305(b)/303(d) list within 10 years. Progress toward end goals will be assessed during implementation through tracking of best management practices through the Virginia Agricultural Cost-Share Program 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 control measures installed within certain timeframes, while water quality milestones establish the corresponding improvements in water quality that can be expected as the implementation milestones are met. The milestones described here are intended to achieve full implementation within 10 years.

Following the idea of a staged implementation approach, resources and finances will be concentrated on the most cost-efficient control measures and areas of highest interest first. For instance, concentrating on implementing livestock exclusion fencing within the first several years may provide the highest return on water quality improvement with less cost to landowners. Implementation has been divided into two stages: 2018 – 2022 and 2023 – 2027. Tables 7.1 - 7.4 show implementation and water quality improvement goals for *E. coli* bacteria and sediment for each watershed in each implementation stage.

Table 7-1. Staged implementation goals and percent of land use receiving BMP by stage for Cunningham Creek.

BMP Type	Description	BMP code	Units	Extent		% Land use treated	
				Stage 1	Stage 2	Stage 1	Stage 2
Direct deposit	Livestock exclusion with riparian buffers	LE-1T	feet	4,720	3,147	54	36
	Livestock exclusion with reduced setback	LE-2T		524	350	6	4
Streambank	Streambank stabilization	N/A	feet	500	0	N/A	N/A
Pasture	Grazing systems	LE-1T	acres	28	19	6	4
	Improved pasture management	EQIP (529,512)		246	164	54	36
	Aforestation of hay and pasture land	FR-1		1.2	0.8	0.26	0.17
	Permanent vegetation on critical areas	SL-11		0.6	0.4	0.13	0.09
	Riparian buffers	LE-1T		3.9	2.6	0.9	0.6
Cropland	Continuous no-till	SL-15A	acres	0.6	0.4	6	4
	Cover crops	SL-8B		1.2	0.8	11	8
	Long term vegetation on cropland	SL-1		0.3	0.2	3	2
Residential septic	Onsite sewage system repair	RB-3	repair	0.23	0.16	0.30	0.20
	Full inspection and non-permitted onsite sewage system repair	RB-3R		0.10	0.06	0.12	0.08
	Onsite sewage system installation/replacement	RB-4	system	0.50	0.34	0.65	0.43
	Onsite sewage system installation/replacement w/ pump	RB-4P		0.07	0.04	0.08	0.06
	Alternative sewage system	RB-5		0.04	0.02	0.05	0.03
	Septic tank pump-out	RB-1	pump out	11.7	7.8	15	10
Residential stormwater	Rain gardens	N/A	garden	0	0	-	-
	Increased E&S enforcement		acres/yr	0	0	-	-
Pet waste	Pet waste disposal station		station	0	0	N/A	N/A
	Pet waste digester, composter, or fermenter		composter	0	0		
	Pet waste education program		program	0	0		
	Large scale pet waste treatment system		system	0	0		
Forestry	E&S controls on harvested sites		acres	0.5	0.3	3	2
Average annual fecal coliform load (cfu/yr) Existing load = 4.04 x 10^{14}				3.65×10^{14}	3.51×10^{14}		
% Reduction in fecal coliform load				10%	13%		
Average annual sediment load (tons/yr) Existing load = 256				198	169		
% Reduction in sediment load				23%	34%		

Table 7-2. Staged implementation goals and percent of land use receiving BMP by stage for North Fork Cunningham Creek.

BMP Type	Description	BMP code	Units	Extent		% Land use treated	
				Stage 1	Stage 2	Stage 1	Stage 2
Direct deposit	Livestock exclusion with riparian buffers	LE-1T	feet	5,578	3,719	54	36
	Livestock exclusion with reduced setback	LE-2T		620	413	6	4
Streambank	Streambank stabilization	N/A	feet	500	500	N/A	N/A
Pasture	Grazing systems	LE-1T	acres	187	124	35	23
	Improved pasture management	EQIP (529,512)		134	90	25	17
	Aforestation of hay and pasture land	FR-1		1.2	0.8	0.2	0.1
	Permanent vegetation on critical areas	SL-11		0	0	-	-
	Riparian buffers	LE-1T		4.6	3.1	0.9	0.6
Cropland	Continuous no-till	SL-15A	acres	0	0	-	-
	Cover crops	SL-8B		0	0	-	-
	Long term vegetation on cropland	SL-1		0	0	-	-
Residential septic	Onsite sewage system repair	RB-3	repair	0.91	0.61	0.30	0.20
	Full inspection and non-permitted onsite sewage system repair	RB-3R		0.37	0.24	0.12	0.08
	Onsite sewage system installation/replacement	RB-4	system	1.98	1.32	0.65	0.43
	Onsite sewage system installation/replacement w/ pump	RB-4P		0.26	0.17	0.08	0.06
	Alternative sewage system	RB-5		0.15	0.10	0.05	0.03
	Septic tank pump-out	RB-1	pump out	45.75	30.90	15	10
Residential stormwater	Rain gardens	N/A	garden	1	1	<0.1%	<0.1%
	Increased E&S enforcement		acres/yr	0.7	0.5	0.22	0.16
Pet waste	Pet waste disposal station		station	1	0	N/A	N/A
	Pet waste digester, composter, or fermenter		composter	3	2		
	Pet waste education program		program	1	0		
	Large scale pet waste treatment system		system	1	1		
Forestry	E&S controls on harvested sites		acres	0.8	0. 6	3	2
Average annual fecal coliform load (cfu/yr) Existing load = 6.36 x 10^{14}				5.06×10^{14}	4.41×10^{14}		
% Reduction in fecal coliform load				20%	31%		
Average annual sediment load (tons/yr) Existing load = 329				268	221		
% Reduction in sediment load				18%	33%		

Table 7-3. Staged implementation goals and percent of land use receiving BMP by stage for Middle Fork Cunningham Creek.

BMP Type	Description	BMP code	Units	Extent		% Land use treated	
				Stage 1	Stage 2	Stage 1	Stage 2
Direct deposit	Livestock exclusion with riparian buffers	LE-1T	feet	3,235	2,156	54	36
	Livestock exclusion with reduced setback	LE-2T		359	240	6	4
Streambank	Streambank stabilization	N/A	feet	500	0	N/A	N/A
Pasture	Grazing systems	LE-1T	acres	185	123	23	15
	Improved pasture management	EQIP (529,512)		305	204	37	25
	Aforestation of hay and pasture land	FR-1		1.8	1.2	0.22	0.15
	Permanent vegetation on critical areas	SL-11		0	0	-	-
	Riparian buffers	LE-1T		2.7	1.8	0.3	0.2
Cropland	Continuous no-till	SL-15A	acres	0	0	-	-
	Cover crops	SL-8B		0	0	-	-
	Long term vegetation on cropland	SL-1		0	0	-	-
Residential septic	Onsite sewage system repair	RB-3	repair	0.94	0.62	0.30	0.20
	Full inspection and non-permitted onsite sewage system repair	RB-3R		0.38	0.25	0.12	0.08
	Onsite sewage system installation/replacement	RB-4	system	2.04	1.36	0.65	0.43
	Onsite sewage system installation/replacement w/ pump	RB-4P		0.26	0.14	0.08	0.06
	Alternative sewage system	RB-5		0.15	0.10	0.05	0.03
	Septic tank pump-out	RB-1	pump out	47.1	31.4	15	10
Residential stormwater	Rain gardens	N/A	garden	0	0	-	-
	Increased E&S enforcement		acres/yr	0	0	-	-
Pet waste	Pet waste disposal station		station	0	0	N/A	N/A
	Pet waste digester, composter, or fermenter		composter	0	0		
	Pet waste education program		program	0	0		
	Large scale pet waste treatment system		system	0	0		
Forestry	E&S controls on harvested sites		acres	2.5	1.7	3	2
Average annual fecal coliform load (cfu/yr) Existing load = 1.09×10^{15}				9.28×10^{14}	8.51×10^{14}		
% Reduction in fecal coliform load				15%	22%		
Average annual sediment load (tons/yr) Existing load = 430				362	317		
% Reduction in sediment load				16%	26%		

Table 7-4. Staged implementation goals and percent of land use receiving BMP by stage for South Fork Cunningham Creek.

BMP Type	Description	BMP code	Units	Extent		% Land use treated	
				Stage 1	Stage 2	Stage 1	Stage 2
Direct deposit	Livestock exclusion with riparian buffers	LE-1T	feet	7,640	5,094	54	36
	Livestock exclusion with reduced setback	LE-2T		849	566	6	4
Streambank	Streambank stabilization	N/A	feet	500	0	N/A	N/A
Pasture	Grazing systems	LE-1T	acres	196	130	19	12
	Improved pasture management	EQIP (529,512)		433	288	41	28
	Aforestation of hay and pasture land	FR-1		1.8	1.2	0.17	0.11
	Permanent vegetation on critical areas	SL-11		1.2	0.8	0.11	0.08
	Riparian buffers	LE-1T		6.3	4.2	0.6	0.4
Cropland	Continuous no-till	SL-15A	acres	9.6	6.4	6	4
	Cover crops	SL-8B		14.4	9.6	9	6
	Long term vegetation on cropland	SL-1		5.1	3.4	3	2
Residential septic	Onsite sewage system repair	RB-3	repair	0.60	0.40	0.30	0.20
	Full inspection and non-permitted onsite sewage system repair	RB-3R		0.25	0.16	0.12	0.08
	Onsite sewage system installation/replacement	RB-4	system	1.31	0.87	0.65	0.43
	Onsite sewage system installation/replacement w/ pump	RB-4P		0.17	0.11	0.08	0.06
	Alternative sewage system	RB-5		0.10	0.06	0.05	0.03
	Septic tank pump-out	RB-1	pump out	30.3	20.2	15	10
Residential stormwater	Rain gardens	N/A	garden	0	0	-	-
	Increased E&S enforcement		acres/yr	0	0	-	-
Pet waste	Pet waste disposal station		station	0	0	N/A	N/A
	Pet waste digester, composter, or fermenter		composter	0	0		
	Pet waste education program		program	0	0		
	Large scale pet waste treatment system		system	0	0		
Forestry	E&S controls on harvested sites		acres	2.2	1.4	3	2
Average annual fecal coliform load (cfu/yr) Existing load = 1.09×10^{15}				8.66×10^{14}	7.94×10^{14}		
% Reduction in fecal coliform load				21%	27%		
Average annual sediment load (tons/yr) Existing load = 767				605	540		
% Reduction in sediment load				21%	30%		

7.2 Water Quality Monitoring

Improvements in water quality will be evaluated through water quality monitoring conducted by VADEQ. VADEQ will monitor five locations in the watersheds (Figure 7-1). Chemical monitoring of *E.coli* and field parameters including specific conductance, temperature and dissolved oxygen will be performed monthly at the stations shown in Figure 7.1. VADEQ will also conduct biological monitoring at four stations in the watersheds shown below in orange or green. This monitoring will be conducted twice a year in the fall and spring.

Additional biological monitoring will be conducted by the Rivanna Conservation Alliance should funding be made available to support staff time on this effort. Biological monitoring will be re-established at three stations in the watershed, which were sampled in the spring and fall of 2016 in support of watershed planning efforts (CZA01, CZS01, XNS01, see Figure 3-1 for station locations). In addition, Rivanna Conservation Alliance will establish a bacteria monitoring station within the North Fork Cunningham Creek watershed in order to evaluate the effectiveness of the pet waste education program. Monthly monitoring will be conducted at this station for one year prior to implementation, and then for a minimum of year after implementation.

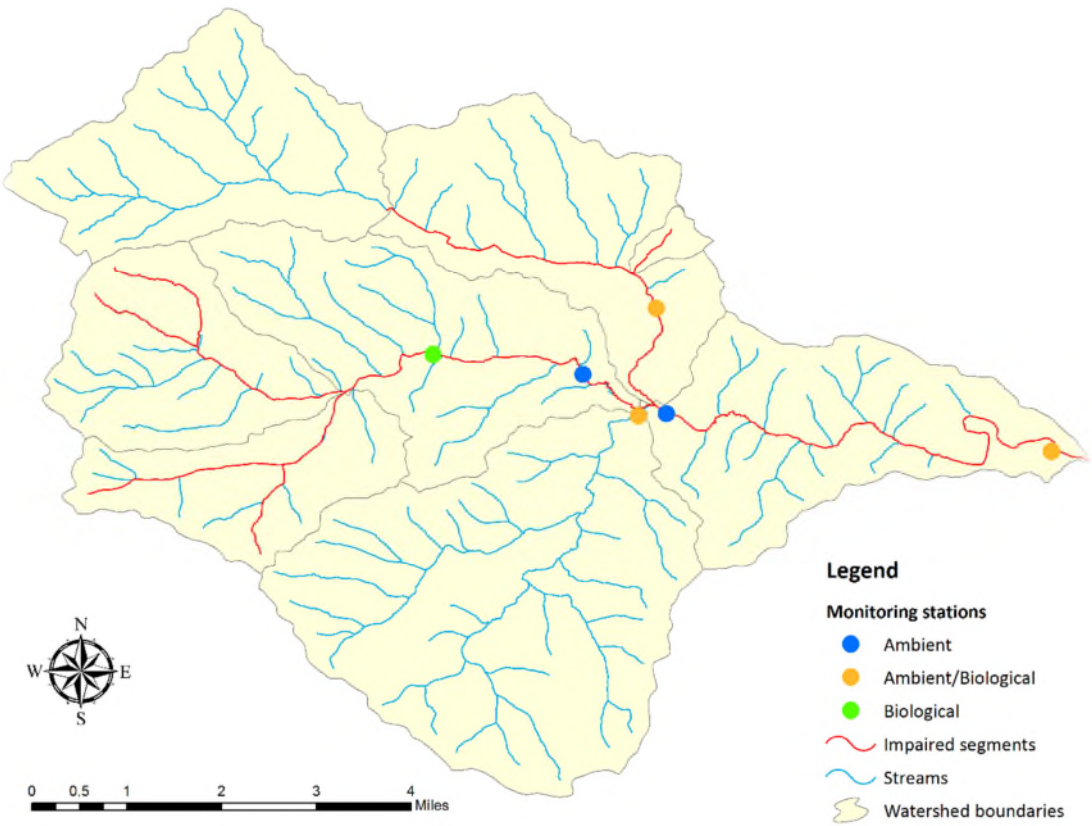

Figure 7-1. Virginia Department of Environmental Quality implementation monitoring stations in the Cunningham Creek watershed.

7.3 Targeting

Implicit in the process of a staged implementation is targeting of best management practices. Targeting ensures optimum utilization of limited technical and financial resources. Due to the size of the watershed and the limited extent of BMPs needed in order to restore the streams, extensive targeting of BMP outreach will not be necessary. Based on input from the TAC, three high priority livestock exclusion systems were identified based on the potential for pollutant runoff. One of these systems is located within the Cunningham Creek mainstem watershed, while the other two are located in the upper North Fork Cunningham Creek watershed. The TJSWCD and NRCS may reach out directly to these landowners to determine their interest in participating in livestock exclusion BMP cost share programs. The North Fork watershed will also be targeted with respect to stormwater and pet waste BMP outreach due to the presence of several new subdivisions in this watershed. Existing erosion and sediment controls will be addressed in these neighborhoods in addition to the targeted pet waste education campaign.

8. STAKEHOLDERS AND THEIR ROLE IN IMPLEMENTATION

Achieving the goals of this plan is dependent on stakeholder participation and strong leadership on the part of both community members and conservation organizations. VA Department of Environmental Quality staff will take the responsibility of working with the Soil and Water Conservation District and other partners in tracking implementation efforts and evaluating progress. Additional partners will be necessary in order to address residential implementation needs including the Fluvanna County Health Department and Fluvanna County Erosion and Sediment Control staff. The following sections in this chapter describe the responsibilities and expectations for the various components of implementation.

8.1 Partner Roles and Responsibilities

8.1.1 Watershed Landowners

The majority of practices recommended in this plan are related to agriculture since it is a predominant land use in the watersheds. Participation from local farmers is thus a key factor to the success of this plan. Consequently, it is important to consider characteristics of farms and farmers in the watersheds that will affect the decisions farmers make when it comes to implementing conservation practices on their farms. For example, the average size of farms is an important factor to consider, since it affects how much land a farmer can give up for a riparian buffer. The age of a farmer, which was 57 in Virginia in 2012, may also influence their decision to implement best management practices, particularly if they are close to retirement and will be relying on the sale of their land for income during retirement. In such cases, it may be less likely that a farmer would be willing to invest a portion of their income in best management practices. Table 8-1 provides a summary of relevant characteristics of farmers in Fluvanna County from the 2012 Agricultural Census. These characteristics were considered when developing implementation scenarios, and should be utilized to develop suitable education and outreach strategies.

Table 8-1. Characteristics of farms and farmers in Fluvanna County.

Characteristic	Extent
Number of farms	303
Land in farms (acres)	47,077
Full owners of farms	226
Part owners of farms	64
Tenants	13
Operators identifying farming as their primary occupation	131
Operators identifying something other than farming as their primary occupation	172
Average years present on the farm	21.5
Average age of primary operator	60
Average size of farm (acres)	155
Average value of farmland and buildings ($/acre)	$5,097
Average net cash farm income of operation ($)	-$3,214
Farms with internet access	231
Farm typology (farms)	
Family or individual	266
Partnership	12
Family-held corporation	19
Other (cooperative, estate or trust, institutional etc)	6

In addition to local farmers, participation from homeowners is an important piece of this plan. Residential property owners will need to make significant changes in their behavior including management of pet waste and septic system maintenance. Though the amount of bacteria that is coming from failing septic systems and straight pipes is minimal compared to livestock, human waste carries with it pathogens that can cause health problems above and beyond those associated with livestock waste.

8.1.2 Thomas Jefferson SWCD and Natural Resource Conservation Service

During the implementation project, the SWCD and NRCS will continue to reach out to farmers in the watersheds and provide them with technical and financial assistance with conservation practices. Their responsibilities include promoting available funding and the benefits of BMPs and providing assistance in the survey, design, and layout of agricultural

BMPs. The SWCD and NRCS staff will conduct outreach activities in the watershed to encourage participation in conservation programs. Such activities include mailing out newsletters and organizing field days. The Thomas Jefferson SWCD serves the counties of Albemarle, Louisa, Nelson and Fluvanna, as well as the City of Charlottesville. The SWCD employs both agricultural and urban conservation specialists/technicians who work with producers throughout their region. Should funding become available to assist SWCD staff with targeted implementation efforts in the Cunningham Creek watershed, these staff could work cooperatively in their efforts to increase local awareness of water quality issues in the creeks and make agricultural landowners aware of financial and technical assistance available for BMP implementation in the watershed.

8.1.3 Fluvanna County

Decisions made by local governments regarding land use and zoning will play an important role in the implementation of this plan. Currently, Fluvanna County has zoning and land use policies in place that support the preservation of agricultural land and encourage good stewardship of natural resources. The location of the Cunningham Creek watershed and its tributaries within Fluvanna County is such that it has not been subject to intense development pressures, making the predominant land use in the watershed likely to remain in agriculture and forest. However, considerable development has occurred in the Lake Monticello are just north of the watershed. Should growth around this area continue, planning and zoning will become increasingly important with respect to natural resource protection. In addition, local government support for land conservation will become increasingly important as greater numbers of conservation measures are implemented across the watershed. Local government staff and elected officials will play an important role in ensuring compliance with existing stormwater management and erosion and sediment control regulations, which will be important in limiting the impacts of development on Cunningham Creek and its tributaries.

Dedicated staff is currently not available to lead efforts to correct failing septic systems and residential stormwater management. A partnership with Fluvanna County and Rivanna Conservation Alliance could be formed in order to provide technical support to meet stormwater and pet waste BMP goals. In addition, Fluvanna County could work closely

with the Virginia Department of Health and the Thomas Jefferson Soil and Water Conservation District to assist in meeting septic system BMP goals.

8.1.4 Virginia Department of Environmental Quality

Improvements in water quality and implementation progress will be determined through monitoring conducted by the VA Department of Environmental Quality's (VADEQ) ambient and biological monitoring programs. The Code of Virginia directs VADEQ to maintain a list of impaired waters and to develop TMDLs or TMDL alternatives to address impairments. When monitoring shows that a stream is no longer impaired, VADEQ is the agency responsible for removing that stream from the list. Every two years, VADEQ completes the Virginia Water Quality Assessment 305(b)/303(d) Integrated Report. This report covers a five year period of water quality monitoring an includes the state's 303(d) Report on Impaired Waters and de-listings submitted to the Environmental Protection Agency for approval. VADEQ TMDL program staff will also provide support with education and outreach related to water quality and BMP implementation in the Cunningham Creek watershed throughout implementation.

8.1.5 Virginia Department of Conservation and Recreation

The Department of Conservation and Recreation (DCR) will work closely with project partners including the Thomas Jefferson Soil and Water Conservation District to track implementation progress and provide cost share for agricultural best management practices through the Virginia Agricultural Cost Share Program.

8.1.6 The Rivanna Conservation Alliance

The Rivanna Conservation Alliance (RCA) was established on January 1, 2016 through a merger between the Rivanna Conservation Society and StreamWatch, the Rivanna Watershed's local stream monitoring volunteer program. RCA conducts benthic and bacteria monitoring throughout the Rivanna River watershed including several sites in Cunningham Creek. Both benthic and bacteria data collected by RCA monitors is considered to be Level III certified, meaning that it can be used by the VADEQ for listing and delisting of Virginia's waterbodies. RCA also has considerable experience with education and outreach regarding the importance of conservation actions with respect to local water quality. Consequently, they will play a key role in implementation efforts in the Cunningham Creek watershed. RCA will serve as the lead in targeted stormwater and

pet waste BMP implementation in the North Fork Cunningham Creek watershed. In addition, they will conduct bacteria monitoring within the watershed in order to evaluate practice effectiveness. RCA has established two long term benthic monitoring stations in the Cunningham Creek watershed, Cunningham Creek at the bridge on Rte. 15 and Cunningham Creek Middle fork at Bell Farms Lane. RCA conducted benthic monitoring at three additional locations in the watershed in the spring and fall of 2016 in support of watershed planning efforts. Should additional funding become available to support staff time and travel during the implementation process, RCA could resume monitoring at these locations.

8.1.7 Virginia Department of Game and Inland Fisheries

As the owner and operator of the Fluvanna Ruritan Lake and dam, DGIF will play a key role in ensuring that the property is maintained to minimize downstream water quality impacts. The dam rehabilitation project that is scheduled to take plan in 2018 has the potential to result in additional sediment transport downstream, as noted by Fluvanna County government staff. Implementation partners including Fluvanna County will work with DIGF to monitor conditions at the auxiliary spillway to ensure that erosion is not accelerated at the site follow project completion.

8.1.8 Other Potential Local Partners

There are numerous additional opportunities for future partnerships in the implementation of this plan and the partnership noted above. Additional potential partners in implementation include:

- Virginia Cooperative Extension
- Virginia Outdoors Foundation
- Virginia Department of Forestry
- Virginia Department of Health
- Fluvanna County Master Naturalists and Master Gardeners
- Virginia Farm Bureau
- Jefferson Area Board for Aging

8.2 Integration with Other Watershed Plans

Each watershed in the state is under the jurisdiction of a multitude of individual yet related water quality programs and activities, many of which have specific geographic boundaries and goals. These include but are not limited to TMDLs, Roundtables, Water Quality

Management Plans, erosion and sediment control regulations, stormwater management, Source Water Protection Programs, and local comprehensive plans. Coordination of the implementation project with these existing programs could result in additional resources and increased participation.

8.2.1 Fluvanna County Comprehensive Plan

The Fluvanna County Comprehensive Plan includes a section dedicated to the protection of natural resources including water and groundwater resources. The plan recognizes the importance of surface water quality, noting that "drainage problems, erosion and sedimentation, groundwater pollution, failed septic systems, and construction problems are all possible if soil characteristics are not considered when developing land" (Fluvanna County, 2015). The plan includes a map showing suitability for installation of conventional septic systems based on soil types present across the county. In addition, the plan recognizes the importance of StreamWatch (Rivanna Conservation Alliance) as a partner in monitoring surface water quality within the county.

8.2.2 Virginia's Phase II Chesapeake Bay Watershed Implementation Plan

Virginia's Watershed Implementation Plan (WIP) outlines a series of BMPs, programs and regulations that will be implemented across the state in order to meet nitrogen, phosphorous, and sediment loading reductions called for in the Chesapeake Bay TMDL, completed in December, 2010. The TMDL is designed to ensure that all pollution control measures needed to fully restore the Bay are in place by 2025, with at least 60 percent of the actions completed by 2017. A number of the BMPs included in this implementation plan are also found in Virginia's WIP. Consequently, Fluvanna County will be able to track and receive credit for progress in meeting Phase II WIP goals while also working towards implementation goals established in this plan to improve local water quality. For more information about Virginia's Phase II WIP, please visit DCR's Bay TMDL webpage: http://www.dcr.virginia.gov/vabaytmdl/index.shtml.

8.2.3 Additional Natural Resource Management and Conservation Planning

There are a number of organizations working to implement natural resource management and land conservation plans in the watersheds. The Virginia Department of Game and Inland Fisheries is currently working to implement the "Northern Bobwhite Quail Action

Plan for Virginia," which includes a series of recommended management practices that will also help to improve water quality by reducing runoff and filtering out pollutants before they reach the stream. In addition, organizations like the Virginia Outdoors Foundation, Department of Forestry, and the Department of Historic Resources are working to preserve agricultural land in the watersheds through conservation easements. These easements can include some form of riparian buffer protection, and also help to ensure the longevity of efforts made to implement conservation practices on agricultural land. Whenever possible, efforts should be made to integrate the implementation of these and other conservation-related plans that will impact water quality with this plan for Cunningham Creek and its tributaries.

Thomas Jefferson SWCD Easement Program

The TJSWCD administers a conservation easement program through its Thomas Jefferson Water Resources Protection Foundation. The program focuses on riparian lands and small parcels that do not quality for other easement programs. These easements can overlay larger open-space or other easements held by local governments or by entities such as the Virginia Outdoors Foundation. The TJSWCD works cooperatively with local governments and VOF to ensure that their programs work well together.

Virginia Healthy Waters Program

To address the identification and protection of aquatic communities, DCR-Natural Heritage manages the Healthy Waters Program, in collaboration with Virginia Commonwealth University (VCU) and VADEQ. Through this program, Virginia works to seek viable opportunities for best management practices to protect streams that are already considered biologically diverse. The Healthy Waters program operates from a basic understanding: the conservation and protection of healthy waters *today* is ecologically and economically prudent, and deserves precedence over expending resources in attempt to restore streams *after* they have been damaged. In some cases, we find that an impaired stream may also be home to a biologically diverse aquatic community, and therefore also considered to be a healthy water. This is the case with an unnamed tributary of the Middle Fork Cunningham Creek. An INSTAR monitoring station was co-located with the VADEQ ambient monitoring station, 2-XPA000.57 (Figure 3-1), and while INSTAR monitoring indicated that this stream was considered to be a healthy water, VADEQ

monitoring showed that it was impaired due high concentrations of *E. coli*. Healthy streams are identified by factors that include: high numbers of native species, a broad diversity of species, few or no non-native species, few generalist species that are tolerant of degraded water quality, high numbers of native predators, migratory species whose presence indicates that river or stream systems are not blocked by dams or other impediments, and low incidence of disease or parasites. Thus, it is possible for a stream with a bacteria impairment to still be considered "healthy" through this program. Streams evaluated through the Healthy Waters Program are identified and ranked as "outstanding," "healthy", "restoration candidate" or "compromised" through a stream ecological integrity assessment known as the **In**teractive **St**ream **A**ssessment **R**esource (INSTAR), **http://instar.vcu.edu/** . These data are used to communicate with local land trusts; non-profit conservation organizations; local, state and federal government agencies; and private sector partners to guide efforts to:

- Create, maintain, or expand riparian buffers
- Protect headwater streams
- Maintain natural stream flow to ensure aquatic habitat consistent with healthy ecosystems
- Protect natural stream channels

8.3 Legal Authority

The EPA has the responsibility of overseeing the various programs necessary for the success of the CWA. 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 five state agencies responsible for regulating activities that impact water quality in Virginia. These agencies are VADEQ, VADCR, VADOF, VDH, and Virginia Department of Agriculture and Consumer Services (VDACS).

VADEQ has responsibility for monitoring waters to determine compliance with state standards, and for requiring permitted point dischargers to maintain loads within permit limits. It has 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 that

hold 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 surface and groundwater contamination. In response to increasing demand from the public to develop new regulations dealing with animal waste, the Virginia General Assembly passed legislation in 1999 requiring VADEQ 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).

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 level of participation required by TMDLs (near 100%). To meet the needs of the TMDL program and achieve the goals set forth in the CWA, the incentive programs are continually reevaluated to account for this level of participation.

VADOF is responsible for the protection of water quality from excessive sedimentation originating from silvicultural operations on all of Virginia's streams. As such, the agency is responsible for enforcement of the Virginia Silvicultural Water Quality Law (§10.1-1181.2). Any silvicultural activity that is causing or likely to cause sedimentation is in violation of the law. In 1993, VADOF was given the responsibility of inspecting forest harvesting operations for water quality degradation, giving it the authority to 1) recommend corrective action; 2) stop harvesting operations and 3) initiate civil penalties (VADOF, 2011). VADOF water quality inspectors assist loggers and landowners with timber harvest planning and execution and encourage the use of appropriate site specific voluntary best management practices to keep streams free of silvicultural sediments. If loggers fail to apply necessary BMPs on harvest sites, sediment deposition may occur, and that can lead to civil penalties under the Virginia Silvicultural Water Quality Law.

The agency has produced a technical manual and field guide identifying the BMPs necessary to prevent excessive runoff from harvesting operations. The agency also completes field audits of harvesting operations on a quarterly basis and develops an annual report of these audit findings. They also have a major role in protecting watersheds through riparian forest buffers.

Through Virginia's Agricultural Stewardship Act (ASA), the 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 of 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. VDACS has only two staff members dedicated to enforcing the Agricultural Stewardship Act, and very little funding is available to support water quality sampling. The Agricultural Stewardship Act is entirely complaint-driven.

VDH is responsible for maintaining safe drinking water measured by standards set by the EPA. Their duties also include septic system regulation and, historically, regulation of biosolids land application on permitted farmland sites. Like VDACS, VDH's actions are 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 relation to these TMDLs, VDH has the responsibility of enforcing actions to correct or eliminate failed septic systems and straight pipes.

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 shown to be causing some harm to the claimant. The judicial branch of government also plays a significant role in the regulation of activities that impact water quality through hearing the claims of citizens in civil court and the claims of government representatives in criminal court.

8.4 Legal Action

The Clean Water Act Section 303(d) calls for the identification of impaired waters. It also requires that the streams be ranked by the severity of the impairment and that TMDLs be calculated for streams to meet water quality standards. TMDL implementation plans are not required in the Federal Code; however, Virginia State Code does include the development of implementation plans for impaired streams. EPA largely ignored the nonpoint source section of the Clean Water Act until citizens began to realize that regulating only point sources was no longer maintaining water quality standards. Lawsuits from citizens and environmental groups citing EPA for not carrying out the statutes of the CWA began as far back as the 1970s and have continued until the present. In Virginia in 1998, the American Canoe Association and the American Littoral Society filed a complaint against EPA for failure to comply with provisions of §303d. The suit was settled by Consent Decree, which contained a TMDL development schedule through 2010. It is becoming more common for concerned citizens and environmental groups to turn to the courts for the enforcement of water quality issues.

Successful implementation depends on stakeholders taking responsibility for their role in the process. The primary role, of course, falls on the landowner. However, local, state and federal agencies also have a stake in ensuring 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. Virginia's approach to correcting NPS pollution problems has been, and continues to be, encouragement of participation through education and financial incentives.

9. FUNDING

A list of potential funding sources available for implementation has been developed. A brief description of the programs and their requirements is provided in this chapter. Detailed descriptions can be obtained from the Thomas Jefferson SWCD, VADCR, VADOF, NRCS, and VCE.

Virginia Nonpoint Source Implementation Program

Virginia's nonpoint source (NPS) implementation program is administered by VADEQ through local Soil and Water Conservation Districts (SWCD), local governments, nonprofits, planning district commissions (PDC), and local health departments to improve water quality in the Commonwealth's streams and rivers and in the Chesapeake Bay. DEQ, through its partners, provides cost-share assistance to landowners, homeowners, and agricultural operators as an incentive to voluntarily install nonpoint source (NPS) best management practices (BMPs) in designated watersheds. The program uses funds from a variety of sources, including EPA 319(h) and the state-funded Water Quality Improvement Fund (WQIF) to install BMPs with the goal of ultimately meeting Virginia's NPS pollution water quality objectives. Although resource-based problems affecting water quality can occur on all land uses, this manual addresses cost-share assistance on agricultural, residential, and urban lands. The geographic extent of eligible lands is identified in grant agreements and in watershed based plans (WBPs), including TMDL IPs approved by DEQ and the United States Environmental Protection Agency (EPA).

Virginia Agricultural Best Management Practices Cost-Share Program

The cost-share program is funded with state and federal monies through local SWCDs. SWCDs administer the program to encourage farmers and landowners to use BMPs on their land to better control transportation of pollutants into our waters due to excessive surface flow, erosion, leaching, and inadequate animal waste management. Program participants are recruited by SWCDs based upon those factors, which have a great impact on water quality. Cost-share is typically 75% of the actual cost, not to exceed the local maximum.

Virginia Agricultural Best Management Practices Tax Credit Program

For all taxable years, any individual or corporation engaged in agricultural production for market, who has in place a soil conservation plan approved by the local SWCD, is allowed a credit against the tax imposed by Section 58.1-320 of an amount equaling 25% of the first $70,000 expended for agricultural best management practices by the individual. Any practice approved by the local SWCD Board must be completed within the taxable year in which the credit is claimed. The credit is only allowed for expenditures made by the taxpayer from funds of his/her own sources. The amount of the credit cannot exceed $17,500 or the total amount of the tax imposed by this program (whichever is less) in the year the project was completed. If the amount of the credit exceeds the taxpayer's liability for such taxable year, the excess may be carried over for credit against income taxes in the next five taxable years until the total amount of the tax credit has been taken. This program can be used independently or in conjunction with other cost-share programs on the stakeholder's portion of BMP costs. It is also approved for use in supplementing the cost of repairs to streamside fencing.

Virginia Agricultural Best Management Practices Loan Program

Loan requests are accepted through VADEQ. The interest rate is 3% per year and the term of the loan coincides with the life span of the practice. To be eligible for the loan, the BMP must be included in a conservation plan approved by the local SWCD Board. The minimum loan amount is $5,000; there is no maximum limit. Eligible BMPs include 23 structural practices such as animal waste control facilities, loafing lot management systems, and grazing land protection systems. The loans are administered through participating lending institutions.

Virginia Small Business Environmental Assistance Fund Loan Program

The Fund, administered through VADEQ, is used to make loans or to guarantee loans to small businesses for the purchase and installation of environmental pollution control equipment, equipment to implement voluntary pollution prevention measures, or equipment and structures to implement agricultural BMPs. The equipment must be needed by the small business to comply with the federal Clean Air Act, or it will allow the small business to implement voluntary pollution prevention measures. The loans are available in amounts up to $50,000 and will carry an interest rate of 3%, with favorable repayment

terms based on the borrower's ability to repay and the useful life of the equipment being purchased or the life of the BMP being implemented. There is a $30 non-refundable application processing fee. The Fund will not be used to make loans to small businesses for the purchase and installation of equipment needed to comply with an enforcement action. To be eligible for assistance, a business must employ 100 or fewer people and be classified as a small business under the federal Small Business Act.

Virginia Water Quality Improvement Fund

This is a permanent, non-reverting fund established by the Commonwealth of Virginia in order to assist local stakeholders in reducing point and nonpoint nutrient loads to surface waters. Eligible recipients include local governments, SWCDs, and individuals. Grants for point sources are administered through VADEQ and grants for nonpoint sources are administered through VADCR. Most WQIF grants provide matching funds on a 50/50 cost-share basis. A grant through this fund is currently supporting the septic system program that is administered by the Thomas Jefferson SWCD.

Conservation Reserve Program (CRP)

Through this program, cost-share assistance is available to establish cover of trees or herbaceous vegetation on cropland. Offers for the program are ranked, accepted and processed during fixed signup periods that are announced by FSA. If accepted, contracts are developed for a minimum of 10 and not more than 15 years. Payments are based on a per-acre soil rental rate. To be eligible for consideration, the following criteria must be met: 1) cropland was planted or considered planted in an agricultural commodity for two of the five most recent crop years, and 2) cropland is classified as "highly-erodible" by NRCS. Application evaluation points can be increased if certain tree species, spacing, and seeding mixtures that maximize wildlife habitats are selected. Land must have been owned or operated by the applicant for at least 12 months prior to the close of the signup period. The payment to the participant is up to 50% of the cost for establishing ground cover. Incentive payments for wetlands hydrology restoration equal 25% of the cost of restoration.

Conservation Reserve Enhancement Program (CREP)

This program is an "enhancement" of the existing USDA CRP Continuous Sign-up. It has been "enhanced" by increasing the cost-share rates from 50% to 75% and 100%, increasing the rental rates, and offering a flat rate incentive payment to place a permanent "riparian

easement" on the enrolled area. Pasture and cropland (as defined by USDA) adjacent to streams, intermittent streams, seeps, springs, ponds and sinkholes are eligible to be enrolled. Buffers consisting of native, warm-season grasses on cropland, to mixed hardwood trees on pasture, must be established in widths ranging from the minimum of 30% of the floodplain or 35 feet, whichever is greater, to a maximum average of 300 feet. Cost-sharing (75% - 100%) is available to help pay for fencing to exclude livestock from the riparian buffer, watering facilities, hardwood tree planting, filter strip establishment, and wetland restoration. In addition, a 40% incentive payment upon completion is offered and an average rental rate of $70/acre on stream buffer area for 10-15 years. The State of Virginia will make an additional incentive payment to place a perpetual conservation easement on the enrolled area.

The landowner can obtain and complete CREP application forms at the FSA center. The forms are forwarded to local NRCS and SWCD offices while FSA determines land eligibility. If the land is deemed eligible, NRCS and the local SWCD determine and design appropriate conservation practices. A conservation plan is written, and fieldwork is begun, which completes the conservation practice design phase.

FSA then measures CREP acreage, conservation practice contracts are written, and practices are installed. The landowner submits bills for cost-share reimbursement to FSA. Once the landowner completes BMP installation and the practice is approved, FSA and the SWCD make the cost-share payments. The SWCD also pays out the state's one-time, lump sum rental payment. FSA conducts random spot checks throughout the life of the contract, and the agency continues to pay annual rent throughout the contract period.

Environmental Quality Incentives Program (EQIP)

This program was established in the 1996 Farm Bill to provide a single voluntary conservation program for farmers and landowners to address significant natural resource needs and objectives. Approximately 65% of the EQIP funding for the state of Virginia is directed toward “Priority Areas.” These areas are selected from proposals submitted by a locally led conservation work group. Proposals describe serious and critical environmental needs and concerns of an area or watershed, and the corrective actions they desire to take to address these needs and concerns. The remaining 35% of the funds are directed toward statewide priority concerns of environmental needs. EQIP offers 5 to 10-year contracts to

landowners and farmers to provide 75% cost-share assistance, 25% tax credit, and/or incentive payments to implement conservation practices and address the priority concerns statewide or in the priority area. Eligibility is limited to persons who are engaged in livestock or agricultural production. Eligible land includes cropland, pasture, and other agricultural land in priority areas, or land that has an environmental need that matches one of the statewide concerns.

Wildlife Habitat Incentive Program (WHIP)

WHIP is a voluntary program for landowners who want to develop or improve wildlife habitat on private agricultural lands. Participants work with NRCS to prepare a wildlife habitat development plan. This plan describes the landowner's goals for improving wildlife habitat and includes a list of practices and a schedule for installation. A 10-year contract provides cost-share and technical assistance to carry out the plan. In Virginia, these plans are prepared to address one or more of the following high priority habitat needs: early grassland habitats that are home to game species such as quail and rabbit as well as other non-game species like meadowlark and sparrows; riparian zones along streams and rivers that provide benefits to aquatic life and terrestrial species; migration corridors which provide nesting and cover habitats for migrating songbirds, waterfowl and shorebird species; and decreasing natural habitat systems which are environmentally sensitive and have been impacted and reduced through human activities. Cost-share assistance of up to 75% of the total cost of installation (not to exceed $10,000 per applicant) is available for establishing habitat. Types of practices include: disking, prescribed burning, mowing, planting habitat, converting fescue to warm season grasses, establishing riparian buffers, creating habitat for waterfowl, and installing filter strips, field borders and hedgerows. For cost-share assistance, USDA pays up to 75% of the cost of installing wildlife practices.

Wetland Reserve Program (WRP)

This program is a voluntary program to restore and protect wetlands on private property. The program benefits include providing fish and wildlife habitat, improving water quality, reducing flooding, recharging groundwater, protecting and improving biological diversity, and furnishing recreational and esthetic benefits. Sign-up is on a continuous basis. Landowners who choose to participate in WRP may receive payments for a conservation easement or cost-share assistance for a wetland restoration agreement. The landowner will

retain ownership but voluntarily limits future use of the land. The program offers landowners three options: permanent easements, 30-year easements, and restoration cost-share agreements of a minimum 10-year duration. Under the permanent easement option, landowners may receive the agricultural value of the land up to a maximum cap and 100% of the cost of restoring the land. For the 30-year option, a landowner will receive 75% of the easement value and 75% cost-share on the restoration. A ten-year agreement is also available that pays 75% of the restoration cost. To be eligible for WRP, land must be suitable for restoration (formerly wetland and drained) or connect to adjacent wetlands. A landowner continues to control access to the land and may lease the land for hunting, fishing, or other undeveloped recreational activities. At any time, a landowner may request that additional activities be added as compatible uses. Easement participants must have owned the land for at least one year.

VADOF Logging BMP Cost Share Program

VADOF offers cost-share assistance to timber harvest operators through a unique program offered through the utilization of funding from the Commonwealth's Water Quality Improvement Fund. This program shares the cost of the installation of forestry BMPs on timber harvest sites by harvest contractors. Contractors may receive up to 50% of direct project costs, not to exceed $2,500 per parcel for BMP installation practices involving the stream(s). If the project scope involves the purchase of a portable bridge, assistance shall be 50% of direct project costs plus the portable bridge cost, not to exceed $5,000.

VADOF Riparian Forest Buffer Tax Credit Program

The primary goal of this program is to provide an incentive to landowners through a tax credit for preserving riparian forest buffers along waterways during a timber harvest operation. In 2000, the Virginia General Assembly enacted the Riparian Buffer Tax Credit to provide a non refundable credit to: Individuals, S-Corporations or Partnerships. Estates and Trusts are not eligible for this tax credit, but Family Partnerships and Limited Liability Corporations are eligible. Applicants must own land that abuts a waterway on which timber is harvested. Recipients must refrain from timber harvesting on certain portions of the land for 15 consecutive years. The amount of the credit is equal to 25 percent of the value of the timber retained as a buffer up to a specified limit. The buffer must be at least 35 feet wide

and no more than 300 feet and be intact for 15 years. The applicant must have a Stewardship Plan for the tract to qualify.

Southeast Rural Community Assistance Project (SE/R-CAP)

The mission of this project is to promote, cultivate, and encourage the development of water and wastewater facilities to serve low-income residents at affordable costs and to support other development activities that will improve the quality of life in rural areas. Staff members of other community organizations complement the SE/R-CAP staff across the region. They can provide (at no cost): on-site technical assistance and consultation, operation and maintenance/management assistance, training, education, facilitation, volunteers, and financial assistance. Financial assistance includes $1,500 toward repair/replacement/ installation of a septic system and $2,000 toward repair/replacement/installation of an alternative waste treatment system. Funding is only available for families making less than 125% of the federal poverty level.

National Fish and Wildlife Foundation

Grant proposals for this funding are accepted throughout the year and processed during fixed signup periods. There are two decision cycles per year. Each cycle consists of a pre-proposal evaluation, a full proposal evaluation, and a Board of Directors' decision. Grants generally range between $10,000 and $150,000. Grants are awarded for the purpose of conserving fish, wildlife, plants, and their habitats. Special grant programs are listed and described on the NFWF website (http://www.nfwf.org). If the project does not fall into the criteria of any special grant programs, a proposal may be submitted as a general grant if it falls under the following guidelines: 1) it promotes fish, wildlife and habitat conservation, 2) it involves other conservation and community interests, 3) it leverages available funding, and 4) project outcomes are evaluated.

Chesapeake Bay Watershed Initiative

This initiative was authorized in the 2008 Farm Bill for 2009-2012. It provides technical and financial assistance to producers to implement practices that reduce sediment and nutrients to help protect and restore the Chesapeake Bay. Priority has been given to the Shenandoah and Potomac River Basins and selected watersheds that have impaired streams due to high levels of nutrients and sediment. Producers who live in an NRCS high priority

Chesapeake Bay watershed receive additional consideration in the funding ranking process.

Virginia Natural Resources Commitment Fund

The fund was established in the Virginia Code as a subfund of the Water Quality Improvement Fund in 2008. Monies placed in the fund are to be used solely for the Virginia Agricultural BMP Cost Share Program as well as agricultural needs for targeted TMDL implementation areas. Watersheds addressed in the water quality improvement plan are eligible for these funds, which are appropriated by DCR to Thomas Jefferson SWCD.

Clean Water State Revolving Fund

EPA awards grants to states to capitalize their Clean Water State Revolving Funds (CWSRFs). The states, through the CWSRF, make loans for high-priority water quality activities. As loan recipients make payments back into the fund, money is available for new loans to be issued to other recipients. Eligible projects include point source, nonpoint source and estuary protection projects. Point source projects typically include building wastewater treatment facilities, combined sewer overflow and sanitary sewer overflow correction, urban stormwater control, and water quality aspects of landfill projects. Nonpoint source projects include agricultural, silvicultural, rural, and some urban runoff control; on-site wastewater disposal systems (septic tanks); land conservation and riparian buffers; leaking underground storage tank remediation, etc.

Wetland and Stream Mitigation Banking

Mitigation banks are sites where aquatic resources such as wetlands, streams and streamside buffers are restored, created, enhanced, or in exceptional circumstances, preserved expressly for the purpose of providing compensatory mitigation in advance of authorized impacts to similar resources. Mitigation banking is a commercial venture that provides compensation for aquatic resources in financially and environmentally preferable ways. Not every site or property is suitable for mitigation banking. Mitigation banks are required to be protected in perpetuity, to provide financial assurances and long term stewardship. The mitigation banking process is overseen by an Inter-Agency Review Team made up of state and federal agencies and chaired by DEQ and Army Corps of Engineers.

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APPENDICES

APPENDIX A: Working Group Meeting Minutes

APPENDIX B: Public Outreach